Drive shafts for steel production/ industrial equipment

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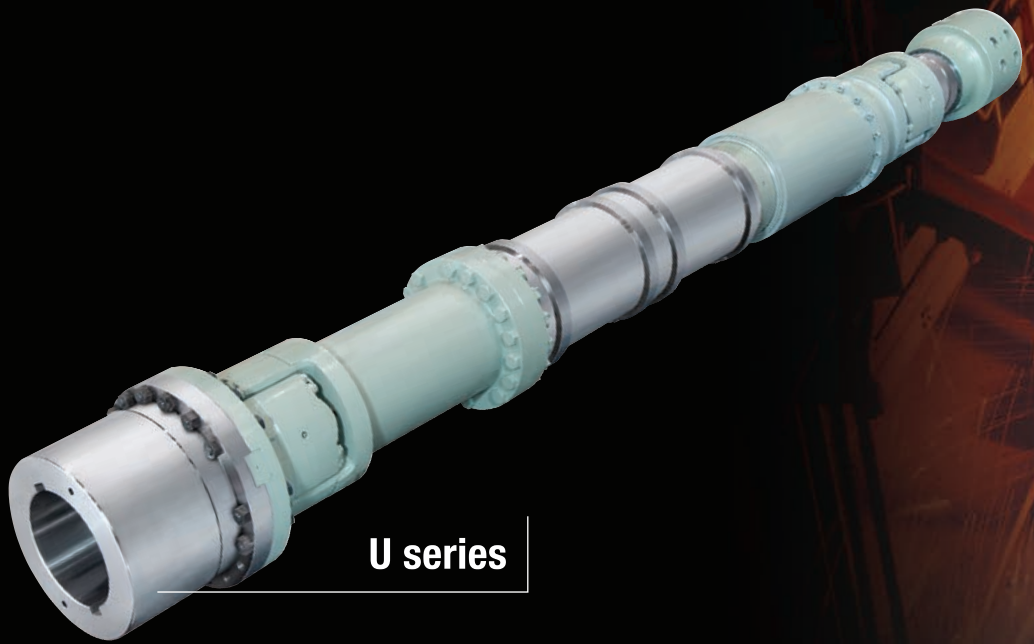
Preface

Throughout the manufacturing industry the pursuit of greater power output at higher efficiency is a priority. Under such circumstances, highly sophisticated and economical drive shafts that fit in a limited space are in great demand for use in various equipment and machines.

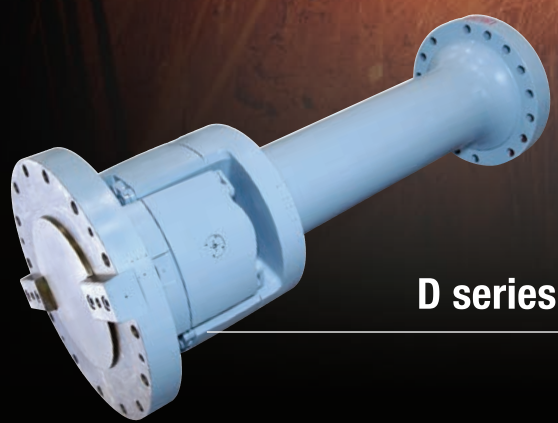
Drive shaft lineup is certain to satisfy your requirements in various applications, including iron manufacturing machines, rolling mills, construction machines, and rolling stock.

We thank you in advance for your support of our drive shafts.



U series

EZ series



D series

T series

KF series

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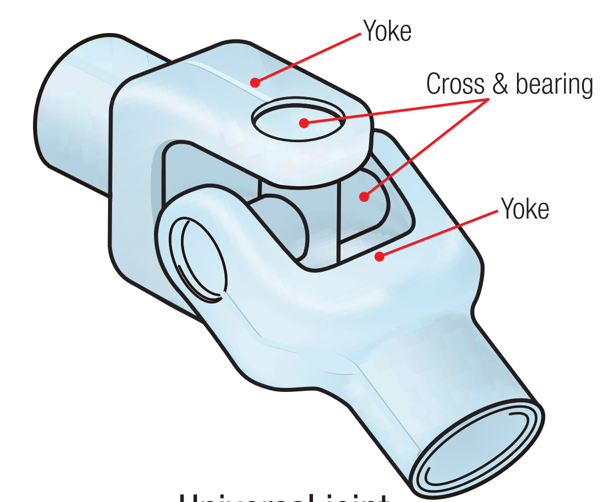
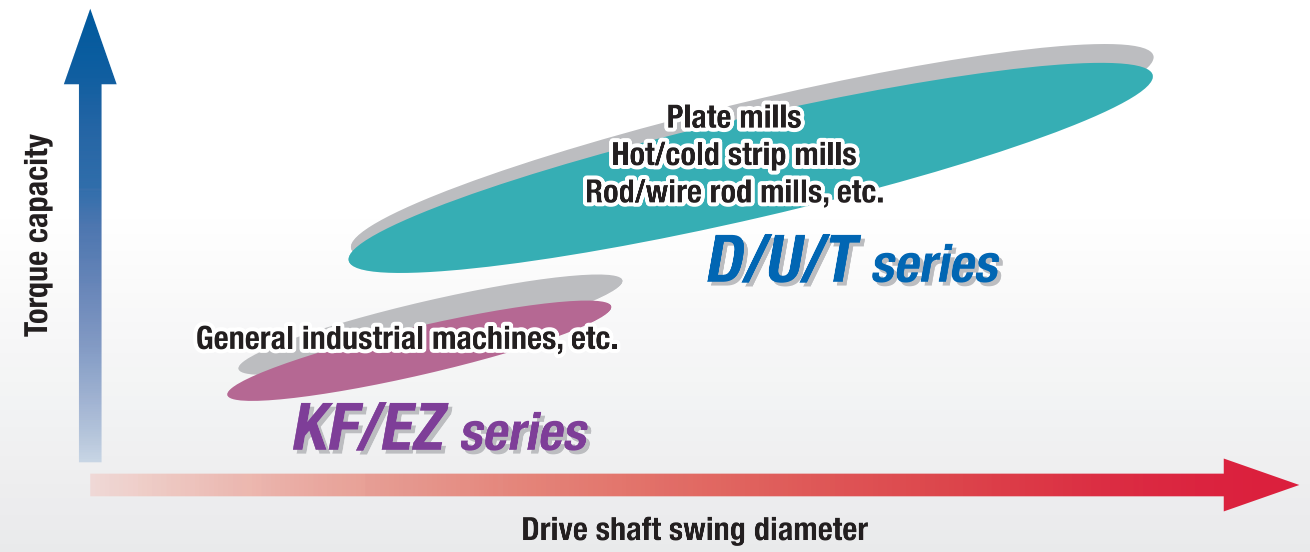
Functions

A drive shaft is a revolving shaft used to transmit the power of a motor to a machine.
Since it is installed in a limited space, the axes are seldom aligned.
However, by using a universal joint, the input axis and the output axis can be flexibly connected even in a limited space, enabling smooth torque transmission.
Each universal joint has four rolling bearings (cross & bearing), realizing low friction and minimizing torque losses.



Universal joint
(Cross-type universal joint)

Position of each series of drive shafts



Configuration of parts

1) Cross & bearings
The cross & bearings are the most critical components of a drive shaft.
A cross & bearing has a cross-shaped shaft and four rolling bearings that individually support each end of the shaft.

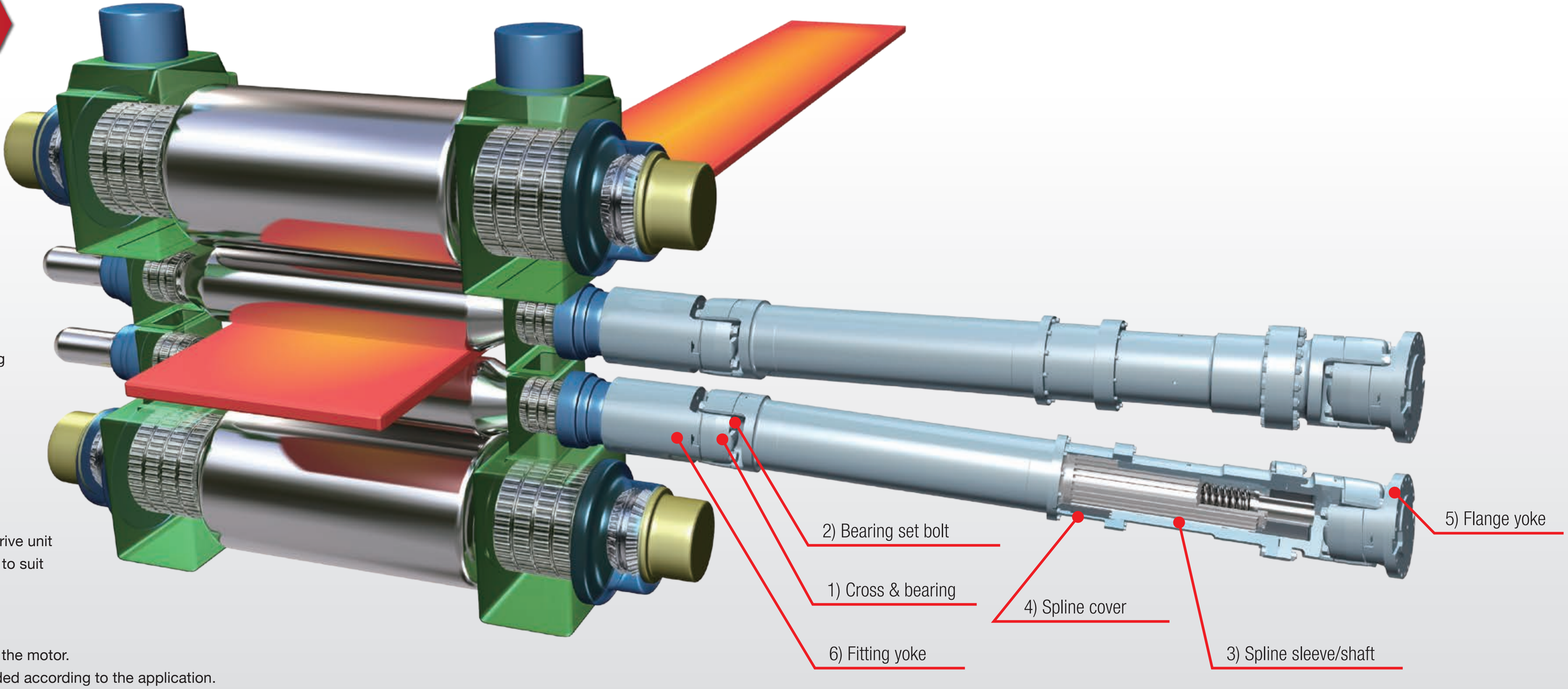
2) Bearing set bolt
Used to connect the cross bearing and its mating part.

3) Spline sleeve/shaft
There are a spline hole and shaft and the attaching length is adjustable.

4) Spline cover
Used to improve the dustproof and waterproof properties if the ambient environment is not good.

5) Flange yoke
The flange yoke is commonly used to connect a drive unit (such as a motor). A variety of joints are available to suit specifically desired applications.

6) Fitting yoke
Used mainly for connection with the machine and the motor.
Various types of coupling arrangements are provided according to the application.



Configurations of drive shafts

Drive shafts are classified into two types: block drive shafts and round drive shafts according to the structure of the cross & bearings used for the universal joint. Features and representative structures of each type are shown below.

- Drive shaft
  - Block type → D/U/T series
  - Round type
    - Bolt type → EZ series
    - Boltless type → KF series

D/U/T series

Features	Characteristics
(1) These series are intended for use in extremely heavy duty applications. (2) High dust resistance makes these series optimal for use under severe operating conditions such as in rolling mills.	(1) Swing diameter (mm) : ϕ160 - 1230
	(2) Torque T_D(kN·m) : 10.9 - 8970
	(3) Torque T_S(kN·m) : 34.1 - 18800
	(4) Maximum operating angle (°) : 4 - 10

• T_D indicates the judgment standard torque for the maximum torque (maximum under normal conditions).
• T_S indicates the judgment standard torque for the breakaway torque (maximum under abnormal conditions).

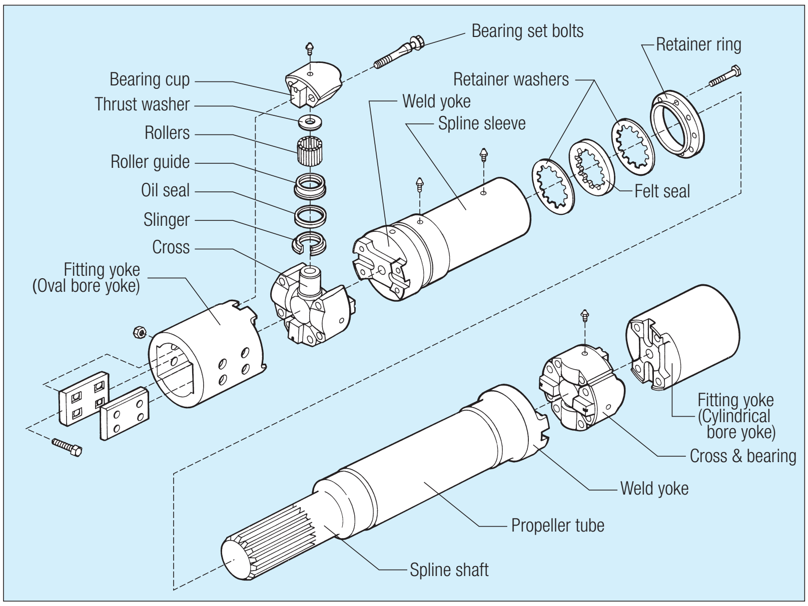
EZ series

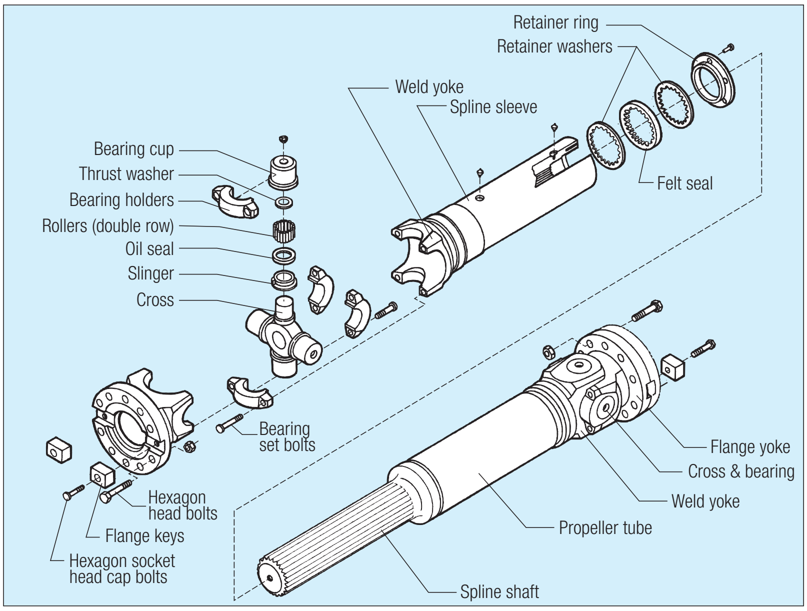
Features	Characteristics
Series for heavy load with excellent balance between performance and price	(1) Swing diameter (mm) : ϕ225 - 435
	(2) Torque T_D(kN·m) : 19.5 - 149.2
	(3) Torque T_S(kN·m) : 71.4 - 546
	(4) Maximum operating angle (°) : 15

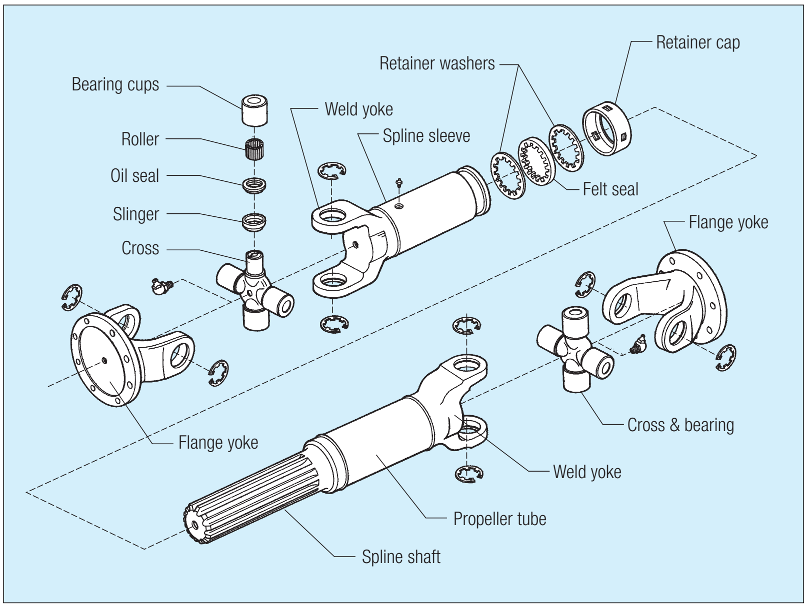
KF series

Features	Characteristics
This cost efficient series is intended for light to medium duty applications.	(1) Swing diameter (mm) : ϕ105 - 180
	(2) Torque T_D(kN·m) : 1.56 - 9.89
	(3) Torque T_S(kN·m) : 4.13 - 36.2
	(4) Maximum operating angle (°) : 18 - 30

Representative configuration







Structural features

With the cross & bearings fixed by bearing set bolts to the yokes, block type drive shafts transfer torque reliably through the key. The rollers, crosses, and bearing set bolts can be greater in size than those of the round type drive shafts, realizing high strength.

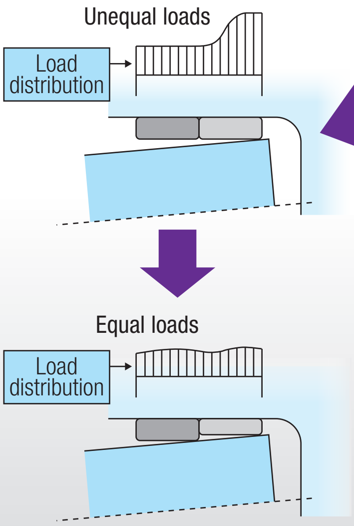
Compared with the block type, this type of drive shaft has cross & bearings of simpler construction and is more economical.
These drive shafts are connected to machines via a flange, enabling easy connection to a variety of machines.

