HANDBOOK

Ceramet

CER.SM

Self-lubricating
maintenance free
sliding material

ceramet.com.pl

Contents

Introduction

WHO WE ARE

Ceramet, trusted manufacturer of plain bearings, bushings, sliding plates and wear parts made of sintered self–lubricating material containing graphite as solid lubricant uniformly distributed throughout the metallic matrix. The companys' know-how is drawn from more than 55 years of experience. Ceramet, a well-known specialty powder metallurgy manufacturer, was founded in 1965 in Poland.

Integrated manufacturing and supply chain at their best

Our supply chain is completely integrated. Starting from own powder metallurgy manufacturing featuring a high efficiency state-of-the-art continuous sintering line the process is followed by an advanced CNC machining plant. Battery of computer controlled milling machines, lathes, grinding centers, drilling and bending machines allow for variability and custom designed production at its best.

Exclusively focused on metallic sintered parts

As unique as we are, less than a handful of manufacturers may be proud of finding themselves exclusively in the business of metallic sintered self-lubricating parts. Our focused approach is providing us with competitive edge offering in-depth knowledge. Expertise and know-how is put in service of our customers recruiting from various parts of world and nearly every industry including wind and hydropower, steel, tire and rubber, food and beverage, oil and gas, marine, aerospace, and many more.

WHY CHOOSE US

Custom made is our standard

We understand that your bearing requirements are special. Our team supports you with customer specific designs and a wide range of materials making sure we provide the best technical and commercial solution.

Fitting and installation facility

Besides our own metal compounds sintering and machining plants we run fitting and installation facility. When replacement parts need to be put in place proper tooling may not always be available. We are here to help with a range of inhouse presses and professional tooling extending lifetime of your critical parts and machines and maintaining warranty.

Easy to deal with

Customer first – We provide a personal and easy way of communication from initial inquiry to after sales service. Put us to the test.

Reliable partner

Choosing the right partner for your bearing needs is a matter of trust. Consistency in product and service quality, loyalty and respect are our core values. We strive to be long term partners for our customers. Building up on decades of successful development we are here to keep providing reliable tribological solutions to the industry for the years to come.

Unique Know-How, Highest Quality Standards

We deploy our unique powder metallurgy recipes resulting from 55+ years of primary manufacturing experience and thousands of successful applications. Our know-how has been globally proven and verified in countless demanding industrial utilizations. Customer projects are carefully reviewed and evaluated based on our rigorous in house testing and control processes. We can therefore guarantee that they will pass our high internal quality standards and will be fully in accordance with our customers´ needs and specifications.

Application Engineering Support

Our team of dedicated Application Engineers is ready to assist, consult and generate lifecycle predictions. Our engineering support covers replacing existing bearings, technical upgrades, eliminating additional lubrication, or replacing plastic or roller bearings to achieve additional value for our customers. No commitment is required. Feel free to consult our application engineers.

Materials

Ceramet sintermetal / CER.SM general characteristics

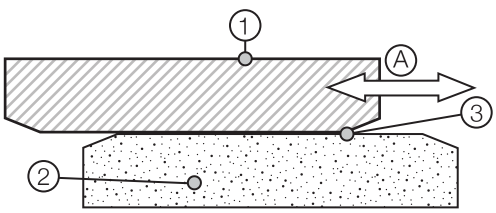
CER.SM is a maintenance free, self-lubricating high performance plain bearing material. It is based on a metallic matrix of tin bronze, iron, iron-nickel-copper, nickel-copper-iron or nickel with embedded solid lubricants, that are uniformly distributed within the complete metallic matrix.

Advantages of CER.SM:

- Excellent tribological behavior with low coefficient of friction and low wear
- Stick-slip effects insignificant
- High static and dynamic load capability
- Useable in a wide temperature range from -200°C to 650°C, dependent on selected alloy
- High corrosion resistance against many chemicals, dependent on alloy selection
- Shows no swelling in water environment
- Can be used in radioactive environment
- No electrostatic charging, electrically conductive
- Useable in dusty, abrasive environments
- External lubrication typically not necessary, but permissible
- Machinable
- Can be used in hydrodynamic applications with water lubrication or as back-up system
- Can be used in sea water, dependent on alloy selection
- All types of movement are permissible, for example rotational, translational and oscillating, or combinations thereof
- Can be installed by press-fitting or super-cooling

The mechanism of solid lubrication

The self-lube parts are sliding against their mating parts with linear or rotational motion. The solid lubricant is drawn out of the CER.SM matrix covering both surfaces with a thin film. As the solid lubricant film is being worn out, it is continuously replenished from the metallic layer throughout the entire life cycle of the product.



A - direction of motion
1 - mating material
2 - CER.SM part
3 - film of continuously replenished solid lubricant

Structure, physical & mechanical properties of materials

The following groups of compounds are available:

- Copper compounds: tin bronze or copper-nickel-iron
- Iron compounds: iron-copper or iron-nickel-copper
- Nickel compounds: nickel-copper-iron or nickel

The selected metal matrix defines the mechanical, physical and chemical properties, specific for each application and environmental condition.

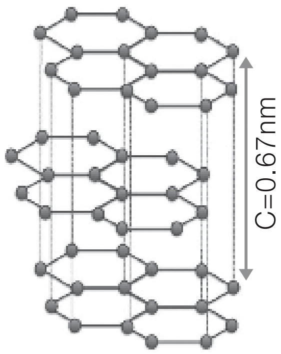
Material contains solid lubricants uniformly distributed within the metallic matrix. The choice of solid lubricant is based on the physical, environmental and chemical conditions of the application.

Yellow color, metallic matrix: bronze, nickel or iron-base
Black color, solid lubricant: graphite, MoS2

Solid lubricants

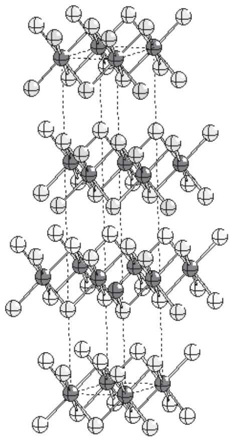
1. GRAPHITE

- Lamellar hexagonal crystal structure
- Anisotropy of the structure and therefore of properties
- Due to lamellar crystal structure of graphite and associated low shear stresses for moving of the planparallel layers, low coefficient of friction of materials can be reached
- Low shear stresses in lamellar planes enable easy release of graphite providing the very basis for self-lubrication
- Graphite can be used in different particle sizes, dependent on application
- Ability to absorb water vapor and oxygen on the surface further enhancing the self-lube properties.
- Creating a high performance lubricating interface layer, that is continuously renewed (healing up) during sliding movement



