FLURO Rod Ends and Spherical Plain Bearings are available from MARYLAND METRICS

FLURO-Gelenklager GmbH products are available from
MARYLAND METRICS P.O. Box 261 Owings Mills, MD 21117 USA
ph: (410)358-3130 (800)638-1830 fx: (410)358-3142 (800)872-9329
email: sales@mdmetric.com web: http://mdmetric.com
RFQ form: http://mdmetric.com/rfq.htm

Introduction

Rod Ends and Spherical Plain Bearings are assembled machine parts to DIN ISO 12240 (former DIN 648), ready for installation. They are used to guarantee the unproblematic movement between shaft and housing, especially where the movement is not directly linear.

The ***FLURO***® production program consists of Spherical Plain Bearings in all Series (DIN ISO 12240-1) and Rod Ends Series K and E (DIN ISO 12240-4), as well as Hydraulic Rod Ends with weld-on surface or female thread fixable with hexagon socket head cap screws. As new products in this catalogue are Thrust Bearings and Angular Contact Spherical Plain Bearings. To supplement the product range Angle Joints, Fork Heads, Locking Nuts and Rubber Seals have been added.

Where bearings with standard dimensions cannot be used, parts to customer designs are manufactured. Alternatively we can develop solutions for special applications. A small selection of these parts may be seen on the last pages of this catalogue. Our premium trained engineering and quality guarantee staff is pleased to offer advise on any application demand.

With high standard machinery we are able to turn, grind and mill parts with the highest precision. A list of our machining capabilities is available on request.

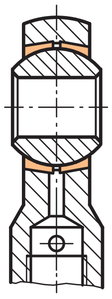
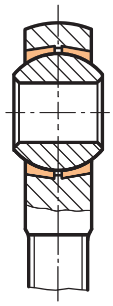
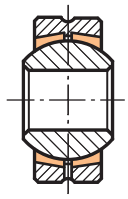
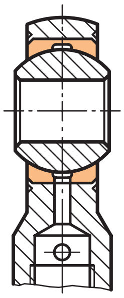
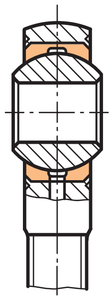
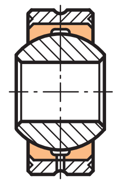
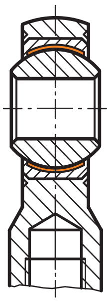
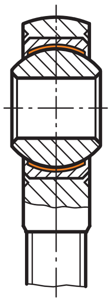
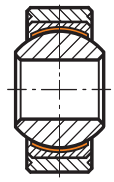
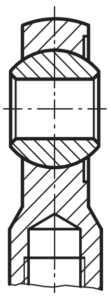
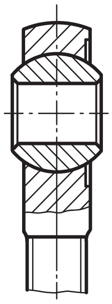
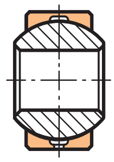
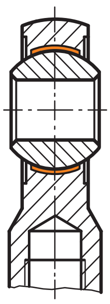
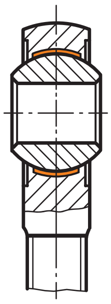
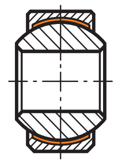
We have been approved for quality assurance to DIN EN ISO 9001 since June 1997.

Our sales staff is happy to assist you with any inquiry.

Just recently our industrial unit was enlarged and modernized. This meant advanced improvements to our logistics and an enlarged stock of products for faster delivery response.

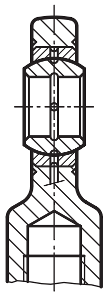
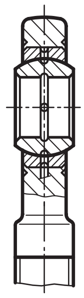
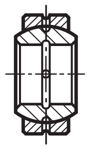
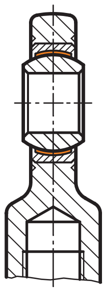
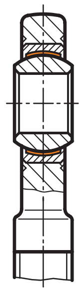
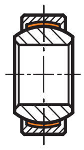
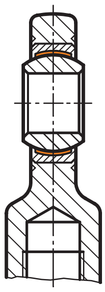
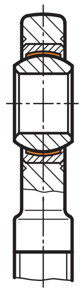
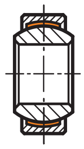
FLURO-Gelenklager GmbH

Production Range Series K

Rod Ends DIN ISO 12240-4 Series K Female Thread			Rod Ends DIN ISO 12240-4 Series K Male Thread			Spherical Plain Bearings DIN ISO 12240-1 Series K with / without outer ring		
GI..	Standard regreasable		GA..	Standard regreasable		GL..	Standard regreasable	
GIS.. GIXS.. GIRS..	Heavy Duty regreasable		GAS.. GAXS.. GARS..	Heavy Duty regreasable		GLXS.. GLRS..	Heavy Duty regreasable	
GISW.. GIXSW.. GIRSW..	Heavy Duty maintenance free		GASW.. GAXSW.. GARSW..	Heavy Duty maintenance free		GLXSW.. GLRSW..	Heavy Duty maintenance free	
GIO..	Steel on Steel		GAO..	Steel on Steel		GXS..	Heavy Duty without Outer Ring regreasable	
GIOW..	maintenance free		GAOW..	maintenance free		GXSW..	Heavy Duty without Outer Ring maintenance free	

FLURO-Gelenklager GmbH

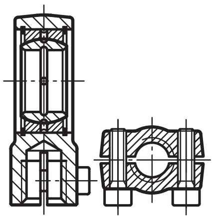
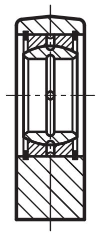
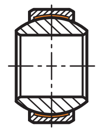
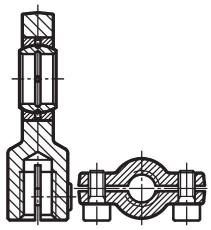
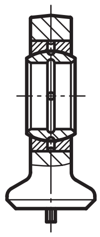
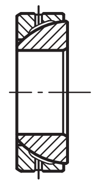
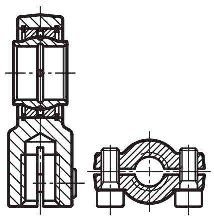
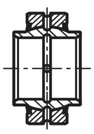
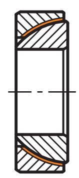
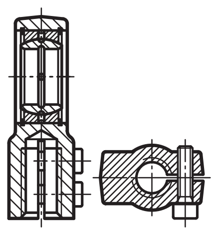
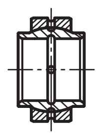
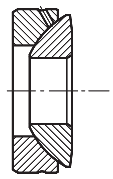
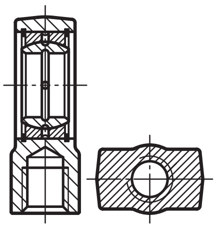
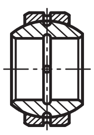
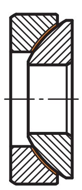
Production Range Series E

Rod Ends DIN ISO 12240-4 Series E Female Thread			Rod Ends DIN ISO 12240-4 Series E Male Thread			Spherical Plain Bearings DIN ISO 12240-1 Series E		
EI..	Steel on Steel		EA..	Steel on Steel		GE..E	Steel on Steel	
EI..D	maintenance free		EA..D	maintenance free		GE..EC	maintenance free	
EI..D-NIRO	Stainless Steel		EA..D-NIRO	Stainless Steel		GE..EC-NIRO	Stainless Steel	

Eccentric Rod End with self-aligning roller bearing

FLURO-Gelenklager GmbH

Production Range

Hydraulic Rod Ends Steel on Steel			Hydraulic Rod Ends + Spherical Plain Bearings Steel on Steel			Spherical Plain Bearings		
FPR..U	Rod End with Locking Device Bearing with Snap Ring		FS..N	rectangular Weld-on Surface Bearing with Snap Ring		GE..FW (-2RS)	maintenance free, Heavy Duty, higher Pivoting Angle	
FPR..S	Rod End with Locking Device Bearing fixed through caulking		FS..C	circular Weld-on Surface Bearing fixed through caulking		GE...SX	Steel on Steel Angular Contact Bearing	
FPR..CE	Rod End with Locking Device Bearing with Snap Ring		GE..HO -2RS	Steel on Steel Ball with Shoulder		GE..SW	maintenance free Angular Contact Bearing	
FMA..D	Rod End with Locking Device Bearing with Snap Ring		GE..LO	Steel on Steel Ball with Shoulder		GE..AX	Steel on Steel Thrust Bearing	
FPR..N	Rod End with shorter thread Bearing with Snap Ring		GE..FO (-2RS)	Steel on Steel, Heavy Duty, higher Pivtoing angle		GX..AW	maintenance free Thrust Bearing	

FLURO-Gelenklager GmbH

Custom made products

Hydraulic Rod Ends designed and intended for marine, harbor and river engineering or lock gates. Completely stainless steel to customer design with maintenance free or regreasable Spherical Plain Bearing. Design and development according to customer requirements.

