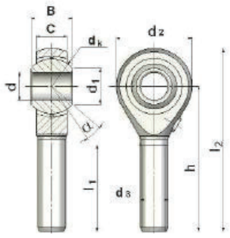
Definitions

Dimensional standards

ISO 12240–4



The international standard sets the dimensions of rods with spherical bearing assembled. It also specifies tolerances relative to the dimensions.

The diameter of the head d2 is sized at the lower value of the standard, which gives our rod-end bearings minimal size and weight, thus ensuring total interchangeability with any other rod-end bearing meeting the standard.

European and American aerospace standards

Schaublin SA manufactures and distributes spherical bearings and self-lubricated bushes to the following standards:
EN2584, EN2585, EN3048, EN4613, EN4614, EN2022, EN2023, EN2501, AS14101, AS14102, AS14103, AS14104, AS81935/1, AS81935/2, AS81820/1, AS81820/2, AS81820/3, AS81820/4, AS81934/1, AS81934/2, AS81936/1, AS81936/2, AS21154, AS21155, AS21240, AS21241, AS21242, AS21243, EN2285, EN2286, EN2287, EN2288

Field of application

Rod-end and spherical bearings are designed to be used between the fixed or moving components of mechanical assemblies.

- Assembly, alignment
- Transmission of movements, loadings
- Joints

Spherical bearings are designed for applications with movements at low rotation speeds. They are sized according to the loading and operating cycle required.

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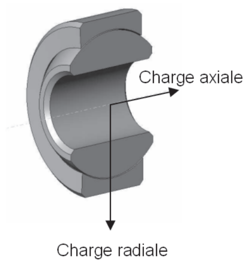
Calculations

Static loading

The **basic static loading** C_0 is given in the tables of dimensions.
For a rod-end bearing, it is limited by the strength of the mount.

The values given in the Unibal standard programme tables are calculated from the elastic limit of the mount material (C_{se}) taking a safety factor into account:

$$C_0 = \frac{C_{se}}{1.25}$$



In the case of a spherical bearing, the basic static loading C_0 is calculated using the following formula:

$$C_0 = d_k \times C \times 0.85 \times X$$

d_K: diameter of the inner bush sphere (mm)
C: width of the mount (mm)
X: Stress admissible by the material ($daN.mm^{-2}$)

Fatigue resistance: Please note that values given in the tables of dimensions are for occasional static loadings. Ask us where fatigue resistance is required.

Axial static loading

The following table gives the values for the axial static loading not to be exceeded for spherical and rod-end bearings.

Standard series, .40, .45, .50,.51 and .52	Limit axial static loadings F_a adm.
SME/SFE/SMEM/SSE	8% C_0
SM/SF SMG/SFG SS/SSA	20% C_0

C_0: Basic static loading (see tables of dimensions pages 24 to 47)

In the case of rod-end bearings, it must also be ensured that the thread is properly located so as to prevent any risk of buckling or stripping of the rod-end bearing shank.
In the case of spherical bearings (SS, SSA, SSE), attention must be paid to maintaining the cage axially (see assembly instructions chapter, page 23)

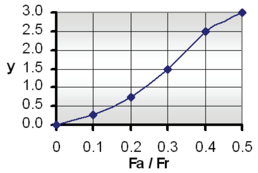
Checking the application

Proceed as follows to check the choice of a spherical bearing:

- Calculate and check whether the pressure is within the allowable limits
- Calculate and check whether the velocity is within the allowable limits
- Calculate the PV factor (Pressure x Velocity) and check the allowable limit

Series	Slip contact		Max. allowable pressure ($daN \cdot mm^{-2}$)	Max. allowable velocity ($m \cdot min^{-1}$)	Maximum allowable PV
	Int. bush	Ext. bush			
-	Steel	Bronze Steel Uniflon® E	5 10 15	5 4 4	3.5 3.5 4.5
.40	Steel	Bronze Uniflon® E	5 15	2.5 4	3 4.5
.45	Stainless steel	Bronze Stainless steel Uniflon® E	5 10 15	4.5 4.5 4	3 3.5 4
.50	Steel	Stainless steel Uniflon® E	10 15	2.5 4	4.5 4.5

Calculating specific pressure



Coefficient of axial loading **y** and equivalent dynamic loading:

- Our spherical bearings are designed to withstand radial loadings (Fr). But the combination with an axial loading (Fa) is sometimes inevitable and spherical bearings are able to accommodate it to a certain extant. So the equivalent dynamic loading F must be calculated taking into account a correction factor y for that axial loading. The table opposite gives the value of y for different Fa / Fr ratios.

$$F = Fr + (y \times Fa)$$ Normal case: F = Fr

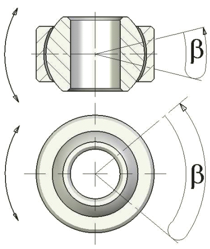
Checking the average pressure according to the force exercised on the friction surface.

