PRODUCT CATALOGUE
LINEAR BEARINGS AND SLIDES

USA Distributor: TPA Motion
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https:\www.tpa-us.com
PM has engineered and manufactured innovative and top quality precision linear bearings and slides at our research and production facilities in the Netherlands since 1966. We are experts in finding solutions that meet the specific requirements of a wide variety of industry applications. A trusted partner for hundreds of industry heavyweights around the globe, our client base ranges from the semiconductor industry, medical technology and metrology sectors, to industrial automation, space and defence industries.

INTRODUCTION

The key to the exceptional quality of PM products lies in our highly specialised manufacturing machinery and facilities. Specifically, the PM production facility is temperature controlled and built to suppress and minimise distortions caused by vibration. Our precision rails are produced with remodeled, non-standard machinery. The resulting high quality of our products makes PM an attractive supplier for various high-tech industries including semiconductor, optical and life sciences.

NEW PRODUCTS

We constantly deploy the latest technologies to create new products or functionally enhance existing products in our range. Clients typically choose to work with PM for our proven ability to meet a complex set of requirements, mostly including maximum performance of parts in the most compact of spaces. We are always working to further refine the performance of PM products, in order to ensure that we consistently meet the requirements of clients in high-tech industries. The following new PM products are the result of our relentless drive to be operating at the cutting edge of the latest technologies:

• Linear bearing type RNG: is a compact design with high load capacity. Available with optional Anti Cage Creep solution (ACC). Perfectly integrates robustness and compactness.


• Flat Mounted Bearing type FMB: is an extremely flat, low-friction and easy to install table bearing.

CUSTOMISED PARTS

In addition to offering high-quality standardised products, we design and manufacture engineered linear bearings and positioning systems meeting our clients’ application-specific requirements. PM combines the latest knowledge from its in-house R&D department, developments in manufacturing technology more widely as well as performance insights generated by industry deployment of precision applications.

Over the past 50 years PM has expanded its reach to serve a global client base. Our experienced, multilingual engineering and sales teams stand ready to work with you in realising your demanding projects.

Technical data in this catalogue is based on standard quality grade Q8 (no suffix). For higher quality grades please contact our product experts to discuss your requirements.

DISCLAIMER

This catalogue is the result of a full revision of its previous edition. It reflects the latest progress in linear bearings technology as well as insights gathered from industry applications. Any information from previous editions that does not correspond to the data in this current edition, is therefore invalid. Due to the continuous development of our product range, we reserve the right to make modifications without prior notice.

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PRODUCT OVERVIEW

PM linear bearings are used as components in multiple industries worldwide. What really sets apart PM products is their unsurpassed quality and technical performance in terms of accuracy, their extremely low levels of friction, high rigidity and long lifetime.

Importantly, PM customers benefit from over 50 years’ experience in the field of linear bearings manufacturing. As a result of our continuous testing of innovations and new insights in engineering and manufacturing, our linear bearings are constantly being optimised further and often become an industry benchmark.

Our wide range of linear bearings allows for maximum design flexibility, realising a play-free linear movement that is both cost-effective and the best fit for its application. Popular linear bearings are also available as set packages including all the essential components like cages, end pieces and attachment screws. In the following pages, this catalogue presents these standard sets, specifying options for load capacity and stroke length.

At PM we are always driven by our goal to be industry leaders in quality and performance. We possess the expertise and manufacturing capability to supply custom made linear bearings and linear slides.

So whether you choose a standard product as presented in this catalogue or a customised component that meets your specific needs, we only ever deliver top quality.

1. LINEAR BEARING TYPE RSD
   - Equipped with balls or rollers
   - For light up to medium load
   - Available in size 1.5 - 24 mm
   - Lengths from 20 - 1400 mm
   - Also available as a set, see page 29

2. LINEAR BEARING TYPE RSDE
   - Equipped with rollers, size 3 – 9 mm
   - For precision applications
   - Lengths from 50 - 1200 mm
   - Anti cage creep technology optional
   - Also available as a set, see page 55

3. LINEAR BEARING TYPE RNG
   - Equipped with rollers 4 and 6 mm
   - Very compact design and high load ratings
   - Offers reduced weight
   - Anti cage creep technology optional
   - Also available as a set, page 65

4. LINEAR BEARINGS TYPE N/O AND M/V
   - Equipped with needle rollers
   - Best load ratings and maximum rigidity
   - Lengths from 100 - 1200 mm
   - Anti cage creep technology optional

5. DOUBLE PRISM TYPE DS
   - Compact design
   - Can be combined with RSD linear bearings and recirculating units UK and UR
   - Available in size 2 - 15 mm
   - Lengths up to 1400 mm

6. RECICULATING UNITS TYPE
   - For unlimited travel
   - Low profile and space saving design
   - Equipped with balls (UK) or rollers (UR)
   - Available in size 2 - 15 mm
TECHNICAL SPECIFICATIONS

GENERAL
PM linear bearings and frictionless precision slides are available in various models with ball and roller diameters available in many standard lengths and sizes.

