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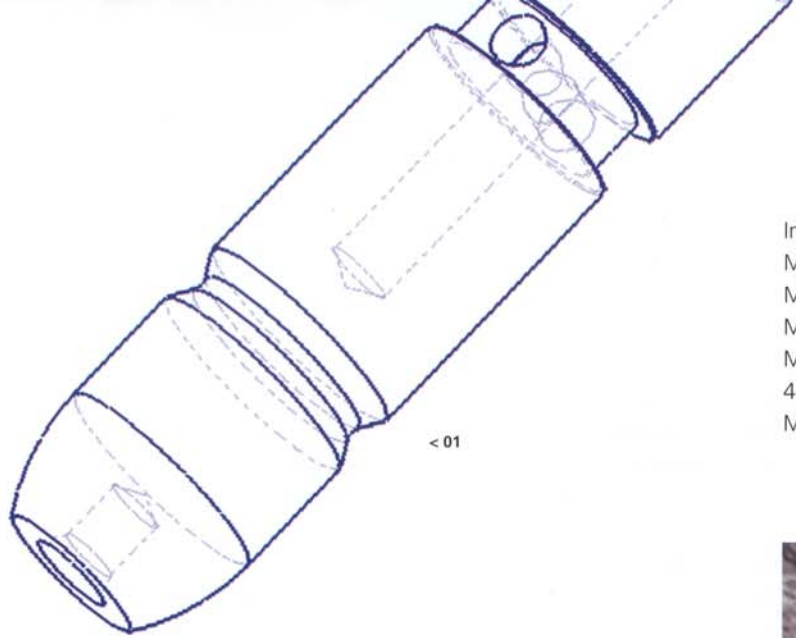
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mps

Solutions in microspace





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01
Pick-up head

02-04
In 1969, during the Apollo mission, our ball bearings took part in mankind's first steps on the Moon

The history of mps started 70 years ago with the development and manufacturing of miniature, high-precision ball bearings. Thanks to the reliability and quality of mps ball-bearings, the company has taken part in the conquest of space.

Today we are continuing to take on the toughest challenges by developing complex microsystems of increasingly minute dimensions while constantly fulfilling the technical requirements set out. Helping to ensure the achievements and success of our customers is our principal motivation. Pushing back the limits of micro technology by devising and continually improving manufacturing processes is a task that fascinates our multidisciplinary workshop teams. Constantly maintaining and developing our unique know-how in assembling micro technical components, the fruit of pure Swiss watchmaking tradition, is the pride of the specialists who work in our micro-assembly departments. Guaranteeing and certifying a high level of quality by putting in place stringent control procedures illustrates the authority of our quality assurance experts.

The enthusiasm with which each new project is approached reflects our passion for our work. We look forward to sharing it with you.

mps is currently enjoying a high rate of growth thanks to its entrepreneurial and innovative ability, and the support of the FAULHABER Group, which puts its two priorities – technology and its employees' skills – at the service of its customers.

mps focuses its activities on developing microsystems for global customers in specific fields, which include medical devices, automation / industrialization, optical measurement systems and the watch industry.

As a traditional manufacturer of high-precision micro mechanical components, mps successfully produces and develops its well-known and reputed product lines:

- microsphere®: micro-balls and four-point contact watch bearings for medical and semi-conductors
- microlinea®: linear bearings and high-performance ball screws

The quality of mps microsystems is appreciated by leading manufacturers. mps supplies several thousands of such systems each year.

The final precision of the systems relies on:

- a creative design using state-of-the-art materials and techniques,
- a long experience in precision machining and in centerless grinding techniques,
- recognized know-how in high-precision linear and/or rotating motion bearing systems,
- selection of parts to be assembled, sorted and matched to the nearest micron,
- an assembly process within a controlled environment, carried out by highly qualified personnel.

mps supplies the pick-up systems for high-speed pick-and-place machines for handling electronic components 2mm x 1mm in size that have to be positioned with a precision of some microns.





