Technical Notes

Bearing slackness:

Bearing slackness or bearing clearance is the dimension by which the inner ring can be moved within the bushings in a radial or axial direction when not installed and unlubricated. Rod ends and spherical bearings are manufactured with differing bearing slackness, as shown in the following charts, depending on the friction pairing and the size of the bearing. **When mounting bearings, please note that the slackness can be reduced to null if necessary, due to possible differences in tolerance (bearing diameter to housing bore hole).**

The test load is 100 N.

Bearing slackness in lubricated design
(at room temperature)

Radial slackness in µm

Size	C2		Normal		C3	
	min	max	min	max	min	max
2– 4	–	–	10	30	–	–
5– 8	5	10	10	30	30	60
10–14	10	20	20	40	40	80
16–20	15	25	30	50	50	100
22–30	20	30	40	60	60	120
35–50	40	60	60	90	90	150

Fig. 1

Bearing slackness in maintenance-free design
(at room temperature)

Radial slackness in µm

Size	C2		Normal		C3	
	min	max	min	max	min	max
2– 4	–	–	2	4	–	–
5–30	–	–	5	10	10	20
35–50	–	–	10	20	20	40

Fig. 2

The axial slackness is 2 to 3 times the radial slackness under the same test load (measured at room temperature).

Selection of bearing slackness:

Lubricated design

If there are no special reasons for a reduced bearing slackness according to C2, the “Normal” radial slackness must be selected as it offers the best lubricating grease distribution with a high bearing contact area.

All rod ends and spherical bearings are supplied with “Normal” radial slackness unless otherwise ordered.

Maintenance-free design

These bearings are remarkable for their low bearing slackness and a high contact area ratio. Unless otherwise ordered, the maintenance-free rod ends are supplied with “Normal” radial slackness.

If the overall friction movement should be kept low when several rod ends or spherical bearings are used, bearings with a radial slackness in accordance with C3 should be used also.

Consideration of the environment:

It is recommendable to apply a stainless or sealed type when using it in a humid environment.

Accordingly to the individual customer’s requirements, the bearings are delivered in the following special designs:

stainless and acid-proof
high temperature-proof
low temperature-proof
etc.

Lubrication:

All relubricatable rod ends and bearings are supplied ungreased. We recommend lubrication with an anticorrosive Lithium-based pressure-resistant grease or a Lithium-complex metal soap (multipurpose antifriction bearing grease) for the temperature range of –20° C to +125° C. For temperatures above 125° C a high temperature grease must be used and for temperatures below –20° C a low temperature grease must be used.

Initial lubrication and relubrication, lubrication intervals

Under severe conditions and at high load, a temperature check is recommended shortly after commissioning. If a temperature rise of 25° C occurs after a running-in time of approx. 1 hour of operation, immediate lubrication is necessary. A periodical relubrication is necessary in any event.

Rod ends and spherical bearings under alternate load from both sides require shorter intervals between lubrication than rod ends and spherical bearings under load from one side only. The lubrication intervals depend on the individual circumstances and on the surrounding conditions.

The following guideline values apply for the minimum lubricating periods:

With load from one direction

$$t = \frac{G_h}{30}$$

With load from alternating directions

$$t = \frac{G_h}{130}$$

t = lubricating period in hours of operation.

G_h = duration of use in hours of operation (see page 9).

Lubricating more often does not have any advantages, furthermore it can damage the hydrodynamic balance on the sliding surface.

If the lubricating periods are not observed, the service life can decrease.

The rod ends with female thread are equipped from size 5 upwards with funnel-type lubricating nipples to DIN 3405, those with thread from size 6 upwards. We can supply other lubricating nipples on request.

During the running-in time of the maintenance-free types only a small part of the PTFE is transferred from the sliding foil to the inner ring. Hereby a smoothing effect arises. This reduces the friction and leads to the longer durability. A greasy or oily film prevents this smoothing effect. Thus, we recommend using these elements without lubrication.

Operating temperature:

All designs can be used without restriction in a temperature range from –30° C to +120° C. Increasing the operating temperature reduces the bearing power and, thus, the service life.

Operation at high temperature of relubricatable rod ends and spherical bearings depends to a very great extent on whether the high-temperature lubricating grease used offers sufficient lubricity at high operating temperatures. These designs could be used in the short term under low load and with suitable lubrication at temperatures up to +250° C.

The maintenance-free bearings can be used in a temperature range from –50° C to +150° C (mind the decrease or the increase of bearing slackness).

Sealed rod ends and spherical bearings can be used at temperatures from –20° C to +120° C (sealing sleeves of Perbunan). For higher temperatures up to +250° C sealing sleeves can be specially made from fluorelastomer rubber (Viton®).

Moment of friction M:

The moment of friction for rod ends and spherical bearings can be calculated using the following equation:

$$M = 5 \cdot 10^{-4} \cdot \mu \cdot P \cdot K$$

M = moment of friction [Nm]
μ = friction coefficient of sliding surface
P = dynamically equivalent bearing load [N]
K = inner ring diameter [mm]

Guideline values for the friction coefficient μ

Bearing type	Friction coefficient μ min	max
lubricated	0,08	0,15
maintenance-free	0,03	0,10

Fig. 3

The low friction coefficients apply for high loads ($p = 80–100$ N/mm²) at low running speeds ($v = 5–10$ m/min). The high friction coefficients are for low loads ($p = 5–10$ N/mm²) at high running speeds ($v = 30–60$ m/min).

p = specific surface pressure [N/mm²]
v = running speed in the lining [m/min]

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Bearing capacities:

The dynamic bearing capacity C:

The dynamic bearing capacity C is a characteristic value for the calculation of the service life of rod ends and spherical bearings under dynamic load, i.e. having to perform tilting, swinging or pivoting movements under load.

The dynamic bearing capacity C is based on the values given in the table for the specific surface pressure k_c:

Type of bearing	Specific surface pressure k_c [N/mm²]
lubricated	50
maintenance-free	150

Fig. 4

The static bearing capacity C_o:

The static bearing capacity C_o represents the maximum permissible load at which no permanent deformation of the lining or the outer part occurs. In the case of the spherical bearing, the surrounding components must be so designed that they prevent any deformation of the bearing.

In the case of rod ends, C_o corresponds to the permissible load based on the weakest cross-section which results form the yield point of the outer material, **with a safety factor of 1,2.**

The ultimate load is at least 1.5 the permissible C_o load.

The axial load-bearing capacity:

The axial load-bearing capacity of the rod ends and the spherical bearings is limited by the axial fixing of the bushing (flanged) in the outer part.

In the case of spherical bearings without steel outer ring (types SC.. and SCP..), it must be ensured that the axial bushing support can absorb the forces given in the table (Fig. 5) both statically and dynamically.

The maximum permissible axial load is calculated on the basis of the values given in the table.

Heavy-duty and maintenance-free series	Permissible axial load dynamic $F_{a\ perm.}$ [N]	static $F_{a\ perm.}$ [N]
SFC/SMC/SSC.. SFRC/SMRC/SSRC..	$0,06 \cdot C_o$	$0,3 \cdot C_o$
SFXC/SMXC/SC..	$0,04 \cdot C_o$	$0,2 \cdot C_o$

Fig. 5