The range of sizes and lengths covers virtually all industry applications and allows the designer to solve most problems in the field of linear movement when it comes to frictionless movement with adjustable preloads. Additionally, PM linear bearings are virtually free of wear and require little lubrication or maintenance (specific conditions of use need to be considered for every application). Application fields include:
- Semiconductor industry
- Machine tools
- Automation technology
- Measuring machines and microscopy
- Optical devices

PM parts are available in compact dimensions, have high accuracy of movement and high durability, resulting in lower maintenance costs. Parts are designed to be easily interchangeable in the event of wear. As linear bearings and slides are crucial components in most applications, PM parts are manufactured with the greatest care to provide the maximum amount of linear accuracy and reliability.

FRICTION
Friction is the mechanical resistance created by the process of one moving surface or object when coming into contact with another. A smoothly ground surface has the beneficial effect of reducing the level of friction. PM uses the highest quality of rollers in combination with auxiliary rollers. The beneficial effect of reducing the level of friction when contact is made with another. A smoothly grinded surface has the beneficial effect of reducing the level of friction.

PM linear bearings are a key component in the construction of machines. The standard of high quality has to be maintained for the duration of the calculated lifetime (page 11).

The linear bearings have to be protected against contaminated environments. Lubrication creates a film between rolling surfaces and helps to protect against corrosion. Due to the process, the attachment holes might not be used for the duration of the calculated lifetime (page 11).

LUBRICATION
PM linear bearings are a crucial component in the construction of machines. The standard of high quality has to be maintained for the duration of the calculated lifetime (page 11).

Lubrication is a factor to be taken into account when using PM linear bearings, due to components being manufactured from non-standardised materials and their potential for use in highly specialised operational environments. Please contact us if you require further information.

\[ \mu = \text{Coefficient of friction} \]
\[ F_n = \text{Normal force} \]
\[ F = \text{Frictional resistance} \]

Note: The use of wipers and seals increases friction.

MATERIALS
The rails are made of tool steel 1.2842 or bearing steel 1.3505, through hardened between 58 and 62 HRC. The rolling elements are made of bearing steel 1.3505 and have a hardness between 60 and 64 HRC. For application which requires stainless steel, the rails and rolling elements are made of 1.4004 or 1.4112, through hardened between 54 and 57 HRC.

Available Coatings for the rails:
- Dicrontite® Dry Lube treatment (suffix DI): in situation were oil or grease cannot be used as for example high temperature or vacuum applications. Temperature range -188°C to +538°C. Is used in aerospace, semiconductor, optical and medical applications.
- Duraloy® coating (suffix DU): thin dense chromium coating providing outstanding chemical resistance and material hardness. It significantly increases the wear and corrosion resistance of the coated material. Is used in aerospace, medical and semiconductor applications. Due to the process, the attachment holes might not be fully coated.

CHARACTERISTICS OF CAGES
Cages in precision rails have a wide range of different purposes:
-They maintain appropriate distance between rolling elements, prevent their mutual contact and thus reduce friction.
-They ensure an even distribution of rolling elements, thus resulting in a smooth run.
-They guide the rolling elements in the unloaded zone of a rail and thus improve rolling conditions to prevent detrimental sliding movements from occurring.

CAGES FOR RSD AND DS RAILS
Cylindrical roller cages
AA-cages: steel cages with retained rollers. Suitable for horizontal application. Available in stainless steel and order code AA-SS with cage body made out of stainless steel or nickel plated and rollers made of stainless steel.

AL-cages: starting from 3 mm to 12 mm. Cage body made from aluminum with retained rollers. Suitable for horizontal and vertical application. Cage is suitable for overrunning use. Due to its low-weight properties and low friction coefficient, this cage is suitable for a wide range of applications.

KZR-cages: plastic cages with retained rollers. Size 1.5 and 2 mm are made from DIN 62541, other sizes are made from reinforced PA12 glass fibre. For size 6 mm, a strong design cage featuring two stainless steel wires in the interior of the cage design is available as an option. The KZR cage is characterised by its low weight and smooth running and sliding quality.

Ball cages
JJ-cages: solid brass ball cages for horizontal and vertical application. Available for size 1.5 – 24 mm, from size 6 mm upwards available with retained balls. This cage is extremely durable, reliable and has low-friction properties.

KKLX-cages: plastic ball cages with retained balls. Size 1, 2 and 3 mm is made of POM (polyacetylene). Other sizes are made of reinforced PA12 glass fibre (30% GF).

