PROTOTIPE SISTEM KONTROL UNTUK MOBIL *HYBRID* BERBASIS MIKROKONTROLER ATMEGA 8535

SKRIPSI

Oleh

ENDIANDIKA TRI PUTRANTO

04 03 02 0289

DEPARTEMEN TEKNIK MESIN
FAKULTAS TEKNIK UNIVERSITAS INDONESIA
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SKRIPSI INI DIAJUKAN UNTUK MELENGKAPI SEBAGIAN PERSYARATAN MENJADI SARJANA TEKNIK

DEPARTEMEN TEKNIK MESIN
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GANJIL 2007/2008

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Saya menyatakan dengan sesungguhnya bahwa skripsi dengan judul :

PROTOTIPE SISTEM KONTROL UNTUK MOBIL *HYBRID* BERBASIS MIKROKONTROLER ATMEGA 8535

yang dibuat untuk melengkapi sebagian persyaratan untuk menjadi Sarjana Teknik pada Program Studi Teknik Mesin Departemen Teknik Mesin Fakultas Teknik Universitas Indonesia, sejauh yang saya ketahui bukan merupakan tiruan atau duplikasi dari skripsi yang sudah dipublikasikan dan atau pernah dipakai untuk mendapatkan gelar kesarjanaan di lingkungan Universitas Indonesia maupun di Perguruan Tinggi atau Instansi manapun, kecuali bagian yang sumber informasinya dicantumkan sebagaimana mestinya.

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PENGESAHAN

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PROTOTIPE SISTEM KONTROL UNTUK MOBIL *HYBRID* BERBASIS MIKROKONTROLER ATMEGA 8535

dibuat untuk melengkapi sebagian persyaratan menjadi Sarjana Teknik pada Program Studi Teknik Mesin Departemen Teknik Mesin Fakultas Teknik Universitas Indonesia. Skripsi ini telah diujikan pada sidang ujian skripsi pada tanggal 4 januari 2008 dan dinyatakan memenuhi syarat/sah sebagai skripsi pada Departemen Teknik Mesin Fakultas Teknik Universitas Indonesia.

Depok, Januari 2008
Dosen Pembimbing

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UCAPAN TERIMA KASIH

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PROTOTIPE SISTEM KONTROL UNTUK MOBIL *HYBRID* BERBASIS MIKROKONTROLER ATMEGA 8535

ABSTRAK

Krisis energi merupakan salah satu masalah besar yang terjadi akhir-akhir ini. Masalah ini berfokus pada kurangnya persediaan minyak dan gas bumi yang digunakan sebagai sumber energi oleh industri dan alat-alat transportasi. Ada banyak solusi untuk masalah ini, tapi yang paling utama adalah dengan memakai sumber energi yang berbasis hidrokarbon ini dengan lebih ekonomis. Sejalan dengan riset di bidang teknologi, sekarang banyak kendaraan dibuat berdasarkan teknologi *hybrid*. Suatu teknologi *hybrid* di suatu mobil atau kendaraan lainnya dapat diartikan sebagai kendaraan yang menggunakan dua jenis *engine* sebagai tenaga penggerak, yaitu motor elektrik dan motor bakar. Teknologi baru ini dikembangkan untuk meningkatkan jarak tempuh tanpa menambah konsumsi bahan bakar.

Masalahnya yang muncul adalah bagaimana mengontrol suatu kendaraan dengan dua jenis *engine*. Suatu sistem kontrol dibutuhkan agar sistem ini bekerja dengan baik. Mikrokontroler digunakan untuk mengolah data digital yang merupakan parameter input. Parameter-parameter kendaraan yang digunakan sebagai input bagi mikrokontroler adalah putaran *engine* (RPM), kecepatan kendaraan, dan posisi sudut/kemiringan kendaraan. Parameter-parameter ini dapat dideteksi menggunakan *encoder* sebagai sensor. *Encoder* menghitung putaran *engine* yang dikonversikan menjadi RPM dan kecepatan kendaraan. *Encoder* juga dapat digunakan untuk menentukan posisi sudut kemiringan kendaraan dengan menggunakan suatu mekanisme yang dipasangkan ke *encoder*.

Kedua sensor ini dan parameter-parameter lainnya, sesuai dengan kondisi kerja kendaraan, akan digunakan sebagai input bagi mikrokontroler untuk menentukan mode operasi yang mana yang akan digunakan. Mode operasi yang pertama adalah *Silent Mode*. Kendaraan menggunakan motor listrik yang terhubung ke baterai sebagai tenaga penggerak utama. Mode ini dibatasi hanya sampai 20 km/jam. Jika kecepatan kendaraan bertambah menjadi lebih dari 20 km/jam, mode kendaraan akan berubah ke mode selanjutnya. Mode kedua adalah *Gasoline Mode*. Ketika kecepatan kendaraan labih dari 20 km/jam, kendaraan akan menghidupkan motor bakar dan mematikan motor listrik. Mode ketiga *Acceleration/Climb Mode*. Kedua *engine* akan hidup dan memberikan cukup torsi untuk kendaraan ketika berakselerasi. Mode keempat adalah *Decelerate/Descend Mode*.Motor listrik akan berubah menjadi generator untuk mengisi baterai. Keseluruhan mode ini akan disimulasikan di sebuah *test bed*, yang merepresantasikan konfigurasi yang mendekati konfigurasi mobil *hybrid*.

Kata kunci: *hybrid*, mikrokontroler, rotari *encoder*.

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HYBRID CAR CONTROL SYSTEM PROTOTYPE BASED ON ATMEGA 8535 MICROCONTROLLER

ABSTRACT

Energy crisis become one of the big problem that happens in the latest century. This problem is focused on the lack supply of oil and gas that being used in many industry and transportation vehicle as an energy resource (fuel). There are many solutions for this problem, but the important thing is to make hydrocarbon based energy resources more economical. Along with the technology research, nowadays many vehicles are built based on the hybrid technology. A Hybrid Technology in a car or any other vehicles can be described as vehicles that use two types of engine as a propulsion the electric motor engine and the gasoline engine. This new technology is invented to increase vehicles mileage without necessarily increase any fuel consumption.

The problem is how to control a vehicle with two types of engine. A control system is needed to make this hybrid system going well. A microcontroller is used to process the digital data that came from the input parameters. The vehicle parameters that are used as the input for the microcontroller are engine rotation (RPM), vehicle speed (km/h), and the vehicle angular position. These parameters can be detected using encoder as the sensors. The encoder counts the engine revolution that is converted into RPM and vehicle speed. It also can be used to determine the vehicle angular position using some mechanism that is attached to the encoder.

This two sensors and other parameters will be used as an input for the microcontroller to determine which operating modes will be used for the vehicle based on the road condition. The first operating mode is Silent Mode. The vehicle uses electric motor connected to a battery as main propulsion. This mode is limited only for speed no more than 20 km/h. If the speed is increasing (more than 20 km/h), the vehicle will change to the next operating mode. The second mode is Gasoline Mode. When the speed vehicle is more than 20 km/h, the vehicle will start the gasoline engine and turn off the electric motor. The third mode is Acceleration/Climb Mode. Both engines will start to make enough torque for the vehicle when it is accelerating. The fourth mode is Decelerate/Descend Mode. The electric motor will change as a generator to charge the battery. All of this mode will be simulated into a test bed project, that represent the aproximate configuration of hybrid car : RPM, speed, and angular position detection.

Keywords : hybrid, microcontroller, rotary encoder.

BAB I

PENDAHULUAN

I.1 Latar Belakang

Isu energi merupakan isu yang sedang hangat diperdebatkan. Topik dari perdebatan ini adalah berkurangnya persediaan sumber-sumber energi terutama sumber energi berbasis hidrokarbon seperti minyak bumi, masih kurangnya penguasaan teknologi, serta besarnya biaya yang diperlukan untuk memanfaatkan sumber energi terbarukan. Cadangan terbukti minyak bumi pada tahun 2002 sekitar 5 miliar barel dan dengan tingkat produksi saat ini, yaitu 500 juta barel pertahun, cadangan tersebut akan habis dalam 10 tahun mendatang. Potensi tenaga air sebesar 75 ribu MW, saat ini baru dimanfaatkan sebesar 4200 MW. Cadangan terbukti panas bumi sebesar 2300 MW, saat ini baru dimanfaatkan sebesar 800 MW [1].

Penggunaan BBM, yang merupakan turunan dari minyak bumi, meningkat pesat. Penggunaan ini terutama untuk transportasi. Penggunaan BBM sebagai bahan bakar untuk alat-alat transportasi sulit digantikan oleh jenis sumber energi lainnya. Ketergantungan pada BBM masih tinggi yaitu 60% dari konsumsi energi final. Pembangkitan tenaga listrik masih mengandalkan BBM dan batubara. Lokasi potensi tenaga air jauh dari konsumen, dan pengembangan panas bumi belum didukung oleh peraturan dan perundang-undangan yang kondusif. Oleh karena itu, penggunaan energi terbarukan belum besar. Hal ini disebabkan juga oleh belum kompetitifnya energi terbarukan dibanding dengan energi konvensional.

Banyak solusi yang muncul untuk mengatasi masalah ini. Dua diantaranya yang paling utama adalah penghematan energi yang berbasis hirdrokarbon, dan percepatan penguasaan teknologi dan penyempurnaan instrumen-instrumen legal untuk memanfaatkan sumber energi terbarukan agar sumber energi ini mencapai keekonomiannya [2].

Sumber energi berbasis hidrokarbon atau sumber energi yang tidak terbarukan banyak dipakai sebagai sumber bahan bakar alat-alat transportasi.

Alat-alat transportasi ini menggunakan *engine* sebagai penggerak. Bahan bakar melepaskan energi selama proses pembakaran di dalam *engine*, di mana proses tersebut akan menghasilkan kerja yang digunakan untuk menggerakkan mobil. Proses ini terjadi dalam satu siklus kerja yang terdiri dari beberapa langkah kerja.

Bahan bakar yang digunakan pada alat-alat tansporasi tesebut pada umumnya adalah bensin dan solar, dan beberapa kendaraan menggunakan alkohol, LPG, dan bahan bakar lainnya. Perkembangan teknologi memungkinkan *engine* mampu beroperasi dengan menggunakan berbagai bahan bakar. Penggunaan bahan bakar alternatif menjadi hal yang sangat diminati, dan banyak diteliti, karena persediaan sumber energi bahan bakar berbasis hirokarbon semakin berkurang. Performa *engine* dan emisi gas buang merupakan hal utama yang dijadikan pertimbangan penelitian tersebut. Langkah yang muncul dalam menggunakan bahan bakar alternatif adalah menggunakan *fuel cell*, energi surya, *hybrid engine*, bahan bakar substitusi, dan *multifuel engine*.

Kendaraan/mobil yang mengkombinasikan dua atau lebih sumber tenaga disebut dengan kendaraan/mobil *hybrid engine*. Contohnya adalah mobil yang menggunakan motor otto dan listrik sebagai sumber tenaganya. Keuntungan utama mobil *hybrid* dibandingkan dengan mobil konvensional yaitu mobil *hybrid* dapat mengurangi emisi gas buang, dan meningkatkan daya tempuh kendaraan (*mileage*). Emisi dapat dikurangi karena motor otto yang dipakai pada mobil *hybrid* tidaklah sebesar motor otto pada mobil biasa. Akibatnya bahan bakar yang dibutuhkan tidak terlalu besar, dengan kata lain pembakarannya tidak sebanyak jika memakai mobil biasa. Emisi gas buang terjadi akibat pembakaran yang kurang sempurna, sehingga dengan mengurangi bahan bakar berarti mengurangi emisi gas buang pula.

Peningkatan *mileage* dapat terjadi karena penghematan bahan bakar. Jika pada mobil biasa dibutuhkan bahan bakar sebanyak 11,76 liter per-100 km, maka mobil *hybrid* hanya membutuhkan 3,92 liter per-100 km. Secara umum, mobil yang dibutuhkan adalah mobil yang hemat bahan bakar dan dapat menempuh jarak yang cukup jauh dengan sekali pengisian bahan bakar. Mobil konvensional yang menggunakan motor otto dapat menempuh jarak yang cukup jauh (sekitar 300 mil) tetapi boros dalam pemakaian bahan bakar. Sedangkan mobil elektrik sangat irit bahan bakar tetapi jarak tempuhnya hanyalah 50-100 mil untuk sekali pengisian baterai. Dengan menggunakan mobil *hybrid*, kedua keuntungan tadi dapat digabungkan.

Pada perkembangannya, mobil *hybrid* membutuhkan suatu mekanisme kontrol untuk mengatur masukan-masukan berupa suatu kondisi tertentu yang telah diperhitungkan, yang memicu aksi-aksi dari motor bakar dan motor listrik. Mikrokontroler digunakan untuk memberikan kecerdasan buatan kepada mobil *hybrid*. Masukan-masukan berupa kondisi tertentu tersebut dapat dikenali oleh mikrokontroler dengan menggunakan seperangkat sensor. Kontrol otomatis menggunakan mikrokontroler dapat meningkatkan kehandalan mobil, karena waktu reaksi yang sangat cepat dengan akurasi tinggi. Sehingga, peningkatan tujuan efisiensi dalam menggunakan mobil *hybrid* bisa dicapai.

I.2 Perumusan Masalah

Penelitian-penelitian mengenai penggunaan mikrokontroler sebagai sistem kontrol mobil *hybrid* perlu dilakukan. Penelitian ini akan mendisain sebuah prototipe sistem kontrol mobil *hybrid* menggunakan mikrokontroler. Bila prototipe sistem kontrol ini telah ada, analisa sistem bisa dengan mudah dilakukan. Analisa ini sangat dibutuhkan untuk pengembangan sistem kontrol sehingga disain yang optimum bisa tercapai. Disain yang optimum sangat penting untuk mencapai tujuan efisiensi dalam penggunaan mobil *hybrid*, yang nantinya akan sangat berpengaruh dalam efisiensi penggunaan BBM.

I.3 Tujuan Penelitian

Penelitian ini dilakukan untuk mencapai beberapa tujuan, yaitu :

1. Tujuan yang pertama adalah mengidentifikasi parameter-parameter kondisi dan aksi yang merupakan masukan (input) dan output yang terjadi pada sebuah mobil *hybrid*.
2. Tujuan yang kedua adalah merancang serangkaian sensor dan aktuator yang mampu mengidentifikasikan input-input parameter kondisi, dan mengeluarkan output-output parameter aksi.

3. Tujuan yang ketiga adalah mengintegrasikan keseluruh parameter, sensor, dan aktuator tersebut ke sebuah kontroler berbasis mikrokontroler ATMEGA 8535 dengan cara menyusun serangkaian kecerdasan buatan yang diimplementasikan ke mikrokontroler.
4. Tujuan yang keempat adalah membuat suatu modul prototipe yang bisa mensimulasikan kerja kontroler tersebut. Modul prototipe ini berbentuk sebuah *test bed*. Pada *test bed* ini dipasangkan seluruh sensor, aktuator, mikrokontroler, dan seluruh perangkat lain yang menunjang simulasi tersebut.

I.4 Pembatasan Masalah

Dengan memperhatikan luasnya bidang pembahasan akan sistem kontrol kendaraan *hybrid*, penelitian ini dibatasi hanya mengenai disain sistem kontrol kendaraan hybrid yang menitikberatkan pada pemilihan sistem input-output untuk kontroler serta proses pemrograman (pemberian logika) pada mikrokontroler. Parameter dan karakteristik kendaraan hybrid yang digunakan diasumsikan merupakan parameter dan karakteristik yang berlaku secara umum. Kontroler ini didesain secara khusus (spesifik) untuk digunakan pada jenis kendaraan tertentu, sesuai dengan parameter dan spesifikasi yang telah ditentukan sebelumnya.

Parameter-parameter tersebut adalah putaran *engine* dan kecepatan kendaraan yang dideteksi oleh sensor encoder, serta posisi kemiringan kendaraan yang menggunakan mekanisme encoder sebagai pendeteksi arah kemiringan kendaraan. Sedangkan spesifikasi kendaraan yang digunakan adalah kendaraan hybrid yang masih dikembangan di laboratorium Departemen Teknik Mesin FTUI.

I.5 Metodologi Penelitian

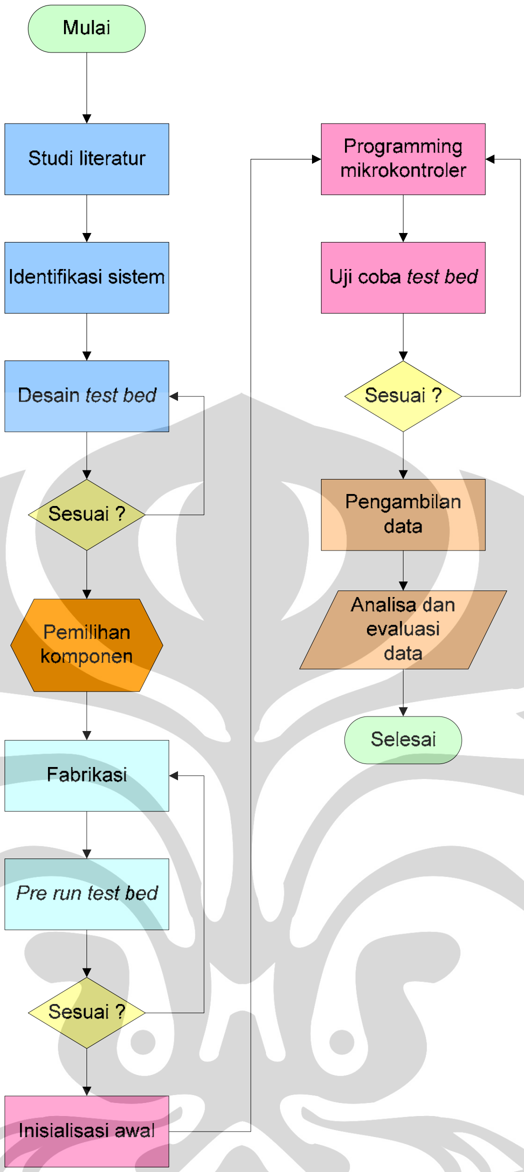
Penelitian ini dibagi kedalam beberapa tahap yang berlangsung secara berurutan : Tahap pertama adalah identifikasi sistem kontrol hybrid berdasarkan studi literatur. Identifikasi sistem ini yang nantinya diperlukan dalam mendesain *test bed* yang akan digunakan untuk mengambil data penelititan. Studi literatur berasal dari buku literatur, materi kuliah, jurnal ilmiah dan referensi internet.

Tahap kedua dilanjutkan dengan pemilihan komponen yang akan digunakan dalam *test bed,* yang dilanjutkan dengan proses perakitan dan fabrikasi. Komponen yang sudah dirakit kemudian diuji coba *(pre run test bed)* tahap pertama untuk memastikan rangkaian komponen tersebut dapat bekerja dengan baik. Apabila proses pengetesan awal dari rangkaian *test bed* ini tidak mengalami masalah, langkah selanjutnya adalah proses inisialisasi komponen input dan output kedalam mikrokontroler. Proses inisialisasi merupakan langkah awal dalam penelitian ini. Inisialisasi dilakukan agar seluruh komponen input (sensor putaran dan kemiringan) yang digunakan dalam *test bed* dapat bekerja secara terintegrasi sehingga menghasilkan output yang diinginkan.

Dilanjutkan dengan proses pemrograman mikrokontroler agar dapat menghasilkan output yang sesuai dengan *logic* parameter yang telah diberikan. Apabila proses pemrograman telah selesai, langkah selanjutnya adalah uji coba *test bed* secara keseluruhan.

Hasil simulasi yang dilakukan tentunya akan menghasilkan data yang dapat dianalisa. Apakah sesuai dengan pengaturan karakteristik yang diberikan atau tidak. Apabila terjadi kesalahan atau ketidak sesuaian maka perlu dilakukan proses evaluasi terhadap *logic* parameter yang telah diberikan.

Keempat tahap ini dapat digambarkan kedalam diagram alir berikut :



Gambar I.1 : Diagram Alir Penelitian

I.6 Sistematika Penulisan

Sistematika penulisan penelitian ini dibagi ke dalam beberapa bagian. Bagian pertama menjelaskan mengenai proses desain sistem kontroler dengan memperhatikan beberapa jenis kontroler yang sudah baku terdapat pada teori pengendalian sistem. Setelah itu dilanjutkan dengan identifikasi masalah dan identifikasi parameter yang akan digunakan sebagai input bagi mikrokontroler. Input yang telah diproses oleh mikrokontroler kemudian akan dieksekusi untuk menghasilkan output keluaran yang diinginkan.

Desain kontroler yang telah berhasil diformulasikan kemudian akan diuji coba atau disimulasikan kedalam sebuah test bed (alat uji coba eksperimental) yang berfungsi untuk memvisualisasikan parameter input dan output yang dihasilkan. Proses desain dari test bed sistem kontrol hybrid juga menjadi pembahasan tersendiri di dalam hasil penelitian ini. Meliputi konsep desain, proses manufaktur, pemilihan material dan komponen, serta proses penggambaran dengan menggunakan bantuan *software* CAD.

Pada bagian ketiga penulisan penelitian ini dibahas jenis-jenis sensor, pengkondisian sinyal serta dasar kerja mikrokontroler yang menjadi fokus utama didalam penelitian ini. Termasuk didalamnya proses pemrograman mikrokontroler yang berbasis pada bahasa pemrograman *assembler,* dengan menggunakan bantuan sintaks bahasa pemrograman C *(High Level Language)* untuk mempermudah proses pemberian logika pemrograman.

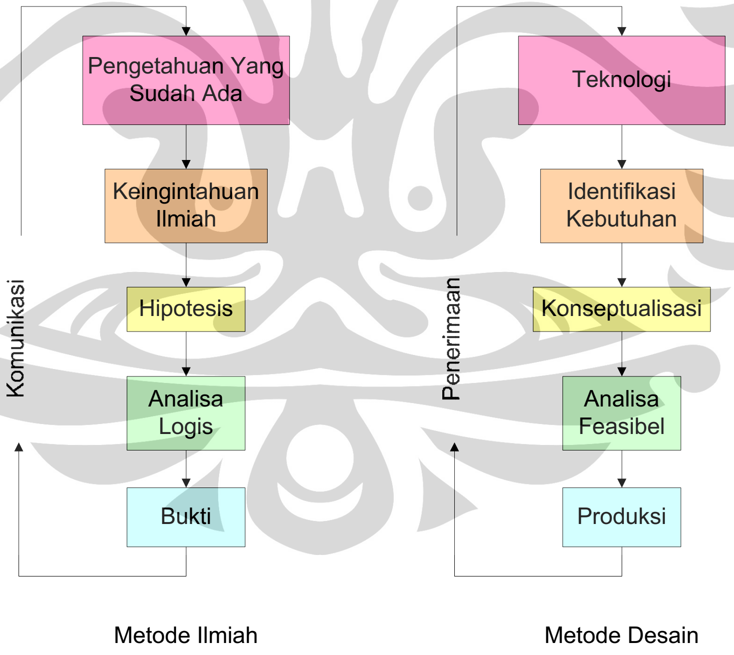
Sedangkan pada bagian akhir dari penulisan penelitian ini berisi mengenai kesimpulan hasil uji coba sistem kontrol yang diaplikasikan pada alat uji eksperimental *(test bed).* Analisa yang dilakukan pada penelitian ini didasarkan atas kinerja dan perbandingan sistem kontrol yang dibuat, dengan sistem kontrol kendaraan hybrid yang sebenarnya. Sehingga didapatkan kesimpulan apakah sistem kontrol ini sudah memenuhi kriteria dan spesifikasi dari sistem kontrol kendaraan hybrid yang sebenarnya. Penulisan ini ditutup dengan saran dan masukan untuk penelitian dan riset pengembangan selanjutnya.

BAB II

PERANCANGAN DESAIN KONTROLER KENDARAAN HYBRID

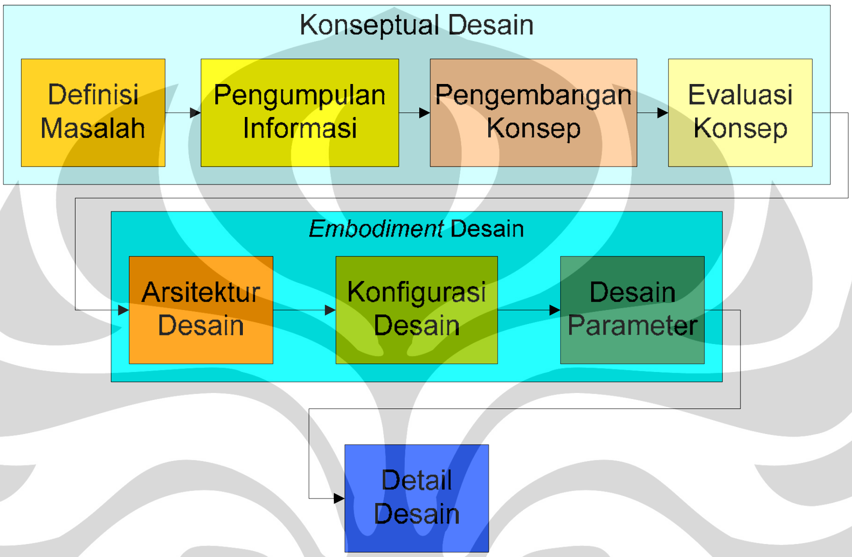
II.1 Alur Perancangan

Proses desain Kontroler Kendaraan *Hybrid* mengacu ini pada metode desain yang sudah lazim dilakukan. Metode desain ini dibagi dalam beberapa tahap, menggunakan metode pendesainan produk yang berbeda dengan proses pendesainan yang menggunakan pendekatan ilmiah. Proses desain diawali dengan proses pembelajaran terhadap teknologi kendaraan *hybrid* yang sudah ada, untuk kemudian mengetahui karakteristik dan cara kerja dari kontroler kendaraan *hybrid* tersebut. Langkah selanjutnya adalah proses pendesainan ulang *(redesign)* yang disesuaikan dengan spesifikasi kendaraan hybrid hasil riset DTM-FTUI.



Gambar II.1 : Perbandingan Antara Metode Ilmiah Dan Metode Desain [6]

Proses desain dibagi kedalam beberapa tahap. Tahap pertama adalah dengan menciptakan konsep desain kontroler yang disesuaikan dengan karakteristik kontroler *Hybrid* yang ada. Langkah selanjutnya adalah proses pengumpulan informasi serta pembentukan desain *(embodiment)* yang dilanjutkan dengan penentuan detail desain dari sistem kontroler. Sedangkan tahap terakhir adalah proses manufaktur dan pembuatan komponen kontroler. Proses pendesain ini sesuai dengan teori Morris Asimow yang menjelaskan mengenai proses desain secara detail yang disebut dengan *morphology of design* yang terdiri (secara berurutan) dari tahap konsep desain, *embodiment* desain, deatail desain, proses manufaktur, distribusi, dan pengembangan produk selanjutnya [6].



Gambar II.2 : Langkah Desain [6]

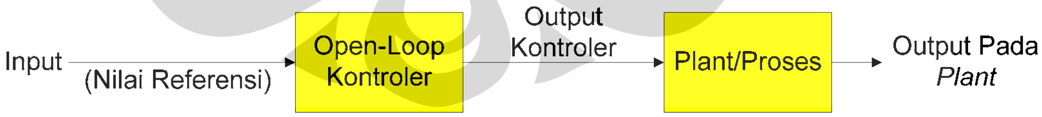
II.1.1 Konsep Desain

Sistem Kontrol ini didesain dan dibuat khusus untuk kendaraan hybrid yang saat ini sedang di riset di DTM-FTUI. Kendaraan ini didesain menggunakan dua buah tenaga penggerak yaitu motor DC dan motor bakar, yang disesuaikan dengan konsep kendaraan hybrid. Kedua buah tenaga penggerak ini dirangkai secara paralel untuk kemudian dioperasikan sesuai dengan kondisi operasi kendaraan. Kondisi operasi yang dimaksud adalah kondisi kendaraan jalan apakah dalam kondisi melaju *(cruising)*, berakselerasi, deselarasi, kendaraan dalam posisi tanjakan atau dalam posisi turunan. Ditambah pula dengan kondisi beban yang dialami oleh kendaraan, yang dismulasikan melalui besaran torsi yang diperlukan untuk menggerakan kendaraan dengan kecepatan tertentu. Kondisi operasi dari kendaraan hybrid akan dijelaskan lebih detail pada bagian selajutnya.

Untuk mengakomodasi berbagai macam kondisi operasi tersebut diperlukan sistem kontrol yang mampu mengatur siklus *(mode)* kerja dari kendaraan hybid. Sistem kontrol tersebut akan mengatur kapan motor DC atau motor bensin akan berfungsi sebagai sumber tenaga penggerak utama, atau bahkan kombinasi dari keduanya. Sistem kontrol sederhana yang dibangun ini akan menggunakan mikrokontroler sebagai *processor* utama, yang akan mengakomodasi seluruh input berupa sensor yang mampu mendeteksi kondisi kendaraan beserta dengan keadaan operasinya. Untuk kemudian menentukan mode operasi apa yang akan digunakan. Pemilihan sistem kontrol dengan menggunakan mikrokontroler didasarkan pada simplifikasi parameter kendaraan hybrid yang digunakan serta kemudahan dalam proses pembuatan yang tidak memerlukan biaya yang besar *(low cost controller)*. Detail mengenai mikrokontroler dan sensor yang digunakan pada kendaraan hybird ini akan dijelaskan pada bab selanjutnya.

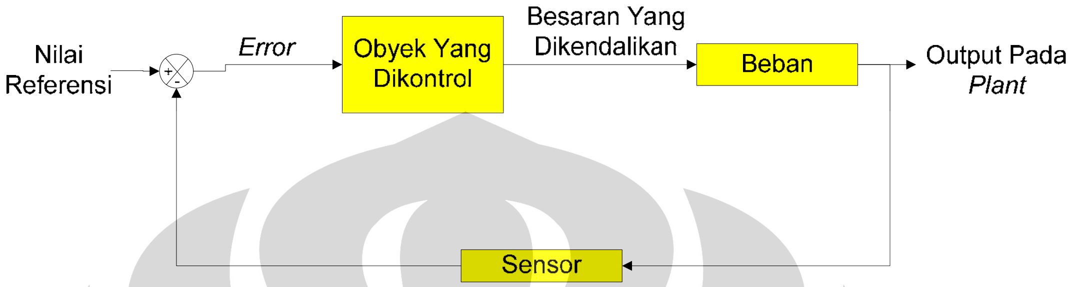
II.1.2 Sistem Kontrol Kendaraan *Hybrid*

Sistem kontrol merupakan dasar utama dalam sebuah sistem mekatronika [8]. Beberapa jenis kontroler yang dipelajari dibidang teknik elektro memberikan beberapa fungsi dan tujuan tertentu, seperti sistem kontrol *open loop* yang diartikan sebagai sistem kontrol terbuka, yaitu hasil output dari kontroler yang hanya bergantung pada input kontroler. Hubungan antara input dan output pada sistem kontrol open loop ini dapat dijelaskan dalam diagram kontrol berikut :



Gambar II.3 : Diagram Blok Yang Merepresentasikan Sistem Kontrol Open Loop [9]

Input dapat didefiniskan sebagai nilai referensi yang akan diolah oleh mikrokontroler untuk menghasilkan output yang selanjutnya diaplikasikan pada mekanisme proses yang dituju. Sedangkan sistem kontrol yang kedua adalah sistem kontrol tertutup *(close loop controller)*, yang memiliki karakteritik yang berbeda dari sistem kontrol sebelumnya. Pada sistem kontrol *close loop*, hasil output yang dihasilkan oleh kontroler akan dijadikan parameter koreksi bagi kontroler untuk mengeksekusi output selanjutnya. Dapat dikatakan pula sistem kontol ini adalah sistem kontrol dengan umpan balik *(feedback)* seperti yang digambarkan pada ilustrasi berikut :

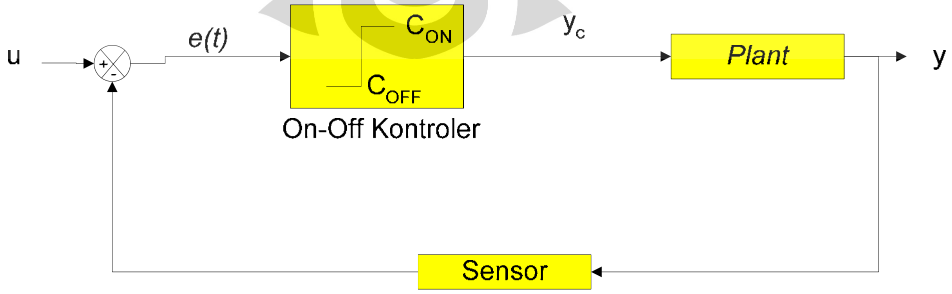


Gambar II.4 : Sistem Kontrol Loop Tertutup [9]

Sesuai dengan spesifikasi dan fungsinya, sistem kontroler yang akan digunakan pada kendaraan hybrid ini adalah sistem kontroler ON/OFF. Kontroler ini memiliki konfigurasi sederhana, yaitu hanya dengan penggunaan saklar *(switch)* ON/OFF. Output dari kontroler ini memiliki dua level, yaitu keadaan ON atau keadaan OFF. Keadaan ON atau OFF didapat dari sinyal error yang terbaca oleh kontroler, sebagai contoh status ON akan aktif apabila sinyal error lebih besar dari 0 (nol), sedangkan status OFF aktif pada saat sinyal error lebih kecil dari 0 (nol). Secara matematis dapat dituliskan [9] :

$$y_c = C_{ON} \text{ untuk } e(t) > 0 \text{ dan } y_c = C_{OFF} \text{ untuk } e(t) < 0 \textit{ (berlaku juga sebaliknya)} \qquad \text{(II.2)}$$

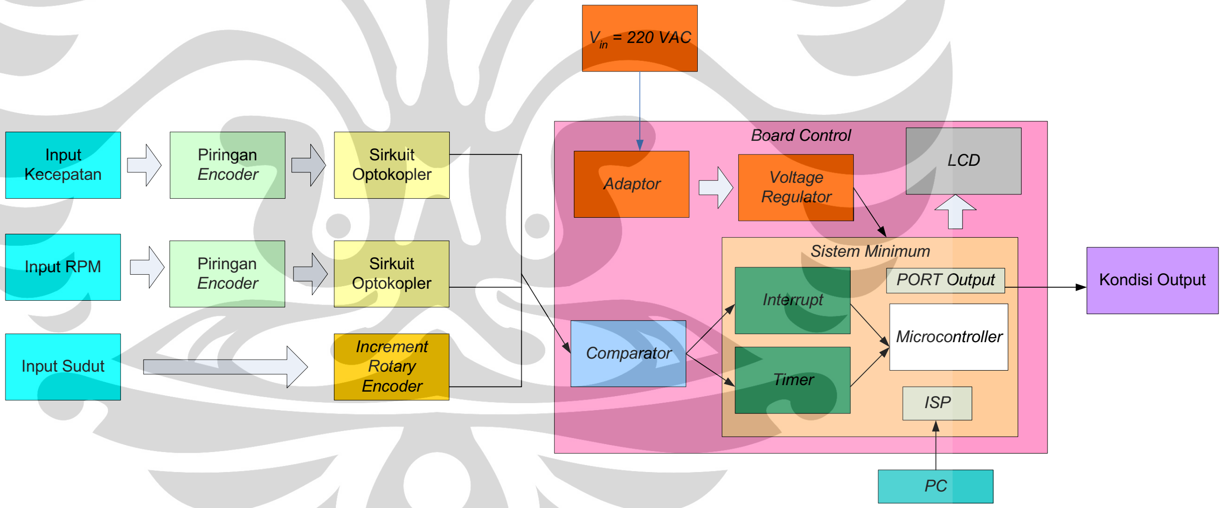
Dimana e(t) adalah sinyal error, C_{on} dan C_{off} adalah dua output sesuai dengan persamaan diatas.



Gambar II.5 : Diagram Blok Kontroler On-Off [9]

II.2 Perancangan Kontroler Kendaraan *Hybrid*

Pada penelitian ini, Kontroler didasarkan pada sistem kontrol *close loop*, dengan pengertian yang telah dijelaskan sebelumnya. Input dan umpan balik *(feedback)* pada kontroler *hybrid* ini merupakan putaran RPM dan kecepatan kendaraan (Km/h), yang dideteksi menggunakan sensor putaran (encoder). Sistem aktivasi output merupakan sistem *switching ON/OFF* sederhana. Parameter putaran yang dideteksi oleh sensor encoder akan diproses oleh mikrokontroler untuk kemudian ditentukan output keluaran atau *mode* apa yang akan digunakan. Selain digunakan pula parameter posisi kendaraan yang direpresentasikan melalui posisi kemiringan kendaraan. Sensor kemiringan ini yang akan menentukan apakah kendaraan sedang dalam keadaan menanjak atau sedang menurun. Sensor kemiringan ini juga berfungsi sebagai parameter validasi dari jenis operasi yang akan digunakan pada kendaraan hybrid. Namun tetap yang menjadi fokus utama adalah perameter RPM mesin dan kecepatan kendaraan.



Gambar II.6 : Skematik Sistem Kontrol Kendaraan Hybrid

Pemilihan input/output dan mikrokontroler 8-bit sebagai sistem kontrol kendaraan hybrid didasarkan pada kemudahan dalam pendeteksian parameter kendaraan serta kemudahan *interfacing* dan pemrograman *logic* kontroler. Mikrokontroler yang digunakan adalah ATMEGA 8535 merupakan mikrokontroler 8-bit keluarga ATMEL AVR. Pendeteksian parameter RPM dan kecepatan digunakan sensor encoder yang tersusun atas rangkaian optocoupler. Sedangakan pendeteksian kemiringan kendaraan dilakukan dengan menggunakan sensor rotary encoder incremental dengan tingkat ketelitian lebih tinggi.

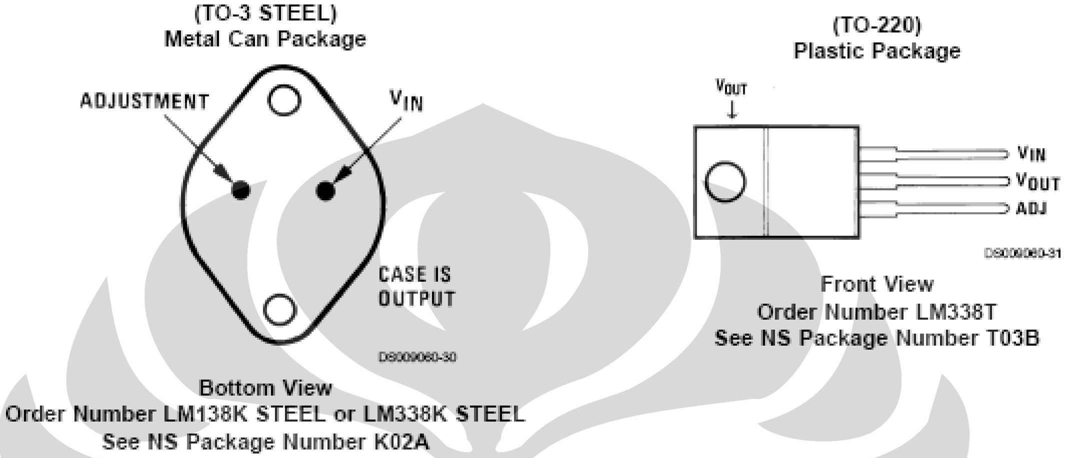
Secara garis besar dapat dijelaskan spesifikasi dari mikrokontroler, pengkondisi sinyal serta perangkat sensor pendeteksi putaran dan kemiringan, sebagai berikut :

Mikrokontroler
Manfacturer : ATMEL
Jenis : Mikrokontroler 8-bit AVR
Tipe : ATMEGA 8535
Memori : 8K Bytes
Voltage : 4.5 – 5.5 DC volt
Fitur : → *In-System Self-Programmable Flash*
→ 512 *Bytes EEPROM*
→ 2 buah 8-bit *Timers/Counters*
→ 1 buah 16-bit *Timers/Counters*
→ 4 buah *PWM channels*
→ 8-*channel*, 10-bit ADC
→ *Programmable Serial UART*
→ 32 *Programmable I/O*

Comparator
Voltage : 4.5 – 5.5 DC volt

Voltage Regulator
Manfacturer : *National Semiconductor*
Jenis : *5-Amps Adjustable Regulators*
Tipe : LM138/LM338
Voltage : 4.5 – 5.5 DC volt
Fitur : - Arus output 7A
- Arus output 5A

- Output yang dapat disesuaikan sampai 1.2V
- Regulasi panas
- Pembatasan arus konstan terhadap suhu
- Tes peningkatan produk P+
- Output diproteksi terhadap sirkuit pendek



Bottom View
Order Number LM138K STEEL or LM338K STEEL
See NS Package Number K02A

Front View
Order Number LM338T
See NS Package Number T03B

Gambar II.7 : Voltage Regulator [Lampiran Data Sheet Voltage Regulator]

Encoder (Optocoupler)

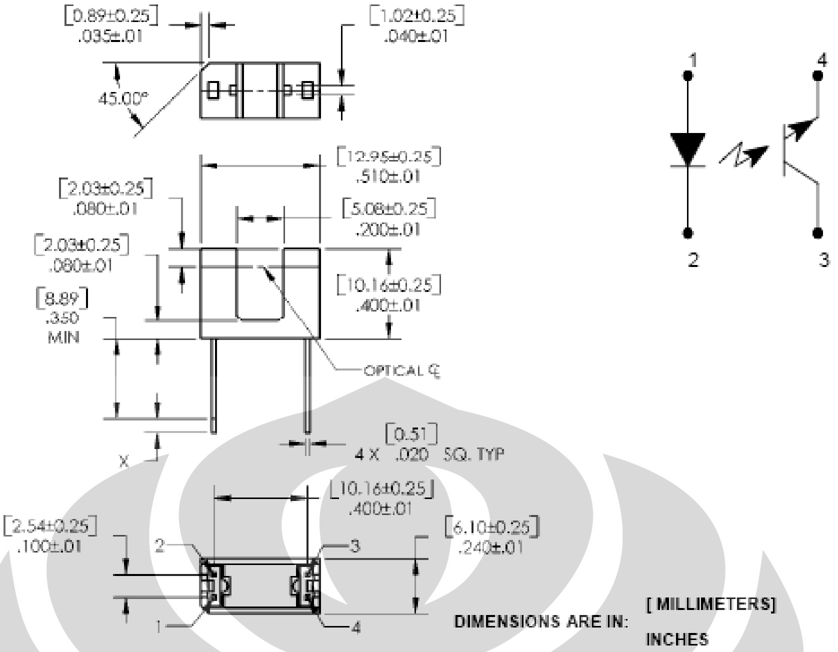
Manfacturer : TT *electronics* OPTEK *Technology*

Jenis : *Slotted Optical Switch*

Tipe : OPB200

Voltage : 4.5 – 5.5 DC volt

Fitur :
- Material *housing* tak tembus cahaya
- *Switch* tanpa-kontak
- Dudukan yang tercetak pada PCB
- Ketebalan slot 0.200” (5.1 mm), Kedalaman slot 0.320” (8.1 mm)

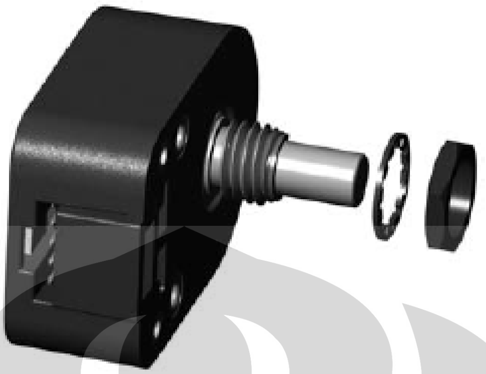


Gambar II.8 : Optokopler [Lampiran Data Sheet Optocoupler]

Rotary Encoder (Incremental)

Manfacturer : US *Digital*
Jenis : *Incremental Rotary encoder*
Tipe : S5
Resolusi : 360º
Voltage : 4.5 – 5.5 DC volt
Fitur : - Ukuran kecil
- Biaya kecil
- Pilihan *pin-out* yang kompatibel dan cerdas
- Pilihan output diferensial / *line-driver*
- Konektor pemasangan jari positif
- Output kuadratur 2-channel, TTL squarewave
- Pilihan indeks chanel ke-3
- Pelacakan dari 0 sampai 100,000 siklus/detik
- Pilihan pelacakan *ball bearing* sampai 10,000 RPM
- Suhu operasi -40 sampai +100°C
- Suplai +5VDC tunggal

- US *Digital* menjamin produknya tidak terdapat cacat pada material dan pengerjaannya selama dua tahun.



Gambar II.9 : Rotary Encoder [Lampiran Data Sheet Rotary Encoder]

II.3 Parameter Kontroler Kendaraan *Hybrid*

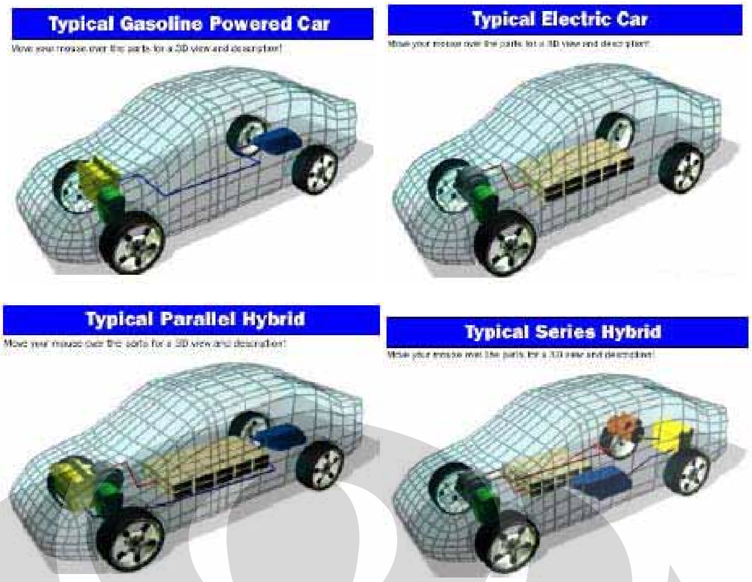
II.3.1 Pengertian Kendaraan *Hybrid*

Kendaraan/mobil yang mengkombinasikan dua atau lebih sumber tenaga disebut dengan kendaraan/mobil *hybrid engine*. Contohnya adalah mobil yang menggunakan motor otto dan listrik sebagai sumber tenaganya. Keuntungan utama mobil *hybrid* dibandingkan dengan mobil konvensional yaitu mobil *hybrid* dapat mengurangi emisi gas buang, dan meningkatkan daya tempuh kendaraan (*mileage*). Emisi dapat dikurangi karena motor otto yang dipakai pada mobil *hybrid* tidaklah sebesar motor otto pada mobil biasa. Akibatnya bahan bakar yang dibutuhkan tidak terlalu besar, dengan kata lain pembakarannya tidak sebanyak jika memakai mobil biasa. Emisi gas buang terjadi akibat pembakaran yang kurang sempurna, sehingga dengan mengurangi bahan bakar berarti mengurangi emisi gas buang pula.

Peningkatan *mileage* dapat terjadi karena penghematan bahan bakar. Jika pada mobil biasa dibutuhkan bahan bakar sebanyak 11,76 liter per-100 km, maka mobil *hybrid* hanya membutuhkan 3,92 liter per-100 km. Secara umum, mobil yang dibutuhkan adalah mobil yang hemat bahan bakar dan dapat menempuh jarak yang cukup jauh dengan sekali pengisian bahan bakar. Mobil konvensional yang menggunakan motor otto dapat menempuh jarak yang cukup jauh (sekitar 300 mil) tetapi boros dalam pemakaian bahan bakar. Sedangkan mobil elektrik sangat irit bahan bakar tetapi jarak tempuhnya hanyalah 50-100 mil untuk sekali pengisian baterai. Dengan menggunakan mobil *hybrid*, kedua keuntungan tadi dapat digabungkan.

Mobil *hybrid* merupakan solusi yang sangat dibutuhkan dalam membuat teknologi yang ramah lingkungan. Teknologi *hybrid* adalah inti dari pengembangan mobil yang ramah lingkungan. Pengembangan teknologi mobil yang ramah lingkungan dimulai dari banyak aspek. Aspek yang pertama adalah pengembangan teknologi yang menggunakan bahan bakar alternatif, yaitu menggunakan *Compressed Natural Gas* (CNG). Pengembangan lain dilakukan dengan mengembangkan teknologi yang menggunakan diesel sebagai motor bakarnya. Pada motor bakar yang menggunakan bahan bakar bensin, teknologi pengaturan katup (*Variable valve timing*) silinder dikembangkan, yang tujuannya adalah penghematan bahan bakar. Teknologi kendaraan yang menggunakan motor listrik sebagai penggerak, juga mengembangkan diri. Teknologi ini mengembangkan penggunaan *fuel cell* sebagai sumber energi penggerak. Teknologi *hybrid* berkembang dari pengembangan teknologi berbasis motor bensin, yang pada akhirnya mengkombinasikan penggunaan motor bensin dan motor listrik.

Telah dikemukakan bahwa penggunaan mobil *hybrid* merupakan salah satu solusi dalam mengatasi kelangkaan bahan bakar minyak. Suatu mobil beroperasi memakai tenaga maksimum hanya 1% dari seluruh waktu perjalanan. Sisanya hanya untuk mengatasi gesekan dengan udara dan jalan, dan untuk mengatasi berat mobil. Menggunakan mobil *hybrid*, yang terdiri dari motor otto dan elektrik, dapat menghemat tenaga. Pada mobil *hybrid* ini terdapat *electric motor* yang menyediakan tenaga untuk menggerakkan roda, dan baterai untuk menghasilkan listrik. Serta motor otto menggerakkan generator dan juga menggerakkan roda. Sewaktu mobil mulai berjalan, motor elektrik ikut bekerja untuk menghasilkan tenaga yang lebih besar. Jika tenaga yang dibutuhkan tidak terlalu besar maka motor elektrik tidak ikut bekerja, dan baterai akan me-*recharge*.



Gambar II.10 : Perbandingan mobil konvensional dengan mobil hybrid [8]

Ada beberapa cara untuk mengkombinasikan kedua sumber tenaga tersebut. Yang pertama adalah *parallel hybrid*, yang mempunyai tangki bahan bakar yang mensuplai bahan bakar ke mesin. Dan ada baterai yang mensuplai tenaga ke motor elektrik. Kedua mesin tersebut dapat menggerakkan transmisi pada saat yang bersamaan. Transmisi inilah yang memutar roda. Tangki bahan bakar pada motor otto terhubung ke transmisi, sedangkan baterai dan motor elektrik juga terhubung ke transmisi secara terpisah. Sehingga *parallel hybrid* dapat menggerakkan transmisi secara bersamaan maupun terpisah.

Yang kedua adalah *series hybrid*, di mana motor otto menggerakkan generator. Generator dapat mengisi baterai ataupun menggerakkan motor elektrik. Motor listrik digerakkan untuk memutar transmisi, sehingga terlihat bahwa motor otto tidak pernah secara langsung menggerakkan transmisi.

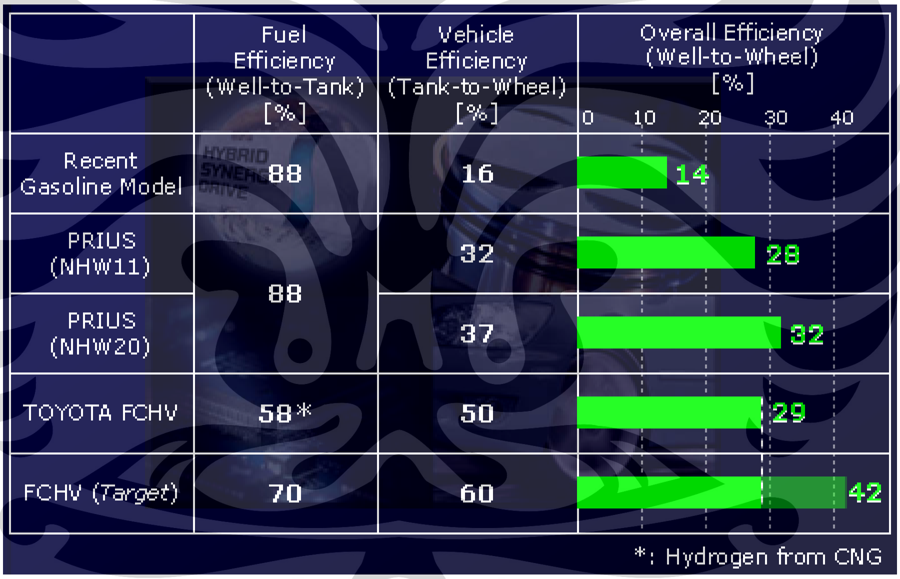
Ada cara lain dalam mengkombinasikan kedua sumber tenaga tersebut. Cara ini merupakan gabungan dari seri, dan paralel *hybrid*. Karena cara ini merupakan kombinasi dari kedua cara sebelumnya, cara ini bisa menghasilkan performa yang lebih baik.

Tabel II. 1 : Perbandingan Performa Jenis-Jenis Mobil Hybrid [4]

Sistem	*Fuel Economy Improvement*				*Driving Performance*	
	Idle-Stop	*Energy Recovery*	*High-efficiency operation control*	*Total efficiency*	*Acceleration*	*Continous High Output*
Seri	O	Δ	O	O	×	×
Paralel	O	O	×	O	O	×
Kombinasi	Δ	Δ	Δ	Δ	O	O

O Superior Δ Excelent × Somewaht unfavourable

Tabel II. 2 : Perbandingan Efisiensi Bahan Bakar [4]

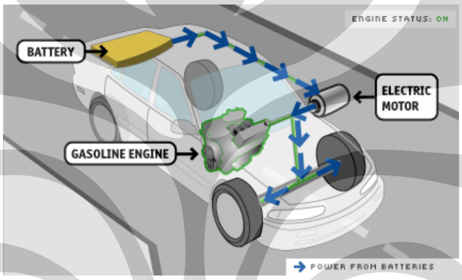


	Fuel Efficiency (Well-to-Tank) [%]	Vehicle Efficiency (Tank-to-Wheel) [%]	Overall Efficiency (Well-to-Wheel) [%]
Recent Gasoline Model	88	16	14
PRIUS (NHW11)	88	32	28
PRIUS (NHW20)		37	32
TOYOTA FCHV	58*	50	29
FCHV (*Target*)	70	60	42

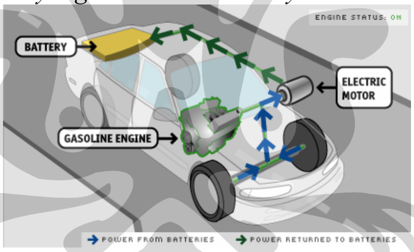
*: Hydrogen from CNG

II.3.2 Parameter Input Dan Output Kendaraan *Hybrid*

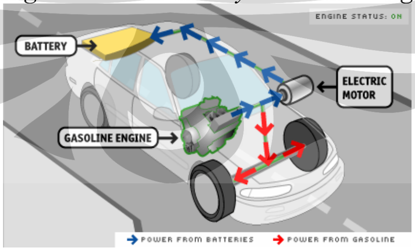
Mobil *hybrid* digerakkan oleh dua jenis motor, dan kedua motor ini bekerja tergantung pada kondisi-kondisi tertentu yang akan memicu masing-masing motor melakukan aksi-aksi yang tertentu pula. Contohnya adalah setiap kali menginjak rem, energi pada mobil terbuang. Semakin cepat mobil berjalan, semakin banyak energi kinetik yang dimilikinya. Pengereman pada mobil membuang energi kinetik dalam bentuk panas. Mobil *hybrid* dapat menangkap energi ini dan menyimpannya di dalam baterai. Mobil *hybrid* melakukannya dengan cara *regenerative breaking*. Dengan cara ini, selain menggunakan rem untuk menghentikan mobil, motor elektrik pada mobil *hybrid* dapat mengurangi kecepatan mobil. Sewaktu mengurangi kecepatan, motor elektrik berfungsi sebagai generator, dan mengisi kembali baterai. Kendaraan juga bisa bekerja dengan hanya menggunakan motor bakar saja, dan tidak perlu di-*recharge*. Jika baterai ”kosong” motor bakar akan menggerakkan generator yang akan me-*recharge* baterai. Sewaktu mobil berhenti, mobil *hybrid* dapat menghemat bahan bakar dengan mematikan motor otto dan hanya menghidupkan motor elektrik dan baterai [10]. Motor bakar akan otomatis hidup kembali jika kendaraan mulai berjalan kembali.



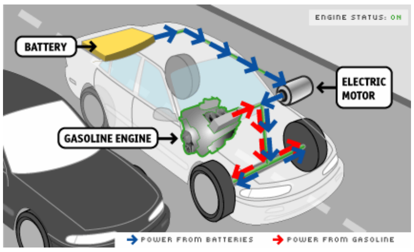
Gambar II.11 : Aksi yang dilakukan mobil hybrid ketika berakselerasi [3]



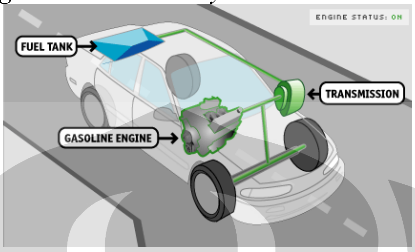
Gambar II.12 : Aksi yang dilakukan mobil hybrid ketika re-generative breaking [3]



Gambar II.13 : Aksi yang dilakukan mobil hybrid ketika sedang menluncur dengan kecepatan tinggi [3]

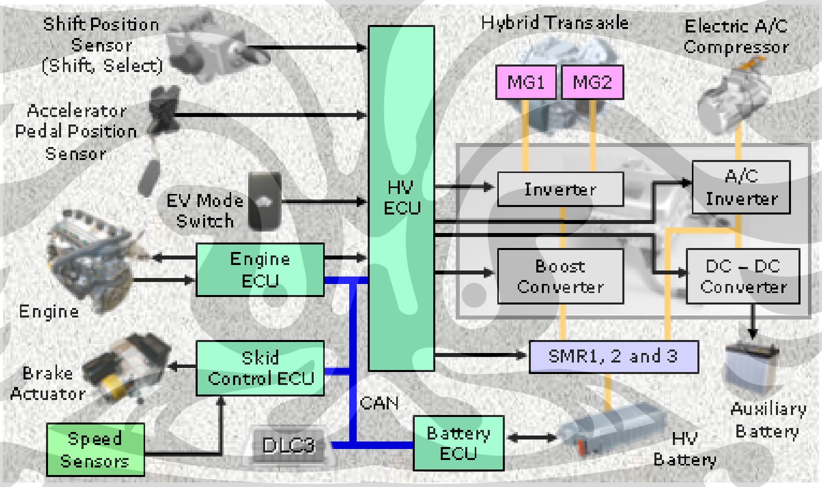


Gambar II.14 : Aksi yang dilakukan mobil hybrid ketika mobil membutuhkan tenaga [3]



Gambar II.15 : Gambar mobil konvensional [3]

Secara luas sistem kerja mobil *hybrid* dapat digambarkan melalui gambar berikut :



Gambar II 16 : Sistem Kerja Mobil Hybrid[4]

Parameter input mobil *hybrid* adalah :

1. Posisi gir transmisi (gigi / *shift*), yang dibaca oleh sensor posisi gigi.
2. Akselerasi, yang dibaca oleh sensor akselerasi posisi pedal.
3. Kondisi beban kerja *engine*, yang dibaca melalui *Electronic Control Unit* (ECU).
4. Kecepatan, yang dibac sensor kecepatan, dan dihubungkan dengan mekanisme yang memungkin mobil melakukan *regenerative breaking*.
5. Kemiringan kendaraan, yang dibaca oleh sensor kemiringan.

Parameter-paremeter tersebut tidak seluruhnya dikenakan pada prototipe sistem kontrol yang dibuat. Karena prototipe yang akan dibuat akan diaplikasikan pada prototipe mobil *hybrid* yang telah ada di DTMFTUI. Prototipe mobil *hybrid* yang sudah ada tidak bisa mengakomodasi keseluruhan parameter input untuk dikelola, dan dikembangkan sistem kontrolnya. Oleh karena itu perlu dibatasi parameter-parameter input yang akan dikenakan pada prototipe mobil *hybrid* yang telah ada. Parameter yang akan dibahas adalah :

1. Kecepatan kendaraan, yang akan dibaca oleh sensor kecepatan.
2. RPM *engine*, yang akan dibaca oleh sensor RPM. Parameter ini digunakan sebagai representasi kondisi torsi mobil.
3. Kemiringan kendaraan, yang dibaca oleh sensor kemiringan.

Berikut ini adalah tabel perbandingan karakteristik antara mobil *hybrid* dan kendaraan konvensional.

Tabel II. 3 : Perbandingan Karakteristik Antarjenis Kendaraan [4]

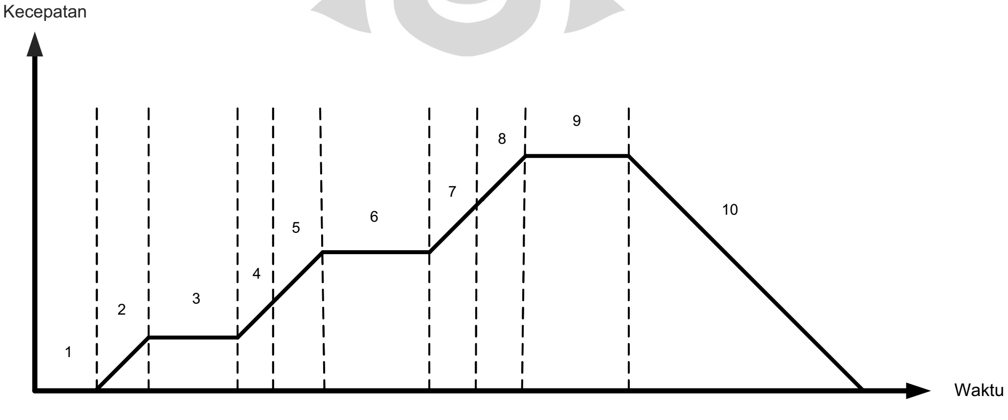
Karakteristik	Konvensional	*Hybrid*	Penjelasan
Sumber tenaga	Motor bakar	✓ Motor bakar ✓ Motor listrik ✓ Generator	✓ Dimungkinkan hanya motor listrik saja yang hidup (motor bakar mati) ✓ Tenaga motor bakar dibagi untuk menggerakkan kendaraan, dan untuk mengisi baterai
Transmisi	✓ A/T ✓ M/T	*Power Splitting Device*	✓ Membagi tenaga untuk

			motor bakar, motor listrik, dan generator. ✓ Berfungsi sebagai CVT ✓ Berupa *Planetary gear*
Rem	Rem hidrolik	✓ Rem hidrolik ✓ *Regenerative breaking*	Kendali kooperatif antara rem hidrolik dan *regenerative breaking*
Baterai	12 Volt	✓ 12 Volt ✓ 201.6 Volt	Suplai tegangan tinggi untuk motor listrik
Power train control	*Engine* ECU	✓ HV ECU ✓ *Engine* ECU ✓ *Inverter*	Mengendalikan motor bakar, motor listrik, dan generator

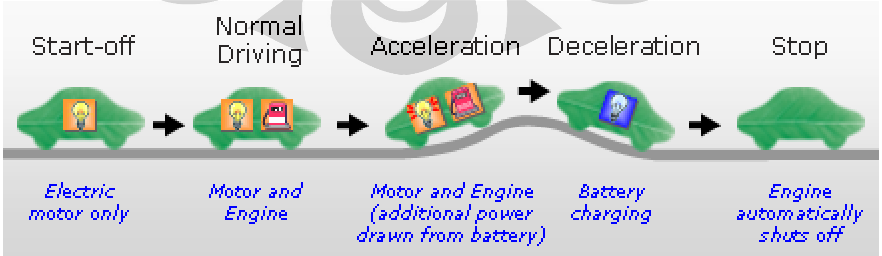
Parameter Output mobil *hybrid* adalah :

1. Motor listrik siap bekerja pada saat kendaraan baru mulai hidup dan motor bakar otomatis mati saat kendaraan berhenti.
2. Motor listrik saja yang bekerja pada saat kendaraan baru mulai hidup.
3. Motor listrik bekerja pada saat berkendaraan dengan beban normal, ditandai dengan RPM rendah dan kecepatan rendah.

Grafik II. 1 : Profil Parameter Output



4. Motor listrik bekerja pada saat berkendaraan dengan beban tinggi, ditandai dengan RPM tinggi di atas RPM operasional 2000 RPM dan kecepatan rendah sampai 20 km/jam.
5. Motor bakar bekerja pada saat kendaraan berakselerasi, beban bertambah, atau beban bertambah karena kemiringan, ditandai dengan RPM di atas RPM operasional 2000 RPM dan kecepatan di atas 20 km/jam.
6. Motor bakar bekerja pada saat berkendaraan dengan beban normal, ditandai dengan RPM rendah di bawah 2000 RPM dan kecepatan operasional antara 20-50 km/jam.
7. Kombinasi motor bakar dan motor listrik pada saat kendaraan berakselerasi, beban bertambah, atau beban bertambah karena kemiringan, ditandai dengan RPM di atas RPM operasional 2000 RPM dan kecepatan masih kecepatan operasional antara 20-50 km/jam.
8. Kombinasi motor bakar dan motor listrik pada saat kendaraan berakselerasi, beban bertambah, atau beban bertambah karena kemiringan, ditandai dengan RPM di atas RPM operasional 2000 RPM dan kecepatan di atas kecepatan operasional 50 km/jam.
9. Motor listrik bekerja pada saat berkendaraan dengan beban rendah tetapi kecepatan tinggi, sehingga torsi yang diberikan hanya untuk mempertahankan kecepatan, ditandai dengan RPM tinggi di atas RPM operasional 2000 RPM dan kecepatan tinggi di atas 50 km/jam.
10. Pengisian baterai pada saat deselerasi, *regenerative breaking*, pengurangan beban karena kemiringan kendaraan, atau pengisian langsung dari baterai.



Gambar II 17 : Parameter Output [4]

BAB III

PEMOGRAMAN MIKROKONTROLER

III.1 Basis Kerja Digital

Sistem digital didefinisikan sebagai suatu sistem yang menggunkan teori dan teknik digital untuk disain sistem informasi serta komponen dan alat elektronik yang digunakan untuk kontrol digital. Dalam teknologi digital, output dan input adalah digital. Dibandingkan analog, teknologi digital sangat serbaguna karena teknologi ini menggunakan sinyal digital, yang lebih akurat, dapat diandalkan, dan bebas *error*. Sistem angka digital membentuk dasar pengertian teknologi digital.

Dalam konteks teknologi dan *engineering*, kuantitas adalah suatu ukuran dan perepresentasian oleh fungsi dari tanda-tanda numerik menggunakan sistem angka. Contohnya, Kuantitas dari tegangan dan arus pada dan melalui konduktor direpresentasikan menggunakan sistem angka. Manusia (dunia alamiah) menggunakan sistem angka desimal, yang mengakomodasi 10 digit (0, 1, 2, ... 9). Kuantitas dari sesuatu dapat direpresentasikan dengan menggunakan sepuluh digit ini. Dalam dunia buatan (artificial/komputer), peralatan komputer menggunakan dua digit, yang disebut ”0”, dan ”1”, karena mereka tidak terlalu ”pintar” dibanding manusia.

Ada dua jenis sistem angka, sistem angka desimal yang umum digunakan oleh manusia, dan sistem angka biner yang hanya menggunakan dua digit dan biasa digunakan dalam dunia komputer. Sistem angka jenis lain juga ada seperti sistem angka oktal, heksadesimal, dan *Binary Coded Decimal* (BCD). Sistem angka oktal mengakomodasi delapan digit seperti 0, 1, 2, 3, 4, 5, 6, dan 7. Sistem angka heksadesimal mengakomodasi 16 digit seperti 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, dan F. Hal yang harus diperhatikan adalah bahwa semua sistem angka adalah digital. Sehingga arti dari Sistem Angka Digital (*digital number system*-DNS) dalam konteks *engineering* dan teknologi melibatkan sistem angka dengan hanya dua digit : 0, dan 1. Sistem inilah yang disebut DNS. Sistem dan komponen mekatronika berhubungan erat dengan dunia perkomputeran.

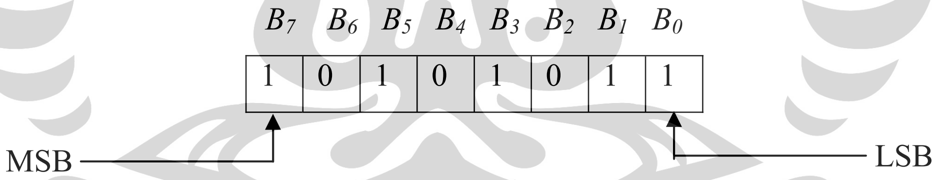
III.1.1 Bilangan Binari

III.1.1.1 Pengertian Bilangan Binari

Seperti yang telah dijelaskan diatas, bilangan Binari hanya terdiri dari dua buah digit yaitu ’0’ dan ’1’. Masing-masing digit ini disebut pula dengan bits. Sebuah sistem angka digital (DNS) dapat terdiri dari dua, tiga, atau empat bit binari sesuai dengan kombinasi yang diperlukan. Kombinasi yang dimaksudkan disini adalah :

- Kombinasi dua bits :
  00, 01, 10 atau 11 → sehingga kombinasi yang didapatkan $2^2 = 4$
- Kombinasi tiga bits :
  000, 001, 010, 011, 100, 101, 110, atau 111 → sehingga kombinasi yang didapatkan $2^3 = 8$
- Kombinasi empat bits :
  0000, 0001, 0010, 0011, 0100, 0101, 0110, 0111, 1000, 1001, 1010, 1011, 1100, 1101, 1110, atau 1111 → sehingga kombinasi yang didapatkan $2^4 = 16$

Dalam sebuah DNS, gabungan dari delapan buah bits paling lazim digunakan yang dikenal juga dengan sebutan *byte*. Sehingga 1 *byte* = 8 bits dengan susunan sebagai berikut :



Gambar III. 1 : Definisi Byte [9]

Dimana bagian bit paling kanan disbut pula dengan *Least Significant Bit* (LSB), sedangkan bit paling kiri disebut dengan *Most Significant Bit* (MSB).

III.1.1.2 Konversi Bilangan Desimal ke Bilangan Binari

Perbedaan mendasar antara bilangan desimal dengan bilangan binari adalah orde yang digunakan. Bilangan desimal menggunakan orde 10, sedangkan bilangan binari menggunakan orde 2. Untuk mengkonversi bilangan desimal ke bilangan binari yang perlu dilakukan adalah membagi setiap bilangan desimal dengan faktor pembagi 2. Pada setiap proses pembagian perlu diperhatikan pula angka pembagi yang tersisa. Apabila tersisa 0, maka ditulis angka 0. Begitu pula apabila tersisa angka 1, maka ditulis pula angka 1. Proses pembagian dilanjutkan hingga bilangan yang terbagi bernilai 0. Untuk lebih jelasnya dapat memperhatikan ilustrasi konversi bilangan desimal 3.442 ke dalam sebuah bilangan binari.

Tabel III. 1 : Tabel Konversi Desimal Setara Dengan Binari [9]

Dibagi 2	Hasil Pembagian	Sisa	Binari
3442	1711	0	
1711	855	1	
855	422	1	$(110100110110)_2$
422	211	0	
211	105	1	
105	52	1	
52	26	0	
26	13	0	
13	6	1	
6	3	0	
3	1	1	
1	0	1	

Berikut ini adalah contoh lain dalam mengkonversi bilang desimal 0.48 ke dalam bilangan binari.

Tabel III. 2 : Tabel Konversi Desimal Setara Dengan Binari [9]

Dikalikan 2	Hasil Perkalian	Sisa	Binari
0.48	0.96	0	
0.96	1.92	1	
0.92	1.84	1	$(0.011110101111)_2$
0.84	1.68	1	
0.68	1.36	1	
0.36	0.72	0	
0.72	1.44	1	
0.44	0.88	0	
0.88	1.76	1	
0.76	1.52	1	
0.52	1.04	1	
0.04	0.08	0	

Sedangkan proses konversi dari bilangan binari kedalam bilangan desimal adalah dengan mengalikan bit pada bilangan binari dengan bilangan berorde dua sesuai dengan susunan dan urutan yang telah dijelaskan sebelumnya. Sebagai contoh konversi bilangan 1110 0011 adalah 227.

$1x2^7 + 1x2^6 + 1x2^5 + 0x2^4 + 0x2^3 + 0x2^2 + 1x2^1 + 1x2^0 =$

$128 + 64 + 32 + 0 + 0 + 0 + 2 + 1 = (227)_{10}$

III.1.2 Bilangan Oktal Dan Hexadesimal

Bilangan Oktal menggunakan angka 8 sebagai orde dan mengakomodasi bilangan digit 0, 1, 2, 3, 4, 5, 6, dan 7. Konversi bilangan oktal kedalam bilangan binari menggunakan tabel konversi bilangan 3 bit binari → bilangan oktal.

Tabel III. 3 : Tabel Konversi 3-Bits Binari Setara Dengan Digit Oktal [9]

Hexadecimal digits	*4-bits binary*
0	000
1	001
2	010
3	011

4	100
5	101
6	110
7	111

Sebagai contoh : bilangan $(4267)_8$ setara dengan bilangan binari $(100010110111)_2$

Proses konveri ini dapat berlaku pula sebaliknya *(vice versa)* untuk konversi dari bilangan binari ke bilangan oktal.

$$\begin{tikzcd}
4 \arrow[d] & 2 \arrow[d] & 6 \arrow[d] & 7 \arrow[d] \arrow[r] & \text{Bilangan Oktal} \\
100 & 010 & 110 & 111 = (100010110111)_2 &
\end{tikzcd}$$

Sedangkan bilangan hexadesimal merupakan sistem angka digital yang bekerja dengan sistem angka digital lainnya. Perbedaan hanya terletak pada konfigurasi nilai yang menggunakan 4 buah bits. Proses pengubahan sama dengan sistem angka oktal, seperti ditunjukkan pada tabel konversi berikut :

Tabel III. 4 : Tabel Konversi 4-Bits Binari Setara Dengan Digit Hexadesimal [9]

Hexadecimal digits	*4-bits binary*
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
A	1010
B	1011

C	1100
D	1101
E	1110
F	1111

Metode konversi yang digunakan juga sama dengan metode konversi yang digunakan pada bilangan oktal *(vice versa)*.

$(10001101)_2$

Diawali dengan pembagian bits

$$\begin{array}{cc} 1000 & 1101 \\ \downarrow & \downarrow \\ 8 & D = (8D)_{16} \end{array}$$

III.2 Mikrokontroler

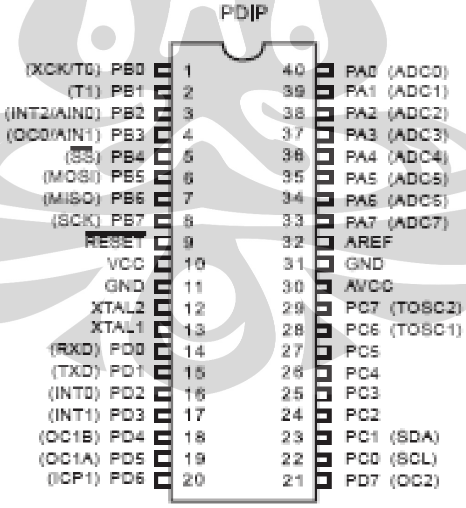
Mikrokontroler adalah sebuah sirkuit terintegrasi secara digital. Mikrokontroler dipergunakan dalam otomasi dan aplikasi kontrol. Saat ini domain aplikasi mikrokontroler sudah meluas dalam sektor komputasi. Banyak mikrokontroler ditambahkan pada modem, *disk drive*, *floppy drive*, dan sebagainya. Mikrokontroler terdiri utamanya dari CPU dan *peripheral* tambahan dalam arsitekrturnya. CPU terdiri dari *ALU, register, buffer, instuction decoder, control unit, Program Counter, Stack Pointer, interrupt controller, SID/SOD unit,* dan *bus*. CPU merupakan fungsi dasar yang umum yang dibutuhkan untuk menginterpretasi dan mengeksekusi instruksi atau program. Unit-unit tambahannya adalah :

- *analog to digital converter* (ADC)
- *programable timer*
- *watchdog timer*
- *interrupt controller*
- *pulse width modulation* (PWM)
- *phase locked loop*
- *memory controller*

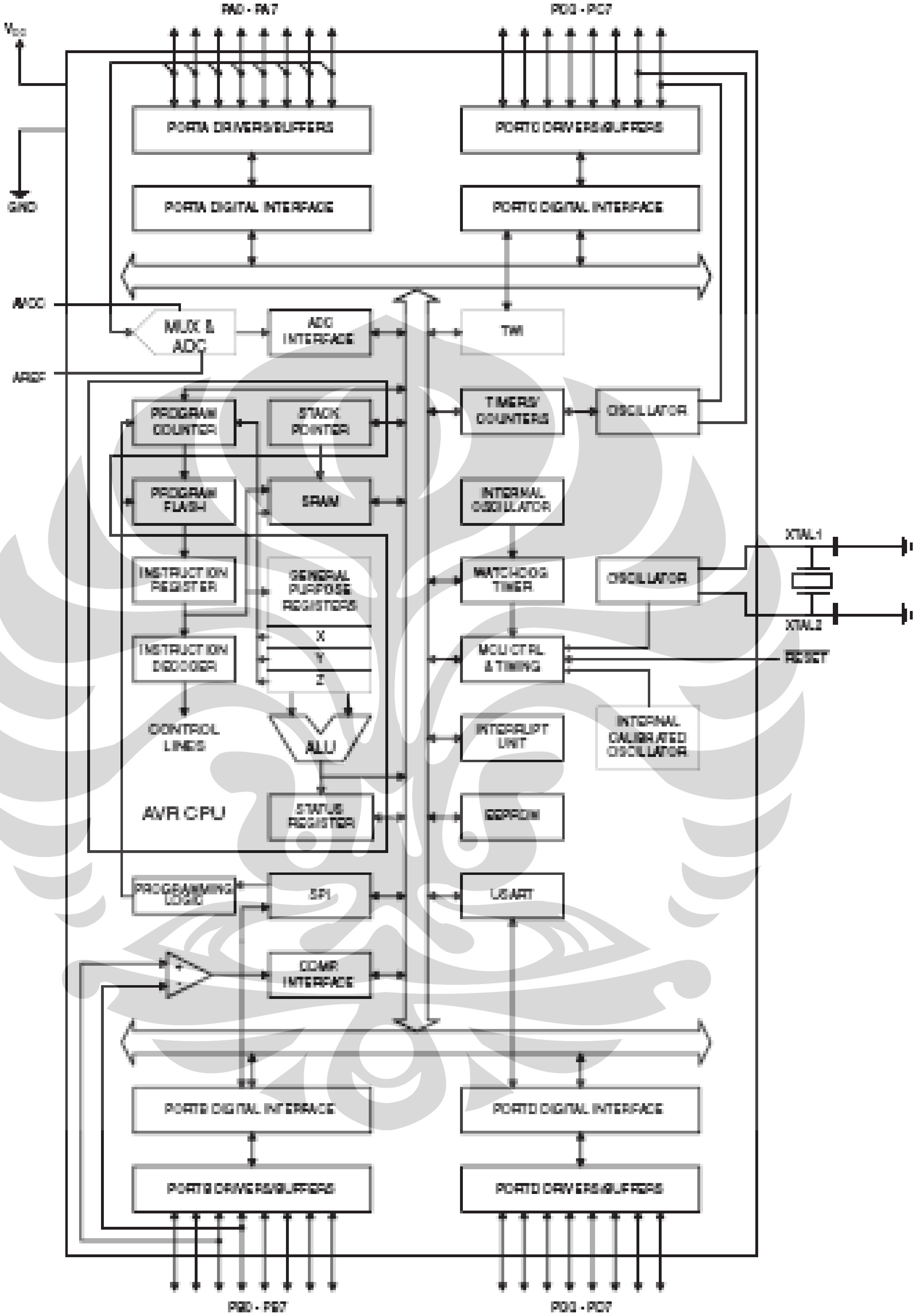
- tipe data dan mode pengalamatan
- I/O *port*
- EPROM, ROM, dan sebagainya

Obyek yang untuknya sistem kontrol ini dibuat disebut *plant*. Suatu *plant* dapat dikendalikan menggunakan mikrokontroler. *Plant* tersebut harus dilengkapi dengan sensor dan aktuator yang terhubung secara logis melalui mikrokontroler untuk mengerjakan pekerjaan tertentu. Dalam sebuah disain berbasis mikrokontroler, kebutuhan sirkuit-sirkuit eksternal seperti pengkondisian sinyal dan unit-unit tambahan lainnya sangat sedikit. Disain sistem kontrol berbasis mikrokontroler adalah sangat tangguh dan dapat diandalkan karena : disain berbasis mikrokontroler tidak memerlukan *peripheral* tambahan karena sudah dibangun satu kesatuan di dalam unit mikrokontrolernya. Mikrokontroler sangat dapat diandalkan karena lebih sedikit koneksi tambahan dan antarmuka yang dibutuhkan, sehingga mengurangi ukuran *part* dan menambah performa dan efisiensi, dan biaya implementasi secara keseluruhan rendah [9].

Mikrokontroler yang digunakan dalam disain sistem kontrol untuk mobil *hybrid* ini adalah mikrokontroler ATMEGA 8535. Arsitektur ATMEGA 8535 dapat dilihat dari gambar berikut :



Gambar III. 2 : Mikrokontroler ATMEGA 8535 [Lampiran Data Sheet ATMEGA 8535]



Gambar III. 3 : Arsitektur Dan Diagram Blok ATMEGA 8535 [Lampiran Data Sheet ATMEGA 8535]

III.3 Fungsi *Interrupt* Dan *Reset*

III.3.1 *Interrupt*

Sebuah *interrupt* adalah perubahan aliran, atau interupsi pada operasi program yang disebabkan oleh sumber eksternal atau internal dari suatu *hardware*. *Interrupt* memiliki efek akan memanggil suatu fungsi lain untuk dieksekusi bila *intrrupt* itu sendiri terjadi. Hasilnya *interrupt* akan menyebabkan aliran eksekusi fungsi program utama berhenti, sementara fungsi *interrupt* yang disebut *interrupt service routine* (ISR) dieksekusi. Setelah ISR selesai dieksekusi, aliran fungsi program utama akan berlanjut kembali dari saat program tersebut diinterupsi.

Interrupt akan menyebabkan status register dan program *counter* disimpan di *stack*, dan berdasarkan sumber *interrupt*, program *counter* akan diberi suatu nilai dari tabel alamat-alamat register. Alamat-alamat ini dianggap sebagai vektor. Ketika aliran program utama sudah diarahkan kembali oleh vektor *interrupt*, aliran program tersebut dapat dikembalikan ke operasinormal melalaui suatu mesin instruksi RETI (*RETurn from Interrupt*). Instruksi RETI mengembalikan status register kepada nilai sebelum terinterupsi dan meletakkan program *counter* pada mesin instruksi selanjutnya setelah instruksi yang diinterupsi.

Banyak *interrupt* tersedia pada mikrokontroler, semakin besar mikrokontroler semakin banyak yang tersedia. Untuk mengetahui suatu mikrokontroler memiliki *interupt* atau tidak, definisi mikrokontroler tersebut dapat ditemukan pada *header file* di awal program, dan spesifik untuk tiap-tiap jenis mikrokontroler.

Untuk membuat suatu ISR yang merupakan fungsi yang dipanggil oleh sistem *interupt* bila *interupt* terjadi, ISR dideklarasikan menggunakan kata-kata ***interrupt*** sebagai tipe fungsi. Kata ***interrupt*** diikuti dengan indeks yang merupakan vektor lokasi sumber *interrupt*. Contoh penulisan ISR adalah :

```
interrupt [EXT_INT0] void external_int0 (void)
{
  //fungsi yang dipanggil bila interrupt pada interrupt 0 terjadi
}
```

atau

```
interrupt [TIM_OVF] void timer0_overflow (void)
{
  //fungsi yang dipanggil bila timer 0 overflow terjadi
}
```

ISR dapat dieksekusi kapan saja bila sumber *interrupt* diinisialisasi dan *interrupt* global diperbolehkan. ISR tidak bisa mengembalikan suatu nilai karena secara teknis tidak ada "*caller*", dan ISR selalu dideklarasikan sebagai tipe ***void***. *Interrupt* di suatu lingkungan yang ditanamkan dapat membuat eksekusi yang *real-time*. Tidaklah tidak biasa pada suatu sistem yang kaya akan *pheripheral* ada fungsi *while*(1) yang kosong di fungsi *main*( ). Fungsi *main* ( ) menginisialisasi *hardware* dan *interrupt* melakukan aksi-aksi yang diperlukan ketika *interrupt* terjadi.

Pada jenis-jenis mikrokontroler yang umum semua *interrupt* memiliki prioritas yang sama. Tidak diperbolehkan suatu *interrupt* menginterupsi *interrupt* yang lain. Dimungkinkan dua *interrupt* muncul berurutan. Suatu skema arbitrasi, kadang dianggap sebagai skema prioritas, disediakan untuk menentukan *interrupt* mana yang dieksekusi lebih dulu, bila kasus seperti ini terjadi. Bila tidak ada skema ini, *interrupt* dengan vektor yang memiliki nilai yang lebih rendah akan dieksekusi lebih dulu.

Pilihan sumber *interrupt* dan vektor-vektornya tergantung pada mikrokontroler yang digunakan. Secara umum vektor *interrupt* adalah seperti tabel berikut.

Tabel III. 5 : Vektor Interrupt [5]

Alamat	Angka Vektor	Sumber	Penjelasan
0x0000	1	*Reset*	*Reset* eksternal, *Power up*, *Watchdog timeout*
0x0001	2	*External Interrupt 0*	Sinyal muncul pada pin INT 0
0x0002	3	*External Interrupt 1*	Sinyal muncul pada pin INT 1

0x0003	4	*Timer 2 Compare*	Muncul pada *Timer* 2 *compare match*
0x0004	5	*Timer 2 Overflow*	Muncul pada suatu overflow pada timer 2

Interrupt harus diinisialisasi sebelum aktif atau bisa diguanakan. Penginisialisasian *interrupt* merupakan proses dua langkah. Langkah pertama adalah membuka *interrupt* yang akan aktif, dan kedua adalah dengan membolehkan secara global *interrupt* yang telah dibuka.

Membuka *interrupt* dengan memberikan nilai 1 pada kontrol register sesuai dengan *interrupt* yang akan digunakan. Kontrol register tersebut tersebut adalah *General Interrupt Mask* (GIMSK). GIMSK digunakan untuk membolehkan *interrupt* eksternal. Mengatur bit INT0 akan membolehkan *interrupt* 0 eksternal, dan mengatur bit INT1 akan membolehkan *interrupt* 1. Mengatur keduanya akan membolehkan keduanya. Bit digunakan sebagai topeng yang menutupi *interrupt*. Pada GIMSK bit INT0 biasanya terletak pada bit ke 6, dan INT1 biasanya terletak pada bit ke 7.

Ketika sinyal muncul di pin *interrupt*, sinyal tersebut secara logis pemrograman di-AND-kan dengan bit *interrupt* di GIMSK. Jika hasilnya 1, *interrupt* diperbolehkan muncul. Jika bit *interrupt* adalah 0, hasilnya secara logis pemrograman adalah o, dan *interrupt* tidak diperbolehkan muncul.

Langkah kedua untuk membolehkan *interrupt* adalah dengan men-set bit global *interrupt* pada status register (SREG) di prosesor. Hal ini bisa dilakukan dengan membuat :

```
#asm(“sei”)
```

Kode ini dimasukkan ke bahasa pemrograman C di tempat di mana bit global *interrupt* diperbolehkan. Kode ini menggunakan pengarah *compiler* “#asm” untuk memasukkan ke dalam program, instruksi bahasa pemrograman *assembly* SEI. Instruksi tersebut untuk men-set bit global *interrupt*.

Pada ISR, definisi [EXT_INTx] datang dari file *#include*, dan INTx memiliki angka vektor tertentu. *Compiler* menggunakan informasi ini untuk meletakkan lompatan relatif ke fungsi ISR pada tempat yang tepat di tabel vekor *interrupt*. *Interrupt* eksternal juga bisa diatur bisa terpicu oleh *falling edge* atau *rising edge*. Pengaturannya ada pada MCU *Control Register* (MCUCR). Kontrol bit untuk *interrupt* 0 ada pada bit 0 dan 1. Kontrol bit untuk *interrupt* 1 ada pada bit 2 dan 3. Tabel MCUCR adalah sebagai berikut :

Tabel III. 6 : MCUCR [5]

ISCx1	**ISCx0**	**Fungsi *Interrupt***
0	0	*Interrupt* x dipicu oleh *low level*
0	1	Tidak digunakan
1	0	*Interrupt* x dipicu oleh *falling edge*
1	1	*Interrupt* x dipicu oleh *rising edge*

III.3.2 *Reset*

Reset adalah *interrupt* dengan angka paling rendah. Ini juga merupakan *interrupt* spesial, karena selalu lebih diutamakan dari seluruh *interrupt* yang lagi berjalan. Tiga sumber dapat mengakibatkan *reset* muncul, yaitu logik *low* diberikan pada pin *reset* eksternal selama lebih dari 50 ns, sebagai bagian dari urutan tenaga mikrokontroler, dan sebagai *timeout* dari *watchdog timer*. *Reset* digunakan untuk me-preset mikrokontroler ke keadaan yang telah diketahui sehingga mikrokontroler dapat mulai kembali mengeksekusi program yang terletak di lokasi 0x000 di memori kode.

Kondisi mikrokontroler yang mengikuti *reset* akan berbeda tergantung dari mikrokontroler yang digunakan.. Secara umum kondisi-kondisi tersebut adalah :

- seluruh *peripheral* termasuk *watchdog timer* dilumpuhkan
- seluruh port paralel di-set ke input

- seluruh *interrupt* dilumpuhkan

Dengan melumpuhkan seluruh *peripheral* dan *interrupt*, mikrokontroler dapat memulai eksekusi program tanpa lompatan yang tidak diharapkan karena *interrupt* atau *peripheral* dapat mengakibatkan kelakuan yang tidak diharapkan. Men-set port paralel ke mode input memastikan bahwa port dan perlengkapan eksternal tidak akan mencoba untuk mengarahkan port pin ke level yang berlawanan, yang bisa merusak port pin.

Watchdog timer adalah perlengkapan keamanan. Ini didesain untuk mengakibatkan mikrokontroler me-*reset* pada saat mikrokontroler "bingung" atau "kehilangan arah" atau melakukan sesuatu yang lain selain menjalankan program yang harus dijalankan. *Watchdog timer* adalah sebuah *timer* yang mngakibatkan mikrokontroler me-*reset* bila diperbolehkan untuk *timeout*. Ketika program beroperasi secara normal, program secara konsisten me-*reset watchdog timer* untuk mencegah *timeout*. Jika program "kehilangan arah", *timout* akan muncul, dan mikrokontroler akan di-*reset*. Teorinya bahwa *reset* ini akan mengembalikan program beroperasi secara nomal.

Untuk menginisialisasi *watchdog timer* bit-bit register pada *watchdog timer control register* (WDTCR) harus di-*set* ke satu. Bit-bit WDTCR adalah :

- bit 0 : WDP0
- bit 1 : WDP1
- bit 2 : WDP2
- bit 3 : WDE
- bit 4 : WDTOE

Tabel III. 7 : WDTCR [5]

Bit	**Nama**	**Penjelasan**
WDTOE	*Watchdog timer off enable*	Memperbolehkan melumpuhkan *watchdog timer* (WDT)
WDE	*Watchdog timer enable*	Mengaktifkan WDT
WDPx	*Watchdog Prescaler* bit x	Mengatur periode *timeout* untuk WDT

Osilator yang memberi detak pada WDT terpisah dari sitem *clock*. Frekuensinya tergantung pada tegangan yang diberikan ke mikrokontroler.

Dengan 5 volt diberikan ke V_{cc}, frukuensinya mendekati 1 MHz, dan pada 3 volt frekuensinya mendekati 350 kHz. Hal ini membuat situasi dimana, walau *watchdog timer presaler bit* di WDTCR di-set untuk menentukan *timeout*, waktu yang diperlukan akan berbeda tergantung V_{cc} yang diberikan ke mikrokontroler Berikut ini waktu-waktu periode bit *prescaler*.

Tabel III. 8 : Pemilihan Periode Watchdog Timeout [5]

WDP2	**WDP1**	**WDP0**	***Timeout* @ 5 V V_{cc}**	***Timeout* @ 3 V V_{cc}**
0	0	0	15 ms	47 ms
0	0	1	30 ms	94 ms
0	1	0	60 ms	190 ms
0	1	1	120 ms	380 ms
1	0	0	240 ms	750 ms
1	0	1	490 ms	1500 ms
1	1	0	970 ms	3000 ms
1	1	1	1900 ms	6000 ms

Tabel ini hanya pendekatan, karena frekuensi osilator sangat tergantung dan merupakan pendekatan terhadap tegangan yang diberikan ke V_{cc}. WDT di-*reset* oleh eksekusi yang disebut instruksi #asm(“wdr”). Instruksi ini merupakan instruksi kode *assembly* yang tidak terdapat di bahasa pemrograman C, dan harus dieksekusi sebelum WDT memiliki kesempatan untuk *timeout*. WDT bisa dilumpuhkan dengan cara memberikan suatu kondisi dimana bila kondisi tersebut terjadi, eksekusi pelumpuhan WDT akan dilakukan. Pelumpuhan ini adalah proses dalam dua langkah. Langkah pertama adalah dengan men-*set* bit WDTOE dan bit WDE dalam satu langkah, diikuti dengan menbersihkan bit WDE pada langkah berikutnya. Melumpuhkan WDT adalah sebuah operasi yang rumit untuk mencegah WDT dilumpuhkan secara tidak sengaja oleh operasi program yang tidak menentu. Normalnya WDT bila di-*enable*-kan, tidak pernah dilumpuhkan lagi, karena tujuan men-*enable*-kan WDT adalah untuk melindungi mikrokontroler dari pemrosesan program yang tak menentu.

III.4 Port Input/Output Paralel

Port input/output (I/O) paralel adalah perlengkapan I/O yang paling umum. Setiap port I/O paralel memiliki tiga register I/O yang berhubungan, yaitu:

- *data direction register* (DDRx), diman x adalah A, B, C, dan seterusnya tergantung dari mikrokontroler dan port paralel yang digunakan
- *port driver register* (PORTx)
- *port pin register* (PINx)

Tujuan DDRx adalah untuk menentukan bit yang mana dari suatu port digunakan sebagai input, dan bit yang mana digunakan sebagai output. Bit input dan output dapat dicampur sesuai keinginan programer. Bila mikrokontroler di-*reset*, mikrokontroler membersihkan semua bit DDRx ke logika 0, men-*set* semua bit port sebagai input. Men-*set* suatu bit DDRx ke logika 1 membuat bit port yang bersangkutan menjadi mode output. Contohnya, men-*set* dua *least significant bit* (LSB) dari DDRA menjadi logika 1 dan bit yang lain ke logika 0 akan men-*set* dua bit LSB port A menjadi output dan bit yang lain menjadi input.

Contoh program untuk menulis ke bit output di PORTA adalah :

```
PORTA = 0x02;  //men-set bit kedua dari port A dengan logika 1 dan membersihkan bit yang
                             lain menjadi logika 0
```

Contoh program untuk membaca bit input PORTA adalah :

```
x = PINA;  //membaca keseluruhan 8 bit dari port A.
```

Pada contoh tersebut, “x” merupakan nialai dari seluruh bit di PORTA, input dan output, karena register PIN merefleksikan nilai dari seluruh bit dari port tersebut. Pin port input adalah tersebar/mengambang, sehingga tidak perlu sebuah resistor *pull-up* diasosiasikan terhadap pin port. Mikrokontroler dapat memberikan resistor *pull-up* jika diinginkan dengan memberikan logika 1 pada bit yang bersangkutan dari PORTx. Contohnya :

```
DDRA = 0xC0;  //2 bit paling atas port A sebagai output, 6 bit terendah sebagai input
PORTA=0x03;   //membolehkan pull-up internal pada dua bit terendah
```

Secara umum walaupun bervariasi pada mikrokontroler yang berbeda, pin port mampu menyediakan 20mA. Artinya bahwa port dapat secara langsung menghidupkan LED.

III.5 Timer/Counter

Timer/counter mungkin merupakan *peripheral* rumit yang paling sering digunakan di mikrokontroler. *Timer/counter* sangat serba guna, dapat digunakan untuk mengukur waktu, PWM, kecepatan, frekuensi, atau menyediakan sinyal output. Walau digunakan dalam mode yang sangat berbeda yaitu, mengukur waktu dan menghitung, *timer/counter* merupakan penghitung biner simpel. Ketika digunakan untuk mengukur waktu, penghitung biner ini menghitung lama periode waktu yang diberikan pada inputnya. Pada mode menghitung, *timer/counter* menghitung kejadian atau pulsa. Contohnya, penghitung biner memiliki 1 ms pulsa sebagai inputnya, periode waktu dapat diukur dengan memulai *counter* pada awal suatu kejadian dan berhenti pada akhir kejadian. Akhir dari penghitungan merupakan jumlah milidetik yang sudah berlalu selama kejadian. Ketika *timer/counter* digunakan sebagai penghitung, kejadian yang mau dihitung diberikan ke input penghitung biner, dan jumlah kejadian yang muncul dihitung.

Mikrokontroler memiliki 8-bit dan 16-bit *timer/counter*. Isu yang sangat penting adalah mengetahui kapan penghitung mencapai nilai maksimum penghitungan dan berulang kembali. Pada 8-bit, hal ini terjadi bila penghitungan mencapai nilai 255, dan pulsa berikutnya akan mengakibatkan penghitung mulai dari 0 lagi. Pada 16-bit, hal yang sama akan terjadi pada 65535. Kejadian penghitung-ulangan ini sangat penting bagi program agar dapat secara akurat membaca hasilnya. Faktanya, penghitung-ulangan ini sangat penting karena *interrupt* disediakan sehingga muncul ketika *timer/counter* menghitung-ulang. Mikrokontroler secara umum memiliki dua buah 8-bit *timer* (Timer 0 dan Timer 2) dan satu buah 16-bit *timer* (Timer 1), walaupun konfigurasi ini akan berbeda tergantung mikrokontroler yang digunakan.

III.5.1 *Timer/Counter Presaler* Dan Pemilihan Input

Timer/counter unit dapat menggunakan berbagai jenis frekuensi internal yang diturunkan dari sistem *clock* sebagai inputnya, atau dapat juga mendapatkan input dari pin eksternal. *Timer/counter control register* (TCCRx) yang berhubungan dengan *timer* memiliki bit *counter select*(CSx2, CSx1, dan CSx0) yang mengatur input mana yang digunakan sebagai *counter* spesifik.

Potongan program berikut menunjukkan sebuah contoh bagaimana menginisalisasi *timer* 0 untuk menggunakan sistem *clock* dibagi dengan 8 sebagai sumber *clock* (bit pemilih *counter* adalah tiga LSB dari TCCR0).

```
TCCR0 = 0x02;    //timer 0 menggunakan sistem clock/8.
```

III.5.2 *Timer 0*

Timer 0 secara umum merupakan 8-bit timer, tetapi bisa berbeda tergantung mikrokontroler yang digunakan. Timer 0 memiliki fungsi umum timer/counter, tetapi lebih sering digunakan untuk membuat waktu dasar atau “denyut” untuk program. Timer control counter register 0 (TCCR0) mengontrol fungsi timer 0 dengan memilih sumber clock untuk diberikan ke timer 0. Definisi bit untuk timer 0 adalah : bit 0 untuk CS00, bit 1 untuk CS01, bit 2 untuk CS02.

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit1	bit 0
					CS02	**CS01**	**CS00**

CS02	CS01	CS00	Interrupt Function
0	0	0	Stop,Timer 0 is stopped
0	0	1	System Clock, CK
0	1	0	System Clock / 8, CK / 8
0	1	1	System Clock / 64, CK / 64
1	0	0	System Clock/256,CK /256
1	0	1	System Clock/1024,CK/1024
1	1	0	External Pin T0, counts a falling edge
1	1	1	External Pin T0, counts a falling edge

III.5.3 *Timer 1*

Timer 16 bit, biasanya *timer* 1, merupakan *peripheral* yang lebih serbaguna dan rumit daripada *timer* 0. Kelebihannya dari *timert/counter* yang lain adalah *timer* 1 memiliki sebuah register 16-bit penangkap input, dan dua buah register pembanding output. Register penangkap input (*input capture register*-ICR) digunakan untuk mengukur ketebalan detak (*pulse width*) atau waktu penangkapan (*capturing time*). Register pembanding output (*output compare register*-OCR) digunakan untuk menghasilkan frekuensi atau detak dari *timer/counter* ke sebuah pin output di mikrokontroler.

*Timer*1 juga secara konsep berbeda dari *timer* 0. *Timer* 0 biasanya dihentikan, dimulai, di-*reset*, dan sebagainya dalam penggunaannya. *Timer* 1 biasanya dibiarkan berjalan. Hal ini membuat beberapa perbedaan yang harus diperhatikan dalam penggunaannya.

III.5.3.1 *Prescaler* Dan Pemilihan *Timer* 1

Timer 1 merupakan penghitung biner yang menghitung kelajuan atau interval waktu tergantung dari sinyal yang diberikan pada inputnya, seperti *timer*

0. Seperti seluruh *peripheral* di mikrokontroler, *timer* 1 dikontrol melalui register kontrol. *Timer counter control register* 1 (TCCR1) disusun oleh dua register yaitu, TCCR1A dan TCCR1B. TCCR1A mengatur mode pembanding dan mode penghasil ketebalan denyut (*pulse width modulation*-PWM) dari *timer* 1. TCCR1B mengatur *prescaler* dan *input multiplexer* dari *timer* 1, dan juga mode *input capture*. Berikut ini adalah definisi bit TCCR1B :

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit1	bit 0
ICNC1	ICES1			CTC1	CS12	CS11	CS10

Tabel III. 9 : Definisi Bit TCCR1B [5]

Bit	**Fungsi**
ICNC1	*Input Capture Noise Canceller (*1*=enable)*
ICES1	*Input Capture Edge Select (*1*=rising edge, 0=falling edge)*
CTC1	*Clear Timer/Counter on Compare Match (*1*=enable)*
CS12	Counter Input Select Bits (definisi yang sama dengan *timer* 0)
CS11	
CS10	

Pemilihan bit TCCR1B mengatur input ke *timer* 1 sama seperti *timer* 0. Bit-bit pengaturnya menyediakan sinyal dengan cara yang sama seperti *timer* 0.

III.5.3.2 Timer 1 Input Capture Mode

Mengukur periode waktu di *timer* 0 melibatkan memulai waktu pada permulaan kejadian, dan memberhentikan pada akhir kejadian, dan membaca waktu kejadian dari *timer control register*. Aktivitas ini ditangani dengan cara yang berbeda pada *timer* 1 karena *timer* 1 selalu bekerja. Untuk mengukur kejadian, waktu pada *timer* 1 ditangkap atau ditahan pada permulaan kejadian, waktu tersebut juga ditangkap pada akhir kejadian, dan keduanya dikurangkan untuk mendapatkan periode waktu kejadian. Aktivitas ini diatur oleh *input capture register* (ICR1).

ICR1 adalah register 16-bit yang akan menangkap pembacaan aktual *timer* 1 ketika mikrokontroler menerima sinyal tertentu. Sinyal ini dapat berupa *rising edge* atau *falling edge* yang diberikan pada *input captur pin* (ICP) mikrokontroler. Pilihan *rising edge* atau *falling edge* diatur pada *input capture edge select bit* (ICES1). Men-*set* bit ICES1 dengan 1 akan membolehkan ICR1 untuk menangkap waktu pada *rising edge*, dan men-*set* bit ICES1 dengan 0 akan membolehkan ICR1 untuk menangkap waktu pada *falling edge*.

Karena hanya ada satu *capture register* pada *timer* 1, data yang ditangkap harus segera dibaca segera setelah data tersebut ditangkap untuk mencegah data berikutnya yang ditangkap menimpa dan menghancurkan data sebelumnya. Untuk mencapai hal ini. Sebuah *interrupt* disediakan ketika data tersebut ditangkap oleh ICR1. Setiap *interrupt* terjadi, program harus menentukan apakah sinyal *interrupt* merupakan awal atau akhir suatu kejadian yang dihitung waktunya, sehingga program bisa memperlakukan data di ICR1 secara benar.

Timer 1 juga menyediakan fitur *noise canceller*, untuk mencegah gangguan yang tidak diinginkan pada sinyal yang diberikan ke ICP, sehingga menyebabkan penangkapan data pada waktu yang salah. Ketika fitur ini aktif, ICP harus tetap pada level aktif (tinggi pada *rising edge*, atau rendah pada *falling edge*) untuk empat sampel yang saling berurutan sebelum mikrokontroler akan memperlakukan pemicu sebagai legitimasi dan menangkap data. Hal ini mencegah *noise* memicu *capture register*. Men-*set input capture noise canceller* (ICNC1) di TCCR1B membolehkan fitur ini.

III.5.3.3 Timer 1 Output Compare Mode

Output Compare Mode digunakan oleh mikrokontroler untuk menghasilkan sinyal output. Output bisa merupakan gelombang kotak atau asimetris, dan bisa bervariasi frekuensi dan simetrinya. *Output compare mode* merupakan kebalikan dari *input capture mode*. Pada *input capture mode*, sinyal eksternal mengakibatkan waktu di *timer* ditangkap atau ditahan di ICR. Pada *output compare mode*, program mengeluarkan *output compare register*. Nilainya dibandingkan dengan nilai nilai pada register *timer/counter*, dan *interrupt* muncul bila nilai keduanya cocok. *Interrupt* ini bertindak sebagai alarm untuk mengakibatkan mikrokontroler mengeksekusi suatu fungsi relatif terhadap sinyal yang dihasilkan saat dibutuhkan.

Untuk menghasilkan *interrupt*, *output compare mode* dapat secara otomatis men-*set*, membersihkan, atau *toggle* spesifik port pin output. Untuk *timer* 1, *oiutput compare mode* diatur oleh *timer counter control register* 1 A (TCCR1A).

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit1	bit 0
COM1A1	COM1A0	COM1B1	COM1B0			PWM11	PWM10

COM1A0 & COM1A1 mengatur fungsi mode pembanding untuk registerpembanding. COM1B0 & COM1B1 mengatur fungsi mode pembanding untuk registerpembanding.

Tabel III. 10 : Definisi Bit TCCR1A [5]

COM1x1	**COM1x0**	**Fungsi(x adalah A atau B)**
0	0	Tidak ada output
0	1	Hasil yang dibandingkan *toggle line* OC1x
1	0	Hasil yang dibandingkan *membersihkan line* OC1x ke bit 0
1	1	Hasil yang dibandingkan men-*set line* OC1x ke bit 1

Bit pengontrol mode pembanding menentukan akasi apa yang akan diambil ketika *match* (kecocokan) timbul antara register pembanding dan register *timer*. Pin output yang bersangkutan dapat tidak terpengaruh, ter-*toggle*, ter-*set*, atau terbersihkan. Kecocokan juga mengakibatkan *interrupt* muncul. Tujuan dari ISR adalah untuk mer-*reset* atau me-*reload* register pembanding untuk kecocokan berikutnya yang akan muncul.

III.5.3.4 Timer 1 Pulse Width Modulation (PWM)

Mode PWM adalah salah satu metode penyediaan konversi analog ke digital. PWM adalah skema dimana siklus kerja dari suatu gelombang kotak output dari mikrokontroler divariasikan untuk menyediakan output DC yang berbeda dengan menyaring bentuk gelombang output aktual untuk mendapatkan

DC rata-rata. Pembedaan siklus kerja, atau proporsi siklus yang tinggi, akan membedakan tegangan DC rata-rata pada bentuk gelombang. Bentuk gelombang kemudian disaring dan digunakan untuk mengatur peralatan analog, membuat sebuah DAC.

Salah satu metode membuat PWM dengan *timer* 1 adalah dengan menggunakan *output compare register*, setiap kecocokan terjadi, pembedaan jumlah inkremen yang di-*reload* untuk membuat bentuk gelombang PWM. *Timer* 1 menyediakan metode *built-in* untuk menghasilkan PWM tanpa harus menggunakan register pembanding untuk membuat PWM.

Timer 1 mengubah mode operasinya untuk menghasilkan PWM. Ketika beroperasi pada mode PWM, *timer* 1 menghitung atas dan bawah, sehingga sulit untuk menggunakan mode-mode lain. Selama mode PWM, *timer* 1 menghitung dari nol sampai nilai atas dan turun lagi sampai nol. Nilai atas ditentukan oleh resolusi yang diinginkan. PWM menyediakan resolusi 8-bit, 9-bit, atau 10-bit sesuai yang ditentukan oleh PWM *select bit* di TCCR1A. Definisi PWM *select bit* adalah :

Tabel III. 11 : Pilihan Bit PWM [5]

PWM *Select Bit*		**Resolusi PWM**	**Nilai Atas *Timer***
PWM11	PWM10		
0	0	PWM *Disable*	
0	1	8-bit	255 (0xff)
1	0	9-bit	511 (0x1ff)
1	1	10-bit	1023 (0x3ff)

Tabel di atas menunjukkan resolusi yang dipilih akan menentukan nilai atas bagi *counter* untuk menghitung dari bawah sampai atas dan ke bawah lagi, dan juga akan mempengaruhi frekuensi dar bentuk gelombang PWM yang dihasilkan. Sebagi contoh, memilih resolusi 9-bit akan menghasilkan hitungan sampai 511 dan frekensi PWM dapat dihitung dengan cara (frekuensi sistem *clock* adalah 8 MHz) :

$$f_{PWM} = f_{system\ clock} / (prescaler * 2 * \text{nilai atas}) \qquad (\text{III.1})$$

$$f_{PWM} = 8\ \text{MHz} / (8 * 2 * 511) = 978.5\ \text{Hz} \qquad (\text{III.2})$$

Resolusi adalah akurasi dari PWM. Dalam mode 8-bit, PWM dikontrol dalam 256, dalam mode 9-bit, PWM dikontrol dalam 512, dan dalam mode 10-bit, PWM dikontrol dalam 1024. Pada PWM, resolusi harus dibedakan dari frekuensi untuk menentukan pilihan optimum.

Siklus kerja aktual yang dioutputkan dalam mode PWM tergantung dari nilai yang diberikan kepada *output compare register*. Dalam mode normal PWM, ketika *counter* menghitung ke bawah, PWM men-*set* bit output dalam *match* dengan OCR, dan bila menghitung ke atas, PWM membersihkan bit output dalam *match* dengan OCR. Dalam keadaan ini, memberi nilai OCR dengan, misalnya, 20% dari nilai atas akan menghasilkan 20 % bentu gelombang siklus kerja. Dimungkinkan juga untuk menyediakan PWM yang terbalik untuk aplikasi seperti mengatur terangnya LED yang terhubung langsung pada pin, memberikan *output compare register* sampai 80% nilai atas pada mode terbalik akan menghasilkan 80% gelombang kotak siklus kerja rendah. Men-*set* frekensi output yang tepat membutuhkan pemadupadanan *prescaler* dan resolusi untuk mendapatkan sedekat mungkin frekuensi yang diinginkan.

III.5.4 Timer 2

Timer 2 biasanya merupakan *timer*/*counter* 8-bit dengan fitur seperti *timer* 1. Perbedaan yang paling menarik adalah *timer* 2 dapat menggunakan sebuah kristal yang terpisah dari sistem *clock* sebagai sumber *clock*. Pemilihan osilator eksternal sebagai sumber *clock* untuk *timer* 2 dicapai dengna men-*set* bit AS2 di *asynchronous status register* (ASSR). Definisi bit dari ASSR adalah :

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit1	bit 0
				AS2	TCN2UB	OCR2UB	TCR2UB

Men-*set* bit AS2 membolehkan *timer* 2 menggunakan osilator eksternal sebagai sumber *clock*. Artinya bahwa sumber *clock timer* 2 bekerja secara tidak sinkron dengan sistem *clock* mikrokontroler. Tiga bit lainnya pada ASSR digunakan oleh programer untuk memastikan bahwa data tidak ditulis di register *timer* 2 pada saat yang bersamaan dengan *hardware* memperbaharui register *timer*

2. Hal ini dibutuhkan karena osilator *timer* 2 tidak sinkron dengan osilator sistem, dan bisa saja merusak data pada register *timer* 2 dengan menuliskan data pada register yang dimaksudkan untuk diperbaharui. Suatu *control register ,* TCCR2, mengatur operasi *timer* 2. Definisi bit TCCR2 ditunjukkan oleh :

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit1	bit 0
	PWM2	COM21	COM20	CTC2	CS22	CS21	CS20

Tabel III. 12 : Definisi Bit TCCR2 [5]

Bit	**Fungsi**
PWM2	Men-*set* bit ini akan mengaktifkan fungsi PWM *timer* 2
COM21	Dua bit ini men-*set* fungsi mode pembanding output. Definisinya sama dengan bit COM1x1 dan COM1x0 pada *timer* 1.
COM20	
CTC2	*Clear Timer/Counter on Compare Match (*1*=enable)*
CS22	Counter Input Select Bits (definisi yang sama dengan *timer* 0, lihat *data sheet* mikrokontroler untuk detailnya)
CS21	
CS20	

III.6 LCD

LCD digunakan sebagai peralatan output dan display. Untuk mengaktifkan LCD perlu diaktifkan fungsi LCD pada status register di prosesor. Hal ini bisa dilakukan dengan membuat :

```
#asm
   .equ __lcd_port=0x1B ;PORTA
#endasm
#include <lcd.h>
```

Kode ini dimasukkan ke bahasa pemrograman C di awal program. Kode ini menggunakan pengarah *compiler* “#asm” untuk memasukkan ke dalam program, instruksi bahasa pemrograman *assembly*. Pin yang digunakan adalah keseluruhan pin pada suatu port. Untuk menggunakan port A bit yang diaktifkan adalah 0x1B, untuk menggunakan port B bit yang diaktifkan adalah 0x18, untuk menggunakan port C bit yang diaktifkan adalah 0x15, dan untuk menggunakan port D bit yang diaktifkan adalah 0x12. Langkah berikutnya adalah menginisialisasi jumlah karakter setiap baris yang sesuai dengan LCD yang digunakan, pada main ( ). Contohnya :

```
lcd_init(16);
```

Pada contoh ini jumlah karakter per baris yang digunakan adalah 16 karakter.

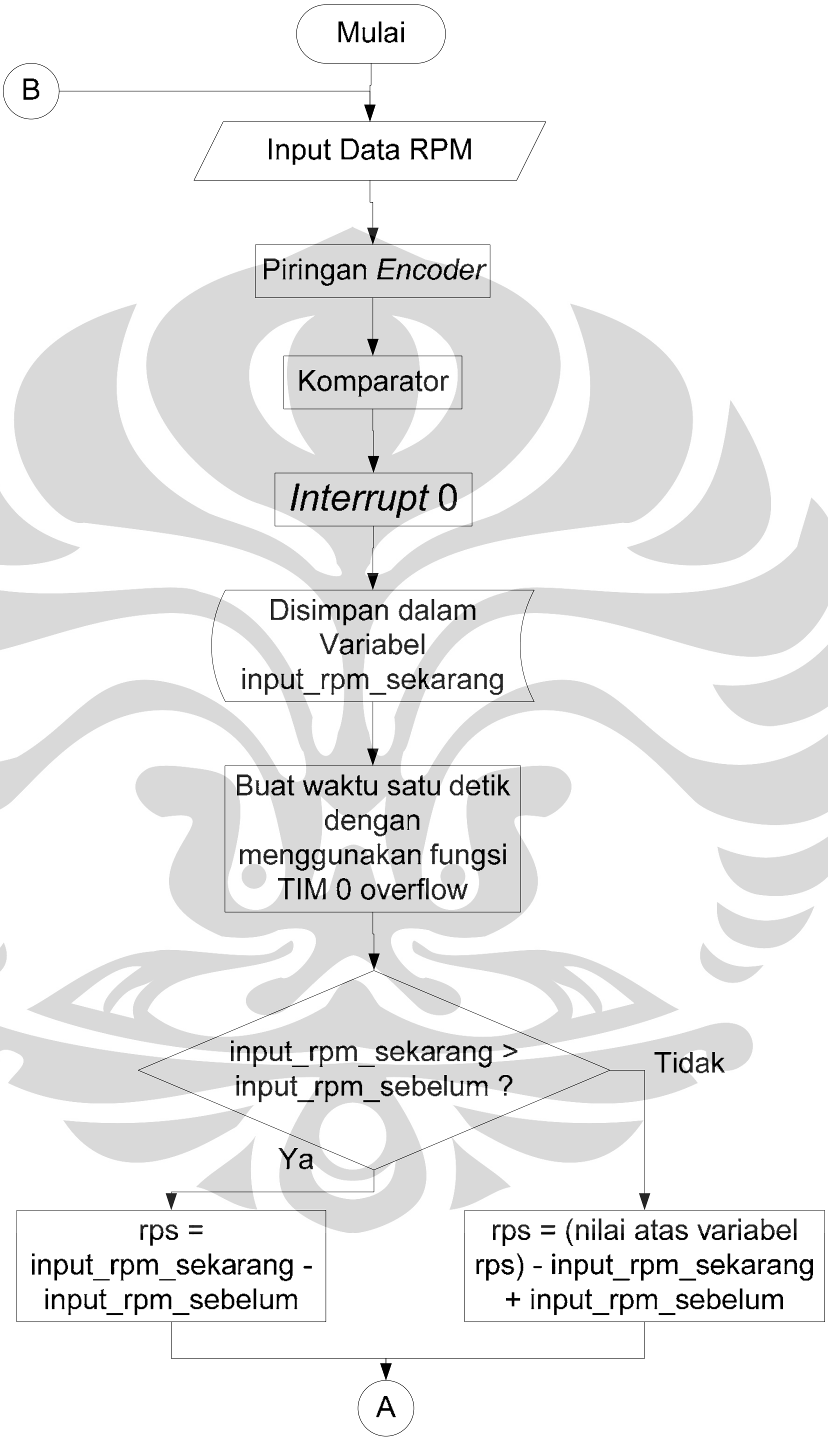
III.7 Logika Pemrograman Sistem Kontrol Mobil *Hybrid*

Dalam proses pemrograman sistem kontrol mobil *hybrid* ini, dibutuhkan suatu logika pemrograman yang sesuai dengan kaidah-kaidah penggunaan *peripheral* mikrokontroler. Setiap *peripheral* memiliki cara-cara yang unik dalam menginisialisasi, menggunakan, memberikan input dan mengeluarkan outputnya. Detail dari kaidah-kaidah tersebut sudah dijelaskan dalam sub bab-sub bab sebelumnya dan dapat dilihat di *data sheet* mikrokontroler yang digunakan, dalam hal ini ATMEGA 8535. Logika pemrograman tersebut harus mampu mewadahi kebutuhan yang diperlukan dalam penggunaan mikrokontroler sebagai sistem kontrol.

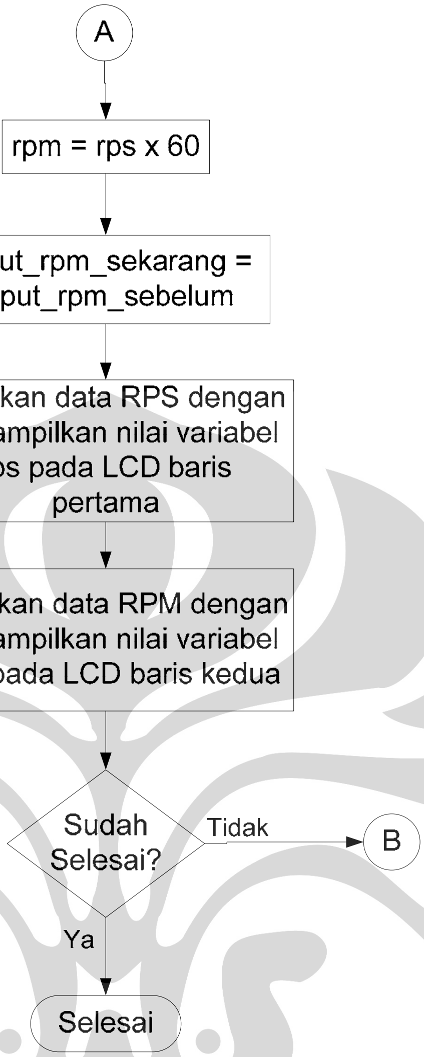
Pemrograman secara langsung keseluruhan sistem kontrol akan menyebabkan kerumitan dalam menyusun logika pemrogramannya. Pembuatan potongan-potongan program sangat membantu dalam mencoba dan membuat modul-modul logika pemrograman sesuai fungsi yang akan digunakan pada masing-masing *peripheral* yang dipakai.

III.7.1 Logika Pemrograman Penghitungan RPM

RPM dihitung dengan menggunakan fungsi *interrupt* pada mikrokontroler. *Peripheral* yang digunakan adalah INT 0 untuk menangkap data detak frekuensinya dan fungsi *timer*/*counter* untuk membuat interval 1 detik dalam pengambilan frekuensi. Mikrokontroler yang digunakan adalah ATMEGA 8535 dengan sistem *clock* 4MHz. *Prescaler* yang digunakan adalah 64 pada *timer* 0, shingga *clock* pada *timer* 0 adalah 4MHz : 64 = 62.5 kHz. Jadi selama 1 detik telah terjadi 62500 *clock*. *Timer* 0 adalah 8-bit *timer*, sehingga hanya dapat menghitung sebanyak 255 kali. Dengan memilih 250 sebagai jumlah hitungan perdetik, *timer interrupt* akan muncul 250 kali (62500 Hz : 250 = 250 kali) selama waktu 1 detik. Logika pemrograman yang dipakai adalah :



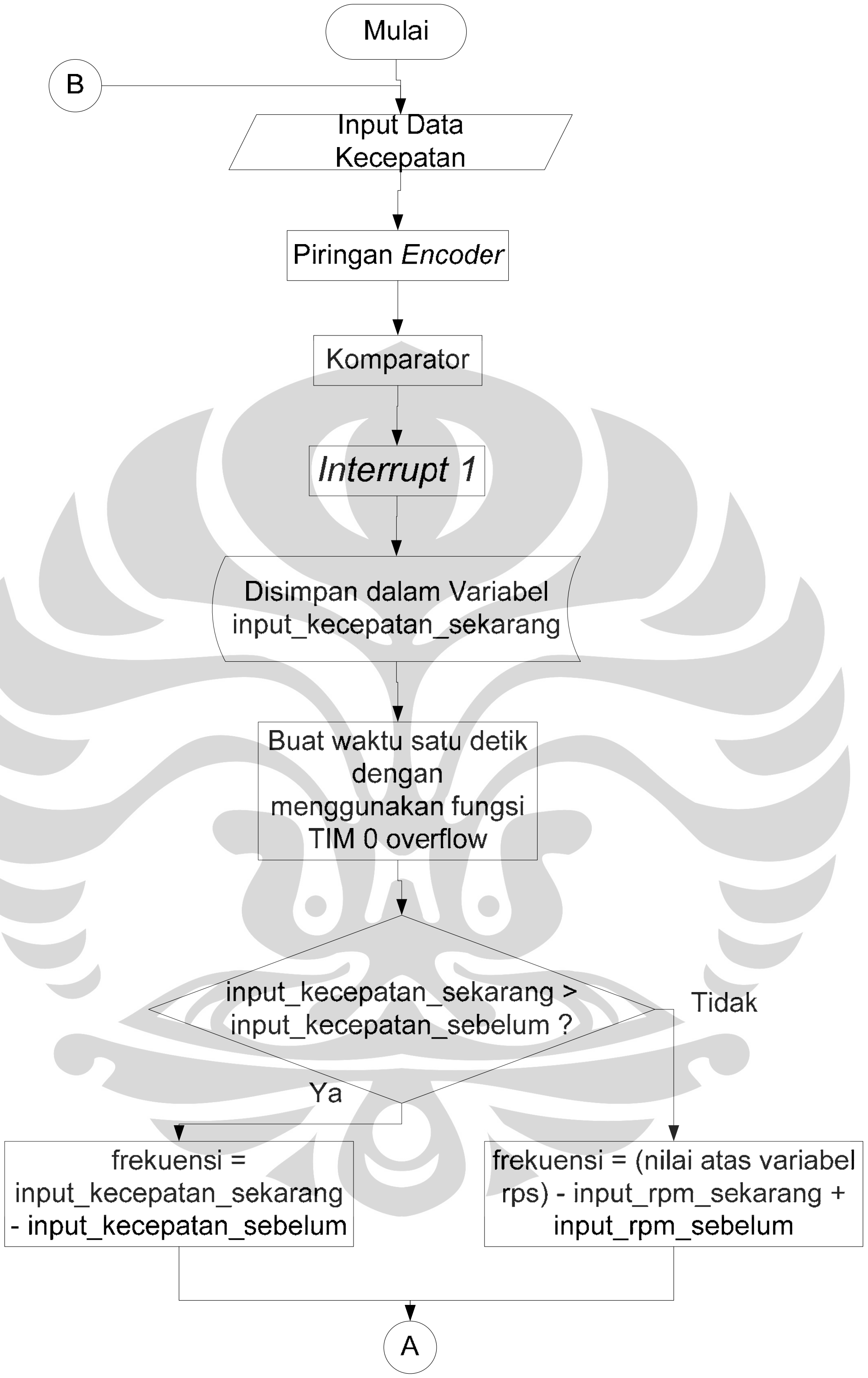
Gambar III. 4 : FLowchart Logika Pemrograman Pembacaan RPM



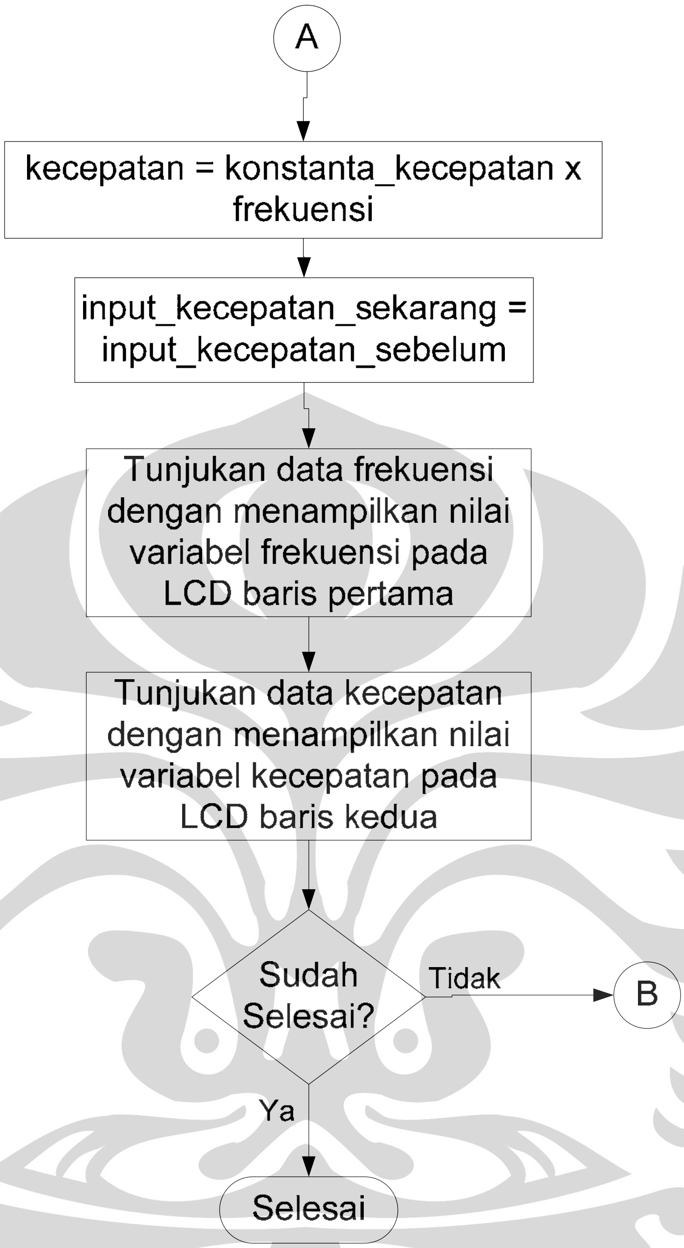
Gambar III. 5 : Flowchart Logika Pemrograman Pembacaan RPM

III.7.2 Logika Pemrograman Penghitungan Kecepatan

Kecepatan dihitung dengan menggunakan fungsi *interrupt* pada mikrokontroler. *Peripheral* yang digunakan adalah INT 1 untuk menangkap data detak frekuensinya dan fungsi *timer/counter* untuk membuat interval 1 detik dalam pengambilan frekuensi. Mikrokontroler yang digunakan adalah ATMEGA 8535 dengan sistem *clock* 4MHz. *Prescaler* yang digunakan adalah 64 pada *timer* 0, sehingga *clock* pada *timer* 0 adalah 4MHz : 64 = 62.5 kHz. Jadi selama 1 detik telah terjadi 62500 *clock*. *Timer* 0 adalah 8-bit *timer*, sehingga hanya dapat menghitung sebanyak 255 kali. Dengan memilih 250 sebagai jumlah hitungan perdetik, *timer interrupt* akan muncul 250 kali (62500 Hz : 250 = 250 kali) selama waktu 1 detik. Logika pemrograman yang dipakai adalah :



Gambar III. 6 : Flowchart Logika Pemrogram Pembacaan Kecepatan

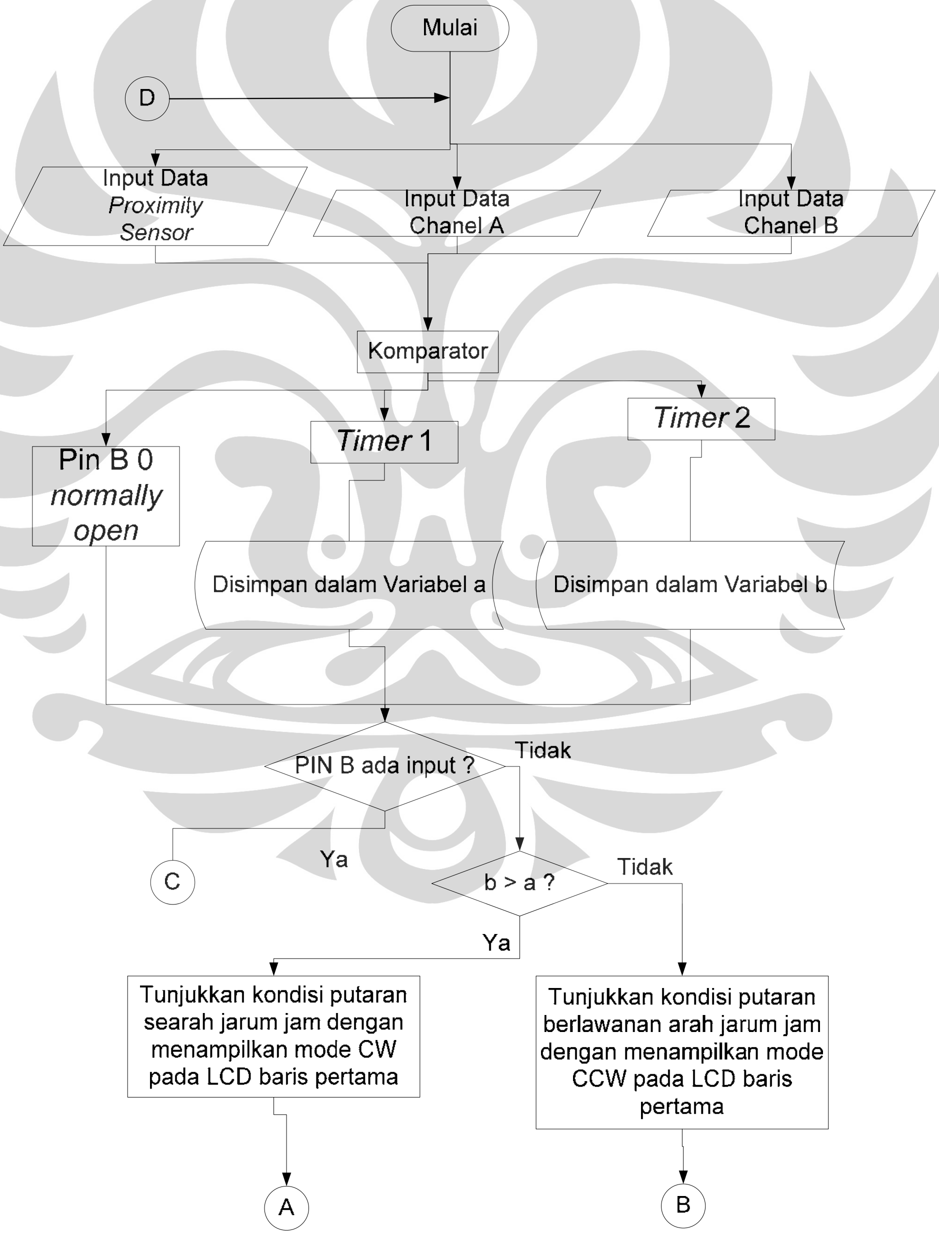


Gambar III. 7 : Flowchart Logika Pemrograman Pembacaan Kecepatan

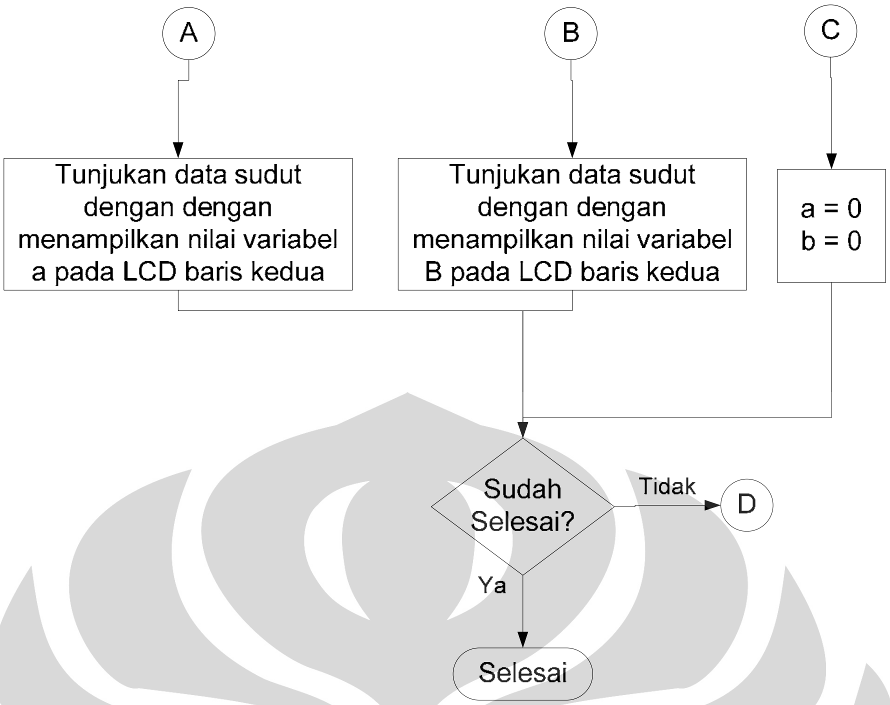
III.7.3 Logika Pemrograman Pengukuran Sudut Kemiringan

Kemiringan diukur dengan menggunakan *incremental rotary encoder*, dengan chanel A dihubungkan ke TIMER 1, dan chanel B dihubungkan ke TIMER 2. *Peripheral* yang digunakan adalah TIMER 1 & 2 untuk menangkap data, dengan menggunakan fungsi *timer* yang dipicu oleh input *rising edge*. Mikrokontroler yang digunakan adalah ATMEGA 8535 dengan sistem input *rising edge*. *Timer* 1 adalah 16-bit *timer*, sehingga dapat menghitung sebanyak

65535 kali, dan *timer* 2 8-bit sehingga dapat menghitung sebanyak 255 kali. *Proximity sensor* digunakan untuk memberi input bahwa massa sensor kemiringan sudah kembali ke tempat semula, sehingga seluruh nilai sudut kemiringan pada *timer* 1 & 2 dikembalikan ke nol. Sensor ini dihubungkan ke port input. Chanel A & B digunakan untuk mengetahui apakah putaran sedang searah jarum jam atau berlawanan arah jarum jam. Jika gelombang sinyal di B mendahului gelombang sinyal di A, putaran searah jarum jam. Jika gelombang sinyal di A mendahului gelombang sinyal di B, putaran berlawanan arah jarum jam. Logika pemrograman yang dipakai adalah :



Gambar III. 8 : Flowchart Logika Pemrograman Pembacaan Kemiringan



Gambar III. 9 : Flowchart Logika Pemrograman Pembacaan Kemiringan

BAB IV

APLIKASI SISTEM KONTROL PADA PROTOTIPE TEST BED

IV.1 Sistem Kontrol

Prototipe *test bed* dibuat untuk mengakomodasi keseluruhan sistem kontrol yang dibuat. Parameter input dan output dipasangkan pada prototipe, sehingga prototipe ini merupakan sebuah sitem kontrol loop tertutup yang bisa mengeluarkan input dan output sendiri. Sensor-sensor sebagai perlatan untuk membaca input juga dipasang pada *test bed*. Mode-mode simulasi output juga dipasang pada *test bed* ini.

Sebagai rangkuman, parameter input yang dikontrol oleh *test bed* adalah :

1. Kecepatan kendaraan, yang akan dibaca oleh sensor kecepatan. Parameter ini dibaca oleh sensor kecepatan bebasis optokopler yang outputnya akan dibaca oleh komparator sebelum diproses oleh mikrokontroler melalui fitur *interrupt* 0.
2. RPM *engine*, yang akan dibaca oleh sensor RPM. Parameter ini digunakan sebagai representasi kondisi torsi mobil. Parameter ini dibaca oleh sensor RPM bebasis optokopler yang outputnya akan dibaca oleh komparator sebelum diproses oleh mikrokontroler melalui fitur *interrupt* 1.
3. Kemiringan kendaraan, yang dibaca oleh sensor kemiringan. Parameter ini dibaca oleh sensor sudut kemiringan bebasis *incremental rotary encoder* yang outputnya akan dibaca oleh komparator sebelum diproses oleh mikrokontroler melalui fitur *timer 1* dan *2*.

Parameter output akan ditunjukkan oleh :

1. Motor listrik siap bekerja pada saat kendaraan baru mulai hidup dan motor bakar otomatis mati saat kendaraan berhenti.
2. Motor listrik saja yang bekerja pada saat kendaraan baru mulai hidup.
3. Motor listrik bekerja pada saat berkendaraan dengan beban normal, ditandai dengan RPM rendah dan kecepatan rendah.

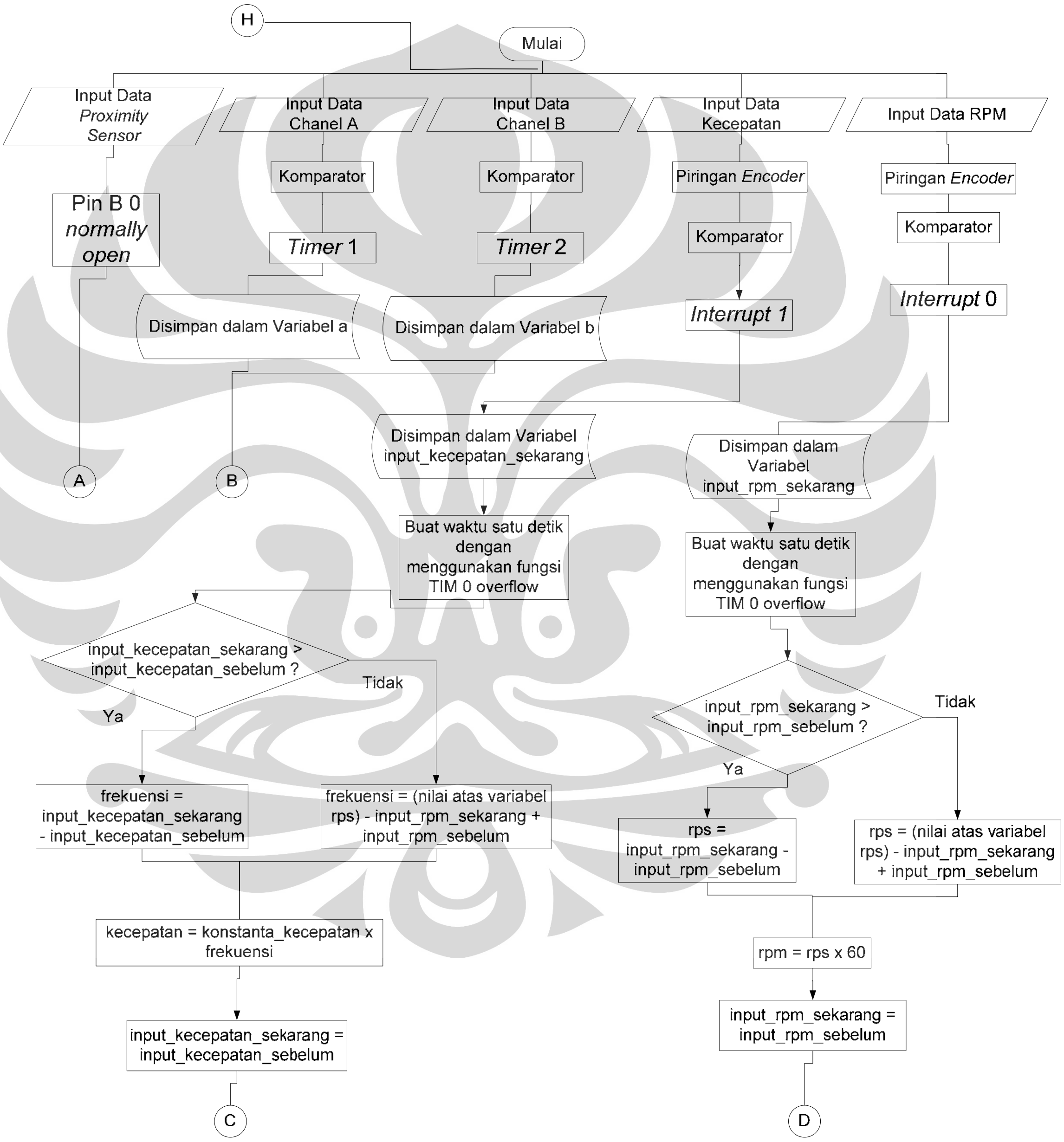
4. Motor listrik bekerja pada saat berkendaraan dengan beban tinggi, ditandai dengan RPM tinggi di atas RPM operasional 2000 RPM dan kecepatan rendah sampai 20 km/jam.
5. Motor bakar bekerja pada saat kendaraan berakselerasi, beban bertambah, atau beban bertambah karena kemiringan, ditandai dengan RPM di atas RPM operasional 2000 RPM dan kecepatan di atas 20 km/jam.
6. Motor bakar bekerja pada saat berkendaraan dengan beban normal, ditandai dengan RPM rendah di bawah 2000 RPM dan kecepatan operasional antara 20-50 km/jam.
7. Kombinasi motor bakar dan motor listrik pada saat kendaraan berakselerasi, beban bertambah, atau beban bertambah karena kemiringan, ditandai dengan RPM di atas RPM operasional 2000 RPM dan kecepatan masih kecepatan operasional antara 20-50 km/jam.
8. Kombinasi motor bakar dan motor listrik pada saat kendaraan berakselerasi, beban bertambah, atau beban bertambah karena kemiringan, ditandai dengan RPM di atas RPM operasional 2000 RPM dan kecepatan di atas kecepatan operasional 50 km/jam.
9. Motor listrik bekerja pada saat berkendaraan dengan beban rendah tetapi kecepatan tinggi, sehingga torsi yang diberikan hanya untuk mempertahankan kecepatan, ditandai dengan RPM tinggi di atas RPM operasional 2000 RPM dan kecepatan tinggi di atas 50 km/jam.
10. Pengisian baterai pada saat deselerasi, *regenerative breaking*, pengurangan beban karena kemiringan kendaraan, atau pengisian langsung dari baterai.

Parameter output ini akan disimulasikan di *test bed* dengan konfigurasi output sebagai berikut :

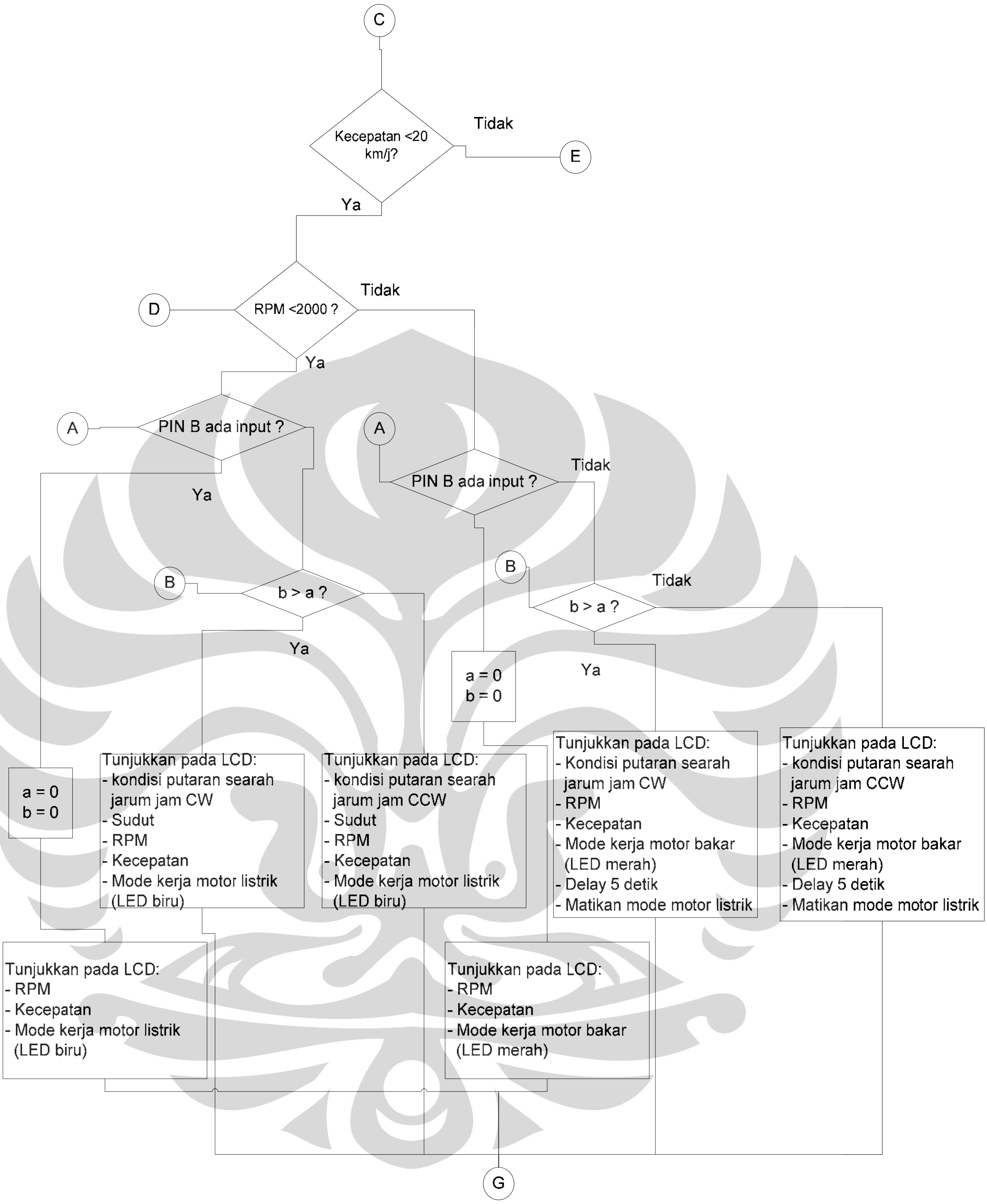
1. Motor listrik merupakan output dari port B bit ke nol, dan dihubungkan ke motor DC dan LED warna biru.
2. Motor bakar merupakan output dari port B bit ke satu, dan dihubungkan ke LED warna merah.
3. Display LCD akan menampilkan besar RPM, kecepatan, sudut, arah kemiringan, dan mode kendaraan.

IV.2 Logika Pemrograman Sistem Kontrol Prototipe *Test Bed*

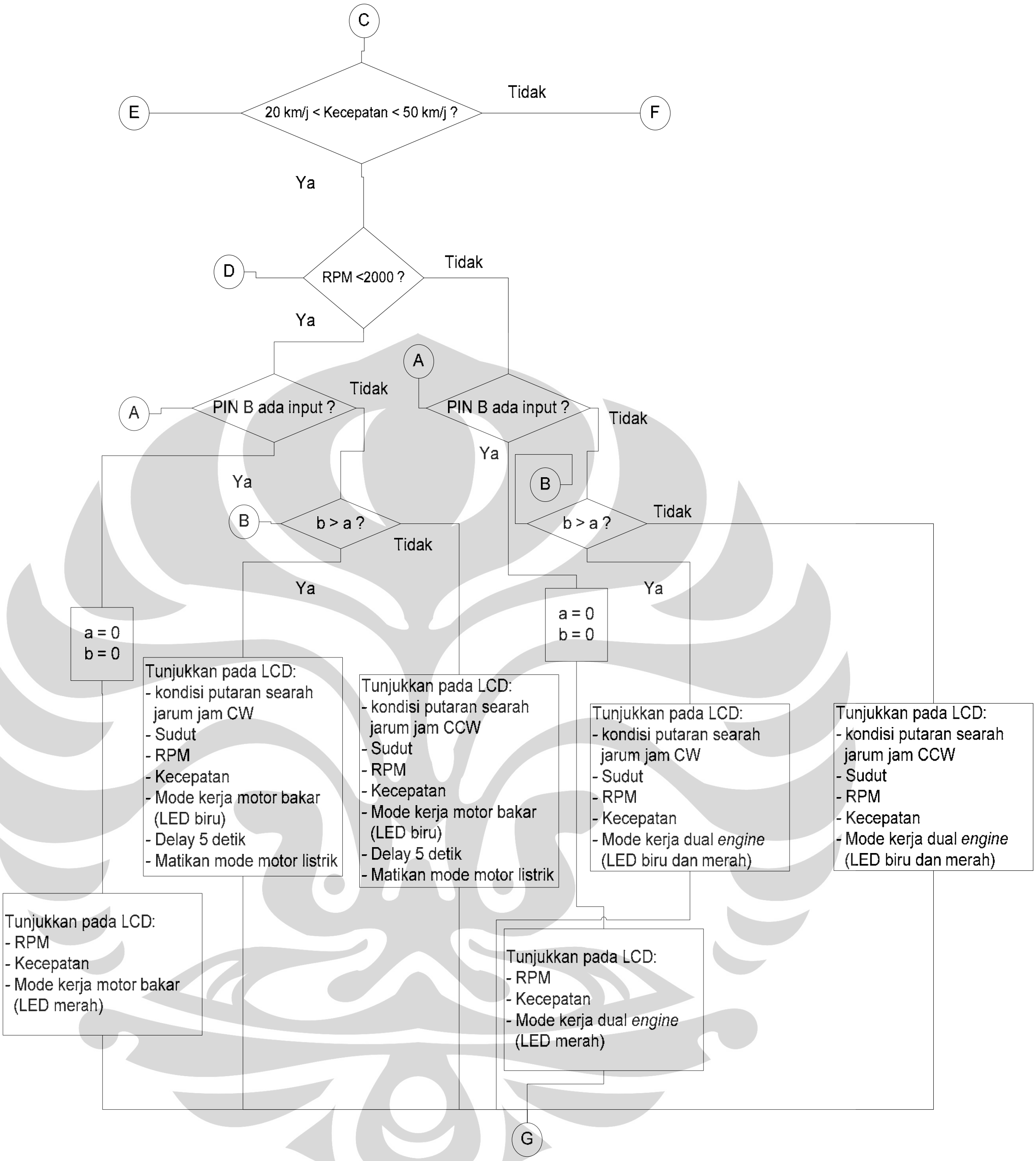
Dengan parameter-parameter yang sudah dideskripsikan pada bab-bab dan sub bab-sub bab sebelumnya, logika pemrograman keseluruhan dari sistem kontrol adalah :



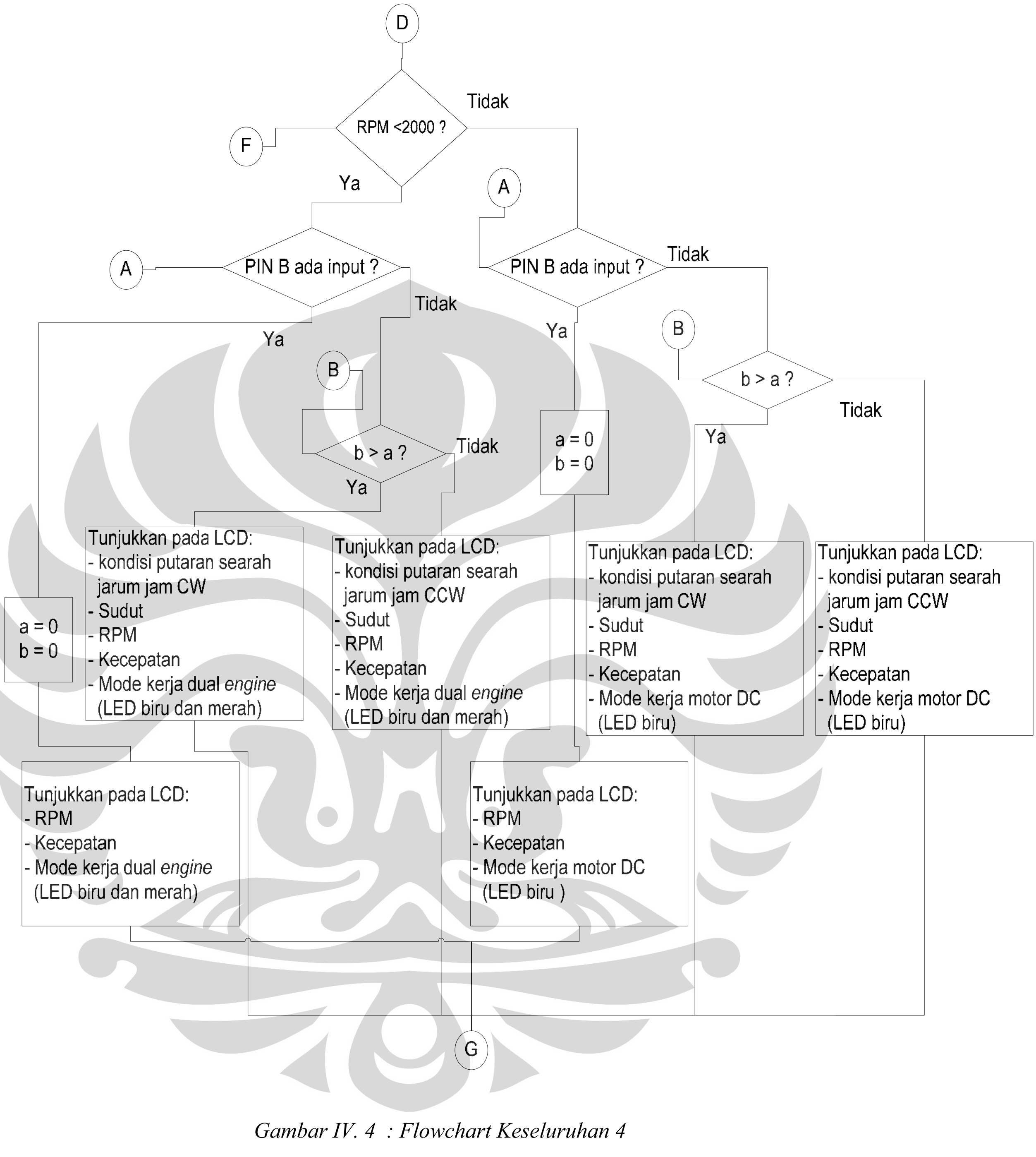
Gambar IV. 1 : Flowchart Keseluruhan 1



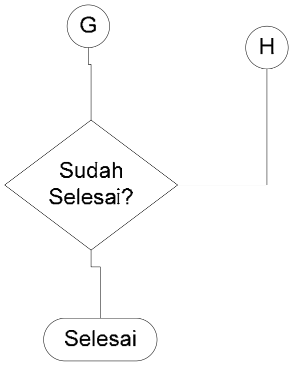
Gambar IV. 2 : Flowchart keseluruhan 2



Gambar IV. 3 : Flowchart Keseluruhan 3



Gambar IV. 4 : Flowchart Keseluruhan 4



Gambar IV. 5 : Flowchart Keseluruhan 5

BAB V

PENGUJIAN DAN ANALISA SISTEM KONTROL KENDARAAN *HYBRID*

Keseluruhan pengaturan dan logika sistem kontrol ini perlu diuji. Pengujian tersebut perlu dilakukan untuk melihat dan membuktikan bahwa *setting* dan logika yang diberikan pada sistem kontrol berjalan dengan baik. Dari pengujian ini bisa dilihat seberapa layak dan *robust* sistem kontrol yang telah dibuat. Analisa pun bisa dilakukan bila pengujian ini telah dilakukan.

Ada beberapa pengujian yang harus dilakukan. Pengujian-pengujian tersebut adalah sebagai berikut.

1. Pengujian sensor penghitungan RPM pada *small test bed.*
2. Pengujian sensor penghitungan kecepatan pada *small test bed.*
3. Pengujian sensor pengukuran sudut kemiringan pada *small test bed.*
4. Pengujian keseluruhan sistem kontrol pada *small test bed.*
5. Pengujian sensor penghitungan RPM pada *large test bed.*
6. Pengujian sensor penghitungan kecepatan pada *large test bed.*
7. Pengujian sensor pengukuran sudut kemiringan pada *large test bed.*
8. Pengujian keseluruhan sistem kontrol pada *large test bed.*

V.1 Peralatan Pengujian

1. Pengujian sensor penghitungan RPM pada *small test bed* menggunakan peralatan sebagai berikut :
    - sensor *encoder*
    - papan kontroler yang berisi mikrokontroler, comparator, port I/O, sistem minimum, *voltage regulator*, dan *power supply*
    - motor listrik sebagai representasi motor bakar yang mengeluarkan RPM
    - *small test bed* sebagai tempat untuk merangkai seluruh peralatan tersebut.
2. Pengujian sensor penghitungan kecepatan pada *small test bed* menggunakan peralatan sebagai berikut :
    - sensor *encoder*

- papan kontroler yang berisi mikrokontroler, comparator, port I/O, sistem minimum, *voltage regulator*, dan *power supply*
- motor listrik sebagai representasi roda yang berputar yang dikonversikan menjadi kecepatan
- *small test bed* sebagai tempat untuk merangkai seluruh peralatan tersebut.

Gambar V. 1 : Sensor *encoder* dan motor listrik

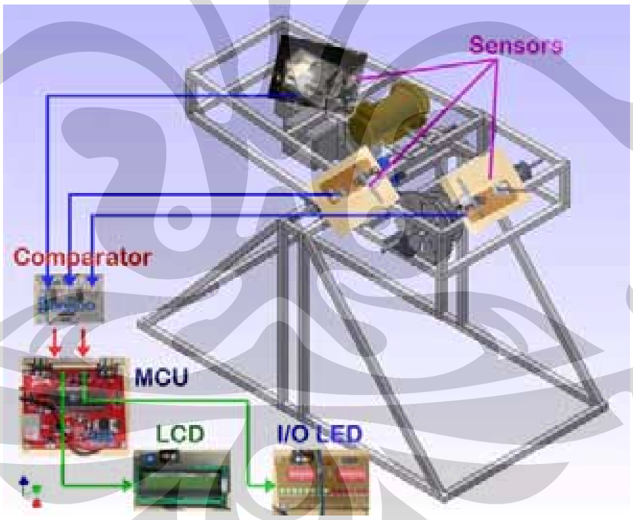
3. Pengujian sensor pengukuran sudut kemiringan pada *small test bed* menggunakan peralatan sebagai berikut :
    - sensor kemiringan
    - papan kontroler yang berisi mikrokontroler, comparator, port I/O, sistem minimum, *voltage regulator*, dan *power supply*
    - *small test bed* sebagai tempat untuk merangkai seluruh peralatan tersebut.

Gambar V. 2 : Sensor Kemiringan dan *Small Test Bed*

4. Pengujian keseluruhan sistem kontrol pada *small test bed* menggunakan peralatan sebagai berikut :
    - 2 buah sensor *encoder*
    - sensor kemiringan

- papan kontroler yang berisi mikrokontroler, comparator, port I/O, sistem minimum, *voltage regulator*, dan *power supply*
- 1 motor listrik sebagai representasi motor bakar yang mengeluarkan RPM, dan 1 motor listrik sebagai representasi roda yang berputar yang dikonversikan menjadi kecepatan
- *small test bed* sebagai tempat untuk merangkai seluruh peralatan tersebut.

5. Pengujian sensor penghitungan RPM pada *large test bed* menggunakan peralatan sebagai berikut :
    - sensor *encoder*
    - papan kontroler yang berisi mikrokontroler, comparator, port I/O, sistem minimum, *voltage regulator*, dan *power supply*
    - motor bakar yang mengeluarkan RPM
    - *large test bed* sebagai tempat untuk merangkai seluruh peralatan tersebut.

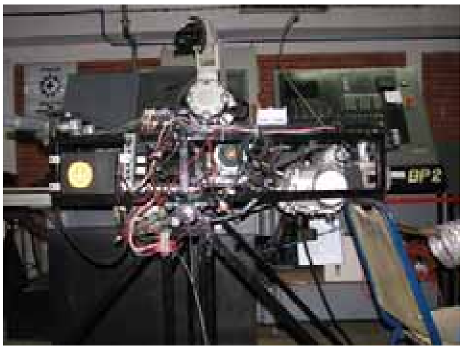


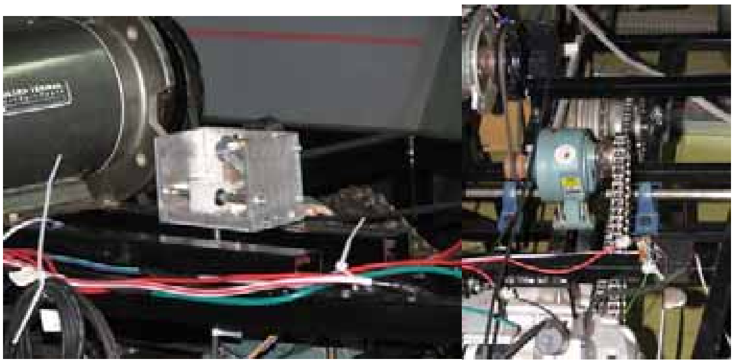
Gambar V. 3 : *Large Test Bed* dan Sistem Kontrol

6. Pengujian sensor penghitungan kecepatan pada *large test bed* menggunakan peralatan sebagai berikut :
    - sensor *encoder*, dengan piringan *encoder* langsung menggunakan roda yang menggunakan perefleksi cahaya, agar kecepatannya bisa dibaca oleh sensor

   - papan kontroler yang berisi mikrokontroler, comparator, port I/O, sistem minimum, *voltage regulator*, dan *power supply*
   - roda yang berputar yang dikonversikan menjadi kecepatan, tenaga putarannya berasal dari motor listrik, dan motor bakar yang digunakan secara bergantian
   - *large test bed* sebagai tempat untuk merangkai seluruh peralatan tersebut.

7. Pengujian sensor pengukuran sudut kemiringan pada *large test bed* menggunakan peralatan sebagai berikut :
   - sensor kemiringan
   - papan kontroler yang berisi mikrokontroler, comparator, port I/O, sistem minimum, *voltage regulator*, dan *power supply*
   - *large test bed* sebagai tempat untuk merangkai seluruh peralatan tersebut.
8. Pengujian keseluruhan sistem kontrol pada *large test bed* menggunakan peralatan sebagai berikut :
   - sensor *encoder*, untuk membaca RPM motor bakar
   - sensor *encoder*, dengan piringan *encoder* langsung menggunakan roda yang menggunakan perefleksi cahaya, agar kecepatannya bisa dibaca oleh sensor
   - sensor kemiringan
   - papan kontroler yang berisi mikrokontroler, comparator, port I/O, sistem minimum, *voltage regulator*, dan *power supply*
   - motor bakar dan motor listrik yang telah dipasang ke *large test bed*
   - *large test bed* sebagai tempat untuk merangkai seluruh peralatan tersebut.





Gambar V. 4 : Keseluruhan Rangkaian *Large Test Bed*

V.2 Metode Dan Hasil Pengujian

Pengujian dilakukan dengan cara-cara sebagai berikut.

1. Pengujian sensor penghitungan RPM pada *small test bed* dilakukan dengan cara mensimulasikan motor bakar dengan sebuah motor listrik. Alasannya adalah pada *large test bed*, RPM dibaca melalui sensor yang dipasangkan langsung ke poros motor bakar. Motor listrik dihubungkan ke suatu *voltage regulator* agar tegangan yang masuk bisa diatur besar kecilnya. Dengan demikian, putaran motor listrik dapat berubah-ubah sesuai dengan tegangan yang masuk dari *voltage regulator*.

   Poros motor listrik dihubungkan ke sebuah piringan *encoder*, dimana piringan tersebut memberikan input putaran melalui sensor *encoder*. Input tersebut diolah oleh mikrokontroler sesuai dengan logika pemrograman penghitungan RPM, dan hasilnya ditampilkan di sebuah layar LCD. Pada layar LCD ditampilkan berapa RPS-nya dan berapa RPM-nya. Nilai-nilai yang muncul di LCD merupakan RPM hasil pengukuran menggunakan mikrokontroler. Diperlukan verifikasi nilai RPM tersebut dengan suatu alat eksternal. Verifikasi dilakukan dengan cara menghitung RPM dengan sebuah *tachometer* eksternal, dengan kesalahan penghitungan maksimal 10%.

2. Pengujian sensor penghitungan kecepatan pada *small test bed* dilakukan dengan cara mensimulasikan roda kendaraan *hybrid* dengan sebuah motor listrik. Alasannya adalah pada *large test bed*, kecepatan dibaca melalui sensor yang dipasangkan langsung ke roda, yang juga berfungsi sebagai piringan *encoder*. Motor listrik dihubungkan ke suatu *voltage regulator* agar tegangan yang masuk bisa diatur besar kecilnya. Dengan demikian,

putaran motor listrik dapat berubah-ubah sesuai dengan tegangan yang masuk dari *voltage regulator*.

Poros motor listrik dihubungkan ke sebuah piringan *encoder*, dimana piringan tersebut memberikan input putaran melalui sensor *encoder*. Input tersebut diolah oleh mikrokontroler sesuai dengan logika pemrograman penghitungan kecepatan, dan hasilnya ditampilkan di sebuah layar LCD. Pada layar LCD ditampilkan berapa RPS-nya dan berapa kecepatannya. Nilai-nilai yang muncul di LCD merupakan kecepatan hasil pengukuran menggunakan mikrokontroler. Diperlukan verifikasi nilai kecepatan tersebut dengan suatu alat eksternal. Verifikasi dilakukan dengan cara menghitung RPM motor listrik tersebut dengan sebuah *tachometer* eksternal. Kemudian RPM tersebut dikalikan dengan suatu konstanta yang mengubah dari besaran RPM ke besaran kecepatan. Kesalahan penghitungan maksimal 10%.

Gambar V. 5 : *Display* LCD

3. Pengujian sensor pengukuran sudut kemiringan pada *small test bed* dilakukan dengan menggerakkan massa pembaca kemiringan. *Increment rotary encoder* yang dipasang pada sensor kemiringan memberikan input kepada mikrokontroler. Input tersebut diolah, dan ditampilan hasilnya pada LCD. Pada LCD akan terlihat berapa besar kemiringan *test bed*, dan apakah putarannya searah atau berlawanan arah jarum jam. Verifikasi kemiringan tidak dilakukan.
4. Pengujian keseluruhan sistem kontrol pada *small test bed* dilakukan dengan cara memasang keseluruhan sensor, motor listrik, dan sistem kontrol pada *small* test bed. Logika pemrograman keseluruhan sistem kontrol juga dimasukkan ke dalam mikrokontroler. Sehingga bila diubah-ubah parameter inputnya, parameter outputnya akan berubah pula. Perubahan parameter I/O tersebut adalah sebagai berikut.

    1. *Start-off*, dengan menggunakan parameter kecepatan (km/j) antara 0-10 km/j, tanpa putaran motor bakar (RPM = 0).
    2. *Normal driving*, dengan menggunakan parameter kecepatan (km/j) antara 10-50 km/j, RPM motor bakar kurang dari 800 RPM.
    3. *Normal driving*, dengan menggunakan parameter kecepatan (km/j) antara 10-50 km/j, RPM motor bakar berada pada kisaran RPM torsional 800-1500 RPM.
    4. *Cruising*, dengan parameter kecepatan (km/j) > 50 km/j, pada kondisi RPM motor bakar berapapun.
    5. *Decelaration*, dengan menggunakan parameter pengereman, serta pengurangan kecepatan kendaraan.

   Mode kerja, besaran RPM, dan besaran kecepatan ditampilkan pada display LCD. Selain itu digunakan pula LED warna merah untuk merepresentasikan motor bakar yang sedang bekerja, dan LED warna biru untuk merepresentasikan motor listrik yang sedang bekerja. Bila mode dual *engine* yang bekerja, kedua LED akan menyala.

5. Pengujian sensor penghitungan RPM pada *large test bed* dilakukan secara langsung dengan cara memasang sensor seporos dengan poros motor bakar. RPM dibaca melalui sensor tersebut. Motor bakar tersebut dinaik-turunkan RPM-nya. Input tersebut diolah oleh mikrokontroler sesuai dengan logika pemrograman penghitungan RPM, dan hasilnya ditampilkan di sebuah layar LCD. Pada layar LCD ditampilkan berapa RPS-nya dan berapa RPM-nya. Nilai-nilai yang muncul di LCD merupakan RPM hasil pengukuran menggunakan mikrokontroler. Diperlukan verifikasi nilai RPM tersebut dengan suatu alat eksternal. Verifikasi dilakukan dengan cara menghitung RPM dengan sebuah *tachometer* eksternal, dengan kesalahan penghitungan maksimal 10%.
6. Pengujian sensor penghitungan kecepatan pada *large test bed* dilakukan secara langsung dengan cara memasang sensor seporos dengan poros roda *large test bed*. Kecepatan dibaca melalui sensor yang dipasangkan langsung ke roda, yang juga berfungsi sebagai piringan *encoder*. Piringan tersebut memberikan input putaran melalui sensor *encoder*. Input tersebut

diolah oleh mikrokontroler sesuai dengan logika pemrograman penghitungan kecepatan, dan hasilnya ditampilkan di sebuah layar LCD. Pada layar LCD ditampilkan berapa RPS-nya dan berapa kecepatannya. Nilai-nilai yang muncul di LCD merupakan kecepatan hasil pengukuran menggunakan mikrokontroler. Diperlukan verifikasi nilai kecepatan tersebut dengan suatu alat eksternal. Verifikasi dilakukan dengan cara menghitung RPM motor listrik tersebut dengan sebuah *tachometer* eksternal. Kemudian RPM tersebut dikalikan dengan suatu konstanta yang mengubah dari besaran RPM ke besaran kecepatan. Kesalahan penghitungan maksimal 10%.

7. Pengujian sensor pengukuran sudut kemiringan pada *large test bed* dilakukan dengan menggerakkan massa pembaca kemiringan. *Increment rotary encoder* yang dipasang pada sensor kemiringan memberikan input kepada mikrokontroler. Input tersebut diolah, dan ditampilan hasilnya pada LCD. Pada LCD akan terlihat berapa besar kemiringan *test bed*, dan apakah putarannya searah atau berlawanan arah jarum jam. Verifikasi kemiringan tidak dilakukan.
8. Pengujian keseluruhan sistem kontrol pada *large test bed* dilakukan dengan cara memasang keseluruhan sensor, motor listrik, dan sistem kontrol pada *large test bed*. Logika pemrograman keseluruhan sistem kontrol juga dimasukkan ke dalam mikrokontroler. Sehingga bila diubah-ubah parameter inputnya, parameter outputnya akan berubah pula. Perubahan parameter I/O tersebut adalah sebagai berikut.
    1. *Start-off*, dengan menggunakan parameter kecepatan (km/j) antara 0-10 km/j, tanpa putaran motor bakar (RPM = 0).
    2. *Normal driving*, dengan menggunakan parameter kecepatan (km/j) antara 10-50 km/j, RPM motor bakar kurang dari 800 RPM.
    3. *Normal driving*, dengan menggunakan parameter kecepatan (km/j) antara 10-50 km/j, RPM motor bakar berada pada kisaran RPM torsional 800-1500 RPM.
    4. *Cruising*, dengan parameter kecepatan (km/j) > 50 km/j, pada kondisi RPM motor bakar berapapun.

5. *Decelaration*, dengan menggunakan parameter pengereman, serta pengurangan kecepatan kendaraan.

Mode kerja, besaran RPM, dan besaran kecepatan ditampilkan pada display LCD. Pada pengujian menggunakan *large test bed* kondisi-kondisi yang mendekati kendaraan *hybrid* komersial suda diterapkan. *Large test bed* bisa dimiringkan naik turun yang mensimulasikan kendaraan sedang menanjak dan menurun. Motor bakar sudah bisa otomatis hidup dan mati dengan menggunaan mekanisme relay dan *electric starter*, bila parameter-parameter kondisinya tercapai. Motor listrik juga sudah bisa otomatis hidup dan mati dengan menggunaan mekanisme relay dan *electric starter*, bila parameter-parameter kondisinya tercapai.

V.3 Analisa Hasil Pengujian

1. Pengujian sensor penghitungan RPM. Sensor RPM bisa membaca RPM baik pada *small test bed*, maupun *large test bed*. Tingkat kesalahan maksimal 10 %. Hal ini membuktikan bahwa logika pemrograman dan rangaian *hardware* sistem kontrol bekerja secara baik. Bagaimanapun juga, ada beberapa kekurangan dalam penghitungan RPM ini. Yang pertama, input yang diambil adalah input selama satu detik. Perlu dikembangkan pembacaan input yang lebih *real time* dengan tempo pangambilan data input lebih kecil dari 1 detik. Yang kedua, Tampilan LCD juga berubah-ubah sesuai input data. Perubahan ini tidak disertai dengan pembersihan kembali karakter-karakter pada LCD. Hal ini bisa mengakibatkan kerancuan dalam pembacaan RPM di LCD, karena masih ada karakter yang tidak ter-*refresh*. Yang ketiga, khusus pada *large test bed*, getaran yang dihasilkan oleh motor bakar memberikan umpan balik ke sensor, sehingga mangganggu pembacaan RPM dari sensor. Hal ini bisa diminimalkan dengan menguatkan dudukan sensor ke *test bed*. Tetapi perlu digunakan sensor yang lebih *robust* dalam pengambilan data dan ketahanan terhadap umpan balik yang tinggi.
2. Pengujian sensor penghitungan kecepatan. Sensor kecepatan bisa membaca kecepatan baik pada *small test bed*, maupun *large test bed*. Tingkat kesalahan maksimal 10 %. Hal ini membuktikan bahwa logika

pemrograman dan rangaian *hardware* sistem kontrol bekerja secara baik. Bagaimanapun juga, ada beberapa kekurangan dalam penghitungan kecepatan ini. Yang pertama, input yang diambil adalah input selama satu detik. Perlu dikembangkan pembacaan input yang lebih *real time* dengan tempo pangambilan data input lebih kecil dari 1 detik. Yang kedua, Tampilan LCD juga berubah-ubah sesuai input data. Perubahan ini tidak disertai dengan pembersihan kembali karakter-karakter pada LCD. Hal ini bisa mengakibatkan kerancuan dalam pembacaan kecepatan di LCD, karena masih ada karakter yang tidak ter-*refresh*. Yang ketiga, khusus pada *large test bed*, material perefleksi cahaya yang ditempelkan pada roda *large test bed* kurang baik. Sehingga ada saatnya input tidak terbaca oleh sensor dan terlewat sehingga pembacaan kecepatan bisa salah. Hal ini bisa dihilangkan dengan menggunakan material yang daya pantulnya tinggi dan dengan luas penampang yang besar. Atau digunakan mekanisme sensor yang lebih *robust* dalam pengambilan data dan ketahanan terhadap umpan balik yang tinggi.

3. Pengujian sensor pengukuran sudut kemiringan. Sensor pengukuran sudut kemiringan membaca sudut baik pada *small test bed*, maupun *large test bed*. Hal ini membuktikan bahwa logika pemrograman dan rangaian *hardware* sistem kontrol bekerja secara baik. Bagaimanapun juga, ada beberapa kekurangan dalam pengukuran sudut ini. Yang pertama, logika yang digunakan untuk menentukan apakah putaran searah atau berlawanan arah jarum jam masih rumit dan tidak *robust*. Perlu dikembangkan logika yang lebih sederhana dan *robust* dalam membaca kemiringan dan arah putarannya, atau digunakan tipe sensor lain yang langsung bisa membaca arah perputaran sekaligus besar kemiringannya, contohnya *absolute encoder*. Yang kedua, Tampilan LCD juga berubah-ubah sesuai input data. Perubahan ini tidak disertai dengan pembersihan kembali karakter-karakter pada LCD. Hal ini bisa mengakibatkan kerancuan dalam pembacaan kemiringan di LCD, karena masih ada karakter yang tidak ter-*refresh*. Yang ketiga, khusus pada *large test bed*, getaran yang dihasilkan oleh motor bakar memberikan umpan balik ke sensor, sehingga mangganggu

pembacaan kemiringan dari sensor. Hal ini bisa diminimalkan dengan menguatkan dudukan sensor ke *test bed*. Tetapi perlu digunakan sensor yang lebih *robust* dalam mekanisme pembacaan inputnya, dalam pengambilan datanya, serta ketahanan terhadap umpan baliknya yang harus tinggi.

4. Pengujian keseluruhan sistem kontrol secara keseluruhan. Sensor, logika pemrograman keseluruhan, dan sistem kontrol diujikan secara keseluruhan dengan parameter I/O yang sudah ditetapkan. Paremeter I/O tersebut adalah sebagai berikut.
    1. *Start-off*, dengan menggunakan parameter kecepatan (km/j) antara 0-10 km/j, tanpa putaran motor bakar (RPM = 0).
    2. *Normal driving*, dengan menggunakan parameter kecepatan (km/j) antara 10-50 km/j, RPM motor bakar kurang dari 800 RPM.
    3. *Normal driving*, dengan menggunakan parameter kecepatan (km/j) antara 10-50 km/j, RPM motor bakar berada pada kisaran RPM torsional 800-1500 RPM.
    4. *Cruising*, dengan parameter kecepatan (km/j) > 50 km/j, pada kondisi RPM motor bakar berapapun.
    5. *Decelaration*, dengan menggunakan parameter pengereman, serta pengurangan kecepatan kendaraan.

    Secara umum, sistem kontrol sudah bekerja dengan baik. Logika pemrograman sudah mencakup *driveability*, dan mekanisme pergantian *engine* pada *large test bed*. Kekurangan-kekurangan yang muncul sama seperti kekurangan yang muncul pada saat pembacaan sensor-sensor.

BAB VI

KESIMPULAN DAN SARAN PENELITIAN SELANJUTNYA

V.1 Kesimpulan

Dari penelitian ini dapat diambil kesimpulan sebagai berikut :

1. Parameter-parameter input dan output mobil *hybrid* asli bisa diidentifikasi, dan dilakukan adaptasi dari parameter-parameter tersebut untuk dijadikan parameter input dan output dari prototype *test bed* sistem kontrol mobil *hybrid*. Adaptasi parameter-parameter tersebut hanya merupakan adaptasi awal, agar parameter tersebut bisa diaplikasikan pada riset mobil *hybrid* yang telah dilakukan sebelumnya di departemen teknik mesin FTUI.
2. Serangkaian sensor bisa dirancang untuk mendeteksi parameter-parameter input *test bed* tersebut, sehingga sinyal input yang dideteksi sensor tersebut bisa diproses untuk mengeluarkan kondisi-kondisi output tertentu, dimana kondisi output tersebut ditampilkan atau disimulasikan dengan peralatan output yang juga merupakan hasil perancangan.
3. Keseluruhan parameter input dan output *test bed*, sensor, dan simulasi output bisa diintegrasikan ke dalam sebuah sistem kontrol yang berbasis mikrokontroler ATMEGA 8535, dengan memberikan logika kecerdasan buatan ke mikrokontroler tersebut.
4. Prototipe *test bed* dapat dibangun untuk mangakomodasi keseluruhan sistem kontrol, sensor, dan simulasi output, sehingga simulasi mobil *hybrid* secara fisik, dan visual dapat disaksikan, dan dianalisa untuk penelitian lebih lanjut.

V.2 Saran Penelitian Selanjutnya

Beberapa rekomendasi saran yang perlu diperhatikan dalam pengembangan modul prototipe *test bed* sistem kontrol pada penelitian selanjutnya, yaitu :

1. Perlu dilakukan analisa yang lebih mendalam mengenai parameter input dan output dari mobil *hybrid* asli, yang bisa dijadikan dasar yang lebih kuat untuk memilih parameter input dan output apa yang digunakan dalam pengembangan sistem kontrol selanjutnya, sehingga parameter-parameter yang digunakan lebih menggambarkan dan mendekati kondisi mobil *hybrid* yang sesungguhnya.
2. Salah satu parameter input yang sangat penting untuk dideteksi adalah parameter torsi, sehingga perlu dikembangkan mekanisme sensor yang dapat mendeteksi torsi tersebut, atau dikembangkan suatu logika kecerdasan buatan baru yang dapat mendeteksi torsi yang lebih akurat, dengan sensor yang sudah ada.

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Features

- **High-performance, Low-power AVR® 8-bit Microcontroller**
- **Advanced RISC Architecture**
  - **130 Powerful Instructions – Most Single Clock Cycle Execution**
  - **32 x 8 General Purpose Working Registers**
  - **Fully Static Operation**
  - **Up to 16 MIPS Throughput at 16 MHz**
  - **On-chip 2-cycle Multiplier**
- **Nonvolatile Program and Data Memories**
  - **8K Bytes of In-System Self-Programmable Flash**
    Endurance: 10,000 Write/Erase Cycles
  - **Optional Boot Code Section with Independent Lock Bits**
    In-System Programming by On-chip Boot Program
    True Read-While-Write Operation
  - **512 Bytes EEPROM**
    Endurance: 100,000 Write/Erase Cycles
  - **512 Bytes Internal SRAM**
  - **Programming Lock for Software Security**
- **Peripheral Features**
  - **Two 8-bit Timer/Counters with Separate Prescalers and Compare Modes**
  - **One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode**
  - **Real Time Counter with Separate Oscillator**
  - **Four PWM Channels**
  - **8-channel, 10-bit ADC**
    8 Single-ended Channels
    7 Differential Channels for TQFP Package Only
    2 Differential Channels with Programmable Gain at 1x, 10x, or 200x for TQFP Package Only
  - **Byte-oriented Two-wire Serial Interface**
  - **Programmable Serial USART**
  - **Master/Slave SPI Serial Interface**
  - **Programmable Watchdog Timer with Separate On-chip Oscillator**
  - **On-chip Analog Comparator**
- **Special Microcontroller Features**
  - **Power-on Reset and Programmable Brown-out Detection**
  - **Internal Calibrated RC Oscillator**
  - **External and Internal Interrupt Sources**
  - **Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby and Extended Standby**
- **I/O and Packages**
  - **32 Programmable I/O Lines**
  - **40-pin PDIP, 44-lead TQFP, 44-lead PLCC, and 44-pad MLF**
- **Operating Voltages**
  - **2.7 - 5.5V for ATmega8535L**
  - **4.5 - 5.5V for ATmega8535**
- **Speed Grades**
  - **0 - 8 MHz for ATmega8535L**
  - **0 - 16 MHz for ATmega8535**

8-bit AVR® Microcontroller with 8K Bytes In-System Programmable Flash

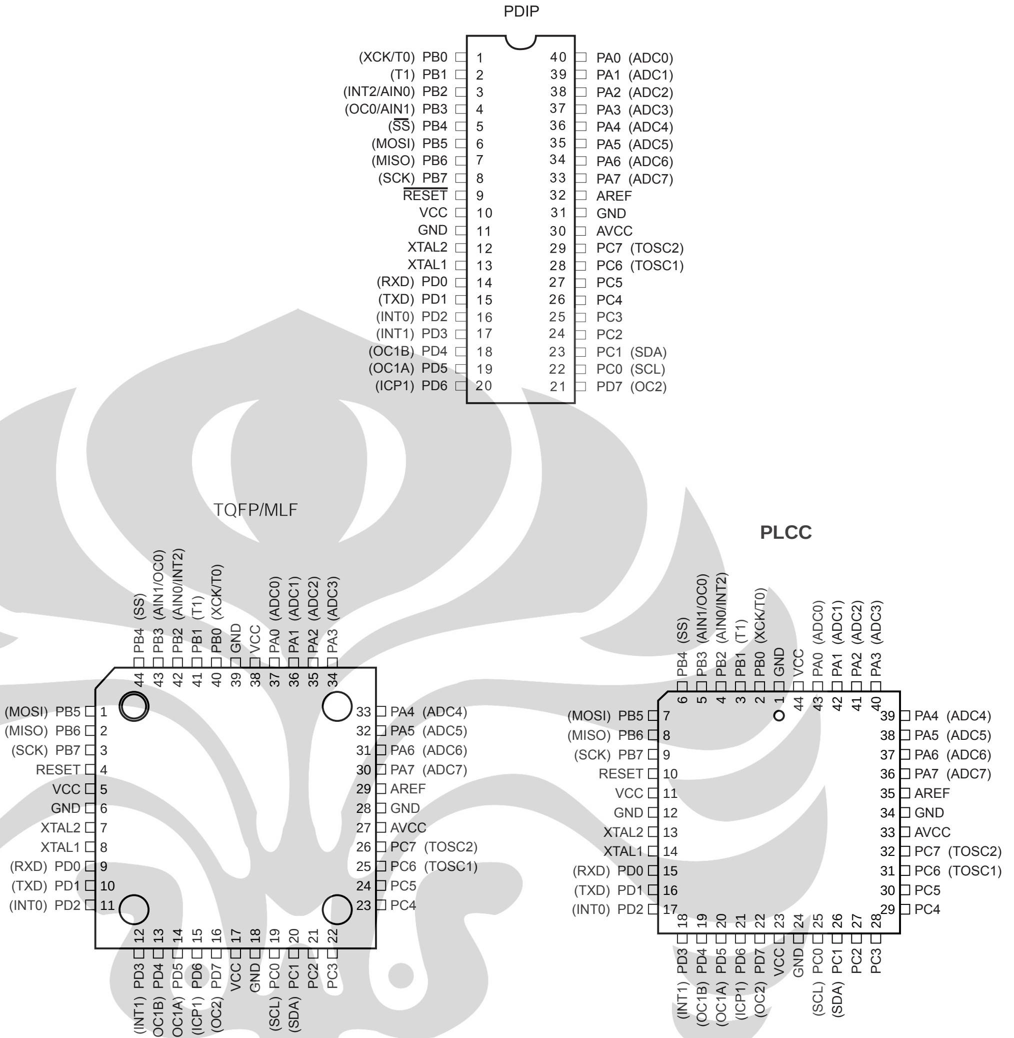
ATmega8535
ATmega8535L

Advance Information

Rev. 2502C–AVR–04/03

Pin Configurations

Figure 1. Pinout ATmega8535



Disclaimer

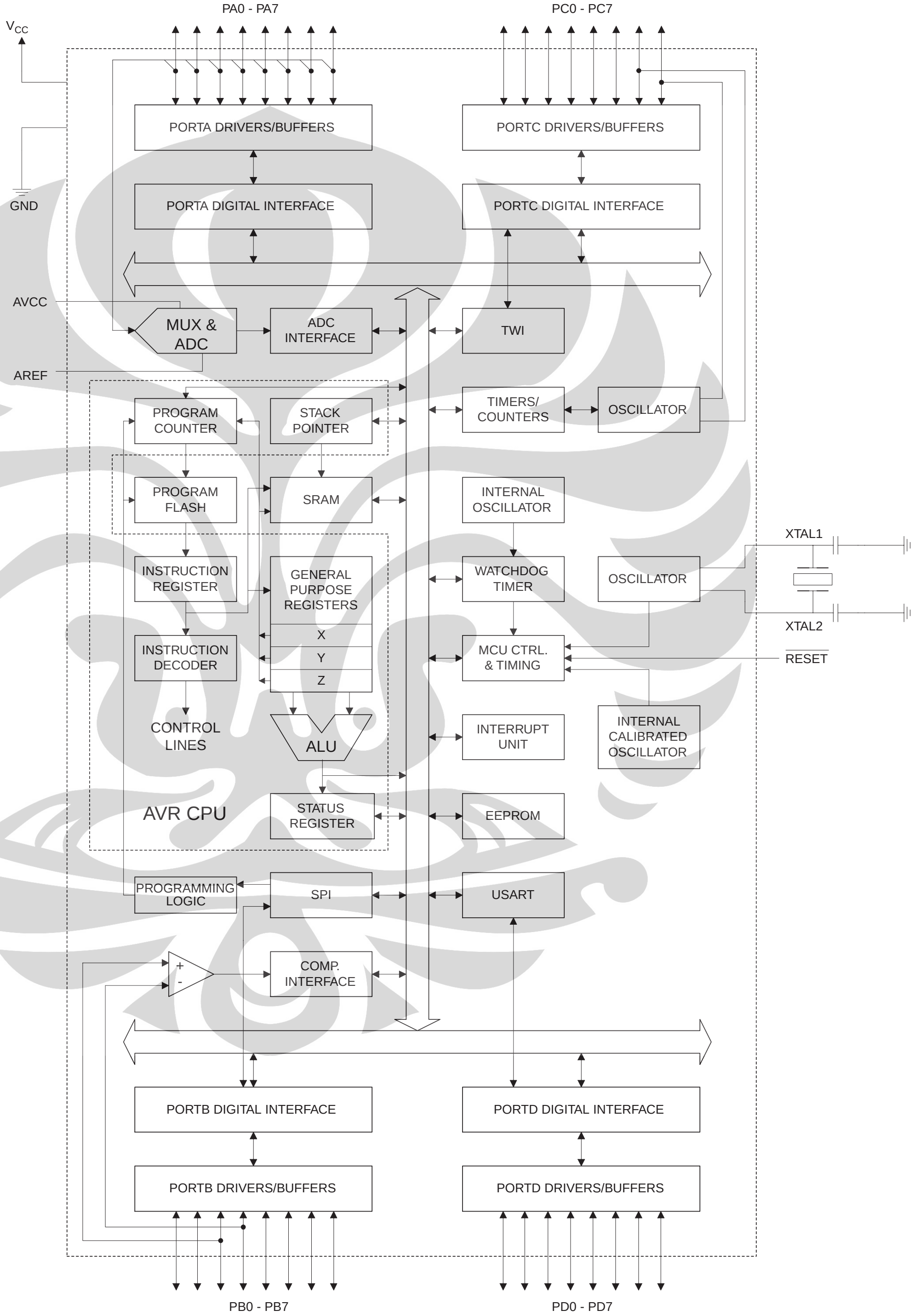
Typical values contained in this data sheet are based on simulations and characterization of other AVR microcontrollers manufactured on the same process technology. Min and Max values will be available after the device is characterized.

Overview

The ATmega8535 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing instructions in a single clock cycle, the ATmega8535 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

Block Diagram

Figure 2. Block Diagram



The AVR core combines a rich instruction set with 32 general purpose working registers. All 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

The ATmega8535 provides the following features: 8K bytes of In-System Programmable Flash with Read-While-Write capabilities, 512 bytes EEPROM, 512 bytes SRAM, 32 general purpose I/O lines, 32 general purpose working registers, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, a byte oriented Two-wire Serial Interface, an 8-channel, 10-bit ADC with optional differential input stage with programmable gain in TQFP package, a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and six software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next interrupt or Hardware Reset. In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption. In Extended Standby mode, both the main Oscillator and the asynchronous timer continue to run.

The device is manufactured using Atmel’s high density nonvolatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, by a conventional nonvolatile memory programmer, or by an On-chip Boot program running on the AVR core. The boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true Read-While-Write operation. By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel ATmega8535 is a powerful microcontroller that provides a highly flexible and cost effective solution to many embedded control applications.

The ATmega8535 AVR is supported with a full suite of program and system development tools including: C compilers, macro assemblers, program debugger/simulators, In-Circuit Emulators, and evaluation kits.

AT90S8535 Compatibility

The ATmega8535 provides all the features of the AT90S8535. In addition, several new features are added. The ATmega8535 is backward compatible with AT90S8535 in most cases. However, some incompatibilities between the two microcontrollers exist. To solve this problem, an AT90S8535 compatibility mode can be selected by programming the S8535C fuse. ATmega8535 is pin compatible with AT90S8535, and can replace the AT90S8535 on current Printed Circuit Boards. However, the location of fuse bits and the electrical characteristics differs between the two devices.

AT90S8535 Compatibility Mode

Programming the S8535C fuse will change the following functionality:

- The timed sequence for changing the Watchdog Time-out period is disabled. See “Timed Sequences for Changing the Configuration of the Watchdog Timer” on page 43 for details.
- The double buffering of the USART Receive Register is disabled. See “AVR USART vs. AVR UART – Compatibility” on page 142 for details.

Pin Descriptions

V_{CC}	Digital supply voltage.
GND	Ground.
Port A (PA7..PA0)	Port A serves as the analog inputs to the A/D Converter. Port A also serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used. Port pins can provide internal pull-up resistors (selected for each bit). The Port A output buffers have symmetrical drive characteristics with both high sink and source capability. When pins PA0 to PA7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.
Port B (PB7..PB0)	Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running. Port B also serves the functions of various special features of the ATmega8535 as listed on page 57.
Port C (PC7..PC0)	Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.
Port D (PD7..PD0)	Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running. Port D also serves the functions of various special features of the ATmega8535 as listed on page 61.
$\overline{\text{RESET}}$	Reset input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running. The minimum pulse length is given in Table 15 on page 35. Shorter pulses are not guaranteed to generate a reset.
XTAL1	Input to the inverting Oscillator amplifier and input to the internal clock operating circuit.
XTAL2	Output from the inverting Oscillator amplifier.
AVCC	AVCC is the supply voltage pin for Port A and the A/D Converter. It should be externally connected to V_{CC}, even if the ADC is not used. If the ADC is used, it should be connected to V_{CC} through a low-pass filter.
AREF	AREF is the analog reference pin for the A/D Converter.

About Code Examples

This documentation contains simple code examples that briefly show how to use various parts of the device. These code examples assume that the part specific header file is included before compilation. Be aware that not all C compiler vendors include bit definitions in the header files and interrupt handling in C is compiler dependent. Please confirm with the C Compiler documentation for more details.

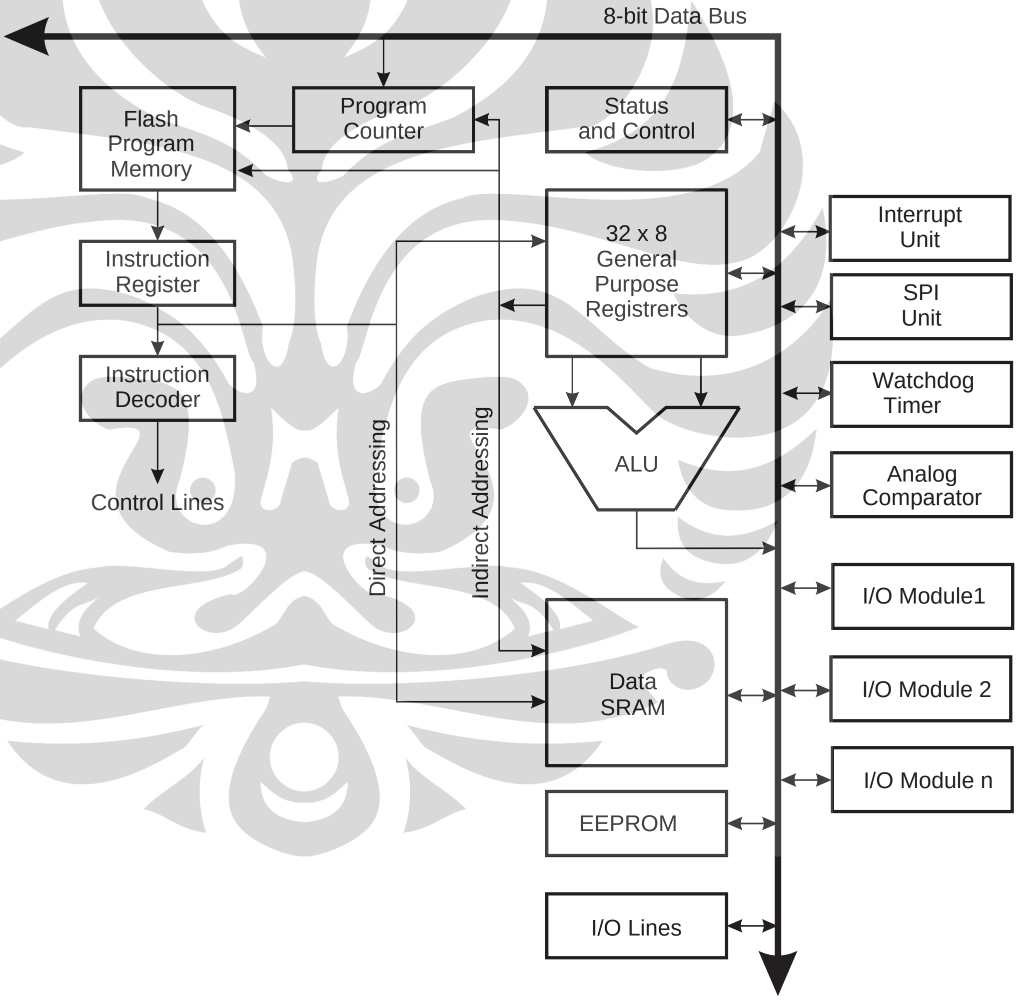
AVR CPU Core

Introduction

This section discusses the AVR core architecture in general. The main function of the CPU core is to ensure correct program execution. The CPU must therefore be able to access memories, perform calculations, control peripherals, and handle interrupts.

Architectural Overview

Figure 3. Block Diagram of the AVR MCU Architecture



In order to maximize performance and parallelism, the AVR uses a Harvard architecture – with separate memories and buses for program and data. Instructions in the program memory are executed with a single level pipelining. While one instruction is being executed, the next instruction is pre-fetched from the program memory. This concept enables instructions to be executed in every clock cycle. The program memory is In-System Re-Programmable Flash memory.

The fast-access Register File contains 32 x 8-bit general purpose working registers with a single clock cycle access time. This allows single-cycle Arithmetic Logic Unit (ALU) operation. In a typical ALU operation, two operands are output from the Register File, the operation is executed, and the result is stored back in the Register File – in one clock cycle.

Six of the 32 registers can be used as three 16-bit indirect address register pointers for Data Space addressing – enabling efficient address calculations. One of the these address pointers can also be used as an address pointer for look up tables in Flash program memory. These added function registers are the 16-bit X-, Y-, and Z-registers, described later in this section.

The ALU supports arithmetic and logic operations between registers or between a constant and a register. Single register operations can also be executed in the ALU. After an arithmetic operation, the Status Register is updated to reflect information about the result of the operation.

Program flow is provided by conditional and unconditional jump and call instructions, able to directly address the whole address space. Most AVR instructions have a single 16-bit word format. Every program memory address contains a 16- or 32-bit instruction.

Program Flash memory space is divided in two sections, the Boot Program section and the Application Program section. Both sections have dedicated Lock bits for write and read/write protection. The SPM instruction that writes into the Application Flash memory section must reside in the Boot Program section.

During interrupts and subroutine calls, the return address Program Counter (PC) is stored on the Stack. The Stack is effectively allocated in the general data SRAM, and consequently the Stack size is only limited by the total SRAM size and the usage of the SRAM. All user programs must initialize the SP in the reset routine (before subroutines or interrupts are executed). The Stack Pointer SP is read/write accessible in the I/O space. The data SRAM can easily be accessed through the five different addressing modes supported in the AVR architecture.

The memory spaces in the AVR architecture are all linear and regular memory maps.

A flexible interrupt module has its control registers in the I/O space with an additional Global Interrupt Enable bit in the Status Register. All interrupts have a separate Interrupt Vector in the Interrupt Vector table. The interrupts have priority in accordance with their Interrupt Vector position. The lower the Interrupt Vector address, the higher the priority.

The I/O memory space contains 64 addresses for CPU peripheral functions as Control Registers, SPI, and other I/O functions. The I/O Memory can be accessed directly, or as the Data Space locations following those of the Register File, 0x20 - 0x5F.

ALU – Arithmetic Logic Unit

The high-performance AVR ALU operates in direct connection with all the 32 general purpose working registers. Within a single clock cycle, arithmetic operations between general purpose registers or between a register and an immediate are executed. The ALU operations are divided into three main categories – arithmetic, logical, and bit-functions. Some implementations of the architecture also provide a powerful multiplier supporting both signed/unsigned multiplication and fractional format. See the “Instruction Set” section for a detailed description.

Status Register

The Status Register contains information about the result of the most recently executed arithmetic instruction. This information can be used for altering program flow in order to perform conditional operations. Note that the Status Register is updated after all ALU operations, as specified in the Instruction Set Reference. This will, in many cases, remove the need for using the dedicated compare instructions, resulting in faster and more compact code.

The Status Register is not automatically stored when entering an interrupt routine and restored when returning from an interrupt. This must be handled by software.

The AVR Status Register – SREG – is defined as:

Bit	7	6	5	4	3	2	1	0	
	I	**T**	**H**	**S**	**V**	**N**	**Z**	**C**	**SREG**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 7 – I: Global Interrupt Enable**

The Global Interrupt Enable bit must be set for the interrupts to be enabled. The individual interrupt enable control is then performed in separate control registers. If the Global Interrupt Enable Register is cleared, none of the interrupts are enabled independent of the individual interrupt enable settings. The I-bit is cleared by hardware after an interrupt has occurred, and is set by the RETI instruction to enable subsequent interrupts. The I-bit can also be set and cleared by the application with the SEI and CLI instructions, as described in the instruction set reference.

- **Bit 6 – T: Bit Copy Storage**

The Bit Copy instructions BLD (Bit LoaD) and BST (Bit STore) use the T-bit as source or destination for the operated bit. A bit from a register in the Register file can be copied into T by the BST instruction, and a bit in T can be copied into a bit in a register in the Register File by the BLD instruction.

- **Bit 5 – H: Half Carry Flag**

The Half Carry Flag H indicates a Half Carry in some arithmetic operations. Half carry is useful in BCD arithmetic. See the “Instruction Set Description” for detailed information.

- **Bit 4 – S: Sign Bit, $S = N \oplus V$**

The S-bit is always an exclusive or between the Negative Flag N and the Two’s Complement Overflow Flag V. See the “Instruction Set Description” for detailed information.

- **Bit 3 – V: Two’s Complement Overflow Flag**

The Two’s Complement Overflow Flag V supports two’s complement arithmetics. See the “Instruction Set Description” for detailed information.

- **Bit 2 – N: Negative Flag**

The Negative Flag N indicates a negative result in an arithmetic or logic operation. See the “Instruction Set Description” for detailed information.

- **Bit 1 – Z: Zero Flag**

The Zero Flag Z indicates a zero result in an arithmetic or logic operation. See the “Instruction Set Description” for detailed information.

- **Bit 0 – C: Carry Flag**

The Carry Flag C indicates a carry in an arithmetic or logic operation. See the “Instruction Set Description” for detailed information.

General Purpose Register File

The Register File is optimized for the AVR Enhanced RISC instruction set. In order to achieve the required performance and flexibility, the following input/output schemes are supported by the Register File:

- One 8-bit output operand and one 8-bit result input
- Two 8-bit output operands and one 8-bit result input
- Two 8-bit output operands and one 16-bit result input
- One 16-bit output operand and one 16-bit result input

Figure 4 shows the structure of the 32 general purpose working registers in the CPU.

Figure 4. AVR CPU General Purpose Working Registers

	7 0	Addr.	
	R0	0x00	
	R1	0x01	
	R2	0x02	
	…		
	R13	0x0D	
General Purpose Working Registers	R14	0x0E	
	R15	0x0F	
	R16	0x10	
	R17	0x11	
	…		
	R26	0x1A	X-register Low Byte
	R27	0x1B	X-register High Byte
	R28	0x1C	Y-register Low Byte
	R29	0x1D	Y-register High Byte
	R30	0x1E	Z-register Low Byte
	R31	0x1F	Z-register High Byte

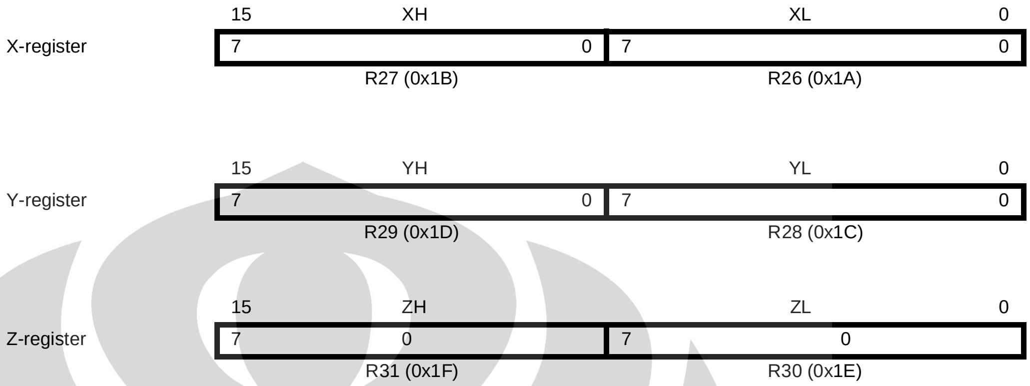
Most of the instructions operating on the Register File have direct access to all registers, and most of them are single cycle instructions.

As shown in Figure 4, each register is also assigned a data memory address, mapping them directly into the first 32 locations of the user Data Space. Although not being physically implemented as SRAM locations, this memory organization provides great flexibility in access of the registers, as the X-, Y-, and Z-pointer Registers can be set to index any register in the file.

The X-register, Y-register, and Z-register

The registers R26..R31 have some added functions to their general purpose usage. These registers are 16-bit address pointers for indirect addressing of the Data Space. The three indirect address registers X, Y, and Z are defined as described in Figure 5.

Figure 5. The X-, Y-, and Z-registers



In the different addressing modes, these address registers have functions as fixed displacement, automatic increment, and automatic decrement (see the instruction set reference for details).

Stack Pointer

The Stack is mainly used for storing temporary data, for storing local variables and for storing return addresses after interrupts and subroutine calls. The Stack Pointer Register always points to the top of the Stack. Note that the Stack is implemented as growing from higher memory locations to lower memory locations. This implies that a Stack PUSH command decreases the Stack Pointer.

The Stack Pointer points to the data SRAM Stack area where the Subroutine and Interrupt Stacks are located. This Stack space in the data SRAM must be defined by the program before any subroutine calls are executed or interrupts are enabled. The Stack Pointer must be set to point above 0x60. The Stack Pointer is decremented by one when data is pushed onto the Stack with the PUSH instruction, and it is decremented by two when the return address is pushed onto the Stack with subroutine call or interrupt. The Stack Pointer is incremented by one when data is popped from the Stack with the POP instruction, and it is incremented by two when data is popped from the Stack with return from subroutine RET or return from interrupt RETI.

The AVR Stack Pointer is implemented as two 8-bit registers in the I/O space. The number of bits actually used is implementation dependent. Note that the data space in some implementations of the AVR architecture is so small that only SPL is needed. In this case, the SPH Register will not be present.

Bit	15	14	13	12	11	10	9	8	
	SP15	**SP14**	**SP13**	**SP12**	**SP11**	**SP10**	**SP9**	**SP8**	**SPH**
	SP7	**SP6**	**SP5**	**SP4**	**SP3**	**SP2**	**SP1**	**SP0**	**SPL**
	7	6	5	4	3	2	1	0	
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	

Instruction Execution Timing

This section describes the general access timing concepts for instruction execution. The AVR CPU is driven by the CPU clock clk_{CPU}, directly generated from the selected clock source for the chip. No internal clock division is used.

Figure 6 shows the parallel instruction fetches and instruction executions enabled by the Harvard architecture and the fast-access Register File concept. This is the basic pipelining concept to obtain up to 1 MIPS per MHz with the corresponding unique results for functions per cost, functions per clocks, and functions per power-unit.

Figure 6. The Parallel Instruction Fetches and Instruction Executions

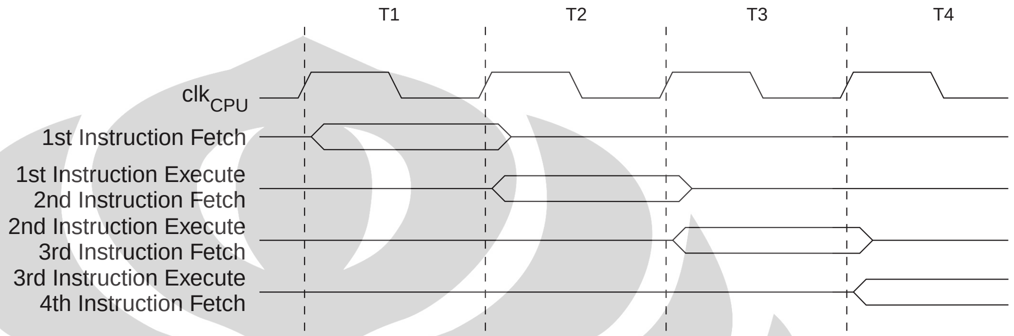
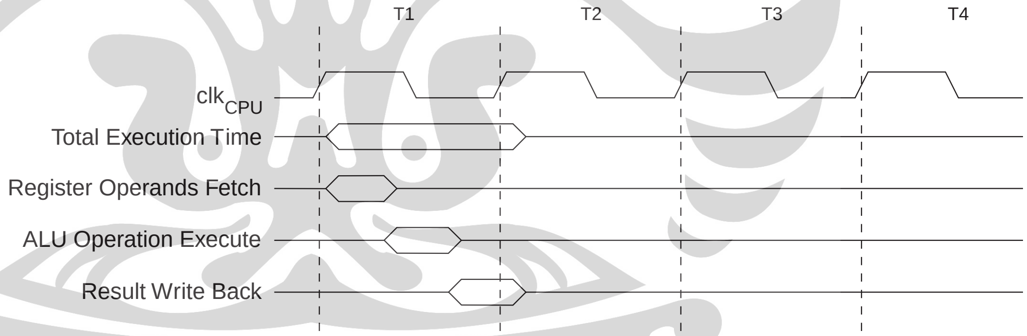


Figure 7 shows the internal timing concept for the Register file. In a single clock cycle an ALU operation using two register operands is executed, and the result is stored back to the destination register.

Figure 7. Single Cycle ALU Operation



Reset and Interrupt Handling

The AVR provides several different interrupt sources. These interrupts and the separate Reset Vector each have a separate Program Vector in the program memory space. All interrupts are assigned individual enable bits which must be written logic one together with the Global Interrupt Enable bit in the Status Register in order to enable the interrupt. Depending on the Program Counter value, interrupts may be automatically disabled when Boot Lock bits BLB02 or BLB12 are programmed. This feature improves software security. See the section “Memory Programming” on page 233 for details.

The lowest addresses in the program memory space are, by default, defined as the Reset and Interrupt Vectors. The complete list of vectors is shown in “Interrupts” on page 44. The list also determines the priority levels of the different interrupts. The lower the address, the higher the priority level is. RESET has the highest priority, and next is INT0 – the External Interrupt Request 0. The Interrupt Vectors can be moved to the start of the Boot Flash section by setting the IVSEL bit in the General Interrupt Control Register (GICR). Refer to “Interrupts” on page 44 for more information. The Reset Vector can also be moved to the start of the Boot Flash section by programming the BOOTRST Fuse, see “Boot Loader Support – Read-While-Write Self-Programming” on page 220.

When an interrupt occurs, the Global Interrupt Enable I-bit is cleared and all interrupts are disabled. The user software can write logic one to the I-bit to enable nested interrupts. All enabled interrupts can then interrupt the current interrupt routine. The I-bit is automatically set when a Return from Interrupt instruction – RETI – is executed.

There are basically two types of interrupts. The first type is triggered by an event that sets the interrupt flag. For these interrupts, the Program Counter is vectored to the actual Interrupt Vector in order to execute the interrupt handling routine, and hardware clears the corresponding interrupt flag. Interrupt flags can also be cleared by writing a logic one to the flag bit position(s) to be cleared. If an interrupt condition occurs while the corresponding interrupt enable bit is cleared, the interrupt flag will be set and remembered until the interrupt is enabled, or the flag is cleared by software. Similarly, if one or more interrupt conditions occur while the Global Interrupt Enable bit is cleared, the corresponding interrupt flag(s) will be set and remembered until the Global Interrupt Enable bit is set, and will then be executed by order of priority.

The second type of interrupts will trigger as long as the interrupt condition is present. These interrupts do not necessarily have interrupt flags. If the interrupt condition disappears before the interrupt is enabled, the interrupt will not be triggered.

When the AVR exits from an interrupt, it will always return to the main program and execute one more instruction before any pending interrupt is served.

Note that the Status Register is not automatically stored when entering an interrupt routine, nor restored when returning from an interrupt routine. This must be handled by software.

When using the CLI instruction to disable interrupts, the interrupts will be immediately disabled. No interrupt will be executed after the CLI instruction, even if it occurs simultaneously with the CLI instruction. The following example shows how this can be used to avoid interrupts during the timed EEPROM write sequence.

Assembly Code Example

```
in   r16, SREG        ; store SREG value
cli                   ; disable interrupts during timed sequence
sbi  EECR, EEMWE      ; start EEPROM write
sbi  EECR, EEWE
out  SREG, r16        ; restore SREG value (I-bit)
```

C Code Example

```
char cSREG;
cSREG = SREG;   /* store SREG value */
/* disable interrupts during timed sequence */
_CLI();
EECR |= (1<<EEMWE); /* start EEPROM write */
EECR |= (1<<EEWE);
SREG = cSREG; /* restore SREG value (I-bit) */
```

When using the SEI instruction to enable interrupts, the instruction following SEI will be executed before any pending interrupts, as shown in this example.

Assembly Code Example

```
sei     ; set global interrupt enable
sleep   ; enter sleep, waiting for interrupt
; note: will enter sleep before any pending
; interrupt(s)
```

C Code Example

```
_SEI(); /* set global interrupt enable */
_SLEEP(); /* enter sleep, waiting for interrupt */
/* note: will enter sleep before any pending interrupt(s) */
```

Interrupt Response Time

The interrupt execution response for all the enabled AVR interrupts is four clock cycles minimum. After four clock cycles, the Program Vector address for the actual interrupt handling routine is executed. During this four clock cycle period, the Program Counter is pushed onto the Stack. The Vector is normally a jump to the interrupt routine, and this jump takes three clock cycles. If an interrupt occurs during execution of a multi-cycle instruction, this instruction is completed before the interrupt is served. If an interrupt occurs when the MCU is in sleep mode, the interrupt execution response time is increased by four clock cycles. This increase comes in addition to the start-up time from the selected sleep mode.

A return from an interrupt handling routine takes four clock cycles. During these four clock cycles, the Program Counter (two bytes) is popped back from the Stack, the Stack Pointer is incremented by two, and the I-bit in SREG is set.

AVR ATmega8535 Memories

This section describes the different memories in the ATmega8535. The AVR architecture has two main memory spaces, the Data Memory and the Program Memory space. In addition, the ATmega8535 features an EEPROM Memory for data storage. All three memory spaces are linear and regular.

In-System Reprogrammable Flash Program Memory

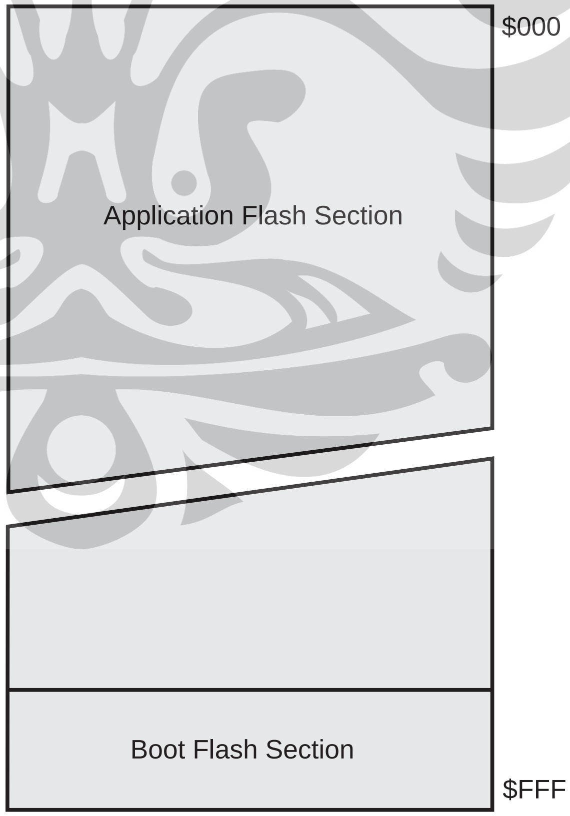
The ATmega8535 contains 8K bytes On-chip In-System Reprogrammable Flash memory for program storage. Since all AVR instructions are 16 or 32 bits wide, the Flash is organized as 4K x 16. For software security, the Flash Program memory space is divided into two sections, Boot Program section and Application Program section.

The Flash memory has an endurance of at least 10,000 write/erase cycles. The ATmega8535 Program Counter (PC) is 12 bits wide, thus addressing the 4K program memory locations. The operation of Boot Program section and associated Boot Lock bits for software protection are described in detail in "Boot Loader Support – Read-While-Write Self-Programming" on page 220. "Memory Programming" on page 233 contains a detailed description on Flash Programming in SPI or Parallel Programming mode.

Constant tables can be allocated within the entire program memory address space (see the LPM – Load Program Memory instruction description).

Timing diagrams for instruction fetch and execution are presented in "Instruction Execution Timing" on page 11.

Figure 8. Program Memory Map



SRAM Data Memory

Figure 9 shows how the ATmega8535 SRAM Memory is organized.

The 608 Data Memory locations address the Register File, the I/O Memory, and the internal data SRAM. The first 96 locations address the Register File and I/O Memory, and the next 512 locations address the internal data SRAM.

The five different addressing modes for the data memory cover: Direct, Indirect with Displacement, Indirect, Indirect with Pre-decrement, and Indirect with Post-increment. In the Register File, registers R26 to R31 feature the indirect addressing pointer registers.

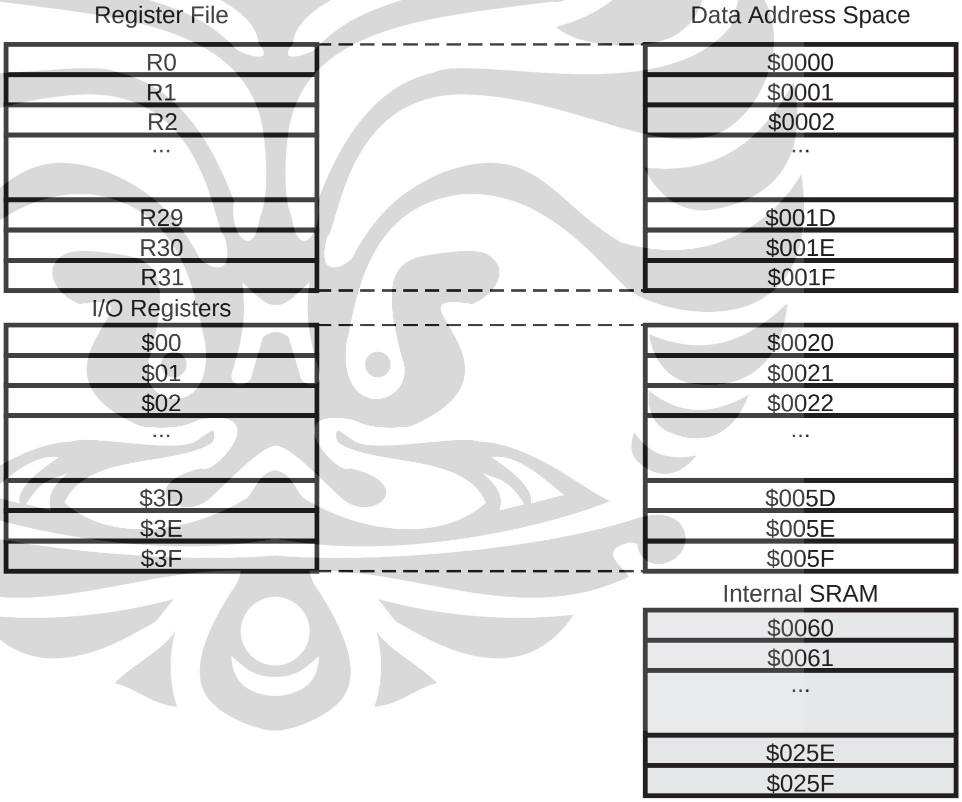
The direct addressing reaches the entire data space.

The Indirect with Displacement mode reaches 63 address locations from the base address given by the Y- or Z-register.

When using register indirect addressing modes with automatic pre-decrement and post-increment, the address registers X, Y, and Z are decremented or incremented.

The 32 general purpose working registers, 64 I/O Registers, and the 512 bytes of internal data SRAM in the ATmega8535 are all accessible through all these addressing modes. The Register File is described in “General Purpose Register File” on page 9.

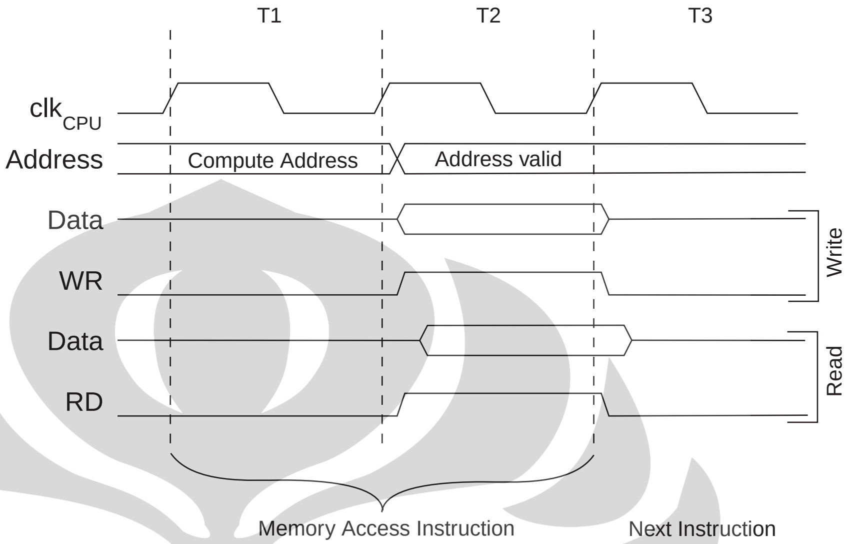
Figure 9. Data Memory Map



Data Memory Access Times

This section describes the general access timing concepts for internal memory access. The internal data SRAM access is performed in two clk_{CPU} cycles as described in Figure 10.

Figure 10. On-chip Data SRAM Access Cycles



EEPROM Data Memory

The ATmega8535 contains 512 bytes of data EEPROM memory. It is organized as a separate data space, in which single bytes can be read and written. The EEPROM has an endurance of at least 100,000 write/erase cycles. The access between the EEPROM and the CPU is described in the following, specifying the EEPROM Address Registers, the EEPROM Data Register, and the EEPROM Control Register.

"Memory Programming" on page 233 contains a detailed description on EEPROM Programming in SPI or Parallel Programming mode.

EEPROM Read/Write Access

The EEPROM Access Registers are accessible in the I/O space.

The write access time for the EEPROM is given in Table 1. A self-timing function, however, lets the user software detect when the next byte can be written. If the user code contains instructions that write the EEPROM, some precautions must be taken. In heavily filtered power supplies, V_{CC} is likely to rise or fall slowly on Power-up/down. This causes the device, for some period of time, to run at a voltage lower than specified as minimum for the clock frequency used, see "Preventing EEPROM Corruption" on page 20 for details on how to avoid problems in these situations.

In order to prevent unintentional EEPROM writes, a specific write procedure must be followed. Refer to the description of the EEPROM Control Register for details on this.

When the EEPROM is read, the CPU is halted for four clock cycles before the next instruction is executed. When the EEPROM is written, the CPU is halted for two clock cycles before the next instruction is executed.

The EEPROM Address Register – EEARH and EEARL

Bit	15	14	13	12	11	10	9	8	
	–	–	–	–	–	–	–	EEAR8	EEARH
	EEAR7	EEAR6	EEAR5	EEAR4	EEAR3	EEAR2	EEAR1	EEAR0	EEARL
	7	6	5	4	3	2	1	0	
Read/Write	R	R	R	R	R	R	R	R/W	
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	X	
	X	X	X	X	X	X	X	X	

- **Bits 15..9 – Res: Reserved Bits**

These bits are reserved bits in the ATmega8535 and will always read as zero.

- **Bits 8..0 – EEAR8..0: EEPROM Address**

The EEPROM Address Registers – EEARH and EEARL specify the EEPROM address in the 512 bytes EEPROM space. The EEPROM data bytes are addressed linearly between 0 and 511. The initial value of EEAR is undefined. A proper value must be written before the EEPROM may be accessed.

The EEPROM Data Register – EEDR

Bit	7	6	5	4	3	2	1	0	
	MSB							LSB	EEDR
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bits 7..0 – EEDR7..0: EEPROM Data**

For the EEPROM write operation, the EEDR Register contains the data to be written to the EEPROM in the address given by the EEAR Register. For the EEPROM read operation, the EEDR contains the data read out from the EEPROM at the address given by EEAR.

The EEPROM Control Register – EECR

Bit	7	6	5	4	3	2	1	0	
	–	–	–	–	EERIE	EEMWE	EEWE	EERE	EECR
Read/Write	R	R	R	R	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	X	0	

- **Bits 7..4 – Res: Reserved Bits**

These bits are reserved bits in the ATmega8535 and will always read as zero.

- **Bit 3 – EERIE: EEPROM Ready Interrupt Enable**

Writing EERIE to one enables the EEPROM Ready Interrupt if the I-bit in SREG is set. Writing EERIE to zero disables the interrupt. The EEPROM Ready interrupt generates a constant interrupt when EEWE is cleared.

- **Bit 2 – EEMWE: EEPROM Master Write Enable**

The EEMWE bit determines whether setting EEWE to one causes the EEPROM to be written. When EEMWE is set, setting EEWE within four clock cycles will write data to the EEPROM at the selected address If EEMWE is zero, setting EEWE will have no effect. When EEMWE has been written to one by software, hardware clears the bit to zero after four clock cycles. See the description of the EEWE bit for an EEPROM write procedure.

- **Bit 1 – EEWE: EEPROM Write Enable**

The EEPROM Write Enable Signal EEWE is the write strobe to the EEPROM. When address and data are correctly set up, the EEWE bit must be written to one to write the value into the EEPROM. The EEMWE bit must be written to one before a logical one is written to EEWE, otherwise no EEPROM write takes place. The following procedure should be followed when writing the EEPROM (the order of steps 3 and 4 is not essential):

1. Wait until EEWE becomes zero.
2. Wait until SPMEN in SPMCR becomes zero.
3. Write new EEPROM address to EEAR (optional).
4. Write new EEPROM data to EEDR (optional).
5. Write a logical one to the EEMWE bit while writing a zero to EEWE in EECR.
6. Within four clock cycles after setting EEMWE, write a logical one to EEWE.

The EEPROM can not be programmed during a CPU write to the Flash memory. The software must check that the Flash programming is completed before initiating a new EEPROM write. Step 2 is only relevant if the software contains a Boot Loader allowing the CPU to program the Flash. If the Flash is never updated by the CPU, step 2 can be omitted. See “Boot Loader Support – Read-While-Write Self-Programming” on page 220 for details about Boot programming.

Caution: An interrupt between step 5 and step 6 will make the write cycle fail, since the EEPROM Master Write Enable will time-out. If an interrupt routine accessing the EEPROM is interrupting another EEPROM access, the EEAR or EEDR Register will be modified, causing the interrupted EEPROM access to fail. It is recommended to have the Global Interrupt Flag cleared during all the steps to avoid these problems.

When the write access time has elapsed, the EEWE bit is cleared by hardware. The user software can poll this bit and wait for a zero before writing the next byte. When EEWE has been set, the CPU is halted for two cycles before the next instruction is executed.

- **Bit 0 – EERE: EEPROM Read Enable**

The EEPROM Read Enable Signal EERE is the read strobe to the EEPROM. When the correct address is set up in the EEAR Register, the EERE bit must be written to a logic one to trigger the EEPROM read. The EEPROM read access takes one instruction, and the requested data is available immediately. When the EEPROM is read, the CPU is halted for four cycles before the next instruction is executed.

The user should poll the EEWE bit before starting the read operation. If a write operation is in progress, it is neither possible to read the EEPROM, nor to change the EEAR Register.

The calibrated Oscillator is used to time the EEPROM accesses. Table 1 lists the typical programming time for EEPROM access from the CPU.

Table 1. EEPROM Programming Time

Symbol	Number of Calibrated RC Oscillator Cycles(1)	Typ Programming Time
EEPROM Write (from CPU)	8448	8.4 ms

Note: 1. Uses 1 MHz clock, independent of CKSEL Fuse settings.

The following code examples show one assembly and one C function for writing to the EEPROM. The examples assume that interrupts are controlled (e.g., by disabling interrupts globally) so that no interrupts will occur during execution of these functions. The examples also assume that no Flash Boot Loader is present in the software. If such code is present, the EEPROM write function must also wait for any ongoing SPM command to finish.

Assembly Code Example

```
EEPROM_write:
  ; Wait for completion of previous write
  sbic  EECR,EEWE
  rjmp  EEPROM_write
  ; Set up address (r18:r17) in address register
  out   EEARH, r18
  out   EEARL, r17
  ; Write data (r16) to Data Register
  out   EEDR,r16
  ; Write logical one to EEMWE
  sbi   EECR,EEMWE
  ; Start eeprom write by setting EEWE
  sbi   EECR,EEWE
  ret
```

C Code Example

```
void EEPROM_write(unsigned int uiAddress, unsigned char ucData)
{
  /* Wait for completion of previous write */
  while(EECR & (1<<EEWE))
    ;
  /* Set up Address and Data Registers */
  EEAR = uiAddress;
  EEDR = ucData;
  /* Write logical one to EEMWE */
  EECR |= (1<<EEMWE);
  /* Start eeprom write by setting EEWE */
  EECR |= (1<<EEWE);
}
```

The next code examples show assembly and C functions for reading the EEPROM. The examples assume that interrupts are controlled so that no interrupts will occur during execution of these functions.

Assembly Code Example

```
EEPROM_read:
    ; Wait for completion of previous write
    sbic  EECR,EEWE
    rjmp  EEPROM_read
    ; Set up address (r18:r17) in Address Register
    out   EEARH, r18
    out   EEARL, r17
    ; Start eeprom read by writing EERE
    sbi   EECR,EERE
    ; Read data from Data Register
    in    r16,EEDR
    ret
```

C Code Example

```
unsigned char EEPROM_read(unsigned int uiAddress)
{
    /* Wait for completion of previous write */
    while(EECR & (1<<EEWE))
        ;
    /* Set up Address Register */
    EEAR = uiAddress;
    /* Start eeprom read by writing EERE */
    EECR |= (1<<EERE);
    /* Return data from Data Register */
    return EEDR;
}
```

EEPROM Write During Power-down Sleep Mode

When entering Power-down sleep mode while an EEPROM write operation is active, the EEPROM write operation will continue, and will complete before the write access time has passed. However, when the write operation is completed, the Oscillator continues running, and as a consequence, the device does not enter Power-down entirely. It is therefore recommended to verify that the EEPROM write operation is completed before entering Power-down.

Preventing EEPROM Corruption

During periods of low V_{CC}, the EEPROM data can be corrupted because the supply voltage is too low for the CPU and the EEPROM to operate properly. These issues are the same as for board level systems using EEPROM and the same design solutions should be applied.

An EEPROM data corruption can be caused by two situations when the voltage is too low. First, a regular write sequence to the EEPROM requires a minimum voltage to operate correctly. Secondly, the CPU itself can execute instructions incorrectly, if the supply voltage is too low.

EEPROM data corruption can easily be avoided by following this design recommendation:

Keep the AVR RESET active (low) during periods of insufficient power supply voltage. This can be done by enabling the internal Brown-out Detector (BOD). If the detection level of the internal BOD does not match the needed detection level, an external low V_{CC} Reset Protection circuit can be used. If a reset occurs while a write operation is in progress, the write operation will be completed provided that the power supply voltage is sufficient.

I/O Memory

The I/O space definition of the ATmega8535 is shown in page 260.

All ATmega8535 I/Os and peripherals are placed in the I/O space. The I/O locations are accessed by the IN and OUT instructions, transferring data between the 32 general purpose working registers and the I/O space. I/O Registers within the address range 0x00 - 0x1F are directly bit-accessible using the SBI and CBI instructions. In these registers, the value of single bits can be checked by using the SBIS and SBIC instructions. Refer to the instruction set section for more details. When using the I/O specific commands IN and OUT, the I/O addresses 0x00 - 0x3F must be used. When addressing I/O Registers as data space using LD and ST instructions, 0x20 must be added to these addresses.

For compatibility with future devices, reserved bits should be written to zero if accessed. Reserved I/O memory addresses should never be written.

Some of the status flags are cleared by writing a logical one to them. Note that the CBI and SBI instructions will operate on all bits in the I/O Register, writing a one back into any flag read as set, thus clearing the flag. The CBI and SBI instructions work with registers 0x00 to 0x1F only.

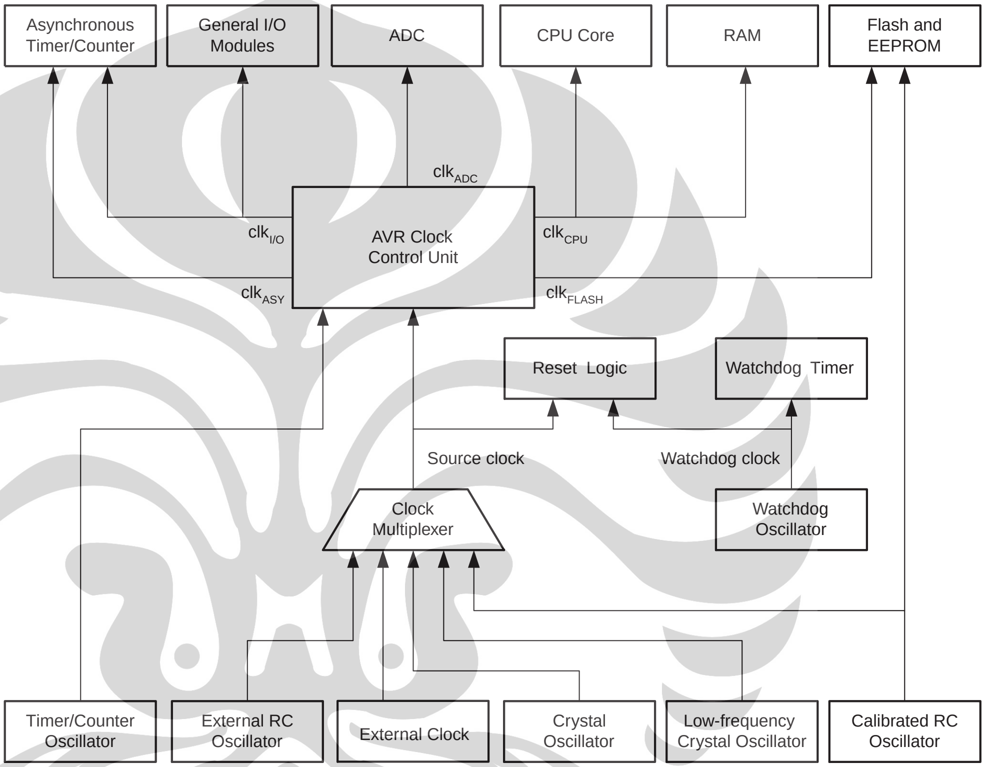
The I/O and peripherals control registers are explained in later sections.

System Clock and Clock Options

Clock Systems and their Distribution

Figure 11 presents the principal clock systems in the AVR and their distribution. All of the clocks need not be active at a given time. In order to reduce power consumption, the clocks to modules not being used can be halted by using different sleep modes, as described in "Power Management and Sleep Modes" on page 30. The clock systems are detailed below.

Figure 11. Clock Distribution



CPU Clock – clk_{CPU}

The CPU clock is routed to parts of the system concerned with operation of the AVR core. Examples of such modules are the General Purpose Register File, the Status Register and the data memory holding the Stack Pointer. Halting the CPU clock inhibits the core from performing general operations and calculations.

I/O Clock – $clk_{I/O}$

The I/O clock is used by the majority of the I/O modules, like Timer/Counters, SPI, and USART. The I/O clock is also used by the External Interrupt module, but note that some external interrupts are detected by asynchronous logic, allowing such interrupts to be detected even if the I/O clock is halted. Also note that address recognition in the TWI module is carried out asynchronously when $clk_{I/O}$ is halted, enabling TWI address reception in all sleep modes.

Flash Clock – clk_{FLASH}

The Flash clock controls operation of the Flash interface. The Flash clock is usually active simultaneously with the CPU clock.

Asynchronous Timer Clock – clk$_{ASY}$

The Asynchronous Timer clock allows the Asynchronous Timer/Counter to be clocked directly from an external 32 kHz clock crystal. The dedicated clock domain allows using this Timer/Counter as a real-time counter even when the device is in sleep mode.

ADC Clock – clk$_{ADC}$

The ADC is provided with a dedicated clock domain. This allows halting the CPU and I/O clocks in order to reduce noise generated by digital circuitry. This gives more accurate ADC conversion results.

Clock Sources

The device has the following clock source options, selectable by Flash Fuse bits as shown below. The clock from the selected source is input to the AVR clock generator, and routed to the appropriate modules.

Table 2. Device Clocking Options Select[1]

Device Clocking Option	CKSEL3..0
External Crystal/Ceramic Resonator	1111 - 1010
External Low-frequency Crystal	1001
External RC Oscillator	1000 - 0101
Calibrated Internal RC Oscillator	0100 - 0001
External Clock	0000

Note: 1. For all fuses "1" means unprogrammed while "0" means programmed.

The various choices for each clocking option is given in the following sections. When the CPU wakes up from Power-down or Power-save, the selected clock source is used to time the start-up, ensuring stable Oscillator operation before instruction execution starts. When the CPU starts from Reset, there is as an additional delay allowing the power to reach a stable level before commencing normal operation. The Watchdog Oscillator is used for timing this real-time part of the start-up time. The number of WDT Oscillator cycles used for each time-out is shown in Table 3. The frequency of the Watchdog Oscillator is voltage dependent as shown in "ATmega8535 Typical Characteristics – Preliminary Data" on page 259.

Table 3. Number of Watchdog Oscillator Cycles

Typ Time-out (V_{CC} = 5.0V)	Typ Time-out (V_{CC} = 3.0V)	Number of Cycles
4.1 ms	4.3 ms	4K (4,096)
65 ms	69 ms	64K (65,536)

Default Clock Source

The device is shipped with CKSEL = "0001" and SUT = "10". The default clock source setting is therefore the Internal RC Oscillator with longest startup time. This default setting ensures that all users can make their desired clock source setting using an In-System or Parallel Programmer.

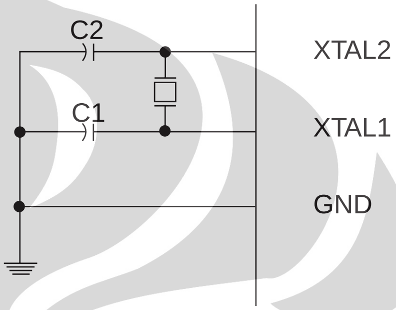
Crystal Oscillator

XTAL1 and XTAL2 are input and output, respectively, of an inverting amplifier which can be configured for use as an On-chip Oscillator, as shown in Figure 12. Either a quartz crystal or a ceramic resonator may be used. The CKOPT Fuse selects between two different oscillator amplifier modes. When CKOPT is programmed, the Oscillator output will oscillate will a full rail-to-rail swing on the output. This mode is suitable when operating in a very noisy environment or when the output from XTAL2 drives a second clock buffer. This mode has a wide frequency range. When CKOPT is unprogrammed, the Oscillator has a smaller output swing. This reduces power consumption considerably.

This mode has a limited frequency range and it can not be used to drive other clock buffers.

For resonators, the maximum frequency is 8 MHz with CKOPT unprogrammed and 16 MHz with CKOPT programmed. C1 and C2 should always be equal for both crystals and resonators. The optimal value of the capacitors depends on the crystal or resonator in use, the amount of stray capacitance, and the electromagnetic noise of the environment. Some initial guidelines for choosing capacitors for use with crystals are given in Table 4. For ceramic resonators, the capacitor values given by the manufacturer should be used.

Figure 12. Crystal Oscillator Connections



The Oscillator can operate in three different modes, each optimized for a specific frequency range. The operating mode is selected by the fuses CKSEL3..1 as shown in Table 4.

Table 4. Crystal Oscillator Operating Modes

CKOPT	CKSEL3..1	Frequency Range[(1)] (MHz)	Recommended Range for Capacitors C1 and C2 for Use with Crystals (pF)
1	101[(2)]	0.4 - 0.9	–
1	110	0.9 - 3.0	12 - 22
1	111	3.0 - 8.0	12 - 22
0	101, 110, 111	1.0 - 16.0	12 - 22

Notes:
1. The frequency ranges are preliminary values.
2. This option should not be used with crystals, only with ceramic resonators.

The CKSEL0 fuse together with the SUT1..0 Fuses select the start-up times as shown in Table 5.

Table 5. Start-up Times for the Crystal Oscillator Clock Selection

CKSEL0	SUT1..0	Start-up Time from Power-down and Power-save	Additional Delay from Reset (V_{CC} = 5.0V)	Recommended Usage
0	00	258 CK(1)	4.1 ms	Ceramic resonator, fast rising power
0	01	258 CK(1)	65 ms	Ceramic resonator, slowly rising power
0	10	1K CK(2)	–	Ceramic resonator, BOD enabled
0	11	1K CK(2)	4.1 ms	Ceramic resonator, fast rising power
1	00	1K CK(2)	65 ms	Ceramic resonator, slowly rising power
1	01	16K CK	–	Crystal Oscillator, BOD enabled
1	10	16K CK	4.1 ms	Crystal Oscillator, fast rising power
1	11	16K CK	65 ms	Crystal Oscillator, slowly rising power

Notes:
1. These options should only be used when not operating close to the maximum frequency of the device, and only if frequency stability at start-up is not important for the application. These options are not suitable for crystals.
2. These options are intended for use with ceramic resonators and will ensure frequency stability at start-up. They can also be used with crystals when not operating close to the maximum frequency of the device, and if frequency stability at start-up is not important for the application.

Low-frequency Crystal Oscillator

To use a 32.768 kHz watch crystal as the clock source for the device, the Low-frequency Crystal Oscillator must be selected by setting the CKSEL Fuses to “1001”. The crystal should be connected as shown in Figure 12. By programming the CKOPT Fuse, the user can enable internal capacitors on XTAL1 and XTAL2, thereby removing the need for external capacitors. The internal capacitors have a nominal value of 36 pF.

When this Oscillator is selected, start-up times are determined by the SUT fuses as shown in Table 6.

Table 6. Start-up Times for the Low-frequency Crystal Oscillator Clock Selection

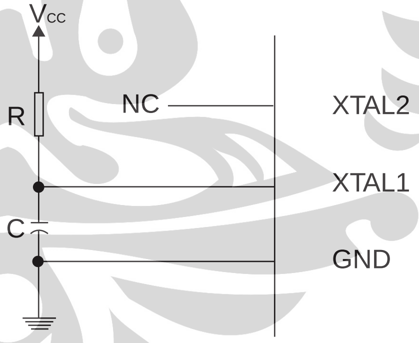
SUT1..0	Start-up Time from Power-down and Power-save	Additional Delay from Reset (V_{CC} = 5.0V)	Recommended Usage
00	1K CK(1)	4.1 ms	Fast rising power or BOD enabled
01	1K CK(1)	65 ms	Slowly rising power
10	32K CK	65 ms	Stable frequency at start-up
11	Reserved		

Note: 1. These options should only be used if frequency stability at start-up is not important for the application.

External RC Oscillator

For timing insensitive applications, the external RC configuration shown in Figure 13 can be used. The frequency is roughly estimated by the equation f = 1/(3RC). C should be at least 22 pF. By programming the CKOPT Fuse, the user can enable an internal 36 pF capacitor between XTAL1 and GND, thereby removing the need for an external capacitor. For more information on Oscillator operation and details on how to choose R and C, refer to the External RC Oscillator application note.

Figure 13. External RC Configuration



The Oscillator can operate in four different modes, each optimized for a specific frequency range. The operating mode is selected by the fuses CKSEL3..0 as shown in Table 7.

Table 7. External RC Oscillator Operating Modes

CKSEL3..0	Frequency Range (MHz)
0101	- 0.9
0110	0.9 - 3.0
0111	3.0 - 8.0
1000	8.0 - 12.0

When this Oscillator is selected, start-up times are determined by the SUT fuses as shown in Table 8.

Table 8. Start-up Times for the External RC Oscillator Clock Selection

SUT1..0	Start-up Time from Power-down and Power-save	Additional Delay from Reset (V_{CC} = 5.0V)	Recommended Usage
00	18 CK	–	BOD enabled
01	18 CK	4.1 ms	Fast rising power
10	18 CK	65 ms	Slowly rising power
11	6 CK(1)	4.1 ms	Fast rising power or BOD enabled

Note: 1. This option should not be used when operating close to the maximum frequency of the device.

Calibrated Internal RC Oscillator

The calibrated internal RC Oscillator provides a fixed 1.0, 2.0, 4.0, or 8.0 MHz clock. All frequencies are nominal values at 5V and 25°C. This clock may be selected as the system clock by programming the CKSEL Fuses as shown in Table 9. If selected, it will operate with no external components. The CKOPT Fuse should always be unprogrammed when using this clock option. During Reset, hardware loads the calibration byte into the OSCCAL Register and thereby automatically calibrates the RC Oscillator. At 5V, 25°C and 1.0 MHz Oscillator frequency selected, this calibration gives a frequency within ± 1% of the nominal frequency. When this Oscillator is used as the chip clock, the Watchdog Oscillator will still be used for the Watchdog Timer and for the Reset Time-out. For more information on the pre-programmed calibration value, see the section “Calibration Byte” on page 235.

Table 9. Internal Calibrated RC Oscillator Operating Modes

CKSEL3..0	Nominal Frequency (MHz)
0001(1)	1.0
0010	2.0
0011	4.0
0100	8.0

Note: 1. The device is shipped with this option selected.

When this Oscillator is selected, start-up times are determined by the SUT Fuses as shown in Table 10. XTAL1 and XTAL2 should be left unconnected (NC).

Table 10. Start-up Times for the Internal Calibrated RC Oscillator Clock Selection

SUT1..0	Start-up Time from Power-down and Power-save	Additional Delay from Reset (V_{CC} = 5.0V)	Recommended Usage
00	6 CK	–	BOD enabled
01	6 CK	4.1 ms	Fast rising power
10(1)	6 CK	65 ms	Slowly rising power
11	Reserved		

Note: 1. The device is shipped with this option selected.

Oscillator Calibration Register – OSCCAL

Bit	7	6	5	4	3	2	1	0	
	CAL7	CAL6	CAL5	CAL4	CAL3	CAL2	CAL1	CAL0	OSCCAL
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	Device Specific Calibration Value								

- **Bits 7..0 – CAL7..0: Oscillator Calibration Value**

Writing the calibration byte to this address will trim the Internal Oscillator to remove process variations from the Oscillator frequency. During Reset, the 1 MHz calibration value which is located in the signature row high byte (address 0x00) is automatically loaded into the OSCCAL Register. If the internal RC is used at other frequencies, the calibration values must be loaded manually. This can be done by first reading the signature row by a programmer, and then store the calibration values in the Flash or EEPROM. Then the value can be read by software and loaded into the OSCCAL Register.

When OSCCAL is zero, the lowest available frequency is chosen. Writing non-zero values to this register will increase the frequency of the Internal Oscillator. Writing 0xFF to the register gives the highest available frequency. The calibrated Oscillator is used to time EEPROM and Flash access. If EEPROM or Flash is written, do not calibrate to more than 10% above the nominal frequency. Otherwise, the EEPROM or Flash write may fail. Note that the Oscillator is intended for calibration to 1.0, 2.0, 4.0, or 8.0 MHz. Tuning to other values is not guaranteed, as indicated in Table 11.

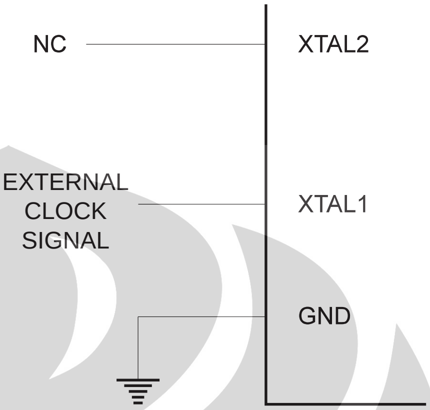
Table 11. Internal RC Oscillator Frequency Range.

OSCCAL Value	Min Frequency in Percentage of Nominal Frequency (%)	Max Frequency in Percentage of Nominal Frequency (%)
0x00	50	100
0x7F	75	150
0xFF	100	200

External Clock

To drive the device from an external clock source, XTAL1 should be driven as shown in Figure 14. To run the device on an external clock, the CKSEL Fuses must be programmed to “0000”. By programming the CKOPT Fuse, the user can enable an internal 36 pF capacitor between XTAL1 and GND.

Figure 14. External Clock Drive Configuration



When this clock source is selected, start-up times are determined by the SUT Fuses as shown in Table 12.

Table 12. Start-up Times for the External Clock Selection

SUT1..0	Start-up Time from Power-down and Power-save	Additional Delay from Reset (V_{CC} = 5.0V)	Recommended Usage
00	6 CK	–	BOD enabled
01	6 CK	4.1 ms	Fast rising power
10	6 CK	65 ms	Slowly rising power
11	Reserved		

When applying an external clock, it is required to avoid sudden changes in the applied clock frequency to ensure stable operation of the MCU. A variation in frequency of more than 2% from one clock cycle to the next can lead to unpredictable behaviour. It is required to ensure that the MCU is kept in Reset during such changes in the clock frequency.

Timer/Counter Oscillator

For AVR microcontrollers with Timer/Counter Oscillator pins (TOSC1 and TOSC2), the crystal is connected directly between the pins. No external capacitors are needed. The Oscillator is optimized for use with a 32.768 kHz watch crystal. Applying an external clock source to TOSC1 is not recommended.

Power Management and Sleep Modes

Sleep modes enable the application to shut down unused modules in the MCU, thereby saving power. The AVR provides various sleep modes allowing the user to tailor the power consumption to the application's requirements.

To enter any of the six sleep modes, the SE bit in MCUCR must be written to logic one and a SLEEP instruction must be executed. The SM2, SM1, and SM0 bits in the MCUCR Register select which sleep mode (Idle, ADC Noise Reduction, Power-down, Power-save, Standby, or Extended Standby) will be activated by the SLEEP instruction. See Table 13 for a summary. If an enabled interrupt occurs while the MCU is in a sleep mode, the MCU wakes up. The MCU is then halted for four cycles in addition to the start-up time, it executes the interrupt routine, and resumes execution from the instruction following SLEEP. The contents of the Register File and SRAM are unaltered when the device wakes up from sleep. If a Reset occurs during sleep mode, the MCU wakes up and executes from the Reset Vector.

Figure 11 on page 22 presents the different clock systems in the ATmega8535, and their distribution. The figure is helpful in selecting an appropriate sleep mode.

MCU Control Register – MCUCR

The MCU Control Register contains control bits for power management.

Bit	7	6	5	4	3	2	1	0	
	SM2	SE	SM1	SM0	ISC11	ISC10	ISC01	ISC00	MCUCR
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bits 7, 5, 4 – SM2..0: Sleep Mode Select Bits 2, 1, and 0**

These bits select between the six available sleep modes as shown in Table 13.

Table 13. Sleep Mode Select

SM2	SM1	SM0	Sleep Mode
0	0	0	Idle
0	0	1	ADC Noise Reduction
0	1	0	Power-down
0	1	1	Power-save
1	0	0	Reserved
1	0	1	Reserved
1	1	0	Standby(1)
1	1	1	Extended Standby(1)

Note: 1. Standby mode and Extended Standby mode are only available with external crystals or resonators.

- **Bit 6 – SE: Sleep Enable**

The SE bit must be written to logic one to make the MCU enter the sleep mode when the SLEEP instruction is executed. To avoid the MCU entering the sleep mode unless it is the programmers purpose, it is recommended to write the Sleep Enable (SE) bit to one just before the execution of the SLEEP instruction and to clear it immediately after waking up.

Idle Mode

When the SM2..0 bits are written to 000, the SLEEP instruction makes the MCU enter Idle mode, stopping the CPU but allowing SPI, USART, Analog Comparator, ADC, Two-wire Serial Interface, Timer/Counters, Watchdog, and the interrupt system to continue operating. This sleep mode basically halts clk_{CPU} and clk_{FLASH}, while allowing the other clocks to run.

Idle mode enables the MCU to wake up from external triggered interrupts as well as internal ones like the Timer Overflow and USART Transmit Complete interrupts. If wake-up from the Analog Comparator interrupt is not required, the Analog Comparator can be powered down by setting the ADC bit in the Analog Comparator Control and Status register – ACSR. This will reduce power consumption in Idle mode. If the ADC is enabled, a conversion starts automatically when this mode is entered.

ADC Noise Reduction Mode

When the SM2..0 bits are written to 001, the SLEEP instruction makes the MCU enter ADC Noise Reduction mode, stopping the CPU but allowing the ADC, the External Interrupts, the Two-wire Serial Interface address watch, Timer/Counter2 and the Watchdog to continue operating (if enabled). This sleep mode basically halts $clk_{I/O}$, clk_{CPU}, and clk_{FLASH}, while allowing the other clocks to run.

This improves the noise environment for the ADC, enabling higher resolution measurements. If the ADC is enabled, a conversion starts automatically when this mode is entered. Apart from the ADC Conversion Complete interrupt, only an External Reset, a Watchdog Reset, a Brown-out Reset, a Two-wire Serial Interface address match interrupt, a Timer/Counter2 interrupt, an SPM/EEPROM ready interrupt, an external level interrupt on INT0 or INT1, or an external interrupt on INT2 can wake up the MCU from ADC Noise Reduction mode.

Power-down Mode

When the SM2..0 bits are written to 010, the SLEEP instruction makes the MCU enter Power-down mode. In this mode, the External Oscillator is stopped, while the External Interrupts, the Two-wire Serial Interface address watch, and the Watchdog continue operating (if enabled). Only an External Reset, a Watchdog Reset, a Brown-out Reset, a Two-wire Serial Interface address match interrupt, an external level interrupt on INT0 or INT1, or an external interrupt on INT2 can wake up the MCU. This sleep mode basically halts all generated clocks, allowing operation of asynchronous modules only.

Note that if a level triggered interrupt is used for wake-up from Power-down mode, the changed level must be held for some time to wake up the MCU. Refer to “External Interrupts” on page 65 for details.

When waking up from Power-down mode, there is a delay from the wake-up condition occurs until the wake-up becomes effective. This allows the clock to restart and become stable after having been stopped. The wake-up period is defined by the same CKSEL fuses that define the Reset Time-out period, as described in “Clock Sources” on page 23.

Power-save Mode

When the SM2..0 bits are written to 011, the SLEEP instruction makes the MCU enter Power-save mode. This mode is identical to Power-down, with one exception:

If Timer/Counter2 is clocked asynchronously, i.e., the AS2 bit in ASSR is set, Timer/Counter2 will run during sleep. The device can wake up from either Timer Overflow or Output Compare event from Timer/Counter2 if the corresponding Timer/Counter2 interrupt enable bits are set in TIMSK, and the Global Interrupt Enable bit in SREG is set.

If the asynchronous timer is NOT clocked asynchronously, Power-down mode is recommended instead of Power-save mode because the contents of the registers in the asynchronous timer should be considered undefined after wake-up in Power-save mode if AS2 is 0.

This sleep mode basically halts all clocks except clk_{ASY}, allowing operation only of asynchronous modules, including Timer/Counter2 if clocked asynchronously.

Standby Mode

When the SM2..0 bits are 110 and an external crystal/resonator clock option is selected, the SLEEP instruction makes the MCU enter Standby mode. This mode is identical to Power-down with the exception that the Oscillator is kept running. From Standby mode, the device wakes up in six clock cycles.

Extended Standby Mode

When the SM2..0 bits are 111 and an external crystal/resonator clock option is selected, the SLEEP instruction makes the MCU enter Extended Standby mode. This mode is identical to Power-save mode with the exception that the Oscillator is kept running. From Extended Standby mode, the device wakes up in six clock cycles.

Table 14. Active Clock Domains and Wake-up Sources in the Different Sleep Modes.

	Active Clock domains					**Oscillators**		**Wake up sources**					
Sleep Mode	clk_{CPU}	clk_{FLASH}	clk_{IO}	clk_{ADC}	clk_{ASY}	Main Clock Source Enabled	Timer Osc Enabled	INT2 INT1 INT0	TWI Address Match	Timer 2	SPM/ EEPROM Ready	ADC	Other I/O
Idle			X	X	X	X	X(2)	X	X	X	X	X	X
ADC Noise Reduction				X	X	X	X(2)	X(3)	X	X	X	X	
Power-down								X(3)	X				
Power-save					X(2)		X(2)	X(3)	X	X(2)			
Standby(1)						X		X(3)	X				
Extended Standby(1)					X(2)	X	X(2)	X(3)	X	X(2)			

Notes:
1. External Crystal or resonator selected as clock source
2. If AS2 bit in ASSR is set
3. Only INT2 or level interrupt INT1 and INT0

Minimizing Power Consumption

There are several issues to consider when trying to minimize the power consumption in an AVR controlled system. In general, sleep modes should be used as much as possible, and the sleep mode should be selected so that as few as possible of the device's functions are operating. All functions not needed should be disabled. In particular, the following modules may need special consideration when trying to achieve the lowest possible power consumption.

Analog-to-Digital Converter

If enabled, the ADC will be enabled in all sleep modes. To save power, the ADC should be disabled before entering any sleep mode. When the ADC is turned off and on again, the next conversion will be an extended conversion. Refer to "Analog-to-Digital Converter" on page 202 for details on ADC operation.

Analog Comparator

When entering Idle mode, the Analog Comparator should be disabled if not used. When entering ADC Noise Reduction mode, the Analog Comparator should be disabled. In the other sleep modes, the Analog Comparator is automatically disabled. However, if the Analog Comparator is set up to use the Internal Voltage Reference as input, the Analog Comparator should be disabled in all sleep modes. Otherwise, the Internal Voltage Reference will be enabled, independent of sleep mode. Refer to "Analog Comparator" on page 199 for details on how to configure the Analog Comparator.

Brown-out Detector

If the Brown-out Detector is not needed in the application, this module should be turned off. If the Brown-out Detector is enabled by the BODEN Fuse, it will be enabled in all sleep modes, and hence, always consume power. In the deeper sleep modes, this will contribute significantly to the total current consumption. Refer to "Brown-out Detection" on page 37 for details on how to configure the Brown-out Detector.

Internal Voltage Reference

The Internal Voltage Reference will be enabled when needed by the Brown-out Detector, the Analog Comparator or the ADC. If these modules are disabled as described in the sections above, the internal voltage reference will be disabled and it will not be consuming power. When turned on again, the user must allow the reference to start up before the output is used. If the reference is kept on in sleep mode, the output can be used immediately. Refer to "Internal Voltage Reference" on page 39 for details on the start-up time.

Watchdog Timer

If the Watchdog Timer is not needed in the application, this module should be turned off. If the Watchdog Timer is enabled, it will be enabled in all sleep modes, and hence, always consume power. In the deeper sleep modes, this will contribute significantly to the total current consumption. Refer to "Watchdog Timer" on page 39 for details on how to configure the Watchdog Timer.

Port Pins

When entering a sleep mode, all port pins should be configured to use minimum power. The most important thing is then to ensure that no pins drive resistive loads. In sleep modes where both the I/O clock ($clk_{I/O}$) and the ADC clock (clk_{ADC}) are stopped, the input buffers of the device will be disabled. This ensures that no power is consumed by the input logic when not needed. In some cases, the input logic is needed for detecting wake-up conditions, and it will then be enabled. Refer to the section "Digital Input Enable and Sleep Modes" on page 53 for details on which pins are enabled. If the input buffer is enabled and the input signal is left floating or have an analog signal level close to $V_{CC}/2$, the input buffer will use excessive power.

System Control and Reset

Resetting the AVR

During Reset, all I/O Registers are set to their initial values, and the program starts execution from the Reset Vector. The instruction placed at the Reset Vector must be an RJMP instruction to the reset handling routine. If the program never enables an interrupt source, the Interrupt Vectors are not used, and regular program code can be placed at these locations. This is also the case if the Reset Vector is in the Application section while the Interrupt Vectors are in the Boot section or vice versa. The circuit diagram in Figure 15 shows the reset logic. Table 15 defines the electrical parameters of the reset circuitry.

The I/O ports of the AVR are immediately reset to their initial state when a reset source goes active. This does not require any clock source to be running.

After all reset sources have gone inactive, a delay counter is invoked, stretching the internal reset. This allows the power to reach a stable level before normal operation starts. The time-out period of the delay counter is defined by the user through the CKSEL Fuses. The different selections for the delay period are presented in “Clock Sources” on page 23.

Reset Sources

The ATmega8535 has four sources of Reset:

- Power-on Reset. The MCU is reset when the supply voltage is below the Power-on Reset threshold (V_{POT}).
- External Reset. The MCU is reset when a low level is present on the $\overline{\text{RESET}}$ pin for longer than the minimum pulse length.
- Watchdog Reset. The MCU is reset when the Watchdog Timer period expires and the Watchdog is enabled.
- Brown-out Reset. The MCU is reset when the supply voltage V_{CC} is below the Brown-out Reset threshold (V_{BOT}) and the Brown-out Detector is enabled.

Figure 15. Reset Logic

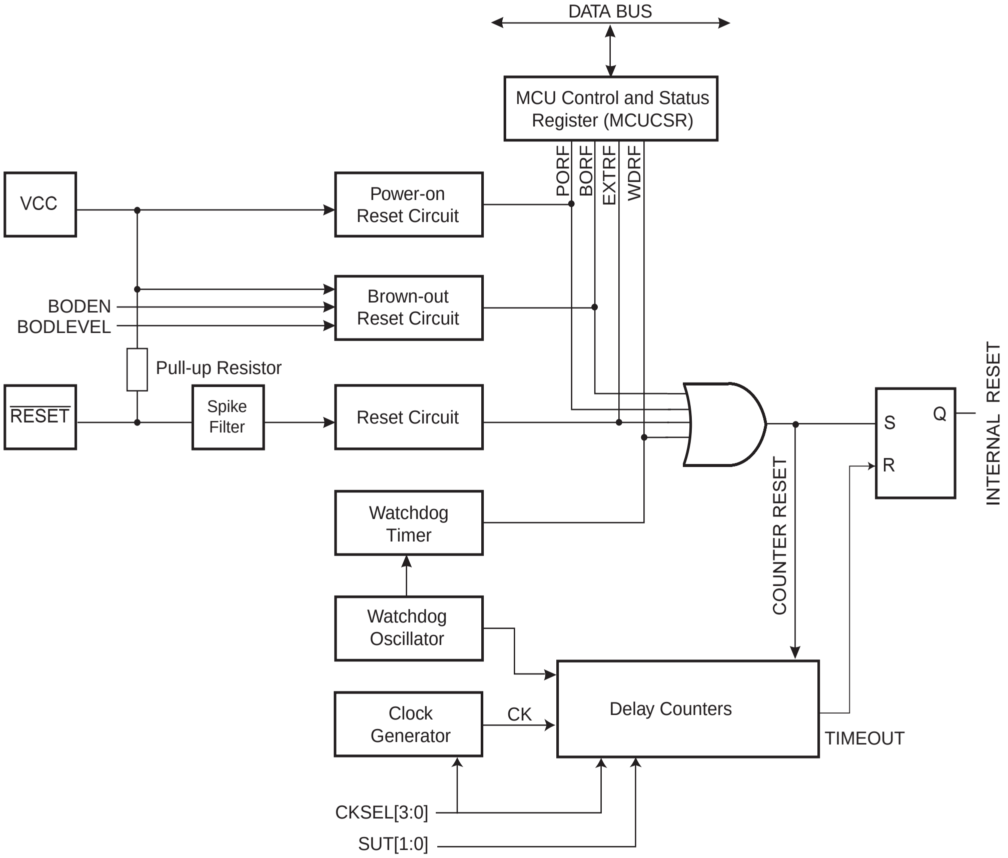


Table 15. Reset Characteristics[1]

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{POT}	Power-on Reset Threshold Voltage (rising)			1.4	2.3	V
	Power-on Reset Threshold Voltage (falling)[2]			1.3	2.3	V
V_{RST}	$\overline{\text{RESET}}$ Pin Threshold Voltage		0.1		0.9	V
t_{RST}	Minimum pulse width on $\overline{\text{RESET}}$ Pin			50		ns
V_{BOT}	Brown-out Reset Threshold Voltage[3]	BODLEVEL = 1	2.5	2.7	3.2	V
		BODLEVEL = 0	3.7	4.0	4.2	
t_{BOD}	Minimum low voltage period for Brown-out Detection	BODLEVEL = 1		2		µs
		BODLEVEL = 0		2		µs
V_{HYST}	Brown-out Detector hysteresis			130		mV

Notes:
1. Values are guidelines only.
2. The Power-on Reset will not work unless the supply voltage has been below V_{POT} (falling).
3. V_{BOT} may be below nominal minimum operating voltage for some devices. For devices where this is the case, the device is tested down to $V_{CC} = V_{BOT}$ during the

production test. This guarantees that a Brown-out Reset will occur before V_{CC} drops to a voltage where correct operation of the microcontroller is no longer guaranteed. The test is performed using BODLEVEL = 1 for ATmega8535L and BODLEVEL = 0 for ATmega8535. BODLEVEL = 1 is not applicable for ATmega8535.

Power-on Reset

A Power-on Reset (POR) pulse is generated by an On-chip detection circuit. The detection level is defined in Table 15. The POR is activated whenever V_{CC} is below the detection level. The POR circuit can be used to trigger the Start-up Reset, as well as to detect a failure in supply voltage.

A Power-on Reset (POR) circuit ensures that the device is reset from Power-on. Reaching the Power-on Reset threshold voltage invokes the delay counter, which determines how long the device is kept in RESET after V_{CC} rise. The RESET signal is activated again, without any delay, when V_{CC} decreases below the detection level.

Figure 16. MCU Start-up, $\overline{\text{RESET}}$ Tied to V_{CC}

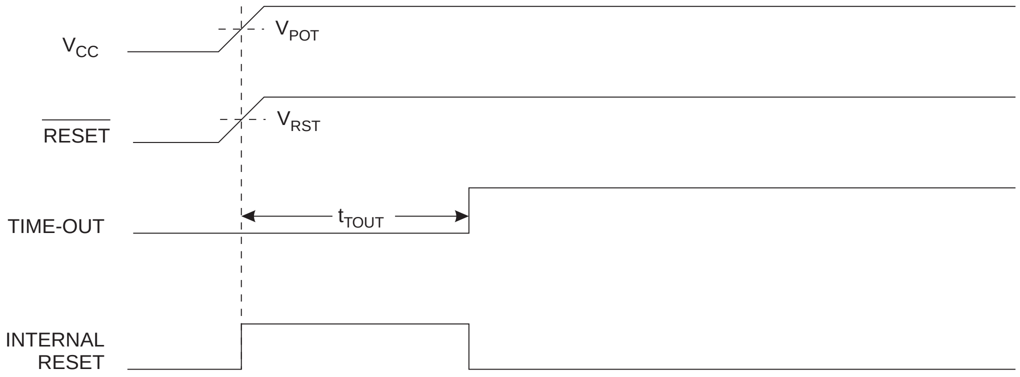
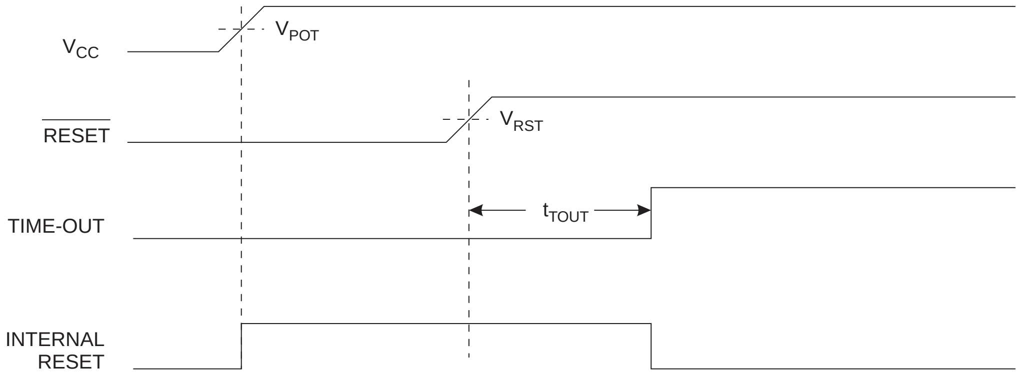


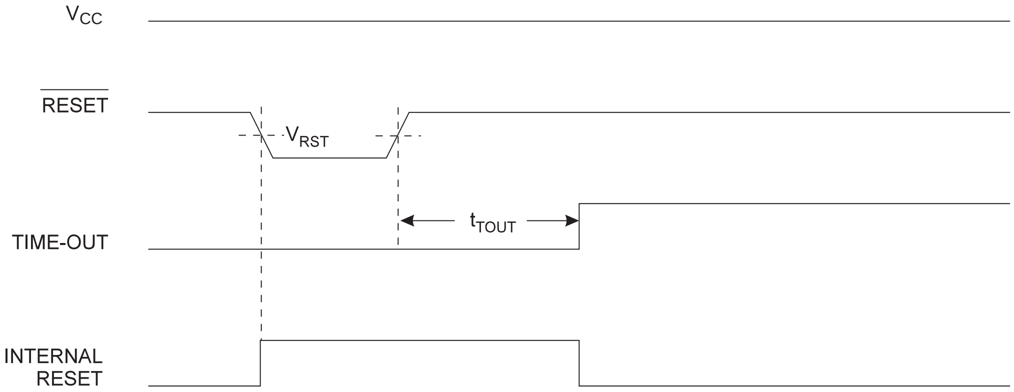
Figure 17. MCU Start-up, $\overline{\text{RESET}}$ Extended Externally



External Reset

An External Reset is generated by a low level on the $\overline{\text{RESET}}$ pin. Reset pulses longer than the minimum pulse width (see Table 15) will generate a reset, even if the clock is not running. Shorter pulses are not guaranteed to generate a reset. When the applied signal reaches the Reset Threshold Voltage – V_{RST} on its positive edge, the delay counter starts the MCU after the Time-out period t_{TOUT} has expired.

Figure 18. External Reset During Operation



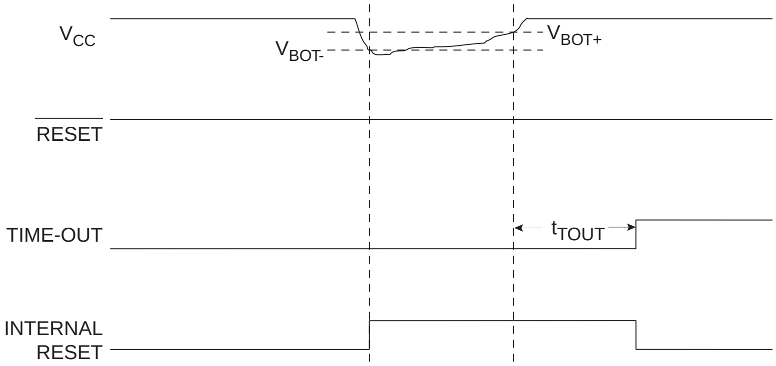
Brown-out Detection

ATmega8535 has an On-chip Brown-out Detection (BOD) circuit for monitoring the V_{CC} level during operation by comparing it to a fixed trigger level. The trigger level for the BOD can be selected by the fuse BODLEVEL to be 2.7V (BODLEVEL unprogrammed), or 4.0V (BODLEVEL programmed). The trigger level has a hysteresis to ensure spike free Brown-out Detection. The hysteresis on the detection level should be interpreted as $V_{BOT+} = V_{BOT} + V_{HYST}/2$ and $V_{BOT-} = V_{BOT} - V_{HYST}/2$.

The BOD circuit can be enabled/disabled by the fuse BODEN. When the BOD is enabled (BODEN programmed), and V_{CC} decreases to a value below the trigger level (V_{BOT-} in Figure 19), the Brown-out Reset is immediately activated. When V_{CC} increases above the trigger level (V_{BOT+} in Figure 19), the delay counter starts the MCU after the time-out period t_{TOUT} has expired.

The BOD circuit will only detect a drop in V_{CC} if the voltage stays below the trigger level for longer than t_{BOD} given in Table 15.

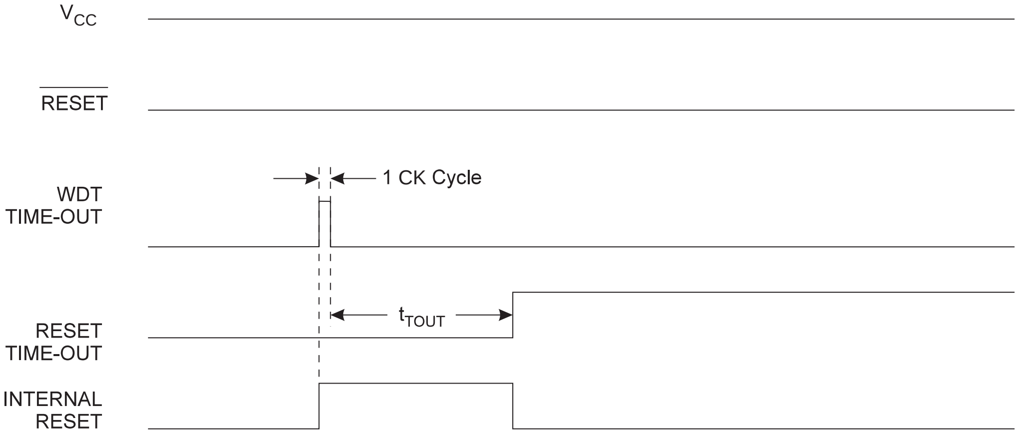
Figure 19. Brown-out Reset During Operation



Watchdog Reset

When the Watchdog times out, it will generate a short reset pulse of one CK cycle duration. On the falling edge of this pulse, the delay timer starts counting the Time-out period t_{TOUT}. Refer to page 39 for details on operation of the Watchdog Timer.

Figure 20. Watchdog Reset During Operation



MCU Control and Status Register – MCUCSR

The MCU Control and Status Register provides information on which reset source caused an MCU Reset.

Bit	7	6	5	4	3	2	1	0	
	–	ISC2	–	–	WDRF	BORF	EXTRF	PORF	MCUCSR
Read/Write	R/W	R/W	R	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	See Bit Description					

- **Bit 3 – WDRF: Watchdog Reset Flag**

This bit is set if a Watchdog Reset occurs. The bit is reset by a Power-on Reset, or by writing a logic zero to the flag.

- **Bit 2 – BORF: Brown-out Reset Flag**

This bit is set if a Brown-out Reset occurs. The bit is reset by a Power-on Reset, or by writing a logic zero to the flag.

- **Bit 1 – EXTRF: External Reset Flag**

This bit is set if an External Reset occurs. The bit is reset by a Power-on Reset, or by writing a logic zero to the flag.

- **Bit 0 – PORF: Power-on Reset Flag**

This bit is set if a Power-on Reset occurs. The bit is reset only by writing a logic zero to the flag.

To make use of the Reset Flags to identify a reset condition, the user should read and then reset the MCUCSR as early as possible in the program. If the register is cleared before another reset occurs, the source of the reset can be found by examining the Reset Flags.

Internal Voltage Reference

ATmega8535 features an internal bandgap reference. This reference is used for Brown-out Detection, and it can be used as an input to the Analog Comparator or the ADC. The 2.56V reference to the ADC is generated from the internal bandgap reference.

Voltage Reference Enable Signals and Start-up Time

The voltage reference has a start-up time that may influence the way it should be used. The start-up time is given in Table 16. To save power, the reference is not always turned on. The reference is on during the following situations:

1. When the BOD is enabled (by programming the BODEN Fuse).
2. When the bandgap reference is connected to the Analog Comparator (by setting the ACBG bit in ACSR).
3. When the ADC is enabled.

Thus, when the BOD is not enabled, after setting the ACBG bit or enabling the ADC, the user must always allow the reference to start up before the output from the Analog Comparator or ADC is used. To reduce power consumption in Power-down mode, the user can avoid the three conditions above to ensure that the reference is turned off before entering Power-down mode.

Table 16. Internal Voltage Reference Characteristics(1)

Symbol	Parameter	Min	Typ	Max	Units
V_{BG}	Bandgap reference voltage	1.15	1.23	1.35	V
t_{BG}	Bandgap reference start-up time		40	70	µs
I_{BG}	Bandgap reference current consumption		10		µA

Note: 1. Values are guidelines only.

Watchdog Timer

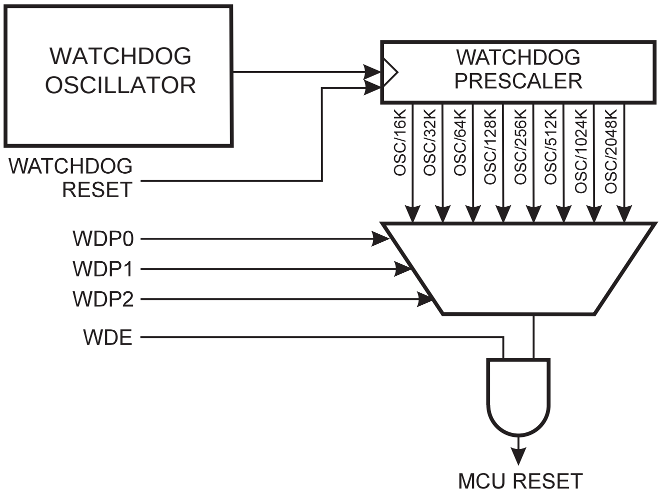
The Watchdog Timer is clocked from a separate On-chip Oscillator which runs at 1 MHz. This is the typical value at V_{CC} = 5V. See characterization data for typical values at other V_{CC} levels. By controlling the Watchdog Timer prescaler, the Watchdog Reset interval can be adjusted as shown in Table 18 on page 41. The WDR – Watchdog Reset – instruction resets the Watchdog Timer. The Watchdog Timer is also reset when it is disabled and when a Chip Reset occurs. Eight different clock cycle periods can be selected to determine the reset period. If the reset period expires without another Watchdog Reset, the ATmega8535 resets and executes from the Reset Vector. For timing details on the Watchdog Reset, refer to page 38.

To prevent unintentional disabling of the Watchdog or unintentional change of Time-out period, three different safety levels are selected by the Fuses S8535C and WDTON as shown in Table 17. Safety level 0 corresponds to the setting in AT90S8535. There is no restriction on enabling the WDT in any of the safety levels.

Table 17. WDT Configuration as a Function of the Fuse Settings of M103C and WDTON

S8535C	WDTON	Safety Level	WDT Initial State	How to Disable the WDT	How to Change Time-out
Unprogrammed	Unprogrammed	1	Disabled	Timed sequence	Timed sequence
Unprogrammed	Programmed	2	Enabled	Always enabled	Timed sequence
Programmed	Unprogrammed	0	Disabled	Timed sequence	No restriction
Programmed	Programmed	2	Enabled	Always enabled	Timed sequence

Figure 21. Watchdog Timer



Watchdog Timer Control Register – WDTCR

Bit	7	6	5	4	3	2	1	0	
	–	–	–	WDCE	WDE	WDP2	WDP1	WDP0	WDTCR
Read/Write	R	R	R	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bits 7..5 – Res: Reserved Bits**

These bits are reserved bits in the ATmega8535 and will always read as zero.

- **Bit 4 – WDCE: Watchdog Change Enable**

This bit must be set when the WDE bit is written to logic zero. Otherwise, the Watchdog will not be disabled. Once written to one, hardware will clear this bit after four clock cycles. Refer to the description of the WDE bit for a Watchdog disable procedure. In Safety Level 1 and 2, this bit must also be set when changing the prescaler bits. See “Timed Sequences for Changing the Configuration of the Watchdog Timer” on page 43.

- **Bit 3 – WDE: Watchdog Enable**

When the WDE is written to logic one, the Watchdog Timer is enabled, and if the WDE is written to logic zero, the Watchdog Timer function is disabled. WDE can only be cleared if the WDCE bit has logic level one. To disable an enabled Watchdog Timer, the following procedure must be followed:

1. In the same operation, write a logic one to WDCE and WDE. A logic one must be written to WDE even though it is set to one before the disable operation starts.
2. Within the next four clock cycles, write a logic 0 to WDE. This disables the watchdog.

In safety level 2, it is not possible to disable the Watchdog Timer, even with the algorithm described above. See “Timed Sequences for Changing the Configuration of the Watchdog Timer” on page 43.

- **Bits 2..0 – WDP2, WDP1, WDP0: Watchdog Timer Prescaler 2, 1, and 0**

The WDP2, WDP1, and WDP0 bits determine the Watchdog Timer prescaling when the Watchdog Timer is enabled. The different prescaling values and their corresponding Timeout Periods are shown in Table 18.

Table 18. Watchdog Timer Prescale Select[1]

WDP2	WDP1	WDP0	Number of WDT Oscillator Cycles	Typical Time-out at V_{CC} = 3.0V	Typical Time-out at V_{CC} = 5.0V
0	0	0	16K (16,384)	17.1 ms	16.3 ms
0	0	1	32K (32,768)	34.3 ms	32.5 ms
0	1	0	64K (65,536)	68.5 ms	65 ms
0	1	1	128K (131,072)	0.14 s	0.13 s
1	0	0	256K (262,144)	0.27 s	0.26 s
1	0	1	512K (524,288)	0.55 s	0.52 s
1	1	0	1,024K (1,048,576)	1.1 s	1.0 s
1	1	1	2,048K (2,097,152)	2.2 s	2.1 s

Note: 1. Values are guidelines only.

The following code example shows one assembly and one C function for turning off the WDT. The example assumes that interrupts are controlled (e.g., by disabling interrupts globally) so that no interrupts will occur during execution of these functions.

Assembly Code Example

```
WDT_off:
  ; Reset WDT
  wdr
  ; Write logical one to WDCE and WDE
  in    r16, WDTCR
  ori   r16, (1<<WDCE)|(1<<WDE)
  out   WDTCR, r16
  ; Turn off WDT
  ldi   r16, (0<<WDE)
  out   WDTCR, r16
  ret
```

C Code Example

```
void WDT_off(void)
{
  /* Reset WDT */
  _WDR()
  /* Write logical one to WDCE and WDE */
  WDTCR |= (1<<WDCE) | (1<<WDE);
  /* Turn off WDT */
  WDTCR = 0x00;
}
```

Timed Sequences for Changing the Configuration of the Watchdog Timer

The sequence for changing the Watchdog Timer configuration differs slightly between the three safety levels. Separate procedures are described for each level.

Safety Level 0

This mode is compatible with the Watchdog operation found in AT90S8535. The Watchdog Timer is initially disabled, but can be enabled by writing the WDE bit to 1 without any restriction. The Time-out period can be changed at any time without restriction. To disable an enabled Watchdog Timer and/or changing the Watchdog Time-out, the following procedure must be followed:

1. In the same operation, write a logic one to WDCE and WDE. A logic one must be written to WDE regardless of the previous value of the WDE bit.
2. Within the next four clock cycles, in the same operation, write the WDE and WDP bits as desired, but with the WDCE bit cleared.

Safety Level 1

In this mode, the Watchdog Timer is initially disabled, but can be enabled by writing the WDE bit to 1 without any restriction. A timed sequence is needed when changing the Watchdog Time-out period or disabling an enabled Watchdog Timer. To disable an enabled Watchdog Timer and/or changing the Watchdog Time-out, the following procedure must be followed:

1. In the same operation, write a logic one to WDCE and WDE. A logic one must be written to WDE regardless of the previous value of the WDE bit.
2. Within the next four clock cycles, in the same operation, write the WDE and WDP bits as desired, but with the WDCE bit cleared.

Safety Level 2

In this mode, the Watchdog Timer is always enabled, and the WDE bit will always read as one. A timed sequence is needed when changing the Watchdog Time-out period. To change the Watchdog Time-out, the following procedure must be followed:

1. In the same operation, write a logical one to WDCE and WDE. Even though the WDE always is set, the WDE must be written to one to start the timed sequence.
2. Within the next four clock cycles, in the same operation, write the WDP bits as desired, but with the WDCE bit cleared. The value written to the WDE bit is irrelevant.

Interrupts

This section describes the specifics of the interrupt handling as performed in ATmega8535. For a general explanation of the AVR interrupt handling, refer to “Reset and Interrupt Handling” on page 11.

Interrupt Vectors in ATmega8535

Table 19. Reset and Interrupt Vectors

Vector No.	Program Address[2]	Source	Interrupt Definition
1	0x000[1]	RESET	External Pin, Power-on Reset, Brown-out Reset and Watchdog Reset
2	0x001	INT0	External Interrupt Request 0
3	0x002	INT1	External Interrupt Request 1
4	0x003	TIMER2 COMP	Timer/Counter2 Compare Match
5	0x004	TIMER2 OVF	Timer/Counter2 Overflow
6	0x005	TIMER1 CAPT	Timer/Counter1 Capture Event
7	0x006	TIMER1 COMPA	Timer/Counter1 Compare Match A
8	0x007	TIMER1 COMPB	Timer/Counter1 Compare Match B
9	0x008	TIMER1 OVF	Timer/Counter1 Overflow
10	0x009	TIMER0 OVF	Timer/Counter0 Overflow
11	0x00A	SPI, STC	Serial Transfer Complete
12	0x00B	USART, RXC	USART, Rx Complete
13	0x00C	USART, UDRE	USART Data Register Empty
14	0x00D	USART, TXC	USART, Tx Complete
15	0x00E	ADC	ADC Conversion Complete
16	0x00F	EE_RDY	EEPROM Ready
17	0x010	ANA_COMP	Analog Comparator
18	0x011	TWI	Two-wire Serial Interface
19	0x012	INT2	External Interrupt Request 2
20	0x013	TIMER0 COMP	Timer/Counter0 Compare Match
21	0x014	SPM_RDY	Store Program Memory Ready

Notes:
1. When the BOOTRST Fuse is programmed, the device will jump to the Boot Loader address at reset, see “Boot Loader Support – Read-While-Write Self-Programming” on page 220.
2. When the IVSEL bit in GICR is set, Interrupt Vectors will be moved to the start of the Boot Flash section. The address of each Interrupt Vector will then be the address in this table added to the start address of the Boot Flash section.

Table 20 shows reset and Interrupt Vectors placement for the various combinations of BOOTRST and IVSEL settings. If the program never enables an interrupt source, the Interrupt Vectors are not used, and regular program code can be placed at these locations. This is also the case if the Reset Vector is in the Application section while the Interrupt Vectors are in the Boot section or vice versa.

Table 20. Reset and Interrupt Vectors Placement

BOOTRST(1)	IVSEL	Reset Address	Interrupt Vectors Start Address
1	0	0x0000	0x0001
1	1	0x0000	Boot Reset Address + 0x0001
0	0	Boot Reset Address	0x0001
0	1	Boot Reset Address	Boot Reset Address + 0x0001

Note: 1. The Boot Reset Address is shown in Table 93 on page 231. For the BOOTRST Fuse "1" means unprogrammed while "0" means programmed.

The most typical and general program setup for the Reset and Interrupt Vector Addresses in ATmega8535 is:

```
AddressLabels  Code                      Comments
0x000          rjmp   RESET              ; Reset Handler
0x001          rjmp   EXT_INT0           ; IRQ0 Handler
0x002          rjmp   EXT_INT1           ; IRQ1 Handler
0x003          rjmp   TIM2_COMP          ; Timer2 Compare Handler
0x004          rjmp   TIM2_OVF           ; Timer2 Overflow Handler
0x005          rjmp   TIM1_CAPT          ; Timer1 Capture Handler
0x006          rjmp   TIM1_COMPA         ; Timer1 Compare A Handler
0x007          rjmp   TIM1_COMPB         ; Timer1 Compare B Handler
0x008          rjmp   TIM1_OVF           ; Timer1 Overflow Handler
0x009          rjmp   TIM0_OVF           ; Timer0 Overflow Handler
0x00A          rjmp   SPI_STC            ; SPI Transfer Complete Handler
0x00B          rjmp   USART_RXC          ; USART RX Complete Handler
0x00C          rjmp   USART_UDRE         ; UDR Empty Handler
0x00D          rjmp   USART_TXC          ; USART TX Complete Handler
0x00E          rjmp   ADC                ; ADC Conversion Complete Handler
0x00F          rjmp   EE_RDY             ; EEPROM Ready Handler
0x010          rjmp   ANA_COMP           ; Analog Comparator Handler
0x011          rjmp   TWSI               ; Two-wire Serial Interface Handler
0x012          rjmp   EXT_INT2           ; IRQ2 Handler
0x013          rjmp   TIM0_COMP          ; Timer0 Compare Handler
0x014          rjmp   SPM_RDY            ; Store Program Memory Ready Handler
;
0x015  RESET:  ldi    r16,high(RAMEND) ; Main program start
0x016          out    SPH,r16            ; Set Stack Pointer to top of RAM
0x017          ldi    r16,low(RAMEND)
0x018          out    SPL,r16
0x019          sei                       ; Enable interrupts
0x020          <instr>  xxx
...    ...     ...
```

When the BOOTRST Fuse is unprogrammed, the Boot section size set to 2K bytes and the IVSEL bit in the GICR Register is set before any interrupts are enabled, the most typical and general program setup for the Reset and Interrupt Vector Addresses is:

```
AddressLabels    Code                     Comments
0x000  RESET:    ldi    r16,high(RAMEND) ; Main program start
0x001            out    SPH,r16          ; Set Stack Pointer to top of RAM
0x002            ldi    r16,low(RAMEND)
0x003            out    SPL,r16
0x004            sei                     ; Enable interrupts
0x005            <instr>  xxx
;
.org 0xC01
0xC01            rjmp   EXT_INT0         ; IRQ0 Handler
0xC02            rjmp   EXT_INT1         ; IRQ1 Handler
...    ....      ..                      ;
0xC14            rjmp   SPM_RDY          ; Store Program Memory Ready Handler
```

When the BOOTRST Fuse is programmed and the Boot section size set to 2K bytes, the most typical and general program setup for the Reset and Interrupt Vector Addresses is:

```
AddressLabels    Code                     Comments
.org 0x001
0x001            rjmp   EXT_INT0         ; IRQ0 Handler
0x002            rjmp   EXT_INT1         ; IRQ1 Handler
...    ... .     ..                      ;
0x014            rjmp   SPM_RDY          ; Store Program Memory Ready Handler
;
.org 0xC00
0xC00  RESET:    ldi    r16,high(RAMEND) ; Main program start
0xC01            out    SPH,r16          ; Set Stack Pointer to top of RAM
0xC02            ldi    r16,low(RAMEND)
0xC03            out    SPL,r16
0xC04            sei                     ; Enable interrupts
0xC05            <instr>  xxx
```

When the BOOTRST Fuse is programmed, the Boot section size set to 2K bytes and the IVSEL bit in the GICR Register is set before any interrupts are enabled, the most typical and general program setup for the Reset and Interrupt Vector Addresses is:

```
AddressLabels    Code                     Comments
.org 0xC00
0xC00            rjmp   RESET            ; Reset handler
0xC01            rjmp   EXT_INT0         ; IRQ0 Handler
0xC02            rjmp   EXT_INT1         ; IRQ1 Handler
...    ... .     ..                      ;
0xC14            rjmp   SPM_RDY          ; Store Program Memory Ready Handler
;
0xC15  RESET:    ldi    r16,high(RAMEND) ;Main program start
0xC16            out    SPH,r16          ; Set Stack Pointer to top of RAM
0xC17            ldi    r16,low(RAMEND)
0xC18            out    SPL,r16
0xC19            sei                     ; Enable interrupts
0xC20            <instr>  xxx
```

Moving Interrupts Between Application and Boot Space

The General Interrupt Control Register controls the placement of the Interrupt Vector table.

General Interrupt Control Register – GICR

Bit	7	6	5	4	3	2	1	0	
	INT1	**INT0**	**INT2**	**–**	**–**	**–**	**IVSEL**	**IVCE**	**GICR**
Read/Write	R/W	R/W	R/W	R	R	R	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 1 – IVSEL: Interrupt Vector Select**

When the IVSEL bit is cleared (zero), the Interrupt Vectors are placed at the start of the Flash memory. When this bit is set (one), the Interrupt Vectors are moved to the beginning of the Boot Loader section of the Flash. The actual address of the start of the Boot Flash section is determined by the BOOTSZ Fuses. Refer to the section "Boot Loader Support – Read-While-Write Self-Programming" on page 220 for details. To avoid unintentional changes of Interrupt Vector tables, a special write procedure must be followed to change the IVSEL bit:

1. Write the Interrupt Vector Change Enable (IVCE) bit to one.
2. Within four cycles, write the desired value to IVSEL while writing a zero to IVCE.

Interrupts will automatically be disabled while this sequence is executed. Interrupts are disabled in the cycle IVCE is set, and they remain disabled until after the instruction following the write to IVSEL. If IVSEL is not written, interrupts remain disabled for four cycles. The I-bit in the Status Register is unaffected by the automatic disabling.

Note: If Interrupt Vectors are placed in the Boot Loader section and Boot Lock bit BLB02 is programmed, interrupts are disabled while executing from the Application section. If Interrupt Vectors are placed in the Application section and Boot Lock bit BLB12 is programed, interrupts are disabled while executing from the Boot Loader section. Refer to the section "Boot Loader Support – Read-While-Write Self-Programming" on page 220 for details on Boot Lock bits.

- **Bit 0 – IVCE: Interrupt Vector Change Enable**

The IVCE bit must be written to logic one to enable change of the IVSEL bit. IVCE is cleared by hardware four cycles after it is written or when IVSEL is written. Setting the IVCE bit will disable interrupts, as explained in the IVSEL description above. See Code Example below.

Assembly Code Example

```
Move_interrupts:
    ; Enable change of interrupt vectors
    ldi    r16, (1<<IVCE)
    out    GICR, r16
    ; Move interrupts to boot Flash section
    ldi    r16, (1<<IVSEL)
    out    GICR, r16
    ret
```

C Code Example

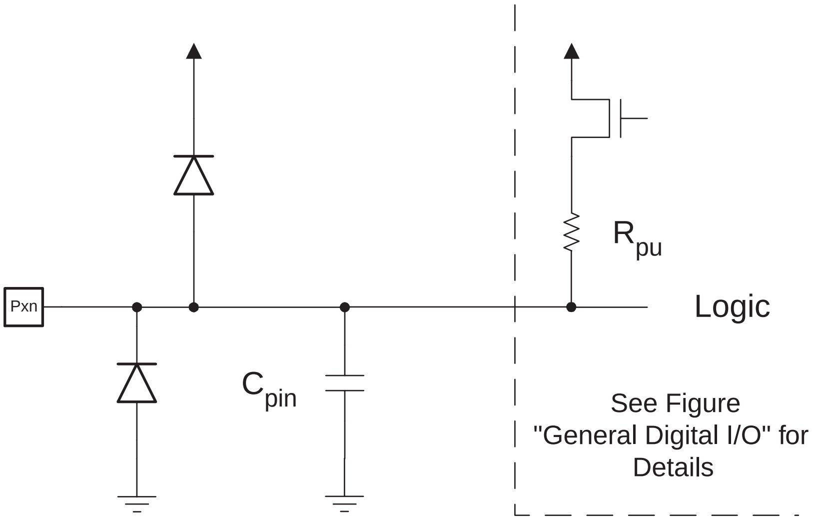
```
void Move_interrupts(void)
{
    /* Enable change of interrupt vectors */
    GICR = (1<<IVCE);
    /* Move interrupts to boot Flash section */
    GICR = (1<<IVSEL);
}
```

I/O-Ports

Introduction

All AVR ports have true Read-Modify-Write functionality when used as general digital I/O ports. This means that the direction of one port pin can be changed without unintentionally changing the direction of any other pin with the SBI and CBI instructions. The same applies when changing drive value (if configured as output) or enabling/disabling of pull-up resistors (if configured as input). Each output buffer has symmetrical drive characteristics with both high sink and source capability. The pin driver is strong enough to drive LED displays directly. All port pins have individually selectable pull-up resistors with a supply-voltage invariant resistance. All I/O pins have protection diodes to both V_{CC} and Ground as indicated in Figure 22. Refer to “Electrical Characteristics” on page 251 for a complete list of parameters.

Figure 22. I/O Pin Equivalent Schematic



All registers and bit references in this section are written in general form. A lower case “x” represents the numbering letter for the port, and a lower case “n” represents the bit number. However, when using the register or bit defines in a program, the precise form must be used. For example, PORTB3 for bit no. 3 in Port B, here documented generally as PORTxn. The physical I/O Registers and bit locations are listed in “Register Description for I/O-Ports” on page 63.

Three I/O memory address locations are allocated for each port, one each for the Data Register – PORTx, Data Direction Register – DDRx, and the Port Input Pins – PINx. The Port Input Pins I/O location is read only, while the Data Register and the Data Direction Register are read/write. In addition, the Pull-up Disable – PUD bit in SFIOR disables the pull-up function for all pins in all ports when set.

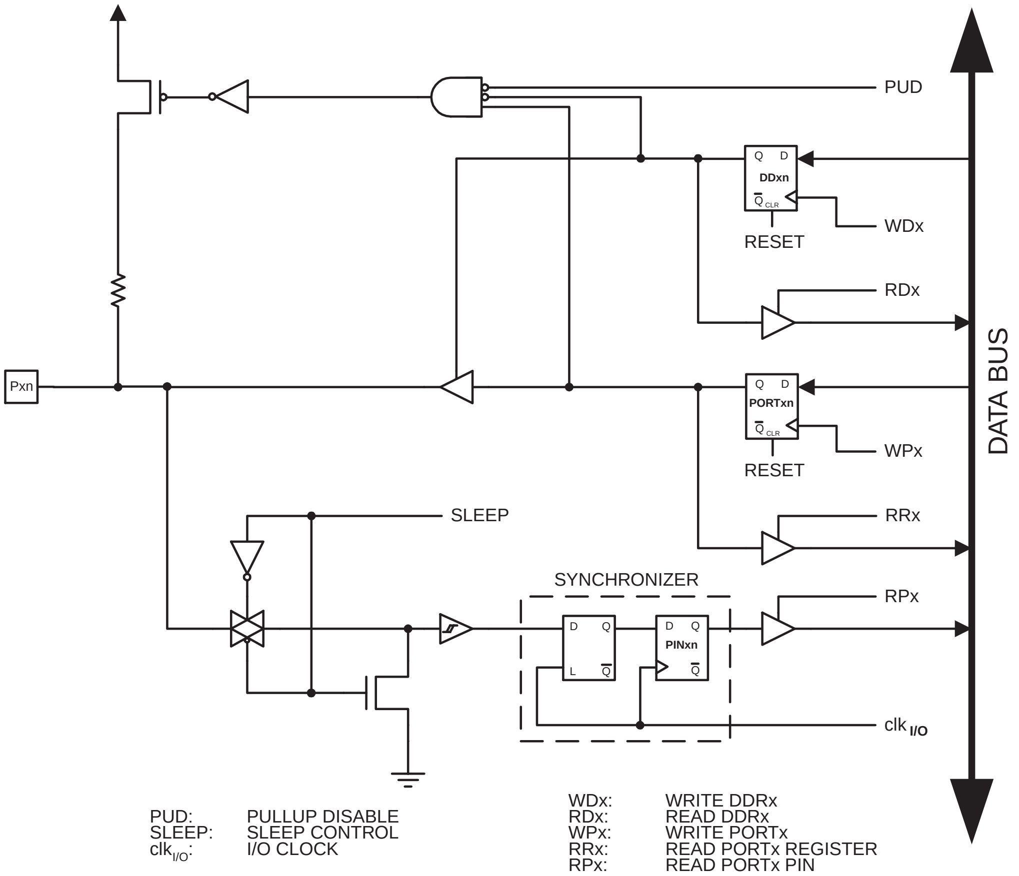
Using the I/O port as General Digital I/O is described in “Ports as General Digital I/O” on page 50. Most port pins are multiplexed with alternate functions for the peripheral features on the device. How each alternate function interferes with the port pin is described in “Alternate Port Functions” on page 54. Refer to the individual module sections for a full description of the alternate functions.

Note that enabling the alternate function of some of the port pins does not affect the use of the other pins in the port as general digital I/O.

Ports as General Digital I/O

The ports are bi-directional I/O ports with optional internal pull-ups. Figure 23 shows a functional description of one I/O-port pin, here generically called Pxn.

Figure 23. General Digital I/O(1)



Note: 1. WPx, WDx, RRx, RPx, and RDx are common to all pins within the same port. clk$_{I/O}$, SLEEP, and PUD are common to all ports.

Configuring the Pin

Each port pin consists of three register bits: DDxn, PORTxn, and PINxn. As shown in "Register Description for I/O-Ports" on page 63, the DDxn bits are accessed at the DDRx I/O address, the PORTxn bits at the PORTx I/O address, and the PINxn bits at the PINx I/O address.

The DDxn bit in the DDRx Register selects the direction of this pin. If DDxn is written logic one, Pxn is configured as an output pin. If DDxn is written logic zero, Pxn is configured as an input pin.

If PORTxn is written a logic one when the pin is configured as an input pin, the pull-up resistor is activated. To switch the pull-up resistor off, PORTxn has to be written logic zero or the pin has to be configured as an output pin. The port pins are tri-stated when a reset condition becomes active, even if no clocks are running.

If PORTxn is written a logic one when the pin is configured as an output pin, the port pin is driven high (one). If PORTxn is written a logic zero when the pin is configured as an output pin, the port pin is driven low (zero).

When switching between tri-state ({DDxn, PORTxn} = 0b00) and output high ({DDxn, PORTxn} = 0b11), an intermediate state with either pull-up enabled ({DDxn, PORTxn} =

0b01) or output low ({DDxn, PORTxn} = 0b10) must occur. Normally, the pull-up enabled state is fully acceptable, as a high-impedant environment will not notice the difference between a strong high driver and a pull-up. If this is not the case, the PUD bit in the SFIOR Register can be set to disable all pull-ups in all ports.

Switching between input with pull-up and output low generates the same problem. The user must use either the tri-state ({DDxn, PORTxn} = 0b00) or the output high state ({DDxn, PORTxn} = 0b10) as an intermediate step.

Table 21 summarizes the control signals for the pin value.

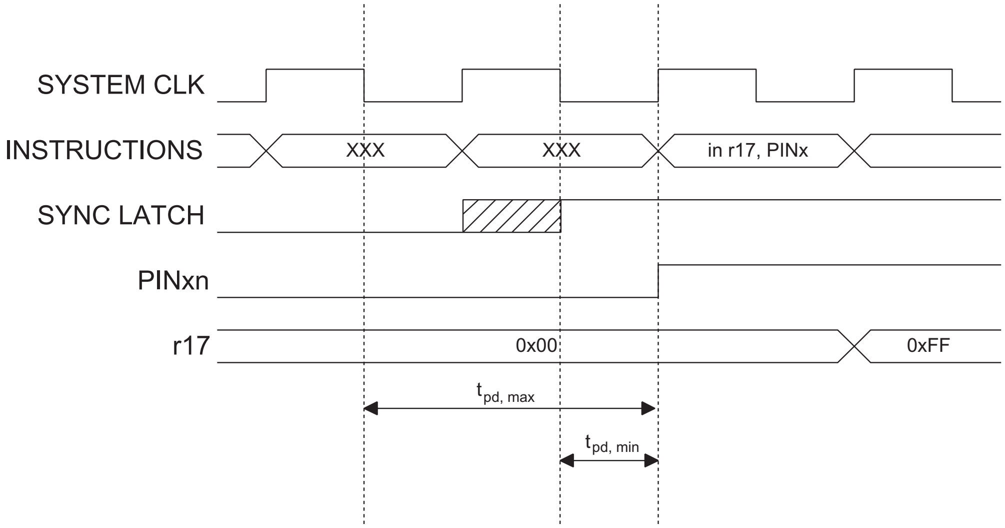
Table 21. Port Pin Configurations

DDxn	PORTxn	PUD (in SFIOR)	I/O	Pull-up	Comment
0	0	X	Input	No	Tri-state (Hi-Z)
0	1	0	Input	Yes	Pxn will source current if ext. pulled low.
0	1	1	Input	No	Tri-state (Hi-Z)
1	0	X	Output	No	Output Low (Sink)
1	1	X	Output	No	Output High (Source)

Reading the Pin Value

Independent of the setting of Data Direction bit DDxn, the port pin can be read through the PINxn Register bit. As shown in Figure 23, the PINxn Register bit and the preceding latch constitute a synchronizer. This is needed to avoid metastability if the physical pin changes value near the edge of the internal clock, but it also introduces a delay. Figure 24 shows a timing diagram of the synchronization when reading an externally applied pin value. The maximum and minimum propagation delays are denoted $t_{pd,max}$ and $t_{pd,min}$ respectively.

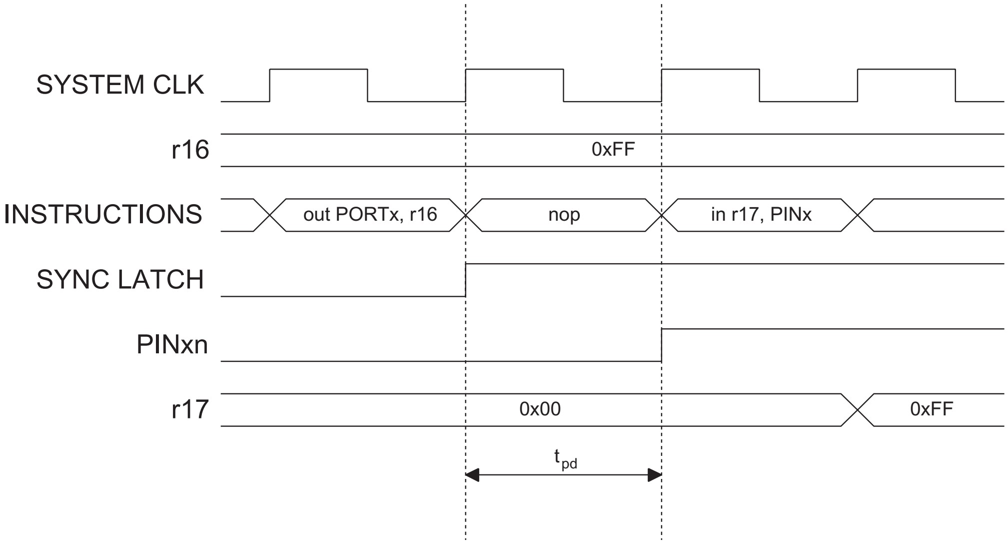
Figure 24. Synchronization when Reading an Externally Applied Pin Value



Consider the clock period starting shortly *after* the first falling edge of the system clock. The latch is closed when the clock is low, and goes transparent when the clock is high, as indicated by the shaded region of the “SYNC LATCH” signal. The signal value is latched when the system clock goes low. It is clocked into the PINxn Register at the succeeding positive clock edge. As indicated by the two arrows $t_{pd,max}$ and $t_{pd,min}$, a single signal transition on the pin will be delayed between ½ and 1½ system clock period depending upon the time of assertion.

When reading back a software assigned pin value, a *nop* instruction must be inserted as indicated in Figure 25. The *out* instruction sets the “SYNC LATCH” signal at the positive edge of the clock. In this case, the delay t_{pd} through the synchronizer is one system clock period.

Figure 25. Synchronization when Reading a Software Assigned Pin Value



The following code example shows how to set port B pins 0 and 1 high, 2 and 3 low, and define the port pins from 4 to 7 as input with pull-ups assigned to port pins 6 and 7. The resulting pin values are read back again, but as previously discussed, a *nop* instruction is included to be able to read back the value recently assigned to some of the pins.

Assembly Code Example[1]

```
...
; Define pull-ups and set outputs high
; Define directions for port pins
ldi    r16,(1<<PB7)|(1<<PB6)|(1<<PB1)|(1<<PB0)
ldi    r17,(1<<DDB3)|(1<<DDB2)|(1<<DDB1)|(1<<DDB0)
out    PORTB,r16
out    DDRB,r17
; Insert nop for synchronization
nop
; Read port pins
in     r16,PINB
...
```

C Code Example

```
unsigned char i;
  ...
  /* Define pull-ups and set outputs high */
  /* Define directions for port pins */
  PORTB = (1<<PB7)|(1<<PB6)|(1<<PB1)|(1<<PB0);
  DDRB = (1<<DDB3)|(1<<DDB2)|(1<<DDB1)|(1<<DDB0);
  /* Insert nop for synchronization*/
  _NOP();
  /* Read port pins */
  i = PINB;
  ...
```

Note: 1. For the assembly program, two temporary registers are used to minimize the time from pull-ups are set on pins 0, 1, 6, and 7, until the direction bits are correctly set, defining bits 2 and 3 as low and redefining bits 0 and 1 as strong high drivers.

Digital Input Enable and Sleep Modes

As shown in Figure 23, the digital input signal can be clamped to ground at the input of the schmitt trigger. The signal denoted SLEEP in the figure, is set by the MCU sleep controller in Power-down mode, Power-save mode, Standby mode, and Extended Standby mode to avoid high power consumption if some input signals are left floating, or have an analog signal level close to $V_{CC}/2$.

SLEEP is overridden for port pins enabled as External Interrupt pins. If the External Interrupt Request is not enabled, SLEEP is active also for these pins. SLEEP is also overridden by various other alternate functions as described in “Alternate Port Functions” on page 54.

If a logic high level (“one”) is present on an Asynchronous External Interrupt pin configured as “Interrupt on Rising Edge, Falling Edge, or Any Logic Change on Pin” while the external interrupt is *not* enabled, the corresponding External Interrupt Flag will be set when resuming from the above mentioned sleep modes, as the clamping in these sleep modes produces the requested logic change.

Unconnected pins

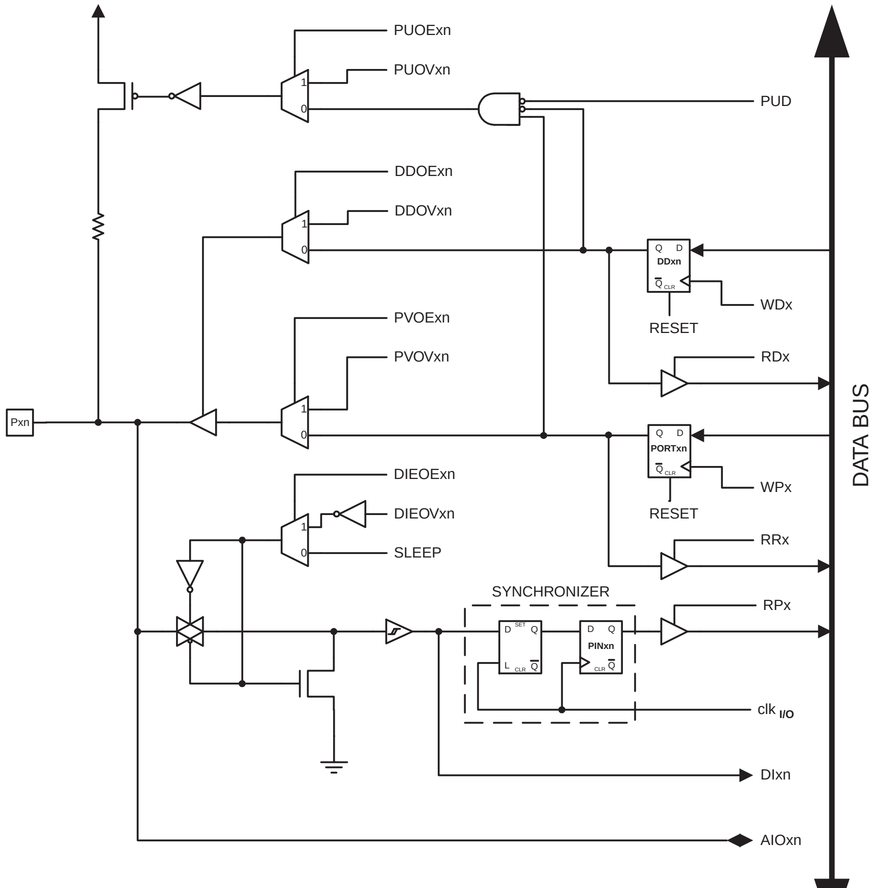
If some pins are unused, it is recommended to ensure that these pins have a defined level. Even though most of the digital inputs are disabled in the deep sleep modes as described above, floating inputs should be avoided to reduce current consumption in all other modes where the digital inputs are enabled (Reset, Active mode and Idle mode).

The simplest method to ensure a defined level of an unused pin, is to enable the internal pullup. In this case, the pullup will be disabled during reset. If low power consumption during reset is important, it is recommended to use an external pullup or pulldown. Connecting unused pins directly to V_{CC} or GND is not recommended, since this may cause excessive currents if the pin is accidentally configured as an output.

Alternate Port Functions

Most port pins have alternate functions in addition to being general digital I/Os. Figure 26 shows how the port pin control signals from the simplified Figure 23 can be overridden by alternate functions. The overriding signals may not be present in all port pins, but the figure serves as a generic description applicable to all port pins in the AVR microcontroller family.

Figure 26. Alternate Port Functions(1)



PUOExn:	Pxn PULL-UP OVERRIDE ENABLE
PUOVxn:	Pxn PULL-UP OVERRIDE VALUE
DDOExn:	Pxn DATA DIRECTION OVERRIDE ENABLE
DDOVxn:	Pxn DATA DIRECTION OVERRIDE VALUE
PVOExn:	Pxn PORT VALUE OVERRIDE ENABLE
PVOVxn:	Pxn PORT VALUE OVERRIDE VALUE
DIEOExn:	Pxn DIGITAL INPUT-ENABLE OVERRIDE ENABLE
DIEOVxn:	Pxn DIGITAL INPUT-ENABLE OVERRIDE VALUE
SLEEP:	SLEEP CONTROL
PUD:	PULLUP DISABLE
WDx:	WRITE DDRx
RDx:	READ DDRx
RRx:	READ PORTx REGISTER
WPx:	WRITE PORTx
RPx:	READ PORTx PIN
$clk_{I/O}$:	I/O CLOCK
DIxn:	DIGITAL INPUT PIN n ON PORTx
AIOxn:	ANALOG INPUT/OUTPUT PIN n ON PORTx

Note: 1. WPx, WDx, RRx, RPx, and RDx are common to all pins within the same port. $clk_{I/O}$, SLEEP, and PUD are common to all ports. All other signals are unique for each pin.

Table 22 summarizes the function of the overriding signals. The pin and port indexes from Figure 26 are not shown in the succeeding tables. The overriding signals are generated internally in the modules having the alternate function.

Table 22. Generic Description of Overriding Signals for Alternate Functions

Signal Name	Full Name	Description
PUOE	Pull-up Override Enable	If this signal is set, the pull-up enable is controlled by the PUOV signal. If this signal is cleared, the pull-up is enabled when {DDxn, PORTxn, PUD} = 0b010.
PUOV	Pull-up Override Value	If PUOE is set, the pull-up is enabled/disabled when PUOV is set/cleared, regardless of the setting of the DDxn, PORTxn, and PUD Register bits.
DDOE	Data Direction Override Enable	If this signal is set, the Output Driver Enable is controlled by the DDOV signal. If this signal is cleared, the Output driver is enabled by the DDxn Register bit.
DDOV	Data Direction Override Value	If DDOE is set, the Output Driver is enabled/disabled when DDOV is set/cleared, regardless of the setting of the DDxn Register bit.
PVOE	Port Value Override Enable	If this signal is set and the Output Driver is enabled, the port value is controlled by the PVOV signal. If PVOE is cleared, and the Output Driver is enabled, the port Value is controlled by the PORTxn Register bit.
PVOV	Port Value Override Value	If PVOE is set, the port value is set to PVOV, regardless of the setting of the PORTxn Register bit.
DIEOE	Digital Input Enable Override Enable	If this bit is set, the Digital Input Enable is controlled by the DIEOV signal. If this signal is cleared, the Digital Input Enable is determined by MCU-state (Normal mode, sleep modes).
DIEOV	Digital Input Enable Override Value	If DIEOE is set, the Digital Input is enabled/disabled when DIEOV is set/cleared, regardless of the MCU state (Normal mode, sleep modes).
DI	Digital Input	This is the Digital Input to alternate functions. In the figure, the signal is connected to the output of the schmitt trigger but before the synchronizer. Unless the Digital Input is used as a clock source, the module with the alternate function will use its own synchronizer.
AIO	Analog Input/output	This is the Analog Input/Output to/from alternate functions. The signal is connected directly to the pad, and can be used bi-directionally.

The following subsections shortly describe the alternate functions for each port, and relate the overriding signals to the alternate function. Refer to the alternate function description for further details.

Special Function IO Register – SFIOR

Bit	7	6	5	4	3	2	1	0	
	ADTS2	ADTS1	ADTS0	–	ACME	PUD	PSR2	PSR10	SFIOR
Read/Write	R/W	R/W	R/W	R	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 2 – PUD: Pull-up disable**

When this bit is written to one, the pull-ups in the I/O ports are disabled even if the DDxn and PORTxn Registers are configured to enable the pull-ups ({DDxn, PORTxn} = 0b01). See “Configuring the Pin” on page 50 for more details about this feature.

Alternate Functions of Port A

Port A has an alternate function as analog input for the ADC as shown in Table 23. If some Port A pins are configured as outputs, it is essential that these do not switch when a conversion is in progress. This might corrupt the result of the conversion.

Table 23. Port A Pins Alternate Functions

Port Pin	Alternate Function
PA7	ADC7 (ADC input channel 7)
PA6	ADC6 (ADC input channel 6)
PA5	ADC5 (ADC input channel 5)
PA4	ADC4 (ADC input channel 4)
PA3	ADC3 (ADC input channel 3)
PA2	ADC2 (ADC input channel 2)
PA1	ADC1 (ADC input channel 1)
PA0	ADC0 (ADC input channel 0)

Table 24 and Table 25 relate the alternate functions of Port A to the overriding signals shown in Figure 26 on page 54.

Table 24. Overriding Signals for Alternate Functions in PA7..PA4

Signal Name	PA7/ADC7	PA6/ADC6	PA5/ADC5	PA4/ADC4
PUOE	0	0	0	0
PUOV	0	0	0	0
DDOE	0	0	0	0
DDOV	0	0	0	0
PVOE	0	0	0	0
PVOV	0	0	0	0
DIEOE	0	0	0	0
DIEOV	0	0	0	0
DI	–	–	–	–
AIO	ADC7 INPUT	ADC6 INPUT	ADC5 INPUT	ADC4 INPUT

Table 25. Overriding Signals for Alternate Functions in PA3..PA0

Signal Name	PA3/ADC3	PA2/ADC2	PA1/ADC1	PA0/ADC0
PUOE	0	0	0	0
PUOV	0	0	0	0
DDOE	0	0	0	0
DDOV	0	0	0	0
PVOE	0	0	0	0
PVOV	0	0	0	0
DIEOE	0	0	0	0
DIEOV	0	0	0	0
DI	–	–	–	–
AIO	ADC3 INPUT	ADC2 INPUT	ADC1 INPUT	ADC0 INPUT

Alternate Functions Of Port B

The Port B pins with alternate functions are shown in Table 26.

Table 26. Port B Pins Alternate Functions

Port Pin	Alternate Functions
PB7	SCK (SPI Bus Serial Clock)
PB6	MISO (SPI Bus Master Input/Slave Output)
PB5	MOSI (SPI Bus Master Output/Slave Input)
PB4	$\overline{\text{SS}}$ (SPI Slave Select Input)
PB3	AIN1 (Analog Comparator Negative Input) OC0 (Timer/Counter0 Output Compare Match Output)
PB2	AIN0 (Analog Comparator Positive Input) INT2 (External Interrupt 2 Input)
PB1	T1 (Timer/Counter1 External Counter Input)
PB0	T0 (Timer/Counter0 External Counter Input) XCK (USART External Clock Input/Output)

The alternate pin configuration is as follows:

- **SCK – Port B, Bit 7**

SCK: Master Clock output, Slave Clock input pin for SPI channel. When the SPI is enabled as a Slave, this pin is configured as an input regardless of the setting of DDB7. When the SPI is enabled as a Master, the data direction of this pin is controlled by DDB7. When the pin is forced by the SPI to be an input, the pull-up can still be controlled by the PORTB7 bit.

- **MISO – Port B, Bit 6**

MISO: Master Data input, Slave Data output pin for SPI channel. When the SPI is enabled as a Master, this pin is configured as an input regardless of the setting of DDB6. When the SPI is enabled as a Slave, the data direction of this pin is controlled by DDB6. When the pin is forced by the SPI to be an input, the pull-up can still be controlled by the PORTB6 bit.

- **MOSI – Port B, Bit 5**

MOSI: SPI Master Data output, Slave Data input for SPI channel. When the SPI is enabled as a Slave, this pin is configured as an input regardless of the setting of DDB5. When the SPI is enabled as a Master, the data direction of this pin is controlled by DDB5. When the pin is forced by the SPI to be an input, the pull-up can still be controlled by the PORTB5 bit.

- **$\overline{\text{SS}}$ – Port B, Bit 4**

$\overline{\text{SS}}$: Slave Select input. When the SPI is enabled as a Slave, this pin is configured as an input regardless of the setting of DDB4. As a Slave, the SPI is activated when this pin is driven low. When the SPI is enabled as a Master, the data direction of this pin is controlled by DDB4. When the pin is forced by the SPI to be an input, the pull-up can still be controlled by the PORTB4 bit.

- **AIN1/OC0 – Port B, Bit 3**

AIN1, Analog Comparator Negative input. Configure the port pin as input with the internal pull-up switched off to avoid the digital port function from interfering with the function of the Analog Comparator.

OC0, Output Compare Match output: The PB3 pin can serve as an external output for the Timer/Counter0 Compare Match. The PB3 pin has to be configured as an output (DDB3 set (one)) to serve this function. The OC0 pin is also the output pin for the PWM mode timer function.

- **AIN0/INT2 – Port B, Bit 2**

AIN0, Analog Comparator Positive input. Configure the port pin as input with the internal pull-up switched off to avoid the digital port function from interfering with the function of the Analog Comparator.

INT2, External Interrupt Source 2: The PB2 pin can serve as an external interrupt source to the MCU.

- **T1 – Port B, Bit 1**

T1, Timer/Counter1 Counter Source.

- **T0/XCK – Port B, Bit 0**

T0, Timer/Counter0 Counter Source.

XCK, USART External Clock. The Data Direction Register (DDB0) controls whether the clock is output (DDB0 set) or input (DDB0 cleared). The XCK pin is active only when the USART operates in synchronous mode.

Table 27 and Table 28 relate the alternate functions of Port B to the overriding signals shown in Figure 26 on page 54. SPI MSTR INPUT and SPI SLAVE OUTPUT constitute the MISO signal, while MOSI is divided into SPI MSTR OUTPUT and SPI SLAVE INPUT.

Table 27. Overriding Signals for Alternate Functions in PB7..PB4

Signal Name	PB7/SCK	PB6/MISO	PB5/MOSI	PB4/$\overline{\text{SS}}$
PUOE	SPE • $\overline{\text{MSTR}}$	SPE • MSTR	SPE • $\overline{\text{MSTR}}$	SPE • $\overline{\text{MSTR}}$
PUOV	PORTB7 • $\overline{\text{PUD}}$	PORTB6 • $\overline{\text{PUD}}$	PORTB5 • $\overline{\text{PUD}}$	PORTB4 • $\overline{\text{PUD}}$
DDOE	SPE • $\overline{\text{MSTR}}$	SPE • MSTR	SPE • $\overline{\text{MSTR}}$	SPE • $\overline{\text{MSTR}}$
DDOV	0	0	0	0
PVOE	SPE • MSTR	SPE • $\overline{\text{MSTR}}$	SPE • MSTR	0
PVOV	SCK OUTPUT	SPI SLAVE OUTPUT	SPI MSTR OUTPUT	0
DIEOE	0	0	0	0
DIEOV	0	0	0	0
DI	SCK INPUT	SPI MSTR INPUT	SPI SLAVE INPUT	SPI $\overline{\text{SS}}$
AIO	–	–	–	–

Table 28. Overriding Signals for Alternate Functions in PB3..PB0

Signal Name	PB3/OC0/AIN1	PB2/INT2/AIN0	PB1/T1	PB0/T0/XCK
PUOE	0	0	0	0
PUOV	0	0	0	0
DDOE	0	0	0	0
DDOV	0	0	0	0
PVOE	OC0 ENABLE	0	0	UMSEL
PVOV	OC0	0	0	XCK OUTPUT
DIEOE	0	INT2 ENABLE	0	0
DIEOV	0	1	0	0
DI	–	INT2 INPUT	T1 INPUT	XCK INPUT/ T0 INPUT
AIO	AIN1 INPUT	AIN0 INPUT	–	–

Alternate Functions of Port C

The Port C pins with alternate functions are shown in Table 29.

Table 29. Port C Pins Alternate Functions

Port Pin	Alternate Function
PC7	TOSC2 (Timer Oscillator Pin 2)
PC6	TOSC1 (Timer Oscillator Pin 1)
PC1	SDA (Two-wire Serial Bus Data Input/Output Line)
PC0	SCL (Two-wire Serial Bus Clock Line)

The alternate pin configuration is as follows:

- **TOSC2 – Port C, Bit 7**

TOSC2, Timer Oscillator pin 2: When the AS2 bit in ASSR is set (one) to enable asynchronous clocking of Timer/Counter2, pin PC7 is disconnected from the port, and becomes the inverting output of the Oscillator amplifier. In this mode, a crystal Oscillator is connected to this pin, and the pin can not be used as an I/O pin.

- **TOSC1 – Port C, Bit 6**

TOSC1, Timer Oscillator pin 1: When the AS2 bit in ASSR is set (one) to enable asynchronous clocking of Timer/Counter2, pin PC6 is disconnected from the port, and becomes the input of the inverting Oscillator amplifier. In this mode, a crystal Oscillator is connected to this pin, and the pin can not be used as an I/O pin.

- **SDA – Port C, Bit 1**

SDA, Two-wire Serial Interface Data: When the TWEN bit in TWCR is set (one) to enable the Two-wire Serial Interface, pin PC1 is disconnected from the port and becomes the Serial Data I/O pin for the Two-wire Serial Interface. In this mode, there is a spike filter on the pin to suppress spikes shorter than 50 ns on the input signal, and the pin is driven by an open drain driver with slew-rate limitation. When this pin is used by the Two-wire Serial Interface, the pull-up can still be controlled by the PORTC1 bit.

- **SCL – Port C, Bit 0**

SCL, Two-wire Serial Interface Clock: When the TWEN bit in TWCR is set (one) to enable the Two-wire Serial Interface, pin PC0 is disconnected from the port and becomes the Serial Clock I/O pin for the Two-wire Serial Interface. In this mode, there is a spike filter on the pin to suppress spikes shorter than 50 ns on the input signal, and the pin is driven by an open drain driver with slew-rate limitation. When this pin is used by the Two-wire Serial Interface, the pull-up can still be controlled by the PORTC0 bit.

Table 30 and Table 31 relate the alternate functions of Port C to the overriding signals shown in Figure 26 on page 54.

Table 30. Overriding Signals for Alternate Functions in PC7..PC6

Signal Name	PC7/TOSC2	PC6/TOSC1
PUOE	AS2	AS2
PUOV	0	0
DDOE	AS2	AS2
DDOV	0	0
PVOE	0	0
PVOV	0	0
DIEOE	AS2	AS2
DIEOV	0	0
DI	–	–
AIO	T/C2 OSC OUTPUT	T/C2 OSC INPUT

Table 31. Overriding Signals for Alternate Functions in PC1..PC0[1]

Signal Name	PC1/SDA	PC0/SCL
PUOE	TWEN	TWEN
PUOV	PORTC1 • $\overline{\text{PUD}}$	PORTC0 • $\overline{\text{PUD}}$
DDOE	TWEN	TWEN
DDOV	SDA_OUT	SCL_OUT
PVOE	TWEN	TWEN
PVOV	0	0
DIEOE	0	0
DIEOV	0	0
DI	–	–
AIO	SDA INPUT	SCL INPUT

Note: 1. When enabled, the Two-wire Serial Interface enables slew-rate controls on the output pins PC0 and PC1. This is not shown in the figure. In addition, spike filters are connected between the AIO outputs shown in the port figure and the digital logic of the TWI module.

Alternate Functions of Port D

The Port D pins with alternate functions are shown in Table 32.

Table 32. Port D Pins Alternate Functions

Port Pin	Alternate Function
PD7	OC2 (Timer/Counter2 Output Compare Match Output)
PD6	ICP1 (Timer/Counter1 Input Capture Pin)
PD5	OC1A (Timer/Counter1 Output Compare A Match Output)
PD4	OC1B (Timer/Counter1 Output Compare B Match Output)
PD3	INT1 (External Interrupt 1 Input)
PD2	INT0 (External Interrupt 0 Input)
PD1	TXD (USART Output Pin)
PD0	RXD (USART Input Pin)

The alternate pin configuration is as follows:

- **OC2 – Port D, Bit 7**

OC2, Timer/Counter2 Output Compare Match output: The PD7 pin can serve as an external output for the Timer/Counter2 Output Compare. The pin has to be configured as an output (DDD7 set (one)) to serve this function. The OC2 pin is also the output pin for the PWM mode timer function.

- **ICP1 – Port D, Bit 6**

ICP1 – Input Capture Pin: The PD6 pin can act as an Input Capture pin for Timer/Counter1.

- **OC1A – Port D, Bit 5**

OC1A, Output Compare Match A output: The PD5 pin can serve as an external output for the Timer/Counter1 Output Compare A. The pin has to be configured as an output (DDD5 set (one)) to serve this function. The OC1A pin is also the output pin for the PWM mode timer function.

- **OC1B – Port D, Bit 4**

OC1B, Output Compare Match B output: The PD4 pin can serve as an external output for the Timer/Counter1 Output Compare B. The pin has to be configured as an output (DDD4 set (one)) to serve this function. The OC1B pin is also the output pin for the PWM mode timer function.

- **INT1 – Port D, Bit 3**

INT1, External Interrupt Source 1: The PD3 pin can serve as an external interrupt source.

- **INT0 – Port D, Bit 2**

INT0, External Interrupt Source 0: The PD2 pin can serve as an external interrupt source.

- **TXD – Port D, Bit 1**

TXD, Transmit Data (Data output pin for the USART). When the USART Transmitter is enabled, this pin is configured as an output regardless of the value of DDD1.

- **RXD – Port D, Bit 0**

RXD, Receive Data (Data input pin for the USART). When the USART Receiver is enabled this pin is configured as an input regardless of the value of DDD0. When the USART forces this pin to be an input, the pull-up can still be controlled by the PORTD0 bit.

Table 33 and Table 34 relate the alternate functions of Port D to the overriding signals shown in Figure 26 on page 54.

Table 33. Overriding Signals for Alternate Functions PD7..PD4

Signal Name	PD7/OC2	PD6/ICP1	PD5/OC1A	PD4/OC1B
PUOE	0	0	0	0
PUOV	0	0	0	0
DDOE	0	0	0	0
DDOV	0	0	0	0
PVOE	OC2 ENABLE	0	OC1A ENABLE	OC1B ENABLE
PVOV	OC2	0	OC1A	OC1B
DIEOE	0	0	0	0
DIEOV	0	0	0	0
DI	–	ICP1 INPUT	–	–
AIO	–	–	–	–

Table 34. Overriding Signals for Alternate Functions in PD3..PD0

Signal Name	PD3/INT1	PD2/INT0	PD1/TXD	PD0/RXD
PUOE	0	0	TXEN	RXEN
PUOV	0	0	0	PORTD0 • $\overline{\text{PUD}}$
DDOE	0	0	TXEN	RXEN
DDOV	0	0	1	0
PVOE	0	0	TXEN	0
PVOV	0	0	TXD	0
DIEOE	INT1 ENABLE	INT0 ENABLE	0	0
DIEOV	1	1	0	0
DI	INT1 INPUT	INT0 INPUT	–	RXD
AIO	–	–	–	–

Register Description for I/O-Ports

Port A Data Register – PORTA

Bit	7	6	5	4	3	2	1	0	
	PORTA7	**PORTA6**	**PORTA5**	**PORTA4**	**PORTA3**	**PORTA2**	**PORTA1**	**PORTA0**	**PORTA**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Port A Data Direction Register – DDRA

Bit	7	6	5	4	3	2	1	0	
	DDA7	**DDA6**	**DDA5**	**DDA4**	**DDA3**	**DDA2**	**DDA1**	**DDA0**	**DDRA**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Port A Input Pins Address – PINA

Bit	7	6	5	4	3	2	1	0	
	PINA7	**PINA6**	**PINA5**	**PINA4**	**PINA3**	**PINA2**	**PINA1**	**PINA0**	**PINA**
Read/Write	R	R	R	R	R	R	R	R	
Initial Value	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

Port B Data Register – PORTB

Bit	7	6	5	4	3	2	1	0	
	PORTB7	**PORTB6**	**PORTB5**	**PORTB4**	**PORTB3**	**PORTB2**	**PORTB1**	**PORTB0**	**PORTB**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Port B Data Direction Register – DDRB

Bit	7	6	5	4	3	2	1	0	
	DDB7	**DDB6**	**DDB5**	**DDB4**	**DDB3**	**DDB2**	**DDB1**	**DDB0**	**DDRB**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Port B Input Pins Address – PINB

Bit	7	6	5	4	3	2	1	0	
	PINB7	**PINB6**	**PINB5**	**PINB4**	**PINB3**	**PINB2**	**PINB1**	**PINB0**	**PINB**
Read/Write	R	R	R	R	R	R	R	R	
Initial Value	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

Port C Data Register – PORTC

Bit	7	6	5	4	3	2	1	0	
	PORTC7	**PORTC6**	**PORTC5**	**PORTC4**	**PORTC3**	**PORTC2**	**PORTC1**	**PORTC0**	**PORTC**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Port C Data Direction Register – DDRC

Bit	7	6	5	4	3	2	1	0	
	DDC7	**DDC6**	**DDC5**	**DDC4**	**DDC3**	**DDC2**	**DDC1**	**DDC0**	**DDRC**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Port C Input Pins Address – PINC

Bit	7	6	5	4	3	2	1	0	
	PINC7	**PINC6**	**PINC5**	**PINC4**	**PINC3**	**PINC2**	**PINC1**	**PINC0**	**PINC**
Read/Write	R	R	R	R	R	R	R	R	
Initial Value	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

Port D Data Register – PORTD

Bit	7	6	5	4	3	2	1	0	
	PORTD7	**PORTD6**	**PORTD5**	**PORTD4**	**PORTD3**	**PORTD2**	**PORTD1**	**PORTD0**	**PORTD**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Port D Data Direction Register – DDRD

Bit	7	6	5	4	3	2	1	0	
	DDD7	**DDD6**	**DDD5**	**DDD4**	**DDD3**	**DDD2**	**DDD1**	**DDD0**	**DDRD**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Port D Input Pins Address – PIND

Bit	7	6	5	4	3	2	1	0	
	PIND7	**PIND6**	**PIND5**	**PIND4**	**PIND3**	**PIND2**	**PIND1**	**PIND0**	**PIND**
Read/Write	R	R	R	R	R	R	R	R	
Initial Value	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

External Interrupts

The External Interrupts are triggered by the INT0, INT1, and INT2 pins. Observe that, if enabled, the interrupts will trigger even if the INT0..2 pins are configured as outputs. This feature provides a way of generating a software interrupt. The External Interrupts can be triggered by a falling or rising edge or a low level (INT2 is only an edge triggered interrupt). This is set up as indicated in the specification for the MCU Control Register – MCUCR and MCU Control and Status Register – MCUCSR. When the External Interrupt is enabled and is configured as level triggered (only INT0/INT1), the interrupt will trigger as long as the pin is held low. Note that recognition of falling or rising edge interrupts on INT0 and INT1 requires the presence of an I/O clock, described in “Clock Systems and their Distribution” on page 22. Low level interrupts on INT0/INT1 and the edge interrupt on INT2 are detected asynchronously. This implies that these interrupts can be used for waking the part also from sleep modes other than Idle mode. The I/O clock is halted in all sleep modes except Idle mode.

Note that if a level triggered interrupt is used for wake-up from Power-down mode, the changed level must be held for some time to wake up the MCU. This makes the MCU less sensitive to noise. The changed level is sampled twice by the Watchdog Oscillator clock. The period of the Watchdog Oscillator is 1 µs (nominal) at 5.0V and 25°C. The frequency of the Watchdog Oscillator is voltage dependent as shown in “Electrical Characteristics” on page 251. The MCU will wake up if the input has the required level during this sampling or if it is held until the end of the start-up time. The start-up time is defined by the SUT Fuses as described in “System Clock and Clock Options” on page 22. If the level is sampled twice by the Watchdog Oscillator clock but disappears before the end of the start-up time, the MCU will still wake up, but no interrupt will be generated. The required level must be held long enough for the MCU to complete the wake up to trigger the level interrupt.

MCU Control Register – MCUCR

The MCU Control Register contains control bits for interrupt sense control and general MCU functions.

Bit	7	6	5	4	3	2	1	0	
	SM2	SE	SM1	SM0	ISC11	ISC10	ISC01	ISC00	MCUCR
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 3, 2 – ISC11, ISC10: Interrupt Sense Control 1 Bit 1 and Bit 0**

The External Interrupt 1 is activated by the external pin INT1 if the SREG I-bit and the corresponding interrupt mask in the GICR are set. The level and edges on the external INT1 pin that activate the interrupt are defined in Table 35. The value on the INT1 pin is sampled before detecting edges. If edge or toggle interrupt is selected, pulses that last longer than one clock period will generate an interrupt. Shorter pulses are not guaranteed to generate an interrupt. If low level interrupt is selected, the low level must be held until the completion of the currently executing instruction to generate an interrupt.

Table 35. Interrupt 1 Sense Control

ISC11	ISC10	Description
0	0	The low level of INT1 generates an interrupt request.
0	1	Any logical change on INT1 generates an interrupt request.
1	0	The falling edge of INT1 generates an interrupt request.
1	1	The rising edge of INT1 generates an interrupt request.

- **Bit 1, 0 – ISC01, ISC00: Interrupt Sense Control 0 Bit 1 and Bit 0**

The External Interrupt 0 is activated by the external pin INT0 if the SREG I-flag and the corresponding interrupt mask are set. The level and edges on the external INT0 pin that activate the interrupt are defined in Table 36. The value on the INT0 pin is sampled before detecting edges. If edge or toggle interrupt is selected, pulses that last longer than one clock period will generate an interrupt. Shorter pulses are not guaranteed to generate an interrupt. If low level interrupt is selected, the low level must be held until the completion of the currently executing instruction to generate an interrupt.

Table 36. Interrupt 0 Sense Control

ISC01	ISC00	Description
0	0	The low level of INT0 generates an interrupt request.
0	1	Any logical change on INT0 generates an interrupt request.
1	0	The falling edge of INT0 generates an interrupt request.
1	1	The rising edge of INT0 generates an interrupt request.

MCU Control and Status Register – MCUCSR

Bit	7	6	5	4	3	2	1	0	
	–	ISC2	–	–	WDRF	BORF	EXTRF	PORF	MCUCSR
Read/Write	R/W	R/W	R	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	See Bit Description					

- **Bit 6 – ISC2: Interrupt Sense Control 2**

The asynchronous External Interrupt 2 is activated by the external pin INT2 if the SREG I-bit and the corresponding interrupt mask in GICR are set. If ISC2 is written to zero, a falling edge on INT2 activates the interrupt. If ISC2 is written to one, a rising edge on INT2 activates the interrupt. Edges on INT2 are registered asynchronously. Pulses on INT2 wider than the minimum pulse width given in Table 37 will generate an interrupt. Shorter pulses are not guaranteed to generate an interrupt. When changing the ISC2 bit, an interrupt can occur. Therefore, it is recommended to first disable INT2 by clearing its Interrupt Enable bit in the GICR Register. Then, the ISC2 bit can be changed. Finally, the INT2 Interrupt Flag should be cleared by writing a logical one to its Interrupt Flag bit (INTF2) in the GIFR Register before the interrupt is re-enabled.

Table 37. Asynchronous External Interrupt Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Units
t_{INT}	Minimum pulse width for asynchronous external interrupt		TBD	50	TBD	ns

General Interrupt Control Register – GICR

Bit	7	6	5	4	3	2	1	0	
	INT1	INT0	INT2	–	–	–	IVSEL	IVCE	GICR
Read/Write	R/W	R/W	R/W	R	R	R	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 7 – INT1: External Interrupt Request 1 Enable**

When the INT1 bit is set (one) and the I-bit in the Status Register (SREG) is set (one), the external pin interrupt is enabled. The Interrupt Sense Control1 bits 1/0 (ISC11 and ISC10) in the MCU General Control Register (MCUCR) define whether the external interrupt is activated on the rising and/or falling edge of the INT1 pin or level sensed.

Activity on the pin will cause an interrupt request even if INT1 is configured as an output. The corresponding interrupt of External Interrupt Request 1 is executed from the INT1 Interrupt Vector.

- **Bit 6 – INT0: External Interrupt Request 0 Enable**

When the INT0 bit is set (one) and the I-bit in the Status Register (SREG) is set (one), the external pin interrupt is enabled. The Interrupt Sense Control0 bits 1/0 (ISC01 and ISC00) in the MCU General Control Register (MCUCR) define whether the external interrupt is activated on rising and/or falling edge of the INT0 pin or level sensed. Activity on the pin will cause an interrupt request even if INT0 is configured as an output. The corresponding interrupt of External Interrupt Request 0 is executed from the INT0 Interrupt Vector.

- **Bit 5 – INT2: External Interrupt Request 2 Enable**

When the INT2 bit is set (one) and the I-bit in the Status Register (SREG) is set (one), the external pin interrupt is enabled. The Interrupt Sense Control2 bit (ISC2) in the MCU Control and Status Register (MCUCSR) defines whether the external interrupt is activated on the rising or falling edge of the INT2 pin. Activity on the pin will cause an interrupt request even if INT2 is configured as an output. The corresponding interrupt of External Interrupt Request 2 is executed from the INT2 Interrupt Vector.

General Interrupt Flag Register – GIFR

Bit	7	6	5	4	3	2	1	0	
	INTF1	**INTF0**	**INTF2**	–	–	–	–	–	**GIFR**
Read/Write	R/W	R/W	R/W	R	R	R	R	R	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 7 – INTF1: External Interrupt Flag 1**

When an edge or logic change on the INT1 pin triggers an interrupt request, INTF1 becomes set (one). If the I-bit in SREG and the INT1 bit in GICR are set (one), the MCU will jump to the corresponding Interrupt Vector. The flag is cleared when the interrupt routine is executed. Alternatively, the flag can be cleared by writing a logical one to it. This flag is always cleared when INT1 is configured as a level interrupt.

- **Bit 6 – INTF0: External Interrupt Flag 0**

When an edge or logic change on the INT0 pin triggers an interrupt request, INTF0 becomes set (one). If the I-bit in SREG and the INT0 bit in GICR are set (one), the MCU will jump to the corresponding Interrupt Vector. The flag is cleared when the interrupt routine is executed. Alternatively, the flag can be cleared by writing a logical one to it. This flag is always cleared when INT0 is configured as a level interrupt.

- **Bit 5 – INTF2: External Interrupt Flag 2**

When an event on the INT2 pin triggers an interrupt request, INTF2 becomes set (one). If the I-bit in SREG and the INT2 bit in GICR are set (one), the MCU will jump to the corresponding Interrupt Vector. The flag is cleared when the interrupt routine is executed. Alternatively, the flag can be cleared by writing a logical one to it. Note that when entering some sleep modes with the INT2 interrupt disabled, the input buffer on this pin will be disabled. This may cause a logic change in internal signals which will set the INTF2 Flag. See “Digital Input Enable and Sleep Modes” on page 53 for more information.

8-bit Timer/Counter0 with PWM

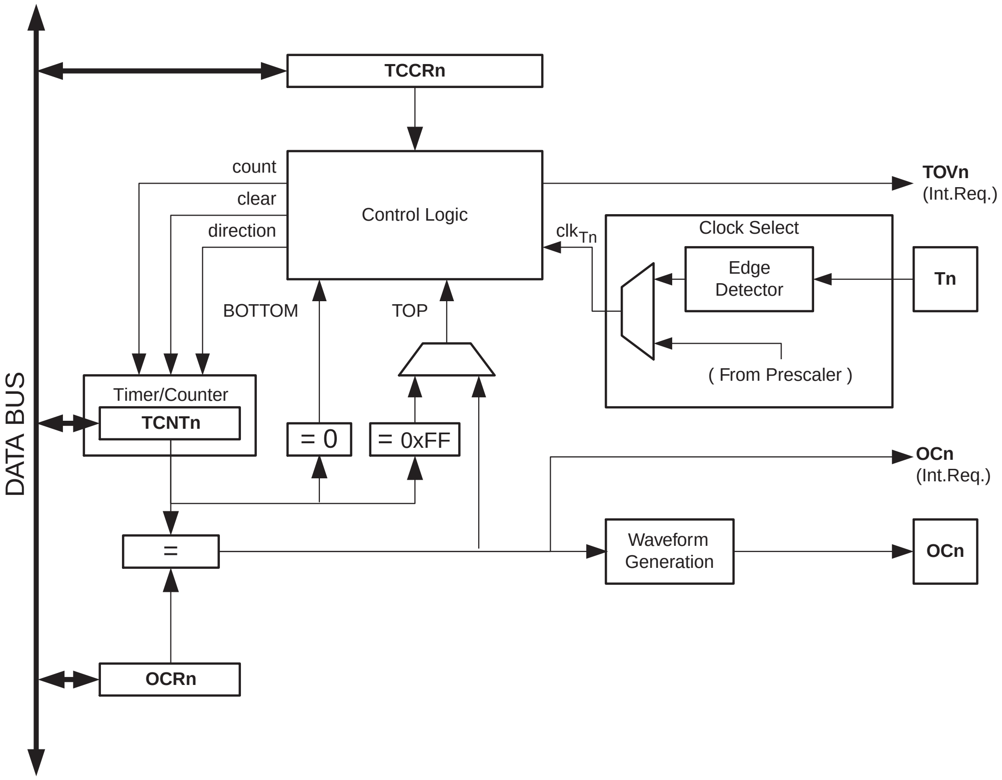
Timer/Counter0 is a general purpose, single channel, 8-bit Timer/Counter module. The main features are:

- **Single Channel Counter**
- **Clear Timer on Compare Match (Auto Reload)**
- **Glitch-free, Phase Correct Pulse Width Modulator (PWM)**
- **Frequency Generator**
- **External Event Counter**
- **10-bit Clock Prescaler**
- **Overflow and Compare Match Interrupt Sources (TOV0 and OCF0)**

Overview

A simplified block diagram of the 8-bit Timer/Counter is shown in Figure 27. For the actual placement of I/O pins, refer to “Pinout ATmega8535” on page 2. CPU accessible I/O Registers, including I/O bits and I/O pins, are shown in bold. The device-specific I/O Register and bit locations are listed in the “8-bit Timer/Counter Register Description” on page 80.

Figure 27. 8-bit Timer/Counter Block Diagram



Registers

The Timer/Counter (TCNT0) and Output Compare Register (OCR0) are 8-bit registers. Interrupt request (abbreviated to Int.Req. in the figure) signals are all visible in the Timer Interrupt Flag Register (TIFR). All interrupts are individually masked with the Timer Interrupt Mask Register (TIMSK). TIFR and TIMSK are not shown in the figure since these registers are shared by other timer units.

The Timer/Counter can be clocked internally, via the prescaler, or by an external clock source on the T0 pin. The Clock Select logic block controls which clock source and edge the Timer/Counter uses to increment (or decrement) its value. The Timer/Counter is inactive when no clock source is selected. The output from the Clock Select logic is referred to as the timer clock (clk_{T0}).

The double buffered Output Compare Register (OCR0) is compared with the Timer/Counter value at all times. The result of the compare can be used by the Waveform Generator to generate a PWM or variable frequency output on the Output Compare pin (OC0). See “Output Compare Unit” on page 70. for details. The Compare Match event will also set the Compare Flag (OCF0) which can be used to generate an output compare interrupt request.

Definitions

Many register and bit references in this document are written in general form. A lower case “n” replaces the Timer/Counter number, in this case 0. However, when using the register or bit defines in a program, the precise form must be used, i.e., TCNT0 for accessing Timer/Counter0 counter value and so on.

The definitions in Table 38 are also used extensively throughout the document.

Table 38. Definitions

BOTTOM	The counter reaches the BOTTOM when it becomes 0x00.
MAX	The counter reaches its MAXimum when it becomes 0xFF (decimal 255).
TOP	The counter reaches the TOP when it becomes equal to the highest value in the count sequence. The TOP value can be assigned to be the fixed value 0xFF (MAX) or the value stored in the OCR0 Register. The assignment is dependent on the mode of operation.

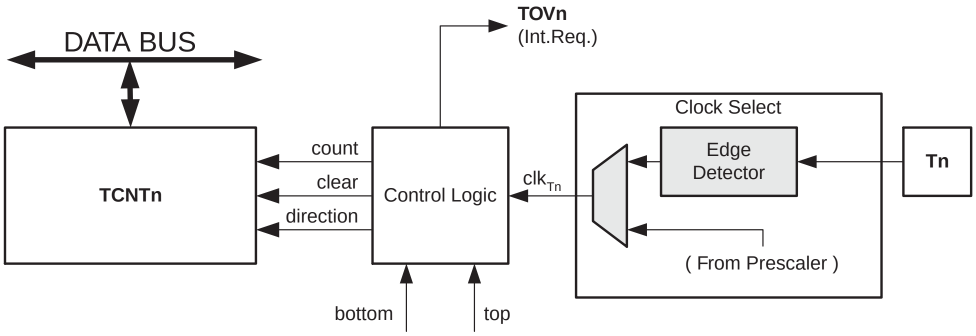
Timer/Counter Clock Sources

The Timer/Counter can be clocked by an internal or an external clock source. The clock source is selected by the Clock Select logic which is controlled by the clock select (CS02:0) bits located in the Timer/Counter Control Register (TCCR0). For details on clock sources and prescaler, see “Timer/Counter0 and Timer/Counter1 Prescalers” on page 84.

Counter Unit

The main part of the 8-bit Timer/Counter is the programmable bi-directional counter unit. Figure 28 shows a block diagram of the counter and its surroundings.

Figure 28. Counter Unit Block Diagram



Signal description (internal signals):

count	Increment or decrement TCNT0 by 1.
direction	Select between increment and decrement.
clear	Clear TCNT0 (set all bits to zero).
clk_{Tn}	Timer/Counter clock, referred to as clk_{T0} in the following.

top	Signalize that TCNT0 has reached maximum value.
bottom	Signalize that TCNT0 has reached minimum value (zero).

Depending of the mode of operation used, the counter is cleared, incremented, or decremented at each timer clock (clk_{T0}). clk_{T0} can be generated from an external or internal clock source, selected by the Clock Select bits (CS02:0). When no clock source is selected (CS02:0 = 0) the timer is stopped. However, the TCNT0 value can be accessed by the CPU, regardless of whether clk_{T0} is present or not. A CPU write overrides (has priority over) all counter clear or count operations.

The counting sequence is determined by the setting of the WGM01 and WGM00 bits located in the Timer/Counter Control Register (TCCR0). There are close connections between how the counter behaves (counts) and how waveforms are generated on the output compare output OC0. For more details about advanced counting sequences and waveform generation, see "Modes of Operation" on page 73.

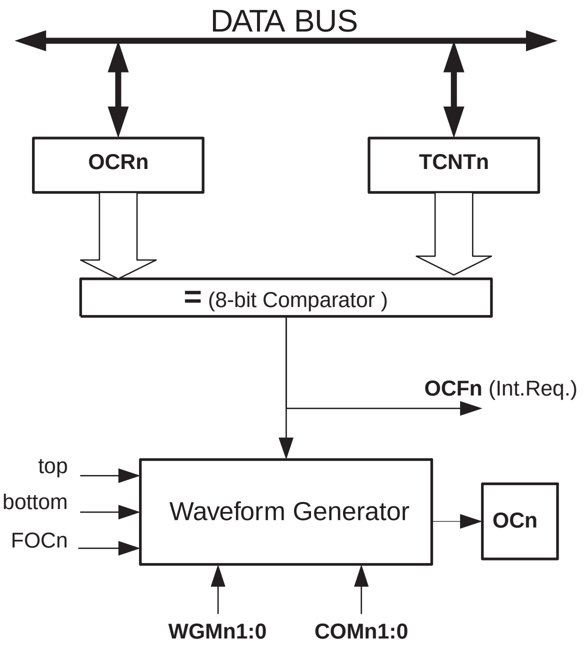
The Timer/Counter Overflow Flag (TOV0) is set according to the mode of operation selected by the WGM01:0 bits. TOV0 can be used for generating a CPU interrupt.

Output Compare Unit

The 8-bit comparator continuously compares TCNT0 with the Output Compare Register (OCR0). Whenever TCNT0 equals OCR0, the comparator signals a match. A match will set the Output Compare Flag (OCF0) at the next timer clock cycle. If enabled (OCIE0 = 1 and Global Interrupt Flag in SREG is set), the Output Compare Flag generates an output compare interrupt. The OCF0 Flag is automatically cleared when the interrupt is executed. Alternatively, the OCF0 Flag can be cleared by software by writing a logical one to its I/O bit location. The Waveform Generator uses the match signal to generate an output according to operating mode set by the WGM01:0 bits and Compare Output mode (COM01:0) bits. The max and bottom signals are used by the Waveform Generator for handling the special cases of the extreme values in some modes of operation (See "Modes of Operation" on page 73.).

Figure 29 shows a block diagram of the output compare unit.

Figure 29. Output Compare Unit, Block Diagram



The OCR0 Register is double buffered when using any of the Pulse Width Modulation (PWM) modes. For the normal and Clear Timer on Compare (CTC) modes of operation, the double buffering is disabled. The double buffering synchronizes the update of the OCR0 Compare Register to either top or bottom of the counting sequence. The synchronization prevents the occurrence of odd-length, non-symmetrical PWM pulses, thereby making the output glitch-free.

The OCR0 Register access may seem complex, but this is not the case. When the double buffering is enabled, the CPU has access to the OCR0 Buffer Register, and if double buffering is disabled the CPU will access the OCR0 directly.

Force Output Compare

In non-PWM waveform generation modes, the match output of the comparator can be forced by writing a one to the Force Output Compare (FOC0) bit. Forcing Compare Match will not set the OCF0 Flag or reload/clear the timer, but the OC0 pin will be updated as if a real Compare Match had occurred (the COM01:0 bits settings define whether the OC0 pin is set, cleared or toggled).

Compare Match Blocking by TCNT0 Write

All CPU write operations to the TCNT0 Register will block any Compare Match that occur in the next timer clock cycle, even when the timer is stopped. This feature allows OCR0 to be initialized to the same value as TCNT0 without triggering an interrupt when the Timer/Counter clock is enabled.

Using the Output Compare Unit

Since writing TCNT0 in any mode of operation will block all compare matches for one timer clock cycle, there are risks involved when changing TCNT0 when using the output compare channel, independently of whether the Timer/Counter is running or not. If the value written to TCNT0 equals the OCR0 value, the Compare Match will be missed, resulting in incorrect waveform generation. Similarly, do not write the TCNT0 value equal to BOTTOM when the counter is down-counting.

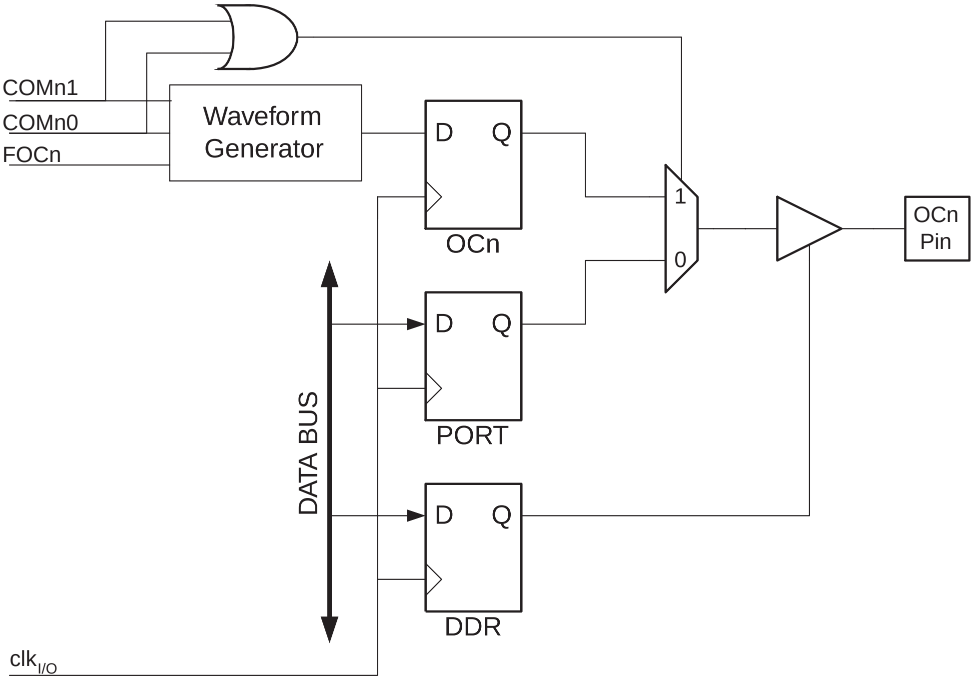
The setup of the OC0 should be performed before setting the Data Direction Register for the port pin to output. The easiest way of setting the OC0 value is to use the force output compare (FOC0) strobe bits in normal mode. The OC0 Register keeps its value even when changing between Waveform Generation modes.

Be aware that the COM01:0 bits are not double buffered together with the compare value. Changing the COM01:0 bits will take effect immediately.

Compare Match Output Unit

The Compare Output mode (COM01:0) bits have two functions. The Waveform Generator uses the COM01:0 bits for defining the Output Compare (OC0) state at the next Compare Match. Also, the COM01:0 bits control the OC0 pin output source. Figure 30 shows a simplified schematic of the logic affected by the COM01:0 bit setting. The I/O Registers, I/O bits, and I/O pins in the figure are shown in bold. Only the parts of the general I/O Port Control Registers (DDR and PORT) that are affected by the COM01:0 bits are shown. When referring to the OC0 state, the reference is for the internal OC0 Register, not the OC0 pin. If a System Reset occur, the OC0 Register is reset to “0”.

Figure 30. Compare Match Output Unit, Schematic



The general I/O port function is overridden by the Output Compare (OC0) from the waveform generator if either of the COM01:0 bits are set. However, the OC0 pin direction (input or output) is still controlled by the Data Direction Register (DDR) for the port pin. The Data Direction Register bit for the OC0 pin (DDR_OC0) must be set as output before the OC0 value is visible on the pin. The port override function is independent of the Waveform Generation mode.

The design of the output compare pin logic allows initialization of the OC0 state before the output is enabled. Note that some COM01:0 bit settings are reserved for certain modes of operation. See “8-bit Timer/Counter Register Description” on page 80.

Compare Output Mode and Waveform Generation

The Waveform Generator uses the COM01:0 bits differently in normal, CTC, and PWM modes. For all modes, setting the COM01:0 = 0 tells the Waveform Generator that no action on the OC0 Register is to be performed on the next Compare Match. For compare output actions in the non-PWM modes refer to Table 40 on page 81. For fast PWM mode, refer to Table 41 on page 81, and for phase correct PWM refer to Table 42 on page 81.

A change of the COM01:0 bits state will have effect at the first Compare Match after the bits are written. For non-PWM modes, the action can be forced to have immediate effect by using the FOC0 strobe bits.

Modes of Operation

The mode of operation, i.e., the behavior of the Timer/Counter and the output compare pins, is defined by the combination of the Waveform Generation mode (WGM01:0) and Compare Output mode (COM01:0) bits. The Compare Output mode bits do not affect the counting sequence, while the Waveform Generation mode bits do. The COM01:0 bits control whether the PWM output generated should be inverted or not (inverted or non-inverted PWM). For non-PWM modes the COM01:0 bits control whether the output should be set, cleared, or toggled at a Compare Match (See "Compare Match Output Unit" on page 72.).

For detailed timing information refer to Figure 34, Figure 35, Figure 36, and Figure 37 in "Timer/Counter Timing Diagrams" on page 77.

Normal Mode

The simplest mode of operation is the Normal mode (WGM01:0 = 0). In this mode the counting direction is always up (incrementing), and no counter clear is performed. The counter simply overruns when it passes its maximum 8-bit value (TOP = 0xFF) and then restarts from the bottom (0x00). In normal operation the Timer/Counter Overflow Flag (TOV0) will be set in the same timer clock cycle as the TCNT0 becomes zero. The TOV0 Flag in this case behaves like a ninth bit, except that it is only set, not cleared. However, combined with the Timer Overflow interrupt that automatically clears the TOV0 Flag, the timer resolution can be increased by software. There are no special cases to consider in the normal mode, a new counter value can be written anytime.

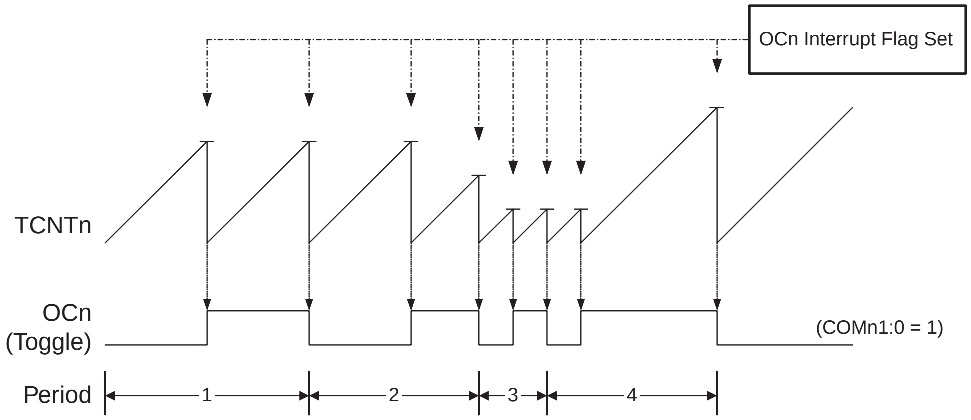
The output compare unit can be used to generate interrupts at some given time. Using the output compare to generate waveforms in Normal mode is not recommended, since this will occupy too much of the CPU time.

Clear Timer on Compare Match (CTC) Mode

In Clear Timer on Compare or CTC mode (WGM01:0 = 2), the OCR0 Register is used to manipulate the counter resolution. In CTC mode the counter is cleared to zero when the counter value (TCNT0) matches the OCR0. The OCR0 defines the top value for the counter, hence also its resolution. This mode allows greater control of the Compare Match output frequency. It also simplifies the operation of counting external events.

The timing diagram for the CTC mode is shown in Figure 31. The counter value (TCNT0) increases until a Compare Match occurs between TCNT0 and OCR0, and then counter (TCNT0) is cleared.

Figure 31. CTC Mode, Timing Diagram



An interrupt can be generated each time the counter value reaches the TOP value by using the OCF0 Flag. If the interrupt is enabled, the interrupt handler routine can be used for updating the TOP value. However, changing TOP to a value close to BOTTOM when the counter is running with none or a low prescaler value must be done with care since the CTC mode does not have the double buffering feature. If the new value written to OCR0 is lower than the current value of TCNT0, the counter will miss the Compare Match. The counter will then have to count to its maximum value (0xFF) and wrap around starting at 0x00 before the Compare Match can occur.

For generating a waveform output in CTC mode, the OC0 output can be set to toggle its logical level on each Compare Match by setting the Compare Output mode bits to toggle mode (COM01:0 = 1). The OC0 value will not be visible on the port pin unless the data direction for the pin is set to output. The waveform generated will have a maximum frequency of $f_{OC0} = f_{clk\_I/O}/2$ when OCR0 is set to zero (0x00). The waveform frequency is defined by the following equation:

$$f_{OCn} = \frac{f_{\text{clk\_I/O}}}{2 \cdot N \cdot (1 + OCRn)}$$

The “*N*” variable represents the prescale factor (1, 8, 64, 256, or 1024).

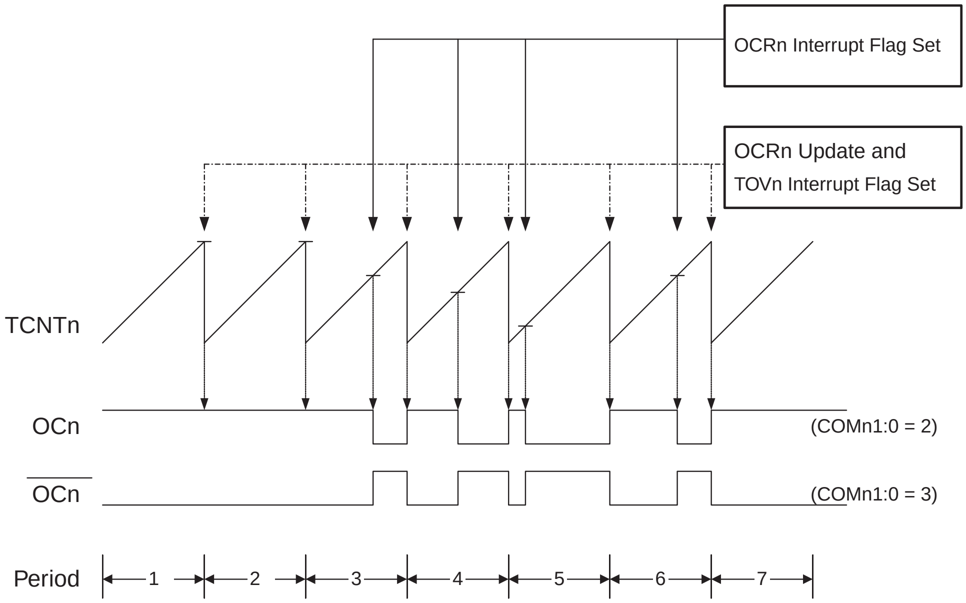
As for the normal mode of operation, the TOV0 Flag is set in the same timer clock cycle that the counter counts from MAX to 0x00.

Fast PWM Mode

The fast Pulse Width Modulation or fast PWM mode (WGM01:0 = 3) provides a high frequency PWM waveform generation option. The fast PWM differs from the other PWM option by its single-slope operation. The counter counts from BOTTOM to MAX then restarts from BOTTOM. In non-inverting Compare Output mode, the Output Compare (OC0) is cleared on the Compare Match between TCNT0 and OCR0, and set at BOTTOM. In inverting Compare Output mode, the output is set on Compare Match and cleared at BOTTOM. Due to the single-slope operation, the operating frequency of the fast PWM mode can be twice as high as the phase correct PWM mode that use dual-slope operation. This high frequency makes the fast PWM mode well suited for power regulation, rectification, and DAC applications. High frequency allows physically small sized external components (coils, capacitors), and therefore reduces total system cost.

In fast PWM mode, the counter is incremented until the counter value matches the MAX value. The counter is then cleared at the following timer clock cycle. The timing diagram for the fast PWM mode is shown in Figure 32. The TCNT0 value is in the timing diagram shown as a histogram for illustrating the single-slope operation. The diagram includes non-inverted and inverted PWM outputs. The small horizontal line marks on the TCNT0 slopes represent compare matches between OCR0 and TCNT0.

Figure 32. Fast PWM Mode, Timing Diagram



The Timer/Counter Overflow Flag (TOV0) is set each time the counter reaches MAX. If the interrupt is enabled, the interrupt handler routine can be used for updating the compare value.

In fast PWM mode, the compare unit allows generation of PWM waveforms on the OC0 pin. Setting the COM01:0 bits to two will produce a non-inverted PWM and an inverted PWM output can be generated by setting the COM01:0 to three (See Table 41 on page 81). The actual OC0 value will only be visible on the port pin if the data direction for the port pin is set as output. The PWM waveform is generated by setting (or clearing) the OC0 Register at the Compare Match between OCR0 and TCNT0, and clearing (or setting) the OC0 Register at the timer clock cycle the counter is cleared (changes from MAX to BOTTOM).

The PWM frequency for the output can be calculated by the following equation:

$$f_{OCnPWM} = \frac{f_{\mathrm{clk\_I/O}}}{N \cdot 256}$$

The "*N*" variable represents the prescale factor (1, 8, 64, 256, or 1024).

The extreme values for the OCR0 Register represents special cases when generating a PWM waveform output in the fast PWM mode. If the OCR0 is set equal to BOTTOM, the output will be a narrow spike for each MAX+1 timer clock cycle. Setting the OCR0 equal to MAX will result in a constantly high or low output (depending on the polarity of the output set by the COM01:0 bits).

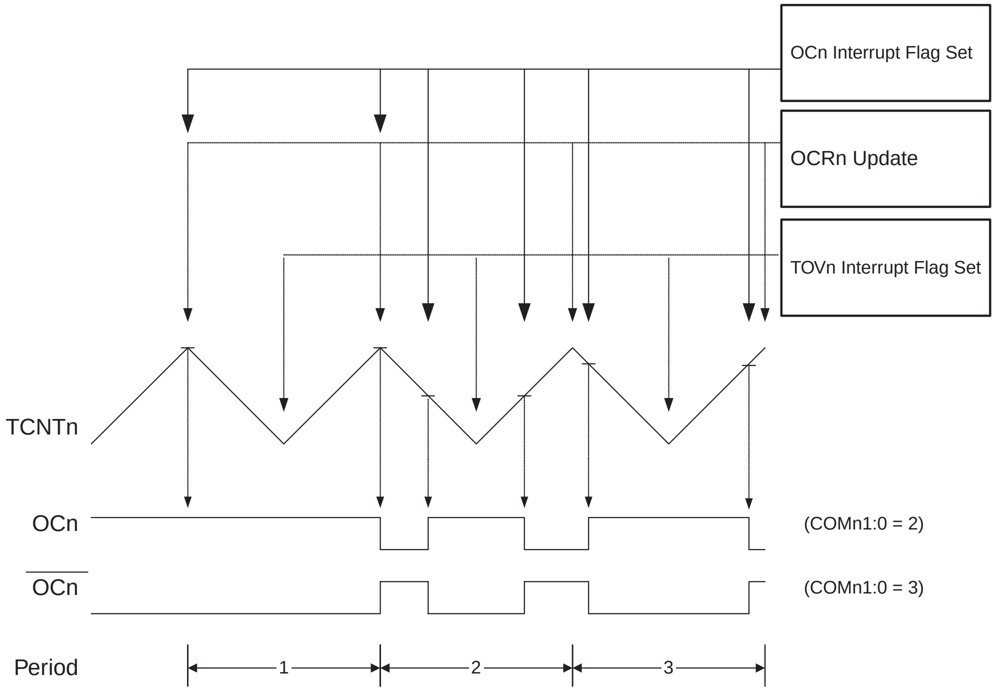
A frequency (with 50% duty cycle) waveform output in fast PWM mode can be achieved by setting OC0 to toggle its logical level on each Compare Match (COM01:0 = 1). The waveform generated will have a maximum frequency of $f_{OC0} = f_{clk\_I/O}/2$ when OCR0 is set to zero. This feature is similar to the OC0 toggle in CTC mode, except the double buffer feature of the output compare unit is enabled in the fast PWM mode.

Phase Correct PWM Mode

The phase correct PWM mode (WGM01:0 = 1) provides a high resolution phase correct PWM waveform generation option. The phase correct PWM mode is based on a dual-slope operation. The counter counts repeatedly from BOTTOM to MAX and then from MAX to BOTTOM. In non-inverting Compare Output mode, the Output Compare (OC0) is cleared on the Compare Match between TCNT0 and OCR0 while up-counting, and set on the Compare Match while down-counting. In inverting Output Compare mode, the operation is inverted. The dual-slope operation has lower maximum operation frequency than single slope operation. However, due to the symmetric feature of the dual-slope PWM modes, these modes are preferred for motor control applications.

The PWM resolution for the phase correct PWM mode is fixed to eight bits. In phase correct PWM mode the counter is incremented until the counter value matches MAX. When the counter reaches MAX, it changes the count direction. The TCNT0 value will be equal to MAX for one timer clock cycle. The timing diagram for the phase correct PWM mode is shown on Figure 33. The TCNT0 value is in the timing diagram shown as a histogram for illustrating the dual-slope operation. The diagram includes non-inverted and inverted PWM outputs. The small horizontal line marks on the TCNT0 slopes represent compare matches between OCR0 and TCNT0.

Figure 33. Phase Correct PWM Mode, Timing Diagram



The Timer/Counter Overflow Flag (TOV0) is set each time the counter reaches BOTTOM. The interrupt flag can be used to generate an interrupt each time the counter reaches the BOTTOM value.

In phase correct PWM mode, the compare unit allows generation of PWM waveforms on the OC0 pin. Setting the COM01:0 bits to two will produce a non-inverted PWM. An inverted PWM output can be generated by setting the COM01:0 to three (See Table 42 on page 81). The actual OC0 value will only be visible on the port pin if the data direction for the port pin is set as output. The PWM waveform is generated by clearing (or setting) the OC0 Register at the Compare Match between OCR0 and TCNT0 when the counter increments, and setting (or clearing) the OC0 Register at Compare Match between

OCR0 and TCNT0 when the counter decrements. The PWM frequency for the output when using phase correct PWM can be calculated by the following equation:

$$f_{OCnPCPWM} = \frac{f_{\text{clk\_I/O}}}{N \cdot 510}$$

The “*N*” variable represents the prescale factor (1, 8, 64, 256, or 1024).

The extreme values for the OCR0 Register represent special cases when generating a PWM waveform output in the phase correct PWM mode. If the OCR0 is set equal to BOTTOM, the output will be continuously low and if set equal to MAX the output will be continuously high for non-inverted PWM mode. For inverted PWM the output will have the opposite logic values.

AT the very start of period 2 in Figure 33 OCn has a transition from high to low even though there is no Compare Match. The point of this transition is to guaratee symmetry around BOTTOM. There are two cases that give a transition without Compare Match.

- OCR0 changes its value from MAX, like in Figure 33. When the OCR0 value is MAX the OCn pin value is the same as the result of a down-counting Compare Match. To ensure symmetry around BOTTOM the OCn value at MAX must correspond to the result of an up-counting Compare Match.
- The timer starts counting from a value higher than the one in OCR0, and for that reason misses the Compare Match and hence the OCn change that would have happened on the way up.

Timer/Counter Timing Diagrams

The Timer/Counter is a synchronous design and the timer clock (clk_{T0}) is therefore shown as a clock enable signal in the following figures. The figures include information on when interrupt flags are set. Figure 34 contains timing data for basic Timer/Counter operation. The figure shows the count sequence close to the MAX value in all modes other than phase correct PWM mode.

Figure 34. Timer/Counter Timing Diagram, no Prescaling

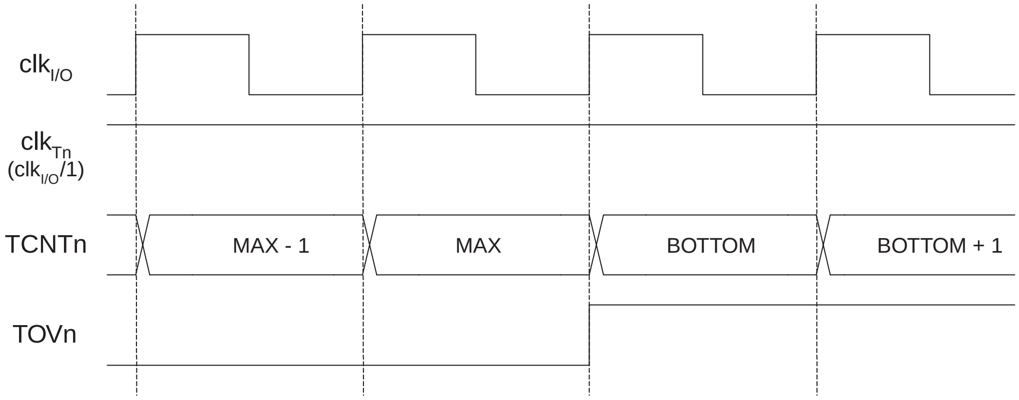


Figure 35 shows the same timing data, but with the prescaler enabled.

Figure 35. Timer/Counter Timing Diagram, with Prescaler ($f_{clk\_I/O}/8$)

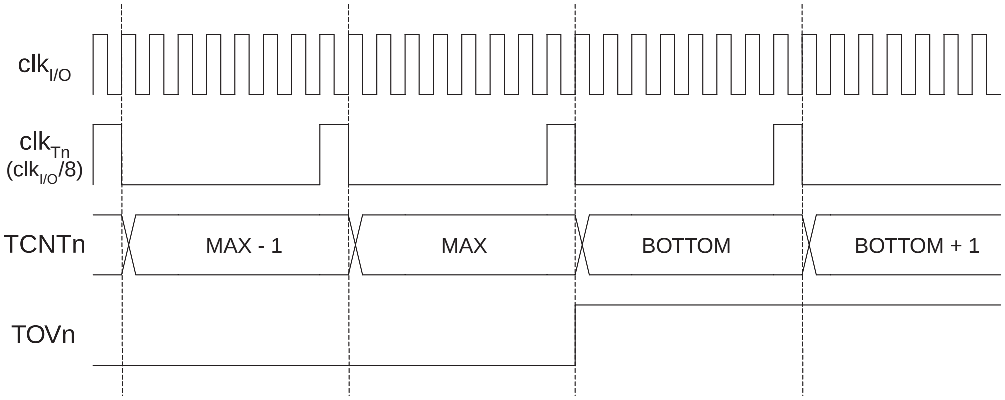


Figure 36 shows the setting of OCF0 in all modes except CTC mode.

Figure 36. Timer/Counter Timing Diagram, Setting of OCF0, with Prescaler ($f_{clk\_I/O}/8$)

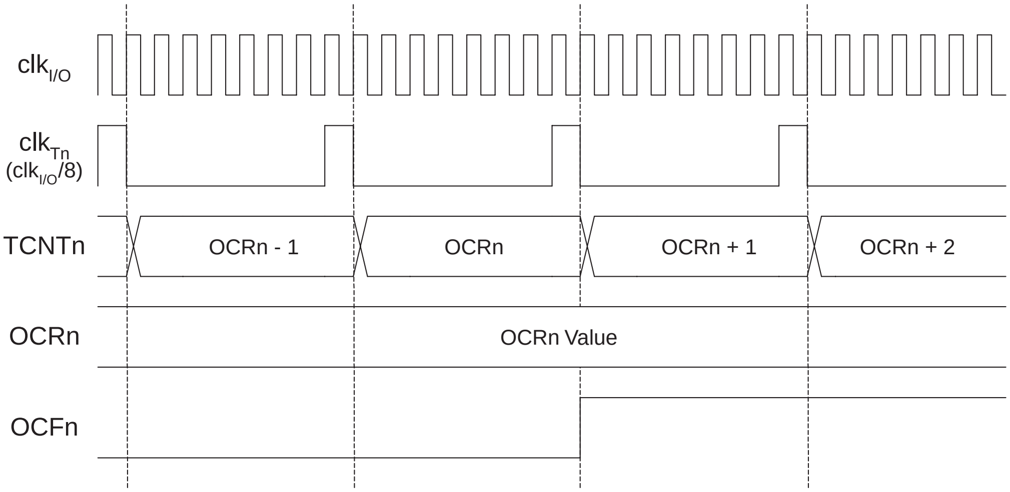
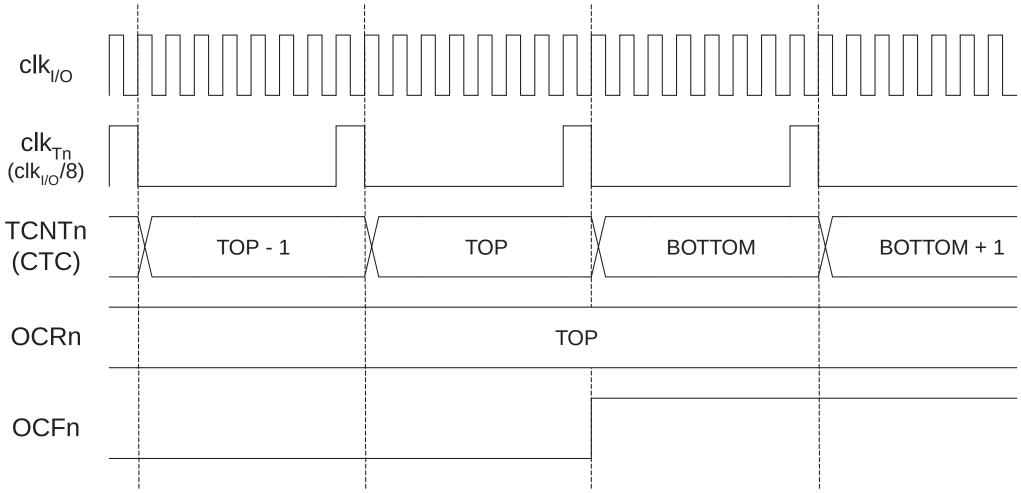


Figure 37 shows the setting of OCF0 and the clearing of TCNT0 in CTC mode.

Figure 37. Timer/Counter Timing Diagram, Clear Timer on Compare Match Mode, with Prescaler ($f_{clk\_I/O}/8$)



8-bit Timer/Counter Register Description

Timer/Counter Control Register – TCCR0

Bit	7	6	5	4	3	2	1	0	
	FOC0	**WGM00**	**COM01**	**COM00**	**WGM01**	**CS02**	**CS01**	**CS00**	**TCCR0**
Read/Write	W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 7 – FOC0: Force Output Compare**

The FOC0 bit is only active when the WGM00 bit specifies a non-PWM mode. However, for ensuring compatibility with future devices, this bit must be set to zero when TCCR0 is written when operating in PWM mode. When writing a logical one to the FOC0 bit, an immediate Compare Match is forced on the Waveform Generation unit. The OC0 output is changed according to its COM01:0 bits setting. Note that the FOC0 bit is implemented as a strobe. Therefore it is the value present in the COM01:0 bits that determines the effect of the forced compare.

A FOC0 strobe will not generate any interrupt, nor will it clear the timer in CTC mode using OCR0 as TOP.

The FOC0 bit is always read as zero.

- **Bit 6, 3 – WGM01:0: Waveform Generation Mode**

These bits control the counting sequence of the counter, the source for the maximum (TOP) counter value, and what type of waveform generation to be used. Modes of operation supported by the Timer/Counter unit are: Normal mode, Clear Timer on Compare Match (CTC) mode, and two types of Pulse Width Modulation (PWM) modes. See Table 39 and “Modes of Operation” on page 73.

Table 39. Waveform Generation Mode Bit Description[1]

Mode	WGM01 (CTC0)	WGM00 (PWM0)	Timer/Counter Mode of Operation	TOP	Update of OCR0	TOV0 Flag Set on
0	0	0	Normal	0xFF	Immediate	MAX
1	0	1	PWM, Phase Correct	0xFF	TOP	BOTTOM
2	1	0	CTC	OCR0	Immediate	MAX
3	1	1	Fast PWM	0xFF	TOP	MAX

Note: 1. The CTC0 and PWM0 bit definition names are now obsolete. Use the WGM01:0 definitions. However, the functionality and location of these bits are compatible with previous versions of the Timer.

- **Bit 5:4 – COM01:0: Compare Match Output Mode**

These bits control the Output Compare pin (OC0) behavior. If one or both of the COM01:0 bits are set, the OC0 output overrides the normal port functionality of the I/O pin it is connected to. However, note that the Data Direction Register (DDR) bit corresponding to the OC0 pin must be set in order to enable the output driver.

When OC0 is connected to the pin, the function of the COM01:0 bits depends on the WGM01:0 bit setting. Table 40 shows the COM01:0 bit functionality when the WGM01:0 bits are set to a normal or CTC mode (non-PWM).

Table 40. Compare Output Mode, non-PWM Mode

COM01	COM00	Description
0	0	Normal port operation, OC0 disconnected.
0	1	Toggle OC0 on Compare Match
1	0	Clear OC0 on Compare Match
1	1	Set OC0 on Compare Match

Table 41 shows the COM01:0 bit functionality when the WGM01:0 bits are set to fast PWM mode.

Table 41. Compare Output Mode, Fast PWM Mode(1)

COM01	COM00	Description
0	0	Normal port operation, OC0 disconnected.
0	1	Reserved
1	0	Clear OC0 on Compare Match, set OC0 at TOP
1	1	Set OC0 on Compare Match, clear OC0 at TOP

Note: 1. A special case occurs when OCR0 equals TOP and COM01 is set. In this case, the Compare Match is ignored, but the set or clear is done at TOP. See "Fast PWM Mode" on page 74 for more details.

Table 42 shows the COM01:0 bit functionality when the WGM01:0 bits are set to phase correct PWM mode.

Table 42. Compare Output Mode, Phase Correct PWM Mode(1)

COM01	COM00	Description
0	0	Normal port operation, OC0 disconnected.
0	1	Reserved
1	0	Clear OC0 on Compare Match when up-counting. Set OC0 on Compare Match when down-counting.
1	1	Set OC0 on Compare Match when up-counting. Clear OC0 on Compare Match when down-counting.

Note: 1. A special case occurs when OCR0 equals TOP and COM01 is set. In this case, the Compare Match is ignored, but the set or clear is done at TOP. See "Phase Correct PWM Mode" on page 76 for more details.

- **Bit 2:0 – CS02:0: Clock Select**

The three Clock Select bits select the clock source to be used by the Timer/Counter.

Table 43. Clock Select Bit Description

CS02	CS01	CS00	Description
0	0	0	No clock source (Timer/counter stopped).
0	0	1	$clk_{I/O}$/(No prescaling)
0	1	0	$clk_{I/O}$/8 (From prescaler)
0	1	1	$clk_{I/O}$/64 (From prescaler)
1	0	0	$clk_{I/O}$/256 (From prescaler)
1	0	1	$clk_{I/O}$/1024 (From prescaler)
1	1	0	External clock source on T0 pin. Clock on falling edge.
1	1	1	External clock source on T0 pin. Clock on rising edge.

If external pin modes are used for the Timer/Counter0, transitions on the T0 pin will clock the counter even if the pin is configured as an output. This feature allows software control of the counting.

Timer/Counter Register – TCNT0

Bit	7	6	5	4	3	2	1	0	
	TCNT0[7:0]								**TCNT0**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

The Timer/Counter Register gives direct access, both for read and write operations, to the Timer/Counter unit 8-bit counter. Writing to the TCNT0 Register blocks (removes) the Compare Match on the following timer clock. Modifying the counter (TCNT0) while the counter is running, introduces a risk of missing a Compare Match between TCNT0 and the OCR0 Register.

Output Compare Register – OCR0

Bit	7	6	5	4	3	2	1	0	
	OCR0[7:0]								**OCR0**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

The Output Compare Register contains an 8-bit value that is continuously compared with the counter value (TCNT0). A match can be used to generate an output compare interrupt, or to generate a waveform output on the OC0 pin.

Timer/Counter Interrupt Mask Register – TIMSK

Bit	7	6	5	4	3	2	1	0	
	OCIE2	**TOIE2**	**TICIE1**	**OCIE1A**	**OCIE1B**	**TOIE1**	**OCIE0**	**TOIE0**	**TIMSK**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 1 – OCIE0: Timer/Counter0 Output Compare Match Interrupt Enable**

When the OCIE0 bit is written to one, and the I-bit in the Status Register is set (one), the Timer/Counter0 Compare Match interrupt is enabled. The corresponding interrupt is executed if a Compare Match in Timer/Counter0 occurs (i.e., when the OCF0 bit is set in the Timer/Counter Interrupt Flag Register – TIFR).

- **Bit 0 – TOIE0: Timer/Counter0 Overflow Interrupt Enable**

When the TOIE0 bit is written to one, and the I-bit in the Status Register is set (one), the Timer/Counter0 Overflow interrupt is enabled. The corresponding interrupt is executed if an overflow in Timer/Counter0 occurs (i.e., when the TOV0 bit is set in the Timer/Counter Interrupt Flag Register – TIFR).

Timer/Counter Interrupt Flag Register – TIFR

Bit	7	6	5	4	3	2	1	0	
	OCF2	**TOV2**	**ICF1**	**OCF1A**	**OCF1B**	**TOV1**	**OCF0**	**TOV0**	**TIFR**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 1 – OCF0: Output Compare Flag 0**

The OCF0 bit is set (one) when a Compare Match occurs between the Timer/Counter0 and the data in OCR0 – Output Compare Register0. OCF0 is cleared by hardware when executing the corresponding interrupt handling vector. Alternatively, OCF0 is cleared by writing a logic one to the flag. When the I-bit in SREG, OCIE0 (Timer/Counter0 Compare Match Interrupt Enable), and OCF0 are set (one), the Timer/Counter0 Compare Match Interrupt is executed.

- **Bit 0 – TOV0: Timer/Counter0 Overflow Flag**

The bit TOV0 is set (one) when an overflow occurs in Timer/Counter0. TOV0 is cleared by hardware when executing the corresponding interrupt handling vector. Alternatively, TOV0 is cleared by writing a logic one to the flag. When the SREG I-bit, TOIE0 (Timer/Counter0 Overflow Interrupt Enable), and TOV0 are set (one), the Timer/Counter0 Overflow Interrupt is executed. In phase correct PWM mode, this bit is set when Timer/Counter0 changes counting direction at 0x00.

Timer/Counter0 and Timer/Counter1 Prescalers

Timer/Counter1 and Timer/Counter0 share the same prescaler module, but the Timer/Counters can have different prescaler settings. The description below applies to both Timer/Counter1 and Timer/Counter0.

Internal Clock Source

The Timer/Counter can be clocked directly by the system clock (by setting the CSn2:0 = 1). This provides the fastest operation, with a maximum Timer/Counter clock frequency equal to system clock frequency ($f_{CLK\_I/O}$). Alternatively, one of four taps from the prescaler can be used as a clock source. The prescaled clock has a frequency of either $f_{CLK\_I/O}/8$, $f_{CLK\_I/O}/64$, $f_{CLK\_I/O}/256$, or $f_{CLK\_I/O}/1024$.

Prescaler Reset

The prescaler is free running (i.e., operates independently of the clock select logic of the Timer/Counter) and it is shared by Timer/Counter1 and Timer/Counter0. Since the prescaler is not affected by the Timer/Counter's clock select, the state of the prescaler will have implications for situations where a prescaled clock is used. One example of prescaling artifacts occurs when the timer is enabled and clocked by the prescaler (6 > CSn2:0 > 1). The number of system clock cycles from when the timer is enabled to the first count occurs can be from 1 to N+1 system clock cycles, where N equals the prescaler divisor (8, 64, 256, or 1024).

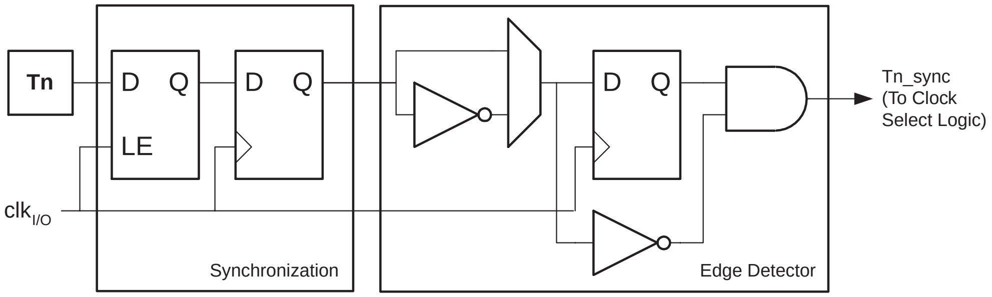
It is possible to use the Prescaler Reset for synchronizing the Timer/Counter to program execution. However, care must be taken if the other Timer/Counter that shares the same prescaler also uses prescaling. A prescaler reset will affect the prescaler period for all Timer/Counters it is connected to.

External Clock Source

An external clock source applied to the T1/T0 pin can be used as Timer/Counter clock (clk_{T1}/clk_{T0}). The T1/T0 pin is sampled once every system clock cycle by the pin synchronization logic. The synchronized (sampled) signal is then passed through the edge detector. Figure 38 shows a functional equivalent block diagram of the T1/T0 synchronization and edge detector logic. The registers are clocked at the positive edge of the internal system clock ($clk_{I/O}$). The latch is transparent in the high period of the internal system clock.

The edge detector generates one clk_{T1}/clk_{T0} pulse for each positive (CSn2:0 = 7) or negative (CSn2:0 = 6) edge it detects.

Figure 38. T1/T0 Pin Sampling



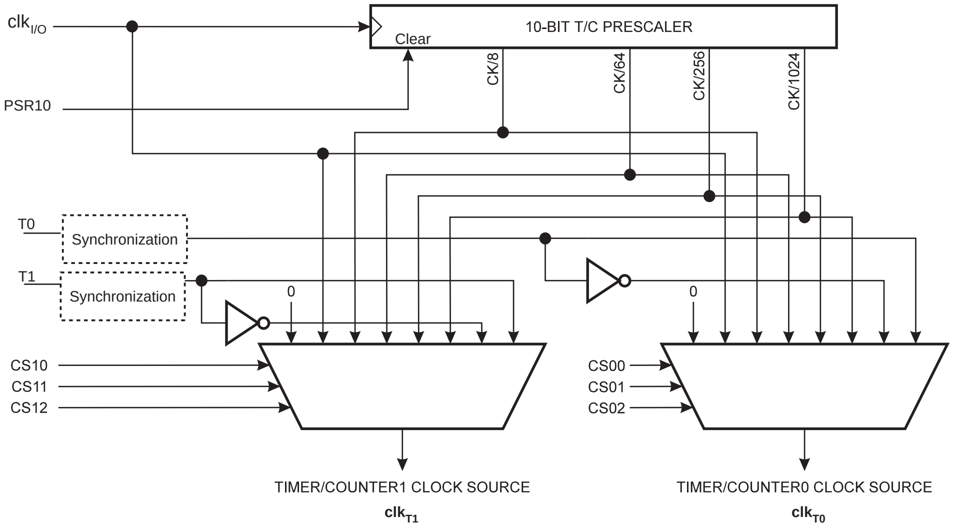
The synchronization and edge detector logic introduces a delay of 2.5 to 3.5 system clock cycles from an edge has been applied to the T1/T0 pin to the counter is updated.

Enabling and disabling of the clock input must be done when T1/T0 has been stable for at least one system clock cycle, otherwise it is a risk that a false Timer/Counter clock pulse is generated.

Each half period of the external clock applied must be longer than one system clock cycle to ensure correct sampling. The external clock must be guaranteed to have less than half the system clock frequency ($f_{ExtClk} < f_{clk\_I/O}/2$) given a 50/50% duty cycle. Since the edge detector uses sampling, the maximum frequency of an external clock it can detect is half the sampling frequency (Nyquist sampling theorem). However, due to variation of the system clock frequency and duty cycle caused by Oscillator source (crystal, resonator, and capacitors) tolerances, it is recommended that maximum frequency of an external clock source is less than $f_{clk\_I/O}/2.5$.

An external clock source can not be prescaled.

Figure 39. Prescaler for Timer/Counter0 and Timer/Counter1(1)



Note: 1. The synchronization logic on the input pins (T1/T0) is shown in Figure 38.

Special Function IO Register – SFIOR

Bit	7	6	5	4	3	2	1	0	
	ADTS2	ADTS1	ADTS0	–	ACME	PUD	PSR2	PSR10	SFIOR
Read/Write	R/W	R/W	R/W	R	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 0 – PSR10: Prescaler Reset Timer/Counter1 and Timer/Counter0**

When this bit is written to one, the Timer/Counter1 and Timer/Counter0 prescaler will be reset. The bit will be cleared by hardware after the operation is performed. Writing a zero to this bit will have no effect. Note that Timer/Counter1 and Timer/Counter0 share the same prescaler and a reset of this prescaler will affect both timers. This bit will always be read as zero.

16-bit Timer/Counter1

The 16-bit Timer/Counter unit allows accurate program execution timing (event management), wave generation, and signal timing measurement. The main features are:

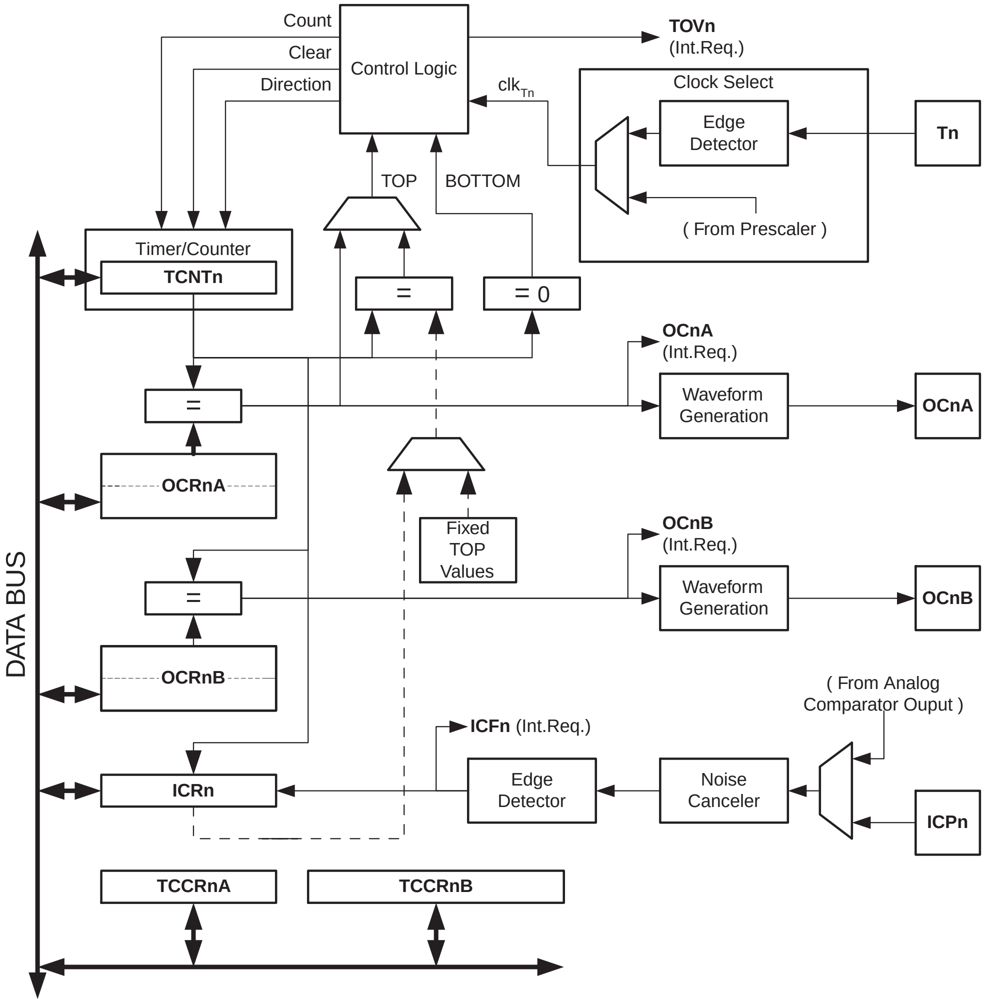
- **True 16-bit Design (i.e., Allows 16-bit PWM)**
- **Two Independent Output Compare Units**
- **Double Buffered Output Compare Registers**
- **One Input Capture Unit**
- **Input Capture Noise Canceler**
- **Clear Timer on Compare Match (Auto Reload)**
- **Glitch-free, Phase Correct Pulse Width Modulator (PWM)**
- **Variable PWM Period**
- **Frequency Generator**
- **External Event Counter**
- **Four Independent Interrupt Sources (TOV1, OCF1A, OCF1B, and ICF1)**

Overview

Most register and bit references in this section are written in general form. A lower case "n" replaces the Timer/Counter number, and a lower case "x" replaces the Output Compare unit channel. However, when using the register or bit defines in a program, the precise form must be used, i.e., TCNT1 for accessing Timer/Counter1 counter value and so on.

A simplified block diagram of the 16-bit Timer/Counter is shown in Figure 40. For the actual placement of I/O pins, refer to "Pinout ATmega8535" on page 2. CPU accessible I/O Registers, including I/O bits and I/O pins, are shown in bold. The device-specific I/O Register and bit locations are listed in the "16-bit Timer/Counter Register Description" on page 107.

Figure 40. 16-bit Timer/Counter Block Diagram(1)



Note: 1. Refer to Figure 1 on page 2, Table 26 on page 57, and Table 32 on page 61 for Timer/Counter1 pin placement and description.

Registers

The *Timer/Counter* (TCNT1), *Output Compare Registers* (OCR1A/B), and *Input Capture Register* (ICR1) are all 16-bit registers. Special procedures must be followed when accessing the 16-bit registers. These procedures are described in the section “Accessing 16-bit Registers” on page 89. The *Timer/Counter Control Registers* (TCCR1A/B) are 8-bit registers and have no CPU access restrictions. Interrupt requests (abbreviated to Int.Req. in the figure) signals are all visible in the *Timer Interrupt Flag Register* (TIFR). All interrupts are individually masked with the *Timer Interrupt Mask Register* (TIMSK). TIFR and TIMSK are not shown in the figure since these registers are shared by other timer units.

The Timer/Counter can be clocked internally, via the prescaler, or by an external clock source on the T1 pin. The Clock Select logic block controls which clock source and edge the Timer/Counter uses to increment (or decrement) its value. The Timer/Counter is inactive when no clock source is selected. The output from the Clock Select logic is referred to as the timer clock (clk_{T1}).

The double buffered Output Compare Registers (OCR1A/B) are compared with the Timer/Counter value at all times. The result of the compare can be used by the

Waveform Generator to generate a PWM or variable frequency output on the Output Compare Pin (OC1A/B). See “Output Compare Units” on page 95. The Compare Match event will also set the Compare Match Flag (OCF1A/B) which can be used to generate an output compare interrupt request.

The Input Capture Register can capture the Timer/Counter value at a given external (edge triggered) event on either the Input Capture Pin (ICP1) or on the Analog Comparator pins (See “Analog Comparator” on page 199.) The Input Capture unit includes a digital filtering unit (Noise Canceler) for reducing the chance of capturing noise spikes.

The TOP value, or maximum Timer/Counter value, can in some modes of operation be defined by either the OCR1A Register, the ICR1 Register, or by a set of fixed values. When using OCR1A as TOP value in a PWM mode, the OCR1A Register can not be used for generating a PWM output. However, the TOP value will, in this case, be double buffered allowing the TOP value to be changed in run time. If a fixed TOP value is required, the ICR1 Register can be used as an alternative, freeing the OCR1A to be used as PWM output.

Definitions

The following definitions are used extensively throughout the document

Table 44. Definitions

BOTTOM	The counter reaches the *BOTTOM* when it becomes 0x0000.
MAX	The counter reaches its *MAX*imum when it becomes 0xFFFF (decimal 65535).
TOP	The counter reaches the *TOP* when it becomes equal to the highest value in the count sequence. The TOP value can be assigned to be one of the fixed values: 0x00FF, 0x01FF, or 0x03FF, or to the value stored in the OCR1A or ICR1 Register. The assignment is dependent of the mode of operation.

Compatibility

The 16-bit Timer/Counter has been updated and improved from previous versions of the 16-bit AVR Timer/Counter. This 16-bit Timer/Counter is fully compatible with the earlier version regarding:

- All 16-bit Timer/Counter related I/O Register address locations, including Timer Interrupt Registers.
- Bit locations inside all 16-bit Timer/Counter Registers, including Timer Interrupt Registers.
- Interrupt Vectors.

The following control bits have changed names, but have the same functionality and register location:

- PWM10 is changed to WGM10.
- PWM11 is changed to WGM11.
- CTC1 is changed to WGM12.

The following bits are added to the 16-bit Timer/Counter Control Registers:

- FOC1A and FOC1B are added to TCCR1A.
- WGM13 is added to TCCR1B.

The 16-bit Timer/Counter has improvements that will affect the compatibility in some special cases.

Accessing 16-bit Registers

The TCNT1, OCR1A/B, and ICR1 are 16-bit registers that can be accessed by the AVR CPU via the 8-bit data bus. The 16-bit register must be byte accessed using two read or write operations. Each 16-bit timer has a single 8-bit register for temporary storing of the high byte of the 16-bit access. The same temporary register is shared between all 16-bit registers within each 16-bit timer. Accessing the low byte triggers the 16-bit read or write operation. When the low byte of a 16-bit register is written by the CPU, the high byte stored in the temporary register, and the low byte written are both copied into the 16-bit register in the same clock cycle. When the low byte of a 16-bit register is read by the CPU, the high byte of the 16-bit register is copied into the temporary register in the same clock cycle as the low byte is read.

Not all 16-bit accesses uses the temporary register for the high byte. Reading the OCR1A/B 16-bit registers does not involve using the temporary register.

To do a 16-bit write, *the high byte must be written before the low byte*. For a 16-bit read, *the low byte must be read before the high byte*.

The following code examples show how to access the 16-bit Timer Registers assuming that no interrupts update the temporary register. The same principle can be used directly for accessing the OCR1A/B and ICR1 Registers. Note that when using "C", the compiler handles the 16-bit access.

Assembly Code Examples[1]

```
...
; Set TCNT1 to 0x01FF
ldi  r17,0x01
ldi  r16,0xFF
out  TCNT1H,r17
out  TCNT1L,r16
; Read TCNT1 into r17:r16
in   r16,TCNT1L
in   r17,TCNT1H
...
```

C Code Examples[1]

```
unsigned int i;
...
/* Set TCNT1 to 0x01FF */
TCNT1 = 0x1FF;
/* Read TCNT1 into i */
i = TCNT1;
...
```

Note: 1. The example code assumes that the part specific header file is included.

The assembly code example returns the TCNT1 value in the r17:r16 register pair.

It is important to notice that accessing 16-bit registers are atomic operations. If an interrupt occurs between the two instructions accessing the 16-bit register, and the interrupt code updates the temporary register by accessing the same or any other of the 16-bit Timer Registers, then the result of the access outside the interrupt will be corrupted. Therefore, when both the main code and the interrupt code update the temporary register, the main code must disable the interrupts during the 16-bit access.

The following code examples show how to do an atomic read of the TCNT1 Register contents. Reading any of the OCR1A/B or ICR1 Registers can be done by using the same principle.

Assembly Code Example(1)

```
TIM16_ReadTCNT1:
  ; Save Global Interrupt Flag
  in    r18,SREG
  ; Disable interrupts
  cli
  ; Read TCNT1 into r17:r16
  in    r16,TCNT1L
  in    r17,TCNT1H
  ; Restore Global Interrupt Flag
  out   SREG,r18
  ret
```

C Code Example(1)

```
unsigned int TIM16_ReadTCNT1( void )
{
  unsigned char sreg;
  unsigned int i;
  /* Save Global Interrupt Flag */
  sreg = SREG;
  /* Disable interrupts */
  _CLI();
  /* Read TCNT1 into i */
  i = TCNT1;
  /* Restore Global Interrupt Flag */
  SREG = sreg;
  return i;
}
```

Note: 1. The example code assumes that the part specific header file is included.

The assembly code example returns the TCNT1 value in the r17:r16 register pair.

The following code examples show how to do an atomic write of the TCNT1 Register contents. Writing any of the OCR1A/B or ICR1 Registers can be done by using the same principle.

Assembly Code Example[1]

```
TIM16_WriteTCNT1:
  ; Save Global Interrupt Flag
  in   r18,SREG
  ; Disable interrupts
  cli
  ; Set TCNT1 to r17:r16
  out  TCNT1H,r17
  out  TCNT1L,r16
  ; Restore Global Interrupt Flag
  out  SREG,r18
  ret
```

C Code Example[1]

```
void TIM16_WriteTCNT1( unsigned int i )
{
  unsigned char sreg;
  /* Save Global Interrupt Flag */
  sreg = SREG;
  /* Disable interrupts */
  _CLI();
  /* Set TCNT1 to i */
  TCNT1 = i;
  /* Restore Global Interrupt Flag */
  SREG = sreg;
}
```

Note: 1. The example code assumes that the part specific header file is included.

The assembly code example requires that the r17:r16 register pair contains the value to be written to TCNT1.

Re-using the Temporary High Byte Register

If writing to more than one 16-bit register where the high byte is the same for all registers written, then the high byte only needs to be written once. However, note that the same rule of atomic operation described previously also applies in this case.

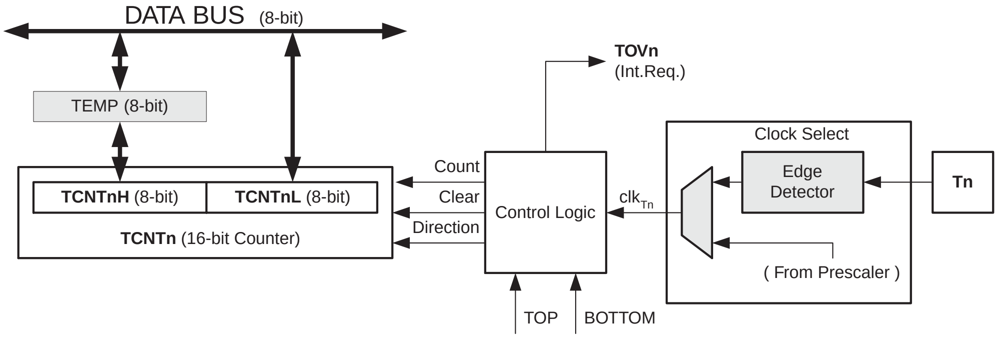
Timer/Counter Clock Sources

The Timer/Counter can be clocked by an internal or an external clock source. The clock source is selected by the Clock Select logic which is controlled by the *Clock Select* (CS12:0) bits located in the *Timer/Counter Control Register B* (TCCR1B). For details on clock sources and prescaler, see “Timer/Counter0 and Timer/Counter1 Prescalers” on page 84.

Counter Unit

The main part of the 16-bit Timer/Counter is the programmable 16-bit bi-directional counter unit. Figure 41 shows a block diagram of the counter and its surroundings.

Figure 41. Counter Unit Block Diagram



Signal description (internal signals):

Count	Increment or decrement TCNT1 by 1.
Direction	Select between increment and decrement.
Clear	Clear TCNT1 (set all bits to zero).
clk$_{T1}$	Timer/Counter clock.
TOP	Signalize that TCNT1 has reached maximum value.
BOTTOM	Signalize that TCNT1 has reached minimum value (zero).

The 16-bit counter is mapped into two 8-bit I/O memory locations: *Counter High* (TCNT1H) containing the upper eight bits of the counter, and *Counter Low* (TCNT1L) containing the lower eight bits. The TCNT1H Register can only be indirectly accessed by the CPU. When the CPU does an access to the TCNT1H I/O location, the CPU accesses the high byte temporary register (TEMP). The temporary register is updated with the TCNT1H value when the TCNT1L is read, and TCNT1H is updated with the temporary register value when TCNT1L is written. This allows the CPU to read or write the entire 16-bit counter value within one clock cycle via the 8-bit data bus. It is important to notice that there are special cases of writing to the TCNT1 Register when the counter is counting that will give unpredictable results. The special cases are described in the sections where they are of importance.

Depending on the mode of operation used, the counter is cleared, incremented, or decremented at each *Timer Clock* (clk$_{T1}$). The clk$_{T1}$ can be generated from an external or internal clock source, selected by the *Clock Select* bits (CS12:0). When no clock source is selected (CS12:0 = 0) the timer is stopped. However, the TCNT1 value can be accessed by the CPU, independent of whether clk$_{T1}$ is present or not. A CPU write overrides (has priority over) all counter clear or count operations.

The counting sequence is determined by the setting of the *Waveform Generation mode* bits (WGM13:0) located in the *Timer/Counter Control Registers* A and B (TCCR1A and

TCCR1B). There are close connections between how the counter behaves (counts) and how waveforms are generated on the Output Compare outputs OC1x. For more details about advanced counting sequences and waveform generation, see "Modes of Operation" on page 98.

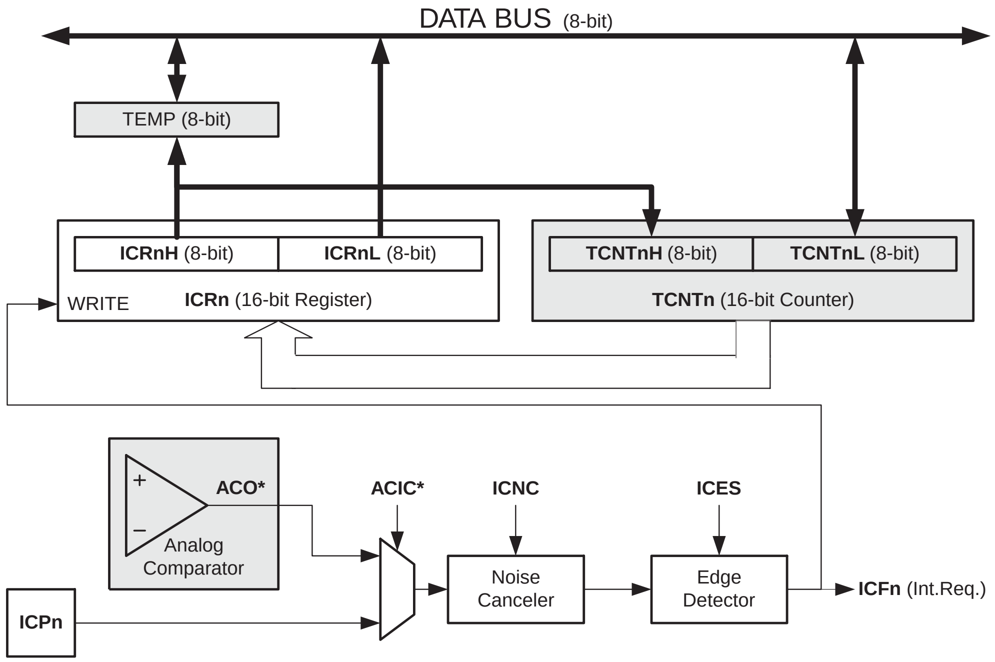
The *Timer/Counter Overflow Flag* (TOV1) is set according to the mode of operation selected by the WGM13:0 bits. TOV1 can be used for generating a CPU interrupt.

Input Capture Unit

The Timer/Counter incorporates an Input Capture unit that can capture external events and give them a time-stamp indicating time of occurrence. The external signal indicating an event, or multiple events, can be applied via the ICP1 pin or alternatively, via the analog comparator unit. The time-stamps can then be used to calculate frequency, duty-cycle, and other features of the signal applied. Alternatively the time-stamps can be used for creating a log of the events.

The Input Capture unit is illustrated by the block diagram shown in Figure 42. The elements of the block diagram that are not directly a part of the Input Capture unit are gray shaded. The small "n" in register and bit names indicates the Timer/Counter number.

Figure 42. Input Capture Unit Block Diagram



When a change of the logic level (an event) occurs on the *Input Capture pin* (ICP1), alternatively on the *Analog Comparator output* (ACO), and this change confirms to the setting of the edge detector, a capture will be triggered. When a capture is triggered, the 16-bit value of the counter (TCNT1) is written to the *Input Capture Register* (ICR1). The *Input Capture Flag* (ICF1) is set at the same system clock as the TCNT1 value is copied into ICR1 Register. If enabled (TICIE1 = 1), the Input Capture Flag generates an Input Capture interrupt. The ICF1 Flag is automatically cleared when the interrupt is executed. Alternatively the ICF1 Flag can be cleared by software by writing a logical one to its I/O bit location.

Reading the 16-bit value in the *Input Capture Register* (ICR1) is done by first reading the low byte (ICR1L) and then the high byte (ICR1H). When the low byte is read the high byte is copied into the high byte temporary register (TEMP). When the CPU reads the ICR1H I/O location it will access the TEMP Register.

The ICR1 Register can only be written when using a Waveform Generation mode that utilizes the ICR1 Register for defining the counter's TOP value. In these cases the *Waveform Generation mode* (WGM13:0) bits must be set before the TOP value can be written to the ICR1 Register. When writing the ICR1 Register the high byte must be written to the ICR1H I/O location before the low byte is written to ICR1L.

For more information on how to access the 16-bit registers, refer to "Accessing 16-bit Registers" on page 89.

Input Capture Trigger Source

The main trigger source for the Input Capture unit is the *Input Capture pin* (ICP1). Timer/Counter1 can alternatively use the Analog Comparator output as trigger source for the Input Capture unit. The Analog Comparator is selected as trigger source by setting the *Analog Comparator Input Capture* (ACIC) bit in the *Analog Comparator Control and Status Register* (ACSR). Be aware that changing trigger source can trigger a capture. The Input Capture Flag must therefore be cleared after the change.

Both the *Input Capture pin* (ICP1) and the *Analog Comparator output* (ACO) inputs are sampled using the same technique as the T1 pin (Figure 38 on page 84). The edge detector is also identical. However, when the noise canceler is enabled, additional logic is inserted before the edge detector, which increases the delay by four system clock cycles. Note that the input of the noise canceler and edge detector is always enabled unless the Timer/Counter is set in a Waveform Generation mode that uses ICR1 to define TOP.

An Input Capture can be triggered by software by controlling the port of the ICP1 pin.

Noise Canceler

The noise canceler improves noise immunity by using a simple digital filtering scheme. The noise canceler input is monitored over four samples, and all four must be equal for changing the output that, in turn, is used by the edge detector.

The noise canceler is enabled by setting the *Input Capture Noise Canceler* (ICNC1) bit in *Timer/Counter Control Register B* (TCCR1B). When enabled, the noise canceler introduces additional four system clock cycles of delay from a change applied to the input, to the update of the ICR1 Register. The noise canceler uses the system clock and is therefore not affected by the prescaler.

Using the Input Capture Unit

The main challenge when using the Input Capture unit is to assign enough processor capacity for handling the incoming events. The time between two events is critical. If the processor has not read the captured value in the ICR1 Register before the next event occurs, the ICR1 will be overwritten with a new value. In this case the result of the capture will be incorrect.

When using the Input Capture interrupt, the ICR1 Register should be read as early in the interrupt handler routine as possible. Even though the Input Capture interrupt has relatively high priority, the maximum interrupt response time is dependent on the maximum number of clock cycles it takes to handle any of the other interrupt requests.

Using the Input Capture unit in any mode of operation when the TOP value (resolution) is actively changed during operation, is not recommended.

Measurement of an external signal's duty cycle requires that the trigger edge is changed after each capture. Changing the edge sensing must be done as early as possible after the ICR1 Register has been read. After a change of the edge, the Input Capture Flag (ICF1) must be cleared by software (writing a logical one to the I/O bit location). For measuring frequency only, the clearing of the ICF1 Flag is not required (if an interrupt handler is used).

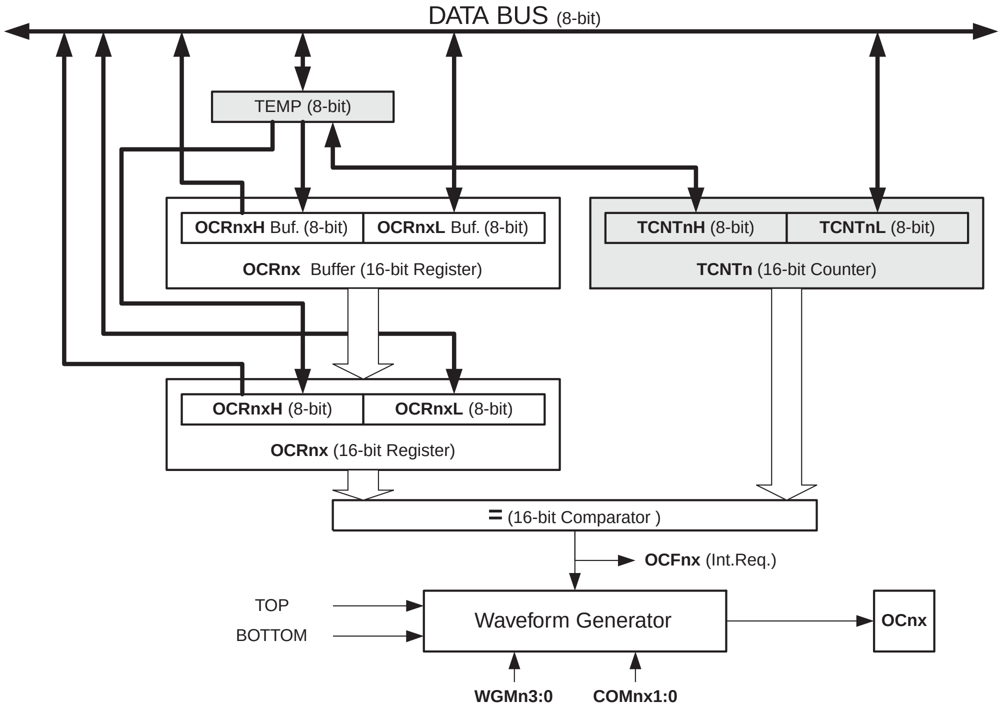
Output Compare Units

The 16-bit comparator continuously compares TCNT1 with the *Output Compare Register* (OCR1x). If TCNT equals OCR1x the comparator signals a match. A match will set the *Output Compare Flag* (OCF1x) at the next timer clock cycle. If enabled (OCIE1x = 1), the Output Compare Flag generates an output compare interrupt. The OCF1x Flag is automatically cleared when the interrupt is executed. Alternatively the OCF1x Flag can be cleared by software by writing a logical one to its I/O bit location. The Waveform Generator uses the match signal to generate an output according to operating mode set by the *Waveform Generation mode* (WGM13:0) bits and *Compare Output mode* (COM1x1:0) bits. The TOP and BOTTOM signals are used by the Waveform Generator for handling the special cases of the extreme values in some modes of operation. (See "Modes of Operation" on page 98.)

A special feature of output compare unit A allows it to define the Timer/Counter TOP value (i.e., counter resolution). In addition to the counter resolution, the TOP value defines the period time for waveforms generated by the Waveform Generator.

Figure 43 shows a block diagram of the output compare unit. The small "n" in the register and bit names indicates the device number (n = 1 for Timer/Counter1), and the "x" indicates output compare unit (A/B). The elements of the block diagram that are not directly a part of the output compare unit are gray shaded.

Figure 43. Output Compare Unit, Block Diagram



The OCR1x Register is double buffered when using any of the twelve *Pulse Width Modulation* (PWM) modes. For the Normal and *Clear Timer on Compare* (CTC) modes of operation, the double buffering is disabled. The double buffering synchronizes the update of the OCR1x Compare Register to either TOP or BOTTOM of the counting sequence. The synchronization prevents the occurrence of odd-length, non-symmetrical PWM pulses, thereby making the output glitch-free.

The OCR1x Register access may seem complex, but this is not the case. When the double buffering is enabled, the CPU has access to the OCR1x Buffer Register, and if double buffering is disabled the CPU will access the OCR1x directly. The content of the OCR1x (Buffer or Compare) Register is only changed by a write operation (the Timer/Counter does not update this register automatically as does the TCNT1– and ICR1 Register). Therefore OCR1x is not read via the high byte temporary register (TEMP). However, it is a good practice to read the low byte first as with accessing other 16-bit registers. Writing the OCR1x Registers must be done via the TEMP Register since the compare of all 16 bits is done continuously. The high byte (OCR1xH) has to be written first. When the high byte I/O location is written by the CPU, the TEMP Register will be updated by the value written. Then when the low byte (OCR1xL) is written to the lower eight bits, the high byte will be copied into the upper 8-bits of either the OCR1x Buffer or OCR1x Compare Register in the same system clock cycle.

For more information of how to access the 16-bit registers refer to “Accessing 16-bit Registers” on page 89.

Force Output Compare

In non-PWM waveform generation modes, the match output of the comparator can be forced by writing a one to the *Force Output Compare* (FOC1x) bit. Forcing Compare Match will not set the OCF1x Flag or reload/clear the timer, but the OC1x pin will be updated as if a real Compare Match had occurred (the COM11:0 bits settings define whether the OC1x pin is set, cleared or toggled).

Compare Match Blocking by TCNT1 Write

All CPU writes to the TCNT1 Register will block any Compare Match that occurs in the next timer clock cycle, even when the timer is stopped. This feature allows OCR1x to be initialized to the same value as TCNT1 without triggering an interrupt when the Timer/Counter clock is enabled.

Using the Output Compare Unit

Since writing TCNT1 in any mode of operation will block all compare matches for one timer clock cycle, there are risks involved when changing TCNT1 when using any of the output compare channels, independent of whether the Timer/Counter is running or not. If the value written to TCNT1 equals the OCR1x value, the Compare Match will be missed, resulting in incorrect waveform generation. Do not write the TCNT1 equal to TOP in PWM modes with variable TOP values. The Compare Match for the TOP will be ignored and the counter will continue to 0xFFFF. Similarly, do not write the TCNT1 value equal to BOTTOM when the counter is down-counting.

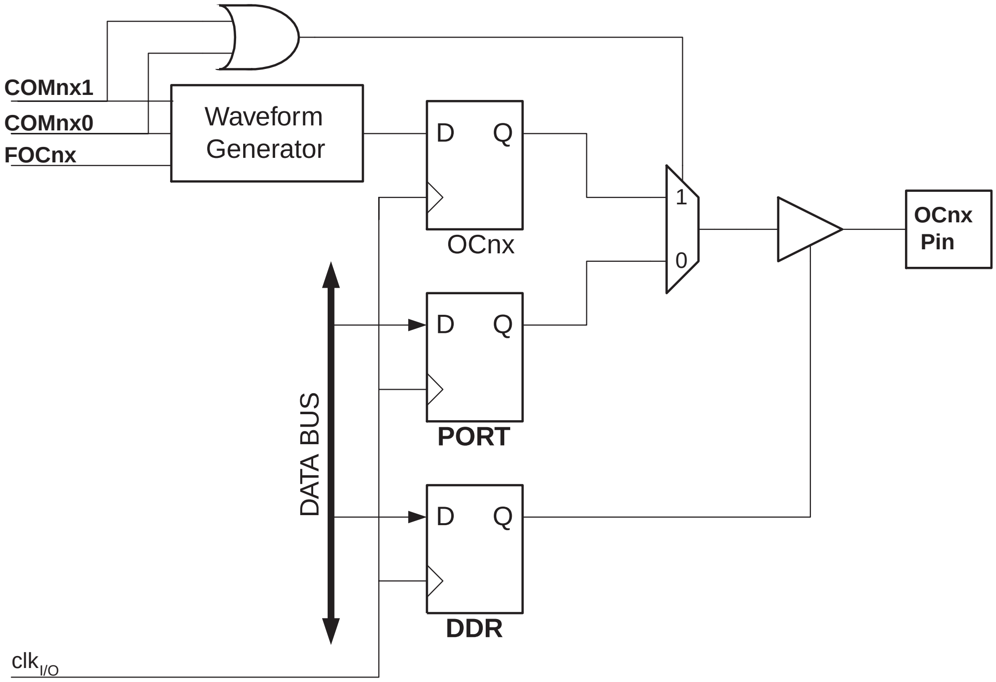
The setup of the OC1x should be performed before setting the Data Direction Register for the port pin to output. The easiest way of setting the OC1x value is to use the Force Output Compare (FOC1x) strobe bits in Normal mode. The OC1x Register keeps its value even when changing between Waveform Generation modes.

Be aware that the COM1x1:0 bits are not double buffered together with the compare value. Changing the COM1x1:0 bits will take effect immediately.

Compare Match Output Unit

The *Compare Output Mode* (COM1x1:0) bits have two functions. The waveform generator uses the COM1x1:0 bits for defining the Output Compare (OC1x) state at the next Compare Match. Secondly the COM1x1:0 bits control the OC1x pin output source. Figure 44 shows a simplified schematic of the logic affected by the COM1x1:0 bit setting. The I/O Registers, I/O bits, and I/O pins in the figure are shown in bold. Only the parts of the general I/O port Control Registers (DDR and PORT) that are affected by the COM1x1:0 bits are shown. When referring to the OC1x state, the reference is for the internal OC1x Register, not the OC1x pin. If a System Reset occurs, the OC1x Register is reset to “0”.

Figure 44. Compare Match Output Unit, Schematic



The general I/O port function is overridden by the Output Compare (OC1x) from the waveform generator if either of the COM1x1:0 bits are set. However, the OC1x pin direction (input or output) is still controlled by the *Data Direction Register* (DDR) for the port pin. The Data Direction Register bit for the OC1x pin (DDR_OC1x) must be set as output before the OC1x value is visible on the pin. The port override function is generally independent of the Waveform Generation mode, but there are some exceptions. Refer to Table 45, Table 46 and Table 47 for details.

The design of the output compare pin logic allows initialization of the OC1x state before the output is enabled. Note that some COM1x1:0 bit settings are reserved for certain modes of operation. See “16-bit Timer/Counter Register Description” on page 107.

The COM1x1:0 bits have no effect on the Input Capture unit.

Compare Output Mode and Waveform Generation

The Waveform Generator uses the COM1x1:0 bits differently in Normal, CTC, and PWM modes. For all modes, setting the COM1x1:0 = 0 tells the Waveform Generator that no action on the OC1x Register is to be performed on the next Compare Match. For compare output actions in the non-PWM modes refer to Table 45 on page 107. For fast PWM mode refer to Table 46 on page 108, and for phase correct and phase and frequency correct PWM refer to Table 47 on page 108.

A change of the COM1x1:0 bits state will have effect at the first Compare Match after the bits are written. For non-PWM modes, the action can be forced to have immediate effect by using the FOC1x strobe bits.

Modes of Operation

The mode of operation, i.e., the behavior of the Timer/Counter and the output compare pins, is defined by the combination of the *Waveform Generation mode* (WGM13:0) and *Compare Output mode* (COM1x1:0) bits. The Compare Output mode bits do not affect the counting sequence, while the Waveform Generation mode bits do. The COM1x1:0 bits control whether the PWM output generated should be inverted or not (inverted or non-inverted PWM). For non-PWM modes the COM1x1:0 bits control whether the output should be set, cleared or toggle at a Compare Match (See "Compare Match Output Unit" on page 97.)

For detailed timing information refer to "Timer/Counter Timing Diagrams" on page 105.

Normal Mode

The simplest mode of operation is the *Normal* mode (WGM13:0 = 0). In this mode the counting direction is always up (incrementing), and no counter clear is performed. The counter simply overruns when it passes its maximum 16-bit value (MAX = 0xFFFF) and then restarts from the BOTTOM (0x0000). In normal operation the *Timer/Counter Overflow Flag* (TOV1) will be set in the same timer clock cycle as the TCNT1 becomes zero. The TOV1 Flag in this case behaves like a 17th bit, except that it is only set, not cleared. However, combined with the timer overflow interrupt that automatically clears the TOV1 Flag, the timer resolution can be increased by software. There are no special cases to consider in the Normal mode, a new counter value can be written anytime.

The Input Capture unit is easy to use in Normal mode. However, observe that the maximum interval between the external events must not exceed the resolution of the counter. If the interval between events are too long, the timer overflow interrupt or the prescaler must be used to extend the resolution for the capture unit.