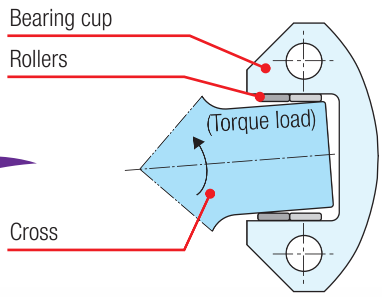
Measures to improve service life and strength

Below are optional specifications for use under severe conditions in which further strength and/or longer life are required.

Application of different diameter rollers for cross & bearing

Because the cross is an elastic cantilever beam and the bearing has some radial clearance, the load on the cross generally becomes heavier toward to the end of the cross.
In order to improve this phenomenon, load on the roller is made uniform by designing the roller to have a minutely smaller diameter at the very close end, which would improve flaking life. (figure on the right).
It is required that the detailed investigation takes into account multitude of JTEKT records and the technology of theoretical analysis by FEM, when this would be applied.
(Rollers with different diameters can be used in a three-row structure.)





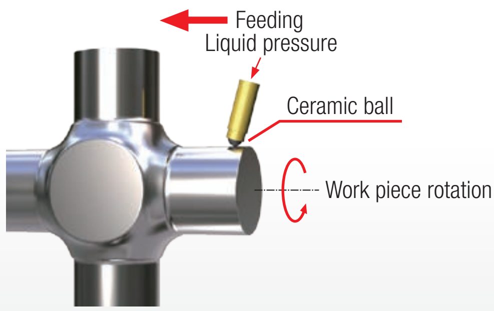
Effect of rollers different in diameter

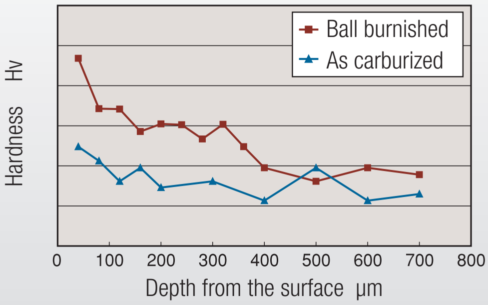
Ball burnishing on cross shaft

The flaking life can be improved by the ball burnishing on cross raceway. This process is a type of plastic working process, which is applied by rolling contact of super-hard ball backed up hydraulically on the cross raceway surface.

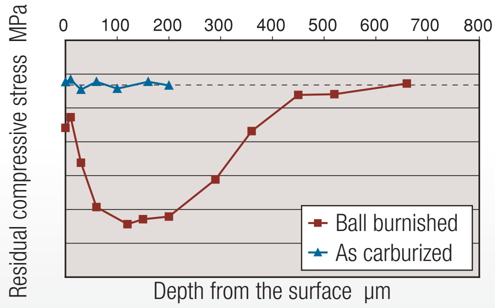
Features

(1) The hardness of the surface becomes higher than that of the carburized original material.
(2) Residual compressive stress at subsurface is larger than in the case of carburizing, and it can be applied deeply.
(3) Raceway roughness of the machined surface is improved. And no further finishing process is required after ball burnishing process.
(4) As the ball burnishing fixture can be used by attaching to lathe or other machine, there is actually no limitation in size of workpieces.





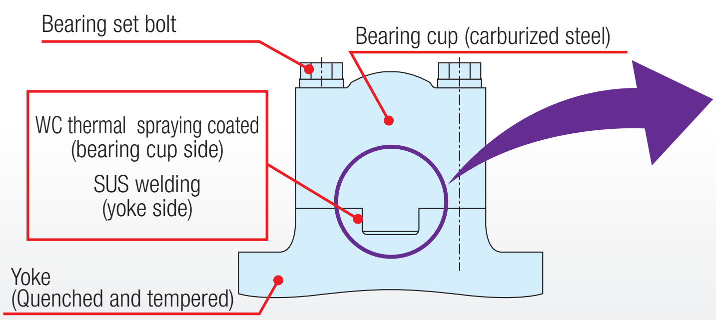
Measurement result of hardness

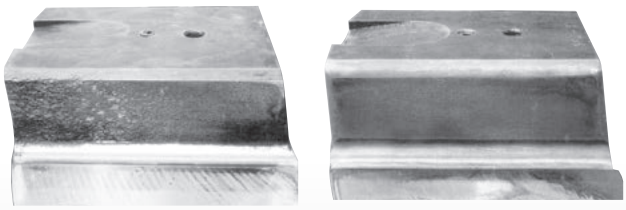


Measurement result of residual compressive stress

Thermal spraying coat of tungsten carbide (WC) on bearing cup key

To avoid corrosion on the side face of bearing cup key applying carburizing heat treatment, one possible method is to apply thermal spraying coat of tungsten carbide (WC) on these surfaces.





Without WC coat (Corrosion wear after 13 months use)

WC coated product (No corrosion wear after 20 months use)

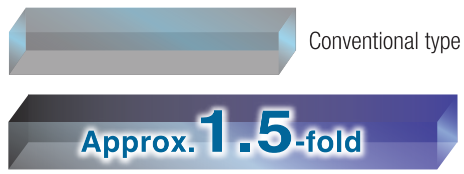
Effect of thermal spraying coat of tungsten carbide (WC)

Effects The following effects are expected in case the generation of clearance due to corrosion at the key area is restrained.

(1) The bending stress of bolt can be alleviated, which leads to the restraint of strength reduction.

(2) The heavier load on raceways at the end of the cross can be restrained, which expects longer fatigue life for cross & bearing.

【Improved corrosion resistance】

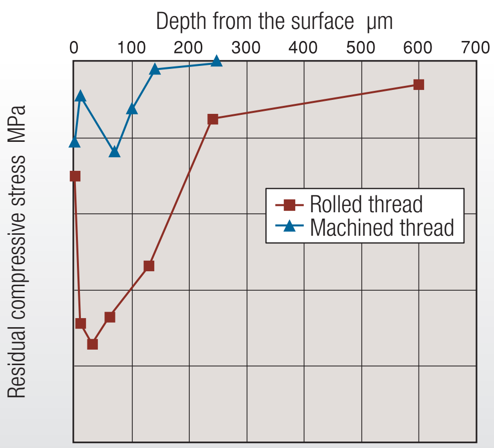


Application of form rolling to bearing set bolt

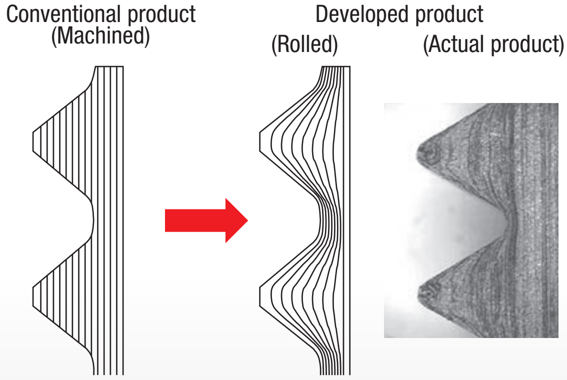
The thread of the bearing set bolt has conventionally been machined after heat treatment. However, by switching this process to form rolling, allowable fatigue stress at the bottom radii of the thread increases significantly.

Features (1) Fiber flow is formed along the shape of the thread. (figure on the right)

(2) Residual compressive stress at subsurface beneath the bottom radius of the thread increases. (figure below)

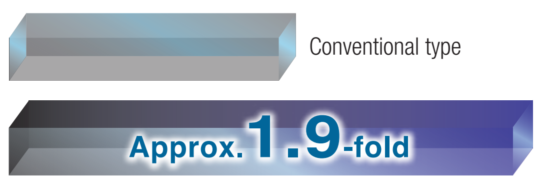


Residual compressive stress distribution of rolled thread



Fiber flow of rolled thread

【Improved fatigue strength】



Maintenance and inspection method of drive shaft

To use drive shafts safely for a long time, periodic inspection is required. Below is the periodic inspection procedure.
We accept servicing of drive shafts.
We can repair JTEKT products with a swing diameter of 500 mm or more as a guide. Please do not hesitate to contact JTEKT if you need more information.

<Examples of repair>

- Repair by grinding of raceway surfaces of cross, bearing cup
- Repair by build-up welding of yoke key grooves and oval bores
- Repair of slight wear and removal of rust

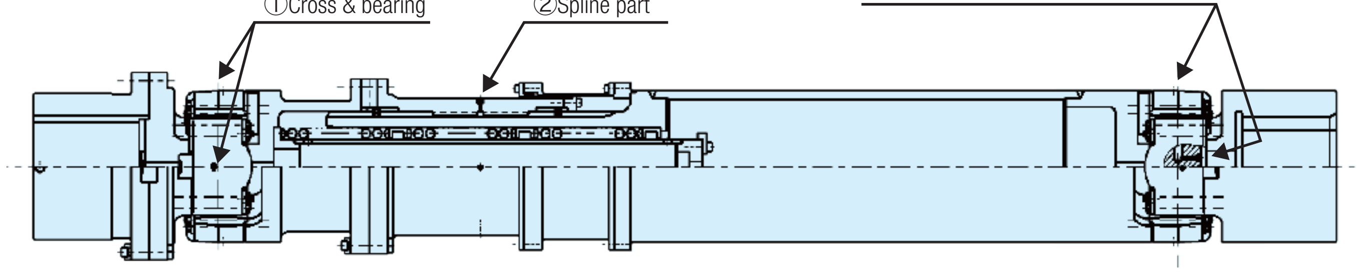
Periodic inspection

(1) Greasing

The greasing amount varies depending on the sizes of the cross & bearing and spline part.
Apply the amount of grease specified by JTEKT.

■ Greasing positions

Apply grease in the positions shown in the figure below.



■ Cycles of periodic greasing

- Hot strip mills: Once a month
- Cold strip mills: Every 3 months
- Others: Every 3 months

*Be sure to apply grease with correct intervals and amount.
The grease to be applied should be the one specified in the drawing.
Use of insufficient or different grease may lead to early damage.

(2) Tightening torque of bolts

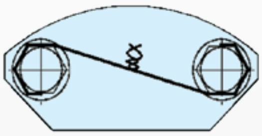
The tightening torque of bolts is set according to the bolt size.
If the bolts are not tightened with the proper tightening torque, it may lead to their early damage.
Refer to the tightening torque of the bolts specified in the drawing.
In addition, a dimension table of torque wrenches is provided on page 28.

■ Periodic inspection of bolts

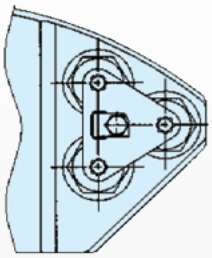
Conduct initial inspection of the bolts one week and one month after operation.
After that, conduct periodic inspection every six months.

Inspection of the bolts includes the following.

- Check for looseness or damage of the whirl-stop
- Check the elongation by hammering or looking



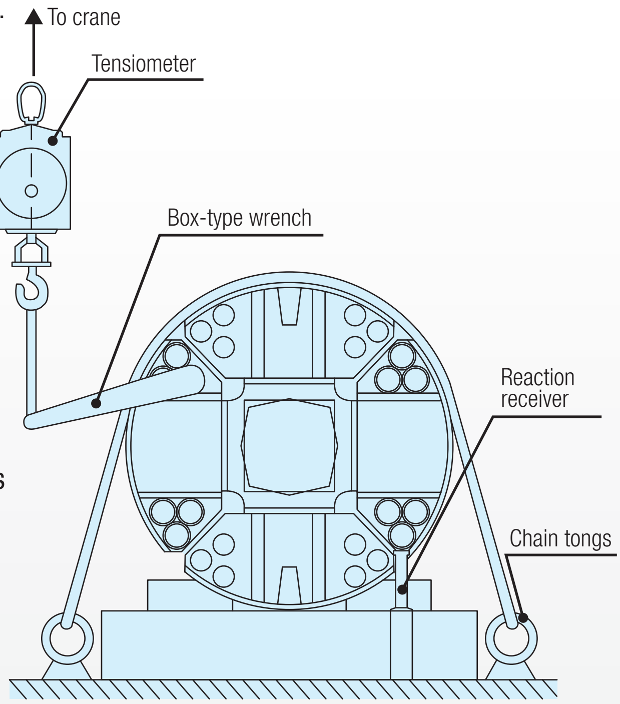
Whirl-stop with one bolt



Whirl-stop with three bolts

■ How to loosen/tighten the bolts of the cross & bearing

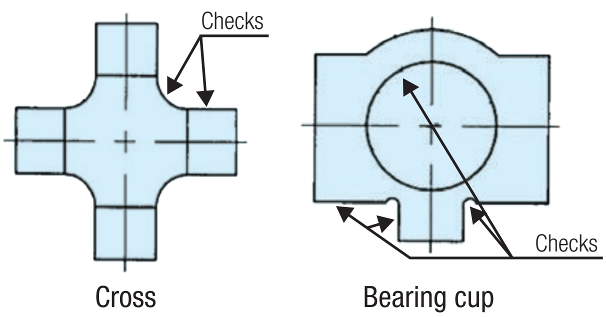
(1) As shown in the figure on the right, tighten the drive shaft with a jig such as chain tongs.
(2) Before tightening, apply a small amount of grease to the thread section and the head seat of the bolt.
(3) Tighten to the specified torque by using a wrench, tensiometer, etc.

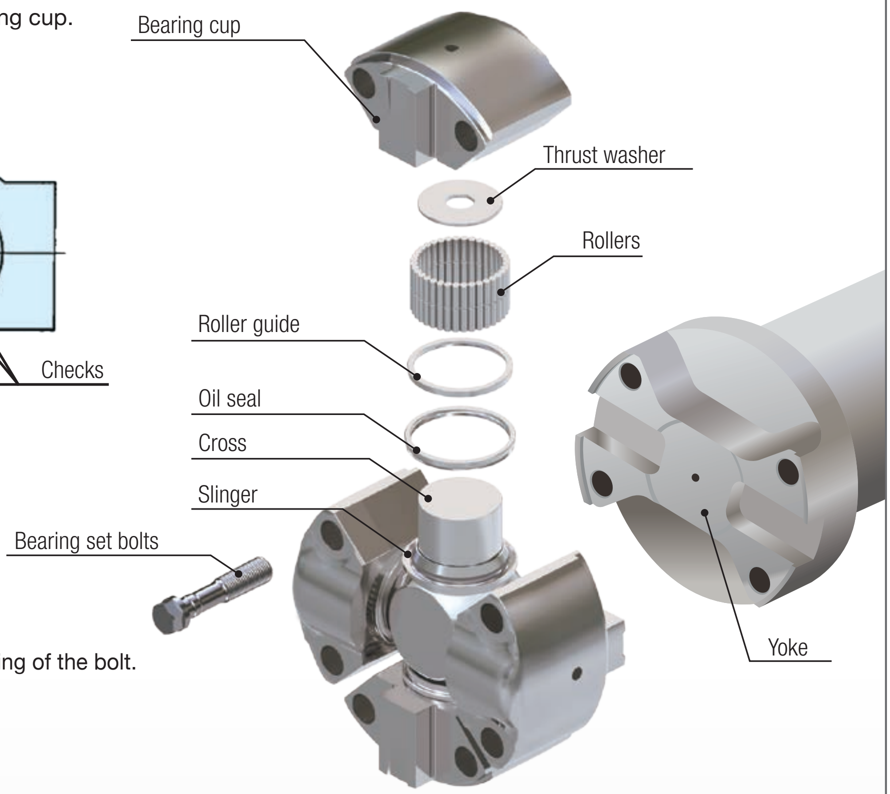


Overhaul

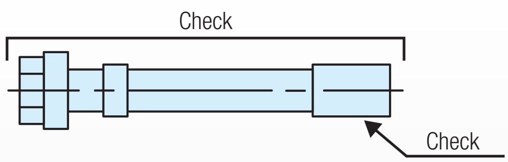
■ As a rule, conduct overhaul of the major parts every year after the start of operation.

■ Cross & bearing
- Check for brinelling, wear, flaking, seizure, cracks, nicks, or rusting, etc. of the cross and bearing cup.



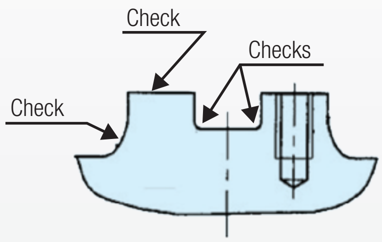


■ Bearing set bolt
- Check for bending, looseness, cracks, or rusting of the bolt.



■ Yoke
- Check for cracks, nicks, or rusting, etc. of each part.
- Especially, check the cross & bearing attaching part and the flange attaching part for signs of the above.

■ Others
- Check for wear, scuffing, or cracking, etc. of the oval bore and spline.



∗Consult with JTEKT about the inspection result.

∗The next page shows some examples of failures of each part.

