# DRAWN CUP ROLLER CLUTCHES

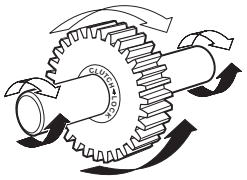
NADELLA

# Technical features

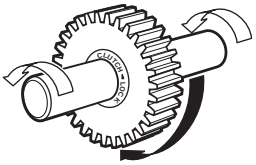
## Drawn cup roller clutches

Drawn cup roller clutch transmits torque between shaft and housing in one direction and allows free overrun in the opposite direction.
When transmitting torque, either the shaft or the housing can be the input member. Applications are generally described as indexing, backstopping or overrunning.

**Lock function**
Shaft drives gear clockwise (white arrows) or gear can drive shaft counter clockwise (black arrows)



**Overrun function**
Shaft overruns in gear counterclockwise (white arrows) or gear overruns on shaft clockwise (black arrow)



**IDENTIFICATION**
The basic types of clutches and clutch and bearing assemblies are listed below:

| | |
|---|---|
| **FCS, FC-K** | Regular clutch, single roller per stainless steel spring. |
| **FC** | Regular clutch, multi-roller per stainless steel spring. |
| **FCB** | Regular clutch and bearing assembly, multi-roller per stainless steel spring. |
| **FCL-K** | Light series clutch, single roller per stainless steel spring. |
| **FCBL-K, FCBN-K** | Light series clutch and bearing assembly. Single roller per stainless steel spring. |

**TYPES OF CLUTCHES AND CLUTCH AND BEARING ASSEMBLIES**

Drawn cup roller clutch **type FC** with stainless steel springs

Drawn cup clutch and bearing assembly **type FCB** with stainless steel springs

Drawn cup roller clutch, **types FCS, FC-K, FCL-K** with stainless steel springs

Drawn cup clutch and bearing assembly **types FCBL-K, FCBN-K** with stainless steel springs

# Technical features

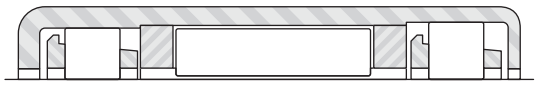
## Drawn cup roller clutches

**CONSTRUCTION**

In many respects, construction is similar to that of needle bushes. The well-established design utilizes the same low-profile radial section as needle bushes.
The precisely formed interior ramps provide surfaces against which the needle rollers wedge. These positively lock the clutch with the shaft when rotated in the proper direction. These ramps, formed during the operation of drawing the cup, are case hardened for wear resistance.

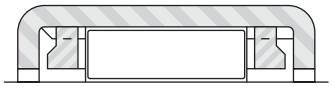
Two designs of precision molded clutch cages are employed. Clutch and clutch and bearing assembly types – **FC, FC-K, FCS, FCL-K, FCB, FCBN-K, FCBL-K** – use a glass fiber, reinforced nylon cage, equipped with inserted stainless steel leaf springs. The stainless steel springs permit higher rates of clutch engagement and achieve greater spring life. The nylon cage permits operation at higher temperatures.

Types **FCB, FCBL-K, FCBN-K**, clutch and bearing assemblies have cages, for retention and guidance of the needle rollers in the bearings, located on both sides of the clutch unit.



**Clutch and bearing assembly**

Types **FC, FC-K, FCS, FCL-K** are of clutch-only configurations for use with external radial support (usually two needle bushes). Separate bearings position the shaft and housing concentrically and carry the radial load during overrun.



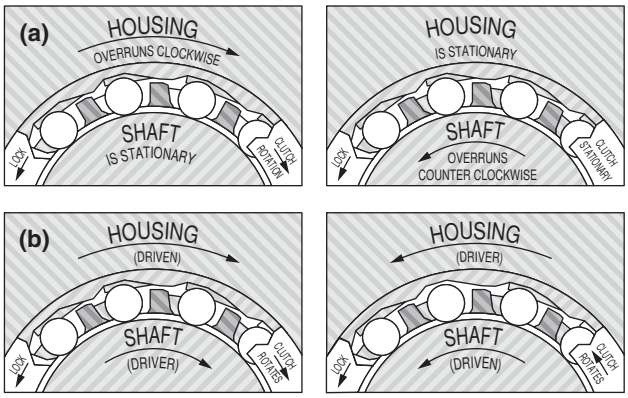
**Clutch only**

**OPERATION**

Operation is in two modes: **the overrun mode and the lock mode.** Operational mode is controlled by the direction of the clutch or shaft rotation with respect to the locking ramps.