2. MoS_2 (Molybdenum-Disulfide)

- Has exactly the same lamellar hexagonal crystal structure as graphite
- MoS_2 (Molybdenum-Disulfide) is used as an alternative to graphite specially in environments containing dry gases
- Combinations of various solid lubricants, dependent on application are possible
- Bonding between molybdenum and sulfur is very strong, while shear resistance between layer packages is considerably weak providing for solid lubricating properties and low friction coefficient



Tribological properties of solid lubricants

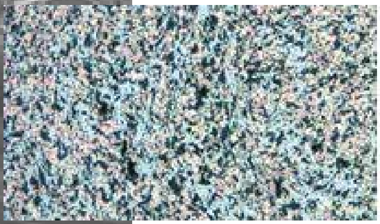
Properties	Graphite	MoS_2
Density [g/cm³]	2.25	4.7
Coefficient of friction in air	0.10 – 0.18	0.08 – 0.12
Operating temp. range	-200°C – 650°C	-100°C – 400°C
Crystalline structure	hexagonal	hexagonal
Performance in air	very good	good
Performance in water	very good	limited
Performance in vacuum	not recommended	good
Chemical resistance	very good	good
Corrosion resistance	good	limited
Radioresistance	very good	good

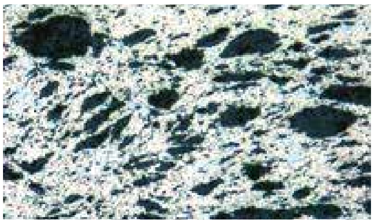
The following pictures show the distribution of solid lubricants within the metallic matrix, regardless of the type of metal.

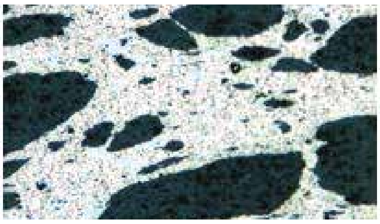
Different solid lubricant particle size fractions are available.
The bearing properties are strongly dependent on the type of solid lubricant used.

Solid lubricants with lamellar structure and low shear strength between the single molecular layers are embedded in the metallic matrix with preload. When the CER.SM sliding material skids on the mating surface the solid lubricant is released forming an interface lubrication.

Micro-wear of bearing surface ensures that new solid lubricant is continuously released renewing the active film (heal-up effect).
Therefore such system becomes self-lubricating maintenance-free.







Compound selection

For the appropriate metallic matrix selection, knowing the operating conditions is essential. These are:

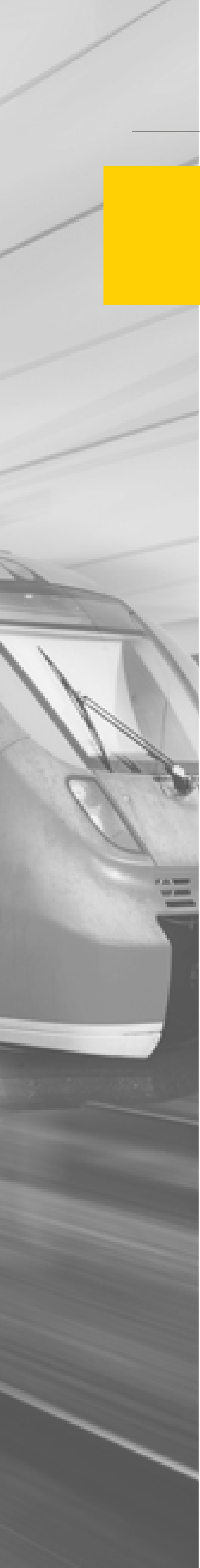
- temperature
- corrosiveness
- sliding speed
- load

As a result, the optimum metallic matrix as well as the type, content and structure will be specified.

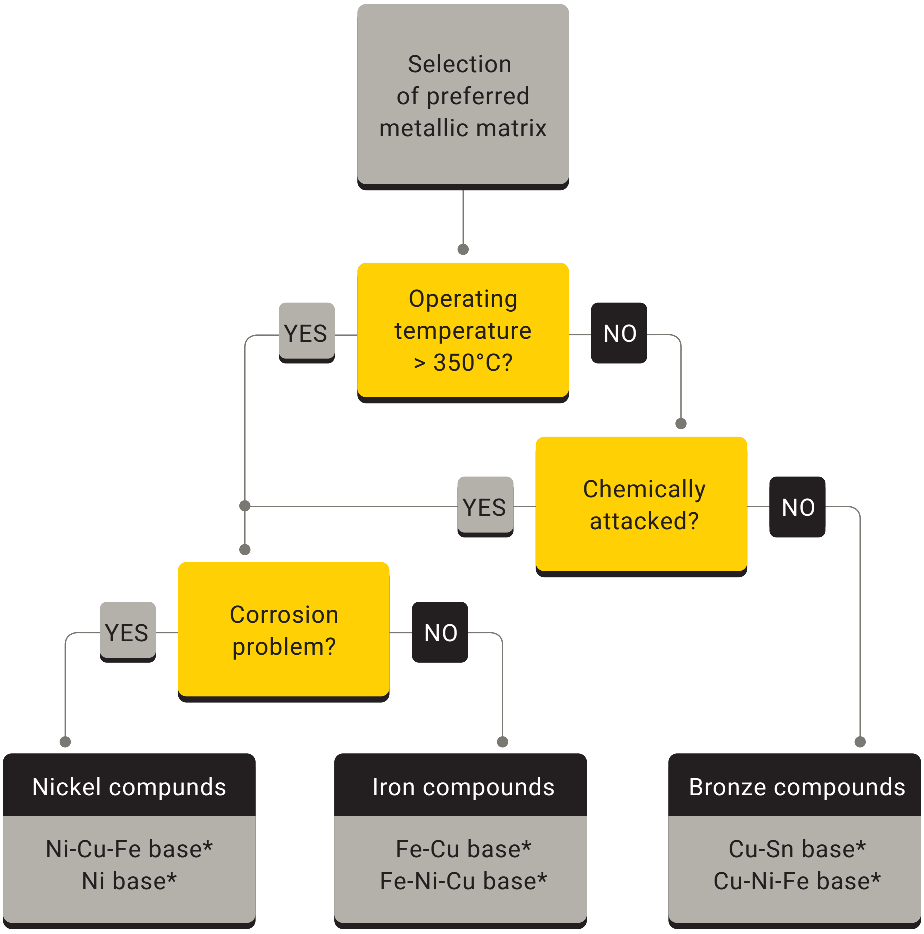
Refer to our application engineering team for selection of the right compound for each individual application and specific working conditions.

