

2. Technical Information

2.1 Precision

Accuracy

MR Miniature Linear Guide series have three accuracy grades (P,H,N) for your choice.

		Table of accuracy			
		Accuracy grades (µm)	Precision P	High H	Normal N
	Tolerance of dimension height H	H	± 10	± 20	± 40
	Variation of height for different runner Block on the same position of Rail	ΔH	7	15	25
	Tolerance of dimension width W	W ₂	± 15	± 25	± 40
	Variation of width for different runner Block on same position of Rail	ΔW ₂	10	20	30

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 V0, capable of reaching 40m/s²)

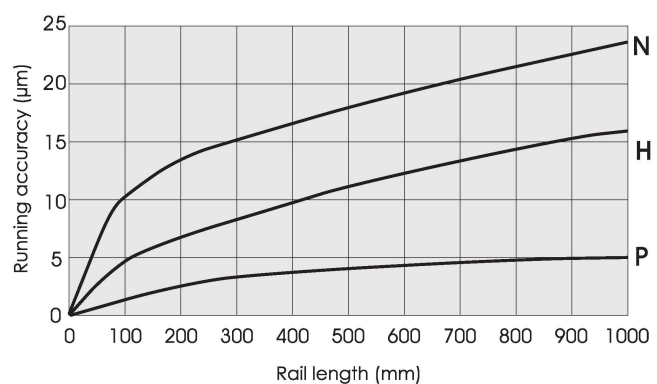
The maximum speed for the standard MR-EE/EZ,EU/UZ,SUE/ZUE type is:

V_{max} > 5 m/s

Maximum acceleration **A_{max} = 300 m/s²**

(If preload V0, capable of reaching 60m/s²)

Accuracy of the running parallelism



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2.2 Preload

Preload

The MR Miniature Linear Guide series have three degrees of preload: V0, VS and V1 (as described in the table of preload below.) Preload can enhance stiffness, precision, and torsion resistance, but will negatively affect life and friction.

Table of Preload

Preload type	Model code	Clearance (um)						Application
		3	5	7	9	12	15	
Clearance	V0	+3 - 0	+3 - 0	+4 - 0	+4 - 0	+5 - 0	+6 - 0	Very smooth
Standard	VS	+1 - 0	+1 - 0	+2 - 0	+2 - 0	+2 - 0	+3 - 0	Smooth and precision
Light preload	V1	0 -- 0.5	0 -- 1	0 -- 3	0 -- 4	0 -- 5	0 -- 6	High rigidity Minimize 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.

2.3 Lubrication

Function

The loaded rolling elements and the raceway will be separated at the contact zone by a thin layer of oil. The lubrication will therefore:

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

Lubrication Caution

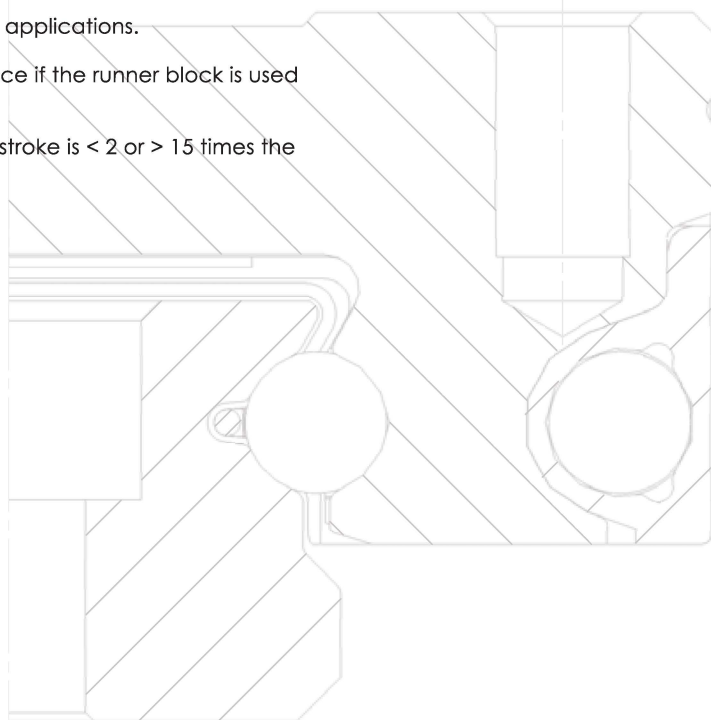
- ZZ/ZU/EZ/UZ/ZUE Lubrication Storage Series
 1. Block contains with lubricant which can directly install on the machine and no need to be washed.
 2. If washing the blocks, please do not soak the block in the lubricant before both the detergent of lubrication storage and Cleaning Naphtha are totally dry. The block is ready for installation only on the condition that the lubrication storage is full of the lubricant.
- The linear guide must be lubricated for protection before first time use. Pollution of any kind should be avoided.
- The runner block should be moved back and forth during lubrication.
- Generally, the lubricant is added onto the rail raceway.
- The lubricant can be injected into the lubrication holes on either end of the runner block.
- A thin layer of lubricant should be maintained on the surface of the rail raceway.
- Re-lubricate before contamination or discoloration of the lubricant occurs.
- Please notify when used in acidic, alkaline, or clean room applications.
- Contact our technical department for lubrication assistance if the runner block is used 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 used, we recommend synthetic oil-based lithium soap grease with a viscosity between ISO VG32-100.

