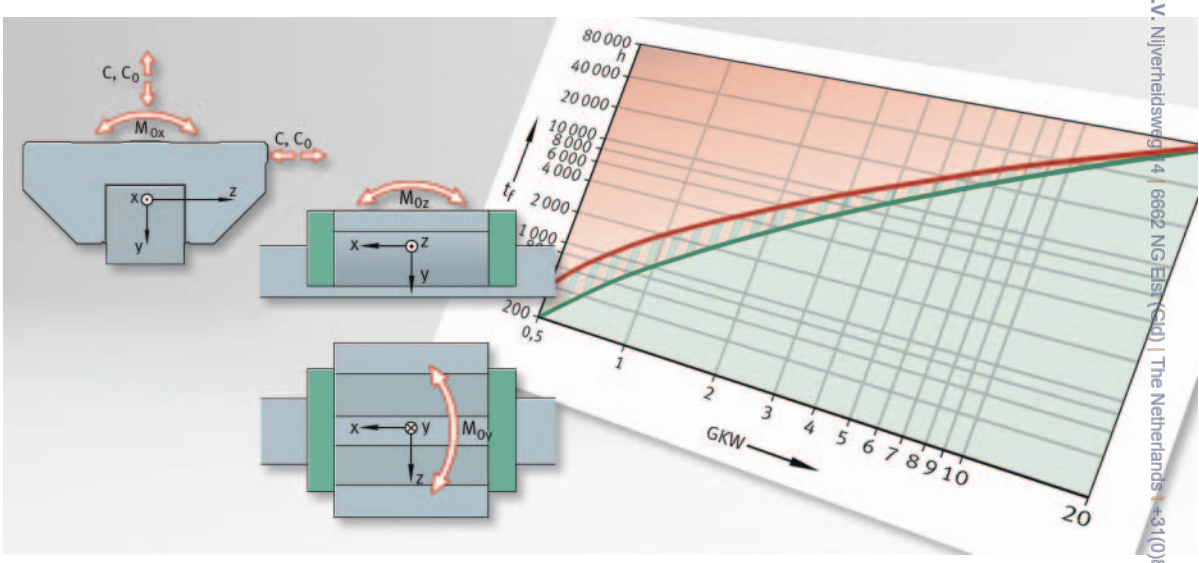


Technical principles for monorail guidance systems

Load carrying capacity and life
INA calculation program
Preload
Friction
Lubrication
Special coatings
Mounting variants
Mounting guidelines

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Load carrying capacity and life

The size of a monorail guidance system is determined by the demands made on its load carrying capacity, life and operational security.

Load carrying capacity

The load carrying capacity is described in terms of the basic dynamic load rating C, the basic static load rating C_0 and the static moment ratings M_{0x}, M_{0y} and M_{0z}, *Figure 1*.

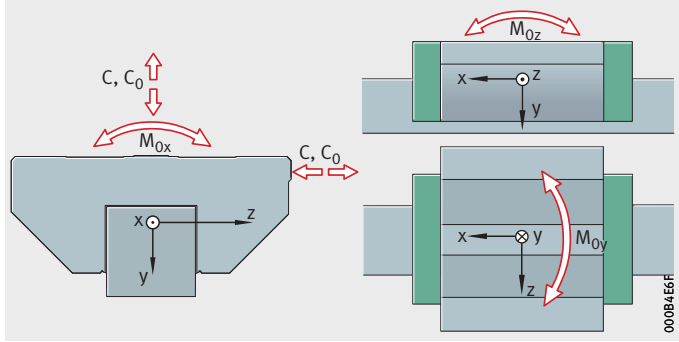


Figure 1
Load carrying capacity and load directions

Calculation of basic load ratings according to DIN ISO

The calculation of the basic dynamic and static load ratings given in the dimension tables is based on DIN ISO 14728-1 and 2.

Differences between DIN ISO and suppliers from the Far East

Suppliers from the Far East frequently calculate basic load ratings using a basic rating life based on a distance of only 50 km in contrast to 100 km according to DIN ISO. This results in comparatively higher basic load ratings.

Conversion of basic load ratings

The conversion factors are applied as follows:

Linear recirculating ball bearing and guideway assemblies

$$C_{50} = \mathbf{1{,}26} \cdot C_{100}$$

$$C_{100} = \mathbf{0{,}79} \cdot C_{50}$$

Linear recirculating roller bearing and guideway assemblies

$$C_{50} = \mathbf{1{,}23} \cdot C_{100}$$

$$C_{100} = \mathbf{0{,}81} \cdot C_{50}$$

C_{100} N
Basic dynamic load rating in accordance with DIN ISO 14728-1 (based on 100 km)

C_{50} N
Basic dynamic load rating in accordance with DIN ISO 14728-1 (based on 50 km).