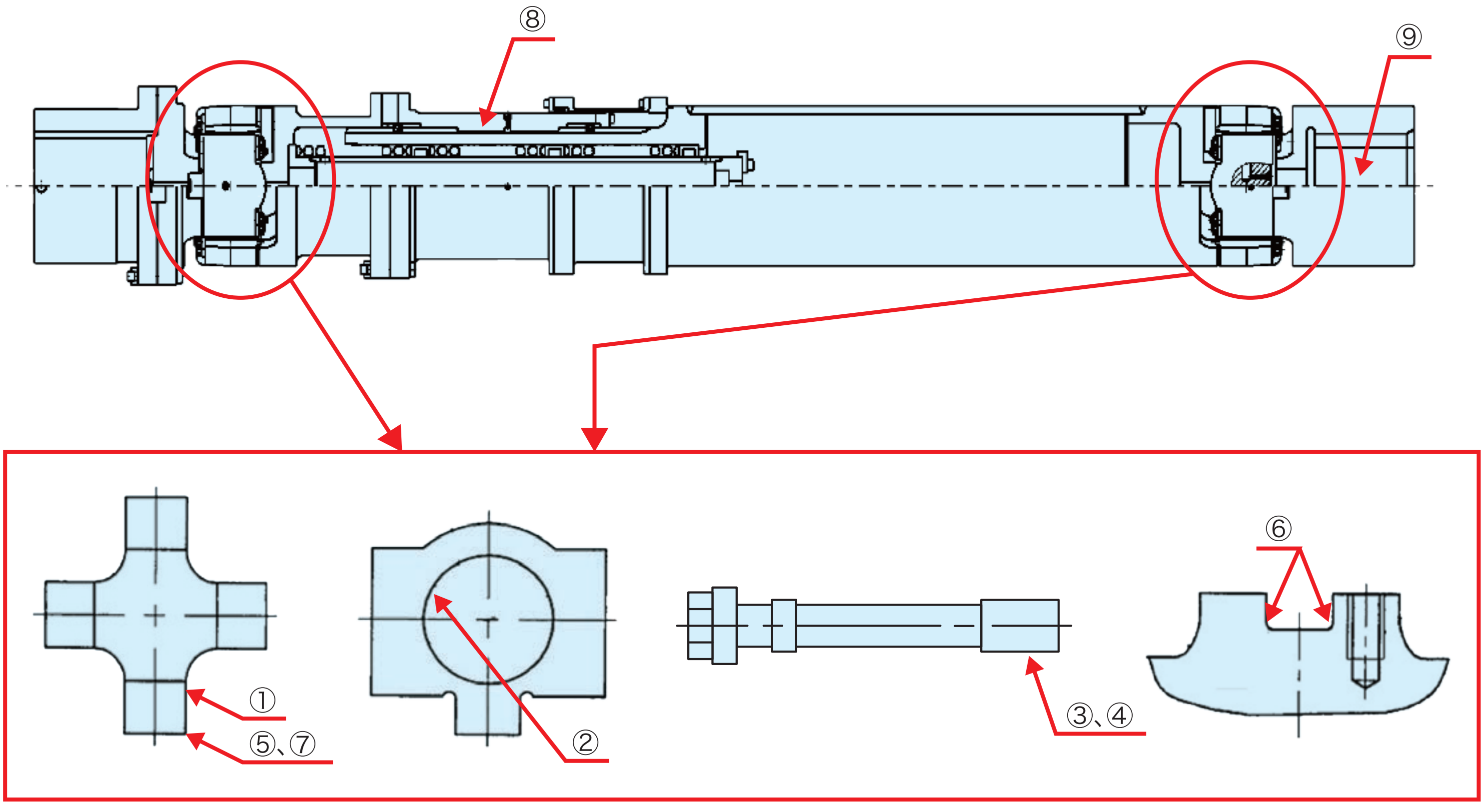
Management/storage

■ When storing the product for a long period of time, take measures to prevent rusting.

■ Before using a product stored for a long period of time, reapply grease to the cross & bearing, spline, etc.

Cases of failures

Here are some examples of failure cases of drive shaft parts.

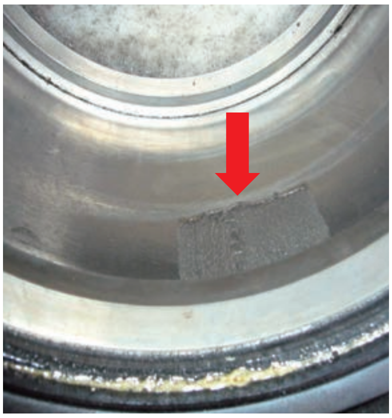


(1) Insufficient greasing

① Flaking of cross raceway surface

<Part>
Cross
<Cause>
- Flaking occurred at the bottom of the cross due to insufficient lubrication
<Measure>
- Periodic greasing
<Treatment>
- Repair by re-grinding

② Flaking of bearing cup raceway surface



<Part>
Bearing cup
<Cause>
- Flaking occurred on the bearing cup inlet side due to insufficient lubrication
<Measure>
- Periodic greasing
<Treatment>
- Repair by re-grinding

(2) Insufficient tightening torque

③ Breakage of bolt

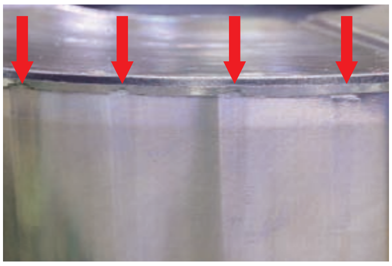
<Part>
Bearing set bolt
<Cause>
- Flat fracture shape because the axial force did not act on the bolt
<Measures>
- Tighten with the proper tightening torque
- Maintenance of the attaching surfaces of the cup and yoke
<Treatment>
- Replace with a new part

(3) Excessive load

④ Breakage of bolt

<Part>
Bearing set bolt
<Cause>
- An excessive bending stress acted on the bolt
<Measures>
- Review the usage conditions
- Apply an appropriate load
- Reduce the bending stress acting on the bolt
<Treatment>
- Replace with a new part

⑤ Brinelling on raceway surface



<Part>
Cross
<Cause>
- An excessive load acted on the raceway surface
<Measures>
- Review the usage conditions
- Apply an appropriate load
<Treatment>
- Repair by re-grinding

⑥ Dent deformation of key

<Part>
Yoke key way
<Cause>
- An excessive load acted on the key way
<Measures>
- Review the usage conditions
- Apply an appropriate load
<Treatment>
- Repair by weld overlaying

(4) Life

⑦ Flaking of raceway surface

<Part>
Cross
<Cause>
- Flaking occurred at the cross end due to long-term use
<Treatment>
- Repair by re-grinding
- Replace with a new part

⑧ Spline wear

<Part>
Spline sleeve
<Cause>
- Wear of the torque transmission surface due to long-term use
<Treatment>
- Reusable in the case of slight wear
- Replace with a new part in the case of serious wear
(Repair by weld overlaying is impossible)

⑨ Oval bore wear

<Part>
Oval bore yoke
<Causes>
- Doglegged surface pressure
- Clearance of the torque transmission surface
- Wear of the torque transmission surface due to long-term use
<Treatment>
-Repair by weld overlaying

General characteristics of universal joint (Cross-type universal joint)

Single universal joints

The driving shaft and driven shaft intermediated by a universal joint has the following relationship between their rotational angles:

$$\tan\phi_2 = \cos\theta \cdot \tan\phi_1 \quad \cdots(1)$$

where ϕ_1 : Rotational angle of driving shaft
ϕ_2 : Rotational angle of driven shaft
θ : Shaft operating angle (**Fig. 1**)

This means that, even if the rotational speed and torque of the driving shaft are constant, the driven shaft is subject to fluctuation in rotational speed and torque.
The speed ratio between the driving shaft and driven shaft can be obtained by differentiating equation (1) with respect to time (t), where ϕ_1 is by $\omega_1 \cdot t$ and ϕ_2 by $\omega_2 \cdot t$:

$$\frac{\omega_2}{\omega_1} = \frac{\cos\theta}{1-\sin^2\phi_1 \cdot \sin^2\theta} \quad \cdots(2)$$

where ω_1 : Rotational angular velocity of driving shaft (rad/s)
ω_2 : Rotational angular velocity of driven shaft (rad/s)
ω_2/ω_1 : Angular velocity ratio

Equation (2) can be expressed in diagram form as shown in **Fig. 2**. The maximum value and minimum value of the angular velocity ratio can be expressed as follows:

$$(\omega_2/\omega_1)\ \text{max.} = 1/\cos\theta \cdots\cdots \phi_1 = 90°$$
$$(\omega_2/\omega_1)\ \text{min.} = \cos\theta \cdots\cdots \phi_1 = 0°$$

The maximum fluctuation rate of angular velocity in a universal joint can be expressed by the following equation:

$$\frac{(\omega_2\,\text{max.} - \omega_2\,\text{min.})}{\omega_1} = \frac{1}{\cos\theta} - \cos\theta$$

The torque ratio between input and output can be expressed by the diagram shown in **Fig. 3**. The maximum value and minimum value can be obtained as shown below, respectively:

$$(T_2/T_1)\ \text{max.} = 1/\cos\theta \cdots\cdots \phi_1 = 0°$$
$$(T_2/T_1)\ \text{min.} = \cos\theta \cdots\cdots \phi_1 = 90°$$

where T_1 : Input torque
T_2 : Output torque
T_2/T_1: Torque ratio

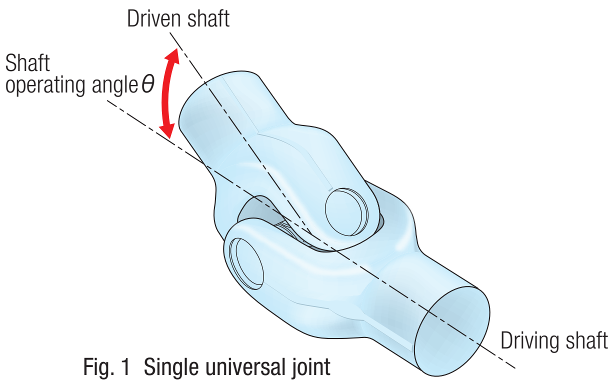


Fig. 1 Single universal joint

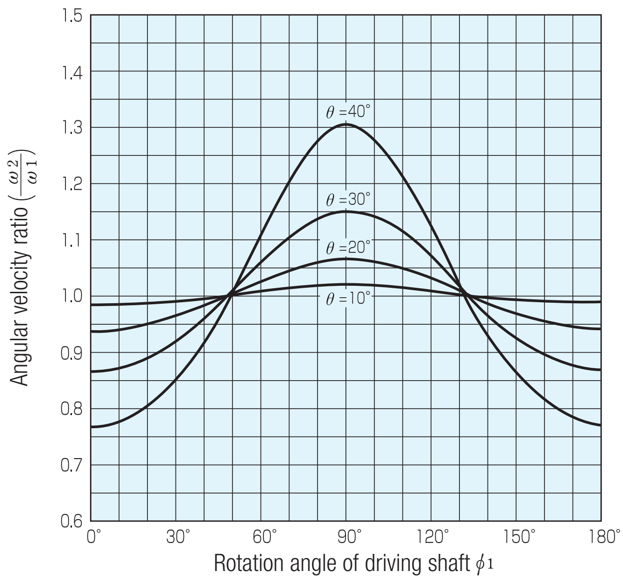


Fig. 2 Angular velocity fluctuation

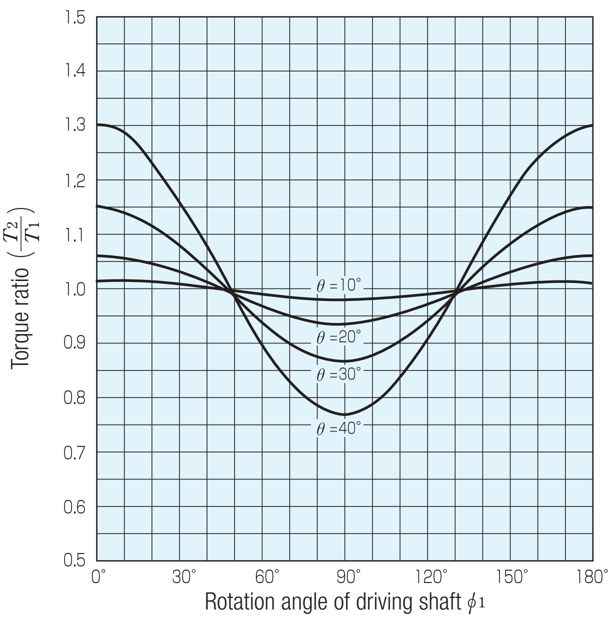


Fig. 3 Torque fluctuation

Double universal joints

Universal joints are usually installed in pairs. When assembled as shown in **Fig. 4**, that is,

(1) With equal operating angles in both joints
(2) Yokes connected to the same shaft in line
(3) Central lines of all three shafts (driving shaft, intermediate shaft, and driven shaft) in the same plane, the driven shaft rotates exactly in the same way as the driving shaft.

Therefore, they should be attached as shown in the figure on the right as far as possible.

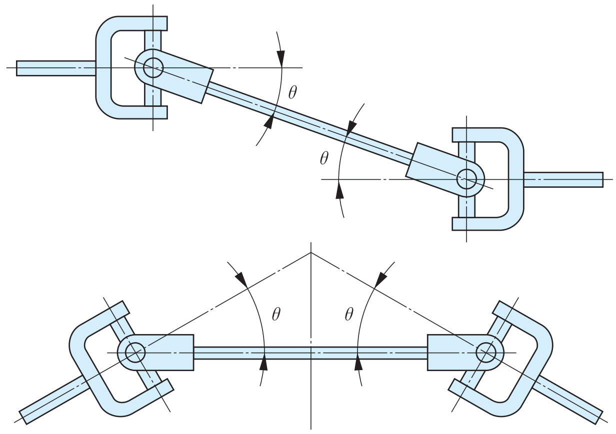


Fig. 4 Installation of double universal joints

Secondary couple

It is often necessary to consider the secondary couples imposed by universal joints operating at an angle; especially under high angle or large torque. These couples must be taken into account in designing the shafts and supporting bearings.

The secondary couples in the universal joints are in the planes of the yoke. These couples are about the intersection of the shaft axis. They impose a load on the bearings and a bending stress in the shaft connecting the joints, and they fluctuate from maximum to zero every 90° of shaft revolution. The broken lines in **Fig. 5** indicate the effect of these secondary couples on the shafts and bearings.

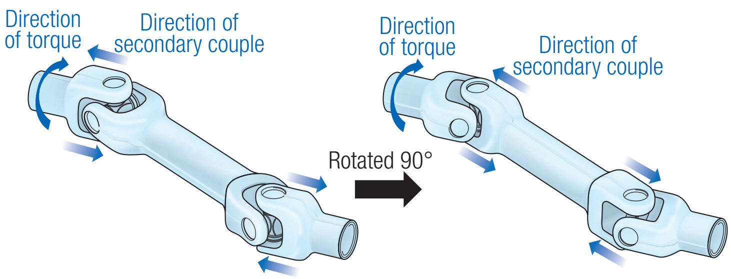
The equation for maximum secondary couple is as follows:

M_1 max. $= T \tan\theta$ (for driving shaft)
M_2 max. $= T \sin\theta$ (for driven shaft)

where M_1: Secondary couple on driving shaft (N·m)
M_2: Secondary couple on driven shaft (N·m)
T : Driving torque (N·m)
θ : Shaft operating angle

The ratio of the secondary couple to the driving torque is shown in **Fig. 6**.

The secondary couple M_1 and M_2 can be obtained by multiplying M_1/T or M_2/T by the driving torque T.



(Maximum secondary couple is produced on the driving side yoke and the driven side yoke alternately at every rotation of 90°)

Fig. 5 Effect of secondary couple

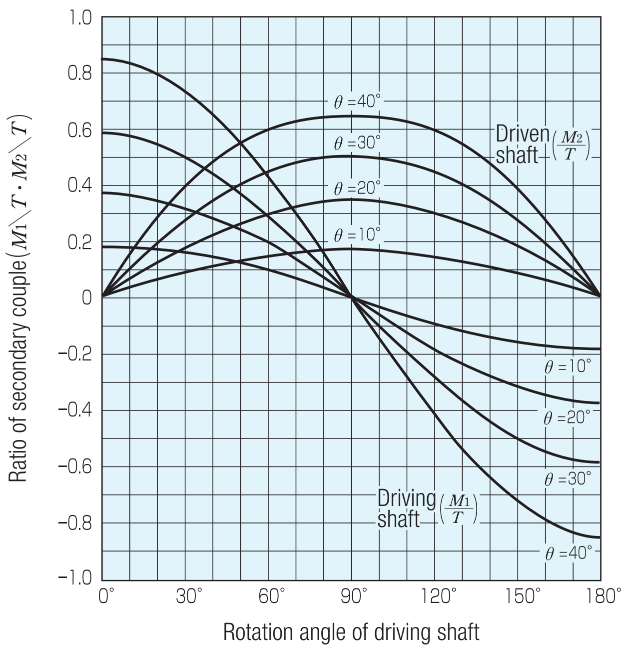


Fig. 6 Fluctuation of secondary couple to driving torque

Drive shaft selection

A drive shaft should be selected so as to satisfy the required strength, service life, operating angle and dimensions necessitated by its purpose. Especially, a drive shaft can be selected if it meets conditions of both strength and life of cross & bearings, except for special cases.

Load torque of drive shaft

To decide the size of the drive shaft, it is necessary to grasp the load torque first.
A maximum torque including an impact torque and a mean torque should be known, and it is essential for selecting an appropriate drive shaft to understand the correct maximum torque and mean torque.

Maximum torque:
 Value to determine if the strength of each part is sufficient.
Mean torque:
 Value necessary to calculate the service life

Mean torque

It is apparent that all kinds of machines are not operating thoroughly by their maximum torque. Therefore, if a drive shaft is selected according to a service life calculated from the maximum torque, it results in being uneconomically larger than necessary.
So, it is reasonable to set up a longer expected service life, if the application condition are severe; and shorter, if the conditions are easy.
If, for instance, a job is expressed as in the table below,

Drive stage	1	2	3 ･････Z
Torque (N･m)	T_1	T_2	$T_3 \cdots T_Z$
Rotational speed (min^{-1})	n_1	n_2	$n_3 \cdots n_Z$
Time ratio (%)	t_1	t_2	$t_3 \cdots t_Z$

the cube root of mean torque (T_m) and the arithmetical mean of rotational speed (n_m) are yielded from the following equations.

$$T_m = \sqrt[3]{\frac{(T_1^3 \cdot n_1 \cdot t_1 + \cdots\cdots\cdots T_Z^3 \cdot n_Z \cdot t_Z)}{(n_1 \cdot t_1 + \cdots\cdots\cdots + n_Z \cdot t_Z)}}$$

$$n_m = \frac{(n_1 \cdot t_1 + \cdots\cdots\cdots + n_Z \cdot t_Z)}{(t_1 + \cdots\cdots\cdots + t_Z)}$$

Strength of drive shaft

A drive shaft should be selected so that the normal maximum torque shall not exceed the " T_D torque." However, it is difficult to determine the true maximum torque, and the engine capacity or motor capacity is used as the maximum torque in many cases. In consideration of the torque amplification factor (TAF) of the drive shaft and various imponderables, the safety factor (f_S) of no less than 1.5 should be considered as the most desirable.