Calculation for the theoretical life expectancy

In Europe we consider a nominal life expectancy of 100'000 meters; this is the reason of the utilization of the factor 10^5 in the following formula (in Japan: 50'000 meters). The load ratings shown in the leaflet were calculated according to DIN 636.

General formulas

The theoretical life expectancy has no practical value unless the following conditions are scrupulously fulfilled:

- Strength and direction of constant loads carefully determined
- Constant speed
- Constant temperature not exceeding 100°C.
- Strict cleanliness in mounting and during running
- Careful choice and dosage of lubricant

In all cases of complexity or doubt it is advisable to consult our technical staff.

In achieved distance

- L:** Life expectancy in meters [m]
- C:** Dynamic load rating [N]
- P:** Equivalent load [N]

- L_h:** Life expectancy in hours [h]
- f:** Frequency, number of double strokes [min-1]
- s:** Length of a double stroke [m]

$$L = \left(\frac{C}{P}\right)^3 \cdot 10^5$$

$$L_h = \left(\frac{C}{P}\right)^3 \cdot \frac{10^5}{f \cdot s \cdot 60}$$

$$L_h = \frac{L}{f \cdot s \cdot 60}$$

Newton / lb conversion

1 Newton = 0.225 lb

1 lb = 4.45 Newton



02 >

Miniature precision linear bearings for linear motion

Automation, medical instrumentation, military and defense industry, space industry

Reference	d [mm]	D [mm]	B [mm]	r min [mm]	Ø balls [mm]	Load ratings	
						static Co [N]	dynamic C [N]
L 204X	2	4	5	0.02	0.500	8	10
L 306X	3	6	7	0.13	0.600	31	30
L 408X	4	8	10	0.24	0.794	66	61
L 510X	5	10	14	0.24	1.250	131	132
L 612X	6	12	18	0.39	1.588	250	245

Example of part number definition

- L 204X-L23ar miniature precision linear bearing
- L 204X-L23ar dimension: first digit bore = 2[mm]
- L 204X-L23ar second 2 digits outer diameter = 4[mm]
- L 204X-L23ar stainless steel material
- L 204X-L23ar lubricant: L = oil; G = grease
- L 204X-L23ar type of lubricant
- L 204X-L23ar rust protection, dipped in oil

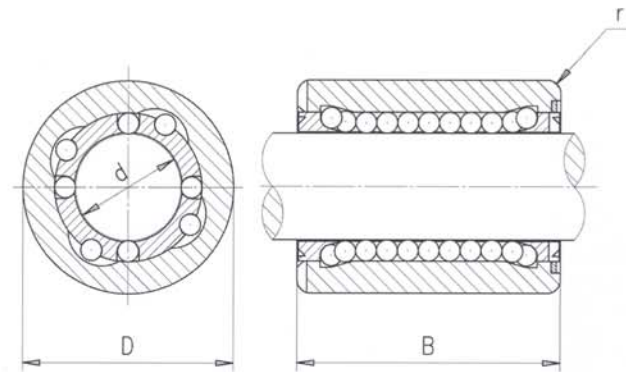
- Housing** stainless steel AISI 440C
- Cage** brass
- Shields** stainless steel AISI 302 or AISI 303
- Balls** stainless steel AISI 440C
- Lubrication** Standard: Winsor Lube L245X (other oil on request)
- Temperature** -40° and +80°C or more with the appropriate lubricant

On request, mps can deliver linear bearings only in stainless steel (with stainless cage)

Bearing tolerances

- Bore diameter 0/+8 [µm]
- Outside diameter 0/-8 [µm]

- Recommended tolerances for shaft: 0/-6 [µm]
- Max. interference fit of outer ring -1/-3 [µm]



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01 Miniature precision linear bearing (serie L)