$$P = \frac{F}{d_K \times C \times 0.85}$$

P: pressure ($daN.mm^{-2}$)
F: total dynamic loading (daN)
Fr: radial dynamic loading (daN)
Fa: axial dynamic loading (daN)
d_K: diameter of the inner sphere bush (mm)
C: width of the mount or cage (mm)

Calculating the slip velocity on contact

Checking the maximum friction velocity between the inner bush and outer bush.



$$V = \frac{d_K \times ß \times f}{114'600}$$

V: velocity ($m.min^{-1}$)
d_K: diameter of the inner bush sphere (mm)
ß: angle of oscillation complete (degrees)
f: frequency of oscillation (Hz)

PV factor

$$PV = P \times V$$

P: pressure ($daN.mm^{-2}$) V: velocity ($m.min^{-1}$)

Calculating life

If your application requires the play or torque of the spherical bearing to be controlled throughout its life, please ask us.

$$D_h = \frac{c_1 \cdot c_2 \cdot c_3 \cdot c_4 \cdot c_5 \cdot c_6 \cdot c_7 \cdot c_8 \cdot X \cdot C \cdot K \cdot 10^7}{F \cdot ß \cdot f}$$

$$D = \frac{c_1 \cdot c_2 \cdot c_3 \cdot c_4 \cdot c_5 \cdot c_6 \cdot c_7 \cdot c_8 \cdot X \cdot C \cdot K \cdot 10^7}{F \cdot ß \cdot 0.0167}$$

D_h : life in hours (h)
D : life (number of oscillations or complete rotations)
C : Width of the cage or rod (P24 to 47)
K : Constant given by the table opposite
F : radial dynamic loading (daN)
ß : angular distance run per cycle (degrees)
f : frequency of oscillations (osc/min)
c1 : coefficient of pressure (p.12)
c2 : coefficient of velocity (p.12)
c3 : coefficient of angle (p.13)
c4 : coefficient of strain (p.13)
c5 : coefficient of alternate loadings (p.13)
c6 : coefficient of maintenance (p.13)
c7 : coefficient of temperature (p.13)
c8 : coefficient of vibration (c8 = 1 or 0.8)
If parts have to withstand vibrations greater than 60 vibr./min., use a coefficient c8 of 0.8.
X : Coefficient of safety (min.=0.7, max.=1)
According to your estimate of external influences, unknowns and their importance from the functional point of view (abrasive environment, corrosion, etc.), use a coefficient X of 0.7 to 1.0

Type	Constant K
SMG, SFG	85
SMG..20, SFG..20	85
SMG..40, SFG..40	70
SMG..45, SFG..45	80
SMGM..50 / 51 / 52	
	105
SME, SFE	105
SME..40, SFE..40	100
SME..45, SFE..45	110
SMEM..50 / 51 / 52	
	85
SS	70
SS..45	
	75
SSA	70
SSA..45	80
SSA..50	
	105
SSE	100
SSE..45	110
SSE..50	

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Determining calculation coefficients

The life of a spherical bearing or rod is the maximum number of running hours or oscillations before play appears that does not allow the spherical bearing to fulfil its function.
The life is a function of the dynamic strain and of the various parameters of the application.

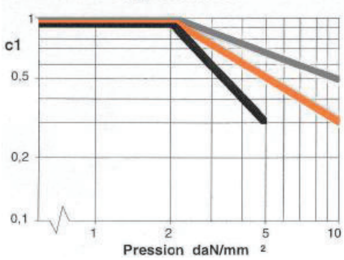
- Pressure
- Velocity (angle and frequency of oscillations)
- Strain (continuous, pulsating, alternate loadings)
- Temperature
- Vibrations

Calculation formulas, worked out from trials conducted on our test benches, enable you to determine the life in accordance with your application.

In the case of a pulsating or alternate loading, the value to use for F is the absolute maximum value reached.

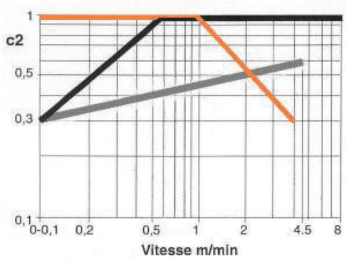
To determine it correctly, all possible data should be taken into consideration – no unknowns should remain that could invalidate the result.
For specific uses in a particular environment (corrosion, vibration, aggressive ambient environment, abrasive dust, etc.), please ask us.