In the **overrun mode**, shown in the drawings below (a), the relative rotation between the housed clutch and the shaft causes the rollers to move away from their locking position against the locking ramps in the needle bush. The housing and the clutch are then free to overrun in one direction, or the shaft is free to overrun in the other direction.

In the **lock mode**, shown in the drawings below (b), the relative rotation between the housed clutch and the shaft is opposite to that in the overrun mode. The rollers, assisted by the leaf-type springs, become wedged between the locking ramps and the shaft to transmit torque between the two members. Either the member housing the clutch drives the shaft in one direction, or the shaft can drive the clutch and its housing member in the other direction.



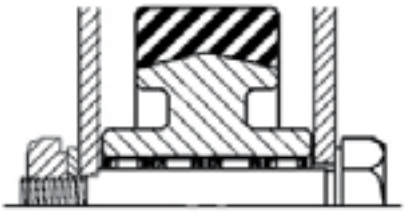

**Clearance between the rollers and cup ramps is exaggerated in these drawings**

# Technical features

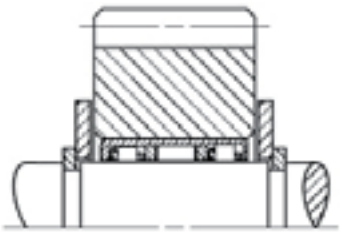
## Drawn cup roller clutches

**APPLICATIONS**

Clutches and clutch and bearing assemblies are successfully applied in a wide range of commercial products where indexing, backstopping and overrunning operations must be performed reliably. The sketches on these pages illustrate some of the many possible uses.
When applying the clutch-only unit, separate bearings on each side of the clutch are required to position the shaft concentrically with the housing, and to carry the radial loads during overrun. Needle bushes, with the same radial section as the clutch, should be used in the through-bored housings for simplicity and economy. Two clutches can be used side by side for greater torque capacity.
Where the radial loads are light, the clutch and bearing assembly can be used without additional support bearings. This reduces the overall assembly width, the number of stocked and ordered parts and assembly costs, as well.



**Clutch and bearing arrangement for heavy loads**



**Clutch and bearing assembly for light loads**

Drawn cup roller clutches are manufactured to commercial hardware standards and are used extensively in appliances, business machines, industrial and recreation equipment and a wide range of other applications.

In any application where our clutch may be considered, it will be part of a system in which the operating conditions and the clutch mounting will affect its function.
Before any clutch selection is made, it is important that the following catalog section be carefully studied to understand the effects of these factors.

Consideration should be given to operating conditions such as:

- Magnitude of externally applied torque, as well as inertial torque.
- Magnitude of applied radial loads during overrunning.
- Potential for vibration or axial shaft movement within the clutch during engagement.
- Engagement rate, as it pertains to the selection of stainless steel or plastic leaf springs.
- Oil lubricant supply during high overrunning speeds.
- External and internal environmental temperatures that can affect clutch performance.
- Lubricant selection effect on clutch engagement.
- Indexing inaccuracies resulting from backlash (lost motion).

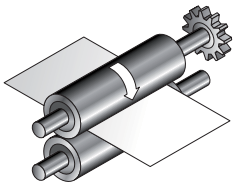
Consideration should be given to the shaft and housing design requirements such as:

- Shaft hardness and strength particularly when approaching torque rating limits.
- Shaft roundness, taper and surface finish necessary to ensure sufficient fatigue life and torque-carrying ability.
- Housing strength (hardness and cross section) to support the applied torque loads.
- Housing roundness, taper and surface finish necessary to ensure uniform torque and load distribution.