CAGES FOR RSDE AND RNG RAILS
Cylindrical roller cages
KRE-cages: POM cages for size 3 to 6 mm with retained rollers. Suitable for horizontal and vertical application. For overrunning cages purposes please consult a PM advisor.

KREV-cages: PEEK (polyetheretherketone) cages are available in size 4 and 6 mm with retained rollers. They are often used in vacuum and ultra-high vacuum applications and suited for horizontal and vertical applications. Also suitable
for high accelerations and high operating temperatures. For overrunning cages purposes please consult a PM advisor.

OPERATING TEMPERATURE

PM linear bearings are capable of operating in temperature of +120 °C. For linear bearings with plastic components, the operating temperature range is -30 °C to 80 °C. In case of any doubt or when using motors, ball screws, measuring systems, etc., please contact us. For any enquiries about applications that are to operate beyond this temperature range, please consult a PM advisor.

TEMPERATURE

Operating environments that have temperature conditions falling outside the usual range (i.e. either lower or higher than usual) require that specific demands for the rails, cages and lubricant be taken into consideration. Both material and mechanical properties change under the influence of temperature, reducing the lifetime of the linear bearing and affecting the running properties. In addition, the attachment screws are subject to thermal stress. If the above is applicable, please contact a PM product expert to discuss an appropriate solution.

PACKAGING

PM products can either be delivered packed as a set or as single components. The rails and roller cages are delivered with an oil-based corrosion protection. Before assembly, the product should be cleaned to remove the corrosion protection oil from the rails and roller cages. Subsequently and prior to operation, they should be lubricated with oil or grease in accordance with lubrication instructions provided by PM.

CERAMIC LINEAR BEARINGS

For decades, PM has supplied linear bearings made out of full ceramic as well as hybrid versions. Hybrid linear bearings are supplied with stainless steel rails and rolling elements made of ceramic, often Si3N4. The cages used are usually made of PEEK material. Hybrid offers great advantages in high dynamic applications where stiffness, reliability, precision, very low friction and long service life are required.

Full ceramic rails are used in applications where properties such as non-magnetic, high temperature, dry running and low weight are required.

For ceramic rails the following materials are available:
- Silicon nitride (Si3N4), article code CRS
- Zirconium oxide (ZrO2), article code CRZ
- Aluminum oxide (Al2O3), article code CRA

Consult a PM advisor for assistance in selecting the right material and for design considerations.

Applications of ceramics:
- Medical technology, e.g. magnetic resonance imaging (MRI)
- Electron microscopy
- Microelectronic industry - Bonding machines
- Cryogenic environment

HIGH VACUUM AND UHV APPLICATION

The semiconductor industry as well as medical and research laboratories require linear rails that do not contaminate the vacuum. Choice of material and modifications such as vented holes and special lubricants are among the many considerations when delivering applications for these industries. Upon request, PM is able to deliver items UHV-cleaned and double-packaged, or according to your specific instructions.

LOAD RATINGS AND EXPECTED LIFETIME

The cylinder and needle rollers we use are compliant with DIN ISO standard 14728-1: 2017. The listed ratings are based on an expected service life L10 of 100.000 m.

Some suppliers, mostly from the Far East, use higher loadings based on an expected service life of 50.000 m (=L50). These C50 values can be converted using the following formula according to L10 values:

Conversion of the load ratings to L50
Ball cage guide C50 = 1.26 · C100
Cylinder and needle roller cage guide C50 = 1.23 · C100

Conversion of the load ratings to L10
Ball cage guide C10 = 0.79 · C50
Cylinder and needle roller cage guide C10 = 0.81 · C50

FATIGUE

Fatigue is a surface-pitting type failure resulting from built-up stress caused by contact between moving surfaces. A loaded surface typically moves over another surface, e.g. in a rolling motion, the rolling elements move over the rail V-grooves. The end of the rolling contact life is reached when the built-up stress causes the material to crack and the contact surface shows damage and “pitting”.

“Pitting” as a function of running time is commonly seen in the running surfaces or in the rolling elements, thus resulting in pitting in the material. Different variables can have an impact on material fatigue, for example:
- Load applied onto rails
- Amount of acceleration and speed
- Quality and age of the lubricant

EXPECTED LIFETIME

NOMINAL OPERATIONAL CALCULATION LIFE (L10)

We refer to the amount of time during which the performance of the linear bearing is satisfactory as the expected lifetime. The calculation below can be used to estimate the expected lifetime for linear bearings – assuming that PM’s recommendations regarding operating conditions, lubrication and protection from contaminants are being followed.

