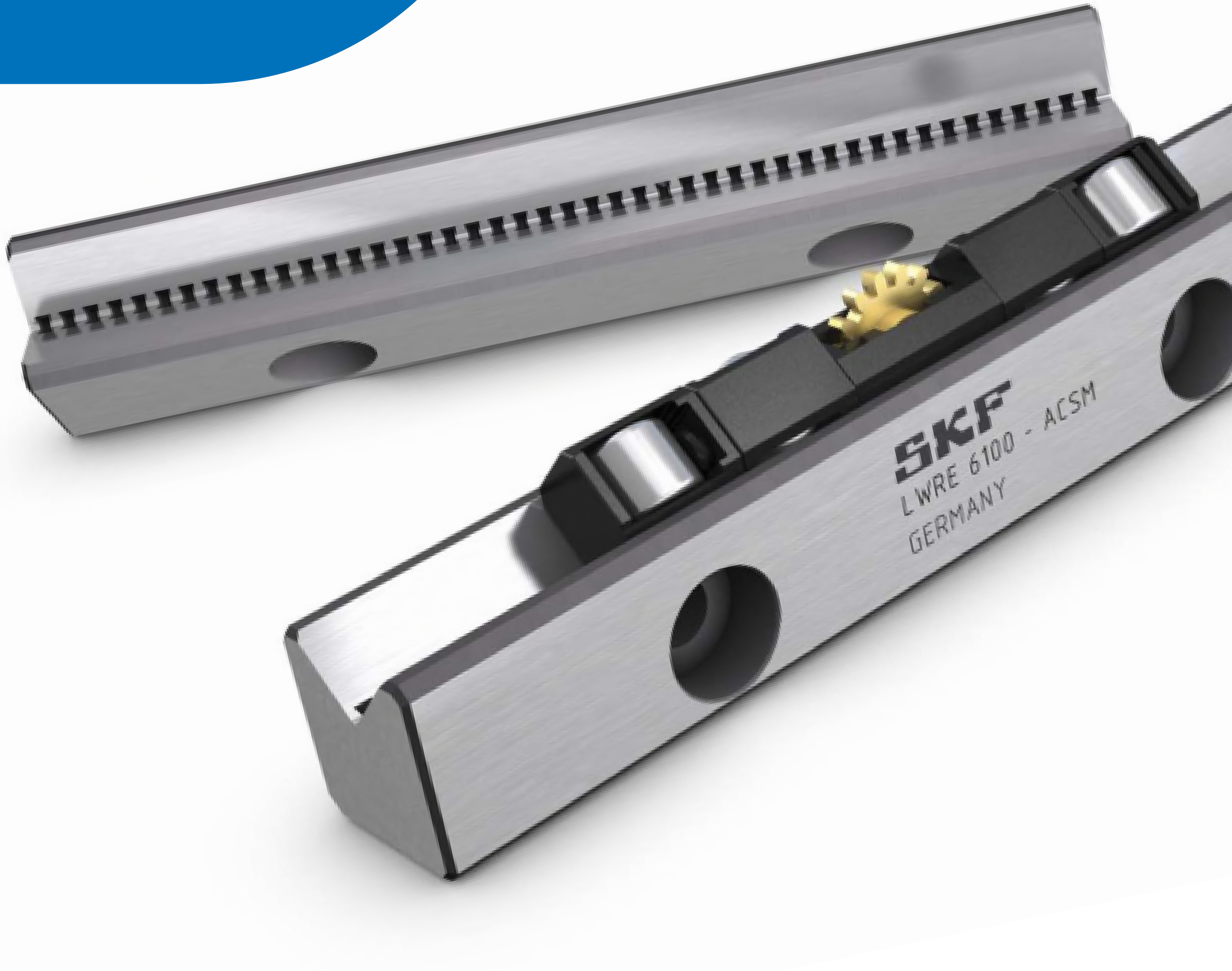
# Precision rail guides



# 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

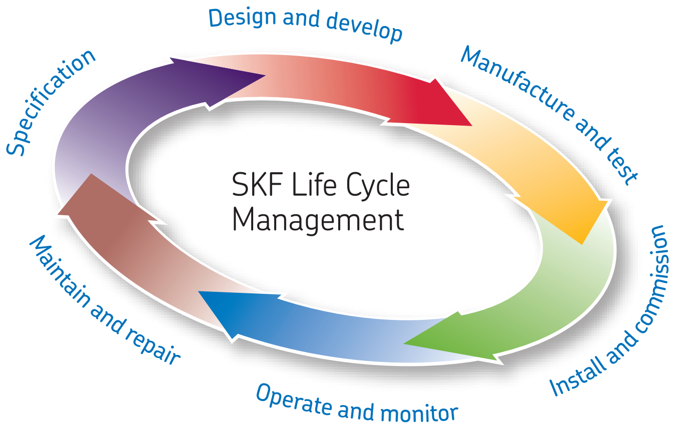
Since 2005, SKF has worked to reduce the negative environmental impact from our operations and those of our suppliers. Our continuing technology development resulted in the introduction of the SKF BeyondZero portfolio of products and services which improve efficiency and reduce energy losses, as well 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.*

# 1 General information

## 1.1 Introduction

As the world's leading rolling bearing manufacturer, SKF supplies practically every type of bearing for rotational and linear motion. SKF is therefore in a position, both technically and economically, to meet almost any customer requirement.

This catalogue covers the entire range of SKF precision rail guides and accessories. SKF precision rail guides are highly accurate products for linear motion and are ideally suited for use in a wide variety of machine tools, machining centres, handling systems and special machinery, as well as in measuring and testing equipment and semi-conductor production machines.

SKF precision rail guides are available in many different designs, sizes and standard lengths and which incorporate ball, roller or needle roller assemblies and slide coatings. They are supplied with the required accessories for attachment and sealing. The use of SKF precision rail guides enables the construction of economical, clearance-free linear guides of almost any type and length, according to the building block principle.

The characteristics of the precision rail guides include:

- A constant, high degree of running accuracy.
- Low-friction, stick-slip free operation.
- High speed of travel.
- Low heat generation.
- Low wear and high reliability.
- High rigidity.
- Excellent load carrying capacity.

If cage creeping is likely, in particular when the guide is mounted vertically, precision rail guides with anti-creeping systems (ACS) are an obvious choice, as they will eliminate this problem. They are available for nearly all types of rolling elements.

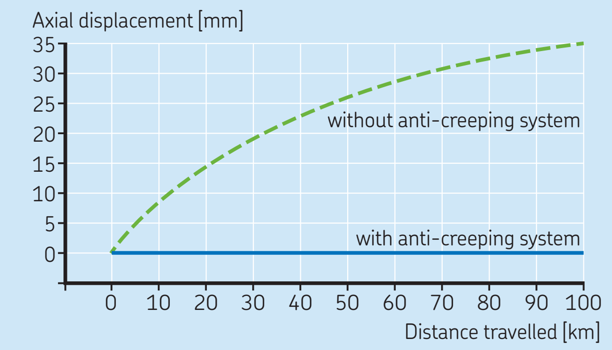
For applications characterised by high accelerations or short strokes of high frequency, SKF rail guides with slide coating are recommended. These rail guides are also suitable for machine tool applications where the damping properties of the guides are of greater importance than is the lower friction of rolling element rail guides. For those applications where precision rail guides are unsuitable, for instance because of their limited travel, SKF can supply alternative forms of linear guidance systems, like profile rail guides or linear ball bearings.

All fast-selling precision rail guides are also available in convenient kit packaging. This ensures the complete delivery of all components including end pieces and screws in one package from stock.

This catalogue brings together all the basic data that we believe will be of interest to customers. For further specialised advice, please contact your nearest SKF sales office.

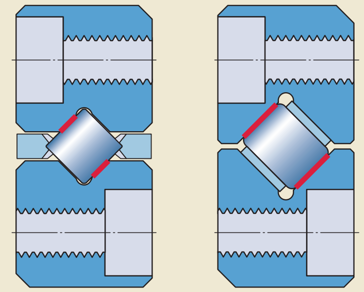
# 1.2 Features and benefits

**Cage creep test results**



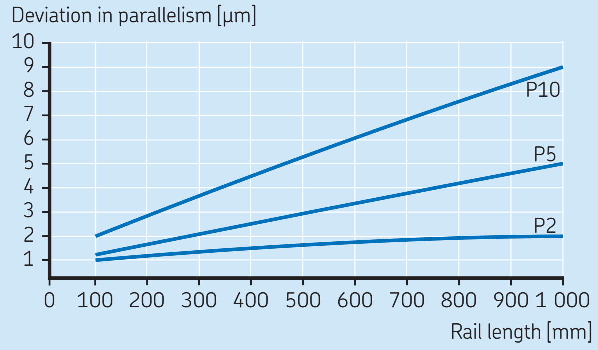
***Anti-creeping system***
*SKF developed the industry's first anti-cage-creep solution. It keeps the movement of the cage in the required position at the loaded zone, avoids cage creep from high operational speed and acceleration to uneven load distribution and weak adjacent parts, and prevents unplanned downtime and additional maintenance.*

*In addition, due to defined cage position, SKF precision rail guides with anti-creeping system, or ACS, enable increased accuracy, higher accelerations (tested up to 160 m/s$^2$), and reliable vertical installation.*

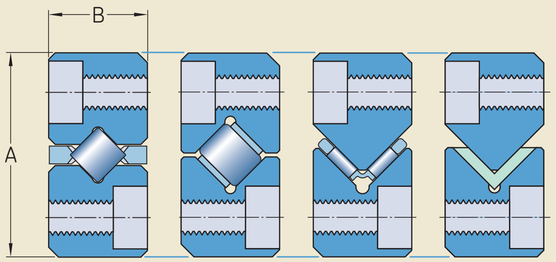


***Higher load rating and rigidity***
*Compared to conventional LWR precision rail guides, SKF optimized the internal geometry and developed LWRE precision rail guides for applications that demand robust performance. Part of our modular range, LWRE precision rail guides feature rollers with a 33% larger diameter and utilize the entire roller length than those in LWR rail guides. These LWRE design upgrades fivefolded the load ratings and doubled the rigidity vs. LWR rail guides. In operation, the increased load rating and rigidity helps to increase process stability and reliability, ultimately extending equipment service life and reducing total cost of ownership.*

**Permissible deviation in parallelism between reference surfaces and raceways**



***Extreme accuracy and positioning repeatability***
*Compared to other linear guiding products, precision rail guides provide the highest linear guiding accuracy. Precision rail guides from SKF are available in three different precision classes to meet a range of requirements for precision. The increased accuracy and repeatability enables higher productivity and product quality in diverse applications, e.g. semi-conductors, machine tools, measurement and testing equipment, and medical equipment.*



***Modular range***
*With the SKF modular range of precision rail guides, outer rail dimensions remain the same, but rolling elements are interchangeable to best meet application demands. With this design modularity, customers can easily increase load rating or extend rating life without having to redesign the equipment. The SKF modular range of precision rail guides covers 80% of dimensions on the market. Additionally, the customer can chose between ball assemblies, crossed roller assemblies, crossed roller assemblies with ACS/ACSM, needle roller assemblies and slide coatings.*

## 1.3 Product overview

SKF can offer a large assortment of precision rail guides (→ **table 1**). The different versions, mainly characterized by their type of rolling elements, are as follows:

- Ball assemblies of LWRB series.
- Ball assemblies with Anti-Creeping System of LWRB ACSM series.
- Crossed roller assemblies of standard LWR series.

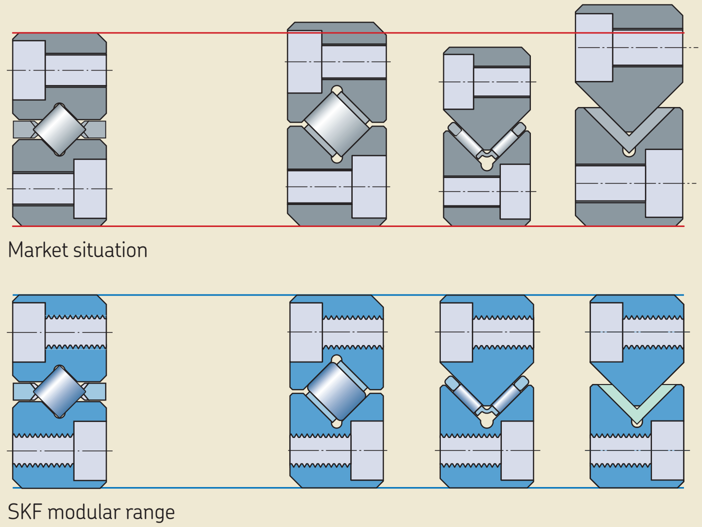
- Crossed roller assemblies of optimised LWRE series.
- Crossed roller assemblies with Anti-Creeping System of LWRE ACS series.
- Crossed roller assemblies with Anti-Creeping System of LWRE ACSM series.

- Needle roller assemblies of LWRM/LWRV series.
- Needle roller assemblies of LWM/LWV series.
- Needle roller assemblies with Anti-Creeping System of LWM/LWV ACSZ series.

- Slide coating of LWRPM/LWRPV series.

The following table shows the complete range of SKF precision rail guides, together with all available sizes. The blue shaded areas indicate the sizes included in the Modular Range. Contrary to the current lack of uniformity within the market, the interchangeable precision rail guides of the Modular Range are all within the same outer dimensions (→ **fig. 1**). For fast delivery, please refer to the rail guides that are available in kit packaging.

**Fig. 1**



Market situation

SKF modular range

**Table 1**

**Product overview**

| **Type** | **Size** (A×B mm)<br>**1**<br>8,5×4 | **2**<br>12×6 | **3**<br>18×8 | **2211**<br>22×11 | **4**<br>25×12 | 30×15 | **6**<br>31×15 | 40×20 | **9**<br>44×22 | 50×25 | **12**<br>58×28 | 60×35 | 70×40 | **15**<br>71×36 | 80×50 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **LWRB** | X | X | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **LWRB ACSM** | – | ○ | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **LWR** | – | – | X ▨ | – | – | – | X ▨ | – | X ▨ | – | ○ | – | – | – | – |
| **LWRE** | – | – | X ▨ | ○ | X | – | X ▨ | – | X ▨ | – | – | – | – | – | – |
| **LWRE ACS** | – | – | X ▨ | ○ | ○ | – | X ▨ | – | ○ ▨ | – | – | – | – | – | – |
| **LWRE ACSM** | – | – | X ▨ | ○ | ○ | – | X ▨ | – | ○ ▨ | – | – | – | – | – | – |
| **LWRM / V** | – | – | – | – | – | – | X ▨ | – | X ▨ | – | – | – | – | – | – |
| **LWM / V** | – | – | – | – | – | X | – | X | – | X | – | ○ | ○ | – | ○ |
| **LWM / V ACSZ** | – | – | – | – | – | ○ | – | ○ | – | ○ | – | ○ | ○ | – | ○ |
| **LWRPM / V** | – | – | X ▨ | – | – | – | X ▨ | – | X ▨ | – | – | – | – | – | – |

X = Prompt delivery in standard lengths (see specific product tables)
○ = Delivery time on request
– = Not available

▨ = Modular range

## 1.4 ACS in general

Many users are familiar with "cage-creeping" in conventional precision rail guides. This occurs when the cage moves out of its intended position, adversely affecting performance and possibly requiring service. This effect may occur, for example, as a result of high acceleration, uneven load distribution or vertical mounting. SKF has solved this problem by offering highly sophisticated Anti-Creeping Systems (ACS) for most guiding types.

**Advantages:**

- Cage-creeping eliminated.
- Suitable for high acceleration, vertical mounting and uneven load distribution.
- Increased accuracy due to defined position of the cage.
- Easily interchangeable with standard precision rail guides because they have identical dimensions.
- Less downtime and maintenance.

### LWRE with ACS

The original anti-creeping system for all types of LWRE rail guides.

### LWRE with ACSM

Refinement of our own ACS solution led to version ACSM for LWRE rail guides with a maximum length of 400 mm. The cage, with an involute-toothed control gear made of brass, and involute teeth directly machined into the rail, are especially suitable for high accelerations.

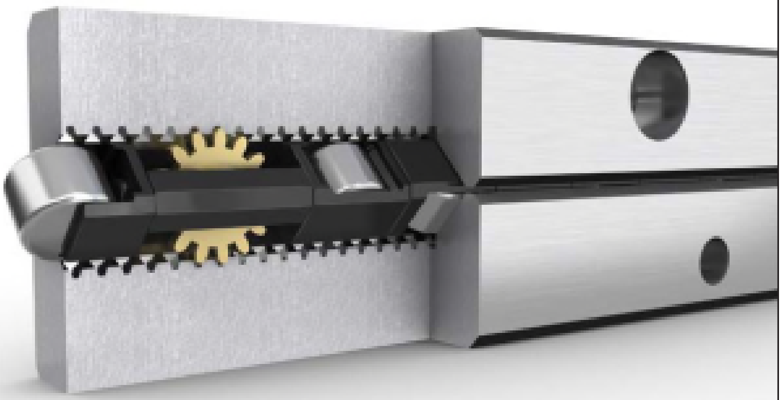
### LWM / LWV with ACSZ

For precision rail guides with needle roller cages, SKF can offer version ACSZ.

Both rails are equipped with gear racks made of steel. The cage carries two steel control gears that help to ensure the correct cage position.

LWRE with ACS

LWRE with ACSM



LWM / LWV with ACSZ

### Rails for anti-creeping cages

Rails for ACS- or ACSZ-cages can be designed for a specified stroke or maximum stroke, with the length of the toothing in the rail varied accordingly (→ **fig. 2** and **3**). Rails for ACSM-cages are always made for maximum stroke.

A rail for maximum stroke has teeth along its entire length. This may be required for mounting, maintenance or dismounting purposes. Rails for ACS- or ACSZ-cages are delivered with maximum stroke as standard and no special ordering code is required. For rails with a specified stroke, the length of the stroke, which is symmetrical to the rail, must be stated in millimetres after the suffix ACS / ACSZ. ACS- and ACSZ-cages must be operated only along the specified stroke length to ensure that the control gear is not damaged.

**Ordering example – maximum stroke:**

4x LWRE 6500 ACS
2x LWAKE 6x30 ACS
8x LWERE 6

**Ordering example – specified stroke of 340 mm:**

4x LWRE 6500 ACS 340
2x LWAKE 6x30 ACS
8x LWERE 6

**Ordering example – kit packaging:**

LWRE 6200 ACSM-KIT

Fig. 2

LWRE ACS standard stroke

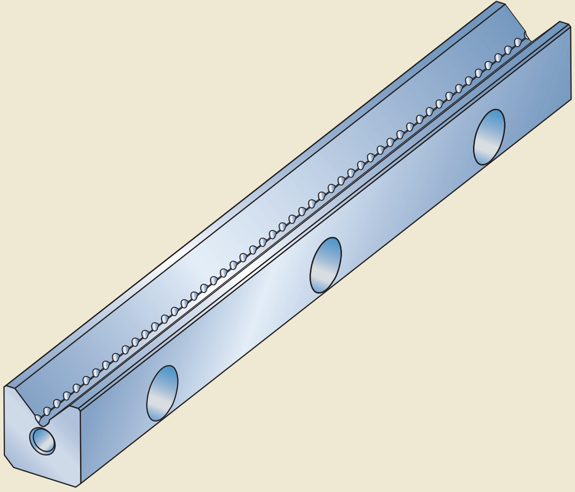
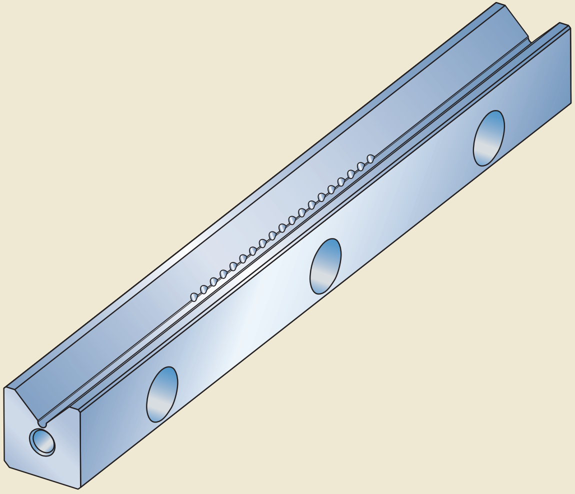


Fig. 3

LWRE ACS specified stroke



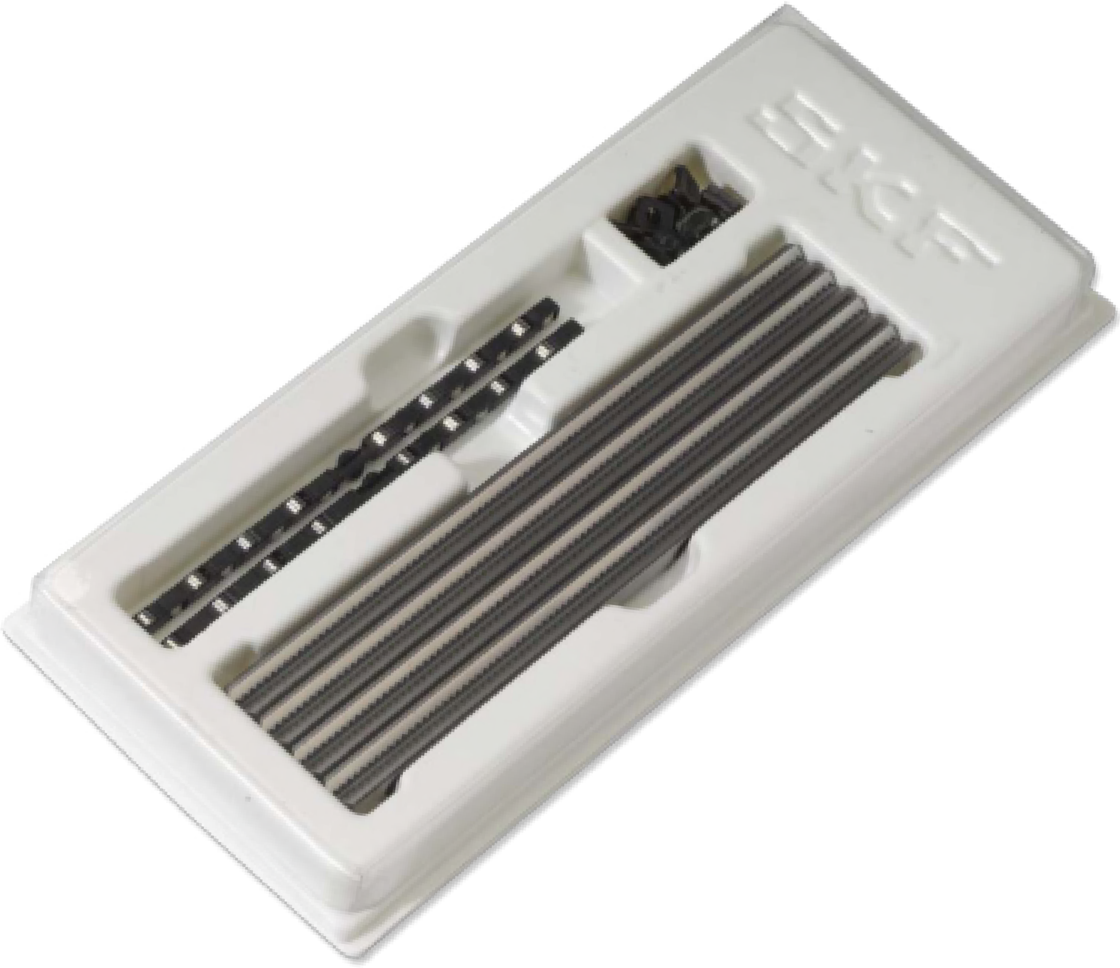
## 1.5 SKF precision rail guides in kit packaging

To simplify the ordering process and warehousing for our customers, SKF offers precision rail guides in pre-defined kits. Each kit consists of 4 rails in precision class P10, 2 cages and 8 end pieces (ACSM kits without end pieces). The available kits can be found in the specific rail guide chapters. On request it is possible to order a kit with two rails in standard length and two short rails with lead in radius. Additionally the number of rolling elements can be varied, see ordering code.

Completely customised precision rail guide sets are also possible on request.

**Advantages of rail guide kits**

- All components required are supplied ready-to-mount and can be ordered with a single order number.
- Most kits are available from stock.
- Cage length is easily adjustable.[1)]
- Load capacities are already calculated for the kit.[2)]
- Available with ACS or ACSM for effective prevention of cage-creeping.
- Rails for ACS- or ACSM-cages with toothing along entire length (rails for maximum stroke).



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[1)] Do not cut the cage shorter than 2/3 of the total rail length.
[2)] Load capacities are given for a kit of 4 rails and 2 cages in clamped arrangement ($C_{0eff}$ slide, $C_{eff}$ slide)

# 1.6 Technical data

## 1.6.1 Materials

As standard, precision rails are manufactured from tool steel 90MnCrV8 (1.2842) with a hardness between 58 and 62 HRC. However, if required by the application, the rails can also be supplied in stainless steel, e.g. X90CrMoV18 (1.4112). All rails from the LWRE ACSM series are made of stainless steel X46Cr13 (1.4034) or X65Cr13 (1.4037).

Standard rolling elements are made from carbon chromium steel 100Cr6 (1.3505) with a hardness between 58 and 65 HRC. Stainless steel rolling elements are available on request.

The cages of SKF rolling element assemblies are manufactured from hard plastic or aluminium. The material of LWAKE crossed roller units is POM, and for all other rolling element assemblies, PA 12 or equivalent, sometimes reinforced with glass fibres. Aluminium cages are made of AlMgSi0,5 (EN AW-6060). For other cage materials such as Peek, steel, brass, etc., please contact SKF.

Standard end pieces are made of blackened steel. Additionally, the standard end pieces can be supplied as chromed end pieces when ordered with suffix "/HV".

## 1.6.2 Coating

For corrosive environments, the rails can be protected with a special TDC (Thin Dense Chrome) coating. This coating, with a layer hardness of 900 to 1300 HV, substantially improves corrosion resistance and thus increases wear resistance under critical operating conditions. The salt spray test, which complies with DIN EN ISO 9227, resulted in 72h corrosion protection. The coating is matt grey in colour and complies with RoHs requirements. The load capacity is not affected by the coating. Due to the electrolytic process, the mounting holes and other grooves or drills might not be fully coated. The suffix for ordering is "/ HD".

## 1.6.3 Permissible operating temperatures

The range of operating temperature for SKF precision rail guides depends largely on the particular cage type used. Guides with metal cages and end pieces without wipers can generally be used up to +120 °C. For rail guides with plastic components, the operating temperature range is –30 °C to +80 °C. Please note that the temperature limit of the used lubricant must also be taken into account.

Permanently higher operating temperatures for precision rail guides without plastic components are possible but the hardness of the material and thus the load carrying capacity will decrease. The detailed explanation of the influence of higher temperatures on the load carrying capacity (factor $f_t$) can be found in *chapter 1.8.3*. The accuracy of the rail guide worsens with increasing temperature due to changes in the material structure and dimensional changes.

## 1.6.4 Permissible speed and acceleration

SKF precision rail guides that are correctly mounted and preloaded, can be used for running speeds up to 2 m/s and accelerations up to 25 $m/s^2$. Needle roller cages can be accelerated with maximum 100 $m/s^2$. For cages with ACSM, the maximum acceleration is 160 $m/s^2$ and for cages with ACSZ the value is 100 $m/s^2$. Higher running speeds and accelerations are possible, depending on bearing design, bearing size, applied load, lubricant and bearing preload. In such instances, please consult SKF.

## 1.6.5 Permissible minimum load

To prevent the rolling elements from sliding on the raceway during operation at higher speeds or high acceleration, the precision rail guide system must be loaded at all times with a minimum 2% of the dynamic load rating. This is particularly important for applications characterized by highly dynamic cycles. Precision rail guide systems preloaded according to the table, *Tightening torques of set screws* (→ *chapter 3.1.10*), are typically able to satisfy the stated minimum load requirements.

## 1.6.6 Permissible maximum load

ISO 14728 Part 1 stipulates that calculation of bearing life is valid only when the equivalent dynamic mean load $P_m$ of a precision rail guide does not exceed 50% of the dynamic load rating C. Any higher loading leads to an imbalance of stress distribution, which can have a negative impact on bearing life. As stated in ISO 14728 Part 2, the maximum load should not exceed 50% of the static load rating $C_0$.

## 1.6.7 Friction

Friction in a precision rail guide with rolling elements depends not only on the loading, but on a number of other factors, notably the type and size of the bearing, the operating speed, and the properties of the lubricant. The cumulative running resistance of a rail guide is composed of the rolling and sliding friction at the contact zone of the rolling elements, friction at the points of sliding contact between the rolling elements and cage, churning work within the lubricant and friction from the seals or wipers.

The coefficients of friction under normal operating conditions, with grease lubrication and good mounting accuracy, are between 0,0005 and 0,004. For rail guides fitted with wipers, the coefficient of friction and the starting friction is significantly higher due to the friction of the wipers themselves.

## 1.6.8 General rigidity behaviour

The rigidity of a precision rail guide (expressed in N/µm) is defined as the ratio between the acting external load and the elastic deflection resulting in the rail guide. Besides the load carrying capacity, rigidity is one of the most important selection criteria for a precision rail guide system. The elastic deflection of a system depends on the magnitude and direction of the external load, the preload, the type of rail guide including size and cage length, and the mechanical properties of the adjacent support structure, including screws and joints between components. On a preloaded rail guide system the deflection under load within a given load range will be less than for a rail guide without preload. Variations in contact geometry are the main factors contributing to the general rigidity behaviour of the cage types (→ **diagram 3**). The details are explained in *chapter 1.11*.

## 1.6.9 Precision classes of rails

In order to meet the precision requirements of rail guide systems, SKF produces rails in three different precision classes. These are classified according to the parallelism between the raceways and reference surfaces A, (as indicated, on the reverse side of the SKF label), and B. See **table 2** and **fig. 4**.

**Table 2**

**Tolerance t of parallelism to reference surfaces**

| **Rail length** | | **Precision class** | | |
|---|---|---|---|---|
| > | ≤ | P10 | P5 | P2 |
| mm | | µm | | |
| 0 | 100 | 2 | 1 | 1 |
| 100 | 200 | 3 | 2 | 1 |
| 200 | 300 | 4 | 2 | 1 |
| 300 | 400 | 5 | 2 | 2 |
| 400 | 500 | 6 | 3 | 2 |
| 500 | 600 | 6 | 3 | 2 |
| 600 | 700 | 7 | 4 | 2 |
| 700 | 800 | 8 | 4 | 2 |
| 800 | 900 | 8 | 5 | 2 |
| 900 | 1 000 | 9 | 5 | 2 |
| 1 000 | 1 200 | 10 | 6 | 3 |
| 1 200 | 1 400 | 11 | 6 | 3 |
| 1 400 | 1 600[1] | 12 | 7 | 3 |

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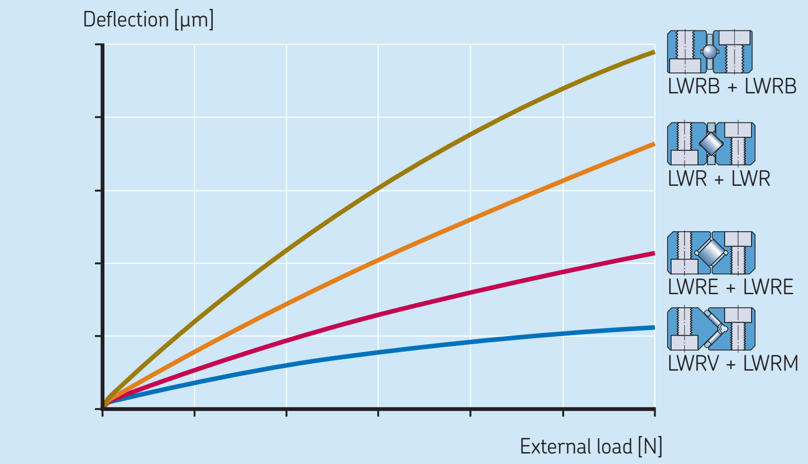
[1] Rail length > 1 600 mm, please contact SKF

**Diagram 3**

**General rigidity behaviour of different rolling elements**



### P10

This is the standard precision class and meets the requirements of general machinery. The tolerance of parallelism for a 1 000 mm long rail is maximum 9 µm.

### P5

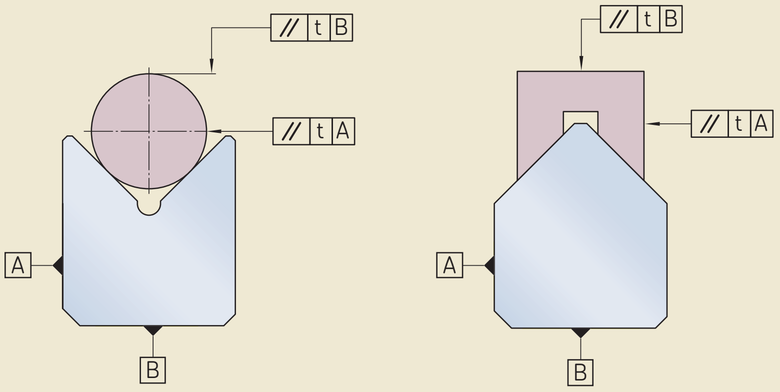
Precision class P5 satisfies the demands normally made on the running accuracy for machine tool applications. The tolerance of parallelism for a 1 000 mm long rail is 5 µm maximum.

### P2

Precision class P2 is for the most exacting demands. Rails made to this precision class should only be used when the associated components are manufactured to a correspondingly high degree of precision. Rails of precision class P2 will be manufactured by SKF to special order.

If the requisite accuracy on the order is not specified, rails with standard P10 tolerances will be supplied.

**Fig. 4**



## 1.6.10 Precision of rolling elements

The rolling elements used in precision rail guide cages are of very high quality and have a specification according to **table 3**. Besides the standard type, needle roller cages can be delivered in class G1, when ordered with suffix /G1.

## 1.6.11 Dimensional accuracy

SKF precision rail guides are produced with the following tolerances (→ **fig 5**):

| | |
|---|---|
| Width A: | +0 / –0,3 mm |
| Height B: | +0 / –0,2 mm |
| Centre Height H1 = H2: | ± 5 µm[1] |
| Assembly Height T = H1 + H2: | ± 10 µm[1] |

Rail length Lrail:

| | |
|---|---|
| $L_{rail} \leq 300$: | ± 0,3 mm |
| $L_{rail} > 300$: | ± 0,001 mm × $L_{rail}$ |

## 1.6.12 Grading

For the typical "clamped" arrangement, four precision rail guides are needed. To reach the best performance in terms of lifetime, rigidity and running behaviour, it is important that the centre height of the four rails is within a small tolerance. This is the reason why SKF rails are graded and packed together according following rules:

**Rails for crossed roller or ball cages:**

Four rails are matched to each other and packaged as a set.

**Rails for needle roller cages or slide coatings:**

Two M shaped and two V shaped rails are matched and packaged as pairs.

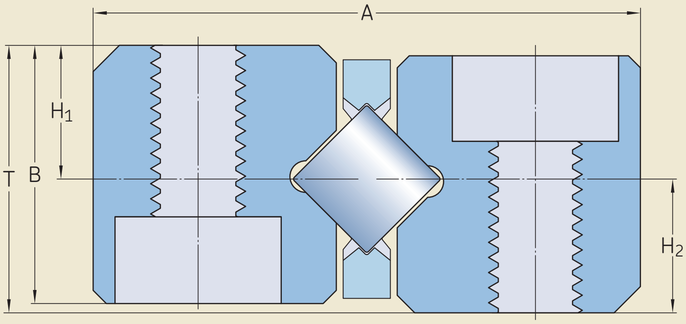
Because of the very close standard tolerance of the centre height, it would also be possible to pair any rail for a standard application (precision class P10) if necessary.

Table 3

**Precision of rolling elements**

| Rolling element | Norm | Class | Roundness | Sorting | Comment |
|---|---|---|---|---|---|
| – | – | – | µm | µm | – |
| **Balls** | DIN 5401-1 | G10 | 0,25 | 1 | Standard |
| **Cylinder roller** | DIN 5402-1 | G1 | 0,5 | 1 | Standard |
| **Needle roller** | DIN 5402-3<br>Not mentioned in DIN | G2<br>G1 | 1<br>0,5 | 2<br>1 | Standard<br>Suffix /G1 |

Fig. 5



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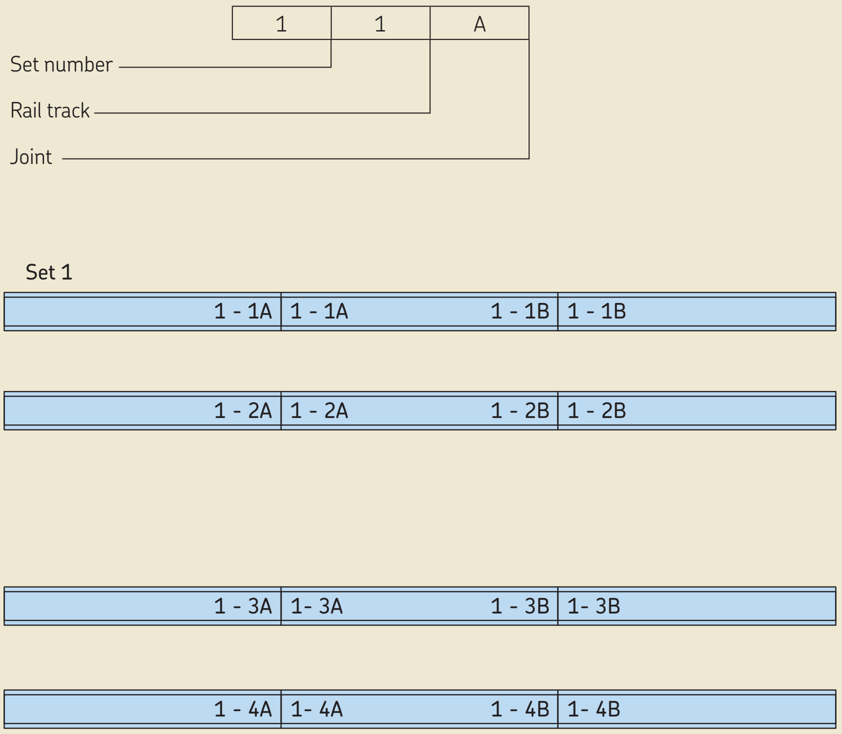
[1] for rail length $L_{rail} < 1\,000$ mm

## 1.6.13 Jointed rails

Jointed rails are always graded and well-sorted by SKF to ensure smooth running. They are delivered with markings as indicated in **fig. 6**. For rails composed of two or more sections, the tolerance for the total length is ±2 mm.

**Fig. 6**



## 1.7 Dimensioning of precision rail guide systems

Often it is not possible to build a prototype machine just to find out which the most suitable guiding for a given application is. Instead, the following established and proven procedures are recommended:

- Calculation of rating life
- Calculation of static safety factor

These two calculation methods must consider all loads and forces acting on the precision rail guide system. Representatives of the acting bearing load that describe the whole load case are needed. These representatives must combine all forces, leverarms and torque loads, which can vary by time or stroke (→ *chapter 1.9* and following). The rating life of a precision rail guide with rolling elements is defined as the total linear distance travelled by the rails before the first sign of material fatigue occurs on one of the raceways and/or the rolling elements. For the selection of rail guides based on rating life calculation (→ *chapter 1.7.3*), the dynamic load rating C, as defined in *chapter 1.8*, is used. It is expressed as the load that results in a bearing life of 100 000 m.