$f_D = T_D$ /maximum torque under normal operating conditions > 1.5

The maximum torque that may occur in an emergency should be determined using " T_S torque." The safety factor (f_S) of no less than 1.5 should be considered as desirable in this case as well.

$f_S = T_S$ /breaking torque under emergency conditions > 1.5

To select a drive shaft based on a safety factor of 1.5 or less, consult JTEKT as close examination is required in consideration of previous performance records.

Life of drive shaft

There is no global standard for the method of calculating the service life of cross & bearings, and this method is based on the results of research performed by each manufacturer.
JTEKT employs the following empirical equation based on extensive experimentation (conforming to SAE).
The service life L_h is defined as the expected number of operating hours before a flaking occurs on the rolling contact surface of the bearing. The use of the bearings over the service life L_h may be practical on a low speed machine such as a rolling mill.

$$L_h = 3000\, K_m \left(\frac{T_R \cdot K_n \cdot K_\theta}{T_m} \right)^{2.907}$$

Where, L_h: Average calculated bearing life (h)
 K_m: Material factor = 1 to 3
 T_R: Rated torque (N･m)
 T_m: Mean torque (N･m)
 K_n: Speed factor = $10.2/n^{0.336}$
 K_θ: Angle factor = $1.46/\theta^{0.344}$
 n : Rotational speed = (min^{-1})
 θ : Shaft operating angle (°)

Note) A drive shaft should be selected by considering the type of the machine, peripheral equipment, particular operating conditions, and other factors. The method outlined in this catalog is a common rough guide. It is recommended to consult JTEKT for details.

Critical number of rotation

When the rotation speed approaches the critical number of rotations of a drive shaft (bending natural frequency), the powertrain may be affected by resonance, and thus when a drive shaft is designed, the rotational flexural rigidity of the drive shaft needs to be considered.

If you need to increase the rotation speed through equipment alteration etc., please contact JTEKT.

Torque calculation from motor output

To obtain the load torque of a drive shaft, there is a method to calculate the torque from the motor output. The following is the calculation equation.

Horsepower → Torque (N・m)

$$T = \frac{HP}{N} \cdot 7122 \quad (\text{N}\cdot\text{m}) \quad \cdots\cdots(1)$$

However, in the case of PS (CV in French) horsepower, the following equation is applied.

$$T = \frac{PS}{N} \cdot 7024 \quad (\text{N}\cdot\text{m}) \quad \cdots\cdots(2)$$

Note) Check if the horsepower specified in the drawing provided means HP horsepower or PS horsepower.

kW → Torque (N・m)

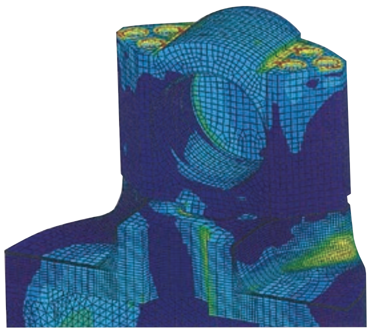
$$T = \frac{kW}{N} \cdot 9552 \quad (\text{N}\cdot\text{m}) \quad \cdots\cdots(3)$$

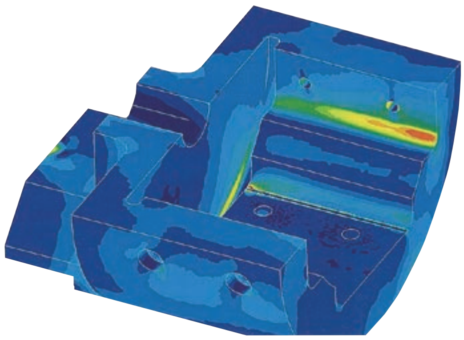
In equations (1) to (3) above,

- T : Torque (N・m)
- N : Rotational speed (min^{-1})
- HP : Horsepower (English horsepower)
- PS : Horsepower (French horse power)
- kW: Kilowatt

Evaluation/analysis

JTEKT conducts FEM analysis as one of the evaluation/analysis approaches to utilize for selection of a drive shaft.





Example of FEM analysis

Balance quality of drive shaft

If a rotating drive shaft is unbalanced, it may adversely influence the equipment and ambient conditions, thus posing a problem. JTEKT designs and manufactures drive shafts to satisfy the balance quality requirements specified in JIS B 0905.

Expression of balance quality

The balance quality is expressed by the following equation:

Balance quality $= e\omega$

or

Balance quality $= en/9.55$

where e: Amount of specific unbalance (mm)
This amount is the quotient of the static unbalance of a rigid rotor by the rotor mass. The amount is equal to the deviation of the center of the rotor mass from the center line of the shaft.

ω: Maximum service angular velocity of the rotor (rad/s)

n: Rotational speed (min^{-1})

Balance quality grades

The JIS specifies the balance quality grades from G0.4 to G4000. Generally, the three grades described in Table 1 below are commonly used.
We apply grade G16 to high speed drive shafts unless otherwise specified.

Correction of the unbalance of drive shafts

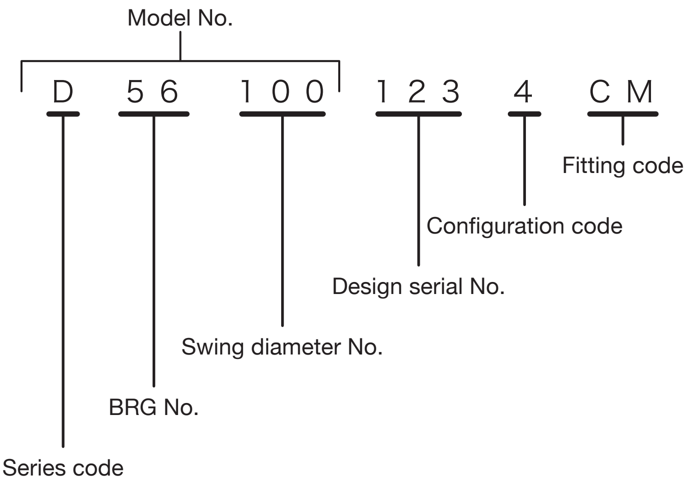
JTEKT corrects the unbalance of drive shafts to the optimal value by the two plane balancing method, using the latest balance system.
To correct the balance of a drive shaft, it is critical to correct the balance between two planes each near the two individual universal joints, instead of by the one plane balancing as used to balance car wheels.
Especially in the case of a long drive shaft, this two plane balancing method is the only way to acquire good results.

Table 1 Recommended balance quality grades (excerpt from JIS B 0905)

Balance quality grade	Upper limit value of balance quality ($e\omega$)	Recommended applicable machines
G40	40	Car wheels, wheel rims, wheel sets and drive shafts Crankshaft systems of elastically mounted high speed four stroke engines (gasoline or diesel) with six or more cylinders Crankshaft systems of the engines of automobiles, trucks and rolling stock
G16	16	Drive shafts with special requirements (propeller shafts and diesel shafts) Components of crushing machines Components of agricultural machines Components of the engines of automobiles, trucks and rolling stock (gasoline or diesel) Crankshaft systems with six or more cylinders with special requirements
G 6.3	6.3	Devices of processing plants Ship engine turbine gears (for merchant ships) Centrifugal drums Papermaking rolls and printing rolls Fans Assembled aerial gas turbine rollers Flywheels Pump impellers Components of machine tools and general industrial machines Medium or large electric armatures (of electric motors having at least 80 mm in the shaft center height) without special requirements Small electric armatures used in vibration insensitive applications and/or provided with vibration insulation (mainly mass produced models) Components of engines with special requirements

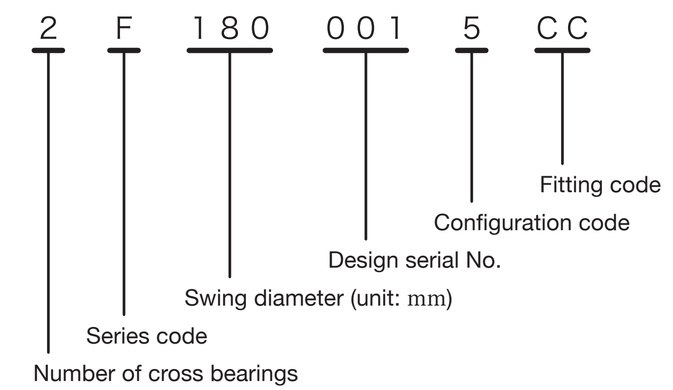
Composition of drive shaft numbers

(1) Block type

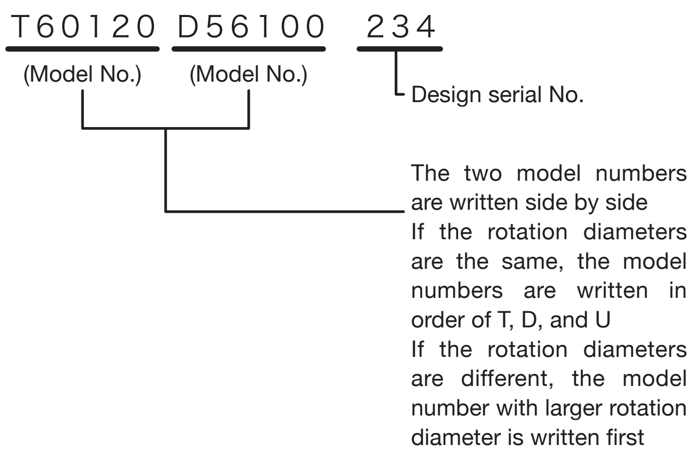


(2) Round type

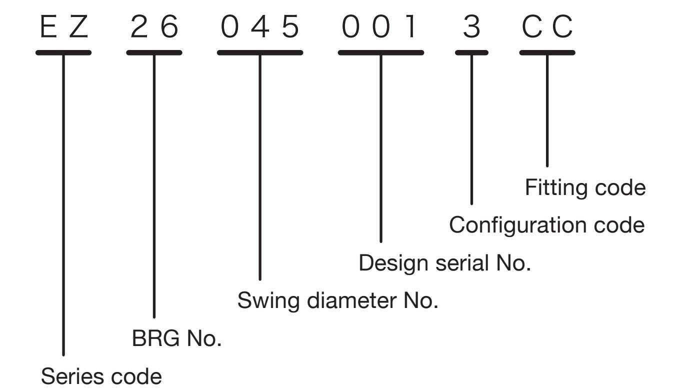
① KF series



(3) Type with different model numbers on the right and left



② EZ series



Supplementary explanation of items

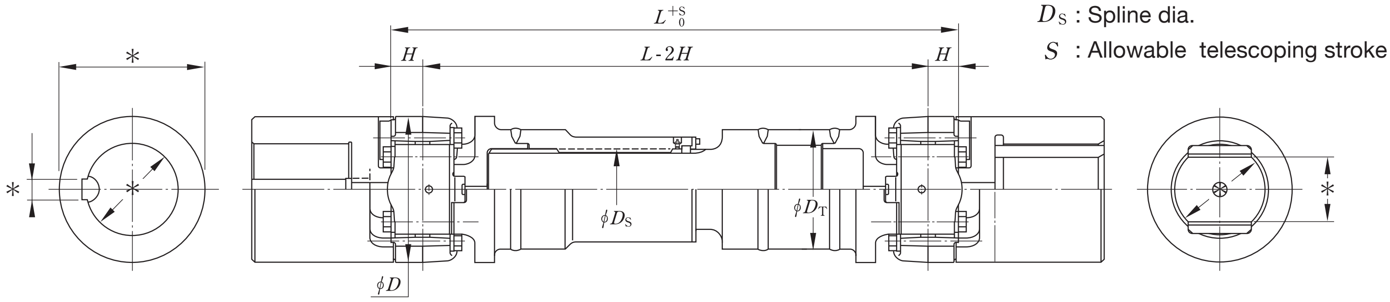
- **Series code** D : D series U : U series T : T series F(Z) : KF series EZ : EZ series
- **BRG. No.** : The raceway diameters of the cross are represented in two digits in order of size (e.g.: 56, 63)
- **Swing diameter No.** : The value is swing diameter of cross & bearing /5 and is represented in three digits (e.g.: ϕ450 mm → 090, ϕ900 mm → 180)
- **Design serial No.** : Represented in three digits for each model number (001 - 999)
- **Configuration code** : Decided according to the configuration of the drive shaft
- **Fitting code** : The following shape codes are added to the left, then to the right, according to the shape of the attaching parts at both ends.
  - B : Cross & bearing
  - C : Cylindrical bore
  - F : Flange
  - M : Oval bore
  - T : Tapered bore

Specifications

D series

Telescoping type (with propeller tube)

D_T : Propeller tube dia.
D_S : Spline dia.
S : Allowable telescoping stroke



Dimensions marked with an asterisk (∗) need to be determined to suit existing equipment.
Please provide the specifications of your equipment when placing an inquiry.

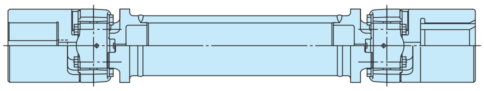
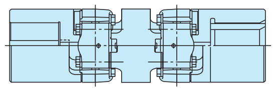
Model No.	Swing dia. (mm) D	Torque capacity (kN·m)			Max. operating angle (°)	Boundary dimensions (mm)					Bearing set bolts					Recommended wrench set [7] (bearing set bolt)
		T_R [1]	T_D [2]	T_S [3]		L [4] (min.)	H	D_T	D_S [5]	S	Nominal thread size	Width across flats	Tightening torque (N·m)	Q'ty [6]	Type	Torque Wrench No. Socket No. Tensiometer No. Wrench No.
D22032	160	2.83	10.9	34.1	9	585	30	139.8	101.6	80	M16×1.5	17	185± 20	8	A	TW4200 HR17×4200
D26038	190	5.33	22.5	54.7	9.5	677	38	159	114.3 (95)	95	M18×1.5	19	285± 20	8	A	TW4200 HR19×4200
D30044	220	8.54	35.3	73.1	10	760	45	177.8	127 (120)	110	M20× 2	22	370± 20	8	A	TW4200 HR22×4200
D34052	260	15.1	56.2	140	7.5	873	52	216.3	152.4 (140)	125	M24× 2	27	645± 30	8	A	TW8500 HR27×8500
D38060	300	22.7	89.9	260	8	965	60	244.5	177.8 (160)	135	M30× 2	32	1 180± 50	8	C	TM500 WR32×500
D44070	350	38.3	144	384	9	1080	70	298.5	203.2 (180)	155	M33× 2	36	1 720± 70	8	C	TM500 WR36×500
D48080	400	54.9	213	560	8	1220	80	339.7	225 (200)	175	M39× 3	50	3 040±200	8	C	TM1000 WR50×500
D50085	425	66.9	264	708	8	1284	86	355.6	250	185	M42× 3	50	4 020±200	8	C	TM1000 WR50×500
D54090	450	80.4	333	739	8	1348	92	381	250	195	M42× 3	50	4 020±200	8	C	TM1000 WR50×500
D56100	500	107	500	1 060	8	1503	107	410	275	205	M48× 3	60	5 980±300	8	C	TM2000 WR60×500
D58110	550	146	747	1 460	6	1604	116	450	300	220	M52× 3	65	7 650±300	8	C	TM2000 WR65×800
D60120	600	195	962	2 040	6	1730	125	490	325	235	M58× 3	70	10 300±300	8	C	TM2000 WR70×800
D62130	650	249	1140	2 520	6	1849	136	530	350	250	M62× 3	75	12 700±300	8	C	TM2000 WR75×800
D64140	700	293	1510	3 370	6	1949	146	580	375	265	M68× 3	85	17 100±500	8	C	TM3000 WR85×800

■ Features

This series is suitable for use under severe conditions, such as in driving rolling mill rolls.
Based on standardized cross & bearings, this series can be designed to suit a wide range of dimensions and a wide variety of fitting configurations.

■ Designs available to order

The fixed type can be designed to order, assembling components shown on the right.
For more details on these designs, consult JTEKT.

