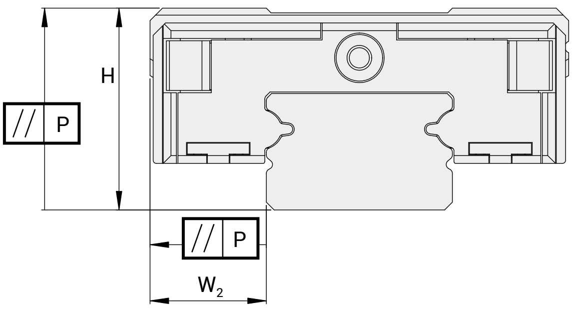
PRECISION

MR miniature linear guide series have three accuracy classes (P,H,N) for your choice.

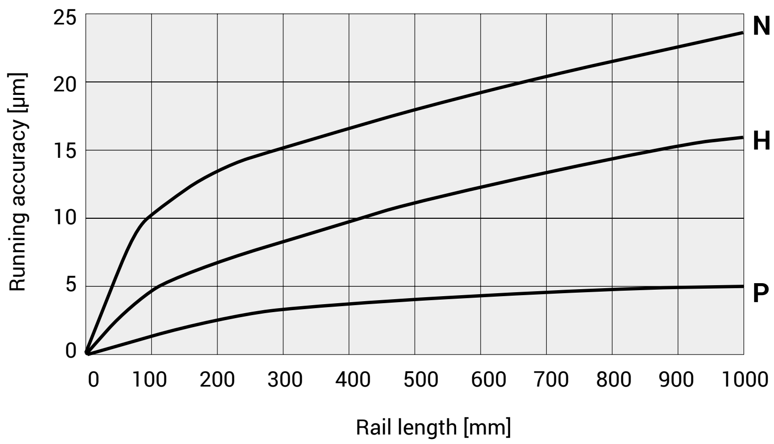
Preload type Z1 on stock (others on request).

Table of accuracy



Accuracy classes [µm]		Precision P	High H	Normal N
Admissible height H dimension tolerance	H	± 10	± 20	± 40
Height variation for different runner blocks on the same rail position	ΔH	7	15	25
Admissible width W dimension tolerance	W_2	± 15	± 25	± 40
Width variation for different runner blocks on the same rail position	ΔW_2	10	20	30

Linear block relative to linear rail, datum plane parallel motion precision



SPEED

The maximum speed for the standard MR-SS/ZZ,SU/ZU type is:
v_{max} = 3 m/s

Maximum acceleration:
a_{max} = 250 m/s²
(If preload is at V0, capability of reaching 40 m/s²)

The maximum speed for the standard MR-EE/EZ,EU/UZ,SUE/ZUE type is:
v_{max} > 5 m/s

Maximum acceleration:
a_{max} = 300 m/s²
(If preload is at V0, capable of reaching 60 m/s²)

PRELOAD

The MR Miniature Linear Guide series has three degrees of preload capacity: V0, VS and V1 (as described in the preload table below.)
Appropriate preload levels can enhance the stiffness, precision and torsion resistance performance of the linear guide. But an inappropriate application thereof can also negatively affect the product life and its motional resistance levels.

Standard preload type on stock (others on request).

Table preload

Preload type	Model code	Clearance [μm]					Application
		5	7	9	12	15	
Clearance	VO	0 ~ +3	0 ~ +4	0 ~ +4	0 ~ +5	0 ~ +6	Very smooth
Standard	VS	0 ~ +1	0 ~ +2	0 ~ +2	0 ~ +2	0 ~ +3	Smooth and high precision
Light preload	V1	-1 ~ 0	-3 ~ 0	-4 ~ 0	-5 ~ 0	-6 ~ 0	High rigidity Minimizes vibration High precision Load balance

OPERATING TEMPERATURE

The MR Miniature Linear Guide can operate in a range of temperatures from -40 °C ~ + 80 °C.
For short term operation, it can reach up to +100 °C.