By definition, within the expected lifetime and under similar operating conditions, 10% of the linear bearings will not attain the lifetime under the dynamic load Cdyn, as listed in below table.

For ceramic rails: $L_{10} = \frac{a_9 \cdot (C_{50}/P)^{1.15} \cdot F_{Re} \cdot 10^8}{F_{W}}$

Where:
- $L_{10}$ = Expected life in meters
- $a_9$ = Reliability factor
- C50 = Effective dynamic load rating in N
- $P$ = Equivalent load in N
- $E$ = 10/3 for cylinder and needle rollers, or 3 for balls
- 1.15 = An empirical factor applicable to the materials employed
- $F_{Re}$ = Correction factor for temperature effects
- $F_{W}$ = Correction factor for rail hardness grades (below 58 HRC)

<table>
<thead>
<tr>
<th>Reliability (%)</th>
<th>L10</th>
<th>D</th>
<th>Fw</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>L20</td>
<td>1.00</td>
<td>0.62</td>
</tr>
<tr>
<td>95</td>
<td>L20</td>
<td>1.00</td>
<td>0.62</td>
</tr>
<tr>
<td>96</td>
<td>L4</td>
<td>0.53</td>
<td>0.44</td>
</tr>
<tr>
<td>97</td>
<td>L3</td>
<td>0.44</td>
<td>0.33</td>
</tr>
<tr>
<td>98</td>
<td>L2</td>
<td>0.33</td>
<td>0.21</td>
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<tr>
<td>99</td>
<td>L1</td>
<td>0.21</td>
<td>0.15</td>
</tr>
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</table>
TEMPERATURE FACTOR FT

Diminished rail hardness will start to occur in PM linear bearings when deployed at temperatures over 150 °C. As a result, load ratings must be reduced with a factor FT as shown in the table below. This applies to the reduction of the dynamic load rating $C_{dyn}$ and the static load rating $C_0$.

<table>
<thead>
<tr>
<th>Temperature in °C</th>
<th>Temperature Factor FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td>1.00</td>
</tr>
<tr>
<td>150</td>
<td>1.00</td>
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<tr>
<td>175</td>
<td>0.95</td>
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<tr>
<td>200</td>
<td>0.90</td>
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<tr>
<td>225</td>
<td>0.82</td>
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<tr>
<td>250</td>
<td>0.76</td>
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<td>275</td>
<td>0.68</td>
</tr>
<tr>
<td>300</td>
<td>0.61</td>
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</tbody>
</table>

HARDNESS FACTOR FH

PM rails have a minimum hardness value of 58 HRC, corresponding to hardness factor FH=1. The table below shows the applicable amount of reduction in load capacity in the case of stainless steel rails which have lower hardness values. For example, rails made of stainless steel 1.4034 have a minimum hardness of 54 HRC, whilst the hardness factor FH=0.75.

<table>
<thead>
<tr>
<th>Rockwell Hardness</th>
<th>Vickers HV</th>
<th>Brinell HB</th>
<th>Hardness Factor FH</th>
</tr>
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<tbody>
<tr>
<td>60</td>
<td>697</td>
<td>-</td>
<td>1.00</td>
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<tr>
<td>59</td>
<td>674</td>
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<td>653</td>
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<td>577</td>
<td>-</td>
<td>0.75</td>
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<td>53</td>
<td>560</td>
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<td>544</td>
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<tr>
<td>40</td>
<td>354</td>
<td>196</td>
<td>0.60</td>
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</table>

Load ratings specified in this catalogue are based on a Rockwell hardness of 58 HRC.

DYNAMIC AND STATIC LOAD RATINGS

Table: Dynamic and static load ratings (material 1.3505)

<table>
<thead>
<tr>
<th>D (mm)</th>
<th>$C_{dyn}$ (N)</th>
<th>$C_0$ (N)</th>
<th>Cage Type</th>
<th>Suitable rails</th>
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<tbody>
<tr>
<td>1.5</td>
<td>52</td>
<td>63</td>
<td>AA</td>
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<td>KZR</td>
<td>RSD</td>
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<td>JJ</td>
<td>RSD</td>
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<td>AA</td>
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<td>KZR</td>
<td>RSD</td>
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<td>21</td>
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<td>JJ</td>
<td>RSD</td>
</tr>
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<tr>
<td>3</td>
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<td>340</td>
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<td>150</td>
<td>KKLK</td>
<td>RSD</td>
</tr>
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<td>JJ</td>
<td>RSD</td>
</tr>
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<td>260</td>
<td>260</td>
<td>KKLK</td>
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</tr>
<tr>
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</tr>
<tr>
<td>15</td>
<td>420</td>
<td>420</td>
<td>JJ</td>
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</table>

