Roller profile rail guides
LLU

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Contents

SKF – the knowledge engineering company

From one simple but inspired solution to a misalignment problem in a textile mill in Sweden, and fifteen employees in 1907, SKF has grown to become a global industrial knowledge leader.

Over the years, we have built on our expertise in bearings, extending it to seals, mechatronics, services and lubrication systems. Our knowledge network includes 46 000 employees, 15 000 distributor partners, offices in more than 130 countries, and a growing number of SKF Solution Factory sites around the world.

Research and development

We have hands-on experience in over forty industries based on our employees' knowledge of real life conditions. In addition, our world-leading experts and university partners pioneer advanced theoretical research and development in areas including tribology, condition monitoring, asset management and bearing life theory. Our ongoing commitment to research and development helps us keep our customers at the forefront of their industries.

Meeting the toughest challenges

Our network of knowledge and experience, along with our understanding of how our core technologies can be combined, helps us create innovative solutions that meet the toughest of challenges. We work closely with our customers throughout the asset life cycle, helping them to profitably and responsibly grow their businesses.

Working for a sustainable future

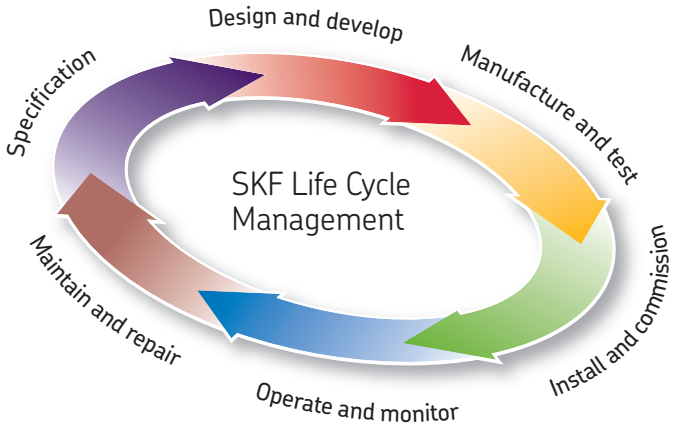
Since 2005, SKF has worked to reduce the negative environmental impact from our operations and those of our suppliers. Our continuing technology development resulted in the introduction of the SKF BeyondZero portfolio of products and services which improve efficiency and reduce energy losses, as well as enable new technologies harnessing wind, solar and ocean power. This combined approach helps reduce the environmental impact both in our operations and our customers' operations.

SKF Solution Factory makes SKF knowledge and manufacturing expertise available locally to provide unique solutions and services to our customers.

Working with SKF IT and logistics systems and application experts, SKF Authorized Distributors deliver a valuable mix of product and application knowledge to customers worldwide.

Our knowledge – your success

SKF Life Cycle Management is how we combine our technology platforms and advanced services, and apply them at each stage of the asset life cycle, to help our customers to be more successful, sustainable and profitable.



Working closely with you

Our objective is to help our customers improve productivity, minimize maintenance, achieve higher energy and resource efficiency, and optimize designs for long service life and reliability.

Innovative solutions

Whether the application is linear or rotary or a combination, SKF engineers can work with you at each stage of the asset life cycle to improve machine performance by looking at the entire application. This approach doesn't just focus on individual components like bearings or seals. It looks at the whole application to see how each component interacts with each other.

Design optimization and verification

SKF can work with you to optimize current or new designs with proprietary 3-D modelling software that can also be used as a virtual test rig to confirm the integrity of the design.

Bearings
SKF is the world leader in the design, development and manufacture of high performance rolling bearings, plain bearings, bearing units and housings.

Machinery maintenance
Condition monitoring technologies and maintenance services from SKF can help minimize unplanned downtime, improve operational efficiency and reduce maintenance costs.

Sealing solutions
SKF offers standard seals and custom engineered sealing solutions to increase uptime, improve machine reliability, reduce friction and power losses, and extend lubricant life.

Mechatronics
SKF fly-by-wire systems for aircraft and drive-by-wire systems for off-road, agricultural and forklift applications replace heavy, grease or oil consuming mechanical and hydraulic systems.

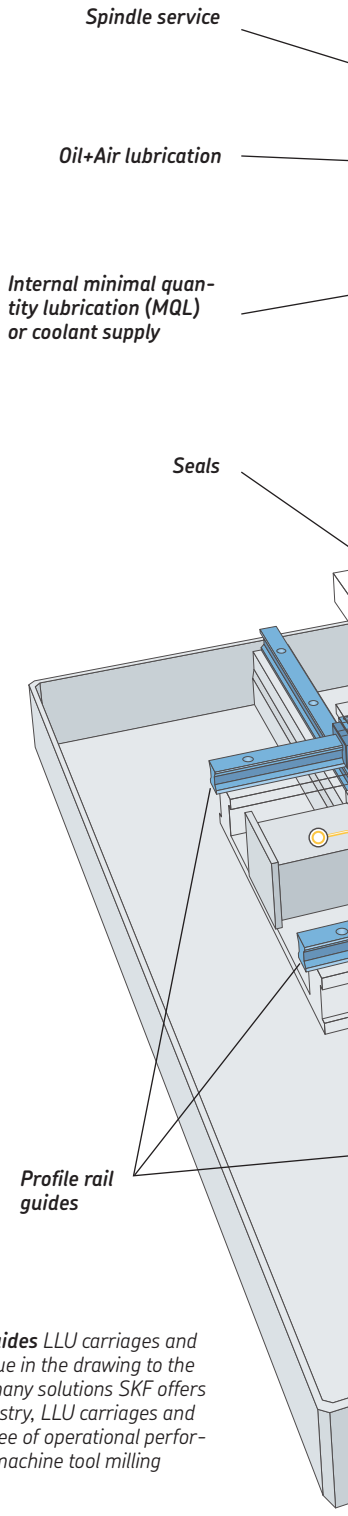
Lubrication solutions
From specialized lubricants to state-of-the-art lubrication systems and lubrication management services, lubrication solutions from SKF can help to reduce lubrication related downtime and lubricant consumption.

Actuation and motion control
With a wide assortment of products – from actuators and ball screws to profile rail guides – SKF can work with you to solve your most pressing linear system challenges.

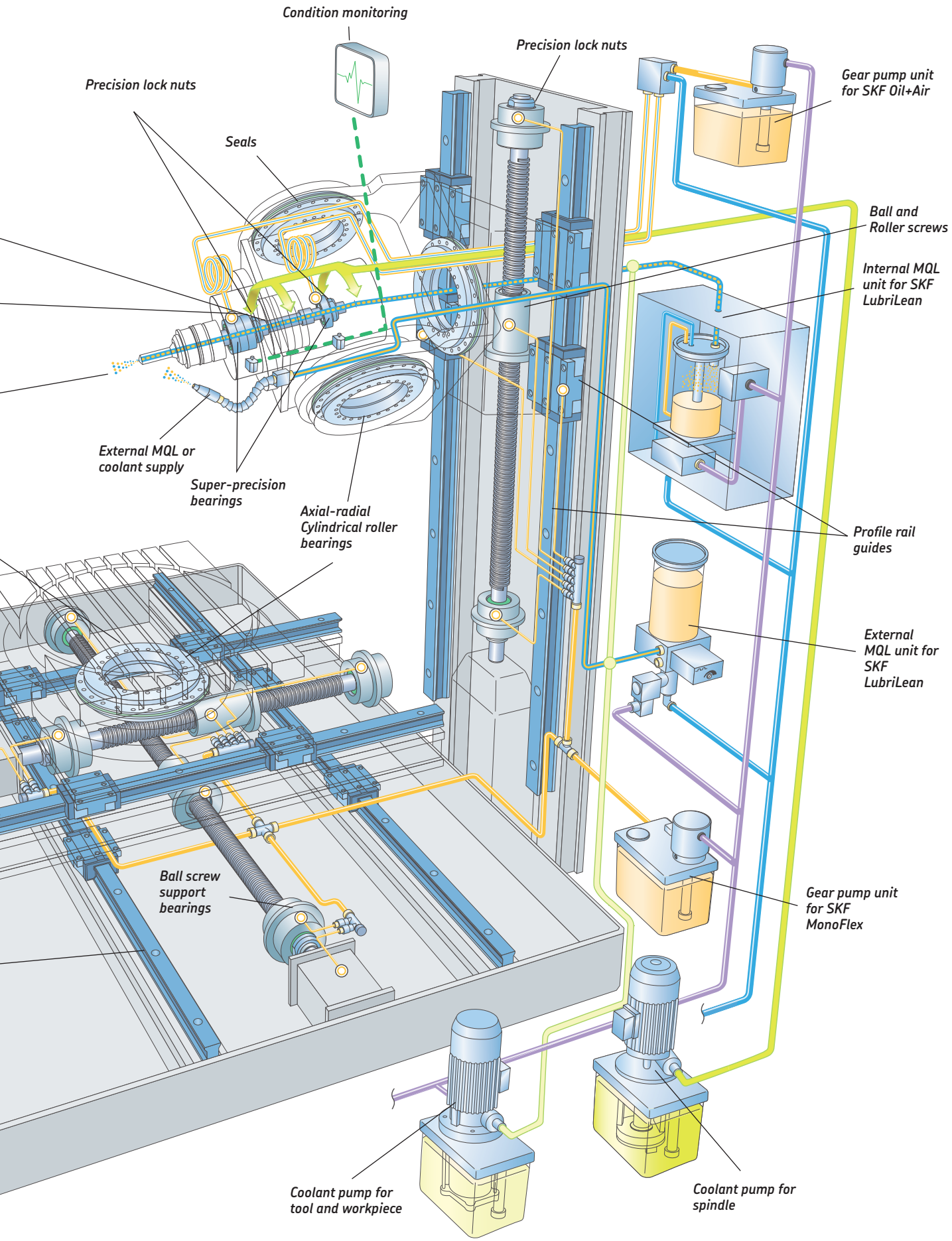
Advanced machine tool components and systems

High accuracy, high system rigidity, low heat generation and low noise and vibration levels are just some of the many requirements for mechanical components to succeed in the challenging field of machine tool applications. In addition, increasingly sophisticated machine tools require advanced and environmentally friendly lubrication and coolant systems in combination with state-of-the-art sealing technologies for optimum operation. In summary, in-process measurements and advanced condition monitoring solutions are the key to machine tool improved reliability.

With the complete SKF product and service offer as well as its global availability, the performance, reliability and efficiency of machine tools can be significantly increased. The following picture is an example of the products and services that SKF offers for a multi-axis milling machining center.



SKF profile rail guide guides *LLU carriages and rails are highlighted in blue in the drawing to the right. In addition to the many solutions SKF offers for the machine tool industry, LLU carriages and rails bring a greater degree of operational performance and efficiency to machine tool milling centres.*


Condition monitoring
Precision lock nuts
Precision lock nuts
Seals
Gear pump unit for SKF Oil+Air
Ball and Roller screws
Internal MQL unit for SKF LubriLean
External MQL or coolant supply
Super-precision bearings
Axial-radial Cylindrical roller bearings
Profile rail guides
External MQL unit for SKF LubriLean
Ball screw support bearings
Gear pump unit for SKF MonoFlex
Coolant pump for tool and workpiece
Coolant pump for spindle

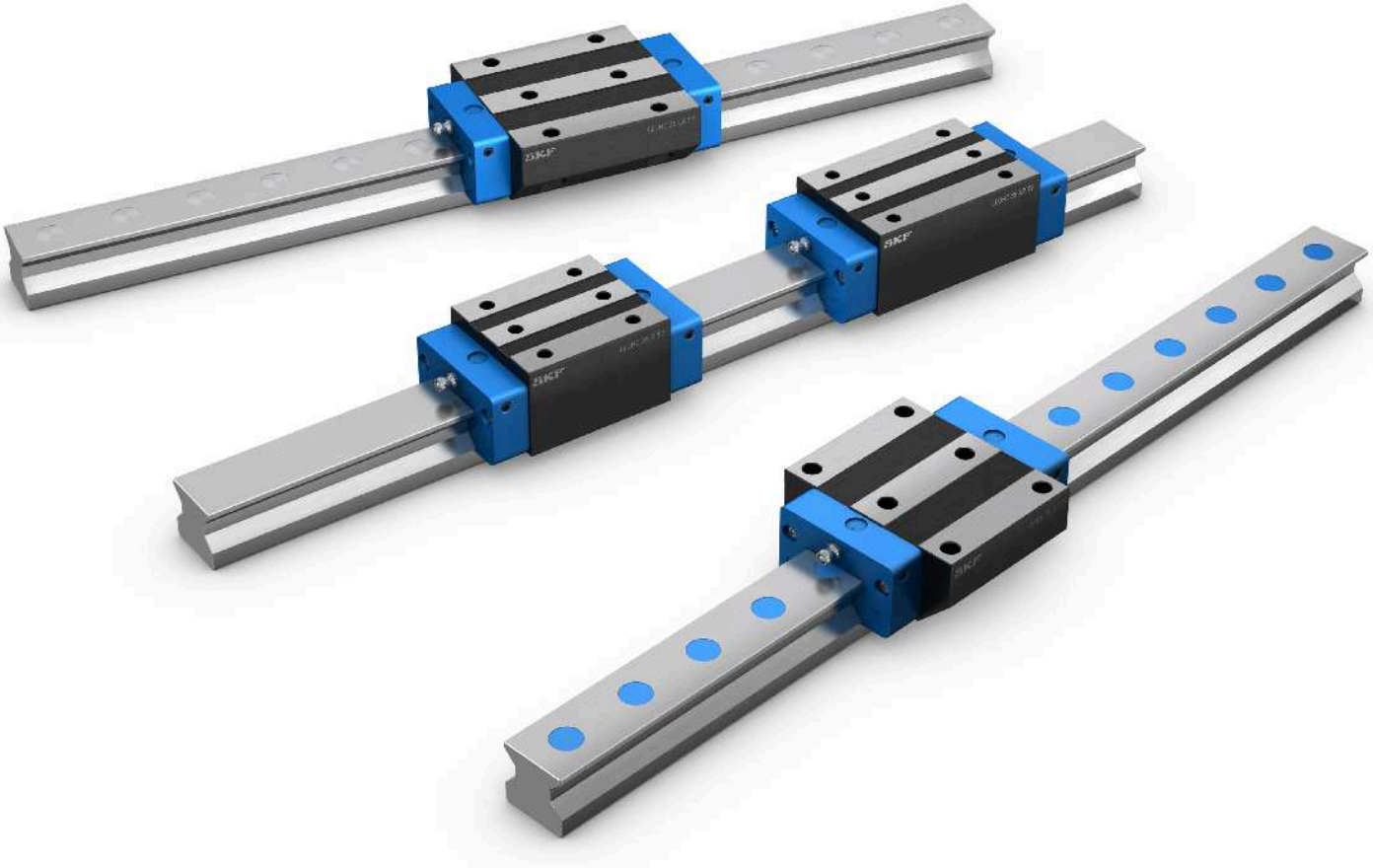
Foreword

The productivity and economic success of a given application depends, to a large extent, on the quality of the selected linear components. Often these components are a significant factor in market acceptance and thus help to obtain a competitive edge for the manufacturer. To do this, the linear components have to be as adaptable as possible to precisely meet the application's requirements, ideally with standard components.

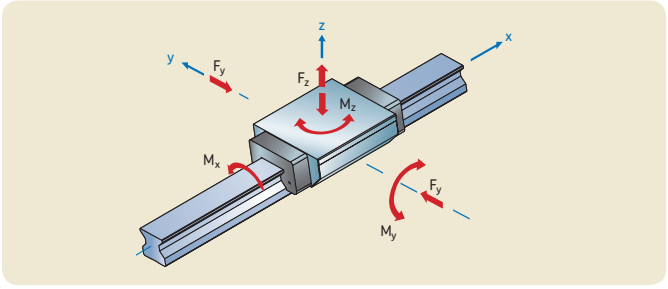
The SKF roller profile rail guide series LLU satisfies these market demands: available in a wide range of sizes, carriages and accessories as well as in various preload and precision classes, LLU roller profile rail guides facilitate adaptation to individual application demands. In combination with their ability to operate at virtually unlimited stroke, this opens up almost any design option.

SKF offers LLU roller profile rail guides in an O-arrangement with a rectangular setup of the raceways and roller sets in a 45° orientation towards the guiding base. This design promotes equal load sharing in all four main load directions to provide greater design flexibility. The range of possible applications reaches from machines for turning, milling and grinding in machine tools, presses and other heavy machinery equipment with demand for very precise and high load carrying guides. In these types of applications, the design of the LLU reveals its full capabilities in reliable and smooth operation under a variety of operating conditions.

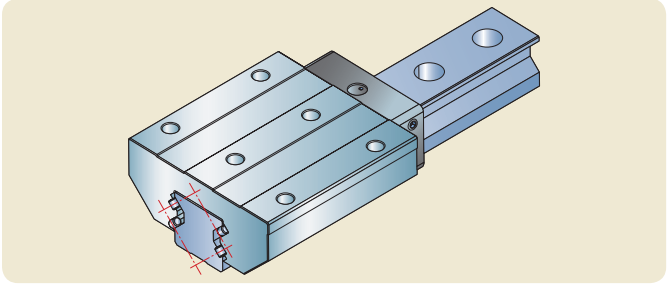
In addition, SKF offers both LLT profile rail guide and LLM miniature profile rail guide series as well as a series of ready assembled profile rail guide slides, e.g. LTS. Contact your SKF representative for additional information.



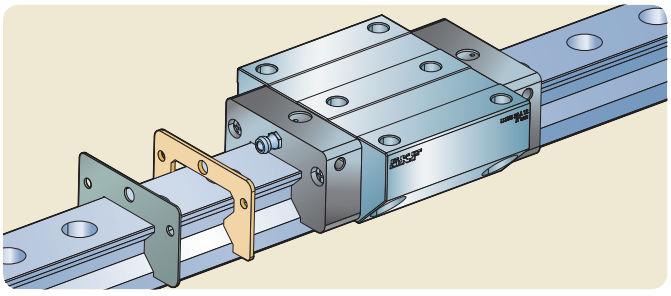
Features and benefits



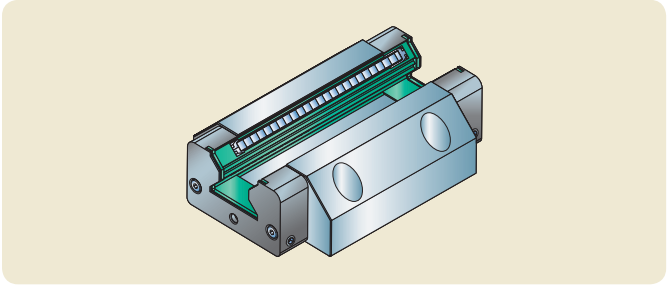
Rigidity, strength and accuracy for improved production processes
The LLU roller profile rail guide has four rows of cylindrical rollers in O-arrangement with the four raceways in 45° orientation towards the guiding base. This arrangement optimizes the load sharing in all four main load directions and is in accordance with ISO 14728. This feature provides a high degree of design flexibility. The ability to accommodate high loads and moment loads makes these rail guides ideal even for very demanding applications.



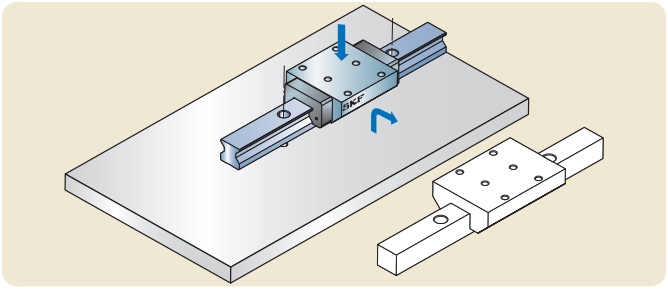
Smooth running performance
Optimized recirculations, raceways and the O-arrangement of the cylindrical rollers enable reliable, stick-slip-free operation for the whole life of the rail guide.



Modular concept for customized solutions
Applications have different load, precision and environmental requirements. As a result, SKF roller profile rail guides LLU use modular components so that cost-effective solutions can be built based on the needs of the application. Various precision and preload classes are available to meet the different needs. Furthermore, a wide range of accessories support its adaptation to specific environmental conditions.

