AJAX Universal Joint

- *High Shock and Overload Capacity*
- *Long Life*
- *Heat Treated Alloy Steel Components*
- *Minimal Lubrication Required*
- *Virtually Backlash-Free*
- *Quick Delivery*

RENOLD

Superior Technology

www.renold.com

Table of Contents

The Renold Inc. Universal Joint

Renold Inc., a leader in power transmission equipment for over 90 years, offers a complete line of universal joints.

The universal joint is considered to be one of the oldest of all flexible couplings. It is commonly known for its use on automobiles and trucks. A universal joint in its simplest form consists of two shaft yokes at right angles to each other and a four point cross which connects the yokes. The cross rides inside the bearing cap assemblies, which are pressed into the yoke eyes.

Industrial applications operate continuously and with high torque loads. This demands maximum strength and long life of the universal joint components. The modern universal joint has become much more complex than its simple ancestor. The universal joints manufactured by Renold are made for demanding industrial applications.

Universal joints have several unique features that make them ideal for a variety of applications. Most significant is the ability of the universal joint to operate at high misalignment angles. Operating angles up to 15 degrees are not uncommon.

Another feature of the universal joint is the bearing and seal design that resists lubrication loss and contamination. This makes Renold Universal Joints suitable for applications where severe atmospheric conditions would put other couplings at a distinct disadvantage.

When compared to other high misalignment couplings, universal joints operate with negligible backlash or radial clearance. The difference can be significant on applications where backlash is critical.

Renold Universal Joint yokes are precisely engineered using the latest design technologies. They are manufactured as a one-piece, closed bearing eye design, assuring the highest degree of strength and minimum distortion under load.

The cross design is even more important and has received careful consideration through extensive computer analysis to match the strength characteristics of the yoke.

Yokes and crosses are both precision machined from heat treated alloy steels. They are assembled with minimum clearance bearing units using the lastest in roller bearing technology including crowned rollers that minimize friction and provide long life.

The universal joint can be used as a single joint or it can be used in pairs. When used as a single joint, only angular misalignment is accommodated. Since nearly every installation requires the coupling to also accommodate offset misalignment, universal joints should be used in pairs. Using universal joints in pairs also corrects for non-uniform angular velocity caused by the rotational characteristics of a single joint.

Advantages and Design: Typical Applications

Advantages and Features

- Domestic manufacture
- High torque capacity
- Long bearing life
- High operating angle capability
- One piece yoke and bearing housing construction
- Eliminates unnecessary bolted connections and serrations in yokes
- Heat treated alloy steel components
- Ideal loading across entire bearing length due to balanced deflection between yokes and cross
- Replaceable inner bearing race on size RA440 and larger significantly reducing cross-maintenance expenses
- Available in four basic types
- Technical support and engineering services available
- Extensive repair facility
- Special sizes and designs available upon request
- Large sizes available

Typical Applications

Following is a partial list of applications for the Renold Universal Joint.

Agitators
Balancing Machines
Blowers and Fans
Compressors
Conveyors
Cooling Tower Fans
Cranes and Hoists
Crushers
Farming Equipment
Generators
Glass Manufacturing
Lumber Mills
Marine Propulsion
Mining Equipment
Oil and Gas
– Drilling
– Pumps
Packaging
Paper Mills
– Calender Drives
– Sizing and Press Rolls
– Couch Rolls
– Process Pumps
Plastic Manufacturing
– Melt Pumps
Printing Presses
Pumps
– Irrigation
– Lift
– Sewage
Railway Drives
Rubber Processing
– Mixers
– Calenders
Shredders
Textile Equipment

Metals Industry

(Steel, Aluminum, Copper and Brass)

Bar and Rod Mills
Cold Reduction
Continuous Casters
Hot Strip Mills
Levelers
Payoff Reels
– Pinch Rolls
– Coilers
– Brush Rolls
– Bridles
– Flatteners
– Slitters
Pipe Mills
Runout Tables
– Piercers
– Transfer Cars
– Structural Mills
Scale Breakers
Shears
Side Trimmers
Straighteners
Temper Mills
Tension Reels
Tube Mills
Vertical Edgers
Wire Mills

Construction: Yoke Assembly and Bearing Design

Basic Designs
The Renold Universal Joint is available in seven basic bearing designs:

1000 Series

Yoke assembly parts furnished by domestic manufacturers.

Sizes RA1310-RA1550: Needle bearing design. Bearing caps are retained by snap rings.

Sizes RA1610-RA1880: Needle bearing design. Bearing caps are retained by bolts.

Sizes RA1990: Uses two rows of roller bearings. Bearing caps are retained by snap rings. Lube fitting in center of cross.

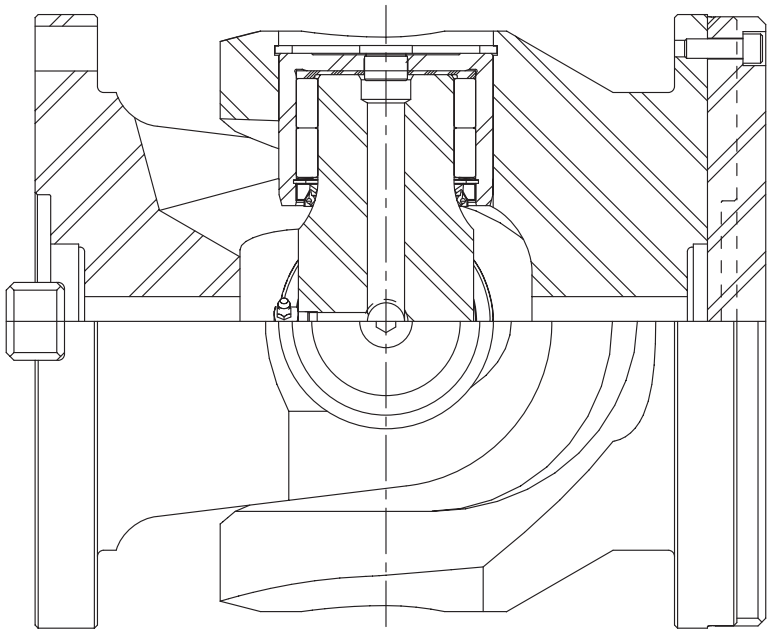
2000 Series

Sizes RA058-RA100: Needle bearing design. Lube fitting in center of cross.

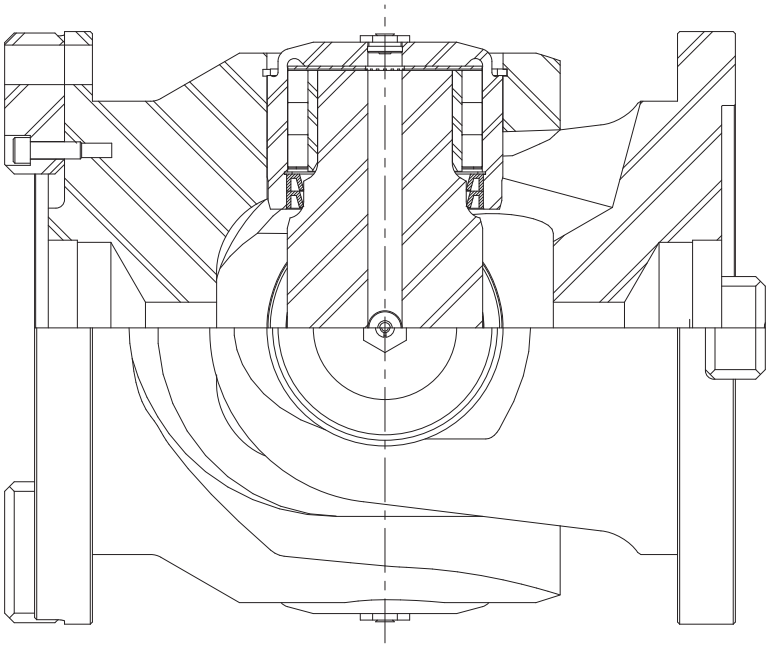
Sizes RA120-RA225: Uses two rows of roller bearings. Bearing caps are retained by snap rings. Lube fitting in center of cross.

Sizes RA250-RA435: Uses two rows of roller bearings Bearing caps are retained by snap rings. Lube fittings in center bearing cap is optional.

Sizes RA440-RA920: Uses three or more rows of roller bearings. Includes replaceable inner races in the bearing assemblies. Bearing caps are retained by large snap rings. Lube fittings are in each bearing cap.



RA250 - RA435



RA440 - RA920

Selection Information and Speed Limits

I. Speed Limit Based on Limits of Mass Acceleration

When universal joints are operated at any angle greater than zero, the center section of the universal joint always runs irregularly, being accelerated and decelerated twice in every revolution. The maximum values of mass acceleration torque arising here are dependent on the operating speed and angle of deviation ß and upon the moment of inertia of the center shaft section [RPM x A].

To ensure smooth running of the universal joint, the mass acceleration torque must not be allowed to exceed the limits shown in Table 1.

II. Speed Limit Based on Lateral Critical Speed

In applications where long lengths of shafts are required, the speed is restricted by the lateral critical speed of the center section. This speed is a function of the center tube diameter wall thickness, and the effective length. The maximum operating speed must be less than the lateral critical speed Nc shown in Table 2.

NOTE:
Allowable Operating Speed =
Nc x .75.

In many applications, operation at 1/2 critical speed will also create unacceptable vibration. For these applications the operating speed should be 8% above or below 50% of the maximum indicated.

For flange-to-flange lengths greater than shown, or if allowable speed is exceeded, contact Renold.

III. Balancing

All standard universal joints under 300 RPM are supplied unbalanced. Between 300-850 RPM they are balanced if required. Consult factory for further information. Over 850 RPM all universal joints are normally supplied balanced. Please consult the factory for special balancing requirements.

Table 1

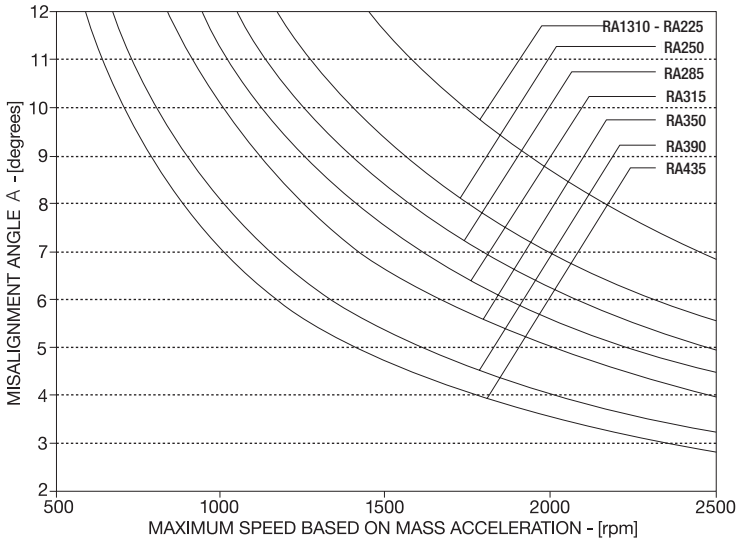
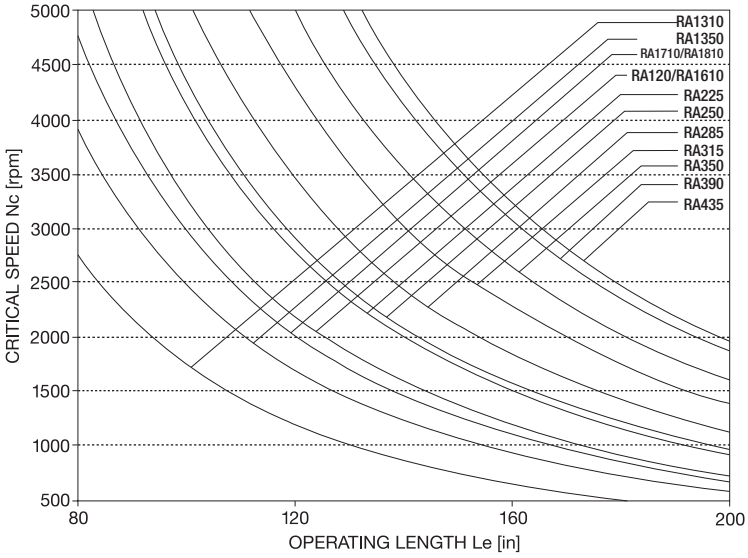


Table 2



The speed limits on this page are only a guide. The actual limits are determined by the characteristics of the system in which the universal joint is installed.

Selection Procedure

See pages 26-27 for Application Data sheets for easy selection.

Four types of torque ratings are given for each joint size.

Endurance torque (T_e) is the normal rating for fully reversing torque based on material strength.

One way endurance torque (T_{ow}) is the normal rating for pulsating one way torque based on material strength.

Life torque (T_L) is the bearing life rating of the universal joint. This torque is based on the B-10 life of the universal joint bearings. The life torque values listed are based on 5000 hours B-10 bearing life at 3° misalignment and 100 RPM. B-10 life is defined as the minimum life expectancy for a 90% probability of survival. Typically the average actual operating life of the bearings is 5X the calculated B-10 life.

Peak torque (T_p) is the maximum allowable torque based on the yield strength capacity of the joint.

The torque ratings are based on material strength. When approaching these limits the capacity of the desired flange connection should be verified. When the selection torque **(T_s)** approaches the endurance torque **(T_e)** or when the maximum torque approaches the peak torque capacity **(T_p)** of the universal joint, integral face pads are recommended. The number of pads and bolts are customized on a per application basis. Hirth radial teeth are also available on a per application basis.