### 1.7.1 The concept of static safety factor calculation

When selecting a precision rail guide, the static safety factor calculation must be considered when one of the following cases arises:

- The bearing operates under load at very low speeds.
- The bearing operates at normal conditions but must also accept heavy shock loads.
- The bearing is loaded stationary for long periods of time.
- The bearing is loaded with P > 50% of the dynamic load rating C where the theory of rating life calculation is not valid any more.

In all such cases, the permissible load is determined not through material fatigue but through the permanent physical deformation at the contact zone of the rolling elements and raceways. Load applied when stationary or at very low operating speeds, as well as heavy shock loads, causes flattening of the rolling elements and results in damage to the raceways. The damage may be uneven or may be spaced along the raceway at intervals corresponding to the rolling element separation. This permanent deformation leads to vibration in the bearing, noisy running and increased friction and even may cause a decrease in preload and, in an advanced stage, an increase in clearance. With continued operation, this permanent deformation may become a starting point for fatigue damage due to resulting peak loads. The seriousness of these phenomena will depend on the particular bearing application.

### 1.7.2 The method of static safety factor calculation

When determining the bearing size according to static load rating (→ *chapter 1.8*), one must consider a certain relationship, known as the static safety factor $s_0$, between the static load rating $C_0$ and the maximum static load $P_0$. The static safety factor $s_0$ determines the degree of safety against excessive permanent deformation of the rolling elements and raceways. The static load rating, $C_0$, is defined as the static load that would produce a permanent deformation of 0,0001 times the rolling element diameter. Experience shows that, depending on the contact conditions, a maximum Hertzian pressure of 4 000 MPa is permissible at the zone of maximum load without affecting the running qualities of the bearing. See also ISO 14728-2.

**Calculation of the static safety factor**

For a chosen precision rail guide and a defined load case, the static safety factor $s_0$ can be calculated by:

$$s_0 = \frac{C_{0,\,\text{eff slide}}}{P_0} = \frac{C_{0,\,\text{eff slide}}}{F_{\text{res max}}}$$

where

$s_0$ = static safety factor
$C_{0,\,\text{eff slide}}$ = effective static load rating of a slide [N]
$P_0$ = maximum static load [N]
$F_{\text{res max}}$ = maximum resulting load [N]

Based on practical experience, guideline values have been specified for the static safety factor $s_0$, which depend on the operating mode and other external factors (→ **table 4**). If, for example, the precision rail guide system is exposed to external vibrations from machinery in close proximity, higher safety factors should be applied. Moreover, the load transfer paths between a precision rail guide system and its support structure should be taken into account. In particular, the screw connections must be examined for adequate safety. For overhead installations of precision rail guides, higher safety factors should be applied.

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

**Table 4**

**Static safety factor depending on operating conditions**

| **Operating conditions** | $s_0$ |
|---|---|
| Normal conditions | > 1–2 |
| 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. If the application poses a risk of serious injury, the user must take appropriate design and safety measures that will prevent all rails from becoming detached from the base (e.g. due to loss of rolling elements or failure of screw connections). |

**Requisite static load rating**

For specific operating conditions with a related recommended static safety factor and a defined load case, the requisite static load rating $C_0$ can be calculated from the following formula:

$$C_{0,\text{ eff slide}} = s_0 \, P_0 = s_0 \, F_{\text{res max}}$$

where

$C_{0,\text{ eff slide}}$ = effective static load rating of a slide [N]
$P_0$ = maximum static load [N]
$s_0$ = static safety factor
$F_{\text{res max}}$ = maximum resulting load [N]

## 1.7.3 Rating life

In laboratory tests and in practice it is found that the rating life of apparently similar bearings under completely identical running conditions can differ. Therefore, calculation of the appropriate bearing size requires a full understanding of the concept of bearing rating life. All references to the dynamic load rating of SKF precision rail guides apply to the basic rating life, as covered by the ISO definition (ISO 14728-1), in which the rating life is understood as the life reached or exceeded by 90% of a large group of identical bearings. The majority of the bearings reach a longer rating life , and half the total number of bearings reach at least five times the basic rating life.

## 1.7.4 Rating life calculation

The rating life of precision rail guides expressed in km, $L_{ns}$, can be calculated using the following formula:

$$L_{ns} = c_1 \, 100 \left( \frac{C_{\text{eff slide}}}{P} \right)^p$$

In load cases where the length of travel and stroke frequency is constant, it is often more useful to calculate the rating lives in operating hours $L_{nh}$ using formula 4:

$$L_{nh} = c_1 \, \frac{5\,10^7}{S\,n\,60} \left( \frac{C_{\text{eff slide}}}{P} \right)^p$$

where

$L_{ns}$ = modified basic rating life [km]
$L_{nh}$ = modified basic rating life [h]
$c_1$ = factor for reliability
$C_{\text{eff slide}}$ = effective dynamic load rating of a slide [N]
P = equivalent dynamic load [N]
p = life exponent; p = 3 for balls, p = 10/3 for rollers
n = stroke frequency [double strokes/min]
S = single stroke length [mm]

**Note:** The concept of rating life calculation is only valid in cases where the equivalent dynamic load P does not exceed 50% of the dynamic load rating C. See also the indication for static calculation in *chapter 1.7.1*.

**Note:** The life of a precision rail guide can be calculated to a degree of precision and reliability governed by the accuracy of the information about the load case and the known or calculable operating conditions.

**Note:** Lifetime calculation is related to the physical effect of fatigue of material. Fatigue is the result of shear stresses cyclically appearing immediately below the load carrying surface. After a time, these stresses cause cracks that gradually extend up to the surface. As the rolling elements pass over the crack, fragments of material break away. This process is known as flaking or spalling. The flaking progressively increases and eventually makes the bearing unserviceable.

**Factor $c_1$ for reliability**

Factor $c_1$ is used in the calculation of bearing life in cases where the intended prediction of reliability has to exceed 90%. The corresponding values for $c_1$ are given in **table 5**.

**Table 5**

**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 |

## 1.7.5 Service life

In addition to rating life, there also exists the concept of “service life”. This term describes the period of time for which a given linear bearing remains operational in a given set of operating conditions. Therefore, the service life of the bearing depends not necessarily on fatigue but also on wear, corrosion, failure of seals, lubrication intervals (grease life), misalignment between the rails, vibration during standstill, etc. Normally, the service life only can be quantified in tests under realistic operating conditions or by comparison with similar applications.

## 1.7.6 Cross reference to related chapters

For the two dimensioning concepts presented in this chapter, static safety factor and basic rating life, the following input data is needed:

- The loads acting on the precision rail guide system. Their calculation will be explained in detail in *chapter 1.9*.
- The effective static and dynamic load rating of a certain precision rail guide system. Their calculation will be presented in the next chapter.

## 1.8 Determination of effective load ratings

For a slide equipped with four precision rails and two rolling element assemblies with an individual number of rolling elements (→ **fig. 11**), the effective static and dynamic load rating are calculated by:

$$C_{0,\,\text{eff slide}} = f_{h0}\, f_t\, C_{0,10}\, \frac{z_T\, 2}{10\, f_1}$$

$$C_{\text{eff slide}} = f_h\, f_t\, C_{10} \left(\frac{z_T\, 2}{10\, f_1}\right)^w$$

where

$C_{0,\,\text{eff slide}}$ = effective static load rating of a slide [N]

$C_{0,10}$ = basic static load rating of a rail guide with specified number of rolling elements [N]

$f_{h0}$ = factor for hardness, static

$f_t$ = factor for operating temperature

$z_T$ = number of load carrying rolling elements (per cage or per row for needle rollers)

$f_1$ = factor for load direction

$C_{\text{eff slide}}$ = effective dynamic load rating of a slide [N]

$C_{10}$ = basic dynamic load rating of a rail guide with specified number of rolling elements [N]

$f_h$ = factor for hardness, dynamic

$w$ = rolling element exponent;
$w$ = 0,7 for balls,
$w$ = 7/9 for rollers

### 1.8.1 Static and dynamic load ratings given in the catalogue

The basic load ratings $C_{10}$ and $C_{0,10}$ quoted in the product data tables of rolling element assemblies are defined for one rail guide loaded in the direction shown in **fig. 7** and the following amount of rolling elements:

- For 10 balls under load (→ **fig. 8**)
- For 10 crossed rollers under load (→ **fig. 9**)
- For 20 needle rollers under load (2×10 needle rollers per row) (→ **fig. 10**)

**Fig. 7**

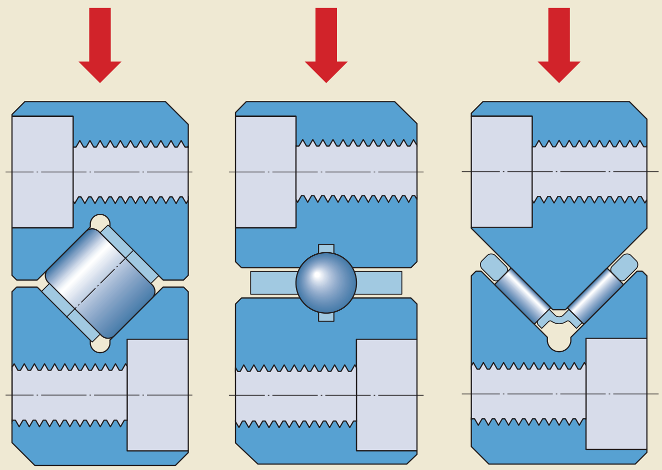


**Fig. 8**

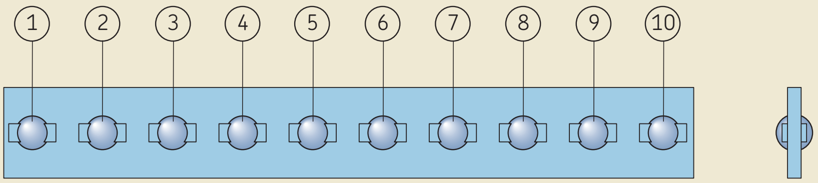


**Fig. 9**

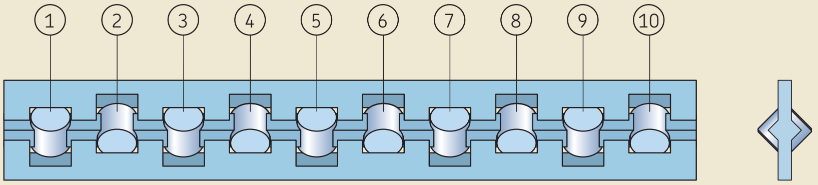
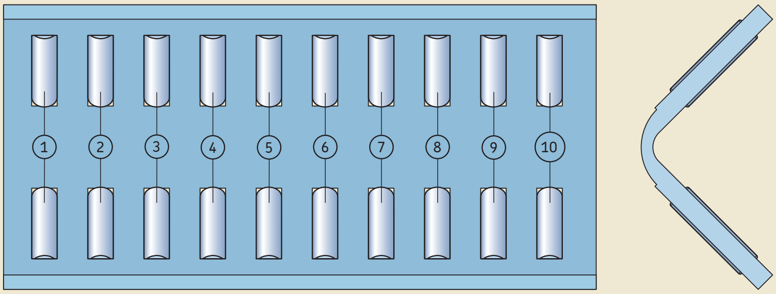


**Fig. 10**



## 1.8.2 Influence of hardness

The full load rating of the rolling element assembly can be utilized completely (both factors equal 1) only if the surface hardness of the raceways is at least 58 HRC. If rails of stainless or acid-resistant steel are used and their raceway hardness doesn't reach the required limit, the values for the factors $f_h$ and $f_{h0}$ can be obtained from **diagram 4**. If rolling elements with a lower hardness, e.g. made from stainless steel, are used, the same factor has to be considered.

**Note:** The static and dynamic load ratings for rolling element assemblies with ACSM, given in the product tables, already are reduced. The corresponding rails are made from stainless steel by standard. For this speciality, it is not useful to additionally utilize the factors $f_{h0} < 1$ and $f_h < 1$.

## 1.8.3 Influence of operating temperature

When a precision rail guide without plastic cage is permanently used with operating temperatures above +120 °C, the load ratings will decrease by a certain amount. In such cases, the temperature factor $f_t$ has to be taken into consideration. Values of factor $f_t$ can be obtained from **diagram 5** as a function of the operating temperature.

**Diagram 4**

**Factor $f_h$ for the influence of hardness**

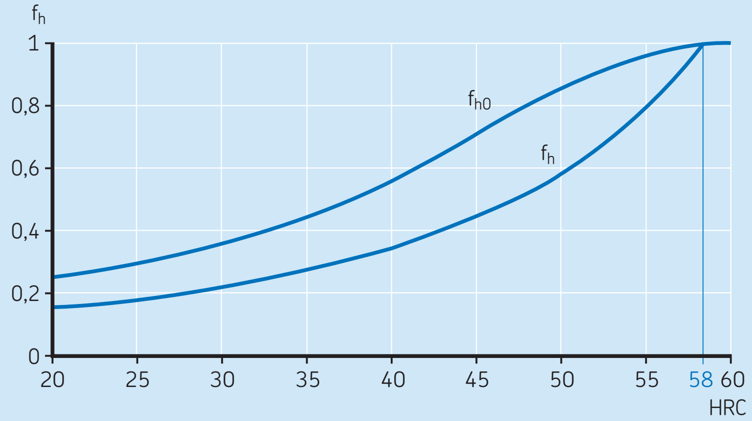
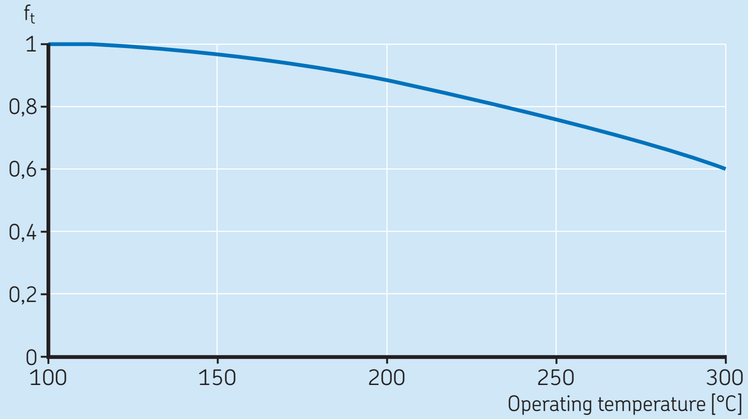


**Diagram 5**

**Factor $f_t$ for the influence of operating temperature**



## 1.8.4 Rail guide arrangements

Precision rail guides can be mounted in several types of arrangements, to suit the requirements of the particular application. Two of these are described below. The impact of the two types of arrangements on the load ratings is expressed in factor $f_1$ for load direction (→ **fig. 11**).

### Clamped arrangement

The most common way to design a precision rail guide system is the clamped arrangement, as it has several advantages:

- The rails can be preloaded to meet demands for rigidity and running accuracy.
- The system can accommodate loads and moments in any direction.
- It has a small cross section for compact construction.

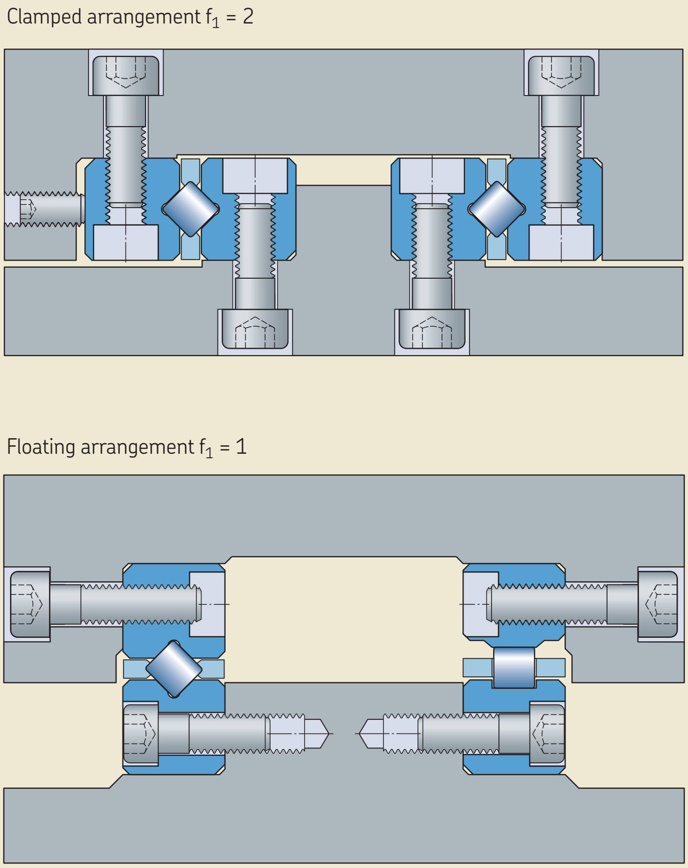
As a rule, rail guide systems in clamped arrangements consist of two identical precision rail guides, as shown in **fig. 11**. With rail guides in such an arrangement, it is even possible to adjust the preload, such as by using set screws, as explained in *chapter 3.1.10*.

### Floating arrangement

A rail guide system in a floating arrangement consists of a “locating” bearing e.g. a LWR rail guide, which provides guidance in the longitudinal and lateral directions, and another rail guide with two flat raceways, which acts as the “non-locating” bearing (→ **fig. 11**). In such arrangements, care should be taken to ensure that both guide systems are of similar load rating and rigidity. Rail guide systems in floating arrangement are able to take up loads that are predominantly vertical only. However, they can support heavy loads and are simple to mount. They can be used to advantage where:

- Thermal expansion must be compensated
- Large distances between supports have to be bridged

**Fig. 11**



## 1.8.5 Rail guide kinematics

Depending on the application, considering the available space, stroke and environmental conditions, precision rail guide systems can be designed in different ways. Possible kinematics and their individual characteristics are described in the next chapters. When selecting the dimension of a rail guide and rolling element assembly, the requirements regarding geometry and installation space or the requirements regarding load rating and rigidity are of primary importance. In the first case, the maximum applicable cage length is calculated depending on stroke and length of the rails. The given equations are transformed, if load capacity or rigidity requirements determine the length of the cage. In this case, the length of the rails is calculated depending on the length of the cage and stroke.

### Not overrunning systems without wipers

The rolling element assembly always moves half the distance travelled by the moving rail and remains between the rails (→ **fig. 12**).

In case the geometry is given

$L_{cage,\ max} = L_{rail} – 0,5\ S$

or the rating life / rigidity defined the length of the rolling element assembly

$L_{rail,\ min} = L_{cage} + 0,5\ S$

where

$L_{cage,\ max}$ = maximum length of rolling element assembly, if rail length and stroke are predefined [mm]

$L_{rail}$ = length of the rail [mm]

$L_{rail,\ min}$ = minimum length of the rail, if length of cage and stroke are predefined [mm]

$L_{cage}$ = length of rolling element assembly [mm]

S = intended stroke length [mm]

### Precision rail guide system with wipers

If the rail guide has to be sealed with wipers, it is important to ensure that the lips of the wipers seal against the raceway of the opposing rail over the whole length of travel. Normally, the rail guide arrangement is fitted with two rails of different length. The wipers are attached to the shorter rail, of which the length is determined according to the formulas given above under heading *Not overrunning systems without wipers*. The minimum length of the long rail is (→ **fig. 13**)

$L_{rail,\ long,\ min} = L_{cage} + 1,5\ S + 2\ L_1$

or in case the geometry is given

$L_{cage,\ max} = L_{rail,\ long} – 1,5\ S – 2\ L_1$

where

$L_{rail,\ long,\ min}$ = minimum length of the long rail, if length of cage and stroke are predefined [mm]

$L_{cage}$ = length of rolling element assembly [mm]

$L_1$ = thickness of end piece with wiper [mm]

$L_{cage,\ max}$ = maximum length of rolling element assembly, if rail length and stroke are predefined [mm]

$L_{rail,\ long}$ = length of the long rail [mm]

S = intended stroke length [mm]

**Fig. 12**

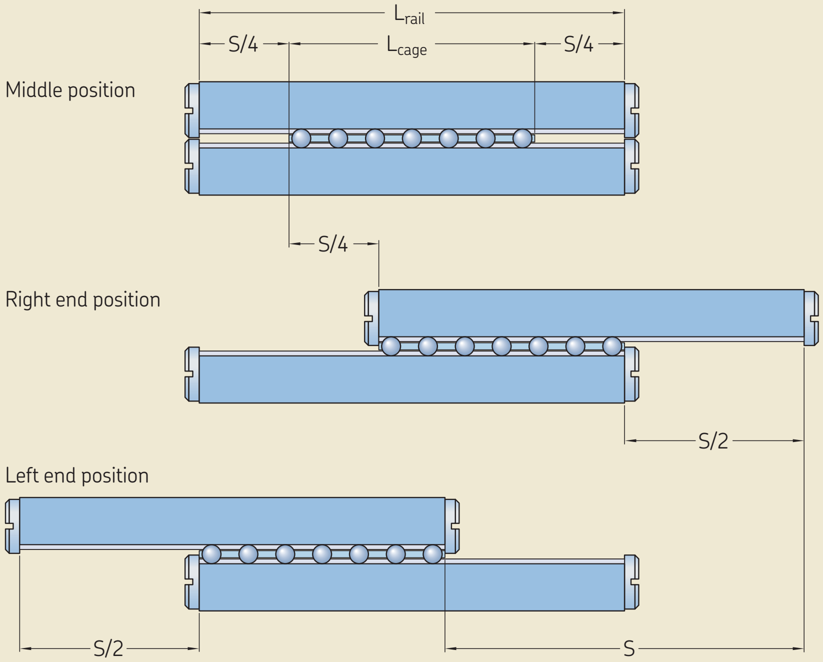
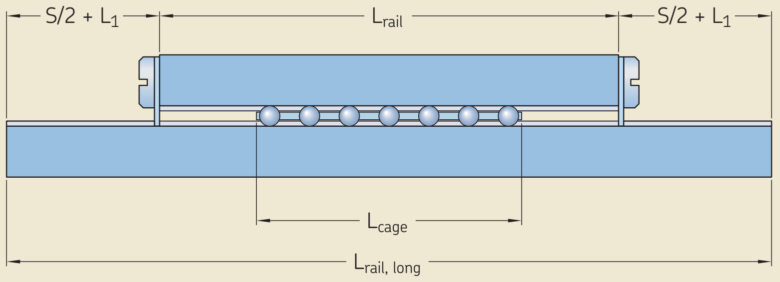


**Fig. 13**



### Overrunning system without wipers

If a short precision rail moves on a long rail, overrunning rolling element assemblies should be preferred. It is important that the short rail has lead in radius at both rail ends (ordered with suffix “EG”) so that the overrunning cage causes as little pulsation as possible. Not every cage is suitable for this application. The maximum cage overrun (“free length“ of the cage) depends on the orientation of the rails and on the cage material.

In case of priority of installation space, the length of the components is calculated by (→ **fig. 14**)

$L_{\text{cage, max}} = L_{\text{rail, long}} - 0{,}5\ S$

and

$L_{\text{rail, short}} = L_{\text{rail, long}} - S$

If rigidity or load rating are more important

$L_{\text{rail, long}} = L_{\text{cage}} + 0{,}5\ S$

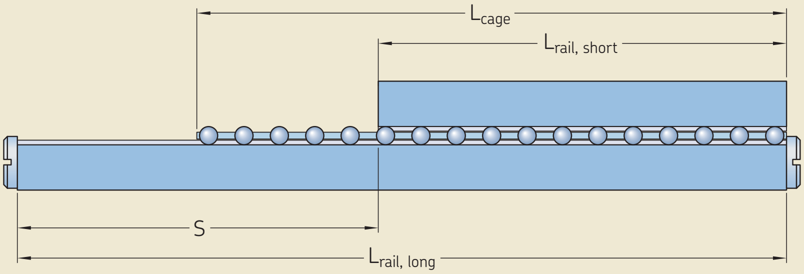
and

$L_{\text{rail, short}} = L_{\text{rail, long}} - S$

where

$L_{\text{cage, max}}$ = maximum length of rolling element assembly, if rail length and stroke are predefined [mm]
$L_{\text{rail, long}}$ = length of the long rail [mm]
$L_{\text{rail, short}}$ = length of the short rail in an overrunning system [mm]
$L_{\text{cage}}$ = length of rolling element assembly [mm]
$S$ = intended stroke length [mm]

**Fig. 14**

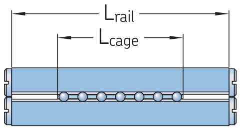


## 1.8.6 Number of rolling elements z, $z_T$

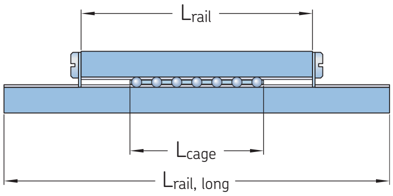
After the calculation of the maximum cage length $L_{cage,\ max}$ and the length of the rails according to demanded geometry, the number of rolling elements z has to be calculated for ordering the right length of rolling element assembly. Depending on the different kinematic types the number of load carrying elements $z_T$ has to be defined for the calculation of the rating life. The following overview shows the formulas for z and $z_T$. For kinematic types, where the rolling element assembly always remains between the rails (not overrunning rail guide without wipers and rail guide with wipers) and all rolling elements carry load, $z = z_T$ is valid. In overrunning systems, only the rolling elements underneath the short rail can carry load, and $z_T$ has to be calculated differently.

The formulas are using the function “truncate” to get an integer number of rolling elements. With that, the real cage length for ordering $L_{cage}$ and the load carrying length $L_T$, defined from the center of the first load carrying rolling element to the center of

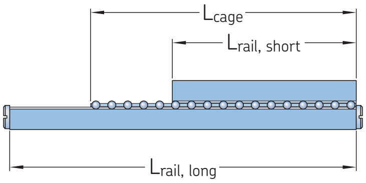
**Not overrunning rail guide without wipers (Standard)**

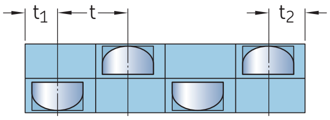


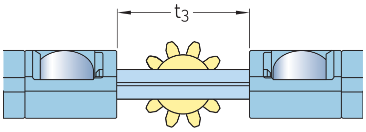
**Rail guide with wipers**



**Overrunning rail guide without wipers**







Values for t, $t_1$, $t_2$ and $t_3$ for the different cage types are given in the *chapter Product data 2.1–2.7.*
if no value for $t_2$ is given: $t_2 = t_1$
if no value for $t_3$ is given: $t_3 = 0$

$$z = \mathrm{TRUNC}\left(\frac{L_{cage,\ max} - t_1 - t_2 - t_3}{t}\right) + 1$$

$$z_T = \mathrm{TRUNC}\left(\frac{L_{cage,\ max} - t_1 - t_2 - t_3}{t}\right) + 1$$

$$z_T = \mathrm{TRUNC}\left(\frac{L_{rail,\ short} - t_3 - 2\ EG}{t}\right) + 1$$

$$L_{cage} = (z - 1)\ t + t_1 + t_2 + t_3$$

$$L_T = (z_T - 1)\ t + t_3$$

$$L_{install} = L_{rail} + S + 2\ L$$

$$L_{install} = L_{rail,\ long}$$

$$L_{install} = L_{rail,\ long} + 2\ L$$

Legend:

$z$ = number of rolling elements (per cage or per row for needles)
$z_T$ = number of load carrying rolling elements (per cage or per row for needles)
$L_{cage}$ = length of rolling element assembly [mm]
$L_{cage,\ max}$ = maximum length of rolling element assembly [mm]
$L_T$ = load carrying length [mm]
$L_{rail,\ short}$ = length of the shorter rail in an overrunning system [mm]
$L_{rail,\ long}$ = length of the long rail [mm]
$t$ = pitch of rolling elements in a cage [mm]
$t_1$, $t_2$ = distance of outer rolling element to the end of cage [mm]
$t_3$ = length of anti-creeping system [mm]
EG = length of lead in radius on each side, typically 1–2 mm [mm]
$L_{install}$ = length of the complete installation space [mm]
L = thickness of the end piece [mm]

**Note:** “TRUNC” is the mathematical function that truncates a number to an integer by removing the fractional part of the number.

the last, can be calculated. Additionally the formulas for the installation length $L_{install}$ are given.

### 1.8.7 General geometry of a rail guide system

As a general recommendation, the length of a rolling element assembly can be chosen using the following guidelines:

| | |
|---|---|
| "clamped" arrangement | $L_{cage} = S$ |
| "floating" arrangement | $L_{cage} = 1{,}5\ S$ |

where
$L_{cage}$ = length of rolling element assembly [mm]
S = intended stroke length [mm]

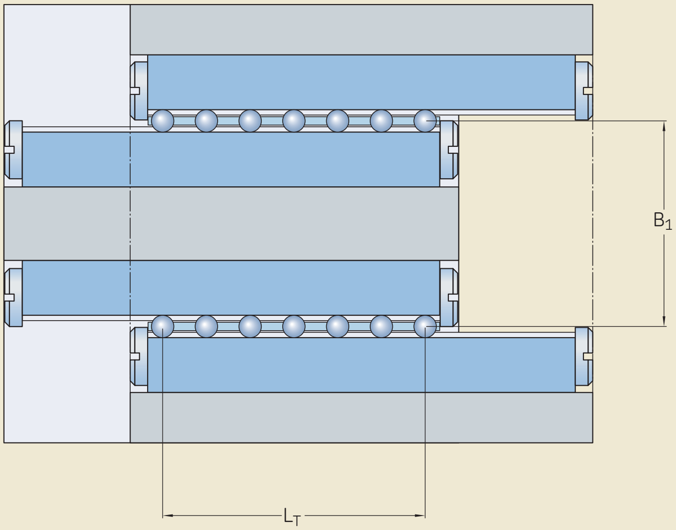
It should be remembered, however, that where loads are heavy, applied off-centre, or include torque loads, the longest possible rolling element assembly should be chosen to achieve both, an even load distribution and high rigidity.

A further recommendation is that the mean distance between the rolling element assemblies $B_1$ should not exceed the load-carrying length $L_T$ (→ **fig. 15**):

$L_T > B_1$

where
$B_1$ = mean distance between the rolling element assemblies [mm]
$L_T$ = load carrying length [mm]

**Fig. 15**



# 1.9 Calculation of bearing loads

The load can be directly inserted into the rating life equations and the static safety factor equation, if the load F acting on a rail guide is constant in magnitude, position and direction and acts vertically and through the centre of the raceway. In all other cases, it is first necessary to calculate the maximum resulting load $F_{res,\,max}$ and the equivalent dynamic load P. These representative loads are defined as the loads that would have the same influence on the rating life and on the static safety factor $s_0$ as the real set of loads.

How to deal with loads that are not vertically and not through the center of the rail guide system is described in *chapter 1.9.1*, and *1.9.3*. How to deal with time- or position-varying loads will be explained in *chapter 1.9.5*.

## 1.9.1 Transfer of external loads to $F_y$, $F_z$, $M_x$, $M_y$, $M_z$

First, the coordinate system for the selected layout has to be defined. It is preferred to define the moving direction as x-axis. The origin of the coordinate system is set to the middle of the rolling element assembly and all lever arms in x-direction are measured from there. This means, that the coordinate system moves and that lever arms change with the movement of the guiding (→ **fig. 16**). In the other directions, the origin should be symmetrically between the rolling element assemblies at $B_1/2$ and on the rails center height (→ *chapter 1.6.11*).

Second, all working loads, that have impact on the rail guide system, have to be collected. Load directions and lever arms must not be ignored. The single external loads are summarized to a set of five values: $F_y$, $F_z$, $M_x$, $M_y$, $M_z$. These five values are calculated by

$$F_y = \sum_{i=1}^{U} F_{y,i}$$

$$F_z = \sum_{i=1}^{U} F_{z,i}$$

$$M_x = -\sum_{i=1}^{U} F_{y,i}\, z_i + \sum_{i=1}^{U} F_{z,i}\, y_i$$

$$M_y = \sum_{i=1}^{U} F_{x,i}\, z_i - \sum_{i=1}^{U} F_{z,i}\, x_i$$

$$M_z = -\sum_{i=1}^{U} F_{x,i}\, y_i + \sum_{i=1}^{U} F_{y,i}\, x_i$$

where

$F_{x,i}$, $F_{y,i}$, $F_{z,i}$ = single loads in x-, y- or z-direction that act simultaneously on the rail guide system [N]

$F_y$, $F_z$, = summarized force (load) in y- or z-direction [N]

$M_x$, $M_y$, $M_z$ = summarized torque load in x-, y- or z-direction [Nm]

$x_i$, $y_i$, $z_i$, = lever arms that are related to the single loads [m]

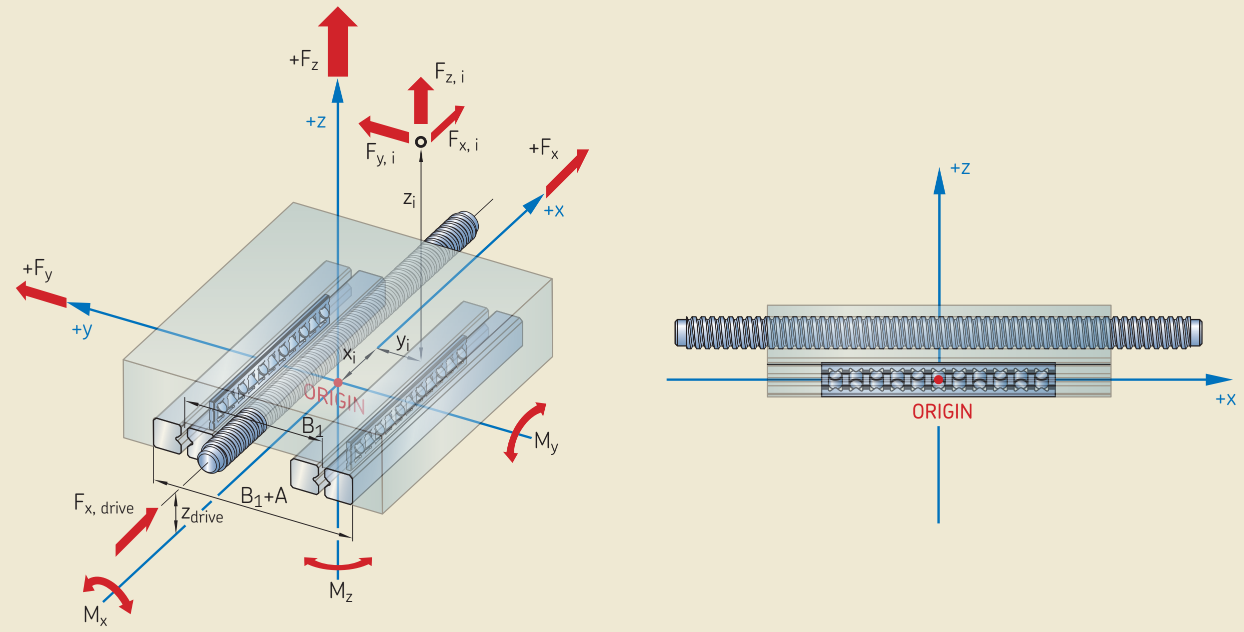
i = counter for single loads in x-, y- or z-direction that act simultaneously

U = amount of loads that act simultaneously

**Note:** The given set of five values, $F_y$, $F_z$, $M_x$, $M_y$, $M_z$, are independent of the concrete geometry of the rail guide system.

The premise for the next calculation steps is that the type and length of rolling element assembly is chosen and the related characteristic values C, $C_0$ and $L_T$ are defined. Additionally, a value for the mean distance between rolling element assemblies, $B_1$, needs to be defined (→ chapter *1.8.7*).

**Fig. 16**



## 1.9.2 Preload force

The additional load generated by the preload in a clamped arrangement has to be considered during the dimensioning calculation. The factor for preload, $f_{Pr}$, depends on the type of rolling element assembly. (→ *chapter 3.1.9*). This so-called preload force is calculated by

$$F_{Pr} = C_{eff} \, f_{Pr}$$

$$C_{eff} = C_{eff\ slide} \quad \text{for clamped arrangement}$$

Where

$F_{Pr}$ = preload force [N]

$C_{eff}$ = effective dynamic load capacity for one rolling element assembly [N]

$f_{Pr}$ = factor for preload, %

## 1.9.3 Transfer of $F_y$, $F_z$, $M_x$, $M_y$, $M_z$ to one load

The set of five load values $F_y$,$F_z$, $M_x$, $M_y$, $M_z$ are summed up to the combined bearing load

$$F_{comb} = \left|F_y\right| + \left|F_z\right| + \left( \left|\frac{2\,000\,M_x}{B_1}\right| + \left|\frac{6\,000\,M_y}{L_T}\right| + \left|\frac{6\,000\,M_z}{L_T}\right| \right)$$

The resulting load $F_{res}$ , that includes the preload force $F_{Pr}$ , is used for the static dimensioning.

$$F_{res} = F_{Pr} + F_{comb} = F_{Pr} + \left|F_y\right| + \left|F_z\right| + \left( \left|\frac{2\,000\,M_x}{B_1}\right| + \left|\frac{6\,000\,M_y}{L_T}\right| + \left|\frac{6\,000\,M_z}{L_T}\right| \right)$$

The equivalent dynamic load P, that considers the factor for stoke length $f_s$ , is used for dynamic dimensioning.

$$P = f_s \, F_{res} = f_s \left[ F_{Pr} + \left|F_y\right| + \left|F_z\right| + \left|\frac{2\,000\,M_x}{B_1}\right| + \left|\frac{6\,000\,M_y}{L_T}\right| + \left|\frac{6\,000\,M_z}{L_T}\right| \right]$$

where

$F_{comb}$ = combined bearing load

$F_{res}$ = resulting load [N]

$F_{Pr}$ = preload force [N]

$F_y$,, $F_z$, = summarized force (load) in y- or z-direction [N]

$M_x$, $M_y$, $M_z$ = summarized torque load in x-, y- or z-direction [Nm]

$B_1$ = mean distance between the rolling element assemblies [mm]

$L_T$ = load carrying length [mm]

P = equivalent dynamic load [N]

$f_s$ = factor for stroke length

## 1.9.4 Influence of stroke length on equivalent dynamic load rating

When defining the operating conditions for the calculation of the basic rating life, it is assumed that the reference stroke length for the precision rail guide is equal to the length of the rolling element assembly. In precision rail guide applications, however, this rarely applies. Exhaustive life tests have shown that there is a reduction in the life of a precision rail operated with a short stroke length. This influence of the stroke length in relation to the length of the rolling element assembly is shown in **diagram 6**. For ratios greater than 0,6, the reduction in rating life is insignificant, but for lower values, the factor $f_s$ modifies the equivalent dynamic load. In the case of values under 0,1, unfavourable tribological conditions render the calculation of bearing life impractical. Under such conditions, the rating life is determined largely by the sliding conditions in the contact zone.