02 Deburring

02 >



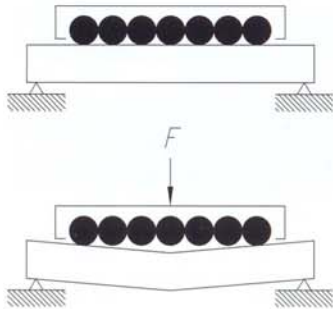
Effective load capacity C_{eff}

The effective load capacity is determined by the following coefficients:

- f_1 coefficient related to the angle of application of the load on the bearing
- f_A coefficient related to the buckling angle of the shaft
- f_B coefficient related to the displacement length
- f_C coefficient related to the hardness of the shaft
- f_D coefficient related to the temperature (for DBL only)
- F_i coefficient related to the number of bearings per unit

On the basis of the above coefficients, the effective load capacity is calculated as follows:

$$C_{eff} = C \cdot f_1 \cdot f_A \cdot f_B \cdot f_C \cdot f_D \cdot f_i$$



Coefficient f_1

If the load applies directly on 1 row of balls, the coefficient $f_1 = 0.7$

In the other case, coefficient $f_1 = 1$

Coefficient f_A

As soon as a radial load is applied, the shaft will bend. This bending change the number of carrying balls.

$$\begin{aligned} \leq 5' & & f_A &= 1 \\ 5' < \leq 10' & & f_A &= 0.8 \\ 10' < \leq 15' & & f_A &= 0.4 \end{aligned}$$

Coefficient f_B

If the distance of displacement is less than twice the width of the bearing, the coefficient f_B must be determined. Consequently, it is possible to take into account the premature wear caused by running on a small zone.

$$\begin{aligned} (\text{course/width } B) \geq 2 & & f_B &= 1 \\ 1 \leq (\text{course/width } B) < 2 & & f_B &= 0.8 \\ (\text{course/width } B) < 1 & & f_B &= 0.5 \end{aligned}$$

Coefficient f_C

This factor takes into consideration the hardness of the guiding shaft. If the hardness is lower than 58 HRC, the life expectancy will be decreased exponentially. It is therefore important to choose materials with hardness near 58 HRC, especially when using stainless steel.

$$\begin{aligned} \text{hardness of the shaft} \geq 58 & & f_C &= 1 \\ 55 \leq \text{hardness of the shaft} < 58 & & f_C &= 0.7 \\ 50 \leq \text{hardness of the shaft} < 55 & & f_C &= 0.5 \end{aligned}$$

Coefficient f_D

As soon the temperature of use higher than 25°C, the life expectancy of the bearing decreases. Therefore it is necessary to define the coefficient f_D .

$$\begin{aligned} T < 25 \text{ } ^\circ\text{C} & & f_D &= 1 \\ 25 \text{ } ^\circ\text{C} \leq T < 40 \text{ } ^\circ\text{C} & & f_D &= 0.7 \\ 40 \text{ } ^\circ\text{C} \leq T < 60 \text{ } ^\circ\text{C} & & f_D &= 0.35 \end{aligned}$$

Coefficient f_i

In most applications, linear bearings are not mounted separately. They are often mounted in block forming compact guiding units. Because of the difference of tolerances, it has been noticed that the starting conditions are not the same for each mounted bearing.

Based on several tests, a formula can be determined taking into account these particular conditions. The coefficient f_i is calculated as follows:

$$f_i = \frac{i^{0.7}}{i}$$

i Number of ball bushings in the nuts

Coefficient C_{eff}

The formula which takes into account the effective load capacity (C_{eff}) and the two correction factors is as follows:

$$L_n = \left(\frac{C_{eff}}{P} \right)^3 \cdot 10^5$$

L_n Nominal life expectancy in meters [m]

C_{eff} Effective dynamic load capacity [N]

P Equivalent dynamic load [N]

Miniature precision linear bearings for linear motion

Automation, medical instrumentation, military and defense industry, space industry

Advantages

- high precision
- low noise
- low friction
- cost effective
- corrosion resistant