LUBRICATION

FUNCTION

When operating the linear guide under sufficient lubrication conditions, an one-micron layer of oil forms at the contact zone, separating the loaded rolling components and the raceway.
Sufficient lubrication will:

- Reduce friction
- Reduce wear
- Reduce corrosion
- Dissipate heat and increase service life

LUBRICATION CAUTION

- ZZ/ZU/EZ/UZ/ZUE Lubrication Storage block
  1. The block already contains lubricants which can be directly installed on the machine, without the need for additional washing.
  2. When first washing the blocks, please do not soak them in the lubricant before both the detergent and cleaning naphtha within are totally dry. The block is ready for installation only after the lubrication storage is full of the lubricant.
- The linear guide must be lubricated for protection before first time use. Contaminants of any kind, weather liquid or solid, should be avoided.
- The runner block should be moved back and forth during lubrication.
- The lubricant can be added either manually or automatically directly onto the rail raceway.
- The lubricant can be injected into the lubrication holes on either end of the runner block.
- A thin layer of observable lubricant should be maintained on the surface of the rail .
- Re-lubrication must be completed before contamination or discoloration of the lubricant occurs.
- Please notify us if product is intended for use in acidic, alkaline, or clean room applications.
- Please contact our technical department for lubrication assistance if the runner block is intended for use in a wall mount configuration.
- The re-lubrication interval must be shortened if the travel stroke is < 2 or > 15 times the length of the steel body of the runner block.

GREASE LUBRICATION

When grease lubrication is applied, we recommend synthetic oil-based lithium soap grease with a viscosity between ISO VG32-100.

OIL LUBRICATION

For oil lubrication, we recommend synthetic oils CLP, CGLP (based on DIN 51517) or HLP (based on DIN 51524) with a viscosity range of between ISO VG32-100 and a working temperature range between 0 ºC ~ + 70 ºC (we recommend ISO VG10 for use in lower temperature environments).

RE-LUBRICATION

- Re-lubrication shall be applied before the lubricant in the block is contaminated or changes color.
- The amount of the lubricant applied should be 1/2 of the first lubrication. When applying lubricant, this should be done until it seeps out from the device.
- Re-lubrication shall be applied under steady operating temperature, with the runner block moved back and forth throughout for optimum distribution.
- If the stroke is smaller than twice or greater than 15 times the steel body length of the block, the re-lubrication interval shall be shortened.

Table 1

Model code	First lubrication [cm^3]	Model code	First lubrication [cm^3]
5 MN	0,03	–	–
5 ML	0,04	–	–
7 MN	0,12	7 WN	0,19
7 ML	0,16	7 WL	0,23
9 MN	0,23	9 WN	0,30
9 ML	0,30	9 WL	0,38
12 MN	0,41	12 WN	0,52
12 ML	0,51	12 WL	0,66
15 MN	0,78	15 WN	0,87
15 ML	1,05	15 WL	1,11

RE-LUBRICATION INTERVAL

The re-lubrication interval depends on individual use, as the speed, load, stroke length and operating environment are all factors. Careful observation of rails and blocks is the basis to determine the optimal re-lubrication interval; as a rule of thumb, re-lubricate at least once per year. Do not apply water-based coolant liquid on the linear rails or slide. Inject lubricant through injection holes on both ends of the runner block.

FRICTION

The MR Miniature Linear Guide Series has low-friction characteristics with a stable and minor starting friction.

Friction

$F_m = \mu \times F$ ——— (1)

F — Applied load [N]

F_m — Friction [N]

The MR Miniature Linear Guide Series friction coefficient is app μ = 0,002 ~ 0,003

SEALING DESIGN

The MR Miniature Linear Guide Series are enclosed by end seals on both ends of the runner block. Optional side seals can also create an all-around sealing system.

Friction of end seal under lubrication

MR size	Friction of end seal according to the rail type [N]	
	M	W
5	0,08	–
7	0,10	0,4
9	0,10	0,8
12	0,40	1,0
15	1,00	1,0

FRICTION FACTORS

- Sealing system.
- Collision between the balls during operation.
- Collision between the balls and the return path.
- Number of balls in the gothic arch load zone.
- Resistance from lubricant to ball pressure.
- Resistance caused by contaminants.

LOAD CAPACITY AND RATING LIFE

STATIC LOAD RATING C_0

When the linear guide is subjected to the excessive load, the groove (track) surfaces and the steel balls can be permanently deformed. At this point the MR Miniature Linear Guide Series will no longer operate smoothly. The static load rating C_0 is defined as the static load which causes a permanent overall deformation of 0,0001 times of the steel ball diameter.

