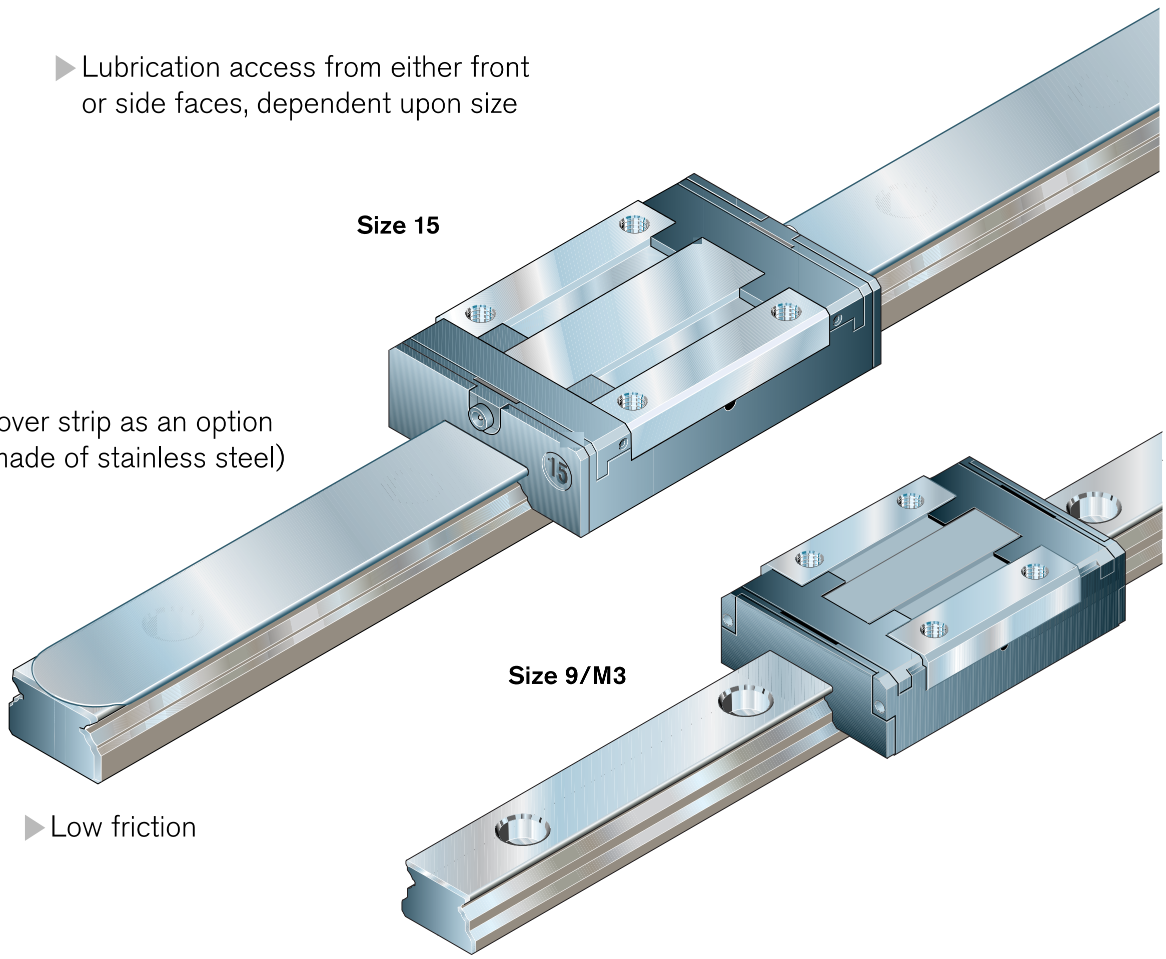
Product Overview

The Miniature version of the Ball Rail System has been developed specifically for the precision engineering sector, i.e. for the production of optical or electronic data processing devices, where rolling-element linear motion guideways of extremely compact dimensions and high load capacity are required.