Connecting rod for highest pressure and tension loads, employed in automotive applications. These parts are supplied completely mounted with required axial distance and torque.

FLURO® Motor Sport Series

FLURO® developed a series for Motor Sport applications:

Motor Sport - MS Series GAXSW..MS / GIXSW..MS
from size 6mm to 25mm, with male or female thread and in fine thread versions. Maintenance free with a tight fit around the Ball.

Design:
- Housing: Heat-treated steel to 42CrMo4, AISI 4140, nickel plated high polish finish
- Insert: Stainless steel to 1.4571, AISI 316Ti with PTFE liner bonded to the inner surface
- Ball: Bearing steel to 100Cr6, AISI 52100 hardened and hard chrome plated
- Zero tolerance through preloaded bearing

Exclusive Motor Sport Catalogue on request !

Motor Sport - MS Series GXSW..MS / GLRSW..MS
from size 6mm to 25mm. Maintenance free with a tight fit around the Ball.

Design:
- Outer Ring (Series GLRSW..MS): Stainless steel to 1.4305, AISI 303
- Insert: Stainless steel to 1.4571, AISI 316Ti with PTFE liner bonded to the inner surface
- Ball: Bearing steel to 100Cr6, AISI 52100, hardened and hard chrome plated
- Zero tolerance through preloaded bearing

Imperial measurements

Rod Ends and Spherical Plain Bearings in imperial measurements
- maintenance free
- with lubrication fittings
- specials on request

FLURO-Gelenklager GmbH

Ordering Details

On pages 4 to 6 we have given full details of our standard range of products. Additional notes to make sure details are correct when placing orders are listed below; additions to and deviations from our standard program are listed, as well.

Female Thread:	The letter **I** is situated in the second place in the reference e.g. G**I** or E**I**
Male Thread:	The letter **A** is situated in the second place in the reference e.g. G**A** or E**A**
Left Hand Thread:	The letter **L** is situated in the third place in the reference e.g. GA**L** or EA**L**
Non-Standard Thread:	Bearing reference with additional thread specification e.g. GISW 30, **M 27x2**
Stainless Steel Ball:	The letter **R** will be added after size reference e.g. GIRSW 10 **R**, GXSW 10 **R**, stainless version (stainless type see pages 26, 27, 32, 33, 43, 45)
Completely Stainless (Series K):	The letters **RR** will be added after size reference e.g. GARSW 16 **RR,** GXSW 16 **RR** (all items in stainless steel)
Completely Stainless (Series E):	The letters **NIRO** will be added after size reference e.g. GE 10 EC-**NIRO** or EI 16 D-**NIRO**
Ball Hard Chrome Plated:	**ICR** will be added after size reference e.g. GASW 10 **ICR**
Seal:	**-2RS** will be added after size reference e.g. GISW 10-**2RS** (see pages 38)
Threaded Bolt:	**Bo** will be added after size reference e.g. GISW 10 **Bo** (for right angle use, see page 39)
Nickel Plated Housing:	**NI** will be added after size reference e.g. GISW 14 **NI** (improved corrosion resistance for the housing) for series on pages 22 to 25, 28 to 31
Special Grease Nipples:	**SN** will be added after size reference e.g. GAS 16 **SN** DIN 71412 H1/A **M6x1** (exact name of grease nipple has to be specified)
Left Hand Thread for Hydraulic Rod Ends:	The letter **L** will be added at the third place replacing the letter **R** e.g. **FPL...N,** except for series FMA...D **= FMAL...D**

For sizes deviating from the standard or for specials, please send us your drawing or sketch – see template on page 78.

The maintenance instructions, selection criteria, tolerances and calculations as shown in the following technical section are intended to be an important guideline for the choice of the correct bearing to suit the particular application of our Rod Ends and Spherical Plain Bearings.

Thread, Pivoting Angle

Threads

Manufactured to standard metric ISO DIN 13 threads. To increase the stability for all standard Rod Ends with male threads, the threads are rolled.

Maximum Pivoting Angle

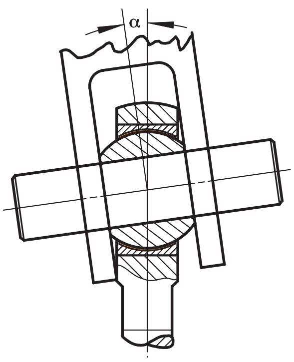
The permissible maximum Pivoting Angle (see picture 3, page 15) ranges between 6° and 35° depending on the series and constructional design.

Rod Ends and Spherical Plain Bearings Series K

Size	Pivoting angle
2	16°
3-4	14°
5-6	13°
8	14°
10-12	13°
14	16°
16	15°

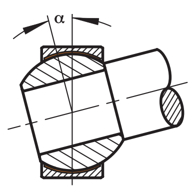
Size	Pivoting angle
18	15°
20	14°
22-25	15°
30	17°
35	19°
40	16°
50	14°

These figures are standard values as indicated in situation 2. Other constructional designs and its calculation examples are indicated in situations 1 and 3.



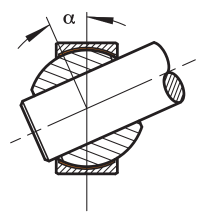
Situation 1

$$\alpha = \sin^{-1}\frac{B}{A} - \sin^{-1}\frac{M}{A}$$



Situation 2

$$\alpha = \sin^{-1}\frac{B}{dK} - \sin^{-1}\frac{M}{dK}$$



Situation 3

$$\alpha = \cos^{-1}\frac{D}{dK} - \sin^{-1}\frac{M}{dK}$$

A = Outside diameter Rod End/Spherical Plain Bearing
B = Width Ball
dK = diameter Ball
M = Width Rod End/Spherical Plain Bearing
D = diameter Bore Ball

Send Inquiries to Maryland Metrics: http://mdmetric.com/rfq.htm email: sales@mdmetric.com web: http://mdmetric.com

Fit, Installation

Recommended fits for the housing's bore to incorporate Spherical Plain Bearings

		Design	Steel Housing Series K	Light Alloy Housing Series K	Steel Series E	Light Alloy Housing Series E
Load	normal	maintenance free	K7	M7	K7	M7
		regreasable	J7/H7	K7	K7	M7
	high	maintenance free	M7	N7	M7	N7
		regreasable	K7	M7	M7	N7

The outside diameter of the Spherical Plain Bearings, Series K is tolerated to h6. For Series E, please refer to each individual product page.