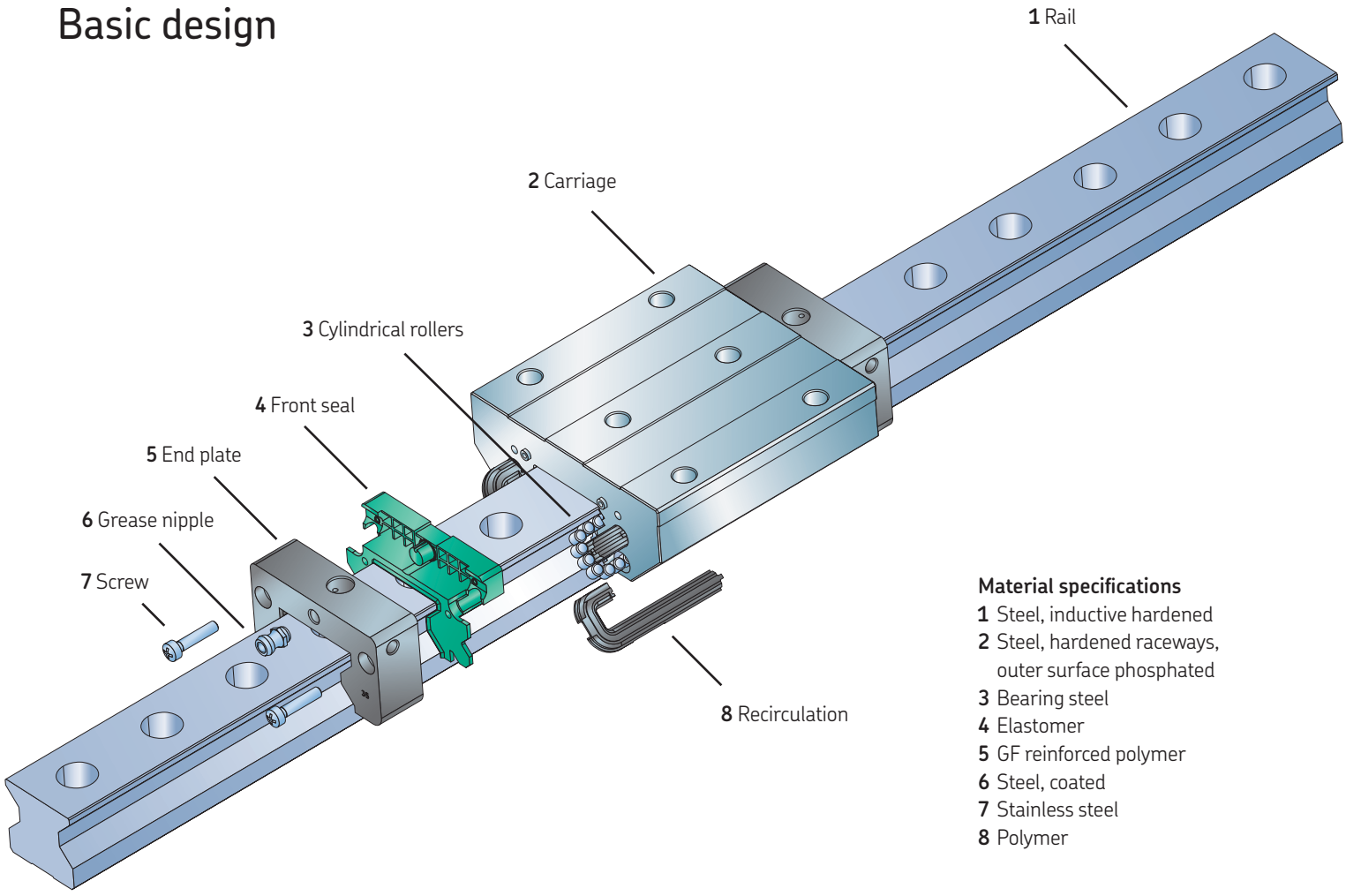


Longer service life and reduced maintenance
SKF roller profile rail guide LLU carriages and rails are protected with anti-corrosion preservation for transport, storage and mounting.
Both end plates of the carriage feature four (3+1) lube ports at different positions for manual lubrication or connection to automatic lubrication systems.
One straight grease nipple is provided as standard with each carriage.
The carriages are fully sealed with double lip seals on both ends and longitudinal seals along the rail. The seals have been proven to be highly effective against the ingress of contaminants and have low friction.



Interchangeability and global availability
The main dimensions of all SKF profile rail guides are in accordance with ISO 12090-1. This enables dimensional interchangeability with all ISO-compliant brands. SKF's global sales and distribution network results in availability of replacement parts and serviceability for all systems worldwide.

Basic design



Material specifications
1 Steel, inductive hardened
2 Steel, hardened raceways, outer surface phosphated
3 Bearing steel
4 Elastomer
5 GF reinforced polymer
6 Steel, coated
7 Stainless steel
8 Polymer

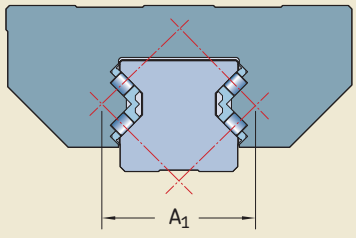
Just as with rotary bearings, the raceways of profile rail guides can be arranged in an X- or O-arrangement. The technical characteristics of these two arrangements are essentially the same. Therefore, there are no basic differences in behavior in the vast majority of load situations, except when they are subjected to moment loads around the X-axis.

The LLU roller profile rail guides from SKF feature an O-arrangement, based on the contact angle of the rolling elements (→ **fig. 1**). The advantage of this arrangement is that especially in one-axis systems, the moment-related rigidity is higher than comparable systems with an X-arrangement. Due to the design-related bigger lever arm, the O-arrangement provides better rigidity and thus higher accuracy.

The line contact between cylindrical rollers and raceways offers superior load carrying capacities to comply with the highest demands in particular applications.

Fig 1

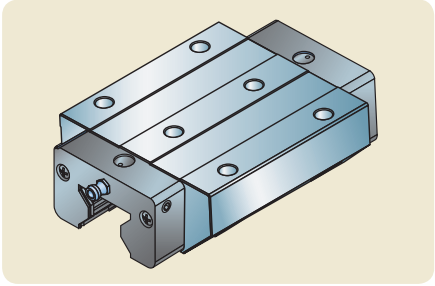
Schematic illustration of the roller arrangement

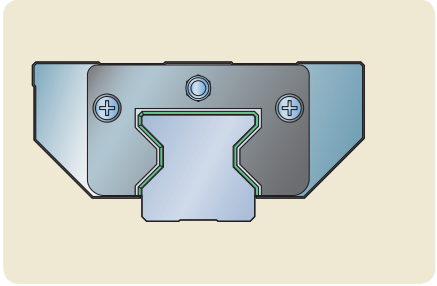


O-arrangement

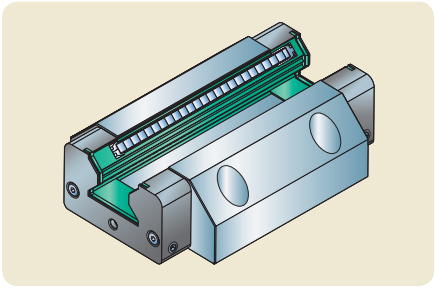
Seals

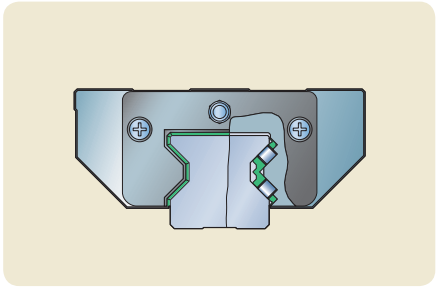
The ingress of dirt, swarf and liquids, as well as lubricant leakage can significantly reduce the service life of a profile rail guide system. SKF roller profile rail guide LLU carriages are therefore supplied with a front and side seal as standard, which can significantly extend service life.





Front seal
Front seals are especially important since they offer protection for the carriage in the direction of movement. They are designed as double-lip seals in order to provide improved wiping properties.





Side seal
Side seals made of elastomer effectively prevent contaminants from working their way into the system from below.

Load rating

Definition of the basic dynamic load rating C

The basic dynamic load rating C is the radial load, constant in magnitude and direction, which a linear rolling bearing can theoretically accommodate for a basic rating life represented by a travelled distance of 100 km (according to ISO 14728 Part 1).

NOTE: As per ISO 14728 Part 1, it is also permissible to reference a distance of 50 km travelled. In this case, a conversion factor of 1,23 for linear guides with roller recirculation should be applied in order to enable proper comparison of the two load rating values (→ **formula 1**).

(**1**) $$C_{100} = \frac{C_{50}}{1,23}$$

Definition of the basic static load rating C_0

The basic static load rating C_0 is the static load in the direction of loading, which corresponds to a calculated stress at the center of the most heavily loaded contact point between the rolling element and each of the raceways of carriage and rail.

NOTE: This stress produces a permanent total deformation of the rolling element and the raceway, which corresponds to about 0,0001 times the rolling element diameter (according to ISO 14728 Part 2).

Verification and validation

The load ratings stated in this catalogue have been calculated for all product types based on the standards cited. The calculation model prescribed in the standards has been complemented and verified by SKF through internal simulations.

SKF carries out standardized durability examinations at regular intervals by means of selected reference sizes. These tests provide statistical evidence and documentation that the theoretically ascertained load ratings are valid under standardized practical test conditions.

In many cases, this SKF internal validation process saves the customer intensive field tests and offers high reliability for LLU roller profile rail guide designs.

Only in cases where the operating conditions are not known, as well as in cases where these conditions are more demanding than usual, are customers advised to conduct further field tests.

In practice, it is common to integrate results and experiences of existing and proven designs in new designs and apply them to new applications. When using LLU roller profile rail guides, it also makes sense for customers to build on previous application experience in the continuous development of their applications.

Rigidity

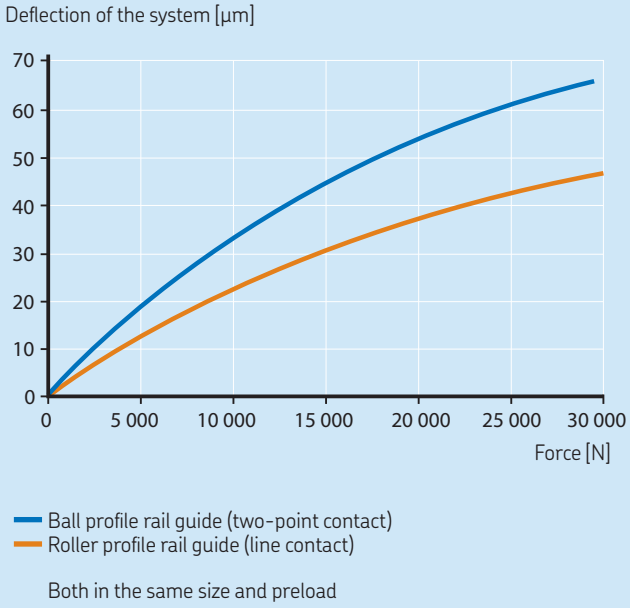
The rigidity of LLU roller profile rail guides, in addition to their load rating, is one of the most important criteria in product selection. Rigidity can be defined as the deflection characteristics of a guiding system under external load. The rigidity of a system depends on the magnitude and direction of the external load, the type of guiding system (size, carriage type, preload) and the mechanical properties of the interface support structure. Usually, this load is indicated, including magnitude and direction, on the point of load application of the mounted guiding system.

Rigidity values, which only take elastic deformation of the rolling elements into consideration, can deviate considerably under realistic conditions due to the elasticity of the support structure, the screw connections and the joints between components. Therefore, the overall rigidity at the bearing point is, as a rule, lower than that of the used guiding system.

The different sizes and types of LLU roller profile rail guides feature significant differences in their deflection behavior. **Diagram 1** represents an example of only the deflection values for a single reference size.

Diagram 1

Rigidity comparison between roller and ball guides



For rigidity values and diagrams of a specific type, please visit **http://www.skf.com/group/products/linear-motion/linear-guides-and-tables/profile-rail-guides/index.html** *or contact SKF.*

Preload classes

Preload and rigidity

To adjust a profile rail guide to the specific requirements of a given application, it is advisable to choose an appropriate preload. Preload can enhance the performance of an entire linear guiding system and increase the rigidity of the carriage under load.

Preload is determined by oversizing between cylindrical rollers and raceways on carriage and rail track. This is ensured by state-of-the-art, high-precision grinding processes carefully matched with rolling elements.

SKF roller profile rail guides LLU are available in two different preload classes, as shown in **table 1.**

Table 1

Determining preload values according to preload class

Preload class	Preload force F_{Pr}
T2	**F_{Pr} = 8% of C** For precise profile rail guide systems with high rigidity and medium to higher bearing loads.
T3	**F_{Pr} = 13% of C** For precise profile rail guide systems with maximum rigidity, high bearing loads and vibrations. Also recommended for single-rail systems. Additional common moment loads are absorbed without any significant elastic deformation.

Accuracy

Precision classes

SKF offers its LLU roller profile rail guides in four precision classes. These precision classes define the tolerance range of a roller profile rail system in terms of height, width and parallelism (→ **table 2**). This choice determines the running accuracy of the system within the application.

Width and height tolerances

The tolerance of width N determines the maximum deviation of the distance from the carriage to the rail in lateral direction. Both side faces of the rail and the ground part of the carriage's side face can be used as reference sides.

The tolerance of height H is measured between the mounting surface of the carriage and the ground bottom face of the rail.

The tolerance values for H and N are arithmetic mean values and refer to the center of the carriage. They are marked on the carriages and also on the marking labels on the product boxes.

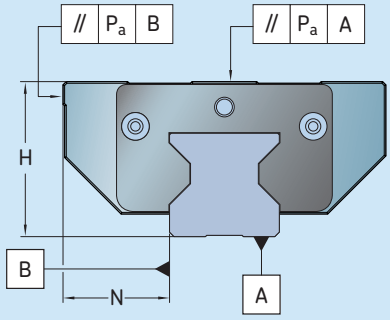
NOTE: The reference side face of the carriage is the ground part opposite of the side with the product designation.

Parallelism

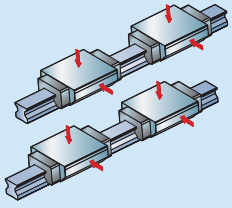
The values in **diagram 2** show the parallelism P_a for the width and the height as explained in **table 2**. They are depending on the rail length and the precision class. The rail has to be bolted with its ground bottom face to a flat and accurate surface.

NOTE: Precision class P001 can only be ordered as a complete system.

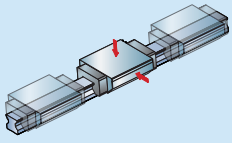
Table 2



Precision class[1]	Tolerances of		Difference in dimension H and N on one rail	
	H	N	ΔH max.	ΔN max.
–	µm		µm	
P3	±30	±20	15	15
P1	±20	±20	7	7
P01	±10	±7	5	5
P001	±5	±5	3	3



For any combination of carriages and rails

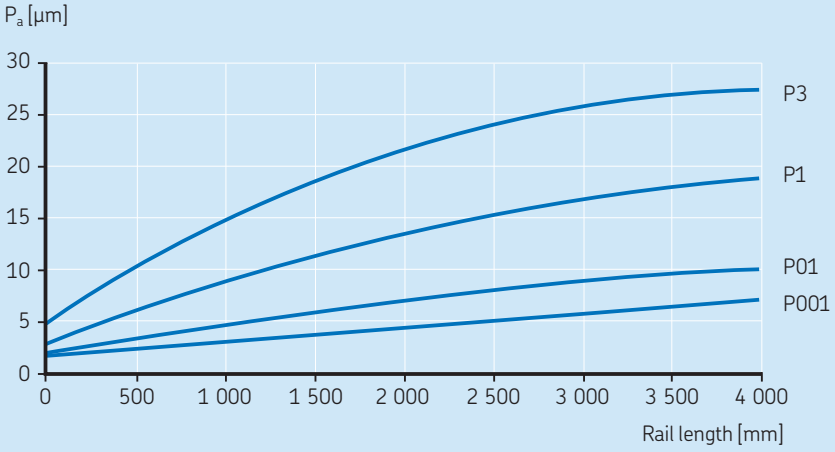


For different carriages on the same rail position

[1] Measured at the centre of the carriage.

Diagram 2

Parallelism P_a



Permissible operating conditions

The function of LLU roller profile rail guides can be realized only if there are no deviations from the specified operating conditions. The formulae and life values stated in the chapter calculation bases (→ **page 15**) are valid only if the operating conditions described in the following are adhered to.

Dynamic values

LLU roller profile rail guides can reach a maximum speed of v_{max} = 3 m/s.

The maximum acceleration is a_{max} = 50 m/s^2.

Required minimum load

To prevent the rolling elements from sliding in the load zone during operation, a linear guide must be under a minimum load at all times. Because the LLU carriage is always preloaded, this minimum load is provided by its design principle. Thus it does not specifically have to be considered for the application by the user.

Permissible maximum load

When selecting a LLU roller profile rail guide, the dynamic and static load ratings are key factors in this process.

For example, the equivalent dynamic mean load P_m during operation must not exceed 50% of the dynamic load rating. To calculate the dynamic bearing load, **see page 17**.

Exceeding the dynamic load ratings in operation results in a deviation of the usual load distribution and can significantly reduce bearing service life. A statistical evaluation according to the Weibull distribution (continuous probability distribution) is not reliable in these cases.

As stated in ISO 14728 Part 2, the maximum load should not exceed 50% of the static load rating C_0.

Standstill

When external forces create vibrations in a stationary LLU roller profile rail guide, surface damage due to micro-movements between the cylindrical rollers and raceways may occur. This can increase noise levels during dynamic operation and reduce system service life.

To avoid this type of damage, the guides should be isolated from external vibration and mechanically unloaded for transport purposes.

Permissible operating temperatures

The permissible temperature range for LLU roller profile rail guides is:

Continuous operation: –10 to +80 °C

This temperature range is determined by the synthetic materials used for the end plates, recirculations and seals.

The time limit for the permissible maximum temperature is dependent on the actual operating conditions. Low speed (< 0,2 m/s), slightly loaded (P < 15% C) or stationary applications can be exposed to an ambient temperature of < 100 °C for up to one hour. Design measures, such as heat shielding can extend this period.

Be sure to check prior to use that the temperature limits of the lubricant can withstand elevated temperatures.

Friction

In addition to the external operating load, the friction in a guiding system is determined by a number of other factors: the preload class, the speed of travel, the viscosity of the lubricant, etc. should be taken into consideration.

The displacement resistance is determined by the proportions of rolling and sliding friction generated by the rolling elements in the contact zone. Also, the recirculation geometry as well as the lubricant has an influence.

The effect of the lubricant depends on its characteristics, quantity and condition.

A running-in phase provides a better distribution of the lubricant in the carriage, and therefore reduces friction.

The operating temperature of the guiding system also influences friction. Higher temperatures reduce the viscosity of the lubricant.

Another factor is the sliding friction of the front and longitudinal seals in contact with the profile rail guide. The friction generated by the seals will, however, decrease after the running-in phase.

Moreover, the mounting accuracy of the rails relative to each other plays an important part, just like the flatness of both the mounting and the base plate.

The coefficient of friction for lubricated roller profile rail guides is typically between μ = 0,004 and 0,006. Lower values should be selected for higher loads, and higher values for lower loads. The friction values of the seals must be added to these values and can be made available upon request.

Lubrication

Two different lubrication methods are available for LLU: grease and oil lubrication.

In addition, LLU roller carriages and rails are protected with high-quality anti-corrosion preservation oil for transport, storage and mounting. This special oil supports initial installation of LLU and can remain in the product if the SKF recommended lubricants are used. For more information, see **page 49.**

Calculation bases

The calculation methods described in this chapter must take into account all actual loads and forces acting on the individual carriages.

Static safety factor

The static safety factor is expressed as the relationship between the static load rating and the maximum static bearing load including preload (→ **page 16**). The load conditions (→ **page 19**) acting on the guiding system during operation must also be taken into account. The static safety factor indicates the level of safety against permanent plastic deformation of the rolling elements and raceways and is calculated according to **formula 2**.

(**2**) $$s_0 = \frac{C_0}{P_0} = \frac{C_0}{f_d F_{res\,max}}$$

where
C_0 = static load rating [N]
f_d = factor for load conditions
$F_{res\,max}$ = maximum resulting load [N]
P_0 = maximum static load [N]
s_0 = static safety factor

Based on practical experience, guideline values have been specified for the static safety factor, which depend on the operating mode and other external factors. See **table 3**.

If, for example, the guiding system is exposed to vibrations from the machining process, higher safety factors should be applied. Moreover, the load transfer paths between a profile rail guide and its support structure should be taken into account. In particular, the bolted connections must be examined for sufficient safety. See also the chapter *Mounting and maintenance* (→ **page 44**). For overhead installations of LLU roller profile rail guides, higher safety factors should be applied. In any case, all provided attachment holes in carriage and rail are to be used in the application to make sure that loads applied on the linear guide will safely be taken and transferred.

NOTE: The maximum resulting load $F_{res\,max}$ should be calculated based on the combined static bearing load $F_{comb\,stat}$ determined according to the chapter *Combined static bearing load*, on **page 16**.

NOTE: The general technical rules and standards in the respective industrial sector must also be observed.

Basic rating life L_{10}

Under controlled laboratory conditions, seemingly identical bearings operating under identical conditions have different individual endurance lives. A clearer definition of the term "bearing life" is therefore essential to calculate bearing size as outlined in *Basic rating life at constant speed*..

IMPORTANT: All information presented by SKF with regard to load ratings is based on the life that 90% of a sufficiently large group of apparently identical bearings can be expected to attain or exceed.

Table 3

Static safety factor depending on operating conditions

Operating conditions	s_0
Normal conditions	min. 2
Smooth, vibration-free operation	>2–4
Medium vibrations or impact loads	3–5
High vibrations or impact loads	>5
Overhead installations	The general technical rules and standards in the respective industrial sector must be observed. And if the application poses a risk of serious injury, the user must take appropriate design and safety measures that will prevent the carriage from becoming detached from the rail (e.g. due to loss of rolling elements or failure of screw connections).

Basic rating life at constant speed

If the speed is constant, the basic rating life, L_{10s} or L_{10h}, can be calculated using **formulae 3** and **5**:

(**3**) $$L_{10s} = \left(\frac{C}{P}\right)^{\frac{10}{3}} 100$$

(**4**) $$P = \frac{f_d}{f_i \sqrt[\frac{10}{3}]{f_s}} F_{res}$$

(**5**) $$L_{10h} = \frac{5 \times 10^7}{S\,n\,60} \left(\frac{C}{P}\right)^{\frac{10}{3}}$$

where
C = dynamic load rating [N]
f_d = factor for load conditions
f_i = factor for number of carriages per rail
F_{res} = resulting load [N]
L_{10h} = basic rating life [h]
L_{10s} = basic rating life [km]
n = stroke frequency [double strokes/min]
P = equivalent dynamic load [N]
f_s = factor for stroke length
S = single stroke length [mm]

Applying a preload

Depending on the combined bearing load and preload class, the resulting load has to be calculated according to the following methodology to get the impact on the life of LLU roller profile rail guides.