Oil lubrication

We recommend the synthetic oils CLP or CGLP (based on DIN 51517) or HLP (based on DIN 51524) with a viscosity range between ISO VG32-100 for working temperatures between 0°C ~ $+70^{\circ}\text{C}$. (We recommend ISO VG10 for use in lower temperature environments.)



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2.3 Lubrication - continued

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.
- Re-lubrication shall be applied under operating temperature with the runner block moved back and forth.
- 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)
-	-	2 WL	0.03
3 MN	0.02	3 WN	0.03
3 ML	0.03	3 WL	0.04
5 MN	0.03	5 WN	0.04
5 ML	0.04	5 WL	0.05
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 speed, load, stroke length and operating environment affect the re-lubrication interval. A safe re-lubrication interval can only be obtained by practical observation. However, the re-lubrication interval shall not exceed one year.

Lubrication can be applied through the injection hole on both ends of the runner block by using a special injector offered by **cpc**.

Lubrication grease

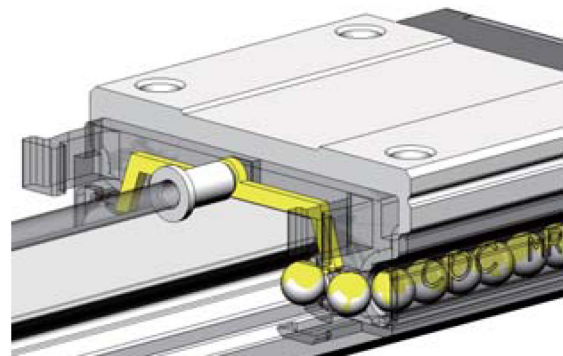
- 00 For general applications
- 01 For low-friction, low-noise applications
- 02 For clean room applications
- 03 For clean room and vacuum environment applications
- 04 For high-speed applications
- 05 For micro-oscillation applications

Lubrication oil

- 11 For general applications, ISO V32-68

Ordering of the lubrication injector

LUB — 01 — 18G	
Lubricant :	Needle model :
00	21G: 5M/5W
01	19G: 7M/7W
02	18G: 9M/9W
03	18G: 12M/12W
04	15G: 15M/15W
05	
11	



Lubricant amount: 10ml





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2.4 Friction

Friction

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

Sealing Design

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

		Friction		Friction of End Seal under lubrication	
		MR size	Friction of End Seal (Nmax) (under lubrication)		
			M	W	
$F_m = \mu \cdot F$	—(1)	2	0,08	0,2	
F	Load (N)	3	0,08	0,2	
F_m	Friction (N)	5	0,08	0,2	
		7	0,1	0,4	
		9	0,1	0,8	
		12	0,4	1,0	
		15	1,0	1,0	
MR Miniature Linear Guide series friction factor is $\mu = 0.002 \sim 0.003$ approximately					

Factors of friction

- 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 churning of the lubricant in the runner block.
- Contaminants.