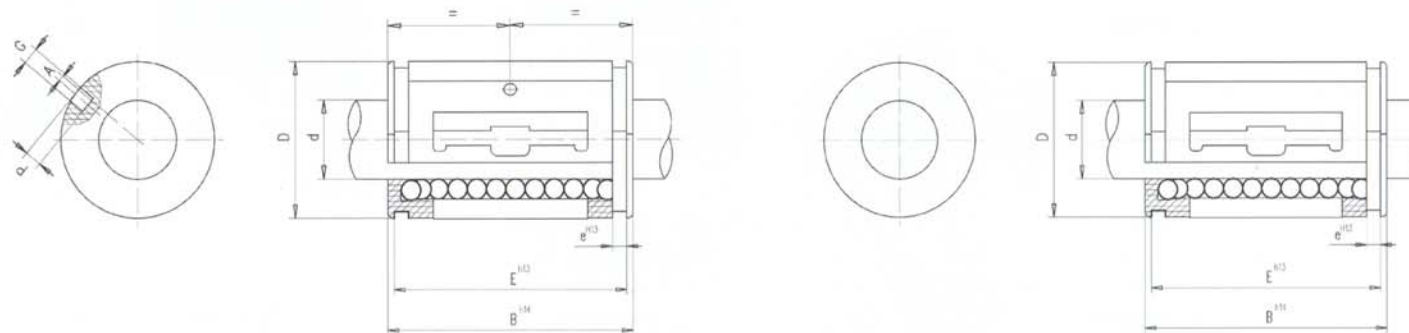
Reference	d [mm]	D [mm]	B [mm]	e [mm]	E [mm]	ØG [mm]	A [mm]	P [mm]	Load ratings		
									stat Co [N]	dyn C [N]	Ball rows
DBL 307X	3	7	10	-	-	1.0	0.0	0.75	27	26	3
DBL 408X	4	8	12	-	-	1.0	0.0	0.9	50	44	4
DBL 510X	5	10	15	-	-	1.2	0.1	1.0	84	72	4
DBL 612X	6	12	19	-	-	1.0	0.0	1.0	132	114	4
DBL 815X	8	15	24	1.1	23	1.5	0.85	1.0	204	167	5
DBL 1017X	10	17	26	1.1	25	1.5	0.85	1.2	234	186	5
DBL 1219X	12	19	28	1.3	26.4	1.5	1.25	1.2	257	202	6
DBL 1222X (-JR)	12	22	32	1.3	22.60				352	310	6
DBL 1626X (-JR)	16	26	36	1.3	24.60				440	372	7
DBL 2032X (-JR)	20	32	45	1.6	31.20				689	591	7
DBL 2540X (-JR)	25	40	58	1.85	43.70				1332	1162	7

Example of part number definition

- DBL 307X precision linear bearing
- DBL 307X dimension: first digit bore = 3[mm]
- DBL 307X second 2 digits outer diameter = 7[mm]
- DBL 307X indicates stainless steel
- Housing polyamide
- balls and needles: stainless steel
- Lubrication standard: Winsor Lube L245X (other oil on request)

Bearings are available with wipers on both sides. Please, indicate **-JR** on the part number (e.g. 1219X-JR).

Material: stainless steel / polyamide



miniature precision bearings (serie DBL)

