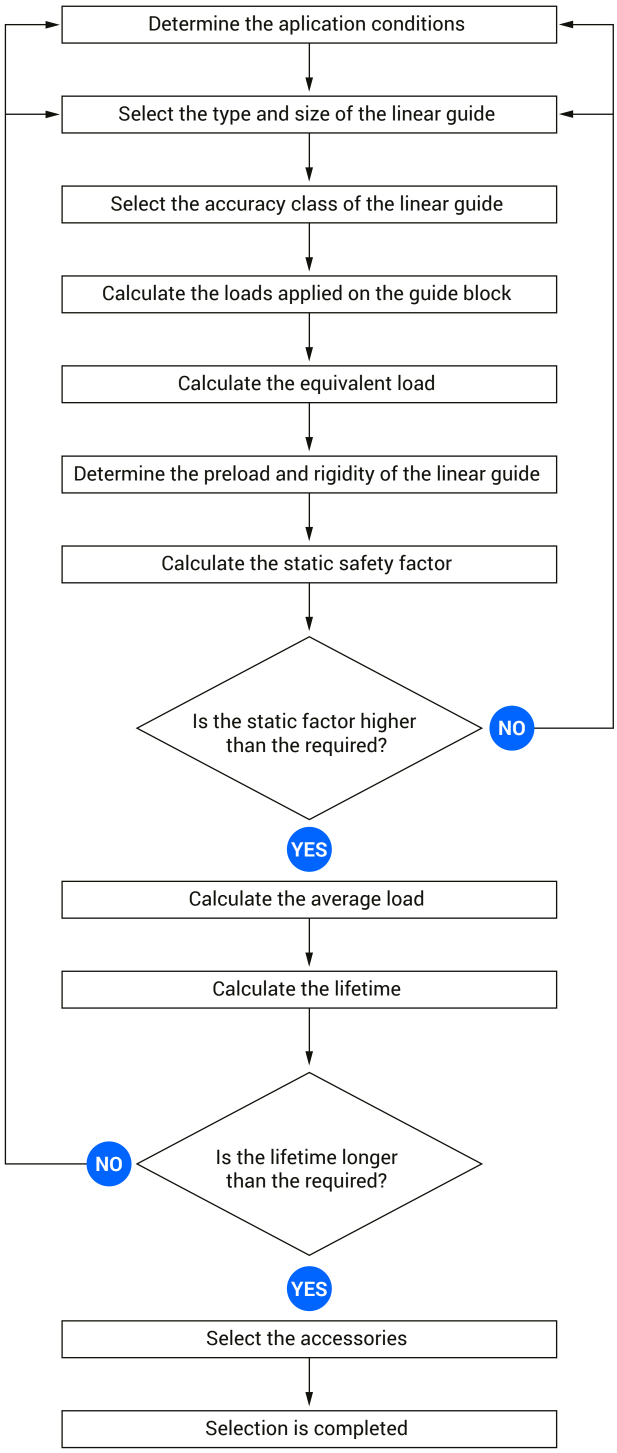
# General information

# HOW TO SELECT A LINEAR GUIDE



# GENERAL TECHNICAL INFORMATION

## Operating conditions

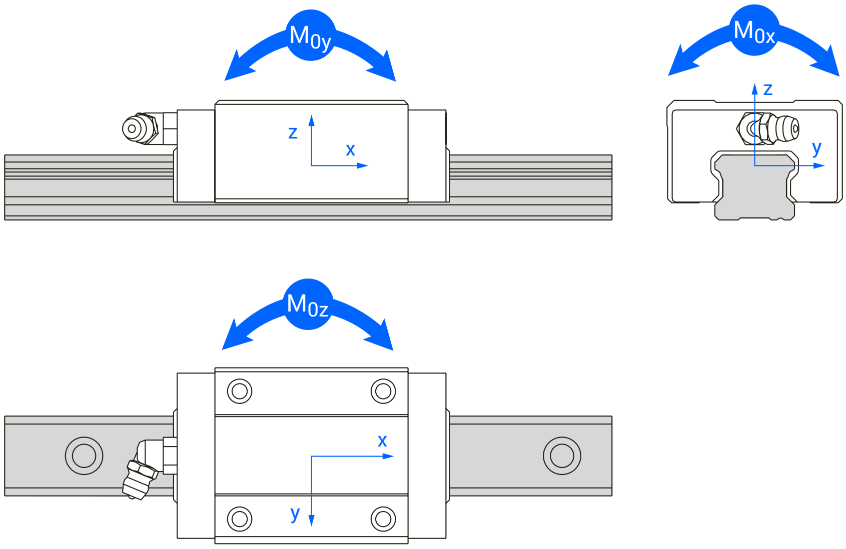
| | |
|---|---|
| Maximum travel speed | 5 m/s |
| Maximum acceleration | 500 m/s² |
| Environmental temperature | 0 °C – 80 °C |

## Basic 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 linear guide will no longer operate smoothly. The basic 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. The values of $C_0$ can be found in the table for the particular linear guide.

## Permissible static moment $M_0$

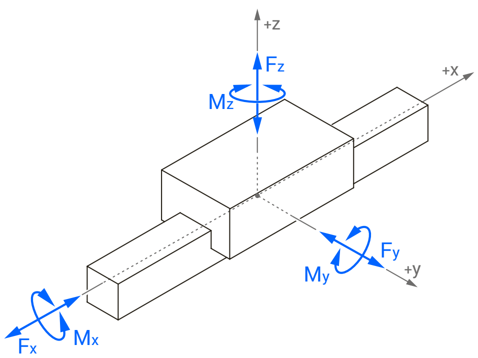
Permissible static moment is a moment which causes a load equivalent to the basic static load rating $C_0$. The permissible static moment is defined about the x, y, and z axis individually, i.e. $M_{0x}$, $M_{0y}$ and $M_{0z}$, respectively (see figure below).




## Equivalent static load $P_0$

Equivalent static load $P_0$ is defined as a single comparison static load, where the combination of all individually loads applied on the linear guide (in a certain load case) is taken into consideration.

$$P_0 = |F_y| + |F_z| + C_0 \cdot \frac{|M_x|}{M_{0x}} + C_0 \cdot \frac{|M_y|}{M_{0y}} + C_0 \cdot \frac{|M_z|}{M_{0z}}$$




| | | |
|---|---|---|
| $P_0$ | Equivalent static load | [N] |
| $C_0$ | Basic static load rating | [N] |
| $M_{0x}$ | Permissible static moment about the x axis | [Nm] |
| $M_{0y}$ | Permissible static moment about the y axis | [Nm] |
| $M_{0z}$ | Permissible static moment about the z axis | [Nm] |
| $F_y$ | Force applied on the guide block in the y direction | [N] |
| $F_z$ | Force applied on the guide block in the z direction | [N] |
| $M_x$ | Moment applied on the guide block about the x axis | [Nm] |
| $M_y$ | Moment applied on the guide block about the y axis | [Nm] |
| $M_z$ | Moment applied on the guide block about the z axis | [Nm] |

## Static safety factor $f_s$

The static safety factor $f_s$ is defined as the ratio between the basic static load rating $C_0$ (of the linear guide) and the equivalent static load applied on the linear guide $P_0$. The static safety factor $f_s$ should never be lower than 1,0 and it is very important when the linear guide is subjected to the impact loads and vibrations. Recommended static safety factor are presented in the following table.

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

| | | |
|---|---|---|
| $f_s$ | Static safety factor | |
| $C_0$ | Basic static load rating | [N] |
| $P_0$ | Equivalent static load | [N] |

**Recommended static safety factor**

| Operating condition | Loading condition | Min. $f_s$ |
|---|---|---|
| Stationary | Light impact and vibrations | 1,0 ~ 1,3 |
| | Heavy impact and vibrations | 2,0 ~ 3,0 |
| Movement | Light impact and vibrations | 1,0 ~ 1,5 |
| | Heavy impact and vibrations | 2,5 ~ 5,0 |

## Nominal life L

Suppose a number of linear guides of the same type operated individually under the same conditions. After a certain period of time 90 % of them will not fail as a result of signs of fatigue on the contact surfaces, known as flaking. The total travel distance at this point is defined as the nominal life L.

## Basic dynamic load rating C

The basic dynamic load rating C is defined as the load of constant direction and magnitude at which a linear guide achieves a nominal life of 50 km.

## Permissible dynamic moment $M_{dyn}$

Permissible dynamic moment is a moment which causes a load equivalent to the basic dynamic load rating C. The permissible dynamic moment is defined about the x, y, and z axis individually, i.e. $M_{dyn\,x}$, $M_{dyn\,y}$ and $M_{dyn\,z}$, respectively.

## Equivalent dynamic load P

Equivalent dynamic load P is defined as a single comparison dynamic load, where the combination of all individually loads applied on the linear guide (in a certain load case) is taken into consideration.

$$P = |F_y| + |F_z| + C \cdot \frac{|M_x|}{M_{dyn\,x}} + C \cdot \frac{|M_y|}{M_{dyn\,y}} + C \cdot \frac{|M_z|}{M_{dyn\,z}}$$

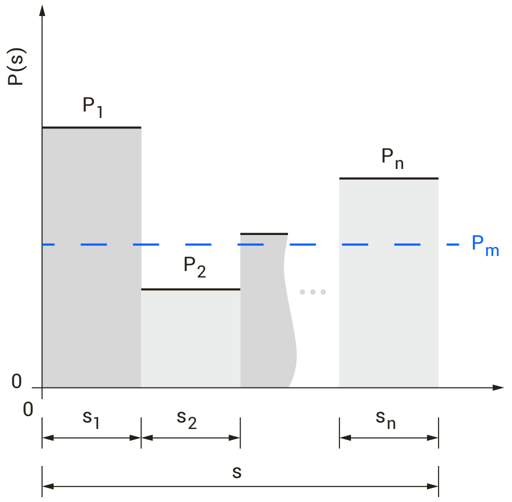
| | | |
|---|---|---|
| P | Equivalent dynamic load | [N] |
| C | Basic dynamic load rating | [N] |
| $M_{dyn\,x}$ | Permissible dynamic moment about the x axis | [Nm] |
| $M_{dyn\,y}$ | Permissible dynamic moment about the y axis | [Nm] |
| $M_{dyn\,z}$ | Permissible dynamic moment about the z axis | [Nm] |

## Average load $P_m$

When the equivalent dynamic load P applied on a linear guide fluctuates, an average load $P_m$ which will yield the same lifetime of a linear guide as the fluctuating load should be calculated. In the following, three common types of the load fluctuation are presented.