With propeller tube	
With coupling yoke	

Model No.	Swing dia. (mm) D	Torque capacity (kN·m)			Max. operating angle (°)	Boundary dimensions (mm)					Bearing set bolts				Recommended wrench set 7) (bearing set bolt)	
		T_R 1)	T_D 2)	T_S 3)		L 4) (min.)	H	D_T	D_S 5)	S	Nominal thread size	Width across flats	Tightening torque (N·m)	Q'ty 6)	Type	Torque Wrench No. Socket No. / Tensiometer No. Wrench No.
D66150	750	371	1 730	3 870	6	2 090	155	620	400	290	M72×4	90	20 400±500	8	C	TM3000 WR90×800
D68160	800	449	2 090	4 600	6	2 225	170	670	450	300	M76×4	95	24 500±500	8	C	TM3000 WR95×1000
D71170	850	497	3 720	6 200	7	2 337	178	710	500	320	M48×2	50	5 590±200	24	D	TM2000 WB50×500
D72180	900	591	4 070	6 610	7	2 445	190	750	500	335	M48×2	50	5 590±200	24	D	TM2000 WB50×500
D7E184	920	621	4 360	8 050	7	2 495	190	780	550	340	M52×2	50	7 350±300	24	D	TM2000 WB50×500
D74190	950	654	3 900	9 250	7	2 564	196	810	550	350	M56×3	60	9 120±300	24	D	TM2000 WB60×800
D75194	970	697	4 600	10 400	7	2 594	196	830	550	370	M56×3	60	9 120±300	24	D	TM2000 WB60×800
D76204	1 020	924	4 540	8 050	7	2 654	211	850	550	385	M52×3	55	7 650±300	24	D	TM2000 WB55×500
D7J214	1 070	1 040	6 780	13 500	6	2 900	230	890	600*	400*	M64×3	65	14 200±300	24	D	TM2000 WB65×800
D81220	1 100	1 100	7 970	13 300	6	2 970	250	920	600*	415*	M64×3	65	14 200±300	24	D	TM2000 WB65×800
D8B226	1 130	1 210	7 550	15 200	6	3 070	260	950	650*	430*	M68×3	70	17 100±500	24	D	TM3000 WB70×800
D8E246	1 230	1 540	8 970	18 800	6	3 165	260	1 030	650*	450*	M72×4	75	20 400±500	24	D	TM3000 WB75×800

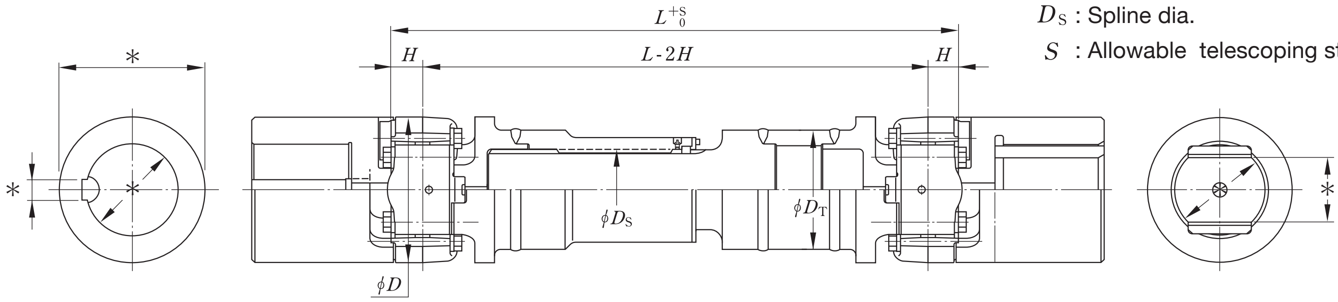
[Notes]
1) T_R refers to the rated torque used for service life calculation (refer to page 15). The material factor K_m is supposed to be 3 in this calculation.
2) T_D refers to the reference torque used as the criterion for evaluation of resistance to the maximum torque under normal operating conditions. T_D divided by the maximum torque should preferably be greater than 1.5.
3) T_S refers to the reference torque used as the criterion for evaluation of resistance to the breaking torque under emergency conditions. T_S divided by the breaking torque should preferably be greater than 1.5.
4) L refers to the minimum dimension when the shaft has neither propeller tube nor welded connection.
5) The parenthesized values refer to the involute spline diameter.
6) Represents the voltage used for one kit of cross & bearing.
7) The types of wrench set are as follows. For details, refer to "Torque wrench set for bolt tightening" on page 28.
Type A: Torque wrench + Ring head　Type C: Tensiometer + Ring wrench
Type B: Torque wrench + Hexagonal bar wrench　Type D: Tensiometer + Socket wrench

[Remarks]
1) The values with * mark are reference values.
2) The T_D values in the table are the values with alternating load. For the values with pulsating load, contact JTEKT.

U series

Telescoping type (with propeller tube)

D_T : Propeller tube dia.
D_S : Spline dia.
S : Allowable telescoping stroke



Dimensions marked with an asterisk (*) need to be determined to suit existing equipment.
Please provide the specifications of your equipment when placing an inquiry.

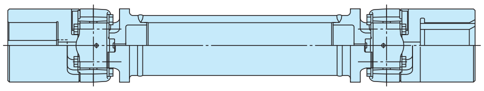
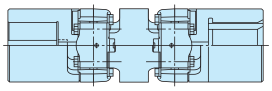
Model No.	Swing dia. (mm) D	Torque capacity (kN·m)			Max. operating angle (°)	Boundary dimensions (mm)					Bearing set bolts					Recommended wrench set[7] (bearing set bolt)
		T_R [1]	T_D [2]	T_S [3]		L [4] (min.)	H	D_T	D_S [5]	S	Nominal thread size	Width across flats	Tightening torque (N·m)	Q'ty [6]	Type	Torque Wrench No. Socket No. Tensiometer No. Wrench No.
U45073	365	45.5	284	497	4	1 185	75	339.7	225 (200)	170	M39×2	41	2 840±150	8	C	TM1000 WR41×500
U4H078	390	53.3	313	745	4	1 240	80	355.6	250	180	M42×2	46	3 820±200	8	C	TM1000 WR46×500
U49084	420	62.7	414	725	4	1 309	86	381	250	190	M45×2	50	4 900±200	8	C	TM2000 WR50×500A
U53088	440	77.1	504	855	4	1 388	92	406.4	275	205	M45×2	55	5 050±200	8	C	TM2000 WR55×500
U5E095	475	94.1	650	1 170	4	1 465	100	420	275	210	M48×2	55	5 880±200	8	C	TM2000 WR55×500A
U55098	490	108	755	1 252	4	1 503	107	440	275	215	M52×2	60	7 350±300	8	C	TM2000 WR60×800A
U5G105	525	127	859	1 410	4	1 630	110	470	325	220	M52×3	65	7 650±300	8	C	TM2000 WR65×800
U57108	540	140	1 160	1 780	4	1 674	116	485	350	230	M56×2	60	9 120±300	8	C	TM2000 WR60×800A
U59118	590	180	1 500	2 270	4	1 775	125	530	375	250	M36×2	36	2 350±100	24	D	TM1000 WB36×500
U63128	640	229	2 120	2 920	4	1 899	136	580	400	265	M39×2	36	2 940±150	24	D	TM1000 WB36×500
U6S132	660	255	2 230	3 030	4	1 963	142	600	400	275	M39×2	36	2 940±150	24	D	TM1000 WB36×500
U6D138	690	285	2 660	3 710	4	2 049	146	620	450	285	M42×2	41	4 270±200	24	D	TM1000 WB41×500

■ Features

The U Series is mainly intended for non reversing mills, such as the finishing stand of a hot strip mill.

■ Designs available to order

The fixed type can be designed to order, assembling components are shown on the right.
For more details on these designs, consult JTEKT.

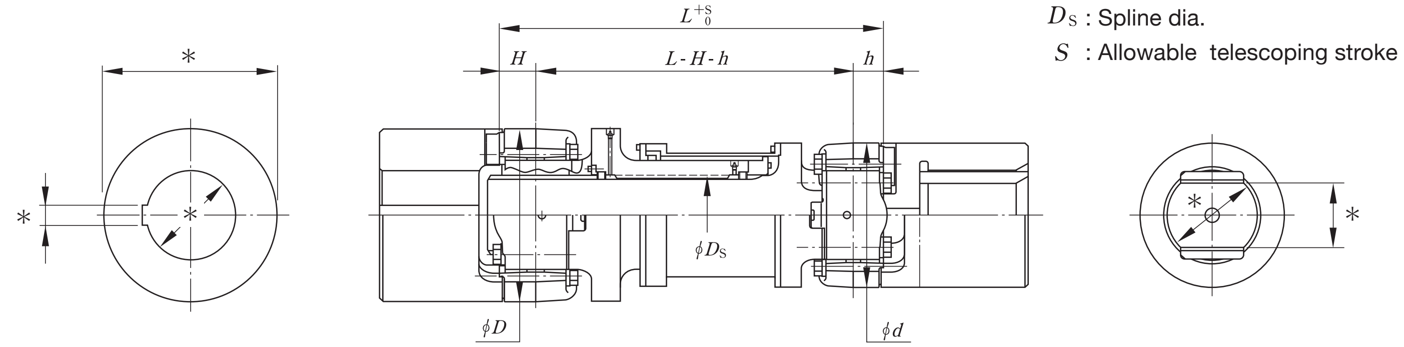
With propeller tube	
With coupling yoke	

Model No.	Swing dia. (mm) D	Torque capacity (kN・m)			Max. operating angle (°)	Boundary dimensions (mm)					Bearing set bolts				Recommended wrench set[7] (bearing set bolt)	
		T_R [1]	T_D [2]	T_S [3]		L [4] (min.)	H	D_T	D_S [5]	S	Nominal thread size	Width across flats	Tightening torque (N・m)	Q'ty[6]	Type	Torque Wrench No. Socket No. Tensiometer No. Wrench No.
U65148	740	360	2 990	4 770	4	2 160	155	670	450	305	M45×2	46	4 900±200	24	D	TM2000 WB46×500
U67152	760	398	3 440	4 840	4	2 195	160	685	450	310	M45×2	46	4 900±200	24	D	TM2000 WB46×500
U6J156	780	416	3 770	5 700	4	2 235	165	705	500	315	M48×2	50	5 590±200	24	D	TM2000 WB50×500
U69168	840	491	4 360	6 650	4	2 357	178	760	500	325	M52×2	55	7 650±300	24	D	TM2000 WB55×500

[Notes]
1) T_R refers to the rated torque used for service life calculation (refer to page 15). The material factor K_m is supposed to be 3 in this calculation.
2) T_D refers to the reference torque used as the criterion for evaluation of resistance to the maximum torque under normal operating conditions.
T_D divided by the maximum torque should preferably be greater than 1.5.
3) T_S refers to the reference torque used as the criterion for evaluation of resistance to the breaking torque under emergency conditions.
T_S divided by the breaking torque should preferably be greater than 1.5.
4) L refers to the minimum dimension when the shaft has neither propeller tube nor welded connection.
5) The value within parentheses indicates the spline diameter of the involute splines.
6) Represents the voltage used for one kit of cross & bearing.
7) The types of wrench set are as follows. For details, refer to "Torque wrench set for bolt tightening" on page 28.
Type A: Torque wrench + Ring head　　Type C: Tensiometer + Ring wrench
Type B: Torque wrench + Hexagonal bar wrench　　Type D: Tensiometer + Socket wrench

[Remarks]
1) The T_D values in the table are values with pulsating load.
2) If you require U series with swing diameter of ϕ285 to ϕ345, contact JTEKT.

T series



D_S : Spline dia.
S : Allowable telescoping stroke

Dimensions marked with an asterisk (*) need to be determined to suit existing equipment.
Please provide the specifications of your equipment when placing an inquiry.

■ Features

The T Series is intended for such applications where telescoping function is required in a small space. Because one of the cross & bearings needs to be hollow to enable the required stroke, this series is applicable in such cases where the swing diameter has a given allowance on either the driving side or driven side.

Model No.	Swing dia. (mm) D (d)	Torque capacity (kN·m)			Max. operating angle (°)	Boundary dimensions (mm)			
		T_R 1)	T_D 2)	T_S 3)		L 4) (min.)	H (h)	D_S	S
T42065 (D30044)	325 (220)	16.9	35.3	73.1	10	699	67 (45)	127	180
T48080 (D38060)	400 (300)	30.8	89.9	260	8	870	80 (60)	177.8	210
T54090 (D44070)	450 (350)	45.0	144	384	9	969	92 (70)	203.2	250
TZ56100 (D48080)	500 (400)	74.1	213	560	8	1 080	107 (80)	225	280
T58110 (D54090)	550 (450)	82.5	333	739	8	1 196	116 (92)	250	305
T60120 (D56100)	600 (500)	111	500	1 060	8	1 319	125 (107)	275	335
T62130 (D58110)	650 (550)	142	747	1 460	6	1 414	136 (116)	300	355
T66150 (D62130)	750 (650)	212	1 140	2 520	6	1 617	155 (136)	350	415

Bearing set bolts				Recommended wrench set 6) (bearing set bolt)	
Nominal thread size	Width across flats	Tightening torque (N·m)	Quantity 5)	Type	Torque Wrench No. Socket No. Tensiometer No. Wrench No.
M24×2	27	645± 30	8	A	TM500 HR27×8500
M30×2	32	1 180± 50	8	C	TM500 WR32×500
M33×2	36	1 720± 70	8	C	TM500 WR36×500
M39×3	50	3 030±200	8	C	TM1000 WR50×500
M42×3	50	4 020±200	8	C	TM1000 WR50×500
M48×3	60	5 980±300	8	C	TM2000 WR60×500
M52×3	65	7 650±300	8	C	TM2000 WR65×800
M62×3	75	12 700±300	8	C	TM2000 WR75×800

[Notes]
1) T_R refers to the rated torque used for service life calculation (refer to page 15). The material factor K_m is supposed to be 3 in this calculation.
2) T_D refers to the reference torque used as the criterion for evaluation of resistance to the maximum torque under normal operating conditions. T_D divided by the maximum torque should preferably be greater than 1.5.
3) T_S refers to the reference torque used as the criterion for evaluation of resistance to the breaking torque under emergency conditions. T_S divided by the breaking torque should preferably be greater than 1.5.
4) L refers to the minimum dimension when the shaft has neither propeller tube nor welded connection.
5) Represents the voltage used for one kit of cross & bearing.
6) The types of wrench set are as follows. For details, refer to "Torque wrench set for bolt tightening" on page 28.
Type A: Torque wrench + Ring head　　Type C: Tensiometer + Ring wrench
Type B: Torque wrench + Hexagonal bar wrench　　Type D: Tensiometer + Socket wrench

[Remarks]
1) The T_D values in the table are the values with alternating load. For the values with pulsating load, contact JTEKT.
2) Specifications in parentheses are recommended model numbers and dimensions for combination.

KF/EZ series

Telescoping type (with propeller tube)

D_T : Propeller tube dia.
D_S : Spline dia.
S : Allowable telescoping stroke

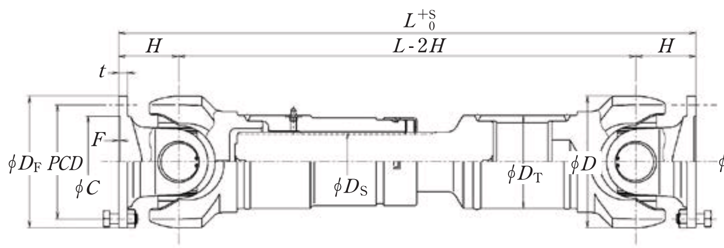


Fig. 1

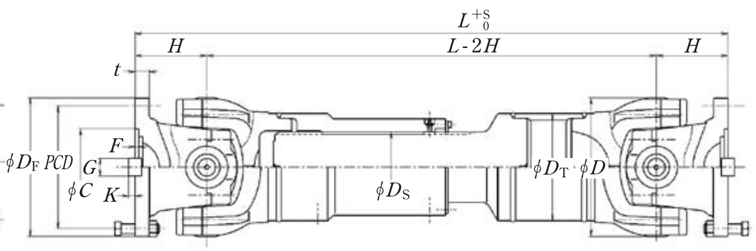


Fig. 2

Model No.	Fig.	Swing dia. (mm) D	Torque capacity (N·m)			Max. operating angle (°)	Boundary dimensions (mm)						
			T_R 1)	T_D 2)	T_S 3)		H	D_T	Telescoping type: Propeller tube dia. L 4)	Telescoping type: With propeller tube L (min.) 4)	Telescoping type: S	Telescoping type: D_S	Fixed type with propeller tube L (min.) 4)
KFZ100	1	105	735	1 560	4 130	30	70 —	73	510 —	550 —	60	45	320 —
KF120	1	120	882	2 870	10 500	20	60 62	89.1	495 499	535 539	70	58	310 314
KF150	1	150	1 860	5 890	21 600	20	72 74	114.3	577 581	617 621	70	70	354 358
KF180	1	180	3 280	9 890	36 200	18	82 90	127	664 680	714 730	90	82	404 420
EZ26045	2	225	6 370	19 500	71 400	15	123 128	165.2	862 872	912 922	90	105	536 546
EZ28050	2	250	8 820	32 900	115 000	15	128 130	203	939 943	999 1 003	110	120	586 590
EZ32057	2	285	13 700	41 400	152 000	15	143 148	216.3	1 042 1 052	1 102 1 112	110	140	666 676
EZ34063	2	315	18 900	54 300	199 000	15	163 166	244.5	1 159 1 165	1 229 1 235	135	160	726 732
KFZ350	2	350	25 500	77 200	283 000	15	175 180	244.5	1 231 1 241	1 301 1 311	135	180	780 790
KFZ390	2	390	32 300	107 000	390 000	15	195 —	273.1	1 369 1 399	1 459 1 489	140	200	880 —
KFZ435	2	435	51 000	149 200	546 000	15	220 —	318.5	1 604 1 614	1 704 1 714	140	200	1 010 —

[Notes]
1) T_R refers to the rated torque used for service life calculation (refer to page 15). The material factor K_m is supposed to be 1 for the drive shafts whose swing diameter is 180 mm or less, and to be 3 for those whose swing diameter is between 225 mm and 435 mm in this calculation.
2) T_D refers to the reference torque used as the criterion for evaluation of resistance to the maximum torque under normal operating conditions. T_D divided by the maximum torque should preferably be greater than 1.5.
3) T_S refers to the reference torque used as the criterion for evaluation of resistance to the breaking torque under emergency conditions. T_S divided by the breaking torque should preferably be greater than 1.5.
4) L refers to the minimum dimension when the shaft has neither propeller tube nor welded connection.

[Remarks] 1) The T_D values in the table are the values with alternating load. For the values with pulsating load, contact JTEKT.

