Technical Information

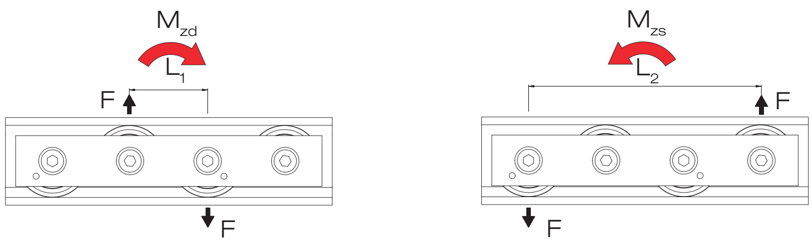
Configuration and Behavior of the Slider under Yawing Moment M_z

Individual slider under load moment M_z

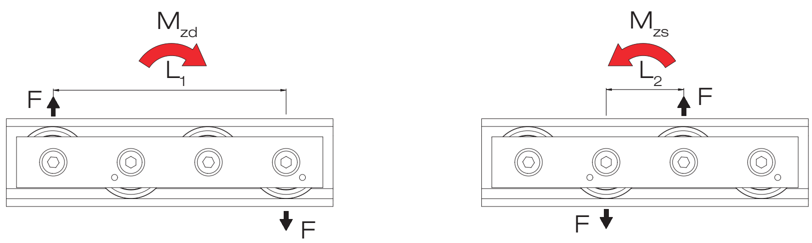
When an overhanging load in an application with a single slider per rail cause an M_z moment in one direction, a 4 or 6 roller Compact Rail slider is available. These sliders are available in both configuration A and B in regards to the roller arrangement to counter the acting M_z moment. The moment capacity of these sliders in the M_z-direction varies significantly through spacing L_1 and L_2 in accordance with the direction of rotation of M_z. Especially in the use of two parallel rails, for example with a T+U-system, it is extremely important to pay attention to the correct combination of the slider configuration A and B, in order to use the maximum load capacities of the slider.

The diagrams below illustrate this concept of the A and B configuration for sliders with 4 and 6 rollers.
The maximum allowable M_z-moment is identical in both directions for all 3 and 5 roller sliders.

Slider with 4 rollers
Configuration A



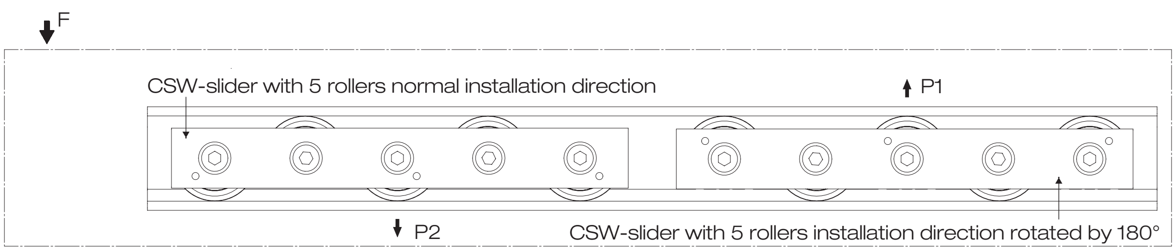
Slider with 4 rollers
Configuration B



Two sliders under load moment M_z

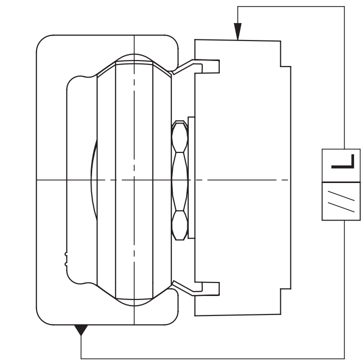
If an overhanging load acts in an application with two sliders per rail and thus causes an M_z-moment in one direction, there are differing support reactions with the two sliders. For this reason, an optimal arrangement of different slider configurations to reach the maximum load capacities must be achieved for the application. In practice this means, when using NTE-, NUE- or CSW-sliders with 3 or 5 rollers, both sliders are installed rotated by 180° so that the slider is always loaded on the side with the most rollers (with NKE-sliders this is not possible due to the different raceway geometry). For an even number of rollers this has no effect. The CD-slider with installation option from above or below cannot be installed due to the position of the rollers in reference to the installation side therefore they are available in the configurations A and B.