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DBL	Recommended tolerances				Radial clearance with the proposed tolerances for the housing and shaft		
	Housing		Shaft		Nominal value [μm]	H5 / h5 [μm]	H6 / h6 [μm]
	H5 [μm]	H6 [μm]	h5 [μm]	h6 [μm]			
307	0/+6	0/+9	0/-4	0/-6	0/6	0/16	0/21
408	0/+6	0/+9	0/-5	0/-8	0/6	0/17	0/23
510	0/+6	0/+9	0/-5	0/-8	0/6	0/17	0/23
612	0/+8	0/+11	0/-5	0/-8	0/6	0/19	0/25
815	0/+8	0/+11	0/-6	0/-9	0/6	0/20	0/26
1017	0/+8	0/+11	0/-6	0/-9	0/6	0/20	0/26
1219	0/+9	0/+13	0/-8	0/-11	0/6	0/23	0/30
1222	0/+9	0/+13	0/-8	0/-11	0/6	0/23	0/30
1626	0/+9	0/+13	0/-8	0/-11	0/6	0/23	0/30
2032	0/+11	0/+16	0/-9	0/-13	0/6	0/26	0/35
2540	0/+11	0/+16	0/-9	0/-13	0/7	0/27	0/36

02 >



03 >



Miniature ball screws high-precision

Automation, medical instrumentation, military and defense industry, space industry

Reference	Nut			Screw					Axial load rating	
	D [mm]	B [mm]	Øballs [mm]	d1 [mm]	P [mm]	d2 [mm]	L [mm]	L1 [mm]	dyn Ca [N]	stat Coa [N]
ED 410X V404X	10	10	0.794	4.25	1.0	3	70	50	439	178
ED 513X V501X	13	12	1.000	5.8	1.25	4	100	75	671	299
ED 616X V601X	16	14	1.191	7.4	1.5	6	140	110	968	471
ED 822X V801X	22	18	1.588	10.5	2.0	8	190	150	1659	879
ED 1028X V1001X	28	22	2.000	13.6	2.5	10	260	210	2544	1396

Example of part number definition

ED 513X/V501X ball nut. (EDD = two ball nuts)
 ED 513X/V501X 4 x pitch of ball nut thread
 ED 513X/V501X outer diameter of ball nut
 ED 513X/V501X ball nut in stainless steel material
 ED 513X/V501X ground precision screw
 ED 513X/V501X 4 x pitch of screw thread
 ED 513X/V501X screw drawing number
 ED 513X/V501X screw in stainless steel material

Housing stainless steel AISI 440C
 Ball nuts ED/ES stainless steel AISI 440C
 Shields stainless steel AISI 302 or AISI 303
 Balls stainless steel AISI 440C
 Lubrication Standard: L23ar
 (rust protection; i.e. dipped in oil)
 oil, greases or dry lubrication on request

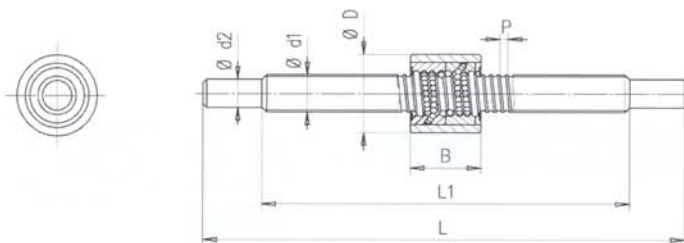
Special The maximum length of a special screw will not exceed 1.5x the length of a standard screw. Nevertheless, each case must be examined individually.

Temperature -40° and +80°C or more with the appropriate lubricant

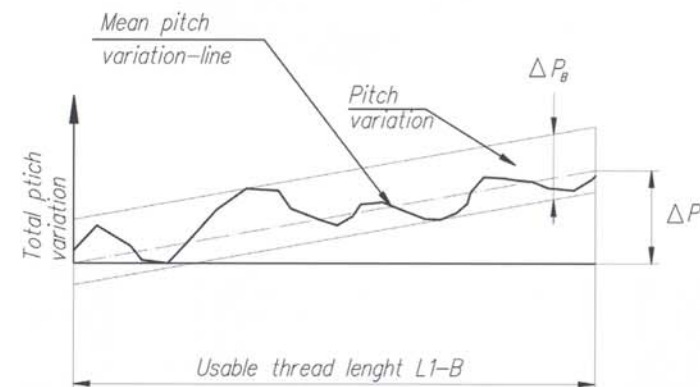
Left hand thread ball screws with left hand thread are available upon request