Load case 1
$F_{comb} \leq 2{,}8\,F_{Pr}$ (F_{Pr} → **table 1**)

(**6**) $$F_{res} = \left(\frac{F_{comb}}{2{,}8\,F_{Pr}} + 1\right)^{1{,}5} F_{Pr}$$

Load case 2
$F_{comb} > 2{,}8\,F_{Pr}$ (F_{Pr} → **table 1**)

(**7**) $$F_{res} = F_{comb}$$

where
F_{comb} = combined, static or dynamic bearing load [N]
F_{Pr} = preload force [N]
F_{res} = resulting load [N]

Equivalent dynamic mean load

The rating life calculation formulae are based on the assumption that the load and the speed are constant. In reality the external loads, positions and speeds are changing in most cases and the workflow has to be separated into load phases with constant or approximately constant conditions along their individual strokes (**diagram 3**). All single load phases are summarized to the equivalent dynamic mean load P_m depending on their individual stroke length (**formulae 8** and **9**).

(**8**) $$P_m = \sqrt[\frac{10}{3}]{\frac{\sum_{j=1}^{V} \left| P_j^{\frac{10}{3}} \right| S_j}{S_{tot}}}$$

(**9**) $$S_{tot} = S_1 + S_2 + \ldots + S_v$$

where

P_m = equivalent dynamic mean load [N]
P = equivalent dynamic load [N]
j = counter for load phases
V = amount of load phases
S_j = individual stroke length [mm]
S_{tot} = total stroke length [mm]

Maximum resulting load

The maximum value of F_{res} is required for calculating the static safety factor s_0. To this end, all loads must be calculated for the individual stroke lengths. With these figures, the maximum resulting load $F_{res\ max}$ can be calculated and then inserted in the equation for s_0.

(**10**) $$F_{res\ max} = \underset{j=1}{\overset{V}{MAX}} \left| F_{res,j} \right|$$

where

$F_{res\ max}$ = maximum resulting load [N]
$F_{res,j}$ = resulting load for load phase [N]
j = counter for load phase
V = amount of load phases

Combined bearing loads

The following chapter describes the method to calculate the combined bearing load with possible combinations of forces and moments. All load components must be constant in magnitude to enable their calculation as one load phase.

If one of the load proportions varies significantly in magnitude over the length of the stroke, a separate load phase must be calculated according to the same method.

NOTE: For the following four calculations, a load, acting on the carriage at any angle, must be broken down into the proportions F_y and F_z. These proportions are then inserted into the respective formula.

Combined static bearing load

For static vertical and horizontal loads, the combined static bearing load $F_{comb,stat}$ can be calculated using **formula 11** (→ **fig. 2**).

Formula 11 applies to a system with two rails and four carriages (no torque loads can occur).

(**11**) $$F_{comb,stat} = |F_y| + |F_z|$$

where

$F_{comb,stat}$ = combined static bearing load [N]
F_y, F_z = external bearing loads in y- and z-direction [N]

For combined static bearing loads – both vertical and horizontal – in combination with static moments, the combined static bearing load $F_{comb,stat}$ can be calculated using **formula 12** (→ **fig. 3**).

(**12**) $$F_{comb,stat} = |F_y| + |F_z| + C_0 \left(\left| \frac{M_x}{M_{xC_0}} \right| + \left| \frac{M_y}{M_{yC_0}} \right| + \left| \frac{M_z}{M_{zC_0}} \right| \right)$$

where

C_0 = static load rating [N]
$F_{comb,stat}$ = combined static bearing load [N]
F_y, F_z = bearing loads in y- and z-direction [N]
M_x, M_y, M_z = bearing moment loads at respective coordinates [Nm]
M_{xC_0}, M_{yC_0}, M_{zC_0} = permissible static moment loads [Nm]

Diagram 3

Variable load acting on a carriage

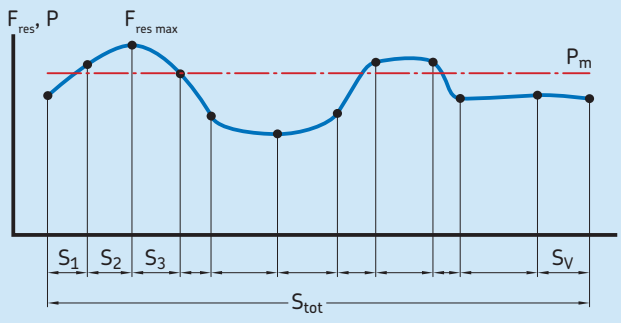
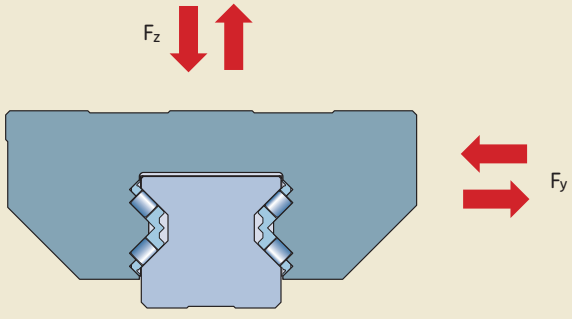


Fig 2



Formula 12 can be used for the following systems:
- One rail with one carriage (all types of moment loads can occur)
- Two rails with one carriage each (M_x cannot occur)
- One rail with two carriages (M_y, M_z cannot occur)

NOTE: The maximum value of $F_{comb,stat}$ is required for calculating the static safety factor s_0. To this end, all loads must be calculated for the individual stroke lengths. With these figures, the maximum resulting load $F_{res\ max}$ can be calculated and then inserted in the equation for s_0.

Combined dynamic bearing load

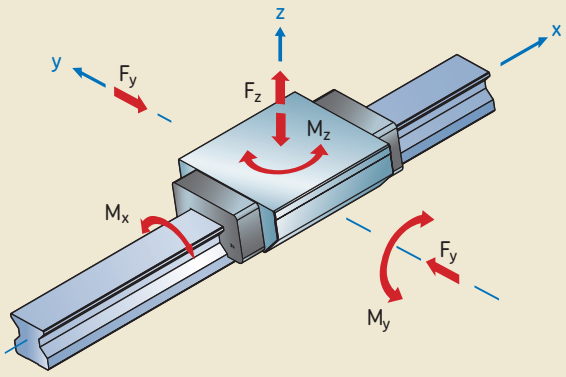
For loads – both vertical and horizontal (→ **fig. 2**) – the combined dynamic bearing load $F_{comb,dyn}$ is calculated by means of **formula 13**. **Formula 13** applies to a system with two rails and four carriages.

(13) $F_{comb,dyn} = |F_y| + |F_z|$

where
$F_{comb,dyn}$ = combined dynamic bearing load [N]
F_y, F_z = bearing loads in y- and z-direction [N]

NOTE: The design of the profile rail guide permits this simplified calculation. If different load phases exist for F_y and F_z, then F_y and F_z must be considered individually in **formula 8**.

Fig 3



When combined dynamic bearing loads and dynamic moments are present, the combined dynamic bearing load $F_{comb,dyn}$ can be calculated using **formula 14** (→ **fig. 3**) .

(14) $$F_{comb,dyn} = |F_y| + |F_z| + C\left(\left|\frac{M_x}{M_{xC}}\right| + \left|\frac{M_y}{M_{yC}}\right| + \left|\frac{M_z}{M_{zC}}\right|\right)$$

where
C = dynamic load rating [N]
$F_{comb,dyn}$ = combined dynamic bearing load [N]
F_y, F_z = bearing loads in y- and z-direction [N]
M_x, M_y, M_z = bearing moment loads at respective coordinates [Nm]
M_{xC}, M_{yC}, M_{zC} = permissible dynamic moment loads [Nm]

Formula 14 can be used for the following systems:
- One rail with one carriage (all types of moment loads can occur)
- Two rails with one carriage each (M_x cannot occur)
- One rail with two carriages (M_y, M_z cannot occur)

Factors of influence

Requisite reliability

Factor c_1 is used for lifetime calculations where reliability higher than 90% is needed. The corresponding values can be found in (→ **table 4**).

Table 4

Factor c_1 for reliability

Reliability %	L_{ns}	C_1
90	L_{10s}	1
95	L_{5s}	0,62
96	L_{4s}	0,53
97	L_{3s}	0,44
98	L_{2s}	0,33
99	L_{1s}	0,21

Operating conditions

The lubrication effectiveness is strongly dependent on the degree of separation between the rolling elements and raceway surfaces in the contact zones. A specific minimum viscosity is required for the formation of an effectively separating lubricating film at operating temperature, taking into account the kinematic conditions. Assuming a normal level of cleanliness of the profile rail guide as well as effective sealing, factor c_2 depends on the viscosity ratio κ exclusively. κ designates the ratio between the actual kinematic viscosity and the requisite minimum viscosity (→ **formula 15**).

(15) $\kappa = \frac{\nu}{\nu_1}$

where
κ = viscosity ratio
ν = actual kinematic viscosity [mm²/s]
ν_1 = requisite minimum viscosity [mm²/s]

The requisite minimum viscosity ν_1 for LLU guides depends on the mean speed (→ **diagram 4**).

The value for ν_1 can be related to the actual viscosity ν according to **formula 15** in order to obtain κ. Now c_2 can be taken from the following diagram (→ **diagram 5**). If the viscosity ratio κ is less than 1, a lubricant with EP additives is recommended. If lubricant with EP additives is used, the higher value for c_2 can be used for calculation.

Diagram 4

Determining the requisite minimum viscosity ν_1

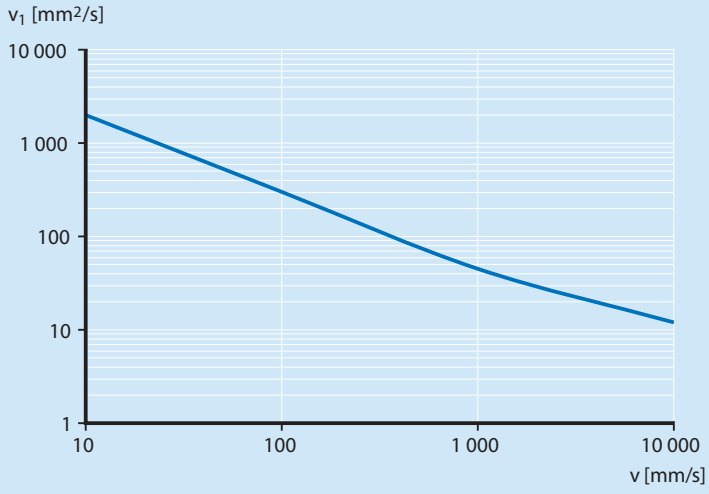
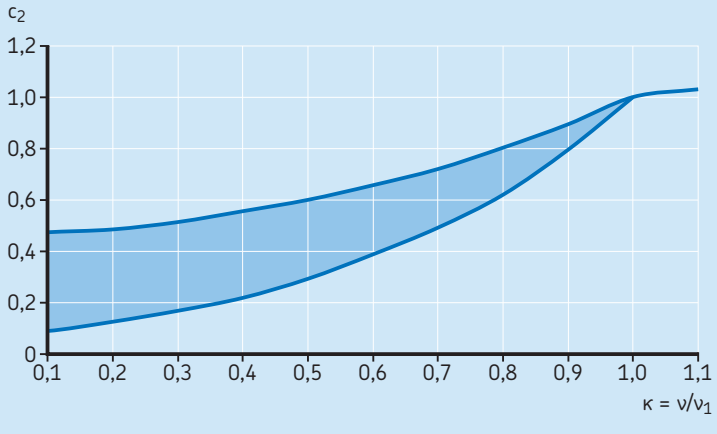


Diagram 5

Determining factor c_2 for operating conditions



Load conditions

The load acting on an LLU roller profile rail guide is resulting from acceleration, impact loads and vibration. It is extremely difficult to quantify these additional dynamic forces. To approximate the impact these indeterminate loads will have on the life of the system, the load must be multiplied by factor f_d. Depending on the mean speed and strength of the impact load, values listed in **table 5** can be selected for f_d.

Number of carriages per rail

Most profile rail guide configurations feature two or more carriages mounted on one rail. The load distribution on these various carriages is strongly influenced by the mounting accuracy, the manufacturing quality of the adjacent components, and particularly, the distance between the carriages. Factor f_i takes these influences on carriage loading into account based on the number of carriages per rail and their distance relative to each other (→ **table 6** and **fig. 4**).

Impact of stroke length

Strokes that are shorter than the metal body of the carriage (dimension L_2) have a negative influence on the achievable life of a guiding system. If the stroke is longer than the carriage metal body length, the factor is $f_s = 1$. Sequenced load phases with identical moving direction deliver a sub stroke length (S_s) according to **formula 16** to determine f_s. Based on the ratio of the sub stroke lengths (S_s) to the metal body of the carriage L_2, the factor f_s is determined according to **table 7**.

(16) $$S_s = \sum_{i=A}^{B} S_i$$

where
S_s = sub stroke length [mm]
S_j = individual stroke length [mm]
j = counter for load phases
A = starting point of movement in one direction
B = next reversal point

Modified basic rating life

If the load situation is known and the factors have been determined, then the modified basic rating life can be calculated with **formula 17**:

(17) $$L_{ns} = 100\, c_1\, c_2\, f_s \left(\frac{f_i C}{f_d F_{res}}\right)^{\frac{10}{3}}$$

In the presence of varying forces as described in the chapter Calculation bases (→ **page 16**), **formula 17** is extended to account for the impacts of operating conditions and loads per phase. This is described in **formula 18**:

(18) $$L_{ns} = 100\, c_1\, c_2 \frac{(f_i\, C)^{\frac{10}{3}} S_{tot}}{\sum_{j=1}^{V} \left(\left| \frac{f_{d,j} F_{res,j}}{\sqrt[3]{f_{s,j}}} \right|^{\frac{10}{3}} S_j \right)}$$

where
C = dynamic load rating [N]
c_1 = factor for reliability
c_2 = factor for operating conditions
f_d = factor for load conditions
$f_{d,j}$ = factor for load conditions for load phase j
f_i = factor for number of carriages per rail
F_{res} = resulting load [N]
$F_{res,j}$ = resulting load for load phase j [N]
f_s = factor for stroke length
$f_{s,j}$ = factor for stroke length for load phase j
j = counter for load phases
L_{ns} = modified basic rating life [km]
S_j = individual stroke length [mm]
S_{tot} = total stroke length [mm]
V = amount of load phases

Table 5

Factor f_d for load conditions

Load conditions	f_d from	up to
Smooth operation, no or light impact loads Speed ≤ 2 m/s	1,0	1,5
High impact loads Speed > 2 m/s	1,5	3,0

Table 6

Factor f_i for number of carriages per rail

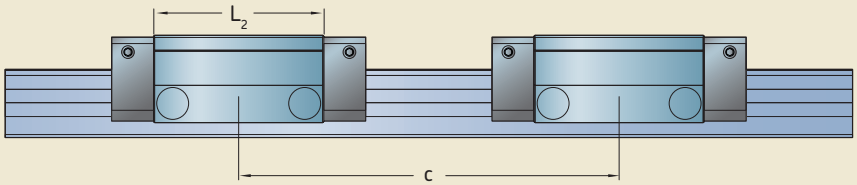
Number of carriages	If $c \geq 1{,}5 * L_2$ f_i	If $c < 1{,}5 * L_2$ f_i
1	1	1
2	1	0,86
3	1	0,78

Table 7

Factor fs depending on the ratio S_s/L_2

S_s/L_2	f_s
1,0	1,0
0,9	0,91
0,8	0,82
0,7	0,73
0,6	0,63
0,5	0,54
0,4	0,44
0,3	0,34
0,2	0,23

Fig. 4



Legend

A	starting point of movement in one direction	
B	next reversal point	
C	dynamic load rating	[N]
C_0	static load rating	[N]
c_1	factor for reliability	
c_2	factor for operating conditions	
f_d	factor for load conditions	
$f_{d,j}$	factor for load conditions for load phase j	
f_i	factor for number of carriages per rail	
f_s	factor for stroke length	
$f_{s,j}$	factor for stroke length for load phase j	
F_y, F_z	bearing loads in y- and z-direction	[N]
$F_{comb,stat}$	combined static bearing load	[N]
$F_{comb,dyn}$	combined dynamic bearing load	[N]
F_{comb}	combined static or dynamic bearing load	[N]
F_{Pr}	preload force	[N]
F_{res}	resulting load	[N]
$F_{res,j}$	resulting load for load phase j	[N]
$F_{res\ max}$	maximum resulting load	[N]
j	counter for load phases	[N]
κ	viscosity ratio	
L_{10h}	basic rating life	[h]
L_{10s}	basic rating life	[km]
L_{ns}	modified basic rating life	[km]
M_x, M_y, M_z	bearing moment loads at respective coordinates	[Nm]
M_{xC}, M_{yC}, M_{zC}	permissible dynamic moment loads	[Nm]
M_{xC_0}, M_{yC_0}, M_{zC_0}	permissible static moment loads	[Nm]
n	stroke frequency	[double strokes/min]
ν	actual kinematic viscosity	[mm^2/s]
$ν_1$	requisite minimum viscosity	[mm^2/s]
P	equivalent dynamic load	[N]
P_m	equivalent dynamic mean load	[N]
P_0	maximum static load	[N]
s_0	static safety factor	
S_j	individual stroke length	[mm]
S_s	sub stroke length	[mm]
S_{tot}	total stroke length	[mm]
t_1, t_2 ... t_n	time proportions for v_1, v_2 ... v_n	[%]
v_1, v_2 ... v_n	speed	[m/min]
v_m	mean speed	[m/min]
V	amount of load phases	

SKF calculation program

Details pertaining to all the relevant load situations and the specification of the general design conditions are crucial for precisely calculating the life expectancy and static load safety of an LLU roller profile rail guide system in a specific application. Ultimately, this information determines the size and carriage type of the LLU roller profile rail guide. This design process can be quite extensive for complex applications. Therefore, SKF offers the "linear guide calculator" program, which is available at www.skf.com. This calculation program supports the user and is extremely effective in the design of LLU roller profile rail guide systems.

The following information must be available prior to starting a calculation:

- number of load phases
- moved masses as well as operating loads including coordinates
- stroke length of single load phases
- reaction forces accommodated by the drive system (in the direction of travel)
- selection of preload applied to the guide
- layout (number of rails and carriages)
- geometry of linear axis (distance between rails relative to each other and carriages relative to each other)

To supply the details needed to select your profile rail guides, please complete the specification sheet found on ***pages 58–61*** *of this publication.*

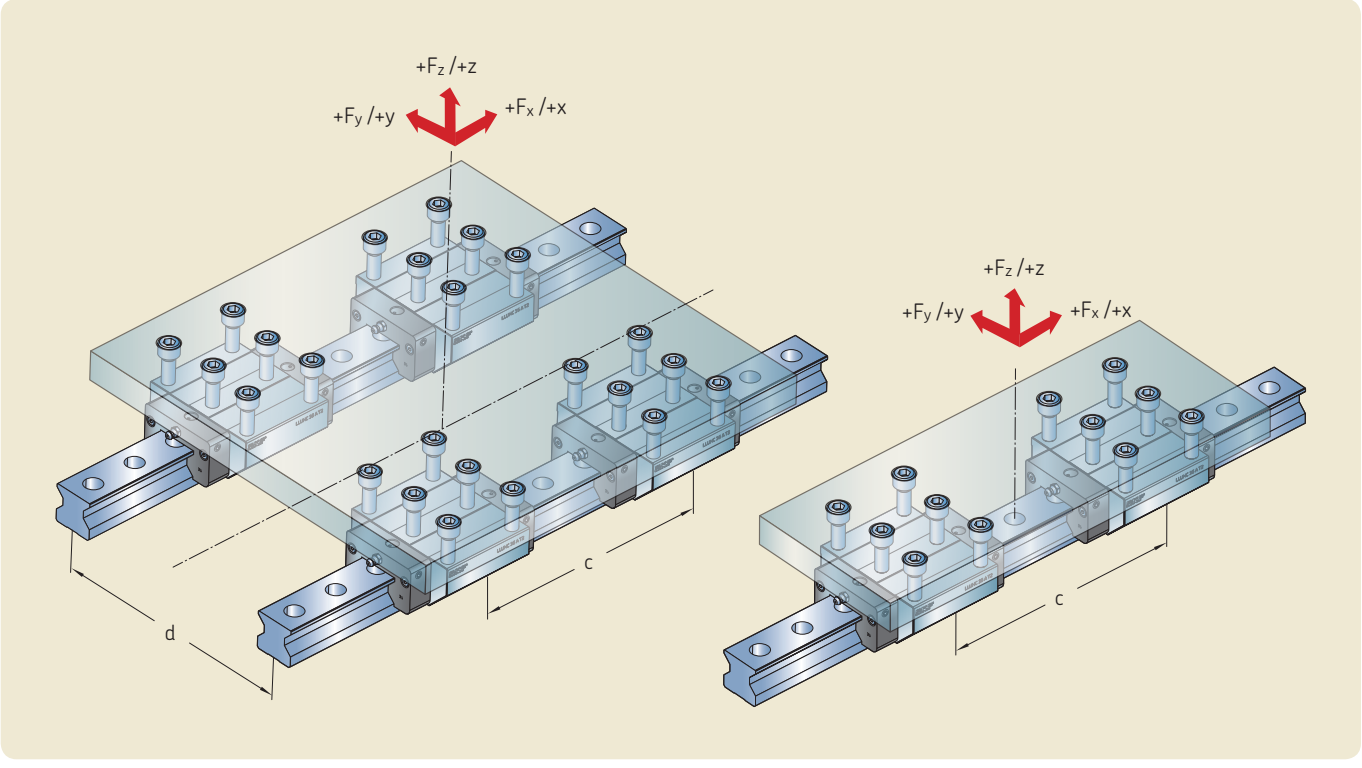
NOTE: If the user is free to select the application coordinate system, SKF recommends using the coordinate system in the program. This facilitates the analysis of all operating loads and the resulting reaction forces in the carriages and prevents transformation errors.