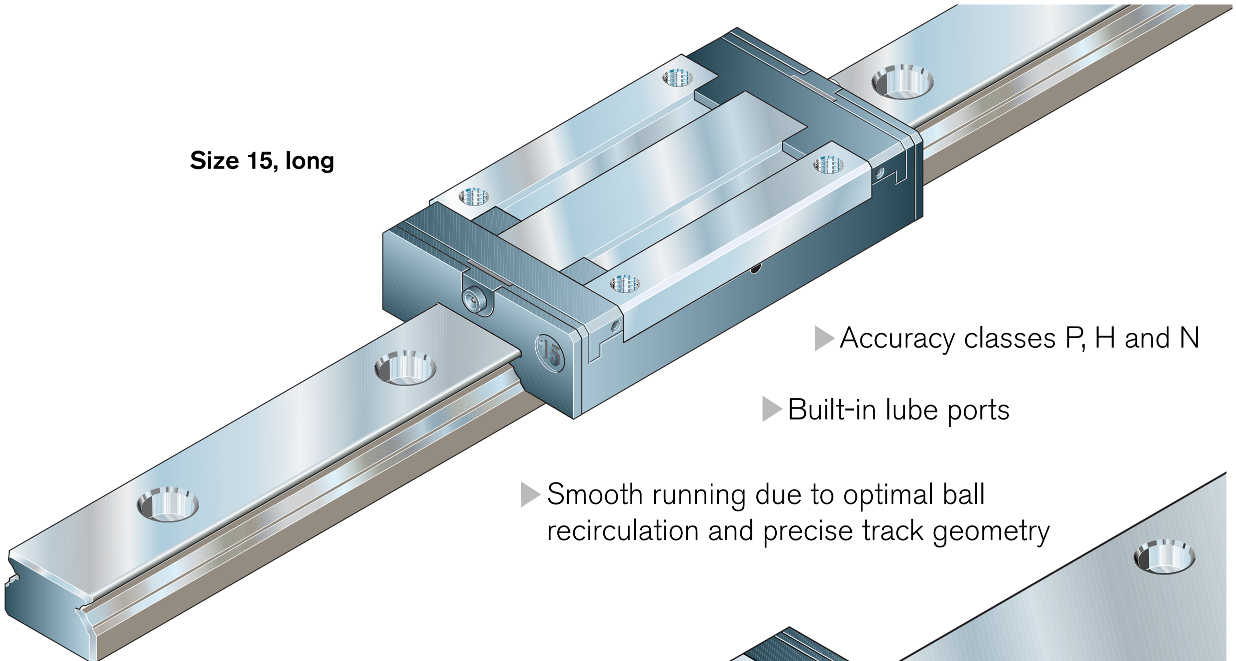
The linear motion guideways have equal load capacities in all four major directions of load application.

- High load capacity in all directions of load application, including moments about all axes, due to construction with the largest possible ball size
- Lubrication access from either front or side faces, dependent upon size



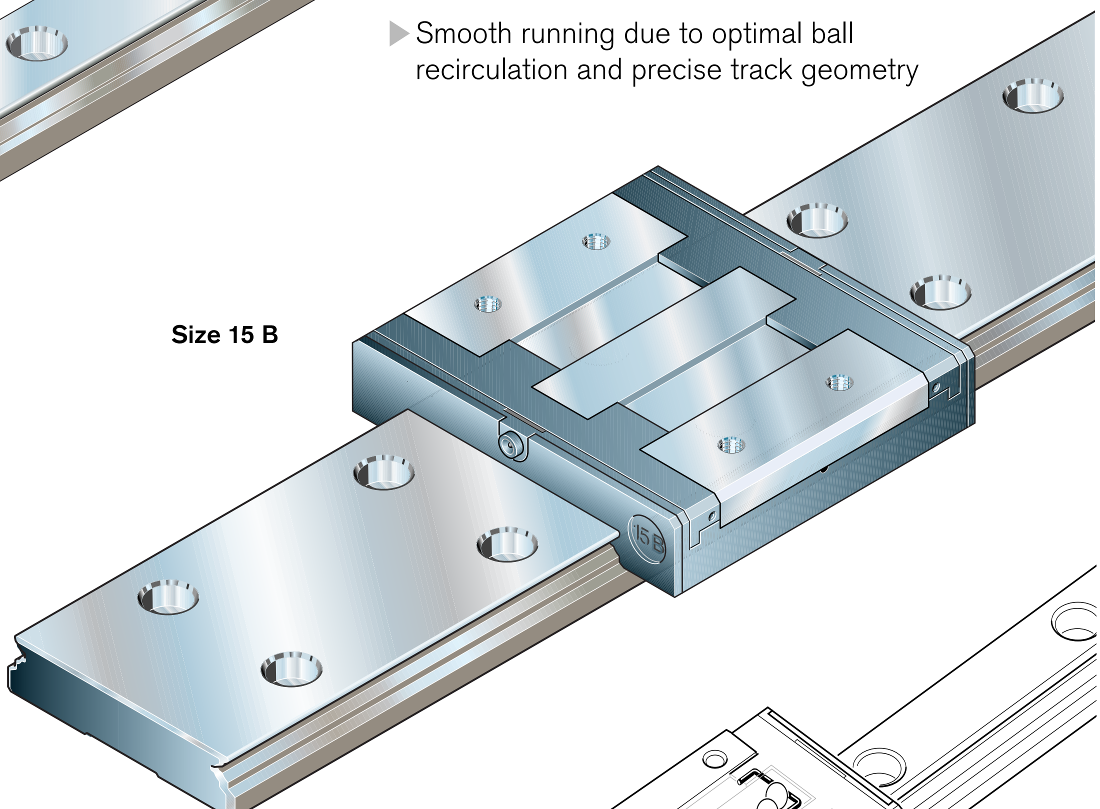
- Cover strip as an option (made of stainless steel)
- Low friction
- **All steel parts of the runner block and the guide rail are made of rust and acid resistant material similar to ISO 683-17 / EN 10088**