**Incremental type**

When the equivalent dynamic load fluctuates incrementally, the average load $P_m$ may be calculated as follows (see figure below):

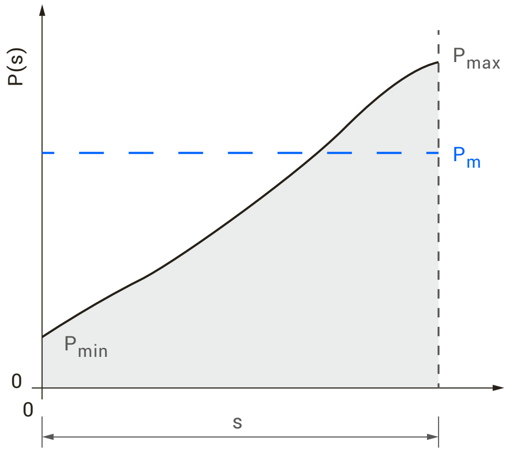



$$P_m = \sqrt[3]{\frac{1}{s} \cdot \left(P_1^3 \cdot s_1 + P_2^3 \cdot s_2 + \cdots + P_n^3 \cdot s_n\right)}$$

| | | |
|---|---|---|
| $P_m$ | Average load | [N] |
| $P_i$ | i-th equivalent dynamic load of a given incremental loading regime P(s), i ∊ {1,2,...,n} | [N] |
| $s_i$ | i-th travel distance of a given incremental loading regime P(s), i ∊ {1,2,...,n} | [mm] |
| s | Total travel distance | [mm] |
| n | Number of increments | |

**Linear type**

When the equivalent dynamic load fluctuation is almost linear, the average load $P_m$ may be calculated as follows (see figure below):



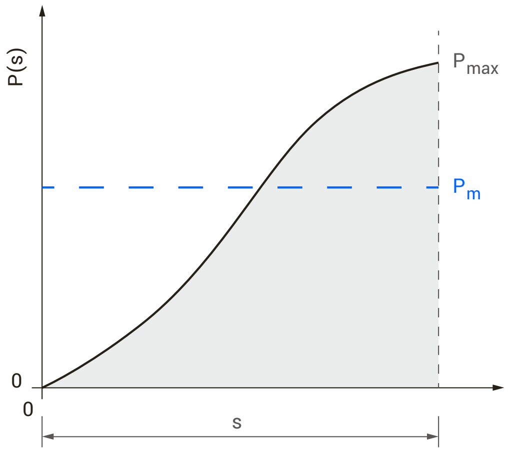

$$P_m = \frac{1}{3} \cdot (P_{min} + 2 \cdot P_{max})$$

| | | |
|---|---|---|
| $P_{min}$ | Minimum value of fluctuating equivalent dynamic load | [N] |
| $P_{max}$ | Maximum value of fluctuating equivalent dynamic load | [N] |

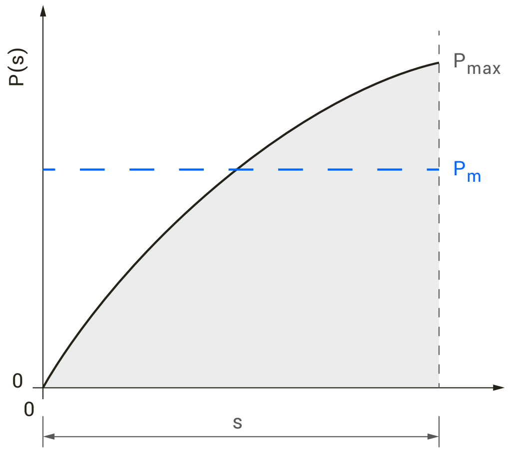
**Sinusoidal type**

When the equivalent dynamic load fluctuates similar to the sinusoidal wave as it is presented in the figures below, the average load $P_m$ may be calculated as follows:

$$P_m = 0{,}65 \cdot P_{max}$$




$$P_m = 0{,}75 \cdot P_{max}$$



# LIFETIME CALCULATIONS

## Nominal life L

Nominal life L of the linear guides can be calculated by the following equations, where the basic dynamic load rating C and average load $P_m$ applied on a linear guide are taken into consideration:

$$L = \left(\frac{C}{P_m}\right)^3 \cdot 50 \cdot 10^3$$

| | | |
|---|---|---|
| L | Nominal life | [m] |

If the lifetime factors, i.e. hardness factor, temperature factor and load factor, are taken into consideration, the nominal life L can be calculated as follows:

$$L = \left(\frac{f_h \cdot f_t \cdot C}{f_w \cdot P_m}\right)^3 \cdot 50 \cdot 10^3$$

| | |
|---|---|
| $f_h$ | Hardness factor |
| $f_t$ | Temperature factor |
| $f_w$ | Load factor |

## Lifetime $L_h$

If total travel distance s of one cycle (in some cases s = 2 · stroke) and number of cycles per minute (cycle frequency) are known, the lifetime $L_h$ can be calculated based on the nominal life.

$$L_h = \frac{L \cdot 10^3}{s \cdot n_m \cdot 60}$$

| | | |
|---|---|---|
| $L_h$ | Lifetime | [h] |
| $n_m$ | Number of cycles per minute | [cyc/min] |
| s | Total travel distance of one cycle | [mm] |

Lifetime can also be calculated using the average travel speed $v_m$:

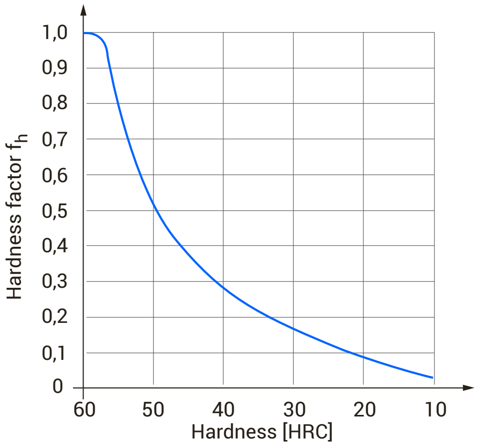
$$v_m = \frac{|v_1| \cdot t_1 + |v_2| \cdot t_2 + \dots + |v_n| \cdot t_n}{t_1 + t_2 + \dots + t_n}$$

$$L_h = \frac{L}{v_m \cdot 3600}$$

| | | |
|---|---|---|
| $v_m$ | Average travel speed | [m/s] |
| $v_i$ | i-th travel speed of a given incremental regime v(t), $i \in \{1,2,\dots,n\}$ | [m/s] |
| $t_i$ | i-th time of a given incremental regime v(t), $i \in \{1,2,\dots,n\}$ | [s] |

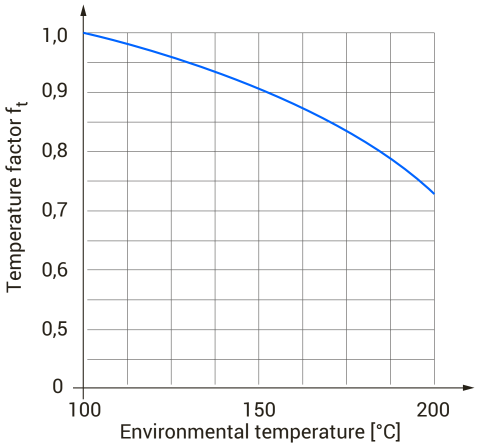
## Hardness factor $f_h$

The hardness of the track surfaces and the steel balls of linear guides is 58 HRC. In this case the hardness factor is 1,0. For the applications where some other material with hardness below 58 HRC is required, the hardness factor $f_h$ according to the following diagram should be used. In this case the basic dynamic and static load rating are reduced. Therefore, C and $C_0$ must be multiplied by the hardness factor $f_h$.




## Temperature factor $f_t$

If the environmental temperature of the linear guide exceeds 100 °C during the operation the temperature factor needs to be considered. In this case the basic dynamic and static load rating are reduced. Therefore, C and $C_0$ must be multiplied by the temperature factor $f_t$. See the diagram below.




If the environmental temperature exceeds 80 °C, high-temperature material for the seals and the end plates must be used.