Coefficient de pression c1



Slip	Slip	Slip
Steel / bronze	Steel / Steel	Steel / Uniflon®
SMG, SFG SMG..40, SFG..40 SMG..45, SFG..45	SMGM..50 SMGM..51 SMGM..52	SME, SFE SME..40, SFE..40 SME..45, SFE..45 SMEM..50 / 51 /52
SS SS..45	SSA SSA..45 SSA..50	SSE SSE..45 SSE..50

Coefficient de vitesse c2



Slip	Slip	Slip
Steel / bronze	Steel / Steel	Steel / Uniflon®
SMG, SFG SMG..40, SFG..40 SMG..45, SFG..45	SMGM..50 SMGM..51 SMGM..52	SME, SFE SME..40, SFE..40 SME..45, SFE..45 SMEM..50 / 51 /52
SS SS..45	SSA SSA..45 SSA..50	SSE SSE..45 SSE..50

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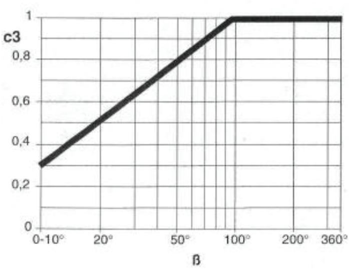
Coefficient d'angle c3



Slip
Steel / bronze

SMG, SFG
SMG..40, SFG..40
SMG..45, SFG..45

SS
SS..45

Slip
Steel / Steel

SMGM..50
SMGM..51
SMGM..52

SSA
SSA..45
SSA..50

Slip
Steel / Uniflon®
Coef. c3=1

SME, SFE
SME..40, SFE..40
SME..45, SFE..45
SMEM..50 / 51 /52

SSE
SSE..45
SSE..50

Coefficient de sollicitations c4

	c4	c4
Continue	0,65	1
Pulsatoire	0,8	0,6
Alternée	1	0,4

Slip
Steel / bronze

SMG, SFG
SMG..40, SFG..40
SMG..45, SFG..45

SS
SS..45

Slip
Steel / Steel

SMGM..50
SMGM..51
SMGM..52

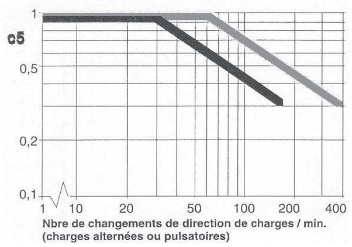
SSA
SSA..45
SSA..50

Slip
Steel / Uniflon®

SME, SFE
SME..40, SFE..40
SME..45, SFE..45
SMEM..50 / 51 /52

SSE
SSE..45
SSE..50

Coefficient de charges alternées et pulsatoires c5



Slip
Steel / bronze

SMG, SFG
SMG..40, SFG..40
SMG..45, SFG..45

SS
SS..45

Slip
Steel / Uniflon®

SME, SFE
SME..40, SFE..40
SME..45, SFE..45
SMEM..50 / 51 /52

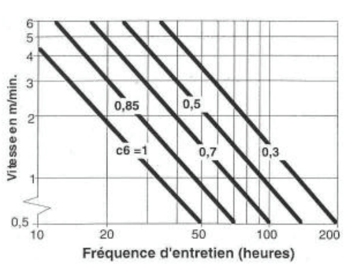
SSE
SSE..45
SSE..50

Slip
Steel / Steel

SMGM..50
SMGM..51
SMGM..52

SSA
SSA..45
SSA..50

Coefficient d'entretien c6



Slip
Steel / bronze

SMG, SFG
SMG..40, SFG..40
SMG..45, SFG..45

SS
SS..45

Slip
Steel / Steel

SMGM..50
SMGM..51
SMGM..52

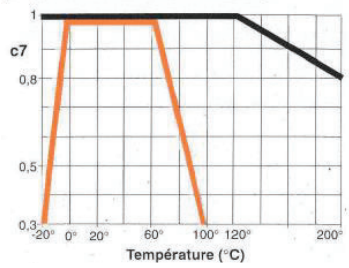
SSA
SSA..45
SSA..50

Slip
Steel / Uniflon®
Coef. c6=1

SME, SFE
SME..40, SFE..40
SME..45, SFE..45
SMEM..50 / 51 /52

SSE
SSE..45
SSE..50

Coefficient de température c7
(Température ambiante du lieu de travail)



Slip
Steel / bronze

SMG, SFG
SMG..40, SFG..40
SMG..45, SFG..45

SS
SS..45

Slip
Steel / Steel

SMGM..50
SMGM..51
SMGM..52

SSA
SSA..45
SSA..50

Slip
Steel / Uniflon®

SME, SFE
SME..40, SFE..40
SME..45, SFE..45
SMEM..50 / 51 /52

SSE
SSE..45
SSE..50

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Examples of dynamic calculations

Calculation n°1: Steel / Bronze

On a machine, an automatic loading system requires size 12 rod-end bearings

1) Data

Type and size wanted:	SMG12
Dynamic radial loading:	180 daN
Type of strain:	continuous
Angle of oscillation:	± 45° (ß = 180°)
Frequency:	125 osc./min
Maintenance:	1 lubrication / 18h
Ambient temperature:	50°C
Life wanted:	7,000,000 osc.

2) Checking the pressure, velocity and PV factor

$$P = \frac{F}{d_K \times C \times 0.85} = \frac{180}{22.23 \times 12 \times 0.85} = \mathbf{0.79\ daN/mm^2}$$

$$V = \frac{D_K \times ß \times f}{114'600} = \frac{22.23 \times 180 \times 125}{114'600} = \mathbf{4.36\ m/min}$$

PV = P x V = 0.79 x 4.36 = **3.46**

After checking the values obtained in table 1, we find that the maximum admissible PV factor is 3.5, the limit admissible velocity is 5 m/min. and the pressure maximum admissible is 5 daN/mm^2
So we can continue the calculation.