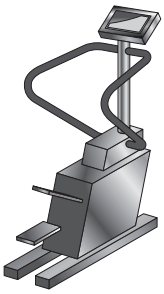
A test program under all expected operating conditions should be carried out before putting a new application into production.
Customer engineers are constantly working with and testing new applications, and their experience can be of great help to the designer considering the use of a drawn cup roller clutch.

# Technical features

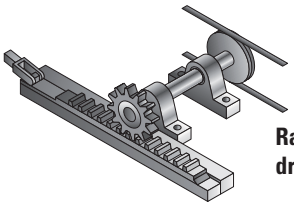
## Drawn cup roller clutches



Paper feed rolls in business machines

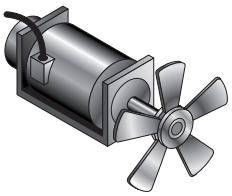


Stair steppers and other athletic equipment



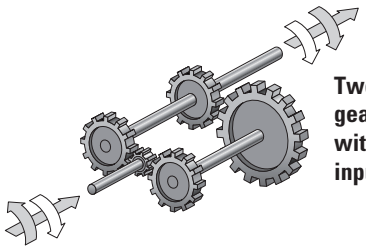
Rack indexing drive

Lawnmower differential

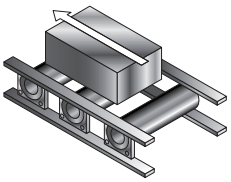


Motor backstops

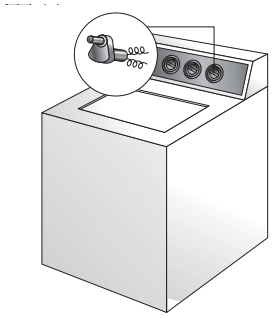
Towel dispensers and similar web roll feed mechanisms



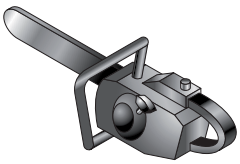
Two-speed gearbox with reversing input



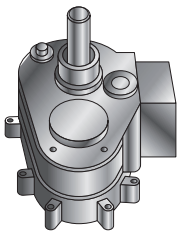
Conveyor rollers



Timing motor freewheels



Chainsaw starters



Washing machine transmission

# Technical features

## Drawn cup roller clutches

**HOUSING DESIGN**

Drawn cup clutches and clutch and bearing assemblies are mounted with a simple press fit in their housings. Through-bored and chamfered housings are preferred. A 30 degree angle is suggested and care should be taken to round the edge where the chamfer meets the housing bore. A sharp edge at this location can greatly increase installation forces. Provisions for axial location, such as shoulders or snap rings, are not required. The case hardened cups must be properly supported. Steel housings are preferred and must be used for applications involving high-torque loads to prevent radial expansion of the clutch cups. The suggested minimum housing outer diameters in the tables of dimensions are for steel. The housing bore should be round within one-half of the diameter tolerance.

The taper within the length of the outer ring should not exceed 0.013 mm. The surface finish of the housing bore should not exceed 1.6 µm Ra.

The torque ratings, given in the clutch tables, are based on a steel housing of a large section. When other housing material must be used (such as aluminium, powdered metal and plastics), the torque rating of the clutch will be reduced. Such housings may be satisfactory for lightly torqued applications. But, the Technical Service should be consulted for appropriate housing and shaft suggestions. Otherwise, an insufficient press fit and use of a lower strength housing material can result in more internal clearance and reduced performance of the clutch.

When using non-steel housings, thorough testing of the design is suggested. Adhesive compounds can be used to prevent creeping rotation of the clutch in plastic housings with low friction properties. Adhesives will not provide proper support in oversized metal housings. When using adhesives, care must be taken to keep the adhesive out of the clutches and bearings.

**SHAFT DESIGN**

The clutch or clutch and bearing assembly operates directly on the shaft whose specifications of dimension, hardness and surface finish are well within standard manufacturing limits.

Either case-hardening or through-hardening grades of good bearing quality steel are satisfactory for raceways. Steels modified for free machining, such as those high in sulfur content and particularly those containing lead, are seldom satisfactory for raceways.