STATIC SAFETY FACTOR

The static safety factor $S_0$ determines the degree of safety against permanent deformation of the contact surfaces of the rails and rolling elements. The safety factor represents the relationship between the basic static load rating $C_0$ and the equivalent maximum static load $P_0$ and can be calculated using the following formula:

$$S_0 = \frac{C_0}{P_0}$$

The static equivalent load $P_0$ is a hypothetical load and is considered to be approximately the maximum applied load $F_{\text{max}}$. as:

$$P_0 = F_{\text{max}}$$

$C_0$ = Static load capacity (N), see dimension slides
$P_0$ = Static equivalent load (N)
$F_{\text{max}}$ = Maximum applied load (N)
$S_0$ = Static safety factor

In use cases where high importance is placed on running accuracy and smoothness, a static $S_0 \leq 2$ should be applied. If not, under normal conditions $S_0$ should be between 2 and 4. For general machinery with loads subject to variable operating conditions, medium vibrations or heavy impact loading on the linear bearings, a static safety factor $S_0$ between 4 and 5 is recommended.
**DESIGN INFORMATION**

**ACCURACY GRADES**

The linear bearings manufactured by PM come in three grades of quality. The quality grade refers to the degree of parallelism between the running surfaces and reference surfaces A and B of the rail, as illustrated in graph and figure below.

- **Q8**: Standard precision grade, is suitable for most machine requirements
- **Q4**: Meets the demands for high precision applications
- **Q2**: Suitable for the highest accuracy requirements

In order to achieve high running accuracy, PM linear bearings are very tightly toleranced (±0.005 mm). This means PM linear bearings can be deployed individually, making it unnecessary to include any identification markers on the rails.

If accuracy grade Q4 or Q2 is required for your order, please add a suffix “Q4” or “Q2” to the rail type number (for example: RSD-6300-Q4).

Higher accuracies can be supplied on request. If applicable, please consult your PM advisor.

**SF-GRADE; SUPER FINISH GRADE**

New technologies require tighter tolerances and higher speeds. Linear bearings finished in SF-Grade meet this requirement and provide outstanding performances for ultra-fine precision equipments.

Key features are:
- Reduction of surface roughness <0.05 µm
- Rail V-groove surfaces obtain mirror finishing through smooth grinding
- Vibrations in sub-micron area are significantly reduced
- Further reduction of friction which results in a more smooth running linear motion

Your advantages:
- Low wear results in longer lifetime
- Virtually friction-free
- Higher rigidity
- Allows microscopic precision positioning

Ideal applications for linear bearings in SF-Grade include wire bonding stages, measuring devices, material testing equipments, microscope stages and manipulators. Please contact us to discuss appropriate use of a lubricant that suits your specific needs.

**MATCHED PAIRS**

For gravity-loaded rails that are matched, the tolerance level on height B for B1 to B2 is <0.01 mm, and the pairs are arranged one behind another in the application, we recommend ordering matched pairs by adding a suffix “MP” in your order note.

**TOLERANCES ON LENGTH AND MOUNTING HOLES**

When using threaded holes in the rails for assembly, special type GD attachment screws with a smaller shaft can be used for the adjustable rail. After inserting the cages between the rails, the linear bearing set needs some adjustment to eliminate play. The adjustable rail will move slowly to the other rail, thus requiring GD screws which allow for additional clearance in the mounting holes.

**HEIGHT DIFFERENCE ΔH**

To achieve best performance and for an even distribution of the load over the rolling elements the offset between mounting surfaces for the linear bearings should be within the calculated value offset ΔH. The ΔH is calculated according to the following formulas.

For rails with crossed roller cages:

\[ ΔH < 0.1 \cdot b \]

For rails with needle roller cages:

\[ ΔH < 0.07 \cdot b \]

ΔH (µm): Maximum permissible deviation from the theoretically correct position
b (mm): Centre distances of the bearings
TOLERANCES OF MOUNTING SURFACE
For standard applications an average mounting surface roughness of Ra 1.6 must be observed. For quality classes Q4 and Q2 the mounting surface roughness values are Ra 0.8 and 0.2.

To achieve precision of the system the rails must be pushed against the mounting surface and reference shoulder.

To achieve best performance, the bearings must be mounted on rigid and fine-machined, (preferably grinded) flat surfaces and be supported over their entire length. The mounting and reference shoulder surfaces must be square to each other, with a maximum angular error of 0.3 µm/mm. The rails must be parallel to each other, with a maximum angular error of 0.3 µm/mm. The rails must be kept clean at all times in order to prevent damage to the linear bearing. If the rails are subjected to contaminants, the use of telescopic bellows, covers or other shields is recommended.

MAXIMUM VELOCITY AND ACCELERATION
RSD type linear bearings
Max. recommended speed \( v \) = 60 m/min.
Max. acceleration \( a \) = 50 m/sec².