Universal Joint Selection

I. Calculate application torque **(T_a)** and selection torque **(T_s)**.

$$T_a = \frac{HP \times 63025}{N} \quad (\text{lb. x in.})$$

$$T_a = \frac{KW \times 9550}{N} \quad (\text{Nm})$$

N = Speed (RPM)

T_s = Selection Torque = T_a x Service Factor (Table 3)

T_s must be less than T_e for reversing torque applications or T_{ow} for one way pulsating torque applications.

II. Check to see if life is sufficient.

$$Lh = \frac{1.5 \times 10^6}{A \times N}\left[\frac{T_L}{T_a}\right]^{\frac{10}{3}}$$

Where:
Lh = B-10 Life in Hours
A = Operating Angle in Degrees
N = Speed (RPM)
T_L = Life Torque
T_a = Application Torque

III. Duty Cycle: In applications where the torque, speed and operating angle vary predictably during a typical load cycle or operational sequence, a duty cycle can be determined. First the load cycle must be analyzed and divided into groups of fixed combinations of torque, speed and operating angle. These groups represent percentages of the total operating time of the load cycle. Life expectancy can then be calculated using Miner's Theory, which takes into account the cumulative effect resulting from operating at varying conditions.

The total life expectancy can be calculated using the following equation:

$$\text{Total Life Expectancy} = \frac{1}{\frac{N_1}{L_1} + \frac{N_2}{L_2} + \frac{N_3}{L_3} + \cdots + \frac{N_m}{L_m}}$$

Where:

N_1 = fraction of total, time at operating condition 1

L_1 = life expectancy at operating condition 1 (hours)

m = total number of operating conditions

IV. Determine Peak Torque conditions. T_p must exceed the maximum operating torque.

V. Other considerations:
There are many other items that can determine the size of a universal joint. These include:

1. Diameter and length limitations.
2. Bore size (see page 19).
3. Equipment restrictions on forces and moments.
4. Speed limits (see Tables 1 and 2)
   a. due to mass acceleration as a function of misalignment
   b. critical speed of center shaft

Telescopic splines are available on ST and FT designs. The splined axial travel sections are required to accommodate movement of the driven end such as a roll position change or axle jounce. SF and FF shaft are properly selected for applications where the roll end has relatively small movements of the driven side along with a clearance or slip fit roll end connection. The amount of required axial movement can be calculated by multiplying the centerline to centerline of the universal joint yokes by 1 minus the cosine of the operating angle for each position.

Nitrided or coated splines are available on request.

Longer or shorter travel is available. Consult Renold.

Axial travel of the telescopic spline on ST and FT designs under torque results in axial forces being applied to the support bearings. These forces are a function of the spline coefficient of friction, operating torque, operating angle, and spline pitch diameter per the following formula.

$$\textbf{F axial} = \frac{2T(\mu)(\cos A)}{PD}$$

F axial = Axial Force
T = Operating Torque
μ = Coefficient of Friction (.11 to .15 for lubricated steel on steel, contact Renold for other coatings)
A = Operating Angle (degrees)
PD = Spline Pitch Diameter

If you have unusual conditions, please supply details with your inquiry. See pages 26-27 for required Selection Data.

Example:
One way cold mill with a 1800 HP motor at 400 RPM and a 2:1 reducer ratio with a 50% torque split requires two universal joints to operate at the following conditions:

900 HP per universal joint

200 RPM

3° Misalignment

1.5 Service Factor

12.5" Maximum O.D.

8.25" Bores

53" Shaft Separation

250% Peak Torque Factor

It is important and necessary to understand the operational characteristics of universal joints before making a selection. See pages 22 and 23. If you have any questions about your application, please contact Renold.

Table 3: Service Factors

Load	Driven Equipment	Continuous Non-Reversing Drivers AC Motors Turbines	Reversing Drivers D.C. Motors Reciprocating Engines
Constant Torque	Generating Centrifugal Pumps Conveyors	1	1.50
Light Shock	Continuous Casters Light Fans Machine Tools Woodworking Machinery Paper Mill Equipment Bar & Rod Mills	1.25	2
Medium Shock	Compressors Pumps Fans Farming Equipment Cold Mills & Auxiliary Equipment Presses	1.50	2.25
Heavy Shock	Traction & Locomotive Drives Mixers Crane Drives Mining Equipment Rapid Transit Drives Hot Rolling Mill Drives Runout Tables Feed Roll Drives	2	3
Very Heavy Shock	Ore Crushers Scale Breakers Feed Roll Drives	3	5

Step 1: Calculate Application Torque

$$T_a = \frac{900 \text{ HP} \times 63{,}025}{200 \text{ RPM}} = 283{,}610 \text{ in.-lbs.}$$

T_s = 283,610 in.-lbs. x 1.5 = 425,420 in.-lbs.

Preliminary Selection: RA315
(Tow = 621,300 in.-lbs.)

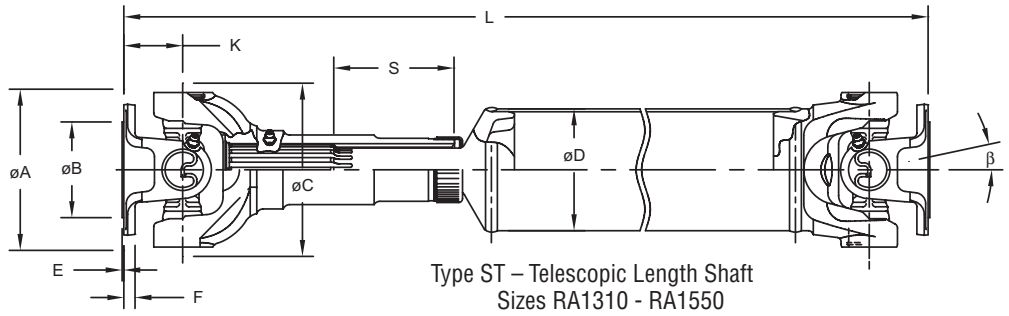
Step II. Check Life

$$Lh = \left(\frac{1.5 \times 10^6}{3 \times 200}\right)\left(\frac{364{,}400}{283{,}610}\right)^{\frac{10}{3}} = 5{,}765 \text{ hr. B-10 life}$$

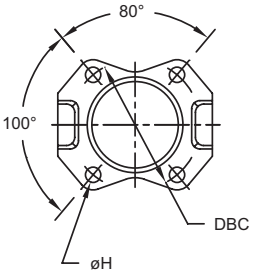
Step III. Duty Cycle - not applicable.
Step IV: Peak Torque
283,610 in.-lbs. x 2.5 = 709,025 in.-lbs.
Step V: Check diameter limits, bore size, and speed limits.
Selection: RA315 with 12.38" O.D. design 2 flange adaptors.

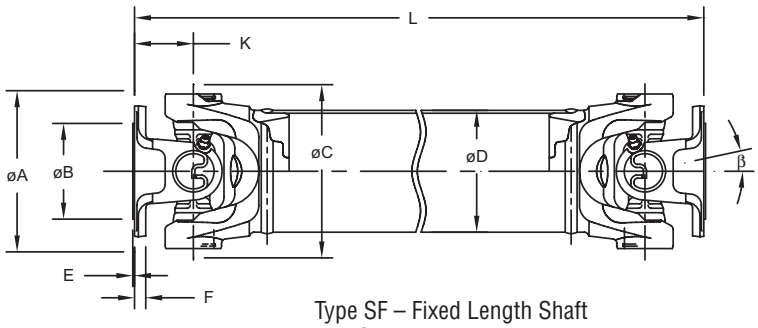
Engineering Data Series 1000

Sizes RA1310 – RA1550

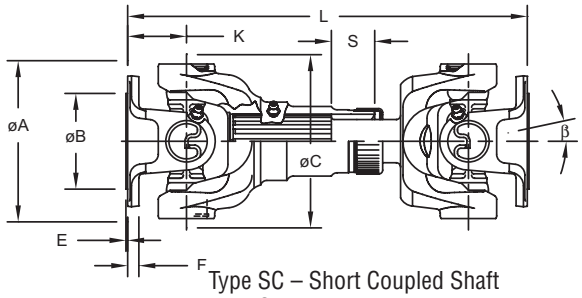


Type ST – Telescopic Length Shaft
Sizes RA1310 - RA1550





Type SF – Fixed Length Shaft
Sizes RA1310 - RA1550



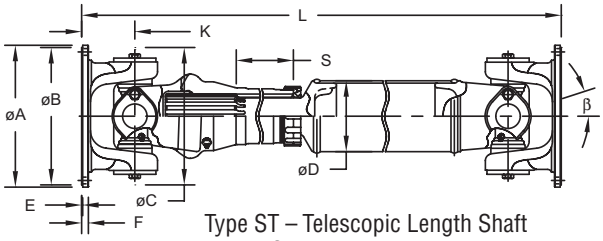
Type SC – Short Coupled Shaft
Sizes RA1310 - RA1550

Size	RA1310		RA1350		RA1410		RA1480		RA1550	
Torque Ratings										
	Lb.in.	Nm	Lb.in.	Nm	Lb.in.	Nm	Lb.in.	Nm	Lb.in.	Nm
T_e	9,419	1,064	13,275	1,500	13,275	1,500	15,171	1,714	19,596	2,214
T_{ow}	13,187	1,490	18,585	2,100	18,585	2,100	21,240	2,400	27,435	3,100
T_L	4,800	542	8,160	922	9,840	1,112	13,200	1,492	16,800	1,898
T_p	19,200	2,169	27,120	3,064	32,400	3,661	39,960	4,515	52,800	5,966
Dimensional Data (inches and millimeters except where noted)										
ß	20˚		20˚		20˚		22˚		22˚	
ß (SC)	15˚		8˚		8˚		8˚		5˚	
	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
A	3.88	98.6	4.62	117.3	4.62	117.3	5.88	149.4	5.88	149.4
B	2.38	60.5	2.75	69.9	2.75	69.9	3.75	95.3	3.75	95.3
C	3.75	95.3	4.25	108.0	4.69	119.1	4.81	122.2	5.63	143.0
D[1]	2.50	63.5	3	76.2	3.50	88.9	3.50	88.9	3.50	88.9
E	0.06	1.5	0.06	1.5	0.06	1.5	0.06	1.5	0.06	1.5
F	0.38	9.7	0.38	9.7	0.38	9.7	0.38	9.7	0.38	9.7
K	1.38	35.1	1.56	39.6	1.69	42.9	2	50.8	2	50.8
K (SC)	1.38	35.1	1.56	39.6	1.69	42.9	1.50	38.1	2	50.8
DBC	3.12	79.2	3.75	95.3	3.75	95.3	4.75	120.7	4.75	120.7
Bolt Qty.	4	4	4	4	4	4	4	4	4	4
H	0.38	9.7	0.44	11.2	0.44	11.2	0.50	12.7	0.50	12.7
Minimum Length L[2] / Length Compensation S										
ST L	13	330.2	14.88	378.0	14.13	358.9	15.25	387.4	15.38	390.7
S	3.06	77.7	3.62	91.9	3.47	88.1	2.50	63.5	2.50	63.5
SF L	7.67	194.8	8.59	218.2	9.03	229.4	10.03	254.8	10.80	274.3
SC L	8.88	225.6	9.50	241.3	9.50	241.3	8.50	215.9	9.75	247.7
S	1.25	31.8	0.75	19.1	0.75	19.1	1	25.4	1	25.4

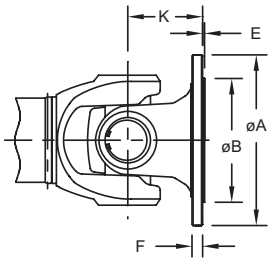
[1] Special tube diameters available upon request
[2] L is minimum for ST and SF design
Longer/shorter length compensation available upon request. Popular flange yoke configurations shown, special designs available upon request.