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Load carrying capacity and life

Dynamic load carrying capacity and life

The dynamic load carrying capacity is described in terms of the basic dynamic load rating and the basic rating life.

The basic dynamic load rating is the load in N at which the guidance system, with a survival probability of 90%, achieves a distance of 100 km (C_{100}).

The data for the basic dynamic load rating C in the dimension tables correspond to the basic dynamic load rating C_{100} in accordance with DIN ISO 14728-1.

Basic rating life

The basic rating life L and L_h is achieved or exceeded by 90% of a sufficiently large group of apparently identical bearings before the first evidence of material fatigue occurs.

$$L = \left(\frac{C_{100}}{P} \right)^p \cdot 100$$

$$L_h = \frac{833}{H \cdot n_{osc}} \cdot \left(\frac{C_{100}}{P} \right)^p$$

$$L_h = \frac{1666}{v_m} \cdot \left(\frac{C_{100}}{P} \right)^p$$

In accordance with DIN ISO 14728-1, the equivalent dynamic load P should not exceed the value 0,5 · C. If lateral forces are present, the frictional locking of the fixing screws must be checked. Ideally, locating edges should be provided.

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Equivalent load and velocity

The equations for calculating the basic rating life assume that the load P and the velocity v_m are constant. Non-constant operating conditions can be taken into consideration by means of equivalent operating values. These have the same effect as the loads occurring in practice.

Equivalent dynamic load

Where the load varies in steps, the equivalent dynamic load is calculated as follows:

$$P = \sqrt[p]{\frac{q_1 \cdot F_1{}^p + q_2 \cdot F_2{}^p + \ldots + q_z \cdot F_z{}^p}{100}}$$

Where the load varies in steps and the velocity varies in steps, the equivalent dynamic load is calculated as follows:

$$P = \sqrt[p]{\frac{q_1 \cdot v_1 \cdot F_1{}^p + q_2 \cdot v_2 \cdot F_2{}^p + \ldots + q_z \cdot v_z \cdot F_z{}^p}{q_1 \cdot v_1 + q_2 \cdot v_2 + \ldots + q_z \cdot v_z}}$$

Mean velocity

Where the velocity varies in steps, the mean velocity is calculated as follows:

$$v_m = v_1 \cdot \frac{q_1}{100} + v_2 \cdot \frac{q_2}{100} + \ldots + v_z \cdot \frac{q_z}{100}$$

Combined load

If the direction of the load acting on an element does not coincide with one of the main load directions, an approximate value for the equivalent load is calculated as follows:

$$P = |F_y| + |F_z|$$

If an element is simultaneously subjected to a force F and a moment M, an approximate value for the equivalent dynamic load is calculated as follows:

$$P = |F| + |M| \cdot \frac{C_0}{M_0}$$

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Load carrying capacity and life

Symbols, units and definitions

C_{100} N
Basic dynamic load rating in accordance with DIN ISO 14728-1 (based on 100 km)

C_0 N
Basic static load rating in the direction of the force acting on the element

F N
Force acting on the element

F_y N
Vertical component

F_z N
Horizontal component

H m
Single stroke length for oscillating motion

L, L_h km, h
Basic rating life in km or in operating hours

M Nm
Moment acting on the element

M_0 Nm
Static moment rating

n_{osc} min^{-1}
Number of return strokes per minute

P N
Equivalent dynamic load

p –
Life exponent:
Monorail guidance systems based on balls: p = 3
Monorail guidance systems based on rollers: p = $^{10}/_{3}$

q_z %
Duration as a proportion of the total operating time

v_z m/min
Variable velocity

v_m m/min
Mean velocity.

Operating life

The operating life is defined as the life actually achieved by monorail guidance systems. It may differ significantly from the calculated life.

The following influences can lead to premature failure through wear or fatigue:

- excess load due to misalignment as a result of temperature differences and manufacturing tolerances (elasticity of the adjacent construction)
- contamination of the guidance systems
- inadequate lubrication
- reciprocating motion with very small stroke length (false brinelling)
- vibration while stationary (false brinelling)
- overloading of the guidance system (even for short periods)
- plastic deformation.

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Static load carrying capacity

The static load carrying capacity of the monorail guidance system is limited by:

- the permissible load on the monorail guidance system
- the load carrying capacity of the raceway
- the permissible load on the screw connections
- the permissible load on the adjacent construction.

For design purposes, the static load safety factor S_0 required for the application must be observed, see tables, page 26. If lateral forces are present, the frictional locking of the fixing screws must be checked. Ideally, locating edges should be provided.

Basic static load ratings and moment ratings

The basic static load ratings and static moment ratings are those loads under which the raceways and rolling elements undergo a permanent overall deformation corresponding to $^1/_{10\,000}$ of the rolling element diameter.