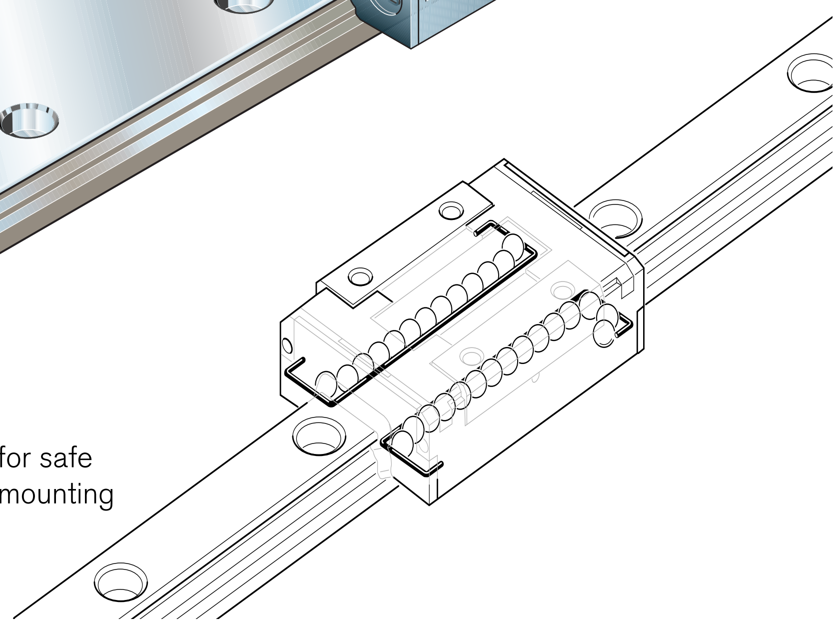
Size 15, long



- Accuracy classes P, H and N
- Built-in lube ports
- Smooth running due to optimal ball recirculation and precise track geometry

Size 15 B





- Built-in ball retention for safe shipping and ease of mounting

General Technical Data and Calculations

Definition of dynamic load capacity

The radial loading of constant magnitude and direction which a linear rolling bearing can theoretically endure for a nominal life of 10^5 meters distance traveled (to DIN 636 Part 2).

Definition of static load capacity

The static loading in the direction of load which corresponds to a calculated stress of 4200 MPa at the center of the most heavily loaded rolling-element/raceway (rail) contact with a ball conformity of ≤ 0.52, 4200 and 4600 MPa with a ball conformity of ≥ 0,6, 4600 MPa.

Note:
With this contact stress, a permanent total deformation of the rolling element and the raceway will occur at the contact point corresponding to approx. 0.0001 x the rolling element diameter (to DIN 636 Part 2).

Definition and calculation of the nominal life

The calculated service life which an individual linear rolling bearing, or a group of apparently identical rolling element bear-ings operating under the same conditions, can attain with a 90% probability, with contemporary, commonly used materials and manufacturing quality under conventional operating conditions (to DIN 636 Part 2).

Calculate the nominal life L or L_h according to formulas (1), (2) or (3):

Nominal life with constant speed

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

(2) $$L_h = \frac{L}{2 \cdot s \cdot n \cdot 60}$$

L = nominal life [m]
L_h = nominal life [h]
C = dynamic load capacity [N]
F = equivalent load [N]
s = length of stroke [m]
n = stroke repetition rate (complete cycles/min.) [min^{-1}]

Nominal life with variable speed

(3) $$L_h = \frac{L}{60 \cdot v_m}$$

(4) $$v_m = \frac{t_1 \cdot v_1 + t_2 \cdot v_2 + \ldots + t_n \cdot v_n}{100}$$

L = nominal life [m]
L_h = nominal life [h]
v_m = average speed [m/min]
$v_1, v_2 \ldots v_n$ = discrete speed steps [m/min]
$t_1, t_2 \ldots t_n$ = percentage of stroke covered at $v_1, v_2 \ldots v_n$ [%]