Recommended fit for the shaft

		Design	Series K	Series E GE..E (-2RS) GE..EC (-2RS) GE..EC-Niro GE..HO-2RS	Series G GE::FO (-2RS) GE..FW (-2RS)	Series W GE..LO
Load	normal		h6	g6	g6	h6
	high		k6	j6/h6	j6/h6	j6

The bore diameter of the ball of Spherical Plain Bearings, Series K is tolerated to H7. For Series E, G and W, please refer to each individual product page.

Installation instructions:

Attention: No tolerance or play can be allowed for the shaft when incorporated in the Ball or the Outer Ring when incorporated in a housing. Through this it is guaranteed that the glide movement arises on the nodular gliding surface only.

When mounting extra precaution has to be taken that the press force does not damage the bearing. The press force should not be initiated via the bearing itself. Thermal installation will reduce the necessary press force.

Axial locking of Spherical Plain Bearings:

When under high static or dynamic axial load, vibration, impacting load changes or high pivoting angles Spherical Plain Bearings have to be locked axially.

Possible locking methods:
- locking through several puncher points
- caulking of bearing on the housing through a flanging groove
- with locking snap rings
- clamped with bushings on the facing surface of the Insert

Internal Clearance

Internal Clearance is defined as the radial and axial movement of the ball in the housing or outer ring. Internal Clearance is measured in the non-lubricated state.
The radial clearances listed in the table below have been established with a load of 100N.

Series K Type	Size	Radial Internal Clearance in mm (min./max.)
GI/GA; GIS/GAS; GIXS/GAXS; GIRS/GARS	02 - 10	0,005 - 0,035
	12 - 20	0,010 - 0,040
	22 - 40	0,010 - 0,050
GISW/GASW; GIXSW/GAXSW; GIRSW/GARSW	05 - 10	0,005 - 0,030
	12 - 18	0,005 - 0,035
	20 - 25	0,005 - 0,045
	30 - 40	0,005 - 0,055
GIOW/GAOW	04 - 10	0,005 - 0,040
	12 - 20	0,005 - 0,050
GIO/GAO	05 - 10	0,010 - 0,050
	12 - 20	0,010 - 0,060
GL; GLXS; GLRS; GXS	02 - 10	0,005 - 0,040
	12 - 18	0,005 - 0,050
	20 - 25	0,010 - 0,060
	30 - 40	0,010 - 0,075
	40 - 50	0,015 - 0,095
GLXSW; GXSW; GLRSW	03 - 10	0,005 - 0,035
	12 - 18	0,005 - 0,040
	20 - 25	0,005 - 0,050
	30 - 40	0,010 - 0,060
	40 - 50	0,010 - 0,075

Series E Type	Size	Radial Internal Clearance in mm (min./max.)
EI/EA	06 - 12	0,015 - 0,050
	15 - 20	0,020 - 0,065
	25 - 35	0,030 - 0,085
	40 - 60	0,035 - 0,100
	70 - 80	0,045 - 0,120
EI..D/EA..D EI..D-NIRO EA..D-NIRO	06 - 12	0,000 - 0,030
	15 - 20	0,000 - 0,040
	25 - 35	0,000 - 0,050
	40 - 60	0,000 - 0,055
	70 - 80	0,000 - 0,060
GE...EC-NIRO	06 - 12	0,000 - 0,032
	15 - 20	0,000 - 0,040
	25 - 35	0,000 - 0,050
	40 - 60	0,000 - 0,060
	70 - 90	0,000 - 0,072
	100 - 120	0,000 - 0,085
	140 - 160	0,000 - 0,100

Series E, G, W Type	Size	Radial Internal Clearance in mm (min./max.)
GE...E (-2RS) GE...HO-2RS GE...LO	04 - 12	0,032 - 0,068
	15 - 20	0,040 - 0,082
	25 - 35	0,050 - 0,100
	40 - 60	0,060 - 0,120
	70 - 90	0,072 - 0,142
	100 - 140	0,085 - 0,165
	160 - 240	0,100 - 0,192
	260 - 300	0,110 - 0,214
	320 - 320	0,135 - 0,261
GE...EC (-2RS)	04 - 20	0,000 - 0,040
	25 - 35	0,000 - 0,050
	40 - 60	0,000 - 0,060
	70 - 90	0,000 - 0,072
	100 - 140	0,050 - 0,130
	160 - 180	0,050 - 0,140
	200 - 300	0,080 - 0,190
GE...FO (-2RS)	04 - 10	0,032 - 0,068
	12 - 17	0,040 - 0,082
	20 - 30	0,050 - 0,100
	35 - 50	0,060 - 0,120
	60 - 80	0,072 - 0,142
	90 - 120	0,085 - 0,165
	140 - 160	0,100 - 0,192
	180 - 220	0,100 - 0,192
	240 - 280	0,110 - 0,214
GE...FW (-2RS)	04 - 30	0,000 - 0,050
	35 - 50	0,000 - 0,060
	60 - 80	0,000 - 0,072
	90 - 120	0,050 - 0,130
	140 - 160	0,050 - 0,140
	260 - 280	0,080 - 0,190

Series Hydraulic	Size	Radial Internal Clearance in mm (min./max.)
FPR...S	10 - 12	0,023 - 0,068
FPR...CE	15 - 20	0,030 - 0,082
FPR...N	25 - 35	0,037 - 0,100
FPR...U	40 - 60	0,043 - 0,120
FMA...D	63 - 90	0,055 - 0,142
FS...C	100 - 125	0,065 - 0,165
FS...N	160 - 200	0,065 - 0,192

For special applications Rod Ends and Spherical Plain Bearings are manufactured with smaller or higher internal clearance. **C2** is smaller (tighter fit) than given above and **C3** is higher (increased internal clearance) than given above.

Send Inquiries to Maryland Metrics: http://mdmetric.com/rfq.htm email: sales@mdmetric.com   web: http://mdmetric.com

Lubrication

Maintenance Free Rod Ends and Spherical Plain Bearings must not be lubricated. The ball revolves on a PTFE liner incorporated in the housing.

Rod Ends with Steel running on special Brass, or with Steel running on Bronze, and Steel on Steel require regular lubrication. The first time lubrication has to be carried out when the part is mounted. The regreasing interval depends on the impacting influences, such as ambient conditions (temperature, dust, etc.) and the mechanical impacts given through the application (surface pressure, number of alternation stress, pivoting angle, gliding speed, etc.).

For the lubrication of Spherical Plain Bearings up to a temperature of +110° Celsius, (+230° Fahrenheit) white paste, such as Gleitmo 805k, is recommended. For higher temperatures from +110° to +220° Celsius, (+230° to +428°) Fahrenheit we recommend high temperature grease, such as Notropeen EHT2.

Regreaseable Rod Ends Series K are lubricated by means of a grease nipple to DIN 3405.

For Steel on Steel Rod Ends Series E from size 20 hydraulic grease nipples to DIN 71412 are incorporated.

Temperature range

FLURO® Rod Ends and Spherical Plain Bearings can be operated within the operating temperatures listed below:

Mating surface	Temperature Celsius	Temperature Fahrenheit
Steel/Special Brass	– 50° to +200°	– 58° to +392°
Steel/Bronze	– 50° to +250°	– 58° to +480°
Steel/PTFE liner	–150° to +250°	–238° to +480°
Steel/PTFE Glass fibre liner	– 75° to +150°	–103° to +302°
Steel/Steel	– 50° to +200°	–103° to +392°
GE...EC, FW, AW, SW	– 50° to +150°	– 58° to +302°
GE...-2RS	– 30° to +130°	– 22° to +266°
GE...EC-NIRO	–150° to +250°	–238° to +480°
PTFE/hard chrome	– 50° to +150°	– 58° to +302°

On request: Spherical Plain Bearings, type Steel on Special Bronze with a temperature range up to +450° Celsius or +842° Fahrenheit are available. Also stainless steel Spherical Plain Bearings, type Steel on Steel, with an operating temperature of up to +500° Celsius or +932° Fahrenheit are available.