Typical applications for CER.SM compounds

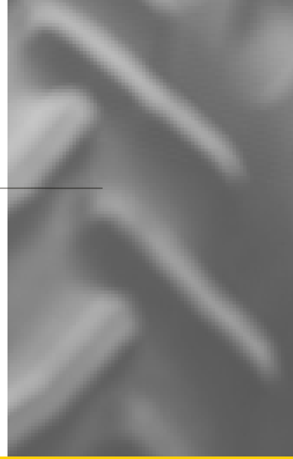
Compound	Application	Characteristics
CER.SM 101	General	Standard material for general engineering
CER.SM 105	Iron, steel, aluminum industry	High abrasion and temperature resistance
CER.SM 113, 118	Oven construction	Withstands temperature
CER.SM 172	Hydro mechanical applications; civil engineering	High load, corrosion and sea water resistance
CER.SM 101	Food and beverage equipment	High speed, long runtime
CER.SM 808	Heavy industry	High load and abrasion resistance
CER.SM 125, 233, 703	Exhaust or smoke flaps	Temperature & corrosion



Selection by temperature & corrosion / environment



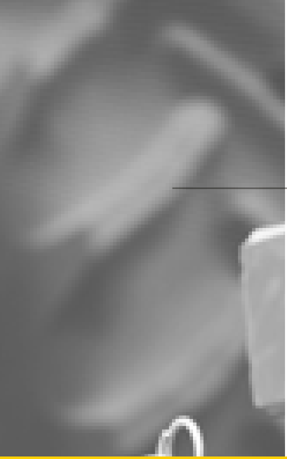
*The exact material specification is defined by individual operating conditions.



Physical & mechanical properties

BRONZE BASE MATRIX

COMPOUND NAME	CER.SM 172	CER.SM 101	CER.SM 105	CER.SM 103
MECHANICAL PROPERTIES				
Tensile strength [MPa]	80	57	85	55
Compressive strength [MPa]	400	310	350	250
Hardness min. [HBW 2.5/31; 25/15]	50	45	65	50
Density [g/cm^3]	6.7	6.3	6.4	6.2
Type of solid lubricant	C	C	C	C
APPLICATION DATA				
Max. static load [MPa]	250	200	230	180
Max. dynamic load [MPa]	130	100	115	90
Max. sliding speed, dry [m/s]	0.5	0.5	0.35	0.35
Max. pv dry [N/mm^2 x m/s]	1.5	1.5	1.5	1.5
Typical coefficient of friction, dry	0.14 - 0.20	0.12 - 0.18	0.12 - 0.18	0.11 - 0.16
Typical coefficient of friction, wet	0.13 - 0.18	0.11 - 0.16	0.11 - 0.17	0.11 - 0.14
Linear coeff. of thermal exp. [10^{-6}/K]	18	18	18	18
Service temperature min/max [°C]	-50 / 200	-50 / 200	-50 / 200	-50 / 200
Min. hardness counter material [HB]	180	180	>35 HRC	>35 HRC
Recommended surface roughness of counter material Ra [µm]	0.2 - 0.8	0.2 - 0.8	0.2 - 0.8	0.2 - 0.8
TYPICAL APPLICATIONS	Standard compound for common applications. Hydropower, tire molds, beverage machines, compressors, blowers, steel industry, smeltery equipment	Standard compound for common applications. Hydropower, beverage machines, compressors, blowers, steel industry, smeltery equipment	Heavy industry. High abrasivity conditions, high loads, hard shaft material	Heavy industry. High abrasivity



IRON AND NICKEL BASE MATRIX

COMPOUND NAME	CER.SM 701	CER.SM 703	CER.SM 118	CER.SM 124	CER.SM 125
MECHANICAL PROPERTIES					
Tensile strength [MPa]	90	75	85	60	60
Compressive strength [MPa]	640	320	560	405	405
Hardness min. [HBW 2.5/31; 25/15]	80	50	80	45	45
Density [g/cm^3]	6.1	6.0	6.0	6.0	6.0
Type of solid lubricant	C	C	C	C	C
APPLICATION DATA					
Max. static load [MPa]	150	70	155	100	100
Max. dynamic load [MPa]	80	30	70	55	55
Max. sliding speed, dry [m/s]	0.2	0.2	0.2	0.2	0.2
Max. pv dry [N/mm^2 x m/s]	0.5	1	1	0.8	0.8
Typical coefficient of friction, dry	0.25 - 0.45	0.30 - 0.45	0.25 - 0.45	0.25 - 0.45	0.25 - 0.45
Typical coefficient of friction, wet	-	-	-	-	-
Linear coeff. of thermal exp. [10^{-6}/K]	13	13	13	15	15
Service temperature min/max [°C]	-50 / 650	280 / 500	0 / 650°C	-200 / 200	-200 / 200
Min. hardness counter material [HB]	>HRC45	>HRC45	>HRC45	>HRC45	>HRC45
Recommended surface roughness of counter material Ra [µm]	0.2 - 0.8	0.2 - 0.8	0.2 - 0.8	0.2 - 0.8	0.2 - 0.8
TYPICAL APPLICATIONS	High temperature furnaces, steel industry, smeltery equipment, furnace equipment, agitators, rabbles, autoclave, reactors		Heat treatment furnaces in steel or aluminum industry, common applications at elevated temperatures	Mainly at liquid media, with corro-sion-danger (for example phosphoric acid, zinc chloride, zinc sulphate etc.)	Vent for exhaust gas, common applications at elevated temperatures with risk of corrosion

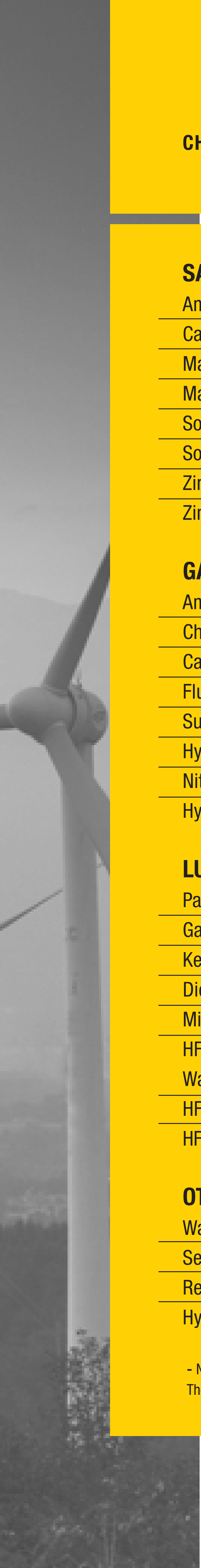
Important remark: the listed material properties, in particular friction coefficients, are no assured properties. They are to be used only as guidelines for selection of materials.

