OVER 55 YEARS of success

PM.nl
DISCOVER PRECISION

LINEAR BEARING SETS TYPE RNG - ACC

PM is a high-end bearing and customised (mechatronic) system supplier, offering full vertical integration from (co-) engineering to production, assembly and qualification - all performed in-house.

INTRODUCTION

Since 1966, PM has been designing and manufacturing innovative, high-quality precision linear bearings and slides at our research and production facilities in the Netherlands. We specialise in delivering solutions to meet the unique demands of a wide range of industries. As a trusted partner to hundreds of global industry leaders, our clients span sectors such as semiconductors, medical technology, metrology, industrial automation, space, and defense.

COMPANY

The exceptional quality of PM products stems from our highly specialized manufacturing machinery and facilities. Our production facility is temperature-controlled and designed to minimize distortions caused by vibrations. Additionally, our precision rails are produced using customized, non-standard machinery. This commitment to quality makes PM an attractive supplier for various high-tech industries, including semiconductors, optics, and life sciences.

NEXT-GENERATION PRODUCTS

At PM, we continuously integrate the latest technologies to enhance the performance and functionality of the existing product range. This approach allows us to meet the ever evolving demands of high-tech industries, where precision, reliability, and compactness are critical.

Our clients value PM for our ability to engineer solutions that deliver maximum performance, even in the most space-constrained applications. Through ongoing innovation and refinement, we take proven designs to the next level, raising the bar for what's possible in precision motion.

The following product is a result of our commitment to meet the demands for next-generation equipment::

- **Miniature Slide MSR:** A compact linear slide designed for high load capacity in very limited spaces. It includes crossed roller bearings and an anti-cage creep mechanism. The slides are made entirely of stainless steel.

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 55 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 comprehensive revision of its previous edition. It reflects the latest advancements in linear bearing 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.

PRODUCT OVERVIEW

PM linear bearings are used as components across multiple industries worldwide. What truly sets PM products apart is their unparalleled quality and technical performance in terms of accuracy, exceptionally low friction, high rigidity, and long lifespan.

Our wide range of linear bearings provides maximum design flexibility, enabling play-free linear movement that is both cost-effective and optimally suited for its application. Popular linear bearings are also available as set packages, including 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.

Importantly, PM customers benefit from over 55 years of experience in the field of linear bearing manufacturing. As a result of our continuous testing and innovations, combined with new insights in engineering and manufacturing, our linear bearings are constantly being further optimized and often set industry benchmarks.

At PM, we are driven by our goal to lead the industry in quality and performance. With our expertise and manufacturing capabilities, we can supply custom-made linear bearings and linear slides.

Whether you choose a standard product from this catalogue or a customized component that meets your specific needs, we deliver only top quality.

1. LINEAR BEARINGS 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 41

2. LINEAR BEARINGS TYPE RSDE

- Equipped with rollers, size 3 – 9 mm
- For precision applications
- For medium up to high loads
- Anti-cage creep technology optional
- Also available as a set, see page 57

3. LINEAR BEARINGS 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 67

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. RECIRCULATING UNITS TYPE UK AND UR

- 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 offered in many standard lengths and sizes.

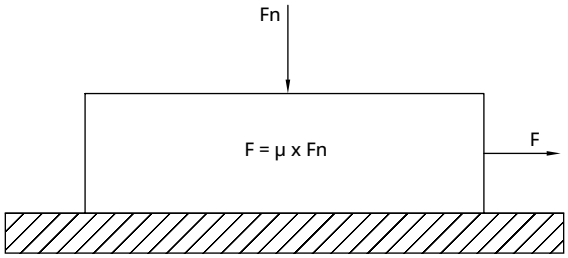
The range of sizes and lengths covers virtually all industry applications, allowing designers to solve most challenges related to frictionless linear movement with adjustable preloads. Additionally, PM linear bearings are virtually wear-free and require minimal lubrication or maintenance (specific conditions of use should be considered for each application).

Application fields include:
- Semiconductor industry
- Machine tools
- Automation technology
- Measuring machines and microscopy
- Optical devices

PM linear bearings are available in compact dimensions, offering high accuracy of movement and durability, resulting in lower maintenance costs. The parts are designed to be easily interchangeable in case of wear. Since linear bearings and slides are critical components in many applications, they are manufactured with the utmost care to ensure maximum 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 grinded surface has the beneficial effect of reducing the level of friction. PM uses the highest quality of rollers in combination with precision ground rails which are manufactured by our own team of specialists.



μ = Coefficient of friction
Fn = Normal force
F = Frictional resistance

Note: The use of wipers and seals increases friction.

LUBRICATION

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.
Other benefits are for example:
- Friction reduction
- Reduction of wear
- Extended lifetime
- Heat reduction

We prefer to use lubrication by CLP oil, such as DIN 51519 and HLP oil, such as DIN 51524. Assuming viscosity values between ISO-VG15 and ISO-VG100. In case of grease, the use of a lubricant on a lithium soap basis is recommended. 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.

MATERIALS

The rails are made of tool steel 1.2842 or bearing steel1.3505, 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 applications which requiring stainless steel, the rails and rolling elements are made of 1.4034 or 1.4112, through-hardened between 54 and 57 HRC. End screws are nickel plated

CAGES

Depending on the type and size of the linear bearing, different cage types are available. In applications with high operating temperatures or extreme operating conditions PM is able to supply customised cages. Please contact a PM advisor to discuss requirements for your application.

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 ocuuring

CAGES FOR RSD AND DS RAILS

Cylindrical roller cages

AA-cages: steel cages with retained rollers.
Available to order with all rail sizes.
Suitable for horizontal application.
Available in stainless steel with 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 4 mm to 12 mm. Cage body made from aluminium 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 POM (polyacetylene), other sizes are made from reinforced PA12 glass fibre.

For size 6 and 9 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.

KKLK-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 (polyether ether ketone) 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 -40 °C to 80 °C. In case of any doubt or when using motors, ball screws, measuring systems, etc., please contact us.

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 are 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 Si_3N_4. 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.

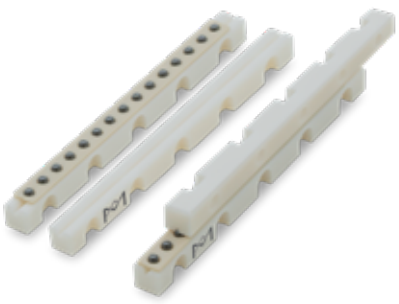
For ceramic rails the following materials are available:

- Silicon nitride (Si_3N_4), article code CRS
- Zirconium oxide (ZrO_2), article code CRZ
- Alumina oxide (Al_2O_3), 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
- Semiconductor 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.

EXPECTED LIFETIME

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 L_{10} of 100.000 m.