## Load factor $f_w$

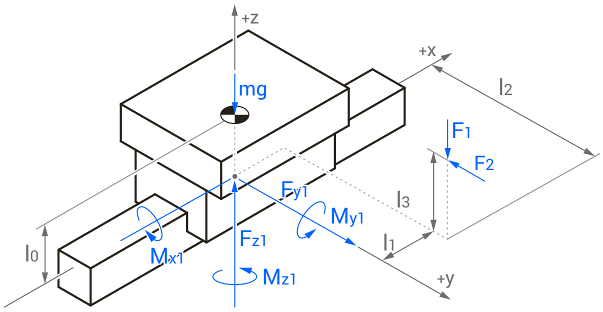
Lifetime of the linear guide can be reduced significantly if the impacts and vibrations as a result of high speed of a linear guide occur during the operation. The average load $P_m$ must be multiplied by the load factor $f_w$. Since the effects of impacts and vibrations are difficult to determine, the empirical values of the load factor (according to the table presented below) should be taken into consideration.

| Impact | Vibrations G | Travel speed v | $f_w$ |
|---|---|---|---|
| Weak | G ≤ 0,5 | Low<br>v ≤ 0,15 m/s | 1,0 ~ 1,5 |
| Medium | 0,5 < G ≤ 1,0 | Medium<br>0,25 m/s < v ≤ 1 m/s | 1,5 ~ 2,0 |
| Strong | 1,0 < G ≤ 2,0 | High<br>v > 1 m/s | 2,0 ~ 3,5 |

# LOADS APPLIED ON THE GUIDE BLOCK CALCULATION

In the following the calculations of the loads applied on the guide blocks are presented for some typical examples of the applications. The mass (inertia) of the plate, eccentric external forces and mounting style (number of guide blocks and rails, orientation position) are taken into consideration.

## Example #1




**Application conditions:**

- Horizontal mounting position
- One rail with one block
- Mass of the table
- Two eccentric loads

**Loads applied on the guide block:**

$$F_{y1} = -F_2$$

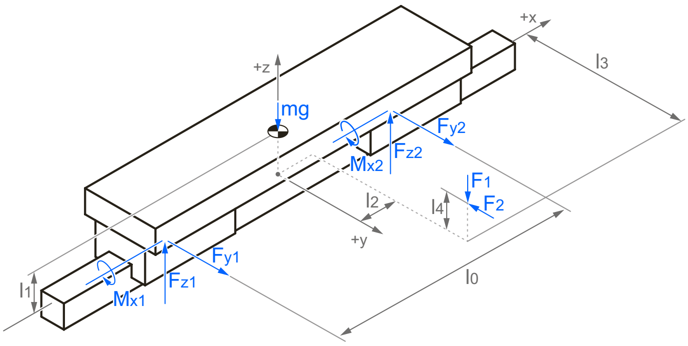
$$F_{z1} = -m \cdot g - F_1$$

$$M_{x1} = (F_1 \cdot l_2 - F_2 \cdot l_3) \cdot 10^{-3}$$

$$M_{y1} = -F_1 \cdot l_1 \cdot 10^{-3}$$

$$M_{z1} = F_2 \cdot l_1 \cdot 10^{-3}$$

## Example #2




**Application conditions:**

- Horizontal mounting position
- One rail with two blocks
- Mass of the table
- Two eccentric loads

**Loads applied on the guide block:**

$$F_{y1} = -\frac{F_2}{2} + \frac{F_2 \cdot l_2}{l_0}$$

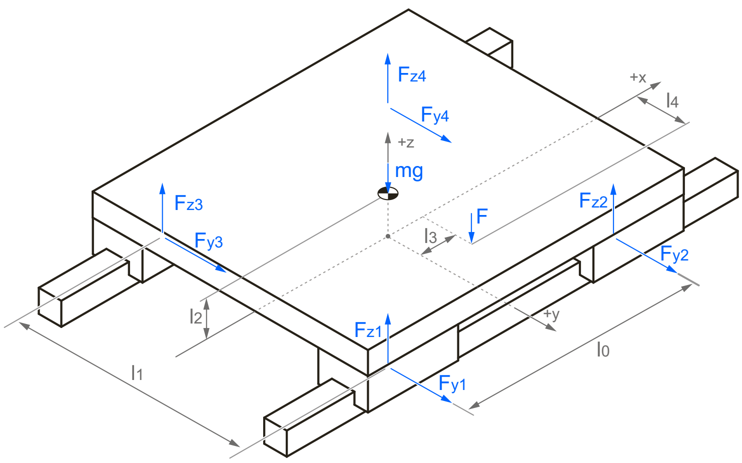
$$F_{y2} = -\frac{F_2}{2} - \frac{F_2 \cdot l_2}{l_0}$$

$$F_{z1} = -\frac{m \cdot g}{2} - \frac{F_1}{2} + \frac{F_1 \cdot l_2}{l_0}$$

$$F_{z2} = -\frac{m \cdot g}{2} - \frac{F_1}{2} - \frac{F_1 \cdot l_2}{l_0}$$

$$M_{x1} = M_{x2} = \left(\frac{F_1 \cdot l_3}{2} - \frac{F_2 \cdot l_4}{2}\right) \cdot 10^{-3}$$

## Example #3




**Application conditions:**

- Horizontal mounting position
- Two rails arranged in parallel with two blocks per rail
- Mass of the table
- One excentric load

**Loads applied on the guide block:**

$$F_{y1} = F_{y2} = F_{y3} = F_{y4} = 0$$

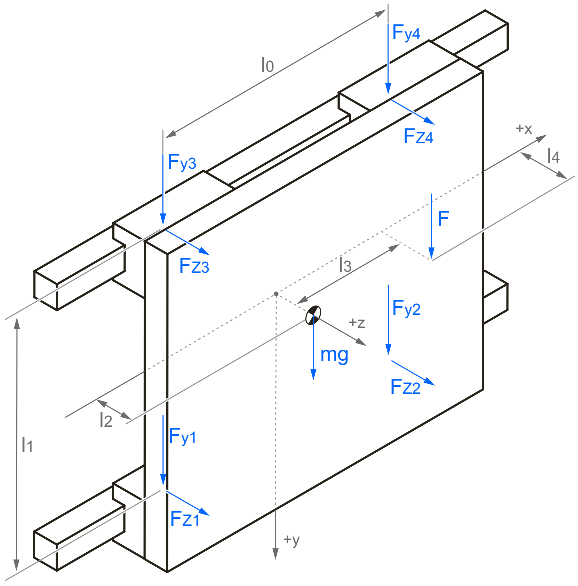
$$F_{z1} = -\frac{m \cdot g}{4} - \frac{F}{4} + \frac{F \cdot l_3}{2 \cdot l_0} - \frac{F \cdot l_4}{2 \cdot l_1}$$

$$F_{z2} = -\frac{m \cdot g}{4} - \frac{F}{4} - \frac{F \cdot l_3}{2 \cdot l_0} - \frac{F \cdot l_4}{2 \cdot l_1}$$

$$F_{z3} = -\frac{m \cdot g}{4} - \frac{F}{4} + \frac{F \cdot l_3}{2 \cdot l_0} + \frac{F \cdot l_4}{2 \cdot l_1}$$

$$F_{z4} = -\frac{m \cdot g}{4} - \frac{F}{4} - \frac{F \cdot l_3}{2 \cdot l_0} + \frac{F \cdot l_4}{2 \cdot l_1}$$

## Example #4




**Application conditions:**

- Vertical mounting position
- Two rails arranged in parallel with two blocks per rail
- Mass of the table
- One excentric load

**Loads applied on the guide block:**

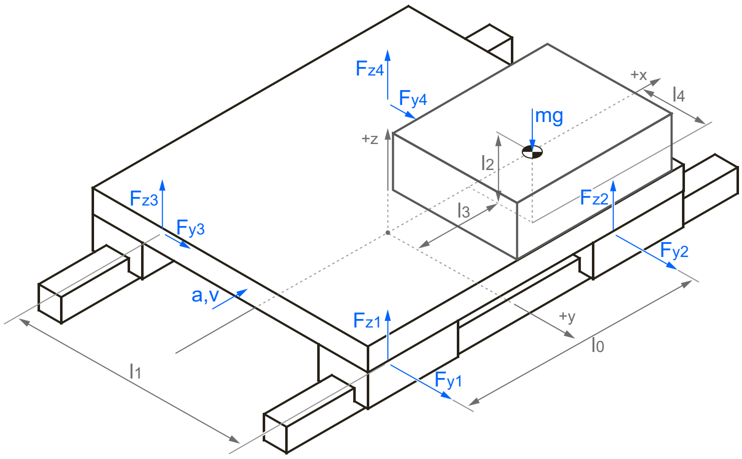
$$F_{y1} = F_{y3} = \frac{m \cdot g}{4} + \frac{F}{4} - \frac{F \cdot l_3}{2 \cdot l_0}$$

$$F_{y2} = F_{y4} = \frac{m \cdot g}{4} + \frac{F}{4} + \frac{F \cdot l_3}{2 \cdot l_0}$$

$$F_{z1} = F_{z2} = -\frac{m \cdot g \cdot l_2}{2 \cdot l_1} - \frac{F \cdot l_4}{2 \cdot l_1}$$

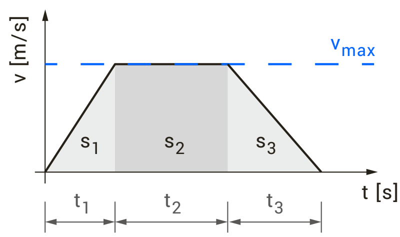
$$F_{z3} = F_{z4} = \frac{m \cdot g \cdot l_2}{2 \cdot l_1} + \frac{F \cdot l_4}{2 \cdot l_1}$$

## Example #5




**Application conditions:**

- Horizontal mounting position
- Two rails arranged in parallel with two blocks per rail
- Mass of the table
- Travel speed as a function of time v(t):