Chemical resistance

The following table provides an indication of the chemical resistance of various compounds. It is recommended to always test the chemical resistance of each coumpound.

CHEMICAL	concen-tration [%]	tempe-rature [°C]	CuSn base	FeNiCu base	Fe base	FeCu base	NiCuFe CER.SM 125	Ni base CER.SM 124
STRONG ACIDS								
Hydrochloric Acid	5	20	⊙	-	⊙	-	⊙	-
Hydrofluoric Acid	5	20	⊙	⊙	-	-	+	+
Nitric Acid	5	20	-	-	-	-	-	-
Sulphuric Acid	5	20	+	-	⊙	-	+	⊙
Phosporic Acid	5	20	+	-	-	-	⊙	+
WEAK ACIDS								
Acetic Acid	5	20	+	-	-		+	⊙
Formic Acid	5	20	+	-	-	-	+	⊙
Boric Acid	5	20	+	-	-	-	+	+
Citric Acid	5	20	+	⊙	⊙	⊙	+	+
BASES								
Ammonia	10	20	-	+	+	+	+	+
Sodium Hydoxide	5	20	+	+	+	+	+	+
Potassium Hydroxide	5	20	+	+	+	+	+	+
SOLVENTS								
Acetone		20	+	+	+	+	+	+
Carbon Tetrachloride		20	+	+	+	+	+	+
Ethanol		20	+	+	+	+	+	+
Ethyl Acetate		20	+	+	+	+	+	+
Ethyl Chloride		20	+	-	-	-	+	+
Glycerin		20	+	+	+	+	+	+

- Not resistant; **+** Resistant; ⊙ Conditionally resistant depending on temperature, O_2-concentration, concentrations etc.
The listed chemical properties are no assured properties. They provide a basis for estimating suitability for various applications.



CHEMICAL	tempe-rature [°C]	CuSn base	FeNiCu base	Fe base	FeCu base	NiCuFe CER.SM 125	Ni base CER.SM 124
SALTS							
Ammonium Nitrate		-	⊙	⊙	⊙	-	+
Calcium Chloride		+	+	-	+	+	+
Magnesium Chloride		+	⊙	⊙	⊙	⊙	+
Magnesium Sulphate		+	⊙	⊙	⊙	⊙	+
Sodium Chloride		+	⊙	⊙	⊙	+	+
Sodium Nitrate		+	+	+	+	+	+
Zinc Chloride		-	-	-	-	-	+
Zinc Sulfate		+	⊙	⊙	⊙	-	+
GASES							
Ammonia		-	+	+	+	⊙	-
Chlorine		-	-	-	-	⊙	n.a.
Carbon Dioxide		+	⊙	⊙	⊙	-	⊙
Fluor-Gas		-	⊙	⊙	⊙	+	+
Sulphur Dioxide		+	-	-	-	⊙	⊙
Hydrogen Sulphide		⊙	-	-	-	+	⊙
Nitrogen		+	+	+	+	+	+
Hydrogen		+	+	+	+	+	+
LUBRICANTS & FUELS							
Paraffin	20	+	+	+	+	+	+
Gasolene	20	+	+	+	+	+	+
Kerosene	20	+	+	+	+	+	+
Diesel Fuel	20	+	+	+	+	+	+
Mineral Oil	70	+	+	+	+	+	+
HFA – ISO46 High Water Fluid	70	+	+	+	+	+	+
HFC – Water-Glycol	70	+	+	+	+	+	+
HFD – Phosphate Ester	70	+	+	+	+	+	+
OTHERS							
Water	20	+	+	-	-	+	+
Sea Water	20	+	-	-	-	+	+
Resin		+	+	+	+	+	+
Hydrocarbon		+	+	+	+	+	+

- Not resistant; **+** Resistant; ⊙ Conditionally resistant depending on temperature, O_2-concentration, concentrations etc.
The listed chemical properties are no assured properties. They provide a basis for estimating suitability for various applications.

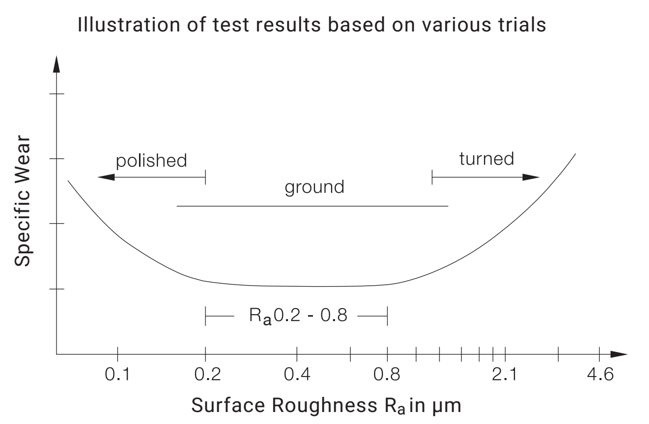
Mating Materials

Performance of bearings is directly dependent on the surface roughness and hardness, as well as the type and properties of the mating material. Stainless and carbon steel usually work very well as mating materials or use of non-iron materials or application of special coatings need to be tested.

Dry running hardness of the counter material needs to be at least 180 HB. In case if conditional conventional lubrication, hardness of 130 HB can be accepted.

If abrasive particles are present 35 HRC minimum hardness is recommended. For iron and nickel based alloys the minimum counter surface hardness for dry running is 35HRC.

MATERIAL NUMBER	DIN DESIGNATION	USA ANSI	UK BS970	FRANCE AFNOR
MATING MATERIALS FOR GENERAL APPLICATIONS				
1.0543	ZSt 60-2	Grade 65	55C	A60-2
1.0503	C45	1045	080M46	CC45
1.7225	42CrMo4	4140	708M40	42CD4
MATING MATERIALS FOR SEA WATER ENVIRONMENTS				
1.4460	X3CrNiMoN27-5-3	329	-	-
1.4462	X2CrNiMoN22-5-3	UNS531803	318513	Z3CND24-08
2.4856	Inconel 625	-	-	-
MATING MATERIALS FOR CORROSIVE ENVIRONMENTS				
1.4021	X20C13	420	420S37	Z20C13
1.4057	X17CuNi-16-2	431	431S29	Z15CN16.02
1.4112	X90CrMoV18	440B	-	Z70CV17
1.4122	X35CrMo17-1	-	-	-



Disadvantages of polished mating material:

- Lower hills and valleys on the surface
- Graphite cannot lock and fill the valleys
- Friction and wear increases
- High adhesive forces, shaft and bush stick together

Disadvantages of turned mating material:

- Hills and valleys of the surface are too deep
- Fill-gaps effect resulting in high wear rates

The best performance is achieved with ground mating material:

- Hills and valleys of the surface are in right shape to reach optimum conditions with low friction and wear. Refer to the above chart, the optimum surface roughness Ra is between 0.2 - 0.8 µm.