01 Miniature ball screws (serie ED)
 02 Ball screw control





Typical pitch variation



Technical data		ED 410X V404X	ED 513X V501X	ED 616X V601X	ED 822X V801X	ED 1028X V1001X
Tolerance of outside diameter of nut	μm	0 / -6	0 / -6	0 / -6	0 / -9	0 / -9
Tolerance of the bearing shaft diameter	d2 / μm	0 / -8	0 / -8	0 / -8	0 / -8	0 / -8
max. pitch variation per L1*	rPL1 / μm	5	5	5	5	5
max. band with	rPB / μm	5	5	5	5	5
max. eccentricity of the nut on the screw	μm	10	10	12	14	16
Average efficiency	%	80-85	80-87	80-89	81-91	83-92
Standard axial play	μm	0-5	0-5	0-5	0-5	0-5
Zero backlash		on request				

*. Above are standard specifications. The precision can be increased on request. Special executions are available on request.

Note: The nut must not be removed from the shaft.

Material: Stainless steel

Ball screws calculations – general formulas

The theoretical life expectancy is generally expressed by the total number of revolutions. The total rotation in hours or total travel distance may also be used to express life. The fatigue life is calculated as follows:

L Life expectancy in millions of revolutions [min-1]

Lh Life expectancy in hours [h]

C Dynamic load rating [N]

Fm Axial load (N)

nm Rotating speed [min-1]

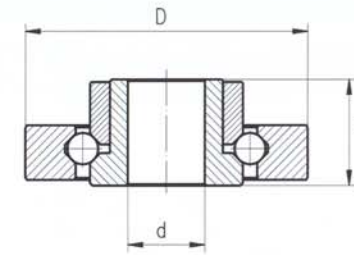
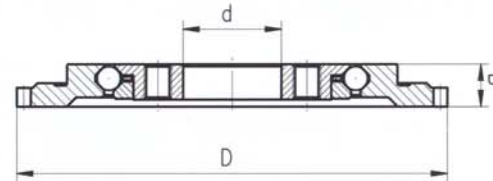
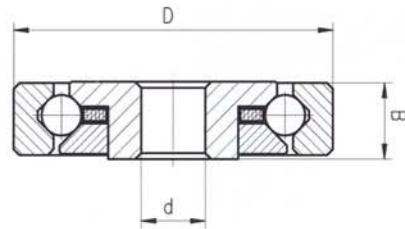
$$L = \left(\frac{C}{F_m} \right)^3 \cdot 10^6$$

$$Lh = \frac{L}{nm \cdot 60}$$

Four-point contact bearings

Watch industry, micromotors, medical technology

Reference	Shaft bearing for micromotors			Bearing for oscillating mass			Biocompatible bearing	
	20/112	30/130	40/210	30/230	50/410	50/530	60/259	60/326
d [mm]	0.32	0.60	1.00	1.00	0.50	2.10	1.00	1.50
D [mm]	1.60	2.40	3.00	0.78	5.76	9.24	4.00	5.50
B [mm]	0.40	0.82	1.00	0.95	0.76	0.90	1.20	2.00
Ball Ø [mm]	0.20	0.30	0.40	0.30	0.50	0.50	0.60	0.60
Axial Play [µm]	6/14	6/14	6/14	6/14	6/14	6/14	6/14	6/14
Tilt angle [°]	< 1.6	< 1.3	< 0.8	< 0.7	< 0.4	< 0.3	< 0.65	< 0.50