Some suppliers, mostly from the Far East, use higher loadings based on an expected service life of 50.000 m (=L_{50}). These C_{50} values can be converted using the following formula according to L_{10} values:

Conversion of the load ratings to L_{50}
Ball cage guide $C_{50} = 1.26 \cdot C_{100}$
Cylinder and needle roller cage guide $C_{50} = 1.23 \cdot C_{100}$

Conversion of the load ratings to L_{100}
Ball cage guide $C_{100} = 0.79 \cdot C_{50}$
Cylinder and needle roller cage guide $C_{100} = 0.81 \cdot C_{50}$

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

SHORT STROKE

“Short stroke” can occur as a consequence of the specific rail and roller size, cage type and travel distance. If the rolling elements fail to roll completely and stroke H < diameter D, this is referred to as “short stroke”. It can result in the surface being compressed, and in combination with very high-frequency strokes this can result in cracks in the lubrication film causing steel-on-steel contact. In either case, the precision rails accuracy and lifetime are negatively affected. To re-instate a lubrication film between the rolling element and the running surface, one or more lubrication strokes (service strokes) should be applied. As a minimum, the recommended stroke H should be greater than the diameter of the rolling element.

NOMINAL OPERATIONAL CALCULATION LIFE (L_{10})

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 C_{dyn}. as listed in below table.

$$\mathbf{L_{10} = a_1 \cdot (C_{dyn}/P)^E \cdot 1.15 \cdot F_T \cdot F_H \cdot 10^5\ Meters}$$

L = Expected life in meters
a_1 = Reliability factor
C_{dyn} = 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_T = Correction factor for temperature effects
F_H = Correction factor for rail hardness grades (below 58 HRC)

Reliability factor		
Reliability (%)	**Ln**	**a_1**
70	L30	2.77
80	L20	1.82
90	**L10**	**1.00**
95	L5	0.62
96	L4	0.53
97	L3	0.44
98	L2	0.33
99	L1	0.21

TEMPERATURE FACTOR F_T

Diminished rail hardness will start to occur in linear bearings when deployed at temperatures over 150 °C. As a result, load ratings must be reduced with a factor F_T 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.

Temperature in °C	Temperature factor F_T
125	1.00
150	1.00
175	0.95
200	0.90
225	0.82
250	0.76
275	0.68
300	0.61

HARDNESS FACTOR F_H

The rails have a minimum hardness value of 58 HRC, corresponding to hardness factor F_H=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 F_H = 0.75.

Hardness			Hardness factor F_H
Rockwell HRC	Vickers HV	Brinell HB	
60	697	-	1.00
59	674	-	1.00
58	**653**	**-**	**1.00**
57	633	-	0.96
56	613	-	0.89
55	595	-	0.81
54	577	-	0.75
53	560	-	0.71
52	544	500	0.67
51	528	487	0.63
50	513	475	0.60
40	392	371	0.30
30	302	286	0.20
20	238	226	0.10
10	196	187	0.07

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

DYNAMIC AND STATIC LOAD RATINGS

D (mm)	C_{dyn} (N)	C_o (N)	Cage type	Suitable rails
1.5	52	63	AA	RSD
1.5	52	63	KZR	RSD
1.5	10	14	JJ	RSD
1.5	10	14	KKLK	RSD
2	86	105	AA	RSD
2	86	105	KZR	RSD
2	21	23	JJ	RSD
2	21	23	KKLK	RSD
3	136	165	AA	RSD
3	136	165	KZR	RSD
3	392	540	KRE	RSDE, RNG
3	30	31	JJ	RSD
3	30	31	KKLK	RSD
4	265	310	AA	RSD
4	48	48	JJ	RSD
4	785	1050	KRE	RSDE, RNG
4	785	1050	KREV	RSDE, RNG
6	540	630	AA	RSD
6	540	630	AL	RSD
6	540	630	KZR	RSD
6	1765	2120	KRE	RSDE, RNG
6	1765	2120	KREV	RSDE, RNG
6	78	78	JJ	RSD
6	78	78	KKLK	RSD
9	1350	1450	AA	RSD
9	1350	1450	AL	RSD
9	1350	1450	KZR	RSD
9	150	150	JJ	RSD
9	150	150	KKLK	RSD
12	2560	2610	AA	RSD
12	2560	2610	AL	RSD
12	260	260	JJ	RSD
12	260	260	KKLK	RSD
15	4500	4520	AA	RSD
15	4500	4520	AL	RSD
15	420	420	JJ	RSD

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 are 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_{max}. as:

$$P_0 = F_{max}$$

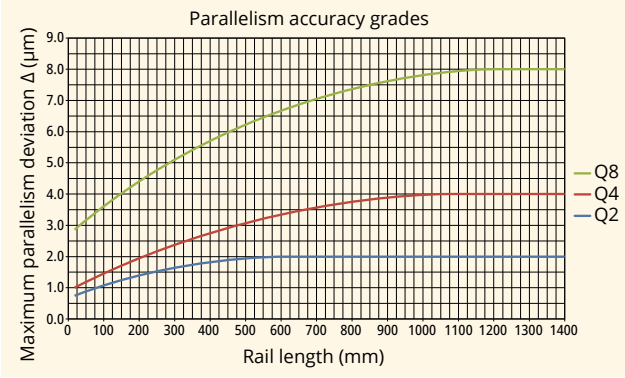
C_0 = Static load capacity (N), see dimension slides
P_0 = Static equivalent load (N)
F_{max} = Maximum applied load (N)
S_0 = Static safety factor

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 parallellism between the running surfaces and reference surfaces A and B of the rail, as illustrated in graph and figure below.



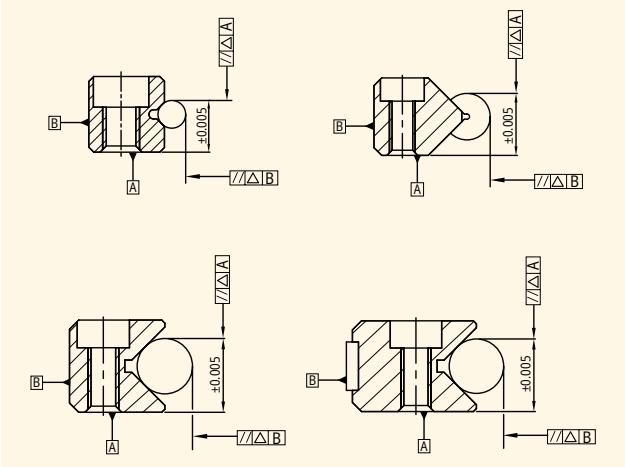
Q8: Standard precision grade, is suitable for most machine requirements

Q4: Meets the demands for high precision applications

Q2: Suitable for the highest accuracy requirements

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.

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



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.

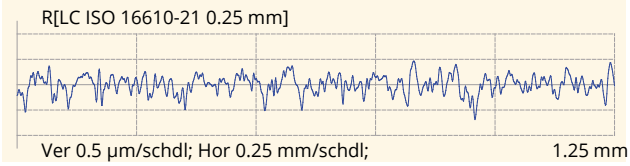
Key features are:

- Reduction of surface roughness <0.05 Ra
- 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

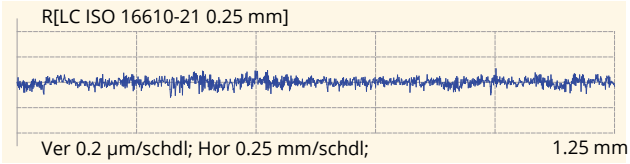
Your advantages:

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

Standard finish

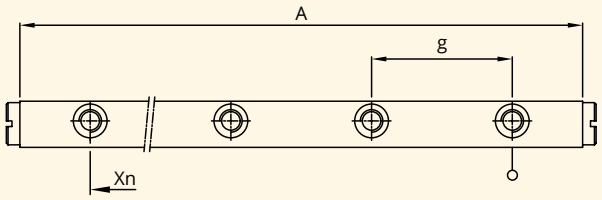


SF-Grade finish



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.