## 1.9.5 Equivalent dynamic mean load

The rating life calculation formulas 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. Since the lever arms in x-direction are changing with the movement of the guiding, the equivalent dynamic load is varying continuously and for calculations without electronical devices simplifications have to be made (→ **diagram 7**). All single load phases are summarized to the equivalent dynamic mean load $P_m$ depending on their individual stroke length:

$$P_m = \sqrt[p]{\frac{\sum\limits_{j=1}^{V} |P_j^p| S_j}{S_{tot}}}$$

$$S_{tot} = S_1 + S_2 + S_3 \, . \, . + S_V$$

**Diagram 6**

**Factor $f_s$ for the influence of stroke length**

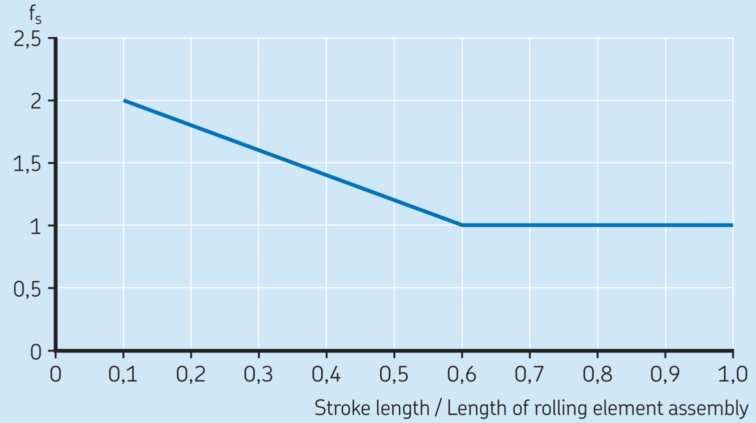
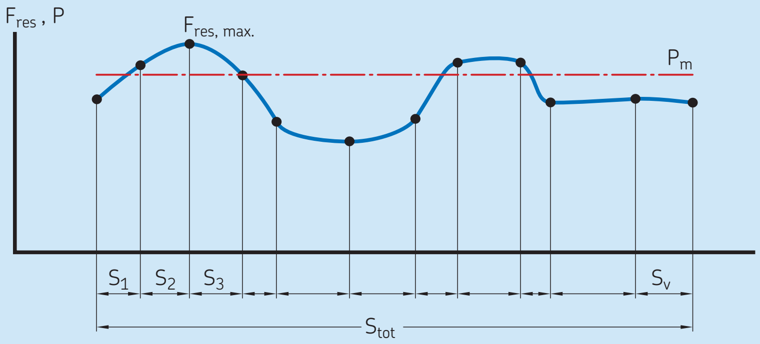


**Diagram 7**

**Variable load on a precision rail guide**



where

$P_m$ = equivalent dynamic mean load [N]

P = equivalent dynamic load [N]

p = life exponent;
p = 3 for balls,
p = 10/3 for rollers

j = counter for load phases

V = amount of load phases

$S_j$ = individual stroke length [mm]

$S_{tot}$ = total stroke length [mm]

**Note:** The distance to the reversal points is relevant for the determination of the factor $f_s$. Sequenced load phases with identical moving direction deliver one complete stroke length.

## 1.9.6 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 $s_0$.

$$F_{\text{res, max}} = \underset{j=1}{\overset{V}{\text{MAX}}} \left| F_{\text{res, j}} \right|$$

$$F_{\text{res, max}} = \text{MAX}\left\{ F_{Pr} + \left|F_y\right| + \left|F_z\right| + \left( \left| \frac{2\,000\, M_x}{B_1} \right| + \left| \frac{6\,000\, M_y}{L_T} \right| + \left| \frac{6\,000\, M_z}{L_T} \right| \right) \right\}$$

## 1.9.7 Elaborated equation for the static safety factor

All given equations related to the static safety factor can be integated into one formula:

$$s_0 = \frac{C_{0,\text{ eff slide}}}{F_{\text{res, max}}} = \frac{f_{h0}\, f_t\, C_{0,10}\, \dfrac{z_T\, 2}{10\, f_1}}{\underset{j=1}{\overset{V}{\text{MAX}}} \left\{ F_{Pr} + \left|F_y\right| + \left|F_z\right| + \left( \left| \dfrac{2\,000\, M_x}{B_1} \right| + \left| \dfrac{6\,000\, M_y}{L_T} \right| + \left| \dfrac{6\,000\, M_z}{L_T} \right| \right) \right\}}$$

## 1.9.8 Elaborated equation for the rating life

All given equations related to the rating life calculation can be integated into one formula:

$$L_{ns} = c_1\, 100 \left( \frac{C_{\text{eff slide}}}{P} \right) = c_1\, 100 \left[ \frac{f_h\, f_t\, C_{10} \left( \dfrac{z_T\, 2}{10\, f_1} \right)^w}{\sqrt[p]{\dfrac{\sum_{j=1}^{V} \left| P_j^p \right| S_j}{S_{tot}}}} \right]^p$$

$$L_{ns} = c_1\, 100 \left[ \frac{f_h\, f_t\, C_{10} \left( \dfrac{z_T\, 2}{10\, f_1} \right)^w}{\sqrt[p]{\dfrac{\sum_{j=1}^{V} f_{s,j}^p \left[ F_{Pr} + \left|F_{y,j}\right| + \left|F_{z,j}\right| + \left| \dfrac{2\,000\, M_{x,j}}{B_1} \right| + \left| \dfrac{6\,000\, M_{y,j}}{L_T} \right| + \left| \dfrac{6\,000\, M_{z,j}}{L_T} \right| \right]^p S_j}{S_{tot}}}} \right]^p$$

$$L_{ns} = c_1\, 100 \frac{\left( f_h\, f_t\, C_{10} \left( \dfrac{z_T\, 2}{10\, f_1} \right)^w \right)^p S_{tot}}{\sum_{j=1}^{V} f_{s,j}^p \left[ F_{Pr} + \left|F_{y,j}\right| + \left|F_{z,j}\right| + \left| \dfrac{2\,000\, M_{x,j}}{B_1} \right| + \left| \dfrac{6\,000\, M_{y,j}}{L_T} \right| + \left| \dfrac{6\,000\, M_{z,j}}{L_T} \right| \right]^p S_j}$$

## 1.10 Example dimensioning calculation

The customised SKF precision rail guide slide we will use for this example is equipped with an ironless linear motor with high velocity constancy as drive, with a sealed optical encoder and with mechanical end stops. The shown design is typical for precision rail guide slides (→ **fig. 17**).

### Description of the application

A construction part (mass 40 kg, length 150 mm, width 100 mm, height 90 mm) has to be moved in several process steps to perform a measurement. The first step is a very precise movement over its entire length. The measurement can be performed at a maximum acceleration of 1 $m/s^2$ and is running at constant room temperature of 22 °C. The next process step, which is done at standstill, creates a load of 600 N downward in z-direction located symmetrically between the precision rail guide units and in x-direction 20 mm inside the construction part. The available construction space limits $L_{rail}$ by 250 mm. To have a certain reserve, the intended stroke of the slide is 160 mm. For forward and backward stroke the values for acceleration and deceleration are equal. Because of the high demands on repeatability of running accuracy in height- and sideward direction, an anti-creeping system is required. So the precision rail guides with ACSM have to be used.

Questions to be answered:

- Which precision rail guide (size, $L_{cage}$) is sufficient for this application?
- Which maximum stroke will be possible?
- Which static safety factor and rating life in kilometers can be achieved?

### Maximum length of rolling element assembly

In this example the geometry is given by the construction space and the demanded stroke. According to *chapter 1.8.5*, following formula has to be used:

$$L_{cage,\,max} = L_{rail} - 0{,}5\ S$$

$$L_{cage,\,max} = 250\ mm - 0{,}5 \times 160\ mm$$

$$= 170\ mm$$

### Number of rolling elements z, $z_T$

Because of the chosen kinematic – not overrunning cage without wipers, all rolling elements carry load all the time and $z = z_T$. To calculate a real value of z, a certain type and size of rolling element assembly has to be chosen. Because of the fact that mass and external load are not too heavy in this example we start the calculation with the smallest possible cage type LWJK 2 ACSM which may fulfill the requirements. When checking the maximum rail length of LWRB2 we find out that 200 mm don't cover the needs and LWRE 3 ACSM is the smallest guiding possible. Following formula has to be used, as described in *chapter 1.8.6*. The needed values are given in the relevant product chapter.

$$z = z_T = \mathrm{TRUNC}\left(\frac{L_{cage,\,max} - t_1 - t_2 - t_3}{t}\right) + 1$$

$$z = z_T = \mathrm{TRUNC}\left(\frac{170\ mm - 2{,}65\ mm - 3{,}6\ mm - 9\ mm}{6{,}25\ mm}\right) + 1 = 25$$

The number of rolling elements is used to calculate $L_{cage}$ needed for ordering:

$$L_{cage} = (z - 1)\ t + t_1 + t_2 + t_3$$

$$L_{cage} = (25 - 1) \times 6{,}25\ mm + 2{,}65\ mm$$

$$+ 3{,}6\ mm + 9\ mm = \quad 165{,}25\ mm$$

The number of rolling elements is used to calculate the load carrying length $L_T$:

$$L_T = (z_T - 1)\ t + t_3$$

$$L_T = (25 - 1) \times 6{,}25\ mm + 9\ mm = 159\ mm$$

With the exact length of the cage, the resulting maximum stroke can be calculated.

$$S = (L_{rail} - L_{cage})\ 2$$

$$S = (250\ mm - 165{,}25\ mm) \times 2 = 169{,}5\ mm$$

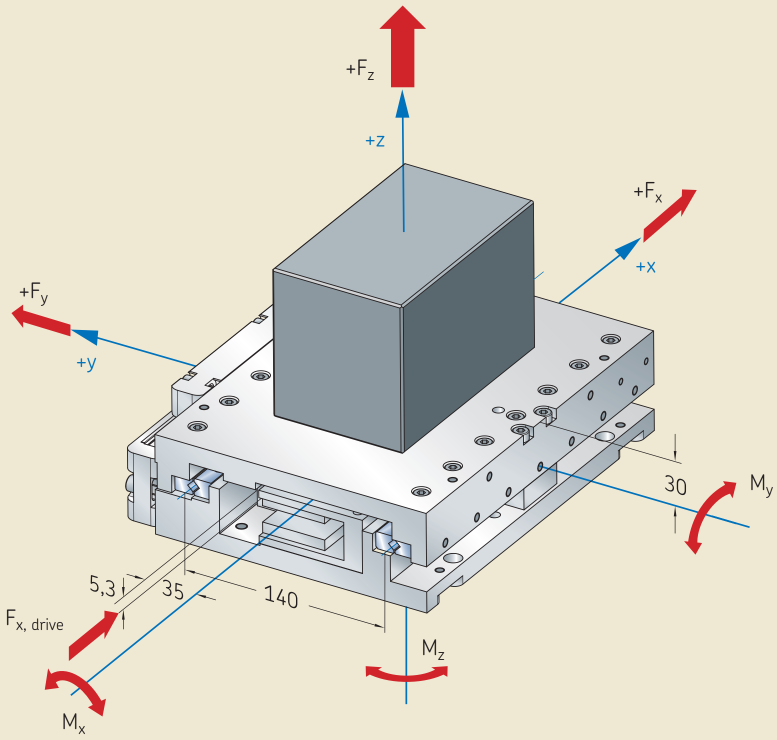
The general rules $L_{cage}$ = S for "clamped" arrangement and $L_T > B_1$ are observed.

**Table 6**

| | Description | Value | Reasons for decision |
|---|---|---|---|
| $f_{h0}$ | factor for hardness, static | 1 | Compare chapter *Influence of hardness, 1.8.2* |
| $f_h$ | factor for hardness, dynamic | 1 | Compare chapter *Influence of hardness, 1.8.2* |
| $f_t$ | factor for operating temperature | 1 | Operating temperature far below 120 °C |
| $f_1$ | factor for load direction | 2 | Clamped arrangement |
| w | rolling element exponent | 7/9 | Cage with rollers |
| $C_{0,10}$ | basic static load rating for 10 rollers | 8160 N | LWAKE 3 ACSM |
| $C_{10}$ | basic dynamic load rating for 10 rollers | 5040 N | LWAKE 3 ACSM |

Fig. 17

**RLM with coordinate system**



# Determination of effective load ratings

For the calculation of the static safety factor and the rating life, the effective load ratings are needed. It is important to know several determining factors as shown in **table 6**. Furthermore the values of $C_{0,10}$ and $C_{10}$ of the selected rolling element assembly have to be gathered in the product chapter.

$$C_{0,\ \mathrm{eff\ slide}} = f_{h0}\ f_t\ C_{0,10}\ \frac{z_T\ 2}{10\ f_1}$$

$$C_{0,\ \mathrm{eff\ slide}} = 1 \times 1 \times 8\,160\ \mathrm{N} \times \frac{25 \times 2}{10 \times 2} = 20\,400\ \mathrm{N}$$

$$C_{\mathrm{eff\ slide}} = f_h\ f_t\ C_{10} \left(\frac{z_T\ 2}{10\ f_1}\right)^{w}$$

$$C_{\mathrm{eff\ slide}} = 1 \times 1 \times 5\,040\ \mathrm{N} \left(\frac{25 \times 2}{10 \times 2}\right)^{\frac{7}{9}} = 10\,279\ \mathrm{N}$$

## Calculation of bearing loads

Beside the effective load ratings it is also necessary to calculate the maximum resulting load $F_{res,\,max}$ and the equivalent dynamic mean load $P_m$ of the application. For that, it is essential to understand the workflow of the application and where and at what time the loads are acting. In most cases it is necessary to separate the workflow into load phases with constant or nearly constant conditions.

The definition of the general coordinate system is shown in **fig. 17** at the beginning of this chapter. **Fig. 18** shows the lever arms in x-direction of load phase 6 of the example. For an explanation, where to set the coordinate system, see also *chapter 1.9.1*.

For each load phase the working loads have to be summarized to a set of five values: $F_y$, $F_z$, $M_x$, $M_y$, $M_z$. After that, those five values and the preload force are transferred to one load which represents the respective load phase. The workflow of the application with its single load phases and the acting loads including their lever arms of the example are shown in following systematic overview (→ **table** *Load calculation*, **page 34 and 35**). Also the needed formulas and calculations can be found there. Since the values for acceleration and deceleration are equal on forward and backward stroke, it is here sufficient to calculate $P_m$ only with the load phases of the forward stroke.

The factor for stroke length has to be determined with the help of **diagram 6**, *chapter 1.9.4*.

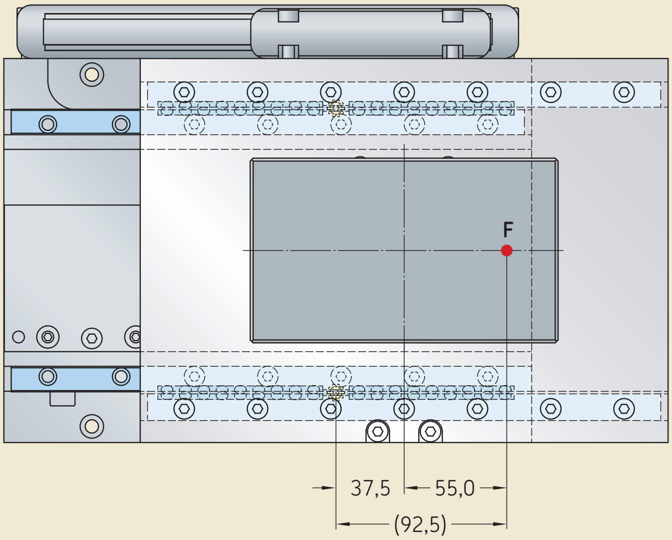
$$\frac{S}{L_{cage}} = \frac{150\ \text{mm}}{165{,}25\ \text{mm}} = 0{,}91 \rightarrow f_s = 1$$

The preload force has to be calculated. The factor for preload $f_{Pr}$ depends on the type of rolling element assembly (→ *chapter 3.1.10*).

$$F_{Pr} = f_{Pr}\, C_{eff\ slide}$$

$$F_{Pr} = 0{,}07 \times 10\,279\ \text{N} = 719{,}5\ \text{N}$$

**Fig. 18**



### Maximum resulting load

The maximum resulting load occurs in load phase 6.

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

$$F_{res,\,max} = 4\,362\ \text{N}$$

### Calculation of the static safety factor

Now for the chosen precision rail guide and the load phase with the highest resulting load, the static safety factor $s_0$ can be calculated.

$$s_0 = \frac{C_{0,\,eff\ slide}}{F_{res,\,max}}$$

$$s_0 = \frac{20\,400\ \text{N}}{4\,362\ \text{N}} = 4{,}68$$

### Equivalent dynamic mean load

For the calculation of the rating life the equivalent dynamic mean load is needed. The single values, the needed formula and the calculations are given in table *Load calculations*, **page 34 and 35**. The result is

$$P_m = \sqrt[p]{\frac{\sum_{j=1}^{V} \left| P_j^p \right| S_j}{S_{tot}}} = 1\,489\ \text{N}$$

### Rating life calculation

The rating life of precision rail guides expressed in km, $L_{ns}$, can now be calculated using following formula:

$$L_{ns} = c_1\ 100\ \text{km} \left( \frac{C_{eff\ slide}}{P_m} \right)^p$$

$$L_{10s} = 1 \times 100\ \text{km} \times \left( \frac{10\,279\ \text{N}}{1\,489\ \text{N}} \right)^{\frac{10}{3}} = 62\,640\ \text{km}$$

# Load calculations

| **Workflow divided in load phases** | **Load phase 1**<br>Acceleration, starting from left position |
|---|---|
| Individual stroke length Sj: | 5 mm |
| Accelleration: | 1 m/s² |
| Speed: | Increasing |
| Position at beginning of load phase: | –75 mm |

Comment:
Forces in Newton [N]
Lever arms in Meter [m]
Torque loads in Newtonmeter [Nm]

| | | Lever arms | | |
|---|---|---|---|---|
| | | x | y | z |
| **Name of force in x-direction** | Force Fx | | | |
| Driving force | 40 | ╳ | 0,035 | –0,0053 |
| Inertia force | –40 | | 0 | 0,075 |
| | | | | |
| | | | | |
| **Name of force in z-direction** | Force Fz | | | |
| Construction part | –392,4 | –0,0375 | 0 | ╳ |
| Additional load | | | | |
| | | | | |
| | | | | |
| $F_y = \sum_{i=1}^{U} F_{y,i}$ | 0 | | | |
| $F_z = \sum_{i=1}^{U} F_{z,i}$ | –392,4 | | | |
| $M_x = -\sum_{i=1}^{U} F_{y,i} z_i + \sum_{i=1}^{U} F_{z,i} y_i$ | 0 | | | |
| $M_y = \sum_{i=1}^{U} F_{x,i} z_i - \sum_{i=1}^{U} F_{z,i} x_i$ | –17,93 | | | |
| $M_z = -\sum_{i=1}^{U} F_{x,i} y_i + \sum_{i=1}^{U} F_{y,i} x_i$ | –1,4 | | | |
| $F_{res} = F_{Pr} + \lvert F_y \rvert + \lvert F_z \rvert + \left( \left\lvert \frac{2\,000\,M_x}{B_1} \right\rvert + \left\lvert \frac{6\,000\,M_y}{L_T} \right\rvert + \left\lvert \frac{6\,000\,M_z}{L_T} \right\rvert \right)$ | 1 841,3 | | | |
| $P = f_s\,F_{res} = f_s \left[ F_{Pr} + \lvert Fy \rvert + \lvert Fz \rvert + \left\lvert \frac{2\,000\,M_x}{B_1} \right\rvert + \left\lvert \frac{6\,000\,M_y}{L_T} \right\rvert + \left\lvert \frac{6\,000\,M_z}{L_T} \right\rvert \right]$ | 1 841,3 | | | |
| $P_m = \sqrt[p]{\frac{\sum_{j=1}^{V} \lvert P_j^p \rvert S_j}{S_{tot}}}$ | | | | |

**Load phase 2**
Constant speed

40 mm
0 m/s²
0,1 m/s
–70 mm

Lever arm is decreasing. As assumption the worst case is chosen for the whole load phase.

| | Lever arms |
|---|---|
| | x |
| Force Fx | |
| | |
| | |
| | |
| | |
| Force Fz | |
| –392,4 | –0,035 |
| | |
| | |
| | |
| 0 | |
| –392,4 | |
| 0 | |
| –13,73 | |
| 0 | |
| 1 630,0 | |
| 1 630,0 | |

**Load phase 3**
Constant speed

60 mm
0 m/s²
0,1 m/s
0 mm

Lever arm is decreasing, becomes zero and is increasing. As assumption the lever arm is set to zero for the whole load phase.

| | Lever arms |
|---|---|
| | x |
| Force Fx | |
| | |
| | |
| | |
| | |
| Force Fz | |
| –392,4 | 0 |
| | |
| | |
| | |
| 0 | |
| –392,4 | |
| 0 | |
| 0 | |
| 0 | |
| 1 111,9 | |
| 1 111,9 | |

**Load phase 4**
Constant speed

40 mm
0 m/s²
0,1 m/s
70 mm

Lever arm is increasing. As assumption the lever arm from the end of this load phase is chosen (worst case).

| | Lever arms |
|---|---|
| | x |
| Force Fx | |
| | |
| | |
| | |
| | |
| Force Fz | |
| –392,4 | 0,035 |
| | |
| | |
| | |
| 0 | |
| –392,4 | |
| 0 | |
| 13,73 | |
| 0 | |
| 1 630,0 | |
| 1 630,0 | |

**Load phase 5**
Deceleration

5 mm
–1 m/s²
Decreasing
70 mm

| | Lever arms | | |
|---|---|---|---|
| | x | y | z |
| Force Fx | | | |
| –40 | | 0,035 | –0,0053 |
| 40 | | 0 | 0,075 |
| | | | |
| | | | |
| Force Fz | | | |
| –392,4 | 0,035 | 0 | |
| | | | |
| | | | |
| | | | |
| 0 | | | |
| –392,4 | | | |
| 0 | | | |
| 16,95 | | | |
| 1,4 | | | |
| 1 804,4 | | | |
| 1 804,4 | | | |

**Load phase 6**
Right position at standstill with load

0 mm
0 m/s²
0 m/s
75 mm

| | Lever arms | | |
|---|---|---|---|
| | x | y | z |
| Force Fx | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| Force Fz | | | |
| –392,4 | 0,0375 | 0 | |
| –600 | 0,0925 | 0 | |
| | | | |
| | | | |
| 0 | | | |
| –992,4 | | | |
| 0 | | | |
| 70,22 | | | |
| 0 | | | |
| 4 361,7 | | | |
| 4 361,7 | | | |

$$P_m = \sqrt[10/3]{\frac{1\,841{,}3\ \text{N}^{10/3} \times 5\ \text{mm} + 1\,630\ \text{N}^{10/3} \times 40\ \text{mm} + 1\,111{,}9\ \text{N}^{10/3} \times 60\ \text{mm} + 1\,630\ \text{N}^{10/3} \times 40\ \text{mm} + 1\,804{,}4\ \text{N}^{10/3} \times 5\ \text{mm}}{5\ \text{mm} + 40\ \text{mm} + 60\ \text{mm} + 40\ \text{mm} + 5\ \text{mm}}} = 1\,489\ \text{N}$$

# 1.11 Rigidity calculation

For the user of precision rail guide systems it is of particular importance to be able to calculate the elastic deflection of the arrangement at the point where the load is applied. To get an approximation of this figure, it is at first necessary to determine the elastic deformation caused by the rolling element on the raceway δ, by using one of the **diagrams 8–12**. This value has to be multiplied with factor $f_k$, to achieve an approximate value for the resulting deflection $\delta_{res}$, that a precision rail guide system, including the adjacent parts made of steel, will have. Following two chapters describe this procedure.

## 1.11.1 Determination of elastic deformation using the nomogram

When using a nomogram from **diagram 8–11** it is first necessary to establish the load conditions in relation to the mechanical dimensions and to define for which load phase and dominating single load in z-direction the elastic deformation should be calculated. **Figure 19** shows the necessary parameters required for the calculation. The rolling element diameter $D_w$ and the contact length of rolling element $L_{w\,eff}$ can be obtained from **table 7**. After these calculations the elastic deformation for the point where the load is applied can be read off the nomogram. The nomograms are based on ”clamped” rail guides (→ *chapter 1.8.4*) and relate as follows to the various types of precision rail guides.

There is a calculation example in *chapter 1.11.3*, for which **diagram 8** and **10** already contain the values and lines.

**Diagram 8**: LWR rail guides with crossed roller assembly
**Diagram 9**: LWR rail guides with ball assembly
**Diagram 10**: LWRE rail guides with crossed roller assembly
**Diagram 11**: LWRM/LWRV and LWM/LWV rail guides with needle roller assembly

Fig. 19

Leverage ratio 1

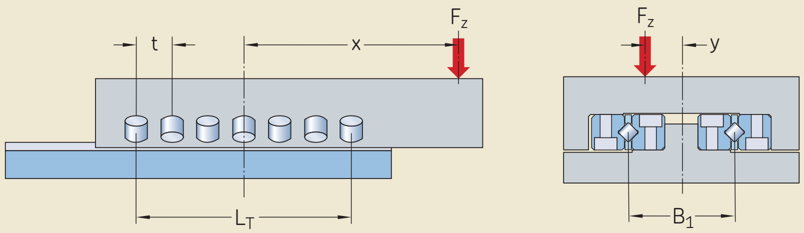


Table 7

Contact length

| Rolling element assembly | Diameter of rolling element $D_w$ | Contact length of rolling element $L_{w\,eff}$ | Product series |
|---|---|---|---|
| – | mm | mm | |
| **LWJK 1,588** | 1,588 | – | LWR |
| **LWJK 2** | 2 | – | |
| **LWAK 3** | 3 | 1,1 | |
| **LWAL 6** | 6 | 2,4 | |
| **LWAL 9** | 9 | 3,6 | |
| **LWAL 12** | 12 | 5,4 | |
| **LWAKE 3** | 4 | 2,3 | LWRE |
| **LWAKE 4** | 6,5 | 3,2 | |
| **LWAKE 6** | 8 | 4,7 | |
| **LWAKE 9** | 12 | 8,2 | |
| **LWHV 10** | 2 | 4,4 | LWRM/V<br>LWM/V |
| **LWHW 10** | 2 | 4,4 | |
| **LWHV 15** | 2 | 7,4 | |
| **LWHW 15** | 2 | 6,4 | |
| **LWHV 20** | 2,5 | 11,4 | |
| **LWHW 20** | 2,5 | 9,4 | |
| **LWHW 25** | 3 | 13,4 | |
| **LWHW 30** | 3,5 | 17,4 | |

**Preparation**

Determination of number of load carrying rolling elements (→ *chapter 1.8.5* and *1.8.6*):

$$z_T = \frac{L_T}{t} + 1$$

Calculation of average rolling element load for:

Ball and crossed roller assembly:

$$Q = \frac{F_z}{z_t}$$

Needle roller assembly:

$$Q = \frac{F_z}{2\,z_t}$$

Calculation of the leverage ratio $R_x$:

$$R_x = \frac{x}{t}$$

Calculation of the leverage ratio $R_y$:

$$R_y = \frac{y}{B_1}$$

Where

$z_T$ = number of load carrying rolling elements (per cage or per row for needles)
$L_T$ = load carrying length [mm]
$t$ = pitch of rolling elements in cage [mm]
$Q$ = average load per rolling element [N]
$F_z$ = single load in z-direction [N]
$x$ = distance from centre of rolling element assembly to point of application of load [mm]
$y$ = distance from centre of rail guide unit to point of application of load [mm]
$B_1$ = mean distance between the rolling element assemblies [mm]

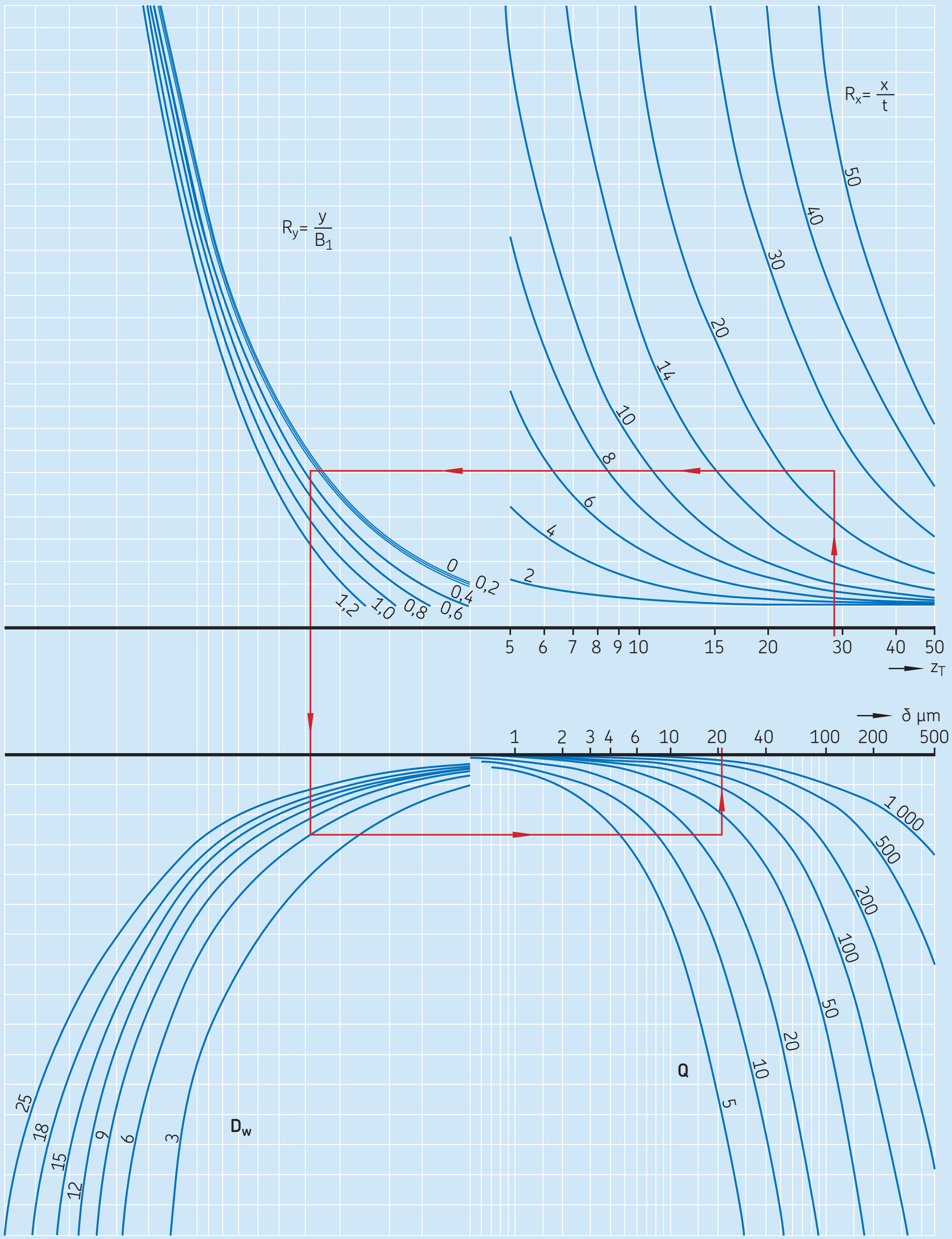
$D_w$ = rolling element diameter [mm]
$L_{w\,eff}$ = contact length of rolling element [mm]

**Identify the elastic deformation in the nomogram**

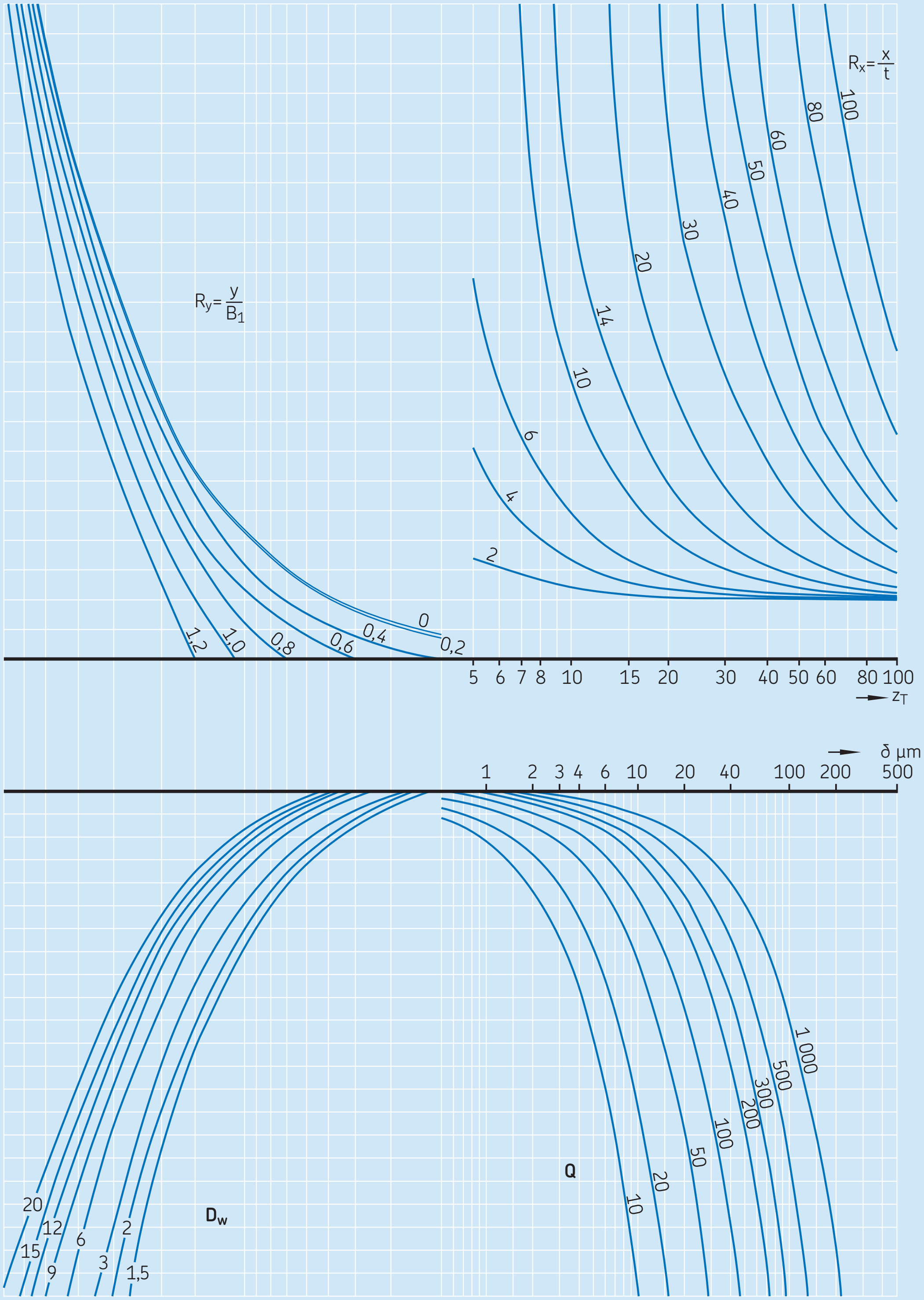
The values created in section preparation are now needed to finally identify the elastic deformation δ in the nomogram (→ **diagram 8–11**).