Static load safety factor calculation

$$S_0 = \frac{C_0}{P_0} \quad \text{——— (11)}$$

$$S_0 = \frac{M_0}{M} \quad \text{——— (12)}$$

$$P_0 = F_{max} \quad \text{——— (13)}$$

$$M_0 = M_{max} \quad \text{——— (14)}$$

Recommended static safety factors S_0

Operation condition	S_0
Normal operation	1 ~ 2
Load with vibration or impact	2 ~ 3
High accuracy and smooth running	≥ 3

S_0	Static load safety factor
C_0	Basic static load in acting direction [N]
P_0	Equivalent static load in acting direction [N]
M_0	Basic static moment in acting direction [Nm]
M	Equivalent static moment in acting direction [Nm]

STATIC LOAD P_0 AND MOMENT M_0

The permissible static and applied static load of the MR Miniature Linear Guide Series is limited by:

- The static load of the linear guide.
- The permissible load of fixed screws.
- The permissible load for the connected parts of the mechanism.
- The static load safety factor required for the application.

The equivalent static load and static moment are the largest load and torque, please consult with formulas (13) and (14).

STATIC LOAD SAFETY FACTOR S_0

In order for the linear bearing to permanently withstand potential deformation while delivering a guaranteed accuracy and reliable motion, the static load safety factor S_0 should be calculated with formulas (11) and (12).

DYNAMIC LOAD RATING C_{100B}

For constant sized and directional loads, when the linear bearing is under such a load, the rating life of a linear guide can reach a theoretical travel distance of 100 km. (The above is according to ISO 14728-1)

Rating life calculation

$$C_{50B} = 1{,}26 \times C_{100B} \qquad (2)$$

$$C_{100B} = 0{,}79 \times C_{50B} \qquad (3)$$

$$L = \left(\frac{C_{100B}}{P}\right)^3 \times 10^5 \qquad (4)$$

$$L_h = \frac{L}{2 \times s \times n \times 60} = \frac{L}{v_m \times 60} \qquad (5)$$

L	Rating life [m]
L_h	Rating life in hours [h]
C_{100B}	Dynamic load rating [N]
P	Equivalent load [N]
s	Length of stroke [m]
n	Stroke repetition [min^{-1}]
v_m	Average speed [m/min]

RATING LIFE L

90 % survival rate for an individual linear guide or a batch of identical linear guides in standard product material and operation conditions is calculated as above (according to ISO 14728-1 standards).
When using the 50 km travel standard, the dynamic load rating will exceed the ISO 14728-1 standard value by 20 % or more. Formula (2) describes the relationship between the two load ratings.

CALCULATION OF RATING LIFE

Formulas (4) and (5) can be used when the equivalent dynamic load and the average speeds are constant.

EQUIVALENT DYNAMIC LOAD AND SPEED

If the load and speed are not constant, it is important to take into account the actual load and speed as both will influence life expectancy.

EQUIVALENT SPEED

If there is a change in speed only, the equivalent speed can be calculated according to formula (7).

EQUIVALENT DYNAMIC LOAD

If there is a change in load only, the equivalent dynamic load can be calculated according to formula (6).

CHANGES IN BOTH LOAD AND SPEED

If there are changes in both load and speed, the equivalent dynamic load can be calculated according to formula (8).

Equivalent load capacities and speed calculation

$$P = \sqrt[3]{\frac{q_1 \times F_1^3 + q_2 \times F_2^3 + \dots + q_n \times F_n^3}{100}} \qquad (6)$$

$$v_m = \frac{q_1 \times v_1 + q_2 \times v_2 + \dots + q_n \times v_n}{100} \qquad (7)$$

$$P = \sqrt[3]{\frac{q_1 \times v_1 \times F_1^3 + q_2 \times v_2 \times F_2^3 + \dots + q_n \times v_n \times F_n^3}{100\ v_m}} \qquad (8)$$

$$P = |F_X| + |F_Y| \qquad (9)$$

$$P = |F| + |M| \times \frac{C_0}{M_0} \qquad (10)$$

P	Equivalent dynamic load [N]
q_i	Percentage of time [%]
F_i	Discrete load steps [N]
v_m	Average speed [m/min]
v_i	Discrete speed steps [m/min]
F	External dynamic load [N]
F_Y	External dynamic load, vertical [N]
F_X	External dynamic load, horizontal [N]
C_0	Static load rating [N]
M	Static moment [Nm]
M_0	Static moment in direction of action [Nm]

COMBINED EQUIVALENT DYNAMIC LOAD

If the linear guide bears the load from arbitrary angels so that the acting force does not conform to horizontal and vertical directions, its equivalent dynamic load is calculated as shown on formula (9).

UNDER THE CONDITION WITH THE MOMENT

If the linear guide bears the load and the moment simultaneously, its equivalent dynamic load is calculated with formula (10).
According to ISO 14728-1, when equivalent dynamic load tolerance rates below ≦ 0,5·C, a realiable product life value can be calculated.