Material Conversion Table

Material	DIN German	France	Italy	Sweden	UK	USA
1.0402	C22	XC25	C21	1450	070M20	M1023
1.0503	C45	1C45	C45	1650	080M46	Aisi 1045
2.1030	CuSn8					
2.0561	CuZn40Al1					
1.3505	100Cr6	100Cr6	100Cr6	2258	2S135	Aisi 52100
1.7225	42CrMo4	42CrMo4	42CrMo4	2244	708M40	Aisi 4140
1.0718	9SMnPb28K	S250Pb	CF9SMnPb28	1912	230M07	12L13
1.4006	X10Cr13	Z10C13	X12Cn13	2302	410C21	Aisi 410
1.4034	X46Cr13	Z44C14	X40Cr14		420S45	Aisi 420C
1.4057	X20CrNi172	Z15CN16-02	X16CrNi16	2321	431S29	Aisi 431
1.4112	X90CrMoV18					Aisi 440B
1.4125	X105CrMo17	Z100CD17				Aisi 440C
1.4301	X5CrNi1810	Z4CN19-10FF	X5CrNi1810	2332	304S17	Aisi 304
1.4305	X10CrNiS189	Z8CNF18-09	X10CrNiS1809	2346	303S22	Aisi 303
1.4401	X5CrNiMo17122	Z7CND17-12-02	X5CrNiMo1712	2347	316S17	Aisi 316
1.4542	X5CrNiCuNb174	Z7CNU15-05	———	——	———	Aisi 630 (174Ph)
1.4571	X6CrNiMoTi17-12-2	Z6CNDT17-12	X6CrNiMoTi1712	2350	320S18	Aisi 316Ti

Technical Information

Bearing Load ratings

Bearing Load ratings are bearing specific data, derived from the characteristics of the materials used. They are used when selecting Spherical Plain Bearings or Rod Ends for a particular load, but may have to be reduced in adverse operating conditions.

Static Load ratings C_o [kN]

C_o indicates the maximum permissible static load which a Rod End at its weakest cross section can withstand without developing permanent distortion. The C_o values listed in the tables of this brochure have been calculated by using the appropiate material specifications and have been tested on a number of Rod Ends during tensile tests carried out at ambient temperature. 80% of the yield strength resulting from the tests have been used so that a safety factor of 1.25 is included.
The static load C_o is also used for establishing the maximum axial load which is limited by an additional bending stress principally due to the method of fastening of the insert. Following are maximum axial values (deformation) which have been established by pressure testing:

(1) $F_a = F_{a,\,max} = a \cdot C_o$ [kN]

a = ≲ 0,4 for GI/GA + GIO/GAO + GXO
a = ≲ 0,2 for GXSW, GXS, GL mounted in a FLURO® rod end housing
a = ≲ 0,1 for EI/EA, EI/EA...D-NIRO

For Spherical Plain Bearings C_o indicates the radial load, which does not deform the mating surface permanently. Precondition is the stable configuration of the housing.

Dynamic Load ratings C [kN]

This rating is used to establish the working life of Spherical Plain Bearings or Rod Ends when under dynamic load conditions. That is to say when they oscillate, rotate or pivot under load. The values listed in the table result from multiplying the maximum surface pressure p_{max} admissible in gliding movements by the projected bearing surface. A_{proj}, whereby a specific load rating is established for each type of Rod End. The established standard values for maximum surface load for various combinations of anti friction material have been listed in table 1 which allows for movement when oscillating.
Information: Depending on the material strength of the Rod End housing (eg. pages 28 and 29) the static load might be lower than the dynamic load. For this the procedure stated on page 19 has to be observed.

p_{max} [N/mm²]	St/Ms	St/Bz	St/St soft	St/St hard	St/TBz	St/TNy
	50	50	50	100	150	50

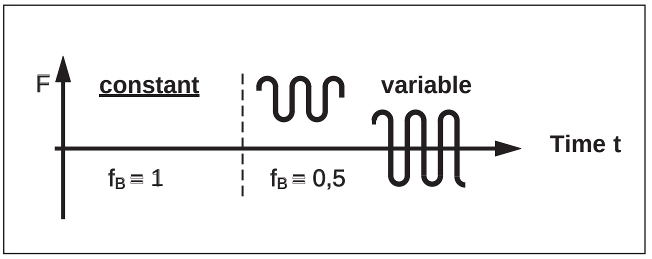
Table 1: Maximum surface pressure

Abbreviations: St = Steel, Ms = Brass, Bz = Bronze, TBz = Woven Bronze Fabric, TNy = Woven Nylon

Forces affecting a Bearing

The loads affecting a Spherical Plain Bearing can vary. They can be:

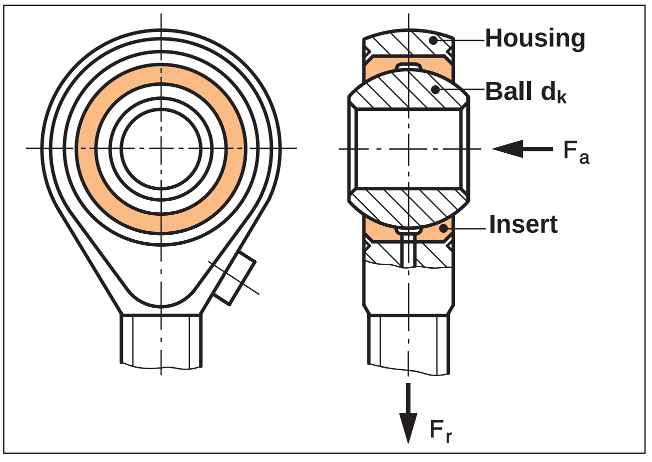
- intermittent, constant or variable (illustration 1)
- static or dynamic



Picture 1: Load factors - check f_B

Forces when under static load

Radial only (F_r) or radial and axial (F_a) forces arise and there is no movement between the ball and the insert (Picture 2).



Picture 2: Radial and axial forces

Forces when under dynamic load

Radial or radial and axial forces arise, when the Ball pivots at angle α, oscillates at angle ß or rotates relative to the Insert.

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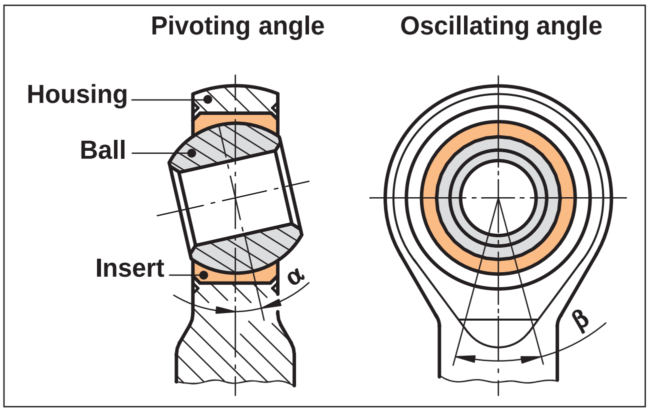


Picture 3: Pivoting and oscillating angle

In the case of a **constant load F_r, F_a** a dynamically equivalent bearing load F_e can be established in accordance with formula (2).

(2) $$F_e = F_r + Y \cdot F_a \quad [kN]$$

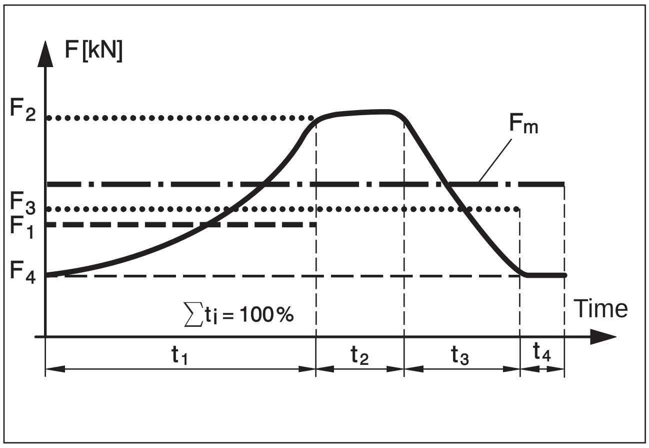
therefore: $F_e \leq F_{r,\,max}$ according to formula (6);
$F_a \leq F_{a,\,max}$ (6_a)

The axial factor Y in table 2 is dependent on the load ratio.