Equivalent dynamic load on bearing for calculation of service life

– with variable load on bearing

If the bearing is subject to variable loads, the equivalent dynamic load F must be calculated according to formula (5):

(5) $$F = \sqrt[3]{F_1^3 \cdot \frac{q_1}{100} + F_2^3 \cdot \frac{q_2}{100} + \ldots + F_n^3 \cdot \frac{q_n}{100}}$$

F = equivalent load [N]
$F_1, F_2 \ldots F_n$ = discrete load steps [N]
$q_1, q_2 \ldots q_n$ = percentage of stroke covered under $F_1, F_2 \ldots F_n$ [%]

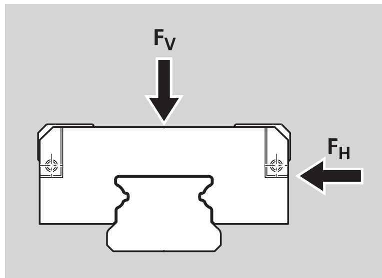
– **with combined load on bearing**

The equivalent dynamic load F resulting from combined vertical and horizontal loads is calculated according to formula (6):

$$F = |F_V| + |F_H| \qquad (6)$$

- F = equivalent dynamic load [N]
- F_V = external dynamic load, vertical [N]
- F_H = external dynamic load, horizontal [N]

Note:
The structure of the Ball Rail System permits this simplified calculation.



Note

If F_V and F_H involve several different load levels, they have to be calculated separately using formula (5).

An external load acting at an angle on the runner block is to be broken down into its F_V and F_H components and these values then used in formula (6).

– **with combined load in combination with a moment**

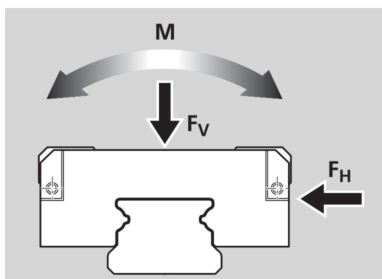
For a combined external load – vertical and horizontal – in conjunction with a moment, calculate the equivalent dynamic load F according to formula (7):

Formula (7) applies only when using a single rail.

$$F = |F_V| + |F_H| + C \cdot \frac{|M|}{M_t} \qquad (7)$$

- F = equivalent dynamic load [N]
- F_V, F_H = external dynamic loads [N]
- M = dynamic moment [Nm]
- C = dynamic load capacity * [N]
- M_t = permissible dyn. moment * [Nm]

* see tables



Note

If F_V and F_H involve several different load levels, they have to be calculated separately using formula (5).

An external load acting at an angle on the runner block is to be broken down into its F_V and F_H components. These values are then used in formula (7).

Equivalent static load on bearing

For a combined external static load – vertical and horizontal – in conjunction with a static moment, calculate the equivalent static load F_0 according to formula (8):

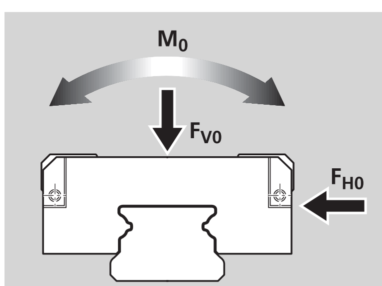
The equivalent static load F_0 must not exceed the static load capacity C_0.

Formula (8) applies only when using a single rail.

$$F_0 = |F_{V0}| + |F_{H0}| + C_0 \cdot \frac{|M_0|}{M_{t0}} \qquad (8)$$

- F_0 = equivalent static load [N]
- F_{V0}, F_{H0} = external static loads [N]
- M_0 = static moment [Nm]
- C_0 = static load capacity * [N]
- M_{t0} = permissible static moment * [Nm]

* see tables



Note

An external load acting at an angle on the runner block is to be broken down into its F_{V0} and F_{H0} components. These values are then used in formula (8).

Technical Data

Speed

$v_{max} = 3$ m/s

Speeds of up to 5 m/s are possible. Service life is limited by wear of plastic parts.

Acceleration

$a_{max} = 250$ m/s^2

Only with preloaded systems.