Running-in film

- Running-in film consists of a thin layer (of a typical thickness of 0.02 - 0.03 mm) of pure graphite applied onto the sliding surface of CER.SM parts, aiming at forming an initial transfer film on both CER.SM and mating surfaces. The thickness of the film is NOT to be considered in any thickness tolerance because it will be rapidly consumed during the running-in period.

CER.SM sliding plate

The same plate, with running-in film applied

Fits, clearance, installation

Specific load and the operational temperature are the basic factors defining operating clearance for dry running applications.

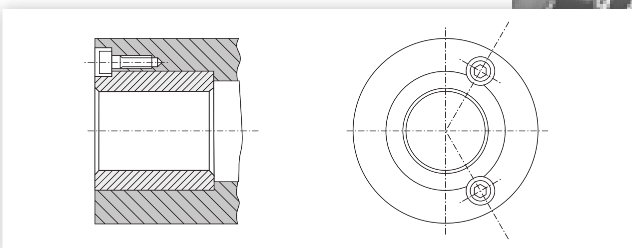
This operational clearance is necessary to assure optimum performance. Self-lubricated, dry running sliding bearings commonly require higher clearance compared to externally lubricated bearings. If the bushing inner diameter has to be manufactured with finished size, the inner diameter of bush reduction by pressing it into the housing needs to be taken into account. The following table shows recommendations and examples for different operationing conditions.

It is essential to maintain optimum fits and clearances for the best performance of our materials.

Installation of the bushing should be carried out with interference fit between outer diameter of bush and inner diameter of housing.

	Recommended tolerances for interference fit bush OD / housing ID
Bushing outer diameter	r6 / s6
Housing inner diameter	H7
Max. recommended surface roughness Ra	3.2 µm

If environmental temperatures exceed 150°C or under axial forces, the bushings have to be mechanically secured against distortion /shifting.



Own machining of bushings by customers after mounting is not necessary. Contraction of bearing when fit into the housing has been considered during the manufacturing process.
If there is a coverage ratio of H7/r6, narrowing of bushing bore will be in the range of 1.05 to 1.25 of average overlap. For fit ranges H to C, narrowing corresponds to one fit jump D/E.
Due to a range of variations of assigned overlaps, bushing bore has to be manufactured one quality step more precise to make sure that the required tolerance will be reached.
This means manufacturing bush ID in quality 7 leads to quality 8 after mounting.
If there is a coverage ratio of H7/s6, the deviation of narrowing of bushing bore will be higher. In this case, 2 quality steps have to be taken into account: quality 7 before mounting, quality 9 after mounting.
Essentially, the required assembly clearance depends on bearing load and operating temperature.
The following table specifies recommended clearances for the bushings in the following table with housing inner diameter tolerance H7 and bushing outer diameter tolerance r6.

APPLICATION	OPERATION CONDITIONS	SHAFT TOLERANCE	BUSH INNER DIAMETER TOLERANCE BEFORE MOUNTING	BUSH INNER DIAMETER TOLERANCE AFTER MOUNTING
General mechanical engineering	Normal operation T < 80°C	h7	C7	D8
	80°C < T < 100°C	h8	C7	D8
	100°C < T < 130°C	h8	B7	C9
	High specific load	h8	B7	C9
	Minimum clearances	h6	D7	E8
Steelwork equipment	Normal operation	h8	B7	C9

The wall thickness of the bush has to follow manufacturing possibilities and operating conditions (specific bearing load). The following table shows recommended values for wall thickness.

Specific load [MPa]	Required minimum wall thickness (D1 = inner diameter of bush)
< 10	$\sqrt{0,5\ D1}$
10 – 25	$\sqrt{0,6\ D1}$
25 - 50	$\sqrt{0,8\ D1}$
> 50	$\sqrt{D1}$

Thermal expansion

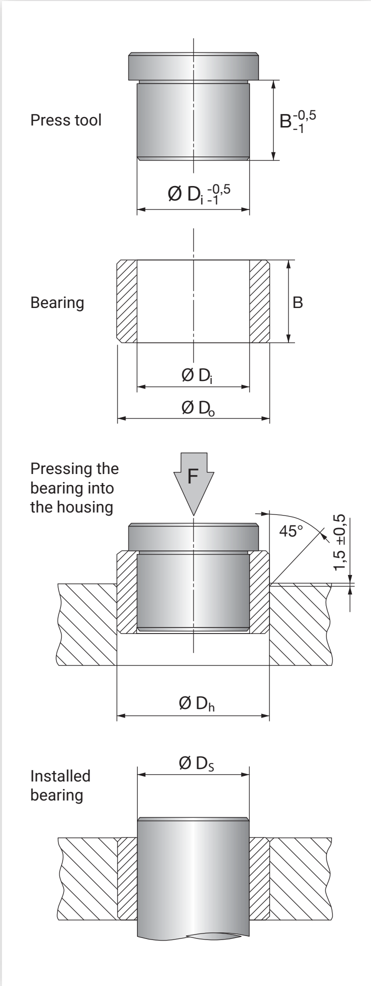
Operating conditions with higher temperatures need to take into account the thermal expansions of housing, bushing and shaft. These factors influence the tight fit of the bushing in the housing and the right clearance between bush and shaft.
In continuous operation at higher temperatures, the following formula applies: $C_{DM} = C_D + [D_W x\ \Delta T\ x\ (a_W + a_{cer} - a_G)]$

Where

C_{DM} Installation clearance
C_D Required operational clearance
D_W Shaft diameter
a_W Linear coefficient of thermal expansion of shaft material
a_{cer} Linear coefficient of thermal expansion of bushing material
a_G Linear coefficient of thermal expansion of housing material
ΔT Operating temperature – ambient temperature

Installation

Cylindrical plain bearings should be assembled into the housing by using a hydraulic or screw press with an appropriate press tool as shown in the picture. To avoid damage to the bearing, the press force must be applied evenly on the side face of the bearing. Hitting the bearing, for example by a hammer will cause damage.



During assembly, the bearing inner diameter will be reduced by an amount equal to the value of interference between the bearing outer diameter and the housing inner diameter. This reduction has been taken into consideration for recommended tolerances of housing inner diameter Dh and shaft outer diameter DS.

Fixation of sliding plates using countersunk screws

Preparation
The thread holes should be machined in the housing part according to ISO Standard. Before installation, the sliding plate has to be tightly fixed with the housing part using suitable clamping tools (e.g., clamping tongs).