Engineering Data Series 1000

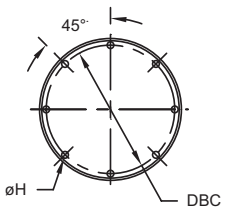
Sizes RA1610 – RA1910



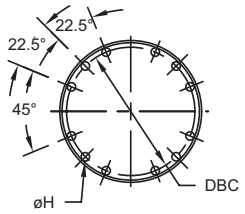
Type ST – Telescopic Length Shaft
Sizes RA1610 - RA1880



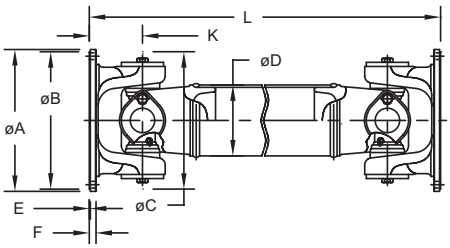
Size RA1910



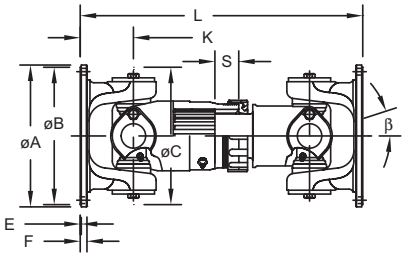
Sizes RA1610 - RA1710



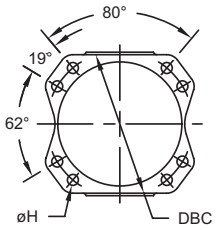
Size RA1810



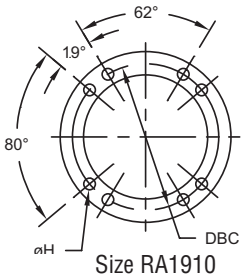
Type SF – Fixed Length Shaft
Sizes RA1610 - RA1880



Type SC – Short Coupled Shaft
Sizes RA1610 - RA1880



Size RA1880



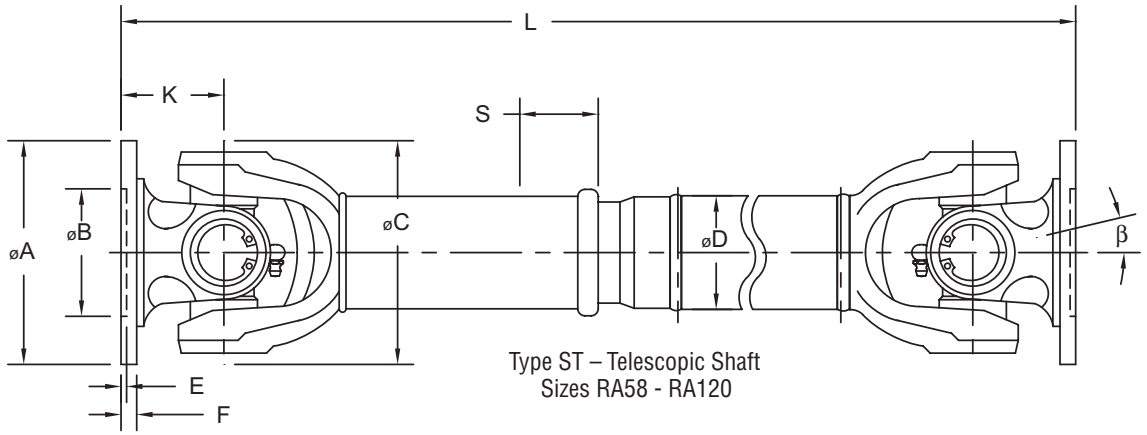
Size RA1910

Size	RA1610		RA1710		RA1810		RA1880		RA1910	
Torque Ratings										
	Lb.in.	Nm	Lb.in.	Nm	Lb.in.	Nm	Lb.in.	Nm	Lb.in.	Nm
T_e	29,521	3,336	39,193	4,429	49,939	5,643	88,816	10,036	100,005	11,300
T_{ow}	41,330	4,670	54,870	6,200	69,915	7,900	124,343	14,050	140,007	15,820
T_L	26,400	2,983	35,160	3,973	45,600	5,153	60,000	6,780	124,103	14,023
T_p	78,000	8,814	96,000	10,847	144,000	16,271	192,000	21,695	243,300	27,492
Dimensional Data (inches and millimeters except where noted)										
ß	26°		22°		30°		22°		25°	
ß (SC)	8°		8°		12°		8°		25°	
	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
A	6.88	174.8	8	203.2	8	203.2	9.63	244.6	9.63	244.6
B	6.62	168.1	7.75	196.9	7.75	196.9	7	177.8	7	177.8
C	7	177.8	7.75	196.9	9.13	231.9	8.63	219.2	8.03	204.0
D[1]	3.50	88.9	4	101.6	4.50	114.3	4.50	114.3	5.50	139.7
E	0.06	1.5	0.06	1.5	0.06	1.5	0.09	2.3	0.09	2.3
F	0.38	9.7	0.38	9.7	0.38	9.7	0.63	16.0	0.59	15.0
K	2.75	69.9	3	76.2	3.38	85.9	3.50	88.9	4.33	110.0
K (SC)	1.88	47.8	2	50.8	2.59	65.8	2.50	63.5	4.33	110.0
DBC	6.13	155.7	7.25	184.2	7.25	184.2	8.25	209.6	8.25	209.6
Bolt Qty.	8	8	8	8	12	12	8	8	8	8
H	0.38	9.7	0.38	9.7	0.44	11.2	0.63	16.0	0.63	16.0
Minimum Length L[2] / Length Compensation S										
ST L	22.94	582.7	23.44	595.4	24.80	629.9	24.81	630.2	27.56	700.0
S	4.88	124.0	3.88	98.6	3.38	85.9	3.50	88.9	2.95	74.9
SF L	13.81	350.8	14.37	365.0	16.30	414.0	19.31	490.5	21.43	544.3
SC L	9.12	231.6	10.62	269.7	13.40	340.4	13.62	345.9	21.46	545.1
S	0.75	19.1	0.75	19.1	1.12	28.4	1	25.4	1.58	40.1

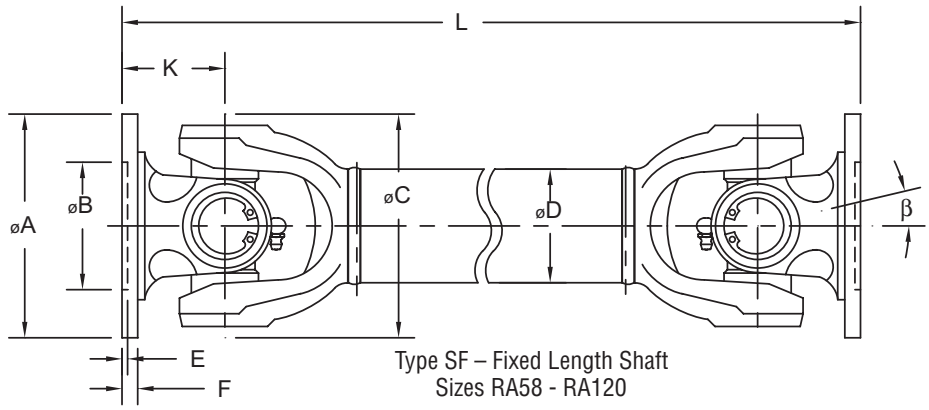
[1] Special tube diameters available upon request
[2] L is minimum for ST and SF designs
Longer/shorter length compensation available upon request. Popular flange yoke configurations shown, special designs available upon request.

Engineering Data Series Metric

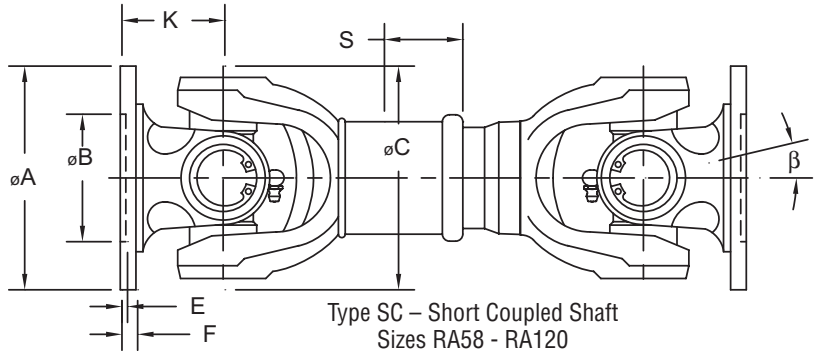
Sizes RA58 - RA120



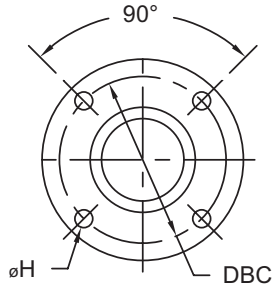
Type ST – Telescopic Shaft
Sizes RA58 - RA120



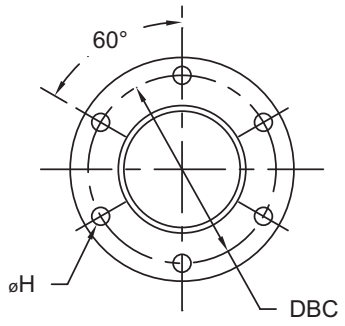
Type SF – Fixed Length Shaft
Sizes RA58 - RA120



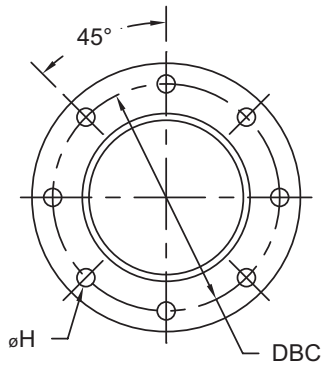
Type SC – Short Coupled Shaft
Sizes RA58 - RA120



4 Bolt
Flange Design



6 Bolt
Flange Design



8 Bolt
Flange Design

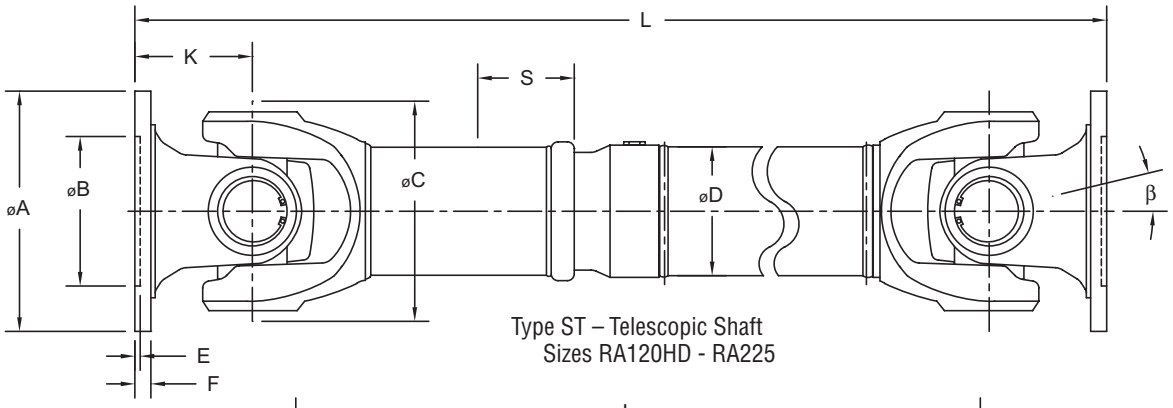
Size	RA58		RA65		RA75	
Torque Ratings						
	Lb.in.	Nm	Lb.in.	Nm	Lb.in.	Nm
T_e	1,037	117	1,382	156	2,852	322
T_{ow}	1,556	176	2,073	234	4,278	483
T_L	1,319	149	2,053	232	3,478	393
T_p	2,213	250	4,602	520	10,620	1,200
Dimensional Data (inches and millimeters except where noted)						
	inch mm	inch mm	inch mm	inch mm	inch mm	inch mm
ß	30°	25°	30°	20°	30°	18°
A	2.28 58	2.56 65	2.56 65	2.95 75	2.95 75	3.54 90
B	1.18 30	1.38 35	1.38 35	1.65 42	1.65 42	1.85 47
C	2.05 52	2.05 52	2.36 60	2.36 60	2.76 70	2.76 70
D[1]	1.12 28	1.12 28	1.25 32	1.25 32	1.56 40	1.56 40
E	0.06 1.5	0.07 1.7	0.07 1.7	0.09 2.2	0.10 2.2	0.10 2.5
F	0.14 3.5	0.16 4	0.16 4	0.22 5.5	0.22 5.5	0.24 6
K	1.18 30	1.18 30	1.26 32	1.26 32	1.42 36	1.42 36
DBC	1.85 47	2.05 52	2.05 52	2.44 62	2.44 62	2.93 74.5
Bolt Qty.	4 4	4 4	4 4	6 6	6 6	4 4
H	0.20 5	0.24 6	0.24 6	0.24 6	0.24 6	0.31 8
Minimum Length L[2] / Length Compensation S						
	inch	mm	inch	mm	inch	mm
ST L/S	10.55/1.57	268/40	11.42/2.36	290/60	11.81/1.38	300/35
SF L	6.30	160	6.50	165	7.87	200
SC L/S	6.50/.79	165/20	7.09/.79	180/20	7.87/.98	200/25
SC L/S	6.89/.98	175/25	7.87/1.18	200/30	8.86/1.38	225/35
SC L/S	7.68/.98	195/25	8.86/1.18	220/30	9.84/1.38	250/35
SC L/S	8.46/.98	215/25	9.25/1.18	235/30	10.63/1.38	270/35

Size	RA90		RA100		RA120	
Torque Ratings						
	Lb.in.	Nm	Lb.in.	Nm	Lb.in.	Nm
T_e	6,195	700	8,850	1,000	13,275	1,500
T_{ow}	8,673	980	12,390	1,400	18,585	2,100
T_L	5,682	642	9,080	1,026	16,381	1851
T_p	19,470	2,200	26,550	3,000	38,498	4,350
Dimensional Data (inches and millimeters except where noted)						
	inch mm	inch mm	inch mm	inch mm	inch mm	inch mm
ß	20°	18°	20°	18°	20°	18°
A	3.54 90	3.94 100	3.94 100	4.72 120	4.72 120	5.91 150
B	1.85 47	2.24 57	2.24 57	2.95 75	2.95 75	3.54 90
C	3.39 86	3.39 86	3.86 98	3.86 98	4.53 115	4.53 115
D[1]	2 50	2 50	2 50	2 50	2.35 60	2.35 60
E	0.10 2.5	0.10 2.5	0.10 2.5	0.10 2.5	0.10 2.5	0.12 3
F	0.24 6	0.28 7	0.28 7	0.31 8	0.31 8	0.35 9
K	1.65 42	1.65 42	1.81 46	1.81 46	2.36 60	2.36 60
DBC	2.93 74.5	3.31 84	3.31 84	4 101.5	4 101.5	5.12 130
Bolt Qty.	4 4	6 6	6 6	8 8	8 8	8 8
H	0.31 8	0.31 8	0.31 8	0.31 8	0.31 8	0.39 10
Minimum Length L[2] / Length Compensation S						
	inch	mm	inch	mm	inch	mm
ST L/S	13.70/1.57	348/40	14.72/1.57	374/40	18.52/2.36	473/60
SF L	8.50	216	9.84	250	11.85	301
SC L/S	8.86/.98	225/25	10.04/1.18	255/30	12.80/1.38	325/35
SC L/S	9.84/1.57	250/40	11.02/1.57	280/40	14.17/1.97	360/50
SC L/S	11.02/1.57	280/40	12.20/1.57	310/40	15.75/2.36	400/60
SC L/S	12.20/1.57	310/40	13.38/1.57	340/40	16.93/2.36	430/60

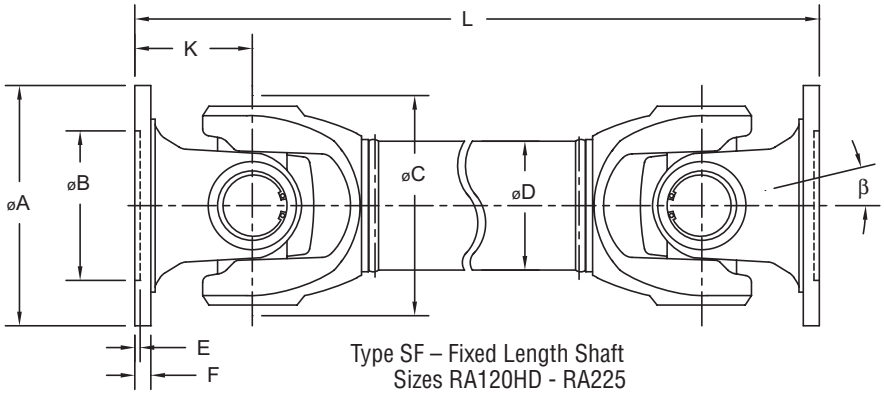
[1] Special tube diameters available upon request
[2] L is minimum for ST and SF designs
Longer/shorter length compensation available upon request. Popular flange yoke configurations shown, special designs available upon request.