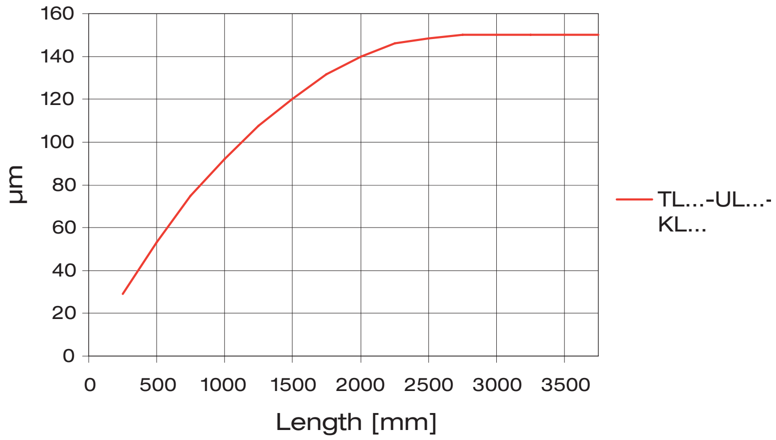
CSW-slider under load moment M_z

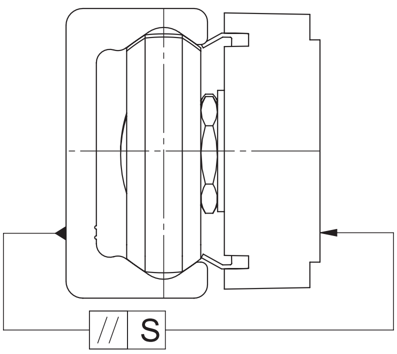


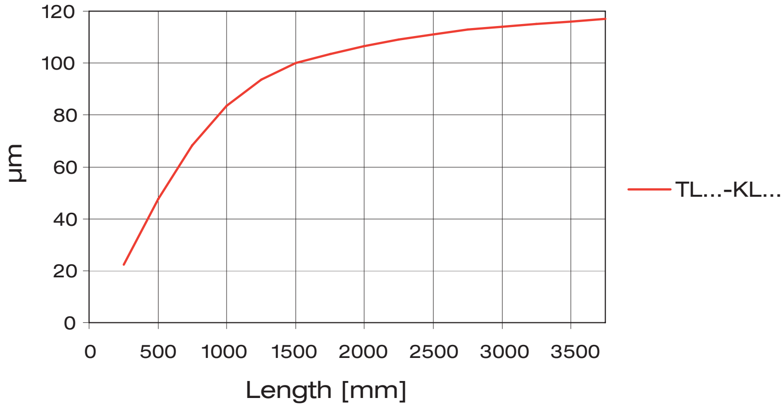
Linear Accuracy

Linear accuracy is defined as the maximum deviation of the slider in the rail based on the side and support surface during straight line movement. The linear accuracy, depicted in the graphs below, applies to rails that are carefully installed with all the provided screws on a level and rigid foundation.







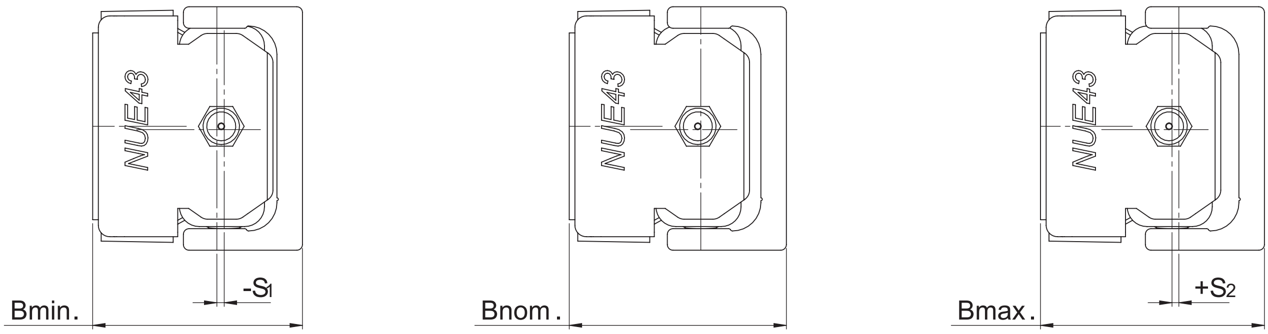


Deviation of accuracy with two 3 roller sliders in one rail

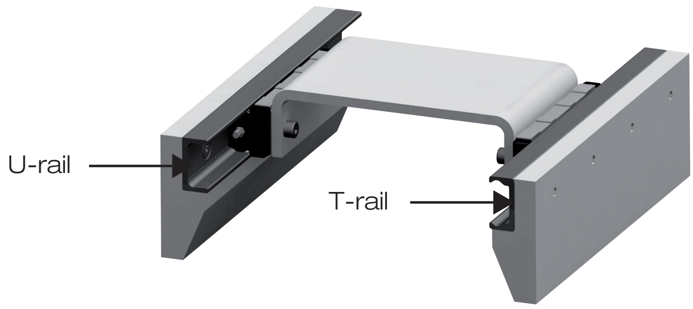
Type	TL..., UL..., KL...
ΔL (mm) Slider with equal arrangement	0,2
ΔL (mm) Slider with opposite arrangement	1,0
ΔS (mm)	0,05

T+U-system maximum offset

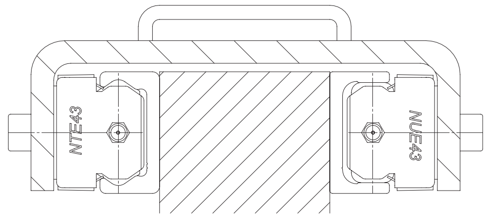
U-rails have flat parallel raceways that allow free lateral movement of the sliders. The maximum axial offset that can be compensated for in each slider of the U-rail is made up of the combined values S1 and S2. Considered from a nominal value Bnom as the starting point, S1 indicates the maximum offset into the rail, while S2 represents the maximum offset towards the outside of the rail.