Representation of results

When the calculation routine is complete, the user will receive the following data in a clearly structured form:

- all input data
- load values per carriage in the y- and z-direction and moment loads for all conceivable load phases
- calculation of maximum resulting load and equivalent dynamic mean load per carriage
- basic rating life of carriages
- static safety factor of carriages

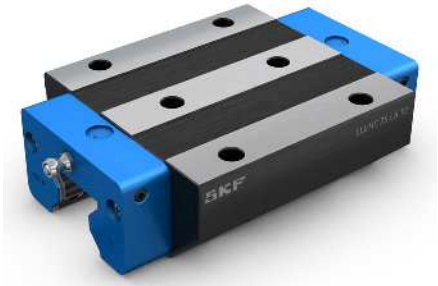
Depending on the expected life or static safety factor, various carriage sizes can be selected for printout.



Product data

LLUHC ... A
Flanged carriage
Standard length, standard height
Further information on ***page 26***

LLUHC ... LA
Flanged carriage
Extended length, standard height
Further information on ***page 28***

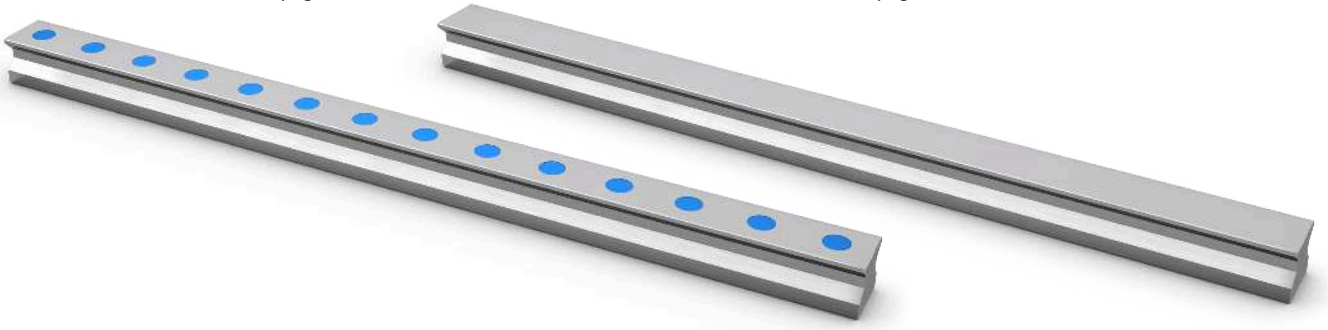


LLUHC ... R
Slim-line carriage
Standard length, extended height
Further information on ***page 30***

LLUHC ... LR
Slim-line carriage
Extended length, extended height
Further information on ***page 32***

LLUHR...
Profile rail with standard hole caps
Further information on ***page 34***

LLUHR...D4
Profile rail with blind holes
Further information on ***page 34***



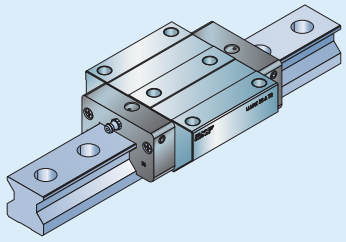
LLUHR...D6
Profile rail with brass hole plugs
Further information on ***page 34***

LLUHR...D8
Profile rail with steel hole plugs
Further information on ***page 34***

Product data
Carriages

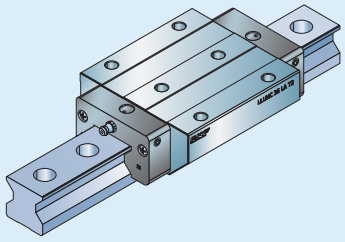
Pages 26–33

LLUHC ... A
Flanged carriage, standard length, standard height



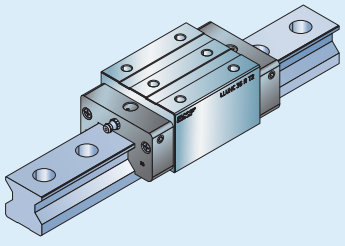
Size	Load ratings C	C_0
–	N	
25	27 000	57 600
35	53 300	99 000
45	95 000	184 000
55	132 600	256 000
65	212 000	414 000

LLUHC ... LA
Flanged carriage, extended length, standard height



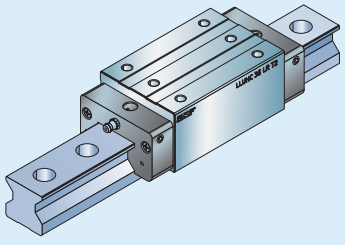
Size	Load ratings C	C_0
–	N	
25	36 500	76 800
35	72 600	136 000
45	119 500	242 200
55	176 000	351 000
65	276 000	579 000

LLUHC ... R
Slim-line carriage, standard length, extended height



Size	Load ratings C	C_0
–	N	
25	27 000	57 600
35	53 300	99 000
45	95 000	184 000
55	132 600	256 000
65	212 000	414 000

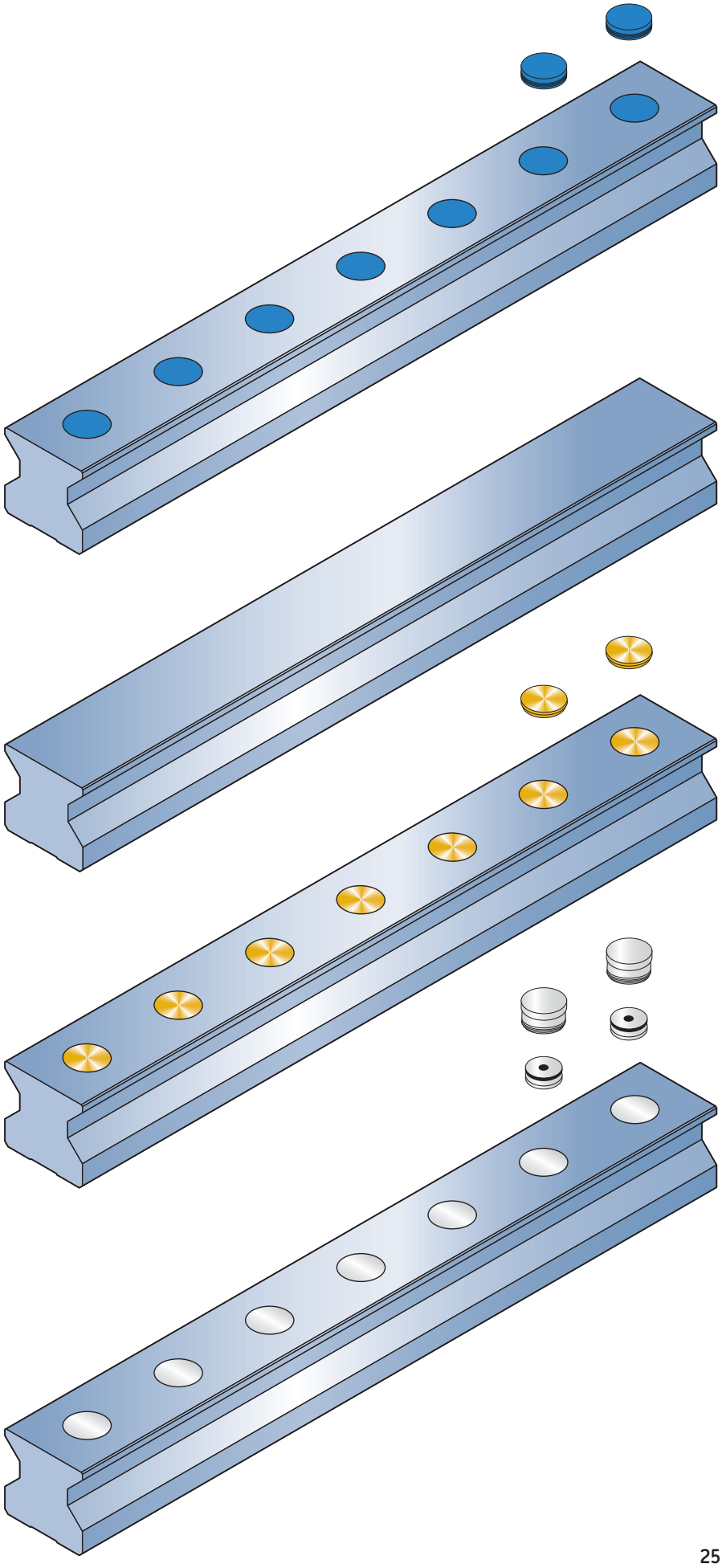
LLUHC ... LR
Slim-line carriage, extended length, extended height



Size	Load ratings C	C_0
–	N	
25	36 500	76 800
35	72 600	136 000
45	119 500	242 200
55	176 000	351 000
65	276 000	579 000

Rails

Pages 34–35



LLUHR rails

Standard rail, always supplied with protective plastic caps for mounting from above.

LLUHR ... D4 rails

With blind holes for mounting from below.

LLUHR ... D6 rails

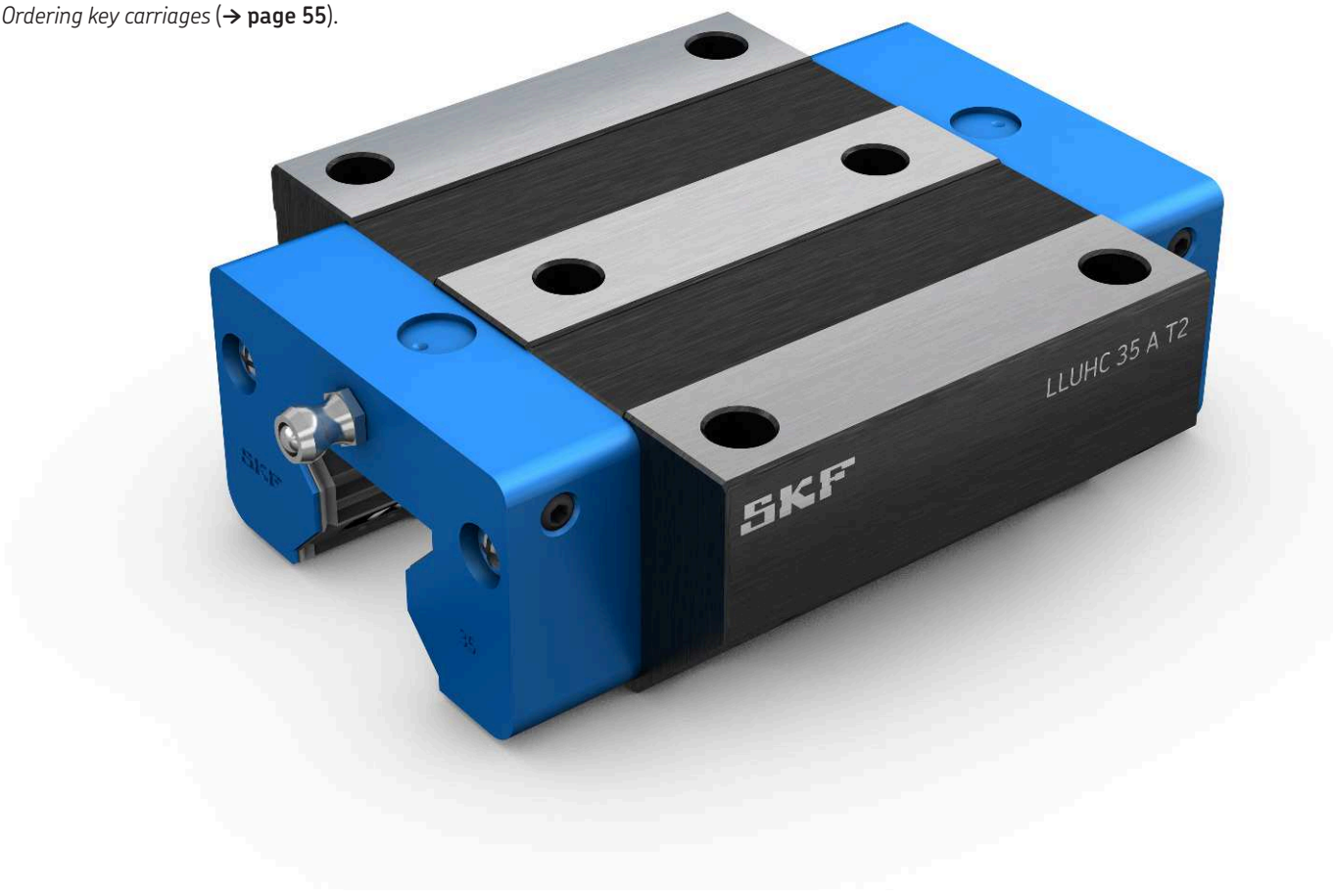
Standard rail supplied with protective brass plugs for mounting from above.

LLUHR ... D8 rails

Standard rail supplied with protective steel plugs for mounting from above.

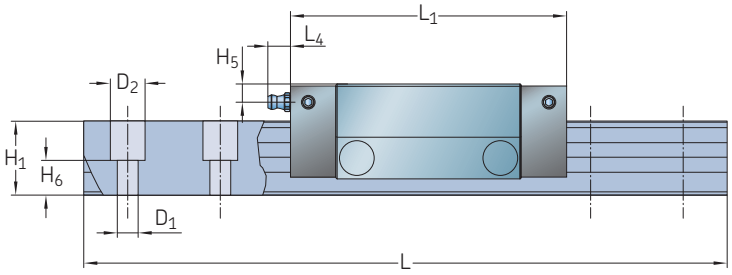
Carriage LLUHC ... A

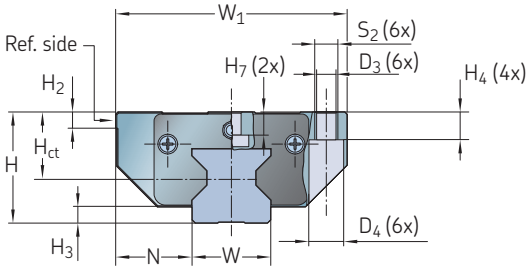
Flanged carriage
Standard length, standard height
For designation, refer to
Ordering key carriages (→ **page 55**).

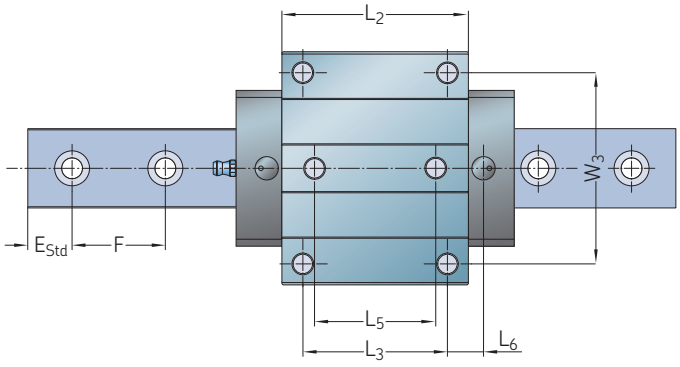


Size	Assembly dimensions						Carriage dimensions												
	W_1	N	H	H_2	H_3	H_{ct}	L_1	L_2	L_3	L_4	L_5	L_6[1)]	W_3	H_4	H_5	H_7	D_3	D_4	S_2
–	mm																		
LLUHS 25 A	70	23,5	36	7,5	6,5	21	90,2	62	45	9,8	40	14	57	9	5,5	6,5	6,8	11	M8
LLUHS 35 A	100	33	48	8	7	28.5	119,3	80	62	9,8	52	15,5	82	12	7,9	10	8,5	15	M10
LLUHS 45 A	120	37,5	60	10	10	35.5	147,3	101,3	80	9,8	60	17,65	100	15	8	12	10,5	18	M12
LLUHS 55 A	140	43,5	70	12	13	40.5	173	120	95	9,8	70	21,5	116	18	9,5	13,5	12,5	20	M14
LLUHS 65 A	170	53,5	90	15,5	12	58	221,8	159,8	110	9,8	82	31,8	142	22	15	19,5	14,5	23	M16

[1)] For size 65, L_6 in the table is valid only with top lubrication adaptor mounted, which is not shown on the drawing.



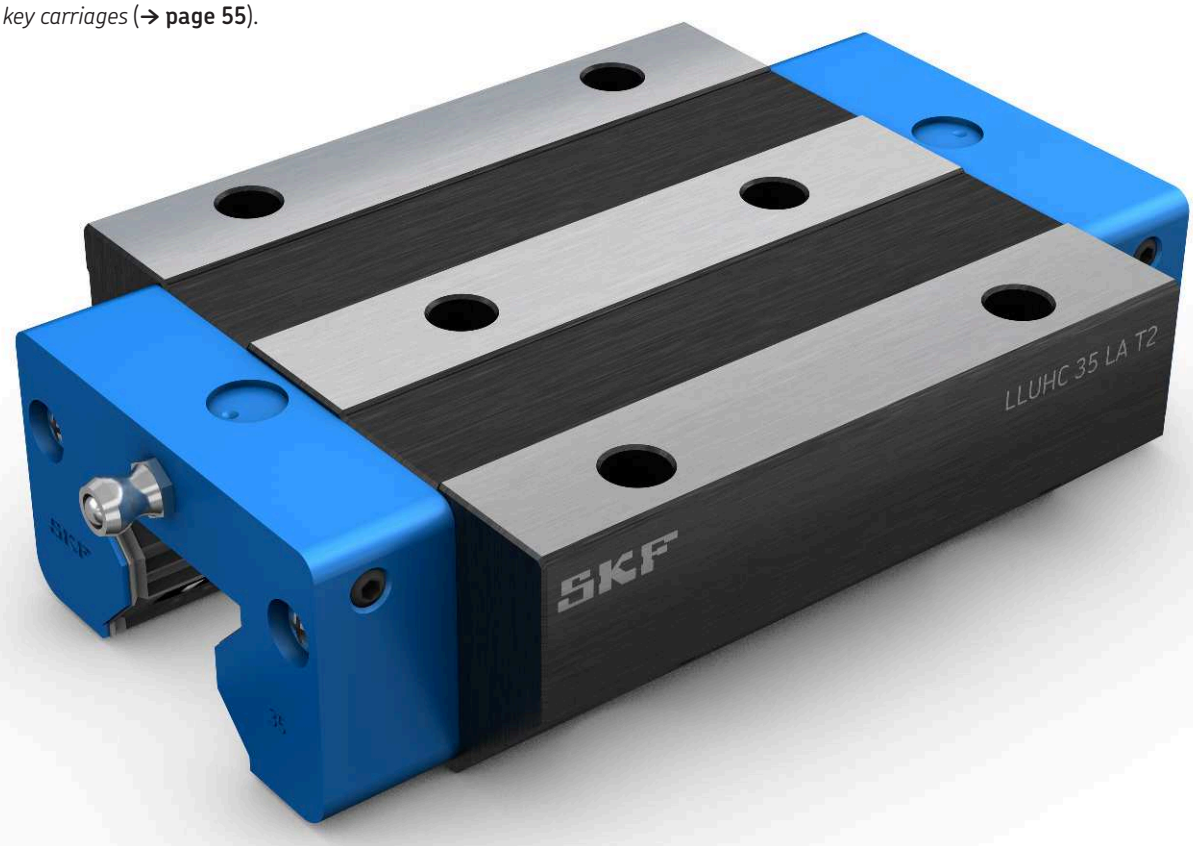




Size	Rail dimensions							Weight		Load ratings		Moments			
								carriage	rail	dynamic	static	dynamic	static	dynamic	static
	W	H_1	H_6	F	D_1	D_2	E_{Std}			C	C_0	M_{xC}	M_{xC_0}	$M_{yC} = M_{zC}$	$M_{yC_0} = M_{zC_0}$
–	mm							kg	kg/m	kN		Nm			
LLUHS 25 A	23	24,35	12,85	30	7	11	12,5	0,7	3,4	27,0	57,6	431	863	285	570
LLUHS 35 A	34	32	15	40	9	15	17,5	1,7	6,5	53,3	99,0	1 179	2 192	674	1 253
LLUHS 45 A	45	39,85	20,85	52,5	14	20	23,75	3,3	10,7	95,0	184,0	2 617	5 070	1 538	2 979
LLUHS 55 A	53	47,8	25,8	60	16	24	27,5	5,1	15,2	132,6	256,0	4 503	8 707	2 576	4 981
LLUHS 65 A	63	55	29	75	18	26	35	9,3	22,5	212,0	414,0	8 100	15 780	5 210	10 140

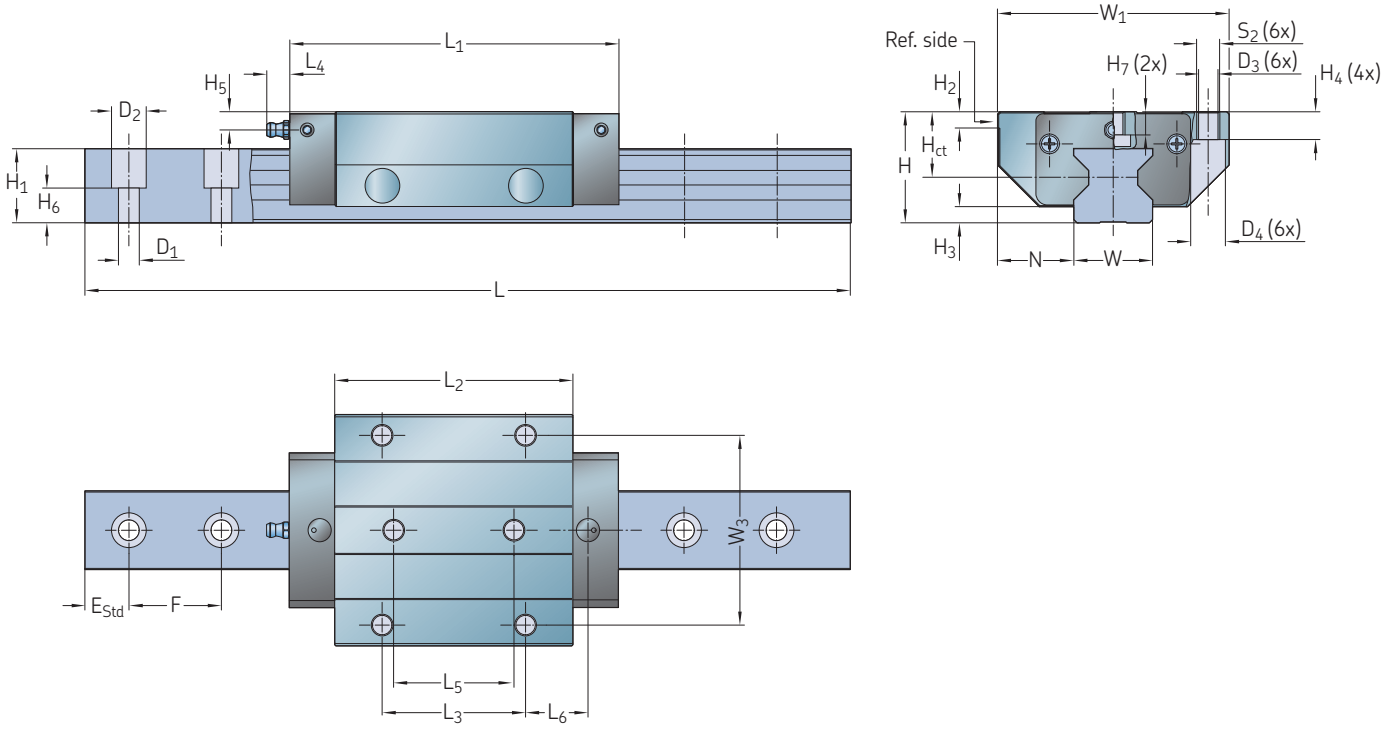
Carriage LLUHC ... LA

Flanged carriage
Extended length, standard height
For designation, refer to
Ordering key carriages (→ **page 55**).