2.5 Load capacity and rating life

Static load rating C_0

For the static load traveling along the acting direction, the maximum calculated stress at the rolling elements and the raceway, by a curvature radius ≤ 0.52 , is 4200 MP a and, by a curvature radius ≤ 0.6 , is 4600 MP a.

Note: Under such stress, a permanent total deformation is generated at this contact point corresponding to about 0.0001 times the rolling element diameter.
(The above is according to ISO 14728-2)

Static load safety factor calculation

$S_0 = C_0 / P_0$ — (11)	Operation condition	S_0
$S_0 = M_0 / M$ — (12)		
$P_0 = F_{max}$ — (13)	Load with vibration or impact	2 ~ 3
$M_0 = M_{max}$ — (14)		
	High accuracy and smooth running	≥ 3

Static load P_0 and moment M_0

Permissible static load and applied static load of the MR Miniature Linear Guide series is limited as follows:

- Static load of the linear guide.
- Permissible load of fixing screws.
- The permissible load of the related 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 moment, calculated by formulas (13) and (14).

Static load safety factor S_0

Under the static load safety factor, the linear guide system demonstrates reliable operation and running accuracy as required by the application. The static load safety factor S_0 is calculated by formulas (11) and (12).

- 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

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2.5 Load capacity and rating life - continued

Dynamic load rating C_{100B}

When the dynamic loads are applied normal to the load zones with constant magnitude and direction, theoretically, the rating life of a linear guide can reach 100km of travel distance. (The above is according to ISO 14728-1).

Rating life calculation

$$C_{50B} = 1.26 \cdot C_{100B} \quad \text{--- (2)}$$

$$C_{100B} = 0.79 \cdot C_{50B} \quad \text{--- (3)}$$

$$L = \left(\frac{C_{100B}}{P} \right)^3 \cdot 10^5 \quad \text{--- (4)}$$

$$L_h = \frac{L}{2 \cdot s \cdot n \cdot 60} = \frac{L}{v_m \cdot 60} \quad \text{--- (5)}$$

L = Rating life for travel distance 100,000 meter (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

An individual Linear Guide or a batch of identical Linear Guides under the same running conditions, using common materials with normal manufacturing quality and operating conditions can reach a 90% survival rate at the calculated life. (The above is according to ISO 14728-1) When the standard of 50km travel distance is used, the dynamic load rating will exceed the value based on the standard ISO 14728-1 by 20% or more. The relationship between two load ratings is based on formula (2).

Calculation of rating life

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

Equivalent dynamic load and speed

If the load and speed are not constant, each actual load and speed must be taken into account and both will influence life expectancy.

Equivalent dynamic load

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

Equivalent speed

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

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

$$P = 3 \sqrt{\frac{q_1 \cdot F_1^3 + q_2 \cdot F_2^3 + \dots + q_n \cdot F_n^3}{100}} \quad (6)$$

$$\bar{v} = \frac{q_1 \cdot v_1 + q_2 \cdot v_2 + \dots + q_n \cdot v_n}{100} \quad (7)$$

$$P = 3 \sqrt{\frac{q_1 \cdot v_1 \cdot F_1^3 + q_2 \cdot v_2 \cdot F_2^3 + \dots + q_n \cdot v_n \cdot F_n^3}{100 \cdot \bar{v}}} \quad (8)$$

$$P = |F_x| + |F_y| \quad (9)$$

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

P	=	Equivalent dynamic load	(N)
q	=	Percentage of stroke	(%)
F _i	=	Discrete load steps	(N)
\bar{v}	=	Average speed	(m/min)
v	=	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 angles, the acting force does not conform to horizontal and vertical direction. Its equivalent dynamic load is calculated as 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 as formula (10).

According to ISO 14728-1, the equivalent dynamic load under the condition of $P \leq 0.5C_0$, $P \leq C_0$ can calculate a reliable life value.

Under the condition that a single block bears moment

For a given structure, if the block needs to bear moments from Mp and My's direction, the maximum moment the block can withstand and still maintain smooth running feature, is about 0.3-0.1 times the static moment rating. The loading value increases with greater preload.

If you have any above design questions, please contact **cpc** technical department.