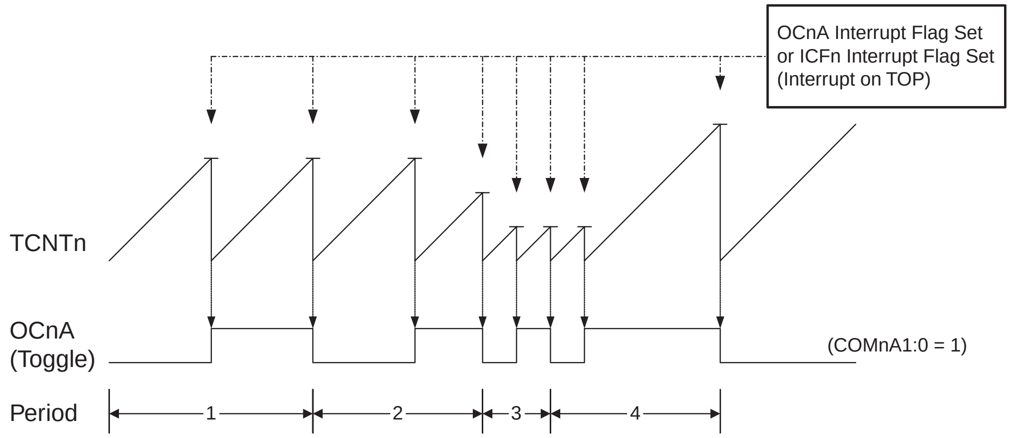
The output compare units can be used to generate interrupts at some given time. Using the output compare to generate waveforms in normal mode is not recommended, since this will occupy too much of the CPU time.

Clear Timer on Compare Match (CTC) Mode

In *Clear Timer on Compare* or CTC mode (WGM13:0 = 4 or 12), the OCR1A or ICR1 Register is used to manipulate the counter resolution. In CTC mode the counter is cleared to zero when the counter value (TCNT1) matches either the OCR1A (WGM13:0 = 4) or the ICR1 (WGM13:0 = 12). The OCR1A or ICR1 define the top value for the counter, hence also its resolution. This mode allows greater control of the Compare Match output frequency. It also simplifies the operation of counting external events.

The timing diagram for the CTC mode is shown in Figure 45. The counter value (TCNT1) increases until a Compare Match occurs with either OCR1A or ICR1, and then counter (TCNT1) is cleared.

Figure 45. CTC Mode, Timing Diagram



An interrupt can be generated each time the counter value reaches the TOP value by either using the OCF1A or ICF1 Flag according to the register used to define the TOP value. If the interrupt is enabled, the interrupt handler routine can be used for updating the TOP value. However, changing the TOP to a value close to BOTTOM when the counter is running with a low or no prescaler value must be done with care since the CTC mode does not have the double buffering feature. If the new value written to OCR1A or ICR1 is lower than the current value of TCNT1, the counter will miss the Compare Match. The counter will then have to count to its maximum value (0xFFFF) and wrap around starting at 0x0000 before the Compare Match can occur. In many cases this feature is not desirable. An alternative will then be to use the fast PWM mode using OCR1A for defining TOP (WGM13:0 = 15) since the OCR1A then will be double buffered.

For generating a waveform output in CTC mode, the OC1A output can be set to toggle its logical level on each Compare Match by setting the compare output mode bits to toggle mode (COM1A1:0 = 1). The OC1A value will not be visible on the port pin unless the data direction for the pin is set to output (DDR_OC1A = 1). The waveform generated will have a maximum frequency of $f_{OC1A} = f_{clk\_I/O}/2$ when OCR1A is set to zero (0x0000). The waveform frequency is defined by the following equation:

$$f_{OCnA} = \frac{f_{\text{clk\_I/O}}}{2 \cdot N \cdot (1 + OCRnA)}$$

The N variable represents the prescaler factor (1, 8, 64, 256, or 1024).

As for the Normal mode of operation, the TOV1 Flag is set in the same timer clock cycle that the counter counts from MAX to 0x0000.

Fast PWM Mode

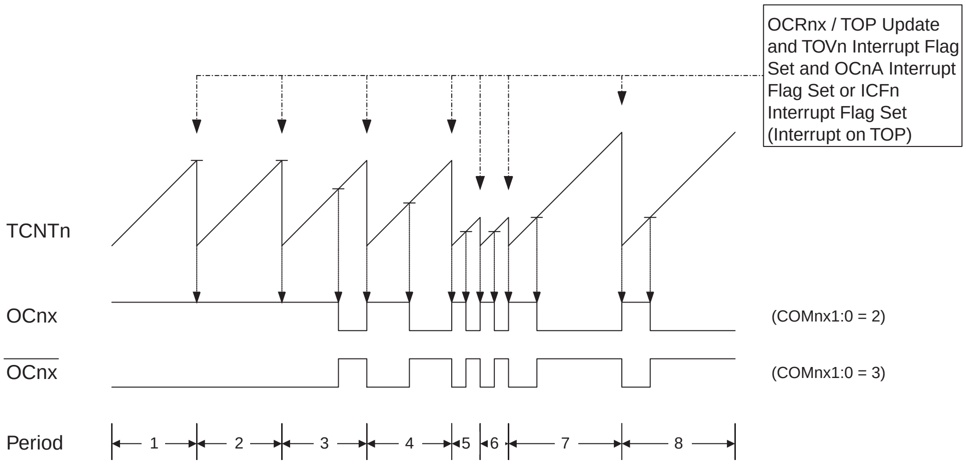
The *fast Pulse Width Modulation* or fast PWM mode (WGM13:0 = 5, 6, 7, 14, or 15) provides a high frequency PWM waveform generation option. The fast PWM differs from the other PWM options by its single-slope operation. The counter counts from BOTTOM to TOP then restarts from BOTTOM. In non-inverting Compare Output mode, the Output Compare (OC1x) is set on the Compare Match between TCNT1 and OCR1x, and cleared at TOP. In inverting Compare Output mode output is cleared on Compare Match and set at TOP. Due to the single-slope operation, the operating frequency of the fast PWM mode can be twice as high as the phase correct and phase and frequency correct PWM modes that use dual-slope operation. This high frequency makes the fast PWM mode well suited for power regulation, rectification, and DAC applications. High frequency allows physically small sized external components (coils, capacitors), hence reducing total system cost.

The PWM resolution for fast PWM can be fixed to 8-, 9-, or 10-bit, or defined by either ICR1 or OCR1A. The minimum resolution allowed is 2-bit (ICR1 or OCR1A set to 0x0003), and the maximum resolution is 16-bit (ICR1 or OCR1A set to MAX). The PWM resolution can be calculated in bits by using the following equation:

$$R_{FPWM} = \frac{\log(TOP + 1)}{\log(2)}$$

In fast PWM mode the counter is incremented until the counter value matches either one of the fixed values 0x00FF, 0x01FF, or 0x03FF (WGM13:0 = 5, 6, or 7), the value in ICR1 (WGM13:0 = 14), or the value in OCR1A (WGM13:0 = 15). The counter is then cleared at the following timer clock cycle. The timing diagram for the fast PWM mode is shown in Figure 46. The figure shows fast PWM mode when OCR1A or ICR1 is used to define TOP. The TCNT1 value is in the timing diagram shown as a histogram for illustrating the single-slope operation. The diagram includes non-inverted and inverted PWM outputs. The small horizontal line marks on the TCNT1 slopes represent compare matches between OCR1x and TCNT1. The OC1x Interrupt Flag will be set when a Compare Match occurs.

Figure 46. Fast PWM Mode, Timing Diagram



The Timer/Counter Overflow Flag (TOV1) is set each time the counter reaches TOP. In addition the OC1A or ICF1 Flag is set at the same timer clock cycle as TOV1 is set when either OCR1A or ICR1 is used for defining the TOP value. If one of the interrupts are enabled, the interrupt handler routine can be used for updating the TOP and compare values.

When changing the TOP value the program must ensure that the new TOP value is higher or equal to the value of all of the compare registers. If the TOP value is lower than any of the compare registers, a Compare Match will never occur between the TCNT1 and the OCR1x. Note that when using fixed TOP values the unused bits are masked to zero when any of the OCR1x Registers are written.

The procedure for updating ICR1 differs from updating OCR1A when used for defining the TOP value. The ICR1 Register is not double buffered. This means that if ICR1 is changed to a low value when the counter is running with a low or none prescaler value, there is a risk that the new ICR1 value written is lower than the current value of TCNT1. The result will then be that the counter will miss the Compare Match at the TOP value.

The counter will then have to count to the MAX value (0xFFFF) and wrap around starting at 0x0000 before the Compare Match can occur. The OCR1A Register however, is double buffered. This feature allows the OCR1A I/O location to be written anytime. When the OCR1A I/O location is written the value written will be put into the OCR1A Buffer Register. The OCR1A Compare Register will then be updated with the value in the Buffer Register at the next timer clock cycle the TCNT1 matches TOP. The update is done at the same timer clock cycle as the TCNT1 is cleared and the TOV1 Flag is set.

Using the ICR1 Register for defining TOP works well when using fixed TOP values. By using ICR1, the OCR1A Register is free to be used for generating a PWM output on OC1A. However, if the base PWM frequency is actively changed (by changing the TOP value), using the OCR1A as TOP is clearly a better choice due to its double buffer feature.

In fast PWM mode, the compare units allow generation of PWM waveforms on the OC1x pins. Setting the COM1x1:0 bits to two will produce a non-inverted PWM and an inverted PWM output can be generated by setting the COM1x1:0 to three (See Table 46 on page 108). The actual OC1x value will only be visible on the port pin if the data direction for the port pin is set as output (DDR_OC1x). The PWM waveform is generated by setting (or clearing) the OC1x Register at the Compare Match between OCR1x and TCNT1, and clearing (or setting) the OC1x Register at the timer clock cycle the counter is cleared (changes from TOP to BOTTOM).

The PWM frequency for the output can be calculated by the following equation:

$$f_{OCnxPWM} = \frac{f_{\text{clk\_I/O}}}{N \cdot (1 + TOP)}$$

The "*N*" variable represents the prescaler divider (1, 8, 64, 256, or 1024).

The extreme values for the OCR1x Register represents special cases when generating a PWM waveform output in the fast PWM mode. If the OCR1x is set equal to BOTTOM (0x0000) the output will be a narrow spike for each TOP+1 timer clock cycle. Setting the OCR1x equal to TOP will result in a constant high or low output (depending on the polarity of the output set by the COM1x1:0 bits).

A frequency (with 50% duty cycle) waveform output in fast PWM mode can be achieved by setting OC1A to toggle its logical level on each Compare Match (COM1A1:0 = 1). This applies only if OCR1A is used to define the TOP value (WGM13:0 = 15). The waveform generated will have a maximum frequency of $f_{OC1A} = f_{\text{clk\_I/O}}/2$ when OCR1A is set to zero (0x0000). This feature is similar to the OC1A toggle in CTC mode, except the double buffer feature of the output compare unit is enabled in the fast PWM mode.

Phase Correct PWM Mode

The *phase correct Pulse Width Modulation* or phase correct PWM mode (WGM13:0 = 1, 2, 3, 10, or 11) provides a high resolution phase correct PWM waveform generation option. The phase correct PWM mode is, like the phase and frequency correct PWM mode, based on a dual-slope operation. The counter counts repeatedly from BOTTOM (0x0000) to TOP and then from TOP to BOTTOM. In non-inverting Compare Output mode, the Output Compare (OC1x) is cleared on the Compare Match between TCNT1 and OCR1x while up-counting and set on the Compare Match while down-counting. In inverting Output Compare mode, the operation is inverted. The dual-slope operation has lower maximum operation frequency than single slope operation. However, due to the symmetric feature of the dual-slope PWM modes, these modes are preferred for motor control applications.

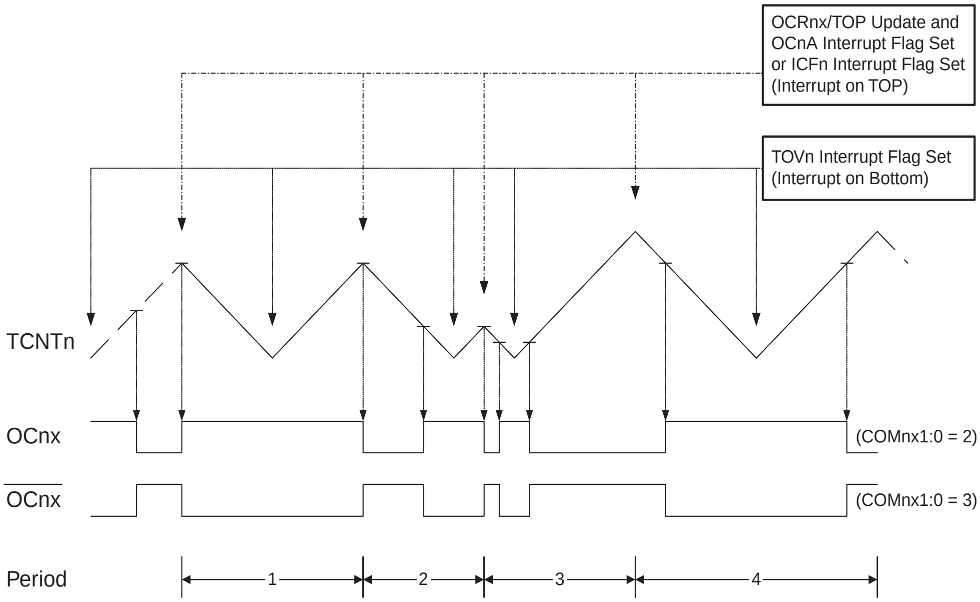
The PWM resolution for the phase correct PWM mode can be fixed to 8-, 9-, or 10-bit, or defined by either ICR1 or OCR1A. The minimum resolution allowed is 2-bit (ICR1 or

OCR1A set to 0x0003), and the maximum resolution is 16-bit (ICR1 or OCR1A set to MAX). The PWM resolution can be calculated in bits by using the following equation:

$$R_{PCPWM} = \frac{\log(TOP + 1)}{\log(2)}$$

In phase correct PWM mode, the counter is incremented until the counter value matches either one of the fixed values 0x00FF, 0x01FF, or 0x03FF (WGM13:0 = 1, 2, or 3), the value in ICR1 (WGM13:0 = 10), or the value in OCR1A (WGM13:0 = 11). The counter has then reached the TOP and changes the count direction. The TCNT1 value will be equal to TOP for one timer clock cycle. The timing diagram for the phase correct PWM mode is shown on Figure 47. The figure shows phase correct PWM mode when OCR1A or ICR1 is used to define TOP. The TCNT1 value is in the timing diagram shown as a histogram for illustrating the dual-slope operation. The diagram includes non-inverted and inverted PWM outputs. The small horizontal line marks on the TCNT1 slopes represent compare matches between OCR1x and TCNT1. The OC1x Interrupt Flag will be set when a Compare Match occurs.

Figure 47. Phase Correct PWM Mode, Timing Diagram



The Timer/Counter Overflow Flag (TOV1) is set each time the counter reaches BOTTOM. When either OCR1A or ICR1 is used for defining the TOP value, the OC1A or ICF1 Flag is set accordingly at the same timer clock cycle as the OCR1x Registers are updated with the double buffer value (at TOP). The interrupt flags can be used to generate an interrupt each time the counter reaches the TOP or BOTTOM value.

When changing the TOP value, the program must ensure that the new TOP value is higher or equal to the value of all of the compare registers. If the TOP value is lower than any of the compare registers, a Compare Match will never occur between the TCNT1 and the OCR1x. Note that when using fixed TOP values, the unused bits are masked to zero when any of the OCR1x Registers are written. As the third period shown in Figure 47 illustrates, changing the TOP actively while the Timer/Counter is running in the phase correct mode can result in an unsymmetrical output. The reason for this can be found in the time of update of the OCR1x Register. Since the OCR1x update occurs at TOP, the PWM period starts and ends at TOP. This implies that the length of the falling slope is determined by the previous TOP value, while the length of the rising slope is determined by the new TOP value. When these two values differ the two slopes of the period will differ in length. The difference in length gives the unsymmetrical result on the output.

It is recommended to use the phase and frequency correct mode instead of the phase correct mode when changing the TOP value while the Timer/Counter is running. When using a static TOP value, there are practically no differences between the two modes of operation.

In phase correct PWM mode, the compare units allow generation of PWM waveforms on the OC1x pins. Setting the COM1x1:0 bits to two will produce a non-inverted PWM and an inverted PWM output can be generated by setting the COM1x1:0 to three (See Table 47 on page 108). The actual OC1x value will only be visible on the port pin if the data direction for the port pin is set as output (DDR_OC1x). The PWM waveform is generated by setting (or clearing) the OC1x Register at the Compare Match between OCR1x and TCNT1 when the counter increments, and clearing (or setting) the OC1x Register at Compare Match between OCR1x and TCNT1 when the counter decrements. The PWM frequency for the output when using phase correct PWM can be calculated by the following equation:

$$f_{OCnxPCPWM} = \frac{f_{\text{clk\_I/O}}}{2 \cdot N \cdot TOP}$$

The "*N*" variable represents the prescaler divider (1, 8, 64, 256, or 1024).

The extreme values for the OCR1x Register represent special cases when generating a PWM waveform output in the phase correct PWM mode. If the OCR1x is set equal to BOTTOM the output will be continuously low and if set equal to TOP the output will be continuously high for non-inverted PWM mode. For inverted PWM the output will have the opposite logic values. If OCR1A is used to define the TOP value (WGM13:0 = 11) and COM1A1:0 = 1, the OC1A output will toggle with a 50% duty cycle.

Phase and Frequency Correct PWM Mode

The *phase and frequency correct Pulse Width Modulation,* or phase and frequency correct PWM mode (WGM13:0 = 8 or 9) provides a high resolution phase and frequency correct PWM waveform generation option. The phase and frequency correct PWM mode is, like the phase correct PWM mode, based on a dual-slope operation. The counter counts repeatedly from BOTTOM (0x0000) to TOP and then from TOP to BOTTOM. In non-inverting Compare Output mode, the Output Compare (OC1x) is cleared on the Compare Match between TCNT1 and OCR1x while up-counting, and set on the Compare Match while down-counting. In inverting Compare Output mode, the operation is inverted. The dual-slope operation gives a lower maximum operation frequency compared to the single-slope operation. However, due to the symmetric feature of the dual-slope PWM modes, these modes are preferred for motor control applications.

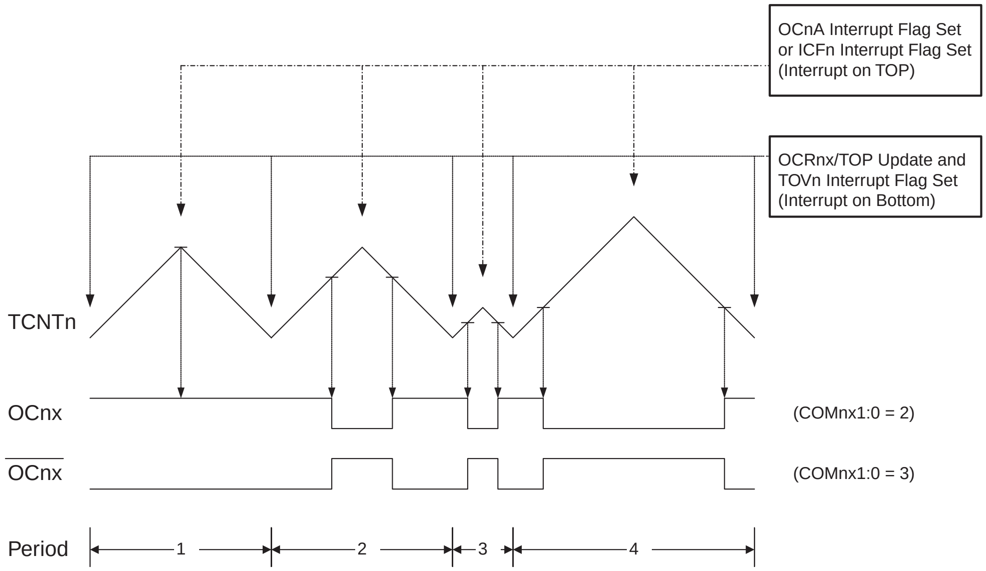
The main difference between the phase correct and the phase and frequency correct PWM mode is the time the OCR1x Register is updated by the OCR1x Buffer Register, (see Figure 47 and Figure 48).

The PWM resolution for the phase and frequency correct PWM mode can be defined by either ICR1 or OCR1A. The minimum resolution allowed is 2-bit (ICR1 or OCR1A set to 0x0003), and the maximum resolution is 16-bit (ICR1 or OCR1A set to MAX). The PWM resolution in bits can be calculated using the following equation:

$$R_{PFCPWM} = \frac{\log(TOP + 1)}{\log(2)}$$

In phase and frequency correct PWM mode the counter is incremented until the counter value matches either the value in ICR1 (WGM13:0 = 8), or the value in OCR1A (WGM13:0 = 9). The counter has then reached the TOP and changes the count direction. The TCNT1 value will be equal to TOP for one timer clock cycle. The timing diagram for the phase correct and frequency correct PWM mode is shown in Figure 48. The figure shows phase and frequency correct PWM mode when OCR1A or ICR1 is used to define TOP. The TCNT1 value is in the timing diagram shown as a histogram for illustrating the dual-slope operation. The diagram includes non-inverted and inverted PWM outputs. The small horizontal line marks on the TCNT1 slopes represent compare matches between OCR1x and TCNT1. The OC1x Interrupt Flag will be set when a Compare Match occurs.

Figure 48. Phase and Frequency Correct PWM Mode, Timing Diagram



The Timer/Counter Overflow Flag (TOV1) is set at the same timer clock cycle as the OCR1x Registers are updated with the double buffer value (at BOTTOM). When either OCR1A or ICR1 is used for defining the TOP value, the OC1A or ICF1 Flag set when TCNT1 has reached TOP. The interrupt flags can then be used to generate an interrupt each time the counter reaches the TOP or BOTTOM value.

When changing the TOP value the program must ensure that the new TOP value is higher or equal to the value of all of the compare registers. If the TOP value is lower than any of the compare registers, a Compare Match will never occur between the TCNT1 and the OCR1x.

As Figure 48 shows the output generated is, in contrast to the phase correct mode, symmetrical in all periods. Since the OCR1x Registers are updated at BOTTOM, the length of the rising and the falling slopes will always be equal. This gives symmetrical output pulses and the frequency is, therefore, correct.

Using the ICR1 Register for defining TOP works well when using fixed TOP values. By using ICR1, the OCR1A Register is free to be used for generating a PWM output on OC1A. However, if the base PWM frequency is actively changed by changing the TOP value, using the OCR1A as TOP is clearly a better choice due to its double buffer feature.

In phase and frequency correct PWM mode, the compare units allow generation of PWM waveforms on the OC1x pins. Setting the COM1x1:0 bits to two will produce a non-inverted PWM and an inverted PWM output can be generated by setting the COM1x1:0 to three (see Table 47 on page 108). The actual OC1x value will only be visible on the port pin if the data direction for the port pin is set as output (DDR_OC1x). The PWM waveform is generated by setting (or clearing) the OC1x Register at the Compare Match between OCR1x and TCNT1 when the counter increments, and clearing (or setting) the OC1x Register at Compare Match between OCR1x and TCNT1 when the counter decrements. The PWM frequency for the output when using phase and frequency correct PWM can be calculated by the following equation:

$$f_{OCnxPFCPWM} = \frac{f_{\text{clk\_I/O}}}{2 \cdot N \cdot TOP}$$

The "*N*" variable represents the prescaler divider (1, 8, 64, 256, or 1024).

The extreme values for the OCR1x Register represents special cases when generating a PWM waveform output in the phase correct PWM mode. If the OCR1x is set equal to BOTTOM the output will be continuously low and if set equal to TOP, the output will be set to high for non-inverted PWM mode. For inverted PWM, the output will have the opposite logic values. If OCR1A is used to define the TOP value (WGM13:0 = 9) and COM1A1:0 = 1, the OC1A output will toggle with a 50% duty cycle.

Timer/Counter Timing Diagrams

The Timer/Counter is a synchronous design and the timer clock (clk_{T1}) is therefore shown as a clock enable signal in the following figures. The figures include information on when interrupt flags are set, and when the OCR1x Register is updated with the OCR1x buffer value (only for modes utilizing double buffering). Figure 49 shows a timing diagram for the setting of OCF1x.

Figure 49. Timer/Counter Timing Diagram, Setting of OCF1x, no Prescaling

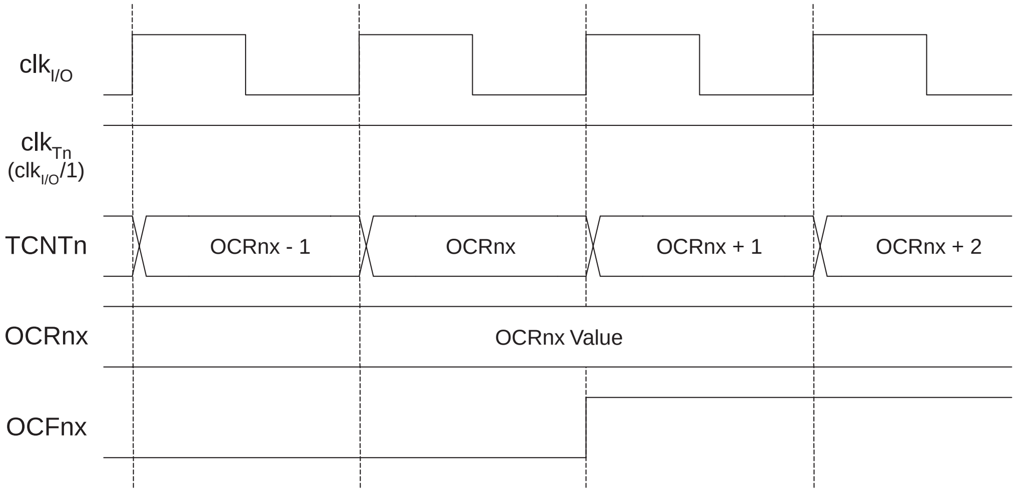


Figure 50 shows the same timing data, but with the prescaler enabled.

Figure 50. Timer/Counter Timing Diagram, Setting of OCF1x, with Prescaler ($f_{clk\_I/O}/8$)

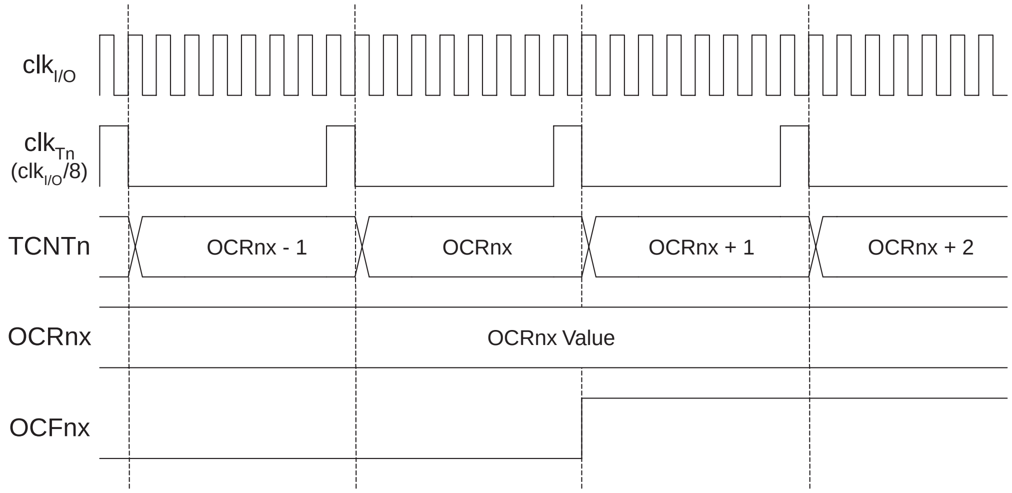


Figure 51 shows the count sequence close to TOP in various modes. When using phase and frequency correct PWM mode, the OCR1x Register is updated at BOTTOM. The timing diagrams will be the same, but TOP should be replaced by BOTTOM, TOP-1 by BOTTOM+1 and so on. The same renaming applies for modes that set the TOV1 Flag at BOTTOM.

Figure 51. Timer/Counter Timing Diagram, no Prescaling

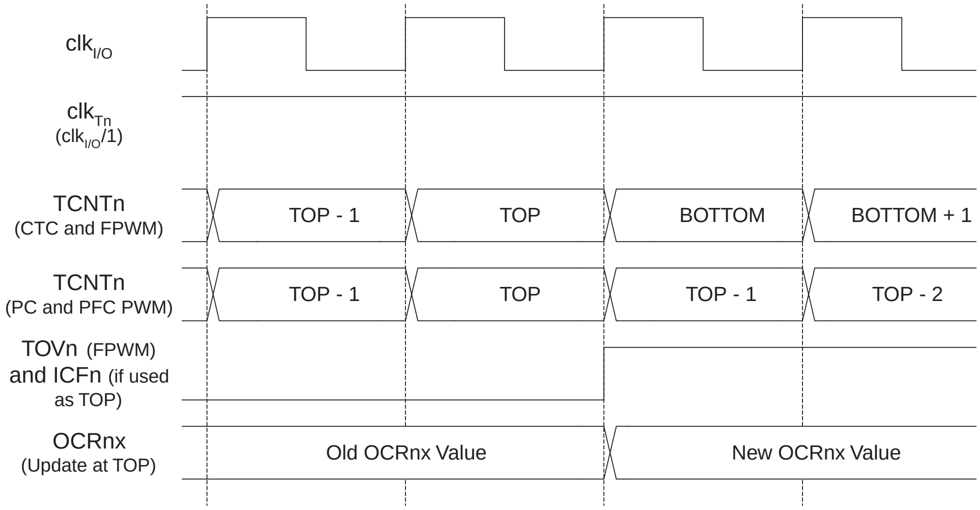
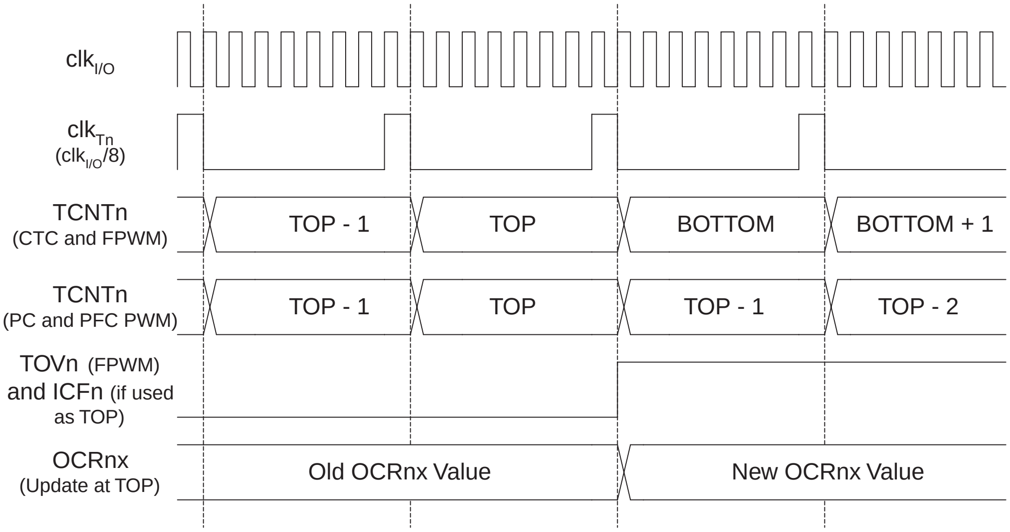


Figure 52 shows the same timing data, but with the prescaler enabled.

Figure 52. Timer/Counter Timing Diagram, with Prescaler ($f_{clk\_I/O}/8$)



16-bit Timer/Counter Register Description

Timer/Counter1 Control Register A – TCCR1A

Bit	7	6	5	4	3	2	1	0	
	COM1A1	COM1A0	COM1B1	COM1B0	FOC1A	FOC1B	WGM11	WGM10	TCCR1A
Read/Write	R/W	R/W	R/W	R/W	W	W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 7:6 – COM1A1:0: Compare Output Mode for Channel A**

- **Bit 5:4 – COM1B1:0: Compare Output Mode for Channel B**

The COM1A1:0 and COM1B1:0 control the Output Compare pins (OC1A and OC1B respectively) behavior. If one or both of the COM1A1:0 bits are written to one, the OC1A output overrides the normal port functionality of the I/O pin it is connected to. If one or both of the COM1B1:0 bit are written to one, the OC1B output overrides the normal port functionality of the I/O pin it is connected to. However, note that the *Data Direction Register* (DDR) bit corresponding to the OC1A or OC1B pin must be set in order to enable the output driver.

When the OC1A or OC1B is connected to the pin, the function of the COM1x1:0 bits is dependent of the WGM13:0 bits setting. Table 45 shows the COM1x1:0 bit functionality when the WGM13:0 bits are set to a normal or a CTC mode (non-PWM).

Table 45. Compare Output Mode, non-PWM

COM1A1/ COM1B1	COM1A0/ COM1B0	Description
0	0	Normal port operation, OC1A/OC1B disconnected.
0	1	Toggle OC1A/OC1B on Compare Match.
1	0	Clear OC1A/OC1B on Compare Match (set output to low level).
1	1	Set OC1A/OC1B on Compare Match (set output to high level).

Table 46 shows the COM1x1:0 bit functionality when the WGM13:0 bits are set to the fast PWM mode.

Table 46. Compare Output Mode, Fast PWM[1]

COM1A1/ COM1B1	COM1A0/ COM1B0	Description
0	0	Normal port operation, OC1A/OC1B disconnected.
0	1	WGM13:0 = 15: Toggle OC1A on Compare Match, OC1B disconnected (normal port operation). For all other WGM1 settings, normal port operation OC1A/OC1B disconnected.
1	0	Clear OC1A/OC1B on Compare Match, set OC1A/OC1B at TOP.
1	1	Set OC1A/OC1B on Compare Match, clear OC1A/OC1B at TOP.

Note: 1. A special case occurs when OCR1A/OCR1B equals TOP and COM1A1/COM1B1 is set. In this case the Compare Match is ignored, but the set or clear is done at TOP. See “Fast PWM Mode” on page 99 for more details.

Table 47 shows the COM1x1:0 bit functionality when the WGM13:0 bits are set to the phase correct or the phase and frequency correct, PWM mode.

Table 47. Compare Output Mode, Phase Correct and Phase and Frequency Correct PWM[1]

COM1A1/ COM1B1	COM1A0/ COM1B0	Description
0	0	Normal port operation, OC1A/OC1B disconnected.
0	1	WGM13:0 = 9 or 14: Toggle OC1A on Compare Match, OC1B disconnected (normal port operation). For all other WGM1 settings, normal port operation, OC1A/OC1B disconnected.
1	0	Clear OC1A/OC1B on Compare Match when up-counting. Set OC1A/OC1B on Compare Match when down-counting.
1	1	Set OC1A/OC1B on Compare Match when up-counting. Clear OC1A/OC1B on Compare Match when down-counting.

Note: 1. A special case occurs when OCR1A/OCR1B equals TOP and COM1A1/COM1B1 is set. See “Phase Correct PWM Mode” on page 101. for more details.

- **Bit 3 – FOC1A: Force Output Compare for Channel A**

- **Bit 2 – FOC1B: Force Output Compare for Channel B**

The FOC1A/FOC1B bits are only active when the WGM13:0 bits specify a non-PWM mode. However, for ensuring compatibility with future devices, these bits must be set to zero when TCCR1A is written when operating in a PWM mode. When writing a logical one to the FOC1A/FOC1B bit, an immediate Compare Match is forced on the waveform generation unit. The OC1A/OC1B output is changed according to its COM1x1:0 bits setting. Note that the FOC1A/FOC1B bits are implemented as strobes. Therefore it is the value present in the COM1x1:0 bits that determine the effect of the forced compare.

A FOC1A/FOC1B strobe will not generate any interrupt nor will it clear the timer in Clear Timer on Compare Match (CTC) mode using OCR1A as TOP.

The FOC1A/FOC1B bits are always read as zero.

- **Bit 1:0 – WGM11:0: Waveform Generation Mode**

Combined with the WGM13:2 bits found in the TCCR1B Register, these bits control the counting sequence of the counter, the source for maximum (TOP) counter value, and what type of waveform generation to be used, see Table 48. Modes of operation supported by the Timer/Counter unit are: Normal mode (counter), Clear Timer on Compare Match (CTC) mode, and three types of Pulse Width Modulation (PWM) modes. See “Modes of Operation” on page 98.

Table 48. Waveform Generation Mode Bit Description[1]

Mode	WGM13	WGM12 (CTC1)	WGM11 (PWM11)	WGM10 (PWM10)	Timer/Counter Mode of Operation	TOP	Update of OCR1x at	TOV1 Flag Set on
0	0	0	0	0	Normal	0xFFFF	Immediate	MAX
1	0	0	0	1	PWM, Phase Correct, 8-bit	0x00FF	TOP	BOTTOM
2	0	0	1	0	PWM, Phase Correct, 9-bit	0x01FF	TOP	BOTTOM
3	0	0	1	1	PWM, Phase Correct, 10-bit	0x03FF	TOP	BOTTOM
4	0	1	0	0	CTC	OCR1A	Immediate	MAX
5	0	1	0	1	Fast PWM, 8-bit	0x00FF	TOP	TOP
6	0	1	1	0	Fast PWM, 9-bit	0x01FF	TOP	TOP
7	0	1	1	1	Fast PWM, 10-bit	0x03FF	TOP	TOP
8	1	0	0	0	PWM, Phase and Frequency Correct	ICR1	BOTTOM	BOTTOM
9	1	0	0	1	PWM, Phase and Frequency Correct	OCR1A	BOTTOM	BOTTOM
10	1	0	1	0	PWM, Phase Correct	ICR1	TOP	BOTTOM
11	1	0	1	1	PWM, Phase Correct	OCR1A	TOP	BOTTOM
12	1	1	0	0	CTC	ICR1	Immediate	MAX
13	1	1	0	1	Reserved	–	–	–
14	1	1	1	0	Fast PWM	ICR1	TOP	TOP
15	1	1	1	1	Fast PWM	OCR1A	TOP	TOP

Note: 1. The CTC1 and PWM11:0 bit definition names are obsolete. Use the WGM12:0 definitions. However, the functionality and location of these bits are compatible with previous versions of the timer.

Timer/Counter1 Control Register B – TCCR1B

Bit	7	6	5	4	3	2	1	0	
	ICNC1	ICES1	–	WGM13	WGM12	CS12	CS11	CS10	TCCR1B
Read/Write	R/W	R/W	R	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 7 – ICNC1: Input Capture Noise Canceler**

Setting this bit (to one) activates the Input Capture Noise Canceler. When the Noise Canceler is activated, the input from the Input Capture Pin (ICP1) is filtered. The filter function requires four successive equal valued samples of the ICP1 pin for changing its output. The Input Capture is therefore delayed by four oscillator cycles when the noise canceler is enabled.

- **Bit 6 – ICES1: Input Capture Edge Select**

This bit selects which edge on the Input Capture Pin (ICP1) is used to trigger a capture event. When the ICES1 bit is written to zero, a falling (negative) edge is used as trigger, and when the ICES1 bit is written to one, a rising (positive) edge will trigger the capture.

When a capture is triggered according to the ICES1 setting, the counter value is copied into the Input Capture Register (ICR1). The event will also set the Input Capture Flag (ICF1), and this can be used to cause an Input Capture Interrupt, if this interrupt is enabled.

When the ICR1 is used as TOP value (see description of the WGM13:0 bits located in the TCCR1A and the TCCR1B Register), the ICP1 is disconnected, and consequently, the Input Capture function is disabled.

- **Bit 5 – Reserved Bit**

This bit is reserved for future use. For ensuring compatibility with future devices, this bit must be written to zero when TCCR1B is written.

- **Bit 4:3 – WGM13:2: Waveform Generation Mode**

See TCCR1A Register description.

- **Bit 2:0 – CS12:0: Clock Select**

The three Clock Select bits select the clock source to be used by the Timer/Counter, see Figure 49 and Figure 50.

Table 49. Clock Select Bit Description

CS12	CS11	CS10	Description
0	0	0	No clock source (Timer/Counter stopped).
0	0	1	$clk_{I/O}$/1 (No prescaling)
0	1	0	$clk_{I/O}$/8 (From prescaler)
0	1	1	$clk_{I/O}$/64 (From prescaler)
1	0	0	$clk_{I/O}$/256 (From prescaler)
1	0	1	$clk_{I/O}$/1024 (From prescaler)
1	1	0	External clock source on T1 pin. Clock on falling edge.
1	1	1	External clock source on T1 pin. Clock on rising edge.

If external pin modes are used for the Timer/Counter1, transitions on the T1 pin will clock the counter even if the pin is configured as an output. This feature allows software control of the counting.

Timer/Counter1 – TCNT1H and TCNT1L

Bit	7	6	5	4	3	2	1	0	
	TCNT1[15:8]								TCNT1H
	TCNT1[7:0]								TCNT1L
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

The two Timer/Counter I/O locations (TCNT1H and TCNT1L, combined TCNT1) give direct access, both for read and for write operations, to the Timer/Counter unit 16-bit counter. To ensure that both the high and low bytes are read and written simultaneously when the CPU accesses these registers, the access is performed using an 8-bit temporary high byte register (TEMP). This temporary register is shared by all the other 16-bit registers. See "Accessing 16-bit Registers" on page 89.

Modifying the counter (TCNT1) while the counter is running introduces a risk of missing a Compare Match between TCNT1 and one of the OCR1x Registers.

Writing to the TCNT1 Register blocks (removes) the Compare Match on the following timer clock for all compare units.

Output Compare Register 1 A – OCR1AH and OCR1AL

Bit	7	6	5	4	3	2	1	0	
	OCR1A[15:8]								OCR1AH
	OCR1A[7:0]								OCR1AL
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Output Compare Register 1 B – OCR1BH and OCR1BL

Bit	7	6	5	4	3	2	1	0	
	OCR1B[15:8]								OCR1BH
	OCR1B[7:0]								OCR1BL
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

The Output Compare Registers contain a 16-bit value that is continuously compared with the counter value (TCNT1). A match can be used to generate an output compare interrupt, or to generate a waveform output on the OC1x pin.

The Output Compare Registers are 16-bit in size. To ensure that both the high and low bytes are written simultaneously when the CPU writes to these registers, the access is performed using an 8-bit temporary high byte register (TEMP). This temporary register is shared by all the other 16-bit registers. See "Accessing 16-bit Registers" on page 89.

Input Capture Register 1 – ICR1H and ICR1L

Bit	7	6	5	4	3	2	1	0	
	ICR1[15:8]								ICR1H
	ICR1[7:0]								ICR1L
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

The Input Capture is updated with the counter (TCNT1) value each time an event occurs on the ICP1 pin (or optionally on the Analog Comparator output for Timer/Counter1). The Input Capture can be used for defining the counter TOP value.

The Input Capture Register is 16-bit in size. To ensure that both the high and low bytes are read simultaneously when the CPU accesses these registers, the access is performed using an 8-bit temporary high byte register (TEMP). This temporary register is shared by all the other 16-bit registers. See “Accessing 16-bit Registers” on page 89.

Timer/Counter Interrupt Mask Register – TIMSK[1]

Bit	7	6	5	4	3	2	1	0	
	OCIE2	TOIE2	TICIE1	OCIE1A	OCIE1B	TOIE1	OCIE0	TOIE0	**TIMSK**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Note: 1. This register contains interrupt control bits for several Timer/Counters, but only Timer1 bits are described in this section. The remaining bits are described in their respective timer sections.

- **Bit 5 – TICIE1: Timer/Counter1, Input Capture Interrupt Enable**

When this bit is written to one and the I-flag in the Status Register is set (interrupts globally enabled), the Timer/Counter1 Input Capture interrupt is enabled. The corresponding Interrupt Vector (see “Interrupts” on page 44) is executed when the ICF1 Flag, located in TIFR, is set.

- **Bit 4 – OCIE1A: Timer/Counter1, Output Compare A Match Interrupt Enable**

When this bit is written to one and the I-flag in the Status Register is set (interrupts globally enabled), the Timer/Counter1 output compare A match interrupt is enabled. The corresponding Interrupt Vector (see “Interrupts” on page 44) is executed when the OCF1A Flag, located in TIFR, is set.

- **Bit 3 – OCIE1B: Timer/Counter1, Output Compare B Match Interrupt Enable**

When this bit is written to one and the I-flag in the Status Register is set (interrupts globally enabled), the Timer/Counter1 output compare B match interrupt is enabled. The corresponding Interrupt Vector (see “Interrupts” on page 44) is executed when the OCF1B Flag, located in TIFR, is set.

- **Bit 2 – TOIE1: Timer/Counter1, Overflow Interrupt Enable**

When this bit is written to one and the I-flag in the Status Register is set (interrupts globally enabled), the Timer/Counter1 overflow interrupt is enabled. The corresponding Interrupt Vector (see “Interrupts” on page 44) is executed when the TOV1 Flag, located in TIFR, is set.

Timer/Counter Interrupt Flag Register – TIFR(1)

Bit	7	6	5	4	3	2	1	0	
	OCF2	TOV2	ICF1	OCF1A	OCF1B	TOV1	OCF0	TOV0	TIFR
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Note: 1. This register contains flag bits for several Timer/Counters, but only Timer1 bits are described in this section. The remaining bits are described in their respective timer sections.

- **Bit 5 – ICF1: Timer/Counter1, Input Capture Flag**

This flag is set when a capture event occurs on the ICP1 pin. When the Input Capture Register (ICR1) is set by the WGM13:0 to be used as the TOP value, the ICF1 Flag is set when the counter reaches the TOP value.

ICF1 is automatically cleared when the Input Capture Interrupt Vector is executed. Alternatively, ICF1 can be cleared by writing a logic one to its bit location.

- **Bit 4 – OCF1A: Timer/Counter1, Output Compare A Match Flag**

This flag is set in the timer clock cycle after the counter (TCNT1) value matches the Output Compare Register A (OCR1A).

Note that a Forced Output Compare (FOC1A) strobe will not set the OCF1A Flag.

OCF1A is automatically cleared when the Output Compare Match A Interrupt Vector is executed. Alternatively, OCF1A can be cleared by writing a logic one to its bit location.

- **Bit 3 – OCF1B: Timer/Counter1, Output Compare B Match Flag**

This flag is set in the timer clock cycle after the counter (TCNT1) value matches the Output Compare Register B (OCR1B).

Note that a Forced Output Compare (FOC1B) strobe will not set the OCF1B Flag.

OCF1B is automatically cleared when the Output Compare Match B Interrupt Vector is executed. Alternatively, OCF1B can be cleared by writing a logic one to its bit location.

- **Bit 2 – TOV1: Timer/Counter1, Overflow Flag**

The setting of this flag is dependent of the WGM13:0 bits setting. In normal and CTC modes, the TOV1 Flag is set when the timer overflows. Refer to Table 48 on page 109 for the TOV1 Flag behavior when using another WGM13:0 bit setting.

TOV1 is automatically cleared when the Timer/Counter1 Overflow Interrupt Vector is executed. Alternatively, TOV1 can be cleared by writing a logic one to its bit location.

8-bit Timer/Counter2 with PWM and Asynchronous Operation

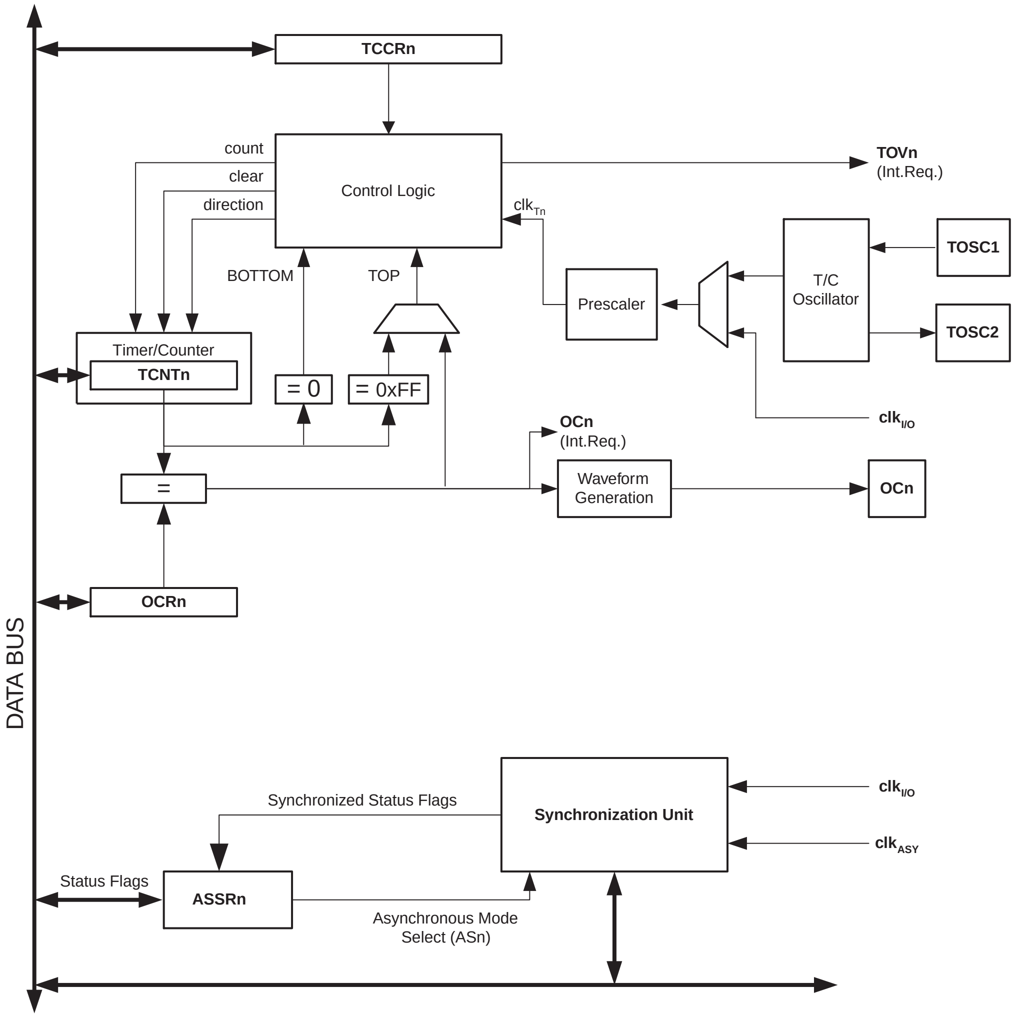
Timer/Counter2 is a general purpose, single channel, 8-bit Timer/Counter module. The main features are:

- **Single Channel Counter**
- **Clear Timer on Compare Match (Auto Reload)**
- **Glitch-free, Phase Correct Pulse Width Modulator (PWM)**
- **Frequency Generator**
- **10-bit Clock Prescaler**
- **Overflow and Compare Match Interrupt Sources (TOV2 and OCF2)**
- **Allows Clocking from External 32 kHz Watch Crystal Independent of the I/O Clock**

Overview

A simplified block diagram of the 8-bit Timer/Counter is shown in Figure 53. For the actual placement of I/O pins, refer to “Pinout ATmega8535” on page 2. CPU accessible I/O Registers, including I/O bits and I/O pins, are shown in bold. The device-specific I/O Register and bit locations are listed in the “8-bit Timer/Counter Register Description” on page 125.

Figure 53. 8-bit Timer/Counter Block Diagram



Registers

The Timer/Counter (TCNT2) and Output Compare Register (OCR2) are 8-bit registers. Interrupt request (shorten as Int.Req.) signals are all visible in the Timer Interrupt Flag Register (TIFR). All interrupts are individually masked with the Timer Interrupt Mask Register (TIMSK). TIFR and TIMSK are not shown in the figure since these registers are shared by other timer units.

The Timer/Counter can be clocked internally, via the prescaler, or asynchronously clocked from the TOSC1/2 pins, as detailed later in this section. The asynchronous operation is controlled by the Asynchronous Status Register (ASSR). The Clock Select logic block controls which clock source the Timer/Counter uses to increment (or decrement) its value. The Timer/Counter is inactive when no clock source is selected. The output from the Clock Select logic is referred to as the timer clock (clk_{T2}).

The double buffered Output Compare Register (OCR2) is compared with the Timer/Counter value at all times. The result of the compare can be used by the Waveform Generator to generate a PWM or variable frequency output on the Output Compare Pin (OC2). See “Output Compare Unit” on page 116 for details. The Compare Match event will also set the Compare Flag (OCF2) which can be used to generate an output compare interrupt request.

Definitions

Many register and bit references in this section are written in general form. A lower case “n” replaces the Timer/Counter number, in this case 2. However, when using the register or bit defines in a program, the precise form must be used (i.e., TCNT2 for accessing Timer/Counter2 counter value and so on).

The definitions in Table 50 are also used extensively throughout this section.

Table 50. Definitions

BOTTOM	The counter reaches the BOTTOM when it becomes zero (0x00).
MAX	The counter reaches its MAXimum when it becomes 0xFF (decimal 255).
TOP	The counter reaches the TOP when it becomes equal to the highest value in the count sequence. The TOP value can be assigned to be the fixed value 0xFF (MAX) or the value stored in the OCR2 Register. The assignment is dependent on the mode of operation.

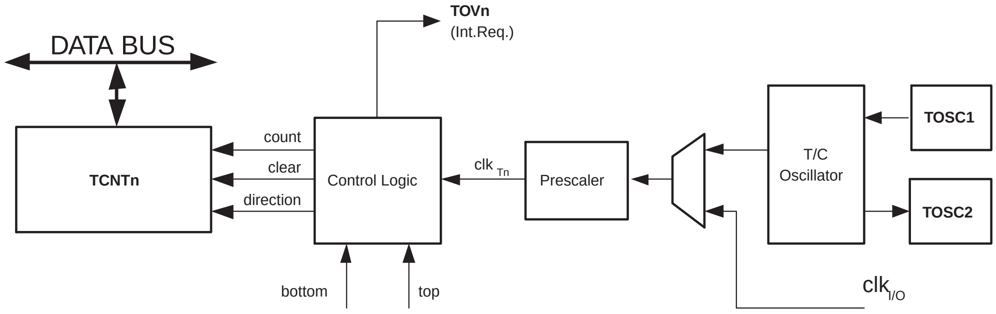
Timer/Counter Clock Sources

The Timer/Counter can be clocked by an internal synchronous or an external asynchronous clock source. The clock source clk_{T2} is by default equal to the MCU clock, $clk_{I/O}$. When the AS2 bit in the ASSR Register is written to logic one, the clock source is taken from the Timer/Counter Oscillator connected to TOSC1 and TOSC2. For details on asynchronous operation, see “Asynchronous Status Register – ASSR” on page 128. For details on clock sources and prescaler, see “Timer/Counter Prescaler” on page 131.

Counter Unit

The main part of the 8-bit Timer/Counter is the programmable bi-directional counter unit. Figure 54 shows a block diagram of the counter and its surrounding environment.

Figure 54. Counter Unit Block Diagram



Signal description (internal signals):

count	Increment or decrement TCNT2 by 1.
direction	Selects between increment and decrement.
clear	Clear TCNT2 (set all bits to zero).
clk_{T2}	Timer/Counter clock.
top	Signalizes that TCNT2 has reached maximum value.
bottom	Signalizes that TCNT2 has reached minimum value (zero).

Depending on the mode of operation used, the counter is cleared, incremented, or decremented at each timer clock (clk_{T2}). clk_{T2} can be generated from an external or internal clock source, selected by the Clock Select bits (CS22:0). When no clock source is selected (CS22:0 = 0) the timer is stopped. However, the TCNT2 value can be accessed by the CPU, regardless of whether clk_{T2} is present or not. A CPU write overrides (has priority over) all counter clear or count operations.

The counting sequence is determined by the setting of the WGM21 and WGM20 bits located in the Timer/Counter Control Register (TCCR2). There are close connections between how the counter behaves (counts) and how waveforms are generated on the output compare output OC2. For more details about advanced counting sequences and waveform generation, see “Modes of Operation” on page 119.

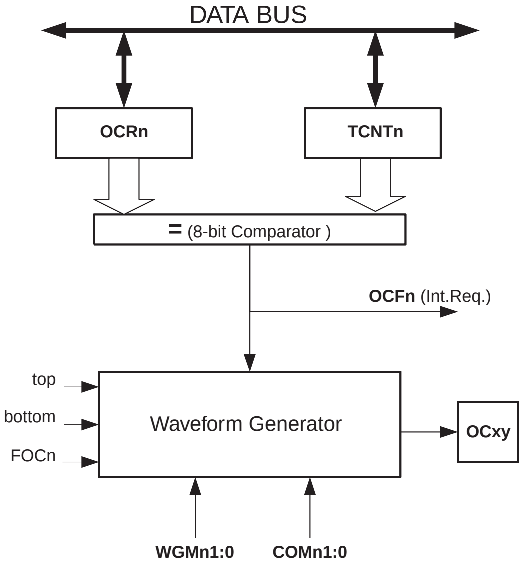
The Timer/Counter Overflow Flag (TOV2) is set according to the mode of operation selected by the WGM21:0 bits. TOV2 can be used for generating a CPU interrupt.

Output Compare Unit

The 8-bit comparator continuously compares TCNT2 with the Output Compare Register (OCR2). Whenever TCNT2 equals OCR2, the comparator signals a match. A match will set the Output Compare Flag (OCF2) at the next timer clock cycle. If enabled (OCIE2 = 1), the Output Compare Flag generates an output compare interrupt. The OCF2 Flag is automatically cleared when the interrupt is executed. Alternatively, the OCF2 Flag can be cleared by software by writing a logical one to its I/O bit location. The Waveform Generator uses the match signal to generate an output according to operating mode set by the WGM21:0 bits and Compare Output mode (COM21:0) bits. The max and bottom signals are used by the Waveform Generator for handling the special cases of the extreme values in some modes of operation (see “Modes of Operation” on page 119).

Figure 55 shows a block diagram of the output compare unit.

Figure 55. Output Compare Unit, Block Diagram



The OCR2 Register is double buffered when using any of the pulse width modulation (PWM) modes. For the normal and Clear Timer on Compare (CTC) modes of operation, the double buffering is disabled. The double buffering synchronizes the update of the OCR2 Compare Register to either top or bottom of the counting sequence. The synchronization prevents the occurrence of odd-length, non-symmetrical PWM pulses, thereby making the output glitch-free.

The OCR2 Register access may seem complex, but this is not the case. When the double buffering is enabled, the CPU has access to the OCR2 Buffer Register, and if double buffering is disabled the CPU will access the OCR2 directly.

Force Output Compare

In non-PWM waveform generation modes, the match output of the comparator can be forced by writing a one to the Force Output Compare (FOC2) bit. Forcing Compare Match will not set the OCF2 Flag or reload/clear the timer, but the OC2 pin will be updated as if a real Compare Match had occurred (the COM21:0 bits settings define whether the OC2 pin is set, cleared or toggled).

Compare Match Blocking by TCNT2 Write

All CPU write operations to the TCNT2 Register will block any Compare Match that occurs in the next timer clock cycle, even when the timer is stopped. This feature allows OCR2 to be initialized to the same value as TCNT2 without triggering an interrupt when the Timer/Counter clock is enabled.

Using the Output Compare Unit

Since writing TCNT2 in any mode of operation will block all compare matches for one timer clock cycle, there are risks involved when changing TCNT2 when using the output compare channel, independently of whether the Timer/Counter is running or not. If the value written to TCNT2 equals the OCR2 value, the Compare Match will be missed, resulting in incorrect waveform generation. Similarly, do not write the TCNT2 value equal to BOTTOM when the counter is down-counting.

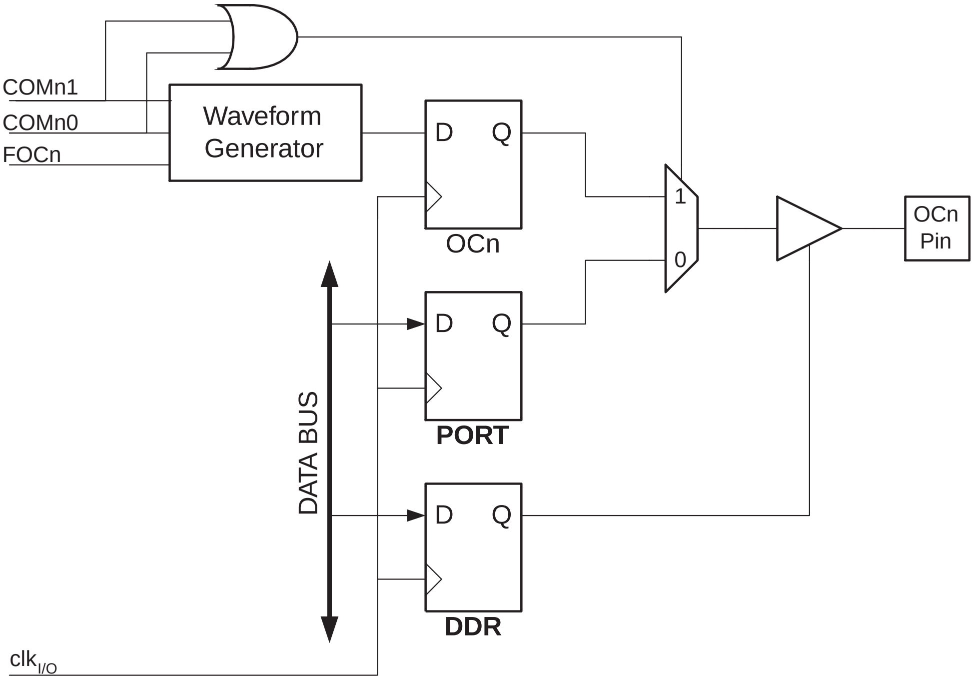
The setup of the OC2 should be performed before setting the Data Direction Register for the port pin to output. The easiest way of setting the OC2 value is to use the force output compare (FOC2) strobe bit in Normal mode. The OC2 Register keeps its value even when changing between Waveform Generation modes.

Be aware that the COM21:0 bits are not double buffered together with the compare value. Changing the COM21:0 bits will take effect immediately.

Compare Match Output Unit

The Compare Output mode (COM21:0) bits have two functions. The Waveform Generator uses the COM21:0 bits for defining the Output Compare (OC2) state at the next Compare Match. Also, the COM21:0 bits control the OC2 pin output source. Figure 56 shows a simplified schematic of the logic affected by the COM21:0 bit setting. The I/O Registers, I/O bits, and I/O pins in the figure are shown in bold. Only the parts of the general I/O port control registers (DDR and PORT) that are affected by the COM21:0 bits are shown. When referring to the OC2 state, the reference is for the internal OC2 Register, not the OC2 pin.

Figure 56. Compare Match Output Unit, Schematic



The general I/O port function is overridden by the Output Compare (OC2) from the waveform generator if either of the COM21:0 bits are set. However, the OC2 pin direction (input or output) is still controlled by the Data Direction Register (DDR) for the port pin. The Data Direction Register bit for the OC2 pin (DDR_OC2) must be set as output before the OC2 value is visible on the pin. The port override function is independent of the Waveform Generation mode.

The design of the output compare pin logic allows initialization of the OC2 state before the output is enabled. Note that some COM21:0 bit settings are reserved for certain modes of operation. See “8-bit Timer/Counter Register Description” on page 125.

Compare Output Mode and Waveform Generation

The Waveform Generator uses the COM21:0 bits differently in normal, CTC, and PWM modes. For all modes, setting the COM21:0 = 0 tells the waveform generator that no action on the OC2 Register is to be performed on the next Compare Match. For compare output actions in the non-PWM modes refer to Table 52 on page 126. For fast PWM mode, refer to Table 53 on page 126, and for phase correct PWM refer to Table 54 on page 127.

A change of the COM21:0 bits state will take effect at the first Compare Match after the bits are written. For non-PWM modes, the action can be forced to have an immediate effect by using the FOC2 strobe bits.

Modes of Operation

The mode of operation (i.e., the behavior of the Timer/Counter and the Output Compare pins) is defined by the combination of the Waveform Generation mode (WGM21:0) and Compare Output mode (COM21:0) bits. The Compare Output mode bits do not affect the counting sequence, while the Waveform Generation mode bits do. The COM21:0 bits control whether the PWM output generated should be inverted or not (inverted or non-inverted PWM). For non-PWM modes the COM21:0 bits control whether the output should be set, cleared, or toggled at a Compare Match (See “Compare Match Output Unit” on page 118.).

For detailed timing information refer to “Timer/Counter Timing Diagrams” on page 123.

Normal Mode

The simplest mode of operation is the Normal mode (WGM21:0 = 0). In this mode the counting direction is always up (incrementing), and no counter clear is performed. The counter simply overruns when it passes its maximum 8-bit value (TOP = 0xFF) and then restarts from the bottom (0x00). In normal operation the Timer/Counter Overflow Flag (TOV2) will be set in the same timer clock cycle as the TCNT2 becomes zero. The TOV2 Flag in this case behaves like a ninth bit, except that it is only set, not cleared. However, combined with the timer overflow interrupt that automatically clears the TOV2 Flag, the timer resolution can be increased by software. There are no special cases to consider in the normal mode, a new counter value can be written anytime.

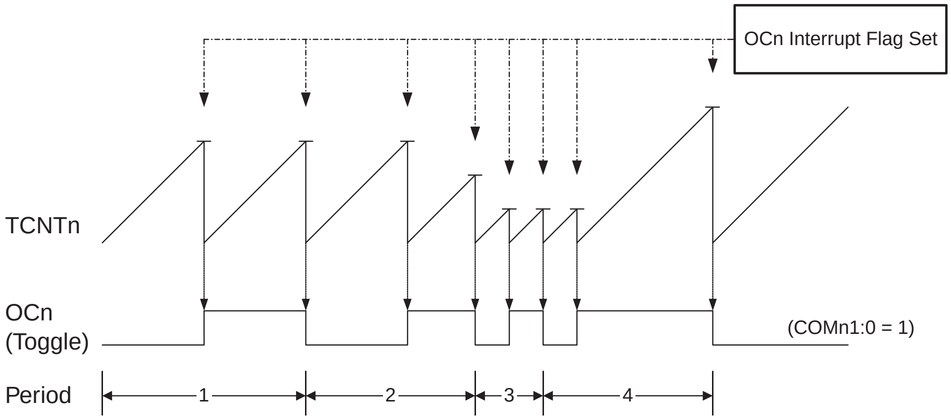
The output compare unit can be used to generate interrupts at some given time. Using the output compare to generate waveforms in Normal mode is not recommended, since this will occupy too much of the CPU time.

Clear Timer on Compare Match (CTC) Mode

In Clear Timer on Compare or CTC mode (WGM21:0 = 2), the OCR2 Register is used to manipulate the counter resolution. In CTC mode, the counter is cleared to zero when the counter value (TCNT2) matches the OCR2. The OCR2 defines the top value for the counter, hence also its resolution. This mode allows greater control of the Compare Match output frequency. It also simplifies the operation of counting external events.

The timing diagram for the CTC mode is shown in Figure 57. The counter value (TCNT2) increases until a Compare Match occurs between TCNT2 and OCR2, and then counter (TCNT2) is cleared.

Figure 57. CTC Mode, Timing Diagram



An interrupt can be generated each time the counter value reaches the TOP value by using the OCF2 Flag. If the interrupt is enabled, the interrupt handler routine can be used for updating the TOP value. However, changing the TOP to a value close to BOTTOM when the counter is running with none or a low prescaler value must be done with care since the CTC mode does not have the double buffering feature. If the new value written to OCR2 is lower than the current value of TCNT2, the counter will miss the Compare Match. The counter will then have to count to its maximum value (0xFF) and wrap around starting at 0x00 before the Compare Match can occur.

For generating a waveform output in CTC mode, the OC2 output can be set to toggle its logical level on each Compare Match by setting the Compare Output mode bits to toggle mode (COM21:0 = 1). The OC2 value will not be visible on the port pin unless the data direction for the pin is set to output. The waveform generated will have a maximum frequency of $f_{OC2} = f_{clk\_I/O}/2$ when OCR2 is set to zero (0x00). The waveform frequency is defined by the following equation:

$$f_{OCn} = \frac{f_{\text{clk\_I/O}}}{2 \cdot N \cdot (1 + OCRn)}$$

The “*N*” variable represents the prescale factor (1, 8, 32, 64, 128, 256, or 1024).

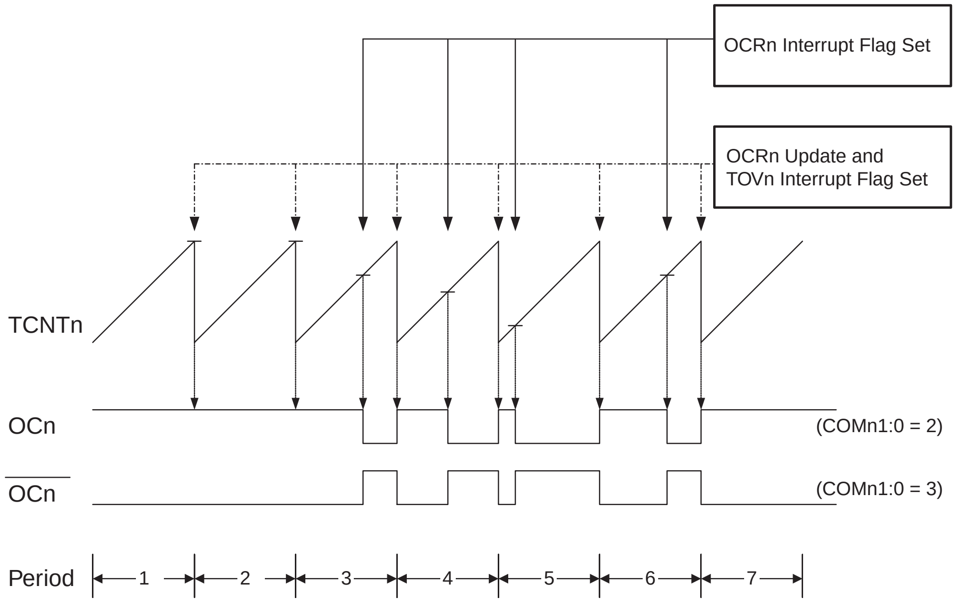
As for the Normal mode of operation, the TOV2 Flag is set in the same timer clock cycle that the counter counts from MAX to 0x00.

Fast PWM Mode

The fast Pulse Width Modulation or fast PWM mode (WGM21:0 = 3) provides a high frequency PWM waveform generation option. The fast PWM differs from the other PWM option by its single-slope operation. The counter counts from BOTTOM to MAX then restarts from BOTTOM. In non-inverting Compare Output mode, the Output Compare (OC2) is cleared on the Compare Match between TCNT2 and OCR2, and set at BOTTOM. In inverting Compare Output mode, the output is set on Compare Match and cleared at BOTTOM. Due to the single-slope operation, the operating frequency of the fast PWM mode can be twice as high as the phase correct PWM mode that uses dual-slope operation. This high frequency makes the fast PWM mode well suited for power regulation, rectification, and DAC applications. High frequency allows physically small sized external components (coils, capacitors), and therefore reduces total system cost.

In fast PWM mode, the counter is incremented until the counter value matches the MAX value. The counter is then cleared at the following timer clock cycle. The timing diagram for the fast PWM mode is shown in Figure 58. The TCNT2 value is in the timing diagram shown as a histogram for illustrating the single-slope operation. The diagram includes non-inverted and inverted PWM outputs. The small horizontal line marks on the TCNT2 slopes represent compare matches between OCR2 and TCNT2.

Figure 58. Fast PWM Mode, Timing Diagram



The Timer/Counter Overflow Flag (TOV2) is set each time the counter reaches MAX. If the interrupt is enabled, the interrupt handler routine can be used for updating the compare value.

In fast PWM mode, the compare unit allows generation of PWM waveforms on the OC2 pin. Setting the COM21:0 bits to two will produce a non-inverted PWM and an inverted PWM output can be generated by setting the COM21:0 to three (See Table 53 on page 126). The actual OC2 value will only be visible on the port pin if the data direction for the port pin is set as output. The PWM waveform is generated by setting (or clearing) the OC2 Register at the Compare Match between OCR2 and TCNT2, and clearing (or setting) the OC2 Register at the timer clock cycle the counter is cleared (changes from MAX to BOTTOM).

The PWM frequency for the output can be calculated by the following equation:

$$f_{OCnPWM} = \frac{f_{\text{clk\_I/O}}}{N \cdot 256}$$

The "*N*" variable represents the prescale factor (1, 8, 32, 64, 128, 256, or 1024).

The extreme values for the OCR2 Register represent special cases when generating a PWM waveform output in the fast PWM mode. If the OCR2 is set equal to BOTTOM, the output will be a narrow spike for each MAX+1 timer clock cycle. Setting the OCR2 equal to MAX will result in a constantly high or low output (depending on the polarity of the output set by the COM21:0 bits.)

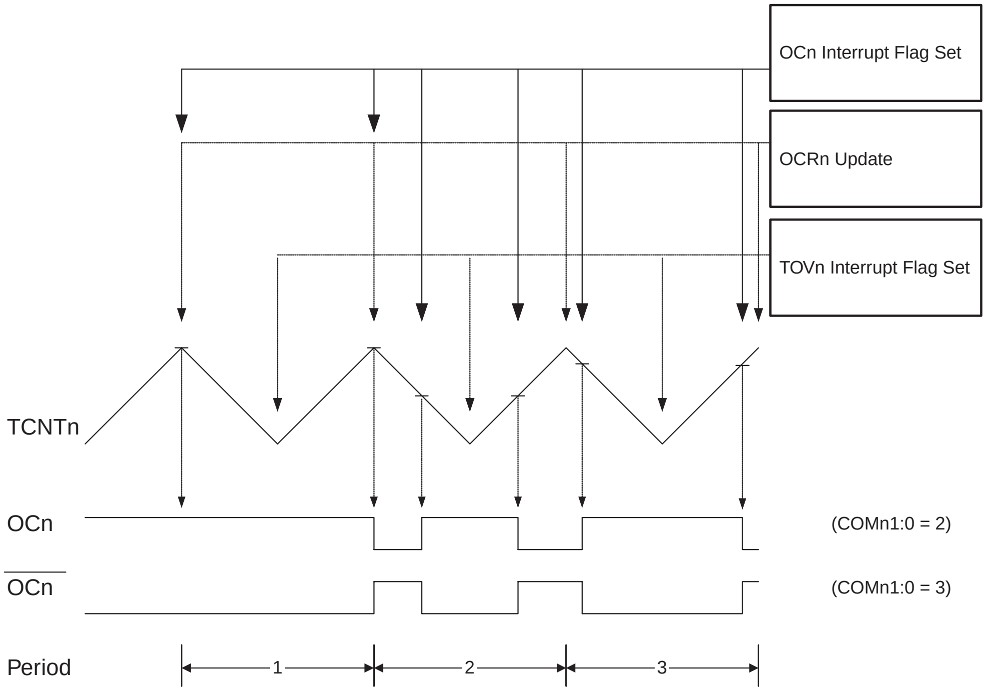
A frequency (with 50% duty cycle) waveform output in fast PWM mode can be achieved by setting OC2 to toggle its logical level on each Compare Match (COM21:0 = 1). The waveform generated will have a maximum frequency of $f_{oc2} = f_{\text{clk\_I/O}}/2$ when OCR2 is set to zero. This feature is similar to the OC2 toggle in CTC mode, except the double buffer feature of the output compare unit is enabled in the fast PWM mode.

Phase Correct PWM Mode

The Phase Correct PWM mode (WGM21:0 = 1) provides a high resolution phase correct PWM waveform generation option. The phase correct PWM mode is based on a dual-slope operation. The counter counts repeatedly from BOTTOM to MAX and then from MAX to BOTTOM. In non-inverting Compare Output mode, the Output Compare (OC2) is cleared on the Compare Match between TCNT2 and OCR2 while up-counting, and set on the Compare Match while down-counting. In inverting output compare mode, the operation is inverted. The dual-slope operation has lower maximum operation frequency than single slope operation. However, due to the symmetric feature of the dual-slope PWM modes, these modes are preferred for motor control applications.

The PWM resolution for the phase correct PWM mode is fixed to eight bits. In phase correct PWM mode the counter is incremented until the counter value matches MAX. When the counter reaches MAX, it changes the count direction. The TCNT2 value will be equal to MAX for one timer clock cycle. The timing diagram for the phase correct PWM mode is shown on Figure 59. The TCNT2 value is in the timing diagram shown as a histogram for illustrating the dual-slope operation. The diagram includes non-inverted and inverted PWM outputs. The small horizontal line marks on the TCNT2 slopes represent compare matches between OCR2 and TCNT2.

Figure 59. Phase Correct PWM Mode, Timing Diagram



The Timer/Counter Overflow Flag (TOV2) is set each time the counter reaches BOTTOM. The Interrupt Flag can be used to generate an interrupt each time the counter reaches the BOTTOM value.

In phase correct PWM mode, the compare unit allows generation of PWM waveforms on the OC2 pin. Setting the COM21:0 bits to two will produce a non-inverted PWM. An inverted PWM output can be generated by setting the COM21:0 to three (See Table 54 on page 127). The actual OC2 value will only be visible on the port pin if the data direction for the port pin is set as output. The PWM waveform is generated by clearing (or setting) the OC2 Register at the Compare Match between OCR2 and TCNT2 when the counter increments, and setting (or clearing) the OC2 Register at Compare Match between OCR2 and TCNT2 when the counter decrements. The PWM frequency for the output when using phase correct PWM can be calculated by the following equation:

$$f_{OCnPCPWM} = \frac{f_{\text{clk\_I/O}}}{N \cdot 510}$$

The "*N*" variable represents the prescale factor (1, 8, 32, 64, 128, 256, or 1024).

The extreme values for the OCR2 Register represent special cases when generating a PWM waveform output in the phase correct PWM mode. If the OCR2 is set equal to BOTTOM, the output will be continuously low and if set equal to MAX the output will be continuously high for non-inverted PWM mode. For inverted PWM the output will have the opposite logic values.

At the very start of period 2 in Figure 59 OCn has a transition from high to low even though there is no Compare Match. The point of this transition is to guarantee symmetry around BOTTOM. There are two cases that give a transition without Compare Match.

- OCR2 changes its value from MAX, like in Figure 59. When the OCR2 value is MAX the OCn pin value is the same as the result of a down-counting Compare Match. To ensure symmetry around BOTTOM the OCn value at MAX must correspond to the result of an up-counting Compare Match.
- The timer starts counting from a value higher than the one in OCR2, and for that reason misses the Compare Match and hence the OCn change that would have happened on the way up.

Timer/Counter Timing Diagrams

The following figures show the Timer/Counter in Synchronous mode, and the Timer Clock (clk_{T2}) is therefore shown as a clock enable signal. In Asynchronous mode, $\text{clk}_{I/O}$ should be replaced by the Timer/Counter Oscillator clock. The figures include information on when interrupt flags are set. Figure 60 contains timing data for basic Timer/Counter operation. The figure shows the count sequence close to the MAX value in all modes other than phase correct PWM mode.

Figure 60. Timer/Counter Timing Diagram, no Prescaling

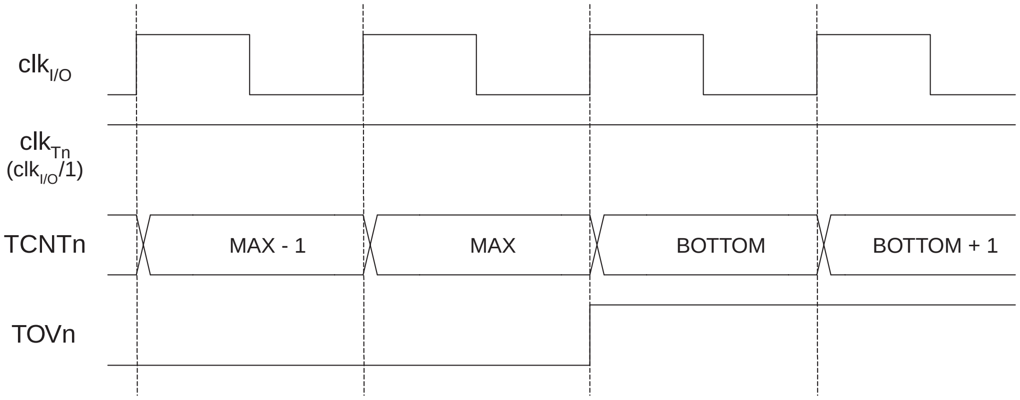


Figure 61 shows the same timing data, but with the prescaler enabled.

Figure 61. Timer/Counter Timing Diagram, with Prescaler ($f_{clk\_I/O}/8$)

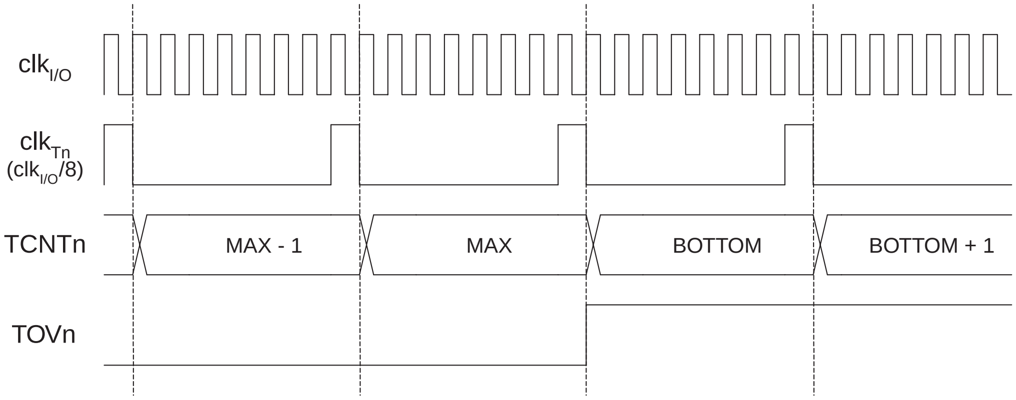


Figure 62 shows the setting of OCF2 in all modes except CTC mode.

Figure 62. Timer/Counter Timing Diagram, Setting of OCF2, with Prescaler ($f_{clk\_I/O}/8$)

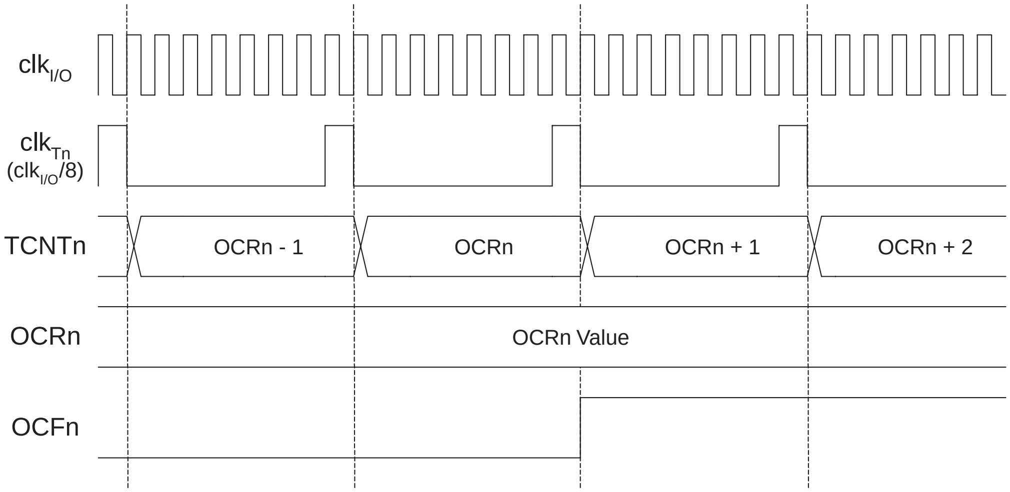
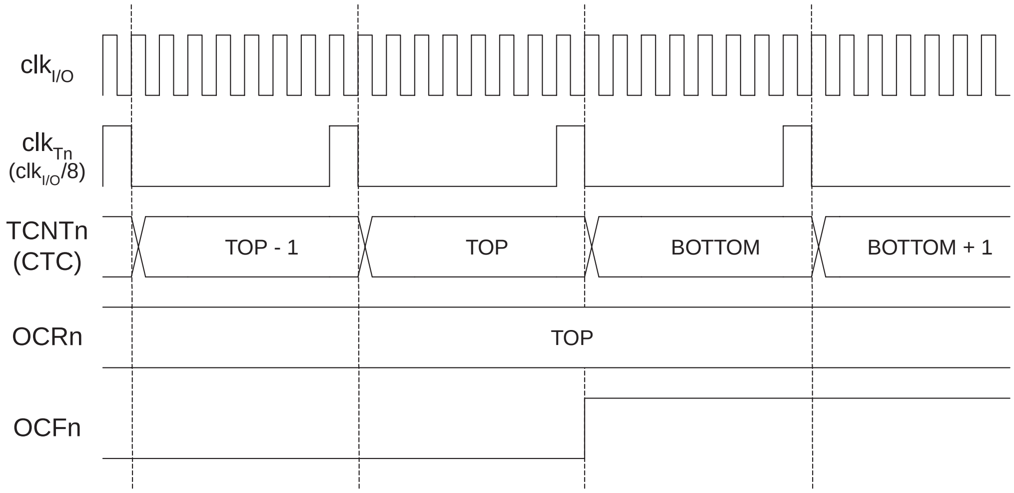


Figure 63 shows the setting of OCF2 and the clearing of TCNT2 in CTC mode.

Figure 63. Timer/Counter Timing Diagram, Clear Timer on Compare Match Mode, with Prescaler ($f_{clk\_I/O}/8$)



8-bit Timer/Counter Register Description

Timer/Counter Control Register – TCCR2

Bit	7	6	5	4	3	2	1	0	
	FOC2	**WGM20**	**COM21**	**COM20**	**WGM21**	**CS22**	**CS21**	**CS20**	**TCCR2**
Read/Write	W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 7 – FOC2: Force Output Compare**

The FOC2 bit is only active when the WGM bits specify a non-PWM mode. However, for ensuring compatibility with future devices, this bit must be set to zero when TCCR2 is written when operating in PWM mode. When writing a logical one to the FOC2 bit, an immediate Compare Match is forced on the Waveform Generation unit. The OC2 output is changed according to its COM21:0 bits setting. Note that the FOC2 bit is implemented as a strobe. Therefore it is the value present in the COM21:0 bits that determines the effect of the forced compare.

A FOC2 strobe will not generate any interrupt, nor will it clear the timer in CTC mode using OCR2 as TOP.

The FOC2 bit is always read as zero.

- **Bit 6, 3 – WGM21:0: Waveform Generation Mode**

These bits control the counting sequence of the counter, the source for the maximum (TOP) counter value, and what type of waveform generation to be used. Modes of operation supported by the Timer/Counter unit are: Normal mode, Clear Timer on Compare Match (CTC) mode, and two types of Pulse Width Modulation (PWM) modes. See Table 51 and “Modes of Operation” on page 119.

Table 51. Waveform Generation Mode Bit Description[1]

Mode	WGM21 (CTC2)	WGM20 (PWM2)	Timer/Counter Mode of Operation	TOP	Update of OCR2	TOV2 Flag Set on
0	0	0	Normal	0xFF	Immediate	MAX
1	0	1	PWM, Phase Correct	0xFF	TOP	BOTTOM
2	1	0	CTC	OCR2	Immediate	MAX
3	1	1	Fast PWM	0xFF	TOP	MAX

Note: 1. The CTC2 and PWM2 bit definition names are now obsolete. Use the WGM21:0 definitions. However, the functionality and location of these bits are compatible with previous versions of the timer.

- **Bit 5:4 – COM21:0: Compare Match Output Mode**

These bits control the Output Compare pin (OC2) behavior. If one or both of the COM21:0 bits are set, the OC2 output overrides the normal port functionality of the I/O pin it is connected to. However, note that the Data Direction Register (DDR) bit corresponding to OC2 pin must be set in order to enable the output driver.

When OC2 is connected to the pin, the function of the COM21:0 bits depends on the WGM21:0 bit setting. Table 52 shows the COM21:0 bit functionality when the WGM21:0 bits are set to a Normal or CTC mode (non-PWM).

Table 52. Compare Output Mode, non-PWM Mode

COM21	COM20	Description
0	0	Normal port operation, OC2 disconnected.
0	1	Toggle OC2 on Compare Match.
1	0	Clear OC2 on Compare Match.
1	1	Set OC2 on Compare Match.

Table 53 shows the COM21:0 bit functionality when the WGM21:0 bits are set to fast PWM mode.

Table 53. Compare Output Mode, Fast PWM Mode[1]

COM21	COM20	Description
0	0	Normal port operation, OC2 disconnected.
0	1	Reserved
1	0	Clear OC2 on Compare Match, set OC2 at TOP.
1	1	Set OC2 on Compare Match, clear OC2 at TOP.

Note: 1. A special case occurs when OCR2 equals TOP and COM21 is set. In this case, the Compare Match is ignored, but the set or clear is done at TOP. See “Fast PWM Mode” on page 120 for more details.

Table 54 shows the COM21:0 bit functionality when the WGM21:0 bits are set to phase correct PWM mode.

Table 54. Compare Output Mode, Phase Correct PWM Mode[(1)]

COM21	COM20	Description
0	0	Normal port operation, OC2 disconnected.
0	1	Reserved
1	0	Clear OC2 on Compare Match when up-counting. Set OC2 on Compare Match when down-counting.
1	1	Set OC2 on Compare Match when up-counting. Clear OC2 on Compare Match when down-counting.

Note: 1. A special case occurs when OCR2 equals TOP and COM21 is set. In this case, the Compare Match is ignored, but the set or clear is done at TOP. See "Phase Correct PWM Mode" on page 122 for more details.

- **Bit 2:0 – CS22:0: Clock Select**

The three clock select bits select the clock source to be used by the Timer/Counter, see Table 55.

Table 55. Clock Select Bit Description

CS22	CS21	CS20	Description
0	0	0	No clock source (Timer/Counter stopped).
0	0	1	clk_{T2S}/(No prescaling)
0	1	0	clk_{T2S}/8 (From prescaler)
0	1	1	clk_{T2S}/32 (From prescaler)
1	0	0	clk_{T2S}/64 (From prescaler)
1	0	1	clk_{T2S}/128 (From prescaler)
1	1	0	clk_{T2S}/256 (From prescaler)
1	1	1	clk_{T2S}/1024 (From prescaler)

Timer/Counter Register – TCNT2

Bit	7	6	5	4	3	2	1	0	
	TCNT2[7:0]								TCNT2
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

The Timer/Counter Register gives direct access, both for read and write operations, to the Timer/Counter unit 8-bit counter. Writing to the TCNT2 Register blocks (removes) the Compare Match on the following timer clock. Modifying the counter (TCNT2) while the counter is running, introduces a risk of missing a Compare Match between TCNT2 and the OCR2 Register.

Output Compare Register – OCR2

Bit	7	6	5	4	3	2	1	0	
	OCR2[7:0]								OCR2
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

The Output Compare Register contains an 8-bit value that is continuously compared with the counter value (TCNT2). A match can be used to generate an output compare interrupt, or to generate a waveform output on the OC2 pin.

Asynchronous Operation of the Timer/Counter

Asynchronous Status Register – ASSR

Bit	7	6	5	4	3	2	1	0	
	–	–	–	–	AS2	TCN2UB	OCR2UB	TCR2UB	ASSR
Read/Write	R	R	R	R	R/W	R	R	R	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 3 – AS2: Asynchronous Timer/Counter2**

When AS2 is written to zero, Timer/Counter2 is clocked from the I/O clock, $clk_{I/O}$. When AS2 is written to one, Timer/Counter2 is clocked from a crystal Oscillator connected to the Timer Oscillator1 (TOSC1) pin. When the value of AS2 is changed, the contents of TCNT2, OCR2, and TCCR2 might be corrupted.

- **Bit 2 – TCN2UB: Timer/Counter2 Update Busy**

When Timer/Counter2 operates asynchronously and TCNT2 is written, this bit becomes set. When TCNT2 has been updated from the temporary storage register, this bit is cleared by hardware. A logical zero in this bit indicates that TCNT2 is ready to be updated with a new value.

- **Bit 1 – OCR2UB: Output Compare Register 2 Update Busy**

When Timer/Counter2 operates asynchronously and OCR2 is written, this bit becomes set. When OCR2 has been updated from the temporary storage register, this bit is cleared by hardware. A logical zero in this bit indicates that OCR2 is ready to be updated with a new value.

- **Bit 0 – TCR2UB: Timer/Counter Control Register 2 Update Busy**

When Timer/Counter2 operates asynchronously and TCCR2 is written, this bit becomes set. When TCCR2 has been updated from the temporary storage register, this bit is cleared by hardware. A logical zero in this bit indicates that TCCR2 is ready to be updated with a new value.

If a write is performed to any of the three Timer/Counter2 Registers while its update busy flag is set, the updated value might get corrupted and cause an unintentional interrupt to occur.

The mechanisms for reading TCNT2, OCR2, and TCCR2 are different. When reading TCNT2, the actual timer value is read. When reading OCR2 or TCCR2, the value in the temporary storage register is read.

Asynchronous Operation of Timer/Counter2

When Timer/Counter2 operates asynchronously, some considerations must be taken.

- Warning: When switching between asynchronous and synchronous clocking of Timer/Counter2, the timer registers TCNT2, OCR2, and TCCR2 might be corrupted. A safe procedure for switching clock source is:
    1. Disable the Timer/Counter2 interrupts by clearing OCIE2 and TOIE2.
    2. Select clock source by setting AS2 as appropriate.
    3. Write new values to TCNT2, OCR2, and TCCR2.
    4. To switch to asynchronous operation: Wait for TCN2UB, OCR2UB, and TCR2UB.
    5. Clear the Timer/Counter2 Interrupt Flags.
    6. Enable interrupts, if needed.
- The Oscillator is optimized for use with a 32.768 kHz watch crystal. Applying an external clock to the TOSC1 pin may result in incorrect Timer/Counter2 operation. The CPU main clock frequency must be more than four times the oscillator frequency.
- When writing to one of the registers TCNT2, OCR2, or TCCR2, the value is transferred to a temporary register, and latched after two positive edges on TOSC1. The user should not write a new value before the contents of the temporary register have been transferred to its destination. Each of the three mentioned registers have their individual temporary register, which means that, e.g., writing to TCNT2 does not disturb an OCR2 write in progress. To detect that a transfer to the destination register has taken place, the Asynchronous Status Register – ASSR – has been implemented.
- When entering Power-save or Extended Standby mode after having written to TCNT2, OCR2, or TCCR2, the user must wait until the written register has been updated if Timer/Counter2 is used to wake up the device. Otherwise, the MCU will enter sleep mode before the changes are effective. This is particularly important if the Output Compare 2 interrupt is used to wake up the device, since the output compare function is disabled during writing to OCR2 or TCNT2. If the write cycle is not finished, and the MCU enters sleep mode before the OCR2UB bit returns to zero, the device will never receive a Compare Match interrupt, and the MCU will not wake up.
- If Timer/Counter2 is used to wake the device up from Power-save or Extended Standby mode, precautions must be taken if the user wants to re-enter one of these modes: The interrupt logic needs one TOSC1 cycle to be reset. If the time between wake-up and re-entering sleep mode is less than one TOSC1 cycle, the interrupt will not occur, and the device will fail to wake up. If the user is in doubt whether the time before re-entering Power-save or Extended Standby mode is sufficient, the following algorithm can be used to ensure that one TOSC1 cycle has elapsed:
    1. Write a value to TCCR2, TCNT2, or OCR2.
    2. Wait until the corresponding Update Busy Flag in ASSR returns to zero.
    3. Enter Power-save or Extended Standby mode.
- When the asynchronous operation is selected, the 32.768 kHz Oscillator for Timer/Counter2 is always running, except in Power-down and Standby modes. After a Power-up Reset or wake-up from Power-down or Standby mode, the user should be aware of the fact that this Oscillator might take as long as one second to stabilize. The user is advised to wait for at least one second before using Timer/Counter2 after Power-up or wake-up from Power-down or Standby mode. The contents of all Timer/Counter2 Registers must be considered lost after a wake-up from Power-

down or Standby mode due to unstable clock signal upon start-up, no matter whether the Oscillator is in use or a clock signal is applied to the TOSC1 pin.

- Description of wake-up from Power-save or Extended Standby mode when the timer is clocked asynchronously: When the interrupt condition is met, the wake up process is started on the following cycle of the timer clock, that is, the timer is always advanced by at least one before the processor can read the counter value. After wake-up, the MCU is halted for four cycles, it executes the interrupt routine, and resumes execution from the instruction following SLEEP.
- Reading of the TCNT2 Register shortly after wake-up from Power-save may give an incorrect result. Since TCNT2 is clocked on the asynchronous TOSC clock, reading TCNT2 must be done through a register synchronized to the internal I/O clock domain. Synchronization takes place for every rising TOSC1 edge. When waking up from Power-save mode, and the I/O clock ($clk_{I/O}$) again becomes active, TCNT2 will read as the previous value (before entering sleep) until the next rising TOSC1 edge. The phase of the TOSC clock after waking up from Power-save mode is essentially unpredictable, as it depends on the wake-up time. The recommended procedure for reading TCNT2 is thus as follows:
    1. Write any value to either of the registers OCR2 or TCCR2.
    2. Wait for the corresponding Update Busy Flag to be cleared.
    3. Read TCNT2.
- During asynchronous operation, the synchronization of the interrupt flags for the asynchronous timer takes three processor cycles plus one timer cycle. The timer is therefore advanced by at least one before the processor can read the timer value causing the setting of the Interrupt Flag. The output compare pin is changed on the timer clock and is not synchronized to the processor clock.

Timer/Counter Interrupt Mask Register – TIMSK

Bit	7	6	5	4	3	2	1	0	
	OCIE2	TOIE2	TICIE1	OCIE1A	OCIE1B	TOIE1	OCIE0	TOIE0	TIMSK
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

• Bit 7 – OCIE2: Timer/Counter2 Output Compare Match Interrupt Enable

When the OCIE2 bit is written to one and the I-bit in the Status Register is set (one), the Timer/Counter2 Compare Match interrupt is enabled. The corresponding interrupt is executed if a Compare Match in Timer/Counter2 occurs (i.e., when the OCF2 bit is set in the Timer/Counter Interrupt Flag Register – TIFR).

• Bit 6 – TOIE2: Timer/Counter2 Overflow Interrupt Enable

When the TOIE2 bit is written to one and the I-bit in the Status Register is set (one), the Timer/Counter2 Overflow interrupt is enabled. The corresponding interrupt is executed if an overflow in Timer/Counter2 occurs (i.e., when the TOV2 bit is set in the Timer/Counter Interrupt Flag Register – TIFR).

Timer/Counter Interrupt Flag Register – TIFR

Bit	7	6	5	4	3	2	1	0	
	OCF2	**TOV2**	**ICF1**	**OCF1A**	**OCF1B**	**TOV1**	**OCF0**	**TOV0**	**TIFR**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 7 – OCF2: Output Compare Flag 2**

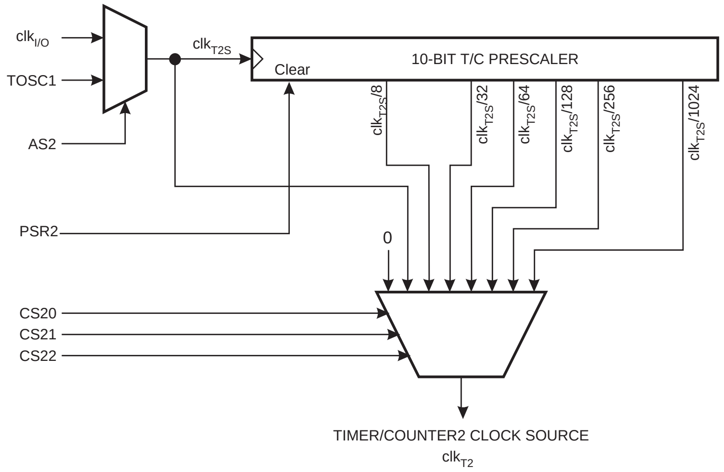
The OCF2 bit is set (one) when a Compare Match occurs between the Timer/Counter2 and the data in OCR2 – Output Compare Register 2. OCF2 is cleared by hardware when executing the corresponding interrupt handling vector. Alternatively, OCF2 is cleared by writing a logic one to the flag. When the I-bit in SREG, OCIE2 (Timer/Counter2 Compare Match interrupt enable), and OCF2 are set (one), the Timer/Counter2 Compare Match Interrupt is executed.

- **Bit 6 – TOV2: Timer/Counter2 Overflow Flag**

The TOV2 bit is set (one) when an overflow occurs in Timer/Counter2. TOV2 is cleared by hardware when executing the corresponding interrupt handling vector. Alternatively, TOV2 is cleared by writing a logic one to the flag. When the SREG I-bit, TOIE2 (Timer/Counter2 Overflow Interrupt Enable), and TOV2 are set (one), the Timer/Counter2 Overflow interrupt is executed. In PWM mode, this bit is set when Timer/Counter2 changes counting direction at 0x00.

Timer/Counter Prescaler

Figure 64. Prescaler for Timer/Counter2



The clock source for Timer/Counter2 is named clk_{T2S}. clk_{T2S} is, by default, connected to the main system I/O clock clk_{IO}. By setting the AS2 bit in ASSR, Timer/Counter2 is asynchronously clocked from the TOSC1 pin. This enables use of Timer/Counter2 as a Real Time Counter (RTC). When AS2 is set, pins TOSC1 and TOSC2 are disconnected from Port C. A crystal can then be connected between the TOSC1 and TOSC2 pins to serve as an independent clock source for Timer/Counter2. The Oscillator is optimized for use with a 32.768 kHz crystal. Applying an external clock source to TOSC1 is not recommended.

For Timer/Counter2, the possible prescaled selections are: $clk_{T2S}/8$, $clk_{T2S}/32$, $clk_{T2S}/64$, $clk_{T2S}/128$, $clk_{T2S}/256$, and $clk_{T2S}/1024$. Additionally, clk_{T2S} as well as 0 (stop) may be selected. Setting the PSR2 bit in SFIOR resets the prescaler. This allows the user to operate with a predictable prescaler.

Special Function IO Register – SFIOR

Bit	7	6	5	4	3	2	1	0	
	ADTS2	**ADTS1**	**ADTS0**	**–**	**ACME**	**PUD**	**PSR2**	**PSR10**	**SFIOR**
Read/Write	R/W	R/W	R/W	R	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 1 – PSR2: Prescaler Reset Timer/Counter2**

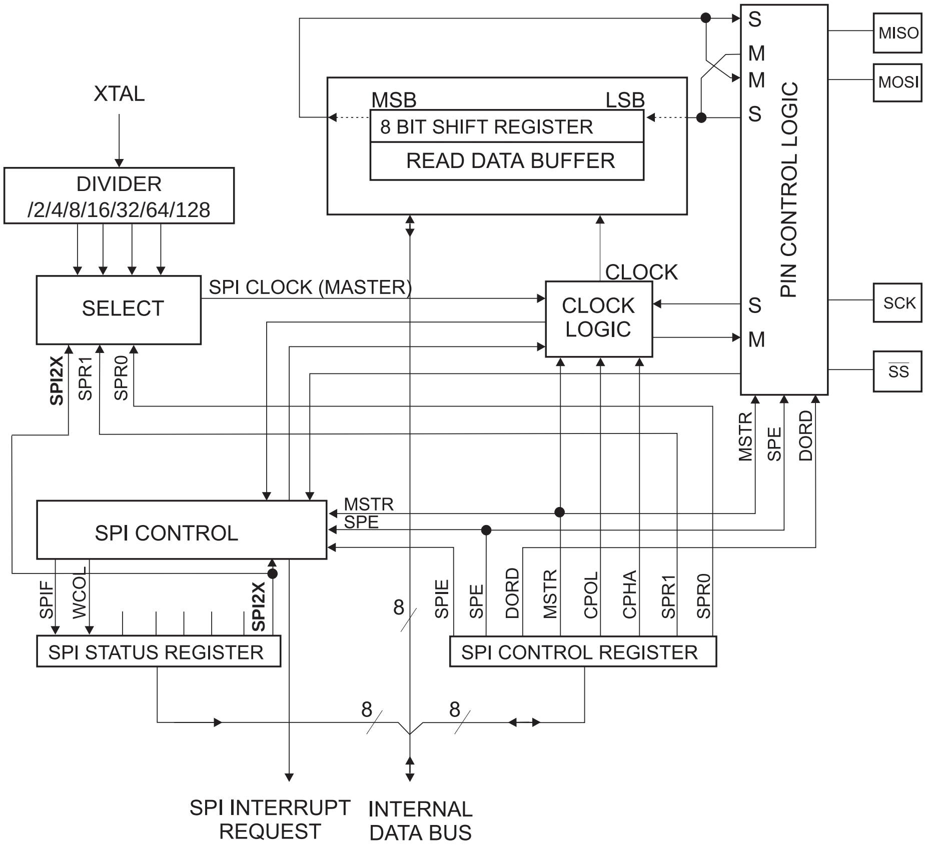
When this bit is written to one, the Timer/Counter2 prescaler will be reset. The bit will be cleared by hardware after the operation is performed. Writing a zero to this bit will have no effect. This bit will always be read as zero if Timer/Counter2 is clocked by the internal CPU clock. If this bit is written when Timer/Counter2 is operating in asynchronous mode, the bit will remain one until the prescaler has been reset.

Serial Peripheral Interface – SPI

The Serial Peripheral Interface (SPI) allows high-speed synchronous data transfer between the ATmega8535 and peripheral devices or between several AVR devices. The ATmega8535 SPI includes the following features:

- **Full Duplex, Three-wire Synchronous Data Transfer**
- **Master or Slave Operation**
- **LSB First or MSB First Data Transfer**
- **Seven Programmable Bit Rates**
- **End of Transmission Interrupt Flag**
- **Write Collision Flag Protection**
- **Wake-up from Idle Mode**
- **Double Speed (CK/2) Master SPI Mode**

Figure 65. SPI Block Diagram(1)



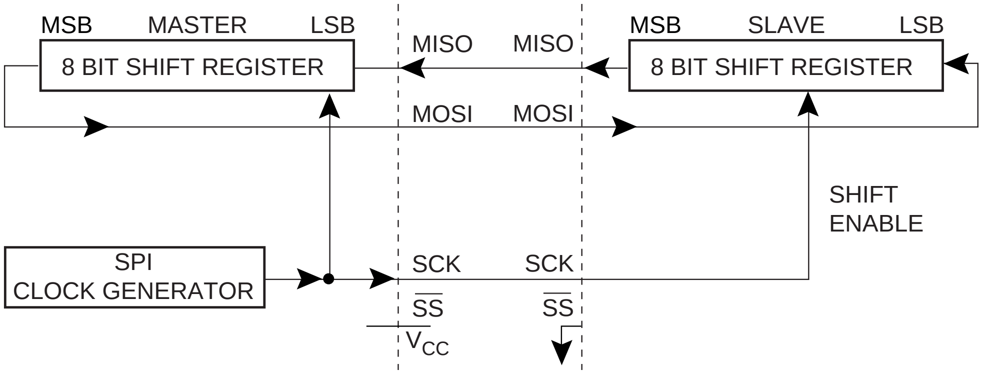
Note: 1. Refer to Figure 1 on page 2, and Table 26 on page 57 for SPI pin placement.

The interconnection between Master and Slave CPUs with SPI is shown in Figure 66. The system consists of two Shift Registers, and a Master clock generator. The SPI Master initiates the communication cycle when pulling low the Slave Select $\overline{\text{SS}}$ pin of the desired Slave. Master and Slave prepare the data to be sent in their respective Shift Registers, and the Master generates the required clock pulses on the SCK line to interchange data. Data is always shifted from Master to Slave on the Master Out – Slave In, MOSI, line, and from Slave to Master on the Master In – Slave Out, MISO, line. After each data packet, the Master will synchronize the Slave by pulling high the Slave Select, $\overline{\text{SS}}$, line.

When configured as a Master, the SPI interface has no automatic control of the $\overline{\text{SS}}$ line. This must be handled by user software before communication can start. When this is done, writing a byte to the SPI Data Register starts the SPI Clock Generator, and the hardware shifts the eight bits into the Slave. After shifting one byte, the SPI clock generator stops, setting the end of Transmission Flag (SPIF). If the SPI Interrupt Enable bit (SPIE) in the SPCR Register is set, an interrupt is requested. The Master may continue to shift the next byte by writing it into SPDR, or signal the end of packet by pulling high the Slave Select, $\overline{\text{SS}}$ line. The last incoming byte will be kept in the buffer register for later use.

When configured as a Slave, the SPI interface will remain sleeping with MISO tri-stated as long as the $\overline{\text{SS}}$ pin is driven high. In this state, software may update the contents of the SPI Data Register, SPDR, but the data will not be shifted out by incoming clock pulses on the SCK pin until the $\overline{\text{SS}}$ pin is driven low. As one byte has been completely shifted, the end of Transmission Flag, SPIF is set. If the SPI Interrupt Enable bit, SPIE, in the SPCR Register is set, an interrupt is requested. The Slave may continue to place new data to be sent into SPDR before reading the incoming data. The last incoming byte will be kept in the buffer register for later use.

Figure 66. SPI Master-Slave Interconnection



The system is single buffered in the transmit direction and double buffered in the receive direction. This means that bytes to be transmitted cannot be written to the SPI Data Register before the entire shift cycle is completed. When receiving data, however, a received character must be read from the SPI Data Register before the next character has been completely shifted in. Otherwise, the first byte is lost.

In SPI Slave mode, the control logic will sample the incoming signal of the SCK pin. To ensure correct sampling of the clock signal, the frequency of the SPI clock should never exceed $f_{osc}/4$.

When the SPI is enabled, the data direction of the MOSI, MISO, SCK, and $\overline{\text{SS}}$ pins is overridden according to Table 56. For more details on automatic port overrides, refer to "Alternate Port Functions" on page 54.

Table 56. SPI Pin Overrides(1)

Pin	Direction, Master SPI	Direction, Slave SPI
MOSI	User Defined	Input
MISO	Input	User Defined
SCK	User Defined	Input
$\overline{\text{SS}}$	User Defined	Input

Note: 1. See "Alternate Functions Of Port B" on page 57 for a detailed description of how to define the direction of the user defined SPI pins.

The following code examples show how to initialize the SPI as a Master and how to perform a simple transmission. DDR_SPI in the examples must be replaced by the actual Data Direction Register controlling the SPI pins. DD_MOSI, DD_MISO and DD_SCK must be replaced by the actual data direction bits for these pins. For example, if MOSI is placed on pin PB5, replace DD_MOSI with DDB5, and DDR_SPI with DDRB.

Assembly Code Example(1)

```
SPI_MasterInit:
  ; Set MOSI and SCK output, all others input
  ldi    r17,(1<<DD_MOSI)|(1<<DD_SCK)
  out    DDR_SPI,r17
  ; Enable SPI, Master, set clock rate fck/16
  ldi    r17,(1<<SPE)|(1<<MSTR)|(1<<SPR0)
  out    SPCR,r17
  ret

SPI_MasterTransmit:
  ; Start transmission of data (r16)
  out    SPDR,r16
Wait_Transmit:
  ; Wait for transmission complete
  sbis   SPSR,SPIF
  rjmp   Wait_Transmit
  ret
```

C Code Example(1)

```
void SPI_MasterInit(void)
{
  /* Set MOSI and SCK output, all others input */
  DDR_SPI = (1<<DD_MOSI)|(1<<DD_SCK);
  /* Enable SPI, Master, set clock rate fck/16 */
  SPCR = (1<<SPE)|(1<<MSTR)|(1<<SPR0);
}

void SPI_MasterTransmit(char cData)
{
  /* Start transmission */
  SPDR = cData;
  /* Wait for transmission complete */
  while(!(SPSR & (1<<SPIF)))
    ;
}
```

Note: 1. The example code assumes that the part specific header file is included.

The following code examples show how to initialize the SPI as a Slave and how to perform a simple reception.

Assembly Code Example[1]

```
SPI_SlaveInit:
    ; Set MISO output, all others input
    ldi     r17,(1<<DD_MISO)
    out     DDR_SPI,r17
    ; Enable SPI
    ldi     r17,(1<<SPE)
    out     SPCR,r17
    ret

SPI_SlaveReceive:
    ; Wait for reception complete
    sbis    SPSR,SPIF
    rjmp    SPI_SlaveReceive
    ; Read received data and return
    in      r16,SPDR
    ret
```

C Code Example[1]

```
void SPI_SlaveInit(void)
{
    /* Set MISO output, all others input */
    DDR_SPI = (1<<DD_MISO);
    /* Enable SPI */
    SPCR = (1<<SPE);
}

char SPI_SlaveReceive(void)
{
    /* Wait for reception complete */
    while(!(SPSR & (1<<SPIF)))
        ;
    /* Return Data Register */
    return SPDR;
}
```

Note: 1. The example code assumes that the part specific header file is included.

$\overline{\text{SS}}$ Pin Functionality

Slave Mode

When the SPI is configured as a Slave, the Slave Select ($\overline{\text{SS}}$) pin is always input. When $\overline{\text{SS}}$ is held low, the SPI is activated, and MISO becomes an output if configured so by the user. All other pins are inputs. When $\overline{\text{SS}}$ is driven high, all pins are inputs, and the SPI is passive, which means that it will not receive incoming data. Note that the SPI logic will be reset once the $\overline{\text{SS}}$ pin is driven high.

The $\overline{\text{SS}}$ pin is useful for packet/byte synchronization to keep the Slave bit counter synchronous with the Master clock generator. When the $\overline{\text{SS}}$ pin is driven high, the SPI Slave will immediately reset the send and receive logic, and drop any partially received data in the Shift Register.

Master Mode

When the SPI is configured as a Master (MSTR in SPCR is set), the user can determine the direction of the $\overline{\text{SS}}$ pin.

If $\overline{\text{SS}}$ is configured as an output, the pin is a general output pin which does not affect the SPI system. Typically, the pin will be driving the $\overline{\text{SS}}$ pin of the SPI Slave.

If $\overline{\text{SS}}$ is configured as an input, it must be held high to ensure Master SPI operation. If the $\overline{\text{SS}}$ pin is driven low by peripheral circuitry when the SPI is configured as a Master with the $\overline{\text{SS}}$ pin defined as an input, the SPI system interprets this as another Master selecting the SPI as a Slave and starting to send data to it. To avoid bus contention, the SPI system takes the following actions:

1. The MSTR bit in SPCR is cleared and the SPI system becomes a Slave. As a result of the SPI becoming a Slave, the MOSI and SCK pins become inputs.
2. The SPIF Flag in SPSR is set, and if the SPI interrupt is enabled, and the I-bit in SREG is set, the interrupt routine will be executed.

Thus, when interrupt-driven SPI transmission is used in Master mode, and there exists a possibility that $\overline{\text{SS}}$ is driven low, the interrupt should always check that the MSTR bit is still set. If the MSTR bit has been cleared by a Slave Select, it must be set by the user to re-enable SPI Master mode.

SPI Control Register – SPCR

Bit	7	6	5	4	3	2	1	0	
	SPIE	SPE	DORD	MSTR	CPOL	CPHA	SPR1	SPR0	SPCR
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

• Bit 7 – SPIE: SPI Interrupt Enable

This bit causes the SPI interrupt to be executed if SPIF bit in the SPSR Register is set and the if the Global Interrupt Enable bit in SREG is set.

• Bit 6 – SPE: SPI Enable

When the SPE bit is written to one, the SPI is enabled. This bit must be set to enable any SPI operations.

• Bit 5 – DORD: Data Order

When the DORD bit is written to one, the LSB of the data word is transmitted first.

When the DORD bit is written to zero, the MSB of the data word is transmitted first.

- **Bit 4 – MSTR: Master/Slave Select**

This bit selects Master SPI mode when written to one, and Slave SPI mode when written logic zero. If $\overline{SS}$ is configured as an input and is driven low while MSTR is set, MSTR will be cleared, and SPIF in SPSR will become set. The user will then have to set MSTR to re-enable SPI Master mode.

- **Bit 3 – CPOL: Clock Polarity**

When this bit is written to one, SCK is high when idle. When CPOL is written to zero, SCK is low when idle. Refer to Figure 67 and Figure 68 for an example. The CPOL functionality is summarized below:

Table 57. CPOL Functionality

CPOL	Leading Edge	Trailing Edge
0	Rising	Falling
1	Falling	Rising

- **Bit 2 – CPHA: Clock Phase**

The settings of the Clock Phase bit (CPHA) determine if data is sampled on the leading (first) or trailing (last) edge of SCK. Refer to Figure 67 and Figure 68 for an example. The CPOL functionality is summarized below:

Table 58. CPHA Functionality

CPHA	Leading Edge	Trailing Edge
0	Sample	Setup
1	Setup	Sample

- **Bits 1, 0 – SPR1, SPR0: SPI Clock Rate Select 1 and 0**

These two bits control the SCK rate of the device configured as a Master. SPR1 and SPR0 have no effect on the Slave. The relationship between SCK and the Oscillator Clock frequency f_{osc} is shown in the following table:

Table 59. Relationship between SCK and the Oscillator Frequency

SPI2X	SPR1	SPR0	SCK Frequency
0	0	0	$f_{osc}/4$
0	0	1	$f_{osc}/16$
0	1	0	$f_{osc}/64$
0	1	1	$f_{osc}/128$
1	0	0	$f_{osc}/2$
1	0	1	$f_{osc}/8$
1	1	0	$f_{osc}/32$
1	1	1	$f_{osc}/64$

SPI Status Register – SPSR

Bit	7	6	5	4	3	2	1	0	
	SPIF	**WCOL**	–	–	–	–	–	**SPI2X**	**SPSR**
Read/Write	R	R	R	R	R	R	R	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 7 – SPIF: SPI Interrupt Flag**

When a serial transfer is complete, the SPIF Flag is set. An interrupt is generated if SPIE in SPCR is set and global interrupts are enabled. If $\overline{SS}$ is an input and is driven low when the SPI is in Master mode, this will also set the SPIF Flag. SPIF is cleared by hardware when executing the corresponding interrupt handling vector. Alternatively, the SPIF bit is cleared by first reading the SPI Status Register with SPIF set, then accessing the SPI Data Register (SPDR).

- **Bit 6 – WCOL: Write COLlision flag**

The WCOL bit is set if the SPI Data Register (SPDR) is written during a data transfer. The WCOL bit (and the SPIF bit) are cleared by first reading the SPI Status Register with WCOL set, and then accessing the SPI Data Register.

- **Bit 5..1 – Res: Reserved Bits**

These bits are reserved bits in the ATmega8535 and will always read as zero.

- **Bit 0 – SPI2X: Double SPI Speed Bit**

When this bit is written logic one the SPI speed (SCK Frequency) will be doubled when the SPI is in Master mode (see Table 59). This means that the minimum SCK period will be two CPU clock periods. When the SPI is configured as Slave, the SPI is only guaranteed to work at $f_{osc}/4$ or lower.

The SPI interface on the ATmega8535 is also used for program memory and EEPROM downloading or uploading. See page 247 for Serial Programming and verification.

SPI Data Register – SPDR

Bit	7	6	5	4	3	2	1	0	
	MSB							**LSB**	**SPDR**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	X	X	X	X	X	X	X	X	Undefined

The SPI Data Register is a read/write register used for data transfer between the Register File and the SPI Shift Register. Writing to the register initiates data transmission. Reading the register causes the Shift Register receive buffer to be read.

Data Modes

There are four combinations of SCK phase and polarity with respect to serial data, which are determined by control bits CPHA and CPOL. The SPI data transfer formats are shown in Figure 67 and Figure 68. Data bits are shifted out and latched in on opposite edges of the SCK signal, ensuring sufficient time for data signals to stabilize. This is clearly seen by summarizing Table 57 and Table 58, as done below:

Table 60. CPOL Functionality

	Leading Edge	Trailing Edge	SPI Mode
CPOL=0, CPHA=0	Sample (Rising)	Setup (Falling)	0
CPOL=0, CPHA=1	Setup (Rising)	Sample (Falling)	1
CPOL=1, CPHA=0	Sample (Falling)	Setup (Rising)	2
CPOL=1, CPHA=1	Setup (Falling)	Sample (Rising)	3

Figure 67. SPI Transfer Format with CPHA = 0

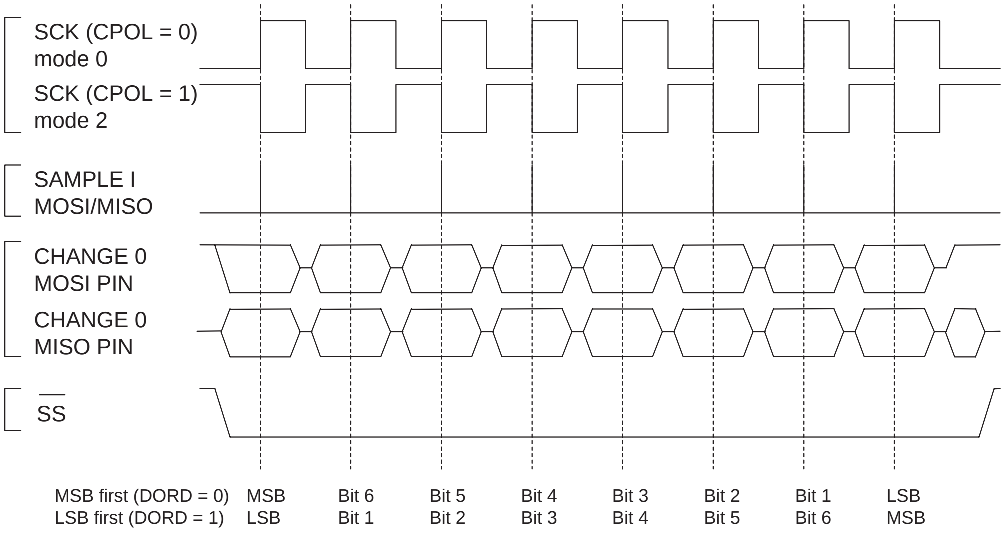
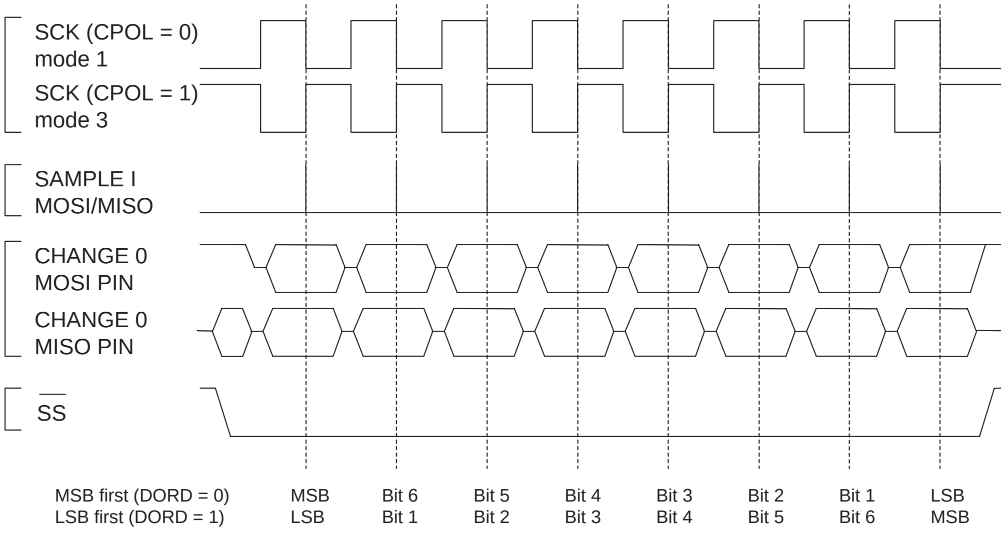


Figure 68. SPI Transfer Format with CPHA = 1



USART

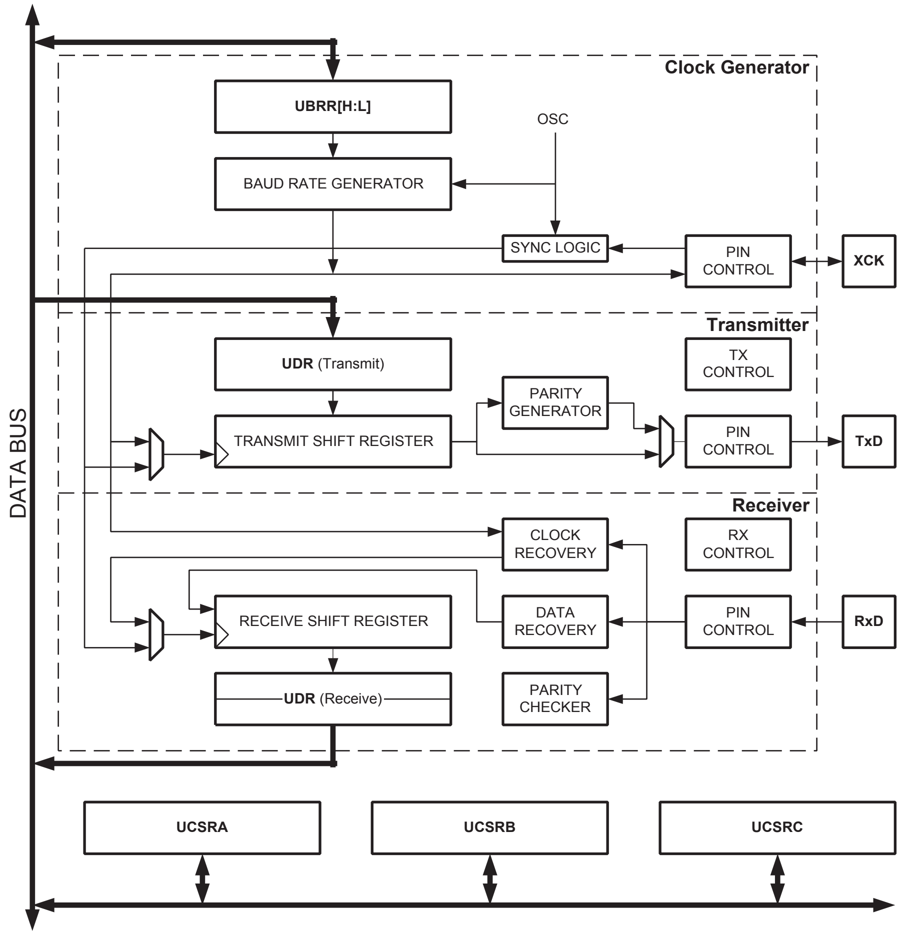
The Universal Synchronous and Asynchronous serial Receiver and Transmitter (USART) is a highly flexible serial communication device. The main features are:

- **Full Duplex Operation (Independent Serial Receive and Transmit Registers)**
- **Asynchronous or Synchronous Operation**
- **Master or Slave Clocked Synchronous Operation**
- **High Resolution Baud Rate Generator**
- **Supports Serial Frames with 5, 6, 7, 8, or 9 Data Bits and 1 or 2 Stop Bits**
- **Odd or Even Parity Generation and Parity Check Supported by Hardware**
- **Data OverRun Detection**
- **Framing Error Detection**
- **Noise Filtering Includes False Start Bit Detection and Digital Low Pass Filter**
- **Three Separate Interrupts on TX Complete, TX Data Register Empty and RX Complete**
- **Multi-processor Communication Mode**
- **Double Speed Asynchronous Communication Mode**

Overview

A simplified block diagram of the USART Transmitter is shown in Figure 69. CPU accessible I/O Registers and I/O pins are shown in bold.

Figure 69. USART Block Diagram(1)



Note: 1. Refer to Figure 1 on page 2, Table 34 on page 63, and Table 28 on page 59 for USART pin placement.

The dashed boxes in the block diagram separate the three main parts of the USART (listed from the top): Clock Generator, Transmitter and Receiver. Control registers are shared by all units. The clock generation logic consists of synchronization logic for external clock input used by synchronous slave operation, and the baud rate generator. The XCK (Transfer Clock) pin is only used by Synchronous Transfer mode. The Transmitter consists of a single write buffer, a serial Shift Register, Parity Generator and control logic for handling different serial frame formats. The write buffer allows a continuous transfer of data without any delay between frames. The Receiver is the most complex part of the USART module due to its clock and data recovery units. The recovery units are used for asynchronous data reception. In addition to the recovery units, the Receiver includes a Parity Checker, control logic, a Shift Register and a two level receive buffer (UDR). The Receiver supports the same frame formats as the Transmitter, and can detect frame error, data overrun and parity errors.

AVR USART vs. AVR UART – Compatibility

The USART is fully compatible with the AVR UART regarding:

- Bit locations inside all USART Registers
- Baud Rate Generation
- Transmitter Operation
- Transmit Buffer Functionality
- Receiver Operation

However, the receive buffering has two improvements that will affect the compatibility in some special cases:

- A second buffer register has been added. The two buffer registers operate as a circular FIFO buffer. Therefore the UDR must only be read once for each incoming data! More important is the fact that the Error Flags (FE and DOR) and the ninth data bit (RXB8) are buffered with the data in the receive buffer. Therefore the status bits must always be read before the UDR Register is read. Otherwise the error status will be lost since the buffer state is lost.
- The Receiver Shift Register can now act as a third buffer level. This is done by allowing the received data to remain in the serial Shift Register (see Figure 69) if the buffer registers are full, until a new start bit is detected. The USART is therefore more resistant to Data OverRun (DOR) error conditions.

The following control bits have changed name, but have same functionality and register location:

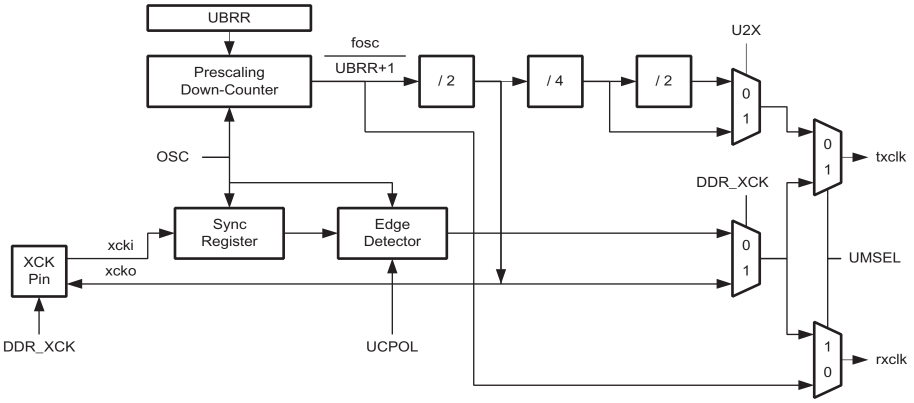
- CHR9 is changed to UCSZ2
- OR is changed to DOR

Clock Generation

The clock generation logic generates the base clock for the Transmitter and Receiver. The USART supports four modes of clock operation: Normal asynchronous, Double Speed asynchronous, Master synchronous and Slave synchronous mode. The UMSEL bit in USART Control and Status Register C (UCSRC) selects between asynchronous and synchronous operation. Double Speed (asynchronous mode only) is controlled by the U2X found in the UCSRA Register. When using Synchronous mode (UMSEL = 1), the Data Direction Register for the XCK pin (DDR_XCK) controls whether the clock source is internal (Master mode) or external (Slave mode). The XCK pin is only active when using synchronous mode.

Figure 70 shows a block diagram of the clock generation logic.

Figure 70. Clock Generation Logic, Block Diagram



Signal description:

txclk	Transmitter clock (Internal Signal).
rxclk	Receiver base clock (Internal Signal).
xcki	Input from XCK pin (internal Signal). Used for synchronous slave operation.
xcko	Clock output to XCK pin (Internal Signal). Used for synchronous master operation.
fosc	XTAL pin frequency (System Clock).

Internal Clock Generation – The Baud Rate Generator

Internal clock generation is used for the asynchronous and the synchronous master modes of operation. The description in this section refers to Figure 70.

The USART Baud Rate Register (UBRR) and the down-counter connected to it function as a programmable prescaler or baud rate generator. The down-counter, running at system clock (fosc), is loaded with the UBRR value each time the counter has counted down to zero or when the UBRRL Register is written. A clock is generated each time the counter reaches zero. This clock is the baud rate generator clock output (= fosc/(UBRR+1)). The Transmitter divides the baud rate generator clock output by 2, 8, or 16 depending on mode. The baud rate generator output is used directly by the receiver's clock and data recovery units. However, the recovery units use a state machine that uses 2, 8, or 16 states depending on mode set by the state of the UMSEL, U2X and DDR_XCK bits.

Table 61 contains equations for calculating the baud rate (in bits per second) and for calculating the UBRR value for each mode of operation using an internally generated clock source.

Table 61. Equations for Calculating Baud Rate Register Setting

Operating Mode	Equation for Calculating Baud Rate[1]	Equation for Calculating UBRR Value
Asynchronous Normal Mode (U2X = 0)	$BAUD = \frac{f_{OSC}}{16(\boldsymbol{UBRR} + 1)}$	$\boldsymbol{UBRR} = \frac{f_{OSC}}{16BAUD} - 1$
Asynchronous Double Speed Mode (U2X = 1)	$BAUD = \frac{f_{OSC}}{8(\boldsymbol{UBRR} + 1)}$	$\boldsymbol{UBRR} = \frac{f_{OSC}}{8BAUD} - 1$
Synchronous Master Mode	$BAUD = \frac{f_{OSC}}{2(\boldsymbol{UBRR} + 1)}$	$\boldsymbol{UBRR} = \frac{f_{OSC}}{2BAUD} - 1$

Note: 1. The baud rate is defined to be the transfer rate in bit per second (bps).

BAUD	Baud rate (in bits per second, bps)
f_{OSC}	System Oscillator clock frequency
UBRR	Contents of the UBRRH and UBRRL Registers, (0 - 4095)

Some examples of UBRR values for some system clock frequencies are found in Table 69 (see page 166).

Double Speed Operation (U2X)

The transfer rate can be doubled by setting the U2X bit in UCSRA. Setting this bit only has effect for the asynchronous operation. Set this bit to zero when using synchronous operation.

Setting this bit will reduce the divisor of the baud rate divider from 16 to 8, effectively doubling the transfer rate for asynchronous communication. Note however that the Receiver will in this case only use half the number of samples (reduced from 16 to 8) for data sampling and clock recovery, and therefore a more accurate baud rate setting and system clock are required when this mode is used. For the Transmitter, there are no downsides.

External Clock

External clocking is used by the synchronous slave modes of operation. The description in this section refers to Figure 70 for details.

External clock input from the XCK pin is sampled by a synchronization register to minimize the chance of meta-stability. The output from the synchronization register must then pass through an edge detector before it can be used by the Transmitter and Receiver. This process introduces a two CPU clock period delay and therefore the maximum external XCK clock frequency is limited by the following equation:

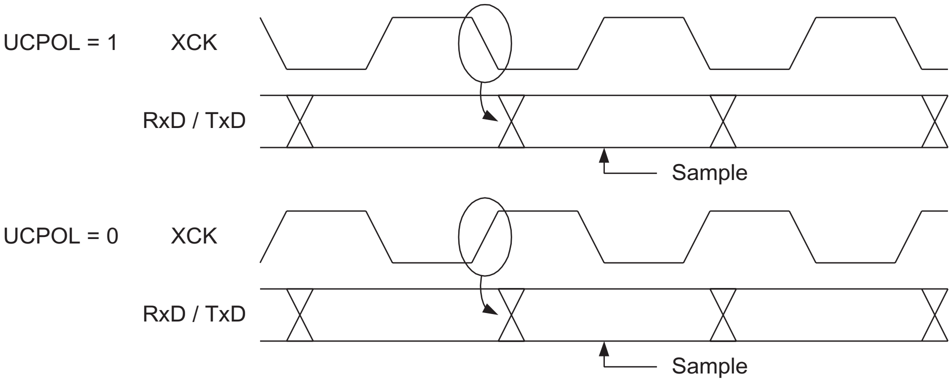
$$f_{XCK} < \frac{f_{OSC}}{4}$$

Note that f_{osc} depends on the stability of the system clock source. It is therefore recommended to add some margin to avoid possible loss of data due to frequency variations.

Synchronous Clock Operation

When Synchronous mode is used (UMSEL = 1), the XCK pin will be used as either clock input (Slave) or clock output (Master). The dependency between the clock edges and data sampling or data change is the same. The basic principle is that data input (on RxD) is sampled at the opposite XCK clock edge of the edge the data output (TxD) is changed.

Figure 71. Synchronous Mode XCK Timing



The UCPOL bit UCRSC selects which XCK clock edge is used for data sampling and which is used for data change. As Figure 71 shows, when UCPOL is zero the data will be changed at rising XCK edge and sampled at falling XCK edge. If UCPOL is set, the data will be changed at falling XCK edge and sampled at rising XCK edge.

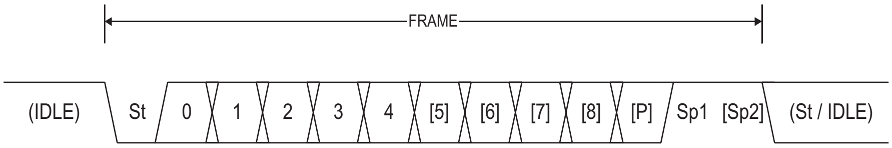
Frame Formats

A serial frame is defined to be one character of data bits with synchronization bits (start and stop bits), and optionally a parity bit for error checking. The USART accepts all 30 combinations of the following as valid frame formats:

- 1 start bit
- 5, 6, 7, 8, or 9 data bits
- no even or odd parity bit
- 1 or 2 stop bits

A frame starts with the start bit followed by the least significant data bit. Then the next data bits, up to a total of nine, are succeeding, ending with the most significant bit. If enabled, the parity bit is inserted after the data bits, before the stop bits. When a complete frame is transmitted, it can be directly followed by a new frame, or the communication line can be set to an idle (high) state. Figure 72 illustrates the possible combinations of the frame formats. Bits inside brackets are optional.

Figure 72. Frame Formats



St	Start bit, always low.
(n)	Data bits (0 to 8).
P	Parity bit. Can be odd or even.

Sp	Stop bit, always high.
IDLE	No transfers on the communication line (RxD or TxD). An IDLE line must be high.

The frame format used by the USART is set by the UCSZ2:0, UPM1:0 and USBS bits in UCSRB and UCSRC. The Receiver and Transmitter use the same setting. Note that changing the setting of any of these bits will corrupt all ongoing communication for both the Receiver and Transmitter.

The USART Character SiZe (UCSZ2:0) bits select the number of data bits in the frame. The USART Parity mode (UPM1:0) bits enable and set the type of parity bit. The selection between one or two stop bits is done by the USART Stop Bit Select (USBS) bit. The Receiver ignores the second stop bit. An FE (Frame Error) will therefore only be detected in the cases where the first stop bit is zero.

Parity Bit Calculation

The parity bit is calculated by doing an exclusive-or of all the data bits. If odd parity is used, the result of the exclusive or is inverted. The relation between the parity bit and data bits is as follows::

$$\begin{aligned} P_{even} &= d_{n-1} \oplus \ldots \oplus d_3 \oplus d_2 \oplus d_1 \oplus d_0 \oplus 0 \\ P_{odd} &= d_{n-1} \oplus \ldots \oplus d_3 \oplus d_2 \oplus d_1 \oplus d_0 \oplus 1 \end{aligned}$$

P_{even}	Parity bit using even parity
P_{odd}	Parity bit using odd parity
d_n	Data bit n of the character

If used, the parity bit is located between the last data bit and first stop bit of a serial frame.

USART Initialization

The USART has to be initialized before any communication can take place. The initialization process normally consists of setting the baud rate, setting frame format and enabling the Transmitter or the Receiver depending on the usage. For interrupt driven USART operation, the Global Interrupt Flag should be cleared (and interrupts globally disabled) when doing the initialization.

Before doing a re-initialization with a changed baud rate or frame format, be sure that there are no ongoing transmissions during the period the registers are changed. The TXC Flag can be used to check that the Transmitter has completed all transfers and the RXC Flag can be used to check that there are no unread data in the receive buffer. Note that the TXC Flag must be cleared before each transmission (before UDR is written) if it is used for this purpose.

The following simple USART initialization code examples show one assembly and one C function that are equal in functionality. The examples assume asynchronous operation using polling (no interrupts enabled) and a fixed frame format. The baud rate is given as a function parameter. For the assembly code, the baud rate parameter is assumed to be stored in the r17:r16 registers. When the function writes to the UCSRC Register, the URSEL bit (MSB) must be set due to the sharing of I/O location by UBRRH and UCSRC.

Assembly Code Example[(1)]

```
USART_Init:
  ; Set baud rate
  out    UBRRH, r17
  out    UBRRL, r16
  ; Enable Receiver and Transmitter
  ldi    r16, (1<<RXEN)|(1<<TXEN)
  out    UCSRB,r16
  ; Set frame format: 8data, 2stop bit
  ldi    r16, (1<<URSEL)|(1<<USBS)|(3<<UCSZ0)
  out    UCSRC,r16
  ret
```

C Code Example[(1)]

```
void USART_Init( unsigned int baud )
{
  /* Set baud rate */
  UBRRH = (unsigned char)(baud>>8);
  UBRRL = (unsigned char)baud;
  /* Enable Receiver and Transmitter */
  UCSRB = (1<<RXEN)|(1<<TXEN);
  /* Set frame format: 8data, 2stop bit */
  UCSRC = (1<<URSEL)|(1<<USBS)|(3<<UCSZ0);
}
```

Note: 1. The example code assumes that the part specific header file is included.

More advanced initialization routines can be made that include frame format as parameters, disable interrupts and so on. However, many applications use a fixed setting of the baud and control registers, and for these types of applications the initialization code can be placed directly in the main routine or be combined with initialization code for other I/O modules.

Data Transmission – The USART Transmitter

The USART Transmitter is enabled by setting the *Transmit Enable* (TXEN) bit in the UCSRB Register. When the Transmitter is enabled, the normal port operation of the TxD pin is overridden by the USART and given the function as the Transmitter's serial output. The baud rate, mode of operation and frame format must be set up once before doing any transmissions. If synchronous operation is used, the clock on the XCK pin will be overridden and used as transmission clock.

Sending Frames with 5 to 8 Data Bits

A data transmission is initiated by loading the transmit buffer with the data to be transmitted. The CPU can load the transmit buffer by writing to the UDR I/O location. The buffered data in the transmit buffer will be moved to the Shift Register when the Shift Register is ready to send a new frame. The Shift Register is loaded with new data if it is in idle state (no ongoing transmission) or immediately after the last stop bit of the previous frame is transmitted. When the Shift Register is loaded with new data, it will transfer one complete frame at the rate given by the baud register, U2X bit or by XCK depending on mode of operation.

The following code examples show a simple USART transmit function based on polling of the *Data Register Empty* (UDRE) Flag. When using frames with less than eight bits, the most significant bits written to the UDR are ignored. The USART has to be initialized before the function can be used. For the assembly code, the data to be sent is assumed to be stored in register R16.

Assembly Code Example[1]

```
USART_Transmit:
  ; Wait for empty transmit buffer
  sbis   UCSRA,UDRE
  rjmp   USART_Transmit
  ; Put data (r16) into buffer, sends the data
  out    UDR,r16
  ret
```

C Code Example[1]

```
void USART_Transmit( unsigned char data )
{
  /* Wait for empty transmit buffer */
  while ( !( UCSRA & (1<<UDRE)) )
        ;
  /* Put data into buffer, sends the data */
  UDR = data;
}
```

Note: 1. The example code assumes that the part specific header file is included.

The function simply waits for the transmit buffer to be empty by checking the UDRE Flag, before loading it with new data to be transmitted. If the Data Register Empty interrupt is utilized, the interrupt routine writes the data into the buffer.

Sending Frames with 9 Data Bits

If 9-bit characters are used (UCSZ = 7), the ninth bit must be written to the TXB8 bit in UCSRB before the low byte of the character is written to UDR. The following code examples show a transmit function that handles 9-bit characters. For the assembly code, the data to be sent is assumed to be stored in registers R17:R16.

Assembly Code Example[1]

```
USART_Transmit:
  ; Wait for empty transmit buffer
  sbis   UCSRA,UDRE
  rjmp   USART_Transmit
  ; Copy 9th bit from r17 to TXB8
  cbi    UCSRB,TXB8
  sbrc   r17,0
  sbi    UCSRB,TXB8
  ; Put LSB data (r16) into buffer, sends the data
  out    UDR,r16
  ret
```

C Code Example[1]

```
void USART_Transmit( unsigned int data )
{
  /* Wait for empty transmit buffer */
  while ( !( UCSRA & (1<<UDRE))) )
        ;
  /* Copy 9th bit to TXB8 */
  UCSRB &= ~(1<<TXB8);
  if ( data & 0x0100 )
    UCSRB |= (1<<TXB8);
  /* Put data into buffer, sends the data */
  UDR = data;
}
```

Note: 1. These transmit functions are written to be general functions. They can be optimized if the contents of the UCSRB is static. (For exapmle, only the TXB8 bit of the UCSRB Register is used after initialization.)

The ninth bit can be used for indicating an address frame when using multi processor communication mode or for other protocol handling as for example synchronization.

Transmitter Flags and Interrupts

The USART Transmitter has two flags that indicate its state: USART Data Register Empty (UDRE) and Transmit Complete (TXC). Both flags can be used for generating interrupts.

The Data Register Empty (UDRE) Flag indicates whether the transmit buffer is ready to receive new data. This bit is set when the transmit buffer is empty, and cleared when the transmit buffer contains data to be transmitted that has not yet been moved into the Shift Register. For compatibility with future devices, always write this bit to zero when writing the UCSRA Register.

When the Data Register Empty Interrupt Enable (UDRIE) bit in UCSRB is written to one, the USART Data Register Empty interrupt will be executed as long as UDRE is set (provided that global interrupts are enabled). UDRE is cleared by writing UDR. When interrupt-driven data transmission is used, the Data Register Empty interrupt routine must either write new data to UDR in order to clear UDRE or disable the Data Register

Empty interrupt, otherwise a new interrupt will occur once the interrupt routine terminates.

The Transmit Complete (TXC) Flag bit is set to one when the entire frame in the transmit Shift Register has been shifted out and there are no new data currently present in the transmit buffer. The TXC Flag bit is automatically cleared when a transmit complete interrupt is executed, or it can be cleared by writing a one to its bit location. The TXC Flag is useful in half-duplex communication interfaces (like the RS-485 standard), where a transmitting application must enter receive mode and free the communication bus immediately after completing the transmission.

When the Transmit Compete Interrupt Enable (TXCIE) bit in UCSRB is set, the USART Transmit Complete Interrupt will be executed when the TXC Flag becomes set (provided that global interrupts are enabled). When the transmit complete interrupt is used, the interrupt handling routine does not have to clear the TXC Flag, this is done automatically when the interrupt is executed.

Parity Generator

The parity generator calculates the parity bit for the serial frame data. When parity bit is enabled (UPM1 = 1), the Transmitter Control Logic inserts the parity bit between the last data bit and the first stop bit of the frame that is sent.

Disabling the Transmitter

The disabling of the Transmitter (setting the TXEN to zero) will not become effective until ongoing and pending transmissions are completed (i.e., when the transmit Shift Register and Transmit Buffer Register do not contain data to be transmitted). When disabled, the Transmitter will no longer override the TxD pin.

Data Reception – The USART Receiver

The USART Receiver is enabled by writing the Receive Enable (RXEN) bit in the UCSRB Register to one. When the Receiver is enabled, the normal pin operation of the RxD pin is overridden by the USART and given the function as the Receiver's serial input. The baud rate, mode of operation and frame format must be set up once before any serial reception can be done. If synchronous operation is used, the clock on the XCK pin will be used as a transfer clock.

Receiving Frames with 5 to 8 Data Bits

The Receiver starts data reception when it detects a valid start bit. Each bit that follows the start bit will be sampled at the baud rate or XCK clock, and shifted into the Receive Shift Register until the first stop bit of a frame is received. A second stop bit will be ignored by the Receiver. When the first stop bit is received, (i.e., a complete serial frame is present in the receive Shift Register, the contents of the Shift Register will be moved into the receive buffer. The receive buffer can then be read by reading the UDR I/O location.

The following code example shows a simple USART receive function based on polling of the Receive Complete (RXC) Flag. When using frames with less than eight bits the most significant bits of the data read from the UDR will be masked to zero. The USART has to be initialized before the function can be used.

Assembly Code Example[1]

```
USART_Receive:
  ; Wait for data to be received
  sbis   UCSRA, RXC
  rjmp   USART_Receive
  ; Get and return received data from buffer
  in     r16, UDR
  ret
```

C Code Example[1]

```
unsigned char USART_Receive( void )
{
  /* Wait for data to be received */
  while ( !(UCSRA & (1<<RXC)) )
        ;
  /* Get and return received data from buffer */
  return UDR;
}
```

Note: 1. The example code assumes that the part specific header file is included.

The function simply waits for data to be present in the receive buffer by checking the RXC Flag, before reading the buffer and returning the value.

Receiving Frames with 9 Data Bits

If 9-bit characters are used (UCSZ=7) the ninth bit must be read from the RXB8 bit in UCSRB **before** reading the low bits from the UDR. This rule applies to the FE, DOR, and PE Status Flags as well. Read status from UCSRA, then data from UDR. Reading the UDR I/O location will change the state of the receive buffer FIFO and consequently the TXB8, FE, DOR, and PE bits, which all are stored in the FIFO, will change.

The following code example shows a simple USART receive function that handles both 9-bit characters and the status bits.

Assembly Code Example(1)

```
USART_Receive:
  ; Wait for data to be received
  sbis   UCSRA, RXC
  rjmp   USART_Receive
  ; Get status and 9th bit, then data from buffer
  in     r18, UCSRA
  in     r17, UCSRB
  in     r16, UDR
  ; If error, return -1
  andi   r18,(1<<FE)|(1<<DOR)|(1<<PE)
  breq   USART_ReceiveNoError
  ldi    r17, HIGH(-1)
  ldi    r16, LOW(-1)
USART_ReceiveNoError:
  ; Filter the 9th bit, then return
  lsr    r17
  andi   r17, 0x01
  ret
```

C Code Example(1)

```
unsigned int USART_Receive( void )
{
  unsigned char status, resh, resl;
  /* Wait for data to be received */
  while ( !(UCSRA & (1<<RXC)) )
        ;
  /* Get status and 9th bit, then data */
  /* from buffer */
  status = UCSRA;
  resh = UCSRB;
  resl = UDR;
  /* If error, return -1 */
  if ( status & (1<<FE)|(1<<DOR)|(1<<PE) )
    return -1;
  /* Filter the 9th bit, then return */
  resh = (resh >> 1) & 0x01;
  return ((resh << 8) | resl);
}
```

Note: 1. The example code assumes that the part specific header file is included.

The receive function example reads all the I/O Registers into the Register File before any computation is done. This gives an optimal receive buffer utilization since the buffer location read will be free to accept new data as early as possible.

Receive Compete Flag and Interrupt

The USART Receiver has one flag that indicates the receiver state.

The Receive Complete (RXC) Flag indicates if there are unread data present in the receive buffer. This flag is one when unread data exist in the receive buffer and zero when the receive buffer is empty (i.e., does not contain any unread data). If the Receiver is disabled (RXEN = 0), the receive buffer will be flushed and consequently the RXC bit will become zero.

When the Receive Complete Interrupt Enable (RXCIE) in UCSRB is set, the USART Receive Complete Interrupt will be executed as long as the RXC Flag is set (provided that global interrupts are enabled). When interrupt-driven data reception is used, the receive complete routine must read the received data from UDR in order to clear the RXC Flag, otherwise a new interrupt will occur once the interrupt routine terminates.

Receiver Error Flags

The USART Receiver has three Error Flags: Frame Error (FE), Data OverRun (DOR) and Parity Error (PE). All can be accessed by reading UCSRA. Common for the error flags is that they are located in the receive buffer together with the frame for which they indicate the error status. Due to the buffering of the error flags, the UCSRA must be read before the receive buffer (UDR), since reading the UDR I/O location changes the buffer read location. Another equality for the error flags is that they can not be altered by software doing a write to the flag location. However, all flags must be set to zero when the UCSRA is written for upward compatibility of future USART implementations. None of the error flags can generate interrupts.

The Frame Error (FE) Flag indicates the state of the first stop bit of the next readable frame stored in the receive buffer. The FE Flag is zero when the stop bit was correctly read (as one), and the FE Flag will be one when the stop bit was incorrect (zero). This flag can be used for detecting out-of-sync conditions, detecting break conditions and protocol handling. The FE Flag is not affected by the setting of the USBS bit in UCSRC since the Receiver ignores all, except for the first, stop bits. For compatibility with future devices, always set this bit to zero when writing to UCSRA.

The Data OverRun (DOR) Flag indicates data loss due to a Receiver Buffer full condition. A Data OverRun occurs when the receive buffer is full (two characters), it is a new character waiting in the receive Shift Register, and a new start bit is detected. If the DOR Flag is set there was one or more serial frame lost between the frame last read from UDR, and the next frame read from UDR. For compatibility with future devices, always write this bit to zero when writing to UCSRA. The DOR Flag is cleared when the frame received was successfully moved from the Shift Register to the receive buffer.

The Parity Error (PE) Flag indicates that the next frame in the receive buffer had a Parity Error when received. If parity check is not enabled the PE bit will always be read zero. For compatibility with future devices, always set this bit to zero when writing to UCSRA. For more details see “Parity Bit Calculation” on page 146 and “Parity Checker” on page 153.

Parity Checker

The Parity Checker is active when the high USART Parity mode (UPM1) bit is set. The type of Parity Check to be performed (odd or even) is selected by the UPM0 bit. When enabled, the Parity Checker calculates the parity of the data bits in incoming frames and compares the result with the parity bit from the serial frame. The result of the check is stored in the receive buffer together with the received data and stop bits. The Parity Error (PE) Flag can then be read by software to check if the frame had a Parity Error.

The PE bit is set if the next character that can be read from the receive buffer had a parity error when received and the parity checking was enabled at that point (UPM1 = 1). This bit is valid until the receive buffer (UDR) is read.

Disabling the Receiver

In contrast to the Transmitter, disabling of the Receiver will be immediate. Data from ongoing receptions will therefore be lost. When disabled (i.e., the RXEN is set to zero) the Receiver will no longer override the normal function of the RxD port pin. The receiver buffer FIFO will be flushed when the Receiver is disabled. Remaining data in the buffer will be lost

Flushing the Receive Buffer

The receiver buffer FIFO will be flushed when the Receiver is disabled, i.e., the buffer will be emptied of its contents. Unread data will be lost. If the buffer has to be flushed during normal operation, due to for instance an error condition, read the UDR I/O location until the RXC Flag is cleared. The following code example shows how to flush the receive buffer.

Assembly Code Example(1)

```
USART_Flush:
  sbis   UCSRA, RXC
  ret
  in     r16, UDR
  rjmp   USART_Flush
```

C Code Example(1)

```
void USART_Flush( void )
{
  unsigned char dummy;
  while ( UCSRA & (1<<RXC) ) dummy = UDR;
}
```

Note: 1. The example code assumes that the part specific header file is included.

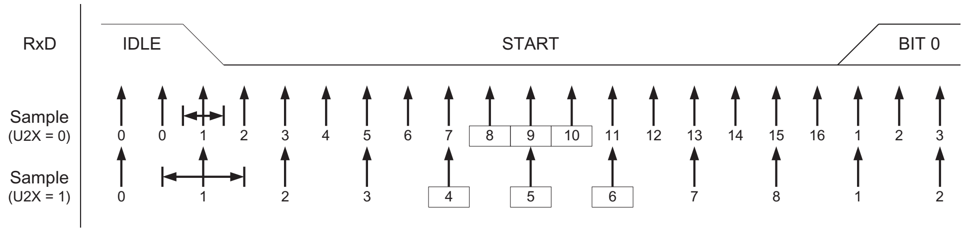
Asynchronous Data Reception

The USART includes a clock recovery and a data recovery unit for handling asynchronous data reception. The clock recovery logic is used for synchronizing the internally generated baud rate clock to the incoming asynchronous serial frames at the RxD pin. The data recovery logic samples and low pass filters each incoming bit, thereby improving the noise immunity of the Receiver. The asynchronous reception operational range depends on the accuracy of the internal baud rate clock, the rate of the incoming frames, and the frame size in number of bits.

Asynchronous Clock Recovery

The clock recovery logic synchronizes internal clock to the incoming serial frames. Figure 73 illustrates the sampling process of the start bit of an incoming frame. The sample rate is 16 times the baud rate for normal mode, and eight times the baud rate for double speed mode. The horizontal arrows illustrate the synchronization variation due to the sampling process. Note the larger time variation when using the Double Speed mode (U2X = 1) of operation. Samples denoted zero are samples done when the RxD line is idle (i.e., no communication activity).

Figure 73. Start Bit Sampling

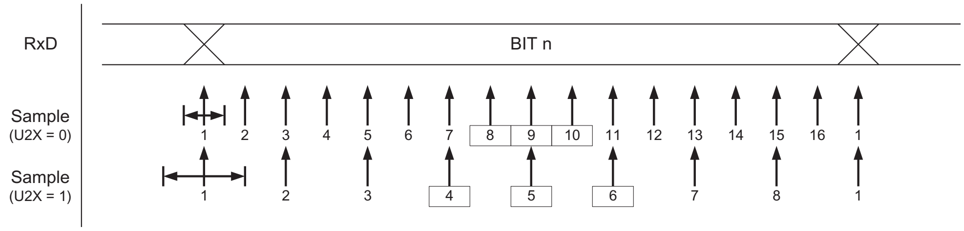


When the clock recovery logic detects a high (idle) to low (start) transition on the RxD line, the start bit detection sequence is initiated. Let sample 1 denote the first zero-sample as shown in the figure. The clock recovery logic then uses samples 8, 9, and 10 for normal mode, and samples 4, 5, and 6 for Double Speed mode (indicated with sample numbers inside boxes on the figure), to decide if a valid start bit is received. If two or more of these three samples have logical high levels (the majority wins), the start bit is rejected as a noise spike and the Receiver starts looking for the next high to low-transition. If however, a valid start bit is detected, the clock recovery logic is synchronized and the data recovery can begin. The synchronization process is repeated for each start bit.

Asynchronous Data Recovery

When the receiver clock is synchronized to the start bit, the data recovery can begin. The data recovery unit uses a state machine that has 16 states for each bit in normal mode and eight states for each bit in Double Speed mode. Figure 74 shows the sampling of the data bits and the parity bit. Each of the samples is given a number that is equal to the state of the recovery unit.

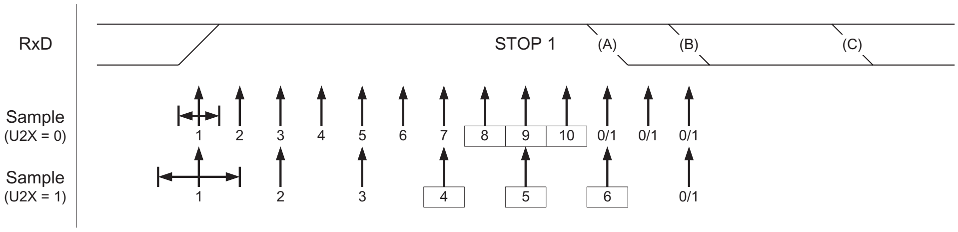
Figure 74. Sampling of Data and Parity Bit



The decision of the logic level of the received bit is taken by doing a majority voting of the logic value to the three samples in the center of the received bit. The center samples are emphasized on the figure by having the sample number inside boxes. The majority voting process is done as follows: If two or all three samples have high levels, the received bit is registered to be a logic 1. If two or all three samples have low levels, the received bit is registered to be a logic 0. This majority voting process acts as a low pass filter for the incoming signal on the RxD pin. The recovery process is then repeated until a complete frame is received. Including the first stop bit. Note that the Receiver only uses the first stop bit of a frame.

Figure 75 shows the sampling of the stop bit and the earliest possible beginning of the start bit of the next frame.

Figure 75. Stop Bit Sampling and Next Start Bit Sampling



The same majority voting is done to the stop bit as done for the other bits in the frame. If the stop bit is registered to have a logic 0 value, the Frame Error (FE) Flag will be set.

A new high to low transition indicating the start bit of a new frame can come right after the last of the bits used for majority voting. For Normal Speed mode, the first low level sample can be at point marked (A) in Figure 75. For Double Speed mode the first low level must be delayed to (B). (C) marks a stop bit of full length. The early start bit detection influences the operational range of the Receiver.

Asynchronous Operational Range

The operational range of the Receiver is dependent on the mismatch between the received bit rate and the internally generated baud rate. If the Transmitter is sending frames at too fast or too slow bit rates, or the internally generated baud rate of the Receiver does not have a similar (see Table 62) base frequency, the Receiver will not be able to synchronize the frames to the start bit.

The following equations can be used to calculate the ratio of the incoming data rate and internal receiver baud rate.

$$R_{slow} = \frac{(D+1)S}{S-1+D\cdot S+S_F} \qquad R_{fast} = \frac{(D+2)S}{(D+1)S+S_M}$$

D	Sum of character size and parity size (D = 5 to 10 bit).
S	Samples per bit. S = 16 for Normal Speed mode and S = 8 for Double Speed mode.
S_F	First sample number used for majority voting. S_F = 8 for Normal Speed and S_F = 4 for Double Speed mode.
S_M	Middle sample number used for majority voting. S_M = 9 for Normal Speed and S_M = 5 for Double Speed mode.
R_{slow}	is the ratio of the slowest incoming data rate that can be accepted in relation to the receiver baud rate. R_{fast} is the ratio of the fastest incoming data rate that can be accepted in relation to the Receiver baud rate.

Table 62 and Table 63 list the maximum receiver baud rate error that can be tolerated. Note that normal speed mode has higher toleration of baud rate variations.

Table 62. Recommended Maximum Receiver Baud Rate Error for Normal Speed Mode (U2X = 0)

D # (Data+Parity Bit)	R_{slow} (%)	R_{fast} (%)	Max Total Error (%)	Recommended Max Receiver Error (%)
5	93.20	106.67	+6.67/-6.8	± 3.0
6	94.12	105.79	+5.79/-5.88	± 2.5
7	94.81	105.11	+5.11 -5.19	± 2.0
8	95.36	104.58	+4.58/-4.54	± 2.0
9	95.81	104.14	+4.14/-4.19	± 1.5
10	96.17	103.78	+3.78/-3.83	± 1.5

Table 63. Recommended Maximum Receiver Baud Rate Error for Double Speed Mode (U2X = 1)

D # (Data+Parity Bit)	R_{slow} (%)	R_{fast} (%)	Max Total Error (%)	Recommended Max Receiver Error (%)
5	94.12	105.66	+5.66/-5.88	± 2.5
6	94.92	104.92	+4.92/-5.08	± 2.0
7	95.52	104.35	+4.35/-4.48	± 1.5
8	96.00	103.90	+3.90/-4.00	± 1.5
9	96.39	103.53	+3.53/-3.61	± 1.5
10	96.70	103.23	+3.23/-3.30	± 1.0

The recommendations of the maximum receiver baud rate error was made under the assumption that the Receiver and Transmitter equally divides the maximum total error.

There are two possible sources for the receivers baud rate error. The receiver's system clock (XTAL) will always have some minor instability over the supply voltage range and the temperature range. When using a crystal to generate the system clock, this is rarely a problem, but for a resonator the system clock may differ more than 2% depending of the resonators tolerance. The second source for the error is more controllable. The baud rate generator can not always do an exact division of the system frequency to get the baud rate wanted. In this case an UBRR value that gives an acceptable low error can be used if possible.

Multi-processor Communication Mode

Setting the Multi-processor Communication Mode (MPCM) bit in UCSRA enables a filtering function of incoming frames received by the USART Receiver. Frames that do not contain address information will be ignored and not put into the receive buffer. This effectively reduces the number of incoming frames that has to be handled by the CPU, in a system with multiple MCUs that communicate via the same serial bus. The Transmitter is unaffected by the MPCM setting, but has to be used differently when it is a part of a system utilizing the Multi-processor Communication Mode.

If the Receiver is set up to receive frames that contain five to eight data bits, then the first stop bit indicates if the frame contains data or address information. If the Receiver is set up for frames with nine data bits, then the ninth bit (RXB8) is used for identifying address and data frames. When the frame type bit (the first stop or the ninth bit) is one, the frame contains an address. When the frame type bit is zero the frame is a data frame.

The Multi-processor Communication Mode enables several slave MCUs to receive data from a Master MCU. This is done by first decoding an address frame to find out which MCU has been addressed. If a particular Slave MCU has been addressed, it will receive the following data frames as normal, while the other Slave MCUs will ignore the received frames until another address frame is received.

Using MPCM

For an MCU to act as a Master MCU, it can use a 9-bit character frame format (UCSZ = 7). The ninth bit (TXB8) must be set when an address frame (TXB8 = 1) or cleared when a data frame (TXB = 0) is being transmitted. The Slave MCUs must, in this case, be set to use a 9-bit character frame format.

The following procedure should be used to exchange data in Multi-processor Communication Mode:

1. All Slave MCUs are in Multi-processor Communication Mode (MPCM in UCSRA is set).
2. The Master MCU sends an address frame, and all slaves receive and read this frame. In the Slave MCUs, the RXC Flag in UCSRA will be set as normal.
3. Each Slave MCU reads the UDR Register and determines if it has been selected. If so, it clears the MPCM bit in UCSRA, otherwise it waits for the next address byte and keeps the MPCM setting.
4. The addressed MCU will receive all data frames until a new address frame is received. The other Slave MCUs, which still have the MPCM bit set, will ignore the data frames.
5. When the last data frame is received by the addressed MCU, the addressed MCU sets the MPCM bit and waits for a new address frame from Master. The process then repeats from 2.

Using any of the 5- to 8-bit character frame formats is possible, but impractical since the Receiver must change between using n and n+1 character frame formats. This makes full-duplex operation difficult since the Transmitter and Receiver uses the same character size setting. If 5- to 8-bit character frames are used, the Transmitter must be set to use two stop bit (USBS = 1) since the first stop bit is used for indicating the frame type.

Do not use Read-Modify-Write instructions (SBI and CBI) to set or clear the MPCM bit. The MPCM bit shares the same I/O location as the TXC Flag and this might accidentally be cleared when using SBI or CBI instructions.

Accessing UBRRH/UCSRC Registers

The UBRRH Register shares the same I/O location as the UCSRC Register. Therefore some special consideration must be taken when accessing this I/O location.

Write Access

When doing a write access of this I/O location, the high bit of the value written, the USART Register Select (URSEL) bit, controls which one of the two registers that will be written. If URSEL is zero during a write operation, the UBRRH value will be updated. If URSEL is one, the UCSRC setting will be updated.

The following code examples show how to access the two registers.

Assembly Code Examples(1)

```
...
; Set UBRRH to 2
ldi   r16,0x02
out   UBRRH,r16
...
; Set the USBS and the UCSZ1 bit to one, and
; the remaining bits to zero.
ldi   r16,(1<<URSEL)|(1<<USBS)|(1<<UCSZ1)
out   UCSRC,r16
...
```

C Code Examples(1)

```
...
/* Set UBRRH to 2 */
UBRRH = 0x02;
...
/* Set the USBS and the UCSZ1 bit to one, and */
/* the remaining bits to zero. */
UCSRC = (1<<URSEL)|(1<<USBS)|(1<<UCSZ1);
...
```

Note: 1. The example code assumes that the part specific header file is included.

As the code examples illustrate, write accesses of the two registers are relatively unaffected of the sharing of I/O location.

Read Access

Doing a read access to the UBRRH or the UCSRC Register is a more complex operation. However, in most applications, it is rarely necessary to read any of these registers.

The read access is controlled by a timed sequence. Reading the I/O location once returns the UBRRH Register contents. If the register location was read in previous system clock cycle, reading the register in the current clock cycle will return the UCSRC contents. Note that the timed sequence for reading the UCSRC is an atomic operation. Interrupts must therefore be controlled (e.g., by disabling interrupts globally) during the read operation.

The following code example shows how to read the UCSRC Register contents.

Assembly Code Example(1)

```
USART_ReadUCSRC:
  ; Read UCSRC
  in    r16,UBRRH
  in    r16,UCSRC
  ret
```

C Code Example(1)

```
unsigned char USART_ReadUCSRC( void )
{
  unsigned char ucsrc;
  /* Read UCSRC */
  ucsrc = UBRRH;
  ucsrc = UCSRC;
  return ucsrc;
}
```

Note: 1. The example code assumes that the part specific header file is included.

The assembly code example returns the UCSRC value in r16.

Reading the UBRRH contents is not an atomic operation and therefore it can be read as an ordinary register, as long as the previous instruction did not access the register location.

USART Register Description

USART I/O Data Register – UDR

Bit	7	6	5	4	3	2	1	0	
	RXB[7:0]								**UDR (Read)**
	TXB[7:0]								**UDR (Write)**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

The USART Transmit Data Buffer Register and USART Receive Data Buffer Registers share the same I/O address referred to as USART Data Register or UDR. The Transmit Data Buffer Register (TXB) will be the destination for data written to the UDR Register location. Reading the UDR Register location will return the contents of the Receive Data Buffer Register (RXB).

For 5-, 6-, or 7-bit characters the upper unused bits will be ignored by the Transmitter and set to zero by the Receiver.

The transmit buffer can only be written when the UDRE Flag in the UCSRA Register is set. Data written to UDR when the UDRE Flag is not set, will be ignored by the USART Transmitter. When data is written to the transmit buffer, and the Transmitter is enabled, the Transmitter will load the data into the transmit Shift Register when the Shift Register is empty. Then the data will be serially transmitted on the TxD pin.

The receive buffer consists of a two-level FIFO. The FIFO will change its state whenever the receive buffer is accessed. Due to this behavior of the receive buffer, do not use Read-Modify-Write instructions (SBI and CBI) on this location. Be careful when using bit test instructions (SBIC and SBIS), since these also will change the state of the FIFO.

USART Control and Status Register A – UCSRA

Bit	7	6	5	4	3	2	1	0	
	RXC	TXC	UDRE	FE	DOR	PE	U2X	MPCM	UCSRA
Read/Write	R	R/W	R	R	R	R	R/W	R/W	
Initial Value	0	0	1	0	0	0	0	0	

- **Bit 7 – RXC: USART Receive Complete**

This flag bit is set when there are unread data in the receive buffer and cleared when the receive buffer is empty (i.e., does not contain any unread data). If the Receiver is disabled, the receive buffer will be flushed and consequently the RXC bit will become zero. The RXC Flag can be used to generate a Receive Complete interrupt (see description of the RXCIE bit).

- **Bit 6 – TXC: USART Transmit Complete**

This flag bit is set when the entire frame in the transmit Shift Register has been shifted out and there are no new data currently present in the transmit buffer (UDR). The TXC Flag bit is automatically cleared when a Transmit Complete interrupt is executed, or it can be cleared by writing a one to its bit location. The TXC Flag can generate a Transmit Complete interrupt (see description of the TXCIE bit).

- **Bit 5 – UDRE: USART Data Register Empty**

The UDRE Flag indicates if the transmit buffer (UDR) is ready to receive new data. If UDRE is one, the buffer is empty, and therefore ready to be written. The UDRE Flag can generate a Data Register Empty interrupt (see description of the UDRIE bit).

UDRE is set after a reset to indicate that the Transmitter is ready.

- **Bit 4 – FE: Frame Error**

This bit is set if the next character in the receive buffer had a Frame Error when received. For example, when the first stop bit of the next character in the receive buffer is zero. This bit is valid until the receive buffer (UDR) is read. The FE bit is zero when the stop bit of received data is one. Always set this bit to zero when writing to UCSRA.

- **Bit 3 – DOR: Data OverRun**

This bit is set if a data overrun condition is detected. A Data OverRun occurs when the receive buffer is full (two characters), it is a new character waiting in the receive Shift Register, and a new start bit is detected. This bit is valid until the receive buffer (UDR) is read. Always set this bit to zero when writing to UCSRA.

- **Bit 2 – PE: Parity Error**

This bit is set if the next character in the receive buffer had a Parity Error when received and the parity checking was enabled at that point (UPM1 = 1). This bit is valid until the receive buffer (UDR) is read. Always set this bit to zero when writing to UCSRA.

- **Bit 1 – U2X: Double the USART Transmission Speed**

This bit only has effect for the asynchronous operation. Write this bit to zero when using synchronous operation.

Writing this bit to one will reduce the divisor of the baud rate divider from 16 to 8 effectively doubling the transfer rate for asynchronous communication.

- **Bit 0 – MPCM: Multi-processor Communication Mode**

This bit enables the Multi-processor Communication mode. When the MPCM bit is written to one, all the incoming frames received by the USART Receiver that do not contain address information will be ignored. The Transmitter is unaffected by the MPCM setting. For more detailed information see “Multi-processor Communication Mode” on page 158.

USART Control and Status Register B – UCSRB

Bit	7	6	5	4	3	2	1	0	
	RXCIE	TXCIE	UDRIE	RXEN	TXEN	UCSZ2	RXB8	TXB8	UCSRB
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 7 – RXCIE: RX Complete Interrupt Enable**

Writing this bit to one enables interrupt on the RXC Flag. A USART Receive Complete interrupt will be generated only if the RXCIE bit is written to one, the Global Interrupt Flag in SREG is written to one and the RXC bit in UCSRA is set.

- **Bit 6 – TXCIE: TX Complete Interrupt Enable**

Writing this bit to one enables interrupt on the TXC Flag. A USART Transmit Complete interrupt will be generated only if the TXCIE bit is written to one, the Global Interrupt Flag in SREG is written to one and the TXC bit in UCSRA is set.

- **Bit 5 – UDRIE: USART Data Register Empty Interrupt Enable**

Writing this bit to one enables interrupt on the UDRE Flag. A Data Register Empty interrupt will be generated only if the UDRIE bit is written to one, the Global Interrupt Flag in SREG is written to one and the UDRE bit in UCSRA is set.

- **Bit 4 – RXEN: Receiver Enable**

Writing this bit to one enables the USART Receiver. The Receiver will override normal port operation for the RxD pin when enabled. Disabling the Receiver will flush the receive buffer invalidating the FE, DOR, and PE Flags.

- **Bit 3 – TXEN: Transmitter Enable**

Writing this bit to one enables the USART Transmitter. The Transmitter will override normal port operation for the TxD pin when enabled. The disabling of the Transmitter (writing TXEN to zero) will not become effective until ongoing and pending transmissions are completed, (i.e., when the transmit Shift Register and transmit Buffer Register do not contain data to be transmitted). When disabled, the Transmitter will no longer override the TxD port.

- **Bit 2 – UCSZ2: Character Size**

The UCSZ2 bits combined with the UCSZ1:0 bit in UCSRC sets the number of data bits (Character Size) in a frame the Receiver and Transmitter use.

- **Bit 1 – RXB8: Receive Data Bit 8**

RXB8 is the ninth data bit of the received character when operating with serial frames with nine data bits. Must be read before reading the low bits from UDR.

- **Bit 0 – TXB8: Transmit Data Bit 8**

TXB8 is the ninth data bit in the character to be transmitted when operating with serial frames with nine data bits. Must be written before writing the low bits to UDR.

USART Control and Status Register C – UCSRC(1)

Bit	7	6	5	4	3	2	1	0	
	URSEL	**UMSEL**	**UPM1**	**UPM0**	**USBS**	**UCSZ1**	**UCSZ0**	**UCPOL**	**UCSRC**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	1	0	0	0	0	1	1	0	

Note: 1. The UCSRC Register shares the same I/O location as the UBRRH Register. See the "Accessing UBRRH/UCSRC Registers" on page 159 section which describes how to access this register.

- **Bit 7 – URSEL: Register Select**

This bit selects between accessing the UCSRC or the UBRRH Register. It is read as one when reading UCSRC. The URSEL must be one when writing the UCSRC.

- **Bit 6 – UMSEL: USART Mode Select**

This bit selects between asynchronous and synchronous mode of operation.

Table 64. UMSEL Bit Settings

UMSEL	Mode
0	Asynchronous Operation
1	Synchronous Operation

- **Bit 5:4 – UPM1:0: Parity Mode**

These bits enable and set type of parity generation and check. If enabled, the Transmitter will automatically generate and send the parity of the transmitted data bits within each frame. The Receiver will generate a parity value for the incoming data and compare it to the UPM0 setting. If a mismatch is detected, the PE Flag in UCSRA will be set.

Table 65. UPM Bits Settings

UPM1	UPM0	Parity Mode
0	0	Disabled
0	1	Reserved
1	0	Enabled, Even Parity
1	1	Enabled, Odd Parity

- **Bit 3 – USBS: Stop Bit Select**

This bit selects the number of stop bits to be inserted by the Transmitter. The Receiver ignores this setting.

Table 66. USBS Bit Settings

USBS	Stop Bit(s)
0	1-bit
1	2-bit

- **Bit 2:1 – UCSZ1:0: Character Size**

The UCSZ1:0 bits combined with the UCSZ2 bit in UCSRB sets the number of data bits (character size) in a frame the Receiver and Transmitter use.

Table 67. UCSZ Bits Settings

UCSZ2	UCSZ1	UCSZ0	Character Size
0	0	0	5-bit
0	0	1	6-bit
0	1	0	7-bit
0	1	1	8-bit
1	0	0	Reserved
1	0	1	Reserved
1	1	0	Reserved
1	1	1	9-bit

- **Bit 0 – UCPOL: Clock Polarity**

This bit is used for Synchronous mode only. Write this bit to zero when asynchronous mode is used. The UCPOL bit sets the relationship between data output change and data input sample, and the synchronous clock (XCK).

Table 68. UCPOL Bit Settings

UCPOL	Transmitted Data Changed (Output of TxD Pin)	Received Data Sampled (Input on RxD Pin)
0	Rising XCK Edge	Falling XCK Edge
1	Falling XCK Edge	Rising XCK Edge

USART Baud Rate Registers – UBRRL and UBRRH(1)

Bit	15	14	13	12	11	10	9	8	
	URSEL	–	–	–	UBRR[11:8]				UBRRH
	UBRR[7:0]								UBRRL
	7	6	5	4	3	2	1	0	
Read/Write	R/W	R	R	R	R/W	R/W	R/W	R/W	
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	

Note: 1. The UBRRH Register shares the same I/O location as the UCSRC Register. See the "Accessing UBRRH/UCSRC Registers" on page 159 section which describes how to access this register.

- **Bit 15 – URSEL: Register Select**

This bit selects between accessing the UBRRH or the UCSRC Register. It is read as zero when reading UBRRH. The URSEL must be zero when writing the UBRRH.

- **Bit 14:12 – Reserved Bits**

These bits are reserved for future use. For compatibility with future devices, these bit must be written to zero when UBRRH is written.

- **Bit 11:0 – UBRR11:0: USART Baud Rate Register**

This is a 12-bit register which contains the USART Baud Rate. The UBRRH contains the four most significant bits, and the UBRRL contains the eight least significant bits of the USART baud rate. Ongoing transmissions by the Transmitter and Receiver will be corrupted if the baud rate is changed. Writing UBRRL will trigger an immediate update of the baud rate prescaler.

Examples of Baud Rate Setting

For standard crystal and resonator frequencies, the most commonly used baud rates for asynchronous operation can be generated by using the UBRR settings in Table 69. UBRR values which yield an actual baud rate differing less than 0.5% from the target baud rate, are bold in the table. Higher error ratings are acceptable, but the Receiver will have less noise resistance when the error ratings are high, especially for large serial frames (see “Asynchronous Operational Range” on page 156). The error values are calculated using the following equation:

$$\text{Error[\%]} = \left(\frac{\text{BaudRate}_{\text{Closest Match}}}{\text{BaudRate}} - 1\right) \bullet 100\%$$

Table 69. Examples of UBRR Settings for Commonly Used Oscillator Frequencies

Baud Rate (bps)	**f_{osc} = 1.0000 MHz**				**f_{osc} = 1.8432 MHz**				**f_{osc} = 2.0000 MHz**			
	U2X = 0		**U2X = 1**		**U2X = 0**		**U2X = 1**		**U2X = 0**		**U2X = 1**	
	UBRR	**Error**	**UBRR**	**Error**	**UBRR**	**Error**	**UBRR**	**Error**	**UBRR**	**Error**	**UBRR**	**Error**
2400	25	0.2%	51	0.2%	47	0.0%	95	0.0%	51	0.2%	103	0.2%
4800	12	0.2%	25	0.2%	23	0.0%	47	0.0%	25	0.2%	51	0.2%
9600	6	-7.0%	12	0.2%	11	0.0%	23	0.0%	12	0.2%	25	0.2%
14.4k	3	8.5%	8	-3.5%	7	0.0%	15	0.0%	8	-3.5%	16	2.1%
19.2k	2	8.5%	6	-7.0%	5	0.0%	11	0.0%	6	-7.0%	12	0.2%
28.8k	1	8.5%	3	8.5%	3	0.0%	7	0.0%	3	8.5%	8	-3.5%
38.4k	1	-18.6%	2	8.5%	2	0.0%	5	0.0%	2	8.5%	6	-7.0%
57.6k	0	8.5%	1	8.5%	1	0.0%	3	0.0%	1	8.5%	3	8.5%
76.8k	–	–	1	-18.6%	1	-25.0%	2	0.0%	1	-18.6%	2	8.5%
115.2k	–	–	0	8.5%	0	0.0%	1	0.0%	0	8.5%	1	8.5%
230.4k	–	–	–	–	–	–	0	0.0%	–	–	–	–
250k	–	–	–	–	–	–	–	–	–	–	0	0.0%
Max [1]	62.5 kbps		125 kbps		115.2 kbps		230.4 kbps		125 kbps		250 kbps	

1. UBRR = 0, Error = 0.0%

Table 70. Examples of UBRR Settings for Commonly Used Oscillator Frequencies (Continued)

Baud Rate (bps)	f_{osc} = 3.6864 MHz				f_{osc} = 4.0000 MHz				f_{osc} = 7.3728 MHz			
	U2X = 0		**U2X = 1**		**U2X = 0**		**U2X = 1**		**U2X = 0**		**U2X = 1**	
	UBRR	**Error**	**UBRR**	**Error**	**UBRR**	**Error**	**UBRR**	**Error**	**UBRR**	**Error**	**UBRR**	**Error**
2400	95	0.0%	191	0.0%	103	0.2%	207	0.2%	191	0.0%	383	0.0%
4800	47	0.0%	95	0.0%	51	0.2%	103	0.2%	95	0.0%	191	0.0%
9600	23	0.0%	47	0.0%	25	0.2%	51	0.2%	47	0.0%	95	0.0%
14.4k	15	0.0%	31	0.0%	16	2.1%	34	-0.8%	31	0.0%	63	0.0%
19.2k	11	0.0%	23	0.0%	12	0.2%	25	0.2%	23	0.0%	47	0.0%
28.8k	7	0.0%	15	0.0%	8	-3.5%	16	2.1%	15	0.0%	31	0.0%
38.4k	5	0.0%	11	0.0%	6	-7.0%	12	0.2%	11	0.0%	23	0.0%
57.6k	3	0.0%	7	0.0%	3	8.5%	8	-3.5%	7	0.0%	15	0.0%
76.8k	2	0.0%	5	0.0%	2	8.5%	6	-7.0%	5	0.0%	11	0.0%
115.2k	1	0.0%	3	0.0%	1	8.5%	3	8.5%	3	0.0%	7	0.0%
230.4k	0	0.0%	1	0.0%	0	8.5%	1	8.5%	1	0.0%	3	0.0%
250k	0	-7.8%	1	-7.8%	0	0.0%	1	0.0%	1	-7.8%	3	-7.8%
0.5M	–	–	0	-7.8%	–	–	0	0.0%	0	-7.8%	1	-7.8%
1M	–	–	–	–	–	–	–	–	–	–	0	-7.8%
Max [1]	230.4 kbps		460.8 kbps		250k bps		0.5 Mbps		460.8 kbps		921.6 kbps	

1. UBRR = 0, Error = 0.0%

Table 71. Examples of UBRR Settings for Commonly Used Oscillator Frequencies (Continued)

Baud Rate (bps)	f_{osc} = 8.0000 MHz				f_{osc} = 11.0592 MHz				f_{osc} = 14.7456 MHz			
	U2X = 0		U2X = 1		U2X = 0		U2X = 1		U2X = 0		U2X = 1	
	UBRR	Error	UBRR	Error	UBRR	Error	UBRR	Error	UBRR	Error	UBRR	Error
2400	207	0.2%	416	-0.1%	287	0.0%	575	0.0%	383	0.0%	767	0.0%
4800	103	0.2%	207	0.2%	143	0.0%	287	0.0%	191	0.0%	383	0.0%
9600	51	0.2%	103	0.2%	71	0.0%	143	0.0%	95	0.0%	191	0.0%
14.4k	34	-0.8%	68	0.6%	47	0.0%	95	0.0%	63	0.0%	127	0.0%
19.2k	25	0.2%	51	0.2%	35	0.0%	71	0.0%	47	0.0%	95	0.0%
28.8k	16	2.1%	34	-0.8%	23	0.0%	47	0.0%	31	0.0%	63	0.0%
38.4k	12	0.2%	25	0.2%	17	0.0%	35	0.0%	23	0.0%	47	0.0%
57.6k	8	-3.5%	16	2.1%	11	0.0%	23	0.0%	15	0.0%	31	0.0%
76.8k	6	-7.0%	12	0.2%	8	0.0%	17	0.0%	11	0.0%	23	0.0%
115.2k	3	8.5%	8	-3.5%	5	0.0%	11	0.0%	7	0.0%	15	0.0%
230.4k	1	8.5%	3	8.5%	2	0.0%	5	0.0%	3	0.0%	7	0.0%
250k	1	0.0%	3	0.0%	2	-7.8%	5	-7.8%	3	-7.8%	6	5.3%
0.5M	0	0.0%	1	0.0%	–	–	2	-7.8%	1	-7.8%	3	-7.8%
1M	–	–	0	0.0%	–	–	–	–	0	-7.8%	1	-7.8%
Max (1)	0.5 Mbps		1 Mbps		691.2 kbps		1.3824 Mbps		921.6 kbps		1.8432 Mbps	

1. UBRR = 0, Error = 0.0%

Table 72. Examples of UBRR Settings for Commonly Used Oscillator Frequencies (Continued)

Baud Rate (bps)	f_{osc} = 16.0000 MHz				f_{osc} = 18.4320 MHz				f_{osc} = 20.0000 MHz			
	U2X = 0		U2X = 1		U2X = 0		U2X = 1		U2X = 0		U2X = 1	
	UBRR	Error	UBRR	Error	UBRR	Error	UBRR	Error	UBRR	Error	UBRR	Error
2400	416	-0.1%	832	0.0%	479	0.0%	959	0.0%	520	0.0%	1041	0.0%
4800	207	0.2%	416	-0.1%	239	0.0%	479	0.0%	259	0.2%	520	0.0%
9600	103	0.2%	207	0.2%	119	0.0%	239	0.0%	129	0.2%	259	0.2%
14.4k	68	0.6%	138	-0.1%	79	0.0%	159	0.0%	86	-0.2%	173	-0.2%
19.2k	51	0.2%	103	0.2%	59	0.0%	119	0.0%	64	0.2%	129	0.2%
28.8k	34	-0.8%	68	0.6%	39	0.0%	79	0.0%	42	0.9%	86	-0.2%
38.4k	25	0.2%	51	0.2%	29	0.0%	59	0.0%	32	-1.4%	64	0.2%
57.6k	16	2.1%	34	-0.8%	19	0.0%	39	0.0%	21	-1.4%	42	0.9%
76.8k	12	0.2%	25	0.2%	14	0.0%	29	0.0%	15	1.7%	32	-1.4%
115.2k	8	-3.5%	16	2.1%	9	0.0%	19	0.0%	10	-1.4%	21	-1.4%
230.4k	3	8.5%	8	-3.5%	4	0.0%	9	0.0%	4	8.5%	10	-1.4%
250k	3	0.0%	7	0.0%	4	-7.8%	8	2.4%	4	0.0%	9	0.0%
0.5M	1	0.0%	3	0.0%	–	–	4	-7.8%	–	–	4	0.0%
1M	0	0.0%	1	0.0%	–	–	–	–	–	–	–	–
Max (1)	1 Mbps		2 Mbps		1.152 Mbps		2.304 Mbps		1.25 Mbps		2.5 Mbps	

1. UBRR = 0, Error = 0.0%

Two-wire Serial Interface

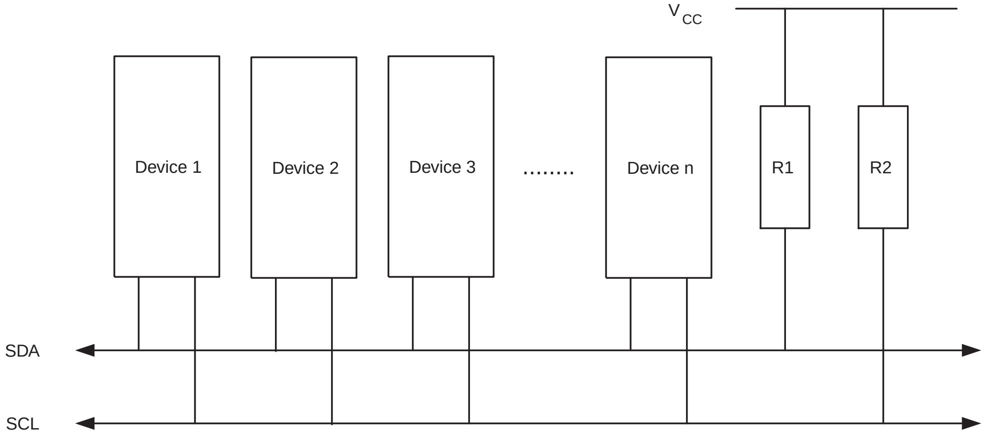
Features

- **Simple yet Powerful and Flexible Communication Interface, only Two Bus Lines Needed**
- **Both Master and Slave Operation Supported**
- **Device can Operate as Transmitter or Receiver**
- **7-bit Address Space Allows up to 128 Different Slave Addresses**
- **Multi-master Arbitration Support**
- **Up to 400 kHz Data Transfer Speed**
- **Slew-rate Limited Output Drivers**
- **Noise Suppression Circuitry Rejects Spikes on Bus Lines**
- **Fully Programmable Slave Address with General Call Support**
- **Address Recognition Causes Wake-up when AVR is in Sleep Mode**

Two-wire Serial Interface Bus Definition

The Two-wire Serial Interface (TWI) is ideally suited for typical microcontroller applications. The TWI protocol allows the systems designer to interconnect up to 128 different devices using only two bi-directional bus lines, one for clock (SCL) and one for data (SDA). The only external hardware needed to implement the bus is a single pull-up resistor for each of the TWI bus lines. All devices connected to the bus have individual addresses, and mechanisms for resolving bus contention are inherent in the TWI protocol.

Figure 76. TWI Bus Interconnection



TWI Terminology

The following definitions are frequently encountered in this section.

Table 73. TWI Terminology

Term	Description
Master	The device that initiates and terminates a transmission. The Master also generates the SCL clock.
Slave	The device addressed by a Master.
Transmitter	The device placing data on the bus.
Receiver	The device reading data from the bus.

Electrical Interconnection

As depicted in Figure 76, both bus lines are connected to the positive supply voltage through pull-up resistors. The bus drivers of all TWI-compliant devices are open-drain or open-collector. This implements a wired-AND function which is essential to the operation of the interface. A low level on a TWI bus line is generated when one or more TWI devices output a zero. A high level is output when all TWI devices tri-state their outputs, allowing the pull-up resistors to pull the line high. Note that all AVR devices connected to the TWI bus must be powered in order to allow any bus operation.

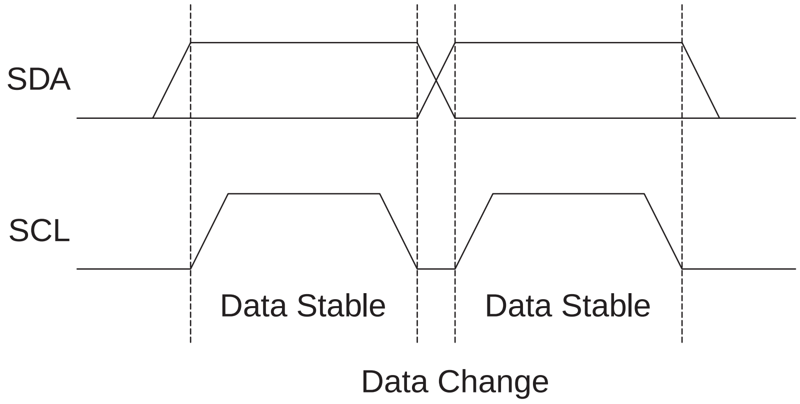
The number of devices that can be connected to the bus is only limited by the bus capacitance limit of 400 pF and the 7-bit slave address space. A detailed specification of the electrical characteristics of the TWI is given in "Two-wire Serial Interface Characteristics" on page 254. Two different sets of specifications are presented there, one relevant for bus speeds below 100 kHz, and one valid for bus speeds up to 400 kHz.

Data Transfer and Frame Format

Transferring Bits

Each data bit transferred on the TWI bus is accompanied by a pulse on the clock line. The level of the data line must be stable when the clock line is high. The only exception to this rule is for generating start and stop conditions.

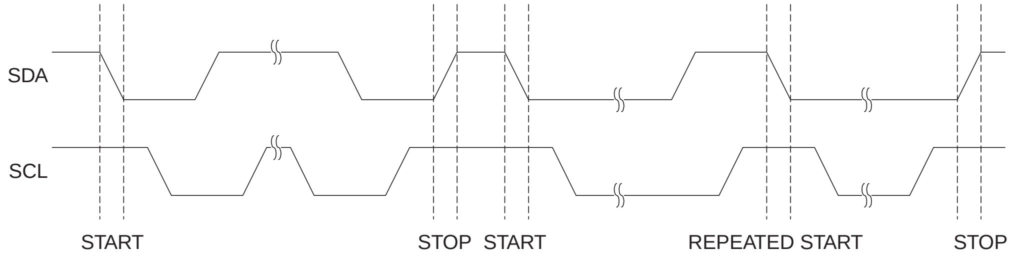
Figure 77. Data Validity



START and STOP Conditions

The Master initiates and terminates a data transmission. The transmission is initiated when the Master issues a START condition on the bus, and it is terminated when the Master issues a STOP condition. Between a START and a STOP condition, the bus is considered busy, and no other Master should try to seize control of the bus. A special case occurs when a new START condition is issued between a START and STOP condition. This is referred to as a REPEATED START condition, and is used when the Master wishes to initiate a new transfer without relinquishing control of the bus. After a REPEATED START, the bus is considered busy until the next STOP. This is identical to the START behaviour, and therefore START is used to describe both START and REPEATED START for the remainder of this datasheet, unless otherwise noted. As depicted below, START and STOP conditions are signalled by changing the level of the SDA line when the SCL line is high.

Figure 78. START, REPEATED START, and STOP Conditions



Address Packet Format

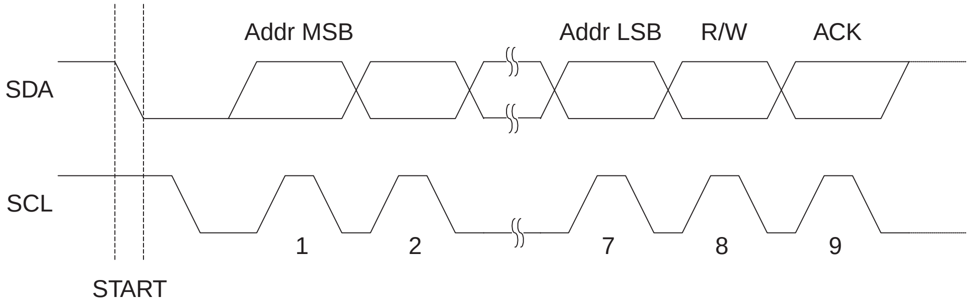
All address packets transmitted on the TWI bus are nine bits long, consisting of seven address bits, one READ/WRITE control bit and an acknowledge bit. If the READ/WRITE bit is set, a read operation is to be performed, otherwise a write operation should be performed. When a Slave recognizes that it is being addressed, it should acknowledge by pulling SDA low in the ninth SCL (ACK) cycle. If the addressed slave is busy, or for some other reason can not service the master's request, the SDA line should be left high in the ACK clock cycle. The Master can then transmit a STOP condition, or a REPEATED START condition to initiate a new transmission. An address packet consisting of a slave address and a READ or a WRITE bit is called SLA+R or SLA+W, respectively.

The MSB of the address byte is transmitted first. Slave addresses can freely be allocated by the designer, but the address 0000 000 is reserved for a general call.

When a general call is issued, all slaves should respond by pulling the SDA line low in the ACK cycle. A general call is used when a Master wishes to transmit the same message to several slaves in the system. When the general call address followed by a Write bit is transmitted on the bus, all slaves set up to acknowledge the general call will pull the SDA line low in the ack cycle. The following data packets will then be received by all the slaves that acknowledged the general call. Note that transmitting the general call address followed by a Read bit is meaningless, as this would cause contention if several slaves started transmitting different data.

All addresses of the format 1111 xxx should be reserved for future purposes.

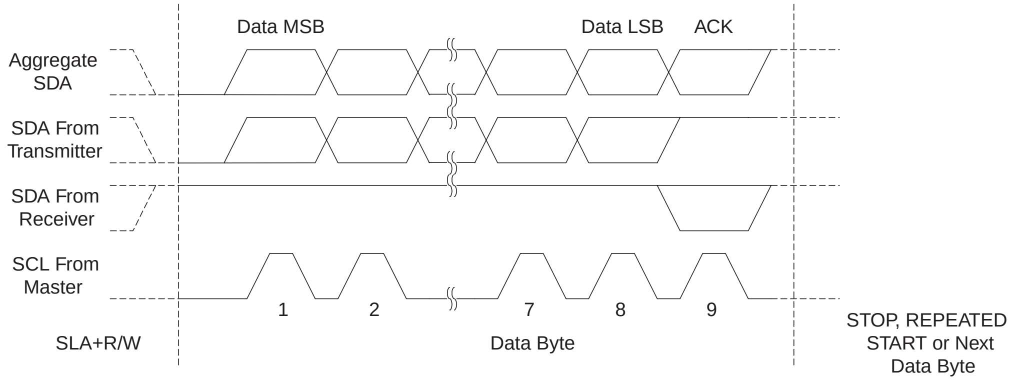
Figure 79. Address Packet Format



Data Packet Format

All data packets transmitted on the TWI bus are nine bits long, consisting of one data byte and an acknowledge bit. During a data transfer, the Master generates the clock and the START and STOP conditions, while the Receiver is responsible for acknowledging the reception. An Acknowledge (ACK) is signalled by the Receiver pulling the SDA line low during the ninth SCL cycle. If the Receiver leaves the SDA line high, a NACK is signalled. When the Receiver has received the last byte, or for some reason cannot receive any more bytes, it should inform the Transmitter by sending a NACK after the final byte. The MSB of the data byte is transmitted first.

Figure 80. Data Packet Format

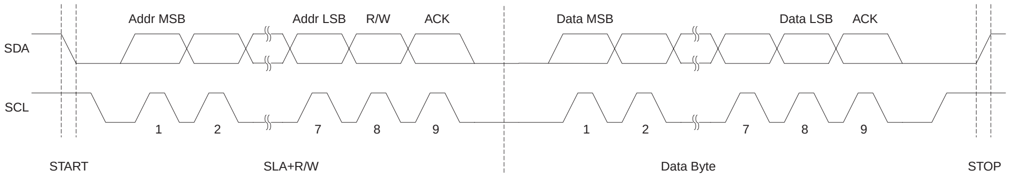


Combining Address and Data Packets into a Transmission

A transmission basically consists of a START condition, a SLA+R/W, one or more data packets and a STOP condition. An empty message, consisting of a START followed by a STOP condition is illegal. Note that the wired-ANDing of the SCL line can be used to implement handshaking between the Master and the Slave. The Slave can extend the SCL low period by pulling the SCL line low. This is useful if the clock speed set up by the Master is too fast for the Slave or the Slave needs extra time for processing between the data transmissions. The Slave extending the SCL low period will not affect the SCL high period, which is determined by the Master. As a consequence, the Slave can reduce the TWI data transfer speed by prolonging the SCL duty cycle.

Figure 81 shows a typical data transmission. Note that several data bytes can be transmitted between the SLA+R/W and the STOP condition, depending on the software protocol implemented by the application software.

Figure 81. Typical Data Transmission



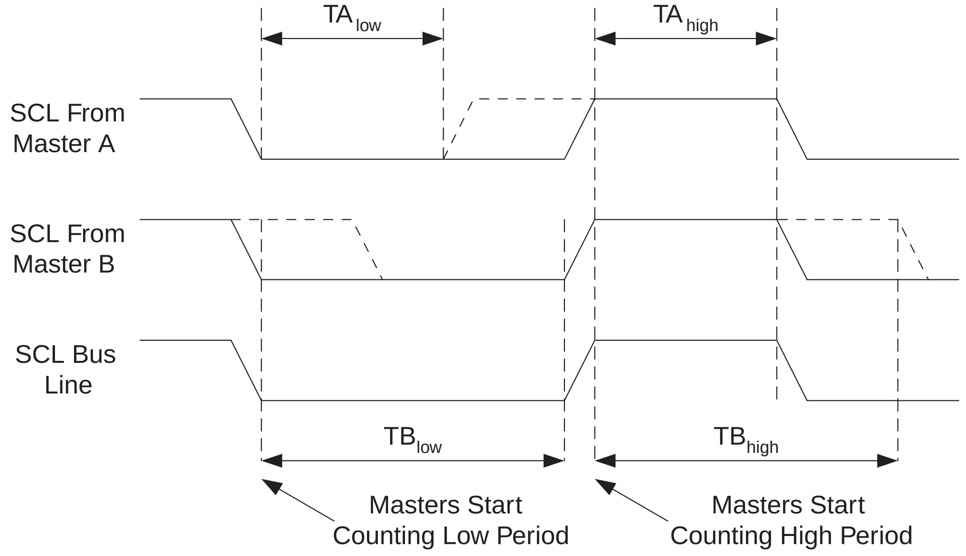
Multi-master Bus Systems, Arbitration and Synchronization

The TWI protocol allows bus systems with several masters. Special concerns have been taken in order to ensure that transmissions will proceed as normal, even if two or more masters initiate a transmission at the same time. Two problems arise in multi-master systems:

- An algorithm must be implemented allowing only one of the Masters to complete the transmission. All other masters should cease transmission when they discover that they have lost the selection process. This selection process is called arbitration. When a contending Master discovers that it has lost the arbitration process, it should immediately switch to Slave mode to check whether it is being addressed by the winning Master. The fact that multiple masters have started transmission at the same time should not be detectable to the slaves, i.e., the data being transferred on the bus must not be corrupted.
- Different Masters may use different SCL frequencies. A scheme must be devised to synchronize the serial clocks from all Masters, in order to let the transmission proceed in a lockstep fashion. This will facilitate the arbitration process.

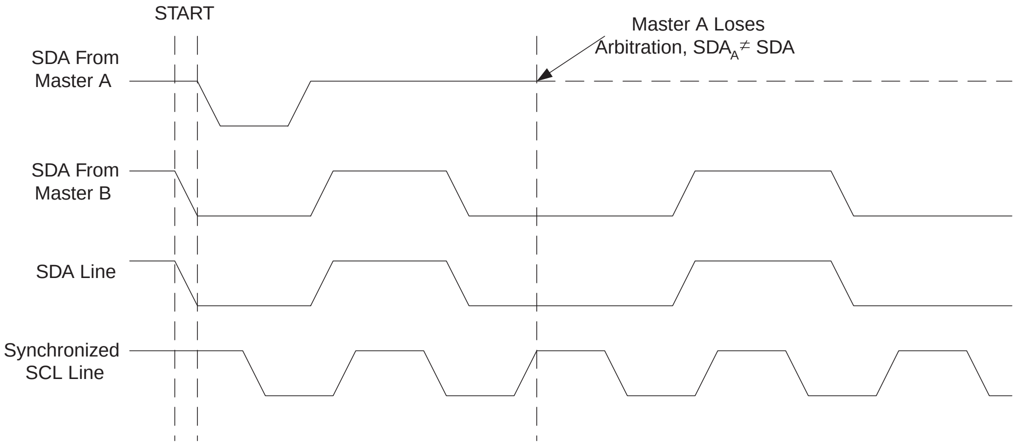
The wired-ANDing of the bus lines is used to solve both these problems. The serial clocks from all Masters will be wired-ANDed, yielding a combined clock with a high period equal to the one from the Master with the shortest high period. The low period of the combined clock is equal to the low period of the Master with the longest low period. Note that all masters listen to the SCL line, effectively starting to count their SCL high and low time-out periods when the combined SCL line goes high or low, respectively.

Figure 82. SCL Synchronization Between Multiple Masters



Arbitration is carried out by all masters continuously monitoring the SDA line after outputting data. If the value read from the SDA line does not match the value the Master had output, it has lost the arbitration. Note that a Master can only lose arbitration when it outputs a high SDA value while another Master outputs a low value. The losing master should immediately go to Slave mode, checking if it is being addressed by the winning master. The SDA line should be left high, but losing masters are allowed to generate a clock signal until the end of the current data or address packet. Arbitration will continue until only one master remains, and this may take many bits. If several masters are trying to address the same Slave, arbitration will continue into the data packet.

Figure 83. Arbitration Between Two Masters



Note that arbitration is not allowed between:

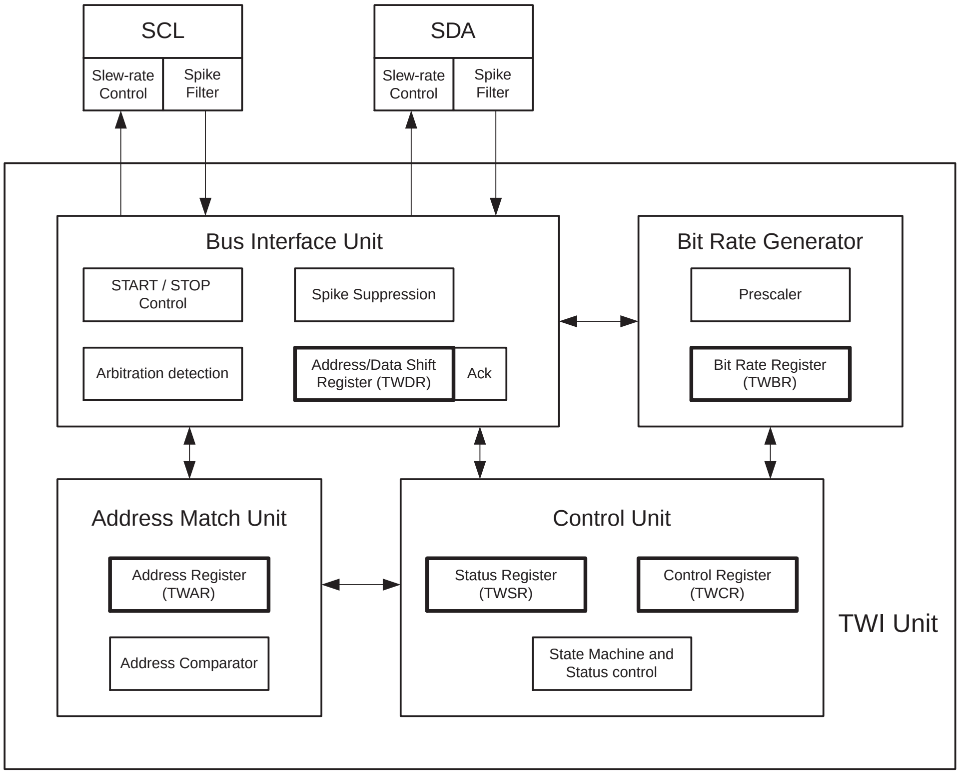
- A REPEATED START condition and a data bit
- A STOP condition and a data bit
- A REPEATED START and a STOP condition

It is the user software's responsibility to ensure that these illegal arbitration conditions never occur. This implies that in multi-master systems, all data transfers must use the same composition of SLA+R/W and data packets. In other words: All transmissions must contain the same number of data packets, otherwise the result of the arbitration is undefined.

Overview of the TWI Module

The TWI module is comprised of several submodules, as shown in Figure 84. All registers drawn in a thick line are accessible through the AVR data bus.

Figure 84. Overview of the TWI Module



SCL and SDA Pins

These pins interface the AVR TWI with the rest of the MCU system. The output drivers contain a slew-rate limiter in order to conform to the TWI specification. The input stages contain a spike suppression unit removing spikes shorter than 50 ns. Note that the internal pullups in the AVR pads can be enabled by setting the PORT bits corresponding to the SCL and SDA pins, as explained in the I/O Port section. The internal pull-ups can in some systems eliminate the need for external ones.

Bit Rate Generator Unit

This unit controls the period of SCL when operating in a Master mode. The SCL period is controlled by settings in the TWI Bit Rate Register (TWBR) and the Prescaler bits in the TWI Status Register (TWSR). Slave operation does not depend on Bit Rate or Prescaler settings, but the CPU clock frequency in the Slave must be at least 16 times higher than the SCL frequency. Note that slaves may prolong the SCL low period, thereby reducing the average TWI bus clock period. The SCL frequency is generated according to the following equation:

$$\text{SCL frequency} = \frac{\text{CPU Clock frequency}}{16 + 2(\text{TWBR}) \cdot 4^{TWPS}}$$

- TWBR = Value of the TWI Bit Rate Register
- TWPS = Value of the prescaler bits in the TWI Status Register

Note: TWBR should nbe 10 or higher if the TWI operates in Master mode. If TWBR is lower than 10, the Master may produce an incorrect output on SDA and SCL for the reminder of the byte. The problem occurs when operating the TWI in Master mode, sending Start + SLA + R/W to a Slave (a Slave does not need to be connected to the bus for the condition to happen).

Bus Interface Unit

This unit contains the Data and Address Shift Register (TWDR), a START/STOP Controller and Arbitration detection hardware. The TWDR contains the address or data bytes to be transmitted, or the address or data bytes received. In addition to the 8-bit TWDR, the Bus Interface Unit also contains a register containing the (N)ACK bit to be transmitted or received. This (N)ACK Register is not directly accessible by the application software. However, when receiving, it can be set or cleared by manipulating the TWI Control Register (TWCR). When in Transmitter mode, the value of the received (N)ACK bit can be determined by the value in the TWSR.

The START/STOP Controller is responsible for generation and detection of START, REPEATED START, and STOP conditions. The START/STOP controller is able to detect START and STOP conditions even when the AVR MCU is in one of the sleep modes, enabling the MCU to wake up if addressed by a Master.

If the TWI has initiated a transmission as Master, the Arbitration Detection hardware continuously monitors the transmission trying to determine if arbitration is in process. If the TWI has lost an arbitration, the Control Unit is informed. Correct action can then be taken and appropriate status codes generated.

Address Match Unit

The Address Match unit checks if received address bytes match the 7-bit address in the TWI Address Register (TWAR). If the TWI General Call Recognition Enable (TWGCE) bit in the TWAR is written to one, all incoming address bits will also be compared against the General Call address. Upon an address match, the Control Unit is informed, allowing correct action to be taken. The TWI may or may not acknowledge its address, depending on settings in the TWCR. The Address Match unit is able to compare addresses even when the AVR MCU is in sleep mode, enabling the MCU to wake up if addressed by a Master.

Control Unit

The Control unit monitors the TWI bus and generates responses corresponding to settings in the TWI Control Register (TWCR). When an event requiring the attention of the application occurs on the TWI bus, the TWI Interrupt Flag (TWINT) is asserted. In the next clock cycle, the TWI Status Register (TWSR) is updated with a status code identifying the event. The TWSR only contains relevant status information when the TWI Interrupt Flag is asserted. At all other times, the TWSR contains a special status code indicating that no relevant status information is available. As long as the TWINT Flag is set, the SCL line is held low. This allows the application software to complete its tasks before allowing the TWI transmission to continue.

The TWINT Flag is set in the following situations:

- After the TWI has transmitted a START/REPEATED START condition.
- After the TWI has transmitted SLA+R/W.
- After the TWI has transmitted an address byte.
- After the TWI has lost arbitration.
- After the TWI has been addressed by own Slave address or general call.
- After the TWI has received a data byte.
- After a STOP or REPEATED START has been received while still addressed as a Slave.
- When a bus error has occurred due to an illegal START or STOP condition.

TWI Register Description

TWI Bit Rate Register – TWBR

Bit	7	6	5	4	3	2	1	0	
	TWBR7	TWBR6	TWBR5	TWBR4	TWBR3	TWBR2	TWBR1	TWBR0	TWBR
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bits 7..0 – TWI Bit Rate Register**

TWBR selects the division factor for the bit rate generator. The bit rate generator is a frequency divider which generates the SCL clock frequency in the Master modes. See “Bit Rate Generator Unit” on page 176 for calculating bit rates.

TWI Control Register – TWCR

Bit	7	6	5	4	3	2	1	0	
	TWINT	TWEA	TWSTA	TWSTO	TWWC	TWEN	–	TWIE	TWCR
Read/Write	R/W	R/W	R/W	R/W	R	R/W	R	R/W	
Initial Value	0	0	0	0	0	0	0	0	

The TWCR is used to control the operation of the TWI. It is used to enable the TWI, to initiate a master access by applying a START condition to the bus, to generate a receiver acknowledge, to generate a stop condition, and to control halting of the bus while the data to be written to the bus are written to the TWDR. It also indicates a write collision if data is attempted written to TWDR while the register is inaccessible.

- **Bit 7 – TWINT: TWI Interrupt Flag**

This bit is set by hardware when the TWI has finished its current job and expects application software response. If the I-bit in SREG and TWIE in TWCR are set, the MCU will jump to the TWI Interrupt Vector. While the TWINT Flag is set, the SCL low period is stretched. The TWINT Flag must be cleared by software by writing a logic one to it. Note that this flag is not automatically cleared by hardware when executing the interrupt routine. Also note that clearing this flag starts the operation of the TWI, so all accesses to the TWI Address Register (TWAR), TWI Status Register (TWSR), and TWI Data Register (TWDR) must be complete before clearing this flag.

- **Bit 6 – TWEA: TWI Enable Acknowledge Bit**

The TWEA bit controls the generation of the acknowledge pulse. If the TWEA bit is written to one, the ACK pulse is generated on the TWI bus if the following conditions are met:

1. The device's own slave address has been received.
2. A general call has been received, while the TWGCE bit in the TWAR is set.
3. A data byte has been received in Master Receiver or Slave Receiver mode.

By writing the TWEA bit to zero, the device can be virtually disconnected from the Two-wire Serial Bus temporarily. Address recognition can then be resumed by writing the TWEA bit to one again.

- **Bit 5 – TWSTA: TWI START Condition Bit**

The application writes the TWSTA bit to one when it desires to become a Master on the Two-wire Serial Bus. The TWI hardware checks if the bus is available, and generates a START condition on the bus if it is free. However, if the bus is not free, the TWI waits until a STOP condition is detected, and then generates a new START condition to claim the bus Master status. TWSTA must be cleared by software when the START condition has been transmitted.

- **Bit 4 – TWSTO: TWI STOP Condition Bit**

Writing the TWSTO bit to one in Master mode will generate a STOP condition on the Two-wire Serial Bus. When the STOP condition is executed on the bus, the TWSTO bit is cleared automatically. In Slave mode, setting the TWSTO bit can be used to recover from an error condition. This will not generate a STOP condition, but the TWI returns to a well-defined unaddressed Slave mode and releases the SCL and SDA lines to a high impedance state.

- **Bit 3 – TWWC: TWI Write Collision Flag**

The TWWC bit is set when attempting to write to the TWI Data Register – TWDR when TWINT is low. This flag is cleared by writing the TWDR Register when TWINT is high.

- **Bit 2 – TWEN: TWI Enable Bit**

The TWEN bit enables TWI operation and activates the TWI interface. When TWEN is written to one, the TWI takes control over the I/O pins connected to the SCL and SDA pins, enabling the slew-rate limiters and spike filters. If this bit is written to zero, the TWI is switched off and all TWI transmissions are terminated, regardless of any ongoing operation.

- **Bit 1 – Res: Reserved Bit**

This bit is a reserved bit and will always read as zero.

- **Bit 0 – TWIE: TWI Interrupt Enable**

When this bit is written to one, and the I-bit in SREG is set, the TWI interrupt request will be activated for as long as the TWINT flag is high.

TWI Status Register – TWSR

Bit	7	6	5	4	3	2	1	0	
	TWS7	TWS6	TWS5	TWS4	TWS3	–	TWPS1	TWPS0	TWSR
Read/Write	R	R	R	R	R	R	R/W	R/W	
Initial Value	1	1	1	1	1	0	0	0	

- **Bits 7..3 – TWS: TWI Status**

These five bits reflect the status of the TWI logic and the Two-wire Serial Bus. The different status codes are described later in this section. Note that the value read from TWSR contains both the 5-bit status value and the 2-bit prescaler value. The application designer should mask the prescaler bits to zero when checking the status bits. This makes status checking independent of prescaler setting. This approach is used in this datasheet, unless otherwise noted.

- **Bit 2 – Res: Reserved bit**

This bit is reserved and will always read as zero.

- **Bits 1..0 – TWPS: TWI Prescaler Bits**

These bits can be read and written, and control the bit rate prescaler.

Table 74. TWI Bit Rate Prescaler

TWPS1	TWPS0	Prescaler Value
0	0	1
0	1	4
1	0	16
1	1	64

To calculate bit reates, see “Bit Rate Generator Unit” on page 176. The value of TWPS1..0 is used in the equation.

TWI Data Register – TWDR

Bit	7	6	5	4	3	2	1	0	
	TWD7	TWD6	TWD5	TWD4	TWD3	TWD2	TWD1	TWD0	TWDR
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	1	1	1	1	1	1	1	1	

In Transmit mode, TWDR contains the next byte to be transmitted. In Receive mode, the TWDR contains the last byte received. It is writable while the TWI is not in the process of shifting a byte. This occurs when the TWI Interrupt Flag (TWINT) is set by hardware. Note that the Data Register cannot be initialized by the user before the first interrupt occurs. The data in TWDR remains stable as long as TWINT is set. While data is shifted out, data on the bus is simultaneously shifted in. TWDR always contains the last byte present on the bus, except after a wake-up from a sleep mode by the TWI interrupt. In this case, the contents of TWDR is undefined. In the case of a lost bus arbitration, no data is lost in the transition from Master to Slave. Handling of the ACK bit is controlled automatically by the TWI logic, the CPU cannot access the ACK bit directly.

- **Bits 7..0 – TWD: TWI Data Register**

These eight bits constitute the next data byte to be transmitted, or the latest data byte received on the Two-wire Serial Bus.

TWI (Slave) Address Register – TWAR

Bit	7	6	5	4	3	2	1	0	
	TWA6	**TWA5**	**TWA4**	**TWA3**	**TWA2**	**TWA1**	**TWA0**	**TWGCE**	**TWAR**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	1	1	1	1	1	1	1	0	

The TWAR should be loaded with the 7-bit slave address (in the seven most significant bits of TWAR) to which the TWI will respond when programmed as a Slave Transmitter or Receiver, and not needed in the Master modes. In multimaster systems, TWAR must be set in masters which can be addressed as slaves by other masters.

The LSB of TWAR is used to enable recognition of the general call address (0x00). There is an associated address comparator that looks for the slave address (or general call address if enabled) in the received serial address. If a match is found, an interrupt request is generated.

- **Bits 7..1 – TWA: TWI (Slave) Address Register**

These seven bits constitute the slave address of the TWI unit.

- **Bit 0 – TWGCE: TWI General Call Recognition Enable Bit**

If set, this bit enables the recognition of a General Call given over the Two-wire Serial Bus.

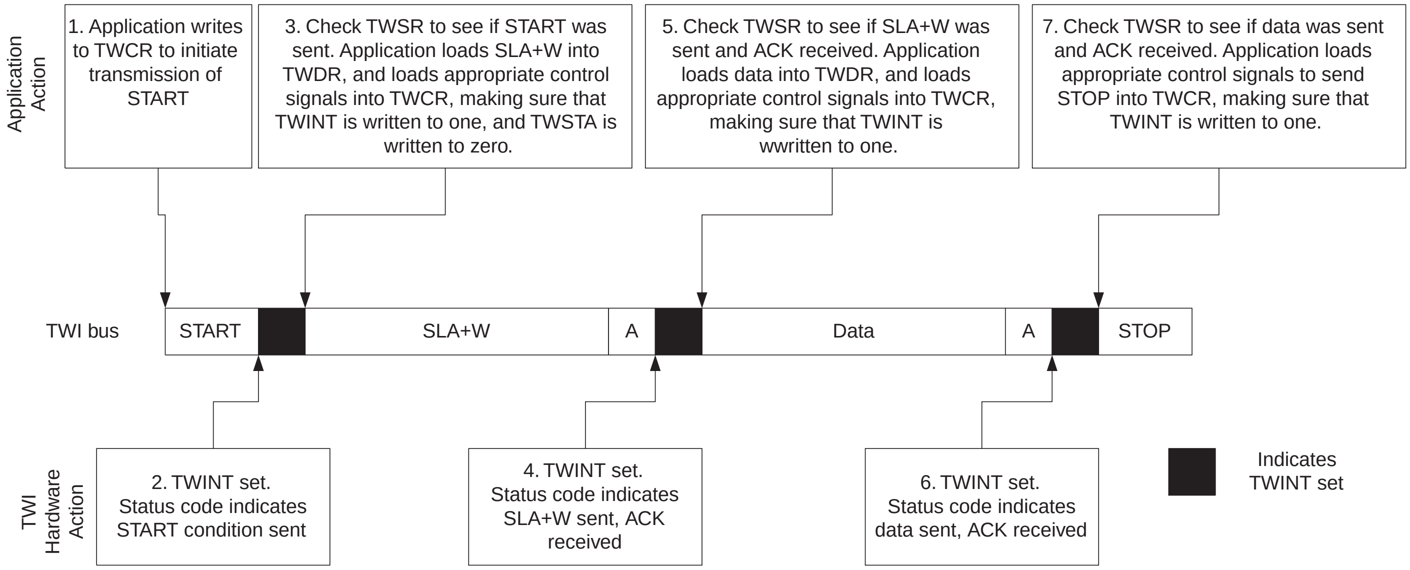
Using the TWI

The AVR TWI is byte-oriented and interrupt based. Interrupts are issued after all bus events, like reception of a byte or transmission of a START condition. Because the TWI is interrupt-based, the application software is free to carry on other operations during a TWI byte transfer. Note that the TWI Interrupt Enable (TWIE) bit in TWCR together with the Global Interrupt Enable bit in SREG allow the application to decide whether or not assertion of the TWINT Flag should generate an interrupt request. If the TWIE bit is cleared, the application must poll the TWINT Flag in order to detect actions on the TWI bus.

When the TWINT Flag is asserted, the TWI has finished an operation and awaits application response. In this case, the TWI Status Register (TWSR) contains a value indicating the current state of the TWI bus. The application software can then decide how the TWI should behave in the next TWI bus cycle by manipulating the TWCR and TWDR Registers.

Figure 85 is a simple example of how the application can interface to the TWI hardware. In this example, a Master wishes to transmit a single data byte to a Slave. This description is quite abstract, a more detailed explanation follows later in this section. A simple code example implementing the desired behavior is also presented.

Figure 85. Interfacing the Application to the TWI in a Typical Transmission



1. The first step in a TWI transmission is to transmit a START condition. This is done by writing a specific value into TWCR, instructing the TWI hardware to transmit a START condition. Which value to write is described later on. However, it is important that the TWINT bit is set in the value written. Writing a one to TWINT clears the flag. The TWI will not start any operation as long as the TWINT bit in TWCR is set. Immediately after the application has cleared TWINT, the TWI will initiate transmission of the START condition.
2. When the START condition has been transmitted, the TWINT Flag in TWCR is set, and TWSR is updated with a status code indicating that the START condition has successfully been sent.
3. The application software should now examine the value of TWSR, to make sure that the START condition was successfully transmitted. If TWSR indicates otherwise, the application software might take some special action, like calling an error routine. Assuming that the status code is as expected, the application must

load SLA+W into TWDR. Remember that TWDR is used both for address and data. After TWDR has been loaded with the desired SLA+W, a specific value must be written to TWCR, instructing the TWI hardware to transmit the SLA+W present in TWDR. Which value to write is described later on. However, it is important that the TWINT bit is set in the value written. Writing a one to TWINT clears the flag. The TWI will not start any operation as long as the TWINT bit in TWCR is set. Immediately after the application has cleared TWINT, the TWI will initiate transmission of the address packet.

4. When the address packet has been transmitted, the TWINT Flag in TWCR is set, and TWSR is updated with a status code indicating that the address packet has successfully been sent. The status code will also reflect whether a Slave acknowledged the packet or not.
5. The application software should now examine the value of TWSR, to make sure that the address packet was successfully transmitted, and that the value of the ACK bit was as expected. If TWSR indicates otherwise, the application software might take some special action, like calling an error routine. Assuming that the status code is as expected, the application must load a data packet into TWDR. Subsequently, a specific value must be written to TWCR, instructing the TWI hardware to transmit the data packet present in TWDR. The value which to write is described later on. However, it is important that the TWINT bit is set in the value written. Writing a one to TWINT clears the flag. The TWI will not start any operation as long as the TWINT bit in TWCR is set. Immediately after the application has cleared TWINT, the TWI will initiate transmission of the data packet.
6. When the data packet has been transmitted, the TWINT Flag in TWCR is set, and TWSR is updated with a status code indicating that the data packet has successfully been sent. The status code will also reflect whether a Slave acknowledged the packet or not.
7. The application software should now examine the value of TWSR, to make sure that the data packet was successfully transmitted, and that the value of the ACK bit was as expected. If TWSR indicates otherwise, the application software might take some special action, like calling an error routine. Assuming that the status code is as expected, the application must write a specific value to TWCR, instructing the TWI hardware to transmit a STOP condition. Which value to write is described later on. However, it is important that the TWINT bit is set in the value written. Writing a one to TWINT clears the flag. The TWI will not start any operation as long as the TWINT bit in TWCR is set. Immediately after the application has cleared TWINT, the TWI will initiate transmission of the STOP condition. Note that TWINT is NOT set after a STOP condition has been sent.

Even though this example is simple, it shows the principles involved in all TWI transmissions. These can be summarized as follows:

- When the TWI has finished an operation and expects application response, the TWINT Flag is set. The SCL line is pulled low until TWINT is cleared.
- When the TWINT Flag is set, the user must update all TWI Registers with the value relevant for the next TWI bus cycle. As an example, TWDR must be loaded with the value to be transmitted in the next bus cycle.
- After all TWI Register updates and other pending application software tasks have been completed, TWCR is written. When writing TWCR, the TWINT bit should be set. Writing a one to TWINT clears the flag. The TWI will then commence executing whatever operation was specified by the TWCR setting.

In the following an assembly and C implementation of the example is given. Note that the code below assumes that several definitions have been made, for example by using include-files.

	Assembly Code Example	C Example	Comments
1	**ldi** r16, (1<<TWINT)|(1<<TWSTA)| (1<<TWEN) **out** TWCR, r16	TWCR = (1<<TWINT)|(1<<TWSTA)| (1<<TWEN)	Send START condition.
2	wait1: **in** r16,TWCR **sbrs** r16,TWINT **rjmp** wait1	**while** (!(TWCR & (1<<TWINT))) ;	Wait for TWINT Flag set. This indicates that the START condition has been transmitted.
3	**in** r16,TWSR **andi** r16, 0xF8 **cpi** r16, START **brne** ERROR	**if** ((TWSR & 0xF8) != START) ERROR();	Check value of TWI Status Register. Mask prescaler bits. If status different from START go to ERROR.
	ldi r16, SLA_W **out** TWDR, r16 **ldi** r16, (1<<TWINT) | (1<<TWEN) **out** TWCR, r16	TWDR = SLA_W; TWCR = (1<<TWINT) | (1<<TWEN);	Load SLA_W into TWDR Register. Clear TWINT bit in TWCR to start transmission of address.
4	wait2: **in** r16,TWCR **sbrs** r16,TWINT **rjmp** wait2	**while** (!(TWCR & (1<<TWINT))) ;	Wait for TWINT Flag set. This indicates that the SLA+W has been transmitted, and ACK/NACK has been received.
5	**in** r16,TWSR **andi** r16, 0xF8 **cpi** r16, MT_SLA_ACK **brne** ERROR	**if** ((TWSR & 0xF8) != MT_SLA_ACK) ERROR();	Check value of TWI Status Register. Mask prescaler bits. If status different from MT_SLA_ACK go to ERROR.
	ldi r16, DATA **out** TWDR, r16 **ldi** r16, (1<<TWINT) | (1<<TWEN) **out** TWCR, r16	TWDR = DATA; TWCR = (1<<TWINT) | (1<<TWEN);	Load DATA into TWDR Register. Clear TWINT bit in TWCR to start transmission of address.
6	wait3: **in** r16,TWCR **sbrs** r16,TWINT **rjmp** wait3	**while** (!(TWCR & (1<<TWINT))) ;	Wait for TWINT Flag set. This indicates that the DATA has been transmitted, and ACK/NACK has been received.
7	**in** r16,TWSR **andi** r16, 0xF8 **cpi** r16, MT_DATA_ACK **brne** ERROR	**if** ((TWSR & 0xF8) != MT_DATA_ACK) ERROR();	Check value of TWI Status Register. Mask prescaler bits. If status different from MT_DATA_ACK go to ERROR.
	ldi r16, (1<<TWINT)|(1<<TWEN)| (1<<TWSTO) **out** TWCR, r16	TWCR = (1<<TWINT)|(1<<TWEN)| (1<<TWSTO);	Transmit STOP condition.

Transmission Modes

The TWI can operate in one of four major modes. These are named Master Transmitter (MT), Master Receiver (MR), Slave Transmitter (ST), and Slave Receiver (SR). Several of these modes can be used in the same application. As an example, the TWI can use MT mode to write data into a TWI EEPROM, MR mode to read the data back from the EEPROM. If other masters are present in the system, some of these might transmit data to the TWI, and then SR mode would be used. It is the application software that decides which modes are legal.

The following sections describe each of these modes. Possible status codes are described along with figures detailing data transmission in each of the modes. These figures contain the following abbreviations:

S:	START condition
Rs:	REPEATED START condition
R:	Read bit (high level at SDA)
W:	Write bit (low level at SDA)
A:	Acknowledge bit (low level at SDA)
$\overline{A}$:	Not acknowledge bit (high level at SDA)
Data:	8-bit data byte
P:	STOP condition
SLA:	Slave Address

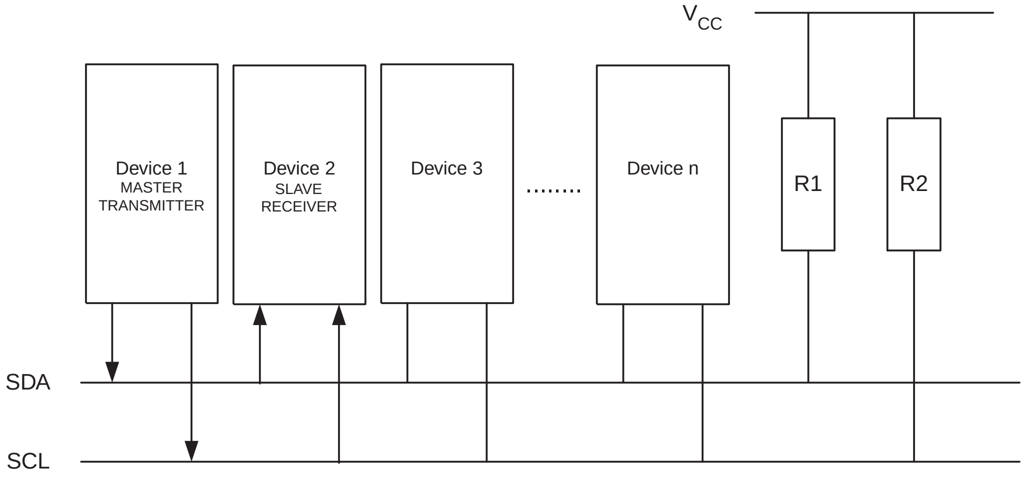
In Figure 87 to Figure 93, circles are used to indicate that the TWINT Flag is set. The numbers in the circles show the status code held in TWSR, with the prescaler bits masked to zero. At these points, actions must be taken by the application to continue or complete the TWI transfer. The TWI transfer is suspended until the TWINT Flag is cleared by software.

When the TWINT Flag is set, the status code in TWSR is used to determine the appropriate software action. For each status code, the required software action and details of the following serial transfer are given in Table 75 to Table 78. Note that the prescaler bits are masked to zero in these tables.

Master Transmitter Mode

In the Master Transmitter mode, a number of data bytes are transmitted to a Slave Receiver (see Figure 86). In order to enter a Master mode, a START condition must be transmitted. The format of the following address packet determines whether Master Transmitter or Master Receiver mode is to be entered. If SLA+W is transmitted, MT mode is entered, if SLA+R is transmitted, MR mode is entered. All the status codes mentioned in this section assume that the prescaler bits are zero or are masked to zero.

Figure 86. Data Transfer in Master Transmitter Mode



A START condition is sent by writing the following value to TWCR:

TWCR	TWINT	TWEA	TWSTA	TWSTO	TWWC	TWEN	–	TWIE
Value	1	X	1	0	X	1	0	X

TWEN must be set to enable the Two-wire Serial Interface, TWSTA must be written to one to transmit a START condition and TWINT must be written to one to clear the TWINT Flag. The TWI will then test the Two-wire Serial Bus and generate a START condition as soon as the bus becomes free. After a START condition has been transmitted, the TWINT Flag is set by hardware, and the status code in TWSR will be 0x08 (see Table 75). In order to enter MT mode, SLA+W must be transmitted. This is done by writing SLA+W to TWDR. Thereafter the TWINT bit should be cleared (by writing it to one) to continue the transfer. This is accomplished by writing the following value to TWCR:

TWCR	TWINT	TWEA	TWSTA	TWSTO	TWWC	TWEN	–	TWIE
Value	1	X	0	0	X	1	0	X

When SLA+W have been transmitted and an acknowledgement bit has been received, TWINT is set again and a number of status codes in TWSR are possible. Possible status codes in Master mode are 0x18, 0x20, or 0x38. The appropriate action to be taken for each of these status codes is detailed in Table 75.

When SLA+W has been successfully transmitted, a data packet should be transmitted. This is done by writing the data byte to TWDR. TWDR must only be written when TWINT is high. If not, the access will be discarded, and the Write Collision bit (TWWC) will be set in the TWCR Register. After updating TWDR, the TWINT bit should be cleared (by writing it to one) to continue the transfer. This is accomplished by writing the following value to TWCR:

TWCR	TWINT	TWEA	TWSTA	TWSTO	TWWC	TWEN	–	TWIE
Value	1	X	0	0	X	1	0	X

This scheme is repeated until the last byte has been sent and the transfer is ended by generating a STOP condition or a repeated START condition. A STOP condition is generated by writing the following value to TWCR:

TWCR	TWINT	TWEA	TWSTA	TWSTO	TWWC	TWEN	–	TWIE
Value	1	X	0	1	X	1	0	X

A REPEATED START condition is generated by writing the following value to TWCR:

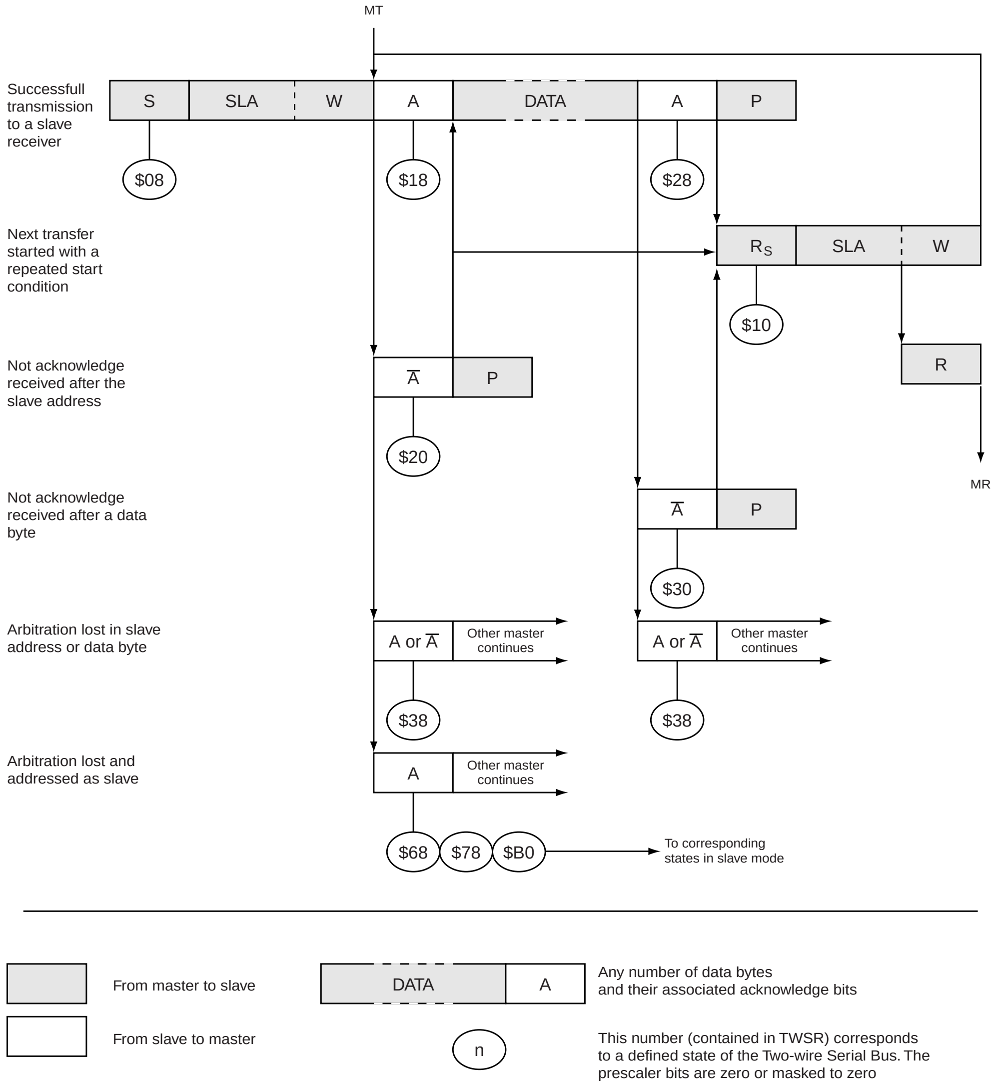
TWCR	TWINT	TWEA	TWSTA	TWSTO	TWWC	TWEN	–	TWIE
Value	1	X	1	0	X	1	0	X

After a repeated START condition (state 0x10) the Two-wire Serial Interface can access the same Slave again, or a new Slave without transmitting a STOP condition. Repeated START enables the Master to switch between Slaves, Master Transmitter mode and Master Receiver mode without losing control of the bus..

Table 75. Status Codes for Master Transmitter Mode

Status Code (TWSR) Prescaler Bits are 0	Status of the Two-wire Serial Bus and Two-wire Serial Interface Hardware	Application Software Response					Next Action Taken by TWI Hardware
		To/from TWDR	To TWCR				
			STA	STO	TWINT	TWEA	
0x08	A START condition has been transmitted	Load SLA+W	0	0	1	X	SLA+W will be transmitted; ACK or NOT ACK will be received
0x10	A repeated START condition has been transmitted	Load SLA+W or	0	0	1	X	SLA+W will be transmitted; ACK or NOT ACK will be received
		Load SLA+R	0	0	1	X	SLA+R will be transmitted; Logic will switch to Master Receiver mode
0x18	SLA+W has been transmitted; ACK has been received	Load data byte or	0	0	1	X	Data byte will be transmitted and ACK or NOT ACK will be received
		No TWDR action or	1	0	1	X	Repeated START will be transmitted
		No TWDR action or	0	1	1	X	STOP condition will be transmitted and TWSTO Flag will be reset
		No TWDR action	1	1	1	X	STOP condition followed by a START condition will be transmitted and TWSTO Flag will be reset
0x20	SLA+W has been transmitted; NOT ACK has been received	Load data byte or	0	0	1	X	Data byte will be transmitted and ACK or NOT ACK will be received
		No TWDR action or	1	0	1	X	Repeated START will be transmitted
		No TWDR action or	0	1	1	X	STOP condition will be transmitted and TWSTO Flag will be reset
		No TWDR action	1	1	1	X	STOP condition followed by a START condition will be transmitted and TWSTO Flag will be reset
0x28	Data byte has been transmitted; ACK has been received	Load data byte or	0	0	1	X	Data byte will be transmitted and ACK or NOT ACK will be received
		No TWDR action or	1	0	1	X	Repeated START will be transmitted
		No TWDR action or	0	1	1	X	STOP condition will be transmitted and TWSTO Flag will be reset
		No TWDR action	1	1	1	X	STOP condition followed by a START condition will be transmitted and TWSTO Flag will be reset
0x30	Data byte has been transmitted; NOT ACK has been received	Load data byte or	0	0	1	X	Data byte will be transmitted and ACK or NOT ACK will be received
		No TWDR action or	1	0	1	X	Repeated START will be transmitted
		No TWDR action or	0	1	1	X	STOP condition will be transmitted and TWSTO Flag will be reset
		No TWDR action	1	1	1	X	STOP condition followed by a START condition will be transmitted and TWSTO Flag will be reset
0x38	Arbitration lost in SLA+W or data bytes	No TWDR action or	0	0	1	X	Two-wire Serial Bus will be released and not addressed Slave mode entered
		No TWDR action	1	0	1	X	A START condition will be transmitted when the bus becomes free

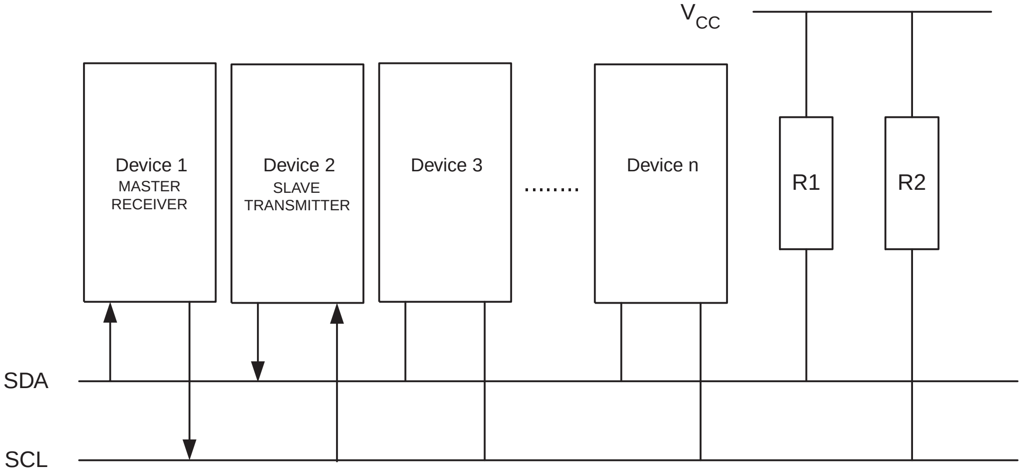
Figure 87. Formats and States in the Master Transmitter Mode



Master Receiver Mode

In the Master Receiver mode, a number of data bytes are received from a Slave Transmitter (see Figure 88). In order to enter a Master mode, a START condition must be transmitted. The format of the following address packet determines whether Master Transmitter or Master Receiver mode is to be entered. If SLA+W is transmitted, MT mode is entered, if SLA+R is transmitted, MR mode is entered. All the status codes mentioned in this section assume that the prescaler bits are zero or are masked to zero.

Figure 88. Data Transfer in Master Receiver Mode



A START condition is sent by writing the following value to TWCR:

TWCR	TWINT	TWEA	TWSTA	TWSTO	TWWC	TWEN	–	TWIE
Value	1	X	1	0	X	1	0	X

TWEN must be written to one to enable the Two-wire Serial Interface, TWSTA must be written to one to transmit a START condition and TWINT must be set to clear the TWINT Flag. The TWI will then test the Two-wire Serial Bus and generate a START condition as soon as the bus becomes free. After a START condition has been transmitted, the TWINT Flag is set by hardware, and the status code in TWSR will be 0x08 (see Table 75). In order to enter MR mode, SLA+R must be transmitted. This is done by writing SLA+R to TWDR. Thereafter the TWINT bit should be cleared (by writing it to one) to continue the transfer. This is accomplished by writing the following value to TWCR:

TWCR	TWINT	TWEA	TWSTA	TWSTO	TWWC	TWEN	–	TWIE
Value	1	X	0	0	X	1	0	X

When SLA+R have been transmitted and an acknowledgement bit has been received, TWINT is set again and a number of status codes in TWSR are possible. Possible status codes in Master mode are 0x38, 0x40, or 0x48. The appropriate action to be taken for each of these status codes is detailed in Table 76. Received data can be read from the TWDR Register when the TWINT Flag is set high by hardware. This scheme is repeated until the last byte has been received. After the last byte has been received, the MR should inform the ST by sending a NACK after the last received data byte. The transfer is ended by generating a STOP condition or a repeated START condition. A STOP condition is generated by writing the following value to TWCR:

TWCR	TWINT	TWEA	TWSTA	TWSTO	TWWC	TWEN	–	TWIE
Value	1	X	0	1	X	1	0	X

A REPEATED START condition is generated by writing the following value to TWCR:

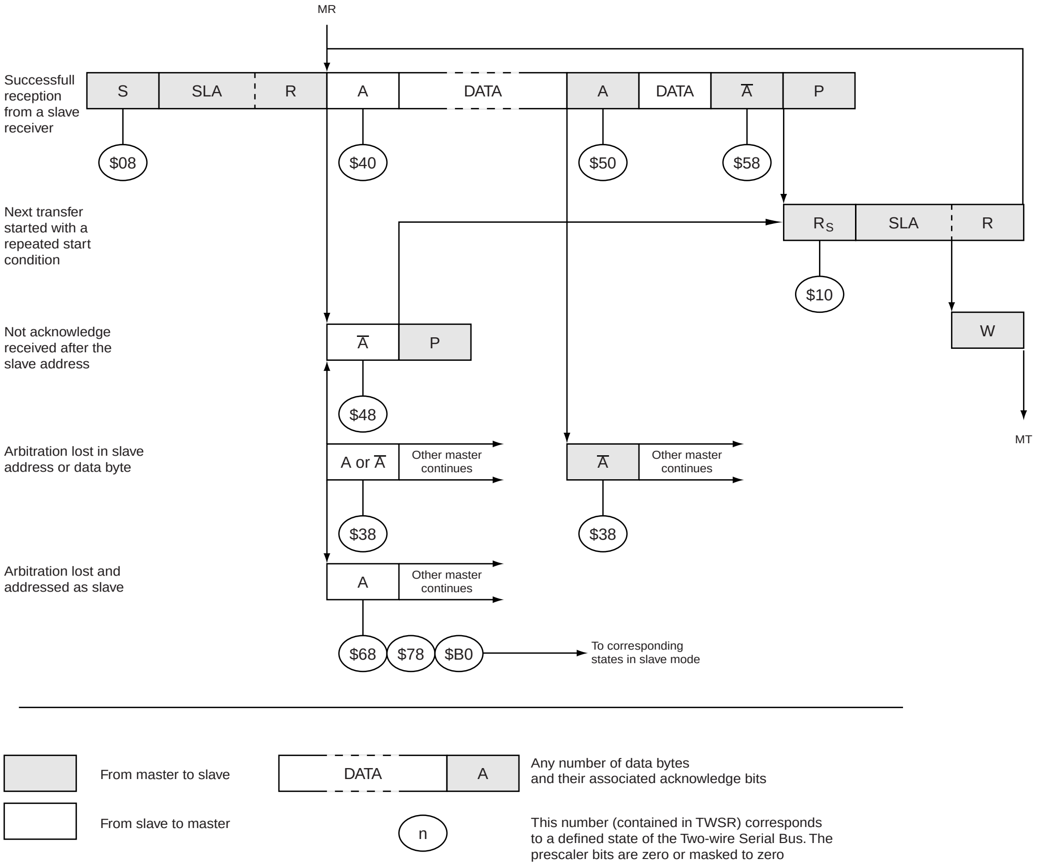
TWCR	TWINT	TWEA	TWSTA	TWSTO	TWWC	TWEN	–	TWIE
Value	1	X	1	0	X	1	0	X

After a repeated START condition (state 0x10) the Two-wire Serial Interface can access the same Slave again, or a new Slave without transmitting a STOP condition. Repeated START enables the Master to switch between Slaves, Master Transmitter mode and Master Receiver mode without losing control over the bus.

Table 76. Status Codes for Master Receiver Mode

Status Code (TWSR) Prescaler Bits are 0	Status of the Two-wire Serial Bus and Two-wire Serial Interface Hardware	Application Software Response					Next Action Taken by TWI Hardware
		To/from TWDR	To TWCR				
			STA	STO	TWINT	TWEA	
0x08	A START condition has been transmitted	Load SLA+R	0	0	1	X	SLA+R will be transmitted ACK or NOT ACK will be received
0x10	A repeated START condition has been transmitted	Load SLA+R or	0	0	1	X	SLA+R will be transmitted ACK or NOT ACK will be received
		Load SLA+W	0	0	1	X	SLA+W will be transmitted Logic will switch to Master Transmitter mode
0x38	Arbitration lost in SLA+R or NOT ACK bit	No TWDR action or	0	0	1	X	Two-wire Serial Bus will be released and not addressed Slave mode will be entered
		No TWDR action	1	0	1	X	A START condition will be transmitted when the bus becomes free
0x40	SLA+R has been transmitted; ACK has been received	No TWDR action or	0	0	1	0	Data byte will be received and NOT ACK will be returned
		No TWDR action	0	0	1	1	Data byte will be received and ACK will be returned
0x48	SLA+R has been transmitted; NOT ACK has been received	No TWDR action or	1	0	1	X	Repeated START will be transmitted
		No TWDR action or	0	1	1	X	STOP condition will be transmitted and TWSTO Flag will be reset
		No TWDR action	1	1	1	X	STOP condition followed by a START condition will be transmitted and TWSTO Flag will be reset
0x50	Data byte has been received; ACK has been returned	Read data byte or	0	0	1	0	Data byte will be received and NOT ACK will be returned
		Read data byte	0	0	1	1	Data byte will be received and ACK will be returned
0x58	Data byte has been received; NOT ACK has been returned	Read data byte or	1	0	1	X	Repeated START will be transmitted
		Read data byte or	0	1	1	X	STOP condition will be transmitted and TWSTO flag will be reset
		Read data byte	1	1	1	X	STOP condition followed by a START condition will be transmitted and TWSTO Flag Will be reset

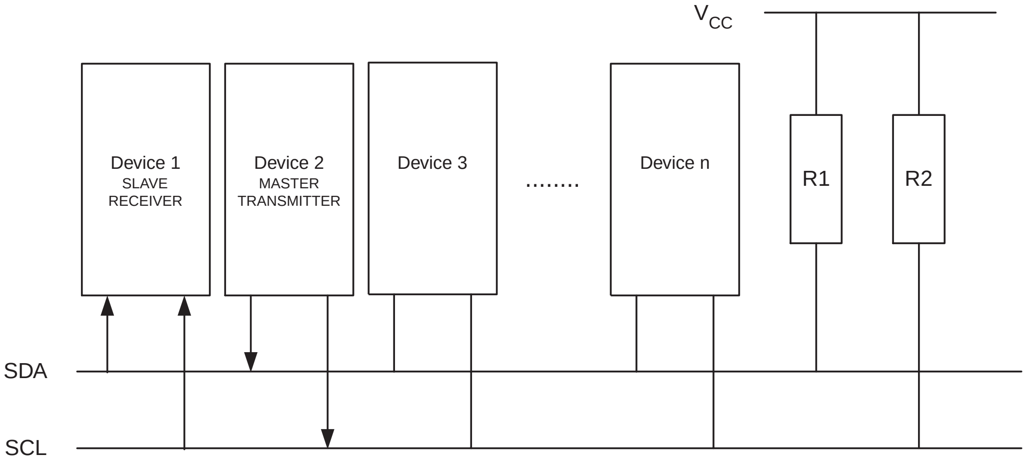
Figure 89. Formats and States in the Master Receiver Mode



Slave Receiver Mode

In the Slave Receiver mode, a number of data bytes are received from a Master Transmitter (see Figure 90). All the status codes mentioned in this section assume that the prescaler bits are zero or are masked to zero.

Figure 90. Data Transfer in Slave Receiver Mode



To initiate the Slave Receiver mode, TWAR and TWCR must be initialized as follows:

TWAR	**TWA6**	**TWA5**	**TWA4**	**TWA3**	**TWA2**	**TWA1**	**TWA0**	**TWGCE**
Value	Device’s Own Slave Address							

The upper seven bits are the address to which the Two-wire Serial Interface will respond when addressed by a Master. If the LSB is set, the TWI will respond to the general call address (0x00), otherwise it will ignore the general call address.

TWCR	**TWINT**	**TWEA**	**TWSTA**	**TWSTO**	**TWWC**	**TWEN**	**–**	**TWIE**
Value	0	1	0	0	0	1	0	X

TWEN must be written to one to enable the TWI. The TWEA bit must be written to one to enable the acknowledgement of the device’s own slave address or the general call address. TWSTA and TWSTO must be written to zero.

When TWAR and TWCR have been initialized, the TWI waits until it is addressed by its own slave address (or the general call address if enabled) followed by the data direction bit. If the direction bit is “0” (write), the TWI will operate in SR mode, otherwise ST mode is entered. After its own slave address and the write bit have been received, the TWINT Flag is set and a valid status code can be read from TWSR. The status code is used to determine the appropriate software action. The appropriate action to be taken for each status code is detailed in Table 77. The Slave Receiver mode may also be entered if arbitration is lost while the TWI is in the Master mode (see states 0x68 and 0x78).

If the TWEA bit is reset during a transfer, the TWI will return a “Not Acknowledge” (“1”) to SDA after the next received data byte. This can be used to indicate that the Slave is not able to receive any more bytes. While TWEA is zero, the TWI does not acknowledge its own slave address. However, the Two-wire Serial Bus is still monitored and address recognition may resume at any time by setting TWEA. This implies that the TWEA bit may be used to temporarily isolate the TWI from the Two-wire Serial Bus.

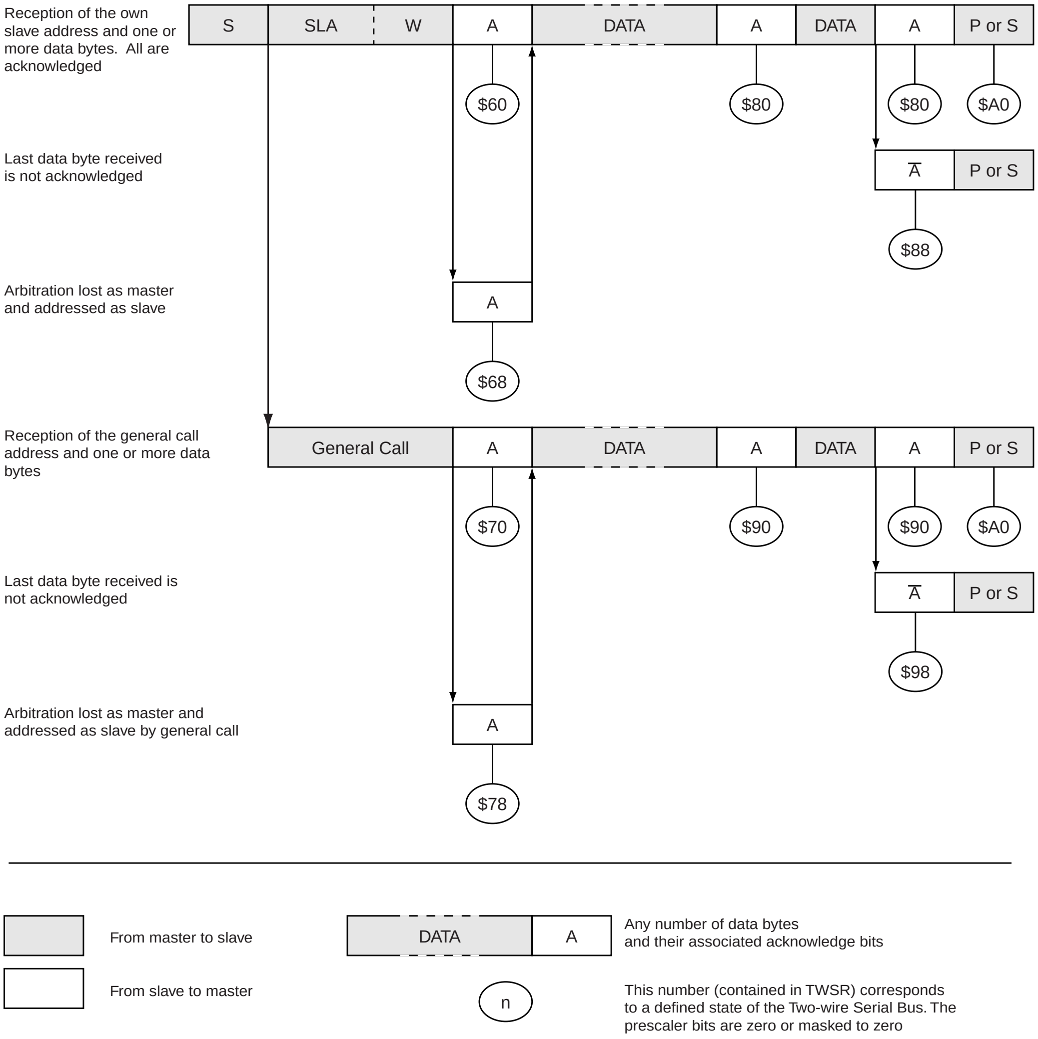
In all sleep modes other than Idle mode, the clock system to the TWI is turned off. If the TWEA bit is set, the interface can still acknowledge its own slave address or the general call address by using the Two-wire Serial Bus clock as a clock source. The part will then wake up from sleep and the TWI will hold the SCL clock low during the wake up and until the TWINT Flag is cleared (by writing it to one). Further data reception will be carried out as normal, with the AVR clocks running as normal. Observe that if the AVR is set up with a long start-up time, the SCL line may be held low for a long time, blocking other data transmissions.

Note that the Two-wire Serial Interface Data Register – TWDR – does not reflect the last byte present on the bus when waking up from these sleep modes.

Table 77. Status Codes for Slave Receiver Mode

Status Code (TWSR) Prescaler Bits are 0	Status of the Two-wire Serial Bus and Two-wire Serial Interface Hardware	Application Software Response					Next Action Taken by TWI Hardware
		To/from TWDR	To TWCR				
			STA	STO	TWINT	TWEA	
0x60	Own SLA+W has been received; ACK has been returned	No TWDR action or	X	0	1	0	Data byte will be received and NOT ACK will be returned
		No TWDR action	X	0	1	1	Data byte will be received and ACK will be returned
0x68	Arbitration lost in SLA+R/W as Master; own SLA+W has been received; ACK has been returned	No TWDR action or	X	0	1	0	Data byte will be received and NOT ACK will be returned
		No TWDR action	X	0	1	1	Data byte will be received and ACK will be returned
0x70	General call address has been received; ACK has been returned	No TWDR action or	X	0	1	0	Data byte will be received and NOT ACK will be returned
		No TWDR action	X	0	1	1	Data byte will be received and ACK will be returned
0x78	Arbitration lost in SLA+R/W as Master; General call address has been received; ACK has been returned	No TWDR action or	X	0	1	0	Data byte will be received and NOT ACK will be returned
		No TWDR action	X	0	1	1	Data byte will be received and ACK will be returned
0x80	Previously addressed with own SLA+W; data has been received; ACK has been returned	Read data byte or	X	0	1	0	Data byte will be received and NOT ACK will be returned
		Read data byte	X	0	1	1	Data byte will be received and ACK will be returned
0x88	Previously addressed with own SLA+W; data has been received; NOT ACK has been returned	Read data byte or	0	0	1	0	Switched to the not addressed Slave mode; no recognition of own SLA or GCA
		Read data byte or	0	0	1	1	Switched to the not addressed Slave mode; own SLA will be recognized; GCA will be recognized if TWGCE = “1”
		Read data byte or	1	0	1	0	Switched to the not addressed Slave mode; no recognition of own SLA or GCA; a START condition will be transmitted when the bus becomes free
		Read data byte	1	0	1	1	Switched to the not addressed Slave mode; own SLA will be recognized; GCA will be recognized if TWGCE = “1”; a START condition will be transmitted when the bus becomes free
0x90	Previously addressed with general call; data has been received; ACK has been returned	Read data byte or	X	0	1	0	Data byte will be received and NOT ACK will be returned
		Read data byte	X	0	1	1	Data byte will be received and ACK will be returned
0x98	Previously addressed with general call; data has been received; NOT ACK has been returned	Read data byte or	0	0	1	0	Switched to the not addressed Slave mode; no recognition of own SLA or GCA
		Read data byte or	0	0	1	1	Switched to the not addressed Slave mode; own SLA will be recognized; GCA will be recognized if TWGCE = “1”
		Read data byte or	1	0	1	0	Switched to the not addressed Slave mode; no recognition of own SLA or GCA; a START condition will be transmitted when the bus becomes free
		Read data byte	1	0	1	1	Switched to the not addressed Slave mode; own SLA will be recognized; GCA will be recognized if TWGCE = “1”; a START condition will be transmitted when the bus becomes free
0xA0	A STOP condition or repeated START condition has been received while still addressed as Slave	No action	0	0	1	0	Switched to the not addressed Slave mode; no recognition of own SLA or GCA
			0	0	1	1	Switched to the not addressed Slave mode; own SLA will be recognized; GCA will be recognized if TWGCE = “1”
			1	0	1	0	Switched to the not addressed Slave mode; no recognition of own SLA or GCA; a START condition will be transmitted when the bus becomes free
			1	0	1	1	Switched to the not addressed Slave mode; own SLA will be recognized; GCA will be recognized if TWGCE = “1”; a START condition will be transmitted when the bus becomes free

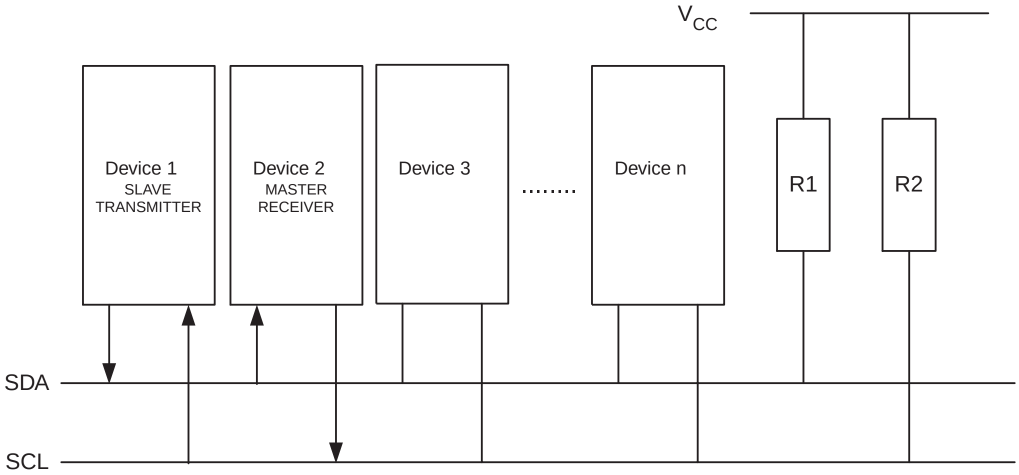
Figure 91. Formats and States in the Slave Receiver Mode



Slave Transmitter Mode

In the Slave Transmitter mode, a number of data bytes are transmitted to a Master Receiver (see Figure 92). All the status codes mentioned in this section assume that the prescaler bits are zero or are masked to zero.

Figure 92. Data Transfer in Slave Transmitter Mode



To initiate the Slave Transmitter mode, TWAR and TWCR must be initialized as follows:

TWAR	**TWA6**	**TWA5**	**TWA4**	**TWA3**	**TWA2**	**TWA1**	**TWA0**	**TWGCE**
Value	Device's Own Slave Address							

The upper seven bits are the address to which the Two-wire Serial Interface will respond when addressed by a Master. If the LSB is set, the TWI will respond to the general call address (0x00), otherwise it will ignore the general call address.

TWCR	**TWINT**	**TWEA**	**TWSTA**	**TWSTO**	**TWWC**	**TWEN**	**–**	**TWIE**
Value	0	1	0	0	0	1	0	X

TWEN must be written to one to enable the TWI. The TWEA bit must be written to one to enable the acknowledgement of the device's own slave address or the general call address. TWSTA and TWSTO must be written to zero.

When TWAR and TWCR have been initialized, the TWI waits until it is addressed by its own slave address (or the general call address if enabled) followed by the data direction bit. If the direction bit is "1" (read), the TWI will operate in ST mode, otherwise SR mode is entered. After its own slave address and the write bit have been received, the TWINT Flag is set and a valid status code can be read from TWSR. The status code is used to determine the appropriate software action. The appropriate action to be taken for each status code is detailed in Table 78. The Slave Transmitter mode may also be entered if arbitration is lost while the TWI is in the Master mode (see state 0xB0).

If the TWEA bit is written to zero during a transfer, the TWI will transmit the last byte of the transfer. State 0xC0 or state 0xC8 will be entered, depending on whether the Master Receiver transmits a NACK or ACK after the final byte. The TWI is switched to the not addressed Slave mode, and will ignore the Master if it continues the transfer. Thus the Master Receiver receives all "1" as serial data. State 0xC8 is entered if the Master demands additional data bytes (by transmitting ACK), even though the Slave has transmitted the last byte (TWEA zero and expecting NACK from the Master).

While TWEA is zero, the TWI does not respond to its own slave address. However, the Two-wire Serial Bus is still monitored and address recognition may resume at any time by setting TWEA. This implies that the TWEA bit may be used to temporarily isolate the TWI from the Two-wire Serial Bus.

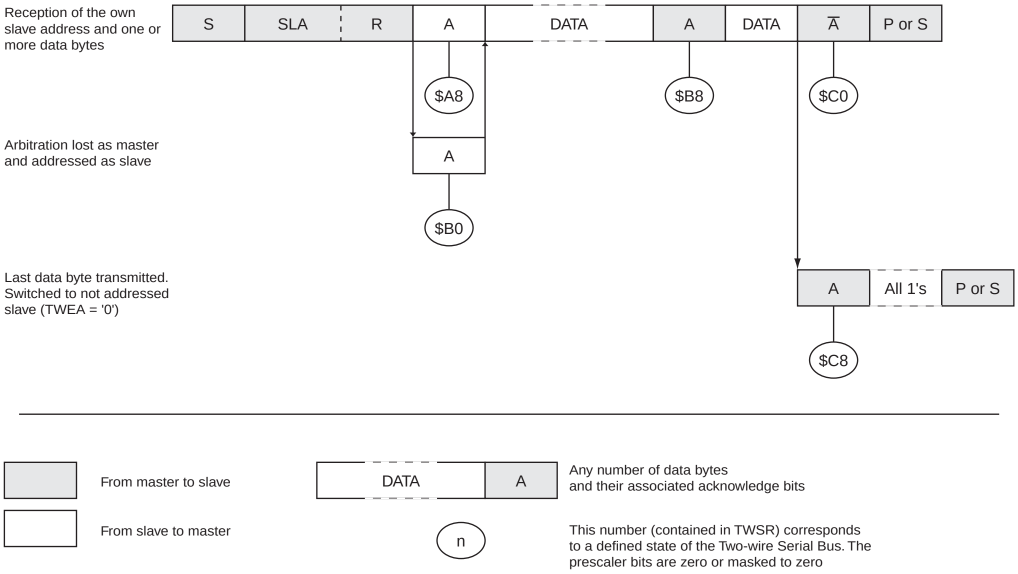
In all sleep modes other than Idle mode, the clock system to the TWI is turned off. If the TWEA bit is set, the interface can still acknowledge its own slave address or the general call address by using the Two-wire Serial Bus clock as a clock source. The part will then wake up from sleep and the TWI will hold the SCL clock will low during the wake up and until the TWINT Flag is cleared (by writing it to one). Further data transmission will be carried out as normal, with the AVR clocks running as normal. Observe that if the AVR is set up with a long start-up time, the SCL line may be held low for a long time, blocking other data transmissions.

Note that the Two-wire Serial Interface Data Register – TWDR – does not reflect the last byte present on the bus when waking up from these sleep modes.

Table 78. Status Codes for Slave Transmitter Mode

Status Code (TWSR) Prescaler Bits are 0	Status of the Two-wire Serial Bus and Two-wire Serial Interface Hardware	Application Software Response					Next Action Taken by TWI Hardware
		To/from TWDR	To TWCR				
			STA	STO	TWINT	TWEA	
0xA8	Own SLA+R has been received; ACK has been returned	Load data byte or	X	0	1	0	Last data byte will be transmitted and NOT ACK should be received
		Load data byte	X	0	1	1	Data byte will be transmitted and ACK should be received
0xB0	Arbitration lost in SLA+R/W as Master; own SLA+R has been received; ACK has been returned	Load data byte or	X	0	1	0	Last data byte will be transmitted and NOT ACK should be received
		Load data byte	X	0	1	1	Data byte will be transmitted and ACK should be received
0xB8	Data byte in TWDR has been transmitted; ACK has been received	Load data byte or	X	0	1	0	Last data byte will be transmitted and NOT ACK should be received
		Load data byte	X	0	1	1	Data byte will be transmitted and ACK should be received
0xC0	Data byte in TWDR has been transmitted; NOT ACK has been received	No TWDR action or	0	0	1	0	Switched to the not addressed Slave mode; no recognition of own SLA or GCA
		No TWDR action or	0	0	1	1	Switched to the not addressed Slave mode; own SLA will be recognized; GCA will be recognized if TWGCE = “1”
		No TWDR action or	1	0	1	0	Switched to the not addressed Slave mode; no recognition of own SLA or GCA; a START condition will be transmitted when the bus becomes free
		No TWDR action	1	0	1	1	Switched to the not addressed Slave mode; own SLA will be recognized; GCA will be recognized if TWGCE = “1”; a START condition will be transmitted when the bus becomes free
0xC8	Last data byte in TWDR has been transmitted (TWEA = “0”); ACK has been received	No TWDR action or	0	0	1	0	Switched to the not addressed Slave mode; no recognition of own SLA or GCA
		No TWDR action or	0	0	1	1	Switched to the not addressed Slave mode; own SLA will be recognized; GCA will be recognized if TWGCE = “1”
		No TWDR action or	1	0	1	0	Switched to the not addressed Slave mode; no recognition of own SLA or GCA; a START condition will be transmitted when the bus becomes free
		No TWDR action	1	0	1	1	Switched to the not addressed Slave mode; own SLA will be recognized; GCA will be recognized if TWGCE = “1”; a START condition will be transmitted when the bus becomes free

Figure 93. Formats and States in the Slave Transmitter Mode



Miscellaneous States

There are two status codes that do not correspond to a defined TWI state, see Table 79.

Status 0xF8 indicates that no relevant information is available because the TWINT Flag is not set. This occurs between other states, and when the TWI is not involved in a serial transfer.

Status 0x00 indicates that a bus error has occurred during a Two-wire Serial Bus transfer. A bus error occurs when a START or STOP condition occurs at an illegal position in the format frame. Examples of such illegal positions are during the serial transfer of an address byte, a data byte, or an acknowledge bit. When a bus error occurs, TWINT is set. To recover from a bus error, the TWSTO Flag must set and TWINT must be cleared by writing a logic one to it. This causes the TWI to enter the not addressed Slave mode and to clear the TWSTO Flag (no other bits in TWCR are affected). The SDA and SCL lines are released, and no STOP condition is transmitted.

Table 79. Miscellaneous States

Status Code (TWSR) Prescaler Bits are 0	Status of the Two-wire Serial Bus and Two-wire Serial Interface Hardware	Application Software Response					Next Action Taken by TWI Hardware
		To/from TWDR	To TWCR				
			STA	STO	TWINT	TWEA	
0xF8	No relevant state information available; TWINT = “0”	No TWDR action	No TWCR Action				Wait or proceed current transfer
0x00	Bus error due to an illegal START or STOP condition	No TWDR action	0	1	1	X	Only the internal hardware is affected, no STOP condition is sent on the bus. In all cases, the bus is released and TWSTO is cleared.

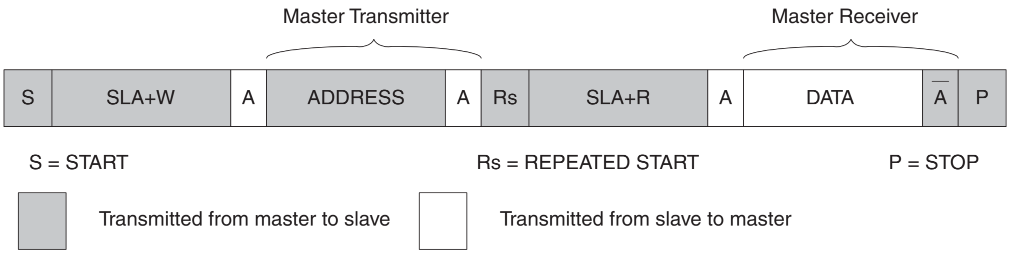
Combining Several TWI Modes

In some cases, several TWI modes must be combined in order to complete the desired action. Consider for example reading data from a serial EEPROM. Typically, such a transfer involves the following steps:

1. The transfer must be initiated.
2. The EEPROM must be instructed what location should be read.
3. The reading must be performed.
4. The transfer must be finished.

Note that data is transmitted both from Master to Slave and vice versa. The Master must instruct the Slave what location it wants to read, requiring the use of the MT mode. Subsequently, data must be read from the Slave, implying the use of the MR mode. Thus, the transfer direction must be changed. The Master must keep control of the bus during all these steps, and the steps should be carried out as an atomical operation. If this principle is violated in a multimaster system, another Master can alter the data pointer in the EEPROM between steps 2 and 3, and the Master will read the wrong data location. Such a change in transfer direction is accomplished by transmitting a REPEATED START between the transmission of the address byte and reception of the data. After a REPEATED START, the Master keeps ownership of the bus. The following figure shows the flow in this transfer.

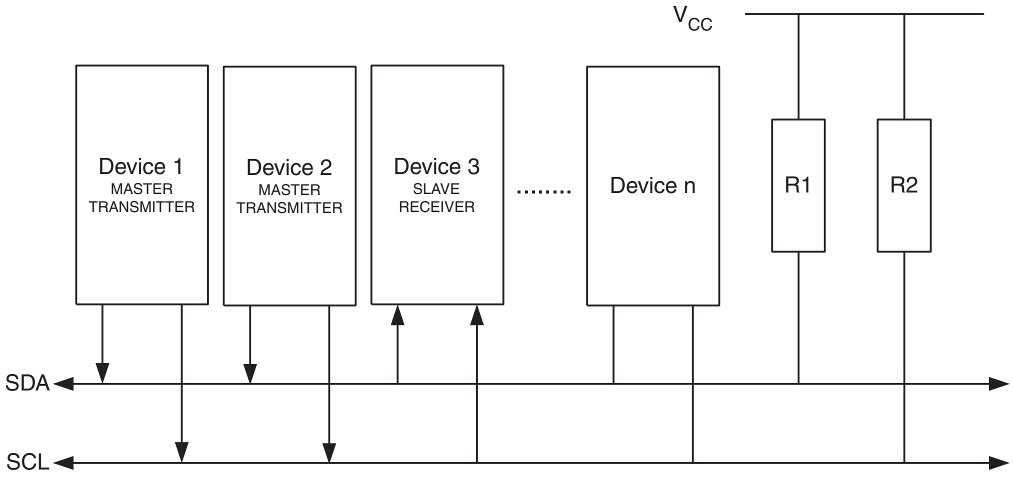
Figure 94. Combining Several TWI Modes to Access a Serial EEPROM



Multi-master Systems and Arbitration

If Multiple Masters are connected to the same bus, transmissions may be initiated simultaneously by one or more of them. The TWI standard ensures that such situations are handled in such a way that one of the masters will be allowed to proceed with the transfer, and that no data will be lost in the process. An example of an arbitration situation is depicted below, where two masters are trying to transmit data to a Slave Receiver.

Figure 95. An Arbitration Example

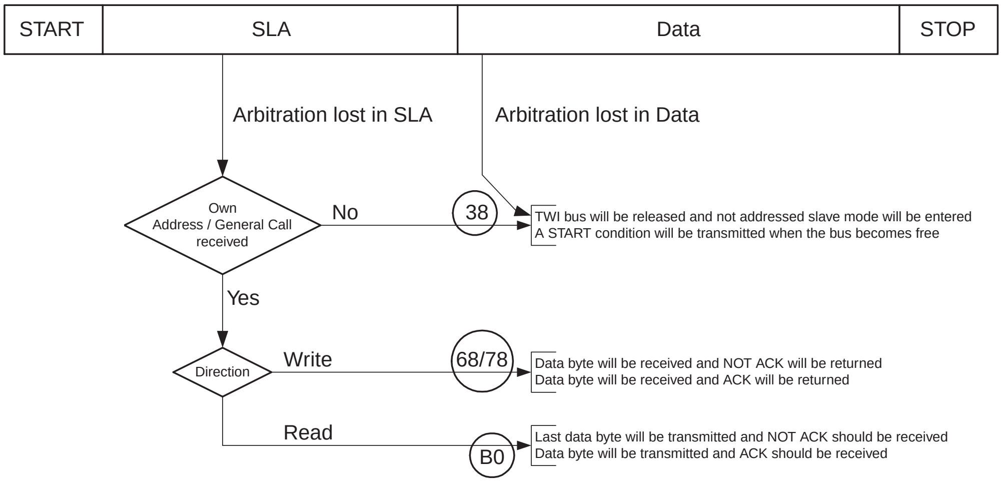


Several different scenarios may arise during arbitration, as described below:

- Two or more masters are performing identical communication with the same Slave. In this case, neither the Slave nor any of the masters will know about the bus contention.
- Two or more masters are accessing the same Slave with different data or direction bit. In this case, arbitration will occur, either in the READ/WRITE bit or in the data bits. The masters trying to output a one on SDA while another Master outputs a zero will lose the arbitration. Losing masters will switch to not addressed Slave mode or wait until the bus is free and transmit a new START condition, depending on application software action.
- Two or more masters are accessing different slaves. In this case, arbitration will occur in the SLA bits. Masters trying to output a one on SDA while another Master outputs a zero will lose the arbitration. Masters losing arbitration in SLA will switch to Slave mode to check if they are being addressed by the winning Master. If addressed, they will switch to SR or ST mode, depending on the value of the READ/WRITE bit. If they are not being addressed, they will switch to not addressed Slave mode or wait until the bus is free and transmit a new START condition, depending on application software action.

This is summarized in Figure 96. Possible status values are given in circles.

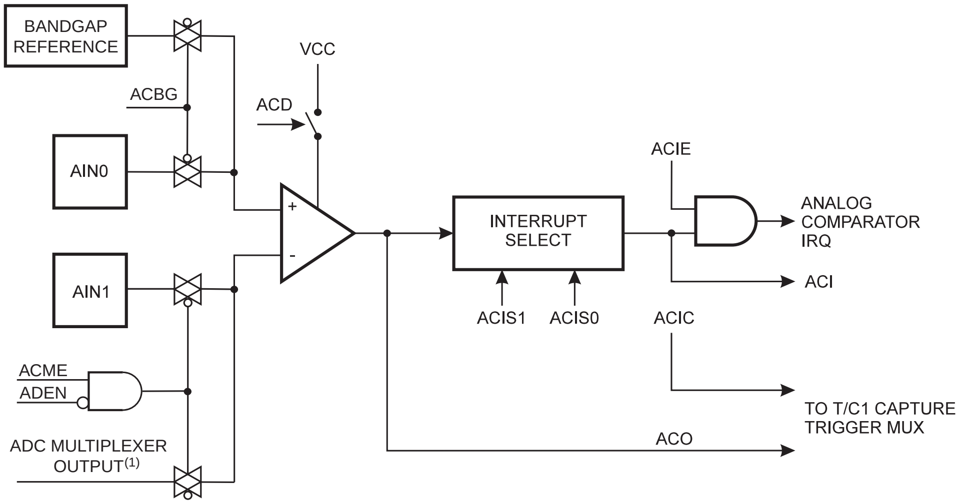
Figure 96. Possible Status Codes Caused by Arbitration



Analog Comparator

The Analog Comparator compares the input values on the positive pin AIN0 and negative pin AIN1. When the voltage on the positive pin AIN0 is higher than the voltage on the negative pin AIN1, the Analog Comparator Output, ACO, is set. The comparator's output can be set to trigger the Timer/Counter1 Input Capture function. In addition, the comparator can trigger a separate interrupt, exclusive to the Analog Comparator. The user can select Interrupt triggering on comparator output rise, fall or toggle. A block diagram of the comparator and its surrounding logic is shown in Figure 97.

Figure 97. Analog Comparator Block Diagram(2)



Notes:
1. See Table 81 on page 201.
2. Refer to Figure 1 on page 2 and Table 26 on page 57 for Analog Comparator pin placement.

Special Function IO Register – SFIOR

Bit	7	6	5	4	3	2	1	0	
	ADTS2	ADTS1	ADTS0	–	ACME	PUD	PSR2	PSR10	SFIOR
Read/Write	R/W	R/W	R/W	R	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 3 – ACME: Analog Comparator Multiplexer Enable**

When this bit is written logic one and the ADC is switched off (ADEN in ADCSRA is zero), the ADC multiplexer selects the negative input to the Analog Comparator. When this bit is written logic zero, AIN1 is applied to the negative input of the Analog Comparator. For a detailed description of this bit, see "Analog Comparator Multiplexed Input" on page 201.

Analog Comparator Control and Status Register – ACSR

Bit	7	6	5	4	3	2	1	0	
	ACD	ACBG	ACO	ACI	ACIE	ACIC	ACIS1	ACIS0	ACSR
Read/Write	R/W	R/W	R	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	N/A	0	0	0	0	0	

- **Bit 7 – ACD: Analog Comparator Disable**

When this bit is written logic one, the power to the Analog Comparator is switched off. This bit can be set at any time to turn off the Analog Comparator. This will reduce power consumption in active and Idle mode. When changing the ACD bit, the Analog Comparator Interrupt must be disabled by clearing the ACIE bit in ACSR. Otherwise an interrupt can occur when the bit is changed.

- **Bit 6 – ACBG: Analog Comparator Bandgap Select**

When this bit is set, a fixed bandgap reference voltage replaces the positive input to the Analog Comparator. When this bit is cleared, AIN0 is applied to the positive input of the Analog Comparator. See “Internal Voltage Reference” on page 39.

- **Bit 5 – ACO: Analog Comparator Output**

The output of the Analog Comparator is synchronized and then directly connected to ACO. The synchronization introduces a delay of 1 - 2 clock cycles.

- **Bit 4 – ACI: Analog Comparator Interrupt Flag**

This bit is set by hardware when a comparator output event triggers the interrupt mode defined by ACIS1 and ACIS0. The Analog Comparator Interrupt routine is executed if the ACIE bit is set and the I-bit in SREG is set. ACI is cleared by hardware when executing the corresponding interrupt handling vector. Alternatively, ACI is cleared by writing a logic one to the flag.

- **Bit 3 – ACIE: Analog Comparator Interrupt Enable**

When the ACIE bit is written logic one and the I-bit in the Status Register is set, the Analog Comparator Interrupt is activated. When written logic zero, the interrupt is disabled.

- **Bit 2 – ACIC: Analog Comparator Input Capture Enable**

When written logic one, this bit enables the Input Capture function in Timer/Counter1 to be triggered by the Analog Comparator. The comparator output is in this case directly connected to the Input Capture front-end logic, making the comparator utilize the noise canceler and edge select features of the Timer/Counter1 Input Capture interrupt. When written logic zero, no connection between the analog comparator and the Input Capture function exists. To make the comparator trigger the Timer/Counter1 Input Capture interrupt, the TICIE1 bit in the Timer Interrupt Mask Register (TIMSK) must be set.

- **Bits 1, 0 – ACIS1, ACIS0: Analog Comparator Interrupt Mode Select**

These bits determine which comparator events that trigger the Analog Comparator Interrupt. The different settings are shown in Table 80.

Table 80. ACIS1/ACIS0 Settings

ACIS1	ACIS0	Interrupt Mode
0	0	Comparator Interrupt on Output Toggle
0	1	Reserved
1	0	Comparator Interrupt on Falling Output Edge
1	1	Comparator Interrupt on Rising Output Edge

When changing the ACIS1/ACIS0 bits, the Analog Comparator Interrupt must be disabled by clearing its Interrupt Enable bit in the ACSR Register. Otherwise an interrupt can occur when the bits are changed.

Analog Comparator Multiplexed Input

It is possible to select any of the ADC7..0 pins to replace the negative input to the Analog Comparator. The ADC multiplexer is used to select this input, and consequently, the ADC must be switched off to utilize this feature. If the Analog Comparator Multiplexer Enable bit (ACME in SFIOR) is set and the ADC is switched off (ADEN in ADCSRA is zero), MUX2..0 in ADMUX select the input pin to replace the negative input to the Analog Comparator, as shown in Table 81. If ACME is cleared or ADEN is set, AIN1 is applied to the negative input to the Analog Comparator.

Table 81. Analog Comparator Multiplexed Input

ACME	ADEN	MUX2..0	Analog Comparator Negative Input
0	x	xxx	AIN1
1	1	xxx	AIN1
1	0	000	ADC0
1	0	001	ADC1
1	0	010	ADC2
1	0	011	ADC3
1	0	100	ADC4
1	0	101	ADC5
1	0	110	ADC6
1	0	111	ADC7

Analog-to-Digital Converter

Features

- **10-bit Resolution**
- **0.5 LSB Integral Non-linearity**
- **±2 LSB Absolute Accuracy**
- **65 - 260 µs Conversion Time**
- **Up to 15 kSPS at Maximum Resolution**
- **8 Multiplexed Single Ended Input Channels**
- **7 Differential Input Channels**
- **2 Differential Input Channels with Optional Gain of 10x and 200x**(1)
- **Optional Left Adjustment for ADC Result Readout**
- **0 - V_{CC} ADC Input Voltage Range**
- **Selectable 2.56V ADC Reference Voltage**
- **Free Running or Single Conversion Mode**
- **ADC Start Conversion by Auto Triggering on Interrupt Sources**
- **Interrupt on ADC Conversion Complete**
- **Sleep Mode Noise Canceler**

Note: 1. The differential input channel are not tested for devices in PDIP and PLCC Package. This feature is only guaranteed to work for devices in TQFP and MLF Packages.

The ATmega8535 features a 10-bit successive approximation ADC. The ADC is connected to an 8-channel Analog Multiplexer which allows eight single-ended voltage inputs constructed from the pins of Port A. The single-ended voltage inputs refer to 0V (GND).

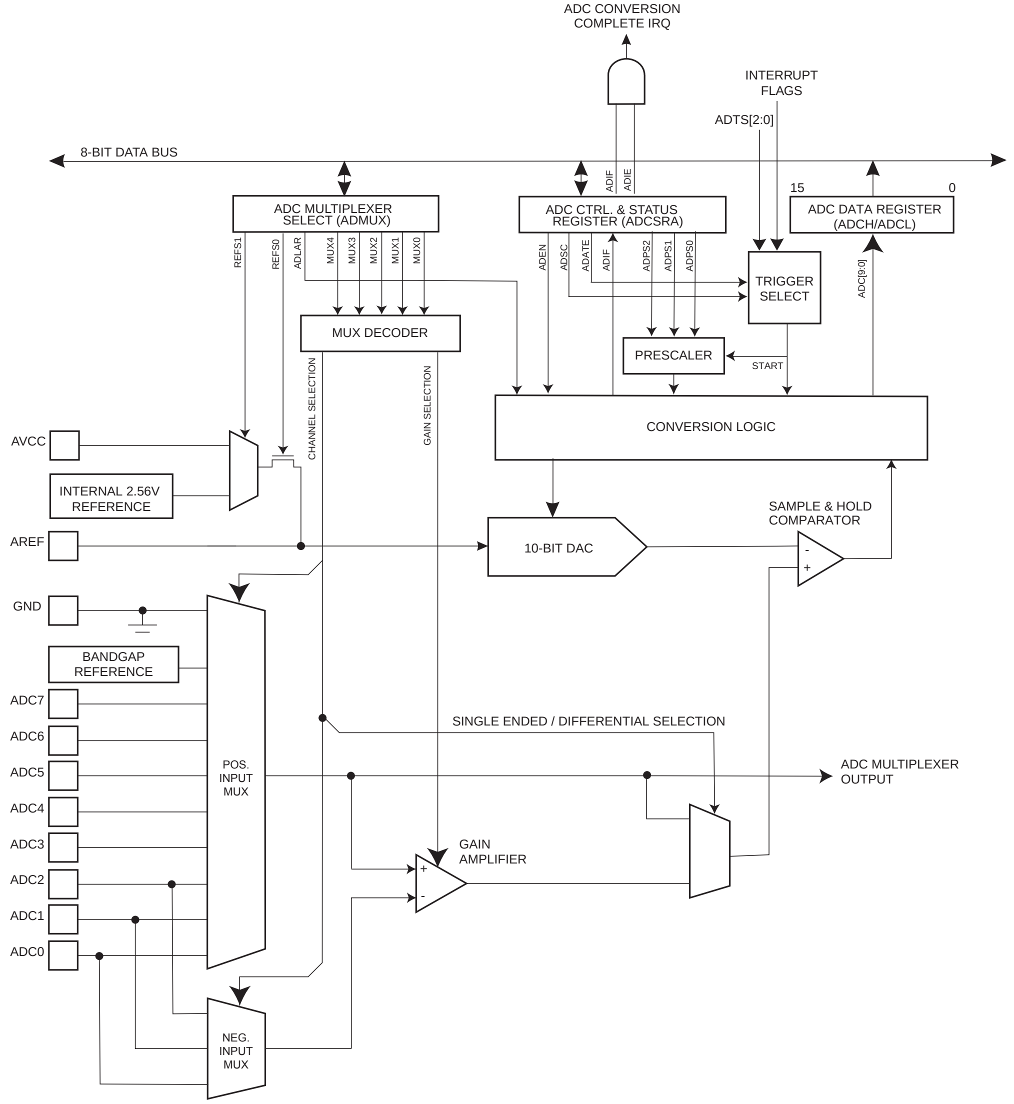
The device also supports 16 differential voltage input combinations. Two of the differential inputs (ADC1, ADC0 and ADC3, ADC2) are equipped with a programmable gain stage, providing amplification steps of 0 dB (1x), 20 dB (10x), or 46 dB (200x) on the differential input voltage before the A/D conversion. Seven differential analog input channels share a common negative terminal (ADC1), while any other ADC input can be selected as the positive input terminal. If 1x or 10x gain is used, 8-bit resolution can be expected. If 200x gain is used, 7-bit resolution can be expected.

The ADC contains a Sample and Hold circuit which ensures that the input voltage to the ADC is held at a constant level during conversion. A block diagram of the ADC is shown in Figure 98.

The ADC has a separate analog supply voltage pin, AVCC. AVCC must not differ more than ±0.3V from V_{CC}. See the paragraph “ADC Noise Canceler” on page 210 on how to connect this pin.

Internal reference voltages of nominally 2.56V or AVCC are provided On-chip. The voltage reference may be externally decoupled at the AREF pin by a capacitor for better noise performance.

Figure 98. Analog-to-Digital Converter Block Schematic



Operation

The ADC converts an analog input voltage to a 10-bit digital value through successive approximation. The minimum value represents GND and the maximum value represents the voltage on the AREF pin minus 1 LSB. Optionally, AVCC or an internal 2.56V reference voltage may be connected to the AREF pin by writing to the REFSn bits in the ADMUX Register. The internal voltage reference may thus be decoupled by an external capacitor at the AREF pin to improve noise immunity.

The analog input channel and differential gain are selected by writing to the MUX bits in ADMUX. Any of the ADC input pins, as well as GND and a fixed bandgap voltage reference, can be selected as single ended inputs to the ADC. A selection of ADC input pins can be selected as positive and negative inputs to the differential gain amplifier.

If differential channels are selected, the differential gain stage amplifies the voltage difference between the selected input channel pair by the selected gain factor. This amplified value then becomes the analog input to the ADC. If single ended channels are used, the gain amplifier is bypassed altogether.

The ADC is enabled by setting the ADC Enable bit, ADEN in ADCSRA. Voltage reference and input channel selections will not go into effect until ADEN is set. The ADC does not consume power when ADEN is cleared, so it is recommended to switch off the ADC before entering power saving sleep modes.

The ADC generates a 10-bit result which is presented in the ADC Data Registers, ADCH and ADCL. By default, the result is presented right adjusted, but can optionally be presented left adjusted by setting the ADLAR bit in ADMUX.

If the result is left adjusted and no more than 8-bit precision is required, it is sufficient to read ADCH. Otherwise, ADCL must be read first, then ADCH, to ensure that the content of the data registers belongs to the same conversion. Once ADCL is read, ADC access to data registers is blocked. This means that if ADCL has been read, and a conversion completes before ADCH is read, neither register is updated and the result from the conversion is lost. When ADCH is read, ADC access to the ADCH and ADCL Registers is re-enabled.

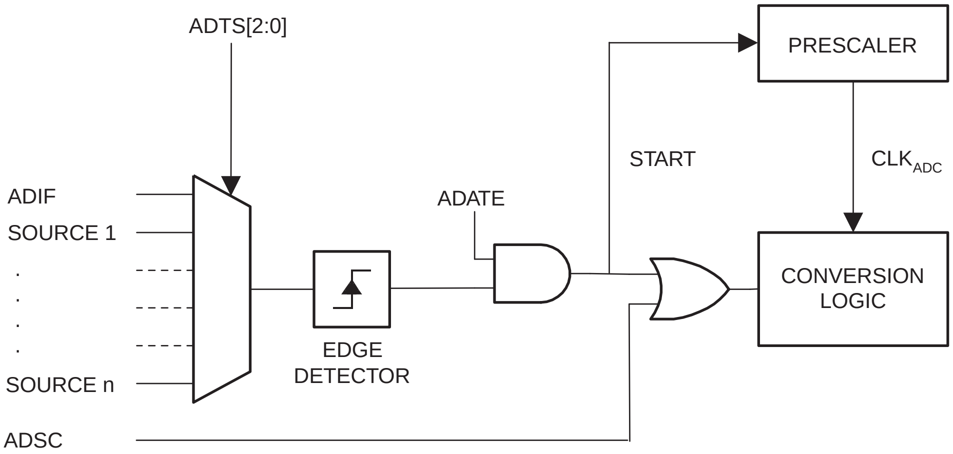
The ADC has its own interrupt which can be triggered when a conversion completes. When ADC access to the data registers is prohibited between reading of ADCH and ADCL, the interrupt will trigger even if the result is lost.

Starting a Conversion

A single conversion is started by writing a logical one to the ADC Start Conversion bit, ADSC. This bit stays high as long as the conversion is in progress and will be cleared by hardware when the conversion is completed. If a different data channel is selected while a conversion is in progress, the ADC will finish the current conversion before performing the channel change.

Alternatively, a conversion can be triggered automatically by various sources. Auto Triggering is enabled by setting the ADC Auto Trigger Enable bit, ADATE in ADCSRA. The trigger source is selected by setting the ADC Trigger Select bits, ADTS in SFIOR (See description of the ADTS bits for a list of the trigger sources). When a positive edge occurs on the selected trigger signal, the ADC prescaler is reset and a conversion is started. This provides a method of starting conversions at fixed intervals. If the trigger signal still is set when the conversion completes, a new conversion will not be started. If another positive edge occurs on the trigger signal during conversion, the edge will be ignored. Note that an interrupt flag will be set even if the specific interrupt is disabled or the global interrupt enable bit in SREG is cleared. A conversion can thus be triggered without causing an interrupt. However, the interrupt flag must be cleared in order to trigger a new conversion at the next interrupt event.

Figure 99. ADC Auto Trigger Logic

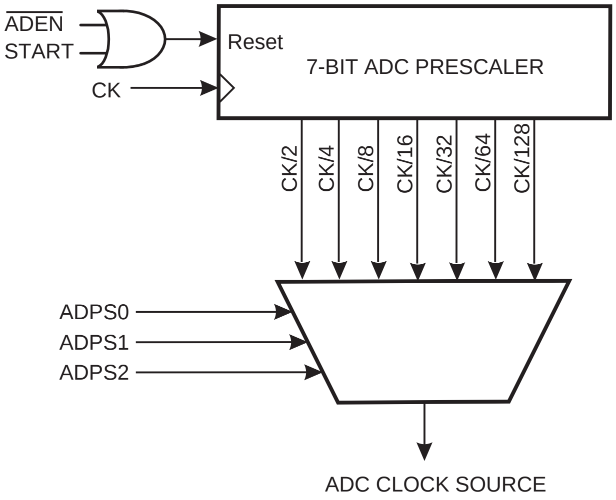


Using the ADC Interrupt Flag as a trigger source makes the ADC start a new conversion as soon as the ongoing conversion has finished. The ADC then operates in Free Running mode, constantly sampling and updating the ADC Data Register. The first conversion must be started by writing a logical one to the ADSC bit in ADCSRA. In this mode the ADC will perform successive conversions independently of whether the ADC Interrupt Flag, ADIF is cleared or not.

If Auto Triggering is enabled, single conversions can be started by writing ADSC in ADCSRA to one. ADSC can also be used to determine if a conversion is in progress. The ADSC bit will be read as one during a conversion, independently of how the conversion was started.

Prescaling and Conversion Timing

Figure 100. ADC Prescaler



By default, the successive approximation circuitry requires an input clock frequency between 50 kHz and 200 kHz to get maximum resolution. If a lower resolution than 10 bits is needed, the input clock frequency to the ADC can be higher than 200 kHz to get a higher sample rate.

The ADC module contains a prescaler, which generates an acceptable ADC clock frequency from any CPU frequency above 100 kHz. The prescaling is set by the ADPS bits in ADCSRA. The prescaler starts counting from the moment the ADC is switched on by setting the ADEN bit in ADCSRA. The prescaler keeps running for as long as the ADEN bit is set, and is continuously reset when ADEN is low.

When initiating a single ended conversion by setting the ADSC bit in ADCSRA, the conversion starts at the following rising edge of the ADC clock cycle. See “Differential Gain Channels” on page 208 for details on differential conversion timing.

A normal conversion takes 13 ADC clock cycles. The first conversion after the ADC is switched on (ADEN in ADCSRA is set) takes 25 ADC clock cycles in order to initialize the analog circuitry.

The actual sample-and-hold takes place 1.5 ADC clock cycles after the start of a normal conversion and 13.5 ADC clock cycles after the start of an first conversion. When a conversion is complete, the result is written to the ADC Data Registers, and ADIF is set. In Single Conversion mode, ADSC is cleared simultaneously. The software may then set ADSC again, and a new conversion will be initiated on the first rising ADC clock edge.

When Auto Triggering is used, the prescaler is reset when the trigger event occurs. This assures a fixed delay from the trigger event to the start of conversion. In this mode, the sample-and-hold takes place two ADC clock cycles after the rising edge on the trigger source signal. Three additional CPU clock cycles are used for synchronization logic.

In Free Running mode, a new conversion will be started immediately after the conversion completes, while ADSC remains high. For a summary of conversion times, see Table 82.

Figure 101. ADC Timing Diagram, First Conversion (Single Conversion Mode)

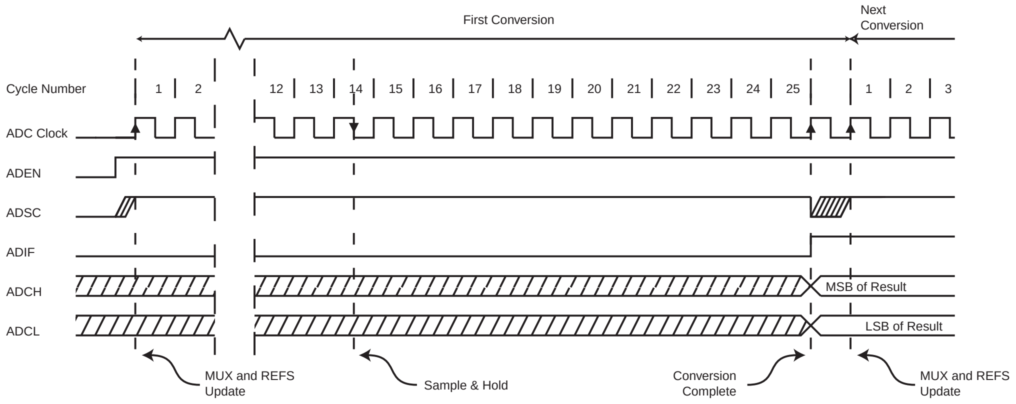


Figure 102. ADC Timing Diagram, Single Conversion

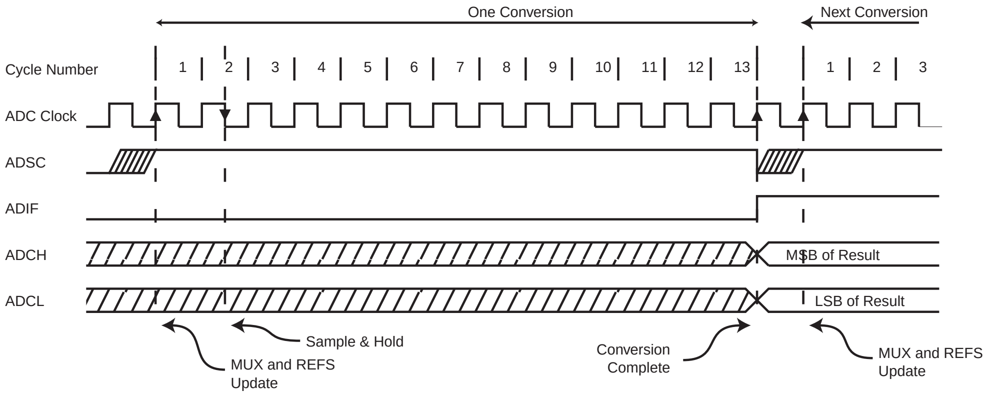


Figure 103. ADC Timing Diagram, Auto Triggered Conversion

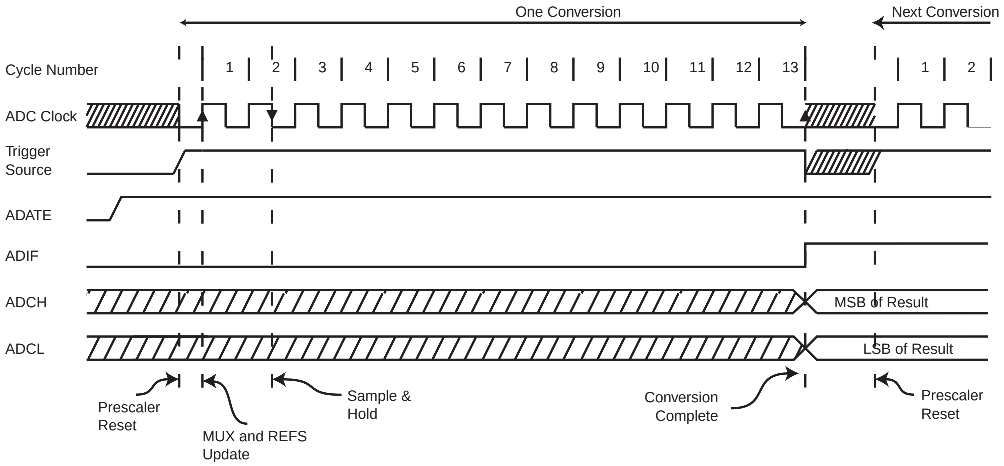


Figure 104. ADC Timing Diagram, Free Running Conversion

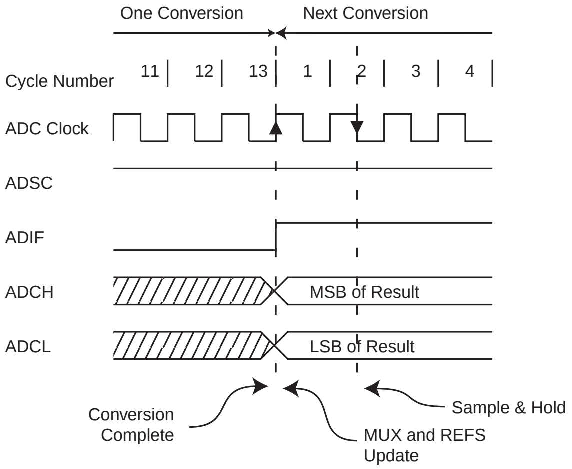


Table 82. ADC Conversion Time

Condition	Sample & Hold (Cycles from Start of Conversion)	Conversion Time (Cycles)
First conversion	14.5	25
Normal conversions, single ended	1.5	13
Auto Triggered conversions	2	13.5
Normal conversions, differential	1.5/2.5[1]	13/14[1]

Note: 1. Depending on the state of CK_{ADC2}.

Differential Gain Channels

When using differential gain channels, certain aspects of the conversion need to be taken into consideration.

Differential conversions are synchronized to the internal clock CK_{ADC2} equal to half the ADC clock. This synchronization is done automatically by the ADC interface in such a way that the sample-and-hold occurs at a specific phase of CK_{ADC2}. A conversion initiated by the user (i.e., all single conversions, and the first free running conversion) when CK_{ADC2} is low will take the same amount of time as a single ended conversion (13 ADC clock cycles from the next prescaled clock cycle). A conversion initiated by the user when CK_{ADC2} is high will take 14 ADC clock cycles due to the synchronization mechanism. In free running mode, a new conversion is initiated immediately after the previous conversion completes, and since CK_{ADC2} is high at this time, all automatically started (i.e., all but the first) free running conversions will take 14 ADC clock cycles.

The gain stage is optimized for a bandwidth of 4 kHz at all gain settings. Higher frequencies may be subjected to non-linear amplification. An external low-pass filter should be used if the input signal contains higher frequency components than the gain stage bandwidth. Note that the ADC clock frequency is independent of the gain stage bandwidth limitation. For example, the ADC clock period may be 6 µs, allowing a channel to be sampled at 12 kSPS, regardless of the bandwidth of this channel.

If differential gain channels are used and conversions are started by Auto Triggering, the ADC must be switched off between conversions. When Auto Triggering is used, the ADC prescaler is reset before the conversion is started. Since the gain stage is dependent of a stable ADC clock prior to the conversion, this conversion will not be valid. By disabling and then re-enabling the ADC between each conversion (writing ADEN in ADCSRA to “0” then to “1”), only extended conversions are performed. The result from the extended conversions will be valid. See “Prescaling and Conversion Timing” on page 205 for timing details.

Changing Channel or Reference Selection

The MUXn and REFS1:0 bits in the ADMUX Register are single buffered through a temporary register to which the CPU has random access. This ensures that the channels and reference selection only takes place at a safe point during the conversion. The channel and reference selection is continuously updated until a conversion is started. Once the conversion starts, the channel and reference selection is locked to ensure a sufficient sampling time for the ADC. Continuous updating resumes in the last ADC clock cycle before the conversion completes (ADIF in ADCSRA is set). Note that the conversion starts on the following rising ADC clock edge after ADSC is written. The user is thus advised not to write new channel or reference selection values to ADMUX until one ADC clock cycle after ADSC is written.

If Auto Triggering is used, the exact time of the triggering event can be indeterminable. Special care must be taken when updating the ADMUX Register, in order to control which conversion will be affected by the new settings.

If both ADATE and ADEN is written to one, an interrupt event can occur at any time. If the ADMUX Register is changed in this period, the user cannot tell if the next conversion is based on the old or the new settings. ADMUX can be safely updated in the following ways:

1. When ADATE or ADEN is cleared.
2. During conversion, minimum one ADC clock cycle after the trigger event.
3. After a conversion, before the interrupt flag used as trigger source is cleared.

When updating ADMUX in one of these conditions, the new settings will affect the next ADC conversion.

Special care should be taken when changing differential channels. Once a differential channel has been selected, the gain stage may take as much as 125 µs to stabilize to the new value. Thus conversions should not be started within the first 125 µs after selecting a new differential channel. Alternatively, conversion results obtained within this period should be discarded.

The same settling time should be observed for the first differential conversion after changing ADC reference (by changing the REFS1:0 bits in ADMUX).

ADC Input Channels

When changing channel selections, the user should observe the following guidelines to ensure that the correct channel is selected:

In Single Conversion mode, always select the channel before starting the conversion. The channel selection may be changed one ADC clock cycle after writing one to ADSC. However, the simplest method is to wait for the conversion to complete before changing the channel selection.

In Free Running mode, always select the channel before starting the first conversion. The channel selection may be changed one ADC clock cycle after writing one to ADSC. However, the simplest method is to wait for the first conversion to complete, and then change the channel selection. Since the next conversion has already started automatically, the next result will reflect the previous channel selection. Subsequent conversions will reflect the new channel selection.

When switching to a differential gain channel, the first conversion result may have a poor accuracy due to the required settling time for the automatic offset cancellation circuitry. The user should preferably disregard the first conversion result.

ADC Voltage Reference

The reference voltage for the ADC (V_{REF}) indicates the conversion range for the ADC. Single ended channels that exceed V_{REF} will result in codes close to 0x3FF. V_{REF} can be selected as either AVCC, internal 2.56V reference, or external AREF pin.

AVCC is connected to the ADC through a passive switch. The internal 2.56V reference is generated from the internal bandgap reference (V_{BG}) through an internal amplifier. In either case, the external AREF pin is directly connected to the ADC, and the reference voltage can be made more immune to noise by connecting a capacitor between the AREF pin and ground. V_{REF} can also be measured at the AREF pin with a high impedant voltmeter. Note that V_{REF} is a high impedant source, and only a capacitive load should be connected in a system.

If the user has a fixed voltage source connected to the AREF pin, the user may not use the other reference voltage options in the application, as they will be shorted to the external voltage. If no external voltage is applied to the AREF pin, the user may switch between AVCC and 2.56V as reference selection. The first ADC conversion result after switching reference voltage source may be inaccurate, and the user is advised to discard this result.

If differential channels are used, the selected reference should not be closer to AVCC than indicated in Table 114 on page 258.

ADC Noise Canceler

The ADC features a noise canceler that enables conversion during sleep mode to reduce noise induced from the CPU core and other I/O peripherals. The noise canceler can be used with ADC Noise Reduction and Idle mode. To make use of this feature, the following procedure should be used:

1. Make sure that the ADC is enabled and is not busy converting. Single Conversion mode must be selected and the ADC conversion complete interrupt must be enabled.
2. Enter ADC Noise Reduction mode (or Idle mode). The ADC will start a conversion once the CPU has been halted.
3. If no other interrupts occur before the ADC conversion completes, the ADC interrupt will wake up the CPU and execute the ADC Conversion Complete interrupt routine. If another interrupt wakes up the CPU before the ADC conversion is complete, that interrupt will be executed, and an ADC Conversion Complete interrupt request will be generated when the ADC conversion completes. The CPU will remain in active mode until a new sleep command is executed.

Note that the ADC will not be automatically turned off when entering other sleep modes than Idle mode and ADC Noise Reduction mode. The user is advised to write zero to ADEN before entering such sleep modes to avoid excessive power consumption. If the ADC is enabled in such sleep modes and the user wants to perform differential conversions, the user is advised to switch the ADC off and on after waking up from sleep to prompt an extended conversion to get a valid result.

Analog Input Circuitry

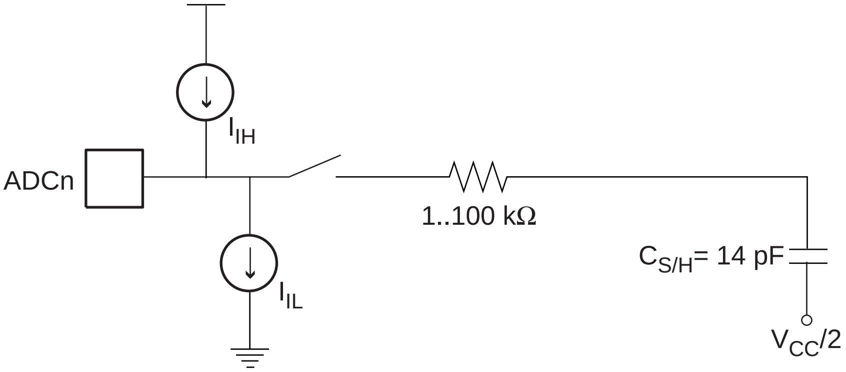
The Analog Input Circuitry for single ended channels is illustrated in Figure 105. An analog source applied to ADCn is subjected to the pin capacitance and input leakage of that pin, regardless of whether that channel is selected as input for the ADC. When the channel is selected, the source must drive the S/H capacitor through the series resistance (combined resistance in the input path).

The ADC is optimized for analog signals with an output impedance of approximately 10 kΩ or less. If such a source is used, the sampling time will be negligible. If a source with higher impedance is used, the sampling time will depend on how long time the source needs to charge the S/H capacitor, with can vary widely. The user is recommended to only use low impedant sources with slowly varying signals, since this minimizes the required charge transfer to the S/H capacitor.

If differential gain channels are used, the input circuitry looks somewhat different, although source impedances of a few hundred kΩ or less is recommended.

Signal components higher than the Nyquist frequency ($f_{ADC}/2$) should not be present for either kind of channels, to avoid distortion from unpredictable signal convolution. The user is advised to remove high frequency components with a low-pass filter before applying the signals as inputs to the ADC.

Figure 105. Analog Input Circuitry

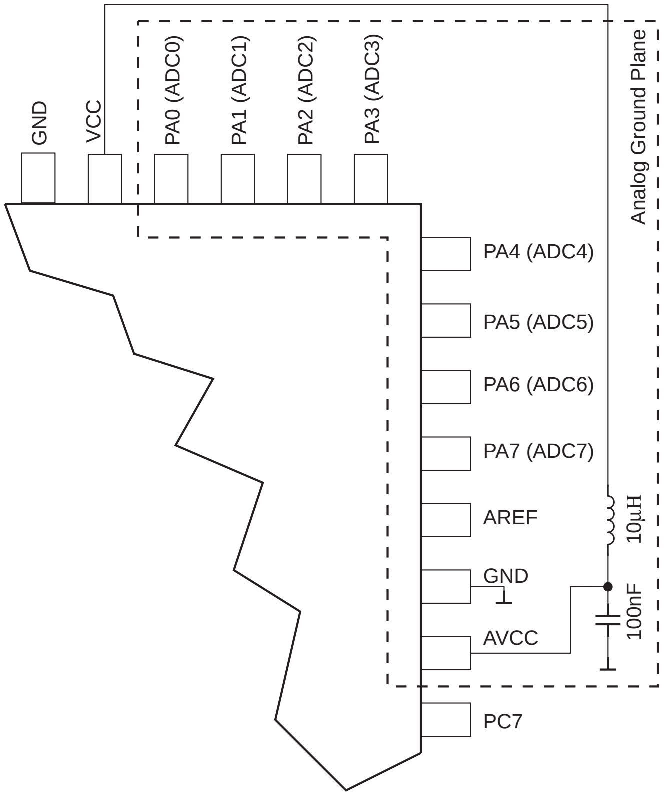


Analog Noise Canceling Techniques

Digital circuitry inside and outside the device generates EMI which might affect the accuracy of analog measurements. If conversion accuracy is critical, the noise level can be reduced by applying the following techniques:

1. Keep analog signal paths as short as possible. Make sure analog tracks run over the analog ground plane, and keep them well away from high-speed switching digital tracks.
2. The AVCC pin on the device should be connected to the digital V_{CC} supply voltage via an LC network as shown in Figure 106.
3. Use the ADC noise canceler function to reduce induced noise from the CPU.
4. If any ADC port pins are used as digital outputs, it is essential that these do not switch while a conversion is in progress.

Figure 106. ADC Power Connections



Offset Compensation Schemes

The gain stage has a built-in offset cancellation circuitry that nulls the offset of differential measurements as much as possible. The remaining offset in the analog path can be measured directly by selecting the same channel for both differential inputs. This offset residue can be then subtracted in software from the measurement results. Using this kind of software based offset correction, offset on any channel can be reduced below one LSB.

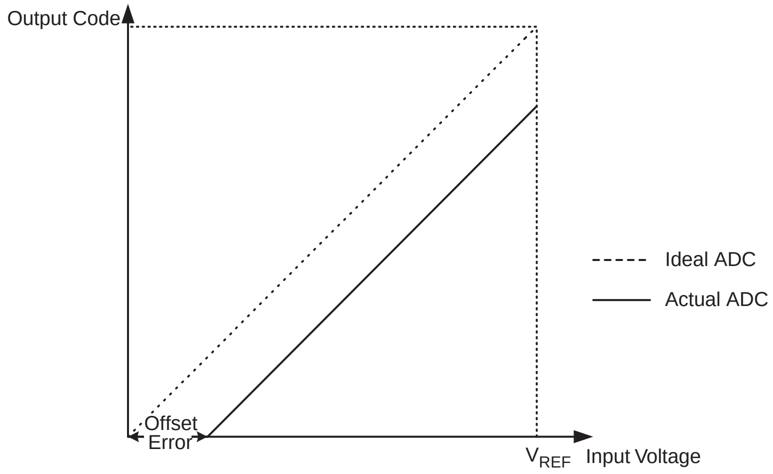
ADC Accuracy Definitions

An n-bit single-ended ADC converts a voltage linearly between GND and V_{REF} in 2^n steps (LSBs). The lowest code is read as 0, and the highest code is read as $2^n - 1$.

Several parameters describe the deviation from the ideal behavior:

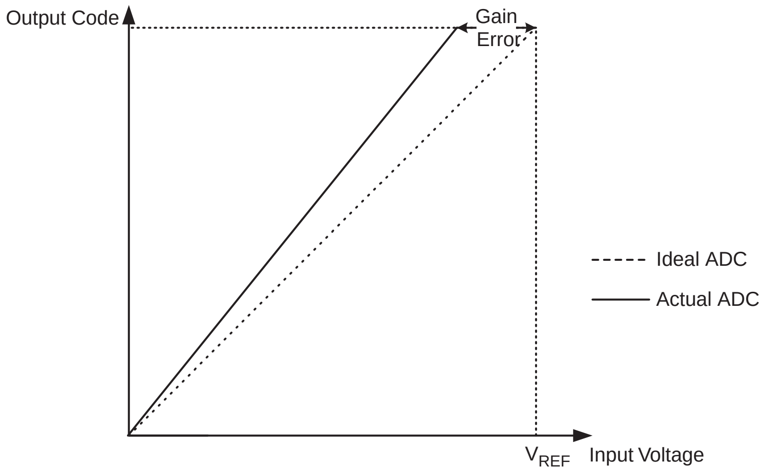
- Offset: The deviation of the first transition (0x000 to 0x001) compared to the ideal transition (at 0.5 LSB). Ideal value: 0 LSB.

Figure 107. Offset Error



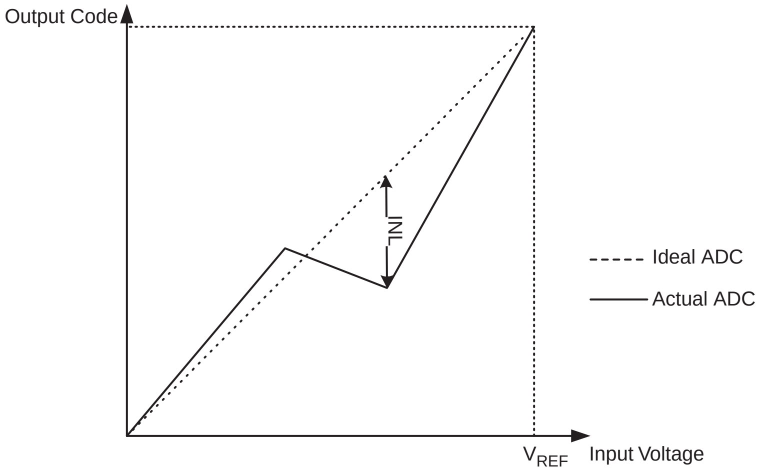
- Gain Error: After adjusting for offset, the Gain Error is found as the deviation of the last transition (0x3FE to 0x3FF) compared to the ideal transition (at 1.5 LSB below maximum). Ideal value: 0 LSB.

Figure 108. Gain Error



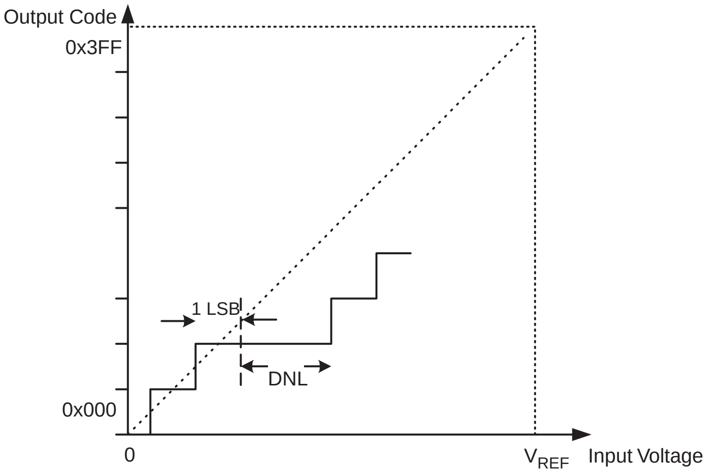
- Integral Non-linearity (INL): After adjusting for offset and gain error, the INL is the maximum deviation of an actual transition compared to an ideal transition for any code. Ideal value: 0 LSB.

Figure 109. Integral Non-linearity (INL)



- Differential Non-linearity (DNL): The maximum deviation of the actual code width (the interval between two adjacent transitions) from the ideal code width (1 LSB). Ideal value: 0 LSB.

Figure 110. Differential Non-linearity (DNL)



- Quantization Error: Due to the quantization of the input voltage into a finite number of codes, a range of input voltages (1 LSB wide) will code to the same value. Always ±0.5 LSB.
- Absolute Accuracy: The maximum deviation of an actual (unadjusted) transition compared to an ideal transition for any code. This is the compound effect of Offset, Gain Error, Differential Error, Non-linearity, and Quantization Error. Ideal value: ±0.5 LSB.

ADC Conversion Result

After the conversion is complete (ADIF is high), the conversion result can be found in the ADC Result Registers (ADCL, ADCH).

For single ended conversion, the result is

$$ADC = \frac{V_{IN} \cdot 1024}{V_{REF}}$$

where V_{IN} is the voltage on the selected input pin and V_{REF} the selected voltage reference (see Table 84 on page 215 and Table 85 on page 216). 0x000 represents analog ground, and 0x3FF represents the selected reference voltage minus one LSB.

If differential channels are used, the result is

$$ADC = \frac{(V_{POS} - V_{NEG}) \cdot GAIN \cdot 512}{V_{REF}}$$

where V_{POS} is the voltage on the positive input pin, V_{NEG} the voltage on the negative input pin, GAIN the selected gain factor, and V_{REF} the selected voltage reference. The result is presented in two's complement form, from 0x200 (-512d) through 0x1FF (+511d). Note that if the user wants to perform a quick polarity chack of the results, it is sufficient to read the MSB of the result (ADC9 in ADCH). If the bit is one, the result is negative, and if the bit is zero, the result is positive. Figure 111 shows the decoding of the differential input range.

Table 83 shows the resulting output codes if the differential input channel pair (ADCn - ADCm) is selected with a gain of GAIN and a reference voltage of V_{REF}.

Figure 111. Differential Measurement Range

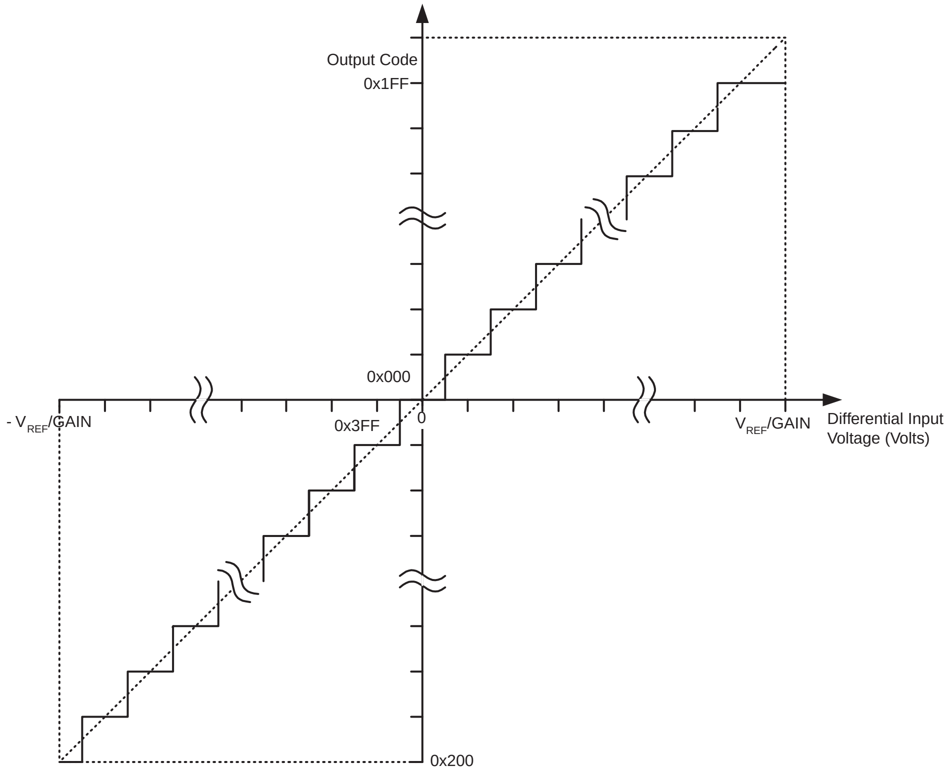


Table 83. Correlation Between Input Voltage and Output Codes

V_{ADCn}	Read Code	Corresponding Decimal Value
V_{ADCm} + V_{REF}/GAIN	0x1FF	511
V_{ADCm} + (511/512) V_{REF}/GAIN	0x1FF	511
V_{ADCm} + (510/512) V_{REF}/GAIN	0x1FE	510
...	...	...
V_{ADCm} + (1/512) V_{REF}/GAIN	0x001	1
V_{ADCm}	0x000	0
V_{ADCm} - (1/512) V_{REF}/GAIN	0x3FF	-1
...	...	...
V_{ADCm} - (511/512) V_{REF}/GAIN	0x201	-511
V_{ADCm} - V_{REF}/GAIN	0x200	-512

Example:

ADMUX = 0xED (ADC3 - ADC2, 10x gain, 2.56V reference, left adjusted result)

Voltage on ADC3 is 300 mV, voltage on ADC2 is 500 mV.

ADCR = 512 * 10 * (300 - 500)/2560 = -400 = 0x270

ADCL will thus read 0x00, and ADCH will read 0x9C. Writing zero to ADLAR right adjusts the result: ADCL = 0x70, ADCH = 0x02.

ADC Multiplexer Selection Register – ADMUX

Bit	7	6	5	4	3	2	1	0	
	REFS1	REFS0	ADLAR	MUX4	MUX3	MUX2	MUX1	MUX0	ADMUX
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 7:6 – REFS1:0: Reference Selection Bits**

These bits select the voltage reference for the ADC, as shown in Table 84. If these bits are changed during a conversion, the change will not go in effect until this conversion is complete (ADIF in ADCSRA is set). The internal voltage reference options may not be used if an external reference voltage is being applied to the AREF pin.

Table 84. Voltage Reference Selections for ADC

REFS1	REFS0	Voltage Reference Selection
0	0	AREF, Internal Vref turned off
0	1	AVCC with external capacitor at AREF pin
1	0	Reserved
1	1	Internal 2.56V Voltage Reference with external capacitor at AREF pin

- **Bit 5 – ADLAR: ADC Left Adjust Result**

The ADLAR bit affects the presentation of the ADC conversion result in the ADC Data Register. Write one to ADLAR to left adjust the result. Otherwise, the result is right adjusted. Changing the ADLAR bit will affect the ADC Data Register immediately, regardless of any ongoing conversions. For a complete description of this bit, see “The ADC Data Register – ADCL and ADCH” on page 218.

- **Bits 4:0 – MUX4:0: Analog Channel and Gain Selection Bits**

The value of these bits selects which combination of analog inputs are connected to the ADC. These bits also select the gain for the differential channels. See Table 85 for details. If these bits are changed during a conversion, the change will not go in effect until this conversion is complete (ADIF in ADCSRA is set).

Table 85. Input Channel and Gain Selections

MUX4..0	Single Ended Input	Pos Differential Input	Neg Differential Input	Gain
00000	ADC0	N/A		
00001	ADC1			
00010	ADC2			
00011	ADC3			
00100	ADC4			
00101	ADC5			
00110	ADC6			
00111	ADC7			
01000	N/A	ADC0	ADC0	10x
01001		ADC1	ADC0	10x
01010		ADC0	ADC0	200x
01011		ADC1	ADC0	200x
01100		ADC2	ADC2	10x
01101		ADC3	ADC2	10x
01110		ADC2	ADC2	200x
01111		ADC3	ADC2	200x
10000		ADC0	ADC1	1x
10001		ADC1	ADC1	1x
10010		ADC2	ADC1	1x
10011		ADC3	ADC1	1x
10100		ADC4	ADC1	1x
10101		ADC5	ADC1	1x
10110		ADC6	ADC1	1x
10111		ADC7	ADC1	1x
11000		ADC0	ADC2	1x
11001		ADC1	ADC2	1x
11010		ADC2	ADC2	1x
11011		ADC3	ADC2	1x
11100		ADC4	ADC2	1x

Table 85. Input Channel and Gain Selections (Continued)

MUX4..0	Single Ended Input	Pos Differential Input	Neg Differential Input	Gain
11101		ADC5	ADC2	1x
11110	1.22V (V_{BG})	N/A		
11111	0V (GND)			

ADC Control and Status Register A – ADCSRA

Bit	7	6	5	4	3	2	1	0	
	ADEN	ADSC	ADATE	ADIF	ADIE	ADPS2	ADPS1	ADPS0	ADCSRA
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

• Bit 7 – ADEN: ADC Enable

Writing this bit to one enables the ADC. By writing it to zero, the ADC is turned off. Turning the ADC off while a conversion is in progress, will terminate this conversion.

• Bit 6 – ADSC: ADC Start Conversion

In Single Conversion mode, write this bit to one to start each conversion. In Free Running mode, write this bit to one to start the first conversion. The first conversion after ADSC has been written after the ADC has been enabled, or if ADSC is written at the same time as the ADC is enabled, will take 25 ADC clock cycles instead of the normal 13. This first conversion performs initialization of the ADC.

ADSC will read as one as long as a conversion is in progress. When the conversion is complete, it returns to zero. Writing zero to this bit has no effect.

• Bit 5 – ADATE: ADC Auto Trigger Enable

When this bit is written to one, Auto Triggering of the ADC is enabled. The ADC will start a conversion on a positive edge of the selected trigger signal. The trigger source is selected by setting the ADC Trigger Select bits, ADTS in SFIOR.

• Bit 4 – ADIF: ADC Interrupt Flag

This bit is set when an ADC conversion completes and the Data Registers are updated. The ADC Conversion Complete Interrupt is executed if the ADIE bit and the I-bit in SREG are set. ADIF is cleared by hardware when executing the corresponding interrupt handling vector. Alternatively, ADIF is cleared by writing a logical one to the flag. Beware that if doing a Read-Modify-Write on ADCSRA, a pending interrupt can be disabled. This also applies if the SBI and CBI instructions are used.

• Bit 3 – ADIE: ADC Interrupt Enable

When this bit is written to one and the I-bit in SREG is set, the ADC Conversion Complete Interrupt is activated.

- **Bits 2:0 – ADPS2:0: ADC Prescaler Select Bits**

These bits determine the division factor between the XTAL frequency and the input clock to the ADC.

Table 86. ADC Prescaler Selections

ADPS2	ADPS1	ADPS0	Division Factor
0	0	0	2
0	0	1	2
0	1	0	4
0	1	1	8
1	0	0	16
1	0	1	32
1	1	0	64
1	1	1	128

The ADC Data Register – ADCL and ADCH

ADLAR = 0

Bit	15	14	13	12	11	10	9	8	
	–	–	–	–	–	–	**ADC9**	**ADC8**	**ADCH**
	ADC7	**ADC6**	**ADC5**	**ADC4**	**ADC3**	**ADC2**	**ADC1**	**ADC0**	**ADCL**
	7	6	5	4	3	2	1	0	
Read/Write	R	R	R	R	R	R	R	R	
	R	R	R	R	R	R	R	R	
Initial Value	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	

ADLAR = 1

Bit	15	14	13	12	11	10	9	8	
	ADC9	**ADC8**	**ADC7**	**ADC6**	**ADC5**	**ADC4**	**ADC3**	**ADC2**	**ADCH**
	ADC1	**ADC0**	–	–	–	–	–	–	**ADCL**
	7	6	5	4	3	2	1	0	
Read/Write	R	R	R	R	R	R	R	R	
	R	R	R	R	R	R	R	R	
Initial Value	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	

When an ADC conversion is complete, the result is found in these two registers. If differential channels are used, the result is presented in two's complement form.

When ADCL is read, the ADC Data Register is not updated until ADCH is read. Consequently, if the result is left adjusted and no more than 8-bit precision is required, it is sufficient to read ADCH. Otherwise, ADCL must be read first, then ADCH.

The ADLAR bit in ADMUX, and the MUXn bits in ADMUX affect the way the result is read from the registers. If ADLAR is set, the result is left adjusted. If ADLAR is cleared (default), the result is right adjusted.

- **ADC9:0: ADC Conversion Result**

These bits represent the result from the conversion, as detailed in "ADC Conversion Result" on page 214.

Special Function IO Register – SFIOR

Bit	7	6	5	4	3	2	1	0	
	ADTS2	ADTS1	ADTS0	–	ACME	PUD	PSR2	PSR10	SFIOR
Read/Write	R/W	R/W	R/W	R	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 7:5 – ADTS2:0: ADC Auto Trigger Source**

If ADATE in ADCSRA is written to one, the value of these bits selects which source will trigger an ADC conversion. If ADATE is cleared, the ADTS2:0 settings will have no effect. A conversion will be triggered by the rising edge of the selected interrupt flag. Note that switching from a trigger source that is cleared to a trigger source that is set, will generate a positive edge on the trigger signal. If ADEN in ADCSRA is set, this will start a conversion. Switching to Free Running mode (ADTS[2:0]=0) will not cause a trigger event, even if the ADC Interrupt Flag is set.

Table 87. ADC Auto Trigger Source Selections

ADTS2	ADTS1	ADTS0	Trigger Source
0	0	0	Free Running mode
0	0	1	Analog Comparator
0	1	0	External Interrupt Request 0
0	1	1	Timer/Counter0 Compare Match
1	0	0	Timer/Counter0 Overflow
1	0	1	Timer/Counter1 Compare Match B
1	1	0	Timer/Counter1 Overflow
1	1	1	Timer/Counter1 Capture Event

- **Bit 4 – RES: Reserved Bit**

This bit is reserved bit in the ATmega8535, and will always read as zero.

Boot Loader Support – Read-While-Write Self-Programming

The Boot Loader Support provides a real Read-While-Write Self-Programming mechanism for downloading and uploading program code by the MCU itself. This feature allows flexible application software updates controlled by the MCU using a Flash-resident Boot Loader program. The Boot Loader program can use any available data interface and associated protocol to read code and write (program) that code into the Flash memory, or read the code from the Program memory. The program code within the Boot Loader section has the capability to write into the entire Flash, including the Boot Loader memory. The Boot Loader can thus even modify itself, and it can also erase itself from the code if the feature is not needed anymore. The size of the Boot Loader memory is configurable with fuses and the Boot Loader has two separate sets of Boot Lock bits which can be set independently. This gives the user a unique flexibility to select different levels of protection.

Boot Loader Features

- **Read-While-Write Self-Programming**
- **Flexible Boot Memory Size**
- **High Security (Separate Boot Lock Bits for a Flexible Protection)**
- **Separate Fuse to Select Reset Vector**
- **Optimized Page(1) Size**
- **Code Efficient Algorithm**
- **Efficient Read-Modify-Write Support**

Note: 1. A page is a section in the Flash consisting of several bytes (see Table 104 on page 237) used during programming. The page organization does not affect normal operation.

Application and Boot Loader Flash Sections

The Flash memory is organized in two main sections, the Application section and the Boot Loader section (see Figure 113). The size of the different sections is configured by the BOOTSZ Fuses as shown in Table 93 on page 231 and Figure 113. These two sections can have different level of protection since they have different sets of Lock bits.

Application Section

The Application section is the section of the Flash that is used for storing the application code. The protection level for the Application section can be selected by the Application Boot Lock bits (Boot Lock bits 0), see Table 89 on page 223. The Application section can never store any Boot Loader code since the SPM instruction is disabled when executed from the Application section.

BLS – Boot Loader Section

While the Application section is used for storing the application code, the The Boot Loader software must be located in the BLS since the SPM instruction can initiate a programming when executing from the BLS only. The SPM instruction can access the entire Flash, including the BLS itself. The protection level for the Boot Loader section can be selected by the Boot Loader Lock bits (Boot Lock bits 1), see Table 90 on page 223.

Read-While-Write and No Read-While-Write Flash Sections

Whether the CPU supports Read-While-Write or if the CPU is halted during a Boot Loader software update is dependent on which address that is being programmed. In addition to the two sections that are configurable by the BOOTSZ Fuses as described above, the Flash is also divided into two fixed sections, the Read-While-Write (RWW) section and the No Read-While-Write (NRWW) section. The limit between the RWW- and NRWW sections is given in Table 94 on page 231 and Figure 113 on page 222. The main difference between the two sections is:

- When erasing or writing a page located inside the RWW section, the NRWW section can be read during the operation.
- When erasing or writing a page located inside the NRWW section, the CPU is halted during the entire operation.

Note that the user software can never read any code that is located inside the RWW section during a Boot Loader software operation. The syntax “Read-While-Write Section” refers to which section that is being programmed (erased or written), not which section that actually is being read during a Boot Loader software update.

RWW – Read-While-Write Section

If a Boot Loader software update is programming a page inside the RWW section, it is possible to read code from the Flash, but only code that is located in the NRWW section. During an on-going programming, the software must ensure that the RWW section never is being read. If the user software is trying to read code that is located inside the RWW section (i.e., by a call/jmp/lpm or an interrupt) during programming, the software might end up in an unknown state. To avoid this, the interrupts should either be disabled or moved to the Boot Loader section. The Boot Loader section is always located in the NRWW section. The RWW Section Busy bit (RWWSB) in the Store Program Memory Control Register (SPMCR) will be read as logical one as long as the RWW section is blocked for reading. After a programming is completed, the RWWSB must be cleared by software before reading code located in the RWW section. See “Store Program Memory Control Register – SPMCR” on page 224. for details on how to clear RWWSB.

NRWW – No Read-While-Write Section

The code located in the NRWW section can be read when the Boot Loader software is updating a page in the RWW section. When the Boot Loader code updates the NRWW section, the CPU is halted during the entire page erase or page write operation.

Table 88. Read-While-Write Features

Which Section does the Z-pointer Address During the Programming?	Which Section can be Read During Programming?	Is the CPU Halted?	Read-While-Write Supported?
RWW section	NRWW section	No	Yes
NRWW section	None	Yes	No

Figure 112. Read-While-Write vs. No Read-While-Write

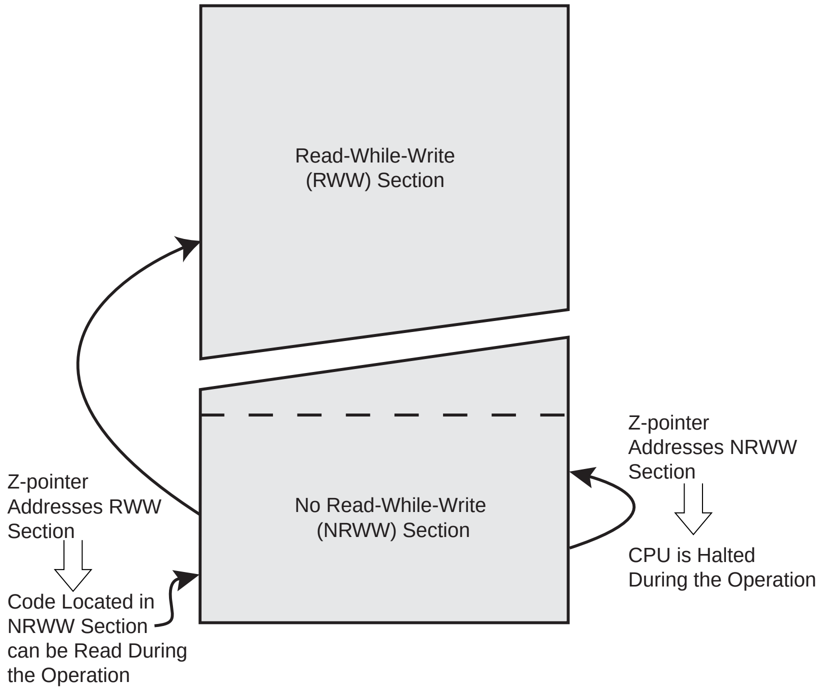
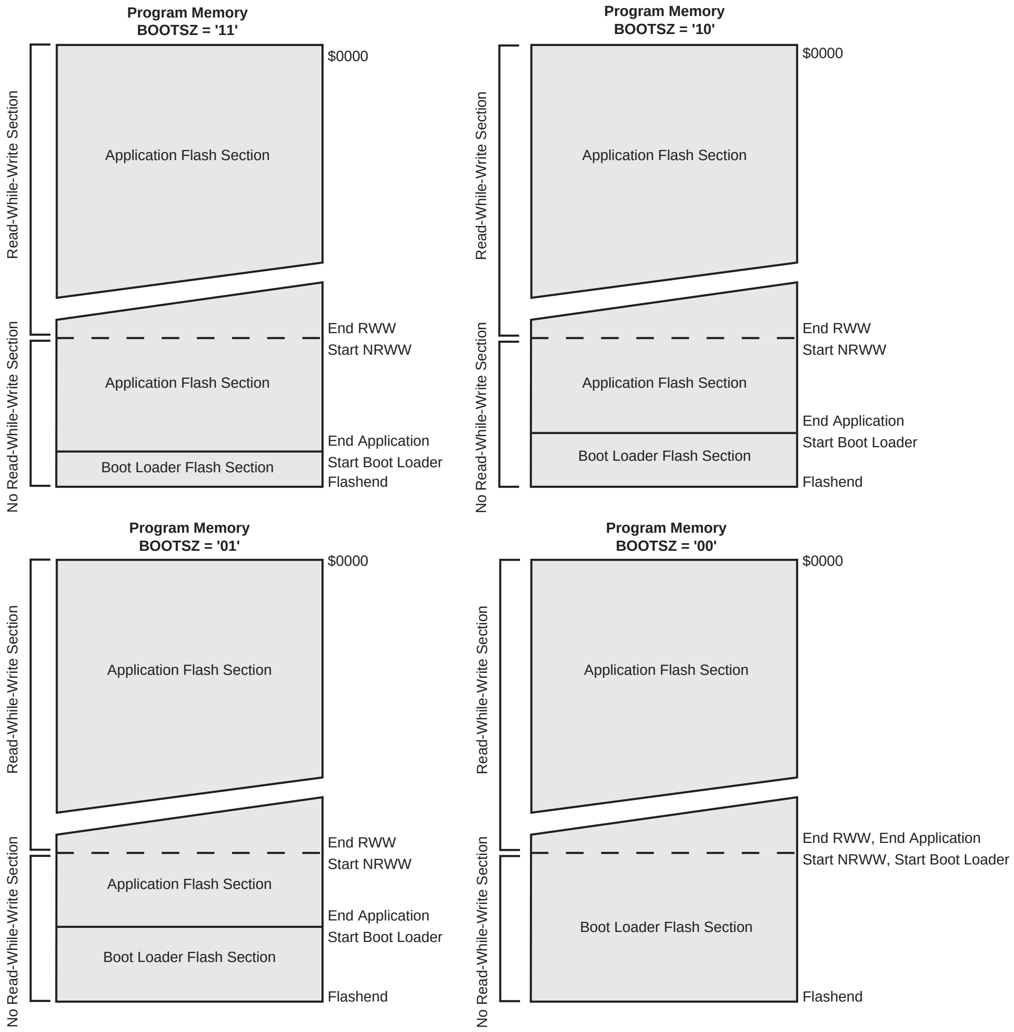


Figure 113. Memory sections[1]



Note: 1. The parameters in the figure above are given in Table 93 on page 231.

Boot Loader Lock Bits

If no Boot Loader capability is needed, the entire Flash is available for application code. The Boot Loader has two separate sets of Boot Lock bits which can be set independently. This gives the user a unique flexibility to select different levels of protection.

The user can select:

- To protect the entire Flash from a software update by the MCU.
- To protect only the Boot Loader Flash section from a software update by the MCU.
- To protect only the Application Flash section from a software update by the MCU.
- Allow software update in the entire Flash.

See Table 89 and Table 90 for further details. The Boot Lock bits can be set in software and in Serial or Parallel Programming mode, but they can be cleared by a Chip Erase command only. The general Write Lock (Lock Bit mode 2) does not control the programming of the Flash memory by SPM instruction. Similarly, the general Read/Write Lock (Lock Bit mode 1) does not control reading nor writing by LPM/SPM, if it is attempted.

Table 89. Boot Lock Bit0 Protection Modes (Application Section)(1)

BLB0 Mode	BLB02	BLB01	Protection
1	1	1	No restrictions for SPM or LPM accessing the Application section.
2	1	0	SPM is not allowed to write to the Application section.
3	0	0	SPM is not allowed to write to the Application section, and LPM executing from the Boot Loader section is not allowed to read from the Application section. If interrupt vectors are placed in the Boot Loader section, interrupts are disabled while executing from the Application section.
4	0	1	LPM executing from the Boot Loader section is not allowed to read from the Application section. If interrupt vectors are placed in the Boot Loader section, interrupts are disabled while executing from the Application section.

Note: 1. "1" means unprogrammed, "0" means programmed.

Table 90. Boot Lock Bit1 Protection Modes (Boot Loader Section)(1)

BLB1 Mode	BLB12	BLB11	Protection
1	1	1	No restrictions for SPM or LPM accessing the Boot Loader section.
2	1	0	SPM is not allowed to write to the Boot Loader section.
3	0	0	SPM is not allowed to write to the Boot Loader section, and LPM executing from the Application section is not allowed to read from the Boot Loader section. If interrupt vectors are placed in the Application section, interrupts are disabled while executing from the Boot Loader section.
4	0	1	LPM executing from the Application section is not allowed to read from the Boot Loader section. If interrupt vectors are placed in the Application section, interrupts are disabled while executing from the Boot Loader section.

Note: 1. "1" means unprogrammed, "0" means programmed.

Entering the Boot Loader Program

Entering the Boot Loader takes place by a jump or call from the application program. This may be initiated by a trigger such as a command received via USART, or SPI interface. Alternatively, the Boot Reset Fuse can be programmed so that the Reset Vector is pointing to the Boot Flash start address after a reset. In this case, the Boot Loader is started after a reset. After the application code is loaded, the program can start executing the application code. Note that the fuses cannot be changed by the MCU itself. This means that once the Boot Reset Fuse is programmed, the Reset Vector will always point to the Boot Loader Reset and the fuse can only be changed through the serial or parallel programming interface.

Table 91. Boot Reset Fuse(1)

BOOTRST	Reset Address
1	Reset Vector = Application Reset (address 0x0000)
0	Reset Vector = Boot Loader Reset (see Table 93 on page 231)

Note: 1. "1" means unprogrammed, "0" means programmed.

Store Program Memory Control Register – SPMCR

The Store Program Memory Control Register contains the control bits needed to control the Boot Loader operations.

Bit	7	6	5	4	3	2	1	0	
	SPMIE	RWWSB	–	RWWSRE	BLBSET	PGWRT	PGERS	SPMEN	SPMCR
Read/Write	R/W	R	R	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 7 – SPMIE: SPM Interrupt Enable**

When the SPMIE bit is written to one, and the I-bit in the Status Register is set (one), the SPM ready interrupt will be enabled. The SPM ready Interrupt will be executed as long as the SPMEN bit in the SPMCR Register is cleared.

- **Bit 6 – RWWSB: Read-While-Write Section Busy**

When a Self-Programming (Page Erase or Page Write) operation to the RWW section is initiated, the RWWSB will be set (one) by hardware. When the RWWSB bit is set, the RWW section cannot be accessed. The RWWSB bit will be cleared if the RWWSRE bit is written to one after a Self-Programming operation is completed. Alternatively the RWWSB bit will automatically be cleared if a page load operation is initiated.

- **Bit 5 – Res: Reserved Bit**

This bit is a reserved bit in the ATmega8535 and always read as zero.

- **Bit 4 – RWWSRE: Read-While-Write Section Read Enable**

When programming (page erase or page write) to the RWW section, the RWW section is blocked for reading (the RWWSB will be set by hardware). To re-enable the RWW section, the user software must wait until the programming is completed (SPMEN will be cleared). Then, if the RWWSRE bit is written to one at the same time as SPMEN, the next SPM instruction within four clock cycles re-enables the RWW section. The RWW section cannot be re-enabled while the Flash is busy with a page erase or a page write (SPMEN is set). If the RWWSRE bit is written while the Flash is being loaded, the Flash load operation will abort and the data loaded will be lost.

- **Bit 3 – BLBSET: Boot Lock Bit Set**

If this bit is written to one at the same time as SPMEN, the next SPM instruction within four clock cycles sets Boot Lock bits, according to the data in R0. The data in R1 and the address in the Z-pointer are ignored. The BLBSET bit will automatically be cleared upon completion of the Lock bit set, or if no SPM instruction is executed within four clock cycles.

An LPM instruction within three cycles after BLBSET and SPMEN are set in the SPMCR Register, will read either the Lock bits or the Fuse bits (depending on Z0 in the Z-pointer) into the destination register. See “Reading the Fuse and Lock Bits from Software” on page 228 for details.

- **Bit 2 – PGWRT: Page Write**

If this bit is written to one at the same time as SPMEN, the next SPM instruction within four clock cycles executes page write, with the data stored in the temporary buffer. The page address is taken from the high part of the Z-pointer. The data in R1 and R0 are ignored. The PGWRT bit will auto-clear upon completion of a page write, or if no SPM instruction is executed within four clock cycles. The CPU is halted during the entire page write operation if the NRWW section is addressed.

- **Bit 1 – PGERS: Page Erase**

If this bit is written to one at the same time as SPMEN, the next SPM instruction within four clock cycles executes page erase. The page address is taken from the high part of the Z-pointer. The data in R1 and R0 are ignored. The PGERS bit will auto-clear upon completion of a page erase, or if no SPM instruction is executed within four clock cycles. The CPU is halted during the entire page write operation if the NRWW section is addressed.

- **Bit 0 – SPMEN: Store Program Memory Enable**

This bit enables the SPM instruction for the next four clock cycles. If written to one together with either RWWSRE, BLBSET, PGWRT' or PGERS, the following SPM instruction will have a special meaning, see description above. If only SPMEN is written, the following SPM instruction will store the value in R1:R0 in the temporary page buffer addressed by the Z-pointer. The LSB of the Z-pointer is ignored. The SPMEN bit will auto-clear upon completion of an SPM instruction, or if no SPM instruction is executed within four clock cycles. During page erase and page write, the SPMEN bit remains high until the operation is completed.

Writing any other combination than “10001”, “01001”, “00101”, “00011” or “00001” in the lower five bits will have no effect.

Addressing the Flash during Self-Programming

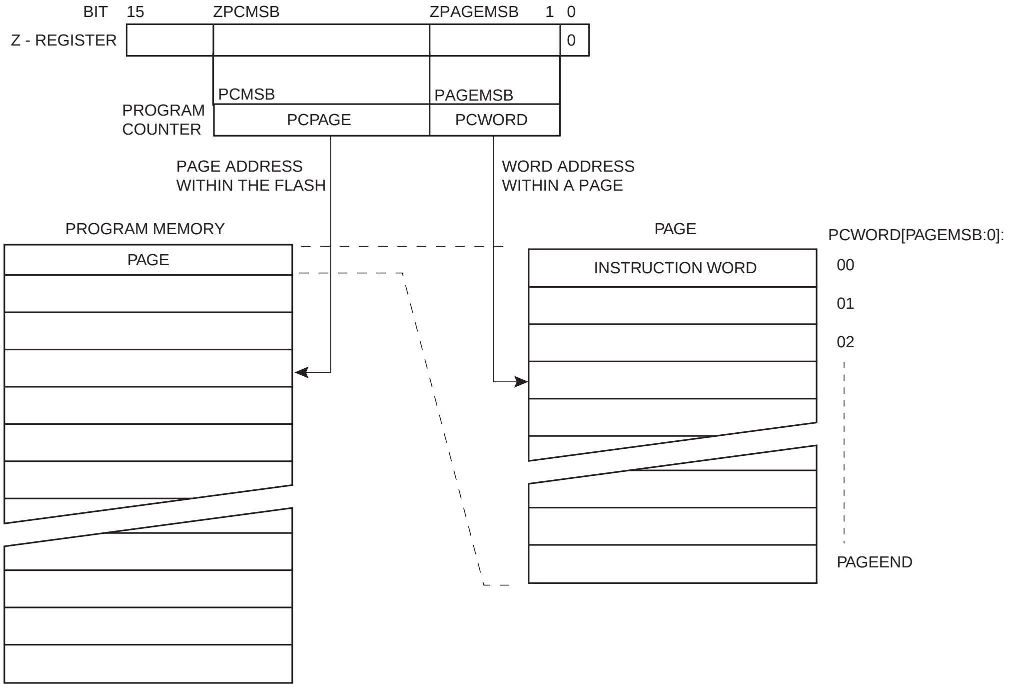
The Z-pointer is used to address the SPM commands.

Bit	15	14	13	12	11	10	9	8
ZH (R31)	**Z15**	**Z14**	**Z13**	**Z12**	**Z11**	**Z10**	**Z9**	**Z8**
ZL (R30)	**Z7**	**Z6**	**Z5**	**Z4**	**Z3**	**Z2**	**Z1**	**Z0**
	7	6	5	4	3	2	1	0

Since the Flash is organized in pages (see Table 104 on page 237), the Program Counter can be treated as having two different sections. One section, consisting of the least significant bits, is addressing the words within a page, while the most significant bits are addressing the pages. This is shown in Figure 114. Note that the Page Erase and Page Write operations are addressed independently. Therefore it is of major importance that the Boot Loader software addresses the same page in both the Page Erase and Page Write operation. Once a programming operation is initiated, the address is latched and the Z-pointer can be used for other operations.

The only SPM operation that does not use the Z-pointer is Setting the Boot Loader Lock bits. The content of the Z-pointer is ignored and will have no effect on the operation. The LPM instruction does also use the Z-pointer to store the address. Since this instruction addresses the Flash byte by byte, also the LSB (bit Z0) of the Z-pointer is used.

Figure 114. Addressing the Flash during SPM[1]



Notes: 1. The different variables used+ in Figure 114 are listed in Table 95 on page 232.
2. PCPAGE and PCWORD are listed in Table 104 on page 237.

Self-Programming the Flash

The program memory is updated in a page by page fashion. Before programming a page with the data stored in the temporary page buffer, the page must be erased. The temporary page buffer is filled one word at a time using SPM and the buffer can be filled either before the Page Erase command or between a Page Erase and a Page Write operation:

Alternative 1, fill the buffer before a Page Erase:

- Fill temporary page buffer
- Perform a Page Erase
- Perform a Page Write

Alternative 2, fill the buffer after Page Erase:

- Perform a Page Erase
- Fill temporary page buffer
- Perform a Page Write

If only a part of the page needs to be changed, the rest of the page must be stored (for example in the temporary page buffer) before the erase, and then be rewritten. When using alternative 1, the Boot Loader provides an effective Read-Modify-Write feature which allows the user software to first read the page, do the necessary changes, and then write back the modified data. If alternative 2 is used, it is not possible to read the old data while loading since the page is already erased. The temporary page buffer can be accessed in a random sequence. It is essential that the page address used in both the page erase and page write operation is addressing the same page. See “Simple Assembly Code Example for a Boot Loader” on page 229 for an assembly code example.

Performing Page Erase by SPM

To execute Page Erase, set up the address in the Z-pointer, write "X0000011" to SPMCR and execute SPM within four clock cycles after writing SPMCR. The data in R1 and R0 is ignored. The page address must be written to PCPAGE in the Z-register. Other bits in the Z-pointer will be ignored during this operation.

- Page Erase to the RWW section: The NRWW section can be read during the Page Erase.
- Page Erase to the NRWW section: The CPU is halted during the operation.

Filling the Temporary Buffer (Page Loading)

To write an instruction word, set up the address in the Z-pointer and data in R1:R0, write "00000001" to SPMCR and execute SPM within four clock cycles after writing SPMCR. The content of PCWORD in the Z-register is used to address the data in the temporary buffer. The temporary buffer will auto-erase after a Page Write operation or by writing the RWWSRE bit in SPMCR. It is also erased after a System Reset. Note that it is not possible to write more than one time to each address without erasing the temporary buffer.

Note: If the EEPROM is written in the middle of of an SPM Page Load operation, all data loaded will be lost.

Performing a Page Write

To execute Page Write, set up the address in the Z-pointer, write "X0000101" to SPMCR and execute SPM within four clock cycles after writing SPMCR. The data in R1 and R0 is ignored. The page address must be written to PCPAGE. Other bits in the Z-pointer must be written to zero during this operation.

- Page Write to the RWW section: The NRWW section can be read during the Page Write.
- Page Write to the NRWW section: The CPU is halted during the operation.

Using the SPM Interrupt

If the SPM interrupt is enabled, the SPM interrupt will generate a constant interrupt when the SPMEN bit in SPMCR is cleared. This means that the interrupt can be used instead of polling the SPMCR Register in software. When using the SPM interrupt, the Interrupt Vectors should be moved to the BLS section to avoid that an interrupt is accessing the RWW section when it is blocked for reading. How to move the interrupts is described in "Interrupts" on page 44.

Consideration While Updating BLS

Special care must be taken if the user allows the Boot Loader section to be updated by leaving Boot Lock bit 11 unprogrammed. An accidental write to the Boot Loader itself can corrupt the entire Boot Loader, and further software updates might be impossible. If it is not necessary to change the Boot Loader software itself, it is recommended to program the Boot Lock bit 11 to protect the Boot Loader software from any internal software changes.

Prevent Reading the RWW Section During Self-Programming

During Self-Programming (either Page Erase or Page Write), the RWW section is always blocked for reading. The user software itself must prevent that this section is addressed during the Self-Programming operation. The RWWSB in the SPMCR will be set as long as the RWW section is busy. During Self-Programming the Interrupt Vector table should be moved to the BLS as described in "Interrupts" on page 44, or the interrupts must be disabled. Before addressing the RWW section after the programming is completed, the user software must clear the RWWSB by writing the RWWSRE. See "Simple Assembly Code Example for a Boot Loader" on page 229 for an example.

Setting the Boot Loader Lock Bits by SPM

To set the Boot Loader Lock bits, write the desired data to R0, write "X0001001" to SPMCR and execute SPM within four clock cycles after writing SPMCR. The only accessible Lock bits are the Boot Lock bits that may prevent the Application and Boot Loader section from any software update by the MCU.

Bit	7	6	5	4	3	2	1	0
R0	**1**	**1**	**BLB12**	**BLB11**	**BLB02**	**BLB01**	**1**	**1**

See Table 89 and Table 90 for how the different settings of the Boot Loader bits affect the Flash access.

If bits 5..2 in R0 are cleared (zero), the corresponding Boot Lock bit will be programmed if an SPM instruction is executed within four cycles after BLBSET and SPMEN are set in SPMCR. The Z-pointer is don't care during this operation, but for future compatibility it is recommended to load the Z-pointer with 0x0001 (same as used for reading the Lock bits). For future compatibility It is also recommended to set bits 7, 6, 1, and 0 in R0 to "1" when writing the Lock bits. When programming the Lock bits the entire Flash can be read during the operation.

EEPROM Write Prevents Writing to SPMCR

Note that an EEPROM write operation will block all software programming to Flash. Reading the Fuses and Lock bits from software will also be prevented during the EEPROM write operation. It is recommended that the user checks the status bit (EEWE) in the EECR Register and verifies that the bit is cleared before writing to the SPMCR Register.

Reading the Fuse and Lock Bits from Software

It is possible to read both the Fuse and Lock bits from software. To read the Lock bits, load the Z-pointer with 0x0001 and set the BLBSET and SPMEN bits in SPMCR. When an LPM instruction is executed within three CPU cycles after the BLBSET and SPMEN bits are set in SPMCR, the value of the Lock bits will be loaded in the destination register. The BLBSET and SPMEN bits will auto-clear upon completion of reading the Lock bits or if no LPM instruction is executed within three CPU cycles or no SPM instruction is executed within four CPU cycles. When BLBSET and SPMEN are cleared, LPM will work as described in the Instruction set Manual.

Bit	7	6	5	4	3	2	1	0
Rd	**–**	**–**	**BLB12**	**BLB11**	**BLB02**	**BLB01**	**LB2**	**LB1**

The algorithm for reading the Fuse Low bits is similar to the one described above for reading the Lock bits. To read the Fuse Low bits, load the Z-pointer with 0x0000 and set the BLBSET and SPMEN bits in SPMCR. When an LPM instruction is executed within three cycles after the BLBSET and SPMEN bits are set in the SPMCR, the value of the Fuse Low bits (FLB) will be loaded in the destination register as shown below. Refer to Table 99 on page 235 for a detailed description and mapping of the Fuse Low bits.

Bit	7	6	5	4	3	2	1	0
Rd	**FLB7**	**FLB6**	**FLB5**	**FLB4**	**FLB3**	**FLB2**	**FLB1**	**FLB0**

Similarly, when reading the Fuse High bits, load 0x0003 in the Z-pointer. When an LPM instruction is executed within three cycles after the BLBSET and SPMEN bits are set in the SPMCR, the value of the Fuse High bits (FHB) will be loaded in the destination register as shown below. Refer to Table 98 on page 234 for detailed description and mapping of the Fuse High bits.

Bit	7	6	5	4	3	2	1	0
Rd	**FHB7**	**FHB6**	**FHB5**	**FHB4**	**FHB3**	**FHB2**	**FHB1**	**FHB0**

Fuse and Lock bits that are programmed, will be read as zero. Fuse and Lock bits that are unprogrammed, will be read as one.

Preventing Flash Corruption

During periods of low $V_{CC,}$ the Flash program can be corrupted because the supply voltage is too low for the CPU and the Flash to operate properly. These issues are the same as for board level systems using the Flash, and the same design solutions should be applied.

A Flash program corruption can be caused by two situations when the voltage is too low. First, a regular write sequence to the Flash requires a minimum voltage to operate correctly. Secondly, the CPU itself can execute instructions incorrectly, if the supply voltage for executing instructions is too low.

Flash corruption can easily be avoided by following these design recommendations (one is sufficient):

1. If there is no need for a Boot Loader update in the system, program the Boot Loader Lock bits to prevent any Boot Loader software updates.
2. Keep the AVR RESET active (low) during periods of insufficient power supply voltage. This can be done by enabling the internal Brown-out Detector (BOD) if the operating voltage matches the detection level. If not, an external low V_{CC} Reset Protection circuit can be used. If a Reset occurs while a write operation is in progress, the write operation will be completed provided that the power supply voltage is sufficient.
3. Keep the AVR core in Power-down Sleep mode during periods of low V_{CC}. This will prevent the CPU from attempting to decode and execute instructions, effectively protecting the SPMCR Register and thus the Flash from unintentional writes.

Programming Time for Flash When Using SPM

The calibrated RC Oscillator is used to time Flash accesses. Table 92 shows the typical programming time for Flash accesses from the CPU.

Table 92. SPM Programming Time

Symbol	Min Programming Time	Max Programming Time
Flash write (Page Erase, Page Write, and write Lock bits by SPM)	3.7 ms	4.5 ms

Simple Assembly Code Example for a Boot Loader

```
    ;-the routine writes one page of data from RAM to Flash
    ; the first data location in RAM is pointed to by the Y pointer
    ; the first data location in Flash is pointed to by the Z pointer
    ;-error handling is not included
    ;-the routine must be placed inside the boot space
    ; (at least the Do_spm sub routine). Only code inside NRWW section can
    ; be read during Self-Programming (page erase and page write).
    ;-registers used: r0, r1, temp1 (r16), temp2 (r17), looplo (r24),
    ; loophi (r25), spmcrval (r20)
    ; storing and restoring of registers is not included in the routine
    ; register usage can be optimized at the expense of code size
    ;-It is assumed that either the interrupt table is moved to the Boot
    ; loader section or that the interrupts are disabled.
.equ    PAGESIZEB = PAGESIZE*2              ;PAGESIZEB is page size in BYTES, not words
.org SMALLBOOTSTART
Write_page:
    ;   page erase
    ldi     spmcrval, (1<<PGERS) | (1<<SPMEN)
    call    Do_spm

    ;   re-enable the RWW section
```

```
    ldi     spmcrval, (1<<RWWSRE) | (1<<SPMEN)
    call    Do_spm

    ;   transfer data from RAM to Flash page buffer
    ldi     looplo, low(PAGESIZEB)              ;init loop variable
    ldi     loophi, high(PAGESIZEB)             ;not required for PAGESIZEB<=256
Wrloop:
    ld      r0, Y+
    ld      r1, Y+
    ldi     spmcrval, (1<<SPMEN)
    call    Do_spm
    adiw    ZH:ZL, 2
    sbiw    loophi:looplo, 2                    ;use subi for PAGESIZEB<=256
    brne    Wrloop

    ;   execute page write
    subi    ZL, low(PAGESIZEB)                  ;restore pointer
    sbci    ZH, high(PAGESIZEB)                 ;not required for PAGESIZEB<=256
    ldi     spmcrval, (1<<PGWRT) | (1<<SPMEN)
    call    Do_spm

    ;   re-enable the RWW section
    ldi     spmcrval, (1<<RWWSRE) | (1<<SPMEN)
    call    Do_spm

    ;   read back and check, optional
    ldi     looplo, low(PAGESIZEB)              ;init loop variable
    ldi     loophi, high(PAGESIZEB)             ;not required for PAGESIZEB<=256
    subi    YL, low(PAGESIZEB)                  ;restore pointer
    sbci    YH, high(PAGESIZEB)
Rdloop:
    lpm     r0, Z+
    ld      r1, Y+
    cpse    r0, r1
    rjmp    Error
    sbiw    loophi:looplo, 1                    ;use subi for PAGESIZEB<=256
    brne    Rdloop

    ;   return to RWW section
    ;   verify that RWW section is safe to read
Return:
    in      temp1, SPMCR
    sbrs    temp1, RWWSB                      ; If RWWSB is set, the RWW section is not ready yet
    ret
    ;   re-enable the RWW section
    ldi     spmcrval, (1<<RWWSRE) | (1<<SPMEN)
    call    Do_spm
    rjmp    Return

Do_spm:
    ;   check for previous SPM complete
Wait_spm:
    in      temp1, SPMCR
    sbrc    temp1, SPMEN
    rjmp    Wait_spm
    ;   input: spmcrval determines SPM action
    ;   disable interrupts if enabled, store status
    in      temp2, SREG
    cli
    ;   check that no EEPROM write access is present
Wait_ee:
    sbic    EECR, EEWE
    rjmp    Wait_ee
    ;   SPM timed sequence
    out     SPMCR, spmcrval
```

```
spm
;   restore SREG (to enable interrupts if originally enabled)
out       SREG, temp2
ret
```

ATmega8535 Boot Loader Parameters

In Table 93 through Table 95, the parameters used in the description of the self programming are given.

Table 93. Boot Size Configuration(1)

BOOTSZ1	BOOTSZ0	Boot Size	Pages	Application Flash Section	Boot Loader Flash Section	End Application Section	Boot Reset Address (Start Boot Loader Section)
1	1	128 words	4	0x000 - 0xF7F	0xF80 - 0xFFF	0xF7F	0xF80
1	0	256 words	8	0x000 - 0xEFF	0xF00 - 0xFFF	0xEFF	0xF00
0	1	512 words	16	0x000 - 0xDFF	0xE00 - 0xFFF	0xDFF	0xE00
0	0	1024 words	32	0x000 - 0xBFF	0xC00 - 0xFFF	0xBFF	0xC00

Note: 1. The different BOOTSZ Fuse configurations are shown in Figure 113

Table 94. Read-While-Write Limit(1)

Section	Pages	Address
Read-While-Write section (RWW)	96	0x000 - 0xBFF
No Read-While-Write section (NRWW)	32	0xC00 - 0xFFF

Note: 1. For details about these two section, see “NRWW – No Read-While-Write Section” on page 221 and “RWW – Read-While-Write Section” on page 221

Table 95. Explanation of Different Variables used in Figure 114 and the Mapping to the Z-pointer(1)

Variable		Corresponding Z-value	Description
PCMSB	11		Most significant bit in the Program Counter. (The Program Counter is 12 bits PC[11:0])
PAGEMSB	4		Most significant bit which is used to address the words within one page (64 words in a page requires five bits PC [4:0]).
ZPCMSB		Z12	Bit in Z-register that is mapped to PCMSB. Because Z0 is not used, the ZPCMSB equals PCMSB + 1.
ZPAGEMSB		Z5	Bit in Z-register that is mapped to PCMSB. Because Z0 is not used, the ZPAGEMSB equals PAGEMSB + 1.
PCPAGE	PC[11:5]	Z12:Z6	Program Counter page address: Page select, for Page Erase and Page Write
PCWORD	PC[4:0]	Z5:Z1	Program Counter word address: Word select, for filling temporary buffer (must be zero during page write operation)

Note: 1. Z15:Z13: always ignored
Z0: should be zero for all SPM commands, byte select for the LPM instruction.
See "Addressing the Flash during Self-Programming" on page 225 for details about the use of Z-pointer during Self-Programming.

Memory Programming

Program And Data Memory Lock Bits

The ATmega8535 provides six Lock bits which can be left unprogrammed (“1”) or can be programmed (“0”) to obtain the additional features listed in Table 97. The Lock bits can only be erased to “1” with the Chip Erase command.

Table 96. Lock Bit Byte[1]

Lock Bit Byte	Bit No	Description	Default Value
	7	–	1 (unprogrammed)
	6	–	1 (unprogrammed)
BLB12	5	Boot Lock bit	1 (unprogrammed)
BLB11	4	Boot Lock bit	1 (unprogrammed)
BLB02	3	Boot Lock bit	1 (unprogrammed)
BLB01	2	Boot Lock bit	1 (unprogrammed)
LB2	1	Lock bit	1 (unprogrammed)
LB1	0	Lock bit	1 (unprogrammed)

Note: 1. “1” means unprogrammed, “0” means programmed

Table 97. Lock Bit Protection Modes[2]

Memory Lock Bits			Protection Type
LB Mode	**LB2**	**LB1**	
1	1	1	No memory lock features enabled.
2	1	0	Further programming of the Flash and EEPROM is disabled in Parallel and Serial Programming mode. The Fuse bits are locked in both Serial and Parallel Programming mode.[1]
3	0	0	Further programming and verification of the Flash and EEPROM is disabled in Parallel and Serial Programming mode. The Fuse bits are locked in both Serial and Parallel Programming mode.[1]
BLB0 Mode	**BLB02**	**BLB01**	
1	1	1	No restrictions for SPM or LPM accessing the Application section.
2	1	0	SPM is not allowed to write to the Application section.
3	0	0	SPM is not allowed to write to the Application section, and LPM executing from the Boot Loader section is not allowed to read from the Application section. If interrupt vectors are placed in the Boot Loader section, interrupts are disabled while executing from the Application section.
4	0	1	LPM executing from the Boot Loader section is not allowed to read from the Application section. If interrupt vectors are placed in the Boot Loader section, interrupts are disabled while executing from the Application section.
BLB1 Mode	**BLB12**	**BLB11**	

Table 97. Lock Bit Protection Modes(2) (Continued)

Memory Lock Bits			Protection Type
1	1	1	No restrictions for SPM or LPM accessing the Boot Loader section.
2	1	0	SPM is not allowed to write to the Boot Loader section.
3	0	0	SPM is not allowed to write to the Boot Loader section, and LPM executing from the Application section is not allowed to read from the Boot Loader section. If interrupt vectors are placed in the Application section, interrupts are disabled while executing from the Boot Loader section.
4	0	1	LPM executing from the Application section is not allowed to read from the Boot Loader section. If interrupt vectors are placed in the Application section, interrupts are disabled while executing from the Boot Loader section.

Notes: 1. Program the Fuse bits before programming the Lock bits.
2. "1" means unprogrammed, "0" means programmed.

Fuse Bits

The ATmega8535 has two Fuse bytes. Table 98 and Table 99 describe briefly the functionality of all the fuses and how they are mapped into the fuse bytes. Note that the fuses are read as logical zero, "0", if they are programmed.

Table 98. Fuse High Byte

Fuse High Byte	Bit No	Description	Default Value
S8535C	7	Select AT90S8535 compatibility mode	1 (unprogrammed)
WDTON	6	WDT always on	1 (unprogrammed, WDT enabled by WDTCR)
SPIEN(1)	5	Enable Serial Program and Data Downloading	0 (programmed, SPI prog. enabled)
CKOPT(2)	4	Oscillator options	1 (unprogrammed)
EESAVE	3	EEPROM memory is preserved through the Chip Erase	1 (unprogrammed, EEPROM not preserved)
BOOTSZ1	2	Select Boot Size (see Table 93 for details)	0 (programmed)(3)
BOOTSZ0	1	Select Boot Size (see Table 93 for details)	0 (programmed)(3)
BOOTRST	0	Select Reset Vector	1 (unprogrammed)

Notes: 1. The SPIEN Fuse is not accessible in Serial Programming mode.
2. The CKOPT Fuse functionality depends on the setting of the CKSEL bits. See "Clock Sources" on page 23. for details.
3. The default value of BOOTSZ1..0 results in maximum Boot Size. See Table 93 on page 231.

Table 99. Fuse Low Byte

Fuse Low Byte	Bit no	Description	Default Value
BODLEVEL	7	Brown out detector trigger level	1 (unprogrammed)
BODEN	6	Brown out detector enable	1 (unprogrammed, BOD disabled)
SUT1	5	Select start-up time	1 (unprogrammed)(1)
SUT0	4	Select start-up time	0 (programmed)(1)
CKSEL3	3	Select Clock source	0 (programmed)(2)
CKSEL2	2	Select Clock source	0 (programmed)(2)
CKSEL1	1	Select Clock source	0 (programmed)(2)
CKSEL0	0	Select Clock source	1 (unprogrammed)(2)

Notes: 1. The default value of SUT1..0 results in maximum start-up time. See Table 10 on page 28 for details.
2. The default setting of CKSEL3..0 results in internal RC Oscillator @ 1 MHz. See Table 2 on page 23 for details.

The status of the Fuse bits is not affected by Chip Erase. Note that the Fuse bits are locked if Lock bit 1 (LB1) is programmed. Program the Fuse bits before programming the Lock bits.

Latching of Fuses

The Fuse values are latched when the device enters Programming mode and changes of the Fuse values will have no effect until the part leaves Programming mode. This does not apply to the EESAVE fuse which will take effect once it is programmed. The fuses are also latched on Power-up in Normal mode.

Signature Bytes

All Atmel microcontrollers have a three-byte signature code which identifies the device. This code can be read in both Serial and Parallel mode, also when the device is locked. The three bytes reside in a separate address space.

For the ATmega8535 the signature bytes are:

1. 0x000: 0x1E (indicates manufactured by Atmel)
2. 0x001: 0x93 (indicates 8 KB Flash memory)
3. 0x002: 0x08 (indicates ATmega8535 device when 0x001 is 0x93)

Calibration Byte

The ATmega8535 stores four different calibration values for the internal RC Oscillator. These bytes resides in the signature row high byte of the addresses 0x000, 0x0001, 0x0002, and 0x0003 for 1, 2, 4, and 8 MHz respectively. During Reset, the 1 MHz value is automatically loaded into the OSCCAL Register. If other frequencies are used, the calibration value has to be loaded manually, see “Oscillator Calibration Register – OSCCAL” on page 28 for details.

Parallel Programming Parameters, Pin Mapping, and Commands

This section describes how to parallel program and verify Flash Program memory, EEPROM Data memory, Memory Lock bits, and Fuse bits in the ATmega8535. Pulses are assumed to be at least 250 ns unless otherwise noted.

Signal Names

In this section, some pins of the ATmega8535 are referenced by signal names describing their functionality during parallel programming, see Figure 115 and Table 100. Pins not described in the following table are referenced by pin names.

The XA1/XA0 pins determine the action executed when the XTAL1 pin is given a positive pulse. The bit coding is shown in Table 102.

When pulsing $\overline{\text{WR}}$ or $\overline{\text{OE}}$, the command loaded determines the action executed. The different Commands are shown in Table 103.

Figure 115. Parallel Programming

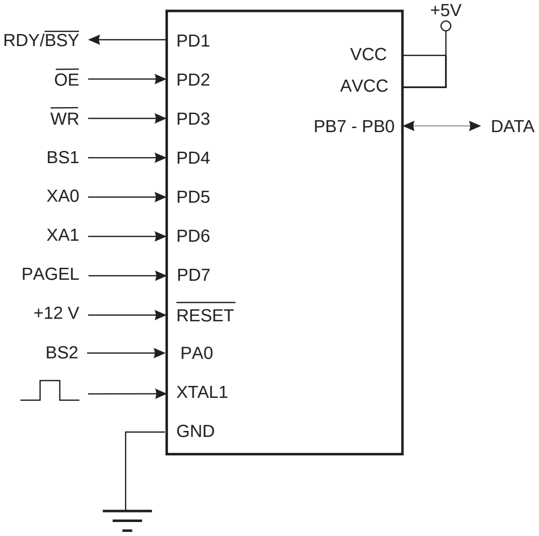


Table 100. Pin Name Mapping

Signal Name in Programming Mode	Pin Name	I/O	Function
RDY/$\overline{\text{BSY}}$	PD1	O	0: Device is busy programming, 1: Device is ready for new command
$\overline{\text{OE}}$	PD2	I	Output Enable (Active low)
$\overline{\text{WR}}$	PD3	I	Write Pulse (Active low)
BS1	PD4	I	Byte Select 1 (“0” selects low byte, “1” selects high byte)
XA0	PD5	I	XTAL Action Bit 0
XA1	PD6	I	XTAL Action Bit 1
PAGEL	PD7	I	Program Memory and EEPROM data Page Load
BS2	PA0	I	Byte Select 2 (“0” selects low byte, “1” selects 2’nd high byte)
DATA	PB7 - 0	I/O	Bi-directional Data bus (Output when $\overline{\text{OE is low}}$)

Table 101. Pin Values Used to Enter Programming Mode

Pin	Symbol	Value
PAGEL	Prog_enable[3]	0
XA1	Prog_enable[2]	0
XA0	Prog_enable[1]	0
BS1	Prog_enable[0]	0

Table 102. XA1 and XA0 Coding

XA1	XA0	Action when XTAL1 is Pulsed
0	0	Load Flash or EEPROM Address (High or low address byte determined by BS1)
0	1	Load Data (High or Low data byte for Flash determined by BS1)
1	0	Load Command
1	1	No Action, Idle

Table 103. Command Byte Bit Coding

Command Byte	Command Executed
1000 0000	Chip Erase
0100 0000	Write Fuse Bits
0010 0000	Write Lock Bits
0001 0000	Write Flash
0001 0001	Write EEPROM
0000 1000	Read Signature Bytes and Calibration byte
0000 0100	Read Fuse and Lock Bits
0000 0010	Read Flash
0000 0011	Read EEPROM

Table 104. No. of Words in a Page and no. of Pages in the Flash

Flash Size	Page Size	PCWORD	No. of Pages	PCPAGE	PCMSB
4K words (8K bytes)	32 words	PC[4:0]	128	PC[11:5]	11

Table 105. No. of Words in a Page and no. of Pages in the EEPROM

EEPROM Size	Page Size	PCWORD	No. of Pages	PCPAGE	EEAMSB
512 bytes	4 bytes	EEA[1:0]	128	EEA[8:2]	8

Parallel Programming

Enter Programming Mode

The following algorithm puts the device in Parallel Programming mode:

1. Apply 4.5 - 5.5V between V_{CC} and GND, and wait at least 100 µs.
2. Set $\overline{\text{RESET}}$ to “0” and toggle XTAL1 at least six times.
3. Set the Prog_enable pins listed in Table 101 on page 237 to “0000” and wait at least 100 ns.
4. Apply 11.5 - 12.5V to $\overline{\text{RESET}}$. Any activity on Prog_enable pins within 100 ns after +12V has been applied to $\overline{\text{RESET}}$, will cause the device to fail entering Programming mode.

Note, if External Crystal or External RC configuration is selected, it may not be possible to apply qualified XTAL1 pulses. In such cases, the following algorithm should be followed:

1. Set Prog_enable pins listed in Table 101 on page 237 to “0000”.
2. Apply 4.5 - 5.5V between V_{CC} and GND simultanously as 11.5 - 12.5V is applied to $\overline{\text{RESET}}$.
3. Wait 100 ns.
4. Re-program the fuses to ensure that External Clock is selected as clock source (CKSEL3:0 = 0b0000) If Lock bits are programmed, a Chip Erase command must be executed before changing the fuses.
5. Exit Programming mode by power the device down or by bringing $\overline{\text{RESET}}$ pin to 0b0.
6. Entering Programming mode with the original algorithm, as described above.

Considerations for Efficient Programming

The loaded command and address are retained in the device during programming. For efficient programming, the following should be considered.

- The command needs only be loaded once when writing or reading multiple memory locations.
- Skip writing the data value 0xFF, that is the contents of the entire EEPROM (unless the EESAVE fuse is programmed) and Flash after a Chip Erase.
- Address high byte needs only be loaded before programming or reading a new 256 word window in Flash or 256 byte EEPROM. This consideration also applies to Signature bytes reading.

Chip Erase

The Chip Erase will erase the Flash and EEPROM(1) memories plus Lock bits. The Lock bits are not reset until the program memory has been completely erased. The Fuse bits are not changed. A Chip Erase must be performed before the Flash and/or the EEPROM is reprogrammed.

Note: 1. The EEPRPOM memory is preserved during Chip Erase if the EESAVE Fuse is programmed.

Load Command “Chip Erase”

1. Set XA1, XA0 to “10”. This enables command loading.
2. Set BS1 to “0”.
3. Set DATA to “1000 0000”. This is the command for Chip Erase.
4. Give XTAL1 a positive pulse. This loads the command.
5. Give $\overline{\text{WR}}$ a negative pulse. This starts the Chip Erase. RDY/$\overline{\text{BSY}}$ goes low.
6. Wait until RDY/$\overline{\text{BSY}}$ goes high before loading a new command.

Programming the Flash

The Flash is organized in pages, see Table 104 on page 237. When programming the Flash, the program data is latched into a page buffer. This allows one page of program data to be programmed simultaneously. The following procedure describes how to program the entire Flash memory:

A. Load Command “Write Flash”

1. Set XA1, XA0 to “10”. This enables command loading.
2. Set BS1 to “0”.
3. Set DATA to “0001 0000”. This is the command for Write Flash.
4. Give XTAL1 a positive pulse. This loads the command.

B. Load Address Low byte

1. Set XA1, XA0 to “00”. This enables address loading.
2. Set BS1 to “0”. This selects low address.
3. Set DATA = Address low byte (0x00 - 0xFF).
4. Give XTAL1 a positive pulse. This loads the address low byte.

C. Load Data Low Byte

1. Set XA1, XA0 to “01”. This enables data loading.
2. Set DATA = Data low byte (0x00 - 0xFF).
3. Give XTAL1 a positive pulse. This loads the data byte.

D. Load Data High Byte

1. Set BS1 to “1”. This selects high data byte.
2. Set XA1, XA0 to “01”. This enables data loading.
3. Set DATA = Data high byte (0x00 - 0xFF).
4. Give XTAL1 a positive pulse. This loads the data byte.

E. Latch Data

1. Set BS1 to “1”. This selects high data byte.
2. Give PAGEL a positive pulse. This latches the data bytes. (See Figure 117 for signal waveforms.)

F. Repeat B through E until the entire buffer is filled or until all data within the page is loaded.

While the lower bits in the address are mapped to words within the page, the higher bits address the pages within the FLASH. This is illustrated in Figure 116 on page 240. Note that if less than eight bits are required to address words in the page (pagesize < 256), the most significant bit(s) in the address low byte are used to address the page when performing a page write.

G. Load Address High byte

1. Set XA1, XA0 to “00”. This enables address loading.
2. Set BS1 to “1”. This selects high address.
3. Set DATA = Address high byte (0x00 - 0xFF).
4. Give XTAL1 a positive pulse. This loads the address high byte.

H. Program Page

1. Set BS1 to “0”.
2. Give $\overline{\text{WR}}$ a negative pulse. This starts programming of the entire page of data. RDY/$\overline{\text{BSY}}$goes low.

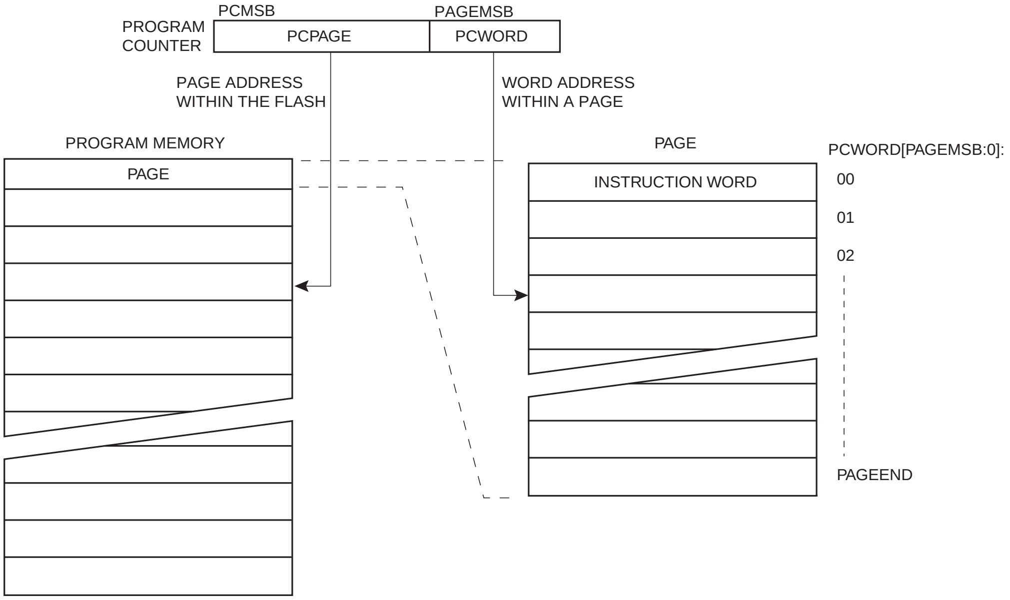
3. Wait until RDY/$\overline{\text{BSY}}$ goes high. (See Figure 117 for signal waveforms)

I. Repeat B through H until the entire Flash is programmed or until all data has been programmed.

J. End Page Programming

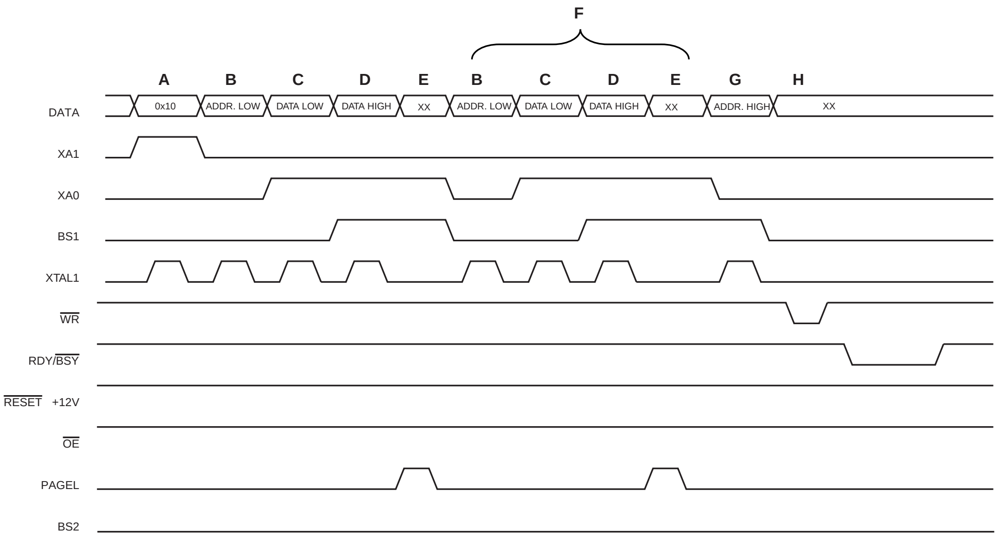
1. 1. Set XA1, XA0 to “10”. This enables command loading.
2. Set DATA to “0000 0000”. This is the command for No Operation.
3. Give XTAL1 a positive pulse. This loads the command, and the internal write signals are reset.

Figure 116. Addressing the Flash which is Organized in Pages(1)



Note: 1. PCPAGE and PCWORD are listed in Table 104 on page 237.

Figure 117. Programming the Flash Waveforms(1)



Note: 1. “XX” is don’t care. The letters refer to the programming description above.

Programming the EEPROM

The EEPROM is organized in pages, see Table 105 on page 237. When programming the EEPROM, the program data is latched into a page buffer. This allows one page of data to be programmed simultaneously. The programming algorithm for the EEPROM data memory is as follows (refer to “Programming the Flash” on page 239 for details on Command, Address and Data loading):

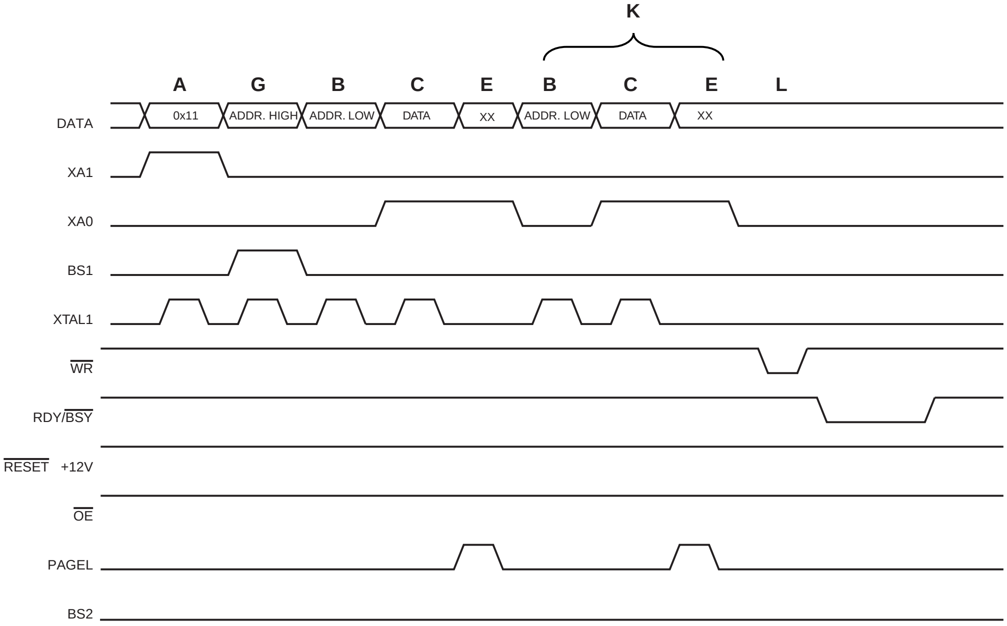
1. A: Load Command “0001 0001”.
2. G: Load Address High Byte (0x00 - 0xFF).
3. B: Load Address Low Byte (0x00 - 0xFF).
4. C: Load Data (0x00 - 0xFF).
5. E: Latch data (give PAGEL a positive pulse).

K: Repeat 3 through 5 until the entire buffer is filled.

L: Program EEPROM page.

1. Set BS1 to “0”.
2. Give $\overline{\text{WR}}$ a negative pulse. This starts programming of the EEPROM page. RDY/$\overline{\text{BSY}}$ goes low.
3. Wait until to RDY/$\overline{\text{BSY}}$ goes high before programming the next page. (See Figure 118 for signal waveforms.)

Figure 118. Programming the EEPROM Waveforms



Reading the Flash

The algorithm for reading the Flash memory is as follows (refer to “Programming the Flash” on page 239 for details on Command and Address loading):

1. A: Load Command “0000 0010”.
2. G: Load Address High Byte (0x00 - 0xFF).
3. B: Load Address Low Byte (0x00 - 0xFF).
4. Set $\overline{\text{OE}}$ to “0”, and BS1 to “0”. The Flash word low byte can now be read at DATA.
5. Set BS1 to “1”. The Flash word high byte can now be read at DATA.
6. Set $\overline{\text{OE}}$ to “1”.

Reading the EEPROM

The algorithm for reading the EEPROM memory is as follows (refer to “Programming the Flash” on page 239 for details on Command and Address loading):

1. A: Load Command “0000 0011”.
2. G: Load Address High Byte (0x00 - 0xFF).
3. B: Load Address Low Byte (0x00 - 0xFF).
4. Set $\overline{OE}$ to “0”, and BS1 to “0”. The EEPROM Data byte can now be read at DATA.
5. Set $\overline{OE}$ to “1”.

Programming the Fuse Low Bits

The algorithm for programming the Fuse Low bits is as follows (refer to “Programming the Flash” on page 239 for details on Command and Data loading):

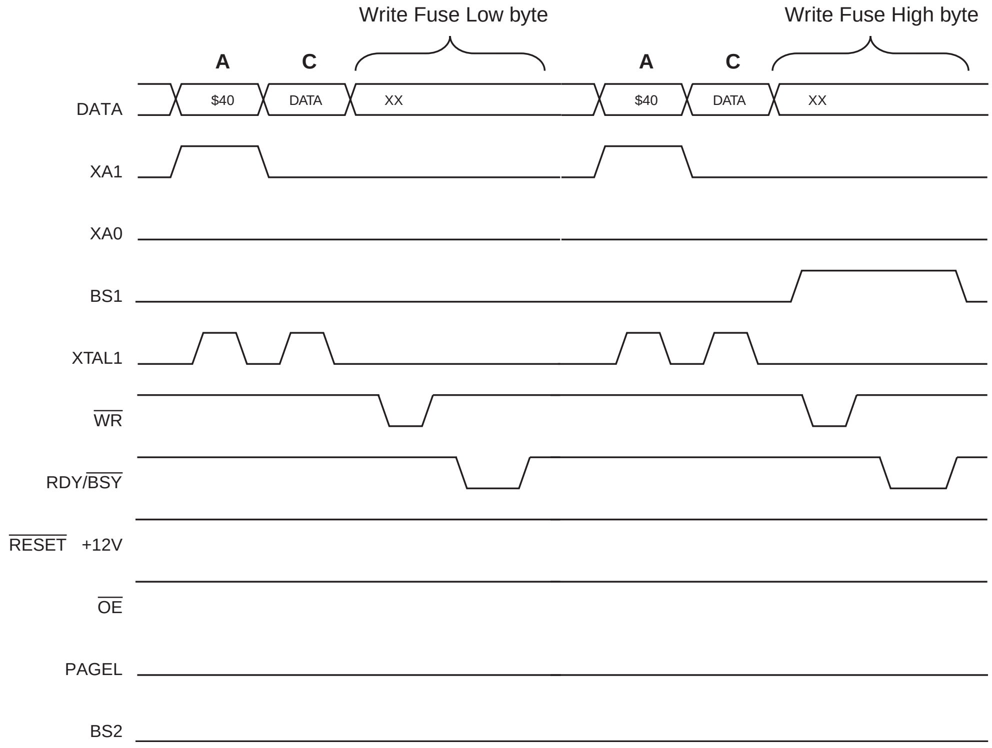
1. A: Load Command “0100 0000”.
2. C: Load Data Low Byte. Bit n = “0” programs and bit n = “1” erases the Fuse bit.
3. Set BS1 to “0” and BS2 to “0”. This selects low data byte.
4. Give $\overline{WR}$ a negative pulse and wait for RDY/$\overline{BSY}$ to go high.

Programming the Fuse High Bits

The algorithm for programming the Fuse high bits is as follows (refer to “Programming the Flash” on page 239 for details on Command and Data loading):

1. A: Load Command “0100 0000”.
2. C: Load Data Low Byte. Bit n = “0” programs and bit n = “1” erases the Fuse bit.
3. Set BS1 to “1” and BS2 to “0”. This selects high data byte.
4. Give $\overline{WR}$ a negative pulse and wait for RDY/$\overline{BSY}$ to go high.
5. Set BS1 to “0”. This selects low data byte.

Figure 119. Programming th Fuses Waveforms



Programming the Lock Bits

The algorithm for programming the Lock bits is as follows (refer to “Programming the Flash” on page 239 for details on Command and Data loading):

1. A: Load Command “0010 0000”.
2. C: Load Data Low Byte. Bit n = “0” programs the Lock bit.
3. Give $\overline{\text{WR}}$ a negative pulse and wait for RDY/$\overline{\text{BSY}}$ to go high.

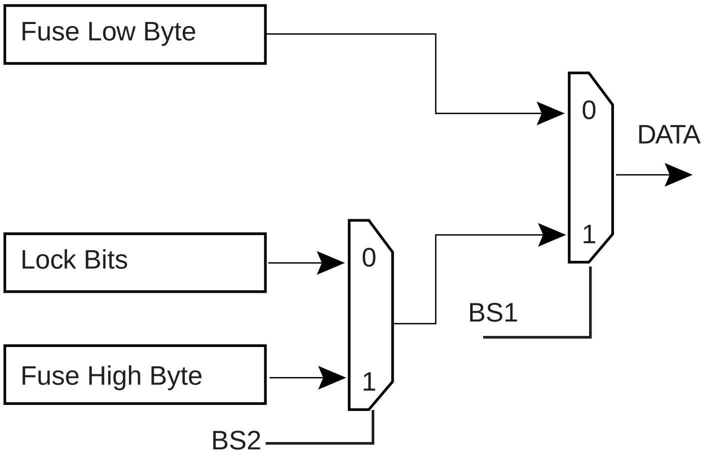
The Lock bits can only be cleared by executing Chip Erase.

Reading the Fuse and Lock Bits

The algorithm for reading the Fuse and Lock bits is as follows (refer to “Programming the Flash” on page 239 for details on Command loading):

1. A: Load Command “0000 0100”.
2. Set $\overline{\text{OE}}$ to “0”, BS2 to “0”, and BS1 to “0”. The status of the Fuse Low bits can now be read at DATA (“0” means programmed).
3. Set $\overline{\text{OE}}$ to “0”, BS2 to “1”, and BS1 to “1”. The status of the Fuse High bits can now be read at DATA (“0” means programmed).
4. Set $\overline{\text{OE}}$ to “0”, BS2 to “0”, and BS1 to “1”. The status of the Lock bits can now be read at DATA (“0” means programmed).
5. Set $\overline{\text{OE}}$ to “1”.

Figure 120. Mapping Between BS1, BS2 and the Fuse- and Lock Bits During Read



Reading the Signature Bytes

The algorithm for reading the Signature bytes is as follows (refer to “Programming the Flash” on page 239 for details on Command and Address loading):

1. A: Load Command “0000 1000”.
2. B: Load Address Low Byte (0x00 - 0x02).
3. Set $\overline{\text{OE}}$ to “0”, and BS to “0”. The selected Signature byte can now be read at DATA.
4. Set $\overline{\text{OE}}$ to “1”.

Reading the Calibration Byte

The algorithm for reading the Calibration byte is as follows (refer to “Programming the Flash” on page 239 for details on Command and Address loading):

1. A: Load Command “0000 1000”.
2. B: Load Address Low Byte, 0x00.
3. Set $\overline{\text{OE}}$ to “0”, and BS1 to “1”. The Calibration byte can now be read at DATA.
4. Set $\overline{\text{OE}}$ to “1”.

Parallel Programming Characteristics

Figure 121. Parallel Programming Timing, Including some General Timing Requirements

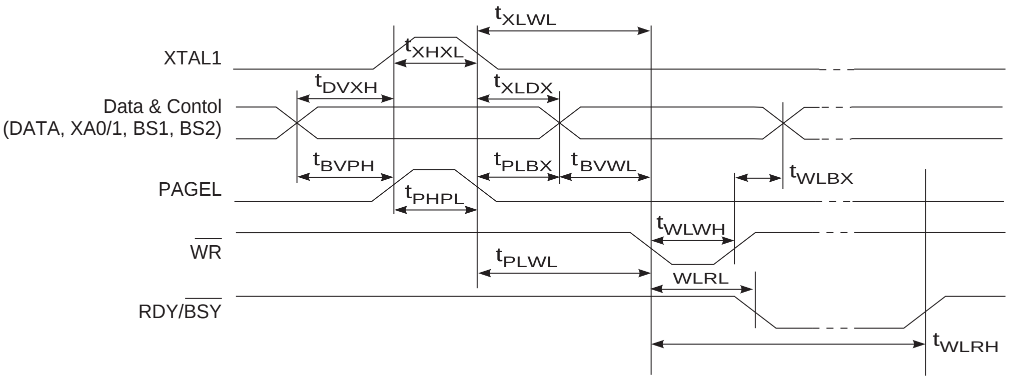
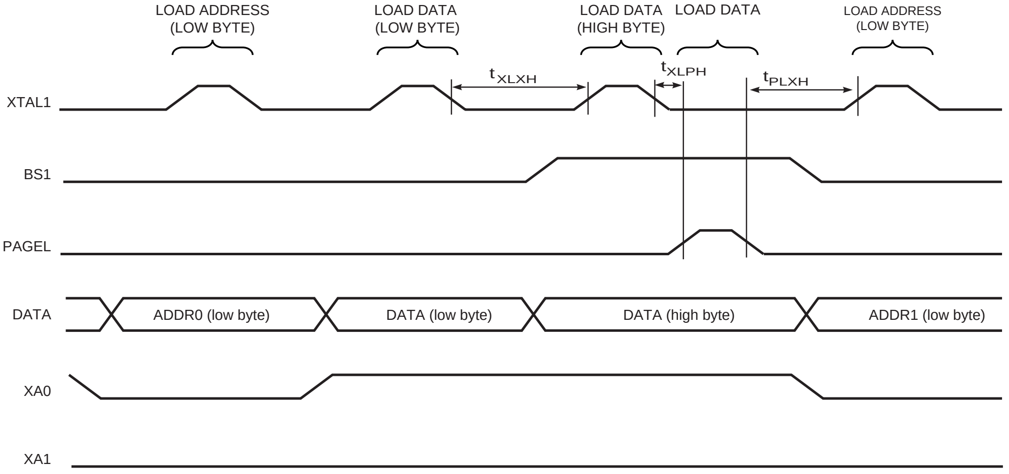
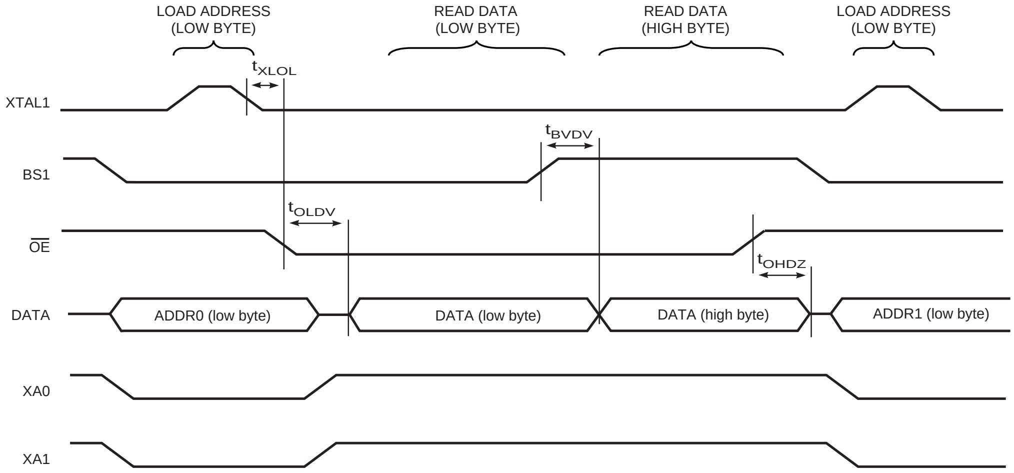


Figure 122. Parallel Programming Timing, Loading Sequence with Timing Requirements(1)



Note: 1. The timing requirements shown in Figure 121 (i.e. t_{DVXH}, t_{XHXL}, and t_{XLDX}) also apply to loading operation.

Figure 123. Parallel Programming Timing, Reading Sequence (within the same Page) with Timing Requirements(1)



Note: 1. The timing requirements shown in Figure 121 (i.e. t_{DVXH}, t_{XHXL}, and t_{XLDX}) also apply to reading operation.

Table 106. Parallel Programming Characteristics, V_{CC} = 5V ± 10%

Symbol	Parameter	Min	Typ	Max	Units
V_{PP}	Programming Enable Voltage	11.5		12.5	V
I_{PP}	Programming Enable Current			250	µA
t_{DVXH}	Data and Control Valid before XTAL1 High	67			ns
t_{XLXH}	XTAL1 Low to XTAL1 High	200			ns
t_{XHXL}	XTAL1 Pulse Width High	150			ns
t_{XLDX}	Data and Control Hold after XTAL1 Low	67			ns
t_{XLWL}	XTAL1 Low to $\overline{\text{WR}}$ Low	0			ns
t_{XLPH}	XTAL1 Low to PAGEL High	0			ns
t_{PLXH}	PAGEL low to XTAL1 High	150			ns
t_{BVPH}	BS1 Valid before PAGEL High	67			ns
t_{PHPL}	PAGEL Pulse Width High	150			ns
t_{PLBX}	BS1 Hold after PAGEL Low	67			ns
t_{WLBX}	BS2/1 Hold after $\overline{\text{WR}}$ Low	67			ns
t_{PLWL}	PAGEL Low to $\overline{\text{WR}}$ Low	67			ns
t_{BVWL}	BS1 Valid to $\overline{\text{WR}}$ Low	67			ns
t_{WLWH}	$\overline{\text{WR}}$ Pulse Width Low	150			ns
t_{WLRL}	$\overline{\text{WR}}$ Low to RDY/$\overline{\text{BSY}}$ Low	0		1	µs
t_{WLRH}	$\overline{\text{WR}}$ Low to RDY/$\overline{\text{BSY}}$ High(1)	3.7		4.5	ms
t_{WLRH_CE}	$\overline{\text{WR}}$ Low to RDY/$\overline{\text{BSY}}$ High for Chip Erase(2)	7.5		9	ms
t_{XLOL}	XTAL1 Low to $\overline{\text{OE}}$ Low	0			ns
t_{BVDV}	BS1 Valid to DATA Valid	0		250	ns
t_{OLDV}	$\overline{\text{OE}}$ Low to DATA Valid			250	ns
t_{OHDZ}	$\overline{\text{OE}}$ High to DATA Tri-stated			250	ns

Notes:
1. t_{WLRH} is valid for the Write Flash, Write EEPROM, Write Fuse bits and Write Lock bits commands.
2. t_{WLRH_CE} is valid for the Chip Erase command.

Serial Downloading

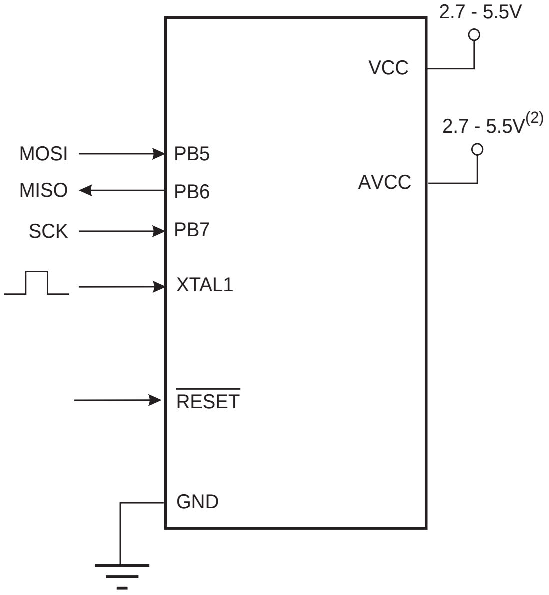
Both the Flash and EEPROM memory arrays can be programmed using the serial SPI bus while $\overline{\text{RESET}}$ is pulled to GND. The serial interface consists of pins SCK, MOSI (input), and MISO (output). After $\overline{\text{RESET}}$ is set low, the Programming Enable instruction needs to be executed first before program/erase operations can be executed. NOTE, in Table 107 on page 247, the pin mapping for SPI programming is listed. Not all parts use the SPI pins dedicated for the internal SPI interface.

Serial Programming Pin Mapping

Table 107. Pin Mapping Serial Programming

Symbol	Pins	I/O	Description
MOSI	PB5	I	Serial Data in
MISO	PB6	O	Serial Data out
SCK	PB7	I	Serial Clock

Figure 124. Serial Programming and Verify(1)



Notes: 1. If the device is clocked by the Internal Oscillator, it is no need to connect a clock source to the XTAL1 pin.
2. VCC - 0.3 < AVCC < VCC + 0.3. However, AVCC should always be within 2.7 - 5.5V.

When programming the EEPROM, an auto-erase cycle is built into the self-timed programming operation (in the Serial mode ONLY) and there is no need to first execute the Chip Erase instruction. The Chip Erase operation turns the content of every memory location in both the Program and EEPROM arrays into 0xFF.

Depending on CKSEL Fuses, a valid clock must be present. The minimum low and high periods for the serial clock (SCK) input are defined as follows:

Low:> 2 CPU clock cycles for f_{ck} < 12 MHz, 3 CPU clock cycles for f_{ck} ≥ 12 MHz

High:> 2 CPU clock cycles for f_{ck} < 12 MHz, 3 CPU clock cycles for f_{ck} ≥ 12 MHz

Serial Programming Algorithm

When writing serial data to the ATmega8535, data is clocked on the rising edge of SCK.

When reading data from the ATmega8535, data is clocked on the falling edge of SCK. See Figure 125 for timing details.

To program and verify the ATmega8535 in the Serial Programming mode, the following sequence is recommended (See four byte instruction formats in Table 109):

1. Power-up sequence:
   Apply power between V_{CC} and GND while $\overline{\text{RESET}}$ and SCK are set to “0”. In some systems, the programmer can not guarantee that SCK is held low during Power-up. In this case, $\overline{\text{RESET}}$ must be given a positive pulse of at least two CPU clock cycles duration after SCK has been set to “0”.
2. Wait for at least 20 ms and enable serial programming by sending the Programming Enable serial instruction to pin MOSI.
3. The serial programming instructions will not work if the communication is out of synchronization. When in synchronization the second byte (0x53), will echo back when issuing the third byte of the Programming Enable instruction. Whether the echo is correct or not, all four bytes of the instruction must be transmitted. If the 0x53 did not echo back, give $\overline{\text{RESET}}$ a positive pulse and issue a new Programming Enable command.
4. The Flash is programmed one page at a time. The page size is found in Table 104 on page 237. The memory page is loaded one byte at a time by supplying the 6 LSB of the address and data together with the Load Program Memory Page instruction. To ensure correct loading of the page, the data low byte must be loaded before data high byte is applied for a given address. The Program Memory Page is stored by loading the Write Program Memory Page instruction with the 8 MSB of the address. If polling is not used, the user must wait at least t_{WD_FLASH} before issuing the next page. (See Table 108.) Accessing the serial programming interface before the Flash write operation completes can result in incorrect programming.
5. The EEPROM array is programmed one byte at a time by supplying the address and data together with the appropriate Write instruction. An EEPROM memory location is first automatically erased before new data is written. If polling is not used, the user must wait at least t_{WD_EEPROM} before issuing the next byte. (See Table 108). In a chip erased device, no 0xFFs in the data file(s) need to be programmed.
6. Any memory location can be verified by using the Read instruction which returns the content at the selected address at serial output MISO.
7. At the end of the programming session, $\overline{\text{RESET}}$ can be set high to commence normal operation.
8. Power-off sequence (if needed):
   Set $\overline{\text{RESET}}$ to “1”.
   Turn V_{CC} power off.

Data Polling Flash

When a page is being programmed into the Flash, reading an address location within the page being programmed will give the value 0xFF. At the time the device is ready for a new page, the programmed value will read correctly. This is used to determine when the next page can be written. Note that the entire page is written simultaneously and any address within the page can be used for polling. Data polling of the Flash will not work for the value 0xFF, so when programming this value, the user will have to wait for at least t_{WD_FLASH} before programming the next page. As a chip erased device contains 0xFF in all locations, programming of addresses that are meant to contain 0xFF, can be skipped. See Table 108 for t_{WD_FLASH} value.

Data Polling EEPROM

When a new byte has been written and is being programmed into EEPROM, reading the address location being programmed will give the value 0xFF. At the time the device is ready for a new byte, the programmed value will read correctly. This is used to determine when the next byte can be written. This will not work for the value 0xFF, but the user should have the following in mind: As a chip erased device contains 0xFF in all locations, programming of addresses that are meant to contain 0xFF, can be skipped. This does not apply if the EEPROM is reprogrammed without chip erasing the device. In this case, data polling cannot be used for the value 0xFF, and the user will have to wait at least t_{WD_EEPROM} before programming the next byte. See Table 108 for t_{WD_EEPROM} value.

Table 108. Minimum Wait Delay Before Writing the Next Flash or EEPROM Location

Symbol	Minimum Wait Delay
t_{WD_FLASH}	4.5 ms
t_{WD_EEPROM}	9.0 ms
t_{WD_ERASE}	9.0 ms
t_{WD_FUSE}	4.5 ms

Figure 125. Serial Programming Waveforms

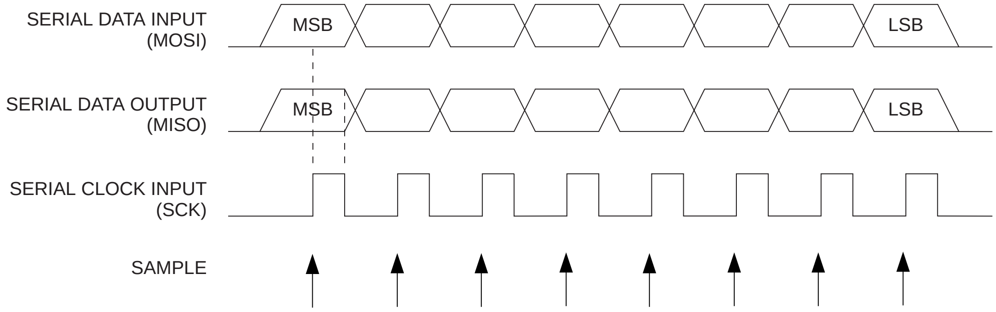


Table 109. Serial Programming Instruction Set
a = address high bits, **b** = address low bits, **H** = 0 - Low byte, 1 - High Byte, **o** = data out, **i** = data in, x = don't care

	Instruction Format				
Instruction	**Byte 1**	**Byte 2**	**Byte 3**	**Byte4**	**Operation**
Programming Enable	1010 1100	0101 0011	xxxx xxxx	xxxx xxxx	Enable Serial Programming after $\overline{\text{RESET}}$ goes low.
Chip Erase	1010 1100	100x xxxx	xxxx xxxx	xxxx xxxx	Chip Erase EEPROM and Flash.
Read Program Memory	0010 **H**000	0000 **aaaa**	**bbbb bbbb**	**oooo oooo**	Read **H** (high or low) data **o** from Program memory at word address **a**:**b**.
Load Program Memory Page	0100 **H**000	0000 xxxx	xxx**b bbbb**	**iiii iiii**	Write **H** (high or low) data **i** to Program Memory page at word address **b**. Data low byte must be loaded before Data high byte is applied within the same address.
Write Program Memory Page	0100 1100	0000 **aaaa**	**bbb**x xxxx	xxxx xxxx	Write Program Memory Page at address **a**:**b**.
Read EEPROM Memory	1010 0000	00xx xxx**a**	**bbbb bbbb**	**oooo oooo**	Read data **o** from EEPROM memory at address **a**:**b**.
Write EEPROM Memory	1100 0000	00xx xxx**a**	**bbbb bbbb**	**iiii iiii**	Write data **i** to EEPROM memory at address **a**:**b**.
Read Lock Bits	0101 1000	0000 0000	xxxx xxxx	xx**oo oooo**	Read Lock bits. "0" = programmed, "1" = unprogrammed. See Table 96 on page 233 for details.
Write Lock Bits	1010 1100	111x xxxx	xxxx xxxx	11**ii iiii**	Write Lock bits. Set bits = "0" to program Lock bits. See Table 96 on page 233 for details.
Read Signature Byte	0011 0000	00xx xxxx	xxxx xx**bb**	**oooo oooo**	Read Signature Byte **o** at address **b**.
Write Fuse Bits	1010 1100	1010 0000	xxxx xxxx	**iiii iiii**	Set bits = "0" to program, "1" to unprogram. See Table 99 on page 235 for details.
Write Fuse High Bits	1010 1100	1010 1000	xxxx xxxx	**iiii iiii**	Set bits = "0" to program, "1" to unprogram. See Table 98 on page 234 for details.
Read Fuse Bits	0101 0000	0000 0000	xxxx xxxx	**oooo oooo**	Read Fuse bits. "0" = programmed, "1" = unprogrammed. See Table 99 on page 235 for details.
Read Fuse High Bits	0101 1000	0000 1000	xxxx xxxx	**oooo oooo**	Read Fuse high bits. "0" = programmed, "1" = unprogrammed. See Table 98 on page 234 for details.
Read Calibration Byte	0011 1000	00xx xxxx	0000 00**bb**	**oooo oooo**	Read Calibration Byte

SPI Serial Programming Characteristics

For characteristics of the SPI module, see "SPI Timing Characteristics" on page 256.

Electrical Characteristics

Absolute Maximum Ratings*

Operating Temperature.................................. -55°C to +125°C

Storage Temperature..................................... -65°C to +150°C

Voltage on any Pin except $\overline{\text{RESET}}$
with respect to Ground ....-1.0V to V_{CC}+0.5V

Voltage on $\overline{\text{RESET}}$ with respect to Ground......-1.0V to +13.0V

Maximum Operating Voltage 6.0V

DC Current per I/O Pin .... 40.0 mA

DC Current V_{CC} and GND Pins .... 200.0 mA

*NOTICE: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

DC Characteristics T_A = -40°C to 85°C, V_{CC} = 2.7V to 5.5V (unless otherwise noted)

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{IL}	Input Low Voltage	Except XTAL1 pin	-0.5		0.2 V_{CC}[1]	V
V_{IL1}	Input Low Voltage	XTAL1 pin, External Clock Selected	-0.5		0.1 V_{CC}[1]	V
V_{IH}	Input High Voltage	Except XTAL1 and $\overline{\text{RESET}}$ pins	0.6 V_{CC}[2]		V_{CC} + 0.5	V
V_{IH1}	Input High Voltage	XTAL1 pin, External Clock Selected	0.8 V_{CC}[2]		V_{CC} + 0.5	V
V_{IH2}	Input High Voltage	$\overline{\text{RESET}}$ pin	0.9 V_{CC}[2]		V_{CC} + 0.4	V
V_{OL}	Output Low Voltage[3] (Ports A,B,C,D)	I_{OL} = 20 mA, V_{CC} = 5V I_{OL} = 10 mA, V_{CC} = 3V			0.7 0.5	V V
V_{OH}	Output High Voltage[4] (Ports A,B,C,D)	I_{OH} = -20 mA, V_{CC} = 5V I_{OH} = -10 mA, V_{CC} = 3V	4.0 2.2			V V
I_{IL}	Input Leakage Current I/O Pin	V_{CC} = 5.5V, pin low (absolute value)			1	µA
I_{IH}	Input Leakage Current I/O Pin	V_{CC} = 5.5V, pin high (absolute value)			1	µA
R_{RST}	Reset Pull-up Resistor		20		100	kΩ
R_{pu}	I/O Pin Pull-up Resistor		20		100	kΩ
I_{CC}	Power Supply Current	Active 4 MHz, V_{CC} = 3V (ATmega8535L)		4		mA
		Active 8 MHz, V_{CC} = 5V (ATmega8535)		14		mA
		Idle 4 MHz, V_{CC} = 3V (ATmega8535L)		2		mA
		Idle 8 MHz, V_{CC} = 5V (ATmega8535)		8		mA
	Power-down mode[5]	WDT enabled, V_{CC} = 3V		< 10		µA
		WDT disabled, V_{CC} = 3V		< 5		µA

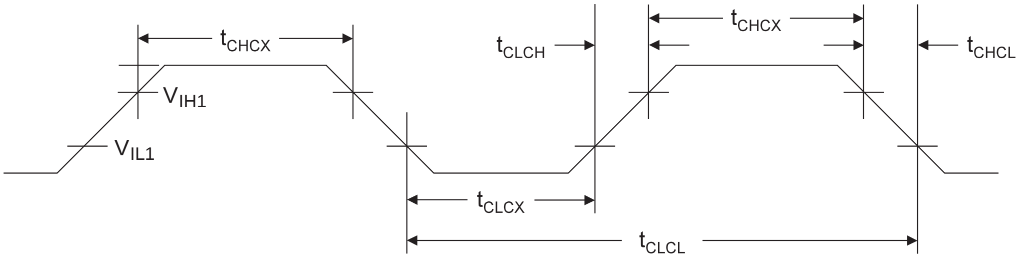
DC Characteristics T_A = -40°C to 85°C, V_{CC} = 2.7V to 5.5V (unless otherwise noted) (Continued)

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{ACIO}	Analog Comparator Input Offset Voltage	V_{CC} = 5V V_{in} = V_{CC}/2			40	mV
I_{ACLK}	Analog Comparator Input Leakage Current	V_{CC} = 5V V_{in} = V_{CC}/2	-50		50	nA
t_{ACID}	Analog Comparator Propagation Delay	V_{CC} = 2.7V V_{CC} = 4.0V		750 500		ns

Notes:
1. "Max" means the highest value where the pin is guaranteed to be read as low.
2. "Min" means the lowest value where the pin is guaranteed to be read as high.
3. Although each I/O port can sink more than the test conditions (20mA at V_{CC} = 5V, 10mA at V_{CC} = 3V) under steady state conditions (non-transient), the following must be observed:
   PDIP Package:
   1] The sum of all IOL, for all ports, should not exceed 200 mA.
   2] The sum of all IOL, for port A0 - A7, should not exceed 100 mA.
   3] The sum of all IOL, for ports B0 - B7,C0 - C7, D0 - D7 and XTAL2, should not exceed 100 mA.
   TQFP Package:
   1] The sum of all IOL, for all ports, should not exceed 400 mA.
   2] The sum of all IOL, for ports A0 - A7, should not exceed 100 mA.
   3] The sum of all IOL, for ports B0 - B3, should not exceed 100 mA.
   4] The sum of all IOL, for ports B4 - B7, should not exceed 100 mA.
   5] The sum of all IOL, for ports C0 - C3, should not exceed 100 mA.
   6] The sum of all IOL, for ports C4 - C7, should not exceed 100 mA.
   7] The sum of all IOL, for ports D0 - D3 and XTAL2, should not exceed 100 mA.
   8] The sum of all IOL, for ports D4 - D7, should not exceed 100 mA.
   If IOL exceeds the test condition, VOL may exceed the related specification. Pins are not guaranteed to sink current greater than the listed test condition.
4. Although each I/O port can source more than the test conditions (20mA at V_{CC} = 5V, 10mA at V_{CC} = 3V) under steady state conditions (non-transient), the following must be observed:
   PDIP Package:
   1] The sum of all IOH, for all ports, should not exceed 200 mA.
   2] The sum of all IOH, for port A0 - A7, should not exceed 100 mA.
   3] The sum of all IOH, for ports B0 - B7,C0 - C7, D0 - D7 and XTAL2, should not exceed 100 mA.
   TQFP Package:
   1] The sum of all IOH, for all ports, should not exceed 400 mA.
   2] The sum of all IOH, for ports A0 - A7, should not exceed 100 mA.
   3] The sum of all IOH, for ports B0 - B3, should not exceed 100 mA.
   4] The sum of all IOH, for ports B4 - B7, should not exceed 100 mA.
   5] The sum of all IOH, for ports C0 - C3, should not exceed 100 mA.
   6] The sum of all IOH, for ports C4 - C7, should not exceed 100 mA.
   7] The sum of all IOH, for ports D0 - D3 and XTAL2, should not exceed 100 mA.
   8] The sum of all IOH, for ports D4 - D7, should not exceed 100 mA
   If IOH exceeds the test condition, VOH may exceed the related specification. Pins are not guaranteed to source current greater than the listed test condition.
5. Minimum V_{CC} for Power-down is 2.5V.

External Clock Drive Waveforms

Figure 126. External Clock Drive Waveforms



External Clock Drive

Table 110. External Clock Drive

Symbol	Parameter	V_{CC} = 2.7V to 5.5V		V_{CC} = 4.5V to 5.5V		Units
		Min	Max	Min	Max	
$1/t_{CLCL}$	Oscillator Frequency	0	8	0	16	MHz
t_{CLCL}	Clock Period	125		62.5		ns
t_{CHCX}	High Time	50		25		ns
t_{CLCX}	Low Time	50		25		ns
t_{CLCH}	Rise Time		1.6		0.5	µs
t_{CHCL}	Fall Time		1.6		0.5	µs
Δt_{CLCL}	Change in period from one clock cycle to the next		2		2	%

Table 111. External RC Oscillator, Typical Frequencies(1)

R [kΩ]	C [pF]	f
100	70	TBD
31.5	20	TBD
6.5	20	TBD

Note: 1. R should be in the range 3 kΩ - 100 kΩ, and C should be at least 20 pF. The C values given in the table includes pin capacitance. This will vary with package type.

Two-wire Serial Interface Characteristics

Table 112 describes the requirements for devices connected to the Two-wire Serial Bus. The ATmega8535 Two-wire Serial Interface meets or exceeds these requirements under the noted conditions.

Timing symbols refer to Figure 127.

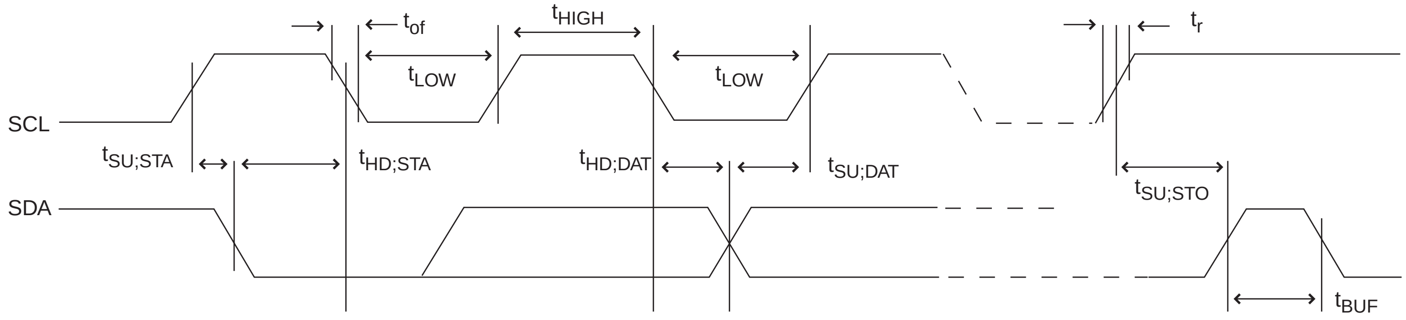
Table 112. Two-wire Serial Bus Requirements

Symbol	Parameter	Condition	Min	Max	Units
V_{IL}	Input Low Voltage		-0.5	0.3 V_{CC}	V
V_{IH}	Input High Voltage		0.7 V_{CC}	V_{CC} + 0.5	V
V_{hys}(1)	Hysteresis of Schmitt Trigger Inputs		0.05 V_{CC}(2)	–	V
V_{OL}(1)	Output Low Voltage	3 mA sink current	0	0.4	V
t_r(1)	Rise Time for both SDA and SCL		20 + 0.1C_b(3)(2)	300	ns
t_{of}(1)	Output Fall Time from V_{IHmin} to V_{ILmax}	10 pF < C_b < 400 pF(3)	20 + 0.1C_b(3)(2)	250	ns
t_{SP}(1)	Spikes Suppressed by Input Filter		0	50(2)	ns
I_i	Input Current each I/O Pin	0.1V_{CC} < V_i < 0.9V_{CC}	-10	10	µA
C_i(1)	Capacitance for each I/O Pin		–	10	pF
f_{SCL}	SCL Clock Frequency	f_{CK}(4) > max(16f_{SCL}, 250kHz)(5)	0	400	kHz
Rp	Value of Pull-up resistor	$f_{SCL} \leq$ 100 kHz	$\frac{V_{CC}-0.4V}{3mA}$	$\frac{1000ns}{C_b}$	Ω
		f_{SCL} > 100 kHz	$\frac{V_{CC}-0.4V}{3mA}$	$\frac{300ns}{C_b}$	Ω
$t_{HD;STA}$	Hold Time (Repeated) START Condition	$f_{SCL} \leq$ 100 kHz	4.0	–	µs
		f_{SCL} > 100 kHz	0.6	–	µs
t_{LOW}	Low Period of the SCL Clock	$f_{SCL} \leq$ 100 kHz(6)	4.7	–	µs
		f_{SCL} > 100 kHz(7)	1.3	–	µs
t_{HIGH}	High Period of the SCL clock	$f_{SCL} \leq$ 100 kHz	4.0	–	µs
		f_{SCL} > 100 kHz	0.6	–	µs
$t_{SU;STA}$	Set-up Time for a Repeated START Condition	$f_{SCL} \leq$ 100 kHz	4.7	–	µs
		f_{SCL} > 100 kHz	0.6	–	µs
$t_{HD;DAT}$	Data hoLd Time	$f_{SCL} \leq$ 100 kHz	0	3.45	µs
		f_{SCL} > 100 kHz	0	0.9	µs
$t_{SU;DAT}$	Data Setup Time	$f_{SCL} \leq$ 100 kHz	250	–	ns
		f_{SCL} > 100 kHz	100	–	ns
$t_{SU;STO}$	Setup Time for STOP Condition	$f_{SCL} \leq$ 100 kHz	4.0	–	µs
		f_{SCL} > 100 kHz	0.6	–	µs
t_{BUF}	Bus Free Time between a STOP and START Condition	$f_{SCL} \leq$ 100 kHz	4.7	–	µs
		f_{SCL} > 100 kHz	1.3	–	µs

Notes:
1. In ATmega8535, this parameter is characterized and not 100% tested.
2. Required only for f_{SCL} > 100 kHz.
3. C_b = capacitance of one bus line in pF.
4. f_{CK} = CPU clock frequency.

5. This requirement applies to all ATmega8535 Two-wire Serial Interface operation. Other devices connected to the Two-wire Serial Bus need only obey the general f_{SCL} requirement.
6. The actual low period generated by the ATmega8535 Two-wire Serial Interface is $(1/f_{SCL} - 2/f_{CK})$, thus f_{CK} must be greater than 6 MHz for the low time requirement to be strictly met at f_{SCL} = 100 kHz.
7. The actual low period generated by the ATmega8535 Two-wire Serial Interface is $(1/f_{SCL} - 2/f_{CK})$, thus the low time requirement will not be strictly met for f_{SCL} > 308 kHz when f_{CK} = 8 MHz. Still, ATmega8535 devices connected to the bus may communicate at full speed (400 kHz) with other ATmega8535 devices, as well as any other device with a proper t_{LOW} acceptance margin.

Figure 127. Two-wire Serial Bus Timing



SPI Timing Characteristics

See Figure 128 and Figure 129 for details.