Size	Assembly dimensions						Carriage dimensions												
	W_1	N	H	H_2	H_3	H_{ct}	L_1	L_2	L_3	L_4	L_5	L_6[1)]	W_3	H_4	H_5	H_7	D_3	D_4	S_2
–	mm																		
LLUHS 25 LA	70	23,5	36	7,5	6,5	21	109,7	81,5	45	9,8	40	23,75	57	9	5,5	6,5	6,8	11	M8
LLUHS 35 LA	100	33	48	8	7	28.5	142,3	103	62	9,8	52	27	82	12	7,9	10	8,5	15	M10
LLUHS 45 LA	120	37,5	60	10	10	35.5	179,8	133,8	80	9,8	60	33,9	100	15	8	12	10,5	18	M12
LLUHS 55 LA	140	43,5	70	12	13	40.5	215	162	95	9,8	70	42,5	116	18	9,5	13,5	12,5	20	M14
LLUHS 65 LA	170	53,5	90	15,5	12	58	272,3	210,3	110	9,8	82	57,1	142	22	15	19,5	14,5	23	M16

[1)] For size 65, L_6 in the table is valid only with top lubrication adaptor mounted, which is not shown on the drawing.



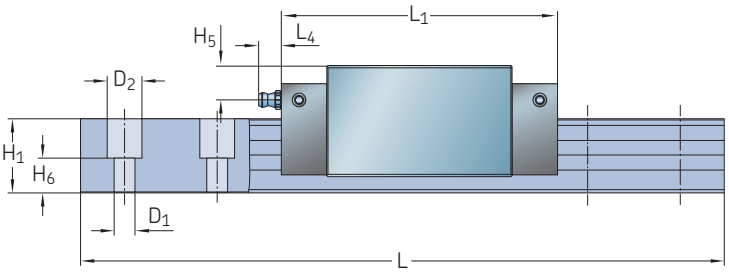
Size	Rail dimensions							Weight		Load ratings		Moments			
								carriage	rail	dynamic	static	dynamic	static	dynamic	static
	W	H_1	H_6	F	D_1	D_2	E_{Std}			C	C_0	M_{xC}	M_{xC_0}	$M_{yC} = M_{zC}$	$M_{yC_0} = M_{zC_0}$
–	mm							kg	kg/m	kN		Nm			
LLUHS 25 LA	23	24,35	12,85	30	7	11	12,5	0,9	3,4	36,5	76,8	583	1 150	491	970
LLUHS 35 LA	34	32	15	40	9	15	17,5	2,2	6,5	72,6	136,0	1 595	3 014	1 187	2 243
LLUHS 45 LA	45	39,85	20,85	52,5	14	20	23,75	4,3	10,7	119,5	242,2	3 293	6 672	2 444	4 951
LLUHS 55 LA	53	47,8	25,8	60	16	24	27,5	7,0	15,2	176,0	351,0	5 977	11 915	4 470	8 910
LLUHS 65 LA	63	55	29	75	18	26	35	13,5	22,5	276,0	579,0	10 530	22 100	8 980	11 840

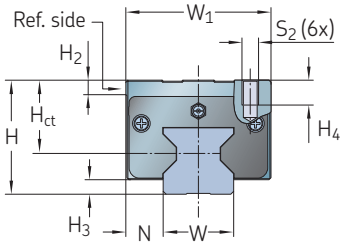
Carriage LLUHC ... R

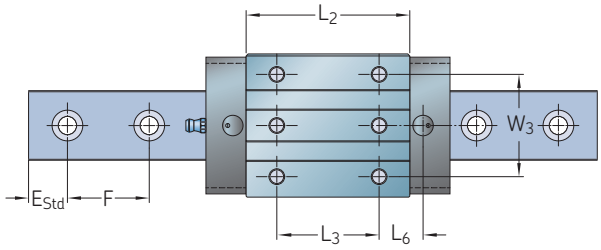
Slim-line carriage
Standard length, extended height
For designation, refer to
Ordering key carriages (→ **page 55**).

Size	Assembly dimensions						Carriage dimensions								
	W_1	N	H	H_2	H_3	H_{ct}	L_1	L_2	L_3	L_4	L_6[1)]	W_3	H_4	H_5	S_2
–	mm														
LLUHS 25 R	48	12,5	40	7,5	6,5	25	90,2	62	35	9,8	19	35	9	9,5	M6
LLUHS 35 R	70	18	55	8	7	35.5	119,3	80	50	9,8	21,5	50	12	14,9	M8
LLUHS 45 R	86	20,5	70	10	10	45.5	147,3	101,3	60	9,8	27,65	60	18	18	M10
LLUHS 55 R	100	23,5	80	12	13	50.5	173	120	75	9,8	31,5	75	19	19.5	M12
LLUHS 65 R	126	31,5	90	15,5	12	58	221,8	159,8	70	9,8	51,8	76	22	15	M16

[1)] For size 65, L_6 in the table is valid only with top lubrication adaptor mounted, which is not shown on the drawing.



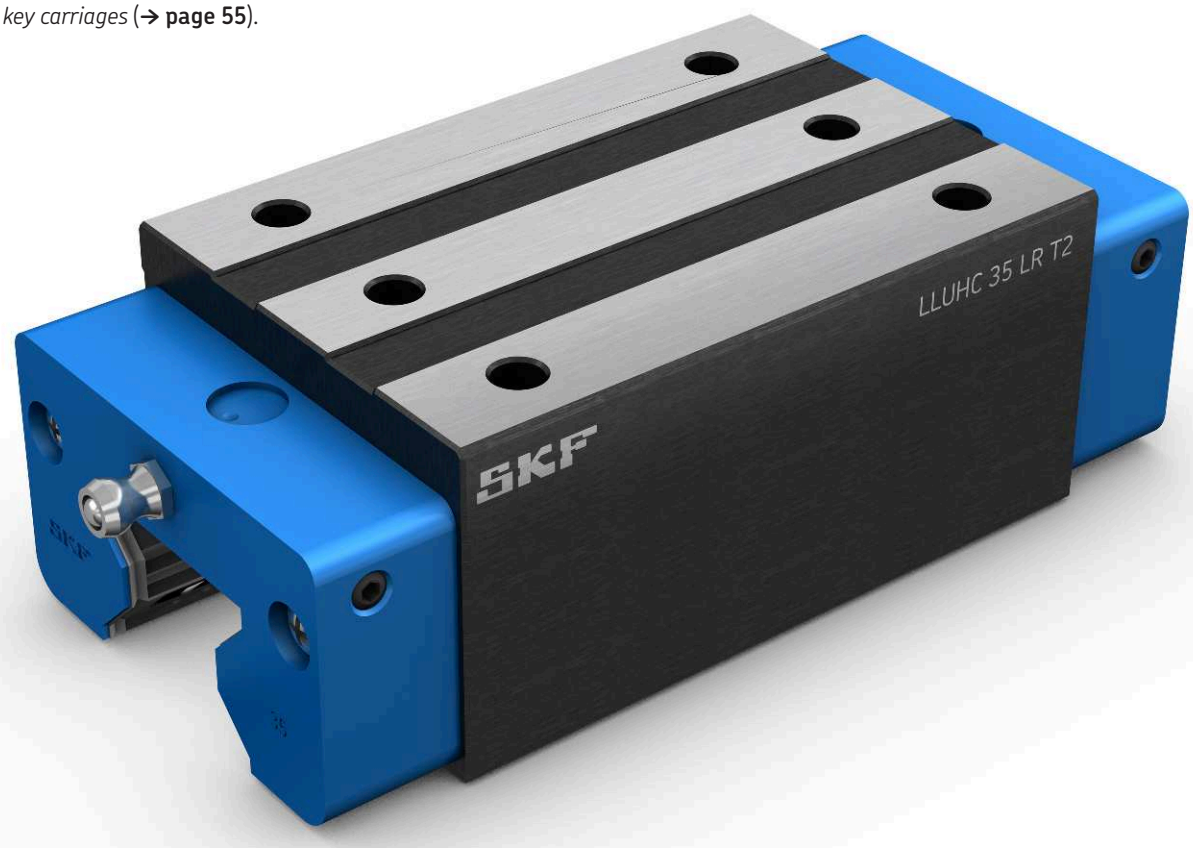




Size	Rail dimensions							Weight		Load ratings		Moments			
								carriage	rail	dynamic	static	dynamic	static	dynamic	static
	W	H_1	H_6	F	D_1	D_2	E_{Std}			C	C_0	M_{xC}	M_{xC_0}	$M_{yC} = M_{zC}$	$M_{yC_0} = M_{zC_0}$
–	mm							kg	kg/m	kN		Nm			
LLUHS 25 R	23	24,35	12,85	30	7	11	12,5	0,6	3,4	27,0	57,6	431	863	285	570
LLUHS 35 R	34	32	15	40	9	15	17,5	1,6	6,5	53,3	99,0	1 179	2 192	674	1 253
LLUHS 45 R	45	39,85	20,85	52,5	14	20	23,75	3,1	10,7	95,0	184,0	2 617	5 070	1 538	2 979
LLUHS 55 R	53	47,8	25,8	60	16	24	27,5	4,7	15,2	132,6	256,0	4 503	8 707	2 576	4 981
LLUHS 65 R	63	55	29	75	18	26	35	8,5	22,5	212,0	414,0	8 100	15 780	5 210	10 140

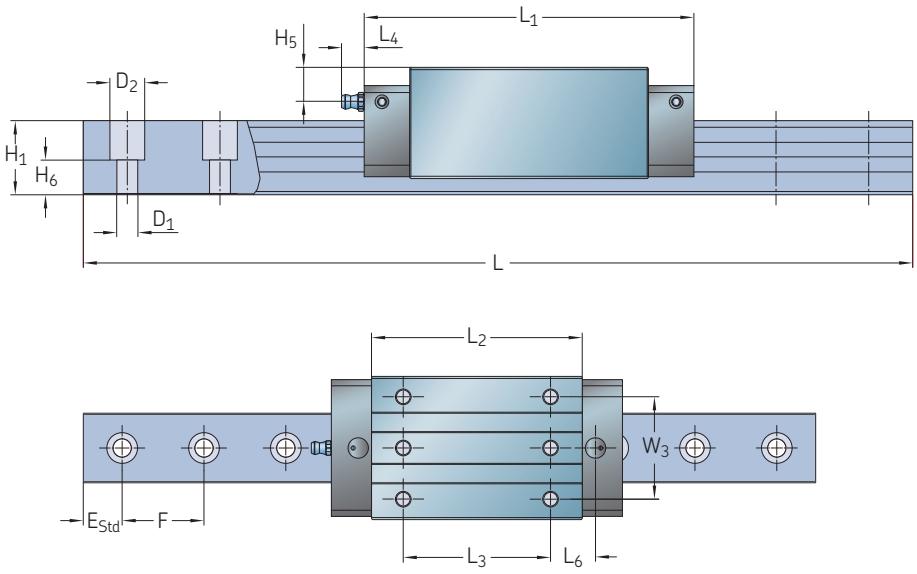
Carriage LLUHC ... LR

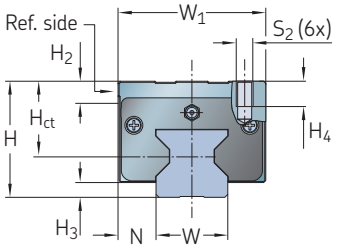
Slim-line carriage
Extended length, extended height
For designation, refer to
Ordering key carriages (→ **page 55**).



Size	Assembly dimensions						Carriage dimensions								
	W_1	N	H	H_2	H_3	H_{ct}	L_1	L_2	L_3	L_4	L_6[1)]	W_3	H_4	H_5	S_2
–	mm														
LLUHS 25 LR	48	12,5	40	7,5	6,5	25	109,7	81,5	50	9,8	21,25	35	9	9,5	M6
LLUHS 35 LR	70	18	55	8	7	35.5	142,3	103	72	9,8	22	50	12	14,9	M8
LLUHS 45 LR	86	20,5	70	10	10	45.5	179,8	133,8	80	9,8	33,9	60	18	18	M10
LLUHS 55 LR	100	23,5	80	12	13	50.5	215	162	95	9,8	42,5	75	19	19.5	M12
LLUHS 65 LR	126	31,5	90	15,5	12	58	272,3	210,3	120	9,8	52,05	76	22	15	M16

[1)] For size 65, L_6 in the table is valid only with top lubrication adaptor mounted, which is not shown on the drawing.





Size	Rail dimensions							Weight		Load ratings		Moments			
								carriage	rail	dynamic	static	dynamic	static	dynamic	static
	W	H_1	H_6	F	D_1	D_2	E_{Std}			C	C_0	M_{xC}	M_{xC_0}	$M_{yC} = M_{zC}$	$M_{yC_0} = M_{zC_0}$
–	mm							kg	kg/m	kN		Nm			
LLUHS 25 LR	23	24,35	12,85	30	7	11	12,5	0,8	3,4	36,5	76,8	583	1 150	491	970
LLUHS 35 LR	34	32	15	40	9	15	17,5	2,0	6,5	72,6	136,0	1 595	3 014	1 187	2 243
LLUHS 45 LR	45	39,85	20,85	52,5	14	20	23,75	4,1	10,7	119,5	242,2	3 293	6 672	2 444	4 951
LLUHS 55 LR	53	47,8	25,8	60	16	24	27,5	6,2	15,2	176,0	351,0	5 977	11 915	4 470	8 910
LLUHS 65 LR	63	55	29	75	18	26	35	12,7	22,5	276,0	579,0	10 530	22 100	8 980	11 840

Rails

SKF offers four different versions of LLU profile rails, which are the following:

LLUHR rails

Standard rail for mounting from above, supplied with protective plastic caps

LLUHR ... D4 rails

Rail with blind holes for mounting from below

LLUHR ... D6 rails

Standard rail for mounting from above, supplied with brass protective plugs

LLUHR ... D8 rails

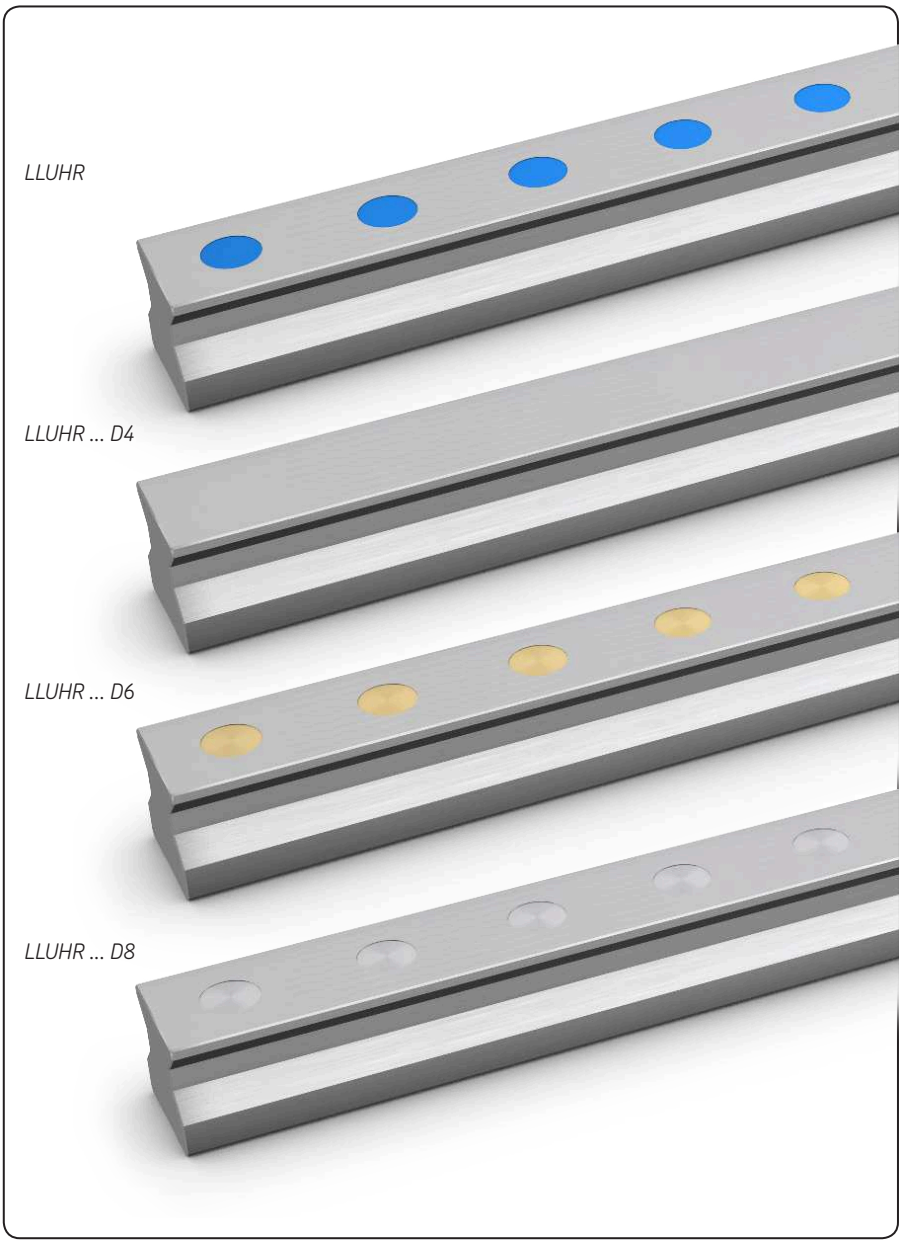
Standard rail for mounting from above, supplied with steel protective plugs

Protective metal plugs ensure that no residues of dirt, swarf, cooling water and other contaminants remain in the area of the attachment holes . After insertion, these plugs align flush with the surface of the profile rail guide to provide effective wiping. The use of additional scraper plates in combination with these protective metal plugs is an option which will further enhance protection.

Size-specific mounting tools for installing the protective brass and steel plugs are available from SKF. Please refer to **page 57** to order the mounting tool.

NOTE: If a rail length is required that exceeds the maximum length available, joint rails can be ordered. These rails are manufactured to match seamlessly with each other.

To determine the rail length and calculate specific equidistant E values see formulae on the following page (→ **page 35**).