**Diagram 8**

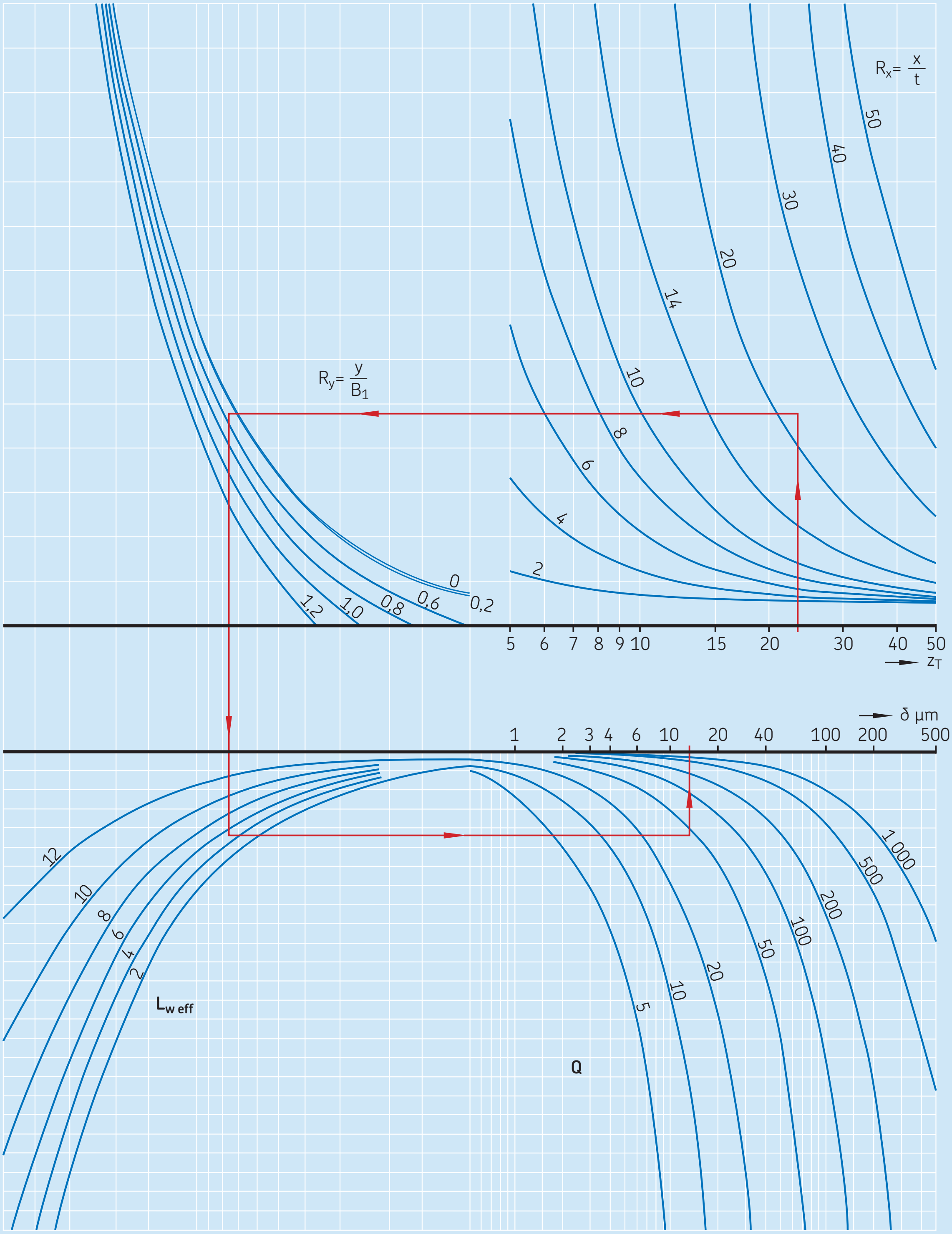
Nomogram of elastic deformation for LWR rail guides with crossed roller assembly



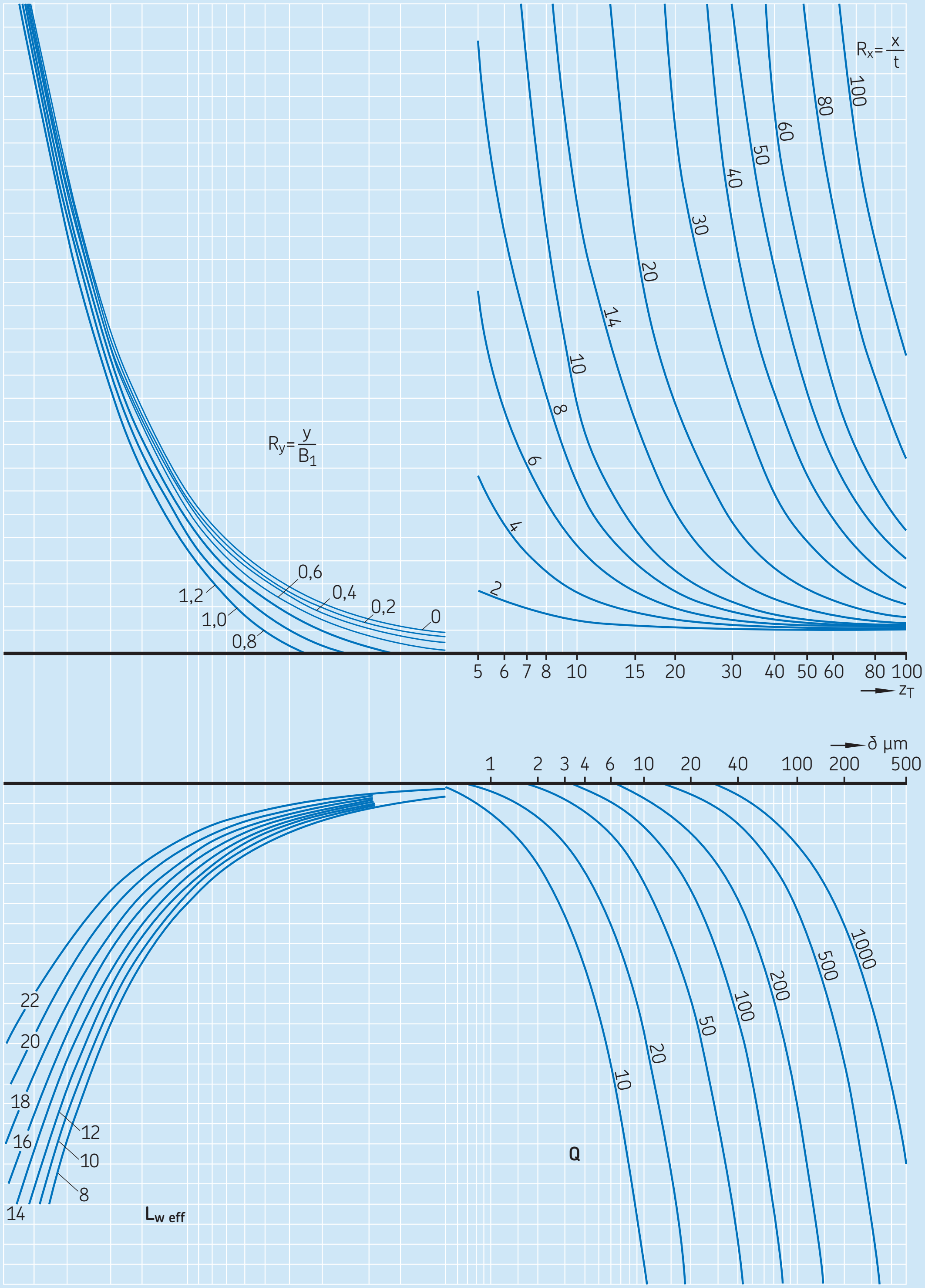
**Nomogram of elastic deformation for LWR rail guides with ball assembly**



**Nomogram of elastic deformation for LWRE rail guides with high capacity crossed roller assembly**



Nomogram of elastic deformation for LWRM / LWRV and LWM / LWV rail guides with needle roller assembly



## 1.11.2 Determination of resulting deflection of a rail guide system

When comparing the measured elastic deflection of a complete slide system with the values of the nomograms, the rigidity of the complete slide system will be found to be significantly less. This discrepancy is mainly due to uneven load distribution along the guide. This happens because inaccuracies of form, deviation from parallelism, improper mounting, etc. and can lead to variations in the loading of the single rolling element along the rail guide. By using factor $f_k$, which is based on the number of load carrying rolling elements $z_T$ and the specific load on a rolling element k, attention is paid to this circumstances. The relevant values of $f_k$ for LWRE rail guides with crossed roller assembly and LWRM/LWRV rail guides or LWM/LWV rail guides with needle roller assembly can be obtained from **diagram 12**. When calculating the elastic deflection of an LWR rail guide, the correction factor $f_k$ has to be obtained from **diagram 13**. When using LWR rail guides with ball assembly the calculated values conform to the measurements and no factor $f_k$ is needed.

For the calculation example in *chapter 1.11.3*, both diagrams already contain the values and lines.

Determination of the specific load per rolling element:

for LWR crossed roller assembly:

$$k = \frac{F_z}{z_T \, D_w^2}$$

for LWRE crossed roller assembly:

$$k = \frac{F_z}{z_T \, D_w \, L_{w\,eff}}$$

for needle roller assembly:

$$k = \frac{F_z}{2 \, z_T \, D_w \, L_{w\,eff}}$$

where

k = specific load per rolling element [N/mm²]

$F_z$ = single load in z-direction [N]

$z_T$ = number of load carrying rolling elements (per cage or per row for needles)

$D_w$ = rolling element diameter [mm]

$L_{w\,eff}$ = contact length of rolling element [mm]

**Diagram 12**

**Correction factor $f_k$ for LWRE, LWRM/LWRV or LWM/LWV rail guides**

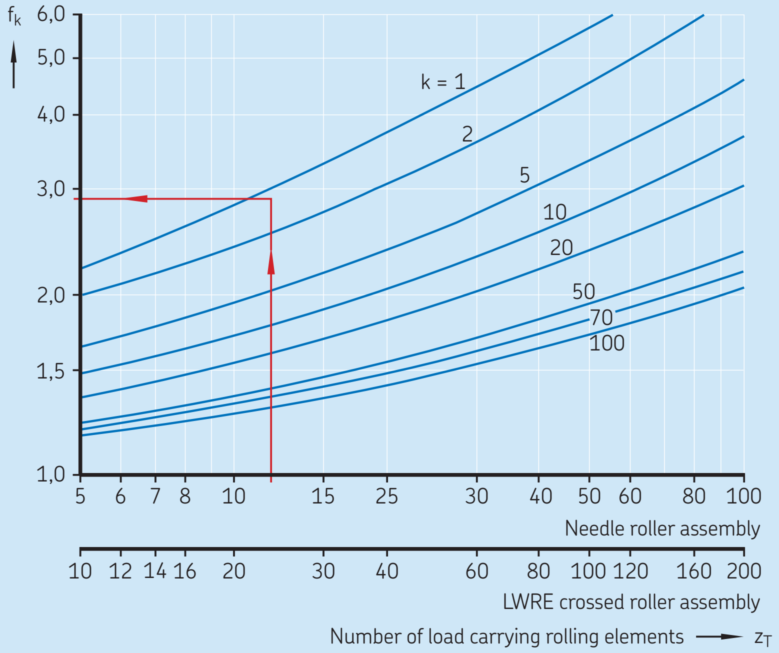
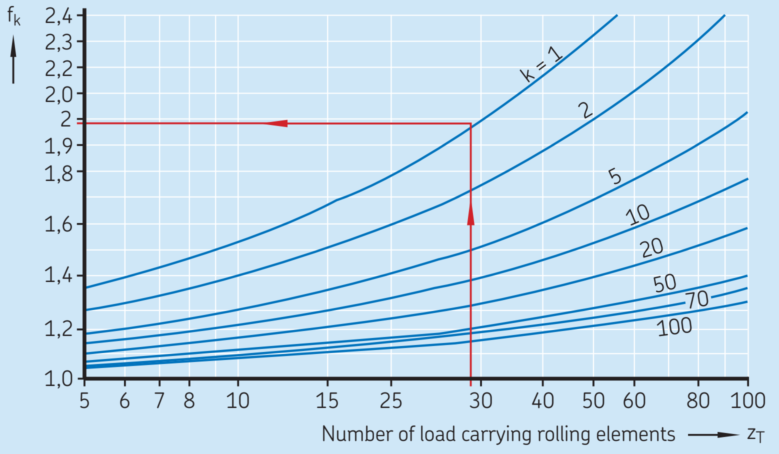


**Diagram 13**

**Correction factor $f_k$ for LWR rail guides**



Calculation of resulting deflection:

$$\delta_{res} = f_k\, \delta$$

where

$\delta_{res}$ = resulting deflection [µm]

$\delta$ = elastic deformation (determined in nomogram) [µm]

$f_k$ = correction factor

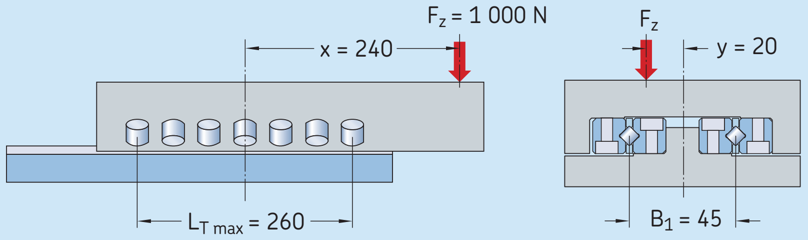
## 1.11.3 Calculation example for the resulting deflection

The standard SKF GCL 6400 slide is loaded in an extended position with a load of 1 000 N as shown in **table 8**. What is the resulting deflection of the LWR6 rail guide at the point where the load is applied in this case? How great would this have been for a LWRE6 rail guide?

Following values have to be determined (→ **table 8**).

**Table 8**

**Calculation example for the resulting deflection**



| Parameter | Unit | LWR | LWRE |
|---|---|---|---|
| Load carrying length $L_T$ | mm | 252 | 253 |
| Pitch of rolling element assembly t | mm | 9 | 11 |
| Number of load carrying rolling elements $z_T$ | | 29 | 24 |
| Leverage ratio $R_x = x/t$ | | 26,7 | 21,8 |
| Leverage ratio $R_y = y/B_1$ | | 0,44 | 0,44 |
| Rolling element diameter $D_w$ | mm | 6 | 8 |
| Contact length of rolling element $L_{w\,eff}$ | mm | 2,4 | 4,7 |
| Average load per rolling element Q | N | 34,5 | 41,7 |
| Elastic deformation $\delta$ (determined in nomogram) | µm | 22,5 | 13 |
| Specific load per rolling element k | N/mm$^2$ | 0,96 | 1,1 |
| Correction factor $f_k$ | | 1,99 | 2,9 |
| Resulting deflection $\delta_{res}$ | µm | 45 | 38 |

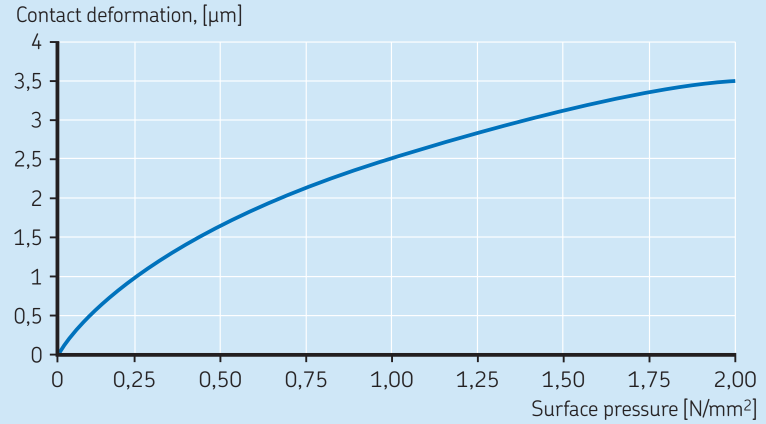
# 1.12 Technical data of precision rail guides with slide coating

## 1.12.1 Surface pressure

To achieve a reasonable value for the contact deformation, the surface pressure of plain bearings or guidings is normally in the region of 0,2 to 1 N/mm². **Diagram 14** shows the surface deformation of Turcite-B rail guides expressed in relation to surface pressure. In case of overload, up to 6 N/mm², the contact deformation rises to 5 µm but recovers to the original dimension when the load is relieved.

**Diagram 14**

**Contact deformation in relation to suface pressure**



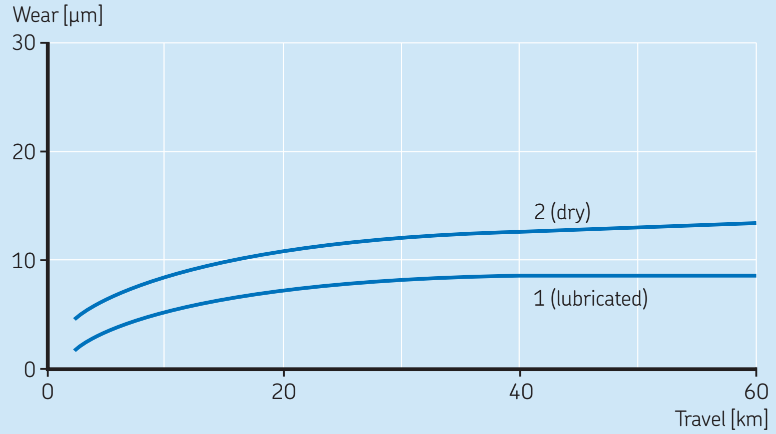
## 1.12.2 Wear

LWRPM / LWRPV rail guides are characterised by their high resistance to wear. The ground surface of the LWRPV guides is matched to suit the Turcite-B so that the degree of wear is kept to a minimum. Even a certain amount of contamination can be tolerated without affecting the sliding qualities since the slide material is capable of allowing small particles to become embedded in the surface.

For optimum performance, however, lubrication of the LWRPM / LWRPV rail guides is recommended. As seen in **diagram 15**, the oil-lubricated guide (curve 1) shows less wear along the length of travel in comparison with the non-lubricated guide (curve 2). The values indicated are for an average surface pressure of 0,4 N/mm².

**Diagram 15**

**Wear in relation to length of travel**



## 1.12.3 Frictional properties

Due to the favourable frictional qualities of Turcite-B, the running speed of a dry sliding rail guide has relatively little effect on the coefficient of friction, and 'stickslip' is virtually eliminated.

**Diagram 16** illustrates the relationship between the coefficient of friction for LWRPM / LWRPV rail guides as a function of sliding speed. Curve 1 applies to an oil-lubricated guide, and curve 2 applies to a non-lubricated installation. The degree of friction is seen to fall during a 'smoothing' phase and then remains relatively constant. The values indicated are based on an average surface pressure of 0,2 N/mm².

**Diagram 16**

**Coefficient of friction as a function of sliding speed**

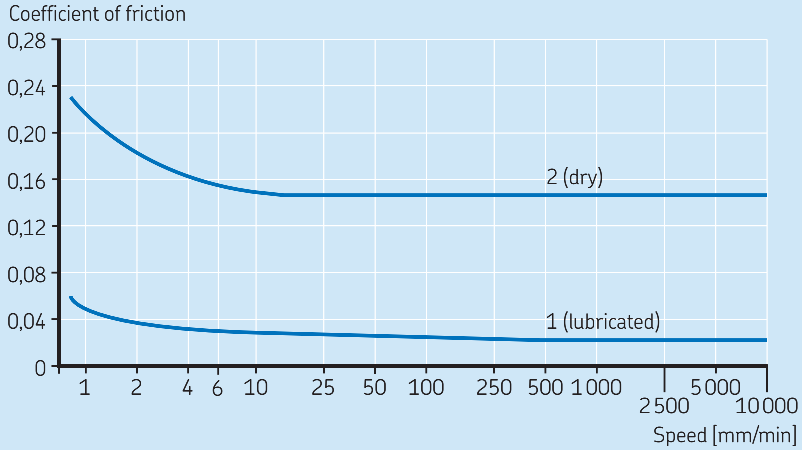


**Diagram 17** shows the coefficient of friction for an oil-lubricated LWRPM / LWRPV rail guide in relation to the surface pressure. Here it will be seen that the coefficient of friction for low load conditions is relatively high, but when the surface pressure reaches 0,2 N/mm$^2$, the coefficient falls to a minimum and remains constant.

## 1.12.4 Temperature range

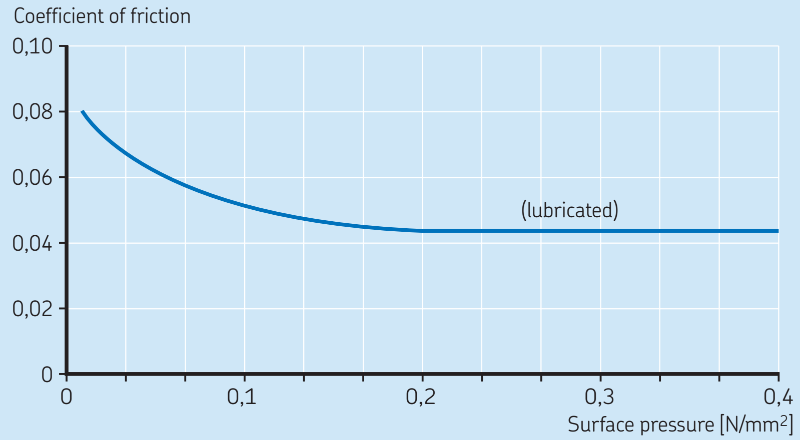
The operating temperature of a linear plain bearing should lie between the limits of –40°C and +80°C. Higher temperatures tend to reduce the pressure resistance. In many cases, the dissipation of heat can be enhanced through the use of lubricating oil.

## 1.12.5 Chemical and humidity resistance

Turcite-B possesses excellent chemical resistance. Moisture absorbency amounts to a maximum of 0,01 percent and has no significant dimensional effect. Sliding surfaces of Turcite-B are consequently highly resistant to cool conditions and the effect of lubricating oils.

**Diagram 17**

**Coefficient of friction as a function of surface pressure**



# 1.13 Legend

Table 9

**Legend**

| | | |
|---|---|---|
| $B_1$ | mean distance between the rolling element assemblies | [mm] |
| $C$ | dynamic load rating | [N] |
| $C_0$ | static load rating | [N] |
| $C_{10}$ | basic dynamic load rating of a cage with 10 rolling elements (balls, rollers) or with 2 rows of 10 needles under load | [N] |
| $C_{0,10}$ | basic static load rating of a cage with 10 rolling elements (balls, rollers) or with 2 rows of 10 needles under load | [N] |
| $C_{eff}$ | effective dynamic load rating of one cage | [N] |
| $C_{eff\ slide}$ | effective dynamic load rating of a slide | [N] |
| $C_{0,\ eff\ slide}$ | effective static load rating of a slide | [N] |
| $c_1$ | factor for reliability | |
| $\delta$ | elastic deformation (determined in nomogram) | [µm] |
| $\delta_{res}$ | resulting deflection | [µm] |
| $EG$ | length of lead in radius on each side | [mm] |
| $f_1$ | factor for load direction | |
| $f_h$ | factor for hardness, dynamic | |
| $f_{h0}$ | factor for hardness, static | |
| $f_k$ | correction factor | |
| $f_{Pr}$ | factor for preload | [%] |
| $f_s$, $f_{s,j}$ | factor for stroke length | |
| $f_t$ | factor for operating temperature | |
| $F_{Pr}$ | preload force | [N] |
| $F_{res}$ | resulting load | [N] |
| $F_{res\ max}$ | maximum resulting load | [N] |
| $F_{x,i}$, $F_{y,i}$, $F_{z,i}$ | single loads in x-, y- or z-direction that act simultaneously on the rail guide system | [N] |
| $F_y$, $F_z$ | summarized force (load) in y- or z-direction | [N] |
| $k$ | specific load per rolling element | [N/mm$^2$] |
| $L_{10h}$ | basic rating life | [h] |
| $L_{10s}$ | basic rating life | [km] |
| $L_{ns}$ | modified basic rating life | [km] |
| $L_{cage}$ | length of rolling element assembly | [mm] |
| $L_{cage,\ max}$ | maximum length of rolling element assembly, if length of rail and stroke are predefined | [mm] |
| $L_{install}$ | length of the complete installation | [mm] |
| $L_{rail}$ | length of the rail | [mm] |
| $L_{rail,\ min}$ | minimum length of the rail, if length of cage and stroke are predefined | [mm] |
| $L_{rail,\ long}$ | length of the long rail | [mm] |
| $L_{rail,\ long,\ min}$ | minimum length of the long rail, if length of cage and stroke are predefined | [mm] |
| $L_{rail,\ short}$ | length of the short rail in an overrunning system | [mm] |
| $L_T$ | load carrying length | [mm] |
| $L_{w\ eff}$ | contact length of rolling element | [mm] |
| $M_x$, $M_y$, $M_z$ | summarized torque loads in x-, y- or z-direction | [Nm] |
| $n$ | stroke frequency | [double strokes/min] |
| $p$ | life exponent; $p = 3$ for balls, $p = 10/3$ for rollers | |
| $P$ | equivalent dynamic load | [N] |
| $P_m$ | equivalent dynamic mean load | [N] |
| $P_0$ | maximum static load | [N] |
| $Q$ | average load per rolling element | [N] |
| $R_x$ | leverage ratio in x-direction | |
| $R_y$ | leverage ratio in y-direction | |
| $s_0$ | static safety factor | |
| $S$ | intended stroke length | [mm] |
| $S_j$ | individual stroke length | [mm] |
| $S_{tot}$ | total stroke length | [mm] |
| $x_i$, $y_i$, $z_i$, | lever arms that are related to the single loads | [m] |
| $w$ | rolling element exponent; $w = 0{,}7$ for balls, $w = 7/9$ for rollers | |
| $z$ | number of rolling elements (per cage or per row for needles) | |
| $z_T$ | number of load carrying rolling elements (per cage or per row for needles) | |

**Dimensions from product data:**

| | | |
|---|---|---|
| $A$ | Width of precision rail guide | [mm] |
| $L$ | thickness of end piece | [mm] |
| $L_1$ | thickness of end piece with wiper | [mm] |
| $t$ | pitch of rolling elements in cage | [mm] |
| $t_1$, $t_2$ | distance of outer rolling element to the end of the cage | [mm] |
| $t_3$ | length of anti-creeping system | [mm] |
| $J_1$ | length between end of rail and first mounting hole | [mm] |

**Indizes**

| | |
|---|---|
| $i$ | counter for single loads in x-, y- or z-direction that act simultaneously |
| $U$ | amount of loads that act simultaneously |
| $j$ | counter for load phases |
| $V$ | amount of load phases |

# 2 Product data

## 2.1 LWR / LWRB

### Rail guides

LWR and LWRB rail guides are well-proven, limited-travel linear guides used in numerous applications. They can be used with crossed roller assemblies or ball assemblies, depending on the respective application. LWR rail guides with crossed roller assemblies are preferred for high load carrying capacity and good rigidity behaviour. LWRB rail guides with ball assembly can be used where loads are light and/or easy running is required. The small cross-section is ideal for applications with limited space.

### Rolling element assemblies

LWJK ball assemblies, which are used together with LWRB rails, are provided with a ball-retaining plastic cage. These are available for sizes 1 and 2.

LWAK crossed roller assemblies comprise a plastic cage with retained cylindrical rollers, available as standard for size 3.

LWAL crossed roller assemblies, consisting of an aluminium cage with retained rollers, are available in sizes 6 to 12.

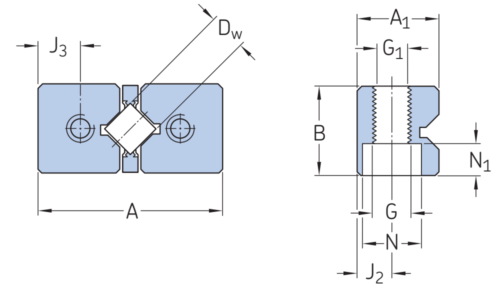
### End pieces

End pieces prevent drift of the cage away from the loaded zone. Available types are LWERA, LWERB as standard end pieces, and LWERC as end pieces with wipers. All end pieces are supplied with appropriate mounting screws.

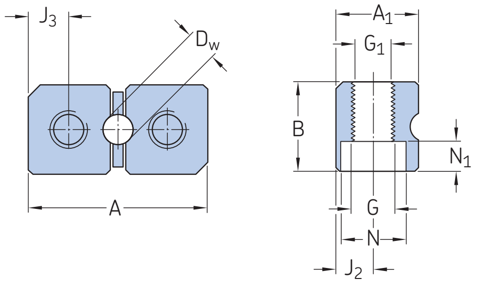
**Ordering example:**

4x LWR 9600
2x LWAL 9x25
8x LWERA 9

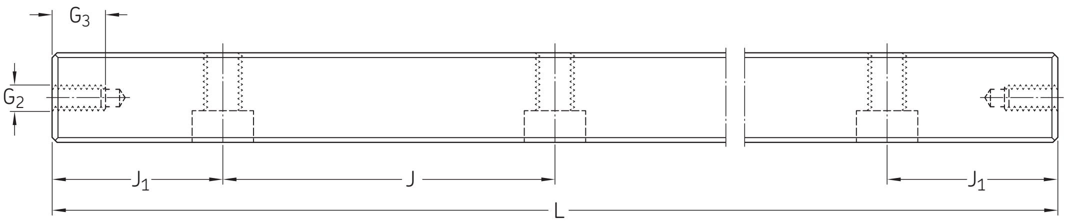
# LWR precision rail guides



LWR



LWRB



| Designation[1] | Dimensions |  |  |  | Weight | Mounting holes |  |  |  |  |  |  |  | End face holes |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | A | B | $A_1$ | $D_w$ |  | J | $J_1$ | $J_{1\,min}$ | $J_2$ | G | $G_1$ | N | $N_1$ | $J_3$ | $G_2$ | $G_3$ |
| – | mm |  |  |  | kg/m | mm |  |  |  | – | mm |  |  | mm | – | mm |
| **LWRB 1** | 8,5 | 4 | 3,9 | 1,588 | 0,11 | 10 | 5 | 5 | 1,8 | M2 | 1,65 | 3 | 1,4 | 1,9 | M1,6 | 2 |
| **LWRB 2** | 12 | 6 | 5,5 | 2 | 0,23 | 15 | 7,5 | 7,5 | 2,5 | M3 | 2,55 | 4,4 | 2 | 2,7 | M2,5 | 3 |

| Designation[1] | Dimensions |  |  |  | Weight | Mounting holes |  |  |  |  |  |  |  | End face holes |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | A | B | $A_1$ | $D_w$ |  | J | $J_1$ | $J_{1\,min}$ | $J_2$ | G | $G_1$ | N | $N_1$ | $J_3$ | $G_2$ | $G_3$ |
| – | mm |  |  |  | kg/m | mm |  |  |  | – | mm |  |  | mm | – | mm |
| **LWR 3** | 18 | 8 | 8,2 | 3 | 0,45 | 25 | 12,5 | 12,5 | 3,5 | M4 | 3,3 | 6 | 3,2 | 4 | M3 | 6 |
| **LWR 6** | 31 | 15 | 13,9 | 6 | 1,46 | 50 | 25 | 20 | 6 | M6 | 5,2 | 9,5 | 5,2 | 7 | M5 | 9 |
| **LWR 9** | 44 | 22 | 19,7 | 9 | 3,14 | 100 | 50 | 20 | 9 | M8 | 6,8 | 10,5 | 6,2 | 10 | M6 | 9 |
| **LWR 12** | 58 | 28 | 25,9 | 12 | 5,23 | 100 | 50 | 30 | 12 | M10 | 8,5 | 13,5 | 8,2 | 13 | M8 | 12 |

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[1] Sizes LWR 15, 18 and 24 are available on request.

**LWR rail guides in kit packaging**

| Designation | Load ratings[1] dyn. C | stat. $C_0$ | Stroke[2] standard | max | Type of rail 4 pieces | Type of cage 2 pieces | Type of end piece 8 pieces |
|---|---|---|---|---|---|---|---|
| – | N | | mm | | – | | – |
| **LWR 3050 – Kit** | 999 | 1 120 | 26 | 33 | LWR 3050 | LWAK 3x7 | LWERA 3 |
| **LWR 3075 – Kit** | 1 422 | 1 760 | 36 | 50 | LWR 3075 | LWAK 3x11 | LWERA 3 |
| **LWR 3100 – Kit** | 1 811 | 2 400 | 46 | 67 | LWR 3100 | LWAK 3x15 | LWERA 3 |
| **LWR 3125 – Kit** | 2 088 | 2 880 | 66 | 83 | LWR 3125 | LWAK 3x18 | LWERA 3 |
| **LWR 3150 – Kit** | 2 442 | 3 520 | 76 | 100 | LWR 3150 | LWAK 3x22 | LWERA 3 |
| **LWR 3175 – Kit** | 2 781 | 4 160 | 86 | 117 | LWR 3175 | LWAK 3x26 | LWERA 3 |
| **LWR 3200 – Kit** | 3 110 | 4 800 | 96 | 133 | LWR 3200 | LWAK 3x30 | LWERA 3 |
| **LWR 6100 - Kit** | 4 915 | 5 440 | 50 | 67 | LWR 6100 | LWAL 6x8 | LWERA 6 |
| **LWR 6150 - Kit** | 6 744 | 8 160 | 78 | 100 | LWR 6150 | LWAL 6x12 | LWERA 6 |
| **LWR 6200 - Kit** | 8 441 | 10 880 | 106 | 133 | LWR 6200 | LWAL 6x16 | LWERA 6 |
| **LWR 6250 - Kit** | 10 045 | 13 600 | 134 | 167 | LWR 6250 | LWAL 6x20 | LWERA 6 |
| **LWR 6300 – Kit** | 11 955 | 17 000 | 144 | 200 | LWR 6300 | LWAL 6x25 | LWERA 6 |
| **LWR 6350 – Kit** | 13 422 | 19 720 | 172 | 233 | LWR 6350 | LWAL 6x29 | LWERA 6 |
| **LWR 6400 – Kit** | 14 846 | 22 440 | 200 | 267 | LWR 6400 | LWAL 6x33 | LWERA 6 |

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[1] Load ratings are given for a kit of 4 rails and 2 cages in clamped arrangement.
[2] Cage length is adjustable but must not be shorter than 2/3 of the total rail length.

| **Available lengths**[1] L | | | | | | | | | | | | | | | **Maximum rail length** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | 30 | 40 | 45 | 50 | 60 | 70 | 75 | 80 | 90 | 100 | 105 | 120 | 135 | 150 | |
| mm | | | | | | | | | | | | | | | mm |
| ● | ● | ● | | ● | ● | ○ | | ○ | ○ | ○ | | | | | 150 |
| | ● | | ● | | ● | | ● | | ● | | ● | ● | ○ | ○ | 200 |

| **Available lengths**[1] L | | | | | | | | | | | | | | | | | | | | | | **Maximum rail length** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 350 | 400 | 450 | 500 | 550 | 600 | 650 | 700 | 800 | 900 | 1 000 | |
| mm | | | | | | | | | | | | | | | | | | | | | | mm |
| ● | ● | ● | ● | ● | ● | ● | ○ | ● | ○ | ● | | | | | | | | | | | | 400 |
| | | ● | ○ | ● | | ● | | ● | | ● | ● | ● | ● | ● | ○ | ○ | ○ | ○ | | | | 1 200 |
| | | | | | | ● | | | | ● | | ● | | ● | | ○ | | ○ | ○ | ○ | ○ | 1 500 |
| | | | | | | ○ | | | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1 500 |

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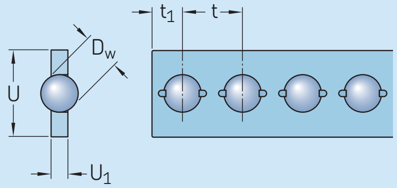
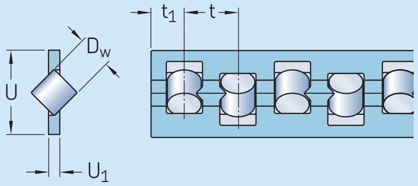
[1] Other rail lengths are available on request but new $J_1$ dimension has to be calculated as described in *chapter 3.1.7, Calculation of $J_1$ dimension.*
●) Prompt delivery
○) Delivery time on request

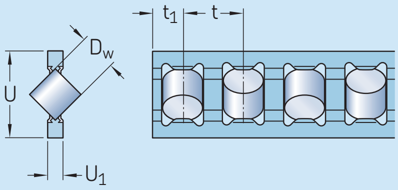
## Ball and crossed roller assemblies



LWJK



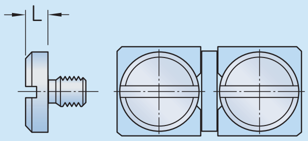
LWAK



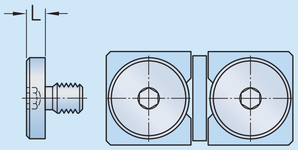
LWAL

| Designation | Dimensions | | | | | Load ratings for 10 rolling elements | | Maximum cage length | Appropriate rail guide |
|---|---|---|---|---|---|---|---|---|---|
| | $D_w$ | U | $U_1$ | t | $t_1$ | dynamic $C_{10}$ | static $C_{0\,10}$ | | |
| – | mm | | | | | N | | Balls/Rollers | – |
| **LWJK 1,588** | 1,588 | 3,5 | 0,5 | 2,2 | 1 | 410 | 580 | 38 | LWRB 1 |
| **LWJK 2** | 2 | 5 | 0,75 | 3,9 | 1,5 | 640 | 720 | 25 | LWRB 2 |
| **LWAK 3** | 3 | 7,5 | 1 | 5 | 3,5 | 1 320 | 1 600 | 200 | LWR 3 |
| **LWAL 6** | 6 | 14,8 | 2,7 | 9 | 6 | 5 850 | 6 800 | 166 | LWR 6 |
| **LWAL 9** | 9 | 20 | 4 | 14 | 9,4 | 17 000 | 18 300 | 106 | LWR 9 |
| **LWAL 12** | 12 | 25 | 5 | 18 | 12 | 30 000 | 30 500 | 83 | LWR 12 |

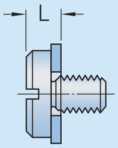
## LWR end pieces



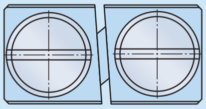
LWERA 1+2



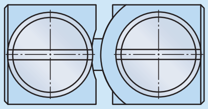
LWERA 3–12



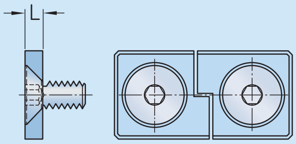
LWERB 1+2



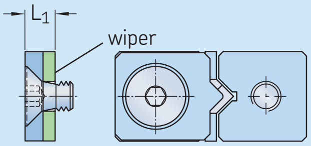
LWERB 1



LWERB 2



LWERB 3–12



LWERC 3–12

| **Designation**<br>End pieces | End pieces with wiper | **Dimensions**<br>L | L1 | **Attachment screw**<br>ISO 1580 | ISO 10642 | **Appropriate rail guide** |
|---|---|---|---|---|---|---|
| – | | mm | | – | | – |
| **LWERA 1** | | 1 | | | | LWRB 1 |
| **LWERB 1** | | 1,8 | | M 1,6 | | |
| **LWERA 2** | | 1,5 | | | | LWRB 2 |
| **LWERB 2** | | 2 | | M 2,5 | | |
| **LWERA 3** | | 2,5 | | | | LWR 3 |
| **LWERB 3** | | 2 | | | M 3 | |
| | **LWERC 3** | | 5 | | M 3 | |
| **LWERA 6** | | 3 | | | | LWR 6 |
| **LWERB 6** | | 3 | | | M 5 | |
| | **LWERC 6** | | 6 | | M 5 | |
| **LWERA 9** | | 4 | | | | LWR 9 |
| **LWERB 9** | | 4 | | | M 6 | |
| | **LWERC 9** | | 7 | | M 6 | |
| **LWERA 12** | | 5 | | | | LWR 12 |
| **LWERB 12** | | 5 | | | M 8 | |
| | **LWERC 12** | | 8 | | M 8 | |

# 2.2 LWRE

## Rail guides

LWRE rail guides are a logical development of the proven LWR rail guides. In addition to the familiar characteristics of the LWR series, the LWRE rail guides offer the advantages of fivefold load ratings and a doubling of the rigidity. This means that for the same load capacity, a 50% reduction in bearing size compared with the standard LWR rail guide is possible (→ **fig. 1**). Alternatively, with the same outer dimensions, greatly increased static safety and lifetime results.

The improvements are achieved through optimized internal geometry in conjunction with larger roller diameters. Furthermore, LWRE rail guides utilise the whole roller length so that no tilting moment or edge stresses can occur (→ **fig. 2**). The mounting and attachment dimensions of the LWRE rail guides conform to those of all the SKF Modular Range rail guides included in this catalogue.

## Rolling element assemblies

LWAKE crossed roller cages consist of individual plastic elements. In LWAKE 3, 6 and 9 cages, these elements are assembled using a 'snap in' technique, whereby each element can be rotated manually through an angle of 90° (→ **fig. 3**). The load rating and rigidity can be increased by turning the rollers in the direction of the main load. As standard, the orientation of the rollers is alternating. The cage retains the rollers and at the same time almost fills the free space between the rails, thus providing good protection against ingress of dirt. LWAKE 4 cages consist of roller segments fitted together to the customer's specific length requirements. Individual rotating is not possible for size 4.

## End pieces

End pieces prevent drift of the cage away from the loaded zone. LWERE end pieces are generally used for horizontal and vertical applications. An end piece with wiper, LWEREC, is available. All end pieces are supplied with appropriate mounting screws.