With non-preloaded systems:

$a_{max} = 50$ m/s^2

Temperature resistance

$T_{max} = 100$°C

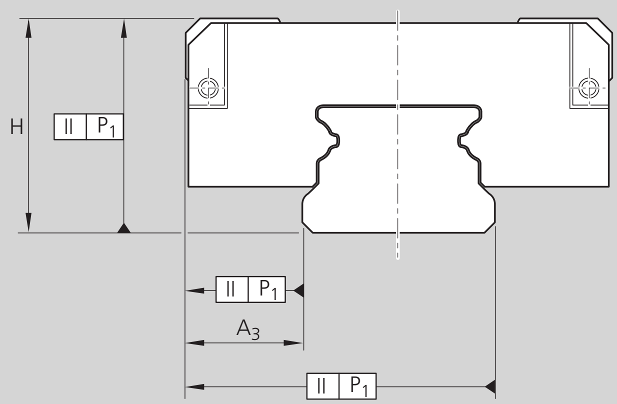
$T_{min} = -20$°C

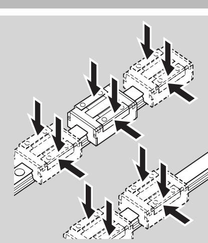
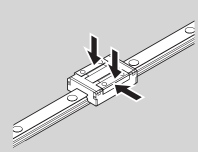
T_{max} only permissible for a short time

In continuous operation, do not exceed a temperature of 80°C.

Accuracy classes and their tolerances [µm]

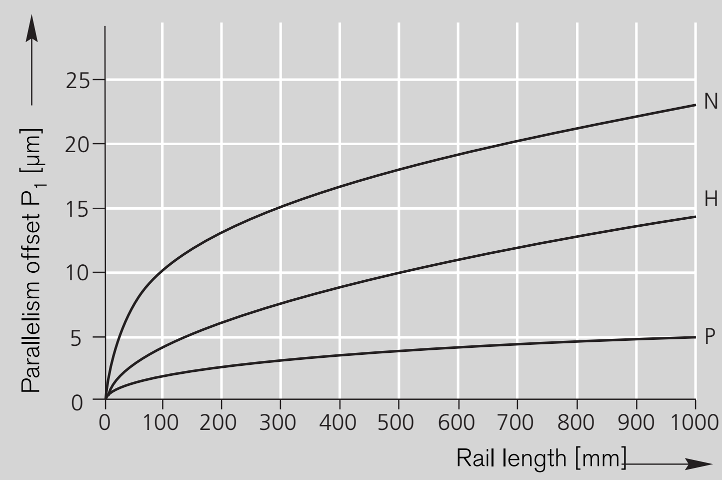
Miniature Ball Rail Systems are offered in three different accuracy classes.



Accuracy classes	Dimensional tolerance [µm] H	Dimensional tolerance [µm] A_3	Max difference in dimensions H and A_3 on the same rail Δ H, Δ A_3 [µm]
P	± 10	± 10	7
H	± 20	± 20	15
N	± 30	± 30	20
Measured at middle of runner block[1]:	 **For any block/rail combination at any position on rail**		 **For different runner blocks at same position on rail**

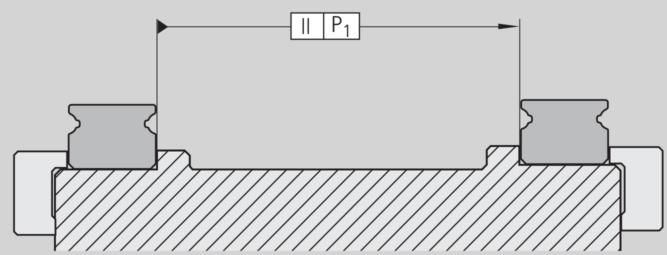
1) In dimensions H and ΔH, the middle of the runner block is calculated from the mean of the two measuring points shown.

Parallelism offset P_1 of the Ball Rail System in service



Parallelism of the installed rails

measured on the guide rails and on the runner blocks



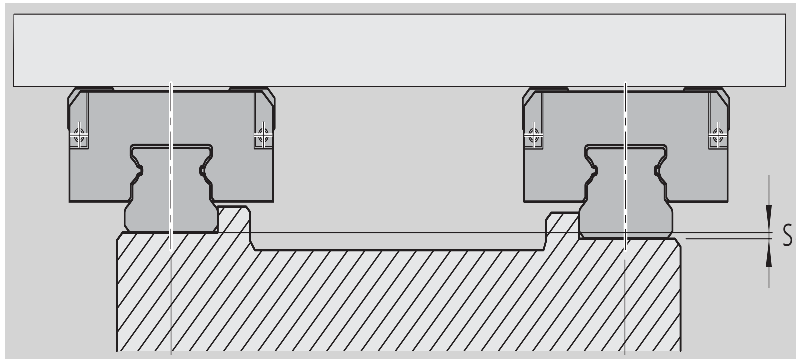
Size	Parallelism offset P_1 [mm]	
	Clearance	Preload
	Standard Guide Rails R0445	
7	0.004	0.002
9/M3	0.005	0.002
12	0.008	0.004
15	0.017	0.008
20	0.025	0.016
	Wide Guide Rails R0455	
9/M3 B	0.010	0.004
12 B	0.014	0.006
15 B	0.018	0.011

Technical Data

Vertical offset

Permissible vertical offset in transverse direction S_1

The permissible vertical offset S_1 includes the tolerance for dimension H (see accuracy classes).