Fixed type (with propeller tube)

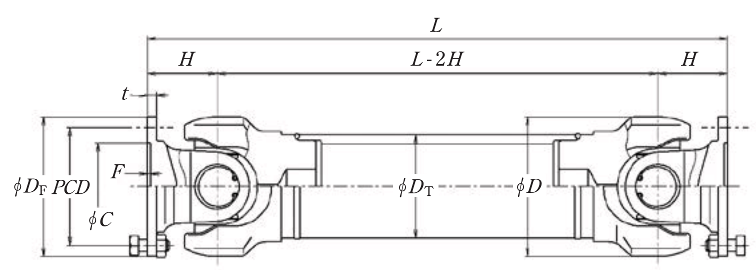


Fig. 1

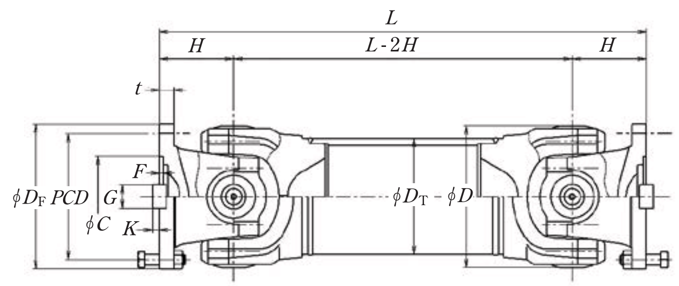


Fig. 2

Bearing set bolts			Flange outside dia. (mm)
Nominal thread size	Width across flats	Tightening torque (N·m)	
—	—	—	120 —
—	—	—	120 150
—	—	—	150 180
—	—	—	180 225
M16×1.5	14	185±10	225 250
M18×2	14	240±20	250 285
M18×2	14	240±20	285 315
M20×2	17	360±20	315 350
M22×1.5	17	745±40	350 390
M27×1.5	19	1 460±80	390 —
M27×1.5	19	1 460±80	435 —

Fixed type (with double flange)

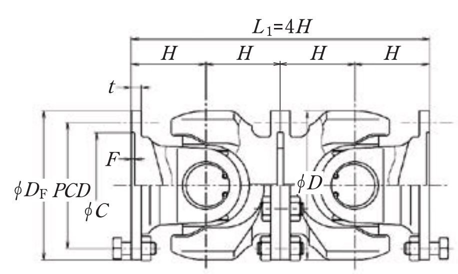


Fig. 1

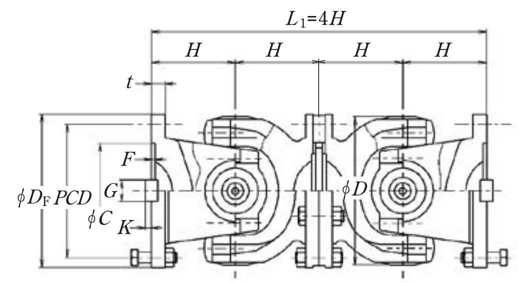


Fig. 2

For the flange dimensions (PCD, C, F, G, K and t) that suit the individual flange outside diameter (D_F) and for the flange bolt hole details, refer to KF/EZ series flange coupling with cylindrical bore on page 27.

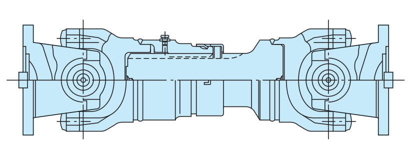
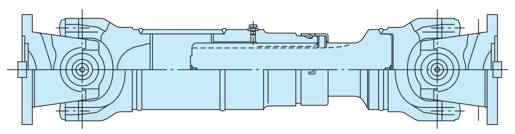
■ Features

The KF/EZ Series products have the following features depending on the swing diameter.

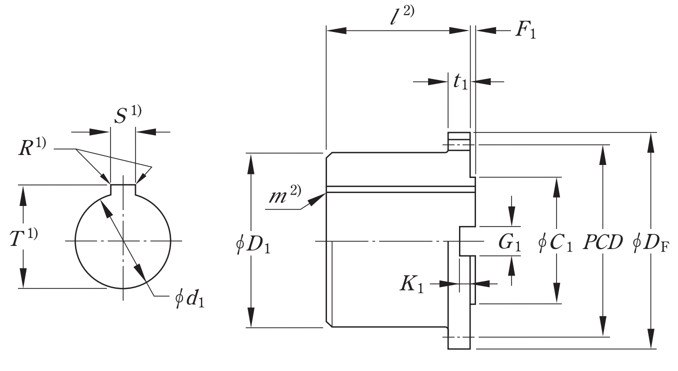
- Swing diameter: 180 mm or less
  The products are suitable for applications where the maximum operating angle is between 18° to 30°. They are suited to light load applications.These products are compatible with a wide variety of equipment. In addition they are economical, with the yokes being integrated.
- Swing diameter: 225 to 435 mm
  The products are suitable for applications where the maximum operating angle is no more than 15°. They are suited to medium load applications.
  Their yokes can be disassembled, so that their cross bearings can be replaced easily.

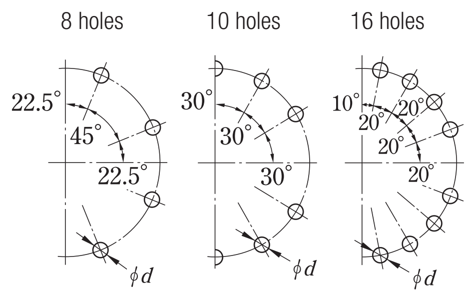
■ Designs available to order

When installation space is limited or when a stroke needs to be long, this series can be designed to order. Assembling components are shown below.
For more details on these designs, consult JTEKT.

Telescoping type without propeller tube	
Long telescoping type	

KF/EZ series flange coupling with cylindrical bore





(Arrangement of bolt holes on the flange)

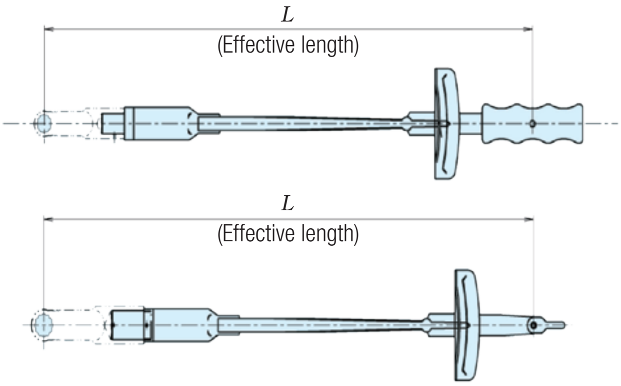
Flange outside dia. D_F (mm)	Boundary dimensions [3] (mm)							Flange bolt holes			Flange set bolts	
	D_1 (max.)	d_1 [4] (max.)	C / C_1	F / F_1	G(e9) / G_1(JS9)	K / K_1	t / t_1	PCD (mm) ±0.1	Dia. d (mm)	Number	Nominal thread size	Tightening torque (N・m)
120	84	52	75 H7/h7	2.5 / 2	—	—	8	101.5	10 (C12)	8	M10×1.25	64± 5
150	110.5	69	90 H7/h7	2.5 / 2	—	—	10	130	12 (C12)	8	M12×1.25	105± 5
180	133	83	110 H7/h7	2.5 / 2	—	—	12	155.5	14 (C12)	8	M14×1.5	175± 10
200	150	94	140 H7/f8	5 / 4.5	32	9	18	172	15 (drilled)	8	M14×1.5	175± 10
225	172	107	140 H7/f8	5 / 4.5	32	9	20	196	17 (drilled)	8	M16×1.5	265± 20
250	191	119	140 H7/f8	6 / 5	40	12.5	25	218	19 (drilled)	8	M18×2.0	360± 20
285	215	134	175 H7/f8	7 / 6	40	15	27	245	21 (drilled)	8	M20×2.0	500± 30
315	248	155	175 H7/f8	8 / 7	40	15	32	280	23 (drilled)	10	M22×2.0	675± 40
350	278	173	220 H7/f8	8 / 7	50	16	35	310	23 (drilled)	10	M22×2.0	675± 40
390	309	193	250 H7/f8	8 / 7	70	18	40	345	25 (drilled)	10	M24×2.0	900± 50
435	344	215	250 H7/f8	10 / 9	80	20	42	385	28 (drilled)	16	M27×2.0	1 320± 70
480	379	235	250 H7/f8	12 / 11	90	22.5	47	425	31 (drilled)	16	M30×2.0	1 810±100
550	446	278	295 H7/f8	12 / 11	100	22.5	50	492	31 (drilled)	16	M30×2.0	1 810±100

[Notes]
1) The keyway dimensions (S, T and R) shall be determined in conformity with JIS B 1301.
2) The dimensions l and m are determined according to customer specifications. (When not specified, l is recommended to be d_1 multiplied by between 1.2 and 1.5 and m to be d_1 multiplied by about 0.02.)
3) The upper line value in each cell is a dimension for the drive shaft end and the lower line value is a dimension for the cylindrical bore flange coupling end.
4) The d_1 max. dimensions are approximately D_1 divided by 1.6.

Torque wrench set for bolt tightening

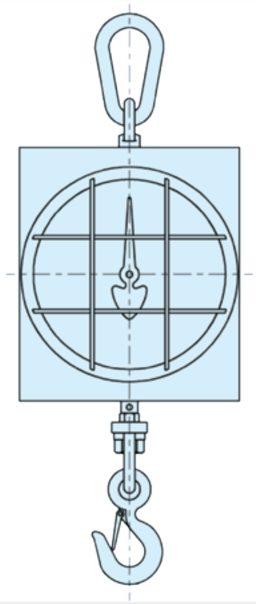
JTEKT provides torque wrench sets suitable for bolt tightening of the drive shaft.
The following are torque wrenches and related tools and their specifications. For details, contact JTEKT.

Torque wrench



No.	L (mm)	Scale range (same on the right and left) (N·m)	Minimum scale (N·m)
TW4200	750	70～420	10
TW8500	1310	100～850	20
TW28000	1240	300～2800	50
TW42000	1400	400～4200	100

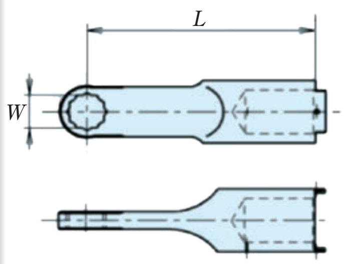
Tensiometer



No.	Weighing (kN)
TM500	5
TM1000	10
TM2000	20
TM3000	30

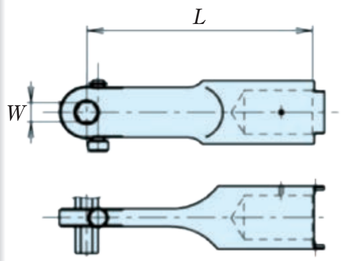
Sockets

(1) Ring head



No.	L (mm)	Width across flat W (mm)
HR17X4200	100	17
HR19X4200	100	19
HR22X4200	100	22
HR24X8500	160	24
HR27X8500	160	27
HR30X8500	160	30
HR32X8500	160	32
HR36X8500	160	36
HR41X8500	160	41

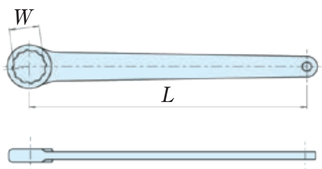
(2) Hexagonal bar head



No.	L (mm)	Width across flat W (mm)
HH12X8500	160	12
HH14X8500	160	14
HH17X8500	160	17
HH19X8500	160	19

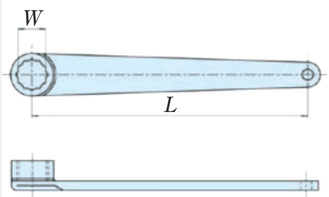
Wrenches

(1) Ring wrench



No.	L (mm)	Width across flat W (mm)
WR32X500	500	32
WR36X500	500	36
WR41X500	500	41
WR46X500	500	46
WR50X500	500	50
WR50X500A	500	50
WR55X500	500	55
WR55X500A	500	55
WR60X500	500	60
WR60X800A	800	60
WR65X800	800	65
WR70X800	800	70
WR75X800	800	75
WR80X800	800	80
WR85X800	800	85
WR90X800	800	90
WR95X1000	1000	95

(2) Socket wrench



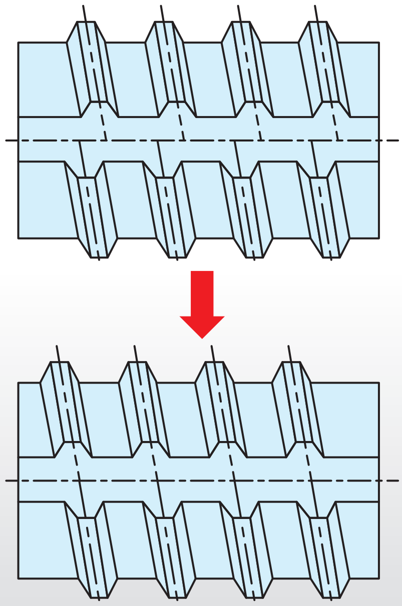
No.	L (mm)	Width across flat W (mm)
WB36X500	500	36
WB41X500	500	41
WB46X500	500	46
WB50X500	500	50
WB55X500	500	55
WB60X800	800	60
WB65X800	800	65
WB70X800	800	70
WB75X800	800	75

Product introduction

Drive shaft with roll phase adjustment device for bar and rod mill

Applications

Used to adjust the rotation direction phase of the upper and lower rolling mill rolls arbitrarily when forming a continuous thread shape in manufacturing of bar and rod steel for building material (screw reinforcing bar) in bar and rod mills.



Reasons for increase of needs of screw reinforcing bar

(1) To simplify operations, the connection method of bar steel was increasingly changed from previous “welding method” to “screw connection method.”

(2) By forming continuous convex in the periphery of bar steel, adhesion with concrete is increased.

Necessity of phase adjustment of rotation direction of rolls

For roll forming of continuous convex screw thread on the surface of bar steel, the rotation direction phase of the upper and lower rolls with concavity spiral groove formed should be adjusted to an arbitrary position.

Features

(1) The rotation phase can be adjusted almost steplessly, which improves the accuracy of products.

(2) The phase can be adjusted in a short time, which improves the efficiency of the work.

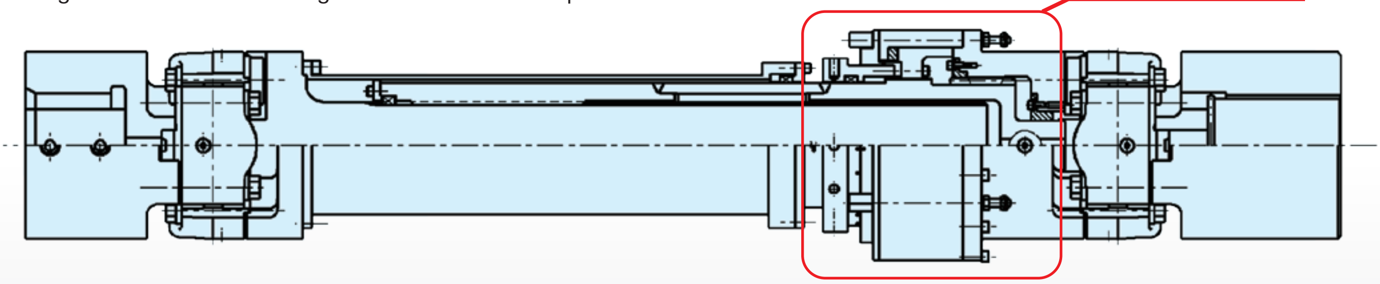
(3) With its unique configuration, the space can be saved in the directions of diameter and shaft.

(4) The lineup of equipment has been enriched to suit most of the bar steel sizes.

(5) On-line work can be conducted without removing the drive shaft.

Installation examples

The phase adjustment device can be attached to both horizontal stand and vertical stand.
The figures below and on the right are installation examples.



For vertical stand

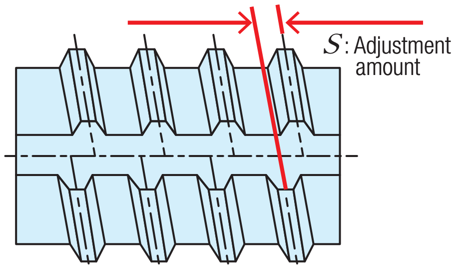
Work procedure

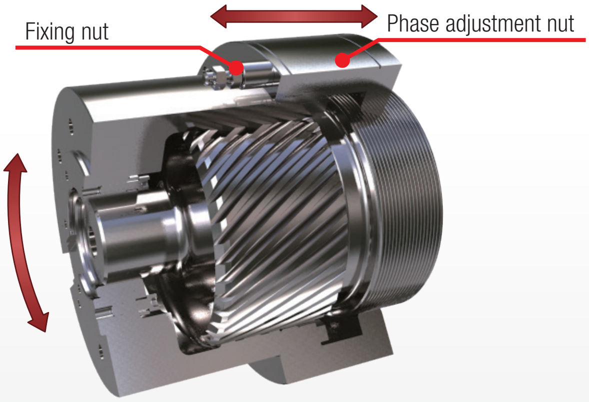
(1) Phase adjustment work should be conducted with the rolls of the rolling mill inserted to the drive shaft. First, measure the adjustment amount.
(2) Decide the number of adjustment scales from the following equation.

$$N = \frac{18 \cdot P \cdot S}{D \cdot L \cdot \tan\theta}$$

N : Number of adjustment scales
P : Helical spline PCD*
S : Adjustment amount (mm) (Measure the dimension in the figure on the right)
D : Roll diameter (mm) (customer dimension)
L : Adjustment nut pitch*
θ : Helical spline helix angle*
For items with *, contact JTEKT.

(3) Loosen the fixing nuts in three positions so that the adjustment nut should be able to rotate.
(4) Proceed with adjustment by rotating the phase adjustment nut. When the adjustment nut is rotated, the helical spline slides. With sliding of the helical spline, the rolls rotate slightly. Adjust them to an arbitrary phase.
(5) When the work is complete, tighten the fixing nuts for whirl-stop so that the adjustment unit should not move. It is fixed to this phase.