For long fatigue life, the shaft raceway must have a hardness equivalent to 58 HRC minimum and must be ground to the suggested diameter shown in the tables of dimensions. It may be through hardened, or it may be case hardened with an effective case depth of 0.40 mm. Effective case depth is defined as the distance from the surface inward to the equivalent of 50 HRC hardness level after grinding.

Taper within the length of the raceway should not exceed 0.008 mm, or one-half the diameter tolerance – whichever is smaller. The radial deviation from true circular form of the raceway should not exceed 0.0025 mm for diameters up to and including 25 mm. For raceways greater than 25 mm, the allowable radial deviation should not exceed 0.0025 mm multiplied by a factor of the raceway diameter divided by 25. Surface finish on the raceway should not exceed 0.4 µm Ra. Deviations will reduce the load capacity and fatigue life of the shaft.

**INSTALLATION**

Simplicity of installation promotes additional cost savings.

The drawn cup roller clutch or the clutch and bearing assembly must be pressed into its housing. Procedures are virtually identical with those for installing needle bushes. The unit is pressed into the bore of a gear or pulley hub or housing of the proper size. No shoulders, splines, keys, screws or snap rings are required.

Installation procedures are summarized in the following sketches on page 84.

Use an arbor press or hydraulic ram press (fig. 1) to exert steady pressure. Never use a hammer, or other tool requiring pounding to drive the clutch into its housing.

# Technical features

## Drawn cup roller clutches

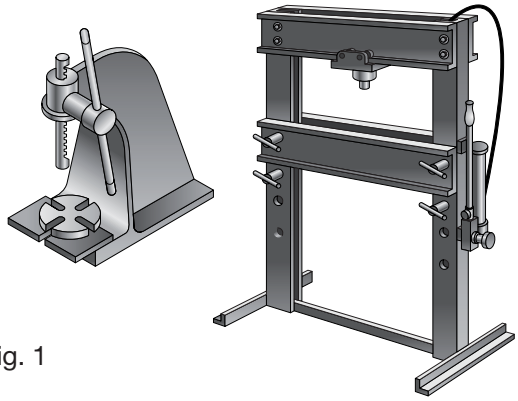


fig. 1

Make sure that the housing bore is chamfered to permit easy introduction of the clutch and bearing or the clutch unit (fig. 3).
Press unit slightly beyond the chamfer in the housing bore to assure full seating.
Through-bored housings are always preferred. If the housing has a shoulder, never seat the clutch against the shoulder.

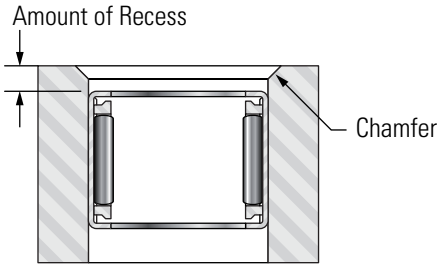



fig. 3

**IMPORTANT:** The mounted clutch engages when the housing is rotated relative to the shaft in the direction of the arrow and lock marking ( LOCK) stamped on the cup. Make sure that the unit is oriented properly before pressing it into its housing.

When assembling the shaft, it should be rotated in the overrun direction during insertion. The end of the shaft should have a large chamfer or rounding (fig. 4).

Use an installation tool as shown in fig. 2. If the clutch is straddled by needle roller bearings, press units into position – in proper sequence – and preferably leave a small clearance between units.