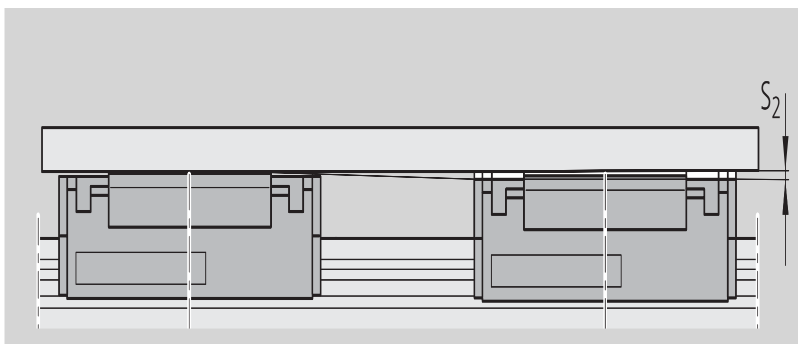
$$S_1 = a \cdot Y$$

S_1 = permissible vertical offset [mm]
a = distance between guide rails [mm]
Y = design factor

Design factor	Preload class	
	Clearance	Preload
Y	$3.0 \cdot 10^{-4}$	$1.5 \cdot 10^{-4}$

Permissible vertical offset in longitudinal direction S_2

The permissible vertical offset S_2 includes the tolerance “max difference of dimension H on the same rail” Δ H (see accuracy classes).



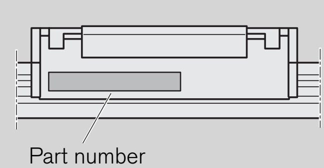
$$S_2 = b \cdot 7 \cdot 10^{-5}$$

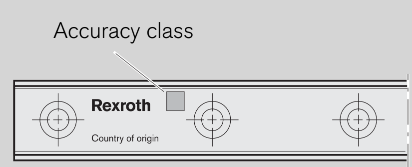
S_2 = permissible vertical offset [mm]
b = distance between runner blocks [mm]

Preloading and clearance

	Accuracy class			
	P	H		N
Preload class	1	1	9	9
Preload and clearance	~0 to moderate preload	~0 to moderate preload	~0 to moderate clearance	Moderate clearance to moderate preload