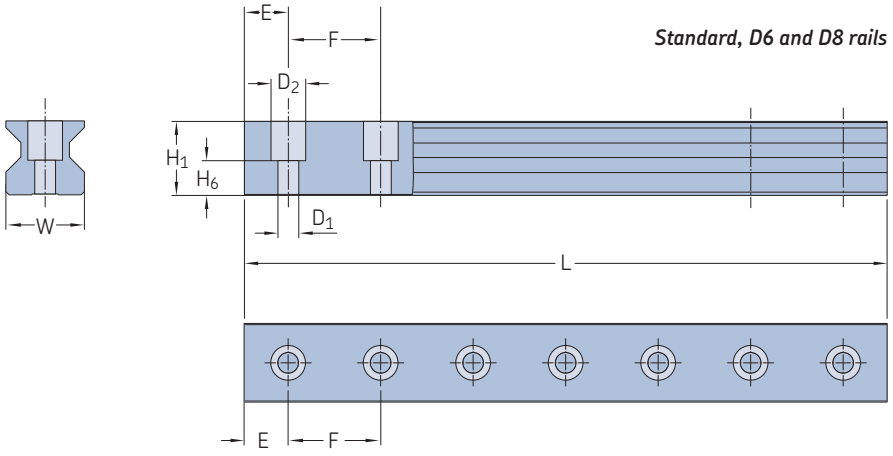


Size	Rail dimensions											
	W	H_1	H_6	F	D_1	D_2	H_8	S_1	E_{Std} –0.75	E_{min} –0.75	E_{max} –0.75	L_{max} [1] –1.5
–	mm											
LLUHR 25	23	24,35	12,85	30	7	11	12	M6	12,5	10	22	3 985
LLUHR 35	34	32	15	40	9	15	15	M8	17,5	12	30	3 995
LLUHR 45	45	39,85	20,85	52,5	14	20	19	M12	23,75	15	40	3 985
LLUHR 55	53	47,8	25,8	60	16	24	22	M14	27,5	17	46	3 955
LLUHR 65	63	55	29	75	18	26	25	M16	35	18	60	3 970

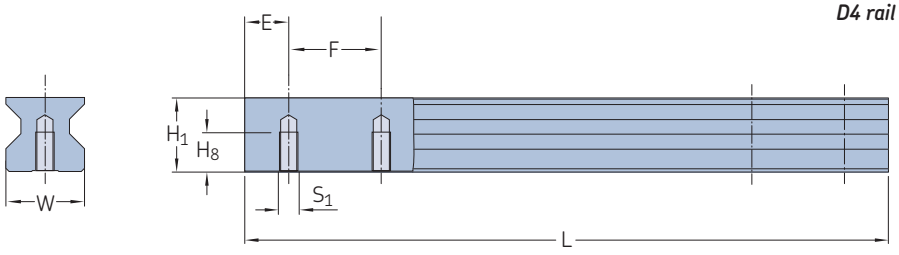
[1] Calculated by using E_{Std}

For the designation of the different rails refer to Ordering key rails (→ **page 56**) .

Standard, D6 and D8 rails



D4 rail



The "E" dimension designates the distance between the end face and the center of the first mounting hole of the rail.
With suffix "ES" in the ordering key, the holes at both rail ends will be positioned equidistantly from either end of the rail using the E_{Std} dimension. This results in predefined rail lengths that should be preferred when ordering:

$L = nF + 2\,E_{Std}$

With suffix "E0", the rail is produced with the shortest possible symmetrical "E" dimension on both rail ends.
With suffix "Exx", the "E" dimension has to be specified.
To calculate specific equidistant "E" dimensions, following formulae are used:

Calculation of number of attachment holes in rail guide

(1) $n_{real} = \frac{L}{F}$

(2) Round down of n_{real} to n

(3) $n + 1 = z$

F = Distance of attachment holes
L = Rail length
n_{real} = Real calculation value for number of hole distances
z = Number of attachment holes in rail

Determination of E dimension based on z

(4) $E_{real} = \frac{L - F\,(z-1)}{2}$

E_{real} = Real calculation value for E-dimension
E_{min} = Minimum E-dimension according to catalogue
E_{Std} = Standard value for E-Dimension

Comparison with catalogue value of E_{min}

(4.1) If $E_{real} \geq E_{min}$
→ Usage of E_{real} from **formula 4**

(4.2) If $E_{real} < E_{min}$
→ Calculation of E_{real} according to **formula 5**

(5) $E_{real} = \frac{L - F\,(z-2)}{2}$

Joint rail tracks

If the requested rail length exceeds the available delivery length of LLU rails, specially paired and joint rails can be supplied as ready-to-mount sets consisting of two or more rails (per rail track). In this case, the rails are marked on the bottom side (→ **fig. 6**) in order to avoid mix-up during mounting (→ **fig. 5**). For specific positions of the joint(s), please add a drawing. If replacement is required, the complete set should be exchanged to provide full functionality.

For the proper designation, refer to *Ordering key rails* (→ **page 56**).

Fig. 7 shows a tool that simplifies the mounting procedure of joint rails. It consists of a c-clamp and two ground shafts.

Fig. 5

Top side of joint rail

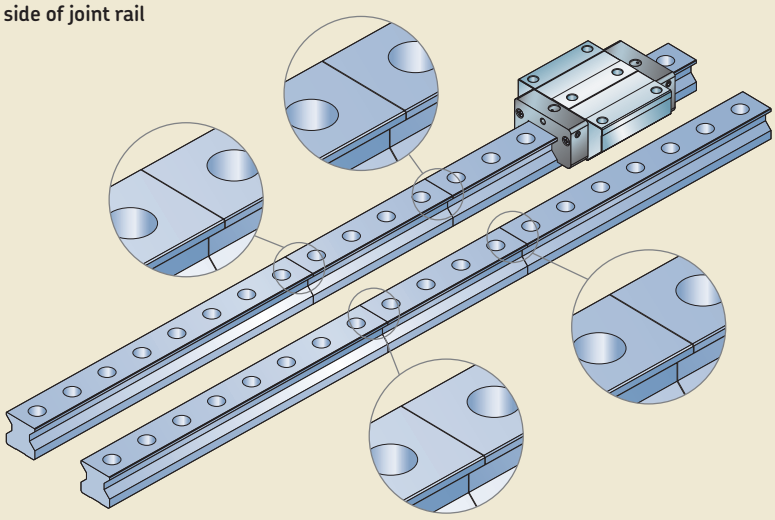


Fig. 6

Bottom side of joint rail

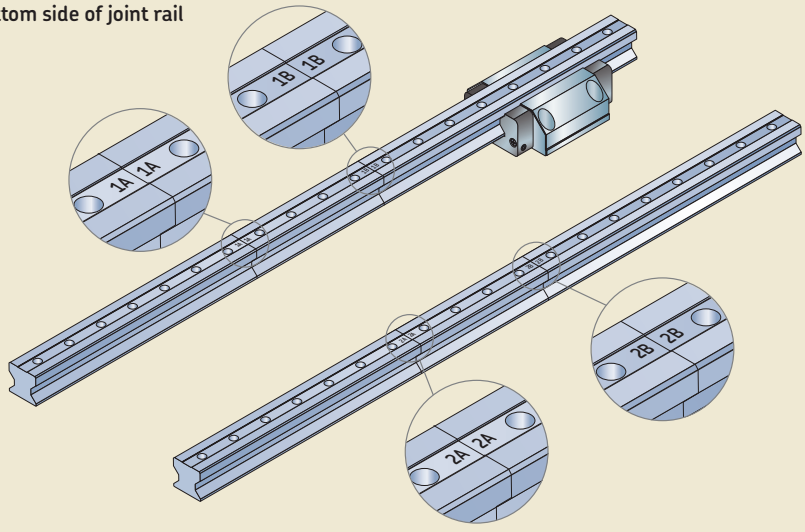
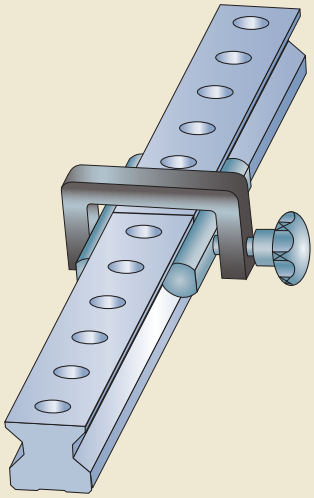
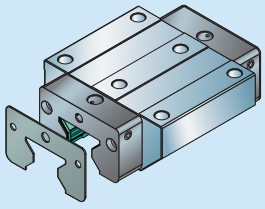
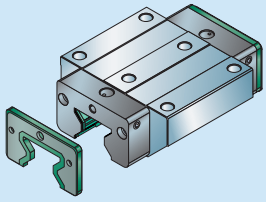
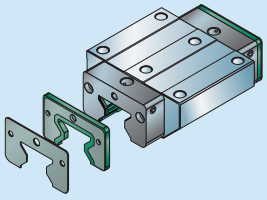
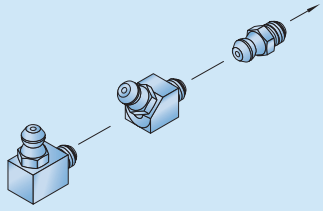
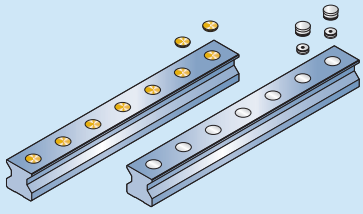
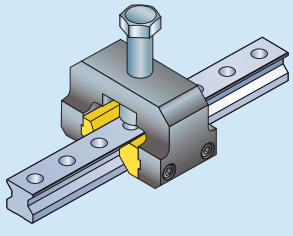


Fig. 7



Accessories

Accessories

Item name	Illustration[1)]	Purpose
Scraper plate LLUHZ ... S1		Scraper plates are spring-steel, non-contact components. They protect the front seal from coarse contaminants or hot metal chips. Lubrication adaptors can be used without modifications. Longer mounting screws are supplied with the scraper plate.
Additional front seal LLUHZ ... S7 LLUHZ ... S4		Additional front seals are contact seals that can be attached to the carriage end faces. They are single-lip seals consisting of special heavy-duty material with rubber (NBR) seal lips (S7) or fluoroelastomere (FKM) seal lips (S4). Both offer additional protection against liquids and smaller contaminants. The FKM seal has a better chemical resistance, e.g. against agressive coolants. One lubrication connector and longer screws are supplied with the seal.
Seal kit LLUHZ ... S3 LLUHZ ... S8		The seal kit consists of a metal scraper and an additional front seal. It is intended for applications involving exposure to coarse and fine dirt as well as liquids. One lubrication connector and longer screws are supplied with the seal kit.
Lubrication adaptors LLUHZ VN ...		To connect different lubrication devices to the carriage, several lubrication adaptors are available.
Protective metal plugs from brass or steel LLUHZ ... TD6 / TD8		Metal plugs protect carriage and rail from damages caused by high thermal and mechanical exposure, e.g. chip formation.
Assembly tool for metal plugs LLUHZ ... D6		Rail size specific assembly tools are available for proper installation of protective metal plugs. There are two sizes available, one covering the range of size 25-45 and one covering size 45-65.

[1)] Appearance can vary slightly depending on the size.

Scraper plate

LLUHZ ... S1

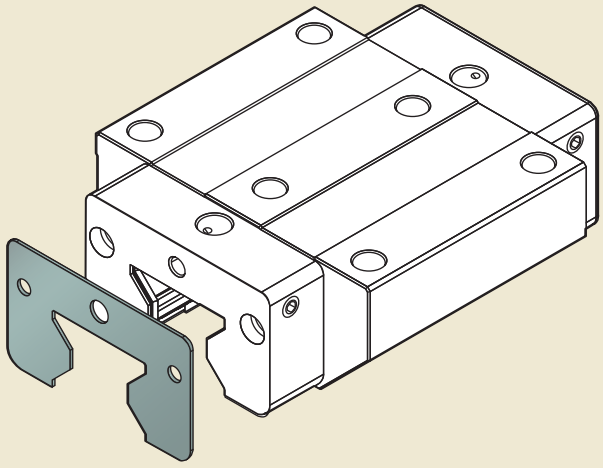
- Material: Spring steel according to DIN EN 10088
- Appearance: Steel grey
- Designed with a specified maximum gap of ~ 50 µm

Mounting

The standard grease nipple still fits. Longer mounting screws are supplied with the scraper plate. When mounting, be sure there is an even space between the rail and scraper plate.

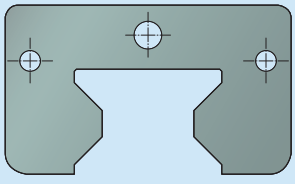
NOTE: Can be ordered in combination with an additional front seal as a kit, designation S3 or S8.

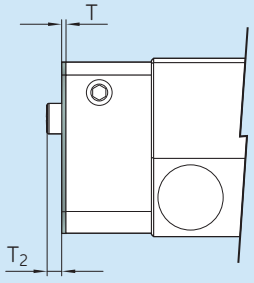
Scraper plate



Appearance can vary slightly depending on the size.

Scraper plate





Carriage size

	T	T_2
–	mm	
25	1	2,6
35	1	3,3
45	1,5	4
55	1,5	4,8
65	2	8

Additional front seal

LLUHZ ... S7

- Material: Elastomer (NBR) on steel carrier
- Design: Single-lip seal

LLUHZ ... S4

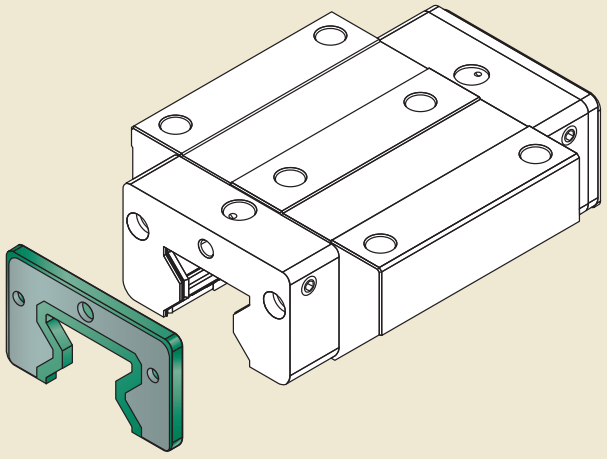
- Material: Fluoroelastomer (FKM) on steel carrier
- Good chemical resistance e.g. against agressive coolants
- Design: Single-lip seal

Mounting

One lubrication connector and longer mounting screws are supplied with the seal. For dimensions of the lubrication connector please refer to **table 8** (→ **page 42**)

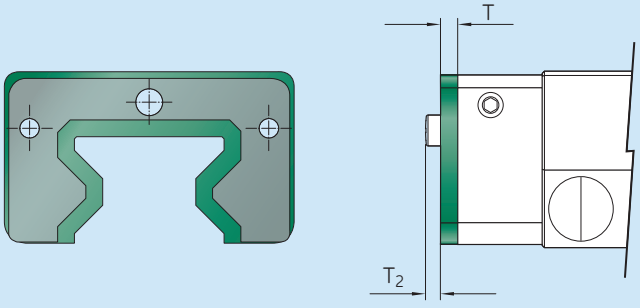
NOTE: Can be ordered in combination with an additional scraper plate as a kit, designation S3 or S8.

Additional front seal



Appearance can vary slightly depending on the size.

Additional front seal



Carriage size

	T	T_2
–	mm	
25	6	2,6
35	6	3,3
45	6	4
55	6	4,8
65	7	8

Seal kit

LLUHZ ... S3

The seal kit consists of the following components:
- Scraper plate
- Additional front seal S7 (NBR)

LLUHZ ... S8

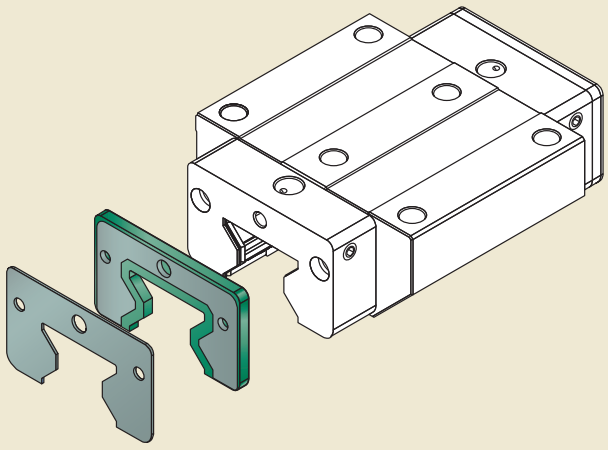
The seal kit consists of the following components:
- Scraper plate
- Additional front seal S4 (FKM)

Mounting

One lubrication connector and longer mounting screws are supplied with the seal kit. For dimensions of the lubrication connector please refer to **table 8** (→ **page 42**).

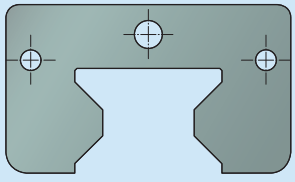
When mounting, be sure there is an even space between the rail and scraper plate.

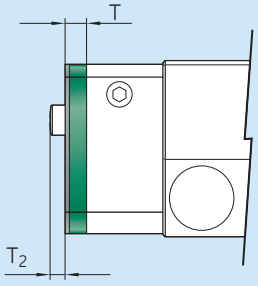
Seal kit



Appearance can vary slightly depending on the size.

Seal kit





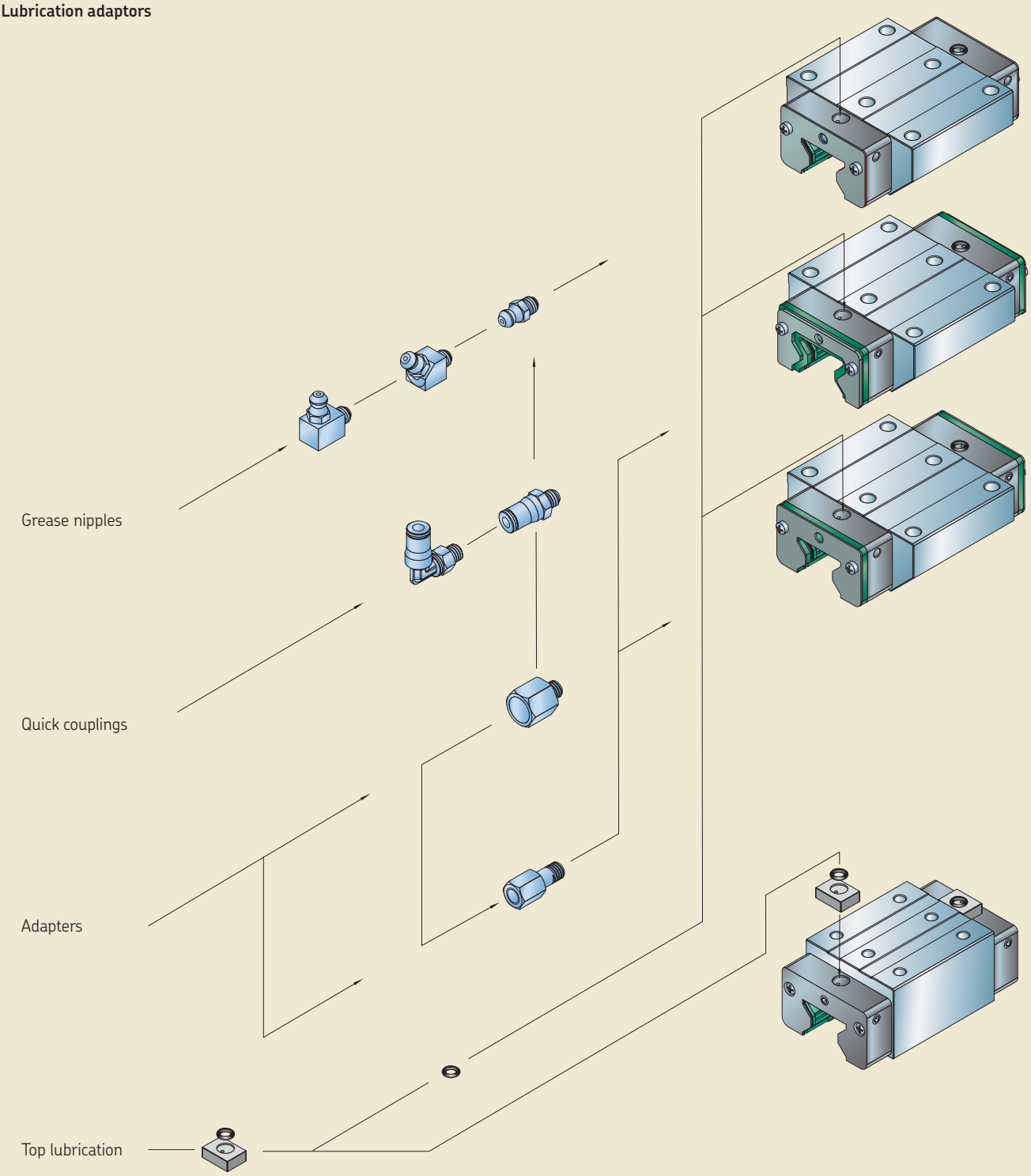
Carriage size

	T	T_2
–	mm	
25	7	2,6
35	7	3,3
45	7,5	4
55	7,5	4,8
65	9	8

Lubrication adaptors

All lubrication adaptors are standardized with a M6 thread for secure attachment to the carriages of all sizes. For our range of grease nipples, couplings and fittings, please refer to **table 8**.