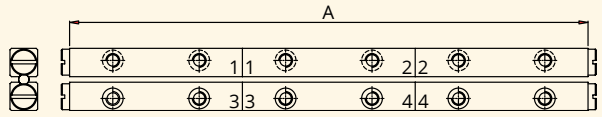
TOLERANCES ON LENGTH AND MOUNTING HOLES



Length A ≤ 300 mm:	±0.3 mm
Length A > 300 mm:	±1‰ of A
Pitch g:	±0.3 mm
Xn ≤ 350 mm:	±0.3 mm
Xn > 350 mm:	±1‰ of A

MULTI-SECTION RAILS

Rails exceeding the maximum length of 1400 mm will be composed of different sections that are ground together. The offset between the raceways is max. 2 micron. The rails are provided with end markings for assembly. The tolerance on length (A) is within ± 2 mm.

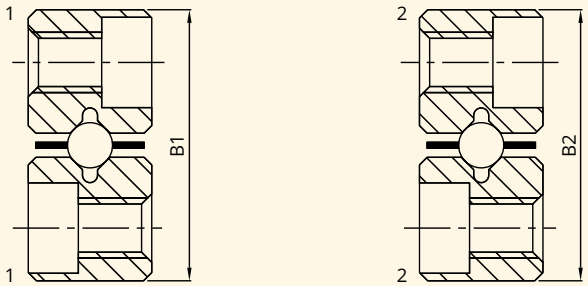


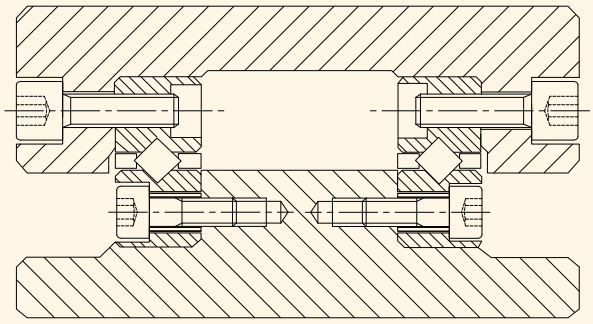
During installation pay attention to the consecutiveley numbering on the rails.

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 marked. If several sets are ordered they will be marked accordingly.

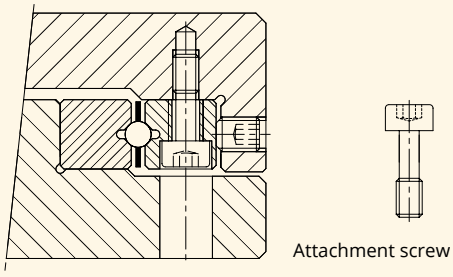
In case of UK/UR recirculating elements, if two or more are arranged one behind another in the application, we recommend ordering matched pairs by adding a suffix “MP” in your order note.





ASSEMBLY OF THE RAILS

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 mouting holes.



Attachment screw Typ GD

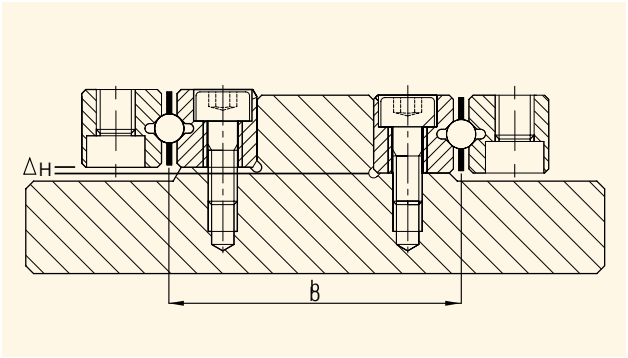
HEIGHT DIFFERENCE ΔH

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 · b

For rails with needle roller cages:
ΔH < 0.07 · b

ΔH (µm): Maximum permissible deviation from the theoretically correct position
b (mm): Centre distances of the bearings



TOLERANCES OF MOUNTING SURFACE

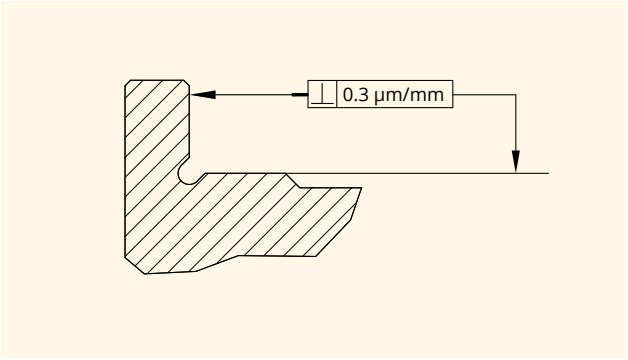
For standard applications an average mounting surface roughness of Ra 1.6 must be observed. For quality classes Q4 and Q2 the mounting surface roughness values are Ra 0.8 and 0.2.

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

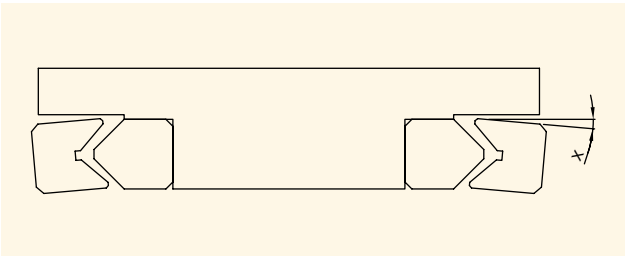
To achieve best performance, the bearings must be mounted on rigid and fine-machined, (preferably grinded) flat surfaces and be supported over their entire length.

ANGULAR ERRORS

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 to prevent local overloading of rollers and dislocation of the cage. For applications with high accelerations we recommend the use of our anti-cage creep mechanism so as to prevent creeping of the cage out of its original position.
Please see page 88 and 89 of this catalogue.