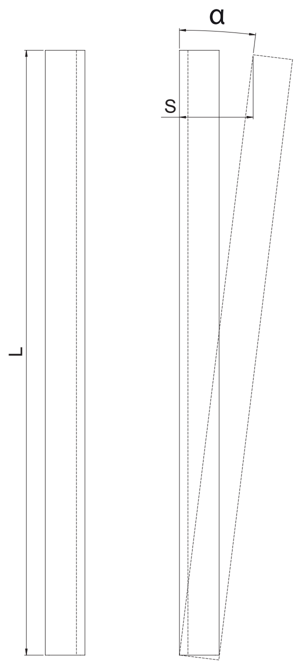
Slider type	S_1 (mm)	S_2 (mm)	B_{min} (mm)	B_{nom} (mm)	B_{max} (mm)
NU18	0	1,1	16,5	16,5	17,6
CSW18	0,3	1,1	14,7	15	16,1
NUE28	0	1,3	24	24	25,3
CSW28	0,6	1,3	23,3	23,9	25,2
NUE43	0	2,5	37	37	39,5
CSW43	1,4	2,5	35,6	37	39,5
NUE63	0	3,5	50,5	50,5	54
CSW63	0,4	3,5	49,4	49,8	53,3



The application example in the adjacent drawing shows that the T+U-system implements a problem-free function of the slider even with an angled offset in the mounting surfaces.



If the length of the guide rails is known, the maximum allowable angle deviation of the screwed surfaces can be determined using this formula (the slider in the U-rail moves here from the innermost position S1 to outermost position S2):



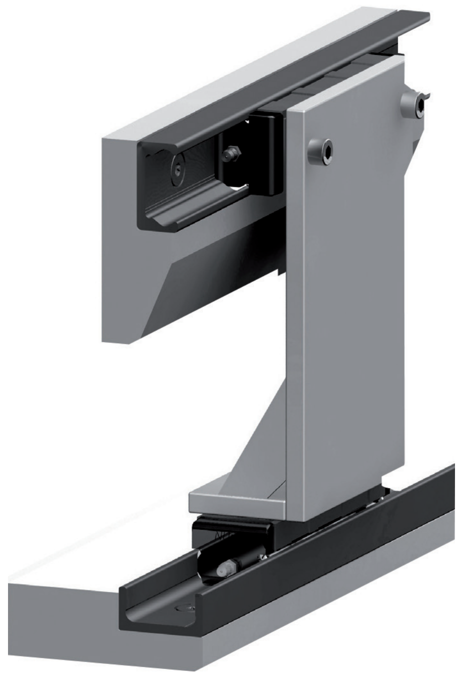
$$\alpha = \arctan \frac{S^*}{L}$$

S^* = sum of S1 and S2
L = length of rail

The following table contains guidelines for this maximum angle deviation α, achievable with the longest guide rail from one piece.

Size	Rail length mm	Offset S mm	Angle α (°)
18	2000	1,4	0,040
28	3200	1,9	0,034
43	4080	3,9	0,062
63	4080	3,9	0,062

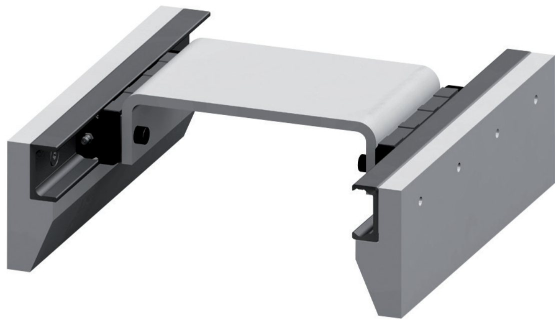
The T+U-system can be designed in different arrangements. A T-rail accepts the vertical components of load P. A U-rail attached underneath the component to be guided prevents the vertical panel from swinging and is used as moment support. In addition a vertical offset in the structure, as well as possible existing unevenness of the support surface, is compensated for.



K + U-system Tolerance Compensation

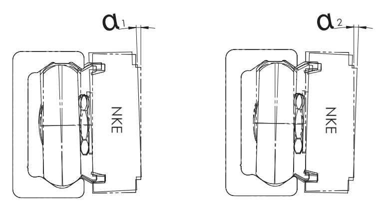
Deviations in parallelism in two planes

The K+U-system, like the T+U-system, can compensate for axial deviations in parallelism. Additionally, the K+U system has the option of rotating the slider in the rail, which will compensate for other deviations in parallelism, e.g. height offset. The unique raceway contour of the K-rail allows the slider a certain rotation around its longitudinal axis, with the same linear precision as with a T-rail. With the use of a K+U-system, the K-rail accounts for the main loads and the motion of the track. The U-rail is used as a support bearing and takes only radial forces and Mz moments. The K-rail must always be installed so that the radial load of the slider is always supported by at least 2 load bearing roller sliders, which lie on the V-shaped raceway (reference line) of the rail.