Installation
Fix the sliding plate with a countersunk screw.

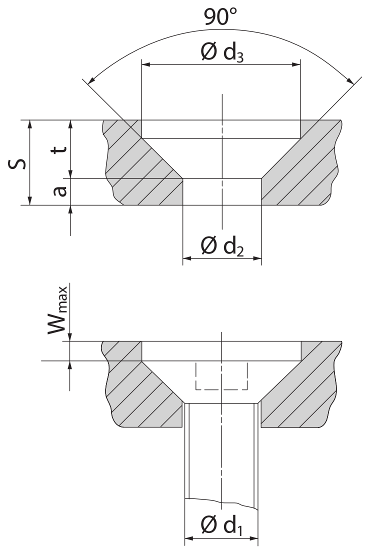
Additional screw securing
If required, the screws may be secured with metal adhesives like "Loctite 603". Follow the glue manufacturer recommendation.

Maximum wear depth: w_{max} = S – a – k (see following page)

DIN EN ISO 10642	Bore in sliding plate			
d_1	d_2	d_3	$\sim a_{min}$	$\sim s_{min}$
M6	6.6	14	3	8
M8	9	18.5	4	10
M10	11	23	5	12
M12	13.5	27.5	6	15
M16	17.5	34.5	8	18
M20	22	41	10	21

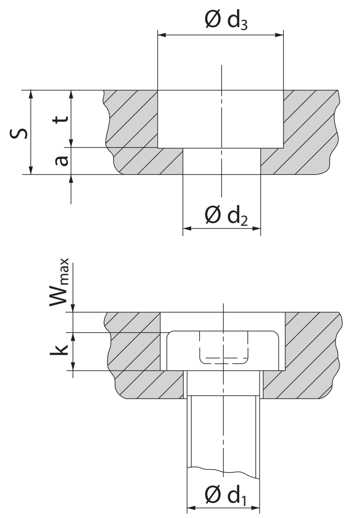
DIN EN 6912	Bore in sliding plate			
d_1	d_2	d_3	$\sim a_{min}$	$\sim s_{min}$
M6	6.6	11	3	8
M8	9	15	4	10
M10	11	18	5	13
M12	13.5	20	6	15
M16	17.5	26	8	20
M20	22	33	10	24

Countersink for DIN EN ISO 10642
(DIN 7991)



Dimensions for bore
in sliding plate
according to DIN EN ISO 10642

Countersink for DIN 6912



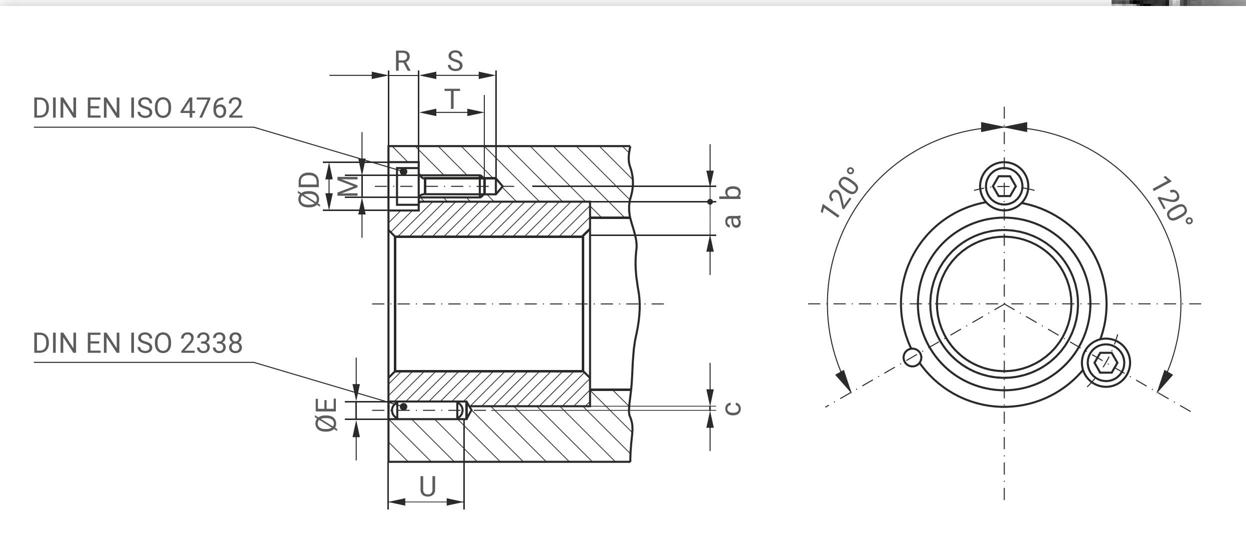
Dimensions for bore
in sliding plate
according to DIN 6912

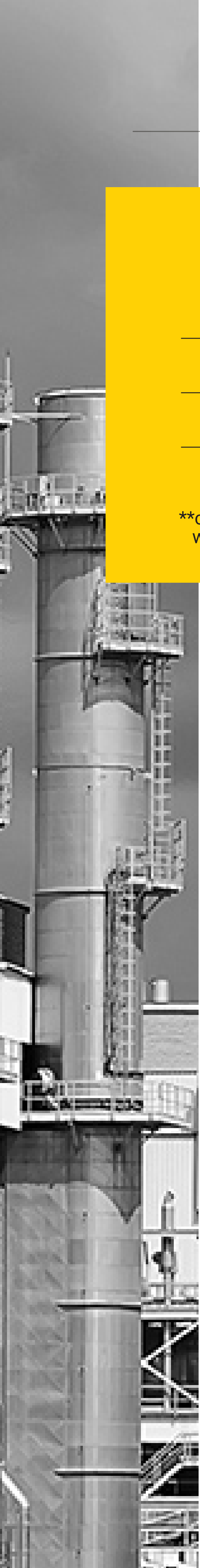
Additionaly to the standard press fit, mechanical fixing should be deployed if bearing operates:

- at temperatures above 150°C
- under large temperature variations
- under high alternating loads due to vibration, impact or edge loading
- under axial loads

a	DIN EN ISO 4762	DIN EN ISO 2338								
	M	b	ØD	R	S	T	Epin	ØE*	U	c
<5	M6 x 12	3.5	11	7	19	14	4_{m6}	4^{H7}	16	0.8
5 - 7	M8 x 16	4.5	14	9	25	18	5_{m6}	5^{H7}	18	1
>7	M10 x 20	6	17	11	28	22	6_{m6}	6^{H7}	20	1.2