**Ordering example:**

4x LWRE 6200
2x LWAKE 6x13
8x LWERE 6

Fig. 1

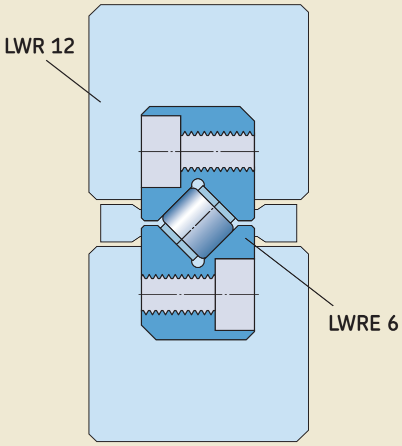


Fig. 2

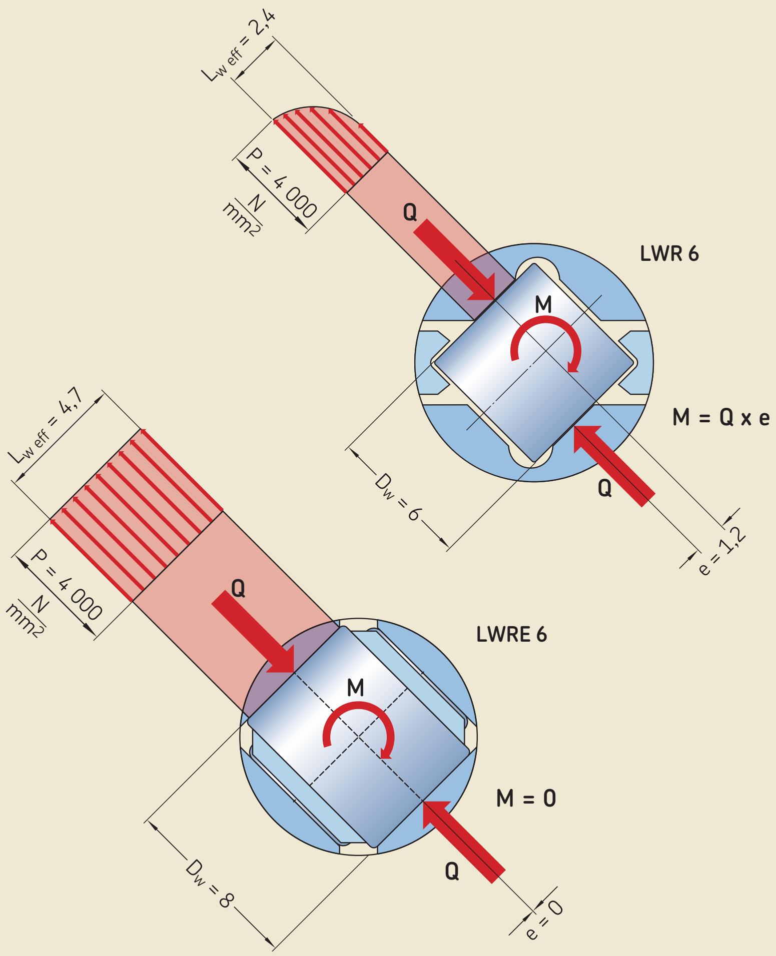
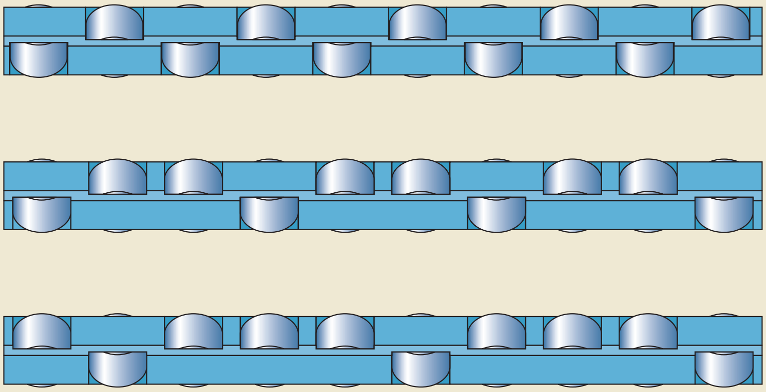
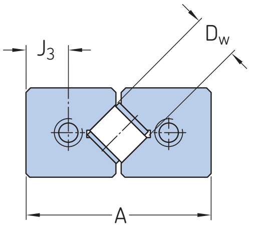
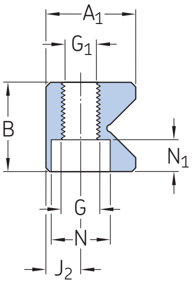


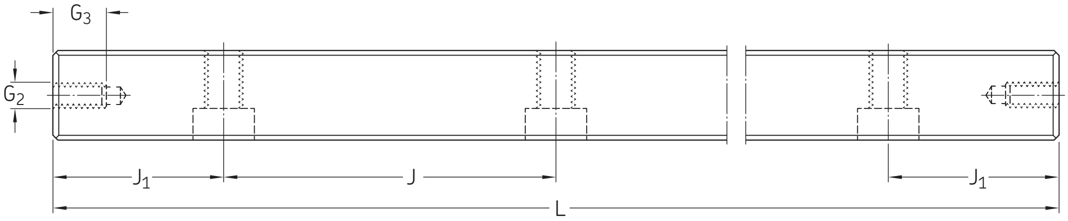
Fig. 3



# LWRE precision rail guides







| **Designation** | **Dimensions** | | | | **Weight** | **Mounting holes** | | | | | | | | **End face holes** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | $A_1$ | $D_w$ | | J | $J_1$ | $J_{1\,min}$ | $J_2$ | G | $G_1$ | N | $N_1$ | $J_3$ | $G_2$ | $G_3$ |
| – | mm | | | | kg/m | mm | | | | – | mm | | | mm | – | mm |
| **LWRE 3** | 18 | 8 | 8,7 | 4 | 0,44 | 25 | 12,5 | 12,5 | 3,5 | M 4 | 3,3 | 6 | 3,2 | 4 | M 3 | 6 |
| **LWRE 4** | 25 | 12 | 12 | 6,5 | 0,93 | 25 | 12,5 | 12,5 | 5 | M 4 | 3,3 | 6 | 3,2 | 5 | M 3 | 6 |
| **LWRE 6** | 31 | 15 | 15,2 | 8 | 1,44 | 50 | 25 | 20 | 6 | M 6 | 5,2 | 9,5 | 5,2 | 6,75 | M 5 | 9 |
| **LWRE 9** | 44 | 22 | 21,7 | 12 | 3,09 | 100 | 50 | 20 | 9 | M 8 | 6,8 | 10,5 | 6,2 | 9,75 | M 6 | 9 |

| **Designation** | **Dimensions** | | | | **Weight** | **Mounting holes** | | | | | | | | **End face holes** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | $A_1$ | $D_w$ | | J | $J_1$ | $J_{1\,min}$ | $J_2$ | G | $G_1$ | N | $N_1$ | $J_3$ | $G_2$ | $G_3$ |
| – | mm | | | | kg/m | mm | | | | – | mm | | | mm | – | mm |
| **LWRE 2211** | 22 | 11 | 10,7 | 4 | 0,8 | 40 | 20 | 15 | 4,5 | M 5 | 4,3 | 7,5 | 4,1 | 6 | M 3 | 6 |

## LWRE rail guides in kit packaging

| Designation | Load ratings[1] dyn. | stat. | Stroke[2] standard | max | Type of rail 4 pieces | Type of cage 2 pieces | Type of end piece 8 pieces |
|---|---|---|---|---|---|---|---|
| | C | $C_0$ | | | | | |
| – | N | | mm | | – | | – |
| **LWRE 3050 – Kit** | 4 230 | 5 100 | 25 | 33 | LWRE 3050 | LWAKE 3x6 | LWERE 3 |
| **LWRE 3075 – Kit** | 5 803 | 7 650 | 38 | 50 | LWRE 3075 | LWAKE 3x9 | LWERE 3 |
| **LWRE 3100 – Kit** | 7 263 | 10 200 | 50 | 67 | LWRE 3100 | LWAKE 3x12 | LWERE 3 |
| **LWRE 3125 – Kit** | 8 644 | 12 750 | 63 | 83 | LWRE 3125 | LWAKE 3x15 | LWERE 3 |
| **LWRE 3150 – Kit** | 9 964 | 15 300 | 75 | 100 | LWRE 3150 | LWAKE 3x18 | LWERE 3 |
| **LWRE 3175 – Kit** | 11 238 | 17 850 | 88 | 117 | LWRE 3175 | LWAKE 3x21 | LWERE 3 |
| **LWRE 3200 – Kit** | 12 471 | 20 400 | 100 | 133 | LWRE 3200 | LWAKE 3x24 | LWERE 3 |
| **LWRE 4100 – Kit** | 17 300 | 20 800 | 39 | 67 | LWRE 4100 | LWAKE 4x10 | LWERE 4 |
| **LWRE 4150 – Kit** | 23 735 | 31 200 | 62 | 100 | LWRE 4150 | LWAKE 4x15 | LWERE 4 |
| **LWRE 4200 – Kit** | 28 541 | 39 520 | 95 | 133 | LWRE 4200 | LWAKE 4x19 | LWERE 4 |
| **LWRE 4250 – Kit** | 34 246 | 49 920 | 118 | 167 | LWRE 4250 | LWAKE 4x24 | LWERE 4 |
| **LWRE 4300 – Kit** | 38 622 | 58 240 | 152 | 200 | LWRE 4300 | LWAKE 4x28 | LWERE 4 |
| **LWRE 4350 – Kit** | 43 902 | 68 640 | 169 | 233 | LWRE 4350 | LWAKE 4x33 | LWERE 4 |
| **LWRE 4400 – Kit** | 49 009 | 79 040 | 192 | 267 | LWRE 4400 | LWAKE 4x38 | LWERE 4 |
| **LWRE 6100 – Kit** | 25 743 | 27 300 | 46 | 67 | LWRE 6100 | LWAKE 6x7 | LWERE 6 |
| **LWRE 6150 – Kit** | 34 000 | 39 000 | 80 | 100 | LWRE 6150 | LWAKE 6x10 | LWERE 6 |
| **LWRE 6200 – Kit** | 44 204 | 54 600 | 92 | 133 | LWRE 6200 | LWAKE 6x14 | LWERE 6 |
| **LWRE 6250 – Kit** | 51 431 | 66 300 | 126 | 167 | LWRE 6250 | LWAKE 6x17 | LWERE 6 |
| **LWRE 6300 – Kit** | 58 382 | 78 000 | 160 | 200 | LWRE 6300 | LWAKE 6x20 | LWERE 6 |
| **LWRE 6350 – Kit** | 67 304 | 93 600 | 172 | 233 | LWRE 6350 | LWAKE 6x24 | LWERE 6 |
| **LWRE 6400 – Kit** | 73 781 | 105 300 | 206 | 267 | LWRE 6400 | LWAKE 6x27 | LWERE 6 |

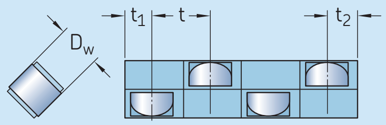
[1] Load ratings are given for a kit of 4 rails and 2 cages in clamped arrangement.
[2] Cage length is adjustable but must not be shorter than 2/3 of the total rail length.

| **Available lengths**[1] | | | | | | | | | | | | | | | | | | | | | | **Maximum rail length** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 350 | 400 | 450 | 500 | 550 | 600 | 650 | 700 | 800 | 900 | 1 000 | |
| L | | | | | | | | | | | | | | | | | | | | | | |
| mm | | | | | | | | | | | | | | | | | | | | | | mm |
| ● | ● | ● | ● | ● | ● | ● | ○ | ○ | ○ | ○ | | | | | | | | | | | | 400 |
| | | ● | | ● | | ● | | ● | | ● | | ● | ○ | ○ | ○ | ○ | | ○ | | | | 700 |
| | | ● | | ● | | ● | | ● | | ● | ○ | ● | ○ | ○ | ○ | ○ | ○ | ○ | | | | 1 200 |
| | | | | | | ● | | | | ● | | ● | | ● | | ● | | ○ | ○ | ○ | ○ | 1 500 |

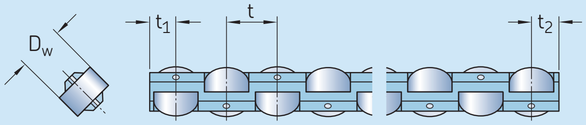
| **Available lengths**[1] | | | | | | | | | **Maximum rail length** |
|---|---|---|---|---|---|---|---|---|---|
| 80 | 120 | 160 | 200 | 240 | 280 | 320 | 360 | 400 | |
| L | | | | | | | | | |
| mm | | | | | | | | | mm |
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 500 |

[1] Other rail lengths are available on request but new $J_1$ dimension has to be calculated as described in *chapter 3.1.7, Calculation of $J_1$ dimension.*
●) Prompt delivery
○) Delivery time on request

## Crossed roller assemblies



LWAKE 3, 6, 9



LWAKE 4

| Designation | Dimensions | | | | Load ratings for 10 rolling elements | | Maximum cage length[1] | Appropriate rail guide |
|---|---|---|---|---|---|---|---|---|
| | $D_w$ | t | $t_1$ | $t_2$ | dynamic<br>$C_{10}$ | static<br>$C_{0\,10}$ | | |
| – | mm | | | | N | | mm | – |
| **LWAKE 3** | 4 | 6,25 | 2,65 | 3,6 | 6 300 | 8 500 | 1 000 | LWRE 3, LWRE 2211 |
| **LWAKE 4** | 6,5 | 8 | 4,3 | 4,3 | 17 300 | 20 800 | 1 000 | LWRE 4 |
| **LWAKE 6** | 8 | 11 | 5 | 6 | 34 000 | 39 000 | 1 000 | LWRE 6 |
| **LWAKE 9** | 12 | 16 | 7,35 | 8,65 | 78 000 | 78 000 | 1 000 | LWRE 9 |

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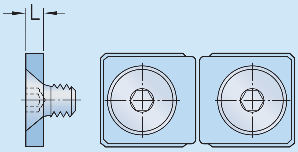
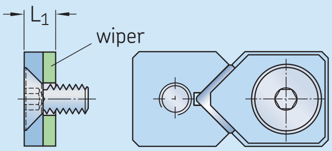
[1] Longer cages are available on request.

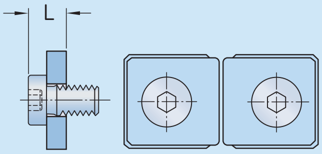
## LWRE end pieces



LWERE 3, 6, 9



LWEREC 3, 6, 9



LWERE 4

| Designation<br>End pieces | End pieces with wiper | Dimensions<br>L | $L_1$ | Attachment screw<br>ISO 10642 | Appropriate rail guide |
|---|---|---|---|---|---|
| – | | mm | | – | – |
| **LWERE 3** | | 2 | | M 3 | LWRE 3, LWRE 2211 |
| | **LWEREC 3** | | 4 | M 3 | LWRE 3, LWRE 2212 |
| **LWERE 4** | | 4 | | M 3 (DIN 7984) | LWRE 4 |
| **LWERE 6** | | 3 | | M 5 | LWRE 6 |
| | **LWEREC 6** | | 5 | M 5 | LWRE 6 |
| **LWERE 9** | | 3 | | M 6 | LWRE 9 |
| | **LWEREC 9** | | 6 | M 6 | LWRE 9 |

# 2.3 LWRE ACS

## Rail guides

LWRE ACS rail guides are identical to LWRE rail guides, but designed for use with anti-creeping LWAKE ACS cages. The non-slip effect is achieved through a patented control gear attached to the cage, which is in mesh between the LWRE ACS rails during operation, thus retaining the cage in its defined position. As standard, the rails are prepared for maximum stroke (→ *chapter 1.4*).

## Rolling element assemblies

In principle, LWAKE ACS are the same as LWAKE cages, whereby LWAKE ACS crossed roller cages incorporate an additional control gear located at the centre of the cage. The load carrying capacity of LWAKE ACS cages is also identical with that of LWAKE standard cages, assuming that they comprise an identical number of rollers. However, consider that due to their additional control gear, LWAKE ACS cages are longer than the corresponding LWAKE cages, even if the number of rollers is identical. Overrunning cages should only be used after consulting SKF.

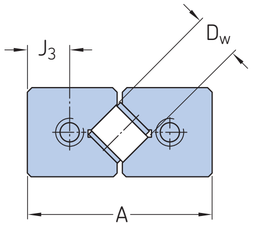
## End pieces

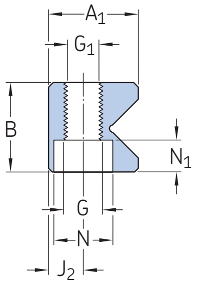
End pieces are generally not needed, but for production reasons, the tapped holes on the rail's end face are standard and end pieces can be mounted. LWERE end pieces are generally used for horizontal and vertical applications. An end piece with wiper, LWEREC, is available. All end pieces are supplied with appropriate mounting screws. The end pieces for LWRE rail guides are also suitable for LWRE ACS rail guides.

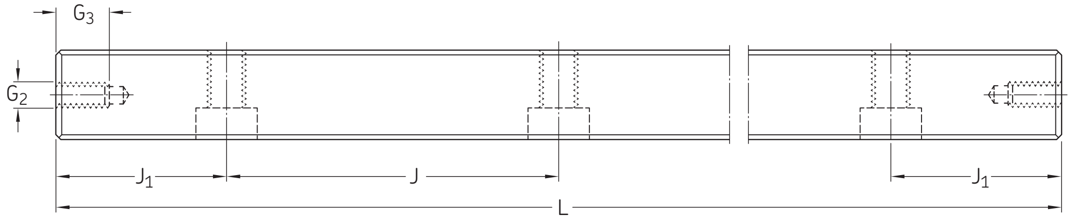
**Ordering example for rail with maximum stroke:**

4x LWRE 6200 ACS
2x LWAKE 6x12 ACS
8x LWERE 6

# LWRE ACS precision rail guides







| Designation | Dimensions | | | | Weight | Mounting holes | | | | | | | | End face holes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | $A_1$ | $D_w$ | | J | $J_1$ | $J_{1\,min}$ | $J_2$ | G | $G_1$ | N | $N_1$ | $J_3$ | $G_2$ | $G_3$ |
| – | mm | | | | kg/m | mm | | | | – | mm | | | mm | – | mm |
| **LWRE 3 ACS** | 18 | 8 | 8,7 | 4 | 0,44 | 25 | 12,5 | 12,5 | 3,5 | M 4 | 3,3 | 6 | 3,2 | 4 | M 3 | 6 |
| **LWRE 4 ACS** | 25 | 12 | 12 | 6,5 | 0,92 | 25 | 12,5 | 12,5 | 5 | M 4 | 3,3 | 6 | 3,2 | 5 | M 3 | 6 |
| **LWRE 6 ACS** | 31 | 15 | 15,2 | 8 | 1,44 | 50 | 25 | 20 | 6 | M 6 | 5,2 | 9,5 | 5,2 | 6,75 | M 5 | 9 |
| **LWRE 9 ACS** | 44 | 22 | 21,7 | 12 | 3,08 | 100 | 50 | 20 | 9 | M 8 | 6,8 | 10,5 | 6,2 | 9,75 | M 6 | 9 |

| Designation | Dimensions | | | | Weight | Mounting holes | | | | | | | | End face holes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | $A_1$ | $D_w$ | | J | $J_1$ | $J_{1\,min}$ | $J_2$ | G | $G_1$ | N | $N_1$ | $J_3$ | $G_2$ | $G_3$ |
| – | mm | | | | kg/m | mm | | | | – | mm | | | mm | – | mm |
| **LWRE 2211 ACS** | 22 | 11 | 10,7 | 4 | 0,8 | 40 | 20 | 15 | 4,5 | M 5 | 4,3 | 7,5 | 4,1 | 6 | M 3 | 6 |

**LWRE ACS rail guides in kit packaging**

| Designation | Load ratings[1]<br>dyn.<br>C | <br>stat.<br>$C_0$ | Stroke[2]<br>standard | <br>max | Type of rail<br>4 pieces | Type of cage<br>2 pieces | Type of end piece<br>8 pieces |
|---|---|---|---|---|---|---|---|
| – | N | | mm | | – | | – |
| **LWRE 3050 ACS – Kit** | 3 465 | 4 250 | 20 | 33 | LWRE 3050 ACS | LWAKE 3 x 5 ACS | LWERE 3 |
| **LWRE 3075 ACS – Kit** | 5 294 | 6 800 | 30 | 50 | LWRE 3075 ACS | LWAKE 3 x 6 ACS | LWERE 3 |
| **LWRE 3100 ACS – Kit** | 6 300 | 8 500 | 45 | 67 | LWRE 3100 ACS | LWAKE 3 x 10 ACS | LWERE 3 |
| **LWRE 3125 ACS – Kit** | 7 731 | 11 050 | 62 | 83 | LWRE 3125 ACS | LWAKE 3 x 13 ACS | LWERE 3 |
| **LWRE 3150 ACS – Kit** | 9 090 | 13 600 | 79 | 100 | LWRE 3150 ACS | LWAKE 3 x 16 ACS | LWERE 3 |
| **LWRE 3175 ACS – Kit** | 9 964 | 15 300 | 94 | 117 | LWRE 3175 ACS | LWAKE 3 x 18 ACS | LWERE 3 |
| **LWRE 3200 ACS – Kit** | 11 653 | 18 700 | 100 | 133 | LWRE 3200 ACS | LWAKE 3 x 22 ACS | LWERE 3 |
| **LWRE 4100 ACS – Kit** | 14 536 | 16 640 | 40 | 67 | LWRE 4100 ACS | LWAKE 4x8 ACS | LWERE 4 |
| **LWRE 4150 ACS – Kit** | 19 944 | 24 960 | 79 | 100 | LWRE 4150 ACS | LWAKE 4x12 ACS | LWERE 4 |
| **LWRE 4200 ACS – Kit** | 26 170 | 35 360 | 96 | 133 | LWRE 4200 ACS | LWAKE 4x17 ACS | LWERE 4 |
| **LWRE 4250 ACS – Kit** | 30 859 | 43 680 | 129 | 167 | LWRE 4250 ACS | LWAKE 4x21 ACS | LWERE 4 |
| **LWRE 4300 ACS – Kit** | 36 452 | 54080 | 152 | 200 | LWRE 4300 ACS | LWAKE 4x26 ACS | LWERE 4 |
| **LWRE 4350 ACS – Kit** | 41 813 | 64 480 | 175 | 233 | LWRE 4350 ACS | LWAKE 4x31 ACS | LWERE 4 |
| **LWRE 4400 ACS – Kit** | 45 964 | 72 800 | 203 | 267 | LWRE 4400 ACS | LWAKE 4x35 ACS | LWERE 4 |
| **LWRE 6100 ACS – Kit** | 22 826 | 23 400 | 37 | 67 | LWRE 6100 ACS | LWAKE 6 x 6 ACS | LWERE 6 |
| **LWRE 6150 ACS – Kit** | 31 318 | 35 100 | 71 | 100 | LWRE 6150 ACS | LWAKE 6 x 9 ACS | LWERE 6 |
| **LWRE 6200 ACS – Kit** | 39 196 | 46 800 | 105 | 133 | LWRE 6200 ACS | LWAKE 6 x 12 ACS | LWERE 6 |
| **LWRE 6250 ACS – Kit** | 49 056 | 62 400 | 117 | 167 | LWRE 6250 ACS | LWAKE 6 x 16 ACS | LWERE 6 |
| **LWRE 6300 ACS – Kit** | 56 093 | 74 100 | 151 | 200 | LWRE 6300 ACS | LWAKE 6 x 19 ACS | LWERE 6 |
| **LWRE 6350 ACS – Kit** | 65 107 | 89 700 | 163 | 233 | LWRE 6350 ACS | LWAKE 6 x 23 ACS | LWERE 6 |
| **LWRE 6400 ACS – Kit** | 71 640 | 101 400 | 197 | 267 | LWRE 6400 ACS | LWAKE 6 x 26 ACS | LWERE 6 |

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[1] Load ratings are given for a kit of 4 rails and 2 cages in clamped arrangement.
[2] Cage length is adjustable but must not be shorter than 2/3 of the total rail length.

| **Available lengths**[1]<br>50<br>L | <br>75 | <br>100 | <br>125 | <br>150 | <br>175 | <br>200 | <br>225 | <br>250 | <br>275 | <br>300 | <br>350 | <br>400 | <br>450 | <br>500 | <br>550 | <br>600 | <br>650 | <br>700 | <br>800 | <br>900 | <br>1 000 | **Maximum rail length** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | | | | | | | | | | | | | | | | | | | | | mm |
| ● | ● | ● | ● | ● | ● | ● | ○ | ○ | ○ | ○ | | | | | | | | | | | | 400 |
| | | ○ | | ○ | | ○ | | ○ | | ○ | | ○ | ○ | ○ | ○ | ○ | | ○ | | | | 700 |
| | | ● | | ● | | ● | | ○ | | ● | ○ | ● | ○ | ● | ○ | ○ | ○ | ○ | | | | 1 200 |
| | | | | | | ○ | | | | ○ | | ○ | | ○ | | ○ | | ○ | ○ | ○ | ○ | 1 500 |

| **Available lengths**[1]<br>80<br>L | <br>120 | <br>160 | <br>200 | <br>240 | <br>280 | <br>320 | <br>360 | <br>400 | **Maximum rail length** |
|---|---|---|---|---|---|---|---|---|---|
| mm | | | | | | | | | mm |
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 500 |

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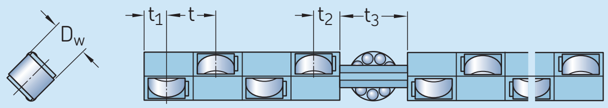
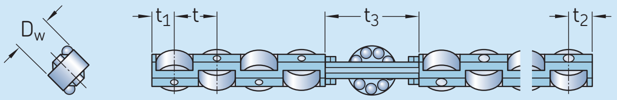
[1] Other rail lengths are available on request but new $J_1$ dimension has to be calculated as described in *chapter 3.1.7, Calculation of $J_1$ dimension.*
●) Prompt delivery
○) Delivery time on request

## Crossed roller assemblies



LWAKE 3, 6, 9  ACS



LWAKE 4 ACS

| Designation | Dimensions | | | | | Load ratings for 10 rolling elements | | Maximum cage length[1] | Appropriate rail guide |
|---|---|---|---|---|---|---|---|---|---|
| | $D_w$ | t | $t_1$ | $t_2$ | $t_3$ | dynamic<br>$C_{10}$ | static<br>$C_{0\,10}$ | | |
| – | mm | | | | | N | | mm | – |
| **LWAKE 3 ACS** | 4 | 6,25 | 2,65 | 3,6 | 9 | 6 300 | 8 500 | 1 000 | LWRE 3 ACS, LWRE 2211 ACS |
| **LWAKE 4 ACS** | 6,5 | 8 | 4,3 | 4,3 | 17 | 17 300 | 20 800 | 1 000 | LWRE 4 ACS |
| **LWAKE 6 ACS** | 8 | 11 | 5 | 6 | 15 | 34 000 | 39 000 | 1 000 | LWRE 6 ACS |
| **LWAKE 9 ACS** | 12 | 16 | 7,35 | 8,65 | 21,5 | 78 000 | 78 000 | 1 000 | LWRE 9 ACS |

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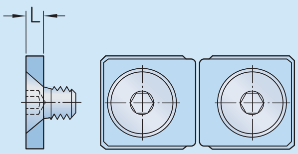
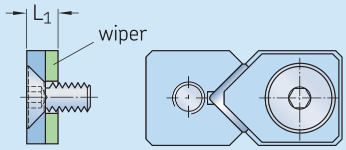
[1] Longer cages are available on request.

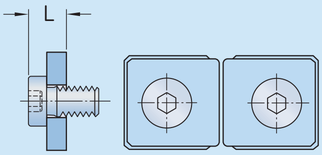
## LWRE ACS end pieces



LWERE 3, 6, 9



LWEREC 3, 6, 9



LWERE 4

| **Designation**<br>End pieces | End pieces with wiper | **Dimensions**<br>L | $L_1$ | **Attachment screw**<br>ISO 10642 | **Appropriate rail guide** |
|---|---|---|---|---|---|
| – | | mm | | – | – |
| **LWERE 3** | | 2 | | M 3 | LWRE 3, LWRE 2211 |
| | **LWEREC 3** | | 4 | M 3 | LWRE 3, LWRE 2212 |
| **LWERE 4** | | 4 | | M 3 (DIN 7984) | LWRE 4 |
| **LWERE 6** | | 3 | | M 5 | LWRE 6 |
| | **LWEREC 6** | | 5 | M 5 | LWRE 6 |
| **LWERE 9** | | 3 | | M 6 | LWRE 9 |
| | **LWEREC 9** | | 6 | M 6 | LWRE 9 |

# 2.4 LWRE / LWRB ACSM

## Rail guides

The refinement of our own ACS solution became the LWRE and LWRB ACSM rail guide version. LWRE and LWRB ACSM rail guides have the same outer dimensions as those without ACSM, but are designed for use with anti-creeping LWAKE ACSM cages. This cage, with an involute-toothed control gear made of brass and involute teeth directly machined into the rail, prevent cage-creeping very effectively and are especially suited for applications with high accelerations (→ *chapter 1.4*). These rails are made of stainless steel as standard.

## Rolling element assemblies

In principle, LWAKE ACSM cages are the same as LWAKE cages, whereby LWAKE ACSM crossed roller cages incorporate an additional control gear made of brass located at the centre of the cage. When defining the cage length, the additional length of the control gear should be considered. Overrunning cages should only be used after consulting SKF. The given load capacities are already calculated for stainless steel rails, which means factor $f_h$ remains at one for calculation of the lifetime.

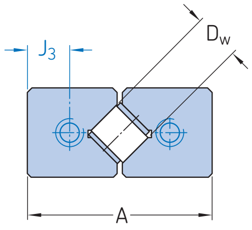
## End pieces

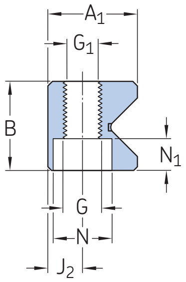
Generally, the LWRE ACSM rail guides are not designed for use with end pieces. However, if required, this must be stated separately in the ordering code of the rail (Option E7). The end pieces for LWRE rail guides are also suitable for LWRE ACSM rail guides.

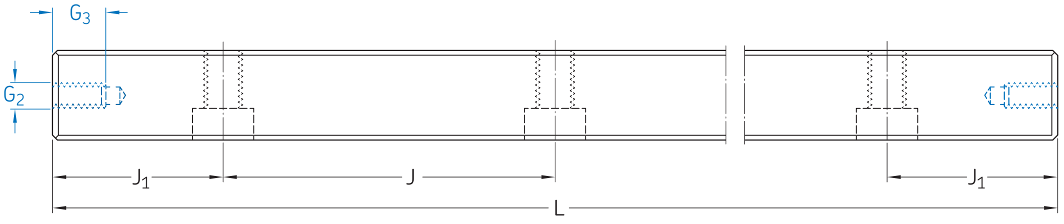
**Ordering example:**

4x LWRE 3150 ACSM
2x LWAKE 3x16 ACSM

# LWRE ACSM precision rail guides







| Designation | Dimensions | | | | Weight | Mounting holes | | | | | | | | End face holes[1] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | $A_1$ | $D_w$ | | J | $J_1$ | $J_{1\,min}$ | $J_2$ | G | $G_1$ | N | $N_1$ | $J_3$ | $G_2$ | $G_3$ |
| – | mm | | | | kg/m | mm | | | | – | mm | | | mm | – | mm |
| **LWRB 2 ACSM** | 12 | 6 | 5,5 | 2 | 0,23 | 15 | 7,5 | 7,5 | 2,5 | M3 | 2,55 | 4,4 | 2 | 2,7 | M2,5 | 3 |
| **LWRE 3 ACSM** | 18 | 8 | 8,7 | 4 | 0,44 | 25 | 12,5 | 12,5 | 3,5 | M 4 | 3,3 | 6 | 3,2 | 4 | M 3 | 6 |
| **LWRE 4 ACSM** | 25 | 12 | 12 | 6,5 | 0,91 | 25 | 12,5 | 12,5 | 5 | M 4 | 3,3 | 6 | 3,2 | 5 | M 3 | 6 |
| **LWRE 6 ACSM** | 31 | 15 | 15,2 | 8 | 1,42 | 50 | 25 | 20 | 6 | M 6 | 5,2 | 9,5 | 5,2 | 6,75 | M 5 | 9 |
| **LWRE 9 ACSM** | 44 | 22 | 21,7 | 12 | 3,05 | 100 | 50 | 20 | 9 | M 8 | 6,8 | 10,5 | 6,2 | 9,75 | M 6 | 9 |

| Designation | Dimensions | | | | Weight | Mounting holes | | | | | | | | End face holes[1] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | $A_1$ | $D_w$ | | J | $J_1$ | $J_{1\,min}$ | $J_2$ | G | $G_1$ | N | $N_1$ | $J_3$ | $G_2$ | $G_3$ |
| – | mm | | | | kg/m | mm | | | | – | mm | | | mm | – | mm |
| **LWRE 2211 ACSM** | 22 | 11 | 10,7 | 4 | 0,79 | 40 | 20 | 15 | 4,5 | M 5 | 4,3 | 7,5 | 4,1 | 6 | M 3 | 6 |

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[1] Standard is without end face holes; Option E7 means with end face holes (blue lines)

**LWRE ACSM rail guides in kit packaging**

| Designation | Load ratings[1], [2]<br>dyn.<br>C | <br>stat.<br>$C_0$ | Stroke[3]<br>standard | <br>max | Type of rail<br>4 pieces | Type of cage<br>2 pieces |
|---|---|---|---|---|---|---|
| – | N | | mm | | – | – |
| **LWRE 3050 ACSM – Kit** | 2 940 | 4 080 | 20 | 33 | LWRE 3050 ACSM | LWAKE 3 x 5 ACSM |
| **LWRE 3075 ACSM – Kit** | 3 380 | 4 900 | 30 | 50 | LWRE 3075 ACSM | LWAKE 3 x 6 ACSM |
| **LWRE 3100 ACSM – Kit** | 5 040 | 8 160 | 45 | 67 | LWRE 3100 ACSM | LWAKE 3 x 10 ACSM |
| **LWRE 3125 ACSM – Kit** | 6 180 | 10 610 | 62 | 83 | LWRE 3125 ACSM | LWAKE 3 x 13 ACSM |
| **LWRE 3150 ACSM – Kit** | 7 270 | 13 060 | 79 | 100 | LWRE 3150 ACSM | LWAKE 3 x 16 ACSM |
| **LWRE 3175 ACSM – Kit** | 7 970 | 14 690 | 94 | 117 | LWRE 3175 ACSM | LWAKE 3 x 18 ACSM |
| **LWRE 3200 ACSM – Kit** | 9 320 | 17 950 | 100 | 133 | LWRE 3200 ACSM | LWAKE 3 x 22 ACSM |
| **LWRE 6100 ACSM – Kit** | 18 260 | 22 460 | 37 | 67 | LWRE 6100 ACSM | LWAKE 6 x 6 ACSM |
| **LWRE 6150 ACSM – Kit** | 25 050 | 33 700 | 71 | 100 | LWRE 6150 ACSM | LWAKE 6 x 9 ACSM |
| **LWRE 6200 ACSM – Kit** | 31 360 | 44 930 | 105 | 133 | LWRE 6200 ACSM | LWAKE 6 x 12 ACSM |
| **LWRE 6250 ACSM – Kit** | 39 240 | 59 900 | 117 | 167 | LWRE 6250 ACSM | LWAKE 6 x 16 ACSM |
| **LWRE 6300 ACSM – Kit** | 44 870 | 71 140 | 151 | 200 | LWRE 6300 ACSM | LWAKE 6 x 19 ACSM |
| **LWRE 6350 ACSM – Kit** | 52 090 | 86 110 | 163 | 233 | LWRE 6350 ACSM | LWAKE 6 x 23 ACSM |
| **LWRE 6400 ACSM – Kit** | 57 310 | 97 340 | 197 | 267 | LWRE 6400 ACSM | LWAKE 6 x 26 ACSM |

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[1] Load ratings are given for a kit of 4 rails and 2 cages in clamped arrangement.
[2] Calculated with HRC 55 due to stainless rails.
[3] Cage length is adjustable but must not be shorter than 2/3 of the total rail length.

| **Available lengths**[1]<br>30<br>L | 45 | 50 | 60 | 75 | 90 | 100 | 105 | 120 | 125 | 135 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 350 | 400 | **Maximum rail length** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | | | | | | | | | | | | | | | | | | | mm |
| ○ | ○ | | ○ | ○ | ○ | | ○ | ○ | | ○ | ○ | | | | | | | | | 200 |
| | | ● | | ● | | ● | | | ● | | ● | ● | ● | ● | ● | ● | ● | ● | ● | 400 |
| | | | | | | ○ | | | | | ○ | | ○ | | ○ | | ○ | | ○ | 400 |
| | | | | | | ● | | | | | ● | | ● | | ● | | ● | ● | ● | 400 |
| | | | | | | | | | | | | | ○ | | | | ○ | | ● | 400 |

| **Available lengths**[1]<br>80<br>L | 120 | 160 | 200 | 240 | 280 | 320 | 360 | 400 | **Maximum rail length** |
|---|---|---|---|---|---|---|---|---|---|
| mm | | | | | | | | | mm |
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 400 |

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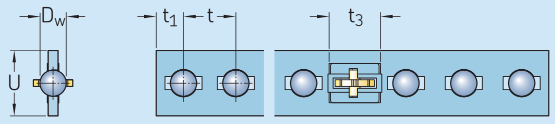
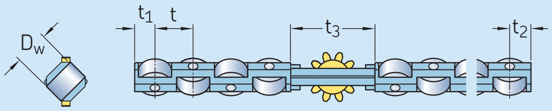
[1] Other rail lengths are available on request but new $J_1$ dimension has to be calculated as described in *chapter 3.1.7, Calculation of $J_1$ dimension.*
●) Prompt delivery
○) Delivery time on request

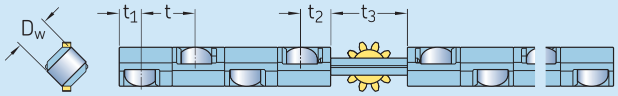
## Ball and crossed roller assemblies



LWJK 2 ACSM



LWAKE 4 ACSM



LWAKE 3, 6, 9 ACSM

| Designation | Dimensions | | | | | Load ratings for 10 rolling elements | | Maximum cage length[1] | Appropriate rail guide |
|---|---|---|---|---|---|---|---|---|---|
| | $D_w$ | t | $t_1$ | $t_2$ | $t_3$ | dynamic $C_{10}$ | static $C_{0\,10}$ | | |
| – | mm | | | | | N | | Balls/mm | |
| **LWJK 2 ACSM** | 2 | 3,9 | 1,5 | 0 | 3,9 | 510 | 650 | 24 balls | LWRB 2 ACSM |
| **LWAKE 3 ACSM** | 4 | 6,25 | 2,65 | 3,6 | 9 | 5 040 | 8 160 | 1 000 | LWRE 3 ACSM, LWRE 2211 ACSM |
| **LWAKE 4 ACSM** | 6,5 | 8 | 4,3 | 4,3 | 17 | 13 840 | 19 968 | 1 000 | LWRE 4 ACSM |
| **LWAKE 6 ACSM** | 8 | 11 | 5 | 6 | 15 | 27 200 | 37 440 | 1 000 | LWRE 6 ACSM |
| **LWAKE 9 ACSM** | 12 | 16 | 7,35 | 8,65 | 21,5 | 62 400 | 74 880 | 1 000 | LWRE 9 ACSM |

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[1] Longer cages are available on request.

# 2.5 LWRM / LWRV

## Rail guides

LWRM/LWRV rail guides offer guiding systems with high load carrying capacity and maximum rigidity. The mounting and interface dimensions of LWRM/LWRV rail guides conform to those of all the SKF Modular Range rail guides included in this catalogue.

## Needle roller assemblies

LWHW needle roller assemblies have aluminium cages with retained needle rollers. LWHV needle roller assemblies consist of a plastic cage with retained needle rollers. They are available for size 6 and 9 units. When ordering, the appropriate cage length in mm should be stated after the cage designation, e.g.: LWHW 10x225.