The above dimensions only give a view of the dimensional range which can be produced. There is no standard design for these types of high-end bearings. Each bearing is developed and adapted to a specific application. If you would like to know the available sizes and specifications fitting your requirements, please contact:

watch@mpsag.com



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- 01 x-myrox: the first lubricant-free watch bearing
- 02 Typical four-point contact bearing
- 03 & 04 Assembly plant at Bonfol



example of calculations: load capacity

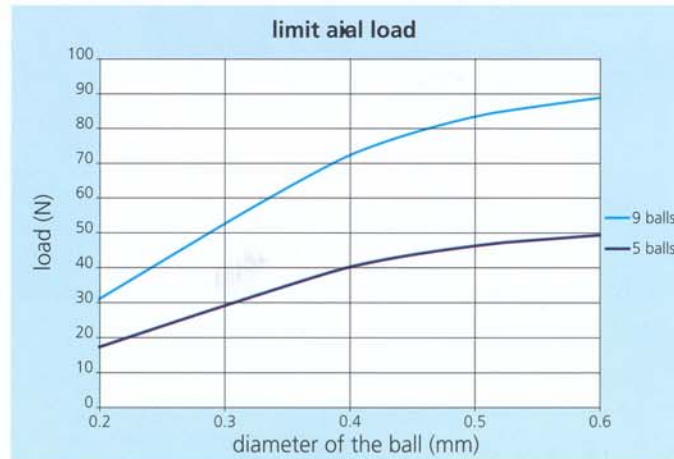


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These tables are valid for steel ring only.
Specific calculations are available at our engineering department.
Please contact : watch@mpsag.com

Miniature precision balls

Watch industry, linear bearings, ball screws



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Tolerances	Grade 3 (ISO 3290/DIN 5401)	
	Stainless steel	myrox®
Spherical variation	0.08 µm	0.08 µm
Diameter variation of one lot*	0.13 µm	0.13 µm
Density	7.7 g/cm ³	6.0 g/cm ³
Hardness	min. 720 HV	1150-1200 HV
E-modules	21 400 Mpa	220 000 Mpa
Linear coefficient of thermal expansion	10.4 x 10 ⁻⁶ K ⁻¹	11 x 10 ⁻⁶ K ⁻¹
Fracture toughness	-	10 Mpa m ^{1/2}
Bending strength	1930 Mpa	>1800 Mpa

* other diameters are available on request.

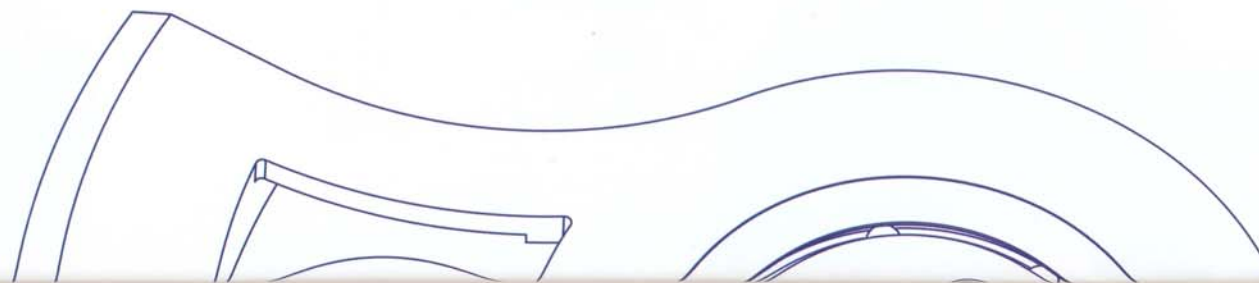
Stainless steel [mm]	myrox® [mm]
0.200X	
0.250X	
0.300X	
0.397X	
0.500X	
0.600X	
0.794X (1/32 inch)	0.700ZRY
1.000X	1.000ZRY
1.150X	
1.250X	
1.450X	
1.500X	
1.588X (1/16 inch)	

Example of part number definition

- 0.250X/G3 Nominal ball diameter in [mm]
- 0.250X/G3 Material : "X" for stainless steel
Steel / "ZRY" for myrox®
- 0.250X/G3 Precision quality ISO grade 3

Material

myrox®: Zirconium oxide (ZrO₂)
stainless steel: AISI 440C



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