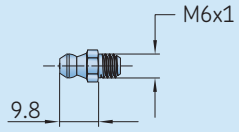
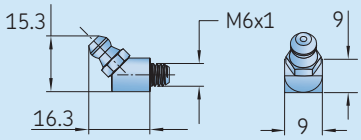
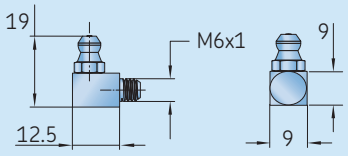
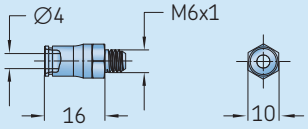
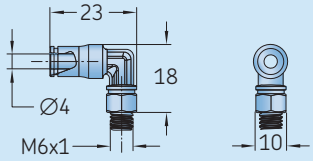
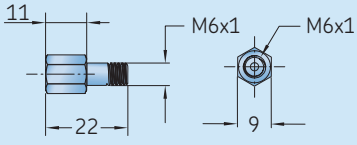
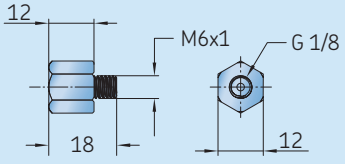
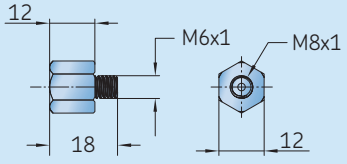
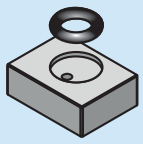
Lubrication adaptors



Lubrication adaptors

Table 8

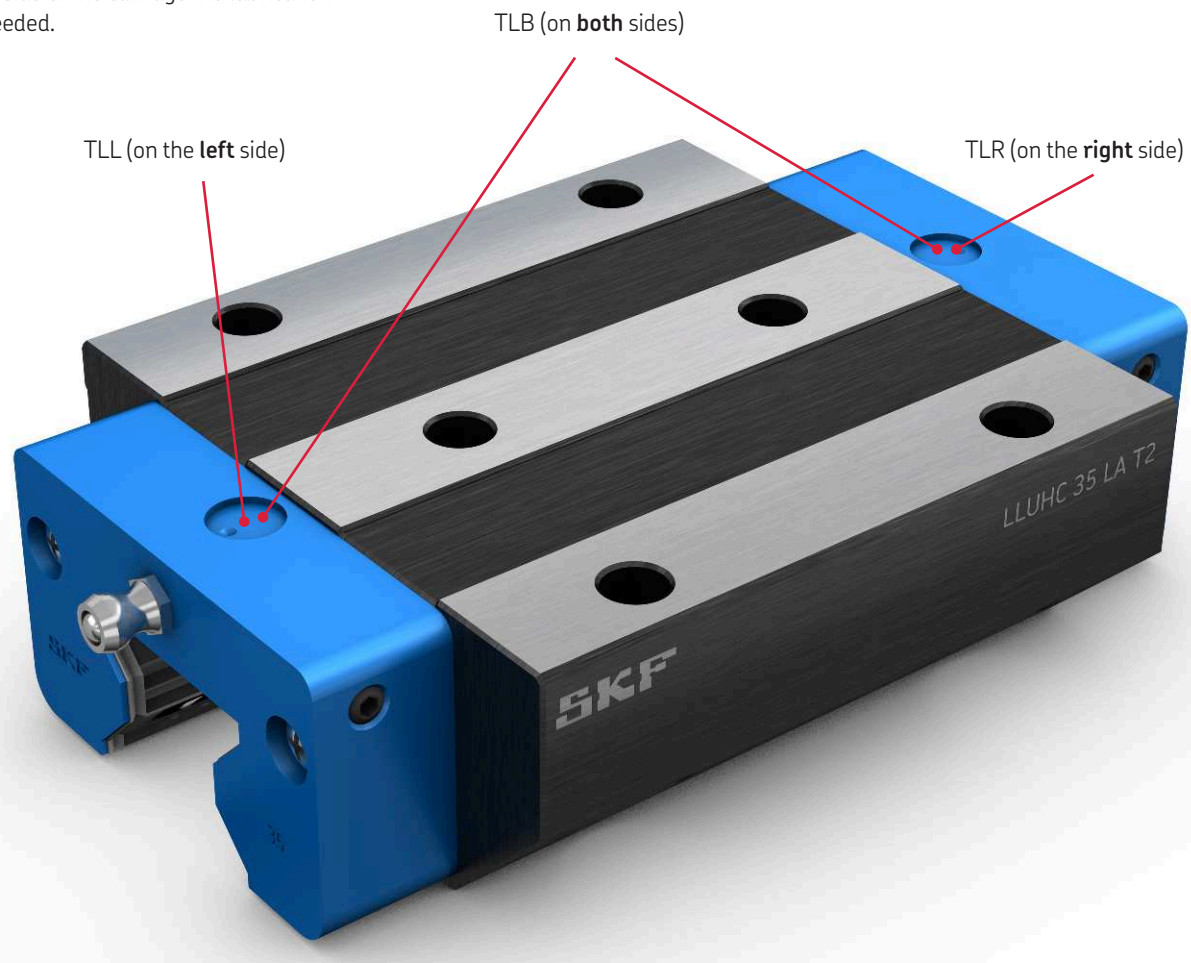
Range overview of lubrication adaptors

Dimensions	Item name, ordering key	Material	Comment
	**Grease nipple straight** LLUHZ VN-M6	Steel, coated	Is supplied with the carriage as standard.
	**Grease nipple 45°** LLUHZ VN-M6-45	Steel, coated	
	**Grease nipple 90°** LLUHZ VN-M6-90	Steel, coated	
	**Quick coupling straight** LLUHZ VN SC	Steel, coated	To connect 4 mm outer diameter plastic pipe. Max. operating pressure: 30 bar
	**Quick coupling 90°, adjustable** LLUHZ VN AC	Steel, coated	Coupling can be rotated 360°. To connect 4 mm outer diameter plastic pipe. Max. operating pressure: 30 bar
	**Lubrication connector** LLUHZ VN UA	Stainless steel	Needed when using seal kit S3, S8 and seal S7, S4.
	**Reduction fitting** LLUHZ VN UB	Stainless steel	Reduction from G1/8 to M6 when connection to a pipe system is needed.
	**Reduction fitting** LLUHZ VN UC	Stainless steel	Reduction from M8x1 to M6.
	**Adaptor for top lubrication** LLUHZ VN TL	Aluminium and O-rings	Supplied with top lubrication option. Separately only if needed as a spare part.

Adaptor for top lubrication

The lube port for top lubrication in the end plate is usually closed. If needed, it is to be ordered separately. In this case the carriage will be delivered with an opened port and the necessary top lubrication adaptor. Reconditioning of delivered carriages to accommodate top lubrication is not possible.

When ordering a system or a single carriage with top lubrication, be sure to specify on which side of the carriage the lubrication port is needed.



When ordering an adaptor for top lubrication as a spare part, be sure to specify which carriage type it is needed for.

TL1	for A, LA carriage	O-ring (size 25-55), O-ring + adaptor (size 65)
TL2	for R, LR carriage	O-ring + adaptor

Mounting and maintenance

General instructions

The following mounting instructions are applicable to all carriage types.

To maintain the high precision of SKF roller profile rail guides LLU, the carriages must be handled carefully during transport and assembly.

To provide protection during transport, storage and assembly, LLU rails and carriages are supplied with a corrosion preservative. This preservative does not need to be removed if the recommended lubricants are used.

NOTE: When carriages are shipped without a rail, they are equipped with a transportation sleeve to keep the rollers in place. This transportation sleeve should never be removed without pushing the carriage onto a rail.

Also, the carriages should never be removed from a rail without using a transportation sleeve to keep the rollers in place.

Failure to follow these directions may result in the rollers falling out of place. If this happens, the carriages cannot be used anymore.

Typical mounting examples

Rails

Each rail has ground reference edges on both sides.

Options for securing the rails laterally (→ figs. 8 and 9)

1 Stop edges
2 Retaining strips
3 Reference edges

[1] For detailed information, please download "Mounting Instruction Profile rail guides LLU" at www.skf.com

Fig. 8

Mounting with laterally fixed rails

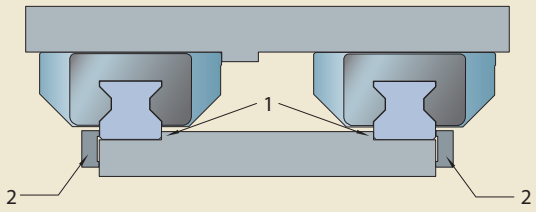
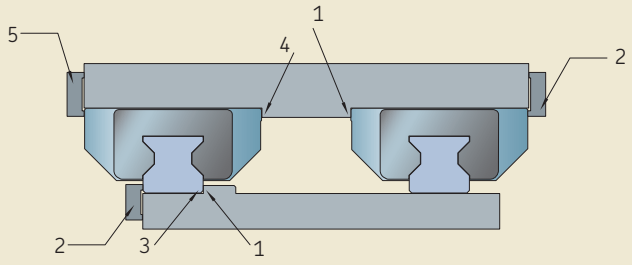


Fig. 9

Mounting with laterally fixed rail and carriages



NOTE: Rail ends must be chamfered to prevent seal damage during installation. However, if two rails are to be joined, do not chamfer either of the mating ends.

Rails that are not laterally fixed must be installed straight and parallel. SKF recommends using a support strip to maintain the rail's position during installation.

Guideline values for the permissible lateral loads for guidings that are not laterally supported are listed in **table 11**.

Carriage

Each carriage has one reference side (please refer to dimension H_2 in the drawings of the carriages) (**→ pages 26 and following**).

Options for securing the carriages laterally (→ fig. 9)

4 Stop edges
5 Retaining strips

NOTE: If mounted correctly, the carriage should move easily on the rail when pushed (moving force depending on preload). During assembly, secure the carriage to prevent it from falling.

Interface design, screw sizes and tightening torques

- The flange-type carriages can be fastened from above (→ **fig. 11**) and below (→ **fig. 12**). For fixation from below, use the attachment holes as pass-through holes for a screw in the next smaller size. For the two inner attachment holes (O_3), special screws with low head height according to **DIN 6912** must be used.
- The slim-type carriages can be fastened only from above (→ **fig. 13**).
- Rails can be fastened from both above (→ **fig. 12** and **13**) or below (→ **fig. 11**).

All screw dimensions and recommended lengths are shown in **table 9**. The correct tightening torque is critical to the proper function of the guide system. It is to be considered according to **table 10**. If no stop edge is provided in the adjacent structure, then the permissible maximum lateral load per carriage should be considered. Values can be found in **table 11**.

Fig. 10

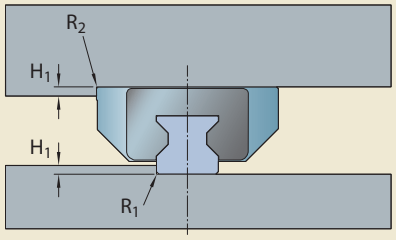


Fig. 11

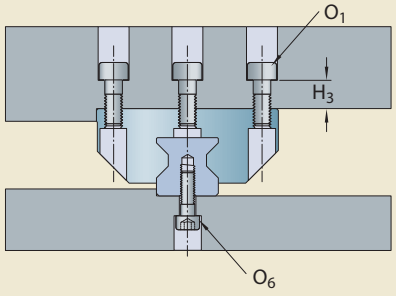


Fig. 12

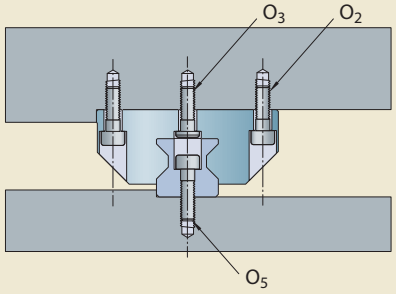


Fig. 13

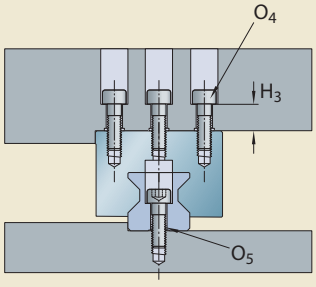


Table 9

Stop edges, corner radii, screw types and sizes per carriage type and fastening direction

Size	Dimensions				Screw					
	H_1	$R_{1\ max}$	$R_{2\ max}$	H_3	O_1[1]	O_2[2]	O_3[3]	O_4[4]	O_5	O_6[5]
–	mm				ISO 4762	ISO 4762	DIN 6912	ISO 4762		
25	5	0,8	0,8	10	M8x20	M6x20	M6x16	M6x18	M6x30	M6x20
35	6	0,8	0,8	13	M10x25	M8x25	M8x20	M8x25	M8x35	M8x25
45	8	0,8	0,8	14	M12x30	M10x30	M10x25	M10x30	M12x45	M12x30
55	10	1,0	1,2	20	M14x40	M12x40	M12x30	M12x35	M14x50	M14x40
65	10	1,5	1,5	25	M16x45	M14x45	M14x35	M16x40	M16x60	M16x45

[1] A, LA type, bolted from above
[2] A, LA type, bolted from below 4 outer screws
[3] A, LA type bolted from below 2 inner screws
[4] R, LR type bolted from above
[5] Please respect the general recommendations for minimum thread engagement lengths

Table 10

Recommended tightening torques of mounting screws

Screw strength class	Screw					
	M6	M8	M10	M12	M14	M16
–	Nm					
8.8	10	24	48	83	130	200
12.9	15	40	81	135	215	265

Table 11

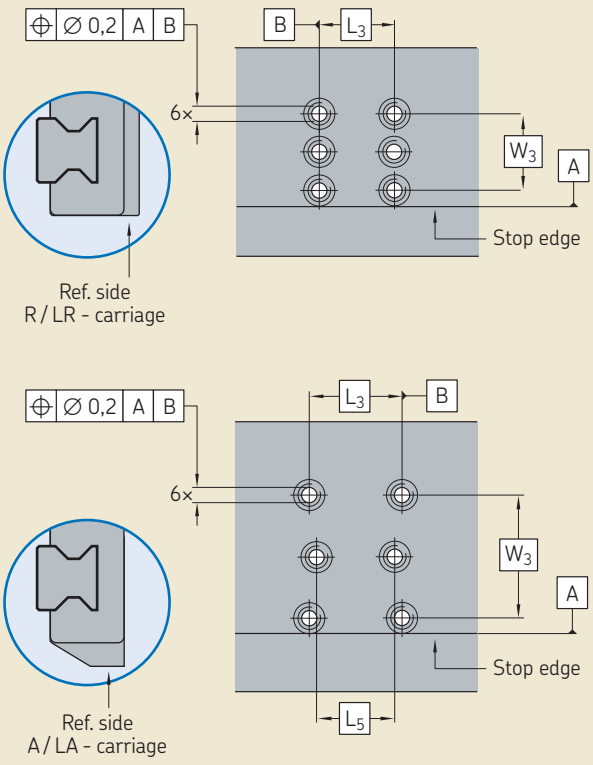
Maximum lateral load per carriage

Screw strength class	Screws used for mounting in line				
	Carriage			Rail	
	O_1	O_2+O_3	O_4	O_5	O_6
8.8	19% C	14% C	14% C	6% C	6% C
12.9	29% C	22% C	22% C	10% C	10% C

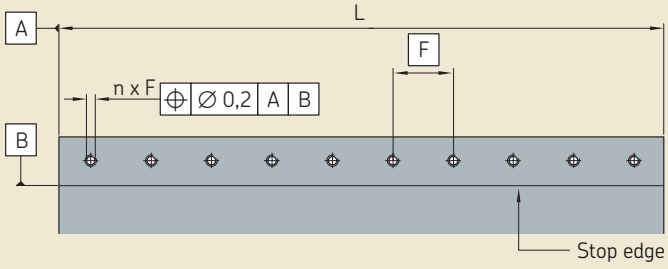
Position tolerances of attachment holes

To ensure the interchangeability between the machine bed and the profile rail guides, it is necessary to match the positions of the corresponding attachment holes of all components to be mounted. When observing the tolerances given in the following drawings, it is not necessary to remachine the machine bed, in particular with long profile rail guides.

Attachment structure for carriages



Attachment structure for rails



Permissible height deviation

The values for height deviation are applicable for all carriage types. If the values for height deviation S_1 and S_2 are within the specified range, the service life of the rail guide system will not be influenced.

Permissible height deviation in lateral direction (→ table 12)

$S_1 = d\ Y$

where
s_1 = Permissible height deviation [mm]
d = Distance between the rails [mm]
Y = Calculation factor lateral direction

NOTE: The height tolerance H for the carriages has to be taken into account. Please refer to **table 2** on **page 13**. If the difference S_1–2 x tolerance H < 0, a new product selection is necessary (other preload, precision).

Permissible height deviation in longitudinal direction (→ table 13)

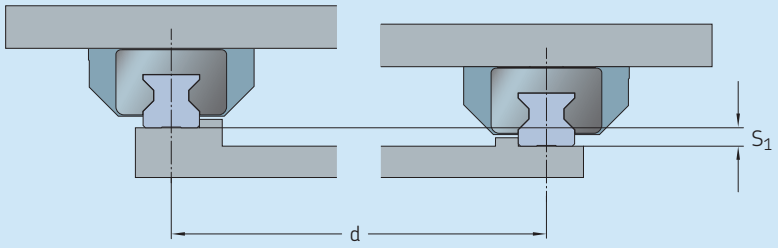
$S_2 = c\ X$

where
S_2 = Permissible height deviation [mm]
c = Distance between the carriages [mm]
X = Calculation factor longitudinal direction

NOTE: The maximum difference ΔH for the carriages has to be taken into account. Please refer to **table 2** on **page 13**. If the difference $S_2 - \Delta H < 0$, a new product selection is necessary (other preload, precision).

Table 12

Permissible height deviation in lateral direction

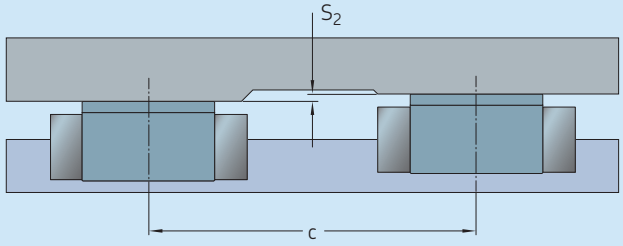


Calculation factor Y for carriages

Calculation factor	Preload T2 (8% C)	T3 (13% C)
Y	$1,7 \times 10^{-4}$	$1,2 \times 10^{-4}$

Table 13

Permissible height deviation in longitudinal direction on one rail



Calculation factor X for carriages

Calculation factor	Standard length	Extended length
X	$4,5 \times 10^{-5}$	$3,5 \times 10^{-5}$

C

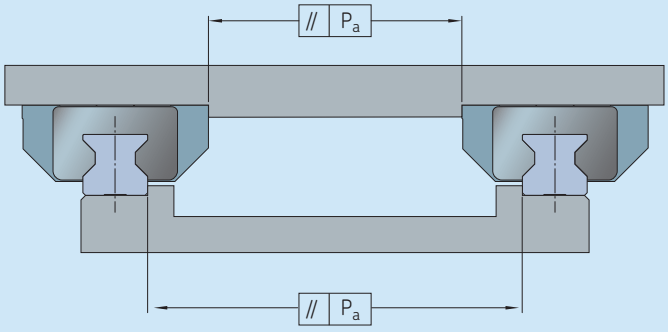
Parallelism

The parallelism of mounted rails is measured on the rails and the carriages.

The values for deviation in parallelism P_a are applicable to all carriage types. Deviation in parallelism P_a increases the internal load. If the values are within the specified range in **table 14**, the service life of the profile rail guide system will not be influenced. With standard mounting, the adjacent structure is slightly resilient. However, a rigid, high-precision adjacent structure is required for precision mounting. In this case, the values in **table 14** must be halved.

Table 14

Deviation in parallelism P_a



Size	P_a in relation to preload class [mm] T2 (8% C)	T3 (13% C)
25	0,008	0,005
35	0,012	0,008
45	0,014	0,009
55	0,017	0,011
65	0,018	0,011

Lubrication

The appropriate type and amount of lubricant is required for rolling bearings to function reliably. To reduce wear, the lubricant prevents direct metal-to-metal contact between the rolling elements and the raceways. In addition, the lubricant protects the carriage from corrosion.

The guiding system can only realize its optimum operating temperature when a suitable amount of lubricant to reliably lubricate the roller profile rail guide is applied.

Basically, two different lubrication methods are available for LLU: grease and oil lubrication.

Delivery condition from factory

LLU roller carriages and rails are protected with high-quality anti-corrosion preservation oil for transport, storage and mounting. This special oil supports initial installation of LLU and can remain in the product if the SKF recommended lubricants are used.

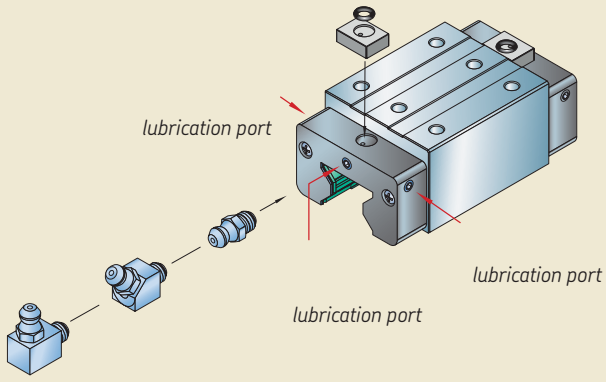
Each carriage is delivered with one straight grease nipple and has to be initially lubricated before usage as described on the next pages.