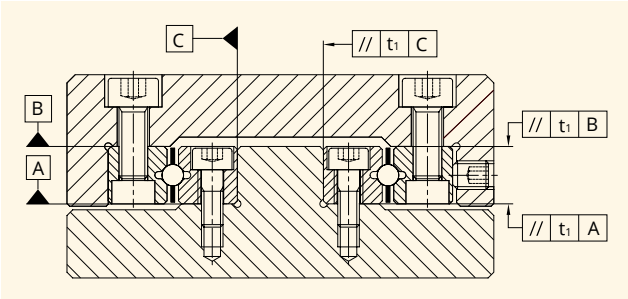


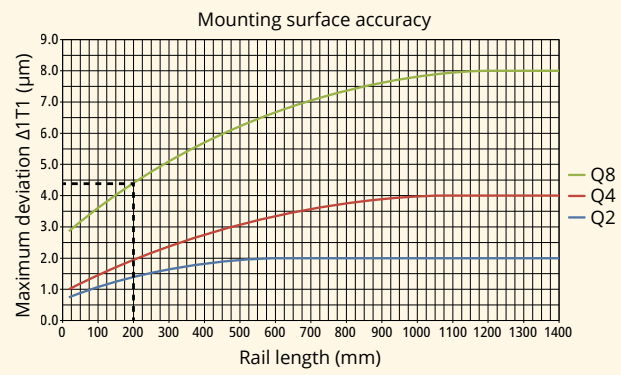
The tolerance of linear bearings in loaded or unloaded situations should not exceed the following values:
Balls or rollers (RSD / RSDE / RNG) 0.3 µm/mm
Needles (N/O / M/V) 0.1 µm/mm



PARALLELISM OF MOUNTING SURFACES

The final assembly accuracy of a linear slide depends on the quality and accuracy of the supporting structure on which the rails are mounted. The parallelism of the mounting en reference surfaces must not exceed the tolerances as illustrated in below graph. Please refer also to the quality grade of the linear bearing sets to read the maximum permissible tolerance. Most common is Q8 which is the standard (normal) quality grade.
For example -> by a rail length of 200 mm the maximum permissible tolerance is 4.4 microns.





Deviations from the listed tolerances reduce the running accuracy and service life of the linear bearing.

RECOMMENDED STROKE LENGTH 'H'

As regards cage length and the associated load capacity, PM recommends a stroke length (H) of 70% of the (longest) rail length (A). In case the rail length is longer than 400 mm the stroke length can be increased up to a maximum of 100%.

H/A ≤ 0.7 (for H ≤ 400 mm)

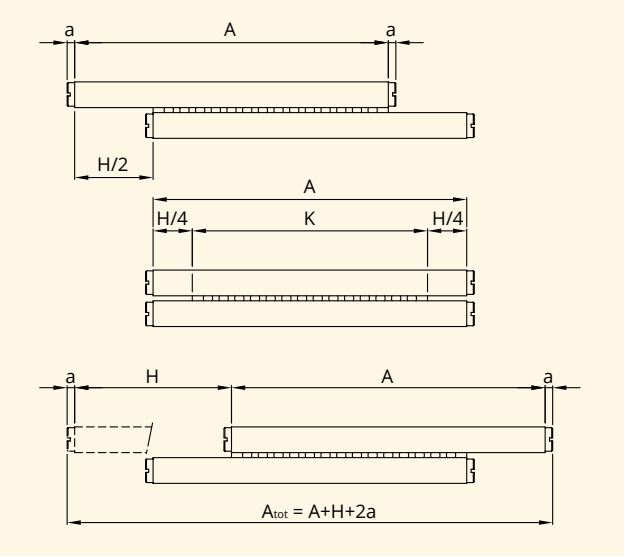
H/A ≤ 1 (for H > 400 mm)

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.

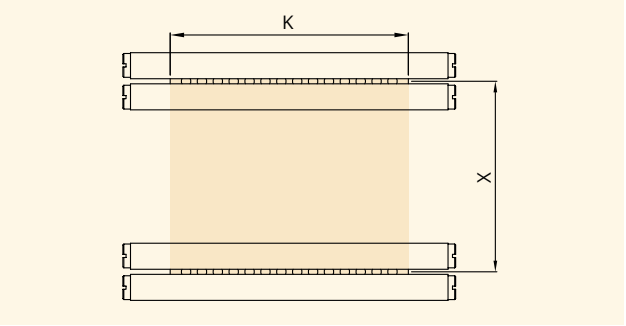
On the other hand, with a normal frictionless sliding table, the upper member can move equal distances to either side of the center.

K = A-H/2 (i.e.: cage length = rail length - half of the max. stroke)



Relationship between cage length and distance between rails (x);

$$\frac{K}{X} \geq 1$$



K	= Cage length	A_{tot}	= Overall length
H	= Stroke / travel	X	= Rail distance
A	= Rail length	a	= End screw

LOAD CAPACITY 'C' USING ROLLERS

Standard constructions with rollers: two roller cages, each in between rails of equal length, both longer than the cage. $\mathbf{C_{total} = Z \cdot C_{roller} \cdot ½}$ (amount of rollers · C_{dyn} 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 and C_{dyn} roller = 136 N per roller.
C_{dyn} total = (22 · 2 · 136) / 2 = 2992 N.

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.

$C_{total} = Z \times C_{ball}$
C_{total} = Total dynamic load capacity
Z = Amount of rolling elements
C_{ball} = Cdyn per ball

Note: all the balls in the cages are load bearing.
C_{total} = Z x C_{ball} = (no. of balls) x (dynamic load rating per ball).
Example: cage K3 x 23JJ; Z = 23; C_{dyn} = 30 N per ball.
C_{total} = 23 x 2 x 30 = 1380 N.

CALCULATION OF NUMBER OF ROLLING ELEMENTS 'Z'

$$Z = \frac{K}{t}$$

Z = Amount of rolling elements
K = Cage length
t = Pitch between rolling elements

Example
K = 200 mm (cage length)
t = 5 mm (for 3 mm diameter rollers / balls)
Z = 200 / 5 = 40 rollers or balls
See load capacity table on page 12.

CAGE DESIGNATION

AA cage; R3x40AA; roller size = 3 mm; 40 rollers; for horizontal application only.
AL cage; R6x18AL; roller size = 6 mm; 18 rollers; horizontal and vertical application.
JJ cage; K3x20JJ; balls size = 3 mm; 20 balls; horizontal and vertical application.

SEALING

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.

END PIECES

End pieces prevent the cage from moving out of the load zone. In order to ensure the quality of the rails during operation, it is necessary to protect the rails against contaminations. For this purpose, end pieces with type GCA wipers are available which are mounted over the end holes in the rails.
Type GC end pieces are also suitable for linear bearing sets with combined rail lengths where the type GC end piece will be mounted in the longest rail.

MAXIMUM VELOCITY AND ACCELERATION

PM linear bearings that are correctly mounted and preloaded should not exceed the following values, unless the design and the application are adapted for higher dynamics*:

RSD type linear bearings
Max. recommended speed v = 50 m/min.
Max. acceleration a = 8 m/sec².

RSDE and RNG type linear bearings
Max. recommended speed v = 50 m/min.
Max. acceleration a = 25 m/sec².

RSDE and RNG type with anti-cage creep (ACC) solution
Max. recommended speed v = 150 m/min.
Max. acceleration a = 300 m/sec².

N/O and M/V type linear bearings
Max. recommended speed v = 50 m/min.
Max. acceleration a = 50 m/sec².
(depending on the cage type used).

UK and UR type recirculating units
Max. recommended speed v = 50 m/min.
Max. acceleration a = 50 m/sec².

To achieve the above mentioned values for maximum acceleration and speed without skidding of balls and rollers (which could result in cage creeping), it is necessary to have a correct assembly procedure with the appropriate preload settings in place. Please contact PM to obtain our expert guidance on preload settings.