**Loads applied on the guide block:**

- During the acceleration ($a_1 = v_{max}/t_1$):

$$F_{y1} = F_{y3} = -\frac{m \cdot a_1 \cdot l_4}{2 \cdot l_0}$$

$$F_{y2} = F_{y4} = \frac{m \cdot a_1 \cdot l_4}{2 \cdot l_0}$$

$$F_{z1} = -\frac{m \cdot g}{4} - \frac{m \cdot g \cdot l_4}{2 \cdot l_1} + \frac{m \cdot g \cdot l_3}{2 \cdot l_0} - \frac{m \cdot a_1 \cdot l_2}{2 \cdot l_0}$$

$$F_{z2} = -\frac{m \cdot g}{4} - \frac{m \cdot g \cdot l_4}{2 \cdot l_1} - \frac{m \cdot g \cdot l_3}{2 \cdot l_0} + \frac{m \cdot a_1 \cdot l_2}{2 \cdot l_0}$$

$$F_{z3} = -\frac{m \cdot g}{4} + \frac{m \cdot g \cdot l_4}{2 \cdot l_1} + \frac{m \cdot g \cdot l_3}{2 \cdot l_0} - \frac{m \cdot a_1 \cdot l_2}{2 \cdot l_0}$$

$$F_{z4} = -\frac{m \cdot g}{4} + \frac{m \cdot g \cdot l_4}{2 \cdot l_1} - \frac{m \cdot g \cdot l_3}{2 \cdot l_0} + \frac{m \cdot a_1 \cdot l_2}{2 \cdot l_0}$$

- During the constant travel speed ($a_2 = 0$ m/s²):

$$F_{y1} = F_{y2} = F_{y3} = F_{y4} = 0$$

$$F_{z1} = -\frac{m \cdot g}{4} - \frac{m \cdot g \cdot l_4}{2 \cdot l_1} + \frac{m \cdot g \cdot l_3}{2 \cdot l_0}$$

$$F_{z2} = -\frac{m \cdot g}{4} - \frac{m \cdot g \cdot l_4}{2 \cdot l_1} - \frac{m \cdot g \cdot l_3}{2 \cdot l_0}$$

$$F_{z3} = -\frac{m \cdot g}{4} + \frac{m \cdot g \cdot l_4}{2 \cdot l_1} + \frac{m \cdot g \cdot l_3}{2 \cdot l_0}$$

$$F_{z4} = -\frac{m \cdot g}{4} + \frac{m \cdot g \cdot l_4}{2 \cdot l_1} - \frac{m \cdot g \cdot l_3}{2 \cdot l_0}$$

- During the deceleration ($a_3 = -v_{max}/t_3$):

$$F_{y1} = F_{y3} = -\frac{m \cdot a_3 \cdot l_4}{2 \cdot l_0}$$

$$F_{y2} = F_{y4} = \frac{m \cdot a_3 \cdot l_4}{2 \cdot l_0}$$

$$F_{z1} = -\frac{m \cdot g}{4} - \frac{m \cdot g \cdot l_4}{2 \cdot l_1} + \frac{m \cdot g \cdot l_3}{2 \cdot l_0} - \frac{m \cdot a_3 \cdot l_2}{2 \cdot l_0}$$

$$F_{z2} = -\frac{m \cdot g}{4} - \frac{m \cdot g \cdot l_4}{2 \cdot l_1} - \frac{m \cdot g \cdot l_3}{2 \cdot l_0} + \frac{m \cdot a_3 \cdot l_2}{2 \cdot l_0}$$

$$F_{z3} = -\frac{m \cdot g}{4} + \frac{m \cdot g \cdot l_4}{2 \cdot l_1} + \frac{m \cdot g \cdot l_3}{2 \cdot l_0} - \frac{m \cdot a_3 \cdot l_2}{2 \cdot l_0}$$

$$F_{z4} = -\frac{m \cdot g}{4} + \frac{m \cdot g \cdot l_4}{2 \cdot l_1} - \frac{m \cdot g \cdot l_3}{2 \cdot l_0} + \frac{m \cdot a_3 \cdot l_2}{2 \cdot l_0}$$

| | | |
|---|---|---|
| $F_y$ | Force applied on j-th guide block in the y direction | [N] |
| $F_z$ | Force applied on j-th guide block in the z direction | [N] |
| $M_x$ | Moment applied on j-th guide block about the x axis | [Nm] |
| $M_y$ | Moment applied on j-th guide block about the y axis | [Nm] |
| $M_z$ | Moment applied on j-th guide block about the z axis | [Nm] |

| | | |
|---|---|---|
| m | Mass of the plate | [kg] |
| g | Gravity ≈ 9,81 | [m/s²] |
| $F, F_1, F_2$ | External force | [N] |
| $l_0, l_1, l_2$... | Distance between two guides blocks or distance from the reference coordinate system xyz | [mm] |
| $a_i$ | Acceleration of the plate within i-th section of a given regime v(t) | [m/s²] |

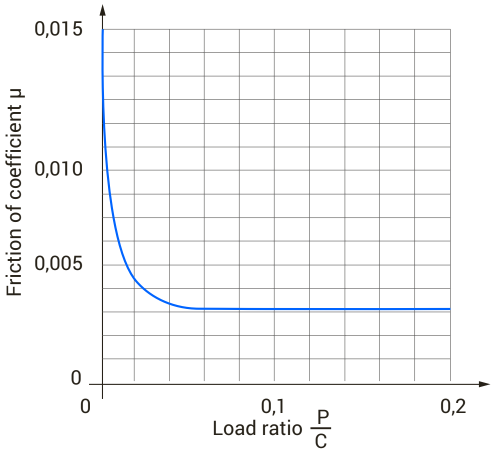
# FRICTION OF THE LINEAR GUIDE

The frictional force of the linear guide varies according to the type of the linear guide (friction between the contact surfaces and friction of the seals), viscosity of lubricant, preload and the load which is applied on the guide block. Frictional force can be calculated as follows:

$$F_f = \mu \cdot W + f$$

| | | |
|---|---|---|
| $F_f$ | Frictional force of the linear guide | [N] |
| μ | Coefficient of friction | |
| W | Load applied on the guide block | [N] |
| f | Sealing resistance | [N] |

Coefficient of friction μ can be obtained from the diagram below, where the ratio between the equivalent dynamic load P and basic dynamic load rating C is taken into account. The values of sealing resistance f of the linear guide are presented in the following table.




| Type | Sealing resistance f [N] |
|---|---|
| BGX 15 | 0,3 |
| BGX 20 | 0,4 |
| BGX 25 | 0,45 |
| BGX 30 | 0,7 |
| BGX 35 | 1,0 |
| BGX 45 | 1,2 |
| BGX 55 | 1,4 |

| Type | Sealing resistance f [N] |
|---|---|
| BGC 15 | 0,45 |
| BGC 20 | 0,6 |
| BGC 25 | 0,7 |
| BGC 30 | 0,9 |
| BGC 35 | 1,2 |
| BGC 45 | 1,8 |
| BGC 55 | 2,0 |

# ACCURACY CLASS

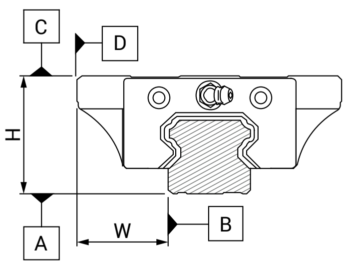
Five accuracy classes are available for BGX and BGC types of the linear guides. Accuracy classes depend on the dimensional deviations (height H and width W) and the running parallelism between guiding block and rail. Proper accuracy class needs to be select based on the application requirements.
In the table below the following dimensional deviations are presented:

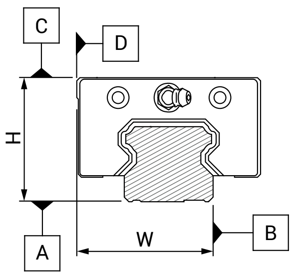
1. Maximum dimensional deviations of height H, which is measured between the top surface of the block and the bottom surface of the rail.
2. Maximum dimensional deviations of width W, which is measured between the lateral reference surface of the block and the lateral reference surface of the rail.
3. Maximum deviations of height H between several blocks on a rail (measured in the same rail position).
4. Maximum deviations of width W between several blocks on a rail (measured in the same rail position).

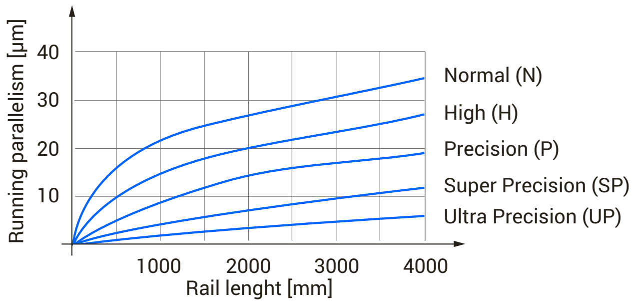
| # | Dimensional deviation | Accuracy class [mm] | | | | |
|---|---|---|---|---|---|---|
| | | Normal (N) | High (H) | Precision (P) | Super Precision (SP) | Ultra Precision (UP) |
| 1 | Height tolerance (H) | ± 0,1 | ± 0,04 | 0<br>-0,04 | 0<br>-0,02 | 0<br>-0,01 |
| 2 | Width tolerance (W) | ± 0,1 | ± 0,04 | 0<br>-0,04 | 0<br>-0,02 | 0<br>-0,01 |
| 3 | Height difference (ΔH) | 0,03 | 0,02 | 0,01 | 0,005 | 0,003 |
| 4 | Width difference (ΔH) | 0,03 | 0,02 | 0,01 | 0,005 | 0,003 |

Accuracy classes N and H on stock (others on request).

The maximum running parallelism deviation between the top surface of the guide block C and the bottom surface of the rail A as a function of the rail length is presented in the following diagram. The same diagram is vailed for the maximum running parallelism deviation between the lateral reference surfaces of the block (D) and rail (B).