Engineering Data Series Metric

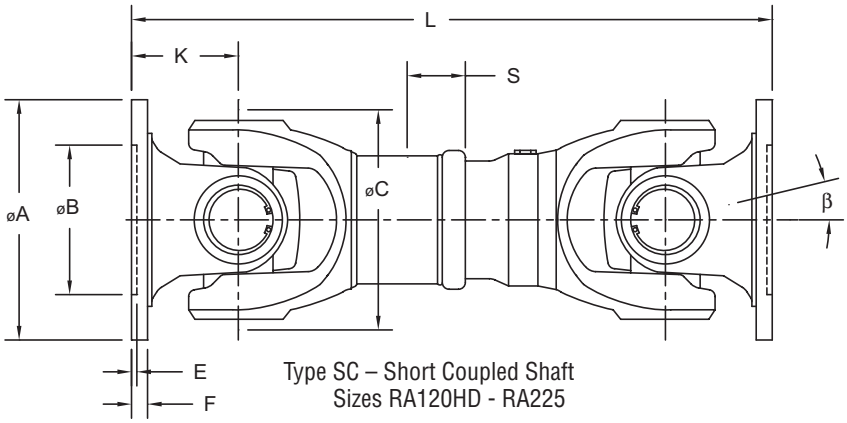
Sizes RA120HD - RA225



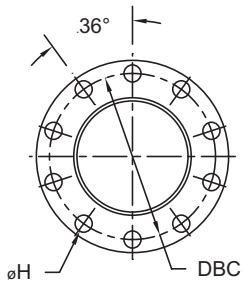
Type ST – Telescopic Shaft
Sizes RA120HD - RA225



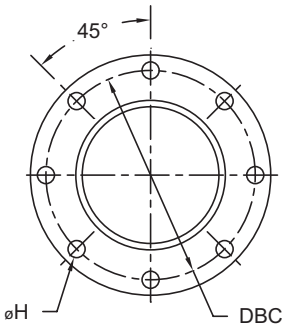
Type SF – Fixed Length Shaft
Sizes RA120HD - RA225



Type SC – Short Coupled Shaft
Sizes RA120HD - RA225



10 Bolt Flange Design



8 Bolt Flange Design

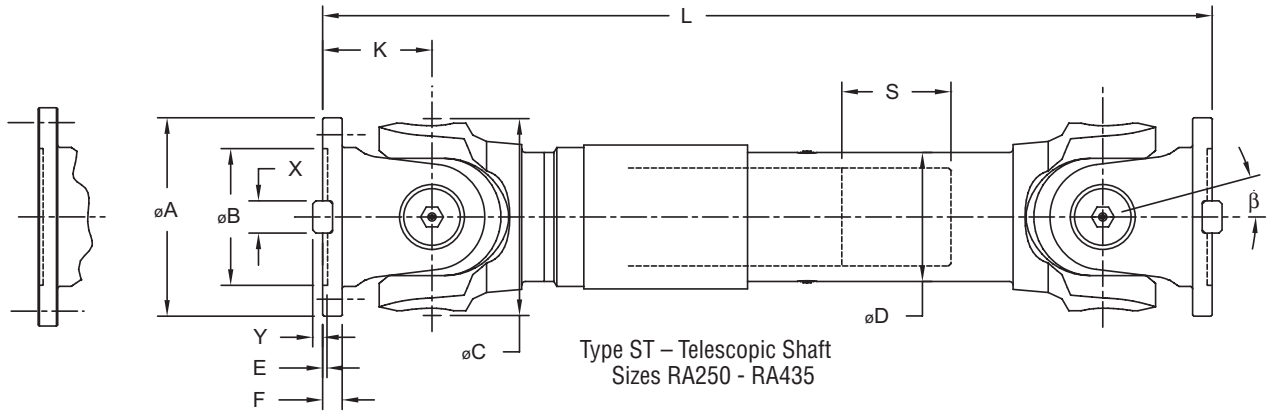
Size	RA120HD		RA150HD		RA150	
Torque Ratings						
	Lb.in.	Nm	Lb.in.	Nm	Lb.in.	Nm
T_e	15,930	1,800	22,125	2,500	35,400	4,000
T_{ow}	22,302	2,520	30,975	3,500	49,560	5,600
T_L	22,037	2,490	30,842	3,485	40,462	4,572
T_p	47,348	5,350	62,393	7,050	94,253	10,650
Dimensional Data (inches and millimeters except where noted)						
	inch mm	inch mm	inch mm	inch mm	inch mm	inch mm
ß	20°	20°	20°	20°	20°	20°
A	4.72 120	5.91 150	5.91 150	7.09 180	5.91 150	7.09 180
B	2.95 75	3.54 90	3.54 90	4.33 110	3.54 90	4.33 110
C	4.92 125	4.92 125	5.43 138	5.43 138	5.91 150	5.91 150
D[1]	2.75 70	2.75 70	3.15 80	3.12 80	3.50 90	3.50 90
E	0.10 2.5	0.12 3	0.12 3	0.14 3.6	0.12 3	0.14 3.6
F	0.35 9	0.35 9	0.39 10	0.39 10	0.47 12	0.47 12
K	2.36 60	2.36 60	2.56 65	2.56 65	2.95 75	2.95 75
DBC	4 101.5	5.12 130	5.12 130	6.12 155.5	5.12 130	6.12 155.5
Bolt Qty.	8 8	8 8	8 8	8 8	8 8	8 8
H	0.39 10	0.39 10	0.47 12	0.47 12	0.47 12	0.55 14
Minimum Length L[2] / Length Compensation S						
	inch	mm	inch	mm	inch	mm
ST L/S	19.33/2.36	491/60	21.65/4.33	550/110	29.21/4.33	742/110
SF L	12.09	307	13.58	345	17.91	455
SC L/S	13.58/1.38	345/35	14.17/1.57	360/40	15.75/1.97	400/50
SC L/S	14.76/1.97	375/50	15.75/3.15	400/80	18.31/3.15	465/80
SC L/S	16.54/2.36	420/60	18.11/3.15	460/80	21.46/1.57[3]	545/40[3]
SC L/S	17.72/2.36	450/60	—	—	23.03/3.15[3]	585/80[3]
SC L/S	—	—	—	—	25.20/4.33[3]	640/110[3]

Size	RA150HD		RA180		RA225	
Torque Ratings						
	Lb.in.	Nm	Lb.in.	Nm	Lb.in.	Nm
T_e	39,825	4,500	64,605	7,300	100,005	11,300
T_{ow}	55,755	6,300	90,447	10,220	140,007	15,820
T_L	51,596	5,830	71,614	8,092	124,100	14,023
T_p	115,050	13,000	193,815	21,900	309,750	35,000
Dimensional Data (inches and millimeters except where noted)						
	inch mm	inch mm	inch mm	inch mm	inch mm	inch mm
ß	30°	30°	30°	30°	30°	25°
A	6.50 165	7.09 180	7.09 180	8.86 225	8.86 225	9.84 250
B	3.74 95	4.33 110	4.33 110	5.51 140	5.51 140	5.51 140
C	6.22 158	6.22 158	7 178	7 178	8.03 204	8.03 204
D[1]	4 100	4 100	4.38 110	4.38 110	5.50 140	5.50 140
E	0.12 3.0	0.14 3.6	0.14 3.6	0.20 5	0.20 5	0.24 6
F	0.47 12	0.47 12	0.55 14	0.59 15	0.59 15	0.71 18
K	3.39 86	3.39 86	3.78 96	3.78 96	4.33 110	4.33 110
DBC	5.51 140	6.12 155.5	6.12 155.5	7.72 196	7.72 196	8.58 218
Bolt Qty.	8 8	8 8	10 10	8 8	8 8	8 8
H	0.63 16	0.63 16	0.63 16	0.63 16	0.63 16	0.71 18
Minimum Length L[2] / Length Compensation S						
	inch	mm	inch	mm	inch	mm
ST L/S	25.98/4.33	660/110	29.13/4.33	740/110	32.68/5.52	830/140
SF L	16.93	430	18.31	465	20.47	520
SC L/S	15.75/1.77[3]	400/45[3]	18.50/1.77[3]	470/45[3]	21.65/1.57[3]	550/40[3]
SC L/S	17.32/3.15[3]	440/80[3]	19.69/2.36[3]	500/60[3]	23.62/2.17[3]	600/55[3]
SC L/S	19.49/1.77	495/45	22.05/1.77	560/45	25.56/4.33	650/110
SC L/S	21.85/3.15	555/80	23.62/2.36	600/60	28.35/4.33	720/110
SC L/S	23.62/4.33	600/110	25.59/4.33	650/110	—	—

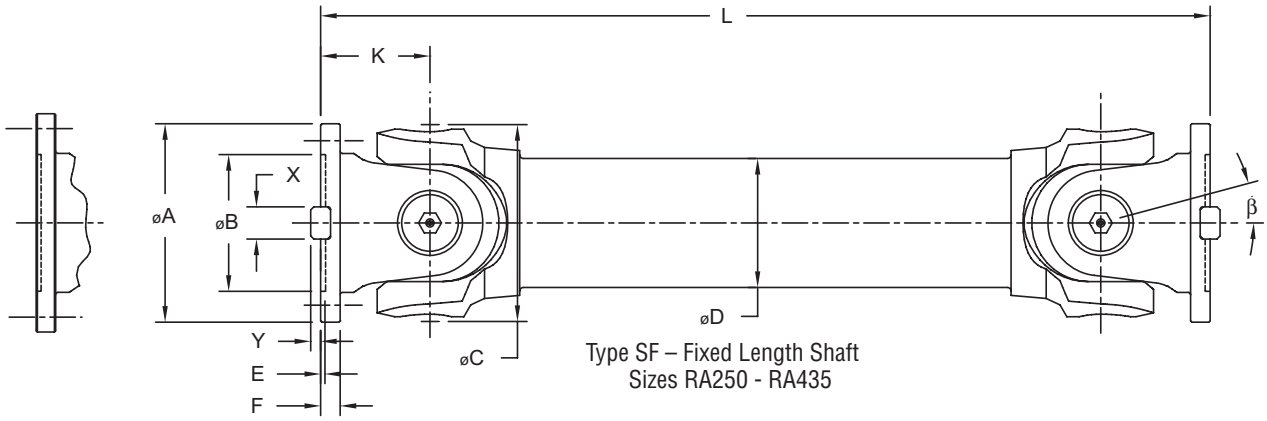
[1] Special tube diameters available upon request
[2] L is minimum for ST and SF designs
[3] Special yokes required, please consult factory
Longer/shorter length compensation available upon request. Popular flange yoke configurations shown, special designs available upon request.