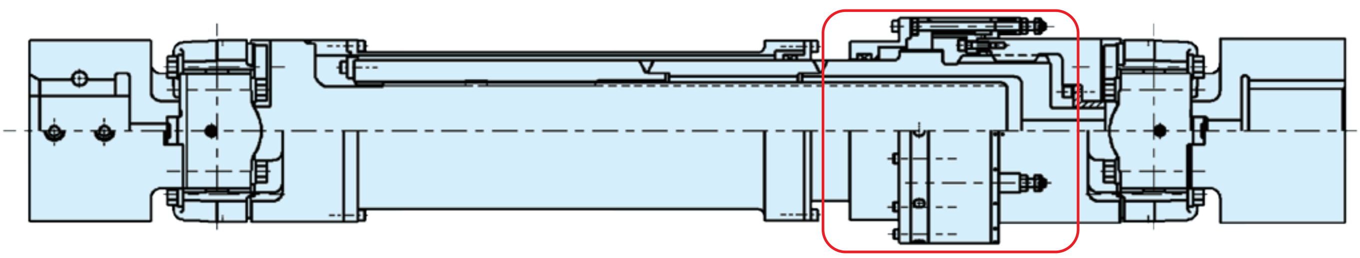




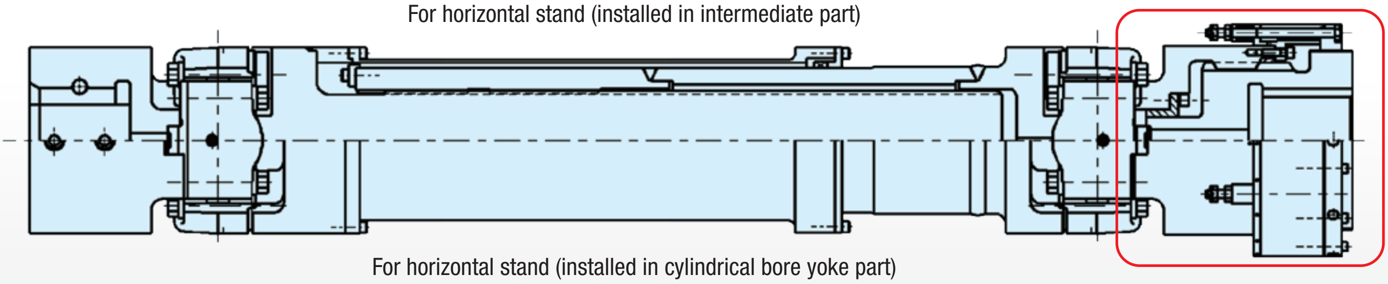
For design of phase adjustment device

Provide JTEKT with the following information for design of the optimal phase adjustment device.
Provide them along with the selection sheet of the drive shaft.

- Stand status (horizontal stand or vertical stand)
- Roll rotation direction (seen from the pinion stand)
- Roll diameter (disposal diameter)
- Pinion PCD
- Pitch in the case of screw reinforcing bar and intercalary dimension in the case of bar steel with different diameters



For horizontal stand (installed in intermediate part)



For horizontal stand (installed in cylindrical bore yoke part)

Product introduction

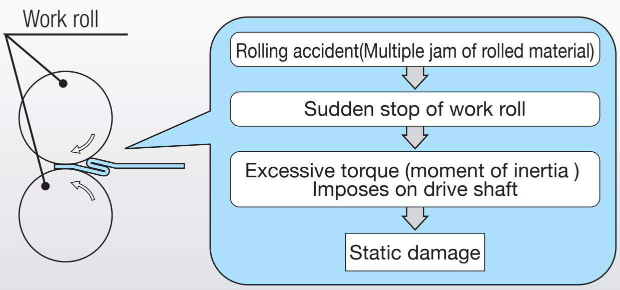
Hyper coupling (1)

Applications

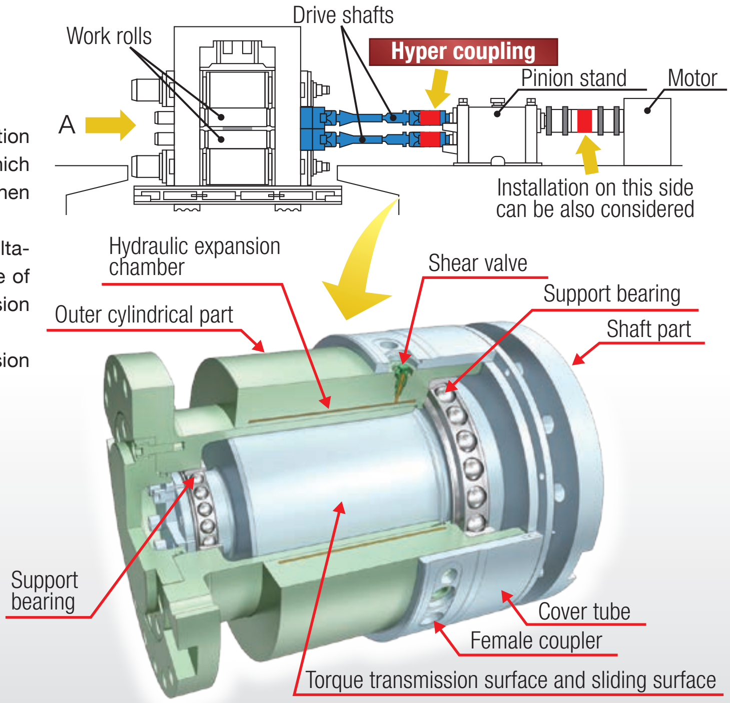
Used to protect peripheral devices of rolling mills against excessive torque.

Structure and working principle

The hydraulic expansion type torque limiter transmits torque by the friction between the shaft components and the welded coupling assemble, which is generated by the bore shrinkage of the welded coupling assemble when oil is filled and pressurized in the hydraulic expansion chamber.
The torque can be set in proportion to hydraulic pressure, which is simultaneously released by the decompression of oil, thanks to the breakage of the shear valve coming concurrently with slipping of torque transmission surface, if the excessive torque beyond set value is generated.
The following illustration shows an example of the hydraulic expansion type torque limiter applied to a rolling mill.



View A (Example of abnormal rolling)



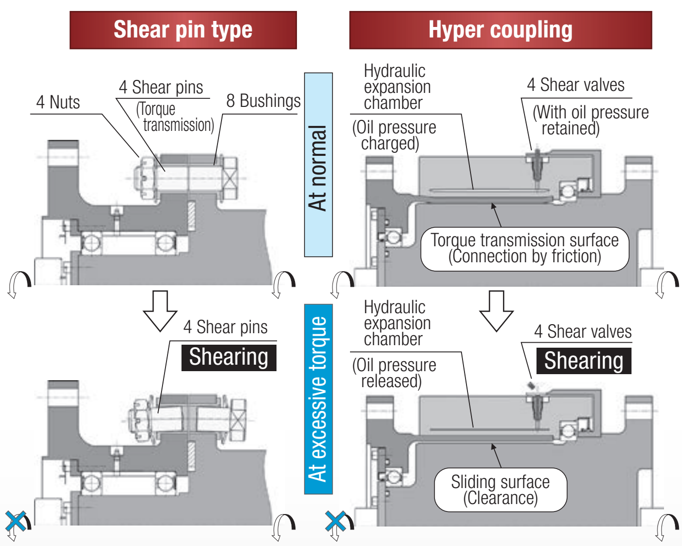
Installation position and structure of hyper coupling

Comparison of Conventional Product

The shear pin type torque limiter has been used as the implement to release torque, however, the maintenance of surrounding parts of the shear pin is required in case the shear pin is broken, which leads to a lot of time consuming for replacement. Furthermore, the pin needs to be periodically replaced in the overhaul in order to prevent the accumulated metal fatigue of the pin. Compared with the share pin type torque limiter, the hydraulic expansion type torque limiter requires only share valve replacement for repair. Since it is not required to replace the shear valves during periodical inspection, it will improve the overhaul time.

		Shear pin type	Hyper coupling
At the time of recovery	Replacement part	◆Shear pin : 4 pieces ◆Nut : 4 pieces ◆Bushe : 8 pieces	◆Shear valves : 4 pieces
	Ratio of required man-hours for part replacement	1	1/4
At the regular inspection time		Periodic replacement of shear pins is required due to accumulated fatigue	Periodic replacement of shear valves is not required

Merits of hyper coupling

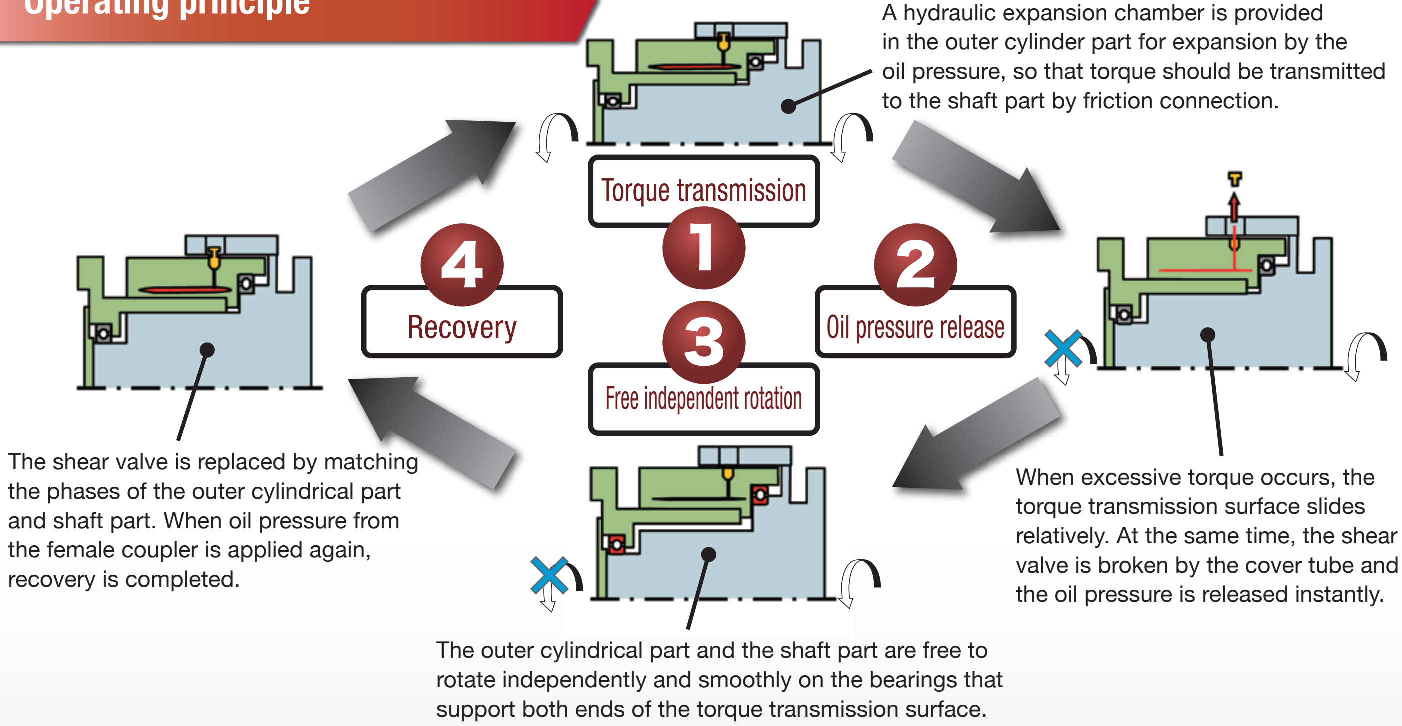


Features

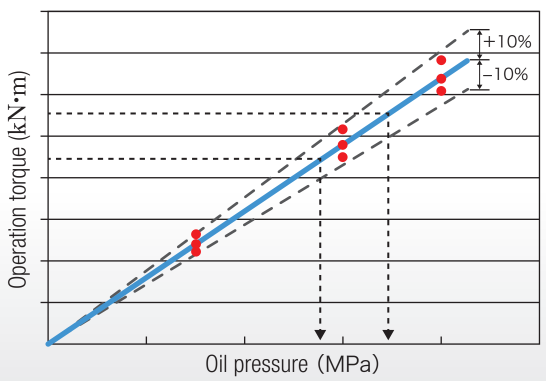
(1) The recovery time after operation (oil pressure release) is significantly shortened.
(2) High operation accuracy.
- The operation torque accuracy is high. The variation of the operation torque is within ±10 %.
- The operation torque is validated by using a large-sized torsion testing machine to improve reliability.

(3) The operation torque can be easily set.
(4) High durability performance.
- A high degree of free independen rotation performance after the release of the oil pressure is secured by utilizing our know-how as a bearing manufacturer.
- Special surface treatment is applied to the operating surface to improve durability.
- The oil pressure release-performance is improved by establishing an analysis method of the oil pressure release time.

Operating principle



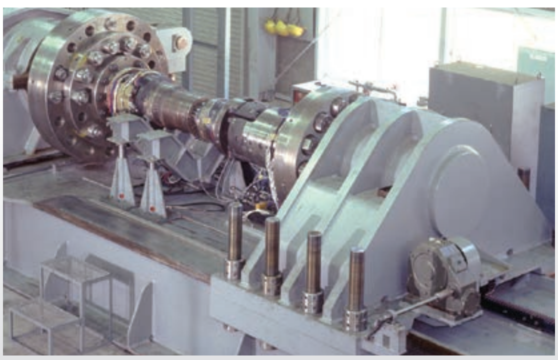
Operation torque



Oil pressure-operation torque diagram (image)

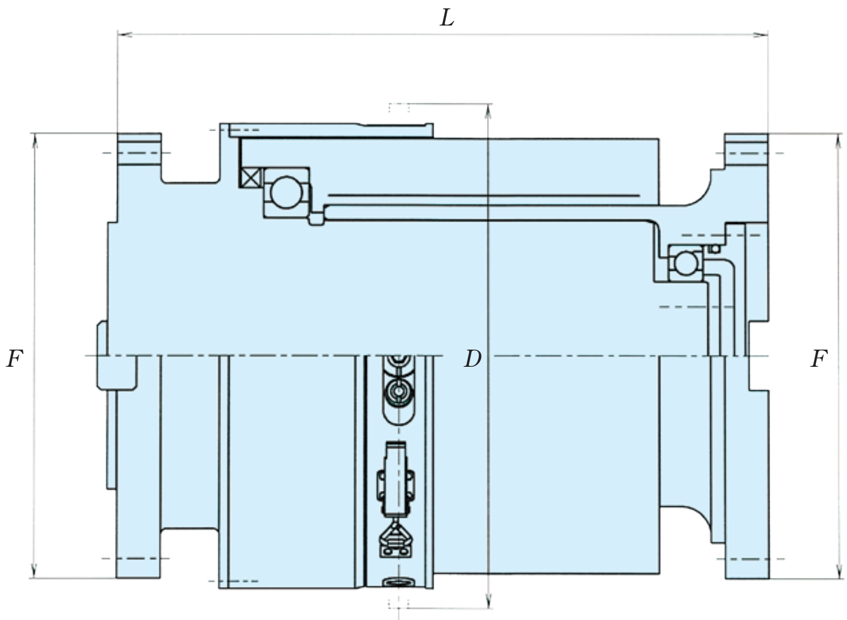
The setting of operation torque can be changed easily by adjusting the oil pressure value.

Before shipping, a large-sized torsion testing machine is used with the actual machine to calculate the relationship between each oil pressure and operation torque.
We set the oil pressure value for the requested operation torque.
The accuracy of the operation torque with each oil pressure value is high: within ±10 %.



Large-sized torsion testing machine

Dimension tables

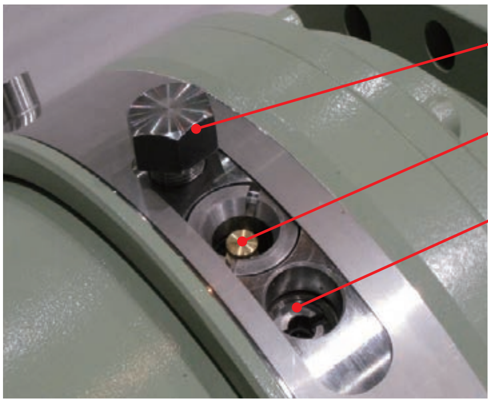


Highper coupling No.	Operation torque (kN·m)	Full length L (mm)	Outside diameter D (mm)	Flange outside dia. F (mm)	Corresponding model No.	
					D series	U series
TL070	80～150	550	420	330	D34052	–
TL088	160～280	650	510	430	D44070	–
TL104	200～510	750	590	525	D50085	U49084
TL120	400～800	850	670	610	D56100	U53088
TL134	600～110	950	740	675	D58110	U5G105
TL148	800～1300	1000	810	735	D60120	U57108
TL160	1000～1800	1100	870	800	D62130	U59118
TL176	1400～2300	1200	950	860	D64140	U6S132
TL188	2100～2900	1300	1010	920	D66150	U6D138
TL204	2500～3600	1400	1090	980	D68160	U67152
TL218	3200～4300	1500	1160	1050	D71170	U69168

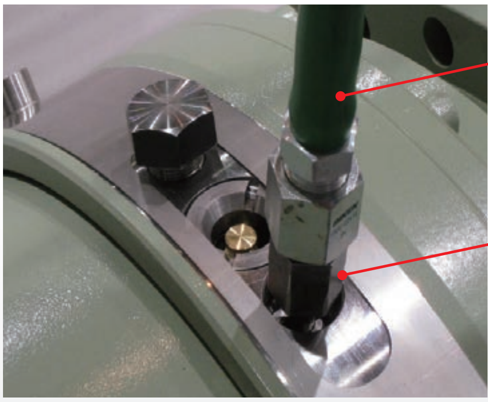
Recovery method after operation

(1) After the drive system (drive shaft) is stopped completely, clean its surroundings.

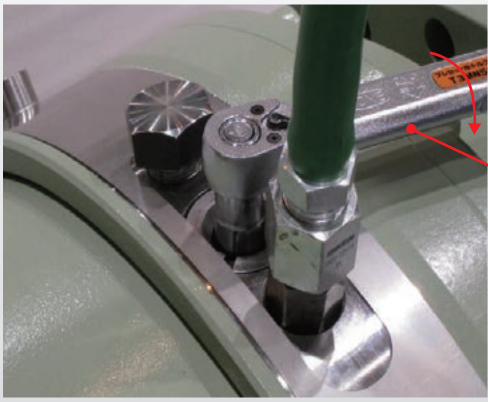
(2) Match the phases of the outer cylinder part and shaft part and fix the cover tube and the outer cylinder part by using the phase fixing pin.
Remove the shear valve that has been cut off and replace with a new shear valve after cleaning.
(figure on the upper right)



(3) Insert the connection hose of the hydraulic pump with a male coupler to the female coupler and fill the hydraulic expansion chamber with oil and pressurize to the set pressure. (figure on the middle right)



(4) The oil pressure is retained by tightening the shear valve with specified torque. (figure on the lower right)



(5) Check for oil leakage of the shear valve.

(6) After removing the residual pressure of the hydraulic pump, remove the connection hose. The recovery is completed.

For details, refer to the operation manual attached to the product to conduct work.

Examples of main tools (attached)

(1) Hydraulic pump
Used to fill the hydraulic expansion chamber with oil and pressurize.

(2) Torque wrench
Used to attach and remove the shear valve assembly, coupler assembly, and phase fixing pin.