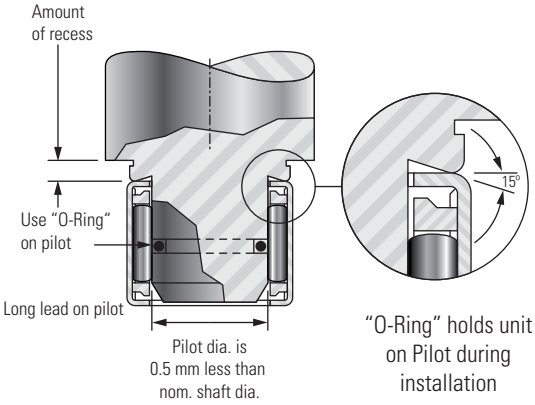



fig. 2

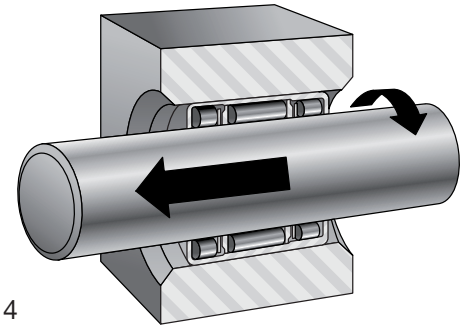


fig. 4

**APPLIED LOADS**
The clutch-only unit is designed to transmit purely torque loads. Applied torque should not exceed the catalog ratings, which are based on the compressive strength of well-aligned clutch components.
Bearings on either side of the clutch are to assure concentricity between the shaft and the housing to support radial loads during clutch overrun. Integral clutch and bearing assemblies are available for this purpose, especially where the radial loads are light. The total maximum dynamic radial load that may be shared by the two needle roller and cage radial bearing assemblies should not be greater than C/3.
In determining the total torque load on a clutch, it is essential to consider the torque, due to inertial forces developed in the mechanism, in addition to the externally applied torque. The larger the clutch, and the greater the mass of the mechanism controlled by it, the more important this consideration becomes.
Clutch lockup depends on friction. For this reason, applications involving severe vibrations or axial motion of the shaft within the clutch are to be avoided. Applications where overhanging or overturning loads occur should incorporate bearings that will maintain alignment between the shaft and the clutch housing.
Consult Technical Service for suggestions.

# Technical features

## Drawn cup roller clutches

**LUBRICATION**
Oil is the preferred lubricant; it minimizes wear and heat generation. For those applications where oil is not practical, clutches are packed with a soft grease containing mineral oil. Thick grease will retard roller engagement and can cause individual rollers to slip, possibly overloading any engaged rollers.

**TEMPERATURE**
Temperature extremes can cause clutch malfunctions and failure. The molded plastic cage with integral springs holds its necessary resiliency and strength when the operating temperature within the clutch is kept below 90° C. The clutch with reinforced nylon cage and separate steel springs operates well at temperatures up to 120° C continuously and to 150° C intermittently. Excessive thickening of the lubricant at low temperatures may prevent some, or all, of the rollers from engaging. New applications should be tested under expected operating conditions to determine whether or not temperature problems exist.

**BACKLASH**
Backlash, or lost motion, prior to engagement is minimal. The variation in backlash from one cycle to another is extremely low. Grease lubrication, or improper fit (housing bore and shaft diameter), may increase backlash. Angular displacement between the shaft and housing increases as an applied torque load is increased.

**RATE OF ENGAGEMENT**
Clutch lockup depends upon static friction. Axial motion between shaft and clutch rollers prevents lockup.
Clutches with integral springs engage satisfactorily at cyclic rates up to 200 engagements per minute. Intermittent operation at higher rates has been successful. The steel spring type clutches have proven dependability at rates up to 6000 or 7000 engagements per minute. Even higher cyclic rates may be practical. Because grease may impair engagement at high cyclic rates, a light oil should be used.

**OVERRUN LIMIT SPEED RATING**
Exact limiting speed ratings are not easily predictable. The value for each clutch given in the bearing tables is not absolute but serves as a guide for the designer. Oil lubrication is absolutely necessary for high speed operations. Consult Technical Service when overrunning speeds are high.

**INSPECTION**
Although the outer cup of the clutch is accurately drawn from strip steel, it can go slightly out of round during heat treat. When the assembly is pressed into a ring gage, or properly prepared housing of correct size and wall thickness, it becomes round and properly sized. Direct measurement of the outer diameter of a drawn cup assembly **is an incorrect procedure**.