Engineering Data Series Metric

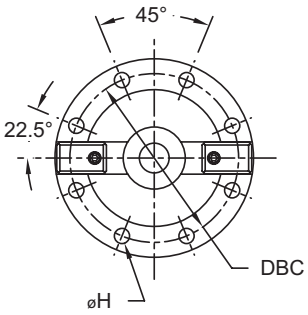
Sizes RA250 - RA435



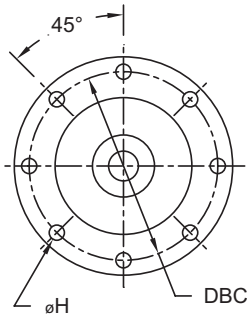
Type ST – Telescopic Shaft
Sizes RA250 - RA435



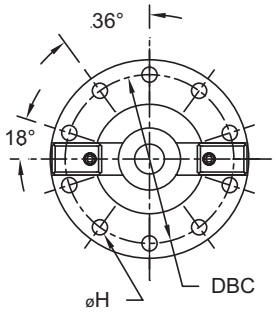
Type SF – Fixed Length Shaft
Sizes RA250 - RA435



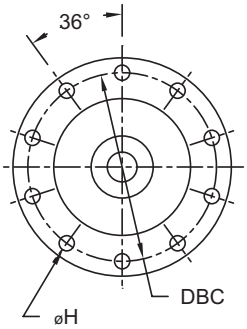
8 Bolt Flange Design
with Face Key



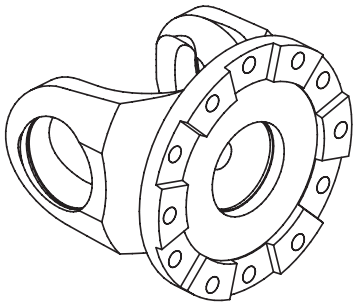
8 Bolt Flange Design



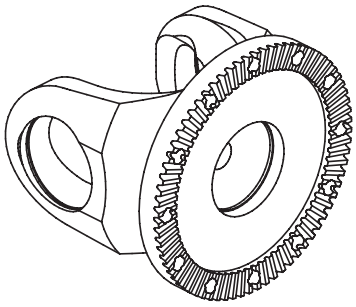
10 Bolt Flange Design
with Face Key



10 Bolt Flange Design



Optional Face Pad Design



Optional Hirth Radial Tooth Design

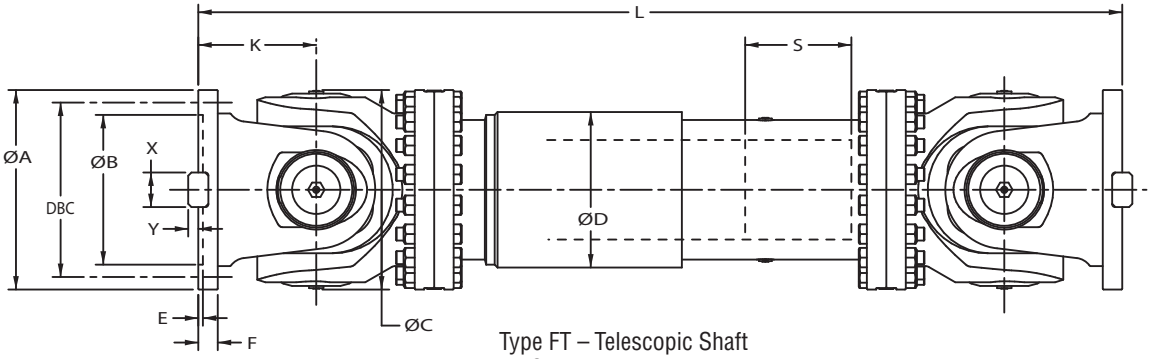
Size	RA250		RA285		RA315	
Torque Ratings						
	Lb.in.	KNm	Lb.in.	KNm	Lb.in.	KNm
T_e	233,800	26.4	265,400	30.0	414,200	46.8
T_{ow}	350,700	39.6	398,000	45.0	621,300	70.2
T_L	170,800	19.3	248,100	28.0	364,400	41.2
T_p	464,800	52.5	538,000	60.8	862,000	97.4
Dimensional Data (inches and millimeters except where noted)						
	inch mm	inch mm	inch mm	inch mm	inch mm	inch mm
ß	15°	15°	15°	15°	15°	15°
A	8.86 225.0	9.84 250.0	9.84 250.0	11.22 285.0	11.22 285.0	12.40 315.0
B	4.13 105.0	5.51 140.0	4.13 105.0	6.89 175.0	4.92 125.0	6.89 175.0
C	8.86 225.0	8.86 225.0	9.84 250.0	9.84 250.0	11.22 285.0	11.22 285.0
D[1]	6 152.0	6 152.0	6.50 165.0	6.50 165.0	7.50 191.0	7.50 191.0
E	0.20 5.0	0.24 6.0	0.24 6.0	0.28 7.0	0.28 7.0	0.28 7.0
F	0.63 16.0	0.71 18.0	0.98 25.0	0.79 20.0	1.06 27.0	0.87 22.0
K	4.92 125.0	4.92 125.0	5.51 140.0	5.51 140.0	6.30 160.0	6.30 160.0
DBC	7.72 196.0	8.58 218.0	8.58 218.0	9.65 245.0	9.65 245.0	11.02 280.0
Bolt Qty.	8 8	8 8	8 8	8 8	8 8	8 8
H	0.63 16.0	0.71 18	0.75 19.0	0.79 20.0	0.83 21.0	0.87 22.0
X	1.26 32.0	– –	1.57 40.0	– –	1.57 40.0	– –
Y	0.35 9.0	– –	0.49 13.0	– –	0.59 15.0	– –
Minimum Length L[2] / Length Compensation S						
	inch	mm	inch	mm	inch	mm
ST L	36.42	925.0	36.81	935.0	46.85	1190.0
S	5.51	140.0	5.51	140.0	5.51	140.0
SF L	22.44	570.0	24.61	625.0	28.35	720.0
FT L	43.31	1100.0	46.06	1170.0	47.64	1210.0
S	5.51	140.0	5.51	140.0	5.51	140.0
FF L	19.69	500.0	22.05	560.0	25.20	640.0

Size	RA350		RA390		RA435	
Torque Ratings						
	Lb.in.	KNm	Lb.in.	KNm	Lb.in.	KNm
T_e	661,600	74.8	979,500	110.7	1,400,000	158.2
T_{ow}	992,300	112.1	1,469,000	166.0	2,100,000	237.3
T_L	507,400	57.3	733,800	82.9	989,500	111.8
T_p	1,348,000	152.3	2,067,000	233.6	2,750,000	310.7
Dimensional Data (inches and millimeters except where noted)						
	inch mm	inch mm	inch mm	inch mm	inch mm	inch mm
ß	15°	15°	15°	15°	15°	15°
A	12.40 315.0	13.78 350.0	13.78 350.0	15.35 390.0	15.35 390.0	17.13 435.0
B	5.12 130.0	8.66 220.0	6.10 155.0	9.84 250.0	6.69 170.0	11.02 280.0
C	12.40 315.0	12.40 315.0	13.78 350.0	13.78 350.0	15.35 390.0	15.35 390.0
D[1]	8.75 222.0	8.75 222.0	10 254.0	10 254.0	10.50 267.0	10.50 267.0
E	0.31 8	0.31 8	0.31 8	0.31 8	0.31 8	0.39 10
F	1.26 32.0	0.98 25.0	1.38 35.0	1.26 32.0	1.57 40.0	1.57 40.0
K	7.09 180.0	7.09 180.0	7.64 194.0	7.64 194.0	8.46 215.0	8.46 215.0
DBC	11.02 280.0	12.20 310.0	12.20 310.0	13.58 345.0	13.58 345.0	15.16 385.0
Bolt Qty.	10 10	10 10	10 10	10 10	10 10	10 10
H	0.91 23.0	0.87 22.0	0.91 23.0	0.94 24.0	0.98 25.0	1.06 27.0
X	1.57 40.0	– –	1.97 50.0	– –	2.76 70.0	– –
Y	0.59 15.0	– –	0.63 16.0	– –	0.71 18.0	– –
Minimum Length L[2] / Length Compensation S						
	inch	mm	inch	mm	inch	mm
ST L	51.77	1315.0	55.51	1410.0	60.24	1530.0
S	5.51	140.0	5.91	150.0	6.50	165.0
SF L	31.69	805.0	33.66	855.0	37.60	955.0
FT L	53.15	1350.0	57.68	1465.0	62.99	1600.0
S	5.51	140.0	5.91	150.0	6.50	165.0
FF L	28.35	720.0	30.55	776.0	33.86	860.0

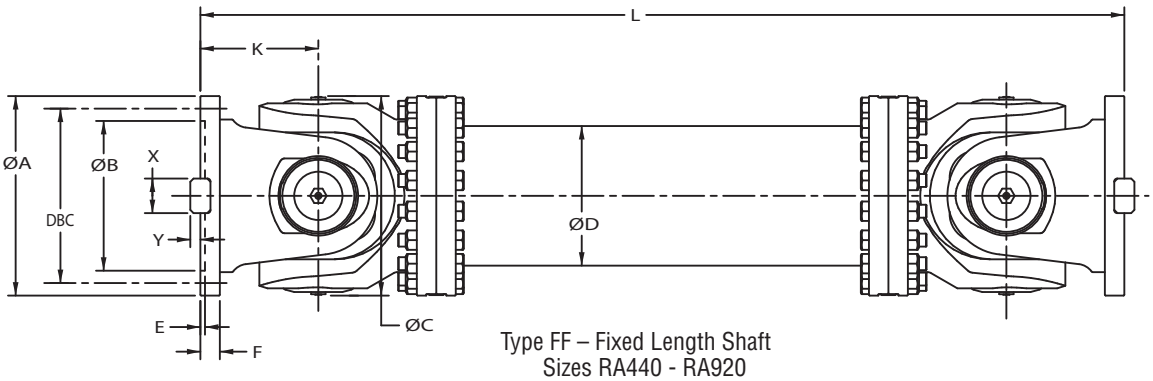
[1] Special tube diameters available upon request
[2] L is minimum for ST and SF designs
Longer/shorter length compensation available upon request. Popular flange yoke configurations shown, special designs available upon request.

Engineering Data Series Metric

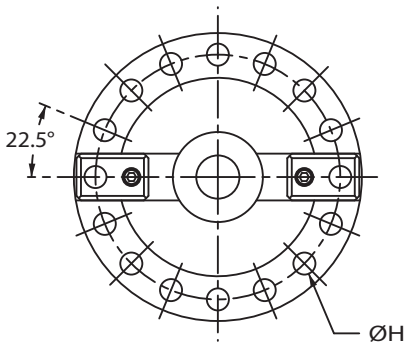
Sizes RA440 - RA920



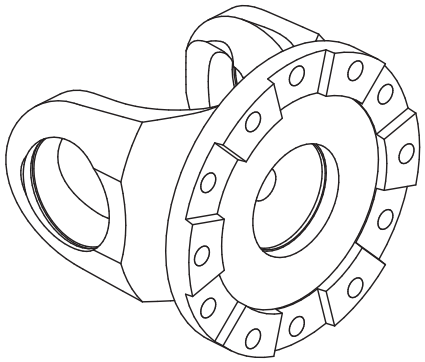
Type FT – Telescopic Shaft
Sizes RA440 - RA920



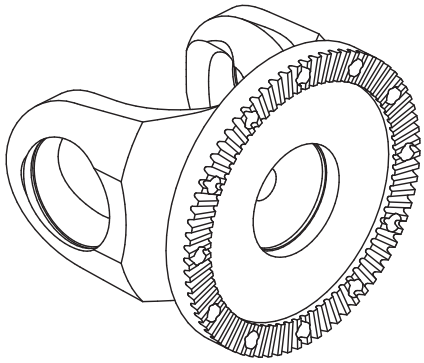
Type FF – Fixed Length Shaft
Sizes RA440 - RA920



Face Key
Flange Yoke
16 Hole



Integral Face Pad



Hirth Radial Tooth Connection

The torque ratings are based on material strength. When approaching these limits the capacity of the desired flange connection should be verified. When the selection torque (T_s) approaches the endurance torque (T_e) or when the maximum torque approaches the peak torque capacity (T_p) of the universal joint, integral face pads or Hirth radial tooth connections are recommended.

The number of pads and bolts are customized on a per application basis.

T_e = normal fully reversing torque rating

T_{ow} = normal pulsating one way torque rating

T_L = B-10 bearing life rating (based on 5000 hours B-10 bearing life at 3° misalignment and 100 RPM)

T_p = peak torque or maximum allowable torque

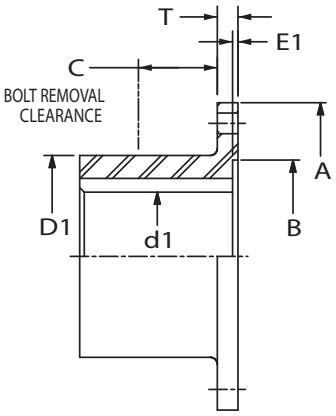
Size	RA440		RA490		RA550		RA620		RA680	
Torque Ratings										
	Lb.in.	KNm	Lb.in.	KNm	Lb.in.	KNm	Lb.in.	KNm	Lb.in.	KNm
T_e	2,382,000	269	3,170,000	358	5,253,000	594	6,660,000	753	8,178,000	924
T_{ow}	3,573,000	404	4,755,000	537	7,880,000	890	9,996,000	1,129	12,267,000	1,386
T_L	1,665,000	188	2,126,000	240	2,994,000	338	4,224,000	477	5,959,000	673
T_p	4,890,000	553	7,180,000	811	11,000,000	1,243	15,000,000	1,695	16,700,000	1,887
Dimensional Data (inches and millimeters except where noted)										
	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
ß	15°		15°		15°		15°		15°	
A	17.32	439.9	19.28	489.7	21.62	549.1	24.41	620.0	26.77	680.0
B	13	330.2	13.50	342.9	16	406.4	18	457.2	19	482.6
C	17.32	440.0	19.28	490.0	21.65	550.0	24.41	620.0	26.77	680.0
D	12.75	323.9	13.38	339.9	16.50	419.1	17.75	450.9	19.75	501.7
E	0.40	10.2	0.47	11.9	0.47	11.9	0.47	11.9	0.59	15.0
F	1.69	42.9	1.75	44.5	2	50.8	2.12	53.8	2.12	53.8
K	10.24	260.0	10.63	270.0	12.01	305.0	13.38	340.0	15.53	395.0
DBC	15.37	390.4	17.12	434.8	19.37	492.0	21.88	555.8	23.75	603.3
Bolt Qty.	16	16	16	16	16	16	16	16	16	16
H	1-1/8	27	1-1/4	30	1-1/4	30	1-1/2	36	1-1/2	36
X	3	76.2	3.50	88.9	3.94	100.1	4.50	114.3	4.50	114.3
Y	0.87	22.1	0.87	22.1	0.87	22.1	0.87	22.1	1	25.4
Minimum Length L / Length Compensation S										
FT L	73.80	1,874.5	78.10	1,983.7	90.60	2,301.2	95.50	2,425.7	105	2,667.0
S	7.50	190.5	7.50	190.5	9.50	241.3	9.50	241.3	10	254.0
FF L	40.96	1,040.4	42.52	1,080.0	48.04	1,220.2	53.52	1,359.4	62.12	1,577.8