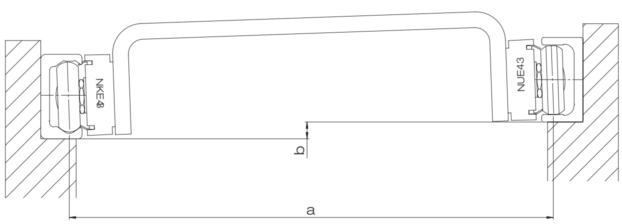
Slider type	α(°)	α(°)
NKE43 and NUE43	2	2
NKE63 and NUE63	1	1

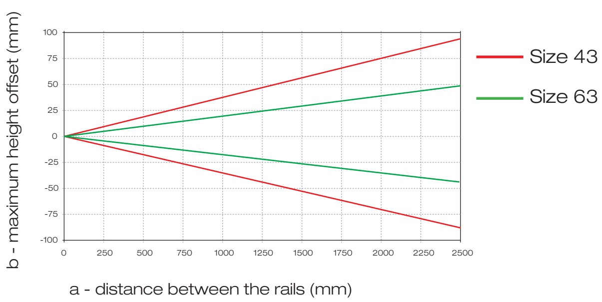
K-rails and sliders are available in both sizes 43 and 63. The custom NKE-slider may only be used in K-rails and cannot be exchanged with other Rollco sliders. The maximum allowable rotation angle of the NKE- and NUE-sliders are shown in the following table. α_1 is the maximum rotation angle counterclockwise, α_2 is clockwise.



K+U-system maximum offset

If a K-rail is used in combination with a U-rail, with guaranteed problemfree running and without extreme slider load, a pronounced height difference between the two rails can also be compensated for. The following illustration shows the maximum height offset b of the mounting surfaces in relation to the distance a of the rails.





Static Load

The radial load capacity rating, C_{0rad}, the axial load capacity rating, C_{0ax}, and moments M_x, M_y, M_z indicate the maximum permissible values of the load. Higher loads will have a detrimental effect on the running quality. A safety factor, S_0, is used to check the static load, which takes into account the basic parameters of the application and is defined more in detail in the following table:

Safety factor S_0

No shock nor vibration, smooth and low-frequency reverse, high assembly accuracy, no elastic deformations	1 - 1,5
Normal installation conditions	1,5 - 2
Shock and vibration, high-frequency reverse, significant elastic deformation	2 - 3,5

The ratio of the actual load to maximum permissible load may be as large as the reciprocal of the accepted safety factor, S_0, at the most.

$$\frac{P_{0rad}}{C_{0rad}} \leq \frac{1}{S_0} \qquad \frac{P_{0ax}}{C_{0ax}} \leq \frac{1}{S_0} \qquad \frac{M_1}{M_x} \leq \frac{1}{S_0} \qquad \frac{M_2}{M_y} \leq \frac{1}{S_0} \qquad \frac{M_3}{M_z} \leq \frac{1}{S_0}$$

The above formulas are valid for a single load case. If two or more forces are acting simultaneously, please check the following formula:

$$\frac{P_{0rad}}{C_{0rad}} + \frac{P_{0ax}}{C_{0ax}} + \frac{M_1}{M_x} + \frac{M_2}{M_y} + \frac{M_3}{M_z} + y \leq \frac{1}{S_0}$$

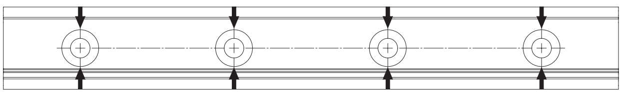
P0rad	=	effective radial load (N)
C0rad	=	permissible radial load (N)
P0ax	=	effective axial load (N)
C0ax	=	permissible axial load (N)
M1, M2, M3	=	external moments (Nm)
Mx, My, Mz	=	maximum permissible moments in the different loading directions (Nm)
y	=	reduction due to preload

The safety factor S0 can lie on the lower given limit if the occurring forces can be determined with sufficient precision. If shock and vibration are present, the higher value should be selected. For dynamic applications higher safety is required. Please contact Rollco.

Fixing Holes

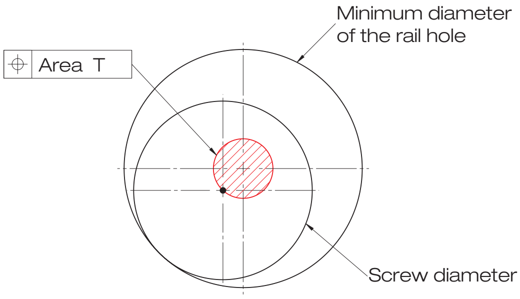
V-holes with 90° bevels

The selection of rails with 90° countersunk holes is based on the precise alignment of the threaded holes for installation. Here the complex alignment of the rail to an external reference is omitted, since the rail aligns during installation by the self-centering of the counter-sunk screws on the existing hole pattern.



C-holes with cylindrical counterbore

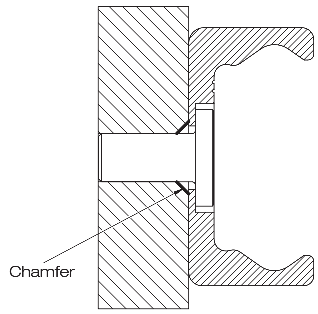
The cylindrical screw has, as shown, some play in the countersunk fixing hole, so that an optimum alignment of the rail can be achieved during installation. The area T is the diameter of the possible offset, in which the screw center point can move during the precise alignment.



Rail type	Area T mm
TLC18 - ULC18	Ø 1,0
TLC28 - ULC28	Ø 1,0
TLC43 - ULC43 - KLC43	Ø 2,0
TLC63 - ULC63 - KLC63	Ø 1,0

The minimum chamfers on the fixing threads are listed in the table below.