The proper inspection procedure is as follows:

1. Press the assembly into a ring gage of the proper size, as given in the tables.

2. Gage the bore with the specified plug gages of the proper size, as given in the tables of dimensions.

   a. The locking plug is rotated to ensure lockup when the
   clutch is operated on a low-limit shaft and is mounted in a high-limit housing, strong enough to properly size the clutch.

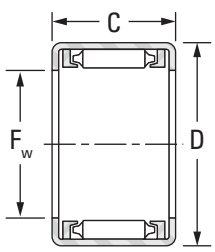
   b. The overrun plug is rotated to ensure free overrunning
   when the clutch is operated on a high-limit shaft and is mounted in a low-limit housing.

   c. The “go” plug and “no go” plug ensure proper size of the bearings in the clutch and bearing assemblies.

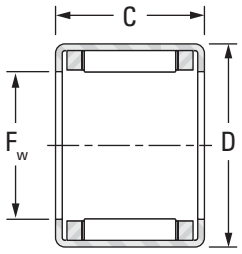
Gage sizes are listed in the tables of dimensions. Plug gage sizes reflect adjustment for the loose and tight conditions resulting from high or low housings or shafts.

# Drawn cup roller clutches

Shaft raceway and housing bore diameters that are necessary for proper mounting and operation are listed on the opposite page. Types **FC, FC-K, FCS** and **FCL-K** clutches have stainless steel springs inserted in molded cage to position rollers for lockup.



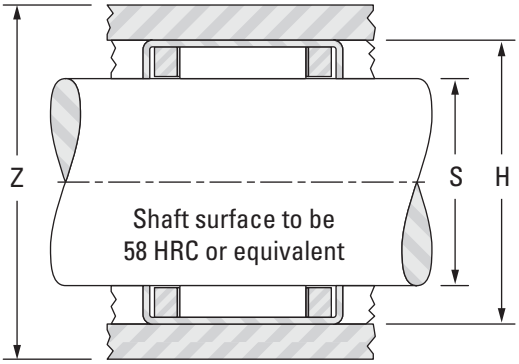

FC




FCS, FCL-K e FC-K

| Shaft ∅ mm | Designation | $F_w$ mm | D mm | C mm | Torque Nm | Overrun limiting speed rating for rotating shaft $min^{-1}$ | Suitable needle bush |
|---|---|---|---|---|---|---|---|
| **4** | **FC-4-K** | 4 | 8 | 6 | 0.349 | 26000 | HK0408 |
| **6** | **FCS-6** | 6 | 10 | 12 | 2.15 | 22000 | HK0608 |
| | **FC-6** | 6 | 10 | 12 | 2.63 | 22000 | HK0608 |
| **8** | **FCL-8-K** | 8 | 12 | 12 | 3.39 | 21000 | HK0808 |
| | **FC-8** | 8 | 14 | 12 | 4.42 | 21000 | DL810 |
| **10** | **FCL-10-K** | 10 | 14 | 12 | 4.60 | 19000 | HK1010 |
| | **FC-10** | 10 | 16 | 12 | 5.82 | 19000 | DL1012 |
| **12** | **FC-12** | 12 | 18 | 16 | 14.0 | 19000 | HK1212 |
| **16** | **FC-16** | 16 | 22 | 16 | 21.7 | 14000 | HK1612 |
| **20** | **FC-20** | 20 | 26 | 16 | 32.6 | 11000 | HK2012 |
| | **FC-20-K** | 20 | 26 | 16 | 30.0 | 11000 | HK2012 |
| **25** | **FC-25-K** | 25 | 32 | 20 | 66.4 | 8700 | HK2512 |
| | **FC-25** | 25 | 32 | 20 | 71.0 | 8700 | HK2512 |
| **30** | **FC-30** | 30 | 37 | 20 | 99.1 | 7300 | HK3012 |
| **35** | **FCS-35** | 35 | 42 | 20 | 107.0 | 6100 | HK3512 |

# Drawn cup roller clutches




Proper inspection requires installation of the clutch in a ring gauge and then checking the bore with the appropriate plug gauges. Please read the section on “INSPECTION” on page 85.