Size	RA720		RA760		RA800		RA860		RA920	
Torque Ratings										
	Lb.in.	KNm	Lb.in.	KNm	Lb.in.	KNm	Lb.in.	KNm	Lb.in.	KNm
T_e	9,800,000	1,107	11,700,000	1,322	13,670,000	1,545	17,000,000	1,921	20,800,000	2,350
T_{ow}	14,701,000	1,661	17,571,000	1,985	20,505,000	2,317	25,500,000	2,881	31,200,000	3,525
T_L	7,077,000	800	8,248,000	932	9,555,000	1,080	11,759,000	1,329	14,263,000	1,612
T_p	20,000,000	2,260	23,900,000	2,701	27,900,000	3,153	34,680,000	3,919	42,450,000	4,797
Dimensional Data (inches and millimeters except where noted)										
	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
ß	15°		15°		15°		15°		15°	
A	28.35	720.0	29.92	760.0	31.50	800.0	33.85	860.0	36.22	920.0
B	20	508.0	21	533.4	22	558.8	24	609.6	25	635.0
C	28.35	720.0	29.92	760.0	31.50	800.0	33.85	860.0	36.22	920.0
D	21.75	552.5	23.25	590.6	24.75	628.7	27	685.8	28	711.2
E	0.62	15.7	0.62	15.7	0.62	15.7	0.62	15.7	0.75	19.1
F	2.25	57.2	2.38	60.5	2.50	63.5	2.62	66.5	2.75	69.9
K	16.44	417.6	17.35	440.7	18.27	464.1	19.64	498.9	20.47	519.9
DBC	25.75	654.1	27.38	695.5	28.88	733.6	31.25	793.8	33.50	850.9
Bolt Qty.	16	16	16	16	16	16	16	16	16	16
H	1-1/2	36	1-1/2	36	1-1/2	36	1-1/2	36	1-1/2	36
X	4.50	114.3	4.50	114.3	4.50	114.3	4.50	114.3	5	127.0
Y	1.06	26.9	1.12	28.4	1.19	30.2	1.25	31.8	1.38	35.1
Minimum Length L / Length Compensation S										
FT L	108.25	2,749.6	113.50	2,882.9	117	2,971.8	123.50	3,136.9	128	3,251.2
S	10	254.0	11	279.4	11	279.4	11	279.4	11	279.4
FF L	65.76	1,670.3	69.40	1,762.8	73.08	1,856.2	78.56	1,995.4	81.88	2,079.8

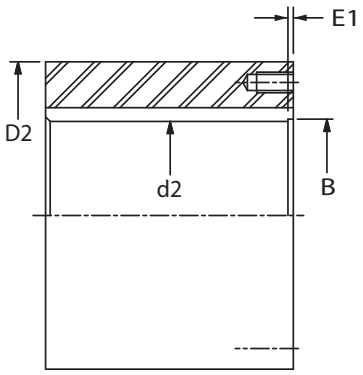
Companion Flange Dimensions

1000 Series

Sizes RA1310 - RA1550 - RA1880 - RA1910

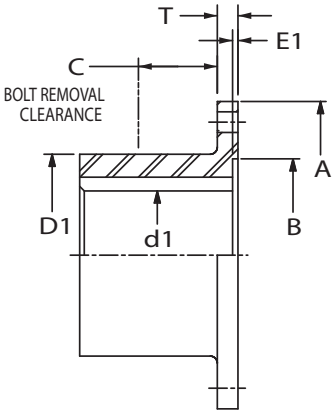


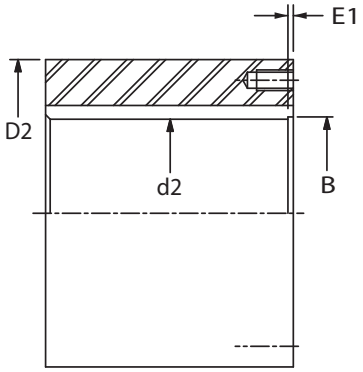
Design 1



Design 2

Sizes RA1610 - RA1880



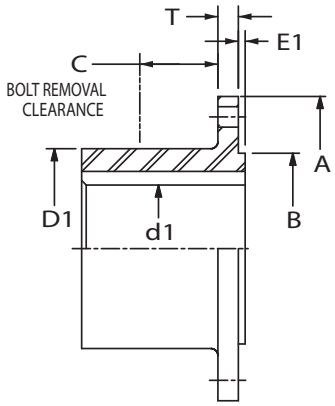


Size	RA1310		RA1350/RA1410		RA1480/RA1550		RA1610		RA1710		RA1810		RA1880/RA1910	
	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
A	3.88	98.6	4.63	117.6	5.88	149.4	6.88	174.8	8	203.2	8	203.2	9.63	244.6
B	2.38	60.5	2.75	69.9	3.75	95.3	6.62	168.1	7.75	196.9	7.75	196.9	7	177.8
E	0.08	2.0	0.08	2.0	0.08	2.0	0.04	1.0	0.04	1.0	0.04	1.4	0.11	2.8
F	0.38	9.7	0.50	12.7	0.38	9.7	0.38	9.7	0.38	9.7	0.50	12.7	0.38	9.7
L1	2	50.8	2	50.8	2.50	63.5	3.50	88.9	4	101.6	4	101.6	4.50	114.3
D1	2.44	62.0	2.88	73.2	3.75	95.3	5.25	133.4	6.38	162.1	6.38	162.1	6.88	174.8
d1	1.69	42.9	1.88	47.8	2.44	62.0	3.12	88.9	4	101.6	4	101.6	4.50	114.3
L2	2.50	63.5	3	76.2	3	88.9	5	127.0	6	152.4	6	152.4	6	152.4
d2	2.38	60.5	2.75	69.9	3.75	95.3	4.75	120.7	5.50	139.7	5.50	139.7	6.50	165.1

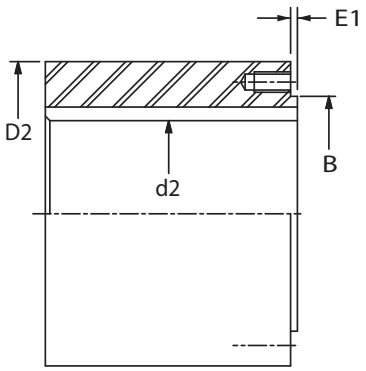
Companion Flange Dimensions

Metric Series

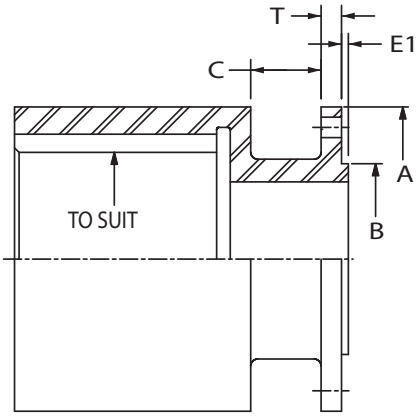
Sizes RA58 - RA435



Design 1
SF



Design 2
SLF



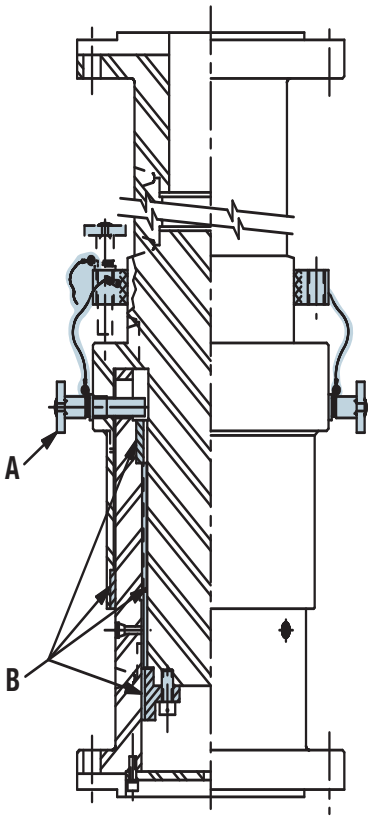
Design 3

Size	RA58		RA58/RA65		RA65/RA75		RA75/RA90		RA90/RA100	
	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
A	2.28	58.0	2.56	65.0	2.95	75.0	3.54	90.0	3.94	100.0
B	1.18	30.0	1.38	35.0	1.65	42.0	1.85	47.0	2.24	84.0
E	0.054	1.4	0.062	1.6	0.074	1.9	0.094	2.4	0.094	2.4
F	—	—	—	—	—	—	0.25	6.4	0.25	6.4
L1	—	—	—	—	—	—	2	50.8	2	50.8
D1	—	—	—	—	—	—	2.12	53.8	2.31	58.7
d1	—	—	—	—	—	—	1.25	31.8	1.62	41.1
L2	2	50.8	2	50.8	2.25	57.2	2.50	63.5	3	76.2
d2	1.18	30.0	1.38	35.1	1.65	41.9	1.85	47.0	2.24	56.9

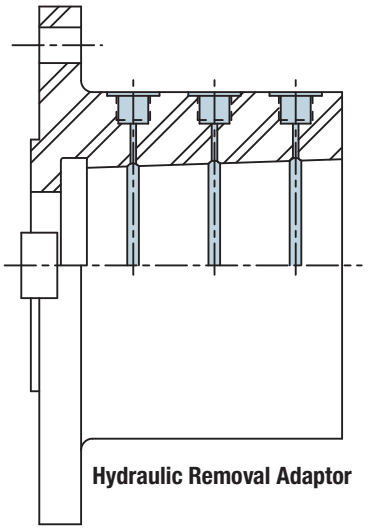
Size	RA100/RA120/RA120HD		RA100/RA150		RA150HD/RA180		RA180/RA225/RA250		RA225/RA250/RA285	
	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
A	4.73	120.0	5.91	150.0	7.09	180.0	8.86	225.0	9.84	250.0
B	4	101.5	5.118	130.0	4.330	110.0	5.512	140.0	5.512	140.0
E	0.094	2.4	0.094	2.4	0.094	2.4	0.157	4.0	0.197	5.0
F	0.38	9.7	0.44	11.2	0.50	12.7	0.63	16.0	0.75	19.1
L1	3	76.2	4	101.6	4	101.6	5.50	139.7	6	152.4
D1	3.30	83.8	4.31	109.5	5.19	131.8	6.59	167.4	7.44	189.0
d1	2.25	57.2	2.88	73.2	3.44	87.4	4.44	112.8	4.94	125.5
L2	4	101.6	5	127.0	4.50	114.3	7.25	184.2	8.25	209.6
d2	2.95	74.9	3.54	89.9	4.13	104.9	5.88	149.4	6.56	166.6

Size	RA285/RA315		RA315/RA350		RA350/RA390		RA390/RA435		RA435	
	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
A	11.22	285.0	12.40	315.0	13.78	350.0	15.35	390.0	15.35	390.0
B	6.890	175.0	6.890	175.0	8.661	220.0	9.843	250.0	9.843	250.0
E	0.236	6.0	0.236	6.0	0.276	7.0	0.276	7.0	0.276	7.0
F	0.81	20.6	0.88	22.4	1	25.4	1.12	28.4	1.12	28.4
L1	7	177.8	8	203.2	9	228.6	10	254.0	10	254.0
D1	8.41	213.6	9.69	246.1	10.88	276.4	12.09	307.1	12.09	307.1
d1	5.56	141.2	6.44	163.6	7.25	184.1	8.06	204.7	8.06	204.7
L2	9.38	238.3	10.25	260.3	11.25	285.8	12.25	311.1	12.25	311.1
d2	7.50	190.5	8.25	209.6	9	228.6	10	254.0	10	254.0

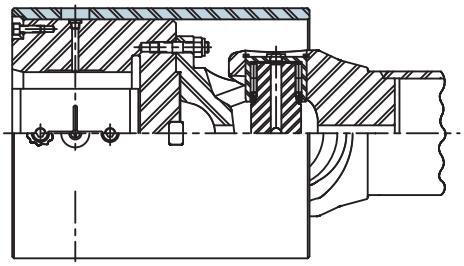
Design Variations and Custom Applications



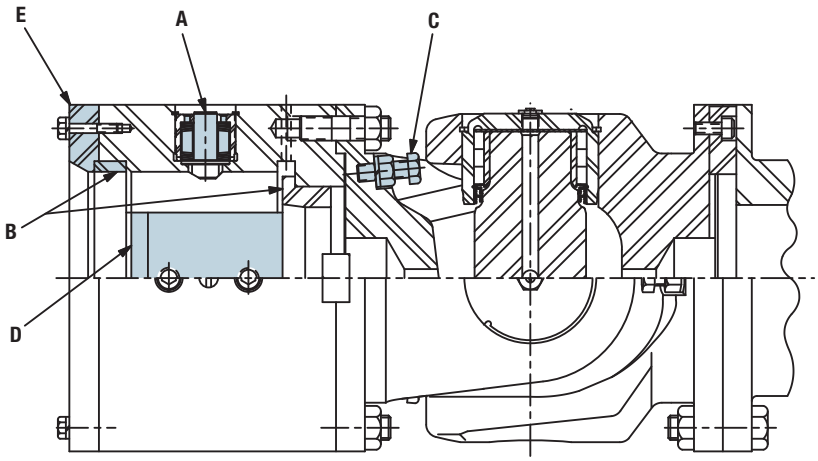
Vertical Edger Design
A. Locking Pin Arrangement
B. Long Travel Shaft With Bearing Support