Table 113. SPI Timing Parameters

	Description	Mode	Min	Typ	Max	
1	SCK period	Master		See Table 59		ns
2	SCK high/low	Master		50% duty cycle		
3	Rise/Fall time	Master		TBD		
4	Setup	Master		10		
5	Hold	Master		10		
6	Out to SCK	Master		$5 \bullet t_{SCK}$		
7	SCK to out	Master		10		
8	SCK to out high	Master		10		
9	SS low to out	Slave		15		
10	SCK period	Slave	$4 \bullet t_{ck}$			
11	SCK high/low	Slave	$2 \bullet t_{ck}$			
12	Rise/Fall time	Slave		TBD		
13	Setup	Slave	10			
14	Hold	Slave	t_{ck}			
15	SCK to out	Slave		15		
16	SCK to $\overline{SS}$ high	Slave	20			
17	$\overline{SS}$ high to tri-state	Slave		10		
18	SS low to SCK	Slave	$2 \bullet t_{ck}$			

Figure 128. SPI Interface Timing Requirements (Master Mode)

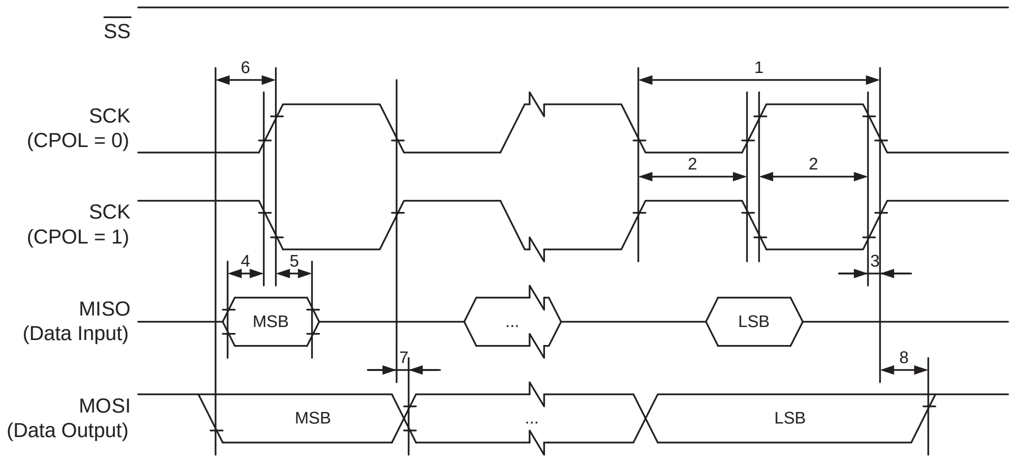
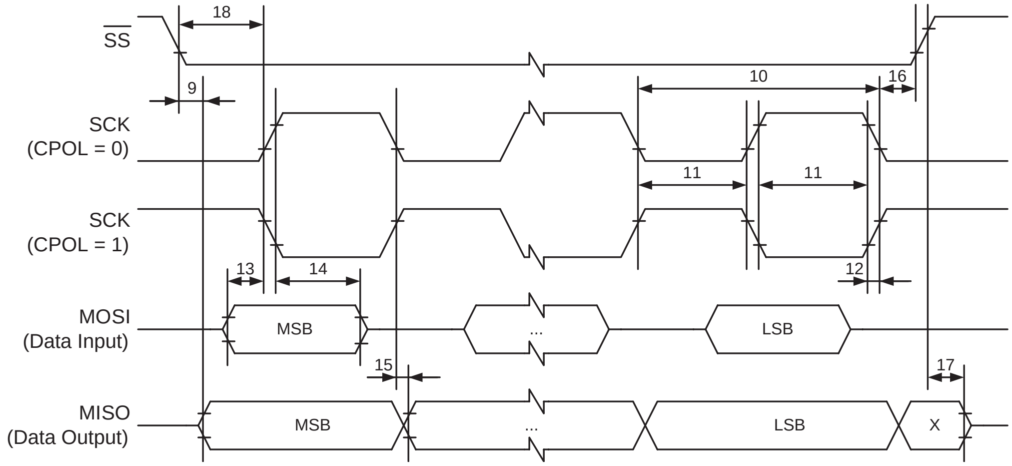


Figure 129. SPI Interface Timing Requirements (Slave Mode)



ADC Characteristics – Preliminary Data

Table 114. ADC Characteristics

Symbol	Parameter	Condition	Min[1]	Typ[1]	Max[1]	Units
	Resolution	Single Ended Conversion		10		Bits
		Differential Conversion Gain = 1x or 20x		8		Bits
		Differential Conversion Gain = 200x		7		Bits
	Absolute Accuracy	Single Ended Conversion V_{REF} = 4V ADC clock = 200 kHz		1	TBD	LSB
	Integral Non-linearity	V_{REF} = 4V		0.5		LSB
	Differential Non-linearity	V_{REF} = 4V		0.5		LSB
	Zero Error (Offset)	V_{REF} = 4V		1		LSB
	Conversion Time	Free Running Conversion	65		260	µs
	Clock Frequency		50		200	kHz
AV_{CC}	Analog Supply Voltage		V_{CC} - 0.3[2]		V_{CC} + 0.3[3]	V
V_{REF}	Reference Voltage	Single Ended Conversion	2.0		AV_{CC}	V
		Differential Conversion	2.0		$AV_{CC - 0.2}$	V
V_{IN}	Input Voltage	Single ended channels	GND		V_{REF}	
		Differential channels	TBD		TBD	
	Input Bandwidth	Single ended channels		TBD		kHz
		Differential channels		4		kHz
V_{INT}	Internal Voltage Reference		TBD	2.56	TBD	V
R_{REF}	Reference Input Resistance		TBD	TBD	TBD	kΩ
R_{AIN}	Analog Input Resistance			TBD		MΩ

Notes:
1. Values are guidelines only. Actual values are TBD.
2. Minimum for AV_{CC} is 2.7V.
3. Maximum for AV_{CC} is 5.5V.

ATmega8535 Typical Characteristics – Preliminary Data

The following charts show typical behavior. These figures are not tested during manufacturing. All current consumption measurements are performed with all I/O pins configured as inputs and with internal pull-ups enabled. A sine wave generator with rail-to-rail output is used as clock source.

The power consumption in Power-down mode is independent of clock selection.

The current consumption is a function of several factors such as: Operating voltage, operating frequency, loading of I/O pins, switching rate of I/O pins, code executed and ambient temperature. The dominating factors are operating voltage and frequency.

The current drawn from capacitive loaded pins may be estimated (for one pin) as C_L*V_{CC}*f where C_L = load capacitance, V_{CC} = operating voltage and f = average switching frequency of I/O pin.

The parts are characterized at frequencies higher than test limits. Parts are not guaranteed to function properly at frequencies higher than the ordering code indicates.

The difference between current consumption in Power-down mode with Watchdog Timer enabled and Power-down mode with Watchdog Timer disabled represents the differential current drawn by the Watchdog Timer.

Register Summary

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page
0x3F (0x5F)	SREG	I	T	H	S	V	N	Z	C	8
0x3E (0x5E)	SPH	–	–	–	–	–	SP10	SP9	SP8	10
0x3D (0x5D)	SPL	SP7	SP6	SP5	SP4	SP3	SP2	SP1	SP0	10
0x3C (0x5C)	OCR0	Timer/Counter0 Output Compare Register								82
0x3B (0x5B)	GICR	INT1	INT0	INT2	–	–	–	IVSEL	IVCE	47, 66
0x3A (0x5A)	GIFR	INTF1	INTF0	INTF2	–	–	–	–	–	67
0x39 (0x59)	TIMSK	OCIE2	TOIE2	TICIE1	OCIE1A	OCIE1B	TOIE1	OCIE0	TOIE0	82, 112, 130
0x38 (0x58)	TIFR	OCF2	TOV2	ICF1	OCF1A	OCF1B	TOV1	OCF0	TOV0	83, 113, 131
0x37 (0x57)	SPMCR	SPMIE	RWWSB	–	RWWSRE	BLBSET	PGWRT	PGERS	SPMEN	224
0x36 (0x56)	TWCR	TWINT	TWEA	TWSTA	TWSTO	TWWC	TWEN	–	TWIE	177
0x35 (0x55)	MCUCR	SM2	SE	SM1	SM0	ISC11	ISC10	ISC01	ISC00	30, 65
0x34 (0x54)	MCUCSR	–	ISC2	–	–	WDRF	BORF	EXTRF	PORF	38, 66
0x33 (0x53)	TCCR0	FOC0	WGM00	COM01	COM00	WGM01	CS02	CS01	CS00	80
0x32 (0x52)	TCNT0	Timer/Counter0 (8 Bits)								82
0x31 (0x51)	OSCCAL	Oscillator Calibration Register								28
0x30 (0x50)	SFIOR	ADTS2	ADTS1	ADTS0	–	ACME	PUD	PSR2	PSR10	56,85,132,199,219
0x2F (0x4F)	TCCR1A	COM1A1	COM1A0	COM1B1	COM1B0	FOC1A	FOC1B	WGM11	WGM10	107
0x2E (0x4E)	TCCR1B	ICNC1	ICES1	–	WGM13	WGM12	CS12	CS11	CS10	110
0x2D (0x4D)	TCNT1H	Timer/Counter1 – Counter Register High Byte								111
0x2C (0x4C)	TCNT1L	Timer/Counter1 – Counter Register Low Byte								111
0x2B (0x4B)	OCR1AH	Timer/Counter1 – Output Compare Register A High Byte								111
0x2A (0x4A)	OCR1AL	Timer/Counter1 – Output Compare Register A Low Byte								111
0x29 (0x49)	OCR1BH	Timer/Counter1 – Output Compare Register B High Byte								111
0x28 (0x48)	OCR1BL	Timer/Counter1 – Output Compare Register B Low Byte								111
0x27 (0x47)	ICR1H	Timer/Counter1 – Input Capture Register High Byte								111
0x26 (0x46)	ICR1L	Timer/Counter1 – Input Capture Register Low Byte								111
0x25 (0x45)	TCCR2	FOC2	WGM20	COM21	COM20	WGM21	CS22	CS21	CS20	125
0x24 (0x44)	TCNT2	Timer/Counter2 (8 Bits)								127
0x23 (0x43)	OCR2	Timer/Counter2 Output Compare Register								128
0x22 (0x42)	ASSR	–	–	–	–	AS2	TCN2UB	OCR2UB	TCR2UB	128
0x21 (0x41)	WDTCR	–	–	–	WDCE	WDE	WDP2	WDP1	WDP0	40
0x20[(1)] (0x40)[(1)]	UBRRH	URSEL	–	–	–	UBRR[11:8]				165
	UCSRC	URSEL	UMSEL	UPM1	UPM0	USBS	UCSZ1	UCSZ0	UCPOL	163
0x1F (0x3F)	EEARH	–	–	–	–	–	–	–	EEAR8	17
0x1E (0x3E)	EEARL	EEPROM Address Register Low Byte								17
0x1D (0x3D)	EEDR	EEPROM Data Register								17
0x1C (0x3C)	EECR	–	–	–	–	EERIE	EEMWE	EEWE	EERE	17
0x1B (0x3B)	PORTA	PORTA7	PORTA6	PORTA5	PORTA4	PORTA3	PORTA2	PORTA1	PORTA0	63
0x1A (0x3A)	DDRA	DDA7	DDA6	DDA5	DDA4	DDA3	DDA2	DDA1	DDA0	63
0x19 (0x39)	PINA	PINA7	PINA6	PINA5	PINA4	PINA3	PINA2	PINA1	PINA0	63
0x18 (0x38)	PORTB	PORTB7	PORTB6	PORTB5	PORTB4	PORTB3	PORTB2	PORTB1	PORTB0	63
0x17 (0x37)	DDRB	DDB7	DDB6	DDB5	DDB4	DDB3	DDB2	DDB1	DDB0	63
0x16 (0x36)	PINB	PINB7	PINB6	PINB5	PINB4	PINB3	PINB2	PINB1	PINB0	64
0x15 (0x35)	PORTC	PORTC7	PORTC6	PORTC5	PORTC4	PORTC3	PORTC2	PORTC1	PORTC0	64
0x14 (0x34)	DDRC	DDC7	DDC6	DDC5	DDC4	DDC3	DDC2	DDC1	DDC0	64
0x13 (0x33)	PINC	PINC7	PINC6	PINC5	PINC4	PINC3	PINC2	PINC1	PINC0	64
0x12 (0x32)	PORTD	PORTD7	PORTD6	PORTD5	PORTD4	PORTD3	PORTD2	PORTD1	PORTD0	64
0x11 (0x31)	DDRD	DDD7	DDD6	DDD5	DDD4	DDD3	DDD2	DDD1	DDD0	64
0x10 (0x30)	PIND	PIND7	PIND6	PIND5	PIND4	PIND3	PIND2	PIND1	PIND0	64
0x0F (0x2F)	SPDR	SPI Data Register								139
0x0E (0x2E)	SPSR	SPIF	WCOL	–	–	–	–	–	SPI2X	139
0x0D (0x2D)	SPCR	SPIE	SPE	DORD	MSTR	CPOL	CPHA	SPR1	SPR0	137
0x0C (0x2C)	UDR	USART I/O Data Register								160
0x0B (0x2B)	UCSRA	RXC	TXC	UDRE	FE	DOR	PE	U2X	MPCM	161
0x0A (0x2A)	UCSRB	RXCIE	TXCIE	UDRIE	RXEN	TXEN	UCSZ2	RXB8	TXB8	162
0x09 (0x29)	UBRRL	USART Baud Rate Register Low Byte								165
0x08 (0x28)	ACSR	ACD	ACBG	ACO	ACI	ACIE	ACIC	ACIS1	ACIS0	199
0x07 (0x27)	ADMUX	REFS1	REFS0	ADLAR	MUX4	MUX3	MUX2	MUX1	MUX0	215
0x06 (0x26)	ADCSRA	ADEN	ADSC	ADATE	ADIF	ADIE	ADPS2	ADPS1	ADPS0	217
0x05 (0x25)	ADCH	ADC Data Register High Byte								218
0x04 (0x24)	ADCL	ADC Data Register Low Byte								218
0x03 (0x23)	TWDR	Two-wire Serial Interface Data Register								179
0x02 (0x22)	TWAR	TWA6	TWA5	TWA4	TWA3	TWA2	TWA1	TWA0	TWGCE	180
0x01 (0x21)	TWSR	TWS7	TWS6	TWS5	TWS4	TWS3	–	TWPS1	TWPS0	179

Register Summary (Continued)

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page
0x00 (0x20)	TWBR	Two-wire Serial Interface Bit Rate Register								177

Notes:
1. Refer to the USART description for details on how to access UBRRH and UCSRC.
2. For compatibility with future devices, reserved bits should be written to zero if accessed. Reserved I/O memory addresses should never be written.
3. Some of the status flags are cleared by writing a logical one to them. Note that the CBI and SBI instructions will operate on all bits in the I/O Register, writing a one back into any flag read as set, thus clearing the flag. The CBI and SBI instructions work with registers 0x00 to 0x1F only.

Instruction Set Summary

Mnemonics	Operands	Description	Operation	Flags	#Clocks
ARITHMETIC AND LOGIC INSTRUCTIONS					
ADD	Rd, Rr	Add two Registers	Rd ← Rd + Rr	Z,C,N,V,H	1
ADC	Rd, Rr	Add with Carry two Registers	Rd ← Rd + Rr + C	Z,C,N,V,H	1
ADIW	Rdl,K	Add Immediate to Word	Rdh:Rdl ← Rdh:Rdl + K	Z,C,N,V,S	2
SUB	Rd, Rr	Subtract two Registers	Rd ← Rd - Rr	Z,C,N,V,H	1
SUBI	Rd, K	Subtract Constant from Register	Rd ← Rd - K	Z,C,N,V,H	1
SBC	Rd, Rr	Subtract with Carry two Registers	Rd ← Rd - Rr - C	Z,C,N,V,H	1
SBCI	Rd, K	Subtract with Carry Constant from Reg.	Rd ← Rd - K - C	Z,C,N,V,H	1
SBIW	Rdl,K	Subtract Immediate from Word	Rdh:Rdl ← Rdh:Rdl - K	Z,C,N,V,S	2
AND	Rd, Rr	Logical AND Registers	Rd ← Rd • Rr	Z,N,V	1
ANDI	Rd, K	Logical AND Register and Constant	Rd ← Rd • K	Z,N,V	1
OR	Rd, Rr	Logical OR Registers	Rd ← Rd v Rr	Z,N,V	1
ORI	Rd, K	Logical OR Register and Constant	Rd ← Rd v K	Z,N,V	1
EOR	Rd, Rr	Exclusive OR Registers	Rd ← Rd ⊕ Rr	Z,N,V	1
COM	Rd	One's Complement	Rd ← 0xFF – Rd	Z,C,N,V	1
NEG	Rd	Two's Complement	Rd ← 0x00 – Rd	Z,C,N,V,H	1
SBR	Rd,K	Set Bit(s) in Register	Rd ← Rd v K	Z,N,V	1
CBR	Rd,K	Clear Bit(s) in Register	Rd ← Rd • (0xFF - K)	Z,N,V	1
INC	Rd	Increment	Rd ← Rd + 1	Z,N,V	1
DEC	Rd	Decrement	Rd ← Rd – 1	Z,N,V	1
TST	Rd	Test for Zero or Minus	Rd ← Rd • Rd	Z,N,V	1
CLR	Rd	Clear Register	Rd ← Rd ⊕ Rd	Z,N,V	1
SER	Rd	Set Register	Rd ← 0xFF	None	1
MUL	Rd, Rr	Multiply Unsigned	R1:R0 ← Rd x Rr	Z,C	2
MULS	Rd, Rr	Multiply Signed	R1:R0 ← Rd x Rr	Z,C	2
MULSU	Rd, Rr	Multiply Signed with Unsigned	R1:R0 ← Rd x Rr	Z,C	2
FMUL	Rd, Rr	Fractional Multiply Unsigned	R1:R0 ← (Rd x Rr) << 1	Z,C	2
FMULS	Rd, Rr	Fractional Multiply Signed	R1:R0 ← (Rd x Rr) << 1	Z,C	2
FMULSU	Rd, Rr	Fractional Multiply Signed with Unsigned	R1:R0 ← (Rd x Rr) << 1	Z,C	2
BRANCH INSTRUCTIONS					
RJMP	k	Relative Jump	PC ← PC + k + 1	None	2
IJMP		Indirect Jump to (Z)	PC ← Z	None	2
JMP	k	Direct Jump	PC ← k	None	3
RCALL	k	Relative Subroutine Call	PC ← PC + k + 1	None	3
ICALL		Indirect Call to (Z)	PC ← Z	None	3
CALL	k	Direct Subroutine Call	PC ← k	None	4
RET		Subroutine Return	PC ← STACK	None	4
RETI		Interrupt Return	PC ← STACK	I	4
CPSE	Rd,Rr	Compare, Skip if Equal	if (Rd = Rr) PC ← PC + 2 or 3	None	1 / 2 / 3
CP	Rd,Rr	Compare	Rd – Rr	Z, N,V,C,H	1
CPC	Rd,Rr	Compare with Carry	Rd – Rr – C	Z, N,V,C,H	1
CPI	Rd,K	Compare Register with Immediate	Rd – K	Z, N,V,C,H	1
SBRC	Rr, b	Skip if Bit in Register Cleared	if (Rr(b)=0) PC ← PC + 2 or 3	None	1 / 2 / 3
SBRS	Rr, b	Skip if Bit in Register is Set	if (Rr(b)=1) PC ← PC + 2 or 3	None	1 / 2 / 3
SBIC	P, b	Skip if Bit in I/O Register Cleared	if (P(b)=0) PC ← PC + 2 or 3	None	1 / 2 / 3
SBIS	P, b	Skip if Bit in I/O Register is Set	if (P(b)=1) PC ← PC + 2 or 3	None	1 / 2 / 3
BRBS	s, k	Branch if Status Flag Set	if (SREG(s) = 1) then PC←PC+k + 1	None	1 / 2
BRBC	s, k	Branch if Status Flag Cleared	if (SREG(s) = 0) then PC←PC+k + 1	None	1 / 2
BREQ	k	Branch if Equal	if (Z = 1) then PC ← PC + k + 1	None	1 / 2
BRNE	k	Branch if Not Equal	if (Z = 0) then PC ← PC + k + 1	None	1 / 2
BRCS	k	Branch if Carry Set	if (C = 1) then PC ← PC + k + 1	None	1 / 2
BRCC	k	Branch if Carry Cleared	if (C = 0) then PC ← PC + k + 1	None	1 / 2
BRSH	k	Branch if Same or Higher	if (C = 0) then PC ← PC + k + 1	None	1 / 2
BRLO	k	Branch if Lower	if (C = 1) then PC ← PC + k + 1	None	1 / 2
BRMI	k	Branch if Minus	if (N = 1) then PC ← PC + k + 1	None	1 / 2
BRPL	k	Branch if Plus	if (N = 0) then PC ← PC + k + 1	None	1 / 2
BRGE	k	Branch if Greater or Equal, Signed	if (N ⊕ V= 0) then PC ← PC + k + 1	None	1 / 2
BRLT	k	Branch if Less Than Zero, Signed	if (N ⊕ V= 1) then PC ← PC + k + 1	None	1 / 2
BRHS	k	Branch if Half Carry Flag Set	if (H = 1) then PC ← PC + k + 1	None	1 / 2
BRHC	k	Branch if Half Carry Flag Cleared	if (H = 0) then PC ← PC + k + 1	None	1 / 2
BRTS	k	Branch if T Flag Set	if (T = 1) then PC ← PC + k + 1	None	1 / 2
BRTC	k	Branch if T Flag Cleared	if (T = 0) then PC ← PC + k + 1	None	1 / 2
BRVS	k	Branch if Overflow Flag is Set	if (V = 1) then PC ← PC + k + 1	None	1 / 2
BRVC	k	Branch if Overflow Flag is Cleared	if (V = 0) then PC ← PC + k + 1	None	1 / 2
BRIE	k	Branch if Interrupt Enabled	if (I = 1) then PC ← PC + k + 1	None	1 / 2

Mnemonics	Operands	Description	Operation	Flags	#Clocks
BRID	k	Branch if Interrupt Disabled	if (I = 0) then PC ← PC + k + 1	None	1 / 2
DATA TRANSFER INSTRUCTIONS					
MOV	Rd, Rr	Move Between Registers	Rd ← Rr	None	1
MOVW	Rd, Rr	Copy Register Word	Rd+1:Rd ← Rr+1:Rr	None	1
LDI	Rd, K	Load Immediate	Rd ← K	None	1
LD	Rd, X	Load Indirect	Rd ← (X)	None	2
LD	Rd, X+	Load Indirect and Post-Inc.	Rd ← (X), X ← X + 1	None	2
LD	Rd, - X	Load Indirect and Pre-Dec.	X ← X - 1, Rd ← (X)	None	2
LD	Rd, Y	Load Indirect	Rd ← (Y)	None	2
LD	Rd, Y+	Load Indirect and Post-Inc.	Rd ← (Y), Y ← Y + 1	None	2
LD	Rd, - Y	Load Indirect and Pre-Dec.	Y ← Y - 1, Rd ← (Y)	None	2
LDD	Rd,Y+q	Load Indirect with Displacement	Rd ← (Y + q)	None	2
LD	Rd, Z	Load Indirect	Rd ← (Z)	None	2
LD	Rd, Z+	Load Indirect and Post-Inc.	Rd ← (Z), Z ← Z+1	None	2
LD	Rd, -Z	Load Indirect and Pre-Dec.	Z ← Z - 1, Rd ← (Z)	None	2
LDD	Rd, Z+q	Load Indirect with Displacement	Rd ← (Z + q)	None	2
LDS	Rd, k	Load Direct from SRAM	Rd ← (k)	None	2
ST	X, Rr	Store Indirect	(X) ← Rr	None	2
ST	X+, Rr	Store Indirect and Post-Inc.	(X) ← Rr, X ← X + 1	None	2
ST	- X, Rr	Store Indirect and Pre-Dec.	X ← X - 1, (X) ← Rr	None	2
ST	Y, Rr	Store Indirect	(Y) ← Rr	None	2
ST	Y+, Rr	Store Indirect and Post-Inc.	(Y) ← Rr, Y ← Y + 1	None	2
ST	- Y, Rr	Store Indirect and Pre-Dec.	Y ← Y - 1, (Y) ← Rr	None	2
STD	Y+q,Rr	Store Indirect with Displacement	(Y + q) ← Rr	None	2
ST	Z, Rr	Store Indirect	(Z) ← Rr	None	2
ST	Z+, Rr	Store Indirect and Post-Inc.	(Z) ← Rr, Z ← Z + 1	None	2
ST	-Z, Rr	Store Indirect and Pre-Dec.	Z ← Z - 1, (Z) ← Rr	None	2
STD	Z+q,Rr	Store Indirect with Displacement	(Z + q) ← Rr	None	2
STS	k, Rr	Store Direct to SRAM	(k) ← Rr	None	2
LPM		Load Program Memory	R0 ← (Z)	None	3
LPM	Rd, Z	Load Program Memory	Rd ← (Z)	None	3
LPM	Rd, Z+	Load Program Memory and Post-Inc	Rd ← (Z), Z ← Z+1	None	3
SPM		Store Program Memory	(Z) ← R1:R0	None	-
IN	Rd, P	In Port	Rd ← P	None	1
OUT	P, Rr	Out Port	P ← Rr	None	1
PUSH	Rr	Push Register on Stack	STACK ← Rr	None	2
POP	Rd	Pop Register from Stack	Rd ← STACK	None	2
BIT AND BIT-TEST INSTRUCTIONS					
SBI	P,b	Set Bit in I/O Register	I/O(P,b) ← 1	None	2
CBI	P,b	Clear Bit in I/O Register	I/O(P,b) ← 0	None	2
LSL	Rd	Logical Shift Left	Rd(n+1) ← Rd(n), Rd(0) ← 0	Z,C,N,V	1
LSR	Rd	Logical Shift Right	Rd(n) ← Rd(n+1), Rd(7) ← 0	Z,C,N,V	1
ROL	Rd	Rotate Left Through Carry	Rd(0)←C,Rd(n+1)← Rd(n),C←Rd(7)	Z,C,N,V	1
ROR	Rd	Rotate Right Through Carry	Rd(7)←C,Rd(n)← Rd(n+1),C←Rd(0)	Z,C,N,V	1
ASR	Rd	Arithmetic Shift Right	Rd(n) ← Rd(n+1), n=0..6	Z,C,N,V	1
SWAP	Rd	Swap Nibbles	Rd(3..0)←Rd(7..4),Rd(7..4)←Rd(3..0)	None	1
BSET	s	Flag Set	SREG(s) ← 1	SREG(s)	1
BCLR	s	Flag Clear	SREG(s) ← 0	SREG(s)	1
BST	Rr, b	Bit Store from Register to T	T ← Rr(b)	T	1
BLD	Rd, b	Bit load from T to Register	Rd(b) ← T	None	1
SEC		Set Carry	C ← 1	C	1
CLC		Clear Carry	C ← 0	C	1
SEN		Set Negative Flag	N ← 1	N	1
CLN		Clear Negative Flag	N ← 0	N	1
SEZ		Set Zero Flag	Z ← 1	Z	1
CLZ		Clear Zero Flag	Z ← 0	Z	1
SEI		Global Interrupt Enable	I ← 1	I	1
CLI		Global Interrupt Disable	I ← 0	I	1
SES		Set Signed Test Flag	S ← 1	S	1
CLS		Clear Signed Test Flag	S ← 0	S	1
SEV		Set Twos Complement Overflow.	V ← 1	V	1
CLV		Clear Twos Complement Overflow	V ← 0	V	1
SET		Set T in SREG	T ← 1	T	1
CLT		Clear T in SREG	T ← 0	T	1
SEH		Set Half Carry Flag in SREG	H ← 1	H	1
CLH		Clear Half Carry Flag in SREG	H ← 0	H	1

Mnemonics	Operands	Description	Operation	Flags	#Clocks
MCU CONTROL INSTRUCTIONS					
NOP		No Operation		None	1
SLEEP		Sleep	(see specific descr. for Sleep function)	None	1
WDR		Watchdog Reset	(see specific descr. for WDR/Timer)	None	1
BREAK		Break	For On-chip Debug Only	None	N/A

Ordering Information[1]

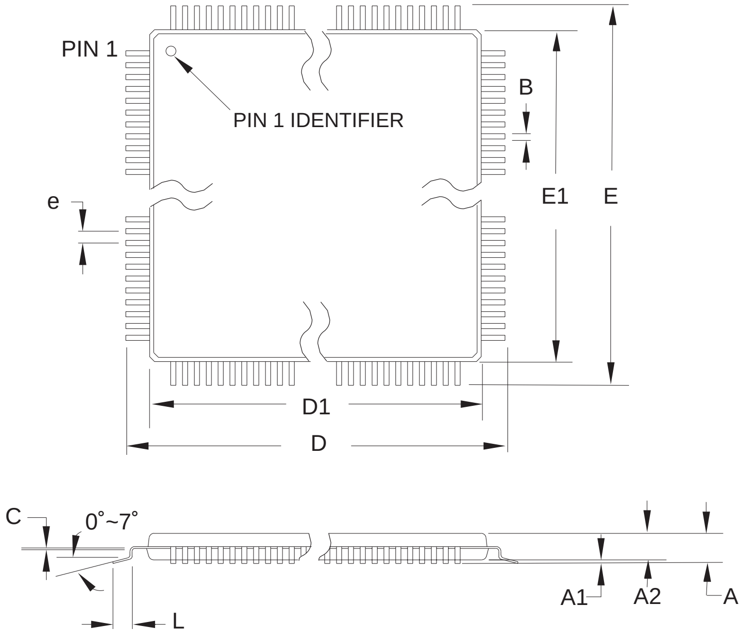
Speed (MHz)	Power Supply	Ordering Code	Package	Operation Range
8	2.7 - 5.5V	ATmega8535L-8AC ATmega8535L-8PC ATmega8535L-8JC ATmega8535L-8MC	44A 40P6 44J 44M1	Commercial (0°C to 70°C)
		ATmega8535L-8AI ATmega8535L-8PI ATmega8535L-8JI ATmega8535L-8MI	44A 40P6 44J 44M1	Industrial (-40°C to 85°C)
16	4.5 - 5.5V	ATmega8535-16AC ATmega8535-16PC ATmega8535-16JC ATmega8535-16MC	44A 40P6 44J 44M1	Commercial (0°C to 70°C)
		ATmega8535-16AI ATmega8535-16PI ATmega8535-16JI ATmega8535-16MI	44A 40P6 44J 44M1	Industrial (-40°C to 85°C)

Note: 1. This device can also be supplied in wafer form. Please contact your local Atmel sales office for detailed ordering information and minimum quantities.

Package Type	
44A	44-lead, Thin (1.0 mm) Plastic Gull Wing Quad Flat Package (TQFP)
40P6	40-pin, 0.600” Wide, Plastic Dual Inline Package (PDIP)
44J	44-lead, Plastic J-ledded Chip Carrier (PLCC)
44M1-A	44-pad, 7 x 7 x 1.0 mm body, lead pitch 0.50 mm, Micro Lead Frame Package (MLF)

Packaging Information

44A



COMMON DIMENSIONS
(Unit of Measure = mm)

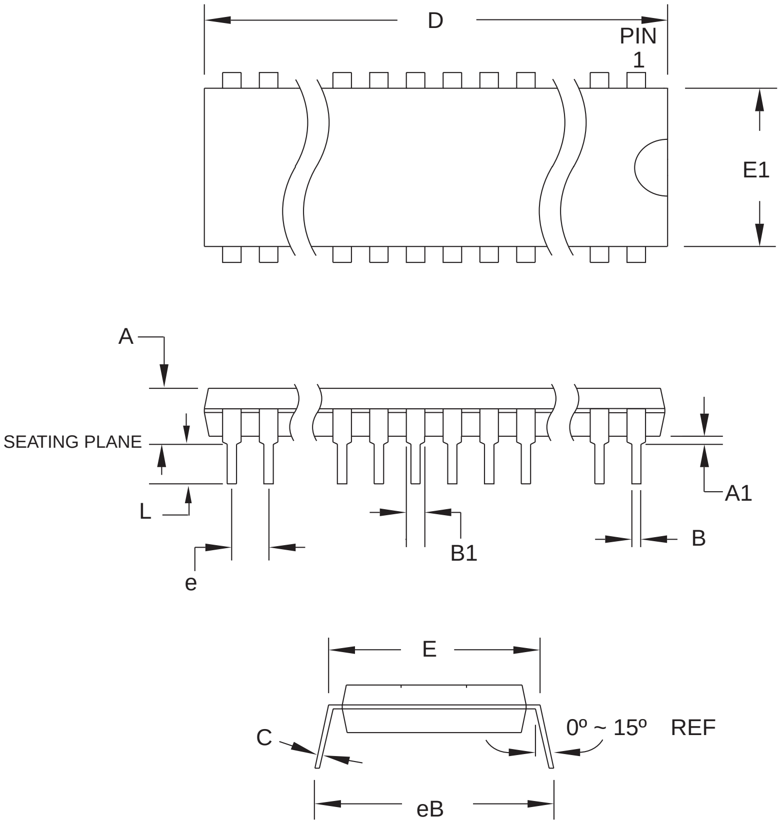
SYMBOL	MIN	NOM	MAX	NOTE
A	–	–	1.20	
A1	0.05	–	0.15	
A2	0.95	1.00	1.05	
D	11.75	12.00	12.25	
D1	9.90	10.00	10.10	Note 2
E	11.75	12.00	12.25	
E1	9.90	10.00	10.10	Note 2
B	0.30	–	0.45	
C	0.09	–	0.20	
L	0.45	–	0.75	
e	0.80 TYP			

Notes:
1. This package conforms to JEDEC reference MS-026, Variation ACB.
2. Dimensions D1 and E1 do not include mold protrusion. Allowable protrusion is 0.25 mm per side. Dimensions D1 and E1 are maximum plastic body size dimensions including mold mismatch.
3. Lead coplanarity is 0.10 mm maximum.

10/5/2001

	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**44A,** 44-lead, 10 x 10 mm Body Size, 1.0 mm Body Thickness, 0.8 mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)	44A	B

40P6



COMMON DIMENSIONS
(Unit of Measure = mm)

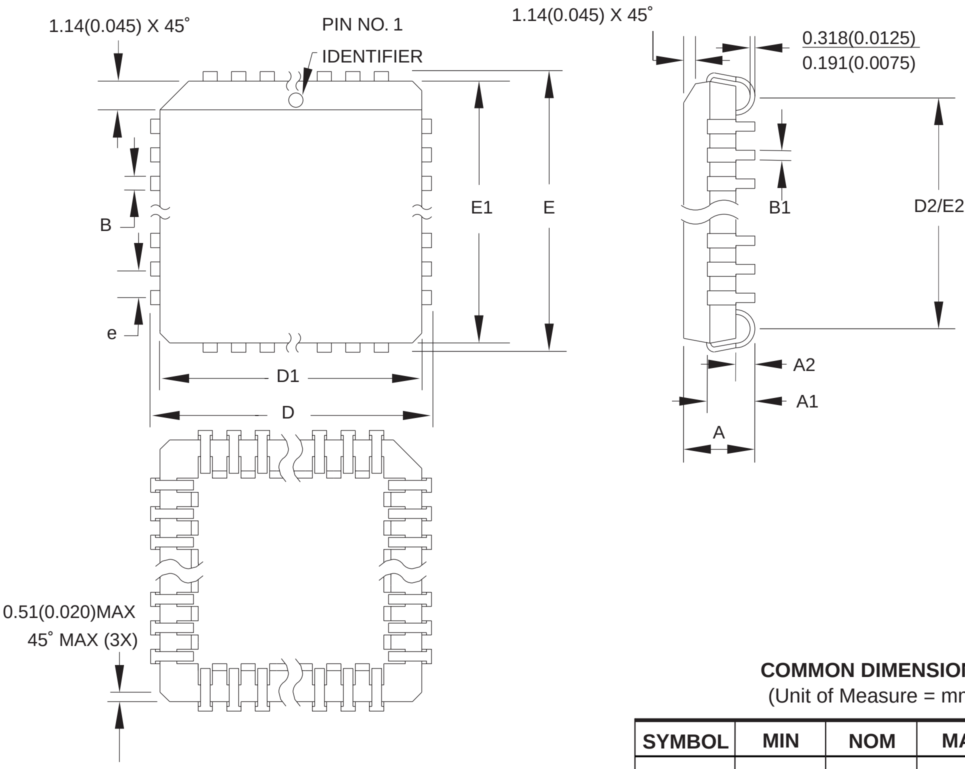
SYMBOL	MIN	NOM	MAX	NOTE
A	–	–	4.826	
A1	0.381	–	–	
D	52.070	–	52.578	Note 2
E	15.240	–	15.875	
E1	13.462	–	13.970	Note 2
B	0.356	–	0.559	
B1	1.041	–	1.651	
L	3.048	–	3.556	
C	0.203	–	0.381	
eB	15.494	–	17.526	
e	2.540 TYP			

Notes:
1. This package conforms to JEDEC reference MS-011, Variation AC.
2. Dimensions D and E1 do not include mold Flash or Protrusion. Mold Flash or Protrusion shall not exceed 0.25 mm (0.010").

09/28/01

	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**40P6**, 40-lead (0.600"/15.24 mm Wide) Plastic Dual Inline Package (PDIP)	40P6	B

44J



COMMON DIMENSIONS
(Unit of Measure = mm)

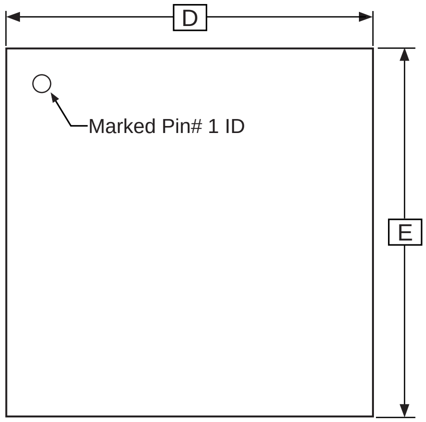
SYMBOL	MIN	NOM	MAX	NOTE
A	4.191	–	4.572	
A1	2.286	–	3.048	
A2	0.508	–	–	
D	17.399	–	17.653	
D1	16.510	–	16.662	Note 2
E	17.399	–	17.653	
E1	16.510	–	16.662	Note 2
D2/E2	14.986	–	16.002	
B	0.660	–	0.813	
B1	0.330	–	0.533	
e	1.270 TYP			

Notes:
1. This package conforms to JEDEC reference MS-018, Variation AC.
2. Dimensions D1 and E1 do not include mold protrusion. Allowable protrusion is .010"(0.254 mm) per side. Dimension D1 and E1 include mold mismatch and are measured at the extreme material condition at the upper or lower parting line.
3. Lead coplanarity is 0.004" (0.102 mm) maximum.

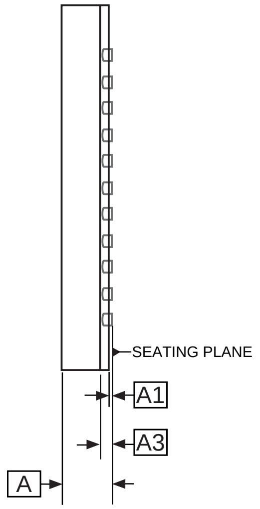
10/04/01

	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**44J**, 44-lead, Plastic J-leaded Chip Carrier (PLCC)	44J	B

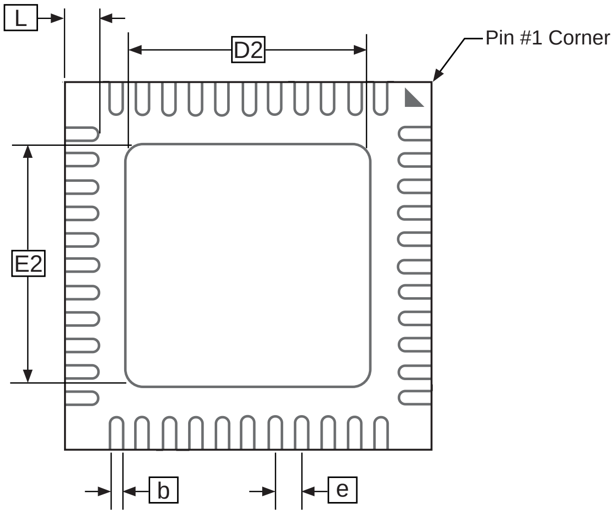
44M1-A



TOP VIEW



SIDE VIEW



BOTTOM VIEW

COMMON DIMENSIONS
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	0.80	0.90	1.00	
A1	–	0.02	0.05	
A3		0.25 REF		
b	0.18	0.23	0.30	
D		7.00 BSC		
D2	5.00	5.20	5.40	
E		7.00 BSC		
E2	5.00	5.20	5.40	
e		0.50 BSC		
L	0.35	0.55	0.75	

Note: JEDEC Standard MO-220, Fig. 1 (SAW Singulation) VKKD-1.

01/15/03

2325 Orchard Parkway
San Jose, CA 95131

TITLE
44M1, 44-pad, 7 x 7 x 1.0 mm Body, Lead Pitch 0.50 mm
Micro Lead Frame Package (MLF)

DRAWING NO. 44M1

REV. C

Data Sheet Change Log for ATmega8535

Please note that the referring page numbers in this section are referred to this document. The referring revision in this section are referring to the document revision.

Changes from Rev. 2502A-06/02 to Rev. 2502B-09/02

1. **Canged the Endurance on the Flash to 10,000 Write/Erase Cycles.**

Changes from Rev. 2502B-09/02 to Rev. 2502C-05/03

1. **Updated "Packaging Information" on page 266.**
2. **Updated Figure 1 on page 2, Figure 84 on page 175, Figure 85 on page 181, Figure 87 on page 187, Figure 98 on page 203.**
3. **Added the section "EEPROM Write During Power-down Sleep Mode" on page 20.**
4. **Removed the references to the application notes "Multi-purpose Oscillator" and "32 kHz Crystal Oscillator", which do not exist.**
5. **Updated code examples on page 42.**
6. **Removed ADHSM bit.**
7. **Renamed Port D pin ICP to ICP1. See "Alternate Functions of Port D" on page 61.**
8. **Added information about PWM symmetry for Timer 0 on page 76 and Timer 2 on page 123.**
9. **Updated Table 68 on page 165, Table 75 on page 186, Table 76 on page 189, Table 77 on page 192, Table 108 on page 249, Table 113 on page 256.**
10. **Updated description on "Bit 5 – TWSTA: TWI START Condition Bit" on page 178.**
11. **Updated the description in "Filling the Temporary Buffer (Page Loading)" and "Performing a Page Write" on page 227.**
12. **Removed the section description in "SPI Serial Programming Characteristics" on page 250.**
13. **Updated "Electrical Characteristics" on page 251.**
14. **Updated "ADC Characteristics – Preliminary Data" on page 258.**
14. **Updated "Register Summary" on page 260.**
15. **Various Timer 1 corrections.**
16. **Added WD_FUSE period in Table 108 on page 249.**

Table of Contents

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EM1 / HEDS Transmissive Optical Encoder Module

Start Here:

- Use charts below to determine which module family your application uses (based on CPR/CPI).

1" Resolutions:

CPR	Non-Index	With Index
32	n/a	EM1
50	HEDS	HEDS
96	HEDS	HEDS
100	HEDS	HEDS
110	HEDS	n/a
120	HEDS	n/a
192	HEDS	HEDS
200	HEDS	HEDS
250	HEDS	HEDS
256	HEDS	HEDS
360	HEDS	HEDS
400	HEDS	HEDS
500	HEDS	HEDS
512	HEDS	HEDS
540	HEDS	n/a
720	n/a	EM1
900	n/a	EM1
1000	HEDS	EM1
1016	HEDS	n/a
1024	HEDS	EM1
1250	n/a	EM1

2" Resolutions:

CPR	Non-Index	With Index
64	n/a	EM1
100	HEDS	HEDS
200	HEDS	HEDS
400	HEDS	HEDS
500	HEDS	HEDS
512	HEDS	n/a
1000	HEDS	HEDS
1024	HEDS	HEDS
1800	n/a	EM1
2000	HEDS	HEDS
2048	HEDS	HEDS
2500	EM1	EM1

Linear Strip Resolutions:

CPI	Non-Index	With Index
120	n/a	EM1
125	n/a	EM1
127	n/a	EM1
150	n/a	EM1
180	HEDS	n/a
200	n/a	EM1
250	n/a	EM1
300	HEDS	n/a
360	HEDS	n/a
500	n/a	EM1

Features:

- Two channel quadrature output with index pulse
- No signal adjustment
- TTL Compatible
- Single +5V supply
- The **EM1** and **HEDS** are both RoHS compliant
- US Digital warrants its products against defects and workmanship for two years. See complete warranty for details.

EM1:

- Resolutions up to 2500 CPR (10,000 PPR)
- Internal 0.1 ufd bypass capacitor
- -55°C to 125°C operating temperature

HEDS:

- Resolutions up to 2048 CPR (8192 PPR)
- -40°C to 100°C operating temperature

Description:

The **EM1** and **HEDS** products are transmissive optical encoder modules. These modules are designed to detect rotary or linear position when used together with a codewheel or linear strip. The **EM1** and **HEDS** modules consist of a lensed LED source and a monolithic detector IC enclosed in a small polymer package. These modules use phased array detector technology to provide superior performance and greater tolerances over traditional aperture mask type encoders.

Both the **EM1** and **HEDS** module provide digital quadrature outputs. The **EM1** comes standard with a third index channel output on all resolutions. The **HEDS** is available with a third index channel output on only some resolutions.

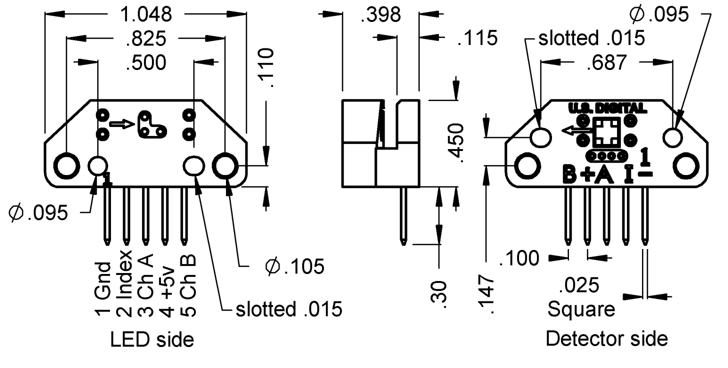
The **EM1** and **HEDS** transmissive optical encoder modules are powered from a single +5VDC power supply. Additional power supply voltages for the **EM1** will be available in the near future. The **EM1** single-ended outputs are capable of sinking or sourcing 8mA each.

The resolution of the modules and encoder disks or linear strips must match. Two mounting holes are provided to accept screws up to .105" dia. Both the **EM1** and **HEDS** have identical mounting and pin-out configurations.

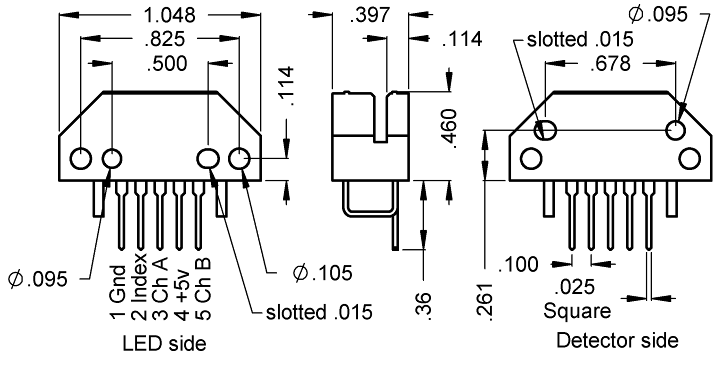
For open collector and higher voltage applications, add the **PC3** device (*see the **PC3** data sheet*), or for differential cable driver outputs, add the **PC4** device (*see the **PC4** data sheet*). Encoder disks, linear strips, quadrature decoder chips, counter chips, computer interface boards, mating connectors and cables are also available.

The **EM1** and **HEDS** are both RoHS compliant.

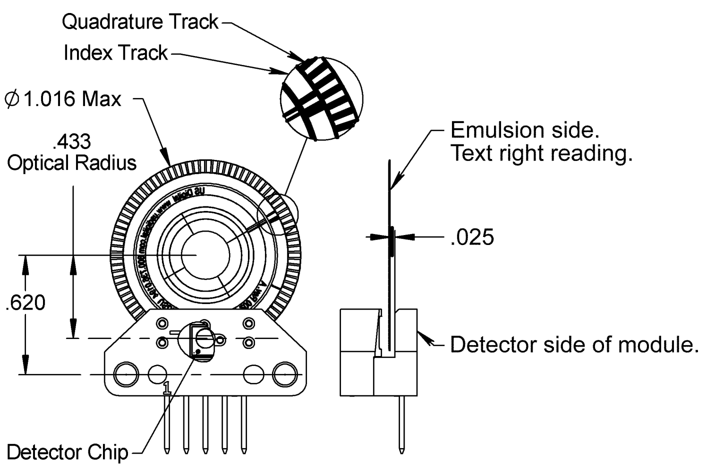
EM1 Mechanical Drawing:

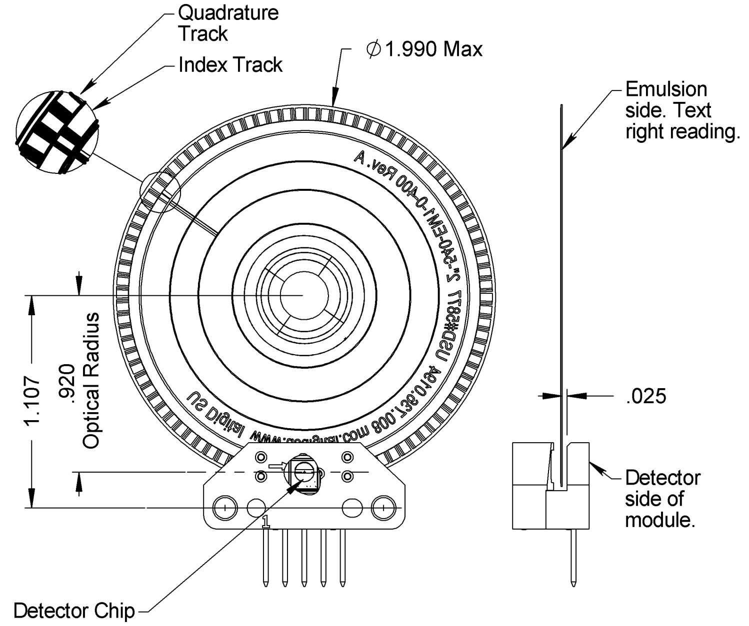


HEDS Mechanical Drawing:

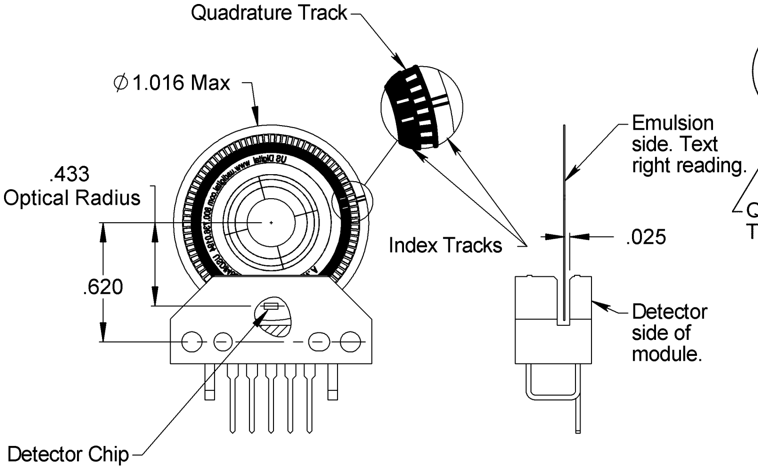


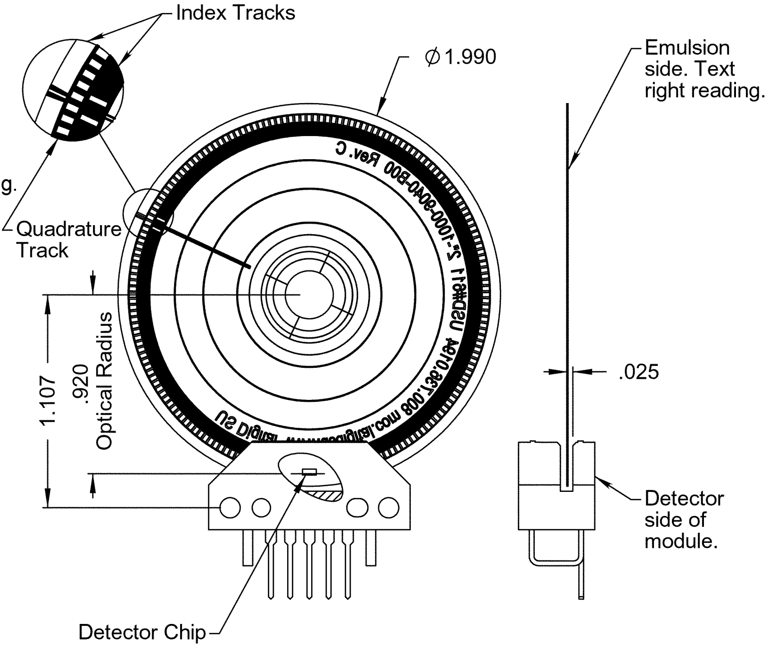
EM1 Module & Disk Mechanical Alignment:



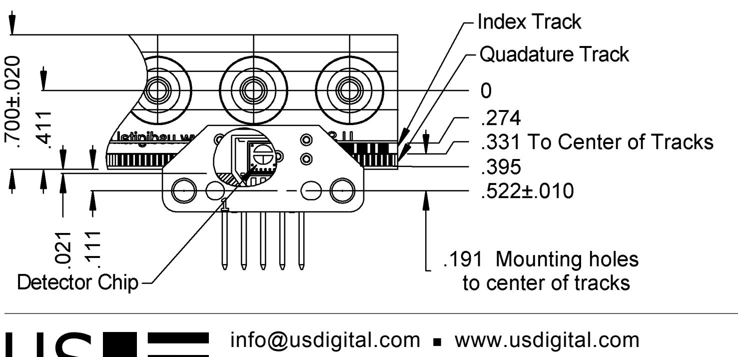


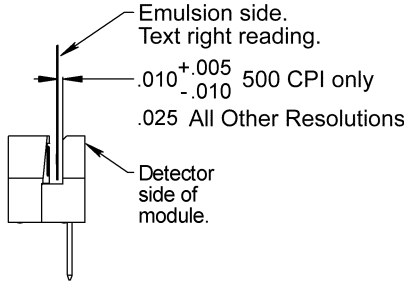
HEDS Module & Disk Mechanical Alignment:



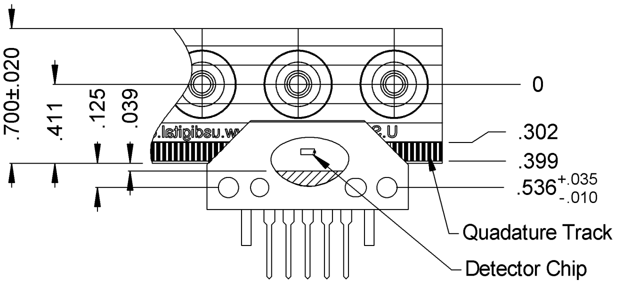


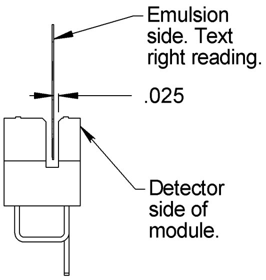
EM1 Module & Linear Strip Mechanical Alignment:





HEDS Module & Linear Strip Mechanical Alignment:





Encoding Characteristics:

- ➢ Specifications apply over entire operating temperature range. Values are for the worst error over a full rotation.
- ➢ Refer to Timing Diagram on next page.

Parameter	Symbol	Min.	Typ.	Max.	Units
Cycle Error					
HEDS (2000 or 2048 CPR only)		-	3.0	7.5	°e
EM1 & HEDS (All Other Resolutions)		-	3.0	5.5	°e
Symmetry					
HEDS (2000 or 2048 CPR only)		130	180	230	°e
EM1 & HEDS (All Other Resolutions)		150	180	210	°e
Quadrature					
HEDS (2000 or 2048 CPR only)		40	90	140	°e
EM1 & HEDS (All Other Resolutions)		60	90	120	°e
Index Pulse Width					
HEDS (2000 or 2048 CPR only)	Po	40	90	140	°e
EM1 & HEDS (All Other Resolutions)	Po	60	90	120	°e
Ch. I Rise After Ch. B or Ch. A Fall					
EM1	t1	10	100	250	ns
HEDS (2000 or 2048 CPR only)	t1	10	450	1500	ns
HEDS (All Other Resolutions)	t1	-300	100	250	ns
Ch. I Fall After Ch. A or Ch. B Rise					
EM1	t2	70	150	300	ns
HEDS (2000 or 2048 CPR only)	t2	10	250	1500	ns
HEDS (All Other Resolutions)	t2	70	150	1000	ns

Recommended Operating Conditions:

Parameter	Min.	Max.	Units	Notes
Temperature				
EM1	-55	125	°C	
HEDS	-40	100	°C	
Supply Voltage	4.5	5.5	Volts	Ripple <100mV$_{P\text{-}P}$
Load Capacitance	-	100	pF	
Count Frequency	-	100	kHz	rpm/60 x cycles/rev.

Electrical Specifications:

- ➢ Specifications apply over entire operating temperature range. Typical values are specified at Vcc = 5.0V and 25°C.
- ➢ Refer to Timing Diagram on next page.

Parameter	Min.	Typ.	Max.	Units	Notes
Output Voltage	-0.5	-	Vcc	Volts	
Supply Current					
EM1 (32 thru 250 CPR)	-	27	30	mA	
EM1 (All Other Resolutions)	-	55	57	mA	
HEDS (Index or 1" >=1000 CPR or 2" >=2000 CPR only)	30	57	85	mA	
HEDS (Non-index or All Other Resolutions)	-	17	40	mA	
Output Low*					
EM1	-	-	0.5	Volts	I_{OL} = 8.0mA max.
HEDS (Index or 1" >=1000 CPR or 2" >=2000 CPR only)	-	-	0.4	Volts	I_{OL} = 3.86mA max.
HEDS (Non-index or All Other Resolutions)	-	-	0.4	Volts	I_{OL} = 3.2mA max.
Output High*					
EM1	2.0	-	-	Volts	I_{OH} = -8.0mA max.
HEDS (Index or 1" >=1000 CPR or 2" >=2000 CPR only)	2.4	-	-	Volts	I_{OH} = -200µA max.
HEDS (Non-index or All Other Resolutions)	2.4	-	-	Volts	I_{OH} = -40µA max.
Output Current Per Channel					
EM1	-8.0	-	8.0	mA	
HEDS	-1.0	-	5.0	mA	

* Unloaded high level output voltage is 4.80V typically, 4.2V minimum.

Phase Relationship:

For Shaft Encoders: (View the encoder so the shaft / bushing side is facing up.)

- A leads B in a clockwise rotation; B leads A in a counterclockwise rotation for the following products: **H1.**
- B leads A in a clockwise rotation; A leads B in a counterclockwse rotation for the following products: **H15, H3**, **H5, H6, HB5M, HB6M, HD25**, **S1**, **S2**, **S5**, **S6** and **SP-16.**

For Kit Encoders: (View the encoder so the cover side is facing up.)

- A leads B in a clockwise rotation; B leads A in a counterclockwise rotation for the following products: **E3**, **E5** and **E6.**
- B leads A in a clockwise rotation; A leads B in a counterclockwise rotation for the following products: **E2.**

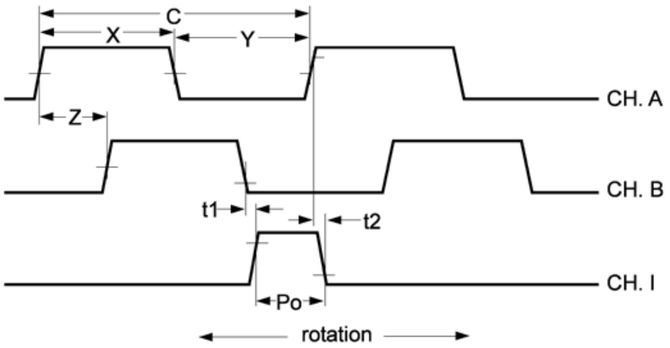
For Probe Encoders:

- A leads B in inward plunger motion; B leads A in outward plunger motion for the following products: **PE.**

For Inclinometers: (View the inclinometer so the cover side is facing up.)

- A leads B in a clockwise rotation; B leads A in a counterclockwise rotation for the following products: **T5** and **T6.**

Timing Diagram:



CPR (N): The number of Cycles Per Revolution.
One Shaft Rotation: 360 mechanical degrees, N cycles.
One Electrical Degree (°e): 1/360th of one cycle.
One Cycle (C): 360 electrical degrees (°e). Each cycle can be decoded into 1 or 4 codes, referred to as X1 or X4 resolution multiplication.
Symmetry: A measure of the relationship between (X) and (Y) in electrical degrees, nominally 180°e.
Quadrature (Z): The phase lag or lead between channels A and B in electrical degrees, nominally 90°e.
Index (CH I.): The index output goes high once per revolution, coincident with the low states of channels A and B, nominally 1/4 of one cycle (90°e).
Position Error: The difference between the actual shaft position and the position indicated by the encoder cycle count.
Cycle Error: An indication of cycle uniformity. The difference between an observed shaft angle which gives rise to one electrical cycle, and the nominal angular increment of 1/N of a revolution.

EM1 / HEDS Encoder Module Differences:

US Digital is the designer and manufacturer of the **EM1** transmissive optical encoder module. The design of the **EM1** provides electrical and mechanical compatibility with the Agilent **HEDS-9000**, **HEDS-9100**, **HEDS-9200**, **HEDS-9040**, and **HEDS-9140** series modules. Non-index codewheels are interchangable between the **EM1** and **HEDS** modules. The process of switching from the **HEDS** to the **EM1** module should not require any mechanical or electrical changes. Simply use the **EM1** and matching codewheel in place of the **HEDS** module and codewheel.

The **EM1** has a built in index channel and is available on all resolutions, for both rotary disks and linear strips. The **EM1** offers improved output drive capability and will source and sink 8mA at TTL levels. The current consumption is reduced over Agilent index versions (27mA vs. 57mA typical). Physically the **EM1** has no external wire loops which interfere when mounting. The connector pins are 0.051" shorter than Agilent, while still providing .30" insertion depth. The **EM1** uses a US Digital designed codewheel with 2 tracks rather than 3 tracks for index versions. US Digital's **EM1** offers custom and special resolutions.

Ordering Information:

- ➢ The part numbers below do not include optical encoder disks or linear strips.
- ➢ Disks and linear strips must be ordered separately (*see the **DISK** or **LIN** data sheet*).

Pricing Levels per Module for 1" Disks:

CPR	Non-Index Part Number	Pricing Level	With Index Part Number	Pricing Level
32	-	-	EM1-1-32	2
50	HEDS-9100-S00	1	HEDS-9140-S00	2
96	HEDS-9100-C00	1	HEDS-9140-C00	2
100	HEDS-9100-C00	1	HEDS-9140-C00	2
110	HEDS-9100-C00	1	-	-
120	HEDS-9100-C00	1	-	-
192	HEDS-9100-E00	1	HEDS-9140-E00	2
200	HEDS-9100-E00	1	HEDS-9140-E00	2
250	HEDS-9100-F00	1	HEDS-9140-F00	2
256	HEDS-9100-F00	1	HEDS-9140-F00	2
360	HEDS-9100-G00	1	HEDS-9140-G00	2
400	HEDS-9100-H00	1	HEDS-9140-H00	2
500	HEDS-9100-A00	1	HEDS-9140-A00	2
512	HEDS-9100-I00	1	HEDS-9140-I00	2
540	HEDS-9100-I00	1	-	-
720	-	-	EM1-1-720	3
900	-	-	EM1-1-900	3
1000	HEDS-9100-B00	2	EM1-1-1000	3
1016	HEDS-9100-J00	2	-	-
1024	HEDS-9100-J00	2	EM1-1-1024	3
1250	-	-	EM1-1-1250	3

Pricing Levels per Module for 2" Disks:

CPR	Non-Index Part Number	Pricing Level	With Index Part Number	Pricing Level
64	-	-	EM1-2-64	2
100	HEDS-9100-S00	1	HEDS-9140-S00	2
200	HEDS-9100-C00	1	HEDS-9140-C00	2
400	HEDS-9100-E00	1	HEDS-9140-E00	2
500	HEDS-9000-A00	1	HEDS-9140-F00	2
512	HEDS-9000-A00	1	-	-
1000	HEDS-9000-B00	1	HEDS-9040-B00	2
1024	HEDS-9000-J00	1	HEDS-9040-J00	2
1800	-	-	EM1-2-1800	3
2000	HEDS-9000-T00	2	HEDS-9040-T00	2
2048	HEDS-9000-U00	2	HEDS-9040-T00	2
2500	EM1-2-2500-N	3	EM1-2-2500	3

Pricing Levels per Module for Linear Strips:

CPR	Non-Index Part Number	Pricing Level	With Index Part Number	Pricing Level
120	-	-	EM1-0-120	2
125	-	-	EM1-0-125	2
127	-	-	EM1-0-127	2
150	-	-	EM1-0-150	2
180	HEDS-9200-Q00	2	-	-
200	-	-	EM1-0-200	2
250	-	-	EM1-0-250	2
300	HEDS-9200-300	2	-	-
360	HEDS-9200-360	2	-	-
500	-	-	EM1-0-500	4

Prices:

Level 1:
$26.25 / 1
$23.35 / 10
$19.92 / 50
$17.65 / 100

Level 2:
$29.40 / 1
$26.16 / 10
$22.30 / 50
$19.76 / 100

Level 3:
$32.55 / 1
$28.96 / 10
$24.70 / 50
$21.88 / 100

Level 4:
$35.70 / 1
$31.76 / 10
$27.09 / 50
$24.00 / 100

S1 Optical Shaft Encoder

Description:

The **S1** series optical shaft encoder is a non-contacting rotary to digital converter. Useful for position feedback or manual interface, the encoder converts real-time shaft angle, speed, and direction into TTL-compatible quadrature outputs with or without index. The encoder utilizes an unbreakable mylar disk, metal shaft and bushing, LED light source, and monolithic electronics. It operates from a single +5VDC supply.

The **S1** is normally designed for applications of 6 feet or less. For longer cable lengths, adding a **PC4** / **PC5** differential line driver is recommended.

The **S1** is available with ball bearings for motion control applications or static drag to feel like a potentiometer for front-panel human interface. The **S1** comes standard with a 1/4" diameter shaft and static drag. The **NT**-option may be added to any non-ball bearing shaft to replace the standard drag with light static drag.

Connection to the **S1** series encoder is made through a 5-pin standard connector (sold separately). The mating connectors are available from US Digital with several cable options and lengths.

Features:

- Small size
- Low cost
- 2-channel quadrature,TTL squarewave outputs
- 3rd channel index option
- Tracks from 0 to 100,000 cycles/sec
- Ball bearing option tracks to 10,000 RPM
- -40 to +100°C operating temperature
- Single +5VDC supply
- US Digital warrants its products against defects in materials and workmanship for two years. See complete warranty for details.

Electrical Specifications:

For complete details see the **EM1 / HEDS** data sheet.

Phase Relationship:

B leads A for clockwise shaft rotation, and A leads B for counterclockwise rotation viewed from the shaft side of the encoder (*see the **EM1 / HEDS** data sheet*).

Mounting:

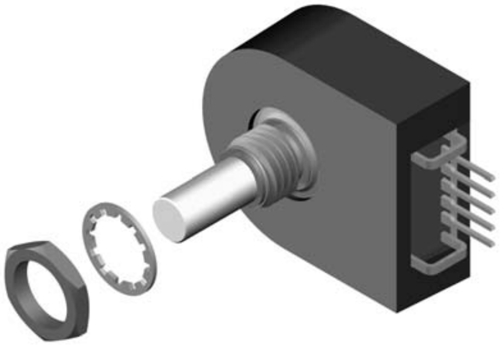
Hole Diameter	.375 in. +.005 - 0
Panel Thickness	.125 in. max.
Panel Nut Max. Torque	20in.-lbs.

Materials:

Shaft	Brass or stainless
Bushing	Brass
Connector	Gold plated

Mechanical Specifications:

Parameter	**Sleeve Bushing (Standard or M6-option)**	**Ball Bearing (B-option or BM6-option)**
Acceleration	250,000 rad/sec^2	250,000 rad/sec^2
Vibration	20 g. 5 to 2KHz	20 g. 5 to 2KHz
Shaft Speed	100 RPM max. continuous	10,000 RPM max. continuous
Shaft Rotation	Continuous and reversible	-
Shaft Torque	0.5 ±0.2 in. oz. 0.3 in. oz. max. (**NT**-option)	0.05 in. oz. max.
Shaft Loading	2 lbs. max. dynamic 20 lbs. max. static	1 lb. max.
Bearing Life	-	$(40/P)^3$ = life in millions of revs. where P = radial load in pounds
Weight	0.74 oz.	0.67 oz.
Shaft Runout	0.0015 T.I.R. max.	0.0015 T.I.R. max.



Compatible Cables & Connectors:

5-pin Locking or Standard:		
Locking	**Standard**	**Description**
CON-LC5	CON-C5-22*	Connector
CA-1094-1FT	CA-434-1FT	Connector on one end with 4 12" wires
CA-1095-1FT	CA-435-1FT	Connector on one end with 5 12" wires
CA-3935-6FT	CA-3934-6FT	Connector on one end of a 6' shielded round cable
CA-1630-6FT	CA-576-6FT	Connector on both ends of a 6' shielded round cable

* 22 AWG is standard. 24, 26 and 28 AWG are also available.

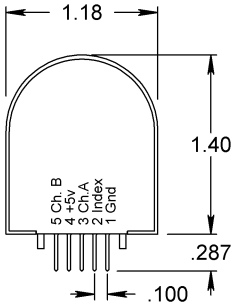
Attention:

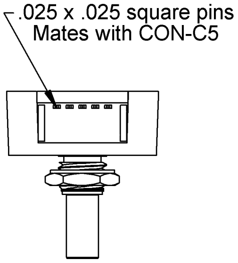
- The **S1** and accompanying cables are typically designed for cable lengths of 6 feet or less; for longer cable lengths, the **PC4** / **PC5** differential line driver and accompanying cables are recommended.
- Specify cable length when ordering.
- Custom cable lengths are available. See the **Cables / Connectors** data sheet for more information.

Pin-out:

Pin	**Description**
1	Ground
2	Index
3	A channel
4	+5VDC power
5	B channel

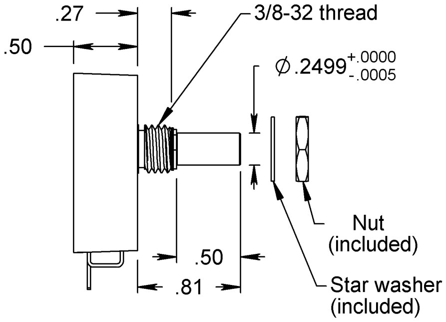
Mechanical Drawing:



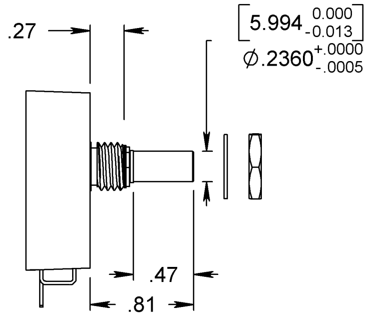


- Module pins are 0.06" shorter for resolutions: 32-I, 720-I, 900-I, 1000-I, 1024-I and 1250-I.

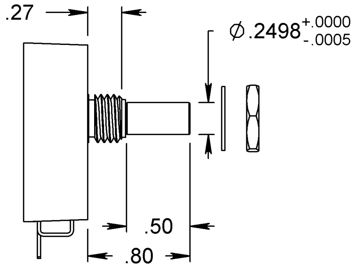
1/4" Sleeve Bushing (Default)



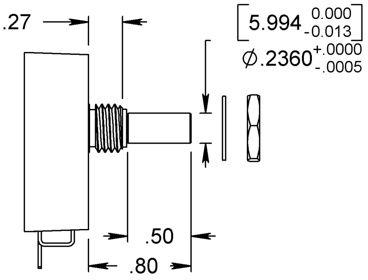
6mm Sleeve Bushing (M6-option)



1/4" Ball Bearing (B-option)



6mm Ball Bearing (BM6-option)



Ordering Information:

Standard:	**Index/HiRes:** (Hi Res: >=1000 CPR)
$51.45 / 1	$60.71 / 1
$47.25 / 10	$55.76 / 10
$43.05 / 50	$50.80 / 50
$40.95 / 100	$48.32 / 100

Cost Modifiers:

- Add $8 for **B**-option.
- Add $5 for **M6**-option.
- Add $13 for **BM6**-option.
- Add $14 for **HS**-option (sealed housing).

S1 - ☐ — ☐

CPR:
32**
50
96
100
110*
120*
192
200
250
256
360
400
500
540*
720**
900**
1000
1016*
1024

Options: (specify in order shown)
Blank (default) = 1/4" diameter shaft (static drag).
I = Index (3rd channel).
B = Ball bearing (free spinning).***
M6 = Metric 6mm diameter shaft (static drag).
BM6 = Ball bearing metric 6mm diameter shaft (free spinning).***
NT = Replaces static drag with light static drag.
HS = Sealed housing.

Notes:
***** Index option not available.
** 32, 720, 900, 1000 CPR only available with index.
*** Not available with **NT**-option (light static drag).

Technical Data, Rev. 10.31.06, October 2006
All information subject to change without notice.

S5 Optical Shaft Encoder

Description:

The **S5** series optical shaft encoder is a non-contacting rotary to digital converter. Useful for position feedback or manual interface, the encoder converts real-time shaft angle, speed, and direction into TTL-compatible quadrature outputs with or without index. The encoder utilizes an unbreakable mylar disk, metal shaft and bushing, LED light source, and monolithic electronics. It operates from a single +5VDC supply.

Three shaft torque versions are available. The standard torque version and **M6**-option have a sleeve bushing lubricated with a viscous motion control gel to provide torque and a feel that is ideal for front panel human interface applications.

The **NT**-option (no torque added) has a sleeve bushing and a low viscosity lubricant (that does not intentionally add torque) for low RPM applications where a small amount of torque is acceptable.

The **B**-option and **BM6**-option have a ball bearing rather than a sleeve bushing for high speed, free spinning, and zero torque applications. The ball bearing options are recommended when a pulley, gear, or friction wheel drives the shaft. This eliminates the wear that would otherwise result from the side load even at slow speeds.

A secure connection to the **S5** series encoder is made through a 5-pin (single-ended version) or 10-pin (differential version) finger-latching connector (sold separately). The mating connectors are available from US Digital with several cable options and lengths.

For differential version: the internal differential line driver (26C31) can source and sink 20mA at TTL levels. The recommended receiver is industry standard 26C32. Maximum noise immunity is achieved when the differential receiver is terminated with a 110 ohm resistor in series with a .0047µf capacitor placed across each differential pair. The capacitor simply conserves power; otherwise power consumption would increase by approximately 20mA per pair, or 60mA for 3 pairs.

Features:

- Small size
- Low cost
- Optional Agilent compatible pin-out
- Optional differential / line-driver output
- Positive finger-latching connector
- 2-channel quadrature,TTL squarewave outputs
- 3rd channel index option
- Tracks from 0 to 100,000 cycles/sec
- Ball bearing option tracks to 10,000 RPM
- -40 to +100°C operating temperature
- Single +5VDC supply
- US Digital warrants its products against defects in materials and workmanship for two years. See complete warranty for details.

Differential Electrical Specifications:

Parameter	Min.	Typ.	Max.	Units	Notes
Supply	4.5	5.0	5.5	Volts	
Current Consumption					
Index: 32 CPR	-	28	53	mA	No load
Index: 720, 900, 1000, 1250 CPR	-	56	59	mA	No load
Index: All Other Resolutions	-	58	88	mA	No load
Non-index: <2000 CPR	-	18	43	mA	No load
Non-index: >=2000 CPR	-	58	88	mA	No load
Output Voltage					
Sourcing to +5	2.4	3.4	-	Volts	@ -20mA
Sinking to Ground	-	0.2	0.4	Volts	@ 20mA

- For complete details see the **EM1 / HEDS** data sheet.

Mounting:

Hole Diameter	.375 in. +.005 - 0
Panel Thickness	.125 in. max.
Panel Nut Max. Torque	20in.-lbs.

Materials:

Shaft	Brass or stainless
Bushing	Brass
Connector	Gold plated

Mechanical Specifications:

Parameter	Sleeve Bushing (Standard or M6-option)	Ball Bearing (B-option or BM6-option)
Acceleration	250,000 rad/sec^2	250,000 rad/sec^2
Vibration	20 g. 5 to 2KHz	20 g. 5 to 2KHz
Shaft Speed	100 RPM max. continuous	10,000 RPM max. continuous
Shaft Rotation	Continuous and reversible	-
Shaft Torque	0.5 ±0.2 in. oz. 0.3 in. oz. max. (**NT**-option)	0.05 in. oz. max.
Shaft Loading	2 lbs. max. dynamic 20 lbs. max. static	1 lb. max.
Bearing Life	-	(40/P)^3 = life in millions of revs. where P = radial load in pounds
Weight		
Single-ended (**S5S**)	1.01 oz.	1.15 oz.
Differential (**S5D**)	1.28 oz.	1.42 oz.
Shaft Runout	0.0015 T.I.R. max.	0.0015 T.I.R. max.

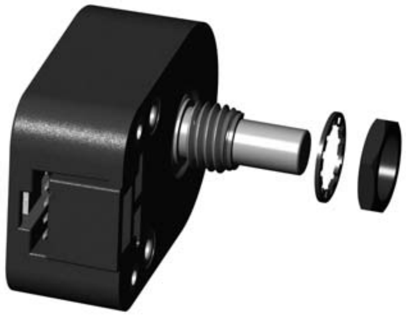
Single-ended Electrical Specifications:

For complete details see the **EM1 / HEDS** data sheet.

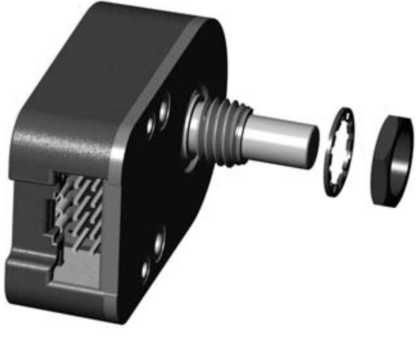
Phase Relationship:

B leads A for clockwise shaft rotation, and A leads B for counterclockwise rotation viewed from the shaft side of the encoder (*see the **EM1 / HEDS** data sheet*).

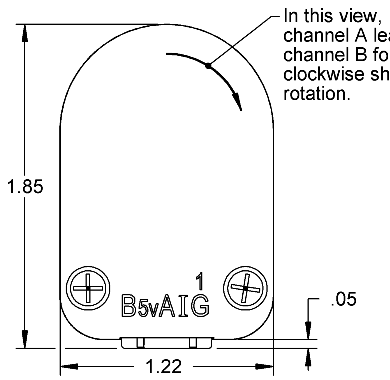
Single-ended (S5S)



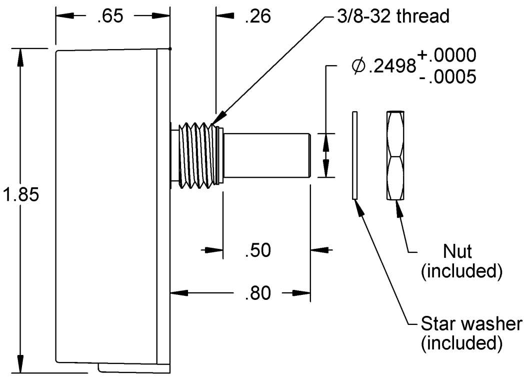
Differential (S5D)



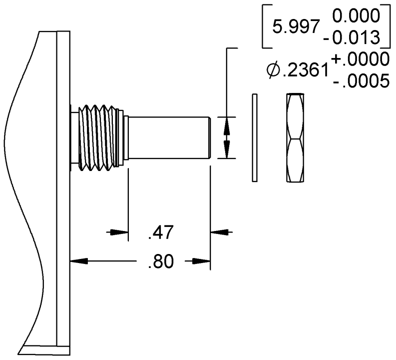
Single-ended Mechanical Drawings (S5S):

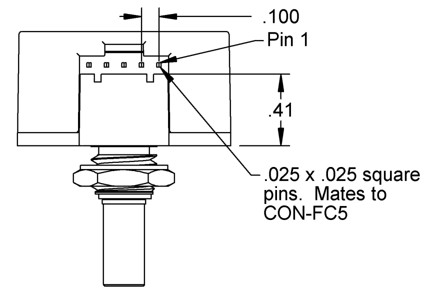


1/4" Sleeve Bushing (Default)

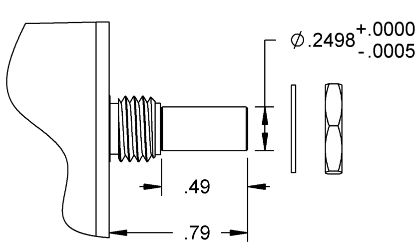


6mm Sleeve Bushing (M6-option)

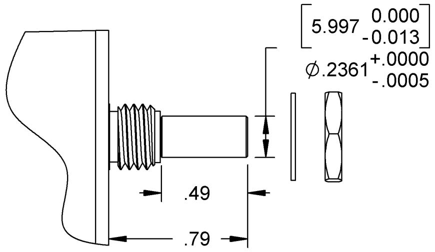




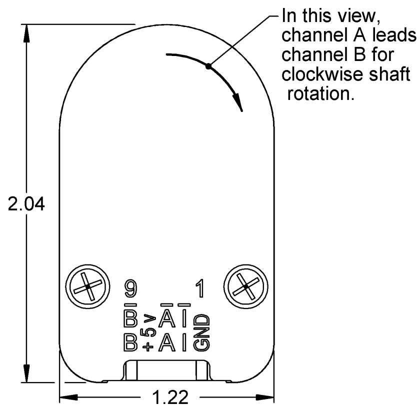
1/4" Ball Bearing (B-option)



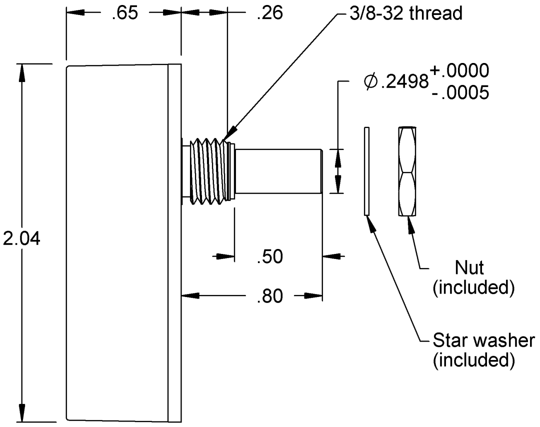
6mm Ball Bearing (BM6-option)



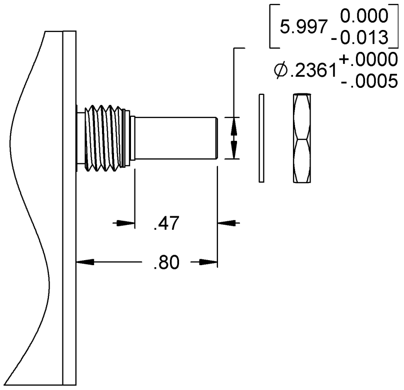
Differential Mechanical Drawings (S5D):

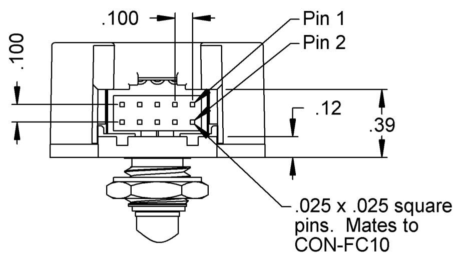


1/4" Sleeve Bushing (Default)

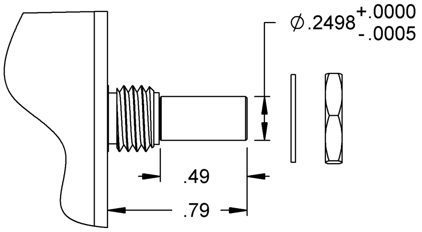


6mm Sleeve Bushing (M6-option)

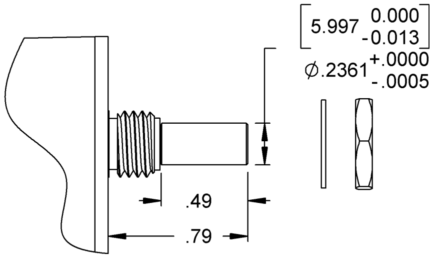




1/4" Ball Bearing (B-option)



6mm Ball Bearing (BM6-option)



Compatible Cables / Connectors:

Finger-latching:

5-pin	10-pin	Description
CON-FC5-22*	CON-FC10	Connector
CA-3133-1FT**	-	Connector on one end with 4 12" wires
CA-3132-1FT**	-	Connector on one end with 5 12" wires
CA-3131-6FT**	CA-4217-6FT	Connector on one end of a 6' shielded round cable
-	CA-4174-6FT***	Same as CA-4217, but for L-option only
CA-3620-6FT**	CA-3619-6FT	Connectors on both ends of a 6' shielded round cable
-	CA-3807-FT***	Same as CA-3807, but for L-option only

* 22 AWG is standard. 24, 26 and 28 AWG are also available.

** Single-ended output and accompanying cables are typically designed for cable lengths of 6 feet or less; for longer cable lengths, differential output and accompanying cables are recommended.

*** Avago / Agilent / HP compatible cable assembly.

Attention:

- Specify cable length when ordering.
- Custom cable lengths are available. See the **Cables / Connectors** data sheet for more information.

Pin-outs:

Pin	5-pin Single-ended	10-pin Differential Standard	10-pin Differential Avago (L-option)
1	Ground	Ground	No connection
2	Index	Ground	+5VDC power
3	A channel	Index-	Ground
4	+5VDC power	Index+	No connection
5	B channel	A- channel	A- channel
6		A+ channel	A+ channel
7		+5VDC power	B- channel
8		+5VDC power	B+ channel
9		B- channel	Index-
10		B+ channel	Index+

Ordering Information:

S5S Standard:	S5S Index/HiRes: (Hi Res: >=1000 CPR)	S5D Standard:	S5D Index/HiRes: (Hi Res: >=1000 CPR)
$52.00 / 1	$61.36 / 1	$65.10 / 1	$74.87 / 1
$47.25 / 10	$55.76 / 10	$60.90 / 10	$70.04 / 10
$43.05 / 50	$50.80 / 50	$56.70 / 50	$65.21 / 50
$40.95 / 100	$48.32 / 100	$53.55 / 100	$61.58 / 100

Cost Modifiers:

- Add $8 for **B**-option.
- Add $5 for **M6**-option.
- Add $13 for **BM6**-option.

S5 ☐ — ☐ — ☐

Version:
S = Single-ended.
D = Differential.

CPR:
32**
50
96
100
110*
120*
192
200
250
256
360
400
500
540*
720**
900**
1000
1016*
1024
1250**

Options: (specify in order shown)
Blank (default) = 1/4" dia. sleeve bushing (standard torque).
I = Index (3rd channel).
L = Avago / Agilent / HP compatible pin-out.***
B = 1/4" dia. ball bearing (free spinning).****
M6 = 6mm dia. sleeve bushing (standard torque).
BM6 = 6mm dia. ball bearing (free spinning).****
NT = Replaces standard torque with no torque added.

Notes:
***** Index option not available.
** 32, 720, 900, 1000, 1250 CPR only available with index.
*** Only available with differential version (**S5D**).
**** Not available with **NT**-option (no torque added).

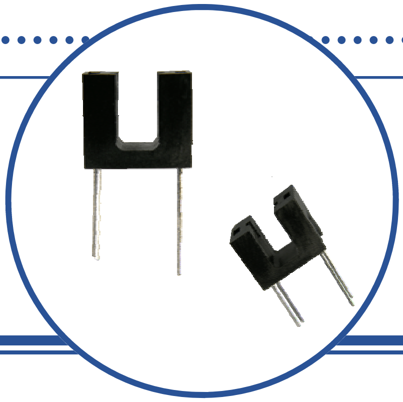
Technical Data, Rev. 06.11.07, June 2007
All information subject to change without notice.

Slotted Optical Switch
OPB200

TT electronics
OPTEK Technology

Features:

- Housing material Opaque to visible and infrared light
- Non–contact switching
- Printed PCBoard mount
- 0.200” (5.1 mm) slot width, 0.320” (8.1 mm) slot depth



Description:

The **OPB200** contains an Infrared LED (890 nm) and a Phototransistor paired in a plastic housing.

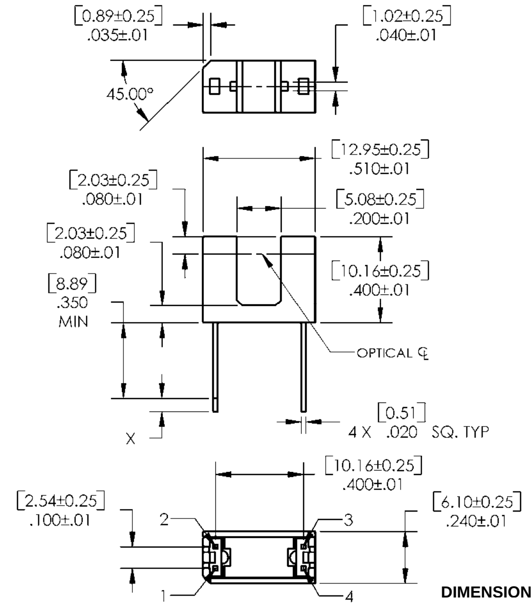
The housing is an opaque grade of injection-molded plastic, which minimizes the assembly’s sensitivity to visible and near-infrared radiation. Each device has approximately 0.060” [1.52 mm] diameter lenses providing the versatility necessary for general switching applications.

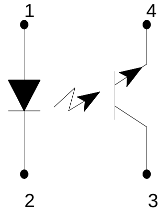
The output Phototransistor ON state conducts current ($I_{C(ON)}$) when no object is in the slot. The output switches to the OFF state when a device interrupts the light beam from the Emitter (LED) to the Phototransistor. The Phototransistor can acknowledge light between 400 nm and 1100 nm with optimum response in the 880 nm range.

Custom electrical, wire and cabling and connectors are available. Contact your local representative or OPTEK for more information.

Applications:

- Non-contact interruptive object sensing
- Assembly line automation
- Machine automation
- Equipment security
- Machine safety





Pin #	Description
1	Anode
2	Cathode
3	Collector
4	Emitter

DIMENSIONS ARE IN: [MILLIMETERS]
INCHES

Ordering Information					
Part Number	LED Peak Wavelength	Sensor	Slot Width / Depth	Aperture Emitter/Sensor	Lead Length / Spacing
OPB200	890 nm	Transistor	0.200” / 0.320”	None	0.425” / 0.400

RoHS

OPTEK reserves the right to make changes at any time in order to improve design and to supply the best product possible.

Absolute Maximum Ratings (T_A=25°C unless otherwise noted)

Storage & Operating Temperature Range	-40°C to +85°C
Lead Soldering Temperature [1/16 inch (1.6mm) from the case for 5 sec. with soldering iron](1)	260°C

Input Diode

Forward DC Current	50 mA
Peak Forward Current (1 µs pulse width, 300 pps)	3 A
Reverse DC Voltage	2 V
Power Dissipation(2)	100 mW

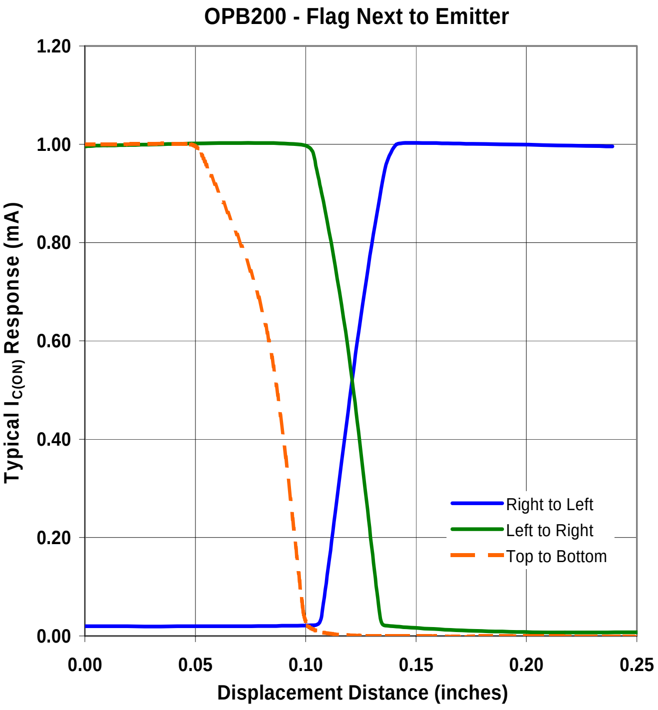
Output Phototransistor

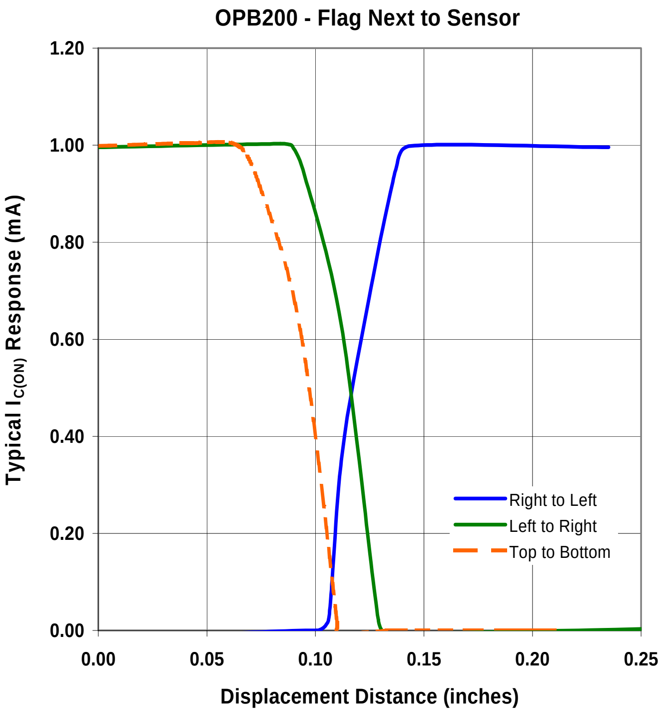
Collector-Emitter Voltage	30 V
Emitter-Collector Voltage	5 V
Collector DC Current	30 mA
Power Dissipation(2)	100 mW

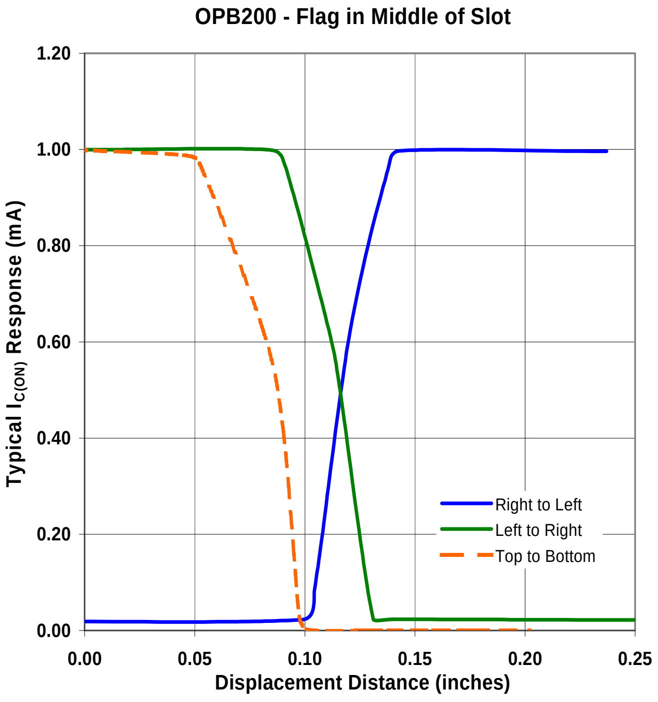
Electrical Characteristics (T_A = 25°C unless otherwise noted)

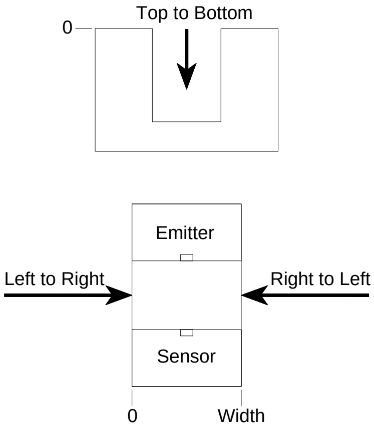
SYMBOL	PARAMETER	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Input Diode (see OP140 for additional information)						
V_F	Forward Voltage	-	-	1.7	V	I_F = 20 mA
I_R	Reverse Current	-	-	100	µA	V_R = 2 V
Output Phototransistor (see OP550 for additional information)						
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	30	-	-	V	I_C = 1 mA
$V_{(BR)ECO}$	Emitter-Collector Breakdown Voltage	5	-	-	V	I_E = 100 µA
I_{CEO}	Collector Dark Current	-	-	100	nA	V_{CE} = 10 V, I_F = 0, E_E = 0
Combined						
$V_{CE(SAT)}$	Collector-Emitter Saturation Voltage	-	-	0.4	V	I_C = 100 µA, I_F = 20 mA
$I_{C(ON)}$	On-State Collector Current	1	4	6	mA	V_{CE} = 0.4 V, I_F = 20 mA

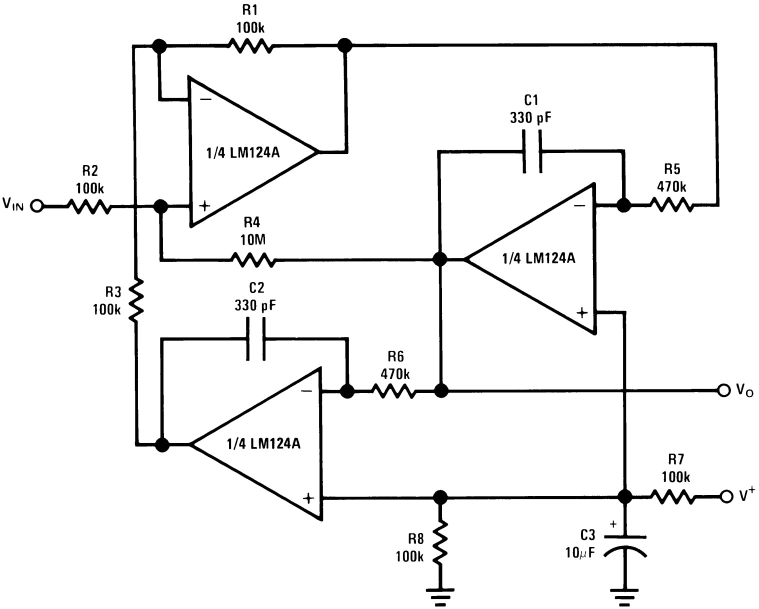
Notes:
(1) RMA flux is recommended. Duration can be extended to 10 seconds maximum when flow soldering.
(2) Derate linearly 1.67 mW/°C above 25 ° C.
(3) All parameters tested using pulse techniques.
(4) Lead spacing of 0.400” (10.16 mm). Leads are a minimum of 0.020” sq. (0.508 mm) and 0.425” (10.795 mm) long.
(5) Methanol or isopropanol are recommended as cleaning agents. Plastic housing is soluble in chlorinated hydrocarbons and ketones.
(6) Polarity is denoted by a notch next to pin 1 (LED Anode) of the package.


OPB200 - Flag Next to Emitter
Typical $I_{C(ON)}$ Response (mA)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
0.05
0.10
0.15
0.20
0.25
Displacement Distance (inches)
Right to Left
Left to Right
Top to Bottom


OPB200 - Flag Next to Sensor
Typical $I_{C(ON)}$ Response (mA)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
0.05
0.10
0.15
0.20
0.25
Displacement Distance (inches)
Right to Left
Left to Right
Top to Bottom


OPB200 - Flag in Middle of Slot
Typical $I_{C(ON)}$ Response (mA)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
0.05
0.10
0.15
0.20
0.25
Displacement Distance (inches)
Right to Left
Left to Right
Top to Bottom


Top to Bottom
0
Emitter
Left to Right
Right to Left
Sensor
0
Width


R1
100k
1/4 LM124A
C1
330 pF
R2
100k
V_IN
R5
470k
R4
10M
1/4 LM124A
R3
100k
C2
330 pF
R6
470k
V_O
1/4 LM124A
R7
100k
V+
R8
100k
C3
10μF

National Semiconductor

August 2000

LM124/LM224/LM324/LM2902
Low Power Quad Operational Amplifiers

General Description

The LM124 series consists of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

Application areas include transducer amplifiers, DC gain blocks and all the conventional op amp circuits which now can be more easily implemented in single power supply systems. For example, the LM124 series can be directly operated off of the standard +5V power supply voltage which is used in digital systems and will easily provide the required interface electronics without requiring the additional ±15V power supplies.

Unique Characteristics

- In the linear mode the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage
- The unity gain cross frequency is temperature compensated
- The input bias current is also temperature compensated

Advantages

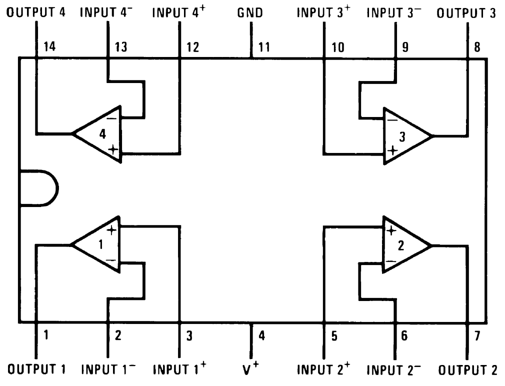
- Eliminates need for dual supplies
- Four internally compensated op amps in a single package
- Allows directly sensing near GND and V_{OUT} also goes to GND
- Compatible with all forms of logic
- Power drain suitable for battery operation

Features

- Internally frequency compensated for unity gain
- Large DC voltage gain 100 dB
- Wide bandwidth (unity gain) 1 MHz (temperature compensated)
- Wide power supply range:
  Single supply 3V to 32V
  or dual supplies ±1.5V to ±16V
- Very low supply current drain (700 µA)—essentially independent of supply voltage
- Low input biasing current 45 nA (temperature compensated)
- Low input offset voltage 2 mV
  and offset current: 5 nA
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing 0V to $V^+ - 1.5V$

Connection Diagrams

Dual-In-Line Package

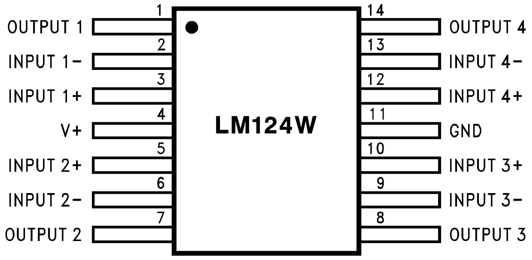


Top View

Order Number LM124J, LM124AJ, LM124J/883 (Note 2)**, LM124AJ/883** (Note 1)**, LM224J, LM224AJ, LM324J, LM324M, LM324MX, LM324AM, LM324AMX, LM2902M, LM2902MX, LM324N, LM324AN, LM324MT, LM324MTX or LM2902N LM124AJRQML and LM124AJRQMLV**(Note 3)

See NS Package Number J14A, M14A or N14A

Connection Diagrams (Continued)



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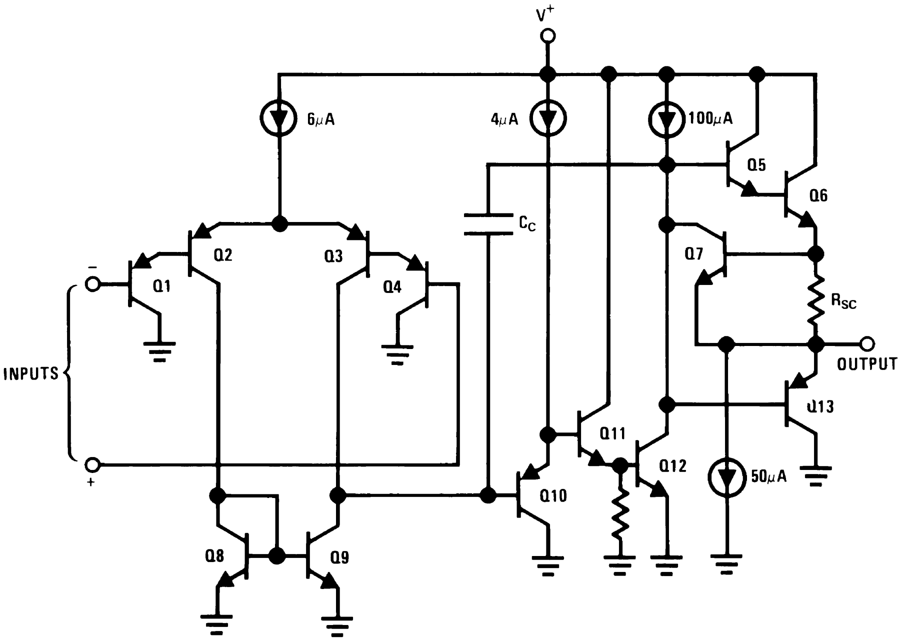
Order Number LM124AW/883, LM124AWG/883, LM124W/883 or LM124WG/883
LM124AWRQML and LM124AWRQMLV(Note 3)
See NS Package Number W14B
LM124AWGRQML and LM124AWGRQMLV(Note 3)
See NS Package Number WG14A

Note 1: LM124A available per JM38510/11006

Note 2: LM124 available per JM38510/11005

Note 3: See STD Mil DWG 5962R99504 for Radiation Tolerant Device

Schematic Diagram (Each Amplifier)



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Absolute Maximum Ratings (Note 12)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

	LM124/LM224/LM324 LM124A/LM224A/LM324A	LM2902
Supply Voltage, V^+	32V	26V
Differential Input Voltage	32V	26V
Input Voltage	−0.3V to +32V	−0.3V to +26V
Input Current		
($V_{IN} < -0.3V$) (Note 6)	50 mA	50 mA
Power Dissipation (Note 4)		
Molded DIP	1130 mW	1130 mW
Cavity DIP	1260 mW	1260 mW
Small Outline Package	800 mW	800 mW
Output Short-Circuit to GND		
(One Amplifier) (Note 5)		
$V^+ \leq 15V$ and $T_A = 25˚C$	Continuous	Continuous
Operating Temperature Range		−40˚C to +85˚C
LM324/LM324A	0˚C to +70˚C	
LM224/LM224A	−25˚C to +85˚C	
LM124/LM124A	−55˚C to +125˚C	
Storage Temperature Range	−65˚C to +150˚C	−65˚C to +150˚C
Lead Temperature (Soldering, 10 seconds)	260˚C	260˚C
Soldering Information		
Dual-In-Line Package		
Soldering (10 seconds)	260˚C	260˚C
Small Outline Package		
Vapor Phase (60 seconds)	215˚C	215˚C
Infrared (15 seconds)	220˚C	220˚C

See AN-450 “Surface Mounting Methods and Their Effect on Product Reliability” for other methods of soldering surface mount devices.

ESD Tolerance (Note 13)	250V	250V

Electrical Characteristics

$V^+ = +5.0V$, (Note 7), unless otherwise stated

Parameter	Conditions	LM124A			LM224A			LM324A			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	(Note 8) $T_A = 25˚C$		1	2		1	3		2	3	mV
Input Bias Current (Note 9)	$I_{IN(+)}$ or $I_{IN(-)}$, $V_{CM} = 0V$, $T_A = 25˚C$		20	50		40	80		45	100	nA
Input Offset Current	$I_{IN(+)}$ or $I_{IN(-)}$, $V_{CM} = 0V$, $T_A = 25˚C$		2	10		2	15		5	30	nA
Input Common-Mode Voltage Range (Note 10)	$V^+ = 30V$, (LM2902, $V^+ = 26V$), $T_A = 25˚C$	0		$V^+-1.5$	0		$V^+-1.5$	0		$V^+-1.5$	V
Supply Current	Over Full Temperature Range $R_L = \infty$ On All Op Amps $V^+ = 30V$ (LM2902 $V^+ = 26V$) $V^+ = 5V$		1.5 0.7	3 1.2		1.5 0.7	3 1.2		1.5 0.7	3 1.2	mA
Large Signal Voltage Gain	$V^+ = 15V$, $R_L \geq 2k\Omega$, ($V_O = 1V$ to $11V$), $T_A = 25˚C$	50	100		50	100		25	100		V/mV
Common-Mode	DC, $V_{CM} = 0V$ to $V^+ - 1.5V$,	70	85		70	85		65	85		dB

Electrical Characteristics (Continued)

$V^+ = +5.0V$, (Note 7), unless otherwise stated

Parameter		Conditions		LM124A			LM224A			LM324A			Units
				Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Rejection Ratio		$T_A = 25^\circ C$											
Power Supply Rejection Ratio		$V^+ = 5V$ to $30V$ (LM2902, $V^+ = 5V$ to $26V$), $T_A = 25^\circ C$		65	100		65	100		65	100		dB
Amplifier-to-Amplifier Coupling (Note 11)		f = 1 kHz to 20 kHz, $T_A = 25^\circ C$ (Input Referred)			−120			−120			−120		dB
Output Current	Source	$V_{IN}^+ = 1V$, $V_{IN}^- = 0V$, $V^+ = 15V$, $V_O = 2V$, $T_A = 25^\circ C$		20	40		20	40		20	40		mA
	Sink	$V_{IN}^- = 1V$, $V_{IN}^+ = 0V$, $V^+ = 15V$, $V_O = 2V$, $T_A = 25^\circ C$		10	20		10	20		10	20		
		$V_{IN}^- = 1V$, $V_{IN}^+ = 0V$, $V^+ = 15V$, $V_O = 200$ mV, $T_A = 25^\circ C$		12	50		12	50		12	50		μA
Short Circuit to Ground		(Note 5) $V^+ = 15V$, $T_A = 25^\circ C$			40	60		40	60		40	60	mA
Input Offset Voltage		(Note 8)				4			4			5	mV
V_{OS} Drift		$R_S = 0\Omega$			7	20		7	20		7	30	μV/°C
Input Offset Current		$I_{IN(+)} - I_{IN(-)}$, $V_{CM} = 0V$				30			30			75	nA
I_{OS} Drift		$R_S = 0\Omega$			10	200		10	200		10	300	pA/°C
Input Bias Current		$I_{IN(+)}$ or $I_{IN(-)}$			40	100		40	100		40	200	nA
Input Common-Mode Voltage Range (Note 10)		$V^+ = +30V$ (LM2902, $V^+ = 26V$)		0		V^+-2	0		V^+-2	0		V^+-2	V
Large Signal Voltage Gain		$V^+ = +15V$ (V_OSwing = 1V to 11V) $R_L \geq 2$ kΩ		25			25			15			V/mV
Output Voltage Swing	V_{OH}	$V^+ = 30V$	$R_L = 2$ kΩ	26			26			26			V
		(LM2902, $V^+ = 26V$)	$R_L = 10$ kΩ	27	28		27	28		27	28		
	V_{OL}	$V^+ = 5V$, $R_L = 10$ kΩ			5	20		5	20		5	20	mV
Output Current	Source	$V_O = 2V$	$V_{IN}^+ = +1V$, $V_{IN}^- = 0V$, $V^+ = 15V$	10	20		10	20		10	20		mA
	Sink		$V_{IN}^- = +1V$, $V_{IN}^+ = 0V$, $V^+ = 15V$	10	15		5	8		5	8		

Electrical Characteristics

$V^+ = +5.0V$, (Note 7), unless otherwise stated

Parameter	Conditions	LM124/LM224			LM324			LM2902			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	(Note 8) $T_A = 25^\circ C$		2	5		2	7		2	7	mV
Input Bias Current (Note 9)	$I_{IN(+)}$ or $I_{IN(-)}$, $V_{CM} = 0V$, $T_A = 25^\circ C$		45	150		45	250		45	250	nA
Input Offset Current	$I_{IN(+)}$ or $I_{IN(-)}$, $V_{CM} = 0V$, $T_A = 25^\circ C$		3	30		5	50		5	50	nA
Input Common-Mode Voltage Range (Note 10)	$V^+ = 30V$, (LM2902, $V^+ = 26V$), $T_A = 25^\circ C$	0		$V^+-1.5$	0		$V^+-1.5$	0		$V^+-1.5$	V

Electrical Characteristics (Continued)

$V^+ = +5.0V$, (Note 7), unless otherwise stated

Parameter		Conditions		LM124/LM224			LM324			LM2902			Units
				Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Supply Current		Over Full Temperature Range $R_L = \infty$ On All Op Amps											mA
		$V^+ = 30V$ (LM2902 $V^+ = 26V$)			1.5	3		1.5	3		1.5	3	
		$V^+ = 5V$			0.7	1.2		0.7	1.2		0.7	1.2	
Large Signal Voltage Gain		$V^+ = 15V$, $R_L \geq 2k\Omega$, ($V_O = 1V$ to $11V$), $T_A = 25°C$		50	100		25	100		25	100		V/mV
Common-Mode Rejection Ratio		DC, $V_{CM} = 0V$ to $V^+ - 1.5V$, $T_A = 25°C$		70	85		65	85		50	70		dB
Power Supply Rejection Ratio		$V^+ = 5V$ to $30V$ (LM2902, $V^+ = 5V$ to $26V$), $T_A = 25°C$		65	100		65	100		50	100		dB
Amplifier-to-Amplifier Coupling (Note 11)		f = 1 kHz to 20 kHz, $T_A = 25°C$ (Input Referred)			−120			−120			−120		dB
Output Current	Source	$V_{IN}^+ = 1V$, $V_{IN}^- = 0V$, $V^+ = 15V$, $V_O = 2V$, $T_A = 25°C$		20	40		20	40		20	40		mA
	Sink	$V_{IN}^- = 1V$, $V_{IN}^+ = 0V$, $V^+ = 15V$, $V_O = 2V$, $T_A = 25°C$		10	20		10	20		10	20		
		$V_{IN}^- = 1V$, $V_{IN}^+ = 0V$, $V^+ = 15V$, $V_O = 200$ mV, $T_A = 25°C$		12	50		12	50		12	50		µA
Short Circuit to Ground		(Note 5) $V^+ = 15V$, $T_A = 25°C$			40	60		40	60		40	60	mA
Input Offset Voltage		(Note 8)				7			9			10	mV
V_{OS} Drift		$R_S = 0\Omega$			7			7			7		µV/°C
Input Offset Current		$I_{IN(+)} - I_{IN(-)}$, $V_{CM} = 0V$				100			150		45	200	nA
I_{OS} Drift		$R_S = 0\Omega$			10			10			10		pA/°C
Input Bias Current		$I_{IN(+)}$ or $I_{IN(-)}$			40	300		40	500		40	500	nA
Input Common-Mode Voltage Range (Note 10)		$V^+ = +30V$ (LM2902, $V^+ = 26V$)		0		V^+-2	0		V^+-2	0		V^+-2	V
Large Signal Voltage Gain		$V^+ = +15V$ (V_OSwing = 1V to 11V) $R_L \geq 2$ kΩ		25			15			15			V/mV
Output Voltage Swing	V_{OH}	$V^+ = 30V$ (LM2902, $V^+ = 26V$)	$R_L = 2$ kΩ	26			26			22			V
			$R_L = 10$ kΩ	27	28		27	28		23	24		
	V_{OL}	$V^+ = 5V$, $R_L = 10$ kΩ			5	20		5	20		5	100	mV
Output Current	Source	$V_O = 2V$	$V_{IN}^+ = +1V$, $V_{IN}^- = 0V$, $V^+ = 15V$	10	20		10	20		10	20		mA
	Sink		$V_{IN}^- = +1V$, $V_{IN}^+ = 0V$, $V^+ = 15V$	5	8		5	8		5	8		

Note 4: For operating at high temperatures, the LM324/LM324A/LM2902 must be derated based on a +125˚C maximum junction temperature and a thermal resistance of 88˚C/W which applies for the device soldered in a printed circuit board, operating in a still air ambient. The LM224/LM224A and LM124/LM124A can be derated based on a +150˚C maximum junction temperature. The dissipation is the total of all four amplifiers — use external resistors, where possible, to allow the amplifier to saturate of to reduce the power which is dissipated in the integrated circuit.

Note 5: Short circuits from the output to V^+ can cause excessive heating and eventual destruction. When considering short circuits to ground, the maximum output current is approximately 40 mA independent of the magnitude of V^+. At values of supply voltage in excess of +15V, continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction. Destructive dissipation can result from simultaneous shorts on all amplifiers.

Note 6: This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistors becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also lateral NPN parasitic transistor action

Electrical Characteristics (Continued)

on the IC chip. This transistor action can cause the output voltages of the op amps to go to the V^+voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative. This is not destructive and normal output states will re-establish when the input voltage, which was negative, again returns to a value greater than −0.3V (at 25˚C).

Note 7: These specifications are limited to $-55˚C \le T_A \le +125˚C$ for the LM124/LM124A. With the LM224/LM224A, all temperature specifications are limited to $-25˚C \le T_A \le +85˚C$, the LM324/LM324A temperature specifications are limited to $0˚C \le T_A \le +70˚C$, and the LM2902 specifications are limited to $-40˚C \le T_A \le +85˚C$.

Note 8: $V_O \simeq 1.4V$, $R_S = 0\Omega$ with V^+ from 5V to 30V; and over the full input common-mode range (0V to $V^+ - 1.5V$) for LM2902, V^+ from 5V to 26V.

Note 9: The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.

Note 10: The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3V (at 25˚C). The upper end of the common-mode voltage range is $V^+ - 1.5V$ (at 25˚C), but either or both inputs can go to +32V without damage (+26V for LM2902), independent of the magnitude of V^+.

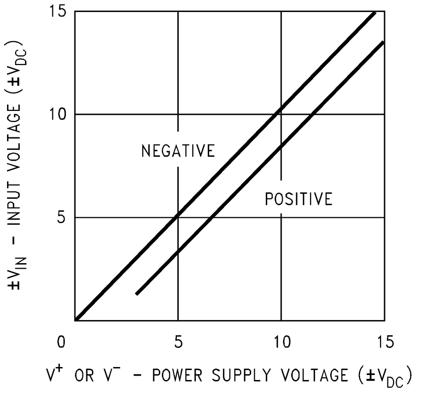
Note 11: Due to proximity of external components, insure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of capacitance increases at higher frequencies.

Note 12: Refer to RETS124AX for LM124A military specifications and refer to RETS124X for LM124 military specifications.

Note 13: Human body model, 1.5 kΩ in series with 100 pF.

Typical Performance Characteristics

Input Voltage Range



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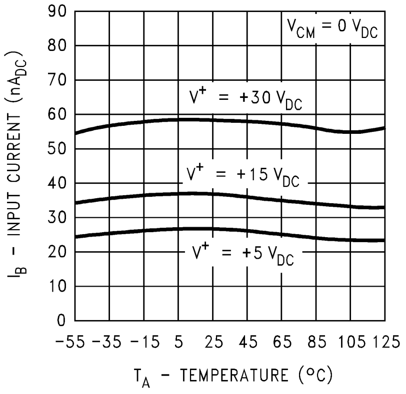
Input Current



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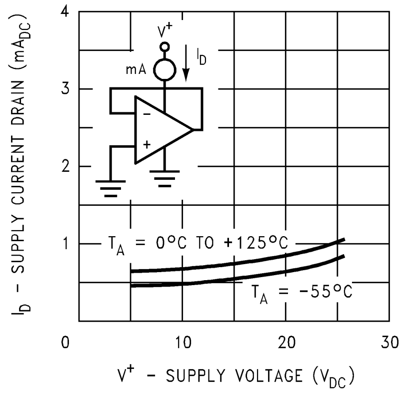
Supply Current



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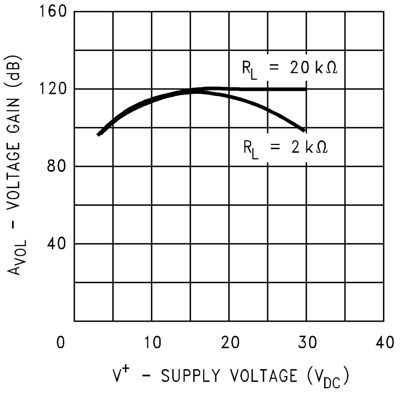
Voltage Gain



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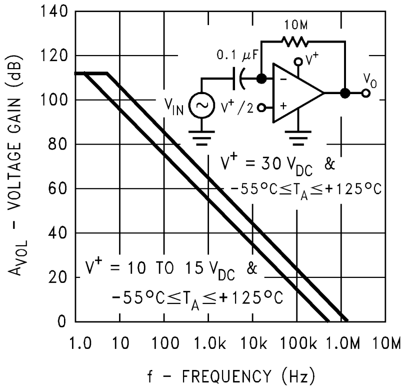
Typical Performance Characteristics (Continued)

Open Loop Frequency Response



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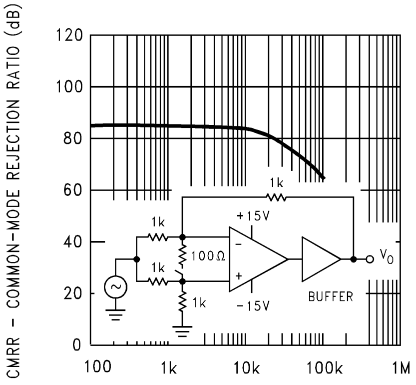
Common Mode Rejection Ratio



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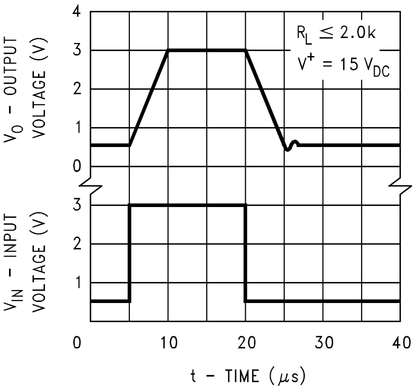
Voltage Follower Pulse Response



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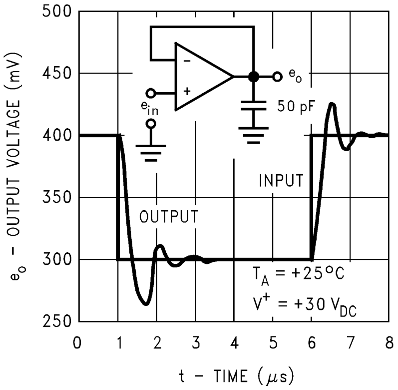
Voltage Follower Pulse Response (Small Signal)



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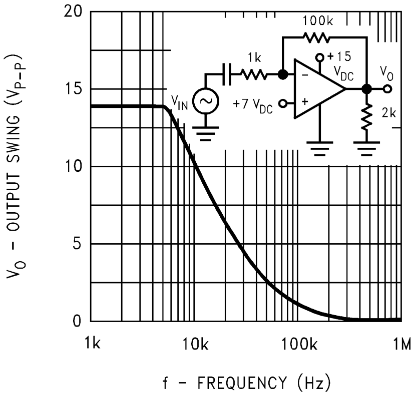
Large Signal Frequency Response



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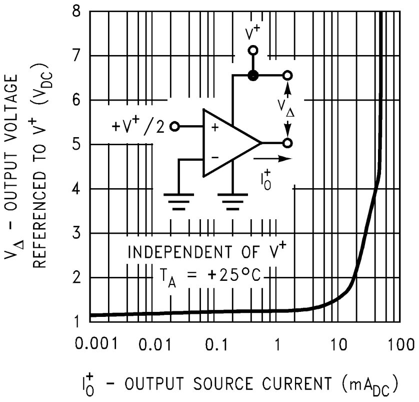
Output Characteristics Current Sourcing



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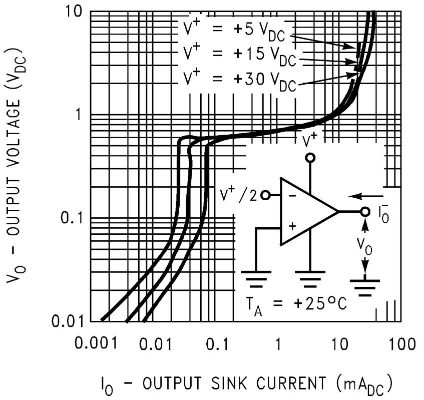
Typical Performance Characteristics (Continued)

Output Characteristics Current Sinking



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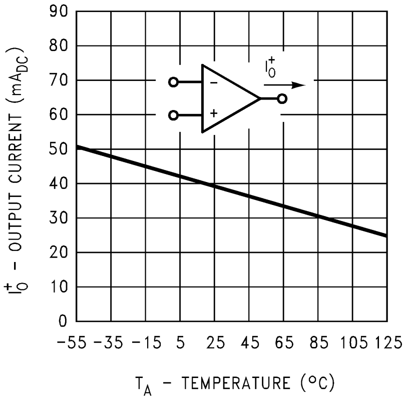
Current Limiting



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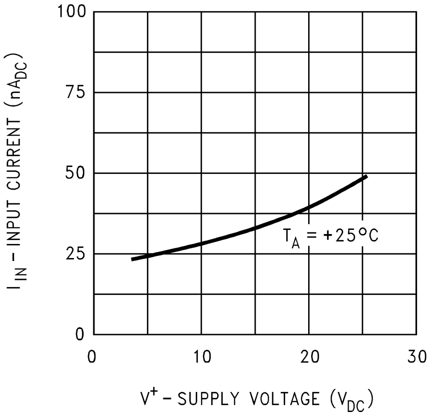
Input Current (LM2902 only)

Voltage Gain (LM2902 only)



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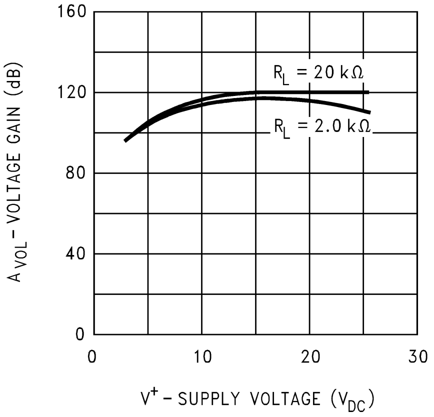

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Application Hints

The LM124 series are op amps which operate with only a single power supply voltage, have true-differential inputs, and remain in the linear mode with an input common-mode voltage of 0 V_{DC}. These amplifiers operate over a wide range of power supply voltage with little change in performance characteristics. At 25˚C amplifier operation is possible down to a minimum supply voltage of 2.3 V_{DC}.

The pinouts of the package have been designed to simplify PC board layouts. Inverting inputs are adjacent to outputs for all of the amplifiers and the outputs have also been placed at the corners of the package (pins 1, 7, 8, and 14).

Precautions should be taken to insure that the power supply for the integrated circuit never becomes reversed in polarity or that the unit is not inadvertently installed backwards in a test socket as an unlimited current surge through the resulting forward diode within the IC could cause fusing of the internal conductors and result in a destroyed unit.

Large differential input voltages can be easily accommodated and, as input differential voltage protection diodes are not needed, no large input currents result from large differential input voltages. The differential input voltage may be larger than V^+ without damaging the device. Protection should be provided to prevent the input voltages from going negative more than −0.3 V_{DC} (at 25˚C). An input clamp diode with a resistor to the IC input terminal can be used.

To reduce the power supply drain, the amplifiers have a class A output stage for small signal levels which converts to class B in a large signal mode. This allows the amplifiers to both source and sink large output currents. Therefore both NPN and PNP external current boost transistors can be used to extend the power capability of the basic amplifiers. The output voltage needs to raise approximately 1 diode drop above ground to bias the on-chip vertical PNP transistor for output current sinking applications.

For ac applications, where the load is capacitively coupled to the output of the amplifier, a resistor should be used, from the output of the amplifier to ground to increase the class A bias current and prevent crossover distortion.

Where the load is directly coupled, as in dc applications, there is no crossover distortion.

Capacitive loads which are applied directly to the output of the amplifier reduce the loop stability margin. Values of 50 pF can be accommodated using the worst-case non-inverting unity gain connection. Large closed loop gains or resistive isolation should be used if larger load capacitance must be driven by the amplifier.

Application Hints (Continued)

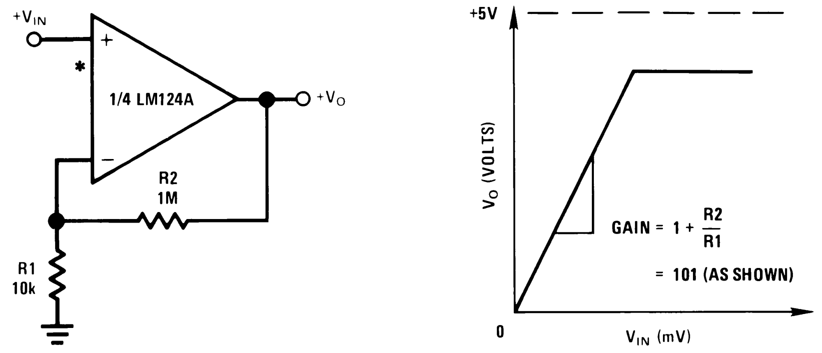
The bias network of the LM124 establishes a drain current which is independent of the magnitude of the power supply voltage over the range of from 3 V_{DC} to 30 V_{DC}.

Output short circuits either to ground or to the positive power supply should be of short time duration. Units can be destroyed, not as a result of the short circuit current causing metal fusing, but rather due to the large increase in IC chip dissipation which will cause eventual failure due to excessive junction temperatures. Putting direct short-circuits on more than one amplifier at a time will increase the total IC power dissipation to destructive levels, if not properly protected with external dissipation limiting resistors in series with the output leads of the amplifiers. The larger value of output source current which is available at 25°C provides a larger output current capability at elevated temperatures (see typical performance characteristics) than a standard IC op amp.

The circuits presented in the section on typical applications emphasize operation on only a single power supply voltage. If complementary power supplies are available, all of the standard op amp circuits can be used. In general, introducing a pseudo-ground (a bias voltage reference of $V^+/2$) will allow operation above and below this value in single power supply systems. Many application circuits are shown which take advantage of the wide input common-mode voltage range which includes ground. In most cases, input biasing is not required and input voltages which range to ground can easily be accommodated.

Typical Single-Supply Applications ($V^+ = 5.0\ V_{DC}$)

Non-Inverting DC Gain (0V Input = 0V Output)



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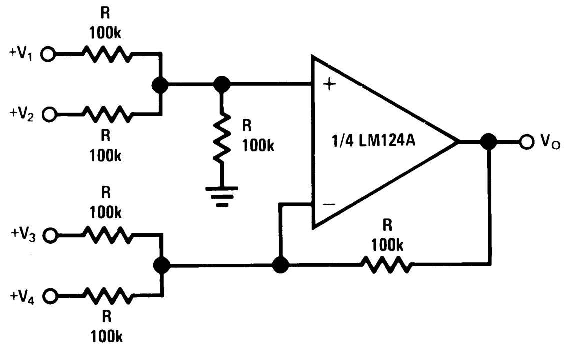
*R not needed due to temperature independent I_{IN}

DC Summing Amplifier ($V_{IN'S} \geq 0\ V_{DC}$ and $V_O \geq V_{DC}$)



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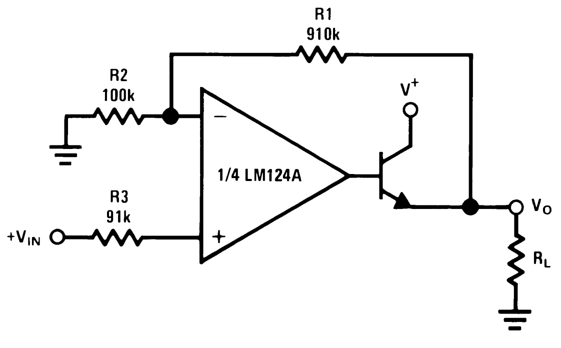
Where: $V_0 = V_1 + V_2 - V_3 - V_4$

$(V_1 + V_2) \geq (V_3 + V_4)$ to keep $V_O > 0\ V_{DC}$

Power Amplifier



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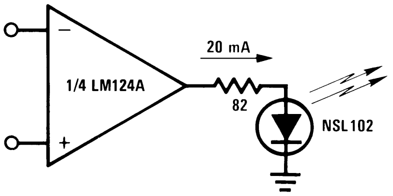
$V_0 = 0\ V_{DC}$ for $V_{IN} = 0\ V_{DC}$

$A_V = 10$

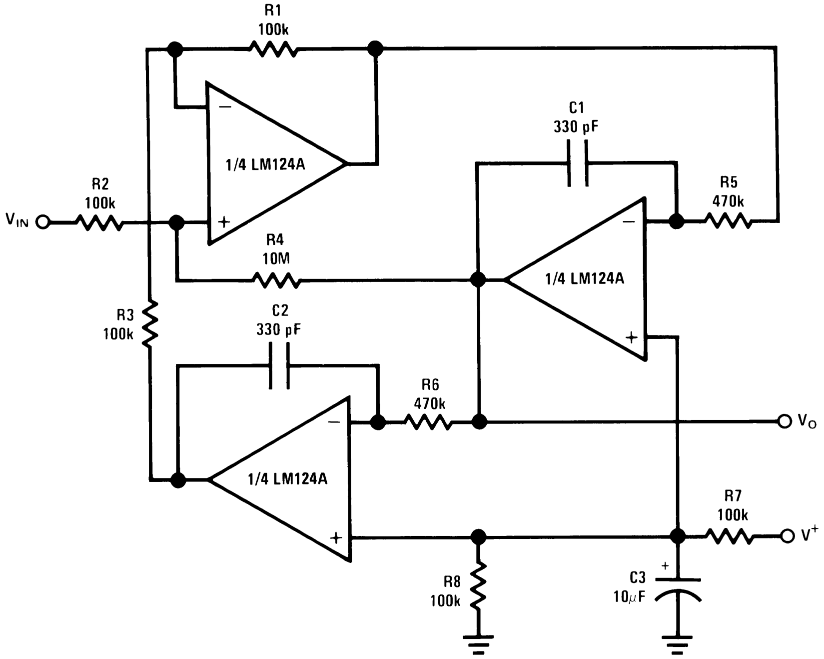
Typical Single-Supply Applications ($V^+ = 5.0\ V_{DC}$) (Continued)

LED Driver



00929908

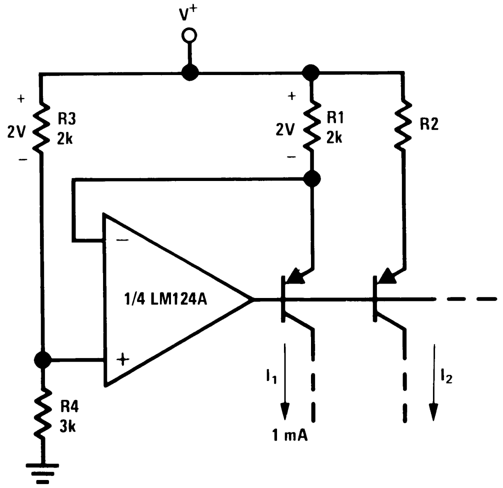
"BI-QUAD" RC Active Bandpass Filter



00929909

f_o = 1 kHz
Q = 50
A_V = 100 (40 dB)

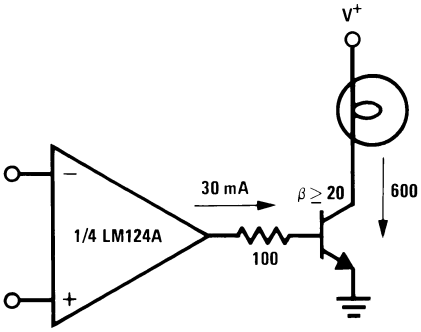
Fixed Current Sources



00929910

$$I_2 = \left(\frac{R1}{R2}\right) I_1$$

Lamp Driver

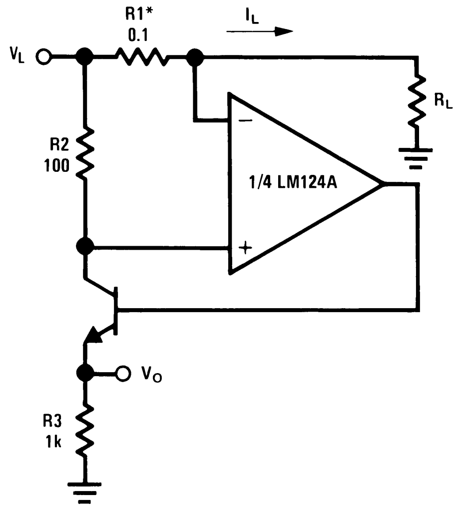


00929911

Typical Single-Supply Applications

($V^+ = 5.0\ V_{DC}$) (Continued)

Current Monitor



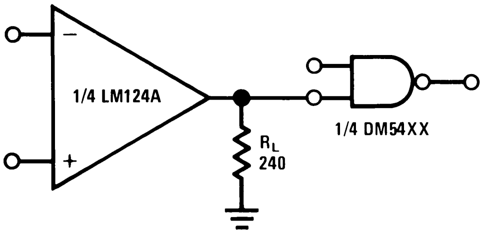
00929912

$$V_O = \frac{1V(I_L)}{1A}$$

$$V_L \leq V^+ - 2V$$

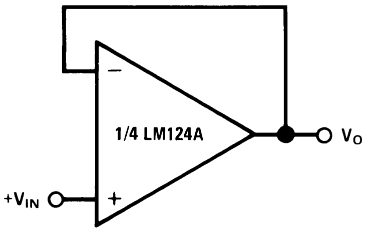
*(Increase R1 for I_L small)

Driving TTL



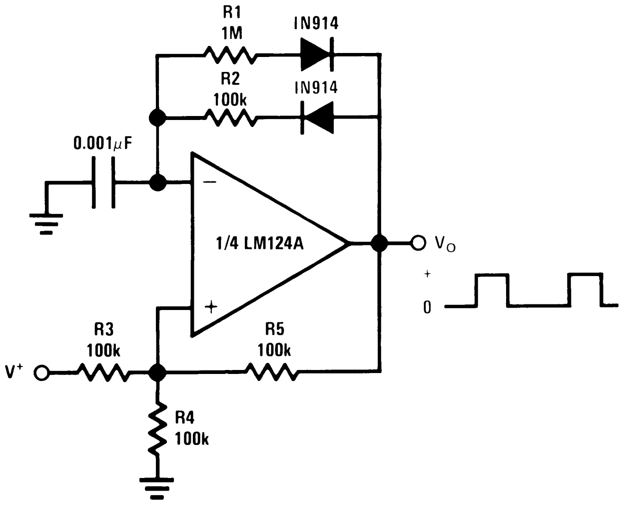
00929913

Voltage Follower



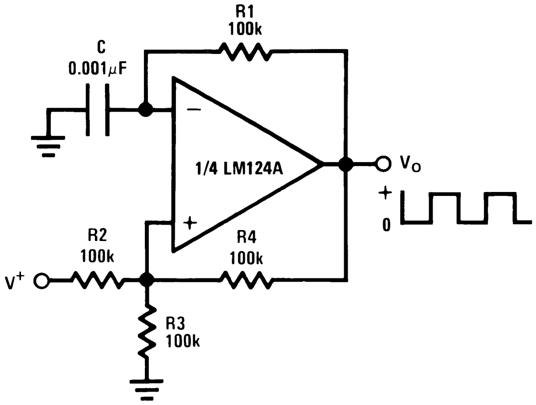
00929914

Pulse Generator



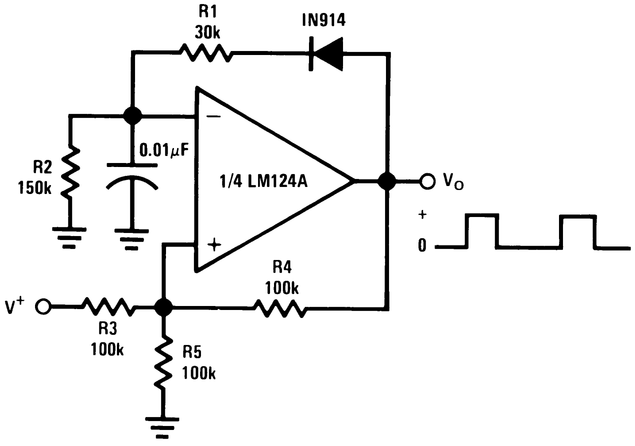
00929915

Squarewave Oscillator



00929916

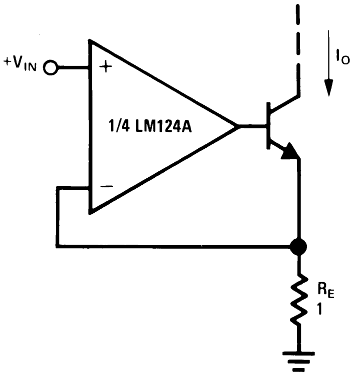
Pulse Generator



00929917

Typical Single-Supply Applications ($V^+ = 5.0\ V_{DC}$) (Continued)

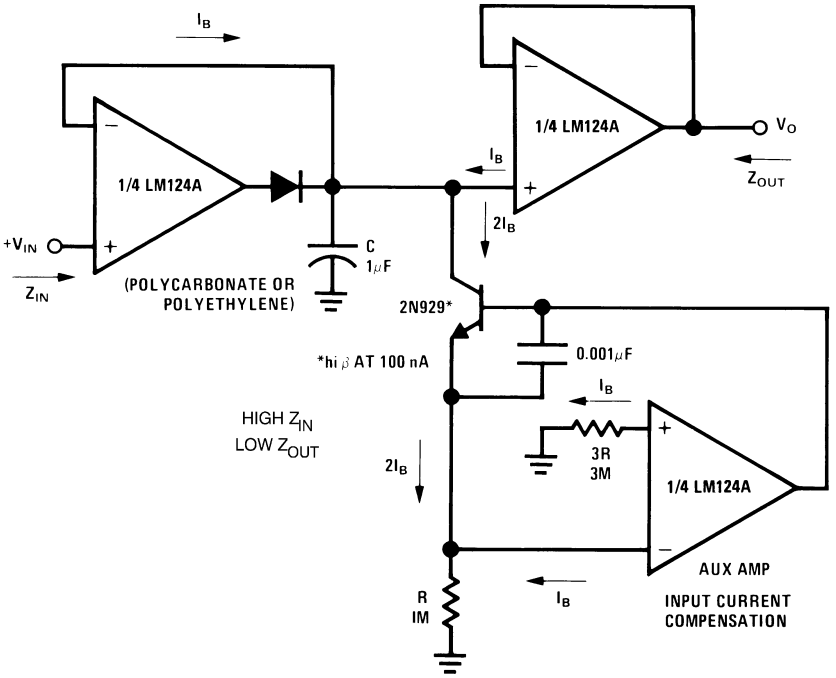
High Compliance Current Sink



00929918

I_O = 1 amp/volt V_{IN}
(Increase R_E for I_o small)

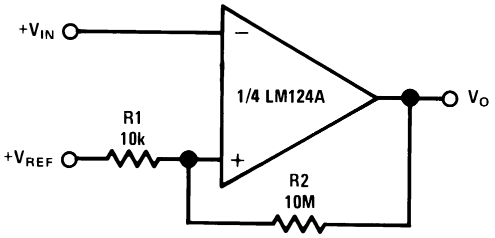
Low Drift Peak Detector



00929919

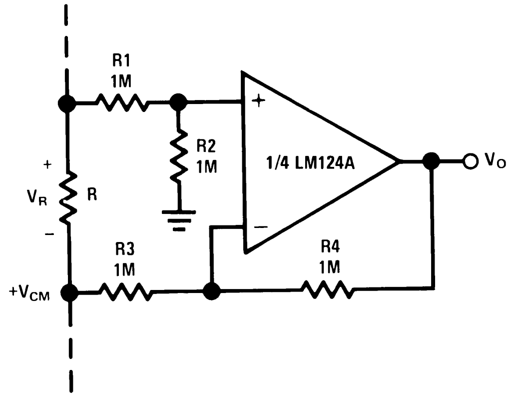
Typical Single-Supply Applications ($V^+ = 5.0\ V_{DC}$) (Continued)

Comparator with Hysteresis



00929920

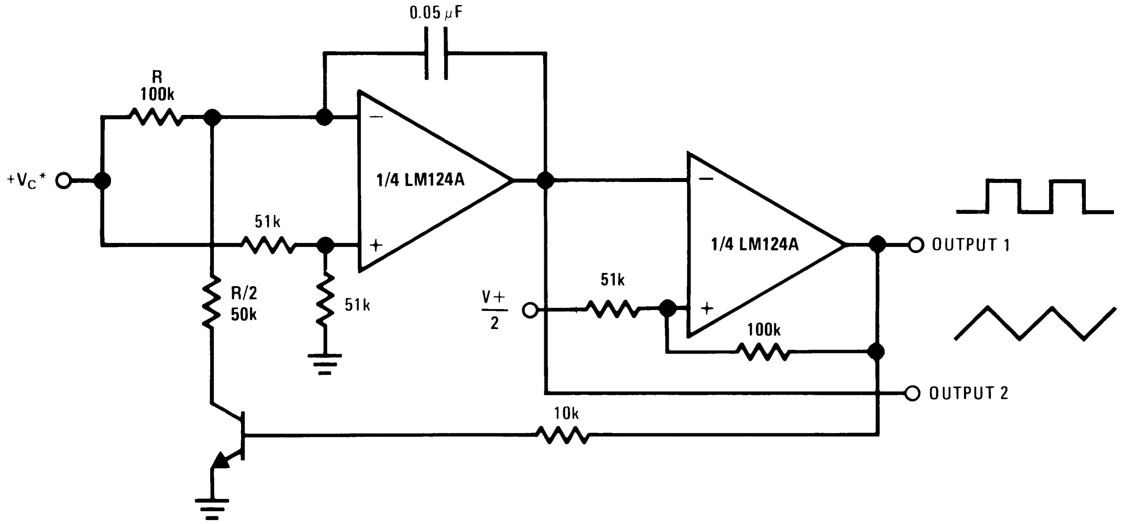
Ground Referencing a Differential Input Signal



00929921

$V_O = V_R$

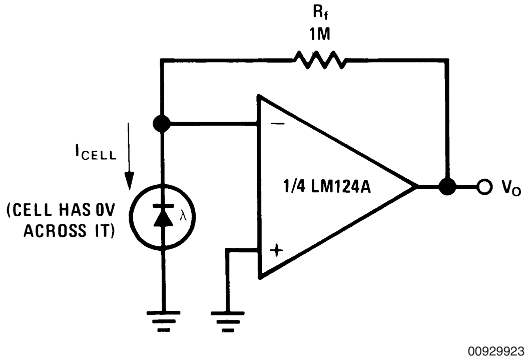
Voltage Controlled Oscillator Circuit



00929922

*Wide control voltage range: $0\ V_{DC} \leq V_C \leq 2\ (V^+ - 1.5\ V_{DC})$

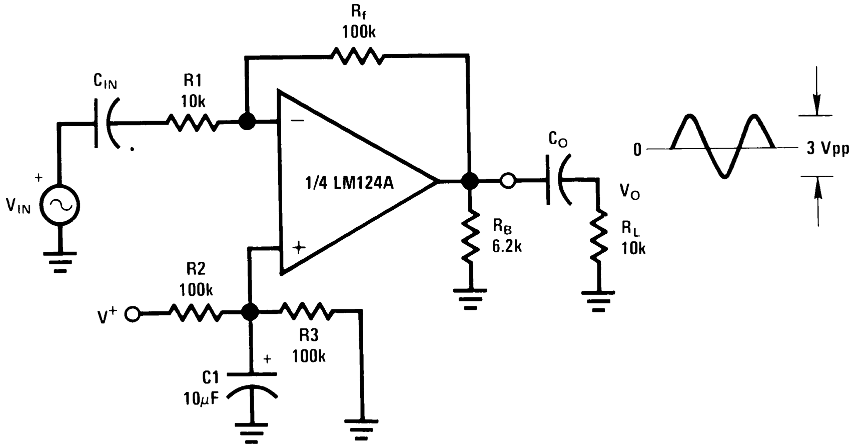
Photo Voltaic-Cell Amplifier



00929923

Typical Single-Supply Applications ($V^+ = 5.0\ V_{DC}$) (Continued)

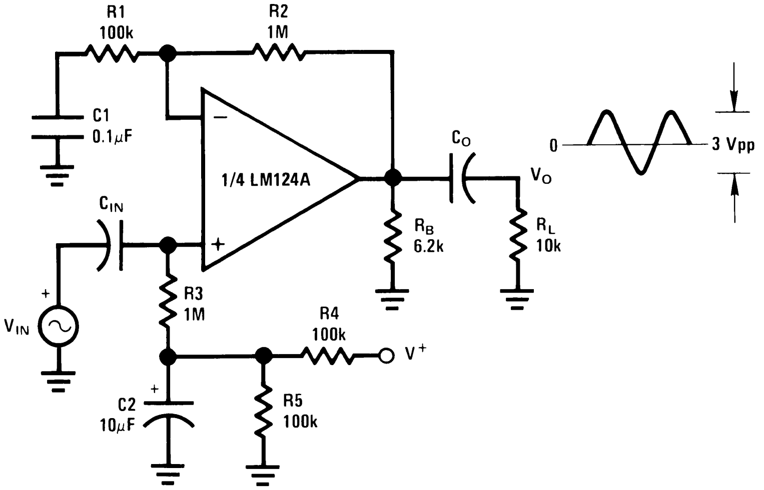
AC Coupled Inverting Amplifier



00929924

$$A_V = \frac{R_f}{R1} \text{ (As shown, } A_V = 10)$$

AC Coupled Non-Inverting Amplifier



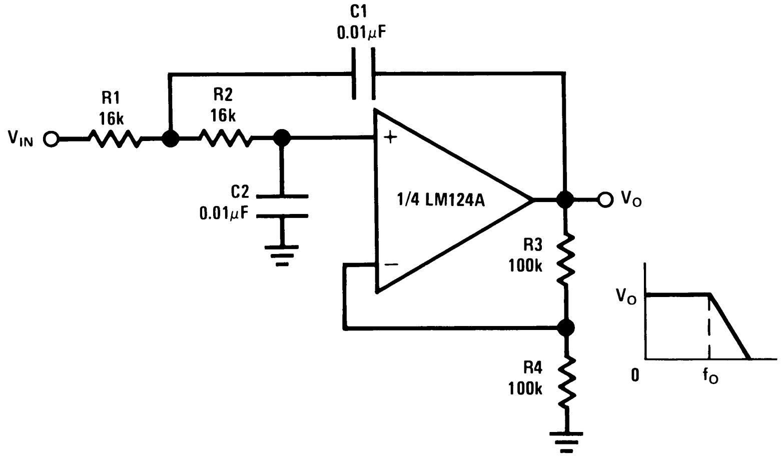
00929925

$$A_V = 1 + \frac{R2}{R1}$$

$A_V = 11$ (As shown)

Typical Single-Supply Applications ($V^+ = 5.0\ V_{DC}$) (Continued)

DC Coupled Low-Pass RC Active Filter



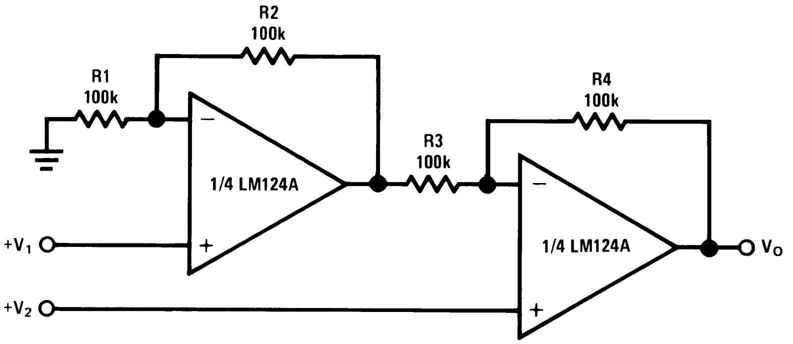
00929926

$f_O = 1$ kHz

$Q = 1$

$A_V = 2$

High Input Z, DC Differential Amplifier



00929927

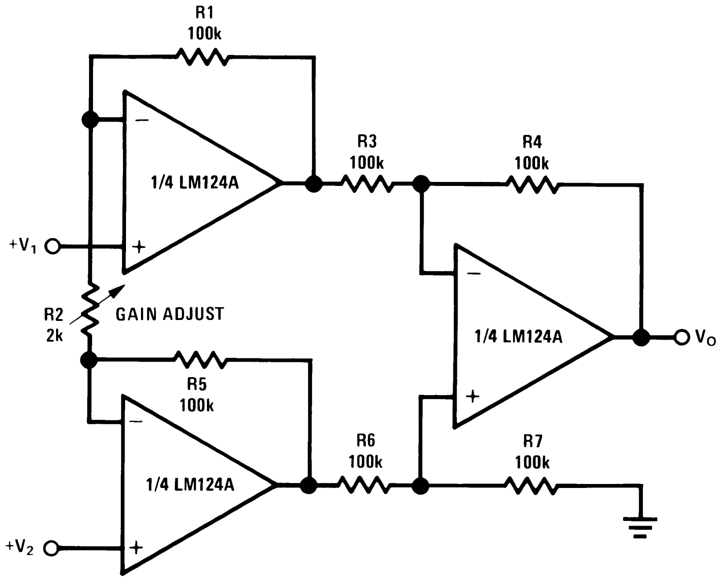
For $\frac{R1}{R2} = \frac{R4}{R3}$ (CMRR depends on this resistor ratio match)

$V_O = 1 + \frac{R4}{R3}(V_2 - V_1)$

As shown: $V_O = 2(V_2 - V_1)$

Typical Single-Supply Applications ($V^+ = 5.0\ V_{DC}$) (Continued)

High Input Z Adjustable-Gain DC Instrumentation Amplifier



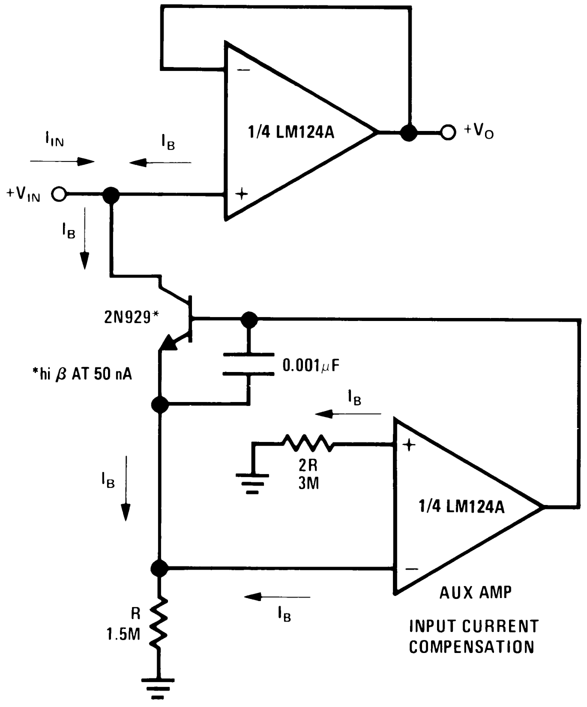
00929928

If R1 = R5 & R3 = R4 = R6 = R7 (CMRR depends on match)

$$V_O = 1 + \frac{2R1}{R2}(V_2 - V_1)$$

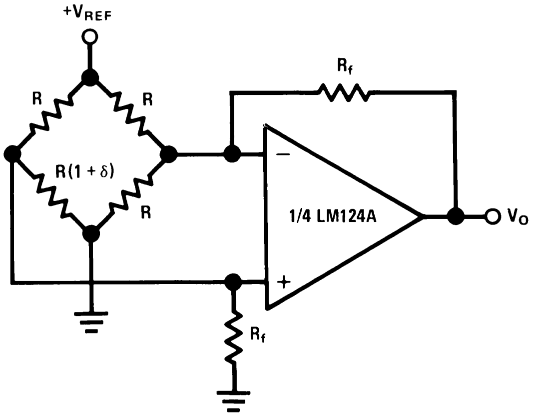
As shown $V_O = 101\ (V_2 - V_1)$

Using Symmetrical Amplifiers to Reduce Input Current (General Concept)



00929929

Bridge Current Amplifier



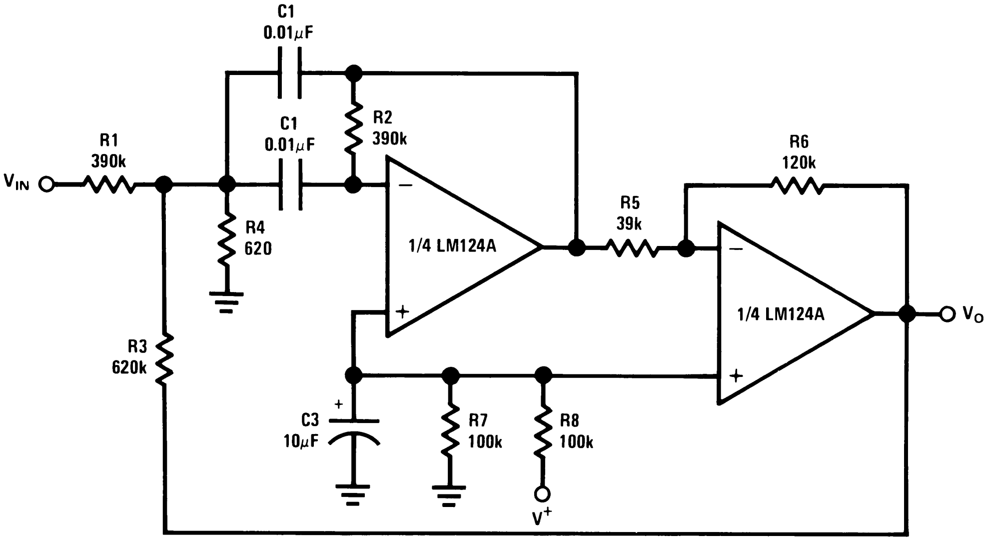
00929930

For $\delta << 1$ and $R_f >> R$

$$V_O \cong V_{REF}\left(\frac{\delta}{2}\right)\frac{R_f}{R}$$

Typical Single-Supply Applications ($V^+ = 5.0\ V_{DC}$) (Continued)

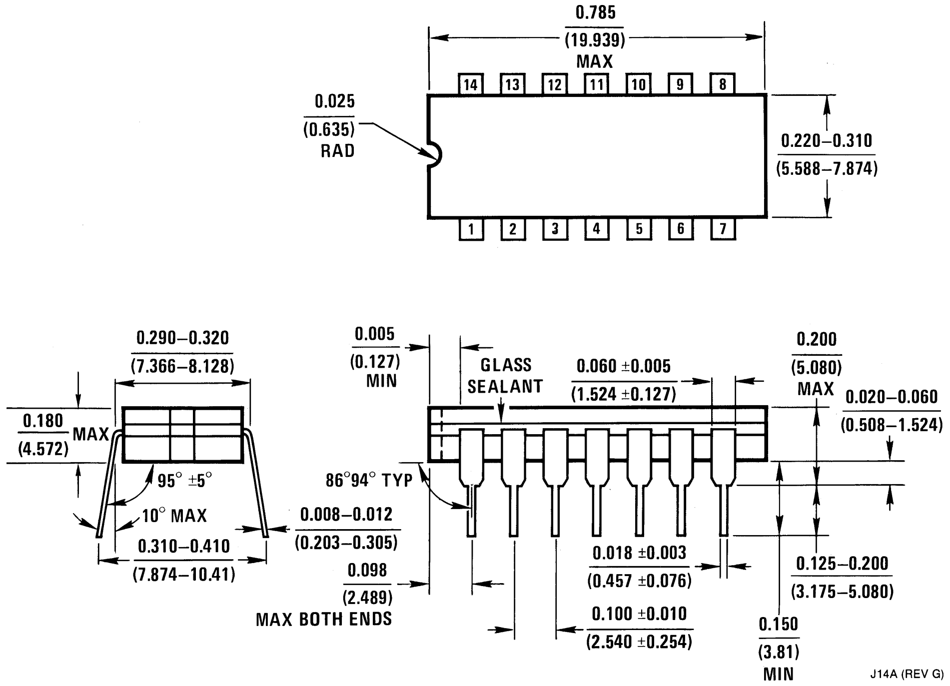
Bandpass Active Filter



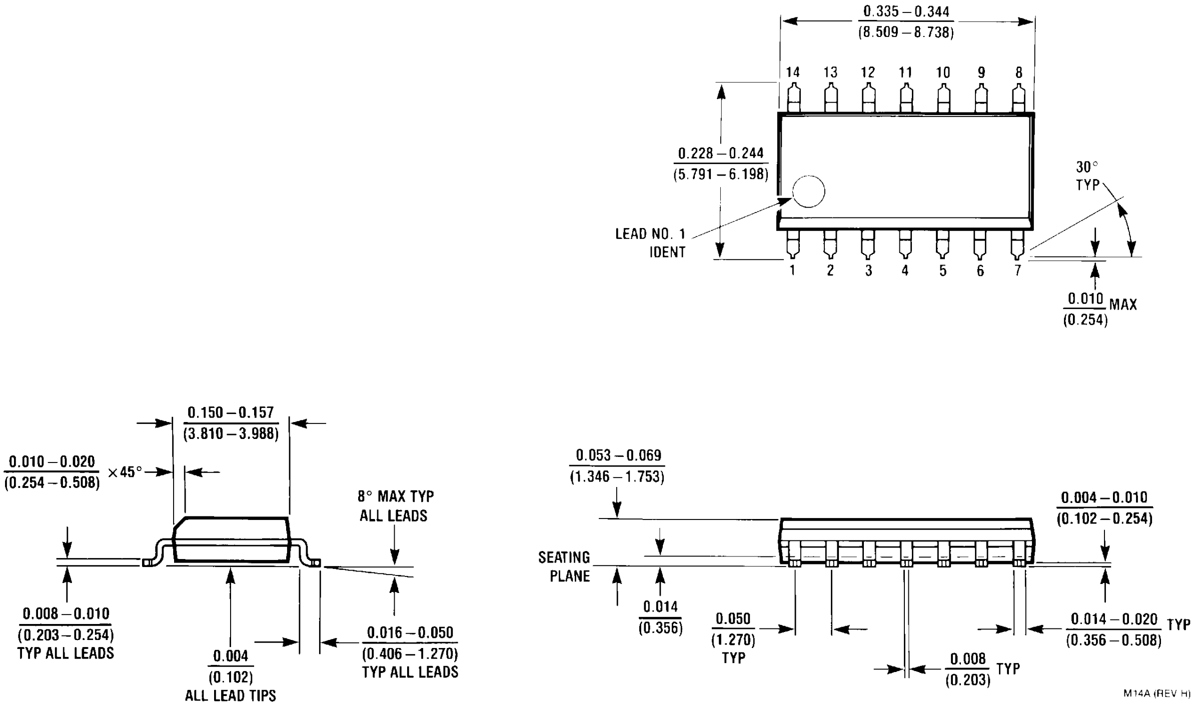
f_O = 1 kHz

Q = 25

Physical Dimensions inches (millimeters) unless otherwise noted

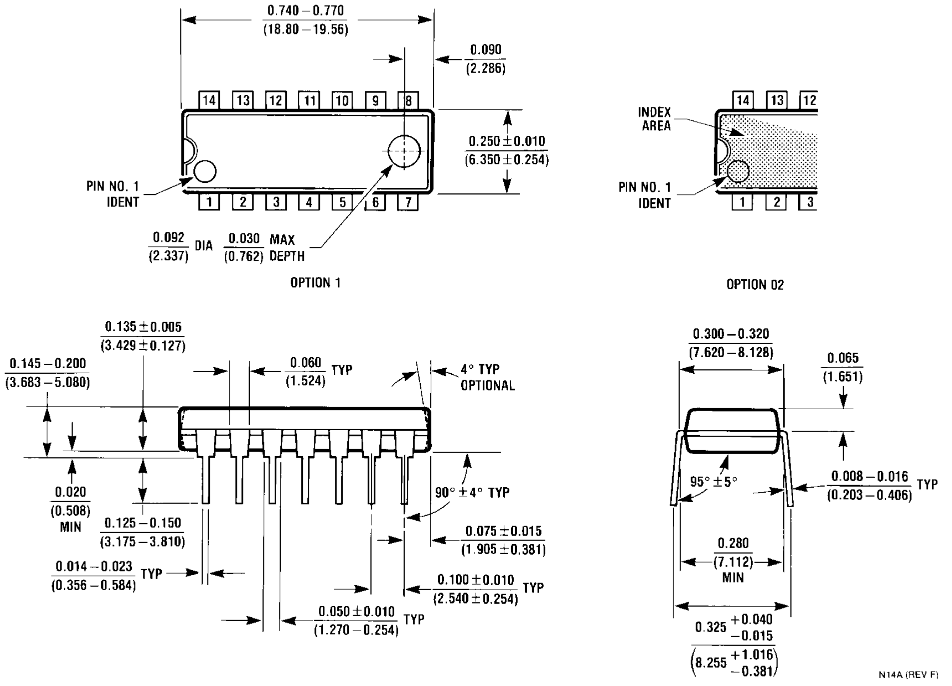


Ceramic Dual-In-Line Package (J)
Order Number JL124ABCA, JL124BCA, JL124ASCA, JL124SCA, LM124J,
LM124AJ, LM124AJ/883, LM124J/883, LM224J, LM224AJ or LM324J
NS Package Number J14A

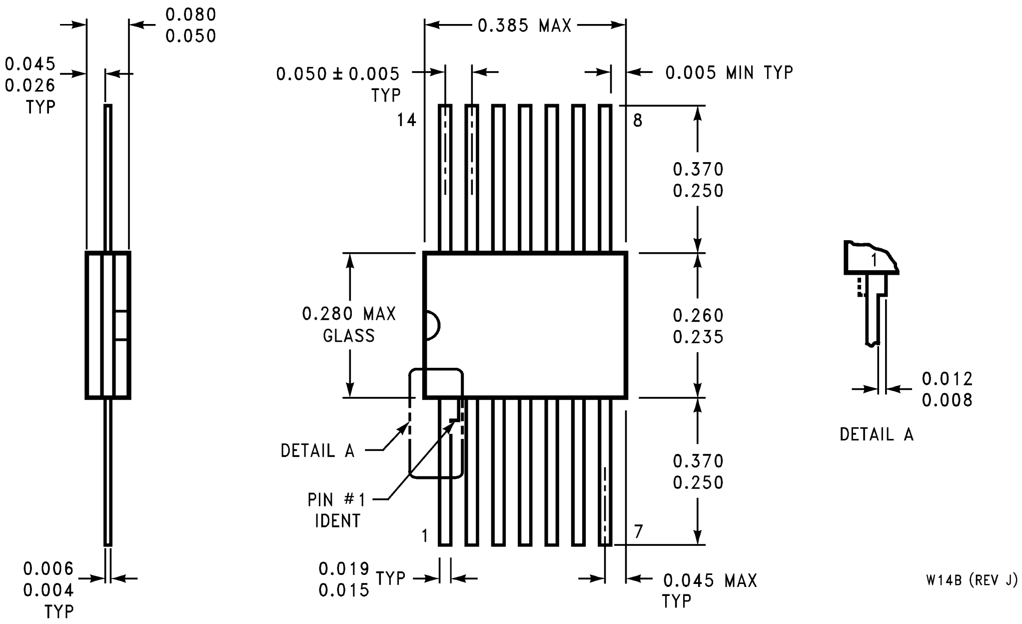


MX S.O. Package (M)
Order Number LM324M, LM324MX, LM324AM, LM324AMX, LM2902M or LM2902MX
NS Package Number M14A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)

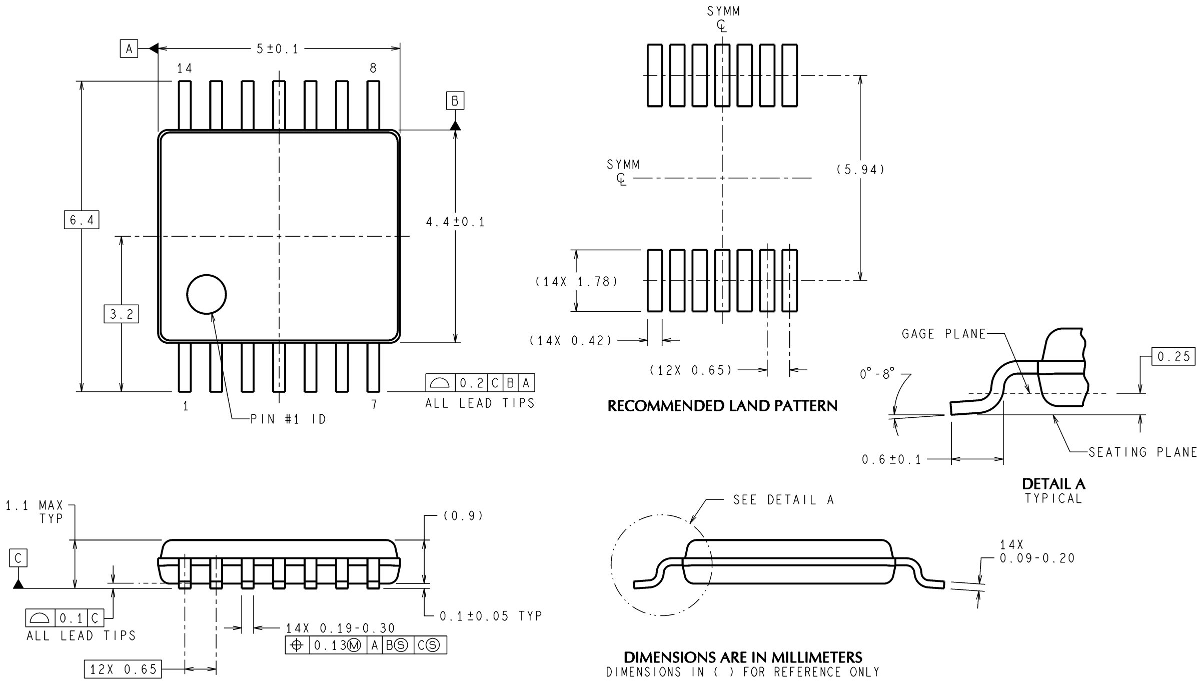


Molded Dual-In-Line Package (N)
Order Number LM324N, LM324AN or LM2902N
NS Package Number N14A



Ceramic Flatpak Package
Order Number JL124ABDA, JL124ABZA, JL124ASDA, JL124BDA, JL124BZA, JL124SDA, LM124AW/883, LM124AWG/883, LM124W/883 or LM124WG/883
NS Package Number W14B

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



MTC14 (Rev D)

14-Pin TSSOP
Order NumberLM324MT or LM324MTX
NS Package Number MTC14

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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National Semiconductor

May 1998

LM138/LM338
5-Amp Adjustable Regulators

General Description

The LM138 series of adjustable 3-terminal positive voltage regulators is capable of supplying in excess of 5A over a 1.2V to 32V output range. They are exceptionally easy to use and require only 2 resistors to set the output voltage. Careful circuit design has resulted in outstanding load and line regulation — comparable to many commercial power supplies. The LM138 family is supplied in a standard 3-lead transistor package.

A unique feature of the LM138 family is time-dependent current limiting. The current limit circuitry allows peak currents of up to 12A to be drawn from the regulator for short periods of time. This allows the LM138 to be used with heavy transient loads and speeds start-up under full-load conditions. Under sustained loading conditions, the current limit decreases to a safe value protecting the regulator. Also included on the chip are thermal overload protection and safe area protection for the power transistor. Overload protection remains functional even if the adjustment pin is accidentally disconnected.

Normally, no capacitors are needed unless the device is situated more than 6 inches from the input filter capacitors in which case an input bypass is needed. An output capacitor can be added to improve transient response, while bypassing the adjustment pin will increase the regulator's ripple rejection.

Besides replacing fixed regulators or discrete designs, the LM138 is useful in a wide variety of other applications. Since the regulator is "floating" and sees only the input-to-output differential voltage, supplies of several hundred volts can be regulated as long as the maximum input to output differential is not exceeded, i.e., do not short-circuit output to ground. The part numbers in the LM138 series which have a K suffix are packaged in a standard Steel TO-3 package, while those with a T suffix are packaged in a TO-220 plastic package. The LM138 is rated for $-55^\circ C \le T_J \le +150^\circ C$, and the LM338 is rated for $0^\circ C \le T_J \le +125^\circ C$.

Features

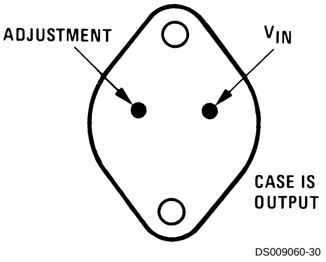
- Guaranteed 7A peak output current
- Guaranteed 5A output current
- Adjustable output down to 1.2V
- Guaranteed thermal regulation
- Current limit constant with temperature
- P^+ Product Enhancement tested
- Output is short-circuit protected

Applications

- Adjustable power supplies
- Constant current regulators
- Battery chargers

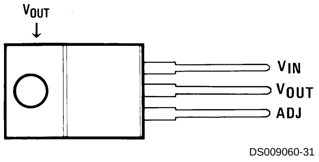
Connection Diagrams (See Physical Dimension section for further information)

(TO-3 STEEL)
Metal Can Package



Bottom View
Order Number LM138K STEEL or LM338K STEEL
See NS Package Number K02A

(TO-220)
Plastic Package



Front View
Order Number LM338T
See NS Package Number T03B

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

(Note 4)

Power Dissipation	Internally limited
Input/Output Voltage Differential	+40V, −0.3V
Storage Temperature	−65˚C to +150˚C
Lead Temperature	
Metal Package (Soldering, 10 seconds)	300˚C
Plastic Package (Soldering, 4 seconds)	260˚C
ESD Tolerance	TBD

Operating Temperature Range

LM138	$-55^\circ C \le T_J \le +150^\circ C$
LM338	$0^\circ C \le T_J \le +125^\circ C$

Electrical Characteristics

Specifications with standard type face are for $T_J = 25^\circ C$, and those with **boldface type** apply over **full Operating Temperature Range.** Unless otherwise specified, $V_{IN} - V_{OUT} = 5V$; and $I_{OUT} = 10$ mA. (Note 2)

Symbol	Parameter	Conditions	LM138			Units
			Min	Typ	Max	
V_{REF}	Reference Voltage	$3V \le (V_{IN} - V_{OUT}) \le 35V$, $10 mA \le I_{OUT} \le 5A$, $P \le 50W$	**1.19**	**1.24**	**1.29**	V
V_{RLINE}	Line Regulation	$3V \le (V_{IN} - V_{OUT}) \le 35V$ (Note 3)		0.005	0.01	%/V
				0.02	**0.04**	%/V
V_{RLOAD}	Load Regulation	$10 mA \le I_{OUT} \le 5A$ (Note 3)		0.1	0.3	%
				0.3	**0.6**	%
	Thermal Regulation	20 ms Pulse		0.002	0.01	%/W
I_{ADJ}	Adjustment Pin Current			**45**	**100**	µA
ΔI_{ADJ}	Adjustment Pin Current Change	$10 mA \le I_{OUT} \le 5A$, $3V \le (V_{IN} - V_{OUT}) \le 35V$		**0.2**	**5**	µA
$\Delta V_{R/T}$	Temperature Stability	$T_{MIN} \le T_J \le T_{MAX}$		**1**		%
I_{LOAD}(Min)	Minimum Load Current	$V_{IN} - V_{OUT} = 35V$		**3.5**	**5**	mA
I_{CL}	Current Limit	$V_{IN} - V_{OUT} \le 10V$				
		DC	**5**	**8**		A
		0.5 ms Peak	**7**	**12**		A
		$V_{IN} - V_{OUT} = 30V$		1	1	A
V_N	RMS Output Noise, % of V_{OUT}	$10 Hz \le f \le 10 kHz$		0.003		%
$\frac{\Delta V_R}{\Delta V_{IN}}$	Ripple Rejection Ratio	$V_{OUT} = 10V$, f = 120 Hz, $C_{ADJ} = 0$ µF		**60**		dB
		$V_{OUT} = 10V$, f = 120 Hz, $C_{ADJ} = 10$ µF	**60**	**75**		dB
	Long-Term Stability	$T_J = 125^\circ C$, 1000 Hrs		0.3	1	%
θ_{JC}	Thermal Resistance, Junction to Case	K Package			1	˚C/W
θ_{JA}	Thermal Resistance, Junction to Ambient (No Heat Sink)	K Package		35		˚C/W

Electrical Characteristics

Symbol	Parameter	Conditions	LM338			Units
			Min	Typ	Max	
V_{REF}	Reference Voltage	$3V \le (V_{IN} - V_{OUT}) \le 35V$, $10 mA \le I_{OUT} \le 5A$, $P \le 50W$	**1.19**	**1.24**	**1.29**	V
V_{RLINE}	Line Regulation	$3V \le (V_{IN} - V_{OUT}) \le 35V$ (Note 3)		0.005	0.03	%/V
				0.02	**0.06**	%/V
V_{RLOAD}	Load Regulation	$10 mA \le I_{OUT} \le 5A$ (Note 3)		0.1	0.5	%
				0.3	**1**	%
	Thermal Regulation	20 ms Pulse		0.002	0.02	%/W
I_{ADJ}	Adjustment Pin Current			**45**	**100**	µA
ΔI_{ADJ}	Adjustment Pin Current Change	$10 mA \le I_{OUT} \le 5A$, $3V \le (V_{IN} - V_{OUT}) \le 35V$		**0.2**	**5**	µA

Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	LM338			Units
			Min	Typ	Max	
$\Delta V_{R/T}$	Temperature Stability	$T_{MIN} \le T_J \le T_{MAX}$		**1**		%
I_{LOAD}(Min)	Minimum Load Current	$V_{IN} - V_{OUT} = 35V$		**3.5**	**10**	mA
I_{CL}	Current Limit	$V_{IN} - V_{OUT} \le 10V$				
		DC	**5**	**8**		A
		0.5 ms Peak	**7**	**12**		A
		$V_{IN} - V_{OUT} = 30V$			1	A
V_N	RMS Output Noise, % of V_{OUT}	10 Hz ≤ f ≤ 10 kHz		0.003		%
$\frac{\Delta V_R}{\Delta V_{IN}}$	Ripple Rejection Ratio	$V_{OUT} = 10V$, f = 120 Hz, $C_{ADJ} = 0\ \mu F$		**60**		dB
		$V_{OUT} = 10V$, f = 120 Hz, $C_{ADJ} = 10\ \mu F$	**60**	**75**		dB
	Long-Term Stability	$T_J = 125^\circ C$, 1000 hrs		0.3	1	%
θ_{JC}	Thermal Resistance	K Package			1	˚C/W
	Junction to Case	T Package			4	˚C/W
θ_{JA}	Thermal Resistance, Junction to	K Package		35		˚C/W
	Ambient (No Heat Sink)	T Package		50		˚C/W

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics.

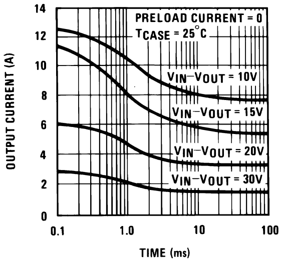
Note 2: These specifications are applicable for power dissipations up to 50W for the TO-3 (K) package and 25W for the TO-220 (T) package. Power dissipation is guaranteed at these values up to 15V input-output differential. Above 15V differential, power dissipation will be limited by internal protection circuitry. All limits (i.e., the numbers in the Min. and Max. columns) are guaranteed to National's AOQL (Average Outgoing Quality Level).

Note 3: Regulation is measured at a constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specifications for thermal regulation.

Note 4: Refer to RETS138K drawing for military specifications of LM138K.

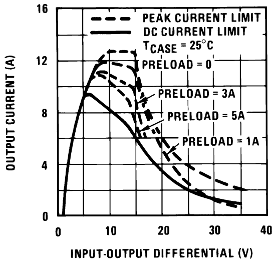
Typical Performance Characteristics

Current Limit



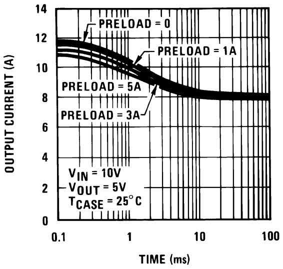
DS009060-32

Current Limit



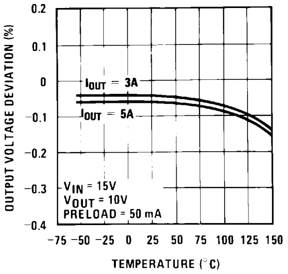
DS009060-33

Current Limit



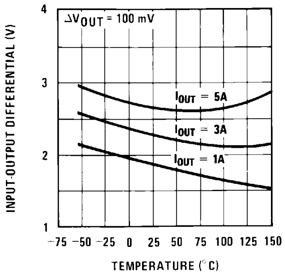
DS009060-34

Load Regulation



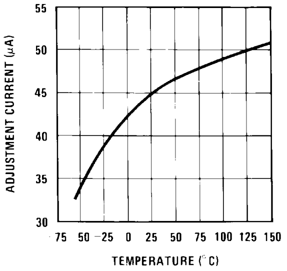
DS009060-35

Dropout Voltage



DS009060-36

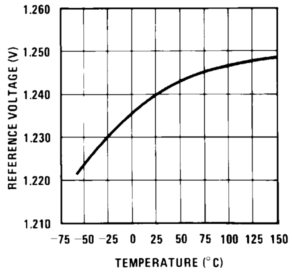
Adjustment Current



DS009060-37

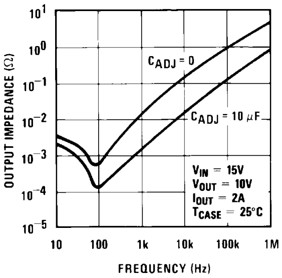
Typical Performance Characteristics (Continued)

Temperature Stability



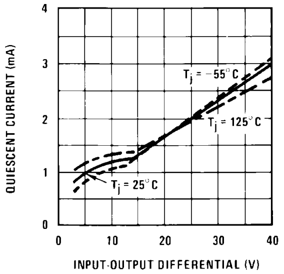
DS009060-38

Output Impedance



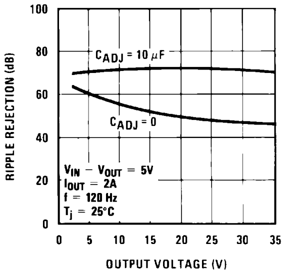
DS009060-39

Minimum Operating Current



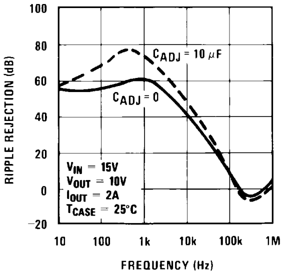
DS009060-40

Ripple Rejection



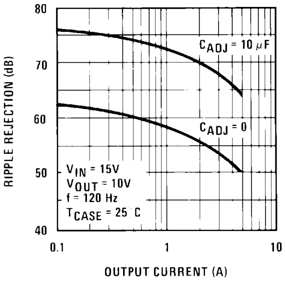
DS009060-41

Ripple Rejection



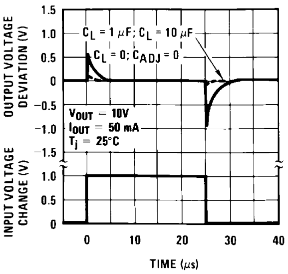
DS009060-42

Ripple Rejection



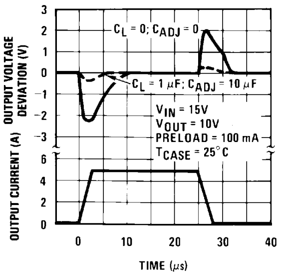
DS009060-43

Line Transient Response



DS009060-44

Load Transient Response



DS009060-45

Application Hints

In operation, the LM138 develops a nominal 1.25V reference voltage, V_{REF}, between the output and adjustment terminal. The reference voltage is impressed across program resistor R1 and, since the voltage is constant, a constant current I_1 then flows through the output set resistor R2, giving an output voltage of

$$V_{OUT} = V_{REF}\left(1 + \frac{R2}{R1}\right) + I_{ADJ}R2.$$

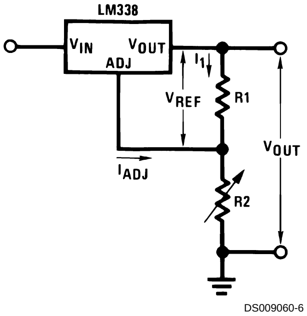


FIGURE 1.

Since the 50 µA current from the adjustment terminal represents an error term, the LM138 was designed to minimize I_{ADJ} and make it very constant with line and load changes. To do this, all quiescent operating current is returned to the output establishing a minimum load current requirement. If there is insufficient load on the output, the output will rise.

External Capacitors

An input bypass capacitor is recommended. A 0.1 µF disc or 1 µF solid tantalum on the input is suitable input bypassing for almost all applications. The device is more sensitive to the absence of input bypassiing when adjustment or output capacitors are used but the above values will eliminate the possiblity of problems.

The adjustment terminal can be bypassed to ground on the LM138 to improve ripple rejection. This bypass capacitor prevents ripple from being amplified as the output voltage is increased. With a 10 µF bypass capacitor 75 dB ripple rejection is obtainable at any output level. Increases over 20 µF do not appreciably improve the ripple rejection at frequencies above 120 Hz. If the bypass capacitor is used, it is sometimes necessary to include protection diodes to prevent the capacitor from discharging through internal low current paths and damaging the device.

In general, the best type of capacitors to use are solid tantalum. Solid tantalum capacitors have low impedance even at high frequencies. Depending upon capacitor construction, it takes about 25 µF in aluminum electrolytic to equal 1 µF solid tantalum at high frequencies. Ceramic capacitors are also good at high frequencies; but some types have a large decrease in capacitance at frequencies around 0.5 MHz. For this reason, 0.01 µF disc may seem to work better than a 0.1 µF disc as a bypass.

Although the LM138 is stable with no output capacitors, like any feedback circuit, certain values of external capacitance can cause excessive ringing. This occurs with values between 500 pF and 5000 pF. A 1 µF solid tantalum (or 25 µF aluminum electrolytic) on the output swamps this effect and insures stability.

Load Regulation

The LM138 is capable of providing extremely good load regulation but a few precautions are needed to obtain maximum performance. The current set resistor connected between the adjustment terminal and the output terminal (usually 240Ω) should be tied directly to the output of the regulator (case) rather than near the load. This eliminates line drops from appearing effectively in series with the reference and degrading regulation. For example, a 15V regulator with 0.05Ω resistance between the regulator and load will have a load regulation due to line resistance of 0.05Ω x I_L. If the set resistor is connected near the load the effective line resistance will be 0.05Ω (1 + R2/R1) or in this case, 11.5 times worse.

Figure 2 shows the effect of resistance between the regulator and 240Ω set resistor.

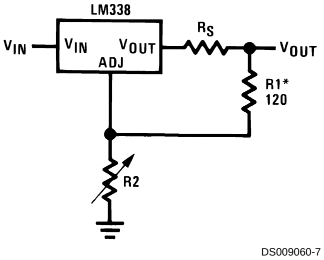


FIGURE 2. Regulator with Line Resistance in Output Lead

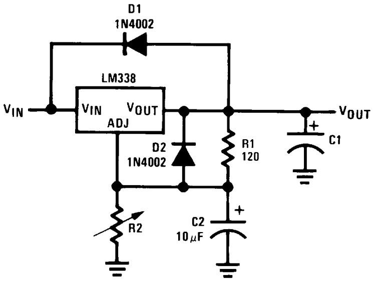
With the TO-3 package, it is easy to minimize the resistance from the case to the set resistor, by using 2 separate leads to the case. The ground of R2 can be returned near the ground of the load to provide remote ground sensing and improve load regulation.

Protection Diodes

When external capacitors are used with *any* IC regulator it is sometimes necessary to add protection diodes to prevent the capacitors from discharging through low current points into the regulator. Most 20 µF capacitors have low enough internal series resistance to deliver 20A spikes when shorted. Although the surge is short, there is enough energy to damage parts of the IC.

When an output capacitor is connected to a regulator and the input is shorted, the output capacitor will discharge into the output of the regulator. The discharge current depends on the value of the capacitor, the output voltage of the regulator, and the rate of decrease of V_{IN}. In the LM138 this discharge path is through a large junction that is able to sustain 25A surge with no problem. This is not true of other types of positive regulators. For output capacitors of 100 µF or less at output of 15V or less, there is no need to use diodes.

The bypass capacitor on the adjustment terminal can discharge through a low current junction. Discharge occurs when *either* the input or output is shorted. Internal to the LM138 is a 50Ω resistor which limits the peak discharge current. No protection is needed for output voltages of 25V or less and 10 µF capacitance. *Figure 3* shows an LM138 with protection diodes included for use with outputs greater than 25V and high values of output capacitance.



DS009060-8

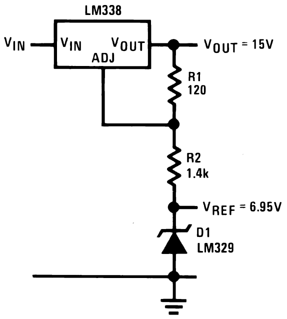
D1 protects against C1
D2 protects against C2

$$V_{OUT} = 1.25V \left(1 + \frac{R2}{R1}\right) + I_{ADJ}R2$$

FIGURE 3. Regulator with Protection Diodes

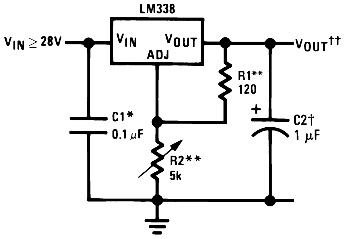
Typical Applications

Regulator and Voltage Reference



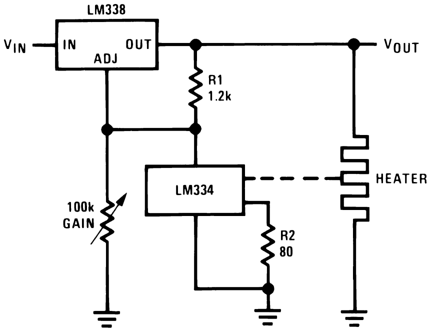
DS009060-3

1.2V–25V Adjustable Regulator



DS009060-1

Temperature Controller



DS009060-10

Full output current not available

at high input-output voltages

†Optional — improves transient response. Output capacitors in the range of 1 µF to 1000 µF of aluminum or tantalum electrolytic are commonly used to provide improved output impedance and rejection of transients.

*Needed if device is more than 6 inches from filter capacitors.

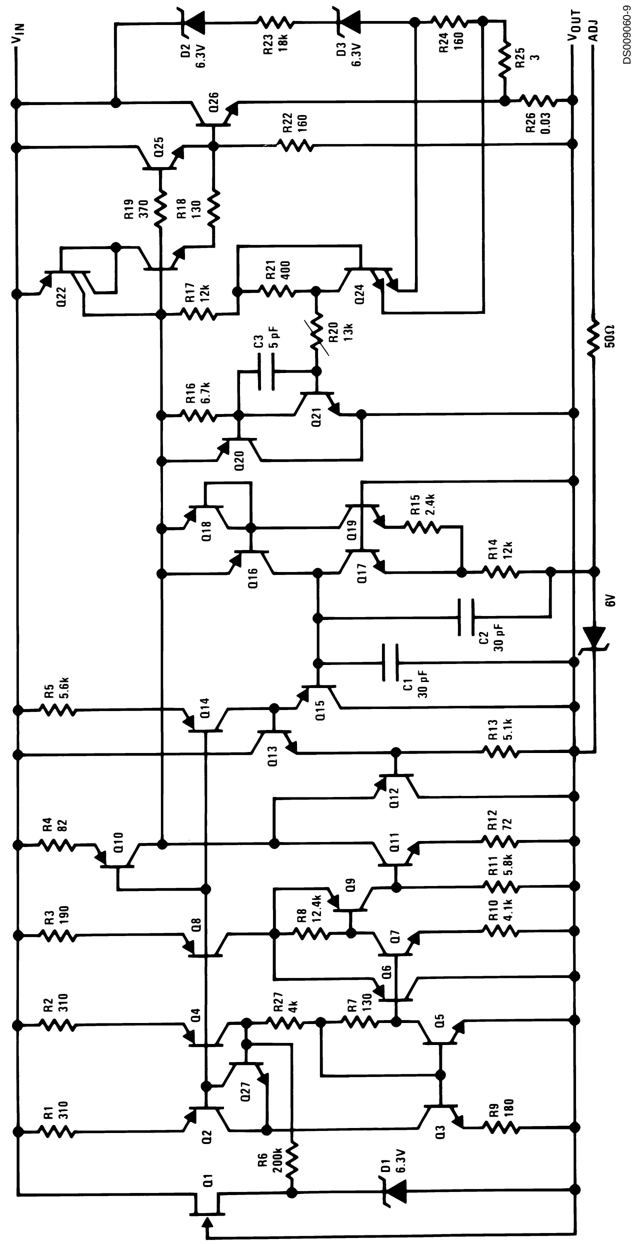
$$\dagger\dagger V_{OUT} = 1.25V\left(1+\frac{R2}{R1}\right)+I_{ADJ}\,(R_2)$$

**R1 = 240Ω for LM138. R1, R2 as an assembly can be ordered from Bourns:

MIL part no. 7105A-AT2-502

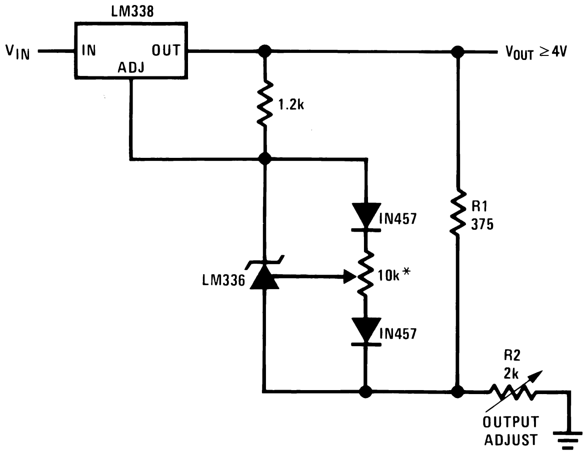
COMM part no. 7105A-AT7-502

Schematic Diagram



Typical Applications

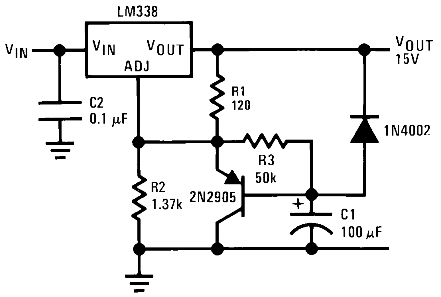
Precision Power Regulator with Low Temperature Coefficient



DS009060-12

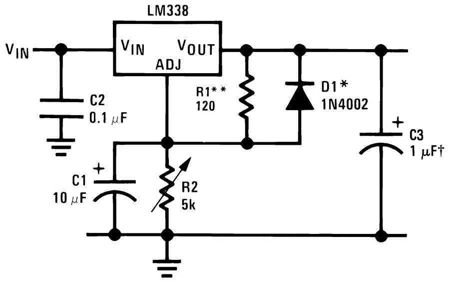
* Adjust for 3.75 across R1

Slow Turn-On 15V Regulator



DS009060-13

Adjustable Regulator with Improved Ripple Rejection



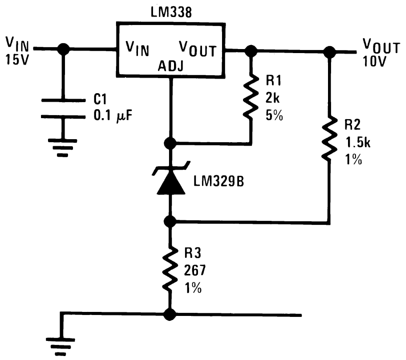
DS009060-14

†Solid tantalum

*Discharges C1 if output is shorted to ground

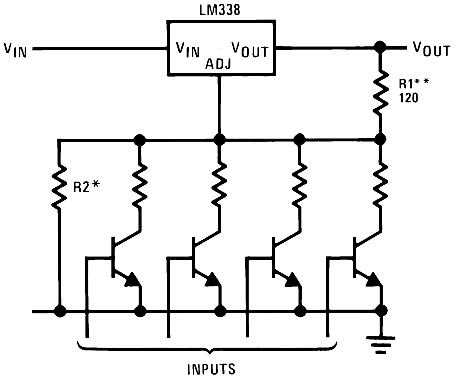
**R1 = 240Ω for LM138

High Stability 10V Regulator



DS009060-15

Digitally Selected Outputs



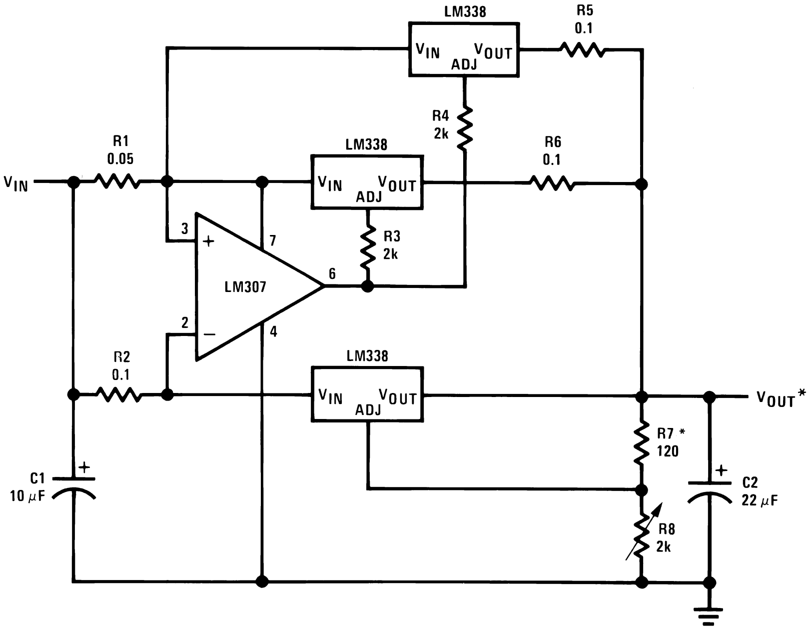
DS009060-16

*Sets maximum V_{OUT}

**R1 = 240Ω for LM138

Typical Applications (Continued)

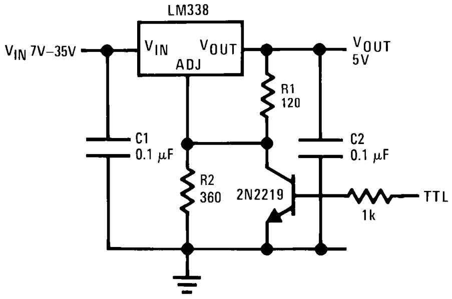
15A Regulator



DS009060-17

* Minimum load — 100 mA

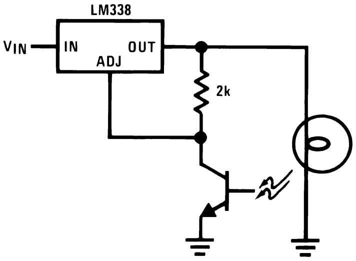
5V Logic Regulator with Electronic Shutdown**



DS009060-18

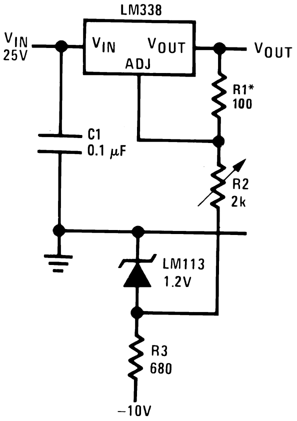
** Minimum output ≈ 1.2V

Light Controller



DS009060-11

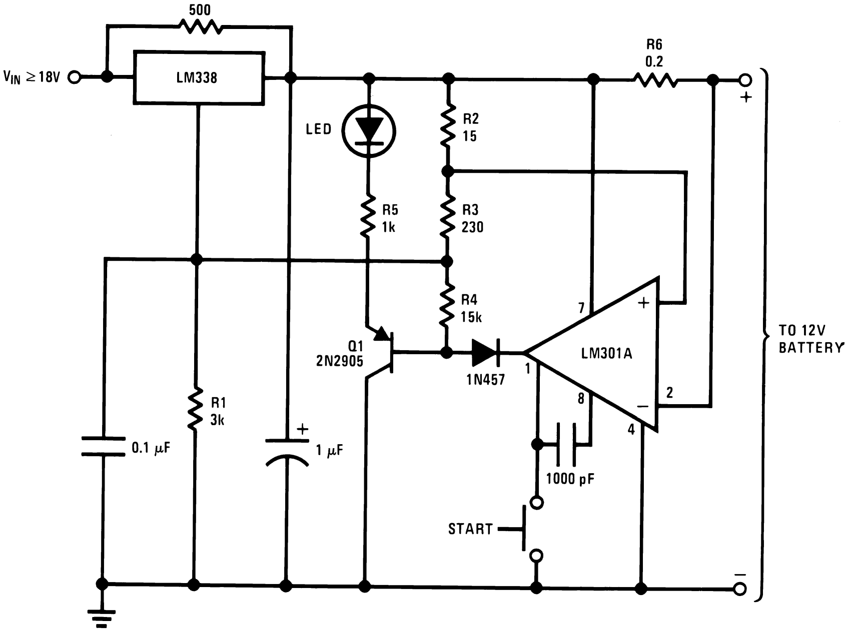
0 to 22V Regulator



DS009060-19

* R1 = 240Ω, R2 = 5k for LM138
Full output current not available
at high input-output voltages

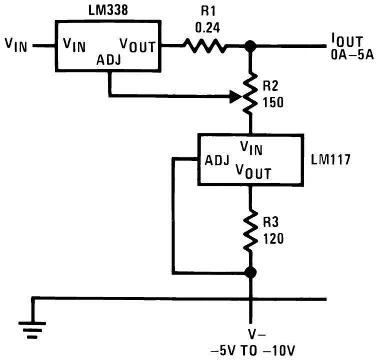
12V Battery Charger



DS009060-20

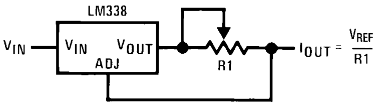
Typical Applications (Continued)

Adjustable Current Regulator



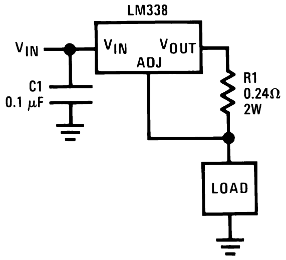
DS009060-21

Precision Current Limiter



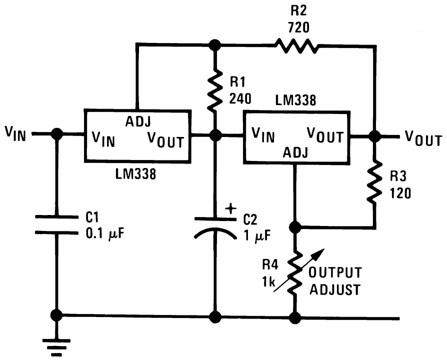
DS009060-22

5A Current Regulator



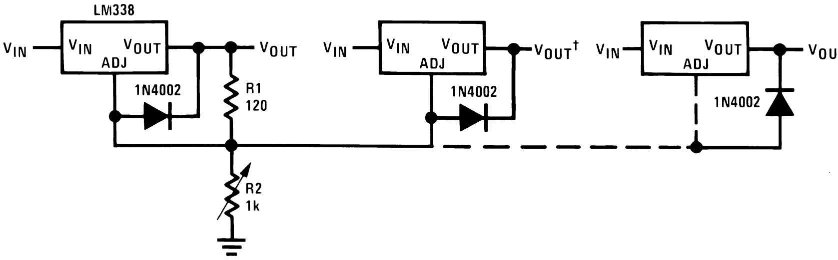
DS009060-23

Tracking Preregulator



DS009060-24

Adjusting Multiple On-Card Regulators with Single Control*



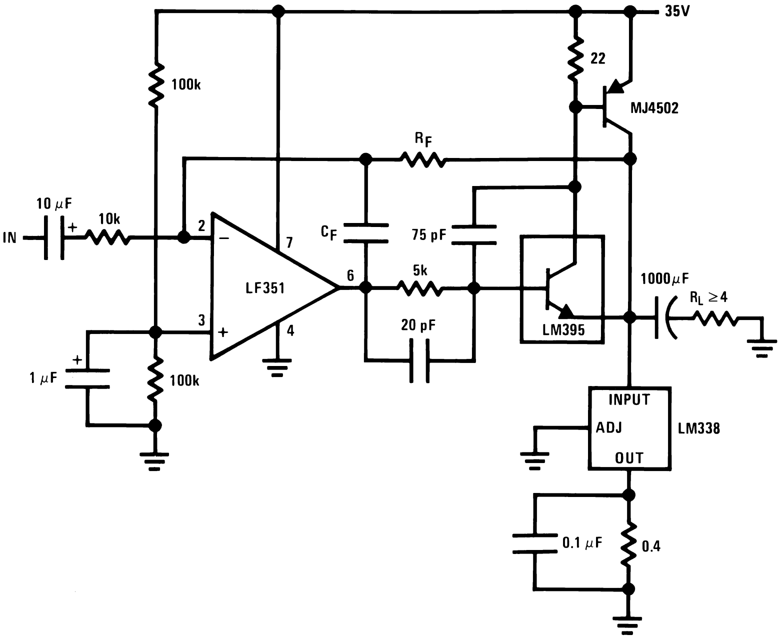
DS009060-25

† Minimum load — 10 mA

* All outputs within ±100 mV

Typical Applications (Continued)

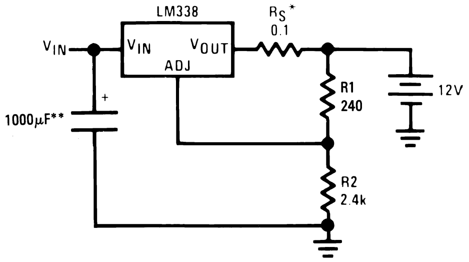
Power Amplifier



DS009060-27

$A_V = 1$, $R_F = 10k$, $C_F = 100$ pF
$A_V = 10$, $R_F = 100k$, $C_F = 10$ pF
Bandwidth ≥ 100 kHz
Distortion ≤ 0.1%

Simple 12V Battery Charger



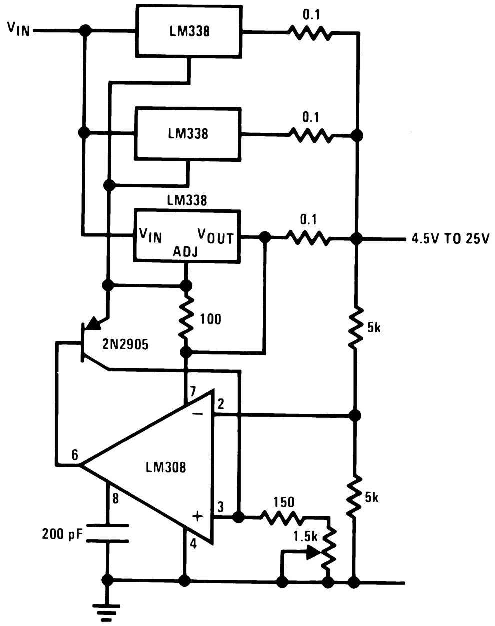
DS009060-28

*R_S—sets output impedance of charger $Z_{OUT} = R_S\left(1 + \frac{R2}{R1}\right)$

Use of R_S allows low charging rates with fully charged battery.
**The 1000 µF is recommended to filter out input transients

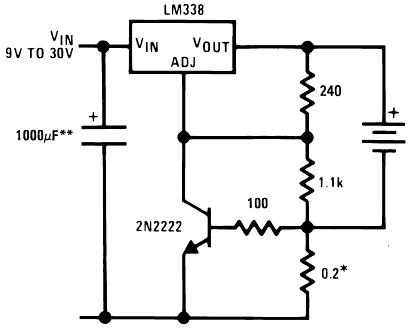
Typical Applications (Continued)

Adjustable 15A Regulator



DS009060-26

Current Limited 6V Charger

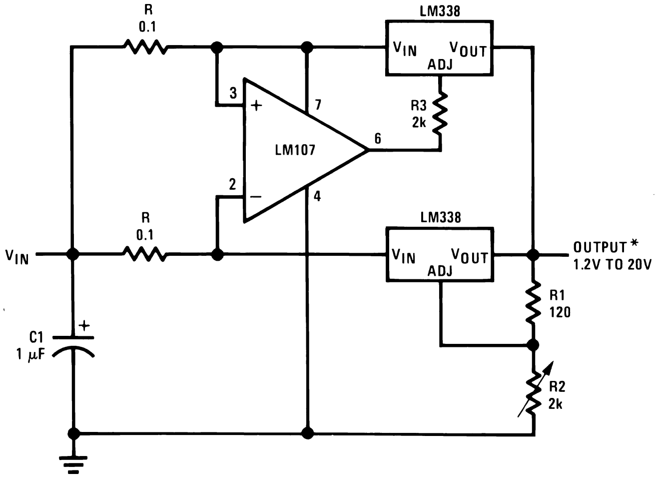


DS009060-29

* Set max charge current to 3A

** THE 1000 µF is recommended to filter out input transients.

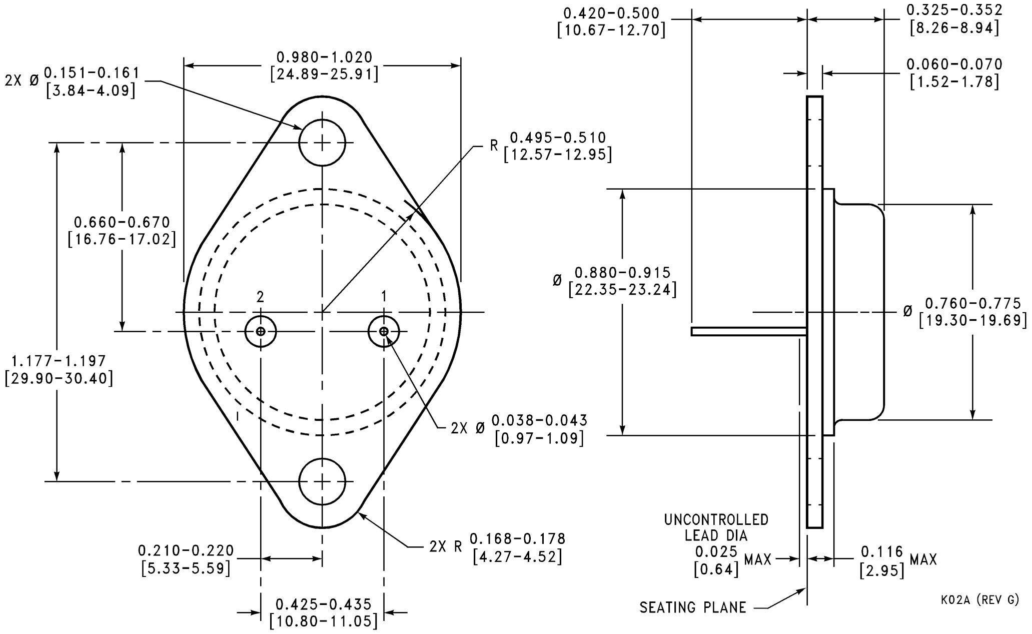
10A Regulator



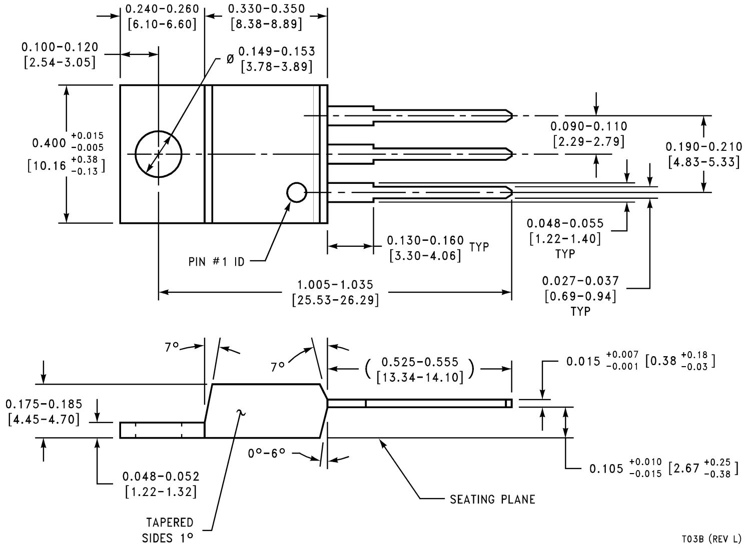
DS009060-2

* Minimum load — 100 mA

Physical Dimensions inches (millimeters) unless otherwise noted



2 Lead TO-3 Metal Can Package (K)
Order Number LM138K or LM338K STEEL
NS Package Number K02A



3 Lead Molded TO-220 (T)
Order Number LM338T
NS Package Number T03B

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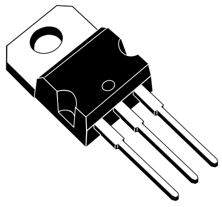
Fax: 65-2504466
Email: sea.support@nsc.com

National Semiconductor Japan Ltd.
Tel: 81-3-5639-7560
Fax: 81-3-5639-7507

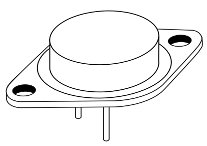
LM123/LM223
LM323

THREE-TERMINAL 3A-5V
POSITIVE VOLTAGE REGULATORS

- OUTPUT CURRENT: 3A
- INTERNAL CURRENT AND THERMAL LIMITING
- TYPICAL OUTPUT IMPEDANCE: 0.01Ω
- MINIMUM INPUT VOLTAGE: 7.5V
- POWER DISSIPATION: 30W



TO-220



TO-3

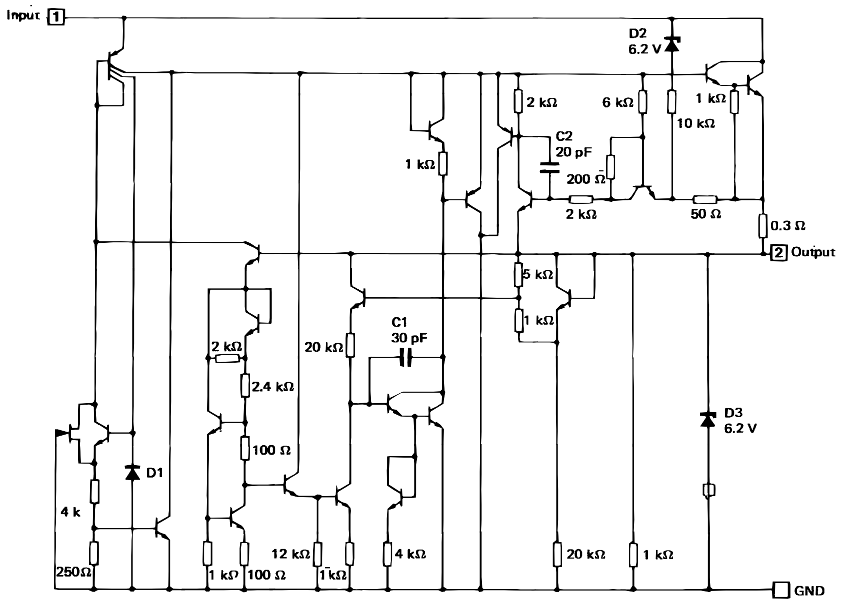
DESCRIPTION

The LM123, LM223, LM323 are three-terminal positive voltage regulators with a preset 5V output and a load driving capability of 3A. New circuit design and processing techniques are used to provide the high output current without sacrificing the regulation characteristics of lower current devices.

The 3A regulator is virtually blowout proof.

Current limiting, power limiting and thermal shut-down provide the same high level of reliability obtained with these techniques in the LM209, 1A regulator. An overall worst case specification for the combined effects of input voltage, load current, ambient temperature, and power dissipation ensure that the LM123, LM223, LM323 will perform satisfactorily as a system element.

SCHEMATIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS

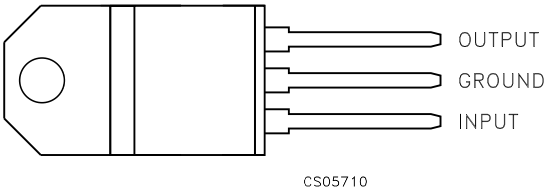
Symbol	Parameter[2]		Value	Unit
V_I	Input Voltage		20	V
I_O	Output Current		Internally Limited	
P_{tot}	Power Dissipation		Internally Limited	
T_{stg}	Storage Temperature Range		-65 to 150	°C
T_{oper}	Operating Junction Temperature Range	LM123	-55 to 150	°C
		LM223	-25 to 125	
		LM323	0 to 125	

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

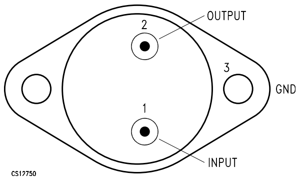
THERMAL DATA

Symbol	Parameter	TO-220	TO-3	Unit
$R_{thj\text{-}case}$	Thermal Resistance Junction-case Max	3	2	°C/W
$R_{thj\text{-}amb}$	Thermal Resistance Junction-ambient Max	50	35	°C/W

CONNECTION DIAGRAM (top view)



TO-220



TO-3

ORDERING CODES

TYPE	TO-220	TO-3	TEMPERATURE RANGE
LM123		LM123K	-55°C to 150°C
LM223		LM223K	-25°C to 150°C
LM323	LM323T	LM323K	0°C to 125°C

ELECTRICAL CHARACTERISTICS OF LM123/LM223 (T_J = -55 to 150°C for LM123, T_J = -25 to 150°C for LM223 unless otherwise specified).

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_O	Output Voltage Range (Note 2)	T_a = 25°C, V_I = 7.5 V, I_O = 0	4.7	5	5.3	V
V_O	Output Voltage Range (Note 2)	$T_J = T_{min}$ to T_{max} $P \le P_{max}$ V_I = 7.5 to 15 V I_O = 0 to 3 A	4.6		5.4	V
K_{VI}	Line Regulation (Note 3)	V_I = 7.5 to 15 V T_J = 25°C		5	25	mV
K_{VO}	Load Regulation (Note 3)	I_O = 0 to 3 A V_I = 7.5 V T_J = 25°C		25	100	mV
I_{IB}	Quiescent Current	V_I = 7.5 to 15 V I_O = 0 to 3 A		12	20	mA
V_{NO}	Output Noise Voltage	T_a = 25°C f = 10 Hz to 100 KHz		40		μV_{rms}
I_{OS}	Short Circuit Current Limit	V_I = 15 V T_J = 25°C		3	4.5	A
		V_I = 7.5 V T_J = 25°C		4	5	
K_{VH}	Long Term Stability				35	mV

Notes:
1. Although power dissipation is internally limited, specifications apply only for $P \le 30W$.
2. Selected devices with tightened tolerance output voltage available.
3. Load and line regulation are specified at constant junction temperature. Pulse testing is required with a pulse width ≤ 1ms and duty cycle ≤ 5%.

ELECTRICAL CHARACTERISTICS OF LM323 (T_J = 0 to 150°C, unless otherwise specified).

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_O	Output Voltage Range (Note 2)	T_a = 25°C, V_I = 7.5 V, I_O = 0	4.8	5	5.2	V
V_O	Output Voltage Range (Note 2)	$T_J = T_{min}$ to T_{max} $P \le P_{max}$ V_I = 7.5 to 15 V I_O = 0 to 3 A	4.75		5.25	V
K_{VI}	Line Regulation (Note 3)	V_I = 7.5 to 15 V T_J = 25°C		5	25	mV
K_{VO}	Load Regulation (Note 3)	I_O = 0 to 3 A V_I = 7.5 V T_J = 25°C		25	100	mV
I_{IB}	Quiescent Current	V_I = 7.5 to 15 V I_O = 0 to 3 A		12	20	mA
V_{NO}	Output Noise Voltage	T_a = 25°C f = 10 Hz to 100 KHz		40		μV_{rms}
I_{OS}	Short Circuit Current Limit	V_I = 15 V T_J = 25°C		3	4.5	A
		V_I = 7.5 V T_J = 25°C		4	5	
K_{VH}	Long Term Stability				35	mV

Notes:
1. Although power dissipation is internally limited, specifications apply only for $P \le 30W$.
2. Selected devices with tightened tolerance output voltage available.
3. Load and line regulation are specified at constant junction temperature. Pulse testing is required with a pulse width ≤ 1ms and duty cycle ≤ 5%.

Figure 1 : Output Noise Voltage

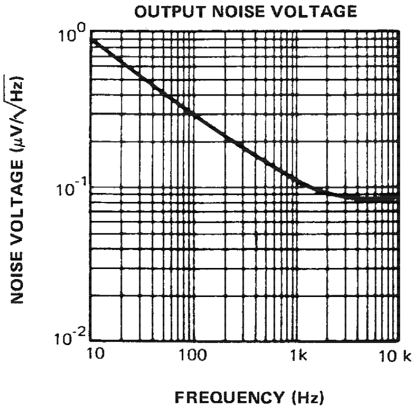


Figure 2 : Output Impedance

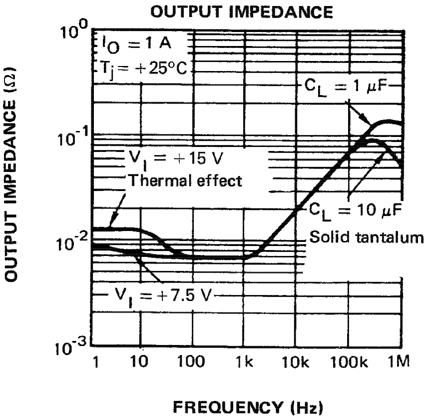


Figure 3 : Peak Available Output Current

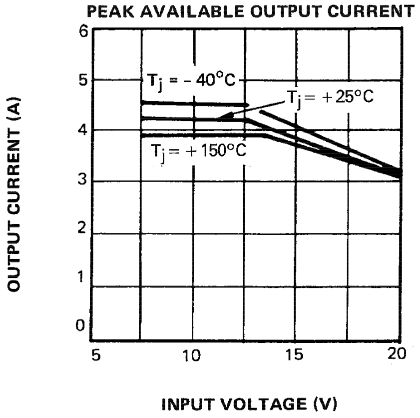


Figure 4 : Short Circuit Current

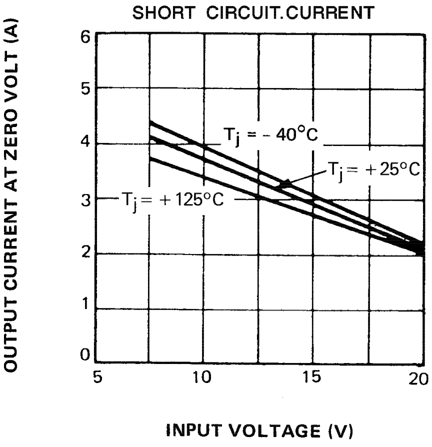


Figure 5 : Ripple Rejection

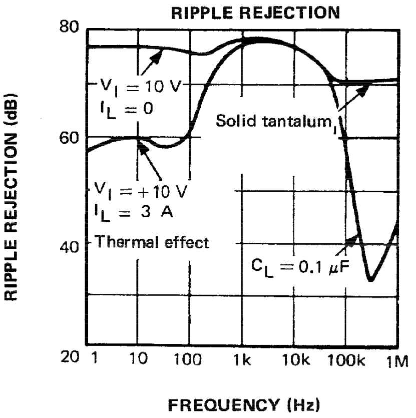


Figure 6 : Dropout Voltage

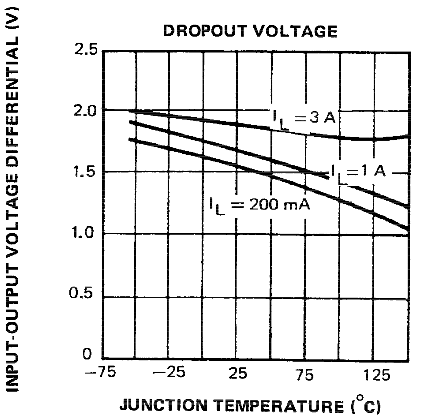


Figure 7 : Line Transient Response

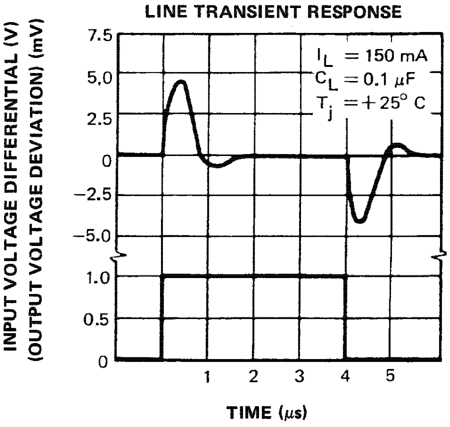


Figure 9 : Quiescent Current

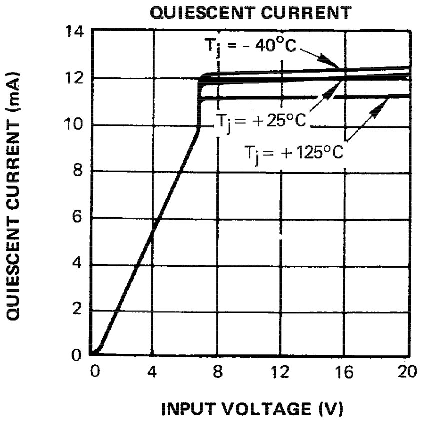


Figure 8 : Output Voltage

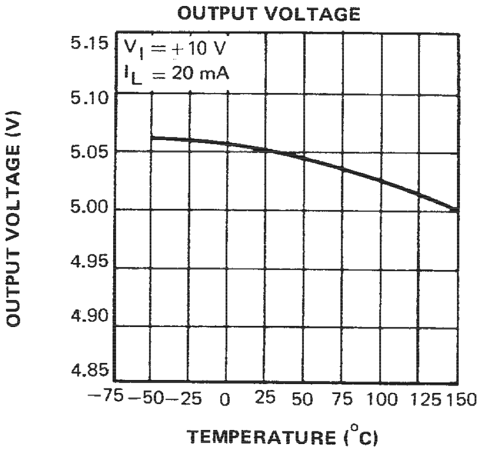
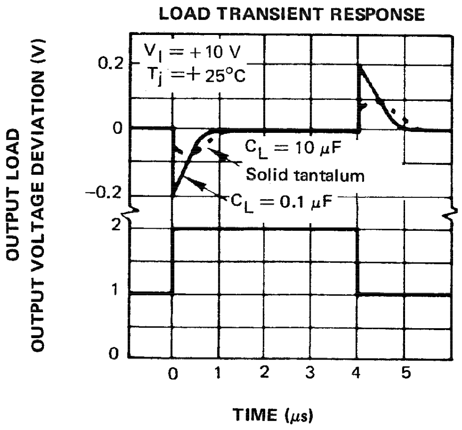
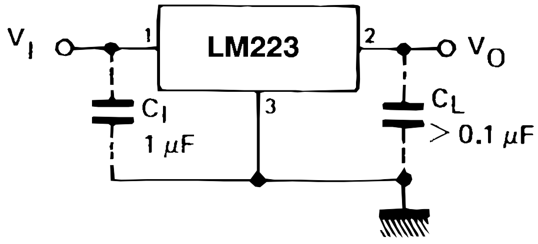


Figure 10 : Load Transient Response



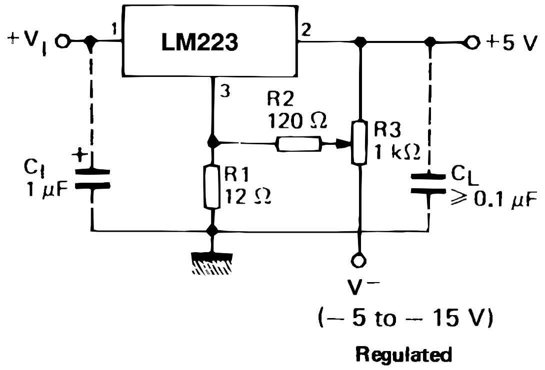
TYPICAL APPLICATION

BASIC 3A REGULATOR

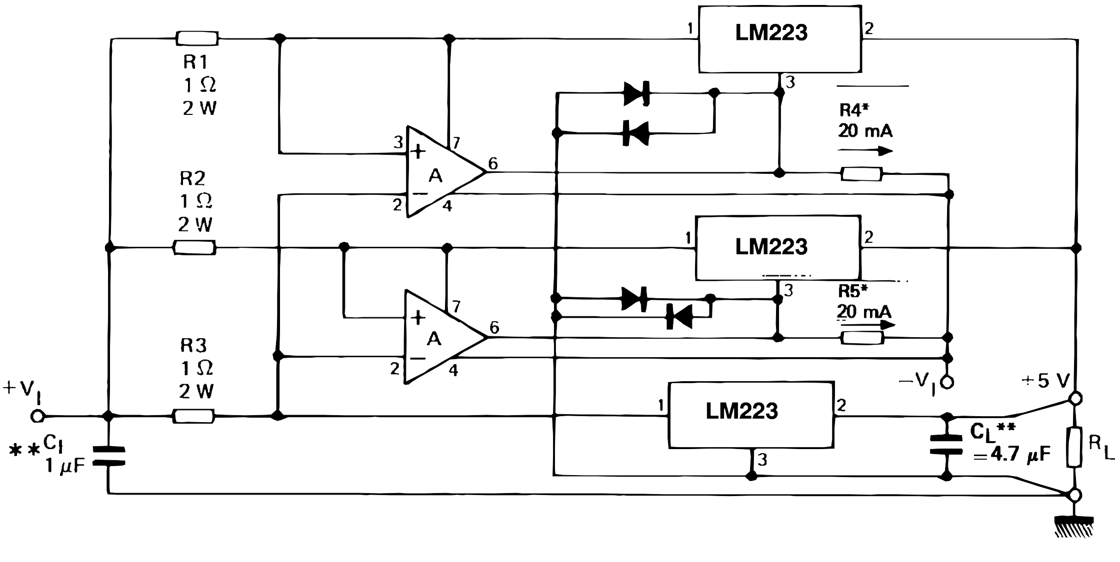


C_1 = Required if regulator is distant from filter capacitors.
C_L = Regulator is stable with no load capacitor into resistive loads.

TRIMING OUTPUT TO 5V

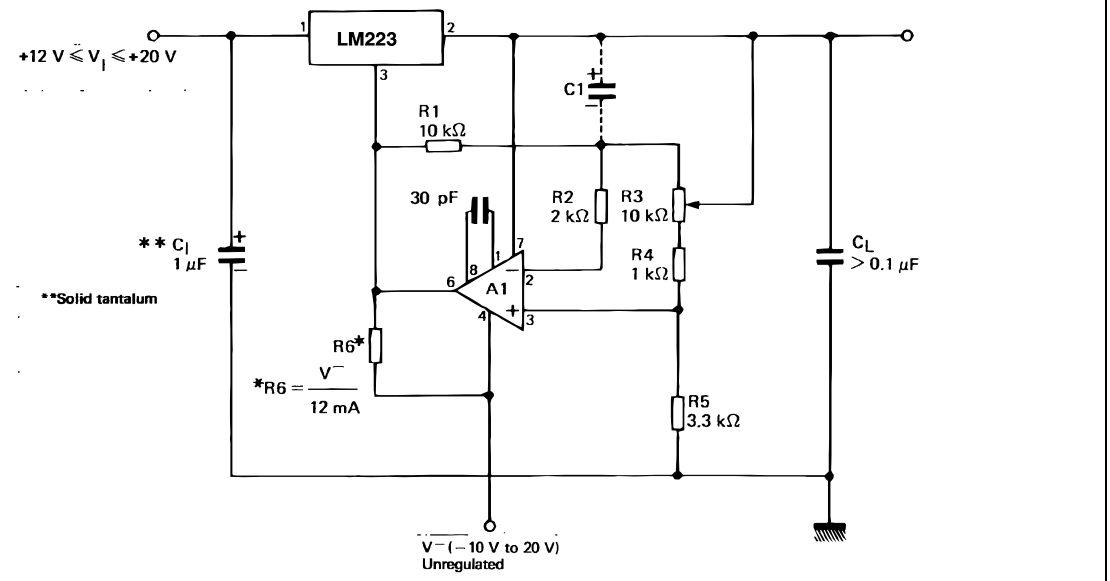


10A REGULATOR WITH COMPLETE OVERLOAD PROTECTION



* Selected for 20 mA current from unregulated negative supply.
** Solid tantalum.
A = LM101A, LM201A, LM301A.

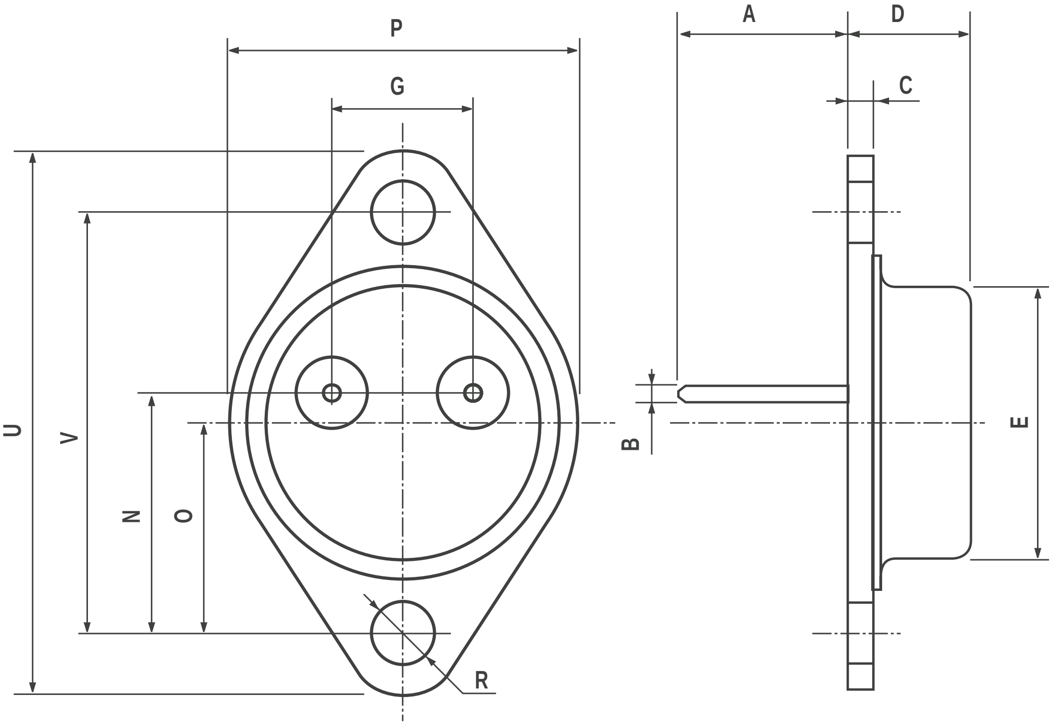
ADJUSTABLE REGULATOR 0 - 10V/3A



A1 = LM101A, LM201A, LM301A.
CI = 2µF optional - improves ripple rejection, noise and transient response.

TO-3 MECHANICAL DATA

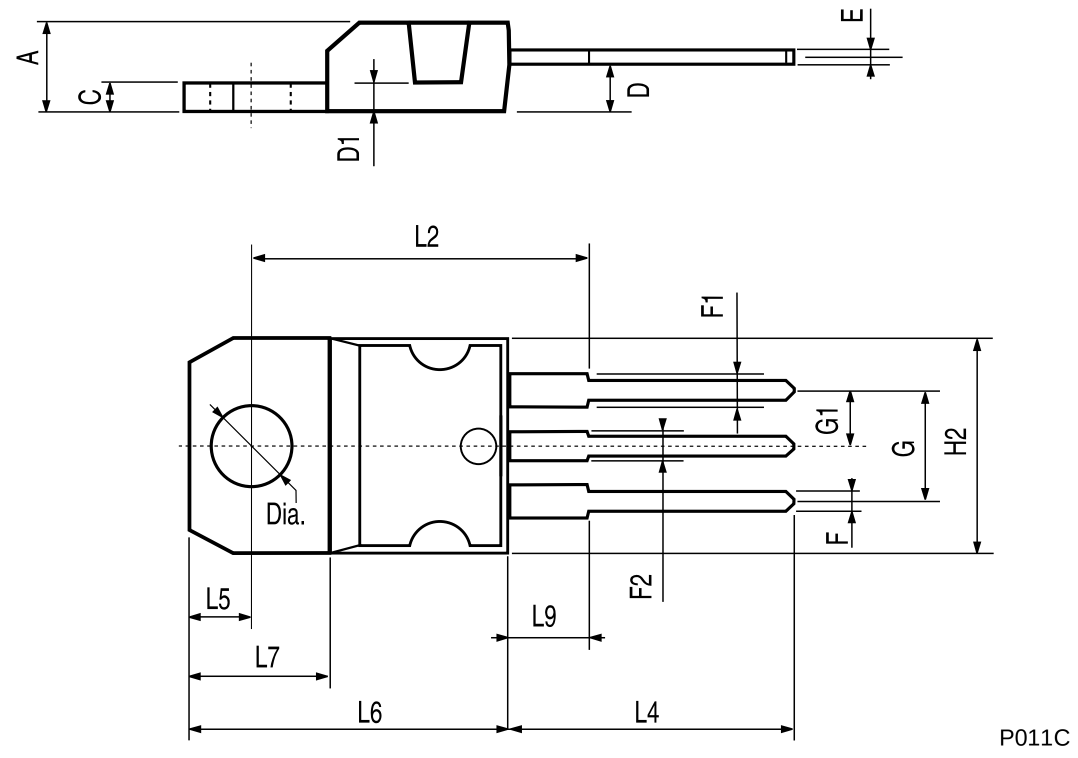
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A		11.85			0.466	
B	0.96	1.05	1.10	0.037	0.041	0.043
C			1.70			0.066
D			8.7			0.342
E			20.0			0.787
G		10.9			0.429	
N		16.9			0.665	
P			26.2			1.031
R	3.88		4.09	0.152		0.161
U			39.5			1.555
V		30.10			1.185	



P003C/C

TO-220 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
C	1.23		1.32	0.048		0.051
D	2.40		2.72	0.094		0.107
D1		1.27			0.050	
E	0.49		0.70	0.019		0.027
F	0.61		0.88	0.024		0.034
F1	1.14		1.70	0.044		0.067
F2	1.14		1.70	0.044		0.067
G	4.95		5.15	0.194		0.203
G1	2.4		2.7	0.094		0.106
H2	10.0		10.40	0.393		0.409
L2		16.4			0.645	
L4	13.0		14.0	0.511		0.551
L5	2.65		2.95	0.104		0.116
L6	15.25		15.75	0.600		0.620
L7	6.2		6.6	0.244		0.260
L9	3.5		3.93	0.137		0.154
DIA.	3.75		3.85	0.147		0.151



LM350

3-Terminal 3A Positive Adjustable Voltage Regulator

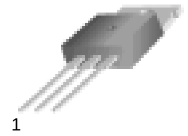
Features

- Output adjustable between 1.2V and 33V
- Guaranteed 3A output current
- Internal thermal overload protection
- Load regulation (Typ: 0.1%)
- Line regulation (Typ: 0.015%/V)
- Internal short-circuit current limit
- Output transistor safe-area compensation

Description

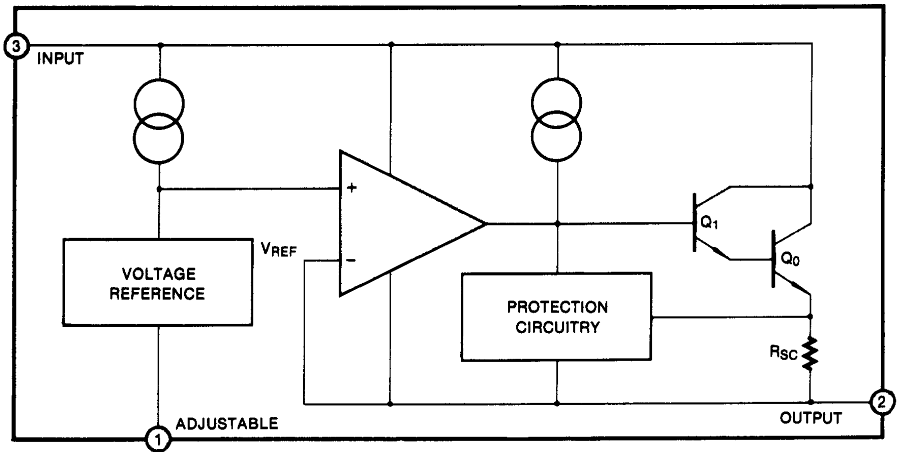
The LM350 is an adjustable 3-terminal positive voltage regulator capable of supplying in excess of 3.0 A over an output voltage range of 1.2V to 33 V

TO-220



1. Adj 2. Output 3. Input

Internal Block Diagram



Rev. 1.0.0

Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Input-Output Voltage Differential	$V_I - V_O$	35	V_{DC}
Lead Temperature (Soldering, 10sec)	T_{LEAD}	300	°C
Power Dissipation	P_D	Internally limited	-
Operating Temperature Range	T_{OPR}	0 ~ +125	°C
Storage Temperature Range	T_{STG}	-65 ~ +150	°C

Electrical Characteristics

(V_I-V_O=5V, I_O=1.5A, T_J=0°C to + 125°C; $P_D \leq P_{DMAX}$, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Line Regulation (Note1)	Rline	T_A = +25°C, 3V ≤ V_I -V_O ≤ 35V	-	0.015	0.03	%/V
Load Regulation (Note1)	Rload	T_A = +25 °C, 3V ≤ V_I -V_O ≤ 35V V_O ≤ 5V V_O ≥ 5V	-	5 0.1	25 0.5	mV %
Adjustment Pin Current	I_{ADJ}	-	-	50	100	µA
Adjustment Pin Current Change	ΔI_{ADJ}	3V ≤ V_I -V_O ≤ 35V, 10mA ≤ I_O ≤ 3A, $P_D \leq P_{MAX}$	-	0.2	5.0	µA
Thermal Regulation	REG_T	Pulse = 20ms, T_A =+ 25°C	-	0.002	-	%/W
Reference Voltage	V_{REF}	3V ≤ V_I -V_O ≤ 35V, 10mA ≤I_O≤ 3A,P_D ≤ 30W	1.2	1.25	1.30	V
Line Regulation	Rline	3.0V ≤ V_I -V_O ≤ 35V	-	0.02	0.07	%/W
Load Regulation	Rload	10mA ≤ I_O ≤ 3.0A V_O ≤ 5.0V V_O ≥ 5.0V	-	20 0.3	70 1.5	mV %
Temperature Stability	ST_T	T_J = 0°C to + 125°C	-	1.0	-	%
Maximum Output Current	$I_{O(MAX)}$	V_I -V_O ≤ 10V, $P_D \leq P_{MAX}$	3.0	4.5	-	A
		V_I -V_O = 30V, $P_D \leq P_{MAX}$,T_A = +25°C	0.25	1.0	-	A
Minimum Load Current	$I_{L(MIN)}$	V_I -V_O = 35V	-	3.5	10	mA
RMS Noise, %of V_{OUT}	V_N	10Hz ≤ f ≤ 10KHz, T_A= +25 °C	-	0.003	-	%/V_O
Ripple Rejection	RR	V_O = 10V, f = 120Hz, C_{ADJ} = 0 C_{ADJ} = 10µF	66	65 80	-	dB dB
Long-Term Stability	ST	T_J =+125 °C	-	0.3	1	%/ 1000HR

Note:

1. Regulation is measured at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

Typical Perfomance Characteristics

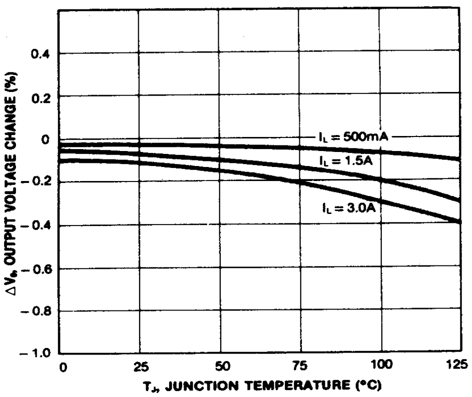


Figure 1. Load Regulation

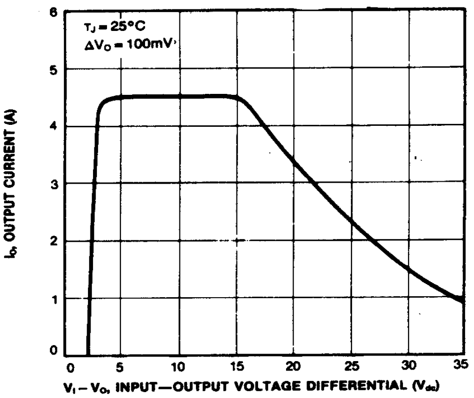


Figure 2. Current Limit

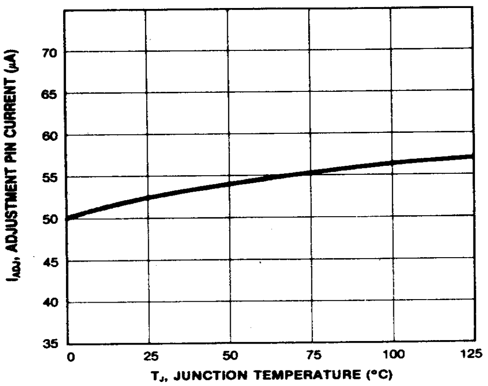


Figure 3. Adjustment Pin Current

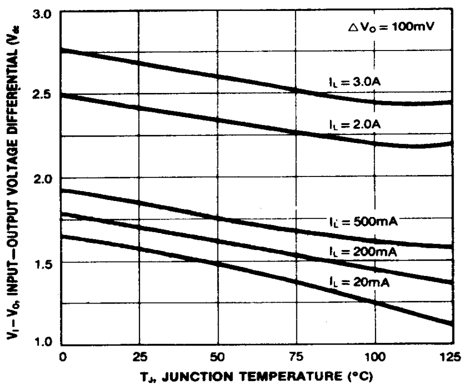


Figure 4. Dropout Voltage

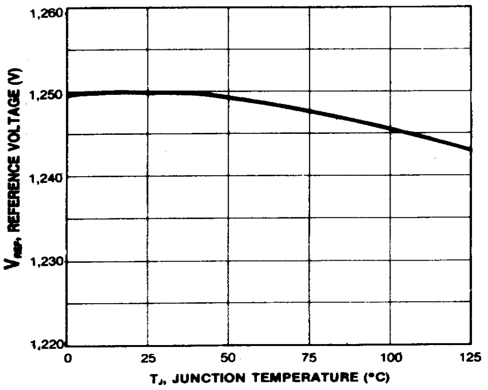


Figure 5. Temperature Stability

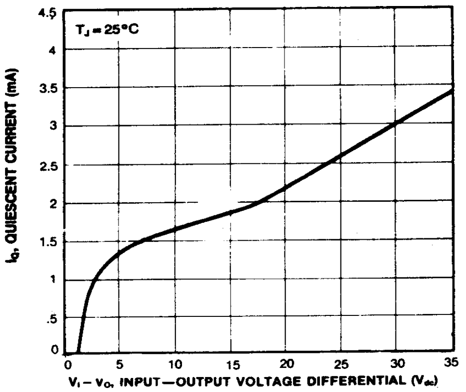


Figure 6. Minimum Load Current

Typical Perfomance Characteristics (continued)

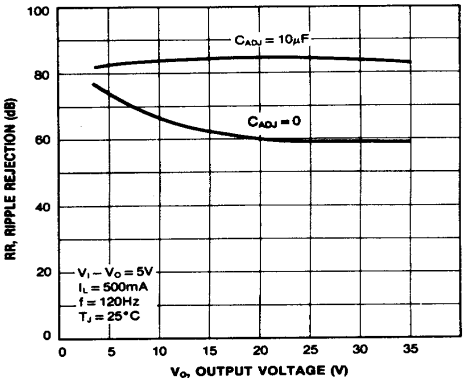


Figure 7. Ripple Rejection vs Vo

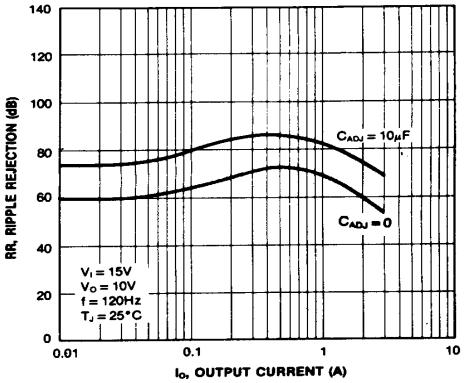


Figure 8. Ripple Rejection vs Io

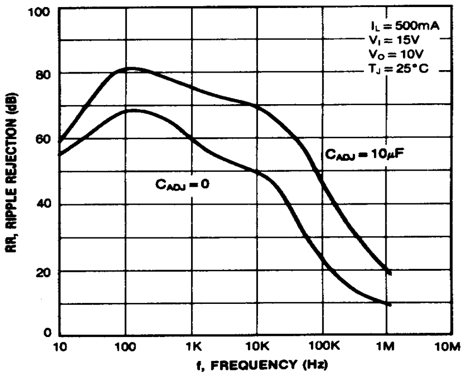


Figure 9. Ripple Rejection vs Frequency

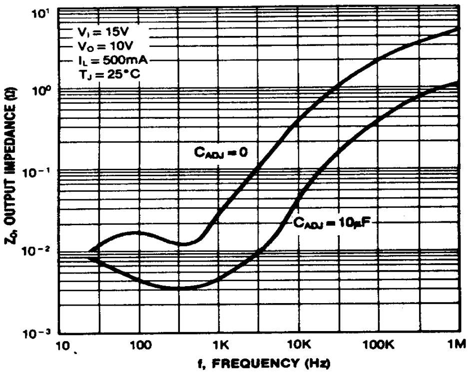


Figure 10. Output Impedance

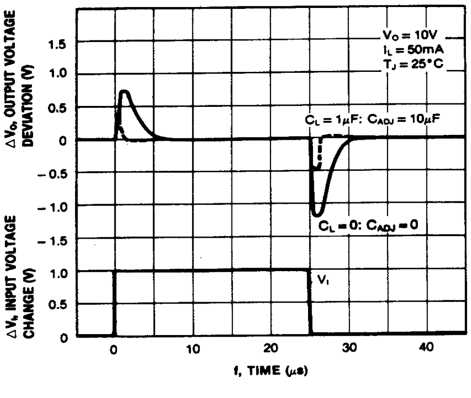


Figure 11. Line Transient Response

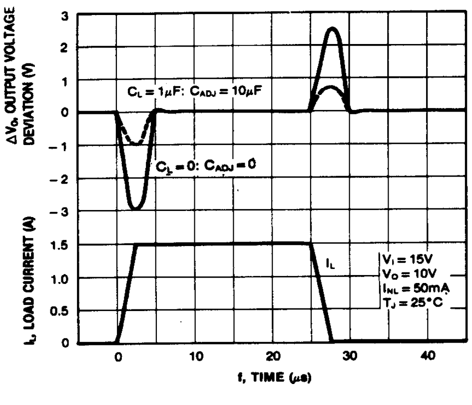


Figure 12. Load Transient Response

Typical Application

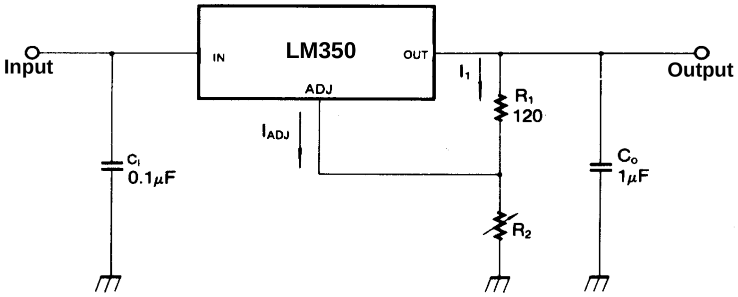


Figure 13.

C_I : C_I is required if the regulator is located an appreciable distance from power supply filter.
C_O : Output capacitors in the range of 1µF to 100µF of aluminum or tantalum electronic are commonly used to provide improved output impedance and rejection of transients.

In operation, the LM350 develops a nominal 1.25V reference voltage, V_{REF}, between the output and adjustment terminal. The reference voltage is impressed across program resistor R_1 and, since the voltage is constant, a constant current I_1 then flows through the output set resistor R_2, giving an output voltage of

$$V_O = 1.25V(1+R_2/R_1) + I_{ADJ} R_2$$

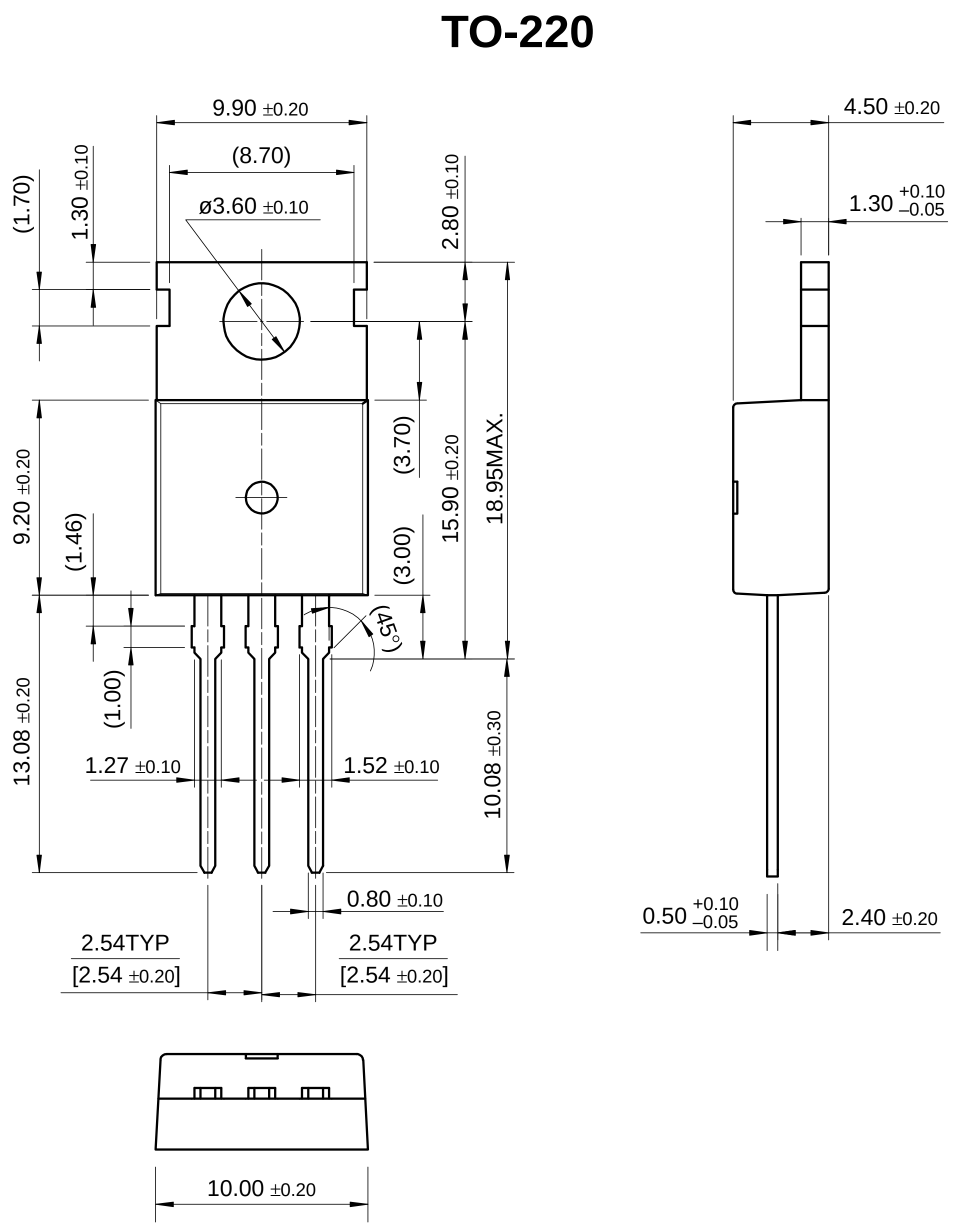
Since I_{ADJ} current (less than 100µF) from the adjustment terminal represents an error term, the LM350 was designed to minimize I_{ADJ} and make it very constant with line and load changes. To do this, all quiescent operating current is returned to the output establishing a minimum load current requirement. If there is insufficient load on the output, the output voltage will rise.

Since the LM350 is a floating regulator, it is only the voltage differential across the circuit which is important to performance, and operation at high voltage with respect to ground is possible.

Since I_{ADJ} is controlled to less than 100µA, the error associated with this term is negligible in most applications.

Mechanical Dimensions (Continued)

Package



Ordering Information

Product Number	Package	Operating Temperature
LM350T	TO-220	0°C to + 125°C

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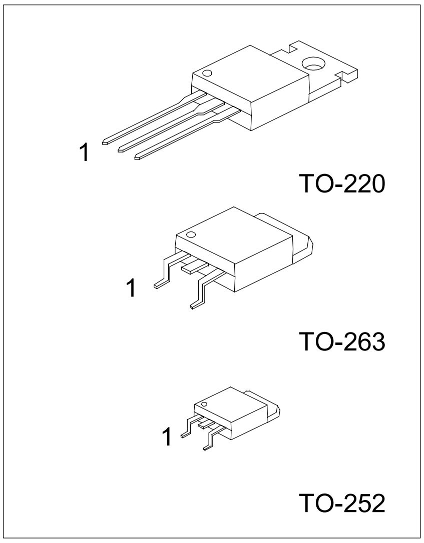
3-TERMINAL 1A POSITIVE VOLTAGE REGULATOR



1: Input 2: GND 3: Output

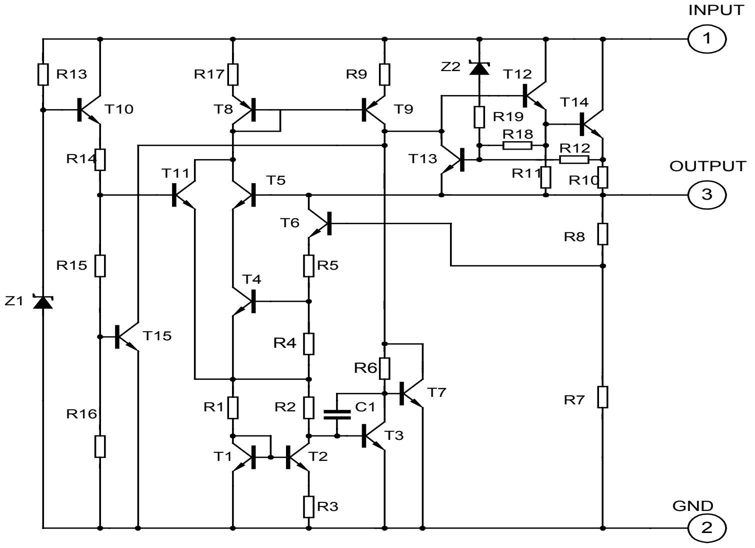
DESCRIPTION

The UTC 78XX family is monolithic fixed voltage regulator integrated circuit. They are suitable for applications that required supply current up to 1 A.

FEATURES

*Output current up to 1.5 A
*Fixed output voltage of 5V, 6V, 8V, 9V, 10V, 12V, 15V ,18V and 24V available
*Thermal overload shutdown protection
*Short circuit current limiting
*Output transistor SOA protection

TEST CIRCUIT



ABSOLUTE MAXIMUM RATINGS

(Operating temperature range applies unless otherwise specified)

PARAMETER	SYMBOL	RATING	UNIT
Input voltage(for Vo=5~18V) (for Vo=24V)	V_I	35 40	V V
Output Current	I o	1	A
Power Dissipation	PD	Internally Limited	W
Operating Junction Temperature Range	T_{OPR}	-20 +150	°C
Storage Temperature Range	T_{STG}	-55 +150	°C

UTC LM7805 ELECTRICAL CHARACTERISTICS

(VI=10V, Io=0.5A, Tj= 0°C - 125°C, C1=0.33uF, Co=0.1uF, unless otherwise specified)(Note 1)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage	Vo	Tj=25°C, I_O=5mA - 1.0A	4.80	5.0	5.20	V
		V_I =7.5V to 20V, I_O=5mA - 1.0A,PD<15W	4.75		5.25	V
Load Regulation	ΔVo	Tj=25°C,I_O=5mA - 1.5A			50	mV
		Tj=25°C,I_O=0.25A - 0.75A			25	mV
Line regulation	ΔVo	V_I =7V to 25V,Tj=25°C			50	mV
		V_I =7.5V to 20V,Tj=25°C,Io=1A			50	mV
Quiescent Current	Iq	Tj=25°C, I_O=<1A			8.0	mA
Quiescent Current Change	ΔIq	V_I =7.5V to 20V			1.0	mA
	ΔIq	I_O=5mA - 1.0A			0.5	mA
Output Noise Voltage	V_N	10Hz<=f<=100kHz		40		µV
Temperature coefficient of Vo	ΔVo/ΔT	Io=5mA		-0.6		mV/°C
Ripple Rejection	RR	V_I =8V - 18V,f=120Hz,Tj=25°C	62	80		dB
Peak Output Current	I_{PK}	Tj=25°C		1.8		A
Short-Circuit Current	I_{SC}	VI=35V, Tj=25°C		250		mA
Dropout Voltage	Vd	Tj=25°C		2.0		V

UTC LM7806 ELECTRICAL CHARACTERISTICS

(VI=11V, Io=0.5A, Tj= 0°C - 125°C, C1=0.33uF, Co=0.1uF, unless otherwise specified)(Note 1)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage	Vo	Tj=25°C, I_O=5mA - 1.0A	5.76	6.0	6.24	V
		V_I =8.5V to 21V, I_O=5mA - 1.0A, PD<15W	5.70		6.30	V
Load Regulation	ΔVo	Tj=25°C,I_O=5mA - 1.5A			60	mV
		Tj=25°C,I_O=0.25A - 0.75A			30	mV
Line regulation	ΔVo	V_I =8V to 25V,Tj=25°C			60	mV
		V_I =8.5V to 21V,Tj=25°C,Io=1A			60	mV
Quiescent Current	Iq	Tj=25°C, I_O=<1A			8.0	mA
Quiescent Current Change	ΔIq	V_I =8.5V to 21V			1.0	mA
	ΔIq	I_O=5mA - 1.0A			0.5	mA
Output Noise Voltage	V_N	10Hz<=f<=100kHz		45		µV
Temperature coefficient of Vo	ΔVo/ΔT	Io=5mA		-0.7		mV/°C
Ripple Rejection	RR	V_I =9V - 19V,f=120Hz,Tj=25°C	59	75		dB

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Peak Output Current	I_{PK}	Tj=25°C		1.8		A
Short-Circuit Current	I_{SC}	VI=35V, Tj=25°C		250		mA
Dropout Voltage	Vd	Tj=25°C		2.0		V

UTC LM7808 ELECTRICAL CHARACTERISTICS

(VI=14V, Io=0.5A, Tj= 0°C - 125°C, C1=0.33uF, Co=0.1uF, unless otherwise specified)(Note 1)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage	Vo	Tj=25°C, I_O=5mA - 1.0A	7.68	8.0	8.32	V
		V_I =10.5V to 23V, I_O=5mA - 1.0A, PD<15W	7.60		8.40	V
Load Regulation	ΔVo	Tj=25°C,I_O=5mA - 1.5A			80	mV
		Tj=25°C,I_O=0.25A - 0.75A			40	mV
Line regulation	ΔVo	V_I =10.5V to 25V,Tj=25°C			80	mV
		V_I =10.5V to 23V,Tj=25°C,Io=1A			80	mV
Quiescent Current	Iq	Tj=25°C, I_O=<1A			8.0	mA
Quiescent Current Change	ΔIq	V_I =10.5V to 23V			1.0	mA
	ΔIq	I_O=5mA - 1.0A			0.5	mA
Output Noise Voltage	V_N	10Hz<=f<=100kHz		58		µV
Temperature coefficient of Vo	ΔVo/ΔT	Io=5mA		-0.9		mV/°C
Ripple Rejection	RR	V_I =11.5V to 21.5V, f=120Hz,Tj=25°C	56	72		dB
Peak Output Current	I_{PK}	Tj=25°C		1.8		A
Short-Circuit Current	I_{SC}	VI=35V, Tj=25°C		250		mA
Dropout Voltage	Vd	Tj=25°C		2.0		V

UTC LM7809 ELECTRICAL CHARACTERISTICS

(VI=15V, Io=0.5A, Tj= 0°C - 125°C, C1=0.33uF, Co=0.1uF, unless otherwise specified)(Note 1)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage	Vo	Tj=25°C, I_O=5mA - 1.0A	8.64	9.0	9.36	V
		V_I =11.5V to 24V, I_O=5mA - 1.0A,PD<15W	8.55		9.45	V
Load Regulation	ΔVo	Tj=25°C,I_O=5mA - 1.5A			90	mV
		Tj=25°C,I_O=0.25A - 0.75A			45	mV
Line regulation	ΔVo	V_I =11.5V to 25 V, Tj=25°C, PD<15W			90	mV
		V_I =11.5V to 24V,Tj=25°C, Io<=1A			90	mV
Quiescent Current	Iq	Tj=25°C, I_O=<1A			8.0	mA
Quiescent Current Change	ΔIq	V_I =11.5V to 24V			1.0	mA
	ΔIq	I_O=5mA – 1.0A			0.5	mA
Output Noise Voltage	V_N	10Hz<=f<=100kHz		58		µV
Temperature coefficient of Vo	ΔVo/ΔT	Io=5mA		-1.1		mV/°C
Ripple Rejection	RR	V_I =12.5V to 22.5V, f=120Hz,Tj=25°C	56	72		dB
Peak Output Current	I_{PK}	Tj=25°C		1.8		A
Short-Circuit Current	I_{SC}	VI=35V, Tj=25°C		250		mA
Dropout Voltage	Vd	Tj=25°C		2.0		V

UTC LM7810 ELECTRICAL CHARACTERISTICS

(VI=16V, Io=0.5A, Tj= 0°C - 125°C, C1=0.33uF, Co=0.1uF, unless otherwise specified)(Note 1)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage	Vo	Tj=25°C, I_O=5mA - 1.0A	9.60	10.0	10.40	V
		VI =12.5V to 25V, I_O=5mA - 1.0A,PD<=15W	9.50		10.50	V
Load Regulation	ΔVo	Tj=25°C,I_O=5mA - 1.5A			100	mV
		Tj=25°C,I_O=0.25A - 0.75A			50	mV
Line regulation	ΔVo	VI =13V to 25V,Tj=25°C			100	mV
		VI =13V to 25V, Tj=25°C,Io<=1A			100	mV
Quiescent Current	Iq	Tj=25°C, I_O=<1A			8.0	mA
Quiescent Current Change	ΔIq	VI =12.6V to 25V			1.0	mA
	ΔIq	I_O=5mA - 1.0A			0.5	mA
Output Noise Voltage	V_N	10Hz<=f<=100kHz		58		µV
Temperature coefficient of Vo	ΔVo/ΔT	Io=5mA		-1.1		mV/°C
Ripple Rejection	RR	VI =13V - 23V,f=120Hz,Tj=25°C	56	72		dB
Peak Output Current	I_{PK}	Tj=25°C		1.8		A
Short-Circuit Current	I_{SC}	VI=35V, Tj=25°C		250		mA
Dropout Voltage	Vd	Tj=25°C		2.0		V

UTC LM7812 ELECTRICAL CHARACTERISTICS

(VI=19V, Io=0.5A, Tj= 0°C - 125°C, C1=0.33uF, Co=0.1uF, unless otherwise specified)(Note 1)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage	Vo	Tj=25°C, I_O=5mA - 1.0A	11.52	12.0	12.48	V
		V_I =14.5V to 27V, I_O=5mA - 1.0A,PD<15W	11.40		12.60	V
Load Regulation	ΔVo	Tj=25°C,I_O=5mA - 1.5A			120	mV
		Tj=25°C,I_O=0.25A - 0.75A			60	mV
Line regulation	ΔVo	V_I =14.5V to 30V,Tj=25°C			120	mV
		V_I =14.6V to 27V,Tj=25°C, Io=1A			120	mV
Quiescent Current	Iq	Tj=25°C, I_O=<1A			8.0	mA
Quiescent Current Change	ΔIq	V_I =14.5V to 30V			1.0	mA
	ΔIq	I_O=5mA - 1.0A			0.5	mA
Output Noise Voltage	V_N	10Hz<=f<=100kHz		75		µV
Temperature coefficient of Vo	ΔVo/ΔT	Io=5mA		-1.5		mV/°C
Ripple Rejection	RR	V_I =15V - 25V,f=120Hz,Tj=25°C	55	72		dB
Peak Output Current	I_{PK}	Tj=25°C		1.8		A
Short-Circuit Current	I_{SC}	VI=35V, Tj=25°C		250		mA
Dropout Voltage	Vd	Tj=25°C		2.0		V

UTC LM7815 ELECTRICAL CHARACTERISTICS

(VI=23V, Io=0.5A, Tj= 0°C - 125°C, C1=0.33uF, Co=0.1uF, unless otherwise specified)(Note 1)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage	Vo	Tj=25°C, IO=5mA - 1.0A	14.40	15.0	15.60	V
		VI =17.5V to 30V, IO=5mA - 1.0A,PD<15W	14.25		15.75	V
Load Regulation	ΔVo	Tj=25°C,IO=5mA - 1.5A			150	mV
		Tj=25°C,IO=0.25A - 0.75A			75	mV
Line regulation	ΔVo	VI =18.5V to 30V,Tj=25°C			150	mV
		VI =17.7V to 30V, Tj=25°C, IO =1A			150	mV
Quiescent Current	Iq	Tj=25°C, IO=<1A			8.0	mA
Quiescent Current Change	ΔIq	VI =17.5V to 30V			1.0	mA
	ΔIq	IO=5mA - 1.0A			0.5	mA
Output Noise Voltage	VN	10Hz<=f<=100kHz		90		µV
Temperature coefficient of Vo	ΔVo/ΔT	Io=5mA		-1.8		mV/°C
Ripple Rejection	RR	VI =18.5V to 28.5V f=120Hz,Tj=25°C	54	70		dB
Peak Output Current	IPK	Tj=25°C		1.8		A
Short-Circuit Current	ISC	VI=35V, Tj=25°C		250		mA
Dropout Voltage	Vd	Tj=25°C		2.0		V

UTC LM7818 ELECTRICAL CHARACTERISTICS

(VI=27V, Io=0.5A, Tj= 0°C - 125°C, C1=0.33uF, Co=0.1uF, unless otherwise specified)(Note 1)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage	Vo	Tj=25°C, IO=5mA - 1.0A	17.28	18.0	18.72	V
		VI =21V to 33V,IO=5mA - 1.0A	17.10		18.90	V
Load Regulation	ΔVo	Tj=25°C,IO=5mA - 1.5A			180	mV
		Tj=25°C,IO=0.25A - 0.75A			90	mV
Line regulation	ΔVo	VI =21V to 33V,Tj=25°C			180	mV
		VI =21V to 33V, Tj=25°C, IO =<1A,PD<15W			180	mV
Quiescent Current	Iq	Tj=25°C, IO=<1A			8.0	mA
Quiescent Current Change	ΔIq	VI =21.5V to 33V			1.0	mA
	ΔIq	IO=5mA - 1.0A			0.5	mA
Output Noise Voltage	VN	10Hz<=f<=100kHz		110		µV
Temperature coefficient of Vo	ΔVo/ΔT	Io=5mA		-2.2		mV/°C
Ripple Rejection	RR	VI =22V - 32V,f=120Hz,Tj=25°C	53	69		dB
Peak Output Current	IPK	Tj=25°C		1.8		A
Short-Circuit Current	ISC	VI=35V, Tj=25°C		250		mA
Dropout Voltage	Vd	Tj=25°C		2.0		V

UTC LM7824 ELECTRICAL CHARACTERISTICS

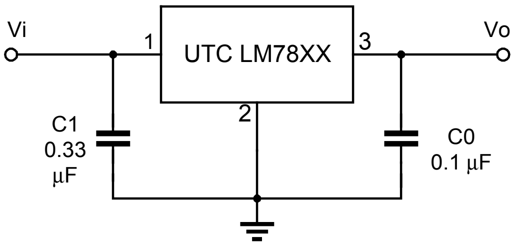
(VI=33V, Io=0.5A, Tj= 0°C - 12°C, C1=0.33uF, Co=0.1uF, unless otherwise specified)(Note 1)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage	Vo	Tj=25°C, I_O=5mA - 1.0A	23.04	24.0	24.96	V
		V_I =27V to 38V,I_O=5mA - 1.0A	22.80		25.20	V
Load Regulation	ΔVo	Tj=25°C,I_O=5mA - 1.5A			240	mV
		Tj=25°C,I_O=0.25A - 0.75A			120	mV
Line regulation	ΔVo	V_I =27V to 38V,Tj=25°C			240	mV
		V_I =27V to 38V,Tj=25°C,Io=1A			240	mV
Quiescent Current	Iq	Tj=25°C, I_O=<1A			8.0	mA
Quiescent Current Change	ΔIq	V_I =28V to 38V			1.0	mA
	ΔIq	I_O=5mA - 1.0A			0.5	mA
Output Noise Voltage	V_N	10Hz<=f<=100kHz		170		μV
Temperature coefficient of Vo	ΔVo/ΔT	Io=5mA		-2.8		mV/°C
Ripple Rejection	RR	V_I =28V - 38V,f=120Hz,Tj=25°C	50	66		dB
Peak Output Current	I_{PK}	Tj=25°C		1.8		A
Short-Circuit Current	I_{SC}	VI=35V, Tj=25°C		250		mA
Dropout Voltage	Vd	Tj=25°C		2.0		V

Note 1: The Maximum steady state usable output current are dependent on input voltage, heat sinking, lead length of the package and copper pattern of PCB. The data above represents pulse test conditions with junction temperatures specified at the initiation of test.

Note 2: Power dissipation<0.5W

APPLICATION CIRCUIT



Note 1: To specify an output voltage, substitute voltage value for "XX".

Note 2: Bypass capacitors are recommended for optimum stability and transient response and should be located as close as possible to the regulators.

LM555/NE555/SA555

Single Timer

Features

- High Current Drive Capability (200mA)
- Adjustable Duty Cycle
- Temperature Stability of 0.005%/°C
- Timing From µSec To Hours
- Turn Off Time Less Than 2µSec

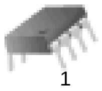
Applications

- Precision Timing
- Pulse Generation
- Time Delay Generation
- Sequential Timing

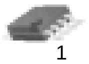
Description

LM555/NE555/SA555 is a highly stable controller capable of producing accurate timing pulses. With monostable operation, the time delay is controlled by one external resistor and one capacitor. With astable operation, the frequency and duty cycle are accurately controlled with two external resistors and one capacitor.

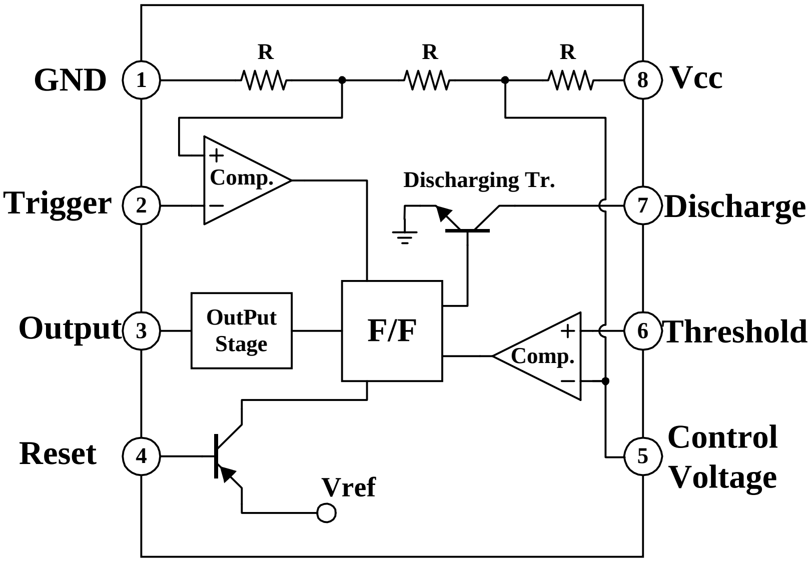
8-DIP



8-SOP



Internal Block Diagram



Rev. 1.0.1

Absolute Maximum Ratings (T_A = 25°C)

Parameter	Symbol	Value	Unit
Supply Voltage	V_{CC}	16	V
Lead Temperature (soldering 10sec)	T_{LEAD}	300	°C
Power Dissipation	P_D	600	mW
Operating Temperature Range LM555/NE555 SA555	T_{OPR}	0 ~ +70 -40 ~ +85	°C
Storage Temperature Range	T_{STG}	- 65 ~ + 150	°C

Electrical Characteristics

(T_A = 25°C, V_{CC} = 5 ~ 15V, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply Voltage	V_{CC}		4.5	-	16	V
Supply Current *[1](low stable)	I_{CC}	V_{CC} = 5V, $R_L = \infty$	-	3	6	mA
		V_{CC} = 15V, $R_L = \infty$	-	7.5	15	mA
Timing Error *[2] (Monostable) Initial Accuracy Drift with Temperature Drift with Supply Voltage	ACCUR $\Delta t/\Delta T$ $\Delta t/\Delta V_{CC}$	R_A = 1KΩ to100KΩ C = 0.1μF	-	1.0 50 0.1	3.0 0.5	% ppm/°C %/V
Timing Error *[2](astable) Intial Accuracy Drift with Temperature Drift with Supply Voltage	ACCUR $\Delta t/\Delta T$ $\Delta t/\Delta V_{CC}$	R_A = 1KΩ to 100KΩ C = 0.1μF	-	2.25 150 0.3	-	% ppm/°C %/V
Control Voltage	V_C	V_{CC} = 15V	9.0	10.0	11.0	V
		V_{CC} = 5V	2.6	3.33	4.0	V
Threshold Voltage	V_{TH}	V_{CC} = 15V	-	10.0	-	V
		V_{CC} = 5V	-	3.33	-	V
Threshold Current *[3]	I_{TH}	-	-	0.1	0.25	μA
Trigger Voltage	V_{TR}	V_{CC} = 5V	1.1	1.67	2.2	V
		V_{CC} = 15V	4.5	5	5.6	V
Trigger Current	I_{TR}	V_{TR} = 0V		0.01	2.0	μA
Reset Voltage	V_{RST}	-	0.4	0.7	1.0	V
Reset Current	I_{RST}	-		0.1	0.4	mA
Low Output Voltage	V_{OL}	V_{CC} = 15V I_{SINK} = 10mA I_{SINK} = 50mA	-	0.06 0.3	0.25 0.75	V V
		V_{CC} = 5V I_{SINK} = 5mA	-	0.05	0.35	V
High Output Voltage	V_{OH}	V_{CC} = 15V I_{SOURCE} = 200mA I_{SOURCE} = 100mA	12.75	12.5 13.3	-	V V
		V_{CC} = 5V I_{SOURCE} = 100mA	2.75	3.3	-	V
Rise Time of Output	t_R	-	-	100	-	ns
Fall Time of Output	t_F	-	-	100	-	ns
Discharge Leakage Current	I_{LKG}	-	-	20	100	nA

Notes:

1. Supply current when output is high is typically 1mA less at V_{CC} = 5V
2. Tested at V_{CC} = 5.0V and V_{CC} = 15V
3. This will determine maximum value of $R_A + R_B$ for 15V operation, the max. total R = 20MΩ, and for 5V operation the max. total R = 6.7MΩ

Application Information

Table 1 below is the basic operating table of 555 timer:

Table 1. Basic Operating Table

Threshold Voltage (V_{th})(PIN 6)	Trigger Voltage (V_{tr})(PIN 2)	Reset(PIN 4)	Output(PIN 3)	Discharging Tr. (PIN 7)
Don't care	Don't care	Low	Low	ON
V_{th} > 2Vcc / 3	V_{th} > 2Vcc / 3	High	Low	ON
Vcc / 3 < V_{th} < 2 Vcc / 3	Vcc / 3 < V_{th} < 2 Vcc / 3	High	-	-
V_{th} < Vcc / 3	V_{th} < Vcc / 3	High	High	OFF

When low signal input is applied to the reset terminal, the timer output remains low regardless of the threshold voltage or the trigger voltage. Only when high signal is applied to the reset terminal, timer's output changes according to threshold voltage and trigger voltage.

When the threshold voltage exceeds 2/3 of the supply voltage while the timer output is high, the timer's internal discharge Tr. turns on, lowering the threshold voltage to below 1/3 of the supply voltage. During this time, the timer output is maintained low. Later, if a low signal is applied to the trigger voltage so that it becomes 1/3 of the supply voltage, the timer's internal discharge Tr. turns off, increasing the threshold voltage and driving the timer output again at high.

1. Monostable Operation

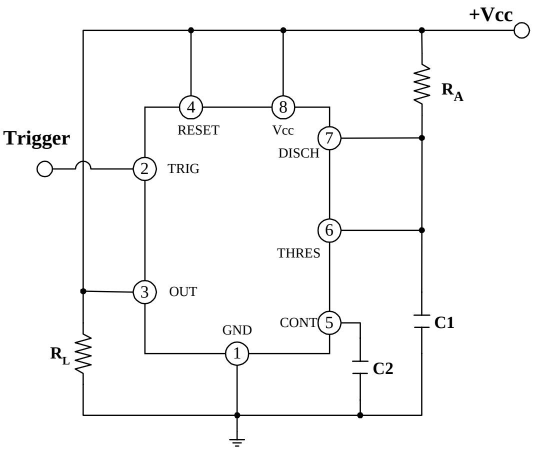


Figure 1. Monoatable Circuit

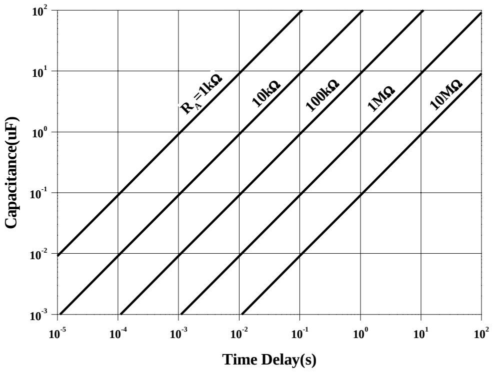
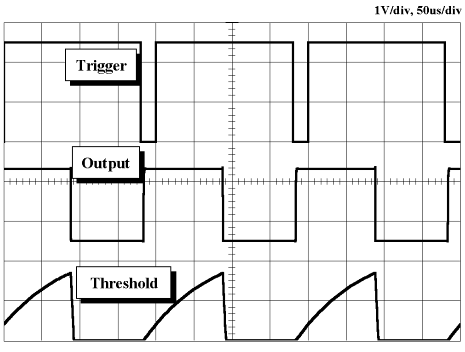


Figure 2. Resistance and Capacitance vs. Time delay(t_d)



R_A=9.1kΩ, R_L=1kΩ, C1=0.01uF, Vcc=5V

Figure 3. Waveforms of Monostable Operation

Figure 1 illustrates a monostable circuit. In this mode, the timer generates a fixed pulse whenever the trigger voltage falls below Vcc/3.

When the trigger pulse voltage applied to the #2 pin falls below Vcc/3 while the timer output is low, the timer's internal flip-flop turns the discharging Tr. off and causes the timer output to become high by charging the external capacitor C1and setting the flip-flop output at the same time.
The voltage across the external capacitor C1, V_{C1} increases exponentially with the time constant $t=R_A*C$ and reaches 2Vcc/3 at $td=1.1R_A*C$. Hence, capacitor C1 is charged through resistor R_A. The greater the time constant R_AC, the longer it takes for the V_{C1} to reach 2Vcc/3. In other words, the time constant R_AC controls the output pulse width.

When the applied voltage to the capacitor C1 reaches 2Vcc/3, the comparator on the trigger terminal resets the flip-flop, turning the discharging Tr. on. At this time, C1 begins to discharge and the timer output converts to low.
In this way, the timer operating in monostable repeats the above process. Figure 2 shows the time constant relationship based on R_A and C. Figure 3 shows the general waveforms during monostable operation.
It must be noted that, for normal operation, the trigger pulse voltage needs to maintain a minimum of Vcc/3 before the timer output turns low. That is, although the output remains unaffected even if a different trigger pulse is applied while the output is high, it may be affected and the waveform not operate properly if the trigger pulse voltage at the end of the output pulse remains at below Vcc/3. Figure 4 shows such timer output abnormality.

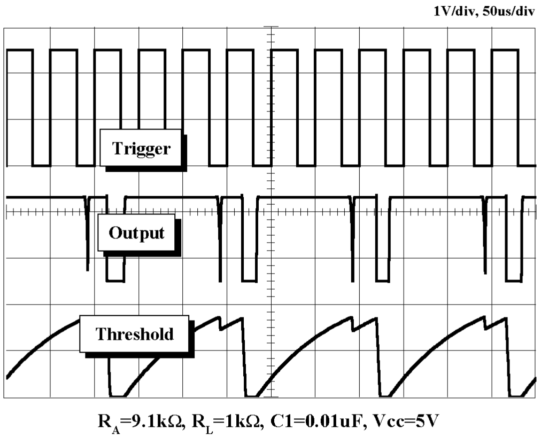


Figure 4. Waveforms of Monostable Operation (abnormal)

2. Astable Operation

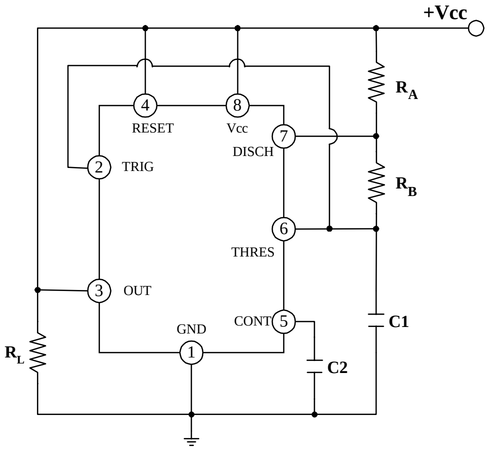


Figure 5. Astable Circuit

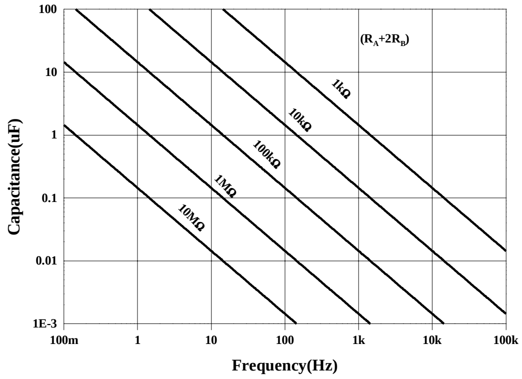
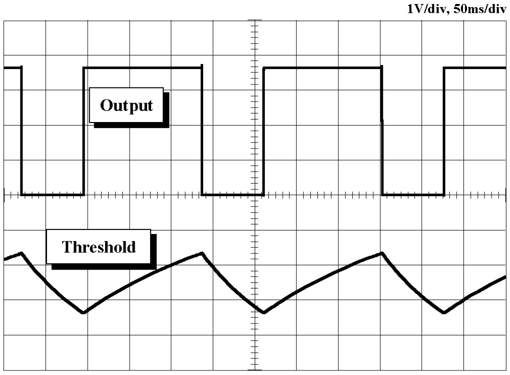


Figure 6. Capacitance and Resistance vs. Frequency



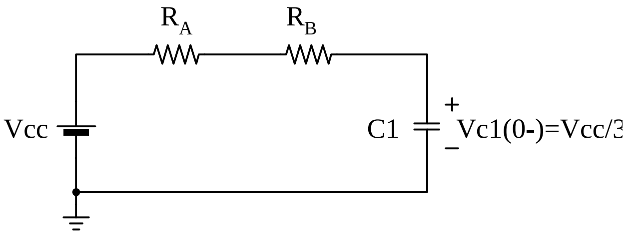
R_A=1kΩ, R_B=1kΩ, R_L=1kW, C1=1uF, Vcc=5V

Figure 7. Waveforms of Astable Operation

An astable timer operation is achieved by adding resistor R_B to Figure 1 and configuring as shown on Figure 5. In astable operation, the trigger terminal and the threshold terminal are connected so that a self-trigger is formed, operating as a multi vibrator. When the timer output is high, its internal discharging Tr. turns off and the V_{C1} increases by exponential function with the time constant (R_A+R_B)*C.

When the V_{C1}, or the threshold voltage, reaches 2Vcc/3, the comparator output on the trigger terminal becomes high, resetting the F/F and causing the timer output to become low. This in turn turns on the discharging Tr. and the C1 discharges through the discharging channel formed by R_B and the discharging Tr. When the V_{C1} falls below Vcc/3, the comparator output on the trigger terminal becomes high and the timer output becomes high again. The discharging Tr. turns off and the V_{C1} rises again.

In the above process, the section where the timer output is high is the time it takes for the V_{C1} to rise from Vcc/3 to 2Vcc/3, and the section where the timer output is low is the time it takes for the V_{C1} to drop from 2Vcc/3 to Vcc/3. When timer output is high, the equivalent circuit for charging capacitor C1 is as follows:



$$C_1\frac{dv_{c1}}{dt} = \frac{V_{cc} - V(0\text{-})}{R_A + R_B} \qquad (1)$$

$$V_{C1}(0+) = V_{CC}/3 \qquad (2)$$

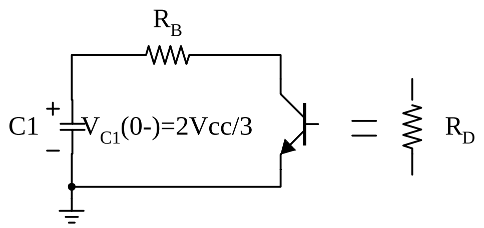
$$V_{C1}(t) = V_{CC}\left(1 - \frac{2}{3}e^{-\left(-\frac{t}{(R_A + R_B)C1}\right)}\right) \qquad (3)$$

Since the duration of the timer output high state(t_H) is the amount of time it takes for the V_{C1}(t) to reach 2Vcc/3,

$$V_{C1}(t) = \frac{2}{3}V_{CC} = V_{CC}\left(1 - \frac{2}{3}e^{-\left(-\frac{t_H}{(R_A + R_B)C1}\right)}\right) \qquad (4)$$

$$t_H = C_1(R_A + R_B)\ln 2 = 0.693(R_A + R_B)C_1 \qquad (5)$$

The equivalent circuit for discharging capacitor C1 when timer output is low as follows:



$$C_1\frac{dv_{C1}}{dt} + \frac{1}{R_A + R_B}V_{C1} = 0 \qquad (6)$$

$$V_{C1}(t) = \frac{2}{3}V_{CC}e^{-\frac{t}{(R_A + R_D)C1}} \qquad (7)$$

Since the duration of the timer output low state(t_L) is the amount of time it takes for the $V_{C1}(t)$ to reach Vcc/3,

$$\frac{1}{3}V_{CC} = \frac{2}{3}V_{CC}e^{-\frac{t_L}{(R_A + R_D)C1}} \qquad (8)$$

$$t_L = C_1(R_B + R_D)\ln 2 = 0.693(R_B + R_D)C_1 \qquad (9)$$

Since R_D is normally $R_B >> R_D$ although related to the size of discharging Tr.,
$t_L = 0.693R_BC_1$ (10)

Consequently, if the timer operates in astable, the period is the same with '$T = t_H + t_L = 0.693(RA + R_B)C_1 + 0.693R_BC_1 = 0.693(R_A + 2R_B)C_1$' because the period is the sum of the charge time and discharge time. And since frequency is the reciprocal of the period, the following applies.

$$\text{frequency,} \qquad f = \frac{1}{T} = \frac{1.44}{(R_A + 2R_B)C_1} \qquad (11)$$

3. Frequency divider

By adjusting the length of the timing cycle, the basic circuit of Figure 1 can be made to operate as a frequency divider. Figure 8. illustrates a divide-by-three circuit that makes use of the fact that retriggering cannot occur during the timing cycle.

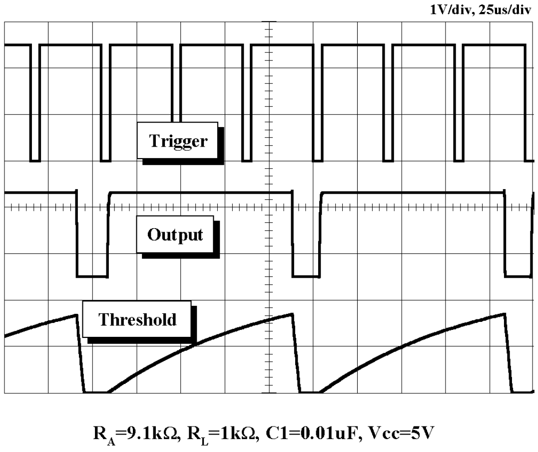


Figure 8. Waveforms of Frequency Divider Operation

4. Pulse Width Modulation

The timer output waveform may be changed by modulating the control voltage applied to the timer's pin 5 and changing the reference of the timer's internal comparators. Figure 9. illustrates the pulse width modulation circuit.
When the continuous trigger pulse train is applied in the monostable mode, the timer output width is modulated according to the signal applied to the control terminal. Sine wave as well as other waveforms may be applied as a signal to the control terminal. Figure 10 shows an example of pulse width modulation waveform.

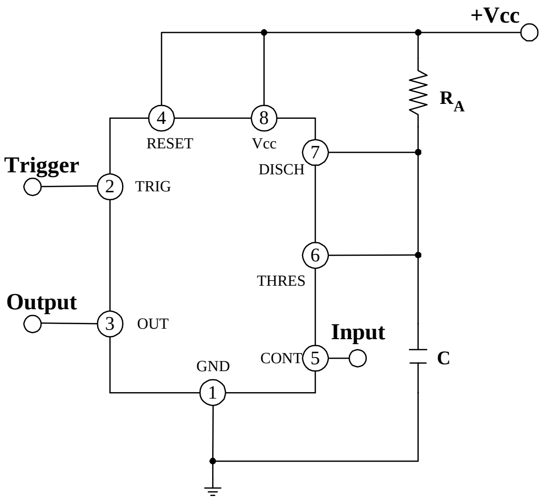


Figure 9. Circuit for Pulse Width Modulation

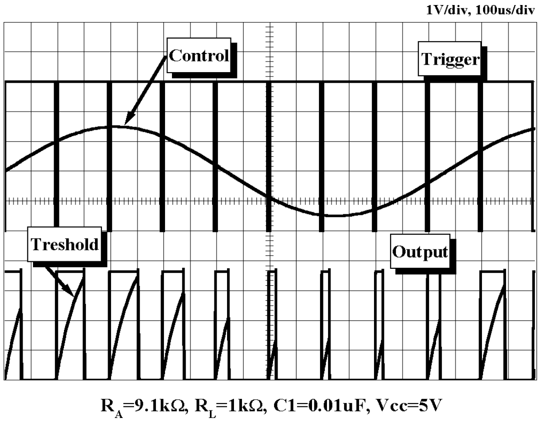


Figure 10. Waveforms of Pulse Width Modulation

5. Pulse Position Modulation

If the modulating signal is applied to the control terminal while the timer is connected for astable operation as in Figure 11, the timer becomes a pulse position modulator.
In the pulse position modulator, the reference of the timer's internal comparators is modulated which in turn modulates the timer output according to the modulation signal applied to the control terminal.
Figure 12 illustrates a sine wave for modulation signal and the resulting output pulse position modulation : however, any wave shape could be used.

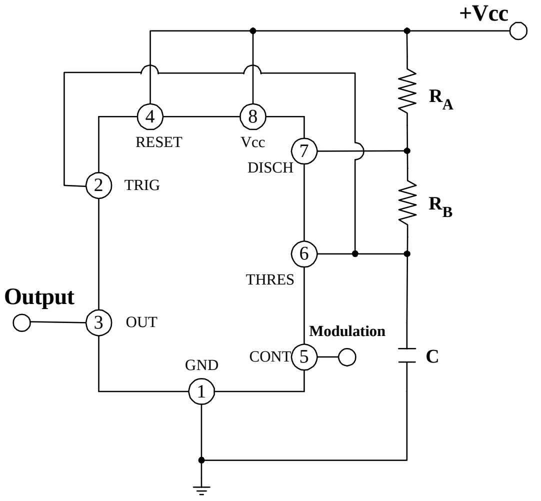
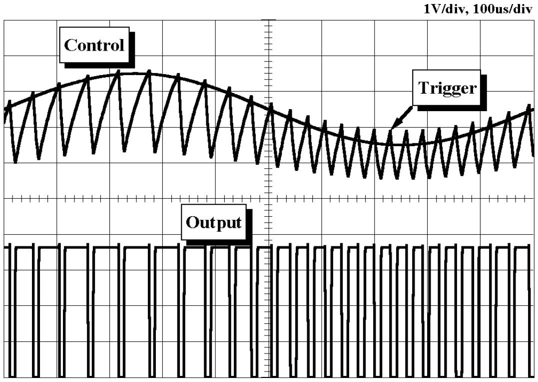


Figure 11. Circuit for Pulse Position Modulation



R_A=3.9kΩ, R_B=1kΩ, R_L=1kΩ, C1=0.01uF, Vcc=5V

Figure 12. Waveforms of pulse position modulation

6. Linear Ramp

When the pull-up resistor RA in the monostable circuit shown in Figure 1 is replaced with constant current source, the V_{C1} increases linearly, generating a linear ramp. Figure 13 shows the linear ramp generating circuit and Figure 14 illustrates the generated linear ramp waveforms.

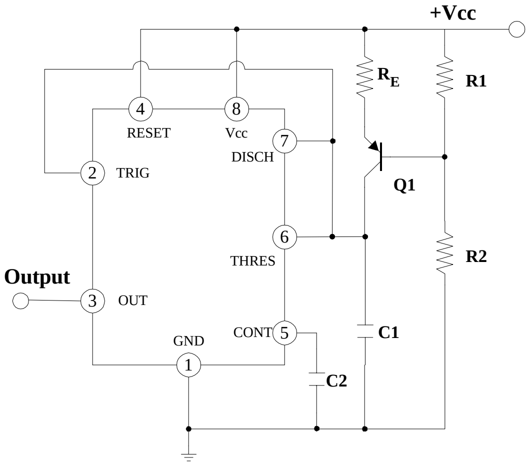
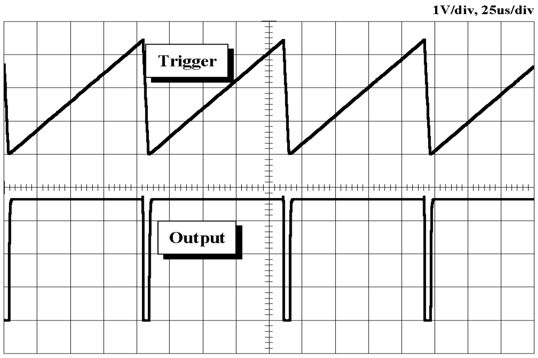


Figure 13. Circuit for Linear Ramp



R1=47kΩ, R2=100kΩ, R_E=2.7kΩ, R_L=1kΩ, C1=0.01uF, Vcc=5V

Figure 14. Waveforms of Linear Ramp

In Figure 13, current source is created by PNP transistor Q1 and resistor R1, R2, and R_E.

$$I_C = \frac{V_{CC} - V_E}{R_E} \qquad (12)$$

Here, V_E is

$$V_E = V_{BE} + \frac{R_2}{R_1 + R_2} V_{CC} \qquad (13)$$

For example, if Vcc=15V, R_E=20kΩ, R1=5kW, R2=10kΩ, and V_{BE}=0.7V,
V_E=0.7V+10V=10.7V
Ic=(15-10.7)/20k=0.215mA

When the trigger is started in a timer configured as shown in Figure 13, the current flowing to capacitor C1 becomes a constant current generated by PNP transistor and resistors.
Hence, the V_C is a linear ramp function as shown in Figure 14. The gradient S of the linear ramp function is defined as follows:

$$S = \frac{V_{p-p}}{T} \qquad (14)$$

Here the Vp-p is the peak-to-peak voltage.
If the electric charge amount accumulated in the capacitor is divided by the capacitance, the V_C comes out as follows:

$$V=Q/C \qquad (15)$$

The above equation divided on both sides by T gives us

$$\frac{V}{T} = \frac{Q/T}{C} \qquad (16)$$

and may be simplified into the following equation.

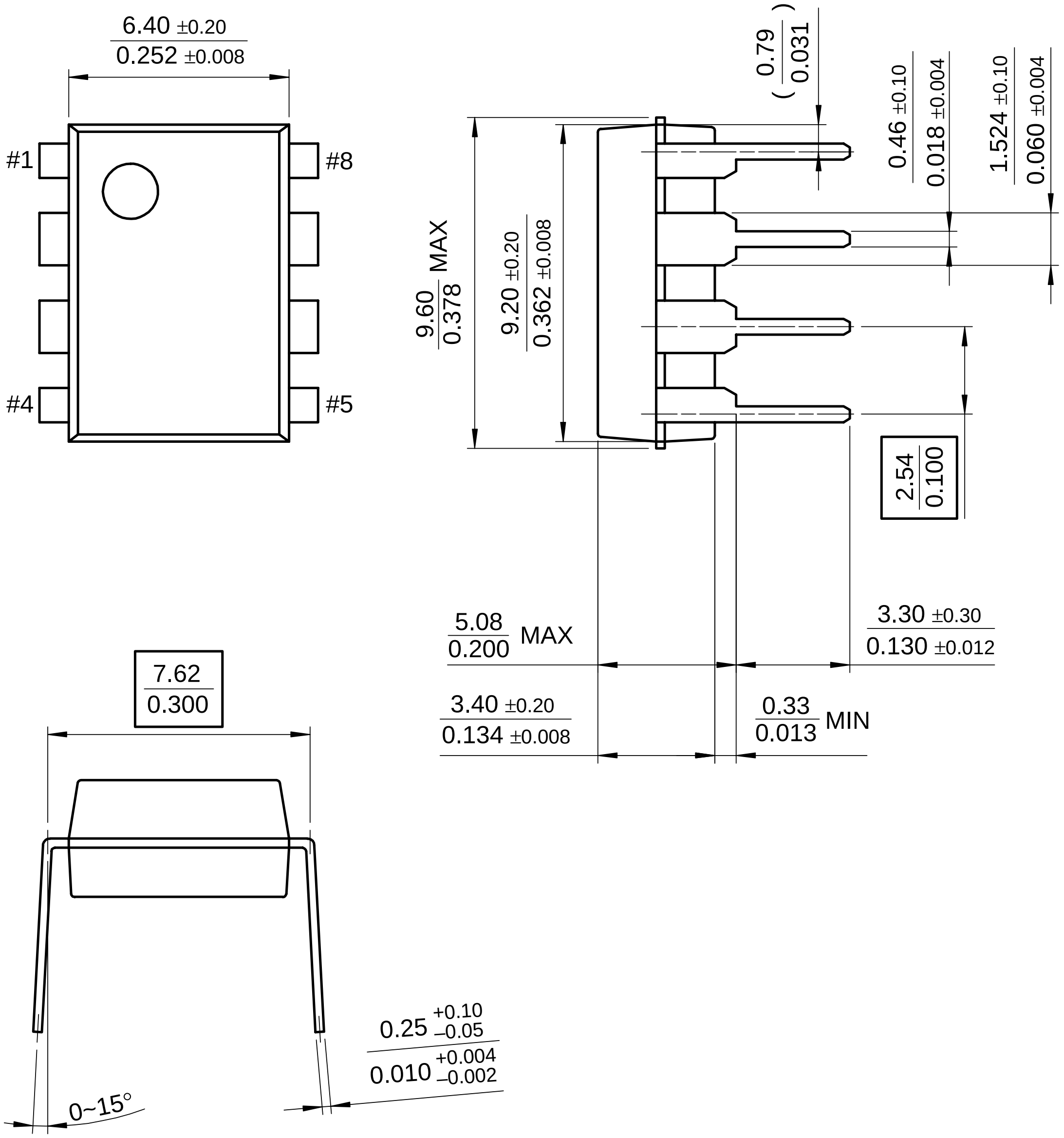
$$S=I/C \qquad (17)$$

In other words, the gradient of the linear ramp function appearing across the capacitor can be obtained by using the constant current flowing through the capacitor.
If the constant current flow through the capacitor is 0.215mA and the capacitance is 0.02uF, the gradient of the ramp function at both ends of the capacitor is S=0.215m/0.022u=9.77V/ms.

Mechanical Dimensions

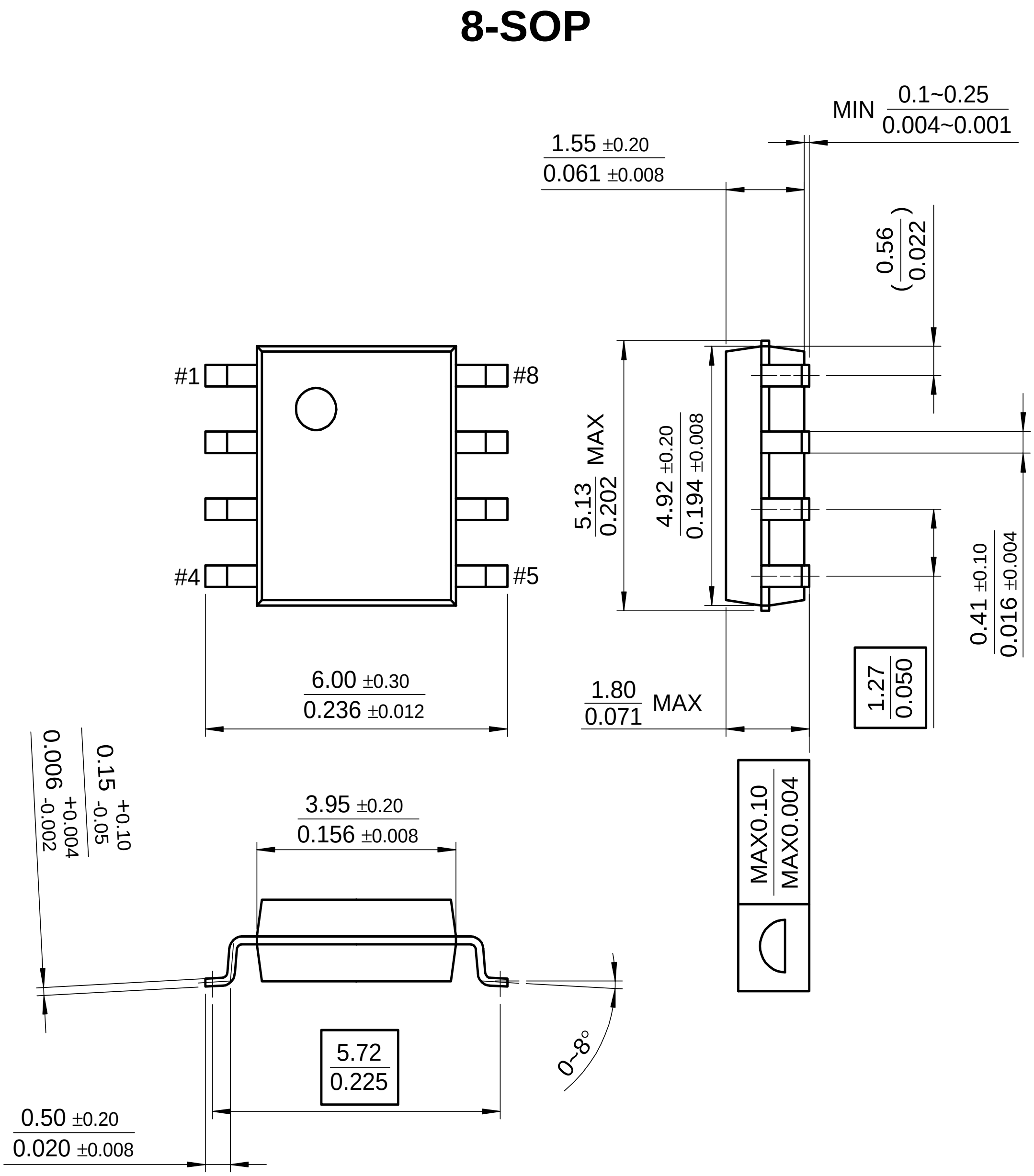
Package

8-DIP



Mechanical Dimensions (Continued)

Package



Ordering Information

Product Number	Package	Operating Temperature
LM555CN	8-DIP	0 ~ +70°C
LM555CM	8-SOP	

Product Number	Package	Operating Temperature
NE555N	8-DIP	0 ~ +70°C
NE555D	8-SOP	

Product Number	Package	Operating Temperature
SA555	8-DIP	-40 ~ +85°C
SA555D	8-SOP	

DISCLAIMER

LIFE SUPPORT POLICY

7/2/01 0.0m 001
Stock#DSxxxxxxxx

SPECIFICATION FOR LCD MODULE

Model No. TM162ABC6-2

Prepared by:	**Date:**
Checked by :	**Date:**
Verified by :	**Date:**
Approved by:	**Date:**

TIANMA MICROELECTRONICS CO., LTD

REVISION RECORD

Date	Ref. Page	Revision No.	Revision Items	Check & Approval

1. General Specifications:

1.1 Display type: STN

1.2 Display color*:

Display color: Blue-Black

Background: Yellow-Green

1.3 Polarizer mode: Transflective/Positive

1.4 Viewing Angle: 6:00

1.5 Driving Method: 1/16 Duty 1/5 Bias

1.6 Backlight: LED

1.7 Controller: S6A0069X01-C0CX (KS0066UP-00CC)

1.8 Display Fonts: 5 x 7 dots + 5 x 1 Cursor (1 Character)

1.9 Data Transfer: 8 Bit Parallel

1.10 Operating Temperature: 0----+50℃

Storage Temperature: -20----+60℃

1.11 Outline Dimensions: Refer to outline drawing on next page

1.12 Dot Matrix: 16 Characters X 2 Lines

1.13 Dot Size: 0.55X0.50(mm)

1.14 Dot Pitch: 0.60X0.55 (mm)

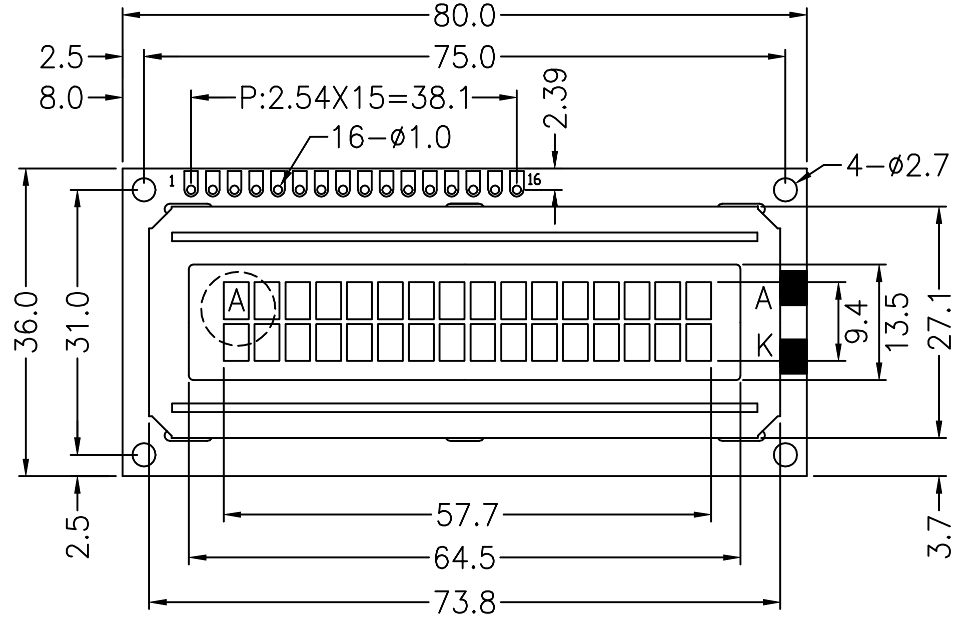
1.15 Font Size: 2.95X4.35(mm)

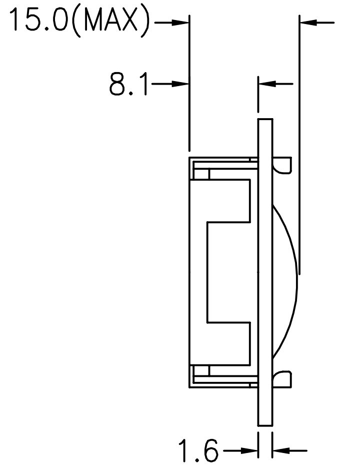
1.16 Font Pitch: 3.65X5.05 (mm)

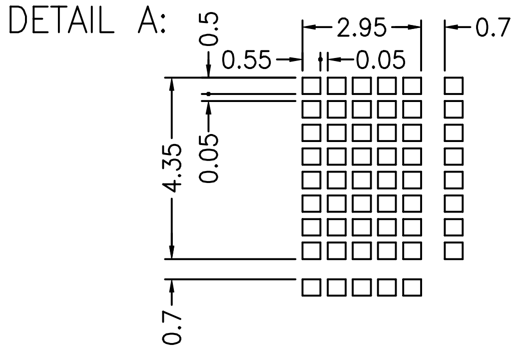
1.17 Weight: 32g

* Color tone is slightly changed by temperature and driving voltage.

2. Outline Drawing







1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Vss	Vcc	Vee	RS	R/W	E	DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7	A	K

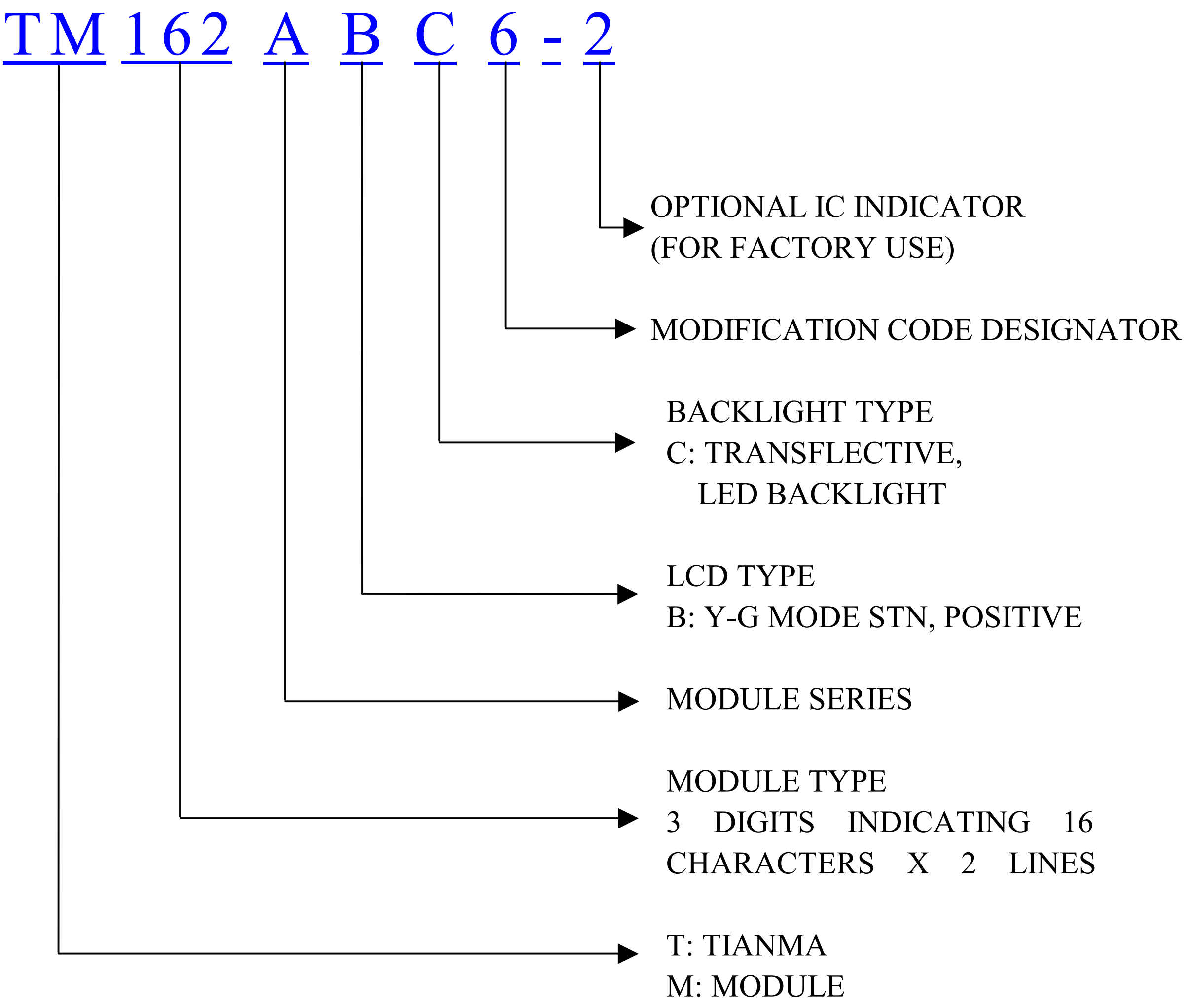
NOTES:

1. DISPLAY TYPE:	STN/Y−G MODE
2. VIEWING DIRETION:	6:00
3. POLARIZER MODE:	TRANSFLECTIVE/POSITIVE
4. DRIVE METHOD:	DUTY 1/16 BIAS 1/5
5. OPERATING TEMP:	0°C~+50°C
6. STORAGE TEMP:	−20°C~+60°C
7. CONTROLLER:	S6A0069X01−C0CX(KS0066UP−00CC)
8. BACKLIGHT:	LED
9. LCD OPERATING VOLTAGE:	4.7V
10.UNMARKED TOLERANCE:	±0.3mm
11.BEZEL IS TO BE PAINTED	BLACK

TIAN−MA MICROELECTRONICS CO.
6/F., CASTIC Building, Shennan Road, Central, Shenzhen, China

DRAWN BY:	TITLE: TM162ABC6−2	
CHECKED BY:	DWG NO: G−1	SCALE:
APPROVED BY:		UNIT: mm
CONFIRMED BY:	DWG NAME: TM162ABC6−2G−1	SHEET NO: OF

3. LCD Module Part Numbering System



TM 162 A B C 6 - 2

OPTIONAL IC INDICATOR
(FOR FACTORY USE)

MODIFICATION CODE DESIGNATOR

BACKLIGHT TYPE
C: TRANSFLECTIVE,
LED BACKLIGHT

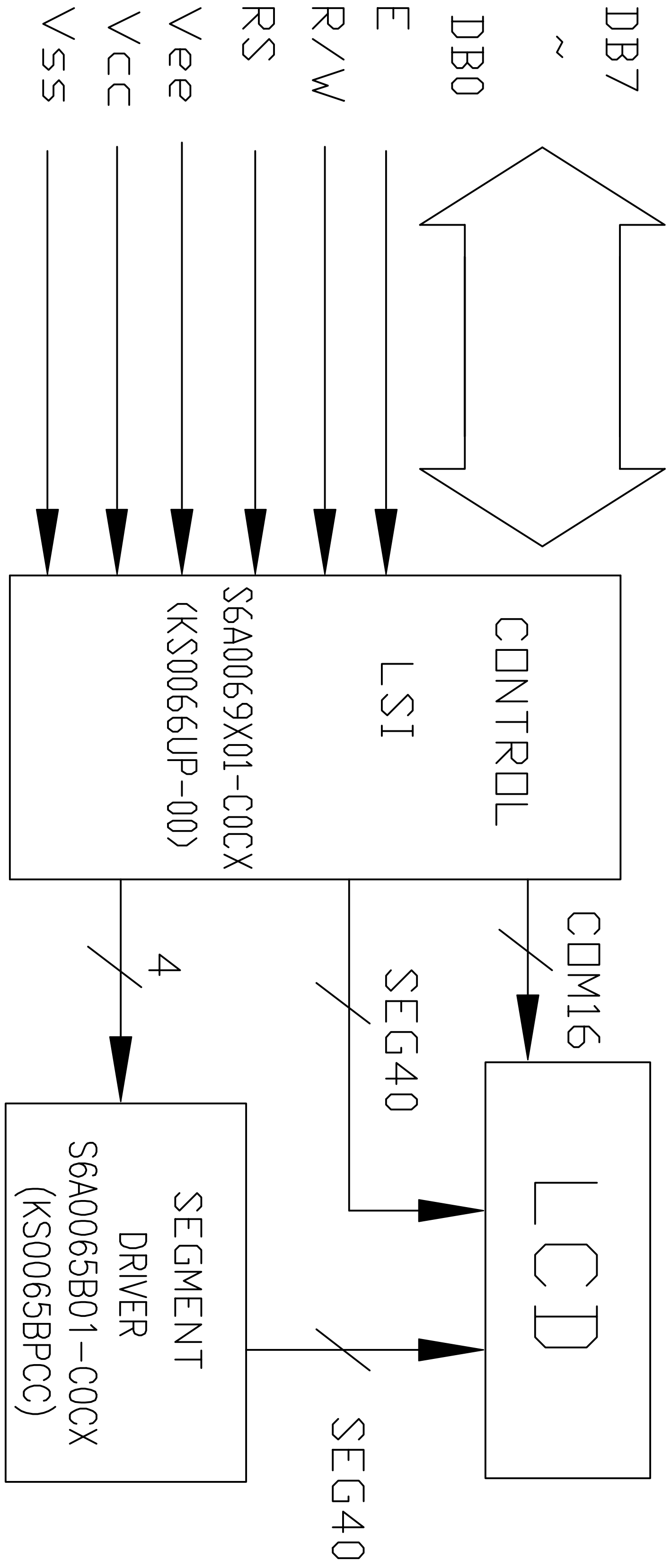
LCD TYPE
B: Y-G MODE STN, POSITIVE

MODULE SERIES

MODULE TYPE
3 DIGITS INDICATING 16 CHARACTERS X 2 LINES

T: TIANMA
M: MODULE

4. Circuit Block Diagram



5. Absolute Maximum Ratings

Item	Symbol	Min.	Max.	Unit	Remark
Power Supply Voltage	$V_{DD}-V_{SS}$	-0.3	7.0	V	
LCD Driving Voltage	V_{LCD}	-0.3	13.0		
Operating Temperature Range	T_{OP}	0	+50	℃	No Condensation
Storage Temperature Range	T_{ST}	-20	+60		

6. Electrical Specifications and Instruction Code

6.1 Electrical characteristics

Item		Symbol	Min.	Typ.	Max.	Unit
Supply Voltage (Logic)		$V_{CC}-V_{SS}$	4.5	5.0	5.5	V
Supply Voltage (LCD Drive)		V_{LCD}	-	4.7	-	V
Input Signal Voltage	High	V_{IH} （$V_{CC}=5.0$）	$0.7V_{DD}$	-	$V_{DD}+0.3$	V
	Low	V_{IL} （$V_{CC}=5.0$）	-0.3	-	$0.2V_{DD}$	V
Supply current (Logic)		I_{DD} （$V_{CC}-V_{SS}=5.0$）	-	1.5	-	mA
Supply current (LCD Drive)		I_{EE}	-	0.40	-	mA
Supply current (LED Drive)		I_{DD} （$V_{LED}=4.2$）	-	-	138.6	mA

6.2 Interface Signals

Pin No.	Symbol	Level	Description
1	Vss	0V	Ground
2	Vcc	5.0V	Power supply voltage for logic and LCD(+)
3	Vee	0.3V	Power supply voltage for LCD(-)
4	RS	H/L	Selects registers (H: Data L: Instruction)
5	R/W	H/L	Selects read or write
6	E	H/L	Data read/write enable signal
7	DB0	H/L	Data bit0
8	DB1	H/L	Data bit1
9	DB2	H/L	Data bit2
10	DB3	H/L	Data bit3
11	DB4	H/L	Data bit4
12	DB5	H/L	Data bit5
13	DB6	H/L	Data bit6
14	DB7	H/L	Data bit7
15	A	4.2V	Power supply voltage for LED(+)
16	K	0V	Power supply voltage for LED(-)

6.3 Interface Timing Chart

AC Characteristics(V_{DD}=4.5V~5.5V,Ta=-30~+85℃)

Mode	Characteristic	Symbol	Min.	Typ.	Max.	Unit
Write Mode (Refer to Fig-6)	E Cycle Time	tc	500	-	-	ns
	E Rise / Fall Time	t_R,t_F	-	-	20	
	E Pulse Width (High, Low)	tw	230	-	-	
	R/W and RS Setup Time	tsu1	40	-	-	
	R/W and RS Hold Time	t_{H1}	10	-	-	
	Data Setup Time	tsu2	80	-	-	
	Data Hold Time	t_{H2}	10	-	-	
Read Mode (Refer to Fig-7)	E Cycle Time	tc	500	-	-	ns
	E Rise / Fall Time	t_R,t_F	-	-	20	
	E Pulse Width (High, Low)	tw	230	-	-	
	R/W and RS Setup Time	tsu	40	-	-	
	R/W and RS Hold Time	t_H	10	-	-	
	Data Output Delay Time	t_D	-	-	120	
	Data Hold Time	t_{DH}	5	-	-	

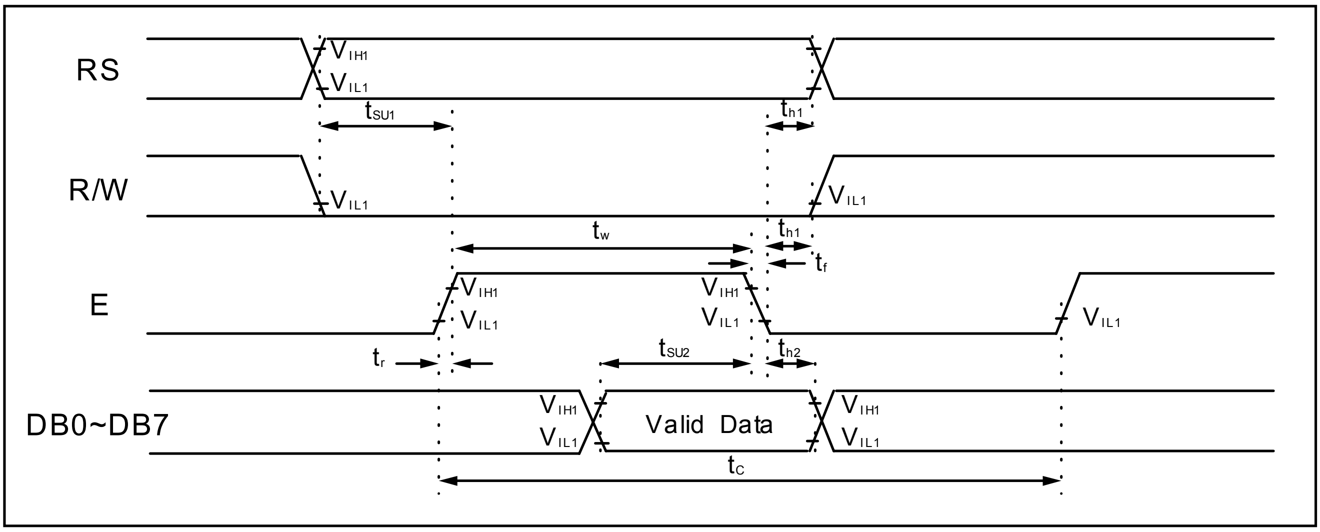


Figure 6 . Write Mode Timing Diagram

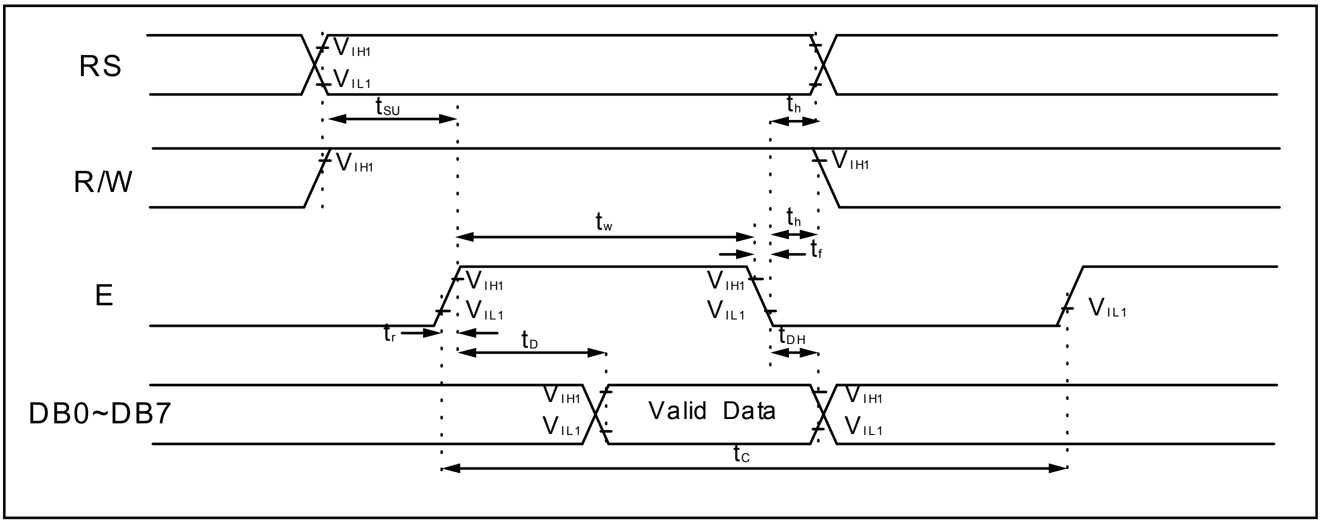


Figure 7 . Read Mode Timing Diagram

6.4 Instruction Code

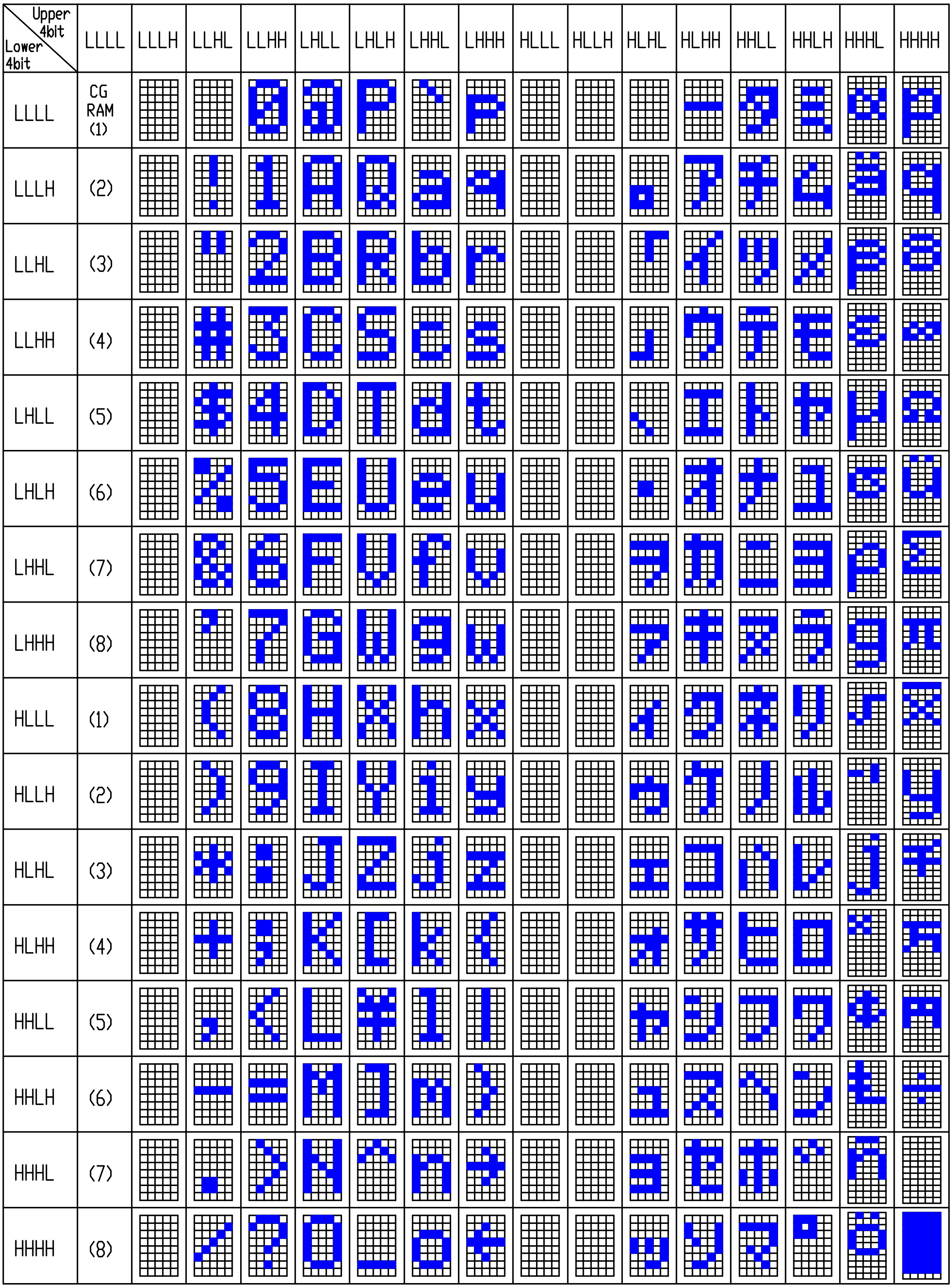
Instruction Table

Instruction	Instruction Code										Description	Execution time (fosc= 270 kHz)
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Write “20H” to DDRAM and set DDRAM address to “00H” from AC	1.53 ms
Return Home	0	0	0	0	0	0	0	0	1	-	Set DDRAM address to “00H” from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.	1.53 ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	SH	Assign cursor moving direction and enable the shift of entire display.	39 μs
Display ON/ OFF Control	0	0	0	0	0	0	1	D	C	B	Set display(D), cursor(C), and blinking of cursor(B) on/off control bit.	39 μs
Cursor or Display Shift	0	0	0	0	0	1	S/C	R/L	-	-	Set cursor moving and display shift control bit, and the direction, without changing of DDRAM data.	39 μs
Function Set	0	0	0	0	1	DL	N	F	-	-	Set interface data length (DL: 8-bit/4-bit), numbers of display line (N: 2-line/1-line) and, display font type (F:5×11dots/5×8 dots)	39 μs
Set CGRAM Address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter.	39 μs
Set DDRAM Address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address counter.	39 μs
Read Busy Flag and Address	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read.	0 μs
Write Data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM).	43 μs
Read Data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM).	43 μs

* “-“: don’t care

NOTE: When an MPU program with checking the Busy Flag(DB7) is made, it must be necessary 1/2Fosc is necessary for executing the next instruction by the falling edge of the 'E' signal after the Busy Flag (DB7) goes to “Low”.

6.5 Character generator ROM(KS0066U-00)



Upper 4bit Lower 4bit	LLLL	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH	HLLL	HLLH	HLHL	HLHH	HHLL	HHLH	HHHL	HHHH
LLLL	CG RAM (1)			0	@	P	`	p				ー	タ	ミ	α	p
LLLH	(2)		!	1	A	Q	a	q			。	ア	チ	ム	ä	q
LLHL	(3)		"	2	B	R	b	r			「	イ	ツ	メ	β	θ
LLHH	(4)		#	3	C	S	c	s			」	ウ	テ	モ	ε	∞
LHLL	(5)		$	4	D	T	d	t			、	エ	ト	ヤ	μ	Ω
LHLH	(6)		%	5	E	U	e	u			・	オ	ナ	ユ	σ	ü
LHHL	(7)		&	6	F	V	f	v			ヲ	カ	ニ	ヨ	ρ	Σ
LHHH	(8)		'	7	G	W	g	w			ァ	キ	ヌ	ラ	g	π
HLLL	(1)		(	8	H	X	h	x			ィ	ク	ネ	リ	√	x̄
HLLH	(2)		)	9	I	Y	i	y			ゥ	ケ	ノ	ル	⁻¹	y
HLHL	(3)		*	:	J	Z	j	z			ェ	コ	ハ	レ	j	千
HLHH	(4)		+	;	K	[	k	{			ォ	サ	ヒ	ロ	ˣ	万
HHLL	(5)		,	<	L	¥	l	|			ャ	シ	フ	ワ	¢	円
HHLH	(6)		-	=	M	]	m	}			ュ	ス	ヘ	ン	£	÷
HHHL	(7)		.	>	N	^	n	→			ョ	セ	ホ	゛	ñ	
HHHH	(8)		/	?	O	_	o	←			ッ	ソ	マ	゜	ö	█

7. Optical Characteristics

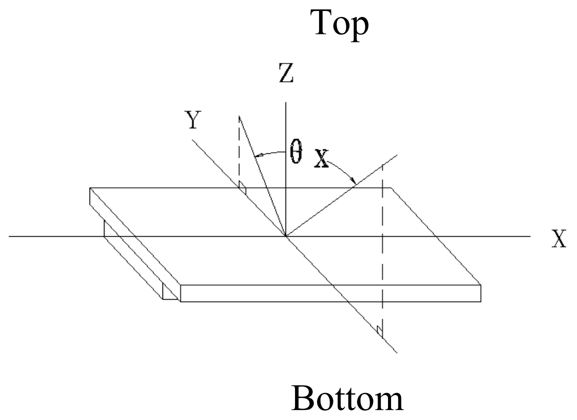
7.1 Optical Characteristics

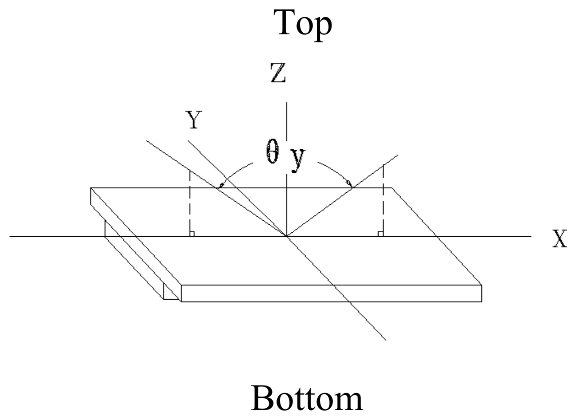
Ta=25℃

Item		Symbol	Condition		Min.	Typ.	Max.	Unit
Viewing Angle		θ_x	Cr≥2	θ_y=0°	-35	--	20	Deg
		θ_y		θ_x=0°	-30	--	30	
Contrast Ratio		Cr	θ_x=0° θ_y=0°		4.0	-	-	
Response Time	Turn on	Ton	θ_x=0° θ_y=0°		-	-	250	ms
	Turn off	Toff			-	-	250	

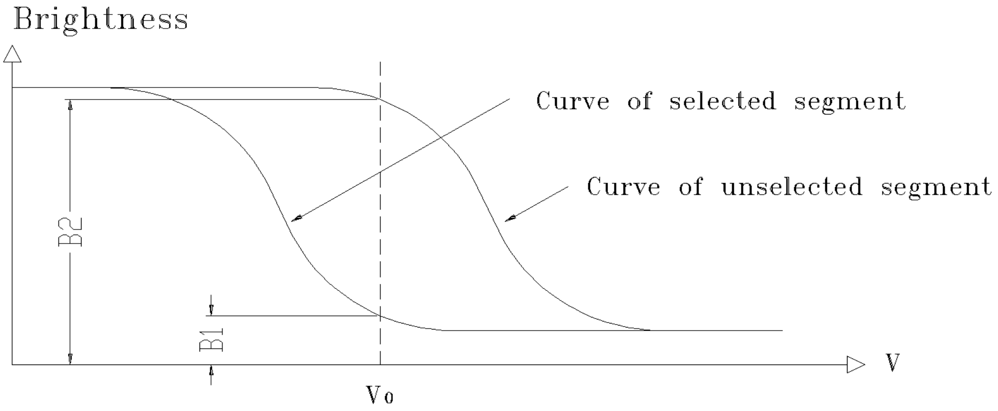
7.2 Definition of Optical Characteristics

7.2.1 Definition of Viewing Angle





7.2.2 Definition of Contrast Ratio

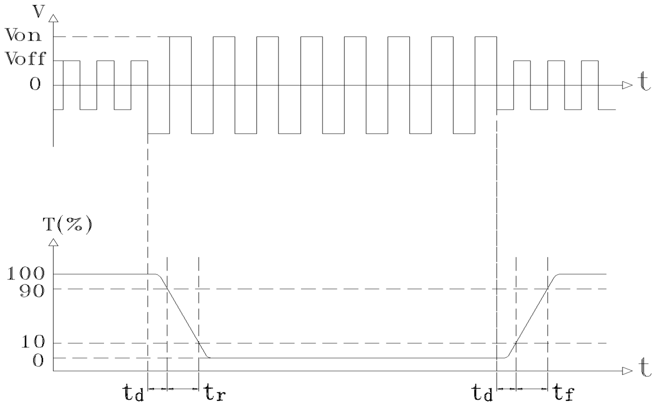


$$\text{Contrast Ratio} = B2/B1 = \frac{\text{unselected state brightness}}{\text{selected state brightness}}$$

Measuring Conditions:

1) Ambient Temperature: 25℃; 2) Frame frequency: 64Hz

7.2.3 Definition of Response time



Turn on time: $t_{on} = t_d + t_r$ Turn off time: $t_{off} = t_d + t_f$

Measuring Condition:

1) LCD Operating Voltage: 4.7V 2) Frame frequency: 64Hz

8. Reliability

8.1 Content of Reliability Test

Ta=25℃

No.	Test Item	Content of Test	Test condition
1	High Temperature Storage	Endurance test applying the high storage temperature for a long time	60℃ 96H
2	Low Temperature Storage	Endurance test applying the low storage temperature for a long time	-20℃ 96H
3	High Temperature Operation	Endurance test applying the electric stress (voltage & current) and the thermal stress to the element for a long time	50℃ 96H
4	Low Temperature Operation	Endurance test applying the electric stress under low temperature for a long time	0℃ 96H
5	High Temperature /Humidity Storage	Endurance test applying the high temperature and high humidity storage for a long time	40℃ 90%RH 96H
6	Temperature Cycle	Endurance test applying the low and high temperature cycle -20℃←→25℃←→60℃←→25℃ 30min 5min 30min 5min ←——→ 1 cycle	-20℃/60℃ 10 cycles
7	Vibration Test (package state)	Endurance test applying the vibration during transportation	10Hz~150Hz, 50m/s^2, 40min
8	Shock Test (package state)	Endurance test applying the shock during transportation	Half- sine wave, 100m/s^2, 11ms
9	Atmospheric Pressure Test	Endurance test applying the atmospheric pressure during transportation by air	40kPa 16H

8.2 Failure Judgment Criterion

Criterion Item	Test Item No.									Failure Judgement Criterion
	1	2	3	4	5	6	7	8	9	
Basic Specification	√	√	√	√	√	√	√	√	√	Out of the basic Specification
Electrical specification	√	√	√	√	√					Out of the electrical specification
Mechanical Specification							√	√		Out of the mechanical specification
Optical Characteristic	√	√	√	√	√	√			√	Out of the optical specification
Note	For test item refer to 8.1									
Remark	Basic specification = Optical specification + Mechanical specification									

9. QUALITY LEVEL

Examination or Test	At Ta=25℃ (unless otherwise stated)	Inspection				
		Min.	Max.	Unit	IL	AQL
External Visual Inspection	Under normal illumination and eyesight condition, the distance between eyes and LCD is 25cm.	See Appendix A			II	Major 1.0 Minor 2.5
Display Defects	Under normal illumination and eyesight condition, display on inspection.	See Appendix B			II	Major 1.0 Minor 2.5
Note: Major defects: Open segment or common, Short, Serious damages, Leakage Miner defects: Others Sampling standard conforms to GB2828						

10. Precautions for Use of LCD Modules

10.1 Handling Precautions

10.1.1 The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.

10.1.2 If the display panel is damaged and the liquid crystal substance inside it leaks out, be sure not to get any in your mouth, if the substance comes into contact with your skin or clothes, promptly wash it off using soap and water.

10.1.3 Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.

10.1.4 The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.

10.1.5 If the display surface is contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If still not completely clear, moisten cloth with one of the following solvents:

— Isopropyl alcohol
— Ethyl alcohol

Solvents other than those mentioned above may damage the polarizer. Especially, do not use the following:

— Water
— Ketone
— Aromatic solvents

10.1.6 Do not attempt to disassemble the LCD Module.

10.1.7 If the logic circuit power is off, do not apply the input signals.

10.1.8 To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.

a. Be sure to ground the body when handling the LCD Modules.
b. Tools required for assembly, such as soldering irons, must be properly ground.
c. To reduce the amount of static electricity generated, do not conduct assembly and other work under dry conditions.
d. The LCD Module is coated with a film to protect the display surface. Be care when peeling off this protective film since static electricity may be generated.

10.2 Storage precautions

10.2.1 When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps.

10.2.2 The LCD modules should be stored under the storage temperature range. If the LCD modules will be stored for a long time, the recommend condition is:

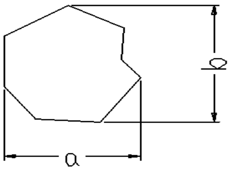
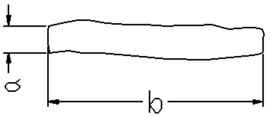
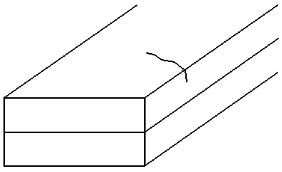
Temperature : 0℃ ～ 40℃
Relatively humidity: ≤80%

10.2.3 The LCD modules should be stored in the room without acid, alkali and harmful gas.

10.3 The LCD modules should be no falling and violent shocking during transportation, and also should avoid excessive press, water, damp and sunshine.

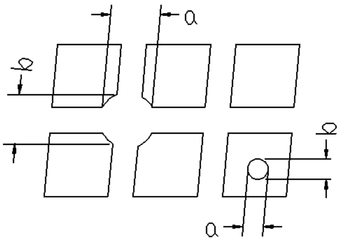
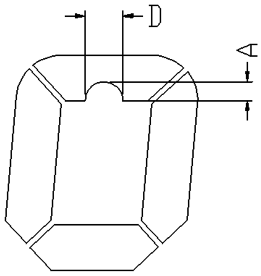
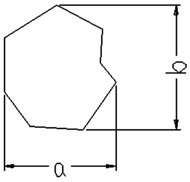
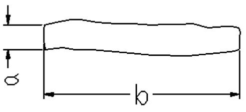
Appendix A

Inspection items and criteria for appearance defects

Items	Contents	Criteria		
Leakage		Not permitted		
Rainbow		According to the limit specimen		
Polarizer	Wrong polarizer attachment	Not permitted		
	Bubble between polarizer and glass	Not counted	Max. 3 defects allowed	
		$\phi<0.3$mm	0.3mm$\leqslant\phi\leqslant$0.5mm	
	Scratches of polarizer	According to the limit specimen		
Black spot (in viewing area)		Not counted	Max. 3 spots allowed	Max. 3 spots (lines) allowed
		$X<0.2$mm	0.2mm$\leqslant X\leqslant$0.5mm	
		$X=(a+b)/2$		
Black line (in viewing area)		Not counted	Max. 3 lines allowed	
		$a<0.02$mm	0.02mm$\leqslant a\leqslant$0.05mm $b\leqslant$2.0mm	
Progressive cracks		Not permitted		

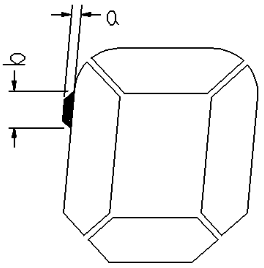
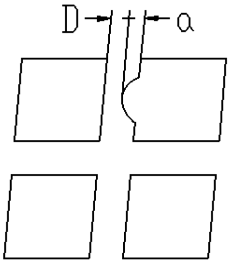
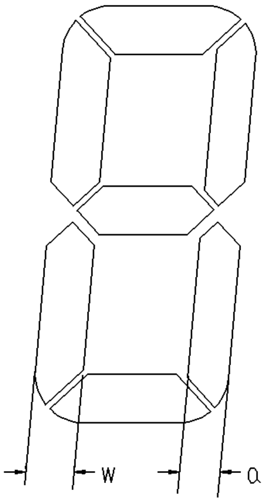
Appendix B

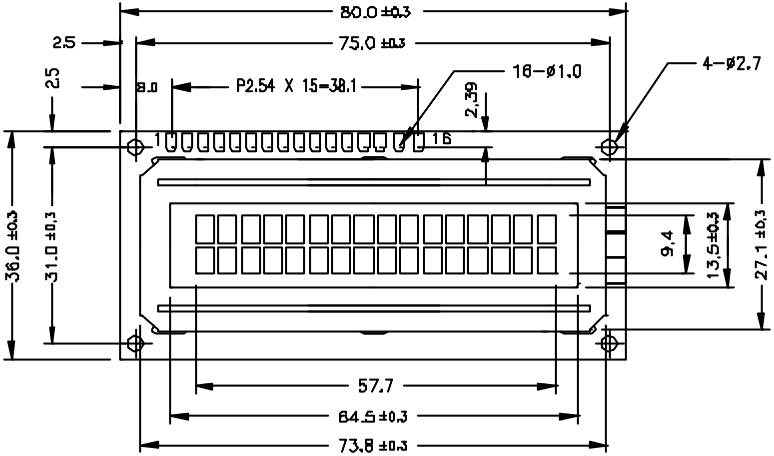
Inspection items and criteria for display defects

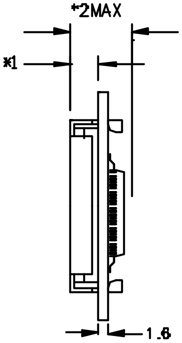
<table>
<tr><td>Items</td><td>Contents</td><td colspan="3">Criteria</td></tr>
<tr><td colspan="2">Open segment or open common</td><td colspan="3">Not permitted</td></tr>
<tr><td colspan="2">Short</td><td colspan="3">Not permitted</td></tr>
<tr><td colspan="2">Wrong viewing angle</td><td colspan="3">Not permitted</td></tr>
<tr><td colspan="2">Contrast radio uneven</td><td colspan="3">According to the limit specimen</td></tr>
<tr><td colspan="2">Crosstalk</td><td colspan="3">According to the limit specimen</td></tr>
<tr><td rowspan="5">Pin holes and cracks in segment (DOT)</td><td rowspan="3"> </td><td>Not counted</td><td>Max.3 dots allowed</td><td rowspan="5">Max.3 dots allowed</td></tr>
<tr><td>X<0.1mm</td><td>0.1mm≤X≤0.2mm</td></tr>
<tr><td colspan="2">X=(a+b)/2</td></tr>
<tr><td rowspan="2"> </td><td>Not counted</td><td>Max.2 dots allowed</td></tr>
<tr><td>A<0.1mm</td><td>0.1mm≤A≤0.2mm
D<0.25mm</td></tr>
<tr><td rowspan="3">Black spot (in viewing area)</td><td rowspan="3"> </td><td>Not counted</td><td>Max.3 spots allowed</td><td rowspan="5">Max.3 spots (lines) allowed</td></tr>
<tr><td>X<0.1mm</td><td>0.1mm≤X≤0.2mm</td></tr>
<tr><td colspan="2">X=(a+b)/2</td></tr>
<tr><td rowspan="2">Black line (in viewing area)</td><td rowspan="2"> </td><td>Not counted</td><td>Max.3 lines allowed</td></tr>
<tr><td>a<0.02mm</td><td>0.02mm≤a≤0.05mm
b≤0.5mm</td></tr>
</table>

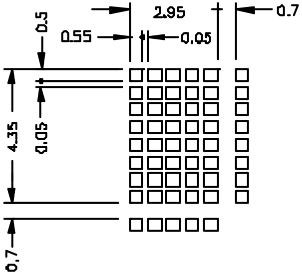
Appendix B

Inspection items and criteria for display defects (continued)

Items	Content	Criteria		
Transfor-mation of segment		Not counted	Max. 2 defects allowed	Max.3 defects allowed
		x＜0.1mm	0.1mm≤x≤0.2mm	
		x=(a+b)/2		
		Not counted	Max. 1 defects allowed	
		a＜0.1mm	0.1mm≤a≤0.2mm D>0	
		Max.2 defects allowed 0.8W≤a≤1.2W a=measured value of width W=nominal value of width		



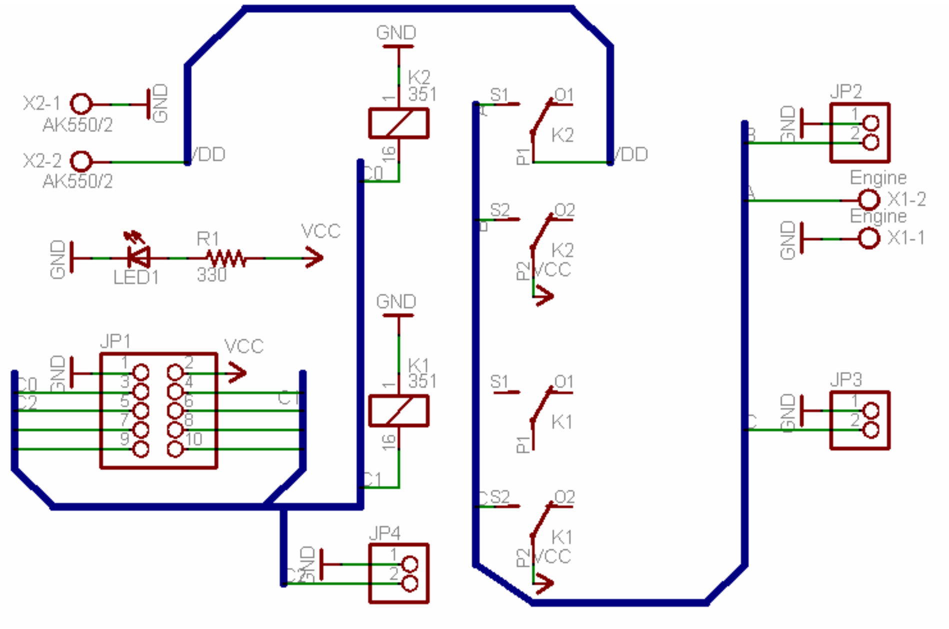




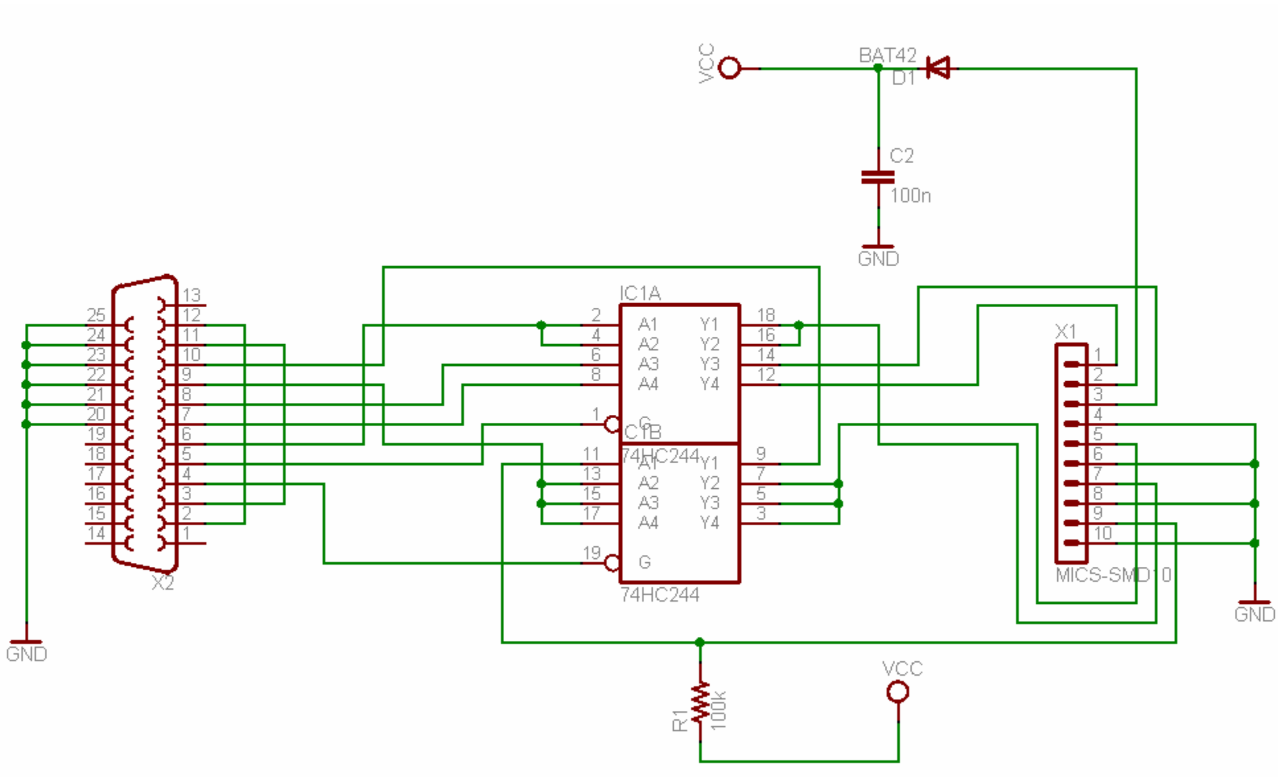
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Vss	Vcc	Vee	RS	R/W	E	DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7	LED+	LED−

TYPE	*1	*2
R&EL	4.5	11.0
LED	7.6	15.0

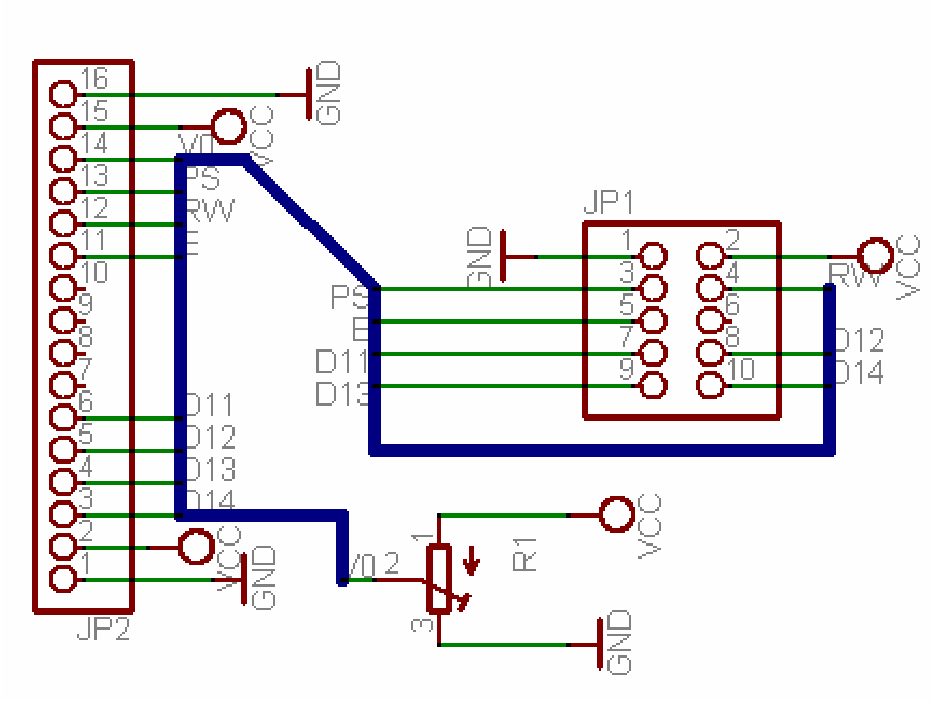
Skematik Ekspansi I/O



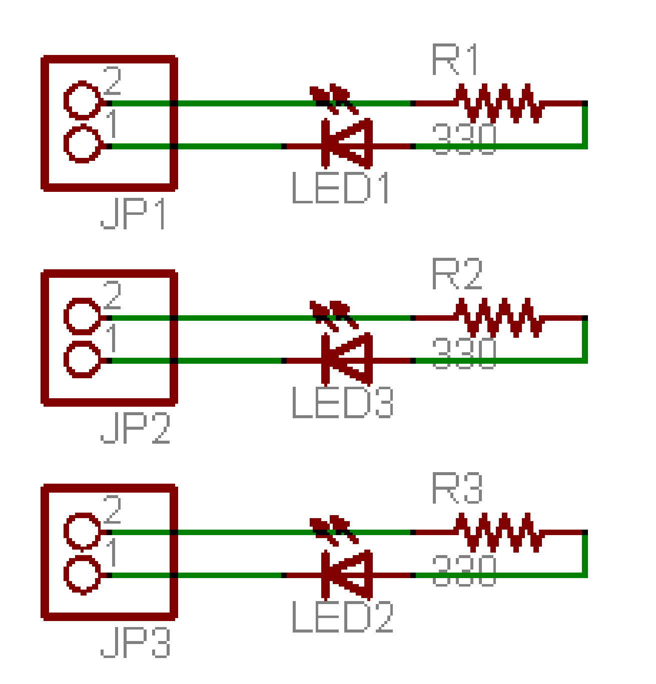
Skematik ISP



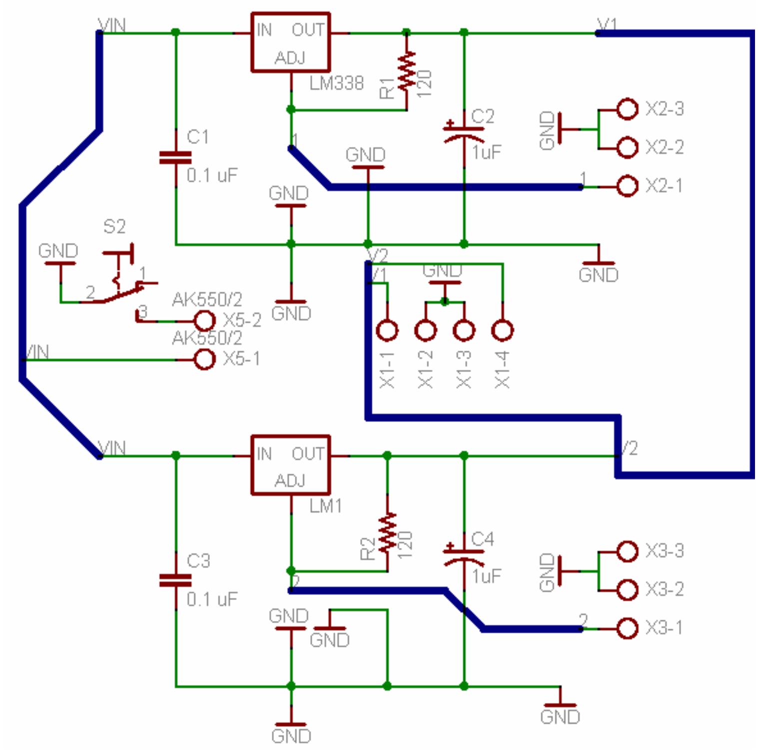
Skematik LCD



Skematik LED



Skematik *Voltage Regulator*



Program Menghitung RPM Menggunakan Interrupt 0

```
#include <mega8535.h>
#include <delay.h>
#include <stdlib.h>
#asm
   .equ __lcd_port=0x1B ;PORTA
#endasm
#include <lcd.h>

unsigned int itung;
unsigned int rps,rpm, sekarang, sebelum;
char lcd1[5];
char lcd2[5];

interrupt [EXT_INT0] void ext_int0_isr(void)
{
    ++sekarang;
}

interrupt [TIM0_OVF] void timer0_ovf_isr(void)
{
  TCNT0=6;
  if (++itung==2000)
  {
    if(sekarang>sebelum)
    rps=sekarang-sebelum;
    else
    rps=0xffff-sekarang+sebelum;
    rpm=rps*60;
    sekarang=sebelum;
    itung=0;
  }
  //TCNT1=0;
}


void main (void)
{

// Timer/Counter 0 initialization
// Clock source: System Clock
// Clock value: 500.000 kHz
// Mode: Normal top=FFh
// OC0 output: Disconnected
TCCR0=0x02;
```

```
TCNT0=0x00;
OCR0=0x00;

// External Interrupt(s) initialization
// INT0: On
// INT0 Mode: Falling Edge
// INT1: Off
// INT2: Off
GICR|=0x40;
MCUCR=0x02;
MCUCSR=0x00;
GIFR=0x40;

// Timer(s)/Counter(s) Interrupt(s) initialization
TIMSK=0x01;

// Analog Comparator initialization
// Analog Comparator: Off
// Analog Comparator Input Capture by Timer/Counter 1: Off
ACSR=0x80;
SFIOR=0x00;


// LCD module initialization
lcd_init(16);

// Global enable interrupts
#asm("sei")

  while (1)
  {

      lcd_gotoxy(0,0);
      //lcd_putsf("ENDI");
      lcd_putsf("RPS = ");
      //lcd_gotoxy(9,0);
      lcd_puts(lcd1);
      itoa (rps,lcd1);// Place your code here
      lcd_gotoxy(0,1);
      lcd_putsf("RPM = ");
      //lcd_gotoxy(5,1);
      lcd_puts(lcd2);
      itoa (rpm,lcd2);
  };
}
```

Program Penghitung RPM Menggunakan *Timer 1*

```
#include <mega8535.h>
#include <delay.h>
#include <stdlib.h>
#asm
   .equ __lcd_port=0x1B ;PORTA
#endasm
#include <lcd.h>

unsigned int itung;
unsigned int rps,rpm, sekarang, sebelum;
char lcd1[5];
char lcd2[5];

interrupt [TIM0_OVF] void timer0_ovf_isr(void)
{
  TCNT0=6;
  sekarang=TCNT1;
  if (++itung==500)
  {
    if(sekarang>sebelum)
    rps=sekarang-sebelum;
    else
    rps=0xffff-sekarang+sebelum;
    rpm=rps*60;
    itung=0;
  }
  //TCNT1=0;
}

void main (void)
{
  TCCR0=0x03;
  TCNT0=0x00;

  TCCR1A=0x00;
  TCCR1B=0x47;
  TCNT1H=0x00;
  TCNT1L=0x00;
  OCR1AH=0x00;
  OCR1AL=0x00;
  OCR1BH=0x00;
  OCR1BL=0x00;
  TIMSK=0x01;
  #asm("sei")
```

```
 lcd_init(16);

 while (1)
 {

    lcd_gotoxy(0,0);
    //lcd_putsf("ENDI");
    lcd_putsf("RPS = ");
    //lcd_gotoxy(9,0);
    lcd_puts(lcd1);
    itoa (rps,lcd1);// Place your code here
    lcd_gotoxy(0,1);
    lcd_putsf("RPM = ");
    //lcd_gotoxy(5,1);
    lcd_puts(lcd2);
    itoa (rpm,lcd2);
 };
}
```

Program Pembaca Sudut

```
#include <mega8535.h>
#include <delay.h>
#include <stdlib.h>
#asm
   .equ __lcd_port=0x1B ;PORTA
#endasm
#include <lcd.h>

unsigned int itung;
unsigned int rps,rpm, sekarang, sebelum,a,b, a_itung, b_itung;
char lcd1[5];
char lcd2[5];
/*
interrupt [TIM0_OVF] void timer0_ovf_isr(void)
{
  TCNT0=6;
  sekarang=TCNT1;
  if (++itung==500)
  {
    if(sekarang>sebelum)
    rps=sekarang-sebelum;
    else
    rps=0xffff-sekarang+sebelum;
    rpm=rps*60;
    sebelum=sekarang;
    itung=0;
  }
  //TCNT1=0;
}
 */
void main (void)
{
  // Timer/Counter 0 initialization
  // Clock source: T0 pin Rising Edge
  // Mode: Normal top=FFh
  // OC0 output: Disconnected
  TCCR0=0x07;
  TCNT0=0x00;
  OCR0=0x00;

  TCCR1A=0x00;
  TCCR1B=0x47;
  TCNT1H=0x00;
  TCNT1L=0x00;
  OCR1AH=0x00;
  OCR1AL=0x00;
  OCR1BH=0x00;
```

```
 OCR1BL=0x00;
 TIMSK=0x01;
 #asm("sei")

 lcd_init(16);

 while (1)
 {
    a=TCNT0;
    b=TCNT1;
    if(a==1 && b==0)
    {
     ++a_itung;
    }
    else if (a==0 && b==1)
    {
     ++b_itung;
    }
    if(a_itung>b_itung)
    {
     lcd_gotoxy(9,0);
     lcd_putsf("CW") ;
    }
    else if (b_itung>a_itung)
    {
     lcd_gotoxy(9,0);
     lcd_putsf("CCW") ;
    }

    // Place your code here
    lcd_gotoxy(0,0);
    lcd_putsf("A = ");
    //lcd_gotoxy(9,0);
    lcd_puts(lcd1);
    itoa (a_itung,lcd1);// Place your code here
    lcd_gotoxy(0,1);
    lcd_putsf("B = ");
    //lcd_gotoxy(5,1);
    lcd_puts(lcd2);
    itoa (b_itung,lcd2);
 };
}
```

Program Utama

```
#include <mega8535.h>
#include <stdlib.h>
#include <delay.h>

// Alphanumeric LCD Module functions
#asm
   .equ __lcd_port=0x1B ;PORTA
#endasm
#include <lcd.h>

#define motor_DC PORTC=0b00000001
#define motor_bakar PORTC=0b00000010
#define DC_bakar PORTC=0b00000011
#define breaking PORTC=0b00001000
#define bakar_off PORTC=0b00000100
#define LCD_RS PINA.0 //rs= a0, a1= rw, a2= e

#define off PORTC=0b00000000

// External Interrupt 0 service routine
//#include <External Interrupt 0 service routine.c>

// External Interrupt 1 service routine
//#include <External Interrupt 1 service routine.c>

// Timer 0 overflow interrupt service routine
//#include <Timer 0 overflow Interrupt service routine.c>

//inisialisasi
//#include <inisialisasi.c>

// Declare your global variables here
unsigned int input_kecepatan, input_kecepatan_sebelum, kecepatan;
unsigned int input_rpm, input_rpm_sebelum, rpm, frekuensi_kecepatan, itung;
unsigned int frekuensi_rpm;
unsigned int sens_miring_a, sens_miring_b;
char lcd1[5];
char lcd2[5];

interrupt [EXT_INT0] void ext_int0_isr(void)
{
    // Place your code here
   ++input_rpm;
}
```

```
interrupt [EXT_INT1] void ext_int1_isr(void)
{

   ++input_kecepatan;// Place your code here
}

interrupt [TIM0_OVF] void timer0_ovf_isr(void)
{
      // Place your code here

  TCNT0=6;
  if(++itung==250)
  {
    if(input_rpm>input_rpm_sebelum)
    {
      frekuensi_rpm=input_rpm-input_rpm_sebelum;
    }
    else if(input_rpm<input_rpm_sebelum)
    {
      frekuensi_rpm = 0xffff - input_rpm + input_rpm_sebelum;
    }

    if(input_kecepatan>input_kecepatan_sebelum)
    {
     frekuensi_kecepatan=input_kecepatan-input_kecepatan_sebelum;
    }
    else if(input_kecepatan>input_kecepatan_sebelum)
    {
     frekuensi_kecepatan=0xffff-input_kecepatan+input_kecepatan_sebelum;
    }
    itung=0;
    rpm = 11*frekuensi_rpm;
    kecepatan=3.5*frekuensi_kecepatan;
    input_kecepatan=input_kecepatan_sebelum;
    input_rpm=input_rpm_sebelum;

  }
}


void clear_display(void)
{
 LCD_RS=0;
 delay_ms(100);
 LCD_RS=1;
}

void main(void)
```

```
{
// Declare your local variables here
//inisialisasi;
// Port C initialization
// Func7=Out Func6=Out Func5=Out Func4=Out Func3=Out Func2=Out
Func1=Out Func0=Out
// State7=1 State6=1 State5=1 State4=1 State3=1 State2=1 State1=1 State0=1
PORTC=0x00;
DDRC=0xFF;
DDRB=0x00;

// Timer/Counter 0 initialization
// Clock source: System Clock
// Clock value: 62.500 kHz
// Mode: Normal top=FFh
// OC0 output: Disconnected
TCCR0=0x03;
TCNT0=0x00;
OCR0=0x00;

// Timer/Counter 1 initialization
// Clock source: System Clock
// Clock value: 4000.000 kHz
// Mode: Normal top=FFFFh
// OC1A output: Discon.
// OC1B output: Discon.
// Noise Canceler: Off
// Input Capture on Falling Edge
TCCR1A=0x00;
TCCR1B=0x00;
TCNT1H=0x00;
TCNT1L=0x00;
OCR1AH=0x00;
OCR1AL=0x00;
OCR1BH=0x00;
OCR1BL=0x00;

// Timer/Counter 2 initialization
// Clock source: System Clock
// Clock value: Timer 2 Stopped
// Mode: Normal top=FFh
// OC2 output: Disconnected
ASSR=0x00;
TCCR2=0x00;
TCNT2=0x00;
OCR2=0x00;

// External Interrupt(s) initialization
```

```
// INT0: On
// INT0 Mode: Rising Edge
// INT1: On
// INT1 Mode: Rising Edge
// INT2: Off
GICR|=0xC0;
MCUCR=0x0F;
MCUCSR=0x00;
GIFR=0xC0;

// Timer(s)/Counter(s) Interrupt(s) initialization
TIMSK=0x01;

// Analog Comparator initialization
// Analog Comparator: Off
// Analog Comparator Input Capture by Timer/Counter 1: Off
// Analog Comparator Output: Off
ACSR=0x80;
SFIOR=0x00;

// LCD module initialization
lcd_init(16);

// Global enable interrupts
#asm("sei")

while (1)
      {
      // Place your code here
      if (kecepatan==0)
      {
       if(rpm==0)
        {
         motor_DC;
         lcd_gotoxy(9,0);
         lcd_putsf("D/C");
        }
      }

      if(kecepatan<10)
      {
         motor_DC;
         lcd_gotoxy(9,0);
         lcd_putsf("D/C");
      }

      if(kecepatan>10)
      {
```

```
   if(rpm==0)
   {
   motor_bakar;
   delay_ms(5000);
   off;
   lcd_gotoxy(9,0);
   lcd_putsf("BKR");
   }
}
if(kecepatan>10)
{
  if(rpm<800)
  {
    off;
    lcd_gotoxy(9,0);
    lcd_putsf("BKR");
  }
}

if(kecepatan>10)
{
  if(rpm>800)
  {
   motor_DC;
   lcd_gotoxy(9,0);
   lcd_putsf("DUA");
  }
}
if(kecepatan>10)
{
  if(rpm<1500)
  {
  motor_DC;
  lcd_gotoxy(9,0);
  lcd_putsf("DUA");
  }
}
if(kecepatan>50)
{
  off;
  lcd_gotoxy(9,0);
  lcd_putsf("BKR");
}

if (PINB.1 == 0)
{
 PORTC=0x04;
 delay_ms(2000);
```

```
        delay_ms(50);
        PORTC=0x00;

       }
            lcd_gotoxy(0,0);
       //lcd_putsf("ENDI");
       lcd_putsf("KM/J=");
       //lcd_gotoxy(9,0);
       lcd_puts(lcd1);
       itoa(kecepatan,lcd1);// Place your code here
       clear_display();
       lcd_gotoxy(0,1);
       lcd_putsf("RPM=");
       //lcd_gotoxy(5,1);
       lcd_puts(lcd2);
       itoa(rpm,lcd2);
       clear_display();
       };
}
```

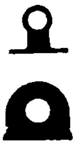
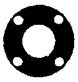
For New Technology Network

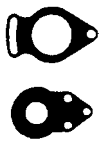
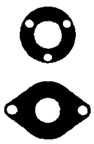
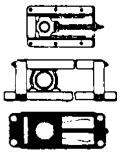
NTN corporation

Bearing Units

CAT. NO. 2400-Ⅵ/E

Dimension Table

HOUSING ▶ ▼ BEARING				Page		Page		Page		Page		Page		Page
Set screw type	 UC2	334	UCP2 UCPL2	46 62	UCHP2 UCUP2	66 70			UCF2	80	UCFC2	104	UCFL2	116
	 UC3	340	UCP3	52					UCF3 UCFS3	86 98			UCFL3	122
	 UCX	346	UCPX	58					UCFX	92	UCFCX	110	UCFLX	128
	 AS2	350	ASPL2	74			ASPP2 ASRPP2	76 78					ASFD2	138
Eccentric locking collar type	 UEL2	358	UELP2 UELPL2	174 184	UELHP2 UELUP2	188 190			UELFU2 UELF2	200 204	UELFC2	220	UELFLU2 UELFL2	224 228
	 UEL3	362	UELP3	178					UELF3 UELFS3	208 214			UELFL3	232
	 AEL2 JEL2	368 370	AELPL2 JELPL2	192 194			AELPP2 AELRPP2	196 198					AELFD2 JELFD2	238 239
Adapter type	 UK2	376	UKP2	266					UKF2	278	UKFC2	294	UKFL2	302
	 UK3	380	UKP3	270					UKF3 UKFS3	282 290			UKFL3	306
	 UKX	384	UKPX	274					UKFX	286	UKFCX	298	UKFLX	310
Other bearings					AR2	352	REL2	368	UCS2	384	UCS3	388	ASS2	394

	Page		Page		Page		Page		Page		Page
UCFA2 UCFH2	130 134			UCHB2	146	UCT2	150	UCC2	166	UCT2 UCL2 UCM2	328 330 331
						UCT3	156	UCC3	168	UCM3	332
						UCTX	162	UCCX	171		
		ASPF2 ASRPF2 ASPFL2	140 142 144							ASPT2	173
						UELT2	248	UELC2	258		
						UELT3	252	UELC3	260		
		AELPF2 AELRPF2 AELPFL2 JELPF2 JELPFL2	240 244 246 242 247							AELPT2 JELPT2	264 264
						UKT2	312	UKC2	324		
						UKT3	316	UKC3	325		
						UKTX	320	UKCX	327		
UELS2	396	UELS3	400	AELS2	406	JELS2	408	CS2	410	Farm implement bearings	412

Warranty

NTN warrants, to the original purchaser only, that the delivered product which is the subject of this sale (a) will conform to drawings and specifications mutually established in writing as applicable to the contract, and (b) be free from defects in material or fabrication. The duration of this warranty is one year from date of delivery. If the buyer discovers within this period a failure of the product to conform to drawings or specifications, or a defect in material or fabrication, it must promptly notify **NTN** in writing. In no event shall such notification be received by **NTN** later than 13 months from the date of delivery. Within a reasonable time after such notification, **NTN** will, at its option, (a) correct any failure of the product to conform to drawings, specifications or any defect in material or workmanship, with either replacement or repair of the product, or (b) refund, in part or in whole, the purchase price. Such replacement and repair, excluding charges for labor, is at **NTN**'s expense. All warranty service will be performed at service centers designated by **NTN**. These remedies are the purchaser's exclusive remedies for breach of warranty.

NTN does not warrant (a) any product, components or parts not manufactured by **NTN**, (b) defects caused by failure to provide a suitable installation environment for the product, (c) damage caused by use of the product for purposes other than those for which it was designed, (d) damage caused by disasters such as fire, flood, wind, and lightning, (e) damage caused by unauthorized attachments or modification, (f) damage during shipment, or (g) any other abuse or misuse by the purchaser.

THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

In no case shall **NTN** be liable for any special, incidental, or consequential damages based upon breach of warranty, breach of contract, negligence, strict tort, or any other legal theory,and in no case shall total liability of **NTN** exceed the purchase price of the part upon which such liability is based. Such damages include, but are not limited to, loss of profits, loss of savings or revenue, loss of use of the product or any associated equipment, cost of capital, cost of any substitute equipment, facilities or services, downtime, the claims of third parties including customers, and injury to property. Some states do not allow limits on warranties, or on remedies for breach in certain transactions. In such states, the limits in this paragraph and in paragraph (2) shall apply to the extent allowable under case law and statutes in such states.

Any action for breach of warranty or any other legal theory must be commenced within 15 months following delivery of the goods.

Unless modified in a writing signed by both parties, this agreement is understood to be the complete and exclusive agreement between the parties, superceding all prior agreements, oral or written, and all other communications between the parties relating to the subject matter of this agreement. No employee of **NTN** or any other party is authorized to make any warranty in addition to those made in this agreement.

This agreement allocates the risks of product failure between **NTN** and the purchaser. This allocation is recognized by both parties and is reflected in the price of the goods. The purchaser acknowledges that it has read this agreement, understands it, and is bound by its terms.

NTN

Bearing Units

TECHNICAL DATA INDEX

1. Construction

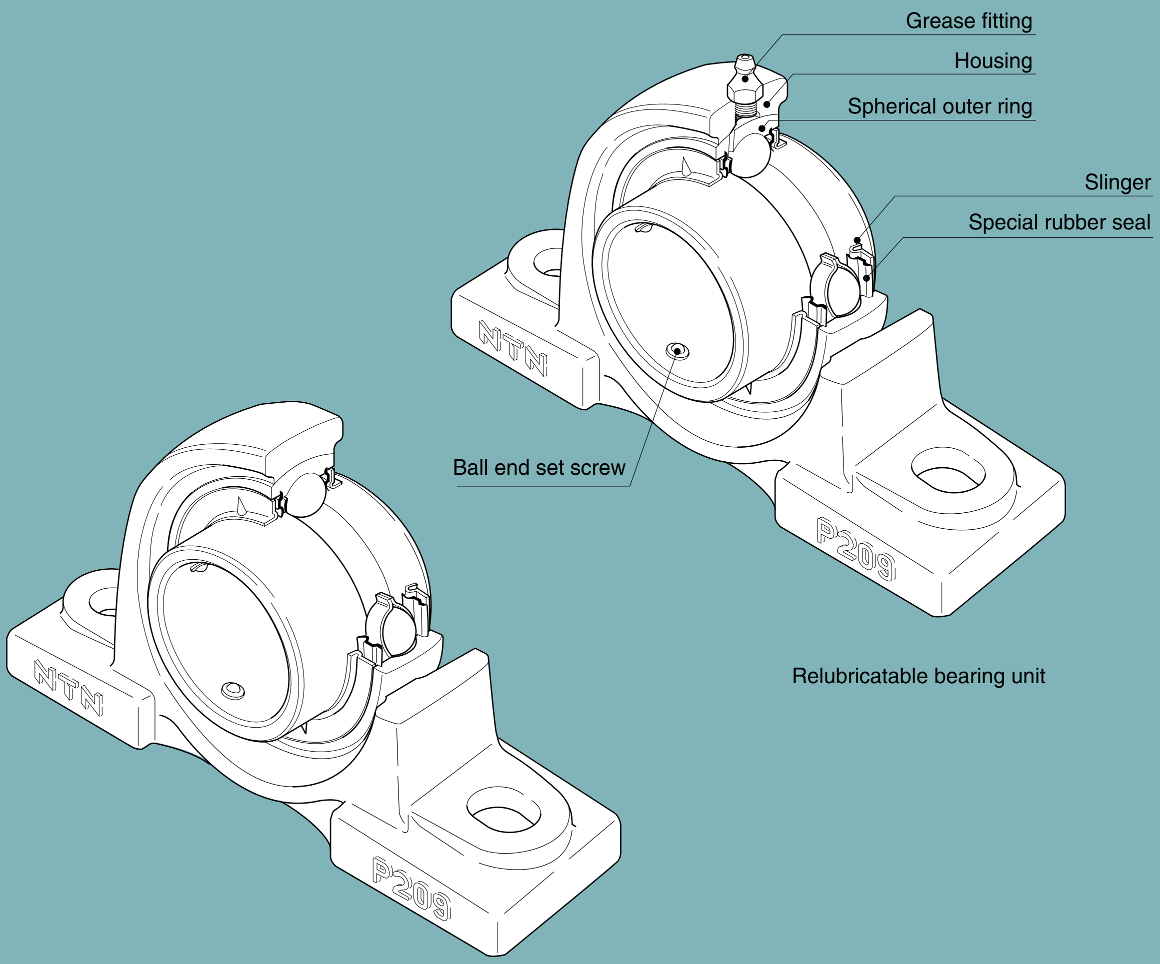
The **NTN** bearing unit is a combination of a radial ball bearing, seal, and a housing of high-grade cast iron or pressed steel, which comes in various shapes.

The outer surface of the bearing and the internal surface of the housing are spherical, so that the unit is self-aligning.

The inside construction of the ball bearing for the unit is such that steel balls and retainers of the same type as in series 62 and 63 of the **NTN** deep groove ball bearing are used. A duplex seal consisting of a combination of an oil-proof synthetic rubber seal and a slinger, unique to **NTN**, is provided on both sides.

Depending on the type, the following methods of fitting to the shaft are employed:

(1) The inner ring is fastened onto the shaft in two places by set screws.
(2) The inner ring has a tapered bore and is fitted to the shaft by means of an adapter.
(3) In the eccentric locking collar system the inner ring is fastened to the shaft by means of eccentric grooves provided at the side of the inner ring and on the collar.



Relubricatable bearing unit

Maintenance free bearing unit

2. Design Features and Advantages

2.1 Maintenance free type

The **NTN** Maintenance free bearing unit contains a high-grade lithium-based grease, good for use over a long period, which is ideally suited to sealed-type bearings. Also provided is an excellent sealing device, unique to **NTN**, which prevents any leakage of grease or penetration of dust and water from outside.

It is designed so that the rotation of the shaft causes the sealed-in grease to circulate through the inside space, effectively providing maximum lubrication. The lubrication effect is maintained over a long period with no need for replenishment of grease.

To summarize the advantages of the **NTN** maintenance free bearing unit:

(1) As an adequate amount of good quality grease is sealed in at the time of manufacture, there is no need for replenishment. This means savings in terms of time and maintenance costs.

(2) Since there is no need for any regreasing facilities, such as piping, a more compact design is possible.

(3) The sealed-in design eliminates the possibility of grease leakage, which could lead to stained products.

2.2 Relubricatable type

The **NTN** relubricatable type bearing unit has an advantage over other simillar units being so designed as to permit regreasing even in the case of misalignment of 2˚ to the right or left. The hole through which the grease fitting is mounted usually causes structural weakening of the housing.

However, as a result of extensive testing, in the **NTN** bearing unit the hole is positioned so as to minimize this adverse effect. In addition, the regreasing groove has been designed to minimize weakening of the housing.

While the **NTN** maintenance free type bearing unit is satisfactory for use under normal operating conditions in-doors, in the following circumstances it is necessary to use the relubricatable type bearing unit:

(1) Cases where the temperature of the bearing rises above 100˚C, 212˚F:
*- Normal temperature of up to 200˚C, 392˚F heatresistant bearing units.

(2) Cases where there is excessive dust, but space does not permit using a bearing unit with a cover.

(3) Cases where the bearing unit is constantly exposed to splashes of water or any other liquid, but space does not permit using a bearing unit with a cover.

(4) Cases in which the humidity is very high, and the machine in which the bearing unit is used is run only intermittently.

(5) Cases involving a heavy load of which the Cr/Pr value is about 10 or below, and the speed is 10 rpm or below, or the movement is oscillatory.

(6) Cases where the number of revolutions is relatively high and the noise problem has to be considered; for example, when the bearing is used with the fan of an air conditioner.

2.3 Special sealing feature

2.3.1 Standard bearing units

The sealing device of the ball bearing for the **NTN** bearing unit is a combination of a heat-resistant and oil-proof synthetic rubber seal and a slinger of an exclusive **NTN** design.

The seal, which is fixed in the outer ring, is steelreinforced, and its lip, in contact with the inner ring, is designed to minimize frictional torque.

The slinger is fixed to the inner ring of the bearing with which it rotates. There is a small clearance between its periphery and the outer ring.

There are triangular protrusions on the outside face of the slinger and, as the bearing rotates, these protrusions on the slinger create a flow of air outward from the bearing. In this way, the slinger acts as a fan which keeps dust and water away from the bearing.

These two types of seals on both sides of the bearing prevent grease leakage, and foreign matter is prevented from entering the bearing from outside.

2.3.2 Bearing units with covers

The **NTN** bearing unit with a cover consists of a standard bearing unit and an outside covering for extra protection against dust. Special consideration has been given to its design with respect to dust-proofing.

Sealing devices are provided in both the bearing and the housing, so that units of this type operate satisfactorily even in such adverse environments as flour mills, steel mills, foundries, galvanizing plants and chemical plants, where excessive dust is produced and/or liquids are used. They are also eminently suitable for outdoor environments where dust and rain are inevitable, and in heavy industrial machinery such as construction and transportation equipment.

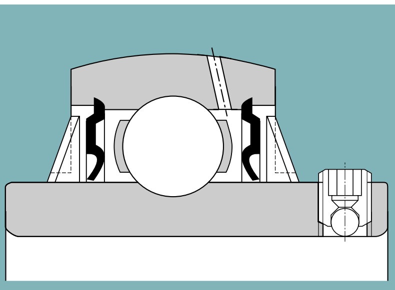


Fig. 2.1

The rubber seal of the cover contacts with the shaft by its two lips, as shown in Fig. 2.2 and 2.3. By filling the groove between the two lips with grease, an excellent sealing effect is obtained and, at the same time, the contacting portions of the lips are lubricated. Furthermore, the groove is so designed that when the shaft is inclined the rubber seal can move in the radial direction.

When bearing units are exposed to splashes of water rather than to dust, a drain hole (5 to 8 mm, 0.2 to 0.3 inches in diameter) is provided at the bottom of the cover, and grease should be applied to the side of the bearing itself instead of into the cover.

2.4 Secure fitting

Fastening the bearing to the shaft is effected by tightening the ball-end set screw, situated on the inner ring. This is a unique **NTN** feature which prevents loosening, even if the bearing is subjected to intense vibrations and shocks.

2.5 Self-aligning

With the **NTN** bearing unit, the outer surface of the ball bearing and the inner surface of the housing are spherical, thus this bearing unit has self-aligning characteristic. Any misalignment of axis that may arise from poor workmanship on the shaft or errors in fitting will be properly adjusted.

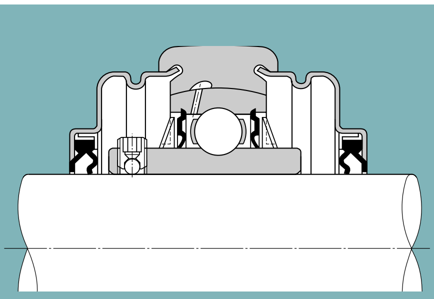


Fig. 2.2 Pressed steel cover

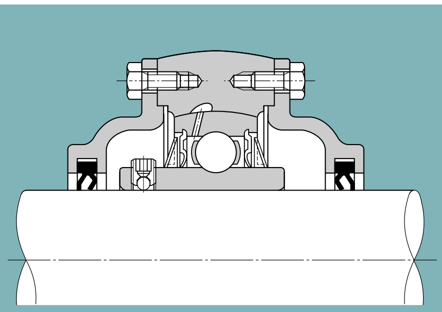


Fig. 2.3 Cast iron cover

2.6 Higher rated load capacity

The bearing used in the unit is of the same internal construction as those in **NTN** bearing series 62 and 63, and is capable of accommodating axial load as well as radial load, or composite load. The rated load capacity of this bearing is considerably higher than that of the corresponding self-aligning ball bearings used for standard plummer blocks.

2.7 Light weight yet strong housing

Housings for **NTN** bearing units come in various shapes. They consist of either high-grade cast iron, one-piece casting, or of precision finished pressed steel, the latter being lighter in weight. In either case, they are practically designed to combine lightness with maximum strength.

2.8 Easy mounting

The **NTN** bearing unit is an integrated unit consisting of a bearing and a housing.

As the bearing is prelubricated at manufacture with the correct amount of high-grade lithium base, it can be mounted on the shaft just as it is. It is sufficient to carry out a short test run after mounting.

2.9 Accurate fitting of the housing

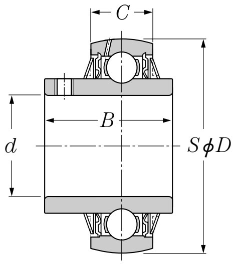
In order to simplify the fitting of the pillow block and flange type bearing units, the housings are provided with a seat for a dowel pin, which may be utilized as needed.

2.10 Bearing replaceability

The bearing used in the **NTN** bearing unit is replaceable. In the event of bearing failure, a new bearing can be fitted to the existing housing.

3. Tolerance

The tolerances of the **NTN** bearing units are in accordance with the following JIS specifications :



Set screw type

3.1 Tolerances of ball bearings for the unit

The tolerances of ball bearings used in the unit are shown in the following tables, 3.1 to 3.4.

Table 3.1 (1) Cylindrical bore (UC, UCS, AS, ASS, UEL, UELS, AEL, AELS)

Unit: μm/0.0001 inch

Nominal bore diameter d				Cylindrical bore					Radial runout K_{ia} (reference)
				Bore diameter			Width		
over		incl.		Δ_{dmp} Deviations		V_{dp} Variations	Δ_{Bs}, Δ_{Cs} Deviations (reference)		
mm	inch	mm	inch	high	low	max.	high	low	(max)
10	0.3937	18	0.7087	+15 + 6	0 0	10 4	0 0	−120 − 47	15 6
18	0.7087	31.750	1.2500	+18 + 7	0 0	12 5	0 0	−120 − 47	18 7
31.750	1.2500	50.800	2.0000	+21 + 8	0 0	14 6	0 0	−120 − 47	20 8
50.800	2.0000	80	3.1496	+24 + 9	0 0	16 6	0 0	−150 − 59	25 10
80	3.1496	120	4.7244	+28 +11	0 0	19 7	0 0	−200 − 79	30 12
120	4.7244	180	7.0866	+33 +13	0 0	22 9	0 0	−250 − 98	35 14

Note: Symbols

Δ_{dmp}: Mean bore diameter deviation V_{dp}: Bore diameter variation
Δ_{Bs}: Inner ring width deviation
Δ_{Cs}: Outer ring width deviation

Table 3.1 (2) Cylindrical bore (UR, AR, JEL, REL)

Unit: μm/0.0001 inch

Nominal bore diameter d				Cylindrical bore diameter		
over		incl.		Δ_{dmp} Deviations		V_{dp} Variations
mm	inch	mm	inch	high	low	max.
10	0.3937	18	0.7087	+13 + 5	0 0	6 2
18	0.7087	31.750	1.2500	+13 + 5	0 0	6 2
31.750	1.2500	50.800	2.0000	+13 + 5	0 0	6 2
50.800	2.0000	80	3.1496	+15 + 6	0 0	8 3

Table 3.1 (3) Cylindrical bore (CS)

Unit: μm/0.0001 inch

Nominal bore diameter d				Cylindrical bore					Radial runout K_{ia} (reference)
				Bore diameter			Width		
over		incl.		Δ_{dmp} Deviations		V_{dp} Variations	Δ_{Bs}, Δ_{Cs} Deviations (reference)		
mm	inch	mm	inch	high	low	max.	high	low	max.
10	0.3937	18	0.7087	0 0	− 8 − 3	10 4	0 0	−120 − 47	15 6
18	0.7087	31.75	1.2500	0 0	−10 − 4	12 5	0 0	−120 − 47	18 7
31.75	1.2500	50.8	2.0000	0 0	−12 − 5	14 6	0 0	−120 − 47	20 8

Table 3.2 Tapered bore (UK, UKS)

Unit: μm/0.0001 inch

Nominal bore diameter d				Δ_{dmp} Deviations		$\Delta_{d1mp} - \Delta_{dmp}$		V_{dp}[1]
over		incl.						
mm	inch	mm	inch	high	low	max.	min.	max.
18	0.7087	30	1.1811	+21 + 8	0 0	+21 + 8	0 0	13 5
30	1.1811	50	1.9685	+25 +10	0 0	+25 +10	0 0	15 6
50	1.9685	80	3.1496	+30 +12	0 0	+30 +12	0 0	19 7
80	3.1496	120	4.7244	+35 +14	0 0	+35 +14	0 0	25 10
120	4.7244	180	7.0866	+40 +16	0 0	+40 +16	0 0	31 12

[1] To be applied for all radial flat surfaces of tapered hole.

Note: 1. To be applied for tapered holes of 1/12.
2. Symbols of quantity or values

d_1: Basic diameter at the theoretical large end of the tapered hole

$$d_1 = d + \frac{1}{12}B$$

Δ_{dmp}: Dimensional difference of the average bore diameter within the flat surface at the theoretical small-end of the tapered hole

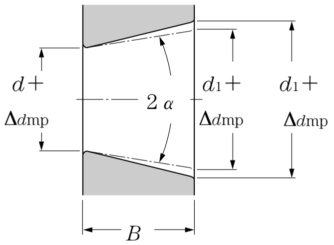
Δ_{d1mp}: Dimensional difference of the average bore diameter within the flat surface at the theoretical large-end of the tapered hole

V_{dp}: Inequality of the bore diameter within the flat surface

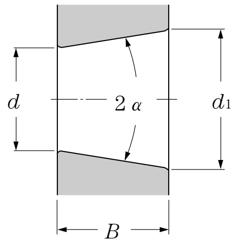
B : Nominal width of inner ring

α : Half of the nominal tapered angle of the tapered hole

α =2˚23'9.4"
=2.385 94˚
=0.041 643rad



Tapered hole having dimensional difference of the average bore diameter within the flat surface



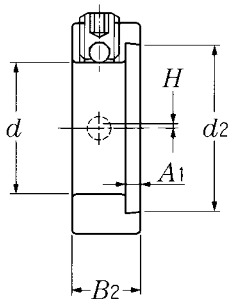
Theoretical tapered hole

Table 3.3 Outer ring

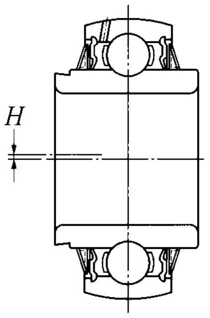
Unit: μm/0.0001 inch

Nominal outside diameter D				Mean outside diameter deviation Δ_{Dm}		Radial runout K_{ea} (reference)
over		incl.				
mm	inch	mm	inch	high	low	max.
18	0.7087	30	1.1811	0 0	−9 −4	15 6
30	1.1811	50	1.9685	0 0	−11 −4	20 8
50	1.9685	80	3.1496	0 0	−13 −5	25 10
80	3.1496	120	4.7244	0 0	−15 −6	35 14
120	4.7244	150	5.9055	0 0	−18 −7	40 16
150	5.9055	180	7.0866	0 0	−25 −10	45 18
180	7.0866	250	9.8425	0 0	−30 −12	50 20
250	9.8425	315	12.4016	0 0	−35 −14	60 24

Note: 1) The low deviation of outside diameter D_m does not apply within the distance of 1/4 the width of the outer ring from the side.



Eccentric locking collar



Eccentric locking collar type

Table 3.4 Eccentric locking collar

Unit: mm/inch

Nominal bore diameter d				Bore diameter deviation Δ_{ds}		Small bore diameter of eccentric surface deviation Δ_{d2s}		Eccentricity deviation Δ_{Hs}		Collar width deviation Δ_{B2s}		Collar eccentric surface width deviation Δ_{A1s}	
over		incl.											
mm	inch	mm	inch	high	low	high	low	high	low	high	low	high	low
10	0.3937	36.512	1.4375	+0.250 +0.010	+0.025 +0.001	+0.3 +0.012	0 0	+0.1 +0.004	−0.1 −0.004	+0.270 +0.011	−0.270 −0.011	0 0	−0.180 −0.007
36.512	1.4375	55.562	2.1875	+0.300 +0.012	+0.025 +0.001	+0.4 +0.016	0 0	+0.1 +0.004	−0.1 −0.004	+0.330 +0.013	−0.330 −0.013	0 0	−0.180 −0.007
55.562	2.1875	61.912	2.4375	+0.300 +0.012	+0.025 +0.001	+0.4 +0.016	0 0	+0.1 +0.004	−0.1 −0.004	+0.330 +0.013	−0.330 −0.013	0 0	−0.220 −0.009

3.2 Tolerances of housings

Table 3.5 Spherical bore diameter of housings

Unit: μm/0.0001 inch

Nominal spherical bore diameter D_a				D_a Deviations Δ_{Dam}			
over		incl.		Tolerance class H7		Tolerance class J7	
mm	inch	mm	inch	high	low	high	low
30	1.1811	50	1.9685	+25 +10	0 0	+14 + 6	−11 − 4
50	1.9685	80	3.1496	+30 +12	0 0	+18 + 7	−12 − 5
80	3.1496	120	4.7244	+35 +14	0 0	+22 + 9	−13 − 5
120	4.7244	180	7.0866	+40 +16	0 0	+26 +10	−14 − 6
180	7.0866	250	9.8425	+46 +18	0 0	+30 +12	−16 − 6
250	9.8425	315	12.4016	+52 +20	0 0	+36 +14	−16 − 6

Note: 1) Symbols

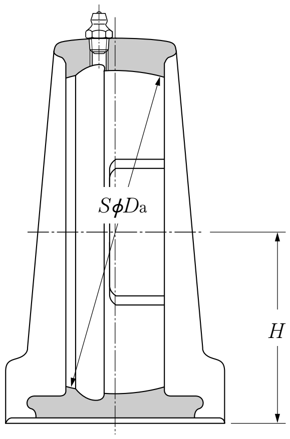
Δ_{Dam}: Mean spherical bore diameter deviation

2) Dimensional tolerances for spherical bore diameter of housing are classified as H7 for clearance fit, and J7 for intermediate fit.

Table 3.6 Pillow block housings (P, HP, UP, PL)

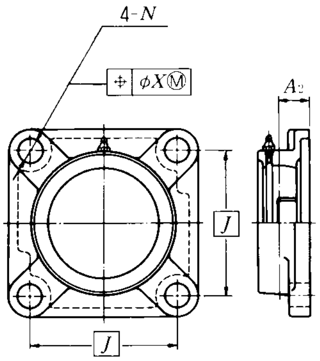
Unit: mm/inch

Housing numbers						H Deviations Δ_{Hs}
P203	—	—	—	—	—	±0.15 ±0.006
P204	—	—	HP204	UP204	PL204	
P205	P305	PX05	HP205	UP205	PL205	
P206	P306	PX06	HP206	UP206	PL206	
P207	P307	PX07	HP207	UP207	PL207	
P208	P308	PX08	HP208	UP208	—	
P209	P309	PX09	HP209	UP209	PL209	
P210	P310	PX10	HP210	UP210	PL210	
P211	P311	PX11	—	—	—	±0.2 ±0.008
P212	P312	PX12	—	—	—	
P213	P313	PX13	—	—	—	
P214	P314	PX14	—	—	—	
P215	P315	PX15	—	—	—	
P216	P316	PX16	—	—	—	
P217	P317	PX17	—	—	—	
P218	P318	PX18	—	—	—	±0.3 ±0.012
—	P319	—	—	—	—	
—	P320	PX20	—	—	—	
—	P321	—	—	—	—	
—	P322	—	—	—	—	
—	P324	—	—	—	—	
—	P326	—	—	—	—	
—	P328	—	—	—	—	

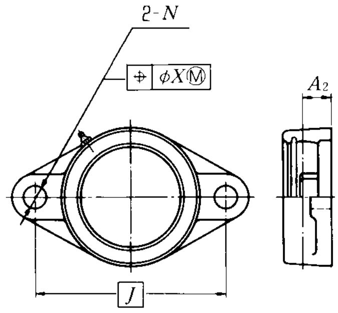


Note: 1) H is height of the shaft center line.

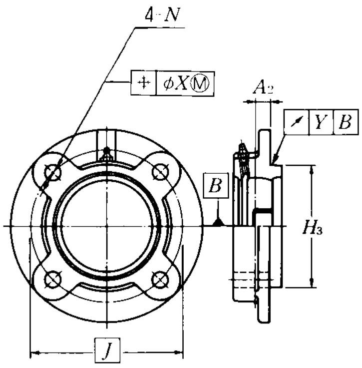
2) This table can be applied for bearing units with dust covers.



(F, FU, FS)



(FL, FLU, FD)



(FC)

Table 3.7 (1) Flange unit housings (F, FU, FC, FS, FL, FLU, FD)

Unit: mm/inch

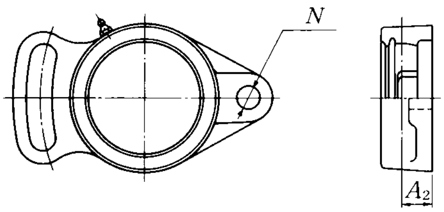
Housing numbers								location tolerance of bolt hole	A_2 Deviations Δ_{A2s}	H_3 Deviations						Radial runout of spigot joint Δ_{is} (max.)
										FC2		FS3		FCX		
										high	low	high	low	high	low	
—	—	—	—	—	—	—	FD201	0.7 0.028	±0.5 ±0.020	0 0	−0.046 −0.0018	—	—	—	—	0.2 0.008
F204	—	—	FC204	—	FL204	—	FD204									
F205	F305	FX05	FC205	FS305	FL205	FL305	FD205					0 0	−0.046 −0.0018	0 0	−0.046 −0.0018	
F206	F306	FX06	FC206	FS306	FL206	FL306	FD206					0 0	−0.054 −0.0021	0 0	−0.054 −0.0021	
F207	F307	FX07	FC207	FS307	FL207	FL307	FD207			0 0	−0.054 −0.0021					
F208	F308	FX08	FC208	FS308	FL208	FL308	—									
F209	F309	FX09	FC209	FS309	FL209	FL309	—					0 0	−0.063 −0.0025			
F210	F310	FX10	FC210	FS310	FL210	FL310	—									
F211	F311	FX11	FC211	FS311	FL211	FL311	—									
F212	F312	FX12	FC212	FS312	FL212	FL312	—	1 0.039	±0.8 ±0.032	0 0	−0.063 −0.0025			0 0	−0.063 −0.0025	0.3 0.012
F213	F313	FX13	FC213	FS313	FL213	FL313	—									
F214	F314	FX14	FC214	FS314	FL214	FL314	—					0 0	−0.072 −0.0028			
F215	F315	FX15	FC215	FS315	FL215	FL315	—									
F216	F316	FX16	FC216	FS316	FL216	FL316	—							0 0	−0.072 −0.0028	
F217	F317	FX17	FC217	FS317	FL217	FL317	—									
F218	F318	FX18	FC218	FS318	FL218	FL318	—			0 0	−0.072 −0.0028					
—	F319	—	—	FS319	—	FL319	—			—	—					0.4 0.016
—	F320	FX20	—	FS320	—	FL320	—					0 0	−0.081 −0.0032			
—	F321	—	—	FS321	—	FL321	—							—	—	
—	F322	—	—	FS322	—	FL322	—									
—	F324	—	—	FS324	—	FL324	—					0 0	−0.089 −0.0035			
—	F326	—	—	FS326	—	FL326	—									
—	F328	—	—	FS328	—	FL328	—									

Note: 1) J is the bolt hole's center line dimension, and P.C.D. A_2 is distance between the center line of spherical bore diameter of the housing and mounting surfaces, and H_3 is outside diameter of the spigot joint.
2) Radial runout of spigot joint is applied for flange units with spigot joints.
3) For FU2 and FLU2 types, tolerances for F2 shall be applied.
4) For FCX and FLX types, tolerances for FX shall be applied.
5) This table can be applied for bearing units with dust covers.

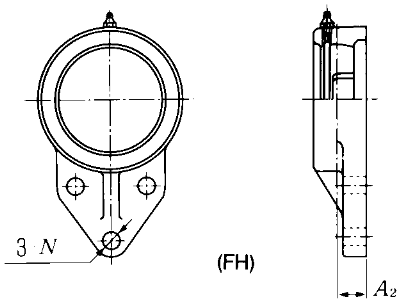
Table 3.7 (2) Flange unit housings (diameter of bolt hole)

Unit: mm/inch

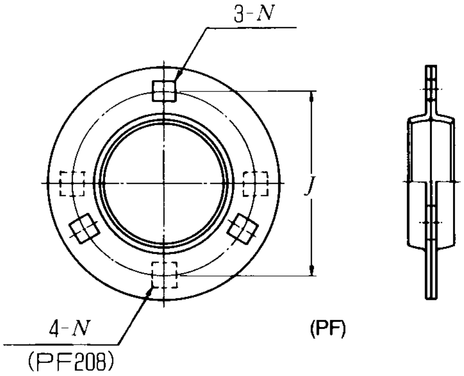
Housing type	Nominal bore diameter N				N Deviations Δ_{Ns}	
	over mm	over inch	incl. mm	incl. inch	mm	inch
F, FL, FC, FS, FA, FH, FU, FLU	–	–	30	1.1811	±0.2	±0.008
	30	1.1811	40	1.614	±0.3	±0.012



(FA)



(FH)



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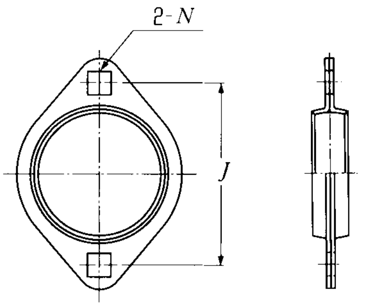
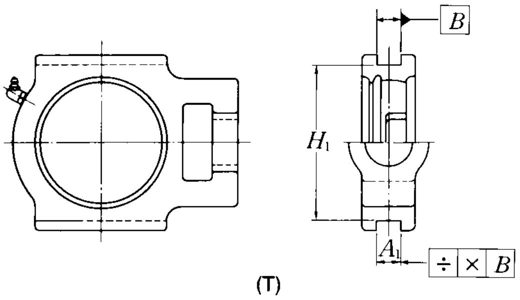


(PFL)



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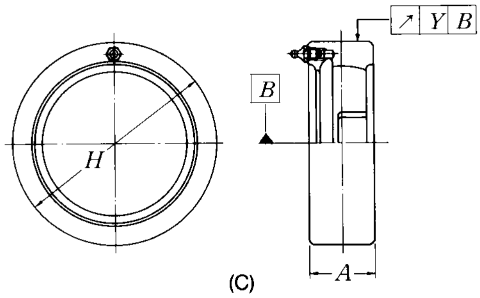


(C)

Table 3.8 Flange unit housings (FH, FA, PF, PFL) Unit: mm/inch

Housing numbers	A_2 Deviations Δ_{A2s}	Housing numbers	J Deviations Δ_{Js}	N Deviations Δ_{Ns}
—	±0.5 ±0.020	PF203	±0.4 ±0.016	±0.25 ±0.010
FA204		PF204		
FA205		PF205		
FA206		PF206		
FA207		PF207		
FA208		PF208		
FA209		PFL203		
FA210		PFL204		
FA211	±0.8 ±0.032	PFL205		
		PFL206		
		PFL207		

Note: 1) A_2 is distance between the center line of spherical bore diameter of housings.
2) J is the bolt hole's center line dimension.

Table 3.9 Take-up unit housings (T)

Unit: mm/inch

Housing numbers			A_1 Deviations Δ_{A1s}	H_1 Deviations Δ_{H1s}		Parallelism of guide
				high	low	
T204	—	—	+0.2 0 +0.008 0	0 0	–0.5 –0.020	0.5 0.020
T205	T305	TX05				
T206	T306	TX06				
T207	T307	TX07				
T208	T308	TX08				
T209	T309	TX09				
T210	T310	TX10	+0.3 0 +0.012 0	0 0	–0.8 –0.032	0.6 0.024
T211	T311	TX11				
T212	T312	TX12				
T213	T313	TX13				
T214	T314	TX14				
T215	T315	TX15				
T216	T316	TX16				
T217	T317	TX17				
—	T318	—				
—	T319	—				0.7 0.028
—	T320	—				
—	T321	—				
—	T322	—				
—	T324	—				0.8 0.032
—	T326	—				
—	T328	—				

Note: 1) A_1 is the width of guide rail grooves.
2) H_1 is the maximum span of guide rail grooves.
3) This table can be applied for bearing units with dust covers.

Table 3.10 Cartridge unit housings (C)

Unit: mm/inch

Housing numbers			H Deviations Δ_{Hs}						Radial runout of outside surface	A Devia-tions Δ_{As}
			C2		C3		CX			
			high	low	high	low	high	low		
C204	—	—	0 0	–0.030 –0.0012	—	—	—	—	0.2 0.008	±0.2 ±0.008
C205	C305	CX05			0 0	–0.035 –0.0014	0 0	–0.035 –0.0014		
C206	C306	CX06	0 0	–0.035 –0.0014						
C207	C307	CX07								
C208	C308	CX08								
C209	C309	CX09			0 0	–0.040 –0.0016	0 0	–0.040 –0.0016		
C210	C310	CX10								
C211	C311	CX11	0 0	–0.040 –0.0016					0.3 0.012	±0.3 ±0.012
C212	C312	CX12								
C213	C313	—					—	—		
—	C314	—	—	—						
—	C315	—			0 0	–0.046 –0.0018				
—	C316	—								
—	C317	—								
—	C318	—								
—	C319	—							0.4 0.016	
—	C320	—			0 0	–0.052 –0.0020				
—	C321	—								
—	C322	—								
—	C324	—			0 0	–0.057 –0.0022				
—	C326	—								
—	C328	—								

Note: 1) H is the outside diameter of cartridge housings.
2) A is width of cartridge housings.

4. Basic Load Rating and Life

4.1 Bearing life

Even in bearings operating under normal conditions, the surfaces of the raceway and rolling elements are constantly being subjected to repeated compressive stresses which cause flaking of these surfaces to occur. This flaking is due to material fatigue and will eventually cause the bearings to fail. The effective life of a bearing is usually defined in terms of the total number of revolutions a bearing can undergo before flaking of either the raceway surface or the rolling element surfaces occurs.

Other causes of bearing failure are often attributed to problems such as seizing, abrasions, cracking, chipping, gnawing, rust, etc. However, these so called "causes" of bearing failure are usually themselves caused by improper installation, insufficient or improper lubrication, faulty sealing or inaccurate bearing selection. Since the above mentioned "causes" of bearing failure can be avoided by taking the proper precautions, and are not simply caused by material fatigue, they are considered separately from the flaking aspect.

4.2 Basic rated life and basic dynamic load rating

A group of seemingly identical bearings when subjected to identical load and operating conditions will exhibit a wide diversity in their durability.

This "life" disparity can be accounted for by the difference in the fatigue of the bearing material itself. This disparity is considered statistically when calculating bearing life, and the basic rated life is defined as follows.

The basic rated life is based on a 90% statistical model which is expressed as the total number of revolutions 90% of the bearings, in an identical group of bearings subjected to identical operating conditions, will attain or surpass before flaking due to material fatigue occurs. For bearings operating at fixed constant speeds, the basic rated life (90% reliability) is expressed in the total number of hours of operation.

The basic dynamic load rating is an expression of the load capacity of a bearing based on a constant load which the bearing can sustain for one million revolutions (the basic life rating). For radial bearings this rating applies to pure radial loads, and for thrust bearings it refers to pure axial loads. The basic dynamic load ratings given in the bearing tables of this catalog are for bearings constructed of **NTN** standard bearing materials, using standard manufacturing techniques. Please consult **NTN** for basic load ratings of bearings constructed of special materials or using special manufacturing techniques.

The relationship between the basic rated life, the basic dynamic load rating and the bearing load is given in formula (4.1).

$$L_{10} = \left(\frac{C_r}{P_r}\right)^3 \quad \cdots\cdots\cdots\cdots \quad (4.1)$$

where,

L_{10} : Basic rated life 10^6 revolutions
C_r : Basic dynamic rated load, N, lbf
P_r : Equivalent dynamic load, N, lbf

The basic rated life can also be expressed in terms of hours of operation (revolution), and is calculated as shown in formula (4.2).

$$L_{10h} = 500 f_h^3 \quad \cdots\cdots\cdots\cdots \quad (4.2)$$

$$f_h = f_n \frac{C_r}{P_r} \quad \cdots\cdots\cdots\cdots \quad (4.3)$$

$$f_n = \left(\frac{33.3}{n}\right)^{1/3} \quad \cdots\cdots\cdots\cdots \quad (4.4)$$

where,

L_{10h} : Basic rated life, h
f_h : Life factor
f_n : Speed factor
n : Rotational speed, r/min

Formula (4.2) can also be expressed as shown in formula (4.5).

$$L_{10h} = \frac{10^6}{60n}\left(\frac{C_r}{P_r}\right)^3 \quad \cdots\cdots\cdots\cdots \quad (4.5)$$

The relation between rotational speed n and speed factor f_n as well as the relation between the basic rated life L_{10h} and the life factor f_h is shown in Fig. 4.1.

When several bearings are incorporated in machines or equipment as complete units, all the bearings in the unit are considered as a whole when computing bearing life (see formula 4.6). The total bearing life of the unit is a life rating based on the viable lifetime of the unit before even one of the bearings fails due to rolling contact fatigue.

$$L = \frac{1}{\left(\frac{1}{L_1^{1.1}} + \frac{1}{L_2^{1.1}} + \cdots\cdots + \frac{1}{L_n^{1.1}}\right)^{1/1.1}} \quad \cdots\cdots \quad (4.6)$$

where,
L : Total life of the whole bearing assembly h
L_1, $L_2 \cdots L_n$: Rated life of bearings 1, 2, $\cdots n$, h

In the case where load and the number of revolutions change at regulated intervals, after finding the rated life L_1,L_2, $\cdots$, L_n under conditions of n_1 , p_1 : n_2 , p_2 : n_n , p_n; the built-in life L_m can be given by the formula (4.7).

$$L_1 = \frac{10^6}{60 n_1}\left(\frac{C_r}{P_1}\right)^3$$

$$L_2 = \frac{10^6}{60 n_2}\left(\frac{C_r}{P_2}\right)^3$$

$$\vdots$$

$$L_n = \frac{10^6}{60 n_n}\left(\frac{C_r}{P_n}\right)^3$$

$$L_m = \left(\frac{\phi_1}{L_1} + \frac{\phi_2}{L_2} + \cdots\cdots \frac{\phi_n}{L_n}\right)^{-1} \cdots\cdots\cdots\cdots\cdots \quad (4.7)$$

where,
L_1,L_2,$\cdots$,L_n: Rated life under condition 1, 2, $\cdots n$, h
n_1,n_2,$\cdots$,n_n: Number of revolutions under condition 1, 2, $\cdots n$, r/min
P_1,P_2,$\cdots$,P_n: Equivalent load under condition 1, 2, $\cdots n$,N, lbf
ϕ_1, ϕ_2,$\cdots$, ϕ_n: Ratio of condition 1, 2, $\cdots n$, accounting for the total operating time
L_m : Built-in life, h

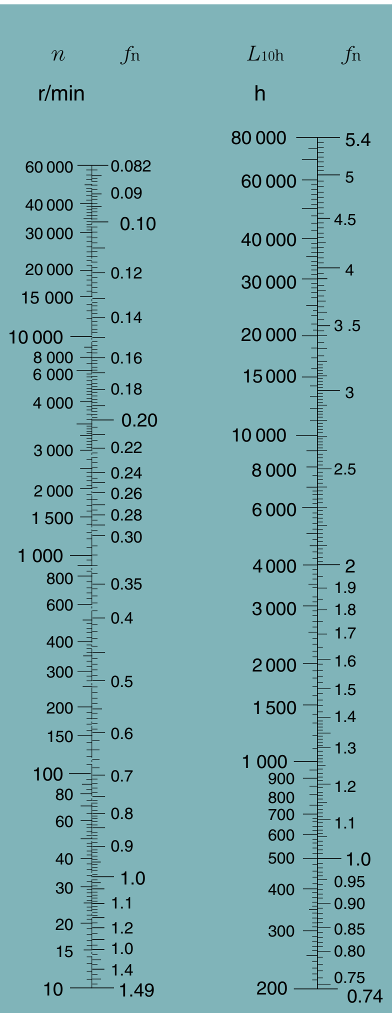


Fig. 4.1 Bearing life rating scale

Table 4.1 Rating life for applications

Service classification	Machine application	Life time L_n
Machines used occasionally	Door mechanisms, Garage shutter	500
Equipment for short period or intermittent serviceinterruption permissible	Household appliances, Electric hand tools, Agricultural machines, Lifting tackles in shops	4 000～ 8 000
Intermittent service machines-high reliability	Power-Station auxiliary equipment, Elevators, Conveyors, Deck cranes	8 000～ 14 000
Machines used for 8 hours a day, but not always in full operation	Ore wagon axles, Important gear units	14 000～ 20 000
Machines fully used for 8 hours	Blowers, General machinery in shops, Continuous operation cranes	20 000～ 30 000
Machines continuously used for 24 hours a day	Compressors, Pumps	50 000～ 60 000
Machines continuously used for 24 hours a day with maximum reliability	Power-station equipment, Water-supply equipment for urban areas, Mine ventilators	100 000～200 000

4.3 Machine applications and requisite life

When selecting a bearing, it is essential that the requisite life of the bearing be established in relation to the operating conditions. The requisite life of the bearing is usually determined by the type of machine the bearing is to be used in, and duration of service and operational reliability requirements. A general guide to these requisite life criteria is shown in Table 4.1. When determining bearing size, the fatigue life of the bearing is an important factor; however, besides bearing life, the strength and rigidity of the shaft and housing must also be taken into consideration.

4.4 Adjusted life rating factor

The basic bearing life rating (90% reliability factor) can be calculated through the formulas mentioned earlier in Section 4.2. However, in some applications a bearing life factor of over 90% reliability may be required. To meet these requirements, bearing life can be lengthened by the use of specially improved bearing materials or special construction techniques. Moreover, according to elastohydrodynamic lubrication theory, it is clear that the bearing operating conditions (lubrication, temperature, speed, etc.) all exert an effect on bearing life. All these adjustment factors are taken into consideration when calculating bearing life, and using the life adjustment factor as prescribed in ISO 281, the adjusted bearing life can be arrived at.

$$L_{na} = a_1 \, a_2 \, a_3 \left(\frac{C}{P}\right)^3 \quad \text{-----------------------------------} \quad (4.8)$$

where,

L_{na} : Adjusted life rating in millions of revolutions (10^6) (adjusted for reliability, material and operating conditions)

a_1 : Reliability adjustment factor

a_2 : Material adjustment factor

a_3 : Operating condition adjustment factor

4.4.1 Life adjustment factor for reliability a_1

The values for the reliability adjustment factor a_1 (for a reliability factor higher than 90%) can be found in Table 4.2.

4.4.2 Life adjustment factor for material a_2

The life of a bearing is affected by the material type and quality as well as the manufacturing process. In this regard, the life is adjusted by the use of an a_2 factor.

The basic dynamic load ratings listed in the catalog are based on **NTN**'s standard material and process, therefore, the adjustment factor $a_2 = 1$. When special materials or processes are used the adjustment factor a_2 can be larger than 1.

NTN bearings can generally be used up to 120˚C. If bearings are operated at a higher temperature, the bearing must be specially heat treated (stabilized) so that inadmissible dimensional change does not occur due to micro-structure change. This special heat treatment might cause the reduction of bearing life because of a hardness change.

Table 4.2 Reliability adjustment factor values a_1

Reliability %	L_n	Reliability factor a_1
90	L_{10}	1.00
95	L_5	0.62
96	L_4	0.53
97	L_3	0.44
98	L_2	0.33
99	L_1	0.21

4.4.3 Life adjustment factor a_3 for operating conditions

The operating conditions life adjustment factor a_3 is used to adjust for such conditions as lubrication, operating temperature, and other operation factors which have an effect on bearing life.

Generally speaking, when lubricating conditions are satisfactory, the a_3 factor has a value of one; and when lubricating conditions are exceptionally favorable, and all other operating conditions are normal, a_3 can have a value greater than one.

However, when lubricating conditions are particularly unfavorable and the oil film formation on the contact surfaces of the raceway and rolling elements is insufficient, the value of a_3 becomes less than one. This insufficient oil film formation can be caused, for example, by the lubricating oil viscosity being too low for the operating temperature (below 13 mm^2/s for ball bearings) ; or by exceptionally low rotational speed (n r/min X d_p mm less than 10000). For bearings used under special operating conditions, please consult **NTN**.

As the operating temperature of the bearing increases, the hardness of the bearing material decreases. Thus, the bearing life correspondingly decreases. The operating temperature adjustment values are shown in Fig. 4.2.

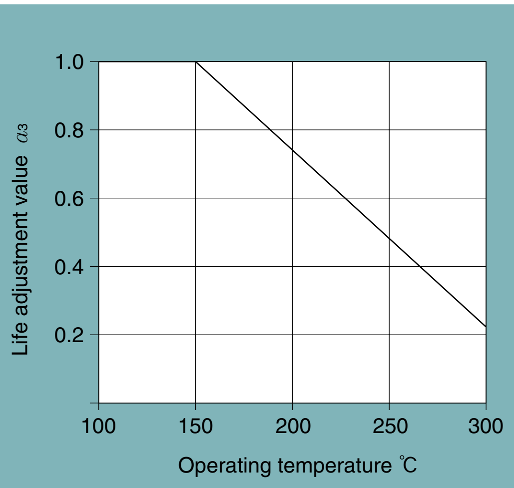


Fig. 4.2 Life adjustment value for operating temperature

4.5 Basic static load rating

When stationary rolling bearings are subjected to static loads, they suffer from partial permanent deformation of the contact surfaces at the contact point between the rolling elements and the raceway. The amount of deformity increases as the load increases, and if this increase in load exceeds certain limits, the subsequent smooth operation of the bearing is impaired.

It has been found through experience that a permanent deformity of 0.0001 times the diameter of the rolling element, occurring at the most heavily stressed contact point between the raceway and the rolling elements, can be tolerated without any impairment in running efficiency.

The basic rated static load refers to a fixed static load limit at which a specified amount of permanent deformation occurs. It applies to pure radial loads for radial bearings. The maximum applied load values for contact stress occurring at the rolling element and raceway contact points are given below.

For ball bearings (for bearing unit) : 4200 Mpa.

4.6 Allowable static equivalent load

Generally the static equivalent load which can be permitted (see section 5.3) is limited by the basic static rated load as stated in Section 4.5. However, depending on requirements regarding friction and smooth operation, these limits may be greater or lesser than the basic static rated load.

In the following formula (4.9) and Table 4.4 the safety factor S_0 can be determined considering the maximum static equivalent load.

$$S_0=\frac{C_0}{P_{0\max}} \cdots\cdots\cdots\cdots\cdots \quad (4.9)$$

where,

S_0: Safety factor
C_0: Basic static rated load, N, lbf
$P_{0\max}$: Maximum static equivalent load, N, lbf

Table 4.4 Minimum safety factor values S_0

Operating conditions	Ball bearings
High rotational accuracy demand	2
Normal rotating accuracy demand (Universal application)	1
Slight rotational accuracy deterioration permitted (Low speed, heavy loading, etc.)	0.5

Note :1) When vibration and/or shock loads are present, a load factor based on the shock load needs to be included in the $P_{0\max}$ value.

5. Loads

5.1 Load acting on the bearing

It is very rare that the load on a bearing can be obtained by a simple calculation. Loads applied to the bearing generally include the weight of the rotating element itself, the load produced by the working of the machine, and the load resulting from transmission of power by the belt and gearwheel. Such loads include the radial load, which works on the bearing at right angles to its axis, and the thrust load, which works on the bearing parallel to its axis. These can work either singly or in combination. In addition, the operation of a machine inevitably produces a varying degree of vibrations and shocks. To take this into account, the theoretical value of a load is multiplied by a safety factor that has been derived from past experience. This is known as the "load factor".

$$\text{Load acting on the bearing} = \text{Load factor } f_w \times \text{Calculated load}$$

Table 5.1 below shows the generally accepted load factors f_w which correspond to the degree of shock to which the machine is subjected.

5.1.1 Load applied to the bearing by power transmission

The force working on the shaft when power is transmitted by belts, chains or gearwheels is obtained, in general, by the following formula:

$$T = 9\,550\,\frac{H}{n}\,,\ 84\,500\,\frac{H}{n} \quad \cdots\cdots\cdots \quad (5.1)$$

$$K_t = \frac{T}{r} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (5.2)$$

where,

T : Torque, N·m, lbf·inch.
H : Transmission power, kW
n : Number of revolutions, r/min
K_t : Transmission force (effective transmission force of belt or chain; tangential force of gearwheel), N, lbf
r: effective radius of belt pulley, sprocket wheel or gearwheel, m, inch

Accordingly, the load actually applied to the shaft by the transmission force can be obtained by the following formula:

$$\text{Actual load} = \text{Factor} \times K_t \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (5.3)$$

Different factors are adopted according to the transmission system in use. These will be dealt with in the following paragraphs.

Belt transmission

When power is transmitted by belt, the effective transmission force working on the belt pulley is calculated by formula (5.2). The term "effective transmission force of the belt" refers to the difference in tension between the tensioned side and the loose side of the belt. Therefore, to obtain the load actually acting on the shaft through the medium of the belt pulley, it is necessary to multiply the effective transmission force by a factor which takes into account the type of belt and the initial tension. This is known as the "belt factor".

Table 5.1 Load factors f_w

Load conditions	f_w	Examples
Little or no shock	1 to 1.2	Machines tools, electric machines, etc.
Some degree of shock; machines with reciprocating parts	1.2 to 1.5	Vehicles, driving mechanism, metal-working machinery, steel-making machines, paper-making machinery, rubber mixing machines, hydraulic equipment, hoists, transportation machinery, power-transmission equipment, woodworking machines, printing machines, etc.
violent shocks	1.5 to 3	Agricultural machines, vibrator screens, ball and tube mills, etc.

In the case of power transmission by belts, gear wheels, etc., load factors adopted are somewhat different from the above.
Factors used for power transmission by belts, gearwheels and chains, respectively, are given in the following sections.

Table 5.2 Belt factors f_b

Belt type	f_b
V-belt	1.5 to 2.0
Timing belt	1.1 to 1.3
Flat belt (with tension pulley)	2.5 to 3.0
Flat belt	3.0 to 4.0

Note :In cases where the distance between shafts is short, the revolution speed is low, or where operating conditions are severe, the higher f_b values should be adopted.

Gear transmission

In the case of gear transmissions, the theoretical gear load can be calculated from the transmission force and the type of gear. With spur gears, only a radial load is involved; whereas, with helical gears and bevel gears, an additional axial load is present.

The simplest case is that of spur gears. In this instance, the tangential force K_t is obtained from the formula (5.2) and the radial force K_s can be obtained from the following formula:

$$K_s = K_t \cdot \tan \alpha \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (5.4)$$

where,

α : is the pressure angle of the gear.

Accordingly, the theoretical composite force, K_r, working on the gear is obtained from the following formula:

$$K_r = \sqrt{K_t^2 + K_s^2} = K_t \cdot \sec \alpha \quad \cdots\cdots\cdots\cdots \quad (5.5)$$

Therefore, to obtain the radial load actually working on the shaft, the theoretical composite force, as above, is multiplied by a factor in which the accuracy and the degree of precision of the gear is taken into account. This is called the "gear factor" and is represented by the symbol f_z. In Table 5.3 is below, f_z values for spur wheels are given.

The gear factor is essentially almost the same as the previously described load factor, f_w. In some cases, however, vibrations and shocks are produced also by the machine of which the gear is a part. Here it is necessary to calculate the actual load working on the gear by further multiplying the gear load, as obtained above, by the load factor shown in Table 5.1, according to the degree of shock.

Table 5.3 Gear factors f_z

Gear	f_z
Precision gears (tolerance 0.02 mm 0.0008 inch max., for both pitch and shape)	1.05 to 1.1
Gears finished by ordinary machining work (tolerance 0.02 to 0.1 mm, 0.0008 to 0.0039 inch for both pitch and shape)	1.1 to 1.3

Chain transmission

When power is transmitted by chain, the effective transmission force working on the sprocket wheel is calculated by formula (5.2). To obtain the load actually working, the effective transmission force must be multiplied by the "chain factor", 1.2 to 1.5.

5.1.2 Distribution of the radial load

The load acting on the shaft is distributed to the bearings which support the shaft.

In Fig. 5.1, the load is applied to the shaft between two bearings; in Fig. 5.2 the load is applied to the shaft outside the two bearings. In practice, however, most cases are combinations of Fig. 5.1 and 5.2, and the load is usually a composite load, that is to say, a combination of radial and axial loads. Therefore they are calculated by the methods described in the following sections.

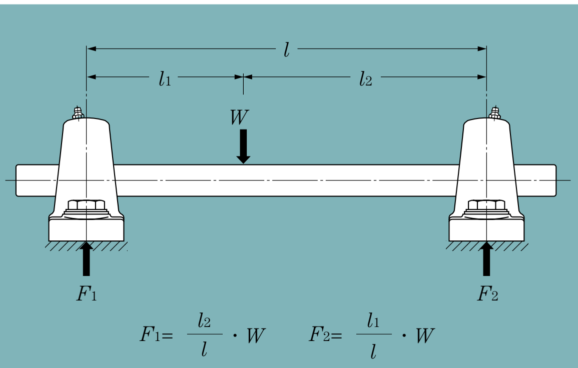


Fig. 5.1

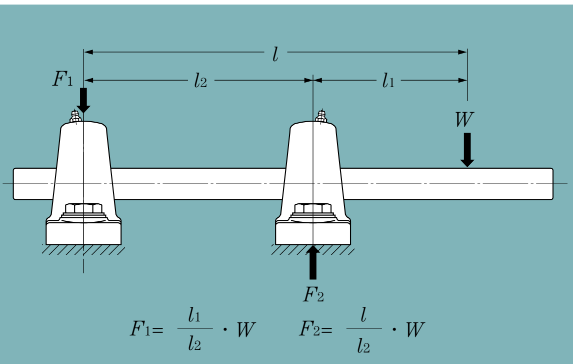


Fig. 5.2

5.2 Equivalent dynamic radial load

For ball bearings used in the **NTN** unit, the basic rated dynamic loads C_r mentioned in the table of dimensions are applicable only when the load is purely radial. In practice, however, bearings are usually subjected to a composite load. As the table of dimensions is not directly applicable here, it is necessary to convert the values of the radial and axial loads into a single radial load value that would have an effect on the life of bearing equivalent to that of the actual load applied. This is known as the "equivalent dynamic radial load", and from this the life of the ball bearings for the unit is the calculated. The equivalent dynamic radial load is calculated by the following formula:

$$P_r = X \cdot F_r + Y \cdot F_a \quad \cdots\cdots \quad (5.6)$$

where,
P_r : equivalent dynamic radial load, N, lbf
F_r : radial load, N, lbf
F_a : axial load, N, lbf
X : radial factor
Y : axial factor

Values of X and Y are shown in Table 5.4 below.