*In this situation PM design expertise support and approval is required.

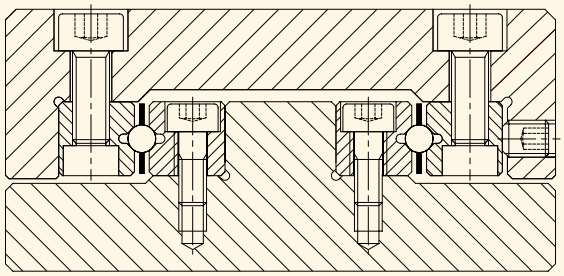
ASSEMBLY INSTRUCTIONS

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

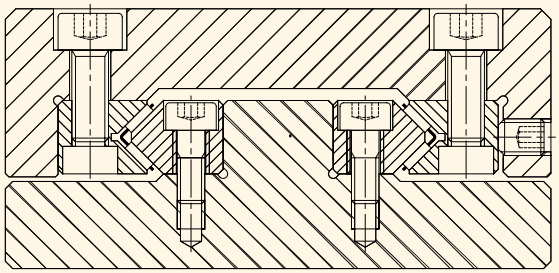
STANDARD FITTING EXAMPLES

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.

Use of RSD, RSDE or RNG



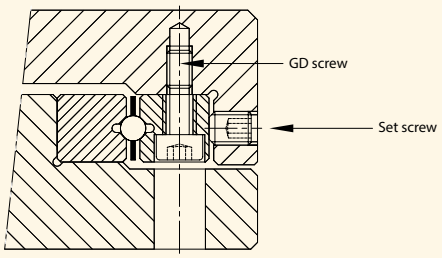
Use of N/O or M/V



PRELOAD SETTINGS

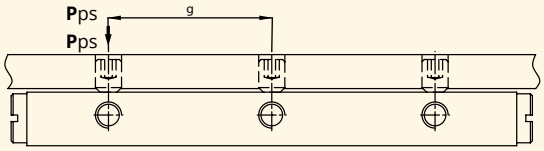
In order to assure a play-free movement and to increase the stiffness and accuracy of the linear bearing, preload adjustment is necessary. To adjust the preload uniformly, PM supplies especially designed type GD attachment screws. These screws are recommended for use with the through holes of the rail and the threaded holes in the slide members. Type GD screws allow for additional clearance in the mounting holes for the preload rail.

Example: Use of a type GD attachment screw



The smoothest running performance can be obtained by adjusting the preload set screws (ISO 4026, DIN 913) opposite the rollers. By moving the slide, each of the preload set screws 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 23). it can be fine adjusted by the use of a torque wrench.



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 23.

AMOUNT OF PRELOAD FORCE

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

Rail RSDE-3150; g = 25 mm
Roller cage type KRE-3; t = 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 on the next page)

Set screw	Factor a
M2	0.0238
M2.5	0.0294
M3	0.0350
M4	0.0469
M5	0.0580
M6	0.0699
M8	0.0926
M10	0.1152
M12	0.1378
M14	0.1591
M16	0.1811

Calculation amount of force per set screw

Pps = g / t · C_{dyn} · p / 100 · f

Pps = 25 / 3.3 · 392 · 8 / 100 · 1 = 237,6 N

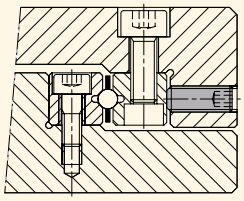
Calculation tightening torque on set screw

Tightening torque = Pps · a

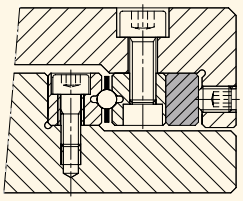
Tightening torque = 237,6 · 0.0469 = 11,14 Ncm

The following figures illustrate typical methods used for applying preload.

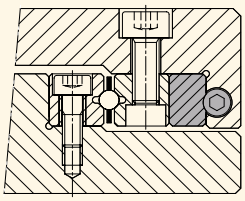
Set screws



Adjusting bar



Longitudinal wedge



Note: The friction in the screw connection affects the final preload force that the set screw will generate. The amount of this friction depends on the material of the table components and any lubrication of the screws. Therefore, the friction factor is unknown and not included in the formula.

RECOMMENDED STROKE LIMITING

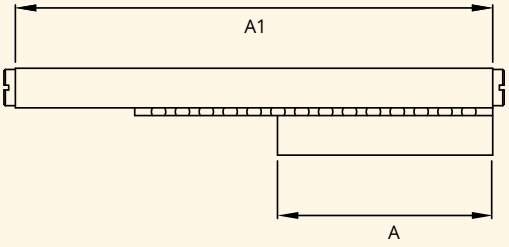
The stroke must be limited either by the machine parts or by using limit switches. Cages may never be used as stroke limit. If they are, they can damage the running surface of the rails. Therefore we recommend the use of emergency hard stops which should be mounted in line with the bearing axis to prevent additional loads and moments on the linear bearings.

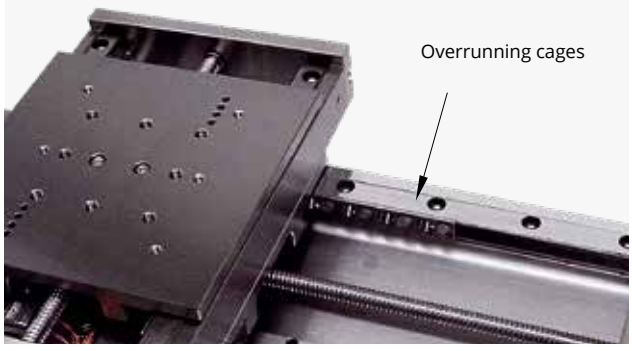
OVERRUNNING CAGES

Overrunning cages are used when a shorter slide moves over a longer rail. As the use of end pieces is not possible for the short rails, which get mounted in the moving slide, the short rails should be ordered with rounded inlets (please add a suffix "RI" in your order note). Rounded inlets enable the rollers to move in and out of the preload smoothly. For the longer rails we recommend type GB and GC end pieces. Not all cages are suitable for overrunning use, as the cage material and length geometry must be taken into account. Please consult a PM expert for advice, or refer to the specifications provided for each type.

As a general guideline the permissible application ratio A to A1 is determined as follows:

- For fixed rails 1 : 2
- For laid on rails 1 : 4





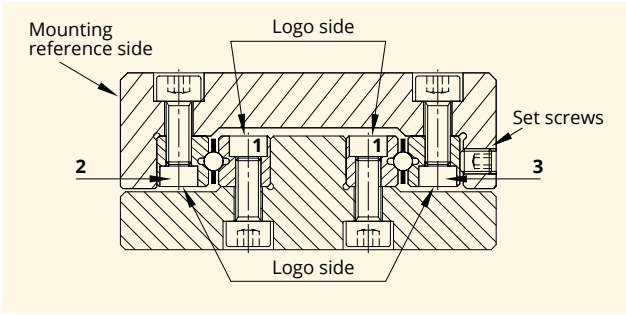
ASSEMBLY PROCEDURE

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:

- 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.