3) Calculating the life

K: table p.11	Constant SMG12	85
c1: coef. p.12	Pressure: 0.79	1
c2: coef. p.12	Velocity: 4.36	1
c3: coef. p.13	Angle ß = 180°	1
c4: coef. p.13	Continuous loading	0.65
c5: coef. p.13	Not applicable	1
c6: coef. p.13	1 lubrication/ 18h	0.8
c7: coef. p.13	50°C	1
c8: coef. p.11	Not applicable	1
X: coef. p.11		1

Life:

$$D = \frac{c_1 \cdot c_2 \cdot c_3 \cdot c_4 \cdot c_5 \cdot c_6 \cdot c_7 \cdot c_8 \cdot X \cdot C \cdot K \cdot 10^7}{F \cdot ß \cdot 0.0167}$$

$$D = \frac{1 \cdot 1 \cdot 1 \cdot 0.65 \cdot 1 \cdot 0.8 \cdot 1 \cdot 1 \cdot 1 \cdot 12 \cdot 85 \cdot 10^7}{180 \cdot 180 \cdot 0.0167}$$

D = 9,800,000 oscillations (> 7,000,000 osc.)
Type SMG12 is entirely suitable for this application.

Calculation n°2: Steel / Steel

You want to fit the tower of a crane with size 16 rod-end bearings. What will the life stress surfaces below be?

1) Data

Type and size wanted:	Gr. 16 Type?
Dynamic radial loading:	2,500 daN with impacts
Type of strain:	alternating
Angle of oscillation:	± 30° (ß = 120°)
Frequency:	0.5 osc./min
Maintenance:	liberal lubrication
Ambient temperature:	120 to 180°C
Life wanted:	10,000h

2) Checking the pressure, velocity and PV factor

$$P = \frac{F}{d_K \times C \times 0.85} = \frac{2,500}{28.58 \times 15 \times 0.85} = \mathbf{6.9\ daN/mm^2}$$

$$V = \frac{D_K \times ß \times f}{114'600} = \frac{28.58 \times 120 \times 0.5}{114'600} = \mathbf{0.015\ m/min}$$

PV = P x V = 6.9 x 0.015 = **0.1**

We have to choose a rod-end bearing withstanding 10daN/mm^2, so steel /steel friction. Type SMGM 16.50 does not withstand very high velocities, but in this application, the velocity is very low. An SMGM 16.50 is particularly suited to this application.

3) Calculating the life

K: table p.11	Constant SMGM 16.50	80
c1: coef. p.12	Pressure: 6.9	0.6
c2: coef. p.12	Velocity: 0.01	0.3
c3: coef. p.13	Angle ß = 120°	1
c4: coef. p.13	Alternating loading	1
c5: coef. p.13	0.5 osc./min	1
c6: coef. p.13	Liberal lubrication	1
c7: coef. p.13	180°C	0.85
c8: coef. p.11	Not applicable	1
X: coef. p.11	Impacts	0.9

Life:

$$D_h = \frac{c_1 \cdot c_2 \cdot c_3 \cdot c_4 \cdot c_5 \cdot c_6 \cdot c_7 \cdot c_8 \cdot X \cdot C \cdot K \cdot 10^7}{F \cdot ß \cdot f}$$

$$D_h = \frac{0.6 \cdot 0.3 \cdot 1 \cdot 1 \cdot 1 \cdot 1 \cdot 0.85 \cdot 1 \cdot 0.9 \cdot 15 \cdot 80 \cdot 10^7}{2500 \cdot 120 \cdot 0.5}$$

D_h = 11,000 hours (> 10,000 h)
It is wise to choose an SMGM16.50 rod-end bearing for this lifting system.
NB: use grease that withstands the 180°C working temperature

Calculation n°3: Steel / Uniflon ® E

An SF..30 rod-end bearing is going to be used for the transmission on a fairground ride. It must be able to run maintenance-free. What type should be used?

1) Data

Type and size wanted:	Gr. 30 Type SF..
Dynamic radial loading:	2,500 daN
Type of strain:	alternating
Angle of oscillation:	± 1.5° (ß = 6°)
Frequency:	80 osc./min
Maintenance:	self-lubricating
Ambient temperature:	0 to 45°C, dust
Life wanted:	3,000 h

2) Checking the pressure, velocity and PV factor

$$P = \frac{F}{d_K \times C \times 0.85} = \frac{2{,}500}{50.8 \times 25 \times 0.85} = \mathbf{2.32\ daN/mm^2}$$

$$V = \frac{D_K \times ß \times f}{114'600} = \frac{50.8 \times 6 \times 80}{114'600} = \mathbf{0.21\ m/min}$$

PV = P x V = 2.32 x 0.21 = **0.49**

After checking the values obtained in table 1, we find that the pressure, velocity and PV factor are below the maximum admissible values. Checking the static loading of an SFE30: 5,130 daN, which is thus greater than the loading stated.
So the SFE30 is suitable for this application.