# PRELOAD

The guide block can be preloaded (based on the oversizing of the balls) to increase the rigidity and eliminate the clearance. Proper preload needs to be select based on the application requirements. In the table below the preload for some common areas of applications are presented.

| | Preload | | |
|---|---|---|---|
| | Clearance / No Preload | Light Preload | Medium & Heavy Preload |
| Conditions | 1. weak impact<br>2. 2 rails in pair<br>3. low accuracy<br>4. small resistance<br>5. small load | 1. cantilever<br>2. single rail<br>3. light load<br>4. high accuracy | 1. strong impact<br>2. strong vibration<br>3. heavy machining |
| Applications | 1. welding machnice<br>2. chopping machnie<br>3. feeding mechanism<br>4. tool change mechanism<br>5. ordinary XY table<br>6. packing machine | 1. NC lathe<br>2. EDM<br>3. precise XY table<br>4. ordinary Z-axis<br>5. industrial robot<br>6. PCB punching machine | 1. machine tool<br>2. NC lathe and milling machine<br>3. feeding axis of grinder<br>4. tool feeding axis |

In the case of the lifetime calculation the preload force (i.e. internal force that occurs on the contact surfaces of the linear guide) must be taken into consideration. The average load $P_m$ must be increased for the preload forces, which can be found in the following table. It should be noted that for the preloaded systems the lifetime is reduced and the friction of the linear guide is increased.

| Preload | Type | Preload force [N] |
|---|---|---|
| Clearance Free | ZF | 0 |
| No preload | Z0 | 0 |
| Light preloaded | Z1 | 0,02 • C |
| Medium preloaded | Z2 | 0,05 • C |
| Heavy preloaded | Z3 | 0,07 • C |

| | | |
|---|---|---|
| C | Basic dynamic load rating | [N] |

In the case of even higher preload, please contact us.

## Radial clearance

Radial clearance is defined as the total distance that the contact surfaces of the linear guide can be displaced in relation to each other in the radial direction.

| Guide block | Preload type [µm] | | | | |
|---|---|---|---|---|---|
| | ZF | Z0 | Z1 | Z2 | Z3 |
| BG 15 | 4 ~ 8 | -3 ~ 3 | -8 ~ -4 | -13 ~ -9 | -18 ~ -14 |
| BG 20 | 4 ~ 8 | -3 ~ 3 | -8 ~ -4 | -14 ~ -9 | -19 ~ -14 |
| BG 25 | 5 ~ 10 | -4 ~ 4 | -10 ~ -5 | -17 ~ -11 | -23 ~ -18 |
| BG 30 | 5 ~ 11 | -4 ~ 4 | -11 ~ -5 | -18 ~ -12 | -25 ~ -19 |
| BG 35 | 6 ~ 12 | -5 ~ 5 | -12 ~ -6 | -20 ~ -13 | -27 ~ -20 |
| BG 45 | 7 ~ 15 | -6 ~ 6 | -15 ~ -7 | -23 ~ -15 | -32 ~ -24 |
| BG 55 | 8 ~ 19 | -7 ~ 7 | -19 ~ -8 | -29 ~ -20 | -38 ~ -30 |

Preload type Z1 on stock (others on request).

## Interchangeability

Preloaded linear guides cannot be made in all accuracy classes interchangeable, since otherwise the quality may not be ensured. For interchangeable linear guides the guide block and rail can be freely interchanged – guide block and rail can be ordered separately and fitted by the customer. Non-interchangeable linear guides are only available as preassembled. In the following table the interchangeability of linear guides is presented.

| Accuracy class | Interchangeable | | Non-interchangeable | | | | |
|---|---|---|---|---|---|---|---|
| | H | N | UP | SP | P | H | N |
| Preload | | ZF | | | | | |
| | Z0 | Z0 | | | Z0 | | |
| | Z1 | Z1 | Z1 | Z1 | Z1 | | |
| | | | Z2 | Z2 | Z2 | Z2 | Z2 |
| | | | Z3 | Z3 | Z3 | | |

# RIGIDITY

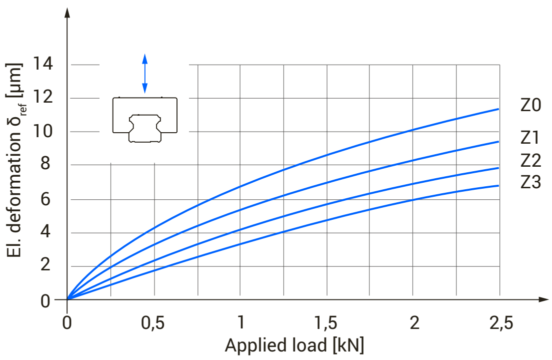
If the load is applied to the linear guide, the guide block will elastically deform (within the allowable load range specified in the table for the particular size of the linear guide). Therefore, the rigidity of the linear guide is defined as the ratio between the applied load (to the guide block) and the elastic deformation of the guide block. In order to reduce the elastic deformations the preload (Z0, Z1, Z2, Z3) should be taken into consideration, see the following diagrams.

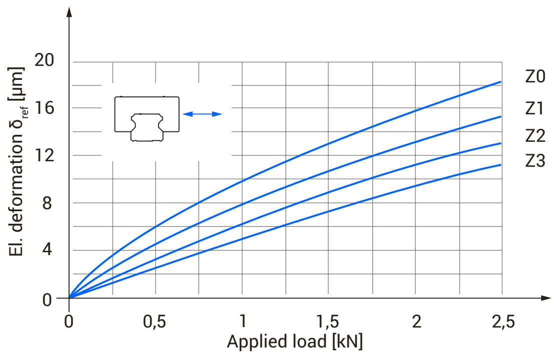
Reference diagrams of the elastic deformations as a function of the applied load together with the presented equations needs be used to determine the elastic deformation for the particular size and length of the guide block.

| | | |
|---|---|---|
| $\delta_{ref}$ | Reference deformation of the guide block | [μm] |
| $\delta_{el}$ | Elastic deformation for particular size and lenght of the guide block | [μm] |

## BG15

**Reference diagrams for BG15:**

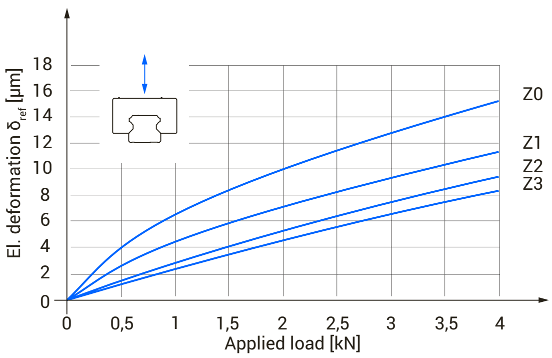


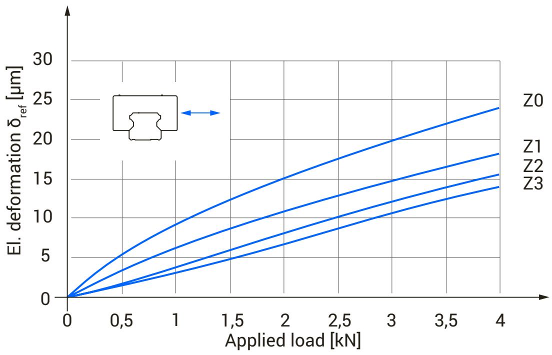




| Guide block lenght | | |
|---|---|---|
| 15-L | 15-N | 15-S |
| $\delta_{el} = \delta_{ref} \cdot 0{,}843$ | $\delta_{el} = \delta_{ref} \cdot 1{,}000$ | $\delta_{el} = \delta_{ref} \cdot 1{,}811$ |

## BG20

**Reference diagrams for BG20:**

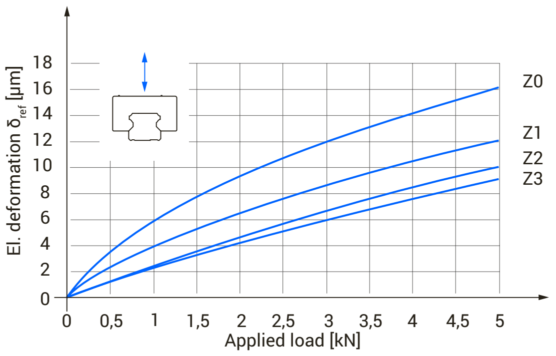


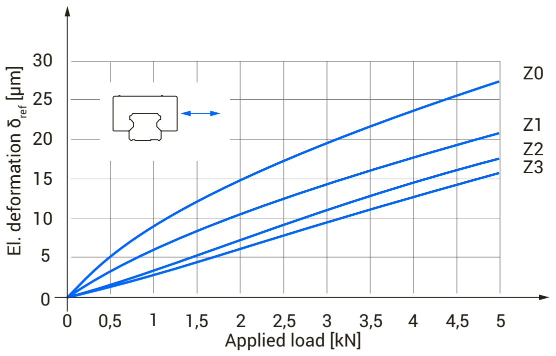




| Guide block lenght | | | |
|---|---|---|---|
| 20-E | 20-L | 20-N | 20-S |
| $\delta_{el} = \delta_{ref} \cdot 0{,}634$ | $\delta_{el} = \delta_{ref} \cdot 0{,}791$ | $\delta_{el} = \delta_{ref} \cdot 1{,}000$ | $\delta_{el} = \delta_{ref} \cdot 1{,}764$ |