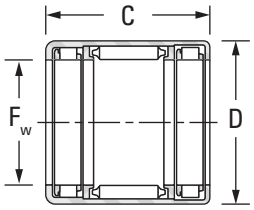
When applying these clutches, it is important that separate bearings be used adjacent to the clutches to carry radial loads and assure concentricity between the shaft and housing.
For full details on “INSTALLATION” see page 83.

**The mounted clutch engages when the housing is rotated relative to the shaft in the direction of the arrow marking (← LOCK) stamped on the cup.**

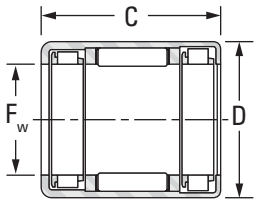
| Shaft ∅ mm | Gaging | | | Z Minimum outer diameter of steel housing for Torque mm | S - Shaft raceway diameter | | H - Housing bore | | Weight kg |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Mounting | | | | |
| | Ring gage mm | Clutch locking plug mm | Clutch overrun plug mm | | Max. mm | Min. mm | Max. mm | Min. mm | |
| 4 | 7.984 | 3.980 | 4.004 | 11 | 4.000 | 3.995 | 7.993 | 7.984 | 0.001 |
| 6 | 9.984 | 5.980 | 6.004 | 14 | 6.000 | 5.995 | 9.993 | 9.984 | 0.003 |
| | 9.984 | 5.980 | 6.004 | 14 | 6.000 | 5.995 | 9.993 | 9.984 | 0.004 |
| 8 | 11.980 | 7.976 | 8.005 | 17 | 8.000 | 7.994 | 11.991 | 11.980 | 0.003 |
| | 13.980 | 7.976 | 8.005 | 20 | 8.000 | 7.994 | 13.991 | 13.980 | 0.007 |
| 10 | 13.980 | 9.976 | 10.005 | 20 | 10.000 | 9.994 | 13.991 | 13.980 | 0.004 |
| | 15.980 | 9.976 | 10.005 | 25 | 10.000 | 9.994 | 15.991 | 15.980 | 0.009 |
| 12 | 17.980 | 11.974 | 12.006 | 27 | 12.000 | 11.992 | 17.991 | 17.980 | 0.012 |
| 16 | 21.976 | 15.972 | 16.006 | 31 | 16.000 | 15.992 | 21.989 | 21.976 | 0.018 |
| 20 | 25.976 | 19.970 | 20.007 | 38 | 20.000 | 19.991 | 25.989 | 25.976 | 0.021 |
| | 25.976 | 19.970 | 20.007 | 38 | 20.000 | 19.991 | 25.989 | 25.976 | 0.016 |
| 25 | 31.972 | 24.967 | 25.007 | 46 | 25.000 | 24.991 | 31.988 | 31.972 | 0.026 |
| | 31.972 | 24.967 | 25.007 | 46 | 25.000 | 24.991 | 31.988 | 31.972 | 0.034 |
| 30 | 36.972 | 29.967 | 30.007 | 51 | 30.000 | 29.991 | 36.988 | 36.972 | 0.042 |
| 35 | 41.972 | 34.964 | 35.009 | 56 | 35.000 | 34.989 | 41.988 | 41.972 | 0.048 |

# Drawn cup roller clutches

Shaft raceway and housing bore diameters that are necessary for proper mounting and operation are listed on the opposite page.
Types **FCB** and **FCBL** clutch and bearing assemblies have stainless steel springs inserted in the molded cage to position rollers for instantaneous lockup.