With ball bearings for the unit, when only radial load is involved, or when $F_a/F_r \leqq e$ (e is a value which is determined by the size of an individual bearing and the load acting thereon), the values of X and Y will be 1 and 0 respectively, resulting in the following equation:

$$P_r = F_r \quad \cdots\cdots \quad (5.7)$$

Table 5.4 Values of X and Y applying when $\frac{F_a}{F_r} > e$

$\frac{F_a}{C_{or}}$	e	$\frac{F_a}{F_r} > e$	
		X	Y
0.010	0.18	0.56	2.46
0.020	0.20		2.14
0.040	0.24		1.83
0.070	0.27		1.61
0.10	0.29		1.48
0.15	0.32		1.35
0.20	0.35		1.25
0.30	0.38		1.13
0.40	0.41		1.05
0.50	0.44		1.00

Note: C_{or} is the basic rated static load. (See the table of dimensions.)
When the value of $\frac{F_a}{C_{or}}$ or $\frac{F_a}{F_r}$ is not in conformity with those given in Table 5.4 above, find the value by interpolation.

5.3 Equivalent static radial load

In the case of a bearing which is stationary, rotates at a low speed of about 10 rpm, or makes slight oscillating movements, it is necessary to take into account the equivalent static radial load, which is the counterpart of the equivalent dynamic radial load of a rotating bearing. In this case, the following formula is used.

$$P_{or} = X_o \cdot F_r + Y_o \cdot F_a \quad \cdots\cdots \quad (5.8)$$

where,
P_{or}: equivalent static radial load, N, lbf
F_r : radial load, N, lbf
F_a : axial load, N, lbf
X_o : static radial factor
Y_o : static axial factor

With the ball bearings for the **NTN** unit, the values of X_o and Y_o are $X_o = 0.6$ $Y_o = 0.5$.

However when only radial load is involved, or when $F_a/F_r \leqq e$, the following values in used:

$$X_o = 1 \qquad Y_o = 0$$

Accordingly, the following equation holds.

$$P_{or} = F_r \quad \cdots\cdots \quad (5.9)$$

6. Bearing Internal Clearance

6.1 Bearing internal clearance

Bearing internal clearance (initial clearance) is the amount of internal clearance a bearing has before being installed on a shaft or in a housing.

As shown in Fig. 6.1, when either the inner ring or the outer ring is fixed and the other ring is free to move, displacement can take place in either an axial or radial direction. This amount of displacement (radially or axially) is termed the internal clearance and, depending on the direction, is called the radial internal clearance or the axial internal clearance.

When the internal clearance of a bearing is measured, a slight measurement load is applied to the raceway so the internal clearance may be measured accurately. However, at this time, a slight amount of elastic deformation of the bearing occurs under the measurement load, and the clearance measurement value (measured clearance) is slightly larger than the true clearance. This discrepancy between the true bearing clearance and the increased amount due to the elastic deformation must be compensated for. These compensation values are given in Table 6.1.

The internal clearance values for each bearing class are shown in Tables 6.3.

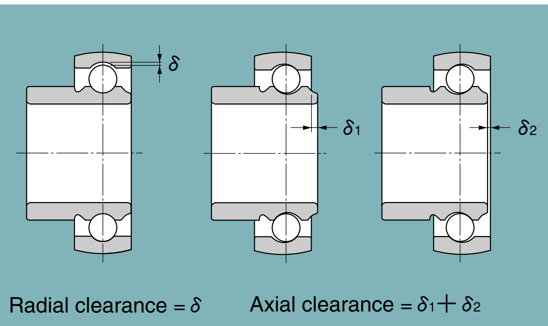


Fig.6.1 Internal clearance

Table 6.1 Adjustment of radial internal clearance based on measured load

Unit : μm

Nominal bore diameter d (mm)		Measuring load (N)	Radial clearance increase				
over	incl.		C2	CN	C3	C4	C5
10	18	24.5	3~4	4	4	4	4
18	50	49	4~5	5	6	6	6
50	200	147	6~8	8	9	9	9

6.2 Internal clearance selection

The internal clearance of a bearing under operating conditions (effective clearance) is usually smaller than the same bearing's initial clearance before being installed and operated. This is due to several factors including bearing fit, the difference in temperature between the inner and outer rings, etc. As a bearing's operating clearance has an effect on bearing life, heat generation, vibration, noise, etc.; care must be taken in selecting the most suitable operating clearance.

Effective internal clearance:

The internal clearance differential between the initial clearance and the operating (effective) clearance (the amount of clearance reduction caused by interference fits, or clearance variation due to the temperature difference between the inner and outer rings) can be calculated by the following formula:

$$\delta_{eff} = \delta_o - (\delta_f + \delta_t) \quad \cdots\cdots (6.1)$$

where,

δ_{eff}: Effective internal clearance, mm

δ_o: Bearing internal clearance, mm

δ_f: Reduced amount of clearance due to interference, mm

δ_t: Reduced amount of clearance due to temperature differential of inner and outer rings, mm

Reduced clearance due to interference:

When bearings are installed with interference fits on shafts and in housings, the inner ring will expand and the outer ring will contract; thus reducing the bearings' internal clearance. The amount of expansion or contraction varies depending on the shape of the bearing, the shape of the shaft or housing, dimensions of the respective parts, and the type of materials used. The differential can range from approximately 70% to 90% of the effective interference.

$$\delta_f = (0.70 \sim 0.90) \cdot \Delta_{deff} \quad \cdots\cdots (6.2)$$

where,

δ_f: Reduced amount of clearance due to interference, mm

Δ_{deff}: Effective interference, mm

Reduced internal clearance due to inner/outer ring temperature difference:

During operation, normally the outer ring will be from 5° to 10°C cooler than the inner ring or rotating parts. However, if the cooling effect of the housing is large, the shaft is connected to a heat source, or a heated substance is conducted through the hollow shaft; the temperature difference between the two rings can be even greater. The amount of internal clearance is thus further reduced by the differential expansion of the two rings.

$$\delta_t = \alpha \cdot \Delta_T \cdot D_o \quad \cdots\cdots (6.3)$$

where,

δ_t : Amount of reduced clearance due to heat differential, mm

α : Bearing steel linear expansion coefficient 12.5 x 10^{-6}/°C

Δ_T : Inner/outer ring temperature differential, °C

D_o : Outer ring raceway diameter, mm

Outer ring raceway diameter, D_o, values can be approximated by using formula 6.4.

For ball bearings,

$$D_o = 0.20 \ (d + 4.0D) \quad \cdots\cdots\cdots \quad (6.4)$$

where,

d : Bearing bore diameter, mm

D : Bearing outside diameter, mm

6.3 Bearing internal clearance selection standards

Theoretically, in regard to bearing life, the optimum operating internal clearance for any bearing would be a slight negative clearance after the bearing had reached normal operating temperature.

Unfortunately, under actual operating conditions, maintaining such optimum tolerances is often difficult at best. Due to various fluctuating operating conditions this slight minus clearance can quickly become a large minus, greatly lowering the life of the bearing and causing excessive heat to be generated. Therefore, an initial internal clearance which will result in a slightly greater than negative internal operating clearance should be selected.

Under normal operating conditions (e.g. normal load, fit, speed, temperature, etc.), a standard internal clearance will give a very satisfactory operating clearance.

Table 6.2 lists non-standard clearance recommendations for various applications and operating conditions.

Table 6.2 Examples of applications where bearing clearances other than normal clearance are used

Operating conditions	Appilcations	Selected clearance
Shaft is heated and housing is cooled.	Conveyor of casting machine	C5
Shaft or inner ring is heated.	Annealing pit, Drying pit, Curing pit	C4
Allows for shaft deflection and fitting errors.	Disc harrows	C4
	Combines	C3
Tight-fitted for both inner and outer rings.	Large blowers	C3
To reduce noise and vibration when rotating.	Multi-wing fan of air conditioners	C2

Table 6.3 (1) Cylindrical bore bearings

Unit: μm/0.0001 inch

Nominal bore diameter d				Radial internal clearance															
				C2				CN				C3				C4			
over		incl.		min.		max.		min.		max.		min.		max.		min.		max.	
mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch
10	0.3937	18	0.7087	0	0	9	4	3	1	18	7	11	4	25	10	18	7	33	13
18	0.7087	24	0.9449	0	0	10	4	5	2	20	8	13	5	28	11	20	8	36	14
24	0.9449	30	1.1811	1	0	11	4	5	2	20	8	13	5	28	11	23	9	41	16
30	1.1811	40	1.5748	1	0	11	4	6	2	20	8	15	6	33	13	28	11	46	18
40	1.5748	50	1.9685	1	0	11	4	6	2	23	9	18	7	36	14	30	12	51	20
50	1.9685	65	2.5591	1	0	15	6	8	3	28	11	23	9	43	17	38	15	61	24
65	2.5591	80	3.1496	1	0	15	6	10	4	30	12	25	10	51	20	46	18	71	28
80	3.1496	100	3.9370	1	0	18	7	12	5	36	14	30	12	58	23	53	21	84	33
100	3.9370	120	4.7244	2	1	20	8	15	6	41	16	36	14	66	26	61	24	97	38
120	4.7244	140	5.5118	2	1	23	9	18	7	48	19	41	16	81	32	71	28	114	45

Note :Heat-resistant bearings with suffix HT2 have C4 clearances.

Table 6.3 (2) Tapered bore bearings

Unit: μm/0.0001 inch

Nominal bore diameter d				Radial internal clearance															
				C2				CN				C3				C4			
over		incl.		min.		max.		min.		max.		min.		max.		min.		max.	
mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch
24	0.9449	30	1.1811	5	2	20	8	13	5	28	11	23	9	41	16	30	12	53	21
30	1.1811	40	1.5748	6	2	20	8	15	6	33	13	28	11	46	18	40	16	54	25
40	1.5748	50	1.9685	6	2	23	9	18	7	36	14	30	12	51	20	45	18	73	29
50	1.9685	65	2.5591	8	3	28	11	23	9	43	17	38	15	61	24	55	22	90	35
65	2.5591	80	3.1496	10	4	30	12	25	10	51	20	46	18	71	28	65	16	105	41
80	3.1496	100	3.9370	12	5	36	14	30	12	58	23	53	21	84	33	75	30	120	47
100	3.9370	120	4.7244	15	6	41	16	36	14	66	26	61	24	97	38	90	35	140	55
120	4.7244	140	5.5118	18	7	48	19	41	16	81	32	71	28	114	45	105	41	160	63

7. Lubrication

As bearings in **NTN** bearing units have sufficient high-grade grease sealed in at the time of manufacture, there is no need for replenishment while in use. The amount of grease necessary for lubrication is, in general, very small. With the **NTN** bearing units, the amount of grease occupies about a half to a third of the space inside the bearing.

7.1 Maximum permissible speed of rotation

The maximum speed possible while ensuring the safety and long life of ball bearings used in the unit is limited by their size, the circumferential speed at the point where the seal comes into contact, and the load acting on them.

To indicate the maximum speed permissible, it is customary to use the value of dn or d_mn (d is the bore of the bearing; d_m is the diameter of the pitch circle= (I.D.+O.D.) /2; n is the number of revolutions).

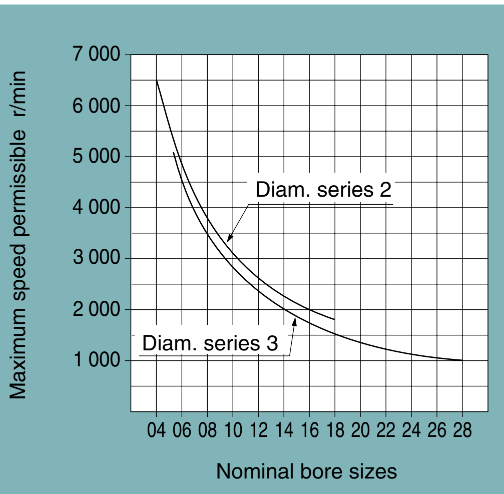


Fig.7.1

Problems connected with the lubrication of bearings are the generation of heat and seizures occurring at the sliding parts inside the bearing, in particular at the points where the ball is in contact with the retainer, inner and outer rings. The contact pressure at the points where friction occurs on the retainer is only slightly affected by the load acting on the bearing; the amount of heat generated there is approximately in proportion to the sliding velocity. Therefore, this sliding velocity serves as a yardstick to measure the limit of the rotating speed of the bearing. In the case of a bearing unit, however, there is another large factor that has to be taken into account– the circumferential speed at the part where the seal is in contact.

The graph in Fig. 7.1 indicates the maximum speed of rotation permissible, taking into account the aforementioned factors.

There are two common methods of locking the bearing unit onto the shaft– the set screw system and the eccentric collar system. However, in both of these systems high-speed operation will cause deformation of the inner ring, which may result in vibration of the bearing. For high-speed operation, therefore, it is recommended that an interference fit or a clearance fit with a near-zero clearance be used, with a shaft of the larger size as shown later in this manual in Fig. 8.1, Fig. 8.6.

For standard bearing units with the contact type seal, the maximum speed permissible is 120 000/d. Where a higher speed is required, bearing units with the non-contact type seal, are advised. Please contact **NTN** regarding the use of the latter type. Additionally, it is necessary that the surface on which the housing is mounted be finished to as a high a degree of accuracy as possible. A regularity of within ± 0.05mm, ± 0.002 inch is required.

Table 7.1 Brands of grease used in NTN bearing units

Bearing units	Grease		Symbols	Operating temperature range
	Thickening agent	Base oil		
Standard	Li soap	Mineral oil	D1	–15˚ to +100˚C, (+5˚ to +212˚F)
Heat-resistant	Li soap	Silicone oil	HT2D1	Normal temp. to +180˚C (356˚F)
Cold-resistant	Li soap	Silicone oil	CT1D1	–60˚C (-76˚F) to normal temp.

7.2 Replenishment of grease

7.2.1 Sealed-in grease

With **NTN** bearing units, no relubrication is the general rule. The standard self-lubricating type of bearing units contain high-grade lithium-based grease which, being suitable for long-term use, is ideal for sealed-type bearings. They also feature **NTN**'s unique sealing device. Relubrication, therefore, is unnecessary under most operating conditions.

At high temperatures, or where there is exposure to water or excessive dust, the highest quality grease is essential. Therefore, **NTN** uses its own specially selected brands which are shown in Table 7.1. It is necessary to use the same brand when replenishing grease.

7.2.2 Mixing of different kinds of grease

Whether or not different kinds of grease may be mixed usually depends on their thickeners. The commonly used criteria are shown in Table 7.2. Properties which are most susceptible to influences from mixing are viscosity, dropping point and penetration. Water and heat resisting properties as well as mechanical stability are also lowered. Therefore, when mixing in a grease which is different to that which is already in use, it is essential that the thickener (soap base) and the base oil be of the same group.

When relubricating **NTN** bearing units, it is advisable to use the brands of grease shown in Table 7.1.

Table 7.2 Mixing properties of grease

Soap base	Ca	Na	Al	Ba	Li
Ca	○	△	△	×	△
Na	△	○	△	×	×
Al	△	△	○	×	×
Ba	×	×	×	○	×
Li	△	×	×	×	○

○ Mixing will not produce any appreciable change of properties.
△ Mixing may produce considerable variations of properties.
× Mixing will cause a drastic change of properties.

7.2.3 Relubrication frequency

Relubrication frequency varies with the kind and quality of grease used as well as the operating conditions. Therefore, it is difficult to establish a general rule, but under ordinary operating conditions, it is desirable that grease be replenished before one third (1/3) of its calculated life elapses. It is necessary, however, to take into consideration such factors as hardening of grease in the oil hole, making replenishment impossible; deterioration of grease while operation of the machine is suspended, and so forth.

In Table 7.3 below are shown standard relubrication frequencies. Irrespective of the calculated life of the grease, this list takes into consideration such factors as the rotational speed of the bearings, operating temperatures and environmental conditions, with a view to safety.

7.2.4 Re-greasing

The performance of a bearing is greatly influenced by the quantity of grease. In order to avoid over-filling, it is advisable to replenish the grease while the machine is in operation.

Continue to insert grease until a little oozes out from between the outer ring raceway and the periphery of the slinger, for optimum performance.

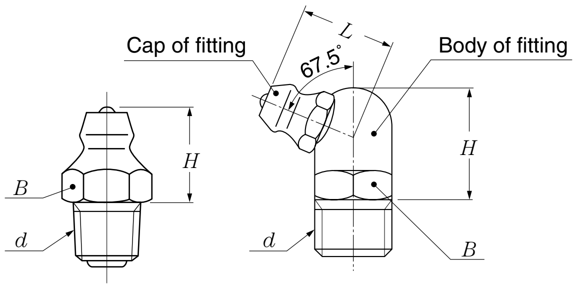
Table 7.3 Standard relubrication frequencies

Type of unit	Symbol	dn Value ($d\times n$)	Environmental conditions	Operating temp. ℃,˚F		Relubrication frequency	
				℃	˚F	Hours	Period
Standard	D1	40 000 and below	Ordinary	−15 to −80,	+5 to +176	1 500 to 3 000	6 to 12 mo.
Standard	D1	70 000 and below	Ordinary	−15 to +80,	+5 to +176	1 000 to 2 000	3 to 6 mo.
Standard	D1	70 000 and below	Ordinary	+80 to +100,	+176 to +212	500 to 700	1 mo.
Heat-resistant	HT2D1	70 000 and below	Ordinary	+100 to +150,	+212 to +302	300 to 700	1 mo.
Heat-resistant	HT2D1	70 000 and below	Ordinary	+150 to +180,	+302 to +356	100	1 wk.
Heat-resistant	CT1D1	70 000 and below	Ordinary	−60 to +80,	−76 to +176	1 000 to 2 000	3 to 6 mo.
Standard	D1	70 000 and below	Very dusty	−15 to +100,	+5 to +212	100 to 500	1 wk. to 1 mo.
Standard	D1	70 000 and below	Exposed to water splashes	−15 to +100,	+5 to +212	30 to 100	1 day to 1 wk.

7.3 Grease fitting

NTN bearing units are, as a general rule, provided with a grease fitting, as shown in Table 7.4, and a grease gun is used for regreasing. However, button-head and pin types may also be furnished on demand.

Grease fitting dimensions and the designation of applicable bearing units are given in Table 7.5.



GA type GB type

Table 7.4 Grease fitting types available for bearing units

Types of housing	**NTN** standard grease fitting types
Pillow type	GA type
Flange type	GA type
Take-up type	GB type
Hanger type	GA type
Cartridge type	GA type

Table 7.5 Grease fitting dimensions and designations of applicable bearing units

GA type (Vertical type)

NTN Designation	d	H		B	
		mm	inch	mm	inch
GA-¼-28 UNF	¼-28 UNF	8.5	0.335	7	0.276
GA-PF⅛	G⅛	12	0.472	10	0.394
GA-PF¼	G¼	14	0.551	14	0.551

GB type (67.5°)

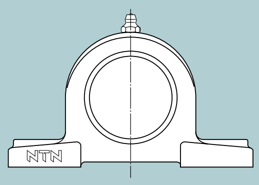
NTN Designation	d	H		L		B	
		mm	inch	mm	inch	mm	inch
GB-¼-28 UNF	¼-28 UNF	10.5	0.413	9.3	0.366	8	0.315
GB-PF⅛	G⅛	14.2	0.559	13.5	0.531	10	0.394
GB-PF¼	G¼	15	0.591	13.5	0.531	14	0.551

Nominal screw size d	Series 2	Series X	Series 3
¼-28 UNF	203-209	X05-X08	305-309
G⅛	210-215	X09-X14	310-315
G¼	216-218	X15-X20	316-328

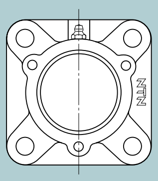
Note:Screw size for the cartridge type is ¼ - 28 UNF.
That for C310D1 to C328D1 is G ⅛ (PF ⅛).

7.4 Standard location of the grease fitting

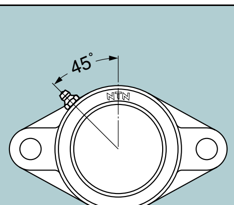
Standard location of grease fitting on the housing for the relubricatable bearing units of each type is illustrated below.



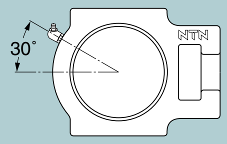
P, PL, PX, S-P, type



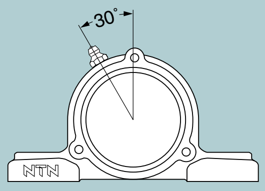
C-F type



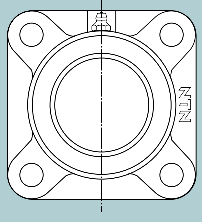
FL, FLU, FLX, S-FL type



T, TX, S-T type

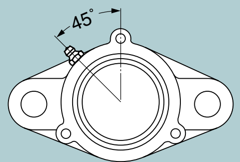


C-P type

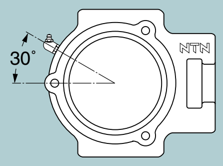


F, FU, S-F (#204, #205)

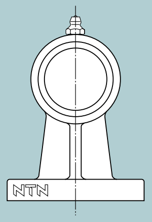
FS type



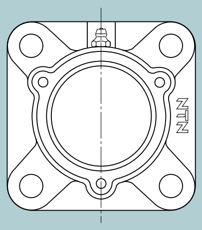
C-FL type



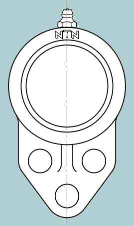
C-T type



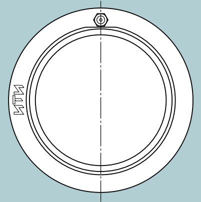
HP type



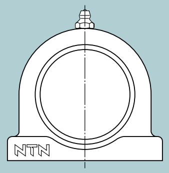
C-FS type



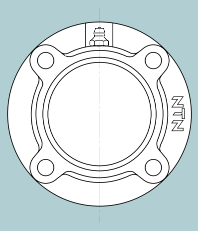
FH type



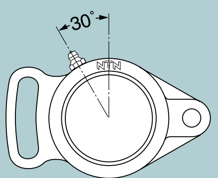
C, CX type



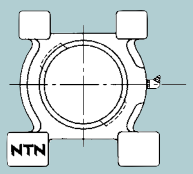
UP type



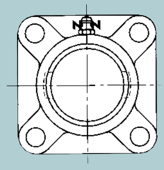
FC, FCX, S-FC type



FA type

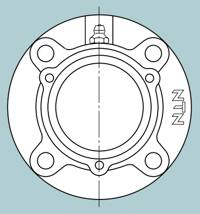


M, L, S-M, S-L type

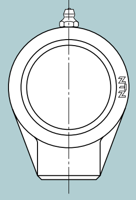


Except (#204, #205)

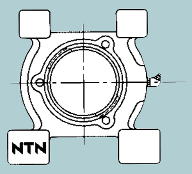
F, FU, FX, S-F type



C-FC type



HB type



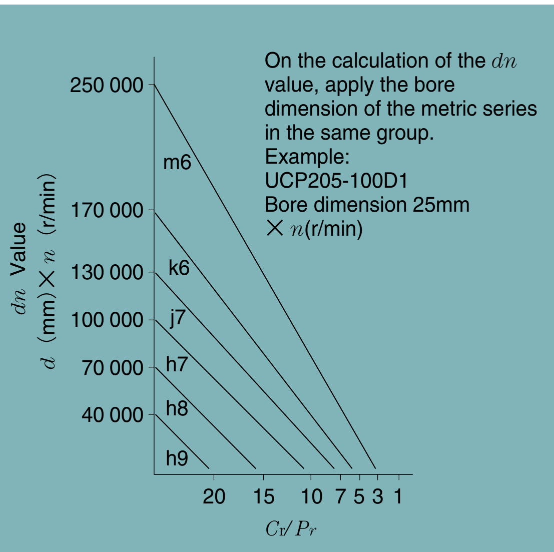
C-M, C-L type

8. Shaft Designs

Although the shafts used for **NTN** bearing units require no particularly high standards of accuracy, it is desirable that, as far as possible, they be free from bends and flaws.

8.1 Set screw system bearing units

With set screw system bearing units, under normal operating conditions the inner ring is usually fitted onto the shaft by means of a clearance fit to ensure convenience of assembly. In this case the values shown in Fig. 8.1 are appropriate dimensional tolerances for the shaft.



On the calculation of the dn value, apply the bore dimension of the metric series in the same group.
Example:
UCP205-100D1
Bore dimension 25mm
× n(r/min)

Fig. 8.1 Dimensional tolerance for the shaft for set screw system bearing units

Step shafts

Wherever there is a noticeably large axial load, a step shaft, as shown in Fig. 8.2, should, if practical, be used.

For bearing units with covers, it is recommended that the units shown in Table 8.1 be used with shafts of the corresponding diameters, as shown in the same table.

The values of the radii of the rounded corners of these shafts are shown in Table 8.2.

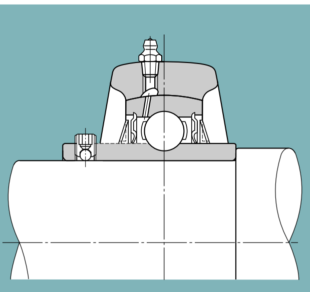


Fig.8.2

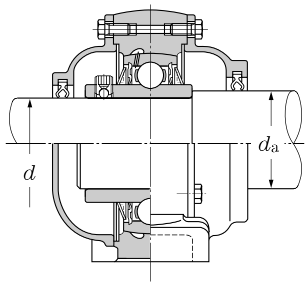


Table 8.1 Bearing units with covers (for use with step shafts) and shaft diameters

A) Metric series

Designation of units		d_a mm
10C-UCP206 to 10C-UCP218	10C-UCT208 to 10C-UCT217	d+10
10C-UCP305 to 10C-UCP311	10C-UCT305 to 10C-UCT311	d+10
15C-UCP312 to 15C-UCP324	15C-UCT312 to 15C-UCT324	d+15
20C-UCP326 to 20C-UCP328	20C-UCT326 to 20C-UCT328	d+20

Remarks : Designation of bearing units with blind covers.
Example : 10CM-UCP206D1

B) Inch series

Designation of units	d_a inch	Designation of units	d_a inch
ZnC-···206-···	1½	ZnC-···305-···	1⅜
ZnC-···207-···	1¾	ZnC-···306-···	1½
ZnC-···208-···	1⅞	ZnC-···307-···	1¾
ZnC-···209-···	2	ZnC-···308-···	1⅞
ZnC-···210-···	2⅜	ZnC-···309-···	2⅛
ZnC-···211-···	2½	ZnC-···310-···	2⅜
ZnC-···212-···	2¾	ZnC-···311-···	2¾
ZnC-···213-···	3	ZnC-···312-···	3
ZnC-···214-···	3⅛	ZnC-···313-···	3⅛
ZnC-···215-···	3⅜	ZnC-···314-···	3¼
ZnC-···216-···	3½	ZnC-···315-···	3½
ZnC-···217-···	3¾	ZnC-···316-···	3¾
ZnC-···218-···	4	ZnC-···317-···	4
		ZnC-···318-···	4

Note :Designations for all units differ from the normal numbering system.
Example 1 Pillow type : ZnC-UCP206-101D1
ZnCM-UCP206-101D1
Example 2 Flange type : ZnC-UCF206-101D1
ZnC-UCFL206-101D1
Example 3 Take-up type : ZnC-UCT206-101D1
ZnCM-UCT206-101D1
n indicates serial number in designing from 1 onward.

As an expedient, there may be provided a bored hole on the shaft as illustrated in Fig. 8.3. In this case it is necessary to ensure the accuracy of the relationship between the positions of the housing of the bearing and of the bored hole on the shaft.

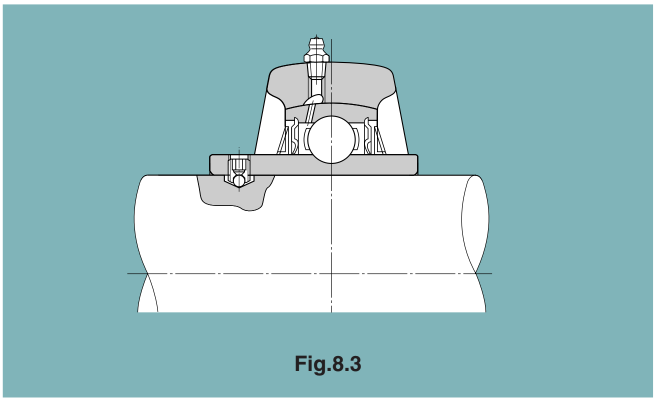


Fig.8.3

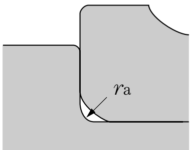


Table 8.2 Radii of the round corners of step shafts

Designation of bearings	r_{as} max.		Designation of bearings	r_{as} max.	
	mm	inch		mm	inch
UC201 to UC203	0.6	0.024	UC305 to UC306	1.5	0.059
UC204 to UC206	1	0.039	UC307 to UC309	2	0.079
UC207 to UC210	1.5	0.059	UC310 to UC311	2.5	0.098
UC211 to UC215	2	0.079	UC312 to UC316	2.5	0.098
UC216 to UC218	2.5	0.098	UC317 to UC324	3	0.118
			UC326 to UC328	4	0.157

Relief in the axial direction

Where several bearing units are fitted on the shaft, or where there is a great distance between two bearing units, one of the bearings is secured to the shaft as the "fixed-side bearing" and is subjected to both the axial and radial loads. The other is mounted on the shaft as the "free-side bearing" and is subjected only to radial load, compensating for expansion of the shaft due to a rise in temperature or for any errors in the distance between bearings that may have occurred during assembly.

If there is no free-side bearing, the bearings will be subjected to an abnormal axial load, which could cause premature breakdown.

Although it is desirable to use a cartridge-type bearing unit for the above purpose (Fig. 8.4), the following method is often employed. As illustrated in Fig. 8.5 (a) and (b), a key way is cut in the shaft, to accommodate a special set screw.

When relief is provided in the axial direction by the use of screwed bolts as above, the dimensional relationships applicable are as shown in Tables 8.3 (a) and 8.3 (b) on the following pages.

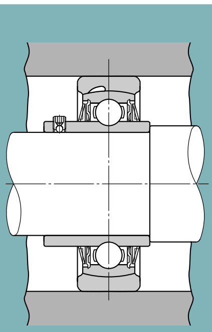


Fig.8.4

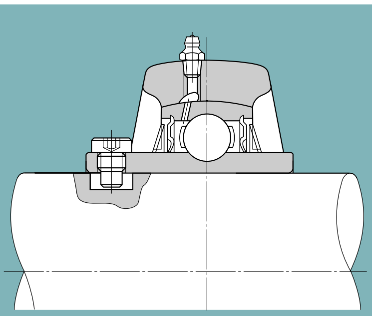


Fig.8.5 (a)

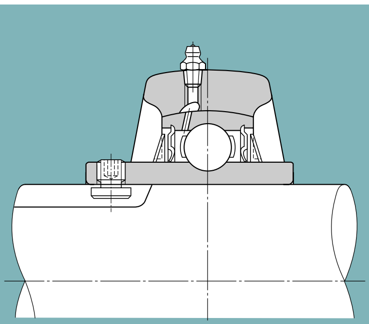
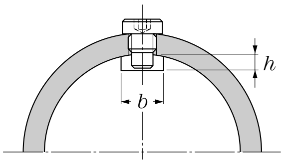


Fig.8.5 (b)



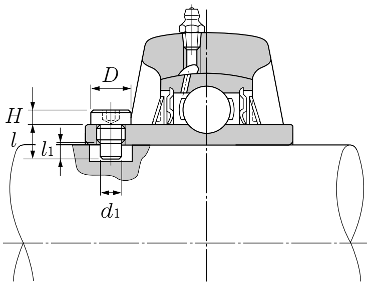
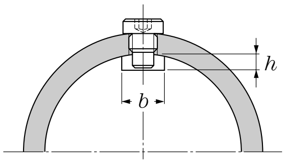


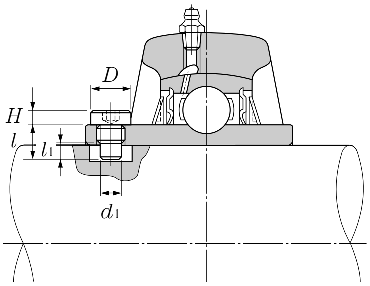
Table 8.3 (a) Screwed bolt system

A) Metric series, applied to metric bore size.

Designation of bearings	Key way		Designation and size of bolts	d_1 mm	l mm	l_1 mm	D mm	H mm
	Width b mm	Depth h mm						
UC201D1W5	3.5	3	S5W5×0.8×11	3.5	11	5	6	3
UC202D1W5	3.5	4.5	S5W5×0.8×11	3.5	11	5	6	3
UC203D1W5	3.5	5.5	S5W5×0.8×11	3.5	11	5	6	3
UC204D1W5	3.5	4.5	S5W5×0.8×8.5	3.5	8.5	5	6	3
UC205D1W5	3.5	5	S5W5×0.8×8.5	3.5	8.5	5	6	3
UC206D1W5	4	5.5	S5W6×0.75×10	4	10	5.9	8	3
UC207D1W5	4	5	S5W6×0.75×10	4	10	5.9	8	3
UC208D1W5	6	5.5	S5W8×1×11.5	6	11.5	5.5	10	3
UC209D1W5	6	6	S5W8×1×11.5	6	11.5	5.5	10	3
UC210D1W5	6	6	S5W8×1×11.5	6	11.5	5.5	10	3
UC211D1W5	6	5.5	S5W8×1×11.5	6	11.5	5.5	10	3
UC212D1W5	7	5.5	S5W10×1.25×13.5	7	13.5	6.5	12	3
UC213D1W5	7	5.5	S5W10×1.25×13.5	7	13.5	6.5	12	3
UC214D1W5	7	5.5	S5W10×1.25×13.5	7	13.5	6.5	12	3
UC215D1W5	7	5	S5W10×1.25×13.5	7	13.5	6.5	12	3
UC216D1W5	7	6.5	S5W10×1.25×15	7	15	7	12	3
UC217D1W5	9	6.5	S5W12×1.5×16.5	9	16.5	7	14	4
UC218D1W5	9	6.5	S5W12×1.5×16.5	9	16.5	7	14	4
UC305D1W5	4	6.5	S5W6×0.75×11.5	4	11.5	6	8	3
UC306D1W5	4	5	S5W6×0.75×11.5	4	11.5	6	8	3
UC307D1W5	6	5	S5W8×1×11.5	6	11.5	5.5	10	3
UC308D1W5	7	6	S5W10×1.25×13.5	7	13.5	6.5	12	3
UC309D1W5	7	6.5	S5W10×1.25×15	7	15	7	12	3
UC310D1W5	9	7	S5W12×1.5×16.5	9	16.5	7	14	4
UC311D1W5	9	6.5	S5W12×1.5×16.5	9	16.5	7	14	4
UC312D1W5	9	6	S5W12×1.5×16.5	9	16.5	7	14	4
UC313D1W5	9	7	S5W12×1.5×18	9	18	7.5	14	4
UC314D1W5	9	6.5	S5W12×1.5×18	9	18	7.5	14	4
UC315D1W5	10	7.5	S5W14×1.5×20	10	20	8.5	17	5
UC316D1W5	10	7	S5W14×1.5×20	10	20	8.5	17	5
UC317D1W5	12	9	S5W16×1.5×23	12	23	9	19	6
UC318D1W5	12	8.5	S5W16×1.5×23	12	23	9	19	6
UC319D1W5	12	7.5	S5W16×1.5×23	12	23	9	19	6
UC320D1W5	14	8	S5W18×1.5×25	14	25	9.5	22	7
UC321D1W5	14	7	S5W18×1.5×25	14	25	9.5	22	7
UC322D1W5	14	9	S5W18×1.5×29	14	29	10	22	7
UC324D1W5	14	7	S5W18×1.5×29	14	29	10	22	7
UC326D1W5	16	9.5	S5W20×1.5×33	16	33	11	24	7
UC328D1W5	16	8.5	S5W20×1.5×33	16	33	11	24	7

Remarks: The tolerance for the width (b) of the key way should preferably be set at the range of 0 to +0.2 mm.

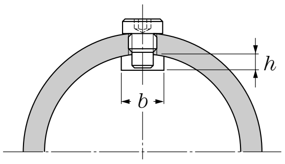


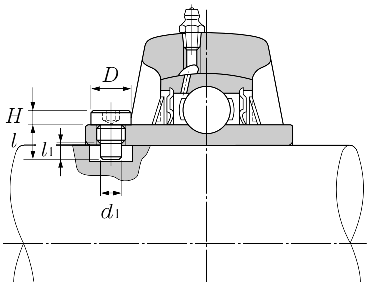


B) Inch series, applied to inch bore size

Designation of bearings	Key way		Designation and size of bolts	d_1 inch	l inch	l_1 inch	D inch	H inch
	Width b inch	Depth h inch						
UC201-008D1W5	0.138	0.118	S7W4.826×32×10.5	0.138	0.413	0.197	0.236	0.118
UC202-009D1W5	0.138	0.177	S7W4.826×32×10.5	0.138	0.413	0.197	0.236	0.118
UC202-010D1W5	0.138	0.177	S7W4.826×32×10.5	0.138	0.413	0.197	0.236	0.118
UC203-011D1W5	0.138	0.217	S7W4.826×32×10.5	0.138	0.413	0.197	0.236	0.118
UC204-012D1W5	0.138	0.177	S7W4.826×32×8	0.138	0.315	0.197	0.236	0.118
UC205-013D1W5	0.138	0.197	S7W4.826×32×8	0.138	0.315	0.197	0.236	0.118
UC205-014D1W5	0.138	0.197	S7W4.826×32×8	0.138	0.315	0.197	0.236	0.118
UC205-015D1W5	0.138	0.197	S7W4.826×32×8	0.138	0.315	0.197	0.236	0.118
UC205-100D1W5	0.138	0.197	S7W4.826×32×8	0.138	0.315	0.197	0.236	0.118
UC206-101D1W5	0.157	0.217	S7W¼×28×9.5	0.157	0.374	0.217	0.315	0.118
UC206-102D1W5	0.157	0.217	S7W¼×28×9.5	0.157	0.374	0.217	0.315	0.118
UC206-103D1W5	0.157	0.217	S7W¼×28×9.5	0.157	0.374	0.217	0.315	0.118
UC206-104D1W5	0.157	0.217	S7W¼×28×9.5	0.157	0.374	0.217	0.315	0.118
UC207-104D1W5	0.157	0.197	S7W¼×28×9.5	0.157	0.374	0.217	0.315	0.118
UC207-105D1W5	0.157	0.197	S7W¼×28×9.5	0.157	0.374	0.217	0.315	0.118
UC207-106D1W5	0.157	0.197	S7W¼×28×9.5	0.157	0.374	0.217	0.315	0.118
UC207-107D1W5	0.157	0.197	S7W¼×28×9.5	0.157	0.374	0.217	0.315	0.118
UC208-108D1W5	0.236	0.197	S7W5⁄16×24×10.5	0.236	0.413	0.205	0.394	0.118
UC208-109D1W5	0.236	0.197	S7W5⁄16×24×10.5	0.236	0.413	0.205	0.394	0.118
UC209-110D1W5	0.236	0.197	S7W5⁄16×24×10.5	0.236	0.413	0.205	0.394	0.118
UC209-111D1W5	0.236	0.197	S7W5⁄16×24×10.5	0.236	0.413	0.205	0.394	0.118
UC209-112D1W5	0.236	0.197	S7W5⁄16×24×10.5	0.236	0.413	0.205	0.394	0.118
UC210-113D1W5	0.236	0.217	S7W5⁄16×24×10.5	0.236	0.413	0.205	0.394	0.118
UC210-114D1W5	0.236	0.217	S7W5⁄16×24×10.5	0.236	0.413	0.205	0.394	0.118
UC210-115D1W5	0.236	0.217	S7W5⁄16×24×10.5	0.236	0.413	0.205	0.394	0.118
UC210-200D1W5	0.236	0.217	S7W5⁄16×24×10.5	0.236	0.413	0.205	0.394	0.118
UC211-200D1W5	0.236	0.197	S7W5⁄16×24×10.5	0.236	0.413	0.205	0.394	0.118
UC211-201D1W5	0.236	0.197	S7W5⁄16×24×10.5	0.236	0.413	0.205	0.394	0.118
UC211-202D1W5	0.236	0.197	S7W5⁄16×24×10.5	0.236	0.413	0.205	0.394	0.118
UC211-203D1W5	0.236	0.197	S7W5⁄16×24×10.5	0.236	0.413	0.205	0.394	0.118
UC212-204D1W5	0.276	0.217	S7W⅜×24×12.5	0.276	0.492	0.224	0.472	0.118
UC212-205D1W5	0.276	0.217	S7W⅜×24×12.5	0.276	0.492	0.224	0.472	0.118
UC212-206D1W5	0.276	0.217	S7W⅜×24×12.5	0.276	0.492	0.224	0.472	0.118
UC212-207D1W5	0.276	0.217	S7W⅜×24×12.5	0.276	0.492	0.224	0.472	0.118
UC213-208D1W5	0.276	0.217	S7W⅜×24×12.5	0.276	0.492	0.224	0.472	0.118
UC213-209D1W5	0.276	0.217	S7W⅜×24×12.5	0.276	0.492	0.224	0.472	0.118
UC214-210D1W5	0.276	0.217	S7W⅜×24×12.5	0.276	0.492	0.224	0.472	0.118
UC214-211D1W5	0.276	0.217	S7W⅜×24×12.5	0.276	0.492	0.224	0.472	0.118
UC214-212D1W5	0.276	0.217	S7W⅜×24×12.5	0.276	0.492	0.224	0.472	0.118
UC215-213D1W5	0.276	0.217	S7W⅜×24×12.5	0.276	0.492	0.224	0.472	0.118
UC215-214D1W5	0.276	0.217	S7W⅜×24×12.5	0.276	0.492	0.224	0.472	0.118
UC215-215D1W5	0.276	0.217	S7W⅜×24×12.5	0.276	0.492	0.224	0.472	0.118
UC215-300D1W5	0.276	0.217	S7W⅜×24×12.5	0.276	0.492	0.224	0.472	0.118
UC216-301D1W5	0.276	0.256	S7W⅜×24×14.5	0.276	0.571	0.264	0.472	0.118
UC216-302D1W5	0.276	0.256	S7W⅜×24×14.5	0.276	0.571	0.264	0.472	0.118
UC216-303D1W5	0.276	0.256	S7W⅜×24×14.5	0.276	0.571	0.264	0.472	0.118
UC217-304D1W5	0.354	0.256	S7W½×20×15	0.354	0.591	0.244	0.472	0.157
UC217-305D1W5	0.354	0.256	S7W½×20×15	0.354	0.591	0.244	0.472	0.157
UC217-307D1W5	0.354	0.256	S7W½×20×15	0.354	0.591	0.244	0.472	0.157
UC218-308D1W5	0.354	0.197	S7W½×20×15	0.354	0.591	0.244	0.472	0.157

Note: The tolerance for the width (b) of the key way should preferably be set at the range of 0 to +0.008 inch.

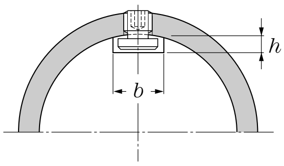




B) Inch series, applied to inch bore size

Designation of bearings	Key way Width *b* inch	Key way Depth *h* inch	Designation and size of bolts	d_1 inch	*l* inch	l_1 inch	*D* inch	*H* inch
UC305-013D1W5	0.157	0.236	S7W¼×28×11	0.157	0.433	0.228	0.315	0.118
UC305-014D1W5	0.157	0.236	S7W¼×28×11	0.157	0.433	0.228	0.315	0.118
UC305-015D1W5	0.157	0.236	S7W¼×28×11	0.157	0.433	0.228	0.315	0.118
UC305-100D1W5	0.157	0.236	S7W¼×28×11	0.157	0.433	0.228	0.315	0.118
UC306-101D1W5	0.157	0.197	S7W¼×28×11	0.157	0.433	0.228	0.315	0.118
UC306-102D1W5	0.157	0.197	S7W¼×28×11	0.157	0.433	0.228	0.315	0.118
UC306-103D1W5	0.157	0.197	S7W¼×28×11	0.157	0.433	0.228	0.315	0.118
UC307-104D1W5	0.236	0.197	S7W5⁄16×24×10.5	0.236	0.413	0.205	0.394	0.118
UC307-105D1W5	0.236	0.197	S7W5⁄16×24×10.5	0.236	0.413	0.205	0.394	0.118
UC307-106D1W5	0.236	0.197	S7W5⁄16×24×10.5	0.236	0.413	0.205	0.394	0.118
UC307-107D1W5	0.236	0.197	S7W5⁄16×24×10.5	0.236	0.413	0.205	0.394	0.118
UC308-108D1W5	0.276	0.197	S7W⅜×24×12.5	0.276	0.492	0.224	0.472	0.118
UC308-109D1W5	0.276	0.197	S7W⅜×24×12.5	0.276	0.492	0.224	0.472	0.118
UC309-110D1W5	0.276	0.236	S7W⅜×24×14.5	0.276	0.571	0.264	0.472	0.118
UC309-111D1W5	0.276	0.236	S7W⅜×24×14.5	0.276	0.571	0.264	0.472	0.118
UC309-112D1W5	0.276	0.236	S7W⅜×24×14.5	0.276	0.571	0.264	0.472	0.118
UC310-113D1W5	0.354	0.256	S7W½×20×15	0.354	0.591	0.244	0.551	0.157
UC310-114D1W5	0.354	0.256	S7W½×20×15	0.354	0.591	0.244	0.551	0.157
UC310-115D1W5	0.354	0.256	S7W½×20×15	0.354	0.591	0.244	0.551	0.157
UC311-200D1W5	0.354	0.236	S7W½×20×15	0.354	0.591	0.244	0.551	0.157
UC311-201D1W5	0.354	0.236	S7W½×20×15	0.354	0.591	0.244	0.551	0.157
UC311-202D1W5	0.354	0.236	S7W½×20×15	0.354	0.591	0.244	0.551	0.157
UC311-203D1W5	0.354	0.236	S7W½×20×15	0.354	0.591	0.244	0.551	0.157
UC312-204D1W5	0.354	0.236	S7W½×20×15	0.354	0.591	0.244	0.551	0.157
UC312-205D1W5	0.354	0.236	S7W½×20×15	0.354	0.591	0.244	0.551	0.157
UC312-206D1W5	0.354	0.236	S7W½×20×15	0.354	0.591	0.244	0.551	0.157
UC312-207D1W5	0.354	0.236	S7W½×20×15	0.354	0.591	0.244	0.551	0.157
UC313-208D1W5	0.354	0.276	S7W½×20×17.5	0.354	0.689	0.276	0.551	0.157
UC313-209D1W5	0.354	0.276	S7W½×20×17.5	0.354	0.689	0.276	0.551	0.157
UC314-210D1W5	0.354	0.256	S7W9⁄16×18×17.5	0.354	0.689	0.276	0.551	0.157
UC314-211D1W5	0.354	0.256	S7W9⁄16×18×17.5	0.354	0.689	0.276	0.551	0.157
UC314-212D1W5	0.354	0.256	S7W9⁄16×18×17.5	0.354	0.689	0.276	0.551	0.157
UC315-213D1W5	0.394	0.295	S7W9⁄16×18×19	0.394	0.748	0.335	0.669	0.197
UC315-214D1W5	0.394	0.295	S7W9⁄16×18×19	0.394	0.748	0.335	0.669	0.197
UC315-215D1W5	0.394	0.295	S7W9⁄16×18×19	0.394	0.748	0.335	0.669	0.197
UC315-300D1W5	0.394	0.295	S7W9⁄16×18×19	0.394	0.748	0.335	0.669	0.197
UC316-301D1W5	0.394	0.276	S7W⅝×18×19	0.394	0.748	0.335	0.669	0.197
UC316-302D1W5	0.394	0.276	S7W⅝×18×19	0.394	0.748	0.335	0.669	0.197
UC316-303D1W5	0.394	0.276	S7W⅝×18×19	0.394	0.748	0.335	0.669	0.197
UC317-304D1W5	0.472	0.354	S7W⅝×18×21.5	0.472	0.846	0.354	0.748	0.236
UC317-305D1W5	0.472	0.354	S7W⅝×18×21.5	0.472	0.846	0.354	0.748	0.236
UC317-307D1W5	0.472	0.354	S7W⅝×18×21.5	0.472	0.846	0.354	0.748	0.236
UC318-307D1W5	0.472	0.276	S7W⅝×18×21.5	0.472	0.846	0.354	0.748	0.236
UC318-308D1W5	0.472	0.276	S7W⅝×18×21.5	0.472	0.846	0.354	0.748	0.236
UC319-310D1W5	0.472	0.276	S7W⅝×18×21.5	0.472	0.846	0.354	0.748	0.236
UC319-311D1W5	0.472	0.276	S7W⅝×18×21.5	0.472	0.846	0.354	0.748	0.236
UC319-312D1W5	0.472	0.276	S7W⅝×18×21.5	0.472	0.846	0.354	0.748	0.236
UC320-314D1W5	0.551	0.315	S7W⅝×18×24	0.551	0.945	0.354	0.866	0.276
UC320-315D1W5	0.551	0.315	S7W⅝×18×24	0.551	0.945	0.354	0.866	0.276
UC320-400D1W5	0.551	0.315	S7W⅝×18×24	0.551	0.945	0.354	0.866	0.276

Note: The tolerance for the width (*b*) of the Key way should preferably be set at the range of 0 to +0.008 inch.



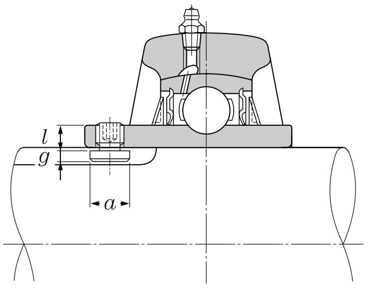
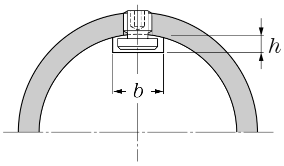


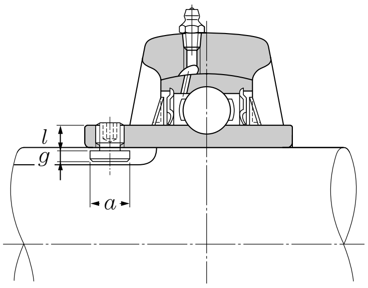
Table 8.3 (b) Key bolt system

A) Metric series, applied to metric bore size.

Designation of bearings	Key way Width b mm	Key way Depth h mm	Designation and size of bolts	a mm	g mm	l mm
UC201D1W6	6	4.5	S6W5×0.8×5-1	5.9	3	6
UC202D1W6	6	4.5	S6W5×0.8×5-1	5.9	3	6
UC203D1W6	6	4	S6W5×0.8×5-1	5.9	3	6
UC204D1W6	7	4.5	S6W5×0.8×5	6.9	3.2	6
UC205D1W6	7	4.5	S6W5×0.8×5	6.9	3.2	6
UC206D1W6	8	4.5	S6W6×0.75×6	7.9	3.2	7
UC207D1W6	8	4.5	S6W6×0.75×6	7.9	3.2	7
UC208D1W6	10	5	S6W8×1×7	9.9	3.6	8
UC209D1W6	10	5	S6W8×1×7	9.9	3.6	8
UC210D1W6	10	5	S6W8×1×7	9.9	3.6	8
UC211D1W6	10	5	S6W8×1×7	9.9	3.6	8
UC212D1W6	12	5.5	S6W10×1.25×9	11.9	4	10
UC213D1W6	12	5.5	S6W10×1.25×9	11.9	4	10
UC214D1W6	12	5.5	S6W10×1.25×9	11.9	4	10
UC215D1W6	12	5.5	S6W10×1.25×9	11.9	4	10
UC216D1W6	12	5.5	S6W10×1.25×9	11.9	4	10
UC217D1W6	14	6	S6W12×1.5×11	13.9	4.8	12
UC218D1W6	14	6	S6W12×1.5×11	13.9	4.8	12
UC305D1W6	8	4.5	S6W6×0.75×6	7.9	3.2	7
UC306D1W6	8	4.5	S6W6×0.75×6	7.9	3.2	7
UC307D1W6	10	5	S6W8×1×7	9.9	3.6	8
UC308D1W6	12	5.5	S6W10×1.25×9	11.9	4	10
UC309D1W6	12	5.5	S6W10×1.25×9	11.9	4	10
UC310D1W6	14	6.5	S6W12×1.5×11	13.9	4.8	12
UC311D1W6	14	6.5	S6W12×1.5×11	13.9	4.8	12
UC312D1W6	14	6.5	S6W12×1.5×11	13.9	4.8	12
UC313D1W6	14	6.5	S6W12×1.5×11	13.9	4.8	12
UC314D1W6	14	6.5	S6W12×1.5×11	13.9	4.8	12
UC315D1W6	16	7.5	S6W14×1.5×13	15.9	5.8	14
UC316D1W6	16	7.5	S6W14×1.5×13	15.9	5.8	14
UC317D1W6	18	8.5	S6W16×1.5×16	17.9	6.5	17
UC318D1W6	18	8.5	S6W16×1.5×16	17.9	6.5	17
UC319D1W6	18	8.5	S6W16×1.5×16	17.9	6.5	17
UC320D1W6	20	10.5	S6W18×1.5×18	19.9	8.5	19
UC321D1W6	20	10.5	S6W18×1.5×18	19.9	8.5	19
UC322D1W6	20	10.5	S6W18×1.5×18	19.9	8.5	19
UC324D1W6	20	10.5	S6W18×1.5×18	19.9	8.5	19
UC326D1W6	22	11	S6W20×1.5×25	21.9	9.5	26
UC328D1W6	22	11	S6W20×1.5×25	21.9	9.5	26

Note: The tolerance for the width (b) of the key way should preferably be set at the range of 0 to +0.2 mm.

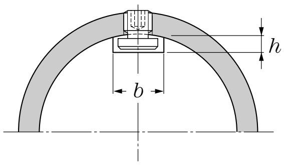


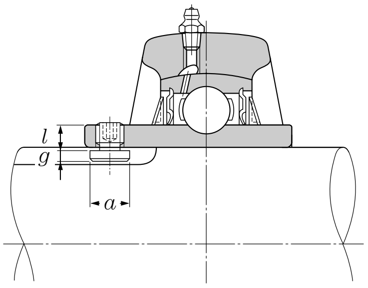


B) Inch series, applied to inch bore size

Designation of bearings	Key way		Designation and size of bolts	*a* inch	*g* inch	*l* inch
	Width *b* inch	Depth *h* inch				
UC201-008D1W6	0.236	0.177	S7W4.826×32×5-1	0.232	0.118	0.236
UC202-009D1W6	0.236	0.177	S7W4.826×32×5-1	0.232	0.118	0.236
UC202-010D1W6	0.236	0.177	S7W4.826×32×5-1	0.232	0.118	0.236
UC203-011D1W6	0.236	0.157	S7W4.826×32×5-1	0.232	0.118	0.236
UC204-012D1W6	0.276	0.177	S7W4.826×32×5	0.272	0.126	0.236
UC205-013D1W6	0.276	0.177	S7W4.826×32×5	0.272	0.126	0.236
UC205-014D1W6	0.276	0.177	S7W4.826×32×5	0.272	0.126	0.236
UC205-015D1W6	0.276	0.177	S7W4.826×32×5	0.272	0.126	0.236
UC205-100D1W6	0.276	0.177	S7W4.826×32×5	0.272	0.126	0.236
UC206-101D1W6	0.315	0.177	S7W$\frac{1}{4}$×28×6	0.311	0.126	0.276
UC206-102D1W6	0.315	0.177	S7W$\frac{1}{4}$×28×6	0.311	0.126	0.276
UC206-103D1W6	0.315	0.177	S7W$\frac{1}{4}$×28×6	0.311	0.126	0.276
UC206-104D1W6	0.315	0.177	S7W$\frac{1}{4}$×28×6	0.311	0.126	0.276
UC207-104D1W6	0.315	0.177	S7W$\frac{1}{4}$×28×6	0.311	0.126	0.276
UC207-105D1W6	0.315	0.177	S7W$\frac{1}{4}$×28×6	0.311	0.126	0.276
UC207-106D1W6	0.315	0.177	S7W$\frac{1}{4}$×28×6	0.311	0.126	0.276
UC207-107D1W6	0.315	0.177	S7W$\frac{1}{4}$×28×6	0.311	0.126	0.276
UC208-108D1W6	0.394	0.197	S7W$\frac{5}{16}$×24×7	0.390	0.142	0.315
UC208-109D1W6	0.394	0.197	S7W$\frac{5}{16}$×24×7	0.390	0.142	0.315
UC209-110D1W6	0.394	0.197	S7W$\frac{5}{16}$×24×7	0.390	0.142	0.315
UC209-111D1W6	0.394	0.197	S7W$\frac{5}{16}$×24×7	0.390	0.142	0.315
UC209-112D1W6	0.394	0.197	S7W$\frac{5}{16}$×24×7	0.390	0.142	0.315
UC210-114D1W6	0.394	0.197	S7W$\frac{5}{16}$×24×7	0.390	0.142	0.315
UC210-113D1W6	0.394	0.197	S7W$\frac{5}{16}$×24×7	0.390	0.142	0.315
UC210-115D1W6	0.394	0.197	S7W$\frac{5}{16}$×24×7	0.390	0.142	0.315
UC210-200D1W6	0.394	0.197	S7W$\frac{5}{16}$×24×7	0.390	0.142	0.315
UC211-200D1W6	0.394	0.197	S7W$\frac{5}{16}$×24×7	0.390	0.142	0.315
UC211-201D1W6	0.394	0.197	S7W$\frac{5}{16}$×24×7	0.390	0.142	0.315
UC211-202D1W6	0.394	0.197	S7W$\frac{5}{16}$×24×7	0.390	0.142	0.315
UC211-203D1W6	0.394	0.197	S7W$\frac{5}{16}$×24×7	0.390	0.142	0.315
UC212-204D1W6	0.472	0.217	S7W$\frac{3}{8}$×24×9	0.469	0.157	0.394
UC212-205D1W6	0.472	0.217	S7W$\frac{3}{8}$×24×9	0.469	0.157	0.394
UC212-206D1W6	0.472	0.217	S7W$\frac{3}{8}$×24×9	0.469	0.157	0.394
UC212-207D1W6	0.472	0.217	S7W$\frac{3}{8}$×24×9	0.469	0.157	0.394
UC213-208D1W6	0.472	0.217	S7W$\frac{3}{8}$×24×9	0.469	0.157	0.394
UC213-209D1W6	0.472	0.217	S7W$\frac{3}{8}$×24×9	0.469	0.157	0.394
UC214-210D1W6	0.472	0.217	S7W$\frac{3}{8}$×24×9	0.469	0.157	0.394
UC214-211D1W6	0.472	0.217	S7W$\frac{3}{8}$×24×9	0.469	0.157	0.394
UC214-212D1W6	0.472	0.217	S7W$\frac{3}{8}$×24×9	0.469	0.157	0.394
UC215-213D1W6	0.472	0.217	S7W$\frac{3}{8}$×24×9	0.469	0.157	0.394
UC215-214D1W6	0.472	0.217	S7W$\frac{3}{8}$×24×9	0.469	0.157	0.394
UC215-215D1W6	0.472	0.217	S7W$\frac{3}{8}$×24×9	0.469	0.157	0.394
UC215-300D1W6	0.472	0.217	S7W$\frac{3}{8}$×24×9	0.469	0.157	0.394
UC216-301D1W6	0.472	0.217	S7W$\frac{3}{8}$×24×9	0.469	0.157	0.394
UC216-302D1W6	0.472	0.217	S7W$\frac{3}{8}$×24×9	0.469	0.157	0.394
UC216-303D1W6	0.472	0.217	S7W$\frac{3}{8}$×24×9	0.469	0.157	0.394
UC217-304D1W6	0.551	0.236	S7W$\frac{1}{2}$×20×11	0.547	0.189	0.472
UC217-305D1W6	0.551	0.236	S7W$\frac{1}{2}$×20×11	0.547	0.189	0.472
UC217-307D1W6	0.551	0.236	S7W$\frac{1}{2}$×20×11	0.547	0.189	0.472
UC218-308D1W6	0.551	0.236	S7W$\frac{1}{2}$×20×11	0.547	0.189	0.472

Note :The tolerance for the width (*b*) of the key way should preferably be set at the range of 0 to +0.008 inch.





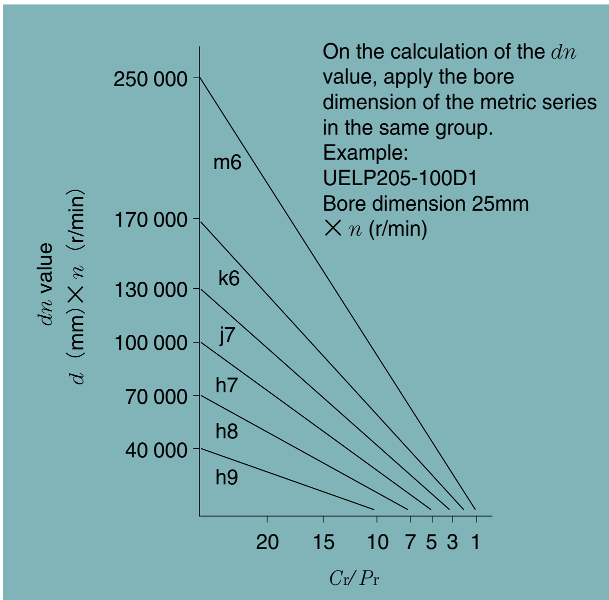
B) Inch series, applied to inch bore size

Designation of bearings	Key way		Designation and size of bolts	*a* inch	*g* inch	*l* inch
	Width *b* inch	Depth *h* inch				
UC305-013D1W6	0.315	0.177	S7W¼×28×6	0.311	0.126	0.276
UC305-014D1W6	0.315	0.177	S7W¼×28×6	0.311	0.126	0.276
UC305-015D1W6	0.315	0.177	S7W¼×28×6	0.311	0.126	0.276
UC305-100D1W6	0.315	0.177	S7W¼×28×6	0.311	0.126	0.276
UC306-101D1W6	0.315	0.177	S7W¼×28×6	0.311	0.126	0.276
UC306-102D1W6	0.315	0.177	S7W¼×28×6	0.311	0.126	0.276
UC306-103D1W6	0.315	0.177	S7W¼×28×6	0.311	0.126	0.276
UC307-104D1W6	0.394	0.197	S7W5⁄16×24×7	0.390	0.142	0.315
UC307-105D1W6	0.394	0.197	S7W5⁄16×24×7	0.390	0.142	0.315
UC307-106D1W6	0.394	0.197	S7W5⁄16×24×7	0.390	0.142	0.315
UC307-107D1W6	0.394	0.197	S7W5⁄16×24×7	0.390	0.142	0.315
UC308-108D1W6	0.472	0.217	S7W⅜×24×9	0.469	0.157	0.394
UC308-109D1W6	0.472	0.217	S7W⅜×24×9	0.469	0.157	0.394
UC309-110D1W6	0.472	0.217	S7W⅜×24×9	0.469	0.157	0.394
UC309-111D1W6	0.472	0.217	S7W⅜×24×9	0.469	0.157	0.394
UC309-112D1W6	0.472	0.217	S7W⅜×24×9	0.469	0.157	0.394
UC310-113D1W6	0.551	0.256	S7W½×20×11	0.547	0.189	0.472
UC310-114D1W6	0.551	0.256	S7W½×20×11	0.547	0.189	0.472
UC310-115D1W6	0.551	0.256	S7W½×20×11	0.547	0.189	0.472
UC311-200D1W6	0.551	0.256	S7W½×20×11	0.547	0.189	0.472
UC311-201D1W6	0.551	0.256	S7W½×20×11	0.547	0.189	0.472
UC311-202D1W6	0.551	0.256	S7W½×20×11	0.547	0.189	0.472
UC311-203D1W6	0.551	0.256	S7W½×20×11	0.547	0.189	0.472
UC312-204D1W6	0.551	0.256	S7W½×20×11	0.547	0.189	0.472
UC312-205D1W6	0.551	0.256	S7W½×20×11	0.547	0.189	0.472
UC312-206D1W6	0.551	0.256	S7W½×20×11	0.547	0.189	0.472
UC312-207D1W6	0.551	0.256	S7W½×20×11	0.547	0.189	0.472
UC313-208D1W6	0.551	0.256	S7W½×20×11	0.547	0.189	0.472
UC313-209D1W6	0.551	0.256	S7W½×20×11	0.547	0.189	0.472
UC314-210D1W6	0.551	0.256	S7W½×20×11	0.547	0.189	0.472
UC314-211D1W6	0.551	0.256	S7W½×20×11	0.547	0.189	0.472
UC314-212D1W6	0.551	0.256	S7W½×20×11	0.547	0.189	0.472
UC315-213D1W6	0.630	0.295	S7W9⁄16×18×13	0.626	0.228	0.551
UC315-214D1W6	0.630	0.295	S7W9⁄16×18×13	0.626	0.228	0.551
UC315-215D1W6	0.630	0.295	S7W9⁄16×18×13	0.626	0.228	0.551
UC315-300D1W6	0.630	0.295	S7W9⁄16×18×13	0.626	0.228	0.551
UC316-301D1W6	0.630	0.295	S7W9⁄16×18×13	0.626	0.228	0.551
UC316-302D1W6	0.630	0.295	S7W9⁄16×18×13	0.626	0.228	0.551
UC316-303D1W6	0.630	0.295	S7W9⁄16×18×13	0.626	0.228	0.551
UC317-304D1W6	0.709	0.335	S7W⅝×18×16	0.705	0.256	0.669
UC317-305D1W6	0.709	0.335	S7W⅝×18×16	0.705	0.256	0.669
UC317-307D1W6	0.709	0.335	S7W⅝×18×16	0.705	0.256	0.669
UC318-307D1W6	0.709	0.335	S7W⅝×18×16	0.705	0.256	0.669
UC318-308D1W6	0.709	0.335	S7W⅝×18×16	0.705	0.256	0.669
UC319-310D1W6	0.709	0.335	S7W⅝×18×16	0.705	0.256	0.669
UC319-311D1W6	0.709	0.335	S7W⅝×18×16	0.705	0.256	0.669
UC319-312D1W6	0.709	0.335	S7W⅝×18×16	0.705	0.256	0.669
UC320-314D1W6	0.787	0.413	S7W⅝×18×18	0.783	0.335	0.748
UC320-315D1W6	0.787	0.413	S7W⅝×18×18	0.783	0.335	0.748
UC320-400D1W6	0.787	0.413	S7W⅝×18×18	0.783	0.335	0.748

Note: The tolerance for the width (*b*) of the key way should preferably be set at the range of 0 to +0.008 inch.

8.2 Eccentric collar system

As in the case of the set screw system, it is usual under normal operating conditions to fit the inner ring onto the shaft by means of a clearance fit, for ease of assembly.Fig. 8.6 shows the appropriate values of dimensional tolerances for the shaft.



On the calculation of the dn value, apply the bore dimension of the metric series in the same group.
Example:
UELP205-100D1
Bore dimension 25mm
×n (r/min)

Fig 8.6 Dimensional tolerances for the shaft eccentric collar system bearing units

8.3 Adapter system bearing units

Since in the case of the adapter system, the bearing unit is fastened onto the shaft by means of a sleeve, for dimensional tolerances for the shaft, h9 is applicable under all operating conditions.

9. Handling of the Bearing Unit

9.1 Mounting of the housing

9.1.1 Pillow block type and flange type

Although an advantage of the **NTN** bearing unit is that it can be fitted easily and will function efficiently on any part of a machine, attention must be paid to the following points in order to ensure its normal service life.

1) The surface on which the housing is mounted must be sufficiently rigid.
2) The surface on which the housing is mounted should be as flat as possible (The housing should set firmly in its position). Deformation of the housing caused by incorrect mounting will in turn cause deformation of the bearing, leading to its premature breakdown.

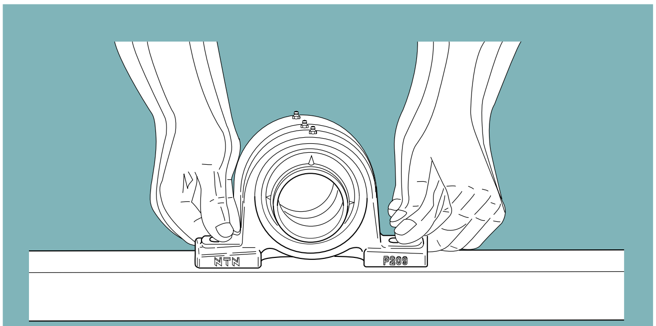


Fig. 9.1

3) It is desirable that the angle between the surface on which the housing is mounted and the shaft be maintained to a tolerance of ±2˚.

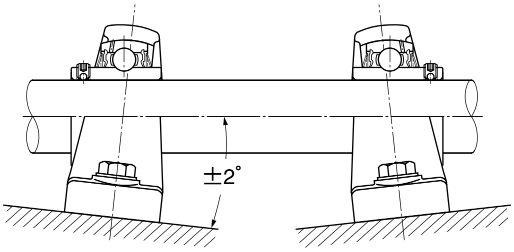


Fig. 9.2

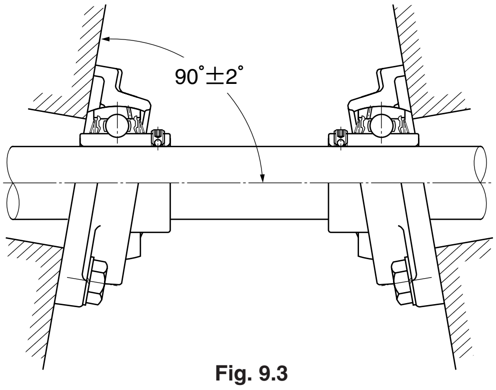
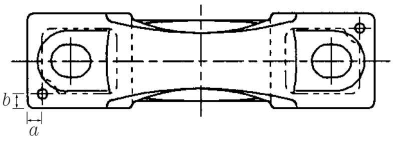


Fig. 9.3

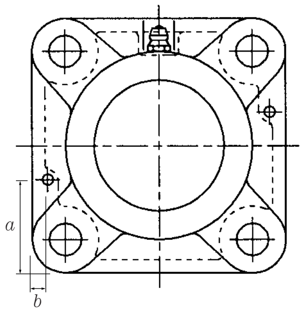
4) The pillow block type and flange type housings are provided with a seat for a dowel for accurate location. For the use of dowel pins, refer to Table 9.1.



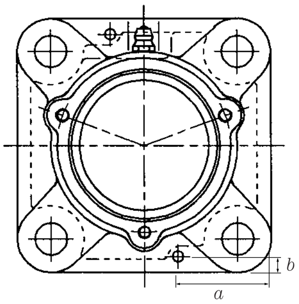
P, C-P

Table 9.1 Recommended dimensions of dowel pins

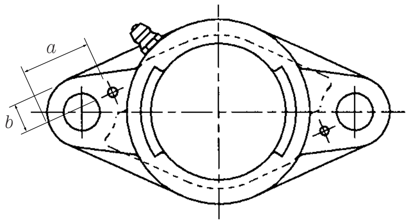
Designation of the housings		*a*		*b*		Recommended pin diameter	
		mm	inch	mm	inch	mm	inch
P203	—	5.5	0.216	5.5	0.216	3	0.118
P204	C-P204	5.5	0.216	5.5	0.216	3	0.118
P205	C-P205	5.5	0.216	5.5	0.216	3	0.118
P206	C-P206	5.5	0.216	5.5	0.216	3	0.118
P207	C-P207	5.5	0.216	5.5	0.216	3	0.118
P208	C-P208	7	0.276	7	0.276	5	0.197
P209	C-P209	7	0.276	7	0.276	5	0.197
P210	C-P210	7.5	0.295	7.5	0.295	5	0.197
P211	C-P211	7.5	0.295	7.5	0.295	5	0.197
P212	C-P212	9	0.354	9	0.354	7	0.276
P213	C-P213	9	0.354	9	0.354	7	0.276
P214	C-P214	9	0.354	9	0.354	7	0.276
P215	C-P215	9	0.354	9	0.354	7	0.276
P216	C-P216	10	0.394	10	0.394	7	0.276
P217	C-P217	12	0.472	12	0.472	10	0.394
P218	C-P218	12	0.472	12	0.472	10	0.394
P305	C-P305	8	0.315	8	0.315	4	0.157
P306	C-P306	8	0.315	8	0.315	4	0.157
P307	C-P307	10	0.394	10	0.394	5	0.197
P308	C-P308	10	0.394	10	0.394	5	0.197
P309	C-P309	10	0.394	10	0.394	5	0.197
P310	C-P310	12	0.472	12	0.472	6	0.236
P311	C-P311	12	0.472	12	0.472	6	0.236
P312	C-P312	14	0.551	14	0.551	6	0.236
P313	C-P313	14	0.551	14	0.551	6	0.236
P314	C-P314	14	0.551	14	0.551	6	0.236
P315	C-P315	17	0.669	17	0.669	8	0.315
P316	C-P316	17	0.669	17	0.669	8	0.315
P317	C-P317	17	0.669	17	0.669	8	0.315
P318	C-P318	17	0.669	17	0.669	8	0.315
P319	C-P319	17	0.669	17	0.669	8	0.315
P320	C-P320	17	0.669	17	0.669	8	0.315
P321	C-P321	17	0.669	17	0.669	8	0.315
P322	C-P322	19	0.748	19	0.748	10	0.394
P324	C-P324	19	0.748	19	0.748	10	0.394
P326	C-P326	23	0.906	23	0.906	12	0.472
P328	C-P328	23	0.906	23	0.906	12	0.472



F



C-F



FL, C-FL

Designation of the housings		*a* mm	*a* inch	*b* mm	*b* inch	Recommended pin diameter mm	Recommended pin diameter inch
F204	C-F204	33	1.229	6	0.236	4	0.157
F205	C-F205	35	1.378	6	0.236	4	0.157
F206	C-F206	35	1.378	6	0.236	4	0.157
F207	C-F207	38	1.496	7	0.276	5	0.197
F208	C-F208	40	1.575	8	0.315	5	0.197
F209	C-F209	43	1.693	8	0.315	5	0.197
F210	C-F210	49	1.929	8	0.315	5	0.197
F211	C-F211	49	1.929	8	0.315	5	0.197
F212	C-F212	49	1.929	8	0.315	5	0.197
F213	C-F213	52	2.047	9	0.354	6	0.236
F214	C-F214	52	2.047	9	0.354	6	0.236
F215	C-F215	52	2.047	9	0.354	6	0.236
F216	C-F216	55	2.165	12	0.472	6	0.236
F217	C-F217	55	2.165	12	0.472	6	0.236
F218	C-F218	61	2.402	14	0.551	6	0.236
F305	C-F305	35	1.378	6	0.236	4	0.157
F306	C-F306	40	1.575	6	0.236	4	0.157
F307	C-F307	47	1.805	8	0.315	5	0.197
F308	C-F308	48	1.890	8	0.315	5	0.197
F309	C-F309	48	1.890	8	0.315	5	0.197
F310	C-F310	48	1.890	8	0.315	5	0.197
F311	C-F311	51	2.008	10	0.394	5	0.197
F312	C-F312	51	2.008	10	0.394	5	0.197
F313	C-F313	57	2.244	10	0.394	6	0.236
F314	C-F314	61	2.402	10	0.394	6	0.236
F315	C-F315	65	2.559	8.5	0.335	6	0.236
F316	C-F316	65	2.559	8.5	0.335	6	0.236
F317	C-F317	70	2.756	9	0.354	6	0.236
F318	C-F318	80	3.150	10	0.394	8	0.315
F319	C-F319	80	3.150	10	0.394	8	0.315
F320	C-F320	80	3.150	10	0.394	8	0.315
F321	C-F321	80	3.150	10	0.394	8	0.315
F322	C-F322	90	3.543	10	0.394	8	0.315
F324	C-F324	90	3.543	13	0.512	10	0.394
F326	C-F326	100	3.937	13	0.512	10	0.394
F328	C-F328	108	4.252	13	0.512	10	0.394

Designation of the housings		*a* mm	*a* inch	*b* mm	*b* inch	Recommended pin diameter mm	Recommended pin diameter inch
FL204	C-FL204	22	0.866	10	0.394	4	0.157
FL205	C-FL205	32	1.260	10	0.394	4	0.157
FL206	C-FL206	33	1.299	12	0.472	4	0.157
FL207	C-FL207	30	1.181	14	0.551	5	0.197
FL208	C-FL208	33	1.299	15	0.591	5	0.197
FL209	C-FL209	38	1.496	15	0.591	5	0.197
FL210	C-FL210	39	1.535	16	0.630	5	0.197
FL211	C-FL211	44	1.732	18	0.709	5	0.197
FL212	C-FL212	54	2.126	19	0.748	5	0.197
FL213	C-FL213	53	2.087	18	0.709	6	0.236
FL214	C-FL214	53	2.087	18	0.709	6	0.236
FL215	C-FL215	55	2.165	21	0.827	6	0.236
FL216	C-FL216	55	2.165	21	0.827	6	0.236
FL217	C-FL217	55	2.165	21	0.827	6	0.236
FL218	C-FL218	55	2.165	22	0.866	6	0.236
FL305	C-FL305	35	1.378	9	0.354	4	0.157
FL306	C-FL306	44	1.732	11	0.433	4	0.157
FL307	C-FL307	43	1.693	13	0.512	5	0.197
FL308	C-FL308	45	1.772	15	0.591	5	0.197
FL309	C-FL309	51	2.008	18	0.709	5	0.197
FL310	C-FL310	55	2.165	15	0.591	5	0.197
FL311	C-FL311	55	2.165	15	0.591	5	0.197
FL312	C-FL312	60	2.363	18	0.709	5	0.197
FL313	C-FL313	59	2.323	24	0.945	6	0.236
FL314	C-FL314	63	2.480	24	0.945	6	0.236
FL315	C-FL315	66	2.598	23	0.906	6	0.236
FL316	C-FL316	72	2.835	27	1.063	6	0.236
FL317	C-FL317	74	2.913	29	1.142	6	0.236
FL318	C-FL318	74	2.913	29	1.142	8	0.315
FL319	C-FL319	80	3.150	30	1.181	8	0.315
FL320	C-FL320	84	3.307	30	1.181	8	0.315
FL321	C-FL321	84	3.307	30	1.181	8	0.315
FL322	C-FL322	84	3.307	36	1.417	8	0.315
FL324	C-FL324	93	3.661	38	1.496	10	0.394
FL326	C-FL326	94	3.701	39	1.535	10	0.394
FL328	C-FL328	102	4.016	40	1.575	10	0.394

9.1.2 Cartridge type

The inside diameter of the housing into which a cartridge type unit is inserted should be H7 under general operating conditions. It should be so furnished as to permit the bearing unit to move freely in the axial direction.

9.2 Mounting the bearing unit on the shaft

9.2.1 Mounting of the set screw system unit

To mount the set screw system bearing unit on the shaft, it is sufficient to tighten the two set screws uniformly.

The construction of the **NTN** "Ball-End Set Screw" is illustrated in Fig. 9.4 with the pin design that prevents it from becoming loose even when it is subjected to vibrations or impact loads.

If the fit clearance between the inner ring and the shaft is very small, it is advisable, prior to fastening on the screw, to file off that part of the shaft at which the end of the set screw (ball) strikes, by approximately 0.2 to 0.5mm 0.01 to 0.02 inches, to flatten it , as illustrated in Fig. 9.5.

This will facilitate dismounting of the bearing from the shaft should it become necessary.

The method of mounting the unit on the shaft is as follows:

1) Make certain that the end of the set screw is not protruding into the bore of the bearing.

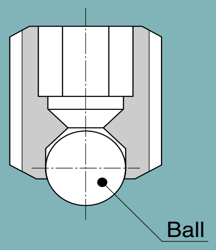


Fig. 9.4

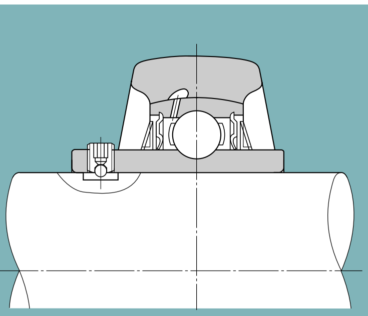


Fig. 9.5

2) Holding the unit at right angles to the shaft, insert the shaft into the bore of the bearing without twisting the bearing. Take care not to strike the slinger nor to subject the unit to any shock (Fig. 9.6).

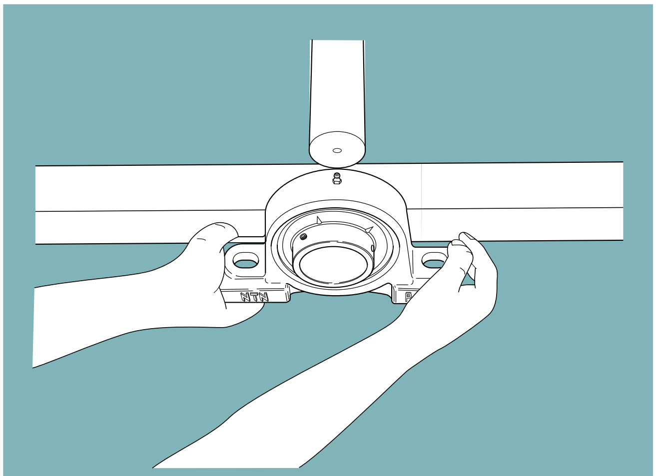


Fig. 9.6

3) Insert a hexagonal bar wrench securely into the hexagonal hole of the set screw, and tighten the two screws uniformly. Use the tightening torque shown in Table 9.2.

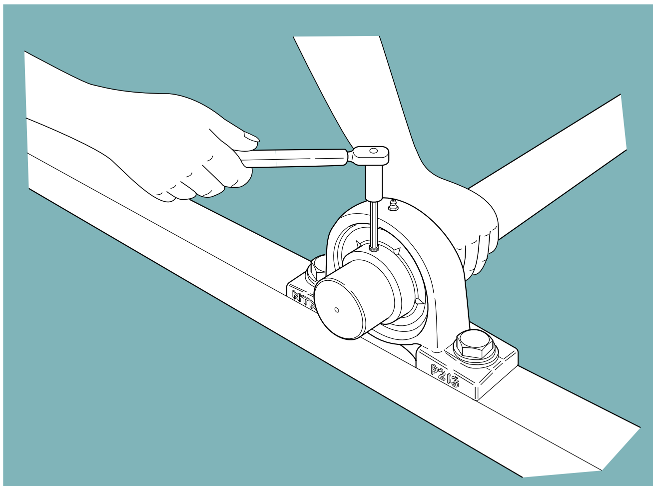


Fig. 9.7

4) Mount the housing securely in position on the machine. Sometimes the order of steps 3) and 4) is reversed.

Table 9.2 Recommended torques for tightening set screws

A) Metric series, applied to metric bore size.

Designation of the bearings of applicable units			Designation of set screws	Tightening torques N・m (max.)
UC201 to UC205	—	—	M 5×0.8 × 7	3.9
UC206	—	UC305 to UC306	M 6×0.75× 8	4.9
UC207	UCX05	—	M 6×0.75× 8	5.8
UC208 to UC210	—	—	M 8×1 ×10	7.8
UC211	UCX06 to UCX08	UC307	M 8×1 ×10	9.8
UC212	UCX09	—	M10×1.25×12	16.6
UC213 to UC215	—	UC308 to UC309	M10×1.25×12	19.6
UC216	UCX10	—	M10×1.25×12	22.5
—	UCX11 to UCX12	—	M10×1.25×12	24.5
UC217 to UC218	UCX13 to UCX15	UC310 to UC314	M12×1.5 ×13	29.4
—	UCX16 to UCX17	—	M12×1.5 ×13	34.3
—	UCX18	UC315 to UC316	M14×1.5 ×15	34.3
—	UCX20	UC317 to UC319	M16×1.5 ×18	53.9
—	—	UC320 to UC324	M18×1.5 ×20	58.8
—	—	UC326 to UC328	M20×1.5 ×25	78.4

B) Inch series, applied to inch bore size.

Designation of the bearings for the unit to which torques given are applicable			Designation of set screws	Tightening torques lbf· inch (max.)
UC201 to UC205	—	—	No.10-32UNF	34
UC206	—	UC305 to UC306	1/4-28UNF	43
UC207	UCX05	—	1/4-28UNF	52
UC208 to UC210	—	—	5/16-24UNF	69
UC211	UCX06 to UCX08	UC307	5/16-24UNF	86
UC212	UCX09	—	3/8-24UNF	147
UC213 to UC215	—	UC308 to UC309	3/8-24UNF	173
UC216	UCX10	—	3/8-24UNF	199
—	UCX11 to UCX12	—	3/8-24UNF	216
UC217 to UC218	UCX13 to UCX15	UC310 to UC314	1/2-20UNF	260
—	UCX16 to UCX17	—	1/2-20UNF	303
—	UCX18	UC315 to UC316	9/16-18UNF	303
—	UCX20	UC317 to UC319	5/8-18UNF	477
—	—	UC320	5/8-18UNF	520

Designation of the bearings of applicable units	Designation of set screws	Tightening torques N・m (max.)
AS201 to 205	M5×0.8 × 7	3.4
AS206	M6×0.75× 8	4.4
AS207	M6×0.75× 8	4.9
AS208	M8×1 ×10	6.8

Designation of the bearings for the unit to which torques given are applicable	Designation of set screws	Tightening torques lbf· inch (max.)
AS201 to 205	No.10-32UNF	30
AS206	1/4-28UNF	39
AS207	1/4-28UNF	43
AS208	5/16-24UNF	60

9.2.2 Mounting the eccentric locking collar system unit

In this system, unlike the screw system, the shaft and inner ring are fastened together by fastening the eccentric collar in the direction of the rotation of the shaft. They are fastened together securely, and deformation of the inner ring seldom occurs. This system, however, is not recommended for applications where the direction of rotation is sometimes reversed.

Directions for mounting the unit are as follows :

1) Make certain that the frame in which the housing is to be mounted is suitable to the operating conditions with regard to rigidity, flatness, etc.
2) Make sure that the end of the shaft is not burred and that the end of the set screw in the eccentric collar is not protruding from the interior surface of the collar (Fig. 9.8).

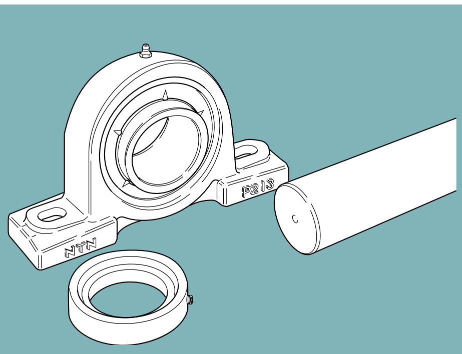


Fig. 9.8

3) Mount the housing of the unit securely onto the frame.
4) Determine the relative position of the unit and the shaft accurately so that the unit will not be subjected to any thrust, and then insert the eccentric collar (Fig. 9.9).

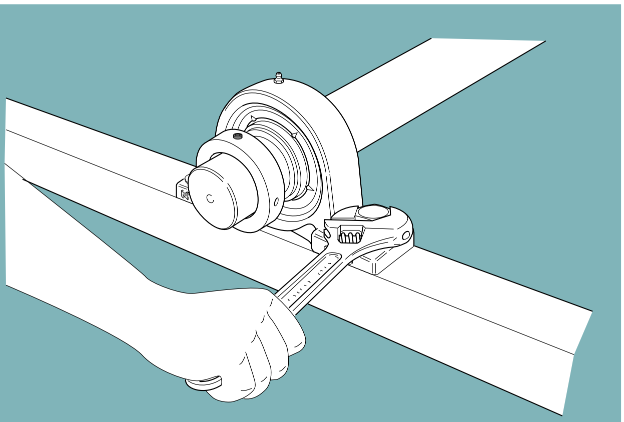


Fig. 9.9

5) Fit the eccentric circular ridge provided on the inner ring into the eccentric circular groove of the eccentric collar, and then provisionally tighten by turning the collar by hand in the direction of the shaft (Fig. 9.10).

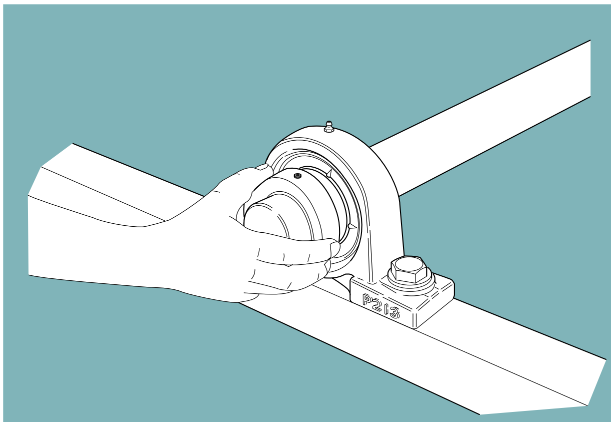


Fig. 9.10

6) Insert a bar into the hole provided on the periphery of the eccentric collar and tap the bar so that the collar turns in the direction of rotation of the shaft (see Fig. 9.11).

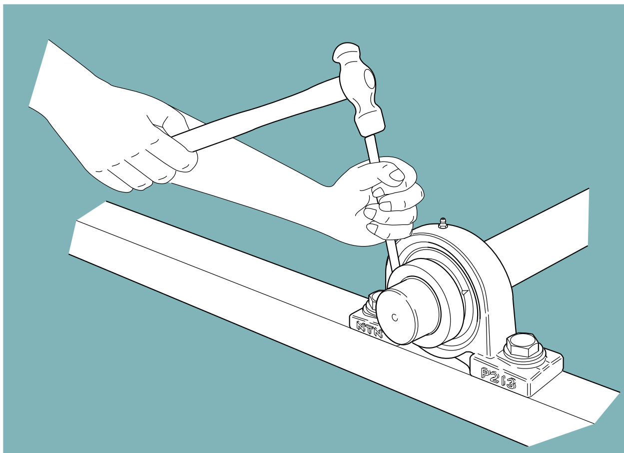


Fig. 9.11

7) Fasten the set screw of the eccentric collar onto the shaft. Recommended tightening torques are given in Table 9.3.

Table 9.3 Recommended torques for tightening set screws of the eccentric collar

A) Metric series, applied to metric bore size.

Designation of the bearings of applicable units			Designation of set screws	Tightening torques N·m (max.)
—	UEL204 to UEL205	AEL201 to AEL205	M 6×0.75× 8	7.8
UEL303 to UEL307	UEL206	AEL206	M 8×1 ×10	9.8
—	UEL207	AEL207	M10×1.25×12	11.7
—	UEL208 to UEL210	AEL208	M10×1.25×12	15.6
—	UEL211	—	M10×1.25×12	19.6
UEL308 to UEL312	UEL212 to UEL215	—	M10×1.25×12	29.4
UEL313 to UEL314	—	—	M12×1.5 ×13	34.3
UEL315 to UEL317	—	—	M16×1.5 ×18	53.9
UEL318 to UEL320	—	—	M20×1.5 ×25	78.4

B) Inch series, applied to inch bore size.

Designation of the bearings for the unit to which torques given are applicable			Designation of set screws	Tightening torques lbf· inch (max.)
—	UEL204 to UEL205	AEL201 to AEL205	1/4-28UNF	69
UEL303 to UEL307	UEL206	AEL206	5/16-24UNF	86
—	UEL207	AEL207	3/8-24UNF	104
—	UEL208 to UEL210	AEL208	3/8-24UNF	138
—	UEL211	—	3/8-24UNF	173
UEL308 to UEL312	UEL212 to UEL215	—	3/8-24UNF	260
UEL313 to UEL314	—	—	1/2-20UNF	350
UEL315 to UEL317	—	—	5/8-18UNF	520
UEL318 to UEL328	—	—	3/4-16UNF	700

9.2.3 Mounting of the adapter system unit

When an adapter system unit is used, there is no danger of the fit between the shaft and the inner ring working loose even if it is subjected to impact loads or vibration. Furthermore, straight shafts of h9 may be used under any operating conditions, except where there is a large axial load.

To mount the adapter system unit onto the shaft, the procedure is as follows:

1) Adjust the position of the sleeve so that the tapered part comes to about the center of the bearing. To facilitate the mounting of the sleeve onto the shaft, the opening in the sleeve can be widened using a screwdriver or similar implement. The sleeve should be positioned so that the nut is located on the opposite side from the pulley, etc., for easier handling (Fig. 9.12).

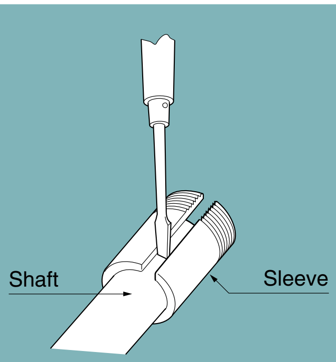


Fig. 9.12

2) Place the bearing unit with the tapered bore properly oriented on the sleeve and abut a cylindrical sleeve against the lock nut side face of the inner ring. Tap the adapter sleeve lightly over its entire periphery, as shown in Fig. 9.13, until a positive contact is made between the bearing and the sleeve.

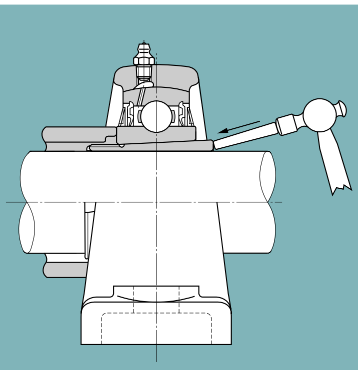


Fig. 9.13

3) Insert the washer and tighten the nut fully by hand.
4) Apply a jig (or screwdriver where no jig is available) to the notch of the nut and tap it with a hammer. Stop tapping after the nut has turned through from 60˚ to 90˚.
   Be careful not to strike the slinger.
   Care should also be taken not to over-tighten the nut, as this will deform the inner ring, causing heat generation and seizure.
5) Bend up the tab on the rim of the washer, which is in line with the notch of the nut. This will prevent the nut from turning. The nut must not be turned backwards to bring the notch into line with the tab on the washer.
6) Mount the housing securely in position on the machine.

9.2.4 Mounting covered bearing units

For selection of the shaft, mounting the bearing onto the shaft and fitting the housing follow the same procedure as for standard bearing units. Furthermore, fitting the cover presents no special difficulty, with no need for special tools or jigs.

The procedure for mounting covered bearing units is as follows:

1) Remove the cover from the bearing unit. The steel cover can usually be removed easily by hand, but should there be any difficulty due to an over-tight fit, insert a screwdriver or similar tool in a twisting motion, as shown in Fig. 9.14.

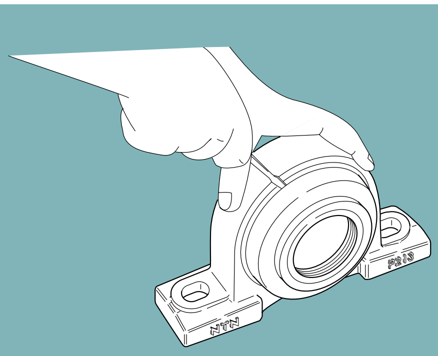


Fig. 9.14

2) In order to augment the dust and waterproofing effects, completely fill the space between the two lips of the rubber seal incorporated in the cover with grease, and apply grease to the inside of the cover, filling about two-thirds of the space. Cup grease is commonly used for this purpose (Fig. 9.15).

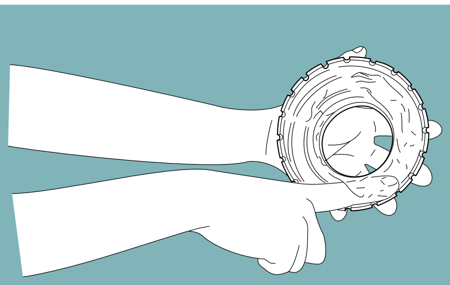


Fig. 9.15

3) First, pass one of the two grease-packed covers along the shaft, and then slide the bearing unit onto the shaft and fix the inner ring fast on the shaft before tightening the bolts holding the housing. Sometimes these steps are reversed for convenience of assembly. It is recommended that the end of the shaft be chamfered beforehand to avoid damaging the lips of the rubber seal.
4) Next take the cover which has been passed along the shaft and press it into the housing as follows: Be careful not to strike the surface of the steel cover directly with a steel hammer but use a synthetic resin or wood block in between. Do not strike only in one place but tap the cover all the way round until it is firmly seated in the housing. (Fig. 9.16)
   The cast iron cover is fastened with three bolts.

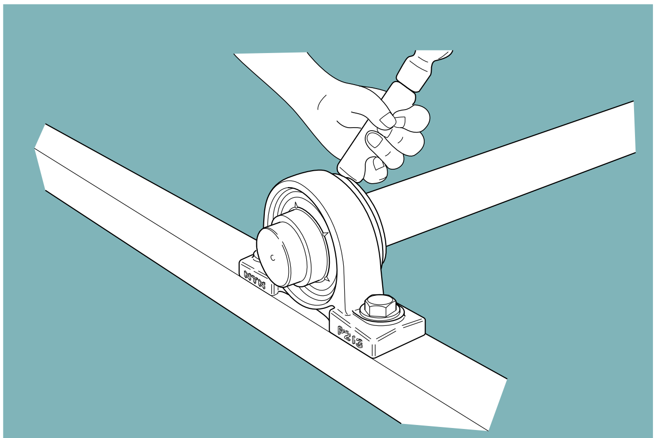


Fig. 9.16

5) Pack the second cover with grease as in step 2 and pass it along the shaft. In the case of a blind cover, the recess of the housing should be filled with grease (Fig. 9.15).
6) Fit the cover into the recess of the housing using the same procedure as detailed in Step 4) (Fig. 9.17).

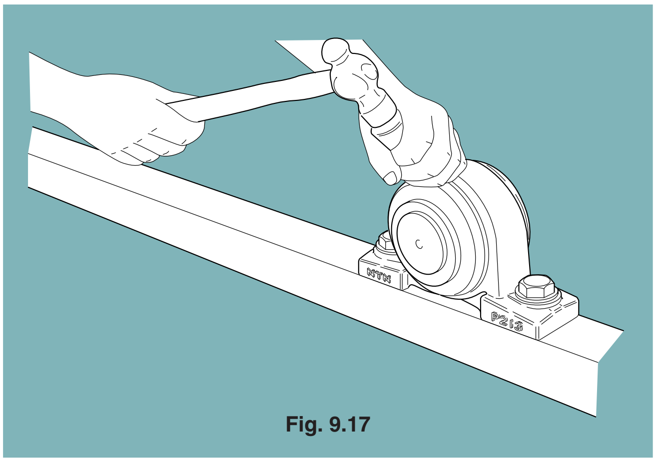


Fig. 9.17

9.3 Running tests

After mounting the bearing unit, check that it has been done correctly.

First, turn the shaft or the rotor by hand to make certain that it rotates smoothly. If there is no irregularity, start up the machine. Run the machine at low speed under no load and gradually bring it up to full operating speed while checking that there are no abnormalities.

Some indications of abnormality or faulty assembly are as follows:

When the shaft is turned by hand a resistance or drag is felt, or the shaft appears to become heavy or light in turn. Or, if the machine is running under power, any abnormal noise, vibration or overheating is evident.

9.4 Inspection during operation

Although the **NTN** lubrication-free bearing unit does not require refilling with grease while in use, periodic inspections are necessary to ensure safe operation of the unit's most important parts. While the interval between inspections varies from case to case, according to the degree of importance and the rate of operation, it is usually some time between two weeks and a month.

Since the inside of the bearing can be examined only by removing the slinger, seal etc., the condition of the bearing should be judged by checking for the presence of vibration, noise, overheating of the housing, etc., while the machine is running.

9.5 Dismounting the bearing unit

If some abnormality makes it necessary to dismount the bearing unit from the shaft in order to replace it, the procedure used to mount the bearing is followed in reverse order. In this case, special care should be given to the following points:

1) Set screw system units:

If the set screw is protruding into the bore of the bearing when the unit is withdrawn from the shaft, it will damage the shaft. Therefore the screw should be turned back fully.

2) Adapter system units:

To remove an adapter system bearing unit from the shaft, raise the tab of the washer, turn the nut two or three turns back, and apply a metal block to the nut and tap it with a hammer. Do this all round the nut, until the sleeve can be moved (Fig. 9.18).

If the nut is turned back too far and the screws are only slightly engaged, tapping to remove it will eventually ruin the screws.

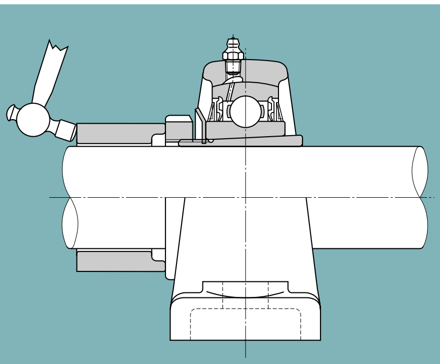


Fig. 9.18

9.6 Replacement of the bearing

If the bearing in the **NTN** bearing unit needs to be replaced, this can be carried out simply with a plummer block. There is no need to replace the housing, as it is reusable.

The bearing is changed using the following procedure: First, the set screw should be tightened as much as possible. Otherwise, there is a danger that it may catch in the housing when the bearing is tilted.

Next, insert the handle of a hammer or similar tool into the bore of the bearing and twist. Tilt the bearing through a full 90, and pull it in the direction of the notch on the housing to remove it. To install a new bearing in the housing, follow the same procedure in reverse.

Dimension Table

PAGE

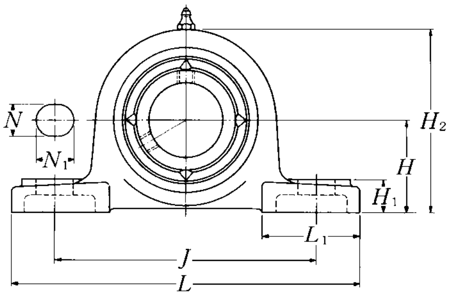
Set screw type

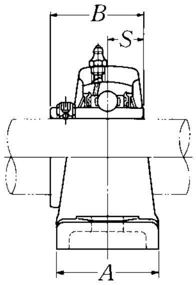
Eccentric locking collar type

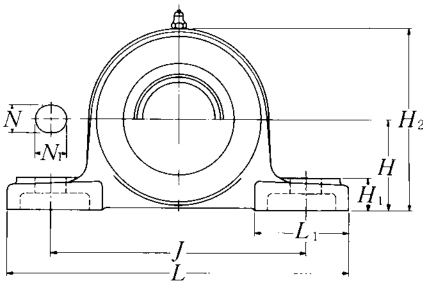
Adapter type

Ball bearings

Pillow blocks cast housing
Set screw type



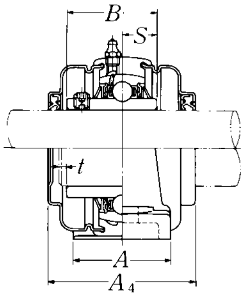


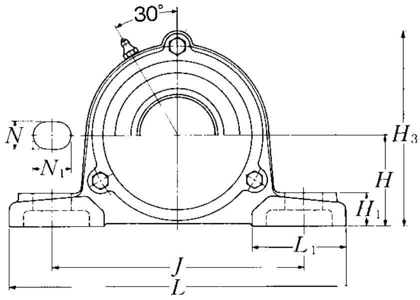


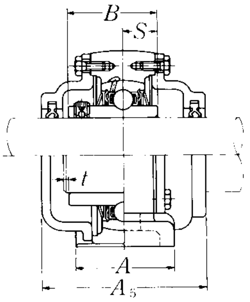
Pressed steel dust cover type
Open end: **S-UCP···D1**
Closed end: **SM-UCP···D1**

Shaft dia. mm inch	Unit number [1]	Nominal dimensions mm inch.											Bolt size mm inch	Bearing number
		H	*L*	*J*	*A*	*N*	*N*1	*H*1	*H*2	*L*1	*B*	*S*		
12	UCP201D1	30.2	127	95	38	13	16	14	62	42	31	12.7	M10	UC201D1
$\frac{1}{2}$	UCP201-008D1	$1\frac{3}{16}$	5	$3\frac{3}{4}$	$1\frac{1}{2}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{9}{16}$	$2\frac{7}{16}$	$1\frac{21}{32}$	1.2205	0.500	$\frac{3}{8}$	UC201-008D1
15	UCP202D1	30.2	127	95	38	13	16	14	62	42	31	12.7	M10	UC202D1
$\frac{9}{16}$	UCP202-009D1	$1\frac{3}{16}$	5	$3\frac{3}{4}$	$1\frac{1}{2}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{9}{16}$	$2\frac{7}{16}$	$1\frac{21}{32}$	1.2205	0.500	$\frac{3}{8}$	UC202-009D1
$\frac{5}{8}$	UCP202-010D1													UC202-010D1
17	UCP203D1	30.2	127	95	38	13	16	14	62	42	31	12.7	M10	UC203D1
$\frac{11}{16}$	UCP203-011D1	$1\frac{3}{16}$	5	$3\frac{3}{4}$	$1\frac{1}{2}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{9}{16}$	$2\frac{7}{16}$	$1\frac{21}{32}$	1.2205	0.500	$\frac{3}{8}$	UC203-011D1
20	UCP204D1	33.3	127	95	38	13	16	14	65	42	31	12.7	M10	UC204D1
$\frac{3}{4}$	UCP204-012D1	$1\frac{5}{16}$	5	$3\frac{3}{4}$	$1\frac{1}{2}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{9}{16}$	$2\frac{9}{16}$	$1\frac{21}{32}$	1.2205	0.500	$\frac{3}{8}$	UC204-012D1
25	UCP205D1	36.5	140	105	38	13	16	15	71	42	34.1	14.3	M10	UC205D1
$\frac{13}{16}$	UCP205-013D1	$1\frac{7}{16}$	$5\frac{1}{2}$	$4\frac{1}{8}$	$1\frac{1}{2}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{19}{32}$	$2\frac{25}{32}$	$1\frac{21}{32}$	1.3425	0.563	$\frac{3}{8}$	UC205-013D1
$\frac{7}{8}$	UCP205-014D1													UC205-014D1
$\frac{15}{16}$	UCP205-015D1													UC205-015D1
1	UCP205-100D1													UC205-100D1
30	UCP206D1	42.9	165	121	48	17	20	17	83	54	38.1	15.9	M14	UC206D1
$1\frac{1}{16}$	UCP206-101D1	$1\frac{11}{16}$	$6\frac{1}{2}$	$4\frac{3}{4}$	$1\frac{7}{8}$	$\frac{21}{32}$	$\frac{25}{32}$	$\frac{21}{32}$	$3\frac{9}{32}$	$2\frac{1}{8}$	1.5000	0.626	$\frac{1}{2}$	UC206-101D1
$1\frac{1}{8}$	UCP206-102D1													UC206-102D1
$1\frac{3}{16}$	UCP206-103D1													UC206-103D1
$1\frac{1}{4}$	UCP206-104D1													UC206-104D1
35	UCP207D1	47.6	167	127	48	17	20	18	93	54	42.9	17.5	M14	UC207D1
$1\frac{1}{4}$	UCP207-104D1	$1\frac{7}{8}$	$6\frac{9}{16}$	5	$1\frac{7}{8}$	$\frac{21}{32}$	$\frac{25}{32}$	$\frac{23}{32}$	$3\frac{21}{32}$	$2\frac{1}{8}$	1.6890	0.689	$\frac{1}{2}$	UC207-104D1
$1\frac{5}{16}$	UCP207-105D1													UC207-105D1
$1\frac{3}{8}$	UCP207-106D1													UC207-106D1
$1\frac{7}{16}$	UCP207-107D1													UC207-107D1
40	UCP208D1	49.2	184	137	54	17	20	18	98	52	49.2	19	M14	UC208D1
$1\frac{1}{2}$	UCP208-108D1	$1\frac{15}{16}$	$7\frac{1}{4}$	$5\frac{13}{32}$	$2\frac{1}{8}$	$\frac{21}{32}$	$\frac{25}{32}$	$\frac{23}{32}$	$3\frac{27}{32}$	$2\frac{1}{16}$	1.9370	0.748	$\frac{1}{2}$	UC208-108D1
$1\frac{9}{16}$	UCP208-109D1													UC208-109D1
45	UCP209D1	54	190	146	54	17	20	20	106	60	49.2	19	M14	UC209D1
$1\frac{5}{8}$	UCP209-110D1	$2\frac{1}{8}$	$7\frac{15}{32}$	$5\frac{3}{4}$	$2\frac{1}{8}$	$\frac{21}{32}$	$\frac{25}{32}$	$\frac{25}{32}$	$4\frac{3}{16}$	$2\frac{3}{8}$	1.9370	0.748	$\frac{1}{2}$	UC209-110D1
$1\frac{11}{16}$	UCP209-111D1													UC209-111D1
$1\frac{3}{4}$	UCP209-112D1													UC209-112D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



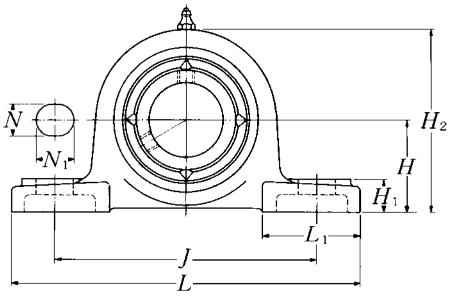


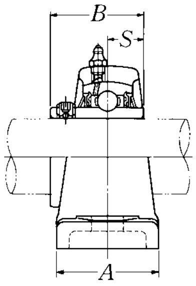


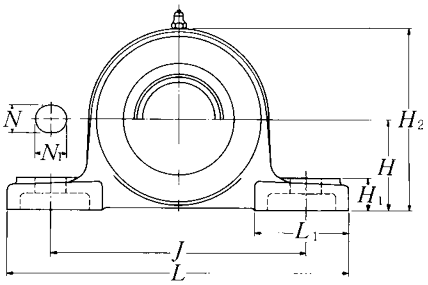
Cast dust cover type
Open end: **C-UCP···D1**
Closed end: **CM-UCP···D1**

Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions				Mass of unit		
				mm	inch		kg	lb	
			t max.	A_4	H_3	A_5	UCP	S(SM)	C(CM)
P203D1	**S(SM)-UCP201D1**	**C(CM)-UCP201D1**	2	51	67	62	0.7	0.7	1.0
P203D1	**S(SM)-UCP201-008D1**	**C(CM)-UCP201-008D1**	$\frac{5}{64}$	2	$2\frac{41}{64}$	$2\frac{7}{16}$	1.5	1.5	2.2
P203D1	**S(SM)-UCP202D1**	**C(CM)-UCP202D1**	2	51	67	62	0.7	0.7	1.0
P203D1	**S(SM)-UCP202-009D1**	**C(CM)-UCP202-009D1**	$\frac{5}{64}$	2	$2\frac{41}{64}$	$2\frac{7}{16}$	1.5	1.5	2.2
P203D1	**S(SM)-UCP202-010D1**	**C(CM)-UCP202-010D1**							
P203D1	**S(SM)-UCP203D1**	**C(CM)-UCP203D1**	2	51	67	62	0.7	0.7	1.0
P203D1	**S(SM)-UCP203-011D1**	**C(CM)-UCP203-011D1**	$\frac{5}{64}$	2	$2\frac{41}{64}$	$2\frac{7}{16}$	1.5	1.5	2.2
P204D1	**S(SM)-UCP204D1**	**C(CM)-UCP204D1**	2	51	70	62	0.7	0.7	1.0
P204D1	**S(SM)-UCP204-012D1**	**C(CM)-UCP204-012D1**	$\frac{5}{64}$	2	$2\frac{3}{4}$	$2\frac{7}{16}$	1.5	1.5	2.2
P205D1	**S(SM)-UCP205D1**	**C(CM)-UCP205D1**	2	57	76	70	0.8	0.9	1.2
P205D1	**S(SM)-UCP205-013D1**	**C(CM)-UCP205-013D1**	$\frac{5}{64}$	$2\frac{1}{4}$	3	$2\frac{3}{4}$	1.8	2.0	2.6
P205D1	**S(SM)-UCP205-014D1**	**C(CM)-UCP205-014D1**							
P205D1	**S(SM)-UCP205-015D1**	**C(CM)-UCP205-015D1**							
P205D1	**S(SM)-UCP205-100D1**	**C(CM)-UCP205-100D1**							
P206D1	**S(SM)-UCP206D1**	**C(CM)-UCP206D1**	2	62	88	75	1.3	1.4	1.9
P206D1	**S(SM)-UCP206-101D1**	**C(CM)-UCP206-101D1**	$\frac{5}{64}$	$2\frac{7}{16}$	$3\frac{14}{32}$	$2\frac{14}{16}$	2.9	3.1	4.2
P206D1	**S(SM)-UCP206-102D1**	**C(CM)-UCP206-102D1**							
P206D1	**S(SM)-UCP206-103D1**	**C(CM)-UCP206-103D1**							
P206D1	—	—							
P207D1	**S(SM)-UCP207D1**	**C(CM)-UCP207D1**	3	72	99	80	1.6	1.7	2.3
P207D1	**S(SM)-UCP207-104D1**	**C(CM)-UCP207-104D1**	$\frac{1}{8}$	$2\frac{26}{32}$	$3\frac{28}{32}$	$3\frac{5}{32}$	3.5	3.7	5.1
P207D1	**S(SM)-UCP207-105D1**	**C(CM)-UCP207-105D1**							
P207D1	**S(SM)-UCP207-106D1**	**C(CM)-UCP207-106D1**							
P207D1	—	—							
P208D1	**S(SM)-UCP208D1**	**C(CM)-UCP208D1**	3	82	105	90	1.9	2.1	3.2
P208D1	**S(SM)-UCP208-108D1**	**C(CM)-UCP208-108D1**	$\frac{1}{8}$	$3\frac{7}{32}$	$4\frac{1}{8}$	$3\frac{16}{32}$	4.2	4.6	7.1
P208D1	**S(SM)-UCP208-109D1**	**C(CM)-UCP208-109D1**							
P209D1	**S(SM)-UCP209D1**	**C(CM)-UCP209D1**	3	82	113	95	2.2	2.4	3.5
P209D1	**S(SM)-UCP209-110D1**	**C(CM)-UCP209-110D1**	$\frac{1}{8}$	$3\frac{7}{32}$	$4\frac{7}{16}$	$3\frac{3}{4}$	4.9	5.3	7.7
P209D1	**S(SM)-UCP209-111D1**	**C(CM)-UCP209-111D1**							
P209D1	**S(SM)-UCP209-112D1**	**C(CM)-UCP209-112D1**							

Pillow blocks cast housing
Set screw type



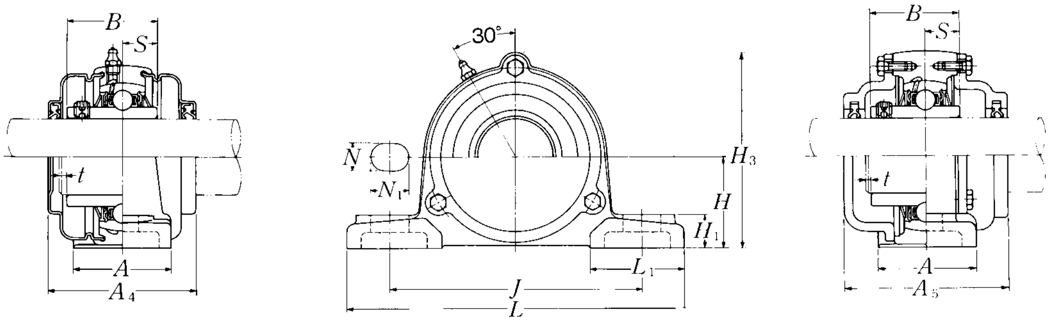




Pressed steel dust cover type
Open end: **S-UCP···D1**
Closed end: **SM-UCP···D1**

Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch											Bolt size mm inch	Bearing number
		H	*L*	*J*	*A*	*N*	N_1	H_1	H_2	L_1	*B*	*S*		
50	UCP210D1	57.2	206	159	60	20	23	21	114	65	51.6	19	M16	UC210D1
1 13/16	UCP210-113D1	2 1/4	8 1/8	6 1/4	2 3/8	25/32	29/32	13/16	4 1/2	2 9/16	2.0315	0.748	5/8	UC210-113D1
1 7/8	UCP210-114D1													UC210-114D1
1 15/16	UCP210-115D1													UC210-115D1
2	UCP210-200D1													UC210-200D1
55	UCP211D1	63.5	219	171	60	20	23	23	126	65	55.6	22.2	M16	UC211D1
2	UCP211-200D1	2 1/2	8 5/8	6 23/32	2 3/8	25/32	29/32	29/32	4 31/32	2 9/16	2.1890	0.874	5/8	UC211-200D1
2 1/16	UCP211-201D1													UC211-201D1
2 1/8	UCP211-202D1													UC211-202D1
2 3/16	UCP211-203D1													UC211-203D1
60	UCP212D1	69.8	241	184	70	20	23	25	138	70	65.1	25.4	M16	UC212D1
2 1/4	UCP212-204D1	2 3/4	9 1/2	7 1/4	2 3/4	25/32	29/32	31/32	5 7/16	2 3/4	2.5630	1.000	5 5/8	UC212-204D1
2 5/16	UCP212-205D1													UC212-205D1
2 3/8	UCP212-206D1													UC212-206D1
2 7/16	UCP212-207D1													UC212-207D1
65	UCP213D1	76.2	265	203	70	25	28	27	151	77	65.1	25.4	M20	UC213D1
2 1/2	UCP213-208D1	3	10 7/16	8	2 3/4	31/32	1 3/32	1 1/16	5 15/16	3 1/32	2.5630	1.000	3/4	UC213-208D1
2 9/16	UCP213-209D1													UC213-209D1
70	UCP214D1	79.4	266	210	72	25	28	27	157	77	74.6	30.2	M20	UC214D1
2 5/8	UCP214-210D1	3 1/8	10 15/32	8 9/32	2 27/32	31/32	1 3/32	1 1/16	6 3/16	3 1/32	2.9370	1.189	3/4	UC214-210D1
2 11/16	UCP214-211D1													UC214-211D1
2 3/4	UCP214-212D1													UC214-212D1
75	UCP215D1	82.6	275	217	74	25	28	28	163	80	77.8	33.3	M20	UC215D1
2 13/16	UCP215-213D1	3 1/4	10 13/16	8 17/32	2 29/32	31/32	1 3/32	1 3/32	6 13/32	3 5/32	3.0630	1.311	3/4	UC215-213D1
2 7/8	UCP215-214D1													UC215-214D1
2 15/16	UCP215-215D1													UC215-215D1
3	UCP215-300D1													UC215-300D1
80	UCP216D1	88.9	292	232	78	25	28	30	175	85	82.6	33.3	M20	UC216D1
3 1/16	UCP216-301D1	3 1/2	11 1/2	9 1/8	3 1/16	31/32	1 3/32	1 3/16	6 7/8	3 11/32	3.2520	1.311	3/4	UC216-301D1
3 1/8	UCP216-302D1													UC216-302D1
3 3/16	UCP216-303D1													UC216-303D1

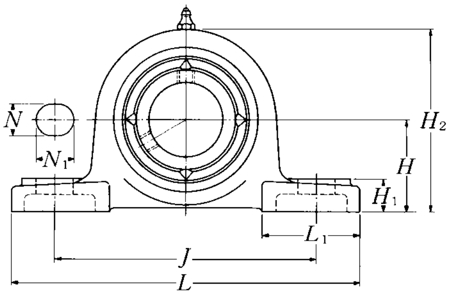
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

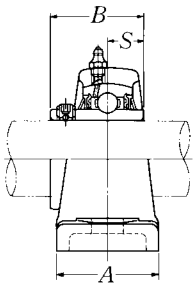


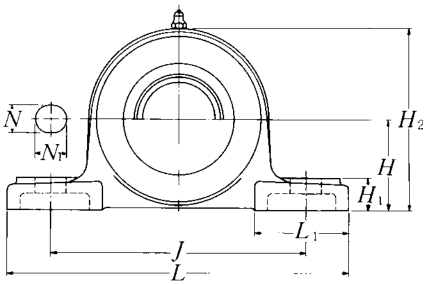
Cast dust cover type
Open end: **C-UCP···D1**
Closed end: **CM-UCP···D1**

Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions				Mass of unit		
				mm	inch		kg	lb	
			t max.	A_4	H_3	A_5	UCP	S(SM)	C(CM)
P210D1	S(SM)-UCP210D1	C(CM)-UCP210D1	3	87	119	100	2.6	2.8	4.3
P210D1	S(SM)-UCP210-113D1	C(CM)-UCP210-113D1	$\frac{1}{8}$	$3\frac{7}{16}$	$4\frac{11}{16}$	$3\frac{15}{16}$	5.7	6.2	9.5
P210D1	S(SM)-UCP210-114D1	C(CM)-UCP210-114D1							
P210D1	S(SM)-UCP210-115D1	C(CM)-UCP210-115D1							
P210D1	—	—							
P211D1	S(SM)-UCP211D1	C(CM)-UCP211D1	4	92	130	100	3.3	3.6	5.2
P211D1	S(SM)-UCP211-200D1	C(CM)-UCP211-200D1	$\frac{5}{32}$	$3\frac{5}{8}$	$5\frac{1}{8}$	$3\frac{15}{16}$	7.3	7.9	11
P211D1	S(SM)-UCP211-201D1	C(CM)-UCP211-201D1							
P211D1	S(SM)-UCP211-202D1	C(CM)-UCP211-202D1							
P211D1	S(SM)-UCP211-203D1	C(CM)-UCP211-203D1							
P212D1	S(SM)-UCP212D1	C(CM)-UCP212D1	4	102	143	115	4.6	5.0	6.7
P212D1	S(SM)-UCP212-204D1	C(CM)-UCP212-204D1	$\frac{5}{32}$	$4\frac{1}{32}$	$5\frac{5}{8}$	$4\frac{17}{32}$	10	11	15
P212D1	S(SM)-UCP212-205D1	C(CM)-UCP212-205D1							
P212D1	S(SM)-UCP212-206D1	C(CM)-UCP212-206D1							
P212D1	—	—							
P213D1	S(SM)-UCP213D1	C(CM)-UCP213D1	4	107	155	120	5.9	6.3	7.8
P213D1	S(SM)-UCP213-208D1	C(CM)-UCP211-208D1	$\frac{5}{32}$	$4\frac{7}{32}$	$6\frac{3}{32}$	$4\frac{23}{32}$	13	14	17
P213D1	S(SM)-UCP213-209D1	C(CM)-UCP213-209D1							
P214D1	—	C(CM)-UCP214D1	4	—	162	135	6.6	—	9.3
P214D1		C(CM)-UCP214-210D1	$\frac{5}{32}$	—	$6\frac{3}{8}$	$5\frac{5}{16}$	15	—	21
P214D1		C(CM)-UCP214-211D1							
P214D1		C(CM)-UCP214-212D1							
P215D1	—	C(CM)-UCP215D1	4	—	168	135	7.4	—	11
P215D1		C(CM)-UCP215-213D1	$\frac{5}{32}$	—	$6\frac{5}{8}$	$5\frac{5}{16}$	16	—	24
P215D1		C(CM)-UCP215-214D1							
P215D1		C(CM)-UCP215-215D1							
P215D1		C(CM)-UCP215-300D1							
P216D1	—	C(CM)-UCP216D1	4	—	181	145	9.0	—	13
P216D1		C(CM)-UCP216-301D1	$\frac{5}{32}$	—	$7\frac{1}{8}$	$5\frac{23}{32}$	20	—	29
P216D1		C(CM)-UCP216-302D1							
P216D1		C(CM)-UCP216-303D1							

Pillow blocks cast housing
Set screw type



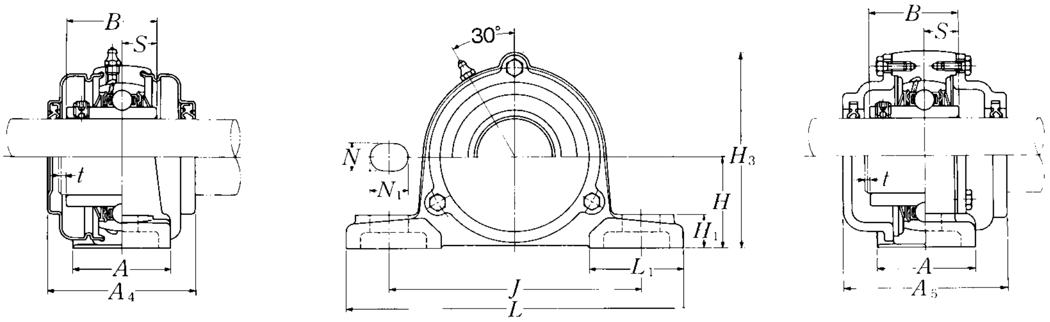




Pressed steel dust cover type
Open end: **S-UCP···D1**
Closed end: **SM-UCP···D1**

Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch H	L	J	A	N	N1	H1	H2	L1	B	S	Bolt size mm inch	Bearing number
85	**UCP217D1**	95.2	310	247	83	25	28	32	187	85	85.7	34.1	M20	UC217D1
3 1/4	**UCP217-304D1**													UC217-304D1
3 5/16	**UCP217-305D1**	3 3/4	12 7/32	9 23/32	3 9/32	31/32	1 3/32	1 1/4	7 3/8	3 11/32	3.3740	1.343	3/4	UC217-305D1
3 7/16	**UCP217-307D1**													UC217-307D1
90	**UCP218D1**	101.6	327	262	88	27	30	33	200	90	96	39.7	M22	UC218D1
3 1/2	**UCP218-308D1**	4	12 7/8	10 5/16	3 15/32	1 1/16	1 3/16	1 5/16	7 7/8	3 17/32	3.7795	1.563	7/8	UC218-308D1

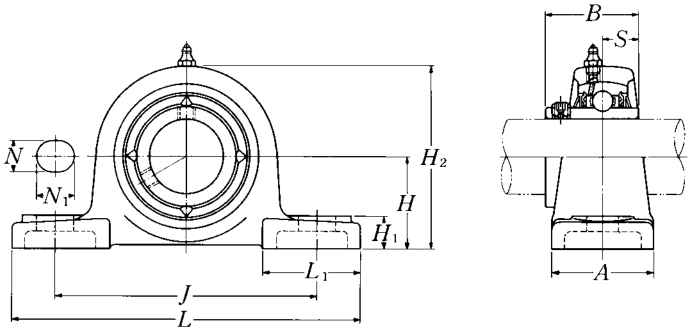
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UCP···D1**
Closed end: **CM-UCP···D1**

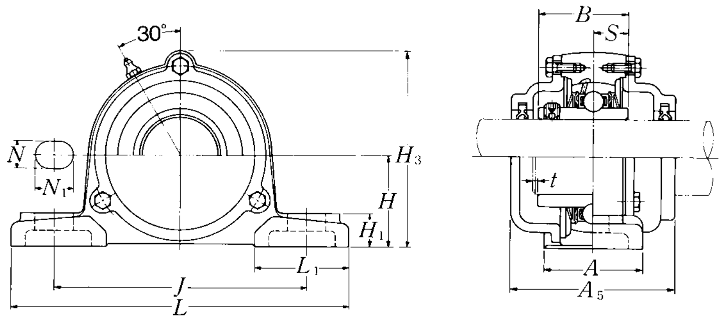
Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions				Mass of unit		
				mm	inch		kg		lb
			t max.	A_4	H_3	A_5	UCP	S(SM)	C(CM)
P217D1	—	**C(CM)-UCP217D1**	5	—	191	155	11	—	15
P217D1	—	**C(CM)-UCP217-304D1**	$\frac{13}{64}$	—	$7\frac{17}{32}$	$6\frac{3}{32}$	24	—	33
P217D1		**C(CM)-UCP217-305D1**							
P217D1		**C(CM)-UCP217-307D1**							
P218D1	—	**C(CM)-UCP218D1**	5	—	204	165	13	—	18
P218D1	—	**C(CM) UCP218-308D1**	$\frac{13}{64}$	—	$8\frac{1}{32}$	$6\frac{1}{2}$	29	—	40

Pillow blocks cast housing
Set screw type



Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch											Bolt size mm inch	Bearing number
		H	L	J	A	N	N1	H1	H2	L1	B	S		
25	**UCP305D1**	45	175	132	45	17	20	15	85	54	38	15	M14	UC305D1
13/16	**UCP305-013D1**	1 49/64	6 7/8	5 3/16	1 25/32	21/32	25/32	19/32	3 11/32	2 1/8	1.4961	0.591	1/2	UC305-013D1
7/8	**UCP305-014D1**													UC305-014D1
15/16	**UCP305-015D1**													UC305-015D1
1	**UCP305-100D1**													UC305-100D1
30	**UCP306D1**	50	180	140	50	17	20	18	95	54	43	17	M14	UC306D1
1 1/16	**UCP306-101D1**	1 31/32	7 3/32	5 1/2	1 31/32	21/32	25/32	23/32	3 3/4	2 1/8	1.6929	0.669	1/2	UC306-101D1
1 1/8	**UCP306-102D1**													UC306-102D1
1 3/16	**UCP306-103D1**													UC306-103D1
35	**UCP307D1**	56	210	160	56	17	25	20	106	60	48	19	M14	UC307D1
1 1/4	**UCP307-104D1**	2 13/64	8 9/32	6 5/16	2 7/32	21/32	31/32	25/32	4 3/16	2 3/8	1.8898	0.748	1/2	UC307-104D1
1 5/16	**UCP307-105D1**													UC307-105D1
1 3/8	**UCP307-106D1**													UC307-106D1
1 7/16	**UCP307-107D1**													UC307-107D1
40	**UCP308D1**	60	220	170	60	17	27	22	116	60	52	19	M14	UC308D1
1 1/2	**UCP308-108D1**	2 23/64	8 21/32	6 11/16	2 3/8	21/32	1 1/16	7/8	4 9/16	2 3/8	2.0472	0.748	1/2	UC308-108D1
1 9/16	**UCP308-109D1**													UC308-109D1
45	**UCP309D1**	67	245	190	67	20	30	24	129	65	57	22	M16	UC309D1
1 5/8	**UCP309-110D1**	2 41/64	9 21/32	7 15/32	2 5/8	25/32	1 3/16	15/16	5 3/32	2 9/16	2.2441	0.866	5/8	UC309-110D1
1 11/16	**UCP309-111D1**													UC309-111D1
1 3/4	**UCP309-112D1**													UC309-112D1
50	**UCP310D1**	75	275	212	75	20	35	27	143	75	61	22	M16	UC310D1
1 13/16	**UCP310-113D1**	2 61/64	10 13/16	8 11/32	2 15/16	25/32	1 3/8	1 1/16	5 5/8	2 15/16	2.4016	0.866	5/8	UC310-113D1
1 7/8	**UCP310-114D1**													UC310-114D1
1 15/16	**UCP310-115D1**													UC310-115D1
55	**UCP311D1**	80	310	236	80	20	38	30	154	85	66	25	M16	UC311D1
2	**UCP311-200D1**	3 5/32	12 7/32	9 9/32	3 5/32	25/32	1 1/2	1 3/16	6 1/16	3 11/32	2.5984	0.984	5/8	UC311-200D1
2 1/16	**UCP311-201D1**													UC311-201D1
2 1/8	**UCP311-202D1**													UC311-202D1
2 3/16	**UCP311-203D1**													UC311-203D1

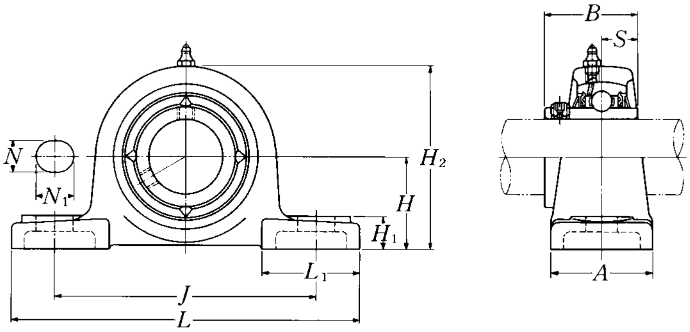
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UCP···D1**
Closed end: **CM-UCP···D1**

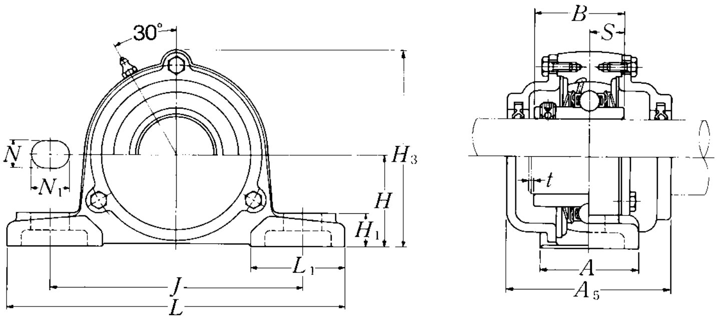
Housing number	Unit number cast dust cover type	Nominal dimensions			Mass of unit	
		mm	inch		kg	lb
		t max.	H_3	A_5	UCP	C(CM)
P305D1	**C(CM)-UCP305D1**	2	91	80	1.4	2.2
P305D1	**C(CM)-UCP305-013D1**	$\frac{5}{64}$	$3\frac{19}{32}$	$3\frac{5}{32}$	3.1	4.9
P305D1	**C(CM)-UCP305-014D1**					
P305D1	**C(CM)-UCP305-015D1**					
P305D1	**C(CM)-UCP305-100D1**					
P306D1	**C(CM)-UCP306D1**	2	105	85	1.8	2.7
P306D1	**C(CM)-UCP306-101D1**	$\frac{5}{64}$	$4\frac{1}{8}$	$3\frac{11}{32}$	4.0	6.0
P306D1	**C(CM)-UCP306-102D1**					
P306D1	**C(CM)-UCP306-103D1**					
P307D1	**C(CM)-UCP307D1**	3	115	95	2.8	3.5
P307D1	**C(CM)-UCP307-104D1**	$\frac{1}{8}$	$4\frac{17}{32}$	$3\frac{3}{4}$	6.2	7.7
P307D1	**C(CM)-UCP307-105D1**					
P307D1	**C(CM)-UCP307-106D1**					
P307D1	**C(CM)-UCP307-107D1**					
P308D1	**C(CM)-UCP308D1**	3	125	105	3.0	4.5
P308D1	**C(CM)-UCP308-108D1**	$\frac{1}{8}$	$4\frac{29}{32}$	$4\frac{1}{8}$	6.6	9.9
P308D1	**C(CM)-UCP308-109D1**					
P309D1	**C(CM)-UCP309D1**	3	140	110	4.1	6.1
P309D1	**C(CM)-UCP309-110D1**	$\frac{1}{8}$	$5\frac{1}{2}$	$4\frac{11}{32}$	9.0	13
P309D1	**C(CM)-UCP309-111D1**					
P309D1	**C(CM)-UCP309-112D1**					
P310D1	**C(CM)-UCP310D1**	3	156	120	5.8	8.4
P310D1	**C(CM)-UCP310-113D1**	$\frac{1}{8}$	$6\frac{5}{32}$	$4\frac{23}{32}$	13	19
P310D1	**C(CM)-UCP310-114D1**					
P310D1	**C(CM)-UCP310-115D1**					
P311D1	**C(CM)-UCP311D1**	4	166	125	7.4	9.7
P311D1	**C(CM)-UCP311-200D1**	$\frac{5}{32}$	$6\frac{17}{32}$	$4\frac{29}{32}$	16	21
P311D1	**C(CM)-UCP311-201D1**					
P311D1	**C(CM)-UCP311-202D1**					
P311D1	**C(CM)-UCP311-203D1**					

Pillow blocks cast housing
Set screw type



Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch *H*	*L*	*J*	*A*	*N*	*N*1	*H*1	*H*2	*L*1	*B*	*S*	Bolt size mm inch	Bearing number
60 **2 1/4** **2 5/16** **2 3/8** **2 7/16**	**UCP312D1** **UCP312-204D1** **UCP312-205D1** **UCP312-206D1** **UCP312-207D1**	85 3 11/32	330 13	250 9 27/32	85 3 11/32	25 31/32	38 1 1/2	32 1 1/4	165 6 1/2	95 3 3/4	71 2.7953	26 1.024	M20 3/4	UC312D1 UC312-204D1 UC312-205D1 UC312-206D1 UC312-207D1
65 **2 1/2** **2 9/16**	**UCP313D1** **UCP313-208D1** **UCP313-209D1**	90 3 35/64	340 13 3/8	260 10 1/4	90 3 17/32	25 31/32	38 1 1/2	33 1 5/16	176 6 15/16	105 4 1/8	75 2.9528	30 1.181	M20 3/4	UC313D1 UC313-208D1 UC313-209D1
70 **2 5/8** **2 11/16** **2 3/4**	**UCP314D1** **UCP314-210D1** **UCP314-211D1** **UCP314-212D1**	95 3 47/64	360 14 3/16	280 11 1/32	90 3 17/32	27 1 1/16	40 1 9/16	35 1 3/8	187 7 3/8	105 4 1/8	78 3.0709	33 1.299	M22 7/8	UC314D1 UC314-210D1 UC314-211D1 UC314-212D1
75 **2 13/16** **2 7/8** **2 15/16** **3**	**UCP315D1** **UCP315-213D1** **UCP315-214D1** **UCP315-215D1** **UCP315-300D1**	100 3 15/16	380 14 31/32	290 11 13/32	100 3 15/16	27 1 1/16	40 1 9/16	35 1 3/8	198 7 25/32	110 4 11/32	82 3.2283	32 1.260	M22 7/8	UC315D1 UC315-213D1 UC315-214D1 UC315-215D1 UC315-300D1
80 **3 1/16** **3 1/8** **3 3/16**	**UCP316D1** **UCP316-301D1** **UCP316-302D1** **UCP316-303D1**	106 4 11/64	400 15 3/4	300 11 13/16	110 4 11/32	27 1 1/16	40 1 9/16	40 1 9/16	210 8 9/32	110 4 11/32	86 3.3858	34 1.339	M22 7/8	UC316D1 UC316-301D1 UC316-302D1 UC316-303D1
85 **3 1/4** **3 5/16** **3 7/16**	**UCP317D1** **UCP317-304D1** **UCP317-305D1** **UCP317-307D1**	112 4 13/32	420 16 17/32	320 12 19/32	110 4 11/32	33 1 5/16	45 1 25/32	40 1 9/16	220 8 21/32	120 4 23/32	96 3.7795	40 1.575	M27 1	UC317D1 UC317-304D1 UC317-305D1 UC317-307D1
90 **3 7/16** **3 1/2**	**UCP318D1** **UCP318-307D1** **UCP318-308D1**	118 4 41/64	430 16 15/16	330 13	110 4 11/32	33 1 5/16	45 1 25/32	45 1 25/32	235 9 1/4	120 4 23/32	96 3.7795	40 1.575	M27 1	UC318D1 UC318-307D1 UC318-308D1

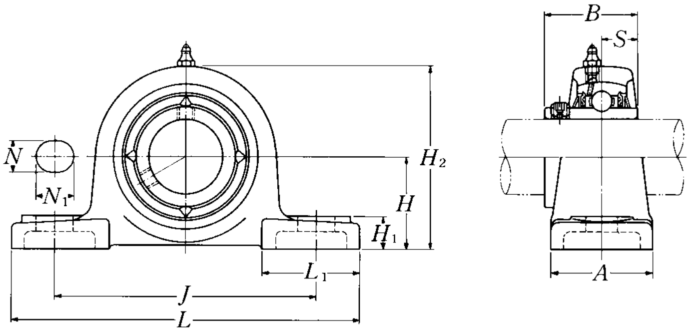
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UCP···D1**
Closed end: **CM-UCP···D1**

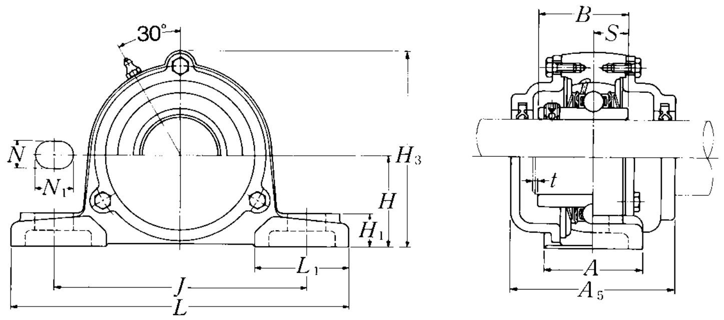
Housing number	Unit number cast dust cover type	Nominal dimensions			Mass of unit	
		mm		inch	kg	lb
		t max.	H_3	A_5	UCP	C(CM)
P312D1	C(CM)-UCP312D1	4	179	135	9.4	12
P312D1	C(CM)-UCP312-204D1	$\frac{5}{32}$	$7\frac{1}{16}$	$5\frac{5}{16}$	21	26
P312D1	C(CM)-UCP312-205D1					
P312D1	C(CM)-UCP312-206D1					
P312D1	C(CM)-UCP312-207D1					
P313D1	C(CM)-UCP313D1	4	190	140	10	15
P313D1	C(CM)-UCP313-208D1	$\frac{5}{32}$	$7\frac{15}{32}$	$5\frac{1}{2}$	22	33
P313D1	C(CM)-UCP313-209D1					
P314D1	C(CM)-UCP314D1	4	200	140	12	16
P314D1	C(CM)-UCP314-210D1	$\frac{5}{32}$	$7\frac{7}{8}$	$5\frac{1}{2}$	26	35
P314D1	C(CM)-UCP314-211D1					
P314D1	C(CM)-UCP314-212D1					
P315D1	C(CM)-UCP315D1	4	210	150	14	20
P315D1	C(CM)-UCP315-213D1	$\frac{5}{32}$	$8\frac{9}{32}$	$5\frac{29}{32}$	31	44
P315D1	C(CM)-UCP315-214D1					
P315D1	C(CM)-UCP315-215D1					
P315D1	C(CM)-UCP315-300D1					
P316D1	C(CM)-UCP316D1	4	221	155	18	23
P316D1	C(CM)-UCP316-301D1	$\frac{5}{32}$	$8\frac{11}{16}$	$6\frac{3}{32}$	40	51
P316D1	C(CM)-UCP316-302D1					
P316D1	C(CM)-UCP316-303D1					
P317D1	C(CM)-UCP317D1	5	235	170	20	27
P317D1	C(CM)-UCP317-304D1	$\frac{13}{64}$	$9\frac{1}{4}$	$6\frac{11}{16}$	44	60
P317D1	C(CM)-UCP317-305D1					
P317D1	C(CM)-UCP317-307D1					
P318D1	C(CM)-UCP318D1	5	246	170	24	30
P318D1	C(CM)-UCP318-307D1	$\frac{13}{64}$	$9\frac{11}{16}$	$6\frac{11}{16}$	53	66
P318D1	C(CM)-UCP318-308D1					

Pillow blocks cast housing
Set screw type



Shaft dia. mm inch	Unit number [1]	Nominal dimensions mm inch H	L	J	A	N	N_1	H_1	H_2	L_1	B	S	Bolt size mm inch	Bearing number
95	**UCP319D1**	125	470	360	120	36	50	45	250	125	103	41	M30	UC319D1
$3\frac{5}{8}$	**UCP319-310D1**													UC319-310D1
$3\frac{11}{16}$	**UCP319-311D1**	$4\frac{59}{64}$	$18\frac{1}{2}$	$14\frac{3}{16}$	$4\frac{23}{32}$	$1\frac{13}{32}$	$1\frac{31}{32}$	$1\frac{25}{32}$	$9\frac{27}{32}$	$4\frac{29}{32}$	4.0551	1.614	$1\frac{1}{8}$	UC319-311D1
$3\frac{3}{4}$	**UCP319-312D1**													UC319-312D1
100	**UCP320D1**	140	490	380	120	36	50	50	275	130	108	42	M30	UC320D1
$3\frac{13}{16}$	**UCP320-313D1**													UC320-313D1
$3\frac{7}{8}$	**UCP320-314D1**	$5\frac{33}{64}$	$19\frac{9}{32}$	$14\frac{31}{32}$	$4\frac{23}{32}$	$1\frac{13}{32}$	$1\frac{31}{32}$	$1\frac{31}{32}$	$10\frac{13}{16}$	$5\frac{1}{8}$	4.2520	1.654	$1\frac{1}{8}$	UC320-314D1
$3\frac{15}{16}$	**UCP320-315D1**													UC320-315D1
4	**UCP320-400D1**													UC320-400D1
105	**UCP321D1**	140	490	380	120	36	50	50	280	130	112	44	M30	UC321D1
110	**UCP322D1**	150	520	400	140	40	55	55	300	135	117	46	M33	UC322D1
120	**UCP324D1**	160	570	450	140	40	55	65	320	140	126	51	M33	UC324D1
130	**UCP326D1**	180	600	480	140	40	55	75	355	140	135	54	M33	UC326D1
140	**UCP328D1**	200	620	500	140	40	55	75	390	140	145	59	M33	UC328D1

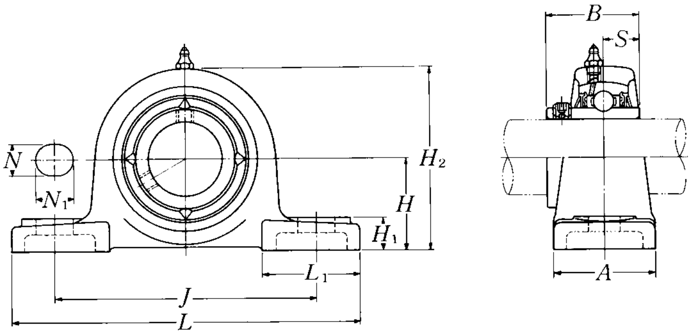
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UCP···D1**
Closed end: **CM-UCP···D1**

Housing number	Unit number cast dust cover type	Nominal dimensions			Mass of unit	
		mm inch			kg lb	
		t max.	H_3	A_5	UCP	C(CM)
P319D1	**C(CM)-UCP319D1**	5	258	180	29	38
P319D1	**C(CM)-UCP319-310D1**	$\frac{13}{64}$	$10\frac{5}{32}$	$7\frac{3}{32}$	64	84
P319D1	**C(CM)-UCP319-311D1**					
P319D1	**C(CM)-UCP319-312D1**					
P320D1	**C(CM)-UCP320D1**	5	283	190	35	46
P320D1	**C(CM)-UCP320-313D1**	$\frac{13}{64}$	$11\frac{5}{32}$	$7\frac{15}{32}$	77	101
P320D1	**C(CM)-UCP320-314D1**					
P320D1	**C(CM)-UCP320-315D1**					
P320D1	**C(CM)-UCP320-400D1**					
P321D1	**C(CM)-UCP321D1**	5	290	195	35	51
P322D1	**C(CM)-UCP322D1**	5	313	200	45	59
P324D1	**C(CM)-UCP324D1**	5	335	215	55	69
P326D1	**C(CM)-UCP326D1**	6	375	225	72	92
P328D1	**C(CM)-UCP328D1**	6	407	235	89	112

Pillow blocks cast housing
Set screw type

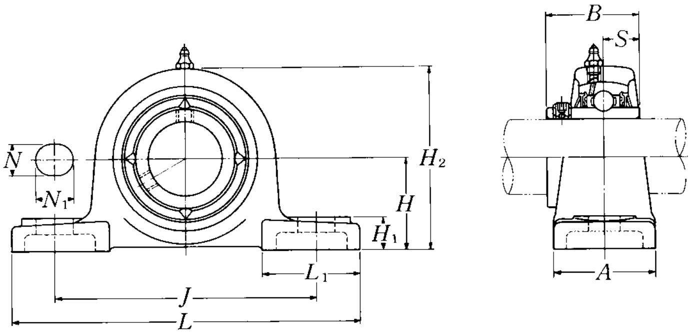


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch											Bolt size mm inch	Bearing number
		H	L	J	A	N	N1	H1	H2	L1	B	S		
25	**UCPX05D1**	44.4	159	119	51	17	20	18	85	50	38.1	15.9	M14	UCX05D1
13/16	**UCPX05-013D1**													UCX05-013D1
7/8	**UCPX05-014D1**	1 3/4	6 1/4	4 11/16	2	21/32	25/32	23/32	3 11/32	1 31/32	1.5000	0.626	1/2	UCX05-014D1
15/16	**UCPX05-015D1**													UCX05-015D1
1	**UCPX05-100D1**													UCX05-100D1
30	**UCPX06D1**	47.6	175	127	57	17	20	20	93	54	42.9	17.5	M14	UCX06D1
1 1/16	**UCPX06-101D1**													UCX06-101D1
1 1/8	**UCPX06-102D1**	1 7/8	6 7/8	5	2 1/4	21/32	25/32	25/32	3 21/32	2 1/8	1.6890	0.689	1/2	UCX06-102D1
1 3/16	**UCPX06-103D1**													UCX06-103D1
1 1/4	**UCPX06-104D1**													UC207-104D1
35	**UCPX07D1**	54	203	144	57	17	20	21	105	60	49.2	19	M14	UCX07D1
1 5/16	**UCPX07-105D1**													UCX07-105D1
1 3/8	**UCPX07-106D1**	2 1/8	8	5 21/32	2 1/4	21/32	25/32	13/16	4 1/8	2 3/8	1.9370	0.748	1/2	UCX07-106D1
1 7/16	**UCPX07-107D1**													UCX07-107D1
40	**UCPX08D1**	58.7	222	156	67	20	23	26	111	65	49.2	19	M16	UCX08D1
1 1/2	**UCPX08-108D1**	2 5/16	8 3/4	6 5/32	2 5/8	25/32	29/32	1 1/32	4 3/8	2 9/16	1.9370	0.748	5/8	UCX08-108D1
1 9/16	**UCPX08-109D1**													UCX08-109D1
45	**UCPX09D1**	58.7	222	156	67	20	23	26	116	65	51.6	19	M16	UCX09D1
1 5/8	**UCPX09-110D1**													UCX09-110D1
1 11/16	**UCPX09-111D1**	2 5/16	8 3/4	6 5/32	2 5/8	25/32	29/32	1 1/32	4 9/16	2 9/16	2.0315	0.748	5/8	UCX09-111D1
1 3/4	**UCPX09-112D1**													UCX09-112D1
1 13/16	**UCPX09-113D1**													UC210-113D1
50	**UCPX10D1**	63.5	241	171	73	20	23	27	126	70	55.6	22.2	M16	UCX10D1
1 7/8	**UCPX10-114D1**													UCX10-114D1
1 15/16	**UCPX10-115D1**	2 1/2	9 1/2	6 23/32	2 7/8	25/32	29/32	1 1/16	4 31/32	2 3/4	2.1890	0.874	5/8	UCX10-115D1
2	**UCPX10-200D1**													UC211-200D1
55	**UCPX11D1**	69.8	260	184	79	25	28	30	137	75	65.1	25.4	M20	UCX11D1
2 1/16	**UCPX11-201D1**													UCX11-201D1
2 1/8	**UCPX11-202D1**													UCX11-202D1
2 3/16	**UCPX11-203D1**	2 3/4	10 1/4	7 1/4	3 1/8	31/32	1 3/32	1 3/16	5 13/32	2 15/16	2.5630	1.000	3/4	UCX11-203D1
2 1/4	**UCPX11-204D1**													UC212-204D1
2 5/16	**UCPX11-205D1**													UC212-205D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
PX05D1	1.5
PX05D1	3.3
PX05D1	
PX05D1	
PX05D1	
PX06D1	2.0
PX06D1	4.4
PX06D1	
PX06D1	
PX06D1	
PX07D1	2.6
PX07D1	5.7
PX07D1	
PX07D1	
PX08D1	3.3
PX08D1	7.3
PX08D1	
PX09D1	3.3
PX09D1	7.3
PX09D1	
PX09D1	
PX09D1	
PX10D1	4.3
PX10D1	9.5
PX10D1	
PX10D1	
PX11D1	5.7
PX11D1	13
PX11D1	
PX11D1	
PX11D1	
PX11D1	

Pillow blocks cast housing
Set screw type

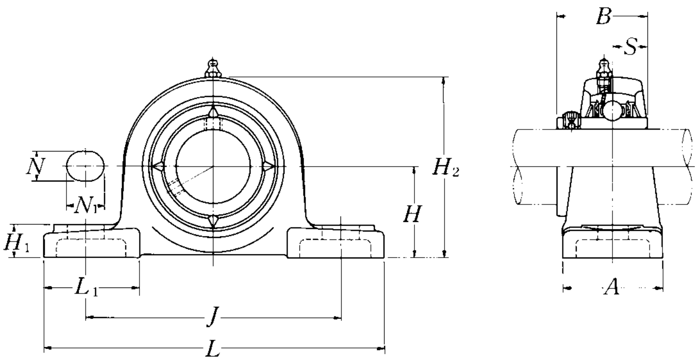


Shaft dia.	Unit number 1)	Nominal dimensions											Bolt size	Bearing number
mm inch		mm inch											mm inch	
		H	L	J	A	N	N1	H1	H2	L1	B	S		
60	**UCPX12D1**	76.2	286	203	83	25	28	33	151	80	65.1	25.4	M20	UCX12D1
2 3/8	**UCPX12-206D1**	3	11 1/4	8	3 9/32	31/32	1 3/32	1 5/16	5 15/16	3 5/32	2.5630	1.000	3/4	UCX12-206D1
2 7/16	**UCPX12-207D1**													UCX12-207D1
65	**UCPX13D1**	76.2	286	203	83	25	28	33	154	80	74.6	30.2	M20	UCX13D1
2 1/2	**UCPX13-208D1**	3	11 1/4	8	3 9/32	31/32	1 3/32	1 5/16	6 1/16	3 5/32	2.9370	1.189	3/4	UCX13-208D1
2 9/16	**UCPX13-209D1**													UCX13-209D1
70	**UCPX14D1**	88.9	330	229	89	27	30	35	170	95	77.8	33.3	M22	UCX14D1
2 5/8	**UCPX14-210D1**													UCX14-210D1
2 11/16	**UCPX14-211D1**	3 1/2	13	9 1/32	3 1/2	1 1/16	1 3/16	1 3/8	6 11/16	3 3/4	3.0630	1.311	7/8	UCX14-211D1
2 3/4	**UCPX14-212D1**													UCX14-212D1
75	**UCPX15D1**	88.9	330	229	89	27	30	35	175	95	82.6	33.3	M22	UCX15D1
2 13/16	**UCPX15-213D1**													UCX15-213D1
2 7/8	**UCPX15-214D1**	3 1/2	13	9 1/32	3 1/2	1 1/16	1 3/16	1 3/8	6 7/8	3 3/4	3.2520	1.311	7/8	UCX15-214D1
2 15/16	**UCPX15-215D1**													UCX15-215D1
3	**UCPX15-300D1**													UCX15-300D1
80	**UCPX16D1**	101.6	381	283	102	27	30	40	194	110	85.7	34.1	M22	UCX16D1
3 1/16	**UCPX16-301D1**													UCX16-301D1
3 1/8	**UCPX16-302D1**	4	15	11 5/32	4 1/32	1 1/16	1 3/16	1 9/16	7 5/8	4 11/32	3.3740	1.343	7/8	UCX16-302D1
3 3/16	**UCPX16-303D1**													UCX16-303D1
3 1/4	**UCPX16-304D1**													UC217-304D1
85	**UCPX17D1**	101.6	381	283	102	27	30	40	200	110	96	39.7	M22	UCX17D1
3 5/16	**UCPX17-305D1**	4	15	11 5/32	4 1/32	1 1/16	1 3/16	1 9/16	7 7/8	4 11/32	3.7795	1.563	7/8	UCX17-305D1
3 7/16	**UCPX17-307D1**													UCX17-307D1
90	**UCPX18D1**	101.6	381	283	111	27	30	40	206	110	104	42.9	M22	UCX18D1
3 7/16	**UCPX18-307D1**	4	15	11 5/32	4 3/8	1 1/16	1 3/16	1 9/16	8 1/8	4 11/32	4.0945	1.689	7/8	UCX18-307D1
3 1/2	**UCPX18-308D1**													UCX18-308D1
100	**UCPX20D1**	127	432	337	121	33	36	45	244	125	117.5	49.2	M27	UCX20D1
3 13/16	**UCPX20-313D1**													UCX20-313D1
3 7/8	**UCPX20-314D1**	5	17	13 9/32	4 3/4	1 5/16	1 13/32	1 25/32	9 19/32	4 29/32	4.6260	1.937	1	UCX20-314D1
3 15/16	**UCPX20-315D1**													UCX20-315D1
4	**UCPX20-400D1**													UCX20-400D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
PX12D1	7.3
PX12D1	16
PX12D1	
PX13D1	7.6
PX13D1	17
PX13D1	
PX14D1	9.9
PX14D1	22
PX14D1	
PX14D1	
PX15D1	11
PX15D1	24
PX15D1	
PX15D1	
PX15D1	
PX16D1	15
PX16D1	33
PX16D1	
PX16D1	
PX16D1	
PX17D1	16
PX17D1	35
PX17D1	
PX18D1	17
PX18D1	37
PX18D1	
PX20D1	30
PX20D1	66
PX20D1	
PX20D1	
PX20D1	

Pillow blocks cast housing low center height
Set screw type

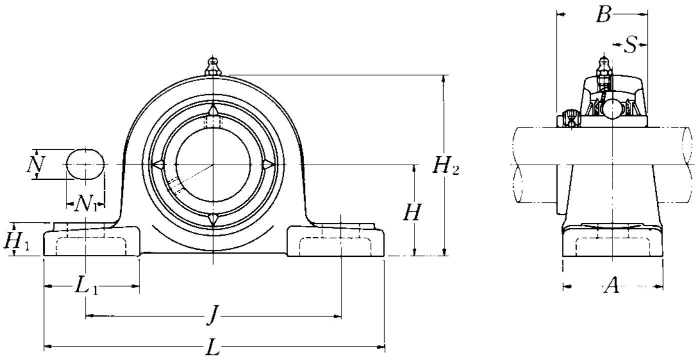


Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch											Bolt size mm inch	Bearing number
		H	L	J	A	N	N_1	H_1	H_2	L_1	B	S		
20	**UCPL204D1**	31.75	127	95	38	13	16	14	64	42	31	12.7	M10	UC204D1
$\frac{3}{4}$	**UCPL204-012D1**	$1\frac{1}{4}$	5	$3\frac{3}{4}$	$1\frac{1}{2}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{9}{16}$	$2\frac{17}{32}$	$1\frac{21}{32}$	1.2205	0.500	$\frac{3}{8}$	UC204-012D1
25	**UCPL205D1**	33.34	140	105	38	13	16	15	68	42	34.1	14.3	M10	UC205D1
$\frac{13}{16}$	**UCPL205-013D1**	$1\frac{5}{16}$	$5\frac{1}{2}$	$4\frac{1}{8}$	$1\frac{1}{2}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{19}{32}$	$2\frac{11}{16}$	$1\frac{21}{32}$	1.3425	0.563	$\frac{3}{8}$	UC205-013D1
$\frac{7}{8}$	**UCPL205-014D1**													UC205-014D1
$\frac{15}{16}$	**UCPL205-015D1**													UC205-015D1
1	**UCPL205-100D1**													UC205-100D1
30	**UCPL206D1**	39.69	165	121	48	17	20	17	80	54	38.1	15.9	M14	UC206D1
$1\frac{1}{16}$	**UCPL206-101D1**	$1\frac{9}{16}$	$6\frac{1}{2}$	$4\frac{3}{4}$	$1\frac{7}{8}$	$\frac{21}{32}$	$\frac{25}{32}$	$\frac{21}{32}$	$3\frac{5}{32}$	$2\frac{1}{8}$	1.5000	0.626	$\frac{1}{2}$	UC206-101D1
$1\frac{1}{8}$	**UCPL206-102D1**													UC206-102D1
$1\frac{3}{16}$	**UCPL206-103D1**													UC206-103D1
$1\frac{1}{4}$	**UCPL206-104D1**													UC206-104D1
35	**UCPL207D1**	46.04	167	127	48	17	20	18	91	54	42.9	17.5	M14	UC207D1
$1\frac{1}{4}$	**UCPL207-104D1**	$1\frac{13}{16}$	$6\frac{9}{16}$	5	$1\frac{7}{8}$	$\frac{21}{32}$	$\frac{25}{32}$	$\frac{23}{32}$	$3\frac{19}{32}$	$2\frac{1}{8}$	1.6890	0.689	$\frac{1}{2}$	UC207-104D1
$1\frac{5}{16}$	**UCPL207-105D1**													UC207-105D1
$1\frac{3}{8}$	**UCPL207-106D1**													UC207-106D1
$1\frac{7}{16}$	**UCPL207-107D1**													UC207-107D1
45	**UCPL209D1**	52.39	190	146	54	17	20	20	104	60	49.2	19	M14	UC209D1
$1\frac{5}{8}$	**UCPL209-110D1**	$2\frac{1}{16}$	$7\frac{15}{32}$	$5\frac{3}{4}$	$2\frac{1}{8}$	$\frac{21}{32}$	$\frac{25}{32}$	$\frac{25}{32}$	$4\frac{3}{32}$	$2\frac{3}{8}$	1.9370	0.748	$\frac{1}{2}$	UC209-110D1
$1\frac{11}{16}$	**UCPL209-111D1**													UC209-111D1
$1\frac{3}{4}$	**UCPL209-112D1**													UC209-112D1
50	**UCPL210D1**	55.56	206	159	60	20	23	21	112	65	51.6	19	M16	UC210D1
$1\frac{13}{16}$	**UCPL210-113D1**	$2\frac{3}{16}$	$8\frac{1}{8}$	$6\frac{1}{4}$	$2\frac{3}{8}$	$\frac{25}{32}$	$\frac{29}{32}$	$\frac{13}{16}$	$4\frac{13}{32}$	$2\frac{9}{16}$	2.0315	0.748	$\frac{5}{8}$	UC210-113D1
$1\frac{7}{8}$	**UCPL210-114D1**													UC210-114D1
$1\frac{15}{16}$	**UCPL210-115D1**													UC210-115D1
2	**UCPL210-200D1**													UC210-200D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) UCPL204 and UCPL205 has solid bases.
3) UCPL208 has the same dimension as UCP208 shown in page 46.
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
PL204D1	0.6
PL204D1	1.3
PL205D1	0.8
PL205D1	1.8
PL205D1	
PL205D1	
PL205D1	
PL206D1	1.2
PL206D1	2.6
PL206D1	
PL206D1	
PL206D1	
PL207D1	1.6
PL207D1	3.5
PL207D1	
PL207D1	
PL207D1	
PL209D1	2.2
PL209D1	4.9
PL209D1	
PL209D1	
PL210D1	2.6
PL210D1	5.7
PL210D1	
PL210D1	
PL210D1	

Pillow blocks cast housing low center height
Set screw type

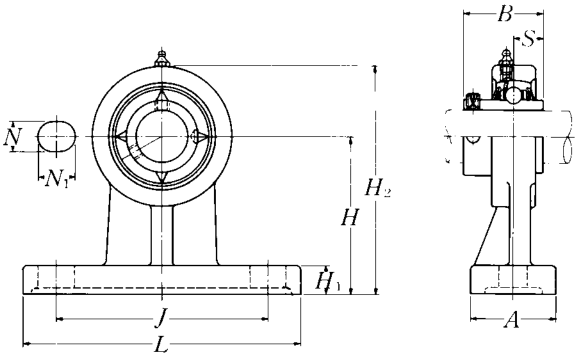


Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch H	L	J	A	N	N_1	H_1	H_2	L_1	B	S	Bolt size mm inch	Bearing number
55	**UCPL211D1**	61.91	219	171	60	20	23	23	124	65	55.6	22.2	M16	UC211D1
2	**UCPL211-200D1**	$2\frac{7}{16}$	$8\frac{5}{8}$	$6\frac{23}{32}$	$2\frac{3}{8}$	$\frac{25}{32}$	$\frac{29}{32}$	$\frac{29}{32}$	$4\frac{7}{8}$	$2\frac{9}{16}$	2.1890	0.874	$\frac{5}{8}$	UC211-200D1
$2\frac{1}{16}$	**UCPL211-201D1**													UC211-201D1
$2\frac{1}{8}$	**UCPL211-202D1**													UC211-202D1
$2\frac{3}{16}$	**UCPL211-203D1**													UC211-203D1
60	**UCPL212D1**	68.26	241	184	70	20	23	25	136	70	65.1	25.4	M16	UC212D1
$2\frac{1}{4}$	**UCPL212-204D1**	$2\frac{11}{16}$	$9\frac{1}{2}$	$7\frac{1}{4}$	$2\frac{3}{4}$	$\frac{25}{32}$	$\frac{29}{32}$	$\frac{31}{32}$	$5\frac{11}{32}$	$2\frac{3}{4}$	2.5630	1.000	$\frac{5}{8}$	UC212-204D1
$2\frac{5}{16}$	**UCPL212-205D1**													UC212-205D1
$2\frac{3}{8}$	**UCPL212-206D1**													UC212-206D1
$2\frac{7}{16}$	**UCPL212-207D1**													UC212-207D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) UCPL204 and UCPL205 has solid bases.
3) UCPL208 has the same dimension as UCP208 shown in page 46.
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit	
	kg	lb
PL211D1	3.2	
PL211D1		7.1
PL211D1		
PL211D1		
PL211D1		
PL212D1	4.5	
PL212D1		9.9
PL212D1		
PL212D1		
PL212D1		

Pillow blocks cast housing high center height
Set screw type

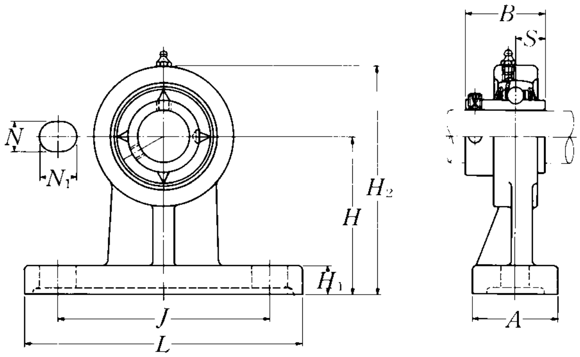


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch										Bolt size mm inch	Bearing number
		H	L	J	A	N	N_1	H_1	H_2	B	S		
12	**UCHP201D1**	70	127	95	40	13	19	13	101	31	12.7	M10	UC201D1
1/2	**UCHP201-008D1**	2 3/4	5	3 3/4	1 9/16	1/2	3/4	1/2	3 31/32	1.2205	0.500	3/8	UC201-008D1
15	**UCHP202D1**	70	127	95	40	13	19	13	101	31	12.7	M10	UC202D1
9/16	**UCHP202-009D1**	2 3/4	5	3 3/4	1 9/16	1/2	3/4	1/2	3 31/32	1.2205	0.500	3/8	UC202-009D1
5/8	**UCHP202-010D1**												UC202-010D1
17	**UCHP203D1**	70	127	95	40	13	19	13	101	31	12.7	M10	UC203D1
11/16	**UCHP203-011D1**	2 3/4	5	3 3/4	1 9/16	1/2	3/4	1/2	3 31/32	1.2205	0.500	3/8	UC203-011D1
20	**UCHP204D1**	70	127	95	40	13	19	13	101	31	12.7	M10	UC204D1
3/4	**UCHP204-012D1**	2 3/4	5	3 3/4	1 9/16	1/2	3/4	1/2	3 31/32	1.2205	0.500	3/8	UC204-012D1
25	**UCHP205D1**	80	142	105	50	13	19	13	114	34.1	14.3	M10	UC205D1
13/16	**UCHP205-013D1**	3 5/32	5 19/32	4 1/8	1 31/32	1/2	3/4	1/2	4 1/2	1.3425	0.563	3/8	UC205-013D1
7/8	**UCHP205-014D1**												UC205-014D1
15/16	**UCHP205-015D1**												UC205-015D1
1	**UCHP205-100D1**												UC205-100D1
30	**UCHP206D1**	90	165	120	50	17	21	16	130	38.1	15.9	M14	UC206D1
1 1/16	**UCHP206-101D1**	3 35/64	6 1/2	4 23/32	1 31/32	21/32	13/16	5/8	5 1/8	1.5000	0.626	1/2	UC206-101D1
1 1/8	**UCHP206-102D1**												UC206-102D1
1 3/16	**UCHP206-103D1**												UC206-103D1
1 1/4	**UCHP206-104D1**												UC206-104D1
35	**UCHP207D1**	95	166	127	60	17	21	18	140	42.9	17.5	M14	UC207D1
1 1/4	**UCHP207-104D1**	3 47/64	6 17/32	5	2 3/8	21/32	13/16	23/32	5 1/2	1.6890	0.689	1/2	UC207-104D1
1 5/16	**UCHP207-105D1**												UC207-105D1
1 3/8	**UCHP207-106D1**												UC207-106D1
1 7/16	**UCHP207-107D1**												UC207-107D1
40	**UCHP208D1**	100	184	136	70	17	21	20	150	49.2	19	M14	UC208D1
1 1/2	**UCHP208-108D1**	3 15/16	7 1/4	5 11/32	2 3/4	21/32	13/16	25/32	5 29/32	1.9370	0.748	1/2	UC208-108D1
1 9/16	**UCHP208-109D1**												UC208-109D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
HP204D1	1.0
HP204D1	2.2
HP204D1	1.0
HP204D1	2.2
HP204D1	
HP204D1	1.0
HP204D1	2.2
HP204D1	1.0
HP204D1	2.2
HP205D1	1.2
HP205D1	2.6
HP205D1	
HP205D1	
HP205D1	
HP206D1	1.8
HP206D1	4.0
HP206D1	
HP206D1	
HP206D1	
HP207D1	2.4
HP207D1	5.3
HP207D1	
HP207D1	
HP207D1	
HP208D1	3.4
HP208D1	7.5
HP208D1	

Pillow blocks cast housing high center height
Set screw type

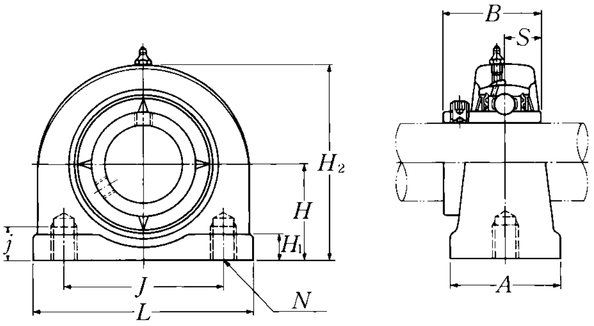


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch										Bolt size mm inch	Bearing number
		H	L	J	A	N	N1	H1	H2	B	S		
45	UCHP209D1	105	190	146	70	17	22	20	158	49.2	19	M14	UC209D1
1 5/8	UCHP209-110D1												UC209-110D1
1 11/16	UCHP209-111D1	4 9/64	7 15/32	5 3/4	2 3/4	21/32	7/8	25/32	6 7/32	1.9370	0.748	1/2	UC209-111D1
1 3/4	UCHP209-112D1												UC209-112D1
50	UCHP210D1	110	206	159	70	20	22	22	165	51.6	19	M16	UC210D1
1 13/16	UCHP210-113D1												UC210-113D1
1 7/8	UCHP210-114D1	4 21/64	8 1/8	6 1/4	2 3/4	25/32	7/8	7/8	6 1/2	2.0315	0.748	5/8	UC210-114D1
1 15/16	UCHP210-115D1												UC210-115D1
2	UCHP210-200D1												UC210-200D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
HP209D1	3.7
HP209D1	
HP209D1	8.2
HP209D1	
HP210D1	4.1
HP210D1	
HP210D1	9.0
HP210D1	
HP210D1	

Pillow blocks cast housing
Set screw type

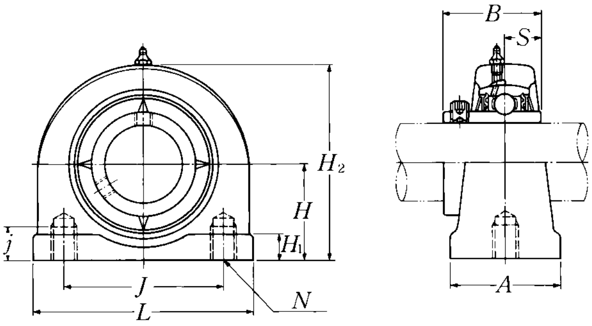


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch										Bearing number
		H	L	J	A	j	H_1	H_2	B	S	N	
12	UCUP201D1	30.2	76	52	38	13	11	62	31	12.7	M10 × 1.5	UC201D1
1/2	UCUP201-008D1	1 3/16	3	2 1/16	1 1/2	1/2	7/16	2 7/16	1.2205	0.500		UC201-008D1
15	UCUP202D1	30.2	76	52	38	13	11	62	31	12.7	M10 × 1.5	UC202D1
9/16	UCUP202-009D1	1 3/16	3	2 1/16	1 1/2	1/2	7/16	2 7/16	1.2205	0.500		UC202-009D1
5/8	UCUP202-010D1											UC202-010D1
17	UCUP203D1	30.2	76	52	38	13	11	62	31	12.7	M10 × 1.5	UC203D1
11/16	UCUP203-011D1	1 3/16	3	2 1/16	1 1/2	1/2	7/16	2 7/16	1.2205	0.500		UC203-011D1
20	UCUP204D1	30.2	76	52	38	13	11	62	31	12.7	M10 × 1.5	UC204D1
3/4	UCUP204-012D1	1 3/16	3	2 1/16	1 1/2	1/2	7/16	2 7/16	1.2205	0.500		UC204-012D1
25	UCUP205D1	36.5	84	56	38	15	12	72	34.1	14.3	M10 × 1.5	UC205D1
13/16	UCUP205-013D1	1 7/16	3 5/16	2 7/32	1 1/2	19/32	15/32	2 27/32	1.3425	0.563		UC205-013D1
7/8	UCUP205-014D1											UC205-014D1
15/16	UCUP205-015D1											UC205-015D1
1	UCUP205-100D1											UC205-100D1
30	UCUP206D1	42.9	94	66	48	18	12	84	38.1	15.9	M14 × 2	UC206D1
1 1/16	UCUP206-101D1	1 11/16	3 11/16	2 19/32	1 7/8	23/32	15/32	3 5/16	1.5000	0.629		UC206-101D1
1 1/8	UCUP206-102D1											UC206-102D1
1 3/16	UCUP206-103D1											UC206-103D1
1 1/4	UCUP206-104D1											UC206-104D1
35	UCUP207D1	47.6	110	80	48	20	13	95	42.9	17.5	M14 × 2	UC207D1
1 1/4	UCUP207-104D1	1 7/8	4 11/32	3 5/32	1 7/8	25/32	1/2	3 3/4	1.6890	0.689		UC207-104D1
1 5/16	UCUP207-105D1											UC207-105D1
1 3/8	UCUP207-106D1											UC207-106D1
1 7/16	UCUP207-107D1											UC207-107D1
40	UCUP208D1	49.2	116	84	54	20	13	100	49.2	19	M14 × 2	UC208D1
1 1/2	UCUP208-108D1	1 15/16	4 9/16	3 5/16	2 1/8	25/32	1/2	3 15/16	1.9370	0.748		UC208-108D1
1 9/16	UCUP208-109D1											UC208-109D1
45	UCUP209D1	54.2	120	90	54	25	13	108	49.2	19	M14 × 2	UC209D1
1 5/8	UCUP209-110D1	2 1/8	4 23/32	3 17/32	2 1/8	31/32	1/2	4 1/4	1.9370	0.748		UC209-110D1
1 11/16	UCUP209-111D1											UC209-111D1
1 3/4	UCUP209-112D1											UC209-112D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
UP204D1 UP204D1	0.6 1.3
UP204D1 UP204D1 UP204D1	0.6 1.3
UP204D1 UP204D1	0.6 1.3
UP204D1 UP204D1	0.6 1.3
UP205D1 UP205D1 UP205D1 UP205D1 UP205D1	0.8 1.8
UP206D1 UP206D1 UP206D1 UP206D1 UP206D1	1.2 2.6
UP207D1 UP207D1 UP207D1 UP207D1 UP207D1	1.7 3.7
UP208D1 UP208D1 UP208D1	2.0 4.4
UP209D1 UP209D1 UP209D1 UP209D1	2.2 4.9

Pillow blocks cast housing
Set screw type

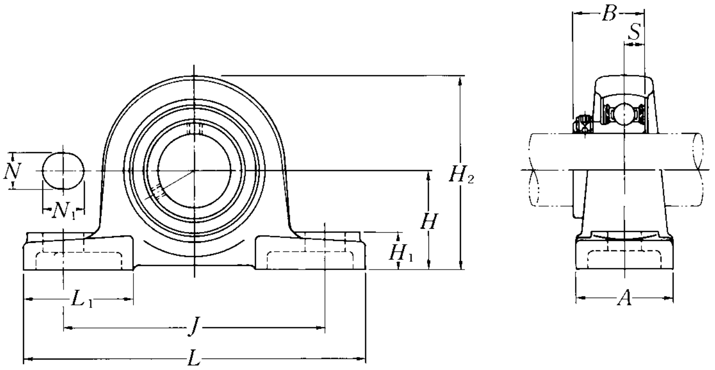


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch										Bearing number
		H	L	J	A	j	H1	H2	B	S	N	
50	UCUP210D1	57.2	130	94	60	25	14	116	51.6	19	M16×2	UC210D1
1 13/16	UCUP210-113D1	2 1/4	5 1/8	3 11/16	2 3/8	31/32	9/16	4 9/16	2.0315	0.748		UC210-113D1
1 7/8	UCUP210-114D1											UC210-114D1
1 15/16	UCUP210-115D1											UC210-115D1
2	UCUP210-200D1											UC210-200D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
UP210D1	2.9
UP210D1	6.4
UP210D1	
UP210D1	
UP210D1	

Pillow blocks cast housing low center height
Set screw type

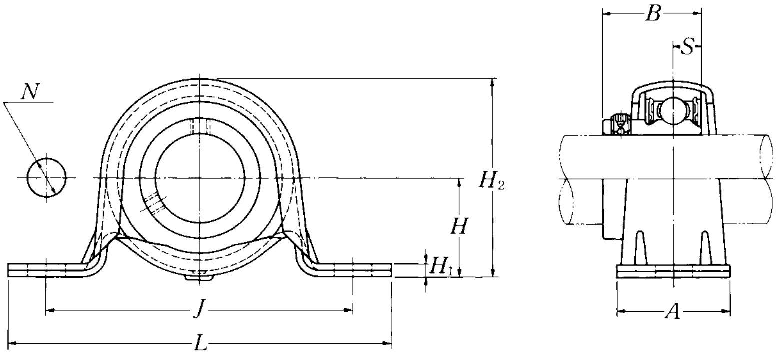


Shaft dia. mm inch	Unit number 1) 2)	Nominal dimensions mm inch											Bolt size mm inch	Bearing number
		H	L	J	A	N	N_1	H_1	H_2	L_1	B	S		
12	**ASPL201**	26.99	121	89	35	11	14	13	54	40	22	6	M10	AS201
1/2	**ASPL201-008**	1 1/16	4 3/4	3 1/2	1 3/8	7/16	9/16	1/2	2 1/8	1 9/16	0.8661	0.236	3/8	AS201-008
15	**ASPL202**	26.99	121	89	35	11	14	13	54	40	22	6	M10	AS202
9/16	**ASPL202-009**	1 1/16	4 3/4	3 1/2	1 3/8	7/16	9/16	1/2	2 1/8	1 9/16	0.8661	0.236	3/8	AS202-009
5/8	**ASPL202-010**													AS202-010
17	**ASPL203**	26.99	121	89	35	11	14	13	54	40	22	6	M10	AS203
11/16	**ASPL203-011**	1 1/16	4 3/4	3 1/2	1 3/8	7/16	9/16	1/2	2 1/8	1 9/16	0.8661	0.236	3/8	AS203-011
20	**ASPL204**	31.75	127	95	38	13	16	14	64	42	25	7	M10	AS204
3/4	**ASPL204-012**	1 1/4	5	3 3/4	1 1/2	1/2	5/8	9/16	2 17/32	1 21/32	0.9843	0.276	3/8	AS204-012
25	**ASPL205**	33.34	140	105	38	13	16	15	68	42	27	7.5	M10	AS205
13/16	**ASPL205-013**	1 5/16	5 1/2	4 1/8	1 1/2	1/2	5/8	19/32	2 11/16	1 21/32	1.0630	0.295	3/8	AS205-013
7/8	**ASPL205-014**													AS205-014
15/16	**ASPL205-015**													AS205-015
1	**ASPL205-100**													AS205-100
30	**ASPL206**	39.69	165	121	48	17	20	17	80	54	29	8	M14	AS206
1 1/16	**ASPL206-101**	1 9/16	6 1/2	4 3/4	1 7/8	21/32	25/32	21/32	3 5/32	2 1/8	1.1417	0.315	1/2	AS206-101
1 1/8	**ASPL206-102**													AS206-102
1 3/16	**ASPL206-103**													AS206-103
1 1/4	**ASPL206-104**													AS206-104
35	**ASPL207**	46.04	167	127	48	17	20	18	91	54	34	8.5	M14	AS207
1 1/4	**ASPL207-104**	1 13/16	6 9/16	5	1 7/8	21/32	25/32	23/32	3 19/32	2 1/8	1.3386	0.335	1/2	AS207-104
1 5/16	**ASPL207-105**													AS207-105
1 3/8	**ASPL207-106**													AS207-106
1 7/16	**ASPL207-107**													AS207-107

Remarks: 1) ASPL201 to ASPL205 has solid bases.
2) If relubricatable type is neede, please order with suffix "D1".

Housing 2) number	Mass of unit kg lb
PL201	0.6
PL201	1.3
PL201	0.6
PL201	1.3
PL201	
PL201	0.5
PL201	1.1
PL204	0.6
PL204	1.3
PL205	0.7
PL205	1.5
PL205	
PL205	
PL205	
PL206	1.2
PL206	2.6
PL206	
PL206	
PL206	
PL207	1.5
PL207	3.3
PL207	
PL207	
PL207	

Pillow blocks pressed steel housing
Set screw type

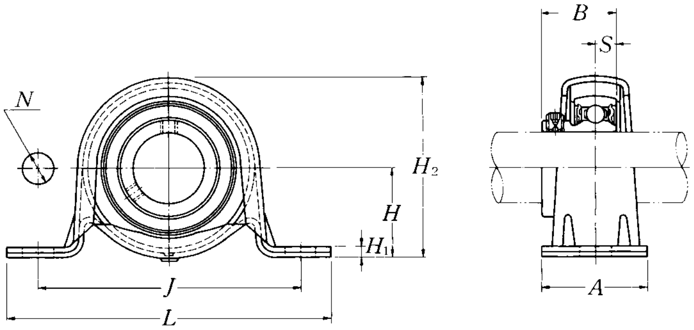


Shaft dia. mm inch	Unit number	Nominal dimensions mm inch									Bolt size mm inch	Bearing number	Housing number	Mass of unit kg lb
		H	L	J	A	N	H_1	H_2	B	S				
12	**ASPP201**	22.2	86	68	25	9.5	3.2	43.8	22	6	M 8	AS201	PP203	0.2
$\frac{1}{2}$	**ASPP201-008**	$\frac{7}{8}$	$3\frac{3}{8}$	$2\frac{11}{16}$	$\frac{31}{32}$	$\frac{3}{8}$	0.126	$1\frac{23}{32}$	0.8661	0.236	$\frac{5}{16}$	AS201-008	PP203	0.4
15	**ASPP202**	22.2	86	68	25	9.5	3.2	43.8	22	6	M 8	AS202	PP203	0.1
$\frac{9}{16}$	**ASPP202-009**	$\frac{7}{8}$	$3\frac{3}{8}$	$2\frac{11}{16}$	$\frac{31}{32}$	$\frac{3}{8}$	0.126	$1\frac{23}{32}$	0.8661	0.236	$\frac{5}{16}$	AS202-009	PP203	0.2
$\frac{5}{8}$	**ASPP202-010**											AS202-010	PP203	
17	**ASPP203**	22.2	86	68	25	9.5	3.2	43.8	22	6	M 8	AS203	PP203	0.1
$\frac{11}{16}$	**ASPP203-011**	$\frac{7}{8}$	$3\frac{3}{8}$	$2\frac{11}{16}$	$\frac{31}{32}$	$\frac{3}{8}$	0.126	$1\frac{23}{32}$	0.8661	0.236	$\frac{5}{16}$	AS203-011	PP203	0.2
20	**ASPP204**	25.4	98	76	32	9.5	3.2	50.5	25	7	M 8	AS204	PP204	0.2
$\frac{3}{4}$	**ASPP204-012**	1	$3\frac{27}{32}$	3	$1\frac{1}{4}$	$\frac{3}{8}$	0.126	2	0.9843	0.276	$\frac{5}{16}$	AS204-012	PP204	0.4
25	**ASPP205**	28.6	108	86	32	11.5	4	56.6	27	7.5	M10	AS205	PP205	0.3
$\frac{13}{16}$	**ASPP205-013**	$1\frac{1}{8}$	$4\frac{1}{4}$	$3\frac{3}{8}$	$1\frac{1}{4}$	$\frac{29}{64}$	0.157	$2\frac{7}{32}$	1.0630	0.295	$\frac{3}{8}$	AS205-013	PP205	0.7
$\frac{7}{8}$	**ASPP205-014**											AS205-014	PP205	
$\frac{15}{16}$	**ASPP205-015**											AS205-015	PP205	
1	**ASPP205-100**											AS205-100	PP205	
30	**ASPP206**	33.3	117	95	38	11.5	4	66.3	29	8	M10	AS206	PP206	0.4
$1\frac{1}{16}$	**ASPP206-101**	$1\frac{5}{16}$	$4\frac{19}{32}$	$3\frac{3}{4}$	$1\frac{1}{2}$	$\frac{29}{64}$	0.157	$2\frac{5}{8}$	1.1417	0.315	$\frac{3}{8}$	AS206-101	PP206	0.9
$1\frac{1}{8}$	**ASPP206-102**											AS206-102	PP206	
$1\frac{3}{16}$	**ASPP206-103**											AS206-103	PP206	
$1\frac{1}{4}$	**ASPP206-104**											AS206-104	PP206	
35	**ASPP207**	39.7	129	106	42	11.5	4.6	78	34	8.5	M10	AS207	PP207	0.6
$1\frac{1}{4}$	**ASPP207-104**	$1\frac{9}{16}$	$5\frac{3}{32}$	$4\frac{3}{16}$	$1\frac{21}{32}$	$\frac{29}{64}$	0.181	$3\frac{1}{16}$	1.3386	0.335	$\frac{3}{8}$	AS207-104	PP207	1.3
$1\frac{5}{16}$	**ASPP207-105**											AS207-105	PP207	
$1\frac{3}{8}$	**ASPP207-106**											AS207-106	PP207	
$1\frac{7}{16}$	**ASPP207-107**											AS207-107	PP207	

Remarks: 1) The permissible load only applies in applications where the load is stable and the speed is 2400 rpm or less.
The mounting surface should be flat.

Max. load [1) recommended N lbf radial	 axial
2 000 440	800 160
2 000 440	800 160
2 000 440	800 160
2 500 550	1 000 200
3 500 770	1 400 280
4 000 880	1 600 320
4 500 990	1 800 360

Pillow blocks pressed steel housing with rubber ring
Set screw type

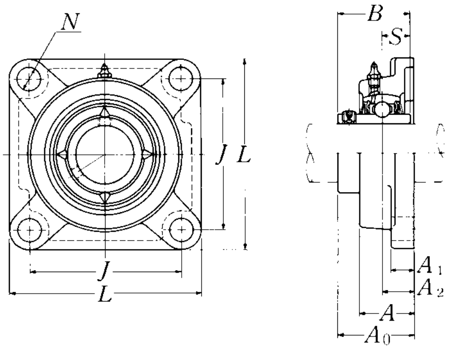


Shaft dia. mm inch	Unit number	Nominal dimensions mm inch									Bolt size mm inch	Bearing number
		H	L	J	A	N	H_1	H_2	B	S		
12	**ASRPP201**	25.4	98	76	32	9.5	3.2	50.5	22	6	M 8	AS201
1/2	**ASRPP201-008**	1	3 27/32	3	1 1/4	3/8	0.126	2	0.8661	0.236	5/16	AS201-008
15	**ASRPP202**	25.4	98	76	32	9.5	3.2	50.5	22	6	M 8	AS202
9/16	**ASRPP202-009**	1	3 27/32	3	1 1/4	3/8	0.126	2	0.8661	0.236	5/16	AS202-009
5/8	**ASRPP202-010**											AS202-010
17	**ASRPP203**	25.4	98	76	32	9.5	3.2	50.5	22	6	M 8	AS203
11/16	**ASRPP203-011**	1	3 27/32	3	1 1/4	3/8	0.126	2	0.8661	0.236	5/16	AS203-011
20	**ASRPP204**	28.6	108	86	32	11.5	4	56.6	25	7	M10	AS204
3/4	**ASRPP204-012**	1 1/8	4 1/4	3 3/8	1 1/4	29/64	0.157	2 7/32	0.9843	0.276	3/8	AS204-012
25	**ASRPP205**	33.3	117	95	38	11.5	4	66.3	27	7.5	M10	AS205
13/16	**ASRPP205-013**	1 5/16	4 19/32	3 3/4	1 1/2	29/64	0.157	2 5/8	1.0630	0.295	3/8	AS205-013
7/8	**ASRPP205-014**											AS205-014
15/16	**ASRPP205-015**											AS205-015
1	**ASRPP205-100**											AS205-100
30	**ASRPP206**	39.7	129	106	42	11.5	4.6	78	29	8	M10	AS206
1 1/16	**ASRPP206-101**	1 9/16	5 3/32	4 3/16	1 21/32	29/64	0.181	3 1/16	1.1417	0.315	3/8	AS206-101
1 1/8	**ASRPP206-102**											AS206-102
1 3/16	**ASRPP206-103**											AS206-103
1 1/4	**ASRPP206-104**											AS206-104

Remarks: 1) The permissible load only applies in applications where the load is stable and the speed is 2400 rpm or less.
The mounting surface should be flat.
2) When an anti-vibration rubber ring is used, the self alignment capability will be reduce.

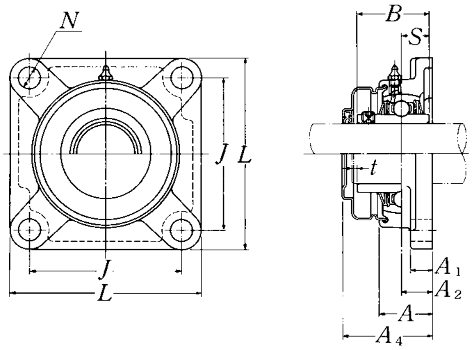
Housing number	Mass of unit kg lb	Max. load [1] recommended N lbf radial	axial
PP204 PP204	0.2 0.4	1 000 220	200 40
PP204 PP204 PP204	0.2 0.4	1 000 220	200 40
PP204 PP204	0.2 0.4	1 000 220	200 40
PP205 PP205	0.3 0.7	1 150 250	200 40
PP206 PP206 PP206 PP206 PP206	0.4 0.9	1 300 280	200 40
PP207 PP207 PP207 PP207 PP207	0.5 1.1	1 500 330	200 40

Flanged units cast housing
Set screw type

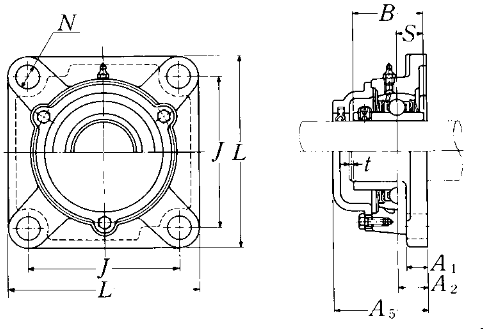


Shaft dia. mm inch	Unit number [1]	Nominal dimensions mm inch									Bolt size mm inch	Bearing number
		L	J	A_2	A_1	A	N	A_0	B	S		
12	UCF201D1	86	64	15	11	25.5	12	33.3	31	12.7	M10	UC201D1
$\frac{1}{2}$	UCF201-008D1	$3\frac{3}{8}$	$2\frac{33}{64}$	$\frac{19}{32}$	$\frac{7}{16}$	1	$\frac{15}{32}$	$1\frac{5}{16}$	1.2205	0.500	$\frac{3}{8}$	UC201-008D1
15	UCF202D1	86	64	15	11	25.5	12	33.3	31	12.7	M10	UC202D1
$\frac{9}{16}$	UCF202-009D1	$3\frac{3}{8}$	$2\frac{33}{64}$	$\frac{19}{32}$	$\frac{7}{16}$	1	$\frac{15}{32}$	$1\frac{5}{16}$	1.2205	0.500	$\frac{3}{8}$	UC202-009D1
$\frac{5}{8}$	UCF202-010D1											UC202-010D1
17	UCF203D1	86	64	15	11	25.5	12	33.3	31	12.7	M10	UC203D1
$\frac{11}{16}$	UCF203-011D1	$3\frac{3}{8}$	$2\frac{33}{64}$	$\frac{19}{32}$	$\frac{7}{16}$	1	$\frac{15}{32}$	$1\frac{5}{16}$	1.2205	0.500	$\frac{3}{8}$	UC203-011D1
20	UCF204D1	86	64	15	11	25.5	12	33.3	31	12.7	M10	UC204D1
$\frac{3}{4}$	UCF204-012D1	$3\frac{3}{8}$	$2\frac{33}{64}$	$\frac{19}{32}$	$\frac{7}{16}$	1	$\frac{15}{32}$	$1\frac{5}{16}$	1.2205	0.500	$\frac{3}{8}$	UC204-012D1
25	UCF205D1	95	70	16	13	27	12	35.8	34.1	14.3	M10	UC205D1
$\frac{13}{16}$	UCF205-013D1	$3\frac{3}{4}$	$2\frac{3}{4}$	$\frac{5}{8}$	$\frac{1}{2}$	$1\frac{1}{16}$	$\frac{15}{32}$	$1\frac{13}{32}$	1.3425	0.563	$\frac{3}{8}$	UC205-013D1
$\frac{7}{8}$	UCF205-014D1											UC205-014D1
$\frac{15}{16}$	UCF205-015D1											UC205-015D1
1	UCF205-100D1											UC205-100D1
30	UCF206D1	108	83	18	13	31	12	40.2	38.1	15.9	M10	UC206D1
$1\frac{1}{16}$	UCF206-101D1	$4\frac{1}{4}$	$3\frac{17}{64}$	$\frac{45}{64}$	$\frac{1}{2}$	$1\frac{7}{32}$	$\frac{15}{32}$	$1\frac{37}{64}$	1.5000	0.626	$\frac{3}{8}$	UC206-101D1
$1\frac{1}{8}$	UCF206-102D1											UC206-102D1
$1\frac{3}{16}$	UCF206-103D1											UC206-103D1
$1\frac{1}{4}$	UCF206-104D1											UC206-104D1
35	UCF207D1	117	92	19	15	34	14	44.4	42.9	17.5	M12	UC207D1
$1\frac{1}{4}$	UCF207-104D1	$4\frac{19}{32}$	$3\frac{5}{8}$	$\frac{3}{4}$	$\frac{19}{32}$	$1\frac{11}{32}$	$\frac{35}{64}$	$1\frac{3}{4}$	1.6890	0.689	$\frac{7}{16}$	UC207-104D1
$1\frac{5}{16}$	UCF207-105D1											UC207-105D1
$1\frac{3}{8}$	UCF207-106D1											UC207-106D1
$1\frac{7}{16}$	UCF207-107D1											UC207-107D1
40	UCF208D1	130	102	21	15	36	16	51.2	49.2	19	M14	UC208D1
$1\frac{1}{2}$	UCF208-108D1	$5\frac{1}{8}$	$4\frac{1}{64}$	$\frac{53}{64}$	$\frac{19}{32}$	$1\frac{13}{32}$	$\frac{5}{8}$	$2\frac{1}{64}$	1.9370	0.748	$\frac{1}{2}$	UC208-108D1
$1\frac{9}{16}$	UCF208-109D1											UC208-109D1
45	UCF209D1	137	105	22	16	38	16	52.2	49.2	19	M14	UC209D1
$1\frac{5}{8}$	UCF209-110D1	$5\frac{13}{32}$	$4\frac{9}{64}$	$\frac{55}{64}$	$\frac{5}{8}$	$1\frac{1}{2}$	$\frac{5}{8}$	$2\frac{1}{16}$	1.9370	0.748	$\frac{1}{2}$	UC209-110D1
$1\frac{11}{16}$	UCF209-111D1											UC209-111D1
$1\frac{3}{4}$	UCF209-112D1											UC209-112D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



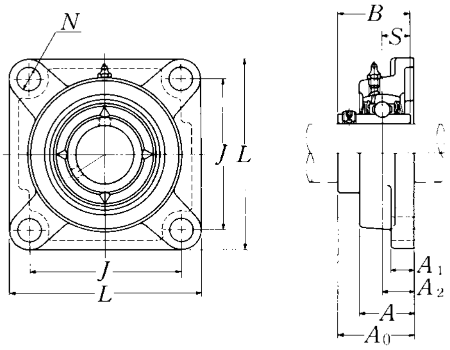
Pressed steel dust cover type
Open end: **S-UCF···D1**
Closed end: **SM-UCF···D1**



Cast dust cover type
Open end: **C-UCF···D1**
Closed end: **CM-UCF···D1**

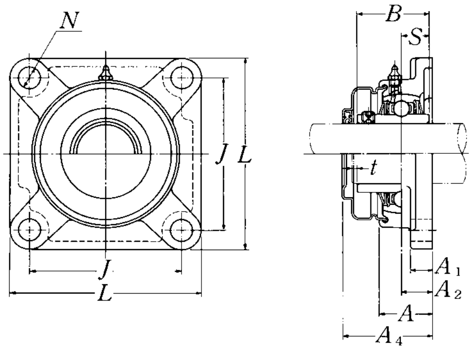
Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions			Mass of unit		
			mm inch			kg lb		
			t max.	A_4	A_5	UCF	S(SM)	C(CM)
F204D1	**S(SM)-UCF201D1**	**C(CM)-UCF201D1**	2	40.5	46	0.7	0.7	0.9
F204D1	**S(SM)-UCF201-008D1**	**C(CM)-UCF201-008D1**	$\frac{5}{64}$	$1\frac{19}{32}$	$1\frac{13}{16}$	1.5	1.5	2.0
F204D1	**S(SM)-UCF202D1**	**C(CM)-UCF202D1**	2	40.5	46	0.7	0.7	0.9
F204D1	**S(SM)-UCF202-009D1**	**C(CM)-UCF202-009D1**	$\frac{5}{64}$	$1\frac{19}{32}$	$1\frac{13}{16}$	1.5	1.5	2.0
F204D1	**S(SM)-UCF202-010D1**	**C(CM)-UCF202-010D1**						
F204D1	**S(SM)-UCF203D1**	**C(CM)-UCF203D1**	2	40.5	46	0.6	0.7	0.9
F204D1	**S(SM)-UCF203-011D1**	**C(CM)-UCF203-011D1**	$\frac{5}{64}$	$1\frac{19}{32}$	$1\frac{13}{16}$	1.3	1.5	2.0
F204D1	**S(SM)-UCF204D1**	**C(CM)-UCF204D1**	2	40.5	46	0.6	0.7	0.9
F204D1	**S(SM)-UCF204-012D1**	**C(CM)-UCF204-012D1**	$\frac{5}{64}$	$1\frac{19}{32}$	$1\frac{13}{16}$	1.3	1.5	2.0
F205D1	**S(SM)-UCF205D1**	**C(CM)-UCF205D1**	2	44.5	51	0.8	0.8	1.0
F205D1	**S(SM)-UCF205-013D1**	**C(CM)-UCF205-013D1**	$\frac{5}{64}$	$1\frac{3}{4}$	2	1.8	1.8	2.2
F205D1	**S(SM)-UCF205-014D1**	**C(CM)-UCF205-014D1**						
F205D1	**S(SM)-UCF205-015D1**	**C(CM)-UCF205-015D1**						
F205D1	**S(SM)-UCF205-100D1**	**C(CM)-UCF205-100D1**						
F206D1	**S(SM)-UCF206D1**	**C(CM)-UCF206D1**	2	49	56	1.0	1.1	1.5
F206D1	**S(SM)-UCF206-101D1**	**C(CM)-UCF206-101D1**	$\frac{5}{64}$	$1\frac{15}{16}$	$2\frac{7}{32}$	2.2	2.4	3.3
F206D1	**S(SM)-UCF206-102D1**	**C(CM)-UCF206-102D1**						
F206D1	**S(SM)-UCF206-103D1**	**C(CM)-UCF206-103D1**						
F206D1	—	—						
F207D1	**S(SM)-UCF207D1**	**C(CM)-UCF207D1**	3	55	59	1.4	1.5	2.0
F207D1	**S(SM)-UCF207-104D1**	**C(CM)-UCF207-104D1**	$\frac{1}{8}$	$2\frac{5}{32}$	$2\frac{5}{16}$	3.1	3.3	4.4
F207D1	**S(SM)-UCF207-105D1**	**C(CM)-UCF207-105D1**						
F207D1	**S(SM)-UCF207-106D1**	**C(CM)-UCF207-106D1**						
F207D1	—	—						
F208D1	**S(SM)-UCF208D1**	**C(CM)-UCF208D1**	3	62	66	1.8	1.9	2.6
F208D1	**S(SM)-UCF208-108D1**	**C(CM)-UCF208-108D1**	$\frac{1}{8}$	$2\frac{7}{16}$	$2\frac{19}{32}$	4.0	4.2	5.7
F208D1	**S(SM)-UCF208-109D1**	**C(CM)-UCF208-109D1**						
F209D1	**S(SM)-UCF209D1**	**C(CM)-UCF209D1**	3	63	70	2.2	2.3	2.8
F209D1	**S(SM)-UCF209-110D1**	**C(CM)-UCF209-110D1**	$\frac{1}{8}$	$2\frac{15}{32}$	$2\frac{3}{4}$	4.9	5.1	6.2
F209D1	**S(SM)-UCF209-111D1**	**C(CM)-UCF209-111D1**						
F209D1	**S(SM)-UCF209-112D1**	**C(CM)-UCF209-112D1**						

Flanged units cast housing
Set screw type

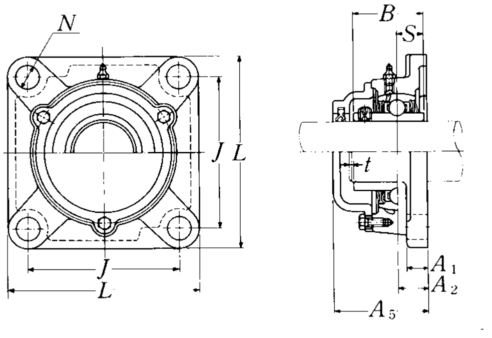


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch									Bolt size mm inch	Bearing number
		L	J	A_2	A_1	A	N	A_0	B	S		
50	UCF210D1	143	111	22	16	40	16	54.6	51.6	19	M14	UC210D1
$1\frac{13}{16}$	UCF210-113D1	$5\frac{5}{8}$	$4\frac{3}{8}$	$\frac{55}{64}$	$\frac{5}{8}$	$1\frac{9}{16}$	$\frac{5}{8}$	$2\frac{5}{32}$	2.0315	0.748	$\frac{1}{2}$	UC210-113D1
$1\frac{7}{8}$	UCF210-114D1											UC210-114D1
$1\frac{15}{16}$	UCF210-115D1											UC210-115D1
2	UCF210-200D1											UC210-200D1
55	UCF211D1	162	130	25	18	43	19	58.4	55.6	22.2	M16	UC211D1
2	UCF211-200D1	$6\frac{3}{8}$	$5\frac{1}{8}$	$\frac{63}{64}$	$\frac{23}{32}$	$1\frac{11}{16}$	$\frac{3}{4}$	$2\frac{19}{64}$	2.1890	0.874	$\frac{5}{8}$	UC211-200D1
$2\frac{1}{16}$	UCF211-201D1											UC211-201D1
$2\frac{1}{8}$	UCF211-202D1											UC211-202D1
$2\frac{3}{16}$	UCF211-203D1											UC211-203D1
60	UCF212D1	175	143	29	18	48	19	68.7	65.1	25.4	M16	UC212D1
$2\frac{1}{4}$	UCF212-204D1	$6\frac{7}{8}$	$5\frac{5}{8}$	$1\frac{9}{64}$	$\frac{23}{32}$	$1\frac{7}{8}$	$\frac{3}{4}$	$2\frac{45}{64}$	2.5630	1.000	$\frac{5}{8}$	UC212-204D1
$2\frac{5}{16}$	UCF212-205D1											UC212-205D1
$2\frac{3}{8}$	UCF212-206D1											UC212-206D1
$2\frac{7}{16}$	UCF212-207D1											UC212-207D1
65	UCF213D1	187	149	30	22	50	19	69.7	65.1	25.4	M16	UC213D1
$2\frac{1}{2}$	UCF213-208D1	$7\frac{3}{8}$	$5\frac{55}{64}$	$1\frac{3}{16}$	$\frac{7}{8}$	$1\frac{31}{32}$	$\frac{3}{4}$	$2\frac{3}{4}$	2.5630	1.000	$\frac{5}{8}$	UC213-208D1
$2\frac{9}{16}$	UCF213-209D1											UC213-209D1
70	UCF214D1	193	152	31	22	54	19	75.4	74.6	30.2	M16	UC214D1
$2\frac{5}{8}$	UCF214-210D1	$7\frac{19}{32}$	$5\frac{63}{64}$	$1\frac{7}{32}$	$\frac{7}{8}$	$2\frac{1}{8}$	$\frac{3}{4}$	$2\frac{31}{32}$	2.9370	1.189	$\frac{5}{8}$	UC214-210D1
$2\frac{11}{16}$	UCF214-211D1											UC214-211D1
$2\frac{3}{4}$	UCF214-212D1											UC214-212D1
75	UCF215D1	200	159	34	22	56	19	78.5	77.8	33.3	M16	UC215D1
$2\frac{13}{16}$	UCF215-213D1	$7\frac{7}{8}$	$6\frac{17}{64}$	$1\frac{11}{32}$	$\frac{7}{8}$	$2\frac{7}{32}$	$\frac{3}{4}$	$3\frac{3}{32}$	3.0630	1.311	$\frac{5}{8}$	UC215-213D1
$2\frac{7}{8}$	UCF215-214D1											UC215-214D1
$2\frac{15}{16}$	UCF215-215D1											UC215-215D1
3	UCF215-300D1											UC215-300D1
80	UCF216D1	208	165	34	22	58	23	83.3	82.6	33.3	M20	UC216D1
$3\frac{1}{16}$	UCF216-301D1	$8\frac{3}{16}$	$6\frac{1}{2}$	$1\frac{11}{32}$	$\frac{7}{8}$	$2\frac{9}{32}$	$\frac{29}{32}$	$3\frac{9}{32}$	3.2520	1.311	$\frac{3}{4}$	UC216-301D1
$3\frac{1}{8}$	UCF216-302D1											UC216-302D1
$3\frac{3}{16}$	UCF216-303D1											UC216-303D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



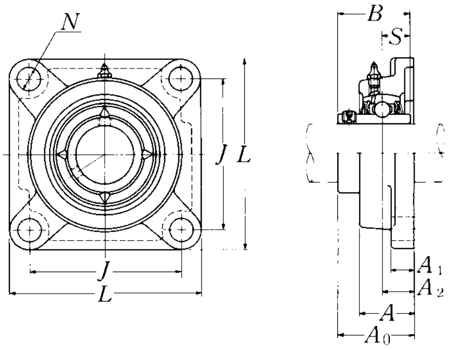
Pressed steel dust cover type
Open end: **S-UCF···D1**
Closed end: **SM-UCF···D1**



Cast dust cover type
Open end: **C-UCF···D1**
Closed end: **CM-UCF···D1**

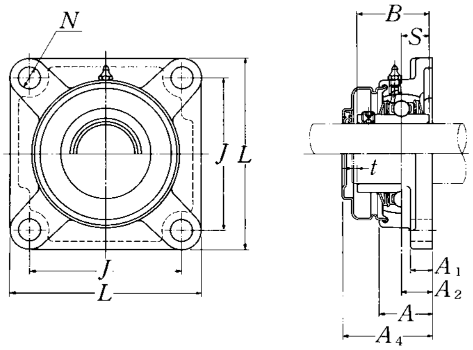
Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions mm inch			Mass of unit kg lb		
			t max.	A_4	A_5	UCF	S(SM)	C(CM)
F210D1	**S(SM)-UCF210D1**	**C(CM)-UCF210D1**	3	65.5	72	2.4	2.5	3.4
F210D1	**S(SM)-UCF210-113D1**	**C(CM)-UCF210-113D1**	$\frac{1}{8}$	$2\frac{19}{32}$	$2\frac{27}{32}$	5.3	5.5	7.5
F210D1	**S(SM)-UCF210-114D1**	**C(CM)-UCF210-114D1**						
F210D1	**S(SM)-UCF210-115D1**	**C(CM)-UCF210-115D1**						
F210D1	—	—						
F211D1	**S(SM)-UCF211D1**	**C(CM)-UCF211D1**	4	71	75	3.6	3.7	4.6
F211D1	**S(SM)-UCF211-200D1**	**C(CM)-UCF211-200D1**	$\frac{5}{32}$	$2\frac{25}{32}$	$2\frac{15}{16}$	7.9	8.2	10
F211D1	**S(SM)-UCF211-201D1**	**C(CM)-UCF211-201D1**						
F211D1	**S(SM)-UCF211-202D1**	**C(CM)-UCF211-202D1**						
F211D1	**S(SM)-UCF211-203D1**	**C(CM)-UCF211-203D1**						
F212D1	**S(SM)-UCF212D1**	**C(CM)-UCF212D1**	4	80	86	4.4	4.6	5.9
F212D1	**S(SM)-UCF212-204D1**	**C(CM)-UCF212-204D1**	$\frac{5}{32}$	$3\frac{25}{32}$	$3\frac{3}{8}$	9.7	10	13
F212D1	**S(SM)-UCF212-205D1**	**C(CM)-UCF212-205D1**						
F212D1	**S(SM)-UCF212-206D1**	**C(CM)-UCF212-206D1**						
F212D1	—	—						
F213D1	**S(SM)-UCF213D1**	**C(CM)-UCF213D1**	4	83.5	90	5.5	5.7	7.2
F213D1	**S(SM)-UCF213-208D1**	**C(CM)-UCF213-208D1**	$\frac{5}{32}$	$3\frac{9}{32}$	$3\frac{17}{32}$	12	13	16
F213D1	**S(SM)-UCF213-209D1**	**C(CM)-UCF213-209D1**						
F214D1	—	**C(CM)-UCF214D1**	4	—	98	6.1	—	7.8
F214D1	—	**C(CM)-UCF214-210D1**	$\frac{5}{32}$	—	$3\frac{27}{32}$	13	—	17
F214D1		**C(CM)-UCF214-211D1**						
F214D1		**C(CM)-UCF214-212D1**						
F215D1	—	**C(CM)-UCF215D1**	4	—	102	6.9	—	8.6
F215D1	—	**C(CM)-UCF215-213D1**	$\frac{5}{32}$	—	$4\frac{1}{32}$	15	—	19
F215D1		**C(CM)-UCF215-214D1**						
F215D1		**C(CM)-UCF215-215D1**						
F215D1		**C(CM)-UCF215-300D1**						
F216D1	—	**C(CM)-UCF216D1**	4	—	106	8.1	—	10
F216D1	—	**C(CM)-UCF216-301D1**	$\frac{5}{32}$	—	$4\frac{3}{16}$	18	—	22
F216D1		**C(CM)-UCF216-302D1**						
F216D1		**C(CM)-UCF216-303D1**						

Flanged units cast housing
Set screw type

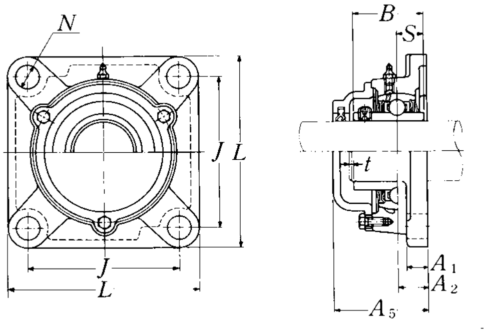


Shaft dia. mm inch	Unit number [1]	Nominal dimensions mm inch									Bolt size mm inch	Bearing number
		L	J	A_2	A_1	A	N	A_0	B	S		
85	**UCF217D1**	220	175	36	24	63	23	87.6	85.7	34.1	M20	UC217D1
$3\frac{1}{4}$	**UCF217-304D1**											UC217-304D1
$3\frac{5}{16}$	**UCF217-305D1**	$8\frac{21}{32}$	$6\frac{57}{64}$	$1\frac{27}{64}$	$\frac{15}{16}$	$2\frac{15}{32}$	$\frac{29}{32}$	$3\frac{29}{64}$	3.3740	1.343	$\frac{3}{4}$	UC217-305D1
$3\frac{7}{16}$	**UCF217-307D1**											UC217-307D1
90	**UCF218D1**	235	187	40	24	68	23	96.3	96	39.7	M20	UC218D1
$3\frac{1}{2}$	**UCF218-308D1**	$9\frac{1}{4}$	$7\frac{23}{64}$	$1\frac{37}{64}$	$\frac{15}{16}$	$2\frac{11}{16}$	$\frac{29}{32}$	$3\frac{51}{64}$	3.7795	1.563	$\frac{3}{4}$	UC218-308D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



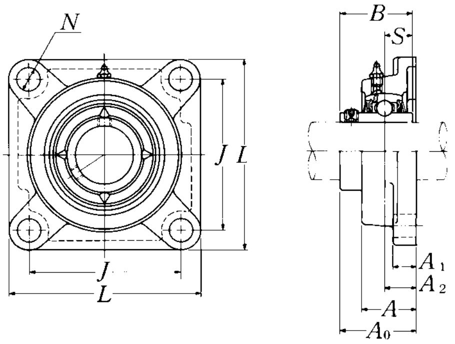
Pressed steel dust cover type
Open end: **S-UCF···D1**
Closed end: **SM-UCF···D1**



Cast dust cover type
Open end: **C-UCF···D1**
Closed end: **CM-UCF···D1**

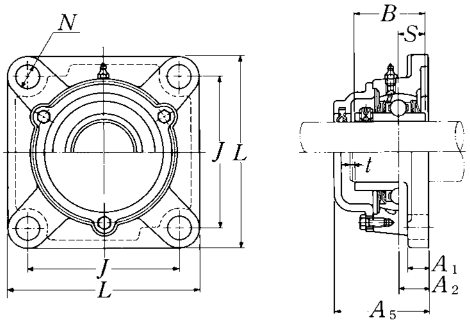
Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions			Mass of unit		
			mm	inch		kg	lb	
			t max.	A_4	A_5	UCF	S(SM)	C(CM)
F217D1	—	**C(CM)-UCF217D1**	5	—	114	9.3	—	12
F217D1	—	**C(CM)-UCF217-304D1**	$\frac{13}{64}$	—	$4\frac{1}{2}$	21	—	26
F217D1		**C(CM)-UCF217-305D1**						
F217D1		**C(CM)-UCF217-307D1**						
F218D1	—	**C(CM)-UCF218D1**	5	—	122	11	—	15
F218D1	—	**C(CM)-UCF218-308D1**	$\frac{13}{64}$	—	$4\frac{13}{16}$	24	—	33

Flanged units cast housing
Set screw type



Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch L	J	A2	A1	A	N	A0	B	S	Bolt size mm inch	Bearing number
25	**UCF305D1**	110	80	16	13	29	16	39	38	15	M14	UC305D1
13/16	**UCF305-013D1**	4 11/32	3 5/32	5/8	1/2	1 5/32	5/8	1 17/32	1.4961	0.591	1/2	UC305-013D1
7/8	**UCF305-014D1**											UC305-014D1
15/16	**UCF305-015D1**											UC305-015D1
1	**UCF305-100D1**											UC305-100D1
30	**UCF306D1**	125	95	18	15	32	16	44	43	17	M14	UC306D1
1 1/16	**UCF306-101D1**	4 29/32	3 47/64	45/64	19/32	1 1/4	5/8	1 47/64	1.6929	0.669	1/2	UC306-101D1
1 1/8	**UCF306-102D1**											UC306-102D1
1 3/16	**UCF306-103D1**											UC306-103D1
35	**UCF307D1**	135	100	20	16	36	19	49	48	19	M16	UC307D1
1 1/4	**UCF307-104D1**	5 5/16	3 15/16	25/32	5/8	1 13/32	3/4	1 59/64	1.8898	0.748	5/8	UC307-104D1
1 5/16	**UCF307-105D1**											UC307-105D1
1 3/8	**UCF307-106D1**											UC307-106D1
1 7/16	**UCF307-107D1**											UC307-107D1
40	**UCF308D1**	150	112	23	17	40	19	56	52	19	M16	UC308D1
1 1/2	**UCF308-108D1**	5 29/32	4 13/32	29/32	21/32	1 9/16	3/4	2 13/64	2.0472	0.748	5/8	UC308-108D1
1 9/16	**UCF308-109D1**											UC308-109D1
45	**UCF309D1**	160	125	25	18	44	19	60	57	22	M16	UC309D1
1 5/8	**UCF309-110D1**	6 5/16	4 59/64	63/64	23/32	1 23/32	3/4	2 23/64	2.2441	0.866	5/8	UC309-110D1
1 11/16	**UCF309-111D1**											UC309-111D1
1 3/4	**UCF309-112D1**											UC309-112D1
50	**UCF310D1**	175	132	28	19	48	23	67	61	22	M20	UC310D1
1 13/16	**UCF310-113D1**	6 7/8	5 13/64	1 7/64	3/4	1 7/8	29/32	2 41/64	2.4016	0.866	3/4	UC310-113D1
1 7/8	**UCF310-114D1**											UC310-114D1
1 15/16	**UCF310-115D1**											UC310-115D1
55	**UCF311D1**	185	140	30	20	52	23	71	66	25	M20	UC311D1
2	**UCF311-200D1**	7 9/32	5 33/64	1 3/16	25/32	2 1/16	29/32	2 51/64	2.5984	0.984	3/4	UC311-200D1
2 1/16	**UCF311-201D1**											UC311-201D1
2 1/8	**UCF311-202D1**											UC311-202D1
2 3/16	**UCF311-203D1**											UC311-203D1

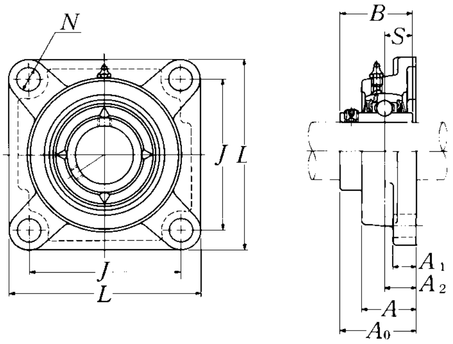
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UCF···D1**
Closed end: **CM-UCF···D1**

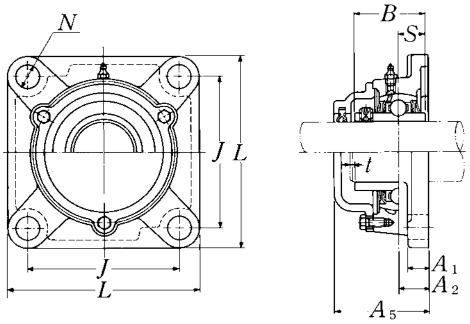
Housing number	Unit number cast dust cover type	Nominal dimensions		Mass of unit	
		mm	inch	kg	lb
		t max.	A_5	UCP	C(CM)
F305D1	**C(CM)-UCF305D1**	2	56	1.1	1.6
F305D1	**C(CM)-UCF305-013D1**	$\frac{5}{64}$	$2\frac{7}{32}$	2.4	3.5
F305D1	**C(CM)-UCF305-014D1**				
F305D1	**C(CM)-UCF305-015D1**				
F305D1	**C(CM)-UCF305-100D1**				
F306D1	**C(CM)-UCF306D1**	2	60	1.6	2.2
F306D1	**C(CM)-UCF306-101D1**	$\frac{5}{64}$	$2\frac{3}{8}$	3.5	4.9
F306D1	**C(CM)-UCF306-102D1**				
F306D1	**C(CM)-UCF306-103D1**				
F307D1	**C(CM)-UCF307D1**	3	68	2.0	2.7
F307D1	**C(CM)-UCF307-104D1**	$\frac{1}{8}$	$2\frac{11}{16}$	4.4	6.0
F307D1	**C(CM)-UCF307-105D1**				
F307D1	**C(CM)-UCF307-106D1**				
F307D1	**C(CM)-UCF307-107D1**				
F308D1	**C(CM)-UCF308D1**	3	76	2.7	3.5
F308D1	**C(CM)-UCF308-108D1**	$\frac{1}{8}$	3	6.0	7.7
F308D1	**C(CM)-UCF308-109D1**				
F309D1	**C(CM)-UCF309D1**	3	80	3.4	4.5
F309D1	**C(CM)-UCF309-110D1**	$\frac{1}{8}$	$3\frac{5}{32}$	7.5	9.9
F309D1	**C(CM)-UCF309-111D1**				
F309D1	**C(CM)-UCF309-112D1**				
F310D1	**C(CM)-UCF310D1**	3	88	4.5	5.6
F310D1	**C(CM)-UCF310-113D1**	$\frac{1}{8}$	$3\frac{15}{32}$	9.9	12
F310D1	**C(CM)-UCF310-114D1**				
F310D1	**C(CM)-UCF310-115D1**				
F311D1	**C(CM)-UCF311D1**	4	92	5.5	7.6
F311D1	**C(CM)-UCF311-200D1**	$\frac{5}{32}$	$3\frac{5}{8}$	12	17
F311D1	**C(CM)-UCF311-201D1**				
F311D1	**C(CM)-UCF311-202D1**				
F311D1	**C(CM)-UCF311-203D1**				

Flanged units cast housing
Set screw type



Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm / inch L	J	A_2	A_1	A	N	A_0	B	S	Bolt size mm inch	Bearing number
60	**UCF312D1**	195	150	33	22	56	23	78	71	26	M20	UC312D1
2 1/4	**UCF312-204D1**											UC312-204D1
2 5/16	**UCF312-205D1**	7 11/16	5 29/32	1 19/64	7/8	2 7/32	29/32	3 5/64	2.7953	1.024	3/4	UC312-205D1
2 3/8	**UCF312-206D1**											UC312-206D1
2 7/16	**UCF312-207D1**											UC312-207D1
65	**UCF313D1**	208	166	33	22	58	23	78	75	30	M20	UC313D1
2 1/2	**UCF313-208D1**	8 3/16	6 17/32	1 19/64	7/8	2 9/32	29/32	3 5/64	2.9528	1.181	3/4	UC313-208D1
2 9/16	**UCF313-209D1**											UC313-209D1
70	**UCF314D1**	226	178	36	25	61	25	81	78	33	M22	UC314D1
2 5/8	**UCF314-210D1**											UC314-210D1
2 11/16	**UCF314-211D1**	8 29/32	6 1/64	1 27/64	31/32	2 13/32	63/64	3 3/16	3.0709	1.299	7/8	UC314-211D1
2 3/4	**UCF314-212D1**											UC314-212D1
75	**UCF315D1**	236	184	39	25	66	25	89	82	32	M22	UC315D1
2 13/16	**UCF315-213D1**											UC315-213D1
2 7/8	**UCF315-214D1**	9 9/32	7 1/4	1 17/32	31/32	2 19/32	63/64	3 1/2	3.2283	1.260	7/8	UC315-214D1
2 15/16	**UCF315-215D1**											UC315-215D1
3	**UCF315-300D1**											UC315-300D1
80	**UCF316D1**	250	196	38	27	68	31	90	86	34	M27	UC316D1
3 1/16	**UCF316-301D1**											UC316-301D1
3 1/8	**UCF316-302D1**	9 27/32	7 23/32	1 1/2	1 1/16	2 11/16	1 7/32	3 35/64	3.3858	1.339	1	UC316-302D1
3 3/16	**UCF316-303D1**											UC316-303D1
85	**UCF317D1**	260	204	44	27	74	31	100	96	40	M27	UC317D1
3 1/4	**UCF317-304D1**											UC317-304D1
3 5/16	**UCF317-305D1**	10 1/4	8 1/32	1 47/64	1 1/16	2 29/32	1 7/32	3 15/16	3.7795	1.575	1	UC317-305D1
3 7/16	**UCF317-307D1**											UC317-307D1
90	**UCF318D1**	280	216	44	30	76	35	100	96	40	M30	UC318D1
3 7/16	**UCF318-307D1**	11 1/32	8 1/2	1 47/64	1 3/16	3	1 3/8	3 15/16	3.7795	1.575	1 1/8	UC318-307D1
3 1/2	**UCF318-308D1**											UC318-308D1

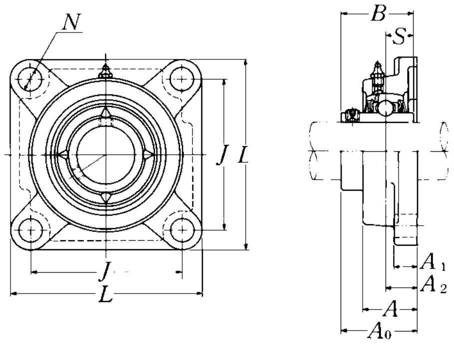
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UCF···D1**
Closed end: **CM-UCF···D1**

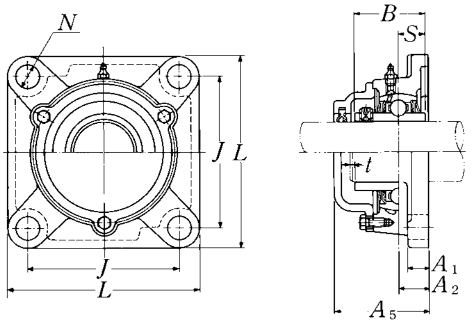
Housing number	Unit number cast dust cover type	Nominal dimensions		Mass of unit	
		mm	inch	kg	lb
		t max.	A_5	UCP	C(CM)
F312D1	**C(CM)-UCF312D1**	4	100	6.5	8.6
F312D1	**C(CM)-UCF312-204D1**	$\frac{5}{32}$	$3\frac{15}{16}$	14	19
F312D1	**C(CM)-UCF312-205D1**				
F312D1	**C(CM)-UCF312-206D1**				
F312D1	**C(CM)-UCF312-207D1**				
F313D1	**C(CM)-UCF313D1**	4	103	7.9	10
F313D1	**C(CM)-UCF313-208D1**	$\frac{5}{32}$	$4\frac{1}{16}$	17	22
F313D1	**C(CM)-UCF313-209D1**				
F314D1	**C(CM)-UCF314D1**	4	106	9.5	13
F314D1	**C(CM)-UCF314-210D1**	$\frac{5}{32}$	$4\frac{3}{16}$	21	29
F314D1	**C(CM)-UCF314-211D1**				
F314D1	**C(CM)-UCF314-212D1**				
F315D1	**C(CM)-UCF315D1**	4	114	12	14
F315D1	**C(CM)-UCF315-213D1**	$\frac{5}{32}$	$4\frac{1}{2}$	26	31
F315D1	**C(CM)-UCF315-214D1**				
F315D1	**C(CM)-UCF315-215D1**				
F315D1	**C(CM)-UCF315-300D1**				
F316D1	**C(CM)-UCF316D1**	4	116	14	18
F316D1	**C(CM)-UCF316-301D1**	$\frac{5}{32}$	$4\frac{9}{16}$	31	40
F316D1	**C(CM)-UCF316-302D1**				
F316D1	**C(CM)-UCF316-303D1**				
F317D1	**C(CM)-UCF317D1**	5	129	16	21
F317D1	**C(CM)-UCF317-304D1**	$\frac{13}{64}$	$5\frac{3}{32}$	35	46
F317D1	**C(CM)-UCF317-305D1**				
F317D1	**C(CM)-UCF317-307D1**				
F318D1	**C(CM)-UCF318D1**	5	129	19	24
F318D1	**C(CM)-UCF318-307D1**	$\frac{13}{64}$	$5\frac{3}{32}$	42	53
F318D1	**C(CM)-UCF318-308D1**				

Flanged units cast housing
Set screw type



Shaft dia. mm inch	Unit number [1]	Nominal dimensions mm inch L	J	A_2	A_1	A	N	A_0	B	S	Bolt size mm inch	Bearing number
95	**UCF319D1**	290	228	59	30	94	35	121	103	41	M30	UC319D1
$3\frac{5}{8}$	**UCF319-310D1**	$11\frac{13}{32}$	$8\frac{31}{32}$	$2\frac{21}{64}$	$1\frac{3}{16}$	$3\frac{11}{16}$	$1\frac{3}{8}$	$4\frac{49}{64}$	4.0551	1.614	$1\frac{1}{8}$	UC319-310D1
$3\frac{11}{16}$	**UCF319-311D1**											UC319-311D1
$3\frac{3}{4}$	**UCF319-312D1**											UC319-312D1
100	**UCF320D1**	310	242	59	32	94	38	125	108	42	M33	UC320D1
$3\frac{13}{16}$	**UCF320-313D1**	$12\frac{7}{32}$	$9\frac{17}{32}$	$2\frac{21}{64}$	$1\frac{1}{4}$	$3\frac{11}{16}$	$1\frac{1}{2}$	$4\frac{59}{64}$	4.2520	1.654	$1\frac{1}{4}$	UC320-313D1
$3\frac{7}{8}$	**UCF320-314D1**											UC320-314D1
$3\frac{15}{16}$	**UCF320-315D1**											UC320-315D1
4	**UCF320-400D1**											UC320-400D1
105	**UCF321D1**	310	242	59	32	94	38	127	112	44	M33	UC321D1
110	**UCF322D1**	340	266	60	35	96	41	131	117	46	M36	UC322D1
120	**UCF324D1**	370	290	65	40	110	41	140	126	51	M36	UC324D1
130	**UCF326D1**	410	320	65	45	115	41	146	135	54	M36	UC326D1
140	**UCF328D1**	450	350	75	55	125	41	161	145	59	M36	UC328D1

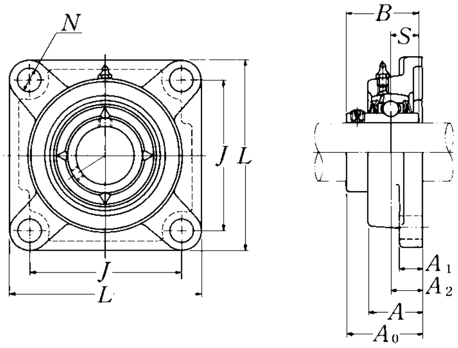
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UCF···D1**
Closed end: **CM-UCF···D1**

Housing number	Unit number cast dust cover type	Nominal dimensions		Mass of unit	
		mm	inch	kg	lb
		t max.	A_5	UCP	C(CM)
F319D1	**C(CM)-UCF319D1**	5	149	22	27
F319D1	**C(CM)-UCF319-310D1**	$\frac{13}{64}$	$5\frac{7}{8}$	49	60
F319D1	**C(CM)-UCF319-311D1**				
F319D1	**C(CM)-UCF319-312D1**				
F320D1	**C(CM)-UCF320D1**	5	154	26	32
F320D1	**C(CM)-UCF320-313D1**	$\frac{13}{64}$	$6\frac{1}{16}$	57	71
F320D1	**C(CM)-UCF320-314D1**				
F320D1	**C(CM)-UCF320-315D1**				
F320D1	**C(CM)-UCF320-400D1**				
F321D1	**C(CM)-UCF321D1**	5	156	27	33
F322D1	**C(CM)-UCF322D1**	5	160	38	45
F324D1	**C(CM)-UCF324D1**	5	172	50	60
F326D1	**C(CM)-UCF326D1**	6	178	66	78
F328D1	**C(CM)-UCF328D1**	6	192	90	106

Flanged units cast housing
Set screw type

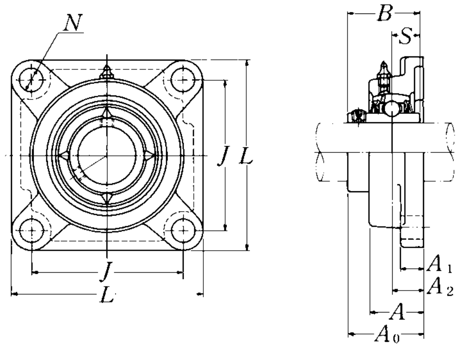


Shaft dia.	Unit number 1)	Nominal dimensions									Bolt size	Bearing number
mm inch		mm inch									mm inch	
		L	J	A2	A1	A	N	A0	B	S		
25	**UCFX05D1**	108	83	18	13	30	12	40.2	38.1	15.9	M10	UCX05D1
13/16	**UCFX05-013D1**	4 1/4	3 17/64	45/64	1/2	1 3/16	15/32	1 37/64	1.5000	0.626	3/8	UCX05-013D1
7/8	**UCFX05-014D1**											UCX05-014D1
15/16	**UCFX05-015D1**											UCX05-015D1
1	**UCFX05-100D1**											UCX05-100D1
30	**UCFX06D1**	117	92	19	14	34	16	44.4	42.9	17.5	M14	UCX06D1
1 1/16	**UCFX06-101D1**	4 19/32	3 5/8	3/4	9/16	1 11/32	5/8	1 3/4	1.6890	0.689	1/2	UCX06-101D1
1 1/8	**UCFX06-102D1**											UCX06-102D1
1 3/16	**UCFX06-103D1**											UCX06-103D1
1 1/4	**UCFX06-104D1**											UC207-104D1
35	**UCFX07D1**	130	102	21	14	38	16	51.2	49.2	19	M14	UCX07D1
1 5/16	**UCFX07-105D1**	5 1/8	4 1/64	53/64	9/16	1 1/2	5/8	2 1/64	1.9370	0.748	1/2	UCX07-105D1
1 3/8	**UCFX07-106D1**											UCX07-106D1
1 7/16	**UCFX07-107D1**											UCX07-107D1
40	**UCFX08D1**	137	105	22	14	40	19	52.2	49.2	19	M16	UCX08D1
1 1/2	**UCFX08-108D1**	5 13/32	4 9/64	55/64	9/16	1 9/16	3/4	2 1/16	1.9370	0.748	5/8	UCX08-108D1
1 9/16	**UCFX08-109D1**											UCX08-109D1
45	**UCFX09D1**	143	111	23	14	40	19	55.6	51.6	19	M16	UCX09D1
1 5/8	**UCFX09-110D1**	5 5/8	4 3/8	29/32	9/16	1 9/16	3/4	2 3/16	2.0315	0.748	5/8	UCX09-110D1
1 11/16	**UCFX09-111D1**											UCX09-111D1
1 3/4	**UCFX09-112D1**											UCX09-112D1
1 13/16	**UCFX09-113D1**											UC210-113D1
50	**UCFX10D1**	162	130	26	20	44	19	59.4	55.6	22.2	M16	UCX10D1
1 7/8	**UCFX10-114D1**	6 3/8	5 1/8	1 1/32	25/32	1 23/32	3/4	2 11/32	2.1890	0.874	5/8	UCX10-114D1
1 15/16	**UCFX10-115D1**											UCX10-115D1
2	**UCFX10-200D1**											UC211-200D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
FX05D1	1.0
FX05D1	2.2
FX05D1	
FX05D1	
FX05D1	
FX06D1	1.7
FX06D1	3.7
FX06D1	
FX06D1	
FX06D1	
FX07D1	2.1
FX07D1	4.6
FX07D1	
FX07D1	
FX08D1	2.4
FX08D1	5.3
FX08D1	
FX09D1	2.5
FX09D1	5.5
FX09D1	
FX09D1	
FX09D1	
FX10D1	3.9
FX10D1	8.6
FX10D1	
FX10D1	

Flanged units cast housing
Set screw type

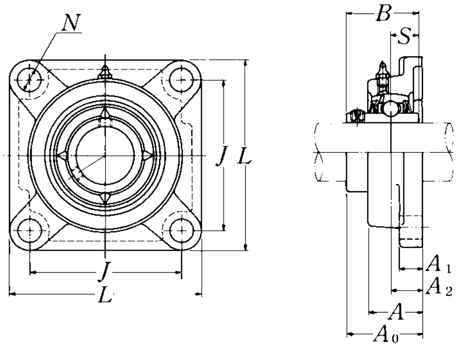


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch									Bolt size mm inch	Bearing number
		L	*J*	A_2	A_1	*A*	*N*	A_0	*B*	*S*		
55	**UCFX11D1**	175	143	29	20	49	19	68.7	65.1	25.4	M16	UCX11D1
$2\frac{1}{16}$	**UCFX11-201D1**	$6\frac{7}{8}$	$5\frac{5}{8}$	$1\frac{9}{64}$	$\frac{25}{32}$	$1\frac{15}{16}$	$\frac{3}{4}$	$2\frac{45}{64}$	2.5630	1.000	$\frac{5}{8}$	UCX11-201D1
$2\frac{1}{8}$	**UCFX11-202D1**											UCX11-202D1
$2\frac{3}{16}$	**UCFX11-203D1**											UCX11-203D1
$2\frac{1}{4}$	**UCFX11-204D1**											UC212-204D1
$2\frac{5}{16}$	**UCFX11-205D1**											UC212-205D1
60	**UCFX12D1**	187	149	34	21	59	19	73.7	65.1	25.4	M16	UCX12D1
$2\frac{3}{8}$	**UCFX12-206D1**	$7\frac{3}{8}$	$5\frac{55}{64}$	$1\frac{11}{32}$	$\frac{13}{16}$	$2\frac{5}{16}$	$\frac{3}{4}$	$2\frac{29}{32}$	2.5630	1.000	$\frac{5}{8}$	UCX12-206D1
$2\frac{7}{16}$	**UCFX12-207D1**											UCX12-207D1
65	**UCFX13D1**	187	149	34	21	59	19	78.4	74.6	30.2	M16	UCX13D1
$2\frac{1}{2}$	**UCFX13-208D1**	$7\frac{3}{8}$	$5\frac{55}{64}$	$1\frac{11}{32}$	$\frac{13}{16}$	$2\frac{5}{16}$	$\frac{3}{4}$	$3\frac{3}{32}$	2.9370	1.189	$\frac{5}{8}$	UCX13-208D1
$2\frac{9}{16}$	**UCFX13-209D1**											UCX13-209D1
70	**UCFX14D1**	197	152	37	24	60	23	81.5	77.8	33.3	M20	UCX14D1
$2\frac{5}{8}$	**UCFX14-210D1**	$7\frac{3}{4}$	$5\frac{63}{64}$	$1\frac{29}{64}$	$\frac{15}{16}$	$2\frac{3}{8}$	$\frac{29}{32}$	$3\frac{13}{64}$	3.0630	1.311	$\frac{3}{4}$	UCX14-210D1
$2\frac{11}{16}$	**UCFX14-211D1**											UCX14-211D1
$2\frac{3}{4}$	**UCFX14-212D1**											UCX14-212D1
75	**UCFX15D1**	197	152	40	24	68	23	89.3	82.6	33.3	M20	UCX15D1
$2\frac{13}{16}$	**UCFX15-213D1**	$7\frac{3}{4}$	$5\frac{63}{64}$	$1\frac{37}{64}$	$\frac{15}{16}$	$2\frac{11}{16}$	$\frac{29}{32}$	$3\frac{33}{64}$	3.2520	1.311	$\frac{3}{4}$	UCX15-213D1
$2\frac{7}{8}$	**UCFX15-214D1**											UCX15-214D1
$2\frac{15}{16}$	**UCFX15-215D1**											UCX15-215D1
3	**UCFX15-300D1**											UCX15-300D1
80	**UCFX16D1**	214	171	40	24	70	23	91.6	85.7	34.1	M20	UCX16D1
$3\frac{1}{16}$	**UCFX16-301D1**	$8\frac{7}{16}$	$6\frac{47}{64}$	$1\frac{37}{64}$	$\frac{15}{16}$	$2\frac{3}{4}$	$\frac{29}{32}$	$3\frac{39}{64}$	3.3740	1.343	$\frac{3}{4}$	UCX16-301D1
$3\frac{1}{8}$	**UCFX16-302D1**											UCX16-302D1
$3\frac{3}{16}$	**UCFX16-303D1**											UCX16-303D1
$3\frac{1}{4}$	**UCFX16-304D1**											UC217-304D1
85	**UCFX17D1**	214	171	40	24	70	23	96.3	96	39.7	M20	UCX17D1
$3\frac{5}{16}$	**UCFX17-305D1**	$8\frac{7}{16}$	$6\frac{47}{64}$	$1\frac{37}{64}$	$\frac{15}{16}$	$2\frac{3}{4}$	$\frac{29}{32}$	$3\frac{51}{64}$	3.7795	1.563	$\frac{3}{4}$	UCX17-305D1
$3\frac{7}{16}$	**UCFX17-307D1**											UCX17-307D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit	
	kg	lb
FX11D1	4.9	11
FX11D1		
FX11D1		
FX11D1		
FX11D1		
FX11D1		
FX12D1	5.2	11
FX12D1		
FX12D1		
FX13D1	5.3	12
FX13D1		
FX13D1		
FX14D1	7.3	16
FX14D1		
FX14D1		
FX14D1		
FX15D1	8.1	18
FX15D1		
FX15D1		
FX15D1		
FX15D1		
FX16D1	9.9	22
FX16D1		
FX16D1		
FX16D1		
FX16D1		
FX17D1	11	24
FX17D1		
FX17D1		

Flanged units cast housing
Set screw type

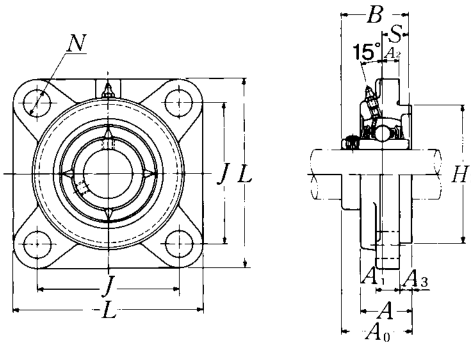


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch L	 J	 A_2	 A_1	 A	 N	 A_0	 B	 S	Bolt size mm inch	Bearing number
90	**UCFX18D1**	214	171	45	24	76	23	106.1	104	42.9	M20	UCX18D1
$3\frac{7}{16}$	**UCFX18-307D1**	$8\frac{7}{16}$	$6\frac{47}{64}$	$1\frac{49}{64}$	$\frac{15}{16}$	3	$\frac{29}{32}$	$4\frac{11}{64}$	4.0945	1.689	$\frac{3}{4}$	UCX18-307D1
$3\frac{1}{2}$	**UCFX18-308D1**											UCX18-308D1
100	**UCFX20D1**	268	211	59	31	97	31	127.3	117.5	49.2	M27	UCX20D1
$3\frac{13}{16}$	**UCFX20-313D1**	$10\frac{9}{16}$	$8\frac{5}{16}$	$2\frac{21}{64}$	$1\frac{7}{32}$	$3\frac{13}{16}$	$1\frac{7}{32}$	$5\frac{1}{64}$	4.6260	1.937	1	UCX20-313D1
$3\frac{7}{8}$	**UCFX20-314D1**											UCX20-314D1
$3\frac{15}{16}$	**UCFX20-315D1**											UCX20-315D1
4	**UCFX20-400D1**											UCX20-400D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

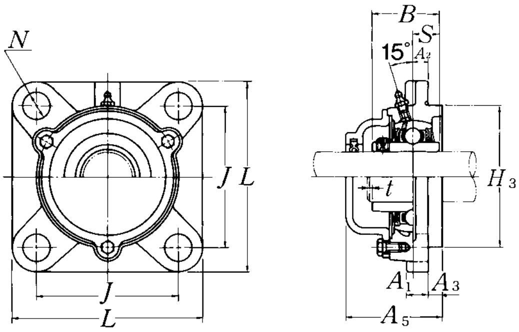
Housing number	Mass of unit
	kg lb
FX18D1	11
FX18D1	24
FX18D1	
FX20D1	17
FX20D1	37
FX20D1	
FX20D1	
FX20D1	

Flanged cartridge units cast housing
Set screw type



Shaft dia. mm inch	Unit number 1)	L	J	A_2	N	A_3	A_1	A	H_3	A_0	B	S	Bolt size mm inch
		Nominal dimensions mm inch											
25	UCFS305D1	110	80	9	16	7	13	29	80	39	38	15	M14
$\frac{13}{16}$	UCFS305-013D1	$4\frac{11}{32}$	$3\frac{5}{32}$	$\frac{23}{64}$	$\frac{5}{8}$	$\frac{9}{32}$	$\frac{1}{2}$	$1\frac{9}{64}$	3.1496	$1\frac{17}{32}$	1.4961	0.591	$\frac{1}{2}$
$\frac{7}{8}$	UCFS305-014D1												
$\frac{15}{16}$	UCFS305-015D1												
1	UCFS305-100D1												
30	UCFS306D1	125	95	10	16	8	15	32	90	44	43	17	M14
$1\frac{1}{16}$	UCFS306-101D1	$4\frac{29}{32}$	$3\frac{47}{64}$	$\frac{25}{64}$	$\frac{5}{8}$	$\frac{5}{16}$	$\frac{19}{32}$	$1\frac{17}{64}$	3.5433	$1\frac{47}{64}$	1.6929	0.669	$\frac{1}{2}$
$1\frac{1}{8}$	UCFS306-102D1												
$1\frac{3}{16}$	UCFS306-103D1												
35	UCFS307D1	135	100	11	19	9	16	36	100	49	48	19	M16
$1\frac{1}{4}$	UCFS307-104D1	$5\frac{5}{16}$	$3\frac{15}{16}$	$\frac{7}{16}$	$\frac{3}{4}$	$\frac{23}{64}$	$\frac{5}{8}$	$1\frac{13}{32}$	3.9370	$1\frac{59}{64}$	1.8898	0.748	$\frac{5}{8}$
$1\frac{5}{16}$	UCFS307-105D1												
$1\frac{3}{8}$	UCFS307-106D1												
$1\frac{7}{16}$	UCFS307-107D1												
40	UCFS308D1	150	112	13	19	10	17	40	115	56	52	19	M16
$1\frac{1}{2}$	UCFS308-108D1	$5\frac{29}{32}$	$4\frac{13}{32}$	$\frac{33}{64}$	$\frac{3}{4}$	$\frac{25}{64}$	$\frac{21}{32}$	$1\frac{9}{16}$	4.5276	$2\frac{13}{64}$	2.0472	0.748	$\frac{5}{8}$
$1\frac{9}{16}$	UCFS308-109D1												
45	UCFS309D1	160	125	14	19	11	18	44	125	60	57	22	M16
$1\frac{5}{8}$	UCFS309-110D1	$6\frac{5}{16}$	$4\frac{59}{64}$	$\frac{35}{64}$	$\frac{3}{4}$	$\frac{7}{16}$	$\frac{23}{32}$	$1\frac{47}{64}$	4.9213	$2\frac{23}{64}$	2.2441	0.866	$\frac{5}{8}$
$1\frac{11}{16}$	UCFS309-111D1												
$1\frac{3}{4}$	UCFS309-112D1												
50	UCFS310D1	175	132	16	23	12	19	48	140	67	61	22	M20
$1\frac{13}{16}$	UCFS310-113D1	$6\frac{7}{8}$	$5\frac{13}{64}$	$\frac{5}{8}$	$\frac{29}{32}$	$\frac{15}{32}$	$\frac{3}{4}$	$1\frac{57}{64}$	5.5118	$2\frac{41}{64}$	2.4016	0.866	$\frac{3}{4}$
$1\frac{7}{8}$	UCFS310-114D1												
$1\frac{15}{16}$	UCFS310-115D1												
55	UCFS311D1	185	140	17	23	13	20	52	150	71	66	25	M20
2	UCFS311-200D1	$7\frac{9}{32}$	$5\frac{33}{64}$	$\frac{43}{64}$	$\frac{29}{32}$	$\frac{33}{64}$	$\frac{25}{32}$	$2\frac{3}{64}$	5.9055	$2\frac{51}{64}$	2.5984	0.984	$\frac{3}{4}$
$2\frac{1}{16}$	UCFS311-201D1												
$2\frac{1}{8}$	UCFS311-202D1												
$2\frac{3}{16}$	UCFS311-203D1												

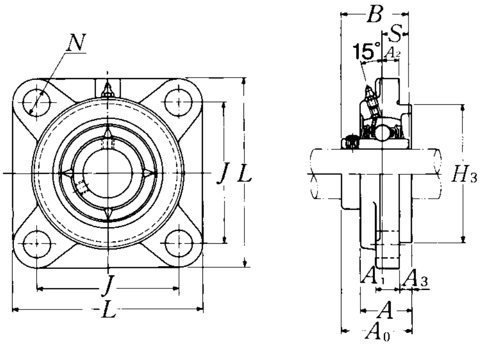
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UCFS···D1**
Closed end: **CM-UCFS···D1**

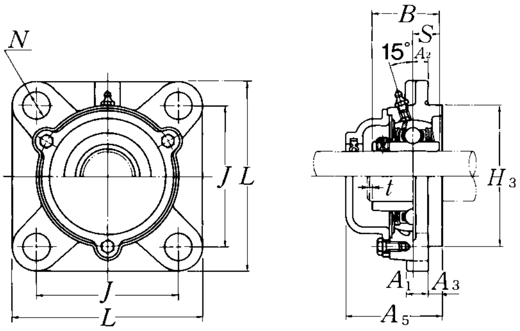
Bearing number	Housing number	Unit number cast dust cover type	Nominal dimensions		Mass of unit	
			mm	inch	kg	lb
			t max.	A_5	UCFS	C(CM)
UC305D1	FS305D1	C(CM)-UCFS305D1	2	56	1.3	1.8
UC305-013D1	FS305D1	C(CM)-UCFS305-013D1	$\frac{5}{64}$	$2\frac{13}{64}$	2.9	4.0
UC305-014D1	FS305D1	C(CM)-UCFS305-014D1				
UC305-015D1	FS305D1	C(CM)-UCFS305-015D1				
UC305-100D1	FS305D1	C(CM)-UCFS305-100D1				
UC306D1	FS306D1	C(CM)-UCFS306D1	2	60	1.9	2.4
UC306-101D1	FS306D1	C(CM)-UCFS306-101D1	$\frac{5}{64}$	$2\frac{23}{64}$	4.2	5.3
UC306-102D1	FS306D1	C(CM)-UCFS306-102D1				
UC306-103D1	FS306D1	C(CM)-UCFS306-103D1				
UC307D1	FS307D1	C(CM)-UCFS307D1	3	67	2.4	3.0
UC307-104D1	FS307D1	C(CM)-UCFS307-104D1	$\frac{1}{8}$	$2\frac{41}{64}$	5.3	6.6
UC307-105D1	FS307D1	C(CM)-UCFS307-105D1				
UC307-106D1	FS307D1	C(CM)-UCFS307-106D1				
UC307-107D1	FS307D1	C(CM)-UCFS307-107D1				
UC308D1	FS308D1	C(CM)-UCFS308D1	3	76	3.3	4.1
UC308-108D1	FS308D1	C(CM)-UCFS308-108D1	$\frac{1}{8}$	$2\frac{63}{64}$	7.3	9.0
UC308-109D1	FS308D1	C(CM)-UCFS308-109D1				
UC309D1	FS309D1	C(CM)-UCFS309D1	3	80	4.0	5.1
UC309-110D1	FS309D1	C(CM)-UCFS309-110D1	$\frac{1}{8}$	$3\frac{5}{32}$	8.8	11
UC309-111D1	FS309D1	C(CM)-UCFS309-111D1				
UC309-112D1	FS309D1	C(CM)-UCFS309-112D1				
UC310D1	FS310D1	C(CM)-UCFS310D1	3	88	5.3	6.7
UC310-113D1	FS310D1	C(CM)-UCFS310-113D1	$\frac{1}{8}$	$3\frac{15}{32}$	12	15
UC310-114D1	FS310D1	C(CM)-UCFS310-114D1				
UC310-115D1	FS310D1	C(CM)-UCFS310-115D1				
UC311D1	FS311D1	C(CM)-UCFS311D1	4	93	6.2	8.2
UC311-200D1	FS311D1	C(CM)-UCFS311-200D1	$\frac{5}{32}$	$3\frac{21}{32}$	14	18
UC311-201D1	FS311D1	C(CM)-UCFS311-201D1				
UC311-202D1	FS311D1	C(CM)-UCFS311-202D1				
UC311-203D1	FS311D1	C(CM)-UCFS311-203D1				

Flanged cartridge units cast housing
Set screw type



Shaft dia.	Unit number 1)	Nominal dimensions											Bolt size
mm inch		mm inch											mm inch
		L	J	A_2	N	A_3	A_1	A	H_3	A_0	B	S	
60	UCFS312D1	195	150	19	23	14	22	56	160	78	71	26	M20
2 1/4	UCFS312-204D1												
2 5/16	UCFS312-205D1	7 11/16	5 29/32	3/4	29/32	35/64	7/8	2 13/64	6.2992	3 5/64	2.7953	1.024	3/4
2 3/8	UCFS312-206D1												
2 7/16	UCFS312-207D1												
65	UCFS313D1	208	166	15	23	18	22	58	175	78	75	30	M20
2 1/2	UCFS313-208D1	8 3/16	6 17/32	19/32	29/32	45/64	7/8	2 9/32	6.8898	3 5/64	2.9528	1.181	3/4
2 9/16	UCFS313-209D1												
70	UCFS314D1	226	178	18	25	18	25	61	185	81	78	33	M22
2 5/8	UCFS314-210D1												
2 11/16	UCFS314-211D1	8 29/32	7 1/64	45/64	63/64	45/64	31/32	2 13/32	7.2835	3 3/16	3.0709	1.299	7/8
2 3/4	UCFS314-212D1												
75	UCFS315D1	236	184	21	25	18	25	66	200	89	82	32	M22
2 13/16	UCFS315-213D1												
2 7/8	UCFS315-214D1	9 9/32	7 1/4	53/64	63/64	45/64	31/32	2 19/32	7.8740	3 1/2	3.2283	1.260	7/8
2 15/16	UCFS315-215D1												
3	UCFS315-300D1												
80	UCFS316D1	250	196	18	31	20	27	68	210	90	86	34	M27
3 1/16	UCFS316-301D1												
3 1/8	UCFS316-302D1	9 27/32	7 23/32	45/64	1 7/32	25/32	1 1/16	2 43/64	8.2677	3 35/64	3.3858	1.339	1
3 3/16	UCFS316-303D1												
85	UCFS317D1	260	204	24	31	20	27	74	220	100	96	40	M27
3 1/4	UCFS317-304D1												
3 5/16	UCFS317-305D1	10 1/4	8 1/32	15/16	1 7/32	25/32	1 1/16	2 29/32	8.6614	3 15/16	3.7795	1.575	1
3 7/16	UCFS317-307D1												
90	UCFS318D1	280	216	24	35	20	30	76	240	100	96	40	M30
3 7/16	UCFS318-307D1	11 1/32	8 1/2	15/16	1 3/8	25/32	1 3/16	2 63/64	9.4488	3 15/16	3.7795	1.575	1 1/8
3 1/2	UCFS318-308D1												

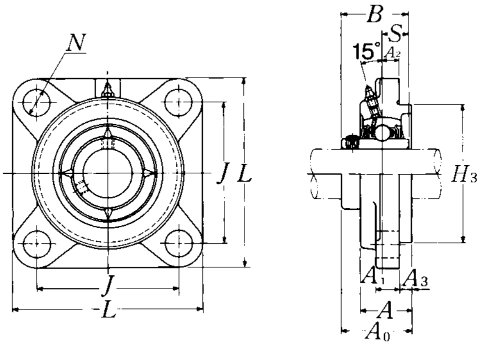
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UCFS···D1**
Closed end: **CM-UCFS···D1**

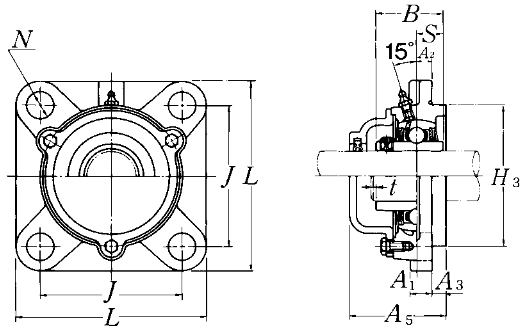
Bearing number	Housing number	Unit number cast dust cover type	Nominal dimensions		Mass of unit	
			mm	inch	kg	lb
			t max.	*A*5	UCFS	C(CM)
UC312D1	FS312D1	**C(CM)-UCFS312D1**	4	100	7.2	9.0
UC312-204D1	FS312D1	**C(CM)-UCFS312-204D1**				
UC312-205D1	FS312D1	**C(CM)-UCFS312-205D1**	5/32	3 15/16	16	20
UC312-206D1	FS312D1	**C(CM)-UCFS312-206D1**				
UC312-207D1	FS312D1	**C(CM)-UCFS312-207D1**				
UC313D1	FS313D1	**C(CM)-UCFS313D1**	4	103	8.9	11
UC313-208D1	FS313D1	**C(CM)-UCFS313-208D1**	5/32	4 1/16	20	24
UC313-209D1	FS313D1	**C(CM)-UCFS313-209D1**				
UC314D1	FS314D1	**C(CM)-UCFS314D1**	4	106	11	14
UC314-210D1	FS314D1	**C(CM)-UCFS314-210D1**				
UC314-211D1	FS314D1	**C(CM)-UCFS314-211D1**	5/32	4 11/64	24	31
UC314-212D1	FS314D1	**C(CM)-UCFS314-212D1**				
UC315D1	FS315D1	**C(CM)-UCFS315D1**	4	114	13	15
UC315-213D1	FS315D1	**C(CM)-UCFS315-213D1**				
UC315-214D1	FS315D1	**C(CM)-UCFS315-214D1**	5/32	4 31/64	29	33
UC315-215D1	FS315D1	**C(CM)-UCFS315-215D1**				
UC315-300D1	FS315D1	**C(CM)-UCFS315-300D1**				
UC316D1	FS316D1	**C(CM)-UCFS316D1**	4	116	15	18
UC316-301D1	FS316D1	**C(CM)-UCFS316-301D1**				
UC316-302D1	FS316D1	**C(CM)-UCFS316-302D1**	5/32	4 9/16	33	40
UC316-303D1	FS316D1	**C(CM)-UCFS316-303D1**				
UC317D1	FS317D1	**C(CM)-UCFS317D1**	5	129	17	22
UC317-304D1	FS317D1	**C(CM)-UCFS317-304D1**				
UC317-305D1	FS317D1	**C(CM)-UCFS317-305D1**	13/64	5 5/64	37	49
UC317-307D1	FS317D1	**C(CM)-UCFS317-307D1**				
UC318D1	FS318D1	**C(CM)-UCFS318D1**	5	129	21	26
UC318-307D1	FS318D1	**C(CM)-UCFS318-307D1**	13/64	5 5/64	46	57
UC318-308D1	FS318D1	**C(CM)-UCFS318-308D1**				

Flanged cartridge units cast housing
Set screw type



Shaft dia. mm inch	Unit number [1]	L	J	A2	N	A3	A1	A	H3	A0	B	S	Bolt size mm inch
		Nominal dimensions mm inch											
95	**UCFS319D1**	290	228	39	35	20	30	94	250	121	103	41	M30
3 5/8	**UCFS319-310D1**	11 13/32	8 31/32	1 17/32	1 3/8	25/32	1 3/16	3 45/64	9.8425	4 49/64	4.0551	1.614	1 1/8
3 11/16	**UCFS319-311D1**												
3 3/4	**UCFS319-312D1**												
100	**UCFS320D1**	310	242	39	38	20	32	94	260	125	108	42	M33
3 13/16	**UCFS320-313D1**	12 7/32	9 17/32	1 17/32	1 1/2	25/32	1 1/4	3 45/64	10.2362	4 59/64	4.2520	1.654	1 1/4
3 7/8	**UCFS320-314D1**												
3 15/16	**UCFS320-315D1**												
4	**UCFS320-400D1**												
105	**UCFS321D1**	310	242	39	38	20	32	94	260	127	112	44	M33
110	**UCFS322D1**	340	266	35	41	25	35	96	300	131	117	46	M36
120	**UCFS324D1**	370	290	35	41	30	40	110	330	140	126	51	M36
130	**UCFS326D1**	410	320	35	41	30	45	115	360	146	135	54	M36
140	**UCFS328D1**	450	350	45	41	30	55	125	400	161	145	59	M36

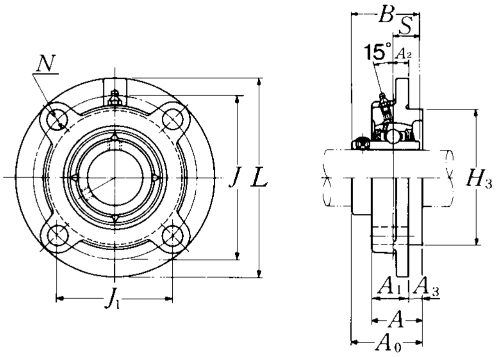
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UCFS···D1**
Closed end: **CM-UCFS···D1**

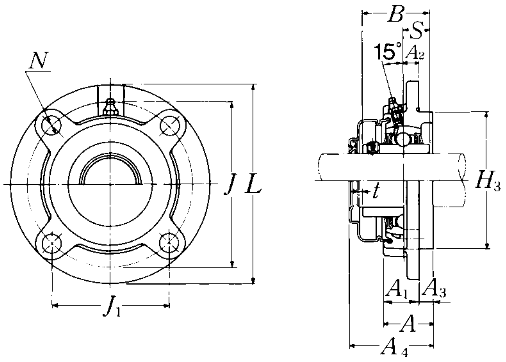
Bearing number	Housing number	Unit number cast dust cover type	Nominal dimensions		Mass of unit	
			mm	inch	kg	lb
			t max.	A_5	UCFS	C(CM)
UC319D1	FS319D1	**C(CM)-UCFS319D1**	5	149	25	30
UC319-310D1	FS319D1	**C(CM)-UCFS319-310D1**	$\frac{13}{64}$	$5\frac{55}{64}$	55	66
UC319-311D1	FS319D1	**C(CM)-UCFS319-311D1**				
UC319-312D1	FS319D1	**C(CM)-UCFS319-312D1**				
UC320D1	FS320D1	**C(CM)-UCFS320D1**	5	154	30	34
UC320-313D1	FS320D1	**C(CM)-UCFS320-313D1**	$\frac{13}{64}$	$6\frac{1}{16}$	66	75
UC320-314D1	FS320D1	**C(CM)-UCFS320-314D1**				
UC320-315D1	FS320D1	**C(CM)-UCFS320-315D1**				
UC320-400D1	FS320D1	**C(CM)-UCFS320-400D1**				
UC321D1	FS321D1	**C(CM)-UCFS321D1**	5	156	29	37
UC322D1	FS322D1	**C(CM)-UCFS322D1**	5	160	39	47
UC324D1	FS324D1	**C(CM)-UCFS324D1**	5	172	54	63
UC326D1	FS326D1	**C(CM)-UCFS326D1**	6	178	71	84
UC328D1	FS328D1	**C(CM)-UCFS328D1**	6	192	100	119

Flanged cartridge units cast housing
Set screw type

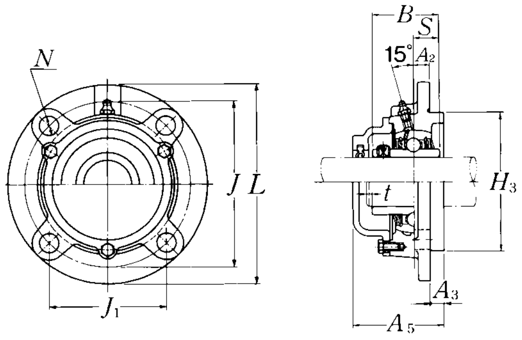


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch												Bolt size mm inch
		L	J	J1	A2	N	A3	A1	A	H3	A0	B	S	
12	UCFC201D1	100	78	55.1	10	12	5	20.5	25.5	62	33.3	31	12.7	M10
1/2	UCFC201-008D1	3 15/16	3 5/64	2 11/64	25/64	15/32	13/64	13/16	1	2.4409	1 15/16	1.2205	0.500	3/8
15	UCFC202D1	100	78	55.1	10	12	5	20.5	25.5	62	33.3	31	12.7	M10
9/16	UCFC202-009D1	3 15/16	3 5/64	2 11/64	25/64	15/32	13/64	13/16	1	2.4409	1 5/16	1.2205	0.500	3/8
5/8	UCFC202-010D1													
17	UCFC203D1	100	78	55.1	10	12	5	20.5	25.5	62	33.3	31	12.7	M10
11/16	UCFC203-011D1	3 15/16	3 5/64	2 11/64	25/64	15/32	13/64	13/16	1	2.4409	1 5/16	1.2205	0.500	3/8
20	UCFC204D1	100	78	55.1	10	12	5	20.5	25.5	62	33.3	31	12.7	M10
3/4	UCFC204-012D1	3 15/16	3 5/64	2 11/64	25/64	15/32	13/64	13/16	1	2.4409	1 5/16	1.2205	0.500	3/8
25	UCFC205D1	115	90	63.6	10	12	6	21	27	70	35.8	34.1	14.3	M10
13/16	UCFC205-013D1	4 17/32	3 35/64	2 1/2	25/64	15/32	15/64	13/16	1 1/16	2.7559	1 13/32	1.3425	0.563	3/8
7/8	UCFC205-014D1													
15/16	UCFC205-015D1													
1	UCFC205-100D1													
30	UCFC206D1	125	100	70.7	10	12	8	23	31	80	40.2	38.1	15.9	M10
1 1/16	UCFC206-101D1	4 29/32	3 15/16	2 25/32	25/64	15/32	5/16	29/32	1 7/32	3.1496	1 37/64	1.5000	0.629	3/8
1 1/8	UCFC206-102D1													
1 3/16	UCFC206-103D1													
1 1/4	UCFC206-104D1													
35	UCFC207D1	135	110	77.8	11	14	8	26	34	90	44.4	42.9	17.5	M12
1 1/4	UCFC207-104D1	5 5/16	4 21/64	3 1/16	7/16	35/64	5/16	1 1/32	1 11/32	3.5433	1 3/4	1.6890	0.689	7/16
1 5/16	UCFC207-105D1													
1 3/8	UCFC207-106D1													
1 7/16	UCFC207-107D1													
40	UCFC208D1	145	120	84.8	11	14	10	26	36	100	51.2	49.2	19	M12
1 1/2	UCFC208-108D1	5 23/32	4 23/32	3 11/32	7/16	35/64	25/64	1 1/32	1 27/64	3.9370	2 1/64	1.9370	0.748	7/16
1 9/16	UCFC208-109D1													
45	UCFC209D1	160	132	93.3	10	16	12	26	38	105	52.2	49.2	19	M14
1 5/8	UCFC209-110D1	6 5/16	5 13/64	3 43/64	25/64	5/8	15/32	1 1/32	1 1/2	4.1339	2 3/64	1.9370	0.748	1/2
1 11/16	UCFC209-111D1													
1 3/4	UCFC209-112D1													

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



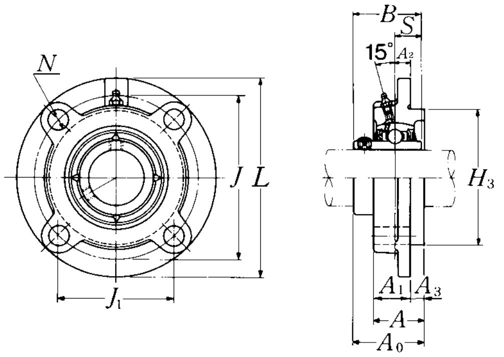
Pressed steel dust cover type
Open end: **S-UCFC···D1**
Closed end: **SM-UCFC···D1**



Cast dust cover type
Open end: **C-UCFC···D1**
Closed end: **CM-UCFC···D1**

Bearing number	Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions mm / inch			Mass of unit kg / lb		
				t max.	A4	A5	UCFC	S(SM)	C(CM)
UC201D1	FC204D1	S(SM)-UCFC201D1	C(CM)-UCFC201D1	2	40.5	46	0.8	0.8	0.9
UC201-008D1	FC204D1	S(SM)-UCFC201-008D1	S(SM)-UCFC201-008D1	$\frac{5}{64}$	$1\frac{19}{32}$	$1\frac{13}{16}$	1.8	1.8	2.0
UC202D1	FC204D1	S(SM)-UCFC202D1	C(CM)-UCFC202D1	2	40.5	46	0.8	0.8	0.9
UC202-009D1	FC204D1	S(SM)-UCFC202-009D1	C(CM)-UCFC202-009D1	$\frac{5}{64}$	$1\frac{19}{32}$	$1\frac{13}{16}$	1.8	1.8	2.0
UC202-010D1	FC204D1	S(SM)-UCFC202-010D1	C(CM)-UCFC202-010D1						
UC203D1	FC204D1	S(SM)-UCFC203D1	C(CM)-UCFC203D1	2	40.5	46	0.7	0.8	0.9
UC203-011D1	FC204D1	S(SM)-UCFC203-011D1	C(CM)-UCFC203-011D1	$\frac{5}{64}$	$1\frac{19}{32}$	$1\frac{13}{16}$	1.5	1.8	2.0
UC204D1	FC204D1	S(SM)-UCFC204D1	C(CM)-UCFC204D1	2	40.5	46	0.7	0.8	0.9
UC204-012D1	FC204D1	S(SM)-UCFC204-012D1	C(CM)-UCFC204-012D1	$\frac{5}{64}$	$1\frac{19}{32}$	$1\frac{13}{16}$	1.5	1.8	2.0
UC205D1	FC205D1	S(SM)-UCFC205D1	C(CM)-UCFC205D1	2	44.5	51	1.0	1.0	1.3
UC205-013D1	FC205D1	S(SM)-UCFC205-013D1	C(CM)-UCFC205-013D1	$\frac{5}{64}$	$1\frac{3}{4}$	2	2.2	2.2	2.9
UC205-014D1	FC205D1	S(SM)-UCFC205-014D1	C(CM)-UCFC205-014D1						
UC205-015D1	FC205D1	S(SM)-UCFC205-015D1	C(CM)-UCFC205-015D1						
UC205-100D1	FC205D1	S(SM)-UCFC205-100D1	C(CM)-UCFC205-100D1						
UC206D1	FC206D1	S(SM)-UCFC206D1	C(CM)-UCFC206D1	2	49	56	1.3	1.4	1.8
UC206-101D1	FC206D1	S(SM)-UCFC206-101D1	C(CM)-UCFC206-101D1	$\frac{5}{64}$	$1\frac{59}{64}$	$2\frac{13}{64}$	2.9	3.1	4.0
UC206-102D1	FC206D1	S(SM)-UCFC206-102D1	C(CM)-UCFC206-102D1						
UC206-103D1	FC206D1	S(SM)-UCFC206-103D1	C(CM)-UCFC206-103D1						
UC206-104D1	FC206D1	—	—						
UC207D1	FC207D1	S(SM)-UCFC207D1	C(CM)-UCFC207D1	3	55	59	1.6	1.7	2.2
UC207-104D1	FC207D1	S(SM)-UCFC207-104D1	C(CM)-UCFC207-104D1	$\frac{1}{8}$	$2\frac{11}{64}$	$2\frac{21}{64}$	3.5	3.7	4.9
UC207-105D1	FC207D1	S(SM)-UCFC207-105D1	C(CM)-UCFC207-105D1						
UC207-106D1	FC207D1	S(SM)-UCFC207-106D1	C(CM)-UCFC207-106D1						
UC207-107D1	FC207D1	—	—						
UC208D1	FC208D1	S(SM)-UCFC208D1	C(CM)-UCFC208D1	3	62	66	2.1	2.1	2.8
UC208-108D1	FC208D1	S(SM)-UCFC208-108D1	C(CM)-UCFC208-108D1	$\frac{1}{8}$	$2\frac{7}{16}$	$2\frac{19}{32}$	4.6	4.6	6.2
UC208-109D1	FC208D1	S(SM)-UCFC208-109D1	C(CM)-UCFC208-109D1						
UC209D1	FC209D1	S(SM)-UCFC209D1	C(CM)-UCFC209D1	3	63	70	2.7	2.8	3.8
UC209-110D1	FC209D1	S(SM)-UCFC209-110D1	C(CM)-UCFC209-110D1	$\frac{1}{8}$	$2\frac{31}{64}$	$2\frac{3}{4}$	6.0	6.2	8.4
UC209-111D1	FC209D1	S(SM)-UCFC209-111D1	C(CM)-UCFC209-111D1						
UC209-112D1	FC209D1	S(SM)-UCFC209-112D1	C(CM)-UCFC209-112D1						

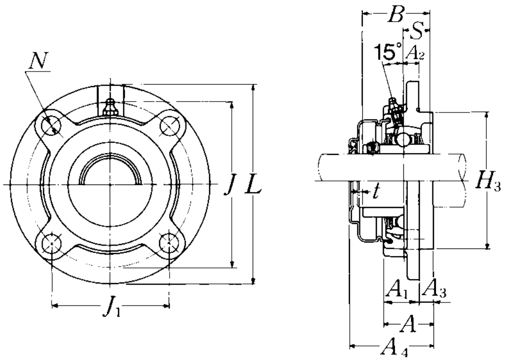
Flanged cartridge units cast housing
Set screw type



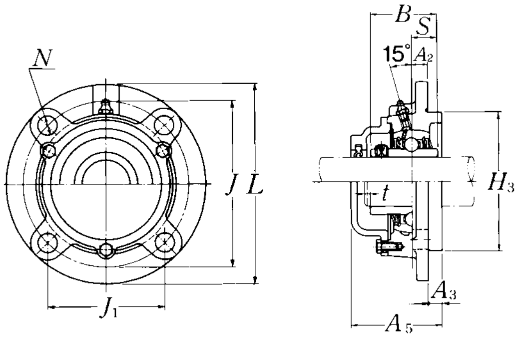
Shaft dia. mm / inch	Unit number 1)	Nominal dimensions mm / inch L	J	J1	A2	N	A3	A1	A	H3	A0	B	S	Bolt size mm / inch
50	UCFC210D1	165	138	97.6	10	16	12	28	40	110	54.6	51.6	19	M14
1 13/16	UCFC210-113D1	6 1/2	5 7/16	3 27/32	25/64	5/8	15/32	1 3/32	1 37/64	4.3307	2 5/32	2.0315	0.748	1/2
1 7/8	UCFC210-114D1													
1 15/16	UCFC210-115D1													
2	UCFC210-200D1													
55	UCFC211D1	185	150	106.1	13	19	12	31	43	125	58.4	55.6	22.2	M16
2	UCFC211-200D1	7 9/32	5 29/32	4 11/64	33/64	3/4	15/32	1 7/32	1 11/16	4.9213	2 19/64	2.1890	0.874	5/8
2 1/16	UCFC211-201D1													
2 1/8	UCFC211-202D1													
2 3/16	UCFC211-203D1													
60	UCFC212D1	195	160	113.1	17	19	12	36	48	135	68.7	65.1	25.4	M16
2 1/4	UCFC212-204D1	7 11/16	6 19/64	4 29/64	43/64	3/4	15/32	1 13/32	1 57/64	5.3150	2 45/64	2.5630	1.000	5/8
2 5/16	UCFC212-205D1													
2 3/8	UCFC212-206D1													
2 7/16	UCFC212-207D1													
65	UCFC213D1	205	170	120.2	16	19	14	36	50	145	69.7	65.1	25.4	M16
2 1/2	UCFC213-208D1	8 1/16	6 11/16	4 47/64	5/8	3/4	35/64	1 13/32	1 31/32	5.7087	2 3/4	2.5630	1.000	5/8
2 9/16	UCFC213-209D1													
70	UCFC214D1	215	177	125.1	17	19	14	40	54	150	75.4	74.6	30.2	M16
2 5/8	UCFC214-210D1	8 15/32	6 31/32	4 59/64	43/64	3/4	35/64	1 37/64	2 1/8	5.9055	2 31/32	2.9370	1.189	5/8
2 11/16	UCFC214-211D1													
2 3/4	UCFC214-212D1													
75	UCFC215D1	220	184	130.1	18	19	16	40	56	160	78.5	77.8	33.3	M16
2 13/16	UCFC215-213D1	8 21/32	7 1/4	5 1/8	45/64	3/4	5/8	1 37/64	2 13/64	6.2992	3 3/32	3.0630	1.311	5/8
2 7/8	UCFC215-214D1													
2 15/16	UCFC215-215D1													
3	UCFC215-300D1													
80	UCFC216D1	240	200	141.4	18	23	16	42	58	170	83.3	82.6	33.3	M20
3 1/16	UCFC216-301D1	9 7/16	7 7/8	5 9/16	45/64	29/32	5/8	1 21/32	2 9/32	6.6929	2 9/32	3.2520	1.311	3/4
3 1/8	UCFC216-302D1													
3 3/16	UCFC216-303D1													

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

UCFC2



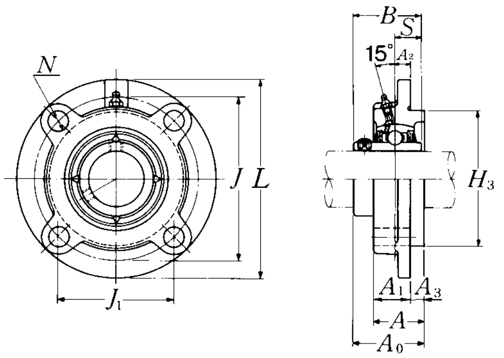
Pressed steel dust cover type
Open end: **S-UCFC···D1**
Closed end: **SM-UCFC···D1**



Cast dust cover type
Open end: **C-UCFC···D1**
Closed end: **CM-UCFC···D1**

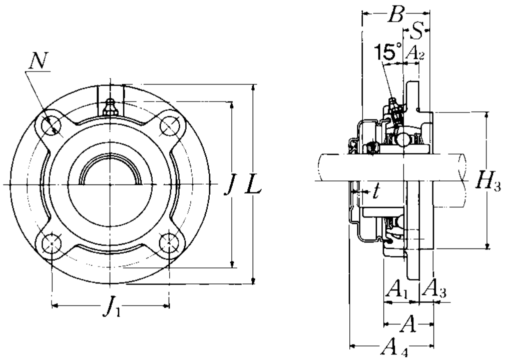
Bearing number	Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions			Mass of unit		
				mm		inch	kg		lb
				t max.	A_4	A_5	UCFC	S(SM)	C(CM)
UC210D1	FC210D1	**S(SM)-UCFC210D1**	**C(CM)-UCFC210D1**	3	65.5	72	3.1	3.2	4.2
UC210-113D1	FC210D1	**S(SM)-UCFC210-113D1**	**C(CM)-UCFC210-113D1**						
UC210-114D1	FC210D1	**S(SM)-UCFC210-114D1**	**C(CM)-UCFC210-114D1**	$\frac{1}{8}$	$2\frac{37}{64}$	$2\frac{53}{64}$	6.8	7.1	9.3
UC210-115D1	FC210D1	**S(SM)-UCFC210-115D1**	**C(CM)-UCFC210-115D1**						
UC210-200D1	FC210D1	—	—						
UC211D1	FC211D1	**S(SM)-UCFC211D1**	**C(CM)-UCFC211D1**	4	71	75	4.2	4.4	5.5
UC211-200D1	FC211D1	**S(SM)-UCFC211-200D1**	**C(CM)-UCFC211-200D1**						
UC211-201D1	FC211D1	**S(SM)-UCFC211-201D1**	**C(CM)-UCFC211-201D1**	$\frac{5}{32}$	$2\frac{51}{64}$	$2\frac{61}{64}$	9.3	9.7	12
UC211-202D1	FC211D1	**S(SM)-UCFC211-202D1**	**C(CM)-UCFC211-202D1**						
UC211-203D1	FC211D1	**S(SM)-UCFC211-203D1**	**C(CM)-UCFC211-203D1**						
UC212D1	FC212D1	**S(SM)-UCFC212D1**	**C(CM)-UCFC212D1**	4	80	86	5.3	5.5	6.5
UC212-204D1	FC212D1	**S(SM)-UCFC212-204D1**	**C(CM)-UCFC212-204D1**						
UC212-205D1	FC212D1	**S(SM)-UCFC212-205D1**	**C(CM)-UCFC212-205D1**	$\frac{5}{32}$	$3\frac{5}{32}$	$3\frac{25}{64}$	12	12	14
UC212-206D1	FC212D1	**S(SM)-UCFC212-206D1**	**C(CM)-UCFC212-206D1**						
UC212-207D1	FC212D1	—	—						
UC213D1	FC213D1	**S(SM)-UCFC213D1**	**C(CM)-UCFC213D1**	4	83.5	89.5	6.0	6.2	7.5
UC213-208D1	FC213D1	**S(SM)-UCFC213-208D1**	**C(CM)-UCFC213-208D1**	$\frac{5}{32}$	$3\frac{9}{32}$	$3\frac{17}{32}$	13	14	17
UC213-209D1	FC213D1	**S(SM)-UCFC213-209D1**	**C(CM)-UCFC213-209D1**						
UC214D1	FC214D1	—	**C(CM)-UCFC214D1**	4	—	98	7.0	—	8.7
UC214-210D1	FC214D1		**C(CM)-UCFC214-210D1**						
UC214-211D1	FC214D1	—	**C(CM)-UCFC214-211D1**	$\frac{5}{32}$	—	$3\frac{55}{64}$	15	—	19
UC214-212D1	FC214D1		**C(CM)-UCFC214-212D1**						
UC215D1	FC215D1	—	**C(CM)-UCFC215D1**	4	—	102	7.8	—	9.5
UC215-213D1	FC215D1		**C(CM)-UCFC215-213D1**						
UC215-214D1	FC215D1	—	**C(CM)-UCFC215-214D1**	$\frac{5}{32}$	—	$4\frac{1}{64}$	17	—	21
UC215-215D1	FC215D1		**C(CM)-UCFC215-215D1**						
UC215-300D1	FC215D1		**C(CM)-UCFC215-300D1**						
UC216D1	FC216D1	—	**C(CM)-UCFC216D1**	4	—	106	9.3	—	12
UC216-301D1	FC216D1		**C(CM)-UCFC216-301D1**						
UC216-302D1	FC216D1	—	**C(CM)-UCFC216-302D1**	$\frac{5}{32}$	—	$4\frac{11}{64}$	21	—	26
UC216-303D1	FC216D1		**C(CM)-UCFC216-303D1**						

Flanged cartridge units cast housing
Set screw type

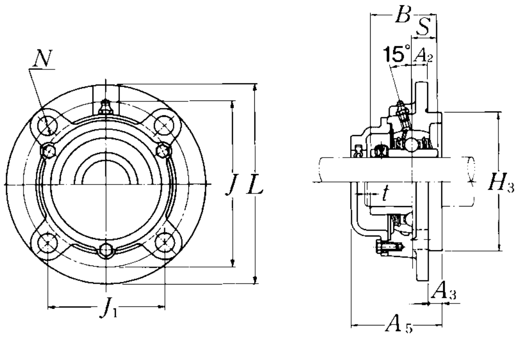


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch												Bolt size mm inch
		L	J	J_1	A_2	N	A_3	A_1	A	H_3	A_0	B	S	
85	**UCFC217D1**	250	208	147.1	18	23	18	45	63	180	87.6	85.7	34.1	M20
3 1/4	**UCFC217-304D1**													
3 5/16	**UCFC217-305D1**	9 27/32	8 3/16	5 51/64	45/64	29/32	45/64	1 25/32	2 31/64	7.0866	3 29/64	3.3740	1.343	3/4
3 7/16	**UCFC217-307D1**													
90	**UCFC218D1**	265	220	155.5	22	23	18	50	68	190	96.3	96	39.7	M20
3 1/2	**UCFC218-308D1**	10 7/16	8 21/32	6 1/8	55/64	29/32	45/64	1 31/32	2 43/64	7.4803	3 51/64	3.7795	1.563	3/4

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



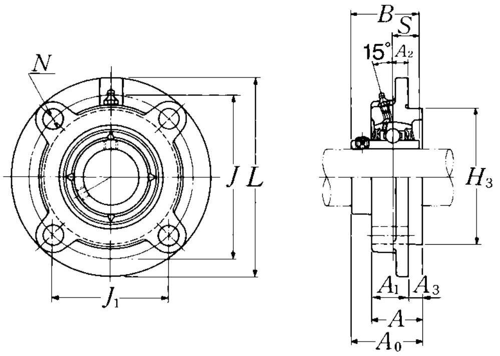
Pressed steel dust cover type
Open end: **S-UCFC···D1**
Closed end: **SM-UCFC···D1**



Cast dust cover type
Open end: **C-UCFC···D1**
Closed end: **CM-UCFC···D1**

Bearing number	Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions			Mass of unit		
				mm inch			kg lb		
				t max.	A_4	A_5	UCFC	S(SM)	C(CM)
UC217D1	FC217D1	—	**C(CM)-UCFC217D1**	5	—	114	11	—	13
UC217-304D1	FC217D1	—	**C(CM)-UCFC217-304D1**	$\frac{13}{64}$	—	$4\frac{31}{64}$	24	—	29
UC217-305D1	FC217D1		**C(CM)-UCFC217-305D1**						
UC217-307D1	FC217D1		**C(CM)-UCFC217-307D1**						
UC218D1	FC218D1	—	**C(CM)-UCFC218D1**	5	—	122	13	—	16
UC218-308D1	FC218D1	—	**C(CM)-UCFC218-308D1**	$\frac{13}{64}$	—	$4\frac{51}{64}$	29	—	35

Flanged cartridge units cast housing
Set screw type

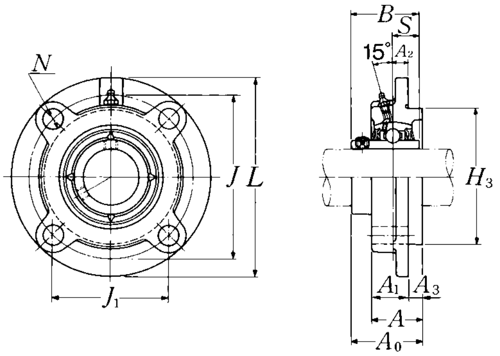


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch												Bolt size mm inch
		L	J	J_1	A_2	N	A_3	A_1	A	H_3	A_0	B	S	
25	**UCFCX05D1**	111	92	65	10	9.5	6	24	30	76	38.2	38.1	15.9	M 8
13/16	**UCFCX05-013D1**	4 3/8	3 5/8	2 9/16	25/64	3/8	1/4	15/16	1 3/16	2.9921	1 1/2	1.5000	0.626	5/16
7/8	**UCFCX05-014D1**													
15/16	**UCFCX05-015D1**													
1	**UCFCX05-100D1**													
30	**UCFCX06D1**	127	105	74.2	8	12	9.5	22.5	32	85	42.9	42.9	17.5	M10
1 1/16	**UCFCX06-101D1**	5	4 9/64	2 59/64	5/16	15/32	3/8	7/8	1 27/64	3.3465	1 11/16	1.6890	0.689	3/8
1 1/8	**UCFCX06-102D1**													
1 3/16	**UCFCX06-103D1**													
1 1/4	**UCFCX06-104D1**													
35	**UCFCX07D1**	133	111	78.5	9	12	11	26	37	92	50.2	49.2	19	M10
1 5/16	**UCFCX07-105D1**	5 1/4	4 3/8	3 3/32	23/64	15/32	7/16	1 1/32	1 29/64	3.6220	1 31/32	1.9370	0.748	3/8
1 3/8	**UCFCX07-106D1**													
1 7/16	**UCFCX07-107D1**													
40	**UCFCX08D1**	133	111	78.5	9	12	11	26	37	92	50.2	49.2	19	M10
1 1/2	**UCFCX08-108D1**	5 1/4	4 3/8	3 3/32	23/64	15/32	7/16	1 1/32	1 29/64	3.6220	1 31/32	1.9370	0.748	3/8
1 9/16	**UCFCX08-109D1**													
45	**UCFCX09D1**	155	130	91.9	8	14	12	25	37	108	52.6	51.6	19	M12
1 5/8	**UCFCX09-110D1**	6 3/32	5 1/8	3 5/8	5/16	35/64	15/32	31/32	1 29/64	4.2520	2 5/64	2.0315	0.748	7/16
1 11/16	**UCFCX09-111D1**													
1 3/4	**UCFCX09-112D1**													
1 13/16	**UCFCX09-113D1**													
50	**UCFCX10D1**	162	136	96.2	7	14	16	25	41	118	56.4	55.6	22.2	M12
1 7/8	**UCFCX10-114D1**	6 3/8	5 23/64	3 25/32	9/32	35/64	5/8	31/32	1 39/64	4.6457	2 7/32	2.1890	0.874	7/16
1 15/16	**UCFCX10-115D1**													
2	**UCFCX10-200D1**													

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit	
		kg	lb
UCX05D1	FCX05D1	1.1	2.4
UCX05-013D1	FCX05D1		
UCX05-014D1	FCX05D1		
UCX05-015D1	FCX05D1		
UCX05-100D1	FCX05D1		
UCX06D1	FCX06D1	1.6	3.5
UCX06-101D1	FCX06D1		
UCX06-102D1	FCX06D1		
UCX06-103D1	FCX06D1		
UC207-104D1	FCX06D1		
UCX07D1	FCX07D1	2.0	4.4
UCX07-105D1	FCX07D1		
UCX07-106D1	FCX07D1		
UCX07-107D1	FCX07D1		
UCX08D1	FCX08D1	1.9	4.2
UCX08-108D1	FCX08D1		
UCX08-109D1	FCX08D1		
UCX09D1	FCX09D1	2.7	6.0
UCX09-110D1	FCX09D1		
UCX09-111D1	FCX09D1		
UCX09-112D1	FCX09D1		
UC210-113D1	FCX09D1		
UCX10D1	FCX10D1	3.2	7.1
UCX10-114D1	FCX10D1		
UCX10-115D1	FCX10D1		
UC211-200D1	FCX10D1		

Flanged cartridge units cast housing
Set screw type

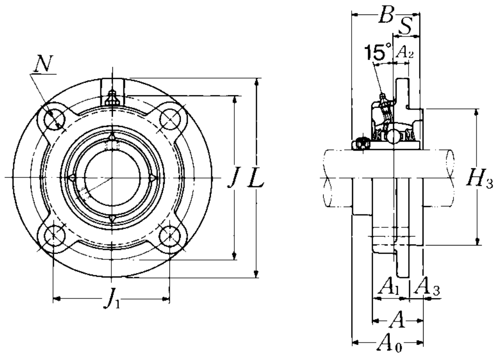


Shaft dia. mm inch	Unit number [1]	Nominal dimensions mm inch												Bolt size mm inch
		L	J	J_1	A_2	N	A_3	A_1	A	H_3	A_0	B	S	
55	**UCFCX11D1**	180	152	107.5	4	16	22	26	48	127	65.7	65.1	25.4	M14
2 1/16	**UCFCX11-201D1**	7 3/32	5 63/64	4 15/64	5/32	5/8	55/64	1 1/32	1 57/64	5.0000	2 19/32	2.5630	1.000	1/2
2 1/8	**UCFCX11-202D1**													
2 3/16	**UCFCX11-203D1**													
2 1/4	**UCFCX11-204D1**													
2 5/16	**UCFCX11-205D1**													
60	**UCFCX12D1**	194	165	116.7	11	16	20	33	53	140	70.7	65.1	25.4	M14
2 3/8	**UCFCX12-206D1**	7 5/8	6 1/2	4 19/32	7/16	5/8	25/32	1 5/16	2 5/64	5.5118	2 25/32	2.5630	1.000	1/2
2 7/16	**UCFCX12-207D1**													
65	**UCFCX13D1**	194	165	116.7	11	16	20	33	53	140	75.4	74.6	30.2	M14
2 1/2	**UCFCX13-208D1**	7 5/8	6 1/2	4 19/32	7/16	5/8	25/32	1 5/16	2 5/64	5.5118	2 31/32	2.9370	1.189	1/2
2 9/16	**UCFCX13-209D1**													
70	**UCFCX14D1**	222	190	134.3	14	19	20	36	56	164	78.5	77.8	33.3	M16
2 5/8	**UCFCX14-210D1**	8 3/4	7 31/64	5 9/32	35/64	3/4	25/32	1 13/32	2 13/64	6.4567	3 3/32	3.0630	1.311	5/8
2 11/16	**UCFCX14-211D1**													
2 3/4	**UCFCX14-212D1**													
75	**UCFCX15D1**	222	190	134.3	12	19	22	35	57	164	83.3	82.6	33.3	M16
2 13/16	**UCFCX15-213D1**	8 3/4	7 31/64	5 9/32	15/32	3/4	55/64	1 3/8	2 1/4	6.4567	3 9/32	3.2520	1.311	5/8
2 7/8	**UCFCX15-214D1**													
2 15/16	**UCFCX15-215D1**													
3	**UCFCX15-300D1**													
80	**UCFCX16D1**	260	219	154.8	10	23	25	36	61	186	86.6	85.7	34.1	M20
3 1/16	**UCFCX16-301D1**	10 1/4	8 5/8	6 3/32	25/64	29/32	63/64	1 13/32	2 13/32	7.3228	3 13/32	3.3740	1.343	3/4
3 1/8	**UCFCX16-302D1**													
3 3/16	**UCFCX16-303D1**													
3 1/4	**UCFCX16-304D1**													
85	**UCFCX17D1**	260	219	154.8	10	23	25	36	61	186	91.3	96	39.7	M20
3 5/16	**UCFCX17-305D1**	10 1/4	8 5/8	6 3/32	25/64	29/32	63/64	1 13/32	2 13/32	7.3228	3 19/32	3.7795	1.563	3/4
3 7/16	**UCFCX17-307D1**													

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit	
		kg	lb
UCX11D1	FCX11D1	4.4	9.7
UCX11-201D1	FCX11D1		
UCX11-202D1	FCX11D1		
UCX11-203D1	FCX11D1		
UC212-204D1	FCX11D1		
UC212-205D1	FCX11D1		
UCX12D1	FCX12D1	5.7	13
UCX12-206D1	FCX12D1		
UCX12-207D1	FCX12D1		
UCX13D1	FCX13D1	5.7	13
UCX13-208D1	FCX13D1		
UCX13-209D1	FCX13D1		
UCX14D1	FCX14D1	7.3	16
UCX14-210D1	FCX14D1		
UCX14-211D1	FCX14D1		
UCX14-212D1	FCX14D1		
UCX15D1	FCX15D1	7.7	17
UCX15-213D1	FCX15D1		
UCX15-214D1	FCX15D1		
UCX15-215D1	FCX15D1		
UCX15-300D1	FCX15D1		
UCX16D1	FCX16D1	11	24
UCX16-301D1	FCX16D1		
UCX16-302D1	FCX16D1		
UCX16-303D1	FCX16D1		
UC217-304D1	FCX16D1		
UCX17D1	FCX17D1	12	26
UCX17-305D1	FCX17D1		
UCX17-307D1	FCX17D1		

Flanged cartridge units cast housing
Set screw type

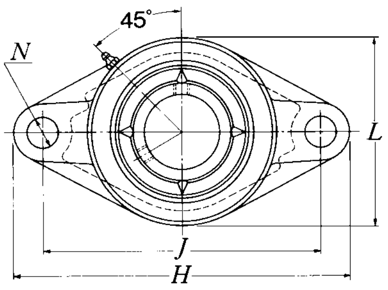


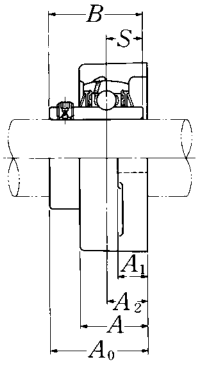
Shaft dia. mm inch	Unit number 1)	Nominal dimensions (mm / inch) L	J	J_1	A_2	N	A_3	A_1	A	H_3	A_0	B	S	Bolt size mm inch
90	**UCFCX18D1**	260	219	154.8	12	23	28	43	71	186	101.1	104	42.9	M20
3 7/16	**UCFCX18-307D1**	10 1/4	8 5/8	6 3/32	15/32	29/32	1 7/64	1 11/16	2 51/64	7.3228	3 63/64	4.0945	1.689	3/4
3 1/2	**UCFCX18-308D1**													
100	**UCFCX20D1**	276	238	168.3	22	23	28	66	94	206	118.3	117.5	49.2	M20
3 13/16	**UCFCX20-313D1**	10 7/8	9 3/8	6 5/8	55/64	29/32	1 7/64	2 19/32	3 45/64	8.1102	4 21/32	4.6260	1.937	3/4
3 7/8	**UCFCX20-314D1**													
3 15/16	**UCFCX20-315D1**													
4	**UCFCX20-400D1**													

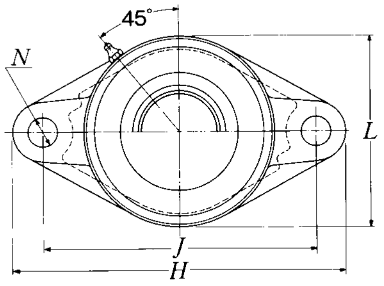
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit	
		kg	lb
UCX18D1	FCX18D1	12	
UCX18-307D1	FCX18D1		26
UCX18-308D1	FCX18D1		
UCX20D1	FCX20D1	16	
UCX20-313D1	FCX20D1		35
UCX20-314D1	FCX20D1		
UCX20-315D1	FCX20D1		
UCX20-400D1	FCX20D1		

Flanged cartridge units cast housing
Set screw type



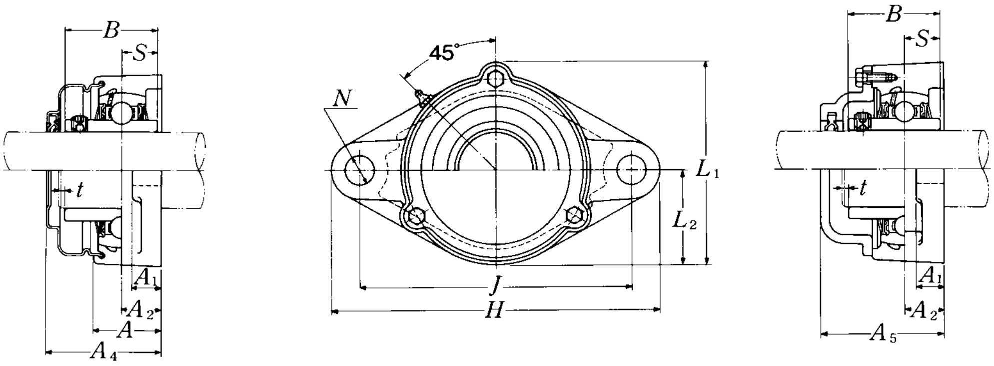




Pressed steel dust cover type
Open end: **S-UCFL···D1**
Closed end: **SM-UCFL···D1**

Shaft dia.	Unit number 1)	Nominal dimensions										Bolt size	Bearing number
mm inch					mm		inch					mm inch	
		H	J	A2	A1	A	N	L	A0	B	S		
12	UCFL201D1	113	90	15	11	25.5	12	60	33.3	31	12.7	M10	UC201D1
1/2	UCFL201-008D1	4 7/16	3 35/64	19/32	7/16	1	15/32	2 3/8	1 5/16	1.2205	0.500	3/8	UC201-008D1
15	UCFL202D1	113	90	15	11	25.5	12	60	33.3	31	12.7	M10	UC202D1
9/16	UCFL202-009D1	4 7/16	3 35/64	19/32	7/16	1	15/32	2 3/8	1 5/16	1.2205	0.500	3/8	UC202-009D1
5/8	UCFL202-010D1												UC202-010D1
17	UCFL203D1	113	90	15	11	25.5	12	60	33.3	31	12.7	M10	UC203D1
11/16	UCFL203-011D1	4 7/16	3 35/64	19/32	7/16	1	15/32	2 3/8	1 5/16	1.2205	0.500	3/8	UC203-011D1
20	UCFL204D1	113	90	15	11	25.5	12	60	33.3	31	12.7	M10	UC204D1
3/4	UCFL204-012D1	4 7/16	3 35/64	19/32	7/16	1	15/32	2 3/8	1 5/16	1.2205	0.500	3/8	UC204-012D1
25	UCFL205D1	130	99	16	13	27	16	68	35.8	34.1	14.3	M14	UC205D1
13/16	UCFL205-013D1	5 1/8	3 57/64	5/8	1/2	1 1/16	5/8	2 11/16	1 13/32	1.3425	0.563	1/2	UC205-013D1
7/8	UCFL205-014D1												UC205-014D1
15/16	UCFL205-015D1												UC205-015D1
1	UCFL205-100D1												UC205-100D1
30	UCFL206D1	148	117	18	13	31	16	80	40.2	38.1	15.9	M14	UC206D1
1 1/16	UCFL206-101D1	5 13/16	4 39/64	45/64	1/2	1 7/32	5/8	3 5/32	1 37/64	1.5000	0.626	1/2	UC206-101D1
1 1/8	UCFL206-102D1												UC206-102D1
1 3/16	UCFL206-103D1												UC206-103D1
1 1/4	UCFL206-104D1												UC206-104D1
35	UCFL207D1	161	130	19	15	34	16	90	44.4	42.9	17.5	M14	UC207D1
1 1/4	UCFL207-104D1	6 11/32	5 1/8	3/4	19/32	1 11/32	5/8	3 17/32	1 3/4	1.6890	0.689	1/2	UC207-104D1
1 5/16	UCFL207-105D1												UC207-105D1
1 3/8	UCFL207-106D1												UC207-106D1
1 7/16	UCFL207-107D1												UC207-107D1
40	UCFL208D1	175	144	21	15	36	16	100	51.2	49.2	19	M14	UC208D1
1 1/2	UCFL208-108D1	6 7/8	5 43/64	53/64	19/32	1 13/32	5/8	3 15/16	2 1/64	1.9370	0.748	1/2	UC208-108D1
1 9/16	UCFL208-109D1												UC208-109D1
45	UCFL209D1	188	148	22	16	38	19	108	52.2	49.2	19	M16	UC209D1
1 5/8	UCFL209-110D1	7 13/32	5 53/64	55/64	5/8	1 1/2	3/4	4 1/4	2 1/16	1.9370	0.748	5/8	UC209-110D1
1 11/16	UCFL209-111D1												UC209-111D1
1 3/4	UCFL209-112D1												UC209-112D1

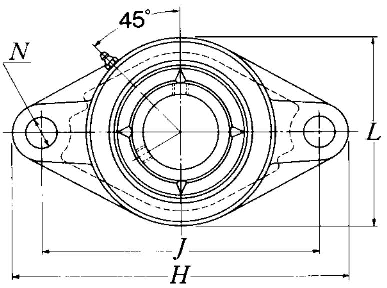
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

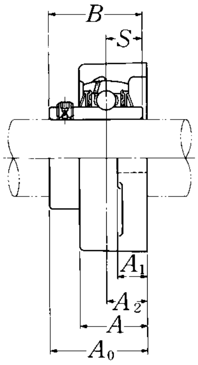


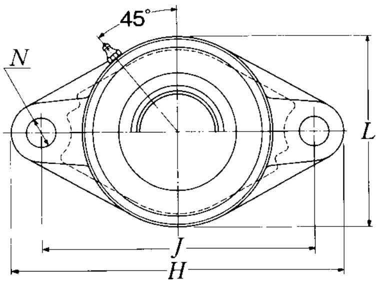
Cast dust cover type
Open end: **C-UCFL···D1**
Closed end: **CM-UCFL···D1**

Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions					Mass of unit		
			mm		inch			kg	lb	
			t max.	*A*4	*A*5	*L*1	*L*2	UCFL	S(SM)	C(CM)
FL204D1	S(SM)-UCFL201D1	C(CM)-UCFL201D1	2	40.5	46	67	30	0.6	0.6	0.8
FL204D1	S(SM)-UCFL201-008D1	C(CM)-UCFL201-008D1	5/64	1 19/32	1 13/16	2 5/8	1 3/16	1.3	1.3	0.8
FL204D1	S(SM)-UCFL202D1	C(CM)-UCFL202D1	2	40.5	46	67	30	0.6	0.6	0.8
FL204D1	S(SM)-UCFL202-009D1	C(CM)-UCFL202-009D1	5/64	1 19/32	1 13/16	2 5/8	1 3/16	1.3	1.3	1.8
FL204D1	S(SM)-UCFL202-010D1	C(CM)-UCFL202-009D1								
FL204D1	S(SM)-UCFL203D1	C(CM)-UCFL203D1	2	40.5	46	67	30	0.5	0.6	0.8
FL204D1	S(SM)-UCFL203-011D1	C(CM)-UCFL203-011D1	5/64	1 19/32	1 13/32	2 5/8	1 3/16	1.1	1.3	1.8
FL204D1	S(SM)-UCFL204D1	C(CM)-UCFL204D1	2	40.5	46	67	30	0.5	0.6	0.8
FL204D1	S(SM)-UCFL204-012D1	C(CM)-UCFL204-012D1	5/64	1 19/32	1 13/16	2 5/8	1 3/16	1.1	1.3	1.8
FL205D1	S(SM)-UCFL205D1	C(CM)-UCFL205D1	2	44.5	51	74	34	0.6	0.7	0.9
FL205D1	S(SM)-UCFL205-013D1	C(CM)-UCFL205-013D1	5/64	1 3/4	2	2 29/32	1 11/32	1.3	1.5	2.0
FL205D1	S(SM)-UCFL205-014D1	C(CM)-UCFL205-014D1								
FL205D1	S(SM)-UCFL205-015D1	C(CM)-UCFL205-015D1								
FL205D1	S(SM)-UCFL205-100D1	C(CM)-UCFL205-100D1								
FL206D1	S(SM)-UCFL206D1	C(CM)-UCFL206D1	2	49	56	85	40	0.9	1.0	1.2
FL206D1	S(SM)-UCFL206-101D1	C(CM)-UCFL206-101D1	5/64	1 15/16	2 7/32	3 11/32	1 9/16	2.0	2.2	2.6
FL206D1	S(SM)-UCFL206-102D1	C(CM)-UCFL206-102D1								
FL206D1	S(SM)-UCFL206-103D1	C(CM)-UCFL206-103D1								
FL206D1	—	—								
FL207D1	S(SM)-UCFL207D1	C(CM)-UCFL207D1	3	55	59	97	45	1.2	1.2	1.8
FL207D1	S(SM)-UCFL207-104D1	C(CM)-UCFL207-104D1	1/8	2 5/32	2 5/16	3 13/16	1 25/32	2.6	2.6	4.0
FL207D1	S(SM)-UCFL207-105D1	C(CM)-UCFL207-105D1								
FL207D1	S(SM)-UCFL207-106D1	C(CM)-UCFL207-106D1								
FL207D1	—	—								
FL208D1	S(SM)-UCFL208D1	C(CM)-UCFL208D1	3	62	66	106	50	1.6	1.6	2.2
FL208D1	S(SM)-UCFL208-108D1	C(CM)-UCFL208-108D1	1/8	2 7/16	2 19/32	4 3/16	1 31/32	3.5	3.5	4.9
FL208D1	S(SM)-UCFL208-109D1	C(CM)-UCFL208-109D1								
FL209D1	S(SM)-UCFL209D1	C(CM)-UCFL209D1	3	63	70	113	54	1.9	2.0	2.5
FL209D1	S(SM)-UCFL209-110D1	C(CM)-UCFL209-110D1	1/8	2 15/32	2 3/4	4 7/16	2 1/8	4.2	4.4	5.5
FL209D1	S(SM)-UCFL209-111D1	C(CM)-UCFL209-111D1								
FL209D1	S(SM)-UCFL209-112D1	C(CM)-UCFL209-112D1								

Flanged cartridge units cast housing
Set screw type



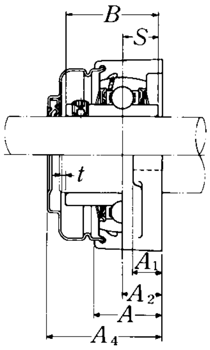


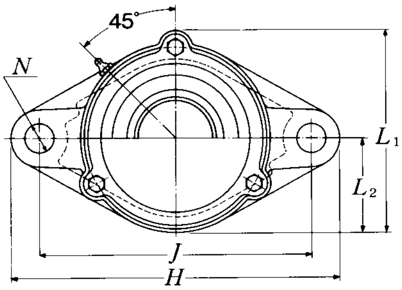


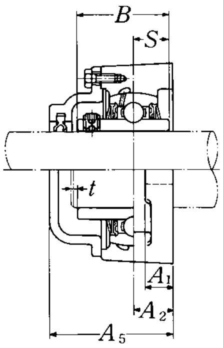
Pressed steel dust cover type
Open end: **S-UCFL···D1**
Closed end: **SM-UCFL···D1**

Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch										Bolt size mm inch	Bearing number
		H	J	A_2	A_1	A	N	L	A_0	B	S		
50	UCFL210D1	197	157	22	16	40	19	115	54.6	51.6	19	M16	UC210D1
1 13/16	UCFL210-113D1	7 3/4	6 3/16	55/64	5/8	1 9/16	3/4	4 17/32	2 5/32	2.0315	0.748	5/8	UC210-113D1
1 7/8	UCFL210-114D1												UC210-114D1
1 15/16	UCFL210-115D1												UC210-115D1
2	UCFL210-200D1												UC210-200D1
55	UCFL211D1	224	184	25	18	43	19	130	58.4	55.6	22.2	M16	UC211D1
2	UCFL211-200D1	8 13/16	7 1/4	63/64	23/32	1 11/16	3/4	5 1/8	2 19/64	2.1890	0.874	5/8	UC211-200D1
2 1/16	UCFL211-201D1												UC211-201D1
2 1/8	UCFL211-202D1												UC211-202D1
2 3/16	UCFL211-203D1												UC211-203D1
60	UCFL212D1	250	202	29	18	48	23	140	68.7	65.1	25.4	M20	UC212D1
2 1/4	UCFL212-204D1	9 27/32	7 61/64	1 9/64	23/32	1 7/8	29/32	5 1/2	2 45/64	2.5630	1.000	3/4	UC212-204D1
2 5/16	UCFL212-205D1												UC212-205D1
2 3/8	UCFL212-206D1												UC212-206D1
2 7/16	UCFL212-207D1												UC212-207D1
65	UCFL213D1	258	210	30	22	50	23	155	69.7	65.1	25.4	M20	UC213D1
2 1/2	UCFL213-208D1	10 5/32	8 17/64	1 3/16	7/8	1 31/32	29/32	6 3/32	2 3/4	2.5630	1.000	3/4	UC213-208D1
2 9/16	UCFL213-209D1												UC213-209D1
70	UCFL214D1	265	216	31	22	54	23	160	75.4	74.6	30.2	M20	UC214D1
2 5/8	UCFL214-210D1	10 7/16	8 1/2	1 7/32	7/8	2 1/8	29/32	6 5/16	2 31/32	2.9370	1.189	3/4	UC214-210D1
2 11/16	UCFL214-211D1												UC214-211D1
2 3/4	UCFL214-212D1												UC214-212D1
75	UCFL215D1	275	225	34	22	56	23	165	78.5	77.8	33.3	M20	UC215D1
2 13/16	UCFL215-213D1	10 13/16	8 55/64	1 11/32	7/8	2 7/32	29/32	6 1/2	3 3/32	3.0630	1.311	3/4	UC215-213D1
2 7/8	UCFL215-214D1												UC215-214D1
2 15/16	UCFL215-215D1												UC215-215D1
3	UCFL215-300D1												UC215-300D1
80	UCFL216D1	290	233	34	22	58	25	180	83.3	82.6	33.3	M22	UC216D1
3 1/16	UCFL216-301D1	11 13/32	9 11/64	1 11/32	7/8	2 9/32	63/64	7 3/32	3 9/32	3.2520	1.311	7/8	UC216-301D1
3 1/8	UCFL216-302D1												UC216-302D1
3 3/16	UCFL216-303D1												UC216-303D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



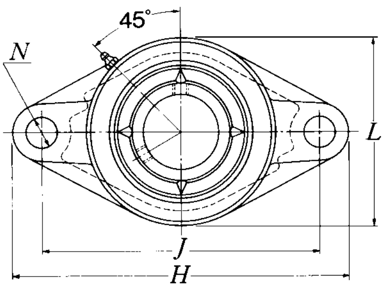


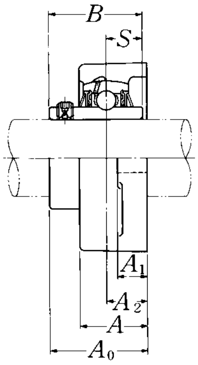


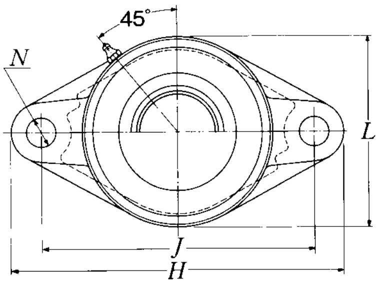
Cast dust cover type
Open end: **C-UCFL···D1**
Closed end: **CM-UCFL···D1**

Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions					Mass of unit		
			mm / inch					kg / lb		
			t max.	A4	A5	L1	L2	UCFL	S(SM)	C(CM)
FL210D1	S(SM)-UCFL210D1	C(CM)-UCFL210D1	3	65.5	72	120	58	2.2	2.3	3.0
FL210D1	S(SM)-UCFL210-113D1	C(CM)-UCFL210-113D1	1/8	2 19/32	2 27/32	4 23/32	2 9/32	4.9	5.1	6.6
FL210D1	S(SM)-UCFL210-114D1	C(CM)-UCFL210-114D1								
FL210D1	S(SM)-UCFL210-115D1	C(CM)-UCFL210-115D1								
FL210D1	—	—								
FL211D1	S(SM)-UCFL211D1	C(CM)-UCFL211D1	4	71	75	133	65	3.1	3.2	4.3
FL211D1	S(SM)-UCFL211-200D1	C(CM)-UCFL211-200D1	5/32	2 25/32	2 15/16	5 1/4	2 9/16	6.8	7.1	9.5
FL211D1	S(SM)-UCFL211-201D1	C(CM)-UCFL211-201D1								
FL211D1	S(SM)-UCFL211-202D1	C(CM)-UCFL211-202D1								
FL211D1	S(SM)-UCFL211-203D1	C(CM)-UCFL211-203D1								
FL212D1	S(SM)-UCFL212D1	C(CM)-UCFL212D1	4	80	86	144	70	4.0	4.2	5.1
FL212D1	S(SM)-UCFL212-204D1	C(CM)-UCFL212-204D1	5/32	3 5/32	3 3/8	5 21/32	2 3/4	8.8	9.3	11
FL212D1	S(SM)-UCFL212-205D1	C(CM)-UCFL212-205D1								
FL212D1	S(SM)-UCFL212-206D1	C(CM)-UCFL212-206D1								
FL212D1	—	—								
FL213D1	S(SM)-UCFL213D1	C(CM)-UCFL213D1	4	83.5	90	157	78	5.0	5.2	6.6
FL213D1	S(SM)-UCFL213-208D1	C(CM)-UCFL213-208D1	5/32	3 9/32	3 17/32	6 3/16	3 1/16	11	11	15
FL213D1	S(SM)-UCFL213-209D1	C(CM)-UCFL213-209D1								
FL214D1	—	C(CM)-UCFL214D1	4	—	98	164	80	5.6	—	7.3
FL214D1	—	C(CM)-UCFL214-210D1	5/32	—	3 27/32	6 15/32	3 5/32	12	—	16
FL214D1		C(CM)-UCFL214-211D1								
FL214D1		C(CM)-UCFL214-212D1								
FL215D1	—	C(CM)-UCFL215D1	4	—	102	169	82	6.2	—	7.8
FL215D1	—	C(CM)-UCFL215-213D1	5/32	—	4 1/32	6 21/32	3 7/32	14	—	17
FL215D1		C(CM)-UCFL215-214D1								
FL215D1		C(CM)-UCFL215-215D1								
FL215D1		C(CM)-UCFL215-300D1								
FL216D1	—	C(CM)-UCFL216D1	4	—	106	183	90	8.2	—	11
FL216D1	—	C(CM)-UCFL216-301D1	5/32	—	4 3/16	7 7/32	3 17/32	18	—	24
FL216D1		C(CM)-UCFL216-302D1								
FL216D1		C(CM)-UCFL216-303D1								

Flanged cartridge units cast housing
Set screw type



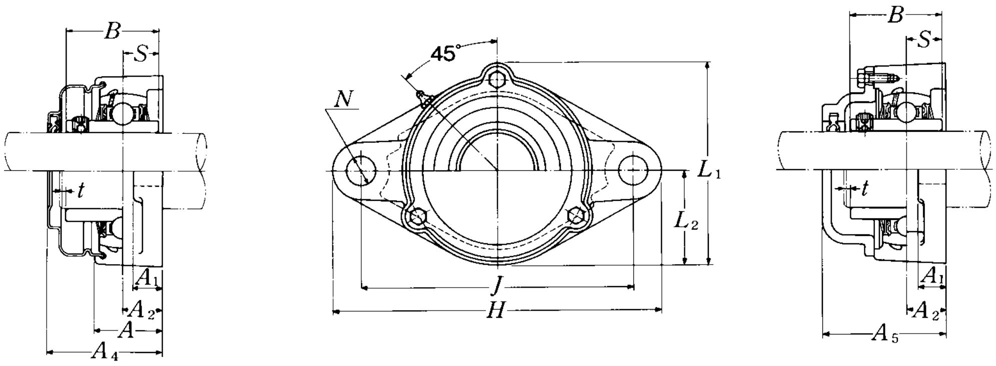




Pressed steel dust cover type
Open end: **S-UCFL···D1**
Closed end: **SM-UCFL···D1**

Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch										Bolt size mm inch	Bearing number
		H	J	A_2	A_1	A	N	L	A_0	B	S		
85	**UCFL217D1**	305	248	36	24	63	25	190	87.6	85.7	34.1	M22	UC217D1
$3\frac{1}{4}$	**UCFL217-304D1**												UC217-304D1
$3\frac{5}{16}$	**UCFL217-305D1**	12	$9\frac{49}{64}$	$1\frac{27}{64}$	$\frac{15}{16}$	$2\frac{15}{32}$	$\frac{63}{64}$	$7\frac{15}{32}$	$3\frac{29}{64}$	3.3740	1.343	$\frac{7}{8}$	UC217-305D1
$3\frac{7}{16}$	**UCFL217-307D1**												UC217-307D1
90	**UCFL218D1**	320	265	40	24	68	25	205	96.3	96	39.7	M22	UC218D1
$3\frac{1}{2}$	**UCFL218-308D1**	$12\frac{19}{32}$	$10\frac{7}{16}$	$1\frac{37}{64}$	$\frac{15}{16}$	$2\frac{11}{16}$	$\frac{63}{64}$	$8\frac{1}{16}$	$3\frac{51}{64}$	3.7795	1.563	$\frac{7}{8}$	UC218-308D1

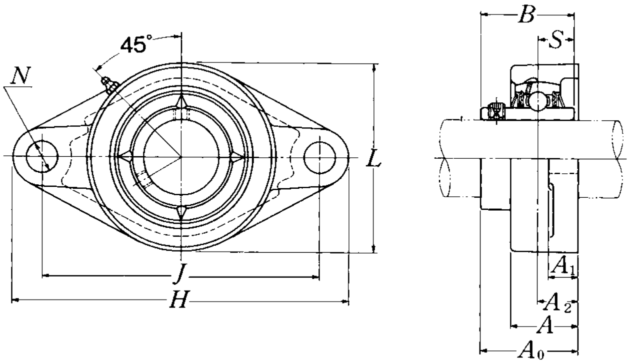
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UCFL···D1**
Closed end: **CM-UCFL···D1**

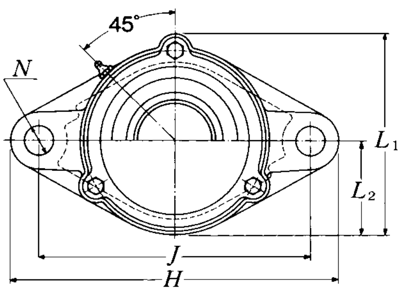
Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions					Mass of unit		
			mm					kg		
			inch					lb		
			t max.	*A*4	*A*5	*L*1	*L*2	UCFL	S(SM)	C(CM)
FL217D1	—	**C(CM)-UCFL217D1**	5	—	114	192	95	9.3	—	11
FL217D1	—	**C(CM)-UCFL217-304D1**	13⁄64	—	4½	7 9⁄16	3¾	21	—	24
FL217D1		**C(CM)-UCFL217-305D1**								
FL217D1		**C(CM)-UCFL217-307D1**								
FL218D1	—	**C(CM)-UCFL218D1**	5	—	122	205	102	11	—	14
FL218D1	—	**C(CM)-UCFL218-308D1**	13⁄64	—	4 13⁄16	8 1⁄16	4 1⁄32	24	—	31

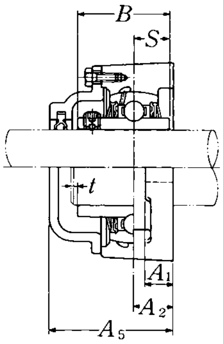
Flanged cartridge units cast housing
Set screw type



Shaft dia.	Unit number 1)	Nominal dimensions										Bolt size	Bearing number
mm inch						mm		inch				mm inch	
		H	J	A_2	A_1	A	N	L	A_0	B	S		
25	**UCFL305D1**	150	113	16	13	29	19	80	39	38	15	M16	UC305D1
13/16	**UCFL305-013D1**	5 29/32	4 7/16	5/8	1/2	1 5/32	3/4	3 5/32	1 17/32	1.4961	0.591	5/8	UC305-013D1
7/8	**UCFL305-014D1**												UC305-014D1
15/16	**UCFL305-015D1**												UC305-015D1
1	**UCFL305-100D1**												UC305-100D1
30	**UCFL306D1**	180	134	18	15	32	23	90	44	43	17	M20	UC306D1
1 1/16	**UCFL306-101D1**	7 3/32	5 9/32	45/64	19/32	1 1/4	29/32	3 17/32	1 47/64	1.6929	0.669	3/4	UC306-101D1
1 1/8	**UCFL306-102D1**												UC306-102D1
1 3/16	**UCFL306-103D1**												UC306-103D1
35	**UCFL307D1**	185	141	20	16	36	23	100	49	48	19	M20	UC307D1
1 1/4	**UCFL307-104D1**	7 9/32	5 35/64	25/32	5/8	1 13/32	29/32	3 15/16	1 59/64	1.8898	0.748	3/4	UC307-104D1
1 5/16	**UCFL307-105D1**												UC307-105D1
1 3/8	**UCFL307-106D1**												UC307-106D1
1 7/16	**UCFL307-107D1**												UC307-107D1
40	**UCFL308D1**	200	158	23	17	40	23	112	56	52	19	M20	UC308D1
1 1/2	**UCFL308-108D1**	7 7/8	6 7/32	29/32	21/32	1 9/16	29/32	4 13/32	2 13/64	2.0472	0.748	3/4	UC308-108D1
1 9/16	**UCFL308-109D1**												UC308-109D1
45	**UCFL309D1**	230	177	25	18	44	25	125	60	57	22	M22	UC309D1
1 5/8	**UCFL309-110D1**	9 1/16	6 31/32	63/64	23/32	1 23/32	63/64	4 29/32	2 23/64	2.2441	0.866	7/8	UC309-110D1
1 11/16	**UCFL309-111D1**												UC309-111D1
1 3/4	**UCFL309-112D1**												UC309-112D1
50	**UCFL310D1**	240	187	28	19	48	25	140	67	61	22	M22	UC310D1
1 13/16	**UCFL310-113D1**	9 7/16	7 23/64	1 7/64	3/4	1 7/8	63/64	5 1/2	2 41/64	2.4016	0.866	7/8	UC310-113D1
1 7/8	**UCFL310-114D1**												UC310-114D1
1 15/16	**UCFL310-115D1**												UC310-115D1
55	**UCFL311D1**	250	198	30	20	52	25	150	71	66	25	M22	UC311D1
2	**UCFL311-200D1**	9 27/32	7 51/64	1 3/16	25/32	2 1/16	63/64	5 29/32	2 51/64	2.5984	0.984	7/8	UC311-200D1
2 1/16	**UCFL311-201D1**												UC311-201D1
2 1/8	**UCFL311-202D1**												UC311-202D1
2 3/16	**UCFL311-203D1**												UC311-203D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

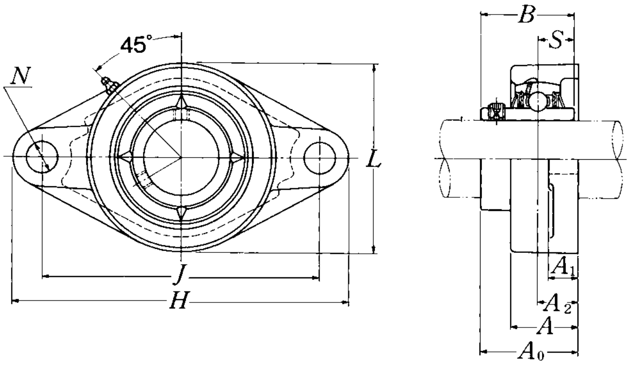




Cast dust cover type
Open end: **C-UCFL···D1**
Closed end: **CM-UCFL···D1**

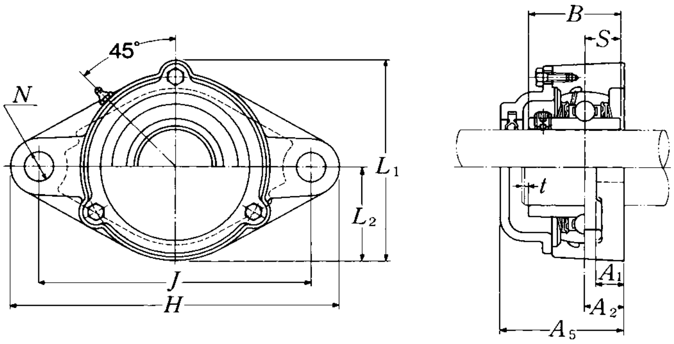
Housing number	Unit number cast dust cover type	Nominal dimensions				Mass of unit	
		mm				kg	lb
		inch					
		t max.	A_5	L_1	L_2	UCFL	C(CM)
FL305D1	C(CM)-UCFL305D1	2	56	86	40	1.1	1.5
FL305D1	C(CM)-UCFL305-013D1	$\frac{5}{64}$	$2\frac{7}{32}$	$3\frac{3}{8}$	$1\frac{9}{16}$	2.4	3.3
FL305D1	C(CM)-UCFL305-014D1						
FL305D1	C(CM)-UCFL305-015D1						
FL305D1	C(CM)-UCFL305-100D1						
FL306D1	C(CM)-UCFL306D1	2	60	101	45	1.5	1.9
FL306D1	C(CM)-UCFL306-101D1	$\frac{5}{64}$	$2\frac{3}{8}$	$3\frac{31}{32}$	$1\frac{25}{32}$	3.3	4.2
FL306D1	C(CM)-UCFL306-102D1						
FL306D1	C(CM)-UCFL306-103D1						
FL307D1	C(CM)-UCFL307D1	3	68	110	50	1.9	2.3
FL307D1	C(CM)-UCFL307-104D1	$\frac{1}{8}$	$2\frac{11}{16}$	$4\frac{11}{32}$	$1\frac{31}{32}$	4.2	5.1
FL307D1	C(CM)-UCFL307-105D1						
FL307D1	C(CM)-UCFL307-106D1						
FL307D1	C(CM)-UCFL307-107D1						
FL308D1	C(CM)-UCFL308D1	3	76	122	56	2.5	3.3
FL308D1	C(CM)-UCFL308-108D1	$\frac{1}{8}$	3	$4\frac{13}{16}$	$2\frac{7}{32}$	5.5	7.3
FL308D1	C(CM)-UCFL308-109D1						
FL309D1	C(CM)-UCFL309D1	3	80	135	62	3.4	4.2
FL309D1	C(CM)-UCFL309-110D1	$\frac{1}{8}$	$3\frac{5}{32}$	$5\frac{5}{16}$	$2\frac{7}{16}$	7.5	9.3
FL309D1	C(CM)-UCFL309-111D1						
FL309D1	C(CM)-UCFL309-112D1						
FL310D1	C(CM)-UCFL310D1	3	88	152	70	4.4	5.3
FL310D1	C(CM)-UCFL310-113D1	$\frac{1}{8}$	$3\frac{15}{32}$	$5\frac{31}{32}$	$2\frac{3}{4}$	9.7	12
FL310D1	C(CM)-UCFL310-114D1						
FL310D1	C(CM)-UCFL310-115D1						
FL311D1	C(CM)-UCFL311D1	4	92	162	75	5.1	6.2
FL311D1	C(CM)-UCFL311-200D1	$\frac{5}{32}$	$3\frac{5}{8}$	$6\frac{3}{8}$	$2\frac{15}{16}$	11	14
FL311D1	C(CM)-UCFL311-201D1						
FL311D1	C(CM)-UCFL311-202D1						
FL311D1	C(CM)-UCFL311-203D1						

Flanged units cast housing
Set screw type



Shaft dia. mm inch	Unit number [1]	Nominal dimensions mm inch H	J	A_2	A_1	A	N	L	A_0	B	S	Bolt size mm inch	Bearing number
60	**UCFL312D1**	270	212	33	22	56	31	160	78	71	26	M27	UC312D1
2 1/4	**UCFL312-204D1**	10 5/8	8 11/32	1 19/64	7/8	2 7/32	1 7/32	6 5/16	3 5/64	2.7953	1.024	1	UC312-204D1
2 5/16	**UCFL312-205D1**												UC312-205D1
2 3/8	**UCFL312-206D1**												UC312-206D1
2 7/16	**UCFL312-207D1**												UC312-207D1
65	**UCFL313D1**	295	240	33	25	58	31	175	78	75	30	M27	UC313D1
2 1/2	**UCFL313-208D1**	11 5/8	9 29/64	1 19/64	31/32	2 9/32	1 7/32	6 7/8	3 5/64	2.9528	1.181	1	UC313-208D1
2 9/16	**UCFL313-209D1**												UC313-209D1
70	**UCFL314D1**	315	250	36	28	61	35	185	81	78	33	M30	UC314D1
2 5/8	**UCFL314-210D1**	12 13/32	9 27/32	1 27/64	1 3/32	2 13/32	1 3/8	7 9/32	3 3/16	3.0709	1.299	1 1/8	UC314-210D1
2 11/16	**UCFL314-211D1**												UC314-211D1
2 3/4	**UCFL314-212D1**												UC314-212D1
75	**UCFL315D1**	320	260	39	30	66	35	195	89	82	32	M30	UC315D1
2 13/16	**UCFL315-213D1**	12 19/32	10 15/64	1 17/32	1 3/16	2 19/32	1 3/8	7 11/16	3 1/2	3.2283	1.260	1 1/8	UC315-213D1
2 7/8	**UCFL315-214D1**												UC315-214D1
2 15/16	**UCFL315-215D1**												UC315-215D1
3	**UCFL315-300D1**												UC315-300D1
80	**UCFL316D1**	355	285	38	32	68	38	210	90	86	34	M33	UC316D1
3 1/16	**UCFL316-301D1**	13 31/32	11 7/32	1 1/2	1 1/4	2 11/16	1 1/2	8 9/32	3 35/64	3.3858	1.339	1 1/4	UC316-301D1
3 1/8	**UCFL316-302D1**												UC316-302D1
3 3/16	**UCFL316-303D1**												UC316-303D1
85	**UCFL317D1**	370	300	44	32	74	38	220	100	96	40	M33	UC317D1
3 1/4	**UCFL317-304D1**	14 9/16	11 13/16	1 47/64	1 1/4	2 29/32	1 1/2	8 21/32	3 15/16	3.7795	1.575	1 1/4	UC317-304D1
3 5/16	**UCFL317-305D1**												UC317-305D1
3 7/16	**UCFL317-307D1**												UC317-307D1
90	**UCFL318D1**	385	315	44	36	76	38	235	100	96	40	M33	UC318D1
3 7/16	**UCFL318-307D1**	15 5/32	12 13/32	1 47/64	1 13/32	3	1 1/2	9 1/4	3 15/16	3.7795	1.575	1 1/4	UC318-307D1
3 1/2	**UCFL318-308D1**												UC318-308D1

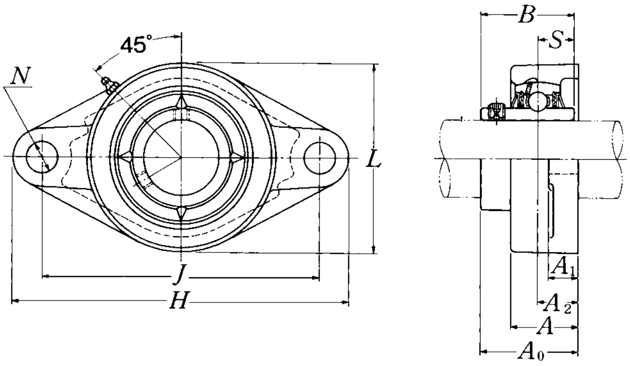
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UCFL···D1**
Closed end: **CM-UCFL···D1**

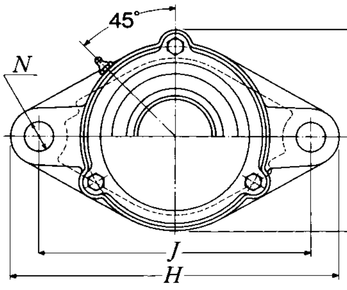
Housing number	Unit number cast dust cover type	Nominal dimensions				Mass of unit	
		mm		inch		kg	lb
		t max.	A_5	L_1	L_2	UCFL	C(CM)
FL312D1	**C(CM)-UCFL312D1**	4	100	175	80	6.1	7.7
FL312D1	**C(CM)-UCFL312-204D1**	$\frac{5}{32}$	$3\frac{15}{16}$	$6\frac{7}{8}$	$3\frac{5}{32}$	13	17
FL312D1	**C(CM)-UCFL312-205D1**						
FL312D1	**C(CM)-UCFL312-206D1**						
FL312D1	**C(CM)-UCFL312-207D1**						
FL313D1	**C(CM)-UCFL313D1**	4	103	189	88	7.8	9.9
FL313D1	**C(CM)-UCFL313-208D1**	$\frac{5}{32}$	$4\frac{1}{16}$	$7\frac{7}{16}$	$3\frac{15}{32}$	17	22
FL313D1	**C(CM)-UCFL313-209D1**						
FL314D1	**C(CM)-UCFL314D1**	4	106	198	92	9.0	12
FL314D1	**C(CM)-UCFL314-210D1**	$\frac{5}{32}$	$4\frac{3}{16}$	$7\frac{25}{32}$	$3\frac{5}{8}$	20	26
FL314D1	**C(CM)-UCFL314-211D1**						
FL314D1	**C(CM)-UCFL314-212D1**						
FL315D1	**C(CM)-UCFL315D1**	4	114	210	98	10	12
FL315D1	**C(CM)-UCFL315-213D1**	$\frac{5}{32}$	$4\frac{1}{2}$	$8\frac{9}{32}$	$3\frac{27}{32}$	22	26
FL315D1	**C(CM)-UCFL315-214D1**						
FL315D1	**C(CM)-UCFL315-215D1**						
FL315D1	**C(CM)-UCFL315-300D1**						
FL316D1	**C(CM)-UCFL316D1**	4	116	222	105	13	16
FL316D1	**C(CM)-UCFL316-301D1**	$\frac{5}{32}$	$4\frac{9}{16}$	$8\frac{3}{4}$	$4\frac{1}{8}$	29	35
FL316D1	**C(CM)-UCFL316-302D1**						
FL316D1	**C(CM)-UCFL316-303D1**						
FL317D1	**C(CM)-UCFL317D1**	5	127	234	110	15	18
FL317D1	**C(CM)-UCFL317-304D1**	$\frac{13}{64}$	5	$9\frac{7}{32}$	$4\frac{11}{32}$	33	40
FL317D1	**C(CM)-UCFL317-305D1**						
FL317D1	**C(CM)-UCFL317-307D1**						
FL318D1	**C(CM)-UCFL318D1**	5	129	247	118	18	21
FL318D1	**C(CM)-UCFL318-307D1**	$\frac{13}{64}$	$5\frac{3}{32}$	$9\frac{23}{32}$	$4\frac{21}{32}$	40	46
FL318D1	**C(CM)-UCFL318-308D1**						

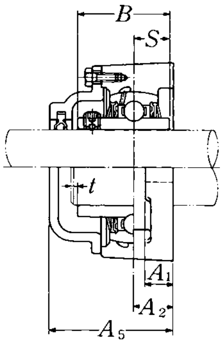
Flanged units cast housing
Set screw type



Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch										Bolt size mm inch	Bearing number
		H	J	A_2	A_1	A	N	L	A_0	B	S		
95	**UCFL319D1**	405	330	59	40	94	41	250	121	103	41	M36	UC319D1
$3\frac{5}{8}$	**UCFL319-310D1**	$15\frac{15}{16}$	$12\frac{63}{64}$	$2\frac{21}{64}$	$1\frac{9}{16}$	$3\frac{11}{16}$	$1\frac{39}{64}$	$9\frac{27}{32}$	$4\frac{49}{64}$	4.0551	1.614	$1\frac{3}{8}$	UC319-310D1
$3\frac{11}{16}$	**UCFL319-311D1**												UC319-311D1
$3\frac{3}{4}$	**UCFL319-312D1**												UC319-312D1
100	**UCFL320D1**	440	360	59	40	94	44	270	125	108	42	M39	UC320D1
$3\frac{13}{16}$	**UCFL320-313D1**	$17\frac{5}{16}$	$14\frac{11}{64}$	$2\frac{21}{64}$	$1\frac{9}{16}$	$3\frac{11}{16}$	$1\frac{47}{64}$	$10\frac{5}{8}$	$4\frac{59}{64}$	4.2520	1.654	$1\frac{1}{2}$	UC320-313D1
$3\frac{7}{8}$	**UCFL320-314D1**												UC320-314D1
$3\frac{15}{16}$	**UCFL320-315D1**												UC320-315D1
4	**UCFL320-400D1**												UC320-400D1
105	**UCFL321D1**	440	360	59	40	94	44	270	127	112	44	M39	UC321D1
110	**UCFL322D1**	470	390	60	42	96	44	300	131	117	46	M39	UC322D1
120	**UCFL324D1**	520	430	65	48	110	47	330	140	126	51	M42	UC324D1
130	**UCFL326D1**	550	460	65	50	115	47	360	146	135	54	M42	UC326D1
140	**UCFL328D1**	600	500	75	60	125	51	400	161	145	59	M45	UC328D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

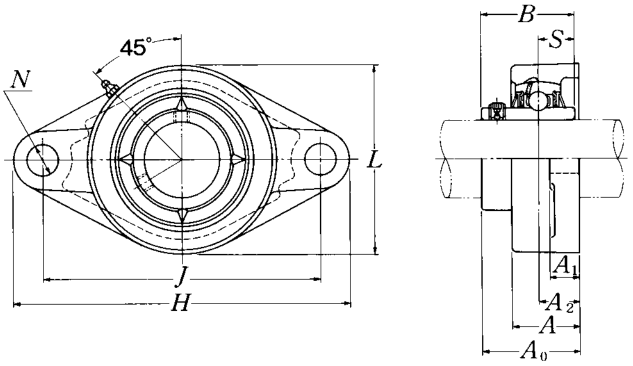




Cast dust cover type
Open end: **C-UCFL···D1**
Closed end: **CM-UCFL···D1**

Housing number	Unit number cast dust cover type	Nominal dimensions				Mass of unit	
			mm	inch		kg	lb
		t max.	A_5	L_1	L_2	UCFL	C(CM)
FL319D1	**C(CM)-UCFL319D1**	5	149	260	125	22	26
FL319D1	**C(CM)-UCFL319-310D1**						
FL319D1	**C(CM)-UCFL319-311D1**	$\frac{13}{64}$	$5\frac{7}{8}$	$10\frac{1}{4}$	$4\frac{29}{32}$	49	57
FL319D1	**C(CM)-UCFL319-312D1**						
FL320D1	**C(CM)-UCFL320D1**	5	154	280	135	27	31
FL320D1	**C(CM)-UCFL320-313D1**						
FL320D1	**C(CM)-UCFL320-314D1**	$\frac{13}{64}$	$6\frac{1}{16}$	$11\frac{1}{32}$	$5\frac{5}{16}$	60	68
FL320D1	**C(CM)-UCFL320-315D1**						
FL320D1	**C(CM)-UCFL320-400D1**						
FL321D1	**C(CM)-UCFL321D1**	5	156	287	135	27	32
FL322D1	**C(CM)-UCFL322D1**	5	160	315	150	33	39
FL324D1	**C(CM)-UCFL324D1**	5	172	342	165	48	52
FL326D1	**C(CM)-UCFL326D1**	6	178	376	180	58	64
FL328D1	**C(CM)-UCFL328D1**	6	192	410	200	81	89

Flanged units cast housing
Set screw type

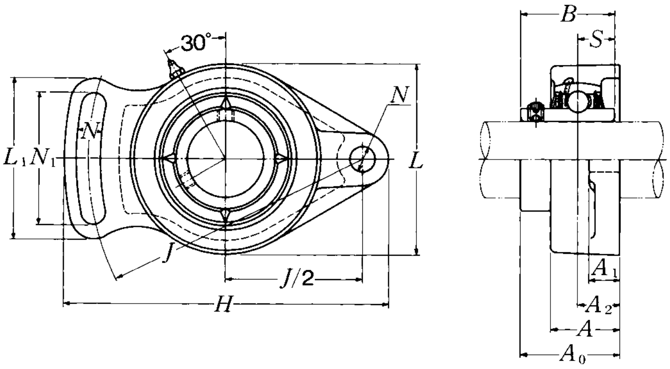


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch H	J	A2	A1	A	N	L	A0	B	S	Bolt size mm inch	Bearing number
25	UCFLX05D1	141	117	18	13	30	12	83	40.2	38.1	15.9	M10	UCX05D1
13/16	UCFLX05-013D1	5 9/16	4 39/64	45/64	1/2	1 3/16	15/32	3 9/32	1 37/64	1.5000	0.626	3/8	UCX05-013D1
7/8	UCFLX05-014D1												UCX05-014D1
15/16	UCFLX05-015D1												UCX05-015D1
1	UCFLX05-100D1												UCX05-100D1
30	UCFLX06D1	156	130	19	15	34	16	95	44.4	42.9	17.5	M14	UCX06D1
1 1/16	UCFLX06-101D1	6 5/32	5 1/8	3/4	19/32	1 11/32	5/8	3 3/4	1 3/4	1.6890	0.689	1/2	UCX06-101D1
1 1/8	UCFLX06-102D1												UCX06-102D1
1 3/16	UCFLX06-103D1												UCX06-103D1
1 1/4	UCFLX06-104D1												UC207-104D1
35	UCFLX07D1	171	144	21	16	38	16	105	51.2	49.2	19	M14	UCX07D1
1 5/16	UCFLX07-105D1	6 23/32	5 43/64	53/64	5/8	1 1/2	5/8	4 1/8	2 1/64	1.9370	0.748	1/2	UCX07-105D1
1 3/8	UCFLX07-106D1												UCX07-106D1
1 7/16	UCFLX07-107D1												UCX07-107D1
40	UCFLX08D1	179	148	22	16	40	16	111	52.2	49.2	19	M14	UCX08D1
1 1/2	UCFLX08-108D1	7 1/16	5 53/64	55/64	5/8	1 9/16	5/8	4 3/8	2 1/16	1.9370	0.748	1/2	UCX08-108D1
1 9/16	UCFLX08-109D1												UCX08-109D1
45	UCFLX09D1	189	157	23	16	40	16	116	55.6	51.6	19	M14	UCX09D1
1 5/8	UCFLX09-110D1	7 7/16	6 3/16	29/32	5/8	1 9/16	5/8	4 9/16	2 3/16	2.0315	0.748	1/2	UCX09-110D1
1 11/16	UCFLX09-111D1												UCX09-111D1
1 3/4	UCFLX09-112D1												UCX09-112D1
1 13/16	UCFLX09-113D1												UC210-113D1
50	UCFLX10D1	216	184	26	18	44	19	133	59.4	55.6	22.2	M16	UCX10D1
1 7/8	UCFLX10-114D1	8 1/2	7 1/4	1 1/32	23/32	1 23/32	3/4	5 1/4	2 11/32	2.1890	0.874	5/8	UCX10-114D1
1 15/16	UCFLX10-115D1												UCX10-115D1
2	UCFLX10-200D1												UC211-200D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
FLX05D1	1.0
FLX05D1	2.2
FLX05D1	
FLX05D1	
FLX05D1	
FLX06D1	1.5
FLX06D1	3.3
FLX06D1	
FLX06D1	
FLX06D1	
FLX07D1	2.0
FLX07D1	4.4
FLX07D1	
FLX07D1	
FLX08D1	2.2
FLX08D1	4.9
FLX08D1	
FLX09D1	2.4
FLX09D1	5.3
FLX09D1	
FLX09D1	
FLX09D1	
FLX10D1	3.4
FLX10D1	7.5
FLX10D1	
FLX10D1	

Flanged units cast housing special type
Set screw type

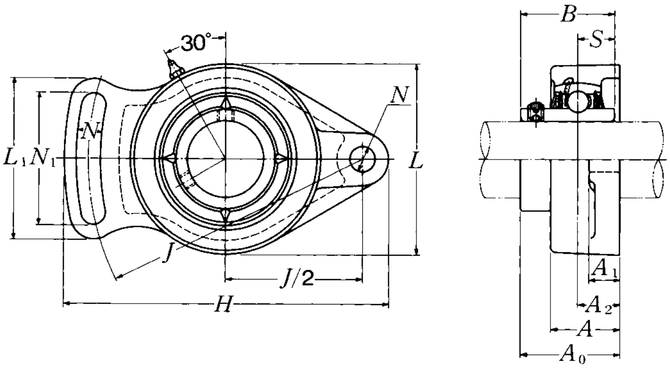


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch												Bolt size mm inch
		H	J	A2	A1	A	N	N1	L	L1	A0	B	S	
12	UCFA201D1	98	78	15	12	25.5	10	40	60	50	33.3	31	12.7	M 8
1/2	UCFA201-008D1	3 27/32	3 1/16	19/32	15/32	1	25/64	1 9/16	2 3/8	1 31/32	1 5/16	1.2205	0.500	5/16
15	UCFA202D1	98	78	15	12	25.5	10	40	60	50	33.3	31	12.7	M 8
9/16	UCFA202-009D1	3 27/32	3 1/16	19/32	15/32	1	25/64	1 9/16	2 3/8	1 31/32	1 5/16	1.2205	0.500	5/16
5/8	UCFA202-010D1													
17	UCFA203D1	98	78	15	12	25.5	10	40	60	50	33.3	31	12.7	M 8
11/16	UCFA203-011D1	3 27/32	3 1/16	19/32	15/32	1	25/64	1 9/16	2 3/8	1 31/32	1 5/16	1.2205	0.500	5/16
20	UCFA204D1	98	78	15	12	25.5	10	40	60	50	33.3	31	12.7	M 8
3/4	UCFA204-012D1	3 27/32	3 1/16	19/32	15/32	1	25/64	1 9/16	2 3/8	1 31/32	1 5/16	1.2205	0.500	5/16
25	UCFA205D1	124	96	15	14	26.5	13	49	70	64	34.8	34.1	14.3	M10
13/16	UCFA205-013D1	4 7/8	3 25/32	19/32	9/16	1 1/32	33/64	1 15/16	2 3/4	2 17/32	1 3/8	1.3425	0.563	3/8
7/8	UCFA205-014D1													
15/16	UCFA205-015D1													
1	UCFA205-100D1													
30	UCFA206D1	141	115	18	14	31	13	53	80	68	40.2	38.1	15.9	M10
1 1/16	UCFA206-101D1	5 9/16	4 17/32	45/64	9/16	1 7/32	33/64	2 3/32	3 5/32	2 11/16	1 37/64	1.5000	0.626	3/8
1 1/8	UCFA206-102D1													
1 3/16	UCFA206-103D1													
1 1/4	UCFA206-104D1													
35	UCFA207D1	155	128	20	16	34	15	60	90	75	45.4	42.9	17.5	M12
1 1/4	UCFA207-104D1	6 3/32	5 1/32	25/32	5/8	1 11/32	19/32	2 3/8	3 17/32	2 15/16	1 25/32	1.6890	0.689	7/16
1 5/16	UCFA207-105D1													
1 3/8	UCFA207-106D1													
1 7/16	UCFA207-107D1													
40	UCFA208D1	171	142	22	16	36	15	69	100	84	52.2	49.2	19	M12
1 1/2	UCFA208-108D1	6 23/32	5 19/32	55/64	5/8	1 13/32	19/32	2 23/32	3 15/16	3 5/16	2 1/16	1.9370	0.748	7/16
1 9/16	UCFA208-109D1													

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit	
		kg	lb
UC201D1	FA204D1	0.7	
UC201-008D1	FA204D1		1.5
UC202D1	FA204D1	0.6	
UC202-009D1	FA204D1		1.3
UC202-010D1	FA204D1		
UC203D1	FA204D1	0.6	
UC203-011D1	FA204D1		1.3
UC204D1	FA204D1	0.6	
UC204-012D1	FA204D1		1.3
UC205D1	FA205D1	0.8	
UC205-013D1	FA205D1		1.8
UC205-014D1	FA205D1		
UC205-015D1	FA205D1		
UC205-100D1	FA205D1		
UC206D1	FA206D1	1.2	
UC206-101D1	FA206D1		2.6
UC206-102D1	FA206D1		
UC206-103D1	FA206D1		
UC206-104D1	FA206D1		
UC207D1	FA207D1	1.5	
UC207-104D1	FA207D1		3.3
UC207-105D1	FA207D1		
UC207-106D1	FA207D1		
UC207-107D1	FA207D1		
UC208D1	FA208D1	1.8	
UC208-108D1	FA208D1		4.0
UC208-109D1	FA208D1		

Flanged units cast housing special type
Set screw type

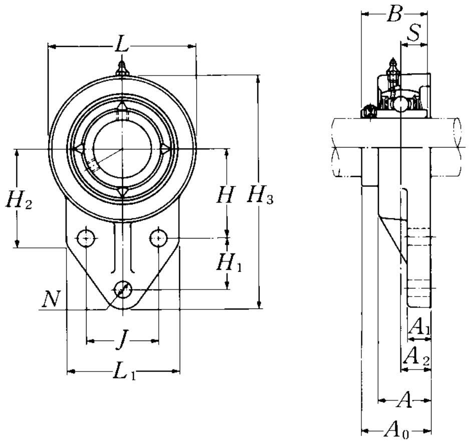


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch												Bolt size mm inch
		H	J	A2	A1	A	N	N1	L	L1	A0	B	S	
45	**UCFA209D1**	179	146	22	18	38	17	72	110	88	52.2	49.2	19	M14
1 5/8	**UCFA209-110D1**	7 1/16	5 3/4	55/64	23/32	1 1/2	43/64	2 27/32	4 11/32	3 15/32	2 1/16	1.9370	0.748	1/2
1 11/16	**UCFA209-111D1**													
1 3/4	**UCFA209-112D1**													
50	**UCFA210D1**	189	155	22	18	40	17	75	115	92	54.6	51.6	19	M14
1 13/16	**UCFA210-113D1**	7 7/16	6 3/32	55/64	23/32	1 9/16	43/64	2 15/16	4 17/32	3 5/8	2 5/32	2.0315	0.748	1/2
1 7/8	**UCFA210-114D1**													
1 15/16	**UCFA210-115D1**													
2	**UCFA210-200D1**													
55	**UCFA211D1**	216	182	26	20	43	17	85	130	102	59.4	55.6	22.2	M14
2	**UCFA211-200D1**	8 1/8	7 5/32	1 1/32	25/32	1 11/16	43/64	3 11/32	5 1/8	4 1/32	2 11/32	2.1890	0.874	1/2
2 1/16	**UCFA211-201D1**													
2 1/8	**UCFA211-202D1**													
2 3/16	**UCFA211-203D1**													

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit	
		kg	lb
UC209D1	FA209D1	2.2	4.9
UC209-110D1	FA209D1		
UC209-111D1	FA209D1		
UC209-112D1	FA209D1		
UC210D1	FA210D1	2.6	5.7
UC210-113D1	FA210D1		
UC210-114D1	FA210D1		
UC210-115D1	FA210D1		
UC210-200D1	FA210D1		
UC211D1	FA211D1	3.6	7.9
UC211-200D1	FA211D1		
UC211-201D1	FA211D1		
UC211-202D1	FA211D1		
UC211-203D1	FA211D1		

Flanged units cast housing special type
Set screw type

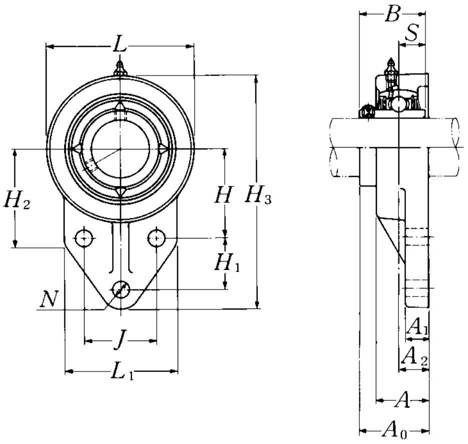


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch													
		H_3	J	A_2	A_1	A	N	H	H_1	L_1	H_2	L	A_0	B	S
12	UCFH201D1	110	32	15	13	25.5	10	42	27	52	52	62	33.3	31	12.7
1/2	UCFH201-008D1	4 11/32	1 17/64	19/32	1/2	1	25/64	1 21/32	1 1/16	2 1/16	2 1/16	2 7/16	1 5/16	1.2205	0.500
15	UCFH202D1	110	32	15	13	25.5	10	42	27	52	52	62	33.3	31	12.7
9/16	UCFH202-009D1	4 11/32	1 17/64	19/32	1/2	1	25/64	1 21/32	1 1/16	2 1/16	2 1/16	2 7/16	1 5/16	1.2205	0.500
5/8	UCFH202-010D1														
17	UCFH203D1	110	32	15	13	25.5	10	42	27	52	52	62	33.3	31	12.7
11/16	UCFH203-011D1	4 11/32	1 17/64	19/32	1/2	1	25/64	1 21/32	1 1/16	2 1/16	2 1/16	2 7/16	1 5/16	1.2205	0.500
20	UCFH204D1	110	32	15	13	25.5	10	42	27	52	52	62	33.3	31	12.7
3/4	UCFH204-012D1	4 11/32	1 17/64	19/32	1/2	1	25/64	1 21/32	1 1/16	2 1/16	2 1/16	2 7/16	1 5/16	1.2205	0.500
25	UCFH205D1	116	34	16	13	27	10	45	27	56	52	68	35.8	34.1	14.3
13/16	UCFH205-013D1	4 9/16	1 11/32	5/8	1/2	1 1/16	25/64	1 49/64	1 1/16	2 7/32	2 1/16	2 11/16	1 13/32	1.3425	0.563
7/8	UCFH205-014D1														
15/16	UCFH205-015D1														
1	UCFH205-100D1														
30	UCFH206D1	130	40	18	13	31	10	50	29	65	55	78	40.2	38.1	15.9
1 1/16	UCFH206-101D1	5 1/8	37/64	45/64	1/2	1 7/32	25/64	1 31/32	1 9/64	2 9/16	2 5/32	3 1/16	1 37/64	1.5000	0.626
1 1/8	UCFH206-102D1														
1 3/16	UCFH206-103D1														
1 1/4	UCFH206-104D1														
35	UCFH207D1	144	46	19	15	34	10	55	32	70	62	90	44.4	42.9	17.5
1 1/4	UCFH207-104D1	5 21/32	1 13/16	3/4	19/32	1 11/32	25/64	2 11/64	1 17/64	2 3/4	2 7/16	3 17/32	1 3/4	1.6890	0.689
1 5/16	UCFH207-105D1														
1 3/8	UCFH207-106D1														
1 7/16	UCFH207-107D1														
40	UCFH208D1	164	50	21	16	36	12	60	41	78	72	100	51.2	49.2	19
1 1/2	UCFH208-108D1	6 15/32	1 31/32	53/64	5/8	1 13/32	15/32	2 23/64	1 39/64	3 1/16	2 27/32	3 15/16	2 1/64	1.9370	0.748
1 9/16	UCFH208-109D1														
45	UCFH209D1	174	54	22	18	38	12	65	43	80	76	106	52.2	49.2	19
1 5/8	UCFH209-110D1	6 27/32	2 1/8	55/64	23/32	1 1/2	15/32	2 9/16	1 11/16	3 5/32	3	4 3/16	2 1/16	1.9370	0.748
1 11/16	UCFH209-111D1														
1 3/4	UCFH209-112D1														

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bolt size mm inch	Bearing number	Housing number	Mass of unit kg lb
M 8	UC201D1	FH204D1	0.7
5/16	UC201-008D1	FH204D1	1.5
M 8	UC202D1	FH204D1	0.7
5/16	UC202-009D1	FH204D1	1.5
	UC202-010D1	FH204D1	
M 8	UC203D1	FH204D1	0.7
5/16	UC203-011D1	FH204D1	1.5
M 8	UC204D1	FH204D1	0.7
5/16	UC204-012D1	FH204D1	1.5
M 8	UC205D1	FH205D1	0.8
5/16	UC205-013D1	FH205D1	1.8
	UC205-014D1	FH205D1	
	UC205-015D1	FH205D1	
	UC205-100D1	FH205D1	
M 8	UC206D1	FH206D1	1.0
5/16	UC206-101D1	FH206D1	2.2
	UC206-102D1	FH206D1	
	UC206-103D1	FH206D1	
	UC206-104D1	FH206D1	
M 8	UC207D1	FH207D1	1.3
5/16	UC207-104D1	FH207D1	2.9
	UC207-105D1	FH207D1	
	UC207-106D1	FH207D1	
	UC207-107D1	FH207D1	
M10	UC208D1	FH208D1	1.4
3/8	UC208-108D1	FH208D1	3.1
	UC208-109D1	FH208D1	
M10	UC209D1	FH209D1	2.2
3/8	UC209-110D1	FH209D1	4.9
	UC209-111D1	FH209D1	
	UC209-112D1	FH209D1	

Flanged units cast housing special type
Set screw type

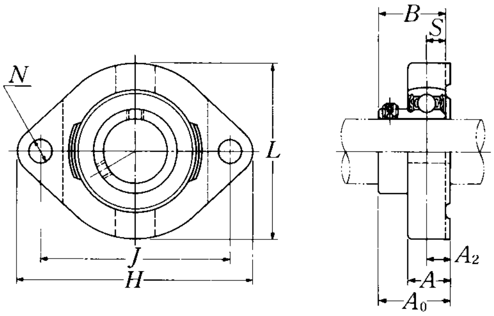


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch													
		H_3	J	A_2	A_1	A	N	H	H_1	L_1	H_2	L	A_0	B	S
50	**UCFH210D1**	184	58	22	18	40	12	68	46	86	82	112	54.6	51.6	19
1 13/16	**UCFH210-113D1**	7 1/4	2 9/32	55/64	23/32	1 9/16	15/32	2 43/64	1 13/16	3 3/8	3 7/32	4 13/32	2 5/32	2.0315	0.748
1 7/8	**UCFH210-114D1**														
1 15/16	**UCFH210-115D1**														
2	**UCFH210-200D1**														

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bolt size mm inch	Bearing number	Housing number	Mass of unit kg lb
M10	UC210D1	FH210D1	2.5
⅜	UC210-113D1	FH210D1	5.5
	UC210-114D1	FH210D1	
	UC210-115D1	FH210D1	
	UC210-200D1	FH210D1	

Flanged units cast housing
Set screw type

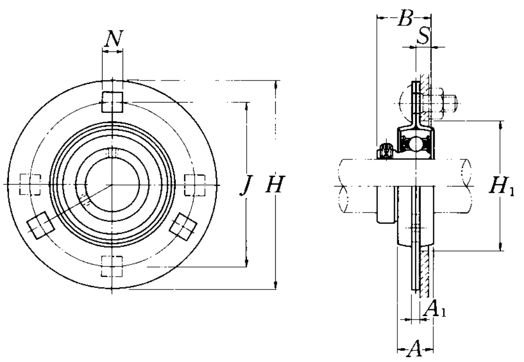


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch									Bolt size mm inch	Bearing number 1)
		H	J	A_2	A	N	L	A_0	B	S		
12	**ASFD201**	81	63	8.5	15	7	59	24.5	22	6	M6	AS201
1/2	**ASFD201-008**	3 3/16	2 31/64	21/64	19/32	9/32	2 5/16	31/32	0.8661	0.236	1/4	AS201-008
15	**ASFD202**	81	63	8.5	15	7	59	24.5	22	6	M6	AS202
9/16	**ASFD202-009**	3 3/16	2 31/64	21/64	19/32	9/32	2 5/16	31/32	0.8661	0.236	1/4	AS202-009
5/8	**ASFD202-010**											AS202-010
17	**ASFD203**	81	63	8.5	15	7	59	24.5	22	6	M6	AS203
11/16	**ASFD203-011**	3 3/16	2 31/64	21/64	19/32	9/32	2 5/16	31/32	0.8661	0.236	1/4	AS203-011
20	**ASFD204**	90	71	9.5	17	10	67	27.5	25	7	M8	AS204
3/4	**ASFD204-012**	3 35/64	2 51/64	3/8	21/32	25/64	2 5/8	1 5/64	0.9843	0.276	5/16	AS204-012
25	**ASFD205**	95	76	9.5	17	10	71	29	27	7.5	M8	AS205
13/16	**ASFD205-013**	3 3/4	2 63/64	3/8	21/32	25/64	2 25/32	1 9/64	1.0630	0.295	5/16	AS205-013
7/8	**ASFD205-014**											AS205-014
15/16	**ASFD205-015**											AS205-015
1	**ASFD205-100**											AS205-100
30	**ASFD206**	113	90	12	21	12	84	33	29	8	M10	AS206
1 1/16	**ASFD206-101**	4 7/16	3 35/64	15/32	13/16	15/32	3 5/16	1 19/64	1.1417	0.315	3/8	AS206-101
1 1/8	**ASFD206-102**											AS206-102
1 3/16	**ASFD206-103**											AS206-103
1 1/4	**ASFD206-104**											AS206-104
35	**ASFD207**	125	100	12.5	22	12	94	38	34	8.5	M10	AS207
1 1/4	**ASFD207-104**	4 29/32	3 15/16	31/64	7/8	15/32	3 11/16	1 1/2	1.3386	0.335	3/8	AS207-104
1 5/16	**ASFD207-105**											AS207-105
1 3/8	**ASFD207-106**											AS207-106
1 7/16	**ASFD207-107**											AS207-107

Remarks: 1) If relubricatable type is needed, please order with suffix "A-" "D1". ex. A-ASFD201D1

Housing 1) number	Mass of unit kg lb
FD201	0.3
FD201	0.7
FD201	0.3
FD201	0.7
FD201	
FD201	0.3
FD201	0.7
FD204	0.4
FD204	0.9
FD205	0.5
FD205	1.1
FD205	
FD205	
FD205	
FD206	0.8
FD206	1.8
FD206	
FD206	
FD206	
FD207	0.9
FD207	2.0
FD207	
FD207	
FD207	

Flanged units pressed steel housing
Set screw type



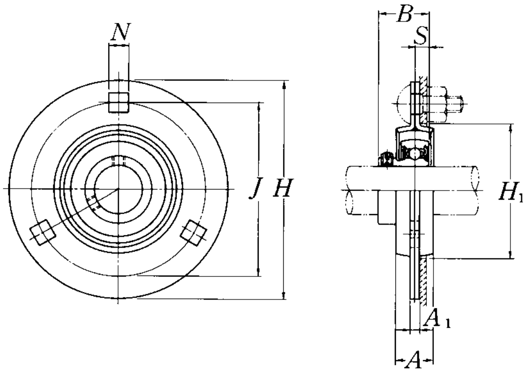
Shaft dia.	Unit number	Nominal dimensions								Bolt size	Max. load recommended		Bearing number
mm inch		mm inch								mm inch	N lbf		
		H	J	A_1	N 1)	A	B	S	H_1 min.		radial	axial	
12 1/2	ASPF201 ASPF201-008	81 3 3/16	63.5 2 1/2	4 0.157	7.1 9/32	14 9/16	22 0.8661	6 0.236	49 1 59/64	M6 1/4	2 700 600	1 350 300	AS201 AS201-008
15 9/16 5/8	ASPF202 ASPF202-009 ASPF202-010	81 3 3/16	63.5 2 1/2	4 0.157	7.1 9/32	14 9/16	22 0.8661	6 0.236	49 1 59/64	M6 1/4	2 700 600	1 350 300	AS202 AS202-009 AS202-010
17 11/16	ASPF203 ASPF203-011	81 3 3/16	63.5 2 1/2	4 0.157	7.1 9/32	14 9/16	22 0.8661	6 0.236	49 1 59/64	M6 1/4	2 700 600	1 350 300	AS203 AS203-011
20 3/4	ASPF204 ASPF204-012	90 3 35/64	71.5 2 13/16	4 0.157	9 23/64	16 5/8	25 0.9843	7 0.276	56 2 13/64	M8 5/16	3 000 660	1 500 330	AS204 AS204-012
25 13/16 7/8 15/16 1	ASPF205 ASPF205-013 ASPF205-014 ASPF205-015 ASPF205-100	95 3 3/4	76 2 63/64	4 0.157	9 23/64	18 23/32	27 1.0630	7.5 0.295	60 2 23/64	M8 5/16	4 000 880	2 000 440	AS205 AS205-013 AS205-014 AS205-015 AS205-100
30 1 1/16 1 1/8 1 3/16 1 1/4	ASPF206 ASPF206-101 ASPF206-102 ASPF206-103 ASPF206-104	113 4 7/16	90.5 3 9/16	5.2 0.205	11 7/16	18 23/32	29 1.1417	8 0.315	71 2 51/64	M10 3/8	5 000 1 100	2 500 550	AS206 AS206-101 AS206-102 AS206-103 AS206-104
35 1 1/4 1 5/16 1 3/8 1 7/16	ASPF207 ASPF207-104 ASPF207-105 ASPF207-106 ASPF207-107	122 4 13/16	100 3 15/16	5.2 0.205	11 7/16	20 25/32	34 1.3386	8.5 0.335	81 3 3/16	M10 3/8	6 000 1 300	3 000 650	AS207 AS207-104 AS207-105 AS207-106 AS207-107
40 1 1/2 1 9/16	ASPF208 ASPF208-108 ASPF208-109	148 5 13/16	119 4 11/16	6.8 0.268	13.5 17/32	21 13/16	38 1.4961	9 0.354	91 3 37/64	M12 1/2	7 000 1 500	3 500 750	AS208 AS208-108 AS208-109

Remarks: 1) ASPF208 has four bolt holes.

Housing number	Mass of unit kg lb
PF203	0.2
PF203	0.4
PF203	0.2
PF203	0.4
PF203	
PF203	0.2
PF203	0.4
PF204	0.3
PF204	0.7
PF205	0.3
PF205	0.7
PF205	
PF205	
PF205	
PF206	0.5
PF206	1.1
PF206	
PF206	
PF206	
PF207	0.7
PF207	1.5
PF207	
PF207	
PF207	
PF208	1.1
PF208	2.4
PF208	

ASRPF2

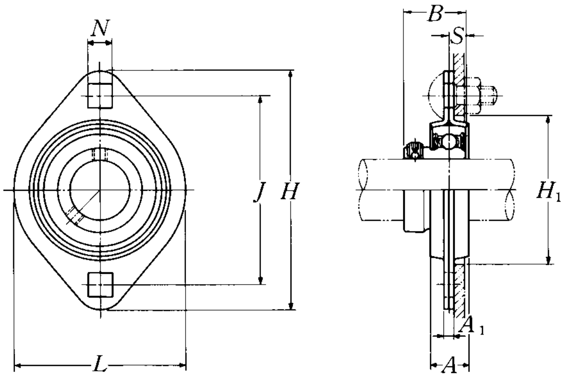
Flanged units pressed steel housing with rubber ring
Set screw type



Shaft dia. mm / inch	Unit number	Nominal dimensions mm / inch: H	J	A_1	N	A	B	S	H_1 min.	Bolt size mm / inch	Max. load recommended N / lbf: radial	axial	Bearing number
12	**ASRPF201**	90	71.5	4	9	16	22	6	56	M 8	1 000	200	AS201
1/2	**ASRPF201-008**	3 17/32	2 13/16	0.157	2 3/64	5/8	0.8661	0.236	2 13/64	5/16	220	40	AS201-008
15	**ASRPF202**	90	71.5	4	9	16	22	6	56	M 8	1 000	200	AS202
9/16	**ASRPF202-009**	3 17/32	2 13/16	0.157	23/64	5/8	0.8661	0.236	2 13/64	5/16	220	40	AS202-009
5/8	**ASRPF202-010**												AS202-010
17	**ASRPF203**	90	71.5	4	9	16	22	6	56	M 8	1 000	200	AS203
11/16	**ASRPF203-011**	3 17/32	2 13/16	0.157	23/64	5/8	0.8661	0.236	2 13/64	5/16	220	40	AS203-011
20	**ASRPF204**	95	76	4	9	18	25	7	60	M 8	1 150	200	AS204
3/4	**ASRPF204-012**	3 3/4	2 63/64	0.157	23/64	23/32	0.9843	0.276	2 23/64	5/16	250	40	AS204-012
25	**ASRPF205**	113	90.5	5.2	11	18	27	7.5	71	M10	1 300	200	AS205
13/16	**ASRPF205-013**	4 7/16	3 9/16	0.205	7/16	23/32	1.0630	0.295	2 51/64	3/8	280	40	AS205-013
7/8	**ASRPF205-014**												AS205-014
15/16	**ASRPF205-015**												AS205-015
1	**ASRPF205-100**												AS205-100
30	**ASRPF206**	122	100	5.2	11	20	29	8	81	M10	1 500	200	AS206
1 1/16	**ASRPF206-101**	4 13/16	3 15/16	0.205	7/16	25/32	1.1417	0.315	3 3/16	3/8	330	40	AS206-101
1 1/8	**ASRPF206-102**												AS206-102
1 3/16	**ASRPF206-103**												AS206-103
1 1/4	**ASRPF206-104**												AS206-104

Housing number	Mass of unit kg lb
PF204	0.3
PF204	0.7
PF204	0.3
PF204	0.7
PF204	
PF204	0.3
PF204	0.7
PF205	0.4
PF205	0.9
PF206	0.4
PF206	0.9
PF206	
PF206	
PF206	
PF207	0.6
PF207	1.3
PF207	
PF207	
PF207	

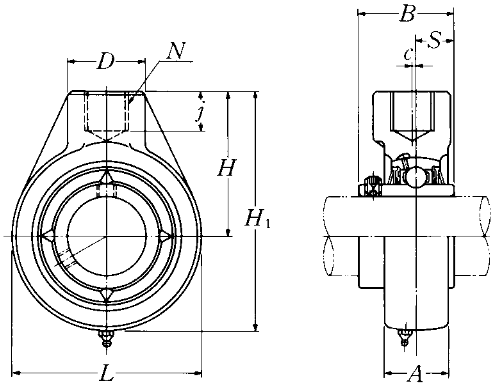
Flanged units pressed steel housing
Set screw type



Shaft dia.	Unit number	Nominal dimensions									Bolt size	Max. load recommended		Bearing number
mm inch		H	J	A_1	N	A	L	B	S	H_1 min.	mm inch	N lbf radial	axial	
12	ASPFL201	81	63.5	4	7.1	14	59	22	6	49	M 6	2 700	1 350	AS201
$\frac{1}{2}$	ASPFL201-008	$3\frac{3}{16}$	$2\frac{1}{2}$	0.157	$\frac{9}{32}$	$\frac{9}{16}$	$2\frac{5}{16}$	0.8661	0.236	$1\frac{59}{64}$	$\frac{1}{4}$	600	300	AS201-008
15	ASPFL202	81	63.5	4	7.1	14	59	22	6	49	M 6	2 700	1 350	AS202
$\frac{9}{16}$	ASPFL202-009	$3\frac{3}{16}$	$2\frac{1}{2}$	0.157	$\frac{9}{32}$	$\frac{9}{16}$	$2\frac{5}{16}$	0.8661	0.236	$1\frac{59}{64}$	$\frac{1}{4}$	600	300	AS202-009
$\frac{5}{8}$	ASPFL202-010													AS202-010
17	ASPFL203	81	63.5	4	7.1	14	59	22	6	49	M 6	2 700	1 350	AS203
$\frac{11}{16}$	ASPFL203-011	$3\frac{3}{16}$	$2\frac{1}{2}$	0.157	$\frac{9}{32}$	$\frac{9}{16}$	$2\frac{5}{16}$	0.8661	0.236	$1\frac{59}{64}$	$\frac{1}{4}$	600	300	AS203-011
20	ASPFL204	90	71.5	4	9	16	67	25	7	56	M 8	3 000	1 500	AS204
$\frac{3}{4}$	ASPFL204-012	$3\frac{17}{32}$	$2\frac{13}{16}$	0.157	$\frac{23}{64}$	$\frac{5}{8}$	$2\frac{5}{8}$	0.9843	0.276	$2\frac{13}{64}$	$\frac{5}{16}$	660	330	AS204-012
25	ASPFL205	95	76	4	9	18	71	27	7.5	60	M 8	4 000	2 000	AS205
$\frac{13}{16}$	ASPFL205-013	$3\frac{3}{4}$	$2\frac{63}{64}$	0.157	$\frac{23}{64}$	$\frac{23}{32}$	$2\frac{25}{32}$	1.0630	0.295	$2\frac{23}{64}$	$\frac{5}{16}$	880	440	AS205-013
$\frac{7}{8}$	ASPFL205-014													AS205-014
$\frac{15}{16}$	ASPFL205-015													AS205-015
1	ASPFL205-100													AS205-100
30	ASPFL206	113	90.5	5.2	11	18	84	29	8	71	M10	5 000	2 500	AS206
$1\frac{1}{16}$	ASPFL206-101	$4\frac{7}{16}$	$3\frac{9}{16}$	0.205	$\frac{7}{16}$	$\frac{23}{32}$	$3\frac{5}{16}$	1.1417	0.315	$2\frac{51}{64}$	$\frac{3}{8}$	1 100	550	AS206-101
$1\frac{1}{8}$	ASPFL206-102													AS206-102
$1\frac{3}{16}$	ASPFL206-103													AS206-103
$1\frac{1}{4}$	ASPFL206-104													AS206-104
35	ASPFL207	122	100	5.2	11	20	94	34	8.5	81	M10	6 000	3 000	AS207
$1\frac{1}{4}$	ASPFL207-104	$4\frac{13}{16}$	$3\frac{15}{16}$	0.205	$\frac{7}{16}$	$\frac{25}{32}$	$3\frac{11}{16}$	1.3386	0.335	$3\frac{3}{16}$	$\frac{3}{8}$	1 300	650	AS207-104
$1\frac{5}{16}$	ASPFL207-105													AS207-105
$1\frac{3}{8}$	ASPFL207-106													AS207-106
$1\frac{7}{16}$	ASPFL207-107													AS207-107
40	ASPFL208	148	119	6.8	13.5	21	100	38	9	91	M12	7 000	3 500	AS208
$1\frac{1}{2}$	ASPFL208-108	$5\frac{53}{64}$	$4\frac{11}{16}$	0.268	$\frac{17}{32}$	$\frac{53}{64}$	$3\frac{15}{16}$	1.4961	0.354	$3\frac{37}{64}$	$\frac{1}{2}$	1 500	750	AS208-108
$1\frac{9}{16}$	ASPFL208-109													AS208-109

Housing number	Mass of unit kg lb
PFL203	0.1
PFL203	0.2
PFL203	0.1
PFL203	0.2
PFL203	
PFL203	0.1
PFL203	0.2
PFL204	0.2
PFL204	0.4
PFL205	0.3
PFL205	0.7
PFL205	
PFL205	
PFL205	
PFL206	0.4
PFL206	0.9
PFL206	
PFL206	
PFL206	
PFL207	0.5
PFL207	1.1
PFL207	
PFL207	
PFL207	
PFL208	0.8
PFL208	1.4
PFL208	

Hanger units cast housing
Set screw type



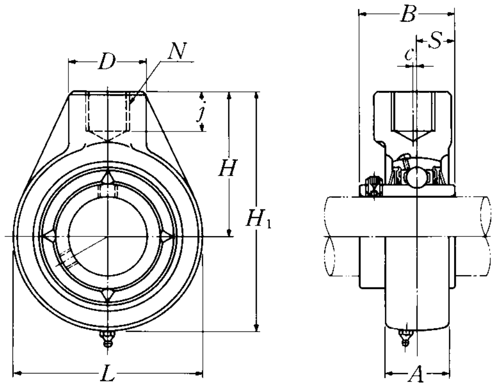
Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch										Bearing number
		L	H1	c	A	H	N	D	j	B	S	
12	UCHB201D1	64	96	0	21	64	Rp3/4	40	19	31	12.7	UC201D1
1/2	UCHB201-008D1	2 17/32	3 25/32	0	13/16	2 33/64	Rp3/4	1 9/16	3/4	1.2205	0.500	UC201-008D1
15	UCHB202D1	64	96	0	21	64	Rp3/4	40	19	31	12.7	UC202D1
9/16	UCHB202-009D1	2 17/32	3 25/32	0	13/16	2 33/64	Rp3/4	1 9/16	3/4	1.2205	0.500	UC202-009D1
5/8	UCHB202-010D1											UC202-010D1
17	UCHB203D1	64	96	0	21	64	Rp3/4	40	19	31	12.7	UC203D1
11/16	UCHB203-011D1	2 17/32	3 25/32	0	13/16	2 33/64	Rp3/4	1 9/16	3/4	1.2205	0.500	UC203-011D1
20	UCHB204D1	64	96	0	21	64	Rp3/4	40	19	31	12.7	UC204D1
3/4	UCHB204-012D1	2 17/32	3 25/32	0	13/16	2 33/64	Rp3/4	1 9/16	3/4	1.2205	0.500	UC204-012D1
25	UCHB205D1	78	103	0	24	64	Rp3/4	40	19	34.1	14.3	UC205D1
13/16	UCHB205-013D1	3 1/16	4 1/16	0	15/16	2 33/64	Rp3/4	1 9/16	3/4	1.3425	0.563	UC205-013D1
7/8	UCHB205-014D1											UC205-014D1
15/16	UCHB205-015D1											UC205-015D1
1	UCHB205-100D1											UC205-100D1
30	UCHB206D1	78	103	0	28	64	Rp3/4	40	19	38.1	15.9	UC206D1
1 1/16	UCHB206-101D1	3 1/16	4 1/16	0	1 3/32	2 33/64	Rp3/4	1 9/16	3/4	1.5000	0.626	UC206-101D1
1 1/8	UCHB206-102D1											UC206-102D1
1 3/16	UCHB206-103D1											UC206-103D1
1 1/4	UCHB206-104D1											UC206-104D1
35	UCHB207D1	92	116	0	30	70	Rp3/4	40	19	42.9	17.5	UC207D1
1 1/4	UCHB207-104D1	3 5/8	4 9/16	0	1 3/16	2 3/4	Rp3/4	1 9/16	3/4	1.6890	0.689	UC207-104D1
1 5/16	UCHB207-105D1											UC207-105D1
1 3/8	UCHB207-106D1											UC207-106D1
1 7/16	UCHB207-107D1											UC207-107D1
40	UCHB208D1	96	121	2	33	73	Rp3/4	40	19	49.2	19	UC208D1
1 1/2	UCHB208-108D1	3 25/32	4 3/4	3/32	1 5/16	2 7/8	Rp3/4	1 9/16	3/4	1.9370	0.748	UC208-108D1
1 9/16	UCHB208-109D1											UC208-109D1
45	UCHB209D1	108	136	5	35	82	Rp1	48	21	49.2	19	UC209D1
1 5/8	UCHB209-110D1	4 1/4	5 11/32	3/16	1 3/8	3 15/64	Rp1	1 7/8	13/16	1.9370	0.748	UC209-110D1
1 11/16	UCHB209-111D1											UC209-111D1
1 3/4	UCHB209-112D1											UC209-112D1

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg	lb
HB204D1	0.7	
HB204D1		1.5
HB204D1	0.7	
HB204D1		1.5
HB204D1		
HB204D1	0.7	
HB204D1		1.5
HB204D1	0.7	
HB204D1		1.5
HB205D1	1.0	
HB205D1		2.2
HB205D1		
HB205D1		
HB205D1		
HB206D1	1.0	
HB206D1		2.2
HB206D1		
HB206D1		
HB206D1		
HB207D1	1.4	
HB207D1		3.1
HB207D1		
HB207D1		
HB207D1		
HB208D1	1.5	
HB208D1		3.3
HB208D1		
HB209D1	2.1	
HB209D1		4.6
HB209D1		
HB209D1		

Nominal Designation of Thread	Nominal dimensions mm		
	Major Diameter of Internal Thread	Pitch Diameter	Minor Diameter of Internal Thread
Rp¾ (PS¾)	26.441	25.279	24.117
Rp1(PS1)	33.249	31.770	30.291
Rp1¼ (PS1¼)	41.910	40.431	38.952
Rp1½ (PS1½)	47.803	46.324	44.845

Hanger units cast housing
Set screw type



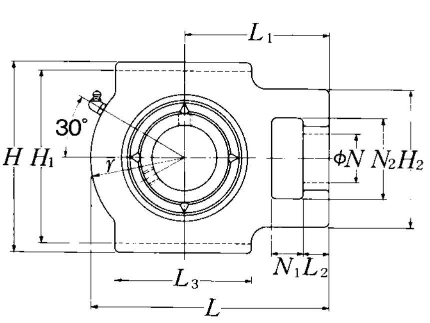
Shaft dia. mm inch	Unit number [1]	Nominal dimensions mm inch										Bearing number
		L	H_1	c	A	H	N	D	j	B	S	
50	UCHB210D1	118	142	5	37	83	Rp1	48	21	51.6	19	UC210D1
1 13/16	UCHB210-113D1	4 21/32	5 19/32	3/16	1 15/32	3 17/64	Rp1	1 7/8	13/16	2.0315	0.748	UC210-113D1
1 7/8	UCHB210-114D1											UC210-114D1
1 15/16	UCHB210-115D1											UC210-115D1
2	UCHB210-200D1											UC210-200D1
55	UCHB211D1	126	158	7	38	95	Rp1 1/4	60	25	55.6	22.2	UC211D1
2	UCHB211-200D1	4 31/32	6 7/32	9/32	1 1/2	3 47/64	Rp1 1/4	2 3/8	31/32	2.1890	0.874	UC211-200D1
2 1/16	UCHB211-201D1											UC211-201D1
2 1/8	UCHB211-202D1											UC211-202D1
2 3/16	UCHB211-203D1											UC211-203D1
60	UCHB212D1	142	173	9	42	102	Rp1 1/4	60	28	65.1	25.4	UC212D1
2 1/4	UCHB212-204D1	5 19/32	6 13/16	11/32	1 21/32	4 1/64	Rp1 1/4	2 3/8	1 3/32	2.5630	1.000	UC212-204D1
2 5/16	UCHB212-205D1											UC212-205D1
2 3/8	UCHB212-206D1											UC212-206D1
2 7/16	UCHB212-207D1											UC212-207D1
65	UCHB213D1	166	200	9.5	44	117	Rp1 1/2	70	32	65.1	25.4	UC213D1
2 1/2	UCHB213-208D1	6 17/32	7 7/8	3/8	1 23/32	4 39/64	Rp1 1/2	2 3/4	1 1/4	2.5630	1.000	UC213-208D1

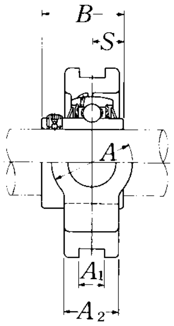
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

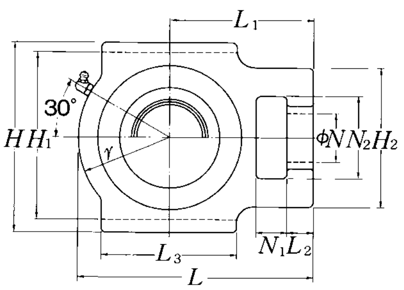
Housing number	Mass of unit kg lb
HB210D1	2.6
HB210D1	5.7
HB210D1	
HB210D1	
HB210D1	
HB211D1	2.9
HB211D1	6.4
HB211D1	
HB211D1	
HB211D1	
HB212D1	4.4
HB212D1	9.7
HB212D1	
HB212D1	
HB212D1	
HB213D1	6.6
HB213D1	15

Nominal Designation of Thread	**Nominal dimensions** mm		
	Major Diameter of Internal Thread	Pitch Diameter	Minor Diameter of Internal Thread
Rp¾ (PS¾)	26.441	25.279	24.117
Rp1(PS1)	33.249	31.770	30.291
Rp1¼ (PS1¼)	41.910	40.431	38.952
Rp1½ (PS1½)	47.803	46.324	44.845

Take-up units cast housing
Set screw type



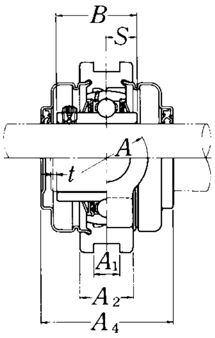


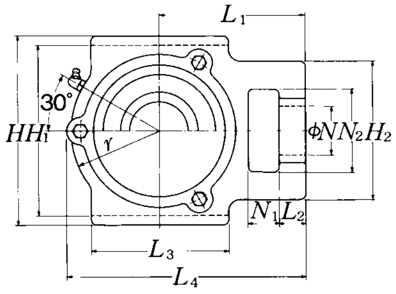


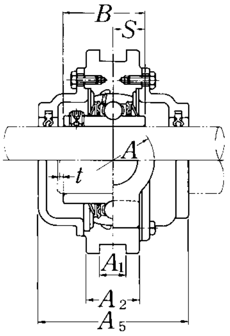
Pressed steel dust cover type
Open end: **S-UCT···D1**
Closed end: **SM-UCT···D1**

Shaft dia. mm / inch	Unit number 1)	Nominal dimensions mm / inch															
		N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B	S
12	UCT201D1	16	12	51	32	19	51	12	76	89	94	21	32	33	61	31	12.7
1/2	UCT201-008D1	5/8	15/32	2	1 1/4	3/4	2	0.472	2 63/64	3 1/2	3 11/16	13/16	1 1/4	1 5/16	2 13/32	1.2205	0.500
15	UCT202D1	16	12	51	32	19	51	12	76	89	94	21	32	33	61	31	12.7
9/16	UCT202-009D1	5/8	15/32	2	1 1/4	3/4	2	0.472	2 63/64	3 1/2	3 11/16	13/16	1 1/4	1 5/16	2 13/32	1.2205	0.500
5/8	UCT202-010D1																
17	UCT203D1	16	12	51	32	19	51	12	76	89	94	21	32	33	61	31	12.7
11/16	UCT203-011D1	5/8	15/32	2	1 1/4	3/4	2	0.472	2 63/64	3 1/2	3 11/16	13/16	1 1/4	1 5/16	2 13/32	1.2205	0.500
20	UCT204D1	16	12	51	32	19	51	12	76	89	94	21	32	33	61	31	12.7
3/4	UCT204-012D1	5/8	15/32	2	1 1/4	3/4	2	0.472	2 63/64	3 1/2	3 11/16	13/16	1 1/4	1 5/16	2 13/32	1.2205	0.500
25	UCT205D1	16	12	51	32	19	51	12	76	89	97	24	32	35	62	34.1	14.3
13/16	UCT205-013D1	5/8	15/32	2	1 1/4	3/4	2	0.472	2 63/64	3 1/2	3 13/16	15/16	1 1/4	1 3/8	2 7/16	1.3425	0.563
7/8	UCT205-014D1																
15/16	UCT205-015D1																
1	UCT205-100D1																
30	UCT206D1	16	12	56	37	22	57	12	89	102	113	28	37	43	70	38.1	15.9
1 1/16	UCT206-101D1	5/8	15/32	2 7/32	1 15/32	7/8	2 1/4	0.472	3 1/2	4 1/32	4 7/16	1 3/32	1 15/32	1 11/16	2 3/4	1.5000	0.626
1 1/8	UCT206-102D1																
1 3/16	UCT206-103D1																
1 1/4	UCT206-104D1																
35	UCT207D1	16	15	64	37	22	64	12	89	102	129	30	37	51	78	42.9	17.5
1 1/4	UCT207-104D1	5/8	19/32	2 17/32	1 15/32	7/8	2 17/32	0.472	3 1/2	4 1/32	5 3/32	1 3/16	1 15/32	2	3 1/16	1.6890	0.689
1 5/16	UCT207-105D1																
1 3/8	UCT207-106D1																
1 7/16	UCT207-107D1																
40	UCT208D1	19	18	83	49	29	83	16	102	114	144	33	49	56	88	49.2	19
1 1/2	UCT208-108D1	3/4	23/32	3 9/32	1 15/16	1 5/32	3 9/32	0.630	4 1/64	4 1/2	5 21/32	1 5/16	1 15/16	2 7/32	3 15/32	1.9370	0.748
1 9/16	UCT208-109D1																
45	UCT209D1	19	18	83	49	29	83	16	102	117	145	35	49	57	88	49.2	19
1 5/8	UCT209-110D1	3/4	23/32	3 9/32	1 15/16	1 5/32	3 9/32	0.630	4 1/64	4 19/32	5 23/32	1 3/8	1 15/16	2 1/4	3 15/32	1.9370	0.748
1 11/16	UCT209-111D1																
1 3/4	UCT209-112D1																

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



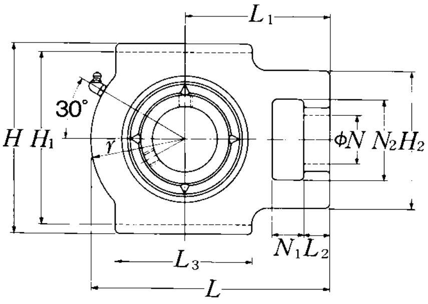


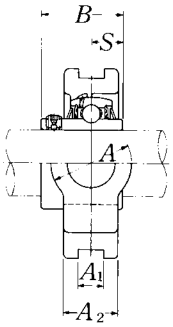


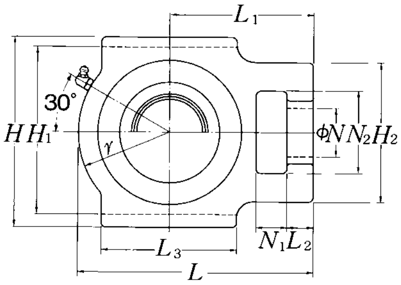
Cast dust cover type
Open end: **C-UCT···D1**
Closed end: **CM-UCT···D1**

Bearing number	Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions				Mass of unit		
					mm		inch	kg		lb
				t max.	A_4	L_4	A_5	UCT	S(SM)	C(CM)
UC201D1	T204D1	**S(SM)-UCT201D1**	**C(CM)-UCT201D1**	2	51	97	62	0.8	0.8	1.3
UC201-008D1	T204D1	**S(SM)-UCT201-008D1**	**C(CM)-UCT201-008D1**	$\frac{5}{64}$	2	$3\frac{13}{16}$	$2\frac{7}{16}$	1.8	1.8	2.9
UC202D1	T204D1	**S(SM)-UCT202D1**	**C(CM)-UCT202D1**	2	51	97	62	0.8	0.8	1.3
UC202-009D1	T204D1	**S(SM)-UCT202-009D1**	**C(CM)-UCT202-009D1**	$\frac{5}{64}$	2	$3\frac{13}{16}$	$2\frac{7}{16}$	1.8	1.8	2.9
UC202-010D1	T204D1	**S(SM)-UCT202-010D1**	**C(CM)-UCT202-010D1**							
UC203D1	T204D1	**S(SM)-UCT203D1**	**C(CM)-UCT203D1**	2	51	97	62	0.8	0.8	1.3
UC203-011D1	T204D1	**S(SM)-UCT203-011D1**	**C(CM)-UCT203-011D1**	$\frac{5}{64}$	2	$3\frac{13}{16}$	$2\frac{7}{16}$	1.8	1.8	2.9
UC204D1	T204D1	**S(SM)-UCT204D1**	**C(CM)-UCT204D1**	2	51	97	62	0.8	0.8	1.3
UC204-012D1	T204D1	**S(SM)-UCT204-012D1**	**C(CM)-UCT204-012D1**	$\frac{5}{64}$	2	$3\frac{13}{16}$	$2\frac{7}{16}$	1.8	1.8	2.9
UC205D1	T205D1	**S(SM)-UCT205D1**	**C(CM)-UCT205D1**	2	57	100.5	70	0.9	0.9	1.6
UC205-013D1	T205D1	**S(SM)-UCT205-013D1**	**C(CM)-UCT205-013D1**	$\frac{5}{64}$	$2\frac{1}{4}$	$3\frac{31}{32}$	$2\frac{3}{4}$	2.0	2.0	3.5
UC205-014D1	T205D1	**S(SM)-UCT205-014D1**	**C(CM)-UCT205-014D1**							
UC205-015D1	T205D1	**S(SM)-UCT205-015D1**	**C(CM)-UCT205-015D1**							
UC205-100D1	T205D1	**S(SM)-UCT205-100D1**	**C(CM)-UCT205-100D1**							
UC206D1	T206D1	**S(SM)-UCT206D1**	**C(CM)-UCT206D1**	2	62	113.5	75	1.3	1.4	1.9
UC206-101D1	T206D1	**S(SM)-UCT206-101D1**	**C(CM)-UCT206-101D1**	$\frac{5}{64}$	$2\frac{7}{16}$	$4\frac{15}{32}$	$2\frac{15}{16}$	2.9	3.1	4.2
UC206-102D1	T206D1	**S(SM)-UCT206-102D1**	**C(CM)-UCT206-102D1**							
UC206-103D1	T206D1	**S(SM)-UCT206-103D1**	**C(CM)-UCT206-103D1**							
UC206-104D1	T206D1	—	—							
UC207D1	T207D1	**S(SM)-UCT207D1**	**C(CM)-UCT207D1**	3	72	129	80	1.7	1.7	2.7
UC207-104D1	T207D1	**S(SM)-UCT207-104D1**	**C(CM)-UCT207-104D1**	$\frac{1}{8}$	$2\frac{27}{32}$	$5\frac{3}{32}$	$3\frac{5}{32}$	3.7	3.7	6.0
UC207-105D1	T207D1	**S(SM)-UCT207-105D1**	**C(CM)-UCT207-105D1**							
UC207-106D1	T207D1	**S(SM)-UCT207-106D1**	**C(CM)-UCT207-106D1**							
UC207-107D1	T207D1	—	—							
UC208D1	T208D1	**S(SM)-UCT208D1**	**C(CM)-UCT208D1**	3	82	144	90	2.3	2.3	3.7
UC208-108D1	T208D1	**S(SM)-UCT208-108D1**	**C(CM)-UCT208-108D1**	$\frac{1}{8}$	$3\frac{7}{32}$	$5\frac{21}{32}$	$3\frac{17}{32}$	5.1	5.1	8.2
UC208-109D1	T208D1	**S(SM)-UCT208-109D1**	**C(CM)-UCT208-109D1**							
UC209D1	T209D1	**S(SM)-UCT209D1**	**C(CM)-UCT209D1**	3	82	145.5	95	2.4	2.5	4.1
UC209-110D1	T209D1	**S(SM)-UCT209-110D1**	**C(CM)-UCT209-110D1**	$\frac{1}{8}$	$3\frac{7}{32}$	$5\frac{23}{32}$	$3\frac{3}{4}$	5.3	5.5	9.0
UC209-111D1	T209D1	**S(SM)-UCT209-111D1**	**C(CM)-UCT209-111D1**							
UC209-112D1	T209D1	**S(SM)-UCT209-112D1**	**C(CM)-UCT209-112D1**							

Take-up units cast housing
Set screw type



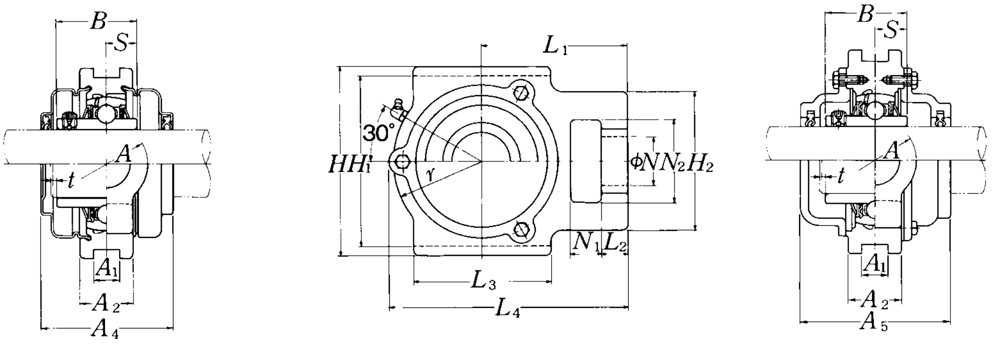




Pressed steel dust cover type
Open end: **S-UCT···D1**
Closed end: **SM-UCT···D1**

Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch															
		N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B	S
50	UCT210D1	19	18	83	49	29	86	16	102	117	151	37	49	59	92	51.6	19
1 13/16	UCT210-113D1																
1 7/8	UCT210-114D1	3/4	23/32	3 9/32	1 15/16	1 5/32	3 3/8	0.630	4 1/64	4 19/32	5 15/16	1 15/32	1 15/16	2 5/16	3 5/8	2.0315	0.748
1 15/16	UCT210-115D1																
2	UCT210-200D1																
55	UCT211D1	25	21	102	64	35	95	22	130	146	171	38	64	65	106	55.6	22.2
2	UCT211-200D1																
2 1/16	UCT211-201D1	31/32	13/16	4 1/32	2 17/32	1 3/8	3 3/4	0.866	5 1/8	5 3/4	6 23/32	1 1/2	2 17/32	2 9/16	4 3/16	2.1890	0.874
2 1/8	UCT211-202D1																
2 3/16	UCT211-203D1																
60	UCT212D1	32	21	102	64	35	102	22	130	146	194	42	64	75	119	65.1	25.4
2 1/4	UCT212-204D1																
2 5/16	UCT212-205D1	1 1/4	13/16	4 1/32	2 17/32	1 3/8	4 1/32	0.866	5 1/8	5 3/4	7 5/8	1 21/32	2 17/32	2 15/16	4 11/16	2.5630	1.000
2 3/8	UCT212-206D1																
2 7/16	UCT212-207D1																
65	UCT213D1	32	23	111	70	41	121	26	151	167	224	44	70	87	137	65.1	25.4
2 1/2	UCT213-208D1	1 1/4	29/32	4 3/8	2 3/4	1 5/8	4 3/4	1.024	5 15/16	6 9/16	8 13/16	1 23/32	2 3/4	3 7/16	5 13/32	2.5630	1.000
2 9/16	UCT213-209D1																
70	UCT214D1	32	23	111	70	41	121	26	151	167	224	46	70	87	137	74.6	30.2
2 5/8	UCT214-210D1																
2 11/16	UCT214-211D1	1 1/4	29/32	4 3/8	2 3/4	1 5/8	4 3/4	1.024	5 15/16	6 9/16	8 13/16	1 13/16	2 3/4	3 7/16	5 13/32	2.9370	1.189
2 3/4	UCT214-212D1																
75	UCT215D1	32	23	111	70	41	121	26	151	167	232	48	70	92	140	77.8	33.3
2 13/16	UCT215-213D1																
2 7/8	UCT215-214D1	1 1/4	29/32	4 3/8	2 3/4	1 5/8	4 3/4	1.024	5 15/16	6 9/16	9 1/8	1 7/8	2 3/4	3 5/8	5 1/2	3.0630	1.311
2 15/16	UCT215-215D1																
3	UCT215-300D1																
80	UCT216D1	32	23	111	70	41	121	26	165	184	235	51	70	95	140	82.6	33.3
3 1/16	UCT216-301D1																
3 1/8	UCT216-302D1	1 1/4	29/32	4 3/8	2 3/4	1 5/8	4 3/4	1.024	6 1/2	7 1/4	9 1/4	2	2 3/4	3 3/4	5 1/2	3.2520	1.311
3 3/16	UCT216-303D1																

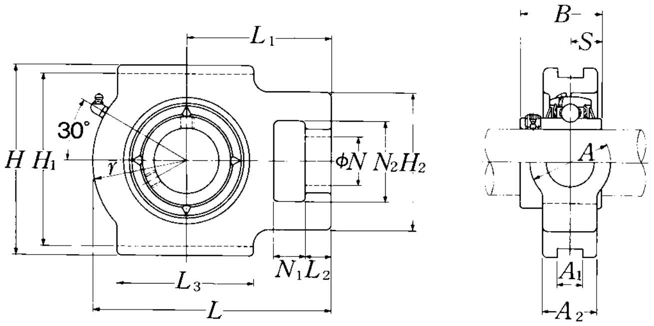
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

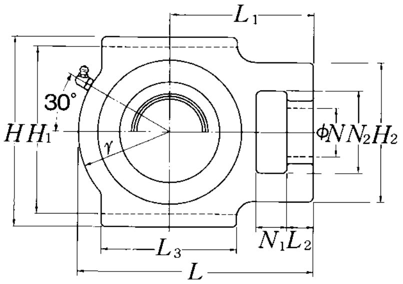


Cast dust cover type
Open end: **C-UCT···D1**
Closed end: **CM-UCT···D1**

Bearing number	Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions				Mass of unit		
					mm		inch	kg		lb
				t max.	A_4	L_4	A_5	UCT	S(SM)	C(CM)
UC210D1	T210D1	**S(SM)-UCT210D1**	**C(CM)-UCT210D1**	3	87	152	100	2.5	2.6	4.5
UC210-113D1	T210D1	**S(SM)-UCT210-113D1**	**C(CM)-UCT210-113D1**	$\frac{1}{8}$	$3\frac{7}{16}$	$5\frac{31}{32}$	$3\frac{15}{16}$	5.5	5.7	9.9
UC210-114D1	T210D1	**S(SM)-UCT210-114D1**	**C(CM)-UCT210-114D1**							
UC210-115D1	T210D1	**S(SM)-UCT210-115D1**	**C(CM)-UCT210-115D1**							
UC210-200D1	T210D1	—	—							
UC211D1	T211D1	**S(SM)-UCT211D1**	**C(CM)-UCT211D1**	4	92	171.5	100	3.8	3.9	7.2
UC211-200D1	T211D1	**S(SM)-UCT211-200D1**	**C(CM)-UCT211-200D1**	$\frac{5}{32}$	$3\frac{5}{8}$	$6\frac{3}{4}$	$3\frac{15}{16}$	8.4	8.6	16
UC211-201D1	T211D1	**S(SM)-UCT211-201D1**	**C(CM)-UCT211-201D1**							
UC211-202D1	T211D1	**S(SM)-UCT211-202D1**	**C(CM)-UCT211-202D1**							
UC211-203D1	T211D1	**S(SM)-UCT211-203D1**	**C(CM)-UCT211-203D1**							
UC212D1	T212D1	**S(SM)-UCT212D1**	**C(CM)-UCT212D1**	4	102	194	115	4.7	4.9	7.5
UC212-204D1	T212D1	**S(SM)-UCT212-204D1**	**C(CM)-UCT212-204D1**	$\frac{5}{32}$	$4\frac{1}{32}$	$7\frac{5}{8}$	$4\frac{17}{32}$	10	11	17
UC212-205D1	T212D1	**S(SM)-UCT212-205D1**	**C(CM)-UCT212-205D1**							
UC212-206D1	T212D1	**S(SM)-UCT212-206D1**	**C(CM)-UCT212-206D1**							
UC212-207D1	T212D1	—	—							
UC213D1	T213D1	**S(SM)-UCT213D1**	**C(CM)-UCT213D1**	4	107	224	120	7.0	7.2	11
UC213-208D1	T213D1	**S(SM)-UCT213-208D1**	**C(CM)-UCT213-208D1**	$\frac{5}{32}$	$4\frac{7}{32}$	$8\frac{13}{16}$	$4\frac{23}{32}$	15	16	24
UC213-209D1	T213D1	**S(SM)-UCT213-209D1**	**C(CM)-UCT213-209D1**							
UC214D1	T214D1	—	**C(CM)-UCT214D1**	4	—	224	135	7.3	—	11
UC214-210D1	T214D1	—	**C(CM)-UCT214-210D1**	$\frac{5}{32}$	—	$8\frac{13}{16}$	$5\frac{5}{16}$	16	—	24
UC214-211D1	T214D1		**C(CM)-UCT214-211D1**							
UC214-212D1	T214D1		**C(CM)-UCT214-212D1**							
UC215D1	T215D1	—	**C(CM)-UCT215D1**	4	—	232	135	7.7	—	11
UC215-213D1	T215D1	—	**C(CM)-UCT215-213D1**	$\frac{5}{32}$	—	$9\frac{1}{8}$	$5\frac{5}{16}$	17	—	24
UC215-214D1	T215D1		**C(CM)-UCT215-214D1**							
UC215-215D1	T215D1		**C(CM)-UCT215-215D1**							
UC215-300D1	T215D1		**C(CM)-UCT215-300D1**							
UC216D1	T216D1	—	**C(CM)-UCT216D1**	4	—	235	145	8.4	—	13
UC216-301D1	T216D1	—	**C(CM)-UCT216-301D1**	$\frac{5}{32}$	—	$9\frac{1}{4}$	$5\frac{23}{32}$	19	—	29
UC216-302D1	T216D1		**C(CM)-UCT216-302D1**							
UC216-303D1	T216D1		**C(CM)-UCT216-303D1**							

Take-up units cast housing
Set screw type

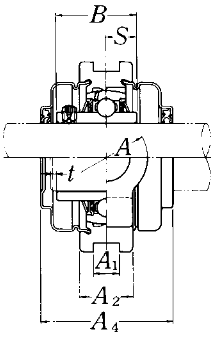


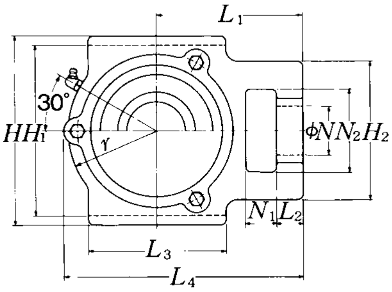


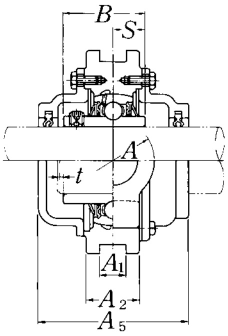
Pressed steel dust cover type
Open end: **S-UCT···D1**
Closed end: **SM-UCT···D1**

Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B	S
85	**UCT217D1**	38	31	124	73	48	157	30	173	198	260	54	73	98	162	85.7	34.1
3 1/4	**UCT217-304D1**	1 1/2	1 7/32	4 7/8	2 7/8	1 7/8	6 3/16	1.181	6 13/16	7 25/32	10 1/4	2 1/8	2 7/8	3 27/32	6 3/8	3.3740	1.343
3 5/16	**UCT217-305D1**																
3 7/16	**UCT217-307D1**																

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



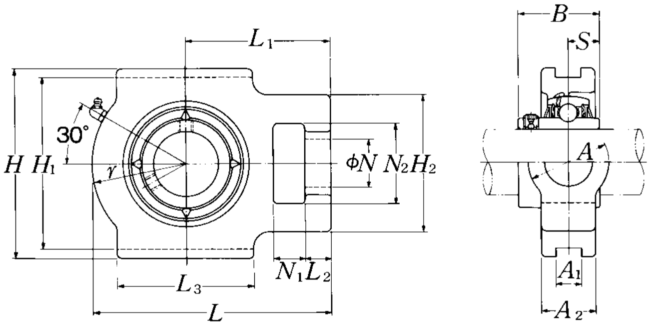




Cast dust cover type
Open end: **C-UCT···D1**
Closed end: **CM-UCT···D1**

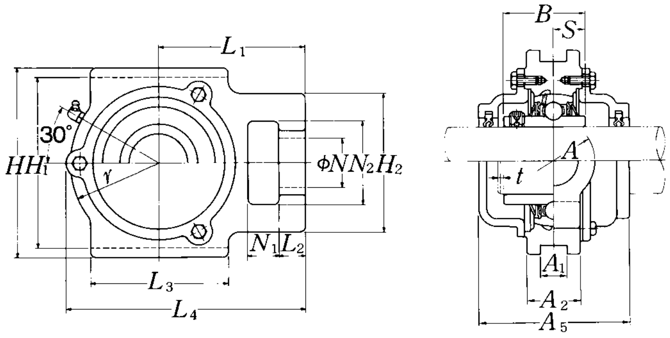
Bearing number	Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions				Mass of unit		
				mm inch				kg lb		
				t max.	A_4	L_4	A_5	UCT	S(SM)	C(CM)
UC217D1	T217D1	—	**C(CM)-UCT217D1**	5	—	260	155	11	—	16
UC217-304D1	T217D1	—	**C(CM)-UCT217-304D1**	$\frac{13}{64}$	—	$10\frac{1}{4}$	$6\frac{3}{32}$	24	—	35
UC217-305D1	T217D1		**C(CM)-UCT217-305D1**							
UC217-307D1	T217D1		**C(CM)-UCT217-307D1**							

Take-up units cast housing
Set screw type



Shaft dia.	Unit number 1)	Nominal dimensions															
mm inch		N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B	S
25	**UCT305D1**	16	14	62	36	26	65	12	80	89	122	26	36	46	76	38	15
13/16	UCT305-013D1	5/8	9/16	2 7/16	1 13/32	1 1/32	2 9/16	0.472	3 5/32	3 1/2	4 13/16	1 1/32	1 13/32	1 13/16	3	1.4961	0.591
7/8	UCT305-014D1																
15/16	UCT305-015D1																
1	UCT305-100D1																
30	**UCT306D1**	18	16	70	41	28	74	16	90	100	137	28	41	52	85	43	17
1 1/16	UCT306-101D1	23/32	5/8	2 3/4	1 5/8	1 3/32	2 29/32	0.630	3 35/64	3 15/16	5 13/32	1 3/32	1 5/8	2 1/16	3 11/32	1.6929	0.669
1 1/8	UCT306-102D1																
1 3/16	UCT306-103D1																
35	**UCT307D1**	20	17	75	45	30	80	16	100	111	150	32	45	56	94	48	19
1 1/4	UCT307-104D1	25/32	21/32	2 15/16	1 25/32	1 3/16	3 5/32	0.630	3 15/16	4 3/8	5 29/32	1 1/4	1 25/32	2 7/32	3 11/16	1.8898	0.748
1 5/16	UCT307-105D1																
1 3/8	UCT307-106D1																
1 7/16	UCT307-107D1																
40	**UCT308D1**	22	19	83	50	32	89	18	112	124	162	34	50	62	100	52	19
1 1/2	UCT308-108D1	7/8	3/4	3 9/32	1 31/32	1 1/4	3 1/2	0.709	4 13/32	4 7/8	6 3/8	1 11/32	1 31/32	2 7/16	3 15/16	2.0472	0.748
1 9/16	UCT308-109D1																
45	**UCT309D1**	24	20	90	55	34	97	18	125	138	178	38	55	68	110	57	22
1 5/8	UCT309-110D1	15/16	25/32	3 17/32	2 5/32	1 11/32	3 13/16	0.709	4 59/64	5 7/16	7	1 1/2	2 5/32	2 11/16	4 11/32	2.2441	0.866
1 11/16	UCT309-111D1																
1 3/4	UCT309-112D1																
50	**UCT310D1**	27	22	98	61	37	106	20	140	151	192	40	61	74	118	61	22
1 13/16	UCT310-113D1	1 1/16	7/8	3 27/32	2 13/32	1 15/32	4 3/16	0.787	5 33/64	5 15/16	7 9/16	1 9/16	2 13/32	2 29/32	4 21/32	2.4016	0.866
1 7/8	UCT310-114D1																
1 15/16	UCT310-115D1																
55	**UCT311D1**	29	23	105	66	39	115	22	150	163	207	44	66	80	127	66	25
2	UCT311-200D1	1 5/32	29/32	4 1/8	2 19/32	1 17/32	4 17/32	0.866	5 29/32	6 13/32	8 5/32	1 23/32	2 19/32	3 5/32	5	2.5984	0.984
2 1/16	UCT311-201D1																
2 1/8	UCT311-202D1																
2 3/16	UCT311-203D1																

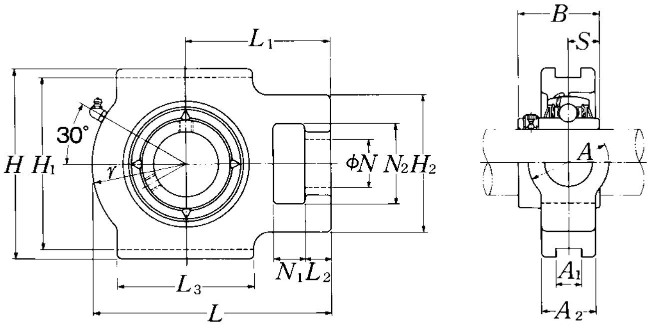
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UCT···D1**
Closed end: **CM-UCT···D1**

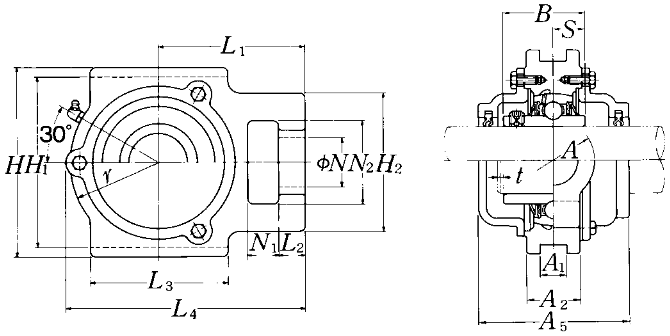
Bearing number	Housing number	Unit number cast dust cover type	Nominal dimensions mm inch			Mass of unit kg lb	
			t max.	L_4	A_5	UCT	C(CM)
UC305D1	T305D1	**C(CM)-UCT305D1**	2	122	80	1.4	2.2
UC305-013D1	T305D1	**C(CM)-UCT305-013D1**	5/64	4 13/16	3 5/32	3.1	4.9
UC305-014D1	T305D1	**C(CM)-UCT305-014D1**					
UC305-015D1	T305D1	**C(CM)-UCT305-015D1**					
UC305-100D1	T305D1	**C(CM)-UCT305-100D1**					
UC306D1	T306D1	**C(CM)-UCT306D1**	2	139	85	1.8	2.9
UC306-101D1	T306D1	**C(CM)-UCT306-101D1**	5/64	5 31/32	3 11/32	4.0	6.4
UC306-102D1	T306D1	**C(CM)-UCT306-102D1**					
UC306-103D1	T306D1	**C(CM)-UCT306-103D1**					
UC307D1	T307D1	**C(CM)-UCT307D1**	3	152	95	2.4	3.7
UC307-104D1	T307D1	**C(CM)-UCT307-104D1**	1/8	5 31/32	3 3/4	5.3	8.2
UC307-105D1	T307D1	**C(CM)-UCT307-105D1**					
UC307-106D1	T307D1	**C(CM)-UCT307-106D1**					
UC307-107D1	T307D1	**C(CM)-UCT307-107D1**					
UC308D1	T308D1	**C(CM)-UCT308D1**	3	164	105	3.0	4.7
UC308-108D1	T308D1	**C(CM)-UCT308-108D1**	1/8	6 15/32	4 1/8	6.6	10
UC308-109D1	T308D1	**C(CM)-UCT308-109D1**					
UC309D1	T309D1	**C(CM)-UCT309D1**	3	181	110	4.0	6.2
UC309-110D1	T309D1	**C(CM)-UCT309-110D1**	1/8	7 1/8	4 11/32	8.8	14
UC309-111D1	T309D1	**C(CM)-UCT309-111D1**					
UC309-112D1	T309D1	**C(CM)-UCT309-112D1**					
UC310D1	T310D1	**C(CM)-UCT310D1**	3	197	120	5.0	7.7
UC310-113D1	T310D1	**C(CM)-UCT310-113D1**	1/8	7 3/4	4 23/32	11	17
UC310-114D1	T310D1	**C(CM)-UCT310-114D1**					
UC310-115D1	T310D1	**C(CM)-UCT310-115D1**					
UC311D1	T311D1	**C(CM)-UCT311D1**	4	211	125	6.4	9.5
UC311-200D1	T311D1	**C(CM)-UCT311-200D1**	5/32	8 5/16	4 29/32	14	21
UC311-201D1	T311D1	**C(CM)-UCT311-201D1**					
UC311-202D1	T311D1	**C(CM)-UCT311-202D1**					
UC311-203D1	T311D1	**C(CM)-UCT311-203D1**					

Take-up units cast housing
Set screw type



Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm / inch N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B	S
60	**UCT312D1**	31	25	113	71	41	123	22	160	178	220	46	71	85	135	71	26
2 1/4	**UCT312-204D1**	1 7/32	31/32	4 7/16	2 25/32	1 5/8	4 27/32	0.866	6 19/64	7	8 21/32	1 13/16	2 25/32	3 11/32	5 5/16	2.7953	1.024
2 5/16	**UCT312-205D1**																
2 3/8	**UCT312-206D1**																
2 7/16	**UCT312-207D1**																
65	**UCT313D1**	32	27	116	70	43	134	26	170	190	238	50	80	92	146	75	30
2 1/2	**UCT313-208D1**	1 1/4	1 1/16	4 9/16	2 3/4	1 11/16	5 9/32	1.024	6 11/16	7 15/32	9 3/8	1 31/32	3 5/32	3 5/8	5 3/4	2.9528	1.181
2 9/16	**UCT313-209D1**																
70	**UCT314D1**	36	27	130	85	46	140	26	180	202	252	52	90	97	155	78	33
2 5/8	**UCT314-210D1**	1 13/32	1 1/16	5 1/8	3 11/32	1 13/16	5 1/2	1.024	7 3/32	7 15/16	9 29/32	2 1/16	3 17/32	3 13/16	6 3/32	3.0709	1.299
2 11/16	**UCT314-211D1**																
2 3/4	**UCT314-212D1**																
75	**UCT315D1**	36	27	132	85	46	150	26	192	216	262	55	90	102	160	82	32
2 13/16	**UCT315-213D1**	1 13/32	1 1/16	5 3/16	3 11/32	1 13/16	5 29/32	1.024	7 9/16	8 1/2	10 5/16	2 5/32	3 17/32	4 1/32	6 5/16	3.2283	1.260
2 7/8	**UCT315-214D1**																
2 15/16	**UCT315-215D1**																
3	**UCT315-300D1**																
80	**UCT316D1**	42	30	150	98	53	160	30	204	230	282	60	102	108	174	86	34
3 1/16	**UCT316-301D1**	1 21/32	1 3/16	5 29/32	3 27/32	2 3/32	6 5/16	1.181	8 1/32	9 1/16	11 3/32	2 3/8	4 1/32	4 1/4	6 27/32	3.3858	1.339
3 1/8	**UCT316-302D1**																
3 3/16	**UCT316-303D1**																
85	**UCT317D1**	42	32	152	98	53	170	32	214	240	298	64	102	115	183	96	40
3 1/4	**UCT317-304D1**	1 21/32	1 1/4	5 31/32	3 27/32	2 3/32	6 11/16	1.260	8 27/64	9 7/16	11 23/32	2 17/32	4 1/32	4 17/32	7 7/32	3.7795	1.575
3 5/16	**UCT317-305D1**																
3 7/16	**UCT317-307D1**																
90	**UCT318D1**	46	32	160	106	57	175	32	228	255	312	66	110	120	192	96	40
3 7/16	**UCT318-307D1**	1 13/16	1 1/4	6 5/16	4 3/16	2 1/4	6 7/8	1.260	8 31/32	10 1/32	12 9/32	2 19/32	4 11/32	4 23/32	7 9/16	3.7795	1.575
3 1/2	**UCT318-308D1**																

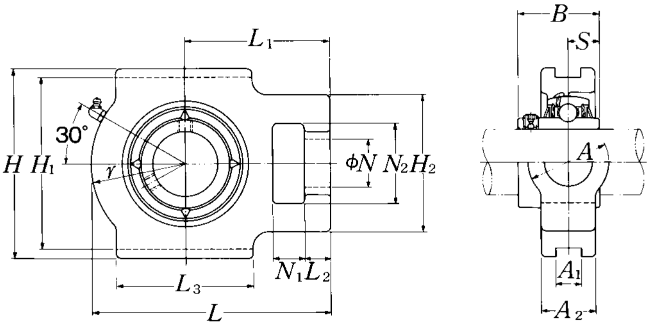
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UCT···D1**
Closed end: **CM-UCT···D1**

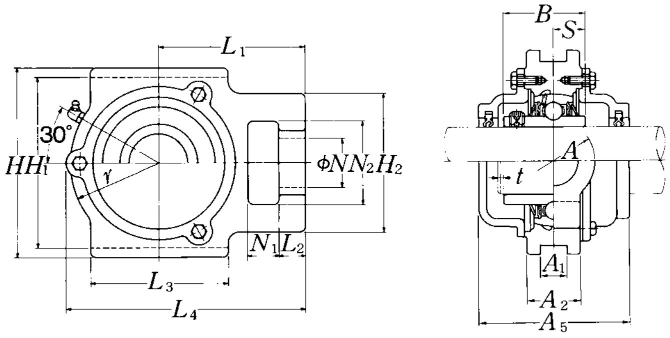
Bearing number	Housing number	Unit number cast dust cover type	Nominal dimensions			Mass of unit	
			mm		inch	kg	lb
			t max.	L_4	A_5	UCT	C(CM)
UC312D1	T312D1	**C(CM)-UCT312D1**	4	227	135	7.6	11
UC312-204D1	T312D1	**C(CM)-UCT312-204D1**	5/32	8 15/16	5 5/16	17	24
UC312-205D1	T312D1	**C(CM)-UCT312-205D1**					
UC312-206D1	T312D1	**C(CM)-UCT312-206D1**					
UC312-207D1	T312D1	**C(CM)-UCT312-207D1**					
UC313D1	T313D1	**C(CM)-UCT313D1**	4	244	140	9.7	14
UC313-208D1	T313D1	**C(CM)-UCT313-208D1**	5/32	9 19/32	5 1/2	21	31
UC313-209D1	T313D1	**C(CM)-UCT313-209D1**					
UC314D1	T314D1	**C(CM)-UCT314D1**	4	258	140	11	15
UC314-210D1	T314D1	**C(CM)-UCT314-210D1**	5/32	10 5/32	5 1/2	24	33
UC314-211D1	T314D1	**C(CM)-UCT314-211D1**					
UC314-212D1	T314D1	**C(CM)-UCT314-212D1**					
UC315D1	T315D1	**C(CM)-UCT315D1**	4	268	150	14	19
UC315-213D1	T315D1	**C(CM)-UCT315-213D1**	5/32	10 9/16	5 29/32	31	42
UC315-214D1	T315D1	**C(CM)-UCT315-214D1**					
UC315-215D1	T315D1	**C(CM)-UCT315-215D1**					
UC315-300D1	T315D1	**C(CM)-UCT315-300D1**					
UC316D1	T316D1	**C(CM)-UCT316D1**	4	287	155	16	23
UC316-301D1	T316D1	**C(CM)-UCT316-301D1**	5/32	11 5/16	6 3/32	35	51
UC316-302D1	T316D1	**C(CM)-UCT316-302D1**					
UC316-303D1	T316D1	**C(CM)-UCT316-303D1**					
UC317D1	T317D1	**C(CM)-UCT317D1**	5	303	170	20	27
UC317-304D1	T317D1	**C(CM)-UCT317-304D1**	13/64	11 15/16	6 11/16	44	60
UC317-305D1	T317D1	**C(CM)-UCT317-305D1**					
UC317-307D1	T317D1	**C(CM)-UCT317-307D1**					
UC318D1	T318D1	**C(CM)-UCT318D1**	5	317	170	22	30
UC318-307D1	T318D1	**C(CM)-UCT318-307D1**	13/64	12 15/32	6 11/16	49	66
UC318-308D1	T318D1	**C(CM)-UCT318-308D1**					

Take-up units cast housing
Set screw type



Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B	S
95	**UCT319D1**	46	33	165	106	57	180	35	240	270	322	72	110	125	197	103	41
$3\frac{5}{8}$	**UCT319-310D1**	$1\frac{13}{16}$	$1\frac{5}{16}$	$6\frac{1}{2}$	$4\frac{3}{16}$	$2\frac{1}{4}$	$7\frac{3}{32}$	1.378	$9\frac{29}{64}$	$10\frac{5}{8}$	$12\frac{11}{16}$	$2\frac{27}{32}$	$4\frac{11}{32}$	$4\frac{29}{32}$	$7\frac{3}{4}$	4.0551	1.614
$3\frac{11}{16}$	**UCT319-311D1**																
$3\frac{3}{4}$	**UCT319-312D1**																
100	**UCT320D1**	48	34	175	115	59	200	35	260	290	345	75	120	135	210	108	42
$3\frac{13}{16}$	**UCT320-313D1**	$1\frac{7}{8}$	$1\frac{11}{32}$	$6\frac{7}{8}$	$4\frac{17}{32}$	$2\frac{5}{16}$	$7\frac{7}{8}$	1.378	$10\frac{15}{64}$	$11\frac{13}{32}$	$13\frac{19}{32}$	$2\frac{15}{16}$	$4\frac{23}{32}$	$5\frac{5}{16}$	$8\frac{9}{32}$	4.2520	1.654
$3\frac{7}{8}$	**UCT320-314D1**																
$3\frac{15}{16}$	**UCT320-315D1**																
4	**UCT320-400D1**																
105	**UCT321D1**	48	34	175	115	59	200	35	260	290	347	75	120	135	212	112	44
110	**UCT322D1**	52	40	185	125	65	215	38	285	320	385	80	130	150	235	117	46
120	**UCT324D1**	60	44	210	140	70	230	45	320	355	432	90	140	165	267	126	51
130	**UCT326D1**	65	47	220	150	75	240	50	350	385	465	100	150	180	285	135	54
140	**UCT328D1**	70	52	230	160	80	255	50	380	415	515	100	155	200	315	145	59

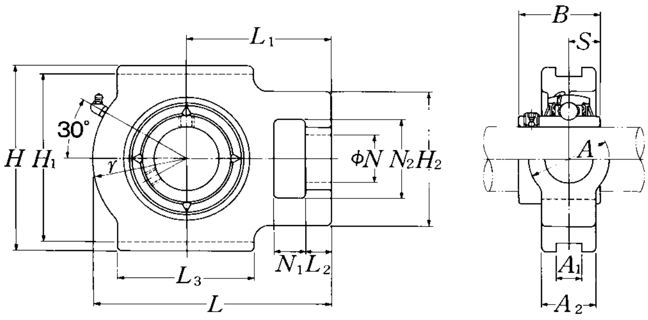
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UCT···D1**
Closed end: **CM-UCT···D1**

Bearing number	Housing number	Unit number cast dust cover type	Nominal dimensions			Mass of unit	
			mm	inch		kg	lb
			t max.	L_4	A_5	UCT	C(CM)
UC319D1	T319D1	**C(CM)-UCT319D1**	5	327	180	25	34
UC319-310D1	T319D1	**C(CM)-UCT319-310D1**	$\frac{13}{64}$	$12\frac{7}{8}$	$7\frac{3}{32}$	55	75
UC319-311D1	T319D1	**C(CM)-UCT319-311D1**					
UC319-312D1	T319D1	**C(CM)-UCT319-312D1**					
UC320D1	T320D1	**C(CM)-UCT320D1**	5	350	190	32	43
UC320-313D1	T320D1	**C(CM)-UCT320-313D1**	$\frac{13}{64}$	$13\frac{25}{32}$	$7\frac{15}{32}$	71	95
UC320-314D1	T320D1	**C(CM)-UCT320-314D1**					
UC320-315D1	T320D1	**C(CM)-UCT320-315D1**					
UC320-400D1	T320D1	**C(CM)-UCT320-400D1**					
UC321D1D1	T321D1	**C(CM)-UCT321D1**	5	359	195	32	43
UC322D1D1	T322D1	**C(CM)-UCT322D1**	5	395	200	40	55
UC324D1D1	T324D1	**C(CM)-UCT324D1**	5	439	215	55	71
UC326D1D1	T326D1	**C(CM)-UCT326D1**	6	476	225	69	92
UC328D1D1	T328D1	**C(CM)-UCT328D1**	6	519	235	84	111

Take-up units cast housing
Set screw type

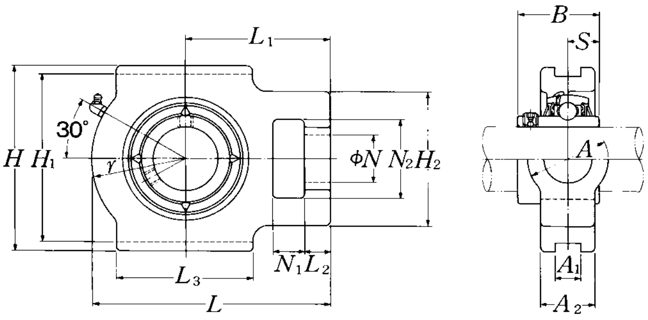


Shaft dia.	Unit number 1)	Nominal dimensions															
mm inch									mm		inch						
		N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B	S
25	UCTX05D1	16	12	56	37	22	57	12	89	102	113	28	37	43	70	38.1	15.9
13/16	UCTX05-013D1	5/8	15/32	2 7/32	1 15/32	7/8	2 1/4	0.472	3 1/2	4 1/32	4 7/16	1 3/32	1 15/32	1 11/16	2 3/4	1.5000	0.626
7/8	UCTX05-014D1																
15/16	UCTX05-015D1																
1	UCTX05-100D1																
30	UCTX06D1	16	15	64	37	22	64	12	89	102	129	30	37	51	78	42.9	17.5
1 1/16	UCTX06-101D1	5/8	19/32	2 17/32	1 15/32	7/8	2 17/32	0.472	3 1/2	4 1/32	5 3/32	1 3/16	1 15/32	2	3 1/16	1.6890	0.689
1 1/8	UCTX06-102D1																
1 3/16	UCTX06-103D1																
1 1/4	UCTX06-104D1																
35	UCTX07D1	19	17	83	49	29	83	16	102	114	144	36	49	56	88	49.2	19
1 5/16	UCTX07-105D1	3/4	21/32	3 9/32	1 15/16	1 5/32	3 9/32	0.630	4 1/64	4 1/2	5 21/32	1 13/32	1 15/16	2 7/32	3 15/32	1.9370	0.748
1 3/8	UCTX07-106D1																
1 7/16	UCTX07-107D1																
40	UCTX08D1	19	17	83	49	29	83	16	102	117	144	36	49	57	87	49.2	19
1 1/2	UCTX08-108D1	3/4	21/32	3 9/32	1 15/16	1 5/32	3 9/32	0.630	4 1/64	4 19/32	5 21/32	1 13/32	1 15/16	2 1/4	3 7/16	1.9370	0.748
1 9/16	UCTX08-109D1																
45	UCTX09D1	19	18	83	49	29	86	16	102	117	151	38	49	59	92	51.6	19
1 5/8	UCTX09-110D1	3/4	23/32	3 9/32	1 15/16	1 5/32	3 3/8	0.630	4 1/64	4 19/32	5 15/16	1 1/2	1 15/16	2 5/16	3 5/8	2.0315	0.748
1 11/16	UCTX09-111D1																
1 3/4	UCTX09-112D1																
1 13/16	UCTX09-113D1																
50	UCTX10D1	25	21	102	64	35	95	22	130	146	171	42	64	65	106	55.6	22.2
1 7/8	UCTX10-114D1	31/32	13/16	4 1/32	2 17/32	1 3/8	3 3/4	0.866	5 1/8	5 3/4	6 23/32	1 21/32	2 17/32	2 9/16	4 3/16	2.1890	0.874
1 15/16	UCTX10-115D1																
2	UCTX10-200D1																