3) Calculating the life

K: table p.11	Constant SFE30	105
c1: coef. p.12	Pressure: 2.32	1
c2: coef. p.12	Velocity: 0.21	1
c3: coef. p.13	Angle β = 6°	1
c4: coef. p.13	Alternating loading	0.4
c5: coef. p.13	80 osc,/min	0.5
c6: coef. p.13	self-lubricating	1
c7: coef. p.13	0 to 45°C	1
c8: coef. p.11	Not applicable	1
X: coef. p.11	Dusty	0.8

Life:

$$D_h = \frac{c_1 \cdot c_2 \cdot c_3 \cdot c_4 \cdot c_5 \cdot c_6 \cdot c_7 \cdot c_8 \cdot X \cdot C \cdot K \cdot 10^7}{F \cdot ß \cdot f}$$

$$D_h = \frac{1 \cdot 1 \cdot 1 \cdot 0.4 \cdot 0.5 \cdot 1 \cdot 1 \cdot 1 \cdot 0.8 \cdot 25 \cdot 105 \cdot 10^7}{2500 \cdot 6 \cdot 80}$$

D = 3,500 hours (> 3,000 h.)
The Unibal SFE30 rod-end bearing will ensure that the ride runs correctly.

Calculation n°4: Steel / Steel

Several type SSA 3.45 spherical bearings are fitted to scale models (model boats). Despite the corrosive environment and stresses, these Unibals must withstand 300,000 oscillations.

1) Data

Type and size wanted:	SSA 3.45
Dynamic radial loading:	190 daN
Type of strain:	continuous
Angle of oscillation:	β = 360°
Frequency:	20 rpm
Maintenance:	liberal lubrication
Ambient temperature:	5 to 30°C
Life wanted:	300,000 osc.

2) Checking the pressure, velocity and PV factor

$$P = \frac{F}{d_K \times C \times 0.85} = \frac{190}{7.93 \times 4.5 \times 0.85} = \mathbf{6.26\ daN/mm^2}$$

$$V = \frac{D_K \times ß \times f}{114'600} = \frac{7.93 \times 360 \times 20}{114'600} = \mathbf{0.50\ m/min}$$

PV = P x V = 6.26 x 0.5 = **3.12**

After checking the values obtained, we find that the velocity and PV factor are acceptable. As concerns pressure, an SSA 3.45 withstands pressure of 10 daN/mm2. The admissible static loading is much greater than 190 daN. So we now have to check the required number of oscillations.

3) Calculating the life

K: table p.11	Constant SSA 3.45	70
c1: coef. p.12	Pressure: 6.26	0.62
c2: coef. p.12	Velocity: 0.5	0.35
c3: coef. p.13	Angle β = 360°	1
c4: coef. p.13	Continuous loading	0.65
c5: coef. p.13	Not applicable	1
c6: coef. p.13	Liberal lubrication	1
c7: coef. p.13	5 to 30°C	1
c8: coef. p.11	Not applicable	1
X: coef. p.11		1

Life:

$$D = \frac{c_1 \cdot c_2 \cdot c_3 \cdot c_4 \cdot c_5 \cdot c_6 \cdot c_7 \cdot c_8 \cdot X \cdot C \cdot K \cdot 10^7}{F \cdot ß \cdot 0.0167}$$

$$D = \frac{0.62 \cdot 0.35 \cdot 1 \cdot 0.65 \cdot 1 \cdot 1 \cdot 1 \cdot 1 \cdot 1 \cdot 4.5 \cdot 70 \cdot 10^7}{190 \cdot 360 \cdot 0.0167}$$

D_h = 389,000 osc. (> 300,000 osc.)
According to the calculation performed, SSA 3.45 spherical bearings are suitable for this application.

Materials

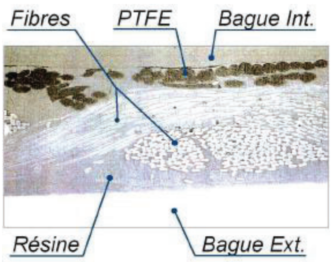
Uniflon® Type E

Uniflon® is the registered trademark of the self-lubricating fabric fitted exclusively to Unibal® self-lubricating spherical bearings.
Uniflon® E self-lubricating fabric comes from a development for aerospace applications and complies with the SAE-AS81820 standard.

Uniflon® E can be used in combination with different materials such as toughened steel, aluminium and titanium, in various environments and extreme temperatures from –30℃ to +175℃.