Markings on runner block and guide rail

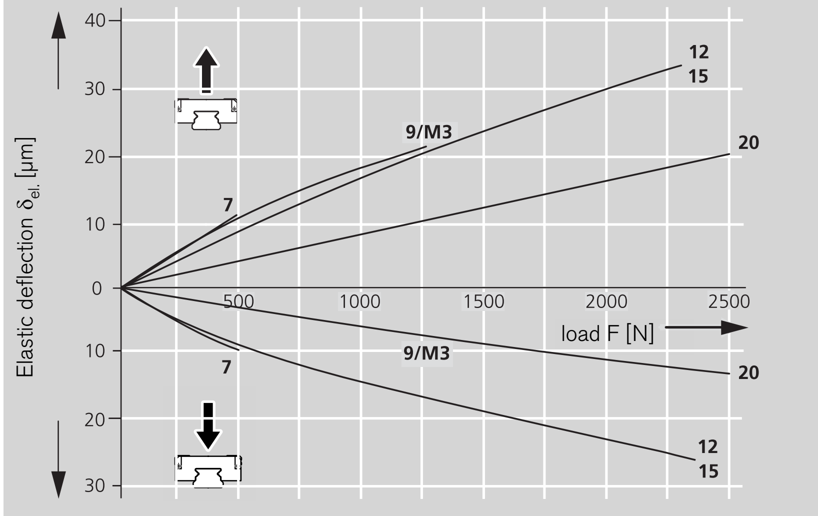




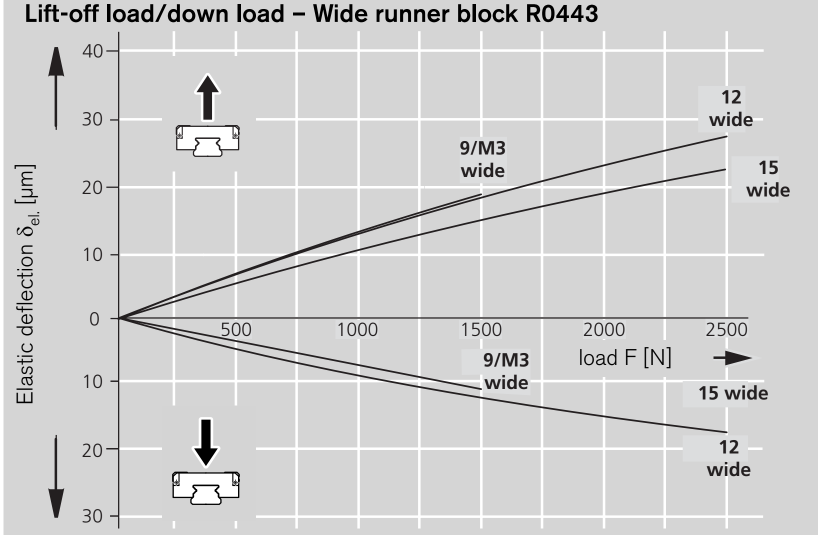
Rigidity of the Miniature Ball Rail System when preloaded

Runner block mounted with 4 screws, screw strength class 12.9

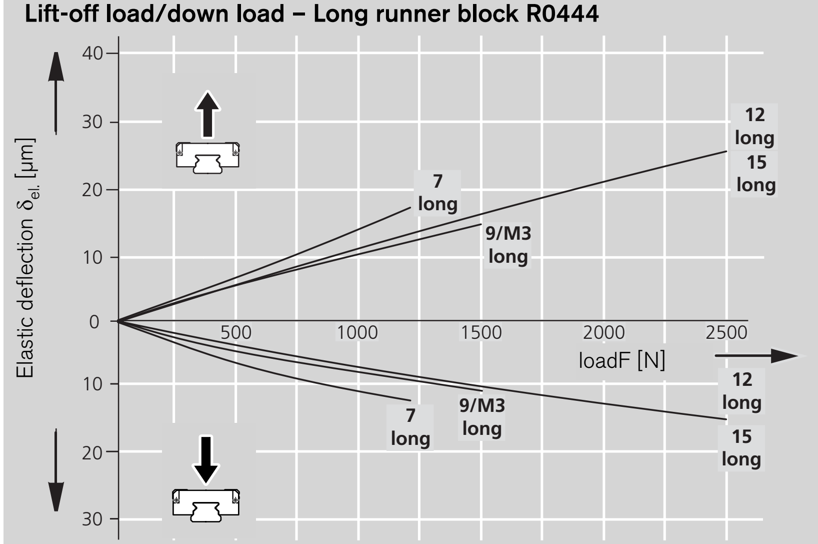
Lift-off load / down load – Standard runner block R0442



Lift-off load/down load – Wide runner block R0443



Lift-off load/down load – Long runner block R0444



Technical Data

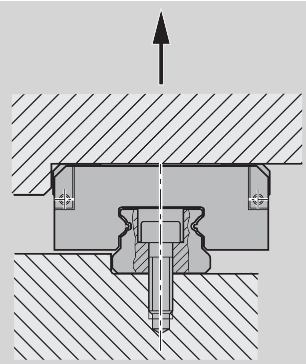
General Notes

The screw connections specified in the DIN 645-1 standard can be overstressed due to the high performance capability of profiled rail systems. The most critical point is the screw connection between the guide rail and the mounting base. If the lift-off loads (F) or moments (M_t) are higher than the respective load values given in the table, the screw connections have to be recalculated separately.

The data applies for the following conditions:

- Mounting screw quality 12.9
- Screws tightened using a torque wrench
- Screws lightly oiled (for screws in quality 8.8, an approximation factor of 0.6 can be applied)

Miniature Ball Rail Systems					
Guide Rails	Runner block R0442			Runner block R0444	
	Size	F_{max} [N]	M_{tmax} [Nm]	F_{max} [N]	M_{tmax} [Nm]
R0445	7	1000	3.2	1150	3.7
	12	–	–	4300	23.7
	15	3740	26.0	4280	30.0
	No restriction for sizes				
R0445	R0442: 9/M3, 12 and 20				
	R0444: 9/M3				
R0455	R0443: 9/M3 wide, 12 wide and 15 wide				



Friction and seals

The total frictional drag of the runner block is the sum of the frictional drag of the runner block and the frictional drag of the seals (see tables on right).