## BG25

**Reference diagrams for BG25:**

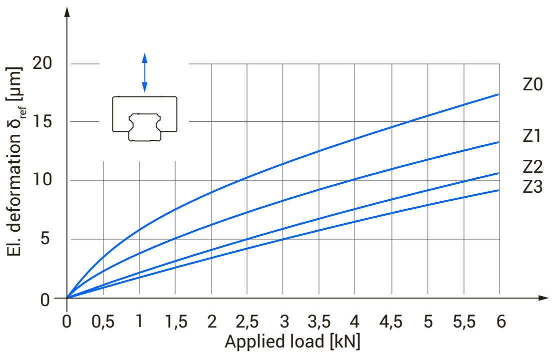


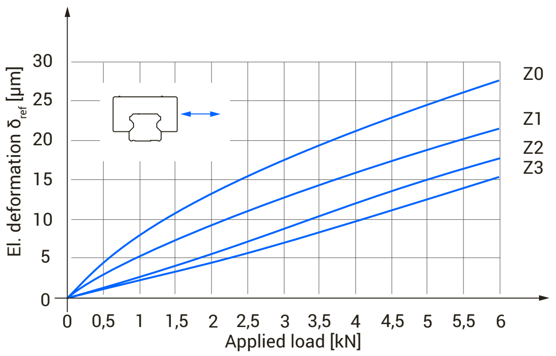




| Guide block lenght | | | |
|---|---|---|---|
| 25-E | 25-L | 25-N | 25-S |
| $\delta_{el} = \delta_{ref} \cdot 0,662$ | $\delta_{el} = \delta_{ref} \cdot 0,796$ | $\delta_{el} = \delta_{ref} \cdot 1,000$ | $\delta_{el} = \delta_{ref} \cdot 1,780$ |

## BG30

**Reference diagrams for BG30:**

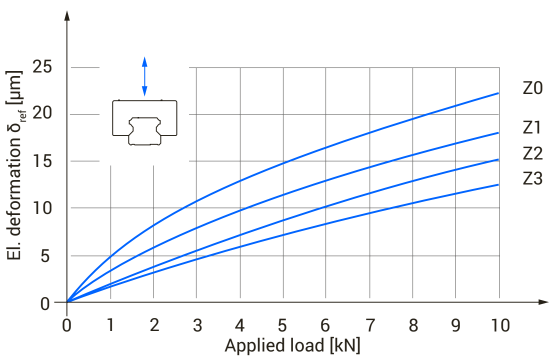


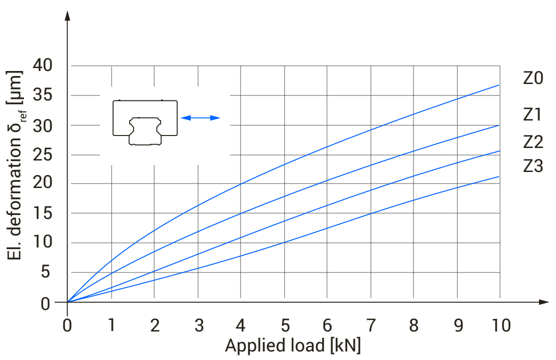




| Guide block lenght | | | |
|---|---|---|---|
| 30-E | 30-L | 30-N | 30-S |
| $\delta_{el} = \delta_{ref} \cdot 0,655$ | $\delta_{el} = \delta_{ref} \cdot 0,869$ | $\delta_{el} = \delta_{ref} \cdot 1,000$ | $\delta_{el} = \delta_{ref} \cdot 1,823$ |

## BG35

**Reference diagrams for BG35:**

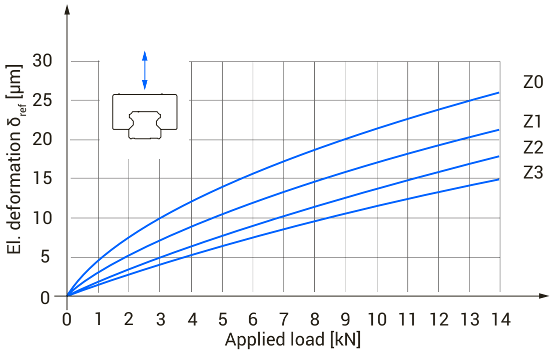


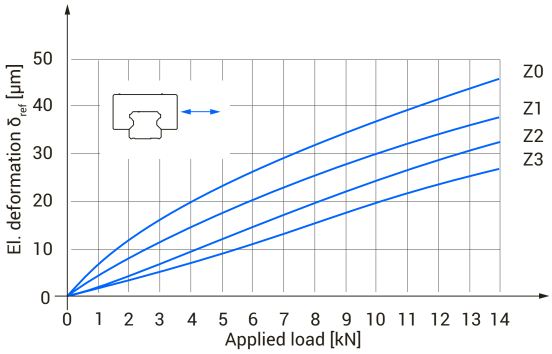




| Guide block lenght | | | |
|---|---|---|---|
| 35-E | 35-L | 35-N | 35-S |
| $\delta_{el} = \delta_{ref} \cdot 0,657$ | $\delta_{el} = \delta_{ref} \cdot 0,870$ | $\delta_{el} = \delta_{ref} \cdot 1,000$ | $\delta_{el} = \delta_{ref} \cdot 1,809$ |

## BG45

**Reference diagrams for BG45:**

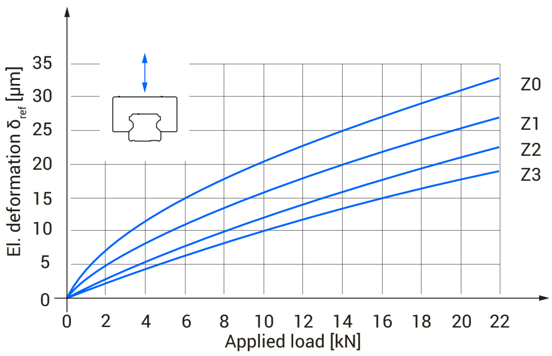


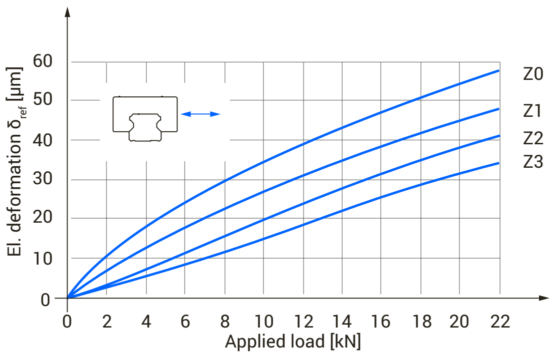




| Guide block lenght | | |
|---|---|---|
| 45-E | 45-L | 45-N |
| $\delta_{el} = \delta_{ref} \cdot 0{,}676$ | $\delta_{el} = \delta_{ref} \cdot 0{,}855$ | $\delta_{el} = \delta_{ref} \cdot 1{,}000$ |

## BG55

**Reference diagrams for BG55:**




| Guide block lenght | | |
|---|---|---|
| 55-E | 55-L | 55-N |
| $\delta_{el} = \delta_{ref} \cdot 0{,}678$ | $\delta_{el} = \delta_{ref} \cdot 0{,}753$ | $\delta_{el} = \delta_{ref} \cdot 1{,}000$ |

# LUBRICATION

Linear guide needs a sufficient amount of the lubricant (both grease and oil can be used), which is essential for optimal operating. The lubricant ensures a lubricating film between the steel balls and the track surfaces to reduce wear and friction. Furthermore, the lubricant protects the metallic surfaces against corrosion and contamination, reduces the noise and heating and lubricant's properties extend the lifetime of the linear guide. Linear guides are pre-lubricated before shipment.

## Lubricant

Recommended grease for the lubrication: Lubcon TURMOGREASE LC 802 EP (K HC P 2/3 N -30).

Do not use the lubricant which contains any solid parts!

## Lubrication quantities and intervals

In the following table both initial lubrication (lubrication for initial operation) and re-lubrication amounts of the lubricant that have to be supplied to linear guide are presented.

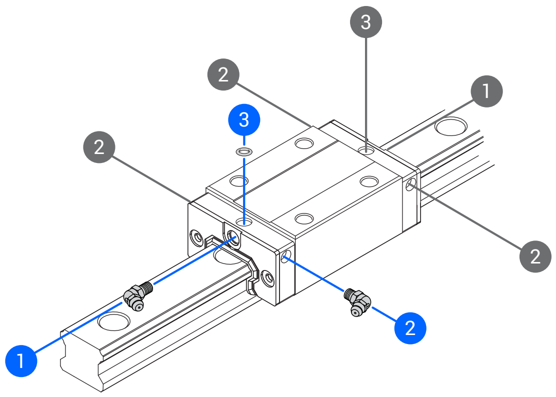
- Grease lubrication: it is recommended to re-lubricate after 100 km of traveled distance or every six month. In the case of caged type of the guide block it is recommended to re-lubricate after 500 km of traveled distance or every year.
- Oil lubrication: it is recommended to re-lubricate every hour.