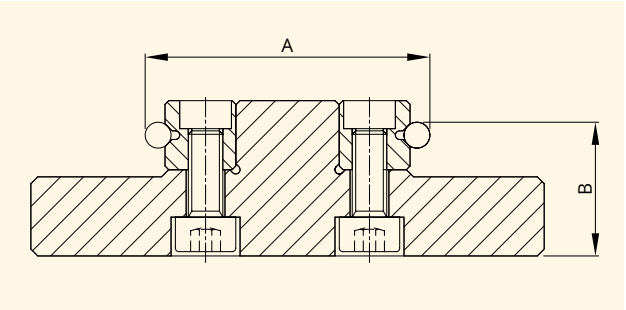
ASSEMBLY LINEAR BEARINGS



For satisfactory installation of all types of linear bearings in this catalogue, it is necessary to consider the following points:

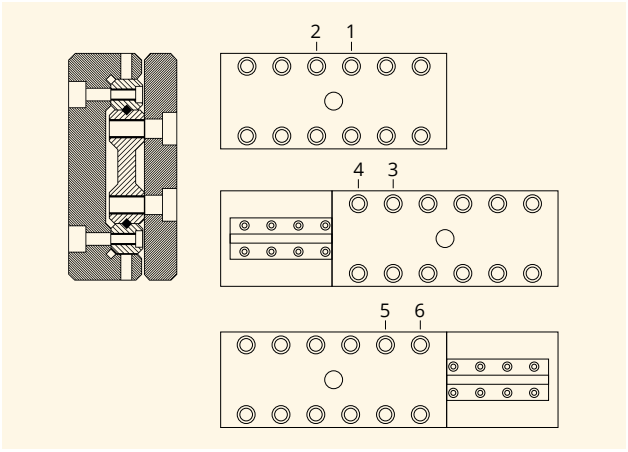
1) To determine the location of fixing holes in the support structure (slide base) the holes in the rails should be taken as a reference and "copied" onto the support structure. This is highly desirable as the original pitch of individual holes may have altered during hardening by as much as 0.4 mm. 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. We advise the use of a torque wrench. Please note that the company logo and item number are marked opposite to the surface reference.
4) 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.

Parallelism of rails V-groove: ΔA and ΔB



4.1) 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.
5) If any end stop screws are present, remove them now.
6) Carefully insert the cages. When placed in their exact position, lightly secure the adjustable rail until the screws are finger-tight.
7) Fit the end screws or end pieces, and wipers.
8.1) The linear bearing set is now ready to be backlash free-adjusted using the lateral preload set screws (page 19, Preload Settings). The amount of preload is given in the tables at page 23. The use of a torque wrench is advised.
8.2) Before starting the preload procedure carefully move the slide top over its stroke length back and forth and feel that there are no irregularities.
9) Preload procedure: put the slide on a clean surface on its side with the lateral preload set screws up. Follow step 1, 2 and 3 for the correct preload sequence.

Step 1. Start in the middle position and adjust the set screws with the recommended torque value, working outwards from the middle. Notice: Only adjust the screws directly above the cage.
Step 2. Move the slide top in one direction and adjust the set screws to the recommended torque value. (As given in table 1-5, page 23)
Step 3. Move the slide top in opposite position and repeat the adjusting for the screws which are now above the cages.



Again move the slide top back and foth a couple of times and feel that there are no irregularities.

10) Secure the attachment screws on the adjusting rail.

11) When assembly is complete, the linear bearings must be checked for absence of play and inspected for running quality.

TABLES

RECOMMENDED PRELOAD SETTINGS

Table 1 Linear bearings type RSD with roller cages

Roller size (mm)	Pitch cage (mm)	Set screw	Pitch* (mm)	Preload (Ncm)
1.5	3	M2.5	10	0.75
2	4	M3	15	1.50
3	5	M5	25	4.50
4	7	M5	40	11.50
6	9	M6	100	27.50
9	14	M8	100	105.50
12	18	M10	100	212.00
15	20	M12	100	370.00

Table 2 Linear bearings type RSD with ball cages

Ball size (mm)	Pitch cage (mm)	Set screw	Pitch* (mm)	Preload (Ncm)
1.5	3	M2.5	10	0.15
2	4	M3	15	0.36
3	5	M5	25	1.05
4	7	M5	40	2.70
6	9	M6	50	4.00
9	14	M8	100	11.70
12	18	M10	100	25.00
15	20	M12	100	34.50

Table 3 Linear bearings type RSDE with roller cages

Roller size (mm)	Pitch cage (mm)	Set screw	Pitch* (mm)	Preload (Ncm)
3	3.3	M5	25	14
4	4.4	M5	40	41
6	6.6	M6	50	86
9	On request			

Table 4 Linear bearings type RNG with roller cages

Roller size (mm)	Pitch cage (mm)	Set screw	Pitch* (mm)	Preload (Ncm)
4	4.4	M3	25	14
6	6.6	M4	25	25

Table 5 Linear bearings type N/O and M/V with needle cages

Needle roller size (mm)	Pitch cage (mm)	Set screw	Pitch* (mm)	Preload (Ncm)
2	4	M6	50	1.05
2	4.5	M8	100	1.30
2.5	5	M8	100	2.70
2.5	5.5	M8	100	2.90
3	6	M12	100	5.70
3.5	7	M14	100	7.70

**pitch between the preload set screws*

AVAILABLE OPTIONS LINEAR BEARINGS

		RSD	RSDE	RNG	N/O & M/V	DS	UK & UR
Order code	Catalogue page	27	49	63	71	97	99
Material / coating							
SS	Linear bearings made of stainless steel	●	●	●	●	●	●
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 [2)]	Quality grade suitable for highest accuracy requirements	●	●	●	●	●	●
Special environment							
UHV	Ultra high vacuum cleaned and packed	●	●	●	●	●	●
CL	Cleanroom cleaned and packed	●	●	●	●	●	●
Anti-cage creep technology							
ACC	Anti-cage creep technology	●	●	●	●	●	●
ACCI	Anti-cage creep integrated technology	●	● [3)]	●	●	●	●
Mounting holes							
03	Threaded hole	●	●	●	● [4)]	●	●
10	Through hole	●	●	●	● [4)]	●	●
13	Threaded inserts integrated in the rail	●	●	●	● [4)]	●	●
15	Through hole with countersunk (standard at M/V, no suffix needed)	●	●	●	● [4)]	●	●

●Available ●Not available

[1)] There are limitations to maximum rail lenght. Options available for standard grade, other quality grades on request