FCB



FCBL-K, FCBN-K

| Shaft ∅ mm | Designation | $F_w$ mm | D mm | C mm | Torque Nm | Load ratings [1] | | Overrun limiting speed rating for rotating shaft $min^{-1}$ |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Dynamic C kN | Static $C_0$ kN | |
| **4** | **FCBN-4-K** | 4 | 10 | 9 | 0.19 | 1.86 | 0.99 | 26000 |
| **6** | **FCBN-6-K** | 6 | 12 | 10 | 0.56 | 2.48 | 1.48 | 22000 |
| **8** | **FCBL-8-K** | 8 | 12 | 22 | 3.39 | 3.62 | 3.28 | 21000 |
| | **FCB-8** | 8 | 14 | 20 | 4.42 | 4.22 | 3.04 | 21000 |
| **10** | **FCB-10** | 10 | 16 | 20 | 5.82 | 4.84 | 3.80 | 19000 |
| **12** | **FCB-12** | 12 | 18 | 26 | 14.0 | 6.30 | 5.84 | 19000 |
| **16** | **FCB-16** | 16 | 22 | 26 | 21.7 | 6.64 | 7.12 | 14000 |
| **20** | **FCB-20** | 20 | 26 | 26 | 32.6 | 8.16 | 9.46 | 11000 |
| **25** | **FCB-25** | 25 | 32 | 30 | 71.0 | 11.3 | 13.1 | 8700 |
| **30** | **FCB-30** | 30 | 37 | 30 | 99.1 | 11.5 | 14.9 | 7300 |

1) Load ratings are based on a minimum raceway hardness of 58 HRC or equivalent.

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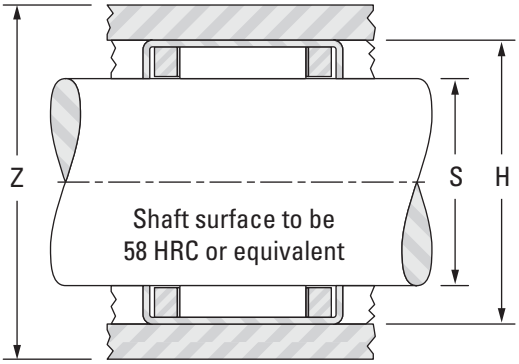


Proper inspection requires installation of the clutch and bearing assembly in a ring gauge and then checking the bore with the appropriate plug gauges. Please read the section on “INSPECTION” on the page 85.

For full details on “INSTALLATION” see page 83.

**The mounted clutch engages when the housing is rotated relative to the shaft in the direction of the arrow marking (← LOCK) stamped on the cup.**

| Shaft ∅ mm | Gaging | | | | Z Minimum outer diameter of steel housing for Torque mm | S - Shaft raceway diameter | | H - Housing bore | | Weight kg |
|---|---|---|---|---|---|---|---|---|---|---|
| | Ring gage mm | Clutch locking plug mm | Clutch overrun and bearing go plug mm | Bearing no go plug mm | | Mounting | | | | |
| | | | | | | Max. mm | Min. mm | Max. mm | Min. mm | |
| **4** | 9.984 | 3.980 | 4.004 | 4.030 | 16 | 4.000 | 3.995 | 9.993 | 9.984 | 0.003 |
| **6** | 11.980 | 5.977 | 6.004 | 6.030 | 18 | 6.000 | 5.995 | 11.991 | 11.980 | 0.004 |
| **8** | 11.980 | 7.976 | 8.005 | 8.033 | 17 | 8.000 | 7.994 | 11.991 | 11.980 | 0.005 |
| | 13.980 | 7.976 | 8.005 | 8.033 | 20 | 8.000 | 7.994 | 13.991 | 13.980 | 0.011 |
| **10** | 15.980 | 9.976 | 10.005 | 10.033 | 25 | 10.000 | 9.994 | 15.991 | 15.980 | 0.013 |
| **12** | 17.980 | 11.974 | 12.006 | 12.036 | 27 | 12.000 | 11.992 | 17.991 | 17.980 | 0.018 |
| **16** | 21.976 | 15.972 | 16.006 | 16.036 | 31 | 16.000 | 15.992 | 21.989 | 21.976 | 0.024 |
| **20** | 25.976 | 19.970 | 20.007 | 20.043 | 38 | 20.000 | 19.991 | 25.989 | 25.976 | 0.028 |
| **25** | 31.972 | 24.967 | 25.007 | 25.043 | 46 | 25.000 | 24.991 | 31.988 | 31.972 | 0.048 |
| **30** | 36.972 | 29.967 | 30.007 | 30.043 | 51 | 30.000 | 29.991 | 36.988 | 36.972 | 0.054 |