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit kg	 lb
UCX05D1	TX05D1	1.4	3.1
UCX05-013D1	TX05D1		
UCX05-014D1	TX05D1		
UCX05-015D1	TX05D1		
UCX05-100D1	TX05D1		
UCX06D1	TX06D1	1.8	4.0
UCX06-101D1	TX06D1		
UCX06-102D1	TX06D1		
UCX06-103D1	TX06D1		
UC207-104D1	TX06D1		
UCX07D1	TX07D1	2.6	5.7
UCX07-105D1	TX07D1		
UCX07-106D1	TX07D1		
UCX07-107D1	TX07D1		
UCX08D1	TX08D1	2.6	5.7
UCX08-108D1	TX08D1		
UCX08-109D1	TX08D1		
UCX09D1	TX09D1	2.8	6.2
UCX09-110D1	TX09D1		
UCX09-111D1	TX09D1		
UCX09-112D1	TX09D1		
UC210-113D1	TX09D1		
UCX10D1	TX10D1	4.3	9.5
UCX10-114D1	TX10D1		
UCX10-115D1	TX10D1		
UC211-200D1	TX10D1		

Take-up units cast housing
Set screw type

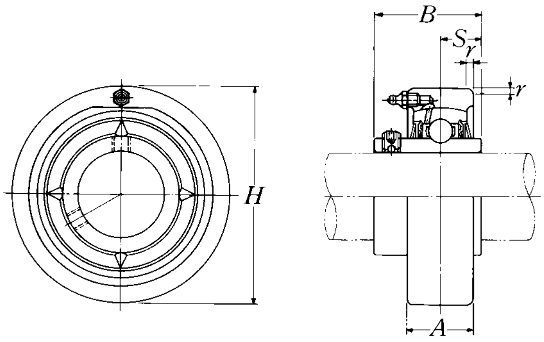


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch															
		N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B	S
55	UCTX11D1	32	21	102	64	35	102	22	130	146	194	44	64	75	119	65.1	25.4
2 1/16	UCTX11-201D1	1 1/4	13/16	4 1/32	2 17/32	1 3/8	4 1/32	0.866	5 1/8	5 3/4	7 5/8	1 23/32	2 17/32	2 15/16	4 11/16	2.5630	1.000
2 1/8	UCTX11-202D1																
2 3/16	UCTX11-203D1																
2 1/4	UCTX11-204D1																
2 5/16	UCTX11-205D1																
60	UCTX12D1	32	23	111	70	41	121	26	151	167	224	48	70	87	137	65.1	25.4
2 3/8	UCTX12-206D1	1 1/4	29/32	4 3/8	2 3/4	1 5/8	4 3/4	1.024	5 15/16	6 9/16	8 13/16	1 7/8	2 3/4	3 7/16	5 13/32	2.5630	1.000
2 7/16	UCTX12-207D1																
65	UCTX13D1	32	23	111	70	41	121	26	151	167	224	48	70	87	137	74.6	30.2
2 1/2	UCTX13-208D1	1 1/4	29/32	4 3/8	2 3/4	1 5/8	4 3/4	1.024	5 15/16	6 9/16	8 13/16	1 7/8	2 3/4	3 7/16	5 13/32	2.9370	1.189
2 9/16	UCTX13-209D1																
70	UCTX14D1	32	23	111	70	41	121	26	151	167	232	48	70	92	140	77.8	33.3
2 5/8	UCTX14-210D1	1 1/4	29/32	4 3/8	2 3/4	1 5/8	4 3/4	1.024	5 15/16	6 9/16	9 1/8	1 7/8	2 3/4	3 5/8	5 1/2	3.0630	1.311
2 11/16	UCTX14-211D1																
2 3/4	UCTX14-212D1																
75	UCTX15D1	32	23	111	70	41	121	28	165	184	235	48	70	95	140	82.6	33.3
2 13/16	UCTX15-213D1	1 1/4	29/32	4 3/8	2 3/4	1 5/8	4 3/4	1.102	6 1/2	7 1/4	9 1/4	1 7/8	2 3/4	3 3/4	5 1/2	3.2520	1.311
2 7/8	UCTX15-214D1																
2 15/16	UCTX15-215D1																
3	UCTX15-300D1																
80	UCTX16D1	38	30	124	73	48	157	28	173	198	260	54	73	98	162	85.7	34.1
3 1/16	UCTX16-301D1	1 1/2	1 3/16	4 7/8	2 7/8	1 7/8	6 3/16	1.102	6 13/16	7 25/32	10 1/4	2 1/8	2 7/8	3 27/32	6 3/8	3.3740	1.343
3 1/8	UCTX16-302D1																
3 3/16	UCTX16-303D1																
3 1/4	UCTX16-304D1																
85	UCTX17D1	38	30	124	73	48	157	28	173	198	260	54	73	98	162	96	39.7
3 5/16	UCTX17-305D1	1 1/2	1 3/16	4 7/8	2 7/8	1 7/8	6 3/16	1.102	6 13/16	7 25/32	10 1/4	2 1/8	2 7/8	3 27/32	6 3/8	3.7795	1.563
3 7/16	UCTX17-307D1																

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

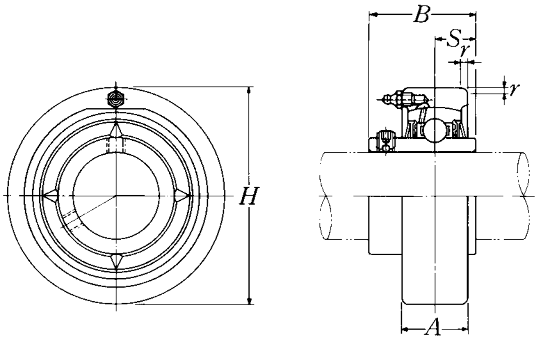
Bearing number	Housing number	Mass of unit	
		kg	lb
UCX11D1	TX11D1	5.2	11
UCX11-201D1	TX11D1		
UCX11-202D1	TX11D1		
UCX11-203D1	TX11D1		
UC212-204D1	TX11D1		
UC212-205D1	TX11D1		
UCX12D1	TX12D1	7.6	17
UCX12-206D1	TX12D1		
UCX12-207D1	TX12D1		
UCX13D1	TX13D1	7.6	17
UCX13-208D1	TX13D1		
UCX13-209D1	TX13D1		
UCX14D1	TX14D1	7.7	17
UCX14-210D1	TX14D1		
UCX14-211D1	TX14D1		
UCX14-212D1	TX14D1		
UCX15D1	TX15D1	8.4	19
UCX15-213D1	TX15D1		
UCX15-214D1	TX15D1		
UCX15-215D1	TX15D1		
UCX15-300D1	TX15D1		
UCX16D1	TX16D1	11	24
UCX16-301D1	TX16D1		
UCX16-302D1	TX16D1		
UCX16-303D1	TX16D1		
UC217-304D1	TX16D1		
UCX17D1	TX17D1	12	26
UCX17-305D1	TX17D1		
UCX17-307D1	TX17D1		

Cylindrical cartridge units cast housing
Set screw type



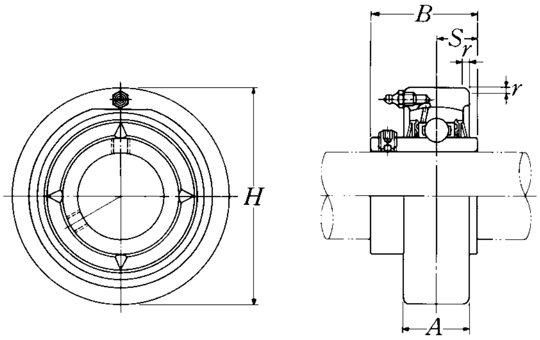
Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch					Bearing number 1)	Housing number	Mass of unit kg lb
		H	A	r	B	S			
12	**UCC201D1**	72	20	2	31	12.7	UC201D1	C204D1	0.6
1/2	**UCC201-008D1**	2.8346	25/32	0.079	1.2205	0.500	UC201-008D1	C204D1	1.3
15	**UCC202D1**	72	20	2	31	12.7	UC202D1	C204D1	0.6
9/16	**UCC202-009D1**	2.8346	25/32	0.079	1.2205	0.500	UC202-009D1	C204D1	1.3
5/8	**UCC202-010D1**						UC202-010D1	C204D1	
17	**UCC203D1**	72	20	2	31	12.7	UC203D1	C204D1	0.5
11/16	**UCC203-011D1**	2.8346	25/32	0.079	1.2205	0.500	UC203-011D1	C204D1	1.1
20	**UCC204D1**	72	20	2	31	12.7	UC204D1	C204D1	0.5
3/4	**UCC204-012D1**	2.8346	25/32	0.079	1.2205	0.500	UC204-012D1	C204D1	1.1
25	**UCC205D1**	80	22	2	34.1	14.3	UC205D1	C205D1	0.7
13/16	**UCC205-013D1**	3.1496	55/64	0.079	1.3425	0.563	UC205-013D1	C205D1	1.5
7/8	**UCC205-014D1**						UC205-014D1	C205D1	
15/16	**UCC205-015D1**						UC205-015D1	C205D1	
1	**UCC205-100D1**						UC205-100D1	C205D1	
30	**UCC206D1**	85	27	2	38.1	15.9	UC206D1	C206D1	0.9
1 1/16	**UCC206-101D1**	3.3465	1 1/16	0.079	1.5000	0.626	UC206-101D1	C206D1	2.0
1 1/8	**UCC206-102D1**						UC206-102D1	C206D1	
1 3/16	**UCC206-103D1**						UC206-103D1	C206D1	
1 1/4	**UCC206-104D1**						UC206-104D1	C206D1	
35	**UCC207D1**	90	28	2	42.9	17.5	UC207D1	C207D1	1.0
1 1/4	**UCC207-104D1**	3.5433	1 7/64	0.079	1.6890	0.689	UC207-104D1	C207D1	2.2
1 5/16	**UCC207-105D1**						UC207-105D1	C207D1	
1 3/8	**UCC207-106D1**						UC207-106D1	C207D1	
1 7/16	**UCC207-107D1**						UC207-107D1	C207D1	
40	**UCC208D1**	100	30	2.5	49.2	19	UC208D1	C208D1	1.3
1 1/2	**UCC208-108D1**	3.9370	1 3/16	0.098	1.9370	0.748	UC208-108D1	C208D1	2.9
1 9/16	**UCC208-109D1**						UC208-109D1	C208D1	
45	**UCC209D1**	110	31	2.5	49.2	19	UC209D1	C209D1	1.6
1 5/8	**UCC209-110D1**	4.3307	1 7/32	0.098	1.9370	0.748	UC209-110D1	C209D1	3.5
1 11/16	**UCC209-111D1**						UC209-111D1	C209D1	
1 3/4	**UCC209-112D1**						UC209-112D1	C209D1	

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



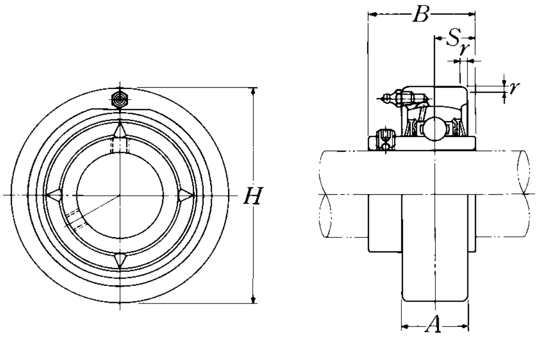
Shaft dia.	Unit number [1]	Nominal dimensions					Bearing number [1]	Housing number	Mass of unit
mm inch		mm inch							kg lb
		H	*A*	*r*	*B*	*S*			
50	**UCC210D1**	120	33	2.5	51.6	19	UC210D1	C210D1	2.0
$1\tfrac{13}{16}$	**UCC210-113D1**	4.7244	$1\tfrac{19}{64}$	0.098	2.0315	0.748	UC210-113D1	C210D1	4.4
$1\tfrac{7}{8}$	**UCC210-114D1**						UC210-114D1	C210D1	
$1\tfrac{15}{16}$	**UCC210-115D1**						UC210-115D1	C210D1	
2	**UCC210-200D1**						UC210-200D1	C210D1	
55	**UCC211D1**	125	35	2.5	55.6	22.2	UC211D1	C211D1	2.2
2	**UCC211-200D1**	4.9213	$1\tfrac{3}{8}$	0.098	2.1890	0.874	UC211-200D1	C211D1	4.9
$2\tfrac{1}{16}$	**UCC211-201D1**						UC211-201D1	C211D1	
$2\tfrac{1}{8}$	**UCC211-202D1**						UC211-202D1	C211D1	
$2\tfrac{3}{16}$	**UCC211-203D1**						UC211-203D1	C211D1	
60	**UCC212D1**	130	38	2.5	65.1	25.4	UC212D1	C212D1	2.6
$2\tfrac{1}{4}$	**UCC212-204D1**	5.1181	$1\tfrac{1}{2}$	0.098	2.5630	1.000	UC212-204D1	C212D1	5.7
$2\tfrac{5}{16}$	**UCC212-205D1**						UC212-205D1	C212D1	
$2\tfrac{3}{8}$	**UCC212-206D1**						UC212-206D1	C212D1	
$2\tfrac{7}{16}$	**UCC212-207D1**						UC212-207D1	C212D1	
65	**UCC213D1**	140	40	3	65.1	25.4	UC213D1	C213D1	3.1
$2\tfrac{1}{2}$	**UCC213-208D1**	5.5118	$1\tfrac{37}{64}$	0.118	2.5630	1.000	UC213-208D1	C213D1	6.8
$2\tfrac{9}{16}$	**UCC213-209D1**						UC213-209D1	C213D1	

Cylindrical cartridge units cast housing
Set screw type



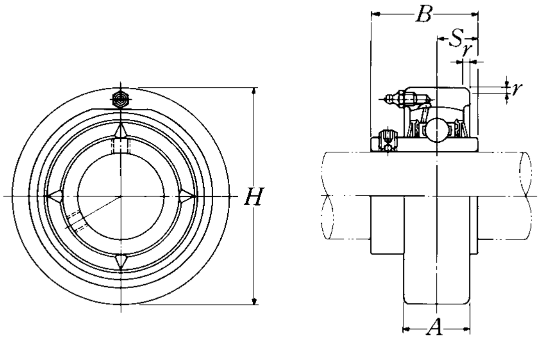
Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch H	 A	 r	 B	 S	Bearing number 1)	Housing number	Mass of unit kg lb
25	**UCC305D1**	90	26	2.5	38	15	UC305D1	C305D1	1.1
13/16	**UCC305-013D1**						UC305-013D1	C305D1	
7/8	**UCC305-014D1**	3.5433	1 1/32	0.098	1.4961	0.591	UC305-014D1	C305D1	2.4
15/16	**UCC305-015D1**						UC305-015D1	C305D1	
1	**UCC305-100D1**						UC305-100D1	C305D1	
30	**UCC306D1**	100	28	2.5	43	17	UC306D1	C306D1	1.4
1 1/16	**UCC306-101D1**						UC306-101D1	C306D1	
1 1/8	**UCC306-102D1**	3.9370	1 7/64	0.098	1.6929	0.669	UC306-102D1	C306D1	3.1
1 3/16	**UCC306-103D1**						UC306-103D1	C306D1	
35	**UCC307D1**	110	32	3	48	19	UC307D1	C307D1	1.8
1 1/4	**UCC307-104D1**						UC307-104D1	C307D1	
1 5/16	**UCC307-105D1**	4.3307	1 17/64	0.118	1.8898	0.748	UC307-105D1	C307D1	4.0
1 3/8	**UCC307-106D1**						UC307-106D1	C307D1	
1 7/16	**UCC307-107D1**						UC307-107D1	C307D1	
40	**UCC308D1**	120	34	3	52	19	UC308D1	C308D1	2.2
1 1/2	**UCC308-108D1**	4.7244	1 11/32	0.118	2.0472	0.748	UC308-108D1	C308D1	4.9
1 9/16	**UCC308-109D1**						UC308-109D1	C308D1	
45	**UCC309D1**	130	38	3.5	57	22	UC309D1	C309D1	2.7
1 5/8	**UCC309-110D1**						UC309-110D1	C309D1	
1 11/16	**UCC309-111D1**	5.1181	1 1/2	0.138	2.2441	0.866	UC309-111D1	C309D1	6.0
1 3/4	**UCC309-112D1**						UC309-112D1	C309D1	
50	**UCC310D1**	140	40	3.5	61	22	UC310D1	C310D1	3.3
1 13/16	**UCC310-113D1**						UC310-113D1	C310D1	
1 7/8	**UCC310-114D1**	5.5118	1 37/64	0.138	2.4016	0.866	UC310-114D1	C310D1	7.3
1 15/16	**UCC310-115D1**						UC310-115D1	C310D1	
55	**UCC311D1**	150	44	3.5	66	25	UC311D1	C311D1	3.9
2	**UCC311-200D1**						UC311-200D1	C311D1	
2 1/16	**UCC311-201D1**	5.9055	1 47/64	0.138	2.5984	0.984	UC311-201D1	C311D1	8.6
2 1/8	**UCC311-202D1**						UC311-202D1	C311D1	
2 3/16	**UCC311-203D1**						UC311-203D1	C311D1	

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch					Bearing number 1)	Housing number	Mass of unit kg lb
		H	A	r	B	S			
60	**UCC312D1**	160	46	3.5	71	26	UC312D1	C312D1	4.8
2 1/4	**UCC312-204D1**	6.2992	1 13/16	0.138	2.7953	1.024	UC312-204D1	C312D1	11
2 5/16	**UCC312-205D1**						UC312-205D1	C312D1	
2 3/8	**UCC312-206D1**						UC312-206D1	C312D1	
2 7/16	**UCC312-207D1**						UC312-207D1	C312D1	
65	**UCC313D1**	170	50	3.5	75	30	UC313D1	C313D1	5.8
2 1/2	**UCC313-208D1**	6.6929	1 31/32	0.138	2.9528	1.181	UC313-208D1	C313D1	13
2 9/16	**UCC313-209D1**						UC313-209D1	C313D1	
70	**UCC314D1**	180	52	4	78	33	UC314D1	C314D1	6.6
2 5/8	**UCC314-210D1**	7.0866	2 3/64	0.157	3.0709	1.299	UC314-210D1	C314D1	15
2 11/16	**UCC314-211D1**						UC314-211D1	C314D1	
2 3/4	**UCC314-212D1**						UC314-212D1	C314D1	
75	**UCC315D1**	190	55	4	82	32	UC315D1	C315D1	7.8
2 13/16	**UCC315-213D1**	7.4803	2 11/64	0.157	3.2283	1.260	UC315-213D1	C315D1	17
2 7/8	**UCC315-214D1**						UC315-214D1	C315D1	
2 15/16	**UCC315-215D1**						UC315-215D1	C315D1	
3	**UCC315-300D1**						UC315-300D1	C315D1	
80	**UCC316D1**	200	60	4	86	34	UC316D1	C316D1	9.0
3 1/16	**UCC316-301D1**	7.8740	2 23/64	0.157	3.3858	1.339	UC316-301D1	C316D1	20
3 1/8	**UCC316-302D1**						UC316-302D1	C316D1	
3 3/16	**UCC316-303D1**						UC316-303D1	C316D1	
85	**UCC317D1**	215	64	4	96	40	UC317D1	C317D1	11
3 1/4	**UCC317-304D1**	8.4646	2 33/64	0.157	3.7795	1.575	UC317-304D1	C317D1	24
3 5/16	**UCC317-305D1**						UC317-305D1	C317D1	
3 7/16	**UCC317-307D1**						UC317-307D1	C317D1	
90	**UCC318D1**	225	66	4	96	40	UC318D1	C318D1	12
3 1/2	**UCC318-308D1**	8.8583	2 19/32	0.157	3.7795	1.575	UC318-308D1	C318D1	26
95	**UCC319D1**	240	72	4	103	41	UC319D1	C319D1	15
3 5/8	**UCC319-310D1**	9.4488	2 53/64	0.157	4.0551	1.614	UC319-310D1	C319D1	33
3 11/16	**UCC319-311D1**						UC319-311D1	C319D1	
3 3/4	**UCC319-312D1**						UC319-312D1	C319D1	

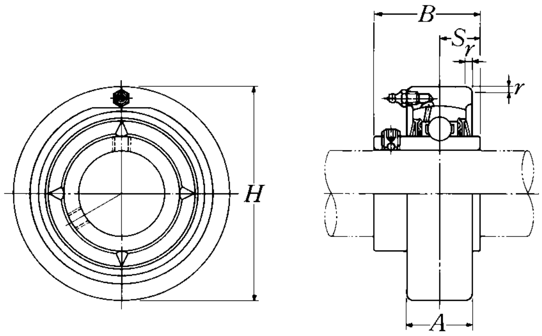
Cylindrical cartridge units cast housing
Set screw type



Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch					Bearing number 1)	Housing number	Mass of unit kg lb
		H	*A*	*r*	*B*	*S*			
100	**UCC320D1**	260	75	4	108	42	UC320D1	C320D1	19
$3\frac{13}{16}$	**UCC320-313D1**	10.2362	$2\frac{61}{64}$	0.157	4.2520	1.654	UC320-313D1	C320D1	42
$3\frac{7}{8}$	**UCC320-314D1**						UC320-314D1	C320D1	
$3\frac{15}{16}$	**UCC320-315D1**						UC320-315D1	C320D1	
4	**UCC320-400D1**						UC320-400D1	C320D1	
105	**UCC321D1**	260	75	4	112	44	UC321D1	C321D1	19
110	**UCC322D1**	300	80	5	117	46	UC322D1	C322D1	28
120	**UCC324D1**	320	90	5	126	51	UC324D1	C324D1	35
130	**UCC326D1**	340	100	5	135	54	UC326D1	C326D1	42
140	**UCC328D1**	360	100	5	145	59	UC328D1	C328D1	49

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

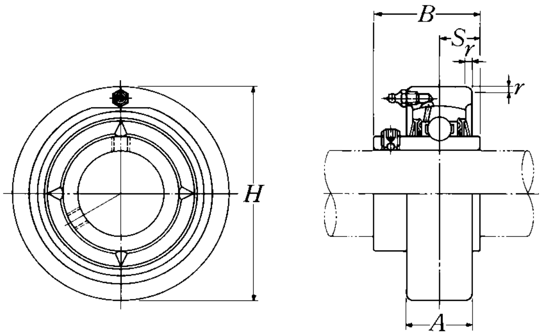
Cylindrical cartridge units cast housing
Set screw type



Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch H	A	r	B	S	Bearing number 1)	Housing number	Mass of unit kg lb
25	**UCCX05D1**	90	27	2	38.1	15.9	UCX05D1	CX05D1	1.1
$\frac{13}{16}$	**UCCX05-013D1**						UCX05-013D1	CX05D1	
$\frac{7}{8}$	**UCCX05-014D1**	3.5433	$1\frac{1}{16}$	0.079	1.5000	0.626	UCX05-014D1	CX05D1	2.4
$\frac{15}{16}$	**UCCX05-015D1**						UCX05-015D1	CX05D1	
1	**UCCX05-100D1**						UCX05-100D1	CX05D1	
30	**UCCX06D1**	100	30	2.5	42.9	17.5	UCX06D1	CX06D1	1.6
$1\frac{1}{16}$	**UCCX06-101D1**						UCX06-101D1	CX06D1	
$1\frac{1}{8}$	**UCCX06-102D1**	3.9370	$1\frac{3}{16}$	0.098	1.6890	0.689	UCX06-102D1	CX06D1	3.5
$1\frac{3}{16}$	**UCCX06-103D1**						UCX06-103D1	CX06D1	
$1\frac{1}{4}$	**UCCX06-104D1**						UC207-104D1	CX06D1	
35	**UCCX07D1**	110	34	2.5	49.2	19	UCX07D1	CX07D1	2.0
$1\frac{5}{16}$	**UCCX07-105D1**						UCX07-105D1	CX07D1	
$1\frac{3}{8}$	**UCCX07-106D1**	4.3307	$1\frac{11}{32}$	0.098	1.9370	0.748	UCX07-106D1	CX07D1	4.4
$1\frac{7}{16}$	**UCCX07-107D1**						UCX07-107D1	CX07D1	
40	**UCCX08D1**	120	38	2.5	49.2	19	UCX08D1	CX08D1	2.5
$1\frac{1}{2}$	**UCCX08-108D1**	4.7244	$1\frac{1}{2}$	0.098	1.9370	0.748	UCX08-108D1	CX08D1	5.5
$1\frac{9}{16}$	**UCCX08-109D1**						UCX08-109D1	CX08D1	
45	**UCCX09D1**	120	38	2.5	51.6	19	UCX09D1	CX09D1	2.4
$1\frac{5}{8}$	**UCCX09-110D1**						UCX09-110D1	CX09D1	
$1\frac{11}{16}$	**UCCX09-111D1**	4.7244	$1\frac{1}{2}$	0.098	2.0315	0.748	UCX09-111D1	CX09D1	5.3
$1\frac{3}{4}$	**UCCX09-112D1**						UCX09-112D1	CX09D1	
$1\frac{13}{16}$	**UCCX09-113D1**						UC210-113D1	CX09D1	
50	**UCCX10D1**	130	40	2.5	55.6	22.2	UCX10D1	CX10D1	3.0
$1\frac{7}{8}$	**UCCX10-114D1**						UCX10-114D1	CX10D1	
$1\frac{15}{16}$	**UCCX10-115D1**	5.1181	$1\frac{37}{64}$	0.098	2.1890	0.874	UCX10-115D1	CX10D1	6.6
2	**UCCX10-200D1**						UC211-200D1	CX10D1	

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Cylindrical cartridge units cast housing
Set screw type

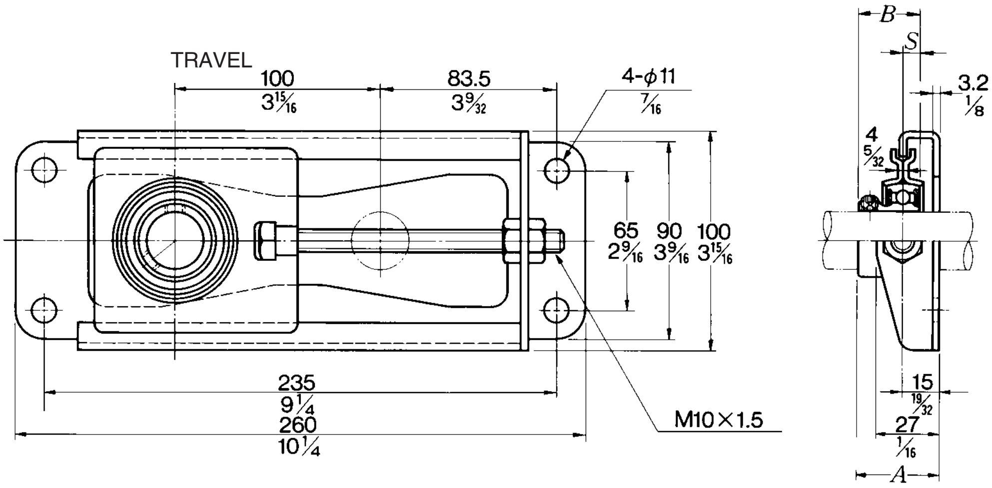


Shaft dia.	Unit number 1)	Nominal dimensions					Bearing number 1)	Housing number	Mass of unit
mm inch		mm inch							kg lb
		H	A	r	B	S			
55	UCCX11D1	150	42	3	65.1	25.4	UCX11D1	CX11D1	4.4
$2\frac{1}{16}$	UCCX11-201D1	5.9055	$1\frac{21}{32}$	0.118	2.5630	1.000	UCX11-201D1	CX11D1	9.7
$2\frac{1}{8}$	UCCX11-202D1						UCX11-202D1	CX11D1	
$2\frac{3}{16}$	UCCX11-203D1						UCX11-203D1	CX11D1	
$2\frac{1}{4}$	UCCX11-204D1						UC212-204D1	CX11D1	
$2\frac{5}{16}$	UCCX11-205D1						UC212-205D1	CX11D1	
60	UCCX12D1	160	44	3	65.1	25.4	UCX12D1	CX12D1	5.0
$2\frac{3}{8}$	UCCX12-206D1	6.2992	$1\frac{47}{64}$	0.118	2.5630	1.000	UCX12-206D1	CX12D1	11
$2\frac{7}{16}$	UCCX12-207D1						UCX12-207D1	CX12D1	

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

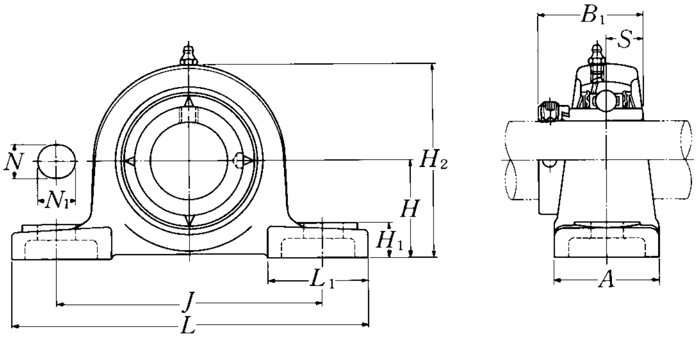
ASPT2

Mini stretcher
Set screw type



Shaft dia. mm inch	Unit number	Nominal dimensions mm inch A	 B	 S	Bolt size mm inch	Max. load recommended N lbf	Bearing number	Mass of unit kg lb
12 1/2	**ASPT201-10** **ASPT201-008-10**	31 1 7/32	22 0.8661	6 0.236	M10 3/8	3 500 770	AS201 AS201-008	1.0 2.2
15 9/16 5/8	**ASPT202-10** **ASPT202-009-10** **ASPT202-010-10**	31 1 7/32	22 0.8661	6 0.236	M10 3/8	3 500 770	AS202 AS202-009 AS202-010	1.0 2.2
17 11/16	**ASPT203-10** **ASPT203-011-10**	31 1 7/32	22 0.8661	6 0.236	M10 3/8	3 500 770	AS203 AS203-011	1.0 2.2
20 3/4	**ASPT204-10** **ASPT204-012-10**	33 1 19/64	25 0.9843	7 0.276	M10 3/8	3 500 770	AS204 AS204-012	1.0 2.2
25 13/16 7/8 15/16 **1**	**ASPT205-10** **ASPT205-013-10** **ASPT205-014-10** **ASPT205-015-10** **ASPT205-100-10**	34.5 1 23/64	27 1.0630	7.5 0.295	M10 3/8	3 500 770	AS205 AS205-013 AS205-014 AS205-015 AS205-100	1.1 2.4

Pillow blocks cast housing
Eccentric locking collar type

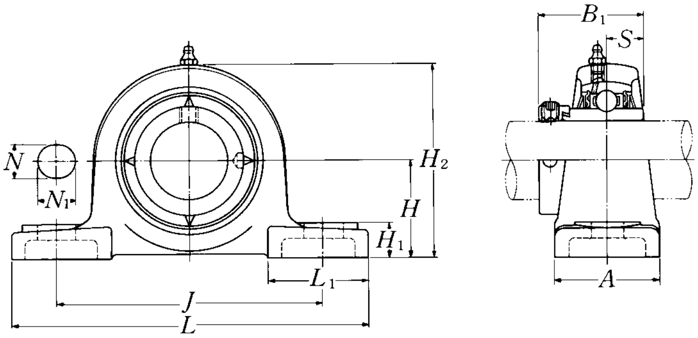


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch											Bolt size mm inch
		H	L	J	A	N	N1	H1	H2	L1	B1	S	
20	**UELP204D1W3**	33.3	127	95	38	13	16	14	65	42	43.7	17.1	M10
3/4	**UELP204-012D1W3**	1 5/16	5	3 3/4	1 1/2	1/2	5/8	9/16	2 9/16	1 21/32	1.720	0.673	3/8
25	**UELP205D1W3**	36.5	140	105	38	13	16	15	71	42	44.4	17.5	M10
13/16	**UELP205-013D1W3**												
7/8	**UELP205-014D1W3**	1 7/16	5 1/2	4 1/8	1 1/2	1/2	5/8	19/32	2 25/32	1 21/32	1.748	0.689	3/8
15/16	**UELP205-015D1W3**												
1	**UELP205-100D1W3**												
30	**UELP206D1W3**	42.9	165	121	48	17	20	17	83	54	48.4	18.3	M14
1 1/16	**UELP206-101D1W3**												
1 1/8	**UELP206-102D1W3**	1 11/16	6 1/2	4 3/4	1 7/8	21/32	25/32	21/32	3 9/32	2 1/8	1.906	0.720	1/2
1 3/16	**UELP206-103D1W3**												
1 1/4	**UELP206-104D1W3**												
35	**UELP207D1W3**	47.6	167	127	48	17	20	18	93	54	51.1	18.8	M14
1 1/4	**UELP207-104D1W3**												
1 5/16	**UELP207-105D1W3**	1 7/8	6 9/16	5	1 7/8	21/32	25/32	23/32	3 21/32	2 1/8	2.012	0.740	1/2
1 3/8	**UELP207-106D1W3**												
1 7/16	**UELP207-107D1W3**												
40	**UELP208D1W3**	49.2	184	137	54	17	20	18	98	52	56.3	21.4	M14
1 1/2	**UELP208-108D1W3**	1 15/16	7 1/4	5 13/32	2 1/8	21/32	25/32	23/32	3 27/32	2 1/16	2.217	0.843	1/2
1 9/16	**UELP208-109D1W3**												
45	**UELP209D1W3**	54	190	146	54	17	20	20	106	60	56.3	21.4	M14
1 5/8	**UELP209-110D1W3**												
1 11/16	**UELP209-111D1W3**	2 1/8	7 15/32	5 3/4	2 1/8	21/32	25/32	25/32	4 3/16	2 3/8	2.217	0.843	1/2
1 3/4	**UELP209-112D1W3**												
50	**UELP210D1W3**	57.2	206	159	60	20	23	21	114	65	62.7	24.6	M16
1 13/16	**UELP210-113D1W3**												
1 7/8	**UELP210-114D1W3**	2 1/4	8 1/8	6 1/4	2 3/8	25/32	29/32	13/16	4 1/2	2 9/16	2.469	0.969	5/8
1 15/16	**UELP210-115D1W3**												
2	**UELP210-200D1W3**												

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit kg lb
UEL204D1W3	P204D1	0.7
UEL204-012D1W3	P204D1	1.5
UEL205D1W3	P205D1	0.9
UEL205-013D1W3	P205D1	2.0
UEL205-014D1W3	P205D1	
UEL205-015D1W3	P205D1	
UEL205-100D1W3	P205D1	
UEL206D1W3	P206D1	1.4
UEL206-101D1W3	P206D1	3.1
UEL206-102D1W3	P206D1	
UEL206-103D1W3	P206D1	
UEL206-104D1W3	P206D1	
UEL207D1W3	P207D1	1.8
UEL207-104D1W3	P207D1	4.0
UEL207-105D1W3	P207D1	
UEL207-106D1W3	P207D1	
UEL207-107D1W3	P207D1	
UEL208D1W3	P208D1	2.0
UEL208-108D1W3	P208D1	4.4
UEL208-109D1W3	P208D1	
UEL209D1W3	P209D1	2.4
UEL209-110D1W3	P209D1	5.3
UEL209-111D1W3	P209D1	
UEL209-112D1W3	P209D1	
UEL210D1W3	P210D1	2.8
UEL210-113D1W3	P210D1	6.2
UEL210-114D1W3	P210D1	
UEL210-115D1W3	P210D1	
UEL210-200D1W3	P210D1	

Pillow blocks cast housing
Eccentric locking collar type

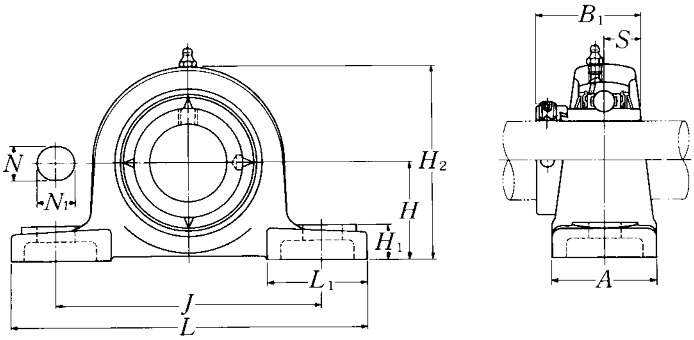


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch											Bolt size mm inch
		H	*L*	*J*	*A*	*N*	*N*1	*H*1	*H*2	*L*1	*B*1	*S*	
55	UELP211D1W3	63.5	219	171	60	20	23	23	126	65	71.4	27.8	M16
2	UELP211-200D1W3	2 1/2	8 5/8	6 23/32	2 3/8	25/32	29/32	29/32	4 31/32	2 9/16	2.811	1.094	5/8
2 1/16	UELP211-201D1W3												
2 1/8	UELP211-202D1W3												
2 3/16	UELP211-203D1W3												
60	UELP212D1W3	69.8	241	184	70	20	23	25	138	70	77.8	31	M16
2 1/4	UELP212-204D1W3	2 3/4	9 1/2	7 1/4	2 3/4	25/32	29/32	31/32	5 7/16	2 3/4	3.063	1.220	5/8
2 5/16	UELP212-205D1W3												
2 3/8	UELP212-206D1W3												
2 7/16	UELP212-207D1W3												
65	UELP213D1W3	76.2	265	203	70	25	28	27	151	77	85.7	34.15	M20
2 1/2	UELP213-208D1W3	3	10 7/16	8	2 3/4	31/32	1 3/32	1 1/16	5 15/16	3 1/32	3.374	1.344	3/4
2 9/16	UELP213-209D1W3												
70	UELP214D1W3	79.4	266	210	72	25	28	27	157	77	85.7	34.15	M20
2 5/8	UELP214-210D1W3	3 1/8	10 15/32	8 9/32	2 27/32	31/32	1 3/32	1 1/16	6 3/16	3 1/32	3.374	1.344	3/4
2 11/16	UELP214-211D1W3												
2 3/4	UELP214-212D1W3												
75	UELP215D1W3	82.6	275	217	74	25	28	28	163	80	92	37.3	M20
2 13/16	UELP215-213D1W3	3 1/4	10 13/16	8 17/32	2 29/32	31/32	1 3/32	1 3/32	6 13/32	3 5/32	3.622	1.469	3/4
2 7/8	UELP215-214D1W3												
2 15/16	UELP215-215D1W3												
3	UELP215-300D1W3												

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit kg lb
UEL211D1W3	P211D1	3.5
UEL211-200D1W3	P211D1	7.7
UEL211-201D1W3	P211D1	
UEL211-202D1W3	P211D1	
UEL211-203D1W3	P211D1	
UEL212D1W3	P212D1	5.0
UEL212-204D1W3	P212D1	11
UEL212-205D1W3	P212D1	
UEL212-206D1W3	P212D1	
UEL212-207D1W3	P212D1	
UEL213D1W3	P213D1	6.4
UEL213-208D1W3	P213D1	14
UEL213-209D1W3	P213D1	
UEL214D1W3	P214D1	6.8
UEL214-210D1W3	P214D1	15
UEL214-211D1W3	P214D1	
UEL214-212D1W3	P214D1	
UEL215D1W3	P215D1	7.6
UEL215-213D1W3	P215D1	17
UEL215-214D1W3	P215D1	
UEL215-215D1W3	P215D1	
UEL215-300D1W3	P215D1	

Pillow blocks cast housing
Eccentric locking collar type

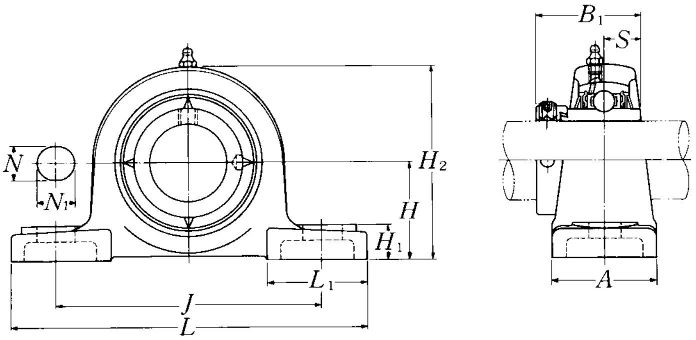


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch											Bolt size mm inch
		H	L	J	A	N	N_1	H_1	H_2	L_1	B_1	S	
25	**UELP305D1W3**	45	175	132	45	17	20	15	85	54	46.8	16.7	M14
13/16	**UELP305-013D1W3**	1 49/64	6 7/8	5 3/16	1 25/32	21/32	25/32	19/32	3 11/32	2 1/8	1.843	0.657	1/2
7/8	**UELP305-014D1W3**												
15/16	**UELP305-015D1W3**												
1	**UELP305-100D1W3**												
30	**UELP306D1W3**	50	180	140	50	17	20	18	95	54	50	17.5	M14
1 1/16	**UELP306-101D1W3**	1 31/32	7 3/32	5 1/2	1 31/32	21/32	25/32	23/32	3 3/4	2 1/8	1.969	0.689	1/2
1 1/8	**UELP306-102D1W3**												
1 3/16	**UELP306-103D1W3**												
35	**UELP307D1W3**	56	210	160	56	17	25	20	106	60	51.6	18.3	M14
1 1/4	**UELP307-104D1W3**	2 13/64	8 9/32	6 5/16	2 7/32	21/32	31/32	25/32	4 3/16	2 3/8	2.031	0.720	1/2
1 5/16	**UELP307-105D1W3**												
1 3/8	**UELP307-106D1W3**												
1 7/16	**UELP307-107D1W3**												
40	**UELP308D1W3**	60	220	170	60	17	27	22	116	60	57.1	19.8	M14
1 1/2	**UELP308-108D1W3**	2 23/64	8 21/32	6 11/16	2 3/8	21/32	1 1/16	7/8	4 9/16	2 3/8	2.248	0.780	1/2
1 9/16	**UELP308-109D1W3**												
45	**UELP309D1W3**	67	245	190	67	20	30	24	129	65	58.7	19.8	M16
1 5/8	**UELP309-110D1W3**	2 41/64	9 21/32	7 15/32	2 5/8	25/32	1 3/16	15/16	5 3/32	2 9/16	2.311	0.780	5/8
1 11/16	**UELP309-111D1W3**												
1 3/4	**UELP309-112D1W3**												
50	**UELP310D1W3**	75	275	212	75	20	35	27	143	75	66.6	24.6	M16
1 13/16	**UELP310-113D1W3**	2 61/64	10 13/16	8 11/32	2 15/16	25/32	1 3/8	1 1/16	5 5/8	2 15/16	2.622	0.969	5/8
1 7/8	**UELP310-114D1W3**												
1 15/16	**UELP310-115D1W3**												
55	**UELP311D1W3**	80	310	236	80	20	38	30	154	85	73	27.8	M16
2	**UELP311-200D1W3**	3 5/32	12 7/32	9 9/32	3 5/32	25/32	1 1/2	1 3/16	6 1/16	3 11/32	2.874	1.094	5/8
2 1/16	**UELP311-201D1W3**												
2 1/8	**UELP311-202D1W3**												
2 3/16	**UELP311-203D1W3**												

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit kg lb
UEL305D1W3	P305D1	1.4
UEL305-013D1W3	P305D1	3.1
UEL305-014D1W3	P305D1	
UEL305-015D1W3	P305D1	
UEL305-100D1W3	P305D1	
UEL306D1W3	P306D1	1.9
UEL306-101D1W3	P306D1	4.2
UEL306-102D1W3	P306D1	
UEL306-103D1W3	P306D1	
UEL307D1W3	P307D1	2.9
UEL307-104D1W3	P307D1	6.4
UEL307-105D1W3	P307D1	
UEL307-106D1W3	P307D1	
UEL307-107D1W3	P307D1	
UEL308D1W3	P308D1	3.1
UEL308-108D1W3	P308D1	6.8
UEL308-109D1W3	P308D1	
UEL309D1W3	P309D1	4.3
UEL309-110D1W3	P309D1	9.5
UEL309-111D1W3	P309D1	
UEL309-112D1W3	P309D1	
UEL310D1W3	P310D1	6.0
UEL310-113D1W3	P310D1	13
UEL310-114D1W3	P310D1	
UEL310-115D1W3	P310D1	
UEL311D1W3	P311D1	7.7
UEL311-200D1W3	P311D1	17
UEL311-201D1W3	P311D1	
UEL311-202D1W3	P311D1	
UEL311-203D1W3	P311D1	

Pillow blocks cast housing
Eccentric locking collar type

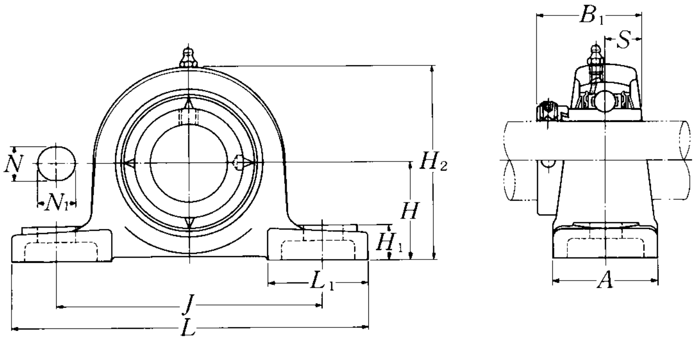


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch											Bolt size mm inch
		H	*L*	*J*	*A*	*N*	N_1	H_1	H_2	L_1	B_1	*S*	
60	**UELP312D1W3**	85	330	250	85	25	38	32	165	95	79.4	30.95	M20
2 1/4	**UELP312-204D1W3**	3 11/32	13	9 27/32	3 11/32	31/32	1 1/2	1 1/4	6 1/2	3 3/4	3.126	1.219	3/4
2 5/16	**UELP312-205D1W3**												
2 3/8	**UELP312-206D1W3**												
2 7/16	**UELP312-207D1W3**												
65	**UELP313D1W3**	90	340	260	90	25	38	33	176	105	85.7	32.55	M20
2 1/2	**UELP313-208D1W3**	3 35/64	13 3/8	10 1/4	3 17/32	31/32	1 1/2	1 5/16	6 15/16	4 1/8	3.374	1.281	3/4
2 9/16	**UELP313-209D1W3**												
70	**UELP314D1W3**	95	360	280	90	27	40	35	187	105	92.1	34.15	M22
2 5/8	**UELP314-210D1W3**	3 47/64	14 3/16	11 1/32	3 17/32	1 1/16	1 9/16	1 3/8	7 3/8	4 1/8	3.626	1.344	7/8
2 11/16	**UELP314-211D1W3**												
2 3/4	**UELP314-212D1W3**												
75	**UELP315D1W3**	100	380	290	100	27	40	35	198	110	100	37.3	M22
2 13/16	**UELP315-213D1W3**	3 15/16	14 31/32	11 13/32	3 15/16	1 1/16	1 9/16	1 3/8	7 25/32	4 11/32	3.937	1.469	7/8
2 7/8	**UELP315-214D1W3**												
2 15/16	**UELP315-215D1W3**												
3	**UELP315-300D1W3**												
80	**UELP316D1W3**	106	400	300	110	27	40	40	210	110	106.4	40.5	M22
3 1/16	**UELP316-301D1W3**	4 11/64	15 3/4	11 13/16	4 11/32	1 1/16	1 9/16	1 9/16	8 9/32	4 11/32	4.189	1.594	7/8
3 1/8	**UELP316-302D1W3**												
3 3/16	**UELP316-303D1W3**												
85	**UELP317D1W3**	112	420	320	110	33	45	40	220	120	109.5	42.05	M27
3 1/4	**UELP317-304D1W3**	4 13/32	16 17/32	12 19/32	4 11/32	1 5/16	1 25/32	1 9/16	8 21/32	4 23/32	4.311	1.656	1
3 5/16	**UELP317-305D1W3**												
3 7/16	**UELP317-307D1W3**												
90	**UELP318D1W3**	118	430	330	110	33	45	45	235	120	115.9	43.65	M27
3 7/16	**UELP318-307D1W3**	4 41/64	16 15/16	13	4 11/32	1 5/16	1 25/32	1 25/32	9 1/4	4 23/32	4.563	1.719	1
3 1/2	**UELP318-308D1W3**												

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit kg	 lb
UEL312D1W3	P312D1	9.7	21
UEL312-204D1W3	P312D1		
UEL312-205D1W3	P312D1		
UEL312-206D1W3	P312D1		
UEL312-207D1W3	P312D1		
UEL313D1W3	P313D1	11	24
UEL313-208D1W3	P313D1		
UEL313-209D1W3	P313D1		
UEL314D1W3	P314D1	12	26
UEL314-210D1W3	P314D1		
UEL314-211D1W3	P314D1		
UEL314-212D1W3	P314D1		
UEL315D1W3	P315D1	15	33
UEL315-213D1W3	P315D1		
UEL315-214D1W3	P315D1		
UEL315-215D1W3	P315D1		
UEL315-300D1W3	P315D1		
UEL316D1W3	P316D1	19	42
UEL316-301D1W3	P316D1		
UEL316-302D1W3	P316D1		
UEL316-303D1W3	P316D1		
UEL317D1W3	P317D1	21	46
UEL317-304D1W3	P317D1		
UEL317-305D1W3	P317D1		
UEL317-307D1W3	P317D1		
UEL318D1W3	P318D1	25	55
UEL318-307D1W3	P318D1		
UEL318-308D1W3	P318D1		

Pillow blocks cast housing
Eccentric locking collar type

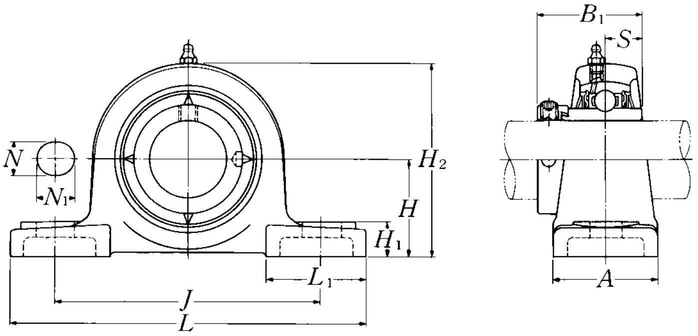


Shaft dia. mm inch	Unit number 1)	H	L	J	A	N	N1	H1	H2	L1	B1	S	Bolt size mm inch
95	**UELP319D1W3**	125	470	360	120	36	50	45	250	125	122.3	38.9	M30
3 5/8	**UELP319-310D1W3**	4 59/64	18 1/2	14 3/16	4 23/32	1 13/32	1 31/32	1 25/32	9 27/32	4 29/32	4.815	1.531	1 1/8
3 11/16	**UELP319-311D1W3**												
3 3/4	**UELP319-312D1W3**												
100	**UELP320D1W3**	140	490	380	120	36	50	50	275	130	128.6	50	M30
3 13/16	**UELP320-313D1W3**	5 33/64	19 9/32	14 31/32	4 23/32	1 13/32	1 31/32	1 31/32	10 13/16	5 1/8	5.063	1.969	1 1/8
3 7/8	**UELP320-314D1W3**												
3 15/16	**UELP320-315D1W3**												
4	**UELP320-400D1W3**												
105	**UELP321D1W3**	140	490	380	120	36	50	50	280	130	139.7	48.4	M30
110	**UELP322D1W3**	150	520	400	140	40	55	55	300	135	141.3	49.2	M33

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit kg lb
UEL319D1W3	P319D1	30
UEL319-310D1W3	P319D1	
UEL319-311D1W3	P319D1	66
UEL319-312D1W3	P319D1	
UEL320D1W3	P320D1	37
UEL320-313D1W3	P320D1	
UEL320-314D1W3	P320D1	82
UEL320-315D1W3	P320D1	
UEL320-400D1W3	P320D1	
UEL321D1W3	P321D1	37
UEL322D1W3	P322D1	48

Pillow blocks cast housing low center height
Eccentric locking collar type

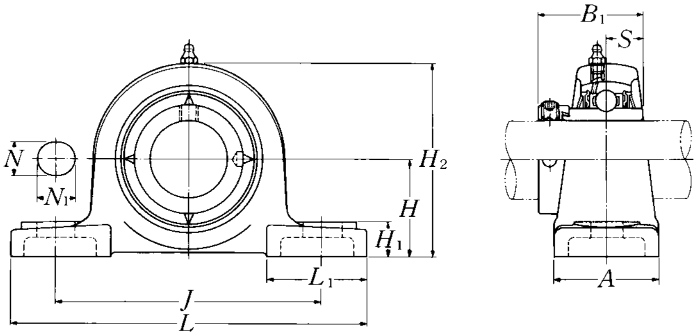


Shaft dia. mm inch	Unit number 1)2)3)	Nominal dimensions mm inch											Bolt size mm inch
		H	L	J	A	N	N_1	H_1	H_2	L_1	B_1	S	
20	UELPL204D1W3	31.75	127	95	38	13	16	14	64	42	43.7	17.1	M10
3/4	UELPL204-012D1W3	1 1/4	5	3 3/4	1 1/2	1/2	5/8	9/16	2 17/32	1 21/32	1.720	0.673	3/8
25	UELPL205D1W3	33.34	140	105	38	13	16	15	68	42	44.4	17.5	M10
13/16	UELPL205-013D1W3	1 5/16	5 1/2	4 1/8	1 1/2	1/2	5/8	19/32	2 11/16	1 21/32	1.748	0.689	3/8
7/8	UELPL205-014D1W3												
15/16	UELPL205-015D1W3												
1	UELPL205-100D1W3												
30	UELPL206D1W3	39.69	165	121	48	17	20	17	80	54	48.4	18.3	M14
1 1/16	UELPL206-101D1W3	1 9/16	6 1/2	4 3/4	1 7/8	21/32	25/32	21/32	3 5/32	2 1/8	1.906	0.720	1/2
1 1/8	UELPL206-102D1W3												
1 3/16	UELPL206-103D1W3												
1 1/4	UELPL206-104D1W3												
35	UELPL207D1W3	46.04	167	127	48	17	20	18	91	54	51.1	18.8	M14
1 1/4	UELPL207-104D1W3	1 13/16	6 9/16	5	1 7/8	21/32	25/32	23/32	3 19/32	2 1/8	2.012	0.740	1/2
1 5/16	UELPL207-105D1W3												
1 3/8	UELPL207-106D1W3												
1 7/16	UELPL207-107D1W3												
45	UELPL209D1W3	52.39	190	146	54	17	20	20	104	60	56.3	21.4	M14
1 5/8	UELPL209-110D1W3	2 1/16	7 15/32	5 3/4	2 1/8	21/32	25/32	25/32	4 3/32	2 3/8	2.217	0.843	1/2
1 11/16	UELPL209-111D1W3												
1 3/4	UELPL209-112D1W3												
50	UELPL210D1W3	55.56	206	159	60	20	23	21	112	65	62.7	24.6	M16
1 13/16	UELPL210-113D1W3	2 3/16	8 1/8	6 1/4	2 3/8	25/32	29/32	13/16	4 13/32	2 9/16	2.469	0.969	5/8
1 7/8	UELPL210-114D1W3												
1 15/16	UELPL210-115D1W3												
2	UELPL210-200D1W3												

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1"
2) UELPL204 and UELPL205 has solid bases.
3) UELPL208 has the same dimension as UELP208 shown in page 174.
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit kg lb
UEL204D1W3	PL204D1	0.7
UEL204-012D1W3	PL204D1	1.5
UEL205D1W3	PL205D1	0.8
UEL205-013D1W3	PL205D1	1.8
UEL205-014D1W3	PL205D1	
UEL205-015D1W3	PL205D1	
UEL205-100D1W3	PL205D1	
UEL206D1W3	PL206D1	1.4
UEL206-101D1W3	PL206D1	3.1
UEL206-102D1W3	PL206D1	
UEL206-103D1W3	PL206D1	
UEL206-104D1W3	PL206D1	
UEL207D1W3	PL207D1	1.7
UEL207-104D1W3	PL207D1	3.7
UEL207-105D1W3	PL207D1	
UEL207-106D1W3	PL207D1	
UEL207-107D1W3	PL207D1	
UEL209D1W3	PL209D1	2.3
UEL209-110D1W3	PL209D1	5.1
UEL209-111D1W3	PL209D1	
UEL209-112D1W3	PL209D1	
UEL210D1W3	PL210D1	2.7
UEL210-113D1W3	PL210D1	6.0
UEL210-114D1W3	PL210D1	
UEL210-115D1W3	PL210D1	
UEL210-200D1W3	PL210D1	

Pillow blocks cast housing low center height
Eccentric locking collar type



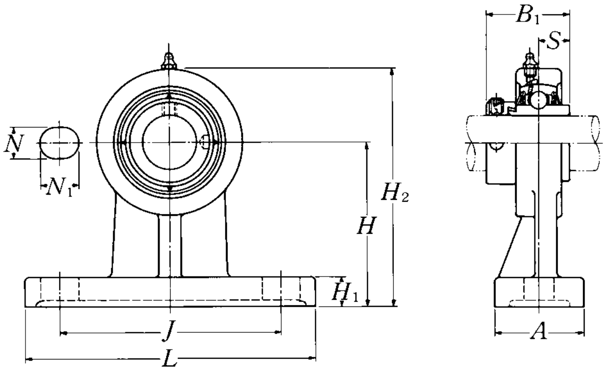
Shaft dia. mm inch	Unit number 1)2)3)	Nominal dimensions mm inch											Bolt size mm inch
		H	L	J	A	N	N_1	H_1	H_2	L_1	B_1	S	
55	**UELPL211D1W3**	61.91	219	171	60	20	23	23	124	65	71.4	27.8	M16
2	**UELPL211-200D1W3**	$2\frac{7}{16}$	$8\frac{5}{8}$	$6\frac{23}{32}$	$2\frac{3}{8}$	$\frac{25}{32}$	$\frac{29}{32}$	$\frac{29}{32}$	$4\frac{7}{8}$	$2\frac{9}{16}$	2.811	1.094	$\frac{5}{8}$
$2\frac{1}{16}$	**UELPL211-201D1W3**												
$2\frac{1}{8}$	**UELPL211-202D1W3**												
$2\frac{3}{16}$	**UELPL211-203D1W3**												
60	**UELPL212D1W3**	68.26	241	184	70	20	23	25	136	70	77.8	31	M16
$2\frac{1}{4}$	**UELPL212-204D1W3**	$2\frac{11}{16}$	$9\frac{1}{2}$	$7\frac{1}{4}$	$2\frac{3}{4}$	$\frac{25}{32}$	$\frac{29}{32}$	$\frac{31}{32}$	$5\frac{11}{32}$	$2\frac{3}{4}$	3.063	1.220	$\frac{5}{8}$
$2\frac{5}{16}$	**UELPL212-205D1W3**												
$2\frac{3}{8}$	**UELPL212-206D1W3**												
$2\frac{7}{16}$	**UELPL212-207D1W3**												

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit	
		kg	lb
UEL211D1W3	PL211D1	3.4	7.5
UEL211-200D1W3	PL211D1		
UEL211-201D1W3	PL211D1		
UEL211-202D1W3	PL211D1		
UEL211-203D1W3	PL211D1		
UEL212D1W3	PL212D1	4.9	11
UEL212-204D1W3	PL212D1		
UEL212-205D1W3	PL212D1		
UEL212-206D1W3	PL212D1		
UEL212-207D1W3	PL212D1		

UELHP2

Pillow blocks cast housing high center height
Eccentric locking collar type

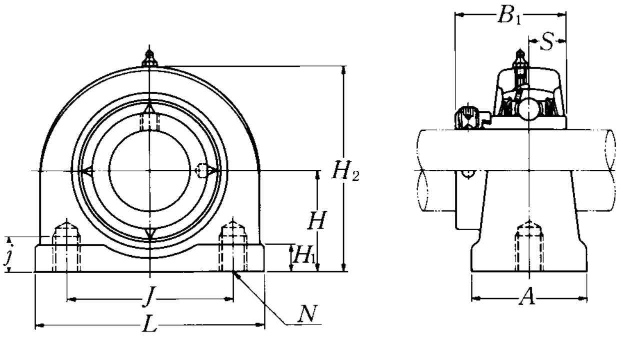


Shaft dia. mm inch	Unit number [1]	Nominal dimensions mm inch										Bolt size mm inch	Bearing number
		H	L	J	A	N	N_1	H_1	H_2	B_1	S		
20	**UELHP204D1W3**	70	127	95	40	13	19	13	101	43.7	17.1	M10	UEL204D1W3
3/4	**UELHP204-012D1W3**	2 3/4	5	3 3/4	1 9/16	1/2	3/4	1/2	3 31/32	1.720	0.673	3/8	UEL204-012D1W3
25	**UELHP205D1W3**	80	142	105	50	13	19	13	114	44.4	17.5	M10	UEL205D1W3
13/16	**UELHP205-013D1W3**	3 5/32	5 19/32	4 1/8	1 31/32	1/2	3/4	1/2	4 1/2	1.748	0.689	3/8	UEL205-013D1W3
7/8	**UELHP205-014D1W3**												UEL205-014D1W3
15/16	**UELHP205-015D1W3**												UEL205-015D1W3
1	**UELHP205-100D1W3**												UEL205-100D1W3
30	**UELHP206D1W3**	90	165	120	50	17	21	16	130	48.4	18.3	M14	UEL206D1W3
1 1/16	**UELHP206-101D1W3**	3 35/64	6 1/2	4 23/32	1 31/32	21/32	13/16	5/8	5 1/8	1.906	0.720	1/2	UEL206-101D1W3
1 1/8	**UELHP206-102D1W3**												UEL206-102D1W3
1 3/16	**UELHP206-103D1W3**												UEL206-103D1W3
1 1/4	**UELHP206-104D1W3**												UEL206-104D1W3
35	**UELHP207D1W3**	95	166	127	60	17	21	18	140	51.1	18.8	M14	UEL207D1W3
1 1/4	**UELHP207-104D1W3**	3 47/64	6 17/32	5	2 3/8	21/32	13/16	23/32	5 1/2	2.012	0.740	1/2	UEL207-104D1W3
1 5/16	**UELHP207-105D1W3**												UEL207-105D1W3
1 3/8	**UELHP207-106D1W3**												UEL207-106D1W3
1 7/16	**UELHP207-107D1W3**												UEL207-107D1W3
40	**UELHP208D1W3**	100	184	136	70	17	21	20	150	56.3	21.4	M14	UEL208D1W3
1 1/2	**UELHP208-108D1W3**	3 15/16	7 1/4	5 11/32	2 3/4	21/32	13/16	25/32	5 29/32	2.217	0.843	1/2	UEL208-108D1W3
1 9/16	**UELHP208-109D1W3**												UEL208-109D1W3
45	**UELHP209D1W3**	105	190	146	70	17	22	20	158	56.3	21.4	M14	UEL209D1W3
1 5/8	**UELHP209-110D1W3**	4 9/64	7 15/32	5 3/4	2 3/4	21/32	7/8	25/32	6 7/32	2.217	0.843	1/2	UEL209-110D1W3
1 11/16	**UELHP209-111D1W3**												UEL209-111D1W3
1 3/4	**UELHP209-112D1W3**												UEL209-112D1W3
50	**UELHP210D1W3**	110	206	159	70	20	22	22	165	62.7	24.6	M16	UEL210D1W3
1 13/16	**UELHP210-113D1W3**	4 21/64	8 1/8	6 1/4	2 3/4	25/32	7/8	7/8	6 1/2	2.469	0.969	5/8	UEL210-113D1W3
1 7/8	**UELHP210-114D1W3**												UEL210-114D1W3
1 15/16	**UELHP210-115D1W3**												UEL210-115D1W3
2	**UELHP210-200D1W3**												UEL210-200D1W3

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
HP204D1	1.1
HP204D1	2.4
HP205D1	1.3
HP205D1	2.9
HP205D1	
HP205D1	
HP205D1	
HP206D1	1.9
HP206D1	4.2
HP206D1	
HP206D1	
HP206D1	
HP207D1	2.5
HP207D1	5.5
HP207D1	
HP207D1	
HP207D1	
HP208D1	3.5
HP208D1	7.7
HP208D1	
HP209D1	3.9
HP209D1	8.6
HP209D1	
HP209D1	
HP210D1	4.3
HP210D1	9.5
HP210D1	
HP210D1	
HP210D1	

Pillow blocks cast housing
Eccentric locking collar type

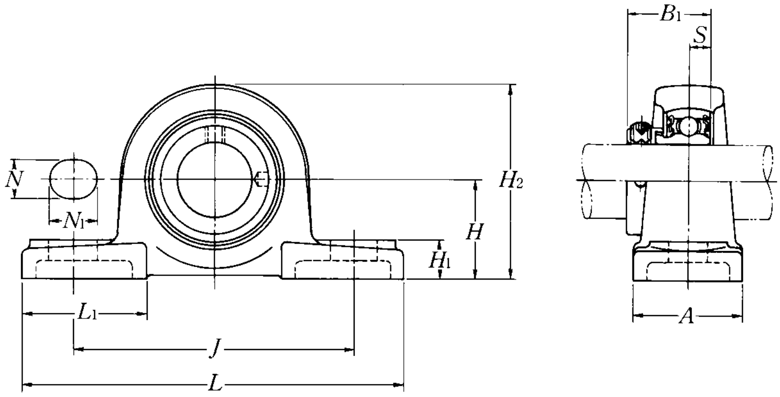


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch										Bearing number
		H	L	J	A	j	H_1	H_2	B_1	S	N	
20	**UELUP204D1W3**	30.2	76	52	38	13	11	62	43.7	17.1	M10 × 1.5	UEL204D1W3
$\frac{3}{4}$	**UELUP204-012D1W3**	$1\frac{3}{16}$	3	$2\frac{1}{16}$	$1\frac{1}{2}$	$\frac{1}{2}$	$\frac{7}{16}$	$2\frac{7}{16}$	1.720	0.673	M10 × 1.5	UEL204-012D1W3
25	**UELUP205D1W3**	36.5	84	56	38	15	12	72	44.4	17.5	M10 × 1.5	UEL205D1W3
$\frac{13}{16}$	**UELUP205-013D1W3**	$1\frac{7}{16}$	$3\frac{5}{16}$	$2\frac{7}{32}$	$1\frac{1}{2}$	$\frac{19}{32}$	$\frac{15}{32}$	$2\frac{27}{32}$	1.748	0.689	M10 × 1.5	UEL205-013D1W3
$\frac{7}{8}$	**UELUP205-014D1W3**											UEL205-014D1W3
$\frac{15}{16}$	**UELUP205-015D1W3**											UEL205-015D1W3
1	**UELUP205-100D1W3**											UEL205-100D1W3
30	**UELUP206D1W3**	42.9	94	66	48	18	12	84	48.4	18.3	M14 × 2	UEL206D1W3
$1\frac{1}{16}$	**UELUP206-101D1W3**	$1\frac{11}{16}$	$3\frac{11}{16}$	$2\frac{19}{32}$	$1\frac{7}{8}$	$\frac{23}{32}$	$\frac{15}{32}$	$3\frac{5}{16}$	1.906	0.720	M14 × 2	UEL206-101D1W3
$1\frac{1}{8}$	**UELUP206-102D1W3**											UEL206-102D1W3
$1\frac{3}{16}$	**UELUP206-103D1W3**											UEL206-103D1W3
$1\frac{1}{4}$	**UELUP206-104D1W3**											UEL206-104D1W3
35	**UELUP207D1W3**	47.6	110	80	48	20	13	95	51.1	18.8	M14 × 2	UEL207D1W3
$1\frac{1}{4}$	**UELUP207-104D1W3**	$1\frac{7}{8}$	$4\frac{11}{32}$	$3\frac{5}{32}$	$1\frac{7}{8}$	$\frac{25}{32}$	$\frac{1}{2}$	$3\frac{3}{4}$	2.012	0.740	M14 × 2	UEL207-104D1W3
$1\frac{5}{16}$	**UELUP207-105D1W3**											UEL207-105D1W3
$1\frac{3}{8}$	**UELUP207-106D1W3**											UEL207-106D1W3
$1\frac{7}{16}$	**UELUP207-107D1W3**											UEL207-107D1W3
40	**UELUP208D1W3**	49.2	116	84	54	20	13	100	56.3	21.4	M14 × 2	UEL208D1W3
$1\frac{1}{2}$	**UELUP208-108D1W3**	$1\frac{15}{16}$	$4\frac{9}{16}$	$3\frac{5}{16}$	$2\frac{1}{8}$	$\frac{25}{32}$	$\frac{1}{2}$	$3\frac{15}{16}$	2.217	0.843	M14 × 2	UEL208-108D1W3
$1\frac{9}{16}$	**UELUP208-109D1W3**											UEL208-109D1W3
45	**UELUP209D1W3**	54.2	120	90	54	25	13	108	56.3	21.4	M14 × 2	UEL209D1W3
$1\frac{5}{8}$	**UELUP209-110D1W3**	$2\frac{1}{8}$	$4\frac{23}{32}$	$3\frac{17}{32}$	$2\frac{1}{8}$	$\frac{31}{32}$	$\frac{1}{2}$	$4\frac{1}{4}$	2.217	0.843	M14 × 2	UEL209-110D1W3
$1\frac{11}{16}$	**UELUP209-111D1W3**											UEL209-111D1W3
$1\frac{3}{4}$	**UELUP209-112D1W3**											UEL209-112D1W3
50	**UELUP210D1W3**	57.2	130	94	60	25	14	116	62.7	24.6	M16 × 2	UEL210D1W3
$1\frac{13}{16}$	**UELUP210-113D1W3**	$2\frac{1}{4}$	$5\frac{1}{8}$	$3\frac{11}{16}$	$2\frac{3}{8}$	$\frac{31}{32}$	$\frac{9}{16}$	$4\frac{9}{16}$	2.469	0.969	M16 × 2	UEL210-113D1W3
$1\frac{7}{8}$	**UELUP210-114D1W3**											UEL210-114D1W3
$1\frac{15}{16}$	**UELUP210-115D1W3**											UEL210-115D1W3
2	**UELUP210-200D1W3**											UEL210-200D1W3

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
UP204D1	0.7
UP204D1	1.5
UP205D1	0.9
UP205D1	2.0
UP205D1	
UP205D1	
UP205D1	
UP206D1	1.3
UP206D1	2.9
UP206D1	
UP206D1	
UP206D1	
UP207D1	1.8
UP207D1	4.0
UP207D1	
UP207D1	
UP207D1	
UP208D1	2.1
UP208D1	4.6
UP208D1	
UP209D1	2.4
UP209D1	5.3
UP209D1	
UP209D1	
UP210D1	3.1
UP210D1	6.8
UP210D1	
UP210D1	
UP210D1	

Pillow blocks cast housing low center height
Eccentric locking collar type

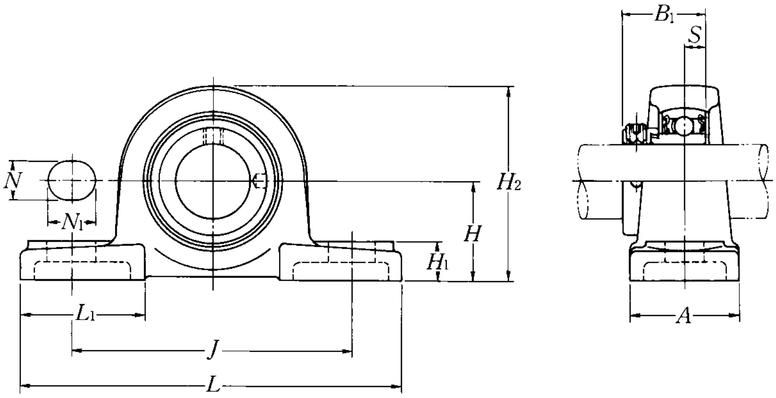


Shaft dia. mm inch	Unit number 1) 2)	Nominal dimensions mm inch											Bolt size mm inch
		H	L	J	A	N	N_1	H_1	H_2	L_1	B_1	S	
12	AELPL201W3	26.99	121	89	35	11	14	13	54	40	28.6	6.5	M10
1/2	AELPL201-008W3	1 1/16	4 3/4	3 1/2	1 3/8	7/16	9/16	1/2	2 1/8	1 9/16	1.126	0.256	3/8
15	AELPL202W3	26.99	121	89	35	11	14	13	54	40	28.6	6.5	M10
9/16	AELPL202-009W3	1 1/16	4 3/4	3 1/2	1 3/8	7/16	9/16	1/2	2 1/8	1 9/16	1.126	0.256	3/8
5/8	AELPL202-010W3												
17	AELPL203W3	26.99	121	89	35	11	14	13	54	40	28.6	6.5	M10
11/16	AELPL203-011W3	1 1/16	4 3/4	3 1/2	1 3/8	7/16	9/16	1/2	2 1/8	1 9/16	1.126	0.256	3/8
20	AELPL204W3	31.75	127	95	38	13	16	14	64	42	31	7.5	M10
3/4	AELPL204-012W3	1 1/4	5	3 3/4	1 1/2	1/2	5/8	9/16	2 17/32	1 21/32	1.220	0.295	3/8
25	AELPL205W3	33.34	140	105	38	13	16	15	68	42	31	7.5	M10
13/16	AELPL205-013W3	1 5/16	5 1/2	4 1/8	1 1/2	1/2	5/8	19/32	2 11/16	1 21/32	1.220	0.295	3/8
7/8	AELPL205-014W3												
15/16	AELPL205-015W3												
1	AELPL205-100W3												
30	AELPL206W3	39.69	165	121	48	17	20	17	80	54	35.7	9	M14
1 1/16	AELPL206-101W3	1 9/16	6 1/2	4 3/4	1 7/8	21/32	25/32	21/32	3 5/32	2 1/8	1.406	0.354	1/2
1 1/8	AELPL206-102W3												
1 3/16	AELPL206-103W3												
1 1/4	AELPL206-104W3												
35	AELPL207W3	46.04	167	127	48	17	20	18	91	54	38.9	9.5	M14
1 1/4	AELPL207-104W3	1 13/16	6 9/16	5	1 7/8	21/32	25/32	23/32	3 19/32	2 1/8	1.531	0.374	1/2
1 5/16	AELPL207-105W3												
1 3/8	AELPL207-106W3												
1 7/16	AELPL207-107W3												

Remarks: 1) AELPL201 to AELPL205 has solid base.
2) If relubricatable type is neede, please order with suffix "D1".

Bearing number 2)	Housing 2) number	Mass of unit kg lb
AEL201W3	PL201	0.6
AEL201-008W3	PL201	1.3
AEL202W3	PL201	0.6
AEL202-009W3	PL201	1.3
AEL202-010W3	PL201	
AEL203W3	PL201	0.6
AEL203-011W3	PL201	1.3
AEL204W3	PL204	0.7
AEL204-012W3	PL204	1.5
AEL205W3	PL205	0.8
AEL205-013W3	PL205	1.8
AEL205-014W3	PL205	
AEL205-015W3	PL205	
AEL205-100W3	PL205	
AEL206W3	PL206	1.2
AEL206-101W3	PL206	2.6
AEL206-102W3	PL206	
AEL206-103W3	PL206	
AEL206-104W3	PL206	
AEL207W3	PL207	1.6
AEL207-104W3	PL207	3.5
AEL207-105W3	PL207	
AEL207-106W3	PL207	
AEL207-107W3	PL207	

Pillow blocks cast housing low center height
Eccentric locking collar type

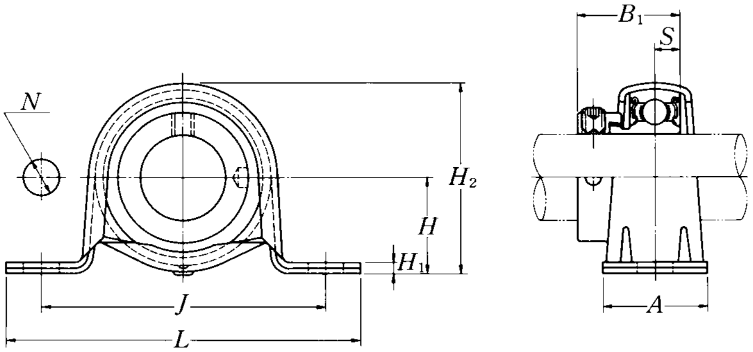


Shaft dia. mm inch	Unit number 1) 2)	Nominal dimensions mm inch											Bolt size mm inch
		H	L	J	A	N	N_1	H_1	H_2	L_1	B_1	S	
12	JELPL201W3	26.99	121	89	35	11	14	13	54	40	28.6	6.5	M10
1/2	JELPL201-008W3	1 1/16	4 3/4	3 1/2	1 3/8	7/16	9/16	1/2	2 1/8	1 9/16	1.126	0.256	3/8
15	JELPL202W3	26.99	121	89	35	11	14	13	54	40	28.6	6.5	M10
9/16	JELPL202-009W3	1 1/16	4 3/4	3 1/2	1 3/8	7/16	9/16	1/2	2 1/8	1 9/16	1.126	0.256	3/8
5/8	JELPL202-010W3												
17	JELPL203W3	26.99	121	89	35	11	14	13	54	40	28.6	6.5	M10
11/16	JELPL203-011W3	1 1/16	4 3/4	3 1/2	1 3/8	7/16	9/16	1/2	2 1/8	1 9/16	1.126	0.256	3/8
20	JELPL204W3	31.75	127	95	38	13	16	14	64	42	31	7.5	M10
3/4	JELPL204-012W3	1 1/4	5	3 3/4	1 1/2	1/2	5/8	9/16	2 17/32	1 21/32	1.220	0.295	3/8
25	JELPL205W3	33.34	140	105	38	13	16	15	68	42	31	7.5	M10
13/16	JELPL205-013W3	1 5/16	5 1/2	4 1/8	1 1/2	1/2	5/8	19/32	2 11/16	1 21/32	1.220	0.295	3/8
7/8	JELPL205-014W3												
15/16	JELPL205-015W3												
1	JELPL205-100W3												
30	JELPL206W3	39.69	165	121	48	17	20	17	80	54	35.7	9	M14
1 1/16	JELPL206-101W3	1 9/16	6 1/2	4 3/4	1 7/8	21/32	25/32	21/32	3 5/32	2 1/8	1.406	0.354	1/2
1 1/8	JELPL206-102W3												
1 3/16	JELPL206-103W3												
1 1/4	JELPL206-104W3												
35	JELPL207W3	46.04	167	127	48	17	20	18	91	54	38.9	9.5	M14
1 1/4	JELPL207-104W3	1 13/16	6 9/16	5	1 7/8	21/32	25/32	23/32	3 19/32	2 1/8	1.531	0.374	1/2
1 5/16	JELPL207-105W3												
1 3/8	JELPL207-106W3												
1 7/16	JELPL207-107W3												

Remarks: 1) JELPL201 to JELPL205 has solid base.
2) If relubricatable type is neede, please order with suffix "D1".

Bearing number 2)	Housing 2) number	Mass of unit kg lb
JEL201W3	PL201	0.6
JEL201-008W3	PL201	1.3
JEL202W3	PL201	0.6
JEL202-009W3	PL201	1.3
JEL202-010W3	PL201	
JEL203W3	PL201	0.6
JEL203-011W3	PL201	1.3
JEL204W3	PL204	0.7
JEL204-012W3	PL204	1.5
JEL205W3	PL205	0.8
JEL205-013W3	PL205	1.8
JEL205-014W3	PL205	
JEL205-015W3	PL205	
JEL205-100W3	PL205	
JEL206W3	PL206	1.2
JEL206-101W3	PL206	2.6
JEL206-102W3	PL206	
JEL206-103W3	PL206	
JEL206-104W3	PL206	
JEL207W3	PL207	1.6
JEL207-104W3	PL207	3.5
JEL207-105W3	PL207	
JEL207-106W3	PL207	
JEL207-107W3	PL207	

Pillow blocks pressed steel housing
Eccentric locking collar type



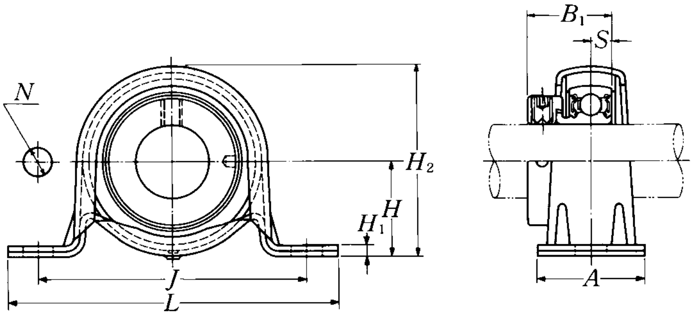
Shaft dia.	Unit number	Nominal dimensions									Bolt size	Bearing number
mm inch		mm inch H	L	J	A	N	H_1	H_2	B_1	S	mm inch	
12	**AELPP201W3**	22.2	86	68	25	9.5	3.2	43.8	28.6	6.5	M 8	AEL201W3
1/2	**AELPP201-008W3**	7/8	3 3/8	2 11/16	31/32	3/8	0.126	1 23/32	1.126	0.256	5/16	AEL201-008W3
15	**AELPP202W3**	22.2	86	68	25	9.5	3.2	43.8	28.6	6.5	M 8	AEL202W3
9/16	**AELPP202-009W3**	7/8	3 3/8	2 11/16	31/32	3/8	0.126	1 23/32	1.126	0.256	5/16	AEL202-009W3
5/8	**AELPP202-010W3**											AEL202-010W3
17	**AELPP203W3**	22.2	86	68	25	9.5	3.2	43.8	28.6	6.5	M 8	AEL203W3
11/16	**AELPP203-011W3**	7/8	3 3/8	2 11/16	31/32	3/8	0.126	1 23/32	1.126	0.256	5/16	AEL203-011W3
20	**AELPP204W3**	25.4	98	76	32	9.5	3.2	50.5	31	7.5	M 8	AEL204W3
3/4	**AELPP204-012W3**	1	3 27/32	3	1 1/4	3/8	0.126	2	1.220	0.295	5/16	AEL204-012W3
25	**AELPP205W3**	28.6	108	86	32	11.5	4	56.6	31	7.5	M10	AEL205W3
13/16	**AELPP205-013W3**	1 1/8	4 1/4	3 3/8	1 1/4	29/64	0.157	2 7/32	1.220	0.295	3/8	AEL205-013W3
7/8	**AELPP205-014W3**											AEL205-014W3
15/16	**AELPP205-015W3**											AEL205-015W3
1	**AELPP205-100W3**											AEL205-100W3
30	**AELPP206W3**	33.3	117	95	38	11.5	4	66.3	35.7	9	M10	AEL206W3
1 1/16	**AELPP206-101W3**	1 5/16	4 19/32	3 3/4	1 1/2	29/64	0.157	2 5/8	1.406	0.354	3/8	AEL206-101W3
1 1/8	**AELPP206-102W3**											AEL206-102W3
1 3/16	**AELPP206-103W3**											AEL206-103W3
1 1/4	**AELPP206-104W3**											AEL206-104W3
35	**AELPP207W3**	39.7	129	106	42	11.5	4.6	78	38.9	9.5	M10	AEL207W3
1 1/4	**AELPP207-104W3**	1 9/16	5 3/32	4 3/16	1 21/32	29/64	0.181	3 1/16	1.531	0.374	3/8	AEL207-104W3
1 5/16	**AELPP207-105W3**											AEL207-105W3
1 3/8	**AELPP207-106W3**											AEL207-106W3
1 7/16	**AELPP207-107W3**											AEL207-107W3

Remarks: 1) The permissible load only applies in applications where the load is stable and the speed is 2400 rpm or less.
The mounting surface should be flat.

Housing number	Mass of unit kg lb	Max. load [1) recommended N lbf	
		radial	axial
PP203 PP203	0.2 0.4	2 000 440	800 160
PP203 PP203 PP203	0.2 0.4	2 000 440	800 160
PP203 PP203	0.2 0.4	2 000 440	800 160
PP204 PP204	0.2 0.4	2 500 550	1 000 200
PP205 PP205 PP205 PP205 PP205	0.3 0.7	3 500 770	1 400 280
PP206 PP206 PP206 PP206 PP206	0.5 1.1	4 000 880	1 600 320
PP207 PP207 PP207 PP207 PP207	0.7 1.5	4 500 990	1 800 360

AELRPP2

Pillow blocks pressed steel housing with rubber ring
Eccentric locking collar type

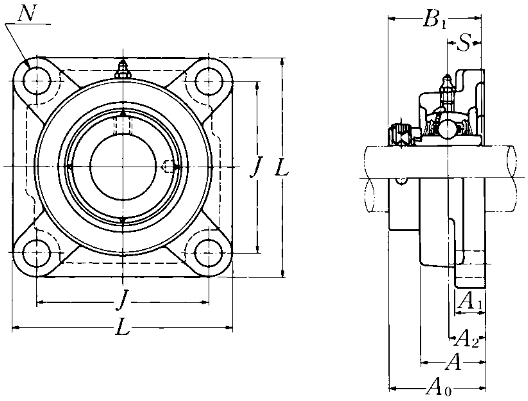


Shaft dia.	Unit number	Nominal dimensions									Bolt size	Bearing number
mm inch		mm inch									mm inch	
		H	L	J	A	N	H_1	H_2	B_1	S		
12	**AELRPP201W3**	25.4	98	76	32	9.5	3.2	50.5	28.6	6.5	M 8	AEL201W3
$\frac{1}{2}$	**AELRPP201-008W3**	1	$3\frac{27}{32}$	3	$1\frac{1}{4}$	$\frac{3}{8}$	0.126	2	1.126	0.256	$\frac{5}{16}$	AEL201-008W3
15	**AELRPP202W3**	25.4	98	76	32	9.5	3.2	50.5	28.6	6.5	M 8	AEL202W3
$\frac{9}{16}$	**AELRPP202-009W3**	1	$3\frac{27}{32}$	3	$1\frac{1}{4}$	$\frac{3}{8}$	0.126	2	1.126	0.256	$\frac{5}{16}$	AEL202-009W3
$\frac{5}{8}$	**AELRPP202-010W3**											AEL202-010W3
17	**AELRPP203W3**	25.4	98	76	32	9.5	3.2	50.5	28.6	6.5	M 8	AEL203W3
$\frac{11}{16}$	**AELRPP203-011W3**	1	$3\frac{27}{32}$	3	$1\frac{1}{4}$	$\frac{3}{8}$	0.126	2	1.126	0.256	$\frac{5}{16}$	AEL203-011W3
20	**AELRPP204W3**	28.6	108	86	32	11.5	4	56.6	31	7.5	M10	AEL204W3
$\frac{3}{4}$	**AELRPP204-012W3**	$1\frac{1}{8}$	$4\frac{1}{4}$	$3\frac{3}{8}$	$1\frac{1}{4}$	$\frac{29}{64}$	0.157	$2\frac{7}{32}$	1.220	0.295	$\frac{3}{8}$	AEL204-012W3
25	**AELRPP205W3**	33.3	117	95	38	11.5	4	66.3	31	7.5	M10	AEL205W3
$\frac{13}{16}$	**AELRPP205-013W3**	$1\frac{5}{16}$	$4\frac{19}{32}$	$3\frac{3}{4}$	$1\frac{1}{2}$	$\frac{29}{64}$	0.157	$2\frac{5}{8}$	1.220	0.295	$\frac{3}{8}$	AEL205-013W3
$\frac{7}{8}$	**AELRPP205-014W3**											AEL205-014W3
$\frac{15}{16}$	**AELRPP205-015W3**											AEL205-015W3
1	**AELRPP205-100W3**											AEL205-100W3
30	**AELRPP206W3**	39.7	129	106	42	11.5	4.6	78	35.7	9	M10	AEL206W3
$1\frac{1}{16}$	**AELRPP206-101W3**	$1\frac{9}{16}$	$5\frac{3}{32}$	$4\frac{3}{16}$	$1\frac{21}{32}$	$\frac{29}{64}$	0.181	$3\frac{1}{16}$	1.406	0.354	$\frac{3}{8}$	AEL206-101W3
$1\frac{1}{8}$	**AELRPP206-102W3**											AEL206-102W3
$1\frac{3}{16}$	**AELRPP206-103W3**											AEL206-103W3
$1\frac{1}{4}$	**AELRPP206-104W3**											AEL206-104W3

Remarks: 1) The permissible load only applies in applications where the load is stable and the speed is 2400 rpm or less.
The mounting surface should be flat.
2) When an anti-vibration rubber ring is used, the self alignment capability will be reduce.

Housing number	Mass of unit	Max. load [1)] recommended	
	kg lb	N lbf	
		radial	axial
PP204 PP204	0.2 0.4	1 000 220	200 40
PP204 PP204 PP204	0.2 0.4	1 000 220	200 40
PP204 PP204	0.2 0.4	1 000 220	200 40
PP205 PP205	0.3 0.7	1 150 250	200 40
PP206 PP206 PP206 PP206 PP206	0.5 1.1	1 300 280	200 40
PP207 PP207 PP207 PP207 PP207	0.7 1.5	1 500 330	200 40

Flanged units cast housing
Eccentric locking collar type

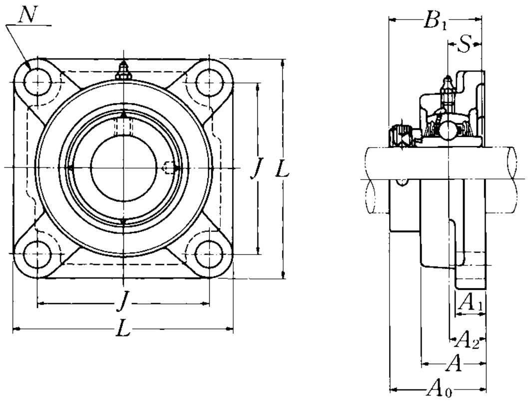


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch									Bolt size mm inch	Bearing number
		L	J	A_2	A_1	A	N	A_0	B_1	S		
20	**UELFU204D1W3**	86	63.5	19	15	29.5	11.5	45.6	43.7	17.1	M10	UEL204D1W3
3/4	**UELFU204-012D1W3**	3 3/8	2 1/2	3/4	19/32	1 5/32	29/64	1 51/64	1.720	0.673	3/8	UEL204-012D1W3
25	**UELFU205D1W3**	96	70	19	15	30	11.5	45.9	44.4	17.5	M10	UEL205D1W3
13/16	**UELFU205-013D1W3**	3 25/32	2 3/4	3/4	19/32	1 3/16	29/64	1 13/16	1.748	0.689	3/8	UEL205-013D1W3
7/8	**UELFU205-014D1W3**											UEL205-014D1W3
15/16	**UELFU205-015D1W3**											UEL205-015D1W3
1	**UELFU205-100D1W3**											UEL205-100D1W3
30	**UELFU206D1W3**	109	82.5	20	16	33	11.5	50.1	48.4	18.3	M10	UEL206D1W3
1 1/16	**UELFU206-101D1W3**	4 9/32	3 1/4	25/32	5/8	1 5/16	29/64	1 31/32	1.906	0.720	3/8	UEL206-101D1W3
1 1/8	**UELFU206-102D1W3**											UEL206-102D1W3
1 3/16	**UELFU206-103D1W3**											UEL206-103D1W3
1 1/4	**UELFU206-104D1W3**											UEL206-104D1W3
35	**UELFU207D1W3**	118	92	21	17	36	14	53.3	51.1	18.8	M12	UEL207D1W3
1 1/4	**UELFU207-104D1W3**	4 21/32	3 5/8	53/64	21/32	1 13/32	35/64	2 3/32	2.012	0.740	1/2	UEL207-104D1W3
1 5/16	**UELFU207-105D1W3**											UEL207-105D1W3
1 3/8	**UELFU207-106D1W3**											UEL207-106D1W3
1 7/16	**UELFU207-107D1W3**											UEL207-107D1W3
40	**UELFU208D1W3**	131	101.5	24	17	39	14	58.9	56.3	21.4	M12	UEL208D1W3
1 1/2	**UELFU208-108D1W3**	5 5/32	4	15/16	21/32	1 17/32	35/64	2 5/16	2.217	0.843	1/2	UEL208-108D1W3
1 9/16	**UELFU208-109D1W3**											UEL208-109D1W3
45	**UELFU209D1W3**	137	105	24	18	40	16	58.9	56.3	21.4	M14	UEL209D1W3
1 5/8	**UELFU209-110D1W3**	5 13/32	4 9/64	15/16	23/32	1 9/16	5/8	2 5/16	2.217	0.843	1/2	UEL209-110D1W3
1 11/16	**UELFU209-111D1W3**											UEL209-111D1W3
1 3/4	**UELFU209-112D1W3**											UEL209-112D1W3
50	**UELFU210D1W3**	144	111	28	20	46	18	66.1	62.7	24.6	M16	UEL210D1W3
1 13/16	**UELFU210-113D1W3**	5 21/32	4 3/8	1 7/64	25/32	1 13/16	45/64	2 39/64	2.469	0.969	5/8	UEL210-113D1W3
1 7/8	**UELFU210-114D1W3**											UEL210-114D1W3
1 15/16	**UELFU210-115D1W3**											UEL210-115D1W3
2	**UELFU210-200D1W3**											UEL210-200D1W3

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
FU204D1	0.8
FU204D1	1.8
FU205D1	0.9
FU205D1	2.0
FU205D1	
FU205D1	
FU205D1	
FU206D1	1.3
FU206D1	2.9
FU206D1	
FU206D1	
FU206D1	
FU207D1	1.8
FU207D1	4.0
FU207D1	
FU207D1	
FU207D1	
FU208D1	2.1
FU208D1	4.6
FU208D1	
FU209D1	2.5
FU209D1	5.5
FU209D1	
FU209D1	
FU210D1	2.9
FU210D1	6.4
FU210D1	
FU210D1	
FU210D1	

Flanged units cast housing
Eccentric locking collar type

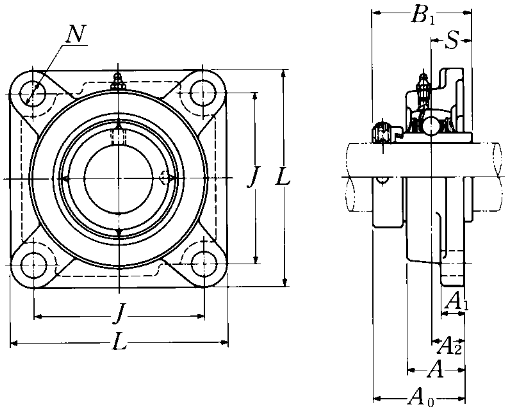


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch									Bolt size mm inch	Bearing number
		L	*J*	*A*₂	*A*₁	*A*	*N*	*A*₀	*B*₁	*S*		
55	**UELFU211D1W3**	163	130	31	21	49	18	74.6	71.4	27.8	M16	UEL211D1W3
2	**UELFU211-200D1W3**	$6\frac{13}{32}$	$5\frac{1}{8}$	$1\frac{7}{32}$	$\frac{13}{16}$	$1\frac{15}{16}$	$\frac{45}{64}$	$2\frac{15}{16}$	2.811	1.094	$\frac{5}{8}$	UEL211-200D1W3
$2\frac{1}{16}$	**UELFU211-201D1W3**											UEL211-201D1W3
$2\frac{1}{8}$	**UELFU211-202D1W3**											UEL211-202D1W3
$2\frac{3}{16}$	**UELFU211-203D1W3**											UEL211-203D1W3
60	**UELFU212D1W3**	175	143	34	21	53	18	80.8	77.8	31	M16	UEL212D1W3
$2\frac{1}{4}$	**UELFU212-204D1W3**	$6\frac{7}{8}$	$5\frac{5}{8}$	$1\frac{11}{32}$	$\frac{13}{16}$	$2\frac{3}{32}$	$\frac{45}{64}$	$3\frac{3}{16}$	3.063	1.220	$\frac{5}{8}$	UEL212-204D1W3
$2\frac{5}{16}$	**UELFU212-205D1W3**											UEL212-205D1W3
$2\frac{3}{8}$	**UELFU212-206D1W3**											UEL212-206D1W3
$2\frac{7}{16}$	**UELFU212-207D1W3**											UEL212-207D1W3
65	**UELFU213D1W3**	187	149	38	22	59	20.5	89.55	85.7	34.15	M18	UEL213D1W3
$2\frac{1}{2}$	**UELFU213-208D1W3**	$7\frac{3}{8}$	$5\frac{55}{64}$	$1\frac{1}{2}$	$\frac{7}{8}$	$2\frac{5}{16}$	$\frac{13}{16}$	$3\frac{17}{32}$	3.374	1.344	$\frac{5}{8}$	UEL213-208D1W3
$2\frac{9}{16}$	**UELFU213-209D1W3**											UEL213-209D1W3
70	**UELFU214D1W3**	193	152	38	22	62	20.5	89.55	85.7	34.15	M18	UEL214D1W3
$2\frac{5}{8}$	**UELFU214-210D1W3**	$7\frac{19}{32}$	$5\frac{63}{64}$	$1\frac{1}{2}$	$\frac{7}{8}$	$2\frac{7}{16}$	$\frac{13}{16}$	$3\frac{17}{32}$	3.374	1.344	$\frac{5}{8}$	UEL214-210D1W3
$2\frac{11}{16}$	**UELFU214-211D1W3**											UEL214-211D1W3
$2\frac{3}{4}$	**UELFU214-212D1W3**											UEL214-212D1W3
75	**UELFU215D1W3**	200	159	41	22	65	20.5	95.7	92	37.3	M18	UEL215D1W3
$2\frac{13}{16}$	**UELFU215-213D1W3**	$7\frac{7}{8}$	$6\frac{17}{64}$	$1\frac{39}{64}$	$\frac{7}{8}$	$2\frac{9}{16}$	$\frac{13}{16}$	$3\frac{49}{64}$	3.622	1.469	$\frac{5}{8}$	UEL215-213D1W3
$2\frac{7}{8}$	**UELFU215-214D1W3**											UEL215-214D1W3
$2\frac{15}{16}$	**UELFU215-215D1W3**											UEL215-215D1W3
3	**UELFU215-300D1W3**											UEL215-300D1W3

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
FU211D1	4.2
FU211D1	9.3
FU211D1	
FU211D1	
FU211D1	
FU212D1	5.2
FU212D1	11
FU212D1	
FU212D1	
FU212D1	
FU213D1	6.1
FU213D1	13
FU213D1	
FU214D1	6.0
FU214D1	13
FU214D1	
FU214D1	
FU215D1	7.5
FU215D1	17
FU215D1	
FU215D1	
FU215D1	

Flanged units cast housing
Eccentric locking collar type



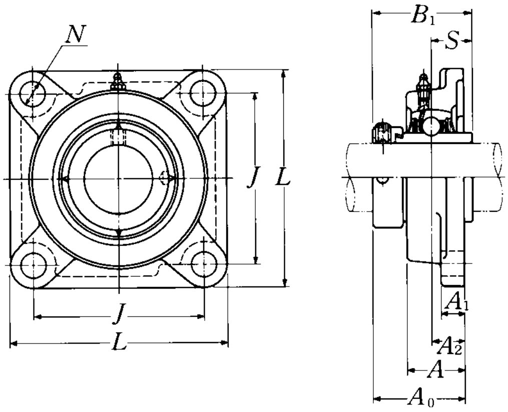
Shaft dia. mm inch	Unit number [1]	Nominal dimensions mm inch									Bolt size mm inch	Bearing number
		L	J	A_2	A_1	A	N	A_0	B_1	S		
20	UELF204D1W3	86	64	15	11	25.5	12	41.6	43.7	17.1	M10	UEL204D1W3
3/4	UELF204-012D1W3	3 3/8	2 33/64	19/32	7/16	1	15/32	1 41/64	1.720	0.673	3/8	UEL204-012D1W3
25	UELF205D1W3	95	70	16	13	27	12	42.9	44.4	17.5	M10	UEL205D1W3
13/16	UELF205-013D1W3	3 3/4	2 3/4	5/8	1/2	1 1/16	15/32	1 11/16	1.748	0.689	3/8	UEL205-013D1W3
7/8	UELF205-014D1W3											UEL205-014D1W3
15/16	UELF205-015D1W3											UEL205-015D1W3
1	UELF205-100D1W3											UEL205-100D1W3
30	UELF206D1W3	108	83	18	13	31	12	48.1	48.4	18.3	M10	UEL206D1W3
1 1/16	UELF206-101D1W3	4 1/4	3 17/64	45/64	1/2	1 7/32	15/32	1 57/64	1.906	0.720	3/8	UEL206-101D1W3
1 1/8	UELF206-102D1W3											UEL206-102D1W3
1 3/16	UELF206-103D1W3											UEL206-103D1W3
1 1/4	UELF206-104D1W3											UEL206-104D1W3
35	UELF207D1W3	117	92	19	15	34	14	51.3	51.1	18.8	M12	UEL207D1W3
1 1/4	UELF207-104D1W3	4 19/32	3 5/8	3/4	19/32	1 11/32	35/64	2 1/64	2.012	0.740	7/16	UEL207-104D1W3
1 5/16	UELF207-105D1W3											UEL207-105D1W3
1 3/8	UELF207-106D1W3											UEL207-106D1W3
1 7/16	UELF207-107D1W3											UEL207-107D1W3
40	UELF208D1W3	130	102	21	15	36	16	55.9	56.3	21.4	M14	UEL208D1W3
1 1/2	UELF208-108D1W3	5 1/8	4 1/64	53/64	19/32	1 13/32	5/8	2 13/64	2.217	0.843	1/2	UEL208-108D1W3
1 9/16	UELF208-109D1W3											UEL208-109D1W3
45	UELF209D1W3	137	105	22	16	38	16	56.9	56.3	21.4	M14	UEL209D1W3
1 5/8	UELF209-110D1W3	5 13/32	4 9/64	55/64	5/8	1 1/2	5/8	2 15/64	2.217	0.843	1/2	UEL209-110D1W3
1 11/16	UELF209-111D1W3											UEL209-111
1 3/4	UELF209-112D1W3											UEL209-112
50	UELF210D1W3	143	111	22	16	40	16	60.1	62.7	24.6	M14	UEL210D1W3
1 13/16	UELF210-113D1W3	5 5/8	4 3/8	55/64	5/8	1 9/16	5/8	2 23/64	2.469	0.969	1/2	UEL210-113D1W3
1 7/8	UELF210-114D1W3											UEL210-114D1W3
1 15/16	UELF210-115D1W3											UEL210-115D1W3
2	UELF210-200D1W3											UEL210-200D1W3

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
F204D1	0.7
F204D1	1.5
F205D1	0.8
F205D1	1.8
F205D1	
F205D1	
F205D1	
F206D1	1.2
F206D1	2.6
F206D1	
F206D1	
F206D1	
F207D1	1.6
F207D1	3.5
F207D1	
F207D1	
F207D1	
F208D1	1.9
F208D1	4.2
F208D1	
F209D1	2.3
F209D1	5.1
F209D1	
F209D1	
F210D1	2.6
F210D1	5.7
F210D1	
F210D1	
F210D1	

UELF2

Flanged units cast housing
Eccentric locking collar type

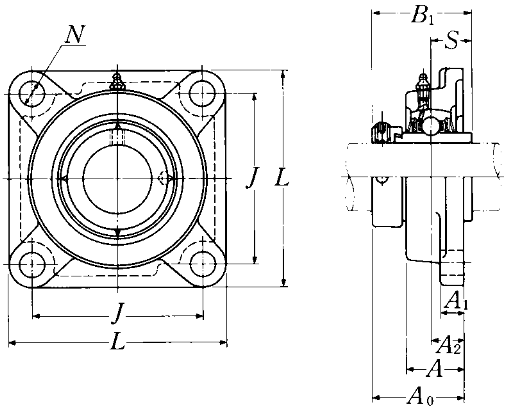


Shaft dia.	Unit number 1)	Nominal dimensions									Bolt size	Bearing number
mm inch		L	J	A_2	A_1	A	N	A_0	B_1	S	mm inch	
55	**UELF211D1W3**	162	130	25	18	43	19	68.6	71.4	27.8	M16	UEL211D1W3
2	**UELF211-200D1W3**	6 3/8	5 1/8	63/64	23/32	1 11/16	3/4	2 45/64	2.811	1.094	5/8	UEL211-200D1W3
2 1/16	**UELF211-201D1W3**											UEL211-201D1W3
2 1/8	**UELF211-202D1W3**											UEL211-202D1W3
2 3/16	**UELF211-203D1W3**											UEL211-203D1W3
60	**UELF212D1W3**	175	143	29	18	48	19	75.8	77.8	31	M16	UEL212D1W3
2 1/4	**UELF212-204D1W3**	6 7/8	5 5/8	1 9/64	23/32	1 7/8	3/4	2 63/64	3.063	1.220	5/8	UEL212-204D1W3
2 5/16	**UELF212-205D1W3**											UEL212-205D1W3
2 3/8	**UELF212-206D1W3**											UEL212-206D1W3
2 7/16	**UELF212-207D1W3**											UEL212-207D1W3
65	**UELF213D1W3**	187	149	30	22	50	19	81.55	85.7	34.15	M16	UEL213D1W3
2 1/2	**UELF213-208D1W3**	7 3/8	5 55/64	1 3/16	7/8	1 31/32	3/4	3 13/16	3.374	1.344	5/8	UEL213-208D1W3
2 9/16	**UELF213-209D1W3**											UEL213-209D1W3
70	**UELF214D1W3**	193	152	31	22	54	19	82.55	85.7	34.15	M16	UEL214D1W3
2 5/8	**UELF214-210D1W3**	7 19/32	5 63/64	1 7/32	7/8	2 1/8	3/4	3 1/4	3.374	1.344	5/8	UEL214-210D1W3
2 11/16	**UELF214-211D1W3**											UEL214-211D1W3
2 3/4	**UELF214-212D1W3**											UEL214-212D1W3
75	**UELF215D1W3**	200	159	34	22	56	19	88.7	92	37.3	M16	UEL215D1W3
2 13/16	**UELF215-213D1W3**	7 7/8	6 17/64	1 11/32	7/8	2 7/32	3/4	3 31/64	3.622	1.469	5/8	UEL215-213D1W3
2 7/8	**UELF215-214D1W3**											UEL215-214D1W3
2 15/16	**UELF215-215D1W3**											UEL215-215D1W3
3	**UELF215-300D1W3**											UEL215-300D1W3

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
F211D1	3.8
F211D1	8.4
F211D1	
F211D1	
F211D1	
F212D1	4.8
F212D1	11
F212D1	
F212D1	
F212D1	
F213D1	6.0
F213D1	13
F213D1	
F214D1	6.3
F214D1	14
F214D1	
F214D1	
F215D1	7.2
F215D1	16
F215D1	
F215D1	
F215D1	

Flanged units cast housing
Eccentric locking collar type

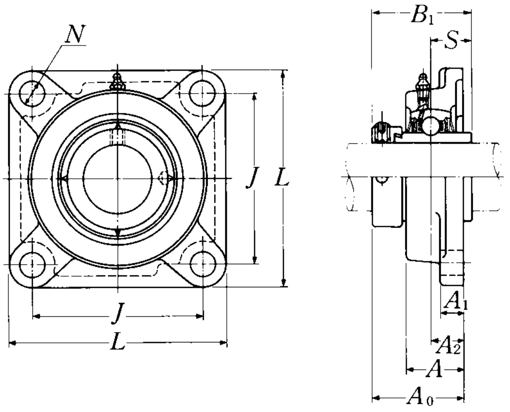


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch									Bolt size mm inch	Bearing number
		L	J	A_2	A_1	A	N	A_0	B_1	S		
25	**UELF305D1W3**	110	80	16	13	29	16	46.1	46.8	16.7	M14	UEL305D1W3
13/16	**UELF305-013D1W3**	4 11/32	3 5/32	5/8	1/2	1 5/32	5/8	1 3/16	1.843	0.657	1/2	UEL305-013D1W3
7/8	**UELF305-014D1W3**											UEL305-014D1W3
15/16	**UELF305-015D1W3**											UEL305-015D1W3
1	**UELF305-100D1W3**											UEL305-100D1W3
30	**UELF306D1W3**	125	95	18	15	32	16	50.5	50	17.5	M14	UEL306D1W3
1 1/16	**UELF306-101D1W3**	4 29/32	3 47/64	45/64	19/32	1 1/4	5/8	1 63/64	1.969	0.689	1/2	UEL306-101D1W3
1 1/8	**UELF306-102D1W3**											UEL306-102D1W3
1 3/16	**UELF306-103D1W3**											UEL306-103D1W3
35	**UELF307D1W3**	135	100	20	16	36	19	53.3	51.6	18.3	M16	UEL307D1W3
1 1/4	**UELF307-104D1W3**	5 5/16	3 15/16	25/32	5/8	1 13/32	3/4	2 3/32	2.031	0.720	5/8	UEL307-104D1W3
1 5/16	**UELF307-105D1W3**											UEL307-105D1W3
1 3/8	**UELF307-106D1W3**											UEL307-106D1W3
1 7/16	**UELF307-107D1W3**											UEL307-107D1W3
40	**UELF308D1W3**	150	112	23	17	40	19	60.3	57.1	19.8	M16	UEL308D1W3
1 1/2	**UELF308-108D1W3**	5 29/32	4 13/32	29/32	21/32	1 9/16	3/4	2 3/8	2.248	0.780	5/8	UEL308-108D1W3
1 9/16	**UELF308-109D1W3**											UEL308-109D1W3
45	**UELF309D1W3**	160	125	25	18	44	19	63.9	58.7	19.8	M16	UEL309D1W3
1 5/8	**UELF309-110D1W3**	6 5/16	4 59/64	63/64	23/32	1 23/32	3/4	2 33/64	2.311	0.780	5/8	UEL309-110D1W3
1 11/16	**UELF309-111D1W3**											UEL309-111D1W3
1 3/4	**UELF309-112D1W3**											UEL309-112D1W3
50	**UELF310D1W3**	175	132	28	19	48	23	70	66.6	24.6	M20	UEL310D1W3
1 13/16	**UELF310-113D1W3**	6 7/8	5 13/64	1 7/64	3/4	1 7/8	29/32	2 3/4	2.622	0.969	3/4	UEL310-113D1W3
1 7/8	**UELF310-114D1W3**											UEL310-114D1W3
1 15/16	**UELF310-115D1W3**											UEL310-115D1W3
55	**UELF311D1W3**	185	140	30	20	52	23	75.2	73	27.8	M20	UEL311D1W3
2	**UELF311-200D1W3**	7 9/32	5 33/64	1 3/16	25/32	2 1/16	29/32	2 61/64	2.874	1.094	3/4	UEL311-200D1W3
2 1/16	**UELF311-201D1W3**											UEL311-201D1W3
2 1/8	**UELF311-202D1W3**											UEL311-202D1W3
2 3/16	**UELF311-203D1W3**											UEL311-203D1W3

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1"
2) Inner race face does not protrude from the housing face except UELF305 and UELF316.
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
F305D1	1.2
F305D1	2.6
F305D1	
F305D1	
F305D1	
F306D1	1.7
F306D1	3.7
F306D1	
F306D1	
F307D1	2.0
F307D1	4.4
F307D1	
F307D1	
F307D1	
F308D1	2.8
F308D1	6.2
F308D1	
F309D1	3.6
F309D1	7.9
F309D1	
F309D1	
F310D1	4.7
F310D1	10
F310D1	
F310D1	
F311D1	5.7
F311D1	13
F311D1	
F311D1	
F311D1	

Flanged units cast housing
Eccentric locking collar type



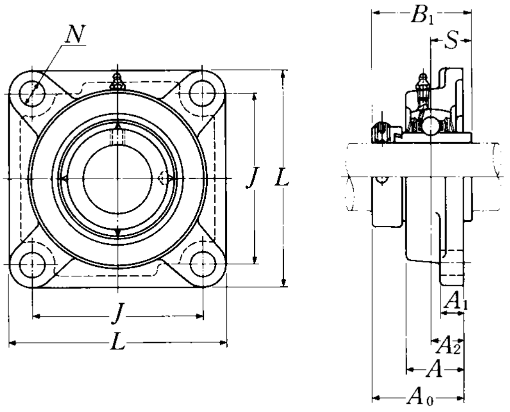
Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch									Bolt size mm inch	Bearing number
		L	J	A_2	A_1	A	N	A_0	B_1	S		
60	**UELF312D1W3**	195	150	33	22	56	23	81.45	79.4	30.95	M20	UEL312D1W3
2 1/4	**UELF312-204D1W3**	7 11/16	5 29/32	1 19/64	7/8	2 7/32	29/32	3 13/64	3.126	1.219	3/4	UEL312-204D1W3
2 5/16	**UELF312-205D1W3**											UEL312-205D1W3
2 3/8	**UELF312-206D1W3**											UEL312-206D1W3
2 7/16	**UELF312-207D1W3**											UEL312-207D1W3
65	**UELF313D1W3**	208	166	33	22	58	23	86.15	85.7	32.55	M20	UEL313D1W3
2 1/2	**UELF313-208D1W3**	8 3/16	6 17/32	1 19/64	7/8	2 9/32	29/32	3 25/64	3.374	1.281	3/4	UEL313-208D1W3
2 9/16	**UELF313-209D1W3**											UEL313-209D1W3
70	**UELF314D1W3**	226	178	36	25	61	25	93.95	92.1	34.15	M22	UEL314D1W3
2 5/8	**UELF314-210D1W3**	8 29/32	6 1/64	1 27/64	31/32	2 13/32	63/64	3 45/64	3.626	1.344	7/8	UEL314-210D1W3
2 11/16	**UELF314-211D1W3**											UEL314-211D1W3
2 3/4	**UELF314-212D1W3**											UEL314-212D1W3
75	**UELF315D1W3**	236	184	39	25	66	25	101.7	100	37.3	M22	UEL315D1W3
2 13/16	**UELF315-213D1W3**	9 9/32	7 1/4	1 17/32	31/32	2 19/32	63/64	4	3.937	1.469	7/8	UEL315-213D1W3
2 7/8	**UELF315-214D1W3**											UEL315-214D1W3
2 15/16	**UELF315-215D1W3**											UEL315-215D1W3
3	**UELF315-300D1W3**											UEL315-300D1W3
80	**UELF316D1W3**	250	196	38	27	68	31	103.9	106.4	40.5	M27	UEL316D1W3
3 1/16	**UELF316-301D1W3**	9 27/32	7 23/32	1 1/2	1 1/16	2 11/16	1 7/32	4 3/32	4.189	1.594	1	UEL316-301D1W3
3 1/8	**UELF316-302D1W3**											UEL316-302D1W3
3 3/16	**UELF316-303D1W3**											UEL316-303D1W3
85	**UELF317D1W3**	260	204	44	27	74	31	111.45	109.5	42.05	M27	UEL317D1W3
3 1/4	**UELF317-304D1W3**	10 1/4	8 1/32	1 47/64	1 1/16	2 29/32	1 7/32	4 25/64	4.311	1.656	1	UEL317-304D1W3
3 5/16	**UELF317-305D1W3**											UEL317-305D1W3
3 7/16	**UELF317-307D1W3**											UEL317-307D1W3
90	**UELF318D1W3**	280	216	44	30	76	35	116.25	115.9	43.65	M30	UEL318D1W3
3 7/16	**UELF318-307D1W3**	11 1/32	8 1/2	1 47/64	1 3/16	3	1 3/8	4 37/64	4.563	1.719	1 1/8	UEL318-308D1W3
3 1/2	**UELF318-308D1W3**											UEL318-308D1W3

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Inner race face does not protrude from the housing face except UELF305 and UELF316.

Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit	
	kg	lb
F312D1	6.8	
F312D1		15
F312D1		
F312D1		
F312D1		
F313D1	8.3	
F313D1		18
F313D1		
F314D1	10	
F314D1		22
F314D1		
F314D1		
F315D1	12	
F315D1		26
F315D1		
F315D1		
F315D1		
F316D1	16	
F316D1		35
F316D1		
F316D1		
F317D1	17	
F317D1		37
F317D1		
F317D1		
F318D1	21	
F318D1		46
F318D1		

Flanged units cast housing
Eccentric locking collar type

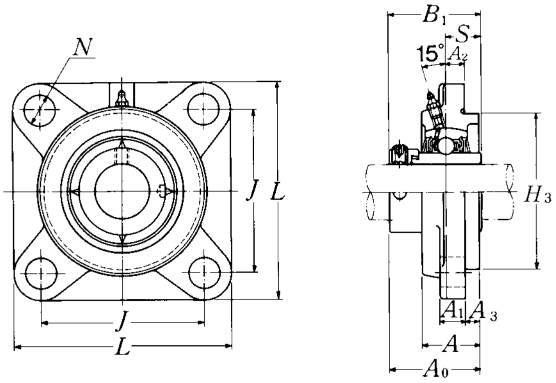


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch L	J	A_2	A_1	A	N	A_0	B_1	S	Bolt size mm inch	Bearing number
95	**UELF319D1W3**	290	228	59	30	94	35	142.4	122.3	38.9	M30	UEL319D1W3
$3\frac{5}{8}$	**UELF319-310D1W3**	$11\frac{13}{32}$	$8\frac{31}{32}$	$2\frac{21}{64}$	$1\frac{3}{16}$	$3\frac{11}{16}$	$1\frac{3}{8}$	$5\frac{39}{64}$	4.815	1.531	$1\frac{1}{8}$	UEL319-310D1W3
$3\frac{11}{16}$	**UELF319-311D1W3**											UEL319-311D1W3
$3\frac{3}{4}$	**UELF319-312D1W3**											UEL319-312D1W3
100	**UELF320D1W3**	310	242	59	32	94	38	137.6	128.6	50	M33	UEL320D1W3
$3\frac{13}{16}$	**UELF320-313D1W3**	$12\frac{7}{32}$	$9\frac{17}{32}$	$2\frac{21}{64}$	$1\frac{1}{4}$	$3\frac{11}{16}$	$1\frac{1}{2}$	$5\frac{27}{64}$	5.063	1.969	$1\frac{1}{4}$	UEL320-313D1W3
$3\frac{7}{8}$	**UELF320-314D1W3**											UEL320-314D1W3
$3\frac{15}{16}$	**UELF320-315D1W3**											UEL320-315D1W3
4	**UELF320-400D1W3**											UEL320-400D1W3
105	**UELF321D1W3**	310	242	59	32	94	38	150.3	139.7	48.4	M33	UEL321D1W3
110	**UELF322D1W3**	340	266	60	35	96	41	152.1	141.3	49.2	M36	UEL322D1W3

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
F319D1	23
F319D1	51
F319D1	
F319D1	
F320D1	28
F320D1	62
F320D1	
F320D1	
F320D1	
F321D1	29
F322D1	40

Flanged cartridge units cast housing
Eccentric locking collar type

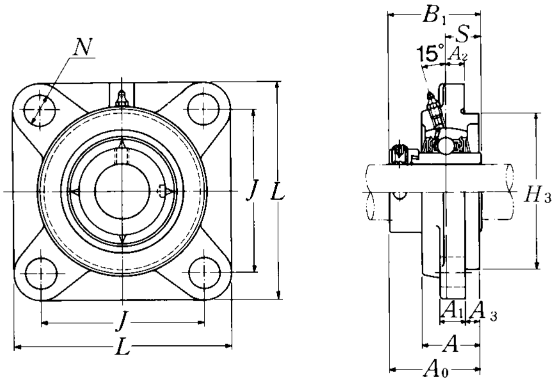


Shaft dia. mm inch	Unit number [1]	Nominal dimensions mm inch											Bolt size mm inch
		L	J	A_2	N	A_3	A_1	A	H_3	A_0	B_1	S	
25	UELFS305D1W3	110	80	9	16	7	13	29	80	46.1	46.8	16.7	M14
13/16	UELFS305-013D1W3												
7/8	UELFS305-014D1W3	4 11/32	3 5/32	23/64	5/8	9/32	1/2	1 9/64	3.1496	1 13/16	1.843	0.657	1/2
15/16	UELFS305-015D1W3												
1	UELFS305-100D1W3												
30	UELFS306D1W3	125	95	10	16	8	15	32	90	50.5	50	17.5	M14
1 1/16	UELFS306-101D1W3												
1 1/8	UELFS306-102D1W3	4 29/32	3 47/64	25/64	5/8	5/16	19/32	1 17/64	3.5433	1 63/64	1.969	0.689	1/2
1 3/16	UELFS306-103D1W3												
35	UELFS307D1W3	135	100	11	19	9	16	36	100	53.3	51.6	18.3	M16
1 1/4	UELFS307-104D1W3												
1 5/16	UELFS307-105D1W3	5 5/16	3 15/16	7/16	3/4	23/64	5/8	1 13/32	3.9370	2 3/32	2.031	0.720	5/8
1 3/8	UELFS307-106D1W3												
1 7/16	UELFS307-107D1W3												
40	UELFS308D1W3	150	112	13	19	10	17	40	115	60.3	57.1	19.8	M16
1 1/2	UELFS308-108D1W3	5 29/32	4 13/32	33/64	3/4	25/64	21/32	1 9/16	4.5276	2 3/8	2.248	0.780	5/8
1 9/16	UELFS308-109D1W3												
45	UELFS309D1W3	160	125	14	19	11	18	44	125	63.9	58.7	19.8	M16
1 5/8	UELFS309-110D1W3												
1 11/16	UELFS309-111D1W3	6 5/16	4 59/64	35/64	3/4	7/16	23/32	1 47/64	4.9213	2 33/64	2.311	0.780	5/8
1 3/4	UELFS309-112D1W3												
50	UELFS310D1W3	175	132	16	23	12	19	48	140	70	66.6	24.6	M20
1 13/16	UELFS310-113D1W3												
1 7/8	UELFS310-114D1W3	6 7/8	5 13/64	5/8	29/32	15/32	3/4	1 57/64	5.5118	2 3/4	2.622	0.969	3/4
1 15/16	UELFS310-115D1W3												
55	UELFS311D1W3	185	140	17	23	13	20	52	150	75.2	73	27.8	M20
2	UELFS311-200D1W3												
2 1/16	UELFS311-201D1W3	7 9/32	5 33/64	43/64	29/32	33/64	25/32	2 3/64	5.9055	2 61/64	2.874	1.094	3/4
2 1/8	UELFS311-202D1W3												
2 3/16	UELFS311-203D1W3												

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit	
		kg	lb
UEL305D1W3	FS305D1	1.4	3.1
UEL305-013D1W3	FS305D1		
UEL305-014D1W3	FS305D1		
UEL305-015D1W3	FS305D1		
UEL305-100D1W3	FS305D1		
UEL306D1W3	FS306D1	2.0	4.4
UEL306-101D1W3	FS306D1		
UEL306-102D1W3	FS306D1		
UEL306-103D1W3	FS306D1		
UEL307D1W3	FS307D1	2.4	5.3
UEL307-104D1W3	FS307D1		
UEL307-105D1W3	FS307D1		
UEL307-106D1W3	FS307D1		
UEL307-107D1W3	FS307D1		
UEL308D1W3	FS308D1	3.4	7.5
UEL308-108D1W3	FS308D1		
UEL308-109D1W3	FS308D1		
UEL309D1W3	FS309D1	4.2	9.3
UEL309-110D1W3	FS309D1		
UEL309-111D1W3	FS309D1		
UEL309-112D1W3	FS309D1		
UEL310D1W3	FS310D1	5.5	12
UEL310-113D1W3	FS310D1		
UEL310-114D1W3	FS310D1		
UEL310-115D1W3	FS310D1		
UEL311D1W3	FS311D1	6.5	14
UEL311-200D1W3	FS311D1		
UEL311-201D1W3	FS311D1		
UEL311-202D1W3	FS311D1		
UEL311-203D1W3	FS311D1		

Flanged cartridge units cast housing
Eccentric locking collar type

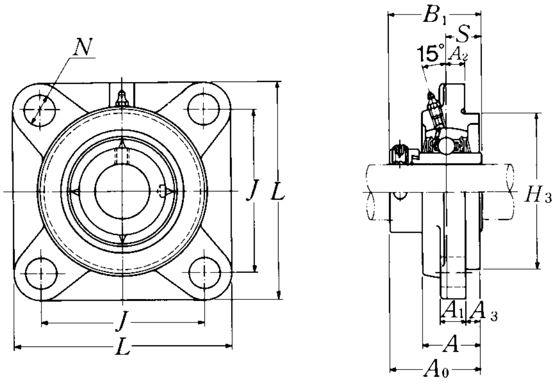


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch											Bolt size mm inch
		L	*J*	A_2	*N*	A_3	A_1	*A*	H_3	A_0	B_1	*S*	
60	**UELFS312D1W3**	195	150	19	23	14	22	56	160	81.5	79.4	30.95	M20
2 1/4	**UELFS312-204D1W3**	7 11/16	5 29/32	3/4	29/32	35/64	7/8	2 13/16	6.2992	3 13/64	3.126	1.219	3/4
2 5/16	**UELFS312-205D1W3**												
2 3/8	**UELFS312-206D1W3**												
2 7/16	**UELFS312-207D1W3**												
65	**UELFS313D1W3**	208	166	15	23	18	22	58	175	86.2	85.7	32.55	M20
2 1/2	**UELFS313-208D1W3**	8 3/16	6 17/32	19/32	29/32	45/64	7/8	2 9/32	6.8898	3 25/64	3.374	1.281	3/4
2 9/16	**UELFS313-209D1W3**												
70	**UELFS314D1W3**	226	178	18	25	18	25	61	185	94.0	92.1	34.15	M22
2 5/8	**UELFS314-210D1W3**	8 29/32	7 1/64	45/64	63/64	45/64	31/32	2 13/32	7.2835	3 45/64	3.626	1.344	7/8
2 11/16	**UELFS314-211D1W3**												
2 3/4	**UELFS314-212D1W3**												
75	**UELFS315D1W3**	236	184	21	25	18	25	66	200	101.7	100	37.3	M22
2 13/16	**UELFS315-213D1W3**	9 9/32	7 1/4	53/64	63/64	45/64	31/32	2 19/32	7.8740	4	3.937	1.469	7/8
2 7/8	**UELFS315-214D1W3**												
2 15/16	**UELFS315-215D1W3**												
3	**UELFS315-300D1W3**												
80	**UELFS316D1W3**	250	196	18	31	20	27	68	210	103.9	106.4	40.5	M27
3 1/16	**UELFS316-301D1W3**	9 27/32	7 23/32	45/64	1 7/32	25/32	1 1/16	2 43/64	8.2677	4 3/32	4.189	1.594	1
3 1/8	**UELFS316-302D1W3**												
3 3/16	**UELFS316-303D1W3**												
85	**UELFS317D1W3**	260	204	24	31	20	27	74	220	111.5	109.5	42.05	M27
3 1/4	**UELFS317-304D1W3**	10 1/4	8 1/32	15/16	1 7/32	25/32	1 1/16	2 29/32	8.6614	4 25/64	4.311	1.656	1
3 5/16	**UELFS317-305D1W3**												
3 7/16	**UELFS317-307D1W3**												
90	**UELFS318D1W3**	280	216	24	35	20	30	76	240	116.3	115.9	43.65	M30
3 7/16	**UELFS318-307D1W3**	11 1/32	8 1/2	15/16	1 3/8	25/32	1 3/16	2 63/64	9.4488	4 37/64	4.563	1.719	1 1/8
3 1/2	**UELFS318-308D1W3**												

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit kg	lb
UEL312D1W3	FS312D1	7.5	
UEL312-204D1W3	FS312D1		17
UEL312-205D1W3	FS312D1		
UEL312-206D1W3	FS312D1		
UEL312-207D1W3	FS312D1		
UEL313D1W3	FS313D1	9.3	
UEL313-208D1W3	FS313D1		21
UEL313-209D1W3	FS313D1		
UEL314D1W3	FS314D1	11	
UEL314-210D1W3	FS314D1		24
UEL314-211D1W3	FS314D1		
UEL314-212D1W3	FS314D1		
UEL315D1W3	FS315D1	13	
UEL315-213D1W3	FS315D1		29
UEL315-214D1W3	FS315D1		
UEL315-215D1W3	FS315D1		
UEL315-300D1W3	FS315D1		
UEL316D1W3	FS316D1	16	
UEL316-301D1W3	FS316D1		35
UEL316-302D1W3	FS316D1		
UEL316-303D1W3	FS316D1		
UEL317D1W3	FS317D1	19	
UEL317-304D1W3	FS317D1		42
UEL317-305D1W3	FS317D1		
UEL317-307D1W3	FS317D1		
UEL318D1W3	FS318D1	23	
UEL318-307D1W3	FS318D1		51
UEL318-308D1W3	FS318D1		

Flanged cartridge units cast housing
Eccentric locking collar type

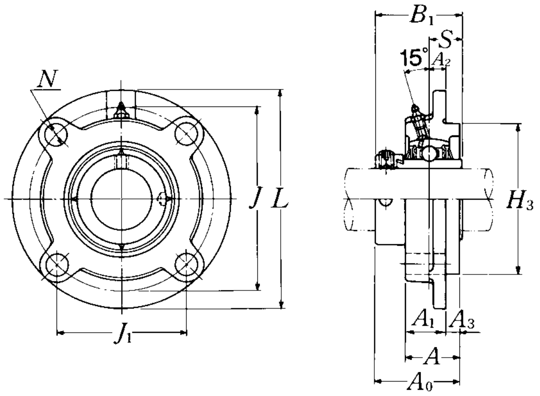


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch											Bolt size mm inch
		L	J	A_2	N	A_3	A_1	A	H_3	A_0	B_1	S	
95	UELFS319D1W3	290	228	39	35	20	30	94	250	142.4	122.3	38.9	M30
3 5/8	UELFS319-310D1W3	11 13/32	8 31/32	1 17/32	1 3/8	25/32	1 3/16	3 45/64	9.8425	5 39/64	4.815	1.531	1 1/8
3 11/16	UELFS319-311D1W3												
3 3/4	UELFS319-312D1W3												
100	UELFS320D1W3	310	242	39	38	20	32	94	260	137.6	128.6	50	M33
3 13/16	UELFS320-313D1W3	12 7/32	9 17/32	1 17/32	1 1/2	25/32	1 1/4	3 45/64	10.2362	5 27/64	5.063	1.969	1 1/4
3 7/8	UELFS320-314D1W3												
3 15/16	UELFS320-315D1W3												
4	UELFS320-400D1W3												
105	UELFS321D1W3	310	242	39	38	20	32	94	260	150.3	139.7	48.4	M33
110	UELFS322D1W3	340	266	35	41	25	35	96	300	152.1	141.3	49.2	M36

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit	
		kg	lb
UEL319D1W3	FS319D1	26	
UEL319-310D1W3	FS319D1		57
UEL319-311D1W3	FS319D1		
UEL319-312D1W3	FS319D1		
UEL320D1W3	FS320D1	32	
UEL320-313D1W3	FS320D1		71
UEL320-314D1W3	FS320D1		
UEL320-315D1W3	FS320D1		
UEL320-400D1W3	FS320D1		
UEL321D1W3	FS321D1	32	
UEL322D1W3	FS322D1	42	

Flanged cartridge units cast housing
Eccentric locking collar type

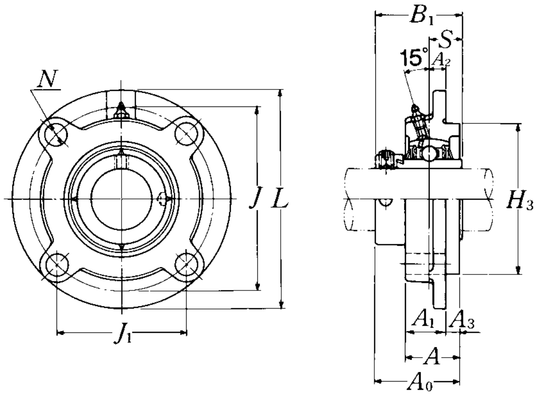


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch L	J	J1	A2	N	A3	A1	A	H3	A0	B1	S	Bolt size mm inch
20	UELFC204D1W3	100	78	55.1	10	12	5	20.5	25.5	62	41.6	43.7	17.1	M10
3/4	UELFC204-012D1W3	3 15/16	3 5/64	2 11/64	25/64	15/32	13/64	13/16	1	2.4409	1 41/64	1.720	0.673	3/8
25	UELFC205D1W3	115	90	63.6	10	12	6	21	27	70	42.9	44.4	17.5	M10
13/16	UELFC205-013D1W3	4 17/32	3 35/64	2 1/2	25/64	15/32	15/64	13/16	1 1/16	2.7559	1 11/16	1.748	0.689	3/8
7/8	UELFC205-014D1W3													
15/16	UELFC205-015D1W3													
1	UELFC205-100D1W3													
30	UELFC206D1W3	125	100	70.7	10	12	8	23	31	80	48.1	48.4	18.3	M10
1 1/16	UELFC206-110D1W3	4 29/32	3 15/16	2 25/32	25/64	15/32	5/16	29/32	1 7/32	3.1496	1 57/64	1.906	0.720	3/8
1 1/8	UELFC206-102D1W3													
1 3/16	UELFC206-103D1W3													
1 1/4	UELFC206-104D1W3													
35	UELFC207D1W3	135	110	77.8	11	14	8	26	34	90	51.3	51.1	18.8	M12
1 1/4	UELFC207-104D1W3	5 5/16	4 21/64	3 1/16	7/16	35/64	5/16	1 1/32	1 11/32	3.5433	2 1/64	2.012	0.740	7/16
1 5/16	UELFC207-105D1W3													
1 3/8	UELFC207-106D1W3													
1 7/16	UELFC207-107D1W3													
40	UELFC208D1W3	145	120	84.8	11	14	10	26	36	100	55.9	56.3	21.4	M12
1 1/2	UELFC208-108D1W3	5 23/32	4 23/32	3 11/32	7/16	35/64	25/64	1 1/32	1 27/64	3.9370	2 13/64	2.217	0.843	7/16
1 9/16	UELFC208-109D1W3													
45	UELFC209D1W3	160	132	93.3	10	16	12	26	38	105	56.9	56.3	21.4	M14
1 5/8	UELFC209-110D1W3	6 5/16	5 13/64	3 43/64	25/64	5/8	15/32	1 1/32	1 1/2	4.1339	2 15/64	2.217	0.843	1/2
1 11/16	UELFC209-111D1W3													
1 3/4	UELFC209-112D1W3													
50	UELFC210D1W3	165	138	97.6	10	16	12	28	40	110	60.1	62.7	24.6	M14
1 13/16	UELFC210-113D1W3	6 1/2	5 7/16	3 27/32	25/64	5/8	15/32	1 3/32	1 37/64	4.3307	2 23/64	2.469	0.969	1/2
1 7/8	UELFC210-114D1W3													
1 15/16	UELFC210-115D1W3													
2	UELFC210-200D1W3													

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit	
		kg	lb
UEL204D1W3	FC204D1	0.8	
UEL204-012D1W3	FC204D1		1.8
UEL205D1W3	FC205D1	1.1	
UEL205-013D1W3	FC205D1		2.4
UEL205-014D1W3	FC205D1		
UEL205-015D1W3	FC205D1		
UEL205-100D1W3	FC205D1		
UEL206D1W3	FC206D1	1.5	
UEL206-101D1W3	FC206D1		3.3
UEL206-102D1W3	FC206D1		
UEL206-103D1W3	FC206D1		
UEL206-104D1W3	FC206D1		
UEL207D1W3	FC207D1	1.8	
UEL207-104D1W3	FC207D1		4.0
UEL207-105D1W3	FC207D1		
UEL207-106D1W3	FC207D1		
UEL207-107D1W3	FC207D1		
UEL208D1W3	FC208D1	2.2	
UEL208-108D1W3	FC208D1		4.9
UEL208-109D1W3	FC208D1		
UEL209D1W3	FC209D1	2.8	
UEL209-110D1W3	FC209D1		6.2
UEL209-111D1W3	FC209D1		
UEL209-112D1W3	FC209D1		
UEL210D1W3	FC210D1	3.3	
UEL210-113D1W3	FC210D1		7.3
UEL210-114D1W3	FC210D1		
UEL210-115D1W3	FC210D1		
UEL210-200D1W3	FC210D1		

Flanged cartridge units cast housing
Eccentric locking collar type



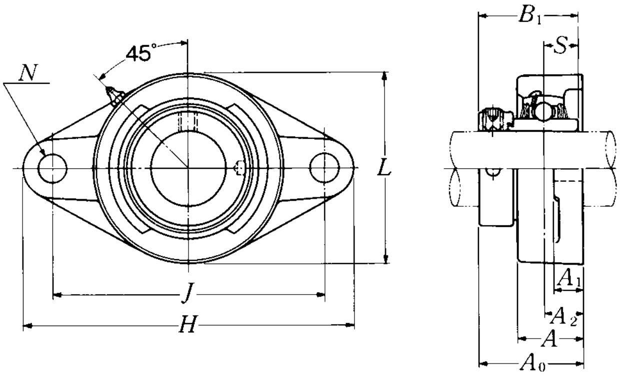
Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch												Bolt size mm inch
		L	J	J1	A2	N	A3	A1	A	H3	A0	B1	S	
55	UELFC211D1W3	185	150	106.1	13	19	12	31	43	125	68.6	71.4	27.8	M16
2	UELFC211-200D1W3	7 9/32	5 29/32	4 11/64	33/64	3/4	15/32	1 7/32	1 11/16	4.9213	2 45/64	2.811	1.094	5/8
2 1/16	UELFC211-201D1W3													
2 1/8	UELFC211-202D1W3													
2 3/16	UELFC211-203D1W3													
60	UELFC212D1W3	195	160	113.1	17	19	12	36	48	135	75.8	77.8	31	M16
2 1/4	UELFC212-204D1W3	7 11/16	6 19/64	4 29/64	43/64	3/4	15/32	1 13/32	1 57/64	5.3150	2 63/64	3.063	1.220	5/8
2 5/16	UELFC212-205D1W3													
2 3/8	UELFC212-206D1W3													
2 7/16	UELFC212-207D1W3													
65	UELFC213D1W3	205	170	120.2	16	19	14	36	50	145	81.6	85.7	34.15	M16
2 1/2	UELFC213-208D1W3	8 1/16	6 11/16	4 47/64	5/8	3/4	35/64	1 13/32	1 31/32	5.7087	3 7/32	3.374	1.344	5/8
2 9/16	UELFC213-209D1W3													
70	UELFC214D1W3	215	177	125.1	17	19	14	40	54	150	82.6	85.7	34.15	M16
2 5/8	UELFC214-210D1W3	8 15/32	6 31/32	4 59/64	43/64	3/4	35/64	1 9/16	2 1/8	5.9055	3 1/4	3.374	1.344	5/8
2 11/16	UELFC214-211D1W3													
2 3/4	UELFC214-212D1W3													
75	UELFC215D1W3	220	184	130.1	18	19	16	40	56	160	88.7	92	37.3	M16
2 13/16	UELFC215-213D1W3	8 21/32	7 1/4	5 1/8	45/64	3/4	5/8	1 9/16	2 13/64	6.2992	3 31/64	3.622	1.469	5/8
2 7/8	UELFC215-214D1W3													
2 15/16	UELFC215-215D1W3													
3	UELFC215-300D1W3													

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit	
		kg	lb
UEL211D1W3	FC211D1	4.5	9.9
UEL211-200D1W3	FC211D1		
UEL211-201D1W3	FC211D1		
UEL211-202D1W3	FC211D1		
UEL211-203D1W3	FC211D1		
UEL212D1W3	FC212D1	5.7	13
UEL212-204D1W3	FC212D1		
UEL212-205D1W3	FC212D1		
UEL212-206D1W3	FC212D1		
UEL212-207D1W3	FC212D1		
UEL213D1W3	FC213D1	6.5	14
UEL213-208D1W3	FC213D1		
UEL213-209D1W3	FC213D1		
UEL214D1W3	FC214D1	7.2	16
UEL214-210D1W3	FC214D1		
UEL214-211D1W3	FC214D1		
UEL214-212D1W3	FC214D1		
UEL215D1W3	FC215D1	8.0	18
UEL215-213D1W3	FC215D1		
UEL215-214D1W3	FC215D1		
UEL215-215D1W3	FC215D1		
UEL215-300D1W3	FC215D1		

UELFLU2

Flanged cartridge units cast housing
Eccentric locking collar type

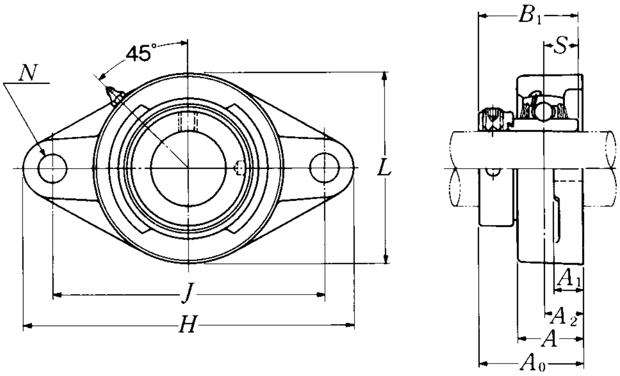


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch										Bolt size mm inch
		H	J	A_2	A_1	A	N	L	A_0	B_1	S	
20	**UELFLU204D1W3**	113	90	19	15	29.5	11.5	61	45.6	43.7	17.1	M10
3/4	**UELFLU204-012D1W3**	4 7/16	3 35/64	3/4	19/32	1 5/32	29/64	2 13/32	1 51/64	1.720	0.673	5/16
25	**UELFLU205D1W3**	125	99	19	15	30	11.5	70	45.9	44.4	17.5	M10
13/16	**UELFLU205-013D1W3**											
7/8	**UELFLU205-014D1W3**	4 29/32	3 57/64	3/4	19/32	1 3/16	29/64	2 3/4	1 13/16	1.748	0.689	3/8
15/16	**UELFLU205-015D1W3**											
1	**UELFLU205-100D1W3**											
30	**UELFLU206D1W3**	142	116.5	20	16	33	11.5	83	50.1	48.4	18.3	M10
1 1/16	**UELFLU206-101D1W3**											
1 1/8	**UELFLU206-102D1W3**	5 19/32	4 19/32	25/32	5/8	1 5/16	29/64	3 9/32	1 31/32	1.906	0.720	3/8
1 3/16	**UELFLU206-103D1W3**											
1 1/4	**UELFLU206-104D1W3**											
35	**UELFLU207D1W3**	156	130	21	17	36	14	96	53.3	51.1	18.8	M12
1 1/4	**UELFLU207-104D1W3**											
1 5/16	**UELFLU207-105D1W3**	6 5/32	5 1/8	53/64	21/32	1 13/32	35/64	3 25/32	2 3/32	2.012	0.740	1/2
1 3/8	**UELFLU207-106D1W3**											
1 7/16	**UELFLU207-107D1W3**											
40	**UELFLU208D1W3**	172	143.5	24	17	39	14	105	58.9	56.3	21.4	M12
1 1/2	**UELFLU208-108D1W3**	6 25/32	5 21/32	15/16	21/32	1 17/32	35/64	4 1/8	2 5/16	2.217	0.843	1/2
1 9/16	**UELFLU208-109D1W3**											
45	**UELFLU209D1W3**	180	148.5	24	18	40	16	111	58.9	56.3	21.4	M14
1 5/8	**UELFLU209-110D1W3**											
1 11/16	**UELFLU209-111D1W3**	7 3/32	5 27/32	15/16	23/32	1 9/16	5/8	4 3/8	2 5/16	2.217	0.843	1/2
1 3/4	**UELFLU209-112D1W3**											
50	**UELFLU210D1W3**	190	157	28	20	46	18	116	66.1	62.7	24.6	M16
1 13/16	**UELFLU210-113D1W3**											
1 7/8	**UELFLU210-114D1W3**	7 15/32	6 3/16	1 7/64	25/32	1 13/16	45/64	4 9/16	2 39/64	2.469	0.969	5/8
1 15/16	**UELFLU210-115D1W3**											
2	**UELFLU210-200D1W3**											

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit kg lb
UEL204D1W3	FLU204D1	0.6
UEL204-012D1W3	FLU204D1	1.3
UEL205D1W3	FLU205D1	0.8
UEL205-013D1W3	FLU205D1	1.8
UEL205-014D1W3	FLU205D1	
UEL205-015D1W3	FLU205D1	
UEL205-100D1W3	FLU205D1	
UEL206D1W3	FLU206D1	1.1
UEL206-101D1W3	FLU206D1	2.4
UEL206-102D1W3	FLU206D1	
UEL206-103D1W3	FLU206D1	
UEL206-104D1W3	FLU206D1	
UEL207D1W3	FLU207D1	1.4
UEL207-104D1W3	FLU207D1	3.1
UEL207-105D1W3	FLU207D1	
UEL207-106D1W3	FLU207D1	
UEL207-107D1W3	FLU207D1	
UEL208D1W3	FLU208D1	1.8
UEL208-108D1W3	FLU208D1	4.0
UEL208-109D1W3	FLU208D1	
UEL209D1W3	FLU209D1	2.1
UEL209-110D1W3	FLU209D1	4.6
UEL209-111D1W3	FLU209D1	
UEL209-112D1W3	FLU209D1	
UEL210D1W3	FLU210D1	2.5
UEL210-113D1W3	FLU210D1	5.5
UEL210-114D1W3	FLU210D1	
UEL210-115D1W3	FLU210D1	
UEL210-200D1W3	FLU210D1	

Flanged cartridge units cast housing
Eccentric locking collar type

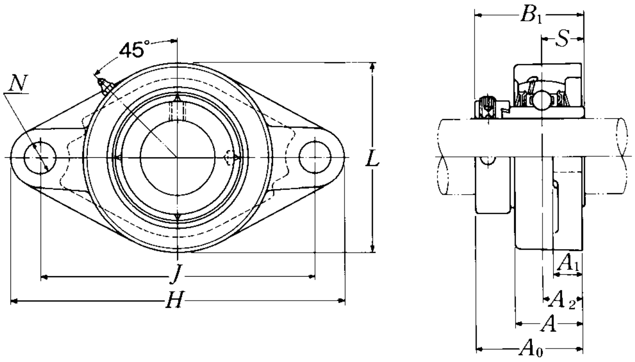


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch										Bolt size mm inch
		H	J	A_2	A_1	A	N	L	A_0	B_1	S	
55	UELFLU211D1W3	217	184	31	21	49	18	134	74.6	71.4	27.8	M16
2	UELFLU211-200D1W3	$8\frac{17}{32}$	$7\frac{1}{4}$	$1\frac{7}{32}$	$\frac{13}{16}$	$1\frac{15}{16}$	$\frac{45}{64}$	$5\frac{9}{32}$	$2\frac{15}{16}$	2.811	1.094	$\frac{5}{8}$
$2\frac{1}{16}$	UELFLU211-201D1W3											
$2\frac{1}{8}$	UELFLU211-202D1W3											
$2\frac{3}{16}$	UELFLU211-203D1W3											
60	UELFLU212D1W3	235	202	34	21	53	18	138	80.8	77.8	31	M16
$2\frac{1}{4}$	UELFLU212-204D1W3	$9\frac{1}{4}$	$7\frac{61}{64}$	$1\frac{11}{32}$	$\frac{13}{16}$	$2\frac{3}{32}$	$\frac{45}{64}$	$5\frac{7}{16}$	$3\frac{3}{16}$	3.063	1.220	$\frac{5}{8}$
$2\frac{5}{16}$	UELFLU212-205D1W3											
$2\frac{3}{8}$	UELFLU212-206D1W3											
$2\frac{7}{16}$	UELFLU212-207D1W3											
65	UELFLU213D1W3	248	210	38	22	59	20.5	152	89.55	85.7	34.15	M18
$2\frac{1}{2}$	UELFLU213-208D1W3	$9\frac{3}{4}$	$8\frac{17}{64}$	$1\frac{1}{2}$	$\frac{7}{8}$	$2\frac{5}{16}$	$\frac{13}{16}$	$5\frac{31}{32}$	$3\frac{17}{32}$	3.374	1.344	$\frac{5}{8}$
$2\frac{9}{16}$	UELFLU213-209D1W3											
70	UELFLU214D1W3	257	216	38	22	62	20.5	159	89.55	85.7	34.15	M18
$2\frac{5}{8}$	UELFLU214-210D1W3	$10\frac{1}{8}$	$8\frac{1}{2}$	$1\frac{1}{2}$	$\frac{7}{8}$	$2\frac{7}{16}$	$\frac{13}{16}$	$6\frac{1}{4}$	$3\frac{17}{32}$	3.374	1.344	$\frac{5}{8}$
$2\frac{11}{16}$	UELFLU214-211D1W3											
$2\frac{3}{4}$	UELFLU214-212D1W3											
75	UELFLU215D1W3	266	225	41	22	65	20.5	165	95.7	92	37.3	M18
$2\frac{13}{16}$	UELFLU215-213D1W3	$10\frac{15}{32}$	$8\frac{55}{64}$	$1\frac{39}{64}$	$\frac{7}{8}$	$2\frac{9}{16}$	$\frac{13}{16}$	$6\frac{1}{2}$	$3\frac{49}{64}$	3.622	1.469	$\frac{5}{8}$
$2\frac{7}{8}$	UELFLU215-214D1W3											
$2\frac{15}{16}$	UELFLU215-215D1W3											
3	UELFLU215-300D1W3											

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit	
		kg	lb
UEL211D1W3	FLU211D1	3.5	
UEL211-200D1W3	FLU211D1		7.7
UEL211-201D1W3	FLU211D1		
UEL211-202D1W3	FLU211D1		
UEL211-203D1W3	FLU211D1		
UEL212D1W3	FLU212D1	4.5	
UEL212-204D1W3	FLU212D1		9.9
UEL212-205D1W3	FLU212D1		
UEL212-206D1W3	FLU212D1		
UEL212-207D1W3	FLU212D1		
UEL213D1W3	FLU213D1	5.6	
UEL213-208D1W3	FLU213D1		12
UEL213-209D1W3	FLU213D1		
UEL214D1W3	FLU214D1	5.7	
UEL214-210D1W3	FLU214D1		13
UEL214-211D1W3	FLU214D1		
UEL214-212D1W3	FLU214D1		
UEL215D1W3	FLU215D1	6.6	
UEL215-213D1W3	FLU215D1		15
UEL215-214D1W3	FLU215D1		
UEL215-215D1W3	FLU215D1		
UEL215-300D1W3	FLU215D1		

Flanged units cast housing
Eccentric locking collar type

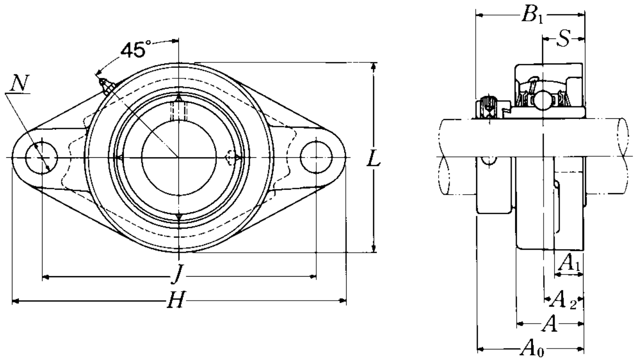


Shaft dia. mm inch	Unit number 1)	H	J	A2	A1	A	N	L	A0	B1	S	Bolt size mm inch	Bearing number
		mm inch											
20	UELFL204D1W3	113	90	15	11	25.5	12	60	41.6	43.7	17.1	M10	UEL204D1W3
3/4	UELFL204-012D1W3	4 7/16	3 35/64	19/32	7/16	1	15/32	2 3/8	1 41/64	1.720	0.673	3/8	UEL204-012D1W3
25	UELFL205D1W3	130	99	16	13	27	16	68	42.9	44.4	17.5	M14	UEL205D1W3
13/16	UELFL205-013D1W3	5 1/8	3 57/64	5/8	1/2	1 1/16	5/8	2 11/64	1 11/16	1.748	0.689	1/2	UEL205-013D1W3
7/8	UELFL205-014D1W3												UEL205-014D1W3
15/16	UELFL205-015D1W3												UEL205-015D1W3
1	UELFL205-100D1W3												UEL205-100D1W3
30	UELFL206D1W3	148	117	18	13	31	16	80	48.1	48.4	18.3	M14	UEL206D1W3
1 1/6	UELFL206-101D1W3	5 13/16	4 9/64	45/64	1/2	1 7/32	5/8	3 5/32	1 57/64	1.906	0.720	1/2	UEL206-101D1W3
1 1/8	UELFL206-102D1W3												UEL206-102D1W3
1 3/16	UELFL206-103D1W3												UEL206-103D1W3
1 1/4	UELFL206-104D1W3												UEL206-104D1W3
35	UELFL207D1W3	161	130	19	15	34	16	90	51.3	51.1	18.8	M14	UEL207D1W3
1 1/4	UELFL207-104D1W3	6 11/32	5 1/8	3/4	19/32	1 11/32	5/8	3 17/32	2 1/64	2.012	0.740	1/2	UEL207-104D1W3
1 5/16	UELFL207-105D1W3												UEL207-105D1W3
1 3/8	UELFL207-106D1W3												UEL207-106D1W3
1 7/16	UELFL207-107D1W3												UEL207-107D1W3
40	UELFL208D1W3	175	144	21	15	36	16	100	55.9	56.3	21.4	M14	UEL208D1W3
1 1/2	UELFL208-108D1W3	6 7/8	5 43/64	53/64	19/32	1 13/32	5/8	3 15/16	2 13/16	2.217	0.843	1/2	UEL208-108D1W3
1 9/16	UELFL208-109D1W3												UEL208-109D1W3
45	UELFL209D1W3	188	148	22	16	38	19	108	56.9	56.3	21.4	M16	UEL209D1W3
1 5/8	UELFL209-110D1W3	7 13/32	5 53/64	55/64	5/8	1 1/2	3/4	4 1/4	2 15/64	2.217	0.843	5/8	UEL209-110D1W3
1 11/16	UELFL209-111D1W3												UEL209-111D1W3
1 3/4	UELFL209-112D1W3												UEL209-112D1W3
50	UELFL210D1W3	197	157	22	16	40	19	115	60.1	62.7	24.6	M16	UEL210D1W3
1 13/16	UELFL210-113D1W3	7 3/4	6 3/16	55/64	5/8	1 9/16	3/4	4 17/32	2 23/64	2.469	0.969	5/8	UEL210-113D1W3
1 7/8	UELFL210-114D1W3												UEL210-114D1W3
1 15/16	UELFL210-115D1W3												UEL210-115D1W3
2	UELFL210-200D1W3												UEL210-200D1W3

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
FL204D1	0.6
FL204D1	1.3
FL205D1	0.7
FL205D1	1.5
FL205D1	
FL205D1	
FL205D1	
FL206D1	1.0
FL206D1	2.2
FL206D1	
FL206D1	
FL206D1	
FL207D1	1.3
FL207D1	2.9
FL207D1	
FL207D1	
FL207D1	
FL208D1	1.7
FL208D1	3.7
FL208D1	
FL209D1	2.0
FL209D1	4.4
FL209D1	
FL209D1	
FL210D1	2.3
FL210D1	5.1
FL210D1	
FL210D1	
FL210D1	

Flanged units cast housing
Eccentric locking collar type



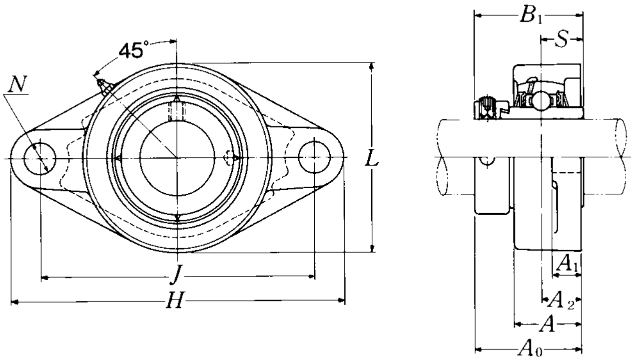
Shaft dia. mm inch	Unit number [1]	Nominal dimensions mm inch H	J	A2	A1	A	N	L	A0	B1	S	Bolt size mm inch	Bearing number
55	UELFL211D1W3	224	184	25	18	43	19	130	68.6	71.4	27.8	M16	UEL211D1W3
2	UELFL211-200D1W3	8 13/16	7 1/4	63/64	23/32	1 11/16	3/4	5 1/8	2 45/64	2.811	1.094	5/8	UEL211-200D1W3
2 1/16	UELFL211-201D1W3												UEL211-201D1W3
2 1/8	UELFL211-202D1W3												UEL211-202D1W3
2 3/16	UELFL211-203D1W3												UEL211-203D1W3
60	UELFL212D1W3	250	202	29	18	48	23	140	75.8	77.8	31	M20	UEL212D1W3
2 1/4	UELFL212-204D1W3	9 27/32	7 61/64	1 9/64	23/32	1 7/8	29/32	5 1/2	2 63/64	3.063	1.220	3/4	UEL212-204D1W3
2 5/16	UELFL212-205D1W3												UEL212-205D1W3
2 3/8	UELFL212-206D1W3												UEL212-206D1W3
2 7/16	UELFL212-207D1W3												UEL212-207D1W3
65	UELFL213D1W3	258	210	30	22	50	23	155	81.55	85.7	34.15	M20	UEL213D1W3
2 1/2	UELFL213-208D1W3	10 5/32	8 17/64	1 3/16	7/8	1 31/32	29/32	6 3/32	3 13/64	3.374	1.344	3/4	UEL213-208D1W3
2 9/16	UELFL213-209D1W3												UEL213-209D1W3
70	UELFL214D1W3	265	216	31	22	54	23	160	82.55	85.7	34.15	M20	UEL214D1W3
2 5/8	UELFL214-210D1W3	10 7/16	8 1/2	1 7/32	7/8	2 1/8	29/32	6 5/16	3 1/4	3.374	1.344	3/4	UEL214-210D1W3
2 11/16	UELFL214-211D1W3												UEL214-211D1W3
2 3/4	UELFL214-212D1W3												UEL214-212D1W3
75	UELFL215D1W3	275	225	34	22	56	23	165	88.7	92	37.3	M20	UEL215D1W3
2 13/16	UELFL215-213D1W3	10 13/16	8 55/64	1 11/32	7/8	2 7/32	29/32	6 1/2	3 31/64	3.622	1.469	3/4	UEL215-213D1W3
2 7/8	UELFL215-214D1W3												UEL215-214D1W3
2 15/16	UELFL215-215D1W3												UEL215-215D1W3
3	UELFL215-300D1W3												UEL215-300D1W3

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
FL211D1	3.3
FL211D1	7.3
FL211D1	
FL211D1	
FL211D1	
FL212D1	4.3
FL212D1	9.5
FL212D1	
FL212D1	
FL212D1	
FL213D1	5.5
FL213D1	12
FL213D1	
FL214D1	5.8
FL214D1	13
FL214D1	
FL214D1	
FL215D1	6.4
FL215D1	14
FL215D1	
FL215D1	
FL215D1	

UELFL3

Flanged units cast housing
Eccentric locking collar type



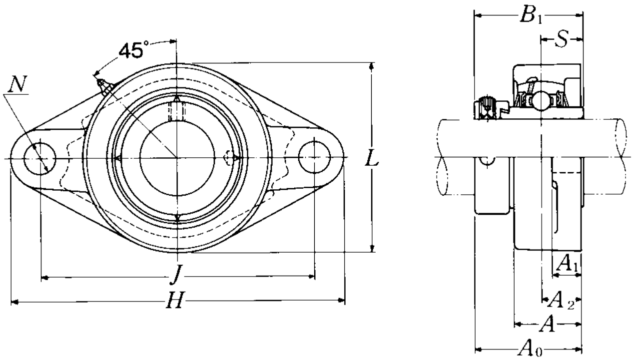
Shaft dia. mm inch	Unit number 1) 2)	Nominal dimensions mm inch H	J	A2	A1	A	N	L	A0	B1	S	Bolt size mm inch	Bearing number
25	UELFL305D1W3	150	113	16	13	29	19	80	46.1	46.8	16.7	M16	UEL305D1W3
$\frac{13}{16}$	UELFL305-013D1W3	$5\frac{29}{32}$	$4\frac{29}{64}$	$\frac{5}{8}$	$\frac{1}{2}$	$1\frac{5}{32}$	$\frac{3}{4}$	$3\frac{5}{32}$	$1\frac{13}{16}$	1.843	0.657	$\frac{5}{8}$	UEL305-013D1W3
$\frac{7}{8}$	UELFL305-014D1W3												UEL305-014D1W3
$\frac{15}{16}$	UELFL305-015D1W3												UEL305-015D1W3
1	UELFL305-100D1W3												UEL305-100D1W3
30	UELFL306D1W3	180	134	18	15	32	23	90	50.5	50	17.5	M20	UEL306D1W3
$1\frac{1}{16}$	UELFL306-101D1W3	$7\frac{3}{32}$	$5\frac{9}{32}$	$\frac{45}{64}$	$\frac{19}{32}$	$1\frac{1}{4}$	$\frac{29}{32}$	$3\frac{17}{32}$	$1\frac{63}{64}$	1.969	0.689	$\frac{3}{4}$	UEL306-101D1W3
$1\frac{1}{8}$	UELFL306-102D1W3												UEL306-102D1W3
$1\frac{3}{16}$	UELFL306-103D1W3												UEL306-103D1W3
35	UELFL307D1W3	185	141	20	16	36	23	100	53.3	51.6	18.3	M20	UEL307D1W3
$1\frac{1}{4}$	UELFL307-104D1W3	$7\frac{9}{32}$	$5\frac{35}{64}$	$\frac{25}{32}$	$\frac{5}{8}$	$1\frac{13}{32}$	$\frac{29}{32}$	$3\frac{15}{16}$	$2\frac{3}{32}$	2.031	0.720	$\frac{3}{4}$	UEL307-104D1W3
$1\frac{5}{16}$	UELFL307-105D1W3												UEL307-105D1W3
$1\frac{3}{8}$	UELFL307-106D1W3												UEL307-106D1W3
$1\frac{7}{16}$	UELFL307-107D1W3												UEL307-107D1W3
40	UELFL308D1W3	200	158	23	17	40	23	112	60.3	57.1	19.8	M20	UEL308D1W3
$1\frac{1}{2}$	UELFL308-108D1W3	$7\frac{7}{8}$	$6\frac{7}{32}$	$\frac{29}{32}$	$\frac{21}{32}$	$1\frac{9}{16}$	$\frac{29}{32}$	$4\frac{13}{32}$	$2\frac{3}{8}$	2.248	0.780	$\frac{3}{4}$	UEL308-108D1W3
$1\frac{9}{16}$	UELFL308-109D1W3												UEL308-109D1W3
45	UELFL309D1W3	230	177	25	18	44	25	125	63.9	58.7	19.8	M22	UEL309D1W3
$1\frac{5}{8}$	UELFL309-110D1W3	$9\frac{1}{16}$	$6\frac{31}{32}$	$\frac{63}{64}$	$\frac{23}{32}$	$1\frac{23}{32}$	$\frac{63}{64}$	$4\frac{29}{32}$	$2\frac{33}{64}$	2.311	0.780	$\frac{7}{8}$	UEL309-110D1W3
$1\frac{11}{16}$	UELFL309-111D1W3												UEL309-111D1W3
$1\frac{3}{4}$	UELFL309-112D1W3												UEL309-112D1W3
50	UELFL310D1W3	240	187	28	19	48	25	140	70	66.6	24.6	M22	UEL310D1W3
$1\frac{13}{16}$	UELFL310-113D1W3	$9\frac{7}{16}$	$7\frac{23}{64}$	$1\frac{7}{64}$	$\frac{3}{4}$	$1\frac{7}{8}$	$\frac{63}{64}$	$5\frac{1}{2}$	$2\frac{3}{4}$	2.622	0.969	$\frac{7}{8}$	UEL310-113D1W3
$1\frac{7}{8}$	UELFL310-114D1W3												UEL310-114D1W3
$1\frac{15}{16}$	UELFL310-115D1W3												UEL310-115D1W3
55	UELFL311D1W3	250	198	30	20	52	25	150	75.2	73	27.8	M22	UEL311D1W3
2	UELFL311-200D1W3	$9\frac{27}{32}$	$7\frac{51}{64}$	$1\frac{3}{16}$	$\frac{25}{32}$	$2\frac{1}{16}$	$\frac{63}{64}$	$5\frac{29}{32}$	$2\frac{61}{64}$	2.874	1.094	$\frac{7}{8}$	UEL311-200D1W3
$2\frac{1}{16}$	UELFL311-201D1W3												UEL311-201D1W3
$2\frac{1}{8}$	UELFL311-202D1W3												UEL311-202D1W3
$2\frac{3}{16}$	UELFL311-203D1W3												UEL311-203D1W3

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Inner race face does not protrude from the housing face except UELFL305 and UELFL316.

Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
FL305D1	1.1
FL305D1	2.4
FL305D1	
FL305D1	
FL305D1	
FL306D1	1.6
FL306D1	3.5
FL306D1	
FL306D1	
FL307D1	2.0
FL307D1	4.4
FL307D1	
FL307D1	
FL307D1	
FL308D1	2.6
FL308D1	5.7
FL308D1	
FL309D1	3.6
FL309D1	7.9
FL309D1	
FL309D1	
FL310D1	4.6
FL310D1	10
FL310D1	
FL310D1	
FL311D1	5.3
FL311D1	12
FL311D1	
FL311D1	
FL311D1	

Flanged units cast housing
Eccentric locking collar type



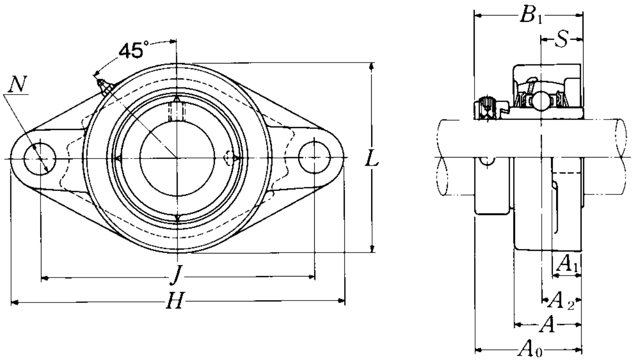
Shaft dia. mm inch	Unit number 1) 2)	Nominal dimensions mm inch										Bolt size mm inch	Bearing number
		H	J	A_2	A_1	A	N	L	A_0	B_1	S		
60	**UELFL312D1W3**	270	212	33	22	56	31	160	81.45	79.4	30.95	M27	UEL312D1W3
2 1/4	**UELFL312-204D1W3**												UEL312-204D1W3
2 5/16	**UELFL312-205D1W3**	10 5/8	8 11/32	1 19/64	7/8	2 7/32	1 7/32	6 5/16	3 13/64	3.126	1.219	1	UEL312-205D1W3
2 3/8	**UELFL312-206D1W3**												UEL312-206D1W3
2 7/16	**UELFL312-207D1W3**												UEL312-207D1W3
65	**UELFL313D1W3**	295	240	33	25	58	31	175	86.15	85.7	32.55	M27	UEL313D1W3
2 1/2	**UELFL313-208D1W3**	11 5/8	9 29/64	1 19/64	31/32	2 9/32	1 7/32	6 7/8	3 25/64	3.374	1.281	1	UEL313-208D1W3
2 9/16	**UELFL313-209D1W3**												UEL313-209D1W3
70	**UELFL314D1W3**	315	250	36	28	61	35	185	93.95	92.1	34.15	M30	UEL314D1W3
2 5/8	**UELFL314-210D1W3**												UEL314-210D1W3
2 11/16	**UELFL314-211D1W3**	12 13/32	9 27/32	1 27/64	1 3/32	2 13/32	1 3/8	7 9/32	3 45/64	3.626	1.344	1 1/8	UEL314-211D1W3
2 3/4	**UELFL314-212D1W3**												UEL314-212D1W3
75	**UELFL315D1W3**	320	260	39	30	66	35	195	101.7	100	37.3	M30	UEL315D1W3
2 13/16	**UELFL315-213D1W3**												UEL315-213D1W3
2 7/8	**UELFL315-214D1W3**	12 19/32	10 15/64	1 17/32	1 3/16	2 19/32	1 3/8	7 11/16	4	3.937	1.469	1 1/8	UEL315-214D1W3
2 15/16	**UELFL315-215D1W3**												UEL315-215D1W3
3	**UELFL315-300D1W3**												UEL315-300D1W3
80	**UELFL316D1W3**	355	285	38	32	68	38	210	103.9	106.4	40.5	M33	UEL316D1W3
3 1/16	**UELFL316-301D1W3**												UEL316-301D1W3
3 1/8	**UELFL316-302D1W3**	13 31/32	11 7/32	1 1/2	1 1/4	2 11/16	1 1/2	8 9/32	4 3/32	4.189	1.594	1 1/4	UEL316-302D1W3
3 3/16	**UELFL316-303D1W3**												UEL316-303D1W3
85	**UELFL317D1W3**	370	300	44	32	74	38	220	111.45	109.5	42.05	M33	UEL317D1W3
3 1/4	**UELFL317-304D1W3**												UEL317-304D1W3
3 5/16	**UELFL317-305D1W3**	14 9/16	11 13/16	1 47/64	1 1/4	2 29/32	1 1/2	8 21/32	4 25/64	4.311	1.656	1 1/4	UEL317-305D1W3
3 7/16	**UELFL317-307D1W3**												UEL317-307D1W3
90	**UELFL318D1W3**	385	315	44	36	76	38	235	116.25	115.9	43.65	M33	UEL318D1W3
3 7/16	**UELFL318-307D1W3**	15 5/32	12 13/32	1 47/64	1 13/32	3	1 1/2	9 1/4	4 37/64	4.563	1.719	1 1/4	UEL318-307D1W3
3 1/2	**UELFL318-308D1W3**												UEL318-308D1W3

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Inner race face does not protrude from the housing face except UELFL305 and UELFL316.
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
FL312D1	6.4
FL312D1	14
FL312D1	
FL312D1	
FL312D1	
FL313D1	8.2
FL313D1	18
FL313D1	
FL314D1	9.5
FL314D1	21
FL314D1	
FL314D1	
FL315D1	11
FL315D1	24
FL315D1	
FL315D1	
FL315D1	
FL316D1	14
FL316D1	31
FL316D1	
FL316D1	
FL317D1	16
FL317D1	35
FL317D1	
FL317D1	
FL318D1	19
FL318D1	42
FL318D1	

UELFL3

Flanged units cast housing
Eccentric locking collar type

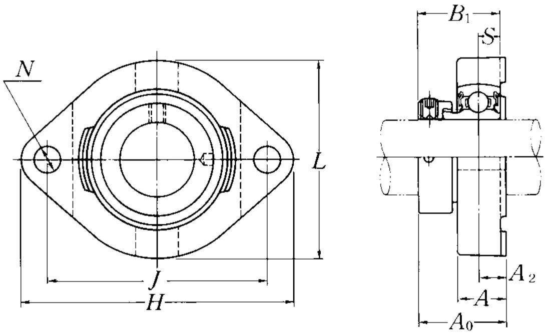


Shaft dia. mm inch	Unit number 1) 2)	Nominal dimensions mm inch H	J	A_2	A_1	A	N	L	A_0	B_1	S	Bolt size mm inch	Bearing number
95	**UELFL319D1W3**	405	330	59	40	94	41	250	142.4	122.3	38.9	M36	UEL319D1W3
$3\frac{5}{8}$	**UELFL319-310D1W3**	$15\frac{15}{16}$	$12\frac{63}{64}$	$2\frac{21}{64}$	$1\frac{9}{16}$	$3\frac{11}{16}$	$1\frac{39}{64}$	$9\frac{27}{32}$	$5\frac{39}{64}$	4.815	1.531	$1\frac{3}{8}$	UEL319-310D1W3
$3\frac{11}{16}$	**UELFL319-311D1W3**												UEL319-311D1W3
$3\frac{3}{4}$	**UELFL319-312D1W3**												UEL319-312D1W3
100	**UELFL320D1W3**	440	360	59	40	94	44	270	137.6	128.6	50	M39	UEL320D1W3
$3\frac{13}{16}$	**UELFL320-313D1W3**	$17\frac{5}{16}$	$14\frac{11}{64}$	$2\frac{21}{64}$	$1\frac{9}{16}$	$3\frac{11}{16}$	$1\frac{47}{64}$	$10\frac{5}{8}$	$5\frac{27}{64}$	5.063	1.969	$1\frac{1}{2}$	UEL320-313D1W3
$3\frac{7}{8}$	**UELFL320-314D1W3**												UEL320-314D1W3
$3\frac{15}{16}$	**UELFL320-315D1W3**												UEL320-315D1W3
4	**UELFL320-400D1W3**												UEL320-400D1W3
105	**UELFL321D1W3**	440	360	59	40	94	44	270	150.3	139.7	48.4	M39	UEL321D1W3
110	**UELFL322D1W3**	470	390	60	42	96	44	300	152.1	141.3	49.2	M39	UEL322D1W3

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
FL319D1	24
FL319D1	
FL319D1	53
FL319D1	
FL320D1	29
FL320D1	
FL320D1	64
FL320D1	
FL320D1	
FL321D1	30
FL322D1	36

Flanged units cast housing
Eccentric locking collar type

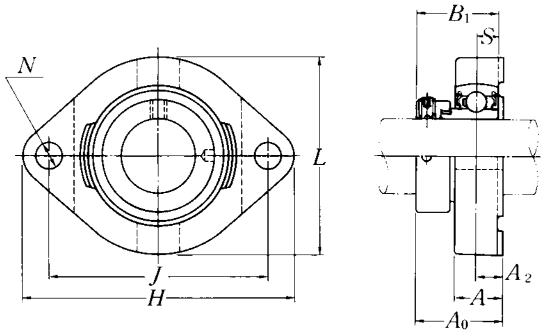


Shaft dia. mm inch	Unit number 1)	H	J	A2	A	N	L	A0	B1	S	Bolt size mm inch	Bearing 1) number	Housing 1) number	Mass of unit kg lb
		Nominal dimensions mm inch												
12	AELFD201W3	81	63	8.5	15	7	59	30.6	28.6	6.5	M 6	AEL201W3	FD201	0.3
1/2	AELFD201-008W3	3 3/16	2 31/64	21/64	19/32	9/32	2 5/16	1 13/64	1.126	0.256	1/4	AEL201-008W3	FD201	0.7
15	AELFD202W3	81	63	8.5	15	7	59	30.6	28.6	6.5	M 6	AEL202W3	FD201	0.3
9/16	AELFD202-009W3	3 3/16	2 31/64	21/64	19/32	9/32	2 5/16	1 13/64	1.126	0.256	1/4	AEL202-009W3	FD201	0.7
5/8	AELFD202-010W3											AEL202-010W3	FD201	
17	AELFD203W3	81	63	8.5	15	7	59	30.6	28.6	6.5	M 6	AEL203W3	FD201	0.3
11/16	AELFD203-011W3	3 3/16	2 31/64	21/64	19/32	9/32	2 5/16	1 13/64	1.126	0.256	1/4	AEL203-011W3	FD201	0.7
20	AELFD204W3	90	71	9.5	17	10	67	33	31	7.5	M 8	AEL204W3	FD204	0.5
3/4	AELFD204-012W3	3 17/32	2 51/64	3/8	21/32	25/64	2 5/8	1 19/64	1.220	0.295	5/16	AEL204-012W3	FD204	1.1
25	AELFD205W3	95	76	9.5	17	10	71	33	31	7.5	M 8	AEL205W3	FD205	0.5
13/16	AELFD205-013W3	3 3/4	2 63/64	3/8	21/32	25/64	2 25/32	1 19/64	1.220	0.295	5/16	AEL205-013W3	FD205	1.1
7/8	AELFD205-014W3											AEL205-014W3	FD205	
15/16	AELFD205-015W3											AEL205-015W3	FD205	
1	AELFD205-100W3											AEL205-100W3	FD205	
30	AELFD206W3	113	90	12	21	12	84	38.7	35.7	9	M10	AEL206W3	FD206	0.8
1 1/16	AELFD206-101W3	4 7/16	3 17/32	15/32	13/16	15/32	3 5/16	1 17/32	1.406	0.354	3/8	AEL206-101W3	FD206	1.8
1 1/8	AELFD206-102W3											AEL206-102W3	FD206	
1 3/16	AELFD206-103W3											AEL206-103W3	FD206	
1 1/4	AELFD206-104W3											AEL206-104W3	FD206	
35	AELFD207W3	125	100	12.5	22	12	94	41.9	38.9	9.5	M10	AEL207W3	FD207	1.0
1 1/4	AELFD207-104W3	4 29/32	3 15/16	31/64	7/8	15/32	3 11/16	1 21/32	1.531	0.374	3/8	AEL207-104W3	FD207	2.2
1 5/16	AELFD207-105W3											AEL207-105W3	FD207	
1 3/8	AELFD207-106W3											AEL207-106W3	FD207	
1 7/16	AELFD207-107W3											AEL207-107W3	FD207	

Remarks: 1) If relubricatable type is needed, please order with suffix "A-" "D1". ex. A-AELFD201D1W3

JELFD2

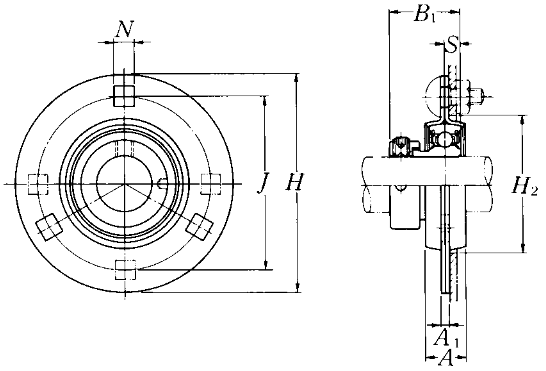
Flanged units cast housing
Eccentric locking collar type



Shaft dia.	Unit number [1]	Nominal dimensions									Bolt size	Bearing [1] number	Housing[1] number	Mass of unit
mm inch		mm inch									mm inch			kg lb
		H	*J*	*A*₂	*A*	*N*	*L*	*A*₀	*B*₁	*S*				
12	**JELFD201W3**	81	63	8.5	15	7	59	30.6	28.6	6.5	M 6	JEL201W3	FD201	0.3
1/2	**JELFD201-008W3**	3 3/16	2 31/64	21/64	19/32	9/32	2 5/16	1 13/64	1.126	0.256	1/4	JEL201-008W3	FD201	0.7
15	**JELFD202W3**	81	63	8.5	15	7	59	30.6	28.6	6.5	M 6	JEL202W3	FD201	0.3
9/16	**JELFD202-009W3**	3 3/16	2 31/64	21/64	19/32	9/32	2 5/16	1 13/64	1.126	0.256	1/4	JEL202-009W3	FD201	0.7
5/8	**JELFD202-010W3**											JEL202-010W3	FD201	
17	**JELFD203W3**	81	63	8.5	15	7	59	30.6	28.6	6.5	M 6	JEL203W3	FD201	0.3
11/16	**JELFD203-011W3**	3 3/16	2 31/64	21/64	19/32	9/32	2 5/16	1 13/64	1.126	0.256	1/4	JEL203-011W3	FD201	0.7
20	**JELFD204W3**	90	71	9.5	17	10	67	33	31	7.5	M 8	JEL204W3	FD204	0.5
3/4	**JELFD204-012W3**	3 17/32	2 51/64	3/8	21/32	25/64	2 5/8	1 19/64	1.220	0.295	5/16	JEL204-012W3	FD204	1.1
25	**JELFD205W3**	95	76	9.5	17	10	71	33	31	7.5	M 8	JEL205W3	FD205	0.5
13/16	**JELFD205-013W3**	3 3/4	2 63/64	3/8	21/32	25/64	2 25/32	1 19/64	1.220	0.295	5/16	JEL205-013W3	FD205	1.1
7/8	**JELFD205-014W3**											JEL205-014W3	FD205	
15/16	**JELFD205-015W3**											JEL205-015W3	FD205	
1	**JELFD205-100W3**											JEL205-100W3	FD205	
30	**JELFD206W3**	113	90	12	21	12	84	38.7	35.7	9	M10	JEL206W3	FD206	0.8
1 1/16	**JELFD206-101W3**	4 7/16	3 17/32	15/32	13/16	15/32	3 5/16	1 17/32	1.406	0.354	3/8	JEL206-101W3	FD206	1.8
1 1/8	**JELFD206-102W3**											JEL206-102W3	FD206	
1 3/16	**JELFD206-103W3**											JEL206-103W3	FD206	
1 1/4	**JELFD206-104W3**											JEL206-104W3	FD206	
35	**JELFD207W3**	125	100	12.5	22	12	94	41.9	38.9	9.5	M10	JEL207W3	FD207	1.0
1 1/4	**JELFD207-104W3**	4 29/32	3 15/16	31/64	7/8	15/32	3 11/16	1 21/32	1.531	0.374	3/8	JEL207-104W3	FD207	2.2
1 5/16	**JELFD207-105W3**											JEL207-105W3	FD207	
1 3/8	**JELFD207-106W3**											JEL207-106W3	FD207	
1 7/16	**JELFD207-107W3**											JEL207-107W3	FD207	

Remarks: 1) If relubricatable type is needed, please order with suffix "A-" "D1". ex. A-JELFD201D1W3

Flanged units pressed steel housing
Eccentric locking collar type

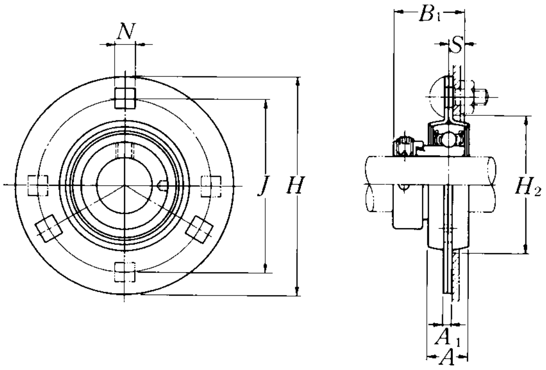


Shaft dia. mm inch	Unit number	Nominal dimensions mm / inch H	J	A_1	N 1)	A	B_1	S	H_2 min.	Bolt size mm inch	Max. load recommended N / lbf radial	axial	Bearing number
12	**AELPF201W3**	81	63.5	4	7.1	14	28.6	6.5	49	M6	2 700	1 350	AEL201W3
1/2	**AELPF201-008W3**	3 3/16	2 1/2	0.157	9/32	9/16	1.126	0.256	1 59/64	1/4	600	300	AEL201-008W3
15	**AELPF202W3**	81	63.5	4	7.1	14	28.6	6.5	49	M6	2 700	1 350	AEL202W3
9/16	**AELPF202-009W3**	3 3/16	2 1/2	0.157	9/32	9/16	1.126	0.256	1 59/64	1/4	600	300	AEL202-009W3
5/8	**AELPF202-010W3**												AEL202-010W3
17	**AELPF203W3**	81	63.5	4	7.1	14	28.6	6.5	49	M6	2 700	1 350	AEL203W3
11/16	**AELPF203-011W3**	3 3/16	2 1/2	0.157	9/32	9/16	1.126	0.256	1 59/64	1/4	600	300	AEL203-011W3
20	**AELPF204W3**	90	71.5	4	9	16	31	7.5	56	M8	3 000	1 500	AEL204W3
3/4	**AELPF204-012W3**	3 17/32	2 13/16	0.157	23/64	5/8	1.220	0.295	2 13/64	5/16	660	330	AEL204-012W3
25	**AELPF205W3**	95	76	4	9	18	31	7.5	60	M8	4 000	2 000	AEL205W3
13/16	**AELPF205-013W3**	3 3/4	2 63/64	0.157	23/64	23/32	1.220	0.295	2 23/64	5/16	880	440	AEL205-013W3
7/8	**AELPF205-014W3**												AEL205-014W3
15/16	**AELPF205-015W3**												AEL205-015W3
1	**AELPF205-100W3**												AEL205-100W3
30	**AELPF206W3**	113	90.5	5.2	11	18	35.7	9	71	M10	5 000	2 500	AEL206W3
1 1/16	**AELPF206-101W3**	4 7/16	3 9/16	0.205	7/16	23/32	1.406	0.354	2 51/64	3/8	1 100	550	AEL206-101W3
1 1/8	**AELPF206-102W3**												AEL206-102W3
1 3/16	**AELPF206-103W3**												AEL206-103W3
1 1/4	**AELPF206-104W3**												AEL206-104W3
35	**AELPF207W3**	122	100	5.2	11	20	38.9	9.5	81	M10	6 000	3 000	AEL207W3
1 1/4	**AELPF207-104W3**	4 13/16	3 15/16	0.205	7/16	25/32	1.531	0.374	3 3/16	3/8	1 300	650	AEL207-104W3
1 5/16	**AELPF207-105W3**												AEL207-105W3
1 3/8	**AELPF207-106W3**												AEL207-106W3
1 7/16	**AELPF207-107W3**												AEL207-107W3
40	**AELPF208W3**	148	119	6.8	13.5	21	43.7	11	91	M12	7 000	3 500	AEL208W3
1 1/2	**AELPF208-108W3**	5 13/16	4 11/16	0.268	17/32	13/16	1.720	0.433	3 37/64	1/2	1 500	750	AEL208-108W3
1 9/16	**AELPF208-109W3**												AEL208-109W3

Remarks: 1) AELPF208 has four bolt holes.

Housing number	Mass of unit kg lb
PF203	0.2
PF203	0.4
PF203	0.2
PF203	0.4
PF203	
PF203	0.2
PF203	0.4
PF204	0.3
PF204	0.7
PF205	0.4
PF205	0.9
PF205	
PF205	
PF205	
PF206	0.6
PF206	1.3
PF206	
PF206	
PF206	
PF207	0.8
PF207	1.8
PF207	
PF207	
PF207	
PF208	1.3
PF208	2.9
PF208	

Flanged units pressed steel housing
Eccentric locking collar type

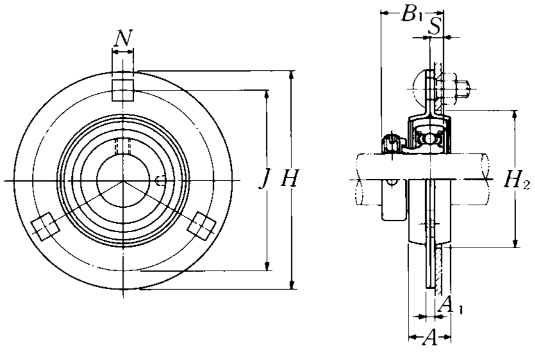


Shaft dia. mm inch	Unit number	Nominal dimensions mm inch H	J	A1	N 1)	A	B1	S	H2 min.	Bolt size mm inch	Max. load recommended N lbf radial	axial	Bearing number
12	**JELPF201W3**	81	63.5	4	7.1	14	28.6	6.5	49	M6	2 700	1 350	JEL201W3
1/2	**JELPF201-008W3**	3 3/16	2 1/2	0.157	9/32	9/16	1.126	0.256	1 59/64	1/4	600	300	JEL201-008W3
15	**JELPF202W3**	81	63.5	4	7.1	14	28.6	6.5	49	M6	2 700	1 350	JEL202W3
9/16	**JELPF202-009W3**	3 3/16	2 1/2	0.157	9/32	9/16	1.126	0.256	1 59/64	1/4	600	300	JEL202-009W3
5/8	**JELPF202-010W3**												JEL202-010W3
17	**JELPF203W3**	81	63.5	4	7.1	14	28.6	6.5	49	M6	2 700	1 350	JEL203W3
11/16	**JELPF203-011W3**	3 3/16	2 1/2	0.157	9/32	9/16	1.126	0.256	1 59/64	1/4	600	300	JEL203-011W3
20	**JELPF204W3**	90	71.5	4	9	16	31	7.5	56	M8	3 000	1 500	JEL204W3
3/4	**JELPF204-012W3**	3 17/32	2 13/16	0.157	23/64	5/8	1.220	0.295	2 13/64	5/16	660	330	JEL204-012W3
25	**JELPF205W3**	95	76	4	9	18	31	7.5	60	M8	4 000	2 000	JEL205W3
13/16	**JELPF205-013W3**	3 3/4	2 63/64	0.157	23/64	23/32	1.220	0.295	2 23/64	5/16	800	440	JEL205-013W3
7/8	**JELPF205-014W3**												JEL205-014W3
15/16	**JELPF205-015W3**												JEL205-015W3
1	**JELPF205-100W3**												JEL205-100W3
30	**JELPF206W3**	113	90.5	5.2	11	18	35.7	9	71	M10	5 000	2 500	JEL206W3
1 1/16	**JELPF206-101W3**	4 7/16	3 9/16	0.205	7/16	23/32	1.406	0.354	2 51/64	3/8	1 100	550	JEL206-101W3
1 1/8	**JELPF206-102W3**												JEL206-102W3
1 3/16	**JELPF206-103W3**												JEL206-103W3
1 1/4	**JELPF206-104W3**												JEL206-104W3
35	**JELPF207W3**	122	100	5.2	11	20	38.9	9.5	81	M10	6 000	3 000	JEL207W3
1 1/4	**JELPF207-104W3**	4 13/16	3 15/16	0.205	7/16	25/32	1.531	0.374	3 3/16	3/8	1 300	650	JEL207-104W3
1 5/16	**JELPF207-105W3**												JEL207-105W3
1 3/8	**JELPF207-106W3**												JEL207-106W3
1 7/16	**JELPF207-107W3**												JEL207-107W3
40	**JELPF208W3**	148	119	6.8	13.5	21	43.7	11	91	M12	7 000	3 500	JEL208W3
1 1/2	**JELPF208-108W3**	5 3/16	4 11/16	0.268	17/32	13/16	1.720	0.433	3 37/64	1/2	1 500	750	JEL208-108W3
1 9/16	**JELPF208-109W3**												JEL208-109W3

Remarks: 1) JELPF208 has four bolt holes.

Housing number	Mass of unit kg lb
PF203 PF203	0.2 0.4
PF203 PF203 PF203	0.2 0.4
PF203 PF203	0.2 0.4
PF204 PF204	0.3 0.7
PF205 PF205 PF205 PF205 PF205	0.4 0.9
PF206 PF206 PF206 PF206 PF206	0.6 1.3
PF207 PF207 PF207 PF207 PF207	0.8 1.8
PF208 PF208 PF208	1.3 2.9

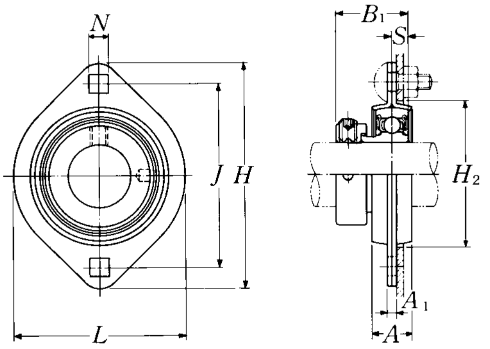
Flanged units pressed steel housing with rubber ring
Eccentric locking collar type



Shaft dia.	Unit number	Nominal dimensions								Bolt size	Max. load recommended		Bearing number
		mm inch									N	lbf	
mm inch		H	J	A_1	N	A	B_1	S	H_2 min.	mm inch	radial	axial	
12 1/2	**AELRPF201W3** **AELRPF201-008W3**	90 3 17/32	71.5 2 13/16	4 0.157	9 23/64	16 5/8	28.6 1.126	6.5 0.256	56 2 13/64	M8 5/16	1 000 220	200 40	AEL201W3 AEL201-008W3
15 9/16 5/8	**AELRPF202W3** **AELRPF202-009W3** **AELRPF202-010W3**	90 3 17/32	71.5 2 13/16	4 0.157	9 23/64	16 5/8	28.6 1.126	6.5 0.256	56 2 13/64	M8 5/16	1 000 220	200 40	AEL202W3 AEL202-009W3 AEL202-010W3
17 11/16	**AELRPF203W3** **AELRPF203-011W3**	90 3 17/32	71.5 2 13/16	4 0.157	9 23/64	16 5/8	28.6 1.126	6.5 0.256	56 2 13/64	M8 5/16	1 000 220	200 40	AEL203W3 AEL203-011W3
20 3/4	**AELRPF204W3** **AELRPF204-012W3**	95 3 3/4	76 2 63/64	4 0.157	9 23/64	18 23/32	31 1.220	7.5 0.295	60 2 23/64	M8 5/16	1 150 250	200 40	AEL204W3 AEL204-012W3
25 13/16 7/8 15/16 1	**AELRPF205W3** **AELRPF205-013W3** **AELRPF205-014W3** **AELRPF205-015W3** **AELRPF205-100W3**	113 4 7/16	90.5 3 9/16	5.2 0.205	11 7/16	18 23/32	31 1.220	7.5 0.295	71 2 51/64	M10 3/8	1 300 280	200 40	AEL205W3 AEL205-013W3 AEL205-014W3 AEL205-015W3 AEL205-100W3
30 1 1/16 1 1/8 1 3/16 1 1/4	**AELRPF206W3** **AELRPF206-101W3** **AELRPF206-102W3** **AELRPF206-103W3** **AELRPF206-104W3**	122 4 13/16	100 3 15/16	5.2 0.205	11 7/16	20 25/32	35.7 1.406	9 0.354	81 3 3/16	M10 3/8	1 500 330	200 40	AEL206W3 AEL206-101W3 AEL206-102W3 AEL206-103W3 AEL206-104W3

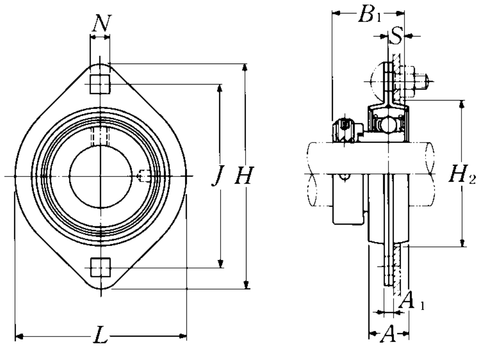
Housing number		Mass of unit
Rubber	Housing	kg lb
R201	PF204	0.3
R201	PF204	0.7
R201	PF204	0.3
R201	PF204	0.7
R201	PF204	
R201	PF204	0.3
R201	PF204	0.7
R204	PF205	0.4
R204	PF205	0.9
R205	PF206	0.5
R205	PF206	1.1
R205	PF206	
R205	PF206	
R205	PF206	
R206	PF207	0.7
R206	PF207	1.5
R206	PF207	
R206	PF207	
R206	PF207	

Flanged units pressed steel housing
Eccentric locking collar type



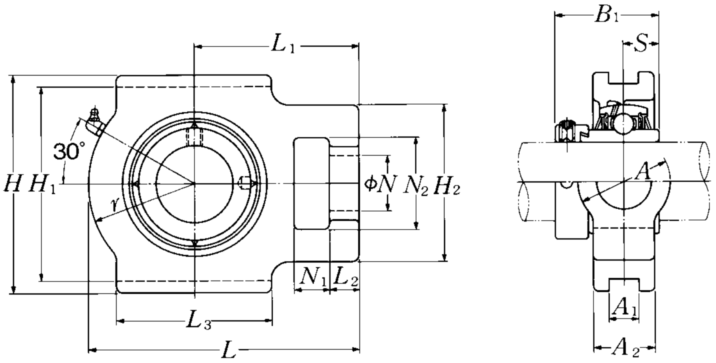
Shaft dia.	Unit number	Nominal dimensions mm inch									Bolt size	Bearing number	Housing number	Mass of unit
mm inch		H	J	A_1	N	A	L	B_1	S	H_2	mm inch			kg lb
12	AELPFL201W3	81	63.5	4	7.1	14	59	28.6	6.5	49	M 6	AEL201W3	PFL203	0.2
1/2	AELPFL201-008W3	3 3/16	2 1/2	0.157	9/32	9/16	2 5/16	1.126	0.256	1 59/64	1/4	AEL201-008W3	PFL203	0.4
15	AELPFL202W3	81	63.5	4	7.1	14	59	28.6	6.5	49	M 6	AEL202W3	PFL203	0.2
9/16	AELPFL202-009W3	3 3/16	2 1/2	0.157	9/32	9/16	2 5/16	1.126	0.256	1 59/64	1/4	AEL202-009W3	PFL203	0.4
5/8	AELPFL202-010W3											AEL202-010W3	PFL203	
17	AELPFL203W3	81	63.5	4	7.1	14	59	28.6	6.5	49	M 6	AEL203W3	PFL203	0.1
11/16	AELPFL203-011W3	3 3/16	2 1/2	0.157	9/32	9/16	2 5/16	1.126	0.256	1 59/64	1/4	AEL203-011W3	PFL203	0.2
20	AELPFL204W3	90	71.5	4	9	16	67	31	7.5	56	M 8	AEL204W3	PFL204	0.3
3/4	AELPFL204-012W3	3 17/32	2 13/16	0.157	23/64	5/8	2 5/8	1.220	0.295	2 13/64	5/16	AEL204-012W3	PFL204	0.7
25	AELPFL205W3	95	76	4	9	18	71	31	7.5	60	M 8	AEL205W3	PFL205	0.3
13/16	AELPFL205-013W3	3 3/4	2 63/64	0.157	23/64	23/32	2 25/32	1.220	0.295	2 23/64	5/16	AEL205-013W3	PFL205	0.7
7/8	AELPFL205-014W3											AEL205-014W3	PFL205	
15/16	AELPFL205-015W3											AEL205-015W3	PFL205	
1	AELPFL205-100W3											AEL205-100W3	PFL205	
30	AELPFL206W3	113	90.5	5.2	11	18	84	35.7	9	71	M10	AEL206W3	PFL206	0.5
1 1/16	AELPFL206-101W3	4 7/16	3 9/16	0.205	7/16	23/32	3 5/16	1.406	0.354	2 51/64	3/8	AEL206-101W3	PFL206	1.1
1 1/8	AELPFL206-102W3											AEL206-102W3	PFL206	
1 3/16	AELPFL206-103W3											AEL206-103W3	PFL206	
1 1/4	AELPFL206-104W3											AEL206-104W3	PFL206	
35	AELPFL207W3	122	100	5.2	11	20	94	38.9	9.5	81	M10	AEL207W3	PFL207	0.7
1 1/4	AELPFL207-104W3	4 13/16	3 15/16	0.205	7/16	25/32	3 11/16	1.531	0.374	3 3/16	3/8	AEL207-104W3	PFL207	1.5
1 5/16	AELPFL207-105W3											AEL207-105W3	PFL207	
1 3/8	AELPFL207-106W3											AEL207-106W3	PFL207	
1 7/16	AELPFL207-107W3											AEL207-107W3	PFL207	
40	AELPFL208W3	148	119	6.8	13.5	21	100	43.7	11	91	M12	AEL208W3	PFL208	1.0
1 1/2	AELPFL208-108W3	5 13/16	4 11/16	0.268	17/32	13/16	3 15/16	1.720	0.433	3 37/64	1/2	AEL208-108W3	PFL208	2.2
1 9/16	AELPFL208-109W3											AEL208-109W3	PFL208	

Flanged units pressed steel housing
Eccentric locking collar type



Shaft dia. mm inch	Unit number	Nominal dimensions mm inch									Bolt size mm inch	Bearing number	Housing number	Mass of unit kg lb
		H	J	A_1	N	A	L	B_1	S	H_2				
12	**JELPFL201W3**	81	63	4	7.1	14	59	28.6	6.5	49	M 6	JEL201W3	PFL203	0.2
1/2	**JELPFL201-008W3**	3 3/16	2 31/64	0.157	9/32	9/16	2 5/16	1.126	0.256	1 59/64	1/4	JEL201-008W3	PFL203	0.4
15	**JELPFL202W3**	81	63	4	7.1	14	59	28.6	6.5	49	M 6	JEL202W3	PFL203	0.2
9/16	**JELPFL202-009W3**	3 3/16	2 31/64	0.157	9/32	9/16	2 5/16	1.126	0.256	1 59/64	1/4	JEL202-009W3	PFL203	0.4
5/8	**JELPFL202-010W3**											JEL202-010W3	PFL203	
17	**JELPFL203W3**	81	63	4	7.1	14	59	28.6	6.5	49	M 6	JEL203W3	PFL203	0.1
11/16	**JELPFL203-011W3**	3 3/16	2 31/64	0.157	9/32	9/16	2 5/16	1.126	0.256	1 59/64	1/4	JEL203-011W3	PFL203	0.2
20	**JELPFL204W3**	90	71	4	9	16	67	31	7.5	56	M 8	JEL204W3	PFL204	0.3
3/4	**JELPFL204-012W3**	3 17/32	2 51/64	0.157	23/64	5/8	2 5/8	1.220	0.295	2 13/64	5/16	JEL204-012W3	PFL204	0.7
25	**JELPFL205W3**	95	76	4	9	18	71	31	7.5	60	M 8	JEL205W3	PFL205	0.3
13/16	**JELPFL205-013W3**	3 3/4	2 63/64	0.157	23/64	23/32	2 25/32	1.220	0.295	2 23/64	5/16	JEL205-013W3	PFL205	0.7
7/8	**JELPFL205-014W3**											JEL205-014W3	PFL205	
15/16	**JELPFL205-015W3**											JEL205-015W3	PFL205	
1	**JELPFL205-100W3**											JEL205-100W3	PFL205	
30	**JELPFL206W3**	113	90	5.2	11	18	84	35.7	9	71	M10	JEL206W3	PFL206	0.5
1 1/16	**JELPFL206-101W3**	4 7/16	3 35/64	0.205	7/16	23/32	3 5/16	1.406	0.354	2 51/64	3/8	JEL206-101W3	PFL206	1.1
1 1/8	**JELPFL206-102W3**											JEL206-102W3	PFL206	
1 3/16	**JELPFL206-103W3**											JEL206-103W3	PFL206	
1 1/4	**JELPFL206-104W3**											JEL206-104W3	PFL206	
35	**JELPFL207W3**	122	100	5.2	11	20	94	38.9	9.5	81	M10	JEL207W3	PFL207	0.7
1 1/4	**JELPFL207-104W3**	4 13/16	3 15/16	0.205	7/16	25/32	3 11/16	1.531	0.374	3 3/16	3/8	JEL207-104W3	PFL207	1.5
1 5/16	**JELPFL207-105W3**											JEL207-105W3	PFL207	
1 3/8	**JELPFL207-106W3**											JEL207-106W3	PFL207	
1 7/16	**JELPFL207-107W3**											JEL207-107W3	PFL207	
40	**JELPFL208W3**	148	119	6.8	13.5	21	100	43.7	11	91	M12	JEL208W3	PFL208	1.0
1 1/2	**JELPFL208-108W3**	5 13/16	4 11/16	0.268	17/32	13/16	3 15/16	1.720	0.433	3 37/64	1/2	JEL208-108W3	PFL208	2.2
1 9/16	**JELPFL208-109W3**											JEL208-109W3	PFL208	

Take-up units cast housing
Eccentric locking collar type

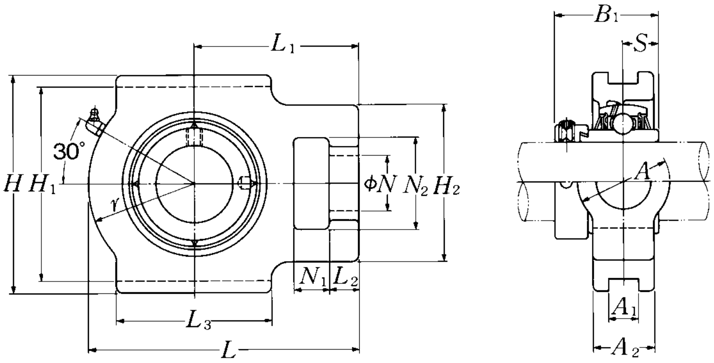


Shaft dia. mm inch	Unit number [1]	Nominal dimensions mm inch															
		N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B_1	S
20	**UELT204D1W3**	16	12	51	32	19	51	12	76	89	94	21	32	33	61	43.7	17.1
3/4	**UELT204-012D1W3**	5/8	15/32	2	1 1/4	3/4	2	0.472	2 63/64	3 1/2	3 11/16	13/16	1 1/4	1 5/16	2 13/32	1.720	0.673
25	**UELT205D1W3**	16	12	51	32	19	51	12	76	89	97	24	32	35	62	44.4	17.5
13/16	**UELT205-013D1W3**	5/8	15/32	2	1 1/4	3/4	2	0.472	2 63/64	3 1/2	3 13/16	15/16	1 1/4	1 3/8	2 7/16	1.748	0.689
7/8	**UELT205-014D1W3**																
15/16	**UELT205-015D1W3**																
1	**UELT205-100D1W3**																
30	**UELT206D1W3**	16	12	56	37	22	57	12	89	102	113	28	37	43	70	48.4	18.3
1 1/16	**UELT206-101D1W3**	5/8	15/32	2 7/32	1 15/32	7/8	2 1/4	0.472	3 1/2	4 1/32	4 7/16	1 3/32	1 15/32	1 11/16	2 3/4	1.906	0.720
1 1/8	**UELT206-102D1W3**																
1 3/16	**UELT206-103D1W3**																
1 1/4	**UELT206-104D1W3**																
35	**UELT207D1W3**	16	15	64	37	22	64	12	89	102	129	30	37	51	78	51.1	18.8
1 1/4	**UELT207-104D1W3**	5/8	19/32	2 17/32	1 15/32	7/8	2 17/32	0.472	3 1/2	4 1/32	5 3/32	1 3/16	1 15/32	2	3 1/16	2.012	0.740
1 5/16	**UELT207-105D1W3**																
1 3/8	**UELT207-106D1W3**																
1 7/16	**UELT207-107D1W3**																
40	**UELT208D1W3**	19	18	83	49	29	83	16	102	114	144	33	49	56	88	56.3	21.4
1 1/2	**UELT208-108D1W3**	3/4	23/32	3 9/32	1 15/16	1 5/32	3 9/32	0.630	4 1/64	4 1/2	5 21/32	1 5/16	1 15/16	2 7/32	3 15/32	2.217	0.843
1 9/16	**UELT208-109D1W3**																
45	**UELT209D1W3**	19	18	83	49	29	83	16	102	117	145	35	49	57	88	56.3	21.4
1 5/8	**UELT209-110D1W3**	3/4	23/32	3 9/32	1 15/16	1 5/32	3 9/32	0.630	4 1/64	4 19/32	5 23/32	1 3/8	1 15/16	2 1/4	3 15/32	2.217	0.843
1 11/16	**UELT209-111D1W3**																
1 3/4	**UELT209-112D1W3**																
50	**UELT210D1W3**	19	18	83	49	29	86	16	102	117	151	37	49	59	92	62.7	24.6
1 13/16	**UELT210-113D1W3**	3/4	23/32	3 9/32	1 15/16	1 5/32	3 3/8	0.630	4 1/64	4 19/32	5 15/16	1 15/32	1 15/16	2 5/16	3 5/8	2.469	0.969
1 7/8	**UELT210-114D1W3**																
1 15/16	**UELT210-115D1W3**																
2	**UELT210-200D1W3**																

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit kg	 lb
UEL204D1W3	T204D1	0.8	
UEL204-012D1W3	T204D1		1.8
UEL205D1W3	T205D1	1.0	
UEL205-013D1W3	T205D1		2.2
UEL205-014D1W3	T205D1		
UEL205-015D1W3	T205D1		
UEL205-100D1W3	T205D1		
UEL206D1W3	T206D1	1.5	
UEL206-101D1W3	T206D1		3.3
UEL206-102D1W3	T206D1		
UEL206-103D1W3	T206D1		
UEL206-104D1W3	T206D1		
UEL207D1W3	T207D1	1.8	
UEL207-104D1W3	T207D1		4.0
UEL207-105D1W3	T207D1		
UEL207-106D1W3	T207D1		
UEL207-107D1W3	T207D1		
UEL208D1W3	T208D1	2.4	
UEL208-108D1W3	T208D1		5.3
UEL208-109D1W3	T208D1		
UEL209D1W3	T209D1	2.5	
UEL209-110D1W3	T209D1		5.5
UEL209-111D1W3	T209D1		
UEL209-112D1W3	T209D1		
UEL210D1W3	T210D1	2.6	
UEL210-113D1W3	T210D1		5.7
UEL210-114D1W3	T210D1		
UEL210-115D1W3	T210D1		
UEL210-200D1W3	T210D1		

Take-up units cast housing
Eccentric locking collar type

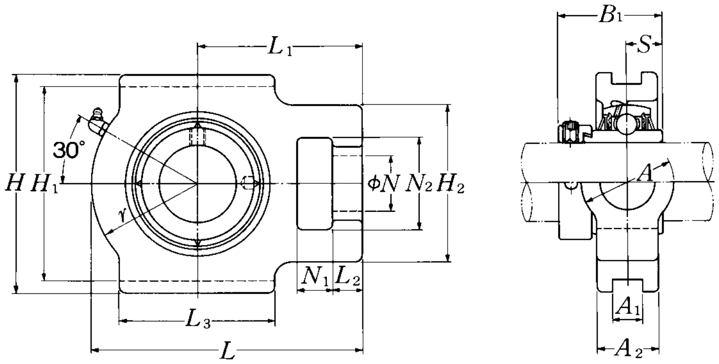


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch															
		N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B_1	S
55	**UELT211D1W3**	25	21	102	64	35	95	22	130	146	171	38	64	65	106	71.4	27.8
2	**UELT211-200D1W3**	31/32	13/16	4 1/32	2 17/32	1 3/8	3 3/4	0.866	5 1/8	5 3/4	6 23/32	1 1/2	2 17/32	2 9/16	4 3/16	2.811	1.094
2 1/16	**UELT211-201D1W3**																
2 1/8	**UELT211-202D1W3**																
2 3/16	**UELT211-203D1W3**																
60	**UELT212D1W3**	32	21	102	64	35	102	22	130	146	194	42	64	75	119	77.8	31
2 1/4	**UELT212-204D1W3**	1 1/4	13/16	4 1/32	2 17/32	1 3/8	4 1/32	0.866	5 1/8	5 3/4	7 5/8	1 21/32	2 17/32	2 15/16	4 11/16	3.063	1.220
2 5/16	**UELT212-205D1W3**																
2 3/8	**UELT212-206D1W3**																
2 7/16	**UELT212-207D1W3**																
65	**UELT213D1W3**	32	23	111	70	41	121	26	151	167	224	44	70	87	137	85.7	34.15
2 1/2	**UELT213-208D1W3**	1 1/4	29/32	4 3/8	2 3/4	1 5/8	4 3/4	1.024	5 15/16	6 9/16	8 13/16	1 23/32	2 3/4	3 7/16	5 13/32	3.374	1.344
2 9/16	**UELT213-209D1W3**																
70	**UELT214D1W3**	32	23	111	70	41	121	26	151	167	224	46	70	87	137	85.7	34.15
2 5/8	**UELT214-210D1W3**	1 1/4	29/32	4 3/8	2 3/4	1 5/8	4 3/4	1.024	5 15/16	6 9/16	8 13/16	1 13/16	2 3/4	3 7/16	5 13/32	3.374	1.344
2 11/16	**UELT214-211D1W3**																
2 3/4	**UELT214-212D1W3**																
75	**UELT215D1W3**	32	23	111	70	41	121	26	151	167	232	48	70	92	140	92	37.3
2 13/16	**UELT215-213D1W3**	1 1/4	29/32	4 3/8	2 3/4	1 5/8	4 3/4	1.024	5 15/16	6 9/16	9 1/8	1 7/8	2 3/4	3 5/8	5 1/2	3.622	1.469
2 7/8	**UELT215-214D1W3**																
2 15/16	**UELT215-215D1W3**																
3	**UELT215-300D1W3**																

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit kg lb
UEL211D1W3	T211D1	4.0
UEL211-200D1W3	T211D1	8.8
UEL211-201D1W3	T211D1	
UEL211-202D1W3	T211D1	
UEL211-203D1W3	T211D1	
UEL212D1W3	T212D1	5.1
UEL212-204D1W3	T212D1	11
UEL212-205D1W3	T212D1	
UEL212-206D1W3	T212D1	
UEL212-207D1W3	T212D1	
UEL213D1W3	T213D1	7.5
UEL213-208D1W3	T213D1	17
UEL213-209D1W3	T213D1	
UEL214D1W3	T214D1	7.5
UEL214-210D1W3	T214D1	17
UEL214-211D1W3	T214D1	
UEL214-212D1W3	T214D1	
UEL215D1W3	T215D1	8.0
UEL215-213D1W3	T215D1	18
UEL215-214D1W3	T215D1	
UEL215-215D1W3	T215D1	
UEL215-300D1W3	T215D1	

Take-up units cast housing
Eccentric locking collar type

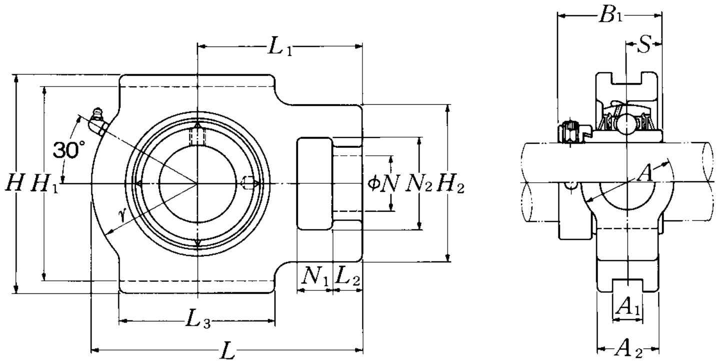


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B_1	S
25	**UELT305D1W3**	16	14	62	36	26	65	12	80	89	122	26	36	46	76	46.8	16.7
13/16	**UELT305-013D1W3**	5/8	9/16	2 7/16	1 13/32	1 1/32	2 9/16	0.472	3 5/32	3 1/2	4 13/16	1 1/32	1 13/32	1 13/16	3	1.843	0.657
7/8	**UELT305-014D1W3**																
15/16	**UELT305-015D1W3**																
1	**UELT305-100D1W3**																
30	**UELT306D1W3**	18	16	70	41	28	74	16	90	100	137	28	41	52	85	50	17.5
1 1/16	**UELT306-101D1W3**	23/32	5/8	2 3/4	1 5/8	1 3/32	2 29/32	0.630	3 35/64	3 15/16	5 13/32	1 3/32	1 5/8	2 1/16	3 11/32	1.969	0.689
1 1/8	**UELT306-102D1W3**																
1 3/16	**UELT306-103D1W3**																
35	**UELT307D1W3**	20	17	75	45	30	80	16	100	111	150	32	45	56	94	51.6	18.3
1 1/4	**UELT307-104D1W3**	25/32	21/32	2 15/16	1 25/32	1 3/16	3 5/32	0.630	3 15/16	4 3/8	5 29/32	1 1/4	1 25/32	2 7/32	3 11/16	2.031	0.720
1 5/16	**UELT307-105D1W3**																
1 3/8	**UELT307-106D1W3**																
1 7/16	**UELT307-107D1W3**																
40	**UELT308D1W3**	22	19	83	50	32	89	18	112	124	162	34	50	62	100	57.1	19.8
1 1/2	**UELT308-108D1W3**	7/8	3/4	3 9/32	1 31/32	1 1/4	3 1/2	0.709	4 13/32	4 7/8	6 3/8	1 11/32	1 31/32	2 7/16	3 15/16	2.248	0.780
1 9/16	**UELT308-109D1W3**																
45	**UELT309D1W3**	24	20	90	55	34	97	18	125	138	178	38	55	68	110	58.7	19.8
1 5/8	**UELT309-110D1W3**	15/16	25/32	3 17/32	2 5/32	1 11/32	3 13/16	0.709	4 59/64	5 7/16	7	1 1/2	2 5/32	2 11/16	4 11/32	2.311	0.780
1 11/16	**UELT309-111D1W3**																
1 3/4	**UELT309-112D1W3**																
50	**UELT310D1W3**	27	22	98	61	37	106	20	140	151	192	40	61	74	118	66.6	24.6
1 13/16	**UELT310-113D1W3**	1 1/16	7/8	3 27/32	2 13/32	1 15/32	4 3/16	0.787	5 33/64	5 15/16	7 9/16	1 9/16	2 13/32	2 29/32	4 21/32	2.622	0.969
1 7/8	**UELT310-114D1W3**																
1 15/16	**UELT310-115D1W3**																
55	**UELT311D1W3**	29	23	105	66	39	115	22	150	163	207	44	66	80	127	73	27.8
2	**UELT311-200D1W3**	1 5/32	29/32	4 1/8	2 19/32	1 17/32	4 17/32	0.866	5 29/32	6 13/32	8 5/32	1 23/32	2 19/32	3 5/32	5	2.874	1.094
2 1/16	**UELT311-201D1W3**																
2 1/8	**UELT311-202D1W3**																
2 3/16	**UELT311-203D1W3**																

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit	
		kg	lb
UEL305D1W3	T305D1	1.4	3.1
UEL305-013D1W3	T305D1		
UEL305-014D1W3	T305D1		
UEL305-015D1W3	T305D1		
UEL305-100D1W3	T305D1		
UEL306D1W3	T306D1	1.9	4.2
UEL306-101D1W3	T306D1		
UEL306-102D1W3	T306D1		
UEL306-103D1W3	T306D1		
UEL307D1W3	T307D1	2.5	5.5
UEL307-104D1W3	T307D1		
UEL307-105D1W3	T307D1		
UEL307-106D1W3	T307D1		
UEL307-107D1W3	T307D1		
UEL308D1W3	T308D1	3.1	6.8
UEL308-108D1W3	T308D1		
UEL308-109D1W3	T308D1		
UEL309D1W3	T309D1	4.2	9.3
UEL309-110D1W3	T309D1		
UEL309-111D1W3	T309D1		
UEL309-112D1W3	T309D1		
UEL310D1W3	T310D1	5.2	11
UEL310-113D1W3	T310D1		
UEL310-114D1W3	T310D1		
UEL310-115D1W3	T310D1		
UEL311D1W3	T311D1	6.6	15
UEL311-200D1W3	T311D1		
UEL311-201D1W3	T311D1		
UEL311-202D1W3	T311D1		
UEL311-203D1W3	T311D1		

Take-up units cast housing
Eccentric locking collar type

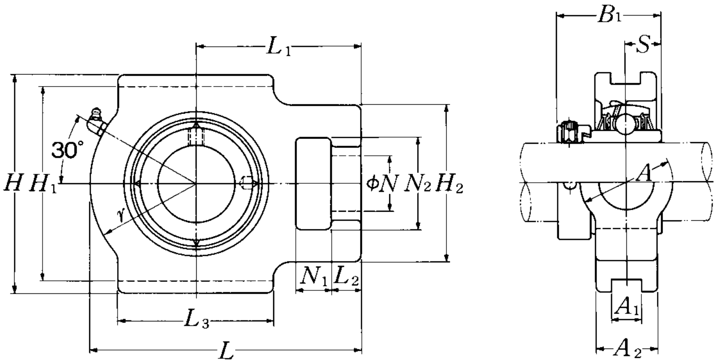


Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch															
		N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B_1	S
60	UELT312D1W3	31	25	113	71	41	123	22	160	178	220	46	71	85	135	79.4	30.95
2 1/4	UELT312-204D1W3	1 7/32	31/32	4 7/16	2 25/32	1 5/8	4 27/32	0.866	6 19/64	7	8 21/32	1 13/16	2 25/32	3 11/32	5 5/16	3.126	1.219
2 5/16	UELT312-205D1W3																
2 3/8	UELT312-206D1W3																
2 7/16	UELT312-207D1W3																
65	UELT313D1W3	32	27	116	70	43	134	26	170	190	238	50	80	92	146	85.7	32.55
2 1/2	UELT313-208D1W3	1 1/4	1 1/16	4 9/16	2 3/4	1 11/16	5 9/32	1.024	6 11/16	7 15/32	9 3/8	1 31/32	3 5/32	3 5/8	5 3/4	3.374	1.281
2 9/16	UELT313-209D1W3																
70	UELT314D1W3	36	27	130	85	46	140	26	180	202	252	52	90	97	155	92.1	34.15
2 5/8	UELT314-210D1W3	1 13/32	1 1/16	5 1/8	3 11/32	1 13/16	5 1/2	1.024	7 3/32	7 15/16	9 29/32	2 1/16	3 17/32	3 13/16	6 3/32	3.626	1.344
2 11/16	UELT314-211D1W3																
2 3/4	UELT314-212D1W3																
75	UELT315D1W3	36	27	132	85	46	150	26	192	216	262	55	90	102	160	100	37.3
2 13/16	UELT315-213D1W3	1 13/32	1 1/16	5 3/16	3 11/32	1 13/16	5 29/32	1.024	7 9/16	8 1/2	10 5/16	2 5/32	3 17/32	4 1/32	6 5/16	3.937	1.469
2 7/8	UELT315-214D1W3																
2 15/16	UELT315-215D1W3																
3	UELT315-300D1W3																
80	UELT316D1W3	42	30	150	98	53	160	30	204	230	282	60	102	108	174	106.4	40.5
3 1/16	UELT316-301D1W3	1 21/32	1 3/16	5 29/32	3 27/32	2 3/32	6 5/16	1.181	8 1/32	9 1/16	11 3/32	2 3/8	4 1/32	4 1/4	6 27/32	4.189	1.594
3 1/8	UELT316-302D1W3																
3 3/16	UELT316-303D1W3																
85	UELT317D1W3	42	32	152	98	53	170	32	214	240	298	64	102	115	183	109.5	42.05
3 1/4	UELT317-304D1W3	1 21/32	1 1/4	5 31/32	3 27/32	2 3/32	6 11/16	1.260	8 27/64	9 7/16	11 23/32	2 17/32	4 1/32	4 17/32	7 7/32	4.311	1.656
3 5/16	UELT317-305D1W3																
3 7/16	UELT317-307D1W3																
90	UELT318D1W3	46	32	160	106	57	175	32	228	255	312	66	110	120	192	115.9	43.65
3 7/16	UELT318-307D1W3	1 13/16	1 1/4	6 5/16	4 3/16	2 1/4	6 7/8	1.260	8 31/32	10 1/32	12 9/32	2 19/32	4 11/32	4 23/32	7 9/16	4.563	1.719
3 1/2	UELT318-308D1W3																

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit kg	 lb
UEL312D1W3	T312D1	7.9	17
UEL312-204D1W3	T312D1		
UEL312-205D1W3	T312D1		
UEL312-206D1W3	T312D1		
UEL312-207D1W3	T312D1		
UEL313D1W3	T313D1	10	22
UEL313-208D1W3	T313D1		
UEL313-209D1W3	T313D1		
UEL314D1W3	T314D1	12	26
UEL314-210D1W3	T314D1		
UEL314-211D1W3	T314D1		
UEL314-212D1W3	T314D1		
UEL315D1W3	T315D1	14	31
UEL315-213D1W3	T315D1		
UEL315-214D1W3	T315D1		
UEL315-215D1W3	T315D1		
UEL315-300D1W3	T315D1		
UEL316D1W3	T316D1	18	40
UEL316-301D1W3	T316D1		
UEL316-302D1W3	T316D1		
UEL316-303D1W3	T316D1		
UEL317D1W3	T317D1	21	46
UEL317-304D1W3	T317D1		
UEL317-305D1W3	T317D1		
UEL317-307D1W3	T317D1		
UEL318D1W3	T318D1	23	51
UEL318-307D1W3	T318D1		
UEL318-308D1W3	T318D1		

Take-up units cast housing
Eccentric locking collar type



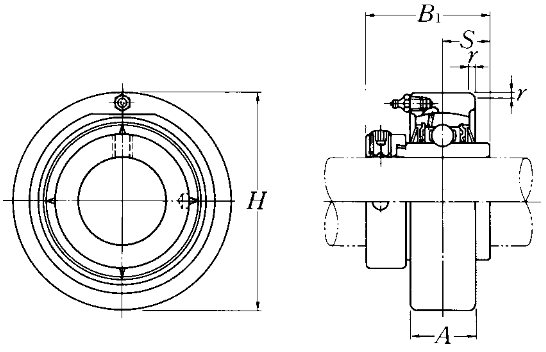
Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch															
		N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B_1	S
95	**UELT319D1W3**	46	33	165	106	57	180	35	240	270	322	72	110	125	197	122.3	38.9
3 5/8	**UELT319-310D1W3**	1 13/16	1 5/16	6 1/2	4 3/16	2 1/4	7 3/32	1.378	9 29/64	10 5/8	12 11/16	2 27/32	4 11/32	4 29/32	7 3/4	4.815	1.531
3 11/16	**UELT319-311D1W3**																
3 3/4	**UELT319-312D1W3**																
100	**UELT320D1W3**	48	34	175	115	59	200	35	260	290	345	75	120	135	210	128.6	50
3 13/16	**UELT320-313D1W3**	1 7/8	1 11/32	6 7/8	4 17/32	2 5/16	7 7/8	1.378	10 15/64	11 13/32	13 19/32	2 15/16	4 23/32	5 5/16	8 9/32	5.063	1.969
3 7/8	**UELT320-314D1W3**																
3 15/16	**UELT320-315D1W3**																
4	**UELT320-400D1W3**																
105	**UELT321D1W3**	48	34	175	115	59	200	35	260	290	347	75	120	135	212	139.7	48.4
110	**UELT322D1W3**	52	40	185	125	65	215	38	285	320	385	80	130	150	235	141.3	49.2

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit kg lb
UEL319D1W3	T319D1	26
UEL319-310D1W3	T319D1	
UEL319-311D1W3	T319D1	57
UEL319-312D1W3	T319D1	
UEL320D1W3	T320D1	34
UEL320-313D1W3	T320D1	
UEL320-314D1W3	T320D1	75
UEL320-315D1W3	T320D1	
UEL320-400D1W3	T320D1	
UEL321D1D1W3	T321D1	35
UEL322D1D1W3	T322D1	43

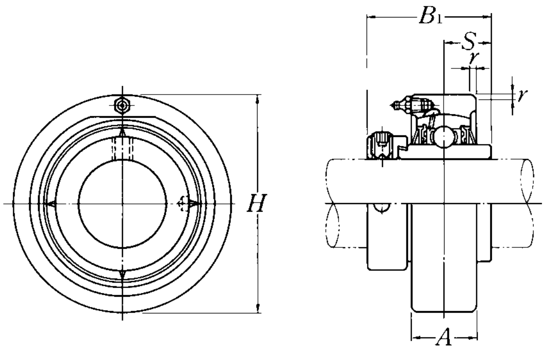
UELC2

Cylindrical cartridge units cast housing
Eccentric locking collar type



Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch					Bearing number	Housing number	Mass of unit kg lb
		H	A	r	B1	S			
20	**UELC204D1W3**	72	20	2	43.7	17.1	UEL204D1W3	C204D1	0.6
3/4	**UELC204-012D1W3**	2.8346	25/32	0.079	1.720	0.673	UEL204-012D1W3	C204D1	1.3
25	**UELC205D1W3**	80	22	2	44.4	17.5	UEL205D1W3	C205D1	0.8
13/16	**UELC205-013D1W3**	3.1496	55/64	0.079	1.748	0.689	UEL205-013D1W3	C205D1	1.8
7/8	**UELC205-014D1W3**						UEL205-014D1W3	C205D1	
15/16	**UELC205-015D1W3**						UEL205-015D1W3	C205D1	
1	**UELC205-100D1W3**						UEL205-100D1W3	C205D1	
30	**UELC206D1W3**	85	27	2	48.4	18.3	UEL206D1W3	C206D1	1.0
1 1/16	**UELC206-101D1W3**	3.3465	1 1/16	0.079	1.906	0.720	UEL206-101D1W3	C206D1	2.2
1 1/8	**UELC206-102D1W3**						UEL206-102D1W3	C206D1	
1 3/16	**UELC206-103D1W3**						UEL206-103D1W3	C206D1	
1 1/4	**UELC206-104D1W3**						UEL206-104D1W3	C206D1	
35	**UELC207D1W3**	90	28	2	51.1	18.8	UEL207D1W3	C207D1	1.1
1 1/4	**UELC207-104D1W3**	3.5433	1 7/64	0.079	2.012	0.740	UEL207-104D1W3	C207D1	2.4
1 5/16	**UELC207-105D1W3**						UEL207-105D1W3	C207D1	
1 3/8	**UELC207-106D1W3**						UEL207-106D1W3	C207D1	
1 7/16	**UELC207-107D1W3**						UEL207-107D1W3	C207D1	
40	**UELC208D1W3**	100	30	2.5	56.3	21.4	UEL208D1W3	C208D1	1.4
1 1/2	**UELC208-108D1W3**	3.9370	1 3/16	0.098	2.217	0.843	UEL208-108D1W3	C208D1	3.1
1 9/16	**UELC208-109D1W3**						UEL208-109D1W3	C208D1	
45	**UELC209D1W3**	110	31	2.5	56.3	21.4	UEL209D1W3	C209D1	1.7
1 5/8	**UELC209-110D1W3**	4.3307	1 7/32	0.098	2.217	0.843	UEL209-110D1W3	C209D1	3.7
1 11/16	**UELC209-111D1W3**						UEL209-111D1W3	C209D1	
1 3/4	**UELC209-112D1W3**						UEL209-112D1W3	C209D1	
50	**UELC210D1W3**	120	33	2.5	62.7	24.6	UEL210D1W3	C210D1	2.1
1 13/16	**UELC210-113D1W3**	4.7244	1 19/64	0.098	2.469	0.969	UEL210-113D1W3	C210D1	4.6
1 7/8	**UELC210-114D1W3**						UEL210-114D1W3	C210D1	
1 15/16	**UELC210-115D1W3**						UEL210-115D1W3	C210D1	
2	**UELC210-200D1W3**						UEL210-200D1W3	C210D1	

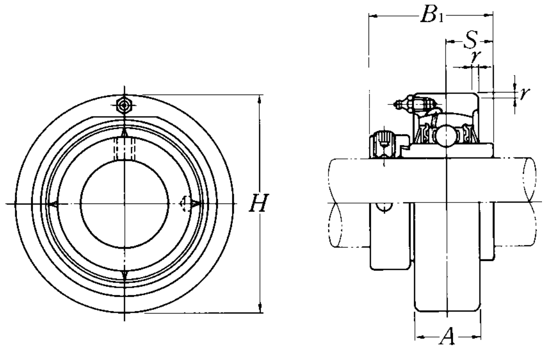
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Shaft dia. mm inch	Unit number [1]	Nominal dimensions mm inch					Bearing number	Housing number	Mass of unit kg lb
		H	A	r	B_1	S			
55	**UELC211D1W3**	125	35	2.5	71.4	27.8	UEL211D1W3	C211D1	2.4
2	**UELC211-200D1W3**	4.9213	1$\frac{3}{8}$	0.098	2.811	1.094	UEL211-200D1W3	C211D1	5.3
2$\frac{1}{16}$	**UELC211-201D1W3**						UEL211-201D1W3	C211D1	
2$\frac{1}{8}$	**UELC211-202D1W3**						UEL211-202D1W3	C211D1	
2$\frac{3}{16}$	**UELC211-203D1W3**						UEL211-203D1W3	C211D1	
60	**UELC212D1W3**	130	38	2.5	77.8	31	UEL212D1W3	C212D1	2.9
2$\frac{1}{4}$	**UELC212-204D1W3**	5.1181	1$\frac{1}{2}$	0.098	3.063	1.220	UEL212-204D1W3	C212D1	6.4
2$\frac{5}{16}$	**UELC212-205D1W3**						UEL212-205D1W3	C212D1	
2$\frac{3}{8}$	**UELC212-206D1W3**						UEL212-206D1W3	C212D1	
2$\frac{7}{16}$	**UELC212-207D1W3**						UEL212-207D1W3	C212D1	

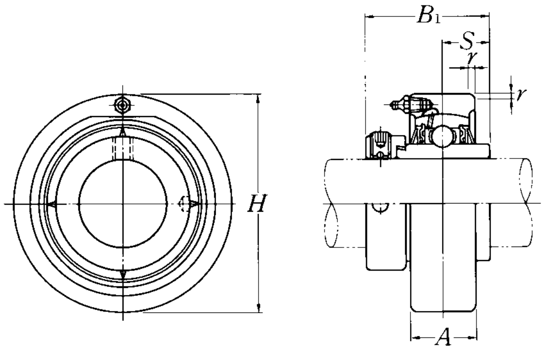
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Cylindrical cartridge units cast housing
Eccentric locking collar type



Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch H	A	r	B1	S	Bearing number	Housing number	Mass of unit kg lb
25	UELC305D1W3	90	26	2.5	46.8	16.7	UEL305D1W3	C305D1	1.1
13/16	UELC305-013D1W3	3.5433	1 1/32	0.098	1.843	0.657	UEL305-013D1W3	C305D1	2.4
7/8	UELC305-014D1W3						UEL305-014D1W3	C305D1	
15/16	UELC305-015D1W3						UEL305-015D1W3	C305D1	
1	UELC305-100D1W3						UEL305-100D1W3	C305D1	
30	UELC306D1W3	100	28	2.5	50	17.5	UEL306D1W3	C306D1	1.5
1 1/16	UELC306-101D1W3	3.9370	1 7/64	0.098	1.969	0.689	UEL306-101D1W3	C306D1	3.3
1 1/8	UELC306-102D1W3						UEL306-102D1W3	C306D1	
1 3/16	UELC306-103D1W3						UEL306-103D1W3	C306D1	
35	UELC307D1W3	110	32	3	51.6	18.3	UEL307D1W3	C307D1	1.8
1 1/4	UELC307-104D1W3	4.3307	1 17/64	0.118	2.031	0.720	UEL307-104D1W3	C307D1	4.0
1 5/16	UELC307-105D1W3						UEL307-105D1W3	C307D1	
1 3/8	UELC307-106D1W3						UEL307-106D1W3	C307D1	
1 7/16	UELC307-107D1W3						UEL307-107D1W3	C307D1	
40	UELC308D1W3	120	34	3	57.1	19.8	UEL308D1W3	C308D1	2.3
1 1/2	UELC308-108D1W3	4.7244	1 11/32	0.118	2.248	0.780	UEL308-108D1W3	C308D1	5.1
1 9/16	UELC308-109D1W3						UEL308-109D1W3	C308D1	
45	UELC309D1W3	130	38	3.5	58.7	19.8	UEL309D1W3	C309D1	2.9
1 5/8	UELC309-110D1W3	5.1181	1 1/2	0.138	2.311	0.780	UEL309-110D1W3	C309D1	6.4
1 11/16	UELC309-111D1W3						UEL309-111D1W3	C309D1	
1 3/4	UELC309-112D1W3						UEL309-112D1W3	C309D1	
50	UELC310D1W3	140	40	3.5	66.6	24.6	UEL310D1W3	C310D1	3.5
1 13/16	UELC310-113D1W3	5.5118	1 37/64	0.138	2.622	0.969	UEL310-113D1W3	C310D1	7.7
1 7/8	UELC310-114D1W3						UEL310-114D1W3	C310D1	
1 15/16	UELC310-115D1W3						UEL310-115D1W3	C310D1	
55	UELC311D1W3	150	44	3.5	73	27.8	UEL311D1W3	C311D1	4.2
2	UELC311-200D1W3	5.9055	1 47/64	0.138	2.874	1.094	UEL311-200D1W3	C311D1	9.3
2 1/16	UELC311-201D1W3						UEL311-201D1W3	C311D1	
2 1/8	UELC311-202D1W3						UEL311-202D1W3	C311D1	
2 3/16	UELC311-203D1W3						UEL311-203D1W3	C311D1	

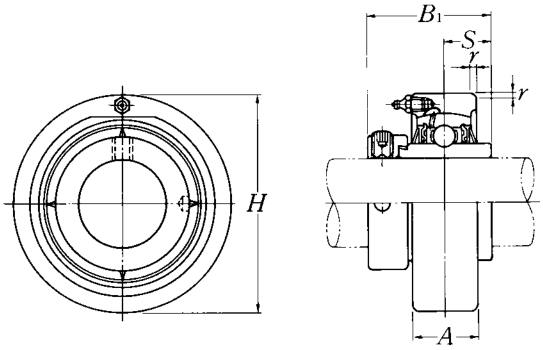
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.



Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch H	A	r	B_1	S	Bearing number	Housing number	Mass of unit kg lb
60	**UELC312D1W3**	160	46	3.5	79.4	30.95	UEL312D1W3	C312D1	5.1
$2\frac{1}{4}$	**UELC312-204D1W3**	6.2992	$1\frac{13}{16}$	0.138	3.126	1.219	UEL312-204D1W3	C312D1	11
$2\frac{5}{16}$	**UELC312-205D1W3**						UEL312-205D1W3	C312D1	
$2\frac{3}{8}$	**UELC312-206D1W3**						UEL312-206D1W3	C312D1	
$2\frac{7}{16}$	**UELC312-207D1W3**						UEL312-207D1W3	C312D1	
65	**UELC313D1W3**	170	50	3.5	85.7	32.55	UEL313D1W3	C313D1	6.2
$2\frac{1}{2}$	**UELC313-208D1W3**	6.6929	$1\frac{31}{32}$	0.138	3.374	1.281	UEL313-208D1W3	C313D1	14
$2\frac{9}{16}$	**UELC313-209D1W3**						UEL313-209D1W3	C313D1	
70	**UELC314D1W3**	180	52	4	92.1	34.15	UEL314D1W3	C314D1	7.2
$2\frac{5}{8}$	**UELC314-210D1W3**	7.0866	$2\frac{3}{64}$	0.157	3.626	1.344	UEL314-210D1W3	C314D1	16
$2\frac{11}{16}$	**UELC314-211D1W3**						UEL314-211D1W3	C314D1	
$2\frac{3}{4}$	**UELC314-212D1W3**						UEL314-212D1W3	C314D1	
75	**UELC315D1W3**	190	55	4	100	37.3	UEL315D1W3	C315D1	8.4
$2\frac{13}{16}$	**UELC315-213D1W3**	7.4803	$2\frac{11}{64}$	0.157	3.937	1.469	UEL315-213D1W3	C315D1	19
$2\frac{7}{8}$	**UELC315-214D1W3**						UEL315-214D1W3	C315D1	
$2\frac{15}{16}$	**UELC315-215D1W3**						UEL315-215D1W3	C315D1	
3	**UELC315-300D1W3**						UEL315-300D1W3	C315D1	
80	**UELC316D1W3**	200	60	4	106.4	40.5	UEL316D1W3	C316D1	10
$3\frac{1}{16}$	**UELC316-301D1W3**	7.8740	$2\frac{23}{64}$	0.157	4.189	1.594	UEL316-301D1W3	C316D1	22
$3\frac{1}{8}$	**UELC316-302D1W3**						UEL316-302D1W3	C316D1	
$3\frac{3}{16}$	**UELC316-303D1W3**						UEL316-303D1W3	C316D1	
85	**UELC317D1W3**	215	64	4	109.5	42.05	UEL317D1W3	C317D1	13
$3\frac{1}{4}$	**UELC317-304D1W3**	8.4646	$2\frac{33}{64}$	0.157	4.311	1.656	UEL317-304D1W3	C317D1	29
$3\frac{5}{16}$	**UELC317-305D1W3**						UEL317-305D1W3	C317D1	
$3\frac{7}{16}$	**UELC317-307D1W3**						UEL317-307D1W3	C317D1	
90	**UELC318D1W3**	225	66	4	115.9	43.65	UEL318D1W3	C318D1	14
$3\frac{7}{16}$	**UELC318-307D1W3**	8.8583	$2\frac{19}{32}$	0.157	4.563	1.719	UEL318-307D1W3	C318D1	31
$3\frac{1}{2}$	**UELC318-308D1W3**						UEL318-308D1W3	C318D1	

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

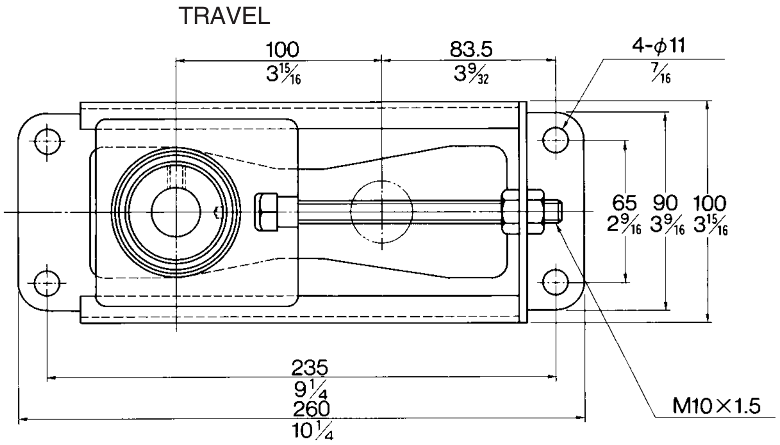
Cylindrical cartridge units cast housing
Eccentric locking collar type



Shaft dia. mm inch	Unit number 1)	Nominal dimensions mm inch					Bearing number	Housing number	Mass of unit kg lb
		H	*A*	*r*	B_1	*S*			
95	**UELC319D1W3**	240	72	4	122.3	38.9	UEL319D1W3	C319D1	17
$3\frac{5}{8}$	**UELC319-310D1W3**	9.4488	$2\frac{53}{64}$	0.157	4.815	1.531	UEL319-310D1W3	C319D1	37
$3\frac{11}{16}$	**UELC319-311D1W3**						UEL319-311D1W3	C319D1	
$3\frac{3}{4}$	**UELC319-312D1W3**						UEL319-312D1W3	C319D1	
100	**UELC320D1W3**	260	75	4	128.6	50	UEL320D1W3	C320D1	21
$3\frac{13}{16}$	**UELC320-313D1W3**	10.2362	$2\frac{61}{64}$	0.157	5.063	1.969	UEL320-313D1W3	C320D1	46
$3\frac{7}{8}$	**UELC320-314D1W3**						UEL320-314D1W3	C320D1	
$3\frac{15}{16}$	**UELC320-315D1W3**						UEL320-315D1W3	C320D1	
4	**UELC320-400D1W3**						UEL320-400D1W3	C320D1	
105	**UELC321D1W3**	260	75	4	139.7	48.4	UEL321D1W3	C321D1	22
110	**UELC322D1W3**	300	80	5	141.3	49.2	UEL322D1W3	C322D1	31

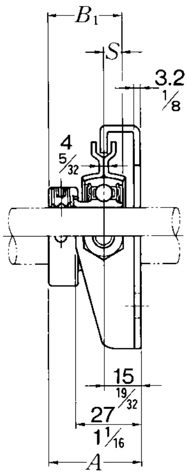
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
Note: Please refer to page 25 for size of grease fitting.

Mini stretcher
Eccentric locking collar type

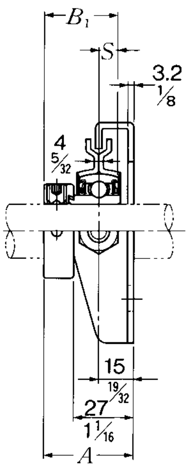


Shaft dia. mm inch	Unit number	Nominal dimensions mm inch *A*	*B*₁	*S*	Bolt size mm inch	Max. load recommended N lbf	Bearing number	Mass of unit kg lb
12 1/2	**AELPT201-10W3** **AELPT201-008-10W3**	37.1 1 29/64	28.6 1.126	6.5 0.256	M10 3/8	3 500 770	AEL201W3 AEL201-008W3	1.0 2.2
15 9/16 5/8	**AELPT202-10W3** **AELPT202-009-10W3** **AELPT202-010-10W3**	37.1 1 29/64	28.6 1.126	6.5 0.256	M10 3/8	3 500 770	AEL202W3 AEL202-009W3 AEL202-010W3	1.0 2.2
17 11/16	**AELPT203-10W3** **AELPT203-011-10W3**	37.1 1 29/64	28.6 1.126	6.5 0.256	M10 3/8	3 500 770	AEL203W3 AEL203-011W3	1.0 2.2
20 3/4	**AELPT204-10W3** **AELPT204-012-10W3**	38.5 1 33/64	31 1.220	7.5 0.295	M10 3/8	3 500 770	AEL204W3 AEL204-012W3	1.1 2.4
25 13/16 7/8 15/16 1	**AELPT205-10W3** **AELPT205-013-10W3** **AELPT205-014-10W3** **AELPT205-015-10W3** **AELPT205-100-10W3**	38.5 1 33/64	31 1.220	7.5 0.295	M10 3/8	3 500 770	AEL205W3 AEL205-013W3 AEL205-014W3 AEL205-015W3 AEL205-100W3	1.1 2.4

AELPT2, JELPT2



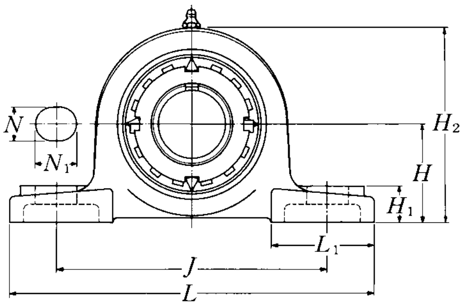
AELPT type

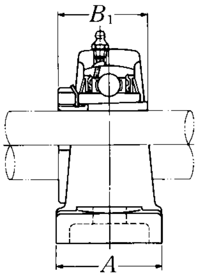


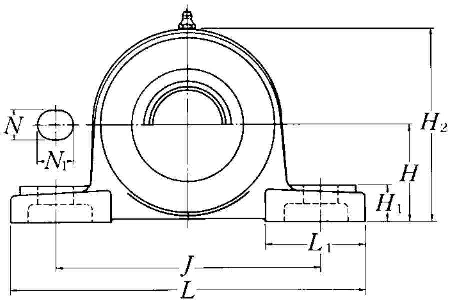
JELPT type

Shaft dia. mm inch	Unit number	Nominal dimensions mm inch			Bolt size mm inch	Max. load recommended N lbf	Bearing number	Mass of unit kg lb
		A	*B*1	*S*				
12 1/2	**JELPT201-10W3** **JELPT201-008-10W3**	37.1 1 29/64	28.6 1.126	6.5 0.256	M10 3/8	3 500 770	JEL201W3 JEL201-008W3	1.0 2.2
15 9/16 5/8	**JELPT202-10W3** **JELPT202-009-10W3** **JELPT202-010-10W3**	37.1 1 29/64	28.6 1.126	6.5 0.256	M10 3/8	3 500 770	JEL202W3 JEL202-009W3 JEL202-010W3	1.0 2.2
17 11/16	**JELPT203-10W3** **JELPT203-011-10W3**	37.1 1 29/64	28.6 1.126	6.5 0.256	M10 3/8	3 500 770	JEL203W3 JEL203-011W3	1.0 2.2
20 3/4	**JELPT204-10W3** **JELPT204-012-10W3**	38.5 1 33/64	31 1.220	7.5 0.295	M10 3/8	3 500 770	JEL204W3 JEL204-012W3	1.1 2.4
25 13/16 7/8 15/16 **1**	**JELPT205-10W3** **JELPT205-013-10W3** **JELPT205-014-10W3** **JELPT205-015-10W3** **JELPT205-100-10W3**	38.5 1 33/64	31 1.220	7.5 0.295	M10 3/8	3 500 770	JEL205W3 JEL205-013W3 JEL205-014W3 JEL205-015W3 JEL205-100W3	1.1 2.4

Pillow blocks cast housing
Adapter type





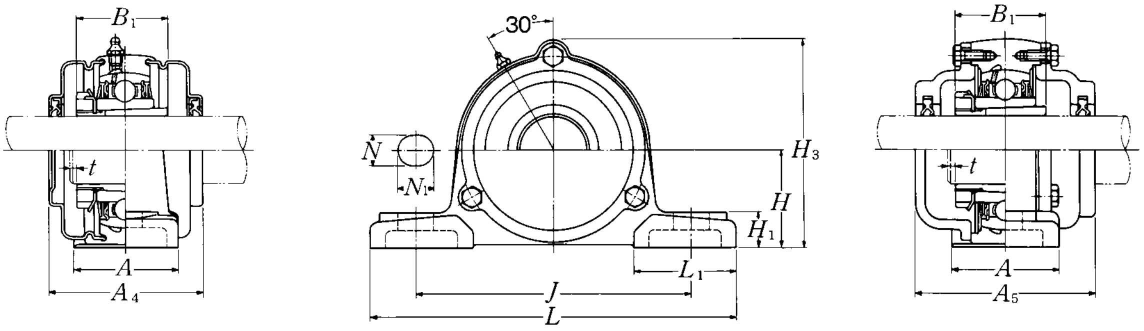


Pressed steel dust cover type
Open end: **S-UKP···D1**
Closed end: **SM-UKP···D1**

Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch										Bolt size mm inch	Bearing number
		H	L	J	A	N	N_1	H_1	H_2	B_1	L_1		
20	**UKP205D1;H2305X**	36.5	140	105	38	13	16	15	71	35	42	M10	UK205D1;H2305X
3/4	**UKP205D1;HE2305**	1 7/16	5 1/2	4 1/8	1 1/2	1/2	5/8	19/32	2 25/32	1.378	1 21/32	3/8	UK205D1;HE2305
25	**UKP206D1;H2306X**	42.9	165	121	48	17	20	17	83	38	54	M14	UK206D1;H2306X
7/8	**UKP206D1;HS2306**	1 11/16	6 1/2	4 3/4	1 7/8	21/32	25/32	21/32	3 9/32	1.496	2 1/8	1/2	UK206D1;HS2306
1	**UKP206D1;HE2306X**												UK206D1;HE2306X
30	**UKP207D1;H2307X**	47.6	167	127	48	17	20	18	93	43	54	M14	UK207D1;H2307X
1 1/8	**UKP207D1;HS2307**	1 7/8	6 9/16	5	1 7/8	21/32	25/32	23/32	3 21/32	1.693	2 1/8	1/2	UK207D1;HS2307
35	**UKP208D1;H2308X**	49.2	184	137	54	17	20	18	98	46	52	M14	UK208D1;H2308X
1 1/4	**UKP208D1;HE2308X**	1 15/16	7 1/4	5 13/32	2 1/8	21/32	25/32	23/32	3 27/32	1.811	2 1/16	1/2	UK208D1;HE2308X
1 3/8	**UKP208D1;HS2308X**												UK208D1;HS2308X
40	**UKP209D1;H2309X**	54	190	146	54	17	20	20	106	50	60	M14	UK209D1;H2309X
1 7/16	**UKP209D1;HA2309**												UK209D1;HA2309
1 1/2	**UKP209D1;HE2309X**	2 1/8	7 15/32	5 3/4	2 1/8	21/32	25/32	25/32	4 3/16	1.969	2 3/8	1/2	UK209D1;HE2309X
1 5/8	**UKP209D1;HS2309X**												UK209D1;HS2309X
45	**UKP210D1;H2310X**	57.2	206	159	60	20	23	21	114	55	65	M16	UK210D1;H2310X
1 5/8	**UKP210D1;HS2310**												UK210D1;HS2310
1 11/16	**UKP210D1;HA2310**	2 1/4	8 1/8	6 1/4	2 3/8	25/32	29/32	13/16	4 1/2	2.165	2 9/16	5/8	UK210D1;HA2310
1 3/4	**UKP210D1;HE2310X**												UK210D1;HE2310X
50	**UKP211D1;H2311X**	63.5	219	171	60	20	23	23	126	59	65	M16	UK211D1;H2311X
1 7/8	**UKP211D1;HS2311**												UK211D1;HS2311
1 15/16	**UKP211D1;HA2311**	2 1/2	8 5/8	6 23/32	2 3/8	25/32	29/32	29/32	4 31/32	2.323	2 9/16	5/8	UK211D1;HA2311
2	**UKP211D1;HE2311XY**												UK211D1;HE2311XY
55	**UKP212D1;H2312X**	69.8	241	184	70	20	23	25	138	62	70	M16	UK212D1;H2312X
2 1/8	**UKP212D1;HS2312**	2 3/4	9 1/2	7 1/4	2 3/4	25/32	29/32	31/32	5 7/16	2.441	2 3/4	5/8	UK212D1;HS2312
60	**UKP213D1;H2313X**	76.2	265	203	70	25	28	27	151	65	77	M20	UK213D1;H2313X
2 3/16	**UKP213D1;HA2313**												UK213D1;HA2313
2 1/4	**UKP213D1;HE2313X**	3	10 7/16	8	2 3/4	31/32	1 3/32	1 1/16	5 15/16	2.559	3 1/32	3/4	UK213D1;HE2313X
2 3/8	**UKP213D1;HS2313X**												UK213D1;HS2313X

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

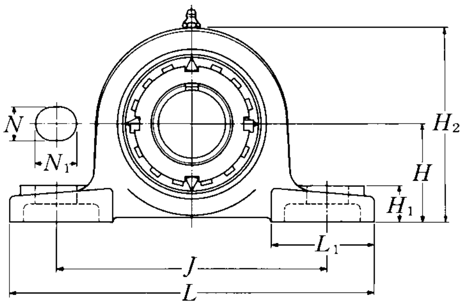
Note: Please refer to page 25 for size of grease fitting.

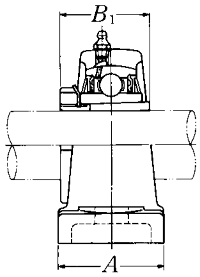


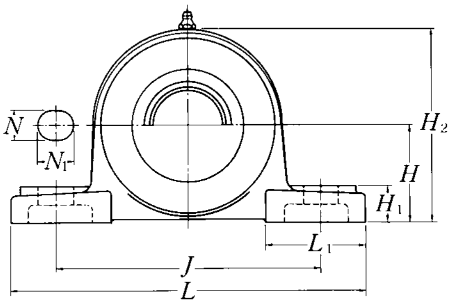
Cast dust cover type
Open end: **C-UKP···D1**
Closed end: **CM-UKP···D1**

Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions				Mass of unit		
			mm		inch		kg		lb
			t max.	A_4	H_3	A_5	UKP	S(SM)	C(CM)
P205D1	S(SM)-UKP205D1;H2305X	C(CM)-UKP205D1;H2305X	2	57	76	70	0.9	0.9	1.3
P205D1	S(SM)-UKP205ED1;HE2305	C(CM)-UKP205ED1;HE2305	$\frac{5}{64}$	$2\frac{1}{4}$	3	$2\frac{3}{4}$	2.0	2.0	2.9
P206D1	S(SM)-UKP206D1;H2306X	C(CM)-UKP206D1;H2306X	2	62	88	75	1.3	1.4	1.9
P206D1	S(SM)-UKP206SD1;HS2306	C(CM)-UKP206SD1;HS2306	$\frac{5}{64}$	$2\frac{7}{16}$	$3\frac{15}{32}$	$2\frac{15}{16}$	2.9	3.1	4.2
P206D1	S(SM)-UKP206ED1;HE2306X	C(CM)-UKP206ED1;HE2306X							
P207D1	S(SM)-UKP207D1;H2307X	C(CM)-UKP207D1;H2307X	3	72	99	80	1.7	1.8	2.4
P207D1	S(SM)-UKP207SD1;HS2307	C(CM)-UKP207SD1;HS2307	$\frac{1}{8}$	$2\frac{27}{32}$	$3\frac{29}{32}$	$3\frac{5}{32}$	3.7	4.0	5.3
P208D1	S(SM)-UKP208D1;H2308X	C(CM)-UKP208D1;H2308X	3	82	105	90	2.0	2.1	3.4
P208D1	S(SM)-UKP208ED1;HE2308X	C(CM)-UKP208ED1;HE2308X	$\frac{1}{8}$	$3\frac{7}{32}$	$4\frac{1}{8}$	$3\frac{17}{32}$	4.4	4.6	7.5
P208D1	S(SM)-UKP208D1;HS2308X	C(CM)-UKP208D1;HS2308X							
P209D1	S(SM)-UKP209D1;H2309X	C(CM)-UKP209D1;H2309X	3	82	113	95	2.3	2.5	3.7
P209D1	S(SM)-UKP209AD1;HA2309	C(CM)-UKP209AD1;HA2309	$\frac{1}{8}$	$3\frac{7}{32}$	$4\frac{7}{16}$	$3\frac{3}{4}$	5.1	5.5	8.2
P209D1	S(SM)-UKP209ED1;HE2309X	C(CM)-UKP209ED1;HE2309X							
P209D1	S(SM)-UKP209SD1;HS2309X	C(CM)-UKP209SD1;HS2309X							
P210D1	S(SM)-UKP210D1;H2310X	C(CM)-UKP210D1;H2310X	3	87	119	100	2.8	3.0	4.5
P210D1	S(SM)-UKP210SD1;HS2310	C(CM)-UKP210SD1;HS2310	$\frac{1}{8}$	$3\frac{7}{16}$	$4\frac{11}{16}$	$3\frac{15}{16}$	6.2	6.6	9.9
P210D1	S(SM)-UKP210AD1;HA2310	C(CM)-UKP210AD1;HA2310							
P210D1	S(SM)-UKP210ED1;HE2310X	C(CM)-UKP210ED1;HE2310X							
P211D1	S(SM)-UKP211D1;H2311X	C(CM)-UKP211D1;H2311X	4	92	130	100	3.5	3.8	5.6
P211D1	S(SM)-UKP211SD1;HS2311	C(CM)-UKP211SD1;HS2311	$\frac{5}{32}$	$3\frac{5}{8}$	$5\frac{1}{8}$	$3\frac{15}{16}$	7.7	8.4	12
P211D1	S(SM)-UKP211AD1;HA2311	C(CM)-UKP211AD1;HA2311							
P211D1	S(SM)-UKP211ED1;HE2311XY	C(CM)-UKP211ED1;HE2311XY							
P212D1	S(SM)-UKP212D1;H2312X	C(CM)-UKP212D1;H2312X	4	102	143	115	4.7	5.0	6.9
P212D1	S(SM)-UKP212SD1;HS2312	C(CM)-UKP212SD1;HS2312	$\frac{5}{32}$	$4\frac{1}{32}$	$5\frac{5}{8}$	$4\frac{17}{32}$	10	11	15
P213D1	S(SM)-UKP213D1;H2313X	C(CM)-UKP213D1;H2313X	4	107	155	120	6.0	6.4	8.1
P213D1	S(SM)-UKP213AD1;HA2313	C(CM)-UKP213AD1;HA2313	$\frac{5}{32}$	$4\frac{7}{32}$	$6\frac{3}{32}$	$4\frac{23}{32}$	13	14	18
P213D1	S(SM)-UKP213ED1;HE2313X	C(CM)-UKP213ED1;HE2313X							
P213D1	S(SM)-UKP213SD1;HS2313X	C(CM)-UKP213SD1;HS2313X							

Pillow blocks cast housing
Adapter type





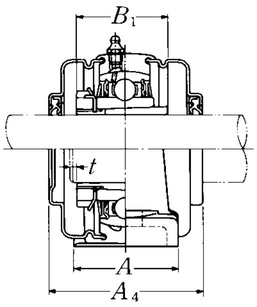


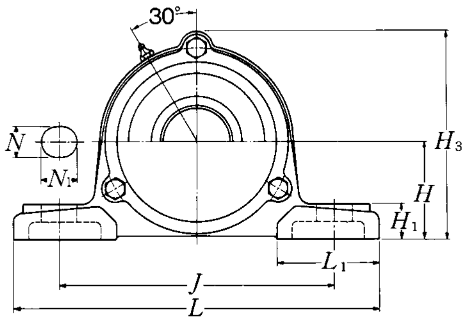
Pressed steel dust cover type
Open end: **S-UKP···D1**
Closed end: **SM-UKP···D1**

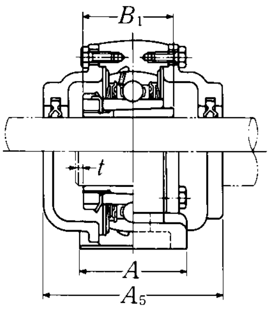
Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch H	L	J	A	N	N1	H1	H2	B1	L1	Bolt size mm inch	Bearing number
65	UKP215D1;H2315X	82.6	275	217	74	25	28	28	163	73	80	M20	UK215D1;H2315X
2 7/16	UKP215D1;HA2315	3 1/4	10 13/16	8 17/32	2 29/32	31/32	1 3/32	1 3/32	6 13/32	2.874	3 5/32	3/4	UK215D1;HA2315
2 1/2	UKP215D1;HE2315X												UK215D1;HE2315X
70	UKP216D1;H2316X	88.9	292	232	78	25	28	30	175	78	85	M20	UK216D1;H2316X
2 11/16	UKP216D1;HA2316	3 1/2	11 1/2	9 1/8	3 1/16	31/32	1 3/32	1 3/16	6 7/8	3.071	3 11/32	3/4	UK216D1;HA2316
2 3/4	UKP216D1;HE2316X												UK216D1;HE2316X
75	UKP217D1;H2317X	95.2	310	247	83	25	28	32	187	82	85	M20	UK217D1;H2317X
2 15/16	UKP217D1;HA2317X	3 3/4	12 7/32	9 23/32	3 9/32	31/32	1 3/32	1 1/4	7 3/8	3.228	3 11/32	3/4	UK217D1;HA2317X
3	UKP217D1;HE2317X												UK217D1;HE2317X
80	UKP218D1;H2318X	101.6	327	262	88	27	30	33	200	86	90	M22	UK218D1;H2318X
3 3/16	UKP218D1;HA2318X	4	12 7/8	10 5/16	3 15/32	1 1/16	1 3/16	1 5/16	7 7/8	3.386	3 17/32	7/8	UK218D1;HA2318X

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Note: Please refer to page 25 for size of grease fitting.



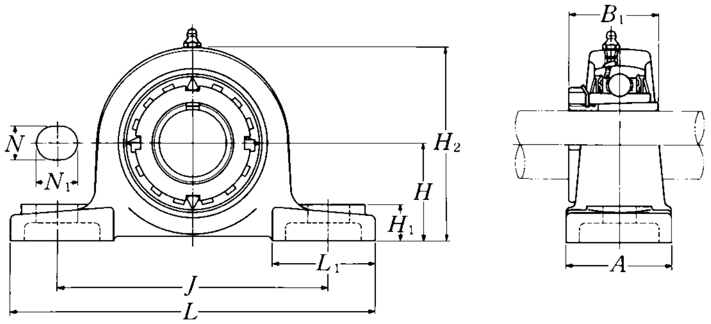




Cast dust cover type
Open end: **C-UKP···D1**
Closed end: **CM-UKP···D1**

Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions mm inch				Mass of unit kg lb		
			t max.	A_4	H_3	A_5	UKP	S(SM)	C(CM)
P215D1	—	**C(CM)-UKP215D1;H2315X**	4	—	168	135	7.6	—	12
P215D1	—	**C(CM)-UKP215AD1;HA2315**	5/32	—	6 5/8	5 5/16	17	—	26
P215D1		**C(CM)-UKP215ED1;HE2315X**							
P216D1	—	**C(CM)-UKP216D1;H2316X**	4	—	181	145	9.4	—	13
P216D1	—	**C(CM)-UKP216AD1;HA2316**	5/32	—	7 1/8	5 23/32	21	—	29
P216D1		**C(CM)-UKP216D1;HE2316X**							
P217D1	—	**C(CM)-UKP217D1;H2317X**	5	—	191	155	12	—	16
P217D1	—	**C(CM)-UKP217AD1;HA2317X**	13/64	—	7 17/32	6 3/32	26	—	35
P217D1		**C(CM)-UKP217ED1;HE2317X**							
P218D1	—	**C(CM)-UKP218D1;H2318X**	5	—	204	165	14	—	19
P218D1	—	**C(CM)-UKP218AD1;HA2318X**	13/64	—	8 1/32	6 1/2	31	—	42

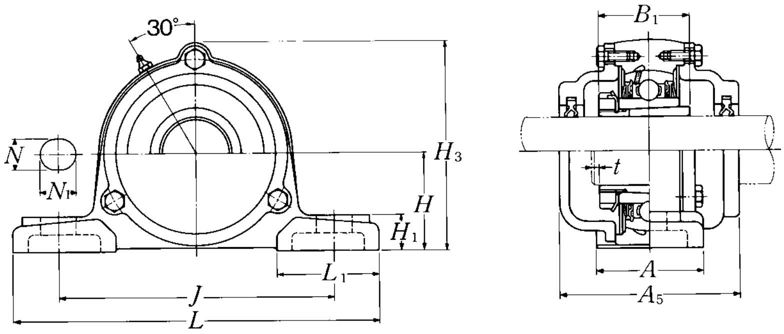
Pillow blocks cast housing
Adapter type



Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch										Bolt size mm inch	Bearing number
		H	*L*	*J*	*A*	*N*	N_1	H_1	H_2	B_1	L_1		
20	**UKP305D1;H2305X**	45	175	132	45	17	20	15	85	35	54	M14	UK305D1;H2305X
3/4	**UKP305D1;HE2305**	1 49/64	6 7/8	5 3/16	1 25/32	21/32	25/32	19/32	3 11/32	1.378	2 1/8	1/2	UK305D1;HE2305
25	**UKP306D1;H2306X**	50	180	140	50	17	20	18	95	38	54	M14	UK306D1;H2306X
7/8	**UKP306D1;HS2306**	1 31/32	7 3/32	5 1/2	1 31/32	21/32	25/32	23/32	3 3/4	1.496	2 1/8	1/2	UK306D1;HS2306
1	**UKP306D1;HE2306X**												UK306D1;HE2306X
30	**UKP307D1;H2307X**	56	210	160	56	17	25	20	106	43	60	M14	UK307D1;H2307X
1 1/8	**UKP307D1;HS2307**	2 13/64	8 9/32	6 5/16	2 7/32	21/32	31/32	25/32	4 3/16	1.693	2 3/8	1/2	UK307D1;HS2307
35	**UKP308D1;H2308X**	60	220	170	60	17	27	22	116	46	60	M14	UK308D1;H2308X
1 1/4	**UKP308D1;HE2308X**	2 23/64	8 21/32	6 11/16	2 3/8	21/32	1 1/16	7/8	4 9/16	1.811	2 3/8	1/2	UK308D1;HE2308X
1 3/8	**UKP308D1;HS2308X**												UK308D1;HS2308X
40	**UKP309D1;H2309X**	67	245	190	67	20	30	24	129	50	65	M16	UK309D1;H2309X
1 7/16	**UKP309D1;HA2309**	2 41/64	9 21/32	7 15/32	2 5/8	25/32	1 3/16	15/16	5 3/32	1.969	2 9/16	5/8	UK309D1;HA2309
1 1/2	**UKP309D1;HE2309X**												UK309D1;HE2309X
1 5/8	**UKP309D1;HS2309X**												UK309D1;HS2309X
45	**UKP310D1;H2310X**	75	275	212	75	20	35	27	143	55	75	M16	UK310D1;H2310X
1 5/8	**UKP310D1;HS2310**	2 61/64	10 13/16	8 11/32	2 15/16	25/32	1 3/8	1 1/16	5 5/8	2.165	2 15/16	5/8	UK310D1;HS2310
1 11/16	**UKP310D1;HA2310**												UK310D1;HA2310
1 3/4	**UKP310D1;HE2310X**												UK310D1;HE2310X
50	**UKP311D1;H2311X**	80	310	236	80	20	38	30	154	59	85	M16	UK311D1;H2311X
1 7/8	**UKP311D1;HS2311**	3 5/32	12 7/32	9 9/32	3 5/32	25/32	1 1/2	1 3/16	6 1/16	2.323	3 11/32	5/8	UK311D1;HS2311
1 15/16	**UKP311D1;HA2311**												UK311D1;HA2311
2	**UKP311D1;HE2311XY**												UK311D1;HE2311XY
55	**UKP312D1;H2312X**	85	330	250	85	25	38	32	165	62	95	M20	UK312D1;H2312X
2 1/8	**UKP312D1;HS2312**	3 11/32	13	9 27/32	3 11/32	31/32	1 1/2	1 1/4	6 1/2	2.441	3 3/4	3/4	UK312D1;HS2312
60	**UKP313D1;H2313X**	90	340	260	90	25	38	33	176	65	105	M20	UK313D1;H2313X
2 3/16	**UKP313D1;HA2313**	3 35/64	13 3/8	10 1/4	3 17/32	31/32	1 1/2	1 5/16	6 15/16	2.559	4 1/8	3/4	UK313D1;HA2313
2 1/4	**UKP313D1;HE2313X**												UK313D1;HE2313X
2 3/8	**UKP313D1;HS2313X**												UK313D1;HS2313X

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

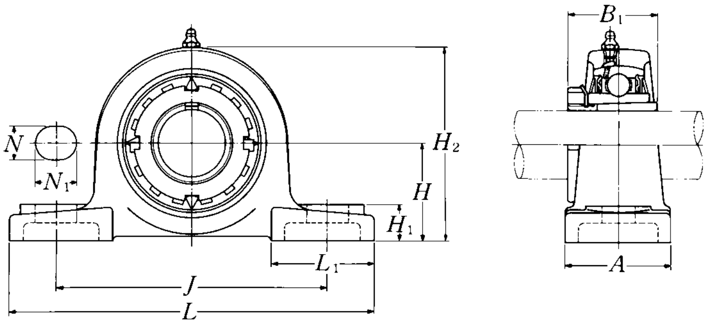
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UKP···D1**
Closed end: **CM-UKP···D1**

Housing number	Unit number cast dust cover type	Nominal dimensions mm inch t max.	 H3	 A5	Mass of unit kg lb UKP	 C(CM)
P305D1	**C(CM)-UKP305D1;H2305X**	2	91	80	1.4	2.2
P305D1	**C(CM)-UKP305ED1;HE2305**	5/64	3 19/32	3 5/32	3.1	4.9
P306D1	**C(CM)-UKP306D1;H2306X**	2	105	85	1.8	2.8
P306D1	**C(CM)-UKP306SD1;HS2306**	5/64	4 1/8	3 11/32	4.0	6.2
P306D1	**C(CM)-UKP306ED1;HE2306X**					
P307D1	**C(CM)-UKP307D1;H2307X**	3	115	95	2.9	3.6
P307D1	**C(CM)-UKP307SD1;HS2307**	1/8	4 17/32	3 3/4	6.4	7.9
P308D1	**C(CM)-UKP308D1;H2308X**	3	125	105	3.1	4.6
P308D1	**C(CM)-UKP308ED1;HE2308X**	1/8	4 29/32	4 1/8	6.8	10
P308D1	**C(CM)-UKP308D1;HS2308X**					
P309D1	**C(CM)-UKP309D1;H2309X**	3	140	110	4.2	6.3
P309D1	**C(CM)-UKP309AD1;HA2309**					
P309D1	**C(CM)-UKP309ED1;HE2309X**	1/8	5 1/2	4 11/32	9.3	14
P309D1	**C(CM)-UKP309SD1;HS2309X**					
P310D1	**C(CM)-UKP310D1;H2310X**	3	156	120	5.8	8.5
P310D1	**C(CM)-UKP310SD1;HS2310**					
P310D1	**C(CM)-UKP310AD1;HA2310**	1/8	6 5/32	4 23/32	13	19
P310D1	**C(CM)-UKP310ED1;HE2310X**					
P311D1	**C(CM)-UKP311D1;H2311X**	4	166	125	7.4	9.8
P311D1	**C(CM)-UKP311SD1;HS2311**					
P311D1	**C(CM)-UKP311AD1;HA2311**	5/32	6 17/32	4 29/32	16	22
P311D1	**C(CM)-UKP311ED1;HE2311XY**					
P312D1	**C(CM)-UKP312D1;H2312X**	4	179	135	9.3	12
P312D1	**C(CM)-UKP312SD1;HS2312**	5/32	7 1/16	5 5/16	21	26
P313D1	**C(CM)-UKP313D1;H2313X**	4	190	140	10	15
P313D1	**C(CM)-UKP313AD1;HA2313**					
P313D1	**C(CM)-UKP313ED1;HE2313X**	5/32	7 15/32	5 1/2	22	33
P313D1	**C(CM)-UKP313SD1;HS2313X**					

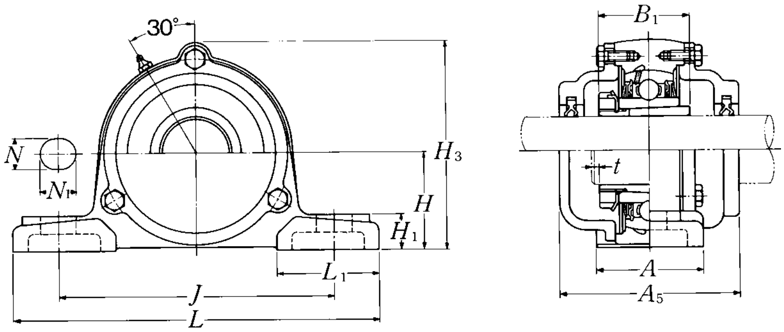
Pillow blocks cast housing
Adapter type



Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch										Bolt size mm inch	Bearing number
		H	*L*	*J*	*A*	*N*	N_1	H_1	H_2	B_1	L_1		
65 **2 7/16** **2 1/2**	**UKP315D1;H2315X** **UKP315D1;HA2315** **UKP315D1;HE2315X**	100 3 15/16	380 14 31/32	290 11 13/32	100 3 15/16	27 1 1/16	40 1 9/16	35 1 3/8	198 7 25/32	73 2.874	110 4 11/32	M22 7/8	UK315D1;H2315X UK315D1;HA2315 UK315D1;HE2315X
70 **2 11/16** **2 3/4**	**UKP316D1;H2316X** **UKP316D1;HA2316** **UKP316D1;HE2316X**	106 4 11/64	400 15 3/4	300 11 13/16	110 4 11/32	27 1 1/16	40 1 9/16	40 1 9/16	210 8 9/32	78 3.071	110 4 11/32	M22 7/8	UK316D1;H2316X UK316D1;HA2316 UK316D1;HE2316X
75 **2 15/16** **3**	**UKP317D1;H2317X** **UKP317D1;HA2317X** **UKP317D1;HE2317X**	112 4 13/32	420 16 17/32	320 12 19/32	110 4 11/32	33 1 5/16	45 1 25/32	40 1 9/16	220 8 21/32	82 3.228	120 4 23/32	M27 1	UK317D1;H2317X UK317D1;HA2317X UK317D1;HE2317X
80 **3 3/16**	**UKP318D1;H2318X** **UKP318D1;HA2318X**	118 4 41/64	430 16 15/16	330 13	110 4 11/32	33 1 5/16	45 1 25/32	45 1 25/32	235 9 1/4	86 3.386	120 4 23/32	M27 1	UK318D1;H2318X UK318D1;HA2318X
85 **3 1/4**	**UKP319D1;H2319X** **UKP319D1;HE2319X**	125 4 59/64	470 18 1/2	360 14 3/16	120 4 23/32	36 1 13/32	50 1 31/32	45 1 25/32	250 9 27/32	90 3.543	125 4 29/32	M30 1 1/8	UK319D1;H2319X UK319D1;HE2319X
90 **3 7/16** **3 1/2**	**UKP320D1;H2320X** **UKP320D1;HA2320** **UKP320D1;HE2320X**	140 5 33/64	490 19 9/32	380 14 31/32	120 4 23/32	36 1 13/32	50 1 31/32	50 1 31/32	275 10 13/16	97 3.819	130 5 1/8	M30 1 1/8	UK320D1;H2320X UK320D1;HA2320 UK320D1;HE2320X
100	**UKP322D1;H2322X**	150	520	400	140	40	55	55	300	105	135	M33	UK322D1;H2322X
110	**UKP324D1;H2324X**	160	570	450	140	40	55	65	320	112	140	M33	UK324D1;H2324X
115	**UKP326D1;H2326**	180	600	480	140	40	55	75	355	121	140	M33	UK326D1;H2326
125	**UKP328D1;H2328**	200	620	500	140	40	55	75	390	131	140	M33	UK328D1;H2328

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

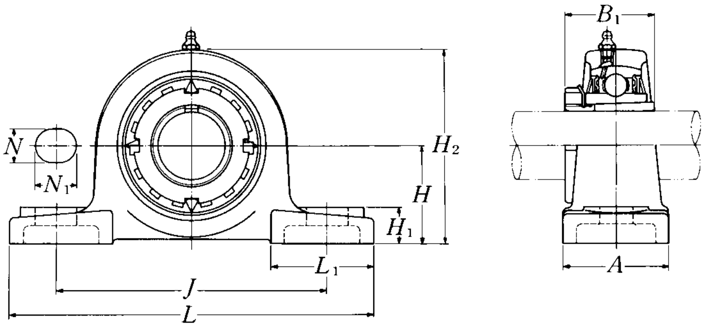
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UKP···D1**
Closed end: **CM-UKP···D1**

Housing number	Unit number cast dust cover type	Nominal dimensions mm inch			Mass of unit kg lb	
		t max.	H_3	A_5	UKP	C(CM)
P315D1	C(CM)-UKP315D1;H2315X	4	210	150	15	21
P315D1	C(CM)-UKP315AD1;HA2315	5/32	8 9/32	5 29/32	33	46
P315D1	C(CM)-UKP315ED1;HE2315X					
P316D1	C(CM)-UKP316D1;H2316X	4	221	155	18	24
P316D1	C(CM)-UKP316AD1;HA2316	5/32	8 11/16	6 3/32	40	53
P316D1	C(CM)-UKP316D1;HE2316X					
P317D1	C(CM)-UKP317D1;H2317X	5	235	170	20	27
P317D1	C(CM)-UKP317AD1;HA2317X	13/64	9 1/4	6 11/16	44	60
P317D1	C(CM)-UKP317ED1;HE2317X					
P318D1	C(CM)-UKP318D1;H2318X	5	246	170	24	31
P318D1	C(CM)-UKP318AD1;HA2318X	13/64	9 11/16	6 11/16	53	68
P319D1	C(CM)-UKP319D1;H2319X	5	258	180	29	38
P319D1	C(CM)-UKP319ED1;HE2319X	13/64	10 5/32	7 3/32	64	84
P320D1	C(CM)-UKP320D1;H2320X	5	283	190	35	47
P320D1	C(CM)-UKP320AD1;HA2320	13/64	11 5/32	7 15/32	77	104
P320D1	C(CM)-UKP320ED1;HE2320X					
P322D1	C(CM)-UKP322D1;H2322X	5	313	200	46	60
P324D1	C(CM)-UKP324D1;H2324X	5	335	215	55	69
P326D1	C(CM)-UKP326D1;H2326	6	375	225	73	94
P328D1	C(CM)-UKP328D1;H2328	6	407	235	89	114

Pillow blocks cast housing
Adapter type



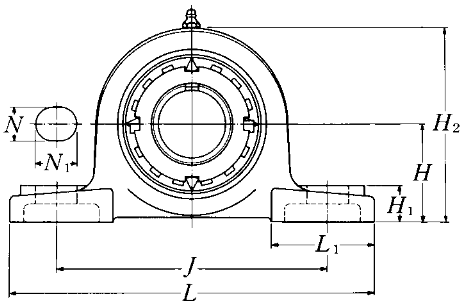
Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch H	L	J	A	N	N1	H1	H2	B1	L1	Bolt size mm inch
20	UKPX05D1;H2305X	44.4	159	119	51	17	20	18	85	35	50	M14
3/4	UKPX05D1;HE2305	1 3/4	6 1/4	4 11/16	2	21/32	25/32	23/32	3 11/32	1.378	1 31/32	1/2
25	UKPX06D1;H2306X	47.6	175	127	57	17	20	20	93	38	54	M14
7/8 1	UKPX06D1;HS2306 UKPX06D1;HE2306X	1 7/8	6 7/8	5	2 1/4	21/32	25/32	25/32	3 21/32	1.496	2 1/8	1/2
30	UKPX07D1;H2307X	54	203	144	57	17	20	21	105	43	60	M14
1 1/8	UKPX07D1;HS2307	2 1/8	8	5 21/32	2 1/4	21/32	25/32	13/16	4 1/8	1.693	2 3/8	1/2
35	UKPX08D1;H2308X	58.7	222	156	67	20	23	26	111	46	65	M16
1 1/4 1 3/8	UKPX08D1;HE2308X UKPX08D1;HS2308X	2 5/16	8 3/4	6 5/32	2 5/8	25/32	29/32	1 1/32	4 3/8	1.811	2 9/16	5/8
40	UKPX09D1;H2309X	58.7	222	156	67	20	23	26	116	50	65	M16
1 7/16 1 1/2 1 5/8	UKPX09D1;HA2309 UKPX09D1;HE2309X UKPX09D1;HS2309X	2 5/16	8 3/4	6 5/32	2 5/8	25/32	29/32	1 1/32	4 9/16	1.969	2 9/16	5/8
45	UKPX10D1;H2310X	63.5	241	171	73	20	23	27	126	55	70	M16
1 5/8 1 11/16 1 3/4	UKPX10D1;HS2310 UKPX10D1;HA2310 UKPX10D1;HE2310X	2 1/2	9 1/2	6 23/32	2 7/8	25/32	29/32	1 1/16	4 31/32	2.165	2 3/4	5/8
50	UKPX11D1;H2311X	69.8	260	184	79	25	28	30	137	59	75	M20
1 7/8 1 15/16 2	UKPX11D1;HS2311 UKPX11D1;HA2311 UKPX11D1;HE2311XY	2 3/4	10 1/4	7 1/4	3 1/8	31/32	1 3/32	1 3/16	5 13/32	2.323	2 15/16	3/4
55	UKPX12D1;H2312X	76.2	286	203	83	25	28	33	151	62	80	M20
2 1/8	UKPX12D1;HS2312	3	11 1/4	8	3 9/32	31/32	1 3/32	1 5/16	5 15/16	2.441	3 5/32	3/4
60	UKPX13D1;H2313X	76.2	286	203	83	25	28	33	154	65	80	M20
2 3/16 2 1/4 2 3/8	UKPX13D1;HA2313 UKPX13D1;HE2313X UKPX13D1;HS2313X	3	11 1/4	8	3 9/32	31/32	1 3/32	1 5/16	6 1/16	2.559	3 5/32	3/4

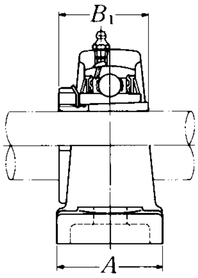
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit kg lb
UKX05D1;H2305X	PX05D1	1.5
UKX05D1;HE2305	PX05D1	3.3
UKX06D1;H2306X	PX06D1	1.8
UKX06D1;HS2306	PX06D1	4.0
UKX06D1;HE2306X	PX06D1	
UKX07D1;H2307X	PX07D1	2.5
UKX07D1;HS2307	PX07D1	5.5
UKX08D1;H2308X	PX08D1	3.2
UKX08D1;HE2308X	PX08D1	7.1
UKX08D1;HS2308X	PX08D1	
UKX09D1;H2309X	PX09D1	3.3
UKX09D1;HA2309	PX09D1	7.3
UKX09D1;HE2309X	PX09D1	
UKX09D1;HS2309X	PX09D1	
UKX10D1;H2310X	PX10D1	4.2
UKX10D1;HS2310	PX10D1	9.3
UKX10D1;HA2310	PX10D1	
UKX10D1;HE2310X	PX10D1	
UKX11D1;H2311X	PX11D1	5.4
UKX11D1;HS2311	PX11D1	12
UKX11D1;HA2311	PX11D1	
UKX11D1;HE2311XY	PX11D1	
UKX12D1;H2312X	PX12D1	7.1
UKX12D1;HS2312	PX12D1	16
UKX13D1;H2313X	PX13D1	7.3
UKX13D1;HA2313	PX13D1	16
UKX13D1;HE2313X	PX13D1	
UKX13D1;HS2313X	PX13D1	

Pillow blocks cast housing
Adapter type





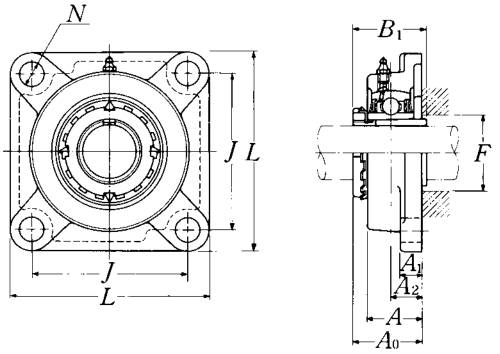
Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions										Bolt size mm inch
		mm inch										
		H	L	J	A	N	N1	H1	H2	B1	L1	
65	**UKPX15D1;H2315X**	88.9	330	229	89	27	30	35	175	73	95	M22
$2\frac{7}{16}$	**UKPX15D1;HA2315**	$3\frac{1}{2}$	13	$9\frac{1}{32}$	$3\frac{1}{2}$	$1\frac{1}{16}$	$1\frac{3}{16}$	$1\frac{3}{8}$	$6\frac{7}{8}$	2.874	$3\frac{3}{4}$	$\frac{7}{8}$
$2\frac{1}{2}$	**UKPX15D1;HE2315X**											
70	**UKPX16D1;H2316X**	101.6	381	283	102	27	30	40	194	78	110	M22
$2\frac{11}{16}$	**UKPX16D1;HA2316**	4	15	$11\frac{5}{32}$	$4\frac{1}{32}$	$1\frac{1}{16}$	$1\frac{3}{16}$	$1\frac{9}{16}$	$7\frac{5}{8}$	3.071	$4\frac{11}{32}$	$\frac{7}{8}$
$2\frac{3}{4}$	**UKPX16D1;HE2316X**											
75	**UKPX17D1;H2317X**	101.6	381	283	102	27	30	40	200	82	110	M22
$2\frac{15}{16}$	**UKPX17D1;HA2317X**	4	15	$11\frac{5}{32}$	$4\frac{1}{32}$	$1\frac{1}{16}$	$1\frac{3}{16}$	$1\frac{9}{16}$	$7\frac{7}{8}$	3.228	$4\frac{11}{32}$	$\frac{7}{8}$
3	**UKPX17D1;HE2317X**											
80	**UKPX18D1;H2318X**	101.6	381	283	111	27	30	40	206	86	110	M22
$3\frac{3}{16}$	**UKPX18D1;HA2318X**	4	15	$11\frac{5}{32}$	$4\frac{3}{8}$	$1\frac{1}{16}$	$1\frac{3}{16}$	$1\frac{9}{16}$	$8\frac{1}{8}$	3.386	$4\frac{11}{32}$	$\frac{7}{8}$
90	**UKPX20D1;H2320X**	127	432	337	121	33	36	45	244	97	125	M27

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit	
		kg	lb
UKX15D1;H2315X	PX15D1	11	24
UKX15D1;HA2315	PX15D1		
UKX15D1;HE2315X	PX15D1		
UKX16D1;H2316X	PX16D1	16	35
UKX16D1;HA2316	PX16D1		
UKX16D1;HE2316X	PX16D1		
UKX17D1;H2317X	PX17D1	16	35
UKX17D1;HA2317X	PX17D1		
UKX17D1;HE2317X	PX17D1		
UKX18D1;H2318X	PX18D1	17	37
UKX18D1;HA2318X	PX18D1		
UKX20D1;H2320X	PX20D1	29	

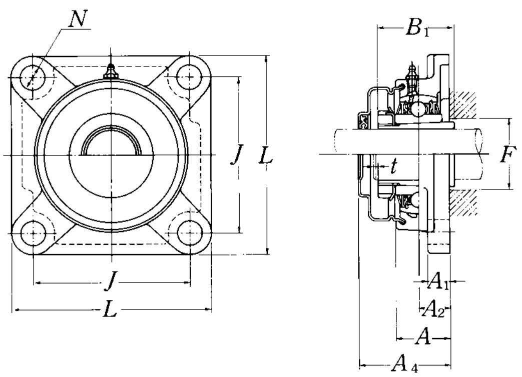
Flanged units cast housing
Adapter type



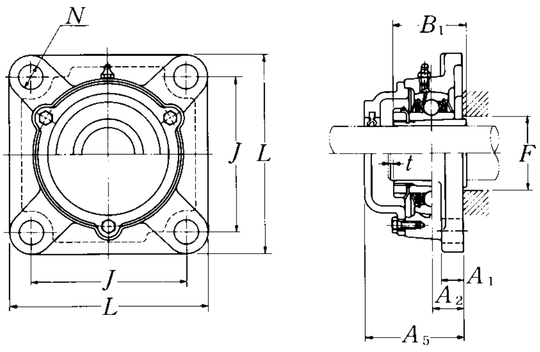
Shaft dia.	Unit number 1) 2) 3)	Nominal dimensions									Bolt size	Bearing number
mm inch		mm inch									mm inch	
		L	J	A_2	A_1	A	N	A_0	B_1	F min.		
20	UKF205D1;H2305X	95	70	16	13	27	12	35.5	35	30	M10	UK205D1;H2305X
3/4	UKF205D1;HE2305	3 3/4	2 3/4	5/8	1/2	1 1/16	15/32	1 25/64	1.378	1 3/16	3/8	UK205D1;HE2305
25	UKF206D1;H2306X	108	83	18	13	31	12	39	38	36	M10	UK206D1;H2306X
7/8	UKF206D1;HS2306	4 1/4	3 17/64	45/64	1/2	1 7/32	15/32	1 17/32	1.496	1 13/32	3/8	UK206D1;HS2306
1	UKF206D1;HE2306X											UK206D1;HE2306X
30	UKF207D1;H2307X	117	92	19	15	34	14	42.5	43	40	M12	UK207D1;H2307X
1 1/8	UKF207D1;HS2307	4 19/32	3 5/8	3/4	19/32	1 11/32	35/64	1 43/64	1.693	1 9/16	7/16	UK207D1;HS2307
35	UKF208D1;H2308X	130	102	21	15	36	16	46.5	46	46	M14	UK208D1;H2308X
1 1/4	UKF208D1;HE2308X	5 1/8	4 1/64	53/64	19/32	1 13/32	5/8	1 53/64	1.811	1 13/16	1/2	UK208D1;HE2308X
1 3/8	UKF208D1;HS2308X											UK208D1;HS2308X
40	UKF209D1;H2309X	137	105	22	16	38	16	48.5	50	52	M14	UK209D1;H2309X
1 7/16	UKF209D1;HA2309											UK209D1;HA2309
1 1/2	UKF209D1;HE2309X	5 13/32	4 9/64	55/64	5/8	1 1/2	5/8	1 29/32	1.969	2 1/16	1/2	UK209D1;HE2309X
1 5/8	UKF209D1;HS2309X											UK209D1;HS2309X
45	UKF210D1;H2310X	143	111	22	16	40	16	50	55	57	M14	UK210D1;H2310X
1 5/8	UKF210D1;HS2310											UK210D1;HS2310
1 11/16	UKF210D1;HA2310	5 5/8	4 3/8	55/64	5/8	1 9/16	5/8	1 31/32	2.165	2 1/4	1/2	UK210D1;HA2310
1 3/4	UKF210D1;HE2310X											UK210D1;HE2310X
50	UKF211D1;H2311X	162	130	25	18	43	19	54.5	59	64	M16	UK211D1;H2311X
1 7/8	UKF211D1;HS2311											UK211D1;HS2311
1 15/16	UKF211D1;HA2311	6 3/8	5 1/8	63/64	23/32	1 11/16	3/4	2 9/64	2.323	2 17/32	5/8	UK211D1;HA2311
2	UKF211D1;HE2311XY											UK211D1;HE2311XY
55	UKF212D1;H2312X	175	143	29	18	48	19	61	62	69	M16	UK212D1;H2312X
2 1/8	UKF212D1;HS2312	6 7/8	5 5/8	1 9/64	23/32	1 7/8	3/4	2 13/32	2.441	2 23/32	5/8	UK212D1;HS2312
60	UKF213D1;H2313X	187	149	30	22	50	19	64	65	74	M16	UK213D1;H2313X
2 3/16	UKF213D1;HA2313											UK213D1;HA2313
2 1/4	UKF213D1;HE2313X	7 3/8	5 55/64	1 3/16	7/8	1 31/32	3/4	2 33/64	2.559	2 29/32	5/8	UK213D1;HE2313X
2 3/8	UKF213D1;HS2313X											UK213D1;HS2313X

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.
4) If the inch series housing units with dust cover are ordered with a closed end, the suffixes E, S or A are not included.
Example: SM-UKF205D1; HE2305

Note: Please refer to page 25 for size of grease fitting.



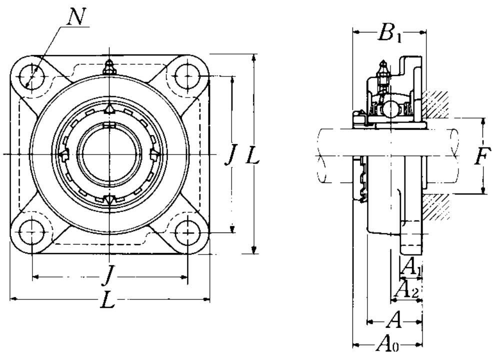
Pressed steel dust cover type
Open end: **S-UKF···D1**
Closed end: **SM-UKF···D1**



Cast dust cover type
Open end: **C-UKF···D1**
Closed end: **CM-UKF···D1**

Housing number	Unit number 4) pressed steel dust cover type	Unit number 4) cast dust cover type	Nominal dimensions			Mass of unit		
			mm		inch	kg	lb	
			t max.	A_4	A_5	UKF	S(SM)	C(CM)
F205D1	S(SM)-UKF205D1;H2305X	C(CM)-UKF205D1;H2305X	2	44.5	51	0.8	0.8	1.1
F205D1	S(SM)-UKF205ED1;HE2305	C(CM)-UKF205ED1;HE2305	$\frac{5}{64}$	$1\frac{3}{4}$	2	1.8	1.8	2.4
F206D1	S(SM)-UKF206D1;H2306X	C(CM)-UKF206D1;H2306X	2	49	56	1.1	1.1	1.6
F206D1	S(SM)-UKF206SD1;HS2306	C(CM)-UKF206SD1;HS2306	$\frac{5}{64}$	$1\frac{15}{16}$	$2\frac{7}{32}$	2.4	2.4	3.5
F206D1	S(SM)-UKF206ED1;HE2306X	C(CM)-UKF206ED1;HE2306X						
F207D1	S(SM)-UKF207D1;H2307X	C(CM)-UKF207D1;H2307X	3	55	59	1.5	1.6	2.1
F207D1	S(SM)-UKF207SD1;HS2307	C(CM)-UKF207SD1;HS2307	$\frac{1}{8}$	$2\frac{5}{32}$	$2\frac{5}{16}$	3.3	3.5	4.6
F208D1	S(SM)-UKF208D1;H2308X	C(CM)-UKF208D1;H2308X	3	62	66	1.9	2.0	2.7
F208D1	S(SM)-UKF208ED1;HE2308X	C(CM)-UKF208ED1;HE2308X	$\frac{1}{8}$	$2\frac{7}{16}$	$2\frac{19}{32}$	4.2	4.4	6.0
F208D1	S(SM)-UKF208D1;HS2308X	C(CM)-UKF208D1;HS2308X						
F209D1	S(SM)-UKF209D1;H2309X	C(CM)-UKF209D1;H2309X	3	63	70	2.3	2.4	3.0
F209D1	S(SM)-UKF209AD1;HA2309	C(CM)-UKF209AD1;HA2309						
F209D1	S(SM)-UKF209ED1;HE2309X	C(CM)-UKF209ED1;HE2309X	$\frac{1}{8}$	$2\frac{15}{32}$	$2\frac{3}{4}$	5.1	5.3	6.6
F209D1	S(SM)-UKF209SD1;HS2309X	C(CM)-UKF209SD1;HS2309X						
F210D1	S(SM)-UKF210D1;H2310X	C(CM)-UKF210D1;H2310X	3	65.5	72	2.6	2.7	3.6
F210D1	S(SM)-UKF210SD1;HS2310	C(CM)-UKF210SD1;HS2310						
F210D1	S(SM)-UKF210AD1;HA2310	C(CM)-UKF210AD1;HA2310	$\frac{1}{8}$	$2\frac{19}{32}$	$2\frac{27}{32}$	5.7	6.0	7.9
F210D1	S(SM)-UKF210ED1;HE2310X	C(CM)-UKF210ED1;HE2310X						
F211D1	S(SM)-UKF211D1;H2311X	C(CM)-UKF211D1;H2311X	4	71	75	3.8	3.9	4.9
F211D1	S(SM)-UKF211SD1;HS2311	C(CM)-UKF211SD1;HS2311						
F211D1	S(SM)-UKF211AD1;HA2311	C(CM)-UKF211AD1;HA2311	$\frac{5}{32}$	$2\frac{25}{32}$	$2\frac{15}{16}$	8.4	8.6	11
F211D1	S(SM)-UKF211ED1;HE2311XY	C(CM)-UKF211ED1;HE2311XY						
F212D1	S(SM)-UKF212D1;H2312X	C(CM)-UKF212D1;H2312X	4	80	86	4.5	4.7	6.0
F212D1	S(SM)-UKF212SD1;HS2312	C(CM)-UKF212SD1;HS2312	$\frac{5}{32}$	$3\frac{5}{32}$	$3\frac{3}{8}$	9.9	10	13
F213D1	S(SM)-UKF213D1;H2313X	C(CM)-UKF213D1;H2313X	4	83.5	90	5.6	5.8	7.4
F213D1	S(SM)-UKF213AD1;HA2313	C(CM)-UKF213AD1;HA2313						
F213D1	S(SM)-UKF213ED1;HE2313X	C(CM)-UKF213ED1;HE2313X	$\frac{5}{32}$	$3\frac{5}{16}$	$3\frac{17}{32}$	12	13	16
F213D1	S(SM)-UKF213SD1;HS2313X	C(CM)-UKF213SD1;HS2313X						

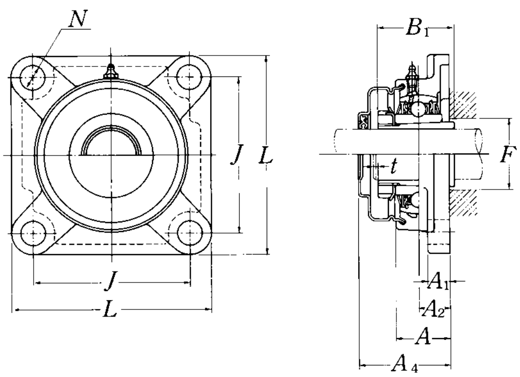
Flanged units cast housing
Adapter type



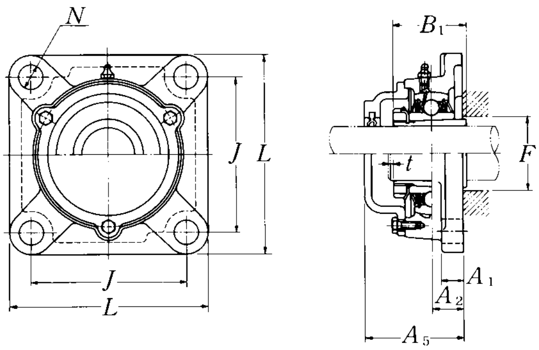
Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch L	 J	 A2	 A1	 A	 N	 A0	 B1	 F min.	Bolt size mm inch	Bearing number
65	**UKF215D1;H2315X**	200	159	34	22	56	19	71	73	84	M16	UK215D1;H2315X
2 7/16	**UKF215D1;HA2315**	7 7/8	6 17/64	1 11/32	7/8	2 7/32	3/4	2 51/64	2.874	3 5/16	5/8	UK215D1;HA2315
2 1/2	**UKF215D1;HE2315X**											UK215D1;HE2315X
70	**UKF216D1;H2316X**	208	165	34	22	58	23	73.5	78	90	M20	UK216D1;H2316X
2 11/16	**UKF216D1;HA2316**	8 3/16	6 1/2	1 11/32	7/8	2 9/32	29/32	2 57/64	3.071	3 17/32	3/4	UK216D1;HA2316
2 3/4	**UKF216D1;HE2316X**											UK216D1;HE2316X
75	**UKF217D1;H2317X**	220	175	36	24	63	23	77	82	95	M20	UK217D1;H2317X
2 15/16	**UKF217D1;HA2317X**	8 21/32	6 57/64	1 27/64	15/16	2 15/32	29/32	3 1/32	3.228	3 3/4	3/4	UK217D1;HA2317X
3	**UKF217D1;HE2317X**											UK217D1;HE2317X
80	**UKF218D1;H2318X**	235	187	40	24	68	23	81.5	86	102	M20	UK218D1;H2318X
3 3/16	**UKF218D1;HA2318X**	9 1/4	7 23/64	1 37/64	15/16	2 11/16	29/32	3 13/64	3.386	4 1/32	3/4	UK218D1;HA2318X

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.
4) If the inch series housing units with dust cover are ordered with a closed end, the suffixes E, S or A are not included.
Example: SM-UKF205D1; HE2305

Note: Please refer to page 25 for size of grease fitting.



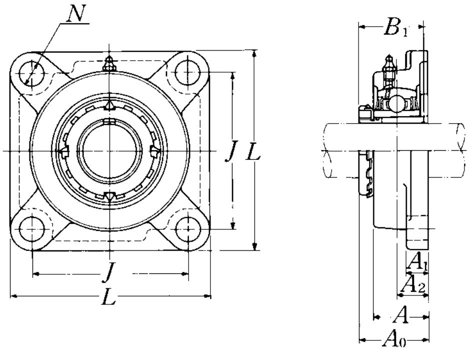
Pressed steel dust cover type
Open end: **S-UKF···D1**
Closed end: **SM-UKF···D1**



Cast dust cover type
Open end: **C-UKF···D1**
Closed end: **CM-UKF···D1**

Housing number	Unit number 4) pressed steel dust cover type	Unit number 4) cast dust cover type	Nominal dimensions			Mass of unit		
			mm		inch	kg		lb
			t max.	A_4	A_5	UKF	S(SM)	C(CM)
F215D1	—	**C(CM)-UKF215D1;H2315X**	4	—	102	7.1	—	9.1
F215D1	—	**C(CM)-UKF215AD1;HA2315**	5/32	—	4 1/32	16	—	20
F215D1		**C(CM)-UKF215ED1;HE2315X**						
F216D1	—	**C(CM)-UKF216D1;H2316X**	4	—	106	8.5	—	11
F216D1	—	**C(CM)-UKF216AD1;HA2316**	5/32	—	4 3/16	19	—	24
F216D1		**C(CM)-UKF216D1;HE2316X**						
F217D1	—	**C(CM)-UKF217D1;H2317X**	5	—	114	9.9	—	13
F217D1	—	**C(CM)-UKF217AD1;HA2317X**	13/64	—	4 1/2	22	—	29
F217D1		**C(CM)-UKF217ED1;HE2317X**						
F218D1	—	**C(CM)-UKF218D1;H2318X**	5	—	122	12	—	16
F218D1	—	**C(CM)-UKF218AD1;HA2318X**	13/64	—	4 13/16	26	—	35

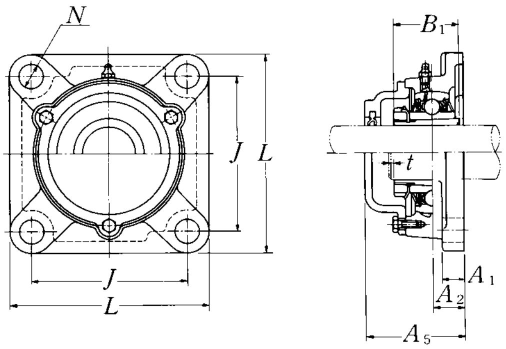
Flanged units cast housing
Adapter type



Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch								Bolt size mm inch	Bearing number
		L	J	A_2	A_1	A	N	A_0	B_1		
20	**UKF305D1;H2305X**	110	80	16	13	29	16	37	35	M14	UK305D1;H2305X
$\frac{3}{4}$	**UKF305D1;HE2305**	$4\frac{11}{32}$	$3\frac{5}{32}$	$\frac{5}{8}$	$\frac{1}{2}$	$1\frac{5}{32}$	$\frac{5}{8}$	$1\frac{29}{64}$	1.378	$\frac{1}{2}$	UK305D1;HE2305
25	**UKF306D1;H2306X**	125	95	18	15	32	16	40.5	38	M14	UK306D1;H2306X
$\frac{7}{8}$	**UKF306D1;HS2306**	$4\frac{29}{32}$	$3\frac{47}{64}$	$\frac{45}{64}$	$\frac{19}{32}$	$1\frac{1}{4}$	$\frac{5}{8}$	$1\frac{19}{32}$	1.496	$\frac{1}{2}$	UK306D1;HS2306
1	**UKF306D1;HE2306X**										UK306D1;HE2306X
30	**UKF307D1;H2307X**	135	100	20	16	36	19	45.5	43	M16	UK307D1;H2307X
$1\frac{1}{8}$	**UKF307D1;HS2307**	$5\frac{5}{16}$	$3\frac{15}{16}$	$\frac{25}{32}$	$\frac{5}{8}$	$1\frac{13}{32}$	$\frac{3}{4}$	$1\frac{51}{64}$	1.693	$\frac{5}{8}$	UK307D1;HS2307
35	**UKF308D1;H2308X**	150	112	23	17	40	19	50	46	M16	UK308D1;H2308X
$1\frac{1}{4}$	**UKF308D1;HE2308X**	$5\frac{29}{32}$	$4\frac{13}{32}$	$\frac{29}{32}$	$\frac{21}{32}$	$1\frac{9}{16}$	$\frac{3}{4}$	$1\frac{31}{32}$	1.811	$\frac{5}{8}$	UK308D1;HE2308X
$1\frac{3}{8}$	**UKF308D1;HS2308X**										UK308D1;HS2308X
40	**UKF309D1;H2309X**	160	125	25	18	44	19	54.5	50	M16	UK309D1;H2309X
$1\frac{7}{16}$	**UKF309D1;HA2309**	$6\frac{5}{16}$	$4\frac{59}{64}$	$\frac{63}{64}$	$\frac{23}{32}$	$1\frac{23}{32}$	$\frac{3}{4}$	$2\frac{9}{64}$	1.969	$\frac{5}{8}$	UK309D1;HA2309
$1\frac{1}{2}$	**UKF309D1;HE2309X**										UK309D1;HE2309X
$1\frac{5}{8}$	**UKF309D1;HS2309X**										UK309D1;HS2309X
45	**UKF310D1;H2310X**	175	132	28	19	48	23	60.5	55	M20	UK310D1;H2310X
$1\frac{5}{8}$	**UKF310D1;HS2310**	$6\frac{7}{8}$	$5\frac{13}{64}$	$1\frac{7}{64}$	$\frac{3}{4}$	$1\frac{7}{8}$	$\frac{29}{32}$	$2\frac{3}{8}$	2.165	$\frac{3}{4}$	UK310D1;HS2310
$1\frac{11}{16}$	**UKF310D1;HA2310**										UK310D1;HA2310
$1\frac{3}{4}$	**UKF310D1;HE2310X**										UK310D1;HE2310X
50	**UKF311D1;H2311X**	185	140	30	20	52	23	64	59	M20	UK311D1;H2311X
$1\frac{7}{8}$	**UKF311D1;HS2311**	$7\frac{9}{32}$	$5\frac{33}{64}$	$1\frac{3}{16}$	$\frac{25}{32}$	$2\frac{1}{16}$	$\frac{29}{32}$	$2\frac{33}{64}$	2.323	$\frac{3}{4}$	UK311D1;HS2311
$1\frac{15}{16}$	**UKF311D1;HA2311**										UK311D1;HA2311
2	**UKF311D1;HE2311XY**										UK311D1;HE2311XY
55	**UKF312D1;H2312X**	195	150	33	22	56	23	69.5	62	M20	UK312D1;H2312X
$2\frac{1}{8}$	**UKF312D1;HS2312**	$7\frac{11}{16}$	$5\frac{29}{32}$	$1\frac{19}{64}$	$\frac{7}{8}$	$2\frac{7}{32}$	$\frac{29}{32}$	$2\frac{47}{64}$	2.441	$\frac{3}{4}$	UK312D1;HS2312
60	**UKF313D1;H2313X**	208	166	33	22	58	23	71.5	65	M20	UK313D1;H2313X
$2\frac{3}{16}$	**UKF313D1;HA2313**	$8\frac{3}{16}$	$6\frac{17}{32}$	$1\frac{19}{64}$	$\frac{7}{8}$	$2\frac{9}{32}$	$\frac{29}{32}$	$2\frac{13}{16}$	2.559	$\frac{3}{4}$	UK313D1;HA2313
$2\frac{1}{4}$	**UKF313D1;HE2313X**										UK313D1;HE2313X
$2\frac{3}{8}$	**UKF313D1;HS2313X**										UK313D1;HS2313X

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.
4) If the inch series housing units with dust cover are ordered with a closed end, the suffixes E, S or A are not included.
Example: CM-UKF305D1; HE2305

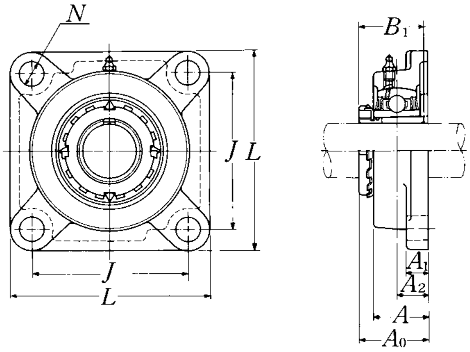
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UKF···D1**
Closed end: **CM-UKF···D1**

Housing number	Unit number 4) cast dust cover type	Nominal dimensions		Mass of unit	
		mm	inch	kg	lb
		t max.	A_5	UKF	C(CM)
F305D1	**C(CM)-UKF305D1;H2305X**	2	56	1.1	1.6
F305D1	**C(CM)-UKF305ED1;HE2305**	5/64	2 7/32	2.4	3.5
F306D1	**C(CM)-UKF306D1;H2306X**	2	60	1.6	2.3
F306D1	**C(CM)-UKF306SD1;HS2306**	5/64	2 3/8	3.5	5.1
F306D1	**C(CM)-UKF306ED1;HE2306X**				
F307D1	**C(CM)-UKF307D1;H2307X**	3	68	2.0	2.8
F307D1	**C(CM)-UKF307SD1;HS2307**	1/8	2 11/16	4.4	6.2
F308D1	**C(CM)-UKF308D1;H2308X**	3	76	2.7	3.6
F308D1	**C(CM)-UKF308ED1;HE2308X**	1/8	3	6.0	7.9
F308D1	**C(CM)-UKF308D1;HS2308X**				
F309D1	**C(CM)-UKF309D1;H2309X**	3	80	3.5	4.7
F309D1	**C(CM)-UKF309AD1;HA2309**				
F309D1	**C(CM)-UKF309ED1;HE2309X**	1/8	3 5/32	7.7	10
F309D1	**C(CM)-UKF309SD1;HS2309X**				
F310D1	**C(CM)-UKF310D1;H2310X**	3	88	4.5	5.7
F310D1	**C(CM)-UKF310SD1;HS2310**				
F310D1	**C(CM)-UKF310AD1;HA2310**	1/8	3 15/32	9.9	13
F310D1	**C(CM)-UKF310ED1;HE2310X**				
F311D1	**C(CM)-UKF311D1;H2311X**	4	92	5.5	7.7
F311D1	**C(CM)-UKF311SD1;HS2311**				
F311D1	**C(CM)-UKF311AD1;HA2311**	5/32	3 5/8	12	17
F311D1	**C(CM)-UKF311ED1;HE2311XY**				
F312D1	**C(CM)-UKF312D1;H2312X**	4	100	6.4	8.6
F312D1	**C(CM)-UKF312SD1;HS2312**	5/32	3 15/16	14	19
F313D1	**C(CM)-UKF313D1;H2313X**	4	103	7.7	9.9
F313D1	**C(CM)-UKF313AD1;HA2313**				
F313D1	**C(CM)-UKF313ED1;HE2313X**	5/32	4 1/16	17	22
F313D1	**C(CM)-UKF313SD1;HS2313X**				

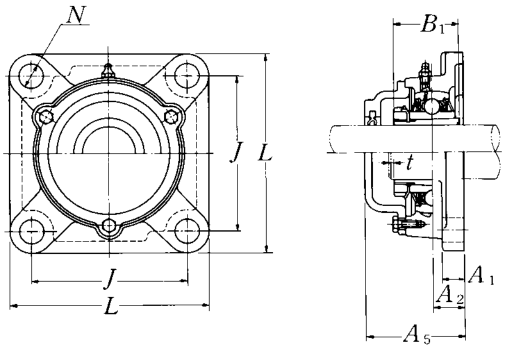
Flanged units cast housing
Adapter type



Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch L	J	A2	A1	A	N	A0	B1	Bolt size mm inch	Bearing number
65 **2 7/16** **2 1/2**	**UKF315D1;H2315X** **UKF315D1;HA2315** **UKF315D1;HE2315X**	236 9 9/32	184 7 1/4	39 1 17/32	25 31/32	66 2 19/32	25 63/64	81.5 3 13/64	73 2.874	M22 7/8	UK315D1;H2315X UK315D1;HA2315 UK315D1;HE2315X
70 **2 11/16** **2 3/4**	**UKF316D1;H2316X** **UKF316D1;HA2316** **UKF316D1;HE2316X**	250 9 27/32	196 7 23/32	38 1 1/2	27 1 1/16	68 2 11/16	31 1 7/32	84 3 5/16	78 3.071	M27 1	UK316D1;H2316X UK316D1;HA2316 UK316D1;HE2316X
75 **2 15/16** **3**	**UKF317D1;H2317X** **UKF317D1;HA2317X** **UKF317D1;HE2317X**	260 10 1/4	204 8 1/32	44 1 47/64	27 1 1/16	74 2 29/32	31 1 7/32	92 3 5/8	82 3.228	M27 1	UK317D1;H2317X UK317D1;HA2317X UK317D1;HE2317X
80 **3 3/16**	**UKF318D1;H2318X** **UKF318D1;HA2318X**	280 11 1/32	216 8 1/2	44 1 47/64	30 1 3/16	76 3	35 1 3/8	94 3 45/64	86 3.386	M30 1 1/8	UK318D1;H2318X UK318D1;HA2318X
85 **3 1/4**	**UKF319D1;H2319X** **UKF319D1;HE2319X**	290 11 13/32	228 8 31/32	59 2 21/64	30 1 3/16	94 3 11/16	35 1 3/8	111.5 4 25/64	90 3.543	M30 1 1/8	UK319D1;H2319X UK319D1;HE2319X
90 **3 7/16** **3 1/2**	**UKF320D1;H2320X** **UKF320D1;HA2320** **UKF320D1;HE2320X**	310 12 7/32	242 9 17/32	59 2 21/64	32 1 1/4	94 3 11/16	38 1 1/2	115.5 4 35/64	97 3.819	M33 1 1/4	UK320D1;H2320X UK320D1;HA2320 UK320D1;HE2320X
100	**UKF322D1;H2322X**	340	266	60	35	96	41	121	105	M36	UK322D1;H2322X
110	**UKF324D1;H2324X**	370	290	65	40	110	41	130	112	M36	UK324D1;H2324X
115	**UKF326D1;H2326**	410	320	65	45	115	41	133	121	M36	UK326D1;H2326
125	**UKF328D1;H2328**	450	350	75	55	125	41	146.5	131	M36	UK328D1;H2328

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.
4) If the inch series housing units with dust cover are ordered with a closed end, the suffixes E, S or A are not included.
Example: CM-UKF305D1; HE2305

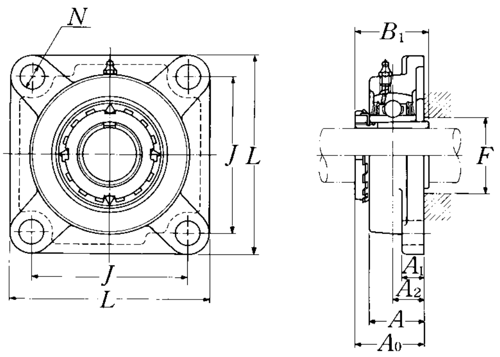
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UKF···D1**
Closed end: **CM-UKF···D1**

Housing number	Unit number 4) cast dust cover type	Nominal dimensions		Mass of unit	
		mm / inch		kg / lb	
		t max.	A_5	UKF	C(CM)
F315D1	**C(CM)-UKF315D1;H2315X**	4	114	12	14
F315D1	**C(CM)-UKF315AD1;HA2315**	$\frac{5}{32}$	$4\frac{1}{2}$	26	31
F315D1	**C(CM)-UKF315ED1;HE2315X**				
F316D1	**C(CM)-UKF316D1;H2316X**	4	116	15	19
F316D1	**C(CM)-UKF316AD1;HA2316**	$\frac{5}{32}$	$4\frac{9}{16}$	33	42
F316D1	**C(CM)-UKF316D1;HE2316X**				
F317D1	**C(CM)-UKF317D1;H2317X**	5	129	16	21
F317D1	**C(CM)-UKF317AD1;HA2317X**	$\frac{13}{64}$	$5\frac{3}{32}$	35	46
F317D1	**C(CM)-UKF317ED1;HE2317X**				
F318D1	**C(CM)-UKF318D1;H2318X**	5	129	20	25
F318D1	**C(CM)-UKF318AD1;HA2318X**	$\frac{13}{64}$	$5\frac{3}{32}$	44	55
F319D1	**C(CM)-UKF319D1;H2319X**	5	149	22	28
F319D1	**C(CM)-UKF319ED1;HE2319X**	$\frac{13}{64}$	$5\frac{7}{8}$	49	62
F320D1	**C(CM)-UKF320D1;H2320X**	5	154	26	33
F320D1	**C(CM)-UKF320AD1;HA2320**	$\frac{13}{64}$	$6\frac{1}{16}$	57	73
F320D1	**C(CM)-UKF320ED1;HE2320X**				
F322D1	**C(CM)-UKF322D1;H2322X**	5	160	38	46
F324D1	**C(CM)-UKF324D1;H2324X**	5	172	49	60
F326D1	**C(CM)-UKF326D1;H2326**	6	178	66	79
F328D1	**C(CM)-UKF328D1;H2328**	6	192	91	108

Flanged units cast housing
Adapter type



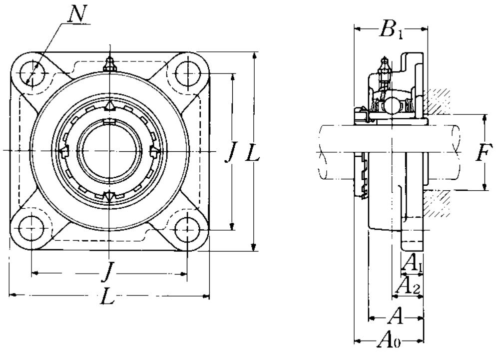
Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch L	J	A2	A1	A	N	A0	B1	F min.	Bolt size mm inch	Bearing number
20 3/4	**UKFX05D1;H2305X** **UKFX05D1;HE2305**	108 4 1/4	83 3 17/64	18 45/64	13 1/2	30 1 3/16	12 15/32	39 1 17/32	35 1.378	30 1 3/16	M10 3/8	UKX05D1;H2305X UKX05D1;HE2305
25 7/8 1	**UKFX06D1;H2306X** **UKFX06D1;HS2306** **UKFX06D1;HE2306X**	117 4 19/32	92 3 5/8	19 3/4	14 9/16	34 1 11/32	16 5/8	41.5 1 41/64	38 1.496	36 1 13/32	M14 1/2	UKX06D1;H2306X UKX06D1;HS2306 UKX06D1;HE2306X
30 1 1/8	**UKFX07D1;H2307X** **UKFX07D1;HS2307**	130 5 1/8	102 4 1/64	21 53/64	14 9/16	38 1 1/2	16 5/8	45.5 1 51/64	43 1.693	40 1 9/16	M14 1/2	UKX07D1;H2307X UKX07D1;HS2307
35 1 1/4 1 3/8	**UKFX08D1;H2308X** **UKFX08D1;HE2308X** **UKFX08D1;HS2308X**	137 5 13/32	105 4 9/64	22 55/64	14 9/16	40 1 9/16	19 3/4	47.5 1 7/8	46 1.811	46 1 13/16	M16 5/8	UKX08D1;H2308X UKX08D1;HE2308X UKX08D1;HS2308X
40 1 7/16 1 1/2 1 5/8	**UKFX09D1;H2309X** **UKFX09D1;HA2309** **UKFX09D1;HE2309X** **UKFX09D1;HS2309X**	143 5 5/8	111 4 3/8	23 29/32	14 9/16	40 1 9/16	19 3/4	50 1 31/32	50 1.969	52 2 1/16	M16 5/8	UKX09D1;H2309X UKX09D1;HA2309 UKX09D1;HE2309X UKX09D1;HS2309X
45 1 5/8 1 11/16 1 3/4	**UKFX10D1;H2310X** **UKFX10D1;HS2310** **UKFX10D1;HA2310** **UKFX10D1;HE2310X**	162 6 3/8	130 5 1/8	26 1 1/32	20 25/32	44 1 23/32	19 3/4	55.5 2 3/16	55 2.165	57 2 1/4	M16 5/8	UKX10D1;H2310X UKX10D1;HS2310 UKX10D1;HA2310 UKX10D1;HE2310X
50 1 7/8 1 15/16 2	**UKFX11D1;H2311X** **UKFX11D1;HS2311** **UKFX11D1;HA2311** **UKFX11D1;HE2311XY**	175 6 7/8	143 5 5/8	29 1 9/64	20 25/32	49 1 15/16	19 3/4	60 2 23/64	59 2.323	64 2 17/32	M16 5/8	UKX11D1;H2311X UKX11D1;HS2311 UKX11D1;HA2311 UKX11D1;HE2311XY
55 2 1/8	**UKFX12D1;H2312X** **UKFX12D1;HS2312**	187 7 3/8	149 5 55/64	34 1 11/32	21 13/16	59 2 5/16	19 3/4	67 2 41/64	62 2.441	69 2 23/32	M16 5/8	UKX12D1;H2312X UKX12D1;HS2312
60 2 3/16 2 1/4 2 3/8	**UKFX13D1;H2313X** **UKFX13D1;HA2313** **UKFX13D1;HE2313X** **UKFX13D1;HS2313X**	187 7 3/8	149 5 55/64	34 1 11/32	21 13/16	59 2 5/16	19 3/4	69 2 23/32	65 2.559	74 2 29/32	M16 5/8	UKX13D1;H2313X UKX13D1;HA2313 UKX13D1;HE2313X UKX13D1;HS2313X

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit
	kg lb
FX05D1	1.0
FX05D1	2.2
FX06D1	1.6
FX06D1	3.5
FX06D1	
FX07D1	2.0
FX07D1	4.4
FX08D1	2.4
FX08D1	5.3
FX08D1	
FX09D1	2.5
FX09D1	5.5
FX09D1	
FX09D1	
FX10D1	3.8
FX10D1	8.4
FX10D1	
FX10D1	
FX11D1	4.6
FX11D1	10
FX11D1	
FX11D1	
FX12D1	5.0
FX12D1	11
FX13D1	5.0
FX13D1	11
FX13D1	
FX13D1	

Flanged units cast housing
Adapter type



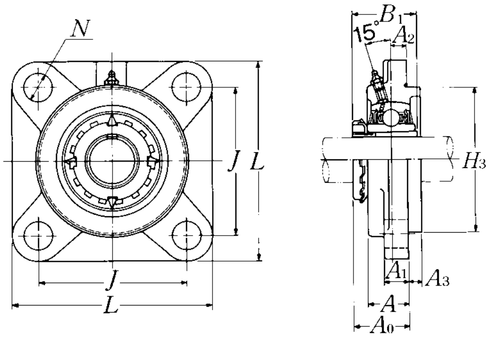
Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch L	J	A2	A1	A	N	A0	B1	F min.	Bolt size mm inch	Bearing number
65	**UKFX15D1;H2315X**	197	152	40	24	68	23	77.5	73	84	M20	UKX15D1;H2315X
2 7/16	**UKFX15D1;HA2315**	7 3/4	5 63/64	1 37/64	15/16	2 11/16	29/32	3 3/64	2.874	3 5/16	3/4	UKX15D1;HA2315
2 1/2	**UKFX15D1;HE2315X**											UKX15D1;HE2315X
70	**UKFX16D1;H2316X**	214	171	40	24	70	23	80	78	90	M20	UKX16D1;H2316X
2 11/16	**UKFX16D1;HA2316**	8 7/16	6 47/64	1 37/64	15/16	2 3/4	29/32	3 5/32	3.071	3 17/32	3/4	UKX16D1;HA2316
2 3/4	**UKFX16D1;HE2316X**											UKX16D1;HE2316X
75	**UKFX17D1;H2317X**	214	171	40	24	70	23	81.5	82	95	M20	UKX17D1;H2317X
2 15/16	**UKFX17D1;HA2317X**	8 7/16	6 47/64	1 37/64	15/16	2 3/4	29/32	3 13/64	3.228	3 3/4	3/4	UKX17D1;HA2317X
3	**UKFX17D1;HE2317X**											UKX17D1;HE2317X
80	**UKFX18D1;H2318X**	214	171	45	24	76	23	87.5	86	102	M20	UKX18D1;H2318X
3 3/16	**UKFX18D1;HA2318X**	8 7/16	6 47/64	1 49/64	15/16	3	29/32	3 7/16	3.386	4 1/32	3/4	UKX18D1;HA2318X
90	**UKFX20D1;H2320X**	268	211	59	31	97	31	107.5	97	112	M27	UKX20D1;H2320X

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Note: Please refer to page 25 for size of grease fitting.

Housing number	Mass of unit kg lb
FX15D1	8.2
FX15D1	18
FX15D1	
FX16D1	10
FX16D1	22
FX16D1	
FX17D1	11
FX17D1	24
FX17D1	
FX18D1	11
FX18D1	24
FX20D1	15

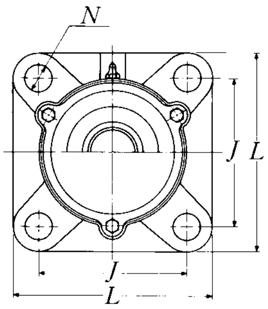
Flanged cartridge units cast housing
Adapter type

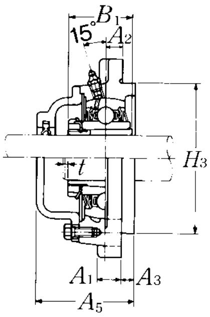


Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch										Bolt size mm inch	Bearing number
		L	J	A_2	N	A_3	A_1	A	H_3	A_0	B_1		
20	UKFS305D1;H2305X	110	80	9	16	7	13	29	80	37	35	M14	UK305D1;H2305X
3/4	UKFS305D1;HE2305	4 11/32	3 5/32	23/64	5/8	9/32	1/2	1 9/64	3.1496	1 29/64	1.378	1/2	UK305D1;HE2305
25	UKFS306D1;H2306X	125	95	10	16	8	15	32	90	40.5	38	M14	UK306D1;H2306X
7/8	UKFS306D1;HS2306	4 29/32	3 47/64	25/64	5/8	5/16	19/32	1 17/64	3.5433	1 19/32	1.496	1/2	UK306D1;HS2306
1	UKFS306D1;HE2306X												UK306D1;HE2306X
30	UKFS307D1;H2307X	135	100	11	19	9	16	36	100	45.5	43	M16	UK307D1;H2307X
1 1/8	UKFS307D1;HS2307	5 5/16	3 15/16	7/16	3/4	23/64	5/8	1 13/32	3.9370	1 51/64	1.693	5/8	UK307D1;HS2307
35	UKFS308D1;H2308X	150	112	13	19	10	17	40	115	50	46	M16	UK308D1;H2308X
1 1/4	UKFS308D1;HE2308X	5 29/32	4 13/32	33/64	3/4	25/64	21/32	1 9/16	4.5276	1 31/32	1.811	5/8	UK308D1;HE2308X
1 3/8	UKFS308D1;HS2308X												UK308D1;HS2308X
40	UKFS309D1;H2309X	160	125	14	19	11	18	44	125	54.5	50	M16	UK309D1;H2309X
1 7/16	UKFS309D1;HA2309	6 5/16	4 59/64	35/64	3/4	7/16	23/32	1 47/64	4.9213	2 9/64	1.969	5/8	UK309D1;HA2309
1 1/2	UKFS309D1;HE2309X												UK309D1;HE2309X
1 5/8	UKFS309D1;HS2309X												UK309D1;HS2309X
45	UKFS310D1;H2310X	175	132	16	23	12	19	48	140	60.5	55	M20	UK310D1;H2310X
1 5/8	UKFS310D1;HS2310	6 7/8	5 13/64	5/8	29/32	15/32	3/4	1 57/64	5.5118	2 3/8	2.165	3/4	UK310D1;HS2310
1 11/16	UKFS310D1;HA2310												UK310D1;HA2310
1 3/4	UKFS310D1;HE2310X												UK310D1;HE2310X
50	UKFS311D1;H2311X	185	140	17	23	13	20	52	150	64	59	M20	UK311D1;H2311X
1 7/8	UKFS311D1;HS2311	7 9/32	5 33/64	43/64	29/32	33/64	25/32	2 3/64	5.9055	2 33/64	2.323	3/4	UK311D1;HS2311
1 15/16	UKFS311D1;HA2311												UK311D1;HA2311
2	UKFS311D1;HE2311XY												UK311D1;HE2311XY
55	UKFS312D1;H2312X	195	150	19	23	14	22	56	160	69.5	62	M20	UK312D1;H2312X
2 1/8	UKFS312D1;HS2312	7 11/16	5 29/32	3/4	29/32	35/64	7/8	2 13/64	6.2992	2 47/64	2.441	3/4	UK312D1;HS2312
60	UKFS313D1;H2313X	208	166	15	23	18	22	58	175	71.5	65	M20	UK313D1;H2313X
2 3/16	UKFS313D1;HA2313	8 3/16	6 17/32	19/32	29/32	45/64	7/8	2 9/32	6.8898	2 13/16	2.559	3/4	UK313D1;HA2313
2 1/4	UKFS313D1;HE2313X												UK313D1;HE2313X
2 3/8	UKFS313D1;HS2313X												UK313D1;HS2313X

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.
4) If the inch series housing units with dust cover are ordered with a closed end, the suffixes E, S or A are not included.
Example: CM-UKFS305D1; HE2305

Note: Please refer to page 25 for size of grease fitting.

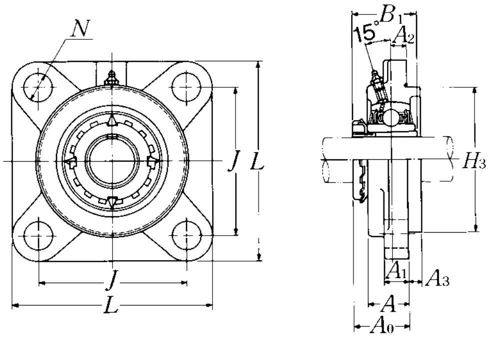




Cast dust cover type
Open end: **C-UKFS···D1**
Closed end: **CM-UKFS···D1**

Housing number	Unit number 4) cast dust cover type	Nominal dimensions		Mass of unit	
		mm	inch	kg	lb
		t max.	A_5	UKFS	C(CM)
FS305D1	**C(CM)-UKFS305D1;H2305X**	2	56	1.3	1.8
FS305D1	**C(CM)-UKFS305ED1;HE2305**	5/64	2 13/64	2.9	4.0
FS306D1	**C(CM)-UKFS306D1;H2306X**	2	60	1.9	2.5
FS306D1	**C(CM)-UKFS306SD1;HS2306**	5/64	2 23/64	4.2	5.5
FS306D1	**C(CM)-UKFS306ED1;HE2306X**				
FS307D1	**C(CM)-UKFS307D1;H2307X**	3	67	2.4	3.1
FS307D1	**C(CM)-UKFS307SD1;HS2307**	1/8	2 41/64	5.3	6.8
FS308D1	**C(CM)-UKFS308D1;H2308X**	3	76	3.3	4.2
FS308D1	**C(CM)-UKFS308ED1;HE2308X**	1/8	2 63/64	7.3	9.3
FS308D1	**C(CM)-UKFS308D1;HS2308X**				
FS309D1	**C(CM)-UKFS309D1;H2309X**	3	80	4.1	5.2
FS309D1	**C(CM)-UKFS309AD1;HA2309**	1/8	3 5/32	9.0	11
FS309D1	**C(CM)-UKFS309ED1;HE2309X**				
FS309D1	**C(CM)-UKFS309SD1;HS2309X**				
FS310D1	**C(CM)-UKFS310D1;H2310X**	3	88	5.3	6.8
FS310D1	**C(CM)-UKFS310SD1;HS2310**	1/8	3 15/32	12	15
FS310D1	**C(CM)-UKFS310AD1;HA2310**				
FS310D1	**C(CM)-UKFS310ED1;HE2310X**				
FS311D1	**C(CM)-UKFS311D1;H2311X**	4	93	6.2	8.3
FS311D1	**C(CM)-UKFS311SD1;HS2311**	5/32	3 21/32	14	18
FS311D1	**C(CM)-UKFS311AD1;HA2311**				
FS311D1	**C(CM)-UKFS311ED1;HE2311XY**				
FS312D1	**C(CM)-UKFS312D1;H2312X**	4	100	7.1	9.0
FS312D1	**C(CM)-UKFS312SD1;HS2312**	5/32	3 15/16	16	20
FS313D1	**C(CM)-UKFS313D1;H2313X**	4	103	8.7	11
FS313D1	**C(CM)-UKFS313AD1;HA2313**	5/32	4 1/16	19	24
FS313D1	**C(CM)-UKFS313ED1;HE2313X**				
FS313D1	**C(CM)-UKFS313SD1;HS2313X**				

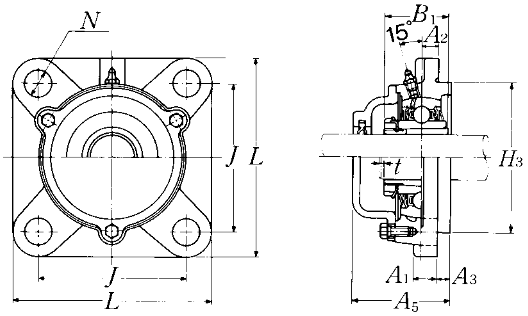
Flanged cartridge units cast housing
Adapter type



Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch L	J	A_2	N	A_3	A_1	A	H_3	A_0	B_1	Bolt size mm inch	Bearing number
65 2 7/16 2 1/2	UKFS315D1;H2315X UKFS315D1;HA2315 UKFS315D1;HE2315X	236 9 9/32	184 7 1/4	21 53/64	25 63/64	18 45/64	25 31/32	66 2 19/32	200 7.8740	81.5 3 13/64	73 2.874	M22 7/8	UK315D1;H2315X UK315D1;HA2315 UK315D1;HE2315X
70 2 11/16 2 3/4	UKFS316D1;H2316X UKFS316D1;HA2316 UKFS316D1;HE2316X	250 9 27/32	196 7 23/32	18 45/64	31 1 7/32	20 25/32	27 1 1/16	68 2 43/64	210 8.2677	84 3 5/16	78 3.071	M27 1	UK316D1;H2316X UK316D1;HA2316 UK316D1;HE2316X
75 2 15/16 3	UKFS317D1;H2317X UKFS317D1;HA2317X UKFS317D1;HE2317X	260 10 1/4	204 8 1/32	24 15/16	31 1 7/32	20 25/32	27 1 1/16	74 2 29/32	220 8.6614	92 3 5/8	82 3.228	M27 1	UK317D1;H2317X UK317D1;HA2317X UK317D1;HE2317X
80 3 3/16	UKFS318D1;H2318X UKFS318D1;HA2318X	280 11 1/32	216 8 1/2	24 15/16	35 1 3/8	20 25/32	30 1 3/16	76 2 63/64	240 9.4488	94 3 45/64	86 3.386	M30 1 1/8	UK318D1;H2318X UK318D1;HA2318X
85 3 1/4	UKFS319D1;H2319X UKFS319D1;HE2319X	290 11 13/32	228 8 31/32	39 1 17/32	35 1 3/8	20 25/32	30 1 3/16	94 3 45/64	250 9.8425	111.5 4 25/64	90 3.543	M30 1 1/8	UK319D1;H2319X UK319D1;HE2319X
90 3 7/16 3 1/2	UKFS320D1;H2320X UKFS320D1;HA2320 UKFS320D1;HE2320X	310 12 7/32	242 9 17/32	39 1 17/32	38 1 1/2	20 25/32	32 1 1/4	94 3 45/64	260 10.2362	115.5 4 35/64	97 3.819	M33 1 1/4	UK320D1;H2320X UK320D1;HA2320 UK320D1;HE2320X
100	UKFS322D1;H2322X	340	266	35	41	25	35	96	300	121	105	M36	UK322D1;H2322X
110	UKFS324D1;H2324X	370	290	35	41	30	40	110	330	130	112	M36	UK324D1;H2324X
115	UKFS326D1;H2326	410	320	35	41	30	45	115	360	133	121	M36	UK326D1;H2326
125	UKFS328D1;H2328	450	350	45	41	30	55	125	400	146.5	131	M36	UK328D1;H2328

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.
4) If the inch series housing units with dust cover are ordered with a closed end, the suffixes E, S or A are not included.
Example: CM-UKFS305D1; HE2305

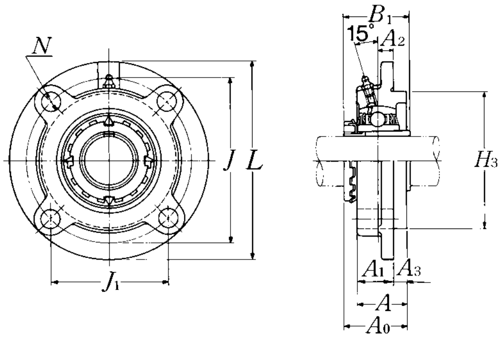
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UKFS···D1**
Closed end: **CM-UKFS···D1**

Housing number	Unit number 4) cast dust cover type	Nominal dimensions		Mass of unit	
		mm	inch	kg	lb
		t max.	A5	UKFS	C(CM)
FS315D1	**C(CM)-UKFS315D1;H2315X**	4	114	13	16
FS315D1	**C(CM)-UKFS315AD1;HA2315**	5/32	4 31/64	29	35
FS315D1	**C(CM)-UKFS315ED1;HE2315X**				
FS316D1	**C(CM)-UKFS316D1;H2316X**	4	116	15	18
FS316D1	**C(CM)-UKFS316AD1;HA2316**	5/32	4 9/16	33	40
FS316D1	**C(CM)-UKFS316D1;HE2316X**				
FS317D1	**C(CM)-UKFS317D1;H2317X**	5	129	17	22
FS317D1	**C(CM)-UKFS317AD1;HA2317X**	13/64	5 5/64	37	49
FS317D1	**C(CM)-UKFS317ED1;HE2317X**				
FS318D1	**C(CM)-UKFS318D1;H2318X**	5	129	21	26
FS318D1	**C(CM)-UKFS318AD1;HA2318X**	13/64	5 5/64	46	57
FS319D1	**C(CM)-UKFS319D1;H2319X**	5	149	25	31
FS319D1	**C(CM)-UKFS319ED1;HE2319X**	13/64	5 55/64	55	68
FS320D1	**C(CM)-UKFS320D1;H2320X**	5	154	30	35
FS320D1	**C(CM)-UKFS320AD1;HA2320**	13/64	6 1/16	66	77
FS320D1	**C(CM)-UKFS320ED1;HE2320X**				
FS322D1	**C(CM)-UKFS322D1;H2322X**	5	160	39	48
FS324D1	**C(CM)-UKFS324D1;H2324X**	5	172	53	63
FS326D1	**C(CM)-UKFS326D1;H2326**	6	178	61	85
FS328D1	**C(CM)-UKFS328D1;H2328**	6	192	100	120

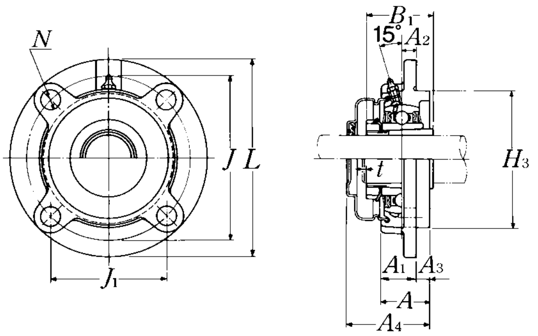
Flanged cartridge units cast housing Adapter type



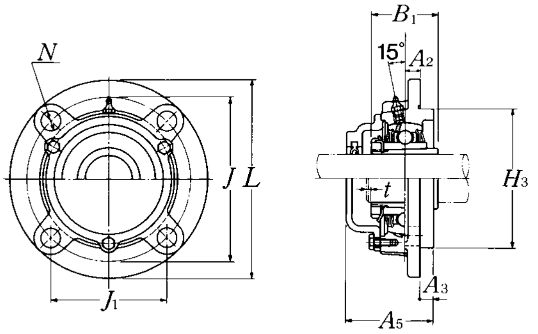
Shaft dia.	Unit number 1) 2) 3)	Nominal dimensions											Bolt size	Bearing number
mm inch		mm inch L	J	J1	A2	N	A3	A1	A	H3	A0	B1	mm inch	
20	**UKFC205D1;H2305X**	115	90	63.6	10	12	6	21	27	70	35.5	35	M10	UK205D1;H2305X
3/4	**UKFC205D1;HE2305**	4 17/32	3 35/64	2 1/2	25/64	15/32	15/64	13/16	1 1/16	2.7559	1 25/64	1.378	3/8	UK205D1;HE2305
25	**UKFC206D1;H2306X**	125	100	70.7	10	12	8	23	31	80	39	38	M10	UK206D1;H2306X
7/8	**UKFC206D1;HS2306**	4 29/32	3 15/16	2 25/32	25/64	15/32	5/16	29/32	1 7/32	3.1496	1 17/32	1.496	3/8	UK206D1;HS2306
1	**UKFC206D1;HE2306X**													UK206D1;HE2306X
30	**UKFC207D1;H2307X**	135	110	77.8	11	14	8	26	34	90	42.5	43	M12	UK207D1;H2307X
1 1/8	**UKFC207D1;HS2307**	5 5/16	4 21/64	3 1/16	7/16	35/64	5/16	1 1/32	1 11/32	3.5433	1 43/64	1.693	7/16	UK207D1;HS2307
35	**UKFC208D1;H2308X**	145	120	84.8	11	14	10	26	36	100	46.5	46	M12	UK208D1;H2308X
1 1/4	**UKFC208D1;HE2308X**	5 23/32	4 23/32	3 11/32	7/16	35/64	25/64	1 1/32	1 27/64	3.9370	1 53/64	1.811	7/16	UK208D1;HE2308X
1 3/8	**UKFC208D1;HS2308X**													UK208D1;HS2308X
40	**UKFC209D1;H2309X**	160	132	93.3	10	16	12	26	38	105	48.5	50	M14	UK209D1;H2309X
1 7/16	**UKFC209D1;HA2309**	6 5/16	5 13/64	3 43/64	25/64	5/8	15/32	1 1/32	1 1/2	4.1339	1 29/32	1.969	1/2	UK209D1;HA2309
1 1/2	**UKFC209D1;HE2309X**													UK209D1;HE2309X
1 5/8	**UKFC209D1;HS2309X**													UK209D1;HS2309X
45	**UKFC210D1;H2310X**	165	138	97.6	10	16	12	28	40	110	50	55	M14	UK210D1;H2310X
1 5/8	**UKFC210D1;HS2310**	6 1/2	5 7/16	3 27/32	25/64	5/8	15/32	1 3/32	1 37/64	4.3307	1 31/32	2.165	1/2	UK210D1;HS2310
1 11/16	**UKFC210D1;HA2310**													UK210D1;HA2310
1 3/4	**UKFC210D1;HE2310X**													UK210D1;HE2310X
50	**UKFC211D1;H2311X**	185	150	106.1	13	19	12	31	43	125	54.5	59	M16	UK211D1;H2311X
1 7/8	**UKFC211D1;HS2311**	7 9/32	5 29/32	4 11/64	33/64	3/4	15/32	1 7/32	1 11/16	4.9213	2 9/64	2.323	5/8	UK211D1;HS2311
1 15/16	**UKFC211D1;HA2311**													UK211D1;HA2311
2	**UKFC211D1;HE2311XY**													UK211D1;HE2311XY
55	**UKFC212D1;H2312X**	195	160	113.1	17	19	12	36	48	135	61	62	M16	UK212D1;H2312X
2 1/8	**UKFC212D1;HS2312**	7 11/16	6 19/64	4 29/64	43/64	3/4	15/32	1 13/32	1 57/64	5.3150	2 13/32	2.441	5/8	UK212D1;HS2312
60	**UKFC213D1;H2313X**	205	170	120.2	16	19	14	36	50	145	64	65	M16	UK213D1;H2313X
2 3/16	**UKFC213D1;HA2313**	8 1/16	6 11/16	4 47/64	5/8	3/4	35/64	1 13/32	1 31/32	5.7087	2 33/64	2.559	5/8	UK213D1;HA2313
2 1/4	**UKFC213D1;HE2313X**													UK213D1;HE2313X
2 3/8	**UKFC213D1;HS2313X**													UK213D1;HS2313X

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.
4) If the inch series housing units with dust cover are ordered with a closed end, the suffixes E, S or A are not included.
Example: SM-UKFC205D1; HE2305

Note: Please refer to page 25 for size of grease fitting.



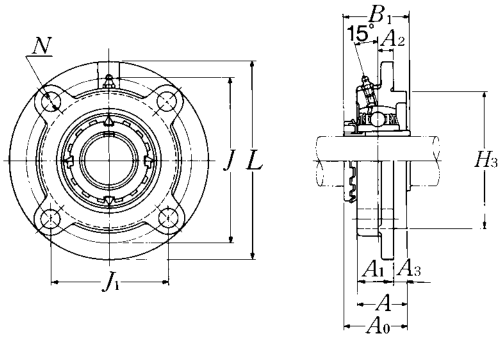
Pressed steel dust cover type
Open end: **S-UKFC···D1**
Closed end: **SM-UKFC···D1**



Cast dust cover type
Open end: **C-UKFC···D1**
Closed end: **CM-UKFC···D1**

Housing number	Unit number 4) pressed steel dust cover type	Unit number 4) cast dust cover type	Nominal dimensions			Mass of unit		
			mm		inch	kg		lb
			t max.	A_4	A_5	UKFC	S(SM)	C(CM)
FC205D1	S(SM)-UKFC205D1;H2305X	C(CM)-UKFC205D1;H2305X	2	44.5	51	1.0	1.1	1.4
FC205D1	S(SM)-UKFC205ED1;HE2305	C(CM)-UKFC205ED1;HE2305	5/64	1 3/4	2	2.2	2.4	3.1
FC206D1	S(SM)-UKFC206D1;H2306X	C(CM)-UKFC206D1;H2306X	2	49	56	1.4	1.4	1.8
FC206D1	S(SM)-UKFC206SD1;HS2306	C(CM)-UKFC206SD1;HS2306	5/64	1 59/64	2 13/16	3.1	3.1	4.0
FC206D1	S(SM)-UKFC206ED1;HE2306X	C(CM)-UKFC206ED1;HE2306X						
FC207D1	S(SM)-UKFC207D1;H2307X	C(CM)-UKFC207D1;H2307X	3	55	59	1.7	1.8	2.3
FC207D1	S(SM)-UKFC207SD1;HS2307	C(CM)-UKFC207SD1;HS2307	1/8	2 11/64	2 21/64	3.7	4.0	5.1
FC208D1	S(SM)-UKFC208D1;H2308X	C(CM)-UKFC208D1;H2308X	3	62	66	2.1	2.2	2.9
FC208D1	S(SM)-UKFC208ED1;HE2308X	C(CM)-UKFC208ED1;HE2308X	1/8	2 7/16	2 19/32	4.6	4.9	6.4
FC208D1	S(SM)-UKFC208D1;HS2308X	C(CM)-UKFC208D1;HS2308X						
FC209D1	S(SM)-UKFC209D1;H2309X	C(CM)-UKFC209D1;H2309X	3	63	70	2.8	2.9	4.0
FC209D1	S(SM)-UKFC209AD1;HA2309	C(CM)-UKFC209AD1;HA2309	1/8	2 31/64	2 3/4	6.2	6.4	8.8
FC209D1	S(SM)-UKFC209ED1;HE2309X	C(CM)-UKFC209ED1;HE2309X						
FC209D1	S(SM)-UKFC209SD1;HS2309X	C(CM)-UKFC209SD1;HS2309X						
FC210D1	S(SM)-UKFC210D1;H2310X	C(CM)-UKFC210D1;H2310X	3	65.5	72	3.3	3.4	4.4
FC210D1	S(SM)-UKFC210SD1;HS2310	C(CM)-UKFC210SD1;HS2310	1/8	2 37/64	2 53/64	7.3	7.5	9.7
FC210D1	S(SM)-UKFC210AD1;HA2310	C(CM)-UKFC210AD1;HA2310						
FC210D1	S(SM)-UKFC210ED1;HE2310X	C(CM)-UKFC210ED1;HE2310X						
FC211D1	S(SM)-UKFC211D1;H2311X	C(CM)-UKFC211D1;H2311X	4	71	75	4.4	4.6	5.8
FC211D1	S(SM)-UKFC211SD1;HS2311	C(CM)-UKFC211SD1;HS2311	5/32	2 51/64	2 61/64	9.7	10	13
FC211D1	S(SM)-UKFC211AD1;HA2311	C(CM)-UKFC211AD1;HA2311						
FC211D1	S(SM)-UKFC211ED1;HE2311XY	C(CM)-UKFC211ED1;HE2311XY						
FC212D1	S(SM)-UKFC212D1;H2312X	C(CM)-UKFC212D1;H2312X	4	80	86	5.4	5.6	6.6
FC212D1	S(SM)-UKFC212SD1;HS2312	C(CM)-UKFC212SD1;HS2312	5/32	3 5/32	3 25/64	12	12	15
FC213D1	S(SM)-UKFC213D1;H2313X	C(CM)-UKFC213D1;H2313X	4	83.5	90	6.1	6.3	7.8
FC213D1	S(SM)-UKFC213AD1;HA2313	C(CM)-UKFC213AD1;HA2313	5/32	3 9/32	3 35/64	13	14	17
FC213D1	S(SM)-UKFC213ED1;HE2313X	C(CM)-UKFC213ED1;HE2313X						
FC213D1	S(SM)-UKFC213SD1;HS2313X	C(CM)-UKFC213SD1;HS2313X						

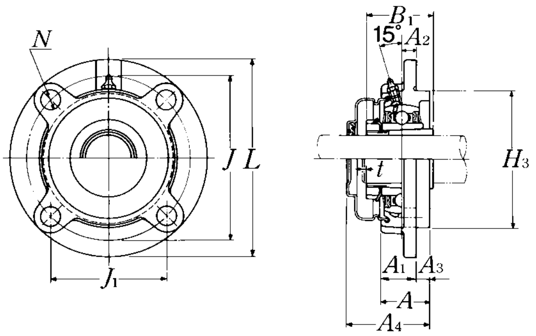
Flanged cartridge units cast housing
Adapter type



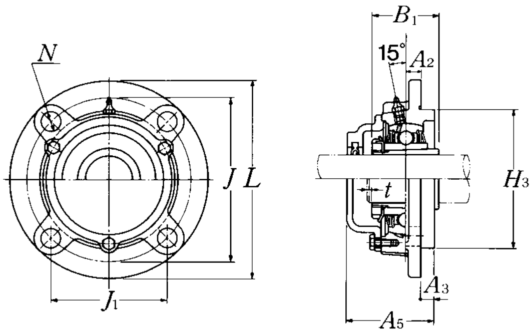
Shaft dia.	Unit number 1) 2) 3)	Nominal dimensions mm inch											Bolt size	Bearing number
mm inch		L	J	J_1	A_2	N	A_3	A_1	A	H_3	A_0	B_1	mm inch	
65 **$2\frac{7}{16}$** **$2\frac{1}{2}$**	**UKFC215D1;H2315X** **UKFC215D1;HA2315** **UKFC215D1;HE2315X**	220 $8\frac{21}{32}$	184 $7\frac{1}{4}$	130.1 $5\frac{1}{8}$	18 $\frac{45}{64}$	19 $\frac{3}{4}$	16 $\frac{5}{8}$	40 $1\frac{9}{16}$	56 $2\frac{13}{64}$	160 6.2992	71 $2\frac{51}{64}$	73 2.874	M16 $\frac{5}{8}$	UK215D1;H2315X UK215D1;HA2315 UK215D1;HE2315X
70 **$2\frac{11}{16}$** **$2\frac{3}{4}$**	**UKFC216D1;H2316X** **UKFC216D1;HA2316** **UKFC216D1;HE2316X**	240 $9\frac{7}{16}$	200 $7\frac{7}{8}$	141.4 $5\frac{9}{16}$	18 $\frac{45}{64}$	23 $\frac{29}{32}$	16 $\frac{5}{8}$	42 $1\frac{21}{32}$	58 $2\frac{9}{32}$	170 6.6929	73.5 $2\frac{57}{64}$	78 3.071	M20 $\frac{3}{4}$	UK216D1;H2316X UK216D1;HA2316 UK216D1;HE2316X
75 **$2\frac{15}{16}$** **3**	**UKFC217D1;H2317X** **UKFC217D1;HA2317X** **UKFC217D1;HE2317X**	250 $9\frac{27}{32}$	208 $8\frac{3}{16}$	147.1 $5\frac{51}{64}$	18 $\frac{45}{64}$	23 $\frac{29}{32}$	18 $\frac{45}{64}$	45 $1\frac{25}{32}$	63 $2\frac{31}{64}$	180 7.0866	77 $3\frac{1}{32}$	82 3.228	M20 $\frac{3}{4}$	UK217D1;H2317X UK217D1;HA2317X UK217D1;HE2317X
80 **$3\frac{3}{16}$**	**UKFC218D1;H2318X** **UKFC218D1;HA2318X**	265 $10\frac{7}{16}$	220 $8\frac{21}{32}$	155.5 $6\frac{1}{8}$	22 $\frac{55}{64}$	23 $\frac{29}{32}$	18 $\frac{45}{64}$	50 $1\frac{31}{32}$	68 $2\frac{43}{64}$	190 7.4803	81.5 $3\frac{13}{64}$	86 3.386	M20 $\frac{3}{4}$	UK218D1;H2318X UK218D1;HA2318X

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.
4) If the inch series housing units with dust cover are ordered with a closed end, the suffixes E, S or A are not included.
Example: SM-UKFC205D1; HE2305

Note: Please refer to page 25 for size of grease fitting.



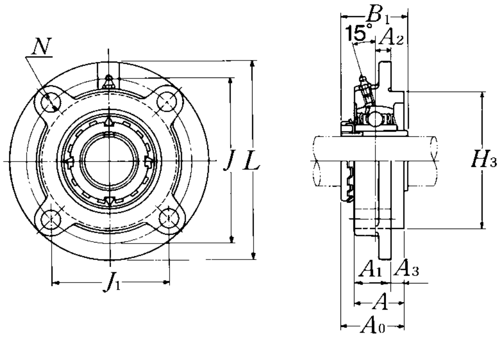
Pressed steel dust cover type
Open end: **S-UKFC···D1**
Closed end: **SM-UKFC···D1**



Cast dust cover type
Open end: **C-UKFC···D1**
Closed end: **CM-UKFC···D1**

Housing number	Unit number [4] pressed steel dust cover type	Unit number [4] cast dust cover type	Nominal dimensions			Mass of unit		
			mm / inch			kg / lb		
			t max.	A_4	A_5	UKFC	S(SM)	C(CM)
FC215D1	—	**C(CM)-UKFC215D1;H2315X**	4	—	102	8.0	—	10
FC215D1	—	**C(CM)-UKFC215AD1;HA2315**	$\frac{5}{32}$	—	$4\frac{1}{64}$	18	—	22
FC215D1		**C(CM)-UKFC215ED1;HE2315X**						
FC216D1	—	**C(CM)-UKFC216D1;H2316X**	4	—	106	9.7	—	16
FC216D1	—	**C(CM)-UKFC216AD1;HA2316**	$\frac{5}{32}$	—	$4\frac{11}{64}$	21	—	26
FC216D1		**C(CM)-UKFC216D1;HE2316X**						
FC217D1	—	**C(CM)-UKFC217D1;H2317X**	5	—	114	11	—	14
FC217D1	—	**C(CM)-UKFC217AD1;HA2317X**	$\frac{13}{64}$	—	$4\frac{31}{64}$	24	—	31
FC217D1		**C(CM)-UKFC217ED1;HE2317X**						
FC218D1	—	**C(CM)-UKFC218D1;H2318X**	5	—	122	14	—	17
FC218D1	—	**C(CM)-UKFC218AD1;HA2318X**	$\frac{13}{64}$	—	$4\frac{51}{64}$	31	—	37

Flanged cartridge units cast housing
Adapter type



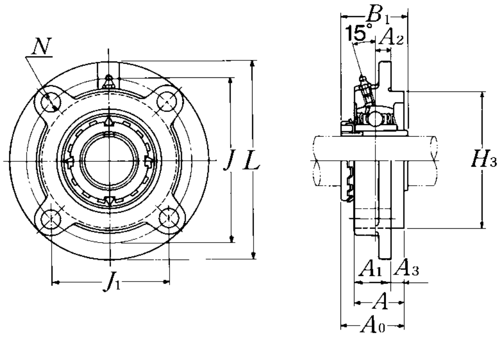
Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch L	J	J_1	A_2	N	A_3	A_1	A	H_3	A_0	B_1	Bolt size mm inch
20	UKFCX05D1;H2305X	111	92	65	10	9.5	6	24	30	76	37	35	M8
3/4	UKFCX05D1;HE2305	4 3/8	3 5/8	2 9/16	25/64	3/8	1/4	15/16	1 3/16	2.9921	1 29/64	1.378	5/16
25	UKFCX06D1;H2306X	127	105	74.2	8	12	9.5	22.5	32	85	40	38	M10
7/8	UKFCX06D1;HS2306	5	4 9/64	2 59/64	5/16	15/32	3/8	7/8	1 17/64	3.3465	1 37/64	1.496	3/8
1	UKFCX06D1;HE2306X												
30	UKFCX07D1;H2307X	133	111	78.5	9	12	11	26	37	92	44.5	43	M10
1 1/8	UKFCX07D1;HS2307	5 1/4	4 3/8	3 3/32	23/64	15/32	7/16	1 1/32	1 29/64	3.6220	1 3/4	1.693	3/8
35	UKFCX08D1;H2308X	133	111	78.5	9	12	11	26	37	92	45.5	46	M10
1 1/4	UKFCX08D1;HE2308X	5 1/4	4 3/8	3 3/32	23/64	15/32	7/16	1 1/32	1 29/64	3.6220	1 51/64	1.811	3/8
1 3/8	UKFCX08D1;HS2308X												
40	UKFCX09D1;H2309X	155	130	91.9	8	14	12	25	37	108	47	50	M12
1 7/16	UKFCX09D1;HA2309	6 3/32	5 1/8	3 5/8	5/16	35/64	15/32	31/32	1 29/64	4.2520	1 27/32	1.969	7/16
1 1/2	UKFCX09D1;HE2309X												
1 5/8	UKFCX09D1;HS2309X												
45	UKFCX10D1;H2310X	162	136	96.2	7	14	16	25	41	118	52.5	55	M12
1 5/8	UKFCX10D1;HS2310												
1 11/16	UKFCX10D1;HA2310	6 3/8	5 23/64	3 25/32	9/32	35/64	5/8	31/32	1 39/64	4.6457	2 1/16	2.165	7/16
1 3/4	UKFCX10D1;HE2310X												
50	UKFCX11D1;H2311X	180	152	107.5	4	16	22	26	48	127	57	59	M14
1 7/8	UKFCX11D1;HS2311												
1 15/16	UKFCX11D1;HA2311	7 3/32	5 63/64	4 15/64	5/32	5/8	55/64	1 1/32	1 57/64	5.0000	2 1/4	2.323	1/2
2	UKFCX11D1;HE2311XY												
55	UKFCX12D1;H2312X	194	165	116.7	11	16	20	33	53	140	64	62	M14
2 1/8	UKFCX12D1;HS2312	7 5/8	6 1/2	4 19/32	7/16	5/8	25/32	1 5/16	2 5/64	5.5118	2 33/64	2.441	1/2
60	UKFCX13D1;H2313X	194	165	116.7	11	16	20	33	53	140	66	65	M14
2 3/16	UKFCX13D1;HA2313												
2 1/4	UKFCX13D1;HE2313X	7 5/8	6 1/2	4 19/32	7/16	5/8	25/32	1 5/16	2 5/64	5.5118	2 19/32	2.559	1/2
2 3/8	UKFCX13D1;HS2313X												

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit
		kg lb
UKX05D1;H2305X	FCX05D1	1.1
UKX05D1;HE2305	FCX05D1	2.4
UKX06D1;H2306X	FCX06D1	1.5
UKX06D1;HS2306	FCX06D1	3.3
UKX06D1;HE2306X	FCX06D1	
UKX07D1;H2307X	FCX07D1	1.9
UKX07D1;HS2307	FCX07D1	4.2
UKX08D1;H2308X	FCX08D1	1.9
UKX08D1;HE2308X	FCX08D1	4.2
UKX08D1;HS2308X	FCX08D1	
UKX09D1;H2309X	FCX09D1	2.6
UKX09D1;HA2309	FCX09D1	5.7
UKX09D1;HE2309X	FCX09D1	
UKX09D1;HS2309X	FCX09D1	
UKX10D1;H2310X	FCX10D1	3.1
UKX10D1;HS2310	FCX10D1	6.8
UKX10D1;HA2310	FCX10D1	
UKX10D1;HE2310X	FCX10D1	
UKX11D1;H2311X	FCX11D1	4.2
UKX11D1;HS2311	FCX11D1	9.3
UKX11D1;HA2311	FCX11D1	
UKX11D1;HE2311XY	FCX11D1	
UKX12D1;H2312X	FCX12D1	5.5
UKX12D1;HS2312	FCX12D1	12
UKX13D1;H2313X	FCX13D1	5.4
UKX13D1;HA2313	FCX13D1	12
UKX13D1;HE2313X	FCX13D1	
UKX15D1;HS2313X	FCX13D1	

Flanged cartridge units cast housing
Adapter type



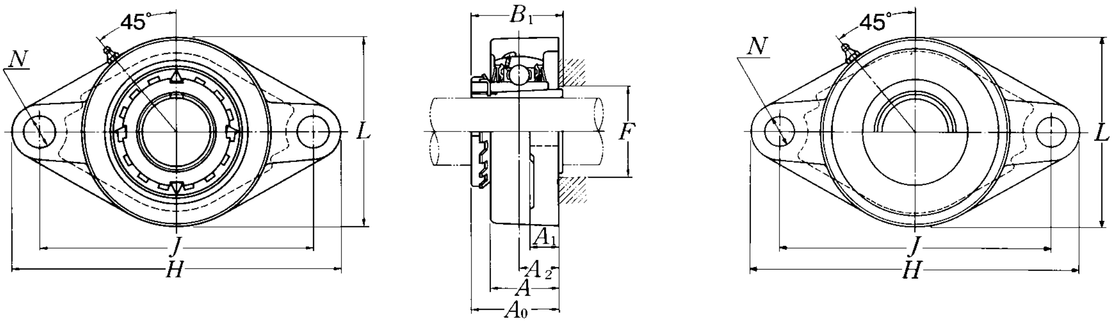
Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm / inch											Bolt size mm inch
		L	J	J_1	A_2	N	A_3	A_1	A	H_3	A_0	B_1	
65	**UKFCX15D1;H2315X**	222	190	134.3	12	19	22	35	57	164	71.5	73	M16
$2\frac{7}{16}$	**UKFCX15D1;HA2315**	$8\frac{3}{4}$	$7\frac{31}{64}$	$5\frac{9}{32}$	$\frac{15}{32}$	$\frac{3}{4}$	$\frac{55}{64}$	$1\frac{3}{8}$	$2\frac{1}{4}$	6.4567	$2\frac{13}{16}$	2.874	$\frac{5}{8}$
$2\frac{1}{2}$	**UKFCX15D1;HE2315X**												
70	**UKFCX16D1;H2316X**	260	219	154.8	10	23	25	36	61	186	75	78	M20
$2\frac{11}{16}$	**UKFCX16D1;HA2316**	$10\frac{1}{4}$	$8\frac{5}{8}$	$6\frac{3}{32}$	$\frac{25}{64}$	$\frac{29}{32}$	$\frac{63}{64}$	$1\frac{13}{32}$	$2\frac{13}{32}$	7.3228	$2\frac{61}{64}$	3.071	$\frac{3}{4}$
$2\frac{3}{4}$	**UKFCX16D1;HE2316X**												
75	**UKFCX17D1;H2317X**	260	219	154.8	10	23	25	36	61	186	76.5	82	M20
$2\frac{15}{16}$	**UKFCX17D1;HA2317X**	$10\frac{1}{4}$	$8\frac{5}{8}$	$6\frac{3}{32}$	$\frac{25}{64}$	$\frac{29}{32}$	$\frac{63}{64}$	$1\frac{13}{32}$	$2\frac{13}{32}$	7.3228	$3\frac{1}{64}$	3.228	$\frac{3}{4}$
3	**UKFCX17D1;HE2317X**												
80	**UKFCX18D1;H2318X**	260	219	154.8	12	23	28	43	71	186	82.5	86	M20
$3\frac{3}{16}$	**UKFCX18D1;HA2318X**	$10\frac{1}{4}$	$8\frac{5}{8}$	$6\frac{3}{32}$	$\frac{15}{32}$	$\frac{29}{32}$	$1\frac{7}{64}$	$1\frac{11}{16}$	$2\frac{51}{64}$	7.3228	$3\frac{1}{4}$	3.386	$\frac{3}{4}$
90	**UKFCX20D1;H2320X**	276	238	168.3	22	23	28	66	94	206	99	97	M20

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit	
		kg	lb
UKX15D1;H2315X	FCX15D1	7.8	
UKX15D1;HA2315	FCX15D1		17
UKX15D1;HE2315X	FCX15D1		
UKX16D1;H2316X	FCX16D1	11	
UKX16D1;HA2316	FCX16D1		24
UKX16D1;HE2316X	FCX16D1		
UKX17D1;H2317X	FCX17D1	12	
UKX17D1;HA2317X	FCX17D1		26
UKX17D1;HE2317X	FCX17D1		
UKX18D1;H2318X	FCX18D1	12	
UKX18D1;HA2318X	FCX18D1		26
UKFX20D1;H2320X	FCX20D1	15	

Flanged units cast housing
Adapter type

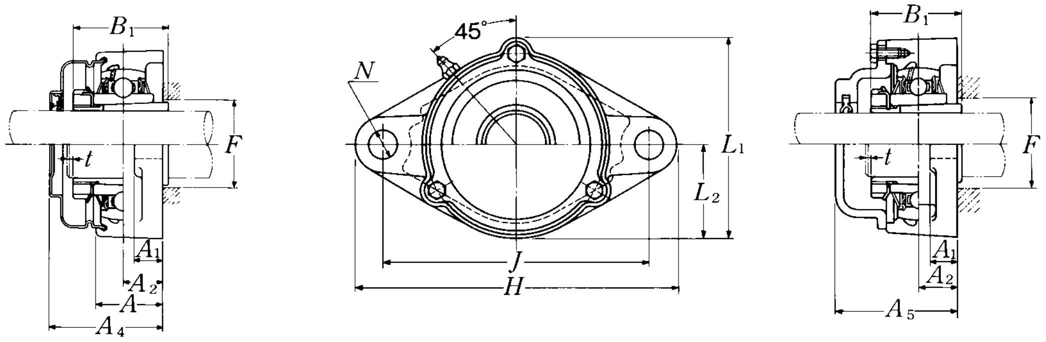


Pressed steel dust cover type
Open end: **S-UKFL···D1**
Closed end: **SM-UKFL···D1**

Shaft dia. mm / inch	Unit number 1) 2) 3)	Nominal dimensions mm / inch H	J	A_2	A_1	A	N	L	A_0	B_1	F min.	Bolt size mm / inch	Bearing number
20	UKFL205D1;H2305X	130	99	16	13	27	16	68	35.5	35	30	M14	UK205D1;H2305X
3/4	UKFL205D1;HE2305	5 1/8	3 57/64	5/8	1/2	1 1/16	5/8	2 11/16	1 25/64	1.378	1 3/16	1/2	UK205D1;HE2305
25	UKFL206D1;H2306X	148	117	18	13	31	16	80	39	38	36	M14	UK206D1;H2306X
7/8	UKFL206D1;HS2306	5 13/16	4 39/64	45/64	1/2	1 7/32	5/8	3 5/32	1 17/32	1.496	1 13/32	1/2	UK206D1;HS2306
1	UKFL206D1;HE2306X												UK206D1;HE2306X
30	UKFL207D1;H2307X	161	130	19	15	34	16	90	42.5	43	40	M14	UK207D1;H2307X
1 1/8	UKFL207D1;HS2307	6 11/32	5 1/8	3/4	19/32	1 11/32	5/8	3 17/32	1 43/64	1.693	1 9/16	1/2	UK207D1;HS2307
35	UKFL208D1;H2308X	175	144	21	15	36	16	100	46.5	46	46	M14	UK208D1;H2308X
1 1/4	UKFL208D1;HE2308X	6 7/8	5 43/64	53/64	19/32	1 13/32	5/8	3 15/16	1 53/64	1.811	1 13/16	1/2	UK208D1;HE2308X
1 3/8	UKFL208D1;HS2308X												UK208D1;HS2308X
40	UKFL209D1;H2309X	188	148	22	16	38	19	108	48.5	50	52	M16	UK209D1;H2309X
1 7/16	UKFL209D1;HA2309												UK209D1;HA2309
1 1/2	UKFL209D1;HE2309X	7 13/32	5 53/64	55/64	5/8	1 1/2	3/4	4 1/4	1 29/32	1.969	2 1/16	5/8	UK209D1;HE2309X
1 5/8	UKFL209D1;HS2309X												UK209D1;HS2309X
45	UKFL210D1;H2310X	197	157	22	16	40	19	115	50	55	57	M16	UK210D1;H2310X
1 5/8	UKFL210D1;HS2310												UK210D1;HS2310
1 11/16	UKFL210D1;HA2310	7 3/4	6 3/16	55/64	5/8	1 9/16	3/4	4 17/32	1 31/32	2.165	2 1/4	5/8	UK210D1;HA2310
1 3/4	UKFL210D1;HE2310X												UK210D1;HE2310X
50	UKFL211D1;H2311X	224	184	25	18	43	19	130	54.5	59	64	M16	UK211D1;H2311X
1 7/8	UKFL211D1;HS2311												UK211D1;HS2311
1 15/16	UKFL211D1;HA2311	8 13/16	7 1/4	63/64	23/32	1 11/16	3/4	5 1/8	2 9/64	2.323	2 17/32	5/8	UK211D1;HA2311
2	UKFL211D1;HE2311XY												UK211D1;HE2311XY
55	UKFL212D1;H2312X	250	202	29	18	48	23	140	61	62	69	M20	UK212D1;H2312X
2 1/8	UKFL212D1;HS2312	9 27/32	7 61/64	1 9/64	23/32	1 7/8	29/32	5 1/2	2 13/32	2.441	2 23/32	3/4	UK212D1;HS2312
60	UKFL213D1;H2313X	258	210	30	22	50	23	155	64	65	74	M20	UK213D1;H2313X
2 3/16	UKFL213D1;HA2313												UK213D1;HA2313
2 1/4	UKFL213D1;HE2313X	10 5/32	8 17/64	1 3/16	7/8	1 31/32	29/32	6 3/32	2 33/64	2.559	2 29/32	3/4	UK213D1;HE2313X
2 3/8	UKFL213D1;HS2313X												UK213D1;HS2313X

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.
4) If the inch series housing units with dust cover are ordered with a closed end, the suffixes E, S or A are not included.
Example: SM-UKFL205D1; HE2305

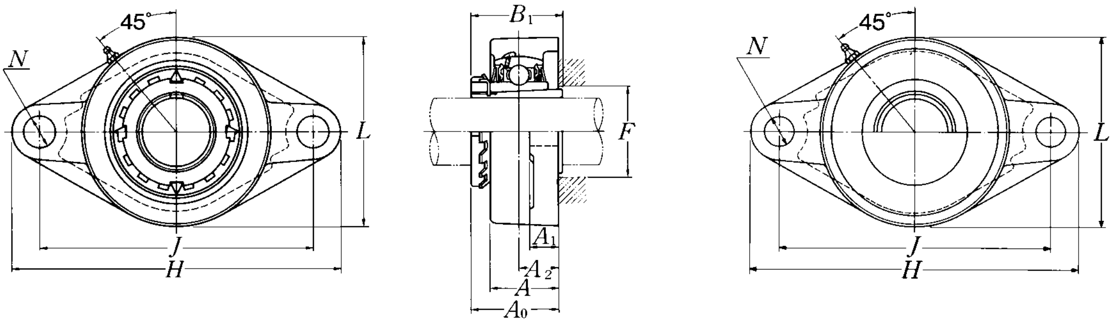
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UKFL···D1**
Closed end: **CM-UKFL···D1**

Housing number	Unit number [4)] pressed steel dust cover type	Unit number [4)] cast dust cover type	Nominal dimensions mm / inch					Mass of unit kg / lb		
			t max.	A_4	A_5	L_1	L_2	UKFL	S(SM)	C(CM)
FL205D1	S(SM)-UKFL205D1;H2305X	C(CM)-UKFL205D1;H2305X	2	44.5	51	74	34	0.6	0.7	0.9
FL205D1	S(SM)-UKFL205ED1;HE2305	C(CM)-UKFL205ED1;HE2305	5/64	1 3/4	2	2 29/32	1 11/32	1.3	1.5	2.0
FL206D1	S(SM)-UKFL206D1;H2306X	C(CM)-UKFL206D1;H2306X	2	49	56	85	40	1.0	1.0	1.3
FL206D1	S(SM)-UKFL206SD1;HS2306	C(CM)-UKFL206SD1;HS2306	5/64	1 15/16	2 7/32	3 11/32	1 9/16	2.2	2.2	2.9
FL206D1	S(SM)-UKFL206ED1;HE2306X	C(CM)-UKFL206ED1;HE2306X								
FL207D1	S(SM)-UKFL207D1;H2307X	C(CM)-UKFL207D1;H2307X	3	55	59	97	45	1.3	1.3	1.9
FL207D1	S(SM)-UKFL207SD1;HS2307	C(CM)-UKFL207SD1;HS2307	1/8	2 5/32	2 5/16	3 13/16	1 25/32	2.9	2.9	4.2
FL208D1	S(SM)-UKFL208D1;H2308X	C(CM)-UKFL208D1;H2308X	3	62	66	106	50	1.6	1.7	2.3
FL208D1	S(SM)-UKFL208ED1;HE2308X	C(CM)-UKFL208ED1;HE2308X	1/8	2 7/16	2 19/32	4 3/16	1 31/32	3.5	3.7	5.1
FL208D1	S(SM)-UKFL208D1;HS2308X	C(CM)-UKFL208D1;HS2308X								
FL209D1	S(SM)-UKFL209D1;H2309X	C(CM)-UKFL209D1;H2309X	3	63	70	113	54	2.0	2.1	2.7
FL209D1	S(SM)-UKFL209AD1;HA2309	C(CM)-UKFL209AD1;HA2309	1/8	2 15/32	2 3/4	4 7/16	2 1/8	4.4	4.6	6.0
FL209D1	S(SM)-UKFL209ED1;HE2309X	C(CM)-UKFL209ED1;HE2309X								
FL209D1	S(SM)-UKFL209SD1;HS2309X	C(CM)-UKFL209SD1;HS2309X								
FL210D1	S(SM)-UKFL210D1;H2310X	C(CM)-UKFL210D1;H2310X	3	65.5	72	120	58	2.3	2.4	3.2
FL210D1	S(SM)-UKFL210SD1;HS2310	C(CM)-UKFL210SD1;HS2310	1/8	2 19/32	2 27/32	4 23/32	2 9/32	5.1	5.3	7.1
FL210D1	S(SM)-UKFL210AD1;HA2310	C(CM)-UKFL210AD1;HA2310								
FL210D1	S(SM)-UKFL210ED1;HE2310X	C(CM)-UKFL210ED1;HE2310X								
FL211D1	S(SM)-UKFL211D1;H2311X	C(CM)-UKFL211D1;H2311X	4	71	75	133	65	3.3	3.4	4.6
FL211D1	S(SM)-UKFL211SD1;HS2311	C(CM)-UKFL211SD1;HS2311	5/32	2 25/32	2 15/16	5 1/4	2 9/16	7.3	7.5	10
FL211D1	S(SM)-UKFL211AD1;HA2311	C(CM)-UKFL211AD1;HA2311								
FL211D1	S(SM)-UKFL211ED1;HE2311XY	C(CM)-UKFL211ED1;HE2311XY								
FL212D1	S(SM)-UKFL212D1;H2312X	C(CM)-UKFL212D1;H2312X	4	80	86	144	70	4.0	4.2	5.2
FL212D1	S(SM)-UKFL212SD1;HS2312	C(CM)-UKFL212SD1;HS2312	5/32	3 5/32	3 3/8	5 21/32	2 3/4	8.8	9.3	11
FL213D1	S(SM)-UKFL213D1;H2313X	C(CM)-UKFL213D1;H2313X	4	83.5	90	157	78	5.2	5.4	6.8
FL213D1	S(SM)-UKFL213AD1;HA2313	C(CM)-UKFL213AD1;HA2313	5/32	3 9/32	3 17/32	6 3/16	3 1/16	11	12	15
FL213D1	S(SM)-UKFL213ED1;HE2313X	C(CM)-UKFL213ED1;HE2313X								
FL213D1	S(SM)-UKFL213SD1;HS2313X	C(CM)-UKFL213SD1;HS2313X								

Flanged units cast housing
Adapter type

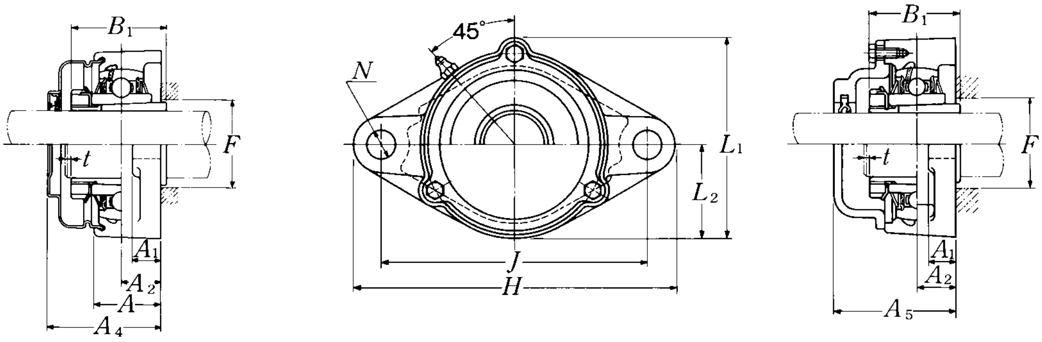


Pressed steel dust cover type
Open end: **S-UKFL···D1**
Closed end: **SM-UKFL···D1**

Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch H	J	A2	A1	A	N	L	A0	B1	F min.	Bolt size mm inch	Bearing number
65	**UKFL215D1;H2315X**	275	225	34	22	56	23	165	71	73	84	M20	UK215D1;H2315X
2 7/16	**UKFL215D1;HA2315**	10 13/16	8 55/64	1 11/32	7/8	2 7/32	29/32	6 1/2	2 51/64	2.874	3 5/16	3/4	UK215D1;HA2315
2 1/2	**UKFL215D1;HE2315X**												UK215D1;HE2315X
70	**UKFL216D1;H2316X**	290	233	34	22	58	25	180	73.5	78	90	M22	UK216D1;H2316X
2 11/16	**UKFL216D1;HA2316**	11 13/32	9 11/64	1 11/32	7/8	2 9/32	63/64	7 3/32	2 57/64	3.071	3 17/32	7/8	UK216D1;HA2316
2 3/4	**UKFL216D1;HE2316X**												UK216D1;HE2316X
75	**UKFL217D1;H2317X**	305	248	36	24	63	25	190	77	82	95	M22	UK217D1;H2317X
2 15/16	**UKFL217D1;HA2317X**	12	9 49/64	1 27/64	15/16	2 15/32	63/64	7 15/32	3 1/32	3.228	3 3/4	7/8	UK217D1;HA2317X
3	**UKFL217D1;HE2317X**												UK217D1;HE2317X
80	**UKFL218D1;H2318X**	320	265	40	24	68	25	205	81.5	86	102	M22	UK218D1;H2318X
3 3/16	**UKFL218D1;HA2318X**	12 19/32	10 7/16	1 37/64	15/16	2 11/16	63/64	8 1/16	3 13/64	3.386	4 1/32	7/8	UK218D1;HA2318X

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.
4) If the inch series housing units with dust cover are ordered with a closed end, the suffixes E, S or A are not included.
Example: SM-UKFL205D1; HE2305

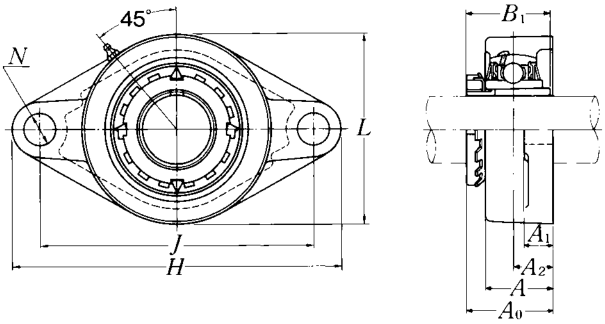
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UKFL···D1**
Closed end: **CM-UKFL···D1**

Housing number	Unit number 4) pressed steel dust cover type	Unit number 4) cast dust cover type	Nominal dimensions					Mass of unit		
			mm inch					kg lb		
			t max.	A_4	A_5	L_1	L_2	UKFL	S(SM)	C(CM)
FL215D1	—	**C(CM)-UKFL215D1;H2315X**	4	—	102	169	82	6.4	—	8.3
FL215D1	—	**C(CM)-UKFL215AD1;HA2315**	5⁄32	—	4 1⁄32	6 21⁄32	3 7⁄32	14	—	18
FL215D1		**C(CM)-UKFL215ED1;HE2315X**								
FL216D1	—	**C(CM)-UKFL216D1;H2316X**	4	—	106	183	90	8.6	—	11
FL216D1	—	**C(CM)-UKFL216AD1;HA2316**	5⁄32	—	4 3⁄16	7 7⁄32	3 17⁄32	19	—	24
FL216D1		**C(CM)-UKFL216D1;HE2316X**								
FL217D1	—	**C(CM)-UKFL217D1;H2317X**	5	—	114	192	95	9.8	—	12
FL217D1	—	**C(CM)-UKFL217AD1;HA2317X**	13⁄64	—	4 1⁄2	7 9⁄16	3 3⁄4	22	—	26
FL217D1		**C(CM)-UKFL217ED1;HE2317X**								
FL218D1	—	**C(CM)-UKFL218D1;H2318X**	5	—	122	205	102	12	—	15
FL218D1	—	**C(CM)-UKFL218AD1;HA2318X**	13⁄64	—	4 13⁄16	8 1⁄16	4 1⁄32	26	—	33

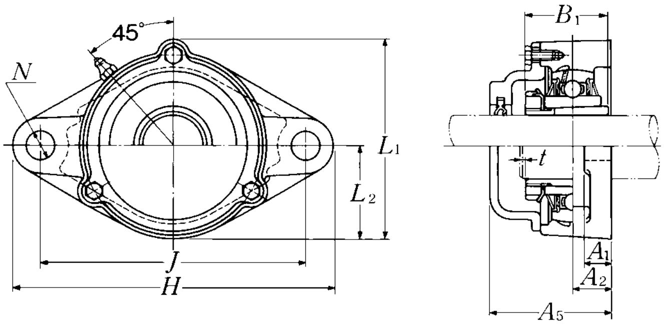
Flanged units cast housing
Adapter type



Shaft dia.	Unit number 1) 2) 3)	Nominal dimensions									Bolt size	Bearing number
mm inch		mm inch									mm inch	
		H	J	A_2	A_1	A	N	L	A_0	B_1		
20	UKFL305D1;H2305X	150	113	16	13	29	19	80	37	35	M16	UK305D1;H2305X
3/4	UKFL305D1;HE2305	5 29/32	4 29/64	5/8	1/2	1 5/32	3/4	3 5/32	1 29/64	1.378	5/8	UK305D1;HE2305
25	UKFL306D1;H2306X	180	134	18	15	32	23	90	40.5	38	M20	UK306D1;H2306X
7/8	UKFL306D1;HS2306	7 3/32	5 9/32	45/64	19/32	1 1/4	29/32	3 17/32	1 19/32	1.496	3/4	UK306D1;HS2306
1	UKFL306D1;HE2306X											UK306D1;HE2306X
30	UKFL307D1;H2307X	185	141	20	16	36	23	100	45.5	43	M20	UK307D1;H2307X
1 1/8	UKFL307D1;HS2307	7 9/32	5 35/64	25/32	5/8	1 13/32	29/32	3 15/16	1 51/64	1.693	3/4	UK307D1;HS2307
35	UKFL308D1;H2308X	200	158	23	17	40	23	112	50	46	M20	UK308D1;H2308X
1 1/4	UKFL308D1;HE2308X	7 7/8	6 7/32	29/32	21/32	1 9/16	29/32	4 13/32	1 31/32	1.811	3/4	UK308D1;HE2308X
1 3/8	UKFL308D1;HS2308X											UK308D1;HS2308X
40	UKFL309D1;H2309X	230	177	25	18	44	25	125	54.5	50	M22	UK309D1;H2309X
1 7/16	UKFL309D1;HA2309											UK309D1;HA2309
1 1/2	UKFL309D1;HE2309X	9 1/16	6 31/32	63/64	23/32	1 23/32	63/64	4 29/32	2 9/64	1.969	7/8	UK309D1;HE2309X
1 5/8	UKFL309D1;HS2309X											UK309D1;HS2309X
45	UKFL310D1;H2310X	240	187	28	19	48	25	140	60.5	55	M22	UK310D1;H2310X
1 5/8	UKFL310D1;HS2310											UK310D1;HS2310
1 11/16	UKFL310D1;HA2310	9 7/16	7 23/64	1 7/64	3/4	1 7/8	63/64	5 1/2	2 3/8	2.165	7/8	UK310D1;HA2310
1 3/4	UKFL310D1;HE2310X											UK310D1;HE2310X
50	UKFL311D1;H2311X	250	198	30	20	52	25	150	64	59	M22	UK311D1;H2311X
1 7/8	UKFL311D1;HS2311											UK311D1;HS2311
1 15/16	UKFL311D1;HA2311	9 27/32	7 51/64	1 3/16	25/32	2 1/16	63/64	5 29/32	2 33/64	2.323	7/8	UK311D1;HA2311
2	UKFL311D1;HE2311XY											UK311D1;HE2311XY
55	UKFL312D1;H2312X	270	212	33	22	56	31	160	69.5	62	M27	UK312D1;H2312X
2 1/8	UKFL312D1;HS2312	10 5/8	8 11/32	1 19/64	7/8	2 7/32	1 7/32	6 5/16	2 47/64	2.441	1	UK312D1;HS2312
60	UKFL313D1;H2313X	295	240	33	25	58	31	175	71.5	65	M27	UK313D1;H2313X
2 3/16	UKFL313D1;HA2313											UK313D1;HA2313
2 1/4	UKFL313D1;HE2313X	11 5/8	9 29/64	1 19/64	31/32	2 9/32	1 7/32	6 7/8	2 13/16	2.559	1	UK313D1;HE2313X
2 3/8	UKFL313D1;HS2313X											UK313D1;HS2313X

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.
4) If the inch series housing units with dust cover are ordered with a closed end, the suffixes E, S or A are not included.
Example: CM-UKFL305D1; HE2305

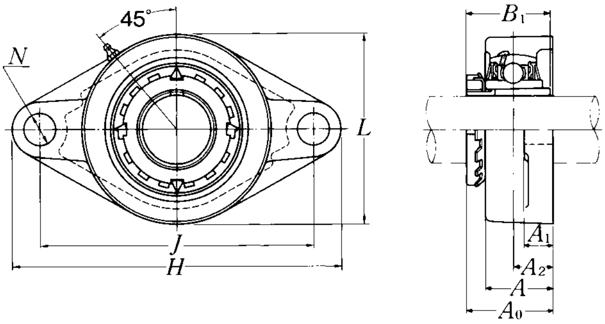
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UKFL···D1**
Closed end: **CM-UKFL···D1**

Housing number	Unit number [4)] cast dust cover type	Nominal dimensions mm inch				Mass of unit kg lb	
		t max.	A_5	L_1	L_2	UKFL	C(CM)
FL305D1	**C(CM)-UKFL305D1;H2305X**	2	56	86	40	1.1	1.6
FL305D1	**C(CM)-UKFL305ED1;HE2305**	$\frac{5}{64}$	$2\frac{7}{32}$	$3\frac{3}{8}$	$1\frac{9}{16}$	2.4	3.5
FL306D1	**C(CM)-UKFL306D1;H2306X**	2	60	101	45	1.5	1.9
FL306D1	**C(CM)-UKFL306SD1;HS2306**	$\frac{5}{64}$	$2\frac{3}{8}$	$3\frac{31}{32}$	$1\frac{25}{32}$	3.3	4.2
FL306D1	**C(CM)-UKFL306ED1;HE2306X**						
FL307D1	**C(CM)-UKFL307D1;H2307X**	3	68	110	50	1.9	2.4
FL307D1	**C(CM)-UKFL307SD1;HS2307**	$\frac{1}{8}$	$2\frac{11}{16}$	$4\frac{11}{32}$	$1\frac{31}{32}$	4.2	5.3
FL308D1	**C(CM)-UKFL308D1;H2308X**	3	76	122	56	2.5	3.3
FL308D1	**C(CM)-UKFL308ED1;HE2308X**	$\frac{1}{8}$	3	$4\frac{13}{16}$	$2\frac{7}{32}$	5.5	7.3
FL308D1	**C(CM)-UKFL308D1;HS2308X**						
FL309D1	**C(CM)-UKFL309D1;H2309X**	3	80	135	62	3.5	4.4
FL309D1	**C(CM)-UKFL309AD1;HA2309**						
FL309D1	**C(CM)-UKFL309ED1;HE2309X**	$\frac{1}{8}$	$3\frac{5}{32}$	$5\frac{5}{16}$	$2\frac{7}{16}$	7.7	9.7
FL309D1	**C(CM)-UKFL309SD1;HS2309X**						
FL310D1	**C(CM)-UKFL310D1;H2310X**	3	88	152	70	4.4	5.4
FL310D1	**C(CM)-UKFL310SD1;HS2310**						
FL310D1	**C(CM)-UKFL310AD1;HA2310**	$\frac{1}{8}$	$3\frac{15}{32}$	$5\frac{31}{32}$	$2\frac{3}{4}$	9.7	12
FL310D1	**C(CM)-UKFL310ED1;HE2310X**						
FL311D1	**C(CM)-UKFL311D1;H2311X**	4	92	162	75	5.1	6.3
FL311D1	**C(CM)-UKFL311SD1;HS2311**						
FL311D1	**C(CM)-UKFL311AD1;HA2311**	$\frac{5}{32}$	$3\frac{5}{8}$	$6\frac{3}{8}$	$2\frac{15}{16}$	11	14
FL311D1	**C(CM)-UKFL311ED1;HE2311XY**						
FL312D1	**C(CM)-UKFL312D1;H2312X**	4	100	175	80	6.0	7.7
FL312D1	**C(CM)-UKFL312SD1;HS2312**	$\frac{5}{32}$	$3\frac{15}{16}$	$6\frac{7}{8}$	$3\frac{5}{32}$	13	17
FL313D1	**C(CM)-UKFL313D1;H2313X**	4	103	189	88	7.6	9.8
FL313D1	**C(CM)-UKFL313AD1;HA2313**						
FL313D1	**C(CM)-UKFL313ED1;HE2313X**	$\frac{5}{32}$	$4\frac{1}{16}$	$7\frac{7}{16}$	$3\frac{15}{32}$	17	22
FL313D1	**C(CM)-UKFL313SD1;HS2313X**						

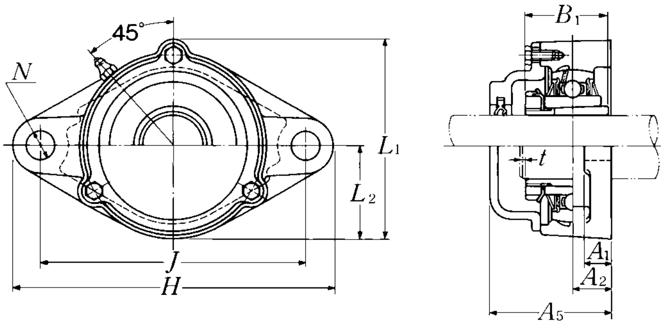
Flanged units cast housing
Adapter type



Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch H	J	A2	A1	A	N	L	A0	B1	Bolt size mm inch	Bearing number
65	UKFL315D1;H2315X	320	260	39	30	66	35	195	81.5	73	M30	UK315D1;H2315X
2 7/16	UKFL315D1;HA2315	12 19/32	10 15/64	1 17/32	1 3/16	2 19/32	1 3/8	7 11/16	3 13/64	2.874	1 1/8	UK315D1;HA2315
2 1/2	UKFL315D1;HE2315X											UK315D1;HE2315X
70	UKFL316D1;H2316X	355	285	38	32	68	38	210	84	78	M33	UK316D1;H2316X
2 11/16	UKFL316D1;HA2316	13 31/32	11 7/32	1 1/2	1 1/4	2 11/16	1 1/2	8 9/32	3 5/16	3.071	1 1/4	UK316D1;HA2316
2 3/4	UKFL316D1;HE2316X											UK316D1;HE2316X
75	UKFL317D1;H2317X	370	300	44	32	74	38	220	92	82	M33	UK317D1;H2317X
2 15/16	UKFL317D1;HA2317X	14 9/16	11 13/16	1 47/64	1 1/4	2 29/32	1 1/2	8 21/32	3 5/8	3.228	1 1/4	UK317D1;HA2317X
3	UKFL317D1;HE2317X											UK317D1;HE2317X
80	UKFL318D1;H2318X	385	315	44	36	76	38	235	94	86	M33	UK318D1;H2318X
3 3/16	UKFL318D1;HA2318X	15 5/32	12 13/32	1 47/64	1 13/32	3	1 1/2	9 1/4	3 45/64	3.386	1 1/4	UK318D1;HA2318X
85	UKFL319D1;H2319X	405	330	59	40	94	41	250	111.5	90	M36	UK319D1;H2319X
3 1/4	UKFL319D1;HE2319X	15 15/16	12 63/64	2 21/64	1 9/16	3 11/16	1 39/64	9 27/32	4 25/64	3.543	1 3/8	UK319D1;HE2319X
90	UKFL320D1;H2320X	440	360	59	40	94	44	270	115.5	97	M39	UK320D1;H2320X
3 7/16	UKFL320D1;HA2320	17 5/16	14 11/64	2 21/64	1 9/16	3 11/16	1 47/64	10 5/8	4 35/64	3.819	1 1/2	UK320D1;HA2320
3 1/2	UKFL320D1;HE2320X											UK320D1;HE2320X
100	UKFL322D1;H2322X	470	390	60	42	96	44	300	121	105	M39	UK322D1;H2322X
110	UKFL324D1;H2324X	520	430	65	48	110	47	330	130	112	M42	UK324D1;H2324X
115	UKFL326D1;H2326	550	460	65	50	115	47	360	133	121	M42	UK326D1;H2326
125	UKFL328D1;H2328	600	500	75	60	125	51	400	146.5	131	M45	UK328D1;H2328

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.
4) If the inch series housing units with dust cover are ordered with a closed end, the suffixes E, S or A are not included.
Example: CM-UKFL305D1; HE2305

Note: Please refer to page 25 for size of grease fitting.

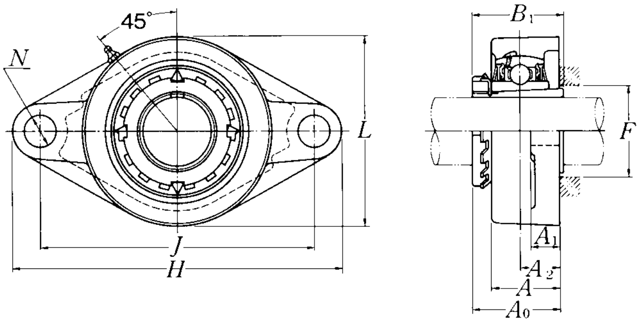


Cast dust cover type
Open end: **C-UKFL···D1**
Closed end: **CM-UKFL···D1**

Housing number	Unit number [4] cast dust cover type	Nominal dimensions				Mass of unit	
		mm inch				kg lb	
		t max.	A_5	L_1	L_2	UKFL	C(CM)
FL315D1	**C(CM)-UKFL315D1;H2315X**	4	114	210	98	10	13
FL315D1	**C(CM)-UKFL315AD1;HA2315**	$\frac{5}{32}$	$4\frac{1}{2}$	$8\frac{9}{32}$	$3\frac{27}{32}$	22	29
FL315D1	**C(CM)-UKFL315ED1;HE2315X**						
FL316D1	**C(CM)-UKFL316D1;H2316X**	4	116	222	105	13	17
FL316D1	**C(CM)-UKFL316AD1;HA2316**	$\frac{5}{32}$	$4\frac{9}{16}$	$8\frac{3}{4}$	$4\frac{1}{8}$	29	37
FL316D1	**C(CM)-UKFL316D1;HE2316X**						
FL317D1	**C(CM)-UKFL317D1;H2317X**	5	127	234	110	15	18
FL317D1	**C(CM)-UKFL317AD1;HA2317X**	$\frac{13}{64}$	5	$9\frac{7}{32}$	$4\frac{11}{32}$	33	40
FL317D1	**C(CM)-UKFL317ED1;HE2317X**						
FL318D1	**C(CM)-UKFL318D1;H2318X**	5	129	247	118	18	21
FL318D1	**C(CM)-UKFL318AD1;HA2318X**	$\frac{13}{64}$	$5\frac{3}{32}$	$9\frac{23}{32}$	$4\frac{21}{32}$	40	46
FL319D1	**C(CM)-UKFL319D1;H2319X**	5	149	260	125	22	27
FL319D1	**C(CM)-UKFL319ED1;HE2319X**	$\frac{13}{64}$	$5\frac{7}{8}$	$10\frac{1}{4}$	$4\frac{29}{32}$	49	60
FL320D1	**C(CM)-UKFL320D1;H2320X**	5	154	280	135	27	31
FL320D1	**C(CM)-UKFL320AD1;HA2320**	$\frac{13}{64}$	$6\frac{1}{16}$	$11\frac{1}{32}$	$5\frac{5}{16}$	60	68
FL320D1	**C(CM)-UKFL320ED1;HE2320X**						
FL322D1	**C(CM)-UKFL322D1;H2322X**	5	160	315	150	34	41
FL324D1	**C(CM)-UKFL324D1;H2324X**	5	172	342	165	47	52
FL326D1	**C(CM)-UKFL326D1;H2326**	6	178	376	180	58	65
FL328D1	**C(CM)-UKFL328D1;H2328**	6	192	410	200	82	90

UKFLX

Flanged units cast housing
Adapter type



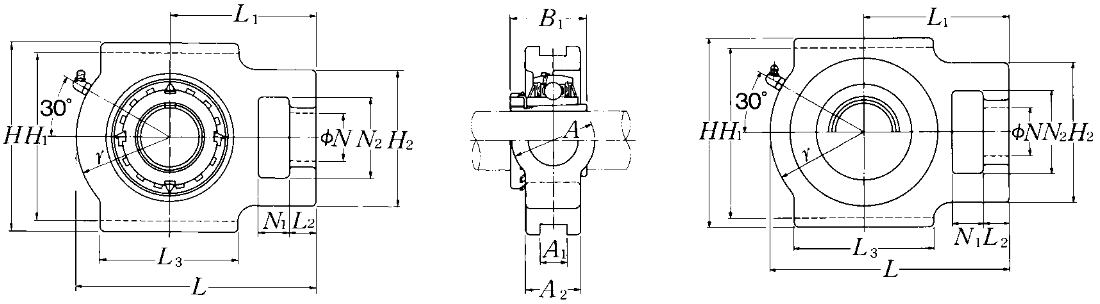
Shaft dia. mm inch	Unit number 1) 2)	Nominal dimensions mm inch *H*	*J*	*A*₂	*A*₁	*A*	*N*	*L*	*A*₀	*B*₁	*F* min.	Bolt size mm inch
20	**UKFLX05D1;H2305X**	141	117	18	13	30	12	83	39	35	30	M10
$\frac{3}{4}$	**UKFLX05D1;HE2305**	$5\frac{9}{16}$	$4\frac{39}{64}$	$\frac{45}{64}$	$\frac{1}{2}$	$1\frac{3}{16}$	$\frac{15}{32}$	$3\frac{9}{32}$	$1\frac{17}{32}$	1.378	$1\frac{3}{16}$	$\frac{3}{8}$
25	**UKFLX06D1;H2306X**	156	130	19	15	34	16	95	41.5	38	36	M14
$\frac{7}{8}$	**UKFLX06D1;HS2306**	$6\frac{5}{32}$	$5\frac{1}{8}$	$\frac{3}{4}$	$\frac{19}{32}$	$1\frac{11}{32}$	$\frac{5}{8}$	$3\frac{3}{4}$	$1\frac{41}{64}$	1.496	$1\frac{13}{32}$	$\frac{1}{2}$
1	**UKFLX06D1;HE2306X**											
30	**UKFLX07D1;H2307X**	171	144	21	16	38	16	105	45.5	43	40	M14
$1\frac{1}{8}$	**UKFLX07D1;HS2307**	$6\frac{23}{32}$	$5\frac{43}{64}$	$\frac{53}{64}$	$\frac{5}{8}$	$1\frac{1}{2}$	$\frac{5}{8}$	$4\frac{1}{8}$	$1\frac{51}{64}$	1.693	$1\frac{9}{16}$	$\frac{1}{2}$
35	**UKFLX08D1;H2308X**	179	148	22	16	40	16	111	47.5	46	46	M14
$1\frac{1}{4}$	**UKFLX08D1;HE2308X**	$7\frac{1}{16}$	$5\frac{53}{64}$	$\frac{55}{64}$	$\frac{5}{8}$	$1\frac{9}{16}$	$\frac{5}{8}$	$4\frac{3}{8}$	$1\frac{7}{8}$	1.811	$1\frac{13}{16}$	$\frac{1}{2}$
$1\frac{3}{8}$	**UKFLX08D1;HS2308X**											
40	**UKFLX09D1;H2309X**	189	157	23	16	40	16	116	50	50	52	M14
$1\frac{7}{16}$	**UKFLX09D1;HA2309**	$7\frac{7}{16}$	$6\frac{3}{16}$	$\frac{29}{32}$	$\frac{5}{8}$	$1\frac{9}{16}$	$\frac{5}{8}$	$4\frac{9}{16}$	$1\frac{31}{32}$	1.969	$2\frac{1}{16}$	$\frac{1}{2}$
$1\frac{1}{2}$	**UKFLX09D1;HE2309X**											
$1\frac{5}{8}$	**UKFLX09D1;HS2309X**											
45	**UKFLX10D1;H2310X**	216	184	26	18	44	19	133	55.5	55	57	M16
$1\frac{5}{8}$	**UKFLX10D1;HS2310**	$8\frac{1}{2}$	$7\frac{1}{4}$	$1\frac{1}{32}$	$\frac{23}{32}$	$1\frac{23}{32}$	$\frac{3}{4}$	$5\frac{1}{4}$	$2\frac{3}{16}$	2.165	$2\frac{1}{4}$	$\frac{5}{8}$
$1\frac{11}{16}$	**UKFLX10D1;HA2310**											
$1\frac{3}{4}$	**UKFLX10D1;HE2310X**											

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.

Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit kg lb
UKX05D1;H2305X	FLX05D1	1.0
UKX05D1;HE2305	FLX05D1	2.2
UKX06D1;H2306X	FLX06D1	1.3
UKX06D1;HS2306	FLX06D1	2.9
UKX06D1;HE2306X	FLX06D1	
UKX07D1;H2307X	FLX07D1	2.0
UKX07D1;HS2307	FLX07D1	4.4
UKX08D1;H2308X	FLX08D1	2.1
UKX08D1;HE2308X	FLX08D1	4.6
UKX08D1;HS2308X	FLX08D1	
UKX09D1;H2309X	FLX09D1	2.4
UKX09D1;HA2309	FLX09D1	5.3
UKX09D1;HE2309X	FLX09D1	
UKX09D1;HS2309X	FLX09D1	
UKX10D1;H2310X	FLX10D1	3.3
UKX10D1;HS2310	FLX10D1	7.3
UKX10D1;HA2310	FLX10D1	
UKX10D1;HE2310X	FLX10D1	

Take-up units cast housing
Adapter type

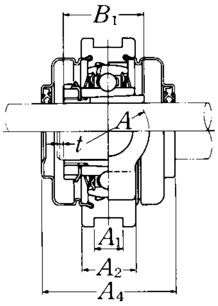


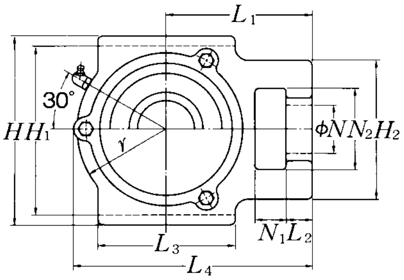
Pressed steel dust cover type
Open end: **S-UKT···D1**
Closed end: **SM-UKT···D1**

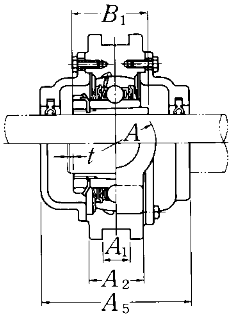
Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch															Bearing number
		N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B_1	
20	**UKT205D1;H2305X**	16	12	51	32	19	51	12	76	89	97	24	32	35	62	35	UK205D1;H2305X
3/4	**UKT205D1;HE2305**	5/8	15/32	2	1 1/4	3/4	2	0.472	2 63/64	3 1/2	3 13/16	15/16	1 1/4	1 3/8	2 7/16	1.378	UK205D1;HE2305
25	**UKT206D1;H2306X**	16	12	56	37	22	57	12	89	102	113	28	37	43	70	38	UK206D1;H2306X
7/8	**UKT206D1;HS2306**	5/8	15/32	2 7/32	1 15/32	7/8	2 1/4	0.472	3 1/2	4 1/32	4 7/16	1 3/32	1 15/32	1 11/16	2 3/4	1.496	UK206D1;HS2306
1	**UKT206D1;HE2306X**																UK206D1;HE2306X
30	**UKT207D1;H2307X**	16	15	64	37	22	64	12	89	102	129	30	37	51	78	43	UK207D1;H2307X
1 1/8	**UKT207D1;HS2307**	5/8	19/32	2 17/32	1 15/32	7/8	2 17/32	0.472	3 1/2	4 1/32	5 3/32	1 3/16	1 15/32	2	3 1/16	1.693	UK207D1;HS2307
35	**UKT208D1;H2308X**	19	18	83	49	29	83	16	102	114	144	33	49	56	88	46	UK208D1;H2308X
1 1/4	**UKT208D1;HE2308X**	3/4	23/32	3 9/32	1 15/16	1 5/32	3 9/32	0.630	4 1/64	4 1/2	5 21/32	1 5/16	1 15/16	2 7/32	3 15/32	1.811	UK208D1;HE2308X
1 3/8	**UKT208D1;HS2308X**																UK208D1;HS2308X
40	**UKT209D1;H2309X**	19	18	83	49	29	83	16	102	117	145	35	49	57	88	50	UK209D1;H2309X
1 7/16	**UKT209D1;HA2309**																UK209D1;HA2309
1 1/2	**UKT209D1;HE2309X**	3/4	23/32	3 9/32	1 15/16	1 5/32	3 9/32	0.630	4 1/64	4 19/32	5 23/32	1 3/8	1 15/16	2 1/4	3 15/32	1.969	UK209D1;HE2309X
1 5/8	**UKT209D1;HS2309X**																UK209D1;HS2309X
45	**UKT210D1;H2310X**	19	18	83	49	29	86	16	102	117	151	37	49	59	92	55	UK210D1;H2310X
1 5/8	**UKT210D1;HS2310**																UK210D1;HS2310
1 11/16	**UKT210D1;HA2310**	3/4	23/32	3 9/32	1 15/16	1 5/32	3 3/8	0.630	4 1/64	4 19/32	5 15/16	1 15/32	1 15/16	2 5/16	3 5/8	2.165	UK210D1;HA2310
1 3/4	**UKT210D1;HE2310X**																UK210D1;HE2310X
50	**UKT211D1;H2311X**	25	21	102	64	35	95	22	130	146	171	38	64	65	106	59	UK211D1;H2311X
1 7/8	**UKT211D1;HS2311**																UK211D1;HS2311
1 15/16	**UKT211D1;HA2311**	31/32	13/16	4 1/32	2 17/32	1 3/8	3 3/4	0.866	5 1/8	5 3/4	6 23/32	1 1/2	2 17/32	2 9/16	4 3/16	2.323	UK211D1;HA2311
2	**UKT211D1;HE2311XY**																UK211D1;HE2311XY
55	**UKT212D1;H2312X**	32	21	102	64	35	102	22	130	146	194	42	64	75	119	62	UK212D1;H2312X
2 1/8	**UKT212D1;HS2312**	1 1/4	13/16	4 1/32	2 17/32	1 3/8	4 1/32	0.866	5 1/8	5 3/4	7 5/8	1 21/32	2 17/32	2 15/16	4 11/16	2.441	UK212D1;HS2312
60	**UKT213D1;H2313X**	32	23	111	70	41	121	26	151	167	224	44	70	87	137	65	UK213D1;H2313X
2 3/16	**UKT213D1;HA2313**																UK213D1;HA2313
2 1/4	**UKT213D1;HE2313X**	1 1/4	29/32	4 3/8	2 3/4	1 5/8	4 3/4	1.024	5 15/16	6 9/16	8 13/16	1 23/32	2 3/4	3 7/16	5 13/32	2.559	UK213D1;HE2313X
2 3/8	**UKT213D1;HS2313X**																UK213D1;HS2313X

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Note: Please refer to page 25 for size of grease fitting.



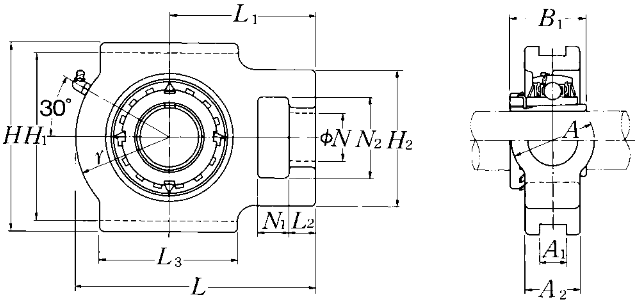


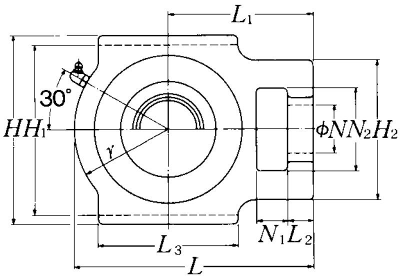


Cast dust cover type
Open end: **C-UKT···D1**
Closed end: **CM-UKT···D1**

Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions				Mass of unit		
			mm inch				kg lb		
			t max.	A_4	L_4	A_5	UKT	S(SM)	C(CM)
T205D1	S(SM)-UKT205D1;H2305X	C(CM)-UKT205D1;H2305X	2	57	100.5	70	0.9	1.0	1.6
T205D1	S(SM)-UKT205ED1;HE2305	C(CM)-UKT205ED1;HE2305	5/64	2 1/4	3 31/32	2 3/4	2.0	2.2	3.5
T206D1	S(SM)-UKT206D1;H2306X	C(CM)-UKT206D1;H2306X	2	62	113.5	75	1.4	1.4	1.9
T206D1	S(SM)-UKT206SD1;HS2306	C(CM)-UKT206SD1;HS2306	5/64	2 7/16	4 15/32	2 15/16	3.1	3.1	4.2
T206D1	S(SM)-UKT206ED1;HE2306X	C(CM)-UKT206ED1;HE2306X							
T207D1	S(SM)-UKT207D1;H2307X	C(CM)-UKT207D1;H2307X	3	72	129	80	1.8	1.9	2.8
T207D1	S(SM)-UKT207SD1;HS2307	C(CM)-UKT207SD1;HS2307	1/8	2 27/32	5 3/32	3 5/32	4.0	4.2	6.2
T208D1	S(SM)-UKT208D1;H2308X	C(CM)-UKT208D1;H2308X	3	82	144	90	2.3	2.5	3.8
T208D1	S(SM)-UKT208ED1;HE2308X	C(CM)-UKT208ED1;HE2308X	1/8	3 7/32	5 21/32	3 17/32	5.1	5.5	8.4
T208D1	S(SM)-UKT208D1;HS2308X	C(CM)-UKT208D1;HS2308X							
T209D1	S(SM)-UKT209D1;H2309X	C(CM)-UKT209D1;H2309X	3	82	145.5	95	2.5	2.7	4.3
T209D1	S(SM)-UKT209AD1;HA2309	C(CM)-UKT209AD1;HA2309							
T209D1	S(SM)-UKT209ED1;HE2309X	C(CM)-UKT209ED1;HE2309X	1/8	3 7/32	5 23/32	3 3/4	5.5	6.0	9.5
T209D1	S(SM)-UKT209SD1;HS2309X	C(CM)-UKT209SD1;HS2309X							
T210D1	S(SM)-UKT210D1;H2310X	C(CM)-UKT210D1;H2310X	3	87	152	100	2.6	2.8	4.7
T210D1	S(SM)-UKT210SD1;HS2310	C(CM)-UKT210SD1;HS2310							
T210D1	S(SM)-UKT210AD1;HA2310	C(CM)-UKT210AD1;HA2310	1/8	3 7/16	5 31/32	3 15/16	5.7	6.2	10
T210D1	S(SM)-UKT210ED1;HE2310X	C(CM)-UKT210ED1;HE2310X							
T211D1	S(SM)-UKT211D1;H2311X	C(CM)-UKT211D1;H2311X	4	92	171.5	100	4.0	4.3	7.5
T211D1	S(SM)-UKT211SD1;HS2311	C(CM)-UKT211SD1;HS2311							
T211D1	S(SM)-UKT211AD1;HA2311	C(CM)-UKT211AD1;HA2311	5/32	3 5/8	6 3/4	3 15/16	8.8	9.5	17
T211D1	S(SM)-UKT211ED1;HE2311XY	C(CM)-UKT211ED1;HE2311XY							
T212D1	S(SM)-UKT212D1;H2312X	C(CM)-UKT212D1;H2312X	4	102	194	115	4.8	5.1	7.6
T212D1	S(SM)-UKT212SD1;HS2312	C(CM)-UKT212SD1;HS2312	5/32	4 1/32	7 5/8	4 17/32	11	11	17
T213D1	S(SM)-UKT213D1;H2313X	C(CM)-UKT213D1;H2313X	4	107	224	120	7.1	7.5	11
T213D1	S(SM)-UKT213AD1;HA2313	C(CM)-UKT213AD1;HA2313							
T213D1	S(SM)-UKT213ED1;HE2313X	C(CM)-UKT213ED1;HE2313X	5/32	4 7/32	8 13/16	4 23/32	16	17	24
T213D1	S(SM)-UKT213SD1;HS2313X	C(CM)-UKT213SD1;HS2313X							

Take-up units cast housing
Adapter type



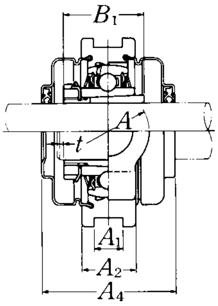


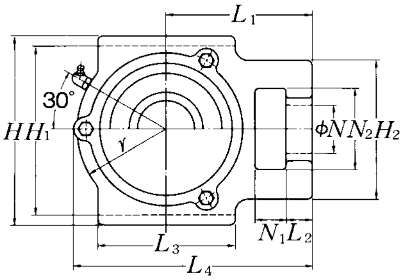
Pressed steel dust cover type
Open end: **S-UKT···D1**
Closed end: **SM-UKT···D1**

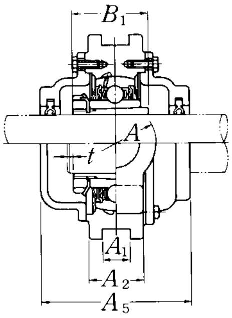
Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B_1	Bearing number
65	UKT215D1;H2315X	32	23	111	70	41	121	26	151	167	232	48	70	92	140	73	UK215D1;H2315X
2 7/16	UKT215D1;HA2315	1¼	29/32	4⅜	2¾	1⅝	4¾	1.024	5 15/16	6 9/16	9⅛	1⅞	2¾	3⅝	5½	2.874	UK215D1;HA2315
2½	UKT215D1;HE2315X																UK215D1;HE2315X
70	UKT216D1;H2316X	32	23	111	70	41	121	26	165	184	235	51	70	95	140	78	UK216D1;H2316X
2 11/16	UKT216D1;HA2316	1¼	29/32	4⅜	2¾	1⅝	4¾	1.024	6½	7¼	9¼	2	2¾	3¾	5½	3.071	UK216D1;HA2316
2¾	UKT216D1;HE2316X																UK216D1;HE2316X
75	UKT217D1;H2317X	38	31	124	73	48	157	30	173	198	260	54	73	98	162	82	UK217D1;H2317X
2 15/16	UKT217D1;HA2317X	1½	1 7/32	4⅞	2⅞	1⅞	6 3/16	1.181	6 13/16	7 25/32	10¼	2⅛	2⅞	3 27/32	6⅜	3.228	UK217D1;HA2317X
3	UKT217D1;HE2317X																UK217D1;HE2317X

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Note: Please refer to page 25 for size of grease fitting.



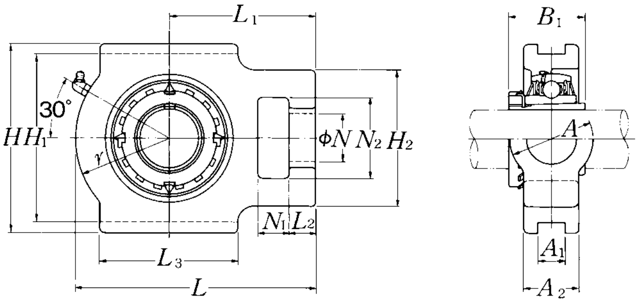




Cast dust cover type
Open end: **C-UKT···D1**
Closed end: **CM-UKT···D1**

Housing number	Unit number pressed steel dust cover type	Unit number cast dust cover type	Nominal dimensions mm inch t max.	A_4	L_4	A_5	Mass of unit kg lb UKT	S(SM)	C(CM)
T215D1	—	**C(CM)-UKT215D1;H2315X**	4	—	232	135	7.9	—	11
T215D1	—	**C(CM)-UKT215AD1;HA2315**	$\frac{5}{32}$	—	$9\frac{1}{8}$	$5\frac{5}{16}$	17	—	24
T215D1		**C(CM)-UKT215ED1;HE2315X**							
T216D1	—	**C(CM)-UKT216D1;H2316X**	4	—	235	145	8.8	—	13
T216D1	—	**C(CM)-UKT216AD1;HA2316**	$\frac{5}{32}$	—	$9\frac{1}{4}$	$5\frac{23}{32}$	19	—	29
T216D1		**C(CM)-UKT216D1;HE2316X**							
T217D1	—	**C(CM)-UKT217D1;H2317X**	5	—	260	155	11	—	17
T217D1	—	**C(CM)-UKT217AD1;HA2317X**	$\frac{13}{64}$	—	$10\frac{1}{4}$	$6\frac{3}{32}$	24	—	37
T217D1		**C(CM)-UKT217ED1;HE2317X**							

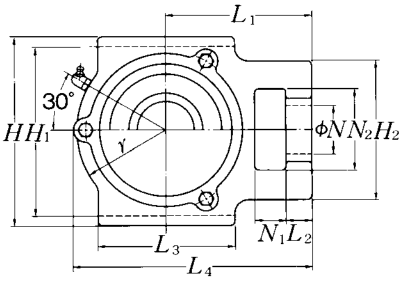
Take-up units cast housing
Adapter type

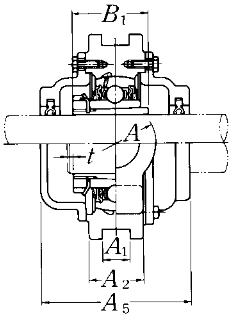


Shaft dia. mm inch	Unit number 1) 2) 3)	N1	L2	H2	N2	N	L3	A1	H1	H	L	A2	A	r	L1	B1
		Nominal dimensions mm inch														
20	**UKT305D1;H2305X**	16	14	62	36	26	65	12	80	89	122	26	36	46	76	35
3/4	**UKT305D1;HE2305**	5/8	9/16	2 7/16	1 13/32	1 1/32	2 9/16	0.472	3 5/32	3 1/2	4 13/16	1 1/32	1 13/32	1 13/16	3	1.378
25	**UKT306D1;H2306X**	18	16	70	41	28	74	16	90	100	137	28	41	52	85	38
7/8	**UKT306D1;HS2306**	23/32	5/8	2 3/4	1 5/8	1 3/32	2 29/32	0.630	3 35/64	3 15/16	5 13/32	1 3/32	1 5/8	2 1/16	3 11/32	1.496
1	**UKT306D1;HE2306X**															
30	**UKT307D1;H2307X**	20	17	75	45	30	80	16	100	111	150	32	45	56	94	43
1 1/8	**UKT307D1;HS2307**	25/32	21/32	2 15/16	1 25/32	1 3/16	3 5/32	0.630	3 15/16	4 3/8	5 29/32	1 1/4	1 25/32	2 7/32	3 11/16	1.693
35	**UKT308D1;H2308X**	22	19	83	50	32	89	18	112	124	162	34	50	62	100	46
1 1/4	**UKT308D1;HE2308X**	7/8	3/4	3 9/32	1 31/32	1 1/4	3 1/2	0.709	4 13/32	4 7/8	6 3/8	1 11/32	1 31/32	2 7/16	3 15/16	1.811
1 3/8	**UKT308D1;HS2308X**															
40	**UKT309D1;H2309X**	24	20	90	55	34	97	18	125	138	178	38	55	68	110	50
1 7/16	**UKT309D1;HA2309**															
1 1/2	**UKT309D1;HE2309X**	15/16	25/32	3 17/32	2 5/32	1 11/32	3 13/16	0.709	4 59/64	5 7/16	7	1 1/2	2 5/32	2 11/16	4 11/32	1.969
1 5/8	**UKT309D1;HS2309X**															
45	**UKT310D1;H2310X**	27	22	98	61	37	106	20	140	151	192	40	61	74	118	55
1 5/8	**UKT310D1;HS2310**															
1 11/16	**UKT310D1;HA2310**	1 1/16	7/8	3 27/32	2 13/32	1 15/32	4 3/16	0.787	5 33/64	5 15/16	7 9/16	1 9/16	2 13/32	2 29/32	4 21/32	2.165
1 3/4	**UKT310D1;HE2310X**															
50	**UKT311D1;H2311X**	29	23	105	66	39	115	22	150	163	207	44	66	80	127	59
1 7/8	**UKT311D1;HS2311**															
1 15/16	**UKT311D1;HA2311**	1 5/32	29/32	4 1/8	2 19/32	1 17/32	4 17/32	0.866	5 29/32	6 13/32	8 5/32	1 23/32	2 19/32	3 5/32	5	2.323
2	**UKT311D1;HE2311XY**															
55	**UKT312D1;H2312X**	31	25	113	71	41	123	22	160	178	220	46	71	85	135	62
2 1/8	**UKT312D1;HS2312**	1 7/32	31/32	4 7/16	2 25/32	1 5/8	4 27/32	0.866	6 19/64	7	8 21/32	1 13/16	2 25/32	3 11/32	5 5/16	2.441
60	**UKT313D1;H2313X**	32	27	116	70	43	134	26	170	190	238	50	80	92	146	65
2 3/16	**UKT313D1;HA2313**															
2 1/4	**UKT313D1;HE2313X**	1 1/4	1 1/16	4 9/16	2 3/4	1 11/16	5 9/32	1.024	6 11/16	7 15/32	9 3/8	1 31/32	3 5/32	3 5/8	5 3/4	2.559
2 3/8	**UKT313D1;HS2313X**															

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Note: Please refer to page 25 for size of grease fitting.

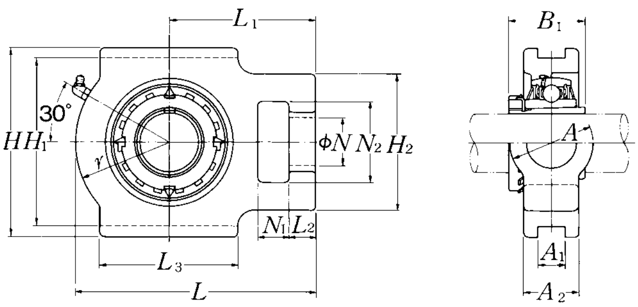




Cast dust cover type
Open end: **C-UKT···D1**
Closed end: **CM-UKT···D1**

Bearing number	Housing number	Unit number cast dust cover type	Nominal dimensions			Mass of unit	
			mm inch			kg	lb
			t max.	L_4	A_5	UKT	C(CM)
UK305D1;H2305X	T305D1	**C(CM)-UKT305D1;H2305X**	2	122	80	1.4	2.2
UK305D1;HE2305	T305D1	**C(CM)-UKT305ED1;HE2305**	5/64	4 13/16	3 5/32	3.1	4.9
UK306D1;H2306X	T306D1	**C(CM)-UKT306D1;H2306X**	2	139	85	1.8	2.9
UK306D1;HS2306	T306D1	**C(CM)-UKT306SD1;HS2306**	5/64	5 31/32	3 11/32	4.0	6.4
UK306D1;HE2306X	T306D1	**C(CM)-UKT306ED1;HE2306X**					
UK307D1;H2307X	T307D1	**C(CM)-UKT307D1;H2307X**	3	152	95	2.4	3.7
UK307D1;HS2307	T307D1	**C(CM)-UKT307SD1;HS2307**	1/8	5 31/32	3 3/4	5.3	8.2
UK308D1;H2308X	T308D1	**C(CM)-UKT308D1;H2308X**	3	164	105	3.0	4.8
UK308D1;HE2308X	T308D1	**C(CM)-UKT308ED1;HE2308X**	1/8	6 15/32	4 1/8	6.6	11
UK308D1;HS2308X	T308D1	**C(CM)-UKT308D1;HS2308X**					
UK309D1;H2309X	T309D1	**C(CM)-UKT309D1;H2309X**	3	181	110	4.1	6.3
UK309D1;HA2309	T309D1	**C(CM)-UKT309AD1;HA2309**					
UK309D1;HE2309X	T309D1	**C(CM)-UKT309ED1;HE2309X**	1/8	7 1/8	4 11/32	9.0	14
UK309D1;HS2309X	T309D1	**C(CM)-UKT309SD1;HS2309X**					
UK310D1;H2310X	T310D1	**C(CM)-UKT310D1;H2310X**	3	197	120	5.0	7.7
UK310D1;HS2310	T310D1	**C(CM)-UKT310SD1;HS2310**					
UK310D1;HA2310	T310D1	**C(CM)-UKT310AD1;HA2310**	1/8	7 3/4	4 23/32	11	17
UK310D1;HE2310X	T310D1	**C(CM)-UKT310ED1;HE2310X**					
UK311D1;H2311X	T311D1	**C(CM)-UKT311D1;H2311X**	4	211	125	6.4	9.6
UK311D1;HS2311	T311D1	**C(CM)-UKT311SD1;HS2311**					
UK311D1;HA2311	T311D1	**C(CM)-UKT311AD1;HA2311**	5/32	8 5/16	4 29/32	14	21
UK311D1;HE2311XY	T311D1	**C(CM)-UKT311ED1;HE2311XY**					
UK312D1;H2312X	T312D1	**C(CM)-UKT312D1;H2312X**	4	227	135	7.5	11
UK312D1;HS2312	T312D1	**C(CM)-UKT312SD1;HS2312**	5/32	8 15/16	5 5/16	17	24
UK313D1;H2313X	T313D1	**C(CM)-UKT313D1;H2313X**	4	244	140	9.5	14
UK313D1;HA2313	T313D1	**C(CM)-UKT313AD1;HA2313**					
UK313D1;HE2313X	T313D1	**C(CM)-UKT313ED1;HE2313X**	5/32	9 19/32	5 1/2	21	31
UK313D1;HS2313X	T313D1	**C(CM)-UKT313SD1;HS2313X**					

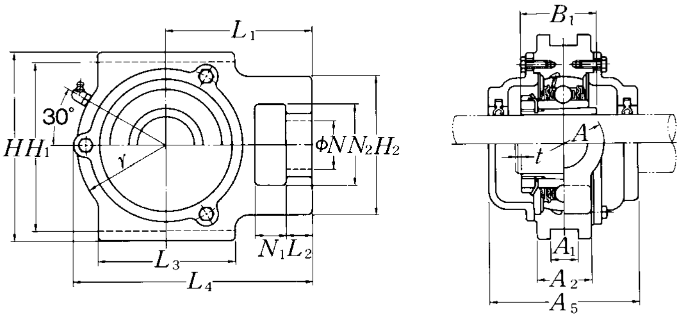
Take-up units cast housing
Adapter type



Shaft dia. mm inch	Unit number 1) 2) 3)	N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B_1
		Nominal dimensions mm inch														
65	**UKT315D1;H2315X**	36	27	132	85	46	150	26	192	216	262	55	90	102	160	73
2 7/16 **2 1/2**	**UKT315D1;HA2315** **UKT315D1;HE2315X**	1 13/32	1 1/16	5 3/16	3 11/32	1 13/16	5 29/32	1.024	7 9/16	8 1/2	10 5/16	2 5/32	3 17/32	4 1/32	6 5/16	2.874
70	**UKT316D1;H2316X**	42	30	150	98	53	160	30	204	230	282	60	102	108	174	78
2 11/16 **2 3/4**	**UKT316D1;HA2316** **UKT316D1;HE2316X**	1 21/32	1 3/16	5 29/32	3 27/32	2 3/32	6 5/16	1.181	8 1/32	9 1/16	11 3/32	2 3/8	4 1/32	4 1/4	6 27/32	3.071
75	**UKT317D1;H2317X**	42	32	152	98	53	170	32	214	240	298	64	102	115	183	82
2 15/16 **3**	**UKT317D1;HA2317X** **UKT317D1;HE2317X**	1 21/32	1 1/4	5 31/32	3 27/32	2 3/32	6 11/16	1.260	8 27/64	9 7/16	11 23/32	2 17/32	4 1/32	4 17/32	7 7/32	3.228
80	**UKT318D1;H2318X**	46	32	160	106	57	175	32	228	255	312	66	110	120	192	86
3 3/16	**UKT318D1;HA2318X**	1 13/16	1 1/4	6 5/16	4 3/16	2 1/4	6 7/8	1.260	8 31/32	10 1/32	12 9/32	2 19/32	4 11/32	4 23/32	7 9/16	3.386
85	**UKT319D1;H2319X**	46	33	165	106	57	180	35	240	270	322	72	110	125	197	90
3 1/4	**UKT319D1;HE2319X**	1 13/16	1 5/16	6 1/2	4 3/16	2 1/4	7 3/32	1.378	9 29/64	10 5/8	12 11/16	2 27/32	4 11/32	4 29/32	7 3/4	3.543
90	**UKT320D1;H2320X**	48	34	175	115	59	200	35	260	290	345	75	120	135	210	97
3 7/16 **3 1/2**	**UKT320D1;HA2320** **UKT320D1;HE2320X**	1 7/8	1 11/32	6 7/8	4 17/32	2 5/16	7 7/8	1.378	10 15/64	11 13/32	13 19/32	2 15/16	4 23/32	5 5/16	8 9/32	3.819
100	**UKT322D1;H2322X**	52	40	185	125	65	215	38	285	320	385	80	130	150	235	105
110	**UKT324D1;H2324X**	60	44	210	140	70	230	45	320	355	432	90	140	165	267	112
115	**UKT326D1;H2326**	65	47	220	150	75	240	50	350	385	465	100	150	180	285	121
125	**UKT328D1;H2328**	70	52	230	160	80	255	50	380	415	515	100	155	200	315	131

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

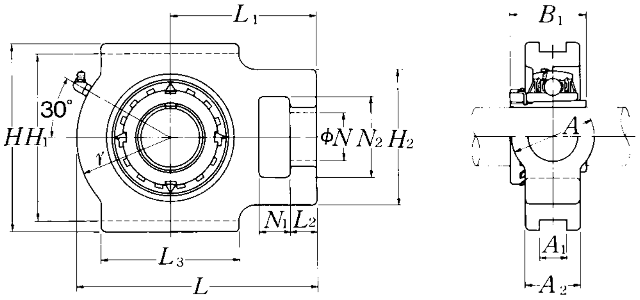
Note: Please refer to page 25 for size of grease fitting.