[2)] Q2 quality grade only made to order

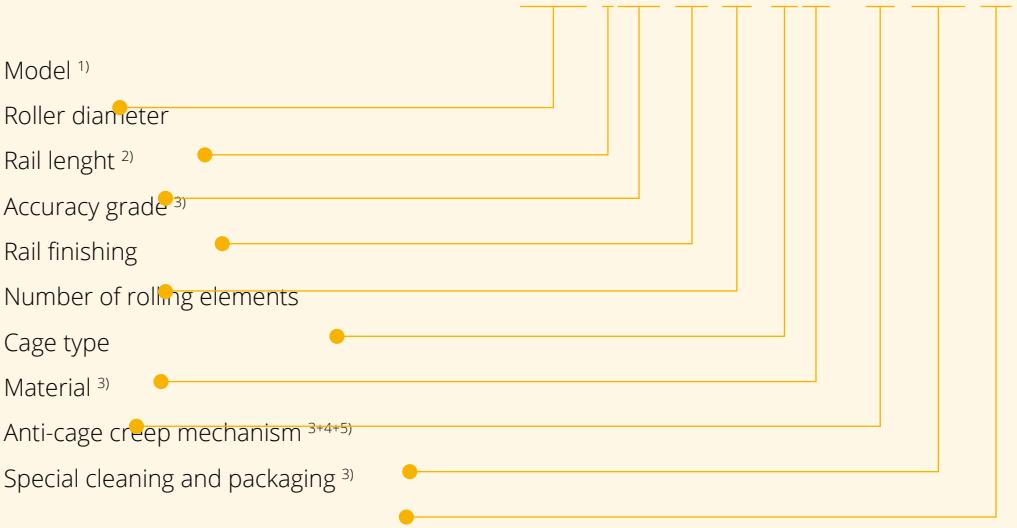
[3)] Only available for linear bearings type RSDE made from stainless steel, max. length 240 mm

[4)] Only available for linear bearings type M/V

ORDERING CODE LINEAR BEARINGS PACKED AS SET

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

Example: **RSDE-6250-Q4-SFx32KRE-SS-ACC-CL**



*(AA cage with end screws GA, other cages supplied with end pieces GB)

1) Type of rails RSD, RSDE and RNG
2) Standard 4 rails of the same lenght
3) No code, supplied as standard listed in the product tables
4) Sets with ACC and ACCI are delivered without end pieces
5) By order ACC and ACCI always indicate stroke lenght in order text

ANTI-CAGE CREEP TECHNOLOGY

PM Anti-Cage Creep (ACC) technology reduces cage creep down to zero.

With high acceleration up to 15 g, the design is compact and cost-effective.

ACC is integrated in a crossed roller bearing design. Available also for stainless steel designs with an ECM-machined (Electro-Chemical Machining) integrated rack (ACCI all metal design) and UHV-compatibility.

A robust brass rack is locked in place inside the V-groove.

In its integrated form, anti-cage creep (ACCI) is ECM-machined and available for stainless steel rails and selected rail types only.

THE PROBLEM: CAGE CREEP

In the push for faster production times, machine designers are constantly striving for higher process speeds, reduced size and weight of designs, while simultaneously requiring the highest possible machine travel and positioning accuracy.

Cage creep can occur in non-recirculating linear bearing applications when there are vibrations, improper mounting, very high acceleration and deceleration, inadequate tolerances on the mounting surfaces, uneven preloading, or moment loading.

As the cage shifts from its original position, friction increases, travel length is reduced, and premature wear of the linear bearings occurs. This shortens the bearing's lifespan and can result in early failures.

OUR SOLUTION: ANTI-CAGE CREEP (ACC)

PM engineers have further enhanced ACC technology, making it suitable for high-tech and extremely dynamic applications. For decades, the ACC solution has demonstrated its superior ability to prevent cage creep in the most demanding applications and under the toughest conditions.

The ACC system is integrated into the linear bearing design without altering the external boundary or mounting dimensions. This allows a direct replacement of linear bearings in underperforming applications with the ACC solution.

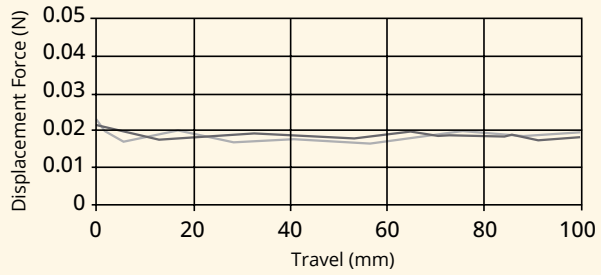
PROVEN RECORD OF RESULTS

- No increase in friction
- No reduction in accuracy
- No adverse influence from lubrication
- Operational lifetime extended to its limit
- Zero cage creeping
- Works with all mounting applications
- Easy to assemble

The ACC system is the most effective and cost-efficient solution available on the market. Currently, our precision rails with optional ACC can be ordered with the RSDE and RNG series, in all accuracy grades.

FRICTION FORCE

The ACC solution is the result of a highly precise design and manufacturing process. The graph below illustrates that the force required to overcome friction remains virtually unchanged.



APPLICATIONS

The ACC solution is ideal for the high speed, high precision demands of the electronics and semiconductor industries, including applications such as wire bonding stages and pick-and-place units.

OPERATING TEMPERATURE

Linear bearings with the ACC solution can operate in temperatures ranging from -40 °C to +80 °C. This gives ACC a significant advantage over similar systems that use plastic components.

ACCELERATION

Max. acceleration 150 m/s^2 (15 g)

ONE ACC SET INCLUDES

A standard linear bearing set with ACC solution consists of:
- 4 pcs. rail type RSDE-ACC
- 2 pcs. roller cages type KRE(V)-ACC (rollers retained)

No end screws are required

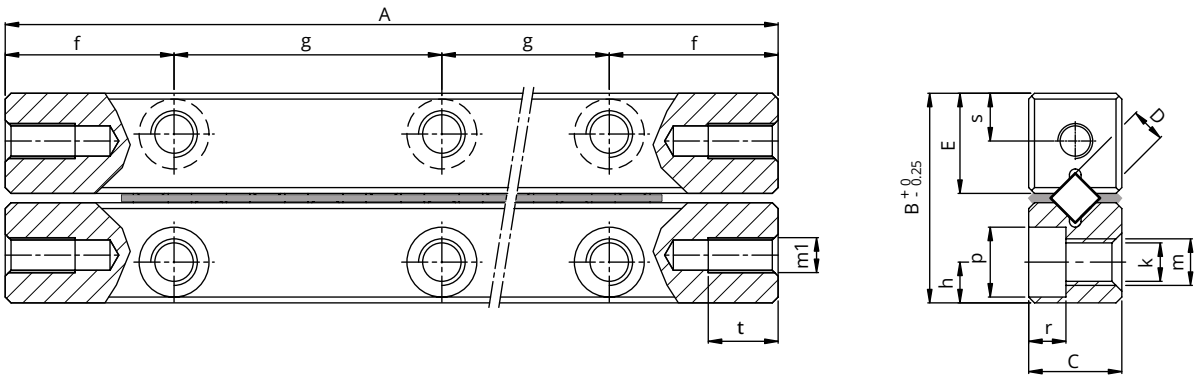
Leading global manufacturers have chosen the ACC solution as the best available solution against cage creep.

Optional:
End screws type GA and attachment screws type GD.