(3) Phase fixing pin
Used for whirl-stop at the time of recovery of the hyper coupling.

(4) Male coupler
Attached to the end of the hose attached to the hydraulic pump.
It is inserted to the female coupler of the hyper coupling to pressurize and depressurize the hydraulic expansion chamber.

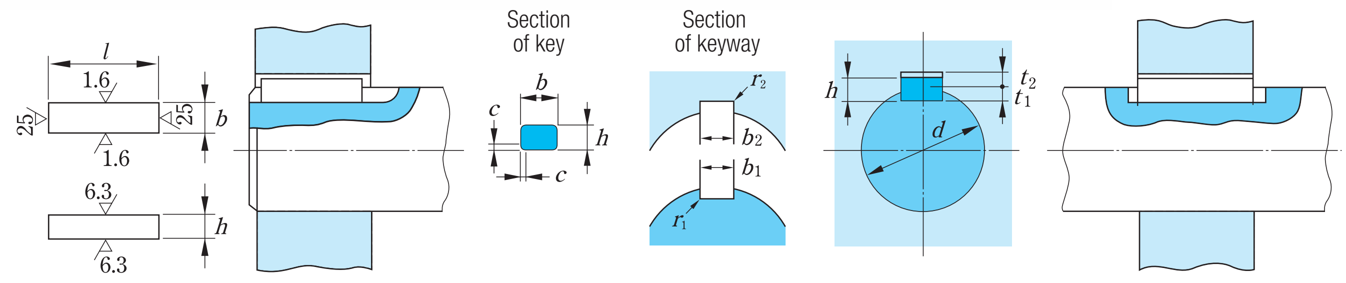
Recommended tightening torque for flange bolts

	Designation	Pitch (mm)	Width across flats (mm)	Tightening torque (N・m)	Tightening force (N)
Coarse screw thread	M 6	1	10	12±1	11 500
	M 8	1.25	13	29±2	21 100
	M10	1.5	17	59±5	33 500
	M12	1.75	19	98±5	47 400
	M14	2	22	155±10	65 400
	M16	2	24	245±20	91 800
	M18	2.5	27	345±20	114 000
	M20	2.5	30	480±30	144 000
	M22	2.5	32	645±40	179 000
	M24	3	36	825±50	207 000
	M27	3	41	1 230±70	276 000
	M30	3.5	46	1 670±100	334 000
	M33	3.5	50	2 260±150	417 000
	M36	4	55	2 840±150	479 000
	M39	4	60	3 730±200	582 000
	M42	4.5	65	4 610±300	665 000
	M45	4.5	70	5 790±300	783 000
	M48	5	75	6 960±400	876 000
	M52	5	80	9 020±500	1 060 000
	M56	5.5	85	11 300±600	1 240 000
	M60	5.5	90	13 700±700	1 410 000
	M64	6	95	16 700±900	1 610 000
	M68	6	100	20 100±1000	1 840 000

	Designation	Pitch (mm)	Width across flats (mm)	Tightening torque (N・m)	Tightening force (N)
Fine screw thread	M 6	0.75	10	14±1	12 900
	M 8	1	13	31±2	23 000
	M10	1.25	17	64±5	37 200
	M12	1.25	19	105±5	54 400
	M12	1.5	19	105±5	52 800
	M14	1.5	22	175±10	75 400
	M16	1.5	24	265±20	102 000
	M18	2	27	360±20	123 000
	M20	2	30	500±30	153 000
	M22	2	32	675±40	191 000
	M24	2	36	900±50	233 000
	M27	2	41	1 320±70	305 000
	M30	2	46	1 810±100	378 000
	M33	2	50	2 450±150	468 000
	M36	3	55	3 040±150	523 000
	M39	3	60	3 920±200	624 000
	M42	3	65	5 000±300	740 000
	M45	3	70	6 180±300	855 000
	M48	3	75	7 550±400	979 000
	M52	3	80	9 610±500	1 160 000
	M56	3	85	12 300±700	1 380 000
	M60	3	90	14 700±800	1 560 000
	M64	3	95	18 100±1000	1 810 000
	M68	3	100	21 600±1000	2 040 000

[Remarks] 1) The recommended values are applicable to the following bolts.
Hexagon head bolts of JIS strength class 10.9 (bolt holes is JIS class 1)
Non treated (including blackening), grease lubrication (μ = 0.125 to 0.14)
2) The values are also applicable to class 2 bolt holes and reamer bolt holes as well as hexagon socket head cap screws as far as the designation and pitch are identical.

Shape and dimensions of parallel key and keyway (JIS B 1301)



unit : mm

Nominal size of key $b \times h$	Dimension of key: b Basic dimension	Dimension of key: b Tolerance (h9)	Dimension of key: h Basic dimension	Dimension of key: h Tolerance		Dimension of key: c	Dimension of key: l [1)]	Dimension of keyway: Basic dimension of b_1 and b_2	Close grade: b_1 and b_2 Tolerance (P9)	Normal grade: b_1 Tolerance (N9)	Normal grade: b_2 Tolerance (JS9)	r_1 and r_2	Basic dimension of t_1	Basic dimension of t_2	Tolerance of t_1 and t_2	Informative note: Applicable shaft dia. d [2)]
2× 2	2	0 −0.025	2	0 −0.025	h9	0.16 ~0.25	6~ 20	2	−0.006 −0.031	−0.004 −0.029	±0.0125	0.08 ~0.16	1.2	1.0	+0.1 0	6~ 8
3× 3	3		3				6~ 36	3					1.8	1.4		8~ 10
4× 4	4	0 −0.030	4	0 −0.030			8~ 45	4	−0.012 −0.042	0 −0.030	±0.0150		2.5	1.8		10~ 12
5× 5	5		5			0.25 ~0.40	10~ 56	5				0.16 ~0.25	3.0	2.3		12~ 17
6× 6	6		6				14~ 70	6					3.5	2.8		17~ 22
(7× 7)	7	0 −0.036	7	0 −0.036			16~ 80	7	−0.015 −0.051	0 −0.036	±0.0180		4.0	3.0	+0.2 0	20~ 25
8× 7	8		7	0 −0.090	h11		18~ 90	8					4.0	3.3		22~ 30
10× 8	10	0 −0.043	8			0.40 ~0.60	22~110	10	−0.018 −0.061	0 −0.043	±0.0215	0.25 ~0.40	5.0	3.3		30~ 38
12× 8	12		8				28~140	12					5.0	3.3		38~ 44
14× 9	14		9				36~160	14					5.5	3.8		44~ 50
(15×10)	15		10				40~180	15					5.0	5.0		50~ 55
16×10	16		10				45~180	16					6.0	4.3		50~ 58
18×11	18		11	0 −0.110			50~200	18					7.0	4.4		58~ 65
20×12	20	0 −0.052	12			0.60 ~0.80	56~220	20	−0.022 −0.074	0 −0.052	±0.0260	0.40 ~0.60	7.5	4.9		65~ 75
22×14	22		14				63~250	22					9.0	5.4		75~ 85
(24×16)	24		16				70~280	24					8.0	8.0		80~ 90
25×14	25		14				70~280	25					9.0	5.4		85~ 95
28×16	28		16				80~320	28					10.0	6.4		95~110
32×18	32	0 −0.062	18				99~360	32	−0.026 −0.088	0 −0.062	±0.0310		11.0	7.4		110~130
(35×22)	35		22	0 −0.130		1.00 ~1.20	100~400	35				0.70 ~1.00	11.0	11.0	+0.3 0	125~140
36×20	36		20				—	36					12.0	8.4		130~150
(38×24)	38		24				—	38					12.0	12.0		140~160
40×22	40		22				—	40					13.0	9.4		150~170
(42×26)	42		26				—	42					13.0	13.0		160~180
45×25	45		25				—	45					15.0	10.4		170~200
50×28	50		28				—	50					17.0	11.4		200~230
56×32	56	0 −0.074	32	0 −0.160		1.60 ~2.00	—	56	−0.032 −0.106	0 −0.074	±0.0370	1.20 ~1.60	20.0	12.4		230~260
63×32	63		32				—	63					20.0	12.4		260~290
70×36	70		36				—	70					22.0	14.4		290~330
80×40	80		40			2.50 ~3.00	—	80				2.00 ~2.50	25.0	15.4		330~380
90×45	90	0 −0.087	45				—	90	−0.037 −0.124	0 −0.087	±0.0435		28.0	17.4		380~440
100×50	100		50				—	100					31.0	19.5		440~500

[Notes] 1) Dimension l shall be selected among the following within the range given in Table.
The dimensional tolerance on l shall be generally h12 in JIS B0401.
6 , 8 , 10 , 12 , 14 , 16 , 18 , 20 , 22 , 25 , 28 , 32 , 36 , 40 , 45 , 50 , 56 , 63 , 70 , 80 , 90 , 100 , 110 , 125 , 140 , 160 , 180 , 200 , 220 , 250 , 280 , 320 , 360 , 400

2) The applicable shaft diameter is appropriate to the torque corresponding to the strength of the key.

[Remark] The nominal sizes given in parentheses should be avoided from use, as possible.

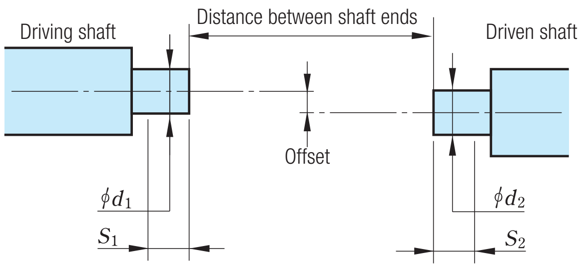
[Reference] Where the key of the smaller tolerance than that specified in this standard is needed, the tolerance on width b of the key shall be h7. In this case, the tolerance on height h shall be h7 for the key 7× 7 or less in nominal size and h11 for the key of 8 × 7 or more.

Drive shaft selection sheet

Item	Necessity	Description	Remarks
Name of the machine			
Location of installation			
(1) Rated motor output (kW)	○		
(2) Motor speed (min^{-1})	○	Min. Max.	
(3) Reduction ratio	○		
Drive shaft			
(4) Number of drive shafts per motor	○		
(5) Torque transmission (kN·m)	○	Normal Normal max. Emergency max.	
(6) Rotational speed (min^{-1})	○	Min. Max.	Unnecessary if (2) and (3) are filled in
(7) Direction(s) of rotation (Circle one of the two listed on the right.)	○	Non reversing Reversing	
(8) Limit swing dia. (mm)	△		
(9) Required stroke (mm)	○		
(10) Pinion PCD (mm)	△		Enter when the shaft is used for reduction rolls as an example.
(11) Roll minimum dia. (mm)	△		
(12) Paint color	△		Black if not specified
(13) Ambient temperature (℃)	△		
(14) Special environmental conditions	△		Water, steam, etc.

(15) Installation dimensions (Must be filled out.)

○ : Must be filled in.
△ : Should be filled in as appropriate.



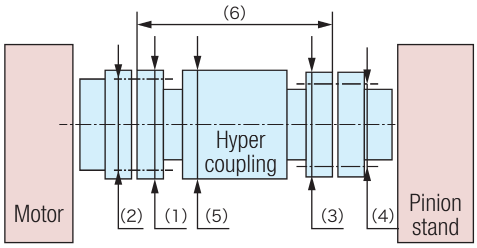
Distance between shaft ends (mm)		
Offset		
	Horizontal (mm)	
	Vertical (mm)	
Fit		
Driving shaft	ϕd_1 (mm)	
	S_1 (mm)	
Driven shaft	ϕd_2 (mm)	
	S_2 (mm)	

Hyper coupling selection sheet

Item	Necessity	Description			Remarks
Name of the machine					
Location of installation	○				
(1) Rated motor output (kW)	○				
(2) Motor speed	○				
(3) Reduction ratio	○				
Existing overload prevention device			Yes	No	
If "Yes"					
(4) Installation position (refer to (11))	○		A	B	
(5) Type		Shear pin	Hydraulic	Others	
Installation position (refer to (11))					
(6) (1) - (7) in the figure below	○				
Transmission torque (kN·m)					
(7) Normal	○				
(8) Max.	○				
(9) Emergency max.	○				
(10) Operation torque	○				
Rotational speed (min^{-1})	○				
Paint color					
Ambient temperature (℃)	△				
Special environmental conditions	△				

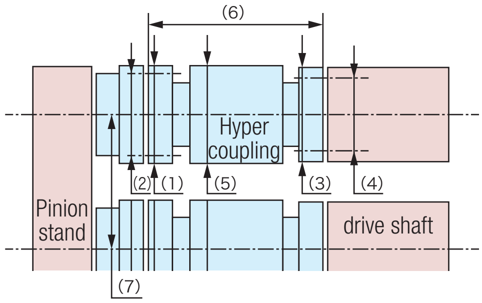
(11) Installation dimensions (Must be filled out.)

○ : Must be filled in.
△ : Should be filled in as appropriate.



A. When installed between the motor and the pinion stand

(1) Flange outside diameter	
(2) Mounting hole PCD x quantity	
(3) Flange outside diameter	
(4) Mounting hole PCD x quantity	
(5) Hyper coupling outside diameter	
(6) Full length	



B. When installed between the pinion stand and the drive shaft

(1) Flange outside diameter	
(2) Mounting hole PCD x quantity	
(3) Flange outside diameter	
(4) Mounting hole PCD x quantity	
(5) Hyper coupling outside diameter	
(6) Full length	
(7) Pinion PCD	

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JTEKT Koyo TOYODA

OFFICES

KOYO CANADA INC.
3800A Laird Road, Units 4 & 5 Mississauga, Ontario L5L 0B2, CANADA
TEL : 1-905-820-2090
FAX : 1-877-326-5696

JTEKT NORTH AMERICA CORPORATION
-Regional Headquarters-
7 Research Drive Greenville, SC 29607, U.S.A.
TEL : 1-864-770-2100
FAX : 1-864-770-2399
-Plymouth Office-
47771 Halyard Drive, Plymouth, MI 48170, U.S.A.
TEL : 1-734-454-1500
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TEL : 1-847-253-0340
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KOYO MEXICANA, S.A. DE C.V.
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FAX : 52-55-5207-3873

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TEL : 55-11-3372-7500

KOYO MIDDLE EAST FZCO
6EA 619, Dubai Airport Free Zone, P.O.Box 54816, Dubai, U.A.E.
TEL : 971-4-299-3600
FAX : 971-4-299-3700

KOYO BEARINGS INDIA PRIVATE LTD.
M3M Cosmopolitan, C-101-108 & 114-117 First Floor,
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172/1 Moo 12 Tambol Bangwua, Amphur Bangpakong,
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TEL : 66-38-533-310~7
FAX : 66-38-532-776

PT. JTEKT INDONESIA
Jl. Surya Madya Plot I-27b, Kawasan Industri Surya Cipta,
Kutanegara, Ciampel, Karawang Jawa Barat, 41363 INDONESIA
TEL : 62-267-8610-270
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KOYO SINGAPORE BEARING (PTE.) LTD.
24 Penjuru Road #06-01 CWT Commodity Hub,
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TEL : 65-6274-2200
FAX : 65-6862-1623

JTEKT KOREA CO., LTD.
-Seoul Head Office-
13F Seong-do Bldg, 207, Dosan-daero, Gangnam-gu, Seoul,
06026 KOREA
TEL : 82-2-549-7922
FAX : 82-2-549-7923

JTEKT (CHINA) CO., LTD.
-Head Office (Shanghai)-
Room A2,Floor 25, V-Capital Building, No.333 Xianxia Road,
Changning District, Shanghai, CHINA
TEL : 86-21-5178-1000
FAX : 86-21-5178-1008

KOYO AUSTRALIA PTY. LTD.
Unit1 /17 Stanton Road, Seven Hills, NSW, 2147, AUSTRALIA
TEL : 61-2-8719-5300
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Markerkant 13-01, 1314 AL Almere, THE NETHERLANDS
TEL : 31-36-5383333
FAX : 31-36-5347212
-Benelux Branch Office-
Energieweg 10a, 2964 LE, Groot-Ammers, THE NETHERLANDS
TEL : 31-184-606800
FAX : 31-184-606857

KOYO KULLAGER SCANDINAVIA A.B.
Kanalvägen 5 A, 194 61 Upplands Väsby, SWEDEN
TEL : 46-8-594-212-10
FAX : 46-8-594-212-29

KOYO (U.K.) LIMITED
Whitehall Avenue, Kingston, Milton Keynes MK10 0AX,
UNITED KINGDOM
TEL : 44-1908-289300
FAX : 44-1908-289333

KOYO DEUTSCHLAND GMBH
Bargkoppelweg 4, D-22145 Hamburg, GERMANY
TEL : 49-40-67-9090-0
FAX : 49-40-67-9203-0

KOYO FRANCE S.A.
1 rue François Jacob, 92500 Rueil-Malmaison, FRANCE
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FAX : 33-1-3998-4230

KOYO IBERICA, S.L.
Centro de Negocios Calle La Mancha no.1, oficina 1.2 28823
Coslada, Madrid, SPAIN
TEL : 34-91-329-0818
FAX : 34-91-747-1194

KOYO ITALIA S.R.L.
Via Stephenson 43/a 20157 Milano, ITALY
TEL : 39-02-2951-0844
FAX : 39-02-2951-0954
-Romanian Representative Office-
24, Lister Street, ap. 1, sector 5, Bucharest, ROMANIA
TEL : 40-21-410-4182
FAX : 40-21-410-1178

PUBLISHER

JTEKT CORPORATION NAGOYA HEAD OFFICE
No.7-1, Meieki 4-chome, Nakamura-ku, Nagoya, Aichi 450-8515, JAPAN —— TEL : 81-52-527-1900 FAX : 81-52-527-1911

JTEKT CORPORATION OSAKA HEAD OFFICE
No.5-8, Minamisemba 3-chome, Chuo-ku, Osaka 542-8502, JAPAN —— TEL : 81-6-6271-8451 FAX : 81-6-6245-3712

Sales & Marketing Headquarters
No.5-8, Minamisemba 3-chome, Chuo-ku, Osaka 542-8502, JAPAN —— TEL : 81-6-6245-6087 FAX : 81-6-6244-9007

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