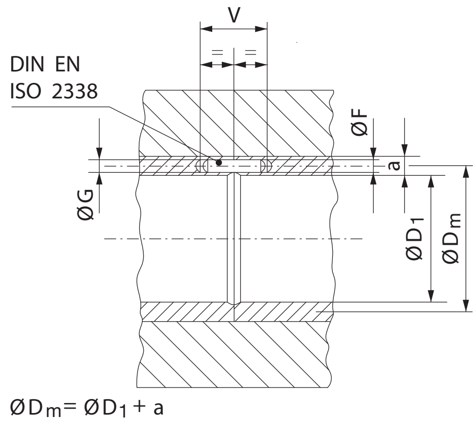
Type A: Combined fixing against rotary and translational displacement





a	DIN EN ISO 2338			
	Fpin**	ØF	G	V
<8	3_{m6}	3^{H7}	3.5	16
8-12	4_{m6}	4^{H7}	4.5	18
≥12	5_{m6}	5^{H7}	5.5	80

**cylinder pins should be inserted with metal adhesive, e.g., Loctite 603



Max screw connection tightening torque

Tightened screw connection must not exceed maximum allowed pressure under screw head.

Therefore tightening must be done with a consideration to maximum allowed static load.

The calculation of tightening torque is as follows :

$$M_{max} = p_{stat/max} \times A_{contact} \times (0{,}16 \times P + \mu \times 1.5\, d)$$

Where:

M_{max} - max. permissible screw tightening torque [Nm]
$p_{stat/max}$ - max. static loading capacity of CER.SM material [N/mm^2]
$A_{contact}$ - contact surface between the screw head (or washer) surface and the CER.SM component [mm^2]
P - thread pitch [mm]
μ - total coefficient of friction (thread and screw head to CER.SM = 0.1)
d - pitch diameter [mm]

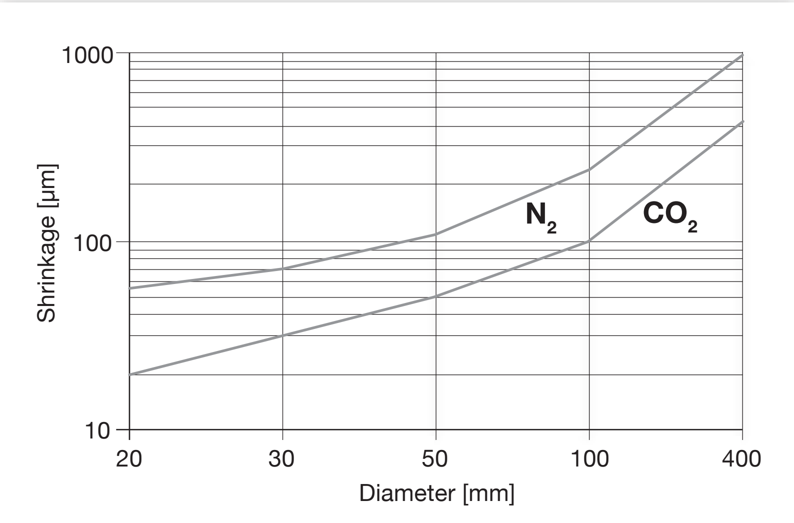
Installation by Supercooling

Supercooling is permitted only for bronze-based materials. Supercooling of other materials may result in undesired microstructural changes.

Use of liquid nitrogen or solid carbon dioxide (dry ice) is recommended.

Shrinkage can be determined by the following formula:

$$s = 0.8 \times a_1 \times \Delta T \times D_2$$



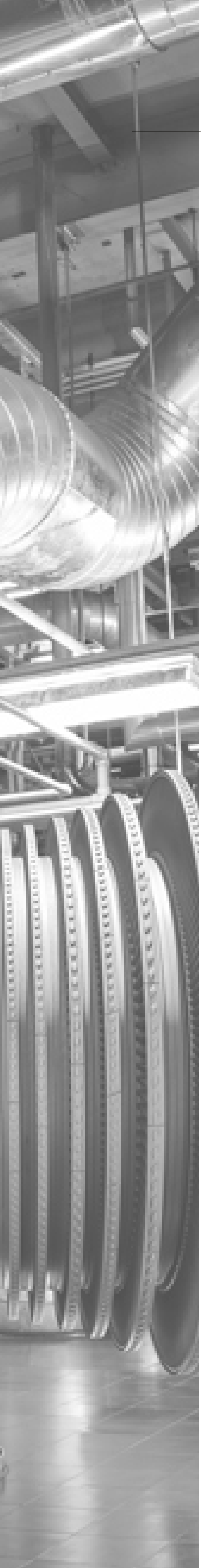
s - shrinkage [µm]

ΔT - temperature difference [°C] or [K]

a_1 - linear coefficient of thermal expansion [1/K]

D_2 - outer diameter

Use caution during supercooling. Use of cooling box, covered with polystyrene, approx. 30 mm thick is recommended. A top cover prevents loss of cooling and leads to faster cooling of the part. Cooling time depends on size and should take between 0.5 and 2 hours. Supercooled bushes can be easily installed into the housing without using excessive force.



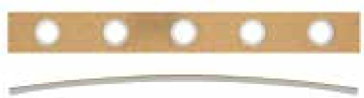
Available designs

Examples of available sliding plates & plain bearings

CER.SM bushing

Bushing with cleaning grooves

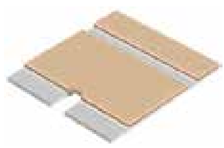
Flanged bushing with cleaning grooves and running-in film



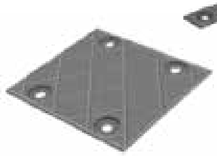
SLIDING PLATE , radial

SLIDING PLATE, axial

T-GUIDE

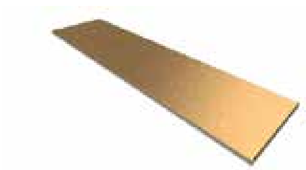


SLIDING PLATE without running-in film

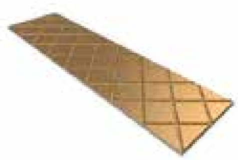


SLIDING PLATE with running-in film

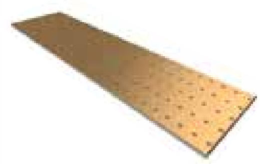
SEGMENT RING with running-in film



For standard applications, the sliding layer can be plain. A graphite running-in film helps during the initial stage of the service life



For harsh enviroments and non lubricating conditions, cleaning grooves can prolong the service life