Because of its composition, Uniflon® E is unique in the PTFE (Polytetrafluoroethylene) fibre friction materials range

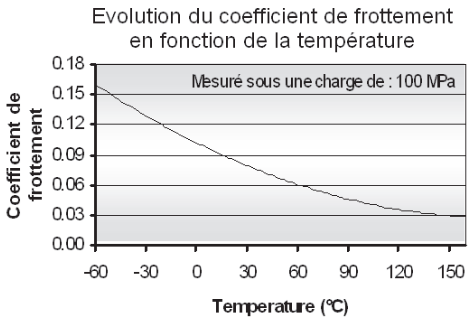
Composition

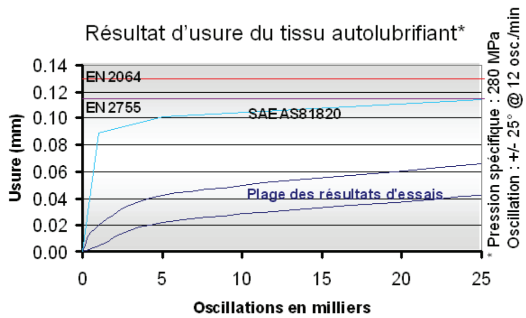


The perfect composite, Uniflon® E brings you the following benefits:
- A fabric (fibres) that is highly resistant to heat, abrasion, breaking and compression.
- A high proportion of PTFE fibres, which have superb slip properties.
- A matrix chemically linked by a resin with a low coefficient of friction.

Features

Spherical bearings with self-lubricating linings do not have a constant coefficient of friction for all applications. If the applied loading increases, the coefficient of friction decreases. Similarly, if the temperature decreases, the coefficient of friction increases.
The following figure shows how the in the coefficient of friction reduces as the temperature rises.





Alternatives

For applications at low loadings, high temperature and/or higher velocity, we suggest a self-lubricating lining with more suitable characteristics:
- Uniflon® type VV

On request, we make other maintenance-free formulas such as:
- Plastic materials
- Self-lubricating bronzes

Lubrication

Lubrication and maintenance

Lubrication and the maintenance apply to products not fitted with self-lubricating fabric (Uniflon®), i.e. spherical bearings and rod-end bearings of **SMG/SFG**, **SS/SSA** type - whose the slip contact is of the following type:

- Steel / bronze
- Steel / steel

These products are built so that an internal groove carries the lubricating liquid to the slip surface.

Regular lubrication is necessary for two reasons:

- To provide the application with optimal running conditions to extend its life.
- To prevent corrosion, mainly due to steel/steel friction

Our rod-end bearings, from size 8, are fitted with a small lubricator, in order to minimise weakening mounts – symbol **G** (SMG.., SFG..)
The lubrication tip to use is the one designed for type D concave head lubricators.

Standard lubrication

The Mobil **Greaserex 47** grease (ISO 3498 XM2) is used for assembling all types of product where grease is necessary.
This universal grease is an ideal lubricant.
Features:

- Base: calcium complex
- Drop point: 260℃
- Working temperature: -25℃ to +125℃
- Excellent wear protection properties
- Withstands shearing. Binding of the bearing possible, partial lining given when substantial vibration.

Special lubrication

We offer different types of lubrication and surface treatment, on request. For example:

1) Molykote BR2 plus, very haute quality grease:

- Base: lithium soap, mineral oil
- Drop point: 185℃
- Working temperature: -30℃ to +130℃
- Multifunction grease containing solid lubricants
- Excellent properties under extreme pressure and ideally suited to high velocities
- A permanent film of grease ensures safety and extends lubrication intervals

This grease is recommended for very high stress levels (loading or velocity).

2) Moly-PAUL PBC, synthetic grease, organo-metallic complex:

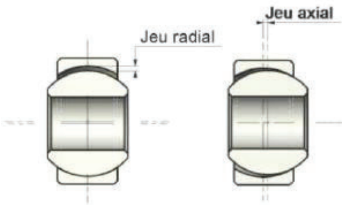
- Excellent anti-corrosive.
- Excellent resistance to salt, acid and bases.
- Excellent seizure prevention.
- Does not carbonise or run at temperature
- Provides long-lasting lubrication
- Working temperatures: -10℃ to 1,100℃ for static (300℃ for dynamic, slow movement)

3) Molykote 106, slip coating:

- Before assembly, the sphere is treated to ensure lasting lubrication. Once created, the film reduces wear and optimises operating safety even after long stationary periods.

Play, rotation torque, tilt torque

Play



Spherical bearings and rod-end bearings have initial play or slip torque that is specific to the type and size.
Working play is typified by the radial and axial movements of the inner bush.
For our standard construction, the relationship between the radial and axial play is as follows:

Axial play = **Radial play** x **2.5**

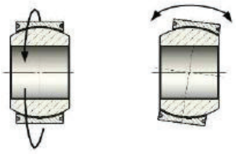
Play given in the table below is the max. value for our standard spherical bearings, tested under a loading of ±10 daN.
Some of our products are routinely assembled with reduced play, or even without play (types in **bold**):

- Series .40 and .50 (all types)
- Self-lubricated types (all series)

Size	2 to 6	8 to 12	14 to 18	20 to 22	25 to 30
Max. radial play	0.03	0.04	0.05	0.06	0.08

These play values are valid for parts of SM/SMG, SF/SFG, SS/SSA type in the standard series and.45 (stainless steel) series

Torque



The spherical bearing's torque can be measured in relation to two perpendicular axes.
There is:

- rotation torque
- tilt torque.