Load ratio $F_a : F_r$	0,1	0,2	0,3	0,4	0,5
Axial factor Y	0,8	1	1,5	2,5	3

Table 2: Axial factor Y

In the case of a **variable load** (picture 4), formula (4) can be used to calculate a mean dynamic bearing load F_m from the individual load levels F_i and the appropriate time factor t_i.



Picture 4: Variable load against time

(3) $$F_m = 0{,}1\sqrt{F_1^2 \cdot t_1 + F_2^2 \cdot t_2 + \ldots)} \quad [kN]$$

Force F [kN] : time component t [%]
therefore the following must be valid: $F_{i,\,max} \leq F_{r,\,max}$ according to (6)

In case of an additional axial load the equivalent bearing load is calculated according to formula (4).

(4) $$F_e = F_m + Y \cdot F_a \quad [kN]$$

Axial factor Y according to table 2
$F_a \leq F_{a,\,max}$ according to (6a)

Selection of the bearing size

The selection is usually made step by step, repeated if necessary, by comparing -

1. the load ratio involved with the normal minimum values for that ratio;
2. the forces affecting the bearing and the maximum permitted load of the bearing proposed;
3. the maximum surface pressure and the surface pressure on the proposed bearings;
4. the maximum glide speed and the glide speed involved of the bearing proposed;
5. the specific performance of the bearing involved with the published catalogue limits.

Re 1:
The load ratio (C/F) is a value for a specific use of a bearing according to formula (5).

(5) $$(C/F)_{exist} \geq (C/F)_{min}$$

The common minimum values for (C/F) for different antifriction surfaces as listed in table 3, can be used to establish the required dynamic load rating C in accordance with formula (5a) by changing formula (5). By this means a suitable bearing size can be selected from the tables of this catalogue.

	St/Ms	St/Bz	St/St	St/TBz	St/TNy
$(C/F)_{min}$	2	2	2	1,75	1,5

Table 3: Typical load ratios

(5a) $$C_{reg} \geq (C/F)_{min} \cdot F_{exist} \quad [kN]$$

Technical Information

Re 2:
When the existing force affecting the bearing is a static load, it can be used as is for a comparison. When it is a dynamic load, it can be calculated by using formula (2), (3) or (4).
When a Rod End is mounted with a locking nut or retransfer with two nuts, the additional tensile stress at the male thread or the connecting rod has to be taken into consideration.
However the static or dynamic load must always be smaller than the maximum permitted load, which is calculated from the static load rating C_o using formula (6).This might have to be further reduced by the load factor f_B (picture1) and the temperature factor f_T (table4).

Temperature C Temperature F	80° 176°	100° 212°	150° 302°	200° 392°	250° 480°
greased	1	1	1	0,8	0,5
maintenance free	1	1	0,8	0,5	0,3

Table 4: Temperature factor F_T

(6) $$F_{r,\,max} = C_o \cdot f_B \cdot f_T \quad [kN]$$

(6a) $$F_{a,\,max} = a \cdot F_{r,\,max} \quad [kN]$$

If no bearing size is given in the application the required static load rating can be established by changing formula (6) and a Rod End can be selected from the tables accordingly.

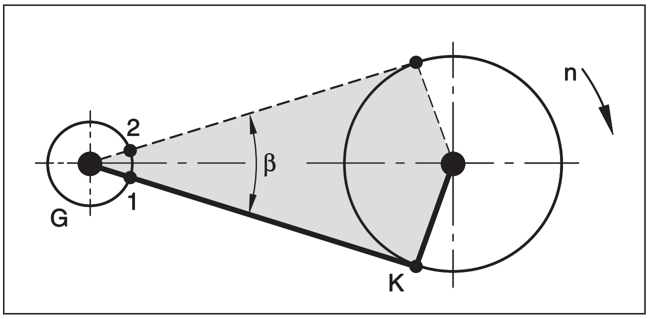
(7) $$C_{o,\,reg} \geq \frac{F_{exist}}{f_B \cdot f_T} \quad [kN]$$

Re 3:
The load on a mating surface can be worked out by using formula (8). It must be less than the standard value for surface load according to the antifriction combination of materials, selected as listed in table (1).

(8) $$p_{exist} = p_{max} / (C/F)_{exist} \quad [N/mm^2]$$

p_{max} acc.to table1, F acc.to formula (2),(3) or (4)

Re 4:
The existing average glide speed v_m is calculated according to formula (9) using the frequency of rotation of the crank K and the glide distance of the Spherical Plain Bearing G. (At one rotation of K it corresponds to the double arc b between the centres 1 and 2 in Picture 5 and thus to the double maximum oscillating angle ß).



Picture 5: Oscillating angle ß relative to crank rotation

(9) $$v_{m,\,exist} = 2 \cdot b \cdot f = \frac{d_k \cdot ß \cdot f}{1000 \cdot 57{,}3 \cdot 60} \quad [m/s]$$

Diameter of ball d_k [mm] (page 17) and f [1/min]

In case where the bearing rotates fully ß needs to be substituted by 180°. The slip speed has to be less than the speed permissible listed in table 5.

V_{max} [m/s]	Oscillation	Revolution
Steel/Steel	0,15	0,10
Steel/Bronze (Brass)	0,25	1,00
Maintenance free	0,25	0,35 short temporary intervals only

Table 5: Maximum slip speed

Re 5:
The product p.v can be defined as a specific bearing performance P_L (see formula 10). Thus, an estimated value for the heat build-up per mm^2 of the Spherical Plain Bearing surface ist available, mainly dependent on the antifriction material combination, the lubrication/ cooling applied and the surface pressure and glide speed. By increasing temperate the allowable surface pressure of maintenance free bearings is decreasing (picture 1 and 4).

(10) $$P_{L,\,exist} = p_{exist} \cdot v_{exist} \quad \left[\frac{N \cdot m}{mm^2 \cdot s} = \frac{W}{mm^2}\right]$$

Slip speed v according to (9)
Surface pressure p according to (8)

After the selection of the bearing the following is valid:
$P_{L,\,exist} \leq P_{L,\,max}$

$P_{L,\,max}$ [W/mm²]	Steel/Bz, (Brass), (Steel)	Maintenance free
	0,5	1,3

Table 6: Maximum specific bearing performance

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Technical Information

Bearing life calculations

In the case of a static load it is not necessary to calculate the working life. The permissible limit set at 80% of the breaking point allows the forces to act indefinitely.

In the case of dynamic loads calculating the bearing life is problematic. There are many, sometimes interdependent influences, that cannot always be taken into consideration.Therefore, a calculation of the bearing life can only be approximate. As an approximation the bearing has an increased life proportional to its load rating and also when used at a moderate speed.

Additional influences can be taken into account by making use of the factors in formula (11).

(11) $$G_h \approx 3 \cdot f_L \cdot f_T \cdot f_G \cdot f_V \left(\frac{C/F}{v_m}\right)_{exist} \quad [h]$$

f_L = Direction of load to table 7
f_T = Temperature factor to table 4
f_G = Glide factor to table 8
f_V = Relubrication factor to table 9
C/F = Load ratio
v_m = Mean glide speed [m/s]

The direction of load factor indicates whether the direction of load is uni-directional, constant, variable or oscillating.