RSDE and RNG type linear bearings
Max. recommended speed \( v \) = 60 m/min.
Max. acceleration \( a \) = 50 m/sec².

RSDE and RNG type with ACC-solution
Max. recommended speed \( v \) = 60 m/min.
Max. acceleration \( a \) = 150 m/sec² (115g).

A standard construction with balls consists of two ball cages, each interposed between rails of equal length, each longer than the cage.

\[ C_{total} = Z \times C_{ball} \]

Note: all the balls in the cages are load bearing.

LOAD CAPACITY 'C' USING ROLLERS
Standard constructions with rollers: two roller cages, each in between rails of equal length, both longer than the cage. \( C_{total} = Z \times C_{roller} \) (amount of rollers \( C_{per} \) per roller).

Normally only half of the total number of rollers will have load on them; the other half resists possible lift-off forces.

There is one exception: all rollers will be loaded if a pair of rails is installed horizontal, but one above the other, with the V-groove of the lower rail facing up and that of the upper rail facing down; i.e.: in the direction of the applied load, assumed here to be vertical.

For example: assuming a normal horizontal application, with two roller cages:

\[ R3x22AA; Z = 22 \text{ and } C_{per} = 136 \text{ N}. \]

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LOAD CAPACITY 'C' USING BALLS
A standard construction with balls consists of two ball cages, each interposed between rails of equal length, each longer than the cage.

\[ C_{total} = Z \times C_{ball} \]

Note: all the balls in the cages are load bearing.

CALCULATION OF THE CAGE LENGTH 'K'
Cages travel at half the speed of moving rails and through half the distance i.e.: the stroke of the cage equals half the stroke of the moving bearing member or the slide top:

\[ K = \frac{A-H}{2} \]

On the other hand, with a normal frictionless sliding table, the upper member can move equal distances to either side of the center.

\[ K = \frac{A-H}{2} \text{ (i.e.: cage length = rail length - half of the max. stroke)}. \]

CALCULATION OF NUMBER OF ROLLING ELEMENTS 'Z'
\[ Z = \text{Amount of rolling elements} \]

Note: all the balls in the cages are load bearing.

\[ C_{ball} = \text{Amount of rolling elements} \times \text{ (dynamic load rating per ball)} \]

Example: cage K3 x 20JJ; Z = 20; \( C_{ball} = 30 \text{ N} \) per ball.

\[ C_{total} = 20 \times 30 = 600 \text{ N}. \]

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\[ C_{total} = 20 \times 30 = 600 \text{ N}. \]
ASSEMBLY INSTRUCTIONS

One set of linear bearings consists of 4 pcs. rails (2 pairs), 2 pcs. cages and 8 pcs. end screws or end pieces.

STANDARD FITTING EXAMPLES

Our range of linear bearing components can be positioned in any spatial orientation or direction required for your application. Rails can be attached to the slide base construction either using the threaded holes or using the through holes.

Example: Use of a type GD attachment screw

The smoothest running performance can be obtained by adjusting the preload setscrews (ISO 4026, DIN 913) opposite the rollers. By moving the slide, each of the preload setscrews can be adjusted. In applications where the cage runs outside the rails it is the shorter rail that has to be preloaded. For each mounting screw along the rail length one preload screw should be used.

The size of the preload set screw depends on the size of the rail (table 1 - 5, page 21).

The amount of preload depends on the size of the rail and the rigidity of the base construction. Based on our experience we recommend that the amount of preload, under normal conditions, is set between 2% to 20% of the permissible load C. For linear bearings type N/O we advise 2.5%C.

Under normal operating conditions, the recommended preload settings can be selected from table 1 - 5 on page 21.

AMOUNT OF PRELOAD FORCE

A calculation example of preload torque and the resulting preload force is provided here:

Rail RSDE-3150; g = 25 mm
Roller cage type KRE-3; f = 3.3 mm, C_{dyn} = 392 N
Attachment screw M4
Factor f (for rollers = 1, for balls / needles = 2); f = 1
Amount of preload p; p = 8%
Factor a in cm (please refer to the table below)

Calculation amount of force per set screw

\[ P_{ps} = \frac{g}{t} \cdot C_{dyn} \cdot \frac{p}{100} \cdot f \]

Calculation tightening torque on set screw

\[ \text{Tightening torque} = P_{ps} \cdot a \]

The smoothest running performance can be obtained by adjusting the preload setscrews (ISO 4026, DIN 913) opposite the rollers. By moving the slide, each of the preload setscrews can be adjusted. In applications where the cage runs outside the rails it is the shorter rail that has to be preloaded. For each mounting screw along the rail length one preload screw should be used.