For parts in this catalogue, there is the relationship:

$$\textbf{Tilt torque} = \frac{\textbf{Rotation torque}}{\textbf{1.6}}$$

The torque given in the table below are for the min. and max. values tested.

General rules

1) The torque should be reduced for high velocity applications (low loading). If there must be no play for your application, we offer variants with reduced play or even without play, to your requirements.

2) The torque should be raised for applications with high or alternating loadings, or with impacts and low velocity.

3) An abnormally short life can result from inappropriate torque. For non-standard applications, we offer advice and will adapt the torque to your requirements for optimal running.

		Rotation torque (daNcm)							
	Series	**-**		**.40**		**.45**		**.50**		
	Type	SM, SMG SF, SFG SS, SSA	**SME SFE SSE**	**SM, SMG SF, SFG**	**SME SFE**	SM, SMG SF, SFG SS, SSA	**SME SFE SSE**	**SMM, SMGM**	**SMEM SSE**	**SSA**
Size	**2 to 5**	< 0.4	0.1 – 0.7	0.6 – 3.4		< 0.4	0.1 – 0.7	1 – 5		1 – 4
	6 to 10	< 0.6	0.2 – 1.3	1.0 – 6.0		< 0.6	0.2 – 1.3	2 – 10		1 – 5
	12 to 18	< 1.0	0.3 – 2.1	1.6 – 10		< 1.0	0.3 – 2.1	4 – 16		2 – 8
	20 to 30	< 1.7	0.5 – 3.4	2.5 – 16		< 1.7	0.5 – 3.4	–		3 – 10

Spherical bearings with a reference **in bold** are supplied with zero radial play

Polígono Industrial O Rebullón s/n. 36416 - Mos - España - rodavigo@rodavigo.com

Unibal

Tilt angle

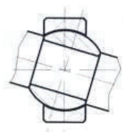
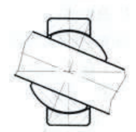
The maximum tilt angle depends on the type of assembly. It is not recommended to exceed the tilt angle given in the tables of dimensions.

The maximum tilt angle is governed by:

- d_k the diameter of the sphere
- d the diameter of the bore
- d_1 the diameter of flat
- B the width of the bush
- C the width of the cage or mount

$$\alpha 1 = \cos^{-1}\left(\frac{C}{d_k}\right) - tg^{-1}\left(\frac{D_1}{B}\right)$$

$$\alpha 2 = \cos^{-1}\left(\frac{C}{d_k}\right) - \sin^{-1}\left(\frac{d_1}{B}\right)$$

Size	Value of angle α	
		
	α1	α2
2	16°	33°
3	15°	
4	14°	31°
5	13°	30°
6		
8	14°	25°
10		
12	13°	25°
14	16°	24°
16	15°	24°
18		
20		
22	15°	23°
25		
30	17°	24°

Assembly

Assembly instructions

After assembly, there must be slip between the inner bush and outer bush of the spherical bearing. To achieve this, the inner bush should be firmly fixed to the shaft, and the outer bush fixed to the housing in which it is fitted.

1) Fitting the spherical bearing in its housing

To ensure correct operation, it is important to comply with adjustments when fitting. It is advisable to tighten spherical bearings in their housing in accordance with the values in the following table:

Size	Self-lubricated spherical bearings	Metal/Metal spherical bearings
2 to 4	0.000 to 0.010mm	0.005 to 0.015mm
5 to 8	0.005 to 0.015mm	0.010 to 0.020mm
10 to 16	0.005 to 0.020mm	0.010 to 0.025mm
18 to 30	0.005 to 0.025mm	0.010 to 0.030mm

Parts should be assembled using a press. Tooling used should ensure perfect alignment of the axis of the spherical bearing and the axis housing when assembling. There should be a 10 to 20° chamfer on the housing so as to facilitate seating.

Caution:
The fixture of the spherical bearing in its housing is not under any circumstances a mechanical stop keeping the spherical bearing from movement due to an axial loading.
To prevent the cage from slipping, bearing surfaces or stop segments should be provided or it must be crimped.

2) Fitting the shaft in the bush

For self-lubricated spherical bearings, it is essential that the shaft is dry-fitted. An m6 adjustment will be used for the standard and stainless steel series with steel/steel friction contact, and a k6 adjustment for all other lines.

Incorrect assembly can adversely affect the life of the spherical bearing. A very high proportion of failures directly related to incorrect assembly.
Here are some examples of common mistakes:

- Adjustment too tight between the spherical bearing and the housing.
- Unsuitable tools used for assembly
- Excess force applied when assembling.

Materials

The materials of the different constituents of Unibal standard spherical bearings, shown on the following pages, are given as an indication.
We reserve the right to change them for other materials with similar properties that do not alter the mechanical characteristics of spherical bearings.