Direction of load	Steel/Steel	Steel/Bz	Steel/PTFE
unidirectional	1	1	1
varying	2,5	2	1

Table 7: Directional load factors f_L

The slip factor f_G takes into account the materials used on the mating surfaces of a bearing. As a result the only distinction that can be made is between being maintenance-free (not lubricated) and where lubrication is necessary.

$(C/F)_{exist}$	1,5	2	3	4	6	8	10	15	20
maint. free	1,5	2,0	2,5	3,0	3,5	4,0	4,3	4,7	5,0
greased	1,1	1,2	1,3	1,4	1,6	1,8	2,1	2,4	2,5

Table 8: Glide factors f_G

The relubrication factor f_v takes into account the extension of the bearing life G_h when regularly lubricated. The greater the surface pressure p_{exist} the more often the bearing has to be relubricated. If the bearing is only lubricated on commissioning as in the case of bearings with PTFE liners, f_v = 1 has be inserted.

p_{exist} [N/mm²]	5	10	25	40
Regular regreasing regreasable bearing	6	4	3	2
Initial greasing + PTFE	1	1	1	1

Table 9: Relubrication factors f_v

Lubrication intervals are dependent on load conditions and therefore have to be set by the operator.

Ball diameter for Rod Ends and Spherical Plain Bearings

Series K		Series E	
Size	Ø dk	Size	Ø dk
2	5,20	6	10,0
3	7,94	8	13,0
4	9,52	10	16,0
5	11,11	12	18,0
6	12,70	15	22,0
8	15,87	17	25,0
10	19,05	20	29,0
12	22,22	25	35,5
14	25,40	30	40,7
16	28,57	35	47,0
18	31,75	40	53,0
20	34,92	45	60,0
22	38,10	50	66,0
25	42,86	60	80,0
30	50,80	70	92,0
35	57,15	80	105,0
40	65,96	90	115,0
50	82,00	100	130,0

Calculation Examples

1. Example:

In a paper machine used for manufacturing writing pads a rod end with female thread is used.
The dimensions of the components in the machine require size 16, and the following values are also given:

Variable radial load through $F_r = \pm 2$ kN; No axial load
Max. angle of misalignment $ß = 20°$; Oscillating interval f = 150/min.; operating temperature T = +50º Celsius, +122º Fahrenheit
Regular lubrication possible

1. Initial selection of Rod End

a) Type of Bearing Rod Ends Series GI, GIS, GIXS, GIRS, GIO can be used when relubricating.
However, the following have to be excluded
- GIO, because it cannot be lubricated and only moderate movements are possible.
- GIRS, a stainless steel type is unneccessary as the working environment is not corrosive.
  So we can choose from female rod end types GI, GIS, GIXS.

b) Size The required diameter of the ball is 16 mm and the following values for GIS can be ascertained from the brochure on pages 17 and 22.

$d_k = 28{,}6$ mm; $C_o = 32{,}0$ kN; $C = 21{,}5$ kN

b_1) required static load rating C_o [formula 7 + picture 1 + table 4]

$$C_{o,\,req} \geq \frac{F_{exist}}{f_B \cdot f_T} = \frac{2}{0{,}5 \cdot 1} = \underline{\underline{4\text{ kN}}}$$

b_2) required dynamic load rating C [formula 5a + table 3]

$$C_{req} \geq (C/F)_{min} \cdot F_{exist} = 2 \cdot 2 = \underline{\underline{4\text{ kN}}}$$

Check

$C_{o,\,exist} = 32{,}0\text{ kN} > C_{o,\,req} = 4\text{ kN}$
$C_{exist} = 21{,}5\text{ kN} > C_{req} = 4\text{ kN}$
$F_r = 2\text{ kN} \leq F_{r,\,max} = C_o \cdot f_B \cdot f_T = 32{,}0 \cdot 0{,}5 \cdot 1 = 16{,}0\text{ kN}$

2. Checking the surface pressure [formula 8 + table 1]

$$p_{exist} = \frac{p_{max}}{(C/F)_{exist}} = \frac{50}{21{,}5/2} = \frac{50}{10{,}75} = \underline{\underline{4{,}65\text{ N/mm}^2}} < p_{max} = 50\text{ N/mm}^2$$

3. Checking the slip speed [formula 9 + table 5]

$$v_{m,\,exist} = \frac{d_k \cdot ß \cdot f}{1000 \cdot 57{,}3 \cdot 60} = \frac{28{,}6 \cdot 20 \cdot 150}{1000 \cdot 57{,}3 \cdot 60} = \underline{\underline{0{,}025\text{ m/s}}} < v_{max} = 0{,}25\text{ m/s}$$

4. Checking the specific bearing performance [formula 10 + table 6]

$$P_{L,\,exist} = p_{exist} \cdot v_{m,\,exist} = 4{,}65 \cdot 0{,}025 = \underline{\underline{0{,}12\text{ W/mm}^2}} < P_{L,\,max} = 0{,}5\text{ W/mm}^2$$

5. Calculation of bearing life [formula 11 + table 7 + 4 + 8 + 9]

$$G_h \approx 3 \cdot f_L \cdot f_T \cdot f_G \cdot f_V \cdot \left(\frac{C/F}{v_m}\right)_{exist} = 3 \cdot 2 \cdot 1 \cdot 2{,}1 \cdot 6 \cdot \frac{10{,}75}{0{,}025} = \underline{\underline{32.500\text{ hrs.}}}$$

6. Final selection

Following steps 1b to 5. - the calulations for rod ends GI 16 and GIXS 16 can be checked.
When making a decision on the bearing to use, design, application and price have to be taken into consideration for each type.

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Calculation Examples

2. Example:

In a mechanical handling facility multi-directional radial loads are applied to the rod end. These loads are the same as shown in illustration 4, page 15. Four separate loads $F_{r,i}$ with the four appropriate time components have been substituted as shown below:

$F_{r1} = 2$ kN, $t_1 = 50\%$; $F_{r2} = 4$ kN, $t_2 = 16\%$; $F_{r3} = 2{,}4$ kN, $t_3 = 24\%$; $F_{r4} = 1$ kN, $t_4 = 10\%$;
Additionally the rod end is subjected to a constant axial load $F_a = 0{,}65$ kN
Further operating conditions: max. angle ß = 30º; oscillation frequency f = 60/min.; max. temperature 70ºC

1. Initial selection of Rod End

a) Type of bearing As regular lubrication is not possible due to poor accessibility a maintenance free type must be used. Rod Ends GASW, GAXSW, GARSW, GAOW could be suitable, but the following series have to be ruled out.
- GAOW - these Rod Ends are only suitable for restricted movement.
- GARSW - because the working environment is not corrosive.