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Calculation tightening torque on set screw

\[ \text{Tightening torque} = P_{ps} \cdot a \]
ASSEMBLY PROCEDURE

PRIOR TO ASSEMBLY
PM linear bearings are precision components; they have to be handled with meticulous care. To achieve a perfect linear bearing, it is necessary to respect the following guidelines:
1) To determine the location of fixing holes in the points:
   - When handling the components. Damage on the rail surface will impact the running performance and operational lifetime.
   - Prevent contact with any foreign materials when mounting the rails.
   - During assembly, ensure that all linear bearing components have the same temperature.
   - For uniform tightening of the bolts the use of a torque screw driver is recommended. Various models are available.
2) Carefully de-burr and clean all elements, to ensure for satisfactory installation of all types of linear bearings in this catalogue, it is necessary to consider the following points:
   1) To determine the location of fixing holes in the support structure (slide base) the holes in the rails should be taken as a reference and “copied” onto the support structure. This is highly desirable as the original pitch of individual holes may have altered during hardening by as much as 0.4 mm. To compensate this, special type GD or GDN attachment screws can be supplied. The dimensions of these screws are listed in the tables at the end of each chapter.
   2) Carefully de-burr and clean all elements, to ensure a flat surface and a perfect fit of the rails.
   3) Now, as a required first step, to fasten the inner rail pair (marked as 1 in figure above) the base and reference face 1 of the linear bearing rails should be lightly oiled before they are clamped against the mounting and reference shoulder. Subsequently, they can be fastened by starting from one end and working towards the opposite end.
3) Parallelism of the V-groove of the rails (A and B) should be checked to ensure they don’t exceed the tolerance of the linear bearings (page 14). After these steps have been followed, the slide element is ready for assembly.
4) The fixed bearing rail (2) should be mounted as described under step 3 above, but care should be taken not to tighten the adjustable rail (marked as 3 in figure on the left side) too much, so as to leave a gap between the V-grooves for the insertion of ball cages, roller cages or needle cages. If any end stop screws are present, remove them now.
5) Carefully insert the cages. When placed in their exact position, lightly secure the adjustable rail until the screws are finger-tight.
6) Fit the end screws or end pieces.
7) The linear bearing set is now ready to be backlash free-adjusted using the lateral preload set screws (page 18, Preload Settings). The amount of preload is given in the tables at page 21.
8) Secure the attachment screws on the adjusting rail.
9) When assembly is complete, the linear bearings must be checked for absence of play and inspected for running quality.
10) When assembly is complete, the linear bearings should be lightly oiled before they are clamped against the mounting and reference shoulder. Subsequently, they can be fastened by starting from one end and working towards the opposite end.

ASSEMBLY LINEAR BEARINGS

TABLES

RECOMMENDED PRELOAD SETTINGS

Table 1 Linear bearings type RSD with roller cages

<table>
<thead>
<tr>
<th>Roller size (mm)</th>
<th>Pitch cage (mm)</th>
<th>Set screw</th>
<th>Pitch* (mm)</th>
<th>Preload (Ncm)</th>
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</thead>
<tbody>
<tr>
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<td>3</td>
<td>M2 5</td>
<td>10</td>
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<td>2</td>
<td>4</td>
<td>M3 15</td>
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<td></td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>M5 25</td>
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<td>4</td>
<td>7</td>
<td>M6 40</td>
<td>11.50</td>
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<tr>
<td>6</td>
<td>12</td>
<td>M6 100</td>
<td>18.50</td>
<td></td>
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<td>9</td>
<td>14</td>
<td>M8 100</td>
<td>106.50</td>
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<td>12</td>
<td>22</td>
<td>M10 100</td>
<td>176.50</td>
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<td>15</td>
<td>20</td>
<td>M12 100</td>
<td>370.00</td>
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</table>

Table 2 Linear bearings type RSD with ball cages

<table>
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<th>Pitch cage (mm)</th>
<th>Set screw</th>
<th>Pitch* (mm)</th>
<th>Preload (Ncm)</th>
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<tbody>
<tr>
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<td>M2 5</td>
<td>10</td>
<td>0.70</td>
</tr>
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<td>4</td>
<td>M3 15</td>
<td>0.40</td>
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<td>14</td>
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<td>25.00</td>
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<td>M12 100</td>
<td>34.50</td>
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Table 3 Linear bearings type RSDE with roller cages

<table>
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<th>Roller size (mm)</th>
<th>Pitch cage (mm)</th>
<th>Set screw</th>
<th>Pitch* (mm)</th>
<th>Preload (Ncm)</th>
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<td>M5 25</td>
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Table 4 Linear bearings type RNG with roller cages