Cast dust cover type
Open end: **C-UKT···D1**
Closed end: **CM-UKT···D1**

Bearing number	Housing number	Unit number cast dust cover type	Nominal dimensions			Mass of unit	
			mm inch			kg lb	
			t max.	L_4	A_5	UKT	C(CM)
UK315D1;H2315X	T315D1	**C(CM)-UKT315D1;H2315X**	4	268	150	14	19
UK315D1;HA2315	T315D1	**C(CM)-UKT315AD1;HA2315**	$\frac{5}{32}$	$10\frac{9}{16}$	$5\frac{29}{32}$	31	42
UK315D1;HE2315X	T315D1	**C(CM)-UKT315ED1;HE2315X**					
UK316D1;H2316X	T316D1	**C(CM)-UKT316D1;H2316X**	4	287	155	17	23
UK316D1;HA2316	T316D1	**C(CM)-UKT316AD1;HA2316**	$\frac{5}{32}$	$11\frac{5}{16}$	$6\frac{3}{32}$	37	51
UK316D1;HE2316X	T316D1	**C(CM)-UKT316D1;HE2316X**					
UK317D1;H2317X	T317D1	**C(CM)-UKT317D1;H2317X**	5	303	170	20	27
UK317D1;HA2317X	T317D1	**C(CM)-UKT317AD1;HA2317X**	$\frac{13}{64}$	$11\frac{15}{16}$	$6\frac{11}{16}$	44	60
UK317D1;HE2317X	T317D1	**C(CM)-UKT317ED1;HE2317X**					
UK318D1;H2318X	T318D1	**C(CM)-UKT318D1;H2318X**	5	317	170	22	31
UK318D1;HA2318X	T318D1	**C(CM)-UKT318AD1;HA2318X**	$\frac{13}{64}$	$12\frac{15}{32}$	$6\frac{11}{16}$	49	68
UK319D1;H2319X	T319D1	**C(CM)-UKT319D1;H2319X**	5	327	180	25	35
UK319D1;HE2319X	T319D1	**C(CM)-UKT319ED1;HE2319X**	$\frac{13}{64}$	$12\frac{7}{8}$	$7\frac{3}{32}$	55	77
UK320D1;H2320X	T320D1	**C(CM)-UKT320D1;H2320X**	5	350	190	33	44
UK320D1;HA2320	T320D1	**C(CM)-UKT320AD1;HA2320**	$\frac{13}{64}$	$13\frac{25}{32}$	$7\frac{15}{32}$	73	97
UK320D1;HE2320X	T320D1	**C(CM)-UKT320ED1;HE2320X**					
UK322D1;H2322X	T322D1	**C(CM)-UKT322D1;H2322X**	5	395	200	40	56
UK324D1;H2324X	T324D1	**C(CM)-UKT324D1;H2324X**	5	439	215	54	71
UK326D1;H2326	T326D1	**C(CM)-UKT326D1;H2326**	6	476	225	69	93
UK328D1;H2328	T328D1	**C(CM)-UKT328D1;H2328**	6	519	235	84	112

Take-up units cast housing
Adapter type



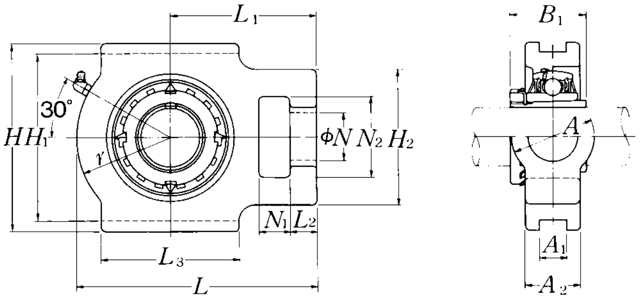
Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B_1
20	**UKTX05D1;H2305X**	16	12	56	37	22	57	12	89	102	113	28	37	43	70	35
3/4	**UKTX05D1;HE2305**	5/8	15/32	2 7/32	1 15/32	7/8	2 1/4	0.472	3 1/2	4 1/32	4 7/16	1 3/32	1 15/32	1 11/16	2 3/4	1.378
25	**UKTX06D1;H2306X**	16	15	64	37	22	64	12	89	102	129	30	37	51	78	38
7/8	**UKTX06D1;HS2306**	5/8	19/32	2 17/32	1 15/32	7/8	2 17/32	0.472	3 1/2	4 1/32	5 3/32	1 3/16	1 15/32	2	3 1/16	1.496
1	**UKTX06D1;HE2306X**															
30	**UKTX07D1;H2307X**	19	17	83	49	29	83	16	102	114	144	36	49	56	88	43
1 1/8	**UKTX07D1;HS2307**	3/4	21/32	3 9/32	1 15/16	1 5/32	3 9/32	0.630	4 1/64	4 1/2	5 21/32	1 13/32	1 15/16	2 7/32	3 15/32	1.693
35	**UKTX08D1;H2308X**	19	17	83	49	29	83	16	102	117	144	36	49	57	87	46
1 1/4	**UKTX08D1;HE2308X**	3/4	21/32	3 9/32	1 15/16	1 5/32	3 9/32	0.630	4 1/64	4 19/32	5 21/32	1 13/32	1 15/16	2 1/4	3 7/16	1.811
1 3/8	**UKTX08D1;HS2308X**															
40	**UKTX09D1;H2309X**	19	18	83	49	29	86	16	102	117	151	38	49	59	92	50
1 7/16	**UKTX09D1;HA2309**															
1 1/2	**UKTX09D1;HE2309X**	3/4	23/32	3 9/32	1 15/16	1 5/32	3 3/8	0.630	4 1/64	4 19/32	5 15/16	1 1/2	1 15/16	2 5/16	3 5/8	1.969
1 5/8	**UKTX09D1;HS2309X**															
45	**UKTX10D1;H2310X**	25	21	102	64	35	95	22	130	146	171	42	64	65	106	55
1 5/8	**UKTX10D1;HS2310**															
1 11/16	**UKTX10D1;HA2310**	31/32	13/16	4 1/32	2 17/32	1 3/8	3 3/4	0.866	5 1/8	5 3/4	6 23/32	1 21/32	2 17/32	2 9/16	4 3/16	2.165
1 3/4	**UKTX10D1;HE2310X**															
50	**UKTX11D1;H2311X**	32	21	102	64	35	102	22	130	146	194	44	64	75	119	59
1 7/8	**UKTX11D1;HS2311**															
1 15/16	**UKTX11D1;HA2311**	1 1/4	13/16	4 1/32	2 17/32	1 3/8	4 1/32	0.866	5 1/8	5 3/4	7 5/8	1 23/32	2 17/32	2 15/16	4 11/16	2.323
2	**UKTX11D1;HE2311XY**															
55	**UKTX12D1;H2312X**	32	23	111	70	41	121	26	151	167	224	48	70	87	137	62
2 1/8	**UKTX12D1;HS2312**	1 1/4	29/32	4 3/8	2 3/4	1 5/8	4 3/4	1.024	5 15/16	6 9/16	8 13/16	1 7/8	2 3/4	3 7/16	5 13/32	2.441
60	**UKTX13D1;H2313X**	32	23	111	70	41	121	26	151	167	224	48	70	87	137	65
2 3/16	**UKTX13D1;HA2313**															
2 1/4	**UKTX13D1;HE2313X**	1 1/4	29/32	4 3/8	2 3/4	1 5/8	4 3/4	1.024	5 15/16	6 9/16	8 13/16	1 7/8	2 3/4	3 7/16	5 13/32	2.559
2 3/8	**UKTX13D1;HS2313X**															

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit kg lb
UKX05D1;H2305X	TX05D1	1.4
UKX05D1;HE2305	TX05D1	3.1
UKX06D1;H2306X	TX06D1	1.7
UKX06D1;HS2306	TX06D1	3.7
UKX06D1;HE2306X	TX06D1	
UKX07D1;H2307X	TX07D1	2.5
UKX07D1;HS2307	TX07D1	5.5
UKX08D1;H2308X	TX08D1	2.6
UKX08D1;HE2308X	TX08D1	5.7
UKX08D1;HS2308X	TX08D1	
UKX09D1;H2309X	TX09D1	2.8
UKX09D1;HA2309	TX09D1	6.2
UKX09D1;HE2309X	TX09D1	
UKX09D1;HS2309X	TX09D1	
UKX10D1;H2310X	TX10D1	4.2
UKX10D1;HS2310	TX10D1	9.3
UKX10D1;HA2310	TX10D1	
UKX10D1;HE2310X	TX10D1	
UKX11D1;H2311X	TX11D1	5.0
UKX11D1;HS2311	TX11D1	11
UKX11D1;HA2311	TX11D1	
UKX11D1;HE2311XY	TX11D1	
UKX12D1;H2312X	TX12D1	7.4
UKX12D1;HS2312	TX12D1	16
UKX13D1;H2313X	TX13D1	7.3
UKX13D1;HA2313	TX13D1	16
UKX13D1;HE2313X	TX13D1	
UKX13D1;HS2313X	TX13D1	

Take-up units cast housing
Adapter type

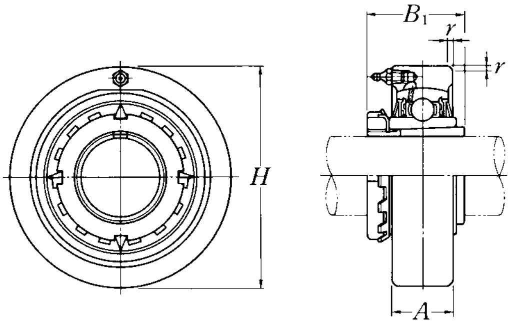


Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch														
		N_1	L_2	H_2	N_2	N	L_3	A_1	H_1	H	L	A_2	A	r	L_1	B_1
65	**UKTX15D1;H2315X**	32	23	111	70	41	121	28	165	184	235	48	70	95	140	73
2 7/16	**UKTX15D1;HA2315**	1 1/4	29/32	4 3/8	2 3/4	1 5/8	4 3/4	1.102	6 1/2	7 1/4	9 1/4	1 7/8	2 3/4	3 3/4	5 1/2	2.874
2 1/2	**UKTX15D1;HE2315X**															
70	**UKTX16D1;H2316X**	38	30	124	73	48	157	28	173	198	260	54	73	98	162	78
2 11/16	**UKTX16D1;HA2316**	1 1/2	1 3/16	4 7/8	2 7/8	1 7/8	6 3/16	1.102	6 13/16	7 25/32	10 1/4	2 1/8	2 7/8	3 27/32	6 3/8	3.071
2 3/4	**UKTX16D1;HE2316X**															
75	**UKTX17D1;H2317X**	38	30	124	73	48	157	28	173	198	260	54	73	98	162	82
2 15/16	**UKTX17D1;HA2317X**	1 1/2	1 3/16	4 7/8	2 7/8	1 7/8	6 3/16	1.102	6 13/16	7 25/32	10 1/4	2 1/8	2 7/8	3 27/32	6 3/8	3.228
3	**UKTX17D1;HE2317X**															

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.
Note: Please refer to page 25 for size of grease fitting.

Bearing number	Housing number	Mass of unit kg	 lb
UKX15D1;H2315X	TX15D1	8.5	19
UKX15D1;HA2315	TX15D1		
UKX15D1;HE2315X	TX15D1		
UKX16D1;H2316X	TX16D1	11	24
UKX16D1;HA2316	TX16D1		
UKX16D1;HE2316X	TX16D1		
UKX17D1;H2317X	TX17D1	12	26
UKX17D1;HA2317X	TX17D1		
UKX17D1;HE2317X	TX17D1		

Cylindrical cartridge units cast housing
Adapter type

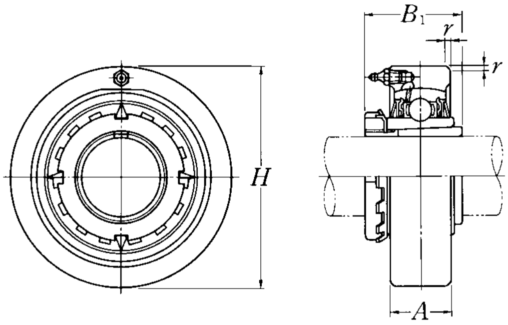


Shaft dia.	Unit number 1) 2) 3)	Nominal dimensions				Bearing number	Housing number	Mass of unit
mm inch			mm	inch				kg lb
		H	A	r	B1			
20	UKC205D1;H2305X	80	22	2	35	UK205D1;H2305X	C205D1	0.8
3/4	UKC205D1;HE2305	3.1496	55/64	0.079	1.378	UK205D1;HE2305	C205D1	1.8
25	UKC206D1;H2306X	85	27	2	38	UK206D1;H2306X	C206D1	0.9
7/8	UKC206D1;HS2306	3.3465	1 1/16	0.079	1.496	UK206D1;HS2306	C206D1	2.0
1	UKC206D1;HE2306X					UK206D1;HE2306X	C206D1	
30	UKC207D1;H2307X	90	28	2	43	UK207D1;H2307X	C207D1	1.1
1 1/8	UKC207D1;HS2307	3.5433	1 7/64	0.079	1.693	UK207D1;HS2307	C207D1	2.4
35	UKC208D1;H2308X	100	30	2.5	46	UK208D1;H2308X	C208D1	1.4
1 1/4	UKC208D1;HE2308X	3.9370	1 3/16	0.098	1.811	UK208D1;HE2308X	C208D1	3.1
1 3/8	UKC208D1;HS2308X					UKC208D1;HS2308X	C208D1	
40	UKC209D1;H2309X	110	31	2.5	50	UK209D1;H2309X	C209D1	1.7
1 7/16	UKC209D1;HA2309	4.3307	1 7/32	0.098	1.969	UK209D1;HA2309	C209D1	3.7
1 1/2	UKC209D1;HE2309X					UK209D1;HE2309X	C209D1	
1 5/8	UKC209D1;HS2309X					UK209D1;HS2309X	C209D1	
45	UKC210D1;H2310X	120	33	2.5	55	UK210D1;H2310X	C210D1	2.1
1 5/8	UKC210D1;HS2310	4.7244	1 19/64	0.098	2.165	UK210D1;HS2310	C210D1	4.6
1 11/16	UKC210D1;HA2310					UK210D1;HA2310	C210D1	
1 3/4	UKC210D1;HE2310X					UK210D1;HE2310X	C210D1	
50	UKC211D1;H2311X	125	35	2.5	59	UK211D1;H2311X	C211D1	2.4
1 7/8	UKC211D1;HS2311	4.9213	1 3/8	0.098	2.323	UK211D1;HS2311	C211D1	5.3
1 15/16	UKC211D1;HA2311					UK211D1;HA2311	C211D1	
2	UKC211D1;HE2311XY					UK211D1;HE2311XY	C211D1	
55	UKC212D1;H2312X	130	38	2.5	62	UK212D1;H2312X	C212D1	2.6
2 1/8	UKC212D1;HS2312	5.1181	1 1/2	0.098	2.441	UK212D1;HS2312	C212D1	5.7
60	UKC213D1;H2313X	140	40	3	65	UK213D1;H2313X	C213D1	3.2
2 3/16	UKC213D1;HA2313	5.5118	1 37/64	0.118	2.559	UK213D1;HA2313	C213D1	7.1
2 1/4	UKC213D1;HE2313X					UK213D1;HE2313X	C213D1	
2 3/8	UKC213D1;HS2313X					UK213D1;HS2313X	C213D1	

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Note: Please refer to page 25 for size of grease fitting.

Cylindrical cartridge units cast housing
Adapter type

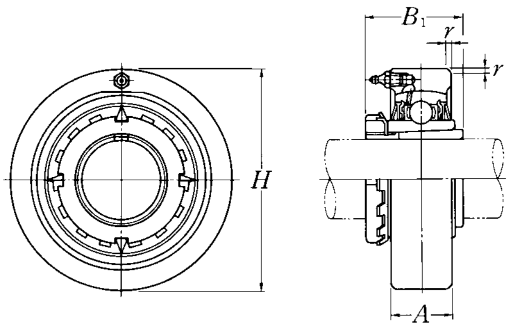


Shaft dia.	Unit number 1) 2) 3)	Nominal dimensions				Bearing number	Housing number	Mass of unit
mm inch		mm inch						kg lb
		H	A	r	B_1			
20	UKC305D1;H2305X	90	26	2.5	35	UK305D1;H2305X	C305D1	1.2
$\frac{3}{4}$	UKC305D1;HE2305	3.5433	$1\frac{1}{32}$	0.098	1.378	UK305D1;HE2305	C305D1	2.6
25	UKC306D1;H2306X	100	28	2.5	38	UK306D1;H2306X	C306D1	1.4
$\frac{7}{8}$	UKC306D1;HS2306	3.9370	$1\frac{7}{64}$	0.098	1.496	UK306D1;HS2306	C306D1	3.1
1	UKC306D1;HE2306X					UK306D1;HE2306X	C306D1	
30	UKC307D1;H2307X	110	32	3	43	UK307D1;H2307X	C307D1	1.8
$1\frac{1}{8}$	UKC307D1;HS2307	4.3307	$1\frac{17}{64}$	0.118	1.693	UK307D1;HS2307	C307D1	4.0
35	UKC308D1;H2308X	120	34	3	46	UK308D1;H2308X	C308D1	2.2
$1\frac{1}{4}$	UKC308D1;HE2308X	4.7244	$1\frac{11}{32}$	0.118	1.811	UK308D1;HE2308X	C308D1	4.9
$1\frac{3}{8}$	UKC308D1;HS2308X					UK308D1;HS2308X	C308D1	
40	UKC309D1;H2309X	130	38	3.5	50	UK309D1;H2309X	C309D1	2.8
$1\frac{7}{16}$	UKC309D1;HA2309	5.1181	$1\frac{1}{2}$	0.138	1.969	UK309D1;HA2309	C309D1	6.2
$1\frac{1}{2}$	UKC309D1;HE2309X					UK309D1;HE2309X	C309D1	
$1\frac{5}{8}$	UKC309D1;HS2309X					UK309D1;HS2309X	C309D1	
45	UKC310D1;H2310X	140	40	3.5	55	UK310D1;H2310X	C310D1	3.3
$1\frac{5}{8}$	UKC310D1;HS2310	5.5118	$1\frac{37}{64}$	0.138	2.165	UK310D1;HS2310	C310D1	7.3
$1\frac{11}{16}$	UKC310D1;HA2310					UK310D1;HA2310	C310D1	
$1\frac{3}{4}$	UKC310D1;HE2310X					UK310D1;HE2310X	C310D1	
50	UKC311D1;H2311X	150	44	3.5	59	UK311D1;H2311X	C311D1	3.9
$1\frac{7}{8}$	UKC311D1;HS2311	5.9055	$1\frac{47}{64}$	0.138	2.323	UK311D1;HS2311	C311D1	8.6
$1\frac{15}{16}$	UKC311D1;HA2311					UK311D1;HA2311	C311D1	
2	UKC311D1;HE2311XY					UK311D1;HE2311XY	C311D1	
55	UKC312D1;H2312X	160	46	3.5	62	UK312D1;H2312X	C312D1	4.7
$2\frac{1}{8}$	UKC312D1;HS2312	6.2992	$1\frac{13}{16}$	0.138	2.441	UK312D1;HS2312	C312D1	10
60	UKC313D1;H2313X	170	50	3.5	65	UK313D1;H2313X	C313D1	5.6
$2\frac{3}{16}$	UKC313D1;HA2313	6.6929	$1\frac{31}{32}$	0.138	2.559	UK313D1;HA2313	C313D1	12
$2\frac{1}{4}$	UKC313D1;HE2313X					UK313D1;HE2313X	C313D1	
$2\frac{3}{8}$	UKC313D1;HS2313X					UK313D1;HS2313X	C313D1	

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Note: Please refer to page 25 for size of grease fitting.

Cylindrical cartridge units cast housing
Adapter type

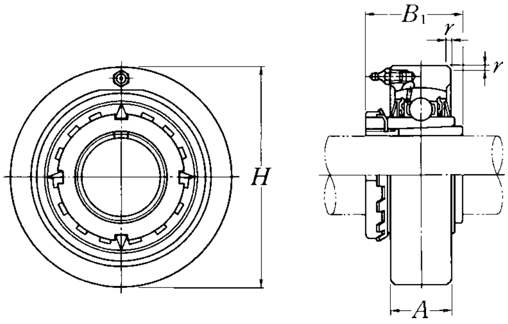


Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch				Bearing number	Housing number	Mass of unit kg lb
		H	A	r	B_1			
65 **$2\frac{7}{16}$** **$2\frac{1}{2}$**	**UKC315D1;H2315X** **UKC315D1;HA2315** **UKC315D1;HE2315X**	190 7.4803	55 $2\frac{11}{16}$	4 0.157	73 2.874	UK315D1;H2315X UK315D1;HA2315 UK315D1;HE2315X	C315D1 C315D1 C315D1	7.9 17
70 **$2\frac{11}{16}$** **$2\frac{3}{4}$**	**UKC316D1;H2316X** **UKC316D1;HA2316** **UKC316D1;HE2316X**	200 7.8740	60 $2\frac{23}{64}$	4 0.157	78 3.071	UK316D1;H2316X UK316D1;HA2316 UK316D1;HE2316X	C316D1 C316D1 C316D1	9.2 20
75 **$2\frac{15}{16}$** **3**	**UKC317D1;H2317X** **UKC317D1;HA2317X** **UKC317D1;HE2317X**	215 8.4646	64 $2\frac{33}{64}$	4 0.157	82 3.228	UK317D1;H2317X UK317D1;HA2317X UK317D1;HE2317X	C317D1 C317D1 C317D1	11 24
80 **$3\frac{3}{16}$**	**UKC318D1;H2318X** **UKC318D1;HA2318X**	225 8.8583	66 $2\frac{19}{32}$	4 0.157	86 3.386	UK318D1;H2318X UK318D1;HA2318X	C318D1 C318D1	13 29
85 **$3\frac{1}{4}$**	**UKC319D1;H2319X** **UKC319D1;HE2319X**	240 9.4488	72 $2\frac{53}{64}$	4 0.157	90 3.543	UK319D1;H2319X UK319D1;HE2319X	C319D1 C319D1	16 35
90 **$3\frac{7}{16}$** **$3\frac{1}{2}$**	**UKC320D1;H2320X** **UKC320D1;HA2320** **UKC320D1;HE2320X**	260 10.2362	75 $2\frac{61}{64}$	4 0.157	97 3.819	UK320D1;H2320X UK320D1;HA2320 UK320D1;HE2320X	C320D1 C320D1 C320D1	20 44
100	**UKC322D1;H2322X**	300	80	5	105	UK322D1;H2322X	C322D1	29
110	**UKC324D1;H2324X**	320	90	5	112	UK324D1;H2324X	C324D1	35
115	**UKC326D1;H2326**	340	100	5	121	UK326D1;H2326	C326D1	43
125	**UKC328D1;H2328**	360	100	5	131	UK328D1;H2328	C328D1	49

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Note: Please refer to page 25 for size of grease fitting.

Cylindrical cartridge units cast housing
Adapter type

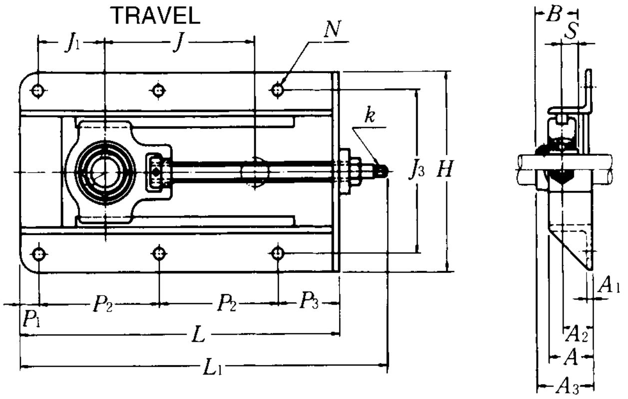


Shaft dia. mm inch	Unit number 1) 2) 3)	Nominal dimensions mm inch				Bearing number	Housing number	Mass of unit kg lb
		H	A	r	B1			
20	UKCX05D1;H2305X	90	27	2	35	UKX05D1;H2305X	CX05D1	1.1
3/4	UKCX05D1;HE2305	3.5433	1 1/16	0.079	1.378	UKX05D1;HE2305	CX05D1	2.4
25	UKCX06D1;H2306X	100	30	2.5	38	UKX06D1;H2306X	CX06D1	1.4
7/8	UKCX06D1;HS2306	3.9370	1 3/16	0.098	1.496	UKX06D1;HS2306	CX06D1	3.1
1	UKCX06D1;HE2306X					UKX06D1;HE2306X	CX06D1	
30	UKCX07D1;H2307X	110	34	2.5	43	UKX07D1;H2307X	CX07D1	1.9
1 1/8	UKCX07D1;HS2307	4.3307	1 11/32	0.098	1.693	UKX07D1;HS2307	CX07D1	4.2
35	UKCX08D1;H2308X	120	38	2.5	46	UKX08D1;H2308X	CX08D1	2.5
1 1/4	UKCX08D1;HE2308X	4.7244	1 1/2	0.098	1.811	UKX08D1;HE2308X	CX08D1	5.5
1 3/8	UKCX08D1;HS2308X					UKX08D1;HS2308X	CX08D1	
40	UKCX09D1;H2309X	120	38	2.5	50	UKX09D1;H2309X	CX09D1	2.4
1 7/16	UKCX09D1;HA2309					UKX09D1;HA2309	CX09D1	
1 1/2	UKCX09D1;HE2309X	4.7244	1 1/2	0.098	1.969	UKX09D1;HE2309X	CX09D1	5.3
1 5/8	UKCX09D1;HS2309X					UKX09D1;HS2309X	CX09D1	
45	UKCX10D1;H2310X	130	40	2.5	55	UKX10D1;H2310X	CX10D1	2.9
1 5/8	UKCX10D1;HS2310					UKX10D1;HS2310	CX10D1	
1 11/16	UKCX10D1;HA2310	5.1181	1 37/64	0.098	2.165	UKX10D1;HA2310	CX10D1	6.4
1 3/4	UKCX10D1;HE2310X					UKX10D1;HE2310X	CX10D1	
50	UKCX11D1;H2311X	150	42	3	59	UKX11D1;H2311X	CX11D1	4.2
1 7/8	UKCX11D1;HS2311					UKX11D1;HS2311	CX11D1	
1 15/16	UKCX11D1;HA2311	5.9055	1 21/32	0.118	2.323	UKX11D1;HA2311	CX11D1	9.3
2	UKCX11D1;HE2311XY					UKX11D1;HE2311X	CX11D1	
55	UKCX12D1;H2312X	160	44	3	62	UKX12D1;H2312X	CX12D1	4.8
2 1/8	UKCX12D1;HS2312	6.2992	1 47/64	0.118	2.441	UKX12D1;HS2312	CX12D1	11

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Note: Please refer to page 25 for size of grease fitting.

Take-up stretcher units
Set screw type

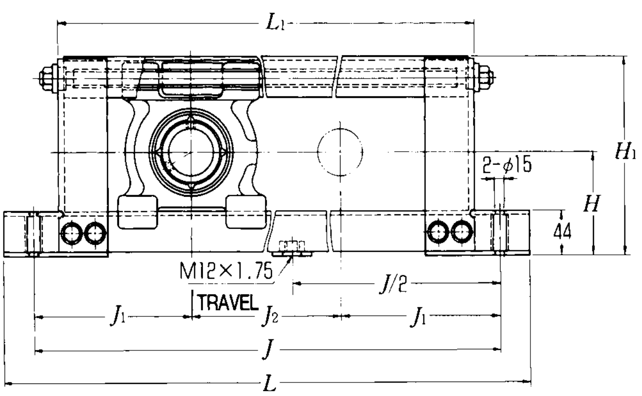


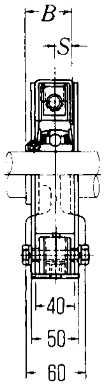
Shaft dia.	Unit [1] number	Nominal dimensions																
mm		mm																
		L	H	J [1]	J_1	J_3	A_1	A_2	A	P_1	P_2	P_3	N	L_1	A_3	B	S	k square
12	**UCT201-15**	317	199	150	64	154	6	30	50	19	117	64	12	370	48.3	31	12.7	9
15	**UCT202-15**	317	199	150	64	154	6	30	50	19	117	64	12	370	48.3	31	12.7	9
17	**UCT203-15**	317	199	150	64	154	6	30	50	19	117	64	12	370	48.3	31	12.7	9
20	**UCT204-15**	317	199	150	64	154	6	30	50	19	117	64	12	370	48.3	31	12.7	9
25	**UCT205-15**	317	199	150	63	154	6	30	50	19	117	64	12	370	49.8	34.1	14.3	9
30	**UCT206-15**	337	212	150	73	166	6	32	50	19	127	64	12	393	54.2	38.1	15.9	10
35	**UCT207-23**	429	212	230	80	166	6	32	50	19	173	64	12	485	57.4	42.9	17.5	10
40	**UCT208-30**	520	233	300	88	192	6	32	50	22	217	64	12	593	62.2	49.2	19	15
45	**UCT209-30**	520	233	300	88	192	6	32	50	22	217	64	12	593	62.2	49.2	19	15
50	**UCT210-30**	524	233	300	92	192	6	35	50	22	219	64	15	597	67.6	51.6	19	15
55	**UCT211-30**	542	285	300	90	240	8	38	65	22	230	60	15	626	71.4	55.6	22.2	17
60	**UCT212-30**	568	285	300	101	240	8	38	65	22	243	60	15	652	77.7	65.1	25.4	17
65	**UCT213-30**	606	306	300	109	260	8	43	65	22	260	64	15	700	82.7	65.1	25.4	23

Remarks: If relubricatable type is needed, please order with suffix "D1".

Bolt size	Max. load recommended N	Bearing number	Basic load ratings N dynamic C_r	static C_{or}	Mass of unit kg
M10	7 650	UC201D1	12 800	6 650	6.4
M10	7 650	UC202D1	12 800	6 650	6.3
M10	7 650	UC203D1	12 800	6 650	6.3
M10	7 650	UC204D1	12 800	6 650	6.3
M10	7 850	UC205D1	14 000	7 850	6.5
M10	9 810	UC206D1	19 500	11 300	7.6
M10	12 750	UC207D1	25 700	15 300	9.2
M10	15 690	UC208D1	29 100	17 800	13
M10	15 690	UC209D1	32 500	20 400	16
M12	16 670	UC210D1	35 000	23 200	16
M12	19 610	UC211D1	43 500	29 200	22
M12	21 570	UC212D1	52 500	36 000	25
M12	23 540	UC213D1	57 500	40 000	33

Type L stretcher units
Set screw type

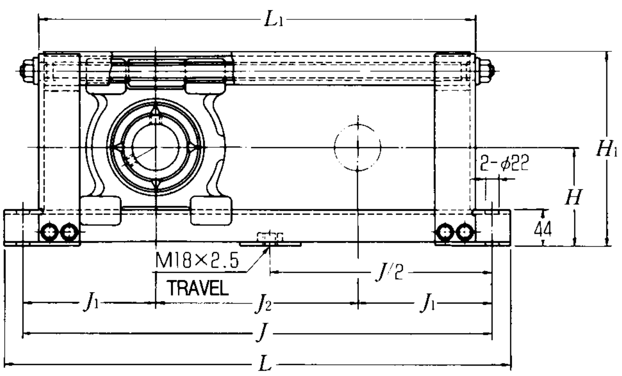


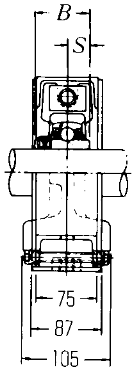


Shaft dia.	Unit 1) number	Nominal dimensions									Bolt size	Max. load recommended	Bearing number	Basic load ratings		Mass of unit
mm		mm										N		N		kg
		H	L	J	J_2	L_1	J_1	H_1	B	S				dynamic C_r	static C_{or}	
20	**UCL204-10**	77	430	370	100	320	135	146	31	12.7	M12	1 960	UC204D1	12 800	6 650	6.0
	UCL204-20	77	530	470	200	420	135	146	31	12.7	M12	1 960	UC204D1	12 800	6 650	6.8
	UCL204-30	77	630	570	300	520	135	146	31	12.7	M12	1 960	UC204D1	12 800	6 650	7.5
	UCL204-40	77	730	670	400	620	135	146	31	12.7	M12	1 960	UC204D1	12 800	6 650	8.2
25	**UCL205-10**	82	440	380	100	330	140	156	34.1	14.3	M12	2 250	UC205D1	14 000	7 850	6.4
	UCL205-20	82	540	480	200	430	140	156	34.1	14.3	M12	2 250	UC205D1	14 000	7 850	7.1
	UCL205-30	82	640	580	300	530	140	156	34.1	14.3	M12	2 250	UC205D1	14 000	7 850	7.8
	UCL205-40	82	740	680	400	630	140	156	34.1	14.3	M12	2 250	UC205D1	14 000	7 850	8.4
30	**UCL206-10**	87	450	390	100	340	145	166	38.1	15.9	M12	3 230	UC206D1	19 500	11 300	7.0
	UCL206-20	87	550	490	200	440	145	166	38.1	15.9	M12	3 230	UC206D1	19 500	11 300	7.7
	UCL206-30	87	650	590	300	540	145	166	38.1	15.9	M12	3 230	UC206D1	19 500	11 300	8.4
	UCL206-40	87	750	690	400	640	145	166	38.1	15.9	M12	3 230	UC206D1	19 500	11 300	9.2
35	**UCL207-10**	92	460	400	100	350	150	176	42.9	17.5	M12	4 210	UC207D1	25 700	15 300	7.5
	UCL207-20	92	560	500	200	450	150	176	42.9	17.5	M12	4 210	UC207D1	25 700	15 300	8.2
	UCL207-30	92	660	600	300	550	150	176	42.9	17.5	M12	4 210	UC207D1	25 700	15 300	8.9
	UCL207-40	92	760	700	400	650	150	176	42.9	17.5	M12	4 210	UC207D1	25 700	15 300	9.7
40	**UCL208-10**	97	470	410	100	360	155	186	49.2	19	M12	4 500	UC208D1	29 100	17 800	8.2
	UCL208-20	97	570	510	200	460	155	186	49.2	19	M12	4 500	UC208D1	29 100	17 800	8.9
	UCL208-30	97	670	610	300	560	155	186	49.2	19	M12	4 500	UC208D1	29 100	17 800	9.5
	UCL208-40	97	770	710	400	660	155	186	49.2	19	M12	4 500	UC208D1	29 100	17 800	10.1
45	**UCL209-10**	100	480	420	100	370	160	192	49.2	19	M12	4 500	UC209D1	32 500	20 400	8.8
	UCL209-20	100	580	520	200	470	160	192	49.2	19	M12	4 500	UC209D1	32 500	20 400	9.4
	UCL209-30	100	680	620	300	570	160	192	49.2	19	M12	4 500	UC209D1	32 500	20 400	10.0
	UCL209-40	100	780	720	400	670	160	192	49.2	19	M12	4 500	UC209D1	32 500	20 400	11.1

Remarks: If relubricatable type is needed, please order with suffix "D1".

Type M stretcher units
Set screw type

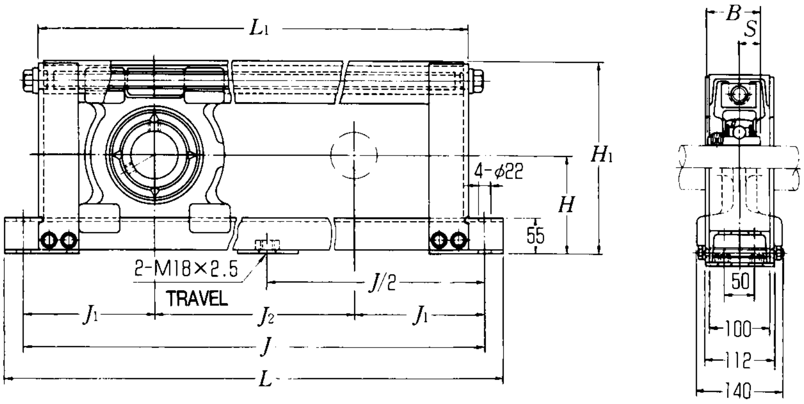




Shaft dia. mm	Unit [1)] number	Nominal dimensions mm H	L	J	J_2	L_1	J_1	H_1	B	S	Bolt size	Max. load recommended N	Bearing number	Basic load ratings N dynamic C_r	static C_{or}	Mass of unit kg
40	**UCM208-50**	97	870	810	500	760	155	190	49.2	19	M18	5 190	UC208D1	29 100	17 800	20
	UCM208-60	97	970	910	600	860	155	190	49.2	19	M18	5 190	UC208D1	29 100	17 800	22
	UCM208-70	97	1 070	1 010	700	960	155	190	49.2	19	M18	5 190	UC208D1	29 100	17 800	23
	UCM208-80	97	1 170	1 110	800	1 060	155	190	49.2	19	M18	5 190	UC208D1	29 100	17 800	24
	UCM208-90	97	1 270	1 210	900	1 160	155	190	49.2	19	M18	5 190	UC208D1	29 100	17 800	30
45	**UCM209-50**	102	880	820	500	770	160	200	49.2	19	M18	5 880	UC209D1	32 500	20 400	21
	UCM209-60	102	980	920	600	870	160	200	49.2	19	M18	5 880	UC209D1	32 500	20 400	23
	UCM209-70	102	1 080	1 020	700	970	160	200	49.2	19	M18	5 880	UC209D1	32 500	20 400	24
	UCM209-80	102	1 180	1 120	800	1 070	160	200	49.2	19	M18	5 880	UC209D1	32 500	20 400	30
	UCM209-90	102	1 280	1 220	900	1 170	160	200	49.2	19	M18	5 880	UC209D1	32 500	20 400	32
50	**UCM210-50**	107	890	830	500	780	165	210	51.6	19	M18	6 460	UC210D1	35 000	23 200	23
	UCM210-60	107	990	930	600	880	165	210	51.6	19	M18	6 460	UC210D1	35 000	23 200	24
	UCM210-70	107	1 090	1 030	700	980	165	210	51.6	19	M18	6 460	UC210D1	35 000	23 200	30
	UCM210-80	107	1 190	1 130	800	1 080	165	210	51.6	19	M18	6 460	UC210D1	35 000	23 200	32
	UCM210-90	107	1 290	1 230	900	1 180	165	210	51.6	19	M18	6 460	UC210D1	35 000	23 200	33
55	**UCM211-50**	115	910	850	500	800	175	230	55.6	22.2	M18	6 460	UC211D1	43 500	29 200	25
	UCM211-60	115	1 010	950	600	900	175	230	55.6	22.2	M18	6 460	UC211D1	43 500	29 200	27
	UCM211-70	115	1 110	1 050	700	1 000	175	230	55.6	22.2	M18	6 460	UC211D1	43 500	29 200	32
	UCM211-80	115	1 210	1 150	800	1 100	175	230	55.6	22.2	M18	6 460	UC211D1	43 500	29 200	34
	UCM211-90	115	1 310	1 250	900	1 200	175	230	55.6	22.2	M18	6 460	UC211D1	43 500	29 200	36
60	**UCM212-50**	120	920	860	500	810	180	240	65.1	25.4	M18	6 460	UC212D1	52 500	36 000	26
	UCM212-60	120	1 020	960	600	910	180	240	65.1	25.4	M18	6 460	UC212D1	52 500	36 000	29
	UCM212-70	120	1 120	1 060	700	1 010	180	240	65.1	25.4	M18	6 460	UC212D1	52 500	36 000	35
	UCM212-80	120	1 220	1 160	800	1 110	180	240	65.1	25.4	M18	6 460	UC212D1	52 500	36 000	36
	UCM212-90	120	1 320	1 260	900	1 210	180	240	65.1	25.4	M18	6 460	UC212D1	52 500	36 000	38
65	**UCM213-50**	125	940	880	500	830	190	250	65.1	25.4	M18	6 460	UC213D1	57 500	40 000	30
	UCM213-60	125	1 040	980	600	930	190	250	65.1	25.4	M18	6 460	UC213D1	57 500	40 000	31
	UCM213-70	125	1 140	1 080	700	1 030	190	250	65.1	25.4	M18	6 460	UC213D1	57 500	40 000	36
	UCM213-80	125	1 240	1 180	800	1 130	190	250	65.1	25.4	M18	6 460	UC213D1	57 500	40 000	38
	UCM213-90	125	1 340	1 280	900	1 230	190	250	65.1	25.4	M18	6 460	UC213D1	57 500	40 000	40

Remarks: If relubricatable type is needed, please order with suffix "D1".

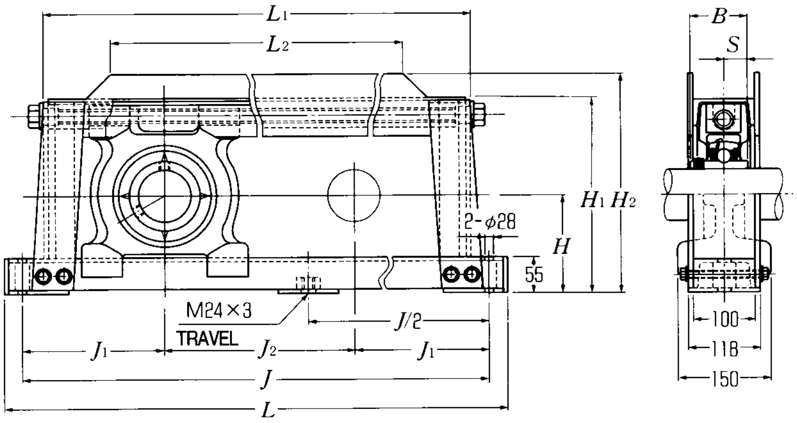
Type M stretcher units
Set screw type



Shaft dia.	Unit [1] number	Nominal dimensions									Bolt size	Max. load recommended	Bearing number	Basic load ratings		Mass of unit
mm		mm										N		N		kg
		H	L	J	J_2	L_1	J_1	H_1	B	S				dynamic C_r	static C_{0r}	
65	**UCM313-50**	145	940	880	500	830	190	285	75	30	M18	16 260	UC313D1	92 500	60 000	47
	UCM313-60	145	1 040	980	600	930	190	285	75	30	M18	16 260	UC313D1	92 500	60 000	50
	UCM313-70	145	1 140	1 080	700	1 030	190	285	75	30	M18	16 260	UC313D1	92 500	60 000	53
	UCM313-80	145	1 240	1 180	800	1 130	190	285	75	30	M18	16 260	UC313D1	92 500	60 000	55
	UCM313-90	145	1 340	1 280	900	1 230	190	285	75	30	M18	16 260	UC313D1	92 500	60 000	58
70	**UCM314-50**	150	960	900	500	850	200	295	78	33	M18	19 600	UC314D1	104 000	68 000	49
	UCM314-60	150	1 060	1 000	600	950	200	295	78	33	M18	19 600	UC314D1	104 000	68 000	52
	UCM314-70	150	1 160	1 100	700	1 050	200	295	78	33	M18	19 600	UC314D1	104 000	68 000	55
	UCM314-80	150	1 260	1 200	800	1 150	200	295	78	33	M18	19 600	UC314D1	104 000	68 000	58
	UCM314-90	150	1 360	1 300	900	1 250	200	295	78	33	M18	19 600	UC314D1	104 000	68 000	61
75	**UCM315-50**	155	980	920	500	870	210	305	82	32	M18	19 600	UC315D1	113 000	77 000	52
	UCM315-60	155	1 080	1 020	600	970	210	305	82	32	M18	19 600	UC315D1	113 000	77 000	55
	UCM315-70	155	1 180	1 120	700	1 070	210	305	82	32	M18	19 600	UC315D1	113 000	77 000	58
	UCM315-80	155	1 280	1 220	800	1 170	210	305	82	32	M18	19 600	UC315D1	113 000	77 000	60
	UCM315-90	155	1 380	1 320	900	1 270	210	305	82	32	M18	19 600	UC315D1	113 000	77 000	63
80	**UCM316-50**	160	1 000	940	500	890	220	315	86	34	M18	19 600	UC316D1	123 000	86 500	54
	UCM316-60	160	1 100	1 040	600	990	220	315	86	34	M18	19 600	UC316D1	123 000	86 500	57
	UCM316-70	160	1 200	1 140	700	1 090	220	315	86	34	M18	19 600	UC316D1	123 000	86 500	60
	UCM316-80	160	1 300	1 240	800	1 190	220	315	86	34	M18	19 600	UC316D1	123 000	86 500	63
	UCM316-90	160	1 400	1 340	900	1 290	220	315	86	34	M18	19 600	UC316D1	123 000	86 500	66
85	**UCM317-50**	165	1 020	960	500	910	230	325	96	40	M18	19 600	UC317D1	133 000	97 000	60
	UCM317-60	165	1 120	1 060	600	1 010	230	325	96	40	M18	19 600	UC317D1	133 000	97 000	63
	UCM317-70	165	1 220	1 160	700	1 110	230	325	96	40	M18	19 600	UC317D1	133 000	97 000	65
	UCM317-80	165	1 320	1 260	800	1 210	230	325	96	40	M18	19 600	UC317D1	133 000	97 000	68
	UCM317-90	165	1 420	1 360	900	1 310	230	325	96	40	M18	19 600	UC317D1	133 000	97 000	71
90	**UCM318-50**	170	1 050	990	500	940	245	335	96	40	M18	19 600	UC318D1	143 000	107 000	65
	UCM318-60	170	1 150	1 090	600	1 040	245	335	96	40	M18	19 600	UC318D1	143 000	107 000	68
	UCM318-70	170	1 250	1 190	700	1 140	245	335	96	40	M18	19 600	UC318D1	143 000	107 000	71
	UCM318-80	170	1 350	1 290	800	1 240	245	335	96	40	M18	19 600	UC318D1	143 000	107 000	74
	UCM318-90	170	1 450	1 390	900	1 340	245	335	96	40	M18	19 600	UC318D1	143 000	107 000	77

Remarks: If relubricatable type is needed, please order with suffix "D1".

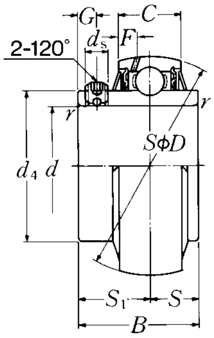
Type M stretcher units
Set screw type



Shaft dia. mm	Unit [1] number	Nominal dimensions mm H	L	J	J_2	L_1	L_2	J_1	H_1	H_2	B	S	Bolt size	Max. load recommended N	Bearing number	Basic load ratings N dynamic C_r	static C_{or}	Mass of unit kg
95	**UCM319-50**	185	1 180	1 100	500	1 021	775	300	377	400	103	41	M24	19 600	UC319D1	153 000	119 000	105
	UCM319-60	185	1 280	1 200	600	1 121	875	300	377	400	103	41	M24	19 600	UC319D1	153 000	119 000	109
	UCM319-70	185	1 380	1 300	700	1 221	975	300	377	400	103	41	M24	19 600	UC319D1	153 000	119 000	112
	UCM319-80	185	1 480	1 400	800	1 321	1 075	300	377	400	103	41	M24	19 600	UC319D1	153 000	119 000	116
	UCM319-90	185	1 580	1 500	900	1 421	1 175	300	377	400	103	41	M24	19 600	UC319D1	153 000	119 000	120
100	**UCM320-50**	200	1 220	1 140	500	1 063	809	320	403	430	108	42	M24	19 600	UC320D1	173 000	141 000	99
	UCM320-60	200	1 320	1 240	600	1 163	909	320	403	430	108	42	M24	19 600	UC320D1	173 000	141 000	123
	UCM320-70	200	1 420	1 340	700	1 263	1 009	320	403	430	108	42	M24	19 600	UC320D1	173 000	141 000	126
	UCM320-80	200	1 520	1 440	800	1 363	1 109	320	403	430	108	42	M24	19 600	UC320D1	173 000	141 000	130
	UCM320-90	200	1 620	1 540	900	1 463	1 209	320	403	430	108	42	M24	19 600	UC320D1	173 000	141 000	134

Remarks: If relubricatable type is needed, please order with suffix "D1".

Ball bearings
Set screw type

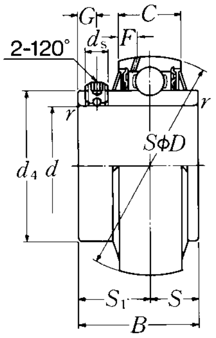


Shaft dia.	Bearing number 1)	Nominal dimensions										
mm inch		mm inch										
		d	D	B	C	rs min.	S	S1	G	ds	d4	F
12	**UC201D1**	12	47	31	17	0.6	12.7	18.3	4.5	M5 × 0.8	29.6	4.7
1/2	**UC201-008D1**	0.5000	1.8504	1.2205	0.6693	0.024	0.500	0.720	0.177	No.10-32UNF	1.1654	0.185
15	**UC202D1**	15	47	31	17	0.6	12.7	18.3	4.5	M5 × 0.8	29.6	4.7
9/16	**UC202-009D1**	0.5625	1.8504	1.2205	0.6693	0.024	0.500	0.720	0.177	No.10-32UNF	1.1654	0.185
5/8	**UC202-010D1**	0.6250										
17	**UC203D1**	17	47	31	17	0.6	12.7	18.3	4.5	M5 × 0.8	29.6	4.7
11/16	**UC203-011D1**	0.6875	1.8504	1.2205	0.6693	0.024	0.500	0.720	0.177	No.10-32UNF	1.1654	0.185
20	**UC204D1**	20	47	31	17	1	12.7	18.3	4.5	M5 × 0.8	29.6	4.7
3/4	**UC204-012D1**	0.7500	1.8504	1.2205	0.6693	0.039	0.500	0.720	0.177	No.10-32UNF	1.1654	0.185
25	**UC205D1**	25	52	34.1	17	1	14.3	19.8	5	M5 × 0.8	33.9	4.5
13/16	**UC205-013D1**	0.8125	2.0472	1.3425	0.6693	0.039	0.563	0.780	0.197	No.10-32UNF	1.3346	0.177
7/8	**UC205-014D1**	0.8750										
15/16	**UC205-015D1**	0.9375										
1	**UC205-100D1**	1.0000										
30	**UC206D1**	30	62	38.1	19	1	15.9	22.2	5	M6 × 0.75	40.8	4.6
1 1/16	**UC206-101D1**	1.0625	2.4409	1.5000	0.7480	0.039	0.626	0.874	0.197	1/4-28UNF	1.6063	0.181
1 1/8	**UC206-102D1**	1.1250										
1 3/16	**UC206-103D1**	1.1875										
1 1/4	**UC206-104D1**	1.2500										
35	**UC207D1**	35	72	42.9	20	1.5	17.5	25.4	6	M6 × 0.75	46.8	4.6
1 1/4	**UC207-104D1**	1.2500	2.8346	1.6890	0.7874	0.059	0.689	1.000	0.236	1/4-28UNF	1.8425	0.181
1 5/16	**UC207-105D1**	1.3125										
1 3/8	**UC207-106D1**	1.3750										
1 7/16	**UC207-107D1**	1.4375										
40	**UC208D1**	40	80	49.2	21	1.5	19	30.2	8	M8 × 1	53	4.5
1 1/2	**UC208-108D1**	1.5000	3.1496	1.9370	0.8268	0.059	0.748	1.189	0.315	5/16-24UNF	2.0866	0.177
1 9/16	**UC208-109D1**	1.5625										
45	**UC209D1**	45	85	49.2	22	1.5	19	30.2	8	M8 × 1	57.5	4.9
1 5/8	**UC209-110D1**	1.6250	3.3465	1.9370	0.8661	0.059	0.748	1.189	0.315	5/16-24UNF	2.2638	0.193
1 11/16	**UC209-111D1**	1.6875										
1 3/4	**UC209-112D1**	1.7500										

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Basic load ratings		Mass
N	lbf	kg lb
dynamic	static	
C_r	C_{or}	
12 800	6 650	0.21
2 890	1 500	0.46
12 800	6 650	0.20
2 890	1 500	0.44
		0.42
12 800	6 650	0.18
2 890	1 500	0.39
12 800	6 650	0.17
2 890	1 500	0.39
14 000	7 850	0.20
3 150	1 770	0.53
		0.51
		0.46
		0.44
19 500	11 300	0.33
4 400	2 540	0.82
		0.77
		0.73
		0.66
25 700	15 300	0.49
5 750	3 450	1.21
		1.15
		1.08
		1.01
29 100	17 800	0.65
6 550	4 000	1.52
		1.46
32 500	20 400	0.70
7 350	4 600	1.76
		1.68
		1.57

Ball bearings
Set screw type

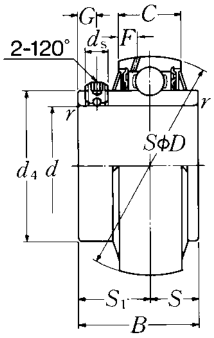


Shaft dia.	Bearing number [1]	Nominal dimensions										
mm inch		mm inch										
		d	D	B	C	r_s min.	S	S_1	G	ds	d_4	F
50	**UC210D1**	50	90	51.6	24	1.5	19	32.6	9	M8 × 1	62.4	5.9
$1\frac{13}{16}$	**UC210-113D1**	1.8125	3.5433	2.0315	0.9449	0.059	0.748	1.283	0.354	$\frac{5}{16}$-24UNF	2.4567	0.232
$1\frac{7}{8}$	**UC210-114D1**	1.8750										
$1\frac{15}{16}$	**UC210-115D1**	1.9375										
2	**UC210-200D1**	2.0000										
55	**UC211D1**	55	100	55.6	25	2	22.2	33.4	9	M8 × 1	69	6.0
2	**UC211-200D1**	2.0000	3.9370	2.1890	0.9843	0.079	0.874	1.315	0.354	$\frac{5}{16}$-24UNF	2.7165	0.236
$2\frac{1}{16}$	**UC211-201D1**	2.0625										
$2\frac{1}{8}$	**UC211-202D1**	2.1250										
$2\frac{3}{16}$	**UC211-203D1**	2.1875										
60	**UC212D1**	60	110	65.1	27	2	25.4	39.7	10	M10 × 1.25	77	6.2
$2\frac{1}{4}$	**UC212-204D1**	2.2500	4.3307	2.5630	1.0630	0.079	1.000	1.563	0.394	$\frac{3}{8}$-24UNF	3.0315	0.244
$2\frac{5}{16}$	**UC212-205D1**	2.3125										
$2\frac{3}{8}$	**UC212-206D1**	2.3750										
$2\frac{7}{16}$	**UC212-207D1**	2.4375										
65	**UC213D1**	65	120	65.1	32	2	25.4	39.7	10	M10 × 1.25	82.5	8.7
$2\frac{1}{2}$	**UC213-208D1**	2.5000	4.7244	2.5630	1.2598	0.079	1.000	1.563	0.394	$\frac{3}{8}$-24UNF	3.2480	0.343
$2\frac{9}{16}$	**UC213-209D1**	2.5625										
70	**UC214D1**	70	125	74.6	33	2	30.2	44.4	12	M10 × 1.25	87	8.8
$2\frac{5}{8}$	**UC214-210D1**	2.6250	4.9213	2.9370	1.2992	0.079	1.189	1.748	0.472	$\frac{3}{8}$-24UNF	3.4252	0.346
$2\frac{11}{16}$	**UC214-211D1**	2.6875										
$2\frac{3}{4}$	**UC214-212D1**	2.7500										
75	**UC215D1**	75	130	77.8	34	2	33.3	44.5	12	M10 × 1.25	93	9.0
$2\frac{13}{16}$	**UC215-213D1**	2.8125	5.1181	3.0630	1.3386	0.079	1.311	1.752	0.472	$\frac{3}{8}$-24UNF	3.6614	0.354
$2\frac{7}{8}$	**UC215-214D1**	2.8750										
$2\frac{15}{16}$	**UC215-215D1**	2.9375										
3	**UC215-300D1**	3.0000										
80	**UC216D1**	80	140	82.6	35	2.5	33.3	49.3	12	M10 × 1.25	98.1	9.5
$3\frac{1}{16}$	**UC216-301D1**	3.0625	5.5118	3.2520	1.3780	0.098	1.311	1.941	0.472	$\frac{3}{8}$-24UNF	3.8622	0.374
$3\frac{1}{8}$	**UC216-302D1**	3.1250										
$3\frac{3}{16}$	**UC216-303D1**	3.1875										

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Basic load ratings		Mass
N lbf		kg lb
dynamic C_r	static C_{or}	
35 000	23 200	0.80
		2.03
7 900	5 200	1.92
		1.81
		1.69
43 500	29 200	1.08
		2.71
9 750	6 550	2.60
		2.46
		2.34
52 500	36 000	1.53
		3.66
11 800	8 150	3.50
		3.33
		3.17
57 500	40 000	1.85
12 900	9 000	4.26
		4.09
62 000	44 000	2.10
		5.09
14 000	9 900	4.87
		4.65
66 000	49 500	2.35
		5.73
14 900	11 100	5.49
		5.25
		4.98
72 500	53 000	2.80
		6.57
16 300	11 900	6.28
		6.00

Ball bearings
Set screw type

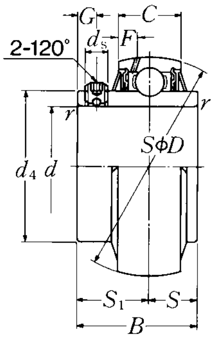


Shaft dia.	Bearing number [1]	Nominal dimensions										
mm inch		mm inch										
		d	D	B	C	r_s min.	S	S_1	G	ds	d_4	F
85	**UC217D1**	85	150	85.7	36	2.5	34.1	51.6	12	M12×1.5	106.4	10.1
3¼	**UC217-304D1**	3.2500										
3 5/16	**UC217-305D1**	3.3125	5.9055	3.3740	1.4173	0.098	1.343	2.031	0.472	½-20UNF	4.1890	0.398
3 7/16	**UC217-307D1**	3.4375										
90	**UC218D1**	90	160	96	37	2.5	39.7	56.3	12	M12×1.5	111.6	9.8
3½	**UC218-308D1**	3.5000	6.2992	3.7795	1.4570	0.098	1.563	2.217	0.472	½-20UNF	4.3937	0.386

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Basic load ratings		Mass
N lbf		kg lb
dynamic C_r	static C_{or}	
83 500	64 000	3.37
		7.92
18 700	14 300	7.60
		6.97
96 000	71 500	4.36
21 600	16 100	9.88

Ball bearings
Set screw type

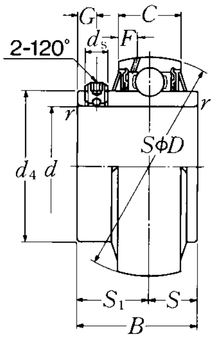


Shaft dia.	Bearing number [1]	Nominal dimensions										
mm inch		mm inch d	D	B	C	r_s min.	S	S_1	G	ds	d_4	F
25	**UC305D1**	25	62	38	20	1.5	15	23	6	M6 × 0.75	36.8	5.0
13/16	**UC305-013D1**	0.8125	2.4409	1.4961	0.7874	0.059	0.591	0.906	0.236	1/4-28UNF	1.4488	0.197
7/8	**UC305-014D1**	0.8750										
15/16	**UC305-015D1**	0.9375										
1	**UC305-100D1**	1.0000										
30	**UC306D1**	30	72	43	23	1.5	17	26	6	M6 × 0.75	44.9	5.9
1 1/16	**UC306-101D1**	1.0625	2.8346	1.6929	0.9055	0.059	0.669	1.024	0.236	1/4-28UNF	1.7677	0.232
1 1/8	**UC306-102D1**	1.1250										
1 3/16	**UC306-103D1**	1.1875										
35	**UC307D1**	35	80	48	25	2	19	29	8	M8 × 1	49.4	6.8
1 1/4	**UC307-104D1**	1.2500	3.1496	1.8898	0.9843	0.079	0.748	1.142	0.315	5/16-24UNF	1.9449	0.268
1 5/16	**UC307-105D1**	1.3125										
1 3/8	**UC307-106D1**	1.3750										
1 7/16	**UC307-107D1**	1.4375										
40	**UC308D1**	40	90	52	27	2	19	33	10	M10 × 1.25	56	7.4
1 1/2	**UC308-108D1**	1.5000	3.5433	2.0472	1.0630	0.079	0.748	1.299	0.394	3/8-24UNF	2.2047	0.291
1 9/16	**UC308-109D1**	1.5625										
45	**UC309D1**	45	100	57	29	2	22	35	10	M10 × 1.25	63.5	7.4
1 5/8	**UC309-110D1**	1.6250	3.9370	2.2441	1.1417	0.079	0.866	1.378	0.394	3/8-24UNF	2.5000	0.291
1 11/16	**UC309-111D1**	1.6875										
1 3/4	**UC309-112D1**	1.7500										
50	**UC310D1**	50	110	61	32	2.5	22	39	12	M12 × 1.5	70.6	8.1
1 13/16	**UC310-113D1**	1.8125	4.3307	2.4016	1.2598	0.098	0.866	1.535	0.472	1/2-20UNF	2.7795	0.319
1 7/8	**UC310-114D1**	1.8750										
1 15/16	**UC310-115D1**	1.9375										
55	**UC311D1**	55	120	66	34	2.5	25	41	12	M12 × 1.5	76.6	8.5
2	**UC311-200D1**	2.0000	4.7244	2.5984	1.3386	0.098	0.984	1.614	0.472	1/2-20UNF	3.0157	0.335
2 1/16	**UC311-201D1**	2.0625										
2 1/8	**UC311-202D1**	2.1250										
2 3/16	**UC311-203D1**	2.1875										

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Basic load ratings		Mass
N lbf		kg lb
dynamic C_r	static C_{or}	
21 200	10 900	0.35
4 750	2 460	0.88
		0.84
		0.79
		0.77
26 700	15 000	0.56
6 000	3 400	1.34
		1.28
		1.23
33 500	19 100	0.71
7 500	4 300	1.70
		1.63
		1.57
		1.50
40 500	24 000	0.96
9 150	5 400	2.23
		2.14
53 000	32 000	1.28
11 900	7 200	3.06
		2.98
		2.87
62 000	38 500	1.65
13 900	8 600	3.95
		3.84
		3.70
71 500	45 000	2.07
16 100	10 100	4.96
		4.81
		4.67
		4.50

Ball bearings
Set screw type

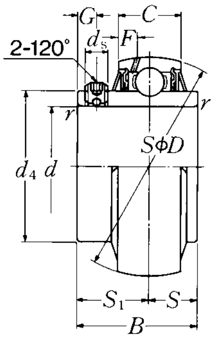


Shaft dia.	Bearing number [1]	Nominal dimensions										
mm inch							mm inch					
		d	D	B	C	r_s min.	S	S_1	G	ds	d_4	F
60	UC312D1	60	130	71	36	2.5	26	45	12	M12×1.5	82.7	9.0
2 1/4	UC312-204D1	2.2500	5.1181	2.7953	1.4173	0.098	1.024	1.772	0.472	1/2-20UNF	3.2559	0.354
2 5/16	UC312-205D1	2.3125										
2 3/8	UC312-206D1	2.3750										
2 7/16	UC312-207D1	2.4375										
65	UC313D1	65	140	75	39	2.5	30	45	12	M12×1.5	88.2	10.1
2 1/2	UC313-208D1	2.5000	5.5118	2.9528	1.5354	0.098	1.181	1.772	0.472	1/2-20UNF	3.4724	0.398
2 9/16	UC313-209D1	2.5625										
70	UC314D1	70	150	78	41	2.5	33	45	12	M12×1.5	94.8	10.5
2 5/8	UC314-210D1	2.6250	5.9055	3.0709	1.6142	0.098	1.299	1.772	0.472	1/2-20UNF	3.7323	0.413
2 11/16	UC314-211D1	2.6875										
2 3/4	UC314-212D1	2.7500										
75	UC315D1	75	160	82	43	2.5	32	50	14	M14×1.5	101.3	11.0
2 13/16	UC315-213D1	2.8125	6.2992	3.2283	1.6929	0.098	1.260	1.969	0.551	9/16-18UNF	3.9882	0.433
2 7/8	UC315-214D1	2.8750										
2 15/16	UC315-215D1	2.9375										
3	UC315-300D1	3.0000										
80	UC316D1	80	170	86	45	2.5	34	52	14	M14×1.5	107.9	11.4
3 1/16	UC316-301D1	3.0625	6.6929	3.3858	1.7717	0.098	1.339	2.047	0.551	9/16-18UNF	4.2480	0.449
3 1/8	UC316-302D1	3.1250										
3 3/16	UC316-303D1	3.1875										
85	UC317D1	85	180	96	47	3	40	56	16	M16×1.5	114.4	12.0
3 1/4	UC317-304D1	3.2500	7.0866	3.7795	1.8504	0.118	1.575	2.205	0.630	5/8-18UNF	4.5039	0.472
3 5/16	UC317-305D1	3.3125										
3 7/16	UC317-307D1	3.4375										
90	UC318D1	90	190	96	49	3	40	56	16	M16×1.5	120.9	12.3
3 7/16	UC318-307D1	3.4375	7.4803	3.7795	1.9291	0.118	1.575	2.205	0.630	5/8-18UNF	4.7598	0.484
3 1/2	UC318-308D1	3.5000										

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Basic load ratings		Mass
N lbf		kg lb
dynamic C_r	static C_{or}	
82 000	52 000	2.60
		6.06
18 400	11 700	5.89
		5.68
		5.51
92 500	60 000	3.25
20 800	13 400	7.36
		7.14
104 000	68 000	3.89
		9.06
23 400	15 300	8.82
		8.60
113 000	77 000	4.72
		11.0
25 500	17 400	10.7
		10.5
		10.2
123 000	86 500	5.55
		12.6
27 600	19 500	12.3
		12.1
133 000	97 000	6.67
		15.2
29 800	21 800	14.9
		14.2
143 000	107 000	7.56
32 000	24 100	17.3
		16.9

Ball bearings
Set screw type

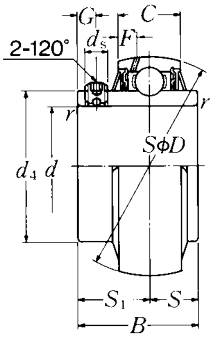


Shaft dia.	Bearing number 1)	Nominal dimensions										
mm inch		mm inch										
		d	D	B	C	r_s min.	S	S_1	G	ds	d_4	F
95	**UC319D1**	95	200	103	51	3	41	62	16	M16 × 1.5	127.5	12.8
$3\frac{5}{8}$	**UC319-310D1**	3.6250	7.8740	4.0551	2.0079	0.118	1.614	2.441	0.630	$\frac{5}{8}$-18UNF	5.0197	0.504
$3\frac{11}{16}$	**UC319-311D1**	3.6875										
$3\frac{3}{4}$	**UC319-312D1**	3.7500										
100	**UC320D1**	100	215	108	55	3	42	66	18	M18 × 1.5	135.6	13.5
$3\frac{13}{16}$	**UC320-313D1**	3.8125	8.4646	4.2520	2.1654	0.118	1.654	2.598	0.709	$\frac{5}{8}$-18UNF	5.3386	0.531
$3\frac{7}{8}$	**UC320-314D1**	3.8750										
$3\frac{15}{16}$	**UC320-315D1**	3.9375										
4	**UC320-400D1**	4.0000										
105	**UC321D1**	105	225	112	57	3	44	68	18	M18 × 1.5	142.1	13.9
110	**UC322D1**	110	240	117	59	3	46	71	18	M18 × 1.5	151.7	13.9
120	**UC324D1**	120	260	126	63	3	51	75	18	M18 × 1.5	165.2	16.0
130	**UC326D1**	130	280	135	67	4	54	81	20	M20 × 1.5	178.3	16.9
140	**UC328D1**	140	300	145	71	4	59	86	20	M20 × 1.5	190.4	17.7

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Basic load ratings		Mass
N lbf dynamic C_r	static C_{or}	kg lb
153 000	119 000	8.70
		19.9
34 500	26 600	19.5
		19.1
173 000	141 000	10.8
		24.7
39 000	31 500	24.2
		23.8
		23.4
184 000	153 000	12.2
205 000	179 000	14.3
207 000	185 000	18.5
229 000	214 000	23.0
253 000	246 000	28.5

Ball bearings
Set screw type

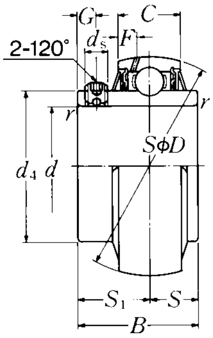


Shaft dia.	Bearing number 1)	Nominal dimensions										
mm inch							mm	inch				
		d	D	B	C	r_s min.	S	S_1	G	ds	d_4	F
25	**UCX05D1**	25	62	38.1	19	1	15.9	22.2	5	M6 × 0.75	40.8	4.6
$\frac{13}{16}$	**UCX05-013D1**	0.8125	2.4409	1.5000	0.7480	0.039	0.626	0.874	0.197	$\frac{1}{4}$-28UNF	1.6063	0.181
$\frac{7}{8}$	**UCX05-014D1**	0.8750										
$\frac{15}{16}$	**UCX05-015D1**	0.9375										
1	**UCX05-100D1**	1.0000										
30	**UCX06D1**	30	72	42.9	20	1	17.5	25.4	6	M8 × 1	46.8	4.6
$1\frac{1}{16}$	**UCX06-101D1**	1.0625	2.8346	1.6890	0.7874	0.039	0.689	1.000	0.236	$\frac{5}{16}$-24UNF	1.8425	0.181
$1\frac{1}{8}$	**UCX06-102D1**	1.1250										
$1\frac{3}{16}$	**UCX06-103D1**	1.1875										
35	**UCX07D1**	35	80	49.2	21	1.5	19	30.2	8	M8 × 1	53	4.5
$1\frac{5}{16}$	**UCX07-105D1**	1.3125	3.1496	1.9370	0.8268	0.059	0.748	1.189	0.315	$\frac{5}{16}$-24UNF	2.0866	0.177
$1\frac{3}{8}$	**UCX07-106D1**	1.3750										
$1\frac{7}{16}$	**UCX07-107D1**	1.4375										
40	**UCX08D1**	40	85	49.2	22	1.5	19	30.2	8	M8 × 1	57.5	4.9
$1\frac{1}{2}$	**UCX08-108D1**	1.5000	3.3465	1.9370	0.8661	0.059	0.748	1.189	0.315	$\frac{5}{16}$-24UNF	2.2638	0.193
$1\frac{9}{16}$	**UCX08-109D1**	1.5625										
45	**UCX09D1**	45	90	51.6	24	1.5	19	32.6	9	M10 × 1.25	62.4	5.9
$1\frac{5}{8}$	**UCX09-110D1**	1.6250	3.5433	2.0315	0.9449	0.059	0.748	1.283	0.354	$\frac{3}{8}$-24UNF	2.4567	0.232
$1\frac{11}{16}$	**UCX09-111D1**	1.6875										
$1\frac{3}{4}$	**UCX09-112D1**	1.7500										
50	**UCX10D1**	50	100	55.6	25	1.5	22.2	33.4	9	M10 × 1.25	69	6.0
$1\frac{7}{8}$	**UCX10-114D1**	1.8750	3.9370	2.1890	0.9843	0.059	0.874	1.315	0.354	$\frac{3}{8}$-24UNF	2.7165	0.236
$1\frac{15}{16}$	**UCX10-115D1**	1.9375										
55	**UCX11D1**	55	110	65.1	27	2	25.4	39.7	10	M10 × 1.25	77	6.2
$2\frac{1}{16}$	**UCX11-201D1**	2.0625	4.3307	2.5630	1.0630	0.079	1.000	1.563	0.394	$\frac{3}{8}$-24UNF	3.0315	0.244
$2\frac{1}{8}$	**UCX11-202D1**	2.1250										
$2\frac{3}{16}$	**UCX11-203D1**	2.1875										
60	**UCX12D1**	60	120	65.1	32	2	25.4	39.7	10	M10 × 1.25	82.5	8.7
$2\frac{3}{8}$	**UCX12-206D1**	2.3750	4.7244	2.5630	1.2598	0.079	1.000	1.563	0.394	$\frac{3}{8}$-24UNF	3.2480	0.343
$2\frac{7}{16}$	**UCX12-207D1**	2.4375										

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Basic load ratings N lbf		Mass kg lb
dynamic C_r	static C_{or}	
19 500	11 300	0.39
		0.97
4 400	2 540	0.93
		0.88
		0.84
25 700	15 300	0.68
		1.61
5 750	3 450	1.54
		1.50
29 100	17 800	0.82
		1.87
6 550	4 000	1.81
		1.74
32 500	20 400	0.93
7 350	4 600	2.16
		2.07
35 000	23 200	1.00
		2.43
7 900	5 200	2.34
		2.25
43 500	29 200	1.35
9 750	6 550	3.15
		3.04
52 500	36 000	1.90
		4.43
11 800	8 150	4.30
		4.12
57 500	40 000	2.27
12 900	9 000	4.96
		4.81

Ball bearings
Set screw type

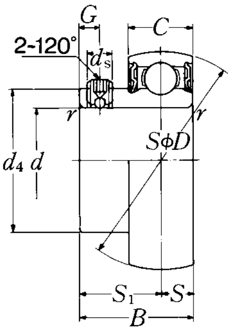


Shaft dia.	Bearing number [1]	Nominal dimensions										
mm inch		mm inch										
		d	D	B	C	r_s min.	S	S_1	G	ds	d_4	F
65	UCX13D1	65	125	74.6	33	2	30.2	44.4	12	M12×1.5	87	8.8
2 1/2	UCX13-208D1	2.5000	4.9213	2.9370	1.2992	0.079	1.189	1.748	0.472	1/2-20UNF	3.4252	0.346
2 9/16	UCX13-209D1	2.5625										
70	UCX14D1	70	130	77.8	34	2	33.3	44.5	12	M12×1.5	93	9.0
2 5/8	UCX14-210D1	2.6250	5.1181	3.0630	1.3386	0.079	1.311	1.752	0.472	1/2-20UNF	3.6614	0.354
2 11/16	UCX14-211D1	2.6875										
2 3/4	UCX14-212D1	2.7500										
75	UCX15D1	75	140	82.6	35	2	33.3	49.3	12	M12×1.5	98.1	9.5
2 13/16	UCX15-213D1	2.8125	5.5118	3.2520	1.3780	0.079	1.311	1.941	0.472	1/2-20UNF	3.8622	0.374
2 7/8	UCX15-214D1	2.8750										
2 15/16	UCX15-215D1	2.9375										
3	UCX15-300D1	3.0000										
80	UCX16D1	80	150	85.7	36	2.5	34.1	51.6	12	M12×1.5	106.4	10.1
3 1/16	UCX16-301D1	3.0625	5.9055	3.3740	1.4173	0.098	1.343	2.031	0.472	1/2-20UNF	4.1890	0.398
3 1/8	UCX16-302D1	3.1250										
3 3/16	UCX16-303D1	3.1875										
85	UCX17D1	85	160	96	37	2.5	39.7	56.3	12	M12×1.5	111.6	9.8
3 5/16	UCX17-305D1	3.3125	6.2992	3.7795	1.4567	0.098	1.563	2.217	0.472	1/2-20UNF	4.3937	0.386
3 7/16	UCX17-307D1	3.4375										
90	UCX18D1	90	170	104	39	2.5	42.9	61.1	14	M14×1.5	118.2	10.5
3 7/16	UCX18-307D1	3.4375	6.6929	4.0945	1.5354	0.098	1.689	2.406	0.551	9/16-18UNF	4.6535	0.413
3 1/2	UCX18-308D1	3.5000										
100	UCX20D1	100	190	117.5	44	2.5	49.2	68.3	16	M16×1.5	131.3	11.3
3 13/16	UCX20-313D1	3.8125	7.4803	4.6260	1.7323	0.098	1.937	2.689	0.630	5/8-18UNF	5.1693	0.445
3 7/8	UCX20-314D1	3.8750										
3 15/16	UCX20-315D1	3.9375										
4	UCX20-400D1	4.0000										

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Basic load ratings		Mass
N	lbf	kg lb
dynamic C_r	static C_{or}	
62 000	44 000	2.45
14 000	9 900	5.60
		5.38
66 000	49 500	2.47
		5.93
14 900	11 100	5.69
		5.47
72 500	53 000	3.11
		7.43
16 300	11 900	7.19
		6.92
		6.66
83 500	64 000	3.79
		8.75
18 700	14 300	8.47
		8.18
96 000	71 500	4.82
21 600	16 100	10.8
		10.1
109 000	82 000	5.51
24 500	18 400	13.3
		12.4
133 000	105 000	8.95
		18.8
29 900	23 500	18.4
		19.7
		19.2

Ball bearings
Set screw type

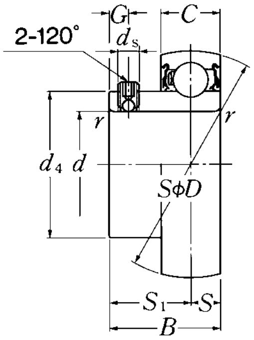


Shaft dia.	Bearing number [1]	Nominal dimensions									
mm inch		d	D	B	C	r_s min.	S	S_1	G	ds	d_4
12	**AS201**	12	40	22	12	0.6	6	16	4.2	M5 × 0.8	24.3
1/2	**AS201-008**	0.5000	1.5748	0.8661	0.4724	0.024	0.236	0.630	0.165	No.10-32UNF	0.957
15	**AS202**	15	40	22	12	0.6	6	16	4.2	M5 × 0.8	24.3
9/16	**AS202-009**	0.5625	1.5748	0.8661	0.4724	0.024	0.236	0.630	0.165	No.10-32UNF	0.957
5/8	**AS202-010**	0.6250									
17	**AS203**	17	40	22	12	0.6	6	16	4.2	M5 × 0.8	24.3
11/16	**AS203-011**	0.6875	1.5748	0.8661	0.4724	0.024	0.236	0.630	0.165	No.10-32UNF	0.957
20	**AS204**	20	47	25	14	1	7	18	4.2	M5 × 0.8	29.6
3/4	**AS204-012**	0.7500	1.8504	0.9843	0.5512	0.039	0.276	0.709	0.165	No.10-32UNF	1.165
25	**AS205**	25	52	27	15	1	7.5	19.5	5	M5 × 0.8	33.9
13/16	**AS205-013**	0.8125	2.0472	1.0630	0.5906	0.039	0.295	0.768	0.197	No.10-32UNF	1.335
7/8	**AS205-014**	0.8750									
15/16	**AS205-015**	0.9375									
1	**AS205-100**	1.0000									
30	**AS206**	30	62	29	16	1	8	21	5	M6 × 0.75	40.8
1 1/16	**AS206-101**	1.0625	2.4409	1.1417	0.6299	0.039	0.315	0.827	0.197	1/4-28UNF	1.606
1 1/8	**AS206-102**	1.1250									
1 3/16	**AS206-103**	1.1875									
1 1/4	**AS206-104**	1.2500									
35	**AS207**	35	72	34	17	1.5	8.5	25.5	6	M6 × 0.75	46.8
1 1/4	**AS207-104**	1.2500	2.8346	1.3386	0.6693	0.059	0.335	1.004	0.236	1/4-28UNF	1.843
1 5/16	**AS207-105**	1.3125									
1 3/8	**AS207-106**	1.3750									
1 7/16	**AS207-107**	1.4375									
40	**AS208**	40	80	38	18	1.5	9	29	8	M8 × 1	53
1 1/2	**AS208-108**	1.5000	3.1496	1.4961	0.7087	0.059	0.354	1.142	0.315	5/16-24UNF	2.087
1 9/16	**AS208-109**	1.5625									

Remarks: 1) If relubricatable type is needed, please order with suffix "D1".

Basic load ratings		Mass
N lbf dynamic C_r	static C_{or}	kg lb
9 600	4 600	0.10
2 160	1 030	0.22
9 600	4 600	0.09
2 160	1 030	0.21
		0.20
9 600	4 600	0.08
2 160	1 030	0.18
12 800	6 650	0.13
2 890	1 500	0.29
14 000	7 850	0.16
3 150	1 770	0.42
		0.40
		0.38
		0.35
19 500	11 300	0.25
4 400	2 540	0.61
		0.59
		0.57
		0.55
25 700	15 300	0.37
5 750	3 450	1.06
		0.93
		0.81
		0.69
29 100	17 800	0.50
6 550	4 000	1.15
		1.06

Ball bearings
Set screw type

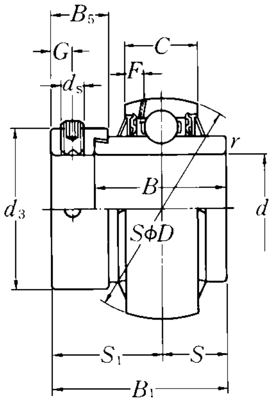


Shaft dia. mm inch	Bearing number 1)	Nominal dimensions mm inch									
		d	D	B	C	r_s min.	S	S_1	G	ds	d_4
12	**AR201**	12	40	22.5	13	0.6	6.5	16	5	M6 × 0.75	24.4
$\frac{1}{2}$	**AR201-008**	0.5000	1.5748	0.8858	0.5118	0.024	0.256	0.630	0.197	$\frac{1}{4}$-28UNF	0.9606
15	**AR202**	15	40	22.5	13	0.6	6.5	16	5	M6 × 0.75	24.4
$\frac{9}{16}$	**AR202-009**	0.5625	1.5748	0.8858	0.5118	0.024	0.256	0.630	0.197	$\frac{1}{4}$-28UNF	0.9606
$\frac{5}{8}$	**AR202-010**	0.6250									
17	**AR203**	17	40	22.5	13	0.6	6.5	16	5	M6 × 0.75	24.4
$\frac{11}{16}$	**AR203-011**	0.6875	1.5748	0.8858	0.5118	0.024	0.256	0.630	0.197	$\frac{1}{4}$-28UNF	0.9606
20	**AR204**	20	47	25.5	15	1	7.5	18	5	M6 × 0.75	29.6
$\frac{3}{4}$	**AR204-012**	0.7500	1.8504	1.0039	0.5906	0.039	0.295	0.709	0.197	$\frac{1}{4}$-28UNF	1.1654
25	**AR205**	25	52	27	15	1	7.5	19.5	5	M6 × 0.75	33.9
$\frac{13}{16}$	**AR205-013**	0.8125	2.0472	1.0630	0.5906	0.039	0.295	0.768	0.197	$\frac{1}{4}$-28UNF	1.3346
$\frac{7}{8}$	**AR205-014**	0.8750									
$\frac{15}{16}$	**AR205-015**	0.9375									
1	**AR205-100**	1.0000									
30	**AR206**	30	62	30	18	1	9	21	5	M6 × 0.75	40.8
$1\frac{1}{16}$	**AR206-101**	1.0625	2.4409	1.1811	0.7087	0.039	0.354	0.827	0.197	$\frac{1}{4}$-28UNF	1.6063
$1\frac{1}{8}$	**AR206-102**	1.1250									
$1\frac{3}{16}$	**AR206-103**	1.1875									
$1\frac{1}{4}$	**AR206-104**	1.2500									
35	**AR207**	35	72	35	19	1.5	9.5	25.5	6	M6 × 0.75	46.8
$1\frac{1}{4}$	**AR207-104**	1.2500	2.8346	1.3780	0.7480	0.059	0.374	1.004	0.236	$\frac{1}{4}$-28UNF	1.8425
$1\frac{5}{16}$	**AR207-105**	1.3125									
$1\frac{3}{8}$	**AR207-106**	1.3750									
$1\frac{7}{16}$	**AR207-107**	1.4375									
40	**AR208**	40	80	40	22	1.5	11	29	8	M8 × 1	53
$1\frac{1}{2}$	**AR208-108**	1.5000	3.1496	1.5748	0.8661	0.059	0.433	1.142	0.315	$\frac{5}{16}$-24UNF	2.0866
$1\frac{9}{16}$	**AR208-109**	1.5625									

Remarks: 1) If relubricatable type is needed, please order with suffix "D1".

Basic load ratings		Mass
N lbf		kg lb
dynamic C_r	static C_{or}	
9 600	4 600	0.11
2 160	1 030	0.24
9 600	4 600	0.10
2 160	1 030	0.23
		0.22
9 600	4 600	0.09
2 160	1 030	0.20
12 800	6 650	0.14
2 890	1 500	0.31
14 000	7 850	0.17
3 150	1 770	0.44
		0.42
		0.40
		0.37
19 500	11 300	0.26
4 400	2 540	0.63
		0.61
		0.59
		0.57
25 700	15 300	0.39
5 750	3 450	1.10
		0.97
		0.85
		0.73
29 100	17 800	0.54
6 550	4 000	1.24
		1.15

Ball bearings
Eccentric locking collar type

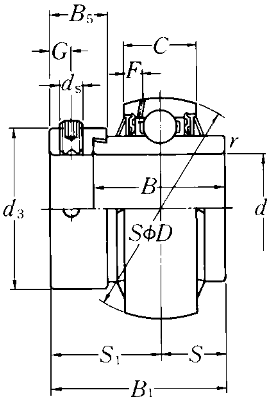


Shaft dia. mm inch	Bearing number [1]	Nominal dimensions mm inch										
		d	D	B_1	B	C	r_s min.	S	S_1	G	ds	d_3
20	**UEL204D1W3**	20	47	43.7	34.2	17	1	17.1	26.6	4.8	M6×0.75	33
3/4	**UEL204-012D1W3**	0.7500	1.8504	1.720	1.3465	0.6693	0.039	0.673	1.047	0.189	1/4-28UNF	1.299
25	**UEL205D1W3**	25	52	44.4	34.9	17	1	17.5	26.9	4.8	M6×0.75	38
13/16	**UEL205-013D1W3**	0.8125	2.0472	1.748	1.3740	0.6693	0.039	0.689	1.059	0.189	1/4-28UNF	1.496
7/8	**UEL205-014D1W3**	0.8750										
15/16	**UEL205-015D1W3**	0.9375										
1	**UEL205-100D1W3**	1.0000										
30	**UEL206D1W3**	30	62	48.4	36.5	19	1	18.3	30.1	6	M8×1	44.5
1 1/16	**UEL206-101D1W3**	1.0625	2.4409	1.906	1.4370	0.7480	0.039	0.720	1.185	0.236	5/16-24UNF	1.752
1 1/8	**UEL206-102D1W3**	1.1250										
1 3/16	**UEL206-103D1W3**	1.1875										
1 1/4	**UEL206-104D1W3**	1.2500										
35	**UEL207D1W3**	35	72	51.1	37.6	20	1.5	18.8	32.3	6.8	M10×1.25	55.5
1 1/4	**UEL207-104D1W3**	1.2500	2.8346	2.012	1.4803	0.7874	0.059	0.740	1.272	0.268	3/8-24UNF	2.185
1 5/16	**UEL207-105D1W3**	1.3125										
1 3/8	**UEL207-106D1W3**	1.3750										
1 7/16	**UEL207-107D1W3**	1.4375										
40	**UEL208D1W3**	40	80	56.3	42.8	21	1.5	21.4	34.9	6.8	M10×1.25	60
1 1/2	**UEL208-108D1W3**	1.5000	3.1496	2.217	1.6850	0.8268	0.059	0.843	1.374	0.268	3/8-24UNF	2.362
1 9/16	**UEL208-109D1W3**	1.5625										
45	**UEL209D1W3**	45	85	56.3	42.8	22	1.5	21.4	34.9	6.8	M10×1.25	63.5
1 5/8	**UEL209-110D1W3**	1.6250	3.3465	2.217	1.6850	0.8661	0.059	0.843	1.374	0.268	3/8-24UNF	2.500
1 11/16	**UEL209-111D1W3**	1.6875										
1 3/4	**UEL209-112D1W3**	1.7500										
50	**UEL210D1W3**	50	90	62.7	49.2	24	1.5	24.6	38.1	6.8	M10×1.25	69.5
1 13/16	**UEL210-113D1W3**	1.8125	3.5433	2.469	1.9370	0.9449	0.059	0.969	1.500	0.268	3/8-24UNF	2.736
1 7/8	**UEL210-114D1W3**	1.8750										
1 15/16	**UEL210-115D1W3**	1.9375										
2	**UEL210-200D1W3**	2.0000										

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Nominal dimensions		Basic load ratings		Mass
mm	inch	N	lbf	kg lb
		dynamic	static	
B_5	F	C_r	C_{or}	
13.5	4.7	12 800	6 650	0.23
0.531	0.185	2 890	1 500	0.45
13.5	4.5	14 000	7 850	0.27
0.531	0.177	3 150	1 770	0.61 0.58 0.55 0.51
15.9	4.6	19 500	11 300	0.45
0.626	0.181	4 400	2 540	0.94 0.89 0.84 0.80
17.5	4.6	25 700	15 300	0.60
0.689	0.181	5 750	3 450	1.45 1.40 1.35 1.28
18.3	4.5	29 100	17 800	0.79
0.720	0.177	6 550	4 000	1.90 1.82
18.3	4.9	32 500	20 400	0.85
0.720	0.193	7 350	4 600	2.05 1.97 1.88
18.3	5.9	35 000	23 200	0.98
0.720	0.232	7 900	5 200	2.46 2.36 2.25 2.09

Ball bearings
Eccentric locking collar type

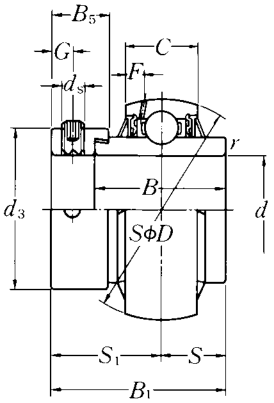


Shaft dia. mm inch	Bearing number 1)	Nominal dimensions mm inch d	D	B1	B	C	rs min.	S	S1	G	ds	d3
55	**UEL211D1W3**	55	100	71.4	55.5	25	2	27.8	43.6	8	M10×1.25	76
2	**UEL211-200D1W3**	2.0000	3.9370	2.811	2.1850	0.9843	0.079	1.094	1.717	0.315	3/8-24UNF	2.992
2 1/16	**UEL211-201D1W3**	2.0625										
2 1/8	**UEL211-202D1W3**	2.1250										
2 3/16	**UEL211-203D1W3**	2.1875										
60	**UEL212D1W3**	60	110	77.8	61.9	27	2	31	46.8	8	M10×1.25	84
2 1/4	**UEL212-204D1W3**	2.2500	4.3307	3.063	2.4370	1.0630	0.079	1.220	1.843	0.315	3/8-24UNF	3.307
2 5/16	**UEL212-205D1W3**	2.3125										
2 3/8	**UEL212-206D1W3**	2.3750										
2 7/16	**UEL212-207D1W3**	2.4375										
65	**UEL213D1W3**	65	120	85.7	68.3	32	2	34.15	51.55	8.7	M10×1.25	97
2 1/2	**UEL213-208D1W3**	2.5000	4.7244	3.374	2.6890	1.2598	0.079	1.344	2.030	0.343	3/8-24UNF	3.819
2 9/16	**UEL213-209D1W3**	2.5625										
70	**UEL214D1W3**	70	125	85.7	68.3	33	2	34.15	51.55	8.7	M10×1.25	97
2 5/8	**UEL214-210D1W3**	2.6250	4.9213	3.374	2.6890	1.2992	0.079	1.344	2.030	0.343	3/8-24UNF	3.819
2 11/16	**UEL214-211D1W3**	2.6875										
2 3/4	**UEL214-212D1W3**	2.7500										
75	**UEL215D1W3**	75	130	92	74.6	34	2	37.3	54.7	8.7	M10×1.25	102
2 13/16	**UEL215-213D1W3**	2.8125	5.1181	3.622	2.9370	1.3386	0.079	1.469	2.154	0.343	3/8-24UNF	4.016
2 7/8	**UEL215-214D1W3**	2.8750										
2 15/16	**UEL215-215D1W3**	2.9375										
3	**UEL215-300D1W3**	3.0000										

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Nominal dimensions		Basic load ratings		Mass
mm	inch	N	lbf	kg lb
		dynamic	static	
B_5	F	C_r	C_{or}	
20.7	6.0	43 500	29 200	1.32
0.815	0.236	9 750	6 550	3.28
				3.12
				3.02
				2.90
22.3	6.2	52 500	36 000	1.87
0.878	0.244	11 800	8 150	4.38
				4.22
				4.05
				3.88
23.8	8.7	57 500	40 000	2.48
0.937	0.343	12 900	9 000	5.47
				5.30
23.8	8.8	62 000	44 000	2.47
0.937	0.346	14 000	9 900	5.67
				5.45
				5.18
23.8	9.0	66 000	49 500	2.68
0.937	0.354	14 900	11 100	6.39
				6.15
				5.91
				5.60

Ball bearings
Eccentric locking collar type

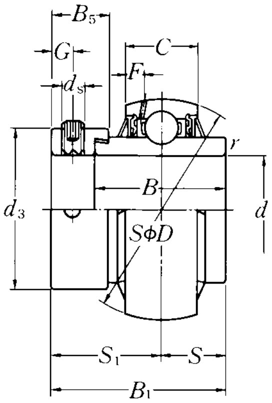


Shaft dia. mm inch	Bearing number [1]	Nominal dimensions mm inch										
		d	D	B_1	B	C	r_s min.	S	S_1	G	ds	d_3
25	**UEL305D1W3**	25	62	46.8	34.9	20	1.5	16.7	30.1	6	M8×1	42.8
13/16	**UEL305-013D1W3**	0.8125	2.4409	1.843	1.3740	0.7874	0.059	0.657	1.185	0.236	5/16-24UNF	1.685
7/8	**UEL305-014D1W3**	0.8750										
15/16	**UEL305-015D1W3**	0.9375										
1	**UEL305-100D1W3**	1.0000										
30	**UEL306D1W3**	30	72	50	36.5	23	1.5	17.5	32.5	6.7	M8×1	50
1 1/16	**UEL306-101D1W3**	1.0625	2.8346	1.969	1.4370	0.9055	0.059	0.689	1.280	0.264	5/16-24UNF	1.969
1 1/8	**UEL306-102D1W3**	1.1250										
1 3/16	**UEL306-103D1W3**	1.1875										
35	**UEL307D1W3**	35	80	51.6	38.1	25	2	18.3	33.3	6.7	M8×1	55
1 1/4	**UEL307-104D1W3**	1.2500	3.1496	2.031	1.5000	0.9843	0.079	0.720	1.311	0.264	5/16-24UNF	2.165
1 5/16	**UEL307-105D1W3**	1.3125										
1 3/8	**UEL307-106D1W3**	1.3750										
1 7/16	**UEL307-107D1W3**	1.4375										
40	**UEL308D1W3**	40	90	57.1	41.3	27	2	19.8	37.3	8	M10×1.25	63.5
1 1/2	**UEL308-108D1W3**	1.5000	3.5433	2.248	1.6260	1.0630	0.079	0.780	1.469	0.315	3/8-24UNF	2.500
1 9/16	**UEL308-109D1W3**	1.5625										
45	**UEL309D1W3**	45	100	58.7	42.9	29	2	19.8	38.9	8	M10×1.25	70
1 5/8	**UEL309-110D1W3**	1.6250	3.9370	2.311	1.6890	1.1417	0.079	0.780	1.531	0.315	3/8-24UNF	2.756
1 11/16	**UEL309-111D1W3**	1.6875										
1 3/4	**UEL309-112D1W3**	1.7500										
50	**UEL310D1W3**	50	110	66.6	49.2	32	2.5	24.6	42	8.7	M10×1.25	76.2
1 13/16	**UEL310-113D1W3**	1.8125	4.3307	2.622	1.9370	1.2598	0.098	0.969	1.654	0.343	3/8-24UNF	3.000
1 7/8	**UEL310-114D1W3**	1.8750										
1 15/16	**UEL310-115D1W3**	1.9375										
55	**UEL311D1W3**	55	120	73	55.6	34	2.5	27.8	45.2	8.7	M10×1.25	83
2	**UEL311-200D1W3**	2.0000	4.7244	2.874	2.1890	1.3386	0.098	1.094	1.780	0.343	3/8-24UNF	3.268
2 1/16	**UEL311-201D1W3**	2.0625										
2 1/8	**UEL311-202D1W3**	2.1250										
2 3/16	**UEL311-203D1W3**	2.1875										

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Nominal dimensions		Basic load ratings		Mass
mm	inch	N	lbf	kg lb
		dynamic	static	
B_5	F	C_r	C_{or}	
15.9	5.0	21 200	10 900	0.43
				1.09
0.626	0.197	4 750	2 460	1.05
				1.01
				0.96
17.5	5.9	26 700	15 000	0.69
				1.57
0.689	0.232	6 000	3 400	1.51
				1.45
17.5	6.8	33 500	19 100	0.80
				1.92
0.689	0.268	7 500	4 300	1.84
				1.77
				1.69
20.6	7.4	40 500	24 000	1.08
0.811	0.291	9 150	5 400	2.58
				2.49
20.6	7.4	53 000	32 000	1.45
				3.36
0.811	0.291	11 900	7 200	3.26
				3.15
22.2	8.1	62 000	38 500	1.86
				4.40
0.874	0.319	13 900	8 600	4.29
				4.15
22.2	8.5	71 500	45 000	2.34
				5.58
0.874	0.335	16 100	10 100	5.39
				5.25
				5.08

Ball bearings
Eccentric locking collar type

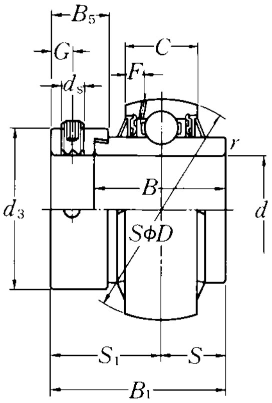


Shaft dia.	Bearing number 1)	Nominal dimensions										
mm inch		mm inch										
		d	D	B_1	B	C	r_s min.	S	S_1	G	ds	d_3
60	**UEL312D1W3**	60	130	79.4	61.9	36	2.5	30.95	48.45	8.7	M10 × 1.25	89
$2\frac{1}{4}$	**UEL312-204D1W3**	2.2500	5.1181	3.126	2.4370	1.4173	0.098	1.219	1.907	0.343	$\frac{3}{8}$-24UNF	3.504
$2\frac{5}{16}$	**UEL312-205D1W3**	2.3125										
$2\frac{3}{8}$	**UEL312-206D1W3**	2.3750										
$2\frac{7}{16}$	**UEL312-207D1W3**	2.4375										
65	**UEL313D1W3**	65	140	85.7	65.1	39	2.5	32.55	53.15	10.3	M12 × 1.5	97
$2\frac{1}{2}$	**UEL313-208D1W3**	2.5000	5.5118	3.374	2.5630	1.5354	0.098	1.281	2.093	0.406	$\frac{1}{2}$-20UNF	3.819
$2\frac{9}{16}$	**UEL313-209D1W3**	2.5625										
70	**UEL314D1W3**	70	150	92.1	68.3	41	2.5	34.15	57.95	10.3	M12 × 1.5	102
$2\frac{5}{8}$	**UEL314-210D1W3**	2.6250	5.9055	3.626	2.6890	1.6142	0.098	1.344	2.281	0.406	$\frac{1}{2}$-20UNF	4.016
$2\frac{11}{16}$	**UEL314-211D1W3**	2.6875										
$2\frac{3}{4}$	**UEL314-212D1W3**	2.7500										
75	**UEL315D1W3**	75	160	100	74.6	43	2.5	37.3	62.7	12.7	M16 × 1.5	113
$2\frac{13}{16}$	**UEL315-213D1W3**	2.8125	6.2992	3.937	2.9370	1.6929	0.098	1.469	2.469	0.500	$\frac{5}{8}$-18UNF	4.449
$2\frac{7}{8}$	**UEL315-214D1W3**	2.8750										
$2\frac{15}{16}$	**UEL315-215D1W3**	2.9375										
3	**UEL315-300D1W3**	3.0000										
80	**UEL316D1W3**	80	170	106.4	81	45	2.5	40.5	65.9	12.7	M16 × 1.5	119
$3\frac{1}{16}$	**UEL316-301D1W3**	3.0625	6.6929	4.189	3.1890	1.7717	0.098	1.594	2.594	0.500	$\frac{5}{8}$-18UNF	4.685
$3\frac{1}{8}$	**UEL316-302D1W3**	3.1250										
$3\frac{3}{16}$	**UEL316-303D1W3**	3.1875										
85	**UEL317D1W3**	85	180	109.5	84.1	47	3	42.05	67.45	12.7	M16 × 1.5	127
$3\frac{1}{4}$	**UEL317-304D1W3**	3.2500	7.0866	4.311	3.3110	1.8504	0.118	1.656	2.656	0.500	$\frac{5}{8}$-18UNF	5.000
$3\frac{5}{16}$	**UEL317-305D1W3**	3.3125										
$3\frac{7}{16}$	**UEL317-307D1W3**	3.4375										
90	**UEL318D1W3**	90	190	115.9	87.3	49	3	43.65	72.25	14.3	M20 × 1.5	133
$3\frac{7}{16}$	**UEL318-307D1W3**	3.4375	7.4803	4.563	3.4370	1.9291	0.118	1.719	2.844	0.563	$\frac{3}{4}$-16UNF	5.236
$3\frac{1}{2}$	**UEL318-308D1W3**	3.5000										
95	**UEL319D1W3**	95	200	122.3	93.7	51	3	38.9	83.4	14.3	M20 × 1.5	140
$3\frac{5}{8}$	**UEL319-310D1W3**	3.6250	7.8740	4.815	3.6890	2.0079	0.118	1.531	3.283	0.563	$\frac{3}{4}$-16UNF	5.512
$3\frac{11}{16}$	**UEL319-311D1W3**	3.6875										
$3\frac{3}{4}$	**UEL319-312D1W3**	3.7500										

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Nominal dimensions		Basic load ratings		Mass
mm inch		N lbf		kg lb
		dynamic	static	
B_5	F	C_r	C_{or}	
23.9	9.0	82 000	52 000	2.94
				6.80
0.941	0.354	18 400	11 700	6.65
				6.48
				6.19
27	10.1	92 500	60 000	3.67
1.063	0.398	20 800	13 400	8.49
				8.27
30.2	10.5	104 000	68 000	4.40
				10.4
1.189	0.413	23 400	15 300	10.2
				9.96
31.8	11.0	113 000	77 000	5.34
				13.2
1.252	0.433	25 500	17 400	12.9
				12.7
				12.5
31.8	11.4	123 000	86 500	6.70
				14.9
1.252	0.449	27 600	19 500	14.8
				14.6
31.8	12.0	133 000	97 000	8.00
				18.0
1.252	0.472	29 800	21 800	17.7
				17.0
36.5	12.3	143 000	107 000	9.10
1.437	0.484	32 000	24 100	20.7
				20.2
36.5	12.8	153 000	119 000	10.4
				23.4
1.437	0.504	34 500	26 600	23.0
				22.6

Ball bearings
Eccentric locking collar type

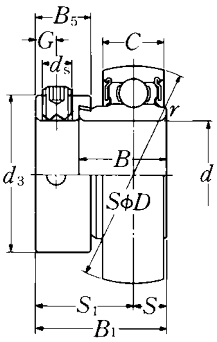


Shaft dia.	Bearing number 1)	Nominal dimensions										
mm inch		mm inch										
		d	D	B_1	B	C	r_s min.	S	S_1	G	ds	d_3
100	**UEL320D1W3**	100	215	128.6	100	55	3	50	78.6	14.3	M20 × 1.5	146
3 13/16	**UEL320-313D1W3**	3.8125	8.4646	5.063	3.9370	2.1654	0.118	1.969	3.094	0.563	3/4-16UNF	5.748
3 7/8	**UEL320-314D1W3**	3.8750										
3 15/16	**UEL320-315D1W3**	3.9375										
4	**UEL320-400D1W3**	4.0000										
105	**UEL321D1W3**	105	225	139.7	104.8	57	3	48.4	91.3	17.5	M20 × 1.5	157
110	**UEL322D1W3**	110	240	141.3	106.4	59	3	49.2	92.1	17.5	M20 × 1.5	168

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Nominal dimensions		Basic load ratings		Mass
mm	inch	N lbf		kg lb
B_5	F	dynamic C_r	static C_{or}	
36.5	13.5	173 000	141 000	12.5
1.437	0.531	39 000	31 500	28.5
				28.0
				27.6
				27.0
42.8	13.9	184 000	153 000	14.6
42.8	13.9	205 000	179 000	17.2

Ball bearings
Eccentric locking collar type

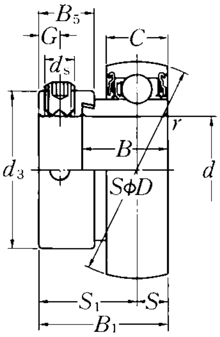


Shaft dia. mm inch	Bearing number 1)	Nominal dimensions mm inch										
		d	D	B_1	B	C	r_s min.	S	S_1	G	ds	d_3
12	AEL201W3	12	40	28.6	19	12	0.6	6.5	22.1	4.8	M6 × 0.75	29
1⁄2	AEL201-008W3	0.5000	1.5748	1.126	0.7480	0.4724	0.024	0.256	0.870	0.189	1⁄4-28UNF	1.142
15	AEL202W3	15	40	28.6	19	12	0.6	6.5	22.1	4.8	M6 × 0.75	29
9⁄16	AEL202-009W3	0.5625	1.5748	1.126	0.7480	0.4724	0.024	0.256	0.870	0.189	1⁄4-28UNF	1.142
5⁄8	AEL202-010W3	0.6250										
17	AEL203W3	17	40	28.6	19	12	0.6	6.5	22.1	4.8	M6 × 0.75	29
11⁄16	AEL203-011W3	0.6875	1.5748	1.126	0.7480	0.4724	0.024	0.256	0.870	0.189	1⁄4-28UNF	1.142
20	AEL204W3	20	47	31	21.5	14	1	7.5	23.5	4.8	M6 × 0.75	33
3⁄4	AEL204-012W3	0.7500	1.8504	1.220	0.8465	0.5512	0.039	0.295	0.925	0.189	1⁄4-28UNF	1.299
25	AEL205W3	25	52	31	21.5	15	1	7.5	23.5	4.8	M6 × 0.75	38
13⁄16	AEL205-013W3	0.8125	2.0472	1.220	0.8465	0.5906	0.039	0.295	0.925	0.189	1⁄4-28UNF	1.496
7⁄8	AEL205-014W3	0.8750										
15⁄16	AEL205-015W3	0.9375										
1	AEL205-100W3	1.0000										
30	AEL206W3	30	62	35.7	23.8	16	1	9	26.7	6	M8 × 1	44.5
1 1⁄16	AEL206-101W3	1.0625	2.4409	1.406	0.9370	0.6299	0.039	0.354	1.051	0.236	5⁄16-24UNF	1.752
1 1⁄8	AEL206-102W3	1.1250										
1 3⁄16	AEL206-103W3	1.1875										
1 1⁄4	AEL206-104W3	1.2500										
35	AEL207W3	35	72	38.9	25.4	17	1.5	9.5	29.4	6.8	M10 × 1.25	55.5
1 1⁄4	AEL207-104W3	1.2500	2.8346	1.531	1.0000	0.6693	0.059	0.374	1.157	0.268	3⁄8-24UNF	2.185
1 5⁄16	AEL207-105W3	1.3125										
1 3⁄8	AEL207-106W3	1.3750										
1 7⁄16	AEL207-107W3	1.4375										
40	AEL208W3	40	80	43.7	30.2	18	1.5	11	32.7	6.8	M10 × 1.25	60
1 1⁄2	AEL208-108W3	1.5000	3.1496	1.720	1.1890	0.7087	0.059	0.433	1.287	0.268	3⁄8-24UNF	2.362
1 9⁄16	AEL208-109W3	1.5625										

Remarks: 1) If relubricatable type is needed, please order with suffix "D1".

Nominal dimensions	Basic load ratings		Mass
mm inch	N lbf		kg lb
B_5	dynamic C_r	static C_{or}	
13.6	9 600	4 600	0.12
0.535	2 160	1 030	0.26
13.6	9 600	4 600	0.11
0.535	2 160	1 030	0.26 0.24
13.6	9 600	4 600	0.10
0.535	2 160	1 030	0.23
13.5	12 800	6 650	0.17
0.531	2 890	1 500	0.35
13.5	14 000	7 850	0.20
0.531	3 150	1 770	0.51 0.48 0.45 0.42
15.9	19 500	11 300	0.31
0.626	4 400	2 540	0.74 0.73 0.66 0.61
17.5	25 700	15 300	0.49
0.689	5 750	3 450	1.15 1.10 1.04 0.98
18.3	29 100	17 800	0.66
0.720	6 550	4 000	1.41 1.34

Ball bearings
Eccentric locking collar type

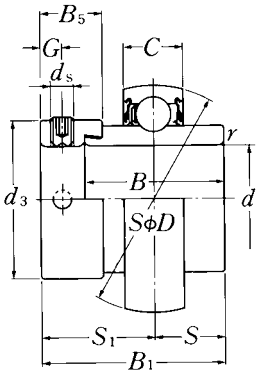


Shaft dia.	Bearing number 1)	Nominal dimensions										
mm inch						mm		inch				
		d	D	B_1	B	C	r_s min.	S	S_1	G	ds	d_3
12	**JEL201W3**	12	40	28.6	19	13	0.6	6.5	22.1	4.8	M6×0.75	29
1/2	**JEL201-008W3**	0.5000	1.5748	1.126	0.7480	0.5118	0.024	0.256	0.870	0.189	1/4-28UNF	1.142
15	**JEL202W3**	15	40	28.6	19	13	0.6	6.5	22.1	4.8	M6×0.75	29
9/16	**JEL202-009W3**	0.5625	1.5748	1.126	0.7480	0.5118	0.024	0.256	0.870	0.189	1/4-28UNF	1.142
5/8	**JEL202-010W3**	0.6250										
17	**JEL203W3**	17	40	28.6	19	13	0.6	6.5	22.1	4.8	M6×0.75	29
11/16	**JEL203-011W3**	0.6875	1.5748	1.126	0.7480	0.5118	0.024	0.256	0.870	0.189	1/4-28UNF	1.142
20	**JEL204W3**	20	47	31	21.5	15	1	7.5	23.5	4.8	M6×0.75	33
3/4	**JEL204-012W3**	0.7500	1.8504	1.220	0.8465	0.5906	0.039	0.295	0.925	0.189	1/4-28UNF	1.299
25	**JEL205W3**	25	52	31	21.5	15	1	7.5	23.5	4.8	M6×0.75	38
13/16	**JEL205-013W3**	0.8125	2.0472	1.220	0.8465	0.5906	0.039	0.295	0.925	0.189	1/4-28UNF	1.496
7/8	**JEL205-014W3**	0.8750										
15/16	**JEL205-015W3**	0.9375										
1	**JEL205-100W3**	1.0000										
30	**JEL206W3**	30	62	35.7	23.8	18	1	9	26.7	6	M8×1	44.5
1 1/16	**JEL206-101W3**	1.0625	2.4409	1.406	0.9370	0.7087	0.039	0.354	1.051	0.236	5/16-24UNF	1.752
1 1/8	**JEL206-102W3**	1.1250										
1 3/16	**JEL206-103W3**	1.1875										
1 1/4	**JEL206-104W3**	1.2500										
35	**JEL207W3**	35	72	38.9	25.4	19	1.5	9.5	29.4	6.8	M10×1.25	55.5
1 1/4	**JEL207-104W3**	1.2500	2.8346	1.531	1.0000	0.7480	0.059	0.374	1.157	0.268	3/8-24UNF	2.185
1 5/16	**JEL207-105W3**	1.3125										
1 3/8	**JEL207-106W3**	1.3750										
1 7/16	**JEL207-107W3**	1.4375										
40	**JEL208W3**	40	80	43.7	30.2	22	1.5	11	32.7	6.8	M10×1.25	60
1 1/2	**JEL208-108W3**	1.5000	3.1496	1.720	1.1890	0.8661	0.059	0.433	1.287	0.268	3/8-24UNF	2.362
1 9/16	**JEL208-109W3**	1.5625										

Remarks: 1) If relubricatable type is needed, please order with suffix "D1".

Nominal dimensions	Basic load ratings		Mass
mm inch	N lbf		kg lb
B_5	dynamic C_r	static C_{or}	
13.6 0.535	9 600 2 160	4 600 1 030	0.12 0.25
13.6 0.535	9 600 2 160	4 600 1 030	0.10 0.24 0.22
13.6 0.535	9 600 2 160	4 600 1 030	0.09 0.20
13.5 0.531	12 800 2 890	6 650 1 500	0.16 0.37
13.5 0.531	14 000 3 150	7 850 1 770	0.19 0.50 0.47 0.44 0.41
15.9 0.626	19 500 4 400	11 300 2 540	0.32 0.78 0.73 0.69 0.64
17.5 0.689	25 700 5 750	15 300 3 450	0.50 1.22 1.16 1.11 1.05
18.3 0.720	29 100 6 550	17 800 4 000	0.65 1.53 1.46

Ball bearings
Eccentric locking collar type

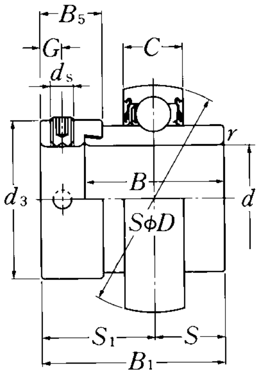


Shaft dia. mm inch	Bearing number[1]	Nominal dimensions mm inch										
		d	D	B_1	B	C	r_s min.	S	S_1	G	ds	d_3
20	**REL204W3**	20	47	43.7	34.2	15	1	17.1	26.6	4.8	M6×0.75	33.0
$\frac{3}{4}$	**REL204-012W3**	0.7500	1.8504	1.720	1.3465	0.5906	0.039	0.673	1.047	0.189	$\frac{1}{4}$-28UNF	1.299
25	**REL205W3**	25	52	44.4	34.9	15	1	17.45	26.9	4.8	M6×0.75	38.0
$\frac{13}{16}$	**REL205-013W3**	0.8125	2.0472	1.748	1.3740	0.5906	0.039	0.687	1.059	0.189	$\frac{1}{4}$-28UNF	1.496
$\frac{7}{8}$	**REL205-014W3**	0.8750										
$\frac{15}{16}$	**REL205-015W3**	0.9375										
1	**REL205-100W3**	1.0000										
30	**REL206W3**	30	62	48.4	36.5	18	1	18.25	30.1	6	M8×1	44.5
$1\frac{1}{16}$	**REL206-101W3**	1.0625	2.4409	1.906	1.4370	0.7087	0.039	0.720	1.185	0.236	$\frac{5}{16}$-24UNF	1.752
$1\frac{1}{8}$	**REL206-102W3**	1.1250										
$1\frac{3}{16}$	**REL206-103W3**	1.1875										
$1\frac{1}{4}$	**REL206-104W3**	1.2500										
35	**REL207W3**	35	72	51.1	37.6	19	1.5	18.8	32.3	6.8	M10×1.25	55.5
$1\frac{1}{4}$	**REL207-104W3**	1.2500	2.8346	2.012	1.4803	0.7480	0.059	0.740	1.272	0.268	$\frac{3}{8}$-24UNF	2.185
$1\frac{5}{16}$	**REL207-105W3**	1.3125										
$1\frac{3}{8}$	**REL207-106W3**	1.3750										
$1\frac{7}{16}$	**REL207-107W3**	1.4375										
40	**REL208W3**	40	80	56.3	42.8	22	1.5	21.4	34.9	6.8	M10×1.25	60.0
$1\frac{1}{2}$	**REL208-108W3**	1.5000	3.1496	2.217	1.6850	0.8661	0.059	0.843	1.374	0.268	$\frac{3}{8}$-24UNF	2.362
$1\frac{9}{16}$	**REL208-109W3**	1.5625										
45	**REL209W3**	45	85	56.3	42.8	22	1.5	21.4	34.9	6.8	M10×1.25	63.5
$1\frac{5}{8}$	**REL209-110W3**	1.6250	3.3465	2.217	1.6850	0.8661	0.059	0.843	1.374	0.268	$\frac{3}{8}$-24UNF	2.500
$1\frac{11}{16}$	**REL209-111W3**	1.6875										
$1\frac{3}{4}$	**REL209-112W3**	1.7500										
50	**REL210W3**	50	90	62.7	49.2	22	1.5	24.6	38.1	6.8	M10×1.25	69.5
$1\frac{13}{16}$	**REL210-113W3**	1.8125	3.5433	2.469	1.9370	0.8661	0.059	0.969	1.500	0.268	$\frac{3}{8}$-24UNF	2.736
$1\frac{7}{8}$	**REL210-114W3**	1.8750										
$1\frac{15}{16}$	**REL210-115W3**	1.9375										
2	**REL210-200W3**	2.0000										

Remarks: 1) If relubricatable type is needed, please order with suffix "D1".

Nominal dimensions	Basic load ratings		Mass
mm inch B_5	N dynamic C_r	lbf static C_{or}	kg lb
13.5	12 800	6 650	0.22
0.531	2 890	1 500	0.43
13.5	14 000	7 850	0.26
			0.59
0.531	3 150	1 770	0.56
			0.53
			0.49
15.9	19 500	11 300	0.44
			0.92
0.626	4 400	2 540	0.87
			0.82
			0.78
17.5	25 700	15 300	0.58
			1.41
0.689	5 750	3 450	1.36
			1.31
			1.24
18.3	29 100	17 800	0.78
0.720	6 550	4 000	1.88
			1.80
18.3	32 500	20 400	0.83
			2.01
0.720	7 350	4 600	1.93
			1.84
18.3	35 000	23 200	0.96
			2.42
0.720	7 900	5 200	2.32
			2.21
			2.05

Ball bearings
Eccentric locking collar type

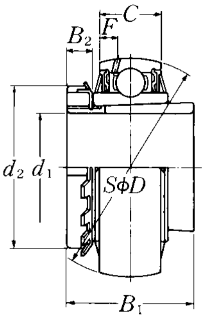


Shaft dia. mm inch	Bearing number 1)	Nominal dimensions mm inch										
		d	D	B_1	B	C	r_s min.	S	S_1	G	ds	d_3
55	**REL211W3**	55	100	71.4	55.5	24	2	27.8	43.6	8	M10×1.25	76
2	**REL211-200W3**	2.0000	3.9370	2.811	2.1850	0.9449	0.079	1.094	1.717	0.315	3⁄8-24UNF	2.992
2 1⁄16	**REL211-201W3**	2.0625										
2 1⁄8	**REL211-202W3**	2.1250										
2 3⁄16	**REL211-203W3**	2.1875										
60	**REL212W3**	60	110	77.8	61.9	27	2	31	46.8	8	M10×1.25	84
2 1⁄4	**REL212-204W3**	2.2500	4.3307	3.063	2.4370	1.0630	0.079	1.220	1.843	0.315	3⁄8-24UNF	3.307
2 5⁄16	**REL212-205W3**	2.3125										
2 3⁄8	**REL212-206W3**	2.3750										
2 7⁄16	**REL212-207W3**	2.4375										

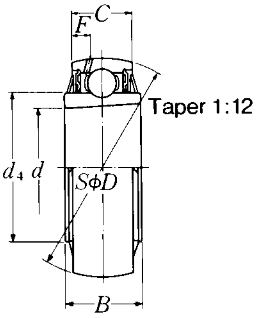
Remarks: 1) If relubricatable type is needed, please order with suffix "D1".

Nominal dimensions	Basic load ratings		Mass
mm inch	N lbf		kg lb
B_5	dynamic C_r	static C_{or}	
20.7	43 500	29 200	1.29
			3.21
0.815	9 750	6 550	3.05
			2.95
			2.83
22.3	52 500	36 000	1.83
			4.29
0.878	11 800	8 150	4.13
			3.96
			3.79

Ball bearings
Adapter type



UK2···D1;H,HA, HE,HS



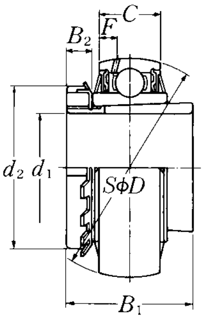
UK2···D1

Shaft dia. mm inch	Bearing number 1) 2) 3)	Nominal dimensions mm inch									
		d	D	B	C	d_4	d_1	B_1	B_2	d_2	F
20	UK205D1;H2305X	25	52	23	17	33.9	20	35	8	38	4.5
$\frac{3}{4}$	UK205D1;HE2305	0.9843	2.0472	0.9055	0.6693	1.335	$\frac{3}{4}$	1.378	0.315	1.496	0.177
25	UK206D1;H2306X	30	62	26	19	40.8	25	38	8	45	4.6
$\frac{7}{8}$	UK206D1;HS2306	1.1811	2.4409	1.0236	0.7480	1.606	$\frac{7}{8}$	1.496	0.315	1.772	0.181
1	UK206D1;HE2306X						1				
30	UK207D1;H2307X	35	72	29	20	46.8	30	43	9	52	4.6
$1\frac{1}{8}$	UK207D1;HS2307	1.3780	2.8346	1.1417	0.7874	1.843	$1\frac{1}{8}$	1.693	0.354	2.047	0.181
35	UK208D1;H2308X	40	80	31	21	53	35	46	10	58	4.5
$1\frac{1}{4}$	UK208D1;HE2308X	1.5748	3.1496	1.2205	0.8268	2.087	$1\frac{1}{4}$	1.811	0.394	2.283	0.177
$1\frac{3}{8}$	UK208D1;HS2308X						$1\frac{3}{8}$				
40	UK209D1;H2309X	45	85	31	22	57.5	40	50	11	65	4.9
$1\frac{7}{16}$	UK209D1;HA2309						$1\frac{7}{16}$				
$1\frac{1}{2}$	UK209D1;HE2309X	1.7717	3.3465	1.2205	0.8661	2.264	$1\frac{1}{2}$	1.969	0.433	2.559	0.193
$1\frac{5}{8}$	UK209D1;HS2309X						$1\frac{5}{8}$				
45	UK210D1;H2310X	50	90	32	24	62.4	45	55	12	70	5.9
$1\frac{5}{8}$	UK210D1;HS2310						$1\frac{5}{8}$				
$1\frac{11}{16}$	UK210D1;HA2310	1.9685	3.5433	1.2598	0.9449	2.457	$1\frac{11}{16}$	2.165	0.472	2.756	0.232
$1\frac{3}{4}$	UK210D1;HE2310X						$1\frac{3}{4}$				
50	UK211D1;H2311X	55	100	35	25	69	50	59	12	75	6.0
$1\frac{7}{8}$	UK211D1;HS2311						$1\frac{7}{8}$				
$1\frac{15}{16}$	UK211D1;HA2311	2.1654	3.9370	1.3780	0.9843	2.717	$1\frac{15}{16}$	2.323	0.472	2.953	0.236
2	UK211D1;HE2311XY						2				
55	UK212D1;H2312X	60	110	38	27	77	55	62	13	80	6.2
$2\frac{1}{8}$	UK212D1;HS2312	2.3622	4.3307	1.4961	1.0630	3.031	$2\frac{1}{8}$	2.441	0.512	3.150	0.244
60	UK213D1;H2313X	65	120	40	32	82.5	60	65	14	85	8.7
$2\frac{3}{16}$	UK213D1;HA2313						$2\frac{3}{16}$				
$2\frac{1}{4}$	UK213D1;HE2313X	2.5591	4.7244	1.5748	1.2598	3.248	$2\frac{1}{4}$	2.559	0.551	3.346	0.343
$2\frac{3}{8}$	UK213D1;HS2313X						$2\frac{3}{8}$				

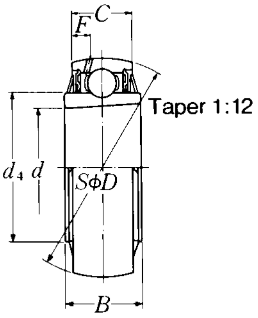
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Basic load ratings		Mass
N lbf		kg lb
dynamic C_r	static C_{or}	
14 000	7 850	0.25
3 150	1 770	0.57
19 500	11 300	0.36
4 400	2 540	0.86
		0.78
25 700	15 300	0.57
5 750	3 450	1.30
29 100	17 800	0.74
6 550	4 000	1.77
		1.63
32 500	20 400	0.83
7 350	4 600	2.01
		1.93
		1.76
35 000	23 200	0.97
7 900	5 200	2.38
		2.28
		2.18
43 500	29 200	1.26
9 750	6 550	2.96
		2.84
		2.70
52 500	36 000	1.59
11 800	8 150	3.60
57 500	40 000	2.00
12 900	9 000	4.86
		4.70
		4.38

Ball bearings
Adapter type



UK2···D1;H,HA, HE,HS



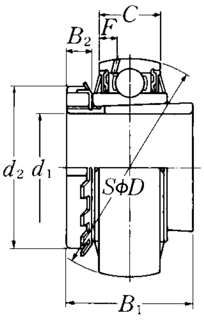
UK2···D1

Shaft dia. mm inch	Bearing number 1) 2) 3)	Nominal dimensions mm inch									
		d	D	B	C	d_4	d_1	B_1	B_2	d_2	F
65	UK215D1;H2315X	75	130	44	34	93	65	73	15	98	9.0
$2\frac{7}{16}$	UK215D1;HA2315	2.9528	5.1181	1.7323	1.3386	3.661	$2\frac{7}{16}$	2.874	0.591	3.858	0.354
$2\frac{1}{2}$	UK215D1;HE2315X						$2\frac{1}{2}$				
70	UK216D1;H2316X	80	140	45	35	98.1	70	78	17	105	9.5
$2\frac{11}{16}$	UK216D1;HA2316	3.1496	5.5118	1.7717	1.3780	3.862	$2\frac{11}{16}$	3.071	0.669	4.134	0.374
$2\frac{3}{4}$	UK216D1;HE2316X						$2\frac{3}{4}$				
75	UK217D1;H2317X	85	150	46	36	106.4	75	82	18	110	10.1
$2\frac{15}{16}$	UK217D1;HA2317X	3.3465	5.9055	1.8110	1.4173	4.189	$2\frac{15}{16}$	3.228	0.709	4.331	0.398
3	UK217D1;HE2317X						3				
80	UK218D1;H2318X	90	160	47	37	111.6	80	86	18	120	9.8
$3\frac{3}{16}$	UK218D1;HA2318X	3.5433	6.2992	1.8504	1.4567	4.394	$3\frac{3}{16}$	3.386	0.709	4.724	0.386

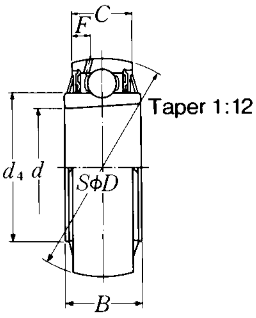
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Basic load ratings		Mass
N	lbf	kg lb
dynamic C_r	static C_{or}	
66 000	49 500	2.56
14 900	11 100	6.04 5.84
72 500	53 000	3.23
16 300	11 900	7.38 7.14
83 500	64 000	3.93
18 700	14 300	8.73 8.46
96 000	71 500	4.74
21 600	16 100	11.0

Ball bearings
Adapter type



UK3···D1;H, HA, HE, HS



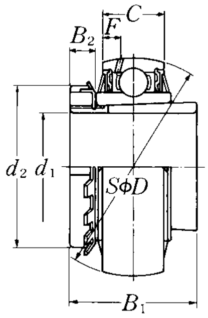
UK3···D1

Shaft dia.	Bearing number 1) 2) 3)	Nominal dimensions									
mm inch		mm inch									
		d	D	B	C	d_4	d_1	B_1	B_2	d_2	F
20	UK305D1;H2305X	25	62	26	20	36.8	20	35	8	38	5.0
3/4	UK305D1;HE2305	0.9843	2.4409	1.0236	0.7874	1.449	3/4	1.378	0.315	1.496	0.197
25	UK306D1;H2306X	30	72	29	23	44.9	25	38	8	45	5.9
7/8	UK306D1;HS2306	1.1811	2.8346	1.1417	0.9055	1.768	7/8	1.496	0.315	1.772	0.232
1	UK306D1;HE2306X						1				
30	UK307D1;H2307X	35	80	33	25	49.4	30	43	9	52	6.8
1 1/8	UK307D1;HS2307	1.3780	3.1496	1.2992	0.9843	1.945	1 1/8	1.693	0.354	2.047	0.268
35	UK308D1;H2308X	40	90	34	27	56	35	46	10	58	7.4
1 1/4	UK308D1;HE2308X	1.5748	3.5433	1.3386	1.0630	2.205	1 1/4	1.811	0.394	2.283	0.291
1 3/8	UK308D1;HS2308X						1 3/8				
40	UK309D1;H2309X	45	100	37	29	63.5	40	50	11	65	7.4
1 7/16	UK309D1;HA2309	1.7717	3.9370	1.4567	1.1417	2.500	1 7/16	1.969	0.433	2.559	0.291
1 1/2	UK309D1;HE2309X						1 1/2				
1 5/8	UK309D1;HS2309X						1 5/8				
45	UK310D1;H2310X	50	110	41	32	70.6	45	55	12	70	8.1
1 5/8	UK310D1;HS2310	1.9685	4.3307	1.6142	1.2598	2.780	1 5/8	2.165	0.472	2.756	0.319
1 11/16	UK310D1;HA2310						1 11/16				
1 3/4	UK310D1;HE2310X						1 3/4				
50	UK311D1;H2311X	55	120	44	34	76.6	50	59	12	75	8.5
1 7/8	UK311D1;HS2311	2.1654	4.7244	1.7323	1.3386	3.016	1 7/8	2.323	0.472	2.953	0.335
1 15/16	UK311D1;HA2311						1 15/16				
2	UK311D1;HE2311XY						2				
55	UK312D1;H2312X	60	130	47	36	82.7	55	62	13	80	9.0
2 1/8	UK312D1;HS2312	2.3622	5.1181	1.8504	1.4173	3.256	2 1/8	2.441	0.512	3.150	0.354
60	UK313D1;H2313X	65	140	49	39	88.2	60	65	14	85	10.1
2 3/16	UK313D1;HA2313	2.5591	5.5118	1.9291	1.5354	3.472	2 3/16	2.559	0.551	3.346	0.398
2 1/4	UK313D1;HE2313X						2 1/4				
2 3/8	UK313D1;HS2313X						2 3/8				

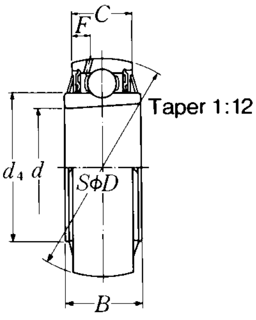
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Basic load ratings		Mass
N lbf		kg lb
dynamic C_r	static C_{or}	
21 200	10 900	0.36
4 750	2 460	0.81
26 700	15 000	0.59
6 000	3 400	1.37 1.29
33 500	19 100	0.75
7 500	4 300	1.70
40 500	24 000	1.02
9 150	5 400	2.38 2.25
53 000	32 000	1.38
11 900	7 200	3.22 3.14 2.97
62 000	38 500	1.68
13 900	8 600	3.95 3.85 3.74
71 500	45 000	2.06
16 100	10 100	4.73 4.60 4.46
82 000	52 000	2.53
18 400	11 700	5.67
92 500	60 000	3.08
20 800	13 400	7.24 7.08 6.76

Ball bearings
Adapter type



UK3···D1;H, HA, HE, HS



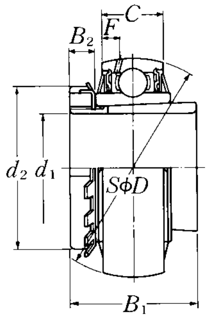
UK3···D1

Shaft dia. mm inch	Bearing number 1) 2) 3)	Nominal dimensions mm inch									
		d	D	B	C	d_4	d_1	B_1	B_2	d_2	F
65	UK315D1;H2315X	75	160	55	43	101.3	65	73	15	98	11.0
2 7/16 2 1/2	UK315D1;HA2315 UK315D1;HE2315X	2.9528	6.2992	2.1654	1.6929	3.988	2 7/16 2 1/2	2.874	0.591	3.858	0.433
70	UK316D1;H2316X	80	170	58	45	107.9	70	78	17	105	11.4
2 11/16 2 3/4	UK316D1;HA2316 UK316D1;HE2316X	3.1496	6.6929	2.2835	1.7717	4.248	2 11/16 2 3/4	3.071	0.669	4.134	0.449
75	UK317D1;H2317X	85	180	60	47	114.4	75	82	18	110	12.0
2 15/16 3	UK317D1;HA2317X UK317D1;HE2317X	3.3465	7.0866	2.3622	1.8504	4.504	2 15/16 3	3.228	0.709	4.331	0.472
80	UK318D1;H2318X	90	190	64	49	120.9	80	86	18	120	12.3
3 3/16	UK318D1;HA2318X	3.5433	7.4803	2.5197	1.9291	4.760	3 3/16	3.386	0.709	4.724	0.484
85	UK319D1;H2319X	95	200	67	51	127.5	85	90	19	125	12.8
3 1/4	UK319D1;HE2319X	3.7402	7.8740	2.6378	2.0079	5.020	3 1/4	3.543	0.748	4.921	0.504
90	UK320D1;H2320X	100	215	73	55	135.6	90	97	20	130	13.5
3 7/16 3 1/2	UK320D1;HA2320 UK320D1;HE2320X	3.9370	8.4646	2.8740	2.1654	5.339	3 7/16 3 1/2	3.819	0.787	5.118	0.531
100	UK322D1;H2322X	110	240	80	59	151.7	100	105	21	145	13.9
110	UK324D1;H2324X	120	260	86	63	165.2	110	112	22	155	16.0
115	UK326D1;H2326	130	280	90	67	178.3	115	121	23	165	16.9
125	UK328D1;H2328	140	300	95	71	190.4	125	131	24	180	17.7

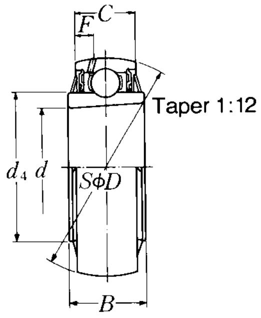
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Basic load ratings		Mass
N	lbf	kg lb
dynamic C_r	static C_{or}	
113 000	77 000	4.84
25 500	17 400	11.1 10.9
123 000	86 500	5.75
27 600	19 500	12.9 12.7
133 000	97 000	6.72
29 800	21 800	14.9 14.6
143 000	107 000	7.87
32 000	24 100	17.2
153 000	119 000	9.02
34 500	26 600	20.4
173 000	141 000	11.1
39 000	31 500	24.7 25.1
205 000	179 000	14.9
207 000	185 000	18.0
229 000	214 000	23.3
253 000	246 000	28.9

Ball bearings
Adapter type



UKX···D1;H, HA, HE, HS



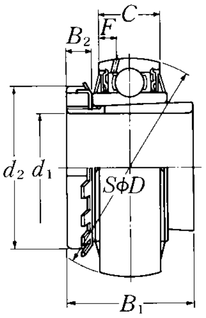
UKX···D1

Shaft dia. mm inch	Bearing number 1) 2) 3)	Nominal dimensions mm inch									
		d	*D*	*B*	*C*	*d*4	*d*1	*B*1	*B*2	*d*2	*F*
20	**UKX05D1;H2305X**	25	62	26	19	40.8	20	35	8	38	4.6
3/4	**UKX05D1;HE2305**	0.9843	2.4409	1.0236	0.7480	1.606	3/4	1.378	0.315	1.496	0.181
25	**UKX06D1;H2306X**	30	72	29	20	46.8	25	38	8	45	4.6
7/8	**UKX06D1;HS2306**	1.1811	2.8346	1.1417	0.7874	1.843	7/8	1.496	0.315	1.772	0.181
1	**UKX06D1;HE2306X**						1				
30	**UKX07D1;H2307X**	35	80	31	21	53	30	43	9	52	4.5
1 1/8	**UKX07D1;HS2307**	1.3780	3.1496	1.2205	0.8268	2.087	1 1/8	1.693	0.354	2.047	0.177
35	**UKX08D1;H2308X**	40	85	31	22	57.5	35	46	10	58	4.9
1 1/4	**UKX08D1;HE2308X**	1.5748	3.3465	1.2205	0.8661	2.264	1 1/4	1.811	0.394	2.283	0.193
1 3/8	**UKX08D1;HS2308X**						1 3/8				
40	**UKX09D1;H2309X**	45	90	32	24	62.4	40	50	11	65	5.9
1 7/16	**UKX09D1;HA2309**	1.7717	3.5433	1.2598	0.9449	2.457	1 7/16	1.969	0.433	2.559	0.232
1 1/2	**UKX09D1;HE2309X**						1 1/2				
1 5/8	**UKX09D1;HS2309X**						1 5/8				
45	**UKX10D1;H2310X**	50	100	35	25	69	45	55	12	70	6.0
1 5/8	**UKX10D1;HS2310**	1.9685	3.9370	1.3780	0.9843	2.717	1 5/8	2.165	0.472	2.756	0.236
1 11/16	**UKX10D1;HA2310**						1 11/16				
1 3/4	**UKX10D1;HE2310X**						1 3/4				
50	**UKX11D1;H2311X**	55	110	38	27	77	50	59	12	75	6.2
1 7/8	**UKX11D1;HS2311**	2.1654	4.3307	1.4961	1.0630	3.031	1 7/8	2.323	0.472	2.953	0.244
1 15/16	**UKX11D1;HA2311**						1 15/16				
2	**UKX11D1;HE2311XY**						2				
55	**UKX12D1;H2312X**	60	120	40	32	82.5	55	62	13	80	8.7
2 1/8	**UKX12D1;HS2312**	2.3622	4.7244	1.5748	1.2598	3.248	2 1/8	2.441	0.512	3.150	0.343
60	**UKX13D1;H2313X**	65	125	42	33	87	60	65	14	85	8.8
2 3/16	**UKX13D1;HA2313**	2.5591	4.9213	1.6535	1.2992	3.425	2 3/16	2.559	0.551	3.346	0.346
2 1/4	**UKX13D1;HE2313X**						2 1/4				
2 3/8	**UKX13D1;HS2313X**						2 3/8				

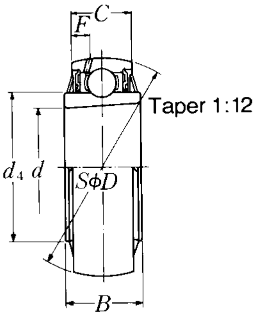
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Basic load ratings N lbf dynamic C_r	 static C_{or}	Mass kg lb
19 500	11 300	0.38
4 400	2 540	0.85
25 700	15 300	0.53
5 750	3 450	1.24
		1.16
29 100	17 800	0.75
6 550	4 000	1.70
32 500	20 400	0.85
7 350	4 600	2.01
		1.88
35 000	23 200	0.97
		2.32
7 900	5 200	2.24
		2.07
43 500	29 200	1.29
		3.09
9 750	6 550	2.99
		2.88
52 500	36 000	1.66
		3.84
11 800	8 150	3.72
		3.58
57 500	40 000	2.07
12 900	9 000	4.66
62 000	44 000	2.19
		5.28
14 000	9 900	5.12
		4.79

Ball bearings
Adapter type



UKX···D1;H, HA, HE, HS



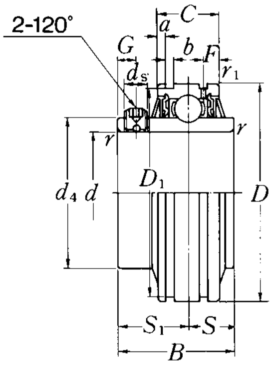
UKX···D1

Shaft dia. mm inch	Bearing number 1) 2) 3)	Nominal dimensions mm inch									
		d	*D*	*B*	*C*	d_4	d_1	B_1	B_2	d_2	*F*
65	**UKX15D1;H2315X**	75	140	45	35	98.1	65	73	15	98	9.5
2 7/16	**UKX15D1;HA2315**	2.9528	5.5118	1.7717	1.3780	3.862	2 7/16	2.874	0.591	3.858	0.374
2 1/2	**UKX15D1;HE2315X**						2 1/2				
70	**UKX16D1;H2316X**	80	150	46	36	106.4	70	78	17	105	10.1
2 11/16	**UKX16D1;HA2316**	3.1496	5.9055	1.8110	1.4173	4.189	2 11/16	3.071	0.669	4.134	0.398
2 3/4	**UKX16D1;HE2316X**						2 3/4				
75	**UKX17D1;H2317X**	85	160	47	37	111.6	75	82	18	110	9.8
2 15/16	**UKX17D1;HA2317X**	3.3465	6.2992	1.8504	1.4567	4.394	2 15/16	3.228	0.709	4.331	0.386
3	**UKX17D1;HE2317X**						3				
80	**UKX18D1;H2318X**	90	170	49	39	118.2	80	86	18	120	10.5
3 3/16	**UKX18D1;HA2318X**	3.5433	6.6929	1.9291	1.5354	4.654	3 3/16	3.386	0.709	4.724	0.413
90	**UKX20D1;H2320X**	100	190	57	44	131.3	90	97	20	130	11.3

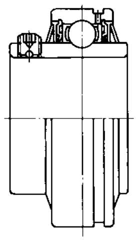
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".
2) Adapter number with suffix "X" means a narrow slot type adapter sleeve.
In this case the lock washer with the straight inner prong should be used.
3) For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.
To distinguish it, a suffix "Y" is added.

Basic load ratings		Mass
N	lbf	kg lb
dynamic C_r	static C_{or}	
72 500 16 300	53 000 11 900	3.21 7.47 7.27
83 500 18 700	64 000 14 300	3.87 8.79 8.56
96 000 21 600	71 500 16 100	4.76 10.6 10.3
109 000 24 500	82 000 18 400	5.17 11.2
133 000	105 000	8.03

Ball bearings
Set screw type



UCS···D1N



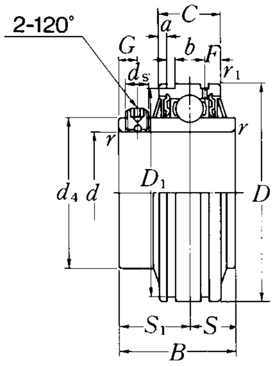
UCS···D1

Shaft dia.	Bearing number [1]	Nominal dimensions									
mm inch		*d*	*D*	*B*	*C*	mm inch r_s min.	r_{1s} min.	*S*	S_1	*G*	*ds*
12	**UCS201LD1N**	12	47	31	17	0.6	0.6	12.7	18.3	4.5	M5×0.8
½	**UCS201-008LD1N**	0.5000	1.8504	1.2205	0.6693	0.024	0.024	0.500	0.720	0.177	No.10-32UNF
15	**UCS202LD1N**	15	47	31	17	0.6	0.6	12.7	18.3	4.5	M5×0.8
9/16	**UCS202-009LD1N**	0.5625	1.8504	1.2205	0.6693	0.024	0.024	0.500	0.720	0.177	No.10-32UNF
⅝	**UCS202-010LD1N**	0.6250									
17	**UCS203LD1N**	17	47	31	17	0.6	0.6	12.7	18.3	4.5	M5×0.8
11/16	**UCS203-011LD1N**	0.6875	1.8504	1.2205	0.6693	0.024	0.024	0.500	0.720	0.177	No.10-32UNF
20	**UCS204LD1N**	20	47	31	17	1	0.6	12.7	18.3	4.5	M5×0.8
¾	**UCS204-012LD1N**	0.7500	1.8504	1.2205	0.6693	0.039	0.024	0.500	0.720	0.177	No.10-32UNF
25	**UCS205LD1N**	25	52	34.1	17	1	0.6	14.3	19.8	5	M5×0.8
13/16	**UCS205-013LD1N**	0.8125	2.0472	1.3425	0.6693	0.039	0.024	0.563	0.780	0.197	No.10-32UNF
⅞	**UCS205-014LD1N**	0.8750									
15/16	**UCS205-015LD1N**	0.9375									
1	**UCS205-100LD1N**	1.0000									
30	**UCS206LD1N**	30	62	38.1	19	1	1	15.9	22.2	5	M6×0.75
1 1/16	**UCS206-101LD1N**	1.0625	2.4409	1.5000	0.7480	0.039	0.039	0.626	0.874	0.197	¼-28UNF
1⅛	**UCS206-102LD1N**	1.1250									
1 3/16	**UCS206-103LD1N**	1.1875									
1¼	**UCS206-104LD1N**	1.2500									
35	**UCS207LD1N**	35	72	42.9	20	1.5	1.5	17.5	25.4	6	M6×0.75
1¼	**UCS207-104LD1N**	1.2500	2.8346	1.6890	0.7874	0.059	0.059	0.689	1.000	0.236	¼-28UNF
1 5/16	**UCS207-105LD1N**	1.3125									
1⅜	**UCS207-106LD1N**	1.3750									
1 7/16	**UCS207-107LD1N**	1.4375									
40	**UCS208LD1N**	40	80	49.2	21	1.5	1.5	19	30.2	8	M8×1
1½	**UCS208-108LD1N**	1.5000	3.1496	1.9370	0.8268	0.059	0.059	0.748	1.189	0.315	5/16-24UNF
1 9/16	**UCS208-109LD1N**	1.5625									
45	**UCS209LD1N**	45	85	49.2	22	1.5	1.5	19	30.2	8	M8×1
1⅝	**UCS209-110LD1N**	1.6250	3.3465	1.9370	0.8661	0.059	0.059	0.748	1.189	0.315	5/16-24UNF
1 11/16	**UCS209-111LD1N**	1.6875									
1¾	**UCS209-112LD1N**	1.7500									

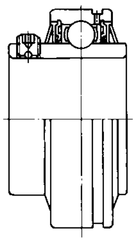
Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Nominal dimensions					Basic load ratings		Mass
	mm	inch			N	lbf	kg lb
d_4	D_1	a	b	F	dynamic C_r	static C_{or}	
29.6	44.6	3.1	1.5	4	12 800	6 650	0.21
1.1654	1.756	0.122	0.059	0.157	2 890	1 500	0.46
29.6	44.6	3.1	1.5	4	12 800	6 650	0.20
1.1654	1.756	0.122	0.059	0.157	2 890	1 500	0.44 0.42
29.6	44.6	3.1	1.5	4	12 800	6 650	0.18
1.1654	1.756	0.122	0.059	0.157	2 890	1 500	0.39
29.6	44.6	3.1	1.5	4	12 800	6 650	0.17
1.1654	1.756	0.122	0.059	0.157	2 890	1 500	0.39
33.9	49.73	3.2	1.5	4.1	14 000	7 850	0.20
1.3346	1.958	0.126	0.059	0.161	3 150	1 770	0.53 0.51 0.46 0.44
40.8	59.61	3.2	2.05	4.2	19 500	11 300	0.33
1.6063	2.374	0.126	0.081	0.165	4 400	2 540	0.82 0.77 0.73 0.66
46.8	68.81	3.3	2.05	5	25 700	15 300	0.49
1.8425	2.079	0.130	0.081	0.197	5 750	3 450	1.21 1.15 1.08 1.01
53	76.81	3.4	2.05	5	29 100	17 800	0.65
2.0866	3.024	0.134	0.081	0.197	6 550	4 000	1.52 1.46
57.5	81.81	3.5	2.05	5.1	32 500	20 400	0.70
2.2638	3.221	0.138	0.081	0.201	7 350	4 600	1.76 1.68 1.57

Ball bearings
Set screw type



UCS···D1N



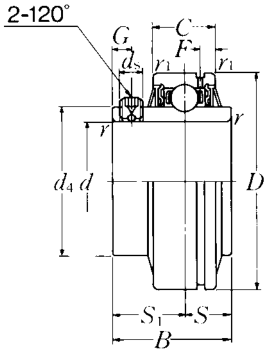
UCS···D1

Shaft dia. mm inch	Bearing number 1)	Nominal dimensions									
		d	D	B	C	mm r_s min.	inch r_{1s} min.	S	S_1	G	ds
50	UCS210LD1N	50	90	51.6	24	1.5	1.5	19	32.6	9	M8×1
$1\frac{13}{16}$	UCS210-113LD1N	1.8125	3.5433	2.0315	0.9449	0.059	0.059	0.748	1.283	0.354	$\frac{5}{16}$-24UNF
$1\frac{7}{8}$	UCS210-114LD1N	1.8750									
$1\frac{15}{16}$	UCS210-115LD1N	1.9375									
2	UCS210-200LD1N	2.0000									
55	UCS211LD1N	55	100	55.6	25	2	2	22.2	33.4	9	M8×1
2	UCS211-200LD1N	2.0000	3.9370	2.1890	0.9843	0.079	0.079	0.874	1.315	0.354	$\frac{5}{16}$-24UNF
$2\frac{1}{16}$	UCS211-201LD1N	2.0625									
$2\frac{1}{8}$	UCS211-202LD1N	2.1250									
$2\frac{3}{16}$	UCS211-203LD1N	2.1875									
60	UCS212LD1N	60	110	65.1	27	2	2	25.4	39.7	10	M10×1.25
$2\frac{1}{4}$	UCS212-204LD1N	2.2500	4.3307	2.5630	1.0630	0.079	0.079	1.000	1.563	0.394	$\frac{3}{8}$-24UNF
$2\frac{5}{16}$	UCS212-205LD1N	2.3125									
$2\frac{3}{8}$	UCS212-206LD1N	2.3750									
$2\frac{7}{16}$	UCS212-207LD1N	2.4375									
65	UCS213D1	65	120	65.1	32	2	2	25.4	39.7	10	M10×1.25
$2\frac{1}{2}$	UCS213-208D1	2.5000	4.7244	2.5630	1.2598	0.079	0.079	1.000	1.563	0.394	$\frac{3}{8}$-24UNF
$2\frac{9}{16}$	UCS213-209D1	2.5625									
70	UCS214D1	70	125	74.6	33	2	2	30.2	44.4	12	M10×1.25
75	UCS215D1	75	130	77.8	34	2	2	33.3	44.5	12	M10×1.25
80	UCS216D1	80	140	82.6	35	2.5	2.5	33.3	49.3	12	M10×1.25
85	UCS217D1	85	150	85.7	36	2.5	2.5	34.1	51.6	12	M12×1.5
90	UCS218D1	90	160	96	37	2.5	2.5	39.7	56.3	12	M12×1.5

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Nominal dimensions					Basic load ratings		Mass
	mm inch				N lbf		kg lb
d_4	D_1	a	b	F	dynamic C_r	static C_{or}	
62.4	86.79	3.7	2.85	5.6	35 000	23 200	0.80
2.4567	3.417	0.146	0.112	0.220	7 900	5 200	2.03 1.92 1.81 1.69
69	96.80	4.4	2.85	5.9	43 500	29 200	1.08
2.7165	3.811	0.173	0.112	0.232	9 750	6 550	2.71 2.60 2.46 2.34
77	106.81	4.4	2.85	6	52 500	36 000	1.59
3.0315	4.205	0.173	0.112	0.236	11 800	8 150	3.78 3.62 3.45 3.29
82.5	—	—	—	6.8	57 500	40 000	1.92
3.2480	—	—	—	0.268	12 900	9 000	4.41 4.24
87	—	—	—	7	62 000	44 000	2.17
93	—	—	—	7	66 000	49 500	2.43
98.1	—	—	—	7.5	72 500	53 000	2.89
106.4	—	—	—	7.5	83 500	64 000	3.47
111.6	—	—	—	7	96 000	71 500	4.46

Ball bearings
Set screw type

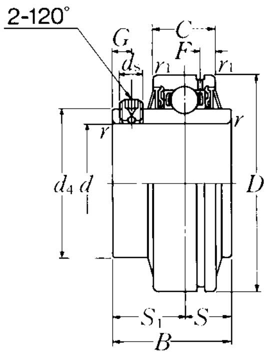


Shaft dia. mm inch	Bearing number [1]	Nominal dimensions									
						mm	inch				
		d	D	B	C	r_s min.	r_{1s} min.	S	S_1	G	ds
25	**UCS305D1**	25	62	38	20	1.5	0.6	15	23	6	M6 × 0.75
$\frac{13}{16}$	**UCS305-013D1**	0.8125	2.4409	1.4961	0.7874	0.059	0.024	0.591	0.906	0.236	$\frac{1}{4}$-28UNF
$\frac{7}{8}$	**UCS305-014D1**	0.8750									
$\frac{15}{16}$	**UCS305-015D1**	0.9375									
1	**UCS305-100D1**	1.0000									
30	**UCS306D1**	30	72	43	23	1.5	1	17	26	6	M6 × 0.75
$1\frac{1}{16}$	**UCS306-101D1**	1.0625	2.8346	1.6929	0.9055	0.059	0.039	0.669	1.024	0.236	$\frac{1}{4}$-28UNF
$1\frac{1}{8}$	**UCS306-102D1**	1.1250									
$1\frac{3}{16}$	**UCS306-103D1**	1.1875									
35	**UCS307D1**	35	80	48	25	2	1	19	29	8	M8 × 1
$1\frac{1}{4}$	**UCS307-104D1**	1.2500	3.1496	1.8898	0.9843	0.079	0.039	0.748	1.142	0.315	$\frac{5}{16}$-24UNF
$1\frac{5}{16}$	**UCS307-105D1**	1.3125									
$1\frac{3}{8}$	**UCS307-106D1**	1.3750									
$1\frac{7}{16}$	**UCS307-107D1**	1.4375									
40	**UCS308D1**	40	90	52	27	2	1	19	33	10	M10 × 1.25
$1\frac{1}{2}$	**UCS308-108D1**	1.5000	3.5433	2.0472	1.0630	0.079	0.039	0.748	1.299	0.394	$\frac{3}{8}$-24UNF
$1\frac{9}{16}$	**UCS308-109D1**	1.5625									
45	**UCS309D1**	45	100	57	29	2	1	22	35	10	M10 × 1.25
$1\frac{5}{8}$	**UCS309-110D1**	1.6250	3.9370	2.2441	1.1417	0.079	0.039	0.866	1.378	0.394	$\frac{3}{8}$-24UNF
$1\frac{11}{16}$	**UCS309-111D1**	1.6875									
$1\frac{3}{4}$	**UCS309-112D1**	1.7500									
50	**UCS310D1**	50	110	61	32	2.5	1.5	22	39	12	M12 × 1.5
$1\frac{13}{16}$	**UCS310-113D1**	1.8125	4.3307	2.4016	1.2598	0.098	0.059	0.866	1.535	0.472	$\frac{1}{2}$-20UNF
$1\frac{7}{8}$	**UCS310-114D1**	1.8750									
$1\frac{15}{16}$	**UCS310-115D1**	1.9375									
55	**UCS311D1**	55	120	66	34	2.5	1.5	25	41	12	M12 × 1.5
2	**UCS311-200D1**	2.0000	4.7244	2.5984	1.3386	0.098	0.059	0.984	1.614	0.472	$\frac{1}{2}$-20UNF
$2\frac{1}{16}$	**UCS311-201D1**	2.0625									
$2\frac{1}{8}$	**UCS311-202D1**	2.1250									
$2\frac{3}{16}$	**UCS311-203D1**	2.1875									

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Nominal dimensions		Basic load ratings		Mass
mm	inch	N	lbf	kg lb
d_4	F	dynamic C_r	static C_{or}	
36.8	4.3	21 200	10 900	0.37
1.4488	0.169	4 750	2 460	0.94 0.90 0.83 0.81
44.9	5.1	26 700	15 000	0.58
1.7677	0.201	6 000	3 400	1.39 1.33 1.28
49.4	5.3	33 500	19 100	0.74
1.9449	0.209	7 500	4 300	1.77 1.70 1.64 1.57
56	5.6	40 500	24 000	1.00
2.2047	0.220	9 150	5 400	2.32 2.23
63.5	5.8	53 000	32 000	1.33
2.5000	0.228	11 900	7 200	3.17 3.09 2.98
70.6	6.3	62 000	38 500	1.72
2.7795	0.248	13 900	8 600	4.10 3.99 3.85
76.6	6.5	71 500	45 000	2.15
3.0157	0.256	16 100	10 100	5.14 4.99 4.85 4.68

Ball bearings
Set screw type

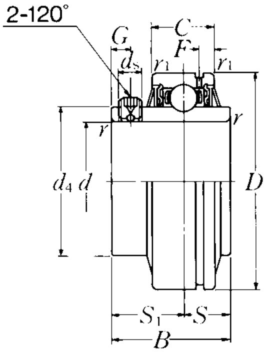


Shaft dia. mm inch	Bearing number [1]	Nominal dimensions d	D	B	C	mm r_s min.	inch r_{1s} min.	S	S_1	G	d_s
60	**UCS312D1**	60	130	71	36	2.5	1.5	26	45	12	M12×1.5
2 1/4	**UCS312-204D1**	2.2500	5.1181	2.7953	1.4173	0.098	0.059	1.024	1.772	0.472	1/2-20UNF
2 5/16	**UCS312-205D1**	2.3125									
2 3/8	**UCS312-206D1**	2.3750									
2 7/16	**UCS312-207D1**	2.4375									
65	**UCS313D1**	65	140	75	39	2.5	2	30	45	12	M12×1.5
2 1/2	**UCS313-208D1**	2.5000	5.5118	2.9528	1.5354	0.098	0.079	1.181	1.772	0.472	1/2-20UNF
2 9/16	**UCS313-209D1**	2.5625									
70	**UCS314D1**	70	150	78	41	2.5	2	33	45	12	M12×1.5
2 5/8	**UCS314-210D1**	2.6250	5.9055	3.0709	1.6142	0.098	0.079	1.299	1.772	0.472	1/2-20UNF
2 11/16	**UCS314-211D1**	2.6875									
2 3/4	**UCS314-212D1**	2.7500									
75	**UCS315D1**	75	160	82	43	2.5	2	32	50	14	M14×1.5
2 13/16	**UCS315-213D1**	2.8125	6.2992	3.2283	1.6929	0.098	0.079	1.260	1.969	0.551	9/16-18UNF
2 7/8	**UCS315-214D1**	2.8750									
2 15/16	**UCS315-215D1**	2.9375									
3	**UCS315-300D1**	3.0000									
80	**UCS316D1**	80	170	86	45	2.5	2	34	52	14	M14×1.5
3 1/16	**UCS316-301D1**	3.0625	6.6929	3.3858	1.7717	0.098	0.079	1.339	2.047	0.551	9/16-18UNF
3 1/8	**UCS316-302D1**	3.1250									
3 3/16	**UCS316-303D1**	3.1875									
85	**UCS317D1**	85	180	96	47	3	2.5	40	56	16	M16×1.5
3 1/4	**UCS317-304D1**	3.2500	7.0866	3.7795	1.8504	0.118	0.098	1.575	2.205	0.630	5/8-18UNF
3 5/16	**UCS317-305D1**	3.3125									
3 7/16	**UCS317-307D1**	3.4375									
90	**UCS318D1**	90	190	96	49	3	2.5	40	56	16	M16×1.5
3 7/16	**UCS318-307D1**	3.4375	7.4803	3.7795	1.9291	0.118	0.098	1.575	2.205	0.630	5/8-18UNF
3 1/2	**UCS318-308D1**	3.5000									

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Nominal dimensions		Basic load ratings		Mass
mm	inch	N	lbf	kg lb
d_4	F	dynamic C_r	static C_{or}	
82.7	6.7	82 000	52 000	2.70
3.2559	0.264	18 400	11 700	6.27
				6.10
				5.89
				5.72
88.2	7.5	92 500	60 000	3.37
3.4724	0.295	20 800	13 400	7.63
				7.41
94.8	7.5	104 000	68 000	4.03
3.7323	0.295	23 400	15 300	9.37
				9.13
				8.91
101.3	7.7	113 000	77 000	4.88
3.9882	0.303	25 500	17 400	11.4
				11.1
				10.9
				10.6
107.9	7.8	123 000	86 500	5.74
4.2480	0.307	27 600	19 500	13.0
				12.7
				12.5
114.4	8.2	133 000	97 000	6.88
4.5039	0.323	29 800	21 800	15.7
				15.4
				14.7
120.9	8.5	143 000	107 000	7.80
4.7598	0.335	32 000	24 100	17.8
				17.4

Ball bearings
Set screw type

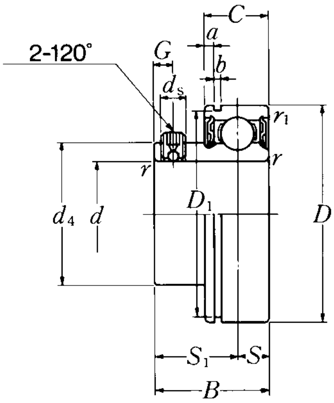


Shaft dia.	Bearing number [1]	Nominal dimensions									
mm inch		d	D	B	C	mm r_s min.	inch r_{1s} min.	S	S_1	G	ds
95	**UCS319D1**	95	200	103	51	3	2.5	41	62	16	M16 × 1.5
3$\frac{5}{8}$	**UCS319-310D1**	3.6250	7.8740	4.0551	2.0079	0.118	0.098	1.614	2.441	0.630	$\frac{5}{8}$-18UNF
3$\frac{11}{16}$	**UCS319-311D1**	3.6875									
3$\frac{3}{4}$	**UCS319-312D1**	3.7500									
100	**UCS320D1**	100	215	108	55	3	2.5	42	66	18	M18 × 1.5
3$\frac{13}{16}$	**UCS320-313D1**	3.8125	8.4646	4.2520	2.1654	0.118	0.098	1.654	2.598	0.709	$\frac{5}{8}$-18UNF
3$\frac{7}{8}$	**UCS320-314D1**	3.8750									
3$\frac{15}{16}$	**UCS320-315D1**	3.9375									
4	**UCS320-400D1**	4.0000									
105	**UCS321D1**	105	225	112	57	3	2.5	44	68	18	M18 × 1.5
110	**UCS322D1**	110	240	117	59	3	2.5	46	71	18	M18 × 1.5
120	**UCS324D1**	120	260	126	63	3	3	51	75	18	M18 × 1.5
130	**UCS326D1**	130	280	135	67	4	3	54	81	20	M20 × 1.5
140	**UCS328D1**	140	300	145	71	4	3	59	86	20	M20 × 1.5

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Nominal dimensions		Basic load ratings		Mass
mm	inch	N	lbf	kg lb
d_4	F	dynamic C_r	static C_{or}	
127.5	8.7	153 000	119 000	8.97
				20.5
5.0197	0.343	34 500	26 600	20.1
				19.7
135.6	9	173 000	141 000	11.1
				25.4
5.3386	0.354	39 000	31 500	24.9
				24.5
				24.1
142.1	9.2	184 000	153 000	12.6
151.7	9	205 000	179 000	14.7
165.2	10	207 000	185 000	19.0
178.3	10.5	229 000	214 000	23.6
190.4	11.5	253 000	246 000	29.2

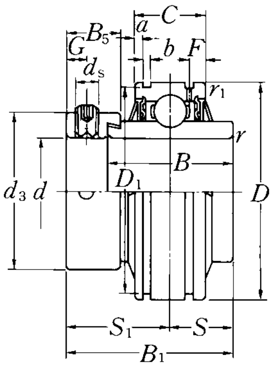
Ball bearings
Set screw type



Shaft dia.	Bearing number 1)	Nominal dimensions										
mm inch						mm		inch				
		d	D	B	C	r_s min.	r_{1s} min.	S	S_1	G	ds	d_4
12	**ASS201N**	12	40	22	12	0.6	0.6	6	16	4.2	M5 × 0.8	24.3
1/2	**ASS201-008N**	0.5000	1.5748	0.8661	0.4724	0.024	0.024	0.236	0.630	0.165	No.10-32UNF	0.957
15	**ASS202N**	15	40	22	12	0.6	0.6	6	16	4.2	M5 × 0.8	24.3
9/16	**ASS202-009N**	0.5625	1.5748	0.8661	0.4724	0.024	0.024	0.236	0.630	0.165	No.10-32UNF	0.957
5/8	**ASS202-010N**	0.6250										
17	**ASS203N**	17	40	22	12	0.6	0.6	6	16	4.2	M5 × 0.8	24.3
11/16	**ASS203-011N**	0.6875	1.5748	0.8661	0.4724	0.024	0.024	0.236	0.630	0.165	No.10-32UNF	0.957
20	**ASS204N**	20	47	25	14	1	0.6	7	18	4.2	M5 × 0.8	29.6
3/4	**ASS204-012N**	0.7500	1.8504	0.9843	0.5512	0.039	0.024	0.276	0.709	0.165	No.10-32UNF	1.165
25	**ASS205N**	25	52	27	15	1	0.6	7.5	19.5	5	M5 × 0.8	33.9
13/16	**ASS205-013N**	0.8125	2.0472	1.0630	0.5906	0.039	0.024	0.295	0.768	0.197	No.10-32UNF	1.335
7/8	**ASS205-014N**	0.8750										
15/16	**ASS205-015N**	0.9375										
1	**ASS205-100N**	1.0000										
30	**ASS206N**	30	62	29	16	1	0.6	8	21	5	M6 × 0.75	40.8
1 1/16	**ASS206-101N**	1.0625	2.4409	1.1417	0.6299	0.039	0.024	0.315	0.827	0.197	1/4-28UNF	1.606
1 1/8	**ASS206-102N**	1.1250										
1 3/16	**ASS206-103N**	1.1875										
1 1/4	**ASS206-104N**	1.2500										
35	**ASS207N**	35	72	34	17	1.5	0.6	8.5	25.5	6	M6 × 0.75	46.8
1 1/4	**ASS207-104N**	1.2500	2.8346	1.3386	0.6693	0.059	0.024	0.335	1.004	0.236	1/4-28UNF	1.843
1 5/16	**ASS207-105N**	1.3125										
1 3/8	**ASS207-106N**	1.3750										
1 7/16	**ASS207-107N**	1.4375										
40	**ASS208N**	40	80	38	18	1.5	0.6	9	29	8	M8 × 1	53
1 1/2	**ASS208-108N**	1.5000	3.1496	1.4961	0.7087	0.059	0.024	0.354	1.142	0.315	5/16-24UNF	2.087
1 9/16	**ASS208-109N**	1.5625										

Nominal dimensions			Basic load ratings		Mass
mm inch			N lbf		kg lb
D_1	a	b	dynamic C_r	static C_{or}	
38.1	1.98	1.5	9 600	4 600	0.12
1.500	0.078	0.059	2 160	1 030	0.24
38.1	1.98	1.5	9 600	4 600	0.11
1.500	0.078	0.059	2 160	1 030	0.23 0.22
38.1	1.98	1.5	9 600	4 600	0.10
1.500	0.078	0.059	2 160	1 030	0.20
44.6	2.38	1.5	12 800	6 650	0.17
1.756	0.094	0.059	2 890	1 500	0.33
49.73	2.38	1.5	14 000	7 850	0.20
1.958	0.094	0.059	3 150	1 770	0.46 0.44 0.42 0.39
59.61	3.18	2.05	19 500	11 300	0.31
2.347	0.125	0.081	4 400	2 540	0.67 0.65 0.63 0.61
68.81	3.18	2.05	25 700	15 300	0.49
2.709	0.125	0.081	5 750	3 450	1.18 1.05 0.93 0.81
76.81	3.18	2.05	29 100	17 800	0.50
3.024	0.125	0.081	6 550	4 000	1.15 1.06

Ball bearings
Eccentric locking collar type



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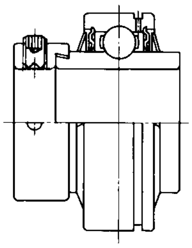


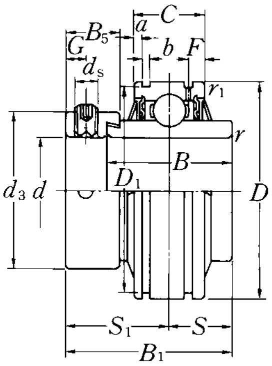
UELS···D1

Shaft dia.	Bearing number 1)	Nominal dimensions									
mm inch		mm inch d	D	B_1	B	C	r_s min.	r_{1s} min.	S	S_1	G
20	**UELS204LD1NW3**	20	47	43.7	34.2	17	1	0.6	17.1	26.6	4.8
3/4	**UELS204-012LD1NW3**	0.7500	1.8504	1.720	1.3465	0.6693	0.039	0.024	0.673	1.047	0.189
25	**UELS205LD1NW3**	25	52	44.4	34.9	17	1	0.6	17.5	26.9	4.8
13/16	**UELS205-013LD1NW3**	0.8125	2.0472	1.748	1.3740	0.6693	0.039	0.024	0.689	1.059	0.189
7/8	**UELS205-014LD1NW3**	0.8750									
15/16	**UELS205-015LD1NW3**	0.9375									
1	**UELS205-100LD1NW3**	1.0000									
30	**UELS206LD1NW3**	30	62	48.4	36.5	19	1	1	18.3	30.1	6
1 1/16	**UELS206-101LD1NW3**	1.0625	2.4409	1.906	1.4370	0.7480	0.039	0.039	0.720	1.185	0.236
1 1/8	**UELS206-102LD1NW3**	1.1250									
1 3/16	**UELS206-103LD1NW3**	1.1875									
1 1/4	**UELS206-104LD1NW3**	1.2500									
35	**UELS207LD1NW3**	35	72	51.1	37.6	20	1.5	1.5	18.8	32.3	6.8
1 1/4	**UELS207-104LD1NW3**	1.2500	2.8346	2.012	1.4803	0.7874	0.059	0.059	0.740	1.272	0.268
1 5/16	**UELS207-105LD1NW3**	1.3125									
1 3/8	**UELS207-106LD1NW3**	1.3750									
1 7/16	**UELS207-107LD1NW3**	1.4375									
40	**UELS208LD1NW3**	40	80	56.3	42.8	21	1.5	1.5	21.4	34.9	6.8
1 1/2	**UELS208-108LD1NW3**	1.5000	3.1496	2.217	1.6850	0.8268	0.059	0.059	0.843	1.374	0.268
1 9/16	**UELS208-109LD1NW3**	1.5625									
45	**UELS209LD1NW3**	45	85	56.3	42.8	22	1.5	1.5	21.4	34.9	6.8
1 5/8	**UELS209-110LD1NW3**	1.6250	3.3465	2.217	1.6850	0.8661	0.059	0.059	0.843	1.374	0.268
1 11/16	**UELS209-111LD1NW3**	1.6875									
1 3/4	**UELS209-112LD1NW3**	1.7500									
50	**UELS210LD1NW3**	50	90	62.7	49.2	24	1.5	1.5	24.6	38.1	6.8
1 13/16	**UELS210-113LD1NW3**	1.8125	3.5433	2.469	1.9370	0.9449	0.059	0.059	0.969	1.500	0.268
1 7/8	**UELS210-114LD1NW3**	1.8750									
1 15/16	**UELS210-115LD1NW3**	1.9375									
2	**UELS210-200LD1NW3**	2.0000									

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Nominal dimensions							Basic load ratings		Mass
		mm	inch				N	lbf	kg lb
							dynamic	static	
d_s	d_3	B_5	D_1	a	b	F	C_r	C_{or}	
M6×0.75	33	13.5	44.6	3.1	1.5	4	12 800	6 650	0.23
¼-28UNF	1.299	0.531	1.756	0.122	0.059	0.157	2 890	1 500	0.45
M6×0.75	38	13.5	49.73	3.2	1.5	4.1	14 000	7 850	0.27
¼-28UNF	1.496	0.531	1.958	0.126	0.059	0.161	3 150	1 770	0.61 0.58 0.55 0.51
M8×1	44.5	15.9	59.61	3.2	2.05	4.2	19 500	11 300	0.45
5⁄16-24UNF	1.752	0.626	2.347	0.126	0.081	0.165	4 400	2 540	0.94 0.89 0.84 0.80
M10×1.25	55.5	17.5	68.81	3.3	2.05	5	25 700	15 300	0.60
⅜-24UNF	2.185	0.689	2.709	0.130	0.081	0.197	5 750	3 450	1.45 1.40 1.35 1.28
M10×1.25	60	18.3	76.81	3.4	2.05	5	29 100	17 800	0.79
⅜-24UNF	2.362	0.720	3.024	0.134	0.081	0.197	6 550	4 000	1.90 1.82
M10×1.25	63.5	18.3	81.81	3.5	2.05	5.1	32 500	20 400	0.85
⅜-24UNF	2.500	0.720	3.221	0.138	0.081	0.201	7 350	4 600	2.05 1.97 1.88
M10×1.25	69.5	18.3	86.79	3.7	2.85	5.6	35 000	23 200	0.98
⅜-24UNF	2.736	0.720	3.417	0.146	0.112	0.220	7 900	5 200	2.46 2.36 2.25 2.09

Ball bearings
Eccentric locking collar type



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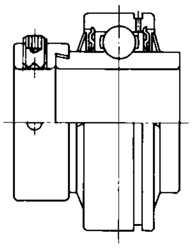


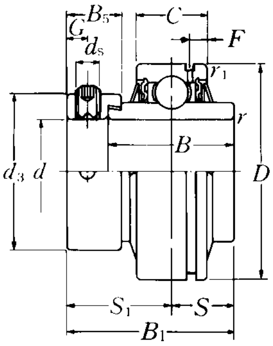
UELS···D1

Shaft dia.	Bearing number 1)	Nominal dimensions									
mm inch		mm inch									
		d	*D*	*B*1	*B*	*C*	*r*s min.	*r*1s min.	*S*	*S*1	*G*
55	**UELS211LD1NW3**	55	100	71.4	55.5	25	2	2	27.8	43.6	8
2	**UELS211-200LD1NW3**	2.0000	3.9370	2.811	2.1850	0.9843	0.079	0.079	1.094	1.717	0.315
2 1/16	**UELS211-201LD1NW3**	2.0625									
2 1/8	**UELS211-202LD1NW3**	2.1250									
2 3/16	**UELS211-203LD1NW3**	2.1875									
60	**UELS212LD1NW3**	60	110	77.8	61.9	27	2	2	31	46.8	8
2 1/4	**UELS212-204LD1NW3**	2.2500	4.3307	3.063	2.4370	1.0630	0.079	0.079	1.220	1.843	0.315
2 5/16	**UELS212-205LD1NW3**	2.3125									
2 3/8	**UELS212-206LD1NW3**	2.3750									
2 7/16	**UELS212-207LD1NW3**	2.4375									

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Nominal dimensions							Basic load ratings		Mass
		mm	inch				N	lbf	kg lb
d_s	d_3	B_5	D_1	a	b	F	dynamic C_r	static C_{or}	
M10 × 1.25	76	20.7	96.80	4.4	2.85	5.9	43 500	29 200	1.32
									3.28
$\frac{3}{8}$-24UNF	2.992	0.815	3.811	0.173	0.112	0.232	9 750	6 550	3.12
									3.02
									2.90
M10 × 1.25	84	22.3	106.81	4.4	2.85	6	52 500	36 000	1.93
									4.50
$\frac{3}{8}$-24UNF	3.307	0.878	4.205	0.173	0.112	0.236	11 800	8 150	4.34
									4.17
									4.00

Ball bearings
Eccentric locking collar type

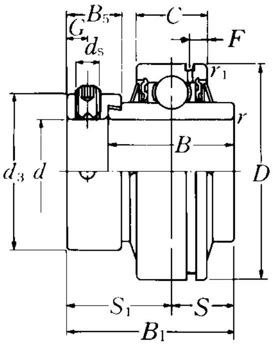


Shaft dia.	Bearing number 1)	Nominal dimensions										
mm inch		mm inch										
		d	D	B1	B	C	rs min.	r1s min.	S	S1	G	ds
25	UELS305D1W3	25	62	46.8	34.9	20	1.5	0.6	16.7	30.1	6	M8×1
13⁄16	UELS305-013D1W3	0.8125	2.4409	1.843	1.3740	0.7874	0.059	0.024	0.657	1.185	0.236	5⁄16-24UNF
7⁄8	UELS305-014D1W3	0.8750										
15⁄16	UELS305-015D1W3	0.9375										
1	UELS305-100D1W3	1.0000										
30	UELS306D1W3	30	72	50	36.5	23	1.5	1	17.5	32.5	6.7	M8×1
1 1⁄16	UELS306-101D1W3	1.0625	2.8346	1.969	1.4370	0.9055	0.059	0.039	0.689	1.280	0.264	5⁄16-24UNF
1 1⁄8	UELS306-102D1W3	1.1250										
1 3⁄16	UELS306-103D1W3	1.1875										
35	UELS307D1W3	35	80	51.6	38.1	25	2	1	18.3	33.3	6.7	M8×1
1 1⁄4	UELS307-104D1W3	1.2500	3.1496	2.031	1.5000	0.9843	0.079	0.039	0.720	1.311	0.264	5⁄16-24UNF
1 5⁄16	UELS307-105D1W3	1.3125										
1 3⁄8	UELS307-106D1W3	1.3750										
1 7⁄16	UELS307-107D1W3	1.4375										
40	UELS308D1W3	40	90	57.1	41.3	27	2	1	19.8	37.3	8	M10×1.25
1 1⁄2	UELS308-108D1W3	1.5000	3.5433	2.248	1.6260	1.0630	0.079	0.039	0.780	1.469	0.315	3⁄8-24UNF
1 9⁄16	UELS308-109D1W3	1.5625										
45	UELS309D1W3	45	100	58.7	42.9	29	2	1	19.8	38.9	8	M10×1.25
1 5⁄8	UELS309-110D1W3	1.6250	3.9370	2.311	1.6890	1.1417	0.079	0.039	0.780	1.531	0.315	3⁄8-24UNF
1 11⁄16	UELS309-111D1W3	1.6875										
1 3⁄4	UELS309-112D1W3	1.7500										
50	UELS310D1W3	50	110	66.6	49.2	32	2.5	1.5	24.6	42	8.7	M10×1.25
1 13⁄16	UELS310-113D1W3	1.8125	4.3307	2.622	1.9370	1.2598	0.098	0.059	0.969	1.654	0.343	3⁄8-24UNF
1 7⁄8	UELS310-114D1W3	1.8750										
1 15⁄16	UELS310-115D1W3	1.9375										
55	UELS311D1W3	55	120	73	55.6	34	2.5	1.5	27.8	45.2	8.7	M10×1.25
2	UELS311-200D1W3	2.0000	4.7244	2.874	2.1890	1.3386	0.098	0.059	1.094	1.780	0.343	3⁄8-24UNF
2 1⁄16	UELS311-201D1W3	2.0625										
2 1⁄8	UELS311-202D1W3	2.1250										
2 3⁄16	UELS311-203D1W3	2.1875										

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Nominal dimensions			Basic load ratings		Mass
mm inch			N lbf		kg lb
d_3	B_5	F	dynamic C_r	static C_{or}	
42.8	15.9	4.3	21 200	10 900	0.45
					1.13
1.685	0.626	0.169	4 750	2 460	1.09
					1.05
					1.00
50	17.5	5.1	26 700	15 000	0.71
					1.62
1.969	0.689	0.201	6 000	3 400	1.56
					1.50
55	17.5	5.3	33 500	19 100	0.83
					1.99
2.165	0.689	0.209	7 500	4 300	1.91
					1.84
					1.76
63.5	20.6	5.6	40 500	24 000	1.12
2.500	0.811	0.220	9 150	5 400	2.67
					2.58
70	20.6	5.8	53 000	32 000	1.50
					3.26
2.756	0.811	0.228	11 900	7 200	3.37
					3.26
76.2	22.2	6.3	62 000	38 500	1.93
					4.55
3.000	0.874	0.248	13 900	8 600	4.44
					4.30
83	22.2	6.5	71 500	45 000	2.42
					5.76
3.268	0.874	0.256	16 100	10 100	5.57
					5.43
					5.26

Ball bearings
Eccentric locking collar type

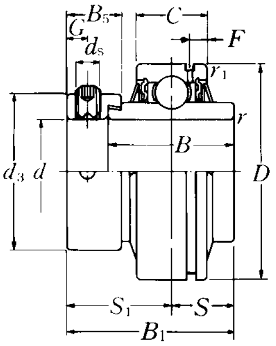


Shaft dia. mm inch	Bearing number 1)	Nominal dimensions mm inch										
		d	D	B1	B	C	rs min.	r1s min.	S	S1	G	ds
60	UELS312D1W3	60	130	79.4	61.9	36	2.5	1.5	30.95	48.45	8.7	M10 × 1.25
2¼	UELS312-204D1W3	2.2500	5.1181	3.126	2.4370	1.4173	0.098	0.059	1.219	1.907	0.343	⅜-24UNF
2 5⁄16	UELS312-205D1W3	2.3125										
2⅜	UELS312-206D1W3	2.3750										
2 7⁄16	UELS312-207D1W3	2.4375										
65	UELS313D1W3	65	140	85.7	65.1	39	2.5	2	32.55	53.15	10.3	M12 × 1.5
2½	UELS313-208D1W3	2.5000	5.5118	3.374	2.5630	1.5354	0.098	0.079	1.281	2.093	0.406	½-20UNF
2 9⁄16	UELS313-209D1W3	2.5625										
70	UELS314D1W3	70	150	92.1	68.3	41	2.5	2	34.15	57.95	10.3	M12 × 1.5
2⅝	UELS314-210D1W3	2.6250	5.9055	3.626	2.6890	1.6142	0.098	0.079	1.344	2.281	0.406	½-20UNF
2 11⁄16	UELS314-211D1W3	2.6875										
2¾	UELS314-212D1W3	2.7500										
75	UELS315D1W3	75	160	100	74.6	43	2.5	2	37.3	62.7	12.7	M16 × 1.5
2 13⁄16	UELS315-213D1W3	2.8125	6.2992	3.937	2.9370	1.6929	0.098	0.079	1.469	2.469	0.500	⅝-18UNF
2⅞	UELS315-214D1W3	2.8750										
2 15⁄16	UELS315-215D1W3	2.9375										
3	UELS315-300D1W3	3.0000										
80	UELS316D1W3	80	170	106.4	81	45	2.5	2	40.5	65.9	12.7	M16 × 1.5
3 1⁄16	UELS316-301D1W3	3.0625	6.6929	4.189	3.1890	1.7717	0.098	0.079	1.594	2.594	0.500	⅝-18UNF
3⅛	UELS316-302D1W3	3.1250										
3 3⁄16	UELS316-303D1W3	3.1875										
85	UELS317D1W3	85	180	109.5	84.1	47	3	2.5	42.05	67.45	12.7	M16 × 1.5
3¼	UELS317-304D1W3	3.2500	7.0866	4.311	3.3110	1.8504	0.118	0.098	1.656	2.656	0.500	⅝-18UNF
3 5⁄16	UELS317-305D1W3	3.3125										
3 7⁄16	UELS317-307D1W3	3.4375										
90	UELS318D1W3	90	190	115.9	87.3	49	3	2.5	43.65	72.25	14.3	M20 × 1.5
3 7⁄16	UELS318-307D1W3	3.4375	7.4803	4.563	3.4370	1.9291	0.118	0.098	1.719	2.844	0.563	¾-16UNF
3½	UELS318-308D1W3	3.5000										

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Nominal dimensions			Basic load ratings		Mass
mm inch			N lbf		kg lb
			dynamic	static	
d_3	B_5	F	C_r	C_{or}	
89	23.9	6.7	82 000	52 000	3.04
					7.01
3.504	0.941	0.264	18 400	11 700	6.86
					6.69
					6.40
97	27	7.5	92 500	60 000	3.79
3.819	1.063	0.295	20 800	13 400	8.76
					8.55
102	30.2	7.5	104 000	68 000	4.54
					10.7
4.016	1.189	0.295	23 400	15 300	10.5
					10.2
113	31.8	7.7	113 000	77 000	5.50
					13.5
4.449	1.252	0.303	25 500	17 400	13.2
					13.0
					12.9
119	31.8	7.8	123 000	86 500	6.89
					15.3
4.685	1.252	0.307	27 600	19 500	15.0
					15.3
127	31.8	8.2	133 000	97 000	8.21
					18.2
5.000	1.252	0.323	29 800	21 800	17.9
					17.2
133	36.5	8.5	143 000	107 000	9.34
5.236	1.437	0.335	32 000	24 100	21.2
					20.7

Ball bearings
Eccentric locking collar type

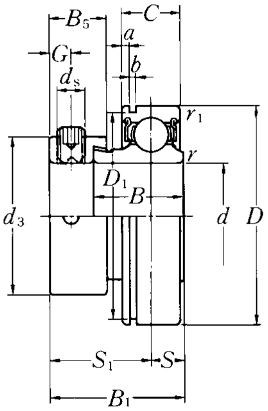


Shaft dia.	Bearing number [1]	Nominal dimensions										
mm inch		mm inch										
		d	D	B_1	B	C	r_s min.	r_{1s} min.	S	S_1	G	ds
95	**UELS319D1W3**	95	200	122.3	93.7	51	3	2.5	38.9	83.4	14.3	M20 × 1.5
3 5/8	**UELS319-310D1W3**	3.6250	7.8740	4.815	3.6890	2.0079	0.118	0.098	1.531	3.283	0.563	3/4-16UNF
3 11/16	**UELS319-311D1W3**	3.6875										
3 3/4	**UELS319-312D1W3**	3.7500										
100	**UELS320D1W3**	100	215	128.6	100	55	3	2.5	50	78.6	14.3	M20 × 1.5
3 13/16	**UELS320-313D1W3**	3.8125	8.4646	5.063	3.9370	2.1654	0.118	0.098	1.969	3.094	0.563	3/4-16UNF
3 7/8	**UELS320-314D1W3**	3.8750										
3 15/16	**UELS320-315D1W3**	3.9375										
4	**UELS320-400D1W3**	4.0000										
105	**UELS321D1W3**	105	225	139.7	104.8	57	3	2.5	48.4	91.3	17.5	M20 × 1.5
110	**UELS322D1W3**	110	240	141.3	106.4	59	3	2.5	49.2	92.1	17.5	M20 × 1.5

Remarks: 1) These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

Nominal dimensions			Basic load ratings		Mass
mm inch			N lbf		kg lb
d_3	B_5	F	dynamic C_r	static C_{or}	
140	36.5	8.7	153 000	119 000	10.7
					24.0
5.512	1.437	0.343	34 500	26 600	23.6
					23.2
146	36.5	9	173 000	141 000	13.3
					29.2
5.748	1.437	0.354	39 000	31 500	28.7
					28.3
					27.8
157	42.8	9.2	184 000	153 000	15.0
168	42.8	9	205 000	179 000	17.6

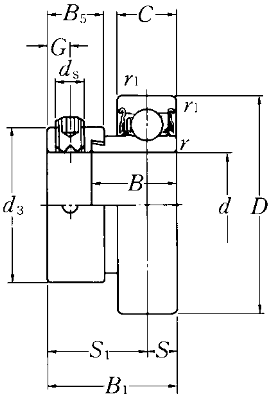
Ball bearings
Eccentric locking collar type



Shaft dia.	Bearing number	Nominal dimensions										
mm inch		mm inch d	D	B_1	B	C	r_s min.	r_{1s} min.	S	S_1	G	ds
12	**AELS201NW3**	12	40	28.6	19	12	0.6	0.6	6.5	22.1	4.8	M6×0.75
1/2	**AELS201-008NW3**	0.5000	1.5748	1.126	0.7480	0.4724	0.024	0.024	0.256	0.870	0.189	1/4-28UNF
15	**AELS202NW3**	15	40	28.6	19	12	0.6	0.6	6.5	22.1	4.8	M6×0.75
9/16	**AELS202-009NW3**	0.5625	1.5748	1.126	0.7480	0.4724	0.024	0.024	0.256	0.870	0.189	1/4-28UNF
5/8	**AELS202-010NW3**	0.6250										
17	**AELS203NW3**	17	40	28.6	19	12	0.6	0.6	6.5	22.1	4.8	M6×0.75
11/16	**AELS203-011NW3**	0.6875	1.5748	1.126	0.7480	0.4724	0.024	0.024	0.256	0.870	0.189	1/4-28UNF
20	**AELS204NW3**	20	47	31	21.5	14	1	0.6	7.5	23.5	4.8	M6×0.75
3/4	**AELS204-012NW3**	0.7500	1.8504	1.220	0.8465	0.5512	0.039	0.024	0.295	0.925	0.189	1/4-28UNF
25	**AELS205NW3**	25	52	31	21.5	15	1	0.6	7.5	23.5	4.8	M6×0.75
13/16	**AELS205-013NW3**	0.8125	2.0472	1.220	0.8465	0.5906	0.039	0.024	0.295	0.925	0.189	1/4-28UNF
7/8	**AELS205-014NW3**	0.8750										
15/16	**AELS205-015NW3**	0.9375										
1	**AELS205-100NW3**	1.0000										
30	**AELS206NW3**	30	62	35.7	23.8	16	1	0.6	9	26.7	6	M8×1
1 1/16	**AELS206-101NW3**	1.0625	2.4409	1.406	0.9370	0.6299	0.039	0.024	0.354	1.051	0.236	5/16-24UNF
1 1/8	**AELS206-102NW3**	1.1250										
1 3/16	**AELS206-103NW3**	1.1875										
1 1/4	**AELS206-104NW3**	1.2500										
35	**AELS207NW3**	35	72	38.9	25.4	17	1.5	0.6	9.5	29.4	6.8	M10×1.25
1 1/4	**AELS207-104NW3**	1.2500	2.8346	1.531	1.0000	0.6693	0.059	0.024	0.374	1.157	0.268	3/8-24UNF
1 5/16	**AELS207-105NW3**	1.3125										
1 4/8	**AELS207-106NW3**	1.3750										
1 7/16	**AELS207-107NW3**	1.4375										
40	**AELS208NW3**	40	80	43.7	30.2	18	1.5	0.6	11	32.7	6.8	M10×1.25
1 1/2	**AELS208-108NW3**	1.5000	3.1496	1.720	1.1890	0.7087	0.059	0.024	0.433	1.287	0.268	3/8-24UNF
1 9/16	**AELS208-109NW3**	1.5625										

Nominal dimensions					Basic load ratings		Mass
	mm	inch			N dynamic	lbf static	kg lb
d_3	D_1	a	b	B_5	C_r	C_{or}	
29	38.1	1.98	1.5	13.6	9 600	4 600	0.12
1.142	1.500	0.078	0.059	0.535	2 160	1 030	0.26
29	38.1	1.98	1.5	13.6	9 600	4 600	0.11
1.142	1.500	0.078	0.059	0.535	2 160	1 030	0.26 0.24
29	38.1	1.98	1.5	13.6	9 600	4 600	0.10
1.142	1.500	0.078	0.059	0.535	2 160	1 030	0.23
33	44.6	2.38	1.5	13.5	12 800	6 650	0.17
1.299	1.756	0.094	0.059	0.531	2 890	1 500	0.35
38	49.73	2.38	1.5	13.5	14 000	7 850	0.20
1.496	1.958	0.094	0.059	0.531	3 150	1 770	0.51 0.48 0.45 0.42
44.5	59.61	3.18	2.05	15.9	19 500	11 300	0.31
1.752	2.347	0.125	0.081	0.626	4 400	2 540	0.74 0.73 0.66 0.61
55.5	68.81	3.18	2.05	17.5	25 700	15 300	0.49
2.185	2.709	0.125	0.081	0.689	5 750	3 450	1.15 1.10 1.04 0.98
60	76.81	3.18	2.05	18.3	29 100	17 800	0.66
2.362	3.024	0.125	0.081	0.720	6 550	4 000	1.41 1.34

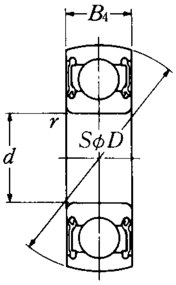
Ball bearings
Eccentric locking collar type



Shaft dia.	Bearing number	Nominal dimensions										
mm inch		mm inch d	D	B_1	B	C	r_s min.	r_{1s} min.	S	S_1	G	ds
12	**JELS201W3**	12	40	28.6	19	13	0.6	0.4	6.5	22.1	4.8	M6×0.75
1/2	**JELS201-008W3**	0.5000	1.5748	1.126	0.7480	0.5118	0.024	0.016	0.256	0.870	0.189	1/4-28UNF
15	**JELS202W3**	15	40	28.6	19	13	0.6	0.4	6.5	22.1	4.8	M6×0.75
9/16	**JELS202-009W3**	0.5625	1.5748	1.126	0.7480	0.5118	0.024	0.016	0.256	0.870	0.189	1/4-28UNF
5/8	**JELS202-010W3**	0.6250										
17	**JELS203W3**	17	40	28.6	19	13	0.6	0.4	6.5	22.1	4.8	M6×0.75
11/16	**JELS203-011W3**	0.6875	1.5748	1.126	0.7480	0.5118	0.024	0.016	0.256	0.870	0.189	1/4-28UNF
20	**JELS204W3**	20	47	31	21.5	15	1	0.6	7.5	23.5	4.8	M6×0.75
3/4	**JELS204-012W3**	0.7500	1.8504	1.220	0.8465	0.5906	0.039	0.024	0.295	0.925	0.189	1/4-28UNF
25	**JELS205W3**	25	52	31	21.5	15	1	0.6	7.5	23.5	4.8	M6×0.75
13/16	**JELS205-013W3**	0.8125	2.0472	1.220	0.8465	0.5906	0.039	0.024	0.295	0.925	0.189	1/4-28UNF
7/8	**JELS205-014W3**	0.8750										
15/16	**JELS205-015W3**	0.9375										
1	**JELS205-100W3**	1.0000										
30	**JELS206W3**	30	62	35.7	23.8	18	1	1	9	26.7	6	M8×1
1 1/16	**JELS206-101W3**	1.0625	2.4409	1.406	0.9370	0.7087	0.039	0.039	0.354	1.051	0.236	5/16-24UNF
1 1/8	**JELS206-102W3**	1.1250										
1 3/16	**JELS206-103W3**	1.1875										
1 1/4	**JELS206-104W3**	1.2500										
35	**JELS207W3**	35	72	38.9	25.4	19	1.5	1.5	9.5	29.4	6.8	M10×1.25
1 1/4	**JELS207-104W3**	1.2500	2.8346	1.531	1.0000	0.7480	0.059	0.059	0.374	1.157	0.268	3/8-24UNF
1 5/16	**JELS207-105W3**	1.3125										
1 3/8	**JELS207-106W3**	1.3750										
1 7/16	**JELS207-107W3**	1.4375										
40	**JELS208W3**	40	80	43.7	30.2	22	1.5	1.5	11	32.7	6.8	M10×1.25
1 1/2	**JELS208-108W3**	1.5000	3.1496	1.720	1.1890	0.8661	0.059	0.059	0.433	1.287	0.268	3/8-24UNF
1 9/16	**JELS208-109W3**	1.5625										

Nominal dimensions		Basic load ratings		Mass
mm	inch	N	lbf	kg lb
d_3	B_5	dynamic C_r	static C_{or}	
29 1.142	13.6 0.535	9 600 2 160	4 600 1 030	0.13 0.28
29 1.142	13.6 0.535	9 600 2 160	4 600 1 030	0.13 0.26 0.24
29 1.142	13.6 0.535	9 600 2 160	4 600 1 030	0.10 0.22
33 1.299	13.5 0.531	12 800 2 890	6 650 1 500	0.18 0.42
38 1.496	13.5 0.531	14 000 3 150	7 850 1 770	0.20 0.54 0.51 0.48 0.44
44.5 1.752	15.9 0.626	19 500 4 400	11 300 2 540	0.34 0.84 0.79 0.75 0.70
55.5 2.185	17.5 0.689	25 700 5 750	15 300 3 450	0.53 1.29 1.24 1.18 1.12
60 2.362	18.3 0.720	29 100 6 550	17 800 4 000	0.71 1.64 1.57

Ball bearings

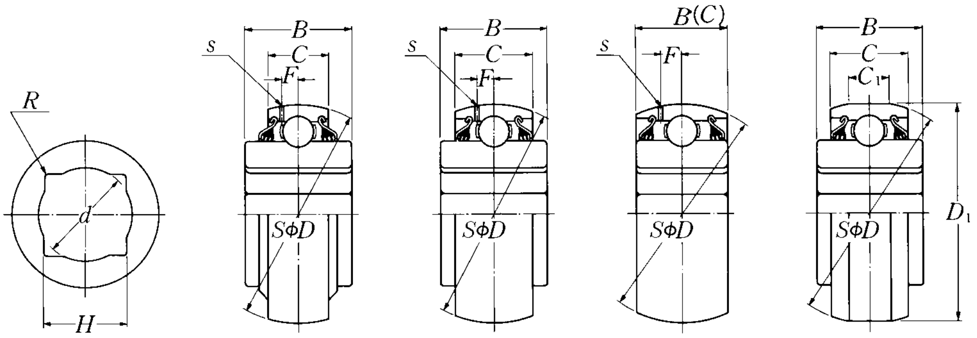


Shaft dia. mm	Bearing number	Nominal dimensions mm inch				Basic load ratings N lbf		Mass kg lb
		d	D	B_4	r_s 1) min.	dynamic C_r	static C_{or}	
10	**CS200LLU**	10 0.3937	30 1.1811	9 0.354	0.6 0.024	3 950 885	2 250 505	0.03 0.07
12	**CS201LLU**	12 0.4724	32 1.2598	10 0.394	0.6 0.024	4 700 1 050	2 640 595	0.04 0.09
15	**CS202LLU**	15 0.5906	35 1.3780	11 0.433	0.6 0.024	5 950 1 340	3 450 775	0.04 0.09
17	**CS203LLU**	17 0.6693	40 1.5748	12 0.472	0.6 0.024	7 400 1 660	4 400 985	0.06 0.13
20	**CS204LLU**	20 0.7874	47 1.8504	14 0.551	1 0.039	9 900 2 220	6 250 1 410	0.10 0.22
25	**CS205LLU**	25 0.9843	52 2.0472	15 0.591	1 0.039	10 800 2 430	7 150 1 610	0.13 0.29
30	**CS206LLU**	30 1.1811	62 2.4409	16 0.630	1 0.039	15 000 3 350	10 300 2 320	0.20 0.44
35	**CS207LLU**	35 1.3780	72 2.8346	17 0.669	1.5 0.059	19 700 4 450	14 000 3 150	0.29 0.64
40	**CS208LLU**	40 1.5748	80 3.1496	18 0.709	1.5 0.059	22 400 5 050	16 200 3 650	0.37 0.82

Note: Symbols

Δd_{mp}: Mean bore diameter deviation
ΔB_s: Inner ring width deviation
ΔC_s: Outer ring width deviation

Ball bearing, square bore, spherical O.D.



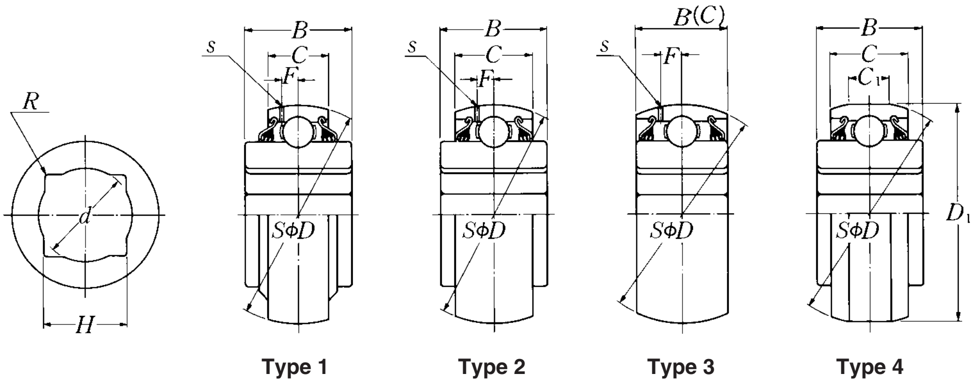
Type 1 Type 2 Type 3 Type 4

Shaft size	Bearing 1) number	Type	Nominal dimensions								
						mm	inch				
inch			H	d max.	R 2) max.	D		C		B	
7/8	**1AS08-7/8**	1	22.987 ±0.127	24.4	2.25	80	0 −0.013	18	0 −0.12	36.5	0 −0.12
			0.9050 ±0.0050	0.961	0.089	3.1496	0 −0.0005	0.7087	0 −0.0047	1.4370	0 −0.0047
7/8	**4AS08-7/8**	4	22.987 ±0.127	24.4	2.25	87.338	0 −0.025	30.2	0 −0.12	36.5	0 −0.12
			0.9050 ±0.0050	0.961	0.089	3.4385	0 −0.0010	1.1890	0 −0.0047	1.4370	0 −0.0047
1	**1AS08-1**	1	26.162 ±0.127	27.8	2.25	80	0 −0.013	18	0 −0.12	36.5	0 −0.12
			1.0300 ±0.0050	1.095	0.089	3.1496	0 −0.0005	0.7087	0 −0.0047	1.4370	0 −0.0047
1	**2AS08-1D1**	2	26.162 ±0.127	27.8	2.25	80	0 −0.013	30.2	0 −0.12	36.5	0 −0.12
			1.0300 ±0.0050	1.095	0.089	3.1496	0 −0.0005	1.1890	0 −0.0047	1.4370	0 −0.0047
1	**4AS08-1**	4	26.162 ±0.127	27.8	2.25	87.338	0 −0.025	30.2	0 −0.12	36.5	0 −0.12
			1.0300 ±0.0050	1.095	0.089	3.4385	0 −0.0010	1.1890	0 −0.0047	1.4370	0 −0.0047
1 1/8	**1AS08-1.1/8**	1	29.972 ±0.127	31.4	2.25	80	0 −0.013	18	0 −0.12	36.5	0 −0.12
			1.1800 ±0.0050	1.236	0.089	3.1496	0 −0.0005	0.7087	0 −0.0047	1.4370	0 −0.0047
1 1/8	**2AS08-1.1/8D1**	2	29.972 ±0.127	31.4	2.25	80	0 −0.013	30.2	0 −0.12	36.5	0 −0.12
			1.1800 ±0.0050	1.236	0.089	3.1496	0 −0.0005	1.1890	0 −0.0047	1.4370	0 −0.0047

Remarks: 1) Bearings suffixed with D1 have oil holes on the outer ring.
2) R min.: 0.059 inch except 3AS14-2D1 R min.: 0.118 inch.

Nominal dimensions					Basic load ratings		Mass
mm inch					N lbf		kg lb
D_1		C_1	s	F	dynamic C_r	static C_{or}	
—		—	—	—	29 100	17 800	0.73
—		—	—	—	6 550	4 000	1.61
85.750	0 — 0.025	16.6	—	—	29 100	17 800	0.93
3.3760	0 — 0.0010	0.6535	—	—	6 550	4 000	2.05
—		—	—	—	29 100	17 800	0.68
—		—	—	—	6 550	4 000	1.50
—		—	2.2	6.6	29 100	17 800	0.76
—		—	0.087	0.260	6 550	4 000	1.68
85.750	0 — 0.025	16.6	—	—	29 100	17 800	0.89
3.3760	0 — 0.0010	0.6535	—	—	6 550	4 000	1.96
—		—	—	—	29 100	17 800	0.60
—		—	—	—	6 550	4 000	1.32
—		—	2.2	6.6	29 100	17 800	0.70
—		—	0.087	0.260	6 550	4 000	1.54

Ball bearing, square bore, spherical O.D.

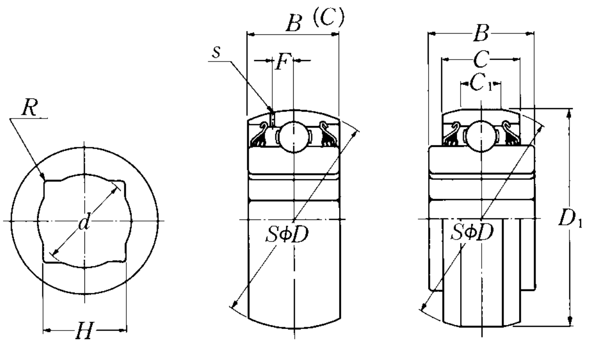


Shaft size inch	Bearing number [1]	Type	Nominal dimensions H		d max.	R [2] max.	D		C		B	
			mm / inch									
1⅛	4AS08-1.⅛	4	29.972	±0.127	31.4	2.25	87.338	0 −0.025	30.2	0 −0.12	36.5	0 −0.12
			1.1800	±0.0050	1.236	0.089	3.4385	0 −0.0010	1.1890	0 −0.0047	1.4370	0 −0.0047
1 5/32	1AS08-1.5/32D1	1	30	±0.127	31.8	2.25	80	0 −0.013	21	0 −0.12	36.5	0 −0.12
			1.1811	±0.0050	1.252	0.089	3.1496	0 −0.0005	0.8268	0 −0.0047	1.4370	0 −0.0047
1¼	2AS09-1.¼D1	2	32.766	±0.127	34.8	2.25	85	0 −0.015	30.2	0 −0.120	36.5	0 −0.12
			1.2900	±0.0050	1.370	0.089	3.3465	0 −0.0006	1.1890	0 −0.0047	1.4370	0 −0.0047
1¼	4AS09-1.¼	4	32.766	±0.127	34.8	2.25	87.338	0 −0.025	30.2	0 −0.12	36.5	0 −0.12
			1.2900	±0.0050	1.370	0.089	3.4385	0 −0.0010	1.1890	0 −0.0047	1.4370	0 −0.0047
1⅛	2AS10-1.⅛D1	2	29.972	±0.127	31.4	2.25	90	0 −0.015	30.2	0 −0.12	36.5	0 −0.12
			1.1800	±0.0050	1.236	0.089	3.5433	0 −0.0006	1.1890	0 −0.0047	1.4370	0 −0.0047
1⅛	3AS10-1.⅛D1	3	29.972	±0.127	31.4	2.25	90	0 −0.015	30.2	0 −0.12	30.2	0 −0.12
			1.1800	±0.0050	1.236	0.089	3.5433	0 −0.0006	1.1890	0 −0.0047	1.1890	0 −0.0047
1½	1AS11-1.½D1	1	38.89	±0.127	41.2	2.25	100	0 −0.015	25	0 −0.15	44.45	0 −0.15
			1.5311	±0.0050	1.622	0.089	3.9370	0 −0.0006	0.9843	0 −0.0059	1.7500	0 −0.0059

Remarks: 1) Bearings suffixed with D1 have oil holes on the outer ring.
2) R min.: 0.059 inch except 3AS14-2D1 R min.: 0.118 inch.

Nominal dimensions					Basic load ratings		Mass
mm inch					N lbf		kg lb
D_1		C_1	s	F	dynamic C_r	static C_{or}	
85.750	0 — 0.025	16.6	—	—	29 100	17 800	0.90
3.3760	0 — 0.0010	0.6535	—	—	6 550	4 000	1.99
—		—	2.2	6.6	29 100	17 800	0.64
—		—	0.087	0.260	6 550	4 000	1.41
—		—	2.2	6.7	32 500	20 400	0.77
—		—	0.087	0.264	7 350	4 600	1.70
85.750	0 — 0.025	16.6	—	—	29 100	17 800	0.82
3.3760	0 — 0.0010	0.6535	—	—	6 550	4 000	1.81
—		—	2.2	6.7	35 000	23 200	0.98
—		—	0.087	0.264	7 900	5 200	2.16
—		—	2.2	6.7	35 000	23 200	0.88
—		—	0.087	0.264	7 900	5 200	1.94
—		—	2.5	7.6	43 500	29 200	1.19
—		—	0.098	0.299	9 750	6 550	2.63

Ball bearing, square bore, spherical O.D.



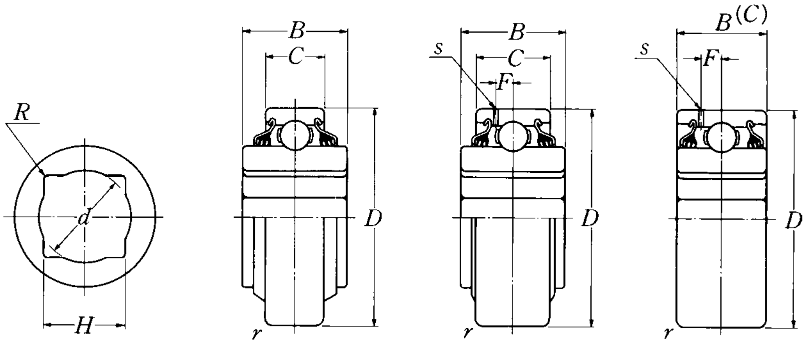
Type 3 Type 4

Shaft size inch	Bearing [1] number	Type	H (mm / inch)		d max.	R [2] max.	D		C		B	
1½	**3AS11-1.½D1**	3	38.89	±0.127	41.2	2.25	100	0 −0.015	33.3	0 −0.15	33.3	0 −0.15
			1.5311	±0.0050	1.622	0.089	3.9370	0 −0.0006	1.3110	0 −0.0059	1.3110	0 −0.0059
1½	**4AS11-1.½**	4	38.89	±0.127	41.2	2.25	104.725	0 −0.025	36.5	0 −0.15	44.45	0 −0.15
			1.5311	±0.0050	1.622	0.089	4.1230	0 −0.0010	1.4370	0 −0.0059	1.7500	0 −0.0059
2	**3AS14-2D1**	3	52.2	±0.127	54.9	4.0	125	0 −0.020	39.69	0 −0.15	39.69	0 −0.15
			2.0551	±0.0050	2.161	0.157	4.9213	0 −0.0008	1.5626	0 −0.0059	1.5626	0 −0.0059

Remarks: 1) Bearings suffixed with D1 have oil holes on the outer ring.
2) *R* min.: 0.059 inch except 3AS14-2D1 *R* min.: 0.118 inch.

Nominal dimensions					Basic load ratings		Mass
mm inch					N lbf		kg lb
D_1		C_1	s	F	dynamic C_r	static C_{or}	
—		—	2.5	7.6	43 500	29 200	1.10
—		—	0.098	0.299	9 750	6 550	2.43
103.556	0 — 0.025	15.9	—	—	43 500	29 200	1.48
4.0770	0 — 0.0010	0.6142	—	—	9 750	6 550	3.26
—		0.6260	3.0	9.4	62 000	44 000	1.90
—		—	0.118	0.370	14 000	9 900	4.19

Ball bearing, square bore, cylindrical O.D.



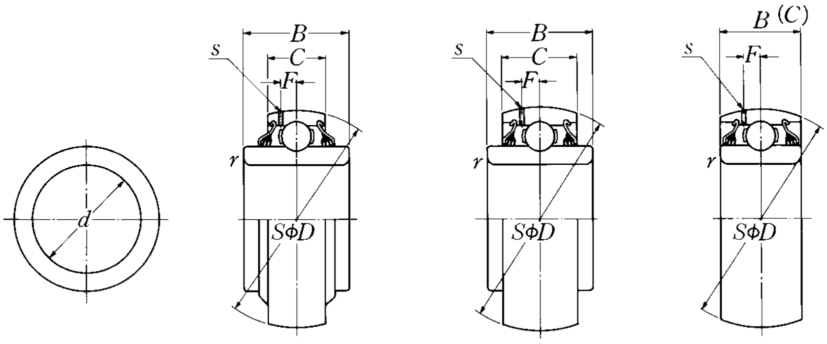
Type 5 Type 6 Type 7

Shaft dia.	Bearing number[1]	Type	Nominal dimensions mm inch									
inch			H		d max.	R[2] max.	D		C		B	
1	5AS08-1	5	26.162	±0.127	27.8	2.25	80	0 −0.013	18	0 −0.12	36.5	0 −0.12
			1.0300	±0.0050	1.095	0.089	3.1496	0 −0.0005	0.7087	0 −0.0047	1.4370	0 −0.0047
1	6AS08-1D1	6	26.162	±0.127	27.8	2.25	80	0 −0.013	30.2	0 −0.12	36.5	0 −0.12
			1.0300	±0.0050	1.095	0.089	3.1496	0 −0.0005	1.1890	0 −0.0047	1.4370	0 −0.0047
1⅛	5AS08-1.⅛	5	29.972	±0.127	31.4	2.25	80	0 −0.013	18	0 −0.12	36.5	0 −0.12
			1.1800	±0.0050	1.236	0.089	3.1496	0 −0.0005	0.7087	0 −0.0047	1.4370	0 −0.0047
1⅛	6AS08-1.⅛D1	6	29.972	±0.127	31.4	2.25	80	0 −0.013	30.2	0 −0.12	36.5	0 −0.12
			1.1800	±0.0050	1.236	0.089	3.1496	0 −0.0005	1.1890	0 −0.0047	1.4370	0 −0.0047
1⅛	7AS10-1.⅛D1	7	29.972	±0.127	31.4	2.25	90	0 −0.015	30.2	0 −0.12	30.2	0 −0.12
			1.1800	±0.0050	1.236	0.089	3.5433	0 −0.0006	1.1890	0 −0.0047	1.1890	0 −0.0047
1½	7AS11-1.½D1	7	38.89	±0.127	41.2	2.25	100	0 −0.015	33.3	0 −0.15	33.3	0 −0.15
			1.5311	±0.0050	1.622	0.089	3.9370	0 −0.0006	1.3110	0 −0.0059	1.3110	0 −0.0059

Remarks: 1) Bearings suffixed with D1 have oil holes on the outer ring.
2) R min.: 0.059 inch.

Nominal dimensions			Basic load ratings		Mass
mm inch			N lbf		kg lb
r_s min.	s	F	dynamic C_r	static C_{or}	
1.5	—	—	29 100	17 800	0.66
0.059	—	—	6 550	4 000	1.46
1.5	2.2	6.6	29 100	17 800	0.78
0.059	0.087	0.260	6 550	4 000	1.72
1.5	—	—	29 100	17 800	0.61
0.059	—	—	6 550	4 000	1.35
1.5	2.2	6.6	29 100	17 800	0.73
0.059	0.087	0.260	6 550	4 000	1.61
1.5	2.2	6.7	35 000	23 200	0.90
0.059	0.087	0.264	7 900	5 200	1.99
2	2.5	7.6	43 500	29 200	1.12
0.079	0.098	0.299	9 750	6 550	2.47

Ball bearing, round bore, spherical O.D.



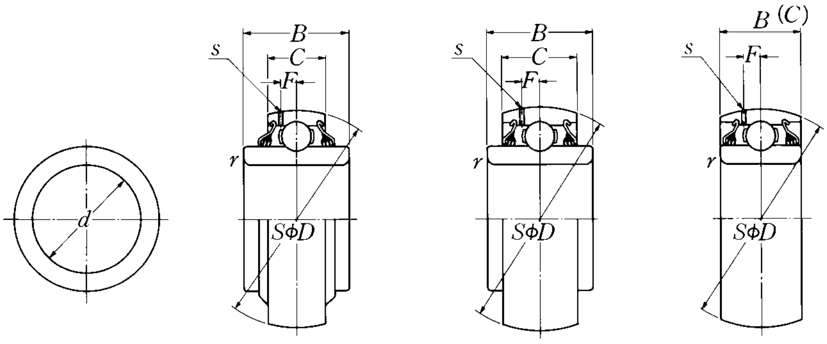
Type 1 Type 2 Type 3

Shaft dia.	Bearing [1] number	Type	Nominal dimensions							
inch			mm / inch							
			d		D		C		B	
1 3/16	1AC08-1. 3/16	1	30.175	0 − 0.013	80	0 − 0.013	18	0 − 0.12	30.2	0 − 0.12
			1.1880	0 − 0.0005	3.1496	0 − 0.0005	0.7087	0 − 0.0047	1.1890	0 − 0.0047
1.7717	3AC09D1	3	45	0 − 0.013	85	0 − 0.015	30.2	0 − 0.12	30.2	0 − 0.12
			1.7717	0 − 0.0005	3.3465	0 − 0.0006	1.1890	0 − 0.0047	1.1890	0 − 0.0047
1 1/2	3AC09-1. 1/2D1	3	38.989	0 − 0.254	85	0 − 0.015	30.2	0 − 0.12	30.2	0 − 0.12
			1.5350	0 − 0.0100	3.3465	0 − 0.0006	1.1890	0 − 0.0047	1.1890	0 − 0.0047
1 3/4	3AC10-1. 3/4D1	3	45.339	0 − 0.254	90	0 − 0.015	30.2	0 − 0.12	30.2	0 − 0.12
			1.7850	0 − 0.0100	3.5433	0 − 0.0006	1.1890	0 − 0.0047	1.1890	0 − 0.0047
1 15/16	3AC10-1. 15/16D1	3	49.225	0 − 0.013	90	0 − 0.015	30.2	0 − 0.12	30.2	0 − 0.12
			1.9380	0 − 0.0005	3.5433	0 − 0.0006	1.1890	0 − 0.0047	1.1890	0 − 0.0047
2 3/16	3AC11-2. 3/16D1	3	55.575	0 − 0.015	100	0 − 0.015	33.3	0 − 0.15	33.3	0 − 0.15
			2.1880	0 − 0.0006	3.9370	0 − 0.0006	1.3110	0 − 0.0059	1.3110	0 − 0.0059

Remarks: 1) Bearings suffixed with D1 have oil holes on the outer ring.

Nominal dimensions			Basic load ratings		Mass
mm inch			N lbf		kg lb
r_s min.	s	F	dynamic C_r	static C_{or}	
1.5	—	—	29 100	17 800	0.61
0.059	—	—	6 550	4 000	1.35
1.5	2.2	6.7	32 500	20 400	0.59
0.059	0.087	0.264	7 350	4 600	1.30
1.5	2.2	6.7	32 500	20 400	0.68
0.059	0.087	0.264	7 350	4 600	1.50
1.5	2.2	6.7	35 000	23 200	0.70
0.059	0.087	0.264	7 900	5 200	1.54
1.5	2.2	6.7	35 000	23 200	0.65
0.059	0.087	0.264	7 900	5 200	1.43
2	2.5	7.6	43 500	29 200	0.87
0.079	0.098	0.299	9 750	6 550	1.92

Ball bearing, round bore, spherical O.D.



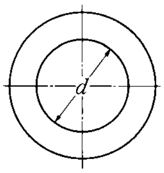
Type 1 Type 2 Type 3

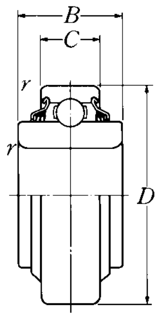
Shaft dia. inch	Bearing number [1]	Type	Nominal dimensions mm inch							
			d		*D*		*C*		*B*	
2.7559	**3AC14D1**	3	70	0 — 0.015	125	0 — 0.020	39.69	0 — 0.15	39.69	0 — 0.15
			2.7559	0 — 0.0006	4.9213	0 — 0.0008	1.5626	0 — 0.0059	1.5626	0 — 0.0059
$1\frac{15}{16}$	**3AC14-1.$\frac{15}{16}$D1**	3	49.225	0 — 0.015	125	0 — 0.020	39.69	0 — 0.15	39.69	0 — 0.15
			1.9380	0 — 0.0006	4.9213	0 — 0.0008	1.5626	0 — 0.0059	1.5626	0 — 0.0059

Remarks: 1) Bearings suffixed with D1 have oil holes on the outer ring.

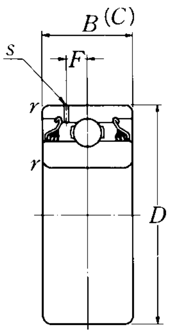
Nominal dimensions			Basic load ratings		Mass
mm inch			N lbf		kg lb
r_s min.	s	F	dynamic C_r	static C_{or}	
2	3.0	9.4	62 000	44 000	1.56
0.079	0.118	0.370	14 000	9 900	3.44
2	3.0	9.4	62 000	4 4000	2.20
0.079	0.118	0.370	14 000	9 900	4.85

Ball bearing, round bore, cylindrical O.D.





Type 5



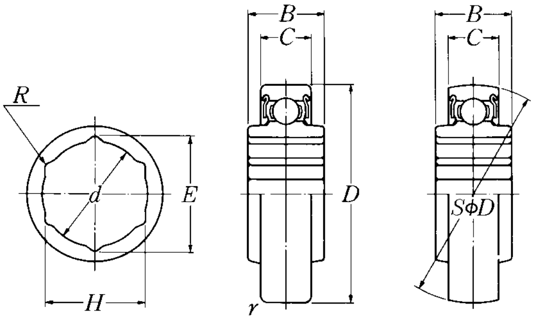
Type 7

Shaft dia. inch	Bearing 1) number	Type	Nominal dimensions mm inch d		D		C		B	
1.1811	**5AC06**	5	30 1.1811	0 − 0.010 0 − 0.0004	62 2.4409	0 − 0.013 0 − 0.0005	16 0.6299	0 − 0.12 0 − 0.0047	25.4 1.0000	0 − 0.12 0 − 0.0047
$1\frac{15}{16}$	**5AC10-1.$\frac{15}{16}$**	5	49.225 1.9380	0 − 0.013 0 − 0.0005	90 3.5433	0 − 0.015 0 − 0.0006	20 0.7874	0 − 0.12 0 − 0.0047	49.2 1.9370	0 − 0.12 0 − 0.0047
$1\frac{13}{32}$	**7AC10-1.$\frac{13}{32}$D1**	7	35.725 1.4065	0 − 0.013 0 − 0.0005	90 3.5433	0 − 0.015 0 − 0.0006	30.2 1.1890	0 − 0.12 0 − 0.0047	30.2 1.1890	0 − 0.12 0 − 0.0047
$1\frac{15}{16}$	**7AC10-1.$\frac{15}{16}$D1**	7	49.225 1.9380	0 − 0.013 0 − 0.0005	90 3.5433	0 − 0.015 0 − 0.0006	30.2 1.1890	0 − 0.12 0 − 0.0047	30.2 1.1890	0 − 0.12 0 − 0.0047
$2\frac{3}{16}$	**7AC11-2.$\frac{3}{16}$D1**	7	55.575 2.1880	0 − 0.015 0 − 0.0006	100 3.9370	0 − 0.015 0 − 0.0006	33.3 1.3110	0 − 0.15 0 − 0.0059	33.3 1.3110	0 − 0.15 0 − 0.0059

Remarks: 1) Bearings suffixed with D1 have oil holes on the outer ring.

Nominal dimensions			Basic load ratings		Mass
mm inch			N lbf		kg lb
r_s min.	s	F	dynamic C_r	static C_{or}	
1	—	—	19 500	11 300	0.21
0.039	—	—	4 400	2 540	0.46
1.5	—	—	35 000	23 200	0.74
0.059	—	—	7 900	5 200	1.63
1.5	2.2	6.7	35 000	23 200	0.88
0.059	0.087	0.264	7 900	5 200	1.94
1.5	2.2	6.7	35 000	23 200	0.68
0.059	0.087	0.264	7 900	5 200	1.50
2	2.5	7.6	43 500	29 200	0.91
0.079	0.098	0.299	9 750	6 550	2.01

Ball bearing, hex-bore



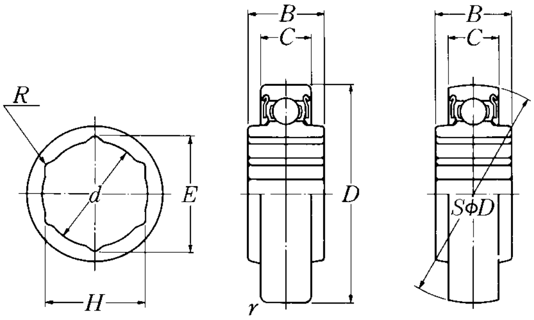
Type 1 Type 2

Shaft size inch	Bearing [1] number	Type	Nominal dimensions mm / inch H		d max.	R max.	E min.	D		C	
9/16	**1AH03-9/16**	1	14.3 0.5630	+0.127 0 +0.0050 0	14.7 0.579	0.25 0.010	16.435 0.6470	40 1.5748	0 −0.013 0 −0.0005	12 0.4724	0 −0.12 0 −0.0047
11/16	**1AH04-11/16**	1	17.653 0.6950	+0.127 0 +0.0050 0	18.1 0.713	0.25 0.010	20.307 0.7995	47 1.8504	0 −0.013 0 −0.0005	14 0.5512	0 −0.12 0 −0.0047
7/8	**1AH05-7/8**	1	22.250 0.8760	+0.127 0 +0.0050 0	22.8 0.898	0.25 0.010	25.615 1.0085	52 2.0472	0 −0.013 0 −0.0005	15 0.5906	0 −0.12 0 −0.0047
1	**1AH06-1**	1	25.425 1.0010	+0.127 0 +0.0050 0	26.1 1.028	0.25 0.010	29.281 1.1528	62 2.4409	0 −0.013 0 −0.0005	16 0.6299	0 −0.12 0 −0.0047
7/8	**2AH05-7/8**	2	22.25 0.8760	+0.127 0 +0.0050 0	22.8 0.898	0.25 0.010	25.615 1.0085	52 2.0472	0 −0.013 0 −0.0005	15 0.5906	0 −0.12 0 −0.0047
1	**2AH06-1**	2	25.425 1.0010	+0.127 0 +0.0050 0	26.1 1.028	0.25 0.010	29.281 1.1528	62 2.4409	0 −0.013 0 −0.0005	16 0.6299	0 −0.12 0 −0.0047
1 1/8	**2AH07-1. 1/8**	2	28.6 1.1260	+0.127 0 +0.0050 0	29.3 1.154	0.25 0.010	32.947 1.2971	72 2.8346	0 −0.013 0 −0.0005	17 0.6693	0 −0.12 0 −0.0047

Remarks: 1) Bearings suffixed with D1 have oil holes on the outer ring.

Nominal dimensions			Basic load ratings		Mass
mm inch			N lbf		kg lb
B		r_s min.	dynamic C_r	static C_{or}	
20.3	0 — 0.12	0.6	9 600	4 600	0.08
0.7992	0 — 0.0047	0.024	2 160	1 030	0.18
21	0 — 0.12	1	12 800	6 650	0.13
0.8268	0 — 0.0047	0.039	2 890	1 500	0.29
25.4	0 — 0.12	1	14 000	7 850	0.16
1.0000	0 — 0.0047	0.039	3 150	1 770	0.35
24	0 — 0.12	1	19 500	11 300	0.24
0.9449	0 — 0.0047	0.039	4 400	2 540	0.53
25.4	0 — 0.12	—	14 000	7 850	0.16
1.0000	0 — 0.0047	—	3 150	1 770	0.35
24	0 — 0.12	—	19 500	11 300	0.24
0.9449	0 — 0.0047	—	4 400	2 540	0.53
37.7	0 — 0.12	—	25 700	15 300	0.45
1.4843	0 — 0.0047	—	5 750	3 450	0.99

Ball bearing, hex-bore



Type 1 Type 2

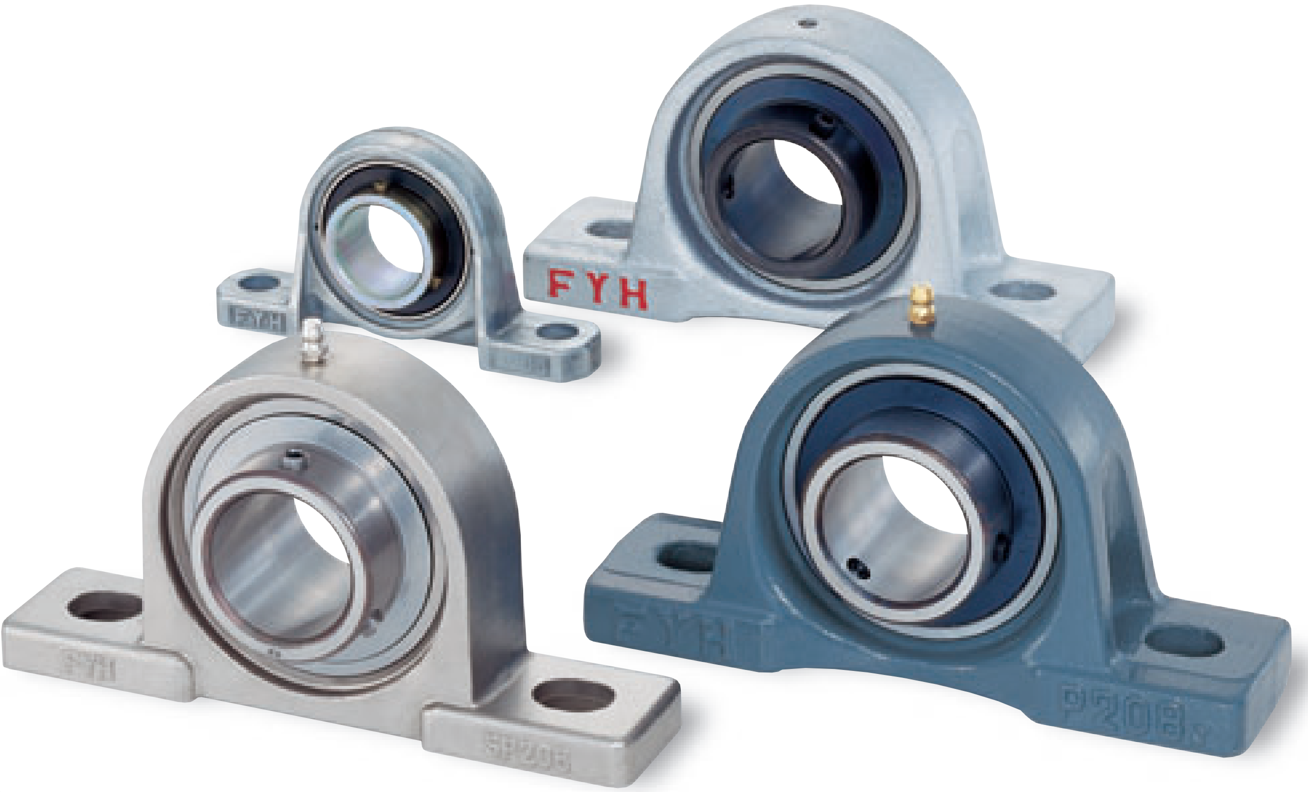
Shaft size	Bearing 1) number	Type	Nominal dimensions								
inch			mm inch								
			H		d max.	R max.	E min.	D		C	
1½	**2AH09-1.½**	2	38.125	+0.127 0	39	0.25	43.946	85	0 −0.015	19	0 −0.12
			1.5010	+0.0050 0	1.535	0.010	1.7302	3.3465	0 −0.0006	0.7480	0 −0.0047

Remarks: 1) Bearings suffixed with D1 have oil holes on the outer ring.

Nominal dimensions			Basic load ratings		Mass
mm inch			N lbf		kg lb
B		r_s min.	dynamic C_r	static C_{or}	
30	0 — 0.12	—	32 500	20 400	0.54
1.1811	0 — 0.0047	—	7 350	4 600	1.19

FYH®

BALL BEARING UNITS



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NIPPON PILLOW BLOCK CO.,LTD.

ISO 9001
JIS Q 9001

JAB
QMS Accreditation
R004

Ball Bearing Units (contents)

Technical section

Appendix table

Technical section — Technical section
Pillow type units
Square four-bolt flange type units
Oval flange type units
Round flange cartridge type units
Stamped steel plate flange type units
Take-up type units
Cartridge type units
Hanger type units
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1 Structure and features

2 Models

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5 Bearing load

6 Allowable rotating speed

7 Operating temperature and bearing specifications

8 Strength of housings

9 Design of shaft and base

11 Accuracy and internal clearance

12 Materials

13 Performance

14 Handlings

Unit dimensional table

1 Pillow type units

2 Square four-bolt flange type units

3 Oval flange type units

5 Stamped steel plate flange type units

6 Take-up type units

7 Other units

Parts and accessories

16 Parts and accessories

FYH®

BALL BEARING UNITS

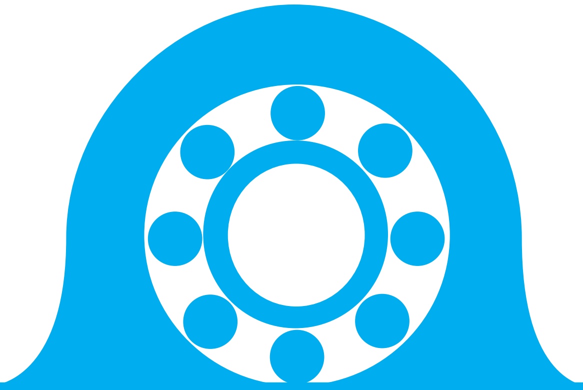
FYH BALL BEARING UNITS

CATALOG. NO. 3300

We produce a broad range of mounted bearings from small lightweight units to large heavy-duty units to meet a wide variety of industries and applications worldwide.

The **Ceraball Bearing Series**, a revolutionary style of bearing, was started by our unique idea of combining the highest grades of ceramic and steel, and now meets various needs in leading Japanese biochemical industries, information technology, aerospace, automotive manufacturing, and ocean development businesses.

This catalog introduces a section of **"Ceraball Bearings for special environments"**. We believe this new line will help to reduce bearing maintenance as well as minimize maintenance costs and downtime.



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1 Structure and features

FYH Ball Bearing Units are manufactured to exacting standards comprising grease sealed deep groove ball bearings and housings in various forms. Self-aligning units allow for easy installation and are supplied with grease nipples in order to facilitate quick and convenient re-lubrication.

1.1 Structure

FYH Ball Bearing Units are constructed of hig-h carbon chromium bearing steel and have precision honed raceways and riveted steel cages (**Fig. 1.1**).

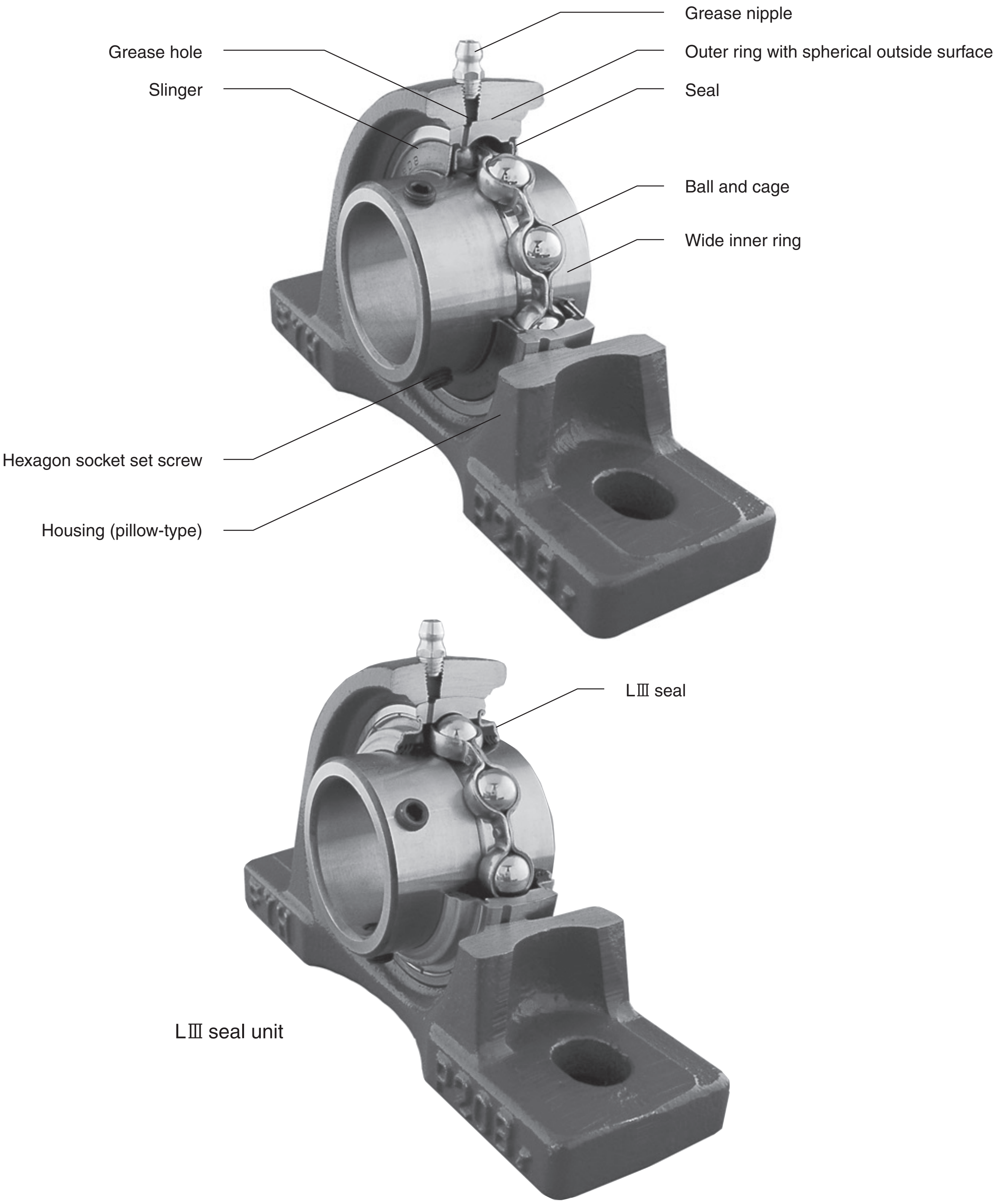


Fig. 1.1 Structure of ball bearing units (representative example)

1.2 Features

FYH Ball Bearing Units have many features and are available in various models. A wide selection of mounted units is offered to fit virtually any application.

1 Supreme load capacity and accuracy

FYH Ball Bearing Units feature an internal structure identical to single row deep groove ball bearings and bear significant radial load, as well as a great deal of axial load in both directions. The hardened steel balls exhibit a high degree of “roundness” and the races are highly polished to accommodate a smoother ride at a wide range of speeds.

2 Rational self-aligning mechanism and optimal fit

FYH Ball Bearing Units have the special ability to self-align inside the housing because of the spherical shape of the outer diameter of the bearing insert and the concave shape of the inner diameter of the housing into which it fits. This design allows the bearing unit to self-adjust for shaft deviation and thereby eliminate abnormal bearing load. Therefore, the original rated life of the bearing can be guaranteed.

Since the spherical outside surface of the bearing is precision ground and the spherical bore of the housing is machined by a boring machine with great accuracy, optimal fitting of the bearing and the housing can be obtained, as well as superior aligning performance.

The allowable aligning angle of standard ball bearing units is 3°, while units with covers is 1°.

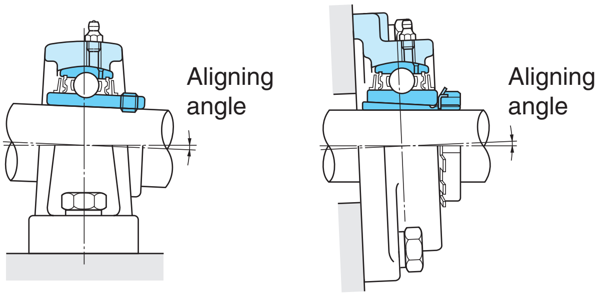


Fig. 1.2 Allowable aligning angle of ball bearing units

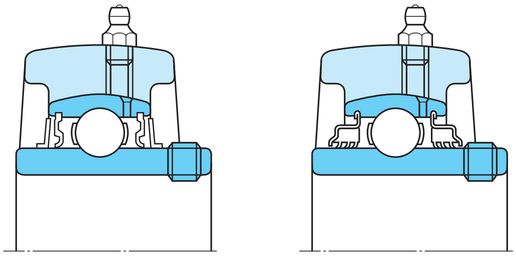
3 Superior sealing performance

FYH Ball Bearing Units efficiently prevent grease from leaking out of the interior of the bearing, and perform extremely well at keeping contaminates, such as dust and water, from entering. This is achieved by installing the seal to the outer ring of the bearing and installing the slinger to the inner ring of the bearing.

The seal is made of synthetic rubber with supreme oil proof characteristics, and the lip of the seal contacts with the inner ring of the bearing with optimal tension.

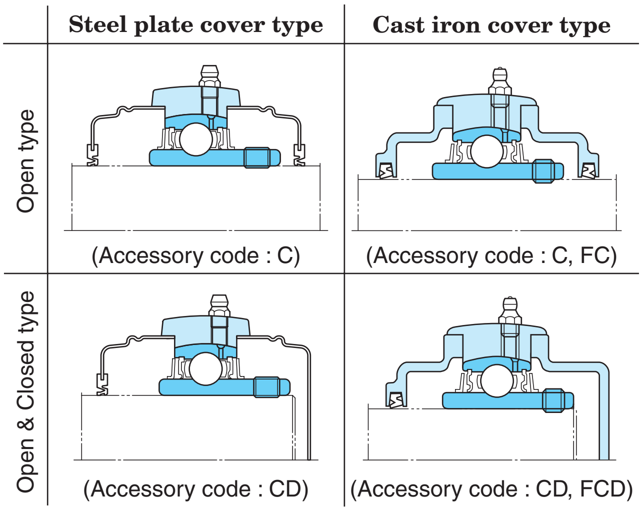
When operating in moist or dusty environments, the triple lip seal unit (suffix code : L3) or a covered unit (accessory code : C, CD, FC, FD) is recommended.

The triple lip seal unit or unit with cover helps prevent ingress of water and dust from the outside, and extends the rated life of the bearing.



Standard type

Triple lip seal type
(Suffix code : L3)



Unit with covers

Fig. 1.3 Sealing mechanism of ball bearing units

4 Simple lubrication

FYH Ball Bearing Units are tapped to accept a grease nipple which is also supplied with every mounted unit. Bearings are pre-lubricated at the factory and do not require additional grease upon installation. When operating in excessively moist, dusty, or hot environments it is recommended that grease be supplied at regular intervals. If appropriately maintained, the rated life of the bearing can be extended.

The grease nipples that are supplied with FYH mounted units include 1/4-28 for smaller units and 1/8 PT for larger units. Additional styles are available upon request.

5 Highly rigid and rugged cast iron housings

FYH Ball Bearing Units housings are designed so that they are optimized for reduction of deformation due to centralization of stress and load. Only the best material is selected to be cast by a highly advanced technique or press working technique, depending on the housing.

Since any abnormal load on the bearing is eliminated by the housing, the life of the bearing can be extended. A special baked on coating helps resist corrosion and protect the surface of the housing for an extended period of time.

6 Simple installation and handling

FYH Ball Bearing Units interchange with many different models and can be bolted to machinery without any modification. The exact amount of clearance is allowed between the bore and the shaft to allow a perfect fit.

Therefore, FYH Ball Bearing Units do not require any additional lubrication or seal installation. As a result, handling and downtime can be drastically reduced.

Three different locking mechanisms are available :
(1) set screw
(2) eccentric locking collar
(3) tapered adapter

Mounting the bearing to the shaft can be executed easily and securely by adopting any of these methods.

7 Series and models

FYH Ball Bearing Units are available in various series and models.

Reliability of machinery or equipment, used together with these units, can be improved by selecting and using units optimal for the application and operating conditions.

●Triple seal bearing series

●Unit with cover series
Water, dust, and debris protection

●Heat and cold resistant series

●Clean series
Compact, lightweight, and corrosion resistant

●Stainless steel series
Corrosion resistant

●Cast steel series
Rugged housings

●Ceraball series
Ability to withstand severe environments, exposure to water, chemicals, high temperature, or high speed

2 Models

2.1 Model list

Table 2.1 and **Table 2.2** show the models of FYH Ball Bearing Units and ball bearing inserts.

Table 2.1 FYH Ball Bearing Units models

Model	Type	Bearing bore dia. Surface (fixing to shaft)	Model code	Shaft dia.		Dimension table
				(inch)	(mm)	
1 Pillow type	(1) Standard	Cylindrical bore (with set screws)	**UCP**	$^{1}/_{2}$ – 4	12 – 140	P.62
		Cylindrical bore (with eccentric locking collar)	**NAP**	$^{1}/_{2}$ – 2 $^{15}/_{16}$	12 – 75	P.68
			NAPK	$^{1}/_{2}$ – 2 $^{15}/_{16}$	12 – 75	P.70
		Tapered bore (with adapter)	**UKP**	$^{3}/_{4}$ – 4 $^{1}/_{2}$	20 – 125	P.72
	(2) Cast steel type	Cylindrical bore (with set screws)	**UCP-sc**	$^{7}/_{8}$ – 4	25 – 140	P.78
		Tapered bore (with adapter)	**UKP-sc**	$^{3}/_{4}$ – 4 $^{1}/_{2}$	20 – 125	P.82
	(3) Thick type	Cylindrical bore (with set screws)	**UCIP**	1 $^{1}/_{2}$ – 4	40 – 140	P.86
		Tapered bore (with adapter)	**UKIP**	1 $^{1}/_{4}$ – 4 $^{1}/_{2}$	35 – 125	P.88
	(4) Tapped-base type	Cylindrical bore (with set screws)	**UCPA**	$^{1}/_{2}$ – 2	12 – 50	P.90
	(5) High centerheight type	Cylindrical bore (with set screws)	**UCPH**	$^{1}/_{2}$ – 2	12 – 50	P.92
	(6) Lightweight type	Cylindrical bore (with set screw locking)	**BLP**	$^{1}/_{2}$ – 1 $^{9}/_{16}$	12 – 40	P.94
		Cylindrical bore (with eccentric locking collar)	**ALP**			
	(7) Clean series	Cylindrical bore (with set screws)	**UP**	N/A	10 – 30	P.96
	(8) Stainless steel series	Cylindrical bore (with set screws)	**UCSP-H1S6**	N/A	20 – 50	P.98
			UCSPA-H1S6	N/A	20 – 40	P.100
			USP-S6	N/A	10 – 30	P.102
	(9) Steel plate type	Cylindrical bore (with set screw locking)	**SBPP**	$^{1}/_{2}$ – 1 $^{1}/_{4}$	12 – 30	P.104
		Cylindrical bore (with eccentric locking collar)	**SAPP**			
2 Square four-bolt flange type	(1) Standard	Cylindrical bore (with set screws)	**UCF**	$^{1}/_{2}$ – 4	12 – 140	P.106
			UCF-E	$^{1}/_{2}$ – 3 $^{7}/_{16}$	12 – 85	P.112
		Cylindrical bore (with eccentric locking collar)	**NANF**	$^{1}/_{2}$ – 2 $^{7}/_{16}$	12 – 60	P.116
		Tapered bore (with adapter)	**UKF**	$^{3}/_{4}$ – 4 $^{1}/_{2}$	20 – 125	P.118
	(2) Piloted cartridge flange type	Cylindrical bore (with set screws)	**UCFS**	1 – 4	25 – 140	P.124
		Tapered bore (with adapter)	**UKFS**	$^{3}/_{4}$ – 4 $^{1}/_{2}$	20 – 125	P.126
	(3) Stainless steel series	Cylindrical bore (with set screws)	**UCSF-H1S6**	N/A	20 – 50	P.128
3 Oval flange type	(1) Two-bolt type	Cylindrical bore (with set screws)	**UCFL**	$^{1}/_{2}$ – 4	12 – 130	P.130
			UCFL-E	$^{1}/_{2}$ – 3 $^{1}/_{4}$	12 – 85	P.136
		Cylindrical bore (with eccentric locking collar)	**NANFL**	$^{1}/_{2}$ – 2 $^{3}/_{16}$	12 – 55	P.140
		Tapered bore (with adapter)	**UKFL**	$^{3}/_{4}$ – 4 $^{1}/_{2}$	20 – 115	P.142
	(2) Adjustable oval two-bolt type	Cylindrical bore (with set screws)	**UCFA**	$^{1}/_{2}$ – 2 $^{3}/_{16}$	12 – 55	P.146
	(3) Three-bolt type	Cylindrical bore (with set screws)	**UCFB**	$^{1}/_{2}$ – 2	12 – 50	P.148
	(4) Lightweight two-bolt type	Cylindrical bore (with set screw locking)	**BLF**	$^{1}/_{2}$ – 1 $^{7}/_{16}$	12 – 35	P.150
		Cylindrical bore (with eccentric locking collar)	**ALF**			
	(5) Clean series two-bolt type	Cylindrical bore (with set screws)	**UFL**	N/A	8 – 30	P.152
	(6) Stainless steel series two-bolt type	Cylindrical bore (with set screws)	**UCSFL-H1S6**	N/A	20 – 50	P.154
			USFL-S6	N/A	10 – 30	P.156
4 Round flange cartridge type		Cylindrical bore (with set screws)	**UCFC**	$^{1}/_{2}$ – 4	12 – 100	P.158
			UCFCX-E	1 – 4	25 – 100	P.162
		Tapered bore (with adapter)	**UKFC**	$^{3}/_{4}$ – 3 $^{1}/_{2}$	20 – 90	P.164
5 Stamped steel plate flange type	(1) Round three-bolt flange type	Cylindrical bore (with set screw locking)	**SBPF**	$^{1}/_{2}$ – 1 $^{7}/_{16}$	12 – 35	P.168
		Cylindrical bore (with eccentric locking collar)	**SAPF**			
	(2) Oval two-bolt flange type	Cylindrical bore (with set screw locking)	**SBPFL**	$^{1}/_{2}$ – 1 $^{7}/_{16}$	12 – 35	P.170
		Cylindrical bore (with eccentric locking collar)	**SAPFL**			

Table 2.1 FYH Ball Bearing Units models (continued)

Model	Type	Bearing bore dia. Surface (fixing to shaft)	Model code	Shaft dia.		Dimension table
				(inch)	(mm)	
6 Take-up type	(1) Standard	Cylindrical bore (with set screws)	**UCT**	$^{1}/_{2}$ – 4	12 – 140	P.172
			UCT-E	$^{1}/_{2}$ – 3 $^{7}/_{16}$	12 – 85	P.178
		Tapered bore (with adapter)	**UKT**	$^{3}/_{4}$ – 4 $^{1}/_{2}$	20 – 125	P.182
	(2) Stainless steel series	Cylindrical bore (with set screws)	**UCST-H1S6**	N/A	20 – 50	P.188
	(3) Section steel frame type	Cylindrical bore (with set screws)	**UCTH**	$^{1}/_{2}$ – 2 $^{1}/_{2}$	12 – 65	P.190
	(4) Channel steel frame type	Cylindrical bore (with set screws)	**UCTL**	N/A	20 – 45	P.192
			UCTU	N/A	40 – 90	P.194
	(5) Steel plate frame type	Cylindrical bore (with set screws)	**SBPTH**	N/A	12 – 25	P.198
			SBNPTH	N/A	12 – 25	P.200
7 Cartridge type		Cylindrical bore (with set screws)	**UCC**	$^{1}/_{2}$ – 4	12 – 140	P.202
		Tapered bore (with adapter)	**UKC**	$^{3}/_{4}$ – 4 $^{1}/_{2}$	20 – 125	P.206
8 Hanger type		Cylindrical bore (with set screws)	**UCHA**	$^{1}/_{2}$ – 3	12 – 75	P.208

Table 2.2 Bearing insert models

Model	Type	Bearing bore dia. Surface (fixing to shaft)	Model code	Shaft dia.		Dimension table
				(inch)	(mm)	
Ball bearing inserts	(1) Standard	Cylindrical bore (with set screws)	**UC**	$^{1}/_{2}$ – 4	12 – 140	P.210
	(2) Standard	Tapered bore(with adapter)	**UK**	$^{3}/_{4}$ – 4 $^{1}/_{2}$	20 – 125	P.218
	(3) Standard	Cylindrical bore (with eccentric locking collar)	**NA**	$^{1}/_{2}$ – 3	12 – 75	P.224
	(4) Lightweight	Cylindrical bore (with set screws)	**SB**	$^{1}/_{2}$ – 1 $^{1}/_{2}$	12 – 40	P.210
	(5) Lightweight	Cylindrical bore (with eccentric locking collar)	**SA**	$^{1}/_{2}$ – 1 $^{9}/_{16}$	12 – 40	P.224
			SA-F	$^{1}/_{2}$ – 2 $^{3}/_{16}$	12 – 55	
	(6) Clean	Cylindrical bore (with set screws)	**SU**	N/A	8 – 30	P.210
	(7) Stainless steel	Cylindrical bore (with set screws)	**UC-S6**	N/A	20 – 50	P.216
			SU-S6	N/A	10 – 30	
	(8) Cylindrical outside surface (with lubricating mechanism and snap ring)	Cylindrical bore (with set screws)	**ER**	$^{1}/_{2}$ – 2 $^{7}/_{16}$	12 – 60	P.228
	(9) Cylindrical outside surface	Cylindrical bore (with set screws)	**RB**	$^{1}/_{2}$ – 1 $^{9}/_{16}$	12 – 40	P.228
	(10) Adapter		**H300X**	$^{3}/_{4}$ – 3	20 – 80	P.230
			H2300X	$^{3}/_{4}$ – 4 $^{1}/_{2}$	20 – 125	

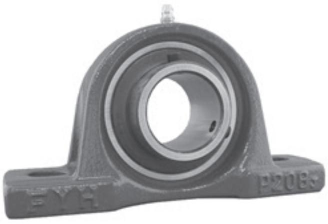
2.2 Models and features

FYH Ball Bearing Units are available in a variety of styles and sizes.

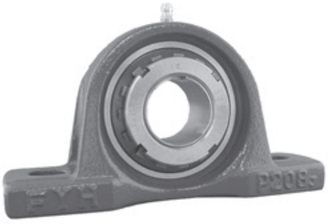
Models and features of the Ball Bearing Units are shown below.

1 Pillow type units

1 Pillow type units : P.62



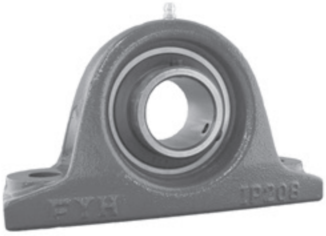
UCP



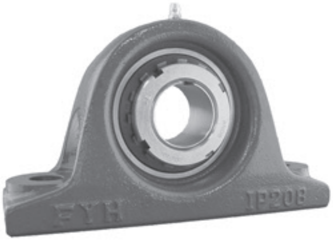
UKP

Cylindrical bore (with set screws)
L3
C, CD (FC, FCD)[1)]
Cylindrical bore (with eccentric locking collar)
Tapered bore (with adapter)
L3
C, CD (FC, FCD)[1)]

2 Thick pillow type units : P.86



UCIP



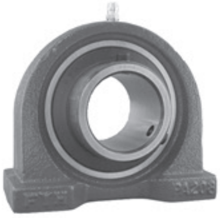
UKIP

Cylindrical bore (with set screws)
L3
C, CD (FC, FCD)[1)]
Tapered bore (with adapter)
L3
C, CD (FC, FCD)[1)]

Note [1)] Descriptions of codes for units with covers are shown in the table below. (common to all the models)

Diameter series	Code	Descriptions
2	C, CD	Stamped steel plate cover type
	FC, FCD	Cast iron cover type
X	C, CD	From **X05** to **X17** : stamped steel plate cover type **X18** and **X20** : cast iron cover type
3	C, CD	Cast iron cover type

3 Tapped-base pillow type units : P.90



UCPA

Cylindrical bore (with set screws)
L3

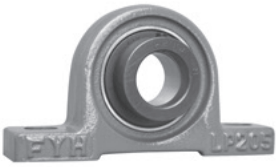
4 High centerheight pillow type units : P.92

UCPH

Cylindrical bore (with set screws)
L3

5 Lightweight pillow type units : P.94

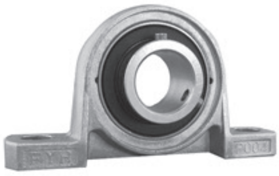
BLP



ALP

Cylindrical bore (with set screw locking)
Cylindrical bore (with eccentric locking collar)

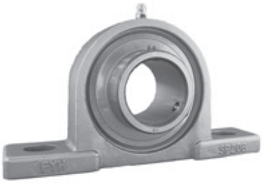
6 Clean series pillow type units : P.96



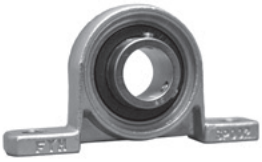
UP

Cylindrical bore (with set screws)
C, CD : Rubber coating cover type

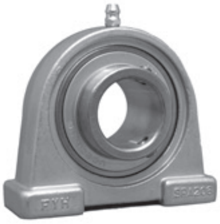
7 Stainless steel series pillow type units : P.98



UCSP-H1S6



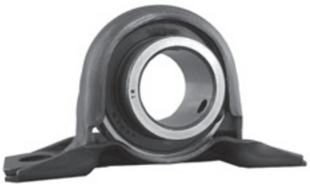
USP-S6



UCSPA-H1S6

Cylindrical bore (with set screws)
C, CD : Stainless steel plate cover type
Compact
C, CD : Rubber coating cover type

8 Steel plate pillow type units : P.104



SBPP

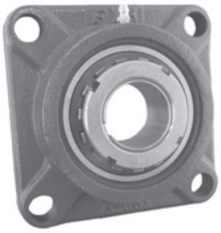
SAPP

Cylindrical bore (with set screw locking)
Cylindrical bore (with eccentric locking collar)

2 Square four-bolt flange type units

1 Square four-bolt flange type units : P.106

UCF



UKF

Cylindrical bore (with set screws)
L3
C, D (FC, FD)[1]
Cylindrical bore (with eccentric locking collar)
Tapered bore (with adapter)
L3
C, D (FC, FD)[1]

2 Square four-bolt flange cartridge type units : P.124

UCFS

UKFS

Cylindrical bore (with set screws)
L3
C, D
Tapered bore (with adapter)
L3
C, D

3 Stainless steel series square four-bolt flange type units : P.128

UCSF-H1S6

Cylindrical bore (with set screws)
C, D : Stainless steel plate cover type

3 Oval flange type units

1 Oval two-bolt flange type units : P.130

UCFL

UKFL

Cylindrical bore (with set screws)
L3
C, D (FC, FD)[1]
Cylindrical bore (with eccentric locking collar)
Tapered bore (with adapter)
L3
C, D (FC, FD)[1]

(3 Oval flange type units)

2 Adjustable oval two-bolt flange type units : P.146

UCFA

Cylindrical bore (with set screws)
L3

3 Three-bolt flange type units : P.148

UCFB

Cylindrical bore (with set screws)
L3

4 Lightweight oval two-bolt flange type units : P.150

BLF

ALF

Cylindrical bore (with set screw locking)
Cylindrical bore (with eccentric locking collar)

5 Clean series oval two-bolt flange type units : P.152

UFL

Cylindrical bore (with set screws)
C, D : Rubber coating cover type

6 Stainless steel series oval two-bolt flange type units : P.154

UCSFL-H1S6

USFL0-S6

Cylindrical bore (with set screws)
C, D : Stainless steel cover type
Compact
C, D : Rubber coating cover type

4 Round flange cartridge type units

Round flange cartridge type units : P.158

UCFC

UKFC

Cylindrical bore (with set screws)
L3
C, D (FC, FD)[1]
Tapered bore (with adapter)
L3
C, D (FC, FD)[1]

5 Stamped steel plate flange type units

1 Stamped steel plate round three-bolt flange type units : P.168

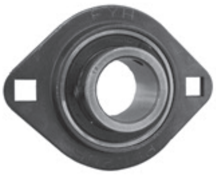
SBPF

SAPF

Cylindrical bore (with set screw locking)
Cylindrical bore (with eccentric locking collar)

As for the descriptions of Note [1], see page 8.

2 Stamped steel plate oval two-bolt flange type units : P.170

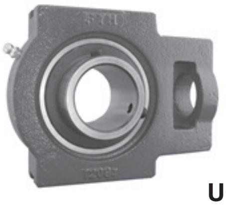


SBPFL **SAPFL**

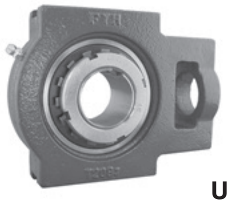
Cylindrical bore (with set screw locking)
Cylindrical bore (with eccentric locking collar)

6 Take-up type units

1 Take-up type units : P.172



UCT



UKT

Cylindrical bore (with set screws)
L3
C, CD (FC, FCD)[1)]
Tapered bore (with adapter)
L3
C, CD (FC, FCD)[1)]

2 Stainless steel series take-up type units : P.188

UCST-H1S6

Cylindrical bore (with set screws)
C, CD : Stainless steel plate cover type

3 Section steel frame take-up type units : P.190

UCTH

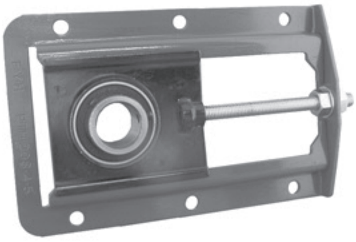
Cylindrical bore (with set screws)
L3
C, CD (FC, FCD)[1)]

4 Channel steel frame take-up type units : P.192

UCTL

Cylindrical bore (with set screws)
L3
C, CD (FC, FCD)[1)]

5 Steel plate frame take-up type units : P.198



SBPTH **SBNPTH**

Cylindrical bore (with set screws)

As for the descriptions of Note [1)], see page 8.

7 Other units

1 Cartridge type units : P.202

UCC

UKC

Cylindrical bore (with set screws)
L3
Tapered bore (with adapter)
L3

2 Hanger type units : P.208

UCHA

Cylindrical bore (with set screws)
L3

3 Ceraball bearing series

Cylindrical bore (with set screws)
UC2 (X, 3)...**Y1** type
UC2 S6...**Y2** type

8 Ball bearing inserts

1 UC type bearing : P.210

UC

Cylindrical bore (with set screws)
L3

2 UK type bearing : P.218

UK

Tapered bore (with adapter)
L3

3 NA type bearing : P.224

NA

Cylindrical bore (with eccentric locking collar)

4 SB type bearing : P.210

SB

Cylindrical bore (with set screws)

5 SA type bearing : P.224

SA **SA-F**

Cylindrical bore (with eccentric locking collar)

6 SU type bearing (clean series) : P.210

SU

Cylindrical bore (with set screws)

7 ER bearing inserts : P.228

ER

Cylindrical bore (with set screws),
cylindrical outside surface, lubricating mechanism,
set screw

8 RB bearing inserts : P.228

RB

Cylindrical bore (with set screws),
cylindrical outside surface

2.3 Units for special use

To meet customer requests for bearings with special purposes FYH offers a variety of bearing options to meet their needs. Various features allow FYH bearings to work in many non-standard environments and conditions.

The following information shows some of the ways FYH can offer solutions to your non-standard bearing needs.

1 LⅢ (L3) units

The triple lip seal is composed of a three lip seal glued to the steel shield plate with vulcanized adhesive. The triple lip seal prevents dust, mud, & water from accessing the raceway of the bearing. The triple lip ensures long bearing life in even the most severe environmental conditions.

The L3 seals are fit to the outer ring of the bearing and do not require the insert to be handled any differently than a standard model. The L3 seal allows for the same amount of misalignment as a standard insert. The L3 seal retains its' sealing performance for the life of the unit.

The L3 unit is helpful in keeping contaminant out of the insert, prolonging life and minimizing bearing change-outs. The L3 insert in available in the UC series as well as the UK series.

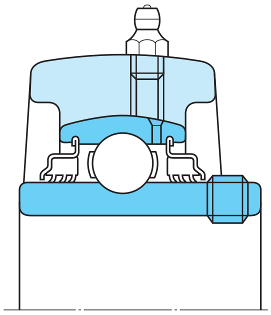
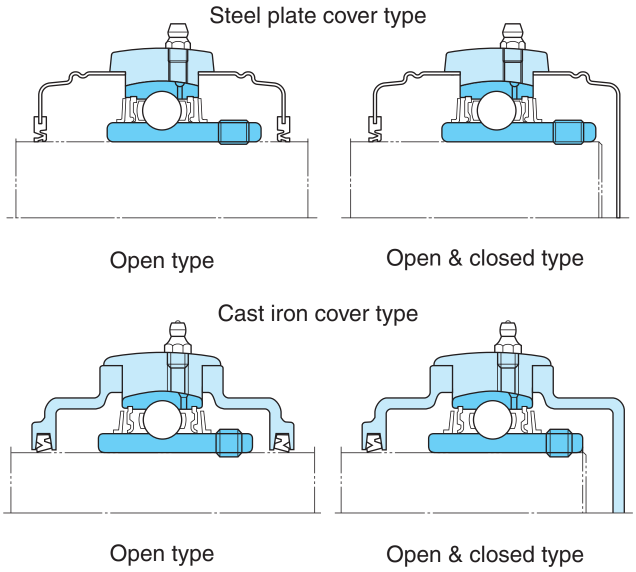


Fig. 2.1 Structure of LⅢ units

2 Units with covers (accessory code C, D, FC, FD)

Covers can be fitted onto most types of housings with some machining necessary. The covers come in both pressed steel type as well as cast iron. Covers are available in open and closed designs. The open design has a hole with a rubber seal that allows shafting to pass through it. The closed design would be used on a pillow block where shafting will not pass through. The covers help ensure that dust and other environmental contaminants will not reach the insert. The covers help improve the rating life of bearing units where conditions have caused other bearings to fail.

Open pressed steel covers use C, open cast iron covers use FC. Closed covers use D for pressed steel and FD for the cast iron type. Pillow blocks can have covers on both sides, and can come in open/open or open/closed designs.



Steel plate cover type

Open type

Open & closed type

Cast iron cover type

Open type

Open & closed type

Fig. 2.2 Model and structure of units with cover

3 High temperature / Low temperature units (accessory code high temperature D1K2 re-lube, D9K2 pre-lube low temperature D2K2)

For applications that require bearing units to be used at a higher or lower temperature range than our standard models FYH offers several options. For high temperature units that require lubrication please specify D1K2 type of inserts. For high temperature units that do not require lubrication specify D9K2. The D9K2 insert uses a fluorogrease, that allows for high heat resistance and operation for a long period of time. Specifications of the high temperature and low temperature grease units are shown in **Table 2.3**.

Table 2.3 Specifications of heat resistant units and cold resistant units

Category	Special code	Operating temperature range (°C)	Grease	Seal rubber material	Bearing internal clearance	
					UC type	UK type
Ordinary	(no code)	−20 to 100	Alvania No.2, Gold No.3A or equivalence (lithium soap)	Nitrile	CN	C3
Stainless steel	S6	−20 to 100	BEL. RAY NO TOXHD2TC	Nitrile	C3	−
Heat resistant	D1K2	−40 to 180	SH44M (lithium soap)	Silicone	C4	C5
Heat resistant	D9K2	−20 to 220	DemnumL-200 (fluorinated grease)	Silicone	C4	C5
Heat resistant	D9P4	−20 to 250	DemnumL-200 (fluorinated grease)	−	C4	C5
Cold resistant	D2K2	−50 to 120	SH33M (lithium soap)	Silicone	CN	C3

Remark　As for the supplying interval in case of faulty temperature and environment, see P.57.

4 High speed units (special code K3)

High speed units are used in applications where low torque and high RPM's are necessary. These units use a non-contact seal that allows for a free spin that cuts down on temperature, and allows for low torque start-up. These units are often used in the printing and textile machinery applications.

5 Units for blowers (special code S5)

Ball bearing units for blowers must meet the demands of high speed rotation, low vibration, low noise and decreased temperature output.

To meet these performance needs FYH produces the S5 series of units for blowers. These units use non-contact seals, as well as an improved machining accuracy to cut down on heat, noise, and vibration.

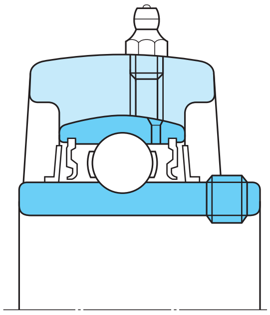


Fig. 2.3 Structure of bearing units for blowers

6 Clean series units

Our clean series unit is a compact design that allows for light conveying in many manufacturing applications. The setscrew design allows for easy installation, as well as reversing. The housing is made of a special alloy, and the insert is zinc plated. Covers coated with rubber increase adhesion with the housing and can be ordered separately in both open and closed designs. The clean series comes in metric sizes only from 10 mm to 30 mm. They are available in both pillow block and 2-bolt flange.

7 Stainless steel series (special code S6)

Our stainless steel series is designed for food, pharmaceutical and other applications that experience frequent wash down or chemical splash. The stainless steel inserts come with USDA approved food grade grease (H1) standard. The insert is composed of 440 grade stainless steel. Stainless covers are available for these units to give additional protection. The operating temperature range is from −20 ℃ to +100 ℃.

8 Ceraball bearing units (special code Y1 to Y7)

Ceraball bearings have Silicon Niteride (Si3N4) ceramic balls, and ensure stable performance for long periods of time even in special operating environments. These environments include : high temperature, corrosion, high speed rotation, low torque, and vacuum.

Y1 type (high speed rotation)

· This bearing is designed for applications with high speed rotation in which the dN value exceeds 200 000. This is made possible by the lightweight ceramic balls.

Y2 type (standard)

· This is the standard model in the Ceraball series. It is designed to withstand temperatures of 250 ℃. It resists corrosive conditions such as heated steam, chemical and solvents. It can be used in clean room conditions due to its' low dust and low torque properties. It will also perform well in insulated or vacuum conditions.

Y3 type (extra high temperature)

· This bearing is designed for environments that experience temperature in excess of 300 ℃, and where greasing is hard to execute. For these applications FYH offers the Y3 type of bearing with solid lubricant used for the cage. These bearings are designed to withstand temperatures of up to 450 ℃.

Y7 type (anticorrosion type)

· This bearing is designed to perform in areas where standard bearings fail. This bearing is suited to corrosive environments where bearings may be exposed to solvents, or underwater applications. This bearing is best for light loads and low speed rotation.

3 Selection of units

3.1 Outline of selection

FYH ball bearings are available in many models and types. To make sure that you are selecting the bearings that will best suit you application many factors must be considered. These include : the structure and space limitations of the machinery, operating conditions, load, temperature, and speed. The life you will get out of the bearing unit will greatly depend on proper selection.

Procedures for choosing the correct ball bearing unit are shown in **Table 3.1**.

Table 3.1 Procedures of selection of ordinary ball bearing units

Procedures of selection	Items to be examined	Operating conditions to be considered	Reference
1 Selection of model	· Pillow type · Flange type · Take-up type · Cartridge type · Hanger type	Structure of machinery, mounting space, mounting dimensions	2 Models (P.6)
2 Selection of shaft dia. and dia. series	· Bearing bore dia. : From 8 to 140 mm · Dia. series : 0, 2, X, 3	Rating life of bearings required, load applied to bearings, rotating speed	4 Rating life of bearings (P.19) 5 Bearing load (P.22) 6 Allowable rotating speed (P.29)
3 Selection against atmosphere	· L3 type · Cover type · Clean series · Stainless steel series · Ceramic series · For high speed use · For blower	Environment (dusts, mud water, moisture, chemicals), rotating speed	2 Models (P.6) (P.14) 6 Allowable rotating speed (P.29)
4 Selection against temperature	· Heat resistant type · Cold resistant type · Ceraball series · Measures against expansion and contraction of shaft · Grease supply	Bearing temperature	2 Models (P.6) (P.14) 7 Operating temperature and bearing specifications (P.30) 9 Design of shaft and base (P.36) 14 Handlings (P.52)
5 Selection of installing to shaft	· Set screw · Adapter · Eccentric locking collar	Rotating speed, load conditions, handling	2 Models (P.6) 14 Handlings (P.52)
6 Selection of shafts	· Dimensional tolerance · Adoption of shouldered shaft · Provision of set screw for shaft · Measures against expansion and contraction of shaft	Rotating speed, load conditions, bearing temperature	2 Models (P.6) (P.14) 6 Allowable rotating speed (P.29) 9 Design of shaft and base (P.36) 14 Handlings (P.52)
7 Selection of strength of housings	· Cast iron · Cast steel · Steel plate	Load conditions, load directions, presence of impact	8 Strength of housings (P.31)
8 Selection of lubricant	· Lubricating type · Non-lubricating type · Centralized lubricating type · Greasing interval	Environment, importance of machine, bearing temperature, grease life	14 Handlings (P.52)
9 Selection of maintenance and check	· Periodic inspection · Grease supply	Environment, importance of machine, bearing temperature, grease life	14 Handlings (P.52)

3.2 Selection of model specifications

FYH ball bearing units are available in various models and offer options for different operating environments. When selecting models and specifications of units care must be taken to consider all factors that can affect the bearing life : **Table 3.2** will help with proper selection of ball bearing unit models.

Table 3.2 Outline of selection of ball bearing unit models and specifications

○ : Acceptable or Yes, × : Unacceptable or No

Category	Performance required		Bearing specifications			Applicable housing
	Operating conditions	Installing to shaft	Sealing structure	Model code	Lubrication	
Bearing	General	Set screw Adapter	Seal and slinger	UC UK	○	C, F, FA, FB, FC, FL, FS, HA, IP, P, PA, PH, T, TH, TL, TU
		Eccentric locking collar		NA	○	C, FC, NF, NFL, P, T
	Dustproof and waterproof	Set screw Adapter	L3	UC-L3 UK-L3	○	C, F, FA, FB, FC, FL, FS, HA, IP, P, PA, PH, T, TH, TL, TU
	Lightweight	Set screw	Seal	SB SU	×	LF, LP, PF, PFL, PP, PTH, NPTH, FL0, P0
	Anticorrosion	Set screw	Seal and slinger	UC-S6 Y2 · Y7	○	SF-H1, SFL-H1, SP-H1, SPA-H1
			Seal	SU-S6	×	SFL, SP
	Heat resistant Cold resistant For high speed For blower	Set screw Adapter	Seal and slinger	UC UK Y1 · Y2 · Y3	○	C, F, FA, FB, FC, FL, FS, HA, IP, P, PA, PH, T

Category	Performance required		Housing specifications				Applicable bearing
	Type	Operating conditions	Model code	Material	Presence of cover	Lubrication	
Housing	Pillow type	General	P	Cast iron	○	○	UC (-L3), UK (-L3)
		Cast steel (highly strong)	Psc	Cast steel			
		Thick (highly strong)	IP	Cast iron			
		Tapped-base	PA	Cast iron	×	○	UC (-L3)
		High centerheight	PH			○	UC (-L3)
		Lightweight	LP			×	SB
		Clean	P0	Special light alloy	○	×	SU
		Anticorrosion	SP-H1,	Stainless steel		○	UC-S6
			SPA-H1	Stainless steel		○	UC-S6
			SP	Stainless steel		×	SU-S6
		Steel plate	PP	Steel plate	×	×	SB
	Flange type	Square	F	Cast iron	○	○	UC (L3), UK (L3)
		Anticorrosion	SF-H1	Stainless steel			UC-S6
		Cartridge (square)	FS	Cast iron			UC (L3), UK (L3)
		(round)	FC	Cast iron			UC (L3), UK (L3)
		Oval	FL	Cast iron	○	○	UC (-L3)
		Shaft alignment (adjustable oval)	FA		×		
		Cantilever (deformed)	FB		×		
		Lightweight (oval)	LF	Cast iron	×	×	SB
		Clean (oval)	FL0	Special light alloy	○		SU

Category	Performance required		Housing specifications				Applicable bearing
	Type	Operating conditions	Model code	Material	Presence of cover	Lubrication	
Housing	Flange type	Anticorrosion (oval)	SFL-H1	Stainless steel	○	○	UC-S6
			SFL	Stainless steel		×	SU-S6
		Steel plate (round)	PF	Steel plate	×	×	SB
		(oval)	PFL				
	Take-up type	General	T	Cast iron	○	○	UC (-L3), UK (-L3)
		Anticorrosion	ST-H1	Stainless steel	○	○	UC-S6
		Section steel frame type	T	Cast iron	○	○	UC (-L3)
		Channel steel frame type	TL	Cast iron	○	○	UC (-L3), UK (-L3)
			TU				
		Steel plate frame type	PTH	Steel plate	×	×	SB
			NPTH				
	Cartridge type	General	C	Cast iron	×	○	UC (-L3), UK (-L3)
	Hanger type	General	HA	Cast iron	×	○	UC (-L3)

3.3 Selection of bearings from a maintenance viewpoint

FYH ball bearing units require little if any maintenance when being used in general operating conditions. Periodic checks will help ensure that the bearings are performing as required. The periodic checks should be based upon your application. Bearings operating in a clean environment with low load, and low RPM need to be checked less often than units in a dirty environment, with higher loads. Care should be taken to make sure that the bearings are being properly lubricated and that the right kind of grease is being used. If great axial load will be present a shouldered shaft should be used. If the bearing environment is wet or dusty a cover of LⅢ type of insert should be used. In an environment exposed to high or low temperature the type of grease and the material of the seals must be taken fully into consideration.

4 Rating life of bearings

When ball bearing units are installed and operated on a piece of machinery eventually a failure will occur. The period of operation until the unit cannot be used due failure is called the bearing life.

Bearing failure is caused by two main reasons. The first is fatigue of bearing material, and the second is degradation of grease. The life is figured on whichever fail first. Proper bearing lubrication will eliminate grease degradation and allow the full bearing life to be achieved. If the bearing units are run without replenishment of the grease the bearing life will have to be factored by either the grease life or the bearing life. During installation care must be taken not to dent or crack the insert. Proper bearing maintenance and lubrication will ensure long bearing life.

4.1 Basic rating life and basic load rating

4.1.1 Basic rating life

When a bearing is rotated under load, the raceways, the surfaces of the inner and outer rings, and the rolling elements are exposed to load continuously. Damages such as scaling appear eventually on the material (flaking or peel-off). The total rotating frequency until the damage appears is called the “fatigue limit of the bearing”. Fatigue limit of the bearing can vary greatly even if the bearings have the same structure, dimensions, materials, machining methods, and are operated under the same conditions.

To solve this if a group of the same bearings operating under the same conditions the total rotating frequency of 90% of the bearings operating with no damage due to rotating fatigue (life of 90% reliability) is called the basic load rating.

4.1.2 Basic load rating

Dynamic ratings are determined by placing a pure radial load on a radial bearing or by placing a central axial load on a thrust bearing. The dynamic rating is the load that the bearing will withstand for one million cycles before failure of the bearing.

These ratings are referred to as the **basic dynamic radial load rating** (C_r) or the **basic dynamic axial load rating** (C_a) These values are shown in the catalog.

In the ball bearings for ball bearing units, it is indicated as the basic dynamic radial load rating (C_r), and the value is shown in the dimensional table.

4.2 Calculation of rating life

The relation between the basic rating life, the basic dynamic load rating, and the dynamic equivalent load of the ball bearings for ball bearing type units are indicated in **Formula (4.1)**. If the ball bearing unit is being used at a fixed rotating speed, the life is indicated as time. This is shown in **Formula (4.2)**.

(Total rotating frequency) $$L_{10} = \left(\frac{C_r}{P_r}\right)^3 \quad \cdots\cdots\cdots\cdots (4.1)$$

(Time) $$L_{10h} = \frac{10^6}{60n}\left(\frac{C_r}{P_r}\right)^3 \quad \cdots\cdots (4.2)$$

Whereas,

L_{10} : Basic rating life, 10^6 rotations
L_{10h} : Basic rating life, hr
C_r : Basic dynamic load rating, N
P_r : Dynamic equivalent load, N
(see **“5 Bearing load”**)
n : Rotating speed, min^{-1}

Calculation of the basic rating life using the life factor (f_h) and the speed factor (f_n) in the **Formula (4.2)** are shown below.

$$L_{10h} = 500\ f_h{}^3 \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (4.3)$$

Life factor $$f_h = f_n \cdot \frac{C_r}{P_r} \quad \cdots\cdots\cdots\cdots\cdots\cdots (4.4)$$

Speed factor $$f_n = \left(\frac{10^6}{500 \times 60n}\right)^{1/3}$$

$$= (0.03n)^{-1/3} \quad \cdots\cdots\cdots\cdots\cdots (4.5)$$

Values of f_n, f_h and L_{10h} can be found using the nomogram of **Fig. 4.1**.

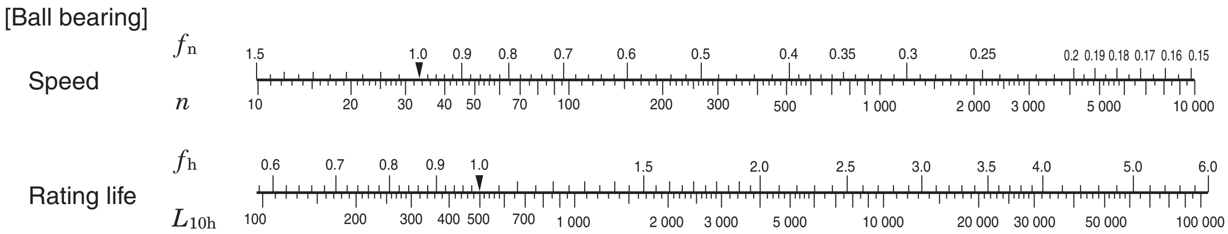


Fig. 4.1 Relation between basic rating life (L_{10h}) and rotating speed (n), speed factor (f_n), and life factor (f_h)

4.2.1 Correction of basic load rating due to temperature

If a ball bearing unit is used at a high temperature the physical composition of the bearing material is changed, leading to decreased hardness. This decreased hardness leads to the basic dynamic load rating being reduced. Once the structure of the bearing material has been changed, it will remain this way for the life of the unit, even when it returns to room temperature.

When using a ball bearing unit at 150 ℃ or more, the basic load rating must be corrected by multiplying the basic dynamic load rating shown in the dimensional table by the temperature factor shown in **Table 4.1**.

Table 4.1 Temperature factor

Bearing temperature, ℃	**125**	**150**	**175**	**200**	**250**
Temperature factor	1	1	0.95	0.9	0.75

4.2.2 Corrected rating life

The basic L_{10} rating life shown in **Formula (4.1)** is the fatigue life of a bearing with 90% reliability ; there are circumstances where bearings need greater reliability. The bearing life may be extended by using special materials. Other conditions including lubrication may influence the bearing life.

The corrected rating life is found by taking the basic rating life and using the points in **Formula (4.6)** into consideration.

$$L_{na} = a_1 a_2 a_3 L_{10} \quad \cdots\cdots (4.6)$$

Whereas,

L_{na} : Corrected rating life, 10^6 rotations
Life that characteristics of bearing and operating conditions are taken into consideration with reliability 100−n% (breakage probability)
L_{10} : Basic load rating, 10^6 rotations
Life with 90% reliability
a_1 : Reliability factor .... see (1)
a_2 : Bearing characterization factor .... see (2)
a_3 : Operating condition factor .... see (3)

(1) Reliability factor a_1

Table 4.2 shows the values used when a corrected bearing life that has less than a 10% breakage probability is necessary.

Table 4.2 Reliability factor a_1

Reliability, %	L_{na}	a_1
90	L_{10a}	1
95	L_{5a}	0.62
96	L_{4a}	0.53
97	L_{3a}	0.44
98	L_{2a}	0.33
99	L_{1a}	0.21

(2) Bearing characterization factor a_2

The material make-up of a bearing can have an affect on its' basic rating life. Factors that can influence the bearing include : bearing material (type of steel), production procedures, and bearing design. Bearing characterization is shown as the factor a_2.

FYH ball bearing inserts use high quality vacuum degassed bearing steel as standard material. This material allows for a longer rating life. For FYH ball bearing units the bearing characterization factor a_2 is 1 ($a_2 = 1$). When bearings with special materials are used for a longer fatigue limit the characterization factor can be shown as a_2 being greater than 1 ($a_2 > 1$).

(3) Operating condition factor a_3

Operating conditions may directly influence the life of the bearing (especially proper or improper greasing). The basic rating life should be corrected using the operating condition factor a_3. If lubrication is being maintained the factor $a_3 = 1$. If excellent re-lubrication practices are being maintained the factor $a_3 > 1$ should be applied.

If any of the following operating conditions are applicable the condition should be applied as $a_3 < 1$.

(1) Kinematical viscosity of lubricant during operation is low
.... Ball bearing : 13 mm^2/s or less,
roller bearing : 20 mm^2/s or less
(2) Rotating speed is low .... $d_m n$: 10 000 or less
Remark d_m (Pitch dia. of ball set) × n (Rotating speed)
(3) Foreign matters are mixed in lubricant

Even if the bearing characterization factor is improved i.e., $a_2 > 1$, the life of the bearing must still be downrated if the combination, $a_2 \times a_3 > 1$.

4.2.3 Required lifetime of bearings

At some point continuing to use a ball bearing unit does not lead to economical operation. Operating conditions, the type of bearing units used, and the type of machine the bearing is used on all influence the lifetime of the bearing.

The required lifetime of the ball bearing units is shown in **Table 4.3**.

Table 4.3 Required life time of ball bearing units (reference)

Operating conditions	Machines used	Required life time, hr
Operated in short period or intermittently	Home electric appliances, electric tool, agricultural machinery, hoist, etc.	4 000 – 8 000
Discontinuously but for a long period	Factory motor, ordinary gear, etc.	12 000 – 20 000
Always operated for 8 hours or longer a day or operated continuously for a long period	General machinery, blower, etc.	20 000 – 30 000
Operated continuously for 24 hours, no fault is allowed	Electric power plant facility, mine drainage facility, etc.	100 000 –200 000

4.3 Grease life

The grease life for ball bearing units is influenced by : the level of the load, rotating speed of the bearing, and the operating temperature.

The grease life for ball bearing units being used under appropriate operating conditions cane be found by the formula shown below.

$$\log L = 6.10 - 4.40 \times 10^{-6}\, d_m n - 2.50\left(\frac{P_r}{C_r} - 0.05\right) - (0.021 - 1.80 \times 10^{-8}\, d_m n)\, T \quad \cdots\cdots\cdots\cdots\cdots (4.7)$$

Whereas,

L : Grease life, hr

d_m : Pitch dia. of ball set, mm

$$d_m = \frac{(D+d)}{2}$$

(D : Nominal bearing outer dia., d : Nominal bearing bore dia.)

n : Rotating speed of bearing, min^{-1}

P_r : Dynamic equivalent radial load, N (see **"5 Bearing load"**)

C_r : Basic dynamic radial load rating of bearing, N

T : Operating temperature of bearing, ºC

Applicable conditions for the **Formula (4.7)** are shown below.

1) Operating temperature of bearing : T °C

To be applied if the following condition is satisfied : $T \leq 100$

(If T is smaller than 50 ($T < 50$), following condition should be applied : $T = 50$.)

If T is larger than 100 ($T > 100$), contact FYH.

2) Rotating speed of bearing : $d_m n$

To be applied if the following condition is satisfied : $d_m n \leq 30 \times 10^4$

(If $d_m n$ is smaller than 12.5×10^4 ($d_m n < 12.5 \times 10^4$), following condition should be applied : $d_m n = 12.5 \times 10^4$)

If $d_m n$ is larger than 30×10^4 ($d_m n > 30 \times 10^4$), contact FYH.

3) Load condition of bearing : $\frac{P_r}{C_r}$

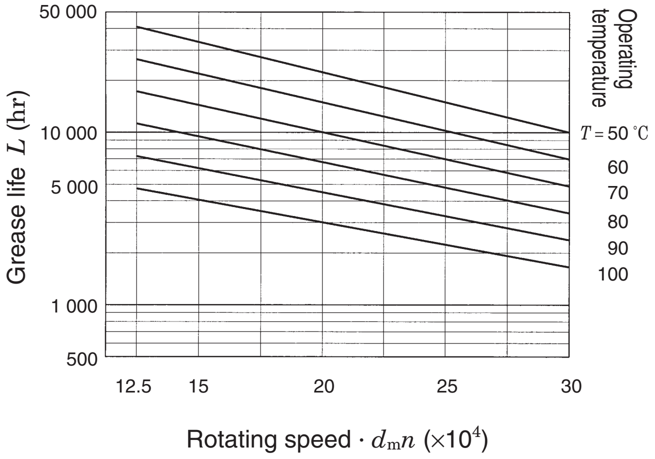
To be applied if the following condition is satisfied : $\frac{P_r}{C_r} \leq 0.2$

(If $\frac{P_r}{C_r}$ is smaller than 0.05 ($\frac{P_r}{C_r} < 0.05$), following condition should be applied : $\frac{P_r}{C_r} = 0.05$)

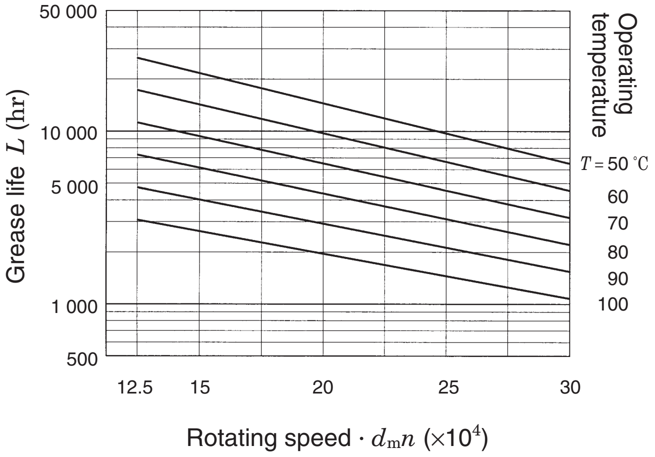
If $\frac{P_r}{C_r}$ is larger than 0.2 ($\frac{P_r}{C_r} > 0.2$), contact FYH.

Reference figure of grease life obtained by the **Formula (4.7)** is shown in **Fig. 4.2**.

(1) Bearing load · $\frac{P_r}{C_r} = 0.05$



(2) Bearing load · $\frac{P_r}{C_r} = 0.125$



(3) Bearing load · $\frac{P_r}{C_r} = 0.2$

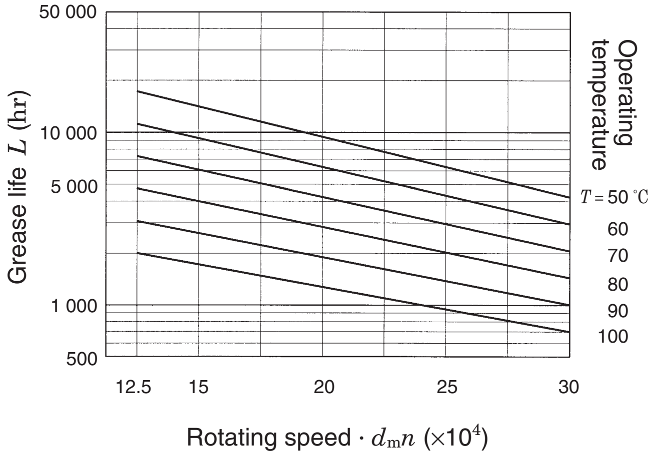


Fig. 4.2 Relation of grease life to bearing load, rotating speed, and operating temperature (reference)

5 Bearing load

Loads applied to bearings come from various considerations. These include the weight of objects supported by the bearing and any resulting shock or dynamic load therefrom, the force exerted by gears and drive belts to pull a load and overcome friction between moving surfaces, e.g., the friction between a conveyor belt and the conveyor frame. In many cases, these loads cannot be determined by a simple calculation.

Since these loads are often fluctuating in intensity, it is difficult to determine the exact magnitude of these loads prior to actual lab or field measurements on the machine involved.

However, in order to approximate the loads involved prior to putting a machine into operation, the following technique may be used. This technique uses multiplication factors that have been determined empirically from sample measurements taken on actual machines in operation.

5.1 Loads applied to bearings

5.1.1 Load factor

Even if the static radial load and the axial load can be accurately calculated, the actual loads are generally greater than this. This is because of vibration and shock loads during actual machine operation.

To find the loads actually applied to a bearing, multiply the values determined for the static load by the following load factors.

$$F = f_w \cdot F_c \quad \cdots\cdots (5.1)$$

Whereas,

F : Load actually applied to bearing, N
F_c : Theoretically calculated load, N
f_w : Load factor (see **Table 5.1**)

Table 5.1 Load factor f_w

Operating conditions	Applications	f_w
Virtually no vibration or impact	Electric machines and instruments	1 –1.2
Ordinary operation (weak impact)	Agricultural machines and blower	1.2–2
Great vibration and impact	Construction machines and grinders	2 –3

5.1.2 Loads from belts or chain drives

The load calculated for the bearing is equal to the tensile load of the belt. However this load must be multiplied by the load factor (f_w) which accounts for vibration and impact of the machine and a belt factor (f_b) which accounts for the vibration and impact generated through the belt.

When calculating loads for a chain drive, use the same factor (f_b) as used for belt drives.

$$F_b = \frac{2M}{D_p} \cdot f_w \cdot f_b$$

$$= \frac{19.1 \times 10^6\, W}{D_p \cdot n} \cdot f_w \cdot f_b \quad \cdots\cdots (5.2)$$

Whereas,

F_b : Load actually applied to pulley shaft or sprocket shaft, N

M : Torque applied to pulley or sprocket, mN · m

W : Transmitted power, kW

D_p : Pitch circle dia. of pulley or sprocket, mm

n : Rotating speed, min^{-1}

f_w : Load factor (see **Table 5.1**)

f_b : Belt factor (see **Table 5.2**)

Table 5.2 Belt factor f_b

Belt type	f_b
Toothed belt	1.3–2
V belt	2–2.5
Flat belt (with tension pulley)	2.5–3
Flat belt	4–5
Chain	1.2–1.5

5.1.3 Load of gear transmissions

Gear transmissions have a load in the tangential direction (K_t), a load in the radial direction (K_r) and an axial load (K_a). Different types of gears are calculated differently.

The following is a sample of a calculation for an ordinary spur gear arrangement. A flat spur gear will not support an axial load.

(1) Load applied to gear in tangential direction (tangential line force)

$$K_t = \frac{2M}{D_p} = \frac{19.1 \times 10^6\, W}{D_p n} \quad \cdots\cdots (5.3)$$

(2) Load applied to gear in radius direction (separating force)

$$K_r = K_t \tan \alpha \quad \cdots\cdots (5.4)$$

(3) Synthetic load applied to gear

$$K_g = \sqrt{{K_t}^2 + {K_r}^2} = K_t \sec\alpha \quad \cdots\cdots (5.5)$$

Whereas,

K_t : Load applied to gear in tangential direction (tangential line force), N

K_r : Load applied to gear in radius direction (separating force), N

K_g : Synthetic load applied to gear, N

M : Torque applied to gear, mN · m

D_p : Pitch circle dia. of gear, mm

W : Transmission power, kW

n : Rotating speed, min^{-1}

α : Pressure angle of gear, °

Note that the actual gear load must be found by multiplying the theoretical load by the load factor (f_w) obtained by taking into consideration the vibration and impact loads generated while the machine is in operation. The gear factor (f_g) is determined by taking into consideration the accuracy of machining and the finish of the gears.

$$F_g = f_w \cdot f_g \cdot K_g \quad \cdots\cdots (5.6)$$

Whereas,

F_g : Load actually applied to gear, N

K_g : Theoretically synthetic load applied to gear, N

f_w : Load factor (see **Table 5.1**)

f_g : Gear factor (see **Table 5.3**)

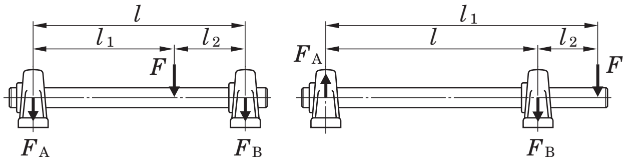
Table 5.3 Gear factor f_g

Gear type	f_g
Precision gear (both pitch error and tooth profile error should be 0.02 mm or less)	1–1.1
Ordinary gear (both pitch error and tooth profile error should be 0.1 mm or less)	1.1–1.3

5.2 Distribution of bearing load

In order to determine the radial load distribution to each bearing attached to a shaft, use the procedure shown below. Use the load factors shown in **Table 5.1** to account for vibration and impact.

Often a bearing bears an axial load component in addition to the radial component. In this case calculate the total vectored load as shown previously be taking the square root of the sum of the squares of each load.



$$F_A = \frac{l_2}{l} \cdot F \quad \cdots\cdots (5.7)$$

$$F_B = \frac{l_1}{l} \cdot F \quad \cdots\cdots (5.8)$$

Fig. 5.1 Distribution of load to bearings

5.3 Dynamic equivalent load

In many cases, a bearing is exposed to the combined vector load of both radial and axial load components. Also it is used under more severe conditions of vibration and impact loads. In this case a direct comparison to the dynamic load rating is not appropriate.

In such a case, find the load equivalent to a direct radial (only) load and compare this with the basic dynamic load rating.

The converted virtual load is called dynamic equivalent load (P).

5.3.1 Calculation of dynamic equivalent load

The dynamic equivalent radial load (P_r) of a bearing that bears radial and axial loads as well as vibration and impact is found by the following formula.

$$P_r = XF_r + YF_a \quad \cdots\cdots (5.9)$$

Whereas,

P_r : Dynamic equivalent radial load, N

F_r : Radial load, N

F_a : Axial load, N

X : Radial load factor (see **Table 5.4**)

Y : Axial load factor (see **Table 5.4**)

Table 5.4 Radial load factor (X) and axial load factor (Y)

$\frac{f_0 F_a}{C_{0r}}$	e	$F_a / F_r \le e$		$F_a / F_r > e$	
		X	Y	X	Y
0.172	0.19	1	0	0.56	2.30
0.345	0.22				1.99
0.689	0.26				1.71
1.03	0.28				1.55
1.38	0.30				1.45
2.07	0.34				1.31
3.45	0.38				1.15
5.17	0.42				1.04
6.89	0.44				1.00

Remarks 1. C_{0r} (basic static radial load rating) and f_0 (factor) are shown in the dimensional tables.

2. If $f_0 F_a / C_{0r}$ does not conform to the table above, find by interpolation.

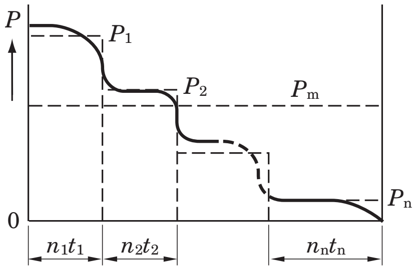
5.3.2 Average dynamic equivalent load in the case of fluctuating loads

If the level or direction of the load applied to a bearing is fluctuating, it is necessary to find the average dynamic equivalent load to calculate the bearing life.

Table 5.5 shows the method of finding the average dynamic equivalent load under various types of fluctuating conditions.

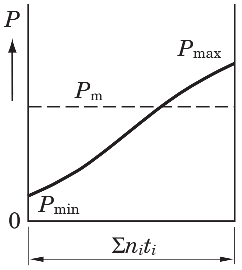
Table 5.5 Calculation of average dynamic equivalent load in case of fluctuated load

(1) Graduated fluctuation



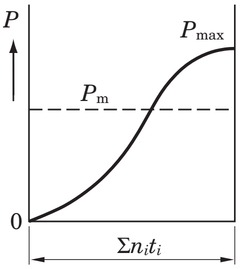
$$P_m = \sqrt[p]{\frac{P_1^{\,p}\, n_1t_1 + P_2^{\,p}\, n_2t_2 + \cdots\cdots + P_n^{\,p}\, n_nt_n}{n_1t_1 + n_2t_2 + \cdots\cdots + n_nt_n}} \quad \cdots\cdots\cdots\cdots \text{(5.10)}$$

(2) Monotone fluctuation



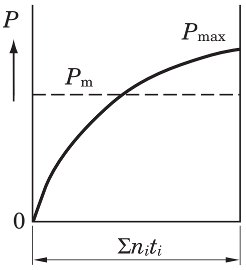
$$P_m = \frac{P_{min} + 2\,P_{max}}{3} \quad \cdots\cdots\cdots\cdots \text{(5.11)}$$

(3) Sine curve fluctuation



$$P_m = 0.68\,P_{max} \quad \cdots\cdots\cdots\cdots \text{(5.12)}$$

(4) Sine curve fluctuation (upper half of sine curve)



$$P_m = 0.75\,P_{max} \quad \cdots\cdots\cdots\cdots \text{(5.13)}$$

Whereas,

P_m : Average dynamic equivalent load, N

P_1 : Dynamic equivalent load actuating for t_1 hours at rotating speed of n_1, N

P_2 : Dynamic equivalent load actuating for t_2 hours at rotating speed of n_2, N

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P_n : Dynamic equivalent load actuating for t_n hours at rotating speed of n_n, N

P_{min} : Minimum dynamic equivalent load, N

P_{max} : Maximum dynamic equivalent load, N

Σn_it_i : Total rotating frequency for t_1 to t_i hours

5.4 Basic static load rating and static equivalent load

5.4.1 Basic static load rating

If a bearing is exposed to excessive static or impact load even when running at low rotational speed, partial permanent deformation occurs to the contact surface of the raceways of the bearing. The amount of permanent deformation increases with increased loads, and at some point, the bearing will no longer rotate smoothly.

The basic static load rating of a bearing is the static load that generates the calculataed contact stresses shown below at the center of the contact surfaces of the raceways.

(1) Automatic aligning ball bearing .... 4 600 MPa
(2) Other ball bearings
(ball bearing for unit is included) .... 4 200 MPa
(3) Roller bearing .... 4 000 MPa

The total permanent deformation that occurs to the raceways and the balls under the above critical contact stresses is 0.000 1 times the diameter of the ball.

In ball bearing units, this is indicated as the basic static radial load rating (C_{0r}) and these values are shown in the dimensional tables.

5.4.2 Static equivalent loads

Static equivalent load is the equivalent of the combined (vectored) load converted to the equivalent direct radial load. Static may be considered to be under conditions of no rotation conditions or very low rotating speeds.

Static equivalent radial load (P_{0r}) can be calculated by the formula below.

$$P_{0r} = 0.6F_r + 0.5F_a \quad \cdots\cdots (5.14)$$

$$P_{0r} = F_r \quad \cdots\cdots (5.15)$$

Whereas,

P_{0r} : Static equivalent radial load, N

F_r : Radial load, N

F_a : Axial load, N

5.4.3 Safety factor

The static equivalent load that can be withstood by a bearing, in addition to the above considerations, sometimes is dependent upon unforeseen conditions in the operating environment. Therefore a safety factor is always built in to insure success in the application.

$$f_s = \frac{C_{0r}}{P_{0r}} \quad \cdots\cdots (5.16)$$

Whereas,

f_s : Safety factor (see **Table 5.6**)

C_{0r} : Basic static radial load rating, N

P_{0r} : Static equivalent radial load, N

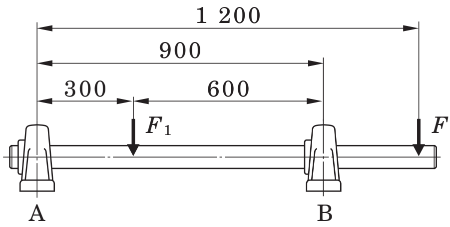
Table 5.6 Safety factor f_s (recommended)

Operating conditions		f_s (Min.)
Being rotated	High rotating accuracy is required	2
	Ordinary operating conditions	1
	Impact	1.5
Not always being rotated (sometimes oscillated)	Ordinary operating conditions	0.5
	Impact, unevenly distributed load	1

5.5 Example of applied calculation

Example 1 Distributing load

Find the load applied to the bearing A and bearing B, if the radial load F_1 ($F_1 = 1.5$ kN) and F_2 ($F_2 = 4.5$ kN) are applied.



(1) Find the radial load F_{1A} applied to the bearing A by F_1, with **Formula (5.7)** and **Formula (5.8)**.

$$F_{1A} = \frac{600}{900} \times 1.5 = 1.0 \text{ (kN)}$$

In a similar manner, find the radial load F_{2A} applied to the bearing A by F_2.

$$F_{2A} = -\frac{1\,200 - 900}{900} \times 4.5 = -1.5 \text{ (kN)}$$

Remark Negative load is the upward load.

Radial load F_A applied to the bearing A :

$$F_A = F_{1A} + F_{2A} = 1.0 + (-1.5) = -0.5 \text{ (kN)}$$

(2) In a similar manner to (1), find the radial load F_B applied to the bearing B.

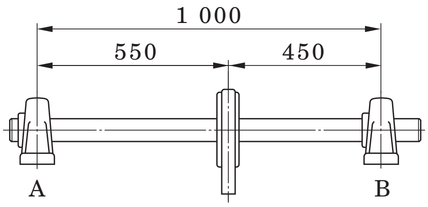
$$F_{1B} = \frac{300}{900} \times 1.5 = 0.5 \text{ (kN)}$$

$$F_{2B} = \frac{1\,200}{900} \times 4.5 = 6.0 \text{ (kN)}$$

$$F_B = F_{1B} + F_{2B} = 0.5 + 6.0 = 6.5 \text{ (kN)}$$

Example 2 Calculating load by V-belt transmission

Find the load applied to the bearing A and bearing B when the shaft is driven by the V-belt, transmission power W is 7.5 kw (W = 7.5 kW), rotating speed n is 300 min^{-1} (n = 300 min^{-1}), effective diameter of pulley D_p is 300 mm (D_p = 300 mm).



(1) Find the load actually applied to the pulley shaft F_b with **Formula (5.2)**.

From **Table 5.1**, load factor f_w is 1.2 ($f_w = 1.2$), and the belt factor f_b is 2.5 ($f_b = 2.5$), from **Table 5.2**.

$$F_b = \frac{19.1 \times 10^6\, W}{D_p \cdot n} \cdot f_w \cdot f_b$$

$$= \frac{19.1 \times 10^6 \times 7.5}{300 \times 300} \times 1.2 \times 2.5 = 4.78 \text{ (kN)}$$

(2) Find the load actually applied to the bearing A and bearing B (F_A and F_B) with **Formulas (5.7)** and **(5.8)**.

$$F_A = \frac{450}{1\,000} \times 4.78 = 2.15 \text{ (kN)}$$

$$F_B = \frac{550}{1\,000} \times 4.78 = 2.63 \text{ (kN)}$$

Example 3 Calculating dynamic equivalent radial load

Find the dynamic equivalent radial load P_r when the radial load F_r, 1.5 kN (F_r = 1.5 kN), and the axial load F_a, 0.85 kN, (F_a = 0.85 kN) are applied to the pillow type unit UCP306J (bearing UC306).

(1) Find the radial load factor (X) and the axial load factor (Y) with using the static radial load rating C_{0r} of UCP306J (bearing UC306), 15.0 kN (C_{0r} = 15.0 kN), and **Table 5.4**.

Find the solutions of the following formulas :

$$\frac{f_0 F_a}{C_{0r}} = \frac{13.3 \times 0.85}{15.0} = 0.754,\ e = 0.264$$

$$\frac{F_a}{F_r} = \frac{0.85}{1.5} = 0.567 > e\ (0.264)$$

Therefore, $X = 0.56$, $Y = 1.68$

(2) Find the dynamic equivalent radial load P_r with **Formula (5.9)**.

$$P_r = XF_r + YF_a = 0.56 \times 1.5 + 1.68 \times 0.85$$

$$= 2.27 \text{ (kN)}$$

Example 4 Calculating bearing life

Under the conditions shown in the **Example 3**, find the bearing life L_{10h} when a bearing is used for a blower of the rotating speed n, 1 000 min^{-1}.

(1) Select the load factor f_w is 1.2 (f_w = 1.2) from **Table 5.1**, and find the bearing load P_r.

$$P_r = f_w \cdot F = 1.2 \times 2.27 = 2.72 \text{ (kN)}$$

(2) The dynamic radial load rating of UCP306J (bearing UC306), C_r, is 26.7 kN (C_r = 26.7 kN), and calculate the bearing life L_{10h} with the **Formula (4.2)**.

$$L_{10h} = \frac{10^6}{60n} \cdot \left(\frac{C_r}{P_r}\right)^3 = \frac{10^6}{60 \times 1\,000} \times \left(\frac{26.7}{2.72}\right)^3$$

$$\approx 15\,800 \text{ (hr)}$$

(3) Calculate bearing life L_{10h} with the nomogram shown in **Fig. 4.1**.

When the rotating speed n is 1 000 min^{-1} (n = 1 000 min^{-1}), rotating factor f_n is 0.32 (f_n = 0.32). next, find the life factor f_h by speed factor f_n, dynamic radial load rating of bearing C_r, and the bearing load P_r.

$$\text{Life factor } f_h = f_n \cdot \frac{C_r}{P_r} = 0.32 \times \frac{26.7}{2.72} = 3.14$$

From life factor f_h, bearing life $L_{10h} \approx 16\,000$ hours.

Example 5 Selecting ball bearing units

If a bearing is operated under the following conditions, select the flange type unit (UCF) with at least two years (5 000 hours) or longer rating life : rotating speed of shaft n is 1 500 min^{-1} (n = 1 500 min^{-1}), and radial load F_r is 5 kN (F_r = 5 kN). The radial load F_r includes the load factor and gear factor.

(1) From the nomogram shown in **Fig. 4.1**, when life time L_h is 5 000 hr (L_h = 5 000 hr), life factor f_h can be found as 2.16 ($f_h \approx 2.16$), and speed factor f_n can be found as 0.28 ($f_n \approx 0.28$) when the rotating speed n is 1 500 min^{-1} (n = 1 500 min^{-1}).

$$\text{Dynamic radial load rating } C_r = F_r \cdot \frac{f_h}{f_n} = 5 \times \frac{2.16}{0.28}$$

$$\approx 38.6 \text{ (kN)}$$

(2) Find the flange type unit that meets the following condition : dynamic radial load rating C_r is 38.6 kN (C_r = 38.6 kN). As for the diameter series 2, UCF211J (dynamic radial load rating C_r is 43.4 kN (C_r = 43.4 kN)) can be selected.

Example 6 Selecting pillow type units for low speed

If a bearing is used for a dolly under the following conditions, select the pillow type unit (UCP) with 10 000 hours rating life : radial load F_r is 12 kN ($F_r = 12$ kN), and rotating speed is 8 min^{-1}.

(1) Find the required dynamic radial load rating C_r with using **Formulas (4.4)** and **(4.5)**.

Speed factor $f_n = (0.03n)^{-1/p} = (0.03 \times 8)^{-1/3} \approx 1.61$

Life factor $f_h = \left(\frac{L_{10h}}{500}\right)^{1/p} = \left(\frac{10\ 000}{500}\right)^{1/3} \approx 2.71$

Dynamic radial load rating $C_r = P_r \cdot \frac{f_h}{f_n} = 12 \times \frac{2.71}{1.61}$

≈ 20.2 (kN)

(2) From **Table 5.6**, define safe factor f_s as 2 ($f_s = 2$), and find the static radial load rating of bearing required C_{0r}.

$C_{0r} = f_s \cdot P_r = 2 \times 12 = 24$ (kN)

(3) The unit is used for a dolly, and vibration or impact may occur. Thus, select UCP308J ($C_r = 40.7$ kN, $C_{0r} = 24.0$ kN).

Example 7 Calculating bearing life in case of use at high temperature

Find the bearing life if the heat resistant pillow type unit (UCP215JD1K2) is operated under the following conditions : operating temperature is 175 ℃, radial load F_r is 4 kN ($F_r = 4$ kN), and the rotating speed n is 800 min^{-1} ($n = 800$ min^{-1}). Note that the radial load F_r includes load factor and gear factor.

(1) From **Table 4.1**, find the dynamic load rating C_r with in the case that a bearing is used at 175 ℃.

$C_r = 67.4 \times 0.95 = 64.0$ (kN)

Find the bearing life L_{10h} with using **Formula (4.2)**.

$$L_{10h} = \frac{10^6}{60n} \cdot \left(\frac{C_r}{P_r}\right)^3 = \frac{10^6}{60 \times 800} \times \left(\frac{64.0}{4}\right)^3$$

$\approx 85\ 000$ (hr)

(2) If a bearing unit is operated at 175 ℃, grease is degraded faster, and it cannot be used without lubrication. Supply grease at intervals specified in **Table 14.4**.

(3) If the shaft is extended excessively, install a bearing unit on the identical shaft on the fixed side (positioning of shaft), and install another bearing unit on the free side
(see **"9 Design of shaft and base"**).

Example 8 Calculating grease life

Find the grease life in the case that pillow type unit UCP204J (bearing UC204) under the following conditions : radial load F_r is 1 kN ($F_r = 1$ kN), and rotating speed n is 800 min^{-1} ($n = 800$ min^{-1}). Note that the radial load F_r includes load factor and belt factor. Operating temperature of the bearing should be 40 ℃.

Find the grease life L with using **Formula (4.7)**.

$$\log L = 6.10 - 4.40 \times 10^{-6}\, d_m n - 2.50 \left(\frac{P_r}{C_r} - 0.05\right)$$

$$- (0.021 - 1.80 \times 10^{-8}\, d_m n)\, T$$

$$= 6.10 - 4.40 \times 10^{-6} \times 12.5 \times 10^4$$

$$- 2.50 \left(\frac{1}{12.8} - 0.05\right)$$

$$- (0.021 - 1.80 \times 10^{-8} \times 12.5 \times 10^4) \times 50$$

$$= 4.542$$

$L \approx 34\ 800$ (hr)

Example 9 Calculating life of bearing units in case of non-lubrication

Find the life of a bearing unit in the case that it is operated under the conditions shown in **Example 8**, but without lubrication.

(1) Find the rating life of bearings L_{10h} with using **Formula (4.2)**.

$$L_{10h} = \frac{10^6}{60n} \cdot \left(\frac{C_r}{P_r}\right)^3 = \frac{10^6}{60 \times 800} \times \left(\frac{12.8}{1}\right)^3$$

$\approx 43\ 700$ (hr)

(2) Compare the grease life L shown in **Example 8** to the rating life of bearings L_h. Then, grease life L is shorter than the bearing rating life. Therefore, life of a bearing unit should be the same as the grease life L, 34 800 hours ($L = 34\ 800$ hours).

6 Allowable rotating speed

6.1 Allowable rotating speed

The rotational speed of a bearing is limited by the temperature increase, mainly due to friction. When the bearing reaches the speed limits shown below, it will seize if operated continuously at these levels.

The limiting rotational speed is the maximum speed at which the bearing can be safely operated continuously.

These allowable rotational speeds of a ball bearing unit is dependent upon the dimensions of the bearing, type of seal and the fit of the bearing inner ring to the shaft.

Table 6.1 shows the standard allowable rotating speeds of ball bearing units.

Table 6.1 Allowable rotating speed of ball bearing units (standard value)

Unit : min^{-1}

Bore dia. code	UC type bearing, UC-S6 type bearing, UK type bearing, NA type bearing, ER, RB type bearing										SA type bearing SB type bearing	SU type bearing SU-S6 type bearing
	Standard type, heat resistant (D1K2), cold resistant type (D2K2)			LⅢ type (L3)			Heat resistant type (D9K2)	Heat resistant type (K3), for blower (S5)				
	Diameter series			Diameter series			Diameter series	Diameter series				
	2	X	3	2	X	3	2, X, 3	2	X	3		
8												10 000
00	–			–			–	–			–	10 000
01	5 800			2 300			3 800	8 700			6 800	8 000
02	5 800			2 300			3 800	8 700			6 800	6 600
03	5 800			2 300			3 800	8 700			6 800	5 800
04	5 800	–	–	2 300	–		3 800	8 700	–	–	5 800	5 000
05	5 100	4 300	4 600	2 100	960		3 000	7 700	6 400	6 700	5 100	4 000
06	4 300	3 700	3 900	960	830	–	2 500	6 400	5 500	5 800	4 300	3 300
07	3 700	3 300	3 400	830	750	770	2 100	5 500	5 000	5 100	3 700	–
08	3 300	3 100	3 100	750	690	690	1 900	5 000	4 600	4 600	3 300	
09	3 100	2 800	2 700	690	640	620	1 700	4 600	4 300	4 100	3 100	
10	2 800	2 500	2 400	640	570	550	1 500	4 300	3 800	3 700	2 800	
11	2 500	2 300	2 300	570	520	510	1 400	3 800	3 500	3 400		
12	2 300	2 200	2 100	520	490	470	1 300	3 500	3 200	3 100		
13	2 200	2 100	1 900	490	460	440	1 200	3 200	3 100	2 900		
14	2 100	2 000	1 800	460	440	410	1 100	3 100	2 900	2 700		
15	2 000	1 800	1 700	440	410	380	1 000	2 900	2 700	2 600		
16	1 800	1 700	1 600	410	380	360	940	2 700	2 600	2 400		
17	1 700	1 600	1 500	380	360	340	880	2 600	2 400	2 300		
18	1 600	1 500	1 400	360	340	320	830	2 400	2 300	2 100		
19	–	–	1 400	–	–	310	790	–	–	2 000		
20		1 300	1 300		300	280	750		2 000	1 900		
21		–	1 200		–	–	710		–	1 800		
22			1 100			250	680			1 700		
24			1 100			240	630			1 600		
26			1 000			220	580			1 500		
28			910			200	540			1 400		

Remarks 1. Allowable rotating speed of the units with covers is 80% of the value shown in the table above.

2. If a bearing unit is used with excessively loose fitting, allowable rotating speed must be corrected by multiplying it by the fitting factor f_c shown in **Table 6.2**.

6.2 Rotational speed adjustment due to shaft fit

Normally for easier installation of a bearing to the shaft, a clearance fit is used. The amount of clearance must be factored in to determine the maximum allowable rotational speed. As rotational speed is increased, this clearance fit must be tighter.

Table 6.2 shows the factor that must be used to correct the allowable rotational speed. The maximum rotational speed is determined by multiplying the speed found in **Table 6.1** by the factors below. This table includes the multiplying factors for set screw units as well as units with adapters and eccentric locking collars. Due to the characteristics of units with adapters, a loose fit, h8 or h9, is acceptable. Likewise the eccentric locking collar does not lend itself to loose tolerances and an h5 or j5 fit is recommended to achieve the maximum speed.

Table 6.2 Fitting factor of ball bearing units f_c (recommended)

Type of ball bearing units	Fitting factor f_c					
	Shaft tolerance range class					
	h5, j5	j6	h6	h7	h8	h9
With set screws						
Standard type	–	1	1	0.8	0.5	0.2
LⅢ type (Accessory code : L3)	–	–	–	1	1	0.9
Heat resistant type (Special code : D1K2)	–	–	–	1	1	0.7
Cold resistant type (Special code : D2K2)	–	–	–	1	1	0.7
For high speed (Special code : K3)	–	1	0.8	0.6	–	–
For blower (Special code : S5)	1	–	0.8	0.6	–	–
With adapters	–	–	–	–	1	1
With eccentric locking collar	1	–	–	–	–	–

7 Operating temperature and bearing specifications

7.1 Operating temperature range

The operating temperature of a ball bearing unit depends on the type of grease, the material of the seal and the internal clearance of the bearing.

FYH Ball Bearing Units are available in high temperature (D1K2) and low temperature (D2K2) series, in addition to the standard models to allow selection of the right bearing for your operational temperature (see **Table 2.3**).

The correct unit must be chosen for temperature range and it is equally important to use the specified grease according to the specified schedule.

7.2 Operating temperature and internal clearance of bearings

When bearings are operated in a high ambient temperature environment or when the operating temperature is high because of rotational speed, differential expansion rates occur within the bearing components. This causes higher friction, grease breakdown and eventual seizure.

If the temperature difference between the inner and outer ring is known or can be approximated, then the following **Formula (7.1)** may be applied.

Under these conditions, decrease in the internal clearance must be calculated, and the internal clearance of bearings needs to be selected properly.

$$S_{t1} = \alpha \cdot D_e \cdot \varDelta_t \quad \cdots\cdots (7.1)$$

Whereas,

S_{t1} : Decrease in the internal clearance of bearings depending on the difference in the temperatures of the bearing inner ring and the bearing outer ring can be found by formula, mm

α : Line expansion factor of bearing steel, 12.5×10^{-6}

D_e : Raceway dia. of bearing outer ring, mm

Diameter series 2, X ····· $D_e \approx 0.92\,D$

Diameter series 3 ·········· $D_e \approx 0.9\,D$

D : Nominal bearing outer dia., mm

$\varDelta_t$: Difference in temperatures of bearing inner ring and outer ring, ºC

If a ball bearing unit is used in a high temperature environment, an abnormal load will be result due to thermal expansion of the shaft. This must be compensated for by allowing free movement of one side of the shaft.

(See **"9 Design of shaft and base"**)

8 Strength of housings

FYH bearings can withstand very high loads due to the design and the usage of only high quality material. However when high static or impact loads are encountered, the load capacity of the bearing must be determined.

The housing design is such that it can withstand loads from any angle ; however the bearing is strongest with a direct downward load through the base of the bearing. For other load directions, the allowable load must be determined for that direction.

Rigidity of the base and flatness of the mounting surface also influence the housing strength. The equipment designer or installer must examine and do calculations for the complete supporting structure of the bearing.

8.1 Strength of cast iron housings

Although gray cast iron has many superior characteristics, it may fail under impact loads, particularly in a low temperature environment.

Table 8.1 shows the applicable design safety factors for gray cast iron. **Fig. 8.1** to **8.8** show the static rupture strength of the various housing types.

Table 8.1 Safety factor of gray cast iron products (recommended)

Property of load	Safety factor of gray cast iron
Static load	4
With vibration	10
With impact	15

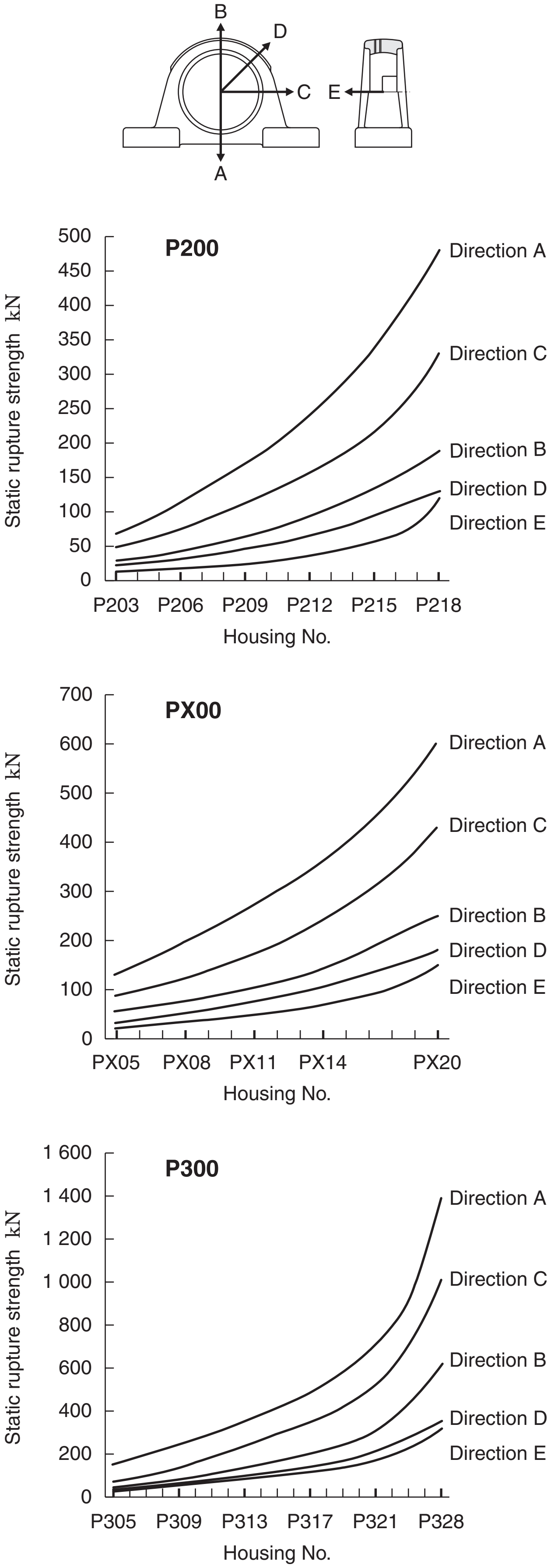


Fig. 8.1 Static rupture strength of pillow type housing (P)

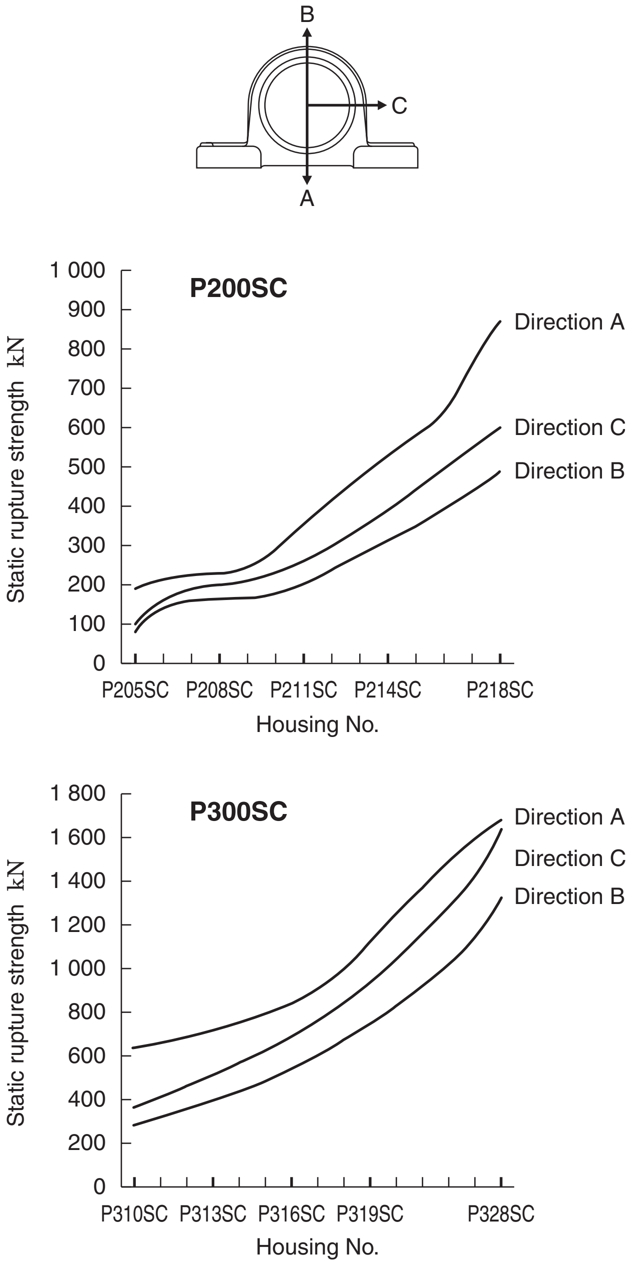


Fig. 8.2 Static rupture strength of cast steel pillow type housings (Psc)

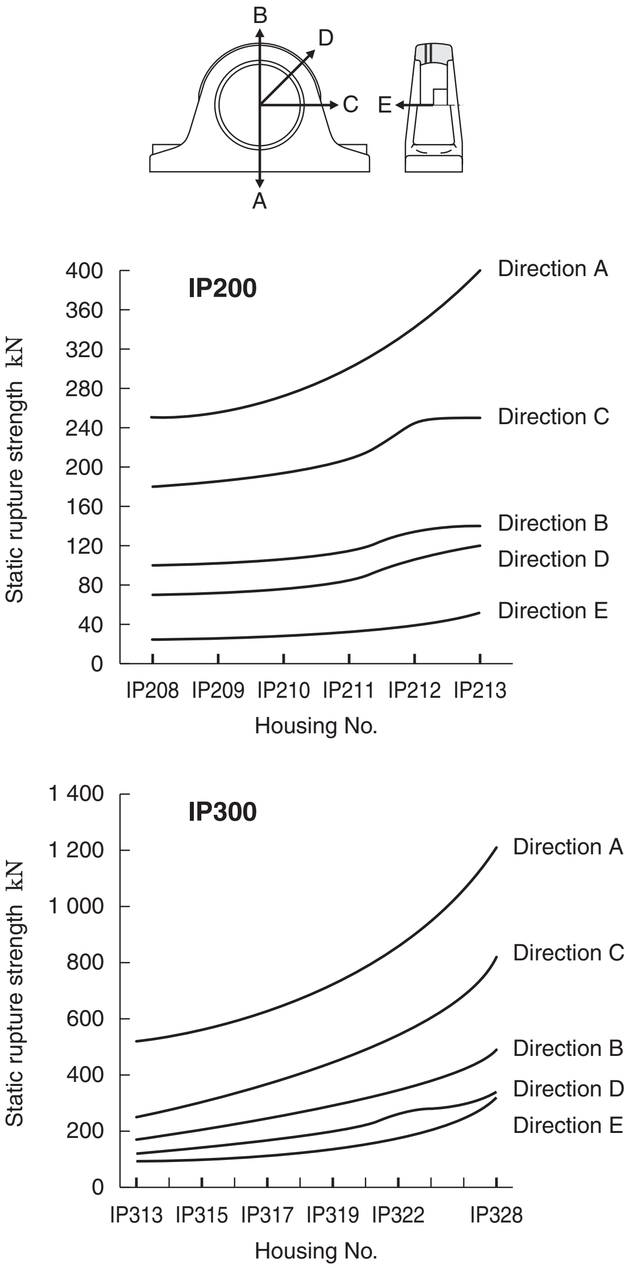


Fig. 8.3 Static rupture strength of thick pillow type housings (IP)

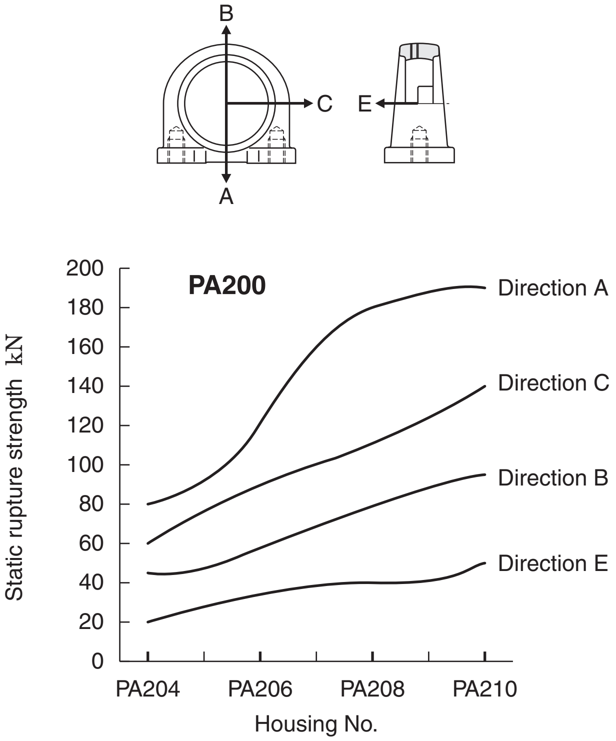


Fig. 8.4 **Static rupture strength of tapped base pillow type housings (PA)**

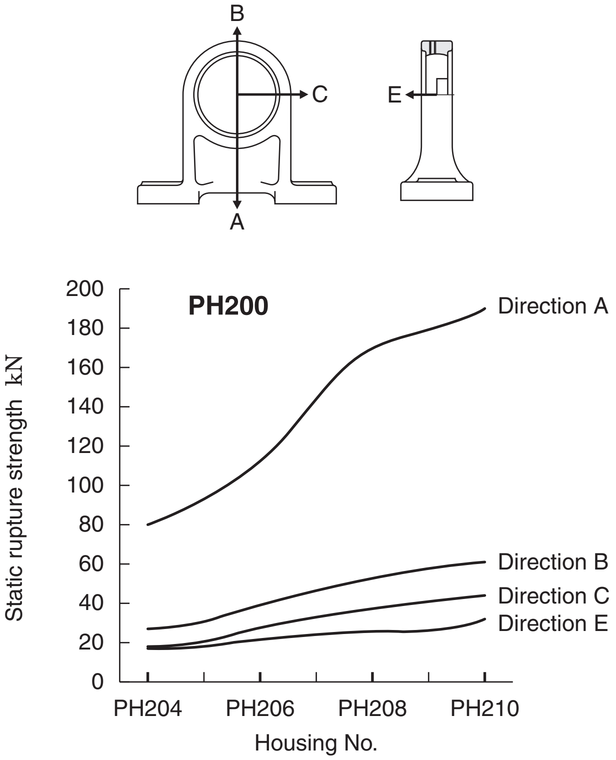


Fig. 8.5 **Static rupture strength of higher center height pillow type housings (PH)**

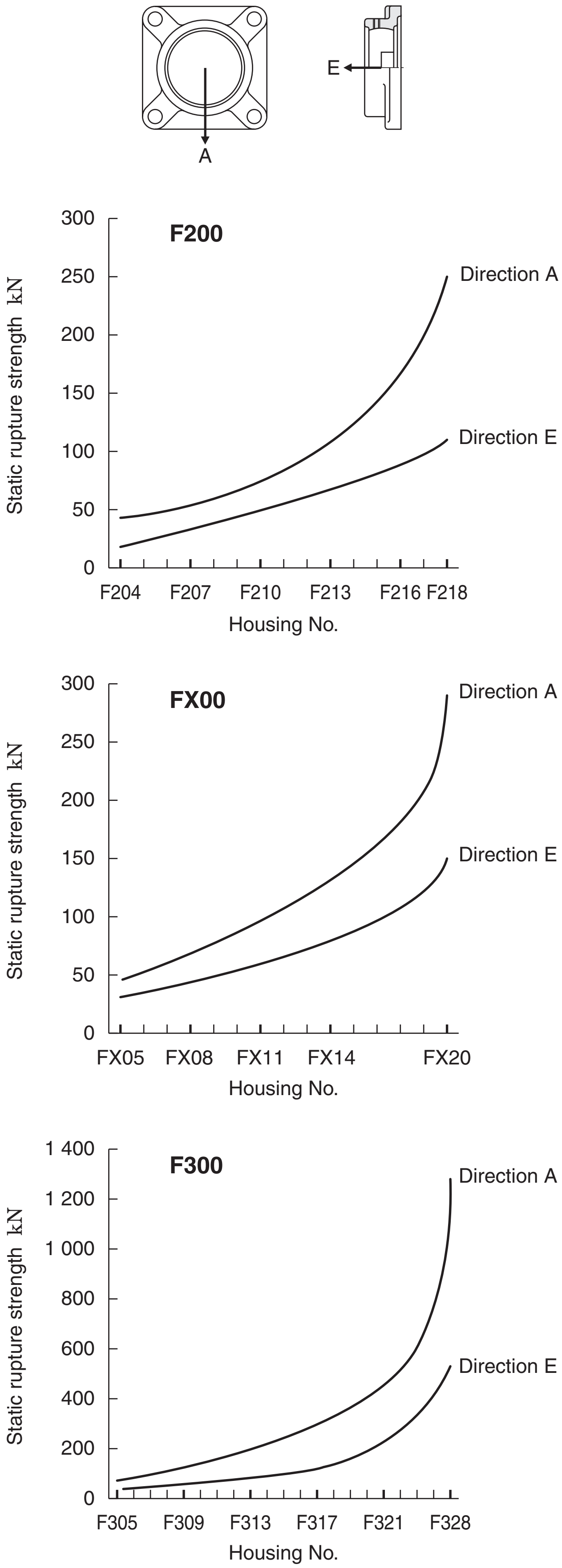


Fig. 8.6 **Static rupture strength of square flange type housings (F)**

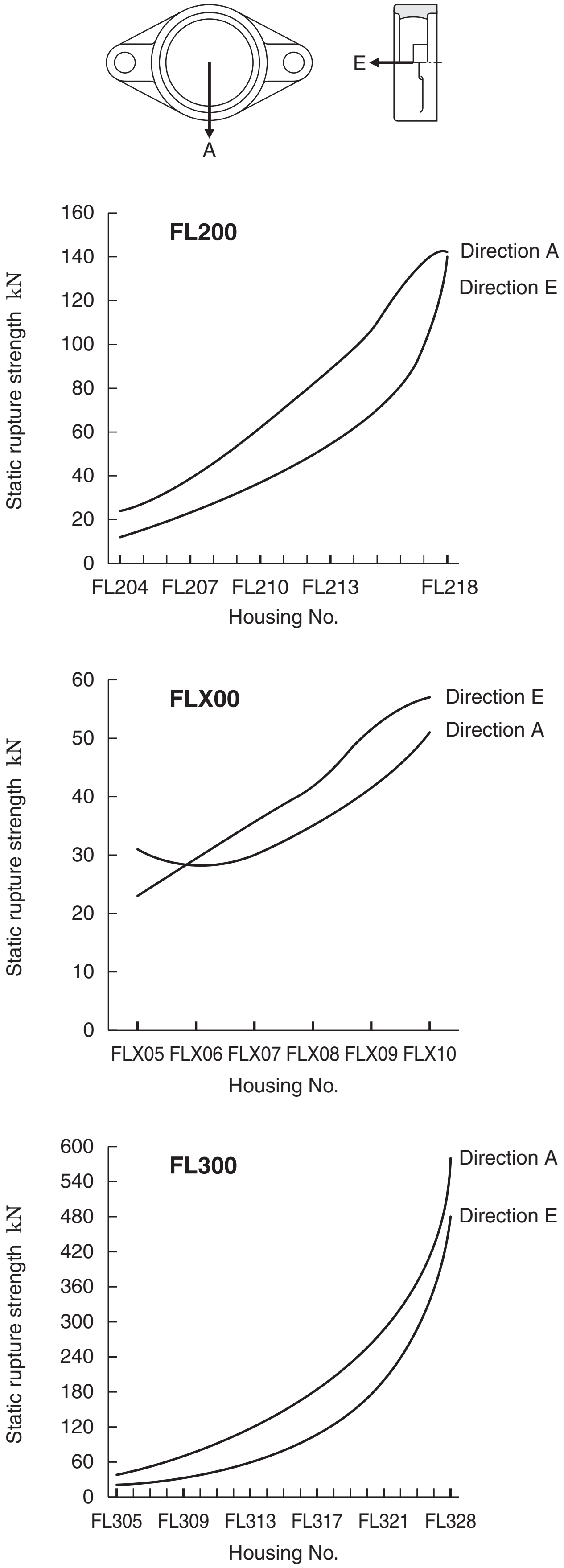


Fig. 8.7 Static rupture strength of oval flange type housings (FL)

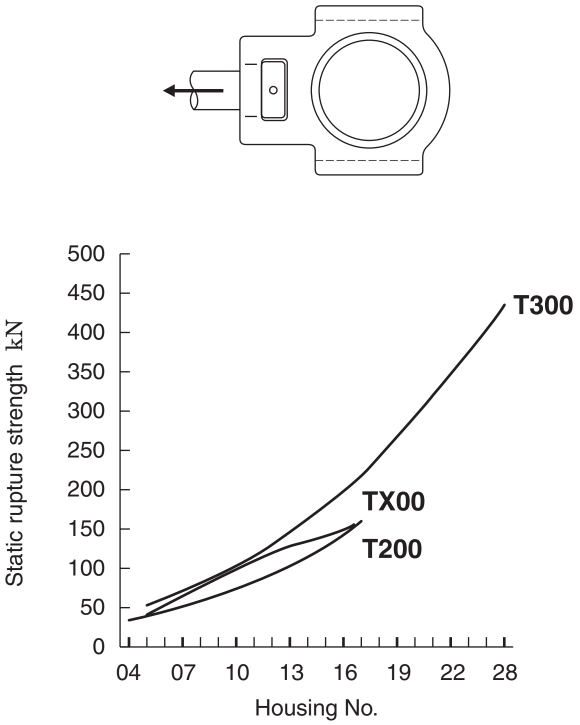


Fig. 8.8 Static rupture strength of take-up type housings (T)

8.2 Strength of cast steel housings

Cast steel housings should be selected where high rupture strength and superior impact resistance are required.

FYH manufactures a cast steel pillow block housing (P200sc, P300sc) series.

To determine the allowable load of a cast steel housing, find the static rupture strength of a steel housing from **Fig. 8.2** and apply the safety factors for steel shown in **Table 8.2**.

Table 8.2 Safety factor of cast steel products (recommended)

Property of load	Safety factor of cast steel product
Static load	3
With vibration	5
With impact	10

8.3 Strength of stamped steel housings

The precisely formed stamped steel housing is very rigid, but it is not as strong as cast iron or cast steel housings. Therefore, it will not support loads to the maximum rating of the bearing itself and must be down rated per **Table 8.3**.

Table 8.3 Allowable load of steel plate housings (recommended)

Load direction	Allowable load of steel plate housings
Radial	Approx. 1/6 of basic dynamic radial load rating of bearing (C_r)
Axial	Approx. 1/18 of basic dynamic radial load rating of bearing (C_r)

8.4 Strength of stainless steel housings

FYH supplies stainless steel housings (SP-H1, SPA-H1, SF- H1, SFL-H1, ST-H1, SP, SFL).

Table 8.4 shows the safety factors for stainless steel products. As for the basic values of the static rupture strength of SP-H1, SPA-H1, SF-H1,SFL-H1, ST-H1 type housings, apply P200 of **Fig. 8.1**, PA200 of **Fig. 8.4**, F200 of **Fig. 8.6**, FL200 of **Fig. 8.7** and T200 of **Fig. 8.8**. For the basic values of the static rupture strength of the SP and SFL type housings, see P000 of **Fig. 8.9** and FL000 of **Fig. 8.10** and multiply them by 1.5 respectively.

Table 8.4 Safety factor of stainless steel products

Property of load	Safety factor of stainless steel products
Static load	3
With vibration	5
With impact	10

8.5 Strength of die-cast housings

The clean series housing is made of die-cast zinc alloy, but the zinc alloy material is not as strong as cast iron or cast steel. **Table 8.5** shows safety factors for die-cast zinc alloy, and **Fig. 8.9** and **8.10** show the basic values of the static rupture strength of the die-cast zinc alloy housing.

Table 8.5 Safety factor of zinc alloy die-cast products

Property of load	Safety factor of die-cast products
Static load	8
With vibration	15
With impact	20

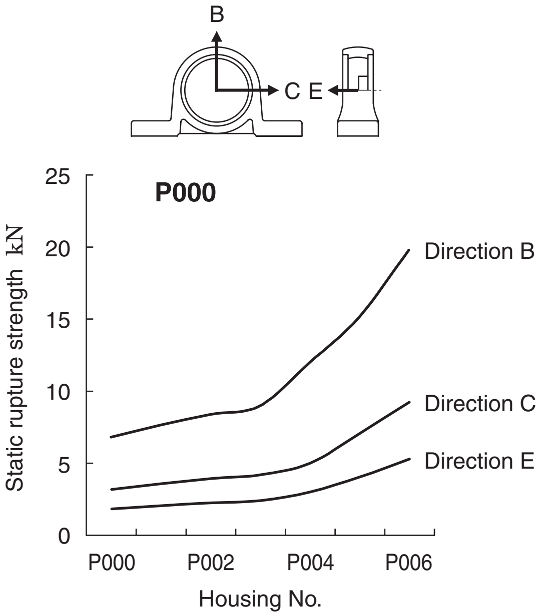


Fig. 8.9 Static rupture strength of clean housings (P)

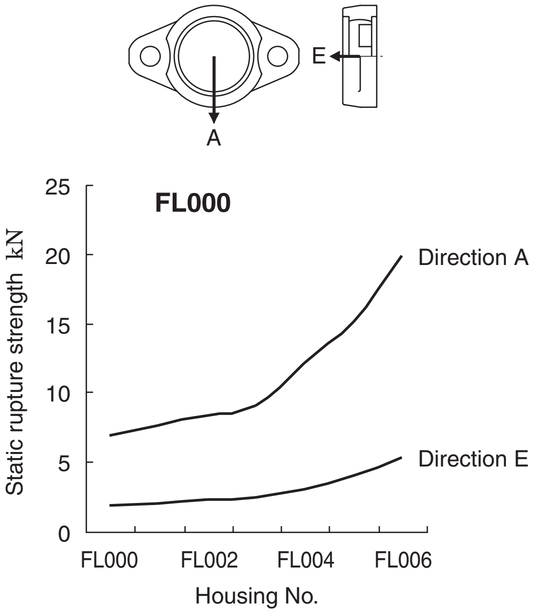


Fig. 8.10 Static rupture strength of clean housings (FL)

9 Design of shaft and base

9.1 Design of shaft

For optimal performance of a ball bearing unit and for maintenance free operation for a long time, the selection of the shaft is very important. The shaft should be of sufficient tensile strength, straight, scratch-free and no burrs should be left.

9.1.1 Dimensional accuracy of shaft

(1) Dimensional tolerance of shaft used for set screw bearings

For bearings with set screws, a relatively looser class of fit makes assembly easier and is perfectly acceptable at low operating speeds. The clearance fit between the i.d. of the bearing inner ring and the shaft must be decreased as the rotational speed is increased.

Table 9.1 shows the guidelines for the tolerance class for the rotational speed of the bearing with set screws.

If the bearing with set screws is exposed to a heavy load ($P_r / C_r > 0.12$), vibration or heavy impact, use a tighter shaft tolerance than normal.

Table 9.2 shows the tolerances for tight fits.

Table 9.3 shows the recommended roundness and cylindricity of the shaft used.

Table 9.1 Dimensional tolerance of shaft used for cylindrical bore bearing with set screws (recommended) (clearance fitting or intermediate fitting)

Unit : μm

Shaft dia. (mm)		Dimensional tolerance of shaft							
		j6		h6		h7		h8	
Over	Incl.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
6	**10**	+ 7	− 2	0	− 9	0	−15	0	−22
10	**18**	+ 8	− 3	0	−11	0	−18	0	−27
18	**30**	+ 9	− 4	0	−13	0	−21	0	−33
30	**50**	+11	− 5	0	−16	0	−25	0	−39
50	**80**	+12	− 7	0	−19	0	−30	0	−46
80	**120**	+13	− 9	0	−22	0	−35	0	−54
120	**180**	+14	−11	0	−25	0	−40	0	−63
Applicable rotating speed dn 1)		Over 120 000		Over 100 000, incl. 120 000		Over 60 000, incl. 100 000		Incl. 60 000	

Note 1) $dn = d$ (bearing bore dia., mm) $\times n$ (rotating speed, min^{-1})

Table 9.2 Dimensional tolerance of shaft used for cylindrical bore bearing with set screws (recommended) (intermediate fitting or tight fitting)

Unit : μm

Shaft dia. (mm)		Dimensional tolerance of shaft					
		k6		k7		m6	
Over	Incl.	Max.	Min.	Max.	Min.	Max.	Min.
6	**10**	+10	+1	+16	+1	+15	+ 6
10	**18**	+12	+1	+19	+1	+18	+ 7
18	**30**	+15	+2	+23	+2	+21	+ 8
30	**50**	+18	+2	+27	+2	+25	+ 9
50	**80**	+21	+2	+32	+2	+30	+11
80	**120**	+25	+3	+38	+3	+35	+13
120	**180**	+28	+3	+43	+3	+40	+15

Table 9.3 Recommended accuracy of shaft used for ball bearing units

Unit : μm

Shaft dia. (mm)		Tolerance of shaft roundness and cylindricity (max.)
Over	Incl.	
6	**10**	6
10	**18**	8
18	**30**	9
30	**50**	11
50	**80**	13
80	**120**	15
120	**180**	18

(2) Dimensional tolerances of shafts for blowers (used with set screw bearings)

In bearings used in blowers (special code : S5), machining accuracy of the internal bearing clearance (C2) is required to reduce vibration and noise during operation.

Therefore, the shaft tolerance classes shown in **Table 9.4** are recommended for bearings with set screws.

Table 9.4 Dimensional tolerance of shaft used for bearings (set screw type) for blowers

Unit : μm

Shaft dia. (mm)		Dimensional tolerance of shaft			
		h5		j5	
Over	Incl.	Max.	Min.	Max.	Min.
10	**18**	0	−8	+5	−3
18	**30**	0	−9	+5	−4
30	**50**	0	−11	+6	−5
50	**80**	0	−13	+6	−7
80	**120**	0	−15	+6	−9
120	**180**	0	−18	+7	−11

(3) Dimensional tolerance of shaft used with tapered bore bearings

Since tapered bore bearings are fixed to the shaft with an adapter, a looser fit is allowable since the adapter provides excellent concentricity. This makes mounting of the bearing to the shaft much easier.

Table 9.5 shows the dimensional tolerance of the shaft used with tapered bore bearings (with adapters).

Table 9.5 Dimensional tolerance of shaft used for tapered bore bearings (with adapters) (recommended)

Unit : μm

Shaft dia. (mm)		Dimensional tolerance of shaft			
		h8		h9	
Over	Incl.	Max.	Min.	Max.	Min.
18	**30**	0	−33	0	−52
30	**50**	0	−39	0	−62
50	**80**	0	−46	0	−74
80	**120**	0	−54	0	−87
120	**180**	0	−63	0	−100

(4) Dimensional tolerance of shaft with eccentric locking collar

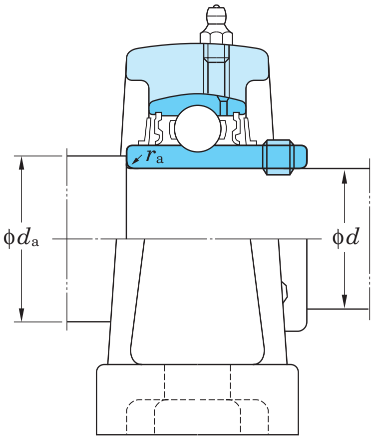
Eccentric lock bearings have a greater clearance (more eccentricity) between the shaft and the inner ring of the bearing when installed. Therefore the shaft tolerances must be tighter (h5 or j5) to reduce the clearance (eccentricity). Therefore the same clearance fits are recommended as with blower bearings, **Table. 9.4**.

9.1.2 Dimensions of shouldered shafts

When using a set screw or eccentric lock bearing which is exposed to a high axial load, excessive vibration or impact, a shouldered shaft may be used. The inner ring of the bearing is then tightened in place with a nut, if the shaft is threaded or with a locking ring otherwise.

Table 9.6 shows the shoulder diameter and the fillet radius of the shouldered shaft.

Table 9.6 Recommended shoulder diameter and fillet radius of a shouldered shaft



Unit : mm

Bore dia. code	Nominal bearing bore dia. d	UC200, UCX00		UC300	
		Shoulder dia. d_a	Fillet roundness radius r_a (max.)	Shoulder dia. d_a	Fillet roundness radius r_a (max.)
01	**12**	17	0.6		
02	**15**	20	0.6		
03	**17**	22	0.6		
04	**20**	30	1	–	–
05	**25**	35	1	35	1
06	**30**	40	1	40	1
07	**35**	45	1	45	1.5
08	**40**	50	1	50	1.5
09	**45**	55	1	55	1.5
10	**50**	60	1	60	2
11	**55**	65	1.5	65	2
12	**60**	70	1.5	75	2
13	**65**	75	1.5	80	2
14	**70**	80	1.5	85	2
15	**75**	85	1.5	90	2
16	**80**	90	2	95	2
17	**85**	95	2	100	2.5
18	**90**	100	2	105	2.5
19	**95**	–	–	110	2.5
20	**100**	–	–	115	2.5
21	**105**	–	–	120	2.5
22	**110**			125	2.5
24	**120**			135	2.5
26	**130**			150	3
28	**140**			160	3

9.1.3 High temperature applications

In general, two or more bearing units are used per shaft. If the distance between the bearings is small, or if the temperature change of the shaft is small, the both bearings may be fixed in position.

However, if the distance between the bearings is large and the shaft is exposed to heat, then only one bearing should be fixed and the opposing bearing must be free to float in the axial direction.

This is because shaft expansion due to temperature change of the shaft causes a high axial load and failure of fixed bearings. The amount of shaft expansion due to temperature change may be calculated by **Formula (9.1)**.

$$\Delta_\ell = \alpha \cdot \Delta_t \cdot l \quad \text{(9.1)}$$

Whereas,

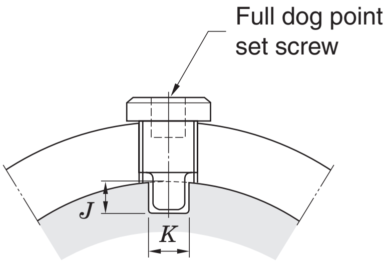
Δ_ℓ : Expansion of shaft, mm

α : Linear expansion coefficient of shaft in the case of ordinary steel, $11\sim12 \times 10^{-6}$

Δ_t : Temperature increase, ℃

l : Installation distance of unit, mm

Proper installation procedures for a shaft exposed to temperature changes are shown below.



(1) Installation with a dog point set screw on the free side

To accommodate expansion in the axial direction, the bearing must be installed so that the shaft can move freely in the axial direction.

To accomplish this, the shaft must be grooved for full dog point set screw (special code : G6). This is on the free side only. The dog point screw allows free movement in the axial direction and provides force to rotate the bearing in the radial direction.

Fig. 9.1 shows an example of the structure of a bearing with a key groove on the shaft and a full dog point set screw. **Table 9.7** shows the dimensions of the key groove for the full dog point set screw.

The tolerance class of the shaft to be used is h7.

If the temperature of the shaft is higher than that of the bearing, then a looser fit tolerance class is specified.

When using this method to allow for free expansion, there is the possibility of fretting corrosion between the shaft and the inner race. In order to prevent fretting corrosion, a high temperature grease must be applied to the inner ring of the bearing and the shaft prior to installation.

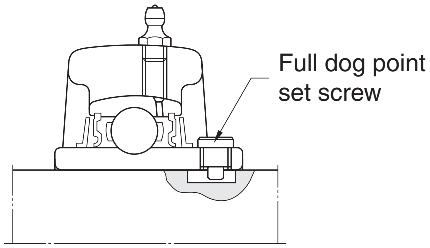


Fig. 9.1 Use on free side with full dog point set screw

Table 9.7 Dimensions of key groove for full dog point set screw (use on free side)

Nominal size of set screw	Dimensions of key groove (mm)		Applicable nominal bearing code		
	J	*K* (Min.)	UC200	UCX00	UC300
M6 × 0.75	5	4	201–206	X05	305, 306
M8 × 1	6	6	207–209	X06–X08	307
M10 × 1.25	6.5	7	210–212	X09–X11	308, 309
M12 × 1.5	7	9	213–218	X12–X17	310–314
M14 × 1.5	7	10		X18	315, 316
M16 × 1.5	8	12		X20	317–319
M18 × 1.5	8	13			320–324
M20 × 1.5	8	15			326, 328

Allowable tolerance of key groove dimension “K” (Recommended value : 0~+0.2)

(2) Installation of cartridge type units on the free side

If the rotational speed is high or the bearing is exposed to high vibration, the cartridge type unit is recommended on the free side. In this case the housing of the cartridge unit is free to move and the bearing insert is rigidly attached to the shaft.

Fig. 9.2 shows the required structure for the cartridge type unit on the free side.

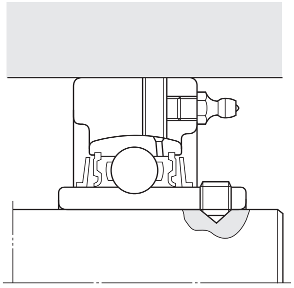


Fig. 9.2 Use of cartridge type units on free side

If, in addition to the expansion of the shaft, the ball bearing itself is exposed to heat, then a calculation of the decrease in internal clearances of the bearing must be made. The appropriate bearing internal clearance must be specified. (see **"7 Operating temperature and bearing specifications"**).

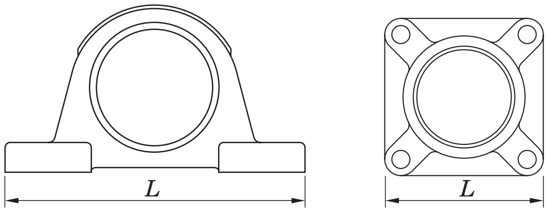
9.2 Mounting base design

9.2.1 Rigidity of base and flatness of mounting surface

If rigidity of the base on which a ball bearing unit is to be mounted is not sufficient or the flatness of the mounting surface is poor, then vibration or abnormal noise may occur to the bearing during operation. This will lead to failure since the strength of the housing is less since it is not properly supported.

The base must be properly machined accurately to eliminate deformation of the housing.

Fig. 9.3 shows the recommended values for flatness of the mounting surface on which the ball bearing unit is to be installed.



Max. : L / 1 000 mm

Fig. 9.3 Flatness of mounting surface of base (recommended value)

9.2.2 Mounting cartridge type units in high temperature applications

Cartridge units are designed to fit into an accurately bored cylindrical opening in the mounting base. Under ordinary operating conditions, H7 is an adequate choice for the tolerance class of the cylindrically bored hole.

In instances in which both the bearing and the shaft are hot, select G7 as the tolerance class of the cylindrical bore.

If the bearing is exposed to excessive vibration or impact, then an even tighter tolerance class must be specified.

Table 9.8 shows the dimensional requirements for the cylindrical bore.

Table 9.8 Dimensional tolerance of cylindrical bore for mounting cartridge type units (recommended values)

Unit : μm

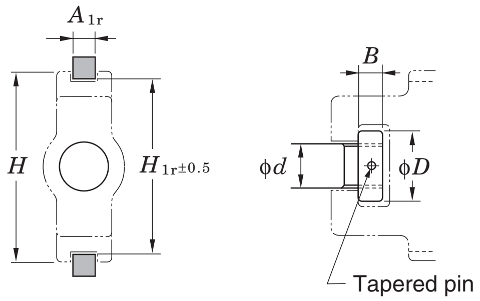
Nominal bore dia. of cylindrical bore (mm)		Dimensional tolerance of cylindrical bore			
		H7		G7	
Over	Incl.	Max.	Min.	Max.	Min.
50	**80**	+30	0	+40	+10
80	**120**	+35	0	+47	+12
120	**180**	+40	0	+54	+14
180	**250**	+46	0	+61	+15
250	**315**	+52	0	+69	+17
315	**400**	+57	0	+75	+18

9.2.3 Installation of take-up units

A take-up unit is positioned between two guide rails and enables linear adjustment by means of the threaded rod and bolt.

Table 9.9 shows the dimensions of the guide rail, adjuster bolt, and the round nut.

Table 9.9 Dimensions relative to installation of take-up type units (recommended values)



Unit : mm

Nominal bearing code	Dimensions of guide rail			Dimensions of adjuster bolt and round nut		
	A_{1r}	H_{1r}	H (Reference)	d	D	B
T204	11	77	89	16	28	14
T205						
T206	11	90	102	18	32	14
T207						
T208	15	103	114	24	42	16
T209	15	103	117	24	42	16
T210						
T211	20	131	146	30	55	20
T212						27
T213	24	152	167	36	60	27
T214						
T215						
T216	24	166	184	36	60	27
T217	28	174	198	42	60	30
TX05	11	90	102	18	32	14
TX06						
TX07	15	103	114	24	42	16
TX08	15	103	117	24	42	16
TX09						
TX10	20	131	146	30	55	20
TX11						27
TX12	24	152	167	36	60	27
TX13						
TX14						
TX15	26	166	184	36	60	27
TX16	26	174	198	42	60	30
TX17						

Remark This table is applicable to the dimensions relative to the stainless steel housing.

Unit : mm

Nominal bearing code	Dimensions of guide rail			Dimensions of adjuster bolt and round nut		
	A_{1r}	H_{1r}	H (Reference)	d	D	B
T305	11	81	89	22	32	12
T306	15	91	100	24	36	14
T307		101	111	26	40	
T308	16	113	124	28	45	16
T309		126	138	30	50	18
T310	18	141	151	32	55	20
T311	20	151	163	34	60	22
T312		161	178	36	65	24
T313	24	171	190	38	65	26
T314		181	202	40	80	28
T315		193	216	40	80	28
T316	28	205	230	46	90	34
T317	30	216	240	46	90	34
T318		230	255	50	95	38
T319	32	242	270	50	95	38
T320	32	262	290	52	100	40
T321						
T322	36	287	320	55	110	44
T324	42	322	355	60	120	50
T326	47	352	385	65	130	55
T328		382	415	70	140	60

9.3 Machining of pin hole for locating housings

The pillow type, square flange type, and oval flange type housing have the dowel pin seat. If accurate positioning of the housing is required, install it with the dowel pin.

As for the position of the pin for locate the housing and pin diameter, see the **Appendix table 5** at the end of this catalogue.

10 Nomenclature

Nomenclature of FYH Ball Bearing Units conform to JIS B 1557, and comprise the bearing unit model code (comprising bearing model code and housing model code), diameter series code, bore dia. code, accessory code, and special code.

UC P 207 J L3

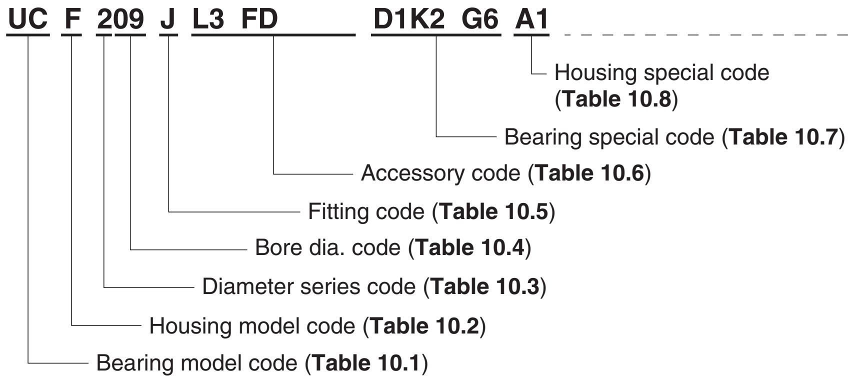
Bearing No. :	UC207L3
Housing No. :	P207J

UK P 209 J CD + H309X

Bearing No. :	UK209+H309X
Housing No. :	P209JE1
Steel plate cover No. :	(Open type) C-9x40
	(Closed type) D-9

UC F 209 J L3 FD D1K2 G6 A1

Bearing No. :	UC209L3D1K2G6
Housing No. :	F209JA1E3
Cast iron cover No. :	(Closed type) 209FD



Remark The above code shows an example of Nomenclature structure. It may depend on the bearing unit model.

Table 10.1 Bearing model code

Bearing model code	Details
UC	Cylindrical bore, with set screws
UC-S6	Cylindrical bore, with set screws (stainless steel series)
UK	Tapered bore (for adapter)
NA	Cylindrical bore, with eccentric locking collar
SB	Cylindrical bore, with set screws (lightweight type)
SU	Cylindrical bore, with set screws (clean series)
SU-S6	Cylindrical bore, with set screws (stainless steel series)
ER	Cylindrical bore, with set screws, cylindrical outer diameter, Lubricating mechanism
RB	Cylindrical bore, with set screws, cylindrical outer diameter

Table 10.2 Housing model code

Housing model code	Details
P	Pillow type
P-SC	Cast steel pillow type
IP	Thick pillow type
PA	Tapped-base pillow
PH	High centerheight pillow type
LP	Lightweight pillow type
P	Pillow type (clean series)
SP-H1	Pillow type (stainless steel series)
SPA-H1	Tapped-base pillow (stainless steel series)

Table 10.2 Housing model code (continued)

Housing model code	Details
SP	Pillow type (stainless steel series)
PP	Cast steel pillow type
F	Square four-bolt flange type
FL	Oval two-bolt flange type
FA	Adjustable oval two-bolt flange type
FB	Three-bolt flange type
FC	Round flange cartridge type
FS	Square four-bolt cartridge flange type
FL	Oval two-bolt flange type (clean series)
SF-H1	Square four-bolt flange type (stainless steel series)
SFL-H1	Oval two-bolt flange type (stainless steel series)
SFL	Oval two-bolt flange type (stainless steel series)
PF	Stamped steel plate round three-bolt flange type
PFL	Stamped steel plate oval two-bolt flange type
T	Take-up type
ST-H1	Take-up type (stainless steel series)
TH	Section steel frame take-up type
TL	Light channel steel frame take-up type
TU	Channel steel frame take-up type
PTH	Steel plate frame take-up type
NPTH	Steel plate frame take-up type
C	Cartridge type
HA	Hanger type

Table 10.3 Diameter series code

Diameter series code	Details
2	For light duty
X	For medium duty
3	For heavy duty

Table 10.4 Bore dia. code

Bore dia. code	Details
8	Nominal bearing bore dia. 8 mm
00	Nominal bearing bore dia. 10 mm
01	Nominal bearing bore dia. 12 mm
02	Nominal bearing bore dia. 15 mm
03	Nominal bearing bore dia. 17 mm
04 or more	(Bore dia. code) × 5 = Nominal bearing bore dia. (mm)
01–8	– (bore dia. code) /16 = nominal bearing bore dia. (inch) (in this case, 8/16 = 1/2 inch = 12.7 mm) As for the bore dia. inch series bearing.

Table 10.5 Fitting code

Fitting code	Details
J	Tolerance class of spherical bore of the housing is J7 (not shown on the bearing that the spherical bore diameter exceeds 120 mm)
H	Tolerance class of spherical bore of the housing is H7
K	Tolerance class of spherical bore of the housing is K7

Table 10.6 Accessory code

Accessory code	Details
C[1]	Cover, open type
D[1]	Cover, closed type
FC	Cast iron cover, open type
FD	Cast iron cover, closed type
L3	Triple lip seal type

Note [1] Standard specifications of codes C and D are as shown below.
201–218, X05–X17..........Steel plate cover
X18–X20, 305–328..........Cast iron cover

Table 10.7 Bearing special code

Item	Bearing special code	Details
Grease	**D1**	SH44M
	D2	SH33M
	D9	Demnum L-200
Set Screw	**G4**	Pointed tip
	G6	With full dog point
	G7	With loose prevent nylon
Seal	**K2**	Silicone rubber
	K3	Non-contact type
Sealing Device	**P3**	Without seal, slinger
	P4	Without seal
Others	**S5**	For blower (seal : K3, inner clearance and bearing accuracy are specially controlled)
	S6	Stainless steel bearing

Table 10.8 Housing special code

Item	Housing special code	Details
Grease Nipple Thread Bore dia.	**A1**	PT1/8 tube thread
	A2	PF1/8 tube thread
	A3	PT1/4 tube thread
	A4	PF1/4 tube thread
Grease Nipple Thread Bore Position	**B1**	Right
	B2	Left
	B3	45º
	B5	30º
	B7	Both right and left
Machining	**E1**	Steel plate
	E3	Cast iron cover mounting groove (diameter series 2, X, 3)
	E4	Non-lubricating type
Material	**H1**	Stainless steel cast steel model (SCS13)
	H5	Rolled steel for general purpose (SS400)
	SC	Carbon steel cast steel model (SC450)
Grease Nipple	**N1**	B type (67.5º)
	N2	C type (90º)

11 Accuracy and internal clearance

Accuracy of a ball bearing unit is specified in JIS B 1558 (ball bearings for ball bearing units) and JIS B 1559 (housing for ball bearing unit). FYH produces products conforming to these standards.

11.1 Accuracy of bearings

Table 11.1 to **Table 11.4** show the accuracy of a ball bearings for ball bearing units.

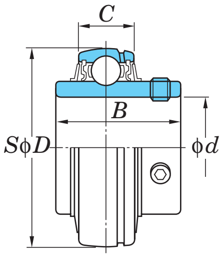
Ball bearings for blower unit (special code : S5) are produced with higher accuracy than standard models (see **Table 11.3**).

Table 11.5 shows the tolerance limitations of cylindrical bore bearing inner ring.

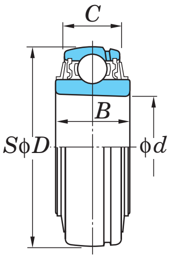
Table 11.2 Tolerances and tolerance values of outer rings of ball bearings for ball bearing units

Unit : μm

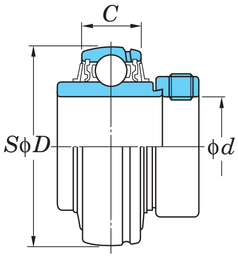
Nominal bearing outer dia. D (mm)		Variation of tolerance of average outer dia. Δ_{Dm}		Radial runout of outer ring K_{ea}
Over	Incl.	Max.	Min.	Max.
18	**30**	0	−9	15
30	**50**	0	−11	20
50	**80**	0	−13	25
80	**120**	0	−15	35
120	**150**	0	−18	40
150	**180**	0	−25	45
180	**250**	0	−30	50
250	**315**	0	−35	60



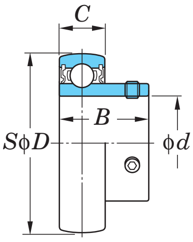
UC



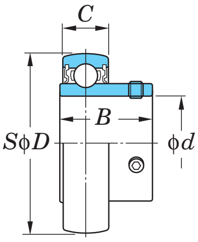
UK



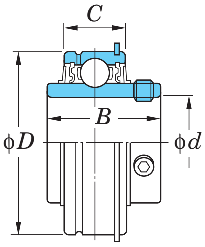
NA



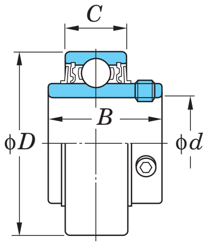
SB



SU



ER



RB

Table 11.1 Tolerances and tolerance values of inner rings of ball bearings for ball bearing units

Unit : μm

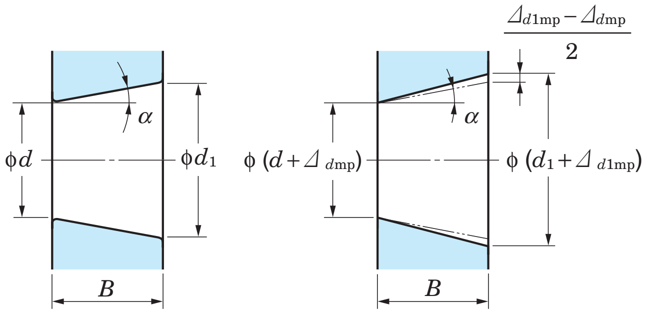
Nominal bearing bore dia. d (mm)		Variation of tolerance of average bore dia. in plane Δ_{dmp}		Unequal bore dia. in plane V_{dp}	Variation of tolerance of eccentricity on eccentric surface of inner ring and eccentric locking collar Δ_{Hs}		Variation of tolerance of inner ring width Δ_{Bs}		Radial runout of inner ring K_{ia}
Over	Incl.	Max.	Min.	Max.	Max.	Min.	Max.	Min.	Max.
–	**10**	+15	0	10	+100	−100	0	−120	10
10	**18**	+15	0	10	+100	−100	0	−120	15
18	**31.75**	+18	0	12	+100	−100	0	−120	18
31.75	**50.8**	+21	0	14	+100	−100	0	−120	20
50.8	**80**	+24	0	16	+100	−100	0	−150	25
80	**120**	+28	0	19	+100	−100	0	−200	30
120	**180**	+33	0	22	+100	−100	0	−250	35

Table 11.3 Tolerances and tolerance values of inner rings of ball bearing units for blowers (S5)

Unit : μm

Nominal bearing bore dia. d (mm)		Variation of tolerance of average bore dia. in plane Δ_{dmp}		Unequal average bore dia. in plane V_{dp}	Radial runout of inner ring K_{ia}
Over	Incl.	Max.	Min.	Max.	Max.
10	**18**	+13	0	6	7
18	**31.75**	+13	0	6	8
31.75	**50.8**	+13	0	10	10
50.8	**80**	+15	0	10	10
80	**120**	+18	0	14	13
120	**180**	+23	0	14	18

Table 11.4 Variation of tolerances and tolerance values of tapered bore on bearing with tapered bore



Theoretical tapered bore

Tapered bore with variation of tolerance of average bore dia. in plane

Unit : μm

Nominal bearing bore dia. d, mm		Δ_{dmp}		$\Delta_{d1mp}-\Delta_{dmp}$		V_{dp}[1]
Over	Incl.	Max.	Min.	Max.	Min.	Max.
18	**30**	+33	0	+21	0	13
30	**50**	+39	0	+25	0	16
50	**80**	+46	0	+30	0	19
80	**120**	+54	0	+35	0	22
120	**180**	+63	0	+40	0	40

Note [1] To be applied to all the radial planes of tapered bore

Remarks 1. Applicable range

Applicable to tapered bore of inner ring of tapered bore radial bearing that standard value of taper ratio is 1/12.

2. Amount code

d_1 : Standard diameter at theoretical large end of tapered bore

Standard diameter $d_1 = d + \frac{1}{12} B$

Δ_{dmp} : Variation of tolerance of average bore diameter in plane at theoretical small end of tapered bore

Δ_{d1mp} : Variation of tolerance of average bore diameter in plane at theoretical large end of tapered bore

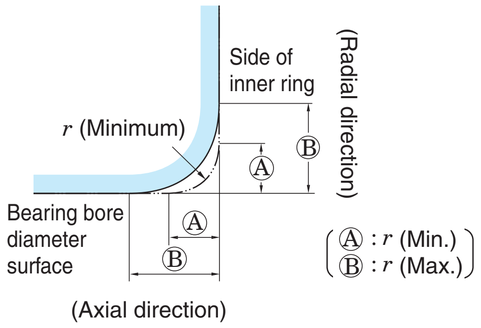
V_{dp} : Unequal bore diameter in plane

B : Nominal inner ring width

α : 1/2 of nominal taper angle of tapered bore

$\alpha = 2° 23' 9.4"$
$= 2.385\ 94°$
$= 0.041\ 643$ rad

Table 11.5 Tolerance limitations of chamfered dimensions for the inner ring of cylindrical bore bearings



Unit : mm

r (Min.)	r (Max.)	
	Radial direction	**Axial direction**
0.6	1	2
1	1.5	3
1.1	2	3.5
1.5	2.3	4
2	3	4.5
2.1	4	6.5
2.5	3.8	6
3	5	8
4	6.5	9

Remark Though accurate profile of chamfered surface is not specified, the profile on the axial plane should not exceed the virtual arc of radius r (minimum) that contacts with the side of inner ring and the bearing bore diameter surface.

11.2 Accuracy of housings

This section details the tolerance specifications of the inner diameter of the spherical bore of FYH housings. These values determine how tight or how loose the bearing fits inside the housing.

Table 11.6 shows the tolerance of the diameter of the spherical bore of housings.

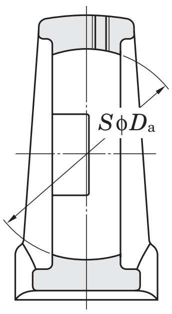
Standard tolerance for mounted units, between the outer diameter of the bearing and the inner diameter of the housing, is a class J7 intermediate fit.

A class H7 tolerance allows greater clearance for applications where minor shaft alignment constantly occurs or in environments where higher temperatures can cause thermal expansion. An anti-rotation pin on the outer ring of the bearing is supplied with these units to prevent the outer ring of the bearing from spinning inside the housing.

A class K7 tolerance allows less clearance and is recommended to prevent the outer ring of the bearing from rotating inside the housing.

Fig. 11.1 shows examples of housing dimensions relative to installation position with tolerance values.

Table 11.6 Allowance of spherical bore diameter of housings



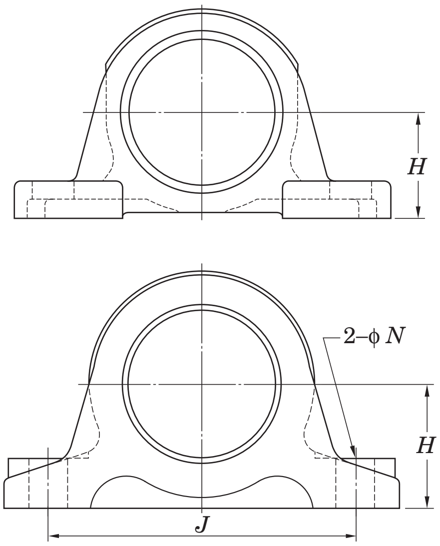
Unit : μm

Nominal dia. of spherical bore D_a (mm)		Tolerance class H7		Tolerance class J7		Tolerance class K7	
		Variation of tolerance of spherical bore dia. $\varDelta_{Dam}$		Variation of tolerance of spherical bore dia. $\varDelta_{Dam}$		Variation of tolerance of spherical bore dia. $\varDelta_{Dam}$	
Over	Incl.	Max.	Min.	Max.	Min.	Max.	Min.
18	**30**	+21	0	+12	− 9	+ 6	−15
30	**50**	+25	0	+14	−11	+ 7	−18
50	**80**	+30	0	+18	−12	+ 9	−21
80	**120**	+35	0	+22	−13	+10	−25
120	**180**	+40	0	+26	−14	+12	−28
180	**250**	+46	0	+30	−16	+13	−33
250	**315**	+52	0	+36	−16	+16	−36

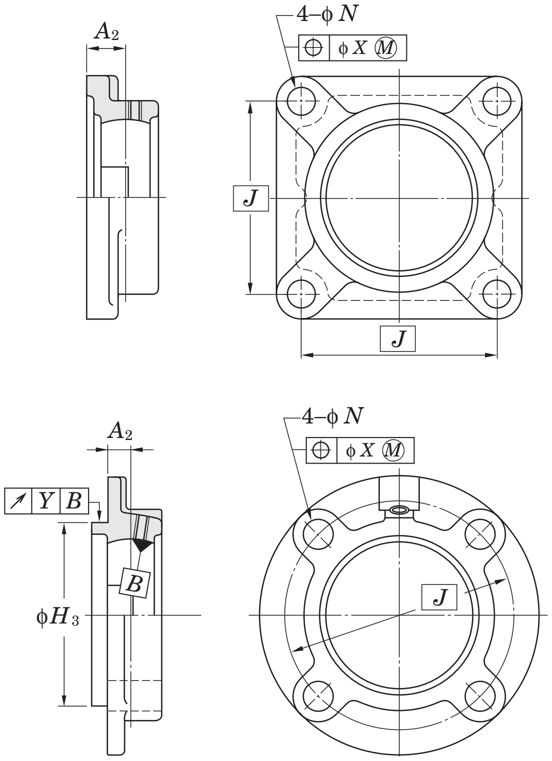
Remark FYH selects J or H, K depending on the applications.

Fig. 11.1 Dimensions relative to installation of housings with tolerances and tolerance values (representative example)

Pillow type housings

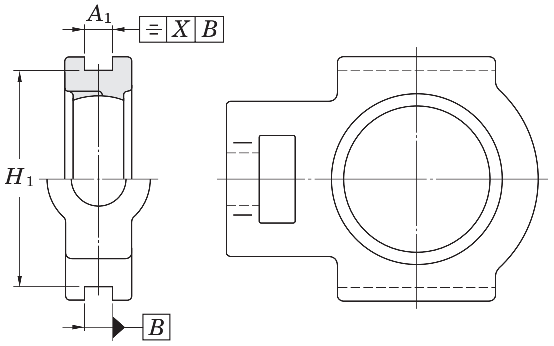


Flange type housings

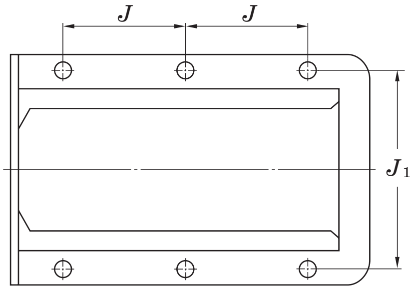


Remark Respective tolerances and tolerance values for housing are shown in dimensional tables.

Take-up type housings



Frame for take-up type units



Cartridge type housings

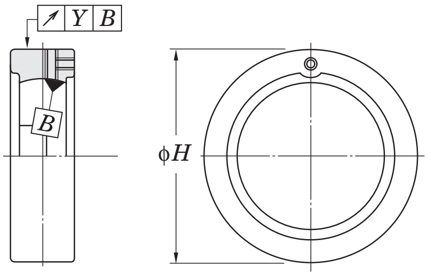


Table 11.7 shows ordinary dimensional tolerance of cut or cast portions not specified in this catalog.

Table 11.7 Ordinary dimensional tolerance not specified respectively

Item	Standard code	Class
Cutting	JIS B 0405	Medium
Casting of cast iron	JIS B 0403	Ordinary
Casting of cast steel	JIS B 0403	Ordinary

11.3 Internal bearing clearance

Internal bearing clearance is defined as the allowable space between the bearing balls and the raceways. The degree of internal clearance, referred to as “operation clearance”, greatly influences operational life of the bearing as well as characteristics of heat, noise, and vibration.

If the clearance is exceptionally tight between the shaft and the inner ring of the bearing then expansion of the inner ring must be taken into consideration and the correct ball clearance should be selected. Transmission heat from the shaft is also a factor to consider when determining the correct amount of ball clearance (see **“7 Operating temperature and bearing specifications”**).

Table 11.8 shows the internal clearance applicable to specific operating conditions and **Table 11.9** shows the available options of internal clearance.

Table 11.8 Internal clearance applicable to specific operating conditions

Type	Applicable internal clearance	
	Bearing with cylindrical bore	Bearing with tapered bore
Standard type	CN	C3
Stainless steel type	C3	–
Heat resistant type (special code : D1K2)	C4	C5
Heat resistant type (special code : D9K2)	C4	C5
Cold resistant type (special code : D2K2)	CN	C3
High speed type (special code : K3)	CN	C3
For blower (special code : S5)	C2	C3

Remark For bearings with special codes, as those indicated above, the clearance is implied and not indicated in the part number.

Table 11.9 Available options for internal clearance

Unit : μm

Nominal bearing bore dia. d (mm)		Internal clearance											
		C2		CN		GN		C3		C4		C5	
Over	Incl.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
6	**10**	0	7	2	13	–	–	8	23	14	29	20	37
10	**18**	0	9	3	18	10	25	11	25	18	33	25	45
18	**24**	0	10	5	20	12	28	13	28	20	36	28	48
24	**30**	1	11	5	20	12	28	13	28	23	41	30	53
30	**40**	1	11	6	20	13	33	15	33	28	46	40	64
40	**50**	1	11	6	23	14	36	18	36	30	51	45	73
50	**65**	1	15	8	28	18	43	23	43	38	61	55	90
65	**80**	1	15	10	30	20	51	25	51	46	71	65	105
80	**100**	1	18	12	36	24	58	30	58	53	84	75	120
100	**120**	2	20	15	41	28	66	36	66	61	97	90	140
120	**140**	2	23	18	48	33	81	41	81	71	114	105	160

Remarks 1. Radial internal clearance in this table conforms to JIS B 1558 (ball bearing inserts).

2. Increase in radial internal clearance generated by measured load conforms to the table below. Smaller correction of C2 clearance is applicable to the minimum clearance, while larger correction is applicable to the maximum clearance.

Unit : μm

Nominal bearing bore dia. d (mm)		Measured load	Correction of clearance				
Over	Incl.	N	C2	CN	GN, C3	C4	C5
2.5	**18**	24.5	3 – 4	4	4		
18	**50**	49	4 – 5	5	6		
50	**280**	147	6 – 8	8	9		

12 Materials

12.1 Bearing material

Ball bearing inserts are comprised of inner and outer rings, balls, and riveted ball cages all of which is made of the highest quality of bearing steel.

These bearings possess the following features.

(1) High elastic limit to resist strong opposing force
(2) High rolling fatigue strength to allow for heavy loads
(3) Superior hardness
(4) Superior wear resistance
(5) Superior toughness against impact and shock loads
(6) Superior stability of dimensional tolerances

High carbon chrome bearing steel specified in JIS (Japanese Industrial Standards) for the bearing components are utilized.

To increase reliability and reduce contamination within the material, a vacuum degassing process is executed to reduce non-metallic elements and any oxygen in the steel. After the bearing is assembled it is heat tempered and quenched until the hardness reaches 60HRC.

Table 12.1 shows the chemical components of high carbon chrome bearing steel. Stainless steel bearing inserts (suffix : S6) utilize superior corrosion resistant JIS certified stainless steel.

Riveted steel ball cages are made of JIS certified cold-rolled steel and steel strip which is shown in **Table 12.2**.

12.2 Housing material

Housings are mainly made of gray cast iron, cast carbon steel, and stamped steel. Gray cast iron is the most popular choice for mounted units because of its optimal characteristics of vibration absorption, high strength, and excellent heat dissipation.

Table 12.3 shows the mechanical properties of gray cast iron.

Nodular graphite cast iron (FCD450-10 of JIS G 5502) may be used in addition to these materials.

If superior strength is required for the housings for ball bearing units, select carbon steel cast steel products with higher rupture strength, carbon steel cast steel, or general structural rolled steel with higher strength against impact.

For the material of housings of the clean series unit, zinc alloy die-cast is used, and stainless steel cast steel products are used for housings of the stainless series unit. Cold rolled sheet steels and steel strips are used as the material of housings for the steel plate unit.

Table 12.4 to **12.8** show the mechanical properties of these housing materials.

Nodular graphite cast iron (FCD450-10 of JIS G 5502) may be used, as well as these materials.

Table 12.1 Chemical components of high carbon chrome bearing steel (JIS G 4805)

Code	Chemical components (%)						
	C	Si	Mn	P	S	Cr	Mo
SUJ 2	0.95–1.10	0.15–0.35	0.50 or less	0.025 or less	0.025 or less	1.30–1.60	0.08 or less

Table 12.2 Chemical components of cold rolled steel and steel strip (SPCC) (JIS G 3141)

Code	Chemical components (%)						
	C	Si	Mn	P	S	Ni	Cr
SPCC	0.12 or less	–	0.50 or less	0.040 or less	0.045 or less	–	–

Table 12.3 Mechanical properties of gray cast iron (FC200)

Type code	Tensile strength N/mm^2	Hardness HB
FC200	200 or more	223 or less

Table 12.4 Mechanical properties of carbon steel cast steel products (SC450)

Type code	Yielding point or bearing force N/mm^2	Tensile strength N/mm^2	Extension %	Construction %
SC450	225 or more	450 or more	19 or more	30 or more

Table 12.5 Mechanical properties of carbon steel cast steel products (JIS G 3101)

Type code	Yielding point or bearing force N/mm^2			Tensile strength N/mm^2	Thickness of steel mm	Tensile test piece	Extension %	Bending property		
	Thickness of steel mm							Bending angle	Inside dia.	Test piece
	incl. 16	Over 16 incl. 40	Over 40							
SS400	245 or more	235 or more	215 or more	400–510	Over 5, 16 max.	No.1A	17 or more	180°	1.5 times of thickness	No.1
					Over 16, 40 max.	No.1A	21 or more			
					Over 40	No.4	23 or more			

Table 12.6 Mechanical properties of zinc alloy die-cast (ZDC02) (JIS H 5301) (Reference)

Code	Tensile strength N/mm^2	Extension %	Impact N · m/cm^2	Hardness HB
ZDC2	285	10	140	82

Table 12.7 Mechanical properties of stainless cast steel products (SCS13) (JIS G 5121)

Type code	Bearing force N/mm^2	Tensile strength N/mm^2	Extension %	Hardness HB
SCS13	185 or more	440 or more	30 or more	183 or more

Table 12.8 Mechanical properties of cold rolled sheet steel and steel strip (SPCC) (JIS G 3141)

Type code	Tensile strength N/mm^2	Extension %
SPCC	270 or more	34 or more

12.3 Materials of parts and accessories

Table 12.9 shows materials of parts and accessories of a ball bearing unit.

Table 12.9 Materials of parts and accessories of ball bearing units

Designations	Materials	Code	Standard code
Seal (standard type)	Nitrile rubber	NBR	–
Seal (heat resistant, cold resistant)	Silicone rubber	VMQ	–
Slinger (flinger)	Cold rolled steel plate and steel strip	SPCC	JIS G 3141
Stainless steel slinger (flinger)	Cold rolled stainless steel plate and steel strip	SUS304-CP, SUS304-CS	JIS G 4305
Steel plate cover	Cold rolled steel plate and steel strip	SPCD	JIS G 3141
Stainless steel plate cover	Cold rolled stainless steel plate and steel strip	SUS304-CP, SUS304-CS	JIS G 4305
Cast iron cover	Gray cast iron products	FC200	JIS G 5501
Hexagon socket set screw	Chrome molybdenum steel	SCM435	JIS G 4105
Stainless steel hexagon socket set screw	Stainless bar steel	SUS410	JIS G 4303
Adapter sleeve for bearing	Mechanical structural carbon steel	S25C	JIS G 4051
Lock nut for bearing	Mechanical structural carbon steel	S25C	JIS G 4051
Washer for bearing	Cold rolled stainless steel plate and steel strip	SPCC	JIS G 3141
Eccentric locking collar	Mechanical structural carbon steel	S20C	JIS G 4051
Grease nipple	Copper and copper alloy rod	C3604 SUM24L	JIS H 3250 JIS G 4804

13 Performance

13.1 Bearing friction torque

Bearing friction torque is the synthesis of rolling friction between the balls, inner and outer rings, sliding friction between the balls and the cages, agitating resistance of lubricants, and friction resistance of the seal.

The specific amount of friction torque is influenced by the particular bearing model, dimensions, bearing load, rotating speed, and lubricating conditions.

Bearings with triple-lip seals and open cover seals will have a greater friction torque and overall greater friction resistance.

Friction torque for bearings can be found by the formulas below.

$$M = M_{\mathrm{p}} + M_{\mathrm{k}} \quad \cdots\cdots\cdots (13.1)$$

$$M_{\mathrm{p}} = \mu \cdot P \cdot \frac{d}{2} \quad \cdots\cdots\cdots (13.2)$$

Whereas,

M : Friction torque of bearing, mN · m

M_{p} : Friction torque of sections changed by load, mN · m

M_{k} : Friction torque of sections changed by rotating speed, mN · m

μ : Friction coefficient (0.001 5 to 0.002)

P : Load applied to bearings, N

d : Nominal bearing bore dia., mm

Note that the agitating resistance of lubricants and the friction resistance of the seals are difficult to calculate since the resistance fluctuates with speed.

Fig. 13.1 shows the result of measurement of friction torque of the typical ball bearing unit.

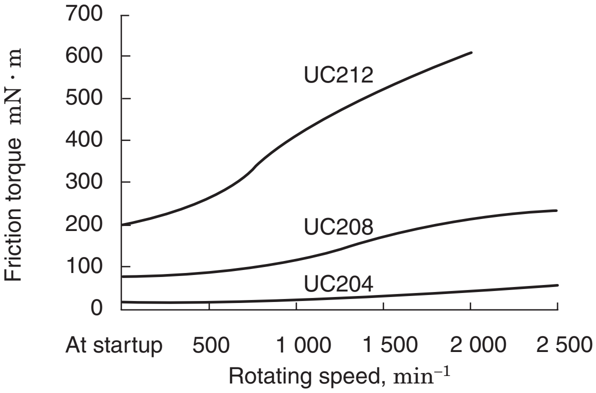


Fig. 13.1 Example of measurement result of ball bearing units

13.2 Bearing temperature increase

The increase in temperature of the bearing is represented as heat energy converted from friction torque in the bearing during operation. The temperature of the bearing during operation increases in proportion to the amount of friction torque, and friction torque increases in proportion to the increase in bearing load.

The increase in temperature of the bearing depends on the heating value generated by friction in the bearing and the amount of heat discharged from the bearing and housing in which it is mounted. Therefore, the temperature level of the bearing is influenced by the environmental conditions of the location in which the bearing unit is installed (quality of heat radiation environment).

Temperature of the bearing unit increases gradually after startup of operation and reaches the maximum level after one or two hours if no abnormalities occur. Then it decreases slightly and enters a steady state (see **Fig. 13.2**).

In this manner, if the operating conditions are not changed, bearing temperature will remain virtually constant, and measurement of the temperature and assumption of the bearing status are enabled.

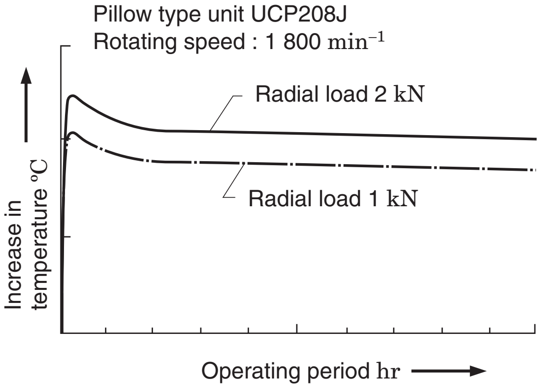


Fig. 13.2 Example of temperature measurement during operation of pillow type units

Increase in temperature during operation of the bearing depends on the type of seal used in the bearing as well as friction torque.

Increase in temperature of triple-lip bearings (suffix code : L3) is greater than that of the standard model, and that of the non-contact seal (suffix code : K3, S5) is lower than the standard model. Bearings for blowers and other high-speed applications are equipped with non-contact seals, with grease or oil, for high-speed operation as well as reduction of heat, vibration, and noise.

13.3 Dustproof and waterproof performance

FYH executes various tests to check dustproof and waterproof performance of different models of bearings. Representative results are shown below.

13.3.1 Dust sprinkle rotating test (dust preventive performance)

In this test, dust is sprinkled directly on the bearing as it is operating in a rotating drum machine. Performance and dust resistance for various sealing mechanisms are judged based on this test.

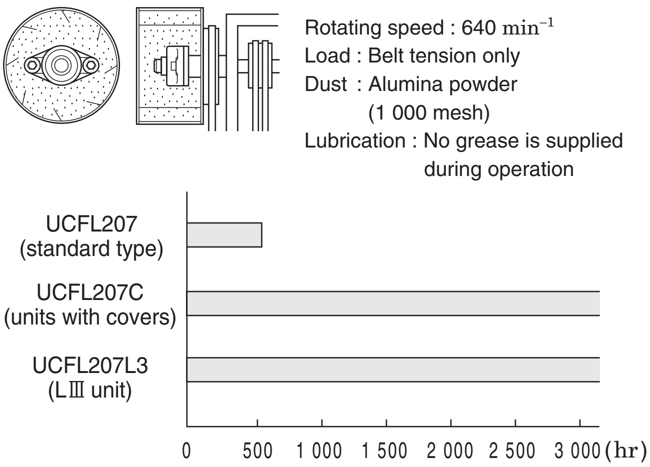

Rotating speed : 640 min^{-1}
Load : Belt tension only
Dust : Alumina powder
(1 000 mesh)
Lubrication : No grease is supplied during operation

Fig. 13.3 Example of result of dust sprinkle rotating test (dust proof performance)

The standard single-lip bearing exhibited abnormal noise after about 500 hours of operation, and ingress of dust was found.

On the other hand, no abnormality was found in both the triple-lip bearing (suffix code : L3) or the covered unit (suffix code : C) even after 3 000 hours of operation, and therefore superior dustproof performance was established.

13.3.2 Dust immersion rotating test (dustproof performance)

In this test, units are completely buried in dust with impellers installed on the shaft to further stir and circulate the dust. This test is executed under the most severe conditions encountered by mounted bearing units.

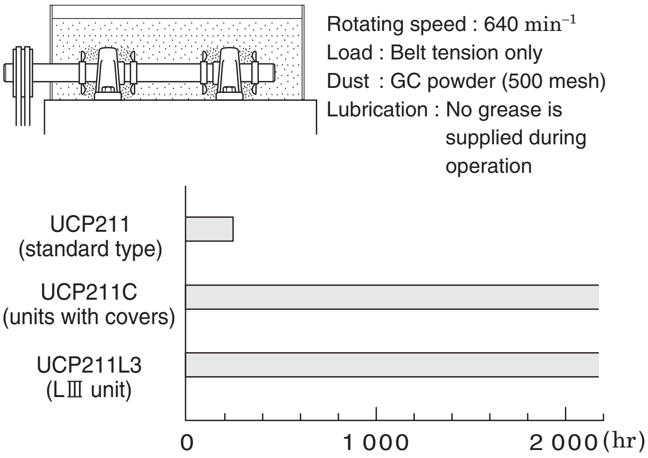

Rotating speed : 640 min^{-1}
Load : Belt tension only
Dust : GC powder (500 mesh)
Lubrication : No grease is supplied during operation

Fig. 13.4 Example result of dust immersion rotating test (dustproof performance)

The standard single-lip bearing exhibited abnormal noise after about 200 hours of operation, and ingress of dust was found.

On the other hand, no abnormality was found in both the triple-lip bearing (suffix code : L3) or the covered unit (suffix code : C) even after 2 000 hours of operation, and therefore superior dustproof performance was established.

13.3.3 Waterproof test

In this test, water is splashed directly onto the units by impellers installed on the shaft.

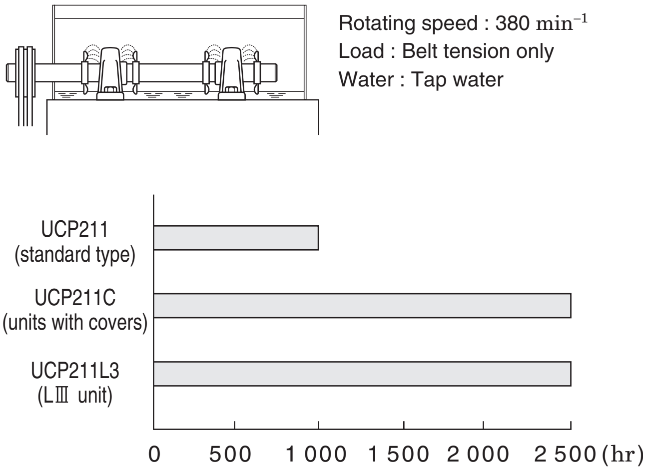

Rotating speed : 380 min^{-1}
Load : Belt tension only
Water : Tap water

Fig. 13.5 Example result of waterproof performance test

The standard single-lip bearing exhibited rust on the balls and surface of the raceways (inner and outer rings) after about 1 000 hours of operation.

On the other hand, rust was found to the same degree as the standard single-lip bearing in both the triple-lip bearing (suffix code : L3) and the covered unit (suffix code : C) after 2 500 hours of operation.

14 Handlings

One of the predominate features of FYH bearing units is their simplicity of handling and installation. It is of the utmost important that these units are handled and installed correctly to ensure reliable performance.

14.1 Installation

14.1.1 Installation of setscrew units

When installing setscrew units, it is important to tighten the setscrews to the shaft with the specified torque.

If the unit is mounted in an environment where it is exposed to impact or vibration, or if the shaft is rotated in normal and reverse directions, or if rotation is started and stopped frequently and repeatedly, then grind or drill the surface of the shaft where it is contacted by the setscrew with a file or drill in order to create a flat seat (**Fig. 14.1**) or drilled seat (**Fig. 14.2**). This will significantly improve the tightening effect of the setscrews.

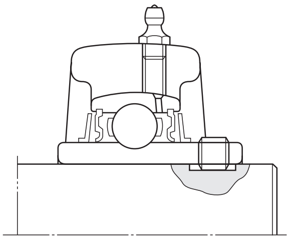


Fig. 14.1 Flat seat provided for shaft
(for improvement in set screw tightening effect)

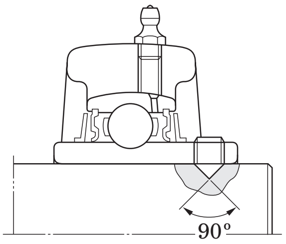


Fig. 14.2 Drilled seat provided for shaft
(for improvement in set screw tightening effect)

If the unit is exposed to great load or excessive vibration, another option is to use a shouldered shaft and tighten the inner ring of the bearing with a shaft nut.

For dimensions of the shouldered shaft, see **"9 Design of shaft and base"**.

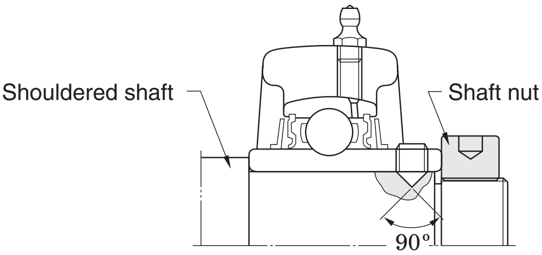


Fig. 14.3 Example of installation with a shouldered shaft and shaft nut

Standard FYH bearings are equipped with double-point setscrews which offer secure tightness to the shaft. Additional styles of setscrews are also available to meet a range of purposes and operating conditions (see **Table 14.1**).

Table 14.1 Set screws of ball bearings for units

Designations (code)	Details
Double point (no indication) 	The cone point at the center of the screw combined with the round point at the outer edge provide excellent shaft contact and greatly reduce fitting error. A nylon film is fused to the thread surface to prevent the screw from loosening during operation.
Double point (**G7**) Locking finish	Prevent looseness with elastic force of nylon film fused to the thread surface.
Pointed (**G4**) 	The cone point setscrew has a 90º angle and fits a drilled cone seat in the shaft. It allows correct positioning on the shaft and prevents shaft movement in an axial direction.
Full dog point cap (**G6**) 	The full dog point setscrew fits into the keyed groove in the shaft and allows for expansion and contraction of the shaft.

Shown below are installation procedures for bearing units with setscrews.

(1) Inspect the unit to ensure that the rigidity of the base, flatness of the mounting surface, and tolerance of the shaft meet the required standards. Check the shaft for bends, burrs, and other flaws.
(2) Make sure that the tip of the setscrew does not exceed the bearing bore diameter surface.
(3) Fit the bearing unit onto the shaft and slide it to the specified position. In order to secure a tight fit, press-fit the bearing unit to the shaft with a press, cold-fit by cooling the shaft, or shrink-fit the bearing unit by warming it with an air bath (100 ℃ or less). Avoid hitting the bearing with a hammer to press-fit the bearing to the shaft.
(4) Align the bearing unit to the specified position on the base and affix it with washers, if necessary, and bolts (**Fig. 14.4**). Use a torque wrench to tighten the bolts to the housing to the specified torque setting. For mounting bolt torque specifications, see **Appendix table 2** in the back of this catalog.

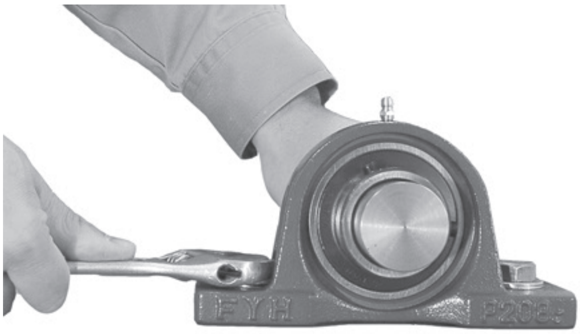


Fig. 14.4　Installation of setscrew units

(5) Tighten both of the setscrews on the inner ring to the specified torque setting (**Fig. 14.5**). For setscrew torque specifications, see **Appendix table 3** in the back of this catalog.

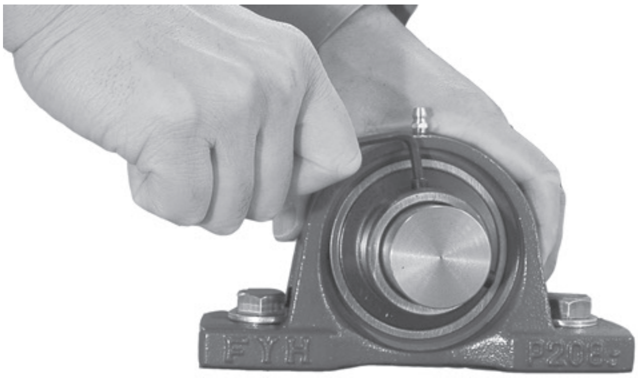


Fig. 14.5　Tightening of set screws

(6) Turn the shaft by hand and tighten the setscrews of all other bearings on the same shaft to the specified torque setting.

(7) Finally, turn the shaft by hand and make sure that it rotates without any problems.

14.1.2 Installation of adapter style units

Adapter units, comprised of an adapter sleeve, locknut, and washer, can be installed into environments where they are exposed to excessive vibration and impact.

It is of great importance that these units are properly mounted. If the locknut is not properly tightened, the sleeve may be loose which could lead to slippage and wear on the shaft or bearing. Conversely, if the locknut is over-tightened, the inner ring of the bearing can expand and reduce internal ball clearance which could cause excessive heat and premature failure.

Installation procedures for adapter style bearings are shown below.

(1) Inspect the unit to ensure that the rigidity of the base, flatness of the mounting surface, and tolerance of the shaft meet the required standards. Check the shaft for bends, burrs, and other flaws.

(2) Slide the adapter sleeve onto the shaft where the bearing unit will be installed.

If the sleeve is too tight, place a screwdriver in the slotted portion of the sleeve and expand the slot to open the sleeve.

(3) Slide the bearing unit over the shaft and onto the adapter sleeve, then place a cylindrical reinforcing place against the inner ring of the front side of the bearing. Seat the adapter sleeve by lightly tapping all around the backside of the sleeve (**Fig. 14.6**).

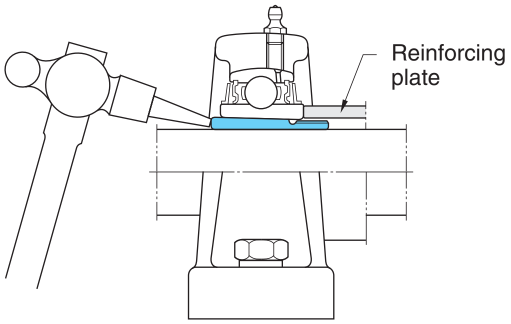


Fig. 14.6　Fitting adapter sleeve to bearing with tapered bore

(4) Attach the lock washer so that the tab fits into the slot in the sleeve, and, making sure the tapered side is facing the bearing, tighten the locknut on the sleeve by hand.

(5) Align the bearing unit to the specified position on the base and affix it with washers, if necessary, and bolts. Use a torque wrench to tighten the bolts to the housing to the specified torque setting. For mounting bolt torque specifications, see **Appendix table 2** in the back of this catalog.

(6) Use a torque wrench to tighten the locknut to the correct specification (**Fig. 14.7**). For locknut torque specifications, see **Appendix table 4** in the back of this catalog.

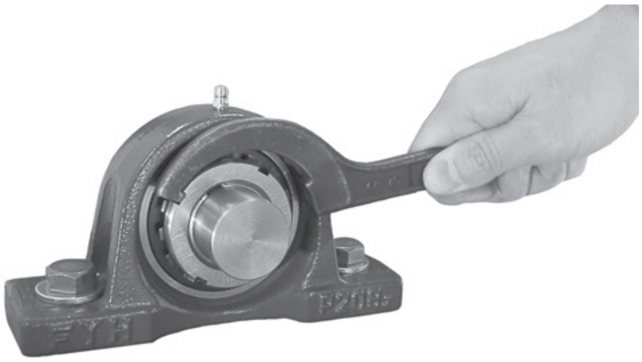


Fig. 14.7 Tightening locknut

(7A) For pillow block housings, loosen the mounting bolts and adjust the unit axially while rotating the shaft by hand. Then re-tighten the mounting bolts to the correct specification.

(7B) For flange block housings, the position of the unit must be in the correct axial position in relation to the shaft, so take extra care to properly align them before completing installation.

(8) Bend one of the tabs on the washer so that it fits into one of the slots on the locknut (**Fig. 14.8**).

Fig. 14.8 Bending claw of washer
(Locking locknut)

(9) Finally, turn the shaft by hand and make sure that it rotates without any problems.

14.1.3 Installation of units with eccentric locking collars

Eccentric locking collar bearings provide another option for shaft locking. Since the rotating force of the shaft increases the tightening force of the eccentric ring to the shaft, this style of bearing allows a secure grip to the shaft.

Since the rotating force of the shaft increases the tightening force of the eccentric ring to the shaft, the unit with eccentric locking collar allows secure fixing of the bearing (**Fig. 14.9**).

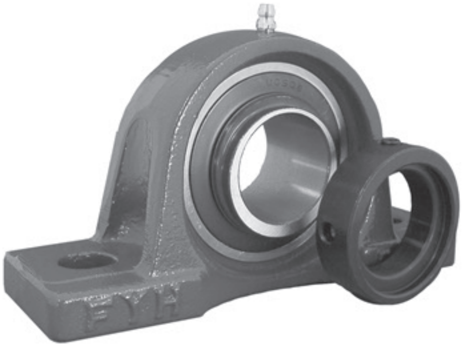


Fig. 14.9 Ball bearing units with eccentric locking collar

Installation procedures for eccentric locking collar style bearings are shown below.

(1) Inspect the unit to ensure that the rigidity of the base, flatness of the mounting surface, and tolerance of the shaft meet the required standards. Check the shaft for bends, burrs, and other flaws.

(2) Slide the bearing unit onto the shaft, and place it at the specified mounting position.

(3) Align the bearing unit to the specified position on the base and affix it with washers, if necessary, and bolts (**Fig. 14.4**). Use a torque wrench to tighten the bolts to the housing to the specified torque setting. For mounting bolt torque specifications, see **Appendix table 2** in the back of this catalog.

(4) Fit the eccentric section of the inner ring of the bearing to the eccentric recessed section of the eccentric locking collar, and rotate the collar in the direction of shaft rotation. Then tighten the setscrew on the eccentric locking collar to the specified torque setting (**Fig. 14.10**). For setscrew torque specifications, see **Appendix table 3** in the back of this catalog.

Fig. 14.10 Installing eccentric locking collar

(5) Rotate the shaft by hand and then install the next eccentric locking collar unit to the shaft.
(6) Finally, turn the shaft by hand and make sure that it rotates without any problems.

14.1.4 Installing units with covers

Covers for ball bearing units are available in two types, steel plate and cast iron. Install both the covers at last after installation of the bearing and housing is complete.

Procedures for installation of the ball bearing units with covers are shown below.

(1) Apply grease all around the seal lip of the cover, and pack the internal space of the cover with grease (approximately 1/3 to 1/2 of the space capacity) (**Fig. 14.11**).

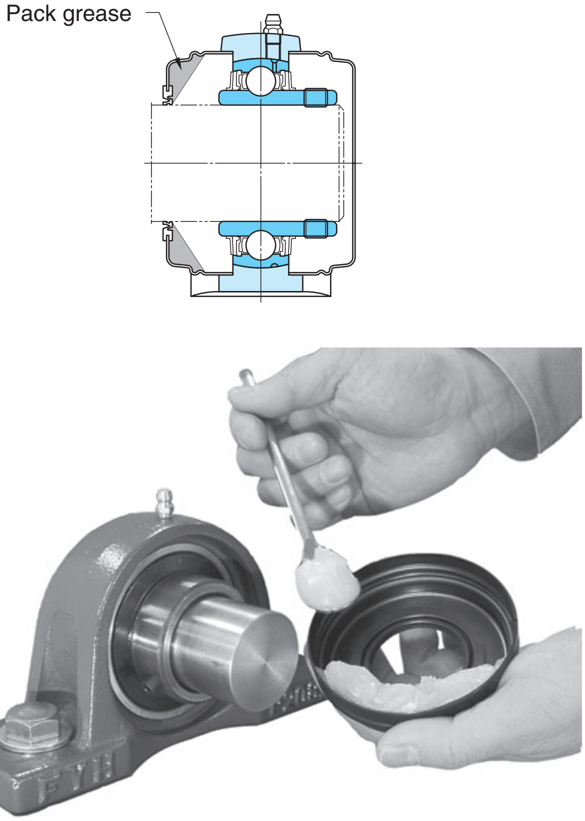


Fig. 14.11 Packing grease in internal space of seal lip of covers

(2) Put a cover through the shaft, and then, fit the bearing unit to the shaft.
(3) Fit the cover through the shaft to the cover groove on the housing, and fix it.
(4A) For the steel plate cover, tap all around the cover evenly with a synthetic resin hammer to prevent deformation, and install it to the housing (**Fig. 14.12**).
To remove the steel plate cover, put a screwdriver into the groove on the periphery of the cover, and slightly pry it.

Fig. 14.12 Installing steel plate covers

(4B) When installing the cast iron cover, fit the cover to the cover groove of the housing, and fix it with the bolt.
For the tightening torque of the cast iron cover mounting bolt, see the **Appendix table 2** at the end of this catalogue.
(5) Install another cover to the housing in a similar manner.
(6) Check for abnormality of the installed cover.
(7) At last, turn the shaft with your hands, and check for abnormality in the rotating status of the bearing.

14.2 Test run inspection

After installation of the ball bearing unit is complete, execute the test run inspection to ensure that it is done appropriately.

The test run inspection should be executed by following the procedures below. Check for abnormality in the bearing unit.

(1) Turn the shaft with your hands, and make sure that the bearing is rotated smoothly.
If any jam, vibration, great rotation torque (heavy), or uneven rotation is found, the bearing is judged to be faulty.
(2) Execute power run with no load and at a low speed, and check for abnormal noise and vibration.
(3) Carry out power run under the specified conditions, and check for abnormal noise, vibration, and temperature increase.

Table 14.2 shows the main faults that may occur during the test run inspection of the ball bearing unit and causes.

Table 14.2 Main causes of bearing failure during test runs and their causes

Faults	Causes
Excessive torque, uneven rotating torque	(1) Faulty installation, causes preload on bearing (2) Inappropriate handling or installation, leading to interference of seal with slinger (3) Excessive tightening of locknut (adapter) causing too small internal clearance of bearing
Abnormal noise, abnormal vibration	(1) Improper tightening of set screws or of mounting bolts (2) Excessively large internal clearance of bearings (3) Bent shaft, or shouldered shaft may be machined eccentrically (4) Shaft tolerance chosen improperly (5) Mounting base not rigid or flat
Abnormal temperature increase	(1) Too small internal clearance of bearing (2) Faulty installation, causes preload on bearing (3) load too great (4) Allowable rotational speed exceeded (5) Mounting base not rigid or flat (6) Inappropriate handling or installation, leading to interference of seal with slinger

14.3 Periodic inspection

FYH Ball Bearing Units do not need to be inspected as frequently as lower quality bearings. However it is good practice to set up an inspection schedule for even these high quality bearings.

Since a ball bearing unit cannot be disassembled for inspection of the internal status of components, the external appearance of the bearing must be inspected to give tell-tale signs of the status and expected life of the bearing. The following characteristics must be checked per the inspection schedule that is established for a particular application.

(1) Overall appearance
(2) Looseness of set screw of bearing inner ring or of the mounting bolts
(3) Noise from vibration
(4) Temperature of the bearing housing or the inner ring
(5) Grease supply interval and quantity of grease injected into the bearing (either too much or too little grease can be detrimental to the life of the bearing)

Table 14.3 shows the main faults that are usually found during periodic inspections and their causes.

If any fault is found in a ball bearing unit during an inspection, then immediate action must be taken to correct the situation and prevent deterioration of the bearing components. If serious damage has already occurred to the bearing unit, then the bearing unit must be replaced immediately to prevent damage to other machine components.

Table 14.3 Main Faults found during periodic inspection and their causes

Faults	Causes
Excessive torque	(1) Degraded grease (2) Interference of seal with slinger due to excessive supply of grease (3) Deformation of slinger causing interference with seal (4) High load due to shaft expansion
Abnormal noise, abnormal vibration	(1) Improper tightening of set screws or of mounting bolts (2) Wear on inner ring of bearing or shaft due to creep or fretting (3) Ingress of foreign matter (dirt) into bearing (4) Damage to cage or ball rolling surfaces due to rolling fatigue (5) Dent on raceway surface or ball rolling surface because of excessive load (6) Warped or bent shaft
Abnormal temperature increase	(1) Degraded grease (2) Interference of seal with slinger due to excessive supply of grease (3) Deformation of slinger causing interference with seal (4) Looseness of setscrew, eccentric locking ring or adapter lock nut for tapered i.d. bearings (5) Load due to shaft expansion (6) Damage to cage or ball rolling surfaces due to rolling fatigue

14.4 Supply of grease

FYH ball bearing units are supplied with high quality grease packed inside a high quality seal. Therefore, under clean operating conditions at lighter loads and lower speeds at normal temperatures, the bearing may be used with no further lubrication.

However, under harsher operating conditions and environment, the grease will deteriorate much more rapidly. This would include environments exposed to dust, moisture or higher operating temperatures.

In such cases, a regreasing schedule must be established to prevent premature failure of the bearings. The life of the bearing can be greatly extended by proper attention to the regreasing schedule and by supplying the proper amount of grease. Please note that too much grease can be detrimental as well as too little grease.

14.4.1 Grease life and supply intervals

The grease life of a packed ball bearing unit can be found using **Formula (4.7)** on page 21.

The regreasing schedule should be set at 1/4 to 1/3 of the grease life found by the calculation shown above ; however this may be adjusted for particularly demanding environments or conditions.

In addition, some environments may be unusually dirty or wet, and these conditions may be exacerbated by higher temperatures. Under such harsh conditions, a more frequent regreasing schedule will extend the life of the bearing.

Under normal operating conditions, please adhere to the guidelines outlined in **Table 14.4**.

14.4.2 Amount of grease

The amount of grease initially supplied in a new FYH Ball Bearing Unit is approximately 30 to 35% of the internal space capacity of the bearing. If the bearing is ever over greased, the agitation of the grease causes internal friction and heating of the bearing. The first sign of failure will be excessive grease finding its way to the outside of the bearing. DO NOT exceed the initial greasing amount.

Table 14.5 shows the recommended amount of grease to be used for regreasing FYH bearings.

In a severely dusty or wet environment, the amount of grease may be increased by two times, only if operating speeds are low.

Remarks 1. Table 14.5 applies to UK units as well.
2. For greasing triple lip (LⅢ) type bearings, use 1 1/2 times the amount of grease recommended in the table.
3. Values shown in the table are applicable to standard grease (specific gravity : 0.9 g/ml). If a compatible grease of another specific gravity is used, then the proper conversion must be made, to insure that the recommended volume is put into the bearing.

Table 14.5 Amount of recommended grease for ball bearing units

Bore dia. code	Greasing amount, g		
	UC200	UCX00	UC300
01	1.8		
02	1.8		
03	1.8		
04	1.8	–	–
05	1.8	3.3	4.2
06	3.3	4.5	5.9
07	4.5	5.6	8.1
08	5.6	6.5	10.1
09	6.5	7.7	12.6
10	7.7	10.3	18.1
11	10.3	13.2	25
12	13.2	14.9	31
13	14.9	18.2	39
14	18.2	21	47
15	21	25	56
16	25	31	65
17	31	38	78
18	38	48	90
19	–	–	108
20		69	141
21		–	165
22			198
24			237
26			291
28			337

Table 14.4 Grease schedule of ball bearing units

Operating temperature, ℃		Grease Intervals			Bearing used	Grease supplied
Over	Incl.	Substantially clean	Excessive dust	Excessive dust and moisture		
	50	(3 months) not necessary	(2 months) 1 year	(1 month) 4 months	(Low temperature D2K2)1) Standard bearing	Shell Alvania RL2, Gold No.3 or equivalent
50	**70**	1 year	4 months	1 month		
70	**100**	6 months	2 months	2 weeks		
100	**120**	2 months	2 weeks	5 days	High temperature D1K2	SH44M
120	**150**	2 weeks	5 days	2 days		
150	**180**	1 week	2 days	1 day		

Note 1) Greasing intervals in parentheses are applicable to low temperature grease (D2K2).

Remark Greasing intervals shown in this table are applicable to a unit operated for 8 to 10 hours per day. If the time of operation is greater than this range, then a more frequent greasing interval must be specified. For example, if the unit is operated 16 to 20 hours per day, then the greasing interval must be twice as frequent.

14.4.3 Types of grease supplied

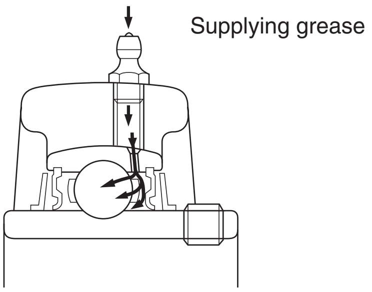
Many different types of grease are available for use in ball bearings. However, if a non-compatible grease is used, particularly a non-lithium based grease, then performance may be drastically reduced.

Please use the grease recommended in **Table 2.3** to assure optimum performance of your bearings.

If another grease is used in an emergency situation, for instance, please assure that this grease is compatible, with a lithium base, at the minimum.

14.4.4 Relubricating the unit at the specified interval

Note **Fig. 14.13** which shows the grease nipple, grease groove and grease holes for relubrication of the unit.



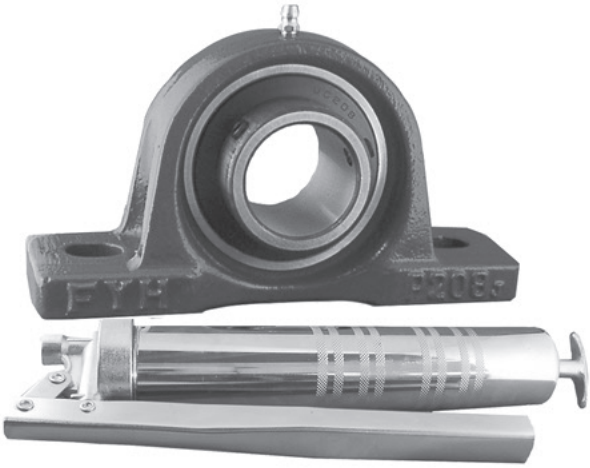


Fig. 14.13 Supplying grease to ball bearing units

(1) Clean the grease nipple and the area around it to prevent dirt and foreign material from entering the unit.
(2) Clean the grease gun and pack clean grease.
(3) Grease the unit with the recommended amount of grease.

When lubricating the ball bearing unit, slowly turn the shaft with your hand. This causes the fresh grease to be uniformly distributed inside the unit.

If it is difficult to access the standard straight type nipple with a grease gun, the 45° and 90° angled units are available as an option. See the picture below of these grease nipples. Please contact us with your special needs.

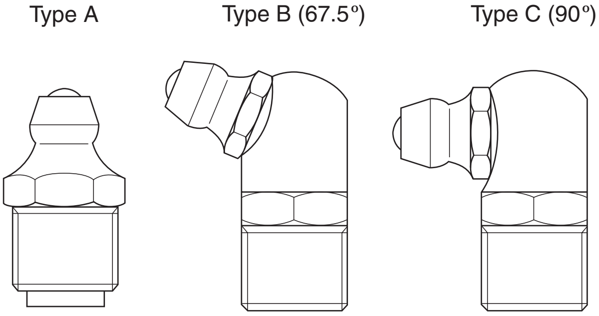


Fig. 14.14 Types of grease nipple for ball bearing units

When using a centralized automatic lubrication system, with ball bearings, it is important to use softer grease than normal. The grease should be specified with a “worked penetration number” between 300 and 380. This is NLGI grade “0” or “1”. Piping from the lubricating system must be sized so that the specified volume of grease is applied.

Piping must be connected to the threaded hole on the ball bearing unit. This is either 1/4-28 tapered threads for units up to “2” in size or 1/8 PT (BSPT) for ball bearing units larger than “2” shaft diameter. If the piping size used is larger than the threaded hole in the ball bearing unit, then the appropriate reducing coupling (or street elbow) must be used to fit the threaded hole.

Fig. 14.15 shows the body of a pipe reducer.

When using an automatic centralized lubrication system, it is imperative to assure that the correct volume of grease is supplied to each individual bearing as specified in **Table 14.5**. The total amount of grease is a multiple of the number of bearings being supplied by the central system.

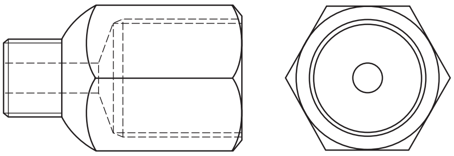


Fig. 14.15 Reducing coupling for centralized lubrication systems

For details of grease nipples and reducing couplings, see **“16 Parts and accessories”**.

14.5 Replacing bearings

If a bearing insert needs to be replaced, it is not always necessary to replace the housing, if the housing is undamaged. Simply insert a new bearing into the old housing, after carefully inspecting the housing to assure that it is not damaged.

Replacement procedures for a bearing insert are listed below.

(1) Remove the complete bearing unit from the shaft and mounting base.

(2) Screw in the set screws so that the head of the set screw does not protrude outside the O.D. of the inner race. Otherwise the head of the set screw may damage the bearing seat inside the housing.

(3) Turn the bearing 90° with a hammer handle or a bar or pipe until the bearing is horizontal.

(4) Remove the bearing insert from the housing via the bearing groove in the housing.

Reverse the above procedure to put in a new bearing insert. Insure that the set screws are screwed in before proceeding with the replacement.

15 Dimensional tables for ball bearing units

15 Dimensional tables for ball bearing units (contents)

1 Pillow type units

Pillow type units

Thick pillow type units

Tapped-base pillow type units

High centerheight pillow type units

Lightweight pillow type units

Clean series pillow type units

Stainless steel series pillow type units

Steel plate pillow type units

2 Square four-bolt flange type units

Square four-bolt flange type units

Square four-bolt flange cartridge type units

Stainless steel series square four-bolt flange type units

3 Oval flange type units

Oval two-bolt flange type units

Adjustable oval two-bolt flange type units

Three-bolt flange type units

Lightweight oval two-bolt flange type units

Clean series oval two-bolt flange type units

Stainless steel series oval two-bolt flange type units

4 Round flange cartridge type units

5 Stamped steel plate flange type units

Stamped steel plate round three-bolt flange type units

Stamped steel plate oval two-bolt flange type units

6 Take-up type units

Take-up type units

Stainless steel series take-up type units

Section steel frame take-up type units

Channel steel frame take-up type units

Steel plate frame take-up type units

7 Other units

Cartridge type units

Hanger type units

8 Ball bearing inserts

Cylindrical bore (with set screws)

Stainless steel series, cylindrical bore (with set screws)

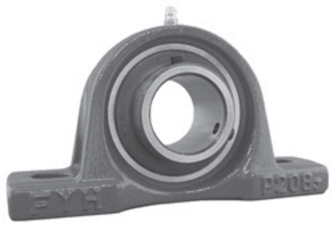
Tapered bore (with adapter)

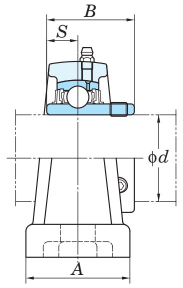
Cylindrical bore (with eccentric locking collar)

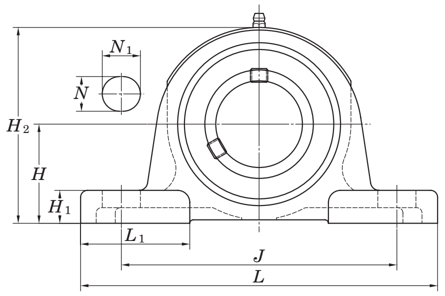
Cylindrical bore (with set screws), cylindrical outside surface

9 Bearing adapters

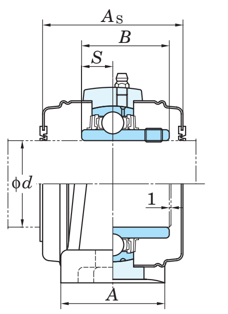
UCP
Cylindrical bore (with set screws)
d 12 ~ (45) mm



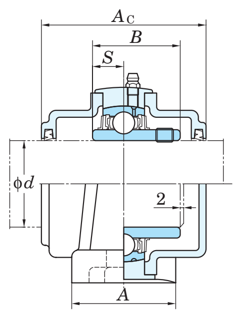




With Pressed Steel Cover



With Cast Iron Cover

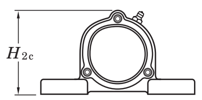


Variations of tolerance of distance from mounting bottom to center of spherical bore ($\varDelta_{Hs}$)

Unit : mm

Housing No.			$\varDelta_{Hs}$
P203~P210	PX05~PX10	P305~P310	±0.15
P211~P218	PX11~PX18	P311~P318	±0.2
	PX20	P319~P328	±0.3

Forms and dimensions of H_{2c} of P204JE3 and P205JE3 (housing with cast iron cover) are shown below.

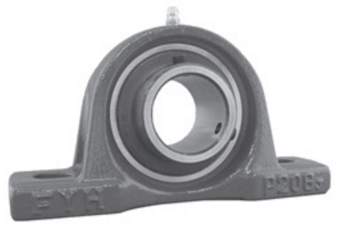


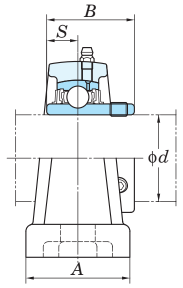
P204JE3 $H_{2c} = 70$ mm
P205JE3 $H_{2c} = 77$ mm

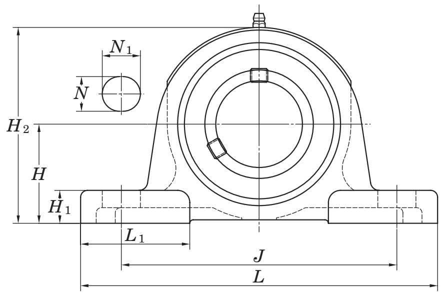
Shaft Dia. mm	Shaft Dia. inch	Dimensions inch mm											Bolt Size inch mm	Standard Unit No.	Housing No.	Bearing No.	Mass	Basic Load Ratings kN		Factor	With Pressed Steel Cover Unit No.		Dimension		Mass	With Cast Iron Cover Unit No.		Dimension		Mass
d		H	L	A	J	N	N_1	H_1	H_2	L_1	B	S					kg	C_r	C_{0r}	f_0	Open Type	One Side Closed Type	mm A_s	inch	kg	Open Type	One Side Closed Type	mm A_c	inch	kg
12		1 3/16 30.2	5 127	1 1/2 38	3 3/4 95	1/2 13	23/32 18	15/32 12	2 3/8 60	1 1/2 38	1.220 31	0.500 12.7	3/8 M10	**UCP201**	P203	UC201	0.63	12.8	6.65	13.2	UCP201C	UCP201CD	44	1 23/32	0.63	–	–	–	–	–
	1/2													**UCP201-8**		UC201-8	0.63				–	–	–	–	–	–	–	–	–	–
15														**UCP202**		UC202	0.61				UCP202C	UCP202CD	44	1 23/32	0.61	–	–	–	–	–
	5/8													**UCP202-10**		UC202-10	0.61				–	–	–	–	–	–	–	–	–	–
17														**UCP203**		UC203	0.60				UCP203C	UCP203CD	44	1 23/32	0.60	–	–	–	–	–
20	3/4	1 5/16 33.3	5 127	1 1/2 38	3 3/4 95	1/2 13	23/32 18	1/2 13	2 17/32 64	1 1/2 38	1.220 31	0.500 12.7	3/8 M10	**UCP204-12**	P204	UC204-12	0.66	12.8	6.65	13.2	–	–	–	–	–	–	–	–	–	–
														UCP204		UC204	0.66				UCP204C	UCP204CD	44	1 23/32	0.66	UCP204FC	UCP204FCD	62	2 7/16	0.96
25	7/8	1 7/16 36.5	5 1/2 140	1 1/2 38	4 1/8 105	1/2 13	23/32 18	1/2 13	2 25/32 71	1 11/16 43	1.343 34.1	0.563 14.3	3/8 M10	**UCP205-14**	P205	UC205-14	0.80	14.0	7.85	13.9	–	–	–	–	–	–	–	–	–	–
	15/16													**UCP205-15**		UC205-15	0.80				–	–	–	–	–	–	–	–	–	–
														UCP205		UC205	0.80				UCP205C	UCP205CD	48	1 7/8	0.80	UCP205FC	UCP205FCD	66	2 19/32	1.2
	1													**UCP205-16**		UC205-16	0.80				–	–	–	–	–	–	–	–	–	–
		1 3/4 44.4	6 1/4 159	2 51	4 11/16 119	21/32 17	31/32 25	5/8 16	3 3/8 86	1 27/32 47	1.500 38.1	0.626 15.9	1/2 M14	**UCPX05**	PX05	UCX05	1.5	19.5	11.3	13.9	UCPX05C	UCPX05CD	52	2 1/16	1.5	–	–	–	–	–
	1													**UCPX05-16**		UCX05-16	1.5				–	–	–	–	–	–	–	–	–	–
		1 49/64 45	6 7/8 175	1 3/4 45	5 3/16 132	21/32 17	25/32 20	5/8 16	3 11/32 85	2 5/32 55	1.496 38	0.591 15	1/2 M14	**UCP305**	P305	UC305	1.7	21.2	10.9	12.6	–	–	–	–	–	UCP305C	UCP305CD	76	3	2.3
	1													**UCP305-16**		UC305-16	1.7				–	–	–	–	–	–	–	–	–	–
30	1 1/8	1 11/16 42.9	6 1/2 165	1 7/8 48	4 3/4 121	21/32 17	13/16 21	19/32 15	3 5/16 84	2 3/32 53	1.500 38.1	0.626 15.9	1/2 M14	**UCP206-18**	P206	UC206-18	1.3	19.5	11.3	13.9	–	–	–	–	–	–	–	–	–	–
														UCP206		UC206	1.3				UCP206C	UCP206CD	52	2 1/16	1.3	UCP206FC	UCP206FCD	70	2 3/4	1.8
	1 3/16													**UCP206-19**		UC206-19	1.3				–	–	–	–	–	–	–	–	–	–
	1 1/4													**UCP206-20**		UC206-20	1.3				–	–	–	–	–	–	–	–	–	–
		1 7/8 47.6	6 7/8 175	2 1/4 57	5 127	21/32 17	31/32 25	21/32 17	3 21/32 93	2 5/32 55	1.689 42.9	0.689 17.5	1/2 M14	**UCPX06**	PX06	UCX06	2.1	25.7	15.4	13.9	UCPX06C	UCPX06CD	59	2 5/16	2.1	–	–	–	–	–
	1 3/16													**UCPX06-19**		UCX06-19	2.1				–	–	–	–	–	–	–	–	–	–
	1 1/4													**UCPX06-20**		UCX06-20	2.1				–	–	–	–	–	–	–	–	–	–
	–	1 31/32 50	7 3/32 180	1 31/32 50	5 1/2 140	21/32 17	25/32 20	21/32 17	3 3/4 95	2 3/32 53	1.693 43	0.669 17	1/2 M14	**UCP306**	P306	UC306	2.2	26.7	15.0	13.3	–	–	–	–	–	UCP306C	UCP306CD	82	3 7/32	2.8
35	1 1/4	1 7/8 47.6	6 9/16 167	1 7/8 48	5 127	21/32 17	13/16 21	5/8 16	3 21/32 93	2 51	1.689 42.9	0.689 17.5	1/2 M14	**UCP207-20**	P207	UC207-20	1.6	25.7	15.4	13.9	–	–	–	–	–	–	–	–	–	–
	1 5/16													**UCP207-21**		UC207-21	1.6				–	–	–	–	–	–	–	–	–	–
	1 3/8													**UCP207-22**		UC207-22	1.6				–	–	–	–	–	–	–	–	–	–
														UCP207		UC207	1.6				UCP207C	UCP207CD	59	2 5/16	1.6	UCP207FC	UCP207FCD	78	3 1/16	2.3
	1 7/16													**UCP207-23**		UC207-23	1.6				–	–	–	–	–	–	–	–	–	–
	1 3/8	2 1/8 54	8 203	2 1/4 57	5 11/16 144	21/32 17	1 3/16 30	3/4 19	4 1/8 105	2 17/32 64	1.937 49.2	0.748 19	1/2 M14	**UCPX07-22**	PX07	UCX07-22	2.7	29.1	17.8	14.0	–	–	–	–	–	–	–	–	–	–
														UCPX07		UCX07	2.7				UCPX07C	UCPX07CD	68	2 11/16	2.7	–	–	–	–	–
	1 7/16													**UCPX07-23**		UCX07-23	2.7				–	–	–	–	–	–	–	–	–	–
	–	2 13/64 56	8 9/32 210	2 7/32 56	6 5/16 160	21/32 17	31/32 25	3/4 19	4 7/32 107	2 9/16 65	1.890 48	0.748 19	1/2 M14	**UCP307**	P307	UC307	3.0	33.4	19.3	13.2	–	–	–	–	–	UCP307C	UCP307CD	88	3 15/32	3.8
40	1 1/2	1 15/16 49.2	7 1/4 184	2 1/8 54	5 13/32 137	21/32 17	13/16 21	21/32 17	3 27/32 98	2 1/4 57	1.937 49.2	0.748 19	1/2 M14	**UCP208-24**	P208	UC208-24	2.0	29.1	17.8	14.0	–	–	–	–	–	–	–	–	–	–
	1 9/16													**UCP208-25**		UC208-25	2.0				–	–	–	–	–	–	–	–	–	–
														UCP208		UC208	2.0				UCP208C	UCP208CD	68	2 11/16	2.0	UCP208FC	UCP208FCD	86	3 3/8	2.8
	1 1/2	2 5/16 58.7	8 3/4 222	2 5/8 67	6 1/8 156	25/32 20	1 1/4 32	13/16 21	4 1/2 114	2 25/32 71	1.937 49.2	0.748 19	5/8 M16	**UCPX08-24**	PX08	UCX08-24	3.5	34.1	21.3	14.0	–	–	–	–	–	–	–	–	–	–
														UCPX08		UCX08	3.5				UCPX08C	UCPX08CD	68	2 11/16	3.5	–	–	–	–	–
	1 1/2	2 23/64 60	8 21/32 220	2 3/8 60	6 11/16 170	21/32 17	1 1/16 27	3/4 19	4 21/32 118	2 9/16 65	2.047 52	0.748 19	1/2 M14	**UCP308-24**	P308	UC308-24	3.8	40.7	24.0	13.2	–	–	–	–	–	–	–	–	–	–
														UCP308		UC308	3.8				–	–	–	–	–	UCP308C	UCP308CD	96	3 25/32	4.8
45	1 5/8	2 1/8 54	7 15/32 190	2 1/8 54	5 3/4 146	21/32 17	13/16 21	21/32 17	4 3/16 106	2 3/8 60	1.937 49.2	0.748 19	1/2 M14	**UCP209-26**	P209	UC209-26	2.2	34.1	21.3	14.0	–	–	–	–	–	–	–	–	–	–
	1 11/16													**UCP209-27**		UC209-27	2.2				–	–	–	–	–	–	–	–	–	–
	1 3/4													**UCP209-28**		UC209-28	2.2				–	–	–	–	–	–	–	–	–	–
														UCP209		UC209	2.2				UCP209C	UCP209CD	68	2 11/16	2.2	UCP209FC	UCP209FCD	88	3 15/32	3.0
	1 3/4	2 5/16 58.7	8 3/4 222	2 5/8 67	6 1/8 156	25/32 20	1 5/16 33	13/16 21	4 9/16 116	2 25/32 71	2.031 51.6	0.748 19	5/8 M16	**UCPX09-28**	PX09	UCX09-28	3.7	35.1	23.3	14.4	–	–	–	–	–	–	–	–	–	–
														UCPX09		UCX09	3.7				UCPX09C	UCPX09CD	73	2 7/8	3.7	–	–	–	–	–

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210, X05~X09, 305~308
A-PT1/8 .... 211~218, X10~X20, 309~328
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (or L2) follows the Part No. of unit or bearing. (Example of Part No. : UCP206JL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.
5. Representative examples of the forms of housing are indicated.