Hydraulic Removal Adaptor



Roll Removal Support Mechanism

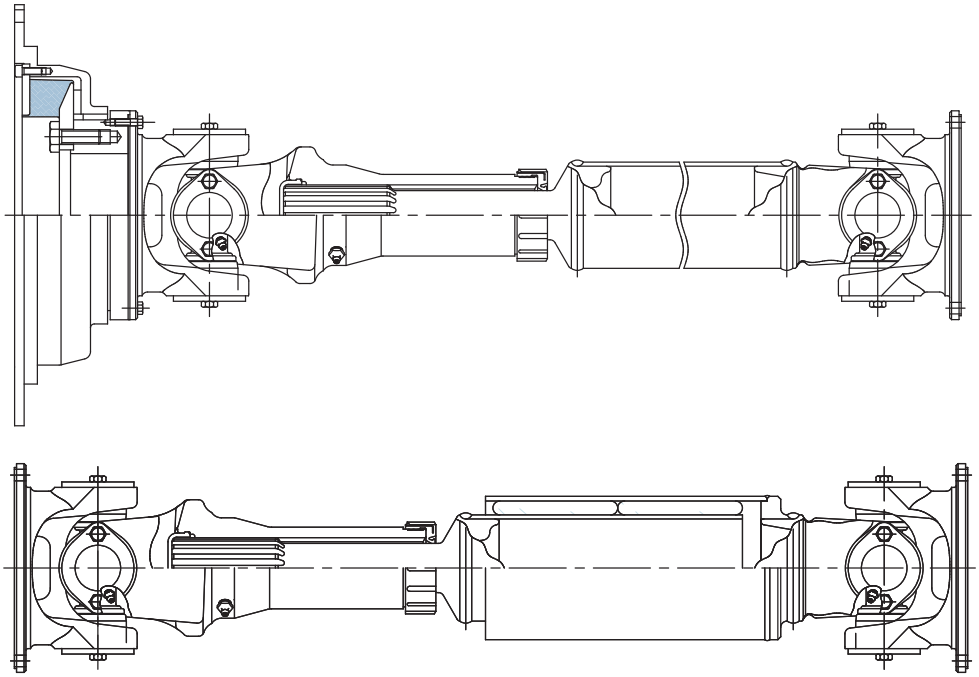


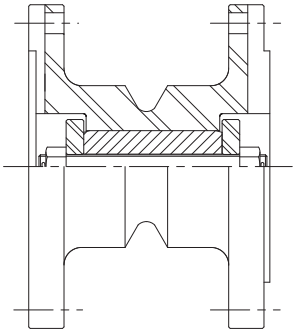
A. Detent Assembly
B. Replaceable Pilot Bearing
C. Angle Limiters
D. Replaceable Wear Keys
E. Hardened, Chamfered End Plate

Specialty Shafts

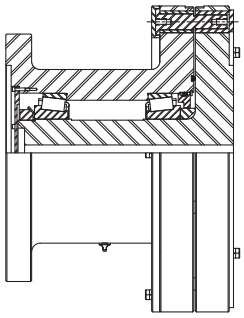
Tosionally Dampened Driveshafts

Renold offers torsionally dampened driveshafts designed to reduce the torsional stress between the drive source and the driven unit. Through use of a torsionally dampened driveshaft resonant frequencies are reduced to below the operating speed, and torque spikes caused by resonance can be brought to within permissible levels. Two designs are available, engine flywheel mounted and integral to the drive shaft. Individual design is based on the application requirements. Typical applications include dynamometers, boat drives, construction machines et al.

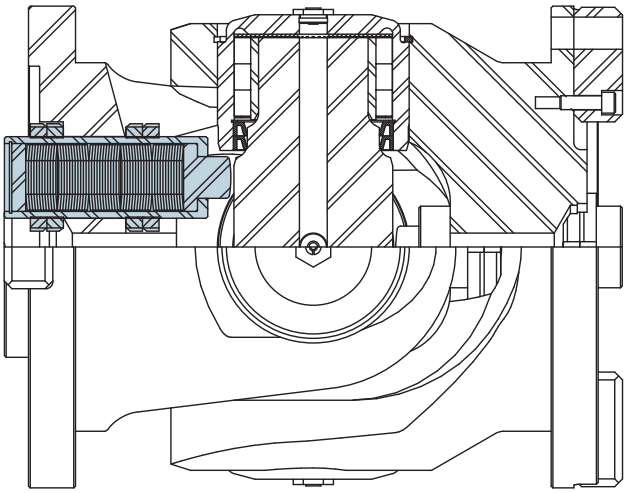




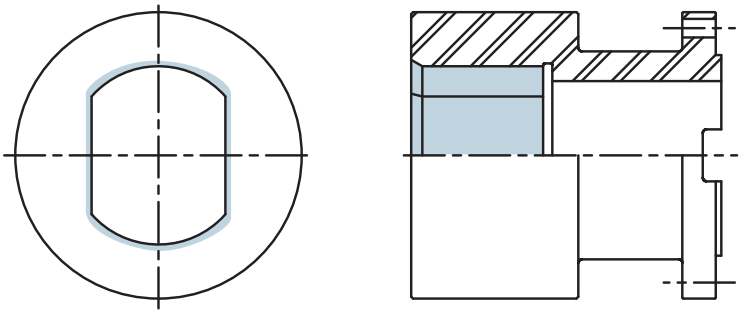
Shear Spacer Assembly



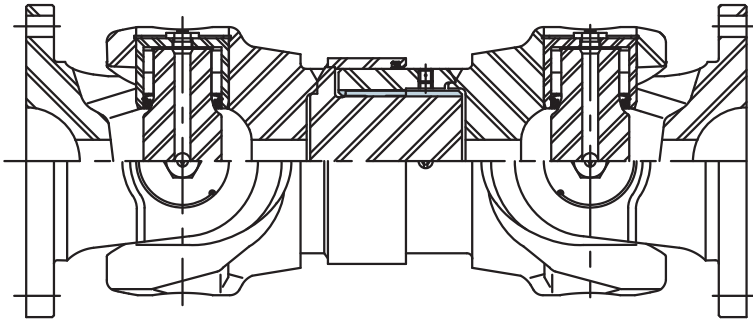
Shear Pin Assembly



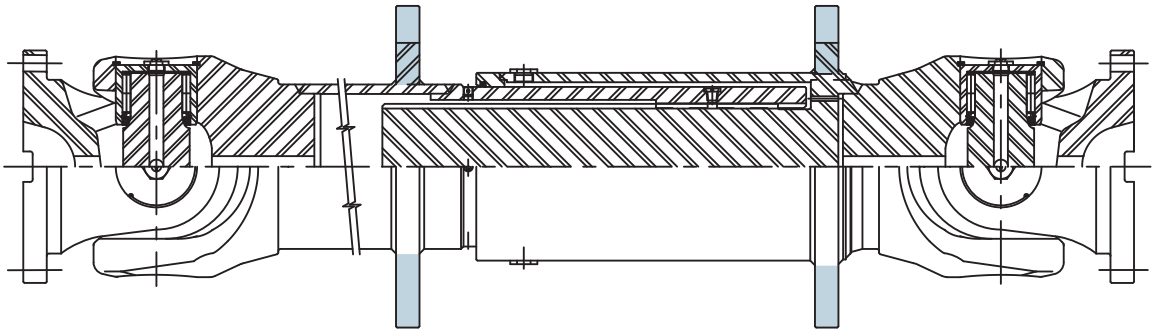
Roll End Support Mechanism



Developed and Hardened Roll End Bore



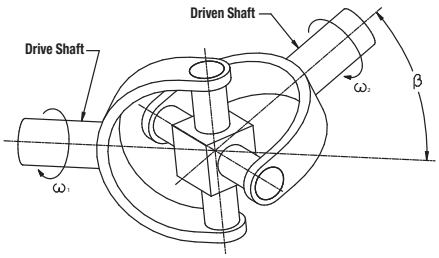
Short Travel Capability



Long Travel Capability With Expansion and Contraction Flanges

Kinematics and Motion Characteristics

When a universal joint is operated at an angle (ß), non-uniform motion is developed. With the driving yoke of the joint operating at a uniform rotational velocity to (ω_1), the driven yoke rotates non-uniformly with respect to angular displacement, velocity (ω_2), and acceleration.



The average angular displacement and velocity is uniform. That is, if the driving yoke rotates one revolution, the driven yoke also rotates one revolution. However, during this one revolution, the incremental angular displacement and instantaneous angular velocity and acceleration are not transmitted uniformly through the joint. The angular displacement of the driven yoke during one revolution lags and leads the driving yoke twice.

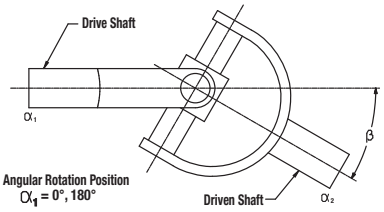
With a constant angular velocity (ω_1), of the driving yoke, the driven yoke has a maximum difference of output angular velocity (φ), with respect to the driving yoke when the driving yoke lies in the plane of the joint angle and also when the driving yoke is normal or perpendicular to this plane. The driven yoke has the same angular velocity as the driving yoke at approximately 45° from the joint angle plane for small angles.

The maximum instantaneous angular acceleration and deceleration of the driven yoke occurs when the angular velocity of the driven yoke is the same as the driving yoke. Also, the maximum acceleration and deceleration coincide with the maximum lead and lag respectively. The incremental angular displacement, velocity and acceleration increase as the joint angle is increased, but at an increasing rate.

For dynamic rotation the angular velocity of the driven yoke (ω_2), can be determined for a given angular displacement (α_1), with the formula

$$\omega_2 = \left(\frac{\cos ß \times \omega_1}{1-\sin^2\alpha_1 \times \sin^2 ß} \right)$$

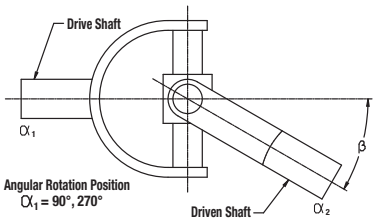
During one revolution of the drive yoke the driven yoke will reach a maximum angular velocity two times at α = 0° and 180°.



The maximum angular velocity will be

$$\omega_2 \max = \frac{\omega_1}{\cos ß}$$

The driven yoke will also reach a minimum angular velocity two times during one revolution at α = 90° and 270°.



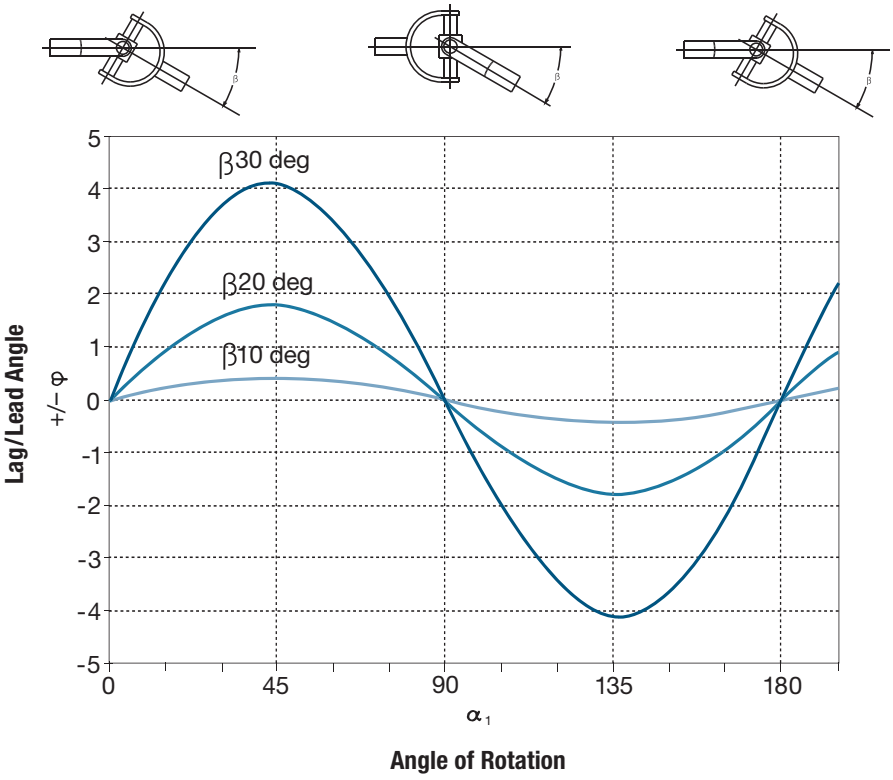
The minimum angular velocity will be

$$\omega_2 \min = \cos ß \ \omega_1$$

Lead and lag angles (ω) of the driven shaft can be determined by the following equations

$$\varphi = \tan^{-1} \left(\frac{\tan\alpha_2 - \tan\alpha_1}{1 + \tan\alpha_1 \times \tan\alpha_2} \right)$$

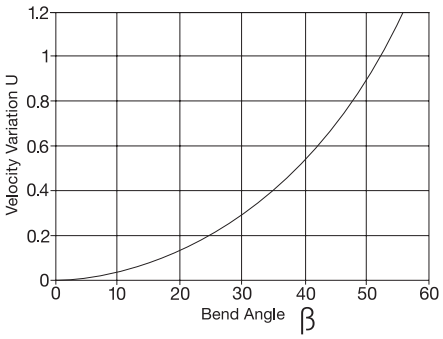
$$\alpha_2 = \tan^{-1} \left(\frac{1}{\cos ß} \times \tan\alpha_1 \right)$$



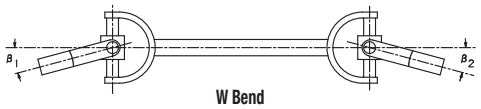
Lag and lead angle (φ) as a function of angular rotation (α) of the joint and bend angle (ß).