## End pieces

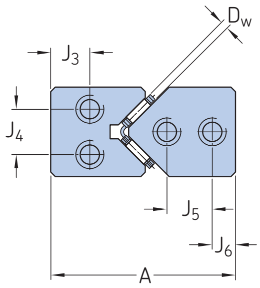
End pieces serve to prevent the drift of the cage away from the loaded zone. Because of the design of LWRM/LWRV rail guides and the respective end pieces, only one rail, the M-shaped or the V-shaped, has to be equipped with end pieces.

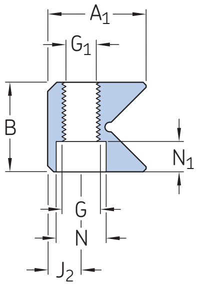
LWEARM and LWEARV end pieces feature a plastic wiper with a sealing lip that keeps the raceways virtually free from contamination. All end pieces are supplied with appropriate mounting screws.

**Ordering example:**

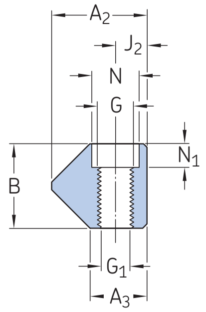
2x LWRM 9400
2x LWRV 9400
2x LWHW 15x358
4x LWERM 9

# LWRM / LWRV precision rail guides

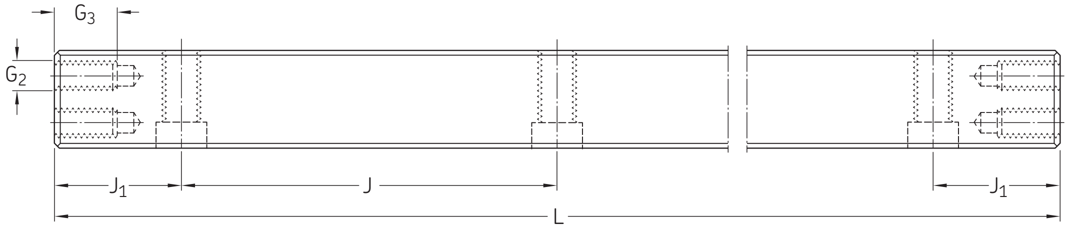




LWRM



LWRV



LWRM

| Designation[1] | Dimensions | | | | | | Weight | Mounting holes | | | | | | | | End face holes | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | $A_1$ | $A_2$ | $A_3$ | $D_w$ | | J | $J_1$ | $J_{1\ min}$ | $J_2$ | G | $G_1$ | N | $N_1$ | $J_3$ | $J_4$ | $J_5$ | $J_6$ | $G_2$ | $G_3$ |
| – | mm | | | | | | kg/m | mm | | | | – | mm | | | mm | | | | – | mm |
| **LWRM 6** | 31 | 15 | 16,5 | | | 2 | 1,48 | 50 | 25 | 20 | 6 | M 6 | 5,2 | 9,5 | 5,2 | 8,5 | 7 | | | M 3 | 6 |
| **LWRV 6** | 31 | 15 | | 17,8 | 10,8 | 2 | 1,61 | 50 | 25 | 20 | 6 | M 6 | 5,2 | 9,5 | 5,2 | | | 7 | 6 | M 3 | 6 |
| **LWRM 9** | 44 | 22 | 23,1 | | | 2 | 3,14 | 100 | 50 | 20 | 9 | M 8 | 6,8 | 10,5 | 6,2 | 10 | 11 | | | M 5 | 8 |
| **LWRV 9** | 44 | 22 | | 26,9 | 16,6 | 2 | 3,71 | 100 | 50 | 20 | 9 | M 8 | 6,8 | 10,5 | 6,2 | | | 10 | 6 | M 5 | 8 |

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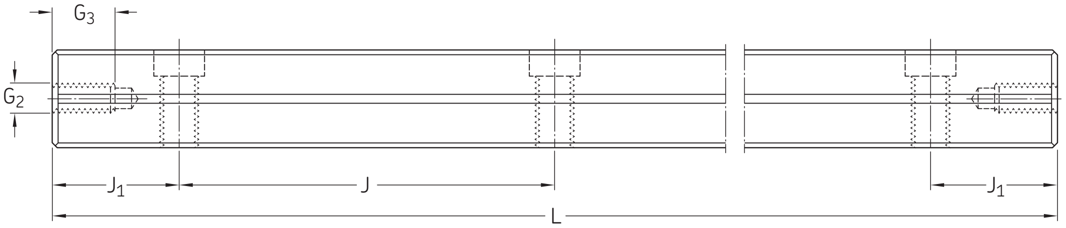
[1] Sizes LWRM/LWRV 12 and 15 are available on request.



LWRV

| Available lengths[1] | | | | | | | | | | | | | Maximum rail length |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 150 | 200 | 250 | 300 | 350 | 400 | 500 | 600 | 700 | 800 | 900 | 1 000 | |
| L | | | | | | | | | | | | | |
| mm | | | | | | | | | | | | | mm |
| ● | ● | ● | ● | ● | ○ | ● | ○ | ○ | ○ | | | | 1 200 |
| ● | ● | ● | ● | ● | ○ | ● | ○ | ○ | ○ | | | | 1 200 |
| | | ● | | ● | | ● | ● | ○ | ○ | ○ | ○ | ○ | 1 500 |
| | | ● | | ● | | ● | ● | ● | ● | ○ | ○ | ○ | 1 500 |

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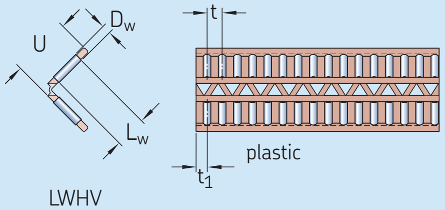
[1] Other rail lengths are available on request but new $J_1$ dimension has to be calculated as described in *chapter 3.1.7, Calculation of $J_1$ dimension.*

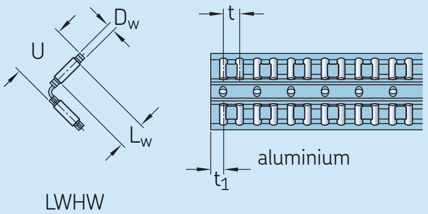
●) Prompt delivery

○) Delivery time on request

## Needle roller assemblies



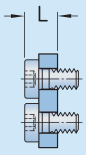
LWHV



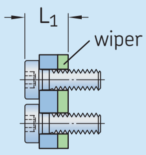
LWHW

| **Designation** | **Dimensions** | | | | | **Load ratings for a cage with 2 rows of 10 needles** dynamic | static | **Maximum cage length** | **Appropriate rail guide** |
|---|---|---|---|---|---|---|---|---|---|
| | $D_w$ | $L_w$ | U | t | $t_1$ | $C_{10}$ | $C_{0\,10}$ | | |
| – | mm | | | | | N | | mm | |
| **LWHV 10** | 2 | 4,8 | 10 | 3,75 | 2,7 | 10 400 | 25 500 | 50 000 | LWRM 6/LWRV 6 |
| **LWHW 10** | 2 | 4,8 | 10 | 3,75 | 2,7 | 10 400 | 25 500 | 2 000 | LWRM 6/LWRV 6 |
| **LWHV 15** | 2 | 7,8 | 15 | 3,75 | 2,7 | 16 300 | 45 000 | 50 000 | LWRM 9/LWRV 9 |
| **LWHW 15** | 2 | 6,8 | 15 | 4,5 | 3,5 | 14 600 | 42 500 | 2 000 | LWRM 9/LWRV 9 |

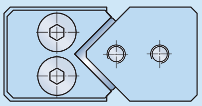
## LWRM / LWRV end pieces

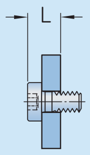


LWERM

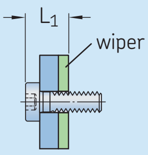


LWEARM

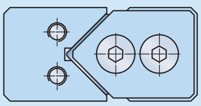




LWERV



LWEARV



| **Designation** End pieces | End pieces with wiper | **Dimensions** L | $L_1$ | **Attachment screw** DIN 7984 | **Appropriate rail guide** |
|---|---|---|---|---|---|
| – | | mm | | – | – |
| **LWERM 6** | | 4 | | M 3 | LWRM 6 |
| **LWERV 6** | | 4 | | M 3 | LWRV 6 |
| | **LWEARM 6** | | 6 | M 3 | LWRM 6 |
| | **LWEARV 6** | | 6 | M 3 | LWRV 6 |
| **LWERM 9** | | 6,5 | | M 5 | LWRM 9 |
| **LWERV 9** | | 6,5 | | M 5 | LWRV 9 |
| | **LWEARM 9** | | 8,5 | M 5 | LWRM 9 |
| | **LWEARV 9** | | 8,5 | M 5 | LWRV 9 |

# 2.6 LWM / LWV

## Rail guides

LWM/LWV rail guides enable linear guiding systems to be designed for heavy loads and with maximum rigidity. The internal geometry is identical with that of the Modular Range rails of the LWRM/LWRV series. As the same needle roller assembly is used, the load ratings are also the same. The external dimensions of the LWM/ LWV rail guides differ slightly from those of the LWRM/LWRV Modular Range dimensions. LWM/LWV rail guides are widely used, especially in the machine tool industry. As standard, they are supplied with mounting holes of type 15 (through hole with counter bore). If attachment hole type 13 is ordered, corresponding threaded inserts are supplied with the guide. Hole type 03, directly-machined thread with dimension G, is available on request. For new designs, LWRM/LWRV rail guides are recommended, and offer the advantage of being interchangeable with other rail guides of the Modular Range.

## Needle roller assemblies

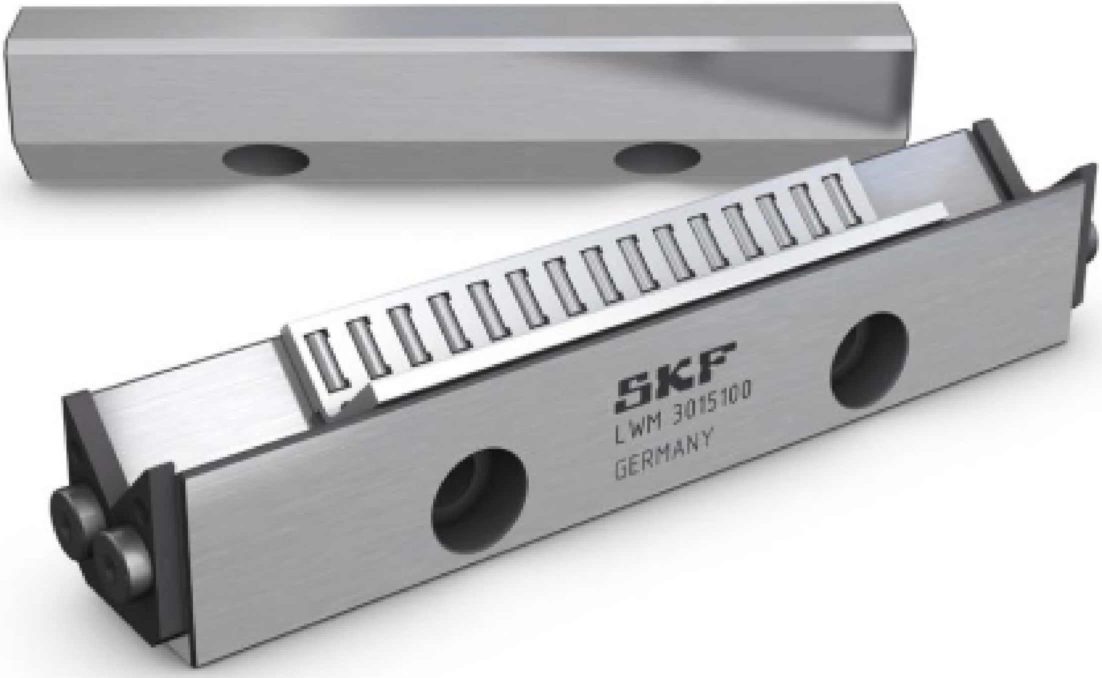
LWHW needle roller assemblies comprise an aluminium cage with needle rollers arranged at right angles to each other. The needle rollers are retained by the cage. LWHV needle roller assemblies, consisting of a plastic cage with retained needle rollers, are available in size LWHV15 and LWHV20.

## End pieces for LWM/LWV rail guides

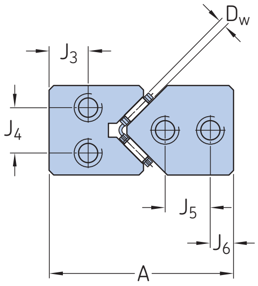
End pieces serve to prevent drift of the cage away from the loaded zone. Because of the design of LWM/LWV rail guides and the respective end pieces, only one rail, the M-shaped or the V-shaped, has to be equipped with end pieces. LWEAM and LWEAV end pieces have the addition of a plastic wiper with a sealing lip that keeps the raceway virtually free of dirt. All end pieces are supplied together with mounting screws.

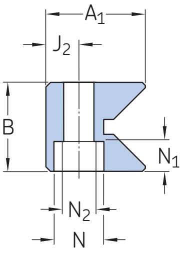
**Ordering example**

2x LWM 4020200
2x LWV 4020200
2x LWHW 15x130
4x LWEM 4020

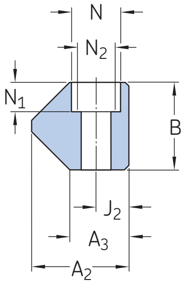


# LWM / LWV precision rail guides

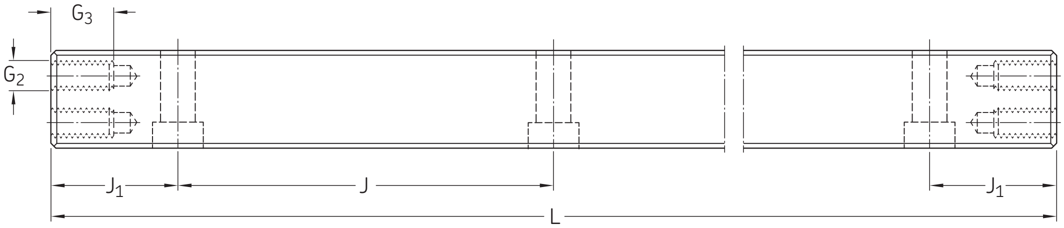




LWM
Hole type 15



LWV
Hole type 15

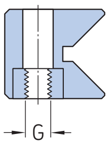


LWM

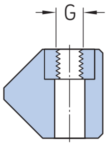
| **Designation** | **Dimensions** | | | | | | **Weight** | **Mounting holes** | | | | | | | **End face holes** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | $A_1$ | $A_2$ | $A_3$ | $D_w$ | | J[1] | $J_{1\ min}$[2] | $J_2$ | G | N | $N_1$ | $N_2$ | $J_3$ | $J_4$ | $J_5$ | $J_6$ | $G_2$ | $G_3$ |
| – | mm | | | | | | kg/m | mm | | | – | mm | | | mm | | | | – | mm |
| **LWM 3015** | 30 | 15 | 16 | | | 2 | 1,4 | 40 | 15 | 5,5 | M 4 | 8,5 | 4,5 | 5,25 | 8 | 7 | | | M 3 | 6 |
| **LWV 3015** | 30 | 15 | | 17,2 | 10,5 | 2 | 1,57 | 40 | 15 | 5,5 | M 4 | 8,5 | 4,5 | 5,25 | | | 7 | 5,5 | M 3 | 6 |
| **LWM 4020** | 40 | 20 | 22,3 | | | 2 | 2,75 | 80 | 20 | 7,5 | M 6 | 11,5 | 6,8 | 7,5 | 10 | 11 | | | M 5 | 7 |
| **LWV 4020** | 40 | 20 | | 22 | 13,5 | 2 | 2,74 | 80 | 20 | 7,5 | M 6 | 11,5 | 6,8 | 7,5 | | | 10,5 | 5,5 | M 5 | 7 |
| **LWM 5025** | 50 | 25 | 28 | | | 2 | 4,39 | 80 | 20 | 10 | M 6 | 11,5 | 6,8 | 7,5 | 12 | 13 | | | M 6 | 8 |
| **LWV 5025** | 50 | 25 | | 28 | 17 | 2 | 4,37 | 80 | 20 | 10 | M 6 | 11,5 | 6,8 | 7,5 | | | 13 | 7 | M 6 | 8 |
| **LWM 6035** | 60 | 35 | 36 | | | 2,5 | 7,23 | 100 | 25 | 11 | M 8 | 15 | 9 | 10 | 14 | 20 | | | M 6 | 8 |
| **LWV 6035** | 60 | 35 | | 36 | 20 | 2,5 | 7,57 | 100 | 25 | 11 | M 8 | 15 | 9 | 10 | | | 18 | 8 | M 6 | 8 |
| **LWM 7040** | 70 | 40 | 40 | | | 3 | 9,3 | 100 | 25 | 13 | M 10 | 18,5 | 11 | 12,5 | 16 | 20 | | | M 6 | 8 |
| **LWV 7040** | 70 | 40 | | 42 | 24 | 3 | 10,1 | 100 | 25 | 13 | M 10 | 18,5 | 11 | 12,5 | | | 20 | 10 | M 6 | 8 |
| **LWM 8050** | 80 | 50 | 45 | | | 3,5 | 13,4 | 100 | 25 | 14 | M 12 | 20 | 13 | 14 | 20 | 30 | | | M 6 | 8 |
| **LWV 8050** | 80 | 50 | | 48,5 | 26 | 3,5 | 14,3 | 100 | 25 | 14 | M 12 | 20 | 13 | 14 | | | 25 | 10 | M 6 | 8 |

---

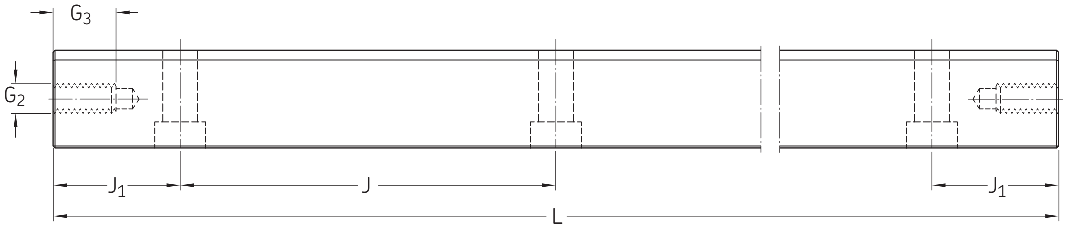
[1] For lengths $L < J+2 \times J_{1min}$ : J = 50 mm (except for LWM/LWV 3015)
[2] $J_1 = (L - \Sigma J) / 2$



LWM
Hole type 13



LWV
Hole type 13

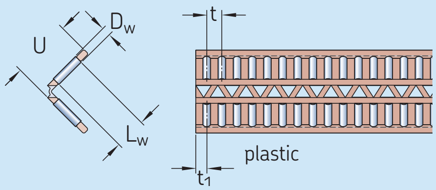


LWV

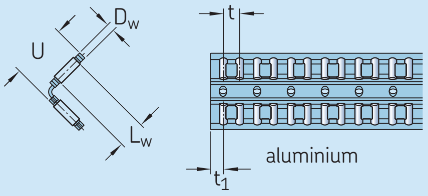
| **Available lengths**[1]<br>100<br>L | 150 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1 000 | **Maximum rail length** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | | | | | | | | | | | mm |
| ●[2] | ● | ● | ● | ● | ○ | ○ | | | | | 1 000 |
| ●[2] | ● | ● | ● | ● | ○ | ○ | | | | | 1 000 |
| ● | ● | ● | ● | ● | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |
| ● | ● | ● | ● | ● | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |
| ● | | ● | ● | ● | ● | ○ | ○ | ○ | ○ | ○ | 1 700 |
| ● | | ● | ● | ● | ● | ○ | ○ | ○ | ○ | ○ | 1 700 |
| | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |
| | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |
| | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |
| | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |
| | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |
| | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |

[1] Other rail lengths available on request
[2] J = 35 mm
●) Prompt delivery
○) Delivery time on request

## Needle roller assemblies



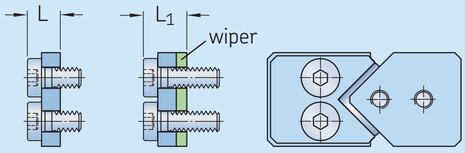
LWHV



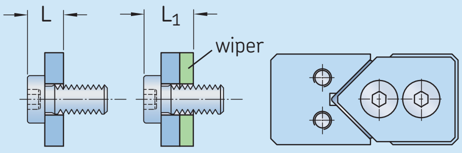
LWHW

| Designation | Dimensions | | | | | Load ratings for a cage with 2 rows of 10 needles | | Maximum cage length | Appropriate rail guide |
|---|---|---|---|---|---|---|---|---|---|
| | $D_w$ | $L_w$ | U | t | $t_1$ | dynamic $C_{10}$ | static $C_{0\,10}$ | | |
| – | mm | | | | | N | | mm | |
| **LWHV 10** | 2 | 4,8 | 10 | 3,75 | 2,7 | 10 400 | 25 500 | 50 000 | LWM/LWV 3015 |
| **LWHW 10** | 2 | 4,8 | 10 | 3,75 | 2,7 | 10 400 | 25 500 | 2 000 | LWM/LWV 3015 |
| **LWHV 15** | 2 | 7,8 | 15 | 3,75 | 2,7 | 16 300 | 45 000 | 50 000 | LWM/LWV 4020 + 5025 |
| **LWHW 15** | 2 | 6,8 | 15 | 4,5 | 3,5 | 14 600 | 42 500 | 2 000 | LWM/LWV 4020 + 5025 |
| **LWHV 20** | 2,5 | 11,8 | 20 | 5 | 3,7 | 32 000 | 88 000 | 50 000 | LWM/LWV 6035 |
| **LWHW 20** | 2,5 | 9,8 | 20 | 5,5 | 4 | 26 000 | 76 550 | 2 000 | LWM/LWV 6035 |
| **LWHW 25** | 3 | 13,8 | 25 | 6 | 4,5 | 43 100 | 129 400 | 2 000 | LWM/LWV 7040 |
| **LWHW 30** | 3,5 | 17,8 | 30 | 7 | 5 | 64 500 | 195 000 | 2 000 | LWM/LWV 8050 |

## LWM / LWV end pieces



LWEM LWEAM



LWEV LWEAV

| Designation End pieces | End pieces with wiper | Dimensions L | $L_1$ | Attachment screw DIN 7984 | Appropriate rail guide |
|---|---|---|---|---|---|
| – | | mm | | – | – |
| **LWEM 3015** | | 4 | | M 3 | LWM 3015 |
| **LWEV 3015** | | 4 | | M 3 | LWV 3015 |
| | **LWEAM 3015** | | 6 | M 3 | LWM 3015 |
| | **LWEAV 3015** | | 6 | M 3 | LWV 3015 |
| **LWEM 4020** | | 6,5 | | M 5 | LWM 4020 |
| **LWEV 4020** | | 6,5 | | M 5 | LWV 4020 |
| | **LWEAM 4020** | | 8,5 | M 5 | LWM 4020 |
| | **LWEAV 4020** | | 8,5 | M 5 | LWV 4020 |
| **LWEM/LWEV 5025 to 8050** | | 7 | | M 6 | LWM / LWV 5025 to 8050 |
| | **LWEAM/LWEAV 5025 to 8050** | | 9 | M 6 | LWM / LWV 5025 to 8050 |

# 2.7 LWM / LWV ACSZ

## Rail guides

LWM / LWV ACSZ rail guides are identical to LWM / LWV rail guides, but designed for use with anti-creeping LWHW ACSZ cages. For this purpose, both rails are equipped with gear racks made of steel. The cage carries two steel control gears that are always in mesh with the racks during operation, and help to ensure the right cage position. As standard, the rails are prepared for maximum stroke, with gear racks over the full rail length (→ *chapter 1.4*).

## Needle roller assemblies

In principle, LWHW ACSZ are the same as LWHW cages, whereby LWHW ACSZ needle roller cages incorporate two steel control gears located at the centre of the cage. The load carrying capacity of LWHW ACSZ cages is also identical with that of LWHW standard cages. ACSZ does not result in additional cage length. LWHW ACSZ needle roller assemblies comprise an aluminium cage with retained needle rollers.

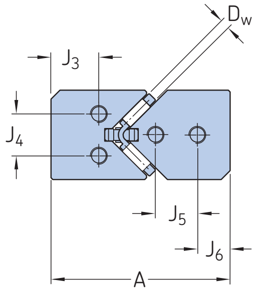
## End pieces

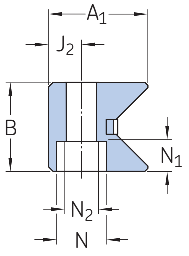
Generally, end pieces are not needed for LWM / LWV ACSZ rail guides, since cage-creeping is prevented by the ACSZ. For production reasons, the tapped holes on the rail's end face are standard, and most end pieces, as for LWM / LWV rail guides, can be used with the exception of LWEAV. If tapped holes on the end face are not required, the rails should be ordered with option "E1".

**Ordering example**

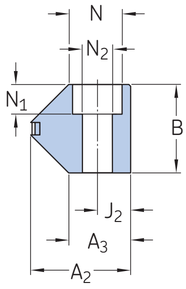
2x LWM 6035300 ACSZ
2x LWV 6035300 ACSZ
2x LWHW 20x220 ACSZ

# LWM / LWV ACSZ precision rail guides

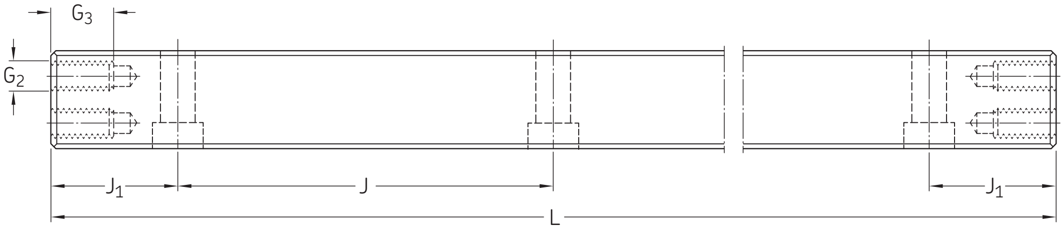




LWM ACSZ
Hole type 15



LWV ACSZ
Hole type 15



LWM ACSZ

| Designation | Dimensions | | | | | | Weight | Mounting holes | | | | | | | End face holes | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | $A_1$ | $A_2$ | $A_3$ | $D_w$ | | J[1] | $J_{1\,min}$[2] | $J_2$ | G | N | $N_1$ | $N_2$ | $J_3$ | $J_4$ | $J_5$ | $J_6$ | $G_2$ | $G_3$ |
| – | mm | | | | | | kg/m | mm | | | – | mm | | | mm | | | | – | mm |
| **LWM 3015 ACSZ** | 30 | 15 | 16 | | | 2 | 1,4 | 40 | 15 | 5,5 | M 4 | 8,5 | 4,5 | 5,25 | 8 | 7 | | | M 3 | 6 |
| **LWV 3015 ACSZ** | 30 | 15 | | 17,2 | 10,5 | 2 | 1,6 | 40 | 15 | 5,5 | M 4 | 8,5 | 4,5 | 5,25 | | | 7 | 5,5 | M 3 | 6 |
| **LWM 4020 ACSZ** | 40 | 20 | 22,3 | | | 2 | 2,8 | 80 | 20 | 7,5 | M 6 | 11,5 | 6,8 | 7,5 | 10 | 11 | | | M 5 | 7 |
| **LWV 4020 ACSZ** | 40 | 20 | | 22 | 13,5 | 2 | 2,8 | 80 | 20 | 7,5 | M 6 | 11,5 | 6,8 | 7,5 | | | 10,5 | 5,5 | M 5 | 7 |
| **LWM 5025 ACSZ** | 50 | 25 | 28 | | | 2 | 4,5 | 80 | 20 | 10 | M 6 | 11,5 | 6,8 | 7,5 | 12 | 13 | | | M 6 | 8 |
| **LWV 5025 ACSZ** | 50 | 25 | | 28 | 17 | 2 | 4,4 | 80 | 20 | 10 | M 6 | 11,5 | 6,8 | 7,5 | | | 13 | 7 | M 6 | 8 |
| **LWM 6035 ACSZ** | 60 | 35 | 36 | | | 2,5 | 7,3 | 100 | 25 | 11 | M 8 | 15 | 9 | 10 | 14 | 20 | | | M 6 | 8 |
| **LWV 6035 ACSZ** | 60 | 35 | | 36 | 20 | 2,5 | 7,6 | 100 | 25 | 11 | M 8 | 15 | 9 | 10 | | | 18 | 8 | M 6 | 8 |
| **LWM 7040 ACSZ** | 70 | 40 | 40 | | | 3 | 9,4 | 100 | 25 | 13 | M 10 | 18,5 | 11 | 12,5 | 16 | 20 | | | M 6 | 8 |
| **LWV 7040 ACSZ** | 70 | 40 | | 42 | 24 | 3 | 10,2 | 100 | 25 | 13 | M 10 | 18,5 | 11 | 12,5 | | | 20 | 10 | M 6 | 8 |
| **LWM 8050 ACSZ** | 80 | 50 | 45 | | | 3,5 | 13,5 | 100 | 25 | 14 | M 12 | 20 | 13 | 14 | 20 | 30 | | | M 6 | 8 |
| **LWV 8050 ACSZ** | 80 | 50 | | 48,5 | 26 | 3,5 | 14,4 | 100 | 25 | 14 | M 12 | 20 | 13 | 14 | | | 25 | 10 | M 6 | 8 |

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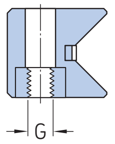
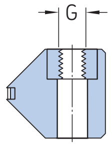
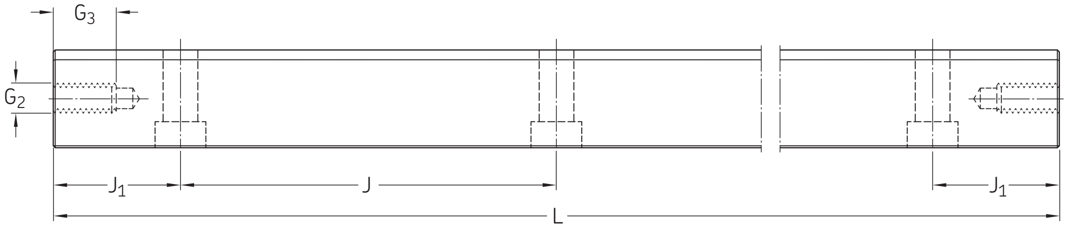
[1] For lengths $L < J+2 \times J_{1min}$ : J = 50 mm (except for LWM/LWV 3015)
[2] $J_1 = (L - \Sigma J) / 2$



LWM ACSZ
Hole type 13



LWV ACSZ
Hole type 13

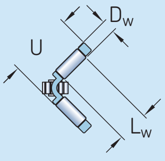


LWV ACSZ

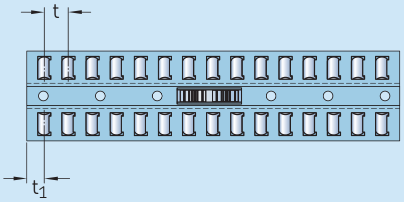
| Available lengths[1] | | | | | | | | | | | Maximum rail length |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 100<br>L | 150 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1 000 | |
| mm | | | | | | | | | | | mm |
| ○[2] | ○ | ○ | ○ | ○ | ○ | ○ | | | | | 1 000 |
| ○[2] | ○ | ○ | ○ | ○ | ○ | ○ | | | | | 1 000 |
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |
| ○ | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |
| ○ | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |
| | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |
| | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |
| | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |
| | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |
| | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |
| | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1 700 |

[1] Other rail lengths available on request
[2] J = 35 mm
●) Prompt delivery
○) Delivery time on request

## Needle roller assemblies

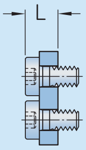


LWHW ACSZ

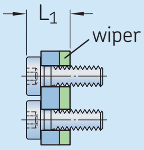


| Designation | Dimensions | | | | | Load ratings for a cage with 2 rows of 10 needles | | Maximum cage length | Appropriate rail guide |
|---|---|---|---|---|---|---|---|---|---|
| | $D_w$ | $L_w$ | U | t | $t_1$ | dynamic $C_{10}$ | static $C_{0\,10}$ | | |
| – | mm | | | | | N | | mm | |
| **LWHW 10 ACSZ** | 2 | 4,8 | 10 | 3,75 | 2,7 | 10 400 | 25 500 | 2 000 | LWM/LWV 3015 ACSZ |
| **LWHW 15 ACSZ** | 2 | 6,8 | 15 | 4,5 | 3,5 | 14 600 | 42 500 | 2 000 | LWM/LWV 4020 + 5025 ACSZ |
| **LWHW 20 ACSZ** | 2,5 | 9,8 | 20 | 5,5 | 4 | 26 000 | 76 550 | 2 000 | LWM/LWV 6035 ACSZ |
| **LWHW 25 ACSZ** | 3 | 13,8 | 25 | 6 | 4,5 | 43 100 | 129 400 | 2 000 | LWM/LWV 7040 ACSZ |
| **LWHW 30 ACSZ** | 3,5 | 17,8 | 30 | 7 | 5 | 64 500 | 195 000 | 2 000 | LWM/LWV 8050 ACSZ |

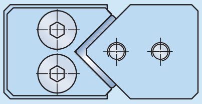
## LWM / LWV ACSZ end pieces

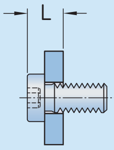


LWEM

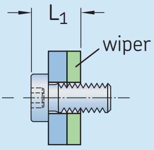


LWEAM

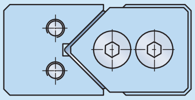




LWEV



LWEAV



| Designation End pieces | End pieces with wiper | Dimensions L | $L_1$ | Attachment screw DIN 7984 | Appropriate rail guide |
|---|---|---|---|---|---|
| – | | mm | | – | – |
| **LWEM 3015** | | 4 | | M 3 | LWM 3015 ACSZ |
| **LWEV 3015** | | 4 | | M 3 | LWV 3015 ACSZ |
| | **LWEAM 3015** | | 6 | M 3 | LWM 3015 ACSZ |
| **LWEM 4020** | | 6,5 | | M 5 | LWM 4020 ACSZ |
| **LWEV 4020** | | 6,5 | | M 5 | LWV 4020 ACSZ |
| | **LWEAM 4020** | | 8,5 | M 5 | LWM 4020 ACSZ |
| **LWEM/LWEV 5025 to 8050** | | 7 | | M 6 | LWM / LWV 5025 to 8050 ACSZ |
| | **LWEAM 5025 to 8050** | | 9 | M 6 | LWM / LWV 5025 to 8050 ACSZ |

# 2.8 LWRPM / LWRPV

## Rail guides

LWRPM/LWRPV rail guides are linear guides for limited travel, fitted with Turcite-B slide coating. Based on PTFE, this material is self-lubricating and offers excellent sliding properties. The coating is bonded to the non-hardened LWRPM rail and subsequently ground to size. Separate ordering of the slide coating is not required. The LWRPV rail is hardened and ground. In order to avoid damage to the sliding surface of the LWRPM rail, the LWRPV rail has a lead-in radius as standard. LWRPM/LWRPV rail guides should be used where rail guides with rolling element assemblies are unsuitable due to external influences, for example, extremely short strokes, high impact loads or dusty environment. The mounting and interface dimensions of the LWRPM/LWRPV rail guides conform to those of all the SKF Modular Range rail guides included in this catalogue. More details can be found in chapter “Technical data of precision rail guides with slide coating”.

LWRPM/LWRPV rail guides are characterised by:

- Stick-slip-free operation.
- Smooth running.
- Good emergency running properties.
- Low wear and high reliability.
- Resistance to contamination.
- Excellent vibration damping properties.

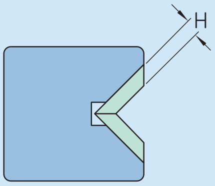
## End pieces

LWRPM/LWRPV rail guides normally do not require end pieces. For this reason, tapped holes on the end faces are also unnecessary. However, for production reasons, LWRPV rail guides will, in certain cases, be supplied with tapped holes.

**Ordering example:**

2 × LWRPM 6300
2 × LWRPV 6300

**LWRPM / LWRPV Slide coating**

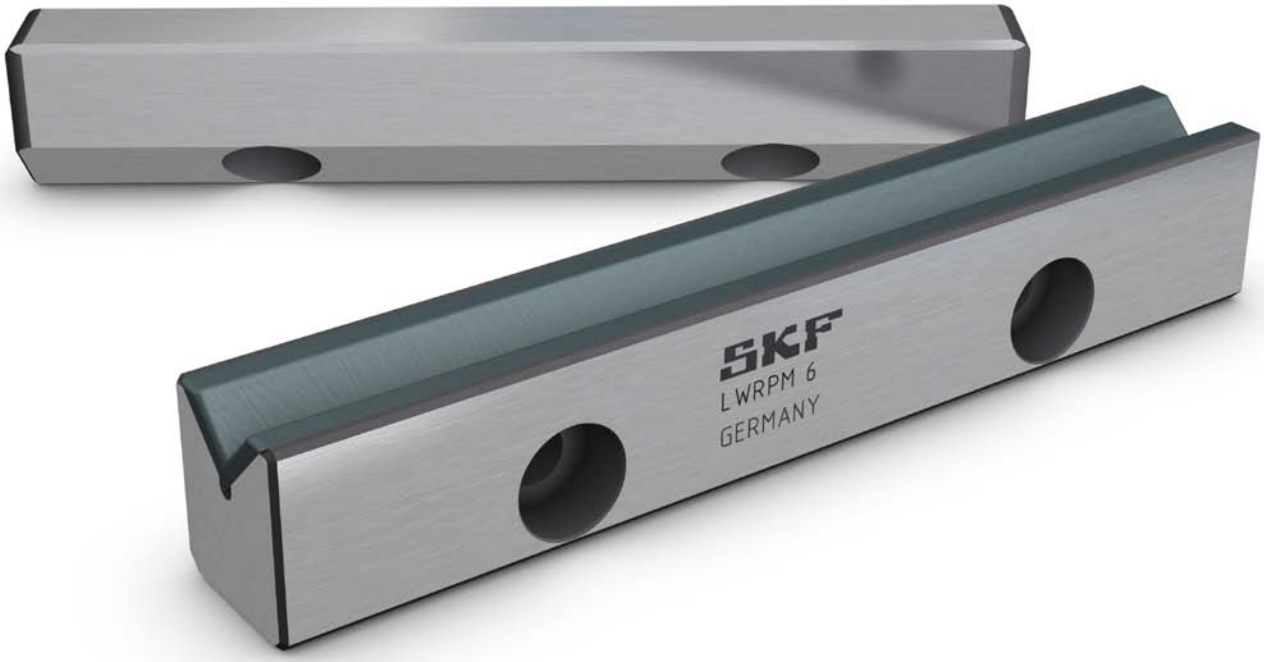


| Designation[1]<br>Rail guide | Dimensions<br>H | Load capacity[2]<br>C |
|---|---|---|
| – | mm | N / 100 mm |
| **LWRPM 3** | 0,7 | 300 |
| **LWRPM 6** | 1,7 | 700 |
| **LWRPM 9** | 1,7 | 1 200 |

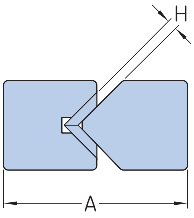
---

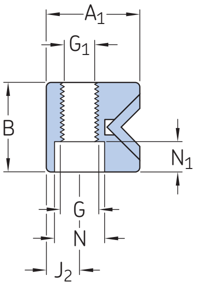
[1] The slide coating is an integral part of the LWRPM rail and does not have to be ordered separately.