This leaves the size of the male thread version of type GASW to be established.

b) Size b_0) mean and equivalent bearing load [formula 3 + 4 + table 2]

$$F_m = 0{,}1\sqrt{\Sigma F_i^2 \cdot t_i} = 0{,}1\sqrt{2^2 \cdot 50 + 4^2 \cdot 16 + 2{,}4^2 \cdot 24 + 1^2 \cdot 10} = \underline{\underline{2{,}46 \text{ kN}}}$$

$$F_e = F_m + Y \cdot F_a = 2{,}46 + 1{,}26 \cdot 0{,}65 = \underline{\underline{3{,}28 \text{ kN}}} \qquad Y = 1{,}26 \text{ for } F_a/F_m = 0{,}65/2{,}46 = 0{,}26$$

b_1) required static load rating C_o [formula 7 + picture 1 + table 4]

$$C_{o,\,req} \geq \frac{F_{exist,\,e}}{f_B \cdot f_T} = \frac{3{,}28}{0{,}5 \cdot 1} = \underline{\underline{6{,}56 \text{ kN}}}$$

b_2) required dynamic load rating C [formula 5a + table 3]

$$C_{req} \geq (C/F)_{min} \cdot F_{exist} = 1{,}75 \cdot 3{,}28 = \underline{\underline{5{,}75 \text{ kN}}}$$

c) Bearing selected GASW 12 with $d_k = 22{,}2$ mm (page 17) and $C_o = 23{,}5$ kN $C = 32{,}0$ kN (page 29)

Check [formula 6 + 6a]

$C_{o,\,exist} = 23{,}5 \text{ kN} > C_{o,\,req} = 6{,}56 \text{ kN}$ $F_{r2} = 4{,}00 \text{ kN} \leq F_{r,\,max} = C_o \cdot f_B \cdot f_T = 23{,}5 \cdot 0{,}5 \cdot 1 = 11{,}75 \text{ kN}$
$C_{exist} = 32{,}0 \text{ kN} > C_{req} = 5{,}75 \text{ kN}$ $F_a = 0{,}65 \text{ kN} \leq F_{a,\,max} = a \cdot F_{r,\,max} = 0{,}2 \cdot 11{,}75 = 2{,}35 \text{ kN}$
[a = 0,2 see formula 1]

Note: When selecting the size the dynamic load C_{req} should not exceed the static load $C_{o,\,exist}$

2. Checking the surface pressure [formula 8 + table 1]

$$p_{exist} = \frac{p_{max}}{(C/F)_{exist}} = \frac{150}{32{,}0/3{,}28} = \frac{150}{9{,}75} = \underline{\underline{15{,}38 \text{ N/mm}^2}} < p_{max} = 150 \text{ N/mm}^2$$

3. Checking the slip speed [formula 9 + table 5]

$$v_{m,\,exist} = \frac{d_k \cdot ß \cdot f}{1000 \cdot 57{,}3 \cdot 60} = \frac{22{,}2 \cdot 30 \cdot 60}{1000 \cdot 57{,}3 \cdot 60} = \underline{\underline{0{,}011 \text{ m/s}}} < v_{max} = 0{,}25 \text{ m/s}$$

4. Checking the specific bearing performance [formula 10 + table 6]

$$P_{L,\,exist} = p_{exist} \cdot v_{m,\,exist} = 15{,}38 \cdot 0{,}011 = 0{,}17 \text{ W/mm}^2 < P_{L,\,max} = 1{,}3 \text{ W/mm}^2$$

5. Calculation of bearing life [formula 11 + table 7 + 4 + 8 + 9]

$$G_h \approx 3 \cdot f_L \cdot f_T \cdot f_G \cdot f_V \cdot \left(\frac{C/F}{v_m}\right)_{exist} = 3 \cdot 1 \cdot 1 \cdot 4{,}2 \cdot 1 \frac{9{,}75}{0{,}011} = \underline{\underline{11.100 \text{ hrs.}}}$$

6. Final selection

Steps 1c to 5 can then be repeated for series GAXSW so that after comparing the required material strength, price etc. of each type, a final decision can be taken.

FLURO-Gelenklager GmbH

Marine / Food Processing and Chemical Application

Rod Ends / Spherical Plain Bearings

with high corrosion resistance

For use in marine applications and high corrosive environments

Standard Series in sizes 6 to 35 mm:

Version: maintenance free, female or male thread, right or left hand thread
dimensions identical with data sheets on pages 32, 33 and 47

Materials:

Housing: stainless steel to 1.4057, Aisi 431 forged, polished

Insert: stainless steel to 1.4571, Aisi 316Ti with PTFE liner with stainless steel fabric

Ball: stainless steel to 1.4401, Aisi 316 ground, polished

Explanation: The high strength housing combined with high corrosion resistance enables the usage for a variety of applications.
Likewise with other stainless steel material, depending on the substances causing corrosion the danger of corrosion still exists, e.g. galvanic corrosion (bimetallic or contact corrosion), crack corrossion, opening corossion, stress crack corrosion etc.
To achieve a higher corrosion protection the following constructional measures are to be observed:
- protection against substances causing corrosion: RERS or RELS seals, FLURO® catalogue page 74
- prevent uncontrollable current, e.g. leakage current
- cathodic corrosion protection, e.g. sacrificial anode
- avoid cracks (crack corrosion)
- connecting components and material of corresponding material, no potential difference

On request: For applications with highest corrosion protection and on request FLURO® can offer Rod Ends and Spherical Plain Bearings to DIN or to customer specifications to all common materials e.g. stainless steel to 1.4542 (17-4Ph), 1.4462, 1.4539, 2.4856 (INCONEL Alloy 625), bronze, Alu bronze, Titanium, just to list a few.

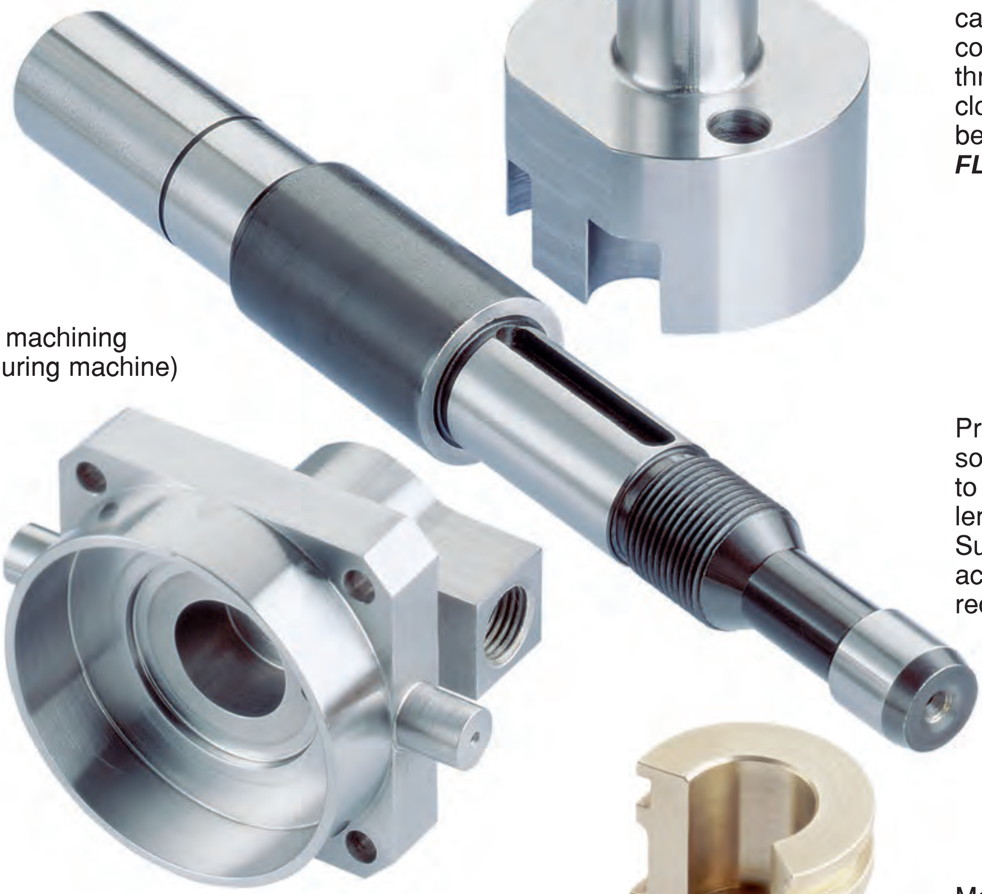
Precision Parts

Martin Höhn GmbH

Höhn Precision Parts - this name represents quality production. Fourty years of experience guarantee the companies reliable capability. The continuously modernized machine park enables a flexible and economic production of turned and machined parts.
Variety for Höhn does mean that besides the turning, machining and grinding of parts, also complete components and assemblies are manufactured.
In agreement with the TÜV Southwest, Höhn received stamp authorization for continued re-stamping of material specification 3.1.B. since 1981. Höhn achieved also the

DIN EN ISO 9001:2000 certification.