Size	Chamfer mm
18	0,5 x 45°
28	0,6 x 45°
43	1 x 45°
63	0,5 x 45°

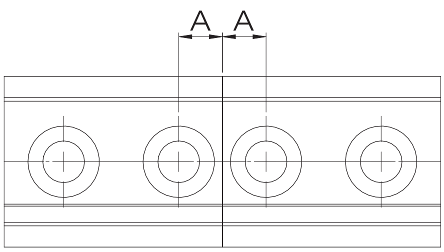


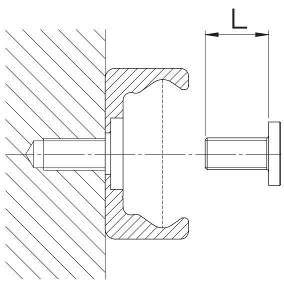
Example for fixing with Torx® screws (custom design)

Joined Rails

The maximum available rail length in one piece is indicated under Order Code Rail. Longer lengths are achieved by joining two or more rails (joined rails). Rollco then machines the rail ends at a right angle to the impact surfaces and marks them. Additional fixing screws are included with the delivery, which ensure a problem-free transition of the slider over the joints, if the installation procedures are followed.
Please see section **Installation of Joined Rails**.

Two additional threaded holes are required in the load-bearing structure. The included end fixing screws correspond to the installation screws for the rails for cylindrical counterbores. The alignment fixture for aligning the rail joint can be ordered using the designation given in the table.





Rail type	A mm	Threaded hole (load-bearing structure)	L mm	Alignment fixture
T..., U... 18	7	M4	8	AT18
T..., U... 28	8	M5	10	AT28
T..., U... 43	11	M8	16	AT43
T..., U... 63	8	M8	20	AT63
K... 43	11	M8	16	AK43
K... 63	8	M8	20	AK63

Operating Conditions

Corrosion Protection

The Compact Rail product family has a standard corrosion protection system by means of electrolytic-zinc plating according to ISO 2081. If increased corrosion protection is required, application-specific surface treatments are available upon request, e.g. as nickel-plated design with FDA approval for use in the food industry. For more information contact Rollco.

Speed and Acceleration

The Compact Rail product family is suitable for high operating speeds and accelerations.

Size	Speed (m/s)	Acceleration (m/s²)
18	3	10
28	5	15
43	7	15
63	9	20

Operating Temperatures

The temperature range for continuous operation is: -30 °C / +120 °C with occasional peaks up to +150 °C. Peaks up to +170 °C can also be reached with the use of CSW-series sliders (except size 63) not equipped with polyamide wipers.

Preload

Preload classes

The factory installed systems, consisting of rails and sliders, are available in two preload classes:

- Standard preload K1 means a rail-slider combination with minimum preload which means the rollers are adjusted free of clearance for optimal running properties.
- Usually preload K2 is used for rail-slider systems for increasing the rigidity. When using a system with K2 preload a reduction of the loading capacities and service life must be taken into consideration (see table below).

This coefficient y is used in the calculation formula for checking the static load and lifetime (see section **Static Load**). The interference is the difference between the contact lines of the rollers and the raceways of the rail.

Preload class	Reduction y	Interference* (mm)	Rail type
K1	-	0.01	all
K2	0.1	0.03	T, U...18
		0.04	T, U...28
		0.05	T, U...35
		0.06	T, U, K...43, T, U, K...63

* Measured on the largest interior dimension between the raceways

ROLLON LinearEvolution

Maintenance

Roller Lubrication

The bearings inside the rollers are lubricated for life. Custom lubrication of the roller sliders for use in high temperature environments or in the food industry is available upon request. For more information, please contact Rollco.

Lubrication of the Raceways

Proper lubrication during normal conditions:

- reduces friction
- reduces wear
- reduces the load of the contact surfaces through elastic deformations
- reduces running noise

To reach the calculated service life a film of lubricant should always be present between the raceway and roller This also serves to protect against corrosion of the ground raceways.

N-slider Lubrication

Lubrication when using N-sliders

NTE-, NUE- and NKE-sliders (except for types NT/NU18) are equipped with a self-lubrication kit for periodic lubrication of the slider. This provides a progressive release of lubricant on the raceway way during operation of the slider. The expected service life is up to 2 million cycles, depending on the type of application. The zerk fittings provide the lubrication.

Lubricant	Thickening agent	Temperature range (°C)	Dynamic viscosity (mPas)
Mineral oil	Lithium soap	-30... to + 120	1000

CSW-slider Lubrication

Lubrication when using CSW-sliders

The CSW series sliders can be provided with wipers made of polyamide, to remove the contaminants on the raceways. Since the sliders do not have a self-lubrication kit, manual lubrication of the raceways is required. A guideline is to lubricate the raceways every 100 km or every 6 months. We recommend a roller bearing lubricant with a lithium base of average consistency as a lubricant.