In the case of normal stroke (stroke is longer than double length of the guide block), it is sufficient to supply lubricant only through one grease fitting. In the case of short stroke (stroke is shorter than double length of the guide block), the lubricant must be supplied through two grease fittings, which are attached at both ends of the block.

| Guide block No. | Guide block type | Grease Lubrication | | | Oil Lubrication | | |
|---|---|---|---|---|---|---|---|
| | | Initial lubrication [cm³] | | Re-lubrication [cm³] | Initial lubrication [ml] | | Re-lubrication [ml] |
| | | Non cage | Cage | | Non cage | Cage | |
| BG15 | BS,FS | 0,3 | 0,2 | 0,1 | 0,2 | 0,1 | 0,1 |
| | BN,FN | 0,4 | 0,3 | 0,2 | 0,2 | 0,1 | 0,1 |
| | BL,FL | 0,5 | 0,4 | 0,3 | 0,2 | 0,1 | 0,1 |
| BG20 | BS,FS | 0,4 | 0,3 | 0,2 | 0,3 | 0,2 | 0,1 |
| | BN,FN | 0,6 | 0,5 | 0,3 | 0,4 | 0,3 | 0,2 |
| | BL,FL | 0,8 | 0,7 | 0,4 | 0,4 | 0,3 | 0,2 |
| | BE,FE | 1 | 0,9 | 0,5 | 0,5 | 0,4 | 0,2 |
| BG25 | BS,FS | 0,8 | 0,7 | 0,4 | 0,4 | 0,3 | 0,1 |
| | BN,FN | 1 | 0,9 | 0,6 | 0,5 | 0,4 | 0,2 |
| | BL,FL | 2 | 1,9 | 1,2 | 0,6 | 0,5 | 0,2 |
| | BE,FE | 2,5 | 2,4 | 1,4 | 0,7 | 0,6 | 0,3 |
| BG30 | BS,FS | 2 | 1,9 | 1,2 | 0,7 | 0,6 | 0,2 |
| | BN,FN | 2,5 | 2,4 | 1,4 | 0,9 | 0,8 | 0,2 |
| | BL,FL | 3 | 2,9 | 1,6 | 1 | 0,9 | 0,3 |
| | BE,FE | 3,5 | 3,4 | 1,8 | 1,2 | 1,1 | 0,3 |
| BG35 | BS,FS | 3 | 2,9 | 1,6 | 0,9 | 0,8 | 0,2 |
| | BN,FN | 3,5 | 3,4 | 1,8 | 1,4 | 1,3 | 0,3 |
| | BL,FL | 4 | 3,9 | 2 | 1,5 | 1,4 | 0,3 |
| | BE,FE | 4,5 | 4,4 | 2,3 | 1,8 | 1,7 | 0,4 |
| BG45 | BN,FN | 4 | 3,9 | 2 | 2 | 1,9 | 0,5 |
| | BL,FL | 5 | 4,9 | 2,5 | 2,3 | 2,2 | 0,5 |
| | BE,FE | 5,5 | 5,4 | 2,8 | 2,8 | 2,7 | 0,6 |
| BG55 | BN,FN | 6 | 5,8 | 3 | 3,5 | 3,3 | 0,6 |
| | BL,FL | 8 | 7,8 | 4 | 4,5 | 4,3 | 0,6 |
| | BE,FE | 10 | 9,8 | 5 | 5,5 | 5,3 | 0,7 |

## Lubrication ports

The lubricant can be supplied to the guide block through several lubrication ports. As standard (1) there are two lubrication ports located at both ends of the block (one of them is sealed with the set screw). As alternative (2, 3) there are also four lubrication ports located on both side of the block and two lubrication ports from the top (for both case the marked lubrication hole must be opened). Lubrication port locations are presented in the figure below. In the case of using the lubrication ports from the top, the O-ring is necessary to adjust the proper height and seal the connection.
For more information about the side and the top lubrication ports please contact us.




Standard grease fitting is included (NGS02 / NGX02 / NGX04).
For more info see section Accessories - Grease fittings.

# DUST PROTECTION – SEAL COMBINATIONS

Entrance of dust or liquid particles and chips into the guide block may significantly reduce the lifetime, since the foreign substances may cause an abnormal wear of the track surfaces. Therefore, the proper sealing option of the linear guide needs to be select according to the environmental conditions of the application. The purpose of the sealing system is also to minimize the loss of the lubricant.
Linear guides can be combined with several sealing options to provide an optimal sealing system, see table below.

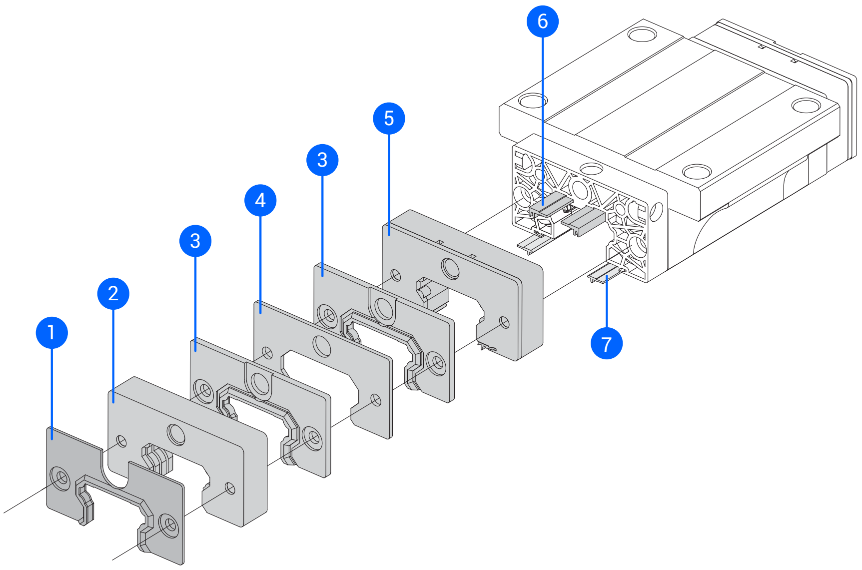
| Standard Seals | |
|---|---|
| Code | Explanation |
| -- | End seal + Side seal |
| UU | End seal |
| SS | End seal + Side seal + Inner seal |
| DD | Double seal + Side seal |
| EE | Double seal + Side Seal + Inner Seal |
| FF | End seal + Side seal + Inner seal + Scrapper |
| GG | Double seal + Side seal + Inner seal + Scrapper |
| ZZ | End seal + Side seal + Scrapper |
| KK | Double seal + Side seal + Scrapper |

| Low Friction Seals (LFS) | |
|---|---|
| Code | Explanation |
| AL | LFS + Side seal |
| UL | LFS |
| SL | LFS + Side seal + Inner seal |
| DL | Double LFS + Side seal |
| EL | Double LFS + Side seal + Inner seal |
| FL | LFS + Side seal + Inner seal + Scrapper |
| GL | Double LFS + Side seal + Inner seal + Scrapper |
| ZL | LFS + Side seal + Scrapper |
| KL | Double LFS + Side seal + Scrapper |

| Reinforced Side Seals (RSS) | |
|---|---|
| Code | Explanation |
| AB | End seal + RSS |
| SB | End seal + RSS + Inner seal |
| DB | Double seal + RSS |
| EB | Double seal + RSS + Inner seal |
| FB | Double seal + RSS + Inner seal + Scrapper |
| GB | Double seal + RSS + Inner seal + Scrapper |
| ZB | End seal + RSS + Scrapper |
| KB | Double seal + RSS + Scrapper |

Standard seals -- and SS on stock (others on request).

The following sealing and lubrication elements are available:




1 – Scraper
2 – Multi-Layer-Scraper (MLS)
3 – End seal
4 – Spacer
5 – Lubrication system
6 – Inner seal
7 – Side seal

**Scraper**

– Sealing against coarse particles and chips from outside
– Protect the end seal from being damaged
– Not suitable as single sealing

**End seal**

– Sealing against fine particles and fluids from outside
– Minimize the loss of the lubricant
– Sealing for normal environmental conditions (little dirt and dust)

**Multi-Layer-Scraper (MLS)**

– Sealing in the case of extreme heavy contamination
– Stacking structure composed of three layers of scrapers
– Suitable also in combination with double seals and scraper

**Lubrication system (LS)**

– Self-lubrication system
– For longer re-lubrication intervals
– The lubrication oil is automatically spread over the track surfaces
– More information can be found in section Accessories

**Inner seal**

– Sealing the interior of the block against fine particles caught in the mounting holes of the rail
– Minimize the loss of the lubricant
– Improve the stability of the block
– Sealing for all environmental conditions

**Side seal**

– Sealing the interior of the block against fine particles from below
– Minimize the loss of the lubricant
– Sealing for all environmental conditions

**Double seals**

– Combination of two end seals and spacer
– Effective sealing against fine particles and fluids from outside
– Sealing in the case of heavy contamination (lot of dirt and dust)
– Suitable also in combination with scraper

**Low friction seals (LFS)**

– One lip seal
– Lower sealing (driving) resistance
– Smoothness
– Sealing in the case of low contamination

**Reinforced Side Seals (RSS)**

– Composed of solid material (ABS) and soft material (TPU) (note: standard side seal is made of Nylon, which has lower driving resistance)
– Seals fits the rail perfectly
– Optimum sealing against foreign particles

**Thickness of a single sealing and lubrication element in mm**

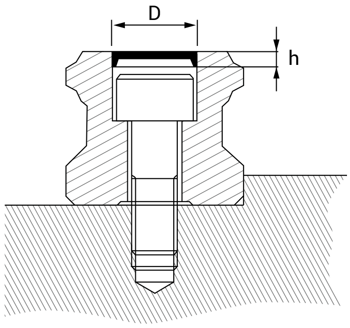
| Block size | End seal | Double end seals | Scrapper | MLS | LS |
|---|---|---|---|---|---|
| 15 | 2,5 | 5,50 | 1,60 | 6,5 | 10,3 |
| 20 | 3,2 | 6,70 | 2,10 | 6,5 | 10,3 |
| 25 | 2,75 | 6,25 | 2,20 | 7,0 | 10,3 |
| 30 | 3,5 | 7,50 | 2,30 | 9,0 | 10,3 |
| 35 | 4,0 | 8,50 | 2,30 | 9,0 | 10,5 |
| 45 | 4,5 | 9,50 | 3,00 | 9,0 | 13,0 |
| 55 | 4,5 | 9,50 | 2,80 | 9,0 | 13,0 |

It should be noted that the total length of the guide block varies according to the selected sealing option and needs to be increased by thickness of the individual sealing and lubrication element, which are presented in the table.