This connecting rod with bearing for carriages shows a constructive solution through the close cooperation between ***Höhn*** and ***FLURO***®.



5-axial symmetric machining (3-D measuring machine)

Production of all sorts of shafts, Ø 20 to Ø 120 x 1000 mm length.
Surface finish according to customer requirements.

Machining of the rod from Ø 10 to Ø 80 mm, chucking parts from Ø 10 to Ø 300 mm.

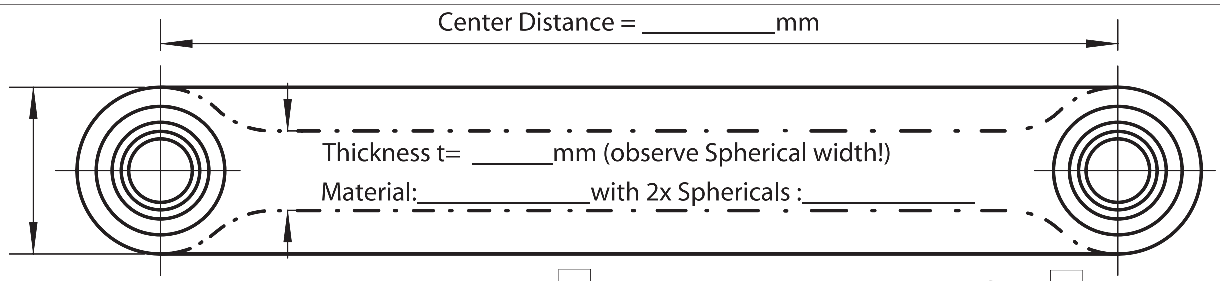
Höhn processes all sorts of steel e.g.: Titan, Hasteloy, 17-4Ph, non-iron and non-ferrous heavy metal. Though constant stock of stainless steel material such as 1.4104, Aisi 430F, 1.4301, Aisi 304, 1.4305, Aisi 303, 1.4571, Aisi 316Ti, 1.4541, Aisi 321 a prompt delivery response is guaranteed.

FLURO-Gelenklager GmbH

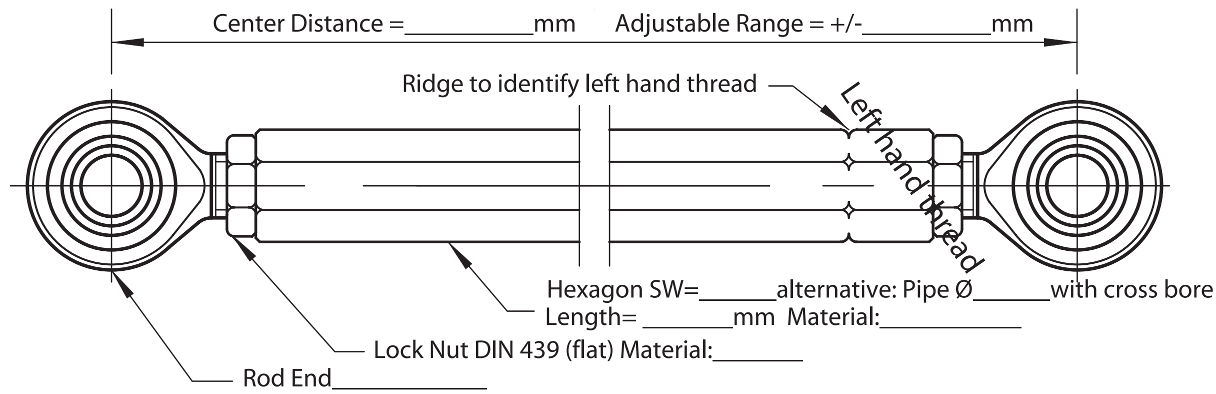
Inquiry Template Special Parts

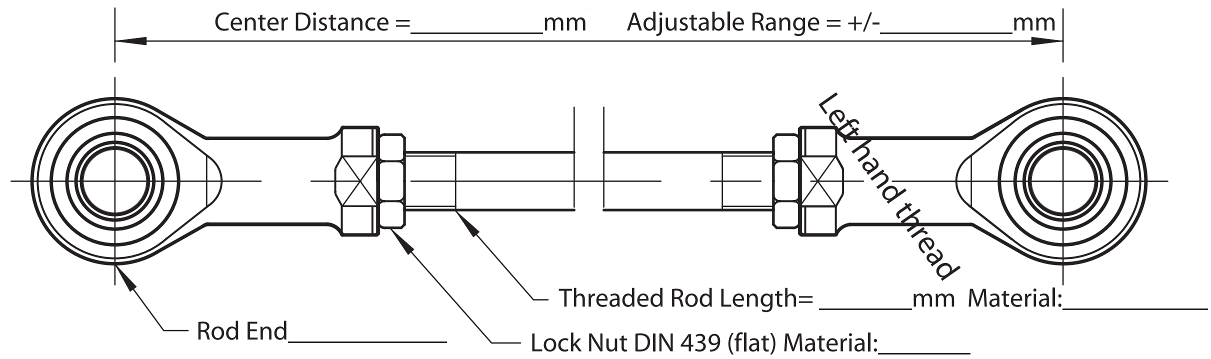
Fax to: (410)358-3142 (800)872-9329
or email to: sales@mdmetric.com

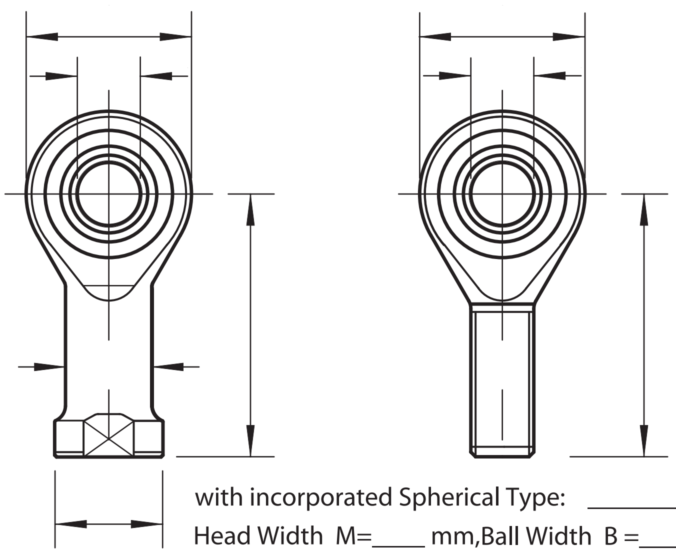
Company: ____________________ Contact: ____________________ Phone: ________________



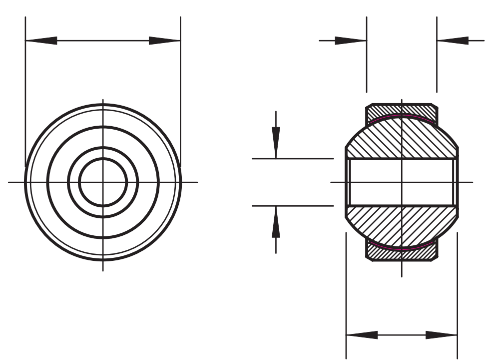
Please indicate: Form A ☐ Form B ☐







with incorporated Spherical Type: __________
Head Width M=____ mm,Ball Width B =____ mm
Thread Length GL=______ mm, Thread G=_____



Material Ball: ______________
Material Outer Ring: ______________
Maintenance free: Yes ☐ No ☐

FLURO-Gelenklager GmbH

Send Inquiries to Maryland Metrics: http://mdmetric.com/rfq.htm email: sales@mdmetric.com web: http://mdmetric.com

Custom-Made Products