The following products are available with anti-cage creep technology:
- Linear bearing sets RSDE
- Linear bearing sets RNG
- Miniature slides MSR

LINEAR BEARING SETS WITH ACC
Type RSDE-ACC, see from page 72 onwards.
Compact type RNG-ACC, see from page 76 onwards

Layout of ACC

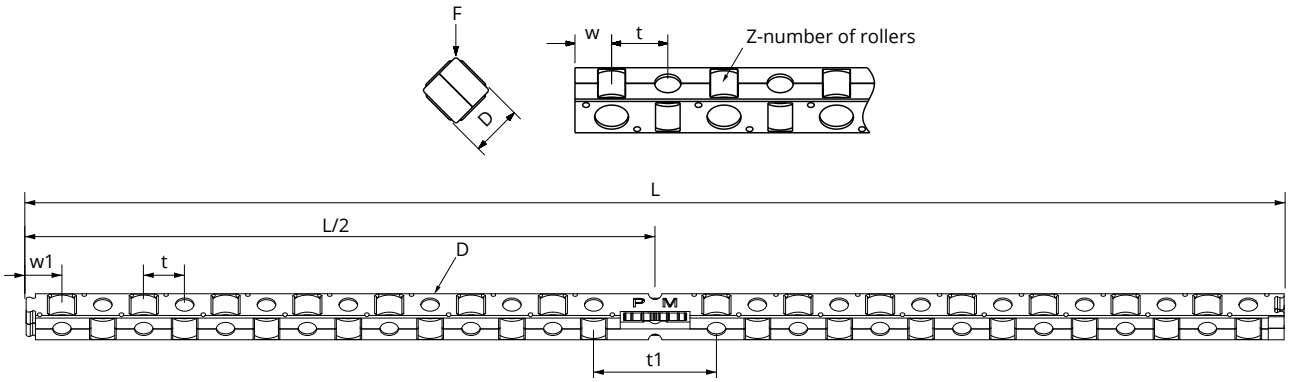


One set consists of: 4 rails + 2 roller cages, both with ACC optional

RNG-ACC Kit	Main dimensions				D	Mounting holes							End holes		
	A	B	C	E		f	g	h	k	m	p	r	m1	s	t
RNG-4050x6KRE-ACC	50						1x25								
RNG-4075x10KRE-ACC	75						2x25								
RNG-4100x14KRE-ACC	100						3x25								
RNG-4125x18KRE-ACC	125						4x25								
RNG-4150x22KRE-ACC	150	19	9	9	4	12.5	5x25	$3.5^{\pm 0.2}$	2.65	M3	5.5	2.7	M3	3.5	6
RNG-4175x26KRE-ACC	175						6x25								
RNG-4200x28KRE-ACC	200						7x25								
RNG-4225x30KRE-ACC	225						8x25								
RNG-4250x34KRE-ACC	250						9x25								
RNG-6100x8KRE-ACC	100						3x25								
RNG-6150x14KRE-ACC	150						5x25								
RNG-6200x16KRE-ACC	200						7x25								
RNG-6250x22KRE-ACC	250	25	12	12	6	12.5	9x25	$5^{\pm 0.2}$	3.3	M4	7	3.2	M3	3.5	6
RNG-6300x28KRE-ACC	300						11x25								
RNG-6350x32KRE-ACC	350						13x25								
RNG-6400x38KRE-ACC	400						15x25								

Bold = Short lead time item

Regular = Long lead time item - please ask us about prices and lead times



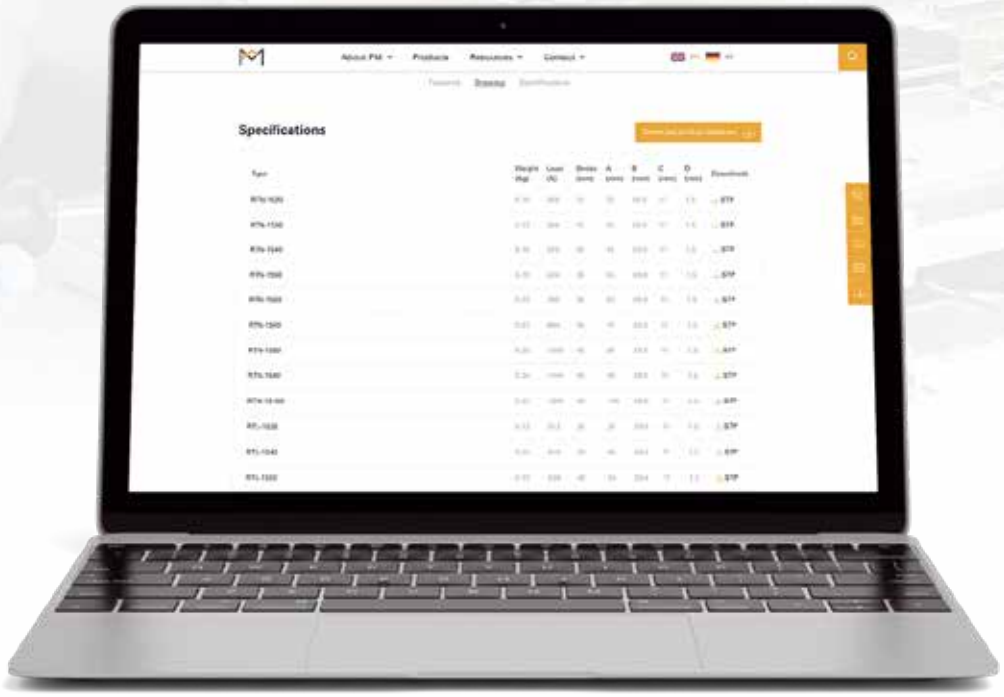
Snap-on cage

Weight (g)	C_{dyn} in (N)	Roller cage							Stroke	Type
		D	t	t1	w	w1	Z	L		
130	5495						6	36.4	27	RNG-4050x6KRE-ACC
210	8635						10	54.0	40	RNG-4075x10KRE-ACC
280	11775						14	71.6	55	RNG-4100x14KRE-ACC
350	14915						18	89.2	70	RNG-4125x18KRE-ACC
420	18055	4	4.4	13.2	2.8	3.85	22	106.8	85	RNG-4150x22KRE-ACC
490	21195						26	124.4	100	RNG-4175x26KRE-ACC
550	23550						28	133.2	130	RNG-4200x28KRE-ACC
615	25120						30	146.6	155	RNG-4225x30KRE-ACC
690	27475						34	164.2	180	RNG-4250x34KRE-ACC
470	17650						8	68	60	RNG-6100x8KRE-ACC
695	28240						14	107.6	80	RNG-6150x14KRE-ACC
905	35300						16	120.8	150	RNG-6200x16KRE-ACC
1130	44125	6	6.6	19.8	4.3	6.3	22	160.4	170	RNG-6250x22KRE-ACC
1365	54715						28	200	200	RNG-6300x28KRE-ACC
1595	63540						32	234.4	230	RNG-6350x32KRE-ACC
1830	70600						38	274	250	RNG-6400x38KRE-ACC

F = For load direction please refer to picture provided

Units: mm

Download the standard product .STP files



PM RESEARCH AND PRODUCTION FACILITIES

PM B.V.
Galileistraat 2
7701 SK Dedemsvaart
The Netherlands

Phone: +31 523 61 22 58
Email: info@PM.nl

www.PM.nl

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