The runner blocks are equipped with low-friction seals as standard.
Part number: R044. ... 01
(see "Part numbers for runner blocks" tables)

Special versions:
Runner blocks are also available with N seals (excellent wiping action)
Part number: R044. ... 00
(otherwise as in "Part numbers for runner blocks" tables)

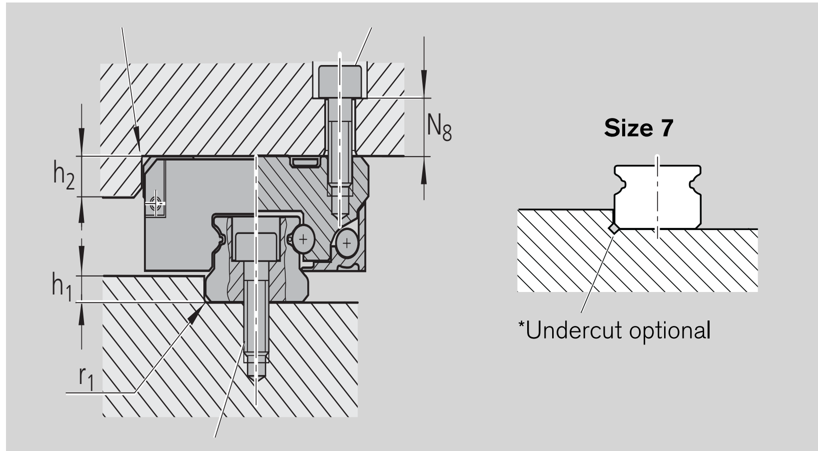
Sizes 15, 20, 9/M3 B, 12 B, 15 B and long runner blocks size 9/M3, 12 and 15 have additional longitudinal seals for full sealing.

Size	Frictional drag of runner blocks (without seals)		Frictional drag of seals	
	with clearance [N]	with preload [N]	Low-friction seal (-01) [N]	N-Seal (-00) [N]
Standard Runner blocks R0442				
7	< 0.1	< 0.1	~0	0.1
9/M3	< 0.1	< 0.1	~0	0.5
12	< 0.1	< 0.2	~0	0.9
15	< 0.2	< 0.4	~0	1.2[1]
20	< 0.2	< 0.5	~0	1.5[1]
Wide Runner blocks R0443				
9/M3 B	< 0.2	< 0.3	~0	1.5[1]
12 B	< 0.2	< 0.3	~0	1.5[1]
15 B	< 0.2	< 0.4	~0	1.5[1]
Long Runner blocks R0444				
7	< 0.1	< 0.3	~0	0.2
9/M3	< 0.2	< 0.4	~0	0.6[1]
12	< 0.2	< 0.4	~0	0.9[1]
15	< 0.2	< 0.5	~0	1.0[1]

[1] with longitudinal seal

Mounting Instructions

Reference edges, corner radii, screw sizes and tightening torques



Size	h_1 [mm]	r_1 max. [mm]	h_2 [mm]	r_2 max. [mm]	O_5 ISO 4762[1)] 4 pcs	O_3 ISO 4762[1)] (rail)	N_8 [mm]
Standard runner block R0442-							
7	$1.2_{-0.1}$	0.1*	2.2	0.3	M2x5	M2x5	3.0
9/M3	$1.5_{-0.2}$	0.3	2.5	0.3	M3x8	M3x8	5.0
12	$2.5_{-0.5}$	0.3	3.5	0.5	M3x8	M3x8	5.0
15	$2.8_{-0.5}$	0.5	4.5	0.5	M3x8	M3x10	4.5
20	$6.3_{-0.5}$	0.5	6.5	0.5	M4x12	M5x14	6.5
Wide runner block R0443-							
9/M3 B	$1.8_{-0.2}$	0.3	2.5	0.3	M3x8	M3x8	5.5
12 B	$2.8_{-0.5}$	0.5	3.0	0.4	M3x8	M4x10	4.5
15 B	$2.8_{-0.5}$	0.5	4.5	0.5	M4x10	M4x12	6.0
Long runner block R0444-							
7	$1.2_{-0.1}$	0.1*	2.2	0.3	M2x5	M2x5	3.0
9/M3	$1_{-0.1}$	0.3	2.5	0.3	M3x8	M3x8	5.0
12	$2_{-0.2}$	0.3	3.5	0.5	M3x8	M3x8	5.0
15	$2.8_{-0.5}$	0.5	4.5	0.5	M3x8	M3x10	4.5

1) formerly DIN 912

Tightening torques of the mounting screws

Nm		M2	M3	M4	M5
Nm	**A2-70**	0.35	1.1	2.0	3.9
Nm	**12.9**	0.50	2.1	4.6	9.5

Note on assembly

The runner block is supplied on a plastic mandrel.

- Position the runner block with the mandrel at the head of the rail and push on; the mandrel will thus be pushed out of the runner block.
- When removing the runner block, carry out the above operations in reverse sequence.