Lubricant	Thickening agent	Temperature range (°C)	Dynamic viscosity (mPas)
Roller bearing lubricant	Lithium soap	-30 to + 170	4500

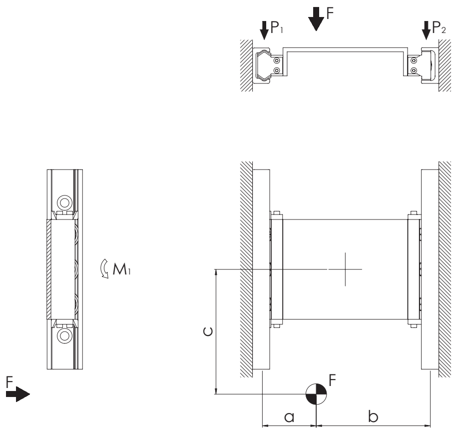
Calculation Formulas

Examples

Formulas for determining the forces on the most heavily loaded slider.

Horizontal movement

Static test



Slider load:

$$P_1 = F \cdot \frac{b}{a+b}$$

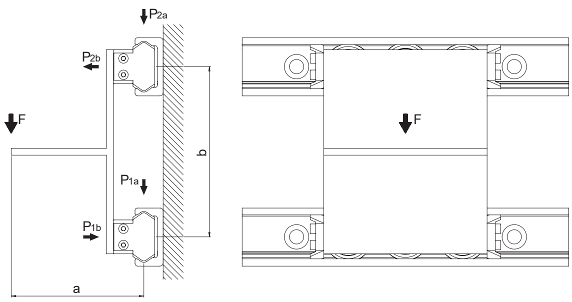
$$P_2 = F - P_1$$

In addition each slider is loaded by a moment:

$$M_1 = \frac{F}{2} \cdot c$$

Horizontal movement

Static test



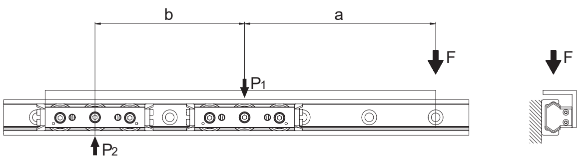
Slider load:

$$P_{1a} \approxeq P_{2a} = \frac{F}{2}$$

$$P_{2b} \approxeq P_{1b} = F \cdot \frac{a}{b}$$

Horizontal movement

Static test



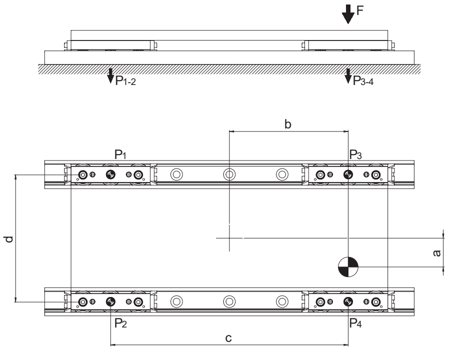
Slider load:

$$P_2 = F \cdot \frac{a}{b}$$

$$P_1 = P_2 + F$$

Horizontal movement

Static test



Note: It is defined that the slider no. 4 is always located closest to the point where the force is applied.

Slider load:

$$P_1 = \frac{F}{4} - \left(\frac{F}{2} \cdot \frac{b}{c}\right) - \left(\frac{F}{2} \cdot \frac{a}{d}\right)$$

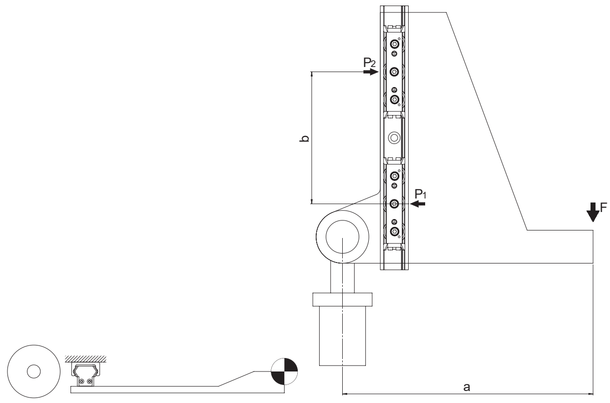
$$P_2 = \frac{F}{4} - \left(\frac{F}{2} \cdot \frac{b}{c}\right) + \left(\frac{F}{2} \cdot \frac{a}{d}\right)$$

$$P_3 = \frac{F}{4} + \left(\frac{F}{2} \cdot \frac{b}{c}\right) - \left(\frac{F}{2} \cdot \frac{a}{d}\right)$$

$$P_4 = \frac{F}{4} + \left(\frac{F}{2} \cdot \frac{b}{c}\right) + \left(\frac{F}{2} \cdot \frac{a}{d}\right)$$

Vertical movement

Static test

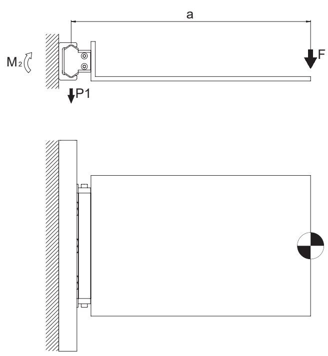


Slider load:

$$P_1 \approx P_2 = F \cdot \frac{a}{b}$$

Horizontal movement

Static test



Slider load:

$$P_1 = F$$

$$M_2 = F \cdot a$$

Explanation of the calculation formula

F	= effective force (N)
F_g	= weight-force (N)
P_1, P_2, P_3, P_4	= effective load on the slider (N)
M_1, M_2	= effective moment (Nm)
m	= mass (kg)