## Rail dust protection

To avoid keeping the dust particles and chips in the mounting holes of the rail the following solutions are available:

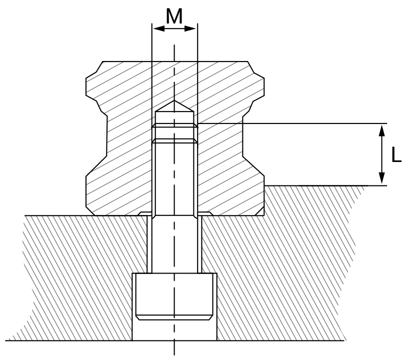
**1. Rail caps:**




| Size | Dimension [mm] | |
|---|---|---|
| | Ø D | h |
| 15 | 7,5 | 1,3 |
| 20 | 9,5 | 2,5 |
| 25 | 11,0 | 2,5 |
| 30 | 14,0 | 3,5 |
| 35 | 14,0 | 3,5 |
| 45 | 20,0 | 3,5 |
| 55 | 23,0 | 4,5 |

– Made of plastic material (dimensions can be found in the table on the left)
– Caps can be easily mounted using a plastic mallet aligned with hole after the rail is installed.

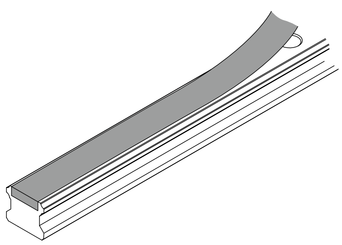
**2. Tapped hole rail:**



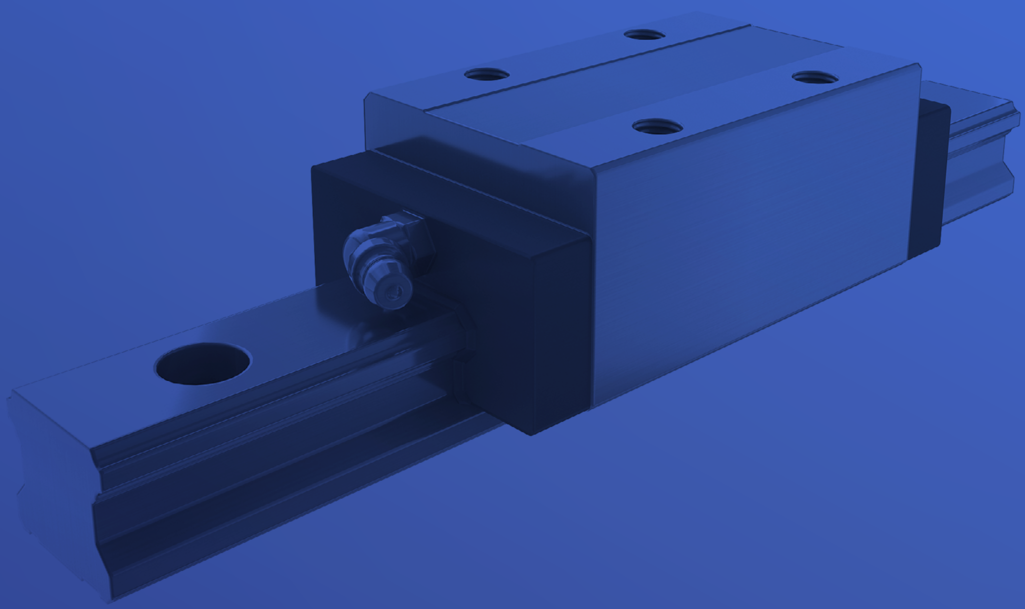

| Rail size | Thread size M | Max. Thread length L [mm] |
|---|---|---|
| BG 15 | M5 | 8 |
| BG 20 | M6 | 10 |
| BG 25 | M6 | 12 |
| BG 30 | M8 | 15 |
| BG 35 | M8 | 17 |
| BG 45 | M12 | 20 |
| BG 55 | M14 | 24 |

– Fastening the rail from below

**3. Cover strip:**

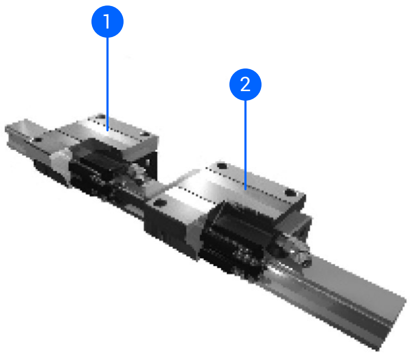


– For covering the top surface of the rail
– More information can be found in section Accessories



# Linear guides – BG Series

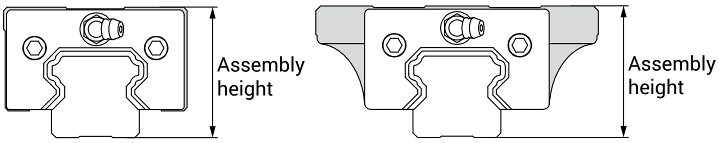
## OVERVIEW




1 – BGX Non-Cage type
2 – BGC Cage type

Both BGX and BGC guide blocks with various assembly heights, flange types and length types are available, see figure below.

Guide blocks with flange have a larger mounting surface. Therefore they are more suitable for applications where higher loads are presented.

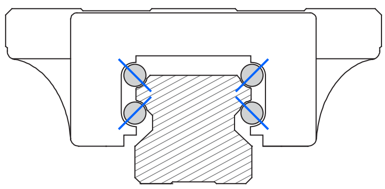



## BGX – NON CAGE TYPE

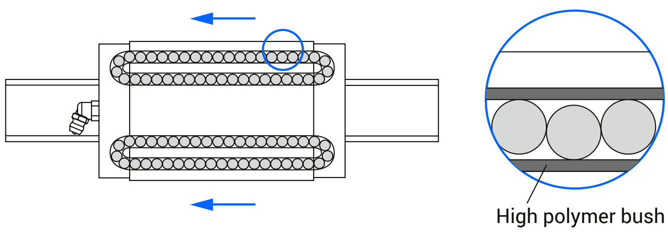
**Features of the BGX type:**

– Four rows of steel balls with contact angle of 45°
– High accuracy and rigidity
– Same high load capacity in all main directions
– Lubrication fittings can be mounted on all sides of the guide block (bottom side is excluded)
– Low friction, light movement
– Various sealing options for different field of the applications
– Velocity of up to 1 m/s

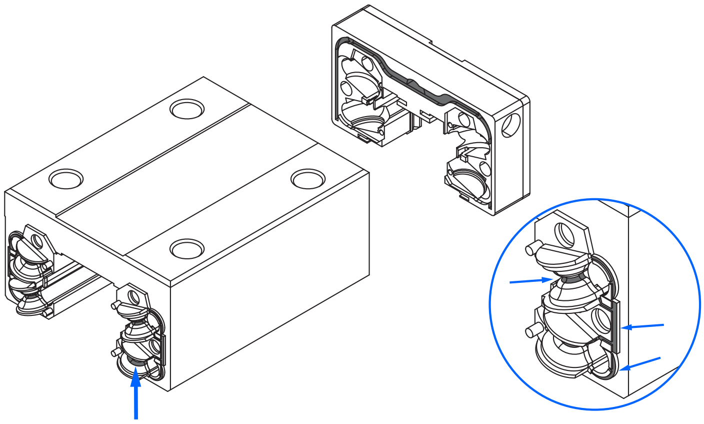
Due to the four rows of steel balls with a contact angle of 45 degree (between the track surfaces and the steel balls) the BGX linear guides can be subjected to the high loads. This design offers the same load capacity of the linear guide in all main directions no matter how the rail in positioned. In comparison with the two-groove gothic design, the four-groove design provides better rigidity, accuracy, higher stability and longer lifetime. In particular, the self-adjust capability allows smooth linear motions by absorbing the deviation of the mounting planes and the assembly errors.



BGX tubular muffling system, i.e. the high polymer bushes inserted in the guide block, highly reduces the collision of the steel balls and its resulting noise, especially at high travel speed. The high polymer bush also improves the lubrication and reduces the friction between the steel balls and the tube.



Design of the BGX circulation system allows a lot of additional space for retaining the lubricant, which is important for the re-lubrication intervals and the lifetime. BGX circulation system spreads the lubricant inside the guide block all over the contact surfaces in the case that linear guide moves. In the case of the stationary conditions the lubricant is returned to the lubricant retainer in the circulation system without loss of the lubricant.



## BGC – CAGE TYPE

**Features of the BGC type (additionally to BGX):**

– For high speed applications (up to 5 m/s)
– Smoother traveling
– Less running noise and vibrations
– Less heating generation
– Better retaining of the lubricant
– More evenly distributed load on the linear guide
– Higher dynamic load and moment capacities

BGC type of the guide block offers all the features of the BGX type. As additional advantage the BGC type of the guide block is designed with the high polymer separator (which has a function of a cage) between the steel balls. Since the separator defines the constant distance between the steel balls, there is no collision between them and the load is more evenly distributed on the linear guide. This result in smoother traveling, less running noise and vibrations, less heating generation, higher reliable travel speed and better retaining of the lubricant on the contact surfaces (lubricant is retained in the space between two steel balls and the separator). Since the lubrication is more reliable, the lifetime of the BGC type is much longer. It should be noted that the dimensions of BGC and BGX types of the linear guides are the same (the same guide rail can be used).


1 – Steel ball
2 – High polymer separator