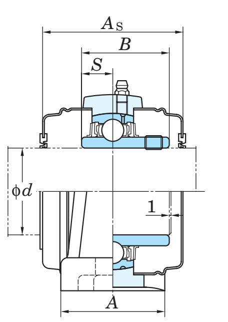
UCP
Cylindrical bore (with set screws)
d (45) ~ (75) mm



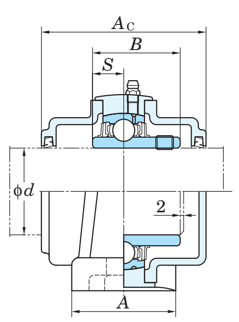




With Pressed Steel Cover



With Cast Iron Cover

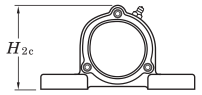


Variations of tolerance of distance from mounting bottom to center of spherical bore (Δ_{Hs})

Unit : mm

Housing No.			Δ_{Hs}
P203~P210	PX05~PX10	P305~P310	±0.15
P211~P218	PX11~PX18	P311~P318	±0.2
	PX20	P319~P328	±0.3

Forms and dimensions of H_{2c} of P204JE3 and P205JE3 (housing with cast iron cover) are shown below.

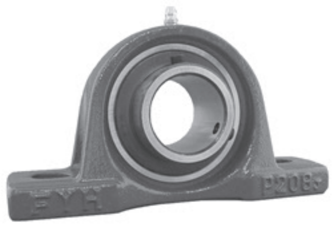


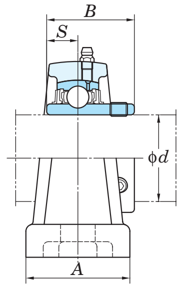
P204JE3 H_{2c} = 70 mm
P205JE3 H_{2c} = 77 mm

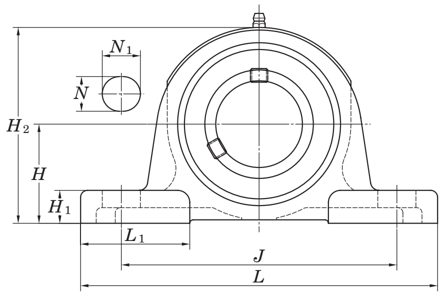
Shaft Dia.		Dimensions inch mm											Bolt Size	Standard			Mass	Basic Load Ratings kN		Factor	With Pressed Steel Cover					With Cast Iron Cover				
d mm	d inch	H	L	A	J	N	N1	H1	H2	L1	B	S	inch mm	Unit No.	Housing No.	Bearing No.	kg	C_r	C_{0r}	f_0	Unit No. Open Type	Unit No. One Side Closed Type	Dimension A_s mm	Dimension A_s inch	Mass kg	Unit No. Open Type	Unit No. One Side Closed Type	Dimension A_c mm	Dimension A_c inch	Mass kg
45	1 3/4	2 41/64 67	9 21/32 245	2 5/8 67	7 15/32 190	25/32 20	1 3/16 30	13/16 21	5 3/16 132	2 15/16 75	2.244 57	0.866 22	5/8 M16	**UCP309-28**	P309	UC309-28	4.9	48.9	29.5	13.3	–	–	–	–	–	–	–	–	–	–
														UCP309		UC309	4.9				–	–	–	–	–	UCP309C	UCP309CD	102	4 1/32	6.2
50	1 7/8	2 1/4 57.2	8 1/8 206	2 3/8 60	6 1/4 159	25/32 20	7/8 22	3/4 19	4 7/16 113	2 15/32 63	2.031 51.6	0.748 19	5/8 M16	**UCP210-30**	P210	UC210-30	2.9	35.1	23.3	14.4	–	–	–	–	–	–	–	–	–	–
	1 15/16													**UCP210-31**		UC210-31	2.9				–	–	–	–	–	–	–	–	–	–
														UCP210		UC210	2.9				UCP210C	UCP210CD	73	2 7/8	2.9	UCP210FC	UCP210FCD	97	3 13/16	3.9
	2													**UCP210-32**		UC210-32	2.9				–	–	–	–	–	–	–	–	–	–
	1 15/16	2 1/2 63.5	9 1/2 241	2 7/8 73	6 23/32 171	25/32 20	1 13/32 36	7/8 22	4 31/32 126	3 76	2.189 55.6	0.874 22.2	5/8 M16	**UCPX10-31**	PX10	UCX10-31	4.6	43.4	29.4	14.4	–	–	–	–	–	–	–	–	–	–
														UCPX10		UCX10	4.6				UCPX10C	UCPX10CD	75	2 15/16	4.6	–	–	–	–	–
	2													**UCPX10-32**		UCX10-32	4.6				–	–	–	–	–	–	–	–	–	–
	–	2 61/64 75	10 13/16 275	2 15/16 75	8 11/32 212	25/32 20	1 3/8 35	15/16 24	5 13/16 148	3 15/32 88	2.402 61	0.866 22	5/8 M16	**UCP310**	P310	UC310	6.6	62.0	38.3	13.2	–	–	–	–	–	UCP310C	UCP310CD	110	4 11/32	8.2
55	2	2 1/2 63.5	8 5/8 219	2 3/8 60	6 23/32 171	25/32 20	7/8 22	3/4 19	4 29/32 125	2 3/4 70	2.189 55.6	0.874 22.2	5/8 M16	**UCP211-32**	P211	UC211-32	3.6	43.4	29.4	14.4	–	–	–	–	–	–	–	–	–	–
	2 1/8													**UCP211-34**		UC211-34	3.6				–	–	–	–	–	–	–	–	–	–
														UCP211		UC211	3.6				UCP211C	UCP211CD	75	2 15/16	3.6	UCP211FC	UCP211FCD	99	3 29/32	4.8
	2 3/16													**UCP211-35**		UC211-35	3.6				–	–	–	–	–	–	–	–	–	–
		2 3/4 69.8	10 1/4 260	3 1/8 79	7 1/4 184	31/32 25	1 13/32 36	1 3/32 28	5 15/32 139	3 9/32 83	2.563 65.1	1.000 25.4	3/4 M20	**UCPX11**	PX11	UCX11	6.5	52.4	36.2	14.4	UCPX11C	UCPX11CD	88	3 15/32	6.5	–	–	–	–	–
	2 3/16													**UCPX11-35**		UCX11-35	6.5				–	–	–	–	–	–	–	–	–	–
	2 1/4													**UCPX11-36**		UCX11-36	6.5				–	–	–	–	–	–	–	–	–	–
	2	3 5/32 80	12 7/32 310	3 5/32 80	9 9/32 236	25/32 20	1 1/2 38	1 1/16 27	6 7/32 158	3 17/32 90	2.598 66	0.984 25	5/8 M16	**UCP311-32**	P311	UC311-32	7.9	71.6	45.0	13.2	–	–	–	–	–	–	–	–	–	–
														UCP311		UC311	7.9				–	–	–	–	–	UCP311C	UCP311CD	114	4 1/2	9.7
60	2 1/4	2 3/4 69.8	9 1/2 241	2 3/4 70	7 1/4 184	25/32 20	31/32 25	7/8 22	5 7/16 138	3 76	2.563 65.1	1.000 25.4	5/8 M16	**UCP212-36**	P212	UC212-36	4.9	52.4	36.2	14.4	–	–	–	–	–	–	–	–	–	–
														UCP212		UC212	4.9				UCP212C	UCP212CD	88	3 15/32	4.9	UCP212FC	UCP212FCD	114	4 1/2	6.4
	2 3/8													**UCP212-38**		UC212-38	4.9				–	–	–	–	–	–	–	–	–	–
	2 7/16													**UCP212-39**		UC212-39	4.9				–	–	–	–	–	–	–	–	–	–
		3 76.2	11 1/4 286	3 1/4 83	8 203	31/32 25	1 9/16 40	1 3/32 28	5 31/32 152	3 15/32 88	2.563 65.1	1.000 25.4	3/4 M20	**UCPX12**	PX12	UCX12	7.7	57.2	40.1	14.4	UCPX12C	UCPX12CD	88	3 15/32	7.7	–	–	–	–	–
	2 7/16													**UCPX12-39**		UCX12-39	7.7				–	–	–	–	–	–	–	–	–	–
	–	3 11/32 85	13 330	3 11/32 85	9 27/32 250	31/32 25	1 1/2 38	1 5/32 29	6 9/16 167	4 1/16 103	2.795 71	1.024 26	3/4 M20	**UCP312**	P312	UC312	9.5	81.9	52.2	13.2	–	–	–	–	–	UCP312C	UCP312CD	124	4 7/8	11.8
65	2 1/2	3 76.2	10 7/16 265	2 3/4 70	8 203	31/32 25	1 3/16 30	31/32 25	5 29/32 150	3 1/16 78	2.563 65.1	1.000 25.4	3/4 M20	**UCP213-40**	P213	UC213-40	5.9	57.2	40.1	14.4	–	–	–	–	–	–	–	–	–	–
														UCP213		UC213	5.9				UCP213C	UCP213CD	88	3 15/32	5.9	UCP213FC	UCP213FCD	114	4 1/2	7.6
	2 1/2	3 76.2	11 1/4 286	3 1/4 83	8 203	31/32 25	1 9/16 40	1 3/32 28	6 3/32 155	3 15/32 88	2.937 74.6	1.189 30.2	3/4 M20	**UCPX13-40**	PX13	UCX13-40	8.1	62.2	44.1	14.5	–	–	–	–	–	–	–	–	–	–
														UCPX13		UCX13	8.1				UCPX13C	UCPX13CD	98	3 27/32	8.1	–	–	–	–	–
	2 1/2	3 35/64 90	13 3/8 340	3 17/32 90	10 1/4 260	31/32 25	1 1/2 38	1 1/4 32	6 15/16 176	4 11/32 110	2.953 75	1.181 30	3/4 M20	**UCP313-40**	P313	UC313-40	10.7	92.7	59.9	13.2	–	–	–	–	–	–	–	–	–	–
														UCP313		UC313	10.7				–	–	–	–	–	UCP313C	UCP313CD	122	4 13/16	12.8
70	2 3/4	3 1/8 79.4	10 15/32 266	2 27/32 72	8 9/32 210	31/32 25	1 3/16 30	1 3/32 28	6 5/32 156	3 1/16 78	2.937 74.6	1.189 30.2	3/4 M20	**UCP214-44**	P214	UC214-44	6.8	62.2	44.1	14.5	–	–	–	–	–	–	–	–	–	–
														UCP214		UC214	6.8				UCP214C	UCP214CD	98	3 27/32	6.8	UCP214FC	UCP214FCD	124	4 7/8	8.7
	2 3/4	3 1/2 88.9	13 330	3 1/2 89	9 229	1 1/16 27	1 31/32 50	1 1/4 32	6 23/32 171	3 27/32 98	3.063 77.8	1.331 33.3	7/8 M22	**UCPX14-44**	PX14	UCX14-44	10.2	67.4	48.3	14.5	–	–	–	–	–	–	–	–	–	–
														UCPX14		UCX14	10.2				UCPX14C	UCPX14CD	98	3 27/32	10.2	–	–	–	–	–
	2 3/4	3 47/64 95	14 3/16 360	3 17/32 90	11 1/32 280	1 1/16 27	1 9/16 40	1 3/8 35	7 5/16 186	4 11/32 110	3.071 78	1.299 33	7/8 M22	**UCP314-44**	P314	UC314-44	12.4	104	68.2	13.2	–	–	–	–	–	–	–	–	–	–
														UCP314		UC314	12.4				–	–	–	–	–	UCP314C	UCP314CD	124	4 7/8	14.7
75	2 15/16	3 1/4 82.6	10 13/16 275	2 29/32 74	8 17/32 217	31/32 25	1 3/16 30	1 3/32 28	6 3/8 162	3 5/32 80	3.063 77.8	1.311 33.3	3/4 M20	**UCP215-47**	P215	UC215-47	7.4	67.4	48.3	14.5	–	–	–	–	–	–	–	–	–	–
														UCP215		UC215	7.4				UCP215C	UCP215CD	98	3 27/32	7.4	UCP215FC	UCP215FCD	124	4 7/8	9.3
	3													**UCP215-48**		UC215-48	7.4				–	–	–	–	–	–	–	–	–	–
	2 15/16	3 1/2 88.9	13 330	3 1/2 89	9 229	1 1/16 27	1 31/32 50	1 1/4 32	6 7/8 175	3 29/32 99	3.252 82.6	1.311 33.3	7/8 M22	**UCPX15-47**	PX15	UCX15-47	10.8	72.7	53.0	14.6	–	–	–	–	–	–	–	–	–	–
														UCPX15		UCX15	10.8				UCPX15C	UCPX15CD	108	4 1/4	10.8	–	–	–	–	–
	3													**UCPX15-48**		UCX15-48	10.8				–	–	–	–	–	–	–	–	–	–

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210, X05~X09, 305~308
A-PT1/8 .... 211~218, X10~X20, 309~328
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (or L2) follows the Part No. of unit or bearing. (Example of Part No. : UCP206JL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.
5. Representative examples of the forms of housing are indicated.

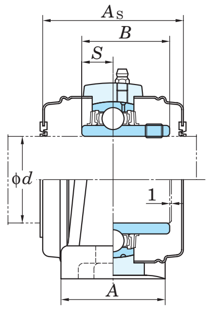
UCP
Cylindrical bore (with set screws)
d (75) ~ 140 mm



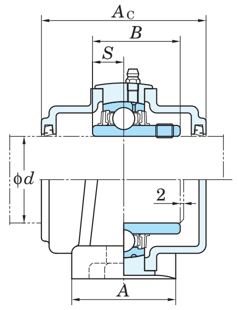




With Pressed Steel Cover



With Cast Iron Cover

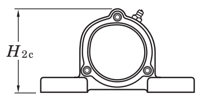


Variations of tolerance of distance from mounting bottom to center of spherical bore (Δ_{Hs})

Unit : mm

Housing No.			Δ_{Hs}
P203~P210	PX05~PX10	P305~P310	±0.15
P211~P218	PX11~PX18	P311~P318	±0.2
	PX20	P319~P328	±0.3

Forms and dimensions of H_{2c} of P204JE3 and P205JE3 (housing with cast iron cover) are shown below.

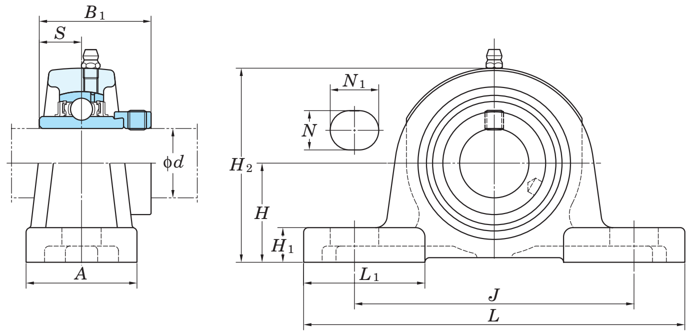


P204JE3 $H_{2c} = 70$ mm
P205JE3 $H_{2c} = 77$ mm

Shaft Dia.		Dimensions											Bolt Size	Standard				Basic Load Ratings		Factor	With Pressed Steel Cover					With Cast Iron Cover				
d mm	d inch	H inch/mm	L	A	J	N	N_1	H_1	H_2	L_1	B	S	inch mm	Unit No.	Housing No.	Bearing No.	Mass kg	C_r kN	C_{0r} kN	f_0	Unit No. Open Type	Unit No. One Side Closed Type	Dimension A_s mm	Dimension A_s inch	Mass kg	Unit No. Open Type	Unit No. One Side Closed Type	Dimension A_c mm	Dimension A_c inch	Mass kg
75	2 15/16	3 15/16 100	14 31/32 380	3 15/16 100	11 13/32 290	1 1/16 27	1 9/16 40	1 3/8 35	7 25/32 198	4 7/32 107	3.228 82	1.260 32	7/8 M22	UCP315-47	P315	UC315-47	14.8	113	77.2	13.2	–	–	–	–	–	–	–	–	–	–
														UCP315		UC315	14.8				–	–	–	–	–	UCP315C	UCP315CD	134	5 9/32	17.3
	3													UCP315-48		UC315-48	14.8				–	–	–	–	–	–	–	–	–	–
80	3 1/8	3 1/2 88.9	11 1/2 292	3 1/16 78	9 1/8 232	31/32 25	1 3/8 35	1 1/4 32	6 27/32 174	3 3/8 86	3.252 82.6	1.311 33.3	3/4 M20	UCP216-50	P216	UC216-50	9.0	72.7	53.0	14.6	–	–	–	–	–	–	–	–	–	–
														UCP216		UC216	9.0				UCP216C	UCP216CD	108	4 1/4	9.0	UCP216FC	UCP216FCD	138	5 7/16	11.4
	–	4 101.6	15 381	4 102	11 1/8 283	1 1/16 27	2 9/32 58	1 11/32 34	7 11/16 195	4 9/16 116	3.374 85.7	1.343 34.1	7/8 M22	UCPX16	PX16	UCX16	15.3	84.0	61.9	14.5	UCPX16C	UCPX16CD	112	4 13/32	15.3	–	–	–	–	–
	–	4 11/64 106	15 3/4 400	4 11/32 110	11 13/16 300	1 1/16 27	1 9/16 40	1 3/8 35	8 7/32 209	4 23/32 120	3.386 86	1.339 34	7/8 M22	UCP316	P316	UC316	18.5	123	86.7	13.3	–	–	–	–	–	UCP316C	UCP316CD	138	5 7/16	21.4
85	3 1/4	3 3/4 95.2	12 7/32 310	3 9/32 83	9 23/32 247	31/32 25	1 9/16 40	1 1/4 32	7 9/32 185	3 17/32 90	3.374 85.7	1.343 34.1	3/4 M20	UCP217-52	P217	UC217-52	10.8	84.0	61.9	14.5	–	–	–	–	–	–	–	–	–	–
														UCP217		UC217	10.8				UCP217C	UCP217CD	112	4 13/32	10.8	UCP217FC	UCP217FCD	142	5 19/32	13.5
		4 101.6	15 381	4 102	11 1/8 283	1 1/16 27	2 3/8 60	1 11/32 34	7 7/8 200	4 9/16 116	3.780 96	1.563 39.7	7/8 M22	UCPX17	PX17	UCX17	16.1	96.1	71.5	14.5	UCPX17C	UCPX17CD	122	4 13/16	16.1	–	–	–	–	–
	3 7/16													UCPX17-55		UCX17-55	16.1				–	–	–	–	–	–	–	–	–	–
	–	4 13/32 112	16 17/32 420	4 11/32 110	12 19/32 320	1 5/16 33	1 25/32 45	1 9/16 40	8 21/32 220	4 23/32 120	3.780 96	1.575 40	1 M27	UCP317	P317	UC317	20.3	133	96.8	13.3	–	–	–	–	–	UCP317C	UCP317CD	146	5 3/4	23.6
90	3 1/2	4 101.6	12 7/8 327	3 15/32 88	10 5/16 262	1 1/16 27	1 25/32 45	1 11/32 34	7 25/32 198	4 3/32 104	3.780 96	1.563 39.7	7/8 M22	UCP218-56	P218	UC218-56	13.9	96.1	71.5	14.5	–	–	–	–	–	–	–	–	–	–
														UCP218		UC218	13.9				UCP218C	UCP218CD	122	4 13/16	13.9	UCP218FC	UCP218FCD	152	6	17.0
	–	4 101.6	15 381	4 3/8 111	11 1/8 283	1 1/16 27	2 3/8 60	1 1/2 38	8 1/32 204	4 9/16 116	4.094 104	1.689 42.9	7/8 M22	UCPX18	PX18	UCX18	19.1	109	81.9	14.4	–	–	–	–	–	UCPX18C	UCPX18C	158	6 7/32	22.5
	3 1/2	4 41/64 118	16 15/16 430	4 11/32 110	13 330	1 5/16 33	1 25/32 45	1 9/16 40	9 7/32 234	4 23/32 120	3.780 96	1.575 40	1 M27	UCP318-56	P318	UC318-56	22.8	143	107	13.3	–	–	–	–	–	–	–	–	–	–
														UCP318		UC318	22.8				–	–	–	–	–	UCP318C	UCP318CD	150	5 29/32	26.6
95	–	4 59/64 125	18 1/2 470	4 23/32 120	14 3/16 360	1 13/32 36	1 31/32 50	1 13/16 46	9 3/4 248	4 29/32 125	4.055 103	1.614 41	1 1/8 M30	UCP319	P319	UC319	29.0	153	119	13.3	–	–	–	–	–	UCP319C	UCP319CD	162	6 3/8	33.3
100		5 127	17 432	4 3/4 121	13 1/4 337	1 5/16 33	2 9/16 65	1 25/32 45	9 21/32 245	4 31/32 126	4.626 117.5	1.937 49.2	1 M27	UCPX20	PX20	UCX20	30.4	133	105	14.4	–	–	–	–	–	UCPX20C	UCPX20CD	186	7 5/16	34.9
	3 15/16													UCPX20-63		UCX20-63	30.4				–	–	–	–	–	–	–	–	–	–
	4													UCPX20-64		UCX20-64	30.4				–	–	–	–	–	–	–	–	–	–
		5 33/64 140	19 9/32 490	4 23/32 120	14 31/32 380	1 13/32 36	1 31/32 50	1 13/16 46	10 3/4 273	5 1/2 140	4.252 108	1.654 42	1 1/8 M30	UCP320	P320	UC320	35.1	173	141	13.2	–	–	–	–	–	UCP320C	UCP320CD	174	6 27/32	40.7
	3 15/16													UCP320-63		UC320-63	35.1				–	–	–	–	–	–	–	–	–	–
	4													UCP320-64		UC320-64	35.1				–	–	–	–	–	–	–	–	–	–
105	–	5 33/64 140	19 9/32 490	4 23/32 120	14 31/32 380	1 13/32 36	1 31/32 50	1 13/16 46	10 15/16 278	5 1/2 140	4.409 112	1.732 44	1 1/8 M30	UCP321	P321	UC321	37.6	184	153	13.2	–	–	–	–	–	UCP321C	UCP321CD	178	7	43.6
110	–	5 29/32 150	20 15/32 520	5 1/2 140	15 3/4 400	1 9/16 40	2 5/32 55	1 31/32 50	11 21/32 296	5 29/32 150	4.606 117	1.811 46	1 1/4 M33	UCP322	P322	UC322	44.0	205	180	13.2	–	–	–	–	–	UCP322C	UCP322CD	188	7 13/32	50.8
120	–	6 19/64 160	22 7/16 570	5 1/2 140	17 23/32 450	1 9/16 40	2 5/32 55	1 31/32 50	12 7/16 316	6 5/16 160	4.961 126	2.008 51	1 1/4 M33	UCP324	P324	UC324	55.4	207	185	13.5	–	–	–	–	–	UCP324C	UCP324CD	196	7 23/32	64.9
130	–	7 3/32 180	23 5/8 600	5 1/2 140	18 29/32 480	1 9/16 40	2 5/32 55	1 31/32 50	13 21/32 355	7 11/16 195	5.315 135	2.126 54	1 1/4 M33	UCP326	P326	UC326	72.1	229	214	13.6	–	–	–	–	–	UCP326C	UCP326CD	214	8 7/16	84.2
140	–	7 7/8 200	24 13/32 620	5 1/2 140	19 11/16 500	1 9/16 40	2 5/32 55	2 3/8 60	15 15/32 393	7 9/32 185	5.709 145	2.323 59	1 1/4 M33	UCP328	P328	UC328	92.5	253	246	13.6	–	–	–	–	–	UCP328C	UCP328CD	222	8 3/4	108

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210, X05~X09, 305~308
A-PT1/8 .... 211~218, X10~X20, 309~328
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (or L2) follows the Part No. of unit or bearing. (Example of Part No. : UCP206JL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.
5. Representative examples of the forms of housing are indicated.

NAP
Cylindrical bore
(with eccentric locking collar)
d 12 ~ 75 mm



Variations of tolerance of distance from mounting bottom to center of spherical bore (Δ_{Hs})

Unit : mm

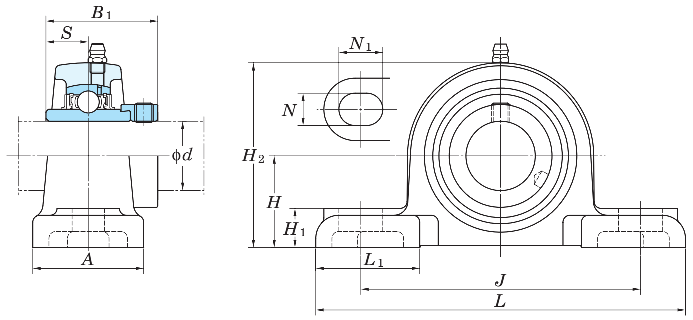
Housing No.	Δ_{Hs}
P203~P210	±0.15
P211~P215	±0.2

Shaft Dia.		Dimensions											Bolt Size	Unit No.	Housing No.	Bearing No.	Basic Load Ratings		Factor	Mass
mm	inch	inch mm											inch mm				kN			
d		H	L	A	J	N	N_1	H_1	H_2	L_1	B_1	S					C_r	C_{0r}	f_0	kg
12		1 3/16 30.2	5 127	1 1/2 38	3 3/4 95	1/2 13	23/32 18	15/32 12	2 3/8 60	1 1/2 38	1.720 43.7	0.673 17.1	3/8 M10	**NAP201**	P203	NA201	12.8	6.65	13.2	0.71
	1/2													**NAP201-8**		NA201-8				
15														**NAP202**		NA202				0.69
	5/8													**NAP202-10**		NA202-10				
17														**NAP203**		NA203				0.66
20	3/4	1 5/16 33.3	5 127	1 1/2 38	3 3/4 95	1/2 13	23/32 18	1/2 13	2 17/32 64	1 1/2 38	1.720 43.7	0.673 17.1	3/8 M10	**NAP204-12**	P204	NA204-12	12.8	6.65	13.2	0.73
														NAP204		NA204				
25	7/8	1 7/16 36.5	5 1/2 140	1 1/2 38	4 1/8 105	1/2 13	23/32 18	1/2 13	2 25/32 71	1 11/16 43	1.748 44.4	0.689 17.5	3/8 M10	**NAP205-14**	P205	NA205-14	14.0	7.85	13.9	0.87
	15/16													**NAP205-15**		NA205-15				
														NAP205		NA205				
	1													**NAP205-16**		NA205-16				
30	1 1/8	1 11/16 42.9	6 1/2 165	1 7/8 48	4 3/4 121	21/32 17	13/16 21	19/32 15	3 5/16 84	2 3/32 53	1.906 48.4	0.720 18.3	1/2 M14	**NAP206-18**	P206	NA206-18	19.5	11.3	13.9	1.4
														NAP206		NA206				
	1 3/16													**NAP206-19**		NA206-19				
	1 1/4													**NAP206-20**		NA206-20				
35	1 1/4	1 7/8 47.6	6 9/16 167	1 7/8 48	5 127	21/32 17	13/16 21	5/8 16	3 21/32 93	2 51	2.012 51.1	0.740 18.8	1/2 M14	**NAP207-20**	P207	NA207-20	25.7	15.4	13.9	1.8
	1 5/16													**NAP207-21**		NA207-21				
	1 3/8													**NAP207-22**		NA207-22				
														NAP207		NA207				
	1 7/16													**NAP207-23**		NA207-23				
40	1 1/2	1 15/16 49.2	7 1/4 184	2 1/8 54	5 13/32 137	21/32 17	13/16 21	21/32 17	3 27/32 98	2 1/4 57	2.217 56.3	0.843 21.4	1/2 M14	**NAP208-24**	P208	NA208-24	29.1	17.8	14.0	2.1
	1 9/16													**NAP208-25**		NA208-25				
														NAP208		NA208				
45	1 5/8	2 1/8 54	7 15/32 190	2 1/8 54	5 3/4 146	21/32 17	13/16 21	21/32 17	4 3/16 106	2 3/8 60	2.217 56.3	0.843 21.4	1/2 M14	**NAP209-26**	P209	NA209-26	34.1	21.3	14.0	2.4
	1 11/16													**NAP209-27**		NA209-27				
	1 3/4													**NAP209-28**		NA209-28				
														NAP209		NA209				
50	1 7/8	2 1/4 57.2	8 1/8 206	2 3/8 60	6 1/4 159	25/32 20	7/8 22	3/4 19	4 7/16 113	2 15/32 63	2.469 62.7	0.969 24.6	5/8 M16	**NAP210-30**	P210	NA210-30	35.1	23.3	14.4	3.1
	1 15/16													**NAP210-31**		NA210-31				
														NAP210		NA210				
	2													**NAP210-32**		NA210-32				
55	2	2 1/2 63.5	8 5/8 219	2 3/8 60	6 23/32 171	25/32 20	7/8 22	3/4 19	4 29/32 125	2 3/4 70	2.811 71.4	1.094 27.8	5/8 M16	**NAP211-32**	P211	NA211-32	43.4	29.4	14.4	3.9
	2 1/8													**NAP211-34**		NA211-34				
														NAP211		NA211				
	2 3/16													**NAP211-35**		NA211-35				
60	2 1/4	2 3/4 69.8	9 1/2 241	2 3/4 70	7 1/4 184	25/32 20	31/32 25	7/8 22	5 7/16 138	3 76	3.063 77.8	1.220 31	5/8 M16	**NAP212-36**	P212	NA212-36	52.4	36.2	14.4	5.2
														NAP212		NA212				
	2 3/8													**NAP212-38**		NA212-38				
	2 7/16													**NAP212-39**		NA212-39				
65	2 1/2	3 76.2	10 7/16 265	2 3/4 70	8 203	31/32 25	1 3/16 30	31/32 25	5 29/32 150	3 1/16 78	3.374 85.7	1.343 34.1	3/4 M20	**NAP213-40**	P213	NA213-40	57.2	40.1	14.4	6.5
														NAP213		NA213				
70	2 3/4	3 1/8 79.4	10 15/32 266	2 27/32 72	8 9/32 210	31/32 25	1 3/16 30	1 3/32 28	6 5/32 156	3 1/16 78	3.374 85.7	1.343 34.1	3/4 M20	**NAP214-44**	P214	NA214-44	62.2	44.1	14.5	7.7
														NAP214		NA214				
75	2 15/16	3 1/4 82.6	10 13/16 275	2 29/32 74	8 17/32 217	31/32 25	1 3/16 30	1 3/32 28	6 3/8 162	3 5/32 80	3.626 92.1	1.469 37.3	3/4 M20	**NAP215-47**	P215	NA215-47	67.4	48.3	14.5	7.9
														NAP215		NA215				

Remarks 1. In Part No. of unit, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210
A-PT1/8 .... 211~215

3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (or L2) follows the Part No. of unit or bearing. (Example of Part No. : NAP206JL3, NA206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.
5. Representative examples of the forms of housing are indicated.

NAPK
Cylindrical bore
(with eccentric locking collar)
d 12 ~ 75 mm



Variations of tolerance of distance from mounting bottom to center of spherical bore (Δ_{Hs})

Unit : mm

Housing No.	Δ_{Hs}
PK204~PK210	±0.15
PK211~PK215	±0.2

Shaft Dia mm (d)	Shaft Dia inch (d)	Dimensions inch / mm H	L	A	J	N	N_1	H_1	H_2	L_1	B_1	S	Bolt Size inch	Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN C_r	C_{0r}	Factor f_0	Mass kg
12		1 1/4 31.8	5 1/4 133	1 5/8 41	3 27/32 98	7/16 11	9/16 14	9/16 14	2 15/32 63	1 25/32 45	1.72 43.7	0.673 17.1	3/8	**NAPK201**	PK204	NA201	12.8	6.65	13.2	0.82
	1/2													**NAPK201-8**		NA201-8				
15														**NAPK202**		NA202				
	5/8													**NAPK202-10**		NA202-10				
17														**NAPK203**		NA203				
	3/4													**NAPK204-12**		NA204-12				
20														**NAPK204**		NA204				
	7/8	1 5/16 33.3	5 1/2 140	1 23/32 44	4 1/8 105	7/16 11	9/16 14	5/8 16	2 11/16 68	1 25/32 45	1.748 44.4	0.689 17.5	3/8	**NAPK205-14**	PK205	NA205-14	14.0	7.85	13.9	1
	15/16													**NAPK205-15**		NA205-15				
25														**NAPK205**		NA205				
	1													**NAPK205-16**		NA205-16				
	1 1/8	1 9/16 39.7	6 5/16 160	1 7/8 48	4 3/4 121	9/16 14	3/4 19	21/32 17	3 5/32 80	1 25/32 45	1.906 48.4	0.72 18.3	1/2	**NAPK206-18**	PK206	NA206-18	19.5	11.3	13.9	1.4
30														**NAPK206**		NA206				
	1 3/16													**NAPK206-19**		NA206-19				
	1 1/4													**NAPK206-20**		NA206-20				
	1 1/4	1 13/16 46	6 9/16 167	1 7/8 48	5 127	9/16 14	3/4 19	3/4 19	3 5/8 92	1 25/32 45	2.012 51.1	0.74 18.8	1/2	**NAPK207-20**	PK207	NA207-20	25.7	15.4	13.9	2
	1 5/16													**NAPK207-21**		NA207-21				
	1 3/8													**NAPK207-22**		NA207-22				
35														**NAPK207**		NA207				
	1 7/16													**NAPK207-23**		NA207-23				
	1 1/2	1 15/16 49.2	7 1/8 181	2 1/8 54	5 1/2 140	9/16 14	3/4 19	3/4 19	3 15/16 100	1 31/32 50	2.217 56.3	0.843 21.4	1/2	**NAPK208-24**	PK208	NA208-24	29.1	17.8	14.0	2.5
	1 9/16													**NAPK208-25**		NA208-25				
40														**NAPK208**		NA208				
	1 5/8	2 1/16 52.4	7 15/32 190	2 1/8 54	5 3/4 146	9/16 14	3/4 19	25/32 20	4 3/16 106	2 1/16 52	2.217 56.3	0.843 21.4	1/2	**NAPK209-26**	PK209	NA209-26	34.1	21.3	14.0	2.7
	1 11/16													**NAPK209-27**		NA209-27				
	1 3/4													**NAPK209-28**		NA209-28				
45														**NAPK209**		NA209				
	1 7/8	2 3/16 55.6	8 203	2 1/4 57	6 1/4 159	9/16 14	3/4 19	7/8 22	4 13/32 112	25/32 55	2.469 62.7	0.969 24.6	1/2	**NAPK210-30**	PK210	NA210-30	35.1	23.3	14.4	3.2
	1 15/16													**NAPK210-31**		NA210-31				
50														**NAPK210**		NA210				
	2													**NAPK210-32**		NA210-32				
	2	2 7/16 61.9	9 1/8 232	2 3/8 60	7 1/8 181	23/32 18	15/16 24	31/32 25	4 7/8 124	2 19/32 66	2.811 71.4	1.094 27.8	5/8	**NAPK211-32**	PK211	NA211-32	43.4	29.4	14.4	4.6
	2 1/8													**NAPK211-34**		NA211-34				
55														**NAPK211**		NA211				
	2 3/16													**NAPK211-35**		NA211-35				
	2 1/4	2 11/16 68.3	9 1/2 241	2 17/32 64	7 17/32 191	23/32 18	15/16 24	13/32 28	5 11/32 136	2 9/16 65	3.063 77.8	1.22 31	5/8	**NAPK212-36**	PK212	NA212-36	52.4	36.2	14.4	5.2
60														**NAPK212**		NA212				
	2 3/8													**NAPK212-38**		NA212-38				
	2 7/16													**NAPK212-39**		NA212-39				
	2 15/16	3 5/16 84.1	11 31/32 304	3 7/32 82	9 1/2 241	7/8 22	1/4 32	1 1/2 38	6 1/2 165	3 7/16 87	3.626 92.1	1.469 37.3	3/4	**NAPK215-47**	PK215	NA215-47	67.4	48.3	14.5	9.6
75														**NAPK215**		NA215				

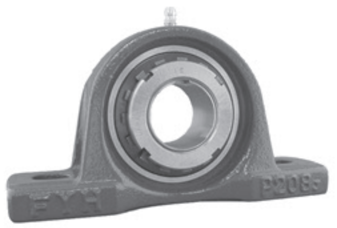
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210
A-PT1/8 .... 211~215

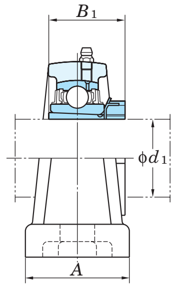
3. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.
4. Representative examples of the forms of housing are indicated.

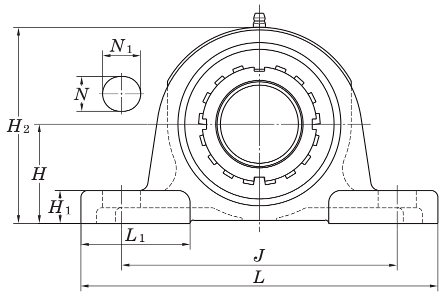
UKP

Tapered bore (with adapter)

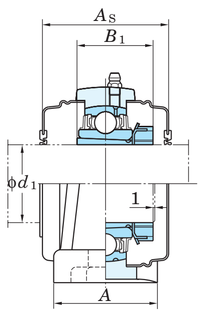
d_1 20 ~ (50) mm



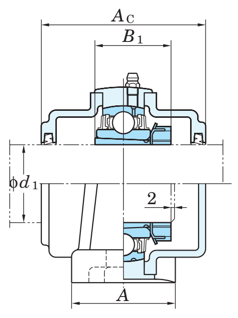




With Pressed Steel Cover



With Cast Iron Cover

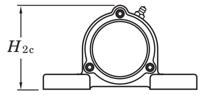


Variations of tolerance of distance from mounting bottom to center of spherical bore (Δ_{Hs})

Unit : mm

Housing No.			Δ_{Hs}
P205~P210	PX05~PX10	P305~P310	±0.15
P211~P218	PX11~PX18	P311~P318	±0.2
	PX20	P319~P328	±0.3

Forms and dimensions of H_{2c} of P205JE3 (housing with cast iron cover) are shown below.



P205JE3 H_{2c} = 77 mm

Shaft Dia.		Dimensions										Bolt Size	Standard					Basic Load Ratings		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm	inch	inch mm										inch mm	Unit No.	Housing No.	Bearing No.	Adapter 1) No.	Mass kg	kN			Unit No.		Dimension		Mass kg	Unit No.		Dimension		Mass kg
d_1		H	L	A	J	N	N_1	H_1	H_2	L_1	B_1 1)							C_r	C_{0r}	f_0	Open Type	One Side Closed Type	mm A_s	inch		Open Type	One Side Closed Type	mm A_c	inch	
20	3/4	1 7/16 36.5	5 1/2 140	1 1/2 38	4 1/8 105	1/2 13	23/32 18	1/2 13	2 25/32 71	1 11/16 43	1 5/32(1 3/8) 29(35)	3/8 M10	UKP205	P205	UK205	HE305X(HE2305X) H305X(H2305X)	0.84 0.84	14.0	7.85	13.9	– UKP205C	– UKP205CD	– 48	– 1 7/8	– 0.84	– UKP205FC	– UKP205FCD	– 66	– 2 19/32	– 1.3
	3/4	1 3/4 44.4	6 1/4 159	2 51	4 11/16 119	21/32 17	31/32 25	5/8 16	3 3/8 86	1 27/32 47	1 3/8 35	1/2 M14	UKPX05	PX05	UKX05	HE2305X H2305X	1.5 1.5	19.5	11.3	13.9	– UKPX05C	– UKPX05CD	– 52	– 2 1/16	– 1.5	– –	– –	– –	– –	– –
	3/4	1 49/64 45	6 7/8 175	1 3/4 45	5 3/16 132	21/32 17	25/32 20	5/8 16	3 11/32 85	2 5/32 55	1 3/8 35	1/2 M14	UKP305	P305	UK305	HE2305X H2305X	1.7 1.7	21.2	10.9	12.6	– –	– –	– –	– –	– –	– UKP305C	– UKP305CD	– 76	– 3	– 2.3
25	1	1 11/16 42.9	6 1/2 165	1 7/8 48	4 3/4 121	21/32 17	13/16 21	19/32 15	3 5/16 84	2 3/32 53	1 7/32(1 1/2) 31(38)	1/2 M14	UKP206	P206	UK206	H306X(H2306X) HE306X(HE2306X)	1.4 1.4	19.5	11.3	13.9	UKP206C –	UKP206CD –	52 –	2 1/16 –	1.4 –	UKP206FC –	UKP206FCD –	70 –	2 3/4 –	1.9 –
	1	1 7/8 47.6	6 7/8 175	2 1/4 57	5 127	21/32 17	31/32 25	21/32 17	3 21/32 93	2 5/32 55	1 1/2 38	1/2 M14	UKPX06	PX06	UKX06	H2306X HE2306X	2.1 2.1	25.7	15.4	13.9	UKPX06C –	UKPX06CD –	59 –	2 5/16 –	2.1 –	– –	– –	– –	– –	– –
	1	1 31/32 50	7 3/32 180	1 31/32 50	5 1/2 140	21/32 17	25/32 20	21/32 17	3 3/4 95	2 3/32 53	1 1/2 38	1/2 M14	UKP306	P306	UK306	H2306X HE2306X	2.3 2.3	26.7	15.0	13.3	– –	– –	– –	– –	– –	UKP306C –	UKP306CD –	82 –	3 7/32 –	2.9 –
30	1 1/8	1 7/8 47.6	6 9/16 167	1 7/8 48	5 127	21/32 17	13/16 21	5/8 16	3 21/32 93	2 51	1 3/8(1 11/16) 35(43)	1/2 M14	UKP207	P207	UK207	HS307X(HS2307X) H307X(H2307X)	1.7 1.7	25.7	15.4	13.9	– UKP207C	– UKP207CD	– 59	– 2 5/16	– 1.7	– UKP207FC	– UKP207FCD	– 78	– 3 1/16	– 2.5
	1 1/8	2 1/8 54	8 203	2 1/4 57	5 11/16 144	21/32 17	1 3/16 30	3/4 19	4 1/8 105	2 17/32 64	1 11/16 43	1/2 M14	UKPX07	PX07	UKX07	HS2307X H2307X	2.7 2.7	29.1	17.8	14.0	– UKPX07C	– UKPX07CD	– 68	– 2 11/16	– 2.7	– –	– –	– –	–	– –
	1 1/8	2 13/64 56	8 9/32 210	2 7/32 56	6 5/16 160	21/32 17	31/32 25	3/4 19	4 7/32 107	2 9/16 65	1 11/16 43	1/2 M14	UKP307	P307	UK307	HS2307X H2307X	3.0 3.0	33.4	19.3	13.2	– –	– –	– –	– –	– –	– UKP307C	– UKP307CD	– 88	– 3 15/32	– 3.9
35	1 1/4 1 3/8	1 15/16 49.2	7 1/4 184	2 1/8 54	5 13/32 137	21/32 17	13/16 21	21/32 17	3 27/32 98	2 1/4 57	1 13/32(1 13/16) 36(46)	1/2 M14	UKP208	P208	UK208	HE308X(HE2308X) HS308X(HS2308X) H308X(H2308X)	2.0 2.0 2.0	29.1	17.8	14.0	– – UKP208C	– – UKP208CD	– – 68	– – 2 11/16	– – 2.0	– – UKP208FC	– – UKP208FCD	– – 86	– – 3 3/8	– – 2.9
	1 1/4 1 3/8	2 5/16 58.7	8 3/4 222	2 5/8 67	6 1/8 156	25/32 20	1 1/4 32	13/16 21	4 1/2 114	2 25/32 71	1 13/16 46	5/8 M16	UKPX08	PX08	UKX08	HE2308X HS2308X H2308X	3.5 3.5 3.5	34.1	21.3	14.0	– – UKPX08C	– – UKPX08CD	– – 68	– – 2 11/16	– – 3.5	– – –	– – –	– – –	– – –	– – –
	1 1/4 1 3/8	2 23/64 60	8 21/32 220	2 3/8 60	6 11/16 170	21/32 17	1 1/16 27	3/4 19	4 21/32 118	2 9/16 65	1 13/16 46	1/2 M14	UKP308	P308	UK308	HE2308X HS2308X H2308X	3.8 3.8 3.8	40.7	24.0	13.2	– – –	– – –	– – –	– – –	– – –	– – UKP308C	– – UKP308CD	– – 96	– – 3 25/32	– – 5.2
40	1 1/2 1 5/8	2 1/8 54	7 15/32 190	2 1/8 54	5 3/4 146	21/32 17	13/16 21	21/32 17	4 3/16 106	2 3/8 60	1 17/32(1 31/32) 39(50)	1/2 M14	UKP209	P209	UK209	HE309X(HE2309X) H309X(H2309X) HS309X(HS2309X)	2.3 2.3 2.3	34.1	21.3	14.0	– UKP209C –	– UKP209CD –	– 68 –	– 2 11/16 –	– 2.3 –	– UKP209FC –	– UKP209FCD –	– 88 –	– 3 15/32 –	– 3.2 –
	1 1/2 1 5/8	2 5/16 58.7	8 3/4 222	2 5/8 67	6 1/8 156	25/32 20	1 5/16 33	13/16 21	4 9/16 116	2 25/32 71	1 31/32 50	5/8 M16	UKPX09	PX09	UKX09	HE2309X H2309X HS2309X	3.7 3.7 3.7	35.1	23.3	14.4	– UKPX09C –	– UKPX09CD –	– 73 –	– 2 7/8 –	– 3.7 –	– – –	– – –	– – –	– – –	– – –
	1 1/2 1 5/8	2 41/64 67	9 21/32 245	2 5/8 67	7 15/32 190	25/32 20	1 3/16 30	13/16 21	5 3/16 132	2 15/16 75	1 31/32 50	5/8 M16	UKP309	P309	UK309	HE2309X H2309X HS2309X	5.0 5.0 5.0	48.9	29.5	13.3	– – –	– – –	– – –	– – –	– – –	– UKP309C –	– UKP309CD –	– 102 –	– 4 1/32 –	– 6.3 –
45	1 3/4	2 1/4 57.2	8 1/8 206	2 3/8 60	6 1/4 159	25/32 20	7/8 22	3/4 19	4 7/16 113	2 15/32 63	1 21/32(2 5/32) 42(55)	5/8 M16	UKP210	P210	UK210	HE310X(HE2310X) H310X(H2310X)	3.0 3.0	35.1	23.3	14.4	– UKP210C	– UKP210CD	– 73	– 2 7/8	– 3.0	– UKP210FC	– UKP210FCD	– 97	– 3 13/16	– 4.1
	1 3/4	2 1/2 63.5	9 1/2 241	2 7/8 73	6 23/32 171	25/32 20	1 13/32 36	7/8 22	4 31/32 126	3 76	2 5/32 55	5/8 M16	UKPX10	PX10	UKX10	HE2310X H2310X	4.6 4.6	43.4	29.4	14.4	– UKPX10C	– UKPX10CD	– 75	– 2 15/16	– 4.6	– –	– –	– –	– –	– –
	1 3/4	2 61/64 75	10 13/16 275	2 15/16 75	8 11/32 212	25/32 20	1 3/8 35	15/16 24	5 13/16 148	3 15/32 88	2 5/32 55	5/8 M16	UKP310	P310	UK310	HE2310X H2310X	6.7 6.7	62.0	38.3	13.2	– –	– –	– –	– –	– –	– UKP310C	– UKP310CD	– 110	– 4 11/32	– 8.4
50	1 7/8 2	2 1/2 63.5	8 5/8 219	2 3/8 60	6 23/32 171	25/32 20	7/8 22	3/4 19	4 29/32 125	2 3/4 70	1 25/32(2 5/16) 45(59)	5/8 M16	UKP211	P211	UK211	HS311X(HS2311X) H311X(H2311X) HE311X(HE2311X)	3.7 3.7 3.7	43.4	29.4	14.4	– UKP211C –	– UKP211CD –	– 75 –	– 2 15/16 –	– 3.7 –	– UKP211FC –	– UKP211FCD –	– 99 –	– 3 29/32 –	– 5.0 –

Note 1) Codes shown in parentheses indicate the dimensions and Part No. of applicable adapter (H2300X series) for UK200L3 series (triple seal type).

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF........205~210, X05~X09, 305~308
A-PT1/8................211~218, X10~X20, 309~328

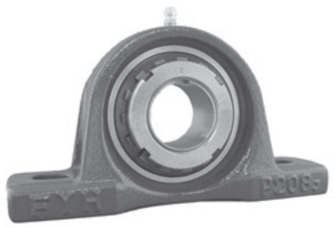
3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables. (Example of Part No. : UKP206J + H306X, UK206 + H306X)

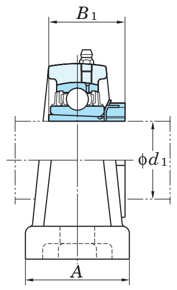
4. As for the triple seal type product (205 is the double seal type product), accessory code L3 (or L2) follows the Part No. of unit or bearing.

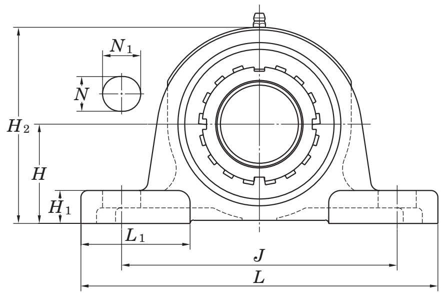
5. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

6. Representative examples of the forms of housing are indicated.

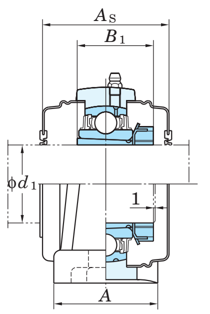
UKP
Tapered bore (with adapter)
d_1 (50) ~ 85 mm



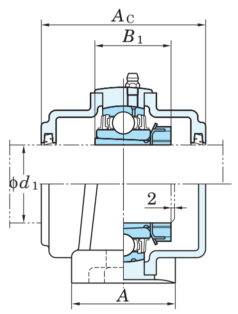




With Pressed Steel Cover



With Cast Iron Cover

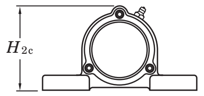


Variations of tolerance of distance from mounting bottom to center of spherical bore ($\varDelta_{Hs}$)

Unit : mm

Housing No.			$\varDelta_{Hs}$
P205~P210	PX05~PX10	P305~P310	±0.15
P211~P218	PX11~PX18	P311~P318	±0.2
	PX20	P319~P328	±0.3

Forms and dimensions of H_{2c} of P205JE3 (housing with cast iron cover) are shown below.



P205JE3 H_{2c} = 77 mm

Shaft Dia. mm d_1	Shaft Dia. inch d_1	Dimensions inch / mm H	L	A	J	N	N_1	H_1	H_2	L_1	B_1 [1]	Bolt Size inch / mm	Standard Unit No.	Housing No.	Bearing No.	Adapter [1] No.	Mass kg	Basic Load Ratings kN C_r	C_{0r}	Factor f_0	With Pressed Steel Cover Unit No. Open Type	One Side Closed Type	Dimension A_s mm	A_s inch	Mass kg	With Cast Iron Cover Unit No. Open Type	One Side Closed Type	Dimension A_c mm	A_c inch	Mass kg
50	1 7/8 2	2 3/4 69.8	10 1/4 260	3 1/8 79	7 1/4 184	31/32 25	1 13/32 36	1 3/32 28	5 15/32 139	3 9/32 83	2 5/16 59	3/4 M20	UKPX11	PX11	UKX11	HS2311X H2311X HE2311X	6.2 6.2 6.2	52.4	36.2	14.4	– UKPX11C –	– UKPX11CD –	– 88 –	– 3 15/32 –	– 6.2 –	– – –	– – –	– – –	– – –	– – –
	1 7/8 2	3 5/32 80	12 7/32 310	3 5/32 80	9 9/32 236	25/32 20	1 1/2 38	1 1/16 27	6 7/32 158	3 17/32 90	2 5/16 59	5/8 M16	UKP311	P311	UK311	HS2311X H2311X HE2311X	8.1 8.1 8.1	71.6	45.0	13.2	– – –	– – –	– – –	– – –	– – –	– UKP311C –	– UKP311CD –	– 114 –	– 4 1/2 –	– 10.0 –
55	2 1/8	2 3/4 69.8	9 1/2 241	2 3/4 70	7 1/4 184	25/32 20	31/32 25	7/8 22	5 7/16 138	3 76	1 27/32(2 7/16) 47(62)	5/8 M16	UKP212	P212	UK212	HS312X(HS2312X) H312X(H2313X)	4.8 4.8	52.4	36.2	14.4	– UKP212C	– UKP212CD	– 88	– 3 15/32	– 4.8	– UKP212FC	– UKP212FCD	– 114	– 4 1/2	– 6.3
	2 1/8	3 76.2	11 1/4 286	3 1/4 83	8 203	31/32 25	1 9/16 40	1 3/32 28	5 31/32 152	3 15/32 88	2 7/16 62	3/4 M20	UKPX12	PX12	UKX12	HS2312X H2312X	7.5 7.5	57.2	40.1	14.4	– UKPX12C	– UKPX12CD	– 88	– 3 15/32	– 7.5	– –	– –	– –	– –	– –
	2 1/8	3 11/32 85	13 330	3 11/32 85	9 27/32 250	31/32 25	1 1/2 38	1 5/32 29	6 9/16 167	4 1/16 103	2 7/16 62	3/4 M20	UKP312	P312	UK312	HS2312X H2312X	9.4 9.4	81.9	52.2	13.2	– –	– –	– –	– –	– –	– UKP312C	– UKP312CD	– 124	– 4 7/8	– 11.8
60	2 1/4 2 3/8	3 76.2	10 7/16 265	2 3/4 70	8 203	31/32 25	1 3/16 30	31/32 25	5 29/32 150	3 1/16 78	1 31/32(2 9/16) 50(65)	3/4 M20	UKP213	P213	UK213	HE313X(HE2313X) H313X(H2313X) HS313X(HS2313X)	5.8 5.8 5.8	57.2	40.1	14.4	– UKP213C –	– UKP213CD –	– 88 –	– 3 15/32 –	– 5.8 –	– UKP213FC –	– UKP213FCD –	– 114 –	– 4 1/2 –	– 7.5 –
	2 1/4 2 3/8	3 76.2	11 1/4 286	3 1/4 83	8 203	31/32 25	1 9/16 40	1 3/32 28	6 3/32 155	3 15/32 88	2 9/16 65	3/4 M20	UKPX13	PX13	UKX13	HE2313X H2313X HS2313X	7.8 7.8 7.8	62.2	44.1	14.5	– UKPX13C –	– UKPX13CD –	– 98 –	– 3 27/32 –	– 7.8 –	– – –	– – –	– – –	– – –	– – –
	2 1/4 2 3/8	3 35/64 90	13 3/8 340	3 17/32 90	10 1/4 260	31/32 25	1 1/2 38	1 1/4 32	6 15/16 176	4 11/32 110	2 9/16 65	3/4 M20	UKP313	P313	UK313	HE2313X H2313X HS2313X	10.8 10.8 10.8	92.7	59.9	13.2	– – –	– – –	– – –	– – –	– – –	– UKP313C –	– UKP313CD –	– 122 –	– 4 13/16 –	– 13.2 –
65	2 1/2	3 1/4 82.6	10 13/16 275	2 29/32 74	8 17/32 217	31/32 25	1 3/16 30	1 3/32 28	6 3/8 162	3 5/32 80	2 5/32(2 7/8) 55(73)	3/4 M20	UKP215	P215	UK215	HE315X(HE2315X) H315X(H2315X)	7.5 7.5	67.4	48.3	14.5	– UKP215C	– UKP215CD	– 98	– 3 27/32	– 7.5	– UKP215FC	– UKP215FCD	– 124	– 4 7/8	– 9.5
	2 1/2	3 1/2 88.9	13 330	3 1/2 89	9 229	1 1/16 27	1 31/32 50	1 1/4 32	6 7/8 175	3 29/32 99	2 7/8 73	7/8 M22	UKPX15	PX15	UKX15	HE2315X H2315X	10.5 10.5	72.7	53.0	14.6	– UKPX15C	– UKPX15CD	– 108	– 4 1/4	– 10.5	– –	– –	– –	–	– –
	2 1/2	3 15/16 100	14 31/32 380	3 15/16 100	11 13/32 290	1 1/16 27	1 9/16 40	1 3/8 35	7 25/32 198	4 7/32 107	2 7/8 73	7/8 M22	UKP315	P315	UK315	HE2315X H2315X	14.9 14.9	113	77.2	13.2	– –	– –	– –	– –	– –	– UKP315C	– UKP315CD	– 134	– 5 9/32	– 17.7
70	2 3/4	3 1/2 88.9	11 1/2 292	3 1/16 78	9 1/8 232	31/32 25	1 3/8 35	1 1/4 32	6 27/32 174	3 3/8 86	2 5/16(3 1/16) 59(78)	3/4 M20	UKP216	P216	UK216	HE316X(HE2316X) H316X(H2316X)	9.2 9.2	72.7	53.0	14.6	– UKP216C	– UKP216CD	– 108	– 4 1/4	– 9.2	– UKP216FC	– UKP216FCD	– 138	– 5 7/16	– 11.7
	2 3/4	4 101.6	15 381	4 102	11 1/8 283	1 1/16 27	2 9/32 58	1 11/32 34	7 11/16 195	4 9/16 116	3 1/16 78	7/8 M22	UKPX16	PX16	UKX16	HE2316X H2316X	15.4 15.4	84.0	61.9	14.5	– UKPX16C	– UKPX16CD	– 112	– 4 13/32	– 15.4	– –	– –	– –	– –	– –
	2 3/4	4 11/64 106	15 3/4 400	4 11/32 110	11 13/16 300	1 1/16 27	1 9/16 40	1 3/8 35	8 7/32 209	4 23/32 120	3 1/16 78	7/8 M22	UKP316	P316	UK316	HE2316X H2316X	18.6 18.6	123	86.7	13.3	– –	– –	– –	– –	– –	– UKP316C	– UKP316CD	– 138	– 5 7/16	– 21.7
75	3	3 3/4 95.2	12 7/32 310	3 9/32 83	9 23/32 247	31/32 25	1 9/16 40	1 1/4 32	7 9/32 185	3 17/32 90	2 15/32(3 7/32) 63(82)	3/4 M20	UKP217	P217	UK217	H317X(H2317X) HE317X(HE2317X)	11.0 11.0	84.0	61.9	14.5	UKP217C –	UKP217CD –	112 –	4 13/32 –	11.0 –	UKP217FC –	UKP217FCD –	142 –	5 19/32 –	13.8 –
	3	4 101.6	15 381	4 102	11 1/8 283	1 1/16 27	2 3/8 60	1 11/32 34	7 7/8 200	4 9/16 116	3 7/32 82	7/8 M22	UKPX17	PX17	UKX17	H2317X HE2317X	15.8 15.8	96.1	71.5	14.5	UKPX17C –	UKPX17CD –	122 –	4 13/16 –	15.8 –	– –	– –	– –	– –	– –
	3	4 13/32 112	16 17/32 420	4 11/32 110	12 19/32 320	1 5/16 33	1 25/32 45	1 9/16 40	8 21/32 220	4 23/32 120	3 7/32 82	1 M27	UKP317	P317	UK317	H2317X HE2317X	20.2 20.2	133	96.8	13.3	– –	– –	– –	– –	– –	UKP317C –	UKP317CD –	146 –	5 3/4 –	23.7 –
80	–	4 101.6	12 7/8 327	3 15/32 88	10 5/16 262	1 1/16 27	1 25/32 45	1 11/32 34	7 25/32 198	4 3/32 104	2 9/16(3 3/8) 65(86)	7/8 M22	UKP218	P218	UK218	H318X(H2318X)	13.8	96.1	71.5	14.5	UKP218C	UKP218CD	122	4 13/16	13.8	UKP218FC	UKP218FCD	152	6	18.8
	–	4 101.6	15 381	4 3/8 111	11 1/8 283	1 1/16 27	2 3/8 60	1 1/2 38	8 1/32 204	4 9/16 116	3 3/8 86	7/8 M22	UKPX18	PX18	UKX18	H2318X	18.6	109	81.9	14.4	–	–	–	–	–	UKPX18C	UKPX18CD	158	6 7/32	22.4
	–	4 41/64 118	16 15/16 430	4 11/32 110	13 330	1 5/16 33	1 25/32 45	1 9/16 40	9 7/32 234	4 23/32 120	3 3/8 86	1 M27	UKP318	P318	UK318	H2318X	22.8	143	107	13.3	–	–	–	–	–	UKP318C	UKP318CD	150	5 29/32	27.0
85	3 1/4	4 59/64 125	18 1/2 470	4 23/32 120	14 3/16 360	1 13/32 36	1 31/32 50	1 13/16 46	9 3/4 248	4 29/32 125	3 17/32 90	1 1/8 M30	UKP319	P319	UK319	HE2319X H2319X	29.3 29.3	153	119	13.3	– –	– –	– –	– –	– –	– UKP319C	– UKP319CD	– 162	– 6 3/8	– 34.0

Note 1) Codes shown in parentheses indicate the dimensions and Part No. of applicable adapter (H2300X series) for UK200L3 series (triple seal type).

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF........205~210, X05~X09, 305~308
A-PT1/8...............211~218, X10~X20, 309~328

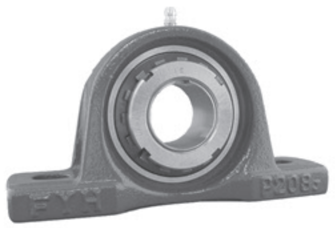
3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables. (Example of Part No. : UKP206J + H306X, UK206 + H306X)

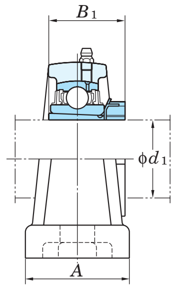
4. As for the triple seal type product (205 is the double seal type product), accessory code L3 (or L2) follows the Part No. of unit or bearing.

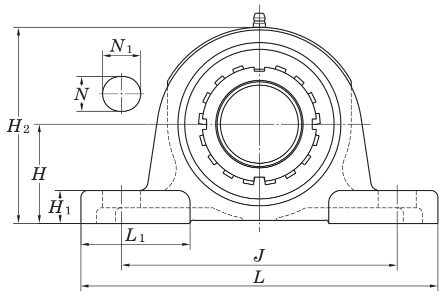
5. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

6. Representative examples of the forms of housing are indicated.

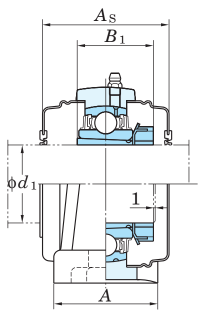
UKP
Tapered bore (with adapter)
d_1 90 ~ 125 mm



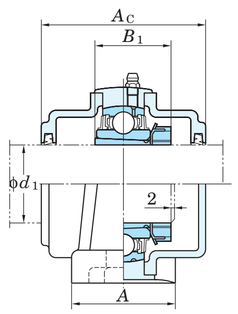




With Pressed Steel Cover



With Cast Iron Cover

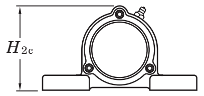


Variations of tolerance of distance from mounting bottom to center of spherical bore ($\varDelta_{Hs}$)

Unit : mm

Housing No.			$\varDelta_{Hs}$
P205~P210	PX05~PX10	P305~P310	±0.15
P211~P218	PX11~PX18	P311~P318	±0.2
	PX20	P319~P328	±0.3

Forms and dimensions of H_{2c} of P205JE3 (housing with cast iron cover) are shown below.



P205JE3 $H_{2c} = 77$ mm

Shaft Dia.		Dimensions										Bolt Size	Standard					Basic Load Ratings		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm	inch	inch mm										inch mm	Unit No.	Housing No.	Bearing No.	Adapter 1) No.	Mass	kN			Unit No.		Dimension mm inch		Mass	Unit No.		Dimension mm inch		Mass
d_1		H	L	A	J	N	N_1	H_1	H_2	L_1	B_1 1)						kg	C_r	C_{0r}	f_0	Open Type	One Side Closed Type	A_s		kg	Open Type	One Side Closed Type	A_c		kg
90	3 1/2	5	17	4 3/4	13 1/4	1 5/16	2 9/16	1 25/32	9 21/32	4 31/32	3 13/16	1	**UKPX20**	PX20	UKX20	HE2320X	29.3	133	105	14.4	–	–	–	–	–	–	–	–	–	–
		127	432	121	337	33	65	45	245	126	97	M27				H2320X	29.3				–	–	–	–	–	UKPX20C	UKPX20CD	186	7 5/16	34.3
	3 1/2	5 33/64	19 9/32	4 23/32	14 31/32	1 13/32	1 31/32	1 13/16	10 3/4	5 1/2	3 13/16	1 1/8	**UKP320**	P320	UK320	HE2320X	34.8	173	141	13.2	–	–	–	–	–	–	–	–	–	–
		140	490	120	380	36	50	46	273	140	97	M30				H2320X	34.8				–	–	–	–	–	UKP320C	UKP320CD	174	6 27/32	41.0
100		5 29/32	20 15/32	5 1/2	15 3/4	1 9/16	2 5/32	1 31/32	11 21/32	5 29/32	4 1/8	1 1/4	**UKP322**	P322	UK322	H2322X	43.9	205	180	13.2	–	–	–	–	–	UKP322C	UKP322CD	188	7 13/32	50.8
	4	150	520	140	400	40	55	50	296	150	105	M33				HE2322X	43.9				–	–	–	–	–	–	–	–	–	–
110	–	6 19/64	22 7/16	5 1/2	17 23/32	1 9/16	2 5/32	1 31/32	12 7/16	6 5/16	4 13/32	1 1/4	**UKP324**	P324	UK324	H2324	55.7	207	185	13.5	–	–	–	–	–	UKP324C	UKP324CD	196	7 23/32	66.0
		160	570	140	450	40	55	50	316	160	112	M33																		
115	4 1/2	7 3/32	23 5/8	5 1/2	18 29/32	1 9/16	2 5/32	1 31/32	13 21/32	7 11/16	4 3/4	1 1/4	**UKP326**	P326	UK326	HE2326	71.9	229	214	13.6	–	–	–	–	–	–	–	–	–	–
		180	600	140	480	40	55	50	355	195	121	M33				H2326	71.9				–	–	–	–	–	UKP326C	UKP326CD	214	8 7/16	85.2
125	–	7 7/8	24 13/32	5 1/2	19 11/16	1 9/16	2 5/32	2 3/8	15 15/32	7 9/32	5 5/32	1 1/4	**UKP328**	P328	UK328	H2328	92.5	253	246	13.6	–	–	–	–	–	UKP328C	UKP328CD	222	8 3/4	109
		200	620	140	500	40	55	60	393	185	131	M33																		

Note 1) Codes shown in parentheses indicate the dimensions and Part No. of applicable adapter (H2300X series) for UK200L3 series (triple seal type).

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF........205~210, X05~X09, 305~308
A-PT1/8................211~218, X10~X20, 309~328

3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables. (Example of Part No. : UKP206J + H306X, UK206 + H306X)

4. As for the triple seal type product (205 is the double seal type product), accessory code L3 (or L2) follows the Part No. of unit or bearing.

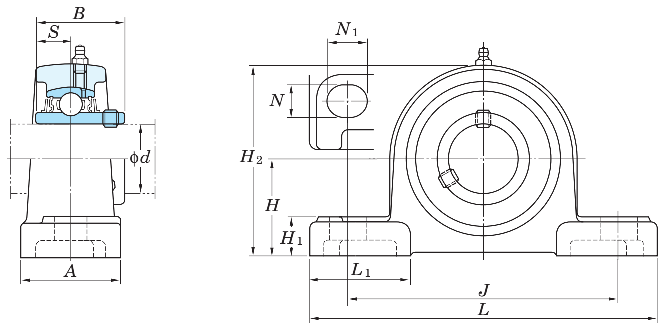
5. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

6. Representative examples of the forms of housing are indicated.

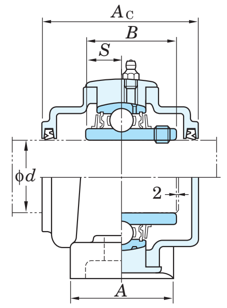
UCP-SC

Cylindrical bore (with set screws), cast steel housing

d 25 ~ 70 mm



With Cast Iron Cover



Variations of tolerance of distance from mounting bottom to center of spherical bore (Δ_{Hs})

Unit : mm

Housing No.		Δ_{Hs}
P205SC~P210SC	P310SC	±0.15
P211SC~P218SC	P311SC~P318SC	±0.2
	P319SC~P328SC	±0.3

Shaft Dia.		Dimensions inch mm											Bolt Size	Standard			Mass	Basic Load Ratings kN		Factor	With Cast Iron Cover				
d mm	inch	H	L	A	J	N	N_1	H_1	H_2	L_1	B	S	inch mm	Unit No.	Housing No.	Bearing No.	kg	C_r	C_{0r}	f_0	Unit No. Open Type	One Side Closed Type	Dimension A_c mm	inch	Mass kg
25	7/8	1 7/16 36.5	5 1/2 140	1 1/2 38	4 1/8 105	1/2 13	23/32 18	5/8 16	2 25/32 71	1 11/16 43	1.343 34.1	0.563 14.3	3/8 M10	**UCP205-14SC**	P205SC	UC205-14	0.90	14.0	7.85	13.9	–	–	–	–	–
	15/16													**UCP205-15SC**		UC205-15	0.90				–	–	–	–	–
														UCP205SC		UC205	0.90				–	–	–	–	–
	1													**UCP205-16SC**		UC205-16	0.90				–	–	–	–	–
30	1 1/8	1 11/16 42.9	6 1/2 165	1 7/8 48	4 3/4 121	21/32 17	13/16 21	23/32 18	3 3/8 86	2 3/32 53	1.500 38.1	0.626 15.9	1/2 M14	**UCP206-18SC**	P206SC	UC206-18	1.5	19.5	11.3	13.9	–	–	–	–	–
														UCP206SC		UC206	1.5				UCP206SCFC	UCP206SCFCD	70	2 3/4	2.0
	1 3/16													**UCP206-19SC**		UC206-19	1.5				–	–	–	–	–
	1 1/4													**UCP206-20SC**		UC206-20	1.5				–	–	–	–	–
35	1 1/4	1 7/8 47.6	6 9/16 167	1 7/8 48	5 127	21/32 17	13/16 21	3/4 19	3 25/32 96	2 51	1.689 42.9	0.689 17.5	1/2 M14	**UCP207-20SC**	P207SC	UC207-20	1.9	25.7	15.4	13.9	–	–	–	–	–
	1 5/16													**UCP207-21SC**		UC207-21	1.9				–	–	–	–	–
	1 3/8													**UCP207-22SC**		UC207-22	1.9				–	–	–	–	–
														UCP207SC		UC207	1.9				UCP207SCFC	UCP207SCFCD	78	3 1/16	2.6
	1 7/16													**UCP207-23SC**		UC207-23	1.9				–	–	–	–	–
40	1 1/2	1 15/16 49.2	7 1/4 184	2 1/8 54	5 13/32 137	21/32 17	13/16 21	3/4 19	3 15/16 100	2 1/4 57	1.937 49.2	0.748 19	1/2 M14	**UCP208-24SC**	P208SC	UC208-24	2.3	29.1	17.8	14.0	–	–	–	–	–
	1 9/16													**UCP208-25SC**		UC208-25	2.3				–	–	–	–	–
														UCP208SC		UC208	2.3				UCP208SCFC	UCP208SCFCD	86	3 3/8	3.1
45	1 5/8	2 1/8 54	7 15/32 190	2 1/8 54	5 3/4 146	21/32 17	13/16 21	25/32 20	4 1/4 108	2 3/8 60	1.937 49.2	0.748 19	1/2 M14	**UCP209-26SC**	P209SC	UC209-26	2.5	34.1	21.3	14.0	–	–	–	–	–
	1 11/16													**UCP209-27SC**		UC209-27	2.5				–	–	–	–	–
	1 3/4													**UCP209-28SC**		UC209-28	2.5				–	–	–	–	–
														UCP209SC		UC209	2.5				UCP209SCFC	UCP209SCFCD	88	3 15/32	3.3
50	1 7/8	2 1/4 57.2	8 1/8 206	2 3/8 60	6 1/4 159	25/32 20	7/8 22	7/8 22	4 17/32 115	2 15/32 63	2.031 51.6	0.748 19	5/8 M16	**UCP210-30SC**	P210SC	UC210-30	3.2	35.1	23.3	14.4	–	–	–	–	–
	1 15/16													**UCP210-31SC**		UC210-31	3.2				–	–	–	–	–
														UCP210SC		UC210	3.2				UCP210SCFC	UCP210SCFCD	97	3 13/16	4.2
	2													**UCP210-32SC**		UC210-32	3.2				–	–	–	–	–
	–	2 61/64 75	10 13/16 275	2 15/16 75	8 11/32 212	25/32 20	1 3/8 35	1 1/16 27	5 13/16 148	3 15/32 88	2.402 61	0.866 22	5/8 M16	**UCP310SC**	P310SC	UC310	9.2	62.0	38.3	13.2	UCP310SCC	UCP310SCCD	110	4 11/32	10.8
55	2	2 1/2 63.5	8 5/8 219	2 3/8 60	6 23/32 171	25/32 20	7/8 22	15/16 24	5 127	2 3/4 70	2.189 55.6	0.874 22.2	5/8 M16	**UCP211-32SC**	P211SC	UC211-32	4.0	43.4	29.4	14.4	–	–	–	–	–
	2 1/8													**UCP211-34SC**		UC211-34	4.0				–	–	–	–	–
														UCP211SC		UC211	4.0				UCP211SCFC	UCP211SCFCD	99	3 29/32	5.2
	2 3/16													**UCP211-35SC**		UC211-35	4.0				–	–	–	–	–
	2	3 5/32 80	12 7/32 310	3 5/32 80	9 9/32 236	25/32 20	1 1/2 38	1 3/16 30	6 7/32 158	3 17/32 90	2.598 66	0.984 25	5/8 M16	**UCP311-32SC**	P311SC	UC311-32	10.9	71.6	45.0	13.2	–	–	–	–	–
														UCP311SC		UC311	10.9				UCP311SCC	UCP311SCCD	114	4 1/2	12.7
60	2 1/4	2 3/4 69.8	9 1/2 241	2 3/4 70	7 1/4 184	25/32 20	31/32 25	31/32 25	5 15/32 139	3 76	2.563 65.1	1.000 25.4	5/8 M16	**UCP212-36SC**	P212SC	UC212-36	5.2	52.4	36.2	14.4	–	–	–	–	–
														UCP212SC		UC212	5.2				UCP212SCFC	UCP212SCFCD	114	4 1/2	6.7
	2 3/8													**UCP212-38SC**		UC212-38	5.2				–	–	–	–	–
	2 7/16													**UCP212-39SC**		UC212-39	5.2				–	–	–	–	–
	–	3 11/32 85	13 330	3 11/32 85	9 27/32 250	31/32 25	1 1/2 38	1 1/4 32	6 5/8 168	4 1/16 103	2.795 71	1.024 26	3/4 M20	**UCP312SC**	P312SC	UC312	12.6	81.9	52.2	13.2	UCP312SCC	UCP312SCCD	124	4 7/8	14.9
65	2 1/2	3 76.2	10 7/16 265	2 3/4 70	8 203	31/32 25	1 3/16 30	1 3/32 28	5 15/16 151	3 1/16 78	2.563 65.1	1.000 25.4	3/4 M20	**UCP213-40SC**	P213SC	UC213-40	6.4	57.2	40.1	14.4	–	–	–	–	–
														UCP213SC		UC213	6.4				UCP213SCFC	UCP213SCFCD	114	4 1/2	8.1
	2 1/2	3 35/64 90	13 3/8 340	3 17/32 90	10 1/4 260	31/32 25	1 1/2 38	1 3/8 35	7 178	4 11/32 110	2.953 75	1.181 30	3/4 M20	**UCP313-40SC**	P313SC	UC313-40	14.2	92.7	59.9	13.2	–	–	–	–	–
														UCP313SC		UC313	14.2				UCP313SCC	UCP313SCCD	122	4 13/16	16.3
70	2 3/4	3 1/8 79.4	10 15/32 266	2 27/32 72	8 9/32 210	31/32 25	1 3/16 30	1 3/32 28	6 3/16 157	3 1/16 78	2.937 74.6	1.189 30.2	3/4 M20	**UCP214-44SC**	P214SC	UC214-44	7.1	62.2	44.1	14.5	–	–	–	–	–
														UCP214SC		UC214	7.1				UCP214SCFC	UCP214SCFCD	124	4 7/8	9.0
	2 3/4	3 47/64 95	14 3/16 360	3 17/32 90	11 1/32 280	1 1/16 27	1 9/16 40	1 1/2 38	7 13/32 188	4 11/32 110	3.071 78	1.299 33	7/8 M22	**UCP314-44SC**	P314SC	UC314-44	14.9	104	68.2	13.2	–	–	–	–	–
														UCP314SC		UC314	14.9				UCP314SCC	UCP314SCCD	124	4 7/8	17.2

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 205~210
A-PT1/8 .... 211~218, 310~328

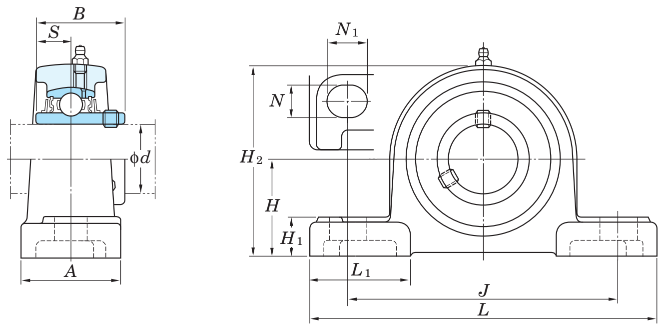
3. As for the triple seal type product (205 is the double seal type product), accessory code L3 (or L2) follows the Part No. of unit or bearing.
(Example of Part No. : UCP206JSCL3, UC206L3)

4. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit.

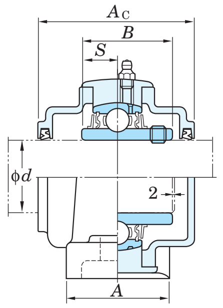
UCP-SC

Cylindrical bore (with set screws), cast steel housing

d 75 ~ 140 mm



With Cast Iron Cover



Variations of tolerance of distance from mounting bottom to center of spherical bore ($\varDelta_{Hs}$)

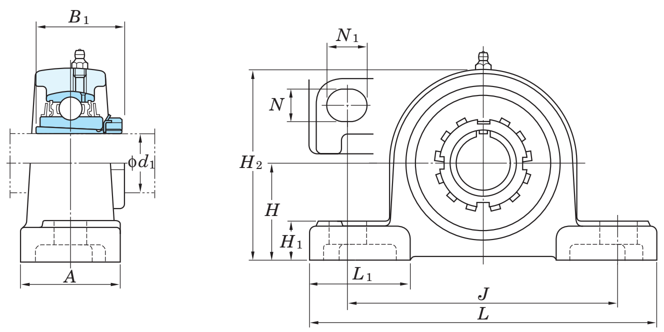
Unit : mm

Housing No.		$\varDelta_{Hs}$
P205SC~P210SC	P310SC	±0.15
P211SC~P218SC	P311SC~P318SC	±0.2
	P319SC~P328SC	±0.3

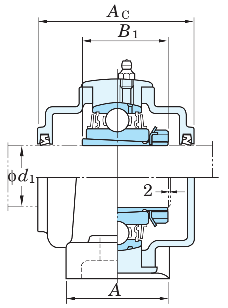
Shaft Dia. mm	Shaft Dia. inch	Dimensions inch mm											Bolt Size inch mm	Standard Unit No.	Housing No.	Bearing No.	Mass	Basic Load Ratings kN		Factor	With Cast Iron Cover Unit No. Open Type	One Side Closed Type	Dimension mm	inch	Mass
d		*H*	*L*	*A*	*J*	*N*	N_1	H_1	H_2	L_1	*B*	*S*					kg	C_r	C_{0r}	f_0			A_c		kg
75	2 15/16 3	3 1/4 82.6	10 13/16 275	2 29/32 74	8 17/32 217	31/32 25	1 3/16 30	1 5/32 29	6 15/32 164	3 5/32 80	3.063 77.8	1.311 33.3	3/4 M20	**UCP215-47SC** **UCP215SC** **UCP215-48SC**	P215SC	UC215-47 UC215 UC215-48	7.7 7.7 7.7	67.4	48.3	14.5	– UCP215SCFC –	– UCP215SCFCD –	– 124 –	– 4 7/8 –	– 9.6 –
	2 15/16 3	3 15/16 100	14 31/32 380	3 15/16 100	11 13/32 290	1 1/16 27	1 9/16 40	1 1/2 38	7 7/8 200	4 7/32 107	3.228 82	1.260 32	7/8 M22	**UCP315-47SC** **UCP315SC** **UCP315-48SC**	P315SC	UC315-47 UC315 UC315-48	20.7 20.7 20.7	113	77.2	13.2	– UCP315SCC –	– UCP315SCCD –	– 134 –	– 5 9/32 –	– 23.2 –
80	3 1/8	3 1/2 88.9	11 1/2 292	3 1/16 78	9 1/8 232	31/32 25	1 3/8 35	1 7/32 31	6 15/16 176	3 3/8 86	3.252 82.6	1.311 33.3	3/4 M20	**UCP216-50SC** **UCP216SC**	P216SC	UC216-50 UC216	9.3 9.3	72.7	53.0	14.6	– UCP216SCFC	– UCP216SCFCD	– 138	– 5 7/16	– 11.7
	–	4 11/64 106	15 3/4 400	4 11/32 110	11 13/16 300	1 1/16 27	1 9/16 40	1 1/2 38	8 5/16 211	4 23/32 120	3.386 86	1.339 34	7/8 M22	**UCP316SC**	P316SC	UC316	24.2	123	86.7	13.3	UCP316SCC	UCP316SCCD	138	5 7/16	27.1
85	3 1/4	3 3/4 95.2	12 7/32 310	3 9/32 83	9 23/32 247	31/32 25	1 9/16 40	1 5/16 33	7 13/32 188	3 17/32 90	3.374 85.7	1.343 34.1	3/4 M20	**UCP217-52SC** **UCP217SC**	P217SC	UC217-52 UC217	11.7 11.7	84.0	61.9	14.5	– UCP217SCFC	– UCP217SCFCD	– 142	– 5 19/32	– 14.4
	–	4 13/32 112	16 17/32 420	4 11/32 110	12 19/32 320	1 5/16 33	1 25/32 45	1 25/32 45	8 3/4 222	4 23/32 120	3.780 96	1.575 40	1 M27	**UCP317SC**	P317SC	UC317	28.4	133	96.8	13.3	UCP317SCC	UCP317SCCD	146	5 3/4	31.7
90	3 1/2	4 101.6	12 7/8 327	3 15/32 88	10 5/16 262	1 1/16 27	1 25/32 45	1 3/8 35	7 7/8 200	4 3/32 104	3.780 96	1.563 39.7	7/8 M22	**UCP218-56SC** **UCP218SC**	P218SC	UC218-56 UC218	13.5 13.5	96.1	71.5	14.5	– UCP218SCFC	– UCP218SCFCD	– 152	– 6	– 16.6
	3 1/2	4 41/64 118	16 15/16 430	4 11/32 110	13 330	1 5/16 33	1 25/32 45	1 25/32 45	9 7/32 234	4 23/32 120	3.780 96	1.575 40	1 M27	**UCP318-56SC** **UCP318SC**	P318SC	UC318-56 UC318	30.9 30.9	143	107	13.3	– UCP318SCC	– UCP318SCCD	– 150	– 5 29/32	– 34.7
95	–	4 59/64 125	18 1/2 470	4 23/32 120	14 3/16 360	1 13/32 36	1 31/32 50	2 51	9 3/4 248	4 29/32 125	4.055 103	1.614 41	1 1/8 M30	**UCP319SC**	P319SC	UC319	37.9	153	119	13.3	UCP319SCC	UCP319SCCD	162	6 3/8	42.2
100	3 15/16 4	5 33/64 140	19 9/32 490	4 23/32 120	14 31/32 380	1 13/32 36	1 31/32 50	2 51	10 3/4 273	5 1/2 140	4.252 108	1.654 42	1 1/8 M30	**UCP320SC** **UCP320-63SC** **UCP320-64SC**	P320SC	UC320 UC320-63 UC320-64	45.2 45.2 45.2	173	141	13.2	UCP320SCC – –	UCP320SCCD – –	174 – –	6 27/32 – –	50.8 – –
110	–	5 29/32 150	20 15/32 520	5 1/2 140	15 3/4 400	1 9/16 40	2 5/32 55	2 1/4 57	11 21/32 296	5 29/32 150	4.606 117	1.811 46	1 1/4 M33	**UCP322SC**	P322SC	UC322	53.1	205	180	13.2	UCP322SCC	UCP322SCCD	188	7 13/32	59.9
120	–	6 19/64 160	22 7/16 570	5 1/2 140	17 23/32 450	1 9/16 40	2 5/32 55	2 1/4 57	12 7/16 316	6 5/16 160	4.961 126	2.008 51	1 1/4 M33	**UCP324SC**	P324SC	UC324	69.0	207	185	13.5	UCP324SCC	UCP324SCCD	196	7 23/32	78.5
130	–	7 3/32 180	23 5/8 600	5 1/2 140	18 29/32 480	1 9/16 40	2 5/32 55	2 1/4 57	13 21/32 355	7 11/16 195	5.315 135	2.126 54	1 1/4 M33	**UCP326SC**	P326SC	UC326	85.6	229	214	13.6	UCP326SCC	UCP326SCCD	214	8 7/16	97.7
140	–	7 7/8 200	24 13/32 620	5 1/2 140	19 11/16 500	1 9/16 40	2 5/32 55	2 3/4 70	15 15/32 393	7 9/32 185	5.709 145	2.323 59	1 1/4 M33	**UCP328SC**	P328SC	UC328	114	253	246	13.6	UCP328SCC	UCP328SCCD	222	8 3/4	129

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 205~210
A-PT1/8 .... 211~218, 310~328
3. As for the triple seal type product (205 is the double seal type product), accessory code L3 (or L2) follows the Part No. of unit or bearing.
(Example of Part No. : UCP206JSCL3, UC206L3)
4. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit.

UKP-SC
Tapered bore (with adapter), cast steel housing
d_1 20 ~ 75 mm



With Cast Iron Cover



Variations of tolerance of distance from mounting bottom to center of spherical bore (Δ_{Hs})

Unit : mm

Housing No.		Δ_{Hs}
P205SC~P210SC	P310SC	±0.15
P211SC~P218SC	P311SC~P318SC	±0.2
	P319SC~P328SC	±0.3

Shaft Dia. d_1 mm	Shaft Dia. d_1 inch	Dimensions inch / mm H	L	A	J	N	N_1	H_1	H_2	L_1	B_1 [1]	Bolt Size inch / mm	Standard Unit No.	Housing No.	Bearing No.	Adapter [1] No.	Mass kg	Basic Load Ratings kN C_r	C_{0r}	Factor f_0	With Cast Iron Cover Unit No. Open Type	One Side Closed Type	Dimension A_c mm	A_c inch	Mass kg
20	3/4	1 7/16 36.5	5 1/2 140	1 1/2 38	4 1/8 105	1/2 13	23/32 18	5/8 16	2 25/32 71	1 11/16 43	1 5/32(1 3/8) 29(35)	3/8 M10	**UKP205SC**	P205SC	UK205	HE305X(HE2305X) H305X(H2305X)	1.0 1.0	14.0	7.85	13.9	– –	– –	– –	– –	– –
25	1	1 11/16 42.9	6 1/2 165	1 7/8 48	4 3/4 121	21/32 17	13/16 21	23/32 18	3 3/8 86	2 3/32 53	1 7/32(1 1/2) 31(38)	1/2 M14	**UKP206SC**	P206SC	UK206	H306X(H2306X) HE306X(HE2306X)	1.6 1.6	19.5	11.3	13.9	UKP206SCFC –	UKP206SCFCD –	70 –	2 3/4 –	2.1 –
30	1 1/8	1 7/8 47.6	6 9/16 167	1 7/8 48	5 127	21/32 17	13/16 21	3/4 19	3 25/32 96	2 51	1 3/8(1 11/16) 35(43)	1/2 M14	**UKP207SC**	P207SC	UK207	HS307X(HS2307X) H307X(H2307X)	2.1 2.1	25.7	15.4	13.9	– UKP207SCFC	– UKP207SCFCD	– 78	– 3 1/16	– 2.8
35	1 1/4 1 3/8	1 15/16 49.2	7 1/4 184	2 1/8 54	5 13/32 137	21/32 17	13/16 21	3/4 19	3 15/16 100	2 1/4 57	1 13/32(1 13/16) 36(46)	1/2 M14	**UKP208SC**	P208SC	UK208	HE308X(HE2308X) HS308X(HS2308X) H308X(H2308X)	2.4 2.4 2.4	29.1	17.8	14.0	– – UKP208SCFC	– – UKP208SCFCD	– – 86	– – 3 3/8	– – 3.2
40	1 1/2 1 5/8	2 1/8 54	7 15/32 190	2 1/8 54	5 3/4 146	21/32 17	13/16 21	25/32 20	4 1/4 108	2 3/8 60	1 17/32(1 31/32) 39(50)	1/2 M14	**UKP209SC**	P209SC	UK209	HE309X(HE2309X) H309X(H2309X) HS309X(HS2309X)	2.7 2.7 2.7	34.1	21.3	14.0	– UKP209SCFC –	– UKP209SCFCD –	– 88 –	– 3 15/32 –	– 3.5 –
45	1 3/4	2 1/4 57.2	8 1/8 206	2 3/8 60	6 1/4 159	25/32 20	7/8 22	7/8 22	4 17/32 115	2 15/32 63	1 21/32(2 5/32) 42(55)	5/8 M16	**UKP210SC**	P210SC	UK210	HE310X(HE2310X) H310X(H2310X)	3.3 3.3	35.1	23.3	14.4	– UKP210SCFC	– UKP210SCFCD	– 97	– 3 13/16	– 4.3
	1 3/4	2 61/64 75	10 13/16 275	2 15/16 75	8 11/32 212	25/32 20	1 3/8 35	1 1/16 27	5 13/16 148	3 15/32 88	2 5/32 55	5/8 M16	**UKP310SC**	P310SC	UK310	HE2310X H2310X	9.3 9.3	62.0	38.3	13.2	– UKP310SCC	– UKP310SCCD	– 110	– 4 11/32	– 11.0
50	1 7/8 2	2 1/2 63.5	8 5/8 219	2 3/8 60	6 23/32 171	25/32 20	7/8 22	15/16 24	5 127	2 3/4 70	1 25/32(2 5/16) 45(59)	5/8 M16	**UKP211SC**	P211SC	UK211	HS311X(HS2311X) H311X(H2311X) HE311X(HE2311X)	4.2 4.2 4.2	43.4	29.4	14.4	– UKP211SCFC –	– UKP211SCFCD –	– 99 –	– 3 29/32 –	– 5.4 –
	1 7/8 2	3 5/32 80	12 7/32 310	3 5/32 80	9 9/32 236	25/32 20	1 1/2 38	1 3/16 30	6 7/32 158	3 17/32 90	2 5/16 59	5/8 M16	**UKP311SC**	P311SC	UK311	HS2311X H2311X HE2311X	11.2 11.2 11.2	71.6	45.0	13.2	– UKP311SCC –	– UKP311SCCD –	– 114 –	– 4 1/2 –	– 13.1 –
55	2 1/8	2 3/4 69.8	9 1/2 241	2 3/4 70	7 1/4 184	25/32 20	31/32 25	31/32 25	5 15/32 139	3 76	1 27/32(2 7/16) 47(62)	5/8 M16	**UKP212SC**	P212SC	UK212	HS312X(HS2312X) H312X(H2313X)	5.1 5.1	52.4	36.2	14.4	– UKP212SCFC	– UKP212SCFCD	– 114	– 4 1/2	– 6.6
	2 1/8	3 11/32 85	13 330	3 11/32 85	9 27/32 250	31/32 25	1 1/2 38	1 1/4 32	6 5/8 168	4 1/16 103	2 7/16 62	3/4 M20	**UKP312SC**	P312SC	UK312	HS2312X H2312X	12.5	81.9	52.2	13.2	– UKP312SCC	– UKP312SCCD	– 124	– 4 7/8	– 14.9
60	2 1/4 2 3/8	3 76.2	10 7/16 265	2 3/4 70	8 203	31/32 25	1 3/16 30	1 3/32 28	5 15/16 151	3 1/16 78	1 31/32(2 9/16) 50(65)	3/4 M20	**UKP213SC**	P213SC	UK213	HE313X(HE2313X) H313X(H2313X) HS313X(HS2313X)	6.3 6.3 6.3	57.2	40.1	14.4	– UKP213SCFC –	– UKP213SCFCD –	– 114 –	– 4 1/2 –	– 8.0 –
	2 1/4 2 3/8	3 35/64 90	13 3/8 340	3 17/32 90	10 1/4 260	31/32 25	1 1/2 38	1 3/8 35	7 178	4 11/32 110	2 9/16 65	3/4 M20	**UKP313SC**	P313SC	UK313	HE2313X H2313X HS2313X	14.3 14.3 14.3	92.7	59.9	13.2	– UKP313SCC –	– UKP313SCCD –	– 122 –	– 4 13/16 –	– 16.5 –
65	2 1/2	3 1/4 82.6	10 13/16 275	2 29/32 74	8 17/32 217	31/32 25	1 3/16 30	1 5/32 29	6 15/32 164	3 5/32 80	2 5/32(2 7/8) 55(73)	3/4 M20	**UKP215SC**	P215SC	UK215	HE315X(HE2315X) H315X(H2315X)	7.9 7.9	67.4	48.3	14.5	– UKP215SCFC	– UKP215SCFCD	– 124	– 4 7/8	– 9.8
	2 1/2	3 15/16 100	14 31/32 380	3 15/16 100	11 13/32 290	1 1/16 27	1 9/16 40	1 1/2 38	7 7/8 200	4 7/32 107	2 7/8 73	7/8 M22	**UKP315SC**	P315SC	UK315	HE2315X H2315X	20.9 20.9	113	77.2	13.2	– UKP315SCC	– UKP315SCCD	– 134	– 5 9/32	– 23.7
70	2 3/4	3 1/2 88.9	11 1/2 292	3 1/16 78	9 1/8 232	31/32 25	1 3/8 35	1 7/32 31	6 15/16 176	3 3/8 86	2 5/16(3 1/16) 59(78)	3/4 M20	**UKP216SC**	P216SC	UK216	HE316X(HE2316X) H316X(H2316X)	9.6 9.6	72.7	53.0	14.6	– UKP216SCFC	– UKP216SCFCD	– 138	– 5 7/16	– 12.0
	2 3/4	4 11/64 106	15 3/4 400	4 11/32 110	11 13/16 300	1 1/16 27	1 9/16 40	1 1/2 38	8 5/16 211	4 23/32 120	3 1/16 78	7/8 M22	**UKP316SC**	P316SC	UK316	HE2316X H2316X	24.2 24.2	123	86.7	13.3	– UKP316SCC	– UKP316SCCD	– 138	– 5 7/16	– 27.3
75	3	3 3/4 95.2	12 7/32 310	3 9/32 83	9 23/32 247	31/32 25	1 9/16 40	1 5/16 33	7 13/16 188	3 17/32 90	2 15/32(3 7/32) 63(82)	3/4 M20	**UKP217SC**	P217SC	UK217	H317X(H2317X) HE317X(HE2317X)	12.0 12.0	84.0	61.9	14.5	UKP217SCFC –	UKP217SCFCD –	142 –	5 19/32 –	14.7 –
	3	4 13/32 112	16 17/32 420	4 11/32 110	12 19/32 320	1 5/16 33	1 25/32 45	1 25/32 45	8 3/4 222	4 23/32 120	3 7/32 82	1 M27	**UKP317SC**	P317SC	UK317	H2317X HE2317X	28.3 28.3	133	96.8	13.3	UKP317SCC –	UKP317SCCD –	146 –	5 3/4 –	31.8 –

Note 1) Codes shown in parentheses indicate the dimensions and Part No. of applicable adapter (H2300X series) for UK200L3 series (triple seal type).

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

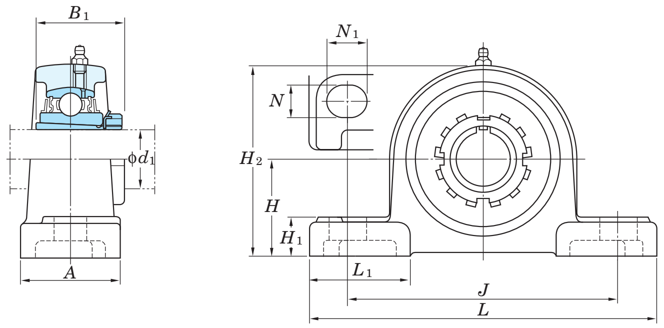
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF........205~210
A-PT1/8................211~218, 310~328

3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables.
(Example of Part No. : UKP206JSC + H306X, UK206 + H306X)

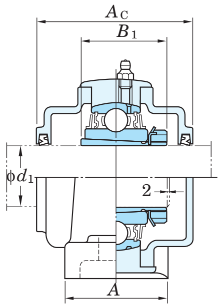
4. As for the triple seal type product (205 is the double seal type product), accessory code L3 (or L2) follows the Part No. of unit or bearing.
(Example of Part No. : UKP206JSCL3 + H2306X, UK206L3 + H2306X)

5. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

UKP-SC
Tapered bore (with adapter), cast steel housing
d_1 80 ~ 125 mm



With Cast Iron Cover



Variations of tolerance of distance from mounting bottom to center of spherical bore (Δ_{Hs})

Unit : mm

Housing No.		Δ_{Hs}
P205SC~P210SC	P310SC	±0.15
P211SC~P218SC	P311SC~P318SC	±0.2
	P319SC~P328SC	±0.3

Shaft Dia.		Dimensions										Bolt Size	Standard			Adapter 1) No.	Mass	Basic Load Ratings		Factor	With Cast Iron Cover				
mm	inch	inch mm										inch mm	Unit No.	Housing No.	Bearing No.			kN			Unit No.		Dimension		Mass
d_1		H	L	A	J	N	N_1	H_1	H_2	L_1	B_1 1)						kg	C_r	C_{0r}	f_0	Open Type	One Side Closed Type	mm A_c	inch	kg
80	–	4	12 7/8	3 15/32	10 5/16	1 1/16	1 25/32	1 3/8	7 7/8	4 3/32	2 9/16(3 3/8)	7/8	**UKP218SC**	P218SC	UK218	H318X(H2318X)	15.3	96.1	71.5	14.5	UKP218SCFC	UKP218SCFCD	152	6	18.4
		101.6	327	88	262	27	45	35	200	104	65(86)	M22													
	–	4 41/64	16 15/16	4 11/32	13	1 5/16	1 25/32	1 25/32	9 7/32	4 23/32	3 3/8	1	**UKP318SC**	P318SC	UK318	H2318X	31.0	143	107	13.3	UKP318SCC	UKP318SCCD	150	5 29/32	35.2
		118	430	110	330	33	45	45	234	120	86	M27													
85	3 1/4	4 59/64	18 1/2	4 23/32	14 3/16	1 13/32	1 31/32	2	9 3/4	4 29/32	3 17/32	1 1/8	**UKP319SC**	P319SC	UK319	HE2319X	38.2	153	119	13.3	–	–	–	–	–
		125	470	120	360	36	50	51	248	125	90	M30				H2319X	38.2				UKP319SCC	UKP319SCCD	162	6 3/8	42.9
90	3 1/2	5 33/64	19 9/32	4 23/32	14 31/32	1 13/32	1 31/32	2	10 3/4	5 1/2	3 13/16	1 1/8	**UKP320SC**	P320SC	UK320	HE2320X	44.9	173	141	13.2	–	–	–	–	–
		140	490	120	380	36	50	51	273	140	97	M30				H2320X	44.9				UKP320SCC	UKP320SCCD	174	6 27/32	51.1
100		5 29/32	20 15/32	5 1/2	15 3/4	1 9/16	2 5/32	2 1/4	11 21/32	5 29/32	4 1/8	1 1/4	**UKP322SC**	P322SC	UK322	H2322X	53.0	205	180	13.2	UKP322SCC	UKP322SCCD	188	7 13/32	59.9
	4	150	520	140	400	40	55	57	296	150	105	M33				HE2322X	53.0				–	–	–	–	–
110	–	6 19/64	22 7/16	5 1/2	17 23/32	1 9/16	2 5/32	2 1/4	12 7/16	6 5/16	4 13/32	1 1/4	**UKP324SC**	P324SC	UK324	H2324	69.3	207	185	13.5	UKP324SCC	UKP324SCCD	196	7 23/32	79.6
		160	570	140	450	40	55	57	316	160	112	M33													
115	4 1/2	7 3/32	23 5/8	5 1/2	18 29/32	1 9/16	2 5/32	2 1/4	13 21/32	7 11/16	4 3/4	1 1/4	**UKP326SC**	P326SC	UK326	HE2326	85.4	229	214	13.6	–	–	–	–	–
		180	600	140	480	40	55	57	355	195	121	M33				H2326	85.4				UKP326SCC	UKP326SCCD	214	8 7/16	98.7
125	–	7 7/8	24 13/32	5 1/2	19 11/16	1 9/16	2 5/32	2 3/4	15 15/32	7 9/32	5 5/32	1 1/4	**UKP328SC**	P328SC	UK328	H2328	114	253	246	13.6	UKP328SCC	UKP328SCCD	222	8 3/4	131
		200	620	140	500	40	55	70	393	185	131	M33													

Note 1) Codes shown in parentheses indicate the dimensions and Part No. of applicable adapter (H2300X series) for UK200L3 series (triple seal type).

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

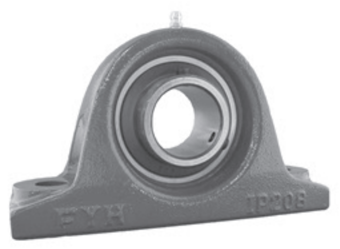
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF........205~210
A-PT1/8................211~218, 310~328

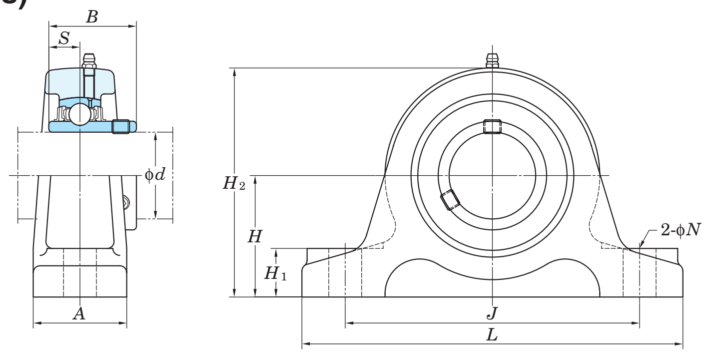
3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables.
(Example of Part No. : UKP206JSC + H306X, UK206 + H306X)

4. As for the triple seal type product (205 is the double seal type product), accessory code L3 (or L2) follows the Part No. of unit or bearing.
(Example of Part No. : UKP206JSCL3 + H2306X, UK206L3 + H2306X)

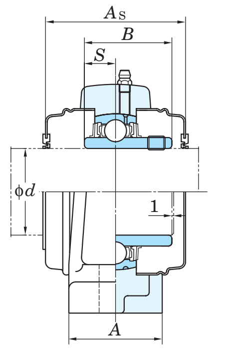
5. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

UCIP
Cylindrical bore (with set screws)
d 40 ~ 140 mm

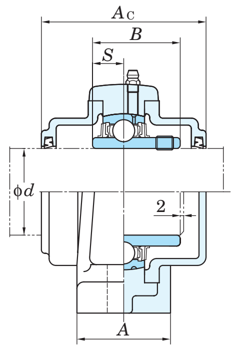




With Pressed Steel Cover



With Cast Iron Cover



Variations of tolerance of distance from mounting bottom to center of spherical bore (Δ_{Hs}) and variations of tolerance of distance between centers of bolt holes (Δ_{Js})

Unit : mm

Housing No.		Δ_{Hs}	Δ_{Js}
IP208~IP210		±0.15	±0.5
IP211~IP213	IP313~IP318	±0.2	±0.7
	IP319~IP328	±0.3	

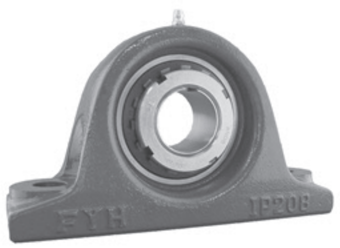
Shaft Dia.		Dimensions									Bolt Size	Standard				Basic Load Ratings		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm	inch	inch mm									inch mm	Unit No.	Housing No.	Bearing No.	Mass	kN			Unit No.		Dimension		Mass	Unit No.		Dimension		Mass
d		H	L	A	J	N	H_1	H_2	B	S					kg	C_r	C_{0r}	f_0	Open Type	One Side Closed Type	mm A_s	inch	kg	Open Type	One Side Closed Type	mm A_c	inch	kg
40	1 1/2	2 23/64 60	7 7/8 200	2 3/8 60	5 29/32 150	3/4 19	31/32 25	4 17/32 115	1.937 49.2	0.748 19	5/8 M16	**UCIP208-24**	IP208	UC208-24	3.4	29.1	17.8	14.0	–	–	–	–	–	–	–	–	–	–
	1 9/16											**UCIP208-25**		UC208-25	3.4				–	–	–	–	–	–	–	–	–	–
												UCIP208		UC208	3.4				UCIP208C	UCIP208CD	68	2 11/16	3.4	UCIP208FC	UCIP208FCD	86	3 3/8	4.2
45	1 5/8	2 3/4 70	8 9/32 210	2 3/8 60	6 19/64 160	3/4 19	31/32 25	5 1/32 128	1.937 49.2	0.748 19	5/8 M16	**UCIP209-26**	IP209	UC209-26	3.9	34.1	21.3	14.0	–	–	–	–	–	–	–	–	–	–
	1 11/16											**UCIP209-27**		UC209-27	3.9				–	–	–	–	–	–	–	–	–	–
	1 3/4											**UCIP209-28**		UC209-28	3.9				–	–	–	–	–	–	–	–	–	–
												UCIP209		UC209	3.9				UCIP209C	UCIP209CD	68	2 11/16	3.9	UCIP209FC	UCIP209FCD	88	3 15/32	4.7
50	1 7/8	2 3/4 70	8 21/32 220	2 3/8 60	6 11/16 170	3/4 19	1 3/32 28	5 3/16 132	2.031 51.6	0.748 19	5/8 M16	**UCIP210-30**	IP210	UC210-30	4.8	35.1	23.3	14.4	–	–	–	–	–	–	–	–	–	–
	1 15/16											**UCIP210-31**		UC210-31	4.8				–	–	–	–	–	–	–	–	–	–
												UCIP210		UC210	4.8				UCIP210C	UCIP210CD	73	2 7/8	4.8	UCIP210FC	UCIP210FCD	97	3 13/16	5.8
	2											**UCIP210-32**		UC210-32	4.8				–	–	–	–	–	–	–	–	–	–
55	2	3 5/32 80	9 1/16 230	2 3/8 60	7 3/32 180	3/4 19	1 3/32 28	5 13/16 148	2.189 55.6	0.874 22.2	5/8 M16	**UCIP211-32**	IP211	UC211-32	5.3	43.4	29.4	14.4	–	–	–	–	–	–	–	–	–	–
	2 1/8											**UCIP211-34**		UC211-34	5.3				–	–	–	–	–	–	–	–	–	–
												UCIP211		UC211	5.3				UCIP211C	UCIP211CD	75	2 15/16	5.3	UCIP211FC	UCIP211FCD	99	3 29/32	6.3
	2 3/16											**UCIP211-35**		UC211-35	5.3				–	–	–	–	–	–	–	–	–	–
60	2 1/4	3 5/32 80	10 1/4 260	2 3/4 70	7 7/8 200	7/8 22	1 3/16 30	6 3/32 155	2.563 65.1	1.000 25.4	3/4 M20	**UCIP212-36**	IP212	UC212-36	7.2	52.4	36.2	14.4	–	–	–	–	–	–	–	–	–	–
												UCIP212		UC212	7.2				UCIP212C	UCIP212CD	88	3 15/32	7.2	UCIP212FC	UCIP212FCD	114	4 1/2	8.7
	2 3/8											**UCIP212-38**		UC212-38	7.2				–	–	–	–	–	–	–	–	–	–
	2 7/16											**UCIP212-39**		UC212-39	7.2				–	–	–	–	–	–	–	–	–	–
65	2 1/2	3 35/64 90	11 1/32 280	2 3/4 70	8 21/32 220	7/8 22	1 3/16 30	6 25/32 172	2.563 65.1	1.000 25.4	3/4 M20	**UCIP213-40**	IP213	UC213-40	8.8	57.2	40.1	14.4	–	–	–	–	–	–	–	–	–	–
												UCIP213		UC213	8.8				UCIP213C	UCIP213CD	88	3 15/32	8.8	UCIP213FC	UCIP213FCD	114	4 1/2	10.5
	2 1/2	4 21/64 110	12 7/32 310	2 3/4 70	9 27/32 250	7/8 22	1 3/16 30	8 3/16 208	2.953 75	1.181 30	3/4 M20	**UCIP313-40**	IP313	UC313-40	13.4	92.7	59.9	13.2	–	–	–	–	–	–	–	–	–	–
												UCIP313		UC313	13.4				–	–	–	–	–	UCIP313C	UCIP313CD	122	4 13/16	15.5
70	2 3/4	4 21/64 110	13 330	2 15/16 75	10 5/8 270	31/32 25	1 3/8 35	8 15/32 215	3.071 78	1.299 33	7/8 M22	**UCIP314-44**	IP314	UC314-44	15.3	104	68.2	13.2	–	–	–	–	–	–	–	–	–	–
												UCIP314		UC314	15.3				–	–	–	–	–	UCIP314C	UCIP314CD	124	4 7/8	17.6
75	2 15/16	4 23/32 120	13 3/8 340	2 15/16 75	11 1/32 280	31/32 25	1 3/8 35	9 1/16 230	3.228 82	1.260 32	7/8 M22	**UCIP315-47**	IP315	UC315-47	17.6	113	77.2	13.2	–	–	–	–	–	–	–	–	–	–
												UCIP315		UC315	17.6				–	–	–	–	–	UCIP315C	UCIP315CD	134	5 9/32	20.1
	3											**UCIP315-48**		UC315-48	17.6				–	–	–	–	–	–	–	–	–	–
80	–	4 23/32 120	13 25/32 350	3 11/32 85	11 27/64 290	31/32 25	1 9/16 40	9 1/4 235	3.386 86	1.339 34	7/8 M22	**UCIP316**	IP316	UC316	20.3	123	86.7	13.3	–	–	–	–	–	UCIP316C	UCIP316CD	138	5 7/16	23.2
85	–	5 1/8 130	14 9/16 370	3 11/32 85	12 13/64 310	31/32 25	1 9/16 40	10 1/32 255	3.780 96	1.575 40	7/8 M22	**UCIP317**	IP317	UC317	25.9	133	96.8	13.3	–	–	–	–	–	UCIP317C	UCIP317CD	146	5 3/4	29.2
90	3 1/2	5 1/8 130	15 3/4 400	3 11/32 85	13 330	1 5/32 29	1 25/32 45	10 1/4 260	3.780 96	1.575 40	1 M27	**UCIP318-56**	IP318	UC318-56	28.6	143	107	13.3	–	–	–	–	–	–	–	–	–	–
												UCIP318		UC318	28.6				–	–	–	–	–	UCIP318C	UCIP318CD	150	5 29/32	32.4
95	–	5 29/32 150	16 5/32 410	3 11/32 85	13 25/64 340	1 5/32 29	1 25/32 45	11 7/32 285	4.055 103	1.614 41	1 M27	**UCIP319**	IP319	UC319	31.7	153	119	13.3	–	–	–	–	–	UCIP319C	UCIP319CD	162	6 3/8	36.0
100		5 29/32 150	16 15/16 430	3 11/32 85	14 11/64 360	1 5/32 29	1 25/32 45	11 5/8 295	4.252 108	1.654 42	1 M27	**UCIP320**	IP320	UC320	36.9	173	141	13.2	–	–	–	–	–	UCIP320C	UCIP320CD	174	6 27/32	42.5
	3 15/16											**UCIP320-63**		UC320-63	36.9				–	–	–	–	–	–	–	–	–	–
	4											**UCIP320-64**		UC320-64	36.9				–	–	–	–	–	–	–	–	–	–
110	–	6 11/16 170	19 9/32 490	3 15/16 100	16 9/64 410	1 1/4 32	1 31/32 50	13 3/16 335	4.606 117	1.811 46	1 1/8 M30	**UCIP322**	IP322	UC322	52.4	205	180	13.2	–	–	–	–	–	UCIP322C	UCIP322CD	188	7 13/32	59.2
120	–	6 11/16 170	20 3/32 510	3 15/16 100	16 59/64 430	1 1/4 32	1 31/32 50	13 19/32 345	4.961 126	2.008 51	1 1/8 M30	**UCIP324**	IP324	UC324	58.7	207	185	13.5	–	–	–	–	–	UCIP324C	UCIP324CD	196	7 23/32	68.2
130	–	7 7/8 200	21 21/32 550	4 11/32 110	18 1/2 470	1 1/4 32	1 31/32 50	15 11/32 390	5.315 135	2.126 54	1 1/8 M30	**UCIP326**	IP326	UC326	76.2	229	214	13.6	–	–	–	–	–	UCIP326C	UCIP326CD	214	8 7/16	88.3
140	–	7 7/8 200	23 7/32 590	4 11/32 110	19 11/16 500	1 3/8 35	2 5/32 55	15 3/4 400	5.709 145	2.323 59	1 1/4 M33	**UCIP328**	IP328	UC328	87.0	253	246	13.6	–	–	–	–	–	UCIP328C	UCIP328CD	222	8 3/4	102

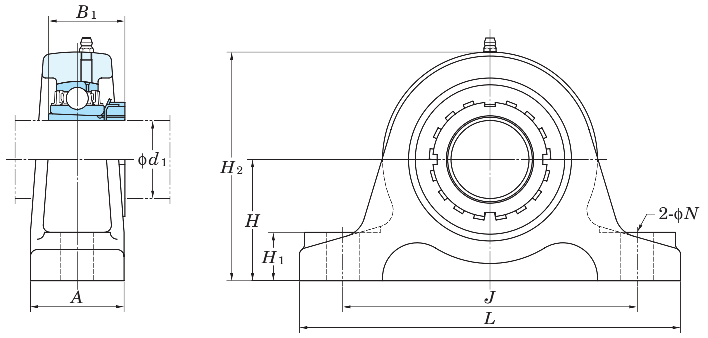
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 208~210
A-PT1/8 .... 211~213, 313~328
3. As for the triple seal type product, accessory code L3 follows the Part No. of unit or bearing.
(Example of Part No. : UCIP208JL3, UC208L3)
4. As for the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UKIP

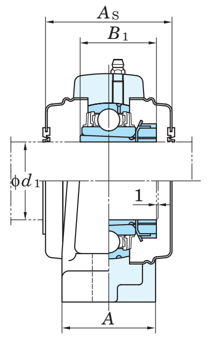
Tapered bore (with adapter)

d_1 35 ~ 125 mm

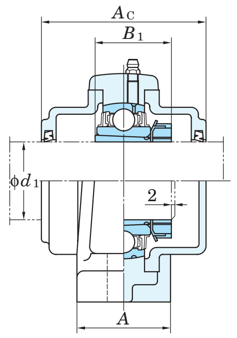




With Pressed Steel Cover



With Cast Iron Cover



Variations of tolerance of distance from mounting bottom to center of spherical bore (Δ_{Hs}) and variations of tolerance of distance between centers of bolt holes (Δ_{Js})

Unit : mm

Housing No.		Δ_{Hs}	Δ_{Js}
IP208~IP210		±0.15	±0.5
IP211~IP213	IP313~IP318	±0.2	±0.7
	IP319~IP328	±0.3	

Shaft Dia.		Dimensions inch / mm								Bolt Size	Standard					Basic Load Ratings kN		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm d_1	inch d_1	H	L	A	J	N	H_1	H_2	B_1 1)	inch mm	Unit No.	Housing No.	Bearing No.	Adapter 1) No.	Mass kg	C_r	C_{0r}	f_0	Unit No. Open Type	Unit No. One Side Closed Type	Dimension mm A_s	Dimension inch A_s	Mass kg	Unit No. Open Type	Unit No. One Side Closed Type	Dimension mm A_c	Dimension inch A_c	Mass kg
35	1 1/4 1 3/8	2 23/64 60	7 7/8 200	2 3/8 60	5 29/32 150	3/4 19	31/32 25	4 17/32 115	1 13/32(1 13/16) 36(46)	5/8 M16	**UKIP208**	IP208	UK208	HE308X(HE2308X) HS308X(HS2308X) H308X(H2308X)	3.5 3.5 3.5	29.1	17.8	14.0	– – UKIP208C	– – UKIP208CD	– – 68	– – 2 11/16	– – 3.5	– – UKIP208FC	– – UKIP208FCD	– – 86	– – 3 3/8	– – 4.4
40	1 1/2 1 5/8	2 3/4 70	8 9/32 210	2 3/8 60	6 19/64 160	3/4 19	31/32 25	5 1/32 128	1 17/32(1 31/32) 39(50)	5/8 M16	**UKIP209**	IP209	UK209	HE309X(HE2309X) H309X(H2309X) HS309X(HS2309X)	4.0 4.0 4.0	34.1	21.3	14.0	– UKIP209C –	– UKIP209CD –	– 68 –	– 2 11/16 –	– 4.0 –	– UKIP209FC –	– UKIP209FCD –	– 88 –	– 3 15/32 –	– 4.9 –
45	1 3/4	2 3/4 70	8 21/32 220	2 3/8 60	6 11/16 170	3/4 19	1 3/32 28	5 3/16 132	1 21/32(2 5/32) 42(55)	5/8 M16	**UKIP210**	IP210	UK210	HE310X(HE2310X) H310X(H2310X)	4.8 4.8	35.1	23.3	14.4	– UKIP210C	– UKIP210CD	– 73	– 2 7/8	– 4.8	– UKIP210FC	– UKIP210FCD	– 97	– 3 13/16	– 5.8
50	1 7/8 2	3 5/32 80	9 1/16 230	2 3/8 60	7 3/32 180	3/4 19	1 3/32 28	5 13/16 148	1 25/32(2 5/16) 45(59)	5/8 M16	**UKIP211**	IP211	UK211	HS311X(HS2311X) H311X(H2311X) HE311X(HE2311X)	5.3 5.3 5.3	43.4	29.4	14.4	– UKIP211C –	– UKIP211CD –	– 75 –	– 2 15/16 –	– 5.3 –	– UKIP211FC –	– UKIP211FCD –	– 99 –	– 3 29/32 –	– 5.9 –
55	2 1/8	3 5/32 80	10 1/4 260	2 3/4 70	7 7/8 200	7/8 22	1 3/16 30	6 3/32 155	1 27/32(2 7/16) 47(62)	3/4 M20	**UKIP212**	IP212	UK212	HS312X(HS2312X) H312X(H2313X)	7.1 7.1	52.4	36.2	14.4	– UKIP212C	– UKIP212CD	– 88	– 3 15/32	– 7.1	– UKIP212FC	– UKIP212FCD	– 114	– 4 1/2	– 8.6
60	2 1/4 2 3/8	3 35/64 90	11 1/32 280	2 3/4 70	8 21/32 220	7/8 22	1 3/16 30	6 25/32 172	1 31/32(2 9/16) 50(65)	3/4 M20	**UKIP213**	IP213	UK213	HE313X(HE2313X) H313X(H2313X) HS313X(HS2313X)	8.7 8.7 8.7	57.2	40.1	14.4	– UKIP213C –	– UKIP213CD –	– 88 –	– 3 15/32 –	– 8.7 –	– UKIP213FC –	– UKIP213FCD –	– 114 –	– 4 1/2 –	– 10.4 –
	2 1/4 2 3/8	4 21/64 110	12 7/32 310	2 3/4 70	9 27/32 250	7/8 22	1 3/16 30	8 3/16 208	2 9/16 65	3/4 M20	**UKIP313**	IP313	UK313	HE2313X H2313X HS2313X	13.5 13.5 13.5	92.7	59.9	13.2	– – –	– – –	– – –	– – –	– – –	– UKIP313C –	– UKIP313CD –	– 122 –	– 4 13/16 –	– 15.7 –
65	2 1/2	4 23/32 120	13 3/8 340	2 15/16 75	11 1/32 280	31/32 25	1 3/8 35	9 1/16 230	2 7/8 73	7/8 M22	**UKIP315**	IP315	UK315	HE2315X H2315X	17.7 17.7	113	77.2	13.2	– –	– –	– –	– –	– –	– UKIP315C	– UKIP315CD	– 134	– 5 9/32	– 20.5
70	2 3/4	4 23/32 120	13 25/32 350	3 11/32 85	11 27/64 290	31/32 25	1 9/16 40	9 1/4 235	3 1/16 78	7/8 M22	**UKIP316**	IP316	UK316	HE2316X H2316X	20.4 20.4	123	86.7	13.3	– –	– –	– –	– –	– –	– UKIP316C	– UKIP316CD	– 138	– 5 7/16	– 23.5
75	3	5 1/8 130	14 9/16 370	3 11/32 85	12 13/64 310	31/32 25	1 9/16 40	10 1/32 255	3 7/32 82	7/8 M22	**UKIP317**	IP317	UK317	H2317X HE2317X	25.7 25.7	133	96.8	13.3	– –	– –	– –	– –	– –	UKIP317C –	UKIP317CD –	146 –	5 3/4 –	29.2 –
80	–	5 1/8 130	15 3/4 400	3 11/32 85	13 330	1 5/32 29	1 25/32 45	10 1/4 260	3 3/8 86	1 M27	**UKIP318**	IP318	UK318	H2318X	28.7	143	107	13.3	–	–	–	–	–	UKIP318C	UKIP318CD	150	5 29/32	32.9
85	3 1/4	5 29/32 150	16 5/32 410	3 11/32 85	13 25/64 340	1 5/32 29	1 25/32 45	11 7/32 285	3 17/32 90	1 M27	**UKIP319**	IP319	UK319	HE2319X H2319X	32.0 32.0	153	119	13.3	– –	– –	– –	– –	– –	– UKIP319C	– UKIP319CD	– 162	– 6 3/8	– 36.7
90	3 1/2	5 29/32 150	16 15/16 430	3 11/32 85	14 11/64 360	1 5/32 29	1 25/32 45	11 5/8 295	3 13/16 97	1 M27	**UKIP320**	IP320	UK320	HE2320X H2320X	36.6 36.6	173	141	13.2	– –	– –	– –	– –	– –	– UKIP320C	– UKIP320CD	– 174	– 6 27/32	– 42.8
100	4	6 11/16 170	19 9/32 490	3 15/16 100	16 9/64 410	1 1/4 32	1 31/32 50	13 3/16 335	4 1/8 105	1 1/8 M30	**UKIP322**	IP322	UK322	H2322X HE2322X	52.2 52.2	205	180	13.2	– –	– –	– –	– –	– –	UKIP322C –	UKIP322CD –	188 –	7 13/32 –	59.1 –
110	–	6 11/16 170	20 3/32 510	3 15/16 100	16 59/64 430	1 1/4 32	1 31/32 50	13 19/32 345	4 13/32 112	1 1/8 M30	**UKIP324**	IP324	UK324	H2324	59.0	207	185	13.5	–	–	–	–	–	UKIP324C	UKIP324CD	196	7 23/32	69.3
115	4 1/2	7 7/8 200	21 21/32 550	4 11/32 110	18 1/2 470	1 1/4 32	1 31/32 50	15 11/32 390	4 3/4 121	1 1/8 M30	**UKIP326**	IP326	UK326	HE2326 H2326	76.0 76.0	229	214	13.6	– –	– –	– –	– –	– –	– UKIP326C	– UKIP326CD	– 214	– 8 7/16	– 89.3
125	–	7 7/8 200	23 7/32 590	4 11/32 110	19 11/16 500	1 3/8 35	2 5/32 55	15 3/4 400	4 5/32 131	1 1/4 M33	**UKIP328**	IP328	UK328	H2328	87.0	253	246	13.6	–	–	–	–	–	UKIP328C	UKIP328CD	222	8 3/4	104

Note 1) Codes shown in parentheses indicate the dimensions and Part No. of applicable adapter (H2300X series) for UK200L3 series (triple seal type).

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

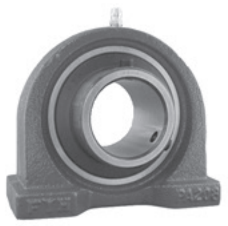
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF........208~210
A-PT1/8................211~213, 313~328

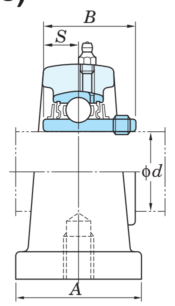
3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables. (Example of Part No. : UKIP208J + H308X, UK208 + H308X)

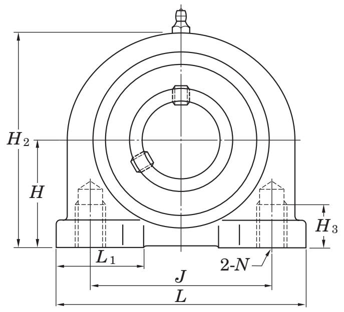
4. As for the triple seal type product, accessory code L3 follows the Part No. of unit or bearing. (Example of Part No. : UKIP208JL3 + H2308X, UK208L3 + H2308X)

5. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

UCPA
Cylindrical bore (with set screws)
d 12 ~ 50 mm







Variations of tolerance of distance from mounting bottom to center of spherical bore (Δ_{Hs}) and variations of tolerance of distance between centers of bolt holes (Δ_{Js})

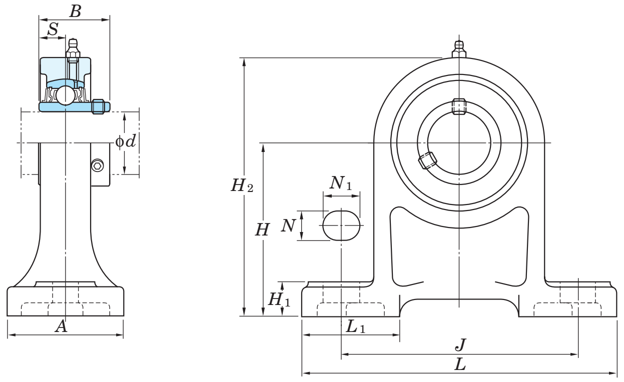
Unit : mm

Housing No.	Δ_{Hs}	Δ_{Js}
PA204~PA210	±0.15	±0.5

Shaft Dia. mm	Shaft Dia. inch	Dimensions inch / mm H	L	A	J	N	H_2	H_3	L_1	B	S	Unit No.	Housing No.	Bearing No.		Basic Load Ratings kN C_r	C_{0r}	Factor f_0	Mass kg
12		1 3/16 30.2	3 76	1 9/16 40	2 3/64 52	M10×1.5	2 3/8 60	1/2 13	1 1/16 27	1.220 31	0.500 12.7	**UCPA201**	PA204	UC201		12.8	6.65	13.2	0.64
	1/2											**UCPA201-8**		UC201-8					
15												**UCPA202**		UC202					0.62
	5/8											**UCPA202-10**		UC202-10					
17												**UCPA203**		UC203					0.61
	3/4											**UCPA204-12**		UC204-12					
20												**UCPA204**		UC204					0.59
	7/8	1 7/16 36.5	3 5/16 84	1 25/32 45	2 13/64 56	M10×1.5	2 25/32 71	1/2 13	1 3/16 30	1.343 34.1	0.563 14.3	**UCPA205-14**	PA205	UC205-14		14.0	7.85	13.9	0.83
	15/16											**UCPA205-15**		UC205-15					
25												**UCPA205**		UC205					
	1											**UCPA205-16**		UC205-16					
	1 1/8	1 11/16 42.9	3 11/16 94	1 31/32 50	2 19/32 66	M14×2	3 5/16 84	23/32 18	1 13/32 36	1.500 38.1	0.626 15.9	**UCPA206-18**	PA206	UC206-18		19.5	11.3	13.9	1.2
30												**UCPA206**		UC206					
	1 3/16											**UCPA206-19**		UC206-19					
	1 1/4											**UCPA206-20**		UC206-20					
	1 1/4	1 7/8 47.6	3 11/32 110	2 5/32 55	3 5/32 80	M14×2	3 21/32 93	25/32 20	1 5/8 41	1.689 42.9	0.689 17.5	**UCPA207-20**	PA207	UC207-20		25.7	15.4	13.9	1.7
	1 5/16											**UCPA207-21**		UC207-21					
35	1 3/8											**UCPA207-22**		UC207-22					
												UCPA207		UC207					
	1 7/16											**UCPA207-23**		UC207-23					
	1 1/2	1 15/16 49.2	4 9/16 116	2 9/32 58	3 5/16 84	M14×2	3 15/16 100	25/32 20	1 5/8 41	1.937 49.2	0.748 19	**UCPA208-24**	PA208	UC208-24		29.1	17.8	14.0	2.0
40	1 9/16											**UCPA208-25**		UC208-25					
												UCPA208		UC208					
	1 5/8	2 9/64 54.2	4 23/32 120	2 3/8 60	3 35/64 90	M14×2	4 3/16 106	31/32 25	1 21/32 42	1.937 49.2	0.748 19	**UCPA209-26**	PA209	UC209-26		34.1	21.3	14.0	2.2
45	1 11/16											**UCPA209-27**		UC209-27					
	1 3/4											**UCPA209-28**		UC209-28					
												UCPA209		UC209					
	1 7/8	2 1/4 57.2	5 1/8 130	2 17/32 64	3 45/64 94	M16×2	4 7/16 113	31/32 25	1 27/32 47	2.031 51.6	0.748 19	**UCPA210-30**	PA210	UC210-30		35.1	23.3	14.4	2.8
50	1 15/16											**UCPA210-31**		UC210-31					
												UCPA210		UC210					
	2											**UCPA210-32**		UC210-32					

Remarks 1. In Part No. of unit, fitting codes follow bore diameter codes. (See **Table 10.5** in P.42.)
2. Part No. of the applicable grease nipple is A-1/4-28UNF.
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (or L2) follows Part No. of unit or bearing. (Example of Part No. : UCPA206JL3, UC206L3)
4. As for the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.
5. Tapered bore (with adapter) type products are also available. (Example of Part No. : UKPA205J + H305X, UK205 + H305X)

UCPH
Cylindrical bore (with set screws)
d 12 ~ 50 mm



Variations of tolerance of distance from mounting bottom to center of spherical bore (Δ_{Hs})

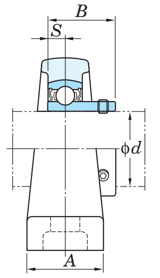
Unit : mm

Housing No.	Δ_{Hs}
PH204~PH210	±0.15

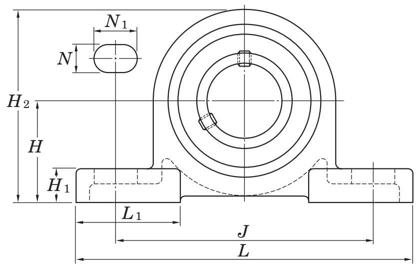
Shaft Dia. *d* mm	Shaft Dia. *d* inch	Dimensions inch / mm *H*	*L*	*A*	*J*	*N*	N_1	H_1	H_2	L_1	*B*	*S*	Bolt Size inch / mm	Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN C_r	C_{0r}	Factor f_0	Mass kg
12		2 3/4 70	5 127	1 9/16 40	3 3/4 95	1/2 13	3/4 19	19/32 15	3 21/32 101	1 13/16 46	1.220 31	0.500 12.7	3/8 M10	**UCPH201**	PH204	UC201	12.8	6.65	13.2	0.96
	1/2													**UCPH201-8**		UC201-8				
15														**UCPH202**		UC202				0.94
	5/8													**UCPH202-10**		UC202-10				
17														**UCPH203**		UC203				0.93
	3/4													**UCPH204-12**		UC204-12				
20														**UCPH204**		UC204				0.91
	7/8	3 5/32 80	5 1/2 140	1 31/32 50	4 1/8 105	1/2 13	3/4 19	5/8 16	3 1/2 114	1 15/16 49	1.343 34.1	0.563 14.3	3/8 M10	**UCPH205-14**	PH205	UC205-14	14.0	7.85	13.9	1.2
	15/16													**UCPH205-15**		UC205-15				
25														**UCPH205**		UC205				
	1													**UCPH205-16**		UC205-16				
	1 1/8	3 35/64 90	6 1/2 165	1 31/32 50	4 3/4 121	21/32 17	13/16 21	23/32 18	5 1/8 130	1 7/32 56	1.500 38.1	0.626 15.9	1/2 M14	**UCPH206-18**	PH206	UC206-18	19.5	11.3	13.9	1.6
30														**UCPH206**		UC206				
	1 3/16													**UCPH206-19**		UC206-19				
	1 1/4													**UCPH206-20**		UC206-20				
	1 1/4	3 47/64 95	6 9/16 167	2 3/8 60	5 127	21/32 17	13/16 21	23/32 18	5 1/2 140	1 1/8 54	1.689 42.9	0.689 17.5	1/2 M14	**UCPH207-20**	PH207	UC207-20	25.7	15.4	13.9	2.0
	1 5/16													**UCPH207-21**		UC207-21				
	1 3/8													**UCPH207-22**		UC207-22				
35														**UCPH207**		UC207				
	1 7/16													**UCPH207-23**		UC207-23				
	1 1/2	3 15/16 100	7 1/4 184	2 3/4 70	5 13/32 137	21/32 17	13/16 21	25/32 20	5 29/32 150	2 1/4 57	1.937 49.2	0.748 19	1/2 M14	**UCPH208-24**	PH208	UC208-24	29.1	17.8	14.0	2.7
	1 9/16													**UCPH208-25**		UC208-25				
40														**UCPH208**		UC208				
	1 5/8	4 9/64 105	7 15/32 190	2 3/4 70	5 3/4 146	21/32 17	13/16 21	25/32 20	6 7/32 158	2 9/32 58	1.937 49.2	0.748 19	1/2 M14	**UCPH209-26**	PH209	UC209-26	34.1	21.3	14.0	3.0
	1 11/16													**UCPH209-27**		UC209-27				
	1 3/4													**UCPH209-28**		UC209-28				
45														**UCPH209**		UC209				
	1 7/8	4 21/64 110	8 1/8 206	2 3/4 70	6 1/4 159	25/32 20	7/8 22	7/8 22	6 1/2 165	2 9/16 65	2.031 51.6	0.748 19	5/8 M16	**UCPH210-30**	PH210	UC210-30	35.1	23.3	14.4	3.5
	1 15/16													**UCPH210-31**		UC210-31				
50														**UCPH210**		UC210				
	2													**UCPH210-32**		UC210-32				

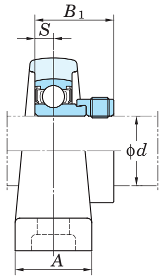
Remarks 1. In Part No. of unit, fitting codes follow bore diameter codes. (See **Table 10.5** in P.42.)
2. Part No. of the applicable grease nipple is A-1/4-28UNF.
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (or L2) follows Part No. of unit or bearing. (Example of Part No. : UCPH206JL3, UC206L3)
4. As for the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.
5. Tapered bore (with adapter) type products are also available. (Example of Part No. : UKPH205J + H305X, UK205 + H305X)

BLP
Cylindrical bore
(with set screw locking)
ALP
Cylindrical bore
(with eccentric locking collar)
d 12 ~ 40 mm



BLP





ALP

Variations of tolerance of distance from mounting bottom to center of spherical bore (Δ_{Hs})

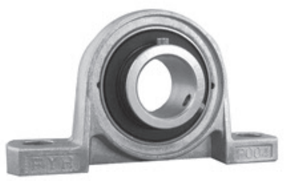
Unit : mm

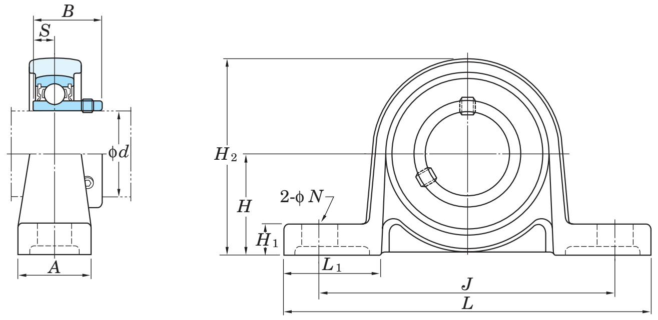
Housing No.	Δ_{Hs}
LP203~LP208	±0.15

Shaft Dia.		Dimensions												Bolt Size	Unit No.	Bearing No.	Unit No.	Bearing No.	Housing No.	Basic Load Ratings		Factor	Mass	
mm	inch	inch mm										BLP	ALP	inch mm						kN			kg	
d		H	L	A	J	N	N_1	H_1	H_2	L_1	S	B	B_1							C_r	C_{0r}	f_0	BLP	ALP
12 15 17	1/2 5/8	1 3/16 30.2	4 1/2 114	31/32 25	3 7/16 87	7/16 11	5/8 16	15/32 12	2 1/4 57	1 3/8 35	0.236 6	0.866 22	1.122 28.5	3/8 M10	**BLP201** **BLP201-8** **BLP202** **BLP202-10** **BLP203**	SB201 SB201-8 SB202 SB202-10 SB203	**ALP201** **ALP201-8** **ALP202** **ALP202-10** **ALP203**	SA201 SA201-8 SA202 SA202-10 SA203	LP203	9.55	4.80	13.2	0.36	0.39
20	3/4	1 5/16 33.3	4 29/32 125	1 1/16 27	3 13/16 97	7/16 11	5/8 16	1/2 13	2 9/16 65	1 1/2 38	0.276 7	0.984 25	1.161 29.5	3/8 M10	**BLP204-12** **BLP204**	SB204-12 SB204	**ALP204-12** **ALP204**	SA204-12 SA204	LP204	12.8	6.65	13.2	0.51	0.51
25	7/8 15/16 1	1 7/16 36.5	5 1/8 130	1 5/32 29	3 15/16 100	7/16 11	5/8 16	1/2 13	2 25/32 71	1 17/32 39	0.295 7.5	1.063 27	1.201 30.5	3/8 M10	**BLP205-14** **BLP205-15** **BLP205** **BLP205-16**	SB205-14 SB205-15 SB205 SB205-16	**ALP205-14** **ALP205-15** **ALP205** **ALP205-16**	SA205-14 SA205-15 SA205 SA205-16	LP205	14.0	7.85	13.9	0.57	0.61
30	1 1/8 1 3/16 1 1/4	1 11/16 42.9	6 5/32 156	1 5/16 33	4 23/32 120	9/16 14	13/16 21	9/16 14	3 9/32 83	1 27/32 47	0.315 8	1.181 30	1.335 33.9	1/2 M12	**BLP206-18** **BLP206** **BLP206-19** **BLP206-20**	SB206-18 SB206 SB206-19 SB206-20	**ALP206-18** **ALP206** **ALP206-19** **ALP206-20**	SA206-18 SA206 SA206-19 SA206-20	LP206	19.5	11.3	13.9	0.69	0.72
35	1 1/4 1 5/16 1 3/8 1 7/16	1 7/8 47.6	6 1/2 165	1 3/8 35	5 127	9/16 14	13/16 21	5/8 16	3 21/32 93	1 31/32 50	0.335 8.5	1.260 32	1.437 36.5	1/2 M12	**BLP207-20** **BLP207-22** **BLP207** **BLP207-23**	SB207-20 SB207-22 SB207 SB207-23	**ALP207-20** **ALP207-21** **ALP207-22** **ALP207** **ALP207-23**	SA207-20 SA207-21 SA207-22 SA207 SA207-23	LP207	25.7	15.4	13.9	0.94	1.0
40	1 1/2 1 9/16	2 50.8	7 1/4 184	1 15/32 37	5 1/2 140	9/16 14	7/8 22	23/32 18	4 1/32 102	2 5/32 55	0.354 9	1.339 34	1.595 40.5	1/2 M12	**BLP208-24** **BLP208**	SB208-24 SB208	**ALP208-24** **ALP208-25** **ALP208**	SA208-24 SA208-25 SA208	LP208	29.1	17.8	14.0	1.8	1.9

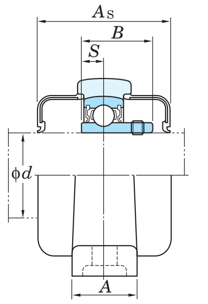
Remarks 1. In Part No. of unit, fitting codes follow bore diameter codes. (See **Table 10.5** in P.42.)
2. Allowable load to housing in radial direction is approximately half of basic load rating of bearing, C_r (when safety factor is 4).
3. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UP
Cylindrical bore (with set screws)
d 10 ~ 30 mm

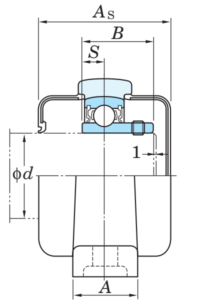




With Through Type Cover



With One Side Sealed Cover



Variations of tolerance of distance from mounting bottom to center of spherical bore ($\mathit{\Delta}_{Hs}$) and variations of tolerance of distance between centers of bolt holes ($\mathit{\Delta}_{Js}$)

Unit : mm

Housing No.	$\mathit{\Delta}_{Hs}$	$\mathit{\Delta}_{Js}$
P000~P006	±0.15	±0.3

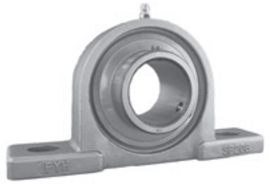
Shaft Dia. mm	Dimensions inch mm										Bolt Size inch mm	Standard			Mass	Basic Load Ratings kN		Factor	With Rubber Coated Cover				
												Unit No.	Housing No.	Bearing No.					Unit No.		Dimension		Mass
d	H	L	A	J	N	H_1	H_2	L_1	B	S					kg	C_r	C_{0r}	f_0	Open Type	One Side Closed Type	A_s mm	A_s inch	kg
10	45/64 18	2 5/8 67	5/8 16	2 3/32 53	9/32 7	1/4 6	1 3/8 35	23/32 18	0.591 15	0.197 5	1/4 M6	**UP000**	P000	SU000	0.070	4.55	1.95	12.3	UP000C	UP000CD	29	1 5/32	0.070
12	3/4 19	2 25/32 71	5/8 16	2 13/64 56	9/32 7	1/4 6	1 1/2 38	3/4 19	0.591 15	0.197 5	1/4 M6	**UP001**	P001	SU001	0.090	5.10	2.40	13.2	UP001C	UP001CD	29	1 5/32	0.090
15	55/64 22	3 5/32 80	5/8 16	2 31/64 63	9/32 7	9/32 7	1 11/16 43	13/16 21	0.650 16.5	0.217 5.5	1/4 M6	**UP002**	P002	SU002	0.11	5.60	2.85	13.9	UP002C	UP002CD	31	1 7/32	0.11
17	15/16 24	3 11/32 85	23/32 18	2 41/64 67	9/32 7	9/32 7	1 27/32 47	13/16 21	0.689 17.5	0.236 6	1/4 M6	**UP003**	P003	SU003	0.15	6.00	3.25	14.4	UP003C	UP003CD	33	1 5/16	0.15
20	1 7/64 28	3 15/16 100	25/32 20	3 5/32 80	13/32 10	11/32 9	2 5/32 55	31/32 25	0.827 21	0.276 7	5/16 M8	**UP004**	P004	SU004	0.23	9.40	5.05	13.9	UP004C	UP004CD	38	1 1/2	0.23
25	1 17/64 32	4 13/32 112	25/32 20	3 35/64 90	13/32 10	13/32 10	2 7/16 62	1 3/32 28	0.866 22	0.276 7	5/16 M8	**UP005**	P005	SU005	0.28	10.1	5.85	14.5	UP005C	UP005CD	40	1 9/16	0.28
30	1 27/64 36	5 3/16 132	1 1/32 26	4 11/64 106	1/2 13	7/16 11	2 3/4 70	1 11/32 34	0.965 24.5	0.295 7.5	3/8 M10	**UP006**	P006	SU006	0.42	13.2	8.25	14.7	UP006C	UP006CD	44	1 23/32	0.42

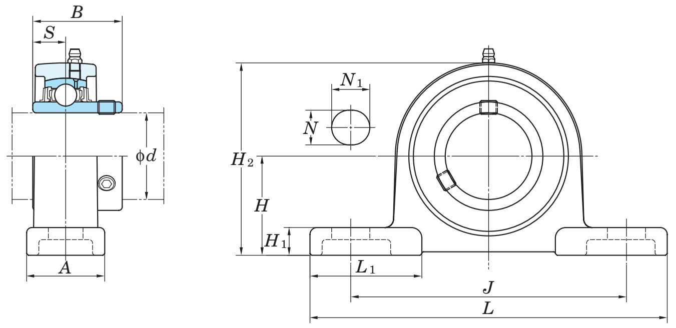
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter codes. (See **Table 10.5** in P.42.)
2. Clean series pillow type unit.
3. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCSP-H1S6

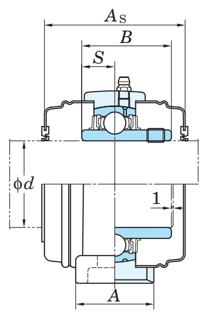
Cylindrical bore (with set screws)

d 20 ~ 50 mm





With Pressed Stainless Steel Cover



Variations of tolerance of distance from mounting bottom to center of spherical bore (Δ_{Hs}) and variations of tolerance of distance between centers of bolt holes (Δ_{Js})

Unit : mm

Housing No.	Δ_{Hs}	Δ_{Js}
SP204H1~SP210H1	±0.15	±0.3

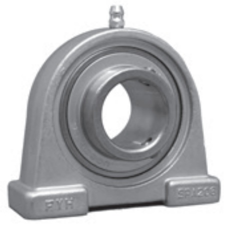
Shaft Dia. mm	Dimensions inch mm											Bolt Size inch mm	Standard					Basic Load Ratings kN		Factor	With Pressed Stainless Steel Cover				
d	H	L	A	J	N	N_1	H_1	H_2	L_1	B	S		Unit No.	Housing No.	Bearing No.		Mass kg	C_r	C_{0r}	f_0	Unit No. Open Type	Unit No. One Side Closed Type	Dimension A_s mm	Dimension A_s inch	Mass kg
20	1 5/16 33.3	5 127	1 3/16 30	3 3/4 95	1/2 13	23/32 18	7/16 11	2 15/32 63	1 21/32 42	1.220 31	0.500 12.7	3/8 M10	**UCSP204H1S6**	SP204H1	UC204S6		0.54	10.9	5.35	13.2	UCSP204H1CS6	UCSP204H1CDS6	45	1 25/32	0.54
25	1 7/16 36.5	5 1/2 140	1 3/16 30	4 1/8 105	1/2 13	3/4 19	15/32 12	2 23/32 69	1 13/16 46	1.343 34.1	0.563 14.3	3/8 M10	**UCSP205H1S6**	SP205H1	UC205S6		0.70	11.9	6.3	13.9	UCSP205H1CS6	UCSP205H1CDS6	49	1 15/16	0.70
30	1 11/16 42.9	6 1/2 165	1 13/32 36	4 3/4 121	21/32 17	13/16 21	1/2 13	3 3/16 81	2 1/8 54	1.500 38.1	0.626 15.9	1/2 M14	**UCSP206H1S6**	SP206H1	UC206S6		1.0	16.5	9.05	13.9	UCSP206H1CS6	UCSP206H1CDS6	53	2 3/32	1.0
35	1 7/8 47.6	6 9/16 167	1 1/2 38	5 127	21/32 17	13/16 21	9/16 14	3 19/32 91	2 51	1.689 42.9	0.689 17.5	1/2 M14	**UCSP207H1S6**	SP207H1	UC207S6		1.4	21.8	12.3	13.9	UCSP207H1CS6	UCSP207H1CDS6	60	2 3/8	1.4
40	1 15/16 49.2	7 1/4 184	1 9/16 40	5 13/32 137	21/32 17	13/16 21	9/16 14	3 13/16 97	2 3/8 60	1.937 49.2	0.748 19	1/2 M14	**UCSP208H1S6**	SP208H1	UC208S6		1.7	24.8	14.3	14.0	UCSP208H1CS6	UCSP208H1CDS6	69	2 23/32	1.7
45	2 1/8 54	7 15/32 190	1 9/16 40	5 3/4 146	21/32 17	13/16 21	19/32 15	4 3/32 104	2 13/32 61	1.937 49.2	0.748 19	1/2 M14	**UCSP209H1S6**	SP209H1	UC209S6		1.8	27.8	16.2	14.0	UCSP209H1CS6	UCSP209H1CDS6	69	2 23/32	1.8
50	2 1/4 57.2	8 1/8 206	1 25/32 45	6 1/4 159	25/32 20	7/8 22	5/8 16	4 3/8 111	2 9/16 65	2.031 51.6	0.748 19	5/8 M16	**UCSP210H1S6**	SP210H1	UC210S6		2.3	29.8	18.6	14.4	UCSP210H1CS6	UCSP210H1CDS6	74	2 29/32	2.3

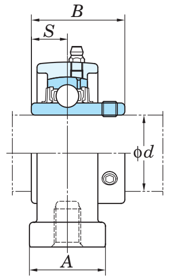
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter codes. (See **Table 10.5** in P.42.)
2. Stainless steel series thin pillow type unit.
3. Part No. of the applicable grease nipple is A-1/4-28UNFN12.
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

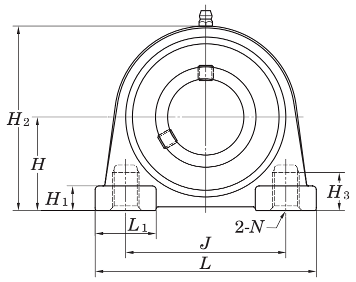
UCSPA-H1S6

Cylindrical bore (with set screws)

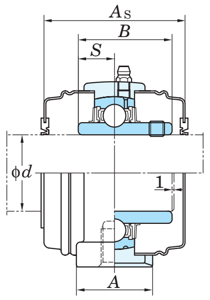
d 20 ~ 40 mm







With Pressed Stainless Steel Cover



Variations of tolerance of distance from mounting bottom to center of spherical bore (Δ_{Hs}) and variations of tolerance of distance between centers of bolt holes (Δ_{Js})

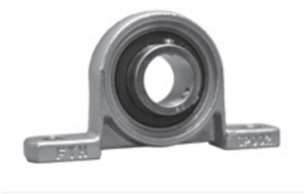
Unit : mm

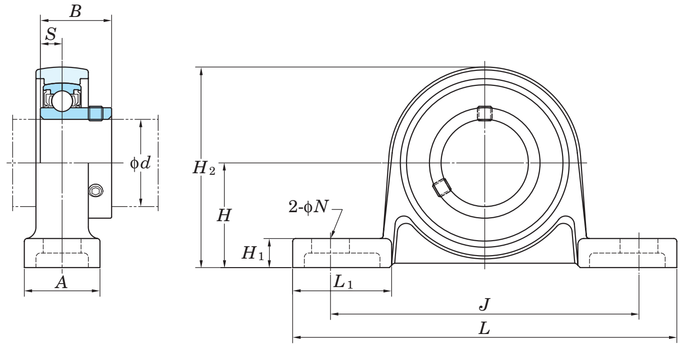
Housing No.	Δ_{Hs}	Δ_{Js}
SPA204H1~SPA208H1	±0.15	±0.5

Shaft Dia. mm	Dimensions inch mm											Standard					Basic Load Ratings kN		Factor	With Pressed Stainless Steel Cover				
												Unit No.	Housing No.	Bearing No.		Mass				Unit No.		Dimension mm	inch	Mass
d	H	L	A	J	N	H_1	H_2	H_3	L_1	B	S					kg	C_r	C_{0r}	f_0	Open Type	One Side Closed Type	A_s		kg
20	1 3/16 30.2	3 76	1 3/16 30	2 3/64 52	M10×1.5	13/32 10	2 3/8 60	1/2 13	7/8 22	1.220 31	0.500 12.7	**UCSPA204H1S6**	SPA204H1	UC204S6		0.46	10.9	5.35	13.2	UCSPA204H1CS6	UCSPA204H1CDS6	45	1 25/32	0.46
25	1 7/16 36.5	3 5/16 84	1 3/16 30	2 13/64 56	M10×1.5	15/32 12	2 23/32 69	1/2 13	15/16 24	1.343 34.1	0.563 14.3	**UCSPA205H1S6**	SPA205H1	UC205S6		0.63	11.9	6.3	13.9	UCSPA205H1CS6	UCSPA205H1CDS6	49	1 15/16	0.63
30	1 11/16 42.9	3 11/16 94	1 13/32 36	2 19/32 66	M14×2	15/32 12	3 3/16 81	23/32 18	1 3/32 28	1.500 38.1	0.626 15.9	**UCSPA206H1S6**	SPA206H1	UC206S6		0.91	16.5	9.05	13.9	UCSPA206H1CS6	UCSPA206H1CDS6	53	2 3/32	0.91
35	1 7/8 47.6	3 11/32 110	1 1/2 38	3 5/32 80	M14×2	1/2 13	3 19/32 91	25/32 20	1 3/16 30	1.689 42.9	0.689 17.5	**UCSPA207H1S6**	SPA207H1	UC207S6		1.3	21.8	12.3	13.9	UCSPA207H1CS6	UCSPA207H1CDS6	60	2 3/8	1.3
40	1 15/16 49.2	4 9/16 116	1 9/16 40	3 5/16 84	M14×2	1/2 13	3 13/16 97	25/32 20	1 1/4 32	1.937 49.2	0.748 19	**UCSPA208H1S6**	SPA208H1	UC208S6		1.5	24.8	14.3	14.0	UCSPA208H1CS6	UCSPA208H1CDS6	69	2 23/32	1.5

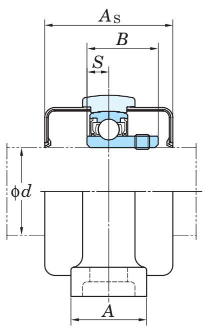
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter codes. (See **Table 10.5** in P.42.)
2. Part No. of the applicable grease nipple is A-1/4-28UNFN12.
3. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

USP-S6
Cylindrical bore (with set screws)
d 10 ~ 30 mm

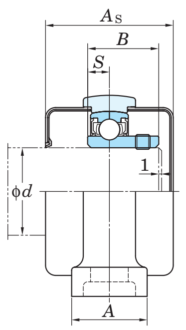




With Through Type Cover



With One Side Sealed Cover



Variations of tolerance of distance from mounting bottom to center of spherical bore ($\varDelta_{Hs}$) and variations of tolerance of distance between centers of bolt holes ($\varDelta_{Js}$)

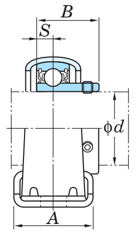
Unit : mm

Housing No.	$\varDelta_{Hs}$	$\varDelta_{Js}$
SP000~SP006	±0.15	±0.3

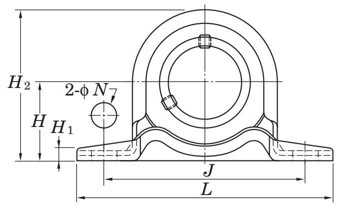
Shaft Dia. mm	Dimensions inch mm										Bolt Size inch mm	Standard Unit No.	Standard Housing No.	Standard Bearing No.	Mass	Basic Load Ratings kN		Factor	With Rubber Coated Cover Unit No. Open Type	With Rubber Coated Cover Unit No. One Side Closed Type	Dimension mm	Dimension inch	Mass
d	H	L	A	J	N	H_1	H_2	L_1	B	S					kg	C_r	C_{0r}	f_0			A_s		kg
10	45/64 18	2 5/8 67	5/8 16	2 3/32 53	9/32 7	3/16 5	1 3/8 35	23/32 18	0.591 15	0.197 5	1/4 M6	**USP000S6**	SP000	SU000S6	0.076	4.55	3.9	1.55	USP000CS6	USP000CDS6	29	1 5/32	0.076
12	3/4 19	2 25/32 71	5/8 16	2 7/32 56	9/32 7	3/16 5	1 15/32 37	23/32 18.5	0.591 15	0.197 5	1/4 M6	**USP001S6**	SP001	SU001S6	0.08	5.10	4.3	1.9	USP001CS6	USP001CDS6	29	1 5/32	0.08
15	55/64 22	3 5/32 80	5/8 16	2 15/32 63	9/32 7	1/4 6	1 11/16 42.5	13/16 20.5	0.650 16.5	0.217 5.5	1/4 M6	**USP002S6**	SP002	SU002S6	0.11	5.60	4.7	2.25	USP002CS6	USP002CDS6	31	1 7/32	0.11
17	15/16 24	3 11/32 85	23/32 18	2 5/8 67	9/32 7	1/4 6	1 13/16 46	13/16 21	0.689 17.5	0.236 6	1/4 M6	**USP003S6**	SP003	SU003S6	0.14	6.00	5.1	2.6	USP003CS6	USP003CDS6	33	1 5/16	0.14
20	1 7/64 28	3 15/16 100	25/32 20	3 5/32 80	13/32 10	5/16 8	2 5/32 54.5	31/32 25	0.827 21	0.276 7	5/16 M8	**USP004S6**	SP004	SU004S6	0.23	9.40	7.9	4	USP004CS6	USP004CDS6	38	1 1/2	0.23
25	1 17/64 32	4 13/32 112	25/32 20	3 17/32 90	13/32 10	11/32 9	2 13/32 61	1 3/32 27.5	0.866 22	0.276 7	5/16 M8	**USP005S6**	SP005	SU005S6	0.28	10.1	8.5	4.65	USP005CS6	USP005CDS6	40	1 9/16	0.28
30	1 27/64 36	5 3/16 132	1 1/32 26	4 3/16 106	1/2 13	13/32 10	2 23/32 69	1 11/32 34	0.965 24.5	0.295 7.5	3/8 M10	**USP006S6**	SP006	SU006S6	0.43	13.2	11.2	6.6	USP006CS6	USP006CDS6	44	1 23/32	0.43

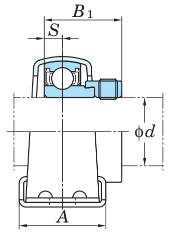
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter codes. (See **Table 10.5** in P.42.)
2. Clean size stainless steel series oval pillow type unit.
3. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

SBPP
Cylindrical bore
(with set screw locking)
SAPP
Cylindrical bore
(with eccentric locking collar)
d 12 ~ 30 mm



SBPP





SAPP

Variations of tolerance of distance between centers of bolt holes ($\varDelta_{Js}$) and variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

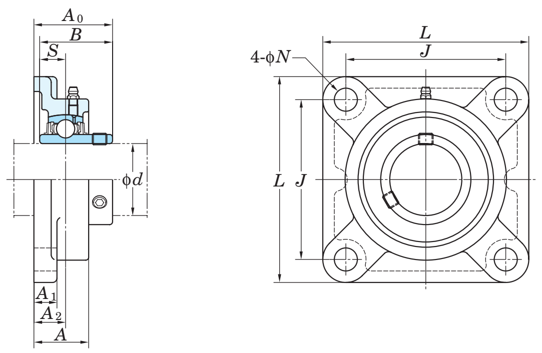
Unit : mm

Housing No.	$\varDelta_{Js}$	$\varDelta_{Ns}$
PP203~PP206	±0.4	±0.5

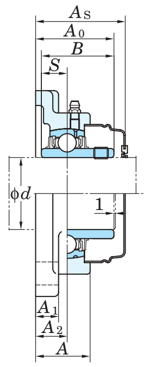
Shaft Dia		Dimensions										Bolt Size	Unit No.	Bearing No.	Unit No.	Bearing No.	Housing No.	Basic Load Ratings		Factor	Mass	
mm	inch	inch mm										inch mm						kN			kg	
d		*H*	*L*	*A*	*J*	*N*	H_1	H_2	*S*	SBPP *B*	SAPP B_1							C_r	C_{0r}	f_0	SBPP	SAPP
12		7/8 22.2	3 3/8 86	31/32 25	2 43/64 68	3/8 9.5	1/8 3.2	1 23/32 43.8	0.236 6	0.866 22	1.122 28.5	5/16 M8	**SBPP201**	SB201	**SAPP201**	SA201	PP203	9.55	4.80	13.2	0.16	0.19
	1/2												**SBPP201-8**	SB201-8	**SAPP201-8**	SA201-8						
15													**SBPP202**	SB202	**SAPP202**	SA202						
	5/8												**SBPP202-10**	SB202-10	**SAPP202-10**	SA202-10						
17													**SBPP203**	SB203	**SAPP203**	SA203						
	3/4	1 25.4	3 27/32 98	1 1/4 32	2 63/64 76	3/8 9.5	1/8 3.2	2 50.5	0.276 7	0.984 25	1.161 29.5	5/16 M8	**SBPP204-12**	SB204-12	**SAPP204-12**	SA204-12	PP204	12.8	6.65	13.2	0.23	0.23
20													**SBPP204**	SB204	**SAPP204**	SA204						
	7/8	1 1/8 28.6	4 1/4 108	1 1/4 32	3 25/64 86	29/64 11.5	5/32 4	27/32 56.6	0.295 7.5	1.063 27	1.201 30.5	3/8 M10	**SBPP205-14**	SB205-14	**SAPP205-14**	SA205-14	PP205	14.0	7.85	13.9	0.28	0.32
	15/16												**SBPP205-15**	SB205-15	**SAPP205-15**	SA205-15						
25													**SBPP205**	SB205	**SAPP205**	SA205						
	1												**SBPP205-16**	SB205-16	**SAPP205-16**	SA205-16						
	1 1/8	15/16 33.3	4 19/32 117	1 1/2 38	3 3/4 95	29/64 11.5	5/32 4	2 5/8 66.3	0.315 8	1.181 30	1.335 33.9	3/8 M10	**SBPP206-18**	SB206-18	**SAPP206-18**	SA206-18	PP206	19.5	11.3	13.9	0.47	0.50
30													**SBPP206**	SB206	**SAPP206**	SA206						
	13/16												**SBPP206-19**	SB206-19	**SAPP206-19**	SA206-19						
	1 1/4												**SBPP206-20**	SB206-20	**SAPP206-20**	SA206-20						

Remark For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

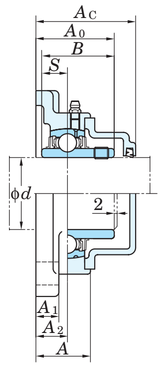
UCF
Cylindrical bore (with set screws)
d 12 ~ (45) mm



With Pressed Steel Cover



With Cast Iron Cover



Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$) and tolerance of position of bolt hole (X)

Unit : mm

Housing No.			$\varDelta_{A2s}$	X
F204~F210	FX05~FX10	F305~F310	±0.5	0.7
F211~F218	FX11~FX20	F311~F328	±0.8	1

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

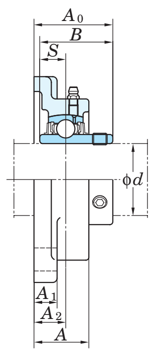
Unit : mm

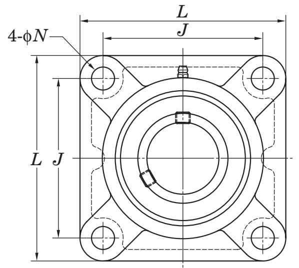
Housing No.			$\varDelta_{Ns}$
F204~F218	FX05~FX18	F305~F315	±0.2
	FX20	F316~F328	±0.3

Shaft Dia.		Dimensions									Bolt Size	Standard			Mass	Basic Load Ratings		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm	inch	inch mm									inch mm	Unit No.	Housing No.	Bearing No.	kg	kN			Unit No.		Dimension		Mass	Unit No.		Dimension		Mass
d		L	A	J	N	A_1	A_2	A_0	B	S						C_r	C_{0r}	f_0	Open Type	Closed Type	mm A_s	inch	kg	Open Type	Closed Type	mm A_c	inch	kg
12		3 3/8 86	1 25.5	2 33/64 64	15/32 12	7/16 11	19/32 15	1 5/16 33.3	1.220 31	0.500 12.7	3/8 M10	**UCF201**	F204	UC201	0.64	12.8	6.65	13.2	UCF201C	UCF201D	37	1 15/32	0.64	–	–	–	–	–
	1/2											**UCF201-8**		UC201-8	0.64				–	–	–	–	–	–	–	–	–	–
15												**UCF202**		UC202	0.62				UCF202C	UCF202D	37	1 15/32	0.62	–	–	–	–	–
	5/8											**UCF202-10**		UC202-10	0.62				–	–	–	–	–	–	–	–	–	–
17												**UCF203**		UC203	0.61				UCF203C	UCF203D	37	1 15/32	0.61	–	–	–	–	–
	3/4											**UCF204-12**		UC204-12	0.61				–	–	–	–	–	–	–	–	–	–
20												**UCF204**		UC204	0.59				UCF204C	UCF204D	37	1 15/32	0.59	UCF204FC	UCF204FD	46	1 13/16	0.74
25	7/8	3 3/4 95	1 1/16 27	2 3/4 70	15/32 12	1/2 13	5/8 16	1 13/32 35.8	1.343 34.1	0.563 14.3	3/8 M10	**UCF205-14**	F205	UC205-14	0.83	14.0	7.85	13.9	–	–	–	–	–	–	–	–	–	–
	15/16											**UCF205-15**		UC205-15	0.83				–	–	–	–	–	–	–	–	–	–
												UCF205		UC205	0.83				UCF205C	UCF205D	40	1 9/16	0.83	UCF205FC	UCF205FD	49	1 15/16	1.0
	1											**UCF205-16**		UC205-16	0.83				–	–	–	–	–	–	–	–	–	–
		4 1/4 108	1 3/16 30	3 17/64 83	15/32 12	1/2 13	45/64 18	1 19/32 40.2	1.500 38.1	0.626 15.9	3/8 M10	**UCFX05**	FX05	UCX05	1.2	19.5	11.3	13.9	UCFX05C	UCFX05D	44	1 23/32	1.2	–	–	–	–	–
	1											**UCFX05-16**		UCX05-16	1.2				–	–	–	–	–	–	–	–	–	–
		4 11/32 110	1 5/32 29	3 5/32 80	5/8 16	1/2 13	5/8 16	1 17/32 39	1.496 38	0.591 15	1/2 M14	**UCF305**	F305	UC305	1.3	21.2	10.9	12.6	–	–	–	–	–	UCF305C	UCF305D	54	2 1/8	1.6
	1											**UCF305-16**		UC305-16	1.3				–	–	–	–	–	–	–	–	–	–
30	1 1/8	4 1/4 108	1 7/32 31	3 17/64 83	15/32 12	1/2 13	45/64 18	1 19/32 40.2	1.500 38.1	0.626 15.9	3/8 M10	**UCF206-18**	F206	UC206-18	1.1	19.5	11.3	13.9	–	–	–	–	–	–	–	–	–	–
												UCF206		UC206	1.1				UCF206C	UCF206D	44	1 23/32	1.1	UCF206FC	UCF206FD	53	2 3/32	1.4
	1 3/16											**UCF206-19**		UC206-19	1.1				–	–	–	–	–	–	–	–	–	–
	1 1/4											**UCF206-20**		UC206-20	1.1				–	–	–	–	–	–	–	–	–	–
		4 19/32 117	1 11/32 34	3 5/8 92	5/8 16	9/16 14	3/4 19	1 3/4 44.4	1.689 42.9	0.689 17.5	1/2 M14	**UCFX06**	FX06	UCX06	1.6	25.7	15.4	13.9	UCFX06C	UCFX06D	49	1 15/16	1.6	–	–	–	–	–
	1 3/16											**UCFX06-19**		UCX06-19	1.6				–	–	–	–	–	–	–	–	–	–
	1 1/4											**UCFX06-20**		UCX06-20	1.6				–	–	–	–	–	–	–	–	–	–
	–	4 29/32 125	1 1/4 32	3 47/64 95	5/8 16	19/32 15	45/64 18	1 23/32 44	1.693 43	0.669 17	1/2 M14	**UCF306**	F306	UC306	1.9	26.7	15.0	13.3	–	–	–	–	–	UCF306C	UCF306D	59	2 5/16	2.2
35	1 1/4	4 19/32 117	1 11/32 34	3 5/8 92	35/64 14	19/32 15	3/4 19	1 3/4 44.4	1.689 42.9	0.689 17.5	7/16 M12	**UCF207-20**	F207	UC207-20	1.5	25.7	15.4	13.9	–	–	–	–	–	–	–	–	–	–
	1 5/16											**UCF207-21**		UC207-21	1.5				–	–	–	–	–	–	–	–	–	–
	1 3/8											**UCF207-22**		UC207-22	1.5				–	–	–	–	–	–	–	–	–	–
												UCF207		UC207	1.5				UCF207C	UCF207D	49	1 15/16	1.5	UCF207FC	UCF207FD	58	2 9/32	1.9
	1 7/16											**UCF207-23**		UC207-23	1.5				–	–	–	–	–	–	–	–	–	–
	1 3/8	5 1/8 130	1 1/2 38	4 1/64 102	5/8 16	9/16 14	53/64 21	2 1/32 51.2	1.937 49.2	0.748 19	1/2 M14	**UCFX07-22**	FX07	UCX07-22	2.0	29.1	17.8	14.0	–	–	–	–	–	–	–	–	–	–
												UCFX07		UCX07	2.0				UCFX07C	UCFX07D	55	2 5/32	2.0	–	–	–	–	–
	1 7/16											**UCFX07-23**		UCX07-23	2.0				–	–	–	–	–	–	–	–	–	–
	–	5 5/16 135	1 13/32 36	3 15/16 100	3/4 19	5/8 16	25/32 20	1 15/16 49	1.890 48	0.748 19	5/8 M16	**UCF307**	F307	UC307	2.3	33.4	19.3	13.2	–	–	–	–	–	UCF307C	UCF307D	64	2 17/32	2.7
40	1 1/2	5 1/8 130	1 13/32 36	4 1/64 102	5/8 16	19/32 15	53/64 21	2 1/32 51.2	1.937 49.2	0.748 19	1/2 M14	**UCF208-24**	F208	UC208-24	1.9	29.1	17.8	14.0	–	–	–	–	–	–	–	–	–	–
	1 9/16											**UCF208-25**		UC208-25	1.9				–	–	–	–	–	–	–	–	–	–
												UCF208		UC208	1.9				UCF208C	UCF208D	55	2 5/32	1.9	UCF208FC	UCF208FD	64	2 17/32	2.3
	1 1/2	5 13/32 137	1 9/16 40	4 9/64 105	3/4 19	9/16 14	55/64 22	2 1/16 52.2	1.937 49.2	0.748 19	5/8 M16	**UCFX08-24**	FX08	UCX08-24	2.4	34.1	21.3	14.0	–	–	–	–	–	–	–	–	–	–
												UCFX08		UCX08	2.4				UCFX08C	UCFX08D	56	2 7/32	2.4	–	–	–	–	–
	1 1/2	5 29/32 150	1 9/16 40	4 13/32 112	3/4 19	21/32 17	29/32 23	2 7/32 56	2.047 52	0.748 19	5/8 M16	**UCF308-24**	F308	UC308-24	3.1	40.7	24.0	13.2	–	–	–	–	–	–	–	–	–	–
												UCF308		UC308	3.1				–	–	–	–	–	UCF308C	UCF308D	71	2 25/32	3.6
45	1 5/8	5 13/32 137	1 1/2 38	4 9/64 105	5/8 16	5/8 16	55/64 22	2 1/16 52.2	1.937 49.2	0.748 19	1/2 M14	**UCF209-26**	F209	UC209-26	2.2	34.1	21.3	14.0	–	–	–	–	–	–	–	–	–	–
	1 11/16											**UCF209-27**		UC209-27	2.2				–	–	–	–	–	–	–	–	–	–
	1 3/4											**UCF209-28**		UC209-28	2.2				–	–	–	–	–	–	–	–	–	–
												UCF209		UC209	2.2				UCF209C	UCF209D	56	2 7/32	2.2	UCF209FC	UCF209FD	66	2 19/32	2.6
	1 3/4	5 5/8 143	1 9/16 40	4 3/8 111	3/4 19	9/16 14	29/32 23	2 3/16 55.6	2.031 51.6	0.748 19	5/8 M16	**UCFX09-28**	FX09	UCX09-28	2.7	35.1	23.3	14.4	–	–	–	–	–	–	–	–	–	–
												UCFX09		UCX09	2.7				UCFX09C	UCFX09D	60	2 3/8	2.7	–	–	–	–	–

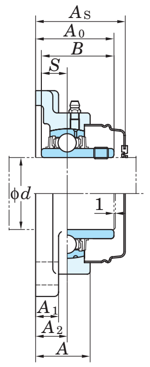
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210, X05~X09, 305~308
A-PT1/8 .... 211~218, X10~X20, 309~328
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (L2) follows the Part No. of unit or bearing. (Example of Part No. : UCF206JL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCF
Cylindrical bore (with set screws)
d (45) ~ (75) mm

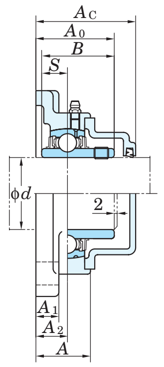




With Pressed Steel Cover



With Cast Iron Cover



Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$) and tolerance of position of bolt hole (X)

Unit : mm

Housing No.			$\varDelta_{A2s}$	X
F204~F210	FX05~FX10	F305~F310	±0.5	0.7
F211~F218	FX11~FX20	F311~F328	±0.8	1

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

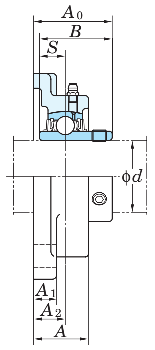
Unit : mm

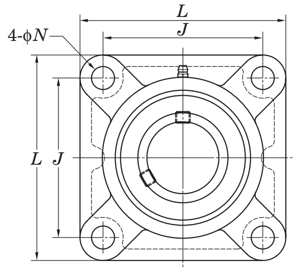
Housing No.			$\varDelta_{Ns}$
F204~F218	FX05~FX18	F305~F315	±0.2
	FX20	F316~F328	±0.3

Shaft Dia.		Dimensions inch mm									Bolt Size inch mm	Standard			Mass	Basic Load Ratings kN		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm	inch											Unit No.	Housing No.	Bearing No.					Unit No.		Dimension		Mass	Unit No.		Dimension		Mass
																			Open Type	Closed Type	mm	inch		Open Type	Closed Type	mm	inch	
d		*L*	*A*	*J*	*N*	A_1	A_2	A_0	*B*	*S*					kg	C_r	C_{0r}	f_0			A_s		kg			A_c		kg
45	1 3/4	6 5/16	1 23/32	4 59/64	3/4	23/32	63/64	2 3/8	2.244	0.866	5/8	**UCF309-28**	F309	UC309-28	4.0	48.9	29.5	13.3	–	–	–	–	–	–	–	–	–	–
		160	44	125	19	18	25	60	57	22	M16	**UCF309**		UC309	4.0				–	–	–	–	–	UCF309C	UCF309D	76	3	4.6
50	1 7/8											**UCF210-30**	F210	UC210-30	2.5	35.1	23.3	14.4	–	–	–	–	–	–	–	–	–	–
	1 15/16	5 5/8	1 9/16	4 3/8	5/8	5/8	55/64	2 5/32	2.031	0.748	1/2	**UCF210-31**		UC210-31	2.5				–	–	–	–	–	–	–	–	–	–
		143	40	111	16	16	22	54.6	51.6	19	M14	**UCF210**		UC210	2.5				UCF210C	UCF210D	59	2 5/16	2.5	UCF210FC	UCF210FD	70.5	2 25/32	3.0
	2											**UCF210-32**		UC210-32	2.5				–	–	–	–	–	–	–	–	–	–
	1 15/16	6 3/8	1 23/32	5 1/8	3/4	25/32	1 1/32	2 11/32	2.189	0.874	5/8	**UCFX10-31**	FX10	UCX10-31	3.7	43.4	29.4	14.4	–	–	–	–	–	–	–	–	–	–
		162	44	130	19	20	26	59.4	55.6	22.2	M16	**UCFX10**		UCX10	3.7				UCFX10C	UCFX10D	64	2 17/32	3.7	–	–	–	–	–
	2											**UCFX10-32**		UCX10-32	3.7				–	–	–	–	–	–	–	–	–	–
	–	6 7/8 175	1 7/8 48	5 13/64 132	29/32 23	3/4 19	1 7/64 28	2 5/8 67	2.402 61	0.866 22	3/4 M20	**UCF310**	F310	UC310	5.1	62.0	38.3	13.2	–	–	–	–	–	UCF310C	UCF310D	83	3 9/32	5.9
55	2											**UCF211-32**	F211	UC211-32	3.4	43.4	29.4	14.4	–	–	–	–	–	–	–	–	–	–
	2 1/8	6 3/8	1 11/16	5 1/8	3/4	23/32	63/64	2 5/16	2.189	0.874	5/8	**UCF211-34**		UC211-34	3.4				–	–	–	–	–	–	–	–	–	–
		162	43	130	19	18	25	58.4	55.6	22.2	M16	**UCF211**		UC211	3.4				UCF211C	UCF211D	63	2 15/32	3.4	UCF211FC	UCF211FD	74.5	2 15/16	4.0
	2 3/16											**UCF211-35**		UC211-35	3.4				–	–	–	–	–	–	–	–	–	–
		6 7/8	1 15/16	5 5/8	3/4	25/32	1 9/64	2 23/32	2.563	1.000	5/8	**UCFX11**	FX11	UCX11	4.9	52.4	36.2	14.4	UCFX11C	UCFX11D	73	2 7/8	4.9	–	–	–	–	–
	2 3/16	175	49	143	19	20	29	68.7	65.1	25.4	M16	**UCFX11-35**		UCX11-35	4.9				–	–	–	–	–	–	–	–	–	–
	2 1/4											**UXPX11-36**		UCX11-36	4.9				–	–	–	–	–	–	–	–	–	–
	2	7 9/32	2 1/16	5 33/64	29/32	25/32	1 3/16	2 25/32	2.598	0.984	3/4	**UCF311-32**	F311	UC311-32	5.6	71.6	45.0	13.2	–	–	–	–	–	–	–	–	–	–
		185	52	140	23	20	30	71	66	25	M20	**UCF311**		UC311	5.6				–	–	–	–	–	UCF311C	UCF311D	87	3 7/16	6.5
60	2 1/4											**UCF212-36**	F212	UC212-36	4.2	52.4	36.2	14.4	–	–	–	–	–	–	–	–	–	–
		6 7/8	1 7/8	5 5/8	3/4	23/32	1 9/64	2 23/32	2.563	1.000	5/8	**UCF212**		UC212	4.2				UCF212C	UCF212D	73	2 7/8	4.2	UCF212FC	UCF212FD	86	3 3/8	5.0
	2 3/8	175	48	143	19	18	29	68.7	65.1	25.4	M16	**UCF212-38**		UC212-38	4.2				–	–	–	–	–	–	–	–	–	–
	2 7/16											**UCF212-39**		UC212-39	4.2				–	–	–	–	–	–	–	–	–	–
		7 3/8	2 5/16	5 55/64	3/4	13/16	1 11/32	2 29/32	2.563	1.000	5/8	**UCFX12**	FX12	UCX12	5.7	57.2	40.1	14.4	UCFX12C	UCFX12D	78	3 1/16	5.7	–	–	–	–	–
	2 7/16	187	59	149	19	21	34	73.7	65.1	25.4	M16	**UCFX12-39**		UCX12-39	5.7				–	–	–	–	–	–	–	–	–	–
	–	7 11/16 195	2 7/32 56	5 29/32 150	29/32 23	7/8 22	1 19/64 33	3 1/16 78	2.795 71	1.024 26	3/4 M20	**UCF312**	F312	UC312	6.9	81.9	52.2	13.2	–	–	–	–	–	UCF312C	UCF312D	95	3 3/4	8.1
65	2 1/2	7 3/8	1 31/32	5 55/64	3/4	7/8	1 3/16	2 3/4	2.563	1.000	5/8	**UCF213-40**	F213	UC213-40	5.2	57.2	40.1	14.4	–	–	–	–	–	–	–	–	–	–
		187	50	149	19	22	30	69.7	65.1	25.4	M16	**UCF213**		UC213	5.2				UCF213C	UCF213D	74	2 29/32	5.2	UCF213FC	UCF213FD	87	3 7/16	6.0
	2 1/2	7 3/8	2 5/16	5 55/64	3/4	13/16	1 11/32	3 3/32	2.937	1.189	5/8	**UCFX13-40**	FX13	UCX13-40	6.3	62.2	44.1	14.5	–	–	–	–	–	–	–	–	–	–
		187	59	149	19	21	34	78.4	74.6	30.2	M16	**UCFX13**		UCX13	6.3				UCFX13C	UCFX13D	83	3 9/32	6.3	–	–	–	–	–
	2 1/2	8 3/16	2 9/32	6 17/32	29/32	7/8	1 19/64	3 1/16	2.953	1.181	3/4	**UCF313-40**	F313	UC313-40	7.8	92.7	59.9	13.2	–	–	–	–	–	–	–	–	–	–
		208	58	166	23	22	33	78	75	30	M20	**UCF313**		UC313	7.8				–	–	–	–	–	UCF313C	UCF313D	94	3 11/16	8.9
70	2 3/4	7 19/32	2 1/8	5 63/64	3/4	7/8	1 7/32	2 31/32	2.937	1.189	5/8	**UCF214-44**	F214	UC214-44	5.9	62.2	44.1	14.5	–	–	–	–	–	–	–	–	–	–
		193	54	152	19	22	31	75.4	74.6	30.2	M16	**UCF214**		UC214	5.9				UCF214C	UCF214D	80	3 5/32	5.9	UCF214FC	UCF214FD	93	3 21/32	6.8
	2 3/4	7 3/4	2 3/8	5 63/64	29/32	7/8	1 29/64	3 7/32	3.063	1.331	3/4	**UCFX14-44**	FX14	UCX14-44	7.0	67.4	48.3	14.5	–	–	–	–	–	–	–	–	–	–
		197	60	152	23	22	37	81.5	77.8	33.3	M20	**UCFX14**		UCX14	7.0				UCFX14C	UCFX14D	86	3 3/8	7.0	–	–	–	–	–
	2 3/4	8 29/32	2 13/32	7 1/64	63/64	31/32	1 27/64	3 3/16	3.071	1.299	7/8	**UCF314-44**	F314	UC314-44	10.1	104	68.2	13.2	–	–	–	–	–	–	–	–	–	–
		226	61	178	25	25	36	81	78	33	M22	**UCF314**		UC314	10.1				–	–	–	–	–	UCF314C	UCF314D	98	3 27/32	11.2
75	2 15/16	7 7/8	2 7/32	6 17/64	3/4	7/8	1 11/32	3 3/32	3.063	1.311	5/8	**UCF215-47**	F215	UC215-47	6.4	67.4	48.3	14.5	–	–	–	–	–	–	–	–	–	–
		200	56	159	19	22	34	78.5	77.8	33.3	M16	**UCF215**		UC215	6.4				UCF215C	UCF215D	83	3 9/32	6.4	UCF215FC	UCF215FD	96	3 25/32	7.4
	3											**UCF215-48**		UC215-48	6.4				–	–	–	–	–	–	–	–	–	–
	2 15/16	7 3/4	2 11/16	5 63/64	29/32	15/16	1 9/16	3 17/32	3.252	1.311	3/4	**UCFX15-47**	FX15	UCX15-47	8.4	72.7	53.0	14.6	–	–	–	–	–	–	–	–	–	–
		197	68	152	23	24	40	89.3	82.6	33.3	M20	**UCFX15**		UCX15	8.4				UCFX15C	UCFX15D	94	3 11/16	8.4	–	–	–	–	–
	3											**UCFX15-48**		UCX15-48	8.4				–	–	–	–	–	–	–	–	–	–

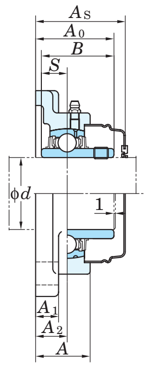
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210, X05~X09, 305~308
A-PT1/8 .... 211~218, X10~X20, 309~328
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (L2) follows the Part No. of unit or bearing. (Example of Part No. : UCF206JL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCF
Cylindrical bore (with set screws)
d (75) ~ 140 mm

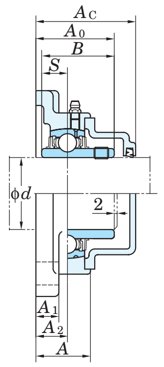




With Pressed Steel Cover



With Cast Iron Cover



Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$) and tolerance of position of bolt hole (X)

Unit : mm

Housing No.			$\varDelta_{A2s}$	X
F204~F210	FX05~FX10	F305~F310	±0.5	0.7
F211~F218	FX11~FX20	F311~F328	±0.8	1

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

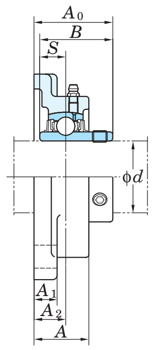
Unit : mm

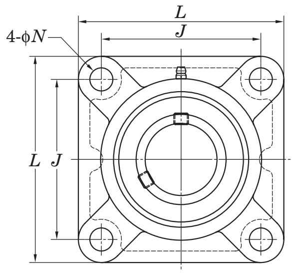
Housing No.			$\varDelta_{Ns}$
F204~F218	FX05~FX18	F305~F315	±0.2
	FX20	F316~F328	±0.3

Shaft Dia.		Dimensions									Bolt Size	Standard			Mass	Basic Load Ratings		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm	inch	inch										Unit No.	Housing No.	Bearing No.		kN			Unit No.		Dimension		Mass	Unit No.		Dimension		Mass
		mm									inch mm								Open Type	Closed Type	mm	inch		Open Type	Closed Type	mm	inch	
d		*L*	*A*	*J*	*N*	A_1	A_2	A_0	*B*	*S*					kg	C_r	C_{0r}	f_0			A_s		kg			A_c		kg
75	2 15/16	9 9/32 236	2 19/32 66	7 1/4 184	63/64 25	31/32 25	1 17/32 39	3 1/2 89	3.228 82	1.260 32	7/8 M22	**UCF315-47**	F315	UC315-47	11.6	113	77.2	13.2	–	–	–	–	–	–	–	–	–	–
												UCF315		UC315	11.6				–	–	–	–	–	UCF315C	UCF315D	106	4 3/16	12.9
	3											**UCF315-48**		UC315-48	11.6				–	–	–	–	–	–	–	–	–	–
80	3 1/8	8 3/16 208	2 9/32 58	6 1/2 165	29/32 23	7/8 22	1 11/32 34	3 9/32 83.3	3.252 82.6	1.311 33.3	3/4 M20	**UCF216-50**	F216	UC216-50	7.3	72.7	53.0	14.6	–	–	–	–	–	–	–	–	–	–
												UCF216		UC216	7.3				UCF216C	UCF216D	88	3 15/32	7.3	UCF216FC	UCF216FD	103	4 1/16	8.5
	–	8 7/16 214	2 3/4 70	6 47/64 171	29/32 23	15/16 24	1 9/16 40	3 19/32 91.6	3.374 85.7	1.343 34.1	3/4 M20	**UCFX16**	FX16	UCX16	9.4	84.0	61.9	14.5	UCFX16C	UCFX16D	96	3 25/32	9.4	–	–	–	–	–
	–	9 27/32 250	2 11/16 68	7 23/32 196	1 7/32 31	1 1/16 27	1 1/2 38	3 17/32 90	3.386 86	1.339 34	1 M27	**UCF316**	F316	UC316	12.8	123	86.7	13.3	–	–	–	–	–	UCF316C	UCF316D	107	4 7/32	14.2
85	3 1/4	8 21/32 220	2 15/32 63	6 57/64 175	29/32 23	15/16 24	1 13/32 36	3 7/16 87.6	3.374 85.7	1.343 34.1	3/4 M20	**UCF217-52**	F217	UC217-52	8.9	84.0	61.9	14.5	–	–	–	–	–	–	–	–	–	–
												UCF217		UC217	8.9				UCF217C	UCF217D	92	3 5/8	8.9	UCF217FC	UCF217FD	107	4 7/32	10.3
		8 7/16 214	2 3/4 70	6 47/64 171	29/32 23	15/16 24	1 9/16 40	3 25/32 96.3	3.780 96	1.563 39.7	3/4 M20	**UCFX17**	FX17	UCX17	10.8	96.1	71.5	14.5	UCFX17C	UCFX17D	101	3 31/32	10.8	–	–	–	–	–
	3 7/16											**UCFX17-55**		UCX17-55	10.8				–	–	–	–	–	–	–	–	–	–
	–	10 1/4 260	2 29/32 74	8 1/32 204	1 7/32 31	1 1/16 27	1 47/64 44	3 15/16 100	3.780 96	1.575 40	1 M27	**UCF317**	F317	UC317	15.3	133	96.8	13.3	–	–	–	–	–	UCF317C	UCF317D	117	4 19/32	16.9
90	3 1/2	9 1/4 235	2 11/16 68	7 23/64 187	29/32 23	31/32 25	1 9/16 40	3 25/32 96.3	3.780 96	1.563 39.7	3/4 M20	**UCF218-56**	F218	UC218-56	11.4	96.1	71.5	14.5	–	–	–	–	–	–	–	–	–	–
												UCF218		UC218	11.4				UCF218C	UCF218D	101	3 31/32	11.4	UCF218FC	UCF218FD	116	4 9/16	12.9
	–	8 7/16 214	3 76	6 47/64 171	29/32 23	15/16 24	1 49/64 45	4 3/16 106.1	4.094 104	1.689 42.9	3/4 M20	**UCFX18**	FX18	UCX18	11.9	109	81.9	14.4	–	–	–	–	–	UCFX18C	UCFX18C	124	4 7/8	13.6
	3 1/2	11 1/32 280	3 76	8 1/2 216	1 3/8 35	1 3/16 30	1 47/64 44	3 15/16 100	3.780 96	1.575 40	1 1/8 M30	**UCF318-56**	F318	UC318-56	18.9	143	107	13.3	–	–	–	–	–	–	–	–	–	–
												UCF318		UC318	18.9				–	–	–	–	–	UCF318C	UCF318D	119	4 11/16	20.8
95	–	11 13/32 290	3 11/16 94	8 31/32 228	1 3/8 35	1 3/16 30	2 21/64 59	4 3/4 121	4.055 103	1.614 41	1 1/8 M30	**UCF319**	F319	UC319	21.6	153	119	13.3	–	–	–	–	–	UCF319C	UCF319D	140	5 1/2	23.8
100		10 9/16 268	3 13/16 97	8 5/16 211	1 7/32 31	1 3/32 28	2 21/64 59	5 127.3	4.626 117.5	1.937 49.2	1 M27	**UCFX20**	FX20	UCX20	19.4	133	105	14.4	–	–	–	–	–	UCFX20C	UCFX20D	152	5 31/32	21.6
	3 15/16											**UCFX20-63**		UCX20-63	19.4				–	–	–	–	–	–	–	–	–	–
	4											**UCFX20-64**		UCX20-64	19.4				–	–	–	–	–	–	–	–	–	–
		12 7/32 310	3 11/16 94	9 17/32 242	1 1/2 38	1 1/4 32	2 21/64 59	4 29/32 125	4.252 108	1.654 42	1 1/4 M33	**UCF320**	F320	UC320	25.8	173	141	13.2	–	–	–	–	–	UCF320C	UCF320D	146	5 3/4	28.6
	3 15/16											**UCF320-63**		UC320-63	25.8				–	–	–	–	–	–	–	–	–	–
	4											**UCF320-64**		UC320-64	25.8				–	–	–	–	–	–	–	–	–	–
105	–	12 7/32 310	3 11/16 94	9 17/32 242	1 1/2 38	1 1/4 32	2 21/64 59	5 127	4.409 112	1.732 44	1 1/4 M33	**UCF321**	F321	UC321	30.2	184	153	13.2	–	–	–	–	–	UCF321C	UCF321D	148	5 13/16	33.2
110	–	13 3/8 340	3 25/32 96	10 15/32 266	1 39/64 41	1 3/8 35	2 23/64 60	5 5/32 131	4.606 117	1.811 46	1 3/8 M36	**UCF322**	F322	UC322	35.3	205	180	13.2	–	–	–	–	–	UCF322C	UCF322D	154	6 1/16	41.7
120	–	14 9/16 370	4 11/32 110	11 27/64 290	1 39/64 41	1 9/16 40	2 9/16 65	5 1/2 140	4.961 126	2.008 51	1 3/8 M36	**UCF324**	F324	UC324	47.3	207	185	13.5	–	–	–	–	–	UCF324C	UCF324D	163	6 13/32	52.1
130	–	16 5/32 410	4 17/32 115	12 19/32 320	1 39/64 41	1 25/32 45	2 9/16 65	5 3/4 146	5.315 135	2.126 54	1 3/8 M36	**UCF326**	F326	UC326	65.5	229	214	13.6	–	–	–	–	–	UCF326C	UCF326D	172	6 25/32	71.6
140	–	17 23/32 450	4 29/32 125	13 25/32 350	1 39/64 41	2 5/32 55	2 61/64 75	6 11/32 161	5.709 145	2.323 59	1 3/8 M36	**UCF328**	F328	UC328	93.4	253	246	13.6	–	–	–	–	–	UCF328C	UCF328D	186	7 5/16	101

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210, X05~X09, 305~308
A-PT1/8 .... 211~218, X10~X20, 309~328
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (L2) follows the Part No. of unit or bearing. (Example of Part No. : UCF206JL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCF-E
Cylindrical bore (with set screws)
d 12 ~ 55 mm





Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$) and tolerance of position of bolt hole (X)

Unit : mm

Housing No.		$\varDelta_{A2s}$	X
F204E~F210E	FX05E~FX10E	±0.5	0.7
F211E~F217E	FX11E~FX17E	±0.8	1

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

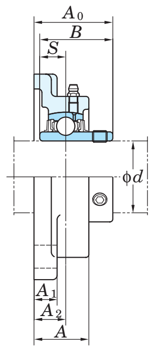
Unit : mm

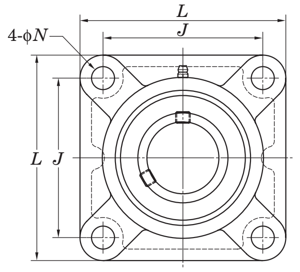
Housing No.		$\varDelta_{Ns}$
F204E~F217E	FX05E~FX17E	±0.2

Shaft Dia.		Dimensions									Bolt Size	Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN		Factor	Mass
mm	inch	inch mm									inch							
d		L	A	J	N	A_1	A_2	A_0	B	S					C_r	C_{0r}	f_0	kg
12		3 3/8 86	1 25.5	2 33/64 64	7/16 11	7/16 11	19/32 15	1 5/16 33.3	1.220 31	0.500 12.7	3/8	**UCF201E**	F204E	UC201	12.8	6.65	13.2	0.64
	1/2											**UCF201E-8**		UC201-8				
15												**UCF202E**		UC202				0.62
	5/8											**UCF202E-10**		UC202-10				
17												**UCF203E**		UC203				0.61
	3/4											**UCF204E-12**		UC204-12				
20												**UCF204E**		UC204				0.59
	7/8	3 3/4 95	1 1/16 27	2 3/4 70	29/64 11.5	1/2 13	5/8 16	1 13/32 35.8	1.343 34.1	0.563 14.3	3/8	**UCF205E-14**	F205E	UC205-14	14.0	7.85	13.9	0.83
	15/16											**UCF205E-15**		UC205-15				
25												**UCF205E**		UC205				
	1											**UCF205E-16**		UC205-16				
		4 1/4 108	1 3/16 30	3 17/64 83	29/64 11.5	1/2 13	45/64 18	1 19/32 40.2	1.500 38.1	0.626 15.9	3/8	**UCFX05E**	FX05E	UCX05	19.5	11.3	13.9	1.2
	1											**UCFX05E-16**		UCX05-16				
	1 1/8	4 1/4 108	1 7/32 31	3 17/64 83	33/64 13	1/2 13	45/64 18	1 19/32 40.2	1.500 38.1	0.626 15.9	7/16	**UCF206E-18**	F206E	UC206-18	19.5	11.3	13.9	1.1
30												**UCF206E**		UC206				
	1 3/16											**UCF206E-19**		UC206-19				
	1 1/4											**UCF206E-20**		UC206-20				
		4 19/32 117	1 11/32 34	3 5/8 92	33/64 13	9/16 14	3/4 19	1 3/4 44.4	1.689 42.9	0.689 17.5	7/16	**UCFX06E**	FX06E	UCX06	25.7	15.4	13.9	1.6
	1 3/16											**UCFX06E-19**		UCX06-19				
	1 1/4											**UCFX06E-20**		UCX06-20				
	1 1/4	4 19/32 117	1 11/32 34	3 5/8 92	33/64 13	19/32 15	3/4 19	1 3/4 44.4	1.689 42.9	0.689 17.5	7/16	**UCF207E-20**	F207E	UC207-20	25.7	15.4	13.9	1.5
	1 5/16											**UCF207E-21**		UC207-21				
	1 3/8											**UCF207E-22**		UC207-22				
35												**UCF207E**		UC207				
	1 7/16											**UCF207E-23**		UC207-23				
	1 3/8	5 1/8 130	1 1/2 38	4 1/64 102	33/64 13	9/16 14	53/64 21	2 1/32 51.2	1.937 49.2	0.748 19	7/16	**UCFX07E-22**	FX07E	UCX07-22	29.1	17.8	14.0	2.0
												UCFX07E		UCX07				
	1 7/16											**UCFX07E-23**		UCX07-23				
	1 1/2	5 1/8 130	1 13/32 36	4 1/64 102	35/64 14	19/32 15	53/64 21	2 1/32 51.2	1.937 49.2	0.748 19	1/2	**UCF208E-24**	F208E	UC208-24	29.1	17.8	14.0	1.9
	1 9/16											**UCF208E-25**		UC208-25				
40												**UCF208E**		UC208				
	1 1/2	5 13/32 137	1 9/16 40	4 9/64 105	19/32 15	9/16 14	55/64 22	2 1/16 52.2	1.937 49.2	0.748 19	1/2	**UCFX08E-24**	FX08E	UCX08-24	34.1	21.3	14.0	2.4
												UCFX08E		UCX08				
	1 3/4	5 5/8 143	1 9/16 40	4 3/8 111	19/32 15	9/16 14	29/32 23	2 3/16 55.6	2.031 51.6	0.748 19	1/2	**UCFX09E-28**	FX09E	UCX09-28	35.1	23.3	14.4	2.7
45												**UCFX09E**		UCX09				
	1 15/16	6 3/8 162	1 23/32 44	5 1/8 130	21/32 16.5	25/32 20	1 1/32 26	2 11/32 59.4	2.189 55.6	0.874 22.2	9/16	**UCFX10E-31**	FX10E	UCX10-31	43.4	29.4	14.4	3.7
50												**UCFX10E**		UCX10				
	2											**UCFX10E-32**		UCX10-32				
	2	6 3/8 162	1 11/16 43	5 1/8 130	43/64 17	23/32 18	63/64 25	2 5/16 58.4	2.189 55.6	0.874 22.2	5/8	**UCF211E-32**	F211E	UC211-32	43.4	29.4	14.4	3.4
	2 1/8											**UCF211E-34**		UC211-34				
55												**UCF211E**		UC211				
	2 3/16											**UCF211E-35**		UC211-35				
		6 7/8 175	1 15/16 49	5 5/8 143	21/32 16.5	25/32 20	1 9/64 29	2 23/32 68.7	2.563 65.1	1.000 25.4	9/16	**UCFX11E**	FX11E	UCX11	52.4	36.2	14.4	4.9
	2 3/16											**UCFX11E-35**		UCX11-35				
	2 1/4											**UCFX11E-36**		UCX11-36				

Remarks 1. In Part No. of unit, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~208, X05~X09
A-PT1/8 .... 211~217, X10~X17
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (L2) follows the Part No. of unit or bearing. (Example of Part No. : UCF206EJL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCF-E
Cylindrical bore (with set screws)
d 60 ~ 85 mm





Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$) and tolerance of position of bolt hole (X)

Unit : mm

Housing No.		$\varDelta_{A2s}$	X
F204E~F210E	FX05E~FX10E	±0.5	0.7
F211E~F217E	FX11E~FX17E	±0.8	1

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

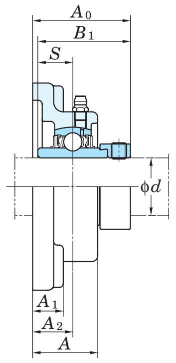
Unit : mm

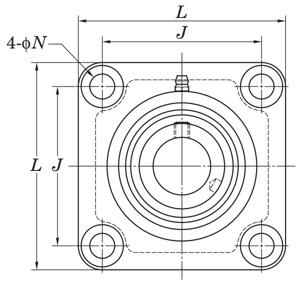
Housing No.		$\varDelta_{Ns}$
F204E~F217E	FX05E~FX17E	±0.2

Shaft Dia. mm	inch	Dimensions inch mm									Bolt Size inch	Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN		Factor	Mass
d		L	A	J	N	A_1	A_2	A_0	B	S					C_r	C_{0r}	f_0	kg
60	2 1/4 2 3/8 2 7/16	6 7/8 175	1 7/8 48	5 5/8 143	43/64 17	23/32 18	1 9/64 29	2 23/32 68.7	2.563 65.1	1.000 25.4	5/8	**UCF212E-36** **UCF212E** **UCF212E-38** **UCF212E-39**	F212E	UC212-36 UC212 UC212-38 UC212-39	52.4	36.2	14.4	4.2
	2 7/16	7 3/8 187	2 5/16 59	5 55/64 149	21/32 16.5	13/16 21	1 11/32 34	2 29/32 73.7	2.563 65.1	1.000 25.4	9/16	**UCFX12E** **UCFX12E-39**	FX12E	UCX12 UCX12-39	57.2	40.1	14.4	5.7
65	2 1/2	7 3/8 187	1 31/32 50	5 55/64 149	43/64 17	7/8 22	1 3/16 30	2 3/4 69.7	2.563 65.1	1.000 25.4	5/8	**UCF213E-40** **UCF213E**	F213E	UC213-40 UC213	57.2	40.1	14.4	5.2
	2 1/2	7 3/8 187	1 31/32 59	5 55/64 149	21/32 16.5	13/16 21	1 11/32 34	3 3/32 78.4	2.937 74.6	1.189 30.2	9/16	**UCFX13E-40** **UCFX13E**	FX13E	UCX13-40 UCX13	62.2	44.1	14.5	6.3
70	2 3/4	7 3/4 197	2 3/8 60	5 63/64 152	25/32 20	7/8 22	1 29/64 37	3 7/32 81.5	3.063 77.8	1.331 33.3	11/16	**UCFX14E-44** **UCFX14E**	FX14E	UCX14-44 UCX14	67.4	48.3	14.5	7.0
75	2 15/16 3	7 3/4 197	2 11/16 68	5 63/64 152	25/32 20	15/16 24	1 9/16 40	3 17/32 89.3	3.252 82.6	1.311 33.3	11/16	**UCFX15E-47** **UCFX15E** **UCFX15E-48**	FX15E	UCX15-47 UCX15 UCX15-48	72.7	53.0	14.6	8.4
80	3 1/8	8 3/16 208	2 9/32 58	6 1/2 165	3/4 19	7/8 22	1 11/32 34	3 9/32 83.3	3.252 82.6	1.311 33.3	11/16	**UCF216E-50** **UCF216E**	F216E	UC216-50 UC216	72.7	53.0	14.6	7.3
	–	8 7/16 214	2 3/4 70	6 47/64 171	25/32 20	15/16 24	1 9/16 40	3 19/32 91.6	3.374 85.7	1.343 34.1	11/16	**UCFX16E**	FX16E	UCX16	84.0	61.9	14.5	9.4
85	3 1/4	8 21/32 220	2 15/32 63	6 57/64 175	3/4 19	15/16 24	1 13/32 36	3 7/16 87.6	3.374 85.7	1.343 34.1	11/16	**UCF217E-52** **UCF217E**	F217E	UC217-52 UC217	84.0	61.9	14.5	8.9
	3 7/16	8 7/16 214	2 3/4 70	6 47/64 171	25/32 20	15/16 24	1 9/16 40	3 25/32 96.3	3.780 96	1.563 39.7	11/16	**UCFX17E** **UCFX17E-55**	FX17E	UCX17 UCX17-55	96.1	71.5	14.5	10.8

Remarks 1. In Part No. of unit, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~208, X05~X09
A-PT1/8 .... 211~217, X10~X17
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (L2) follows the Part No. of unit or bearing. (Example of Part No. : UCF206EJL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

NANF
Cylindrical bore
(with eccentric locking collar)
d 12 ~ 60 mm





Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$) and tolerance of position of bolt hole (X)

Unit : mm

Housing No.	$\varDelta_{A2s}$	X
NF204~NF210	±0.5	0.7
NF211~NF212	±0.8	1

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

Unit : mm

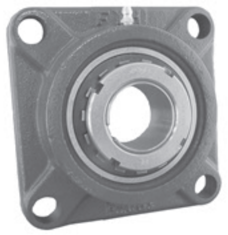
Housing No.	$\varDelta_{Ns}$
NF204~NF212	±0.2

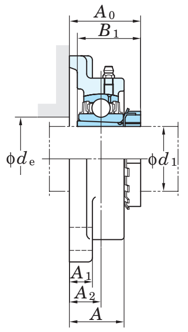
Shaft Dia mm	Shaft Dia inch	Dimensions inch mm									Bolt Size inch	Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN		Factor	Mass
d		L	A	J	N	A_1	A_2	A_0	B_1	S					C_r	C_{0r}	f_0	kg
12 15 17 20	1/2 5/8 3/4	3 3/8 86	1 5/32 29.5	2 33/64 64	7/16 11	19/32 15	3/4 19	1 25/32 45.6	1.720 43.7	0.673 17.1	3/8	**NANF201** **NANF201-8** **NANF202** **NANF202-10** **NANF203** **NANF204-12** **NANF204**	NF204	NA201 NA201-8 NA202 NA202-10 NA203 NA204-12 NA204	12.8	6.65	13.2	0.73
25	7/8 15/16 1	3 3/4 95	1 7/32 31	2 3/4 70	29/64 11.5	19/32 15	25/32 20	1 27/32 46.9	1.748 44.4	0.689 17.5	3/8	**NANF205-14** **NANF205-15** **NANF205** **NANF205-16**	NF205	NA205-14 NA205-15 NA205 NA205-16	14.0	7.85	13.9	0.95
30	1 1/8 1 3/16 1 1/4	4 1/4 108	1 11/32 34	3 17/64 83	33/64 13	5/8 16	53/64 21	2 51.1	1.906 48.4	0.720 18.3	7/16	**NANF206-18** **NANF206** **NANF206-19** **NANF206-20**	NF206	NA206-18 NA206 NA206-19 NA206-20	19.5	11.3	13.9	1.4
35	1 1/4 1 5/16 1 3/8 1 7/16	4 19/32 117	1 7/16 36.5	3 5/8 92	33/64 13	21/32 17	27/32 21.5	2 1/8 53.8	2.012 51.1	0.740 18.8	7/16	**NANF207-20** **NANF207-21** **NANF207-22** **NANF207** **NANF207-23**	NF207	NA207-20 NA207-21 NA207-22 NA207 NA207-23	25.7	15.4	13.9	1.8
40	1 1/2 1 9/16	5 1/8 130	1 17/32 39	4 1/64 102	35/64 14	21/32 17	15/16 24	2 5/16 58.9	2.217 56.3	0.843 21.4	1/2	**NANF208-24** **NANF208-25** **NANF208**	NF208	NA208-24 NA208-25 NA208	29.1	17.8	14.0	2.2
45	1 5/8 1 11/16 1 3/4	5 13/32 137	1 9/16 40	4 9/64 105	5/8 16	23/32 18	15/16 24	2 5/16 58.9	2.217 56.3	0.843 21.4	9/16	**NANF209-26** **NANF209-27** **NANF209-28** **NANF209**	NF209	NA209-26 NA209-27 NA209-28 NA209	34.1	21.3	14.0	2.6
50	1 7/8 1 15/16 2	5 5/8 143	1 27/32 46.5	4 3/8 111	5/8 16	25/32 20	1 1/8 28.5	2 5/8 66.6	2.469 62.7	0.969 24.6	9/16	**NANF210-30** **NANF210-31** **NANF210** **NANF210-32**	NF210	NA210-30 NA210-31 NA210 NA210-32	35.1	23.3	14.4	3
55	2 2 1/8 2 3/16	6 3/8 162	1 31/32 50	5 1/8 130	43/64 17	13/16 21	1 17/64 32	2 31/32 75.6	2.811 71.4	1.094 27.8	5/8	**NANF211-32** **NANF211-34** **NANF211** **NANF211-35**	NF211	NA211-32 NA211-34 NA211 NA211-35	43.4	29.4	14.4	4.1
60	2 1/4 2 3/8 2 7/16	6 7/8 175	2 5/32 55	5 5/8 143	43/64 17	13/16 21	1 27/64 36	3 1/4 82.8	3.063 77.8	1.220 31	5/8	**NANF212-36** **NANF212** **NANF212-38** **NANF212-39**	NF212	NA212-36 NA212 NA212-38 NA212-39	52.4	36.2	14.4	4.9

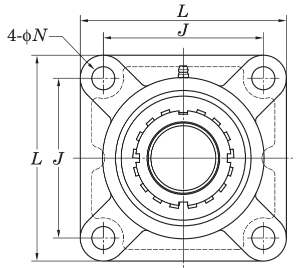
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210
A-PT1/8 .... 211~212

3. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

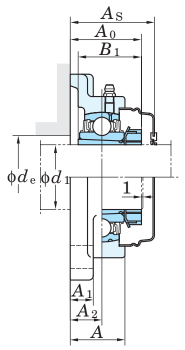
UKF
Tapered bore (with adapter)
d_1 20 ~ (50) mm



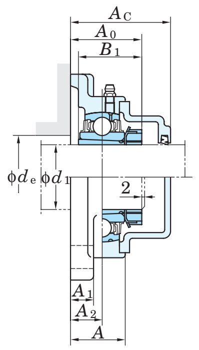




With Pressed Steel Cover



With Cast Iron Cover



Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$) and tolerance of position of bolt hole (X)

Unit : mm

Housing No.			$\varDelta_{A2s}$	X
F205~F210	FX05~FX10	F305~F310	±0.5	0.7
F211~F218	FX11~FX20	F311~F328	±0.8	1

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

Unit : mm

Housing No.			$\varDelta_{Ns}$
F205~F218	FX05~FX18	F305~F315	±0.2
	FX20	F316~F328	±0.3

Shaft Dia.		Dimensions									Bolt Size	Standard					Basic Load Ratings		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm	inch	inch mm									inch mm	Unit No.	Housing No.	Bearing No.	Adapter 1) No.	Mass	kN			Unit No. Open Type	Unit No. Closed Type	Dimension mm	Dimension inch	Mass	Unit No. Open Type	Unit No. Closed Type	Dimension mm	Dimension inch	Mass
d_1		L	A	J	N	A_1	A_2	$A_0$1)	$B_1$1)	d_e (min.)						kg	C_r	C_{0r}	f_0			A_s		kg			A_c		kg
20	3/4	3 3/4	1 1/16	2 3/4	15/32	1/2	5/8	1 11/32(1 13/32)	1 5/32(1 3/8)	1 3/16	3/8	UKF205	F205	UK205	HE305X(HE2305X)	0.87	14.0	7.85	13.9	–	–	–	–	–	–	–	–	–	–
		95	27	70	12	13	16	34.5(36)	29(35)	30	M10				H305X(H2305X)	0.87				UKF205C	UKF205D	40	1 9/16	0.87	UKF205FC	UKF205FD	49	1 15/16	1.1
	3/4	4 1/4	1 3/16	3 17/64	15/32	1/2	45/64	1 15/32	1 3/8	1 3/16	3/8	UKFX05	FX05	UKX05	HE2305X	1.2	19.5	11.3	13.9	–	–	–	–	–	–	–	–	–	–
		108	30	83	12	13	18	37.5	35	30	M10				H2305X	1.2				UKFX05C	UKFX05D	44	1 23/32	1.2	–	–	–	–	–
	3/4	4 11/32	1 5/32	3 5/32	5/8	1/2	5/8	1 15/32	1 3/8	–	1/2	UKF305	F305	UK305	HE2305X	1.4	21.2	10.9	12.6	–	–	–	–	–	–	–	–	–	–
		110	29	80	16	13	16	37.5	35	–	M14				H2305X	1.4				–	–	–	–	–	UKF305C	UKF305D	54	2 1/8	1.7
25		4 1/4	1 7/32	3 17/64	15/32	1/2	45/64	1 15/32(1 9/16)	1 7/32(1 1/2)	1 13/32	3/8	UKF206	F206	UK206	H306X(H2306X)	1.3	19.5	11.3	13.9	UKF206C	UKF206D	44	1 23/32	1.3	UKF206FC	UKF206FD	53	2 3/32	1.6
	1	108	31	83	12	13	18	37.5(39.5)	31(38)	36	M10				HE306X(HE2306X)	1.3				–	–	–	–	–	–	–	–	–	–
		4 19/32	1 11/32	3 5/8	5/8	9/16	3/4	1 9/16	1 1/2	1 13/32	1/2	UKFX06	FX06	UKX06	H2306X	1.6	25.7	15.4	13.9	UKFX06C	UKFX06D	49	1 15/16	1.6	–	–	–	–	–
	1	117	34	92	16	14	19	40	38	36	M14				HE2306X	1.6				–	–	–	–	–	–	–	–	–	–
		4 29/32	1 1/4	3 47/64	5/8	19/32	45/64	1 5/8	1 1/2	–	1/2	UKF306	F306	UK306	H2306X	1.9	26.7	15.0	13.3	–	–	–	–	–	UKF306C	UKF306D	59	2 5/16	2.2
	1	125	32	95	16	15	18	41	38	–	M14				HE2306X	1.9				–	–	–	–	–	–	–	–	–	–
30	1 1/8	4 19/32	1 11/32	3 5/8	35/64	19/32	3/4	1 5/8(1 11/16)	1 3/8(1 11/16)	1 5/8	7/16	UKF207	F207	UK207	HS307X(HS2307X)	1.6	25.7	15.4	13.9	–	–	–	–	–	–	–	–	–	–
		117	34	92	14	15	19	41(43)	35(43)	41	M12				H307X(H2307X)	1.6				UKF207C	UKF207D	49	1 15/16	1.6	UKF207FC	UKF207FD	58	2 9/32	2.0
	1 1/8	5 1/8	1 1/2	4 1/64	5/8	9/16	53/64	1 23/32	1 11/16	1 5/8	1/2	UKFX07	FX07	UKX07	HS2307X	2.0	29.1	17.8	14.0	–	–	–	–	–	–	–	–	–	–
		130	38	102	16	14	21	43.5	43	41	M14				H2307X	2.0				UKFX07C	UKFX07D	55	2 5/32	2.0	–	–	–	–	–
	1 1/8	5 5/16	1 13/32	3 15/16	3/4	5/8	25/32	1 25/32	1 11/16	–	5/8	UKF307	F307	UK307	HS2307X	2.3	33.4	19.3	13.2	–	–	–	–	–	–	–	–	–	–
		135	36	100	19	16	20	45.5	43	–	M16				H2307X	2.3				–	–	–	–	–	UKF307C	UKF307D	64	2 17/32	2.8
35	1 1/4	5 1/8	1 13/32	4 1/64	5/8	19/32	53/64	1 3/4(1 7/8)	1 13/32(1 13/16)	1 13/16	1/2	UKF208	F208	UK208	HE308X(HE2308X)	1.9	29.1	17.8	14.0	–	–	–	–	–	–	–	–	–	–
	1 3/8	130	36	102	16	15	21	44.5(48)	36(46)	46	M14				HS308X(HS2308X)	1.9				–	–	–	–	–	–	–	–	–	–
										–					H308X(H2308X)	1.9				UKF208C	UKF208D	55	2 5/32	1.9	UKF208FC	UKF208FD	64	2 17/32	2.3
	1 1/4	5 13/32	1 9/16	4 9/64	3/4	9/16	55/64	1 27/32	1 13/16	1 13/16	5/8	UKFX08	FX08	UKX08	HE2308X	2.3	34.1	21.3	14.0	–	–	–	–	–	–	–	–	–	–
	1 3/8	137	40	105	19	14	22	46.5	46	46	M16				HS2308X	2.3				–	–	–	–	–	–	–	–	–	–
															H2308X	2.3				UKFX08C	UKFX08D	56	2 7/32	2.3	–	–	–	–	–
	1 1/4	5 29/32	1 9/16	4 13/32	3/4	21/32	29/32	2	1 13/16	–	5/8	UKF308	F308	UK308	HE2308X	3.1	40.7	24.0	13.2	–	–	–	–	–	–	–	–	–	–
	1 3/8	150	40	112	19	17	23	50.5	46	–	M16				HS2308X	3.1				–	–	–	–	–	–	–	–	–	–
															H2308X	3.1				–	–	–	–	–	UKF308C	UKF308D	71	2 25/32	3.6
40	1 1/2	5 13/32	1 1/2	4 9/64	5/8	5/8	55/64	1 7/8(2)	1 17/32(1 31/32)	2 1/16	1/2	UKF209	F209	UK209	HE309X(HE2309X)	2.3	34.1	21.3	14.0	–	–	–	–	–	–	–	–	–	–
		137	38	105	16	16	22	47.5(51)	39(50)	52	M14				H309X(H2309X)	2.3				UKF209C	UKF209D	56	2 7/32	2.3	UKF209FC	UKF209FD	66	2 19/32	2.8
	1 5/8														HS309X(HS2309X)	2.3				–	–	–	–	–	–	–	–	–	–
	1 1/2	5 5/8	1 9/16	4 3/8	3/4	9/16	29/32	1 29/32	1 31/32	2 1/16	5/8	UKFX09	FX09	UKX09	HE2309X	2.7	35.1	23.3	14.4	–	–	–	–	–	–	–	–	–	–
		143	40	111	19	14	23	48.5	50	52	M16				H2309X	2.7				UKFX09C	UKFX09D	60	2 3/8	2.7	–	–	–	–	–
	1 5/8														HS2309X	2.7				–	–	–	–	–	–	–	–	–	–
	1 1/2	6 5/16	1 23/32	4 59/64	3/4	23/32	63/64	2 5/32	1 31/32	–	5/8	UKF309	F309	UK309	HE2309X	4.1	48.9	29.5	13.3	–	–	–	–	–	–	–	–	–	–
		160	44	125	19	18	25	55	50	–	M16				H2309X	4.1				–	–	–	–	–	UKF309C	UKF309D	76	3	4.7
	1 5/8														HS2309X	4.1				–	–	–	–	–	–	–	–	–	–
45	1 3/4	5 5/8	1 9/16	4 3/8	5/8	5/8	55/64	1 29/32(2 1/16)	1 21/32(2 5/32)	2 9/32	1/2	UKF210	F210	UK210	HE310X(HE2310X)	2.6	35.1	23.3	14.4	–	–	–	–	–	–	–	–	–	–
		143	40	111	16	16	22	48.5(52)	42(55)	58	M14				H310X(H2310X)	2.6				UKF210C	UKF210D	59	2 5/16	2.6	UKF210FC	UKF210FD	70.5	2 25/32	3.1
	1 3/4	6 3/8	1 23/32	5 1/8	3/4	25/32	1 1/32	2 3/32	2 5/32	2 9/32	5/8	UKFX10	FX10	UKX10	HE2310X	3.6	43.4	29.4	14.4	–	–	–	–	–	–	–	–	–	–
		162	44	130	19	20	26	53.5	55	58	M16				H2310X	3.6				UKFX10C	UKFX10D	64	2 17/32	3.6	–	–	–	–	–
	1 3/4	6 7/8	1 7/8	5 13/64	29/32	3/4	1 7/64	2 3/8	2 5/32	–	3/4	UKF310	F310	UK310	HE2310X	5.1	62.0	38.3	13.2	–	–	–	–	–	–	–	–	–	–
		175	48	132	23	19	28	60	55	–	M20				H2310X	5.1				–	–	–	–	–	UKF310C	UKF310D	83	3 9/32	5.9
50	1 7/8	6 3/8	1 11/16	5 1/8	3/4	23/32	63/64	2 1/16(2 1/4)	1 25/32(2 5/16)	2 17/32	5/8	UKF211	F211	UK211	HS311X(HS2311X)	3.5	43.4	29.4	14.4	–	–	–	–	–	–	–	–	–	–
		162	43	130	19	18	25	52.5(57)	45(59)	64	M16				H311X(H2311X)	3.5				UKF211C	UKF211D	63	2 15/32	3.5	UKF211FC	UKF211FD	74.5	2 15/16	4.1
	2														HE311X(HE2311X)	3.5				–	–	–	–	–	–	–	–	–	–

Note 1) Codes shown in parentheses indicate the dimensions and Part No. of applicable adapter (H2300X series) for UK200L3 series (triple seal type).

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

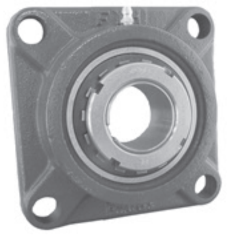
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF........205~210, X05~X09, 305~308
A-PT1/8................211~218, X10~X20, 309~328

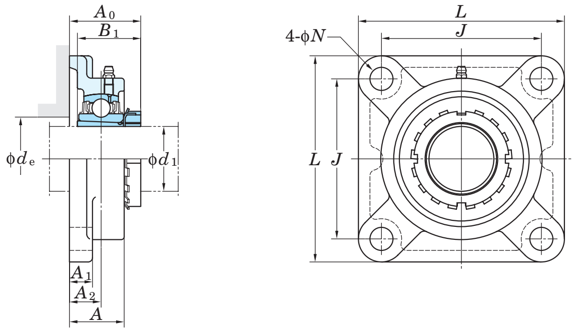
3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables.
(Example of Part No. : UKF206J + H306X, UK206 + H306X)

4. As for the triple seal type product (205 is the double seal type product), accessory code L3 (L2) follows the Part No. of unit or bearing.
(Example of Part No. : UKF206JL3 + H2306X, UK206L3 + H2306X)

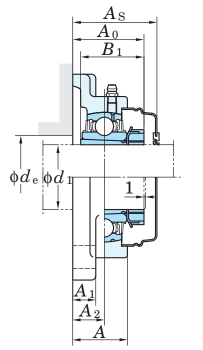
5. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

UKF
Tapered bore (with adapter)
d_1 (50) ~ 85 mm

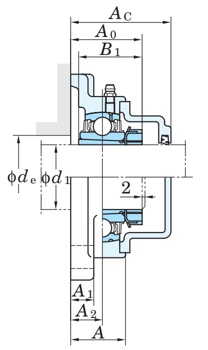




With Pressed Steel Cover



With Cast Iron Cover



Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$) and tolerance of position of bolt hole (X)

Unit : mm

Housing No.			$\varDelta_{A2s}$	X
F205~F210	FX05~FX10	F305~F310	±0.5	0.7
F211~F218	FX11~FX20	F311~F328	±0.8	1

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

Unit : mm

Housing No.			$\varDelta_{Ns}$
F205~F218	FX05~FX18	F305~F315	±0.2
	FX20	F316~F328	±0.3

Shaft Dia.		Dimensions inch mm									Bolt Size inch mm	Standard					Basic Load Ratings kN		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm	inch											Unit No.	Housing No.	Bearing No.	Adapter 1) No.	Mass				Unit No. Open Type	Closed Type	Dimension mm	inch	Mass	Unit No. Open Type	Closed Type	Dimension mm	inch	Mass
d_1		L	A	J	N	A_1	A_2	A_0 1)	B_1 1)	d_e (min.)						kg	C_r	C_{0r}	f_0			A_s		kg			A_c		kg
50	1 7/8 2	6 7/8 175	1 15/16 49	5 5/8 143	3/4 19	25/32 20	1 9/64 29	2 1/4 57.5	2 5/16 59	2 17/32 64	5/8 M16	**UKFX11**	FX11	UKX11	HS2311X H2311X HE2311X	4.6 4.6 4.6	52.4	36.2	14.4	– UKFX11C –	– UKFX11D –	– 73 –	– 2 7/8 –	– 4.6 –	– – –	– – –	– – –	– – –	– – –
	1 7/8 2	7 9/32 185	2 1/16 52	5 33/64 140	29/32 23	25/32 20	1 3/16 30	2 1/2 63.5	2 5/16 59	– –	3/4 M20	**UKF311**	F311	UK311	HS2311X H2311X HE2311X	5.9 5.9 5.9	71.6	45.0	13.2	– – –	– – –	– – –	– – –	– – –	– UKF311C –	– UKF311D –	– 87 –	– 3 7/16 –	– 6.8 –
55	2 1/8	6 7/8 175	1 7/8 48	5 5/8 143	3/4 19	23/32 18	1 9/64 29	2 5/16(2 19/32) 58.5(65.5)	1 27/32(2 7/16) 47(62)	2 23/32 69	5/8 M16	**UKF212**	F212	UK212	HS312X(HS2312X) H312X(H2313X)	4.1 4.1	52.4	36.2	14.4	– UKF212C	– UKF212D	– 73	– 2 7/8	– 4.1	– UKF212FC	– UKF212FD	– 86	– 3 3/8	– 4.9
	2 1/8	7 3/8 187	2 5/16 59	5 55/64 149	3/4 19	13/16 21	1 11/32 34	2 9/16 65	2 7/16 62	2 23/32 69	5/8 M16	**UKFX12**	FX12	UKX12	HS2312X H2312X	5.5 5.5	57.2	40.1	14.4	– UKFX12C	– UKFX12D	– 78	– 3 1/16	– 5.5	– –	– –	– –	– –	– –
	2 1/8	7 11/16 195	2 7/32 56	5 29/32 150	29/32 23	7/8 22	1 19/64 33	2 3/4 69.5	2 7/16 62	– –	3/4 M20	**UKF312**	F312	UK312	HS2312X H2312X	6.8 6.8	81.9	52.2	13.2	– –	– –	– –	– –	– –	– UKF312C	– UKF312D	– 95	– 3 3/4	– 8.0
60	2 1/4 2 3/8	7 3/8 187	1 31/32 50	5 55/64 149	3/4 19	7/8 22	1 3/16 30	2 7/16(2 21/32) 62(67.5)	1 31/32(2 9/16) 50(65)	2 29/32 74	5/8 M16	**UKF213**	F213	UK213	HE313X(HE2313X) H313X(H2313X) HS313X(HS2313X)	5.1 5.1 5.1	57.2	40.1	14.4	– UKF213C –	– UKF213D –	– 74 –	– 2 29/32 –	– 5.1 –	– UKF213FC –	– UKF213FD –	– 87 –	– 3 7/16 –	– 6.0 –
	2 1/4 2 3/8	7 3/8 187	2 5/16 59	5 55/64 149	3/4 19	13/16 21	1 11/32 34	2 11/16 68	2 9/16 65	2 29/32 74	5/8 M16	**UKFX13**	FX13	UKX13	HE2313X H2313X HS2313X	6.0 6.0 6.0	62.2	44.1	14.5	– UKFX13C –	– UKFX13D –	– 83 –	– 3 9/32 –	– 6.0 –	– – –	– – –	– – –	– – –	– – –
	2 1/4 2 3/8	8 3/16 208	2 9/32 58	6 17/32 166	29/32 23	7/8 22	1 19/64 33	2 13/16 71.5	2 9/16 65	– –	3/4 M20	**UKF313**	F313	UK313	HE2313X H2313X HS2313X	7.9 7.9 7.9	92.7	59.9	13.2	– – –	– – –	– – –	– – –	– – –	– UKF313C –	– UKF313D –	– 94 –	– 3 11/16 –	– 9.0 –
65	2 1/2	7 7/8 200	2 7/32 56	6 17/64 159	3/4 19	7/8 22	1 11/32 34	2 23/32(2 15/16) 69(74.5)	2 5/32(2 7/8) 55(73)	3 11/32 85	5/8 M16	**UKF215**	F215	UK215	HE315X(HE2315X) H315X(H2315X)	6.5 6.5	67.4	48.3	14.5	– UKF215C	– UKF215D	– 83	– 3 9/32	– 6.5	– UKF215FC	– UKF215FD	– 96	– 3 25/32	– 7.5
	2 1/2	7 3/4 197	2 11/16 68	5 63/64 152	29/32 23	15/16 24	1 9/16 40	3 76	2 7/8 73	3 11/32 85	3/4 M20	**UKFX15**	FX15	UKX15	HE2315X H2315X	8.1 8.1	72.7	53.0	14.6	– UKFX15C	– UKFX15D	– 94	– 3 11/16	– 8.1	– –	– –	– –	– –	– –
	2 1/2	9 9/32 236	2 19/32 66	7 1/4 184	63/64 25	31/32 25	1 17/32 39	3 7/32 81.5	2 7/8 73	– –	7/8 M22	**UKF315**	F315	UK315	HE2315X H2315X	11.7 11.7	113	77.2	13.2	– –	– –	– –	– –	– –	– UKF315C	– UKF315D	– 106	– 4 3/16	– 13.1
70	2 3/4	8 3/16 208	2 9/32 58	6 1/2 165	29/32 23	7/8 22	1 11/32 34	2 27/32(3 3/32) 72(78.5)	2 5/16(3 1/16) 59(78)	3 17/32 90	3/4 M20	**UKF216**	F216	UK216	HE316X(HE2316X) H316X(H2316X)	7.6 7.6	72.7	53.0	14.6	– UKF216C	– UKF216D	– 88	– 3 15/32	– 7.6	– UKF216FC	– UKF216FD	– 103	– 4 1/16	– 8.9
	2 3/4	8 7/16 214	2 3/4 70	6 47/64 171	29/32 23	15/16 24	1 9/16 40	3 1/8 79	3 1/16 78	3 17/32 90	3/4 M20	**UKFX16**	FX16	UKX16	HE2316X H2316X	9.5 9.5	84.0	61.9	14.5	– UKFX16C	– UKFX16D	– 96	– 3 25/32	– 9.5	– –	– –	– –	– –	– –
	2 3/4	9 27/32 250	2 11/16 68	7 23/32 196	1 7/32 31	1 1/16 27	1 1/2 38	3 1/4 82.5	3 1/16 78	– –	1 M27	**UKF316**	F316	UK316	HE2316X H2316X	12.9 12.9	123	86.7	13.3	– –	– –	– –	– –	– –	– UKF316C	– UKF316D	– 107	– 4 7/32	– 14.5
75	3	8 21/32 220	2 15/32 63	6 57/64 175	29/32 23	15/16 24	1 13/32 36	3(3 1/4) 76(82.5)	2 15/32(3 7/32) 63(82)	3 25/32 96	3/4 M20	**UKF217**	F217	UK217	H317X(H2317X) HE317X(HE2317X)	9.0 9.0	84.0	61.9	14.5	UKF217C –	UKF217D –	92 –	3 5/8 –	9.0 –	UKF217FC –	UKF217FD –	107 –	4 7/32 –	10.4 –
	3	8 7/16 214	2 3/4 70	6 47/64 171	29/32 23	15/16 24	1 9/16 40	3 7/32 82	3 7/32 82	3 25/32 96	3/4 M20	**UKFX17**	FX17	UKX17	H2317X HE2317X	10.4 10.4	96.1	71.5	14.5	UKFX17C –	UKFX17D –	101 –	3 31/32 –	10.4 –	– –	– –	– –	– –	– –
	3	10 1/4 260	2 29/32 74	8 1/32 204	1 7/32 31	1 1/16 27	1 47/64 44	3 5/8 92	3 7/32 82	– –	1 M27	**UKF317**	F317	UK317	H2317X HE2317X	15.2 15.2	133	96.8	13.3	– –	– –	– –	– –	– –	UKF317C –	UKF317D –	117 –	4 19/32 –	17.0 –
80	–	9 1/4 235	2 11/16 68	7 23/64 187	29/32 23	31/32 25	1 9/16 40	3 7/32(3 17/32) 82(89.5)	2 9/16(3 3/8) 65(86)	4 1/32 102	3/4 M20	**UKF218**	F218	UK218	H318X(H2318X)	11.4	96.1	71.5	14.5	UKF218C	UKF218D	101	3 31/32	11.4	UKF218FC	UKF218FD	116	4 9/16	13.0
	–	8 7/16 214	3 76	6 47/64 171	29/32 23	15/16 24	1 49/64 45	3 15/32 88	3 3/8 86	4 1/32 102	3/4 M20	**UKFX18**	FX18	UKX18	H2318X	11.4	109	81.9	14.4	–	–	–	–	–	UKFX18C	UKFX18D	124	4 7/8	13.3
	–	11 1/32 280	3 76	8 1/2 216	1 3/8 35	1 3/16 30	1 47/64 44	3 5/8 92	3 3/8 86	– –	1 1/8 M30	**UKF318**	F318	UK318	H2318X	19.0	143	107	13.3	–	–	–	–	–	UKF318C	UKF318D	119	4 11/16	21.1
85	3 1/4	11 13/32 290	3 11/16 94	8 31/32 228	1 3/8 35	1 3/16 30	2 21/64 59	4 3/8 111	3 17/32 90	– –	1 1/8 M30	**UKF319**	F319	UK319	HE2319X H2319X	21.9 21.9	153	119	13.3	– –	– –	– –	– –	– –	– UKF319C	– UKF319D	– 140	– 5 1/2	– 24.3

Note 1) Codes shown in parentheses indicate the dimensions and Part No. of applicable adapter (H2300X series) for UK200L3 series (triple seal type).

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

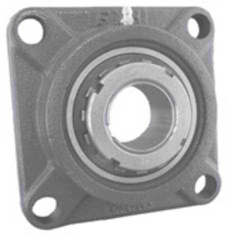
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF........205~210, X05~X09, 305~308
A-PT1/8................211~218, X10~X20, 309~328

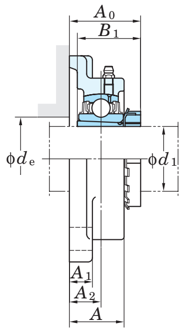
3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables.
(Example of Part No. : UKF206J + H306X, UK206 + H306X)

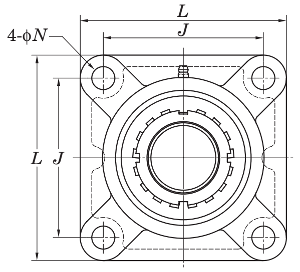
4. As for the triple seal type product (205 is the double seal type product), accessory code L3 (L2) follows the Part No. of unit or bearing.
(Example of Part No. : UKF206JL3 + H2306X, UK206L3 + H2306X)

5. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

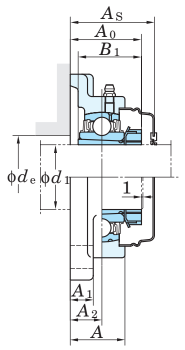
UKF
Tapered bore (with adapter)
d_1 90 ~ 125 mm



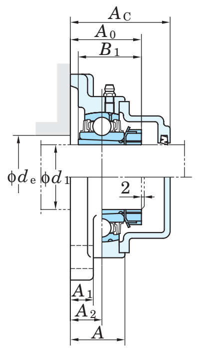




With Pressed Steel Cover



With Cast Iron Cover



Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$) and tolerance of position of bolt hole (X)

Unit : mm

Housing No.			$\varDelta_{A2s}$	X
F205~F210	FX05~FX10	F305~F310	±0.5	0.7
F211~F218	FX11~FX20	F311~F328	±0.8	1

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

Unit : mm

Housing No.			$\varDelta_{Ns}$
F205~F218	FX05~FX18	F305~F315	±0.2
	FX20	F316~F328	±0.3

Shaft Dia.		Dimensions									Bolt Size	Standard					Basic Load Ratings		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm	inch	inch mm									inch mm	Unit No.	Housing No.	Bearing No.	Adapter 1) No.	Mass	kN			Unit No.		Dimension		Mass	Unit No.		Dimension		Mass
d_1		L	A	J	N	A_1	A_2	A_0 1)	B_1 1)	d_e (min.)						kg	C_r	C_{0r}	f_0	Open Type	Closed Type	mm A_s	inch	kg	Open Type	Closed Type	mm A_c	inch	kg
90	3 1/2	10 9/16	3 13/16	8 5/16	1 7/32	1 3/32	2 21/64	4 3/16	3 13/16	4 13/32	1	**UKFX20**	FX20	UKX20	HE2320X	18.4	133	105	14.4	–	–	–	–	–	–	–	–	–	–
		268	97	211	31	28	59	106	97	112	M27				H2320X	18.4				–	–	–	–	–	UKFX20C	UKFX20D	152	5 31/32	20.9
	3 1/2	12 7/32	3 11/16	9 17/32	1 1/2	1 1/4	2 21/64	4 7/16	3 13/16	–	1 1/4	**UKF320**	F320	UK320	HE2320X	25.4	173	141	13.2	–	–	–	–	–	–	–	–	–	–
		310	94	242	38	32	59	113	97	–	M33				H2320X	25.4				–	–	–	–	–	UKF320C	UKF320D	146	5 3/4	28.5
100		13 3/8	3 25/32	10 15/32	1 39/64	1 3/8	2 23/64	4 23/32	4 1/8	–	1 3/8	**UKF322**	F322	UK322	H2322X	35.2	205	180	13.2	–	–	–	–	–	UKF322C	UKF322D	154	6 1/16	38.7
	4	340	96	266	41	35	60	120	105	–	M36				HE2322X	35.2				–	–	–	–	–	–	–	–	–	–
110	–	14 9/16	4 11/32	11 27/64	1 39/64	1 9/16	2 9/16	5 1/8	4 13/32	–	1 3/8	**UKF324**	F324	UK324	H2324	47.6	207	185	13.5	–	–	–	–	–	UKF324C	UKF324D	163	6 13/32	52.7
		370	110	290	41	40	65	130.5	112	–	M36																		
115	4 1/2	16 5/32	4 17/32	12 19/32	1 39/64	1 25/32	2 9/16	5 3/16	4 3/4	–	1 3/8	**UKF326**	F326	UK326	HE2326	65.3	229	214	13.6	–	–	–	–	–	–	–	–	–	–
		410	115	320	41	45	65	131.5	121	–	M36				H2326	65.3				–	–	–	–	–	UKF326C	UKF326D	172	6 25/32	71.9
125	–	17 23/32	4 29/32	13 25/32	1 39/64	2 5/32	2 61/64	5 13/16	5 5/32	–	1 3/8	**UKF328**	F328	UK328	H2328	93.4	253	246	13.6	–	–	–	–	–	UKF328C	UKF328D	186	7 5/16	102
		450	125	350	41	55	75	147.5	131	–	M36																		

Note 1) Codes shown in parentheses indicate the dimensions and Part No. of applicable adapter (H2300X series) for UK200L3 series (triple seal type).

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF........205~210, X05~X09, 305~308
A-PT1/8................211~218, X10~X20, 309~328

3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables.
(Example of Part No. : UKF206J + H306X, UK206 + H306X)

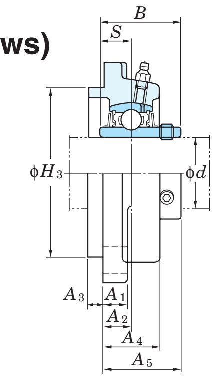
4. As for the triple seal type product (205 is the double seal type product), accessory code L3 (L2) follows the Part No. of unit or bearing.
(Example of Part No. : UKF206JL3 + H2306X, UK206L3 + H2306X)

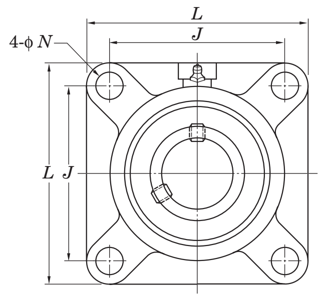
5. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

UCFS

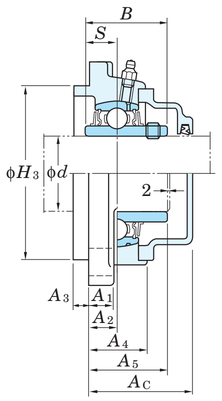
Cylindrical bore (with set screws)

d 25 ~ 140 mm





With Cast Iron Cover



Variations of tolerance of spigot joint outside diameter ($\varDelta_{H3s}$), variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$), tolerance of position of bolt hole (X), and tolerance of circumferential runout of spigot joint (Y)

Unit : mm

Housing No.	$\varDelta_{H3s}$	$\varDelta_{A2s}$	X	Y
FS305	0 –0.046	±0.5	0.7	0.2
FS306~FS308	0 –0.054			
FS309~FS310	0 –0.063			
FS311~FS313		±0.8	1	0.3 ~FS318 FS319~ 0.4
FS314~FS319	0 –0.072			
FS320~FS322	0 –0.081			
FS324~FS328	0 –0.089			

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

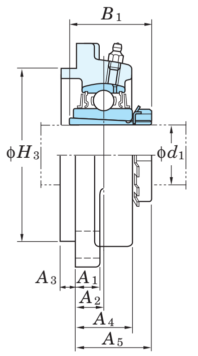
Unit : mm

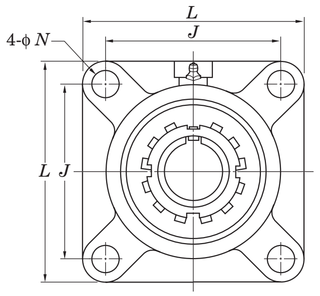
Housing No.	$\varDelta_{Ns}$
FS305~315	±0.2
FS316~328	±0.3

Shaft Dia.		Dimensions											Bolt Size	Standard			Mass	Basic Load Ratings		Factor	With Cast Iron Cover				
mm	inch	inch mm											inch mm	Unit No.	Housing No.	Bearing No.	kg	kN			Unit No. Open Type	Closed Type	Dimension mm	inch	Mass kg
d		L	H_3	J	N	A_1	A_2	A_3	A_4	A_5	B	S						C_r	C_{0r}	f_0			A_c		
25	1	4 11/32 110	3.1496 80	3 5/32 80	5/8 16	1/2 13	23/64 9	9/32 7	7/8 22	1 1/4 32	1.496 38	0.591 15	1/2 M14	**UCFS305** **UCFS305-16**	FS305	UC305 UC305-16	1.4 1.4	21.2	10.9	12.6	UCFS305C –	UCFS305D –	47 –	1 27/32 –	1.7 –
30	–	4 29/32 125	3.5433 90	3 47/64 95	5/8 16	19/32 15	25/64 10	5/16 8	15/16 24	1 13/32 36	1.693 43	0.669 17	1/2 M14	**UCFS306**	FS306	UC306	1.9	26.7	15.0	13.3	UCFS306C	UCFS306D	51	2	2.2
35	–	5 5/16 135	3.9370 100	3 15/16 100	3/4 19	5/8 16	7/16 11	23/64 9	1 1/16 27	1 9/16 40	1.890 48	0.748 19	5/8 M16	**UCFS307**	FS307	UC307	2.3	33.4	19.3	13.2	UCFS307C	UCFS307D	55	2 5/32	2.7
40	1 1/2	5 29/32 150	4.5276 115	4 13/32 112	3/4 19	21/32 17	33/64 13	25/64 10	1 3/16 30	1 13/16 46	2.047 52	0.748 19	5/8 M16	**UCFS308-24** **UCFS308**	FS308	UC308-24 UC308	3.4 3.4	40.7	24.0	13.2	– UCFS308C	– UCFS308D	– 61	– 2 13/32	– 3.9
45	1 3/4	6 5/16 160	4.9213 125	4 59/64 125	3/4 19	23/32 18	35/64 14	7/16 11	1 5/16 33	1 15/16 49	2.244 57	0.866 22	5/8 M16	**UCFS309-28** **UCFS309**	FS309	UC309-28 UC309	4.4 4.4	48.9	29.5	13.3	– UCFS309C	– UCFS309D	– 65	– 2 9/16	– 5.0
50	–	6 7/8 175	5.5118 140	5 13/64 132	29/32 23	3/4 19	5/8 16	15/32 12	1 13/32 36	2 5/32 55	2.402 61	0.866 22	3/4 M20	**UCFS310**	FS310	UC310	5.3	62.0	38.3	13.2	UCFS310C	UCFS310D	71	2 25/32	6.1
55	2	7 9/32 185	5.9055 150	5 33/64 140	29/32 23	25/32 20	43/64 17	33/64 13	1 17/32 39	2 9/32 58	2.598 66	0.984 25	3/4 M20	**UCFS311-32** **UCFS311**	FS311	UC311-32 UC311	6.1 6.1	71.6	45.0	13.2	– UCFS311C	– UCFS311D	– 74	– 2 29/32	– 7.0
60	–	7 11/16 195	6.2992 160	5 29/32 150	29/32 23	7/8 22	3/4 19	35/64 14	1 21/32 42	2 17/32 64	2.795 71	1.024 26	3/4 M20	**UCFS312**	FS312	UC312	7.4	81.9	52.2	13.2	UCFS312C	UCFS312D	81	3 3/16	8.6
65	2 1/2	8 3/16 208	6.8898 175	6 17/32 166	29/32 23	7/8 22	19/32 15	45/64 18	1 9/16 40	2 3/8 60	2.953 75	1.181 30	3/4 M20	**UCFS313-40** **UCFS313**	FS313	UC313-40 UC313	8.8 8.8	92.7	59.9	13.2	– UCFS313C	– UCFS313D	– 76	– 3	– 9.9
70	2 3/4	8 29/32 226	7.2835 185	7 1/64 178	63/64 25	31/32 25	45/64 18	45/64 18	1 11/16 43	2 15/32 63	3.071 78	1.299 33	7/8 M22	**UCFS314-44** **UCFS314**	FS314	UC314-44 UC314	11.2 11.2	104	68.2	13.2	– UCFS314C	– UCFS314D	– 80	– 3 5/32	– 12.3
75	2 15/16 3	9 9/32 236	7.8740 200	7 1/4 184	63/64 25	31/32 25	53/64 21	45/64 18	1 7/8 48	2 25/32 71	3.228 82	1.260 32	7/8 M22	**UCFS315-47** **UCFS315** **UCFS315-48**	FS315	UC315-47 UC315 UC315-48	13.7 13.7 13.7	113	77.2	13.2	– UCFS315C –	– UCFS315D –	– 88 –	– 3 15/32 –	– 15.0 –
80	–	9 27/32 250	8.2677 210	7 23/32 196	1 7/32 31	1 1/16 27	45/64 18	25/32 20	1 7/8 48	2 3/4 70	3.386 86	1.339 34	1 M27	**UCFS316**	FS316	UC316	15.1	123	86.7	13.3	UCFS316C	UCFS316D	87	3 7/16	16.5
85	–	10 1/4 260	8.6614 220	8 1/32 204	1 7/32 31	1 1/16 27	15/16 24	25/32 20	2 1/8 54	3 5/32 80	3.780 96	1.575 40	1 M27	**UCFS317**	FS317	UC317	17.3	133	96.8	13.3	UCFS317C	UCFS317D	97	3 13/16	18.9
90	3 1/2	11 1/32 280	9.4488 240	8 1/2 216	1 3/8 35	1 3/16 30	15/16 24	25/32 20	2 7/32 56	3 5/32 80	3.780 96	1.575 40	1 1/8 M30	**UCFS318-56** **UCFS318**	FS318	UC318-56 UC318	21.3 21.3	143	107	13.3	– UCFS318C	– UCFS318D	– 99	– 3 29/32	– 23.2
95	–	11 13/32 290	9.8425 250	8 31/32 228	1 3/8 35	1 3/16 30	1 17/32 39	25/32 20	2 29/32 74	3 31/32 101	4.055 103	1.614 41	1 1/8 M30	**UCFS319**	FS319	UC319	24.5	153	119	13.3	UCFS319C	UCFS319D	120	4 23/32	26.7
100	3 15/16 4	12 7/32 310	10.2362 260	9 17/32 242	1 1/2 38	1 1/4 32	1 17/32 39	25/32 20	2 29/32 74	4 1/8 105	4.252 108	1.654 42	1 1/4 M33	**UCFS320** **UCFS320-63** **UCFS320-64**	FS320	UC320 UC320-63 UC320-64	29.5 29.5 29.5	173	141	13.2	UCFS320C – –	UCFS320D – –	126 – –	4 31/32 – –	32.3 – –
105	–	12 7/32 310	10.2362 260	9 17/32 242	1 1/2 38	1 1/4 32	1 17/32 39	25/32 20	2 29/32 74	4 7/32 107	4.409 112	1.732 44	1 1/4 M33	**UCFS321**	FS321	UC321	32.7	184	153	13.2	UCFS321C	UCFS321D	128	5 1/32	35.7
110	–	13 3/8 340	11.8110 300	10 15/32 266	1 39/64 41	1 3/8 35	1 3/8 35	63/64 25	2 25/32 71	4 3/16 106	4.606 117	1.811 46	1 3/8 M36	**UCFS322**	FS322	UC322	39.0	205	180	13.2	UCFS322C	UCFS322D	129	5 3/32	42.4
120	–	14 9/16 370	12.9921 330	11 27/64 290	1 39/64 41	1 9/16 40	1 3/8 35	1 3/16 30	3 5/32 80	4 11/32 110	4.961 126	2.008 51	1 3/8 M36	**UCFS324**	FS324	UC324	50.6	207	185	13.5	UCFS324C	UCFS324D	133	5 1/4	55.4
130	–	16 5/32 410	14.1732 360	12 19/32 320	1 39/64 41	1 25/32 45	1 3/8 35	1 3/16 30	3 11/32 85	4 9/16 116	5.315 135	2.126 54	1 3/8 M36	**UCFS326**	FS326	UC326	67.7	229	214	13.6	UCFS326C	UCFS326D	142	5 29/32	73.8
140	–	17 23/32 450	15.7480 400	13 25/32 350	1 39/64 41	2 5/32 55	1 49/64 45	1 3/16 30	3 3/4 95	5 5/32 131	5.709 145	2.323 59	1 3/8 M36	**UCFS328**	FS328	UC328	94.0	253	246	13.6	UCFS328C	UCFS328D	156	6 5/32	102

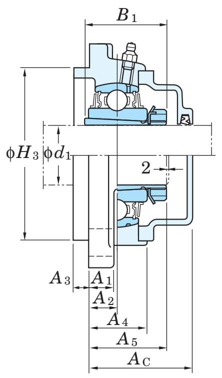
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 305~308
A-PT1/8 .... 309~328
3. As for the triple seal type product, accessory code L3 follows the Part No. of unit or bearing. (Example of Part No. : UCFS307JL3, UC307L3)
4. The dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UKFS
Tapered bore (with adapter)
d_1 20 ~ 125 mm





With Cast Iron Cover



Variations of tolerance of spigot joint outside diameter (Δ_{H3s}), variations of tolerance of distance from mounting surface to center of spherical bore (Δ_{A2s}), tolerance of position of bolt hole (X), and tolerance of circumferential runout of spigot joint (Y)

Unit : mm

Housing No.	Δ_{H3s}	Δ_{A2s}	X	Y
FS305	0 –0.046	±0.5	0.7	0.2
FS306~FS308	0 –0.054			
FS309~FS310	0 –0.063			
FS311~FS313		±0.8	1	0.3 ~FS318
FS315~FS319	0 –0.072			FS319~ 0.4
FS320~FS322	0 –0.081			
FS324~FS328	0 –0.089			

Variations of tolerance of bolt hole diameter (Δ_{Ns})

Unit : mm

Housing No.	Δ_{Ns}
FS305~315	±0.2
FS316~328	±0.3

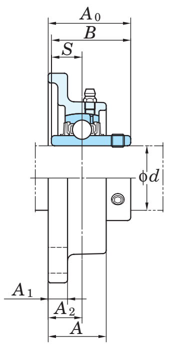
Shaft Dia. d_1 mm	Shaft Dia. d_1 inch	Dimensions inch / mm L	H_3	J	N	A_1	A_2	A_3	A_4	A_5	B_1	Bolt Size inch / mm	Standard Unit No.	Housing No.	Bearing No.	Adapter No.	Mass kg	Basic Load Ratings kN C_r	C_{0r}	Factor f_0	With Cast Iron Cover Unit No. Open Type	Closed Type	Dimension A_c mm	A_c inch	Mass kg
20	3/4	4 11/32 110	3.1496 80	3 5/32 80	5/8 16	1/2 13	23/64 9	9/32 7	7/8 22	1 3/16 30.5	1 3/8 35	1/2 M14	**UKFS305**	FS305	UK305	HE2305X H2305X	1.4 1.4	21.2	10.9	12.6	– UKFS305C	– UKFS305D	– 47	– 1 27/32	– 1.7
25	1	4 29/32 125	3.5433 90	3 47/64 95	5/8 16	19/32 15	25/64 10	5/16 8	15/16 24	1 5/16 33	1 1/2 38	1/2 M14	**UKFS306**	FS306	UK306	H2306X HE2306X	1.9 1.9	26.7	15.0	13.3	UKFS306C –	UKFS306D –	51 –	2 –	2.2 –
30	1 1/8	5 5/16 135	3.9370 100	3 15/16 100	3/4 19	5/8 16	7/16 11	23/64 9	1 1/16 27	1 7/16 36.5	1 11/16 43	5/8 M16	**UKFS307**	FS307	UK307	HS2307X H2307X	2.4 2.4	33.4	19.3	13.2	– UKFS307C	– UKFS307D	– 55	– 2 5/32	– 2.9
35	1 1/4 1 3/8	5 29/32 150	4.5276 115	4 13/32 112	3/4 19	21/32 17	33/64 13	25/64 10	1 3/16 30	1 19/32 40.5	1 13/16 46	5/8 M16	**UKFS308**	FS308	UK308	HE2308X HS2308X H2308X	3.4 3.4 3.4	40.7	24.0	13.2	– – UKFS308C	– – UKFS308D	– – 61	– – 2 13/32	– – 3.9
40	1 1/2 1 5/8	6 5/16 160	4.9213 125	4 59/64 125	3/4 19	23/32 18	35/64 14	7/16 11	1 5/16 33	1 23/32 44	1 31/32 50	5/8 M16	**UKFS309**	FS309	UK309	HE2309X H2309X HS2309X	4.4 4.4 4.4	48.9	29.5	13.3	– UKFS309C –	– UKFS309D –	– 65 –	– 2 9/16 –	– 5.0 –
45	1 3/4	6 7/8 175	5.5118 140	5 13/64 132	29/32 23	3/4 19	5/8 16	15/32 12	1 13/32 36	1 7/8 48	2 5/32 55	3/4 M20	**UKFS310**	FS310	UK310	HE2310X H2310X	5.3 5.3	62.0	38.3	13.2	– UKFS310C	– UKFS310D	– 71	– 2 25/32	– 6.1
50	1 7/8 2	7 9/32 185	5.9055 150	5 33/64 140	29/32 23	25/32 20	43/64 17	33/64 13	1 17/32 39	2 50.5	2 5/16 59	3/4 M20	**UKFS311**	FS311	UK311	HS2311X H2311X HE2311X	6.3 6.3 6.3	71.6	45.0	13.2	– UKFS311C –	– UKFS311D –	– 74 –	– 2 29/32 –	– 7.2 –
55	2 1/8	7 11/16 195	6.2992 160	5 29/32 150	29/32 23	7/8 22	3/4 19	35/64 14	1 21/32 42	2 3/16 55.5	2 7/16 62	3/4 M20	**UKFS312**	FS312	UK312	HS2312X H2312X	7.3 7.3	81.9	52.2	13.2	– UKFS312C	– UKFS312D	– 81	– 3 3/16	– 8.5
60	2 1/4 2 3/8	8 3/16 208	6.8898 175	6 17/32 166	29/32 23	7/8 22	19/32 15	45/64 18	1 9/16 40	2 3/32 53.5	2 9/16 65	3/4 M20	**UKFS313**	FS313	UK313	HE2313X H2313X HS2313X	8.9 8.9 8.9	92.7	59.9	13.2	– UKFS313C –	– UKFS313D –	– 76 –	– 3 –	– 10.0 –
65	2 1/2	9 9/32 236	7.8740 200	7 1/4 184	63/64 25	31/32 25	53/64 21	45/64 18	1 7/8 48	2 1/2 63.5	2 7/8 73	7/8 M22	**UKFS315**	FS315	UK315	HE2315X H2315X	13.4 13.4	113	77.2	13.2	– UKFS315C	– UKFS315D	– 88	– 3 15/32	– 14.8
70	2 3/4	9 27/32 250	8.2677 210	7 23/32 196	1 7/32 31	1 1/16 27	45/64 18	25/32 20	1 7/8 48	2 15/32 62.5	3 1/16 78	1 M27	**UKFS316**	FS316	UK316	HE2316X H2316X	15.1 15.1	123	86.7	13.3	– UKFS316C	– UKFS316D	– 87	– 3 7/16	– 16.7
75	3	10 1/4 260	8.6614 220	8 1/32 204	1 7/32 31	1 1/16 27	15/16 24	25/32 20	2 1/8 54	2 27/32 72	3 7/32 82	1 M27	**UKFS317**	FS317	UK317	H2317X HE2317X	17.1 17.1	133	96.8	13.3	UKFS317C –	UKFS317D –	97 –	3 13/16 –	18.9 –
80	–	11 1/32 280	9.4488 240	8 1/2 216	1 3/8 35	1 3/16 30	15/16 24	25/32 20	2 7/32 56	2 27/32 72	3 3/8 86	1 1/8 M30	**UKFS318**	FS318	UK318	H2318X	21.4	143	107	13.3	UKFS318C	UKFS318D	99	3 29/32	23.5
85	3 1/4	11 13/32 290	9.8425 250	8 31/32 228	1 3/8 35	1 3/16 30	1 17/32 39	25/32 20	2 29/32 74	2 19/32 91	3 17/32 90	1 1/8 M30	**UKFS319**	FS319	UK319	HE2319X H2319X	24.8 24.8	153	119	13.3	– UKFS319C	– UKFS319D	– 120	– 4 23/32	– 26.2
90	3 1/2	12 7/32 310	10.2362 260	9 17/32 242	1 1/2 38	1 1/4 32	1 17/32 39	25/32 20	2 29/32 74	2 21/32 93	3 13/16 97	1 1/4 M33	**UKFS320**	FS320	UK320	HE2320X H2320X	29.1 29.1	173	141	13.2	– UKFS320C	– UKFS320D	– 126	– 4 31/32	– 32.2
100	4	13 3/8 340	11.8110 300	10 15/32 266	1 39/64 41	1 3/8 35	1 3/8 35	63/64 25	2 25/32 71	2 3/4 95	4 1/8 105	1 3/8 M36	**UKFS322**	FS322	UK322	H2322X HE2322X	38.6 38.6	205	180	13.2	UKFS322C –	UKFS322D –	129 –	5 3/32 –	42.1 –
110	–	14 9/16 370	12.9921 330	11 27/64 290	1 39/64 41	1 9/16 40	1 3/8 35	1 3/16 30	3 5/32 80	3 21/32 100.5	4 13/32 112	1 3/8 M36	**UKFS324**	FS324	UK324	H2324	50.9	207	185	13.5	UKFS324C	UKFS324D	133	5 1/4	56.0
115	4 1/2	16 5/32 410	14.1732 360	12 19/32 320	1 39/64 41	1 25/32 45	1 3/8 35	1 3/16 30	3 11/32 85	4 101.5	4 3/4 121	1 3/8 M36	**UKFS326**	FS326	UK326	HE2326 H2326	67.5 67.5	229	214	13.6	– UKFS326C	– UKFS326D	– 142	– 5 29/32	– 74.1
125	–	17 23/32 450	15.7480 400	13 25/32 350	1 39/64 41	2 5/32 55	1 49/64 45	1 3/16 30	3 3/4 95	4 5/8 117.5	5 5/32 131	1 3/8 M36	**UKFS328**	FS328	UK328	H2328	94.0	253	246	13.6	UKFS328C	UKFS328D	156	6 5/32	102

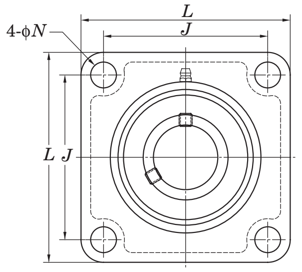
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 305~308
A-PT1/8 .... 309~328
3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables.
(Example of Part No. : UKFS307J + H2307X, UK307 + H2307X)
4. As for the triple seal type product, accessory code L3 follows the Part No. of unit or bearing.
(Example of Part No. : UKFS307JL3 + H2307X, UK307L3 + H2307X)
5. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

UCSF-H1S6

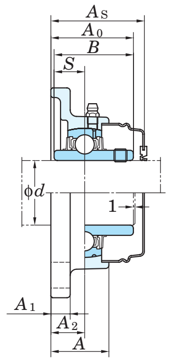
Cylindrical bore (with set screws)

d 20 ~ 50 mm





With Pressed Stainless Steel Cover



Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$) and tolerance of position of bolt hole (X)

Unit : mm

Housing No.	$\varDelta_{A2s}$	X
SF204 H1~210 H1	±0.5	0.7

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

Unit : mm

Housing No.	$\varDelta_{Ns}$
SF204 H1~210 H1	±0.2

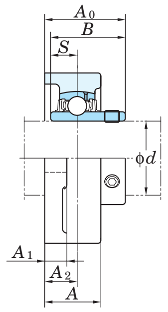
Shaft Dia. mm	Dimensions inch mm									Bolt Size inch mm	Unit No.	Standard Housing No.	Bearing No.	Mass	Basic Load Ratings kN		Factor	With Pressed Stainless Steel Cover Unit No.		Dimension mm inch		Mass
d	L	A	J	N	A_1	A_2	A_0	B	S					kg	C_r	C_{0r}	f_0	Open Type	Closed Type	A_s		kg
20	3 3/8 86	1 1/32 26	2 33/64 64	15/32 12	13/32 10	19/32 15	1 5/16 33.3	1.220 31	0.500 12.7	3/8 M10	**UCSF204H1S6**	SF204H1	UC204S6	0.5	10.9	5.35	13.2	UCSF204H1CS6	UCSF204H1DS6	38	1 1/2	0.5
25	3 3/4 95	1 3/32 27.5	2 3/4 70	15/32 12	13/32 10	5/8 16	1 13/32 35.8	1.343 34.1	0.563 14.3	3/8 M10	**UCSF205H1S6**	SF205H1	UC205S6	0.85	11.9	6.3	13.9	UCSF205H1CS6	UCSF205H1DS6	40	1 9/16	0.85
30	4 1/4 108	1 7/32 31	3 17/64 83	15/32 12	13/32 10	45/64 18	1 19/32 40.2	1.500 38.1	0.626 15.9	3/8 M10	**UCSF206H1S6**	SF206H1	UC206S6	1.1	16.5	9.05	13.9	UCSF206H1CS6	UCSF206H1DS6	45	1 25/32	1.1
35	4 19/32 117	1 11/32 34	3 5/8 92	35/64 14	7/16 11	3/4 19	1 3/4 44.4	1.689 42.9	0.689 17.5	7/16 M12	**UCSF207H1S6**	SF207H1	UC207S6	1.5	21.8	12.3	13.9	UCSF207H1CS6	UCSF207H1DS6	49	1 15/16	1.5
40	5 1/8 130	1 13/32 36	4 1/64 102	5/8 16	15/32 12	53/64 21	2 1/32 51.2	1.937 49.2	0.748 19	1/2 M14	**UCSF208H1S6**	SF208H1	UC208S6	1.7	24.8	14.3	14.0	UCSF208H1CS6	UCSF208H1DS6	56	2 7/32	1.7
45	5 13/32 137	1 1/2 38	4 9/64 105	5/8 16	1/2 13	55/64 22	2 1/16 52.2	1.937 49.2	0.748 19	1/2 M14	**UCSF209H1S6**	SF209H1	UC209S6	1.9	27.8	16.2	14.0	UCSF209H1CS6	UCSF209H1DS6	57	2 1/4	1.9
50	5 5/8 143	1 9/16 40	4 3/8 111	5/8 16	1/2 13	55/64 22	2 5/32 54.6	2.031 51.6	0.748 19	1/2 M14	**UCSF210H1S6**	SF210H1	UC210S6	2.4	29.8	18.6	14.4	UCSF210H1CS6	UCSF210H1DS6	59	2 5/16	2.4

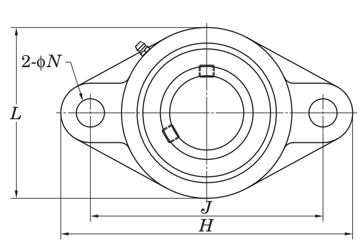
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter codes. (See **Table 10.5** in P.42.)
2. Part No. of the applicable grease nipple is A-1/4-28UNFN12.
3. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCFL

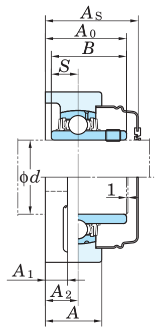
Cylindrical bore (with set screws)

d 12 ~ (45) mm

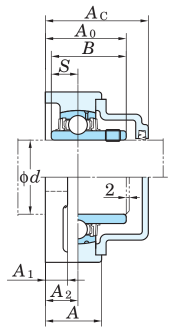




With Pressed Steel Cover



With Cast Iron Cover



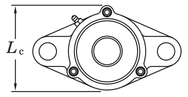
Variations of tolerance of distance from mounting surface to center of spherical bore (Δ_{A2s}) and tolerance of position of bolt hole (X) Unit : mm

Housing No.			Δ_{A2s}	X
FL204~FL210	FLX05~FLX10	FL305~FL310	±0.5	0.7
FL211~FL218		FL311~FL326	±0.8	1

Variations of tolerance of bolt hole diameter (Δ_{Ns}) Unit : mm

Housing No.			Δ_{Ns}
FL204~FL218	FLX05~FLX10	FL305~FL311	±0.2
		FL312~FL326	±0.3

Forms and dimensions of L_c of FL204JE3 and FL205JE3 (housing with cast iron cover) are shown below.



FL204JE3 $L_c = 65$ mm
FL205JE3 $L_c = 73$ mm

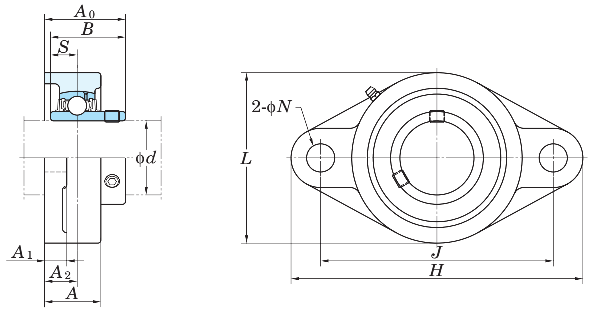
Shaft Dia. mm	Shaft Dia. inch	Dimensions inch / mm										Bolt Size inch / mm	Standard Unit No.	Standard Housing No.	Standard Bearing No.	Mass	Basic Load Ratings kN		Factor	With Pressed Steel Cover Unit No. Open Type	With Pressed Steel Cover Unit No. Closed Type	Dimension mm	Dimension inch	Mass	With Cast Iron Cover Unit No. Open Type	With Cast Iron Cover Unit No. Closed Type	Dimension mm	Dimension inch	Mass
d		H	L	A	J	N	A_1	A_2	A_0	B	S					kg	C_r	C_{0r}	f_0			A_s		kg			A_c		kg
12		4 7/16 113	2 3/8 60	1 25.5	3 35/64 90	15/32 12	7/16 11	19/32 15	1 5/16 33.3	1.220 31	0.500 12.7	3/8 M10	**UCFL201**	FL204	UC201	0.50	12.8	6.65	13.2	UCFL201C	UCFL201D	37	1 15/32	0.50	–	–	–	–	–
	1/2												**UCFL201-8**		UC201-8	0.50				–	–	–	–	–	–	–	–	–	–
15													**UCFL202**		UC202	0.48				UCFL202C	UCFL202D	37	1 15/32	0.48	–	–	–	–	–
	5/8												**UCFL202-10**		UC202-10	0.48				–	–	–	–	–	–	–	–	–	–
17													**UCFL203**		UC203	0.47				UCFL203C	UCFL203D	37	1 15/32	0.47	–	–	–	–	–
	3/4												**UCFL204-12**		UC204-12	0.47				–	–	–	–	–	–	–	–	–	–
20													**UCFL204**		UC204	0.45				UCFL204C	UCFL204D	37	1 15/32	0.45	UCFL204FC	UCFL204FD	46	1 13/16	0.6
25	7/8	5 1/8 130	2 11/16 68	1 1/16 27	3 57/64 99	5/8 16	1/2 13	5/8 16	1 13/32 35.8	1.343 34.1	0.563 14.3	1/2 M14	**UCFL205-14**	FL205	UC205-14	0.64	14.0	7.85	13.9	–	–	–	–	–	–	–	–	–	–
	15/16												**UCFL205-15**		UC205-15	0.64				–	–	–	–	–	–	–	–	–	–
													UCFL205		UC205	0.64				UCFL205C	UCFL205D	40	1 9/16	0.64	UCFL205FC	UCFL205FD	49	1 15/16	0.83
	1												**UCFL205-16**		UC205-16	0.64				–	–	–	–	–	–	–	–	–	–
		5 9/16 141	3 9/32 83	1 3/16 30	4 39/64 117	15/32 12	1/2 13	45/64 18	1 19/32 40.2	1.500 38.1	0.626 15.9	3/8 M10	**UCFLX05**	FLX05	UCX05	1.1	19.5	11.3	13.9	UCFLX05C	UCFLX05D	44	1 23/32	1.1	–	–	–	–	–
	1												**UCFLX05-16**		UCX05-16	1.1				–	–	–	–	–	–	–	–	–	–
		5 29/32 150	3 5/32 80	1 5/32 29	4 29/64 113	3/4 19	1/2 13	5/8 16	1 17/32 39	1.496 38	0.591 15	5/8 M16	**UCFL305**	FL305	UC305	1.1	21.2	10.9	12.6	–	–	–	–	–	UCFL305C	UCFL305D	54	2 1/8	1.4
	1												**UCFL305-16**		UC305-16	1.1				–	–	–	–	–	–	–	–	–	–
30	1 1/8	5 13/16 148	3 5/32 80	1 7/32 31	4 39/64 117	5/8 16	1/2 13	45/64 18	1 19/32 40.2	1.500 38.1	0.626 15.9	1/2 M14	**UCFL206-18**	FL206	UC206-18	0.93	19.5	11.3	13.9	–	–	–	–	–	–	–	–	–	–
													UCFL206		UC206	0.93				UCFL206C	UCFL206D	44	1 23/32	0.93	UCFL206FC	UCFL206FD	53	2 3/32	1.2
	1 3/16												**UCFL206-19**		UC206-19	0.93				–	–	–	–	–	–	–	–	–	–
	1 1/4												**UCFL206-20**		UC206-20	0.93				–	–	–	–	–	–	–	–	–	–
		6 5/32 156	3 3/4 95	1 11/32 34	5 1/8 130	5/8 16	9/16 14	3/4 19	1 3/4 44.4	1.689 42.9	0.689 17.5	1/2 M14	**UCFLX06**	FLX06	UCX06	1.5	25.7	15.4	13.9	UCFLX06C	UCFLX06D	49	1 15/16	1.5	–	–	–	–	–
	1 3/16												**UCFLX06-19**		UCX06-19	1.5				–	–	–	–	–	–	–	–	–	–
	1 1/4												**UCFLX06-20**		UCX06-20	1.5				–	–	–	–	–	–	–	–	–	–
	–	7 3/32 180	3 17/32 90	1 1/4 32	5 9/32 134	29/32 23	19/32 15	45/64 18	1 23/32 44	1.693 43	0.669 17	3/4 M20	**UCFL306**	FL306	UC306	1.5	26.7	15.0	13.3	–	–	–	–	–	UCFL306C	UCFL306D	59	2 5/16	1.8
35	1 1/4	6 11/32 161	3 17/32 90	1 11/32 34	5 1/8 130	5/8 16	9/16 14	3/4 19	1 3/4 44.4	1.689 42.9	0.689 17.5	1/2 M14	**UCFL207-20**	FL207	UC207-20	1.2	25.7	15.4	13.9	–	–	–	–	–	–	–	–	–	–
	1 5/16												**UCFL207-21**		UC207-21	1.2				–	–	–	–	–	–	–	–	–	–
	1 3/8												**UCFL207-22**		UC207-22	1.2				–	–	–	–	–	–	–	–	–	–
													UCFL207		UC207	1.2				UCFL207C	UCFL207D	49	1 15/16	1.2	UCFL207FC	UCFL207FD	58	2 9/32	1.6
	1 7/16												**UCFL207-23**		UC207-23	1.2				–	–	–	–	–	–	–	–	–	–
	1 3/8	6 23/32 171	4 1/8 105	1 1/2 38	5 43/64 144	5/8 16	9/16 14	53/64 21	2 1/32 51.2	1.937 49.2	0.748 19	1/2 M14	**UCFLX07-22**	FLX07	UCX07-22	1.9	29.1	17.8	14.0	–	–	–	–	–	–	–	–	–	–
													UCFLX07		UCX07	1.9				UCFLX07C	UCFLX07D	55	2 5/32	1.9	–	–	–	–	–
	1 7/16												**UCFLX07-23**		UCX07-23	1.9				–	–	–	–	–	–	–	–	–	–
	–	7 9/32 185	3 15/16 100	1 13/32 36	5 35/64 141	29/32 23	5/8 16	25/32 20	1 15/16 49	1.890 48	0.748 19	3/4 M20	**UCFL307**	FL307	UC307	1.8	33.4	19.3	13.2	–	–	–	–	–	UCFL307C	UCFL307D	64	2 17/32	2.2
40	1 1/2	6 7/8 175	3 15/16 100	1 13/32 36	5 43/64 144	5/8 16	9/16 14	53/64 21	2 1/32 51.2	1.937 49.2	0.748 19	1/2 M14	**UCFL208-24**	FL208	UC208-24	1.6	29.1	17.8	14.0	–	–	–	–	–	–	–	–	–	–
	1 9/16												**UCFL208-25**		UC208-25	1.6				–	–	–	–	–	–	–	–	–	–
													UCFL208		UC208	1.6				UCFL208C	UCFL208D	55	2 5/32	1.6	UCFL208FC	UCFL208FD	64	2 17/32	2.0
	1 1/2	7 1/16 179	4 3/8 111	1 9/16 40	5 53/64 148	5/8 16	9/16 14	55/64 22	2 1/16 52.2	1.937 49.2	0.748 19	1/2 M14	**UCFLX08-24**	FLX08	UCX08-24	2.1	34.1	21.3	14.0	–	–	–	–	–	–	–	–	–	–
													UCFLX08		UCX08	2.1				UCFLX08C	UCFLX08D	56	2 7/32	2.1	–	–	–	–	–
	1 1/2	7 7/8 200	4 13/32 112	1 9/16 40	6 7/32 158	29/32 23	21/32 17	29/32 23	2 7/32 56	2.047 52	0.748 19	3/4 M20	**UCFL308-24**	FL308	UC308-24	2.5	40.7	24.0	13.2	–	–	–	–	–	–	–	–	–	–
													UCFL308		UC308	2.5				–	–	–	–	–	UCFL308C	UCFL308D	71	2 25/32	3.0
45	1 5/8	7 13/32 188	4 1/4 108	1 1/2 38	5 53/64 148	3/4 19	19/32 15	55/64 22	2 1/16 52.2	1.937 49.2	0.748 19	5/8 M16	**UCFL209-26**	FL209	UC209-26	1.9	34.1	21.3	14.0	–	–	–	–	–	–	–	–	–	–
	1 11/16												**UCFL209-27**		UC209-27	1.9				–	–	–	–	–	–	–	–	–	–
	1 3/4												**UCFL209-28**		UC209-28	1.9				–	–	–	–	–	–	–	–	–	–
													UCFL209		UC209	1.9				UCFL209C	UCFL209D	56	2 7/32	1.9	UCFL209FC	UCFL209FD	66	2 19/32	2.3
	1 3/4	7 7/16 189	4 9/16 116	1 9/16 40	6 3/16 157	5/8 16	9/16 14	29/32 23	2 3/16 55.6	2.031 51.6	0.748 19	1/2 M14	**UCFLX09-28**	FLX09	UCX09-28	2.4	35.1	23.3	14.4	–	–	–	–	–	–	–	–	–	–
													UCFLX09		UCX09	2.4				UCFLX09C	UCFLX09D	60	2 3/8	2.4	–	–	–	–	–

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210, X05~X09, 305~308
A-PT1/8 .... 211~218, X10, 309~326
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (or L2) follows the Part No. of unit or bearing. (Example of Part No. : UCFL206JL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

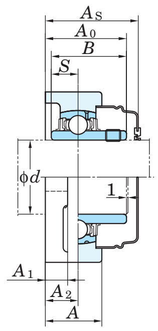
UCFL

Cylindrical bore (with set screws)

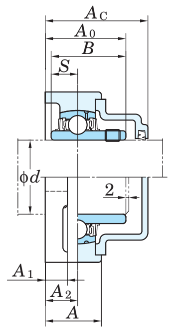
d (45) ~ (90) mm



With Pressed Steel Cover



With Cast Iron Cover



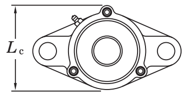
Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$) and tolerance of position of bolt hole (X)
Unit : mm

Housing No.			$\varDelta_{A2s}$	X
FL204~FL210	FLX05~FLX10	FL305~FL310	±0.5	0.7
FL211~FL218		FL311~FL326	±0.8	1

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$) Unit : mm

Housing No.			$\varDelta_{Ns}$
FL204~FL218	FLX05~FLX10	FL305~FL311	±0.2
		FL312~FL326	±0.3

Forms and dimensions of L_c of FL204JE3 and FL205JE3 (housing with cast iron cover) are shown below.

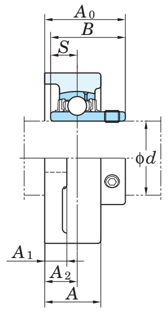


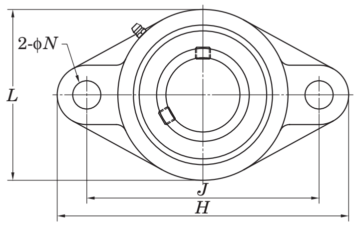
FL204JE3 L_c = 65 mm
FL205JE3 L_c = 73 mm

Shaft Dia.		Dimensions										Bolt Size	Standard				Basic Load Ratings		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm	inch	inch mm										inch mm	Unit No.	Housing No.	Bearing No.	Mass	kN			Unit No.		Dimension		Mass	Unit No.		Dimension		Mass
																				Open Type	Closed Type	mm	inch		Open Type	Closed Type	mm	inch	
d		H	L	A	J	N	A_1	A_2	A_0	B	S					kg	C_r	C_{0r}	f_0			A_s		kg			A_c		kg
45	1 3/4	9 1/16	4 29/32	1 23/32	6 31/32	63/64	23/32	63/64	2 3/8	2.244	0.866	7/8	UCFL309-28	FL309	UC309-28	3.5	48.9	29.5	13.3	–	–	–	–	–	–	–	–	–	–
		230	125	44	177	25	18	25	60	57	22	M22	UCFL309		UC309	3.5				–	–	–	–	–	UCFL309C	UCFL309D	76	3	4.1
50	1 7/8												UCFL210-30	FL210	UC210-30	2.2	35.1	23.3	14.4	–	–	–	–	–	–	–	–	–	–
	1 15/16	7 3/4	4 17/32	1 9/16	6 3/16	3/4	19/32	55/64	2 5/32	2.031	0.748	5/8	UCFL210-31		UC210-31	2.2				–	–	–	–	–	–	–	–	–	–
		197	115	40	157	19	15	22	54.6	51.6	19	M16	UCFL210		UC210	2.2				UCFL210C	UCFL210D	59	2 5/16	2.2	UCFL210FC	UCFL210FD	70.5	2 25/32	2.7
	2												UCFL210-32		UC210-32	2.2				–	–	–	–	–	–	–	–	–	–
	1 15/16	8 1/2	5 1/4	1 23/32	7 1/4	3/4	25/32	1 1/32	2 11/32	2.189	0.874	5/8	UCFLX10-31	FLX10	UCX10-31	3.8	43.4	29.4	14.4	–	–	–	–	–	–	–	–	–	–
		216	133	44	184	19	20	26	59.4	55.6	22.2	M16	UCFLX10		UCX10	3.8				UCFLX10C	UCFLX10D	64	2 17/32	3.8	–	–	–	–	–
	2												UCFLX10-32		UCX10-32	3.8				–	–	–	–	–	–	–	–	–	–
	–	9 7/16	5 1/2	1 7/8	7 23/64	63/64	3/4	1 7/64	2 5/8	2.402	0.866	7/8	UCFL310	FL310	UC310	4.4	62.0	38.3	13.2	–	–	–	–	–	UCFL310C	UCFL310D	83	3 9/32	5.2
		240	140	48	187	25	19	28	67	61	22	M22																	
55	2												UCFL211-32	FL211	UC211-32	3.3	43.4	29.4	14.4	–	–	–	–	–	–	–	–	–	–
	2 1/8	8 13/16	5 1/8	1 11/16	7 1/4	3/4	23/32	63/64	2 5/16	2.189	0.874	5/8	UCFL211-34		UC211-34	3.3				–	–	–	–	–	–	–	–	–	–
		224	130	43	184	19	18	25	58.4	55.6	22.2	M16	UCFL211		UC211	3.3				UCFL211C	UCFL211D	63	2 15/32	3.3	UCFL211FC	UCFL211FD	74.5	2 15/16	3.9
	2 3/16												UCFL211-35		UC211-35	3.3				–	–	–	–	–	–	–	–	–	–
	2	9 27/32	5 29/32	2 1/16	7 51/64	63/64	25/32	1 3/16	2 25/32	2.598	0.984	7/8	UCFL311-32	FL311	UC311-32	5.3	71.6	45.0	13.2	–	–	–	–	–	–	–	–	–	–
		250	150	52	198	25	20	30	71	66	25	M22	UCFL311		UC311	5.3				–	–	–	–	–	UCFL311C	UCFL311D	87	3 7/16	6.2
60	2 1/4												UCFL212-36	FL212	UC212-36	4.2	52.4	36.2	14.4	–	–	–	–	–	–	–	–	–	–
		9 27/32	5 1/2	1 7/8	7 61/64	29/32	23/32	1 9/64	2 23/32	2.563	1.000	3/4	UCFL212		UC212	4.2				UCFL212C	UCFL212D	73	2 7/8	4.2	UCFL212FC	UCFL212FD	86	3 3/8	5.0
	2 3/8	250	140	48	202	23	18	29	68.7	65.1	25.4	M20	UCFL212-38		UC212-38	4.2				–	–	–	–	–	–	–	–	–	–
	2 7/16												UCFL212-39		UC212-39	4.2				–	–	–	–	–	–	–	–	–	–
	–	10 5/8	6 5/16	2 7/32	8 11/32	1 7/32	7/8	1 19/64	3 1/16	2.795	1.024	1	UCFL312	FL312	UC312	6.5	81.9	52.2	13.2	–	–	–	–	–	UCFL312C	UCFL312D	95	3 3/4	7.7
		270	160	56	212	31	22	33	78	71	26	M27																	
65	2 1/2	10 5/32	6 3/32	1 31/32	8 17/64	29/32	25/32	1 3/16	2 3/4	2.563	1.000	3/4	UCFL213-40	FL213	UC213-40	5.1	57.2	40.1	14.4	–	–	–	–	–	–	–	–	–	–
		258	155	50	210	23	20	30	69.7	65.1	25.4	M20	UCFL213		UC213	5.1				UCFL213C	UCFL213D	74	2 29/32	5.1	UCFL213FC	UCFL213FD	87	3 7/16	5.9
	2 1/2	11 5/8	6 7/8	2 9/32	9 29/64	1 7/32	31/32	1 19/64	3 1/16	2.953	1.181	1	UCFL313-40	FL313	UC313-40	8.5	92.7	59.9	13.2	–	–	–	–	–	–	–	–	–	–
		295	175	58	240	31	25	33	78	75	30	M27	UCFL313		UC313	8.5				–	–	–	–	–	UCFL313C	UCFL313D	94	3 11/16	9.6
70	2 3/4	10 7/16	6 5/16	2 1/8	8 1/2	29/32	25/32	1 7/32	2 31/32	2.937	1.189	3/4	UCFL214-44	FL214	UC214-44	5.7	62.2	44.1	14.5	–	–	–	–	–	–	–	–	–	–
		265	160	54	216	23	20	31	75.4	74.6	30.2	M20	UCFL214		UC214	5.7				UCFL214C	UCFL214D	80	3 5/32	5.7	UCFL214FC	UCFL214FD	93	3 21/32	6.6
	2 3/4	12 13/32	7 9/32	2 13/32	9 27/32	1 3/8	1 3/32	1 27/64	3 3/16	3.071	1.299	1 1/8	UCFL314-44	FL314	UC314-44	9.7	104	68.2	13.2	–	–	–	–	–	–	–	–	–	–
		315	185	61	250	35	28	36	81	78	33	M30	UCFL314		UC314	9.7				–	–	–	–	–	UCFL314C	UCFL314D	98	3 27/32	10.8
75	2 15/16	10 13/16	6 1/2	2 7/32	8 55/64	29/32	25/32	1 11/32	3 3/32	3.063	1.311	3/4	UCFL215-47	FL215	UC215-47	6.4	67.4	48.3	14.5	–	–	–	–	–	–	–	–	–	–
		275	165	56	225	23	20	34	78.5	77.8	33.3	M20	UCFL215		UC215	6.4				UCFL215C	UCFL215D	83	3 9/32	6.4	UCFL215FC	UCFL215FD	96	3 25/32	7.4
	3												UCFL215-48		UC215-48	6.4				–	–	–	–	–	–	–	–	–	–
	2 15/16	12 19/32	7 11/16	2 19/32	10 15/64	1 3/8	1 3/16	1 17/32	3 1/2	3.228	1.260	1 1/8	UCFL315-47	FL315	UC315-47	11.3	113	77.2	13.2	–	–	–	–	–	–	–	–	–	–
		320	195	66	260	35	30	39	89	82	32	M30	UCFL315		UC315	11.3				–	–	–	–	–	UCFL315C	UCFL315D	106	4 3/16	12.6
	3												UCFL315-48		UC315-48	11.3				–	–	–	–	–	–	–	–	–	–
80	3 1/8	11 13/32	7 3/32	2 9/32	9 11/64	63/64	25/32	1 11/32	3 9/32	3.252	1.311	7/8	UCFL216-50	FL216	UC216-50	7.8	72.7	53.0	14.6	–	–	–	–	–	–	–	–	–	–
		290	180	58	233	25	20	34	83.3	82.6	33.3	M22	UCFL216		UC216	7.8				UCFL216C	UCFL216D	88	3 15/32	7.8	UCFL216FC	UCFL216FD	103	4 1/16	9.0
	–	13 31/32	8 9/32	2 11/16	11 7/32	1 1/2	1 1/4	1 1/2	3 17/32	3.386	1.339	1 1/4	UCFL316	FL316	UC316	14.4	123	86.7	13.3	–	–	–	–	–	UCFL316C	UCFL316D	107	4 7/32	15.8
		355	210	68	285	38	32	38	90	86	34	M33																	
85	3 1/4	12	7 15/32	2 15/32	9 49/64	63/64	7/8	1 27/64	3 7/16	3.374	1.343	7/8	UCFL217-52	FL217	UC217-52	9.8	84.0	61.9	14.5	–	–	–	–	–	–	–	–	–	–
		305	190	63	248	25	22	36	87.6	85.7	34.1	M22	UCFL217		UC217	9.8				UCFL217C	UCFL217D	92	3 5/8	9.8	UCFL217FC	UCFL217FD	107	4 7/32	11.2
	–	14 9/16	8 21/32	2 29/32	11 13/16	1 1/2	1 1/4	1 47/64	3 15/16	3.780	1.575	1 1/4	UCFL317	FL317	UC317	16.0	133	96.8	13.3	–	–	–	–	–	UCFL317C	UCFL317D	117	4 19/32	17.6
		370	220	74	300	38	32	44	100	96	40	M33																	
90	3 1/2	12 19/32	8 1/16	2 11/16	10 7/16	63/64	29/32	1 37/64	3 25/32	3.780	1.563	7/8	UCFL218-56	FL218	UC218-56	12.3	96.1	71.5	14.5	–	–	–	–	–	–	–	–	–	–
		320	205	68	265	25	23	40	96.3	96	39.7	M22	UCFL218		UC218	12.3				UCFL218C	UCFL218D	101	3 31/32	12.3	UCFL218FC	UCFL218FD	116	4 9/16	13.8

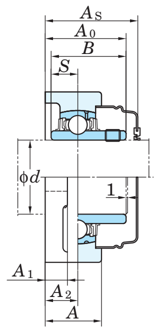
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210, X05~X09, 305~308
A-PT1/8 .... 211~218, X10, 309~326
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (or L2) follows the Part No. of unit or bearing. (Example of Part No. : UCFL206JL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCFL
Cylindrical bore (with set screws)
d (90) ~ 130 mm

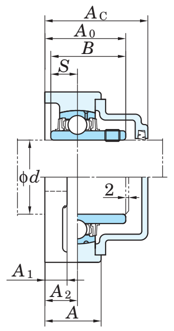




With Pressed Steel Cover



With Cast Iron Cover



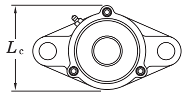
Variations of tolerance of distance from mounting surface to center of spherical bore (Δ_{A2s}) and tolerance of position of bolt hole (X)
Unit : mm

Housing No.			Δ_{A2s}	X
FL204~FL210	FLX05~FLX10	FL305~FL310	±0.5	0.7
FL211~FL218		FL311~FL326	±0.8	1

Variations of tolerance of bolt hole diameter (Δ_{Ns}) Unit : mm

Housing No.			Δ_{Ns}
FL204~FL218	FLX05~FLX10	FL305~FL311	±0.2
		FL312~FL326	±0.3

Forms and dimensions of L_c of FL204JE3 and FL205JE3 (housing with cast iron cover) are shown below.



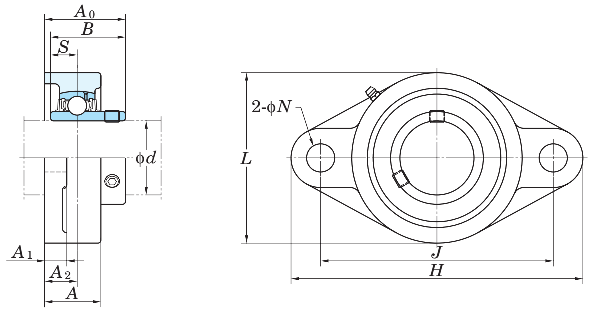
FL204JE3 L_c = 65 mm
FL205JE3 L_c = 73 mm

Shaft Dia.		Dimensions										Bolt Size	Standard			Mass	Basic Load Ratings		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm	inch	inch mm										inch mm	Unit No.	Housing No.	Bearing No.		kN			Unit No.		Dimension		Mass	Unit No.		Dimension		Mass
																				Open Type	Closed Type	mm	inch		Open Type	Closed Type	mm	inch	
d		H	L	A	J	N	A_1	A_2	A_0	B	S					kg	C_r	C_{0r}	f_0			A_s		kg			A_c		kg
90	3 1/2	15 5/32	9 1/4	3	12 13/32	1 1/2	1 13/32	1 47/64	3 15/16	3.780	1.575	1 1/4	**UCFL318-56**	FL318	UC318-56	19.0	143	107	13.3	–	–	–	–	–	–	–	–	–	–
		385	235	76	315	38	36	44	100	96	40	M33	**UCFL318**		UC318	19.0				–	–	–	–	–	UCFL318C	UCFL318D	119	4 11/16	20.9
95	–	15 15/16	9 27/32	3 11/16	13	1 39/64	1 9/16	2 21/64	4 3/4	4.055	1.614	1 3/8	**UCFL319**	FL319	UC319	24.6	153	119	13.3	–	–	–	–	–	UCFL319C	UCFL319D	140	5 1/2	26.8
		405	250	94	330	41	40	59	121	103	41	M36																	
100	3 15/16	17 5/16	10 5/8	3 11/16	14 11/64	1 47/64	1 9/16	2 21/64	4 29/32	4.252	1.654	1 1/2	**UCFL320**	FL320	UC320	29.4	173	141	13.2	–	–	–	–	–	UCFL320C	UCFL320D	146	5 3/4	32.2
		440	270	94	360	44	40	59	125	108	42	M39	**UCFL320-63**		UC320-63	29.4				–	–	–	–	–	–	–	–	–	–
	4												**UCFL320-64**		UC320-64	29.4				–	–	–	–	–	–	–	–	–	–
110	–	18 1/2	11 13/16	3 25/32	15 23/64	1 47/64	1 21/32	2 23/64	5 5/32	4.606	1.811	1 1/2	**UCFL322**	FL322	UC322	36.2	205	180	13.2	–	–	–	–	–	UCFL322C	UCFL322D	154	6 1/16	39.6
		470	300	96	390	44	42	60	131	117	46	M39																	
120	–	20 15/32	13	4 11/32	16 59/64	1 27/32	1 7/8	2 9/16	5 1/2	4.961	2.008	1 5/8	**UCFL324**	FL324	UC324	51.6	207	185	13.5	–	–	–	–	–	UCFL324C	UCFL324D	163	6 13/32	56.4
		520	330	110	430	47	48	65	140	126	51	M42																	
130	–	21 21/32	14 3/16	4 17/32	18 7/64	1 27/32	1 31/32	2 9/16	5 3/4	5.315	2.126	1 5/8	**UCFL326**	FL326	UC326	61.6	229	214	13.6	–	–	–	–	–	UCFL326C	UCFL326D	172	6 25/32	67.7
		550	360	115	460	47	50	65	146	135	54	M42																	

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210, X05~X09, 305~308
A-PT1/8 .... 211~218, X10, 309~326

3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (or L2) follows the Part No. of unit or bearing. (Example of Part No. : UCFL206JL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCFL-E
Cylindrical bore (with set screws)
d 12 ~ 75 mm



Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$) and tolerance of position of bolt hole (X)

Unit : mm

Housing No.	$\varDelta_{A2s}$	X
FL203E~FL210E	±0.5	0.7
FL211E~FL217E	±0.8	1

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

Unit : mm

Housing No.	$\varDelta_{Ns}$
FL203E~FL217E	±0.2

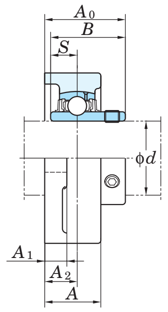
Shaft Dia. d mm	Shaft Dia. d inch	Dimensions inch / mm H	L	A	J	N	A_1	A_2	A_0	B	S	Bolt Size inch	Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN C_r	C_{0r}	Factor f_0	Mass kg
12		3 7/32 98	2 7/32 56	1 25.5	3 76.2	25/64 10	7/16 11	19/32 15	1 5/16 33.3	1.220 31	0.500 12.7	5/16	**UCFL201E**	FL203E	UC201	12.8	6.65	13.2	0.42
	1/2												**UCFL201E-8**		UC201-8				
15													**UCFL202E**		UC202				0.4
	5/8												**UCFL202E-10**		UC202-10				
17													**UCFL203E**		UC203				0.39
20	3/4	4 7/16 113	2 3/8 60	1 25.5	3 17/32 89.7	25/64 10	7/16 11	19/32 15	1 5/16 33.3	1.220 31	0.500 12.7	5/16	**UCFL204E-12**	FL204E	UC204-12	12.8	6.65	13.2	0.48
													UCFL204E		UC204				
25	7/8	5 1/8 130	2 11/16 68	1 1/16 27	3 57/64 98.8	15/32 12	1/2 13	5/8 16	1 13/32 35.8	1.343 34.1	0.563 14.3	3/8	**UCFL205E-14**	FL205E	UC205-14	14.0	7.85	13.9	0.64
	15/16												**UCFL205E-15**		UC205-15				
													UCFL205E		UC205				
	1												**UCFL205E-16**		UC205-16				
30	1 1/8	5 13/16 148	3 5/32 80	1 7/32 31	4 19/32 116.7	15/32 12	1/2 13	45/64 18	1 19/32 40.2	1.500 38.1	0.626 15.9	3/8	**UCFL206E-18**	FL206E	UC206-18	19.5	11.3	13.9	0.93
													UCFL206E		UC206				
	1 3/16												**UCFL206E-19**		UC206-19				
	1 1/4												**UCFL206E-20**		UC206-20				
35	1 1/4	6 11/32 161	3 17/32 90	1 11/32 34	5 1/8 130.2	33/64 13	9/16 14	3/4 19	1 3/4 44.4	1.689 42.9	0.689 17.5	7/16	**UCFL207E-20**	FL207E	UC207-20	3	15.4	13.9	1.2
	1 5/16												**UCFL207E-21**		UC207-21				
	1 3/8												**UCFL207E-22**		UC207-22				
													UCFL207E		UC207				
	1 7/16												**UCFL207E-23**		UC207-23				
40	1 1/2	6 7/8 175	3 15/16 100	1 13/32 36	5 21/32 143.7	33/64 13	9/16 14	53/64 21	2 1/32 51.2	1.937 49.2	0.748 19	7/16	**UCFL208E-24**	FL208E	UC208-24	29.1	17.8	14.0	1.6
	1 9/16												**UCFL208E-25**		UC208-25				
													UCFL208E		UC208				
45	1 5/8	7 13/32 188	4 1/4 108	1 1/2 38	5 27/32 148.4	19/32 15	19/32 15	55/64 22	2 1/16 52.2	1.937 49.2	0.748 19	1/2	**UCFL209E-26**	FL209E	UC209-26	34.1	21.3	14.0	1.9
	1 11/16												**UCFL209E-27**		UC209-27				
	1 3/4												**UCFL209E-28**		UC209-28				
													UCFL209E		UC209				
50	1 7/8	7 3/4 197	4 17/32 115	1 9/16 40	6 3/16 157	19/32 15	19/32 15	55/64 22	2 5/32 54.6	2.031 51.6	0.748 19	1/2	**UCFL210E-30**	FL210E	UC210-30	35.1	23.3	14.4	2.2
	1 15/16												**UCFL210E-31**		UC210-31				
													UCFL210E		UC210				
	2												**UCFL210E-32**		UC210-32				
55	2	8 13/16 224	5 1/8 130	1 11/16 43	7 1/4 184	21/32 16.5	23/32 18	63/64 25	2 5/16 58.4	2.189 55.6	0.874 22.2	9/16	**UCFL211E-32**	FL211E	UC211-32	43.4	29.4	14.4	3.3
	2 1/8												**UCFL211E-34**		UC211-34				
													UCFL211E		UC211				
	2 3/16												**UCFL211E-35**		UC211-35				
60	2 1/4	9 27/32 250	5 1/2 140	1 7/8 48	7 61/64 202	21/32 16.5	23/32 18	1 9/64 29	2 23/32 68.7	2.563 65.1	1.000 25.4	9/16	**UCFL212E-36**	FL212E	UC212-36	52.4	36.2	14.4	4.2
													UCFL212E		UC212				
	2 3/8												**UCFL212E-38**		UC212-38				
	2 7/16												**UCFL212E-39**		UC212-39				
65	2 1/2	10 5/32 258	6 3/32 155	1 31/32 50	8 17/64 210	21/32 16.5	25/32 20	1 3/16 30	2 3/4 69.7	2.563 65.1	1.000 25.4	9/16	**UCFL213E-40**	FL213E	UC213-40	57.2	40.1	14.4	5.2
													UCFL213E		UC213				
70	2 3/4	10 7/16 265	6 5/16 160	2 1/8 54	8 1/2 216	21/32 16.5	25/32 20	1 7/32 31	2 31/32 75.4	2.937 74.6	1.189 30.2	9/16	**UCFL214E-44**	FL214E	UC214-44	62.2	44.1	14.5	5.7
													UCFL214E		UC214				
75	2 15/16	10 13/16 275	6 1/2 165	2 7/32 56	8 55/64 225	3/4 19	25/32 20	1 11/32 34	3 3/32 78.5	3.063 77.8	1.311 33.3	11/16	**UCFL215E-47**	FL215E	UC215-47	67.4	48.3	14.5	6.4
													UCFL215E		UC215				
	3												**UCFL215E-48**		UC215-48				

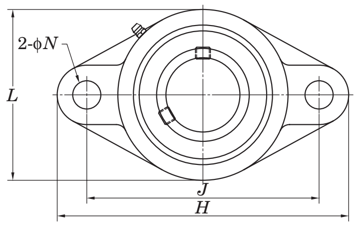
Remarks 1. In Part No. of unit, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210
A-PT1/8 .... 211~217
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (or L2) follows the Part No. of unit or bearing. (Example of Part No. : UCFL206EJL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCFL-E

Cylindrical bore (with set screws)

d 80 ~ 85 mm





Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$) and tolerance of position of bolt hole (X)

Unit : mm

Housing No.	$\varDelta_{A2s}$	X
FL203E~FL210E	±0.5	0.7
FL211E~FL217E	±0.8	1

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

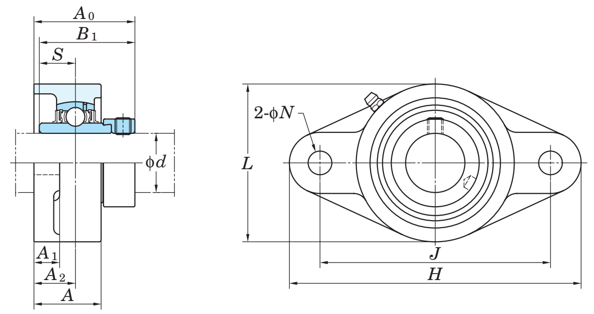
Unit : mm

Housing No.	$\varDelta_{Ns}$
FL203E~FL217E	±0.2

Shaft Dia. mm	Shaft Dia. inch	Dimensions inch mm										Bolt Size inch	Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN		Factor	Mass
d		*H*	*L*	*A*	*J*	*N*	A_1	A_2	A_0	*B*	*S*					C_r	C_{0r}	f_0	kg
80	3 1/8	11 13/32	7 3/32	2 9/32	9 11/64	3/4	25/32	1 11/32	3 9/32	3.252	1.311	11/16	**UCFL216E-50**	FL216E	UC216-50	72.7	53.0	14.6	7.8
		290	180	58	233	19	20	34	83.3	82.6	33.3		**UCFL216E**		UC216				
85	3 1/4	12	7 15/32	2 15/32	9 49/64	3/4	7/8	1 27/64	3 7/16	3.374	1.343	11/16	**UCFL217E-52**	FL217E	UC217-52	84.0	61.9	14.5	9.8
		305	190	63	248	19	22	36	87.6	85.7	34.1		**UCFL217E**		UC217				

Remarks 1. In Part No. of unit, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210
A-PT1/8 .... 211~217
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (or L2) follows the Part No. of unit or bearing. (Example of Part No. : UCFL206EJL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

NANFL
Cylindrical bore
(with eccentric locking collar)
d 12 ~ 55 mm



Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$) and tolerance of position of bolt hole (X)

Unit : mm

Housing No.	$\varDelta_{A2s}$	X
NFL204~NFL210	±0.5	0.7
NFL211	±0.8	1

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

Unit : mm

Housing No.	$\varDelta_{Ns}$
NFL204~NFL211	±0.2

Shaft Dia d mm	Shaft Dia d inch	Dimensions inch mm H	L	A	J	N	A_1	A_2	A_0	B_1	S	Bolt Size inch	Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN C_r	C_{0r}	Factor f_0	Mass kg
12		4 7/16 113	2 3/8 60	1 5/32 29.5	3 17/32 89.7	25/64 10	7/16 11	3/4 19	1 25/32 45.6	1.720 43.7	0.673 17.1	5/16	**NANFL201**	NFL204	NA201	12.8	6.65	13.2	0.59
	1/2												**NANFL201-8**		NA201-8				
15													**NANFL202**		NA202				
	5/8												**NANFL202-10**		NA202-10				
17													**NANFL203**		NA203				
	3/4												**NANFL204-12**		NA204-12				
20													**NANFL204**		NA204				
	7/8	5 1/8 130	2 11/16 68	1 7/32 31	3 57/64 98.8	15/32 12	1/2 13	25/32 20	1 27/32 46.9	1.748 44.4	0.689 17.5	3/8	**NANFL205-14**	NFL205	NA205-14	14.0	7.85	13.9	0.9
	15/16												**NANFL205-15**		NA205-15				
25													**NANFL205**		NA205				
	1												**NANFL205-16**		NA205-16				
	1 1/8	5 13/16 148	3 5/32 80	1 11/32 34	4 19/32 116.7	15/32 12	1/2 13	53/64 21	2 51.1	1.906 48.4	0.720 18.3	3/8	**NANFL206-18**	NFL206	NA206-18	19.5	11.3	13.9	1.1
30													**NANFL206**		NA206				
	1 3/16												**NANFL206-19**		NA206-19				
	1 1/4												**NANFL206-20**		NA206-20				
	1 1/4	6 11/32 161	3 17/32 90	1 7/16 36.5	5 1/8 130.2	33/64 13	9/16 14	27/32 21.5	2 1/8 53.8	2.012 51.1	0.740 18.8	7/16	**NANFL207-20**	NFL207	NA207-20	3	15.4	13.9	1.6
	1 5/16												**NANFL207-21**		NA207-21				
	1 3/8												**NANFL207-22**		NA207-22				
35													**NANFL207**		NA207				
	1 7/16												**NANFL207-23**		NA207-23				
	1 1/2	6 7/8 175	3 15/16 100	1 17/32 39	5 21/32 143.7	33/64 13	9/16 14	15/16 24	2 5/16 58.9	2.217 56.3	0.843 21.4	7/16	**NANFL208-24**	NFL208	NA208-24	29.1	17.8	14.0	2
	1 9/16												**NANFL208-25**		NA208-25				
40													**NANFL208**		NA208				
	1 5/8	7 13/32 188	4 1/4 108	1 9/16 40	5 27/32 148.4	19/32 15	9/16 14	15/16 24	2 5/16 58.9	2.217 56.3	0.843 21.4	1/2	**NANFL209-26**	NFL209	NA209-26	34.1	21.3	14.0	2.3
	1 11/16												**NANFL209-27**		NA209-27				
	1 3/4												**NANFL209-28**		NA209-28				
45													**NANFL209**		NA209				
	1 7/8	7 3/4 197	4 17/32 115	1 27/32 46.5	6 3/16 157	19/32 15	9/16 14	1 1/8 28.5	2 5/8 66.6	2.469 62.7	0.969 24.6	1/2	**NANFL210-30**	NFL210	NA210-30	35.1	23.3	14.4	2.7
	1 15/16												**NANFL210-31**		NA210-31				
50													**NANFL210**		NA210				
	2												**NANFL210-32**		NA210-32				
	2	8 13/16 224	5 1/8 130	1 31/32 50	7 1/4 184	21/32 16.5	25/32 20	1 17/64 32	2 31/32 75.6	2.811 71.4	1.094 27.8	9/16	**NANFL211-32**	NFL211	NA211-32	43.4	29.4	14.4	4.1
	2 1/8												**NANFL211-34**		NA211-34				
55													**NANFL211**		NA211				
	2 3/16												**NANFL211-35**		NA211-35				

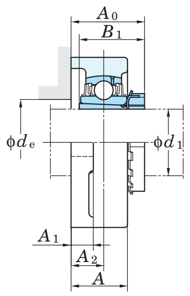
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210
A-PT1/8 211

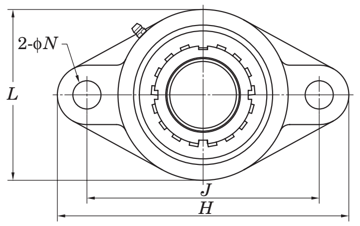
3. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UKFL

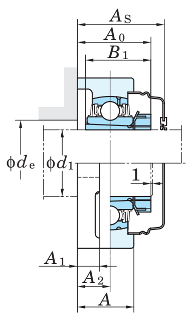
Tapered bore (with adapter)

d_1 **20 ~ (50) mm**

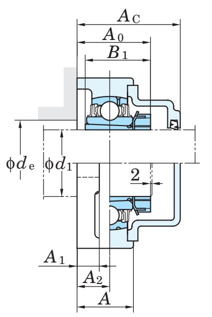




With Pressed Steel Cover



With Cast Iron Cover



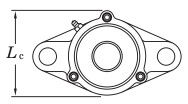
Variations of tolerance of distance from mounting surface to center of spherical bore (Δ_{A2s}) and tolerance of position of bolt hole (X) Unit : mm

Housing No.			Δ_{A2s}	X
FL205~FL210	FLX05~FLX10	FL305~FL310	±0.5	0.7
FL211~FL218		FL311~FL326	±0.8	1

Variations of tolerance of bolt hole diameter (Δ_{Ns}) Unit : mm

Housing No.			Δ_{Ns}
FL205~FL218	FLX05~FLX10	FL305~FL311	±0.2
		FL312~FL326	±0.3

Forms and dimensions of L_c of FL205JE3 (housing with cast iron cover) are shown below.



FL205JE3 $L_c = 73$ mm

Shaft Dia.		Dimensions inch / mm										Bolt Size	Standard			Adapter 1) No.	Mass	Basic Load Ratings kN		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm	inch d_1	H	L	A	J	N	A_1	A_2	A_0 1)	B_1 1)	d_e (min.)	inch mm	Unit No.	Housing No.	Bearing No.		kg	C_r	C_{0r}	f_0	Unit No. Open Type	Unit No. Closed Type	Dimension A_s mm	Dimension A_s inch	Mass kg	Unit No. Open Type	Unit No. Closed Type	Dimension A_c mm	Dimension A_c inch	Mass kg
20	3/4	5 1/8	2 11/16	1 1/16	3 57/64	5/8	1/2	5/8	1 11/32(1 13/32)	1 5/32(1 3/8)	1 3/16	1/2	UKFL205	FL205	UK205	HE305X(HE2305X)	0.68	14.0	7.85	13.9	–	–	–	–	–	–	–	–	–	–
		130	68	27	99	16	13	16	34.5(36)	29(35)	30	M14				H305X(H2305X)	0.68				UKFL205C	UKFL205D	40	1 9/16	0.68	UKFL205FC	UKFL205FD	49	1 15/16	0.89
	3/4	5 9/16	3 9/32	1 3/16	4 39/64	15/32	1/2	45/64	1 15/32	1 3/8	1 3/16	3/8	UKFLX05	FLX05	UKX05	HE2305X	1.0	19.5	11.3	13.9	–	–	–	–	–	–	–	–	–	–
		141	83	30	117	12	13	18	37.5	35	30	M10				H2305X	1.0				UKFLX05C	UKFLX05D	44	1 23/32	1.0	–	–	–	–	–
	3/4	5 29/32	3 5/32	1 5/32	4 29/64	3/4	1/2	5/8	1 15/32	1 3/8	–	5/8	UKFL305	FL305	UK305	HE2305X	1.1	21.2	10.9	12.6	–	–	–	–	–	–	–	–	–	–
		150	80	29	113	19	13	16	37.5	35	–	M16				H2305X	1.1				–	–	–	–	–	UKFL305C	UKFL305D	54	2 1/8	1.4
25		5 13/16	3 5/32	1 7/32	4 39/64	5/8	1/2	45/64	1 15/32(1 9/16)	1 7/32(1 1/2)	1 13/32	3/8	UKFL206	FL206	UK206	H306X(H2306X)	0.97	19.5	11.3	13.9	UKFL206C	UKFL206D	44	1 23/32	0.97	UKFL206FC	UKFL206FD	53	2 3/32	1.2
	1	148	80	31	117	16	13	18	37.5(39.5)	31(38)	36	M14				HE306X(HE2306X)	0.97				–	–	–	–	–	–	–	–	–	–
		6 5/32	3 3/4	1 11/32	5 1/8	5/8	9/16	3/4	1 9/16	1 1/2	1 13/32	3/8	UKFLX06	FLX06	UKX06	H2306X	1.5	25.7	15.4	13.9	UKFLX06C	UKFLX06D	49	1 15/16	1.5	–	–	–	–	–
	1	156	95	34	130	16	14	19	40	38	36	M14				HE2306X	1.5				–	–	–	–	–	–	–	–	–	–
		7 3/32	3 17/32	1 1/4	5 9/32	29/32	19/32	45/64	1 5/8	1 1/2	–	3/4	UKFL306	FL306	UK306	H2306X	1.5	26.7	15.0	13.3	–	–	–	–	–	UKFL306C	UKFL306D	59	2 5/16	1.8
	1	180	90	32	134	23	15	18	41	38	–	M20				HE2306X	1.5				–	–	–	–	–	–	–	–	–	–
30	1 1/8	6 11/32	3 17/32	1 11/32	5 1/8	5/8	9/16	3/4	1 5/8(1 11/16)	1 3/8(1 11/16)	1 5/8	3/8	UKFL207	FL207	UK207	HS307X(HS2307X)	1.3	25.7	15.4	13.9	–	–	–	–	–	–	–	–	–	–
		161	90	34	130	16	14	19	41(43)	35(43)	41	M14				H307X(H2307X)	1.3				UKFL207C	UKFL207D	49	1 15/16	1.3	UKFL207FC	UKFL207FD	58	2 9/32	1.7
	1 1/8	6 23/32	4 1/8	1 1/2	5 43/64	5/8	9/16	53/64	1 23/32	1 11/16	1 5/8	3/8	UKFLX07	FLX07	UKX07	HS2307X	1.8	29.1	17.8	14.0	–	–	–	–	–	–	–	–	–	–
		171	105	38	144	16	14	21	43.5	43	41	M14				H2307X	1.8				UKFLX07C	UKFLX07D	55	2 5/32	1.8	–	–	–	–	–
	1 1/8	7 9/32	3 15/16	1 13/32	5 35/64	29/32	5/8	25/32	1 25/32	1 11/16	–	3/4	UKFL307	FL307	UK307	HS2307X	1.9	33.4	19.3	13.2	–	–	–	–	–	–	–	–	–	–
		185	100	36	141	23	16	20	45.5	43	–	M20				H2307X	1.9				–	–	–	–	–	UKFL307C	UKFL307D	64	2 17/32	2.4
35	1 1/4	6 7/8	3 15/16	1 13/32	5 43/64	5/8	9/16	53/64	1 3/4(1 7/8)	1 13/32(1 13/16)	1 13/16	3/8	UKFL208	FL208	UK208	HE308X(HE2308X)	1.6	29.1	17.8	14.0	–	–	–	–	–	–	–	–	–	–
	1 3/8	175	100	36	144	16	14	21	44.5(48)	36(46)	46	M14				HS308X(HS2308X)	1.6				–	–	–	–	–	–	–	–	–	–
																H308X(H2308X)	1.6				UKFL208C	UKFL208D	55	2 5/32	1.6	UKFL208FC	UKFL208FD	64	2 17/32	2.0
	1 1/4	7 1/16	4 3/8	1 9/16	5 53/64	5/8	9/16	55/64	1 27/32	1 13/16	1 13/16	3/8	UKFLX08	FLX08	UKX08	HE2308X	2.1	34.1	21.3	14.0	–	–	–	–	–	–	–	–	–	–
	1 3/8	179	111	40	148	16	14	22	46.5	46	46	M14				HS2308X	2.1				–	–	–	–	–	–	–	–	–	–
																H2308X	2.1				UKFLX08C	UKFLX08D	56	2 7/32	2.1	–	–	–	–	–
	1 1/4	7 7/8	4 13/32	1 9/16	6 7/32	29/32	21/32	29/32	2	1 13/16	–	3/4	UKFL308	FL308	UK308	HE2308X	2.5	40.7	24.0	13.2	–	–	–	–	–	–	–	–	–	–
	1 3/8	200	112	40	158	23	17	23	50.5	46	–	M20				HS2308X	2.5				–	–	–	–	–	–	–	–	–	–
																H2308X	2.5				–	–	–	–	–	UKFL308C	UKFL308D	71	2 25/32	3.0
40	1 1/2	7 13/32	4 1/4	1 1/2	5 53/64	3/4	19/32	55/64	1 7/8(2)	1 17/32(1 31/32)	2 1/16	5/8	UKFL209	FL209	UK209	HE309X(HE2309X)	2.0	34.1	21.3	14.0	–	–	–	–	–	–	–	–	–	–
		188	108	38	148	19	15	22	47.5(51)	39(50)	52	M16				H309X(H2309X)	2.0				UKFL209C	UKFL209D	56	2 7/32	2.0	UKFL209FC	UKFL209FD	66	2 19/32	2.5
	1 5/8															HS309X(HS2309X)	2.0				–	–	–	–	–	–	–	–	–	–
	1 1/2	7 7/16	4 9/16	1 9/16	6 3/16	5/8	9/16	29/32	1 29/32	1 31/32	2 1/16	3/8	UKFLX09	FLX09	UKX09	HE2309X	2.5	35.1	23.3	14.4	–	–	–	–	–	–	–	–	–	–
		189	116	40	157	16	14	23	48.5	50	52	M14				H2309X	2.5				UKFLX09C	UKFLX09D	60	2 3/8	2.5	–	–	–	–	–
	1 5/8															HS2309X	2.5				–	–	–	–	–	–	–	–	–	–
	1 1/2	9 1/16	4 29/32	1 23/32	6 31/32	63/64	23/32	63/64	2 5/32	1 31/32	–	7/8	UKFL309	FL309	UK309	HE2309X	3.6	48.9	29.5	13.3	–	–	–	–	–	–	–	–	–	–
		230	125	44	177	25	18	25	55	50	–	M22				H2309X	3.6				–	–	–	–	–	UKFL309C	UKFL309D	76	3	4.2
	1 5/8															HS2309X	3.6				–	–	–	–	–	–	–	–	–	–
45	1 3/4	7 3/4	4 17/32	1 9/16	6 3/16	3/4	19/32	55/64	1 29/32(2 1/16)	1 21/32(2 5/32)	2 9/32	5/8	UKFL210	FL210	UK210	HE310X(HE2310X)	2.3	35.1	23.3	14.4	–	–	–	–	–	–	–	–	–	–
		197	115	40	157	19	15	22	48.5(52)	42(55)	58	M16				H310X(H2310X)	2.3				UKFL210C	UKFL210D	59	2 5/16	2.3	UKFL210FC	UKFL210FD	70.5	2 25/32	2.8
	1 3/4	8 1/2	5 1/4	1 23/32	7 1/4	3/4	25/32	1 1/32	1 3/32	2 5/32	2 9/32	5/8	UKFLX10	FLX10	UKX10	HE2310X	3.7	43.4	29.4	14.4	–	–	–	–	–	–	–	–	–	–
		216	133	44	184	19	20	26	53.5	55	58	M16				H2310X	3.7				UKFLX10C	UKFLX10D	64	2 17/32	3.7	–	–	–	–	–
	1 3/4	9 7/16	5 1/2	1 7/8	7 23/64	63/64	3/4	1 7/64	2 3/8	2 5/32	–	7/8	UKFL310	FL310	UK310	HE2310X	4.4	62.0	38.3	13.2	–	–	–	–	–	–	–	–	–	–
		240	140	48	187	25	19	28	60	55	–	M22				H2310X	4.4				–	–	–	–	–	UKFL310C	UKFL310D	83	3 9/32	5.2
50	1 7/8	8 13/16	5 1/8	1 11/16	7 1/4	3/4	23/32	63/64	2 1/16(2 1/4)	1 25/32(2 5/16)	2 17/32	5/8	UKFL211	FL211	UK211	HS311X(HS2311X)	3.3	43.4	29.4	14.4	–	–	–	–	–	–	–	–	–	–
		224	130	43	184	19	18	25	52.5(57)	45(59)	64	M16				H311X(H2311X)	3.3				UKFL211C	UKFL211D	63	2 15/32	3.3	UKFL211FC	UKFL211FD	74.5	2 15/16	3.9
	2															HE311X(HE2311X)	3.3				–	–	–	–	–	–	–	–	–	–

Note 1) Codes shown in parentheses indicate the dimensions and Part No. of applicable adapter (H2300X series) for UK200L3 series (triple seal type).

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

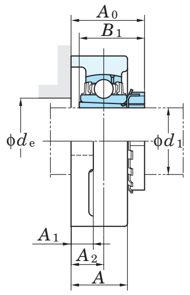
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF........205~210, X05~X09, 305~308
A-PT1/8................211~218, X10, 309~326

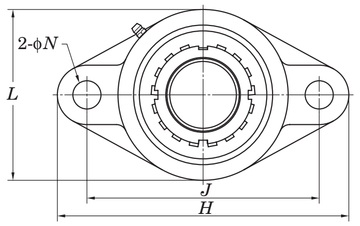
3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables. (Example of Part No. : UKFL206J + H306X, UK206 + H306X)

4. As for the triple seal type product (205 is the double seal type product), accessory code L3 (or L2) follows the Part No. of unit or bearing. (Example of Part No. : UKFL206JL3 + H2306X, UK206L3 + H2306X)

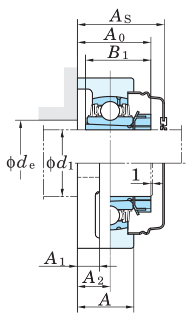
5. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

UKFL
Tapered bore (with adapter)
d_1 (50) ~ 115 mm

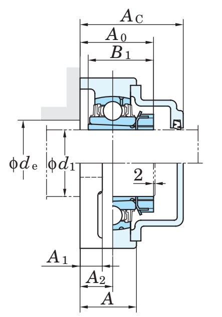




With Pressed Steel Cover



With Cast Iron Cover



Variations of tolerance of distance from mounting surface to center of spherical bore (Δ_{A2s}) and tolerance of position of bolt hole (X)

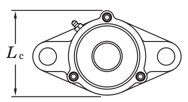
Unit : mm

Housing No.			Δ_{A2s}	X
FL205~FL210	FLX05~FLX10	FL305~FL310	±0.5	0.7
FL211~FL218		FL311~FL326	±0.8	1

Variations of tolerance of bolt hole diameter (Δ_{Ns}) Unit : mm

Housing No.			Δ_{Ns}
FL205~FL218	FLX05~FLX10	FL305~FL311	±0.2
		FL312~FL326	±0.3

Forms and dimensions of L_c of FL205JE3 (housing with cast iron cover) are shown below.



FL205JE3 L_c = 73 mm

Shaft Dia. mm	Shaft Dia. inch	Dimensions inch / mm										Bolt Size inch / mm	Standard					Basic Load Ratings kN		Factor	With Pressed Steel Cover					With Cast Iron Cover				
d_1		H	L	A	J	N	A_1	A_2	A_0[1)]	B_1[1)]	d_e (min.)		Unit No.	Housing No.	Bearing No.	Adapter[1)] No.	Mass kg	C_r	C_{0r}	f_0	Unit No. Open Type	Unit No. Closed Type	Dimension A_s mm	Dimension A_s inch	Mass kg	Unit No. Open Type	Unit No. Closed Type	Dimension A_c mm	Dimension A_c inch	Mass kg
50	1 7/8 2	9 27/32 250	5 29/32 150	2 1/16 52	7 51/64 198	63/64 25	25/32 20	1 3/16 30	2 1/2 63.5	2 5/16 59	– –	7/8 M22	**UKFL311**	FL311	UK311	HS2311X H2311X HE2311X	5.6 5.6 5.6	71.6	45.0	13.2	– – –	– – –	– – –	– – –	– – –	– UKFL311C –	– UKFL311D –	– 87 –	– 3 7/16 –	– 6.5 –
55	2 1/8	9 27/32 250	5 1/2 140	1 7/8 48	7 61/64 202	29/32 23	23/32 18	1 9/64 29	2 5/16(2 19/32) 58.5(65.5)	1 27/32(2 7/16) 47(62)	2 23/32 69	3/4 M20	**UKFL212**	FL212	UK212	HS312X(HS2312X) H312X(H2313X)	4.1 4.1	52.4	36.2	14.4	– UKFL212C	– UKFL212D	– 73	– 2 7/8	– 4.1	– UKFL212FC	– UKFL212FD	– 86	– 3 3/8	– 4.9
	2 1/8	10 5/8 270	6 5/16 160	2 7/32 56	8 11/32 212	1 7/32 31	7/8 22	1 19/64 33	2 3/4 69.5	2 7/16 62	– –	1 M27	**UKFL312**	FL312	UK312	HS2312X H2312X	6.9 6.9	81.9	52.2	13.2	– –	– –	– –	– –	– –	– UKFL312C	– UKFL312D	– 95	– 3 3/8	– 8.1
60	2 1/4 2 3/8	10 5/32 258	6 3/32 155	1 31/32 50	8 17/64 210	29/32 23	25/32 20	1 3/16 30	2 7/16(2 21/32) 62(67.5)	1 31/32(2 9/16) 50(65)	2 29/32 74	3/4 M20	**UKFL213**	FL213	UK213	HE313X(HE2313X) H313X(H2313X) HS313X(HS2313X)	5.0 5.0 5.0	57.2	40.1	14.4	– UKFL213C –	– UKFL213D –	– 74 –	– 2 29/32 –	– 5.0 –	– UKFL213FC –	– UKFL213FD –	– 87 –	– 3 7/16 –	– 5.9 –
	2 1/4 2 3/8	11 5/8 295	6 7/8 175	2 9/32 58	9 29/64 240	1 7/32 31	31/32 25	1 19/64 33	2 13/16 71.5	2 9/16 65	– –	1 M27	**UKFL313**	FL313	UK313	HE2313X H2313X HS2313X	8.6 8.6 8.6	92.7	59.9	13.2	– – –	– – –	– – –	– – –	– – –	– UKFL313C –	– UKFL313D –	– 94 –	– 3 11/16 –	– 9.7 –
65	2 1/2	10 13/16 275	6 1/2 165	2 7/32 56	8 55/64 225	29/32 23	25/32 20	1 11/32 34	2 23/32(2 15/16) 69(74.5)	2 5/32(2 7/8) 55(73)	3 11/32 85	3/4 M20	**UKFL215**	FL215	UK215	HE315X(HE2315X) H315X(H2315X)	6.6 6.6	67.4	48.3	14.5	– UKFL215C	– UKFL215D	– 83	– 3 9/32	– 6.6	– UKFL215FC	– UKFL215FD	– 96	– 3 25/32	– 7.6
	2 1/2	12 19/32 320	7 11/16 195	2 19/32 66	10 15/64 260	1 3/8 35	1 3/16 30	1 17/32 39	2 7/32 81.5	2 7/8 73	– –	1 1/8 M30	**UKFL315**	FL315	UK315	HE2315X H2315X	11.4 11.4	113	77.2	13.2	– –	– –	– –	– –	– –	– UKFL315C	– UKFL315D	– 106	– 4 3/16	– 12.8
70	2 3/4	11 13/32 290	7 3/32 180	2 9/32 58	9 11/64 233	63/64 25	25/32 20	1 11/32 34	2 27/32(3 3/32) 72(78.5)	2 5/16(3 1/16) 59(78)	3 17/32 90	7/8 M22	**UKFL216**	FL216	UK216	HE316X(HE2316X) H316X(H2316X)	8.1 8.1	72.7	53.0	14.6	– UKFL216C	– UKFL216D	– 88	– 3 15/32	– 8.1	– UKFL216FC	– UKFL216FD	– 103	– 4 1/16	– 9.4
	2 3/4	13 31/32 355	8 9/32 210	2 11/16 68	11 7/32 285	1 1/2 38	1 1/4 32	1 1/2 38	3 1/4 82.5	3 1/16 78	– –	1 1/4 M33	**UKFL316**	FL316	UK316	HE2316X H2316X	13.9 13.9	123	86.7	13.3	– –	– –	– –	– –	– –	– UKFL316C	– UKFL316D	– 107	– 4 7/32	– 15.5
75	3	12 305	7 15/32 190	2 15/32 63	9 49/64 248	63/64 25	7/8 22	1 27/64 36	3(3 1/4) 76(82.5)	2 15/32(3 7/32) 63(82)	3 25/32 96	7/8 M22	**UKFL217**	FL217	UK217	H317X(H2317X) HE317X(HE2317X)	9.9 9.9	84.0	61.9	14.5	UKFL217C –	UKFL217D –	92 –	3 5/8 –	9.9 –	UKFL217FC –	UKFL217FD –	107 –	4 7/32 –	11.3 –
	3	14 9/16 370	8 21/32 220	2 29/32 74	11 13/16 300	1 1/2 38	1 1/4 32	1 47/64 44	3 5/8 92	3 7/32 82	– –	1 1/4 M33	**UKFL317**	FL317	UK317	H2317X HE2317X	15.8 15.8	133	96.8	13.3	– –	– –	– –	– –	– –	UKFL317C –	UKFL317D –	117 –	4 19/32 –	17.6 –
80	–	12 19/32 320	8 1/16 205	2 11/16 68	10 7/16 265	63/64 25	29/32 23	1 37/64 40	3 7/32(3 17/32) 82(89.5)	2 9/16(3 3/8) 65(86)	4 1/32 102	7/8 M22	**UKFL218**	FL218	UK218	H318X(H2318X)	12.2	96.1	71.5	14.5	UKFL218C	UKFL218D	101	3 31/32	12.2	UKFL218FC	UKFL218FD	116	4 9/16	13.8
	–	15 5/32 385	9 1/4 235	3 76	12 13/32 315	1 1/2 38	1 13/32 36	1 47/64 44	3 5/8 92	3 3/8 86	– –	1 1/4 M33	**UKFL318**	FL318	UK318	H2318X	19.1	143	107	13.3	–	–	–	–	–	UKFL318C	UKFL318D	119	4 11/16	21.2
85	3 1/4	15 15/16 405	9 27/32 250	3 11/16 94	13 330	1 39/64 41	1 9/16 40	2 21/64 59	4 3/8 111	3 17/32 90	– –	1 3/8 M36	**UKFL319**	FL319	UK319	HE2319X H2319X	24.9 24.9	153	119	13.3	– –	– –	– –	– –	– –	– UKFL319C	– UKFL319D	– 140	– 5 1/2	– 27.3
90	3 1/2	17 5/16 440	10 5/8 270	3 11/16 94	14 11/64 360	1 47/64 44	1 9/16 40	2 21/64 59	4 7/16 113	3 13/16 97	– –	1 1/2 M39	**UKFL320**	FL320	UK320	HE2320X H2320X	29.0 29.0	173	141	13.2	– –	– –	– –	– –	– –	– UKFL320C	– UKFL320D	– 146	– 5 3/4	– 32.1
100	4	18 1/2 470	11 13/16 300	3 25/32 96	15 23/64 390	1 47/64 44	1 21/32 42	2 23/64 60	4 23/32 120	4 1/8 105	– –	1 1/2 M39	**UKFL322**	FL322	UK322	H2322X HE2322X	36.1 36.1	205	180	13.2	– –	– –	– –	– –	– –	UKFL322C –	UKFL322D –	154 –	6 1/16 –	39.6 –
110	–	20 15/32 520	13 330	4 11/32 110	16 59/64 430	1 27/32 47	1 7/8 48	2 9/16 65	5 1/8 130.5	4 13/32 112	– –	1 5/8 M42	**UKFL324**	FL324	UK324	H2324	51.9	207	185	13.5	–	–	–	–	–	UKFL324C	UKFL324D	163	6 13/32	57.0
115	4 1/2	21 21/32 550	14 3/16 360	4 17/32 115	18 7/64 460	1 27/32 47	1 31/32 50	2 9/16 65	5 3/16 131.5	4 3/4 121	– –	1 5/8 M42	**UKFL326**	FL326	UK326	HE2326 H2326	61.4 61.4	229	214	13.6	– –	– –	– –	– –	– –	– UKFL326C	– UKFL326D	– 172	– 6 25/32	– 68.0

Note 1) Codes shown in parentheses indicate the dimensions and Part No. of applicable adapter (H2300X series) for UK200L3 series (triple seal type).

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF........205~210, X05~X09, 305~308
A-PT1/8................211~218, X10, 309~326

3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables.
(Example of Part No. : UKFL206J + H306X, UK206 + H306X)

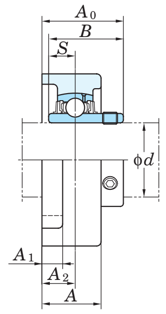
4. As for the triple seal type product (205 is the double seal type product), accessory code L3 (or L2) follows the Part No. of unit or bearing.
(Example of Part No. : UKFL206JL3 + H2306X, UK206L3 + H2306X)

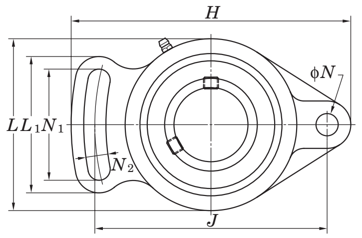
5. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

UCFA

Cylindrical bore (with set screws)

d 12 ~ 55 mm





Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$)

Unit : mm

Housing No.	$\varDelta_{A2s}$
FA204~FA210	±0.5
FA211	±0.8

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

Unit : mm

Housing No.	$\varDelta_{Ns}$
FA204~FA211	±0.2

Shaft Dia. mm	Shaft Dia. inch	Dimensions inch mm													Bolt Size inch mm	Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN		Factor	Mass
d		H	L	A	J	N	N_1	N_2	L_1	A_1	A_2	A_0	B	S					C_r	C_{0r}	f_0	kg
12		3 27/32 98	2 5/16 59	15/16 24	3 5/64 78	25/64 10	1 9/16 40	13/32 10	1 31/32 50	7/16 11	35/64 13.8	1 1/4 32.1	1.220 31	0.500 12.7	5/16 M8	**UCFA201**	FA204	UC201	12.8	6.65	13.2	0.47
	1/2															**UCFA201-8**		UC201-8				
15																**UCFA202**		UC202				0.45
	5/8															**UCFA202-10**		UC202-10				
17																**UCFA203**		UC203				0.44
	3/4															**UCFA204-12**		UC204-12				
20																**UCFA204**		UC204				0.42
	7/8	4 7/8 124	2 3/4 70	1 1/16 27	3 55/64 98	7/16 11	1 15/16 49	7/16 11	2 17/32 64	1/2 13	5/8 16	1 13/32 35.8	1.343 34.1	0.563 14.3	3/8 M10	**UCFA205-14**	FA205	UC205-14	14.0	7.85	13.9	0.68
	15/16															**UCFA205-15**		UC205-15				
25																**UCFA205**		UC205				
	1															**UCFA205-16**		UC205-16				
	1 1/8	5 9/16 141	3 9/32 83	1 3/16 30	4 39/64 117	7/16 11	2 7/32 56	15/32 12	2 11/16 68	1/2 13	45/64 17.8	1 9/16 40	1.500 38.1	0.626 15.9	3/8 M10	**UCFA206-18**	FA206	UC206-18	19.5	11.3	13.9	1.0
30																**UCFA206**		UC206				
	1 3/16															**UCFA206-19**		UC206-19				
	1 1/4															**UCFA206-20**		UC206-20				
	1 1/4	6 3/32 155	3 25/32 96	1 11/32 34	5 1/8 130	33/64 13	2 15/32 63	1/2 13	2 15/16 75	9/16 14	47/64 18.6	1 23/32 44	1.689 42.9	0.689 17.5	7/16 M12	**UCFA207-20**	FA207	UC207-20	25.7	15.4	13.9	1.5
	1 5/16															**UCFA207-21**		UC207-21				
	1 3/8															**UCFA207-22**		UC207-22				
35																**UCFA207**		UC207				
	1 7/16															**UCFA207-23**		UC207-23				
	1 1/2	6 23/32 171	4 1/8 105	1 1/2 38	5 43/64 144	33/64 13	2 3/4 70	1/2 13	3 5/16 84	9/16 14	13/16 20.8	2 51	1.937 49.2	0.748 19	7/16 M12	**UCFA208-24**	FA208	UC208-24	29.1	17.8	14	1.9
	1 9/16															**UCFA208-25**		UC208-25				
40																**UCFA208**		UC208				
	1 5/8	7 1/16 179	4 3/8 111	1 9/16 40	5 53/64 148	19/32 15	2 27/32 72	19/32 15	3 15/32 88	9/16 14	55/64 21.8	2 1/16 52	1.937 49.2	0.748 19	1/2 M14	**UCFA209-26**	FA209	UC209-26	34.1	21.3	14	1.7
	1 11/16															**UCFA209-27**		UC209-27				
	1 3/4															**UCFA209-28**		UC209-28				
45																**UCFA209**		UC209				
	1 7/8	7 7/16 189	4 9/16 116	1 9/16 40	6 3/16 157	19/32 15	2 15/16 75	19/32 15	3 5/8 92	9/16 14	57/64 22.5	2 5/32 55.1	2.031 51.6	0.748 19	1/2 M14	**UCFA210-30**	FA210	UC210-30	35.1	23.3	14.4	2.0
	1 15/16															**UCFA210-31**		UC210-31				
50																**UCFA210**		UC210				
	2															**UCFA210-32**		UC210-32				
	2	8 1/2 216	5 1/4 133	1 23/32 44	7 1/4 184	5/8 16	3 3/8 86	5/8 16	4 1/32 102	25/32 20	1 1/64 25.7	2 5/16 59.1	2.189 55.6	0.874 22.2	1/2 M14	**UCFA211-32**	FA211	UC211-32	43.4	29.4	14.4	3.6
	2 1/8															**UCFA211-34**		UC211-34				
55																**UCFA211**		UC211				
	2 3/16															**UCFA211-35**		UC211-35				

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF 201~210
A-PT1/8................211

3. As for triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (or L2) follows Part No. of unit or bearing. (Example of Part No. : UCFA206JL3, UC206L3)

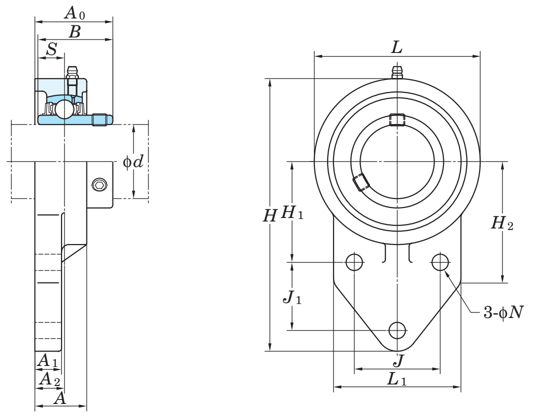
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

5. Tapered bore (with adapter) type products are also available. (Example of Part No. : UKFA205J + H305X, UK205 + H305X)

UCFB

Cylindrical bore (with set screws)

d 12 ~ 50 mm



Variations of tolerance of distance from mounting surface to center of spherical bore (Δ_{A2s}), variations of tolerance of distance between centers of bolt holes (Δ_{Js}, Δ_{J1s}), variations of tolerance of distance between both grooves (Δ_{H1s})

Unit : mm

Housing No.	Δ_{A2s}	Δ_{Js}	Δ_{J1s}	Δ_{H1s}
FB204~FB210	±0.5			

Variations of tolerance of bolt hole diameter (Δ_{Ns})

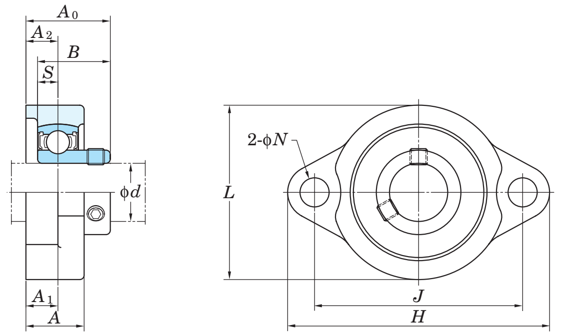
Unit : mm

Housing No.	Δ_{Ns}
FB204~FB210	±0.2

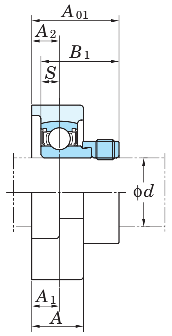
Shaft Dia. mm	inch	Dimensions inch mm H	L	A	J	J_1	N	H_1	H_2	L_1	A_1	A_2	A_0	B	S	Bolt Size inch mm	Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN C_r	C_{0r}	Factor f_0	Mass kg
d																							
12		4 11/32 110	2 7/16 62	15/16 24	1 17/64 32	1 11/16 27	3/8 9.5	1 21/32 42	2 1/16 52	2 1/16 52	1/2 13	17/32 13.5	1 1/4 31.8	1.220 31	0.500 12.7	5/16 M8	**UCFB201**	FB204	UC201	12.8	6.65	13.2	0.64
	1/2																**UCFB201-8**		UC201-8				
15																	**UCFB202**		UC202				0.62
	5/8																**UCFB202-10**		UC202-10				
17																	**UCFB203**		UC203				0.61
	3/4																**UCFB204-12**		UC204-12				
20																	**UCFB204**		UC204				0.59
	7/8	4 9/16 116	2 11/16 68	1 1/32 26	1 11/32 34	1 1/16 27	3/8 9.5	1 49/64 45	2 1/16 52	2 7/32 56	1/2 13	19/32 15	1 3/8 34.8	1.343 34.1	0.563 14.3	5/16 M8	**UCFB205-14**	FB205	UC205-14	14.0	7.85	13.9	0.68
	15/16																**UCFB205-15**		UC205-15				
25																	**UCFB205**		UC205				
	1																**UCFB205-16**		UC205-16				
	1 1/8	5 1/8 130	3 1/16 78	1 5/32 29	1 37/64 40	1 9/64 29	3/8 9.5	1 31/32 50	2 5/32 55	2 9/16 65	1/2 13	43/64 17	1 17/32 39.2	1.500 38.1	0.626 15.9	5/16 M8	**UCFB206-18**	FB206	UC206-18	19.5	11.3	13.9	0.92
30																	**UCFB206**		UC206				
	1 3/16																**UCFB206-19**		UC206-19				
	1 1/4																**UCFB206-20**		UC206-20				
	1 1/4	5 21/32 144	3 17/32 90	1 5/16 33	1 13/16 46	1 17/64 32	3/8 9.5	2 11/64 55	2 7/16 62	2 3/4 70	19/32 15	3/4 19	1 3/4 44.4	1.689 42.9	0.689 17.5	5/16 M8	**UCFB207-20**	FB207	UC207-20	25.7	15.4	13.9	1.3
	1 5/16																**UCFB207-21**		UC207-21				
	1 3/8																**UCFB207-22**		UC207-22				
35																	**UCFB207**		UC207				
	1 7/16																**UCFB207-23**		UC207-23				
	1 1/2	6 15/32 164	3 15/16 100	1 11/32 34	1 31/32 50	1 39/64 41	7/16 11	2 23/64 60	2 27/32 72	3 1/16 78	5/8 16	25/32 20	1 31/32 50.2	1.937 49.2	0.748 19	3/8 M10	**UCFB208-24**	FB208	UC208-24	29.1	17.8	14.0	1.8
	1 9/16																**UCFB208-25**		UC208-25				
40																	**UCFB208**		UC208				
	1 5/8	6 27/32 174	4 3/16 106	1 11/32 34	2 1/8 54	1 11/16 43	7/16 11	2 9/16 65	3 76	3 5/32 80	23/32 18	25/32 20	1 31/32 50.2	1.937 49.2	0.748 19	3/8 M10	**UCFB209-26**	FB209	UC209-26	34.1	21.3	14.0	2.0
	1 11/16																**UCFB209-27**		UC209-27				
	1 3/4																**UCFB209-28**		UC209-28				
45																	**UCFB209**		UC209				
	1 7/8	7 1/4 184	4 13/32 112	1 3/8 35	2 9/32 58	1 13/16 46	7/16 11	2 43/64 68	3 7/32 82	3 3/8 86	23/32 18	25/32 20	2 1/16 52.6	2.031 51.6	0.748 19	3/8 M10	**UCFB210-30**	FB210	UC210-30	35.1	23.3	14.4	2.3
	1 15/16																**UCFB210-31**		UC210-31				
50																	**UCFB210**		UC210				
	2																**UCFB210-32**		UC210-32				

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter codes. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipple is A-1/4-28UNF.
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (or L2) follows Part No. of unit or bearing. (Example of Part No. : UCFB206JL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.
5. Tapered bore (with adapter) type products are also available. (Example of Part No. : UKFB205J + H305X, UK205 + H305X)

BLF
Cylindrical bore
(with set screw locking)
ALF
Cylindrical bore
(with eccentric locking collar)
d 12 ~ 35 mm



BLF



ALF

Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$) and variations of tolerance of distance between centers of bolt holes ($\varDelta_{Js}$)

Unit : mm

Housing No.	$\varDelta_{A2s}$	$\varDelta_{Js}$
LF203~LF207	±0.5	±0.7

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

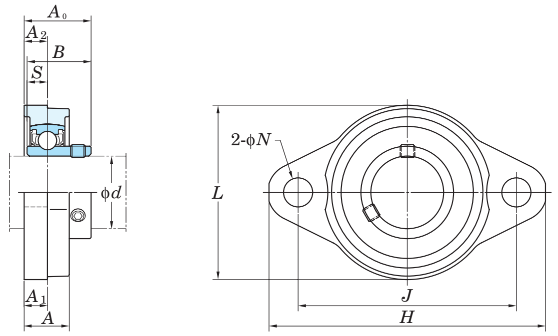
Unit : mm

Housing No.	$\varDelta_{Ns}$
LF203~LF207	±0.2

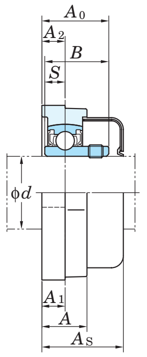
Shaft Dia. mm	Shaft Dia. inch	Dimensions inch / mm												Bolt Size	Unit No.	Bearing No.	Unit No.	Bearing No.	Housing No.	Basic Load Ratings kN		Factor	Mass kg	
										BLF		ALF		inch mm										
d		H	L	A	J	N	A_1	A_2	S	A_0	B	A_{01}	B_1							C_r	C_{0r}	f_0	BLF	ALF
12		3 3/16 81	2 1/16 52	23/32 18	2 1/2 63.5	5/16 8	3/8 9.5	3/8 9.5	0.236 6	1 25.5	0.866 22	1 1/4 32	1.122 28.5	1/4 M6	**BLF201**	SB201	**ALF201**	SA201	LF203	9.55	4.80	13.2	0.25	0.28
	1/2														**BLF201-8**	SB201-8	**ALF201-8**	SA201-8						
15															**BLF202**	SB202	**ALF202**	SA202						
	5/8														**BLF202-10**	SB202-10	**ALF202-10**	SA202-10						
17															**BLF203**	SB203	**ALF203**	SA203						
20	3/4	3 17/32 90	2 3/8 60	25/32 20	2 13/16 71.5	25/64 10	7/16 11	7/16 11	0.276 7	1 5/32 29	0.984 25	1 5/16 33.5	1.161 29.5	5/16 M8	**BLF204-12**	SB204-12	**ALF204-12**	SA204-12	LF204	12.8	6.65	13.2	0.33	0.33
															BLF204	SB204	**ALF204**	SA204						
25	7/8	3 3/4 95	2 17/32 64	25/32 20	2 63/64 76	25/64 10	7/16 11	7/16 11	0.295 7.5	1 3/16 30.5	1.063 27	1 11/32 34	1.201 30.5	5/16 M8	**BLF205-14**	SB205-14	**ALF205-14**	SA205-14	LF205	14.0	7.85	13.9	0.38	0.42
	15/16														**BLF205-15**	SB205-15	**ALF205-15**	SA205-15						
															BLF205	SB205	**ALF205**	SA205						
	1														**BLF205-16**	SB205-16	**ALF205-16**	SA205-16						
30	1 1/8	4 7/16 113	3 76	7/8 22.5	3 9/16 90.5	15/32 12	15/32 12	15/32 12	0.315 8	1 11/32 34	1.181 30	1 1/2 37.9	1.335 33.9	3/8 M10	**BLF206-18**	SB206-18	**ALF206-18**	SA206-18	LF206	19.5	11.3	13.9	0.57	0.60
															BLF206	SB206	**ALF206**	SA206						
	1 3/16														**BLF206-19**	SB206-19	**ALF206-19**	SA206-19						
	1 1/4														**BLF206-20**	SB206-20	**ALF206-20**	SA206-20						
35	1 1/4	4 13/16 122	3 1/2 89	15/16 24	3 15/16 100	15/32 12	1/2 13	33/64 13	0.335 8.5	1 7/16 36.5	1.260 32	1 5/8 41	1.437 36.5	3/8 M10	**BLF207-20**	SB207-20	**ALF207-20**	SA207-20	LF207	25.7	15.4	13.9	0.77	0.85
	1 5/16																**ALF207-21**	SA207-21						
	1 3/8														**BLF207-22**	SB207-22	**ALF207-22**	SA207-22						
															BLF207	SB207	**ALF207**	SA207						
	1 7/16														**BLF207-23**	SB207-23	**ALF207-23**	SA207-23						

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter codes. (See **Table 10.5** in P.42.)
2. Allowable load to housing in radial direction is approximately half of basic load rating of bearing, C_r (when safety factor is 4).
3. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

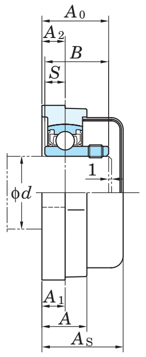
UFL
Cylindrical bore (with set screws)
d 8 ~ 30 mm



With Through Type Cover



With One Side Sealed Cover



Variations of tolerance of distance from mounting surface to center of spherical bore (Δ_{A2s}) and variations of tolerance of distance between centers of bolt holes (Δ_{Js})

Unit : mm

Housing No.	Δ_{A2s}	Δ_{Js}
FL08	±0.5	±0.3
FL000~FL006		

Variations of tolerance of bolt hole diameter (Δ_{Ns})

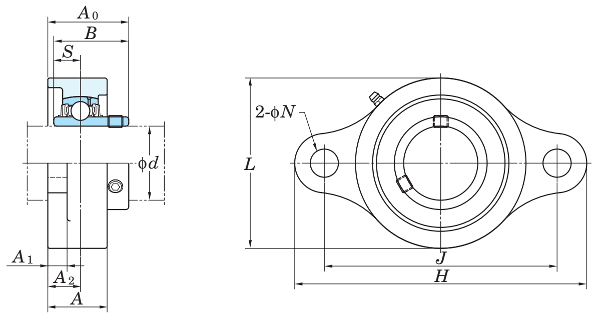
Unit : mm

Housing No.	Δ_{Ns}
FL08	±0.2
FL000~FL006	

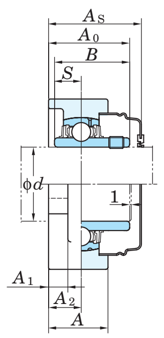
Shaft Dia. mm	Dimensions inch mm										Bolt Size inch mm	Standard							Factor	With Rubber Coated Cover				
												Unit No.	Housing No.	Bearing No.	Mass	Basic Load Ratings kN				Unit No.		Dimension		Mass
																				Open Type	Closed Type	mm	inch	
d	H	L	A	J	N	A_1	A_2	A_0	B	S					kg	C_r	C_{0r}		f_0			A_s		kg
8	1 7/8 48	1 1/16 27	11/32 8.5	1 29/64 37	3/16 4.8	5/32 4	5/32 4	1/2 12.5	0.472 12	0.1378 3.5	No.8 M4	UFL08	FL08	SU08	0.030	3.27	1.37		12.4	–	–	–	–	–
10	2 3/8 60	1 13/32 36	15/32 12	1 49/64 45	9/32 7	1/4 6	15/64 6	5/8 16	0.591 15	0.197 5	1/4 M6	UFL000	FL000	SU000	0.050	4.55	1.95		12.3	UFL000C	UFL000D	20.5	13/16	0.050
12	2 15/32 63	1 1/2 38	15/32 12	1 57/64 48	9/32 7	1/4 6	15/64 6	5/8 16	0.591 15	0.197 5	1/4 M6	UFL001	FL001	SU001	0.065	5.10	2.40		13.2	UFL001C	UFL001D	20.5	13/16	0.065
15	2 5/8 67	1 21/32 42	1/2 13	2 3/32 53	9/32 7	1/4 6.5	1/4 6.5	11/16 17.5	0.650 16.5	0.217 5.5	1/4 M6	UFL002	FL002	SU002	0.085	5.60	2.85		13.9	UFL002C	UFL002D	22	7/8	0.085
17	2 25/32 71	1 13/16 46	9/16 14	2 13/64 56	9/32 7	9/32 7	9/32 7	23/32 18.5	0.689 17.5	0.236 6	1/4 M6	UFL003	FL003	SU003	0.11	6.00	3.25		14.4	UFL003C	UFL003D	23.5	15/16	0.11
20	3 17/32 90	2 5/32 55	5/8 16	2 51/64 71	13/32 10	5/16 8	5/16 8	7/8 22	0.827 21	0.276 7	5/16 M8	UFL004	FL004	SU004	0.18	9.40	5.05		13.9	UFL004C	UFL004D	27	1 1/16	0.18
25	3 3/4 95	2 3/8 60	5/8 16	2 61/64 75	13/32 10	5/16 8	5/16 8	29/32 23	0.866 22	0.276 7	5/16 M8	UFL005	FL005	SU005	0.23	10.1	5.85		14.5	UFL005C	UFL005D	28	1 3/32	0.23
30	4 13/32 112	2 3/4 70	23/32 18	3 11/32 85	1/2 13	11/32 9	23/64 9	1 1/32 26	0.965 24.5	0.295 7.5	3/8 M10	UFL006	FL006	SU006	0.31	13.2	8.25		14.7	UFL006C	UFL006D	31	1 7/32	0.31

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter codes. (See **Table 10.5** in P.42.)
2. Clean series oval flange type unit.
3. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCSFL-H1S6
Cylindrical bore (with set screws)
d 20 ~ 50 mm



With Pressed Stainless Steel Cover



Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$) and variations of tolerance of distance between centers of bolt holes ($\varDelta_{Js}$)

Unit : mm

Housing No.	$\varDelta_{A2s}$	$\varDelta_{Js}$
SFL204H1~SFL210H1	±0.5	0.3

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

Unit : mm

Housing No.	$\varDelta_{Ns}$
SFL204H1~SFL210H1	±0.2

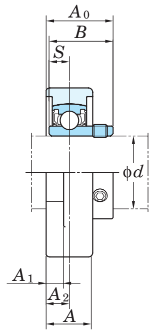
Shaft Dia.	Dimensions										Bolt Size	Standard				Basic Load Ratings		Factor	With Pressed Stainless Steel Cover				
mm	inch mm										inch mm	Unit No.	Housing No.	Bearing No.	Mass	kN			Unit No.		Dimension		Mass
																			Open Type	Closed Type	mm	inch	
d	H	L	A	J	N	A_1	A_2	A_0	B	S					kg	C_r	C_{0r}	f_0			A_s		kg
20	4 7/16 113	2 3/8 60	1 1/32 26	3 35/64 90	15/32 12	13/32 10	19/32 15	1 5/16 33.3	1.220 31	0.500 12.7	3/8 M10	**UCSFL204H1S6**	SFL204H1	UC204S6	0.43	10.9	5.35	13.2	UCSFL204H1CS6	UCSFL204H1DS6	38	1 1/2	0.43
25	5 1/8 130	2 11/16 68	1 3/32 27.5	3 57/64 99	5/8 16	13/32 10	5/8 16	1 13/32 35.8	1.343 34.1	0.563 14.3	1/2 M14	**UCSFL205H1S6**	SFL205H1	UC205S6	0.60	11.9	6.30	13.9	UCSFL205H1CS6	UCSFL205H1DS6	40	1 9/16	0.60
30	5 13/16 148	3 5/32 80	1 7/32 31	4 39/64 117	5/8 16	13/32 10	45/64 18	1 19/32 40.2	1.500 38.1	0.626 15.9	1/2 M14	**UCSFL206H1S6**	SFL206H1	UC206S6	0.86	16.5	9.05	13.9	UCSFL206H1CS6	UCSFL206H1DS6	45	1 15/32	0.86
35	6 11/32 161	3 11/32 85	1 11/32 34	5 1/8 130	5/8 16	7/16 11	3/4 19	1 3/4 44.4	1.689 42.9	0.689 17.5	1/2 M14	**UCSFL207H1S6**	SFL207H1	UC207S6	1.1	21.8	12.3	13.9	UCSFL207H1CS6	UCSFL207H1DS6	49	1 15/16	1.1
40	6 7/8 175	3 11/16 94	1 13/32 36	5 43/64 144	5/8 16	15/32 12	53/64 21	2 1/32 51.2	1.937 49.2	0.748 19	1/2 M14	**UCSFL208H1S6**	SFL208H1	UC208S6	1.5	24.8	14.3	14.0	UCSFL208H1CS6	UCSFL208H1DS6	56	2 7/32	1.5
45	7 13/32 188	3 15/16 100	1 1/2 38	5 53/64 148	3/4 19	1/2 13	55/64 22	2 1/16 52.2	1.937 49.2	0.748 19	5/8 M16	**UCSFL209H1S6**	SFL209H1	UC209S6	1.8	27.8	16.2	14.0	UCSFL209H1CS6	UCSFL209H1DS6	57	1 1/4	1.8
50	7 3/4 197	4 3/16 106	1 9/16 40	6 3/16 157	3/4 19	1/2 13	55/64 22	2 5/32 54.6	2.031 51.6	0.748 19	5/8 M16	**UCSFL210H1S6**	SFL210H1	UC210S6	2.1	29.8	18.6	14.4	UCSFL210H1CS6	UCSFL210H1DS6	59	2 5/16	2.1

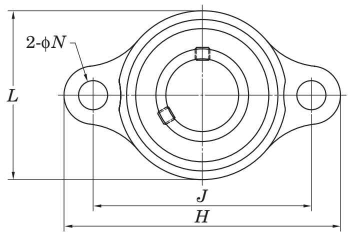
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter codes. (See **Table 10.5** in P.42.)
2. Stainless steel series thin oval flange type unit.
3. Part No. of applicable grease nipple is A-1/4-28UNFN12.
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

USFL-S6

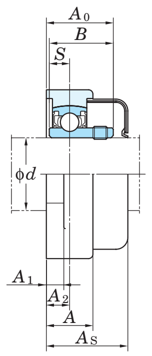
Cylindrical bore (with set screws)

d 10 ~ 30 mm

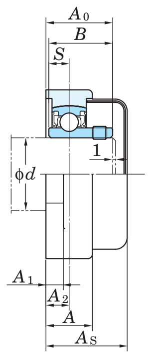




With Through Type Cover



With One Side Sealed Cover



Variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$) and variations of tolerance of distance between centers of bolt holes ($\varDelta_{Js}$)

Unit : mm

Housing No.	$\varDelta_{A2s}$	$\varDelta_{Js}$
SFL000~SFL006	±0.5	±0.3

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

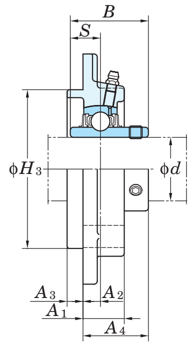
Unit : mm

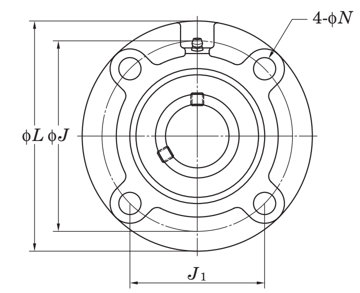
Housing No.	$\varDelta_{Ns}$
SFL000~SFL006	±0.2

Shaft Dia. mm	Dimensions inch mm										Bolt Size inch mm	Standard			Mass	Basic Load Ratings kN		Factor	With Rubber Coated Cover				
												Unit No.	Housing No.	Bearing No.					Unit No.		Dimension		Mass
																			Open Type	Closed Type	mm	inch	
d	H	L	A	J	N	A_1	A_2	A_0	B	S					kg	C_r	C_{0r}	f_0			A_s		kg
10	2 3/8 60	1 11/32 34	15/32 12	1 49/64 45	9/32 7	3/16 5	15/64 6	5/8 16	0.591 15	0.197 5	1/4 M6	**USFL000S6**	SFL000	SU000S6	0.076	3.9	1.55	12.3	USFL000CS6	USFL000DS6	20.5	13/16	0.076
12	2 15/32 63	1 13/32 36	15/32 12	1 57/64 48	9/32 7	3/16 5	15/64 6	5/8 16	0.591 15	0.197 5	1/4 M6	**USFL001S6**	SFL001	SU001S6	0.080	4.3	1.9	13.2	USFL001CS6	USFL001DS6	20.5	13/16	0.080
15	2 5/8 67	1 5/8 41	1/2 13	2 3/32 53	9/32 7	1/4 6	1/4 6.5	11/16 17.5	0.650 16.5	0.217 5.5	1/4 M6	**USFL002S6**	SFL002	SU002S6	0.1	4.7	2.25	13.9	USFL002CS6	USFL002DS6	22	7/8	0.1
17	2 25/32 71	1 23/32 44	9/16 14	2 13/64 56	9/32 7	1/4 6	9/32 7	23/32 18.5	0.689 17.5	0.236 6	1/4 M6	**USFL003S6**	SFL003	SU003S6	0.13	5.1	2.6	14.4	USFL003CS6	USFL003DS6	23.5	15/16	0.13
20	3 19/32 91	2 3/32 53	5/8 16	2 51/64 71	13/32 10	1/4 6	5/16 8	7/8 22	0.827 21	0.276 7	5/16 M8	**USFL004S6**	SFL004	SU004S6	0.21	7.9	4	13.9	USFL004CS6	USFL004DS6	27	1 1/16	0.21
25	3 3/4 95	2 9/32 58	5/8 16	2 61/64 75	13/32 10	1/4 6	5/16 8	29/32 23	0.866 22	0.276 7	5/16 M8	**USFL005S6**	SFL005	SU005S6	0.23	8.5	4.65	14.5	USFL005CS6	USFL005DS6	28	1 3/32	0.23
30	4 11/32 110	2 19/32 66	23/32 18	3 11/32 85	1/2 13	9/32 7	23/64 9	1 1/32 26	0.965 24.5	0.295 7.5	3/8 M10	**USFL006S6**	SFL006	SU006S6	0.33	11.2	6.6	14.7	USFL006CS6	USFL006DS6	31	1 7/32	0.33

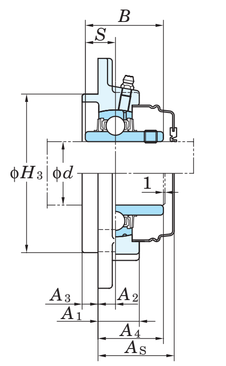
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter codes. (See **Table 10.5** in P.42.)
2. Clean size stainless steel series oval flange type unit.
3. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCFC
Cylindrical bore (with set screws)
d 12 ~ 50 mm

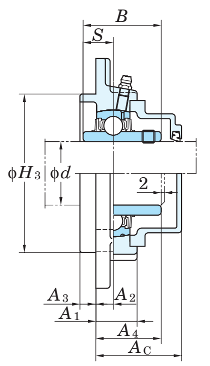




With Pressed Steel Cover



With Cast Iron Cover



Variations of tolerance of spigot joint outside diameter (Δ_{H3s}), variations of tolerance of distance from mounting surface to center of spherical bore (Δ_{A2s}), tolerance of position of bolt hole (X), and tolerance of circumferential runout of spigot joint (Y)

Unit : mm

Housing No.		Δ_{H3s}	Δ_{A2s}	X	Y
FC204~FC206	FCX05	0 –0.046	±0.5	0.7	0.2
FC207~FC210	FCX06~FCX10	0 –0.054			
FC211~FC217	FCX11~FCX15	0 –0.063	±0.8	1	0.3
FC218	FCX16~FCX18	0 –0.072			
	FCX20				0.4

Variations of tolerance of bolt hole diameter (Δ_{Ns})

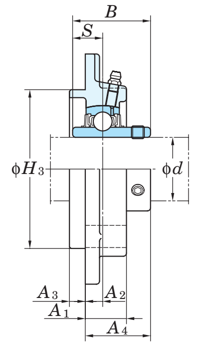
Unit : mm

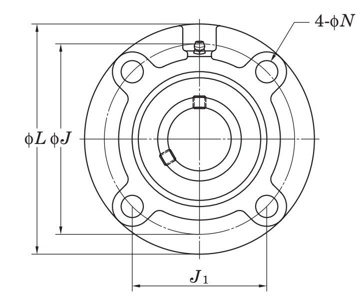
Housing No.		Δ_{Ns}
FC204~FC218	FCX05~FCX20	±0.2

Shaft Dia. mm	Shaft Dia. inch	Dimensions inch / mm L	H3	J	J1	N	A1	A2	A3	A4	B	S	Bolt Size inch / mm	Standard Unit No.	Housing No.	Bearibg No.	Mass kg	Basic Load Ratings kN Cr	C0r	Factor f0	With Pressed Steel Cover Unit No. Open Type	Closed Type	Dimension As mm	As inch	Mass kg	With Cast Iron Cover Unit No. Open Type	Closed Type	Dimension Ac mm	Ac inch	Mass kg
12		3 15/16 100	2.4409 62	3 5/64 78	2 11/64 55.1	15/32 12	13/16 20.5	25/64 10	13/64 5	1 1/8 28.3	1.220 31	0.500 12.7	3/8 M10	**UCFC201**	FC204	UC201	0.78	12.8	6.65	13.2	UCFC201C	UCFC201D	32	1 1/4	0.78	–	–	–	–	–
	1/2													**UCFC201-8**		UC201-8	0.78				–	–	–	–	–	–	–	–	–	–
15														**UCFC202**		UC202	0.76				UCFC202C	UCFC202D	32	1 1/4	0.76	–	–	–	–	–
	5/8													**UCFC202-10**		UC202-10	0.76				–	–	–	–	–	–	–	–	–	–
17														**UCFC203**		UC203	0.75				UCFC203C	UCFC203D	32	1 1/4	0.75	–	–	–	–	–
	3/4													**UCFC204-12**		UC204-12	0.75				–	–	–	–	–	–	–	–	–	–
20														**UCFC204**		UC204	0.73				UCFC204C	UCFC204D	32	1 1/4	0.73	UCFC204FC	UCFC204FD	38.5	1 17/32	0.84
	7/8	4 17/32 115	2.7559 70	3 35/64 90	2 1/2 63.6	15/32 12	13/16 21	25/64 10	15/64 6	1 3/16 29.8	1.343 34.1	0.563 14.3	3/8 M10	**UCFC205-14**	FC205	UC205-14	0.95	14.0	7.85	13.9	–	–	–	–	–	–	–	–	–	–
	15/16													**UCFC205-15**		UC205-15	0.95				–	–	–	–	–	–	–	–	–	–
25														**UCFC205**		UC205	0.95				UCFC205C	UCFC205D	34	1 11/32	0.95	UCFC205FC	UCFC205FD	42	1 21/32	1.1
	1													**UCFC205-16**		UC205-16	0.95				–	–	–	–	–	–	–	–	–	–
		4 3/8 111	2.9921 76	3 5/8 92	2 9/16 65	3/8 9.5	15/16 24	25/64 10	15/64 6	1 9/32 32.2	1.500 38.1	0.626 15.9	5/16 M8	**UCFCX05**	FCX05	UCX05	1.2	19.5	11.3	13.9	UCFCX05C	UCFCX05D	36	1 13/32	1.2	–	–	–	–	–
	1													**UCFCX05-16**		UCX05-16	1.2				–	–	–	–	–	–	–	–	–	–
	1 1/8	4 29/32 125	3.1496 80	3 15/16 100	2 25/32 70.7	15/32 12	29/32 23	25/64 10	5/16 8	1 9/32 32.2	1.500 38.1	0.626 15.9	3/8 M10	**UCFC206-18**	FC206	UC206-18	1.3	19.5	11.3	13.9	–	–	–	–	–	–	–	–	–	–
30														**UCFC206**		UC206	1.3				UCFC206C	UCFC206D	36	1 13/32	1.3	UCFC206FC	UCFC206FD	45	1 25/32	1.6
	1 3/16													**UCFC206-19**		UC206-19	1.3				–	–	–	–	–	–	–	–	–	–
	1 1/4													**UCFC206-20**		UC206-20	1.3				–	–	–	–	–	–	–	–	–	–
		5 127	3.3465 85	4 9/64 105	2 59/64 74.2	15/32 12	7/8 22.5	5/16 8	3/8 9.5	1 5/16 33.4	1.689 42.9	0.689 17.5	3/8 M10	**UCFCX06**	FCX06	UCX06	1.5	25.7	15.4	13.9	UCFCX06C	UCFCX06D	38	1 1/2	1.5	–	–	–	–	–
	1 3/16													**UCFCX06-19**		UCX06-19	1.5				–	–	–	–	–	–	–	–	–	–
	1 1/4													**UCFCX06-20**		UCX06-20	1.5				–	–	–	–	–	–	–	–	–	–
	1 1/4	5 5/16 135	3.5433 90	4 21/64 110	3 1/16 77.8	35/64 14	1 1/32 26	7/16 11	5/16 8	1 7/16 36.4	1.689 42.9	0.689 17.5	7/16 M12	**UCFC207-20**	FC207	UC207-20	1.7	25.7	15.4	13.9	–	–	–	–	–	–	–	–	–	–
	1 5/16													**UCFC207-21**		UC207-21	1.7				–	–	–	–	–	–	–	–	–	–
	1 3/8													**UCFC207-22**		UC207-22	1.7				–	–	–	–	–	–	–	–	–	–
35														**UCFC207**		UC207	1.7				UCFC207C	UCFC207D	41	1 5/8	1.7	UCFC207FC	UCFC207FD	50	1 31/32	2.1
	1 7/16													**UCFC207-23**		UC207-23	1.7				–	–	–	–	–	–	–	–	–	–
	1 3/8	5 1/4 133	3.6220 92	4 3/8 111	3 3/32 78.5	15/32 12	1 1/32 26	23/64 9	7/16 11	1 17/32 39.2	1.937 49.2	0.748 19	3/8 M10	**UCFCX07-22**	FCX07	UCX07-22	1.9	29.1	17.8	14.0	–	–	–	–	–	–	–	–	–	–
														UCFCX07		UCX07	1.9				UCFCX07C	UCFCX07D	43	1 11/16	1.9	–	–	–	–	–
	1 7/16													**UCFCX07-23**		UCX07-23	1.9				–	–	–	–	–	–	–	–	–	–
	1 1/2	5 23/32 145	3.9370 100	4 23/32 120	3 11/32 84.8	35/64 14	1 1/32 26	7/16 11	25/64 10	1 5/8 41.2	1.937 49.2	0.748 19	7/16 M12	**UCFC208-24**	FC208	UC208-24	2.0	29.1	17.8	14.0	–	–	–	–	–	–	–	–	–	–
	1 9/16													**UCFC208-25**		UC208-25	2.0				–	–	–	–	–	–	–	–	–	–
40														**UCFC208**		UC208	2.0				UCFC208C	UCFC208D	45	1 25/32	2.0	UCFC208FC	UCFC208FD	54	2 1/8	2.4
	1 1/2	5 1/4 133	3.6220 92	4 3/8 111	3 3/32 78.5	15/32 12	1 1/32 26	23/64 9	7/16 11	1 17/32 39.2	1.937 49.2	0.748 19	3/8 M10	**UCFCX08-24**	FCX08	UCX08-24	2.0	34.1	21.3	14.0	–	–	–	–	–	–	–	–	–	–
														UCFCX08		UCX08	2.0				UCFCX08C	UCFCX08D	43	1 11/16	2.0	–	–	–	–	–
	1 5/8	6 5/16 160	4.1339 105	5 13/64 132	3 43/64 93.3	5/8 16	1 1/32 26	25/64 10	15/32 12	1 19/32 40.2	1.937 49.2	0.748 19	1/2 M14	**UCFC209-26**	FC209	UC209-26	2.6	34.1	21.3	14.0	–	–	–	–	–	–	–	–	–	–
	1 11/16													**UCFC209-27**		UC209-27	2.6				–	–	–	–	–	–	–	–	–	–
	1 3/4													**UCFC209-28**		UC209-28	2.6				–	–	–	–	–	–	–	–	–	–
45														**UCFC209**		UC209	2.6				UCFC209C	UCFC209D	44	1 23/32	2.6	UCFC209FC	UCFC209FD	54	2 1/8	3.0
	1 3/4	6 3/32 155	4.2520 108	5 1/8 130	3 5/8 91.9	35/64 14	31/32 25	5/16 8	15/32 12	1 19/32 40.6	2.031 51.6	0.748 19	7/16 M12	**UCFCX09-28**	FCX09	UCX09-28	2.6	35.1	23.3	14.4	–	–	–	–	–	–	–	–	–	–
														UCFCX09		UCX09	2.6				UCFCX09C	UCFCX09D	45	1 25/32	2.6	–	–	–	–	–
	1 7/8	6 1/2 165	4.3307 110	5 7/16 138	3 27/32 97.6	5/8 16	1 3/32 28	25/64 10	15/32 12	1 11/16 42.6	2.031 51.6	0.748 19	1/2 M14	**UCFC210-30**	FC210	UC210-30	2.9	35.1	23.3	14.4	–	–	–	–	–	–	–	–	–	–
	1 15/16													**UCFC210-31**		UC210-31	2.9				–	–	–	–	–	–	–	–	–	–
50														**UCFC210**		UC210	2.9				UCFC210C	UCFC210D	47	1 27/32	2.9	UCFC210FC	UCFC210FD	58.5	2 5/16	3.4
	2													**UCFC210-32**		UC210-32	2.9				–	–	–	–	–	–	–	–	–	–
	1 15/16	6 3/8 162	4.6457 118	5 23/64 136	3 25/32 96.2	35/64 14	31/32 25	9/32 7	5/8 16	1 19/32 40.4	2.189 55.6	0.874 22.2	7/16 M12	**UCFCX10-31**	FCX10	UCX10-31	3.2	43.4	29.4	14.4	–	–	–	–	–	–	–	–	–	–
														UCFCX10		UCX10	3.2				UCFCX10C	UCFCX10D	45	1 25/32	3.2	–	–	–	–	–
	2													**UCFCX10-32**		UCX10-32	3.2				–	–	–	–	–	–	–	–	–	–

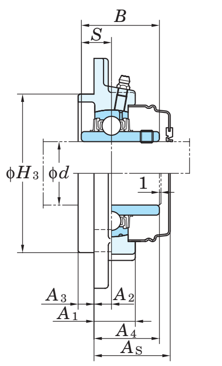
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210, X05~X09
A-PT1/8 .... 211~218, X10~X20
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (L2) follows the Part No. of unit or bearing. (Example of Part No. : UCFC206JL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCFC
Cylindrical bore (with set screws)
d 55 ~ 100 mm

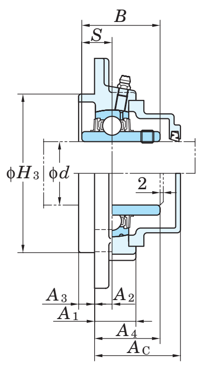




With Pressed Steel Cover



With Cast Iron Cover



Variations of tolerance of spigot joint outside diameter (Δ_{H3s}), variations of tolerance of distance from mounting surface to center of spherical bore (Δ_{A2s}), tolerance of position of bolt hole (X), and tolerance of circumferential runout of spigot joint (Y)

Unit : mm

Housing No.		Δ_{H3s}	Δ_{A2s}	X	Y
FC204~FC206	FCX05	0 –0.046	±0.5	0.7	0.2
FC207~FC210	FCX06~FCX10	0 –0.054			
FC211~FC217	FCX11~FCX15	0 –0.063	±0.8	1	0.3
FC218	FCX16~FCX18	0 –0.072			
	FCX20				0.4

Variations of tolerance of bolt hole diameter (Δ_{Ns})

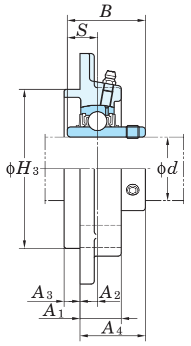
Unit : mm

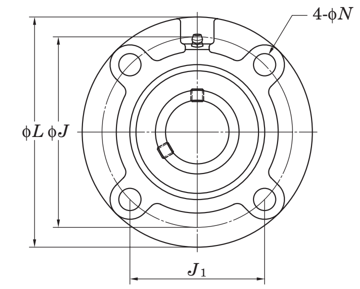
Housing No.		Δ_{Ns}
FC204~FC218	FCX05~FCX20	±0.2

Shaft Dia.		Dimensions											Bolt Size	Standard				Basic Load Ratings		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm	inch	inch mm											inch mm	Unit No.	Housing No.	Bearibg No.	Mass	kN			Unit No.		Dimension		Mass	Unit No.		Dimension		Mass
d		L	H_3	J	J_1	N	A_1	A_2	A_3	A_4	B	S					kg	C_r	C_{0r}	f_0	Open Type	Closed Type	mm A_s	inch	kg	Open Type	Closed Type	mm A_c	inch	kg
55	2	7 9/32 185	4.9213 125	5 29/32 150	4 11/64 106.1	3/4 19	1 7/32 31	33/64 13	15/32 12	1 13/16 46.4	2.189 55.6	0.874 22.2	5/8 M16	**UCFC211-32**	FC211	UC211-32	4.2	43.4	29.4	14.4	–	–	–	–	–	–	–	–	–	–
	2 1/8													**UCFC211-34**		UC211-34	4.2				–	–	–	–	–	–	–	–	–	–
														UCFC211		UC211	4.2				UCFC211C	UCFC211D	51	2	4.2	UCFC211FC	UCFC211FD	62.5	2 15/32	4.8
	2 3/16													**UCFC211-35**		UC211-35	4.2				–	–	–	–	–	–	–	–	–	–
		7 3/32 180	5 127	5 63/64 152	4 15/64 107.5	5/8 16	1 1/32 26	5/32 4	55/64 22	1 23/32 43.7	2.563 65.1	1.000 25.4	1/2 M14	**UCFCX11**	FCX11	UCX11	4.3	52.4	36.2	14.4	UCFCX11C	UCFCX11D	46	1 13/16	4.3	–	–	–	–	–
	2 3/16													**UCFCX11-35**		UCX11-35	4.3				–	–	–	–	–	–	–	–	–	–
	2 1/4													**UCFCX11-36**		UCX11-36	4.3				–	–	–	–	–	–	–	–	–	–
60	2 1/4	7 11/16 195	5.3150 135	6 19/64 160	4 29/64 113.1	3/4 19	1 13/32 36	43/64 17	15/32 12	2 7/32 56.7	2.563 65.1	1.000 25.4	5/8 M16	**UCFC212-36**	FC212	UC212-36	5.0	52.4	36.2	14.4	–	–	–	–	–	–	–	–	–	–
														UCFC212		UC212	5.0				UCFC212C	UCFC212D	61	2 13/32	5.0	UCFC212FC	UCFC212FD	74	2 29/32	5.8
	2 3/8													**UCFC212-38**		UC212-38	5.0				–	–	–	–	–	–	–	–	–	–
	2 7/16													**UCFC212-39**		UC212-39	5.0				–	–	–	–	–	–	–	–	–	–
		7 5/8 194	5.5118 140	6 1/2 165	4 19/32 116.7	5/8 16	1 5/16 33	7/16 11	25/32 20	2 50.7	2.563 65.1	1.000 25.4	1/2 M14	**UCFCX12**	FCX12	UCX12	5.3	57.2	40.1	14.4	UCFCX12C	UCFCX12D	55	2 5/32	5.3	–	–	–	–	–
	2 7/16													**UCFCX12-39**		UCX12-39	5.3				–	–	–	–	–	–	–	–	–	–
65	2 1/2	8 1/16 205	5.7087 145	6 11/16 170	4 47/64 120.2	3/4 19	1 13/32 36	5/8 16	35/64 14	2 3/16 55.7	2.563 65.1	1.000 25.4	5/8 M16	**UCFC213-40**	FC213	UC213-40	5.6	57.2	40.1	14.4	–	–	–	–	–	–	–	–	–	–
														UCFC213		UC213	5.6				UCFC213C	UCFC213D	60	2 3/8	5.6	UCFC213FC	UCFC213FD	73	2 7/8	6.4
	2 1/2	7 5/8 194	5.5118 140	6 1/2 165	4 19/32 116.7	5/8 16	1 5/16 33	7/16 11	25/32 20	2 3/16 55.4	2.937 74.6	1.189 30.2	1/2 M14	**UCFCX13-40**	FCX13	UCX13-40	5.7	62.2	44.1	14.5	–	–	–	–	–	–	–	–	–	–
														UCFCX13		UCX13	5.7				UCFCX13C	UCFCX13D	60	2 3/8	5.7	–	–	–	–	–
70	2 3/4	8 15/32 215	5.9055 150	6 31/32 177	4 59/64 125.1	3/4 19	1 9/16 40	43/64 17	35/64 14	2 13/32 61.4	2.937 74.6	1.189 30.2	5/8 M16	**UCFC214-44**	FC214	UC214-44	6.8	62.2	44.1	14.5	–	–	–	–	–	–	–	–	–	–
														UCFC214		UC214	6.8				UCFC214C	UCFC214D	66	2 19/32	6.8	UCFC214FC	UCFC214FD	79	3 1/8	7.7
	2 3/4	8 3/4 222	6.4567 164	7 31/64 190	5 9/32 134.3	3/4 19	1 13/32 36	35/64 14	25/32 20	2 5/16 58.5	3.063 77.8	1.331 33.3	5/8 M16	**UCFCX14-44**	FCX14	UCX14-44	7.3	67.4	48.3	14.5	–	–	–	–	–	–	–	–	–	–
														UCFCX14		UCX14	7.3				UCFCX14C	UCFCX14D	63	2 15/32	7.3	–	–	–	–	–
75	2 15/16	8 21/32 220	6.2992 160	7 1/4 184	5 1/8 130.1	3/4 19	1 9/16 40	45/64 18	5/8 16	2 15/32 62.5	3.063 77.8	1.331 33.3	5/8 M16	**UCFC215-47**	FC215	UC215-47	7.2	67.4	48.3	14.5	–	–	–	–	–	–	–	–	–	–
														UCFC215		UC215	7.2				UCFC215C	UCFC215D	67	2 5/8	7.2	UCFC215FC	UCFC215FD	80	3 5/32	8.2
	3													**UCFC215-48**		UC215-48	7.2				–	–	–	–	–	–	–	–	–	–
	2 15/16	8 3/4 222	6.4567 164	7 31/64 190	5 9/32 134.3	3/4 19	1 3/8 35	15/32 12	55/64 22	2 13/32 61.3	3.252 82.6	1.311 33.3	5/8 M16	**UCFCX15-47**	FCX15	UCX15-47	8.0	72.7	53.0	14.6	–	–	–	–	–	–	–	–	–	–
														UCFCX15		UCX15	8.0				UCFCX15C	UCFCX15D	66	2 19/32	8.0	–	–	–	–	–
	3													**UCFCX15-48**		UCX15-48	8.0				–	–	–	–	–	–	–	–	–	–
80	3 1/8	9 7/16 240	6.6929 170	7 7/8 200	5 9/16 141.4	29/32 23	1 31/32 42	45/64 18	5/8 16	2 21/32 67.3	3.252 82.6	1.311 33.3	3/4 M20	**UCFC216-50**	FC216	UC216-50	8.7	72.7	53.0	14.6	–	–	–	–	–	–	–	–	–	–
														UCFC216		UC216	8.7				UCFC216C	UCFC216D	72	2 27/32	8.7	UCFC216FC	UCFC216FD	87	3 7/16	9.9
	–	10 1/4 260	7.3228 186	8 5/8 219	6 3/32 154.8	29/32 23	1 13/32 36	25/64 10	63/64 25	2 7/16 61.6	3.374 85.7	1.343 34.1	3/4 M20	**UCFCX16**	FCX16	UCX16	11.3	84.0	61.9	14.5	UCFCX16C	UCFCX16D	66	2 19/32	11.3	–	–	–	–	–
85	3 1/4	9 27/32 250	7.0866 180	8 3/16 208	5 51/64 147.1	29/32 23	1 25/32 45	45/64 18	45/64 18	2 3/4 69.6	3.374 85.7	1.343 34.1	3/4 M20	**UCFC217-52**	FC217	UC217-52	10.3	84.0	61.9	14.5	–	–	–	–	–	–	–	–	–	–
														UCFC217		UC217	10.3				UCFC217C	UCFC217D	74	2 29/32	10.3	UCFC217FC	UCFC217FD	89	3 1/2	11.7
		10 1/4 260	7.3228 186	8 5/8 219	6 3/32 154.8	29/32 23	1 13/32 36	25/64 10	63/64 25	2 5/8 66.3	3.780 96	1.563 39.7	3/4 M20	**UCFCX17**	FCX17	UCX17	12.9	96.1	71.5	14.5	UCFCX17C	UCFCX17D	71	2 25/32	12.9	–	–	–	–	–
	3 7/16													**UCFCX17-55**		UCX17-55	12.9				–	–	–	–	–	–	–	–	–	–
90	3 1/2	10 7/16 265	7.4803 190	8 21/32 220	6 1/8 155.5	29/32 23	1 31/32 50	55/64 22	45/64 18	3 3/32 78.3	3.780 96	1.563 39.7	3/4 M20	**UCFC218-56**	FC218	UC218-56	13.3	96.1	71.5	14.5	–	–	–	–	–	–	–	–	–	–
														UCFC218		UC218	13.3				UCFC218C	UCFC218D	83	3 9/32	13.3	UCFC218FC	UCFC218FD	98	3 27/32	14.8
	–	10 1/4 260	7.3228 186	8 5/8 219	6 3/32 154.8	29/32 23	1 11/16 43	15/32 12	1 7/64 28	2 7/8 73.1	4.094 104	1.689 42.9	3/4 M20	**UCFCX18**	FCX18	UCX18	13.5	109	81.9	14.4	–	–	–	–	–	UCFCX18C	UCFCX18C	92	3 5/8	15.4
100		10 7/8 276	8.1102 206	9 3/8 238	6 5/8 168.3	29/32 23	2 19/32 66	55/64 22	1 7/64 28	3 9/16 90.3	4.626 117.5	1.937 49.2	3/4 M20	**UCFCX20**	FCX20	UCX20	18.2	133	105	14.4	–	–	–	–	–	UCFCX20C	UCFCX20D	116	4 9/16	20.7
	3 15/16													**UCFCX20-63**		UCX20-63	18.2				–	–	–	–	–	–	–	–	–	–
	4													**UCFCX20-64**		UCX20-64	18.2				–	–	–	–	–	–	–	–	–	–

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210, X05~X09
A-PT1/8 .... 211~218, X10~X20
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (L2) follows the Part No. of unit or bearing. (Example of Part No. : UCFC206JL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCFCX-E
Cylindrical bore (with set screws)
d 25 ~ 100 mm





Variations of tolerance of spigot joint outside diameter ($\varDelta_{H3s}$), variations of tolerance of distance from mounting surface to center of spherical bore ($\varDelta_{A2s}$), tolerance of position of bolt hole (X), and tolerance of circumferential runout of spigot joint (Y)

Unit : mm

Housing No.	$\varDelta_{H3s}$	$\varDelta_{A2s}$	X	Y
FCX05E	0 −0.046	±0.5	0.7	0.2
FCX06E~FCX10E	0 −0.054			
FCX12E~FCX15E	0 −0.063	±0.8	1	0.3
FCX16E~FCX18E	0 −0.072			
FCX20E				0.4

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

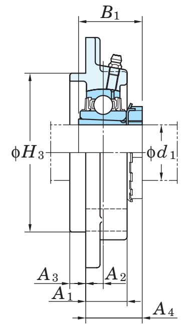
Unit : mm

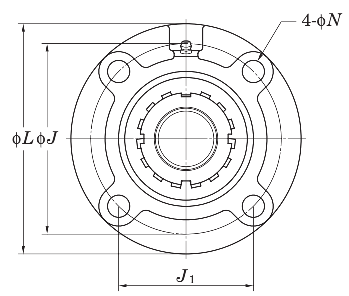
Housing No.	$\varDelta_{Ns}$
FCX05E~FCX20E	±0.2

Shaft Dia. mm	inch	Dimensions inch mm											Bolt Size inch mm	Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN		Factor	Mass
d		L	H_3	J	J_1	N	A_1	A_2	A_3	A_4	B	S					C_r	C_{0r}	f_0	kg
25	1	4 3/8 111	3.000 76.2	3 5/8 92	2 9/16 65	3/8 9.5	15/16 24	25/64 10	15/64 6	1 9/32 32.2	1.500 38.1	0.626 15.9	5/16 M8	**UCFCX05E** **UCFCX05E-16**	FCX05E	UCX05 UCX05-16	19.5	11.3	13.9	1.2
30	1 3/16 1 1/4	5 127	3.375 85.725	4 9/64 105	2 59/64 74.2	15/32 12	7/8 22.5	5/16 8	3/8 9.5	1 5/16 33.4	1.689 42.9	0.689 17.5	3/8 M10	**UCFCX06E** **UCFCX06E-19** **UCFCX06E-20**	FCX06E	UCX06 UCX06-19 UCX06-20	25.7	15.4	13.9	1.5
35	1 3/8 1 7/16	5 1/4 133	3.625 92.075	4 3/8 111	3 3/32 78.5	15/32 12	1 1/32 26	23/64 9	7/16 11	1 17/32 39.2	1.937 49.2	0.748 19	3/8 M10	**UCFCX07E-22** **UCFCX07E** **UCFCX07E-23**	FCX07E	UCX07-22 UCX07 UCX07-23	29.1	17.8	14.0	1.9
40	1 1/2	5 1/4 133	3.625 92.075	4 3/8 111	3 3/32 78.5	15/32 12	1 1/32 26	23/64 9	7/16 11	1 17/32 39.2	1.937 49.2	0.748 19	3/8 M10	**UCFCX08E-24** **UCFCX08E**	FCX08E	UCX08-24 UCX08	34.1	21.3	14.0	2.0
45	1 3/4	6 3/32 155	4.250 107.95	5 1/8 130	3 5/8 91.9	35/64 14	31/32 25	5/16 8	15/32 12	1 19/32 40.6	2.031 51.6	0.748 19	7/16 M12	**UCFCX09E-28** **UCFCX09E**	FCX09E	UCX09-28 UCX09	35.1	23.3	14.4	2.6
50	1 15/16 2	6 3/8 162	4.5 114.3	5 23/64 136	3 25/32 96.2	35/64 14	31/32 25	9/32 7	5/8 16	1 19/32 40.4	2.189 55.6	0.874 22.2	7/16 M12	**UCFCX10E-31** **UCFCX10E** **UCFCX10E-32**	FCX10E	UCX10-31 UCX10 UCX10-32	43.4	29.4	14.4	3.2
60	2 7/16	7 5/8 194	5.500 139.7	6 1/2 165	4 19/32 116.7	5/8 16	1 5/16 33	7/16 11	25/32 20	2 50.7	2.563 65.1	1.000 25.4	1/2 M14	**UCFCX12E** **UCFCX12E-39**	FCX12E	UCX12 UCX12-39	57.2	40.1	14.4	5.3
65	2 1/2	7 5/8 194	5.500 139.7	6 1/2 165	4 19/32 116.7	5/8 16	1 5/16 33	7/16 11	25/32 20	2 3/16 55.4	2.937 74.6	1.189 30.2	1/2 M14	**UCFCX13E-40** **UCFCX13E**	FCX13E	UCX13-40 UCX13	62.2	44.1	14.5	5.7
70	2 3/4	8 3/4 222	6.375 161.925	7 31/64 190	5 9/32 134.3	3/4 19	1 13/32 36	35/64 14	25/32 20	2 5/16 58.5	3.063 77.8	1.331 33.3	5/8 M16	**UCFCX14E-44** **UCFCX14E**	FCX14E	UCX14-44 UCX14	67.4	48.3	14.5	7.3
75	2 15/16 3	8 3/4 222	6.375 161.925	7 31/64 190	5 9/32 134.3	3/4 19	1 3/8 35	15/32 12	55/64 22	2 13/32 61.3	3.252 82.6	1.311 33.3	5/8 M16	**UCFCX15E-47** **UCFCX15E** **UCFCX15E-48**	FCX15E	UCX15-47 UCX15 UCX15-48	72.7	53.0	14.6	8.0
80	–	10 1/4 260	7.375 187.325	8 5/8 219	6 3/32 154.8	29/32 23	1 13/32 36	25/64 10	63/64 25	2 7/16 61.6	3.374 85.7	1.343 34.1	3/4 M20	**UCFCX16E**	FCX16E	UCX16	84.0	61.9	14.5	11.3
85	3 7/16	10 1/4 260	7.375 187.325	8 5/8 219	6 3/32 154.8	29/32 23	1 13/32 36	25/64 10	63/64 25	2 5/8 66.3	3.780 96	1.563 39.7	3/4 M20	**UCFCX17E** **UCFCX17E-55**	FCX17E	UCX17 UCX17-55	96.1	71.5	14.5	12.9
90	–	10 1/4 260	7.375 187.325	8 5/8 219	6 3/32 154.8	29/32 23	1 11/16 43	15/32 12	1 7/64 28	2 7/8 73.1	4.094 104	1.689 42.9	3/4 M20	**UCFCX18E**	FCX18E	UCX18	109	81.9	14.4	13.5
100	3 15/16 4	10 7/8 276	8.125 206.375	9 3/8 238	6 5/8 168.3	29/32 23	2 19/32 66	55/64 22	1 7/64 28	3 9/16 90.3	4.626 117.5	1.937 49.2	3/4 M20	**UCFCX20E** **UCFCX20E-63** **UCFCX20E-64**	FCX20E	UCX20 UCX20-63 UCX20-64	133	105	14.4	18.2

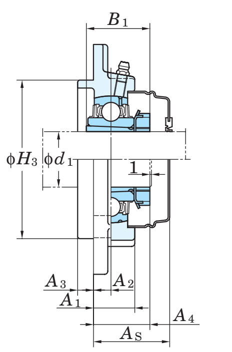
Remarks 1. In Part No. of unit, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... X05~X09
A-PT1/8 .... X10~X20
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (L2) follows the Part No. of unit or bearing. (Example of Part No. : UCFCX06EL3, UCX06L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UKFC
Tapered bore (with adapter)
d_1 20 ~ (65) mm

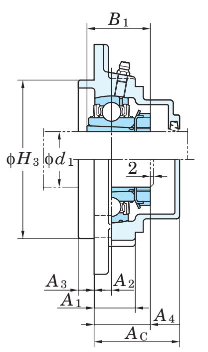




With Pressed Steel Cover



With Cast Iron Cover



Variations of tolerance of spigot joint outside diameter (Δ_{H3s}), variations of tolerance of distance from mounting surface to center of spherical bore (Δ_{A2s}), tolerance of position of bolt hole (X), and tolerance of circumferential runout of spigot joint (Y)

Unit : mm

Housing No.		Δ_{H3s}	Δ_{A2s}	X	Y
FC205~FC206	FCX05	0 –0.046	±0.5	0.7	0.2
FC207~FC210	FCX06~FCX10	0 –0.054			
FC211~FC217	FCX11~FCX15	0 –0.063	±0.8	1	0.3
FC218	FCX16~FCX18	0 –0.072			
	FCX20				0.4

Variations of tolerance of bolt hole diameter (Δ_{Ns})

Unit : mm

Housing No.		Δ_{Ns}
FC204~FC218	FCX05~FCX20	±0.2

Shaft Dia. mm d_1	Shaft Dia. inch d_1	Dimensions inch / mm L	H_3	J	J_1	N	A_1	A_2	A_3	A_4 1)	B_1 1)	Bolt Size inch / mm	Standard Unit No.	Housing No.	Bearing No.	Adapter 1) No.	Mass kg	Basic Load Ratings kN C_r	C_{0r}	Factor f_0	With Pressed Steel Cover Unit No. Open Type	Closed Type	Dimension A_s mm	Dimension A_s inch	Mass kg	With Cast Iron Cover Unit No. Open Type	Closed Type	Dimension A_c mm	Dimension A_c inch	Mass kg
20	3/4	4 17/32 115	2.7559 70	3 35/64 90	2 1/2 63.6	15/32 12	13/16 21	25/64 10	15/64 6	1 1/8(1 3/16) 28.5(30)	1 5/32(1 3/8) 29(35)	3/8 M10	**UKFC205**	FC205	UK205	HE305X(HE2305X) H305X(H2305X)	0.99 0.99	14.0	7.85	13.9	– UKFC205C	– UKFC205D	– 34	– 1 11/32	– 0.99	– UKFC205FC	– UKFC205FD	– 42	– 1 21/32	– 1.2
	3/4	4 3/8 111	2.9921 76	3 5/8 92	2 9/16 65	3/8 9.5	15/16 24	25/64 10	15/64 6	1 5/32 29.5	1 3/8 35	5/16 M8	**UKFCX05**	FCX05	UKX05	HE2305X H2305X	1.2 1.2	19.5	11.3	13.9	– UKFCX05C	– UKFCX05D	– 36	– 1 13/32	– 1.2	– –	– –	– –	– –	– –
25	1	4 29/32 125	3.1496 80	3 15/16 100	2 25/32 70.7	15/32 12	29/32 23	25/64 10	5/16 8	1 5/32(1 1/4) 29.5(31.5)	1 7/32(1 1/2) 31(38)	3/8 M10	**UKFC206**	FC206	UK206	H306X(H2306X) HE306X(HE2306X)	1.3 1.3	19.5	11.3	13.9	UKFC206C –	UKFC206D –	36 –	1 13/32 –	1.3 –	UKFC206FC –	UKFC206FD –	45 –	1 25/32 –	1.6 –
	1	5 127	3.3465 85	4 9/64 105	2 59/64 74.2	15/32 12	7/8 22.5	5/16 8	3/8 9.5	1 5/32 29	1 1/2 38	3/8 M10	**UKFCX06**	FCX06	UKX06	H2306X HE2306X	1.5 1.5	25.7	15.4	13.9	UKFCX06C –	UKFCX06D –	38 –	1 1/2 –	1.5 –	– –	– –	– –	 –	– –
30	1 1/8	5 5/16 135	3.5433 90	4 21/64 110	3 1/16 77.8	35/64 14	1 1/32 26	7/16 11	5/16 8	1 5/16(1 3/8) 33(35)	1 3/8(1 11/16) 35(43)	7/16 M12	**UKFC207**	FC207	UK207	HS307X(HS2307X) H307X(H2307X)	1.7 1.7	25.7	15.4	13.9	– UKFC207C	– UKFC207D	– 41	– 1 5/8	– 1.7	– UKFC207FC	– UKFC207FD	– 50	– 1 31/32	– 2.1
	1 1/8	5 1/4 133	3.6220 92	4 3/8 111	3 3/32 78.5	15/32 12	1 1/32 26	23/64 9	7/16 11	1 1/4 31.5	1 11/16 43	3/8 M10	**UKFCX07**	FCX07	UKX07	HS2307X H2307X	1.9 1.9	29.1	17.8	14.0	– UKFCX07C	– UKFCX07D	– 43	– 1 11/16	– 1.9	– –	– –	– –	– –	– –
35	1 1/4 1 3/8	5 23/32 145	3.9370 100	4 23/32 120	3 11/32 84.8	35/64 14	1 1/32 26	7/16 11	25/64 10	1 11/32(1 1/2) 34.5(38)	1 13/32(1 13/16) 36(46)	7/16 M12	**UKFC208**	FC208	UK208	HE308X(HE2308X) HS308X(HS2308X) H308X(H2308X)	2.0 2.0 2.0	29.1	17.8	14.0	– – UKFC208C	– – UKFC208D	– – 45	– – 1 25/32	– – 2.0	– – UKFC208FC	– – UKFC208FD	– – 54	– – 2 1/8	– – 2.4
	1 1/4 1 3/8	5 1/4 133	3.6220 92	4 3/8 111	3 3/32 78.5	15/32 12	1 1/32 26	23/64 9	7/16 11	1 5/16 33.5	1 13/16 46	3/8 M10	**UKFCX08**	FCX08	UKX08	HE2308X HS2308X H2308X	1.9 1.9 1.9	34.1	21.3	14.0	– – UKFCX08C	– – UKFCX08D	– – 43	– – 1 11/16	– – 1.9	– – –	– – –	– – –	– – –	– – –
40	1 1/2 1 5/8	6 5/16 160	4.1339 105	5 13/64 132	3 43/64 93.3	5/8 16	1 1/32 26	25/64 10	15/32 12	1 13/32(1 17/32) 35.5(39)	1 17/32(1 31/32) 39(50)	1/2 M14	**UKFC209**	FC209	UK209	HE309X(HE2309X) H309X(H2309X) HS309X(HS2309X)	2.7 2.7 2.7	34.1	21.3	14.0	– UKFC209C –	– UKFC209D –	– 44 –	– 1 23/32 –	– 2.7 –	– UKFC209FC –	– UKFC209FD –	– 54 –	– 2 1/8 –	– 3.2 –
	1 1/2 1 5/8	6 3/32 155	4.2520 108	5 1/8 130	3 5/8 91.9	35/64 14	31/32 25	5/16 8	15/32 12	1 5/16 33.5	1 31/32 50	7/16 M12	**UKFCX09**	FCX09	UKX09	HE2309X H2309X HS2309X	2.6 2.6 2.6	35.1	23.3	14.4	– UKFCX09C –	– UKFCX09D –	– 45 –	– 1 25/32 –	– 2.6 –	– – –	– – –	– – –	– – –	– – –
45	1 3/4	6 1/2 165	4.3307 110	5 7/16 138	3 27/32 97.6	5/8 16	1 3/32 28	25/64 10	15/32 12	1 7/16(1 9/16) 36.5(40)	1 21/32(2 5/32) 42(55)	1/2 M14	**UKFC210**	FC210	UK210	HE310X(HE2310X) H310X(H2310X)	3.0 3.0	35.1	23.3	14.4	– UKFC210C	– UKFC210D	– 47	– 1 27/32	– 3.0	– UKFC210FC	– UKFC210FD	– 58.5	– 2 5/16	– 3.5
	1 3/4	6 3/8 162	4.6457 118	5 23/64 136	3 25/32 96.2	35/64 14	31/32 25	9/32 7	5/8 16	1 11/32 34.5	2 5/32 55	7/16 M12	**UKFCX10**	FCX10	UKX10	HE2310X H2310X	3.1 3.1	43.4	29.4	14.4	– UKFCX10C	– UKFCX10D	– 45	– 1 25/32	– 3.1	– –	– –	– –	– –	– –
50	1 7/8 2	7 9/32 185	4.9213 125	5 29/32 150	4 11/64 106.1	3/4 19	1 7/32 31	33/64 13	15/32 12	1 19/32(1 25/32) 40.5(45)	1 25/32(2 5/16) 45(59)	5/8 M16	**UKFC211**	FC211	UK211	HS311X(HS2311X) H311X(H2311X) HE311X(HE2311X)	4.3 4.3 4.3	43.4	29.4	14.4	– UKFC211C –	– UKFC211D –	– 51 –	– 2 –	– 4.3 –	– UKFC211FC –	– UKFC211FD –	– 62.5 –	– 2 15/32 –	– 4.9 –
	1 7/8 2	7 3/32 180	5 127	5 63/64 152	4 15/64 107.5	5/8 16	1 1/32 26	5/32 4	55/64 22	1 9/32 32.5	2 5/16 59	1/2 M14	**UKFCX11**	FCX11	UKX11	HS2311X H2311X HE2311X	4.0 4.0 4.0	52.4	36.2	14.4	– UKFCX11C –	– UKFCX11D –	– 48 –	– 1 7/8 –	– 4.0 –	– – –	– – –	– – –	– – –	– – –
55	2 1/8	7 11/16 195	5.3150 135	6 19/64 160	4 29/64 113.1	3/4 19	1 13/32 36	43/64 17	15/32 12	1 27/32(2 3/32) 46.5(53.5)	1 27/32(2 7/16) 47(62)	5/8 M16	**UKFC212**	FC212	UK212	HS312X(HS2312X) H312X(H2313X)	4.9 4.9	52.4	36.2	14.4	– UKFC212C	– UKFC212D	– 61	– 2 13/32	– 4.9	– UKFC212FC	– UKFC212FD	– 74	– 2 29/32	– 5.7
	2 1/8	7 5/8 194	5.5118 140	6 1/2 165	4 19/32 116.7	5/8 16	1 5/16 33	7/16 11	25/32 20	1 21/32 42	2 7/16 62	1/2 M14	**UKFCX12**	FCX12	UKX12	HS2312X H2312X	5.1 5.1	57.2	40.1	14.4	– UKFCX12C	– UKFCX12D	– 55	– 2 5/32	– 5.1	– –	– –	– –	– –	– –
60	2 1/4 2 3/8	8 1/16 205	5.7087 145	6 11/16 170	4 47/64 120.2	3/4 19	1 13/32 36	5/8 16	35/64 14	1 7/8(2 3/32) 48(53.5)	1 31/32(2 9/16) 50(65)	5/8 M16	**UKFC213**	FC213	UK213	HE313X(HE2313X) H313X(H2313X) HS313X(HS2313X)	5.5 5.5 5.5	57.2	40.1	14.4	– UKFC213C –	– UKFC213D –	– 60 –	– 2 3/8 –	– 5.5 –	– UKFC213FC –	– UKFC213FD –	– 73 –	– 2 7/8 –	– 6.4 –
	2 1/4 2 3/8	7 5/8 194	5.5118 140	6 1/2 165	4 19/32 116.7	5/8 16	1 5/16 33	7/16 11	25/32 20	1 25/32 45	2 9/16 65	1/2 M14	**UKFCX13**	FCX13	UKX13	HE2313X H2313X HS2313X	5.3 5.3 5.3	62.2	44.1	14.5	– UKFCX13C –	– UKFCX13D –	– 60 –	– 2 3/8 –	– 5.3 –	– – –	– – –	– – –	– – –	– – –
65	2 1/2	8 21/32 220	6.2992 160	7 1/4 184	5 1/8 130.1	3/4 19	1 9/16 40	45/64 18	5/8 16	2 3/32(2 5/16) 53(58.5)	2 5/32(2 7/8) 55(73)	5/8 M16	**UKFC215**	FC215	UK215	HE315X(HE2315X) H315X(H2315X)	7.4 7.4	67.4	48.3	14.5	– UKFC215C	– UKFC215D	– 67	– 2 5/8	– 7.4	– UKFC215FC	– UKFC215FD	– 80	– 3 5/32	– 8.4

Note 1) Codes shown in parentheses indicate the dimensions and Part No. of applicable adapter (H2300X series) for UK200L3 series (triple seal type).

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

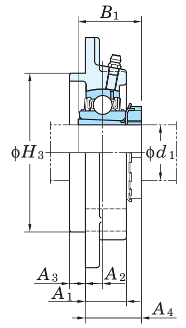
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF 205~210, X05~X09
A-PT1/8................211~218, X10~X20

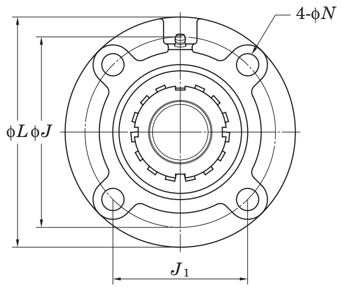
3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables.
(Example of Part No. : UKFC206J + H306X, UK206 + H306X)

4. As for the triple seal type product (205 is the double seal type product), accessory code L3 (or L2) follows the Part No. of unit or bearing.
(Example of Part No. : UKFC206JL3 + H2306X, UK206L3 + H2306X)

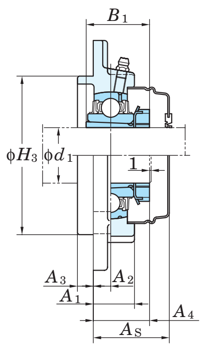
5. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

UKFC
Tapered bore (with adapter)
d_1 (65) ~ 90 mm

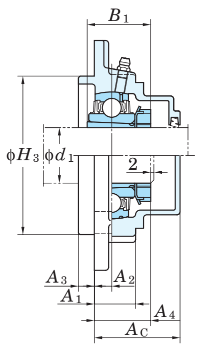




With Pressed Steel Cover



With Cast Iron Cover



Variations of tolerance of spigot joint outside diameter (Δ_{H3s}), variations of tolerance of distance from mounting surface to center of spherical bore (Δ_{A2s}), tolerance of position of bolt hole (X), and tolerance of circumferential runout of spigot joint (Y)

Unit : mm

Housing No.		Δ_{H3s}	Δ_{A2s}	X	Y
FC205~FC206	FCX05	0 −0.046	±0.5	0.7	0.2
FC207~FC210	FCX06~FCX10	0 −0.054			
FC211~FC217	FCX11~FCX15	0 −0.063	±0.8	1	0.3
FC218	FCX16~FCX18	0 −0.072			
	FCX20				0.4

Variations of tolerance of bolt hole diameter (Δ_{Ns})

Unit : mm

Housing No.		Δ_{Ns}
FC204~FC218	FCX05~FCX20	±0.2

Shaft Dia.		Dimensions										Bolt Size	Standard					Basic Load Ratings		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm	inch	inch mm										inch mm	Unit No.	Housing No.	Bearing No.	Adapter 1) No.	Mass	kN			Unit No.		Dimension		Mass	Unit No.		Dimension		Mass
d_1		L	H_3	J	J_1	N	A_1	A_2	A_3	A_4 1)	B_1 1)						kg	C_r	C_{0r}	f_0	Open Type	Closed Type	mm A_s	inch A_s	kg	Open Type	Closed Type	mm A_c	inch A_c	kg
65	2 1/2	8 3/4 222	6.4567 164	7 31/64 190	5 9/32 134.3	3/4 19	1 3/8 35	15/32 12	55/64 22	1 7/8 48	2 7/8 73	5/8 M16	**UKFCX15**	FCX15	UKX15	HE2315X H2315X	7.7 7.7	72.7	53.0	14.6	– UKFCX15C	– UKFCX15D	– 66	– 2 19/32	– 7.7	– –	– –	– –	– –	– –
70	2 3/4	9 7/16 240	6.6929 170	7 7/8 200	5 9/16 141.4	29/32 23	1 31/32 42	45/64 18	5/8 16	2 7/32(2 15/32) 56(62.5)	2 5/16(3 1/16) 59(78)	3/4 M20	**UKFC216**	FC216	UK216	HE316X(HE2316X) H316X(H2316X)	9.0 9.0	72.7	53.0	14.6	– UKFC216C	– UKFC216D	– 72	– 2 27/32	– 9.0	– UKFC216FC	– UKFC216FD	– 87	– 3 7/16	– 10.3
	2 3/4	10 1/4 260	7.3228 186	8 5/8 219	6 3/32 154.8	29/32 23	1 13/32 36	25/64 10	63/64 25	1 15/16 49	3 1/16 78	3/4 M20	**UKFCX16**	FCX16	UKX16	HE2316X H2316X	11.4 11.4	84.0	61.9	14.5	– UKFCX16C	– UKFCX16D	– 66	– 2 19/32	– 11.4	– –	– –	– –	– –	– –
75	 3	9 27/32 250	7.0866 180	8 3/16 208	5 51/64 147.1	29/32 23	1 25/32 45	45/64 18	45/64 18	2 9/32(3 17/32) 58(64.5)	2 15/32(3 7/32) 63(82)	3/4 M20	**UKFC217**	FC217	UK217	H317X(H2317X) HE317X(HE2317X)	10.4 10.4	84.0	61.9	14.5	UKFC217C –	UKFC217D –	74 –	2 29/32 –	10.4 –	UKFC217FC –	UKFC217FD –	89 –	3 1/2 –	11.8 –
	 3	10 1/4 260	7.3228 186	8 5/8 219	6 3/32 154.8	29/32 23	1 13/32 36	25/64 10	63/64 25	2 1/16 52	3 7/32 82	3/4 M20	**UKFCX17**	FCX17	UKX17	H2317X HE2317X	12.6 12.6	96.1	71.5	14.5	UKFCX17C –	UKFCX17D –	71 –	2 25/32 –	12.6 –	– –	– –	– –	 –	– –
80	–	10 7/16 265	7.4803 190	8 21/32 220	6 1/8 155.5	29/32 23	1 31/32 50	55/64 22	45/64 18	2 17/32(2 13/16) 64(71.5)	2 9/16(3 3/8) 65(86)	3/4 M20	**UKFC218**	FC218	UK218	H318X(H2318X)	13.3	96.1	71.5	14.5	UKFC218C	UKFC218D	83	3 9/32	13.3	UKFC218FC	UKFC218FD	98	3 27/32	14.9
	–	10 1/4 260	7.3228 186	8 5/8 219	6 3/32 154.8	29/32 23	1 11/16 43	15/32 12	1 7/64 28	2 5/32 55	3 3/8 86	3/4 M20	**UKFCX18**	FCX18	UKX18	H2318X	13.0	109	81.9	14.4	–	–	–	–	–	UKFCX18C	UKFCX18D	92	3 5/8	15.1
90	3 1/2	10 7/8 276	8.1102 206	9 3/8 238	6 5/8 168.3	29/32 23	2 19/32 66	55/64 22	1 7/64 28	2 23/32 69	3 13/16 97	3/4 M20	**UKFCX20**	FCX20	UKX20	HE2320X H2320X	17.1 17.1	133	105	14.4	– –	– –	– –	– –	– –	– UKFCX20C	– UKFCX20D	– 116	– 4 9/16	– 19.9

Note 1) Codes shown in parentheses indicate the dimensions and Part No. of applicable adapter (H2300X series) for UK200L3 series (triple seal type).

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

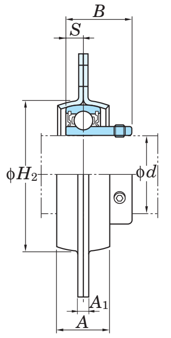
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF 205~210, X05~X09
A-PT1/8................211~218, X10~X20

3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables.
(Example of Part No. : UKFC206J + H306X, UK206 + H306X)

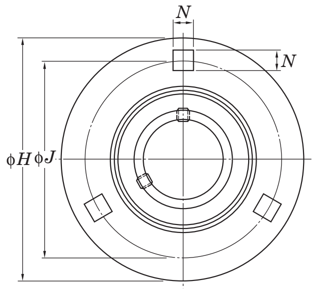
4. As for the triple seal type product (205 is the double seal type product), accessory code L3 (or L2) follows the Part No. of unit or bearing.
(Example of Part No. : UKFC206JL3 + H2306X, UK206L3 + H2306X)

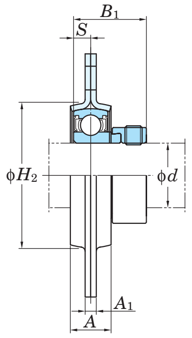
5. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

SBPF
Cylindrical bore
(with set screw locking)
SAPF
Cylindrical bore
(with eccentric locking collar)
d 12 ~ 35 mm



SBPF





SAPF

Variations of tolerance of distance between centers of bolt holes ($\varDelta_{Js}$)

Unit : mm

Housing No.	$\varDelta_{Js}$
PF203~PF207	±0.4

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

Unit : mm

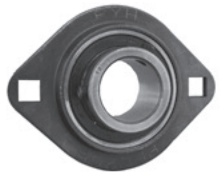
Housing No.	$\varDelta_{Ns}$
PF203~PF207	±0.25

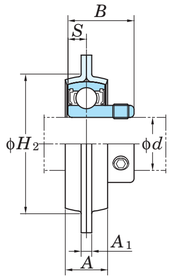
Shaft Dia mm	Shaft Dia inch	Dimensions inch mm H	A	A_1	J	N	H_2	S	SBPF B	SAPF B_1	Bolt Size inch mm	Unit No.	Bearing No.	Unit No.	Bearing No.	Housing No.	Basic Load Ratings kN C_r	C_{0r}	Factor f_0	Mass kg SBPF	SAPF
12		3 3/16 81	9/16 14	5/32 4	2 1/2 63.5	9/32 7.1	1 15/16 49	0.236 6	0.866 22	1.122 28.5	1/4 M6	**SBPF201**	SB201	**SAPF201**	SA201	PF203	9.55	4.80	13.2	0.27	0.3
	1/2											**SBPF201-8**	SB201-8	**SAPF201-8**	SA201-8						
15												**SBPF202**	SB202	**SAPF202**	SA202						
	5/8											**SBPF202-10**	SB202-10	**SAPF202-10**	SA202-10						
17												**SBPF203**	SB203	**SAPF203**	SA203						
	3/4	3 17/32 90	5/8 16	5/32 4	2 13/16 71.5	23/64 9	25/32 55	0.276 7	0.984 25	1.161 29.5	5/16 M8	**SBPF204-12**	SB204-12	**SAPF204-12**	SA204-12	PF204	12.8	6.65	13.2	0.33	0.33
20												**SBPF204**	SB204	**SAPF204**	SA204						
	7/8	3 3/4 95	23/32 18	5/32 4	2 63/64 76	23/64 9	2 3/8 60	0.295 7.5	1.063 27	1.201 30.5	5/16 M8	**SBPF205-14**	SB205-14	**SAPF205-14**	SA205-14	PF205	14.0	7.85	13.9	0.38	0.42
	15/16											**SBPF205-15**	SB205-15	**SAPF205-15**	SA205-15						
25												**SBPF205**	SB205	**SAPF205**	SA205						
	1											**SBPF205-16**	SB205-16	**SAPF205-16**	SA205-16						
	1 1/8	4 7/16 113	3/4 19	13/64 5.2	3 9/16 90.5	7/16 11	2 25/32 71	0.315 8	1.181 30	1.335 33.9	3/8 M10	**SBPF206-18**	SB206-18	**SAPF206-18**	SA206-18	PF206	19.5	11.3	13.9	0.62	0.65
30												**SBPF206**	SB206	**SAPF206**	SA206						
	13/16											**SBPF206-19**	SB206-19	**SAPF206-19**	SA206-19						
	1 1/4											**SBPF206-20**	SB206-20	**SAPF206-20**	SA206-20						
	1 1/4	4 13/16 122	7/8 22	13/64 5.2	3 15/16 100	7/16 11	3 3/16 81	0.335 8.5	1.260 32	1.437 36.5	3/8 M10	**SBPF207-20**	SB207-20	**SAPF207-20**	SA207-20	PF207	25.7	15.4	13.9	0.82	0.9
	15/16													**SAPF207-21**	SA207-21						
	1 3/8											**SBPF207-22**	SB207-22	**SAPF207-22**	SA207-22						
35												**SBPF207**	SB207	**SAPF207**	SA207						
	1 7/16											**SBPF207-23**	SB207-23	**SAPF207-23**	SA207-23						

Note 1) H_2 is the minimum size of the mounting hole.

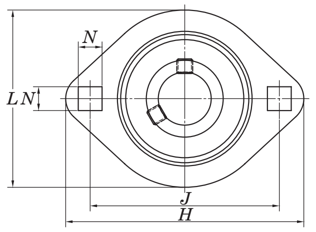
Remark For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

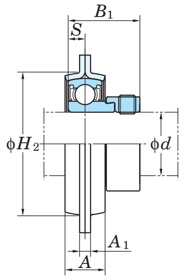
SBPFL
Cylindrical bore
(with set screw locking)
SAPFL
Cylindrical bore
(with eccentric locking collar)
d 12 ~ 35 mm





SBPFL





SAPFL

Variations of tolerance of distance between centers of bolt holes ($\varDelta_{Js}$)

Unit : mm

Housing No.	$\varDelta_{Js}$
PFL203~PFL207	±0.4

Variations of tolerance of bolt hole diameter ($\varDelta_{Ns}$)

Unit : mm

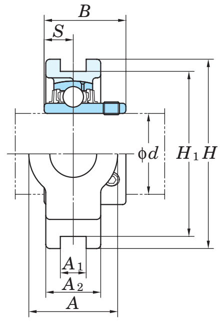
Housing No.	$\varDelta_{Ns}$
PFL203~PFL207	±0.25

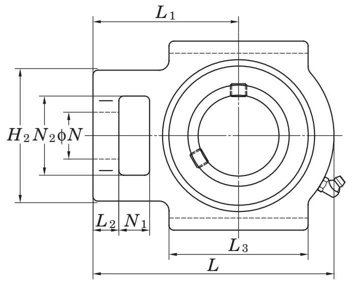
Shaft Dia mm	Shaft Dia inch	Dimensions inch mm										Bolt Size inch mm	Unit No.	Bearing No.	Unit No.	Bearing No.	Housing No.	Basic Load Ratings kN		Factor	Mass kg	
d		H	L	A	A_1	J	N	H_2	S	SBPFL B	SAPFL B_1							C_r	C_{0r}	f_0	SBPFL	SAPFL
12		3 3/16 81	2 5/16 59	9/16 14	5/32 4	2 1/2 63.5	9/32 7.1	1 15/16 49	0.236 6	0.866 22	1.122 28.5	1/4 M6	**SBPFL201**	SB201	**SAPFL201**	SA201	PFL203	9.55	4.80	13.2	0.19	0.22
	1/2												**SBPFL201-8**	SB201-8	**SAPFL201-8**	SA201-8						
15													**SBPFL202**	SB202	**SAPFL202**	SA202						
	5/8												**SBPFL202-10**	SB202-10	**SAPFL202-10**	SA202-10						
17													**SBPFL203**	SB203	**SAPFL203**	SA203						
20	3/4	3 17/32 90	2 5/8 67	5/8 16	5/32 4	2 13/16 71.5	23/64 9	25/32 55	0.276 7	0.984 25	1.161 29.5	5/16 M8	**SBPFL204-12**	SB204-12	**SAPFL204-12**	SA204-12	PFL204	12.8	6.65	13.2	0.24	0.24
													SBPFL204	SB204	**SAPFL204**	SA204						
25	7/8	3 3/4 95	2 25/32 71	23/32 18	5/32 4	2 63/64 76	23/64 9	2 3/8 60	0.295 7.5	1.063 27	1.201 30.5	5/16 M8	**SBPFL205-14**	SB205-14	**SAPFL205-14**	SA205-14	PFL205	14.0	7.85	13.9	0.28	0.32
	15/16												**SBPFL205-15**	SB205-15	**SAPFL205-15**	SA205-15						
													SBPFL205	SB205	**SAPFL205**	SA205						
	1												**SBPFL205-16**	SB205-16	**SAPFL205-16**	SA205-16						
30	1 1/8	4 7/16 113	3 5/16 84	3/4 19	13/64 5.2	3 9/16 90.5	7/16 11	2 25/32 71	0.315 8	1.181 30	1.335 33.9	3/8 M10	**SBPFL206-18**	SB206-18	**SAPFL206-18**	SA206-18	PFL206	19.5	11.3	13.9	0.38	0.41
													SBPFL206	SB206	**SAPFL206**	SA206						
	13/16												**SBPFL206-19**	SB206-19	**SAPFL206-19**	SA206-19						
	1 1/4												**SBPFL206-20**	SB206-20	**SAPFL206-20**	SA206-20						
35	1 1/4	4 13/16 122	3 11/16 94	7/8 22	13/64 5.2	3 15/16 100	7/16 11	3 3/16 81	0.335 8.5	1.260 32	1.437 36.5	3/8 M10	**SBPFL207-20**	SB207-20	**SAPFL207-20**	SA207-20	PFL207	25.7	15.4	13.9	0.66	0.74
	15/16														**SAPFL207-21**	SA207-21						
	1 3/8												**SBPFL207-22**	SB207-22	**SAPFL207-22**	SA207-22						
													SBPFL207	SB207	**SAPFL207**	SA207						
	1 7/16												**SBPFL207-23**	SB207-23	**SAPFL207-23**	SA207-23						

Note 1) H_2 is the minimum size of the mounting hole.

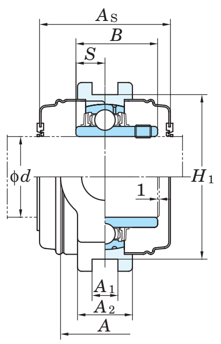
Remark For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCT
Cylindrical bore (with set screws)
d 12 ~ (45) mm

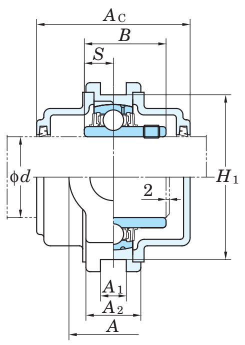




With Pressed Steel Cover



With Cast Iron Cover

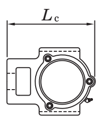


Variations of tolerance of groove width (Δ_{A1s}), variations of tolerance of distance between both grooves (Δ_{H1s}), and tolerance of symmetry of both groove sides (X)

Unit : mm

Housing No.			Δ_{A1s}	Δ_{H1s}	X
T204~T210	TX05~TX10	T305~T310	+0.2 0	0 –0.5	0.5
T211~T217	TX11~TX17	T311~T318	+0.3 0	0 –0.8	0.6
		T319~T322			0.7
		T324~T328			0.8

Form and dimensions of L_c of T204JE3 and T205JE3 (housing with cast iron cover) are shown below.