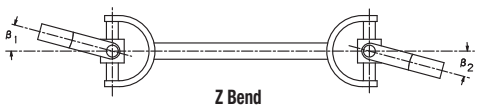
Velocity variation (U) is a means for comparison of the angular velocities of the drive and driven shafts. Velocity variation (U) is calculated using the formula

$$U = \left(\frac{\omega_2 max - \omega_2 min}{\omega_1}\right) = \tan ß \times \sin ß$$



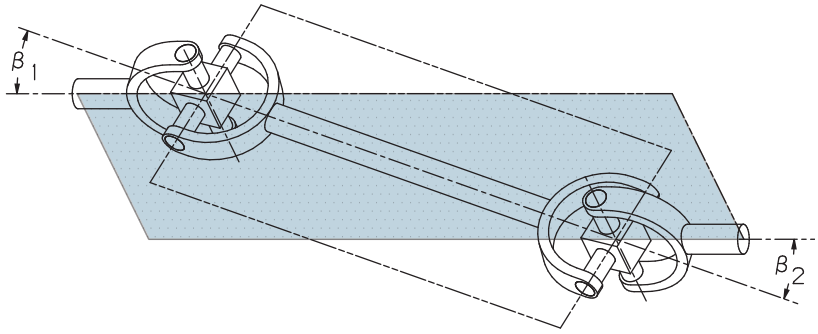
As a result of the non-uniform motion of a universal joint, few applications are suitable for a single universal joint. However, by placing two universal joints in tandem the irregularities of a single joint can be compensated. By arranging the two universal joints in either a “Z” or “W” bend configuration with joint angles $ß_1$ and $ß_2$, equal, the velocity variations developed in the first joint are in effect cancelled by the velocity variations in the second joint.



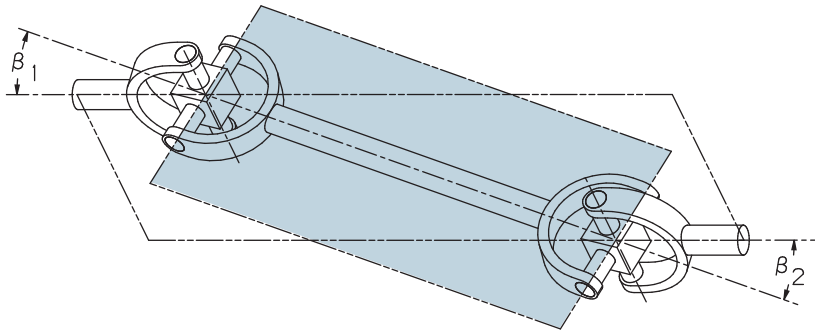


Synchronous rotation of the drive and driven shafts is possible provided that all three of the following conditions are met:

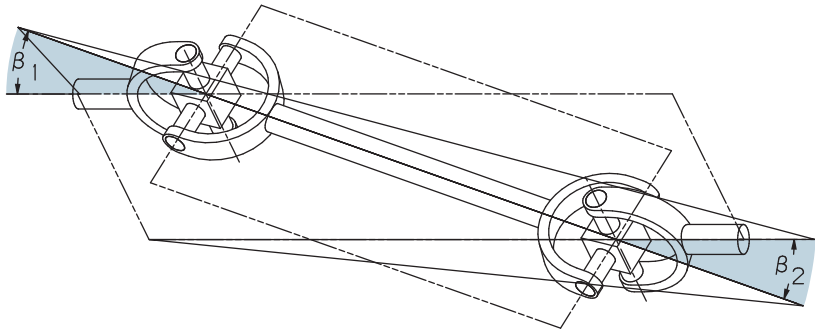
1. The axis of all shaft sections lie in the same plane.



2. The bearing bores of the inboard yokes of the center section lie in the same plane.



3. The bend angles $ß_1$ and $ß_2$ are equal.



This ideal or phased arrangement will result in homokinetic operation of the universal joint driveline assembly. Failure to meet one or more of these requirements will result in some level of velocity fluctuation in the driven shaft. The acceptability of this velocity fluctuation is a function of the speed, system mass and the sensitivity of the application.

Bore Tolerances and Weights

Recommended Bore Tolerances

- Recommended standard bore tolerances for interference fits are shown in table (right).
- Bore tolerances conform to AGMA 9002-A86 standards.

Interference Fits

Unless specified, bores will be furnished with an interference fit.

When **shaft sizes only** are stated on order and they consist of fractional or decimal dimensions without tolerance, the bore will be sized for an interference fit in accordance with table (right). If exact **shaft size** and tolerance do not agree with tables, the smallest shaft dimension will be considered "basic" and the standard negative bore tolerance will be applied.

Example: Interference Fit

Shaft Size – 2.000 (Basic Size)
1.999 (With Tolerance)

Bore Size – 1.999
1.998

Interference Fit (Inches)			
Nominal Bore Size Over / Thru	Shaft Tolerance	Bore Tolerance	Interference Range
0.0000 / 1.5000	+0000 / –.0005	–.0005 / –.0010	–.0000 / –.0010
1.5000 / 3.0000	+.0000 / –.0010	–.0010 / –.0020	–.0000 / –.0020
3.0000 / 4.0000		–.0015 / –.0030	–.0005 / –.0030
4.0000 / 5.0000		–.0020 / –.0035	–.0010 / –.0035
5.0000 / 7.0000		–.0025 / –.0040	–.0015 / –.0040
7.0000 / 8.0000		–.0030 / –.0050	–.0020 / –.0050
8.0000 / 9.0000		–.0035 / –.0055	–.0025 / –.0055
9.0000 / 10.0000		–.0040 / –.0060	–.0030 / –.0060
10.0000 / 11.0000		–.0045 / –.0065	–.0035 / –.0065
11.0000 / 12.0000		–.0050 / –.0070	–.0040 / –.0070
12.0000 / 13.0000		–.0055 / –.0075	–.0045 / –.0075
13.0000 / 14.0000		–.0060 / –.0080	–.0050 / –.0080
14.0000 / 15.0000		–.0065 / –.0085	–.0055 / –.0085
15.0000 / 16.0000		–.0065 / –.0090	–.0055 / –.0090
16.0000 / 17.0000		–.0070 / –.0095	–.0060 / –.0095
17.0000 / 18.0000		–.0075 / –.0100	–.0065 / –.0100
18.0000 / 19.0000		–.0080 / –.0105	–.0070 / –.0105
19.0000 / 20.0000		–.0085 / –.0110	–.0075 / –.0110
20.0000 / 22.0000	+.0000 / –.0020	–.0100 / –.0130	–.0080 / –.0130
22.0000 / 24.0000		–.0110 / –.0140	–.0090 / –.0140
24.0000 / 26.0000		–.0120 / –.0150	–.0100 / –.0150

Standard Recommended Keyways (Inches)			
Nominal Bore Range Over / Thru	Keyway Width	Keyway Depth Sq. Key	Keyway Depth Red. Key
.312 / .438	.094	.047	–
.438 / .562	.125	.063	.047
.562 / .875	.188	.094	.062
.875 / 1.250	.250	.125	.094
1.250 / 1.375	.312	.156	.125
1.375 / 1.750	.375	.188	.125
1.750 / 2.250	.500	.250	.188
2.250 / 2.750	.625	.313	.219
2.750 / 3.250	.750	.375	.250
3.250 / 3.750	.875	.438	.313
3.750 / 4.500	1.000	.500	.375
4.500 / 5.500	1.250	.625	.438
5.500 / 6.500	1.500	.750	.500
6.500 / 7.500	1.750	.875	.750
7.500 / 9.000	2.000	1.000	.750
9.000 / 11.000	2.500	1.250	.875
11.000 / 13.000	3.000	1.500	1.000
13.000 / 15.000	3.500	1.750	1.250
15.000 / 18.000	4.000	–	1.500
18.000 / 22.000	5.000	–	1.750
22.000 / 26.000	6.000	–	2.000

Universal Joint Weights at Minimum Length (pounds)

Size	Flange Dia. (Inches)	TYPE					Tube (Inches)
		ST	SF	FT	FF With Spacer	FF Without Spacer	
RA1310	3.88	14	12	–	–	–	0.18
RA1350	4.63	25	20	–	–	–	0.22
RA1410	4.63	25	20	–	–	–	0.25
RA1480	5.88	27	22	–	–	–	0.25
RA1550	5.88	37	34	–	–	–	0.29
RA1610	6.88	45	36	–	–	–	0.90
RA1710	8	68	55	–	–	–	0.46
RA1810	8	99	83	–	–	–	0.52
RA1880	9.63	152	122	–	–	–	0.98
RA1910	9.63	166	166	–	–	–	1
RA225	8.86	288	214	299	252	178	1.78
	9.84	296	222	345	291	194	1.78
RA250	8.86	362	239	426	352	259	2.22
	9.84	370	247	470	391	275	2.22
RA285	9.84	474	291	579	436	335	2.67
	11.22	483	300	617	466	353	2.67
RA315	11.22	714	446	786	564	445	3.22
	12.40	729	461	842	610	475	3.22
RA350	12.40	1,000	648	1,099	801	639	3.67
	13.78	1,020	668	1,172	866	679	3.67
RA390	13.78	1,354	867	1,490	1,056	882	4.22
	15.35	1,383	896	1,615	1,169	940	4.22
RA435	15.35	1,743	1,179	1,938	1,420	1,191	6.50
	17.13	1,789	1,225	2,104	1,563	1,282	6.50
RA440	17.32	–	–	2,761	1,987	1,737	10.91
RA490	19.28	–	–	3,840	2,965	2,590	11.58
RA550	21.62	–	–	5,204	3,724	3,339	14.13
RA620	24.41	–	–	6,979	5,284	4,728	16.95

Values may vary for specific applications.

Rolling Mill Application Data for Selection and Design

Name _____

Company _____

Phone _____ **Fax** _____

Date _____

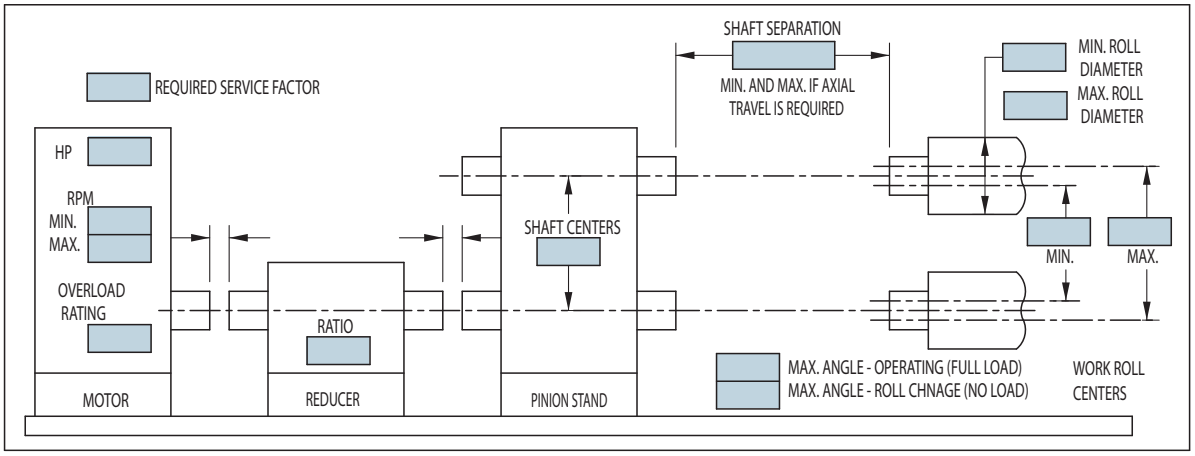
Inquiry Number _____

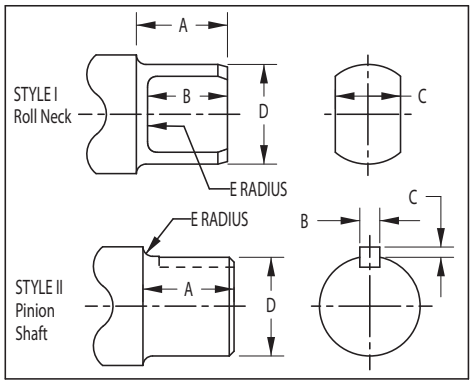
Mill Type _____

Number of Stands _____

Number of Required Assemblies _____

Please provide the following information in the boxes provided:





Bore Requirements				
Style	Pinion Shaft		Roll Neck	
A	Engagement Length		Engagement Length	
B	Key Width		Flat Length	
C	Key Depth		Across Flats	
D	Shaft Dia.		Neck Dia.	
E	Radius		Radius	

Please note any other mill characteristics such as:

- Method of Roll Change _____
- Operating Environment _____
- Restrictions on Diameter _____
- Drive Orientation (Vertical or Horizontal, etc.) _____
- Unidirectional or Reversing Drive _____
- Any Other Pertinent Information

General Application Data for Selection and Design

Name _____

Company _____

Phone _____ Fax _____

Date _____

Inquiry Number _____

Mill Type _____

Number of Stands _____

Number of Required Assemblies _____

Please provide the following information:

1. Motor Horse Power _____
2. Minimum Motor RPM _____
3. Maximum Motor RPM _____
4. Reduction Ratio _____
5. Required Service Factor _____
6. B-10 Life Requirement _____
7. Minimum Shaft Separation _____
8. Maximum Shaft Separation _____
9. Load Offset or Angle _____
10. No-load Offset or Angle _____
11. Axial Travel Requirement _____
12. Horizontal or Vertical Orientation _____
13. Drive End Shaft Configuration _____
14. Driven End Shaft Configuration _____
15. Diameter Restrictions _____
16. Operating Environment _____
17. Special Equipment Interface Requirements _____
18. Other Special Conditions _____

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