[2] For a surface loading of approx. 1 N/mm² (momentary loads of up to 6 N/mm² are permissible).

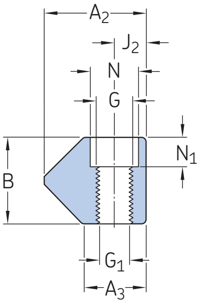


# LWRPM / LWRPV precision rail guides

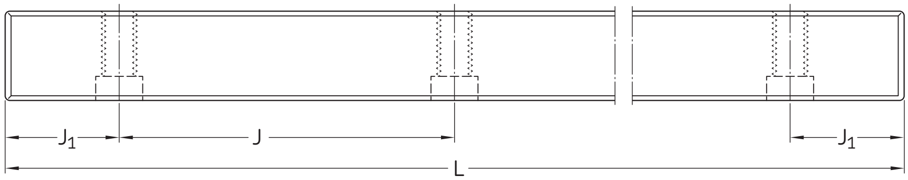




LWRPM



LWRPV



LWRPM

| Designation[1] | Dimensions | | | | | Weight | Mounting holes | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | A$_1$ | A$_2$ | A$_3$ | | J | J$_1$ | J$_{1\,min}$ | J$_2$ | G | G$_1$ | N | N$_1$ |
| – | mm | | | | | kg/m | mm | | | | – | mm | | |
| **LWRPM 3** | 18 | 8 | 9,5 | | | 0,49 | 25 | 12,5 | 5 | 3,5 | M 4 | 3,3 | 6 | 3,2 |
| **LWRPV 3** | 18 | 8 | | 9,6 | 6,45 | 0,48 | 25 | 12,5 | 5 | 3,5 | M 4 | 3,3 | 6 | 3,2 |
| **LWRPM 6** | 31 | 15 | 16,6 | | | 1,6 | 50 | 25 | 7 | 6 | M 6 | 5,2 | 9,5 | 5,2 |
| **LWRPV 6** | 31 | 15 | | 17,8 | 10,8 | 1,61 | 50 | 25 | 7 | 6 | M 6 | 5,2 | 9,5 | 5,2 |
| **LWRPM 9** | 44 | 22 | 23,1 | | | 3,35 | 100 | 50 | 7 | 9 | M 8 | 6,8 | 10,5 | 6,2 |
| **LWRPV 9** | 44 | 22 | | 26,9 | 16,6 | 3,71 | 100 | 50 | 7 | 9 | M 8 | 6,8 | 10,5 | 6,2 |

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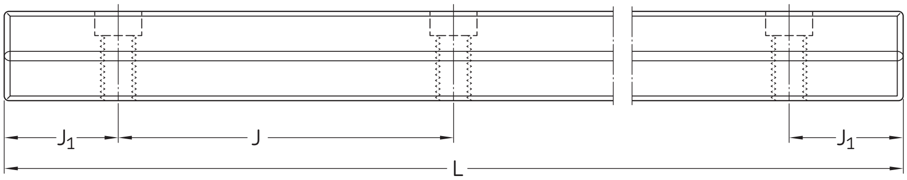
[1] Sizes LWRPM/LWRPV 12 and LWRPM/LWRPV 15 are available on request.



LWRPV

| Available lengths[1] | | | | | | | | | | | | | | | | | | | | | | Maximum rail length |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 50<br>L | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 350 | 400 | 450 | 500 | 550 | 600 | 650 | 700 | 800 | 900 | 1 000 | |
| mm | | | | | | | | | | | | | | | | | | | | | | mm |
| ● | ● | ● | ● | ● | ● | ● | ○ | ○ | ○ | ○ | | | | | | | | | | | | 400 |
| ● | ● | ● | ● | ● | ● | ● | ○ | ○ | ○ | ○ | | | | | | | | | | | | 400 |
| | ○ | ● | | ● | | ● | | ● | | ● | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | | | | 1 200 |
| | | ● | | ● | | ● | | ● | | ● | ○ | ● | ○ | ○ | ○ | ○ | ○ | ○ | | | | 1 200 |
| | | | | | | ● | | | | ● | | ● | | ● | | ○ | | ○ | ○ | ○ | ○ | 1 500 |
| | | | | | | ● | | | | ● | | ● | | ○ | | ○ | | ○ | ○ | ○ | ○ | 1 500 |

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[1] Other rail lengths are available on request but new $J_1$ dimension has to be calculated as described in *chapter 3.1.7, Calculation of $J_1$ dimension.*
●) Prompt delivery
○) Delivery time on request

# 2.9 Other products

Besides the standard product range, on request SKF can offer additional cages and guiding types, such as flat rail guides or wrap-around guidings. Also, completely customized guidings can be manufactured for applications that do not allow the use of standard products.

## 2.9.1 LWML / LWV

The LWML rail guide consists of a modified LWM rail guide with the addition of an integrated adjustment wedge (→ *chapter 3.1.10*, **fig. 6**). Used in conjunction with an LWV guide and a needle roller assembly, this provides a preload-adjustable guide system. Inclination of the wedge surface is 1,5%, so that a displacement of the wedge by 1 mm brings about a 15 µm alteration in the height. LWML rail guides are available in classes P10 and P5. When ordering, it should be specified whether the preloading threads are right-hand or left-hand threads.

## 2.9.2 LWN / LWO

LWN/LWO rail guides differ from the LWM/LWV rail guides only in height, width and attachment holes. The internal geometry of the two rail guide series is the same and their load ratings are identical. LWN/LWO rail guides are available in precision classes P10, P5 and P2.

## 2.9.3 LWJ / LWS flat rail guides

LWJ/LWS flat rail guides are used in conjunction with LWRM/LWRV, LWM/LWV or LWN/LWO rail guides as non-locating linear guides. They are incorporated in floating slides. LWJ/LWS flat rail guides, as well as the appropriate rolling element assemblies and end pieces, are available on request.

**Customised guidings**

With the knowledge and manufacturing capabilities existing within SKF, it is possible for SKF to produce completely customized guidings or other precision parts.

# 2.10 GCL / GCLA standard slides

GCL and GCLA are pre-assembled slides made of steel or aluminium, and crossed roller precision rail guides for applications that require maximum accuracy and rigidity. Typical applications are factory automation, printing, packaging and general machinery. GCL and GCLA standard slides are available on request.

Advantages:

- Top and base plate of a GCL are made of blackened steel or cast iron (depending on size) or aluminium for GCLA.
- Standard patterns of attachment holes for easy mounting.
- Upper and lower mounting surfaces are ground for high running accuracy.
- Reference edge parallel to the slide axis (opposite of preload set screws).
- Internal end stops to limit the stroke.
- Very low friction of the rail guides.
- Relubrication identical with precision rail guides, (→ *chapter 3.3*).

**GCL / GCLA data**

**Guidings:**

| | |
|---|---|
| GCL / GCLA 2 | LWRB 2 with LWJK 2 |
| GCL / GCLA 3 | LWR 3 with LWAK 3 |
| GCL / GCLA 6 | LWR 6 with LWAL 6 |
| GCL / GCLA 9 | LWR 9 with LWAL 9 |
| | Optional with anti creeping solution ACS/ACSM and / or coating |
| Operating temperature | –30 to +80 °C |
| Maximum speed | 2 m/s |
| Maximum acceleration | 25 m/s$^2$ |
| Friction coefficient | 0,003–0,005 (with normal, light lubrication) |
| Preload | Preloaded in factory with standard values |
| Precision class | P10 (other precision class on request) |
| Lubrication | Lightly greased on assembly |
| Optional | customized solutions possible |

**LGCL / GCLA running accuracy**

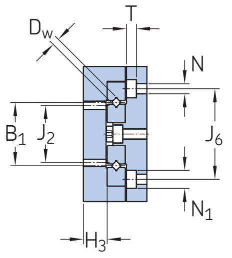
**GCL**

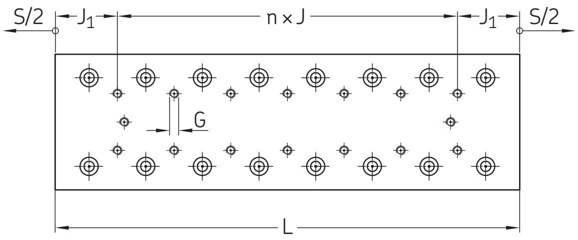
| Stroke (mm) | 25 | 50 | 100 | 200 | 300 |
|---|---|---|---|---|---|
| Straightness height $T_z$ | 2 µm | 2 µm | 3 µm | 3 µm | 4 µm |
| Straightness side $T_y$ | 2 µm | 2 µm | 2 µm | 3 µm | 3 µm |

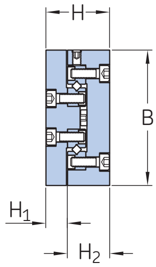
**GCLA**

| Stroke (mm) | 25 | 50 | 100 | 200 | 300 |
|---|---|---|---|---|---|
| Straightness height $T_z$ | 4 µm | 4 µm | 6 µm | 7 µm | 8 µm |
| Straightness side $T_y$ | 4 µm | 4 µm | 5 µm | 6 µm | 7 µm |

# GCL







| Designation[1] | Dimensions | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | –0,2<br>–0,4 | ±0,1 | | Stroke[2] | | | | | | | | | | |
| | B | H | L | $S_1$ | $S_2$ | $B_1$ | $D_w$ | G | $H_1$ | $H_2$ | $H_3$ | n × J | $J_1$ | $J_2$ |
| – | mm | | | | | | | – | mm | | | | | |
| **GCL 2030** | 40 | 21 | 35 | 18 | | 18 | 2 | M3 | 7 | 14 | 8 | | 17,5 | 15 |
| **GCL 2045** | | | 50 | 30 | | | | | | | | 1×15 | | |
| **GCL 2060** | | | 65 | 40 | 46 | | | | | | | 2×15 | | |
| **GCL 2075** | | | 80 | 50 | 60 | | | | | | | 3×15 | | |
| **GCL 2090** | | | 95 | 60 | 75 | | | | | | | 4×15 | | |
| **GCL 2105** | | | 110 | 70 | 90 | | | | | | | 5×15 | | |
| **GCL 2120** | | | 125 | 80 | 105 | | | | | | | 6×15 | | |
| **GCL 3050** | 60 | 28 | 55 | 30 | | 28 | 3 | M4 | 9 | 18,5 | 10 | | 27,5 | 25 |
| **GCL 3075** | | | 80 | 45 | 55 | | | | | | | 1×25 | | |
| **GCL 3100** | | | 105 | 60 | 80 | | | | | | | 2×25 | | |
| **GCL 3125** | | | 130 | 75 | 105 | | | | | | | 3×25 | | |
| **GCL 3150** | | | 155 | 90 | 130 | | | | | | | 4×25 | | |
| **GCL 3175** | | | 180 | 105 | 155 | | | | | | | 5×25 | | |
| **GCL 3200** | | | 205 | 130 | 180 | | | | | | | 6×25 | | |
| **GCL 6100** | 100 | 45 | 110 | 60 | 70 | 45 | 6 | M6 | 13 | 31 | 15,5 | | 55 | 50 |
| **GCL 6150** | | | 160 | 95 | 120 | | | | | | | 1×50 | | |
| **GCL 6200** | | | 210 | 130 | 170 | | | | | | | 2×50 | | |
| **GCL 6250** | | | 260 | 165 | 220 | | | | | | | 3×50 | | |
| **GCL 6300** | | | 310 | 200 | 270 | | | | | | | 4×50 | | |
| **GCL 6400** | | | 410 | 280 | 370 | | | | | | | 6×50 | | |
| **GCL 9200** | 145 | 60 | 210 | 130 | | 72 | 9 | M8 | 16 | 43 | 20,5 | | 105 | 80 |
| **GCL 9300** | | | 310 | 180 | | | | | | | | 1×100 | | |
| **GCL 9400** | | | 410 | 350 | | | | | | | | 2×100 | | |
| **GCL 9500** | | | 510 | 450 | | | | | | | | 3×100 | | |

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[1] Delivery time generally on request

[2] $S_1$ standard stroke order designation, e.g. GCL 2060,
$S_2$ extended stroke order designation, e.g. GCL 2060/L

[3] Take *chapter 1.7.2*, in consideration.

Fig. 1

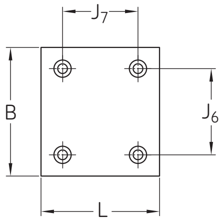


Fig. 2

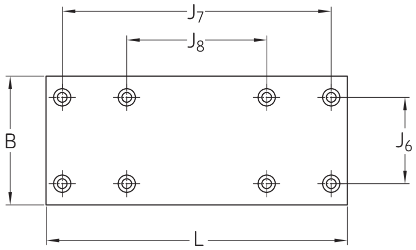


Fig. 3

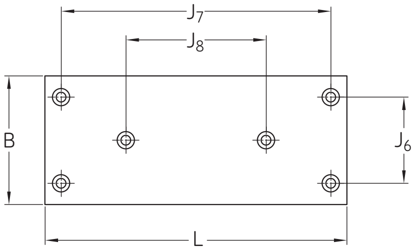
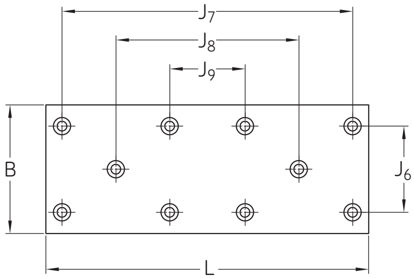
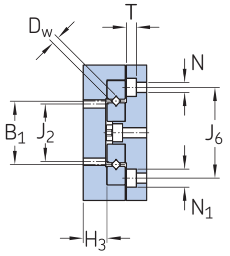


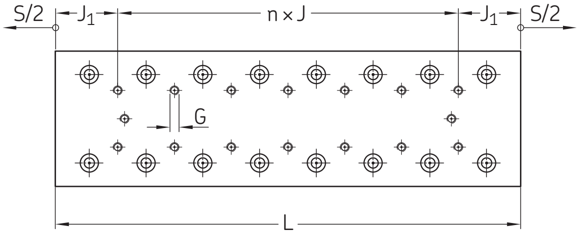
Fig. 4

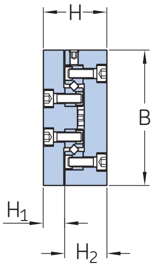


| | | | | | | | | **Effective dynamic load capacity of the slide** | | **Effective static load capacity of the slide**[3)] | | **Weight** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | with $S_1$ | with $S_2$ | with $S_1$ | with $S_2$ | |
| $J_6$ | $J_7$ | $J_8$ | $J_9$ | Fig | N | $N_1$ | T | $C_{\text{eff slide}}$ | | $C_{0\text{ eff slide}}$ | | |
| mm | | | | | | | | N | | N | | kg |
| 30 | 25 | | | 1 | 3 | 6 | 3 | 394 | | 360 | | 0,18 |
| | 40 | | | 1 | | | | 499 | | 504 | | 0,26 |
| | 55 | | | 1 | | | | 640 | 594 | 720 | 648 | 0,34 |
| | 70 | 40 | | 2 | | | | 769 | 684 | 936 | 792 | 0,42 |
| | 85 | 55 | | 2 | | | | 850 | 769 | 1 080 | 936 | 0,5 |
| | 100 | 70 | | 2 | | | | 966 | 850 | 1 296 | 1 080 | 0,58 |
| | 115 | 85 | | 2 | | | | 1 040 | 928 | 1 440 | 1 224 | 0,68 |
| 40 | 35 | | | 1 | 4,5 | 8 | 4,6 | 886 | | 960 | | 0,57 |
| | 60 | | | 1 | | | | 1 320 | 1 216 | 1 600 | 1 440 | 0,8 |
| | 85 | | | 1 | | | | 1 620 | 1 422 | 2 080 | 1 760 | 1 |
| | 110 | | | 1 | | | | 1 997 | 1 716 | 2 720 | 2 240 | 1,3 |
| | 135 | 85 | | 3 | | | | 2 267 | 1 905 | 3 200 | 2 560 | 1,5 |
| | 160 | 110 | | 3 | | | | 2 613 | 2 178 | 3 840 | 3 040 | 1,7 |
| | 185 | 135 | 85 | 4 | | | | 2 781 | 2 355 | 4 160 | 3 360 | 2 |
| 60 | 90 | | | 1 | 6,6 | 11 | 6,8 | 4 429 | 3 927 | 4 760 | 4 080 | 3,1 |
| | 140 | | | 1 | | | | 6 301 | 5 388 | 7 480 | 6 120 | 4,5 |
| | 190 | 90 | | 3 | | | | 7 606 | 6 744 | 9 520 | 8 160 | 5,9 |
| | 240 | 140 | | 3 | | | | 9 253 | 8 026 | 12 240 | 10 200 | 7,2 |
| | 290 | 190 | | 3 | | | | 10 435 | 9 253 | 14 280 | 12 240 | 8,6 |
| | 390 | 290 | | 3 | | | | 13 060 | 11 202 | 19 040 | 15 640 | 11,4 |
| 90 | 100 | | | 1 | 9 | 15 | 9 | 15 659 | | 16 470 | | 11,8 |
| | 200 | | | 1 | | | | 22 102 | | 25 620 | | 17,3 |
| | 300 | 100 | | 3 | | | | 23 324 | | 27 450 | | 22,8 |
| | 400 | 200 | | 3 | | | | 28 046 | | 34 770 | | 28,3 |

# GCLA







| Designation[1] | Dimensions<br>–0,2<br>–0,4 | ±0,1 | | Stroke[2] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B | H | L | $S_1$ | $S_2$ | $B_1$ | $D_w$ | G | $H_1$ | $H_2$ | $H_3$ | n × J | $J_1$ | $J_2$ |
| – | mm | | | | | | | – | mm | | | | | |
| **GCLA 2030** | 40 | 21 | 35 | 18 | | 18 | 2 | M3 | 7 | 14 | 8 | | 17,5 | 15 |
| **GCLA 2045** | | | 50 | 30 | | | | | | | | 1×15 | | |
| **GCLA 2060** | | | 65 | 40 | 46 | | | | | | | 2×15 | | |
| **GCLA 2075** | | | 80 | 50 | 60 | | | | | | | 3×15 | | |
| **GCLA 2090** | | | 95 | 60 | 75 | | | | | | | 4×15 | | |
| **GCLA 2105** | | | 110 | 70 | 90 | | | | | | | 5×15 | | |
| **GCLA 2120** | | | 125 | 80 | 105 | | | | | | | 6×15 | | |
| **GCLA 3050** | 60 | 25 | 55 | 30 | | 28 | 3 | M4 | 9 | 18,5 | 10 | | 27,5 | 25 |
| **GCLA 3075** | | | 80 | 45 | 55 | | | | | | | 1×25 | | |
| **GCLA 3100** | | | 105 | 60 | 80 | | | | | | | 2×25 | | |
| **GCLA 3125** | | | 130 | 75 | 105 | | | | | | | 3×25 | | |
| **GCLA 3150** | | | 155 | 90 | 130 | | | | | | | 4×25 | | |
| **GCLA 3175** | | | 180 | 105 | 155 | | | | | | | 5×25 | | |
| **GCLA 3200** | | | 205 | 130 | 180 | | | | | | | 6×25 | | |
| **GCLA 6100** | 100 | 40 | 110 | 60 | 70 | 45 | 6 | M6 | 13 | 31 | 15,5 | | 55 | 50 |
| **GCLA 6150** | | | 160 | 95 | 120 | | | | | | | 1×50 | | |
| **GCLA 6200** | | | 210 | 130 | 170 | | | | | | | 2×50 | | |
| **GCLA 6250** | | | 260 | 165 | 220 | | | | | | | 3×50 | | |
| **GCLA 6300** | | | 310 | 200 | 270 | | | | | | | 4×50 | | |
| **GCLA 6400** | | | 410 | 280 | 370 | | | | | | | 6×50 | | |
| **GCLA 9200** | 145 | 50 | 210 | 130 | | 72 | 9 | M8 | 16 | 43 | 20,5 | | 105 | 80 |
| **GCLA 9300** | | | 310 | 180 | | | | | | | | 1×100 | | |
| **GCLA 9400** | | | 410 | 350 | | | | | | | | 2×100 | | |
| **GCLA 9500** | | | 510 | 450 | | | | | | | | 3×100 | | |

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[1] Delivery time generally on request

[2] $S_1$ standard stroke order designation, e.g. GCLA 2060,
$S_2$ extended stroke order designation, e.g. GCLA 2060/L

[3] Take *chapter 1.7.2*, in consideration.

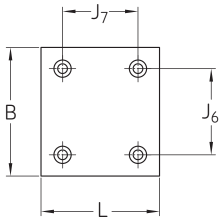


Fig. 1

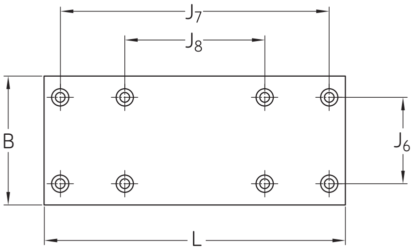


Fig. 2

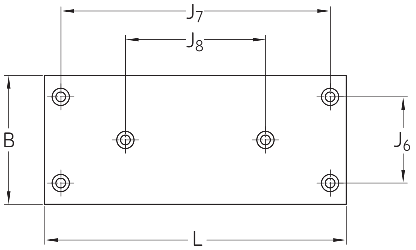


Fig. 3

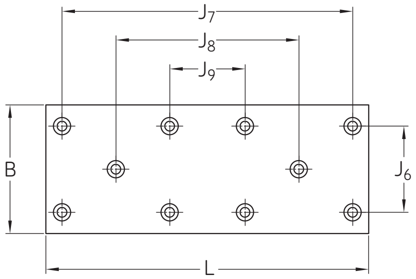


Fig. 4

| | | | | | | | | **Effective dynamic load capacity of the slide** | | **Effective static load capacity of the slide**3) | | **Weight** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | with $S_1$ | with $S_2$ | with $S_1$ | with $S_2$ | |
| $J_6$ | $J_7$ | $J_8$ | $J_9$ | Fig | N | $N_1$ | T | $C_{\text{eff slide}}$ | | $C_{\text{0 eff slide}}$ | | |
| mm | | | | | | | | N | | N | | kg |
| 30 | 25 | | | 1 | 3 | 6 | 3 | 394 | | 360 | | 0,11 |
| | 40 | | | 1 | | | | 499 | | 504 | | 0,15 |
| | 55 | | | 1 | | | | 640 | 594 | 720 | 648 | 0,19 |
| | 70 | 40 | | 2 | | | | 769 | 684 | 936 | 792 | 0,23 |
| | 85 | 55 | | 2 | | | | 850 | 769 | 1 080 | 936 | 0,27 |
| | 100 | 70 | | 2 | | | | 966 | 850 | 1 296 | 1 080 | 0,31 |
| | 115 | 85 | | 2 | | | | 1 040 | 928 | 1 440 | 1 224 | 0,35 |
| 40 | 35 | | | 1 | 4,5 | 8 | 4,6 | 886 | | 960 | | 0,29 |
| | 60 | | | 1 | | | | 1 320 | 1 216 | 1 600 | 1 440 | 0,42 |
| | 85 | | | 1 | | | | 1 620 | 1 422 | 2 080 | 1 760 | 0,55 |
| | 110 | | | 1 | | | | 1 997 | 1 716 | 2 720 | 2 240 | 0,68 |
| | 135 | 85 | | 3 | | | | 2 267 | 1 905 | 3 200 | 2 560 | 0,81 |
| | 160 | 110 | | 3 | | | | 2 613 | 2 178 | 3 840 | 3 040 | 0,94 |
| | 185 | 135 | 85 | 4 | | | | 2 781 | 2 355 | 4 160 | 3 360 | 1,1 |
| 60 | 90 | | | 1 | 6,6 | 11 | 6,8 | 4 429 | 3 927 | 4 760 | 4 080 | 1,5 |
| | 140 | | | 1 | | | | 6 301 | 5 388 | 7 480 | 6 120 | 2,3 |
| | 190 | 90 | | 3 | | | | 7 606 | 6 744 | 9 520 | 8 160 | 3 |
| | 240 | 140 | | 3 | | | | 9 253 | 8 026 | 12 240 | 10 200 | 3,8 |
| | 290 | 190 | | 3 | | | | 10 435 | 9 253 | 14 280 | 12 240 | 4,5 |
| | 390 | 290 | | 3 | | | | 13 060 | 11 202 | 19 040 | 15 640 | 6 |
| 90 | 100 | | | 1 | 9 | 15 | 9 | 15 659 | | 16 470 | | 5,9 |
| | 200 | | | 1 | | | | 22 102 | | 25 620 | | 8,7 |
| | 300 | 100 | | 3 | | | | 23 324 | | 27 450 | | 11,4 |
| | 400 | 200 | | 3 | | | | 28 046 | | 34 770 | | 14,2 |

# 2.11 LZM miniature slide

With the LZM miniature slide product range, SKF offers the ideal solution for linear motion applications with short strokes and compact boundary dimensions. The use of miniature slides has significantly increased in medical applications, measurement technologies and micro mechanics and assembly.

The various LZM miniature slide components are designed to meet the highest precision standards. LZM miniature slides feature high running accuracy and smooth motion, and are manufactured with all-stainless-steel components. The maximum value for parallelism between the raceways and the mounting surface is 3 µm. Optimized hardness enables long service life and high performance within compact boundary dimensions.

Ease of installation is another positive feature of LZM miniature slides. Unlike crossed roller systems using 4 rails and 2 cages to be assembled on the production floor, the LZM miniature slide provides a complete slide that can simply be bolted into place without the use of precision devices to set preload.

Customized miniature slides are also possible, and SKF will modify existing designs to meet specific technical requirements. Wide versions of LZMs for higher torque loads can also be supplied on request. Wide versions of LZMs for higher torque loads, comparable with wide miniature profile rail guides LLMWS, can also be supplied on request.

**Applications:**

- Pneumatics
- Semi-conductor manufacturing
- Medical
- Micro- and electronics assembly
- Measurement applications
- Fibre optics

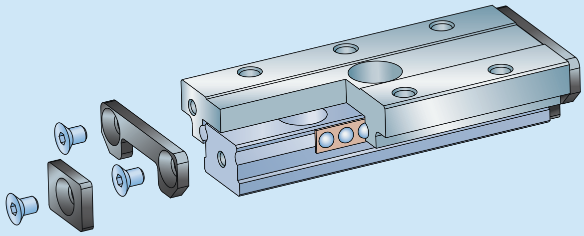
**Advantages:**

- Compact design
- High load capacity
- Very good running accuracy
- Smooth running
- High rigidity
- Easy assembly

**Ordering example**

- LZMHS 9 – 26
  (P5, T0 as standard – no need to specify)
- LZMHS 9 – 26 T2 P1

## LZM data



### LZM technical data

| | |
|---|---|
| **Design** | Four point contact with identical load angles |
| Standard range | Four sizes: 7, 9, 12 and 15 |
| Optional range | Wide versions for 9, 12 and 15 |
| Operating temperature | –20 up to +80 °C |
| Max. speed | 3 m/s |
| Max. acceleration | 80 m/s$^2$ (for preloaded LZMs) |
| Preload classes | T0 = light clearance; Standard<br>T1 = zero play to light preload<br>T2 = preloaded |
| Precision classes | P5 = standard<br>P1 = high |
| Lubrication | Slides are pre-lubricated with ”Paraliq P460” |

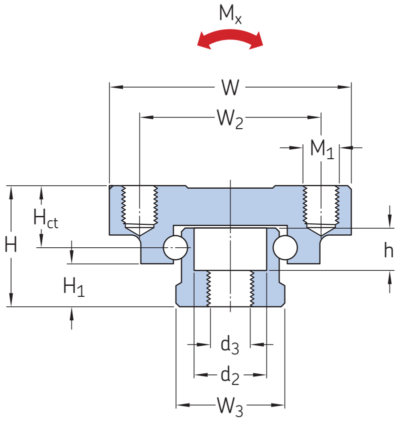
### Material specifications

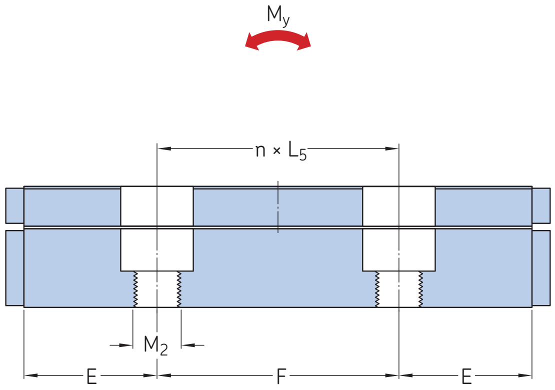
| | |
|---|---|
| Carriage and rail | Steel 1.4034 / 1.4037 |
| Balls | Steel 1.3541 |
| End pieces | Plastic |
| Cage | Plastic |

## Dimensional tolerance of H

| Precision class | mm |
|---|---|
| P5 | +–0,02 |
| P1 | +–0,01 |

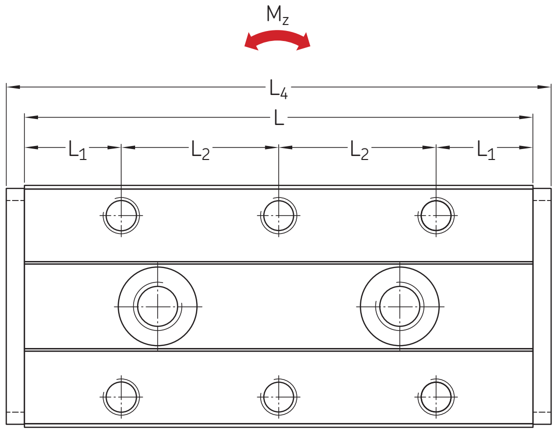
# LZM miniature slides





| Designation | Dimensions | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | $L_1$ | $L_2$ | $L_4$ | n × $L_5$[1] | W | $W_2$ | $W_3$ | H | $H_1$ | $M_1$ × depth | Number of threads $M_1$ |
| – | mm | | | | | | | | | | | |
| **LZM HS 7 – 26** | 26 | 5 | 8 | 29 | – | 17 | 12 | 7 | 8 | 2,35 | M2 × 2,5 | 6 |
| **LZM HS 7 – 34** | 34 | 5 | 8 | 37 | 0 | 17 | 12 | 7 | 8 | 2,35 | M2 × 2,5 | 8 |
| **LZM HS 7 – 50** | 50 | 5 | 8 | 53 | 30 | 17 | 12 | 7 | 8 | 2,35 | M2 × 2,5 | 12 |
| **LZM HS 7 – 66** | 66 | 5 | 8 | 69 | 30 | 17 | 12 | 7 | 8 | 2,35 | M2 × 2,5 | 16 |
| **LZM HS 9 – 32** | 32 | 9,5 | 13 | 35 | – | 20 | 15 | 9 | 10 | 3,55 | M3 × 3 | 4 |
| **LZM HS 9 – 42** | 42 | 8 | 13 | 45 | 0 | 20 | 15 | 9 | 10 | 3,55 | M3 × 3 | 6 |
| **LZM HS 9 – 55** | 55 | 8 | 13 | 58 | 20 | 20 | 15 | 9 | 10 | 3,55 | M3 × 3 | 8 |
| **LZM HS 9 – 81** | 81 | 8 | 13 | 84 | 2×20 | 20 | 15 | 9 | 10 | 3,55 | M3 × 3 | 12 |
| **LZM HS 9 – 94** | 94 | 8 | 13 | 97 | 3×20 | 20 | 15 | 9 | 10 | 3,55 | M3 × 3 | 14 |
| **LZM HS 12 – 37** | 37 | 11 | 15 | 40 | – | 27 | 20 | 12 | 13 | 4,7 | M3 × 3,5 | 4 |
| **LZM HS 12 – 51** | 51 | 10,5 | 15 | 54 | 0 | 27 | 20 | 12 | 13 | 4,7 | M3 × 3,5 | 6 |
| **LZM HS 12 – 66** | 66 | 10,5 | 15 | 69 | 25 | 27 | 20 | 12 | 13 | 4,7 | M3 × 3,5 | 8 |
| **LZM HS 12 – 96** | 96 | 10,5 | 15 | 99 | 50 | 27 | 20 | 12 | 13 | 4,7 | M3 × 3,5 | 12 |
| **LZM HS 12 – 126** | 126 | 10,5 | 15 | 129 | 3×25 | 27 | 20 | 12 | 13 | 4,7 | M3 × 3,5 | 16 |
| **LZM HS 15 – 52** | 52 | 16 | 20 | 56 | – | 32 | 25 | 15 | 16 | 6 | M3 × 4 | 4 |
| **LZM HS 15 – 85** | 85 | 12,5 | 20 | 89 | 0 | 32 | 25 | 15 | 16 | 6 | M3 × 4 | 8 |
| **LZM HS 15 – 105** | 105 | 12,5 | 20 | 109 | 40 | 32 | 25 | 15 | 16 | 6 | M3 × 4 | 10 |
| **LZM HS 15 – 165** | 165 | 12,5 | 20 | 169 | 80 | 32 | 25 | 15 | 16 | 6 | M3 × 4 | 16 |

[1] – means no hole; $L_5$ = 0 means one hole in the center



| E | F | $d_3 \times d_2 \times h$ | $M_2$ | Number of threads $M_2$ | Max. stroke | C | $C_0$ | $M_{yCo}$ / $M_{zCo}$ | $M_{xCo}$ | $H_{ct}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| mm | | | – | mm | | | | | | mm |
| 5,5 | 15 | 2,5 × 4,5 × 2,5 | M3 | 2 | 24 | 700 | 1 100 | 3,5 | 6 | 4,62 |
| 9,5 | 15 | 2,5 × 4,5 × 2,5 | M3 | 2 | 34 | 900 | 1 400 | 5,5 | 7 | 4,62 |
| 10 | 15 | 2,5 × 4,5 × 2,5 | M3 | 3 | 50 | 1 100 | 2 000 | 12 | 10 | 4,62 |
| 10,5 | 15 | 2,5 × 4,5 × 2,5 | M3 | 4 | 66 | 1 400 | 2 700 | 21 | 14 | 4,62 |
| 6 | 20 | 3,5 × 6,5 × 3,5 | M4 | 2 | 28 | 1 200 | 1 800 | 7 | 12 | 5,12 |
| 11 | 20 | 3,5 × 6,5 × 3,5 | M4 | 2 | 40 | 1 400 | 2 100 | 11 | 15 | 5,12 |
| 7,5 | 20 | 3,5 × 6,5 × 3,5 | M4 | 3 | 54 | 1 900 | 3 400 | 18 | 19 | 5,12 |
| 10,5 | 20 | 3,5 × 6,5 × 3,5 | M4 | 4 | 78 | 2 500 | 4 900 | 43 | 29 | 5,12 |
| 7 | 20 | 3,5 × 6,5 × 3,5 | M4 | 5 | 92 | 2 700 | 5 500 | 57 | 33 | 5,12 |
| 6 | 25 | 3,5 × 6,5 × 4,5 | M4 | 2 | 32 | 2 200 | 3 300 | 11 | 21 | 6,5 |
| 13 | 25 | 3,5 × 6,5 × 4,5 | M4 | 2 | 47 | 2 600 | 4 300 | 22 | 28 | 6,5 |
| 8 | 25 | 3,5 × 6,5 × 4,5 | M4 | 3 | 62 | 3 000 | 5 300 | 36 | 36 | 6,5 |
| 10,5 | 25 | 3,5 × 6,5 × 4,5 | M4 | 4 | 95 | 3 800 | 7 200 | 76 | 52 | 6,5 |
| 13 | 25 | 3,5 × 6,5 × 4,5 | M4 | 5 | 122 | 4 700 | 9 700 | 131 | 68 | 6,5 |
| 6 | 40 | 3,5 × 6,5 × 4,5 | M4 | 2 | 50 | 2 800 | 3 900 | 25 | 42 | 7,65 |
| 22,5 | 40 | 3,5 × 6,5 × 4,5 | M4 | 2 | 80 | 4 600 | 7 800 | 73 | 70 | 7,65 |
| 12,5 | 40 | 3,5 × 6,5 × 4,5 | M4 | 3 | 102 | 5 100 | 9 100 | 106 | 84 | 7,65 |
| 22,5 | 40 | 3,5 × 6,5 × 4,5 | M4 | 4 | 162 | 7 300 | 15 000 | 264 | 131 | 7,65 |

# 3 Recommendations

## 3.1 Design rules

### 3.1.1 Designated use

- SKF precision rail guide systems must only be used for linear movement of loads that do not give off emissions which could pose a danger to the system, and that do not overload the rail guides.
- SKF precision rail guide systems must not be used in outdoor, wet or explosive areas.
- End pieces must not be used as a mechanical stroke limitation of the rail guide system, as this can result in cage damage.

### 3.1.2 Typical mounting – clamped arrangement

The most common way to design a precision rail guide system is the clamped arrangement, as it has several advantages. Alternatively or for other designs the floating arrangement exists. Both versions are explained more detailed in *chapter 1.8.4*.

### 3.1.3 Accuracy of mounting surfaces

An important criteria for correct performance of a rail guide system is accuracy of the mounting surfaces. The higher the demand for accuracy of the guidings and for smooth, easy operation, the greater is the requirement for accuracy of form and position of the counterparts. Values for surface roughness, perpendicularity and parallelism of the mounting surfaces are shown for each precision class in **fig. 1** and **table 1**. The values for perpendicularity are given in relation to the relevant height of the mounting surface. To ensure an even load distribution over the full length of the rolling element, the maximum difference in height of the mounting surfaces should not exceed Δh.

$$\Delta h = 0{,}1 \times B_1$$

$\Delta h$ = maximum height deviation [µm]
$B_1$ = mean distance between rolling element assemblies [mm]

**Fig. 1**

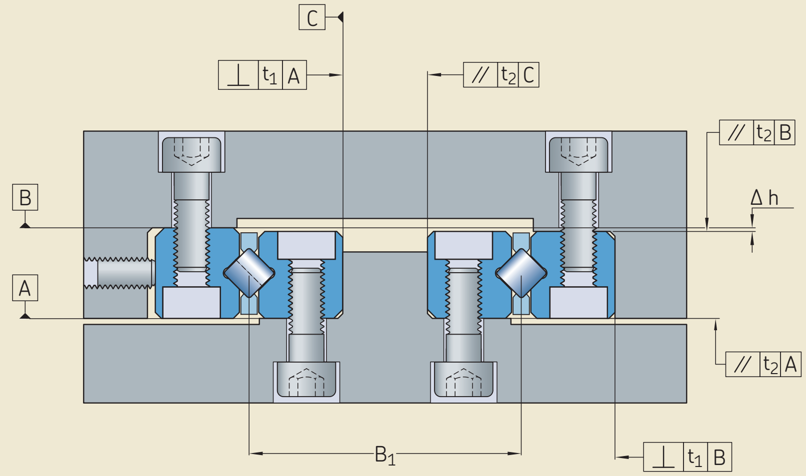


**Table 1**

**Accuracy of form for mounting surfaces**

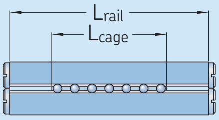
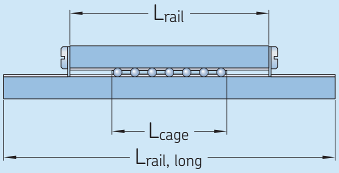
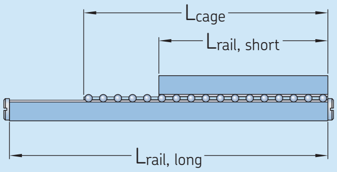
| Characteristic | Symbol | Tolerance | Dimension | Permissible form-deviation for precision class | | |
|---|---|---|---|---|---|---|
| | | | | P10 | P5 | P2 |
| Roughness $R_a$ | √ | | µm | 1,6 | 0,8 | 0,2 |
| Perpendicularity | ⊥ | | | | | |
| for crossed rollers and balls | | $t_1$ | µm/mm | 0,3 | 0,3 | 0,3 |
| for needle rollers | | $t_1$ | µm/mm | 0,1 | 0,1 | 0,1 |
| Parallelism for | // | | | | | |
| rail length ≤ = 200 mm | | $t_2$ | µm | 3 | 2 | 1 |
| rail length ≤ = 500 mm | | $t_2$ | µm | 6 | 4 | 2 |
| rail length ≤ = 1 000 mm | | $t_2$ | µm | 10 | 6 | 3 |

## 3.1.4 End pieces logic

Together with the different kinematics, also the end pieces have to be selected accordingly. **Table 2** shows the logic.