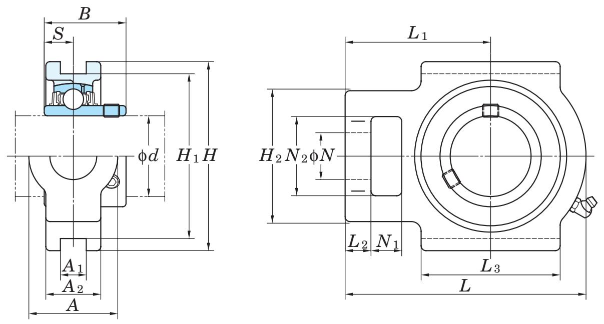


T204JE3 L_c = 97 mm
T205JE3 L_c = 102 mm

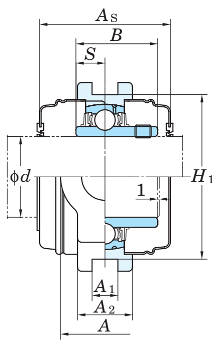
Shaft Dia. mm	Shaft Dia. inch	Dimensions inch / mm															Standard Unit No.	Housing No.	Bearing No.	Mass	Basic Load Ratings kN		Factor	With Pressed Steel Cover Unit No.		Dimension		Mass	With Cast Iron Cover Unit No.		Dimension		Mass
d		A	A_1	A_2	H	H_1	H_2	L	L_1	L_2	L_3	N	N_1	N_2	B	S				kg	C_r	C_{0r}	f_0	Open Type	One Side Closed Type	A_s mm	A_s inch	kg	Open Type	One Side Closed Type	A_c mm	A_c inch	kg
12		1 1/4 32	15/32 12	13/16 21	3 1/2 89	2 63/64 76	2 51	3 11/16 94	2 13/32 61	13/32 10	2 51	3/4 19	5/8 16	1 1/4 32	1.220 31	0.500 12.7	**UCT201**	T204	UC201	0.81	12.8	6.65	13.2	UCT201C	UCT201CD	44	1 23/32	0.81	–	–	–	–	–
	1/2																**UCT201-8**		UC201-8	0.81				–	–	–	–	–	–	–	–	–	–
15																	**UCT202**		UC202	0.79				UCT202C	UCT202CD	44	1 23/32	0.79	–	–	–	–	–
	5/8																**UCT202-10**		UC202-10	0.79				–	–	–	–	–	–	–	–	–	–
17																	**UCT203**		UC203	0.78				UCT203C	UCT203CD	44	1 23/32	0.78	–	–	–	–	–
	3/4																**UCT204-12**		UC204-12	0.78				–	–	–	–	–	–	–	–	–	–
20																	**UCT204**		UC204	0.76				UCT204C	UCT204CD	44	1 23/32	0.76	UCT204FC	UCT204FCD	62	2 7/16	1.1
25	7/8	1 1/4 32	15/32 12	15/16 24	3 1/2 89	2 63/64 76	2 51	3 13/16 97	2 7/16 62	13/32 10	2 51	3/4 19	5/8 16	1 1/4 32	1.343 34.1	0.563 14.3	**UCT205-14**	T205	UC205-14	0.84	14.0	7.85	13.9	–	–	–	–	–	–	–	–	–	–
	15/16																**UCT205-15**		UC205-15	0.84				–	–	–	–	–	–	–	–	–	–
																	UCT205		UC205	0.84				UCT205C	UCT205CD	48	1 7/8	0.84	UCT205FC	UCT205FCD	66	2 19/32	1.2
	1																**UCT205-16**		UC205-16	0.84				–	–	–	–	–	–	–	–	–	–
		1 15/32 37	15/32 12	1 3/32 28	4 1/32 102	3 1/2 89	2 7/32 56	4 7/16 113	2 3/4 70	13/32 10	2 1/4 57	7/8 22	5/8 16	1 15/32 37	1.500 38.1	0.626 15.9	**UCTX05**	TX05	UCX05	1.4	19.5	11.3	13.9	UCTX05C	UCTX05CD	52	2 1/16	1.4	–	–	–	–	–
	1																**UCTX05-16**		UCX05-16	1.4				–	–	–	–	–	–	–	–	–	–
		1 13/32 36	15/32 12	1 1/32 26	3 1/2 89	3 5/32 80	2 7/16 62	4 13/16 122	3 76	15/32 12	2 9/16 65	1 1/32 26	5/8 16	1 13/32 36	1.496 38	0.591 15	**UCT305**	T305	UC305	1.4	21.2	10.9	12.6	–	–	–	–	–	UCT305C	UCT305CD	76	3	2.0
	1																**UCT305-16**		UC305-16	1.4				–	–	–	–	–	–	–	–	–	–
30	1 1/8	1 15/32 37	15/32 12	1 3/32 28	4 1/32 102	3 1/2 89	2 7/32 56	4 7/16 113	2 3/4 70	13/32 10	2 1/4 57	7/8 22	5/8 16	1 15/32 37	1.500 38.1	0.626 15.9	**UCT206-18**	T206	UC206-18	1.3	19.5	11.3	13.9	–	–	–	–	–	–	–	–	–	–
																	UCT206		UC206	1.3				UCT206C	UCT206CD	52	2 1/16	1.3	UCT206FC	UCT206FCD	70	2 3/4	1.8
	1 3/16																**UCT206-19**		UC206-19	1.3				–	–	–	–	–	–	–	–	–	–
	1 1/4																**UCT206-20**		UC206-20	1.3				–	–	–	–	–	–	–	–	–	–
		1 15/32 37	15/32 12	1 3/16 30	4 1/32 102	3 1/2 89	2 17/32 64	5 3/32 129	3 1/16 78	1/2 13	2 17/32 64	7/8 22	5/8 16	1 15/32 37	1.689 42.9	0.689 17.5	**UCTX06**	TX06	UCX06	1.7	25.7	15.4	13.9	UCTX06C	UCTX06CD	59	2 5/16	1.7	–	–	–	–	–
	1 3/16																**UCTX06-19**		UCX06-19	1.7				–	–	–	–	–	–	–	–	–	–
	1 1/4																**UCTX06-20**		UCX06-20	1.7				–	–	–	–	–	–	–	–	–	–
	–	1 5/8 41	5/8 16	1 3/32 28	3 15/16 100	3 35/64 90	2 3/4 70	5 13/32 137	3 11/32 85	9/16 14	2 29/32 74	1 3/32 28	23/32 18	1 5/8 41	1.693 43	0.669 17	**UCT306**	T306	UC306	1.8	26.7	15.0	13.3	–	–	–	–	–	UCT306C	UCT306CD	82	3 7/32	2.4
35	1 1/4	1 15/32 37	15/32 12	1 3/16 30	4 1/32 102	3 1/2 89	2 17/32 64	5 3/32 129	3 1/16 78	1/2 13	2 17/32 64	7/8 22	5/8 16	1 15/32 37	1.689 42.9	0.689 17.5	**UCT207-20**	T207	UC207-20	1.6	25.7	15.4	13.9	–	–	–	–	–	–	–	–	–	–
	1 5/16																**UCT207-21**		UC207-21	1.6				–	–	–	–	–	–	–	–	–	–
	1 3/8																**UCT207-22**		UC207-22	1.6				–	–	–	–	–	–	–	–	–	–
																	UCT207		UC207	1.6				UCT207C	UCT207CD	59	2 5/16	1.6	UCT207FC	UCT207FCD	78	3 1/16	2.3
	1 7/16																**UCT207-23**		UC207-23	1.6				–	–	–	–	–	–	–	–	–	–
	1 3/8	1 15/16 49	5/8 16	1 13/32 36	4 1/2 114	4 1/64 102	3 9/32 83	5 21/32 144	3 15/32 88	19/32 15	3 9/32 83	1 5/32 29	3/4 19	1 15/16 49	1.937 49.2	0.748 19	**UCTX07-22**	TX07	UCX07-22	2.7	29.1	17.8	14.0	–	–	–	–	–	–	–	–	–	–
																	UCTX07		UCX07	2.7				UCTX07C	UCTX07CD	68	2 11/16	2.7	–	–	–	–	–
	1 7/16																**UCTX07-23**		UCX07-23	2.7				–	–	–	–	–	–	–	–	–	–
	–	1 25/32 45	5/8 16	1 1/4 32	4 3/8 111	3 15/16 100	2 15/16 75	5 29/32 150	3 11/16 94	19/32 15	3 5/32 80	1 3/16 30	25/32 20	1 25/32 45	1.890 48	0.748 19	**UCT307**	T307	UC307	2.3	33.4	19.3	13.2	–	–	–	–	–	UCT307C	UCT307CD	88	3 15/32	3.1
40	1 1/2	1 15/16 49	5/8 16	1 5/16 33	4 1/2 114	4 1/64 102	3 9/32 83	5 21/32 144	3 15/32 88	5/8 16	3 9/32 83	1 5/32 29	3/4 19	1 15/16 49	1.937 49.2	0.748 19	**UCT208-24**	T208	UC208-24	2.5	29.1	17.8	14.0	–	–	–	–	–	–	–	–	–	–
	1 9/16																**UCT208-25**		UC208-25	2.5				–	–	–	–	–	–	–	–	–	–
																	UCT208		UC208	2.5				UCT208C	UCT208CD	68	2 11/16	2.5	UCT208FC	UCT208FCD	86	3 3/8	3.3
	1 1/2	1 15/16 49	5/8 16	1 13/32 36	4 19/32 117	4 1/64 102	3 9/32 83	5 21/32 144	3 7/16 87	19/32 15	3 9/32 83	1 5/32 29	3/4 19	1 15/16 49	1.937 49.2	0.748 19	**UCTX08-24**	TX08	UCX08-24	2.6	34.1	21.3	14.0	–	–	–	–	–	–	–	–	–	–
																	UCTX08		UCX08	2.6				UCTX08C	UCTX08CD	68	2 11/16	2.6	–	–	–	–	–
	1 1/2	1 31/32 50	45/64 18	1 11/32 34	4 7/8 124	4 13/32 112	3 9/32 83	6 3/8 162	3 15/16 100	21/32 17	3 1/2 89	1 1/4 32	7/8 22	1 31/32 50	2.047 52	0.748 19	**UCT308-24**	T308	UC308-24	3.0	40.7	24.0	13.2	–	–	–	–	–	–	–	–	–	–
																	UCT308		UC308	3.0				–	–	–	–	–	UCT308C	UCT308CD	96	3 25/32	4.0
45	1 5/8	1 15/16 49	5/8 16	1 3/8 35	4 19/32 117	4 1/64 102	3 9/32 83	5 21/32 144	3 7/16 87	5/8 16	3 9/32 83	1 5/32 29	3/4 19	1 15/16 49	1.937 49.2	0.748 19	**UCT209-26**	T209	UC209-26	2.4	34.1	21.3	14.0	–	–	–	–	–	–	–	–	–	–
	1 11/16																**UCT209-27**		UC209-27	2.4				–	–	–	–	–	–	–	–	–	–
	1 3/4																**UCT209-28**		UC209-28	2.4				–	–	–	–	–	–	–	–	–	–
																	UCT209		UC209	2.4				UCT209C	UCT209CD	68	2 11/16	2.4	UCT209FC	UCT209FCD	88	3 15/32	3.2
	1 3/4	1 15/16 49	5/8 16	1 1/2 38	4 19/32 117	4 1/64 102	3 9/32 83	5 7/8 149	3 17/32 90	5/8 16	3 3/8 86	1 5/32 29	3/4 19	1 15/16 49	2.031 51.6	0.748 19	**UCTX09-28**	TX09	UCX09-28	2.9	35.1	23.3	14.4	–	–	–	–	–	–	–	–	–	–
																	UCTX09		UCX09	2.9				UCTX09C	UCTX09CD	73	2 7/8	2.9	–	–	–	–	–

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
B-1/4-28UNF .... 201~210, X05~X09, 305~308
B-PT1/8 .... 211~217, X10~X17, 309~328
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (L2) follows the Part No. of unit or bearing. (Example of Part No. : UCT206JL3, UC206L3)
4. As for the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

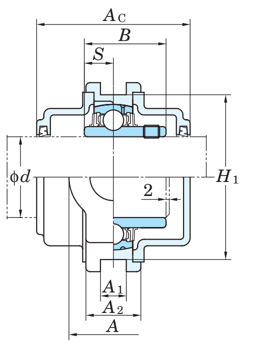
UCT
Cylindrical bore (with set screws)
d (45) ~ (75) mm



With Pressed Steel Cover



With Cast Iron Cover

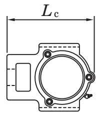


Variations of tolerance of groove width (Δ_{A1s}), variations of tolerance of distance between both grooves (Δ_{H1s}), and tolerance of symmetry of both groove sides (X)

Unit : mm

Housing No.			Δ_{A1s}	Δ_{H1s}	X
T204~T210	TX05~TX10	T305~T310	+0.2 0	0 –0.5	0.5
T211~T217	TX11~TX17	T311~T318	+0.3 0	0 –0.8	0.6
		T319~T322			0.7
		T324~T328			0.8

Form and dimensions of L_c of T204JE3 and T205JE3 (housing with cast iron cover) are shown below.

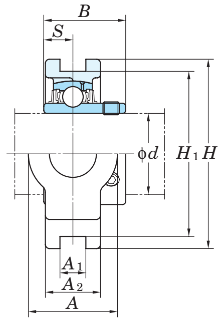


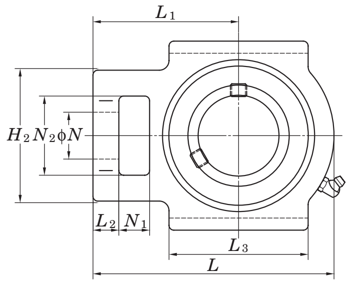
T204JE3 L_c = 97 mm
T205JE3 L_c = 102 mm

Shaft Dia.		Dimensions															Standard				Basic Load Ratings		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm	inch	inch mm															Unit No.	Housing No.	Bearing No.	Mass	kN			Unit No.		Dimension		Mass	Unit No.		Dimension		Mass
d		A	A_1	A_2	H	H_1	H_2	L	L_1	L_2	L_3	N	N_1	N_2	B	S				kg	C_r	C_{0r}	f_0	Open Type	One Side Closed Type	mm A_s	inch	kg	Open Type	One Side Closed Type	mm A_c	inch	kg
45	1 3/4	2 5/32	45/64	1 1/2	5 7/16	4 59/64	3 17/32	7	4 11/32	23/32	3 13/16	1 11/32	15/16	2 5/32	2.244	0.866	**UCT309-28**	T309	UC309-28	4.1	48.9	29.5	13.3	–	–	–	–	–	–	–	–	–	–
		55	18	38	138	125	90	178	110	18	97	34	24	55	57	22	**UCT309**		UC309	4.1				–	–	–	–	–	UCT309C	UCT309CD	102	4 1/32	5.4
50	1 7/8																**UCT210-30**	T210	UC210-30	2.6	35.1	23.3	14.4	–	–	–	–	–	–	–	–	–	–
	1 15/16	1 15/16	5/8	1 15/32	4 19/32	4 1/64	3 9/32	5 7/8	3 17/32	5/8	3 3/8	1 5/32	3/4	1 15/16	2.031	0.748	**UCT210-31**		UC210-31	2.6				–	–	–	–	–	–	–	–	–	–
		49	16	37	117	102	83	149	90	16	86	29	19	49	51.6	19	**UCT210**		UC210	2.6				UCT210C	UCT210CD	73	2 7/8	2.6	UCT210FC	UCT210FCD	97	3 13/16	3.6
	2																**UCT210-32**		UC210-32	2.6				–	–	–	–	–	–	–	–	–	–
	1 15/16	2 17/32	55/64	1 21/32	5 3/4	5 1/8	4 1/32	6 23/32	4 3/16	3/4	3 3/4	1 3/8	31/32	2 17/32	2.189	0.874	**UCTX10-31**	TX10	UCX10-31	4.4	43.4	29.4	14.4	–	–	–	–	–	–	–	–	–	–
		64	22	42	146	130	102	171	106	19	95	35	25	64	55.6	22.2	**UCTX10**		UCX10	4.4				UCTX10C	UCTX10CD	75	2 15/16	4.4	–	–	–	–	–
	2																**UCTX10-32**		UCX10-32	4.4				–	–	–	–	–	–	–	–	–	–
	–	2 13/32	25/32	1 9/16	5 15/16	5 33/64	3 27/32	7 17/32	4 19/32	25/32	4 3/16	1 15/32	1 1/16	2 13/32	2.402	0.866	**UCT310**	T310	UC310	4.9	62.0	38.3	13.2	–	–	–	–	–	UCT310C	UCT310CD	110	4 11/32	6.5
		61	20	40	151	140	98	191	117	20	106	37	27	61	61	22																	
55	2																**UCT211-32**	T211	UC211-32	4.0	43.4	29.4	14.4	–	–	–	–	–	–	–	–	–	–
	2 1/8	2 17/32	55/64	1 1/2	5 3/4	5 1/8	4 1/32	6 23/32	4 3/16	3/4	3 3/4	1 3/8	31/32	2 17/32	2.189	0.874	**UCT211-34**		UC211-34	4.0				–	–	–	–	–	–	–	–	–	–
		64	22	38	146	130	102	171	106	19	95	35	25	64	55.6	22.2	**UCT211**		UC211	4.0				UCT211C	UCT211CD	75	2 15/16	4.0	UCT211FC	UCT211FCD	99	3 29/32	5.2
	2 3/16																**UCT211-35**		UC211-35	4.0				–	–	–	–	–	–	–	–	–	–
		2 17/32	55/64	1 23/32	5 3/4	5 1/8	4 1/32	7 5/8	4 11/16	3/4	4 1/32	1 3/8	1 1/4	2 17/32	2.563	1.000	**UCTX11**	TX11	UCX11	5.3	52.4	36.2	14.4	UCTX11C	UCTX11CD	88	3 15/32	5.3	–	–	–	–	–
	2 3/16	64	22	44	146	130	102	194	119	19	102	35	32	64	65.1	25.4	**UCTX11-35**		UCX11-35	5.3				–	–	–	–	–	–	–	–	–	–
	2 1/4																**UCTX11-36**		UCX11-36	5.3				–	–	–	–	–	–	–	–	–	–
	2	2 19/32	55/64	1 23/32	6 13/32	5 29/32	4 1/8	8 5/32	5	13/16	4 17/32	1 17/32	1 5/32	2 19/32	2.598	0.984	**UCT311-32**	T311	UC311-32	6.1	71.6	45.0	13.2	–	–	–	–	–	–	–	–	–	–
		66	22	44	163	150	105	207	127	21	115	39	29	66	66	25	**UCT311**		UC311	6.1				–	–	–	–	–	UCT311C	UCT311CD	114	4 1/2	7.9
60	2 1/4																**UCT212-36**	T212	UC212-36	4.9	52.4	36.2	14.4	–	–	–	–	–	–	–	–	–	–
		2 17/32	55/64	1 21/32	5 3/4	5 1/8	4 1/32	7 5/8	4 11/16	3/4	4 1/32	1 3/8	1 1/4	2 17/32	2.563	1.000	**UCT212**		UC212	4.9				UCT212C	UCT212CD	88	3 15/32	4.9	UCT212FC	UCT212FCD	114	4 1/2	6.4
	2 3/8	64	22	42	146	130	102	194	119	19	102	35	32	64	65.1	25.4	**UCT212-38**		UC212-38	4.9				–	–	–	–	–	–	–	–	–	–
	2 7/16																**UCT212-39**		UC212-39	4.9				–	–	–	–	–	–	–	–	–	–
		2 3/4	1 1/32	1 7/8	6 9/16	5 15/16	4 3/8	8 13/16	5 13/32	13/16	4 3/4	1 5/8	1 1/4	2 3/4	2.563	1.000	**UCTX12**	TX12	UCX12	7.4	57.2	40.1	14.4	UCTX12C	UCTX12CD	88	3 15/32	7.4	–	–	–	–	–
	2 7/16	70	26	48	167	151	111	224	137	21	121	41	32	70	65.1	25.4	**UCTX12-39**		UCX12-39	7.4				–	–	–	–	–	–	–	–	–	–
	–	2 25/32	55/64	1 13/16	7	6 19/64	4 7/16	8 21/32	5 5/16	29/32	4 27/32	1 5/8	1 7/32	2 25/32	2.795	1.024	**UCT312**	T312	UC312	7.6	81.9	52.2	13.2	–	–	–	–	–	UCT312C	UCT312CD	124	4 7/8	9.9
		71	22	46	178	160	113	220	135	23	123	41	31	71	71	26																	
65	2 1/2	2 3/4	1 1/32	1 23/32	6 9/16	5 15/16	4 3/8	8 13/16	5 13/32	13/16	4 3/4	1 5/8	1 1/4	2 3/4	2.563	1.000	**UCT213-40**	T213	UC213-40	6.9	57.2	40.1	14.4	–	–	–		–	–	–	–		–
		70	26	44	167	151	111	224	137	21	121	41	32	70	65.1	25.4	**UCT213**		UC213	6.9				UCT213C	UCT213CD	88	3 15/32	6.9	UCT213FC	UCT213FCD	114	4 1/2	8.6
	2 1/2	2 3/4	1 1/32	1 7/8	6 9/16	5 15/16	4 3/8	8 13/16	5 13/32	13/16	4 3/4	1 5/8	1 1/4	2 3/4	2.937	1.189	**UCTX13-40**	TX13	UCX13-40	7.6	62.2	44.1	14.5	–	–	–	–	–	–	–	–	–	–
		70	26	48	167	151	111	224	137	21	121	41	32	70	74.6	30.2	**UCTX13**		UCX13	7.6				UCTX13C	UCTX13CD	98	3 27/32	7.6	–	–	–	–	–
	2 1/2	3 5/32	1 1/32	1 31/32	7 15/32	6 11/16	4 9/16	9 3/8	5 3/4	31/32	5 9/32	1 11/16	1 1/4	2 3/4	2.953	1.181	**UCT313-40**	T313	UC313-40	9.3	92.7	59.9	13.2	–	–	–	–	–	–	–	–	–	–
		80	26	50	190	170	116	238	146	25	134	43	32	70	75	30	**UCT313**		UC313	9.3				–	–	–	–	–	UCT313C	UCT313CD	122	4 13/16	11.4
70	2 3/4	2 3/4	1 1/32	1 13/16	6 9/16	5 15/16	4 3/8	8 13/16	5 13/32	13/16	4 3/4	1 5/8	1 1/4	2 3/4	2.937	1.189	**UCT214-44**	T214	UC214-44	7.0	62.2	44.1	14.5	–	–	–	–	–	–	–	–	–	–
		70	26	46	167	151	111	224	137	21	121	41	32	70	74.6	30.2	**UCT214**		UC214	7.0				UCT214C	UCT214CD	98	3 27/32	7.0	UCT214FC	UCT214FCD	124	4 7/8	8.9
	2 3/4	2 3/4	1 1/32	1 7/8	6 9/16	5 15/16	4 3/8	9 1/8	5 1/2	13/16	4 3/4	1 5/8	1 1/4	2 3/4	3.063	1.331	**UCTX14-44**	TX14	UCX14-44	7.9	67.4	48.3	14.5	–	–	–	–	–	–	–	–	–	–
		70	26	48	167	151	111	232	140	21	121	41	32	70	77.8	33.3	**UCTX14**		UCX14	7.9				UCTX14C	UCTX14CD	98	3 27/32	7.9	–	–	–	–	–
	2 3/4	3 17/32	1 1/32	2 1/16	7 15/16	7 3/32	5 1/8	9 29/32	6 3/32	31/32	5 1/2	1 13/16	1 13/32	3 11/32	3.071	1.299	**UCT314-44**	T314	UC314-44	11.1	104	68.2	13.2	–	–	–	–	–	–	–	–	–	–
		90	26	52	202	180	130	252	155	25	140	46	36	85	78	33	**UCT314**		UC314	11.1				–	–	–	–	–	UCT314C	UCT314CD	124	4 7/8	13.4
75	2 15/16	2 3/4	1 1/32	1 7/8	6 9/16	5 15/16	4 3/8	9 1/8	5 1/2	13/16	4 3/4	1 5/8	1 1/4	2 3/4	3.063	1.331	**UCT215-47**	T215	UC215-47	7.3	67.4	48.3	14.5	–	–	–	–	–	–	–	–	–	–
		70	26	48	167	151	111	232	140	21	121	41	32	70	77.8	33.3	**UCT215**		UC215	7.3				UCT215C	UCT215CD	98	3 27/32	7.3	UCT215FC	UCT215FCD	124	4 7/8	9.2
	3																**UCT215-48**		UC215-48	7.3				–	–	–	–	–	–	–	–	–	–
	2 15/16	2 3/4	1 7/64	1 7/8	7 1/4	6 1/2	4 3/8	9 1/4	5 1/2	13/16	4 3/4	1 5/8	1 1/4	2 3/4	3.252	1.311	**UCTX15-47**	TX15	UCX15-47	8.7	72.7	53.0	14.6	–	–	–	–	–	–	–	–	–	–
		70	28	48	184	165	111	235	140	21	121	41	32	70	82.6	33.3	**UCTX15**		UCX15	8.7				UCTX15C	UCTX15CD	108	4 1/4	8.7	–	–	–	–	–
	3																**UCTX15-48**		UCX15-48	8.7				–	–	–	–	–	–	–	–	–	–

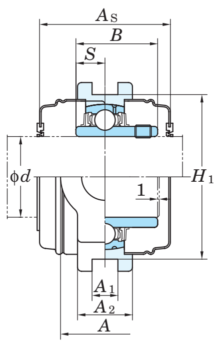
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
B-1/4-28UNF........ 201~210, X05~X09, 305~308
B-PT1/8................ 211~217, X10~X17, 309~328
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (L2) follows the Part No. of unit or bearing. (Example of Part No. : UCT206JL3, UC206L3)
4. As for the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCT
Cylindrical bore (with set screws)
d (75) ~ 140 mm

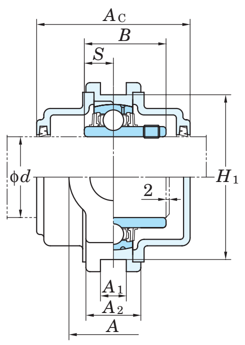




With Pressed Steel Cover



With Cast Iron Cover

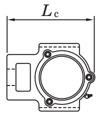


Variations of tolerance of groove width ($\varDelta_{A1s}$), variations of tolerance of distance between both grooves ($\varDelta_{H1s}$), and tolerance of symmetry of both groove sides (X)

Unit : mm

Housing No.			$\varDelta_{A1s}$	$\varDelta_{H1s}$	X
T204~T210	TX05~TX10	T305~T310	+0.2 0	0 –0.5	0.5
T211~T217	TX11~TX17	T311~T318	+0.3 0	0 –0.8	0.6
		T319~T322			0.7
		T324~T328			0.8

Form and dimensions of L_c of T204JE3 and T205JE3 (housing with cast iron cover) are shown below.



T204JE3 L_c = 97 mm
T205JE3 L_c = 102 mm

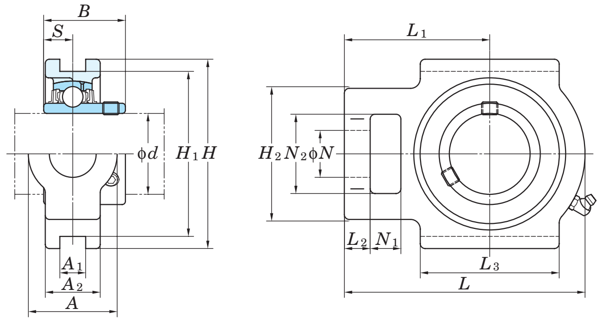
Shaft Dia. mm	Shaft Dia. inch	Dimensions (inch / mm) A	A₁	A₂	H	H₁	H₂	L	L₁	L₂	L₃	N	N₁	N₂	B	S	Standard Unit No.	Housing No.	Bearing No.	Mass kg	Basic Load Ratings kN C_r	C_{0r}	Factor f_0	With Pressed Steel Cover Unit No. Open Type	One Side Closed Type	Dimension A_s mm	A_s inch	Mass kg	With Cast Iron Cover Unit No. Open Type	One Side Closed Type	Dimension A_c mm	A_c inch	Mass kg
75	2 15/16 3	3 17/32 90	1 1/32 26	2 5/32 55	8 1/2 216	7 9/16 192	5 3/16 132	10 5/16 262	6 5/16 160	31/32 25	5 29/32 150	1 13/16 46	1 13/32 36	3 11/32 85	3.228 82	1.260 32	**UCT315-47** **UCT315** **UCT315-48**	T315	UC315-47 UC315 UC315-48	13.0 13.0 13.0	113	77.2	13.2	– – –	– – –	– – –	– – –	– – –	– UCT315C –	– UCT315CD –	– 134 –	– 5 9/32 –	– 15.5 –
80	3 1/8	2 3/4 70	1 1/32 26	2 51	7 1/4 184	6 1/2 165	4 3/8 111	9 1/4 235	5 1/2 140	13/16 21	4 3/4 121	1 5/8 41	1 1/4 32	2 3/4 70	3.252 82.6	1.311 33.3	**UCT216-50** **UCT216**	T216	UC216-50 UC216	8.2 8.2	72.7	53.0	14.6	– UCT216C	– UCT216CD	– 108	– 4 1/4	– 8.2	– UCT216FC	– UCT216FCD	– 138	– 5 7/16	– 10.6
	–	2 7/8 73	1 7/64 28	2 1/8 54	7 25/32 198	6 13/16 173	4 7/8 124	10 1/4 260	6 3/8 162	1 3/32 28	6 3/16 157	1 7/8 48	1 1/2 38	2 7/8 73	3.374 85.7	1.343 34.1	**UCTX16**	TX16	UCX16	11.7	84.0	61.9	14.5	UCTX16C	UCTX16CD	112	4 13/32	11.7	–	–	–	–	–
	–	4 1/32 102	1 3/16 30	2 3/8 60	9 1/16 230	8 1/32 204	5 29/32 150	11 3/32 282	6 27/32 174	1 3/32 28	6 5/16 160	2 3/32 53	1 21/32 42	3 27/32 98	3.386 86	1.339 34	**UCT316**	T316	UC316	16.2	123	86.7	13.3	–	–	–	–	–	UCT316C	UCT316CD	138	5 7/16	19.1
85	3 1/4	2 7/8 73	1 3/16 30	2 1/8 54	7 25/32 198	6 13/16 173	4 7/8 124	10 1/4 260	6 3/8 162	1 5/32 29	6 3/16 157	1 7/8 48	1 1/2 38	2 7/8 73	3.374 85.7	1.343 34.1	**UCT217-52** **UCT217**	T217	UC217-52 UC217	11.0 11.0	84.0	61.9	14.5	– UCT217C	– UCT217CD	– 112	– 4 13/32	– 11.0	– UCT217FC	– UCT217FCD	– 142	– 5 19/32	– 13.7
	3 7/16	2 7/8 73	1 7/64 28	2 1/8 54	7 25/32 198	6 13/16 173	4 7/8 124	10 1/4 260	6 3/8 162	1 3/32 28	6 3/16 157	1 7/8 48	1 1/2 38	2 7/8 73	3.780 96	1.563 39.7	**UCTX17** **UCTX17-55**	TX17	UCX17 UCX17-55	11.7 11.7	96.1	71.5	14.5	UCTX17C –	UCTX17CD –	122 –	4 13/16 –	11.7 –	– –	– –	– –	– –	– –
	–	4 1/32 102	1 17/64 32	2 17/32 64	9 7/16 240	8 27/64 214	5 31/32 152	11 23/32 298	7 7/32 183	1 3/16 30	6 11/16 170	2 3/32 53	1 21/32 42	3 27/32 98	3.780 96	1.575 40	**UCT317**	T317	UC317	19.0	133	96.8	13.3	–	–	–	–	–	UCT317C	UCT317CD	146	5 3/4	22.3
90	3 1/2	4 11/32 110	1 17/64 32	2 19/32 66	10 1/32 255	8 31/32 228	6 5/16 160	12 9/32 312	7 9/16 192	1 3/16 30	6 7/8 175	2 1/4 57	1 13/16 46	4 3/16 106	3.780 96	1.575 40	**UCT318-56** **UCT318**	T318	UC318-56 UC318	21.6 21.6	143	107	13.3	– –	– –	– –	– –	– –	– UCT318C	– UCT318CD	– 150	– 5 29/32	– 25.4
95	–	4 11/32 110	1 3/8 35	2 27/32 72	10 5/8 270	9 29/64 240	6 1/2 165	12 11/16 322	7 3/4 197	1 7/32 31	7 3/32 180	2 1/4 57	1 13/16 46	4 3/16 106	4.055 103	1.614 41	**UCT319**	T319	UC319	24.9	153	119	13.3	–	–	–	–	–	UCT319C	UCT319CD	162	6 3/8	29.2
100	3 15/16 4	4 23/32 120	1 3/8 35	2 15/16 75	11 13/32 290	10 15/64 260	6 7/8 175	13 19/32 345	8 9/32 210	1 1/4 32	7 7/8 200	2 5/16 59	1 7/8 48	4 17/32 115	4.252 108	1.654 42	**UCT320** **UCT320-63** **UCT320-64**	T320	UC320 UC320-63 UC320-64	30.7 30.7 30.7	173	141	13.2	– – –	– – –	– – –	– – –	– – –	UCT320C – –	UCT320CD – –	174 – –	6 27/32 – –	36.3 – –
105	–	4 23/32 120	1 3/8 35	2 15/16 75	11 13/32 290	10 15/64 260	6 7/8 175	13 19/32 345	8 9/32 210	1 1/4 32	7 7/8 200	2 5/16 59	1 7/8 48	4 17/32 115	4.409 112	1.732 44	**UCT321**	T321	UC321	36.7	184	153	13.2	–	–	–	–	–	UCT321C	UCT321CD	178	7	42.7
110	–	5 1/8 130	1 1/2 38	3 5/32 80	12 19/32 320	11 7/32 285	7 9/32 185	15 5/32 385	9 1/4 235	1 1/2 38	8 15/32 215	2 9/16 65	2 1/16 52	4 29/32 125	4.606 117	1.811 46	**UCT322**	T322	UC322	39.7	205	180	13.2	–	–	–	–	–	UCT322C	UCT322CD	188	7 13/32	46.5
120	–	5 1/2 140	1 49/64 45	3 17/32 90	13 31/32 355	12 9/32 320	8 9/32 210	17 432	10 1/2 267	1 21/32 42	9 1/16 230	2 3/4 70	2 3/8 60	5 1/2 140	4.961 126	2.008 51	**UCT324**	T324	UC324	54.4	207	185	13.5	–	–	–	–	–	UCT324C	UCT324CD	196	7 23/32	63.9
130	–	5 29/32 150	1 31/32 50	3 15/16 100	15 5/32 385	13 25/32 350	8 21/32 220	18 5/16 465	11 7/32 285	1 25/32 45	9 7/16 240	2 15/16 75	2 9/16 65	5 29/32 150	5.315 135	2.126 54	**UCT326**	T326	UC326	69.3	229	214	13.6	–	–	–	–	–	UCT326C	UCT326CD	214	8 7/16	81.4
140	–	6 3/32 155	1 31/32 50	3 15/16 100	16 11/32 415	14 61/64 380	9 1/16 230	20 9/32 515	12 13/32 315	1 31/32 50	10 1/32 255	3 5/32 80	2 3/4 70	6 5/16 160	5.709 145	2.323 59	**UCT328**	T328	UC328	85.1	253	246	13.6	–	–	–	–	–	UCT328C	UCT328CD	222	8 3/4	101

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
B-1/4-28UNF .... 201~210, X05~X09, 305~308
B-PT1/8 .... 211~217, X10~X17, 309~328
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (L2) follows the Part No. of unit or bearing. (Example of Part No. : UCT206JL3, UC206L3)
4. As for the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCT-E

Cylindrical bore (with set screws)

d 12 ~ 50 mm



Variations of tolerance of groove width ($\varDelta_{A1s}$), variations of tolerance of distance between both grooves ($\varDelta_{H1s}$), and tolerance of symmetry of both groove sides (X)

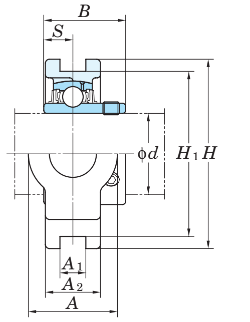
Unit : mm

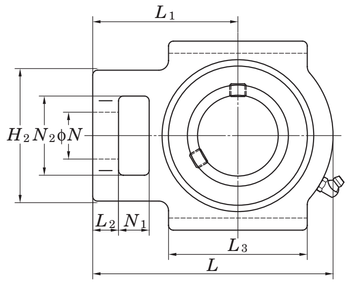
Housing No.		$\varDelta_{A1s}$	$\varDelta_{H1s}$	X
T204E~T210E	TX05E~TX10E	+0.2 0	0 –0.5	0.5
T211E~T217E	TX11E~TX17E	+0.3 0	0 –0.8	0.6

Shaft Dia.		Dimensions inch mm															Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN		Factor	Mass
mm *d*	inch	*A*	A_1	A_2	*H*	H_1	H_2	*L*	L_1	L_2	L_3	*N*	N_1	N_2	*B*	*S*				C_r	C_{0r}	f_0	kg
12		1 1/4 32	17/32 13.5	13/16 21	3 1/2 89	3 76.2	2 51	3 11/16 94	2 13/32 61	13/32 10	2 51	3/4 19	5/8 16	1 1/4 32	1.220 31	0.500 12.7	**UCT201E**	T204E	UC201	12.8	6.65	13.2	0.81
	1/2																**UCT201E-8**		UC201-8				
15																	**UCT202E**		UC202				0.79
	5/8																**UCT202E-10**		UC202-10				
17																	**UCT203E**		UC203				0.78
	3/4																**UCT204E-12**		UC204-12				
20																	**UCT204E**		UC204				0.76
	7/8	1 1/4 32	17/32 13.5	15/16 24	3 1/2 89	3 76.2	2 51	3 13/16 97	2 7/16 62	13/32 10	2 51	3/4 19	5/8 16	1 1/4 32	1.343 34.1	0.563 14.3	**UCT205E-14**	T205E	UC205-14	14.0	7.85	13.9	0.84
	15/16																**UCT205E-15**		UC205-15				
25																	**UCT205E**		UC205				
	1																**UCT205E-16**		UC205-16				
		1 15/32 37	17/32 13.5	1 3/32 28	4 1/32 102	3 1/2 88.9	2 7/32 56	4 7/16 113	2 3/4 70	13/32 10	2 1/4 57	7/8 22	5/8 16	1 15/32 37	1.500 38.1	0.626 15.9	**UCTX05E**	TX05E	UCX05	19.5	11.3	13.9	1.4
	1																**UCTX05E-16**		UCX05-16				
	1 1/8	1 15/32 37	17/32 13.5	1 3/32 28	4 1/32 102	3 1/2 88.9	2 7/32 56	4 7/16 113	2 3/4 70	13/32 10	2 1/4 57	7/8 22	5/8 16	1 15/32 37	1.500 38.1	0.626 15.9	**UCT206E-18**	T206E	UC206-18	19.5	11.3	13.9	1.3
																	UCT206E		UC206				
	1 3/16																**UCT206E-19**		UC206-19				
30	1 1/4																**UCT206E-20**		UC206-20				
		1 15/32 37	17/32 13.5	1 3/16 30	4 1/32 102	3 1/2 88.9	2 17/32 64	5 3/32 129	3 1/16 78	1/2 13	2 17/32 64	7/8 22	5/8 16	1 15/32 37	1.689 42.9	0.689 17.5	**UCTX06E**	TX06E	UCX06	25.7	15.4	13.9	1.7
	1 3/16																**UCTX06E-19**		UCX06-19				
	1 1/4																**UCTX06E-20**		UCX06-20				
	1 1/4	1 15/32 37	17/32 13.5	1 3/16 30	4 1/32 102	3 1/2 88.9	2 17/32 64	5 3/32 129	3 1/16 78	1/2 13	2 17/32 64	7/8 22	5/8 16	1 15/32 37	1.689 42.9	0.689 17.5	**UCT207E-20**	T207E	UC207-20	25.7	15.4	13.9	1.6
	1 5/16																**UCT207E-21**		UC207-21				
	1 3/8																**UCT207E-22**		UC207-22				
35																	**UCT207E**		UC207				
	1 7/16																**UCT207E-23**		UC207-23				
	1 3/8	1 15/16 49	11/16 17.5	1 13/32 36	4 1/2 114	4 101.6	3 9/32 83	5 21/32 144	3 15/32 88	19/32 15	3 9/32 83	1 5/32 29	3/4 19	1 15/16 49	1.937 49.2	0.748 19	**UCTX07E-22**	TX07E	UCX07-22	29.1	17.8	14.0	2.7
																	UCTX07E		UCX07				
	1 7/16																**UCTX07E-23**		UCX07-23				
	1 1/2	1 15/16 49	11/16 17.5	1 5/16 33	4 1/2 114	4 101.6	3 9/32 83	5 21/32 144	3 15/32 88	19/32 16	3 9/32 83	1 5/32 29	3/4 19	1 15/16 49	1.937 49.2	0.748 19	**UCT208E-24**	T208E	UC208-24	29.1	17.8	14.0	2.5
	1 9/16																**UCT208E-25**		UC208-25				
40																	**UCT208E**		UC208				
	1 1/2	1 15/16 49	11/16 17.5	1 13/32 36	4 19/32 117	4 101.6	3 9/32 83	5 21/32 144	3 7/16 87	19/32 15	3 9/32 83	1 5/32 29	3/4 19	1 15/16 49	1.937 49.2	0.748 19	**UCTX08E-24**	TX08E	UCX08-24	34.1	21.3	14.0	2.6
																	UCTX08E		UCX08				
	1 5/8	1 15/16 49	11/16 17.5	1 3/8 35	4 19/32 117	4 101.6	3 9/32 83	5 21/32 144	3 7/16 87	5/8 16	3 9/32 83	1 5/32 29	3/4 19	1 15/16 49	1.937 49.2	0.748 19	**UCT209E-26**	T209E	UC209-26	34.1	21.3	14.0	2.4
	1 11/16																**UCT209E-27**		UC209-27				
	1 3/4																**UCT209E-28**		UC209-28				
45																	**UCT209E**		UC209				
	1 3/4	1 15/16 49	11/16 17.5	1 1/2 38	4 19/32 117	4 101.6	3 9/32 83	5 7/8 149	3 17/32 90	5/8 16	3 3/8 86	1 5/32 29	3/4 19	1 15/16 49	2.031 51.6	0.748 19	**UCTX09E-28**	TX09E	UCX09-28	35.1	23.3	14.4	2.9
																	UCTX09E		UCX09				
	1 7/8	1 15/16 49	11/16 17.5	1 15/32 37	4 19/32 117	4 101.6	3 9/32 83	5 7/8 149	3 17/32 90	5/8 16	3 3/8 86	1 5/32 29	3/4 19	1 15/16 49	2.031 51.6	0.748 19	**UCT210E-30**	T210E	UC210-30	35.1	23.3	14.4	2.6
	1 15/16																**UCT210E-31**		UC210-31				
																	UCT210E		UC210				
50	2																**UCT210E-32**		UC210-32				
	1 15/16	2 17/32 64	1 1/16 27	1 21/32 42	5 3/4 146	5 1/8 130.17	4 1/64 102	6 23/32 171	4 3/16 106	3/4 19	3 3/4 95	1 3/8 35	31/32 25	2 17/32 64	2.189 55.6	0.874 22.2	**UCTX10E-31**	TX10E	UCX10-31	43.4	29.4	14.4	4.4
																	UCTX10E		UCX10				
	2																**UCTX10E-32**		UCX10-32				

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
B-1/4-28UNF .... 201~210, X05~X09, 305~308
B-PT1/8 .... 211~217, X10~X17, 309~328
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (L2) follows the Part No. of unit or bearing. (Example of Part No. : UCT206EL3, UC206L3)
4. As for the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCT-E
Cylindrical bore (with set screws)
d 55 ~ 85 mm





Variations of tolerance of groove width ($\varDelta_{A1s}$), variations of tolerance of distance between both grooves ($\varDelta_{H1s}$), and tolerance of symmetry of both groove sides (X)

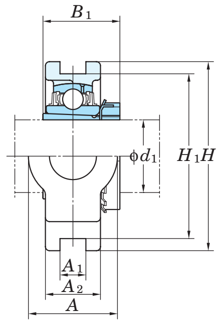
Unit : mm

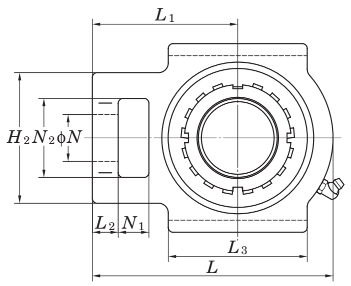
Housing No.		$\varDelta_{A1s}$	$\varDelta_{H1s}$	X
T204E~T210E	TX05E~TX10E	+0.2 0	0 –0.5	0.5
T211E~T217E	TX11E~TX17E	+0.3 0	0 –0.8	0.6

Shaft Dia. mm	Shaft Dia. inch	Dimensions inch / mm															Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN		Factor	Mass
d		*A*	*A*₁	*A*₂	*H*	*H*₁	*H*₂	*L*	*L*₁	*L*₂	*L*₃	*N*	*N*₁	*N*₂	*B*	*S*				*C*r	*C*0r	*f*0	kg
55	2 2 1/8 2 3/16	2 17/32 64	1 1/16 27	1 1/2 38	5 3/4 146	5 1/8 130.17	4 1/64 102	6 23/32 171	4 3/16 106	3/4 19	3 3/4 95	1 3/8 35	31/32 25	2 17/32 64	2.189 55.6	0.874 22.2	UCT211E-32 UCT211E-34 UCT211E UCT211E-35	T211E	UC211-32 UC211-34 UC211 UC211-35	43.4	29.4	14.4	4.0
	2 3/16 2 1/4	2 17/32 64	1 1/16 27	1 23/32 44	5 3/4 146	5 1/8 130.17	4 1/64 102	7 5/8 194	4 11/16 119	3/4 19	4 1/32 102	1 3/8 35	1 1/4 32	2 17/32 64	2.563 65.1	1.000 25.4	UCTX11E UCTX11E-35 UCTX11E-36	TX11E	UCX11 UCX11-35 UCX11-36	52.4	36.2	14.4	5.3
60	2 1/4 2 3/8 2 7/16	2 17/32 64	1 1/16 27	1 21/32 42	5 3/4 146	5 1/8 130.17	4 1/64 102	7 5/8 194	4 11/16 119	3/4 19	4 1/32 102	1 3/8 35	1 1/4 32	2 17/32 64	2.563 65.1	1.000 25.4	UCT212E-36 UCT212E UCT212E-38 UCT212E-39	T212E	UC212-36 UC212 UC212-38 UC212-39	52.4	36.2	14.4	4.9
	2 7/16	2 3/4 70	1 1/16 27	1 7/8 48	6 9/16 167	5 15/16 150.8	4 3/8 111	8 13/16 224	5 13/32 137	13/16 21	4 3/4 121	1 5/8 41	1 1/4 32	2 3/4 70	2.563 65.1	1.000 25.4	UCTX12E UCTX12E-39	TX12E	UCX12 UCX12-39	57.2	40.1	14.4	7.4
65	2 1/2	2 3/4 70	1 1/16 27	1 23/32 44	6 9/16 167	5 15/16 150.8	4 3/8 111	8 13/16 224	5 13/32 137	13/16 21	4 3/4 121	1 5/8 41	1 1/4 32	2 3/4 70	2.563 65.1	1.000 25.4	UCT213E-40 UCT213E	T213E	UC213-40 UC213	57.2	40.1	14.4	6.9
	2 1/2	2 3/4 70	1 1/16 27	1 7/8 48	6 9/16 167	5 15/16 150.8	4 3/8 111	8 13/16 224	5 13/32 137	13/16 21	4 3/4 121	1 5/8 41	1 1/4 32	2 3/4 70	2.937 74.6	1.189 30.2	UCTX13E-40 UCTX13E	TX13E	UCX13-40 UCX13	62.2	44.1	14.5	7.6
70	2 3/4	2 3/4 70	1 1/16 27	1 13/16 46	6 9/16 167	5 15/16 150.8	4 3/8 111	8 13/16 224	5 13/32 137	13/16 21	4 3/4 121	1 5/8 41	1 1/4 32	2 3/4 70	2.937 74.6	1.189 30.2	UCT214E-44 UCT214E	T214E	UC214-44 UC214	62.2	44.1	14.5	7.0
	2 3/4	2 3/4 70	1 1/16 27	1 7/8 48	6 9/16 167	5 15/16 150.8	4 3/8 111	9 1/8 232	5 1/2 140	13/16 21	4 3/4 121	1 5/8 41	1 1/4 32	2 3/4 70	3.063 77.8	1.331 33.3	UCTX14E-44 UCTX14E	TX14E	UCX14-44 UCX14	67.4	48.3	14.5	7.9
75	2 15/16 3	2 3/4 70	1 1/16 27	1 7/8 48	6 9/16 167	5 15/16 150.8	4 3/8 111	9 1/8 232	5 1/2 140	13/16 21	4 3/4 121	1 5/8 41	1 1/4 32	2 3/4 70	3.063 77.8	1.331 33.3	UCT215E-47 UCT215E UCT215E-48	T215E	UC215-47 UC215 UC215-48	67.4	48.3	14.5	7.3
	2 15/16 3	2 3/4 70	1 1/16 27	1 7/8 48	7 1/4 184	6 1/2 165	4 3/8 111	9 1/4 235	5 1/2 140	13/16 21	4 3/4 121	1 5/8 41	1 1/4 32	2 3/4 70	3.252 82.6	1.311 33.3	UCTX15E-47 UCTX15E UCTX15E-48	TX15E	UCX15-47 UCX15 UCX15-48	72.7	53.0	14.6	8.7
80	3 1/8	2 3/4 70	1 1/16 27	2 51	7 1/4 184	6 1/2 165	4 3/8 111	9 1/4 235	5 1/2 140	13/16 21	4 3/4 121	1 5/8 41	1 1/4 32	2 3/4 70	3.252 82.6	1.311 33.3	UCT216E-50 UCT216E	T216E	UC216-50 UC216	72.7	53.0	14.6	8.2
	–	3 1/2 89	1 13/16 46	2 11/16 68	7 25/32 198	6 13/16 173	4 7/8 124	10 1/4 260	6 3/8 162	1 3/32 28	6 3/16 157	1 7/8 48	1 1/2 38	2 7/8 73	3.374 85.7	1.343 34.1	UCTX16E	TX16E	UCX16	84.0	61.9	14.5	12.4
85	3 1/4	3 1/2 89	1 13/16 46	2 11/16 68	7 25/32 198	6 13/16 173	4 7/8 124	10 1/4 260	6 3/8 162	1 5/32 29	6 3/16 157	1 7/8 48	1 1/2 38	2 7/8 73	3.374 85.7	1.343 34.1	UCT217E-52 UCT217E	T217E	UC217-52 UC217	84.0	61.9	14.5	12.1
	3 7/16	3 1/2 89	1 13/16 46	2 11/16 68	7 25/32 198	6 13/16 173	4 7/8 124	10 1/4 260	6 3/8 162	1 3/32 28	6 3/16 157	1 7/8 48	1 1/2 38	2 7/8 73	3.780 96	1.563 39.7	UCTX17E UCTX17E-55	TX17E	UCX17 UCX17-55	96.1	71.5	14.5	13.3

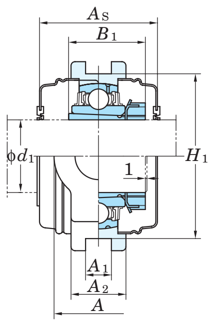
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
B-1/4-28UNF .... 201~210, X05~X09, 305~308
B-PT1/8 .... 211~217, X10~X17, 309~328
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (L2) follows the Part No. of unit or bearing. (Example of Part No. : UCT206EL3, UC206L3)
4. As for the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UKT
Tapered bore (with adapter)
d_1 20 ~ (50) mm

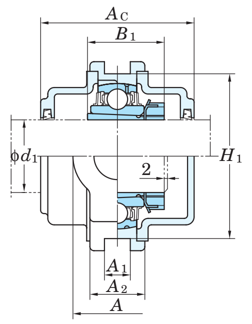




With Pressed Steel Cover



With Cast Iron Cover

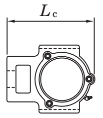


Variations of tolerance of groove width ($\varDelta_{A1s}$), variations of tolerance of distance between both grooves ($\varDelta_{H1s}$), and tolerance of symmetry of both groove sides (X)

Unit : mm

Housing No.			$\varDelta_{A1s}$	$\varDelta_{H1s}$	X
T205~T210	TX05~TX10	T305~T310	+0.2 0	0 –0.5	0.5
T211~T217	TX11~TX17	T311~T318	+0.3 0	0 –0.8	0.6
		T319~T322			0.7
		T324~T328			0.8

Form and dimension of L_c of T205JE3 (housing with cast iron cover) are shown below.



T205JE3 L_c = 102 mm

Shaft Dia.		Dimensions														Standard					Basic Load Ratings		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm	inch	inch mm														Unit No.	Housing No.	Bearing No.	Adapter 1) No.	Mass	kN			Unit No.		Dimension		Mass	Unit No.		Dimension		Mass
d_1		A	A_1	A_2	H	H_1	H_2	L	L_1	L_2	L_3	N	N_1	N_2	B_1 1)					kg	C_r	C_{0r}	f_0	Open Type	One Side Closed Type	mm A_s	inch	kg	Open Type	One Side Closed Type	mm A_c	inch	kg
20	3/4	1 1/4 32	15/32 12	15/16 24	3 1/2 89	2 63/64 76	2 51	3 13/16 97	2 7/16 62	13/32 10	2 51	3/4 19	5/8 16	1 1/4 32	1 5/32(1 3/8) 29(35)	**UKT205**	T205	UK205	HE305X(HE2305X) H305X(H2305X)	0.88 0.88	14.0	7.85	13.9	– UKT205C	– UKT205CD	– 48	– 1 7/8	– 0.88	– UKT205FC	– UKT205FCD	– 66	– 2 19/32	– 1.3
	3/4	1 15/32 37	15/32 12	1 3/32 28	4 1/32 102	3 1/2 89	2 7/32 56	4 7/16 113	2 3/4 70	13/32 10	2 1/4 57	7/8 22	5/8 16	1 15/32 37	1 3/8 35	**UKTX05**	TX05	UKX05	HE2305X H2305X	1.3 1.3	19.5	11.3	13.9	– UKTX05C	– UKTX05CD	– 52	– 2 1/16	– 1.3	– –	– –	– –	– –	– –
	3/4	1 13/32 36	15/32 12	1 1/32 26	3 1/2 89	3 5/32 80	2 7/16 62	4 13/16 122	3 76	15/32 12	2 9/16 65	1 1/32 26	5/8 16	1 13/32 36	1 3/8 35	**UKT305**	T305	UK305	HE2305X H2305X	1.5 1.5	21.2	10.9	12.6	– –	– –	– –	– –	– –	– UKT305C	– UKT305CD	– 76	– 3	– 2.1
25	 1	1 15/32 37	15/32 12	1 3/32 28	4 1/32 102	3 1/2 89	2 7/32 56	4 7/16 113	2 3/4 70	13/32 10	2 1/4 57	7/8 22	5/8 16	1 15/32 37	1 7/32(1 1/2) 31(38)	**UKT206**	T206	UK206	H306X(H2306X) HE306X(HE2306X)	1.3 1.3	19.5	11.3	13.9	UKT206C –	UKT206CD –	52 –	2 1/16 –	1.3 –	UKT206FC –	UKT206FCD –	70 –	2 3/4 –	1.8 –
	 1	1 15/32 37	15/32 12	1 3/16 30	4 1/32 102	3 1/2 89	2 17/32 64	5 3/32 129	3 1/16 78	1/2 13	2 17/32 64	7/8 22	5/8 16	1 15/32 37	1 1/2 38	**UKTX06**	TX06	UKX06	H2306X HE2306X	1.7 1.7	25.7	15.4	13.9	UKTX06C –	UKTX06CD –	59 –	2 5/16 –	1.7 –	– –	– –	– –	– –	– –
	 1	1 5/8 41	5/8 16	1 3/32 28	3 15/16 100	3 35/64 90	2 3/4 70	5 13/32 137	3 11/32 85	9/16 14	2 29/32 74	1 3/32 28	23/32 18	1 5/8 41	1 1/2 38	**UKT306**	T306	UK306	H2306X HE2306X	1.9 1.9	26.7	15.0	13.3	– –	– –	– –	– –	– –	UKT306C –	UKT306CD –	82 –	3 7/32 –	2.5 –
30	1 1/8	1 15/32 37	15/32 12	1 3/16 30	4 1/32 102	3 1/2 89	2 17/32 64	5 3/32 129	3 1/16 78	1/2 13	2 17/32 64	7/8 22	5/8 16	1 15/32 37	1 3/8(1 11/16) 35(43)	**UKT207**	T207	UK207	HS307X(HS2307X) H307X(H2307X)	1.7 1.7	25.7	15.4	13.9	– UKT207C	– UKT207CD	– 59	– 2 5/16	– 1.7	– UKT207FC	– UKT207FCD	– 78	– 3 1/16	– 2.5
	1 1/8	1 15/16 49	5/8 16	1 13/32 36	4 1/2 114	4 1/64 102	3 9/32 83	5 21/32 144	3 15/32 88	19/32 15	3 9/32 83	1 5/32 29	3/4 19	1 15/16 49	1 11/16 43	**UKTX07**	TX07	UKX07	HS2307X H2307X	2.6 2.6	29.1	17.8	14.0	– UKTX07C	– UKTX07CD	– 68	– 2 11/16	– 2.6	– –	– –	– –	– –	– –
	1 1/8	1 25/32 45	5/8 16	1 1/4 32	4 3/8 111	3 15/16 100	2 15/16 75	5 29/32 150	3 11/16 94	19/32 15	3 5/32 80	1 3/16 30	25/32 20	1 25/32 45	1 11/16 43	**UKT307**	T307	UK307	HS2307X H2307X	2.4 2.4	33.4	19.3	13.2	– –	– –	– –	– –	– –	– UKT307C	– UKT307CD	– 88	– 3 15/32	– 3.3
35	1 1/4 1 3/8	1 15/16 49	5/8 16	1 5/16 33	4 1/2 114	4 1/64 102	3 9/32 83	5 21/32 144	3 15/32 88	5/8 16	3 9/32 83	1 5/32 29	3/4 19	1 15/16 49	1 13/32(1 13/16) 36(46)	**UKT208**	T208	UK208	HE308X(HE2308X) HS308X(HS2308X) H308X(H2308X)	2.5 2.5 2.5	29.1	17.8	14.0	– – UKT208C	– – UKT208CD	– – 68	– – 2 11/16	– – 2.5	– – UKT208FC	– – UKT208FCD	– – 86	– – 3 3/8	– – 3.4
	1 1/4 1 3/8	1 15/16 49	5/8 16	1 13/32 36	4 19/32 117	4 1/64 102	3 9/32 83	5 21/32 144	3 7/16 87	19/32 15	3 9/32 83	1 5/32 29	3/4 19	1 15/16 49	1 13/16 46	**UKTX08**	TX08	UKX08	HE2308X HS2308X H2308X	2.6 2.6 2.6	34.1	21.3	14.0	– – UKTX08C	– – UKTX08CD	– – 68	– – 2 11/16	– – 2.6	– – –	– – –	– – –	– – –	– – –
	1 1/4 1 3/8	1 31/32 50	45/64 18	1 11/32 34	4 7/8 124	4 13/32 112	3 9/32 83	6 3/8 162	3 15/16 100	21/32 17	3 1/2 89	1 1/4 32	7/8 22	1 31/32 50	1 13/16 46	**UKT308**	T308	UK308	HE2308X HS2308X H2308X	3.0 3.0 3.0	40.7	24.0	13.2	– – –	– – –	– – –	– – –	– – –	– – UKT308C	– – UKT308CD	– – 96	– – 3 25/32	– – 4.0
40	1 1/2 1 5/8	1 15/16 49	5/8 16	1 3/8 35	4 19/32 117	4 1/64 102	3 9/32 83	5 21/32 144	3 7/16 87	5/8 16	3 9/32 83	1 5/32 29	3/4 19	1 15/16 49	1 17/32(1 31/32) 39(50)	**UKT209**	T209	UK209	HE309X(HE2309X) H309X(H2309X) HS309X(HS2309X)	2.5 2.5 2.5	34.1	21.3	14.0	– UKT209C –	– UKT209CD –	– 68 –	– 2 11/16 –	– 2.5 –	– UKT209FC –	– UKT209FCD –	– 88 –	– 3 15/32 –	– 3.4 –
	1 1/2 1 5/8	1 15/16 49	5/8 16	1 1/2 38	4 19/32 117	4 1/64 102	3 9/32 83	5 7/8 149	3 17/32 90	5/8 16	3 3/8 86	1 5/32 29	3/4 19	1 15/16 49	1 31/32 50	**UKTX09**	TX09	UKX09	HE2309X H2309X HS2309X	2.9 2.9 2.9	35.1	23.3	14.4	– UKTX09C –	– UKTX09CD –	– 73 –	– 2 7/8 –	– 2.9 –	– – –	– – –	– – –	– – –	– – –
	1 1/2 1 5/8	2 5/32 55	45/64 18	1 1/2 38	5 7/16 138	4 59/64 125	3 17/32 90	7 178	4 11/32 110	23/32 18	3 13/16 97	1 11/32 34	15/16 24	2 5/32 55	1 31/32 50	**UKT309**	T309	UK309	HE2309X H2309X HS2309X	4.2 4.2 4.2	48.9	29.5	13.3	– – –	– – –	– – –	– – –	– – –	– UKT309C –	– UKT309CD –	– 102 –	– 4 1/32 –	– 5.5 –
45	1 3/4	1 15/16 49	5/8 16	1 15/32 37	4 19/32 117	4 1/64 102	3 9/32 83	5 7/8 149	3 17/32 90	5/8 16	3 3/8 86	1 5/32 29	3/4 19	1 15/16 49	1 21/32(2 5/32) 42(55)	**UKT210**	T210	UK210	HE310X(HE2310X) H310X(H2310X)	2.7 2.7	35.1	23.3	14.4	– UKT210C	– UKT210CD	– 73	– 2 7/8	– 2.7	– UKT210FC	– UKT210FCD	– 97	– 3 13/16	– 3.8
	1 3/4	2 17/32 64	55/64 22	1 21/32 42	5 3/4 146	5 1/8 130	4 1/32 102	6 23/32 171	4 3/16 106	3/4 19	3 3/4 95	1 3/8 35	31/32 25	2 17/32 64	2 5/32 55	**UKTX10**	TX10	UKX10	HE2310X H2310X	4.4 4.4	43.4	29.4	14.4	– UKTX10C	– UKTX10CD	– 75	– 2 15/16	– 4.4	– –	– –	– –	– –	– –
	1 3/4	2 13/32 61	25/32 20	1 9/16 40	5 15/16 151	5 33/64 140	3 27/32 98	7 17/32 191	4 19/32 117	25/32 20	4 3/16 106	1 15/32 37	1 1/16 27	2 13/32 61	2 5/32 55	**UKT310**	T310	UK310	HE2310X H2310X	5.0 5.0	62.0	38.3	13.2	– –	– –	– –	– –	– –	– UKT310C	– UKT310CD	– 110	– 4 11/32	– 6.7
50	1 7/8 2	2 17/32 64	55/64 22	1 1/2 38	5 3/4 146	5 1/8 130	4 1/32 102	6 23/32 171	4 3/16 106	3/4 19	3 3/4 95	1 3/8 35	31/32 25	2 17/32 64	1 25/32(2 5/16) 45(59)	**UKT211**	T211	UK211	HS311X(HS2311X) H311X(H2311X) HE311X(HE2311X)	4.1 4.1 4.1	43.4	29.4	14.4	– UKT211C –	– UKT211CD –	– 75 –	– 2 15/16 –	– 4.1 –	– UKT211FC –	– UKT211FCD –	– 99 –	– 3 29/32 –	– 5.4 –

Note 1) Codes shown in parentheses indicate the dimensions and Part No. of applicable adapter (H2300X series) for UK200L3 series (triple seal type).

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

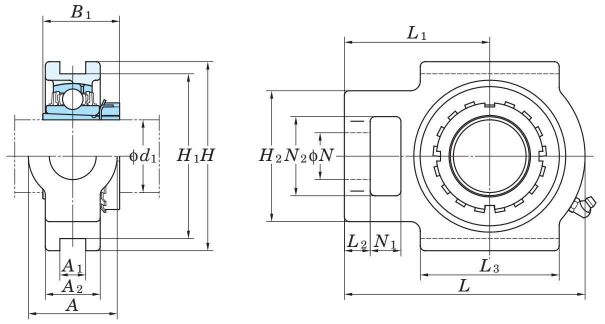
2. Part No. of applicable grease nipples are shown below.
B-1/4-28UNF........205~210, X05~X09, 305~308
B-PT1/8................211~217, X10~X17, 309~328

3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables.
(Example of Part No. : UKT206J + H306X, UK206 + H306X)

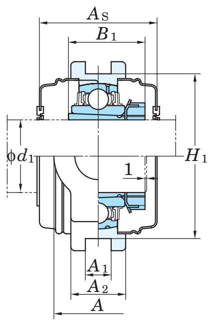
4. As for the triple seal type product (205 is the double seal type product), accessory code L3 (or L2) follows the Part No. of unit or bearing.
(Example of Part No. : UKT206JL3 + H2306X, UK206L3 + H2306X)

5. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

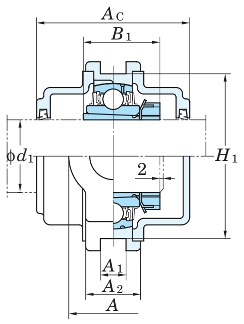
UKT
Tapered bore (with adapter)
d_1 (50) ~ 100 mm



With Pressed Steel Cover



With Cast Iron Cover

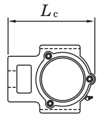


Variations of tolerance of groove width (Δ_{A1s}), variations of tolerance of distance between both grooves (Δ_{H1s}), and tolerance of symmetry of both groove sides (X)

Unit : mm

Housing No.			Δ_{A1s}	Δ_{H1s}	X
T205~T210	TX05~TX10	T305~T310	+0.2 0	0 –0.5	0.5
T211~T217	TX11~TX17	T311~T318	+0.3 0	0 –0.8	0.6
		T319~T322			0.7
		T324~T328			0.8

Form and dimension of L_c of T205JE3 (housing with cast iron cover) are shown below.



T205JE3 L_c = 102 mm

Shaft Dia.		Dimensions inch mm														Standard					Basic Load Ratings kN		Factor	With Pressed Steel Cover					With Cast Iron Cover				
d_1 mm	d_1 inch	A	A_1	A_2	H	H_1	H_2	L	L_1	L_2	L_3	N	N_1	N_2	B_1 1)	Unit No.	Housing No.	Bearing No.	Adapter 1) No.	Mass kg	C_r	C_{0r}	f_0	Unit No. Open Type	Unit No. One Side Closed Type	Dimension A_s mm	Dimension A_s inch	Mass kg	Unit No. Open Type	Unit No. One Side Closed Type	Dimension A_c mm	Dimension A_c inch	Mass kg
50	1 7/8 2	2 17/32 64	55/64 22	1 23/32 44	5 3/4 146	5 1/8 130	4 1/32 102	7 5/8 194	4 11/16 119	3/4 19	4 1/32 102	1 3/8 35	1 1/4 32	2 17/32 64	2 5/16 59	**UKTX11**	TX11	UKX11	HS2311X H2311X HE2311X	5.1 5.1 5.1	52.4	36.2	14.4	– UKTX11C –	– UKTX11CD –	– 88 –	– 3 15/32 –	– 5.1 –	– – –	– – –	– – –	– – –	– – –
	1 7/8 2	2 19/32 66	55/64 22	1 23/32 44	6 13/32 163	5 29/32 150	4 1/8 105	8 5/32 207	5 127	13/16 21	4 17/32 115	1 17/32 39	1 5/32 29	2 19/32 66	2 5/16 59	**UKT311**	T311	UK311	HS2311X H2311X HE2311X	6.4 6.4 6.4	71.6	45.0	13.2	– – –	– – –	– – –	– – –	– – –	– UKT311C –	– UKT311CD –	– 114 –	– 4 1/2 –	– 8.3 –
55	2 1/8	2 17/32 64	55/64 22	1 21/32 42	5 3/4 146	5 1/8 130	4 1/32 102	7 5/8 194	4 11/16 119	3/4 19	4 1/32 102	1 3/8 35	1 1/4 32	2 17/32 64	1 27/32(2 7/16) 47(62)	**UKT212**	T212	UK212	HS312X(HS2312X) H312X(H2313X)	4.8 4.8	52.4	36.2	14.4	– UKT212C	– UKT212CD	– 88	– 3 15/32	– 4.8	– UKT212FC	– UKT212FCD	– 114	– 4 1/2	– 6.3
	2 1/8	2 3/4 70	1 1/32 26	1 7/8 48	6 9/16 167	5 15/16 151	4 3/8 111	8 13/16 224	5 13/32 137	13/16 21	4 3/4 121	1 5/8 41	1 1/4 32	2 3/4 70	2 7/16 62	**UKTX12**	TX12	UKX12	HS2312X H2312X	7.3 7.3	57.2	40.1	14.4	– UKTX12C	– UKTX12CD	– 88	– 3 15/32	– 7.3	– –	– –	– –	– –	– –
	2 1/8	2 25/32 71	55/64 22	1 13/16 46	7 178	6 19/64 160	4 7/16 113	8 21/32 220	5 5/16 135	29/32 23	4 27/32 123	1 5/8 41	1 7/32 31	2 25/32 71	2 7/16 62	**UKT312**	T312	UK312	HS2312X H2312X	7.5 7.5	81.9	52.2	13.2	– –	– –	– –	– –	– –	– UKT312C	– UKT312CD	– 124	– 4 7/8	– 9.9
60	2 1/4 2 3/8	2 3/4 70	1 1/32 26	1 23/32 44	6 9/16 167	5 15/16 151	4 3/8 111	8 13/16 224	5 13/32 137	13/16 21	4 3/4 121	1 5/8 41	1 1/4 32	2 3/4 70	1 31/32(2 9/16) 50(65)	**UKT213**	T213	UK213	HE313X(HE2313X) H313X(H2313X) HS313X(HS2313X)	6.8 6.8 6.8	57.2	40.1	14.4	– UKT213C –	– UKT213CD –	– 88 –	– 3 15/32 –	– 6.8 –	– UKT213FC –	– UKT213FCD –	– 114 –	– 4 1/2 –	– 8.5 –
	2 1/4 2 3/8	2 3/4 70	1 1/32 26	1 7/8 48	6 9/16 167	5 15/16 151	4 3/8 111	8 13/16 224	5 13/32 137	13/16 21	4 3/4 121	1 5/8 41	1 1/4 32	2 3/4 70	2 9/16 65	**UKTX13**	TX13	UKX13	HE2313X H2313X HS2313X	7.2 7.2 7.2	62.2	44.1	14.5	– UKTX13C –	– UKTX13CD –	– 98 –	– 3 27/32 –	– 7.2 –	– – –	– – –	– – –	– – –	– – –
	2 1/4 2 3/8	3 5/32 80	1 1/32 26	1 31/32 50	7 15/32 190	6 11/16 170	4 9/16 116	9 3/8 238	5 3/4 146	31/32 25	5 9/32 134	1 11/16 43	1 1/4 32	2 3/4 70	2 9/16 65	**UKT313**	T313	UK313	HE2313X H2313X HS2313X	9.4 9.4 9.4	92.7	59.9	13.2	– – –	– – –	– – –	– – –	– – –	– UKT313C –	– UKT313CD –	– 122 –	– 4 13/16 –	– 11.6 –
65	2 1/2	2 3/4 70	1 1/32 26	1 13/16 48	6 9/16 167	5 15/16 151	4 3/8 111	8 13/16 232	5 13/32 140	13/16 21	4 3/4 121	1 5/8 41	1 1/4 32	2 3/4 70	2 5/32(2 7/8) 55(73)	**UKT215**	T215	UK215	HE315X(HE2315X) H315X(H2315X)	7.4 7.4	67.4	48.3	14.5	– UKT215C	– UKT215CD	– 98	– 3 27/32	– 7.4	– UKT215FC	– UKT215FCD	– 124	– 4 7/8	– 9.4
	2 1/2	2 3/4 70	1 7/64 28	1 7/8 48	7 1/4 184	6 1/2 165	4 3/8 111	9 1/4 235	5 1/2 140	13/16 21	4 3/4 121	1 5/8 41	1 1/4 32	2 3/4 70	2 7/8 73	**UKTX15**	TX15	UKX15	HE2315X H2315X	8.4 8.4	72.7	53.0	14.6	– UKTX15C	– UKTX15CD	– 108	– 4 1/4	– 8.4	– –	– –	– –	– –	– –
	2 1/2	3 17/32 90	1 1/32 26	2 5/32 55	8 1/2 216	7 9/16 192	5 3/16 132	10 5/16 262	6 5/16 160	31/32 25	5 29/32 150	1 13/16 46	1 13/32 36	3 11/32 85	2 7/8 73	**UKT315**	T315	UK315	HE2315X H2315X	13.1 13.1	113	77.2	13.2	– –	– –	– –	– –	– –	– UKT315C	– UKT315CD	– 134	– 5 9/32	– 15.9
70	2 3/4	2 3/4 70	1 1/32 26	2 51	7 1/4 184	6 1/2 165	4 3/8 111	9 1/4 235	5 1/2 140	13/16 21	4 3/4 121	1 5/8 41	1 1/4 32	2 3/4 70	2 5/16(3 1/16) 59(78)	**UKT216**	T216	UK216	HE316X(HE2316X) H316X(H2316X)	8.5 8.5	72.7	53.0	14.6	– UKT216C	– UKT216CD	– 108	– 4 1/4	– 8.5	– UKT216FC	– UKT216FCD	– 138	– 5 7/16	– 11.0
	2 3/4	2 7/8 73	1 7/64 28	2 1/8 54	7 25/32 198	6 13/16 173	4 7/8 124	10 1/4 260	6 3/8 162	1 3/32 28	6 3/16 157	1 7/8 48	1 1/2 38	2 7/8 73	3 1/16 78	**UKTX16**	TX16	UKX16	HE2316X H2316X	11.8 11.8	84.0	61.9	14.5	– UKTX16C	– UKTX16CD	– 112	– 4 13/32	– 11.8	– –	– –	– –	– –	– –
	2 3/4	4 1/32 102	1 3/16 30	2 3/8 60	9 1/16 230	8 1/32 204	5 29/32 150	11 3/32 282	6 27/32 174	1 3/32 28	6 5/16 160	2 3/32 53	1 21/32 42	3 27/32 98	3 1/16 78	**UKT316**	T316	UK316	HE2316X H2316X	16.3 16.3	123	86.7	13.3	– –	– –	– –	– –	– –	– UKT316C	– UKT316CD	– 138	– 5 7/16	– 19.4
75	3	2 7/8 73	1 3/16 30	2 1/8 54	7 25/32 198	6 13/16 173	4 7/8 124	10 1/4 260	6 3/8 162	1 5/32 29	6 3/16 157	1 7/8 48	1 1/2 38	2 7/8 73	2 15/32(3 7/32) 63(82)	**UKT217**	T217	UK217	H317X(H2317X) HE317X(HE2317X)	11.2 11.2	84.0	61.9	14.5	UKT217C –	UKT217CD –	112 –	4 13/32 –	11.2 –	UKT217FC –	UKT217FCD –	142 –	5 19/32 –	14.0 –
	3	2 7/8 73	1 7/64 28	2 1/8 54	7 25/32 198	6 13/16 173	4 7/8 124	10 1/4 260	6 3/8 162	1 3/32 28	6 3/16 157	1 7/8 48	1 1/2 38	2 7/8 73	3 7/32 82	**UKTX17**	TX17	UKX17	H2317X HE2317X	11.4 11.4	96.1	71.5	14.5	UKTX17C –	UKTX17CD –	122 –	4 13/16 –	11.4 –	– –	– –	– –	– –	– –
	3	4 1/32 102	1 17/64 32	2 17/32 64	9 7/16 240	8 27/64 214	5 31/32 152	11 23/32 298	7 7/32 183	1 3/16 30	6 11/16 170	2 3/32 53	1 21/32 42	3 27/32 98	3 7/32 82	**UKT317**	T317	UK317	H2317X HE2317X	18.9 18.9	133	96.8	13.3	– –	– –	– –	– –	– –	UKT317C –	UKT317CD –	146 –	5 3/4 –	22.4 –
80	–	4 11/32 110	1 17/64 32	2 19/32 66	10 1/32 255	8 31/32 228	6 5/16 160	12 9/32 312	7 9/16 192	1 3/16 30	6 7/8 175	2 1/4 57	1 13/16 46	4 3/16 106	3 3/8 86	**UKT318**	T318	UK318	H2318X	21.7	143	107	13.3	–	–	–	–	–	UKT318C	UKT318CD	150	5 29/32	25.9
85	3 1/4	4 11/32 110	1 3/8 35	2 27/32 72	10 5/8 270	9 29/64 240	6 1/2 165	12 11/16 322	7 3/4 197	1 7/32 31	7 3/32 180	2 1/4 57	1 13/16 46	4 3/16 106	3 17/32 90	**UKT319**	T319	UK319	HE2319X H2319X	25.2 25.2	153	119	13.3	– –	– –	– –	– –	– –	– UKT319C	– UKT319CD	– 162	– 6 3/8	– 29.9
90	3 1/2	4 23/32 120	1 3/8 35	2 15/16 75	11 13/32 290	10 15/64 260	6 7/8 175	13 19/32 345	8 9/32 210	1 1/4 32	7 7/8 200	2 5/16 59	1 7/8 48	4 17/32 115	3 13/16 97	**UKT320**	T320	UK320	HE2320X H2320X	30.4 30.4	173	141	13.2	– –	– –	– –	– –	– –	– UKT320C	– UKT320CD	– 174	– 6 27/32	– 36.6
100	4	5 1/8 130	1 1/2 38	3 5/32 80	12 19/32 320	11 7/32 285	7 9/32 185	15 5/32 385	9 1/4 235	1 1/2 38	8 15/32 215	2 9/16 65	2 1/16 52	4 29/32 125	4 1/8 105	**UKT322**	T322	UK322	H2322X HE2322X	39.5 39.5	205	180	13.2	– –	– –	– –	– –	– –	UKT322C –	UKT322CD –	188 –	7 13/32 –	46.4 –

Note 1) Codes shown in parentheses indicate the dimensions and Part No. of applicable adapter (H2300X series) for UK200L3 series (triple seal type).

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

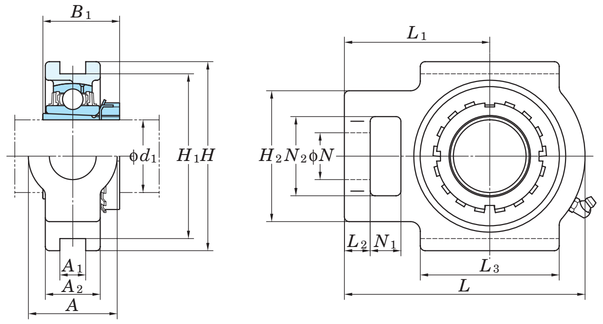
2. Part No. of applicable grease nipples are shown below.
B-1/4-28UNF........205~210, X05~X09, 305~308
B-PT1/8................211~217, X10~X17, 309~328

3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables.
(Example of Part No. : UKT206J + H306X, UK206 + H306X)

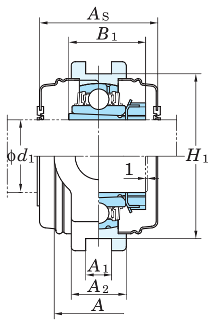
4. As for the triple seal type product (205 is the double seal type product), accessory code L3 (or L2) follows the Part No. of unit or bearing.
(Example of Part No. : UKT206JL3 + H2306X, UK206L3 + H2306X)

5. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

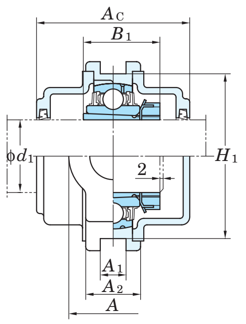
UKT
Tapered bore (with adapter)
d_1 110 ~ 125 mm



With Pressed Steel Cover



With Cast Iron Cover

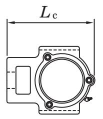


Variations of tolerance of groove width ($\varDelta_{A1s}$), variations of tolerance of distance between both grooves ($\varDelta_{H1s}$), and tolerance of symmetry of both groove sides (X)

Unit : mm

Housing No.			$\varDelta_{A1s}$	$\varDelta_{H1s}$	X
T205~T210	TX05~TX10	T305~T310	+0.2 0	0 –0.5	0.5
T211~T217	TX11~TX17	T311~T318	+0.3 0	0 –0.8	0.6
		T319~T322			0.7
		T324~T328			0.8

Form and dimension of L_c of T205JE3 (housing with cast iron cover) are shown below.



T205JE3 L_c = 102 mm

Shaft Dia. d_1 mm	Shaft Dia. d_1 inch	Dimensions inch / mm A	A_1	A_2	H	H_1	H_2	L	L_1	L_2	L_3	N	N_1	N_2	B_1 1)	Standard Unit No.	Housing No.	Bearing No.	Adapter 1) No.	Mass kg	Basic Load Ratings kN C_r	C_{0r}	Factor f_0	With Pressed Steel Cover Unit No. Open Type	One Side Closed Type	Dimension A_s mm	A_s inch	Mass kg	With Cast Iron Cover Unit No. Open Type	One Side Closed Type	Dimension A_c mm	A_c inch	Mass kg
110	–	5 1/2 140	1 49/64 45	3 17/32 90	13 31/32 355	12 9/32 320	8 9/32 210	17 432	10 1/2 267	1 21/32 42	9 1/16 230	2 3/4 70	2 3/8 60	5 1/2 140	4 13/32 112	**UKT324**	T324	UK324	H2324	54.7	207	185	13.5	–	–	–	–	–	UKT324C	UKT324CD	196	7 23/32	65.0
115	4 1/2	5 29/32 150	1 31/32 50	3 15/16 100	15 5/32 385	13 25/32 350	8 21/32 220	18 5/16 465	11 7/32 285	1 25/32 45	9 7/16 240	2 15/16 75	2 9/16 65	5 29/32 150	4 3/4 121	**UKT326**	T326	UK326	HE2326 H2326	69.1 69.1	229	214	13.6	– –	– –	– –	– –	– –	– UKT326C	– UKT326CD	– 214	– 8 7/16	– 82.4
125	–	6 3/32 155	1 31/32 50	3 15/16 100	16 11/32 415	14 61/64 380	9 1/16 230	20 9/32 515	12 13/32 315	1 31/32 50	10 1/32 255	3 5/32 80	2 3/4 70	6 5/16 160	5 5/32 131	**UKT328**	T328	UK328	H2328	85.1	253	246	13.6	–	–	–	–	–	UKT328C	UKT328CD	222	8 3/4	102

Note 1) Codes shown in parentheses indicate the dimensions and Part No. of applicable adapter (H2300X series) for UK200L3 series (triple seal type).

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

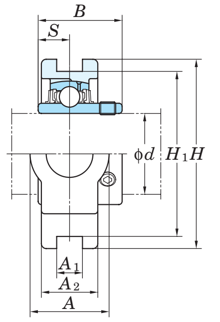
2. Part No. of applicable grease nipples are shown below.
B-1/4-28UNF........205~210, X05~X09, 305~308
B-PT1/8................211~217, X10~X17, 309~328

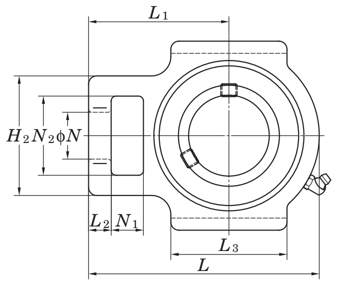
3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables. (Example of Part No. : UKT206J + H306X, UK206 + H306X)

4. As for the triple seal type product (205 is the double seal type product), accessory code L3 (or L2) follows the Part No. of unit or bearing. (Example of Part No. : UKT206JL3 + H2306X, UK206L3 + H2306X)

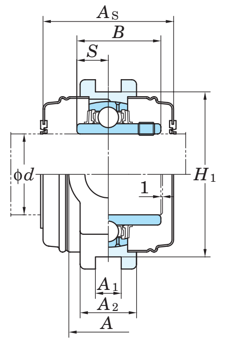
5. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

UCST-H1S6
Cylindrical bore (with set screws)
d 20 ~ 50 mm





With Pressed Stainless Steel Cover



Variations of tolerance of groove width (Δ_{A1s}), variations of tolerance of distance between both grooves (Δ_{H1s}), and tolerance of symmetry of both groove sides (X)

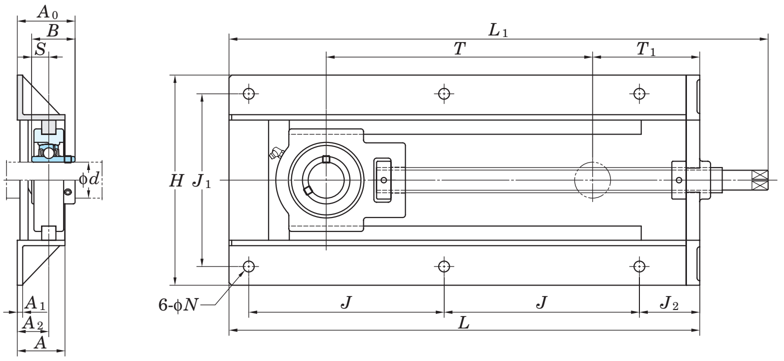
Unit : mm

Housing No.	Δ_{A1s}	Δ_{H1s}	X
ST204H1~ST210H1	+0.2 0	0 −0.5	0.5

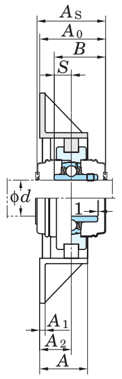
Shaft Dia. mm	Dimensions inch mm															Standard Unit No.	Housing No.	Bearing No.	Mass	Basic Load Ratings kN		Factor	With Pressed Stainless Steel Cover Unit No.		Dimension		Mass
d	A	A_1	A_2	H	H_1	H_2	L	L_1	L_2	L_3	N	N_1	N_2	B	S				kg	C_r	C_{0r}	f_0	Open Type	One Side Closed Type	A_s mm	A_s inch	kg
20	1 1/4 32	15/32 12	29/32 23	3 1/2 89	2 63/64 76	1 13/16 46	3 1/2 89	2 5/16 59	11/32 9	1 23/32 44	3/4 19	23/32 18	1 1/4 32	1.220 31	0.500 12.7	**UCST204H1S6**	ST204H1	UC204S6	0.73	10.9	5.35	13.2	UCST204H1CS6	UCST204H1CDS6	45	1 25/32	0.73
25	1 1/4 32	15/32 12	31/32 25	3 1/2 89	2 63/64 76	1 13/16 46	3 21/32 93	2 3/8 60	11/32 9	1 23/32 44	3/4 19	23/32 18	1 1/4 32	1.343 34.1	0.563 14.3	**UCST205H1S6**	ST205H1	UC205S6	0.79	11.9	6.3	13.9	UCST205H1CS6	UCST205H1CDS6	49	1 15/16	0.79
30	1 15/32 37	15/32 12	1 1/16 27	4 1/32 102	3 1/2 89	2 1/16 52	4 3/16 106	2 5/8 67	11/32 9	1 31/32 50	7/8 22	23/32 18	1 15/32 37	1.500 38.1	0.626 15.9	**UCST206H1S6**	ST206H1	UC206S6	1.1	16.5	9.05	13.9	UCST206H1CS6	UCST206H1CDS6	53	2 3/32	1.1
35	1 15/32 37	15/32 12	1 7/32 31	4 1/32 102	3 1/2 89	2 7/32 56	4 11/16 119	2 15/16 75	7/16 11	2 7/32 56	7/8 22	23/32 18	1 15/32 37	1.689 42.9	0.689 17.5	**UCST207H1S6**	ST207H1	UC207S6	1.5	21.8	12.3	13.9	UCST207H1CS6	UCST207H1CDS6	60	2 3/8	1.5
40	1 15/16 49	5/8 16	1 1/4 32	4 1/2 114	4 1/64 102	2 29/32 74	5 5/16 135	3 11/32 85	9/16 14	2 17/32 64	1 5/32 29	25/32 20	1 15/16 49	1.937 49.2	0.748 19	**UCST208H1S6**	ST208H1	UC208S6	2	24.8	14.3	14.0	UCST208H1CS6	UCST208H1CDS6	69	2 23/32	2
45	1 15/16 49	5/8 16	1 11/32 34	4 19/32 117	4 1/64 102	2 29/32 74	5 13/32 137	3 11/32 85	9/16 14	2 19/32 66	1 5/32 29	25/32 20	1 15/16 49	1.937 49.2	0.748 19	**UCST209H1S6**	ST209H1	UC209S6	2.1	27.8	16.2	14.0	UCST209H1CS6	UCST209H1CDS6	69	2 23/32	2.1
50	1 15/16 49	5/8 16	1 3/8 35	4 19/32 117	4 1/64 102	2 29/32 74	5 5/8 143	3 7/16 87	9/16 14	2 27/32 72	1 5/32 29	25/32 20	1 15/16 49	2.031 51.6	0.748 19	**UCST210H1S6**	ST210H1	UC210S6	2.3	29.8	18.6	14.4	UCST210H1CS6	UCST210H1CDS6	74	2 29/32	2.3

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter codes. (See **Table 10.5** in P.42.)
2. Part No. of the applicable grease nipple is A-1/4-28UNFN12.
3. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

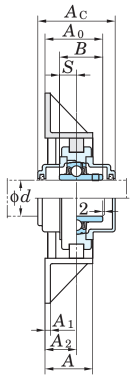
UCTH
Cylindrical bore (with set screws)
d 12 ~ 65 mm



With Pressed Steel Cover



With Cast Iron Cover



Variations of tolerance of distance between centers of bolt holes ($\varDelta_{Js}$, $\varDelta_{J1s}$)

Unit : mm

Nominal unit code	$\varDelta_{Js}$	$\varDelta_{J1s}$
UCTH201~UCTH213	±0.5	±0.5

Shaft Dia.		Dimensions															Bolt Size	Standard			Basic Load Ratings		Factor	With Pressed Steel Cover					With Cast Iron Cover				
mm	inch	inch mm															inch mm	Unit No.	Bearing No.	Mass	kN			Unit No.		Dimension		Mass	Unit No.		Dimension		Mass
d		H	L	L_1	A	J	J_1	J_2	N	T	T_1	A_1	A_2	A_0	B	S				kg	C_r	C_{0r}	f_0	Open Type	One Side Closed Type	mm A_s	inch	kg	Open Type	One Side Closed Type	mm A_c	inch	kg
12		7 7/8 200	12 17/32 318	14 13/16 376	1 31/32 50	4 39/64 117	6 1/16 154	2 9/16 65	15/32 12	5 1/32 153	3 15/32 88	1/4 6	1 7/64 28	1 13/16 46.3	1.220 31	0.500 12.7	3/8 M10	**UCTH201-150**	UC201	6.7	12.8	6.65	13.2	UCTH201C-150	UCTH201CD-150	44	1 23/32	6.7	–	–	–	–	–
	1/2																	**UCTH201-8-150**	UC201-8	6.7				–	–	–	–	–	–	–	–	–	–
15																		**UCTH202-150**	UC202	6.7				UCTH202C-150	UCTH202CD-150	44	1 23/32	6.7	–	–	–	–	–
	5/8																	**UCTH202-10-150**	UC202-10	6.7				–	–	–	–	–	–	–	–	–	–
17																		**UCTH203-150**	UC203	6.7				UCTH203C-150	UCTH203CD-150	44	1 23/32	6.7	–	–	–	–	–
	3/4																	**UCTH204-12-150**	UC204-12	6.7				–	–	–	–	–	–	–	–	–	–
20																		**UCTH204-150**	UC204	6.7				UCTH204C-150	UCTH204CD-150	44	1 23/32	6.7	UCTH204FC-150	UCTH204FCD-150	62	2 7/16	7.0
	7/8	7 7/8 200	12 17/32 318	14 27/32 377	1 31/32 50	4 39/64 117	6 1/16 154	2 9/16 65	15/32 12	5 31/32 152	3 15/32 88	1/4 6	1 7/64 28	1 7/8 47.8	1.343 34.1	0.563 14.3	3/8 M10	**UCTH205-14-150**	UC205-14	6.7	14.0	7.85	13.9	–	–	–	–	–	–	–	–	–	–
	15/16																	**UCTH205-15-150**	UC205-15	6.7				–	–	–	–	–	–	–	–	–	–
25																		**UCTH205-150**	UC205	6.7				UCTH205C-150	UCTH205CD-150	48	1 7/8	6.7	UCTH205FC-150	UCTH205FCD-150	66	2 19/32	7.1
	1																	**UCTH205-16-150**	UC205-16	6.7				–	–	–	–	–	–	–	–	–	–
	1 1/8	8 3/8 213	13 7/32 336	16 1/32 407	1 31/32 50	4 31/32 126	6 17/32 166	2 9/16 65	15/32 12	5 5/8 143	3 15/16 100	1/4 6	1 17/64 32	2 1/8 54.2	1.500 38.1	0.626 15.9	3/8 M10	**UCTH206-18-150**	UC206-18	8.0	19.5	11.3	13.9	–	–	–	–	–	–	–	–	–	–
30																		**UCTH206-150**	UC206	8.0				UCTH206C-150	UCTH206CD-150	52	2 1/16	8.0	UCTH206FC-150	UCTH206FCD-150	70	2 3/4	8.5
	1 3/16																	**UCTH206-19-150**	UC206-19	8.0				–	–	–	–	–	–	–	–	–	–
	1 1/4																	**UCTH206-20-150**	UC206-20	8.0				–	–	–	–	–	–	–	–	–	–
	1 1/4	8 3/8 213	16 15/16 430	19 11/16 500	1 31/32 50	6 13/16 173	6 17/32 166	2 9/16 65	15/32 12	8 5/8 219	4 7/32 107	1/4 6	1 17/64 32	2 1/4 57.4	1.689 42.9	0.689 17.5	3/8 M10	**UCTH207-20-230**	UC207-20	10.5	3	15.4	13.9	–	–	–	–	–	–	–	–	–	–
	1 5/16																	**UCTH207-21-230**	UC207-21	10.5				–	–	–	–	–	–	–	–	–	–
	1 3/8																	**UCTH207-22-230**	UC207-22	10.5				–	–	–	–	–	–	–	–	–	–
35																		**UCTH207-230**	UC207	10.5				UCTH207C-230	UCTH207CD-230	59	2 5/16	10.5	UCTH207FC-230	UCTH207FCD-230	78	3 1/16	11.2
	1 7/16																	**UCTH207-23-230**	UC207-23	10.5				–	–	–	–	–	–	–	–	–	–
	1 1/2	9 7/32 234	20 19/32 523	23 19/32 599	1 31/32 50	8 35/64 217	7 9/16 192	2 5/8 67	15/32 12	11 21/32 296	4 11/16 119	1/4 6	1 3/8 35	2 9/16 65.2	1.937 49.2	0.748 19	3/8 M10	**UCTH208-24-300**	UC208-24	12.5	29.1	17.8	14.0	–	–	–	–	–	–	–	–	–	–
	1 9/16																	**UCTH208-25-300**	UC208-25	12.5				–	–	–	–	–	–	–	–	–	–
40																		**UCTH208-300**	UC208	12.5				UCTH208C-300	UCTH208CD-300	68	2 11/16	12.5	UCTH208FC-300	UCTH208FCD-300	86	3 3/8	13.3
	1 5/8	9 7/32 234	20 19/32 523	23 17/32 598	1 31/32 50	8 35/64 217	7 9/16 192	2 5/8 67	15/32 12	11 11/16 297	4 21/32 118	1/4 6	1 3/8 35	2 9/16 65.2	1.937 49.2	0.748 19	3/8 M10	**UCTH209-26-300**	UC209-26	12.4	34.1	21.3	14.0	–	–	–	–	–	–	–	–	–	–
	1 11/16																	**UCTH209-27-300**	UC209-27	12.4				–	–	–	–	–	–	–	–	–	–
	1 3/4																	**UCTH209-28-300**	UC209-28	12.4				–	–	–	–	–	–	–	–	–	–
45																		**UCTH209-300**	UC209	12.4				UCTH209C-300	UCTH209CD-300	68	2 11/16	12.4	UCTH209FC-300	UCTH209FCD-300	88	3 15/32	13.2
	1 7/8	9 7/32 234	20 3/4 527	23 3/4 603	1 31/32 50	8 5/8 219	7 9/16 192	2 5/8 67	19/32 15	11 21/32 296	4 3/4 121	1/4 6	1 3/8 35	2 21/32 67.6	2.031 51.6	0.748 19	7/16 M12	**UCTH210-30-300**	UC210-30	12.6	35.1	23.3	14.4	–	–	–	–	–	–	–	–	–	–
	1 15/16																	**UCTH210-31-300**	UC210-31	12.6				–	–	–	–	–	–	–	–	–	–
50																		**UCTH210-300**	UC210	12.6				UCTH210C-300	UCTH210CD-300	73	2 7/8	12.6	UCTH210FC-300	UCTH210FCD-300	97	3 13/16	13.6
	2																	**UCTH210-32-300**	UC210-32	12.6				–	–	–	–	–	–	–	–	–	–
	2	11 31/32 304	21 15/32 545	24 3/4 629	2 9/16 65	9 1/16 230	9 7/16 240	2 15/32 63	19/32 15	11 15/32 291	5 9/16 141	1/4 6	1 1/2 38	2 13/16 71.4	2.189 55.6	0.874 22.2	7/16 M12	**UCTH211-32-300**	UC211-32	20.1	43.4	29.4	14.4	–	–	–	–	–	–	–	–	–	–
	2 1/8																	**UCTH211-34-300**	UC211-34	20.1				–	–	–	–	–	–	–	–	–	–
55																		**UCTH211-300**	UC211	20.1				UCTH211C-300	UCTH211CD-300	75	2 15/16	20.1	UCTH211FC-300	UCTH211FCD-300	99	3 29/32	21.3
	2 3/16																	**UCTH211-35-300**	UC211-35	20.1				–	–	–	–	–	–	–	–	–	–
	2 1/4	11 31/32 304	22 15/32 571	25 5/8 651	2 9/16 65	9 9/16 243	9 7/16 240	2 15/32 63	19/32 15	11 11/32 288	6 1/16 154	1/4 6	1 1/2 38	3 1/16 77.7	2.563 65.1	1.000 25.4	7/16 M12	**UCTH212-36-300**	UC212-36	21.4	52.4	36.2	14.4	–	–	–	–	–	–	–	–	–	–
60																		**UCTH212-300**	UC212	21.4				UCTH212C-300	UCTH212CD-300	88	3 15/32	21.4	UCTH212FC-300	UCTH212FCD-300	114	4 1/2	21.9
	2 3/8																	**UCTH212-38-300**	UC212-38	21.4				–	–	–	–	–	–	–	–	–	–
	2 7/16																	**UCTH212-39-300**	UC212-39	21.4				–	–	–	–	–	–	–	–	–	–
	2 1/2	13 1/16 332	23 31/32 609	28 1/16 713	2 9/16 65	10 15/64 260	10 15/64 260	2 5/8 67	19/32 15	11 13/16 300	7 178	1/4 6	1 11/16 43	3 1/4 82.7	2.563 65.1	1.000 25.4	7/16 M12	**UCTH213-40-300**	UC213-40	25.5	57.2	40.1	14.4	–	–	–	–	–	–	–	–	–	–
65																		**UCTH213-300**	UC213	25.5				UCTH213C-300	UCTH213CD-300	88	3 15/32	25.5	UCTH213FC-300	UCTH213FCD-300	114	4 1/2	27.2

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)

2. Part No. of applicable grease nipples are shown below.
B-1/4-28UNF .... 201~210
B-PT1/8 .... 211~213

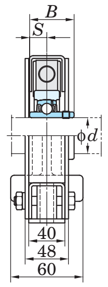
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (or L2) follows the Part No. of unit or bearing. (Example of Part No. : UCTH206JL3-150, UC206L3)

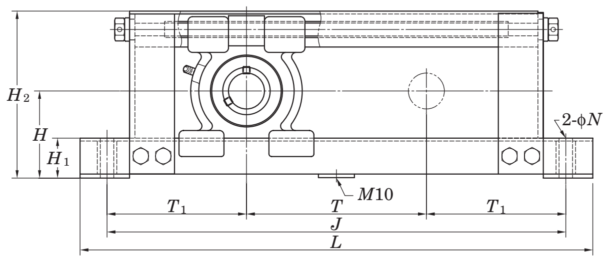
4. If heavy load ($P_r/C_r > 0.12$), vibration, or impact occurs, contact with FYH.

5. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

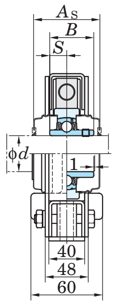
6. Tapered bore (with adapter) type products are also available.
(Example of Part No. : UKTH205J-150 + H305X, UK205 + H305X)

UCTL
Cylindrical bore (with set screws)
d 20 ~ 45 mm

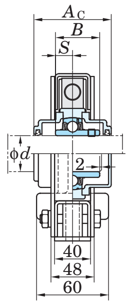




With Pressed Steel Cover



With Cast Iron Cover



Variations of tolerance of distance from mounting bottom to center of spherical bore ($\varDelta_{Hs}$) and variations of tolerance of distance between centers of bolt holes ($\varDelta_{Js}$)

Unit : mm

Nominal unit code	$\varDelta_{Hs}$	$\varDelta_{Js}$
UCTL204~207	±2	±0.5
UCTL208, 209		±0.8

Shaft Dia. mm	Dimensions mm										Bolt Size mm	Standard			Basic Load Ratings kN		Factor	With Pressed Steel Cover				With Cast Iron Cover			
												Unit No.	Bearing No.	Mass				Unit No.		Dimension mm	Mass	Unit No.		Dimension mm	Mass
d	H	H_1	H_2	L	J	N	T	T_1	B	S				kg	C_r	C_{0r}	f_0	Open Type	One Side Closed Type	A_s	kg	Open Type	One Side Closed Type	A_c	kg
20	77	44	146	430	370	15	100	135	31	12.7	M12	**UCTL204-100**	UC204	6.0	12.8	6.65	13.2	UCTL204C-100	UCTL204CD-100	44	6.0	UCTL204FC-100	UCTL204FCD-100	62	6.5
	77	44	146	530	470	15	200	135	31	12.7	M12	**UCTL204-200**	UC204	7.0	12.8	6.65	13.2	UCTL204C-200	UCTL204CD-200	44	7.0	UCTL204FC-200	UCTL204FCD-200	62	7.5
	77	44	146	630	570	15	300	135	31	12.7	M12	**UCTL204-300**	UC204	7.5	12.8	6.65	13.2	UCTL204C-300	UCTL204CD-300	44	7.5	UCTL204FC-300	UCTL204FCD-300	62	8.0
	77	44	146	730	670	15	400	135	31	12.7	M12	**UCTL204-400**	UC204	8.0	12.8	6.65	13.2	UCTL204C-400	UCTL204CD-400	44	8.0	UCTL204FC-400	UCTL204FCD-400	62	8.5
25	82	44	156	440	380	15	100	140	34.1	14.3	M12	**UCTL205-100**	UC205	7.0	14.0	7.85	13.9	UCTL205C-100	UCTL205CD-100	48	7.0	UCTL205FC-100	UCTL205FCD-100	66	7.5
	82	44	156	540	480	15	200	140	34.1	14.3	M12	**UCTL205-200**	UC205	7.5	14.0	7.85	13.9	UCTL205C-200	UCTL205CD-200	48	7.5	UCTL205FC-200	UCTL205FCD-200	66	8.0
	82	44	156	640	580	15	300	140	34.1	14.3	M12	**UCTL205-300**	UC205	8.0	14.0	7.85	13.9	UCTL205C-300	UCTL205CD-300	48	8.0	UCTL205FC-300	UCTL205FCD-300	66	8.5
	82	44	156	740	680	15	400	140	34.1	14.3	M12	**UCTL205-400**	UC205	9.0	14.0	7.85	13.9	UCTL205C-400	UCTL205CD-400	48	9.0	UCTL205FC-400	UCTL205FCD-400	66	9.5
30	87	44	166	450	390	15	100	145	38.1	15.9	M12	**UCTL206-100**	UC206	7.0	19.5	11.3	13.9	UCTL206C-100	UCTL206CD-100	52	7.0	UCTL206FC-100	UCTL206FCD-100	70	7.5
	87	44	166	550	490	15	200	145	38.1	15.9	M12	**UCTL206-200**	UC206	8.0	19.5	11.3	13.9	UCTL206C-200	UCTL206CD-200	52	8.0	UCTL206FC-200	UCTL206FCD-200	70	8.5
	87	44	166	650	590	15	300	145	38.1	15.9	M12	**UCTL206-300**	UC206	9.0	19.5	11.3	13.9	UCTL206C-300	UCTL206CD-300	52	9.0	UCTL206FC-300	UCTL206FCD-300	70	9.5
	87	44	166	750	690	15	400	145	38.1	15.9	M12	**UCTL206-400**	UC206	9.5	19.5	11.3	13.9	UCTL206C-400	UCTL206CD-400	52	9.5	UCTL206FC-400	UCTL206FCD-400	70	10
35	92	44	176	460	400	15	100	150	42.9	17.5	M12	**UCTL207-100**	UC207	8.0	25.7	15.4	13.9	UCTL207C-100	UCTL207CD-100	59	8.0	UCTL207FC-100	UCTL207FCD-100	78	9.0
	92	44	176	560	500	15	200	150	42.9	17.5	M12	**UCTL207-200**	UC207	8.5	25.7	15.4	13.9	UCTL207C-200	UCTL207CD-200	59	8.5	UCTL207FC-200	UCTL207FCD-200	78	9.5
	92	44	176	660	600	15	300	150	42.9	17.5	M12	**UCTL207-300**	UC207	9.0	25.7	15.4	13.9	UCTL207C-300	UCTL207CD-300	59	9.0	UCTL207FC-300	UCTL207FCD-300	78	10
	92	44	176	760	700	15	400	150	42.9	17.5	M12	**UCTL207-400**	UC207	10	25.7	15.4	13.9	UCTL207C-400	UCTL207CD-400	59	10	UCTL207FC-400	UCTL207FCD-400	78	11
40	97	44	186	470	410	15	100	155	49.2	19	M12	**UCTL208-100**	UC208	8.5	29.1	17.8	14.0	UCTL208C-100	UCTL208CD-100	68	8.5	UCTL208FC-100	UCTL208FCD-100	86	9.5
	97	44	186	570	510	15	200	155	49.2	19	M12	**UCTL208-200**	UC208	9.0	29.1	17.8	14.0	UCTL208C-200	UCTL208CD-200	68	9.0	UCTL208FC-200	UCTL208FCD-200	86	10
	97	44	186	670	610	15	300	155	49.2	19	M12	**UCTL208-300**	UC208	10	29.1	17.8	14.0	UCTL208C-300	UCTL208CD-300	68	10	UCTL208FC-300	UCTL208FCD-300	86	11
	97	44	186	770	710	15	400	155	49.2	19	M12	**UCTL208-400**	UC208	10.5	29.1	17.8	14.0	UCTL208C-400	UCTL208CD-400	68	10.5	UCTL208FC-400	UCTL208FCD-400	86	11.5
45	100	44	192	480	420	15	100	160	49.2	19	M12	**UCTL209-100**	UC209	9.0	34.1	21.3	14.0	UCTL209C-100	UCTL209CD-100	68	9.0	UCTL209FC-100	UCTL209FCD-100	88	10
	100	44	192	580	520	15	200	160	49.2	19	M12	**UCTL209-200**	UC209	9.5	34.1	21.3	14.0	UCTL209C-200	UCTL209CD-200	68	9.5	UCTL209FC-200	UCTL209FCD-200	88	10.5
	100	44	192	680	620	15	300	160	49.2	19	M12	**UCTL209-300**	UC209	10.5	34.1	21.3	14.0	UCTL209C-300	UCTL209CD-300	68	10.5	UCTL209FC-300	UCTL209FCD-300	88	11.5
	100	44	192	780	720	15	400	160	49.2	19	M12	**UCTL209-400**	UC209	11	34.1	21.3	14.0	UCTL209C-400	UCTL209CD-400	68	11	UCTL209FC-400	UCTL209FCD-400	88	12

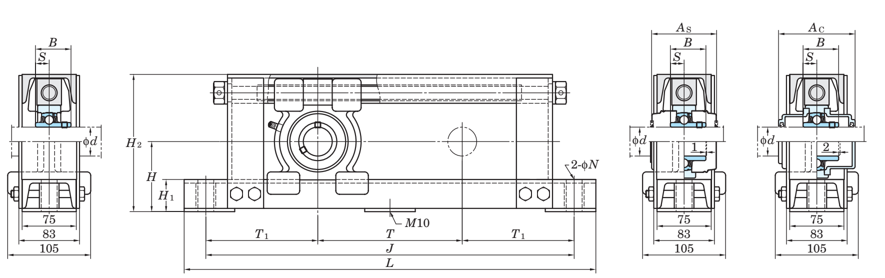
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter codes. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples is C-1/4-28UNF.
3. As for the triple seal type product (204 and 205 are the double seal type products), accessory code L3 (or L2) follows the Part No. of unit or bearing. (Example of Part No. : UCTL206JL3-100, UC206L3)
4. The unit should be mounted so that load is applied to the frame mounting surface vertically and downward.
5. If heavy load ($P_r/C_r > 0.12$), vibration, or impact occurs, contact with FYH.
6. Tapered bore (with adapter) type bearing units are also available. (Example of Part No. : UKTL206J-100 + H306X, UK206 + H306X)
7. If frame parts need to be corrosion resistant, contact with FYH.
8. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCTU
Cylindrical bore (with set screws)
d 40 ~ 80 mm

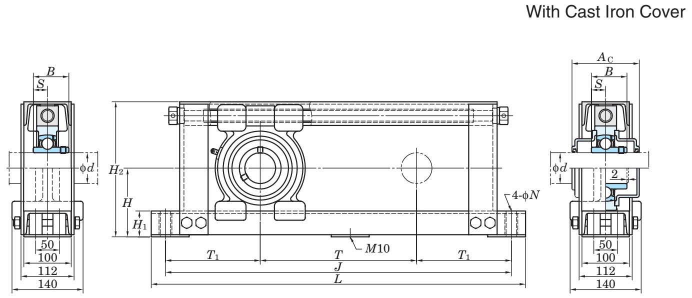
Variations of tolerance of distance from mounting bottom to center of spherical bore (Δ_{Hs}) and variations of tolerance of distance between centers of bolt holes (Δ_{Js})

Unit : mm

Nominal unit code	Δ_{Hs}	Δ_{Js}
UCTU208~212 UCTU313~315	±2	±0.8
UCTU316~318		±1.2



UCTU200



UCTU300

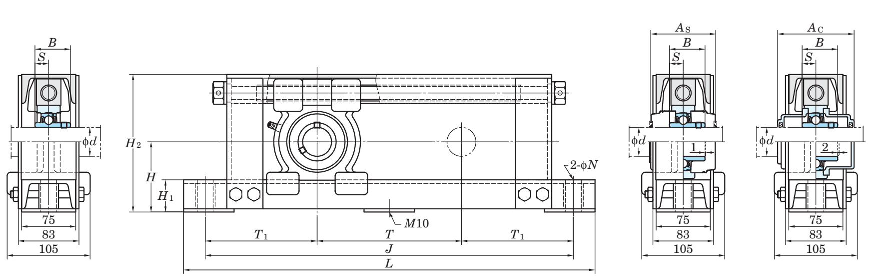
Shaft Dia. mm	Dimensions mm										Bolt Size mm	Standard Unit No.	Standard Bearing No.	Mass kg	Basic Load Ratings kN		Factor	With Pressed Steel Cover Unit No. Open Type	With Pressed Steel Cover Unit No. One Side Closed Type	Dimension mm	Mass kg	With Cast Iron Cover Unit No. Open Type	With Cast Iron Cover Unit No. One Side Closed Type	Dimension mm	Mass kg
d	H	H_1	H_2	L	J	N	T	T_1	B	S					C_r	C_{0r}	f_0			A_s				A_c	
40	97	44	190	870	810	22	500	155	49.2	19	M18	**UCTU208-500**	UC208	21	29.1	17.8	14.0	UCTU208C-500	UCTU208CD-500	68	21	UCTU208FC-500	UCTU208FCD-500	86	22
	97	44	190	970	910	22	600	155	49.2	19	M18	**UCTU208-600**	UC208	22	29.1	17.8	14.0	UCTU208C-600	UCTU208CD-600	68	22	UCTU208FC-600	UCTU208FCD-600	86	23
	97	44	190	1 070	1 010	22	700	155	49.2	19	M18	**UCTU208-700**	UC208	24	29.1	17.8	14.0	UCTU208C-700	UCTU208CD-700	68	24	UCTU208FC-700	UCTU208FCD-700	86	25
	97	44	190	1 170	1 110	22	800	155	49.2	19	M18	**UCTU208-800**	UC208	26	29.1	17.8	14.0	UCTU208C-800	UCTU208CD-800	68	26	UCTU208FC-800	UCTU208FCD-800	86	27
	97	44	190	1 270	1 210	22	900	155	49.2	19	M18	**UCTU208-900**	UC208	28	29.1	17.8	14.0	UCTU208C-900	UCTU208CD-900	68	28	UCTU208FC-900	UCTU208FCD-900	86	29
45	102	44	200	880	820	22	500	160	49.2	19	M18	**UCTU209-500**	UC209	22	34.1	21.3	14.0	UCTU209C-500	UCTU209CD-500	68	22	UCTU209FC-500	UCTU209FCD-500	88	23
	102	44	200	980	920	22	600	160	49.2	19	M18	**UCTU209-600**	UC209	24	34.1	21.3	14.0	UCTU209C-600	UCTU209CD-600	68	24	UCTU209FC-600	UCTU209FCD-600	88	25
	102	44	200	1 080	1 020	22	700	160	49.2	19	M18	**UCTU209-700**	UC209	25	34.1	21.3	14.0	UCTU209C-700	UCTU209CD-700	68	25	UCTU209FC-700	UCTU209FCD-700	88	26
	102	44	200	1 180	1 120	22	800	160	49.2	19	M18	**UCTU209-800**	UC209	27	34.1	21.3	14.0	UCTU209C-800	UCTU209CD-800	68	27	UCTU209FC-800	UCTU209FCD-800	88	28
	102	44	200	1 280	1 220	22	900	160	49.2	19	M18	**UCTU209-900**	UC209	29	34.1	21.3	14.0	UCTU209C-900	UCTU209CD-900	68	29	UCTU209FC-900	UCTU209FCD-900	88	30
50	107	44	210	890	830	22	500	165	51.6	19	M18	**UCTU210-500**	UC210	23	35.1	23.3	14.4	UCTU210C-500	UCTU210CD-500	73	23	UCTU210FC-500	UCTU210FCD-500	97	24
	107	44	210	990	930	22	600	165	51.6	19	M18	**UCTU210-600**	UC210	25	35.1	23.3	14.4	UCTU210C-600	UCTU210CD-600	73	25	UCTU210FC-600	UCTU210FCD-600	97	26
	107	44	210	1 090	1 030	22	700	165	51.6	19	M18	**UCTU210-700**	UC210	27	35.1	23.3	14.4	UCTU210C-700	UCTU210CD-700	73	27	UCTU210FC-700	UCTU210FCD-700	97	28
	107	44	210	1 190	1 130	22	800	165	51.6	19	M18	**UCTU210-800**	UC210	28	35.1	23.3	14.4	UCTU210C-800	UCTU210CD-800	73	28	UCTU210FC-800	UCTU210FCD-800	97	29
	107	44	210	1 290	1 230	22	900	165	51.6	19	M18	**UCTU210-900**	UC210	30	35.1	23.3	14.4	UCTU210C-900	UCTU210CD-900	73	30	UCTU210FC-900	UCTU210FCD-900	97	31
55	115	44	230	910	850	22	500	175	55.6	22.2	M18	**UCTU211-500**	UC211	25	43.4	29.4	14.4	UCTU211C-500	UCTU211CD-500	75	25	UCTU211FC-500	UCTU211FCD-500	99	26
	115	44	230	1 010	950	22	600	175	55.6	22.2	M18	**UCTU211-600**	UC211	27	43.4	29.4	14.4	UCTU211C-600	UCTU211CD-600	75	27	UCTU211FC-600	UCTU211FCD-600	99	28
	115	44	230	1 110	1 050	22	700	175	55.6	22.2	M18	**UCTU211-700**	UC211	28	43.4	29.4	14.4	UCTU211C-700	UCTU211CD-700	75	28	UCTU211FC-700	UCTU211FCD-700	99	29
	115	44	230	1 210	1 150	22	800	175	55.6	22.2	M18	**UCTU211-800**	UC211	30	43.4	29.4	14.4	UCTU211C-800	UCTU211CD-800	75	30	UCTU211FC-800	UCTU211FCD-800	99	31
	115	44	230	1 310	1 250	22	900	175	55.6	22.2	M18	**UCTU211-900**	UC211	32	43.4	29.4	14.4	UCTU211C-900	UCTU211CD-900	75	32	UCTU211FC-900	UCTU211FCD-900	99	33
60	120	44	240	920	860	22	500	180	65.1	25.4	M18	**UCTU212-500**	UC212	26	52.4	36.2	14.4	UCTU212C-500	UCTU212CD-500	88	26	UCTU212FC-500	UCTU212FCD-500	114	28
	120	44	240	1 020	960	22	600	180	65.1	25.4	M18	**UCTU212-600**	UC212	28	52.4	36.2	14.4	UCTU212C-600	UCTU212CD-600	88	28	UCTU212FC-600	UCTU212FCD-600	114	30
	120	44	240	1 120	1 060	22	700	180	65.1	25.4	M18	**UCTU212-700**	UC212	30	52.4	36.2	14.4	UCTU212C-700	UCTU212CD-700	88	30	UCTU212FC-700	UCTU212FCD-700	114	32
	120	44	240	1 220	1 160	22	800	180	65.1	25.4	M18	**UCTU212-800**	UC212	31	52.4	36.2	14.4	UCTU212C-800	UCTU212CD-800	88	31	UCTU212FC-800	UCTU212FCD-800	114	33
	120	44	240	1 320	1 260	22	900	180	65.1	25.4	M18	**UCTU212-900**	UC212	33	52.4	36.2	14.4	UCTU212C-900	UCTU212CD-900	88	33	UCTU212FC-900	UCTU212FCD-900	114	35
65	145	55	285	940	880	22	500	190	75	30	M18	**UCTU313-500**	UC313	40	92.7	59.9	13.2	–	–	–	–	UCTU313C-500	UCTU313CD-500	122	42
	145	55	285	1 040	980	22	600	190	75	30	M18	**UCTU313-600**	UC313	43	92.7	59.9	13.2	–	–	–	–	UCTU313C-600	UCTU313CD-600	122	45
	145	55	285	1 140	1 080	22	700	190	75	30	M18	**UCTU313-700**	UC313	46	92.7	59.9	13.2	–	–	–	–	UCTU313C-700	UCTU313CD-700	122	48
	145	55	285	1 240	1 180	22	800	190	75	30	M18	**UCTU313-800**	UC313	49	92.7	59.9	13.2	–	–	–	–	UCTU313C-800	UCTU313CD-800	122	51
	145	55	285	1 340	1 280	22	900	190	75	30	M18	**UCTU313-900**	UC313	51	92.7	59.9	13.2	–	–	–	–	UCTU313C-900	UCTU313CD-900	122	53
70	150	55	295	960	900	22	500	200	78	33	M18	**UCTU314-500**	UC314	44	104	68.2	13.2	–	–	–	–	UCTU314C-500	UCTU314CD-500	124	46
	150	55	295	1 060	1 000	22	600	200	78	33	M18	**UCTU314-600**	UC314	46	104	68.2	13.2	–	–	–	–	UCTU314C-600	UCTU314CD-600	124	48
	150	55	295	1 160	1 100	22	700	200	78	33	M18	**UCTU314-700**	UC314	48	104	68.2	13.2	–	–	–	–	UCTU314C-700	UCTU314CD-700	124	50
	150	55	295	1 260	1 200	22	800	200	78	33	M18	**UCTU314-800**	UC314	51	104	68.2	13.2	–	–	–	–	UCTU314C-800	UCTU314CD-800	124	53
	150	55	295	1 360	1 300	22	900	200	78	33	M18	**UCTU314-900**	UC314	53	104	68.2	13.2	–	–	–	–	UCTU314C-900	UCTU314CD-900	124	55
75	155	55	305	980	920	22	500	210	82	32	M18	**UCTU315-500**	UC315	54	113	77.2	13.2	–	–	–	–	UCTU315C-500	UCTU315CD-500	134	57
	155	55	305	1 080	1 020	22	600	210	82	32	M18	**UCTU315-600**	UC315	57	113	77.2	13.2	–	–	–	–	UCTU315C-600	UCTU315CD-600	134	60
	155	55	305	1 180	1 120	22	700	210	82	32	M18	**UCTU315-700**	UC315	59	113	77.2	13.2	–	–	–	–	UCTU315C-700	UCTU315CD-700	134	62
	155	55	305	1 280	1 220	22	800	210	82	32	M18	**UCTU315-800**	UC315	61	113	77.2	13.2	–	–	–	–	UCTU315C-800	UCTU315CD-800	134	64
	155	55	305	1 380	1 320	22	900	210	82	32	M18	**UCTU315-900**	UC315	64	113	77.2	13.2	–	–	–	–	UCTU315C-900	UCTU315CD-900	134	67
80	160	55	315	1 000	940	22	500	220	86	34	M18	**UCTU316-500**	UC316	57	123	86.7	13.3	–	–	–	–	UCTU316C-500	UCTU316CD-500	138	60
	160	55	315	1 100	1 040	22	600	220	86	34	M18	**UCTU316-600**	UC316	60	123	86.7	13.3	–	–	–	–	UCTU316C-600	UCTU316CD-600	138	63
	160	55	315	1 200	1 140	22	700	220	86	34	M18	**UCTU316-700**	UC316	62	123	86.7	13.3	–	–	–	–	UCTU316C-700	UCTU316CD-700	138	65
	160	55	315	1 300	1 240	22	800	220	86	34	M18	**UCTU316-800**	UC316	64	123	86.7	13.3	–	–	–	–	UCTU316C-800	UCTU316CD-800	138	67
	160	55	315	1 400	1 340	22	900	220	86	34	M18	**UCTU316-900**	UC316	67	123	86.7	13.3	–	–	–	–	UCTU316C-900	UCTU316CD-900	138	70

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
C-1/4-28UNF........ 208~210
C-PT1/8................ 211, 212, 313~318
3. As for the triple seal type product, accessory code L3 follows the Part No. of unit or bearing.
(Example of Part No. : UCTU208JL3-500, UC208L3)
4. The unit should be mounted so that load is applied to the frame mounting surface vertically and downward.
5. If heavy load ($P_r/C_r > 0.12$), vibration, or impact occurs, contact with FYH.
6. Tapered bore (with adapter) type bearing units are also available. (Example of Part No. : UKTU208J-500 + H308X, UK208 + H308X)
7. If frame parts need to be corrosion resistant, contact with FYH.
8. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

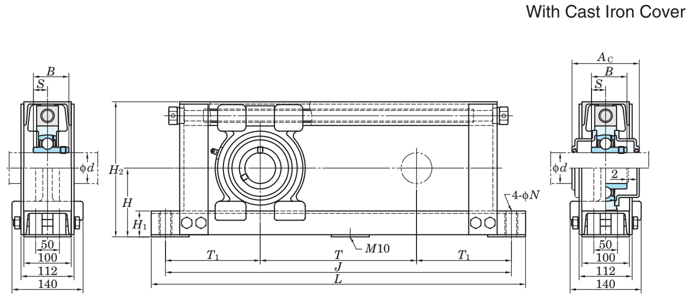
UCTU

Cylindrical bore (with set screws)

d 85 ~ 90 mm



UCTU200



UCTU300

Variations of tolerance of distance from mounting bottom to center of spherical bore ($\varDelta_{Hs}$) and variations of tolerance of distance between centers of bolt holes ($\varDelta_{Js}$)

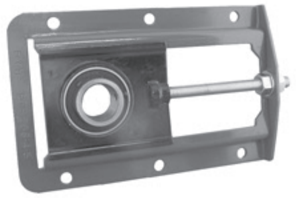
Unit : mm

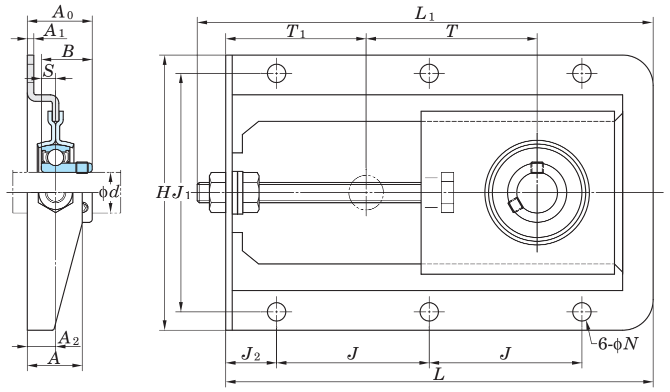
Nominal unit code	$\varDelta_{Hs}$	$\varDelta_{Js}$
UCTU208~212 UCTU313~315	±2	±0.8
UCTU316~318		±1.2

Shaft Dia. mm	Dimensions mm										Bolt Size mm	Standard			Basic Load Ratings kN		Factor	With Pressed Steel Cover				With Cast Iron Cover			
												Unit No.	Bearing No.	Mass				Unit No.		Dimension mm	Mass	Unit No.		Dimension mm	Mass
d	H	H_1	H_2	L	J	N	T	T_1	B	S				kg	C_r	C_{0r}	f_0	Open Type	One Side Closed Type	A_s	kg	Open Type	One Side Closed Type	A_c	kg
85	165	55	325	1 020	960	22	500	230	96	40	M18	**UCTU317-500**	UC317	62	133	96.8	13.3	–	–	–	–	UCTU317C-500	UCTU317CD-500	146	65
	165	55	325	1 120	1 060	22	600	230	96	40	M18	**UCTU317-600**	UC317	64	133	96.8	13.3	–	–	–	–	UCTU317C-600	UCTU317CD-600	146	67
	165	55	325	1 220	1 160	22	700	230	96	40	M18	**UCTU317-700**	UC317	67	133	96.8	13.3	–	–	–	–	UCTU317C-700	UCTU317CD-700	146	70
	165	55	325	1 320	1 260	22	800	230	96	40	M18	**UCTU317-800**	UC317	69	133	96.8	13.3	–	–	–	–	UCTU317C-800	UCTU317CD-800	146	72
	165	55	325	1 420	1 360	22	900	230	96	40	M18	**UCTU317-900**	UC317	71	133	96.8	13.3	–	–	–	–	UCTU317C-900	UCTU317CD-900	146	74
90	170	55	335	1 050	990	22	500	245	96	40	M18	**UCTU318-500**	UC318	65	143	107	13.3	–	–	–	–	UCTU318C-500	UCTU318CD-500	150	68
	170	55	335	1 150	1 090	22	600	245	96	40	M18	**UCTU318-500**	UC318	67	143	107	13.3	–	–	–	–	UCTU318C-600	UCTU318CD-600	150	70
	170	55	335	1 250	1 190	22	700	245	96	40	M18	**UCTU318-500**	UC318	70	143	107	13.3	–	–	–	–	UCTU318C-700	UCTU318CD-700	150	73
	170	55	335	1 350	1 290	22	800	245	96	40	M18	**UCTU318-500**	UC318	72	143	107	13.3	–	–	–	–	UCTU318C-800	UCTU318CD-800	150	75
	170	55	335	1 450	1 390	22	900	245	96	40	M18	**UCTU318-500**	UC318	74	143	107	13.3	–	–	–	–	UCTU318C-900	UCTU318CD-900	150	77

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
C-1/4-28UNF........ 208~210
C-PT1/8................ 211, 212, 313~318
3. As for the triple seal type product, accessory code L3 follows the Part No. of unit or bearing.
(Example of Part No. : UCTU208JL3-500, UC208L3)
4. The unit should be mounted so that load is applied to the frame mounting surface vertically and downward.
5. If heavy load ($P_r/C_r > 0.12$), vibration, or impact occurs, contact with FYH.
6. Tapered bore (with adapter) type bearing units are also available. (Example of Part No. : UKTU208J-500 + H308X, UK208 + H308X)
7. If frame parts need to be corrosion resistant, contact with FYH.
8. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

SBPTH
Cylindrical bore (with set screws)
d 12 ~ 25 mm





Variations of tolerance of distance between centers of bolt holes ($\varDelta_{J\mathrm{s}}$, $\varDelta_{J1\mathrm{s}}$)

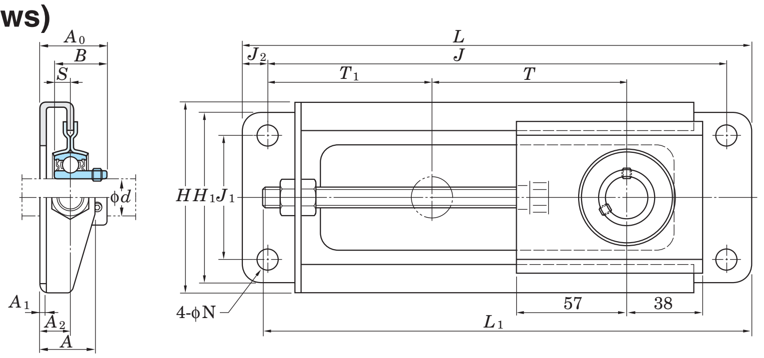
Unit : mm

Nominal unit code	$\varDelta_{J\mathrm{s}}$	$\varDelta_{J1\mathrm{s}}$
SBPTH201~SBPTH205	±0.7	±0.7

Shaft Dia. mm	Dimensions inch mm															Bolt Size inch mm	Unit No.		Bearing No.	Basic Load Ratings kN		Factor	Mass
d	H	L	L_1	A	J	J_1	J_2	N	T	T_1	A_1	A_2	A_0	B	S					C_r	C_{0r}	f_0	kg
12	5 5/16 135	8 9/32 210	8 21/32 220	1 1/16 27	2 61/64 75	4 39/64 117	31/32 25	11/32 9	3 15/32 88	2 23/32 69	1/8 3.2	35/64 13.9	1 3/16 29.9	0.866 22	0.236 6	5/16 M8	**SBPTH201-90**		SB201	9.55	4.80	13.2	0.91
15	5 5/16 135	8 9/32 210	8 21/32 220	1 1/16 27	2 61/64 75	4 39/64 117	31/32 25	11/32 9	3 15/32 88	2 23/32 69	1/8 3.2	35/64 13.9	1 3/16 29.9	0.866 22	0.236 6	5/16 M8	**SBPTH202-90**		SB202	9.55	4.80	13.2	0.91
17	5 5/16 135	8 9/32 210	8 21/32 220	1 1/16 27	2 61/64 75	4 39/64 117	31/32 25	11/32 9	3 15/32 88	2 23/32 69	1/8 3.2	35/64 13.9	1 3/16 29.9	0.866 22	0.236 6	5/16 M8	**SBPTH203-90**		SB203	9.55	4.80	13.2	0.91
20	5 5/16 135	8 9/32 210	8 21/32 220	1 1/16 27	2 61/64 75	4 39/64 117	31/32 25	11/32 9	3 15/32 88	2 23/32 69	1/8 3.2	35/64 13.9	1 1/4 31.9	0.984 25	0.276 7	5/16 M8	**SBPTH204-90**		SB204	12.8	6.65	13.2	0.91
25	5 5/16 135	8 9/32 210	8 21/32 220	1 1/16 27	2 61/64 75	4 39/64 117	31/32 25	11/32 9	3 15/32 88	2 23/32 69	1/8 3.2	35/64 13.9	1 5/16 33.4	1.063 27	0.295 7.5	5/16 M8	**SBPTH205-90**		SB205	14.0	7.85	13.9	0.91

Remark For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

SBNPTH
Cylindrical bore (with set screws)
d 12 ~ 25 mm



Variations of tolerance of distance between centers of bolt holes (Δ_{Js}, Δ_{J1s})

Unit : mm

Nominal unit code	Δ_{Js}	Δ_{J1s}
SBNPTH201~SBNPTH205	±0.7	±0.7

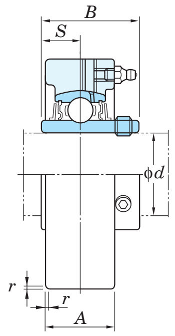
Shaft Dia. mm	Dimensions inch mm																Bolt Size inch mm	Unit No.	Bearing No.	Basic Load Ratings kN		Factor	Mass
d	*H*	H_1	*L*	L_1	*A*	*J*	J_1	J_2	*N*	*T*	T_1	A_1	A_2	A_0	*B*	*S*				C_r	C_{0r}	f_0	kg
12	3 15/16 100	3 17/32 90	10 1/4 260	9 11/16 246	1 1/16 27	9 1/4 235	2 9/16 65	1/2 12.5	7/16 11	3 15/16 100	3 9/32 83.5	1/8 3.2	19/32 15	1 7/32 31	0.866 22	0.236 6	5/16 M8	**SBNPTH201-100**	SB201	9.55	4.80	13.2	0.93
15	3 15/16 100	3 17/32 90	10 1/4 260	9 11/16 246	1 1/16 27	9 1/4 235	2 9/16 65	1/2 12.5	7/16 11	3 15/16 100	3 9/32 83.5	1/8 3.2	19/32 15	1 7/32 31	0.866 22	0.236 6	5/16 M8	**SBNPTH202-100**	SB202	9.55	4.80	13.2	0.93
17	3 15/16 100	3 17/32 90	10 1/4 260	9 11/16 246	1 1/16 27	9 1/4 235	2 9/16 65	1/2 12.5	7/16 11	3 15/16 100	3 9/32 83.5	1/8 3.2	19/32 15	1 7/32 31	0.866 22	0.236 6	5/16 M8	**SBNPTH203-100**	SB203	9.55	4.80	13.2	0.93
20	3 15/16 100	3 17/32 90	10 1/4 260	9 11/16 246	1 1/16 27	9 1/4 235	2 9/16 65	1/2 12.5	7/16 11	3 15/16 100	3 9/32 83.5	1/8 3.2	19/32 15	1 5/16 33	0.984 25	0.276 7	5/16 M8	**SBNPTH204-100**	SB204	12.8	6.65	13.2	0.93
25	3 15/16 100	3 17/32 90	10 1/4 260	9 11/16 246	1 1/16 27	9 1/4 235	2 9/16 65	1/2 12.5	7/16 11	3 15/16 100	3 9/32 83.5	1/8 3.2	19/32 15	1 11/32 34.5	1.063 27	0.295 7.5	5/16 M8	**SBNPTH205-100**	SB205	14.0	7.85	13.9	0.93

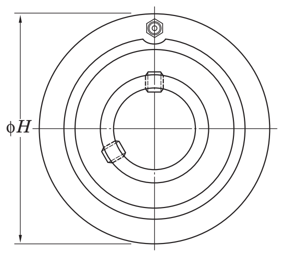
Remark For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

UCC

Cylindrical bore (with set screws)

d 12 ~ (45) mm





Shaft Dia. mm	inch	Dimensions inch mm					Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN		Factor	Mass
d		*H*	*A*	*r*	*B*	*S*				C_r	C_{0r}	f_0	kg
12		2.835 72	25/32 20	0.06 1.5	1.220 31	0.500 12.7	**UCC201**	C204	UC201	12.8	6.65	13.2	0.52
	1/2						**UCC201-8**		UC201-8				
15							**UCC202**		UC202				0.50
	5/8						**UCC202-10**		UC202-10				
17							**UCC203**		UC203				0.49
	3/4						**UCC204-12**		UC204-12				0.47
20							**UCC204**		UC204				
25	7/8	3.150 80	55/64 22	0.06 1.5	1.343 34.1	0.563 14.3	**UCC205-14**	C205	UC205-14	14.0	7.85	13.9	0.64
	15/16						**UCC205-15**		UC205-15				
							UCC205		UC205				
	1						**UCC205-16**		UC205-16				
		3.543 90	11/16 27	0.06 1.5	1.500 38.1	0.626 15.9	**UCCX05**	CX05	UCX05	19.5	11.3	13.9	1.0
	1						**UCCX05-16**		UCX05-16				
		3.543 90	11/32 26	0.08 2	1.496 38	0.591 15	**UCC305**	C305	UC305	21.2	10.9	12.6	1.5
	1						**UCC305-16**		UC305-16				
30	1 1/8	3.346 85	11/16 27	0.06 1.5	1.500 38.1	0.626 15.9	**UCC206-18**	C206	UC206-18	19.5	11.3	13.9	0.81
							UCC206		UC206				
	1 3/16						**UCC206-19**		UC206-19				
	1 1/4						**UCC206-20**		UC206-20				
		3.937 100	13/16 30	0.08 2	1.689 42.9	0.689 17.5	**UCCX06**	CX06	UCX06	25.7	15.4	13.9	1.3
	1 3/16						**UCCX06-19**		UCX06-19				
	1 1/4						**UCCX06-20**		UCX06-20				
	–	3.937 100	17/64 28	0.08 2	1.693 43	0.669 17	**UCC306**	C306	UC306	26.7	15.0	13.3	1.7
35	1 1/4	3.543 90	17/64 28	0.08 2	1.689 42.9	0.689 17.5	**UCC207-20**	C207	UC207-20	25.7	15.4	13.9	0.93
	1 5/16						**UCC207-21**		UC207-21				
	1 3/8						**UCC207-22**		UC207-22				
							UCC207		UC207				
	1 7/16						**UCC207-23**		UC207-23				
	1 3/8	4.331 110	1 11/32 34	0.08 2	1.937 49.2	0.748 19	**UCCX07-22**	CX07	UCX07-22	29.1	17.8	14.0	1.7
							UCCX07		UCX07				
	1 7/16						**UCCX07-23**		UCX07-23				
	–	4.331 110	1 17/64 32	0.12 3	1.890 48	0.748 19	**UCC307**	C307	UC307	33.4	19.3	13.2	2.2
40	1 1/2	3.937 100	1 3/16 30	0.08 2	1.937 49.2	0.748 19	**UCC208-24**	C208	UC208-24	29.1	17.8	14.0	1.2
	1 9/16						**UCC208-25**		UC208-25				
							UCC208		UC208				
	1 1/2	4.724 120	1 1/2 38	0.08 2	1.937 49.2	0.748 19	**UCCX08-24**	CX08	UCX08-24	34.1	21.3	14.0	2.3
							UCCX08		UCX08				
	1 1/2	4.724 120	1 11/32 34	0.12 3	2.047 52	0.748 19	**UCC308-24**	C308	UC308-24	40.7	24.0	13.2	2.2
							UCC308		UC308				
45	1 5/8	4.331 110	1 7/32 31	0.08 2	1.937 49.2	0.748 19	**UCC209-26**	C209	UC209-26	34.1	21.3	14.0	1.5
	1 11/16						**UCC209-27**		UC209-27				
	1 3/4						**UCC209-28**		UC209-28				
							UCC209		UC209				

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~213, X05~X12, 305~308
A-PT1/8 .... 309~328
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (L2) follows the Part No. of unit or bearing. (Example of Part No. : UCC206JL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

d (45) ~ 90 mm

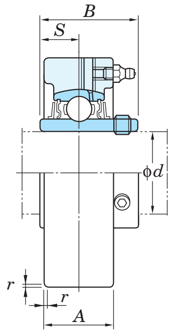
Variations of tolerance of outside diameter ($\varDelta_{Hs}$), variations of tolerance of width ($\varDelta_{As}$), and tolerance of circumferential runout of outside diameter (Y)

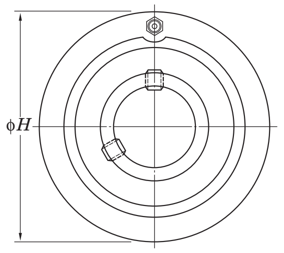
Unit : mm

Housing No.			$\varDelta_{Hs}$	$\varDelta_{As}$	Y
C204~C205			0 –0.030	±0.2	0.2
C206~C210	CX05~CX08	C305~C308	0 –0.035		
	CX09~CX10	C309~C310	0 –0.040		
C211~C213	CX11~CX12	C311~C314		±0.3	0.3
		C315~C318	0 –0.046		
		C319			0.4
		C320~C322	0 –0.052		
		C324~C328	0 –0.057		

Shaft Dia. mm	inch	Dimensions inch mm					Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN		Factor	Mass
d		*H*	*A*	*r*	*B*	*S*				C_r	C_{0r}	f_0	kg
45	1 3/4	4.724 120	1 1/2 38	0.08 2	2.031 51.6	0.748 19	**UCCX09-28**	CX09	UCX09-28	35.1	23.3	14.4	2.3
							UCCX09		UCX09				
	1 3/4	5.118 130	1 1/2 38	0.12 3	2.244 57	0.866 22	**UCC309-28**	C309	UC309-28	48.9	29.5	13.3	2.8
							UCC309		UC309				
50	1 7/8	4.724 120	1 19/64 33	0.08 2	2.031 51.6	0.748 19	**UCC210-30**	C210	UC210-30	35.1	23.3	14.4	2.0
	1 15/16						**UCC210-31**		UC210-31				
							UCC210		UC210				
	2						**UCC210-32**		UC210-32				
	1 15/16	5.118 130	1 37/64 40	0.1 2.5	2.189 55.6	0.874 22.2	**UCCX10-31**	CX10	UCX10-31	43.4	29.4	14.4	2.8
							UCCX10		UCX10				
	2						**UCCX10-32**		UCX10-32				
	–	5.512 140	1 37/64 40	0.12 3	2.402 61	0.866 22	**UCC310**	C310	UC310	62.0	38.3	13.2	3.2
55	2	4.921 125	1 3/8 35	0.1 2.5	2.189 55.6	0.874 22.2	**UCC211-32**	C211	UC211-32	43.4	29.4	14.4	2.2
	2 1/8						**UCC211-34**		UC211-34				
							UCC211		UC211				
	2 3/16						**UCC211-35**		UC211-35				
		5.906 150	1 21/32 42	0.1 2.5	2.563 65.1	1.000 25.4	**UCCX11**	CX11	UCX11	52.4	36.2	14.4	4.0
	2 3/16						**UCCX11-35**		UCX11-35				
	2 1/4						**UCCX11-36**		UCX11-36				
	2	5.906 150	1 47/64 44	0.12 3	2.598 66	0.984 25	**UCC311-32**	C311	UC311-32	71.6	45.0	13.2	3.9
							UCC311		UC311				
60	2 1/4	5.118 130	1 1/2 38	0.1 2.5	2.563 65.1	1.000 25.4	**UCC212-36**	C212	UC212-36	52.4	36.2	14.4	2.6
							UCC212		UC212				
	2 3/8						**UCC212-38**		UC212-38				
	2 7/16						**UCC212-39**		UC212-39				
		6.299 160	1 47/64 44	0.1 2.5	2.563 65.1	1.000 25.4	**UCCX12**	CX12	UCX12	57.2	40.1	14.4	4.6
	2 7/16						**UCCX12-39**		UCX12-39				
	–	6.299 160	1 13/16 46	0.12 3	2.795 71	1.024 26	**UCC312**	C312	UC312	81.9	52.2	13.2	4.8
65	2 1/2	5.512 140	1 37/64 40	0.1 2.5	2.563 65.1	1.000 25.4	**UCC213-40**	C213	UC213-40	57.2	40.1	14.4	3.0
							UCC213		UC213				
	2 1/2	6.693 170	1 31/32 50	0.12 3	2.953 75	1.181 30	**UCC313-40**	C313	UC313-40	92.7	59.9	13.2	5.7
							UCC313-40		UC313				
70	2 3/4	7.087 180	2 3/64 52	0.12 3	3.071 78	1.299 33	**UCC314-44**	C314	UC314-44	104	68.2	13.2	6.7
							UCC314		UC314				
75	2 15/16	7.480 190	2 11/64 55	0.16 4	3.228 82	1.260 32	**UCC315-47**	C315	UC315-47	113	77.2	13.2	7.8
							UCC315		UC315				
	3						**UCC315-48**		UC315-48				
80	–	7.874 200	2 23/64 60	0.16 4	3.386 86	1.339 34	**UCC316**	C316	UC316	123	86.7	13.3	9.2
85	–	8.465 215	2 33/64 64	0.16 4	3.780 96	1.575 40	**UCC317**	C317	UC317	133	96.8	13.3	11.7
90	3 1/2	8.858 225	2 19/32 66	0.16 4	3.780 96	1.575 40	**UCC318-56**	C318	UC318-56	143	107	13.3	13.1
							UCC318		UC318				

UCC
Cylindrical bore (with set screws)
d 95 ~ 140 mm





Shaft Dia. mm *d*	Shaft Dia. inch *d*	Dimensions inch / mm *H*	*A*	*r*	*B*	*S*	Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN C_r	C_{0r}	Factor f_0	Mass kg
95	–	9.449 240	2 53/64 72	0.16 4	4.055 103	1.614 41	**UCC319**	C319	UC319	153	119	13.3	15.8
100	3 15/16 4	10.236 260	2 61/64 75	0.16 4	4.252 108	1.654 42	**UCC320** **UCC320-63** **UCC320-64**	C320	UC320 UC320-63 UC320-64	173	141	13.2	19.6
105	–	10.236 260	2 61/64 75	0.16 4	4.409 112	1.732 44	**UCC321**	C321	UC321	184	153	13.2	27.0
110	–	11.811 300	3 5/32 80	0.2 5	4.606 117	1.811 46	**UCC322**	C322	UC322	205	180	13.2	29.2
120	–	12.598 320	3 35/64 90	0.2 5	4.961 126	2.008 51	**UCC324**	C324	UC324	207	185	13.5	35.9
130	–	13.386 340	3 15/16 100	0.24 6	5.315 135	2.126 54	**UCC326**	C326	UC326	229	214	13.6	43.0
140	–	14.173 360	3 15/16 100	0.24 6	5.709 145	2.323 59	**UCC328**	C328	UC328	253	246	13.6	52.9

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~213, X05~X12, 305~308
A-PT1/8 .... 309~328
3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (L2) follows the Part No. of unit or bearing. (Example of Part No. : UCC206JL3, UC206L3)
4. For the dimensions and forms of applicable bearings, see the dimensional tables of ball bearing for unit.

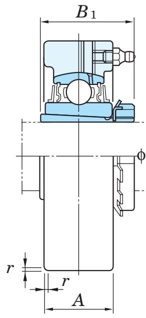
Variations of tolerance of outside diameter ($\varDelta_{Hs}$), variations of tolerance of width ($\varDelta_{As}$), and tolerance of circumferential runout of outside diameter (Y)

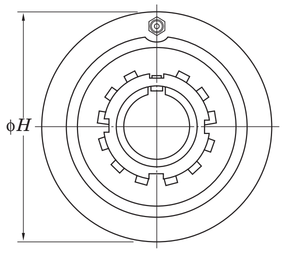
Unit : mm

Housing No.			$\varDelta_{Hs}$	$\varDelta_{As}$	Y
C204~C205			0 –0.030	±0.2	0.2
C206~C210	CX05~CX08	C305~C308	0 –0.035		
	CX09~CX10	C309~C310	0 –0.040		
C211~C213	CX11~CX12	C311~C314		±0.3	0.3
		C315~C318	0 –0.046		
		C319			0.4
		C320~C322	0 –0.052		
		C324~C328	0 –0.057		

UKC
Tapered bore (with adapter)

d_1 20 ~ 45 mm





Shaft Dia. mm	inch	Dimensions inch mm H	A	r	B_1 1)	Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN C_r	C_{0r}	Factor f_0	Adapter 1) No.	Mass 1) kg
20	3/4	3.150 80	55/64 22	0.06 1.5	1 5/32(1 3/8) 29(35)	**UKC205**	C205	UK205	14.0	7.85	13.9	HE305X(HE2305X) H305X(H2305X)	0.68(0.70)
	3/4	3.543 90	11/16 27	0.06 1.5	1 3/8 35	**UKCX05**	CX05	UKX05	19.5	11.3	13.9	HE2305X H2305X	0.99
	3/4	3.543 90	11/32 26	0.08 2	1 3/8 35	**UKC305**	C305	UK305	21.2	10.9	12.6	HE2305X H2305X	1.6
25	1	3.346 85	11/16 27	0.06 1.5	1 7/32(1 1/2) 31(38)	**UKC206**	C206	UK206	19.5	11.3	13.9	H306X(H2306X) HE306X(HE2306X)	0.85(0.89)
	1	3.937 100	13/16 30	0.08 2	1 1/2 38	**UKCX06**	CX06	UKX06	25.7	15.4	13.9	H2306X HE2306X	1.3
	1	3.937 100	13/16 28	0.08 2	1 1/2 38	**UKC306**	C306	UK306	26.7	15.0	13.3	H2306X HE2306X	1.8
30	1 1/8	3.543 90	17/64 28	0.08 2	1 3/8(1 11/16) 35(43)	**UKC207**	C207	UK207	25.7	15.4	13.9	HS307X(HS2307X) H307X(H2307X)	0.97(1.0)
	1 1/8	4.331 110	1 11/32 34	0.08 2	1 11/16 43	**UKCX07**	CX07	UKX07	29.1	17.8	14.0	HS2307X H2307X	1.7
	1 1/8	4.331 110	1 17/64 32	0.12 3	1 11/16 43	**UKC307**	C307	UK307	33.4	19.3	13.2	HS2307X H2307X	2.2
35	1 1/4 1 3/8	3.937 100	1 3/16 30	0.08 2	1 13/32(1 13/16) 36(46)	**UKC208**	C208	UK208	29.1	17.8	14.0	HE308X(HE2308X) HS308X(HS2308X) H308X(H2308X)	1.3(1.4)
	1 1/4 1 3/8	4.724 120	1 1/2 38	0.08 2	1 13/16 46	**UKCX08**	CX08	UKX08	34.1	21.3	14.0	HE2308X HS2308X H2308X	2.3
	1 1/4 1 3/8	4.724 120	1 11/32 34	0.12 3	1 13/16 46	**UKC308**	C308	UK308	40.7	24.0	13.2	HE2308X HS2308X H2308X	2.2
40	1 1/2 1 5/8	4.331 110	1 7/32 31	0.08 2	1 17/32(1 31/32) 39(50)	**UKC209**	C209	UK209	34.1	21.3	14.0	HE309X(H2309X) H309X(H2309X) HS309X(H2309X)	1.6(1.7)
	1 1/2 1 5/8	4.724 120	1 1/2 38	0.08 2	1 31/32 50	**UKCX09**	CX09	UKX09	35.1	23.3	14.4	HE2309X H2309X HS2309X	2.3
	1 1/2 1 5/8	5.118 130	1 1/2 38	0.12 3	1 31/32 50	**UKC309**	C309	UK309	48.9	29.5	13.3	HE2309X H2309X HS2309X	2.8
45	1 3/4	4.724 120	1 19/64 33	0.08 2	1 21/32(2 5/32) 42(55)	**UKC210**	C210	UK210	35.1	23.3	14.4	HE310X(HE2310X) H310X(H2310X)	2.0(2.1)
	1 3/4	5.118 130	1 37/64 40	0.1 2.5	2 5/32 55	**UKCX10**	CX10	UKX10	43.4	29.4	14.4	HE2310X H2310X	2.8
	1 3/4	5.512 140	1 37/64 40	0.12 3	2 5/32 55	**UKC310**	C310	UK310	62.0	38.3	13.2	HE2310X H2310X	3.2

Note 1) Numerals shown in parentheses indicate the dimensions, Part No. of applicable adapters (H2300X series), and the unit weight of UK200L3 series (triple seal type).

Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 205~213, X05~X12, 305~308
A-PT1/8 .... 309~328
3. In Part No. of unit with adapters and bearing with adapters, Part No. of applicable adapter follow the Part No. shown in the dimensional tables. (Example of Part No. : UKC206J + H306X, UK206 + H306X)
4. As for the triple seal type product (205 is the double seal type product), accessory code L3 (or L2) follows the Part No. of unit or bearing. (Example of Part No. : UKC206JL3 + H2306X, UK206L3 + H2306X)
5. As for the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.

d_1 50 ~ 125 mm

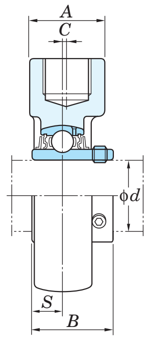
Variations of tolerance of outside diameter (Δ_{Hs}), variations of tolerance of width (Δ_{As}), and tolerance of circumferential runout of outside diameter (Y)

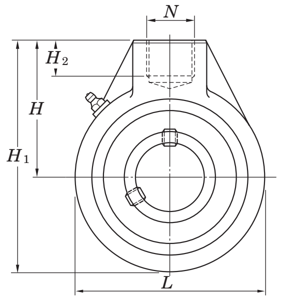
Unit : mm

Housing No.			Δ_{Hs}	Δ_{As}	Y
C205			0 –0.030	±0.2	0.2
C206~C210	CX05~CX08	C305~C308	0 –0.035		
	CX09~CX10	C309~C310	0 –0.040		
C211~C213	CX11~CX12	C311~C314		±0.3	0.3
		C315~C318	0 –0.046		
		C319			0.4
		C320~C322	0 –0.052		
		C324~C328	0 –0.057		

Shaft Dia. mm	inch	Dimensions inch mm H	A	r	B_1 1)	Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN C_r	C_{0r}	Factor f_0	Adapter 1) No.	Mass 1) kg
50	1 7/8 2	4.921 125	1 3/8 35	0.1 2.5	1 25/32(2 5/16) 45(59)	**UKC211**	C211	UK211	43.4	29.4	14.4	HS311X(HS2311X) H311X(H2311X) HE311X(HE2311X)	2.3(2.6)
	1 7/8 2	5.906 150	1 21/32 42	0.1 2.5	2 5/16 59	**UKCX11**	CX11	UKX11	52.4	36.2	14.4	HS2311X H2311X HE2311X	3.8
	1 7/8 2	5.906 150	1 47/64 44	0.12 3	2 5/16 59	**UKC311**	C311	UK311	71.6	45.0	13.2	HS2311X H2311X HE2311X	4.1
55	2 1/8	5.118 130	1 1/2 38	0.1 2.5	1 27/32(2 7/16) 47(62)	**UKC212**	C212	UK212	52.4	36.2	14.4	HS312X(HS2312X) H312X(H2313X)	2.5(2.9)
	2 1/8	6.299 160	1 47/64 44	0.1 2.5	2 7/16 62	**UKCX12**	CX12	UKX12	57.2	40.1	14.4	HS2312X H2312X	4.4
	2 1/8	6.299 160	1 13/16 46	0.12 3	2 7/16 62	**UKC312**	C312	UK312	81.9	52.2	13.2	HS2312X H2312X	4.7
60	2 1/4 2 3/8	5.512 140	1 37/64 40	0.1 2.5	1 31/32(2 9/16) 50(65)	**UKC213**	C213	UK213	57.2	40.1	14.4	HE313X(HE2313X) H313X(H2313X) HS313X(HS2313X)	3.0(3.3)
	2 1/4 2 3/8	6.693 170	1 31/32 50	0.12 3	2 9/16 65	**UKC313**	C313	UK313	92.7	59.9	13.2	HE2313X H2313X HS2313X	5.8
65	2 1/2	7.480 190	2 11/64 55	0.16 4	2 7/8 73	**UKC315**	C315	UK315	113	77.2	13.2	HE2315X H2315X	8.0
70	2 3/4	7.874 200	2 23/64 60	0.16 4	3 1/16 78	**UKC316**	C316	UK316	123	86.7	13.3	HE2316X H2316X	9.2
75	3	8.465 215	2 33/64 64	0.16 4	3 7/32 82	**UKC317**	C317	UK317	133	96.8	13.3	H2317X HE2317X	11.6
80	–	8.858 225	2 19/32 66	0.16 4	3 3/8 86	**UKC318**	C318	UK318	143	107	13.3	H2318X	13.1
85	3 1/4	9.449 240	2 53/64 72	0.16 4	3 17/32 90	**UKC319**	C319	UK319	153	119	13.3	HE2319X H2319X	16.1
90	3 1/2	10.236 260	2 61/64 75	0.16 4	3 13/16 97	**UKC320**	C320	UK320	173	141	13.2	HE2320X H2320X	19.2
100	4	11.811 300	3 5/32 80	0.2 5	4 1/8 105	**UKC322**	C322	UK322	205	180	13.2	H2322X HE2322X	29.1
110	–	12.598 320	3 35/64 90	0.2 5	4 13/32 112	**UKC324**	C324	UK324	207	185	13.5	H2324	36.2
115	4 1/2	13.386 340	3 15/16 100	0.24 6	4 3/4 121	**UKC326**	C326	UK326	229	214	13.6	HE2326 H2326	42.8
125	–	14.173 360	3 15/16 100	0.24 6	5 5/32 131	**UKC328**	C328	UK328	253	246	13.6	H2328	52.9

UCHA
Cylindrical bore (with set screws)
d 12 ~ 75 mm





Shaft Dia. mm	inch	Dimensions inch mm									Unit No.	Housing No.	Bearing No.	Basic Load Ratings kN		Factor	Mass
d		H	A	L	H_1	H_2	N	C	B	S				C_r	C_{0r}	f_0	kg
12		2 17/32 64	1 9/16 40	2 17/32 64	3 25/32 96	3/4 19	PF 3/4	– –	1.220 31	0.500 12.7	**UCHA201**	HA204	UC201	12.8	6.65	13.2	0.77
	1/2										**UCHA201-8**		UC201-8				
15											**UCHA202**		UC202				0.75
	5/8										**UCHA202-10**		UC202-10				
17											**UCHA203**		UC203				0.74
	3/4										**UCHA204-12**		UC204-12				0.72
20											**UCHA204**		UC204				
25	7/8	2 17/32 64	1 9/16 40	3 1/16 78	4 1/16 103	3/4 19	PF 3/4	– –	1.343 34.1	0.563 14.3	**UCHA205-14**	HA205	UC205-14	14.0	7.85	13.9	0.87
	15/16										**UCHA205-15**		UC205-15				
											UCHA205		UC205				
	1										**UCHA205-16**		UC205-16				
30	1 1/8	2 17/32 64	1 9/16 40	3 1/16 78	4 1/16 103	3/4 19	PF 3/4	– –	1.500 38.1	0.626 15.9	**UCHA206-18**	HA206	UC206-18	19.5	11.3	13.9	0.83
											UCHA206		UC206				
	1 3/16										**UCHA206-19**		UC206-19				
	1 1/4										**UCHA206-20**		UC206-20				
35	1 1/4	2 3/4 70	1 9/16 40	3 5/8 92	4 9/16 116	3/4 19	PF 3/4	– –	1.689 42.9	0.689 17.5	**UCHA207-20**	HA207	UC207-20	25.7	15.4	13.9	1.2
	1 5/16										**UCHA207-21**		UC207-21				
	1 3/8										**UCHA207-22**		UC207-22				
											UCHA207		UC207				
	1 7/16										**UCHA207-23**		UC207-23				
40	1 1/2	2 7/8 73	1 9/16 40	3 25/32 96	4 3/4 121	3/4 19	PF 3/4	5/64 2	1.937 49.2	0.748 19	**UCHA208-24**	HA208	UC208-24	29.1	17.8	14.0	1.3
	1 9/16										**UCHA208-25**		UC208-25				
											UCHA208		UC208				
45	1 5/8	3 7/32 82	1 7/8 48	4 1/4 108	5 11/32 136	13/16 21	PF 1	13/64 5	1.937 49.2	0.748 19	**UCHA209-26**	HA209	UC209-26	34.1	21.3	14.0	1.7
	1 11/16										**UCHA209-27**		UC209-27				
	1 3/4										**UCHA209-28**		UC209-28				
											UCHA209		UC209				
50	1 7/8	3 9/32 83	1 7/8 48	4 21/32 118	5 19/32 142	13/16 21	PF 1	13/64 5	2.031 51.6	0.748 19	**UCHA210-30**	HA210	UC210-30	35.1	23.3	14.4	2.1
	1 15/16										**UCHA210-31**		UC210-31				
											UCHA210		UC210				
											UCHA210-32		UC210-32				
55	2	3 7/16 87	2 3/8 60	4 31/32 126	5 29/32 150	31/32 25	PF 1 1/4	9/32 7	2.189 55.6	0.874 22.2	**UCHA211-32**	HA211	UC211-32	43.4	29.4	14.4	2.8
	2 1/8										**UCHA211-34**		UC211-34				
											UCHA211		UC211				
	2 3/16										**UCHA211-35**		UC211-35				
60	2 1/4	4 1/32 102	2 3/8 60	5 19/32 142	6 13/16 173	1 3/32 28	PF 1 1/4	23/64 9	2.563 65.1	1.000 25.4	**UCHA212-36**	HA212	UC212-36	52.4	36.2	14.4	3.9
											UCHA212		UC212				
	2 3/8										**UCHA212-38**		UC212-38				
	2 7/16										**UCHA212-39**		UC212-39				
65	2 1/2	4 19/32 117	2 3/4 70	6 17/32 166	7 7/8 200	1 1/4 32	PF 1 1/2	3/8 9.5	2.563 65.1	1.000 25.4	**UCHA213-40**	HA213	UC213-40	57.2	40.1	14.4	5.8
											UCHA213		UC213				
70	2 3/4	4 19/32 117	2 3/4 70	6 17/32 166	7 7/8 200	1 1/4 32	PF 1 1/2	3/8 9.5	2.937 74.6	1.189 30.2	**UCHA214-44**	HA214	UC214-44	62.2	44.1	14.5	5.9
											UCHA214		UC214				
75	2 15/16	4 19/32 117	2 3/4 70	6 17/32 166	7 7/8 200	1 1/4 32	PF 1 1/2	3/8 9.5	3.063 77.8	1.311 33.3	**UCHA215-47**	HA215	UC215-47	67.4	48.3	14.5	5.6
											UCHA215		UC215				
	3										**UCHA215-48**		UC215-48				

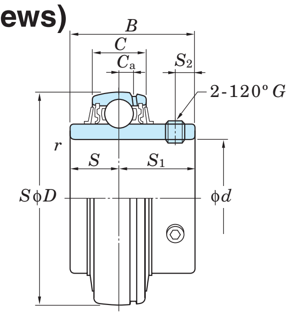
Remarks 1. In Part No. of unit and units with covers, fitting codes follow bore diameter numbers. (See **Table 10.5** in P.42.)
2. Part No. of applicable grease nipples are shown below.
A-1/4-28UNF .... 201~210
A-PT1/8 .... 211~215

3. As for the triple seal type product (from 201 to 205 are the double seal type products), accessory code L3 (or L2) follows the Part No. of unit or bearing. (Example of Part No. : UCHA206JL3, UC206L3)
4. For the dimensions and forms of applicable bearings and adapters, see the dimensional tables of ball bearing for unit and adapter.
5. Tapered bore (with adapter) type products are also available. (Example of Part No. : UKHA205J + H305X, UK205 + H305X)

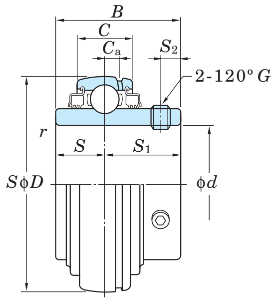
UC, SB, SU

Cylindrical bore (with set screws)

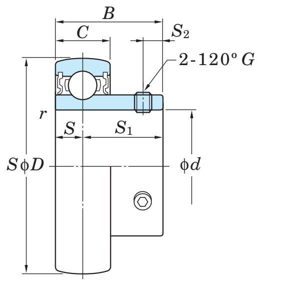
d 8 ~ (30) mm



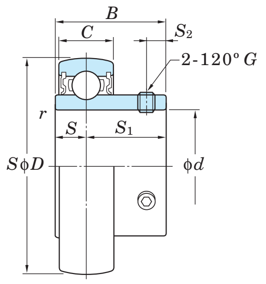
UC



UC-L3



SB



SU

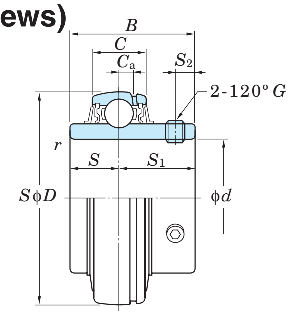
Shaft Dia. *d*		Dimensions *D*		*B*		*C*		*r* (min.)		Basic Load Ratings kN C_r	C_{0r}	Factor f_0	Bearing No. Standard	L3 Type	Dimensions C_a		S		S_1		S_2		Set Screw Brg. Bore G		Mass
mm	inch	mm	inch	mm	inch	mm	inch	mm	inch						mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	kg
8	–	22	0.866	12	0.472	7	0.276	0.3	0.012	3.27	1.37	12.4	**SU08**	–	–	–	3.5	0.138	8.5	0.335	2.8	0.110	M3×0.35	–	0.012
10	–	26	1.024	15	0.591	8	0.315	0.3	0.012	4.55	1.95	12.3	**SU000**	–	–	–	5	0.197	10	0.394	3	0.118	M3×0.35	–	0.024
12	–	28	1.102	15	0.591	8	0.315	0.3	0.012	5.10	2.40	13.2	**SU001**	–	–	–	5	0.197	10	0.394	3	0.118	M3×0.35	–	0.026
		40	1.575	22	0.866	12	0.472	0.6	0.024	9.55	4.80	13.2	**SB201**	–	–	–	6	0.236	16	0.630	4	0.157	M5×0.5	–	0.10
		47	1.850	31	1.220	16	0.630	0.6	0.024	12.8	6.65	13.2	**UC201**	**UC201L2**	4	0.157	12.7	0.500	18.3	0.720	5	0.197	M6×0.75	–	0.21
–	1/2	40	1.575	22	0.866	12	0.472	0.6	0.024	9.55	4.80	13.2	**SB201-8**	–	–	–	6	0.236	16	0.630	4	0.157	–	No.10-32UNF	0.10
		47	1.850	31	1.220	16	0.630	0.6	0.024	12.8	6.65	13.2	**UC201-8**	**UC201-8L2**	4	0.157	12.7	0.500	18.3	0.720	5	0.197	–	1/4-28UNF	0.21
15	–	32	1.260	16.5	0.650	9	0.354	0.3	0.012	5.60	2.85	13.9	**SU002**	–	–	–	5.5	0.217	11	0.433	3.3	0.130	M4×0.5	–	0.038
		40	1.575	22	0.866	12	0.472	0.6	0.024	9.55	4.80	13.2	**SB202**	–	–	–	6	0.236	16	0.630	4	0.157	M5×0.5	–	0.10
		47	1.850	31	1.220	16	0.630	0.6	0.024	12.8	6.65	13.2	**UC202**	**UC202L2**	4	0.157	12.7	0.500	18.3	0.720	5	0.197	M6×0.75	–	0.19
–	5/8	40	1.575	22	0.866	12	0.472	0.6	0.024	9.55	4.80	13.2	**SB202-10**	–	–	–	6	0.236	16	0.630	4	0.157	–	No.10-32UNF	0.10
		47	1.850	31	1.220	16	0.630	0.6	0.024	12.8	6.65	13.2	**UC202-10**	**UC202-10L2**	4	0.157	12.7	0.500	18.3	0.720	5	0.197	–	1/4-28UNF	0.19
17	–	35	1.378	17.5	0.689	10	0.394	0.3	0.012	6.00	3.25	14.4	**SU003**	–	–	–	6	0.236	11.5	0.453	3.3	0.130	M4×0.5	–	0.050
		40	1.575	22	0.866	12	0.472	0.6	0.024	9.55	4.80	13.2	**SB203**	–	–	–	6	0.236	16	0.630	4	0.157	M5×0.5	–	0.10
		47	1.850	31	1.220	16	0.630	0.6	0.024	12.8	6.65	13.2	**UC203**	**UC203L2**	4	0.157	12.7	0.500	18.3	0.720	5	0.197	M6×0.75	–	0.18
–	3/4	47	1.850	25	0.984	14	0.551	1	0.039	12.8	6.65	13.2	**SB204-12**	–	–	–	7	0.276	18	0.709	5	0.197	–	1/4-28UNF	0.15
		47	1.850	31	1.220	16	0.630	1	0.039	12.8	6.65	13.2	**UC204-12**	**UC204-12L2**	4	0.157	12.7	0.500	18.3	0.720	5	0.197	–	1/4-28UNF	0.16
20	–	42	1.654	21	0.827	12	0.472	0.6	0.024	9.40	5.05	13.9	**SU004**	–	–	–	7	0.276	14	0.551	4	0.157	M5×0.5	–	0.080
		47	1.850	25	0.984	14	0.551	1	0.039	12.8	6.65	13.2	**SB204**	–	–	–	7	0.276	18	0.709	5	0.197	M6×0.75	–	0.15
		47	1.850	31	1.220	16	0.630	1	0.039	12.8	6.65	13.2	**UC204**	**UC204L2**	4	0.157	12.7	0.500	18.3	0.720	5	0.197	M6×0.75	–	0.16
–	7/8	52	2.047	27	1.063	15	0.591	1	0.039	14.0	7.85	13.9	**SB205-14**	–	–	–	7.5	0.295	19.5	0.768	5.5	0.217	–	1/4-28UNF	0.18
		52	2.047	34.1	1.343	17	0.669	1	0.039	14.0	7.85	13.9	**UC205-14**	**UC205-14L2**	5	0.197	14.3	0.563	19.8	0.780	5.5	0.217	–	1/4-28UNF	0.23
–	15/16	52	2.047	27	1.063	15	0.591	1	0.039	14.0	7.85	13.9	**SB205-15**	–	–	–	7.5	0.295	19.5	0.768	5.5	0.217	–	1/4-28UNF	0.18
		52	2.047	34.1	1.343	17	0.669	1	0.039	14.0	7.85	13.9	**UC205-15**	**UC205-15L2**	5	0.197	14.3	0.563	19.8	0.780	5.5	0.217	–	1/4-28UNF	0.21
25	–	47	1.850	22	0.866	12	0.472	0.6	0.024	10.1	5.85	14.5	**SU005**	–	–	–	7	0.276	15	0.591	4.5	0.177	M5×0.5	–	0.10
		52	2.047	27	1.063	15	0.591	1	0.039	14.0	7.85	13.9	**SB205**	–	–	–	7.5	0.295	19.5	0.768	5.5	0.217	M6×0.75	–	0.18
		52	2.047	34.1	1.343	17	0.669	1	0.039	14.0	7.85	13.9	**UC205**	**UC205L2**	5	0.197	14.3	0.563	19.8	0.780	5.5	0.217	M6×0.75	–	0.20
		62	2.441	38	1.496	22	0.866	1.1	0.043	21.2	10.9	12.6	**UC305**	–	6	0.236	15	0.591	23	0.906	6	0.236	M6×0.75	–	0.45
		62	2.441	38.1	1.500	19	0.748	1	0.039	19.5	11.3	13.9	**UCX05**	**UCX05L3**	5	0.197	15.9	0.626	22.2	0.874	6	0.236	M6×0.75	–	0.39
–	1	52	2.047	27	1.063	15	0.591	1	0.039	14.0	7.85	13.9	**SB205-16**	–	–	–	7.5	0.295	19.5	0.768	5.5	0.217	–	1/4-28UNF	0.18
		52	2.047	34.1	1.343	17	0.669	1	0.039	14.0	7.85	13.9	**UC205-16**	**UC205-16L2**	5	0.197	14.3	0.563	19.8	0.780	5.5	0.217	–	1/4-28UNF	0.20
		62	2.441	38	1.496	22	0.866	1.1	0.043	21.2	10.9	12.6	**UC305-16**	–	6	0.236	15	0.591	23	0.906	6	0.236	M6×0.75	–	0.44
		62	2.441	38.1	1.500	19	0.748	1	0.039	19.5	11.3	13.9	**UCX05-16**	**UCX05-16L3**	5	0.197	15.9	0.626	22.2	0.874	6	0.236	–	1/4-28UNF	0.38
–	1 1/8	62	2.441	30	1.181	16	0.630	1	0.039	19.5	11.3	13.9	**SB206-18**	–	–	–	8	0.315	22	0.866	6	0.236	–	1/4-28UNF	0.27
		62	2.441	38.1	1.500	19	0.748	1	0.039	19.5	11.3	13.9	**UC206-18**	**UC206-18L2**	5	0.197	15.9	0.626	22.2	0.874	6	0.236	–	1/4-28UNF	0.34
30	–	55	2.165	24.5	0.965	13	0.512	1	0.039	13.2	8.25	14.7	**SU006**	–	–	–	7.5	0.295	17	0.669	5.5	0.217	M5×0.5	–	0.15
		62	2.441	30	1.181	16	0.630	1	0.039	19.5	11.3	13.9	**SB206**	–	–	–	8	0.315	22	0.866	6	0.236	M6×0.75	–	0.27
		62	2.441	38.1	1.500	19	0.748	1	0.039	19.5	11.3	13.9	**UC206**	**UC206L3**	5	0.197	15.9	0.626	22.2	0.874	6	0.236	M6×0.75	–	0.32
		72	2.835	42.9	1.689	20	0.787	1	0.039	25.7	15.4	13.9	**UCX06**	**UCX06L3**	5.5	0.217	17.5	0.689	25.4	1.000	6.5	0.256	M8×1	–	0.58
		72	2.835	43	1.693	24	0.945	1.1	0.043	26.7	15.0	13.3	**UC306**	–	6.5	0.256	17	0.669	26	1.024	6	0.236	M6×0.75	–	0.56
–	1 3/16	62	2.441	30	1.181	16	0.630	1	0.039	19.5	11.3	13.9	**SB206-19**	–	–	–	8	0.315	22	0.866	6	0.236	–	1/4-28UNF	0.27
		62	2.441	38.1	1.500	19	0.748	1	0.039	19.5	11.3	13.9	**UC206-19**	**UC206-19L2**	5	0.197	15.9	0.626	22.2	0.874	6	0.236	–	1/4-28UNF	0.32
		72	2.835	42.9	1.689	20	0.787	1	0.039	25.7	15.4	13.9	**UCX06-19**	**UCX06-19L3**	5.5	0.217	17.5	0.689	25.4	1.000	6.5	0.256	–	5/16-28UNF	0.58
–	1 1/4	62	2.441	30	1.181	16	0.630	1	0.039	19.5	11.3	13.9	**SB206-20**	–	–	–	8	0.315	22	0.866	6	0.236	–	1/4-28UNF	0.27
		62	2.441	38.1	1.500	19	0.748	1	0.039	19.5	11.3	13.9	**UC206-20**	**UC206-20L2**	5	0.197	15.9	0.626	22.2	0.874	6	0.236	–	1/4-28UNF	0.30
		72	2.835	42.9	1.689	20	0.787	1	0.039	25.7	15.4	13.9	**UCX06-20**	**UCX06-20L3**	5.5	0.217	17.5	0.689	25.4	1.000	6.5	0.256	–	5/16-24UNF	0.55
–	1 1/4	72	2.835	32	1.260	17	0.669	1.1	0.043	25.7	15.4	13.9	**SB207-20**	–	–	–	8.5	0.335	23.5	0.925	6	0.236	–	1/4-28UNF	0.42
		72	2.835	42.9	1.689	20	0.787	1.1	0.043	25.7	15.4	13.9	**UC207-20**	**UC207-20L3**	5.5	0.217	17.5	0.689	25.4	1.000	6.5	0.256	–	5/16-24UNF	0.54
–	1 5/16	72	2.835	42.9	1.689	20	0.787	1.1	0.043	25.7	15.4	13.9	**UC207-21**	**UC207-21L3**	5.5	0.217	17.5	0.689	25.4	1.000	6.5	0.256	–	5/16-24UNF	0.51

Remarks 1. SU type product is the clean series ball bearing for unit.
2. From UC201 to 205 are the double seal type products (L2).

UC, SB, SU

Cylindrical bore (with set screws)

d (30) ~ (60) mm



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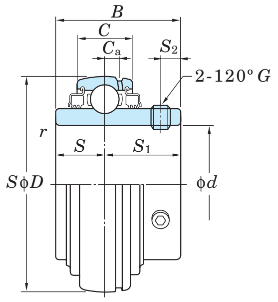
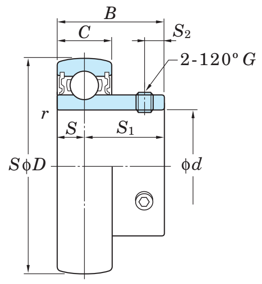
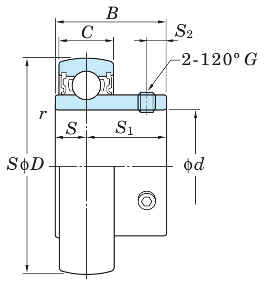


UC-L3



SB

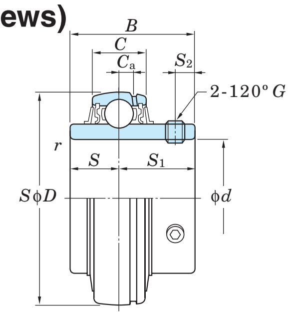


SU

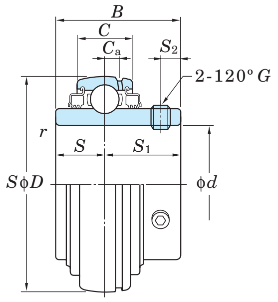
Shaft Dia.		Dimensions								Basic Load Ratings kN		Factor	Bearing No.		Dimensions								Set Screw Brg. Bore G		Mass
mm	inch	D		B		C		r (min.)		C_r	C_{0r}	f_0	Standard	L3 Type	C_a		S		S_1		S_2		mm	inch	kg
d		mm	inch	mm	inch	mm	inch	mm	inch						mm	inch	mm	inch	mm	inch	mm	inch			
–	1 3/8	72	2.835	32	1.260	17	0.669	1.1	0.043	25.7	15.4	13.9	**SB207-22**	–	–	–	8.5	0.335	23.5	0.925	6	0.236	–	1/4-28UNF	0.42
		72	2.835	42.9	1.689	20	0.787	1.1	0.043	25.7	15.4	13.9	**UC207-22**	**UC207-22L3**	5.5	0.217	17.5	0.689	25.4	1.000	6.5	0.256	–	5/16-24UNF	0.48
		80	3.150	49.2	1.937	21	0.827	1.1	0.043	29.1	17.8	14.0	**UCX07-22**	**UCX07-22L3**	6	0.236	19	0.748	30.2	1.189	8	0.315	–	5/16-28UNF	0.75
35	–	72	2.835	32	1.260	17	0.669	1.1	0.043	25.7	15.4	13.9	**SB207**	–	–	–	8.5	0.335	23.5	0.925	6	0.236	M6×0.75	–	0.42
		72	2.835	42.9	1.689	20	0.787	1.1	0.043	25.7	15.4	13.9	**UC207**	**UC207L3**	5.5	0.217	17.5	0.689	25.4	1.000	6.5	0.256	M8×1	–	0.48
		80	3.150	49.2	1.937	21	0.827	1.1	0.043	29.1	17.8	14.0	**UCX07**	**UCX07L3**	6	0.236	19	0.748	30.2	1.189	8	0.315	M8×1	–	0.75
		80	3.150	48	1.890	26	1.024	1.5	0.059	33.4	19.3	13.2	**UC307**	**UC307L3**	7.5	0.295	19	0.748	29	1.142	8	0.315	M8×1	–	0.71
–	1 7/16	72	2.835	32	1.260	17	0.669	1.1	0.043	25.7	15.4	13.9	**SB207-23**	–	–	–	8.5	0.335	23.5	0.925	6	0.236	–	1/4-28UNF	0.42
		72	2.835	42.9	1.689	20	0.787	1.1	0.043	25.7	15.4	13.9	**UC207-23**	**UC207-23L3**	5.5	0.217	17.5	0.689	25.4	1.000	6.5	0.256	–	5/16-28UNF	0.45
		80	3.150	49.2	1.937	21	0.827	1.1	0.043	29.1	17.8	14.0	**UCX07-23**	**UCX07-23L3**	6	0.236	19	0.748	30.2	1.189	8	0.315	–	5/16-28UNF	0.72
–	1 1/2	80	3.150	34	1.339	18	0.709	1.1	0.043	29.1	17.8	14.0	**SB208-24**	–	–	–	9	0.354	25	0.984	8	0.315	–	5/16-24UNF	0.60
		80	3.150	49.2	1.937	21	0.827	1.1	0.043	29.1	17.8	14.0	**UC208-24**	**UC208-24L3**	6	0.236	19	0.748	30.2	1.189	8	0.315	–	5/16-24UNF	0.68
		85	3.346	49.2	1.937	22	0.866	1.1	0.043	34.1	21.3	14.0	**UCX08-24**	**UCX08-24L3**	6	0.236	19	0.748	30.2	1.189	8	0.315	–	5/16-28UNF	0.87
		90	3.543	52	2.047	28	1.102	1.5	0.059	40.7	24.0	13.2	**UC308-24**	**UC308-24L3**	8	0.315	19	0.748	33	1.299	10	0.394	M10×1.25	–	1.05
–	1 9/16	80	3.150	49.2	1.937	21	0.827	1.1	0.043	29.1	17.8	14.0	**UC208-25**	**UC208-25L3**	6	0.236	19	0.748	30.2	1.189	8	0.315	–	5/16-24UNF	0.60
40	–	80	3.150	34	1.339	18	0.709	1.1	0.043	29.1	17.8	14.0	**SB208**	–	–	–	9	0.354	25	0.984	8	0.315	M8×1	–	0.60
		80	3.150	49.2	1.937	21	0.827	1.1	0.043	29.1	17.8	14.0	**UC208**	**UC208L3**	6	0.236	19	0.748	30.2	1.189	8	0.315	M8×1	–	0.64
		85	3.346	49.2	1.937	22	0.866	1.1	0.043	34.1	21.3	14.0	**UCX08**	**UCX08L3**	6	0.236	19	0.748	30.2	1.189	8	0.315	M8×1	–	0.83
		90	3.543	52	2.047	28	1.102	1.5	0.059	40.7	24.0	13.2	**UC308**	**UC308L3**	8	0.315	19	0.748	33	1.299	10	0.394	M10×1.25	–	1.00
–	1 5/8	85	3.346	49.2	1.937	22	0.866	1.1	0.043	34.1	21.3	14.0	**UC209-26**	**UC209-26L3**	6	0.236	19	0.748	30.2	1.189	8	0.315	–	5/16-24UNF	0.78
–	1 11/16	85	3.346	49.2	1.937	22	0.866	1.1	0.043	34.1	21.3	14.0	**UC209-27**	**UC209-27L3**	6	0.236	19	0.748	30.2	1.189	8	0.315	–	5/16-24UNF	0.74
–	1 3/4	85	3.346	49.2	1.937	22	0.866	1.1	0.043	34.1	21.3	14.0	**UC209-28**	**UC209-28L3**	6	0.236	19	0.748	30.2	1.189	8	0.315	–	5/16-24UNF	0.70
		90	3.543	51.6	2.031	24	0.945	1.1	0.043	35.1	23.3	14.4	**UCX09-28**	**UCX09-28L3**	6	0.236	19	0.748	32.6	1.283	9	0.354	–	3/8-24UNF	0.97
		100	3.937	57	2.244	30	1.181	1.5	0.059	48.9	29.5	13.3	**UC309-28**	**UC309-28L3**	8.5	0.335	22	0.866	35	1.378	10	0.394	M10×1.25	–	1.35
45	–	85	3.346	49.2	1.937	22	0.866	1.1	0.043	34.1	21.3	14.0	**UC209**	**UC209L3**	6	0.236	19	0.748	30.2	1.189	8	0.315	M8×1	–	0.68
		90	3.543	51.6	2.031	24	0.945	1.1	0.043	35.1	23.3	14.4	**UCX09**	**UCX09L3**	6	0.236	19	0.748	32.6	1.283	9	0.354	M10×1.25	–	0.95
		100	3.937	57	2.244	30	1.181	1.5	0.059	48.9	29.5	13.3	**UC309**	**UC309L3**	8.5	0.335	22	0.866	35	1.378	10	0.394	M10×1.25	–	1.33
–	1 7/8	90	3.543	51.6	2.031	24	0.945	1.1	0.043	35.1	23.3	14.4	**UC210-30**	**UC210-30L3**	6	0.236	19	0.748	32.6	1.283	9	0.354	–	3/8-24UNF	0.87
–	1 15/16	90	3.543	51.6	2.031	24	0.945	1.1	0.043	35.1	23.3	14.4	**UC210-31**	**UC210-31L3**	6	0.236	19	0.748	32.6	1.283	9	0.354	–	3/8-24UNF	0.82
		100	3.937	55.6	2.189	25	0.984	1.1	0.043	43.4	29.4	14.4	**UCX10-31**	**UCX10-31L3**	7	0.276	22.2	0.874	33.4	1.315	9	0.354	–	3/8-24UNF	1.32
50	–	90	3.543	51.6	2.031	24	0.945	1.1	0.043	35.1	23.3	14.4	**UC210**	**UC210L3**	6	0.236	19	0.748	32.6	1.283	9	0.354	M10×1.25	–	0.80
		100	3.937	55.6	2.189	25	0.984	1.1	0.043	43.4	29.4	14.4	**UCX10**	**UCX10L3**	7	0.276	22.2	0.874	33.4	1.315	9	0.354	M10×1.25	–	1.29
		110	4.331	61	2.402	32	1.260	2	0.079	62.0	38.3	13.2	**UC310**	**UC310L3**	9	0.354	22	0.866	39	1.535	12	0.472	M12×1.5	–	1.69
–	2	90	3.543	51.6	2.031	24	0.945	1.1	0.043	35.1	23.3	14.4	**UC210-32**	**UC210-32L3**	6	0.236	19	0.748	32.6	1.283	9	0.354	–	3/8-24UNF	0.78
		100	3.937	55.6	2.189	25	0.984	1.1	0.043	43.4	29.4	14.4	**UCX10-32**	**UCX10-32L3**	7	0.276	22.2	0.874	33.4	1.315	9	0.354	–	3/8-24UNF	1.26
–	2	100	3.937	55.6	2.189	25	0.984	1.5	0.059	43.4	29.4	14.4	**UC211-32**	**UC211-32L3**	7	0.276	22.2	0.874	33.4	1.315	9	0.354	–	3/8-24UNF	1.26
		120	4.724	66	2.598	34	1.339	2	0.079	71.6	45.0	13.2	**UC311-32**	**UC311-32L3**	10	0.394	25	0.984	41	1.614	12	0.472	M12×1.5	–	2.08
–	2 1/8	100	3.937	55.6	2.189	25	0.984	1.5	0.059	43.4	29.4	14.4	**UC211-34**	**UC211-34L3**	7	0.276	22.2	0.874	33.4	1.315	9	0.354	–	3/8-24UNF	1.15
55	–	100	3.937	55.6	2.189	25	0.984	1.5	0.059	43.4	29.4	14.4	**UC211**	**UC211L3**	7	0.276	22.2	0.874	33.4	1.315	9	0.354	M10×1.25	–	1.11
		110	4.331	65.1	2.563	27	1.063	1.5	0.059	52.4	36.2	14.4	**UCX11**	**UCX11L3**	7.5	0.295	25.4	1.000	39.7	1.563	10.5	0.413	M10×1.25	–	1.80
		120	4.724	66	2.598	34	1.339	2	0.079	71.6	45.0	13.2	**UC311**	**UC311L3**	10	0.394	25	0.984	41	1.614	12	0.472	M12×1.5	–	1.90
–	2 3/16	100	3.937	55.6	2.189	25	0.984	1.5	0.059	43.4	29.4	14.4	**UC211-35**	**UC211-35L3**	7	0.276	22.2	0.874	33.4	1.315	9	0.354	–	3/8-24UNF	1.09
		110	4.331	65.1	2.563	27	1.063	1.5	0.059	52.4	36.2	14.4	**UCX11-35**	**UCX11-35L3**	7.5	0.295	25.4	1.000	39.7	1.563	10.5	0.413	–	3/8-24UNF	1.78
–	2 1/4	110	4.331	65.1	2.563	27	1.063	1.5	0.059	52.4	36.2	14.4	**UCX11-36**	**UCX11-36L3**	7.5	0.295	25.4	1.000	39.7	1.563	10.5	0.413	–	3/8-24UNF	1.7
–	2 1/4	110	4.331	65.1	2.563	27	1.063	1.5	0.059	52.4	36.2	14.4	**UC212-36**	**UC212-36L3**	7.5	0.295	25.4	1.000	39.7	1.563	10.5	0.413	–	3/8-24UNF	1.67
60	–	110	4.331	65.1	2.563	27	1.063	1.5	0.059	52.4	36.2	14.4	**UC212**	**UC212L3**	7.5	0.295	25.4	1.000	39.7	1.563	10.5	0.413	M10×1.25	–	1.54
		120	4.724	65.1	2.563	28	1.102	1.5	0.059	57.2	40.1	14.4	**UCX12**	**UCX12L3**	7.5	0.295	25.4	1.000	39.7	1.563	12	0.472	M12×1.5	–	2.05
		130	5.118	71	2.795	36	1.417	2.1	0.083	81.9	52.2	13.2	**UC312**	**UC312L3**	11.5	0.453	26	1.024	45	1.772	12	0.472	M12×1.5	–	2.60
–	2 3/8	110	4.331	65.1	2.563	27	1.063	1.5	0.059	52.4	36.2	14.4	**UC212-38**	**UC212-38L3**	7.5	0.295	25.4	1.000	39.7	1.563	10.5	0.413	–	3/8-24UNF	1.52

Remarks 1. SU type product is the clean series ball bearing for unit.
2. From UC201 to 205 are the double seal type products (L2).

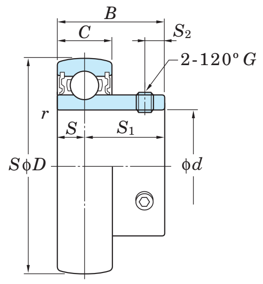
UC, SB, SU
Cylindrical bore (with set screws)
d (60) ~ 140 mm



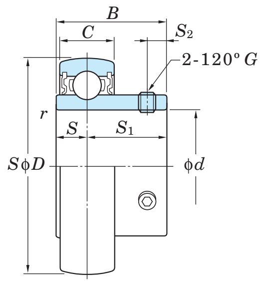
UC



UC-L3



SB

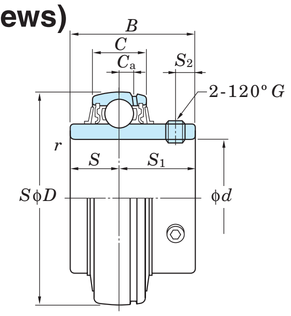


SU

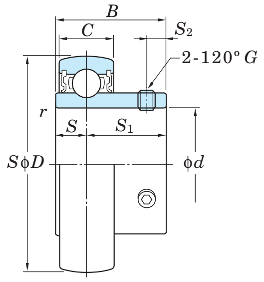
Shaft Dia. mm	Shaft Dia. inch	Dimensions								Basic Load Ratings kN		Factor	Bearing No.		Dimensions								Set Screw Brg. Bore G		Mass
d		D		B		C		r (min.)		C_r	C_{0r}	f_0	Standard	L3 Type	C_a		S		S_1		S_2				
mm	inch	mm	inch	mm	inch	mm	inch	mm	inch						mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	kg
–	2 7/16	110	4.331	65.1	2.563	27	1.063	1.5	0.059	52.4	36.2	14.4	**UC212-39**	**UC212-39L3**	7.5	0.295	25.4	1.000	39.7	1.563	10.5	0.413	–	3/8-24UNF	1.45
		120	4.724	65.1	2.563	28	1.102	1.5	0.059	57.2	40.1	14.4	**UCX12-39**	**UCX12-39L3**	7.5	0.295	25.4	1.000	39.7	1.563	12	0.472	–	1/2-20UNF	1.95
–	2 1/2	120	4.724	65.1	2.563	28	1.102	1.5	0.059	57.2	40.1	14.4	**UC213-40**	**UC213-40L3**	7.5	0.295	25.4	1.000	39.7	1.563	12	0.472	–	1/2-20UNF	1.94
		125	4.921	74.6	2.937	30	1.181	1.5	0.059	62.2	44.1	14.5	**UCX13-40**	**UCX13-40L3**	9	0.354	30.2	1.189	44.4	1.748	12	0.472	–	1/2-20UNF	2.61
		140	5.512	75	2.953	38	1.496	2.1	0.083	92.7	59.9	13.2	**UC313-40**	**UC313-40L3**	12	0.472	30	1.181	45	1.772	12	0.472	M12×1.5	–	3.24
65	–	120	4.724	65.1	2.563	28	1.102	1.5	0.059	57.2	40.1	14.4	**UC213**	**UC213L3**	7.5	0.295	25.4	1.000	39.7	1.563	12	0.472	M12×1.5	–	1.86
		125	4.921	74.6	2.937	30	1.181	1.5	0.059	62.2	44.1	14.5	**UCX13**	**UCX13L3**	9	0.354	30.2	1.189	44.4	1.748	12	0.472	M12×1.5	–	2.52
		140	5.512	75	2.953	38	1.496	2.1	0.083	92.7	59.9	13.2	**UC313**	**UC313L3**	12	0.472	30	1.181	45	1.772	12	0.472	M12×1.5	–	3.16
–	2 3/4	125	4.921	74.6	2.937	30	1.181	1.5	0.059	62.2	44.1	14.5	**UC214-44**	**UC214-44L3**	9	0.354	30.2	1.189	44.4	1.748	12	0.472	–	1/2-20UNF	2.06
		130	5.118	77.8	3.063	32	1.260	1.5	0.059	67.4	48.3	14.5	**UCX14-44**	**UCX14-44L3**	9	0.354	33.3	1.311	44.5	1.752	12	0.472	–	1/2-20UNF	2.75
		150	5.906	78	3.071	40	1.575	2.1	0.083	104	68.2	13.2	**UC314-44**	**UC314-44L3**	12.5	0.492	33	1.299	45	1.772	12	0.472	M12×1.5	–	3.91
70	–	125	4.921	74.6	2.937	30	1.181	1.5	0.059	62.2	44.1	14.5	**UC214**	**UC214L3**	9	0.354	30.2	1.189	44.4	1.748	12	0.472	M12×1.5	–	2.05
		130	5.118	77.8	3.063	32	1.260	1.5	0.059	67.4	48.3	14.5	**UCX14**	**UCX14L3**	9	0.354	33.3	1.311	44.5	1.752	12	0.472	M12×1.5	–	2.74
		150	5.906	78	3.071	40	1.575	2.1	0.083	104	68.2	13.2	**UC314**	**UC314L3**	12.5	0.492	33	1.299	45	1.772	12	0.472	M12×1.5	–	3.90
–	2 15/16	130	5.118	77.8	3.063	32	1.260	1.5	0.059	67.4	48.3	14.5	**UC215-47**	**UC215-47L3**	9	0.354	33.3	1.311	44.5	1.752	12	0.472	–	1/2-20UNF	2.23
		140	5.512	82.6	3.252	33	1.299	1.5	0.059	72.7	53.0	14.6	**UCX15-47**	**UCX15-47L3**	9	0.354	33.3	1.311	49.3	1.941	14	0.551	–	1/2-20UNF	3.43
		160	6.299	82	3.228	42	1.654	2.1	0.083	113	77.2	13.2	**UC315-47**	**UC315-47L3**	14.5	0.571	32	1.260	50	1.969	14	0.551	M14×1.5	–	4.72
75	–	130	5.118	77.8	3.063	32	1.260	1.5	0.059	67.4	48.3	14.5	**UC215**	**UC215L3**	9	0.354	33.3	1.311	44.5	1.752	12	0.472	M12×1.5	–	2.21
		140	5.512	82.6	3.252	33	1.299	1.5	0.059	72.7	53.0	14.6	**UCX15**	**UCX15L3**	9	0.354	33.3	1.311	49.3	1.941	14	0.551	M12×1.5	–	3.41
		160	6.299	82	3.228	42	1.654	2.1	0.083	113	77.2	13.2	**UC315**	**UC315L3**	14.5	0.571	32	1.260	50	1.969	14	0.551	M14×1.5	–	4.70
–	3	130	5.118	77.8	3.063	32	1.260	1.5	0.059	67.4	48.3	14.5	**UC215-48**	**UC215-48L3**	9	0.354	33.3	1.311	44.5	1.752	12	0.472	–	1/2-20UNF	2.12
		140	5.512	82.6	3.252	33	1.299	1.5	0.059	72.7	53.0	14.6	**UCX15-48**	**UCX15-48L3**	9	0.354	33.3	1.311	49.3	1.941	14	0.551	–	1/2-20UNF	3.32
		160	6.299	82	3.228	42	1.654	2.1	0.083	113	77.2	13.2	**UC315-48**	**UC315-48L3**	14.5	0.571	32	1.260	50	1.969	14	0.551	M14×1.5	–	4.61
–	3 1/8	140	5.512	82.6	3.252	33	1.299	2	0.079	72.7	53.0	14.6	**UC216-50**	**UC216-50L3**	9	0.354	33.3	1.311	49.3	1.941	14	0.551	–	1/2-20UNF	2.84
80	–	140	5.512	82.6	3.252	33	1.299	2	0.079	72.7	53.0	14.6	**UC216**	**UC216L3**	9	0.354	33.3	1.311	49.3	1.941	14	0.551	M12×1.5	–	2.79
		150	5.906	85.7	3.374	35	1.378	2	0.079	84.0	61.9	14.5	**UCX16**	**UCX16L3**	10	0.394	34.1	1.343	51.6	2.031	14	0.551	M12×1.5	–	3.87
		170	6.693	86	3.386	44	1.732	2.1	0.083	123	86.7	13.3	**UC316**	**UC316L3**	15	0.591	34	1.339	52	2.047	14	0.551	M14×1.5	–	5.60
–	3 1/4	150	5.906	85.7	3.374	35	1.378	2	0.079	84.0	61.9	14.5	**UC217-52**	**UC217-52L3**	10	0.394	34.1	1.343	51.6	2.031	14	0.551	–	1/2-20UNF	3.66
85	–	150	5.906	85.7	3.374	35	1.378	2	0.079	84.0	61.9	14.5	**UC217**	**UC217L3**	10	0.394	34.1	1.343	51.6	2.031	14	0.551	M12×1.5	–	3.45
		160	6.299	96	3.780	38	1.496	2	0.079	96.1	71.5	14.5	**UCX17**	**UCX17L3**	11	0.433	39.7	1.563	56.3	2.217	15	0.591	M12×1.5	–	5.05
		180	7.087	96	3.780	46	1.811	3	0.118	133	96.8	13.3	**UC317**	**UC317L3**	15	0.591	40	1.575	56	2.205	16	0.630	M16×1.5	–	6.90
–	3 7/16	160	6.299	96	3.780	38	1.496	2	0.079	96.1	71.5	14.5	**UCX17-55**	**UCX17-55L3**	11	0.433	39.7	1.563	56.3	2.217	15	0.591	–	1/2-20UNF	4.80
–	3 1/2	160	6.299	96	3.780	38	1.496	2	0.079	96.1	71.5	14.5	**UC218-56**	**UC218-56L3**	11	0.433	39.7	1.563	56.3	2.217	15	0.591	–	1/2-20UNF	4.46
		190	7.480	96	3.780	48	1.890	3	0.118	143	107	13.3	**UC318-56**	**UC318-56L3**	15.5	0.610	40	1.575	56	2.205	16	0.630	M16×1.5	–	8.03
90	–	160	6.299	96	3.780	38	1.496	2	0.079	96.1	71.5	14.5	**UC218**	**UC218L3**	11	0.433	39.7	1.563	56.3	2.217	15	0.591	M12×1.5	–	4.35
		170	6.693	104	4.094	40	1.575	2	0.079	109	81.9	14.4	**UCX18**	–	11.5	0.453	42.9	1.689	61.1	2.406	16	0.630	M14×1.5	–	6.00
		190	7.480	96	3.780	48	1.890	3	0.118	143	107	13.3	**UC318**	**UC318L3**	15.5	0.610	40	1.575	56	2.205	16	0.630	M16×1.5	–	7.87
95	–	200	7.874	103	4.055	50	1.969	3	0.118	153	119	13.3	**UC319**	**UC319L3**	16.5	0.650	41	1.614	62	2.441	18	0.709	M16×1.5	–	8.91
100	–	190	7.480	117.5	4.626	43	1.693	2.1	0.083	133	105	14.4	**UCX20**	–	13	0.512	49.2	1.937	68.3	2.689	18	0.709	M16×1.5	–	8.56
		215	8.465	108	4.252	54	2.126	3	0.118	173	141	13.2	**UC320**	**UC320L3**	18	0.709	42	1.654	66	2.598	20	0.787	M18×1.5	–	11.2
–	3 15/16	190	7.480	117.5	4.626	43	1.693	2.1	0.083	133	105	14.4	**UCX20-63**	–	13	0.512	49.2	1.937	68.3	2.689	18	0.709	–	5/8-18UNF	8.56
		215	8.465	108	4.252	54	2.126	3	0.118	173	141	13.2	**UC320-63**	**UC320-63L3**	18	0.709	42	1.654	66	2.598	20	0.787	M18×1.5	–	11.2
–	4	190	7.480	117.5	4.626	43	1.693	2.1	0.083	133	105	14.4	**UCX20-64**	–	13	0.512	49.2	1.937	68.3	2.689	18	0.709	–	5/8-18UNF	8.33
		215	8.465	108	4.252	54	2.126	3	0.118	173	141	13.2	**UC320-64**	**UC320-64L3**	18	0.709	42	1.654	66	2.598	20	0.787	M18×1.5	–	11.0
105	–	225	8.858	112	4.409	56	2.205	3	0.118	184	153	13.2	**UC321**	–	19	0.748	44	1.732	68	2.677	20	0.787	M18×1.5	–	12.7
110		240	9.449	117	4.606	60	2.362	3	0.118	205	180	13.2	**UC322**	**UC322L3**	20	0.787	46	1.811	71	2.795	20	0.787	M18×1.5	–	15.1
120		260	10.236	126	4.961	64	2.520	3	0.118	207	185	13.5	**UC324**	**UC324L3**	21	0.827	51	2.008	75	2.953	20	0.787	M18×1.5	–	19.0
130		280	11.024	135	5.315	68	2.677	4	0.157	229	214	13.6	**UC326**	**UC326L3**	22	0.866	54	2.126	81	3.189	20	0.787	M20×1.5	–	23.6
140		300	11.811	145	5.709	72	2.835	4	0.157	253	246	13.6	**UC328**	**UC328L3**	23	0.906	59	2.323	86	3.386	20	0.787	M20×1.5	–	29.4

Remarks 1. SU type product is the clean series ball bearing for unit.
2. From UC201 to 205 are the double seal type products (L2).

UC-S6, SU-S6 (Stainless steel series)
Cylindrical bore (with set screws)
d 10 ~ 50 mm



UC-S6

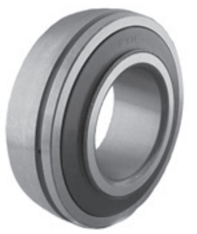


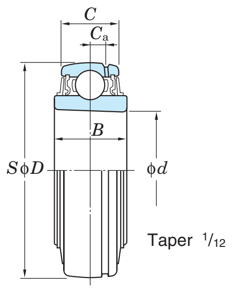
SU-S6

Shaft Dia. mm	Dimensions								Basic Load Ratings kN		Factor	Bearing No.		Dimensions								Set Screw Dia.	Mass
d	D		B		C		r (min.)		C_r	C_{0r}	f_0			C_a		S		S_1		S_2		G	kg
	mm	inch	mm	inch	mm	inch	mm	inch						mm	inch	mm	inch	mm	inch	mm	inch		
10	26	1.024	15	0.591	8	0.315	0.3	0.012	3.9	1.55	12.3	**SU000S6**		–	–	5	0.197	10	0.394	3	0.118	M3×0.35	0.024
12	28	1.102	15	0.591	8	0.315	0.3	0.012	4.3	1.9	13.2	**SU001S6**		–	–	5	0.197	10	0.394	3	0.118	M3×0.35	0.026
15	32	1.260	16.5	0.650	9	0.354	0.3	0.012	4.7	2.25	13.9	**SU002S6**		–	–	5.5	0.217	11	0.433	3.3	0.130	M4×0.5	0.038
17	35	1.378	17.5	0.689	10	0.394	0.3	0.012	5.1	2.6	14.4	**SU003S6**		–	–	6	0.236	11.5	0.453	3.3	0.130	M4×0.5	0.050
20	42	1.654	21	0.827	12	0.472	0.6	0.024	7.9	4	13.9	**SU004S6**		–	–	7	0.276	14	0.551	4	0.157	M5×0.5	0.080
	47	1.850	31	1.220	16	0.630	1	0.039	10.9	5.35	13.2	**UC204S6**		4	0.158	12.7	0.500	18.3	0.720	5	0.197	M6×0.75	0.16
25	47	1.850	22	0.866	12	0.472	0.6	0.024	8.5	4.65	14.5	**SU005S6**		–	–	7	0.276	15	0.591	4.5	0.177	M5×0.5	0.10
	52	2.047	34.1	1.343	17	0.669	1	0.039	11.9	6.3	13.9	**UC205S6**		5	0.197	14.3	0.563	19.8	0.780	5.5	0.217	M6×0.75	0.20
30	55	2.165	24.5	0.965	13	0.512	1	0.039	11.2	6.6	14.7	**SU006S6**		–	–	7.5	0.295	17	0.669	5.5	0.217	M5×0.5	0.15
	62	2.441	38.1	1.500	19	0.748	1	0.039	16.5	9.05	13.9	**UC206S6**		5	0.197	15.9	0.626	22.2	0.874	6	0.236	M6×0.75	0.32
35	72	2.835	42.9	1.689	20	0.787	1.1	0.043	21.8	12.3	13.9	**UC207S6**		5.5	0.217	17.5	0.689	25.4	1.000	6.5	0.256	M8×1	0.48
40	80	3.150	49.2	1.937	21	0.827	1.1	0.043	24.8	14.3	14.0	**UC208S6**		6	0.236	19	0.748	30.2	1.189	8	0.315	M8×1	0.64
45	85	3.346	49.2	1.937	22	0.866	1.1	0.043	27.8	16.2	14.0	**UC209S6**		6	0.236	19	0.748	30.2	1.189	8	0.315	M8×1	0.68
50	90	3.543	51.6	2.031	24	0.945	1.1	0.043	29.8	18.6	14.4	**UC210S6**		6	0.236	19	0.748	32.6	1.283	8	0.315	M8×1	0.80

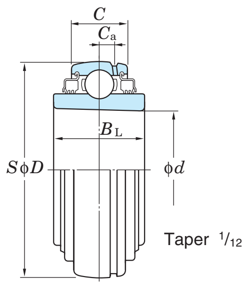
Remark S6 series product is the stainless steel series ball bearing for unit.

UK
Tapered bore (with adapter)
d_1 20 ~ (50) mm

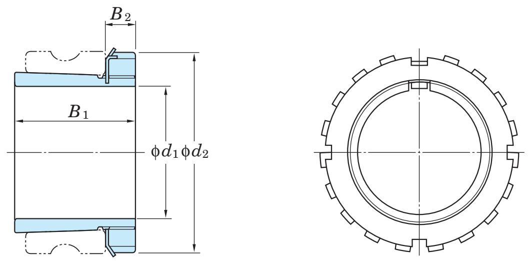




UK



UK-L3



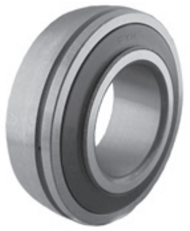
Adapter

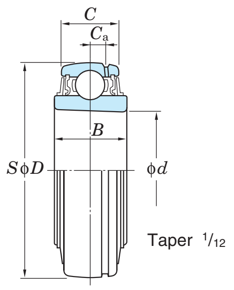
Shaft Dia.		Dimensions						Basic Load Ratings		Factor	Bearing				H3 Series Adapter						H23 Series Adapter					
mm	inch	inch mm						kN			No.		Mass kg		Adapter	Dimensions inch mm			Mass	Sleeve No.	Adapter No.	Dimensions inch mm			Mass	Sleeve No.
d_1		d	D	B	B_L	C	C_a	C_r	C_{0r}	f_0	Standard	L3 Type	Standard	L3 Type	No.	B_1	B_2	d_2	kg			B_1	B_2	d_2	kg	
20	3/4	0.984 25	2.047 52	0.827 21	0.945 24	0.669 17	0.197 5	14.0	7.85	13.9	**UK205**	**UK205L2**	0.16	0.18	HE305X H305X	1.142 29	0.315 8	1.496 38	0.075	AE305X A305X	HE2305X H2305X	1.378 35	0.315 8	1.496 38	0.095	AE2305X A2305X
	3/4	0.984 25	2.441 62	0.906 23	– –	0.748 19	0.197 5	19.5	11.3	13.9	**UKX05**	–	0.27	–	–	– –	– –	– –	–	–	HE2305X H2305X	1.378 35	0.315 8	1.496 38	0.095	AE2305X A2305X
	3/4	0.984 25	2.441 62	1.063 27	– –	0.866 22	0.236 6	21.2	10.9	12.6	**UK305**	–	0.40	–	–	– –	– –	– –	–	–	HE2305X H2305X	1.378 35	0.315 8	1.496 38	0.095	AE2305X A2305X
25	1	1.181 30	2.441 62	0.906 23	1.063 27	0.748 19	0.197 5	19.5	11.3	13.9	**UK206**	**UK206L3**	0.25	0.29	H306X HE306X	1.220 31	0.315 8	1.772 45	0.11	A306X AE306X	H2306X HE2306X	1.496 38	0.315 8	1.772 45	0.13	A2306X HE2306X
	1	1.181 30	2.835 72	1.024 26	– –	0.787 20	0.217 5.5	25.7	15.4	13.9	**UKX06**	–	0.43	–	–	– –	– –	– –	–	–	H2306X HE2306X	1.496 38	0.315 8	1.772 45	0.13	A2306X HE2306X
	1	1.181 30	2.835 72	1.181 30	– –	0.945 24	0.256 6.5	26.7	15.0	13.3	**UK306**	–	0.47	–	–	– –	– –	– –	–	–	H2306X HE2306X	1.496 38	0.315 8	1.772 45	0.13	A2306X HE2306X
30	1 1/8	1.378 35	2.835 72	1.024 26	1.181 30	0.787 20	0.217 5.5	25.7	15.4	13.9	**UK207**	**UK207L3**	0.37	0.43	HS307X H307X	1.378 35	0.354 9	2.047 52	0.14	AS307X A307X	HS2307X H2307X	1.693 43	0.354 9	2.047 52	0.17	AS2307X A2307X
	1 1/8	1.378 35	3.150 80	1.063 27	– –	0.827 21	0.236 6	29.1	17.8	14.0	**UKX07**	–	0.53	–	–	– –	– –	– –	–	–	HS2307X H2307X	1.693 43	0.354 9	2.047 52	0.17	AS2307X A2307X
	1 1/8	1.378 35	3.150 80	1.299 33	1.299 33	1.024 26	0.295 7.5	33.4	19.3	13.2	**UK307**	**UK307L3**	0.60	0.60	–	– –	– –	– –	–	–	HS2307X H2307X	1.693 43	0.354 9	2.047 52	0.17	AS2307X A2307X
35	1 1/4 1 3/8	1.575 40	3.150 80	1.063 27	1.339 34	0.827 21	0.236 6	29.1	17.8	14.0	**UK208**	**UK208L3**	0.47	0.58	HE308X HS308X H308X	1.417 36	0.394 10	2.283 58	0.19	AE308X AS308X A308X	HE2308X HS2308X H2308X	1.811 46	0.394 10	2.283 58	0.22	AE2308X AS2308X A2308X
	1 1/4 1 3/8	1.575 40	3.346 85	1.142 29	– –	0.866 22	0.236 6	34.1	21.3	14.0	**UKX08**	–	0.58	–	–	– –	– –	– –	–	–	HE2308X HS2308X H2308X	1.811 46	0.394 10	2.283 58	0.22	AE2308X AS2308X A2308X
	1 1/4 1 3/8	1.575 40	3.543 90	1.378 35	1.378 35	1.102 28	0.315 8	40.7	24.0	13.2	**UK308**	**UK308L3**	0.80	0.80	–	– –	– –	– –	–	–	HE2308X HS2308X H2308X	1.811 46	0.394 10	2.283 58	0.22	AE2308X AS2308X A2308X
40	1 1/2 1 5/8	1.772 45	3.346 85	1.142 29	1.417 36	0.866 22	0.236 6	34.1	21.3	14.0	**UK209**	**UK209L3**	0.52	0.65	HE309X H309X HS309X	1.535 39	0.433 11	2.559 65	0.25	AE309X A309X AS309X	HE2309X H2309X HS2309X	1.969 50	0.433 11	2.559 65	0.28	AE2309X A2309X AS2309X
	1 1/2 1 5/8	1.772 45	3.543 90	1.142 29	– –	0.945 24	0.236 6	35.1	23.3	14.4	**UKX09**	–	0.67	–	–	– –	– –	– –	–	–	HE2309X H2309X HS2309X	1.969 50	0.433 11	2.559 65	0.28	AE2309X A2309X AS2309X
	1 1/2 1 5/8	1.772 45	3.937 100	1.496 38	1.496 38	1.181 30	0.335 8.5	48.9	29.5	13.3	**UK309**	**UK309L3**	1.08	1.08	–	– –	– –	– –	–	–	HE2309X H2309X HS2309X	1.969 50	0.433 11	2.559 65	0.28	AE2309X A2309X AS2309X
45	1 3/4	1.969 50	3.543 90	1.142 29	1.417 36	0.945 24	0.236 6	35.1	23.3	14.4	**UK210**	**UK210L3**	0.59	0.65	HE310X H310X	1.654 42	0.472 12	2.756 70	0.30	AE310X A310X	HE2310X H2310X	2.165 55	0.472 12	2.756 70	0.36	AE2310X A2310X
	1 3/4	1.969 50	3.937 100	1.220 31	– –	0.984 25	0.276 7	43.4	29.4	14.4	**UKX10**	–	0.89	–	–	– –	– –	– –	–	–	HE2310X H2310X	2.165 55	0.472 12	2.756 70	0.36	AE2310X A2310X
	1 3/4	1.969 50	4.331 110	1.575 40	1.575 40	1.260 32	0.354 9	62.0	38.3	13.2	**UK310**	**UK310L3**	1.38	1.38	–	– –	– –	– –	–	–	HE2310X H2310X	2.165 55	0.472 12	2.756 70	0.36	AE2310X A2310X
50	1 7/8 2	2.165 55	3.937 100	1.220 31	1.575 40	0.984 25	0.276 7	43.4	29.4	14.4	**UK211**	**UK211L3**	0.80	1.09	HS311X H311X HE311X	1.772 45	0.472 12	2.953 75	0.35	AS311X A311X AE311X	HS2311X H2311X HE2311X	2.323 59	0.472 12	2.953 75	0.42	AS2311X A2311X AE2311X

Remarks 1. In Part No. of unit with adapters, Part No. of applicable adapters follow the Part No. shown in the dimensional tables.
(Example of Part No. : UK206 + 306X, UK206L3 + H2306X)

2. Adapter series applicable to UK200 series
UK200....................... H300X series
UK200L3 (or L2) .... H2300X series
3. UK205 is the double seal type product (L2).
4. Inch bore diameter series adapters are also available (see the dimensional tables of adapters).

UK
Tapered bore (with adapter)
d_1 (50) ~ 85 mm





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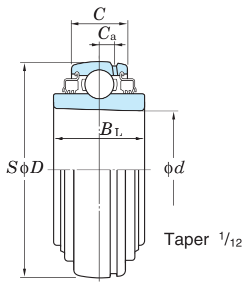
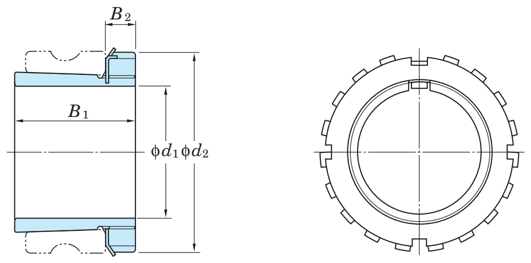


UK-L3



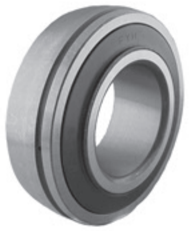
Adapter

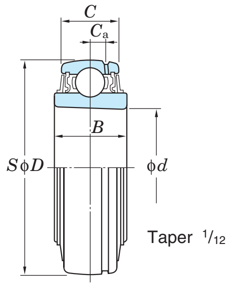
Shaft Dia. mm	Shaft Dia. inch	Dimensions inch / mm						Basic Load Ratings kN		Factor	Bearing No.		Bearing Mass kg		H3 Series Adapter No.	H3 Dimensions inch / mm			H3 Mass kg	H3 Sleeve No.	H23 Series Adapter No.	H23 Dimensions inch / mm			H23 Mass kg	H23 Sleeve No.
d_1		d	D	B	B_L	C	C_a	C_r	C_{0r}	f_0	Standard	L3 Type	Standard	L3 Type		B_1	B_2	d_2				B_1	B_2	d_2		
50	1 7/8 2	2.165 55	4.331 110	1.299 33	– –	1.063 27	0.295 7.5	52.4	36.2	14.4	**UKX11**	–	1.15	–	–	– –	– –	– –	–	–	HS2311X H2311X HE2311X	2.323 59	0.472 12	2.953 75	0.42	AS2311X A2311X AE2311X
	1 7/8 2	2.165 55	4.724 120	1.693 43	1.693 43	1.339 34	0.394 10	71.6	45.0	13.2	**UK311**	**UK311L3**	1.78	1.78	–	– –	– –	– –	–	–	HS2311X H2311X HE2311X	2.323 59	0.472 12	2.953 75	0.42	AS2311X A2311X AE2311X
55	2 1/8	2.362 60	4.331 110	1.299 33	1.850 47	1.063 27	0.295 7.5	52.4	36.2	14.4	**UK212**	**UK212L3**	1.02	1.41	HS312X H312X	1.850 47	0.512 13	3.150 80	0.43	AS312X A312X	HS2312X H2312X	2.441 62	0.512 13	3.150 80	0.48	AS2312X A2312X
	2 1/8	2.362 60	4.724 120	1.417 36	– –	1.102 28	0.295 7.5	57.2	40.1	14.4	**UKX12**	–	1.45	–	–	– –	– –	– –	–	–	HS2312X H2312X	2.441 62	0.512 13	3.150 80	0.48	AS2312X A2312X
	2 1/8	2.362 60	5.118 130	1.850 47	1.850 47	1.417 36	0.453 11.5	81.9	52.2	13.2	**UK312**	**UK312L3**	2.06	2.06	–	– –	– –	– –	–	–	HS2312X H2312X	2.441 62	0.512 13	3.150 80	0.48	AS2312X A2312X
60	2 1/4 2 3/8	2.559 65	4.724 120	1.417 36	1.850 47	1.102 28	0.295 7.5	57.2	40.1	14.4	**UK213**	**UK213L3**	1.34	1.67	HE313X H313X HS313X	1.969 50	0.551 14	3.346 85	0.46	AE313X A313X AS313X	HE2313X H2313X HS2313X	2.559 65	0.551 14	3.346 85	0.56	AE2313X A2313X AS2313X
	2 1/4 2 3/8	2.559 65	4.921 125	1.575 40	– –	1.181 30	0.354 9	62.2	44.1	14.5	**UKX13**	–	1.62	–	–	– –	– –	– –	–	–	HE2313X H2313X HS2313X	2.559 65	0.551 14	3.346 85	0.56	AE2313X A2313X AS2313X
	2 1/4 2 3/8	2.559 65	5.512 140	1.929 49	1.929 49	1.496 38	0.472 12	92.7	59.9	13.2	**UK313**	**UK313L3**	2.71	2.71	–	– –	– –	– –	–	–	HE2313X H2313X HS2313X	2.559 65	0.551 14	3.346 85	0.56	AE2313X A2313X AS2313X
65	2 1/2	2.953 75	5.118 130	1.575 40	2.008 51	1.260 32	0.354 9	67.4	48.3	14.5	**UK215**	**UK215L3**	1.50	1.99	HE315X H315X	2.165 55	0.591 15	3.858 98	0.83	AE315X A315X	HE2315X H2315X	2.874 73	0.591 15	3.858 98	1.05	AE2315X A2315X
	2 1/2	2.953 75	5.512 140	1.654 42	– –	1.299 33	0.354 9	72.7	53.0	14.6	**UKX15**	–	2.10	–	–	– –	– –	– –	–	–	HE2315X H2315X	2.874 73	0.591 15	3.858 98	1.05	AE2315X A2315X
	2 1/2	2.953 75	6.299 160	2.165 55	2.165 55	1.654 42	0.571 14.5	113	77.2	13.2	**UK315**	**UK315L3**	3.80	3.80	–	– –	– –	– –	–	–	HE2315X H2315X	2.874 73	0.591 15	3.858 98	1.05	AE2315X A2315X
70	2 3/4	3.150 80	5.512 140	1.654 42	2.165 55	1.299 33	0.354 9	72.7	53.0	14.6	**UK216**	**UK216L3**	1.96	2.56	HE316X H316X	2.323 59	0.669 17	4.134 105	1.05	AE316X A316X	HE2316X H2316X	3.071 78	0.669 17	4.134 105	1.3	AE2316X A2316X
	2 3/4	3.150 80	5.906 150	1.732 44	– –	1.378 35	0.394 10	84.0	61.9	14.5	**UKX16**	–	2.64	–	–	– –	– –	– –	–	–	HE2316X H2316X	3.071 78	0.669 17	4.134 105	1.3	AE2316X A2316X
	2 3/4	3.150 80	6.693 170	2.165 55	2.165 55	1.732 44	0.591 15	123	86.7	13.3	**UK316**	**UK316L3**	4.39	4.39	–	– –	– –	– –	–	–	HE2316X H2316X	3.071 78	0.669 17	4.134 105	1.3	AE2316X A2316X
75	3	3.346 85	5.906 150	1.732 44	2.244 57	1.378 35	0.394 10	84.0	61.9	14.5	**UK217**	**UK217L3**	2.42	3.10	H317X HE317X	2.480 63	0.709 18	4.331 110	1.2	A317X AE317X	H2317X HE2317X	3.228 82	0.709 18	4.331 110	1.45	A2317X AE2317X
	3	3.346 85	6.299 160	1.890 48	– –	1.496 38	0.433 11	96.1	71.5	14.5	**UKX17**	–	3.25	–	–	– –	– –	– –	–	–	H2317X HE2317X	3.228 82	0.709 18	4.331 110	1.45	A2317X AE2317X
	3	3.346 85	7.087 180	2.362 60	2.362 60	1.811 46	0.591 15	133	96.8	13.3	**UK317**	**UK317L3**	5.30	5.30	–	– –	– –	– –	–	–	H2317X HE2317X	3.228 82	0.709 18	4.331 110	1.45	A2317X AE2317X
80	–	3.543 90	6.299 160	1.890 48	2.480 63	1.496 38	0.433 11	96.1	71.5	14.5	**UK218**	**UK218L3**	2.90	3.77	H318X	2.559 65	0.709 18	4.724 120	1.4	A318X	H2318X	3.386 86	0.709 18	4.724 120	1.7	A2318X
	–	3.543 90	6.693 170	1.969 50	– –	1.575 40	0.453 11.5	109	81.9	14.4	**UKX18**	–	3.80	–	–	– –	– –	– –	–	–	H2318X	3.386 86	0.709 18	4.724 120	1.7	A2318X
	–	3.543 90	7.480 190	2.362 60	2.362 60	1.890 48	0.610 15.5	143	107	13.3	**UK318**	**UK318L3**	6.20	6.20	–	– –	– –	– –	–	–	H2318X	3.386 86	0.709 18	4.724 120	1.7	A2318X
85	3 1/4	3.740 95	7.874 200	2.598 66	2.598 66	1.969 50	0.650 16.5	153	119	13.3	**UK319**	**UK319L3**	7.31	7.31	–	– –	– –	– –	–	–	H2319X	3.543 90	0.748 19	4.921 125	1.95	A2319X

Remarks 1. In Part No. of unit with adapters, Part No. of applicable adapters follow the Part No. shown in the dimensional tables.
(Example of Part No. : UK206 + 306X, UK206L3 + H2306X)

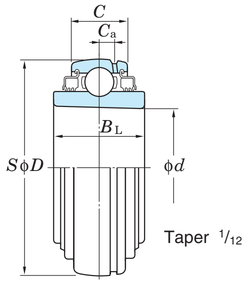
2. Adapter series applicable to UK200 series
UK200...................... H300X series
UK200L3 (or L2) .... H2300X series
3. UK205 is the double seal type product (L2).
4. Inch bore diameter series adapters are also available (see the dimensional tables of adapters).

UK
Tapered bore (with adapter)
d_1 90 ~ 125 mm

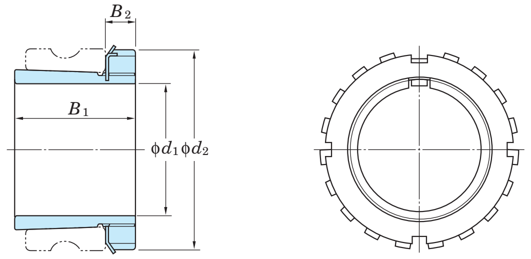




UK



UK-L3



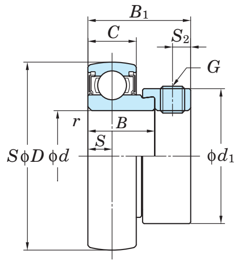
Adapter

Shaft Dia. mm	Shaft Dia. inch	Dimensions inch / mm						Basic Load Ratings kN		Factor	Bearing No.		Bearing Mass kg		H3 Series Adapter						H23 Series Adapter					
d_1		d	D	B	B_L	C	C_a	C_r	C_{0r}	f_0	Standard	L3 Type	Standard	L3 Type	Adapter No.	B_1	B_2	d_2	Mass kg	Sleeve No.	Adapter No.	B_1	B_2	d_2	Mass kg	Sleeve No.
90	3 1/2	3.937 100	7.480 190	2.126 54	– –	1.693 43	0.512 13	133	105	14.4	**UKX20**	–	5.36	–	–	– –	– –	– –	–	–	HE2320X H2320X	3.819 97	0.787 20	5.118 130	2.2	AE2320X A2320X
	3 1/2	3.937 100	8.465 215	2.677 68	2.677 68	2.126 54	0.709 18	173	141	13.2	**UK320**	**UK320L3**	8.70	8.70	–	– –	– –	– –	–	–	HE2320X H2320X	3.819 97	0.787 20	5.118 130	2.2	AE2320X A2320X
100	4	4.331 110	9.449 240	3.071 78	3.071 78	2.362 60	0.787 20	205	180	13.2	**UK322**	**UK322L3**	12.2	12.2	–	– –	– –	– –	–	–	H2322X HE2322X	4.134 105	0.827 21	5.709 145	2.75	A2322X AE2322X
110	–	4.724 120	10.236 260	3.425 87	3.425 87	2.520 64	0.827 21	207	185	13.5	**UK324**	**UK324L3**	16.1	16.1	–	– –	– –	– –	–	–	H2324	4.409 112	0.866 22	6.102 155	3.2	A2324
115	4 1/2	5.118 130	11.024 280	3.425 87	3.425 87	2.677 68	0.866 22	229	214	13.6	**UK326**	**UK326L3**	18.8	18.8	–	– –	– –	– –	–	–	HE2326 H2326	4.764 121	0.906 23	6.496 165	4.6	AE2326 A2326
125	–	5.512 140	11.811 300	3.819 97	3.819 97	2.835 72	0.906 23	253	246	13.6	**UK328**	**UK328L3**	23.9	23.9	–	– –	– –	– –	–	–	H2328	5.157 131	0.945 24	7.087 180	5.5	A2328

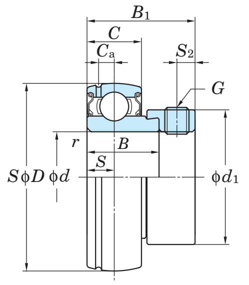
Remarks 1. In Part No. of unit with adapters, Part No. of applicable adapters follow the Part No. shown in the dimensional tables.
(Example of Part No. : UK206 + 306X, UK206L3 + H2306X)

2. Adapter series applicable to UK200 series
UK200....................... H300X series
UK200L3 (or L2) .... H2300X series
3. UK205 is the double seal type product (L2).
4. Inch bore diameter series adapters are also available (see the dimensional tables of adapters).

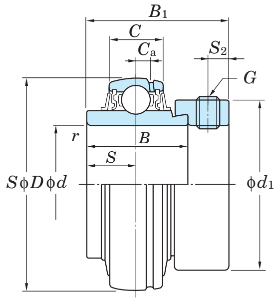
SA, SA-F, NA
Cylindrical bore
(with eccentric locking collar)
d 12 ~ (30) mm



SA



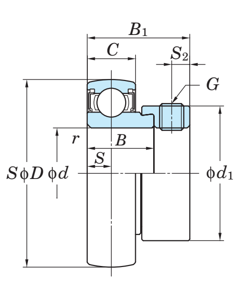
SAF



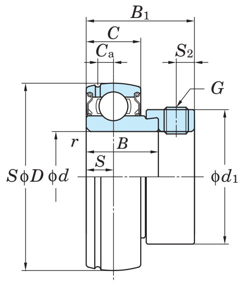
NA

Shaft Dia		Dimensions										Basic Load Ratings kN		Factor	Bearing No.	Dimensions								Set Screw Brg.Bore		Mass
d		*D*		*B*		B_1		*C*		*r* (min.)		C_r	C_{0r}	f_0		C_a		*S*		S_2		d_1				
mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch					mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	kg
12	–	40	1.575	19	0.784	28.5	1.122	12	0.472	0.6	0.024	9.55	4.80	13.2	**SA201**	–	–	6	0.236	4.8	0.189	28.6	1.126	M6×0.75	–	0.13
		40	1.575	19.1	0.752	28.6	1.126	13	0.512	0.6	0.024	9.55	4.80	13.2	**SA201F**	3.4	0.134	6.5	0.256	4.8	0.189	28.6	1.126	M6×0.75	–	0.13
		47	1.850	34.2	1.346	43.7	1.720	16	0.630	1	0.039	12.8	6.65	13.2	**NA201**	4	0.157	17.1	0.673	4.8	0.189	33.3	1.311	M6×0.75	–	0.29
–	1/2	40	1.575	19	0.784	28.5	1.122	12	0.472	0.6	0.024	9.55	4.80	13.2	**SA201-8**	–	–	6	0.236	4.8	0.189	28.6	1.126	–	1/4-28UNF	0.13
		40	1.575	19.1	0.752	28.6	1.126	13	0.512	0.6	0.024	9.55	4.80	13.2	**SA201-8F**	3.4	0.134	6.5	0.256	4.8	0.189	28.6	1.126	–	1/4-28UNF	0.13
		47	1.850	34.2	1.346	43.7	1.720	16	0.630	1	0.039	12.8	6.65	13.2	**NA201-8**	4	0.157	17.1	0.673	4.8	0.189	33.3	1.311	–	1/4-28UNF	0.29
15	–	40	1.575	19	0.784	28.5	1.122	12	0.472	0.6	0.024	9.55	4.80	13.2	**SA202**	–	–	6	0.236	4.8	0.189	28.6	1.126	M6×0.75	–	0.13
		40	1.575	19.1	0.752	28.6	1.126	13	0.512	0.6	0.024	9.55	4.80	13.2	**SA202F**	3.4	0.134	6.5	0.256	4.8	0.189	28.6	1.126	M6×0.75	–	0.13
		47	1.850	34.2	1.346	43.7	1.720	16	0.630	1	0.039	12.8	6.65	13.2	**NA202**	4	0.157	17.1	0.673	4.8	0.189	33.3	1.311	M6×0.75	–	0.27
–	5/8	40	1.575	19	0.784	28.5	1.122	12	0.472	0.6	0.024	9.55	4.80	13.2	**SA202-10**	–	–	6	0.236	4.8	0.189	28.6	1.126	–	1/4-28UNF	0.13
		47	1.850	34.2	1.346	43.7	1.720	16	0.630	1	0.039	12.8	6.65	13.2	**NA202-10**	4	0.157	17.1	0.673	4.8	0.189	33.3	1.311	–	1/4-28UNF	0.26
17	–	40	1.575	19	0.784	28.5	1.122	12	0.472	0.6	0.024	9.55	4.80	13.2	**SA203**	–	–	6	0.236	4.8	0.189	28.6	1.126	M6×0.75	–	0.13
		40	1.575	19.1	0.752	28.6	1.126	13	0.512	0.6	0.024	9.55	4.80	13.2	**SA203F**	3.4	0.134	6.5	0.256	4.8	0.189	28.6	1.126	M6×0.75	–	0.13
		47	1.850	34.2	1.346	43.7	1.720	16	0.630	1	0.039	12.8	6.65	13.2	**NA203**	4	0.157	17.1	0.673	4.8	0.189	33.3	1.311	M6×0.75	–	0.25
–	3/4	47	1.850	20	0.787	29.5	1.161	14	0.551	1	0.039	12.8	6.65	13.2	**SA204-12**	–	–	7	0.276	4.8	0.189	33.3	1.311	–	1/4-28UNF	0.15
		47	1.850	21.5	0.846	31	1.220	15	0.591	1	0.039	12.8	6.65	13.2	**SA204-12F**	3.7	0.146	7.5	0.295	4.8	0.189	33.3	1.311	–	1/4-28UNF	0.19
		47	1.850	34.2	1.346	43.7	1.720	16	0.630	1	0.039	12.8	6.65	13.2	**NA204-12**	4	0.157	17.1	0.673	4.8	0.189	33.3	1.311	–	1/4-28UNF	0.23
20	–	47	1.850	20	0.787	29.5	1.161	14	0.551	1	0.039	12.8	6.65	13.2	**SA204**	–	–	7	0.276	4.8	0.189	33.3	1.311	M6×0.75	–	0.15
		47	1.850	21.5	0.846	31	1.220	15	0.591	1	0.039	12.8	6.65	13.2	**SA204F**	3.7	0.146	7.5	0.295	4.8	0.189	33.3	1.311	M6×0.75	–	0.19
		47	1.850	34.2	1.346	43.7	1.720	16	0.630	1	0.039	12.8	6.65	13.2	**NA204**	4	0.157	17.1	0.673	4.8	0.189	33.3	1.311	M6×0.75	–	0.22
–	7/8	52	2.047	21	0.827	30.5	1.201	15	0.591	1	0.039	14.0	7.85	13.9	**SA205-14**	–	–	7.5	0.295	4.8	0.189	38.1	1.311	–	1/4-28UNF	0.22
		52	2.047	34.9	1.374	44.4	1.748	17	0.669	1	0.039	14.0	7.85	13.9	**NA205-14**	5	0.197	17.5	0.689	4.8	0.189	38.1	1.500	–	1/4-28UNF	0.27
–	15/16	52	2.047	21	0.827	30.5	1.201	15	0.591	1	0.039	14.0	7.85	13.9	**SA205-15**	–	–	7.5	0.295	4.8	0.189	38.1	1.311	–	1/4-28UNF	0.22
		52	2.047	21.5	0.846	31	1.220	15	0.591	1	0.039	14.0	7.85	13.9	**SA205-15F**	3.7	0.146	7.5	0.295	4.8	0.189	38.1	1.311	–	1/4-28UNF	0.23
		52	2.047	34.9	1.374	44.4	1.748	17	0.669	1	0.039	14.0	7.85	13.9	**NA205-15**	5	0.197	17.5	0.689	4.8	0.189	38.1	1.500	–	1/4-28UNF	0.29
25	–	52	2.047	21	0.827	30.5	1.201	15	0.591	1	0.039	14.0	7.85	13.9	**SA205**	–	–	7.5	0.295	4.8	0.189	38.1	1.311	M6×0.75	–	0.22
		52	2.047	21.5	0.846	31	1.220	15	0.591	1	0.039	14.0	7.85	13.9	**SA205F**	3.7	0.146	7.5	0.295	4.8	0.189	38.1	1.311	M6×0.75	–	0.23
		52	2.047	34.9	1.374	44.4	1.748	17	0.669	1	0.039	14.0	7.85	13.9	**NA205**	5	0.197	17.5	0.689	4.8	0.189	38.1	1.500	M6×0.75	–	0.25
–	1	52	2.047	21	0.827	30.5	1.201	15	0.591	1	0.039	14.0	7.85	13.9	**SA205-16**	–	–	7.5	0.295	4.8	0.189	38.1	1.311	–	1/4-28UNF	0.22
		52	2.047	21.5	0.846	31	1.220	15	0.591	1	0.039	14.0	7.85	13.9	**SA205-16F**	3.7	0.146	7.5	0.295	4.8	0.189	38.1	1.311	–	1/4-28UNF	0.23
		52	2.047	34.9	1.374	44.4	1.748	17	0.669	1	0.039	14.0	7.85	13.9	**NA205-16**	5	0.197	17.5	0.689	4.8	0.189	38.1	1.500	–	1/4-28UNF	0.25
–	1 1/8	62	2.441	22	0.866	33.9	1.335	16	0.630	1	0.039	19.5	11.3	13.9	**SA206-18**	–	–	8	0.315	6	0.236	44.5	1.752	–	5/16-24UNF	0.3
		62	2.441	23.8	0.937	35.7	1.406	18	0.709	1	0.039	19.5	11.3	13.9	**SA206-18F**	4.7	0.185	9	0.354	6	0.236	44.5	1.752	–	5/16-24UNF	0.34
		62	2.441	36.5	1.437	48.4	1.906	19	0.748	1	0.039	19.5	11.3	13.9	**NA206-18**	5	0.197	18.3	0.720	6	0.236	44.5	1.752	–	5/16-24UNF	0.43
30	–	62	2.441	22	0.866	33.9	1.335	16	0.630	1	0.039	19.5	11.3	13.9	**SA206**	–	–	8	0.315	6	0.236	44.5	1.752	M8×1	–	0.3
		62	2.441	23.8	0.937	35.7	1.406	18	0.709	1	0.039	19.5	11.3	13.9	**SA206F**	4.7	0.185	9	0.354	6	0.236	44.5	1.752	M8×1	–	0.34
		62	2.441	36.5	1.437	48.4	1.906	19	0.748	1	0.039	19.5	11.3	13.9	**NA206**	5	0.197	18.3	0.720	6	0.236	44.5	1.752	M8×1	–	0.41
–	1 3/16	62	2.441	22	0.866	33.9	1.335	16	0.630	1	0.039	19.5	11.3	13.9	**SA206-19**	–	–	8	0.315	6	0.236	44.5	1.752	–	5/16-24UNF	0.3
		62	2.441	23.8	0.937	35.7	1.406	18	0.709	1	0.039	19.5	11.3	13.9	**SA206-19F**	4.7	0.185	9	0.354	6	0.236	44.5	1.752	–	5/16-24UNF	0.34
		62	2.441	36.5	1.437	48.4	1.906	19	0.748	1	0.039	19.5	11.3	13.9	**NA206-19**	5	0.197	18.3	0.720	6	0.236	44.5	1.752	–	5/16-24UNF	0.41
–	1 1/4	62	2.441	22	0.866	33.9	1.335	16	0.630	1	0.039	19.5	11.3	13.9	**SA206-20**	–	–	8	0.315	6	0.236	44.5	1.752	–	5/16-24UNF	0.3
		62	2.441	23.8	0.937	35.7	1.406	18	0.709	1	0.039	19.5	11.3	13.9	**SA206-20F**	4.7	0.185	9	0.354	6	0.236	44.5	1.752	–	5/16-24UNF	0.34
		62	2.441	36.5	1.437	48.4	1.906	19	0.748	1	0.039	19.5	11.3	13.9	**NA206-20**	5	0.197	18.3	0.720	6	0.236	44.5	1.752	–	5/16-24UNF	0.38
–	1 1/4	72	2.835	23	0.906	36.5	1.437	17	0.669	1.1	0.043	25.7	15.4	13.9	**SA207-20**	–	–	8.5	0.335	6.8	0.268	55.6	2.189	–	5/16-24UNF	0.5
		72	2.835	25.4	1.000	38.9	1.531	19	0.748	1.1	0.043	25.7	15.4	13.9	**SA207-20F**	5.7	0.224	9.5	0.335	6.8	0.268	55.6	2.189	–	5/16-24UNF	0.57
		72	2.835	37.6	1.480	51.1	2.012	20	0.787	1.1	0.043	25.7	15.4	13.9	**NA207-20**	5.5	0.217	18.8	0.740	6.8	0.268	55.6	2.189	–	5/16-24UNF	0.68
–	1 5/16	72	2.835	23	0.906	36.5	1.437	17	0.669	1.1	0.043	25.7	15.4	13.9	**SA207-21**	–	–	8.5	0.335	6.8	0.268	55.6	2.189	–	5/16-24UNF	0.5
		72	2.835	25.4	1.000	38.9	1.531	19	0.748	1.1	0.043	25.7	15.4	13.9	**SA207-21F**	5.7	0.224	9.5	0.335	6.8	0.268	55.6	2.189	–	5/16-24UNF	0.57
		72	2.835	37.6	1.480	51.1	2.012	20	0.787	1.1	0.043	25.7	15.4	13.9	**NA207-21**	5.5	0.217	18.8	0.740	6.8	0.268	55.6	2.189	–	5/16-24UNF	0.65

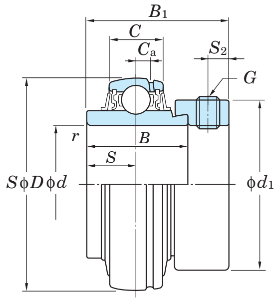
SA, SA-F, NA
Cylindrical bore
(with eccentric locking collar)
d (30) ~ 75 mm



SA



SAF



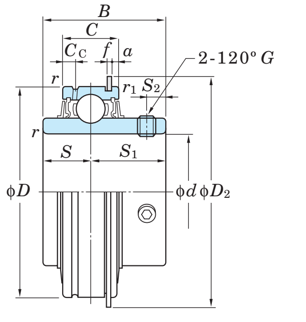
NA

Shaft Dia		Dimensions										Basic Load Ratings kN		Factor	Bearing No.	Dimensions								Set Screw Brg.Bore		Mass
d		D		B		B_1		C		r (min.)		C_r	C_{0r}	f_0		C_a		S		S_2		d_1				
mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch					mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	kg
–	1 3/8	72	2.835	23	0.906	36.5	1.437	17	0.669	1.1	0.043	25.7	15.4	13.9	**SA207-22**	–	–	8.5	0.335	6.8	0.268	55.6	2.189	–	5/16-24UNF	0.5
		72	2.835	25.4	1.000	38.9	1.531	19	0.748	1.1	0.043	25.7	15.4	13.9	**SA207-22F**	5.7	0.224	9.5	0.335	6.8	0.268	55.6	2.189	–	5/16-24UNF	0.57
		72	2.835	37.6	1.480	51.1	2.012	20	0.787	1.1	0.043	25.7	15.4	13.9	**NA207-22**	5.5	0.217	18.8	0.740	6.8	0.268	55.6	2.189	–	5/16-24UNF	0.61
35	–	72	2.835	23	0.906	36.5	1.437	17	0.669	1.1	0.043	25.7	15.4	13.9	**SA207**	–	–	8.5	0.335	6.8	0.268	55.6	2.189	M8×1	–	0.5
		72	2.835	25.4	1.000	38.9	1.531	19	0.748	1.1	0.043	25.7	15.4	13.9	**SA207F**	5.7	0.224	9.5	0.335	6.8	0.268	55.6	2.189	M8×1	–	0.57
		72	2.835	37.6	1.480	51.1	2.012	20	0.787	1.1	0.043	25.7	15.4	13.9	**NA207**	5.5	0.217	18.8	0.740	6.8	0.268	55.6	2.189	M8×1	–	0.61
–	1 7/16	72	2.835	23	0.906	36.5	1.437	17	0.669	1.1	0.043	25.7	15.4	13.9	**SA207-23**	–	–	8.5	0.335	6.8	0.268	55.6	2.189	–	5/16-24UNF	0.5
		72	2.835	25.4	1.000	38.9	1.531	19	0.748	1.1	0.043	25.7	15.4	13.9	**SA207-23F**	5.7	0.224	9.5	0.335	6.8	0.268	55.6	2.189	–	5/16-24UNF	0.57
		72	2.835	37.6	1.480	51.1	2.012	20	0.787	1.1	0.043	25.7	15.4	13.9	**NA207-23**	5.5	0.217	18.8	0.740	6.8	0.268	55.6	2.189	–	5/16-24UNF	0.58
–	1 1/2	80	3.150	27	1.063	40.5	1.595	18	0.709	1.1	0.043	29.1	17.8	14.0	**SA208-24**	–	–	9	0.354	6.8	0.268	60.3	2.374	–	5/16-24UNF	0.67
		80	3.150	30.2	1.189	43.7	1.720	22	0.866	1.1	0.043	29.1	17.8	14.0	**SA208-24F**	6.4	0.252	11	0.433	6.8	0.268	60.3	2.374	–	5/16-24UNF	0.75
		80	3.150	42.8	1.685	56.3	2.217	21	0.827	1.1	0.043	29.1	17.8	14.0	**NA208-24**	6	0.236	21.4	0.843	6.8	0.268	60.3	2.374	–	5/16-24UNF	0.83
–	1 9/16	80	3.150	27	1.063	40.5	1.595	18	0.709	1.1	0.043	29.1	17.8	14.0	**SA208-25**	–	–	9	0.354	6.8	0.268	60.3	2.374	–	5/16-24UNF	0.67
		80	3.150	30.2	1.189	43.7	1.720	22	0.866	1.1	0.043	29.1	17.8	14.0	**SA208-25F**	6.4	0.252	11	0.433	6.8	0.268	60.3	2.374	–	5/16-24UNF	0.75
		80	3.150	42.8	1.685	56.3	2.217	21	0.827	1.1	0.043	29.1	17.8	14.0	**NA208-25**	6	0.236	21.4	0.843	6.8	0.268	60.3	2.374	–	5/16-24UNF	0.79
40	–	80	3.150	27	1.063	40.5	1.595	18	0.709	1.1	0.043	29.1	17.8	14.0	**SA208**	–	–	9	0.354	6.8	0.268	60.3	2.374	M8×1	–	0.67
		80	3.150	30.2	1.189	43.7	1.720	22	0.866	1.1	0.043	29.1	17.8	14.0	**SA208F**	6.4	0.252	11	0.433	6.8	0.268	60.3	2.374	M8×1	–	0.75
		80	3.150	42.8	1.685	56.3	2.217	21	0.827	1.1	0.043	29.1	17.8	14.0	**NA208**	6	0.236	21.4	0.843	6.8	0.268	60.3	2.374	M8×1	–	0.78
–	1 5/8	85	3.346	30.2	1.189	43.7	1.720	22	0.866	1.1	0.043	34.1	21.3	14.0	**SA209-26F**	6	0.236	11	0.433	6.8	0.268	63.5	2.500	–	5/16-24UNF	0.82
		85	3.346	42.8	1.685	56.3	2.217	22	0.866	1.1	0.043	34.1	21.3	14.0	**NA209-26**	6	0.236	21.4	0.843	6.8	0.268	63.5	2.500	–	5/16-24UNF	0.96
–	1 11/16	85	3.346	30.2	1.189	43.7	1.720	22	0.866	1.1	0.043	34.1	21.3	14.0	**SA209-27F**	6	0.236	11	0.433	6.8	0.268	63.5	2.500	–	5/16-24UNF	0.82
		85	3.346	42.8	1.685	56.3	2.217	22	0.866	1.1	0.043	34.1	21.3	14.0	**NA209-27**	6	0.236	21.4	0.843	6.8	0.268	63.5	2.500	–	5/16-24UNF	0.91
–	1 3/4	85	3.346	30.2	1.189	43.7	1.720	22	0.866	1.1	0.043	34.1	21.3	14.0	**SA209-28F**	6	0.236	11	0.433	6.8	0.268	63.5	2.500	–	5/16-24UNF	0.82
		85	3.346	42.8	1.685	56.3	2.217	22	0.866	1.1	0.043	34.1	21.3	14.0	**NA209-28**	6	0.236	21.4	0.843	6.8	0.268	63.5	2.500	–	5/16-24UNF	0.87
45	–	85	3.346	30.2	1.189	43.7	1.720	22	0.866	1.1	0.043	34.1	21.3	14.0	**SA209F**	6	0.236	11	0.433	6.8	0.268	63.5	2.500	M8×1	–	0.82
		85	3.346	42.8	1.685	56.3	2.217	22	0.866	1.1	0.043	34.1	21.3	14.0	**NA209**	6	0.236	21.4	0.843	6.8	0.268	63.5	2.500	M8×1	–	0.85
–	1 7/8	90	3.543	30.2	1.189	43.7	1.720	22	0.866	1.1	0.043	35.1	23.3	14.4	**SA210-30F**	6.6	0.260	11	0.433	6.8	0.268	69.9	2.752	–	5/16-24UNF	0.85
		90	3.543	49.2	1.937	62.7	2.469	24	0.945	1.1	0.043	35.1	23.3	14.4	**NA210-30**	6	0.236	24.6	0.969	6.8	0.268	69.9	2.752	–	5/16-24UNF	1.08
–	1 15/16	90	3.543	30.2	1.189	43.7	1.720	22	0.866	1.1	0.043	35.1	23.3	14.4	**SA210-31F**	6.6	0.260	11	0.433	6.8	0.268	69.9	2.752	–	5/16-24UNF	0.85
		90	3.543	49.2	1.937	62.7	2.469	24	0.945	1.1	0.043	35.1	23.3	14.4	**NA210-31**	6	0.236	24.6	0.969	6.8	0.268	69.9	2.752	–	5/16-24UNF	1.04
50	–	90	3.543	30.2	1.189	43.7	1.720	22	0.866	1.1	0.043	35.1	23.3	14.4	**SA210F**	6.6	0.260	11	0.433	6.8	0.268	69.9	2.752	M8×1	–	0.85
		90	3.543	49.2	1.937	62.7	2.469	24	0.945	1.1	0.043	35.1	23.3	14.4	**NA210**	6	0.236	24.6	0.969	6.8	0.268	69.9	2.752	M8×1	–	1.01
–	2	90	3.543	49.2	1.937	62.7	2.469	24	0.945	1.1	0.043	35.1	23.3	14.4	**NA210-32**	6	0.236	24.6	0.969	6.8	0.268	69.9	2.752	–	5/16-24UNF	0.99
		100	3.937	32.4	1.276	48.4	1.906	24	0.945	1.5	0.059	43.4	29.4	14.4	**SA211-32F**	7	0.276	12	0.472	8	0.315	76.2	3.000	–	3/8-24UNF	1.2
		100	3.937	55.5	2.185	71.4	2.811	25	0.984	1.5	0.059	43.4	29.4	14.4	**NA211-32**	7	0.276	27.8	1.094	8	0.315	76.2	3.000	–	3/8-24UNF	1.58
–	2 1/8	100	3.937	32.4	1.276	48.4	1.906	24	0.945	1.5	0.059	43.4	29.4	14.4	**SA211-34F**	7	0.276	12	0.472	8	0.315	76.2	3.000	–	3/8-24UNF	1.2
		100	3.937	55.5	2.185	71.4	2.811	25	0.984	1.5	0.059	43.4	29.4	14.4	**NA211-34**	7	0.276	27.8	1.094	8	0.315	76.2	3.000	–	3/8-24UNF	1.49
55	–	100	3.937	32.4	1.276	48.4	1.906	24	0.945	1.5	0.059	43.4	29.4	14.4	**SA211F**	7	0.276	12	0.472	8	0.315	76.2	3.000	M10×1.25	–	1.2
		100	3.937	55.5	2.185	71.4	2.811	25	0.984	1.5	0.059	43.4	29.4	14.4	**NA211**	7	0.276	27.8	1.094	8	0.315	76.2	3.000	M10×1.25	–	1.39
–	2 3/16	100	3.937	32.4	1.276	48.4	1.906	24	0.945	1.5	0.059	43.4	29.4	14.4	**SA211-35F**	7	0.276	12	0.472	8	0.315	76.2	3.000	–	3/8-24UNF	1.2
		100	3.937	55.5	2.185	71.4	2.811	25	0.984	1.5	0.059	43.4	29.4	14.4	**NA211-35**	7	0.276	27.8	1.094	8	0.315	76.2	3.000	–	3/8-24UNF	1.36
	2 1/4	110	4.331	61.9	2.437	77.8	3.063	27	1.063	1.5	0.059	52.4	36.2	14.4	**NA212-36**	7.5	0.295	31	1.220	8	0.315	84.2	3.315	–	3/8-24UNF	2.03
60		110	4.331	61.9	2.437	77.8	3.063	27	1.063	1.5	0.059	52.4	36.2	14.4	**NA212**	7.5	0.295	31	1.220	8	0.315	84.2	3.315	M10×1.25	–	1.87
	2 1/2	120	4.724	68.2	2.685	85.7	3.374	28	1.102	1.5	0.059	57.2	40.1	14.4	**NA213-40**	7.5	0.295	34.1	1.343	8.5	0.335	92	3.622	–	3/8-24UNF	2.51
65		120	4.724	68.2	2.685	85.7	3.374	28	1.102	1.5	0.059	57.2	40.1	14.4	**NA213**	7.5	0.295	34.1	1.343	8.5	0.335	92	3.622	M10×1.25	–	2.45
	2 3/4	125	4.921	68.2	2.685	85.7	3.374	30	1.181	1.5	0.059	62.2	44.1	14.5	**NA214-44**	9	0.354	34.1	1.343	8.5	0.335	97	3.819	–	3/8-24UNF	2.94
70		125	4.921	68.2	2.685	85.7	3.374	30	1.181	1.5	0.059	62.2	44.1	14.5	**NA214**	9	0.354	34.1	1.343	8.5	0.335	97	3.819	M10×1.25	–	2.92
75		130	5.118	74.6	2.937	92.1	3.626	32	1.260	1.5	0.059	67.4	48.3	14.5	**NA215**	9	0.354	37.3	1.469	8.5	0.335	102	4.016	M10×1.25	–	2.74
	3	130	5.118	74.6	2.937	92.1	3.626	32	1.260	1.5	0.059	67.4	48.3	14.5	**NA215-48**	9	0.354	37.3	1.469	8.5	0.335	102	4.016	–	3/8-24UNF	2.72

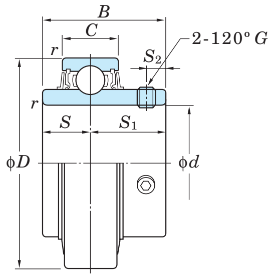
ER, RB

Cylindrical bore (with set screws), cylindrical outside surface

d 12 ~ 60 mm



ER

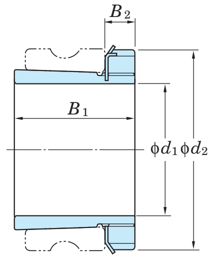


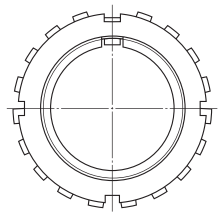
RB

Shaft Dia. d mm	Shaft Dia. d inch	Dimensions (inch / mm) D	B	C	r (min.)	r_1 (min.)	Basic Load Ratings kN C_r	C_{0r}	Factor f_0	Bearing No. (ER)	Bearing No. (RB)	Dimensions (inch / mm) S	S_1	S_2	C_c	a	f	D_2	Set Screw Brg. Bore G mm	G inch	Mass kg (ER)	Mass kg (RB)
12		1.850 47	1.220 31	0.630 16	0.024 0.6	0.020 0.5	12.8	6.65	13.2	**ER201**	**RB201**	0.500 12.7	0.720 18.3	0.197 5	0.157 4	0.094 2.38	0.042 1.07	2.067 52.5	M6×0.75	–	0.27	0.27
	1/2									**ER201-8**	**RB201-8**								–	1/4-28UNF	0.27	0.27
15										**ER202**	**RB202**								M6×0.75	–	0.25	0.25
	5/8									**ER202-10**	**RB202-10**								–	1/4-28UNF	0.25	0.25
17										**ER203**	**RB203**								M6×0.75	–	0.24	0.24
20	3/4	1.850 47	1.220 31	0.630 16	0.039 1	0.020 0.5	12.8	6.65	13.2	**ER204-12**	**RB204-12**	0.500 12.7	0.720 18.3	0.197 5	0.157 4	0.094 2.38	0.042 1.07	2.067 52.5	–	1/4-28UNF	0.22	0.22
										ER204	**RB204**								M6×0.75	–	0.22	0.22
25	7/8	2.047 52	1.343 34.1	0.748 19	0.039 1	0.020 0.5	14.0	7.85	13.9	**ER205-14**	**RB205-14**	0.563 14.3	0.780 19.8	0.217 5.5	0.197 5	0.094 2.38	0.042 1.07	2.272 57.7	–	1/4-28UNF	0.3	0.29
	15/16									**ER205-15**	**RB205-15**								–	1/4-28UNF	0.28	0.27
										ER205	**RB205**								M6×0.75	–	0.27	0.26
	1									**ER205-16**	**RB205-16**								–	1/4-28UNF	0.27	0.26
30	1 1/8	2.441 62	1.500 38.1	0.866 22	0.039 1	0.020 0.5	19.5	11.3	13.9	**ER206-18**	**RB206-18**	0.626 15.9	0.874 22.2	0.236 6	0.217 5.5	0.125 3.18	0.065 1.65	2.657 67.5	–	1/4-28UNF	0.41	0.4
										ER206	**RB206**								M6×0.75	–	0.39	0.38
	1 3/16									**ER206-19**	**RB206-19**								–	1/4-28UNF	0.39	0.38
	1 1/4									**ER206-20**	**RB206-20**								–	1/4-28UNF	0.37	0.36
35	1 1/4	2.835 72	1.689 42.9	0.945 24	0.043 1.1	0.020 0.5	25.7	15.4	13.9	**ER207-20**	**RB207-20**	0.689 17.5	1.000 25.4	0.256 6.5	0.217 5.5	0.125 3.18	0.065 1.65	3.087 78.4	–	5/16-24UNF	0.69	0.68
	1 5/16									**ER207-21**	**RB207-21**								–	5/16-24UNF	0.66	0.65
	1 3/8									**ER207-22**	**RB207-22**								–	5/16-24UNF	0.64	0.63
										ER207	**RB207**								M8×1	–	0.63	0.62
	1 7/16									**ER207-23**	**RB207-23**								–	5/16-24UNF	0.61	0.6
40	1 1/2	3.150 80	1.937 49.2	1.102 28	0.043 1.1	0.020 0.5	29.1	17.8	14.0	**ER208-24**	**RB208-24**	0.748 19	1.189 30.2	0.315 8	0.236 6	0.125 3.18	0.065 1.65	3.402 86.4	–	5/16-24UNF	0.85	0.84
	1 9/16									**ER208-25**	**RB208-25**								–	5/16-24UNF	0.82	0.81
										ER208	**RB208**								M8×1	–	0.81	0.78
45	1 5/8	3.346 85	1.937 49.2	1.102 28	0.043 1.1	0.020 0.5	34.1	21.3	14.0	**ER209-26**	–	0.748 19	1.189 30.2	0.315 8	0.236 6	0.125 3.18	0.065 1.65	3.598 91.4	–	5/16-24UNF	1.0	–
	1 11/16									**ER209-27**	–								–	5/16-24UNF	0.96	–
	1 3/4									**ER209-28**	–								–	5/16-24UNF	0.92	–
										ER209	–								M8×1	–	0.90	–
50	1 7/8	3.543 90	2.031 51.6	1.102 28	0.043 1.1	0.020 0.5	35.1	23.3	14.4	**ER210-30**	–	0.748 19	1.283 32.6	0.354 9	0.295 7.5	0.125 3.18	0.095 2.41	3.791 96.3	–	3/8-24UNF	1.05	–
	1 15/16									**ER210-31**	–								–	3/8-24UNF	1.0	–
										ER210	–								M10×1.25	–	0.98	–
	2									**ER210-32**	–								–	3/8-24UNF	0.96	–
55	2	3.937 100	2.189 55.6	1.181 30	0.059 1.5	0.020 0.5	43.4	29.4	14.4	**ER211-32**	–	0.874 22.2	1.315 33.4	0.354 9	0.295 7.5	0.125 3.18	0.095 2.41	4.185 106.3	–	3/8-24UNF	1.56	–
	2 1/8									**ER211-34**	–								–	3/8-24UNF	1.45	–
										ER211	–								M10×1.25	–	1.41	–
	2 3/16									**ER211-35**	–								–	3/8-24UNF	1.39	–
60	2 1/4	4.331 110	2.563 65.1	1.260 32	0.059 1.5	0.020 0.5	52.4	36.2	14.4	**ER212-36**	–	1.000 25.4	1.563 39.7	0.413 10.5	0.295 7.5	0.125 3.18	0.095 2.41	4.583 116.4	–	3/8-24UNF	2.02	–
										ER212	–								M10×1.25	–	1.89	–
	2 3/8									**ER212-38**	–								–	3/8-24UNF	1.87	–
	2 7/16									**ER212-39**	–								–	3/8-24UNF	1.8	–

H300X, H2300X

d_1 20 ~ (70) mm

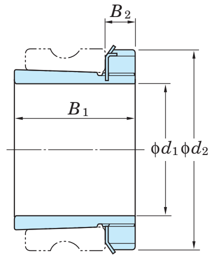


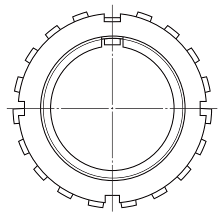


Shaft Dia. d_1			Dimensions			Adapter			Sleeve			Lock Nut	Washer	Mass		
mm	inch		inch mm			No.			No.			No.	No.	kg		
(H)	(HE)	(HS)	B_1	B_2	d_2	(H)	(HE)	(HS)	(H)	(HE)	(HS)			(H)	(HE)	(HS)
20	–	–	1.142	0.315	1.496	**H305X**	–	–	A305X	–	–	AN05	AW05X	0.075	–	–
	3/4	–	29	8	38	–	**HE305X**	–	–	AE305X	–	AN05	AW05X	–	0.08	–
20	–	–	1.378	0.315	1.496	**H2305X**	–	–	A2305X	–	–	AN05	AW05X	0.095	–	–
	3/4	–	35	8	38	–	**HE2305X**	–	–	AE2305X	–	AN05	AW05X	–	0.085	–
25	–	–	1.220	0.315	1.772	**H306X**	–	–	A306X	–	–	AN06	AW06X	0.11	–	–
	1	–	31	8	45	–	**HE306X**	–	–	AE306X	–	AN06	AW06X	–	0.105	–
25	–	–	1.496	0.315	1.772	**H2306X**	–	–	A2306X	–	–	AN06	AW06X	0.13	–	–
	1	–	38	8	45	–	**HE2306X**	–	–	AE2306X	–	AN06	AW06X	–	0.12	–
30	–	–	1.378	0.354	2.047	**H307X**	–	–	A307X	–	–	AN07	AW07X	0.14	–	–
	–	1 1/8	35	9	52	–	–	**HS307X**	–	–	AS307X	AN07	AW07X	–	–	0.15
30	–	–	1.693	0.354	2.047	**H2307X**	–	–	A2307X	–	–	AN07	AW07X	0.17	–	–
	–	1 1/8	43	9	52	–	–	**HS2307X**	–	–	AS2307X	AN07	AW07X	–	–	0.19
35	–	–	1.417	0.394	2.283	**H308X**	–	–	A308X	–	–	AN08	AW08X	0.19	–	–
	1 1/4	–	36	10	58	–	**HE308X**	–	–	AE308X	–	AN08	AW08X	–	0.23	–
	–	1 3/8				–	–	**HS308X**	–	–	AS308X	AN08	AW08X	–	–	0.19
35	–	–	1.811	0.394	2.283	**H2308X**	–	–	A2308X	–	–	AN08	AW08X	0.22	–	–
	1 1/4	–	46	10	58	–	**HE2308X**	–	–	AE2308X	–	AN08	AW08X	–	0.28	–
	–	1 3/8				–	–	**HS2308X**	–	–	AS2308X	AN08	AW08X	–	–	0.22
40	–	–	1.535	0.433	2.559	**H309X**	–	–	A309X	–	–	AN09	AW09X	0.25	–	–
	1 1/2	–	39	11	65	–	**HE309X**	–	–	AE309X	–	AN09	AW09X	–	0.28	–
	–	1 5/8				–	–	**HS309X**	–	–	AS309X	AN09	AW09X	–	–	0.23
40	–	–	1.969	0.433	2.559	**H2309X**	–	–	A2309X	–	–	AN09	AW09X	0.28	–	–
	1 1/2	–	50	11	65	–	**HE2309X**	–	–	AE2309X	–	AN09	AW09X	–	0.32	–
	–	1 5/8				–	–	**HS2309X**	–	–	AS2309X	AN09	AW09X	–	–	0.25
45	–	–	1.654	0.472	2.756	**H310X**	–	–	A310X	–	–	AN10	AW10X	0.30	–	–
	1 3/4	–	42	12	70	–	**HE310X**	–	–	AE310X	–	AN10	AW10X	–	0.31	–
45	–	–	2.165	0.472	2.756	**H2310X**	–	–	A2310X	–	–	AN10	AW10X	0.36	–	–
	1 3/4	–	55	12	70	–	**HE2310X**	–		AE2310X	–	AN10	AW10X	–	0.37	–
50	–	–	1.772	0.472	2.953	**H311X**	–	–	A311X	–	–	AN11	AW11X	0.35	–	–
	2	–	45	12	75	–	**HE311X**	–	–	AE311X	–	AN11	AW11X	–	0.33	–
	–	1 7/8				–	–	**HS311X**	–	–	AS311X	AN11	AW11X	–	–	0.41
50	–	–	2.323	0.472	2.953	**H2311X**	–	–	A2311X	–	–	AN11	AW11X	0.42	–	–
	2	–	59	12	75	–	**HE2311X**	–	–	AE2311X	–	AN11	AW11X	–	0.40	–
	–	1 7/8				–	–	**HS2311X**	–	–	AS2311X	AN11	AW11X	–	–	0.50
55	–	–	1.850	0.512	3.150	**H312X**	–	–	A312X	–	–	AN12	AW12X	0.43	–	–
	–	2 1/8	47	13	80	–	–	**HS312X**	–	–	AS312X	AN12	AW12X	–	–	0.40
55	–	–	2.441	0.512	3.150	**H2312X**	–	–	A2312X	–	–	AN12	AW12X	0.48	–	–
	–	2 1/8	62	13	80	–	–	**HS2312X**	–	–	AS2312X	AN12	AW12X	–	–	0.52
60	–	–	1.969	0.551	3.346	**H313X**	–	–	A313X	–	–	AN13	AW13X	0.46	–	–
	2 1/4	–	50	14	85	–	**HE313X**	–	–	AE313X	–	AN13	AW13X	–	0.56	–
	–	2 3/8				–	–	**HS313X**	–	–	AS313X	AN13	AW13X	–	–	0.45
60	–	–	2.559	0.551	3.346	**H2313X**	–	–	A2313X	–	–	AN13	AW13X	0.56	–	–
	2 1/4	–	65	14	85	–	**HE2313X**	–	–	AE2313X	–	AN13	AW13X	–	0.69	–
	–	2 3/8				–	–	**HS2313X**	–	–	AS2313X	AN13	AW13X	–	–	0.55
65	–	–	2.165	0.591	3.858	**H315X**	–	–	A315X	–	–	AN15	AW15X	0.83	–	–
	2 1/2	–	55	15	98	–	**HE315X**	–	–	AE315X	–	AN15	AW15X	–	0.89	–
65	–	–	2.874	0.591	3.858	**H2315X**	–	–	A2315X	–	–	AN15	AW15X	1.05	–	–
	2 1/2	–	73	15	98	–	**HE2315X**	–	–	AE2315X	–	AN15	AW15X	–	1.15	–
70	–	–	2.323	0.669	4.134	**H316X**	–	–	A316X	–	–	AN16	AW16X	1.05	–	–
	2 3/4	–	59	17	105	–	**HE316X**	–	–	AE316X	–	AN16	AW16X	–	1.05	–

H300X, H2300X

d_1 (70) ~ 125 mm





Shaft Dia. d_1			Dimensions			Adapter No.			Sleeve No.				Lock Nut No.	Washer No.	Mass kg		
mm	inch		inch mm														
(H)	(HE)	(HS)	B_1	B_2	d_2	(H)	(HE)	(HS)	(H)	(HE)	(HS)				(H)	(HE)	(HS)
70	–	–	3.071	0.669	4.134	**H2316X**	–	–	A2316X	–	–		AN16	AW16X	1.3	–	–
	2 3/4	–	78	17	105	–	**HE2316X**	–	–	AE2316X	–		AN16	AW16X	–	1.3	–
75	–	–	2.480	0.709	4.331	**H317X**	–	–	A317X	–	–		AN17	AW17X	1.2	–	–
	3	–	63	18	110	–	**HE317X**	–	–	AE317X	–		AN17	AW17X	–	1.1	–
75	–	–	3.228	0.709	4.331	**H2317X**	–	–	A2317X	–	–		AN17	AW17X	1.45	–	–
	3	–	82	18	110	–	**HE2317X**	–	–	AE2317X	–		AN17	AW17X	–	1.35	–
80	–	–	2.559	0.709	4.724	**H318X**	–	–	A318X	–	–		AN18	AW18X	1.4	–	–
	–	–	65	18	120												
80	–	–	3.386	0.709	4.724	**H2318X**	–	–	A2318X	–	–		AN18	AW18X	1.7	–	–
	–	–	86	18	120												
85	–	–	3.543	0.748	4.921	**H2319X**	–	–	A2319X	–	–		AN19	AW19X	1.95	–	–
	3 1/4	–	90	19	125	–	**HE2319X**	–	–	AE2319X	–		AN19	AW19X	–	2.15	–
90	–	–	3.819	0.787	5.118	**H2320X**	–	–	A2320X	–	–		AN20	AW20X	2.2	–	–
	3 1/2	–	97	20	130	–	**HE2320X**	–	–	AE2320X	–		AN20	AW20X	–	2.3	–
100	–	–	4.134	0.827	5.709	**H2322X**	–	–	A2322X	–	–		AN22	AW22X	2.75	–	–
	4	–	105	21	145	–	**HE2322X**	–	–	AE2322X	–		AN22	AW22X	–	2.55	–
110	–	–	4.409	0.866	6.102	**H2324**	–	–	A2324	–	–		AN24	AW24	3.2	–	–
			112	22	155												
115	–	–	4.764	0.906	6.496	**H2326**	–	–	A2326	–	–		AN26	AW26	4.6	–	–
	4 1/2	–	121	23	165	–	**HE2326**	–	–	AE2326	–		AN26	AW26	–	4.7	–
125	–	–	5.157	0.945	7.087	**H2328**	–	–	A2328	–	–		AN28	AW28	5.5	–	–
			131	24	180												

16 Parts and accessories

16.1 Part No. of steel plate covers

Table 16.1 Part No. of steel plate cover for UC type bearing

Bearing No.	Shaft dia. (mm)	Steel plate cover No.	
		Open type	Sealed type
UC201	12	C– 4×12	D– 4
UC202	15	C– 4×15	D– 4
UC203	17	C– 4×17	D– 4
UC204	20	C– 4×20	D– 4
UC205	25	C– 5×25	D– 5
UC206	30	C– 6×30	D– 6
UC207	35	C– 7×35	D– 7
UC208	40	C– 8×40	D– 8
UC209	45	C– 9×45	D– 9
UC210	50	C–10×50	D–10
UC211	55	C–11×55	D–11
UC212	60	C–12×60	D–12
UC213	65	C–13×65	D–13
UC214	70	C–14×70	D–14
UC215	75	C–15×75	D–15
UC216	80	C–16×80	D–16
UC217	85	C–17×85	D–17
UC218	90	C–18×90	D–18
UCX05	25	C– 6×25	D– 6
UCX06	30	C– 7×30	D– 7
UCX07	35	C– 8×35	D– 8
UCX08	40	C– 9×40	D– 9
UCX09	45	C–10×45	D–10
UCX10	50	C–11×50	D–11
UCX11	55	C–12×55	D–12
UCX12	60	C–13×60	D–13
UCX13	65	C–14×65	D–14
UCX14	70	C–15×70	D–15
UCX15	75	C–16×75	D–16
UCX16	80	C–17×80	D–17
UCX17	85	C–18×85	D–18

Remark In the Part No. of the steel plate covers for shouldered shaft, shaft diameter follows the basic code of the cover. For example, Part No. of the cover for a shaft with 30 mm diameter for UC206 is C–6×30.

Table 16.2 Part No. of steel plate cover for UK type bearing

Bearing No.	Shaft dia. (mm)	Steel plate cover No.	
		Open type	Sealed type
–			
–			
–			
–			
UK205	20	C– 5×20	D– 5
UK206	25	C– 6×25	D– 6
UK207	30	C– 7×30	D– 7
UK208	35	C– 8×35	D– 8
UK209	40	C– 9×40	D– 9
UK210	45	C–10×45	D–10
UK211	50	C–11×50	D–11
UK212	55	C–12×55	D–12
UK213	60	C–13×60	D–13
–			
UK215	65	C–15×65	D–15
UK216	70	C–16×70	D–16
UK217	75	C–17×75	D–17
UK218	80	C–18×80	D–18
UKX05	20	C– 6×20	D– 6
UKX06	25	C– 7×25	D– 7
UKX07	30	C– 8×30	D– 8
UKX08	35	C– 9×35	D– 9
UKX09	40	C–10×40	D–10
UKX10	45	C–11×45	D–11
UKX11	50	C–12×50	D–12
UKX12	55	C–13×55	D–13
UKX13	60	C–14×60	D–14
–			
UKX15	65	C–16×65	D–16
UKX16	70	C–17×70	D–17
UKX17	75	C–18×75	D–18

16.2 Part No. of cast iron covers

Table 16.3 Part No. of cast iron cover for UC type bearing

Bearing No.	Shaft dia. (mm)	Cast iron cover No.		Mounting bolt (reference)
		Open type	Closed type	
UC204	20	204FC×20 (204FC3×20)1)	204FD (204FD3)1)	M3 (M4)
UC205	25	205FC×25 (205FC3×25)1)	205FD (205FD3)1)	M3 (M4)
UC206	30	206FC×30	206FD	M4
UC207	35	207FC×35	207FD	M4
UC208	40	208FC×40	208FD	
UC209	45	209FC×45	209FD	
UC210	50	210FC×50	210FD	M4
UC211	55	211FC×55	211FD	
UC212	60	212FC×60	212FD	
UC213	65	213FC×65	213FD	M4
UC214	70	214FC×70	214FD	
UC215	75	215FC×75	215FD	
UC216	80	216FC×80	216FD	M5
UC217	85	217FC×85	217FD	
UC218	90	218FC×90	218FD	
UCX18	90	X18C×90 (X18C3×90)2)	X18D (X18D3)2)	M5
UCX20	100	X20C×100 (X20C3×100)2)	X20D (X20D3)2)	
UC305	25	305C×25	305D	M4
UC306	30	306C×30	306D	
UC307	35	307C×35	307D	
UC308	40	308C×40	308D	M5
UC309	45	309C×45	309D	
UC310	50	310C×50	310D	
UC311	55	311C×55	311D	M5
UC312	60	312C×60	312D	
UC313	65	313C×65	313D	
UC314	70	314C×70	314D	M5
UC315	75	315C×75	315D	
UC316	80	316C×80	316D	
UC317	85	317C×85	317D	M5
UC318	90	318C×90	318D	
UC319	95	319C×95	319D	
UC320	100	320C×100	320D	M5
UC321	105	321C×105	321D	
UC322	110	322C×110	322D	
UC324	120	324C×120	324D	M5
UC326	130	326C×130	326D	M8
UC328	140	328C×140	328D	

Table 16.4 Part No. of cast iron cover for UK type bearing

Bearing No.	Shaft dia. (mm)	Cast iron cover No.		Mounting bolt (reference)
		Open type	Closed type	
–				
UK205	20	205FC×20 (205FC3×20)1)	205FD (205FD3)1)	M3 (M4)
UK206	25	206FC×25	206FD	M4
UK207	30	207FC×30	207FD	M4
UK208	35	208FC×35	208FD	
UK209	40	209FC×40	209FD	
UK210	45	210FC×45	210FD	M4
UK211	50	211FC×50	211FD	
UK212	55	212FC×55	212FD	
UK213	60	213FC×60	213FD	M4
–				
UK215	65	215FC×65	215FD	
UK216	70	216FC×70	216FD	M5
UK217	75	217FC×75	217FD	
UK218	80	218FC×80	218FD	
UKX18	80	X18C×80 (X18C3×80)2)	X18D (X18D3)2)	M5
UKX20	90	X20C×90 (X20C3×90)2)	X20D (X20D3)2)	
UK305	20	305C×20	305D	M4
UK306	25	306C×25	306D	
UK307	30	307C×30	307D	
UK308	35	308C×35	308D	M5
UK309	40	309C×40	309D	
UK310	45	310C×45	310D	
UK311	50	311C×50	311D	M5
UK312	55	312C×55	312D	
UK313	60	313C×60	313D	
–				
UK315	65	315C×65	315D	M5
UK316	70	316C×70	316D	
UK317	75	317C×75	317D	M5
UK318	80	318C×80	318D	
UK319	85	319C×85	319D	
UK320	90	320C×90	320D	M5
–				
UK322	100	322C×100	322D	
UK324	110	324C×110	324D	M5
UK326	115	326C×115	326D	M8
UK328	125	328C×125	328D	

Note 1) Items in parentheses are applicable to the pillow type (P), square four-bolt flange type (F), oval flange type (FL), and the take-up type (T) bearings, and can be mounted to housings with three hexagon socket head cap screws (use four to mount other items).

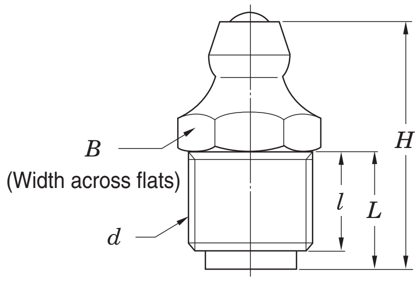
2) Items in parentheses are applicable to the round flange cartridge type bearing (FC), and can be mounted to housings with three hexagon socket head cap screws (use four to mount other items).

Remark In the nominal codes of the cast iron covers for shouldered shaft, shaft diameter follows the basic code of the cover. For example, Part No. of the cover for a shaft with 60 mm diameter for UC210 is 210FC×60.

16.3 Nominal code and dimensions of grease nipples and reducing socket

Table 16.5 Nominal code and dimensions of grease nipple

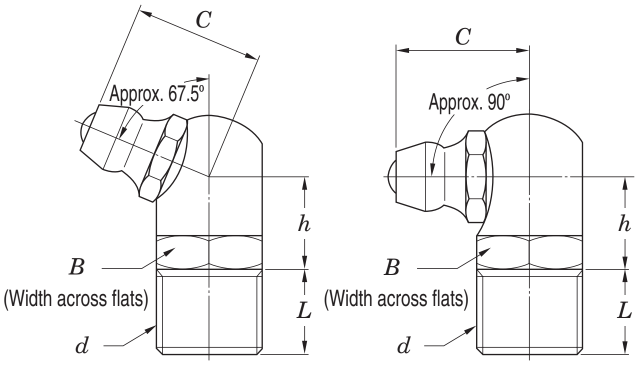
(1) Nominal code and dimensions of A type grease nipple



Unit : mm

Nominal grease nipple code	Nominal screw code d	B	H	L	l
A–1/4-28UNF type	1/4-28UNF	7	13.5	5.4	4
A–PT1/8 type	PT1/8	10	20	9.5	8

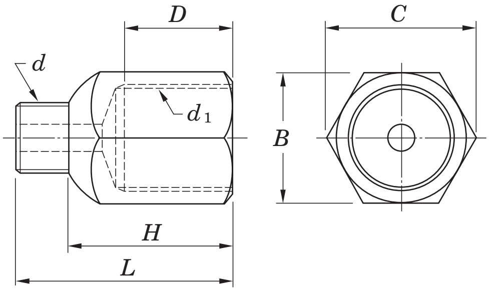
(2) Nominal code and dimensions of B and C type grease nipples


B type C type

Unit : mm

Nominal grease nipple code	Nominal screw code d	B	C	h	L
B–1/4-28UNF type C–1/4-28UNF type	1/4-28UNF	8	9.5	6.5	5
B–PT1/8 type C–PT1/8 type	PT1/8	10	12.5	8.5	8

Table 16.6 Nominal code and dimensions of reducing socket code

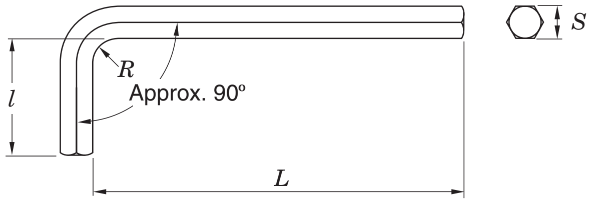


Unit : mm

Nominal code of reducing socket	Nominal male thread code d	Nominal female thread code d_1	B	C	D	H	L
1/4-28UNF–PT1/8 1/4-28UNF–PF1/8	1/4-28UNF	PT1/8 PF1/8	12	13.8	10	15	20
1/4-28UNF–PT1/4 1/4-28UNF–PF1/4	1/4-28UNF	PT1/4 PF1/4	17	19.6	11	17	22
PT1/8–PT1/4 PT1/8–PF1/4	PT1/8	PT1/4 PF1/4	17	19.6	11	19	26

16.4 Nominal code and dimensions of Allen key wrench

Table 16.7 Nominal code and dimensions of Allen key wrench

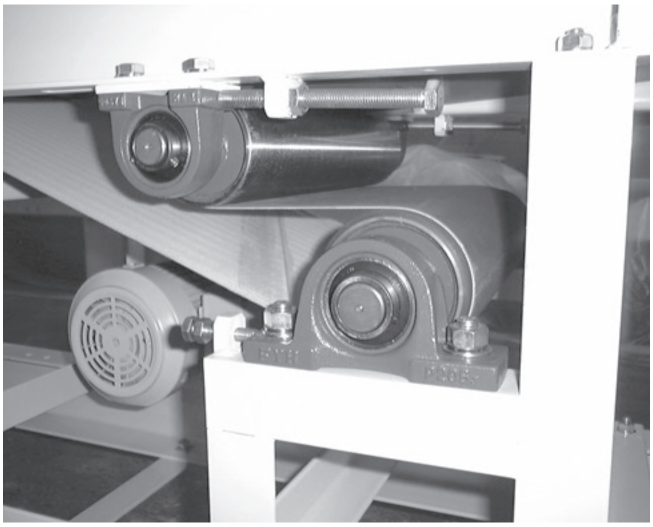


Unit : mm

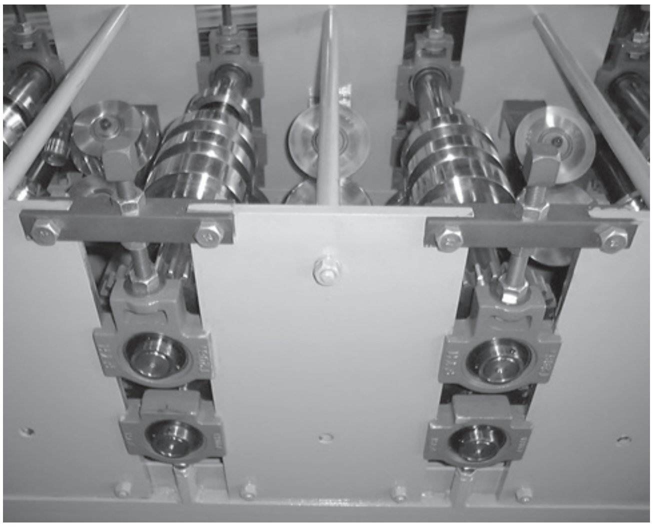
Nominal code of Allen key wrench	S	L (Approx.)	l (Approx.)	R (Approx.)	Applicable set screw
2.5	2.5	56	18	2.5	M5
3	3	63	20	3	M6
4	4	70	25	4	M8
5	5	80	28	5	M10
6	6	90	32	6	M12, M14
8	8	100	36	8	M16, M18
10	10	112	40	10	M20

17 Example of use

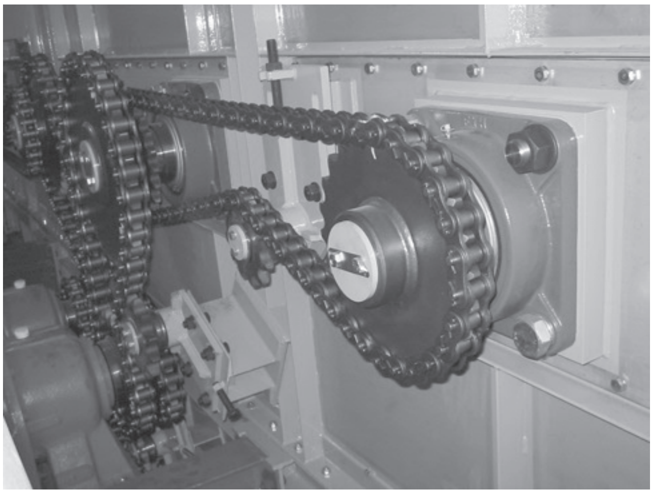
Carrier line



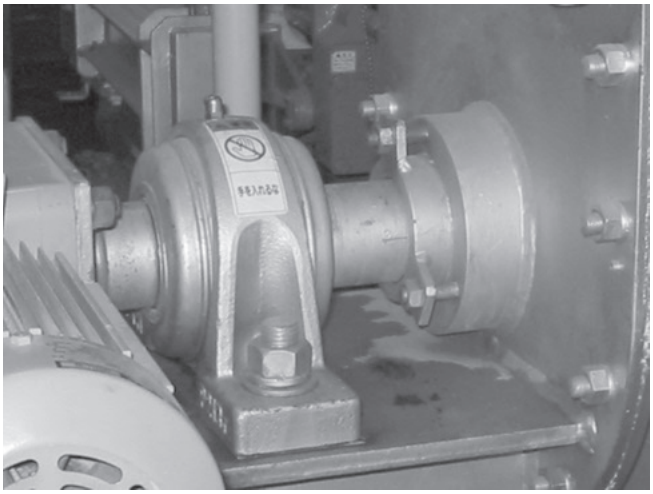
Corrugated plate molding machine



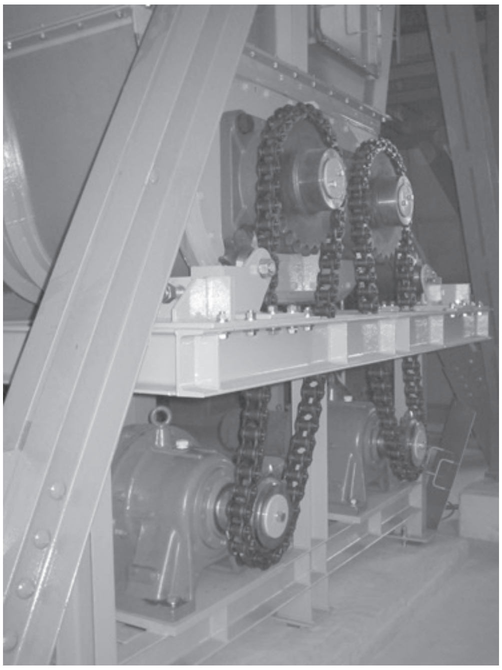
Compost treatment tank



Ash removal conveyor in garbage incineration plant



Discharge feeder



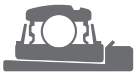
Example of use

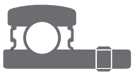
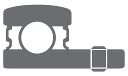
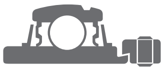
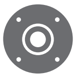
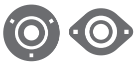
FYH ball bearing units are used in various locations depending on applications and specifications.

Conveyors in pickup and delivery center
Wood working machine
Blower
Textile machine
Agricultural machine
Construction machine
Packing machine
Heat treatment equipment
Wastewater treatment facility

Appendix table (contents)

Appendix table 1 Simplified chart of ball bearing unit combinations

Type	Housing for units	Ball bearing inserts						
		Cylindrical bore (with set screws) 				Tapered bore (with adapter) 		
		UC200	UCX00	UC300	Stainless steel UC200S6	UK200	UKX00	UK300
Pillow type 	P200, PX00, P300 PK200 P200SC, P300SC	UCP200 UCP200SC	UCPX00	UCP300 UCP300SC		UKP200 UKP200SC	UKPX00	UKP300 UKP300SC
	IP200, IP300 PA200, SPA200H1	UCIP200 UCPA200		UCIP300	UCSPA200H1S6	UKIP200		UKIP300
	PH200 LP200	UCPH200						
	P000, SP000 SP200H1 PP200				UCSP200H1S6			
Square four-bolt flange type 	F200, FX00, F300 F200E, FX00E SF200H1 NF200 FS300	UCF200 UCF200E	UCFX00 UCFX00E	UCF300 UCFS300	UCSF200H1S6	UKF200	UKFX00	UKF300 UKFS300
Oval flange type 	FL200, FLX00, FL300 FL200E FA200	UCFL200 UCFL200E UCFA200	UCFLX00	UCFL300		UKFL200	UKFLX00	UKFL300
	FB200 LF200	UCFB200						
	FL000, SFL000 NFL200 SFL200H1				UCSFL200H1S6			
Round flange cartridge type 	FC200, FCX00, FCX00E	UCFC200	UCFCX00 UCFCX00E			UKFC200	UKFCX00	
Stamped steel plate flange type 	PF200 PFL200							
Take-up type 	T200, TX00, T300 T200E, TX00E ST200H1 T200+H	UCT200 UCT200E UCTH200	UCTX00 UCTX200E	UCT300	UCST200H1S6	UKT200	UKTX00	UKT300
	TL200 TU200, TU300	UCTL200 UCTU200		UCTU300		(UKTL200) (UKTU200)		(UKTU300)
	PTH200 NPTH200							
Cartridge type 	C200, CX00, C300	UCC200	UCCX00	UCC300		UKC200	UKCX00	UKC300
Hanger type 	HA200	UCHA200						

	Ball bearing inserts					Housing for units	Type
	Cylindrical bore (with set screws)			Cylindrical bore (with eccentric locking collar)			
							
	Clean series SU000	Stainless steel SU000S6	SB200	SA200	NA200		
					NAP200 NAPK200	P200, PX00, P300 PK200 P200SC, P300SC	Pillow type 
						IP200, IP300 PA200, SPA200H1	
			BLP200	ALP200		PH200 LP200	
	UP000	USP000S6	SBPP200	SAPP200		P000, SP000 SP200H1 PP200	
					NANF200	F200, FX00, F300 F200E, FX00E SF200H1 NF200 FS300	Square four-bolt flange type 
						FL200, FLX00, FL300 FL200E FA200	Oval flange type 
			BLF200	ALF200		FB200 LF200	
	UFL000	USFL000S6			NANFL200	FL000, SFL000 NFL200 SFL200H1	
					NAFC200	FC200, FCX00, FCX00E	Round flange cartridge type 
			SBPF200 SBPFL200	SAPF200 SAPFL200		PF200 PFL200	Stamped steel plate flange type 
					NAT200	T200, TX00, T300 T200E, TX00E ST200H1 T200+H	Take-up type 
						TL200 TU200, TU300	
			SBPTH200 SBNPTH200			PTH200 NPTH200	
					NAC200	C200, CX00, C300	Cartridge type 
						HA200	Hanger type 

Appendix table 2 Tightening torques of housings and cast iron cover mounting bolts

(1) Tightening torques of housings mounting bolts (recommended)

Nominal size of screws	Tightening torques N · m
M 6	2.6– 4.7
M 8	6 – 10
M10	12 – 21
M12	21 – 37
M14	34 – 60
M16	53 – 93
M18	77 – 137
M20	104 – 186
M22	143 – 256
M27	266 – 478
M30	360 – 645
M33	494 – 886
M36	631 –1 130

(2) Tightening torques of cast iron cover mounting bolts (recommended)

Nominal size of screws	Tightening torques, N · m	Part No. of applicable cast iron covers (reference)		
		200 series	X00 series	300 series
M3	0.3– 0.6	204, 205	–	–
M4	0.8– 1.4	204FC3 (FD3), 205FC3 (FD3), 206–215	–	305–307
M5	1.5– 2.8	216–218	X18, X20	308–324
M8	6 –10	–	–	326, 328

Appendix table 3 Tightening torques of inner rings and eccentric locking collar set screws

(1) Tightening torques of inner rings and eccentric locking collar set screws (metric series) (recommended)

Nominal size of screws	Tightening torques, N · m	Part No. of applicable bearings						
		UC2, RB	UCX	UC3	NA	SB	SU	ER
M 3X0.35	0.7						000, 001	
M 4X0.5	1.8	–				–	002, 003	
M 5X0.5	3	201X–203X	–	–		201–203	004–006	–
M 6X0.75	4	201–206	X05	305, 306	–	204–207	–	201–206
M 6X1	4	–	–	–	204, 205	–		
M 8X1	8.5	207–209	X06–X08	307	206–210	208		207–209
M10X1.25	17.5	210–212	X09–X11	308, 309	211, 212	–		210–212
M12X1.5	28	213–218	X12–X17	310–314	–			–
M14X1.5	35	–	X18	315, 316				
M16X1.5	56		X20	317–319				
M18X1.5	62		–	320–324				
M20X1.5	83			326, 328				

Remark Tightening torques of set screws for UC2-S6 are identical to that of UC2. As for UC210S6, tightening torque of the set screw M8 × 1 should be applied.

(2) Tightening torques of inner rings and eccentric locking collar set screws (inch series) (recommended)

Nominal size of screws	Tightening torques, N · m	Part No. of applicable bearings		
		UC2-, ER2-, RB2-	UCX-	SB-
10-32UNF	3	–	–	201, 202
1/4-28UNF	4	201–206	X05	204–207
5/16-24UNF	8.5	207–209	X06–X08	208
3/8-24UNF	17.5	210–212	X09–X11	–
1/2-20UNF	28	213–218	X12–X18	
5/8-18UNF	56	–	X20	

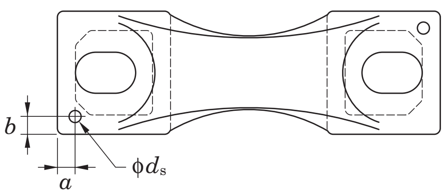
Appendix table 4 Tightening torques of adapter lock nuts (reference)

Bore code	Tightening torques, N · m		
	UK200	UKX00	UK300
05	24.5	34	29
06	29	39	44
07	39	49	59
08	49	73	78
09	59	78	117
10	73	108	147
11	98	137	177
12	127	167	225
13	147	196	265
15	167	215	373

Bore code	Tightening torques, N · m		
	UK200	UKX00	UK300
16	196	255	441
17	225	294	530
18	265	343	608
19	–	–	706
20		490	883
22		–	1 220
24			1 470
26			1 770
28			2 150

Appendix table 5 Machining dimensions of holes of housing dowel pins

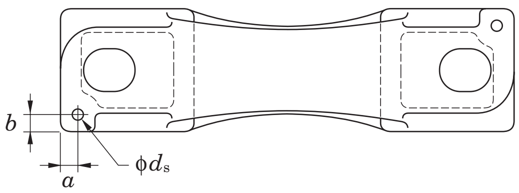
(1) Machining dimensions of holes of pillow type housing (P) dowel pins (recommended)



Unit : mm

Nominal code	a	b	d_s (reference)	Pin seat thickness
P203	6	6	4	12
P204	6	6	4	13
P205	6	6	4	13
P206	6	6	4	15
P207	8	8	5	16
P208	8	8	5	17
P209	8	8	5	17
P210	10	10	5	19
P211	10	10	6	19
P212	10	10	6	22
P213	10	10	6	25
P214	12	12	8	28
P215	12	12	8	28
P216	12	12	8	32
P217	12	12	8	32
P218	15	15	8	34
PX05	7	7	5	16
PX06	8	8	5	17
PX07	8	8	5	19
PX08	8	8	5	21
PX09	8	8	5	21
PX10	9	9	6	22
PX11	9	9	6	28
PX12	9	9	6	28
PX13	10	10	8	28
PX14	10	10	8	32
PX15	10	10	8	32
PX16	12	12	8	34
PX17	12	12	8	34
PX18	15	15	10	38
PX20	19	19	10	45
P305	8	8	5	16
P306	10	10	5	17
P307	10	10	5	19
P308	11	11	6	19
P309	11	11	6	21
P310	11	11	6	24
P311	12	12	8	27
P312	12	12	8	29
P313	12	12	8	32
P314	12	12	10	35
P315	14	14	10	35
P316	15	15	10	35
P317	15	15	10	40
P318	15	15	10	40
P319	15	15	10	46
P320	17	17	13	46
P321	17	17	13	46
P322	17	17	13	50
P324	17	17	13	50
P326	20	20	13	50
P328	20	20	13	60

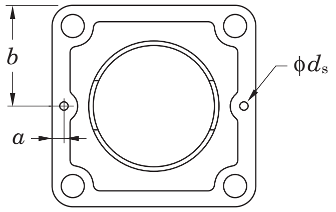
(2) Machining dimensions of holes of cast steel pillow type housing (PSC) dowel pins (recommended)



Unit : mm

Nominal code	a	b	d_s (reference)	Pin seat thickness
P205SC	7.5	6	4	16
P206SC	8.5	6	4	18
P207SC	10	6	5	19
P208SC	12	7	5	19
P209SC	10.5	8	5	20
P210SC	10	8	5	22
P211SC	12	8	6	24
P212SC	15	10	6	25
P213SC	12.5	10	6	28
P214SC	10	10	8	28
P215SC	11.5	10	8	29
P216SC	10	11	8	31
P217SC	12.5	11	8	33
P218SC	12.5	11	8	35
P310SC	14	7	6	27
P311SC	18	10	8	30
P312SC	18	10	8	32
P313SC	18	10	8	35
P314SC	17	10	10	38
P315SC	25	13	10	38
P316SC	30	13	10	38
P317SC	27	15	10	45
P318SC	27	15	10	45
P319SC	30	17	10	51
P320SC	30	18	13	51
P322SC	33	20	13	57
P324SC	33	20	13	57
P326SC	33	20	13	57
P328SC	33	20	13	70

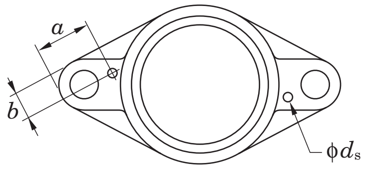
(3) Machining dimensions of holes of square flange type housing (F) dowel pins (recommended)



Unit : mm

Nominal code	a	b	d_s (reference)	Pin seat thickness
F204	6	43	4	11
F205	6	47.5	4	13
F206	7.5	54	4	13
F207	7.5	58.5	5	15
F208	7.5	65	5	15
F209	7.5	68.5	5	16
F210	7.5	71.5	5	16
F211	9	81	6	18
F212	9	87.5	6	18
F213	9	93.5	6	22
F214	10	96.5	8	22
F215	10	100	8	22
F216	10	104	8	22
F217	10	110	8	24
F218	10	117.5	8	25
FX05	7.5	54	5	13
FX06	7.5	58.5	5	14
FX07	7.5	65	5	14
FX08	7.5	68.5	5	14
FX09	7.5	71.5	5	14
FX10	9	81	6	20
FX11	9	87.5	6	20
FX12	9	93.5	6	21
FX13	10	93.5	8	21
FX14	10	98.5	8	22
FX15	10	142	8	24
FX16	10	107	8	24
FX17	10	155	8	24
FX18	12	155	10	24
FX20	12	134	10	28
F305	7.5	55	5	13
F306	7.5	62.5	5	15
F307	7.5	67.5	5	16
F308	9	75	6	17
F309	9	80	6	18
F310	9	87.5	6	19
F311	10	92.5	8	20
F312	10	97.5	8	22
F313	10	104	8	22
F314	12	113	10	25
F315	12	118	10	25
F316	12	125	10	27
F317	12	130	10	27
F318	12	140	10	30
F319	12	145	10	30
F320	16	155	13	32
F321	16	155	13	32
F322	16	170	13	35
F324	16	185	13	40
F326	16	205	13	45
F328	16	225	13	55

(4) Machining dimensions of holes of oval flange type housing (FL) dowel pins (recommended)



Unit : mm

Nominal code	a	b	d_s (reference)	Pin seat thickness
FL204	26	9	4	11
FL205	32	10	4	13
FL206	34	12	4	13
FL207	34	14	5	14
FL208	35	15	5	14
FL209	40	15	5	15
FL210	41	16	5	15
FL211	43	19	6	18
FL212	52	22	6	18
FL213	50	21	6	20
FL214	52	22	8	20
FL215	53	23	8	20
FL216	56	23	8	20
FL217	57	25	8	22
FL218	57	26	8	23
FLX05	27	12	5	13
FLX06	30	14	5	14
FLX07	32	15	5	14
FLX08	33	15	5	14
FLX09	35	16	5	14
FLX10	37	19	6	20
FL305	32	12	5	13
FL306	46	14	5	15
FL307	44	14	5	16
FL308	45	17	6	17
FL309	53	19	6	18
FL310	53	19	6	19
FL311	52	20	8	20
FL312	60	21	8	22
FL313	60	25	8	25
FL314	68	26	10	28
FL315	64	26	10	30
FL316	74	29	10	32
FL317	75	31	10	32
FL318	74	32	10	36
FL319	80	32	10	40
FL320	86	34	13	40
FL321	86	34	13	40
FL322	86	36	13	42
FL324	94	41	13	48
FL326	95	41	13	50
FL328	103	45	13	60

Appendix table 6 Dimensional tolerances of shafts

Classification of shaft (mm)		Tolerance range class of shaft															
Over	Incl.	d 6	e 6	f 6	g 5	g 6	h 5	h 6	h 7	h 8	h 9	h 10	js 5	js 6	js 7	j 5	j 6
3	6	− 30 − 38	− 20 − 28	− 10 − 18	− 4 − 9	− 4 −12	0 − 5	0 − 8	0 −12	0 − 18	0 − 30	0 − 48	± 2.5	± 4	± 6	+ 3 − 2	+ 6 − 2
6	10	− 40 − 49	− 25 − 34	− 13 − 22	− 5 −11	− 5 −14	0 − 6	0 − 9	0 −15	0 − 22	0 − 36	0 − 58	± 3	± 4.5	± 7	+ 4 − 2	+ 7 − 2
10	18	− 50 − 61	− 32 − 43	− 16 − 27	− 6 −14	− 6 −17	0 − 8	0 −11	0 −18	0 − 27	0 − 43	0 − 70	± 4	± 5.5	± 9	+ 5 − 3	+ 8 − 3
18	30	− 65 − 78	− 40 − 53	− 20 − 33	− 7 −16	− 7 −20	0 − 9	0 −13	0 −21	0 − 33	0 − 52	0 − 84	± 4.5	± 6.5	±10	+ 5 − 4	+ 9 − 4
30	50	− 80 − 96	− 50 − 66	− 25 − 41	− 9 −20	− 9 −25	0 −11	0 −16	0 −25	0 − 39	0 − 62	0 −100	± 5.5	± 8	±12	+ 6 − 5	+11 − 5
50	80	−100 −119	− 60 − 79	− 30 − 49	−10 −23	−10 −29	0 −13	0 −19	0 −30	0 − 46	0 − 74	0 −120	± 6.5	± 9.5	±15	+ 6 − 7	+12 − 7
80	120	−120 −142	− 72 − 94	− 36 − 58	−12 −27	−12 −34	0 −15	0 −22	0 −35	0 − 54	0 − 87	0 −140	± 7.5	±11	±17	+ 6 − 9	+13 − 9
120	180	−145 −170	− 85 −110	− 43 − 68	−14 −32	−14 −39	0 −18	0 −25	0 −40	0 − 63	0 −100	0 −160	± 9	±12.5	±20	+ 7 −11	+14 −11
180	250	−170 −199	−100 −129	− 50 − 79	−15 −35	−15 −44	0 −20	0 −29	0 −46	0 − 72	0 −115	0 −185	±10	±14.5	±23	+ 7 −13	+16 −13
250	315	−190 −222	−110 −142	− 56 − 88	−17 −40	−17 −49	0 −23	0 −32	0 −52	0 − 81	0 −130	0 −210	±11.5	±16	±26	+ 7 −16	±16
315	400	−210 −246	−125 −161	− 62 − 98	−18 −43	−18 −54	0 −25	0 −36	0 −57	0 − 89	0 −140	0 −230	±12.5	±18	±28	+ 7 −18	±18
400	500	−230 −270	−135 −175	− 68 −108	−20 −47	−20 −60	0 −27	0 −40	0 −63	0 − 97	0 −155	0 −250	±13.5	±20	±31	+ 7 −20	±20
500	630	−260 −304	−145 −189	− 76 −120	−	−22 −66	−	0 −44	0 −70	0 −110	0 −175	0 −280	−	±22	±35	−	−
630	800	−290 −340	−160 −210	− 80 −130	−	−24 −74	−	0 −50	0 −80	0 −125	0 −200	0 −320	−	±25	±40	−	−
800	1 000	−320 −376	−170 −226	− 86 −142	−	−26 −82	−	0 −56	0 −90	0 −140	0 −230	0 −360	−	±28	±45	−	−

*$\varDelta_{d\mathrm{mp}}$: Variation of tolerance of average bore diameter in plane

Unit : μm (Reference)

k 5	k 6	k 7	m 5	m 6	m 7	n 5	n 6	p 6	r 6	r 7	Classification of shaft (mm) Over	Incl.	Δ_{dmp}* of bearing (class 0)
+ 6 + 1	+ 9 + 1	+13 + 1	+ 9 + 4	+12 + 4	+ 16 + 4	+13 + 8	+ 16 + 8	+ 20 + 12	+ 23 + 15	+ 27 + 15	**3**	**6**	0 – 8
+ 7 + 1	+10 + 1	+16 + 1	+12 + 6	+15 + 6	+ 21 + 6	+16 +10	+ 19 + 10	+ 24 + 15	+ 28 + 19	+ 34 + 19	**6**	**10**	0 – 8
+ 9 + 1	+12 + 1	+19 + 1	+15 + 7	+18 + 7	+ 25 + 7	+20 +12	+ 23 + 12	+ 29 + 18	+ 34 + 23	+ 41 + 23	**10**	**18**	0 – 8
+11 + 2	+15 + 2	+23 + 2	+17 + 8	+21 + 8	+ 29 + 8	+24 +15	+ 28 + 15	+ 35 + 22	+ 41 + 28	+ 49 + 28	**18**	**30**	0 – 10
+13 + 2	+18 + 2	+27 + 2	+20 + 9	+25 + 9	+ 34 + 9	+28 +17	+ 33 + 17	+ 42 + 26	+ 50 + 34	+ 59 + 34	**30**	**50**	0 – 12
+15 + 2	+21 + 2	+32 + 2	+24 +11	+30 +11	+ 41 + 11	+33 +20	+ 39 + 20	+ 51 + 32	+ 60 + 41	+ 71 + 41	**50**	**65**	0 – 15
									+ 62 + 43	+ 73 + 43	**65**	**80**	
+18 + 3	+25 + 3	+38 + 3	+28 +13	+35 +13	+ 48 + 13	+38 +23	+ 45 + 23	+ 59 + 37	+ 73 + 51	+ 86 + 51	**80**	**100**	0 – 20
									+ 76 + 54	+ 89 + 54	**100**	**120**	
+21 + 3	+28 + 3	+43 + 3	+33 +15	+40 +15	+ 55 + 15	+45 +27	+ 52 + 27	+ 68 + 43	+ 88 + 63	+103 + 63	**120**	**140**	0 – 25
									+ 90 + 65	+105 + 65	**140**	**160**	
									+ 93 + 68	+108 + 68	**160**	**180**	
+24 + 4	+33 + 4	+50 + 4	+37 +17	+46 +17	+ 63 + 17	+51 +31	+ 60 + 31	+ 79 + 50	+106 + 77	+123 + 77	**180**	**200**	0 – 30
									+109 + 80	+126 + 80	**200**	**225**	
									+113 + 84	+130 + 84	**225**	**250**	
+27 + 4	+36 + 4	+56 + 4	+43 +20	+52 +20	+ 72 + 20	+57 +34	+ 66 + 34	+ 88 + 56	+126 + 94	+146 + 94	**250**	**280**	0 – 35
									+130 + 98	+150 + 98	**280**	**315**	
+29 + 4	+40 + 4	+61 + 4	+46 +21	+57 +21	+ 78 + 21	+62 +37	+ 73 + 37	+ 98 + 62	+144 +108	+165 +108	**315**	**355**	0 – 40
									+150 +114	+171 +114	**355**	**400**	
+32 + 5	+45 + 5	+68 + 5	+50 +23	+63 +23	+ 86 + 23	+67 +40	+ 80 + 40	+108 + 68	+166 +126	+189 +126	**400**	**450**	0 – 45
									+172 +132	+195 +132	**450**	**500**	
–	+44 0	+70 0	–	+70 +26	+ 96 + 26	–	+ 88 + 44	+122 + 78	+194 +150	+220 +150	**500**	**560**	0 – 50
									+199 +155	+225 +155	**560**	**630**	
–	+50 0	+80 0	–	+80 +30	+110 + 30	–	+100 + 50	+138 + 88	+225 +175	+255 +175	**630**	**710**	0 – 75
									+235 +185	+265 +185	**710**	**800**	
–	+56 0	+90 0	–	+90 +34	+124 + 34	–	+112 + 56	+156 +100	+266 +210	+300 +210	**800**	**900**	0 –100
									+276 +220	+310 +220	**900**	**1 000**	

Appendix table 7 Dimensional tolerances of housing bores

Classification of shaft (mm)		Tolerance range class of bore														
Over	Incl.	E 6	F 6	F 7	G 6	G 7	H 6	H 7	H 8	H 9	H 10	J 6	J 7	JS 5	JS 6	JS 7
10	18	+ 43 + 32	+ 27 + 16	+ 34 + 16	+17 + 6	+ 24 + 6	+11 0	+ 18 0	+ 27 0	+ 43 0	+ 70 0	+ 6 – 5	+10 – 8	± 4	± 5.5	± 9
18	30	+ 53 + 40	+ 33 + 20	+ 41 + 20	+20 + 7	+ 28 + 7	+13 0	+ 21 0	+ 33 0	+ 52 0	+ 84 0	+ 8 – 5	+12 – 9	± 4.5	± 6.5	±10
30	50	+ 66 + 50	+ 41 + 25	+ 50 + 25	+25 + 9	+ 34 + 9	+16 0	+ 25 0	+ 39 0	+ 62 0	+100 0	+10 – 6	+14 –11	± 5.5	± 8	±12
50	80	+ 79 + 60	+ 49 + 30	+ 60 + 30	+29 +10	+ 40 + 10	+19 0	+ 30 0	+ 46 0	+ 74 0	+120 0	+13 – 6	+18 –12	± 6.5	± 9.5	±15
80	120	+ 94 + 72	+ 58 + 36	+ 71 + 36	+34 +12	+ 47 + 12	+22 0	+ 35 0	+ 54 0	+ 87 0	+140 0	+16 – 6	+22 –13	± 7.5	±11	±17
120	180	+110 + 85	+ 68 + 43	+ 83 + 43	+39 +14	+ 54 + 14	+25 0	+ 40 0	+ 63 0	+100 0	+160 0	+18 – 7	+26 –14	± 9	±12.5	±20
180	250	+129 +100	+ 79 + 50	+ 96 + 50	+44 +15	+ 61 + 15	+29 0	+ 46 0	+ 72 0	+115 0	+185 0	+22 – 7	+30 –16	±10	±14.5	±23
250	315	+142 +110	+ 88 + 56	+108 + 56	+49 +17	+ 69 + 17	+32 0	+ 52 0	+ 81 0	+130 0	+210 0	+25 – 7	+36 –16	±11.5	±16	±26
315	400	+161 +125	+ 98 + 62	+119 + 62	+54 +18	+ 75 + 18	+36 0	+ 57 0	+ 89 0	+140 0	+230 0	+29 – 7	+39 –18	±12.5	±18	±28
400	500	+175 +135	+108 + 68	+131 + 68	+60 +20	+ 83 + 20	+40 0	+ 63 0	+ 97 0	+155 0	+250 0	+33 – 7	+43 –20	±13.5	±20	±31
500	630	+189 +145	+120 + 76	+146 + 76	+66 +22	+ 92 + 22	+44 0	+ 70 0	+110 0	+175 0	+280 0	–	–	–	±22	±35
630	800	+210 +160	+130 + 80	+160 + 80	+74 +24	+104 + 24	+50 0	+ 80 0	+125 0	+200 0	+320 0	–	–	–	±25	±40
800	1 000	+226 +170	+142 + 86	+176 + 86	+82 +26	+116 + 26	+56 0	+ 90 0	+140 0	+230 0	+360 0	–	–	–	±28	±45
1 000	1 250	+261 +195	+164 + 98	+203 + 98	+94 +28	+133 + 28	+66 0	+105 0	+165 0	+260 0	+420 0	–	–	–	±33	±52

*$\varDelta_{Dmp}$: Variation of tolerance of average outside diameter in plate

Unit : μm (Reference)

K 5	K 6	K 7	M 5	M 6	M 7	N 5	N 6	N 7	P 6	P 7	R 7	Classification of basic size (mm)		Δ_{Dmp}* of bearing (class 0)
												Over	Incl.	
+ 2 − 6	+ 2 − 9	+ 6 − 12	− 4 −12	− 4 − 15	0 − 18	− 9 −17	− 9 − 20	− 5 − 23	− 15 − 26	− 11 − 29	− 16 − 34	10	18	0 − 8
+ 1 − 8	+ 2 −11	+ 6 − 15	− 5 −14	− 4 − 17	0 − 21	−12 −21	− 11 − 24	− 7 − 28	− 18 − 31	− 14 − 35	− 20 − 41	18	30	0 − 9
+ 2 − 9	+ 3 −13	+ 7 − 18	− 5 −16	− 4 − 20	0 − 25	−13 −24	− 12 − 28	− 8 − 33	− 21 − 37	− 17 − 42	− 25 − 50	30	50	0 − 11
+ 3 −10	+ 4 −15	+ 9 − 21	− 6 −19	− 5 − 24	0 − 30	−15 −28	− 14 − 33	− 9 − 39	− 26 − 45	− 21 − 51	− 30 − 60	50	65	0 − 13
											− 32 − 62	65	80	
+ 2 −13	+ 4 −18	+ 10 − 25	− 8 −23	− 6 − 28	0 − 35	−18 −33	− 16 − 38	− 10 − 45	− 30 − 52	− 24 − 59	− 38 − 73	80	100	0 − 15
											− 41 − 76	100	120	
+ 3 −15	+ 4 −21	+ 12 − 28	− 9 −27	− 8 − 33	0 − 40	−21 −39	− 20 − 45	− 12 − 52	− 36 − 61	− 28 − 68	− 48 − 88	120	140	(150 max.) 0 − 18 (Over 150) 0 − 25
											− 50 − 90	140	160	
											− 53 − 93	160	180	
+ 2 −18	+ 5 −24	+ 13 − 33	−11 −31	− 8 − 37	0 − 46	−25 −45	− 22 − 51	− 14 − 60	− 41 − 70	− 33 − 79	− 60 −106	180	200	0 − 30
											− 63 −109	200	225	
											− 67 −113	225	250	
+ 3 −20	+ 5 −27	+ 16 − 36	−13 −36	− 9 − 41	0 − 52	−27 −50	− 25 − 57	− 14 − 66	− 47 − 79	− 36 − 88	− 74 −126	250	280	0 − 35
											− 78 −130	280	315	
+ 3 −22	+ 7 −29	+ 17 − 40	−14 −39	− 10 − 46	0 − 57	−30 −55	− 26 − 62	− 16 − 73	− 51 − 87	− 41 − 98	− 87 −144	315	355	0 − 40
											− 93 −150	355	400	
+ 2 −25	+ 8 −32	+ 18 − 45	−16 −43	− 10 − 50	0 − 63	−33 −60	− 27 − 67	− 17 − 80	− 55 − 95	− 45 −108	−103 −166	400	450	0 − 45
											−109 −172	450	500	
–	0 −44	0 − 70	–	− 26 − 70	− 26 − 96	–	− 44 − 88	− 44 −114	− 78 −122	− 78 −148	−150 −220	500	560	0 − 50
											−155 −225	560	630	
–	0 −50	0 − 80	–	− 30 − 80	− 30 −110	–	− 50 −100	− 50 −130	− 88 −138	− 88 −168	−175 −255	630	710	0 − 75
											−185 −265	710	800	
–	0 −56	0 − 90	–	− 34 − 90	− 34 −124	–	− 56 −112	− 56 −146	−100 −156	−100 −190	−210 −300	800	900	0 −100
											−220 −310	900	1 000	
–	0 −66	0 −105	–	− 40 −106	− 40 −145	–	− 66 −132	− 66 −171	−120 −186	−120 −225	−250 −355	1 000	1 120	0 −125
											−260 −365	1 120	1 250	

Appendix table 8 Basic tolerance values

Classification of basic size (mm)		Tolerance class (IT)																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14 1)	15 1)	16 1)	17 1)	18 1)
Over	**Incl.**	Basic tolerance value (µm)											Basic tolerance value (mm)						
–	3	0.8	1.2	2	3	4	6	10	14	25	40	60	0.10	0.14	0.26	0.40	0.60	1.00	1.40
3	6	1	1.5	2.5	4	5	8	12	18	30	48	75	0.12	0.18	0.30	0.48	0.75	1.20	1.80
6	10	1	1.5	2.5	4	6	9	15	22	36	58	90	0.15	0.22	0.36	0.58	0.90	1.50	2.20
10	18	1.2	2	3	5	8	11	18	27	43	70	110	0.18	0.27	0.43	0.70	1.10	1.80	2.70
18	30	1.5	2.5	4	6	9	13	21	33	52	84	130	0.21	0.33	0.52	0.84	1.30	2.10	3.30
30	50	1.5	2.5	4	7	11	16	25	39	62	100	160	0.25	0.39	0.62	1.00	1.60	2.50	3.90
50	80	2	3	5	8	13	19	30	46	74	120	190	0.30	0.46	0.74	1.20	1.90	3.00	4.60
80	120	2.5	4	6	10	15	22	35	54	87	140	220	0.35	0.54	0.87	1.40	2.20	3.50	5.40
120	180	3.5	5	8	12	18	25	40	63	100	160	250	0.40	0.63	1.00	1.60	2.50	4.00	6.30
180	250	4.5	7	10	14	20	29	46	72	115	185	290	0.46	0.72	1.15	1.85	2.90	4.60	7.20
250	315	6	8	12	16	23	32	52	81	130	210	320	0.52	0.81	1.30	2.10	3.20	5.20	8.10
315	400	7	9	13	18	25	36	57	89	140	230	360	0.57	0.89	1.40	2.30	3.60	5.70	8.90
400	500	8	10	15	20	27	40	63	97	155	250	400	0.63	0.97	1.55	2.50	4.00	6.30	9.70
500	630	–	–	–	–	–	44	70	110	175	280	440	0.70	1.10	1.75	2.80	4.40	7.00	11.00
630	800	–	–	–	–	–	50	80	125	200	320	500	0.80	1.25	2.00	3.20	5.00	8.00	12.50
800	1 000	–	–	–	–	–	56	90	140	230	360	560	0.90	1.40	2.30	3.60	5.60	9.00	14.00
1 000	1 250	–	–	–	–	–	66	105	165	260	420	660	1.05	1.65	2.60	4.20	6.60	10.50	16.50
1 250	1 600	–	–	–	–	–	78	125	195	310	500	780	1.25	1.95	3.10	5.00	7.80	12.50	19.50
1 600	2 000	–	–	–	–	–	92	150	230	370	600	920	1.50	2.30	3.70	6.00	9.20	15.00	23.00
2 000	2 500	–	–	–	–	–	110	175	280	440	700	1 100	1.75	2.80	4.40	7.00	11.00	17.50	28.00
2 500	3 150	–	–	–	–	–	135	210	330	540	860	1 350	2.10	3.30	5.40	8.60	13.50	21.00	33.00

Note 1) Tolerance classes from IT14 to IT18 can not be applied to basic size 1 mm or less.

Appendix table 9 SI unit conversion charts

Force

N	dyn	kgf
1	1×10^{5}	$1.019\,72\times10^{-1}$
1×10^{-5}	1	$1.019\,72\times10^{-6}$
9.806 65	$9.806\,65\times10^{5}$	1

Moment of force (torque)

N · m	mN · m	μN · m	kgf · m	kgf · cm	gf · cm
1	1×10^{3}	1×10^{6}	$1.019\,72\times10^{-1}$	$1.019\,72\times10$	$1.019\,72\times10^{4}$
1×10^{-3}	1	1×10^{3}	$1.019\,72\times10^{-4}$	$1.019\,72\times10^{-2}$	$1.019\,72\times10$
1×10^{-6}	1×10^{-3}	1	$1.019\,72\times10^{-7}$	$1.019\,72\times10^{-5}$	$1.019\,72\times10^{-2}$
9.806 65	$9.806\,65\times10^{3}$	$9.806\,65\times10^{6}$	1	1×10^{2}	1×10^{5}
$9.806\,65\times10^{-2}$	$9.806\,65\times10$	$9.806\,65\times10^{4}$	1×10^{-2}	1	1×10^{3}
$9.806\,65\times10^{-5}$	$9.806\,65\times10^{-2}$	$9.806\,65\times10$	1×10^{-5}	1×10^{-3}	1

Stress

Pa or N/m^2	MPa or N/mm^2	kgf/mm^2	kgf/cm^2
1	1×10^{-6}	$1.019\,72\times10^{-7}$	$1.019\,72\times10^{-5}$
1×10^{6}	1	$1.019\,72\times10^{-1}$	$1.019\,72\times10$
$9.806\,65\times10^{6}$	9.806 65	1	1×10^{2}
$9.806\,65\times10^{4}$	$9.806\,65\times10^{-2}$	1×10^{-2}	1

Remark 1 Pa = 1 N/m^2, 1 MPa = 1 N/mm^2

Pressure

Pa	kPa	MPa	bar	kgf/cm^2	atm	mmH$_2$O	mmHg or Torr
1	1×10^{-3}	1×10^{-6}	1×10^{-5}	$1.019\,72\times10^{-5}$	$9.869\,23\times10^{-6}$	$1.019\,72\times10^{-1}$	$7.500\,62\times10^{-3}$
1×10^{3}	1	1×10^{-3}	1×10^{-2}	$1.019\,72\times10^{-2}$	$9.869\,23\times10^{-3}$	$1.019\,72\times10^{2}$	7.500 62
1×10^{6}	1×10^{3}	1	1×10	$1.019\,72\times10$	9.869 23	$1.019\,72\times10^{5}$	$7.500\,62\times10^{3}$
1×10^{5}	1×10^{2}	1×10^{-1}	1	1.019 72	$9.869\,23\times10^{-1}$	$1.019\,72\times10^{4}$	$7.500\,62\times10^{2}$
$9.806\,65\times10^{4}$	$9.806\,65\times10$	$9.806\,65\times10^{-2}$	$9.806\,65\times10^{-1}$	1	$9.678\,41\times10^{-1}$	1×10^{4}	$7.355\,59\times10^{2}$
$1.013\,25\times10^{5}$	$1.013\,25\times10^{2}$	$1.013\,25\times10^{-1}$	1.013 25	1.033 23	1	$1.033\,23\times10^{4}$	$7.600\,00\times10^{2}$
9.806 65	$9.806\,65\times10^{-3}$	$9.806\,65\times10^{-6}$	$9.806\,65\times10^{-5}$	1×10^{-4}	$9.678\,41\times10^{-5}$	1	$7.355\,59\times10^{-2}$
$1.333\,22\times10^{2}$	$1.333\,22\times10^{-1}$	$1.333\,22\times10^{-4}$	$1.333\,22\times10^{-3}$	$1.359\,51\times10^{-3}$	$1.315\,79\times10^{-3}$	$1.359\,51\times10$	1

Remark 1 Pa = 1 N/m^2

Kinematic viscosity

m^2/s	cSt	St
1	1×10^{6}	1×10^{4}
1×10^{-6}	1	1×10^{-2}
1×10^{-4}	1×10^{2}	1

Remark 1 cSt = 1 mm^2/s, 1 St = 1 cm^2/s

Appendix table 10 Inch-meter conversion chart

Inch		Inches										
		0	1	2	3	4	5	6	7	8	9	10
		mm										
0	0	0	25.4000	50.8000	76.2000	101.6000	127.0000	152.4000	177.8000	203.2000	228.6000	254.0000
1/64	0.015625	0.3969	25.7969	51.1969	76.5969	101.9969	127.3969	152.7969	178.1969	203.5969	228.9969	254.3969
1/32	0.03125	0.7938	26.1938	51.5938	76.9938	102.3938	127.7938	153.1938	178.5938	203.9938	229.3938	254.7938
3/64	0.046875	1.1906	26.5906	51.9906	77.3906	102.7906	128.1906	153.5906	178.9906	204.3906	229.7906	255.1906
1/16	0.0625	1.5875	26.9875	52.3875	77.7875	103.1875	128.5875	153.9875	179.3875	204.7875	230.1875	255.5875
5/64	0.078125	1.9844	27.3844	52.7844	78.1844	103.5844	128.9844	154.3844	179.7844	205.1844	230.5844	255.9844
3/32	0.09375	2.3812	27.7812	53.1812	78.5812	103.9812	129.3812	154.7812	180.1812	205.5812	230.9812	256.3812
7/64	0.109375	2.7781	28.1781	53.5781	78.9781	104.3781	129.7781	155.1781	180.5781	205.9781	231.3781	256.7781
1/8	0.125	3.1750	28.5750	53.9750	79.3750	104.7750	130.1750	155.5750	180.9750	206.3750	231.7750	257.1750
9/64	0.140625	3.5719	28.9719	54.3719	79.7719	105.1719	130.5719	155.9719	181.3719	206.7719	232.1719	257.5719
5/32	0.15625	3.9688	29.3688	54.7688	80.1688	105.5688	130.9688	156.3688	181.7688	207.1688	232.5688	257.9688
11/64	0.171875	4.3656	29.7656	55.1656	80.5656	105.9656	131.3656	156.7656	182.1656	207.5656	232.9656	258.3656
3/16	0.1875	4.7625	30.1625	55.5625	80.9625	106.3625	131.7625	157.1625	182.5625	207.9625	233.3625	258.7625
13/64	0.203125	5.1594	30.5594	55.9594	81.3594	106.7594	132.1594	157.5594	182.9594	208.3594	233.7594	259.1594
7/32	0.21875	5.5562	30.9562	56.3562	81.7562	107.1562	132.5562	157.9562	183.3562	208.7562	234.1562	259.5562
15/64	0.234375	5.9531	31.3531	56.7531	82.1531	107.5531	132.9531	158.3531	183.7531	209.1531	234.5531	259.9531
1/4	0.25	6.3500	31.7500	57.1500	82.5500	107.9500	133.3500	158.7500	184.1500	209.5500	234.9500	260.3500
17/64	0.265625	6.7469	32.1469	57.5469	82.9469	108.3469	133.7469	159.1469	184.5469	209.9469	235.3469	260.7469
9/32	0.28125	7.1438	32.5438	57.9438	83.3438	108.7438	134.1438	159.5438	184.9438	210.3438	235.7438	261.1438
19/64	0.296875	7.5406	32.9406	58.3406	83.7406	109.1406	134.5406	159.9406	185.3406	210.7406	236.1406	261.5406
5/16	0.3125	7.9375	33.3375	58.7375	84.1375	109.5375	134.9375	160.3375	185.7375	211.1375	236.5375	261.9375
21/64	0.328125	8.3344	33.7344	59.1344	84.5344	109.9344	135.3344	160.7344	186.1344	211.5344	236.9344	262.3344
11/32	0.34375	8.7312	34.1312	59.5312	84.9312	110.3312	135.7312	161.1312	186.5312	211.9312	237.3312	262.7312
23/64	0.359375	9.1281	34.5281	59.9281	85.3281	110.7281	136.1281	161.5281	186.9281	212.3281	237.7281	263.1281
3/8	0.375	9.5250	34.9250	60.3250	85.7250	111.1250	136.5250	161.9250	187.3250	212.7250	238.1250	263.5250
25/64	0.390625	9.9219	35.3219	60.7219	86.1219	111.5219	136.9219	162.3219	187.7219	213.1219	238.5219	263.9219
13/32	0.40625	10.3188	35.7188	61.1188	86.5188	111.9188	137.3188	162.7188	188.1188	213.5188	238.9188	264.3188
27/64	0.421875	10.7156	36.1156	61.5156	86.9156	112.3156	137.7156	163.1156	188.5156	213.9156	239.3156	264.7156
7/16	0.4375	11.1125	36.5125	61.9125	87.3125	112.7125	138.1125	163.5125	188.9125	214.3125	239.7125	265.1125
29/64	0.453125	11.5094	36.9094	62.3094	87.7094	113.1094	138.5094	163.9094	189.3094	214.7094	240.1094	265.5094
15/32	0.46875	11.9062	37.3062	62.7062	88.1062	113.5062	138.9062	164.3062	189.7062	215.1062	240.5062	265.9062
31/64	0.484375	12.3031	37.7031	63.1031	88.5031	113.9031	139.3031	164.7031	190.1031	215.5031	240.9031	266.3031
1/2	0.5	12.7000	38.1000	63.5000	88.9000	114.3000	139.7000	165.1000	190.5000	215.9000	241.3000	266.7000
33/64	0.515625	13.0969	38.4969	63.8969	89.2969	114.6969	140.0969	165.4969	190.8969	216.2969	241.6969	267.0969
17/32	0.53125	13.4938	38.8938	64.2938	89.6938	115.0938	140.4938	165.8938	191.2938	216.6938	242.0938	267.4938
35/64	0.546875	13.8906	39.2906	64.6906	90.0906	115.4906	140.8906	166.2906	191.6906	217.0906	242.4906	267.8906
9/16	0.5625	14.2875	39.6875	65.0875	90.4875	115.8875	141.2875	166.6875	192.0875	217.4875	242.8875	268.2875
37/64	0.578125	14.6844	40.0844	65.4844	90.8844	116.2844	141.6844	167.0844	192.4844	217.8844	243.2844	268.6844
19/32	0.59375	15.0812	40.4812	65.8812	91.2812	116.6812	142.0812	167.4812	192.8812	218.2812	243.6812	269.0812
39/64	0.609375	15.4781	40.8781	66.2781	91.6781	117.0781	142.4781	167.8781	193.2781	218.6781	244.0781	269.4781
5/8	0.625	15.8750	41.2750	66.6750	92.0750	117.4750	142.8750	168.2750	193.6750	219.0750	244.4750	269.8750
41/64	0.640625	16.2719	41.6719	67.0719	92.4719	117.8719	143.2719	168.6719	194.0719	219.4719	244.8719	270.2719
21/32	0.65625	16.6688	42.0688	67.4688	92.8688	118.2688	143.6688	169.0688	194.4688	219.8688	245.2688	270.6688
43/64	0.671875	17.0656	42.4656	67.8656	93.2656	118.6656	144.0656	169.4656	194.8656	220.2656	245.6656	271.0656
11/16	0.6875	17.4625	42.8625	68.2625	93.6625	119.0625	144.4625	169.8625	195.2625	220.6625	246.0625	271.4625
45/64	0.703125	17.8594	43.2594	68.6594	94.0594	119.4594	144.8594	170.2594	195.6594	221.0594	246.4594	271.8594
23/32	0.71875	18.2562	43.6562	69.0562	94.4562	119.8562	145.2562	170.6562	196.0562	221.4562	246.8562	272.2562
47/64	0.734375	18.6531	44.0531	69.4531	94.8531	120.2531	145.6531	171.0531	196.4531	221.8531	247.2531	272.6531
3/4	0.75	19.0500	44.4500	69.8500	95.2500	120.6500	146.0500	171.4500	196.8500	222.2500	247.6500	273.0500
49/64	0.765625	19.4469	44.8469	70.2469	95.6469	121.0469	146.4469	171.8469	197.2469	222.6469	248.0469	273.4469
25/32	0.78125	19.8438	45.2438	70.6438	96.0438	121.4438	146.8438	172.2438	197.6438	223.0438	248.4438	273.8438
51/64	0.796875	20.2406	45.6406	71.0406	96.4406	121.8406	147.2406	172.6406	198.0406	223.4406	248.8406	274.2406
13/16	0.8125	20.6375	46.0375	71.4375	96.8375	122.2375	147.6375	173.0375	198.4375	223.8375	249.2375	274.6375
53/64	0.828125	21.0344	46.4344	71.8344	97.2344	122.6344	148.0344	173.4344	198.8344	224.2344	249.6344	275.0344
27/32	0.84375	21.4312	46.8312	72.2312	97.6312	123.0312	148.4312	173.8312	199.2312	224.6312	250.0312	275.4312
55/64	0.859375	21.8281	47.2281	72.6281	98.0281	123.4281	148.8281	174.2281	199.6281	225.0281	250.4281	275.8281
7/8	0.875	22.2250	47.6250	73.0250	98.4250	123.8250	149.2250	174.6250	200.0250	225.4250	250.8250	276.2250
57/64	0.890625	22.6219	48.0219	73.4219	98.8219	124.2219	149.6219	175.0219	200.4219	225.8219	251.2219	276.6219
29/32	0.90625	23.0188	48.4188	73.8188	99.2188	124.6188	150.0188	175.4188	200.8188	226.2188	251.6188	277.0188
59/64	0.921875	23.4156	48.8156	74.2156	99.6156	125.0156	150.4156	175.8156	201.2156	226.6156	252.0156	277.4156
15/16	0.9375	23.8125	49.2125	74.6125	100.0125	125.4125	150.8125	176.2125	201.6125	227.0125	252.4125	277.8125
61/64	0.953125	24.2094	49.6094	75.0094	100.4094	125.8094	151.2094	176.6094	202.0094	227.4094	252.8094	278.2094
31/32	0.96875	24.6062	50.0062	75.4062	100.8062	126.2062	151.6062	177.0062	202.4062	227.8062	253.2062	278.6062
63/64	0.984375	25.0031	50.4031	75.8031	101.2031	126.6031	152.0031	177.4031	202.8031	228.2031	253.6031	279.0031

Appendix table 11 Hardness conversion chart

Rockwell	Vickers	Brinell		Rockwell		Shore
C scale 1 471.0 N (150 kgf)		Standard steel ball	Tungsten carbide steel ball	A scale 588.4 N (60 kgf)	B scale 980.7 N (100 kgf)	
68	940			85.6		97
67	900			85.0		95
66	865			84.5		92
65	832		739	83.9		91
64	800		722	83.4		88
63	772		705	82.8		87
62	746		688	82.3		85
61	720		670	81.8		83
60	697		654	81.2		81
59	674		634	80.7		80
58	653		615	80.1		78
57	633		595	79.6		76
56	613		577	79.0		75
55	595	–	560	78.5		74
54	577	–	543	78.0		72
53	560	–	525	77.4		71
52	544	500	512	76.8		69
51	528	487	496	76.3		68
50	513	475	481	75.9		67
49	498	464	469	75.2		66
48	484	451	455	74.7		64
47	471	442	443	74.1		63
46	458	432	432	73.6		62
45	446	421		73.1		60
44	434	409		72.5		58
43	423	400		72.0		57
42	412	390		71.5		56
41	402	381		70.9		55
40	392	371		70.4	–	54
39	382	362		69.9	–	52
38	372	353		69.4	–	51
37	363	344		68.9	–	50
36	354	336		68.4	(109.0)	49
35	345	327		67.9	(108.5)	48
34	336	319		67.4	(108.0)	47
33	327	311		66.8	(107.5)	46
32	318	301		66.3	(107.0)	44
31	310	294		65.8	(106.0)	43
30	302	286		65.3	(105.5)	42
29	294	279		64.7	(104.5)	41
28	286	271		64.3	(104.0)	41
27	279	264		63.8	(103.0)	40
26	272	258		63.3	(102.5)	38
25	266	253		62.8	(101.5)	38
24	260	247		62.4	(101.0)	37
23	254	243		62.0	100.0	36
22	248	237		61.5	99.0	35
21	243	231		61.0	98.5	35
20	238	226		60.5	97.8	34
(18)	230	219		–	96.7	33
(16)	222	212		–	95.5	32
(14)	213	203		–	93.9	31
(12)	204	194		–	92.3	29
(10)	196	187			90.7	28
(8)	188	179			89.5	27
(6)	180	171			87.1	26
(4)	173	165			85.5	25
(2)	166	158			83.5	24
(0)	160	152			81.7	24

Appendix table 12 Viscosity conversion chart

Kinematic viscosity mm^2/s	**Saybolt** SUS (second)		**Redwood** R (second)		**Engler** E (degree)
	100 °F	210 °F	50 °C	100 °C	
2	32.6	32.8	30.8	31.2	1.14
3	36.0	36.3	33.3	33.7	1.22
4	39.1	39.4	35.9	36.5	1.31
5	42.3	42.6	38.5	39.1	1.40
6	45.5	45.8	41.1	41.7	1.48
7	48.7	49.0	43.7	44.3	1.56
8	52.0	52.4	46.3	47.0	1.65
9	55.4	55.8	49.1	50.0	1.75
10	58.8	59.2	52.1	52.9	1.84
11	62.3	62.7	55.1	56.0	1.93
12	65.9	66.4	58.2	59.1	2.02
13	69.6	70.1	61.4	62.3	2.12
14	73.4	73.9	64.7	65.6	2.22
15	77.2	77.7	68.0	69.1	2.32
16	81.1	81.7	71.5	72.6	2.43
17	85.1	85.7	75.0	76.1	2.54
18	89.2	89.8	78.6	79.7	2.64
19	93.3	94.0	82.1	83.6	2.76
20	97.5	98.2	85.8	87.4	2.87
21	102	102	89.5	91.3	2.98
22	106	107	93.3	95.1	3.10
23	110	111	97.1	98.9	3.22
24	115	115	101	103	3.34
25	119	120	105	107	3.46
26	123	124	109	111	3.58
27	128	129	112	115	3.70
28	132	133	116	119	3.82
29	137	138	120	123	3.95
30	141	142	124	127	4.07
31	145	146	128	131	4.20
32	150	150	132	135	4.32
33	154	155	136	139	4.45
34	159	160	140	143	4.57
35	163	164	144	147	4.70
36	168	170	148	151	4.83
37	172	173	153	155	4.96
38	177	178	156	159	5.08
39	181	183	160	164	5.21
40	186	187	164	168	5.34
41	190	192	168	172	5.47
42	195	196	172	176	5.59
43	199	201	176	180	5.72
44	204	205	180	185	5.85
45	208	210	184	189	5.98
46	213	215	188	193	6.11
47	218	219	193	197	6.24
48	222	224	197	202	6.37
49	227	228	201	206	6.50
50	231	233	205	210	6.63
55	254	256	225	231	7.24
60	277	279	245	252	7.90
65	300	302	266	273	8.55
70	323	326	286	294	9.21
75	346	349	306	315	9.89
80	371	373	326	336	10.5
85	394	397	347	357	11.2
90	417	420	367	378	11.8
95	440	443	387	399	12.5
100	464	467	408	420	13.2
120	556	560	490	504	15.8
140	649	653	571	588	18.4
160	742	747	653	672	21.1
180	834	840	734	757	23.7
200	927	933	816	841	26.3
250	1 159	1 167	1 020	1 051	32.9
300	1 391	1 400	1 224	1 241	39.5

Remark 1 mm^2/s = 1 cSt (centistokes)

Appendix table 13 Mechanical properties of metal materials (reference)

(1) Modulus of longitudinal elasticity, elastic limit, and ultimate strength

Material	Main components and others	Specific gravity	Modulus of longitudinal elasticity (GPa)	Elastic limit σ_e (MPa)	Ultimate strength (MPa)		
					Tensile K_t	Compression K_c	Shear K_s
Gray cast iron (FC150)		7.1–7.3	69	29	118	590	108
(FC200)		7.1–7.3	98	88	137– 216	740	206
(FC250)		7.1–7.3	103	88	176– 314	880	206
White heart malleable cast iron	Residual carbon : 1.6% or less	7.1–7.3	158	196	314– 392	820	382
Black heart malleable cast iron		7.2–7.6	158	196	274– 392	820	382
Carbon steel	General	7.7–7.8	196–216	176–245	314– 830	–	–
Extra mild steel	C 0.05–0.15%	7.8	196	118	Over 372	Virtually identical to tensile strength, provided buckling can be ignored	0.8 K_t
Mild steel	C 0.15–0.25%	7.8	204	157	372– 392		0.75 K_t
Middle hard steel	C 0.25–0.40%	7.8	206	245–294	490– 590		0.75 K_t
Hard steel	C 0.40–0.50%	7.8	216	343	590– 690		0.7 K_t
Maximum hard steel	C 0.50–0.65%	7.8	216	372	690– 830		0.65 K_t
Mild steel	C 0.18% hot rolling	7.8	206	176	421		314
Hard steel	Oil hardening, tempering at 700 ℃	7.8	206	343	590		461
Tool steel	C 0.60–1.50% hardening	7.8	216	441	660		820
Cast steel	General	7.8–7.9	206–211	176–245	343– 600	343–600	284–382
Cast steel (mild)	C 0.15–0.22%	7.8–7.9	206	196	363– 431	363–431	284
Cast steel (middle hard)	C 0.22–0.30%	7.8–7.9	211	225	392– 490	392–490	333
Cast steel (hard)	C 0.30–0.40%	7.9	211	245	490– 590	490–590	382
Nickel steel	C 0.25–0.35% Ni 2–5%	7.85	206–216	333	640– 830	640	401
Chrome steel	C 0.13–0.48% Cr 0.9–1.2%	7.85	206–216	–	780– 980	–	–
Nickel chrome steel	C, Ni, Cr included	7.85	206–216	–	740– 980	–	382–500
Chromium molybdenum steel	C, Cr, Mo included	7.85	206–216	–	830– 980	–	–
Manganese steel	C 0.2–0.46% Mn 1–1.4%	7.85	206–216	–	440–1 080	–	–
Spring steel		7.86	216	735	1 080–1 670	1 670	–
Stainless steel	C, Cr, Ni included	7.75	206–216	–	620	–	410
Brass casting	Cu 60% Zn 40%	8.5	69	–	176– 216	108	147
Brass (forged plate)	Cu 60% Zn 40%	8.4	78– 98	–	274– 392	314	206
Brass (forged rod)	Cu 60% Zn 40%	8.4	82	–	520	314	314
Phosphor bronze casting	Cu 90% Sn 10% P 0.1%	8.8	93–103	–	196– 294	137	176
Phosphor bronze (forging)	Cu 90% Sn 10% P 0.1%	8.8	132	–	294– 980	206	382
Tin		7.28	39– 54	–	27	–	–
Lead		11.34	15– 17	–	20	–	–
Zinc		7.1	78–127	–	78– 176	–	–

(2) Allowable stress

Unit : MPa

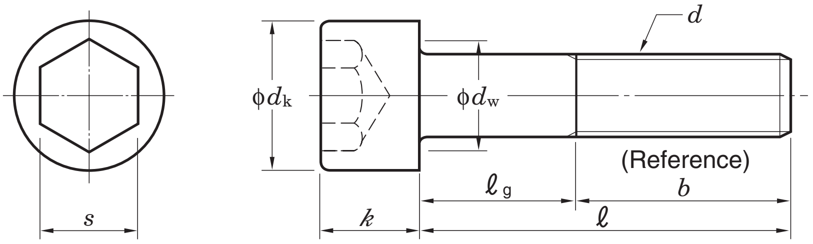
Material	Tensile K_t			Compression K_c		Bending K_b			Shear K_s			Torsion K_d		
	a	*b*	*c*	*a*	*b*	*a*	*b*	*c*	*a*	*b*	*c*	*a*	*b*	*c*
Cast iron (cast)	29– 34	20– 23	10–12	88– 98	59– 65	45– 59	30– 39	15–20	29– 34	20–23	10–12	26– 34	18–23	88–118
Cast iron (machined)	29– 34	20– 23	10–12	88– 98	59– 65	55– 71	–	–	29– 34	20–23	10–12	26– 34	18–23	88–118
Malleable cast iron	44– 69	29– 46	15–23	59– 88	39– 59	44– 98	29– 46	15–23	–	–	–	29– 39	20–26	10– 13
Cast steel	59–118	39– 78	20–39	88–147	59– 98	74–118	49– 78	25–39	47– 94	31–63	16–31	47– 94	31–63	16– 31
Mild steel	98–157	66–105	32–52	98–157	66–105	88–147	59– 98	35–49	78–127	52–85	26–42	78–137	52–91	26– 46
Middle hard steel	118–176	78–118	39–59	118–176	78–118	118–176	78–118	39–59	94–137	63–94	31–47	88–137	59–94	29– 47
Nickel steel	118–176	78–118	39–59	118–176	78–118	118–176	78–118	39–59	94–137	63–94	31–47	88–137	59–92	29– 47
Carbon steel casting	88–118	59– 78	29–39	88–118	59– 78	88–118	59– 78	29–39	71– 93	47–63	24–31	35– 47	24–31	12– 16
Brass (rolled)	10– 59	26– 35	13–20	39– 59	26– 39	39– 59	26– 39	13–20	34– 47	21–31	11–16	31– 47	21–31	11– 16
Bronze	29– 39	20– 26	10–13	29– 39	20– 26	29– 39	20– 26	10–13	–	–	–	–	–	–
Phosphor bronze	59– 88	39– 59	20–29	59– 88	39– 59	59– 88	39– 59	20–29	44– 69	29–46	15–23	44– 69	29–46	15– 23
Aluminum casting	10– 12	7– 8	2– 4	–	–	15– 20	10– 13	5– 7	–	–	–	–	–	–

Remarks 1. *a* is applicable in the case of static load, *b* is applicable in the case of dynamic load, and *c* is applicable to in the case of repeated load.

2. Bending allowable stress K_b and torsion allowable stress K_d of cast iron are applicable when the cross section is round and safety factor is within a range from 5 to 6.

Appendix table 14 (1) Hexagon socket head cap screws (abstract from JIS B 1176)

M 1.6 – 24



Allowance of bolt length (ℓ)

Unit : mm

Bolt length (ℓ)		Allowance of length
Over	Incl.	
–	3	±0.2
3	6	±0.24
6	10	±0.29
10	16	±0.35
16	30	±0.42
30	50	±0.5
50	80	±0.6
80	120	±0.7
120	180	±0.8
180	240	±0.95
240	300	±1.05

(1) Parts class A M 1.6–24

Unit : mm

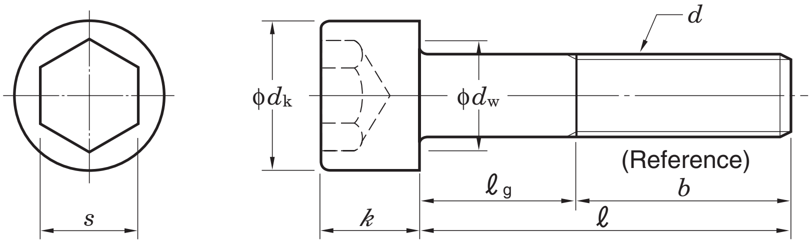
Nominal size of screw d	M 1.6	M 2	M 2.5	M 3	M 4	M 5	M 6	M 8	M 10	M 12	(M 14)	M 16	(M 18)	M 20	(M 22)	M 24
Coarse screw thread pitch	0.35	0.4	0.45	0.5	0.7	0.8	1	1.25	1.5	1.75	2	2	2.5	2.5	2.5	3
Head dia. d_k	3	3.8	4.5	5.5	7	8.5	10	13	16	18	21	24	27	30	33	36
Head height k	1.6	2	2.5	3	4	5	6	8	10	12	14	16	18	20	22	24
Bearing surface dia. d_w (min.)	2.72	3.4	4.18	5.07	6.53	8.03	9.38	12.33	15.33	17.23	20.17	23.17	25.87	28.87	31.81	34.81
Nominal size of hexagon socket s	1.5	1.5	2	2.5	3	4	5	6	8	10	12	14	14	17	17	19
Thread length b (reference)	15	16	17	18	20	22	24	28	32	36	40	44	48	52	56	60

Nominal length ℓ	Body length ℓ_g (max.)															
	M 1.6	M 2	M 2.5	M 3	M 4	M 5	M 6	M 8	M 10	M 12	(M 14)	M 16	(M 18)	M 20	(M 22)	M 24
2.5																
3																
4																
5																
6																
8																
10																
12																
16																
20		4														
25			8	7												
30				12	10	8										
35					15	13	11									
40					20	18	16	12								
45						23	21	17	13							
50						28	26	22	18	14						
55							31	27	23	19						
60							36	32	28	24	20	16				
65								37	33	29	25	21	17			
70								42	38	34	30	26	22	18		
80								52	48	44	40	36	32	28	24	
90									58	54	50	46	42	38	34	30
100									68	64	60	56	52	48	44	40
110										74	70	66	62	58	54	50
120										84	80	76	72	68	64	60
130											90	86	82	78	74	70
140											100	96	92	88	84	80
150												106	102	98	94	90
160												116	112	108	104	100
180													132	128	124	120
200														148	144	140

Remarks
1. Priority is given to the nominal sizes of screws without parentheses.
2. Nominal lengths (ℓ) to be recommended for the nominal sizes of screw are within the range enclosed by bold lines in the column of "Body length ℓ_g". In the column of "Body length ℓ_g", thread of the screw with length shorter than that indicated under dotted lines should be continuous. For the continuous thread stud screw, the incomplete thread portion length under the neck of the screw should be approximately three times of the thread pitch.
3. The sides of the head of screw should be single or double knurled. The d_k values in the table are the maximum values without knurls.
4. Roundness or chamfers on the bearing surface should be provided between the diameter of the head (d_k) and the diameter of bearing surface (d_w), and the surface should be free from burrs.

Appendix table 14 (2) Hexagon socket head cap screws (abstract from JIS B 1176)

M 27 – 52



Allowance of bolt length (ℓ)

Unit : mm

Bolt length (ℓ) Over	Bolt length (ℓ) Incl.	Allowance of length
–	3	±0.2
3	6	±0.24
6	10	±0.29
10	16	±0.35
16	30	±0.42
30	50	±0.5
50	80	±0.6
80	120	±0.7
120	180	±0.8
180	240	±0.95
240	300	±1.05

(2) Parts class A M 27–52

Unit : mm

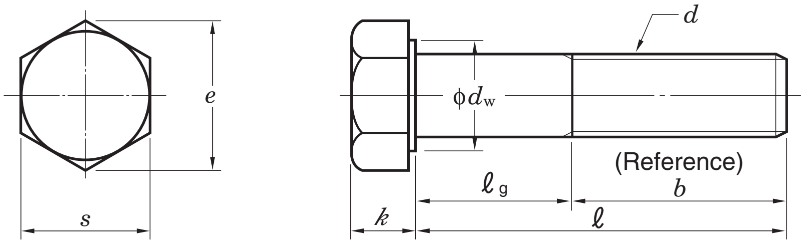
Nominal size of screw d		(M 27)	M 30	(M 33)	M 36	(M 39)	M 42	(M 45)	M 48	(M 52)
	Coarse screw thread pitch	3	3.5	3.5	4	4	4.5	4.5	5	5
Head dia. d_k		40	45	50	54	58	63	68	72	78
Head height k		27	30	33	36	39	42	45	48	52
Bearing surface dia. d_w	(min.)	38.61	43.61	48.61	52.54	56.34	61.34	66.34	70.34	76.34
Nominal size of hexagon socket s		19	22	24	27	27	32	32	36	36
Thread length b	(reference)	66	72	78	84	90	96	102	108	116

Nominal length ℓ	(M 27)	M 30			Body length ℓ_g (max.)				
45									
50			(M 33)	M 36					
55									
60					(M 39)	M 42			
65									
70							(M 45)	M 48	
80	(M 27)								(M 52)
90	24	M 30	(M 33)						
100	34	28	22						
110	44	38	32	M 36	(M 39)	M 42			
120	54	48	42	36	30	24	(M 45)		
130	64	58	52	46	40	34	28	M 48	
140	74	68	62	56	50	44	38	32	(M 52)
150	84	78	72	66	60	54	48	42	34
160	94	88	82	76	70	64	58	52	44
180	114	108	102	96	90	84	78	72	64
200	134	128	122	116	110	104	98	92	84
220	154	148	142	136	130	124	118	112	104
240	174	168	162	156	150	144	138	132	124
260	194	188	182	176	170	164	158	152	144
280	214	208	202	196	190	184	178	172	164
300	234	228	222	216	210	204	198	192	184

Remarks
1. Priority is given to the nominal sizes of screws without parentheses.
2. Nominal lengths (ℓ) to be recommended for the nominal sizes of screw are within the range enclosed by bold lines in the column of "Body length ℓ_g". In the column of "Body length ℓ_g", thread of the screw with length shorter than that indicated under dotted lines should be continuous. For the continuous thread stud screw, the incomplete thread portion length under the neck of the screw should be approximately three times of the thread pitch.
3. The sides of the head of screw should be single or double knurled. The d_k values in the table are the maximum values without knurls.
4. Roundness or chamfers on the bearing surface should be provided between the diameter of the head (d_k) and the diameter of bearing surface (d_w), and the surface should be free from burrs.

Appendix table 15 (1) Hexagon head bolts (abstract from JIS B 1180)

Parts class A M 1.6 – 24



Allowance of bolt length (ℓ)

Unit : mm

Bolt length (ℓ) Over	Bolt length (ℓ) Incl.	Allowance of length
–	20	±0.35
20	30	±0.42
30	50	±0.5
50	80	±0.6
80	120	±0.7
120	150	±0.8

(1) Parts class A M 1.6–24

Unit : mm

Nominal size of screw d	Coarse screw thread pitch	M 1.6	M 2	M 2.5	M 3	(M 3.5)	M 4	M 5	M 6	M 8	M 10	M 12	(M 14)	M 16	(M 18)	M 20	(M 22)	M 24
		0.35	0.4	0.45	0.5	0.6	0.7	0.8	1	1.25	1.5	1.75	2	2	2.5	2.5	2.5	3
	Fine thread	–	–	–	–	–	–	–	–	M 8 × 1	M 10 × 1	M 12 ×1.5	–	M 16 ×1.5	–	M 20 ×1.5	–	M 24 × 2
		–	–	–	–	–	–	–	–	–	(M 10 ×1.25)	(M 12 ×1.25)	(M 14 ×1.5)	–	(M 18 ×1.5)	(M 20 × 2)	(M 22 ×1.5)	–
Bearing surface dia. d_w (min.)		2.27	3.07	4.07	4.57	5.07	5.88	6.88	8.88	11.63	14.63	16.63	19.64	22.49	25.34	28.19	31.71	33.61
Width across flats s (max.)		3.2	4	5	5.5	6	7	8	10	13	16	18	21	24	27	30	34	36
Width across corners e (min.)		3.41	4.32	5.45	6.01	6.58	7.66	8.79	11.05	14.38	17.77	20.03	23.36	26.75	30.14	33.53	37.72	39.98
Head height k (basic)		1.1	1.4	1.7	2	2.4	2.8	3.5	4	5.3	6.4	7.5	8.8	10	11.5	12.5	14	15
Thread length b (reference)	$\ell \leq 125$	9	10	11	12	13	14	16	18	22	26	30	34	38	42	46	50	54
	$125 < \ell \leq 150$	–	–	–	–	–	–	–	–	–	–	–	40	44	48	52	56	60

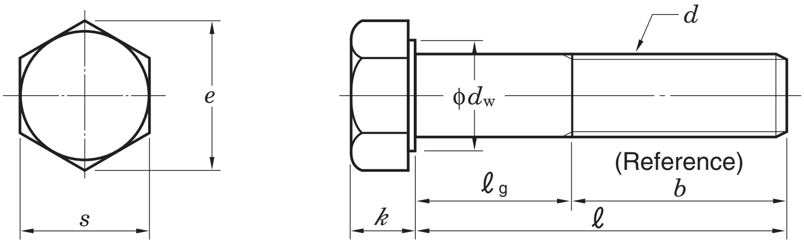
Nominal length ℓ	Body length ℓ_g (max.) M 1.6	M 2	M 2.5	M 3	(M 3.5)	M 4	M 5	M 6	M 8	M 10	M 12	(M 14)	M 16	(M 18)	M 20	(M 22)	M 24
12	3																
16	7	6	5														
20		10	9	8	7												
25			14	13	12	11	9										
30				18	17	16	14	12									
35					22	21	19	17									
40						26	24	22	18								
45							29	27	23	19							
50							34	32	28	24	20						
55								37	33	29	25						
60								42	38	34	30	26					
65									43	39	35	31	27				
70									48	44	40	36	32	28			
80									58	54	50	46	42	38	34		
90										64	60	56	52	48	44	40	36
100										74	70	66	62	58	54	50	46
110											80	76	72	68	64	60	56
120											90	86	82	78	74	70	66
130												90	86	82	78	74	70
140												100	96	92	88	84	80
150													106	102	98	94	90

As for the bolts with nominal length within this area, standards of continuous thread stud hexagon head bolt (parts class A) should be observed.

Remarks 1. Priority is given to the nominal sizes of screws without parentheses.
2. Nominal lengths (ℓ) to be recommended for the nominal sizes of screw are within the range enclosed by bold lines.
3. Body length ℓ_g (maximum) should be found by the following formula : ℓ_g (maximum) = Nominal length (ℓ) – Thread length (b)

Appendix table 15 (2) Hexagon head bolts (abstract from JIS B 1180)

Parts class B M 16 – 64



Allowance of bolt length (ℓ)

Unit : mm

Bolt length (ℓ) Over	Bolt length (ℓ) Incl.	Allowance of length
–	80	±1.5
80	90	±1.7
90	120	±1.75
120	180	±2
180	240	±2.3
240	300	±2.6
300	400	±2.85
400	500	±3.15

(2) Parts class B M 16–64

Unit : mm

		M 16	(M 18)	M 20	(M 22)	M 24	(M 27)	M 30	(M 33)	M 36	(M 39)	M 42	(M 45)	M 48	(M 52)	M 56	(M 60)	M 64
Nominal size of screw d	Coarse screw thread pitch	2	2.5	2.5	2.5	3	3	3.5	3.5	4	4	4.5	4.5	5	5	5.5	5.5	6
	Fine thread	M 16 ×1.5	–	M 20 ×1.5	–	M 24 × 2	–	M 30 × 2	–	M 36 × 3	–	M 42 × 3	–	M 48 × 3	–	M 56 × 4	–	M 64 × 4
		–	(M 18 ×1.5)	(M 20 × 2)	(M 22 ×1.5)	–	(M 27 × 2)	–	(M 33 × 2)	–	(M 39 × 3)	–	(M 45 × 3)	–	(M 52 × 4)	–	(M 60 × 4)	–
Bearing surface dia. d_w (min.)		22	24.85	27.7	31.35	33.25	38	42.75	46.55	51.11	55.86	59.95	64.7	69.45	74.2	78.66	83.41	88.16
Width across flats s (max.)		24	27	30	34	36	41	46	50	55	60	65	70	75	80	85	90	95
Width across corners e (min.)		26.17	29.56	32.95	37.29	39.55	45.2	50.85	55.37	60.79	66.44	71.3	76.95	82.6	88.25	93.56	99.21	104.86
Head height k (basic)		10	11.5	12.5	14	15	17	18.7	21	22.5	25	26	28	30	33	35	38	40
Thread length b (reference)	$\ell \leq 125$	38	42	46	50	54	60	66	–	–	–	–	–	–	–	–	–	–
	$125 < \ell \leq 200$	44	48	52	56	60	66	72	78	84	90	96	102	108	116	–	–	–
	$200 < \ell \leq 500$	–	–	–	69	73	79	85	91	97	103	109	115	121	129	137	145	153

Nominal length ℓ	M 16	(M 18)	M 20	(M 22)	M 24	(M 27)	M 30	(M 33)	M 36	(M 39)	M 42	(M 45)	M 48	(M 52)	M 56	(M 60)	M 64
65																	
70																	
80																	
90																	
100						40											
110						50	44										
120						60	54										
130						64	58	52									
140						74	68	62	56								
150						84	78	72	66	60							
160	116	112	108	104	100	94	88	82	76	70	64						
180		132	128	124	120	114	108	102	96	90	84	78	72				
200			148	144	140	134	128	122	116	110	104	98	92	84			
220				151	147	141	135	129	123	117	111	105	99	91	83		
240					167	161	155	149	143	137	131	125	119	111	103	95	
260						181	175	169	163	157	151	145	139	131	123	115	107
280							195	189	183	177	171	165	159	151	143	135	127
300							215	209	203	197	191	185	179	171	163	155	147
320								229	223	217	211	205	199	191	183	175	167
340									243	237	231	225	219	211	203	195	187
360									263	257	251	245	239	231	223	215	207
380										277	271	265	259	251	243	235	227
400											291	285	279	271	263	255	247
420											311	305	299	291	283	275	267
440												325	319	311	303	295	287
460													339	331	323	315	307
480													359	351	343	335	327
500														371	363	355	347

Body length ℓ_g (max.)

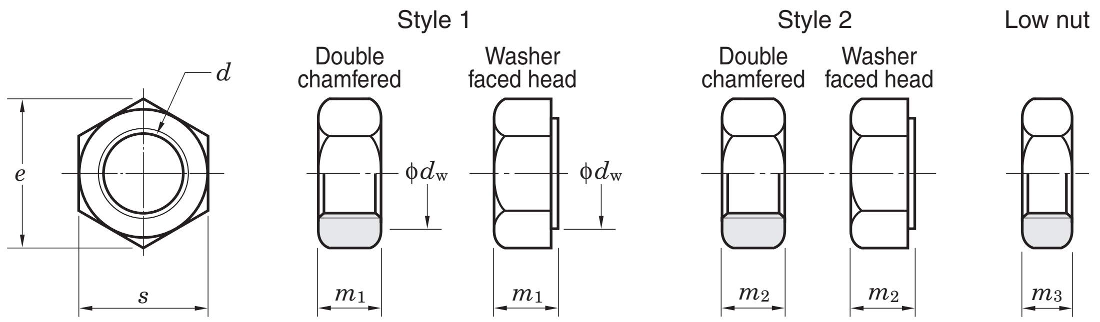
As for the bolts with nominal length within this area, standards of (1) parts class A should be observed.

As for the bolts with nominal length within this area, standards of continuous thread stud hexagon head bolt (parts class A or B) should be observed.

Remarks 1. Priority is given to the nominal sizes of screws without parentheses.
2. Nominal lengths (ℓ) to be recommended for the nominal sizes of screw are within the range enclosed by bold lines.
3. Body length ℓ_g (maximum) should be found by the following formula : ℓ_g (maximum) = Nominal length (ℓ) – Thread length (b)

Appendix table 16 Hexagon head nuts (abstract from JIS B 1181)

Parts class A M 1.6 – 16
Parts class B M 18 – 64



(1) Parts class A M 1.6–16

Unit : mm

Nominal size of screw d	Coarse screw thread pitch	M 1.6	M 2	M 2.5	M 3	(M 3.5)	M 4	M 5	M 6	M 8	M 10	M 12	(M 14)	M 16
		0.35	0.4	0.45	0.5	0.6	0.7	0.8	1	1.25	1.5	1.75	2	2
	Fine thread	–	–	–	–	–	–	–	–	M 8 × 1	M 10 × 1	M 12 × 1.5	–	M 16 × 1.5
		–	–	–	–	–	–	–	–	–	(M 10 ×1.25)	(M 12 ×1.25)	(M 14 × 1.5)	–
Bearing surface dia. d_w (min.)		2.27	3.07	4.07	4.57	5.07	5.88	6.88	8.88	11.63	14.63	16.63	19.64	22.49
Width across flats s (max.)		3.2	4	5	5.5	6	7	8	10	13	16	18	21	24
Width across corners e (min.)		3.41	4.32	5.45	6.01	6.58	7.66	8.79	11.05	14.38	17.77	20.03	23.36	26.75
Height	m_1 (max.)	1.3	1.6	2	2.4	2.8	3.2	4.7	5.2	6.8	8.4	10.8	12.8	14.8
	m_2 (max.)	–	–	–	–	–	–	5.1	5.7	7.5	9.3	12	14.1	16.4
	m_3 (max.)	1	1.2	1.6	1.8	2	2.2	2.7	3.2	4	5	6	7	8

Remark Priority is given to the nominal sizes of screws without parentheses.

(2) Parts class B M 18–64

Unit : mm

Nominal size of screw d	Coarse screw thread pitch	(M 18)	M 20	(M 22)	M 24	(M 27)	M 30	(M 33)	M 36	(M 39)	M 42	(M 45)	M 48	(M 52)	M 56	(M 60)	M 64
		2.5	2.5	2.5	3	3	3.5	3.5	4	4	4.5	4.5	5	5	5.5	5.5	6
	Fine thread	–	M 20 ×1.5	–	M 24 × 2	–	M 30 × 2	–	M 36 × 3	–	M 42 × 3	–	M 48 × 3	–	M 56 × 4	–	M 64 × 4
		(M 18 ×1.5)	(M 20 × 2)	(M 22 ×1.5)	–	(M 27 × 2)	–	(M 33 × 2)	–	(M 39 × 3)	–	(M 45 × 3)	–	(M 52 × 4)	–	(M 60 × 4)	–
Bearing surface dia. d_w (min.)		24.85	27.7	31.35	33.25	38	42.75	46.55	51.11	55.86	59.95	64.7	69.45	74.2	78.66	83.41	88.16
Width across flats s (max.)		27	30	34	36	41	46	50	55	60	65	70	75	80	85	90	95
Width across corners e (min.)		29.56	32.95	37.29	39.55	45.2	50.85	55.37	60.79	66.44	71.3	76.95	82.6	88.25	93.56	99.21	104.86
Height	m_1 (max.)	15.8	18	19.4	21.5	23.8	25.6	28.7	31	33.4	34	36	38	42	45	48	51
	m_2 (max.)	17.6	20.3	21.8	23.9	26.7	28.6	32.5	34.7	–	–	–	–	–	–	–	–
	m_3 (max.)	9	10	11	12	13.5	15	16.5	18	19.5	21	22.5	24	26	28	30	32

Remark Priority is given to the nominal sizes of screws without parentheses.

Appendix table 17 Comparison table of Part No. by manufacturers (cylindrical bore type)

17.1 Pillow type bearing units

	FYH · JTEKT	ASAHI	NSK	NTN
With pressed steel cover	UCP2··C	UCP2··C	Z-UCP2··D1	S-UCP2··D1
	UCP2··CD	UCP2··E	ZM-UCP2··D1	SM-UCP2··D1
With cast iron cover	UCP2··FC	CUCP2··C	C-UCP2··D1	C-UCP2··D1
	UCP2··FCD	CUCP2··CE	CM-UCP2··D1	CM-UCP2··D1
	UCP3··C	CUCP3··C	C-UCP3··D1	C-UCP3··D1
	UCP3··CD	CUCP3··CE	CM-UCP3··D1	CM-UCP3··D1
Cast steel type	UCP2SC	UCPK2··		
	UCP3SC	UCPK3··		
Thick type	UCIP2··	UCIP2··	UCIP2··	UCIP2··
	UCIP3··	UCIP3··	UCIP3··	UCIP3··
Tapped-base type	UCPA2··	UCPA2··	UCUP2··D1	UCUP2··D1
High centerheight type	UCPH2··	UCPH2··	UCHP2··D1	UCHP2··D1
Lightweight type	BLP2··	BLLP··	ASPB2··	ASPB2··
	ALP2··		AELPB2··	AELPB2··
Clean series	UP0··	UP0··		
Stainless steel type	UCSP2··H1S6	MUCP2··	F-UCPM2··/LP03	F-UCPM2··/LP03
	UCSPA2··H1S6	MUCPA2		
	USP0··S6			
Steel plate type	SBPP2··	BPP··	ASPP2··	ASPP2··
	SAPP2··		AELPP2··	AELPP2··

17.2 Flange type bearing units

	FYH · JTEKT	ASAHI	NSK	NTN
With pressed steel cover	UCF2··C	UCF2··C	Z-UCF2··D1	S-UCF2··D1
	UCF2··D	UCF2··E	ZM-UCF2··D1	SM-UCF2··D1
	UCFC2··C	UCFC2··C	Z-UCFC2··D1	S-UCFC2··D1
	UCFC2··D	UCFC2··E	ZM-UCFC2··D1	SM-UCFC2··D1
	UCFL2··C	UCFL2··C	Z-UCFL2··D1	S-UCFL2··D1
	UCFL2··D	UCFL2··E	ZM-UCFL2··D1	SM-UCFL2··D1
With cast iron cover	UCF2··FC	CUCF2··C	C-UCF2··D1	C-UCF2··D1
	UCF2··FD	CUCF2··CE	CM-UCF2··D1	CM-UCF2··D1
	UCF3··C	CUCF3··C	C-UCF3··D1	C-UCF3··D1
	UCF3··D	CUCF3··CE	CM-UCF3··D1	CM-UCF3··D1
	UCFC2··FC	CUCFC2··C	C-UCFC2··D1	C-UCFC2··D1
	UCFC2··FD	CUCFC2··CE	CM-UCFC2··D1	CM-UCFC2··D1
	UCFS3··C	CUCFS3··C	C-UCFS3··D1	C-UCFS3··D1
	UCFS3··D	CUCFS3··CE	CM-UCFS3··D1	CM-UCFS3··D1
	UCFL2··FC	CUCFL2··C	C-UCFL2··D1	C-UCFL2··D1
	UCFL2··FD	CUCFL2··CE	CM-UCFL2··D1	CM-UCFL2··D1
	UCFL3··C	CUCFL3··C	C-UCFL3··D1	C-UCFL3··D1
	UCFL3··D	CUCFL3··CE	CM-UCFL3··D1	CM-UCFL3··D1
Adjustable type	UCFA2··	UCFA2··	UCFA2··D1	UCFA2··D1
	UCFB2··	UCFK2··	UCFH2··D1	UCFH2··D1
Lightweight type	BLF2··	BLFL··	ASFB2··	ASFB2··
	ALF2··		AELFB2··	AELFB2··
Clean series	UFL0··	UFL0··		
Stainless steel type	UCSF2··H1S6	MUCF2		
	UCSFL2··H1S6	MUCFL2··	F-UCFM2··/LP03	F-UCFM2··/LP03
Stamped steel plate type	SBPF2··	BPF··	ASPF2··	ASPF2··
	SAPF2··		AELPF2··	AELPF2··
	SBPFL2··	BPFL··	ASPFL2··	ASPFL2··
	SAPFL2··		AELPFL2··	AELPFL2··

17.3 Take-up type bearing units

	FYH · JTEKT	ASAHI	NSK	NTN
With pressed steel cover	UCT2··C	UCT2··C	Z-UCT2··D1	S-UCT2··D1
	UCT2··CD	UCT2··E	ZM-UCT2··D1	SM-UCT2··D1
With cast iron cover	UCT2··FC	CUCT2··C	C-UCT2··D1	S-UCT2··D1
	UCT2··FCD	CUCT2··CE	CM-UCT2··D1	SM-UCT2··D1
	UCT3··C	CUCT3··C	C-UCT3··D1	C-UCT3··D1
	UCT3··CD	CUCT3··CE	CM-UCT3··D1	CM-UCT3··D1
Stainless steel type	UCST2··H1S6	MUCT2		
Take-up type with frame	UCTH2··-··	UCT2···-WB	UCT2···-D1	UCT2···-D1
	UCTL2··-··	UCTL2··+WL··	UCL2··D1	UCL2··D1
	UCTU2··-··	UCTU2··+WU··	UCM2··D1	UCM2··D1
	UCTU3··-··	UCTU3··+WU··	UCM3··D1	UCM3··D1
Take-up type with steel plate frame	SBPTH2··-··			
	SBNPTH2··-··	BTAW201,X	ASPT2··-··	ASPT2··-··

17.4 Other bearing units

	FYH · JTEKT	ASAHI	NSK	NTN
Hanger type	UCHA2··	UCECH2··	UCHB2··D1	UCHB2··D1

17.5 Bearing

	FYH · JTEKT	ASAHI	NSK	NTN
Ball bearing inserts	UC2··	UC2··	UC2··D1	UC2··D1
	UK2··	UK2··	UK2··D1	UK2··D1
	NA2··	UG2··+ER	UEL2··D1	UEL2··D1
	SB2··	B··	AS2··	AS2··
	SA2··		AEL2··	AEL2··
Outside surface cylindrical bore type	RB2··	UR2·· [*1]		
	ER2··	SER2·· [*1]	UCS2··LN [*1]	UCS2··LN [*1]

[*1] Width of the outer ring for these items differs from that of others.

17.6 Special specification items

	FYH · JTEKT	ASAHI	NSK	NTN
Grease (heat resistant)	D1K2	HR5	HT2	HT2
(cold resistant)	D2K2	CR2A	CT1	CT1
(heat resistant)	D9K2	HR23		
Non-contact	K3		U	U
Spherical nodular graphite cast iron	H4		N1	N1
Lubricated type			D1	D1
Non-lubricated type	E4	GOO		

FYH®

BALL BEARING UNITS

NIPPON PILLOW BLOCK CO., LTD.

HEAD OFFICE/Main Plant
2306 Hirao Miharaku Sakai Osaka 587-0022 JAPAN
TEL: 072-361-3752 FAX: 072-361-4173 E-mail: info@fyhbearings.com

OSAKA SALES
E-mail: exports@fyh.co.jp
osaka@fyh.co.jp

FYH BEARING UNITS USA INC.

FYH BEARING UNITS USA INC.
285 Industrial Drive Wauconda, Illinois 60084, USA
TEL: 847-487-9111 FAX: 847-487-9222 E-mail: sales@fyhusa.com

DOMESTIC BRANCHES IN JAPAN

Tokyo
1-3-49 Katsushima Shinagawaku Tokyo 140-0012 JAPAN
TEL: 03-5767-7270 FAX: 03-5767-7280
E-mail: tokyo@fyhsales.co.jp

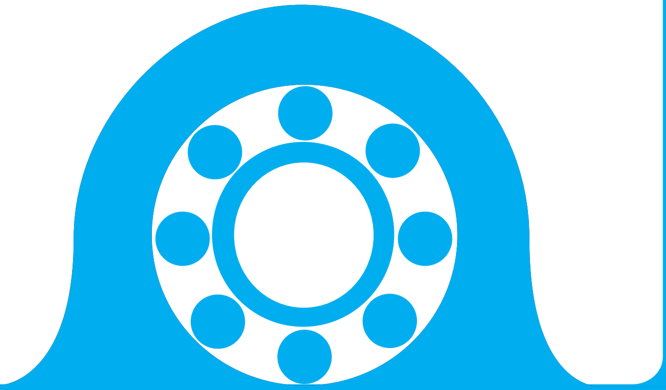
Nagoya
2-1-2 Niban Atsutaku Nagoya Aichi 456-0052 JAPAN
TEL: 052-652-1211 FAX: 052-652-0744
E-mail: nagoya@fyhsales.co.jp

Sapporo E-mail: sapporo@fyhsales.co.jp

Fukuoka E-mail: kyusyuu@fyhsales.co.jp

Hiroshima E-mail: fukuyama@fyhsales.co.jp

Shizuoka E-mail: sizuoka@fyhsales.co.jp



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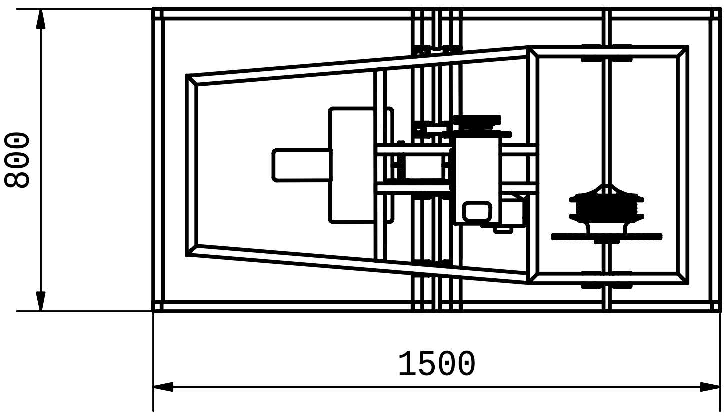
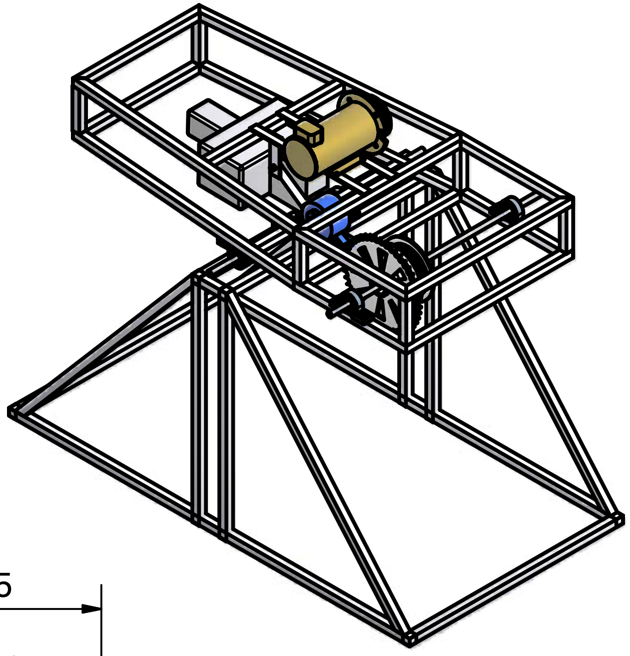
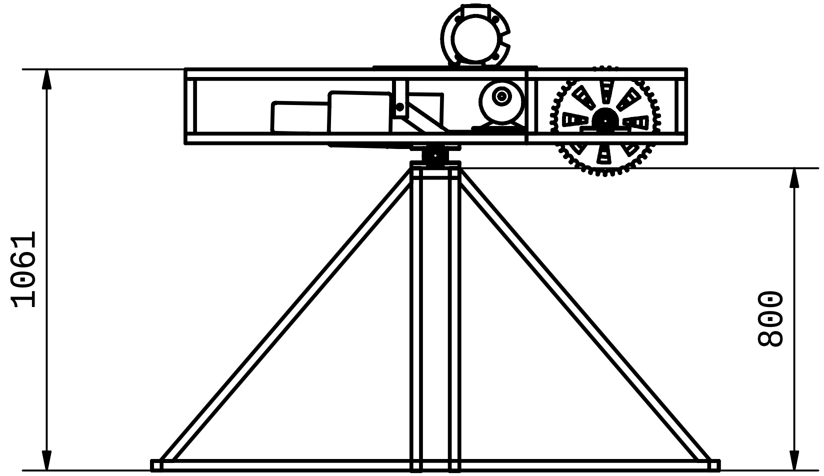
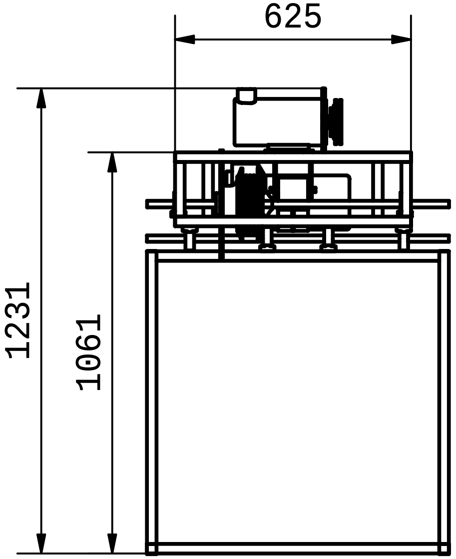
2007.11.10000DS









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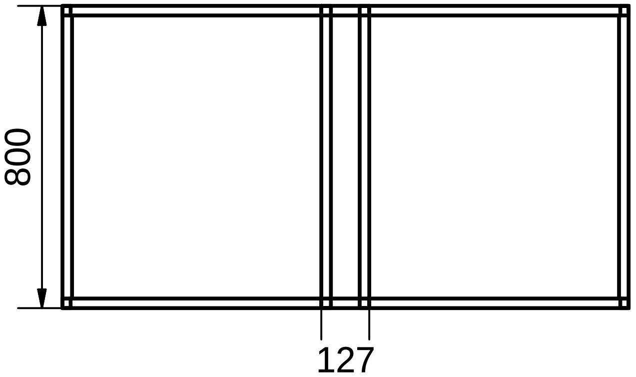
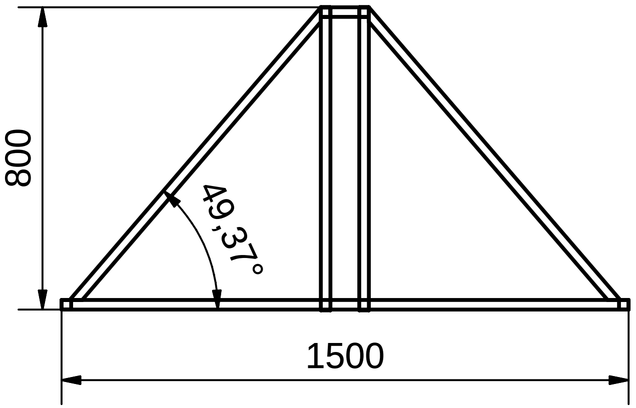
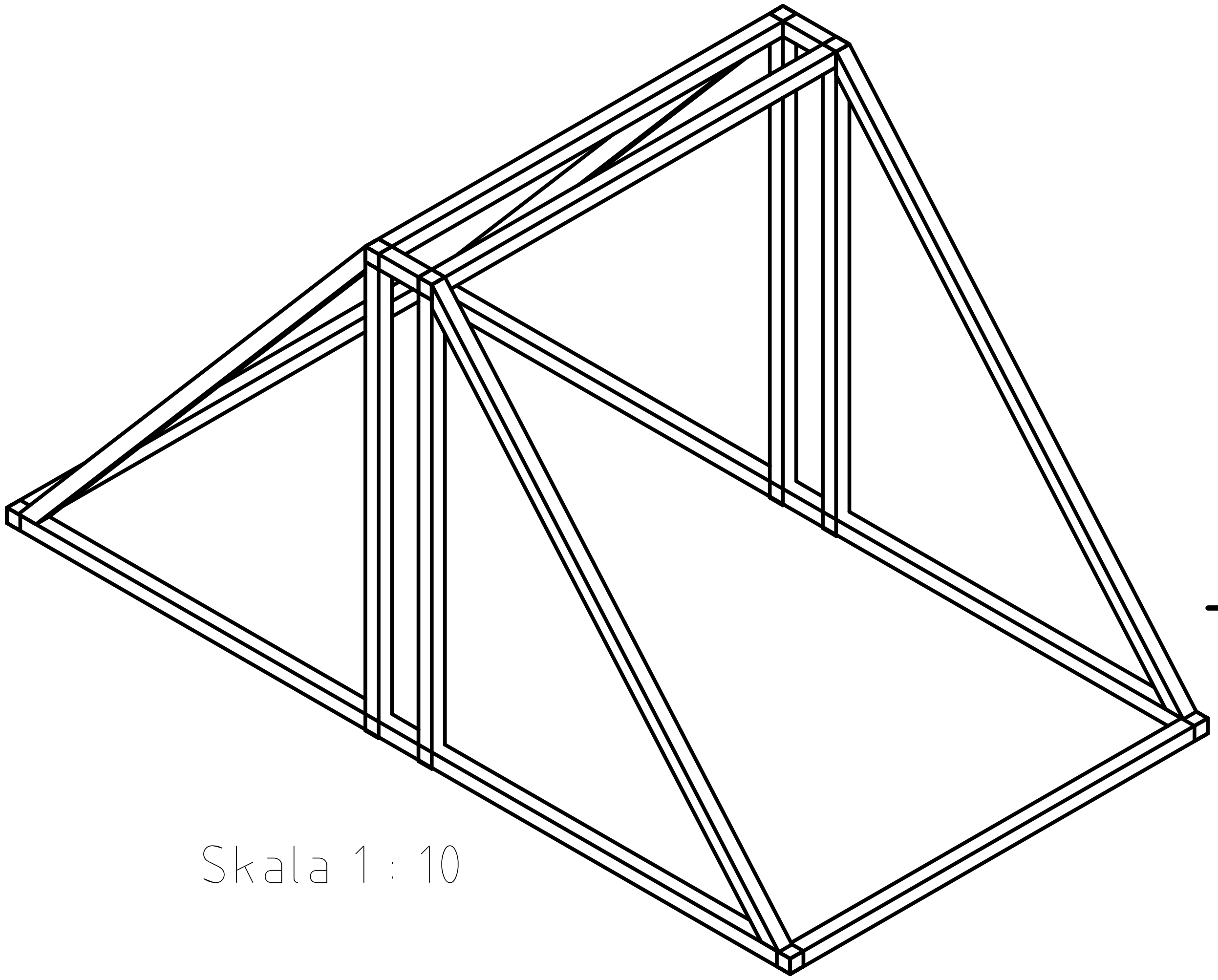
	satuan : mm	NPM : 0403020289/0403020572	
	tanggal : 01-12-2007	disetujui : DR.Ir.Gandjar Kiswanto	
DTM FTUI	LARGE TEST BED		A4







Skala 1 : 10

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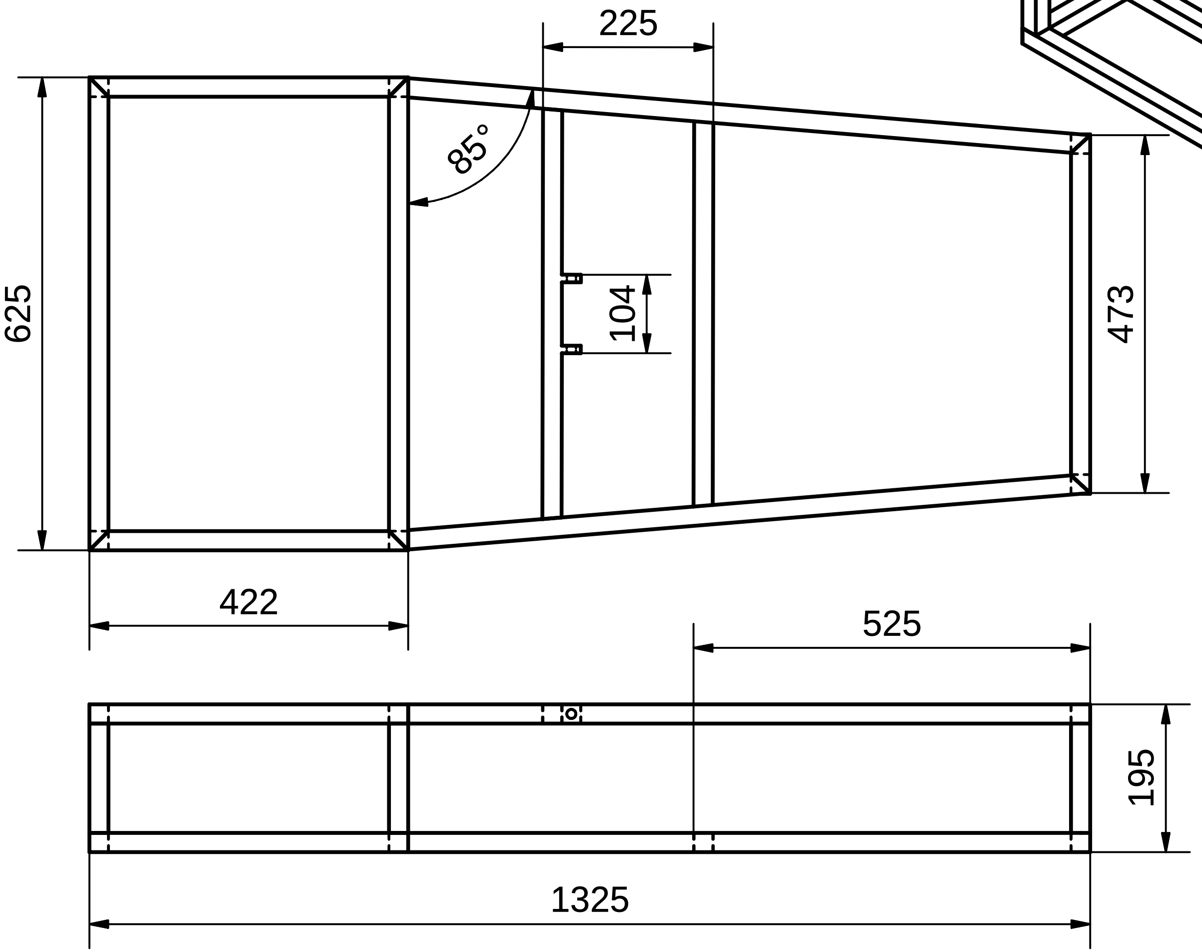
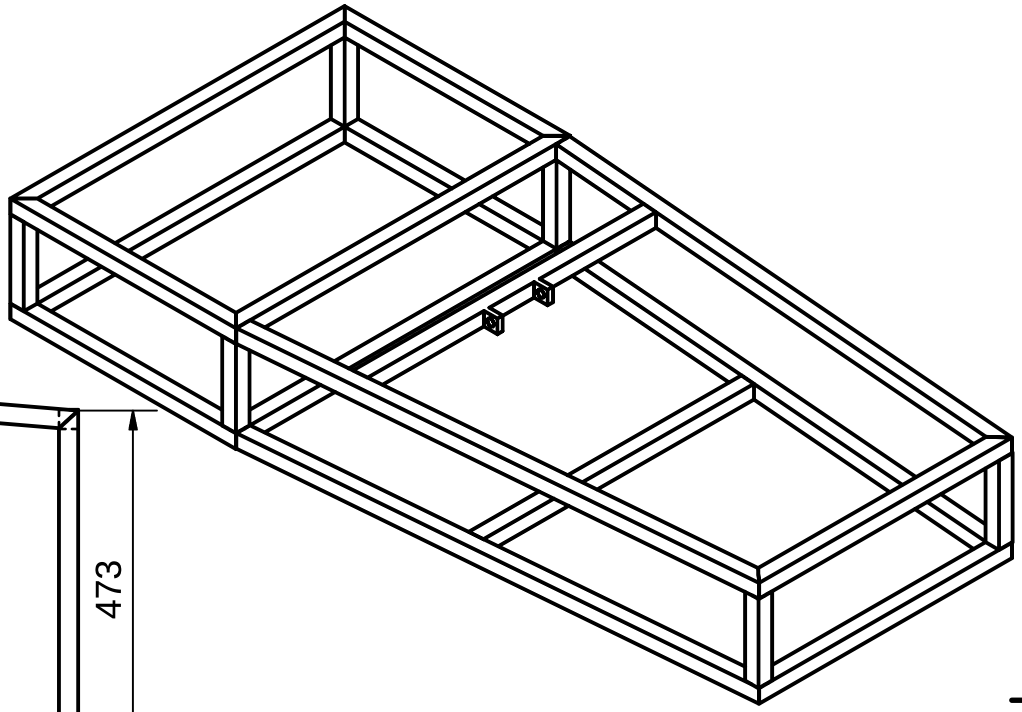
satuan : mm	NPM : 0403020289/0403020572	
tanggal : 01-12-2007	disetujui : DR.Ir.Gandjar Kiswanto	

DTM FTUI

LARGE TEST BED_ BASE

A4





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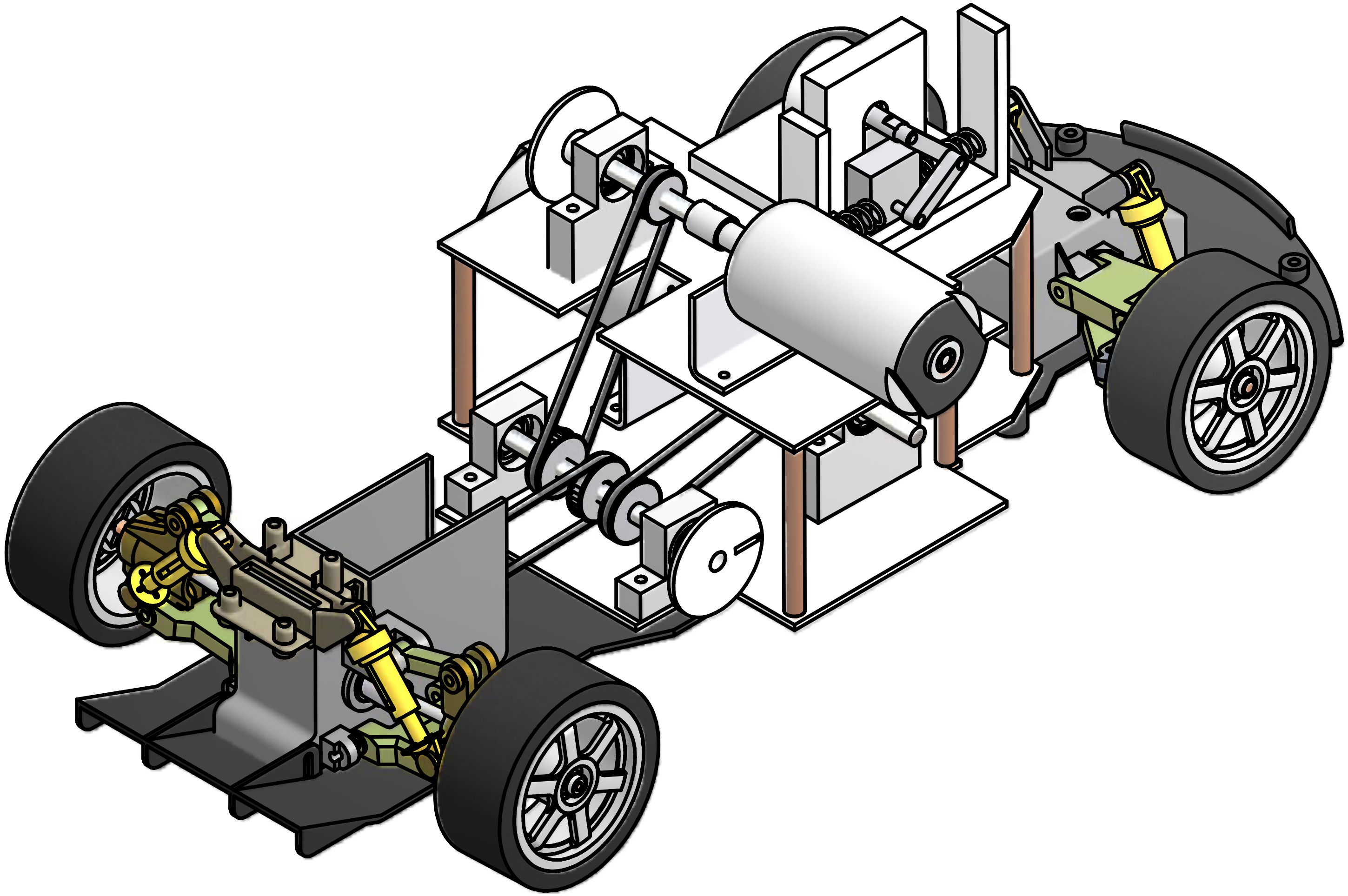
tanggal : 01-12-2007	disetujui : DR.Ir.Gandjar Kiswanto	

DTM FTUI

LARGE TEST BED__FRAME

A4



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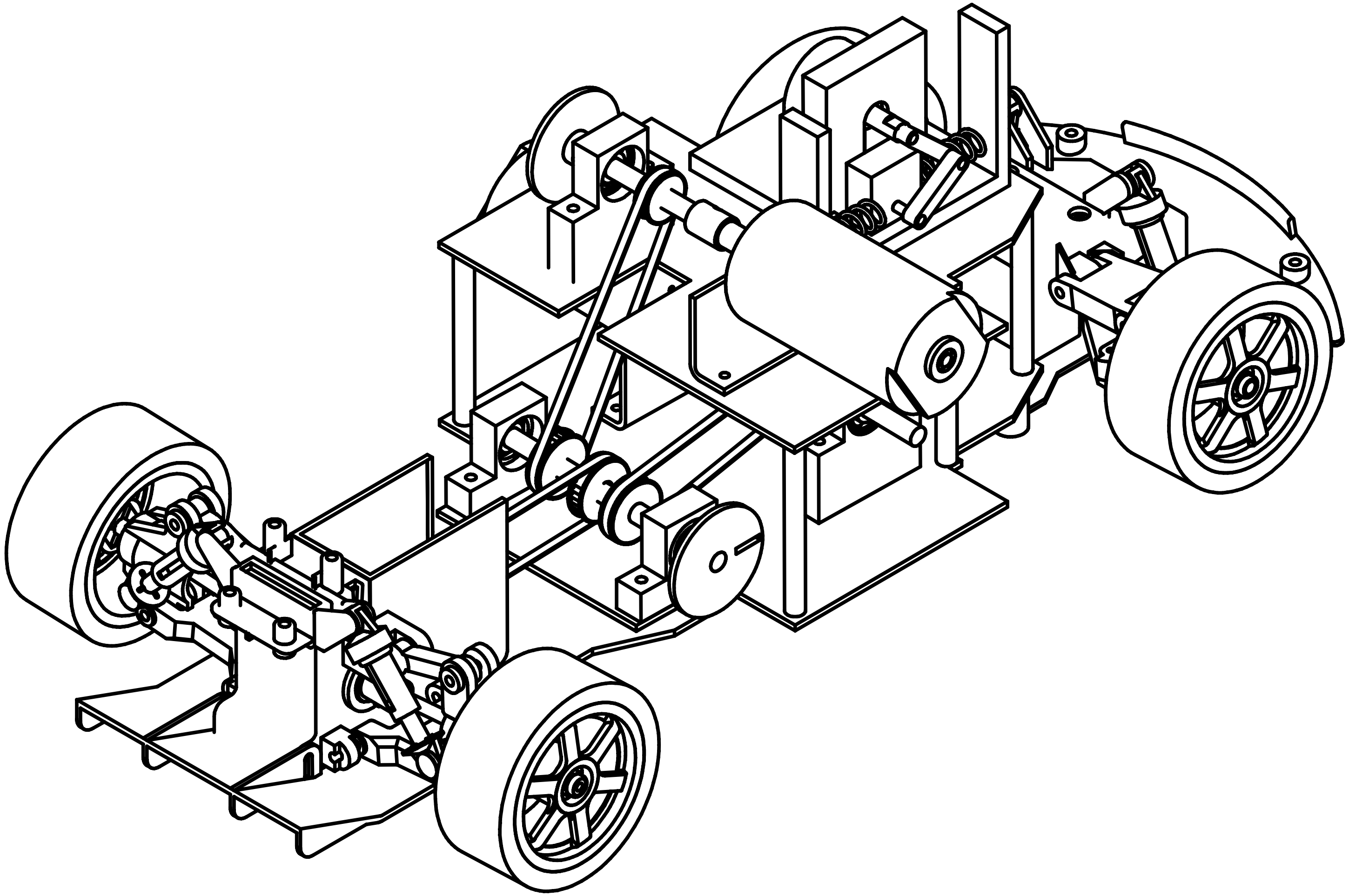
DTM FTUI	SMALL TEST BED		A4



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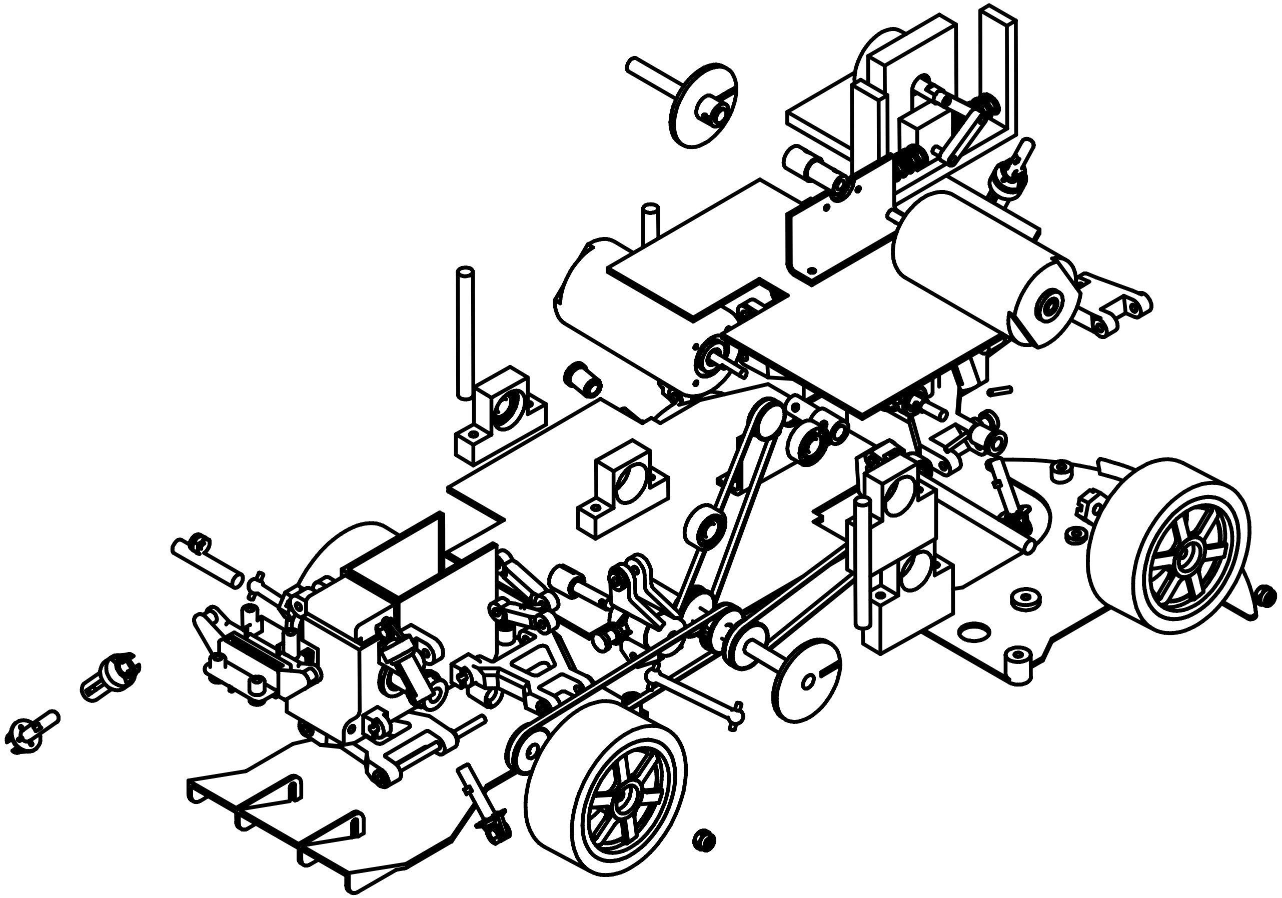
NPM : 0403020289/0403020572
disetujui : DR.Ir.Gandjar Kiswanto

peringatan :

DTM FTUI

SMALL TEST BED

A4



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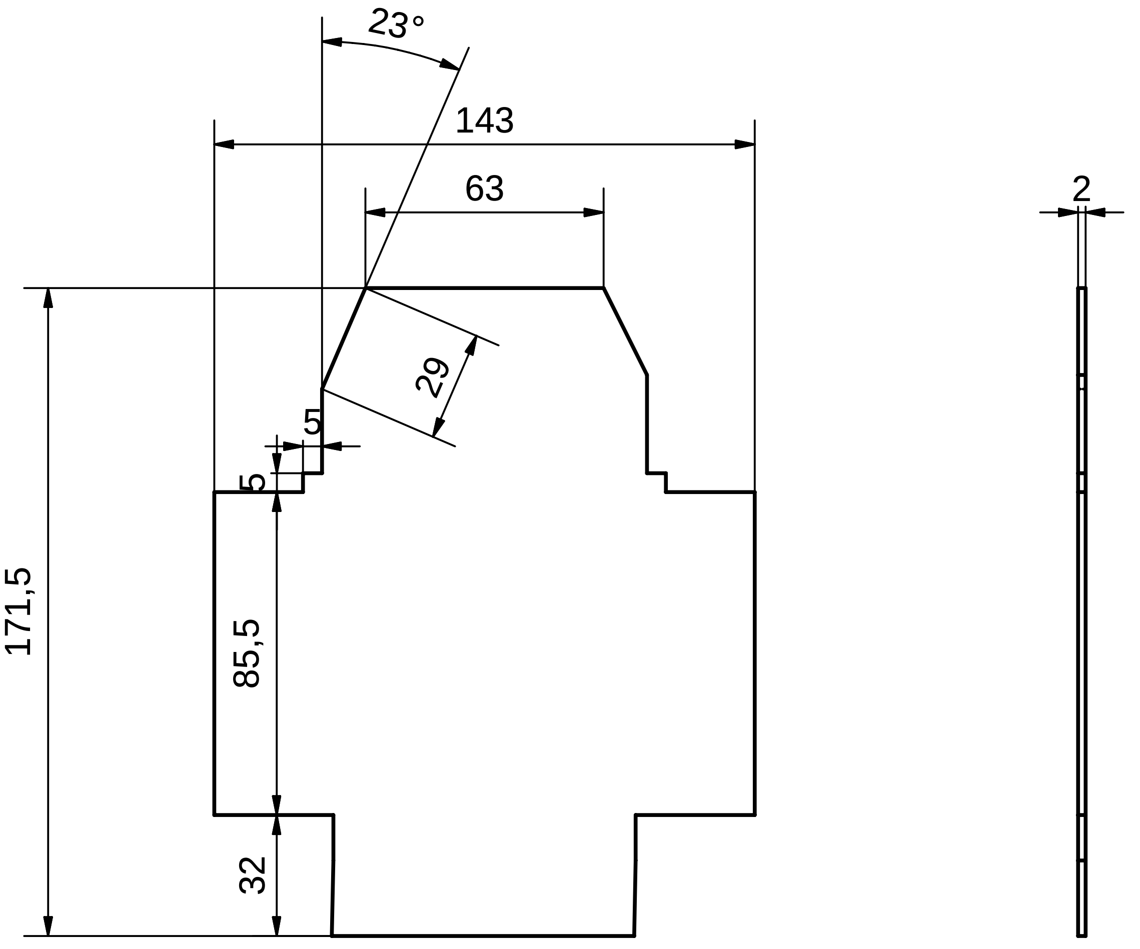
DTM FTUI	SMALL TEST BED		A4



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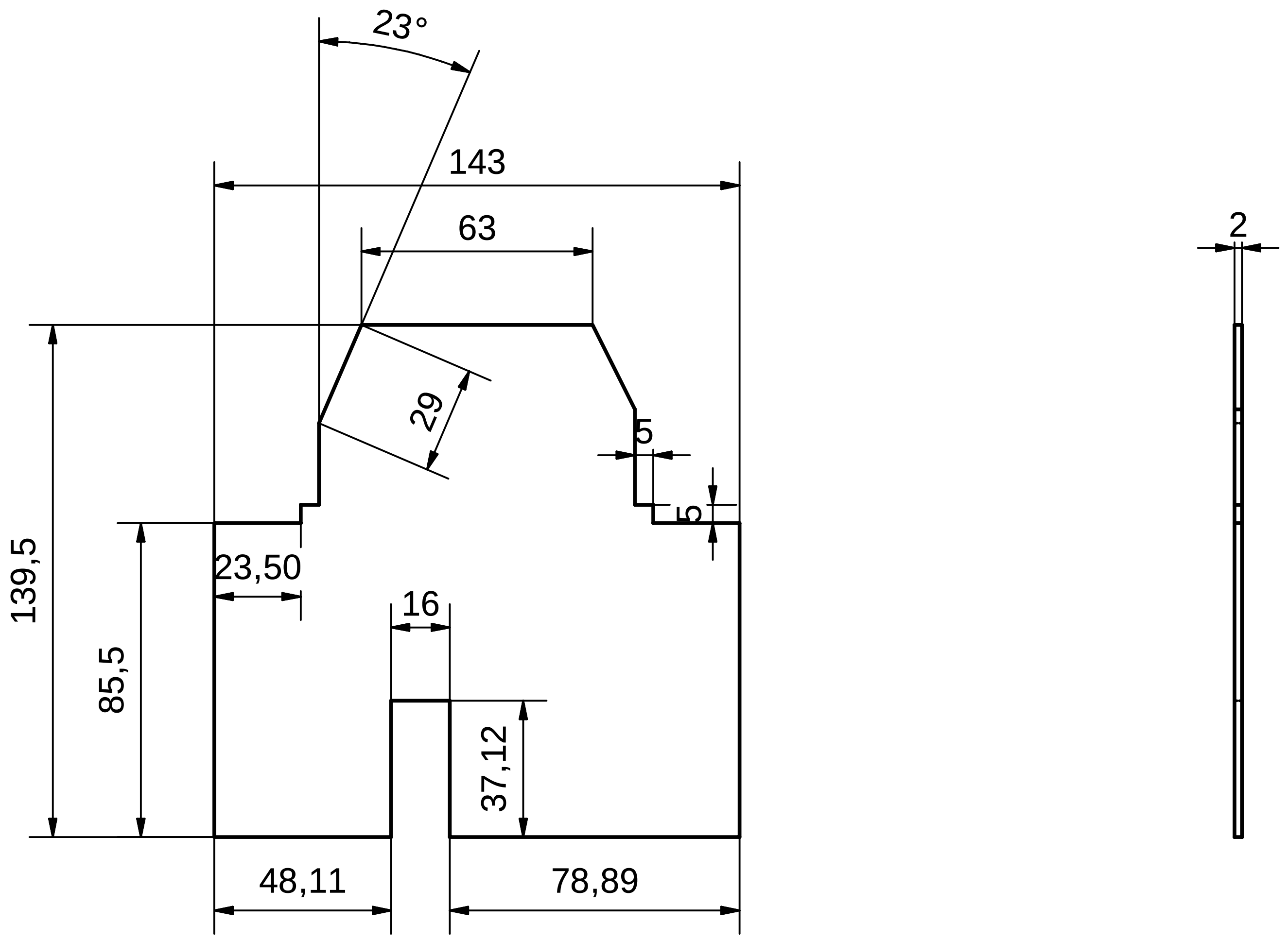
NPM : 0403020289/0403020572
disetujui : DR.Ir.Gandjar Kiswanto

peringatan :

DTM FTUI

CHASIS TENGAH

A4



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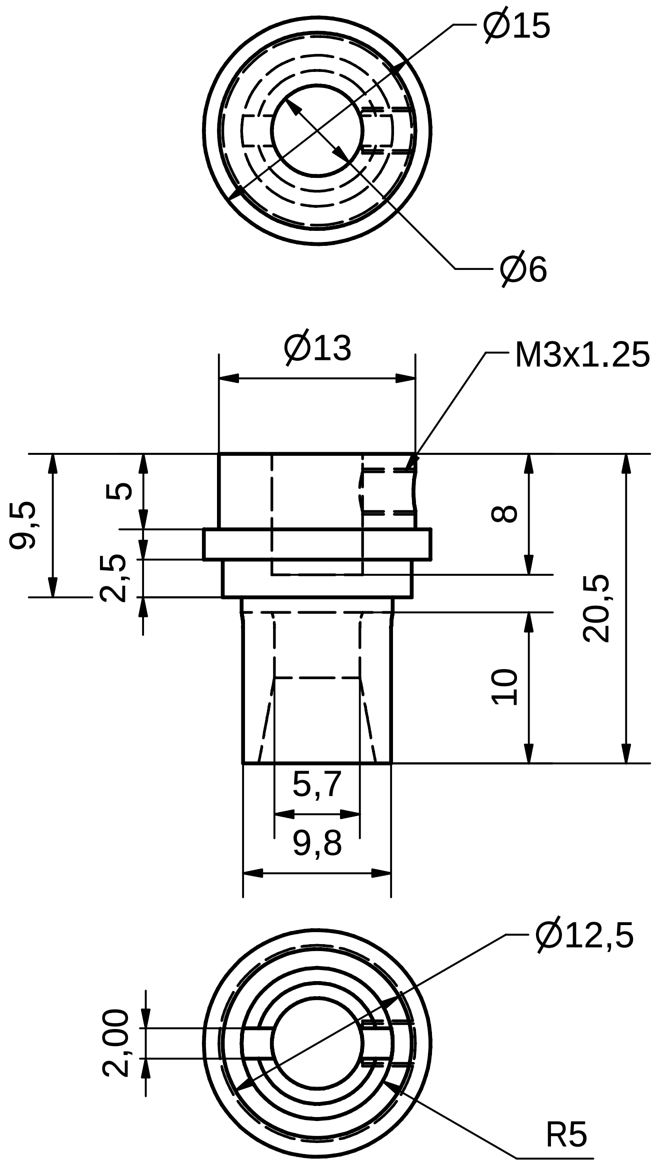
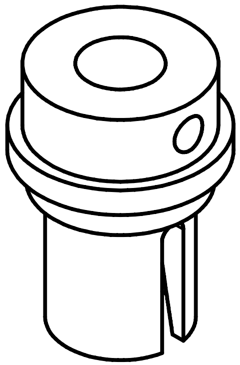
DTM FTUI	CHASIS ATAS		A4





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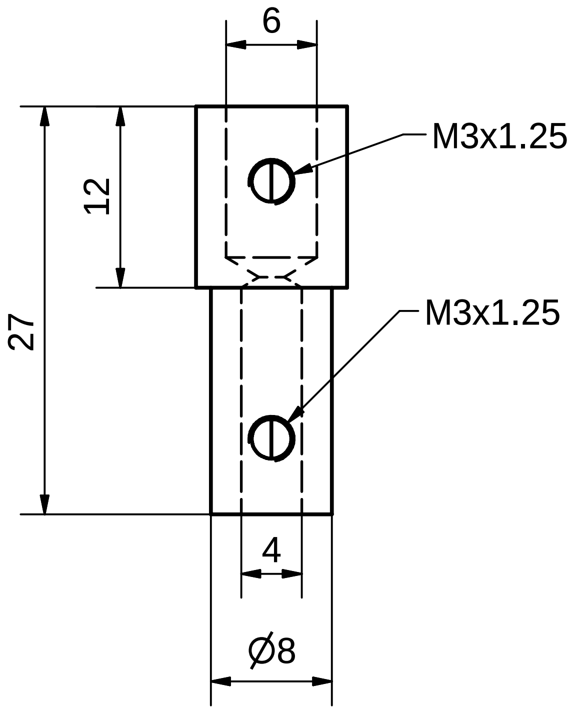
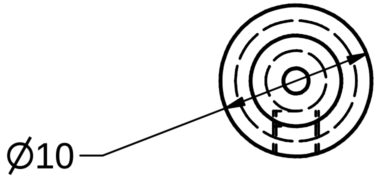
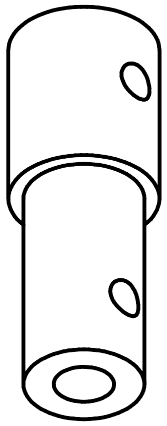
tanggal : 01-12-2007	disetujui : DR.Ir.Gandjar Kiswanto	

DTM FTUI	HUB BELAKANG		A4







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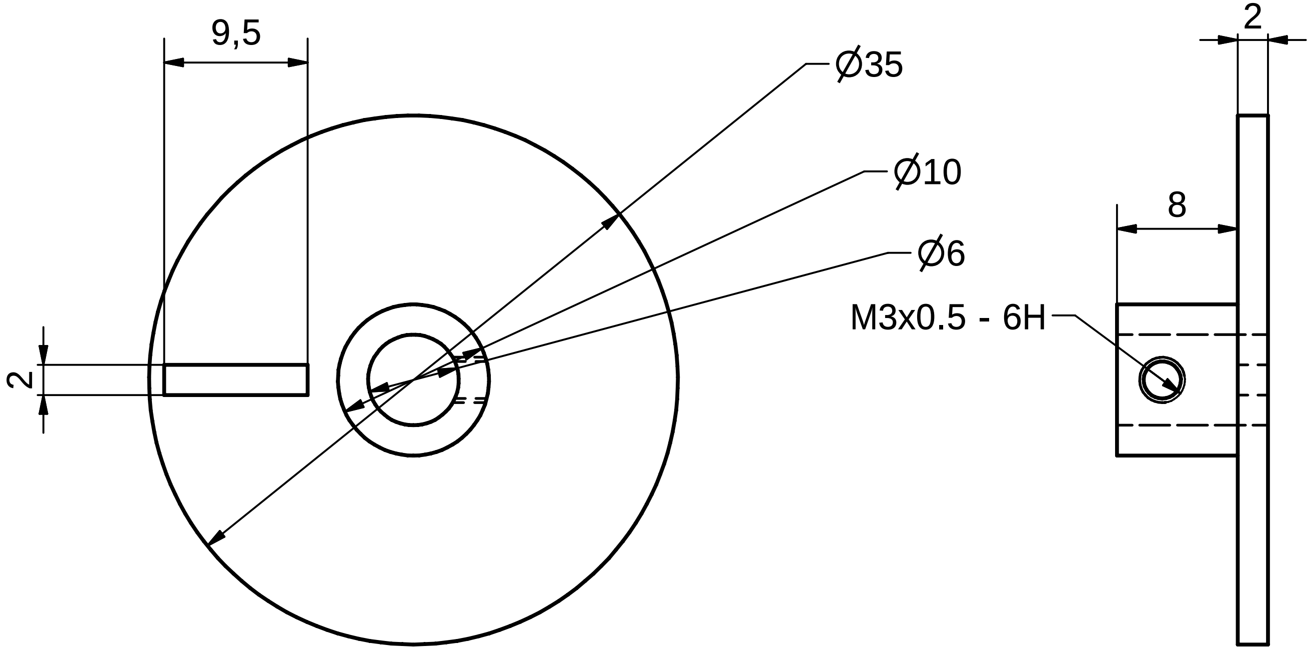
DTM FTUI	HUB	A4



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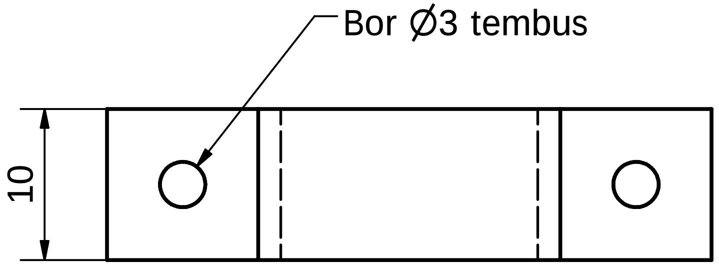
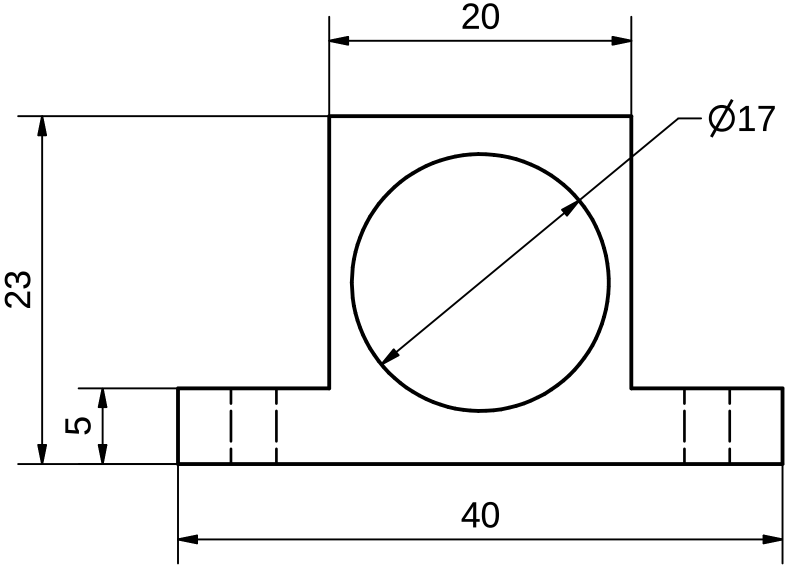
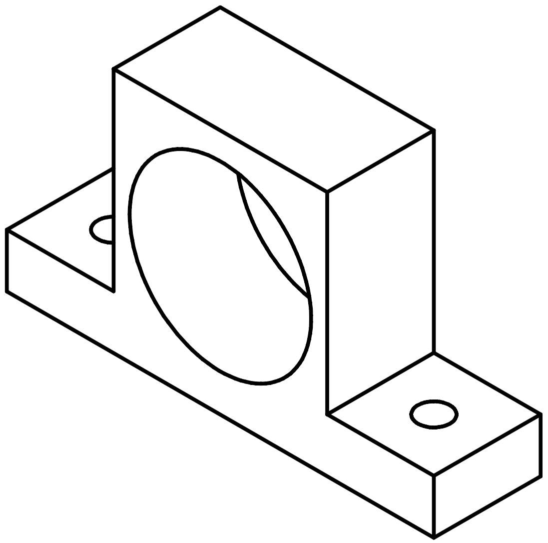
DTM FTUI

PIRINGAN *ENCODER*

A4







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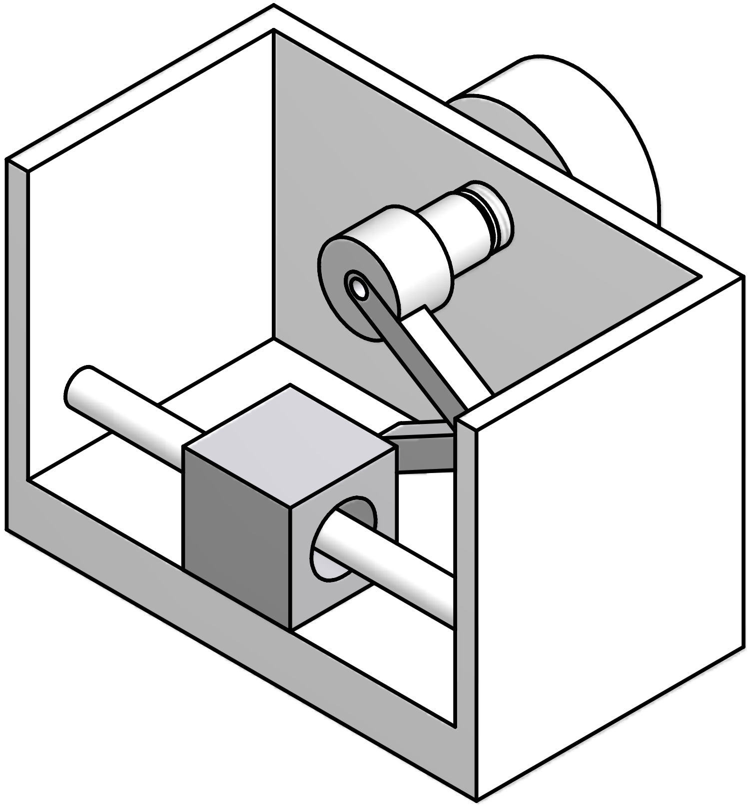
digambar : endiandika t.p./pranadityo
NPM : 0403020289/0403020572
disetujui : DR.Ir.Gandjar Kiswanto

peringatan :

DTM FTUI

RUMAH BEARING

A4



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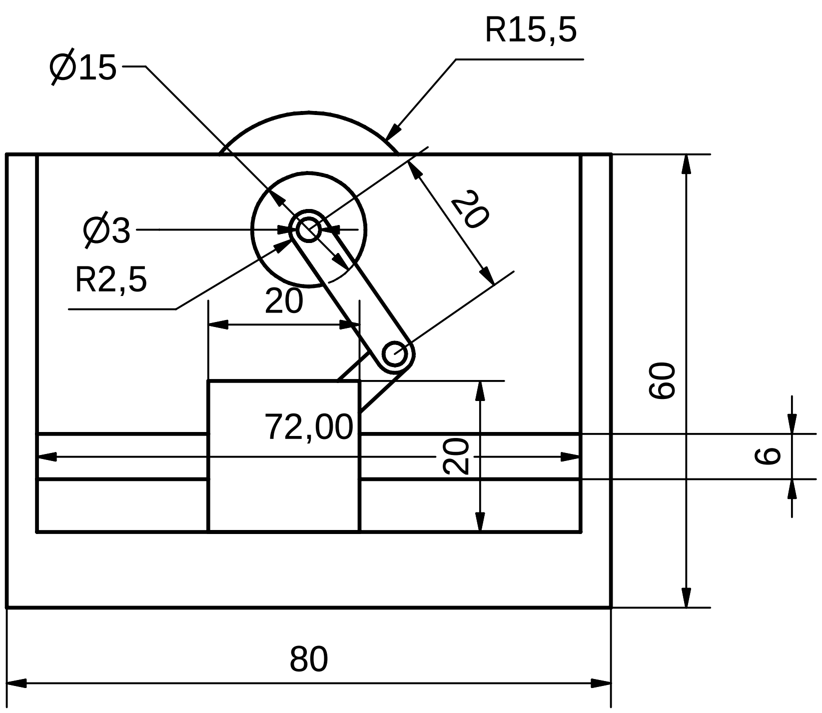
NPM : 0403020289/0403020572
disetujui : DR.Ir.Gandjar Kiswanto

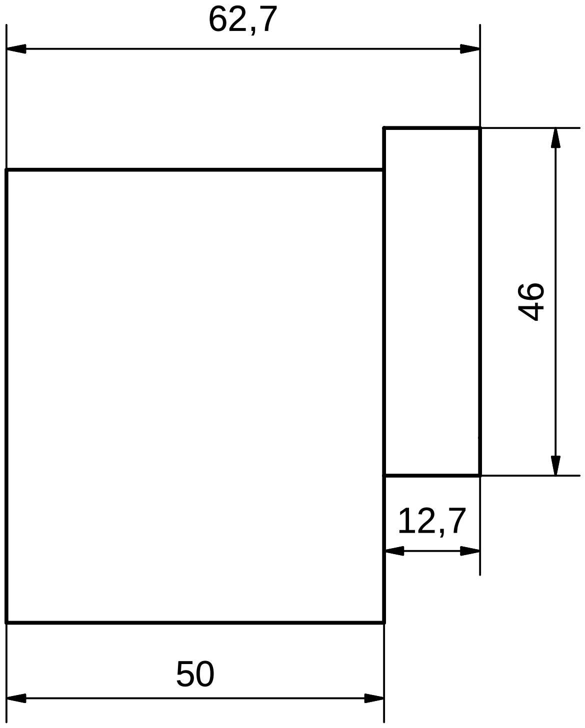
peringatan :

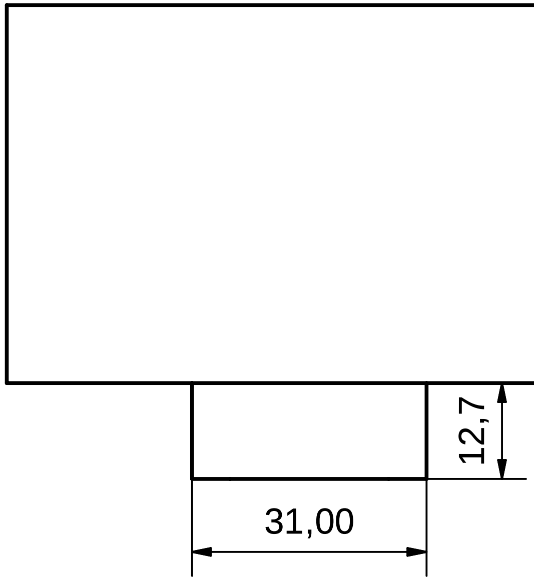
DTM FTUI

SENSOR KEMIRINGAN__2

A4







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digambar : endiandika t.p./pranadityo
NPM : 0403020289/0403020572
disetujui : DR.Ir.Gandjar Kiswanto

peringatan :

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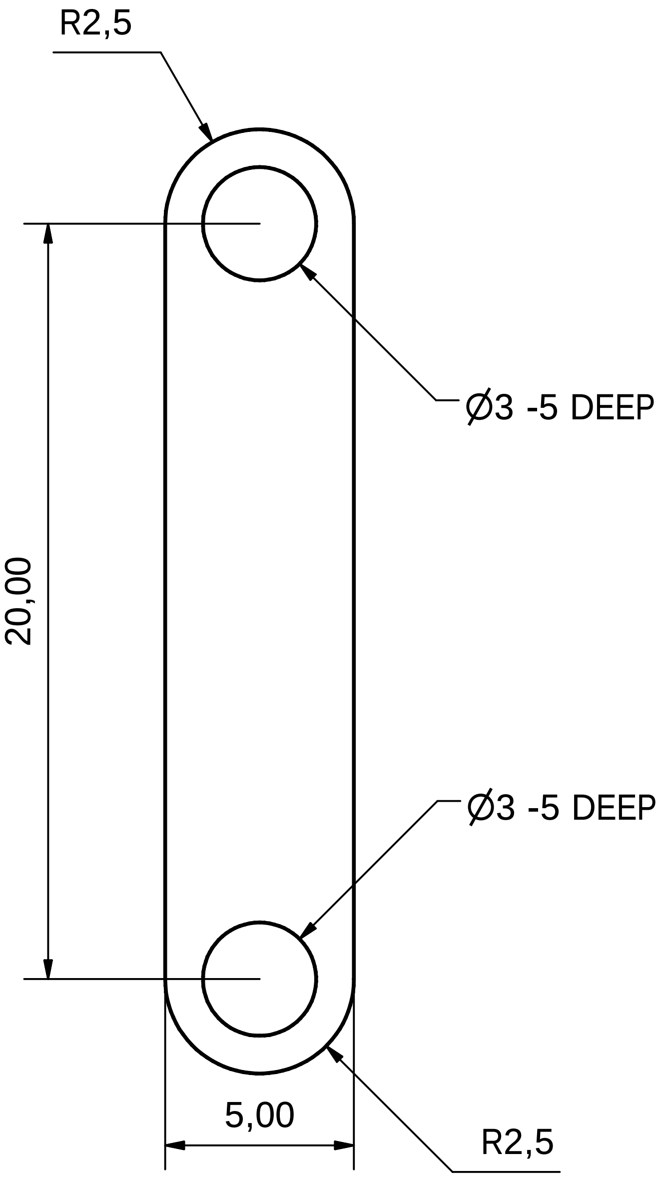
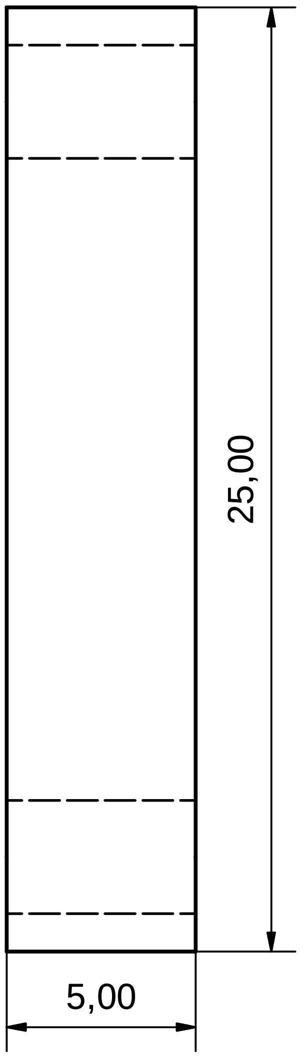
SENSOR KEMIRINGAN__2

A4





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peringatan :

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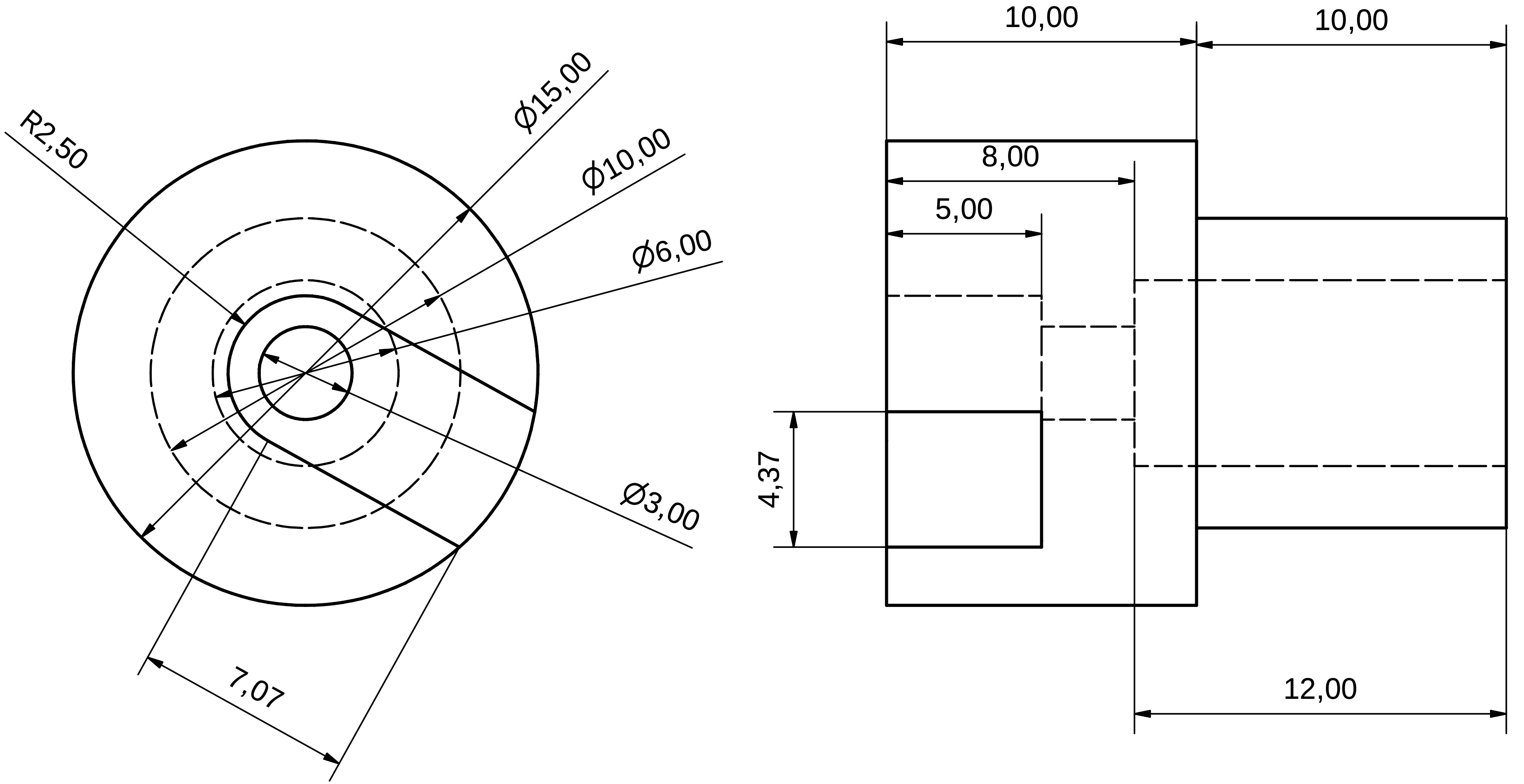
BATANG SENSOR
A4



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peringatan :

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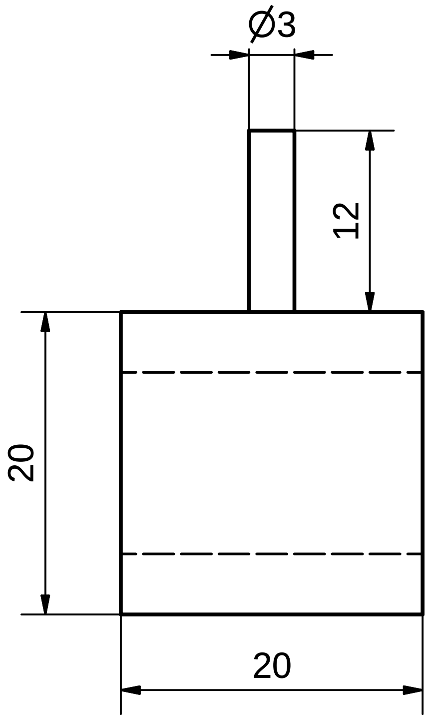
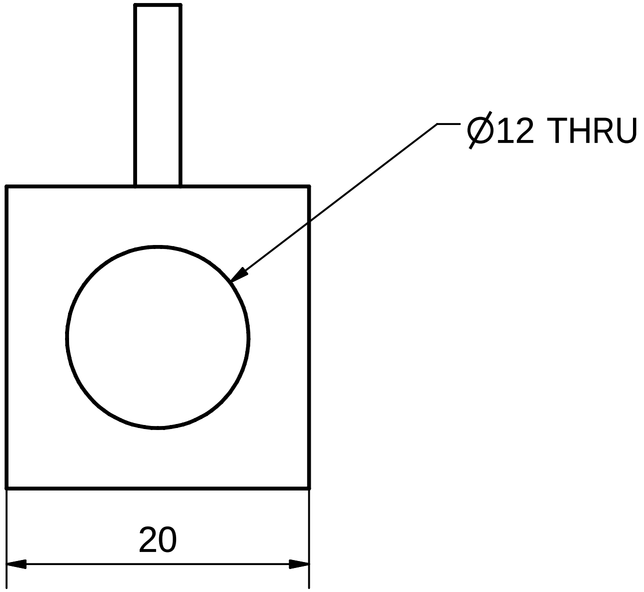
HUB LENGAN

A4





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digambar : endiandika t.p./pranadityo
NPM : 0403020289/0403020572
disetujui : DR.Ir.Gandjar Kiswanto

peringatan :

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MASSA SENSOR

A4