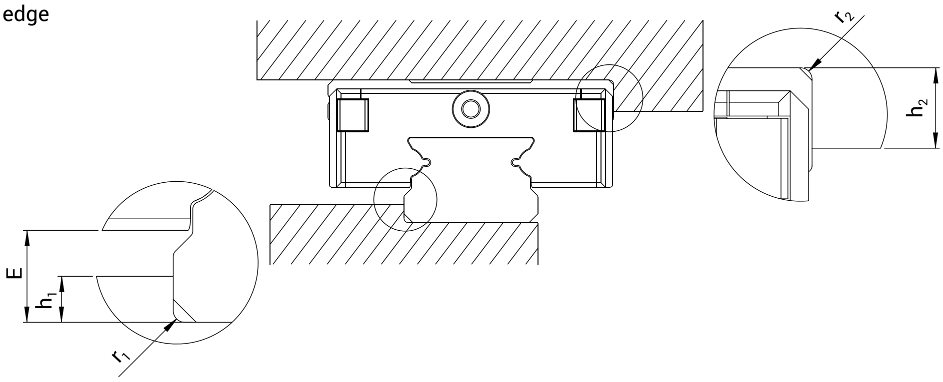
SINGLE BLOCK BEARING THE MOMENT

For a given structure, if the block needs to bear moments from Mp and My directions, the maximum moment that the block can withstand while still maintain smooth running conditions measures at about 0,1 ~ 0,3 times the static moment rating. The higher the preload, the higher the loading value and vice versa.

In the case of any design questions, please contact us.

HEIGHT AND CHAMFER OF REFERENCE EDGE

To avoid interference, the corner of the reference edge should have a chamfer. If not, please refer to the following table for the height of the reference edge corner and the height of the reference edge.



Height and chamfer of the reference surface

Dimension	h_2	r_{2max}	r_{1max}	SS/ZZ		SU/ZU		EE/EZ		EU/UZ		SUE/ZUE	
				h_1	E	h_1	E	h_1	E	h_1	E	h_1	E
5M	1,9	0,3	0,2	1,2	1,5	0,9	1,2	0,8	1,1	-	-	0,7	1,0
7M	2,8	0,3	0,2	1,2	1,5	0,8	1,1	-	-	-	-	-	-
9M	3,0	0,3	0,2	1,8	2,2	1,3	1,7	1,3	1,7	1,0	1,4	1,1	1,5
12M	4,0	0,5	0,3	2,6	3,0	2,1	2,5	1,9	2,3	1,6	2,0	1,7	2,1
15M	4,5	0,5	0,3	3,6	4,0	2,7	3,1	2,8	3,2	2,5	2,9	2,4	2,9

Dimension	h_2	r_{2max}	r_{1max}	SS/ZZ		SU/ZU		EE/EZ		EU/UZ		SUE/ZUE	
				h_1	E	h_1	E	h_1	E	h_1	E	h_1	E
7W	2,8	0,3	0,2	1,7	2,0	1,3	1,6	1,2	1,5	-	-	1,1	1,4
9W	3,0	0,3	0,2	3,0	3,4	2,5	2,9	2,4	2,8	2,1	2,5	2,2	2,6
12W	4,0	0,5	0,3	3,5	3,9	2,9	3,3	2,9	3,3	2,4	2,8	2,4	2,8
15W	4,5	0,5	0,3	3,6	4,0	3,0	3,4	2,8	3,2	2,4	2,8	2,4	2,8

Screw tightening torque [Nm]

Screw grade 12.9 Alloy Steel Screw	Steel	Cast Iron	Non Iron Metal
M2	0,6	0,4	0,3
M2,5/M2,6	1,2	0,8	0,6
M3	1,8	1,3	1,0
M4	4,0	2,5	2,0

THE MOUNTING SURFACE

The mounting surface should be ground or fine milled to reach a surface roughness of Ra 1,6 µm.