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<th>Preload (Ncm)</th>
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<td>4</td>
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<td>M3 25</td>
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<td>6.6</td>
<td>M4 25</td>
<td>25</td>
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Table 5 Linear bearings type N/O and M/V with needle cages

<table>
<thead>
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<th>Roller size (mm)</th>
<th>Pitch cage (mm)</th>
<th>Set screw</th>
<th>Pitch* (mm)</th>
<th>Preload (Ncm)</th>
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</thead>
<tbody>
<tr>
<td>2.5</td>
<td>5</td>
<td>M8 100</td>
<td>2.70</td>
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</tr>
<tr>
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<td>3.5</td>
<td>7</td>
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<td>7.70</td>
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RECOMMENDED TIGHTENING TORQUE FOR ATTACHMENT SCREWS

Table 6 Tightening torque strength grade 12.9

<table>
<thead>
<tr>
<th>Size</th>
<th>Max. tightening torques (Nm)</th>
<th>Attachment screws type GD and GDN</th>
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<tbody>
<tr>
<td>M2</td>
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<td>M4</td>
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<td>M8</td>
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<td>M14</td>
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*Pitch between the preload set screws
Available Options Linear Bearings

<table>
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<tr>
<th>Order code</th>
<th>Catalogue page</th>
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<td>RSDE</td>
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<td>RNG</td>
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<tr>
<td>DS</td>
<td>96</td>
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<tr>
<td>UK &amp; UR</td>
<td>97</td>
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**Linear Bearings**

- **SS** Linear bearings made of stainless steel
- **DI** Dicronite® dry lube treatment
- **DU** Duralloy® coating
- **RI** Rounded inlets at both rail ends
- **MP** Matched pairs, selected on height
- **SF** Super finish grade
- **Q4** Quality grade meet the demands for high precision
- **Q2** Quality grade suitable for highest accuracy requirements
- **UHV** Ultra high vacuum cleaned and packed
- **CL** Cleanroom cleaned and packed
- **ACC** Anti cage creep technology
- **ACCI** Anti cage creep integrated technology
- **03** Threaded hole
- **10** Through hole
- **13** Threaded inserts integrated in the rail
- **15** Through hole with countersunk (standard at M/V no suffix needed)

**Special Environment**

- **UHV** Ultra high vacuum cleaned and packed
- **CL** Cleanroom cleaned and packed

**Anti Cage Creeping Technology**

- **ACC** Anti cage creep technology
- **ACCI** Anti cage creep integrated technology

**Mounting Holes**

- **03** Threaded hole
- **10** Through hole
- **13** Threaded inserts integrated in the rail
- **15** Through hole with countersunk (standard at M/V no suffix needed)

**Material / Coating**

- **SS** Linear bearings made of stainless steel
- **DI** Dicronite® dry lube treatment
- **DU** Duralloy® coating

**Rail Finishing**

- **RI** Rounded inlets at both rail ends
- **MP** Matched pairs, selected on height
- **SF** Super finish grade

**Quality Grade**

- **Q4** Quality grade meet the demands for high precision
- **Q2** Quality grade suitable for highest accuracy requirements

**Special Environment**

- **UHV** Ultra high vacuum cleaned and packed
- **CL** Cleanroom cleaned and packed

**Anti Cage Creeping Technology**

- **ACC** Anti cage creep technology
- **ACCI** Anti cage creep integrated technology

**Mounting Holes**

- **03** Threaded hole
- **10** Through hole
- **13** Threaded inserts integrated in the rail
- **15** Through hole with countersunk (standard at M/V no suffix needed)

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ORDERING CODE LINEAR BEARINGS PACKED AS SET

One set includes: 4 rails + 2 roller cages + 8 end screws/end pieces

**Example:**

RSDE-6250-Q4x32KRE-SS-ACC-DI-CL

**Model**

- **R** Roller diameter
- **L** Rail length
- **G** Accuracy grade
- **N** Number of rolling elements
- **C** Cage type
- **M** Material / Coating
- **A** Anti cage creep mechanism
- **S** Surface treatment
- **D** Special cleaning and packaging
- **I** Anti cage creep integrated technology

**Notes:**

- **AA** Cage with end screws GA, other cages supplied with end pieces GB
- **Type of rails RSD, RSDE and RNG**
- **Standard 4 rails of the same length**
- **No code, supplied as standard listed in the product tables**
- **Sets with ACC are delivered without end pieces**
- **By order ACC always indicate stroke length in order text**

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Available

Not available

There are limitations to maximum rail length. Options available for standard grade, other quality grades on request

Q2 quality grade only made to order

Only available for linear bearings type RSDE made from stainless steel

Only available for linear bearings type M/V
PM RESEARCH AND PRODUCTION FACILITIES