Service life

The dynamic load capacity C is a conventional variable used for calculating the service life. This load corresponds to a nominal service life of 100 km. For values of the individual slider. The following formula links the calculated theoretical service life to the dynamic load capacity and the equivalent load:

$$L_{km} = 100 \cdot \left(\frac{C}{P} \cdot \frac{f_c}{f_i} \cdot f_h\right)^3$$

L_{km} = theoretical service life(km)
C = dynamic load capacity (N)
P = effective equivalent load (N)
f_c = contact factor (N)
f_i = application coefficient
f_h = stroke factor

The equivalent load P corresponds in its effects to the sum of the forces and moments working simultaneously on a slider. If these different load components are known, P results as follows:

$$P = P_1 + \left(\frac{P_a}{C_{0ax}} + \frac{M_1}{M_x} + \frac{M_2}{M_y} + \frac{M_3}{M_z}\right) \cdot C_{0rad}$$

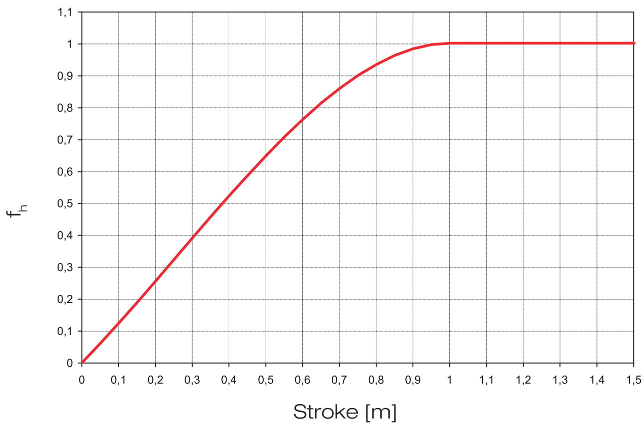
Here the external loads are assumed as constant in time. Brief loads, which do not exceed the maximum load capacities, do not have any relevant effect on the service life and can therefore be neglected. The contact factor f_c refers to applications in which several sliders pass the same rail section. If two or more sliders move over the same point of a rail, the contact factor to be taken into account in the formula for calculation of the service life.

Number of sliders	1	2	3	4
f_c	1	0,8	0,7	0,63

The application coefficient f_i takes into account the operational conditions in the service life calculation. It has a similar significance to the safety factor S_0 in the static load test. It is calculated as described in the following table:

Neither shocks nor vibrations, smooth and low-frequency direction change; clean operating conditions; low speeds (<1 m/s)	1 - 1,5
Slight vibrations, average speeds (1 - 2,5 m/s) and average frequency of direction change	1,5 - 2
Shocks and vibrations, high speeds (>2,5 m/s) and high-frequency direction change, extreme dirt contamination	2 - 3,5

The stroke factor f_h takes into account the higher load of the raceways and rollers during short strokes on the same total length of run. The corresponding values are taken from the following graph (for strokes longer than 1 m, f_h =1):



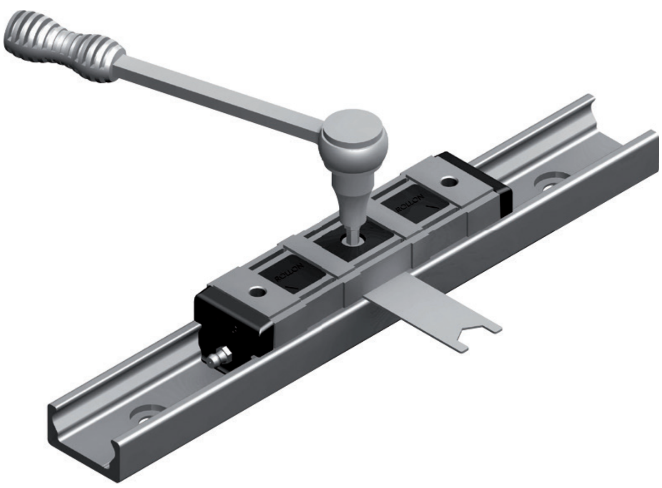
Installation Instructions

Adjusting the Sliders

Normally the linear guides are delivered as a system consisting of rail and adjusted sliders. If rail and slider are delivered separately or if the slider is installed in another raceway, the preload must be set again.

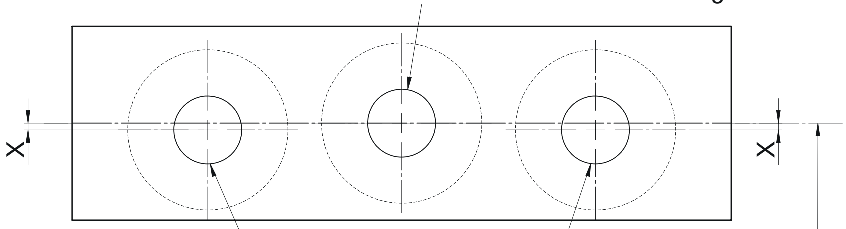
Setting the preload:

1. Check the cleanliness of the tracks.
2. Insert the slider in the rail (CSW sliders should be inserted without wipers). Slightly loosen the fixing screws of the roller pins to be adjusted.
3. Position the slider on one end of the rail.
4. For the U rails there must be a thin support (e.g. set key) under the ends of the slider body to ensure the horizontal alignment of the slider in the flat raceways.
5. Insert the flat key on the side with the triangular symbol combined with a red mark of the screw head (N-series slider), or on the side with a circle symbol (CSW-slider) between rail and slider.
6. By turning the flat key clockwise, the roller to be adjusted is pressed against the upper track and the slider is then without play. Avoid a preload that is too high. It generates increased wear and reduces the service life.
7. While holding the correct position of the roller pin with the adjustment key, the fixing screw can be carefully tightened. The exact tightening torque will be checked later.
8. Move the slider in the rail and check the preload over the entire length of the rail. It should move easily and the slider should not have play at any location of the rail.
9. For sliders with more than 3 rollers, repeat this process with each eccentric roller pin. Always start with the first roller pin after the one with the red marking. Make sure that all roller pins have uniform contact to the raceways.
10. Now tighten the fixing screws with the specified tightening torque from the table while the flat key holds the angle adjustment of the pin. A special thread in the roller pin secures the set position.
11. Now install the wiper of the CSW-sliders and ensure a proper lubrication of the raceways.

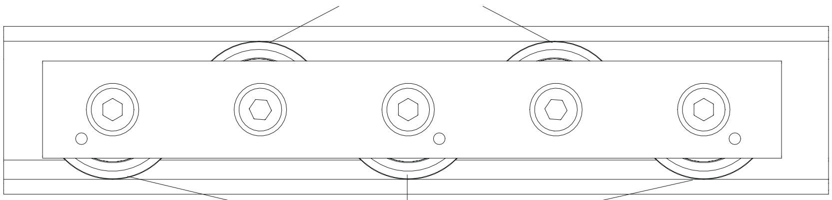


Slider size	Tightening torque Nm
18	3
28	7
43	12
63	35

Use of radial ball bearings



Slider size	x (mm)
18	0.40
28	0.45
43	0.60
63	0.55



Rail installation with reference surface as support

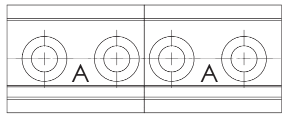
1. Remove unevenness, burrs and dirt from the support surface.
2. Press the rail against the support surface and insert all screws without tightening them.
3. Start tightening the fixing screws to the specified torque on one end of the rail while continuing to hold pressure on the rail against the support surface.

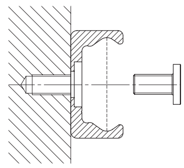
Screw type	Tightening torque Nm
M4 (T..., U... 18)	3
M5 (T..., U... 28)	9
M8 (T..., U..., K... 43)	22
M8 (T..., U..., K... 63)	35

Installation of Joined Rails

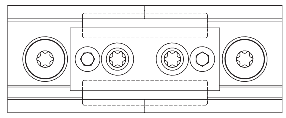
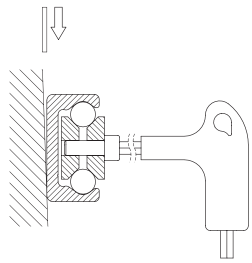
After the fixing holes for the rails are made in the load-bearing structure, the joined rails can be installed according to the following procedure:

1. Fix the individual rails on the mounting surface by tightening all screws except for each last one on the rail joint.
2. Install the end fixing screws without tightening them.

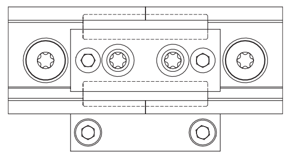
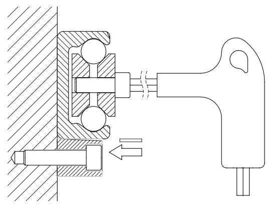




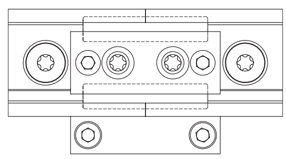
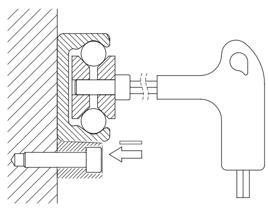
3. Place the alignment fixture on the rail joint and tighten both set screws uniformly, until the race-ways are aligned.
4. After the previous step (3) it must be checked if both rail backs lie evenly on the mounting surface. If a gap has formed there, this must be shimmed.

5. The bottom of the rails should be supported in the area of the transition. Here a possible existing gap must be looked for, which must be closed if necessary for correct support of the rail ends by shims.

6. Insert the key through the holes in the align-ment fixture and tighten the screws on the rail ends.
7. For rails with 90° countersunk holes, tighten the remaining screws starting from the rail joint in the direction of the rail center. For rails with cylindrical counter-sunk holes, first adjust the rail to an external reference, then proceed as described above.
8. Remove the alignment fixture from the rail.

Remarks

- The sliders are equipped with rollers that are in alternating contact with both sides of the raceway. Markings on the body around the roller pins indicate correct arrangement of the rollers to the external load.
- By a simple adjustment of the eccentric rollers, the slider has clearance set by the desired preload in the rail.
- Rails in joined design are available for longer transverse distances.
- The K-rails are not suitable for vertical installation.
- Screws of property class 10.9 must be used.
- Differences in screw sizes must be observed.
- Ensure that the fixing holes of the adjacent construction are sufficiently countersunk during rail installation.