ISO 3506-1 A2-70 Stainless Screw	Cast Iron
M1,6	0,15
M2	0,3
M2,5/M2,6	0,6
M3	1,1
M4	2,5

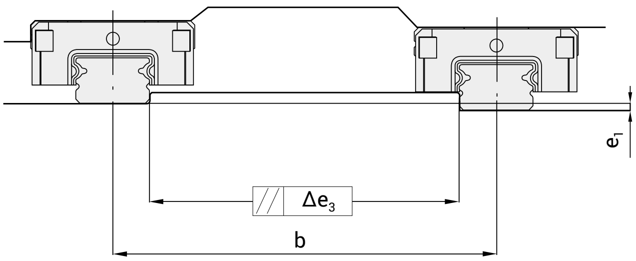
GEOMETRIC AND POSITIONAL ACCURACY OF THE MOUNTING SURFACE

Inaccurate mounting surfaces will affect the operational accuracy of the linear guide when the mounting surface height differential is greater than the values calculated by formulas (15), (16) and (17). The rating lifetime will also be shortened.

e_1 [mm] = b [mm] x f_1 x 10^{-4} ——— (15)

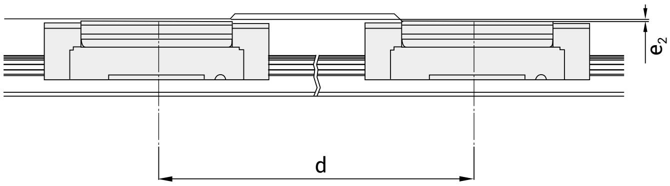
e_2 [mm] = d [mm] x f_2 x 10^{-5} ——— (16)

e_3 [mm] = f_3 x 10^{-3} ——— (17)



REFERENCE EDGE

Rail: Both sides of the track rail can serve as the reference edge without any special marking.
Block: Reference edge is opposite to the groove marking side.

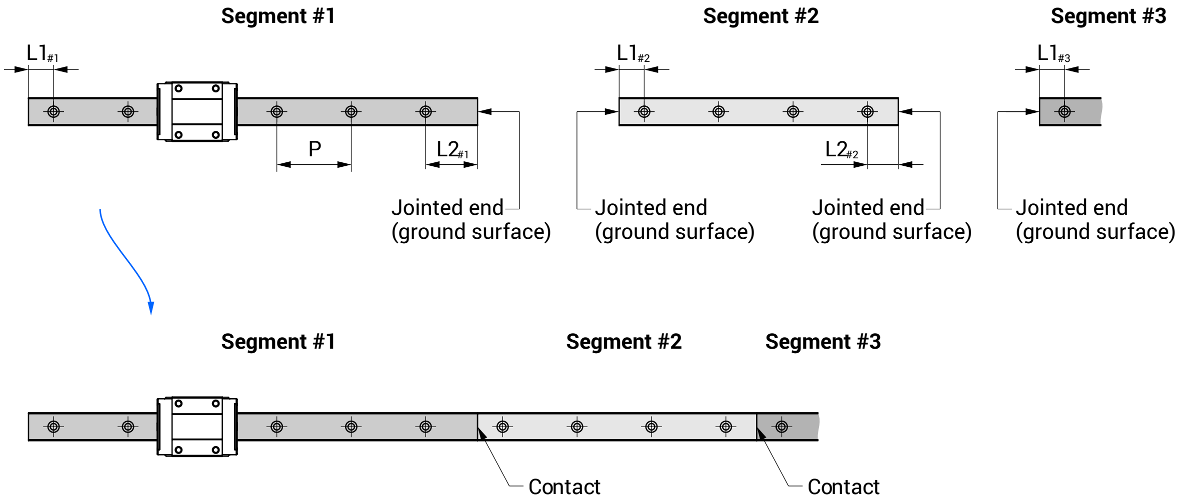


Dimension	VO/VS			V1		
	f_1	f_2	f_3	f_1	f_2	f_3
5MN	4	8	2	2	8	2
7MN	5	11	4	3	10	3
9MN	5	11	6	4	10	4
12MN	6	13	8	4	12	6
15MN	7	11	12	5	10	8
5ML	3	5	2	2	5	1
7ML	4	6	4	3	6	3
9ML	5	7	5	3	7	4
12ML	5	8	8	3	7	5
15ML	7	8	11	4	8	7

Dimension	VO/VS			V1		
	f_1	f_2	f_3	f_1	f_2	f_3
7WN	2	6	4	2	4	3
9WN	2	7	6	2	5	4
12WN	3	8	8	2	5	5
15WN	2	9	11	1	6	7
7WL	2	4	4	1	3	3
9WL	2	5	5	2	3	3
12WL	2	5	7	2	3	5
15WL	2	5	10	1	4	7

JOINTED RAIL

Rails can be assembled by several segments to achieve the desired length. Jointed rails must be assembled correctly, where the contact of ground ends of both jointed rail segments is ensured. In the case of ordering jointed rails each rail segment must be ordered separately, where the jointed segment's end must be clearly specified, please see the following figure and the ordering code.



P	Pitch	[mm]
L1	Starting hole pitch	[mm]
L2	End hole pitch	[mm]