Basic application data
to be provided to calculate life

By request, we are able to make a complete calculation. The calculation formulas used are given in the calculation chapter. You can complete and return this questionnaire.

– Provide as much data as possible
– Provide an explanatory sketch of the application if necessary
– State the mean stresses operating in your system

Complete the information in the following sections:

1.	Size wanted (diameter of the bore):	
2.	Type of spherical bearing wanted:	....
3.	Life wanted:	.... hours
4.	Static loadings:	yes / no
5.	Dynamic loadings:	yes / no
6.	Type of loadings:	....
7.	Change of direction of loadings (alternating or pulsating loadings):	.... /min
8.	Radial loadings:	.... daN
9.	Axial loadings:	.... daN
10.	Impacts:	yes / no
11.	Estimated violence of impacts:	.... daN
12.	Significant vibrations:	yes / no
13.	Frequency of vibrations:	.... osc./min
14.	Complete rotation:	yes / non
15.	Angle of oscillation: Rotation	(±) .... °
16.	Angle of oscillation: Tilt	(±) .... °
17.	Frequency:	.... osc./min
18.	Ambient temperature:	.... °C
19.	Maintenance, lubrication:	....
20.	Frequency of maintenance:	.... hours
21.	Rotation torque wanted:	.... daNm
22.	Particular environment:	yes / no
23.	External influence:	yes / no
24.	Kind of external influences:	

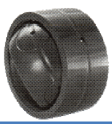
25. Other features:

26. Description of use:

RBC BEARINGS

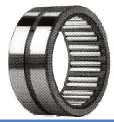
Innovation and Quality

RBC has been producing bearings since 1919. In addition to unique custom bearings, RBC offers a full line of standard industrial and aerospace bearings, including:



Spherical Plain Bearings

Radial, angular contact, extended inner ring, high misalignment. **Quadlube®**, **ImpactTuff®**, **Spreadlock® Seal**, **CrossLube®**, **DuraLube™**, and self-lubricating bearing. Available in inch and metric sizes.

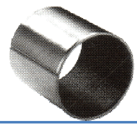


Needle Roller Bearings

Pitchlign® caged heavy duty needle roller bearing, inner rings, **TJ TandemRoller®** bearings for long life.

Thin Section Ball Bearings

Standard cross sections to one inch. Sizes to 40 inches. Stainless steel and other materials are available. Seals are available on all sizes and standard cross sections. Super duplex configurations.

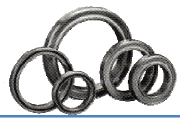


Self-Lubricating Bearings

Radial, thrust, rod ends, spherical bearings, high temperature, high loads. Available in inch and metric sizes. **Fiberglide®** self-lubricating bearings

Tapered Roller Bearings

Tyson® case-hardened and through-hardened tapered roller bearings. Available in many sizes. Used in Class 8 heavy truck and trailer wheel bearings, gearboxes, and final drive transmissions.



Airframe Control Bearings

Ball bearing types, self-lubricating types, needle roller track rollers.

Tapered Roller Thrust Bearings

Case-hardened. Sealed and unsealed for truck, tractor, and construction equipment steer axles, and Class 8 trailer landing gear.

Dowel Pins, Loose Needle Rollers, Shafts

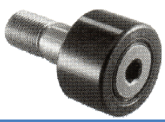
Precision Products dowel pins, loose needle rollers, and shafts.

Integrated Assemblies

For robots and other process tool applications. Engineering design assistance. Production volume capacity.

Commercial Rod Ends

Commercial and industrial, precision, Mil-Spec series, self-lubricating, and aircraft. Sold under the **Heim®**, **Unibal®**, and **Spherco®** names. Available in inch and metric sizes.



Cam Followers

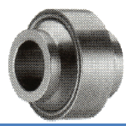
Standard stud, heavy stud, yoke type, caged roller follower cam followers, Patented RBC Roller® cylindrical roller cam followers, HexLube® universal cam follower, airframe track rollers.

Ball Bearings

Precision ground, semiground, unground. High loads, long life, smooth operation. **Nice®** branded products are offered in caged and full complement configurations.

Ball Pin Plain Bearings Asse

Self-lubricating types, greased plain bearings, sealed. High loads, high vibration resistant, long life. **S-Fit™** and **CTRL™** configurations available.



Specials

RBC manufactures many specialty bearings for the aerospace, oil and energy, semiconductor equipment, packaging, transportation, and other industries.

RBC BEARINGS

SCHAUBLIN SA
Rue de la Blancherie 9
2800 Delémont
SWITZERLAND
Tel. +41 (0)32 421 13 00
Fax. +41 (0)32 421 13 01
www.schaublin.com

RBC France S.A.S
19 avenue de Norvège – ZA de Courtabœuf 1
91953 Les Ulis Cedex
FRANCE
Tel. +33(0)1 60 92 17 35
Fax. +33(0)1 69 86 12 84
www.rbcfrance.com