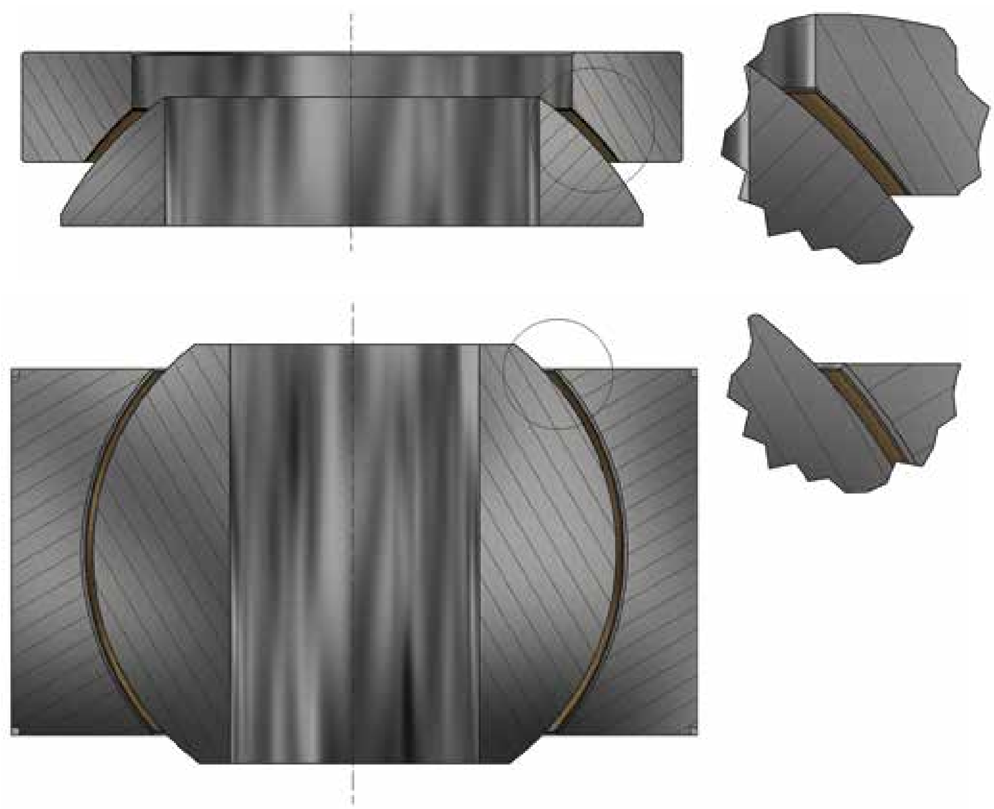
For grease-lubricating conditions, dimples act as a lubricant reservoir to prolong the service life

Special design solutions

Spherical bearings

One of the most required advanced design bearings is the spherical joint featuring self-alignment of its rotation axis and thus providing many desired functional benefits.

Our engineers utilize cutting-edge modelling and in-house expertise when designing customized spherical bearings solutions. Their knowledge and expertise are put in service when helping our customers finding the right answers for their engineering challenges. Contact us now for more information.



Design questionnaire

Application data for the design of GSM bearing / thrust washer / spherical bearing / sliding plate

CUSTOMER

CONTACT PERSON

ADDRESS

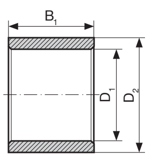
TEL./EMAIL

EXISTING DESIGN ☐

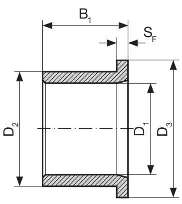
NEW DESIGN ☐

DESCRIPTION OF APPLICATION

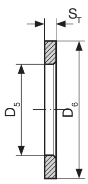
Steel industry	☐	
Wind energy	☐	
Rubber and Plastic Industry	☐	
Steam and Gas Turbines	☐	
Offshore and Marine	☐	
Heavy-duty Vehicles	☐	
Hydro power	☐	
Other*	☐	specify*:



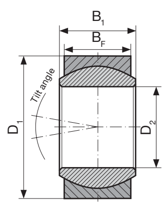
Plain bearing ☐



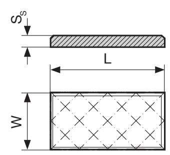
Flanged bearing ☐



Thrust washer ☐



Spherical bearing floating / fixed ☐



Sliding plate ☐

QUANTITY TO BE SUPPLIED (PCS)	Item #1	Item #2	Item #3
Type of part (select from list)			
Type of motion 1 (select from list)			
Type of motion 2 (select from list)			

DIMENSIONS (MM)	Item #1	Item #2	Item #3
Inner diameter D_1 (D_5)			
Outer diameter D_2 (D_6)			
Bearing width B_1			
Outer ring width B_F			
Flange outer diam. D_3			
Flange thickness S_F			
Wall thickness S_T			
Plate length L			
Plate width W			
Plate thickness S_S			

LOAD	Item #1	Item #2	Item #3
Static			
Dynamic			
Alternating			
Impact			
Radial load (kN)			
Axial load (kN)			

SURFACE PRESSURE	Item #1	Item #2	Item #3
Radial			
Axial			

MATING MATERIAL	Item #1	Item #2	Item #3
Material spec/type (W. Nr.)			
Hardness (HB or HRC)			
Roughness R_a (µm)			

HOUSING MATERIAL	Item #1	Item #2	Item #3
Material spec/type (W.Nr.)			

LUBRICATION	Item #1	Item #2	Item #3
Dry running			
Permanent lubrication			
Initial lubrication supplied			
Lubricant type			
Dynamic lubricant viscosity			

MOTION DATA	Item #1	Item #2	Item #3
Rotational speed (rpm)			
Sliding speed (m/s)			
Stroke length (mm)			
Linear freq. (strokes/min)			
Angle “β” (see image)			
Oscill.frequency (n/min)			

MOTION DATA	Item #1	Item #2	Item #3
Rotational speed (rpm)			
Sliding speed (m/s)			
Stroke length (mm)			
Linear freq. (strokes/min)			
Angle “β” (see image)			
Oscill.frequency (n/min)			

OPERATING TIME	Item #1	Item #2	Item #3
Continuous operation			
Intermittent operation			
Working time (hours/day)			
Working time (days/year)			
Frictional distance (km)			

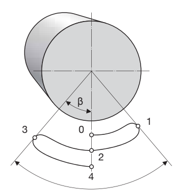
ISO FITS & TOLERANCES	Item #1	Item #2	Item #3
Shaft			
Bearing housing			

ENVIRONMENT	Item #1	Item #2	Item #3
Operating temperature (°C)			
Min. op. temperature (°C)			
Max. op. temperature (°C)			
Chemical medium in touch with the bearing			

LIFETIME	Item #1	Item #2	Item #3
Desired operating time (h)			
Permissible wear (mm)			

ANGLE β

For oscillating motion, one cycle is four time the angle β



REMARKS

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