Lubrication ports

Both end plates of the carriage feature three lube ports with M6 thread, one in longitudinal and two in 90° orientation to moving direction (→**fig. 14**). At delivery these ports are closed by grub screws. As standard, one straight grease nipple for manual lubrication is supplied with the carriage. If needed, the carriage can be adapted for top lubrication. The lube port for top lubrication is usually closed and has to be ordered separately if required (see ordering key system). In this case the carriage will be delivered with an opened port and the necessary adaptor. Reconditioning of delivered carriages to accommodate top lubrication is not possible. For additional lubrication adaptors please refer to **table 8** on **page 42.**

Fig. 14

Lubrication ports



D

Grease lubrication

Under normal operating conditions, LLU roller profile rail guides should be lubricated with grease. The advantage of grease is that it is more easily retained in the bearing, which is particularly important when the axis of travel is inclined or vertical. Moreover, it contributes to sealing the bearing against the ingress of liquid contaminants or humidity.

Base oil viscosity

The viscosity of the lubricating oil in grease is key to the formation of the hydrodynamic film that separates the rolling elements from the raceways.

In general, the viscosity of lubricating oils is based on the flow rate at 40 °C. These values also apply to the mineral base oils contained in lubricating greases.

The base oils of commercially available rolling bearing greases have viscosity values between 15 and 500 mm²/s (at 40 °C). Greases with higher base oil viscosities often release the oil too slowly to sufficiently lubricate bearings.

Consistency class

Lubricating greases are divided into various consistency classes according to a scale by the National Institute of Grease Lubrication (NLGI). These are also reflected in DIN 51 818 and DIN 51 825.

Greases with a metallic soap thickener with a consistency of 2 or 3 on the NLGI scale are particularly suitable for use with LLU roller profile rail guides. The grease consistency should not vary too much with changing operating temperatures or stress levels. Greases that soften at higher temperatures can leak from the bearing position, while greases that stiffen at lower temperatures can impede the operation of the linear guiding system.

Specific requirements are placed on the lubricating grease's purity, composition and compatibility if the grease is to be used in special applications.

Table 15

A selection of SKF rolling bearing greases

Properties	Lubricant (designation)			
	LGEP 2	LGMT 2	LGLT 2	LGFP 2
Thickener	Li	Li	Li	Al complex soap
Base oil	Mineral oil	Mineral oil	Di-ester oil	Medical white oil
Operating temperature, °C (steady state)	–20 up to +100	–30 up to +120	–55 up to +110	–20 up to +110
Kinematic viscosity of base oil	200	110	15	130
Consistency class (acc. to NLGI)	2	2	2	2
Temperature range / Application range	EP grease	normal	low	food compatible

Temperature range

The temperature range over which a grease can be used depends largely on the type of base oil and thickener as well as the additives.

The low temperature limit, the lowest temperature at which the grease enables the bearing to be started up without difficulty, is largely determined by the type of base oil and its viscosity. The high temperature limit is determined by the type of thickener and its dropping point. The dropping point is the temperature at which grease changes its consistency and becomes a fluid.
Note that grease will age with increasing rapidity at higher operating temperatures. The resulting by-products have a detrimental effect on the grease's lubrication properties and conditions in the rolling contact zone.

Lubricating greases with synthetic base oils can be used both at higher and lower temperatures than lubricants with a mineral oil base.

Corrosion-inhibiting additives in lubricants

Lubricants typically contain additives to inhibit corrosion. In addition, the type of thickener is crucially important in this regard.

Lithium-base and calcium-soap greases provide excellent corrosion protection properties. They are also resistant to water wash-out.

SKF bearing greases

The assortment of SKF greases has been developed based on the latest information about rolling bearing lubrication and has undergone extensive testing both in the laboratory and under field conditions. SKF continuously monitors the quality of its greases prior to use or sale.

Table 15 lists those SKF greases that are particularly well-suited for LLU roller profile rail guides. Additional information and special lubricant recommendations are available from SKF upon request.

Initial grease lubrication

LLU roller profile rail guides must be initially lubricated immediately after installation with lubricant quantities specified in **table 16**. During lubrication, the carriage should be moved at least three times' its length for better lubricant distribution within the carriage.

Grease relubrication

The lubrication intervals for LLU roller profile rail guides depend primarily on the average running speed, operating temperature and grease quality. The intervals recommended for fixed operating conditions are listed in **table 17**. For appropriate grease quantity, refer to **table 18**. Where contamination, use of coolants, vibration, shock loads, etc. are part of the environmental conditions, it is advisable to reduce relubrication intervals accordingly.

Table 16

Initial grease lubrication quantities

Quantity/carriage	LLUHC 25	LLUHC 35	LLUHC 45	LLUHC 55	LLUHC 65
–	cm^3				
A, R	1,9	2,9	5,3	8,4	15
LA, LR	2,2	3,7	6,6	10,6	18,9

Table 17

Relubrication interval according to applied carriage load

Load ratio C/F_m		LLUHC 25	LLUHC 35	LLUHC 45	LLUHC 55	LLUHC 65
≥	<	travel interval in km				
8	**–**	800	500	300	200	100
5	**8**	500	300	150	100	50
3	**5**	200	150	80	50	25
2	**3**	120	80	40	25	15

Table 18

Grease relubrication quantities

Quantity/carriage	LLUHC 25	LLUHC 35	LLUHC 45	LLUHC 55	LLUHC 65
–	cm^3				
A, R	0,5	1,2	2,2	3,2	5,9
LA, LR	0,6	1,4	2,6	4	7,4

Oil lubrication

When a LLU roller profile rail guide is used under particular operating conditions, such as unfavorable load scenarios or limited access for relubrication, oil lubrication is advisable.

For small sizes of roller profile rail guides under heavy load conditions oil lubrication might be advantageous to extend the service life in the application.

Oil lubrication can also be advantageous when a centralized lubrication system is installed or where there is a need to unify the lubrication management with other machine parts, e g drive train or secondary lubrication points In this case, SKF recommends oil types according to DIN 51517, type CLP or DIN 51524, type HLP The viscosity range should cover ISO VG 68 to ISO VG 220.

Initial oil lubrication

Immediately after installation, the carriages should be lubricated with the oil quantities specified in **table 19.** The quantities are valid for all carriage types and vary only with the size. During the filling, the carriage should be moved at least three times' its length for better oil distribution within the carriage.

Oil relubrication

The oil relubrication intervals for LLU roller profile rail guides depend primarily on the average running speed, operating temperature and oil quality. The intervals recommended for fixed operating conditions are the same as for grease lubrication and are listed in **table 17**. The appropriate oil quantity is the same as for initial lubrication according to **table 19**. Where contamination, use of coolants, vibration, shock loads, etc. are part of the environmental conditions, it is advisable to reduce relubrication intervals accordingly.

In case of impulse oil lubrication, the minimum quantity per impulse should be 15% of the values from **table 19**.

Temperature range

Note that oil will age with increasing rapidity at higher operating temperatures. The resulting by-products have a detrimental effect on the oil's lubrication properties and conditions in the rolling contact zone.

Short stroke applications

If the stroke is less than twice the carriage length, lube ports on both carriage end plates must be used, each filled equally with the grease or oil quantity stated for initial lubrication or relubrication.

Example

- Short stroke application
- Carriage type A
- Size LLUHC 25
- Grease lubrication

Apply 1,9 cm^3 into the left and 1,9 cm^3 into the right grease nipple for initial lubrication.

IMPORTANT: To avoid serious damage to the rail guides, it is important to consider the miscibility of greases or oils when changing from one lubricant to another.

Moreover, you must also consider the possibility of reduced relubrication intervals and reduced load ratings as well as the possibility of chemical interaction with synthetic materials, lubricants and preservatives. Please refer to the grease and oil manufacturer's instructions. In case of incompatibility between lubricants employed, the carriages should be thoroughly cleaned before regreasing.

Centralized lubrication systems

If the application features a centralized lubrication system using greases with a consistency of 2 or higher on the NLGI scale, contact SKF.

For automatic relubrication systems from SKF, please contact your local SKF representative.

Table 19

Initial oil lubrication quantities

Quantity/carriage	LLUHC 25	LLUHC 35	LLUHC 45	LLUHC 55	LLUHC 65
–	cm^3				
	0,8	1,0	1,4	1,8	3,6

Maintenance

To avoid dirt from adhering to and being embedded into the rails, the rails should be cleaned regularly with a “cleaning stroke”. SKF recommends a cleaning stroke over the entire length of the rails twice a day or at least every eight hours.

Perform a cleaning stroke whenever switching the machine on or off.

Repairs

If the LLU roller profile rail guide system has reached the end of its service life and has to be replaced, SKF recommends replacing the whole system. Please locate the name of the ordering key written on the carriage and measure the rail length and the E-dimension (the distance from the rail end to the first hole) for re-ordering.

Stationary conditions, shipping and storage

If a LLU roller profile rail guide is stationary for long periods and subjected to vibration from external sources, micro movement in the contact zone between rollers and raceways will lead to damage of those surfaces. This damage can result in a significant increase in running noise and premature failure due to material fatigue. Damage of this kind should be avoided at all costs, for instance by isolating the bearings from external vibration and by taking suitable precautions during transport.

Ordering key LLU system

Designations	LLUH	S	35	R	2	T2	1000	P01	A	D4	E0	M	S1	C	TLL	M

LLU roller profile rail guide

Type code
- C Carriage (carriage only)[1]
- R Rail (rail only)[1]
- S System[2]
- Z Accessories (if ordered separately)[1]

Size
25, 35, 45, 55, 65

Carriage type
- A Flanged carriage, standard length, standard height
- LA Flanged carriage, extended length, standard height
- R Slim-line carriage, standard length, extended height
- LR Slim-line carriage, extended length, extended height

Number of carriages per rail
1, 2, 4, 6, ...

Preload class
- T2 Medium preload, 8% C
- T3 Heavy preload, 13% C

Rail length
Maximum rail length without joint: 4 000 mm; in 1 mm increments[3]

Precision class
- P3 Medium
- P1 High
- P01 Super
- P001 Ultra

Joint rails
- – If not selected, no code
- A Yes

Rail
- – Standard rail with plastic caps, no code
- D Rail, if customized according to drawing number
- D4 Rail with blind holes
- D6 Standard rail with brass plugs
- D8 Standard rail with steel plugs

Distance between end face and first mounting hole of the rail [3]
- ES The holes at both rail ends will be positioned equidistantly from either end of the rail using the E_{Std} dimension. This results in predefined rail lengths, details see **page 35**.
- E0 The holes at both rail ends will be positioned equidistantly from either end of the rail with the shortest possible "E" dimension.
- Exx "E" dimension to be specified

System (Carriage mounted on rail)
- – If not selected, no code
- M Yes

Additional sealing, as part of the system (for separate parts see *Ordering Key Accessories*)
- S1 Scraper plate
- S3 Seal kit, additional front seal NBR with scraper plate
- S4 Additional front seal FKM
- S7 Additional front seal NBR
- S8 Seal kit, additional front seal FKM with scraper plate

Number of additional seals
- C Two additional seals per carriage
- S Two additional seals per system, only outer sides of carriages are additionally sealed

Top lubrication (details and definition see **page 43**)
- – If not selected, no code
- TLL Left end plate modified plus adaptor for lubrication from top
- TLR Right end plate modified plus adaptor for lubrication from top
- TLB Both end plates modified plus two adaptors for lubrication from top

Mounting of accessories[4]
- – Not mounted, no code
- M Accessories mounted on the carriages

[1] When ordered separately (not in a system)
[2] System can consist of one rail, one or more carriages and accessories
[3] For details and more information please refer to **page 35**
[4] Can only be selected when option "Carriage mounted on rail" is ordered

Ordering key LLU carriages

Designations LLUH C 35 R T2 P01 TLL

Carriage size
25, 35, 45, 55, 65

Carriage type
A Flanged carriage, standard length, standard height
LA Flanged carriage, extended length, standard height
R Slim-line carriage, standard length, extended height
LR Slim-line carriage, extended length, extended height

Preload class
T2 Medium preload, 8% C
T3 Heavy preload, 13% C

Precision class
P3 Medium
P1 High
P01 Super
P001 Ultra[1)]

Top lubrication (details and definition see **page 43**)
– If not selected, no code
TLL Left end plate modified plus adaptor for lubrication from top
TLR Right end plate modified plus adaptor for lubrication from top
TLB Both end plates modified plus adaptor for lubrication from top

[1)] Can only be ordered as a complete system

D

Ordering key LLU rails

Designations LLUH R 35 1000 P01 A D4 E0

Rail size
25, 35, 45, 55, 65

Rail length
Maximum rail length without joint: 4000 mm; in 1 mm increments[1)]

Precision class
P3 Medium
P1 High
P01 Super
P001 Ultra[5)]

Joint rails[2)]
– If not selected, no code
A Yes

Rail[3)]
– Standard rail with plastic caps, no code
D4 Rail with blind holes
D6 Standard rail with brass plugs[4)]
D8 Standard rail with steel plugs[4)]
D Rail, if customized according to drawing number

Distance between end face and the center of the first mounting hole of the rail[1)]
ES The holes at both rail ends will be positioned equidistantly from either end of the rail using the E_{Std} dimension. This results in predefined rail lengths, details see **page 35**.
E0 The holes at both rail ends will be positioned equidistantly from either end of the rail with the shortest possible "E" dimension.
Exx "E" dimension to be specified.

[1)] For details and more information please refer to **page 35**
[2)] Only if required rail length exceeds the maximum available rail length
[3)] Plastic and metal plugs are available as spare parts, please see *Ordering Key Accessories*
[4)] Mounting Tools are separately available, please see *Ordering Key Accessories*
[5)] Can only be ordered as a complete system

Ordering key LLU accessories

Designations LLUH Z 35 S1

Size
25, 35, 45, 55, 65

Additional sealing options

S1	Scraper plate
S3	Seal kit, additional front seal NBR with scraper plate
S4	Additional front seal FKM
S7	Additional front seal NBR
S8	Seal kit, additional front seal FKM with scraper plate

Assembly tools for metal plugs

25-45 D6	Assembly tool for sizes 25, 35 and 45
45-65 D6	Assembly tool for sizes 45, 55 and 65

Caps and plugs as spare parts

VP	Set of 40 plastic caps
TD6	Set of 40 brass plugs
TD8	Set of 40 steel plugs

Grease nipples[1)]

25-65 VN-M6	Standard grease nipple, straight
25-65 VN-M6-45	Grease nipple, 45 degrees
25-65 VN-M6-90	Grease nipple, 90 degrees

Adaptors[1)]

25-65 VN UA	Lubrication connector, extension M6 to M6
25-65 VN UB	Reduction fitting, from G1/8 to M6
25-65 VN UC	Reduction fitting, from M8x1 to M6

Quick lubrication couplings[1)]

25-65 VN SC	Lubrication coupling, straight
25-65 VN AC	Adjustable coupling, 90 degrees

Adaptors for top lubrication (as spare part)

VN TL1	for A, LA carriage, O-ring (size 25 - 55), O-ring + adaptor (size 65)
VN TL2	for R, LR carriage, O-ring + adapter

[1)] One size (M6) fits for all carriage sizes and types, ordering designation LLUHZ VN.

D

Specification sheet – Roller profile rail guide LLU

Please complete the form with all available information and send it to your SKF representative or authorized distributor for product selection.

SKF contact	Date

General information

Customer

Company		
Address 1		
Address 2		
Post code / Zip	City	State
Country		

Contact

Contact name	
Job title	
Department	
Phone (including country code)	Mobile (including country code)
Mail	

Project title

Reason for request

Current product / brand		Description
○ Replacement	○ New design	○ Other

Application / Industry

			Description
○ Factory automation	○ Food and beverage	○ Machine tools	
○ Medical	○ Semiconductor	○ Other	

Export control and SKF policy (mandatory to mark)

○ The application is not subsidiary or part of industry of national defence and/or nuclear (also not with details of the function).
The application is civil.

Commercial information

General

	Quantity, pcs	Batch size, pcs	Start of supply, YYYY MM DD	Target price / each	Currency
○ One shot business ○ Yearly repeating business					

Application description

Specification sheet – Roller profile rail guide LLU

Stroke
mm

Rail length
mm

Center distance between
carriages, c: mm
rails, d: mm

or Short part dimensions
Length: mm
Width: mm

Guiding system
Maximum height: mm
○ No constraints

Required service life distance or time (fill in all fields)
Distance: km
Total time: h
Period of one cycle: s
Stroke of one cycle: mm

Required static safety (in accordance to your business and application)

Maximum speed[1)]
m/s

Maximum acceleration[1)]
m/s²

1) Here the maximum values. Enter load phase specific values in table "External loads and load phases"

Rigidity of guiding system
N/µm
○ No specific requirements

Running accuracy of guiding system
Parallelism in height: µm
Parallelism in sideward direction: µm

Environment

Presence of dust, dirt or fluids
- ○ Clean environment, e.g. laboratory
- ○ Standard industrial environment
- ○ Dirty environment, e.g. milling machine

Requirements on friction
- ○ Lowest possible friction
- ○ Standard friction
- ○ No requirement

Preferred sealing version
- ○ Standard sealing
- ○ Scraper plate (S1)
- ○ Additional front seal NBR (S7)
- ○ Additional front seal FKM (S4)
- ○ Seal kit (S3)
- ○ Seal kit (S8)

○ Humid or corrosive environment
If yes, please describe:

Temperature [°C]
Minimum | Operating | Maximum

○ Shock loads or vibrations
If yes, please describe:

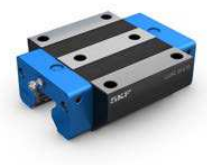
Lubricant in use
○ Grease (preferrably SKF LGEP2)
○ Oil lubrication
Please specify (type, brand):

Sketch of the application (or attach a drawing)

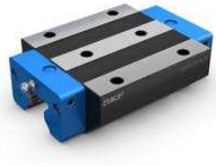
Product details

Product designation (if already known)

Carriage type



○ LLUHC-A

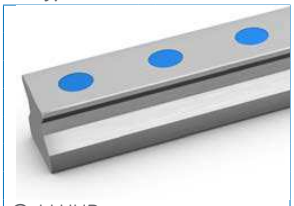


○ LLUHC-LA

○ LLUHC-R

○ LLUHC-LR

Rail type



○ LLUHR

○ LLUHR-D4

○ LLUHR-D6

○ LLUHC-D8

Preload class

○ T2 (8% C)	○ T3 (13% C)	

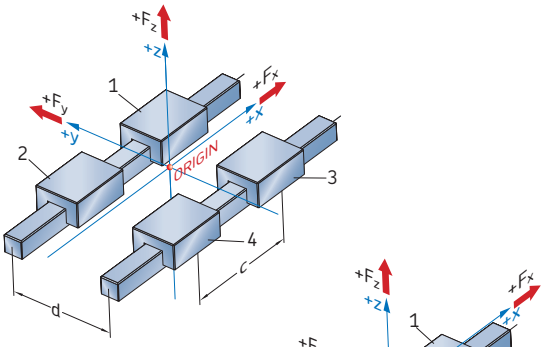
Precision class

○ P3 (Medium)	○ P1 (High)	○ P01 (Super)	○ P001 (Ultra)

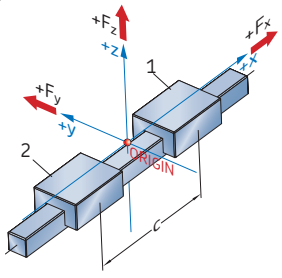
Needed accessories (for details see SKF publication **16404** *Roller profile rail guide LLU*)

○ Grease nipple straight (standard)	(25-65 VN-M6)
○ Grease nipple 45°	(25-65 VN-M6-45)
○ Grease nipple 90°	(25-65 VN-M6-90)
○ Quick coupling straight	(25-65 VN SC)
○ Quick coupling 90°, adjustable	(25-65 VN AC)
○ Lubrication connector, extension M6 to M6	(25-65 VN UA)
○ Reduction fitting, from G 1/8 to M6	(25-65 VN UB)
○ Reduction fitting, from M8x1 to M6	(25-65 VN UC)
○ Assembly tools for metal plugs	(LLUHZ ... D6)

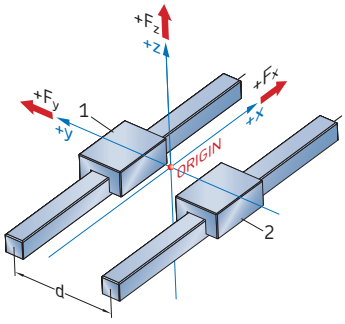
Input for dimensioning calculation



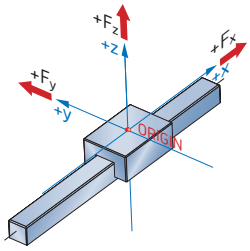
○ Config 24



○ Config 12



○ Config 22



○ Config 11

○ No preference ○ Other	If yes, please describe:

Moving direction (set coordinate system accordingly)

			Please specify:
○ Horizontal	○ Vertical	○ Other	

External loads and load phases

Forces in N, Lever arms in mm measured from defined origin (see graphics above) If the application has more than 3 load phases, please copy this page.

Load phase 1		
Stroke		mm
Acceleration		mm/s²
Speed		m/s

Force F_x	Lever arms in x	y	z

Force F_y	x	Lever arms in y	z

Force F_z	x	y	Lever arms in z

Load phase 2		
Stroke		mm
Acceleration		mm/s²
Speed		m/s

Force F_x	Lever arms in x	y	z

Force F_y	x	Lever arms in y	z

Force F_z	x	y	Lever arms in z

Load phase 3		
Stroke		mm
Acceleration		mm/s²
Speed		m/s

Force F_x	Lever arms in x	y	z

Force F_y	x	Lever arms in y	z

Force F_z	x	y	Lever arms in z

Notes