**Table 2**

**End pieces logic**

| **Description of kinematic** | | **Not overrunning rail guide without wipers (Standard)** | **Rail guide with wipers** | | **Overrunning rail guide without wipers** | |
|---|---|---|---|---|---|---|
| | |  |  | |  | |
| **Type of rail** | **Type of ACS** | | Long rail | Short rail | Long rail | Short rail |
| LWR<br>LWRB<br>LWRE | no | with end pieces | without end pieces | with end pieces and wipers | with end pieces | without end pieces |
| LWRE | ACS | end pieces not needed, but front face of rails equipped with mounting threads. So end pieces mountable by customer. | without end pieces | with end pieces and wipers | end pieces not needed, but front face of rails equipped with mounting threads. So end pieces mountable by customer. | without end pieces |
| LWRE | ACSM | without end pieces | without end pieces | with end pieces and wipers | without end pieces | without end pieces |
| LWM / V<br>LWRM / V | no | with end pieces on one rail only (on M- or V-shaped rail) | without end pieces | with end pieces and wipers | with end pieces | without end pieces |
| LWM / V | ACSZ | end pieces not needed, but front face of rails equipped with mounting threads. So end pieces mountable by customer. | without end pieces | with end piece and wipers mounted at the rail with<br>– M-shaped cross section: o.k.<br>– V-shaped cross section: not feasible | end pieces not needed, but front face of rails equipped with mounting threads. So end pieces mountable by customer. | without end pieces |

☐ Can not be changed

▨ Can be changed on request

## 3.1.5 Chamfers on the precision rail guides

For the design of surrounding parts, the tolerance of the chamfer between the two reference surfaces of the precision rail guide must be taken into account. The value c is depending on the rail width B (→ **fig. 2**).

Rail width B ≤ 8 mm: c = 0,4 mm
Rail width B > 8 mm: c = 0,7 mm

## 3.1.6 Tolerance of distance between mounting holes

The tolerance of distance between the mounting holes depends on the rail length $L_{rail}$, which has an impact on possible thermal expansion during heat treatment. The values shown below are valid for all mounting holes along the rail. Rails with tighter tolerances for the distance between the holes can be supplied on request. For long rails, the use of special mounting screws (LWGD) is recommended (→ **fig. 3**).

$L_{rail} \leq 300$: t = 0,6 mm
$L_{rail} > 300$: t = 0,0016 mm × $L_{rail}$

## 3.1.7 Calculation of $J_1$ dimension

Usually the $J_1$ dimension is chosen symmetrically on both rail ends. If so, the symmetric $J_1$ dimension can be calculated with the following formula. The minimum of $J_1$, $J_{1\,min}$, is stated in the product tables and has to be taken in consideration.

If an unsymmetric $J_1$ dimension is needed it can be stated in the ordering code by using the definition of $J_1$ as shown in figure "$J_1$ unsymmetrical" (→ **fig. 4**).

$$J_1 = \frac{L - \Sigma J}{2}$$

**Fig. 2**

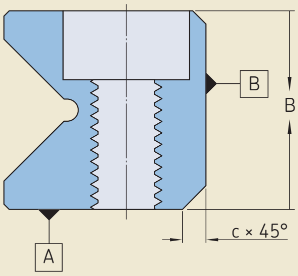


**Fig. 3**

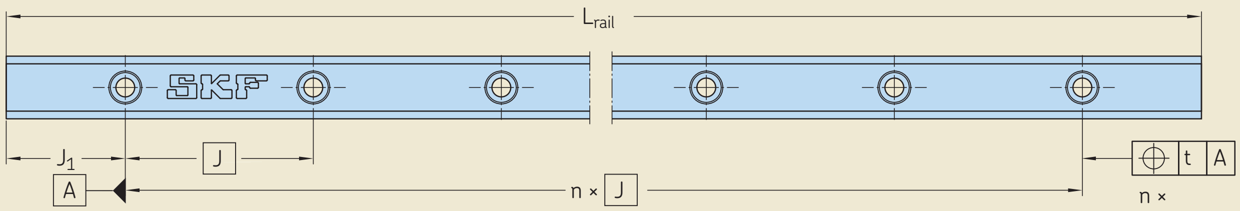
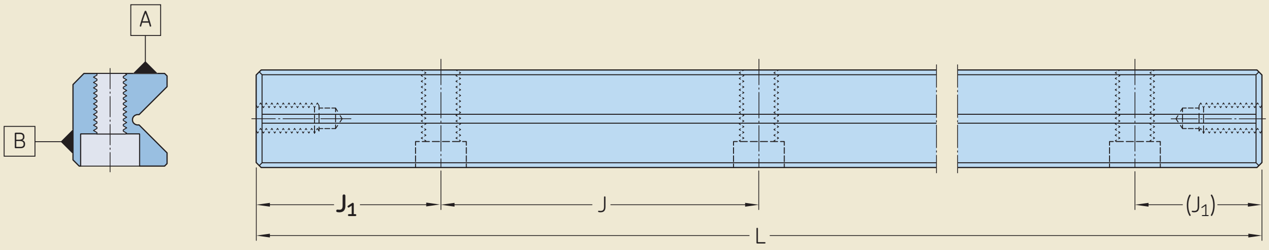


**Fig. 4**

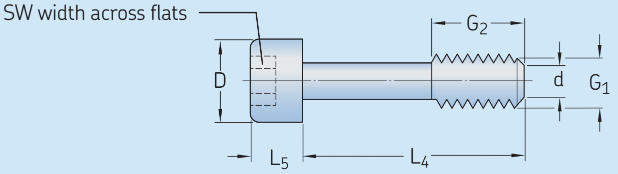


## 3.1.8 Special mounting screws LWGD

Special mounting screws LWGD help to compensate for manufacturing tolerances. The screw strength class is 8.8. All dimensions are given in (→ **table 3**).

**Table 3**

**LWGD special mounting screws**



| **Designation**[1] | **Dimensions** | | | | | | | **Appropriate rail guide** | **Size** |
|---|---|---|---|---|---|---|---|---|---|
| – | G1 | G2 | L4 | L5 | D | d | SW | – | – |
| **LWGD 3** | M3 | 5 | 12 | 3 | 5 | 2,3 | 2,5 | LWR<br>LWRE<br>LWRM, LWRV<br>LWRPM, LWRPV | 3 |
| **LWGD 4** | M3 | 5 | 16 | 3 | 5 | 2,3 | 2,5 | | 4 |
| **LWGD 2211** | M4 | 5 | 14 | 4 | 6 | 3 | 3 | | 2211 |
| **LWGD 6** | M5 | 8 | 20 | 5 | 8 | 3,9 | 4 | | 6 |
| **LWGD 9** | M6 | 12 | 30 | 6 | 8,5 | 4,6 | 5 | | 9 |
| **LWGD 12** | M8 | 17 | 40 | 8 | 11,3 | 6,25 | 6 | | 12 |
| **LWGD 4020** | M6 | 14 | 16 | 5 | 8 | 3,9 | 4 | LWM, LWV | 4020 |
| **LWGD 5025** | M6 | 14 | 21 | 5 | 8 | 3,9 | 4 | | 5025 |
| **LWGD 6035** | M8 | 15 | 30 | 6 | 8,5 | 4,6 | 5 | | 6035 |
| **LWGD 7040** | M10 | 17 | 33 | 8 | 11,3 | 6,3 | 6 | | 7040 |
| **LWGD 8050** | M12 | 19 | 41 | 12 | 15,8 | 9,6 | 10 | | 8050 |

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[1] other sizes are available on request.

## 3.1.9 Preloading

Precision rail guides with rolling elements and in clamped arrangement should always be mounted without clearance and thus with a certain preload. Preloading enhances the rigidity of the system as well as the running accuracy. Peaks of load at the end of the cages, caused by torque load $M_y$ and $M_z$ are consequently decreased.

The magnitude of the adjustable preload depends on the actual application and can be up to 20% of the dynamic load carrying capacity of the rail guide. The presence of preload means that the load acting on the rolling elements must be reduced, and this should be taken into consideration when the operating conditions require high preload. Associated components need corresponding stiffness.

Rail guides can be preloaded in many ways. Some examples are shown in (→ **fig. 5** to **7**). The most common method is the use of set screws for adjustment. The number of these screws should at least be equal to the mounting holes in the rail. Experience is needed to use this method successfully, in order to avoid “pinching” the rail assembly. **Table 4** gives approximate values for a good running precision rail guide system with a balance of rigidity and friction.

Preloading of rolling assemblies with any ACS system is done using the same values.

The use of adjustment bars or adjustment wedges is recommended in cases where large preloads are required or where high demands are placed on running accuracy. For needle roller cages, SKF can offer the LWML rail, which is equipped with a built-in adjustment wedge.

## 3.1.10 Tightening torques for mounting screws

Depending on the material of the adjacent components and the screw size, different values of tightening torques have to be used for mounting a precision rail guide (→ **table 5**). Given values are also valid for the special mounting screws LWGD.

**Fig. 5**

**Preloading with set screws**

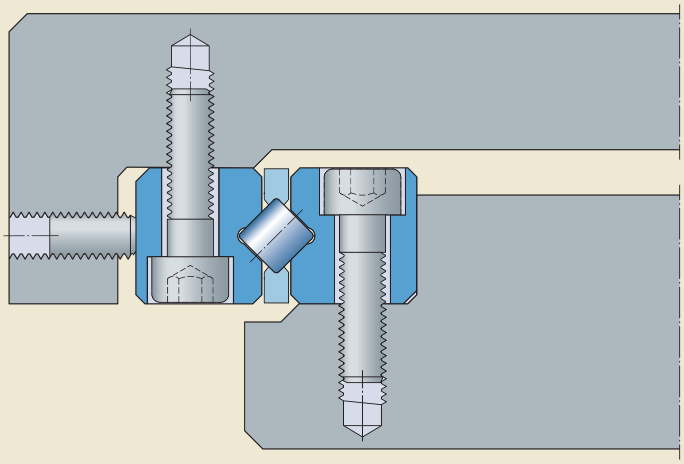


**Fig. 6**

**Preloading with LWML rail**

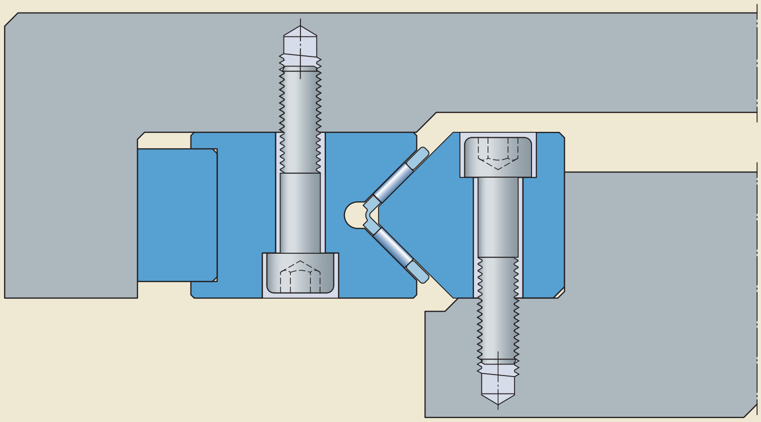


**Fig. 7**

**Preloading with lateral wedge**

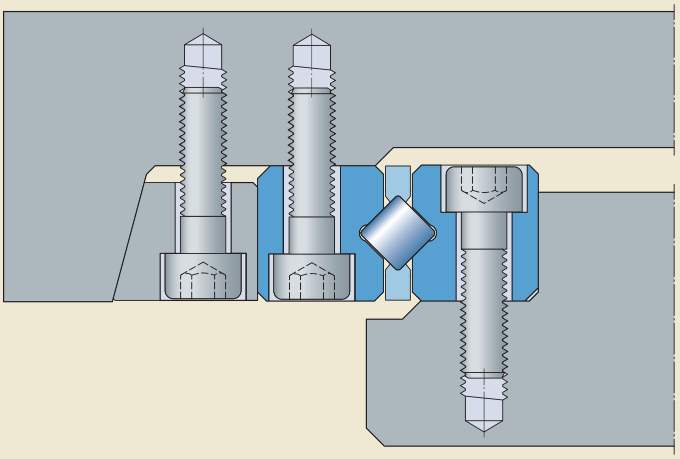


Table 4

**Tightening torques of set screws**

| Rail type | Cage type | Set screw distance | Set screw | Factor for preload | Tightening torque |
|---|---|---|---|---|---|
| – | – | mm | – | % | Ncm |
| **LWRB 1** | LWJK 1,588 | 10 | M2 | 20 | 1,8 |
| **LWRB 2** | LWJK 2 | 15 | M3 | 10 | 1,7 |
| **LWR 3** | LWAK3 | 25 | M3 | 13 | 3 |
| **LWR 3** | LWAK3 | 25 | M4 | 13 | 4 |
| **LWR 6** | LWAL6 | 50 | M5 | 9 | 17 |
| **LWR 6** | LWAL6 | 50 | M6 | 9 | 20,4 |
| **LWR 9** | LWAL9 | 100 | M6 | 8 | 67,9 |
| **LWR 9** | LWAL9 | 100 | M8 | 8 | 90 |
| **LWR 12** | LWAL12 | 100 | M10 | 8 | 153,6 |
| **LWRE 3** | LWAKE3 | 25 | M3 | 7 | 6,2 |
| **LWRE 3** | LWAKE3 | 25 | M4 | 7 | 8,3 |
| **LWRE 2211** | LWAKE3 | 40 | M3 | 7 | 9,9 |
| **LWRE 2211** | LWAKE3 | 40 | M4 | 7 | 13,2 |
| **LWRE 4** | LWAKE4 | 25 | M3 | 5 | 9,5 |
| **LWRE 4** | LWAKE4 | 25 | M4 | 5 | 12,7 |
| **LWRE 6** | LWAKE6 | 50 | M5 | 3 | 26,9 |
| **LWRE 6** | LWAKE6 | 50 | M6 | 3 | 32,4 |
| **LWRE 9** | LWAKE9 | 100 | M6 | 3 | 102,2 |
| **LWRE 9** | LWAKE9 | 100 | M8 | 3 | 135,4 |
| **LWRM / LWRV 6** | LWHV10 | 50 | M6 | 5 | 96,9 |
| **LWRM / LWRV 6** | LWHW10 | 50 | M6 | 5 | 96,9 |
| **LWRM / LWRV 9** | LWHV15 | 100 | M8 | 2 | 161 |
| **LWRM / LWRV 9** | LWHW15 | 100 | M8 | 2 | 120,2 |
| **LWM / LWV 3015** | LWHV10 | 40 | M6 | 5 | 77,5 |
| **LWM / LWV 3015** | LWHW10 | 40 | M6 | 5 | 77,5 |
| **LWM / LWV 4020** | LWHV15 | 80 | M8 | 2 | 128,8 |
| **LWM / LWV 4020** | LWHW15 | 80 | M8 | 2 | 96,1 |
| **LWM / LWV 5025** | LWHV15 | 80 | M8 | 2 | 128,8 |
| **LWM / LWV 5025** | LWHW15 | 80 | M8 | 2 | 96,1 |
| **LWM / LWV 6035** | LWHV20 | 100 | M10 | 2 | 294,9 |
| **LWM / LWV 6035** | LWHW20 | 100 | M10 | 2 | 217,8 |
| **LWM / LWV 7040** | LWHW25 | 100 | M12 | 2 | 395,9 |
| **LWM / LWV 8050** | LWHW30 | 100 | M12 | 2 | 507,9 |

Note: Precision rail guides with slide coating should not be preloaded.

Table 5

**Tightening torque of mounting screws**

Data for mounting screws in strength class 8.8

| Material | | Screw size | M2 | M2,5 | M3 | M3,5 | M4 | M5 | M6 | M8 | M10 | M12 | M14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aluminum | Tightening torque | [Nm] | 0,21 | 0,44 | 0,77 | 1,2 | 1,7 | 3,4 | 6 | 15 | 29 | 50 | 80 |
| | Minimum screw-in length | [mm] | 3,2 | 4 | 4,8 | 5,6 | 6,4 | 8 | 10 | 13 | 16 | 19 | 22 |
| Cast iron | Tightening torque | [Nm] | 0,25 | 0,52 | 0,92 | 1,4 | 2,1 | 4,1 | 7 | 17 | 34 | 60 | 94 |
| | Minimum screw-in length | [mm] | 3 | 3,8 | 4,5 | 5,3 | 6 | 7,5 | 9 | 12 | 15 | 18 | 21 |
| Steel | Tightening torque | [Nm] | 0,3 | 0,61 | 1,1 | 1,6 | 2,4 | 4,8 | 8 | 20 | 40 | 69 | 110 |
| | Minimum screw-in length | [mm] | 2,4 | 3 | 3,6 | 4,2 | 4,8 | 6 | 7,2 | 10 | 12 | 14 | 17 |

# 3.2 Mounting

## 3.2.1 Important requirements

The following instructions describe the mounting procedures for a SKF precision rail guide system. Read these instructions carefully before starting the installation process. Skill and cleanliness are essential when mounting precision rail guides, to obtain optimum performance and to avoid mounting-induced bearing failure. Mounting should be carried out in a dry, dust-free room away from metal-working machines and other machinery producing swarf or dust. Prior to mounting the rail guides, all necessary parts and equipment should be at hand. Appropriate tools and measuring devices are to be used at all times. Rail guides are precision products and should be handled with due care. Not following these instructions could reduce system service life or create a safety risk.

## 3.2.2 General mounting rules

All parts of the linear guiding system should be carefully cleaned and deburred and the accuracy of form and dimension of all adjacent components checked against the specification, (→ *chapter, 3.1.3*). The rails should not be removed from their original packaging until immediately before mounting, to minimise the risk of contamination. After unwrapping, the corrosion inhibitor has to be removed. When using SKF LGEP2 grease, the corrosion inhibitor can remain on the raceways. The reference surfaces of the rails and the mounting surfaces of the adjacent parts should be carefully cleaned and lightly oiled to prevent contact corrosion during operation. The reference surface A is generally on the opposite side of the SKF label. Apply the chosen lubricant onto the raceways and the rolling element assemblies prior to mounting.

**NOTE:** To retain the high performance of precision rail guides, it is recommended not to mix rails of different packages (*compare chapter 1.6.12*).

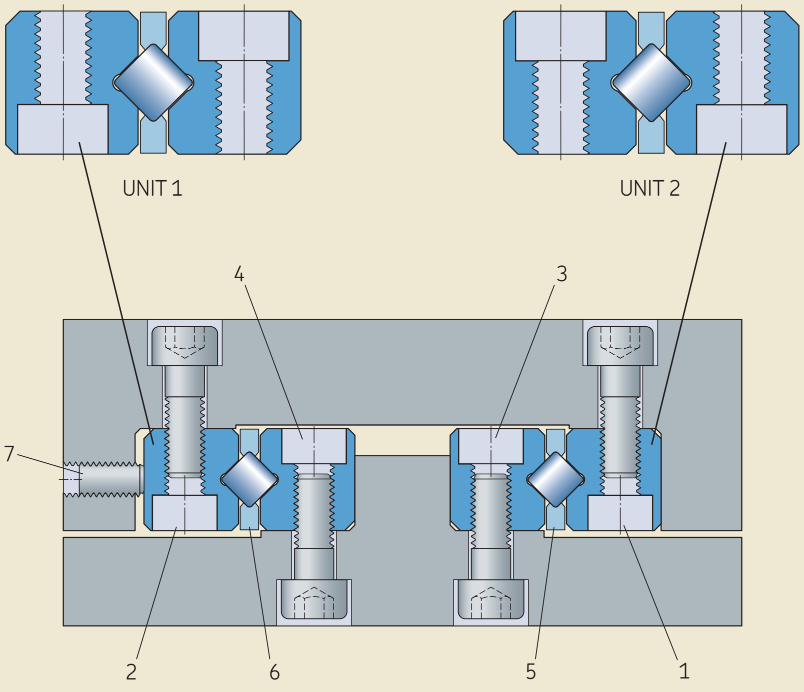
## 3.2.3 Mounting of rail guides without Anti-Creeping System

Mounting of a rail guide in a clamped arrangement should take place in the following sequence (**fig. 8**):

**1** Inner rails 3 and 4 are pressed against the mounting surfaces and bolted down, applying the prescribed torque.
**2** Fixed rail 1 is pressed against the mating mounting surfaces and bolted down, applying the prescribed torque.
**3** The outer rail 2 is pressed onto its counterpart and bolted lightly in position.
**4** The lubricated cages 5 and 6 are moved to their desired position (usually centred).
**5** The outer rail 2 is used for preload adjustment because a system in clamped arrangement has to be operated with zero clearance or with preload, depending on the application. The preload is adjusted by means of set screws 7 with the help of a torque wrench. For the correct adjustment sequence, follow the numbers on the set screws as described in **Fig. 9**. Be sure to tighten the set screws from inside to outside, and have rolling elements underneath the corresponding set screws. Recommended tightening torques, which should only be considered as approximate values, are given in **table 4**, *chapter 3.1.9*.
**6** The fixing bolts on the outer rail 2 are tightened by applying the prescribed torque.
**7** The running accuracy of the slide assembly is checked.
**8** The end pieces, if applicable, are mounted.
**9** The external end stops of the slide assembly are mounted. The rolling element assemblies should not be used as counterparts for the end stops.

Fig. 8

Mounting sequence



## 3.2.4 Mounting of rail guides with Anti-Creeping System

In order to avoid damage to the Anti-Creeping System, the rails have to be mounted as pre-assembled units with the cages correctly positioned. Any direct or indirect force subjected to the ACS control gear will damage it.

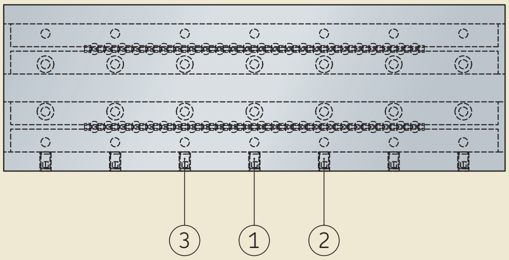
The following instructions are valid for all types of Anti-Creeping Systems (ACS, ACSM, ACSZ).

1. Outer rail 1, inner rail 3, and lubricated cage 5 are put together as unit 1 with the cage in its correct position – typically centred.
2. Unit 2 should be prepared in the same way by using inner rail 4, outer rail 2 and cage 6.
3. Both units are pushed in to the desired position between the bottom and top part from the front side.
4. Unit 1 is pressed against the mounting surfaces and bolted down, applying the prescribed torque.
5. Inner rail 4 is pressed against the mating mounting surfaces and bolted down, applying the prescribed torque.
6. Outer rail 2 is mounted onto its counterpart, and bolted lightly in position.
7. The outer rail 2 is used for preload adjustment because a system in clamped arrangement has to be operated with zero clearance or with preload, depending on the application. The preload is adjusted by means of set screws 7 with the help of a torque wrench. For the correct adjustment sequence, follow the numbers on the set screws as described in **fig. 9**. Be sure to tighten the set screws from inside to outside and have rolling elements underneath the corresponding set screws. Recommended tightening torques, which should only be considered as approximate values, are given in **table 4**, *chapter 3.1.9*.
8. The fixing bolts on the outer rail 2 are tightened by applying the prescribed torque.
9. The running accuracy of the slide assembly is checked.
10. The end pieces, if applicable, are mounted.
11. The external end stops of the slide assembly are mounted. The rolling element assemblies should not be used as counterparts for the end stops.

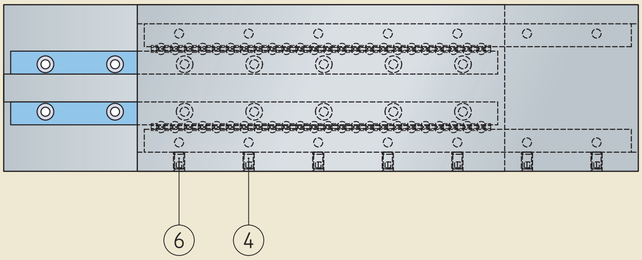
**Fig. 9**

**Preload sequence**

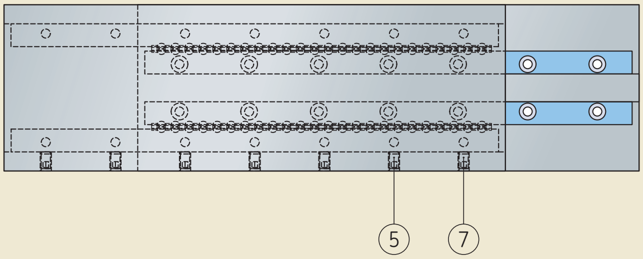
Moving part in centre position; screws 1, 2, 3



Moving part in end position; screws 4, 6



Moving part in other end position, screws 5, 7



# 3.3 Maintenance

## 3.3.1 Lubrication

SKF precision rail guides usually require very small quantities of lubricant. Both grease and oil can be used. Lubricants with solid additives, or grinding emulsions and coolants are unsuitable.

Under normal operating conditions, grease is generally used to lubricate rail guides. Compared to oil, grease is more easily retained in the bearing arrangement, particularly where the rail guides are mounted in an inclined or vertical position. Grease also contributes to the sealing of the rail guide against contamination and humidity.

Since rail guides, particularly in low speed applications, operate almost exclusively under borderline or mixed friction conditions, the use of grease with extreme pressure (EP) additives is advisable. SKF recommends using SKF bearing grease LGEP2. This grease is based on lithium soap and mineral oil. It has excellent water repellent and corrosion resistance properties and can be used in the temperature range –20 °C to +110°C.

Oil lubrication is often employed in situations where neighbouring machine components are oil lubricated, or where high speeds of travel are involved. A simple method of lubrication with oil is the oil drop method. Ordinary mineral oil with EP additives and viscosities in the range of ISO VG 45 to 200 is suitable.

Lubricant can be supplied to the rail guides most easily using the lateral gap between the rails. If this is not possible because of the design of the arrangement, rails provided with lubrication holes can be supplied, in which case a drawing should be forwarded to SKF, indicating the size and location of the holes. It is also possible to connect central lubrication units, which can be offered by SKF. Be aware that the ACS control gears and its axis must also be lubricated.

## 3.3.2 Relubrication interval

There are no general rules given for re-lubrication intervals for precision rail guides, as these must be individually determined for each application. However, we recommend re-lubricating at least once a year.

## 3.3.3 Repairs

If a precision rail guide system has reached the end of its service life and needs to be replaced, SKF recommends replacing the complete system. When re-ordering, please identify the size, rail length, J1 dimension (distance from rail end to first mounting hole), hole type and cage length / stroke.

## 3.3.4 Stationary conditions / shipping / storage

If a precision rail guide is stationary for long periods and subjected to vibration from external sources, micro movement in the contact zone between rolling elements 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.

# 3.4 Ordering code

**Ordering code precision rails**

LWRE90300 ACS 50/P5/J1=25

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LW | RE | 9 | 0300 | ACS | 50 | / | P5 | / | | / | | / | | / | | / | J1= 25 |

**Type**
RB
R
RE
RM
RV
M
V
RPM
RPV

**Size**
For example 6, 9 or 6035, depending on type

**Length in mm**
For sizes 1, 2, 3, 4, 6, 2211 and 3015: 3 digits
For sizes 9 and 4020 to 8050: 4 digits

**Anti-creeping system**

| | |
|---|---|
| No code | without any ACS |
| ACS | for LWRE |
| ACSM | for LWRB and LWRE |
| ACSZ | for LWM/LWV |

**Stroke of anti-creeping system in mm**
(→ *chapter 1.4*)

| | |
|---|---|
| No code | standard, teeth over the entire length |
| Value | possible for ACS and ACSZ, not for ACSM; always symmetrical; |

**Precision class**

| | |
|---|---|
| P10 | standard (no code needed) |
| P5 | medium |
| P2 | high |

**Lead in radius**

| | |
|---|---|
| No code | without |
| EG | lead in radius on both ends |

**Material / Coating**

| | |
|---|---|
| No code | standard, as described in product tables |
| HV | rails in stainless steel (standard for ACSM) |
| HD | thin dense chrome coating |

**End face holes**

| | |
|---|---|
| No code | standard, as described in product tables |
| E1 | without end holes (standard for ACSM, LWRPM and LWRPV) |
| E7 | with end holes (for ACSM, LWRPM and LWRPV) |

**Mounting hole options (on request)**

| | |
|---|---|
| No code | standard, as described in product tables |
| 03 | threaded hole |
| 10 | through hole |
| 13 | threaded inserts integrated in the rail (only LWM and LWV) |
| 15 | through hole with counterbore (standard at LWM and LWV, no code needed) |

**$J_1$ dimension in mm**

| | |
|---|---|
| No code | standard, symmetrical $J_1$ on both ends |
| Value | unsymmetrical $J_1$ in mm; definition (→ *chapter 3.1.7*) |

## Ordering code rolling element assemblies

LWAKE9x13 ACS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LW | AKE | 9 | x | 13 | ACS | / | |

**Type**

| | |
|---|---|
| JK | for LWRB |
| AL, AK | for LWR |
| AKE | for LWRE |
| HV, HW | for LWRM/V and LWM/V |

**Size**

| | |
|---|---|
| 1, 2 | for LWJK |
| 3 | for LWAK |
| 6, 9, 12 | for LWAL |
| 3, 4, 6, 9 | for LWAKE |
| 10, 15 | for LWHV |
| 10, 15, 20, 25, 30 | for LWHW |

**Length**

Number of rolling elements for ball- and roller cages
Length in mm for needle roller cages

**Anti-creeping system**

| | |
|---|---|
| No code | without any ACS |
| ACS | for LWAKE |
| ACSM | for LWJK and LWAKE |
| ACSZ | for LWHW |

**Precision class**

| | |
|---|---|
| No code | standard, as described in product tables |
| G1 | high (only available for needle roller cages) |

## Ordering code special mounting screws

LWGD 9

| | |
|---|---|
| LWGD | |

**Size**[1]

| | |
|---|---|
| 3, 4, 6, 9, 12, 2211 | for all rails of the Modular Range and size 2211 |
| 4020, 5025, 6035, 7040, 8050 | for LWM/V |

Generally the same size as for the rail has to be entered.

---

[1] Other sizes on request

## Ordering code end pieces

| LWERE 9 | LW |  |  | / |  |
|---|---|---|---|---|---|

**Type**[1]

| | | |
|---|---|---|
| ERA | | for LWR / LWRB |
| ERB | | for LWR / LWRB |
| ERC | with wiper | for LWR |
| ERE | | for LWRE |
| EREC | with wiper | for LWRE |
| ERM | | for LWRM |
| ERV | | for LWRV |
| EARM | with wiper | for LWRM |
| EARV | with wiper | for LWRV |
| EM | | for LWM |
| EV | | for LWV |
| EAM | with wiper | for LWM |
| EAV | with wiper | for LWV |

**Size**

1 ... 8050

Generally the same size as for the rail has to be entered.

**Coating**

| | |
|---|---|
| No code | standard, as described in product tables |
| HV | chromed end pieces and screws |

---

[1] Take **table 2**, *Chapter 3.1.4*, in consideration

## Ordering code precision rail guides in kit packaging

| LW | RE | 3 | 300 | / | 100 | EG | ACS | – | KIT | / | z 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|

**Type**

R

RE

**Size**

| | |
|---|---|
| 3, 6 | for R |
| 3, 4, 6 | for RE |

**Rail length in mm** (as defined in product tables)

**Length of short rail in mm** (optional, on request)

| | |
|---|---|
| No code | standard, four rails with the same rail length |
| Value | two short rails with given length and lead in radius and two normal rails |

**Anti-creeping system**

| | |
|---|---|
| No code | without any ACS |
| ACS | for LWRE 3, 4, 6 |
| ACSM | for LWRE 3, 6 |

**Number of rolling elements z (optional, on request)**

| | |
|---|---|
| No code | standard, as described in product tables |
| Value | when other number of rolling elements is needed |

# Specification sheet – Precision rail guide

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 | |

### Reason for request

| | | |
|---|---|---|
| Current product / brand<br>○ Replacement | ○ New design | Description<br>○ Other |

### Application / Industry

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

## Application description

## Specification sheet – Precision rail guide

| **Stroke** | **Rail length** | **Length of shorter rail** | **Distance $B_1$** | | **Distance $B_1$ + A** | **Guiding system** |
|---|---|---|---|---|---|---|
| mm | mm | mm | mm | or | mm | Maximum height<br>mm |
| | | (→ chapter 1.8.5) | | | | ○ No constraints |

**Required service life distance or time** (fill in all fields)

| Distance | Total time | Period of one cycle | Stroke of one cycle |
|---|---|---|---|
| km | h | s | mm |

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

| **Maximum speed**[1] | **Maximum acceleration**[1] | **Rigidity of guiding system** | **Running accuracy of guiding system** |
|---|---|---|---|
| m/s | $m/s^2$ | N/µm | Parallelism in height<br>µm |
| | | ○ No specific requirements | Parallelism in sideward direction<br>µm |

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

**Environment**

| | |
|---|---|
| Presence of dust, dirt or fluids<br>○ Clean environment, e.g. laboratory<br>○ Standard industrial environment<br>○ Dirty environment, e.g. milling machine | Requirements on friction<br>○ Lowest possible friction<br>○ Standard friction<br>○ No requirement |
| ○ Humid or corrosive environment<br>If yes, please describe: | Preferred material<br>○ No preference (standard)<br>○ Stainless steel<br>○ Coated steel |

**Temperature [°C]**

| Minimum | Operating | Maximum |
|---|---|---|
| | | |

○ Shock loads or vibrations

If yes, please describe:

**Lubricant in use**

| | |
|---|---|
| ○ Standard (SKF grease LGEP2) | ○ Other<br>Please specify: |

**Sketch of the application** (or attach a drawing)

## Product details

**Rail designation** (if already known)

**Precision class of rail**

| | | |
|---|---|---|
| ○ P10 (Standard) | ○ P5 (Medium) | ○ P2 (High) |

**Designation of rolling element assembly** (if already known)

**Anti-creeping system needed** (recommended for high accellerations or vertical systems)

| | |
|---|---|
| ○ Yes | ○ No |

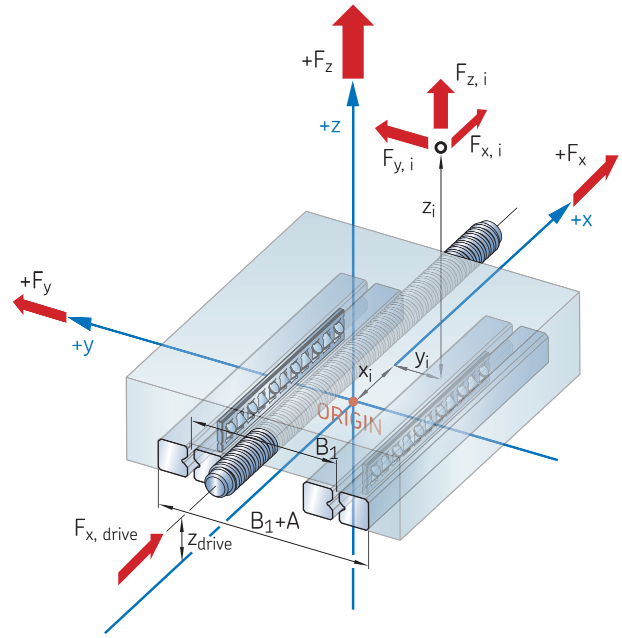
**Needed accessories** (for details see SKF publication 14259, Precision rail guides)

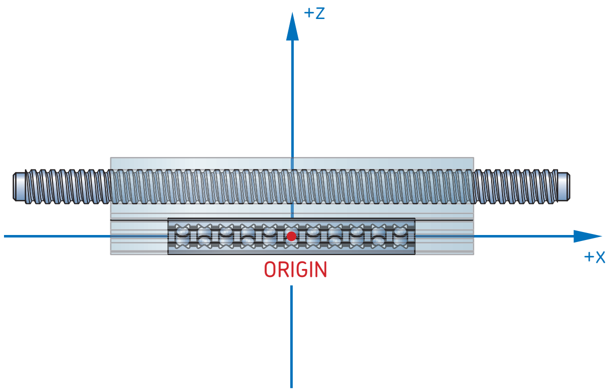
| | |
|---|---|
| ○ End pieces | Designation |
| ○ End pieces with wipers<br>(requires long and short rails) | Designation |
| ○ Special mounting screws – LWGD | |

**Precision rail guides mounted into a complete system**

| | | |
|---|---|---|
| ○ GCL | ○ GCLA | ○ System with drive, e.g. roller screw |

## Input for dimensioning calculation





**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 graphcis above). If the application has more than 3 load phases, please copy this page.

| | | | |
|---|---|---|---|
| **Load phase 1** | | | |
| Stroke | | | mm |
| Acceleration | | | mm/s$^2$ |
| Speed | | | m/s |
| | **Lever arms in** | | |
| **Force $F_x$** | x | y | z |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| **Force $F_y$** | x | y | z |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| **Force $F_z$** | x | y | z |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

| | | | |
|---|---|---|---|
| **Load phase 2** | | | |
| Stroke | | | mm |
| Acceleration | | | mm/s$^2$ |
| Speed | | | m/s |
| | **Lever arms in** | | |
| **Force $F_x$** | x | y | z |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| **Force $F_y$** | x | y | z |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| **Force $F_z$** | x | y | z |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

| | | | |
|---|---|---|---|
| **Load phase 3** | | | |
| Stroke | | | mm |
| Acceleration | | | mm/s$^2$ |
| Speed | | | m/s |
| | **Lever arms in** | | |
| **Force $F_x$** | x | y | z |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| **Force $F_y$** | x | y | z |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| **Force $F_z$** | x | y | z |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

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