Static load safety factor

The static load safety factor S_0 is the security against permanent deformation at the rolling contact:

$$S_0 = \frac{C_0}{P_0}$$

$$S_0 = \frac{M_0}{M}$$

S_0 –
Static load safety factor

C_0 N
Basic static load rating in the load direction (for KUSE: C_{0I}, C_{0II}, C_{0III}), see dimension tables

P_0 N
Equivalent static bearing load in the load direction

M_0 Nm
Static moment rating in the load direction (M_{0x}, M_{0y}, M_{0z}), see dimension tables

M Nm
Equivalent static moment rating in the load direction.

The equivalent static bearing load is determined in approximate terms from the maximum loads:

$$P_0 = F_{max}$$

$$M = M_{max}$$

The static load safety factor S_0 for the design of linear guidance systems must be observed, see tables, page 26.

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Load carrying capacity and life

Application-oriented static load safety factor

For the design of linear guidance systems, the static load safety factor S_0 according to the following tables must be taken into consideration.

Standard arrangement

Preconditions	S_0
Critical case □ High dynamic loading (such as vibrations) is present, one axis is stationary. □ Severe contamination is present. □ Actual load parameters are not defined. □ Catalogue specifications for accuracy of adjacent construction are not observed.	8 – 12
Normal case □ Not all load parameters are completely known. □ Loads are estimated from the performance data of the machine.	5 – 8
□ All load parameters are known.	4 – 5
□ All load parameters are known and definitely correspond to reality.	3 – 4

In the field of machine tools, safety factors of $S_0 > 10$ are normal for reasons of rigidity. For the precise design of the guidance system, Schaeffler offers BEARINX-online or design by the “Schaeffler Technology Center” in conjunction with Application Engineering. In precise design, the displacement of the tool point can also be analysed.

Utilisation in general applications Overhead arrangements[1)]

Preconditions	S_0
□ Not all load parameters are known and fewer than 4 carriages support a coherent weight.	20
□ Not all load parameters are known and at least 4 carriages support a coherent weight. □ All load parameters are known and fewer than 4 carriages support a coherent weight.	8 – 12
□ All load parameters are known and at least 4 carriages support a coherent weight.	5 – 8

1) If the guidance system is in a suspended arrangement, a drop guard is recommended, see page 67.

Strength of guidance systems

If the fixing screw threads are of a sufficient size, monorail guidance systems can be subjected to loads up to the static load carrying capacity C_0 and M_0, see dimension tables.

The load must be transmitted via locating surfaces. The basic load ratings can only be achieved if the whole thread length is utilised.

Mounting variants and mounting work, see page 63.

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INA calculation program

Basic load rating life calculation is used for the preliminary selection of monorail guidance systems, see page 22. It allows an approximate calculation of the equivalent static and dynamic bearing loads.

BEARINX for precise design

In order to achieve precise design of linear guidance elements in relation to basic rating life and static load safety factor, it is necessary to calculate the bearing load in a statically indeterminate system and the internal load distribution of the linear guidance elements (Loading of individual rolling elements, *Figure 1*). This requires a complex calculation process.

For this reason, INA developed the rolling bearing analysis program BEARINX which can be used to calculate linear and guidance system elements as part of the complete system (e.g. machine tool) and thereby ensure reliable designs.

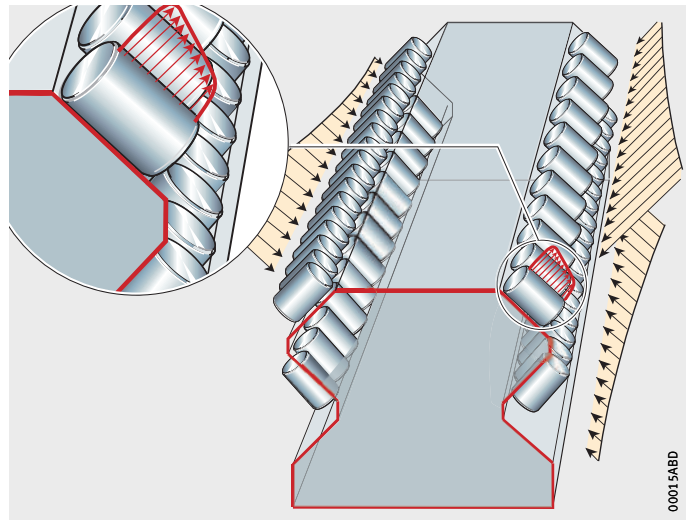


Figure 1
Internal load distribution under combined load

BEARINX linear module

The linear module of BEARINX can be used to calculate linear guidance elements in multi-axis systems under any load combination comprehensively down to the level of the rolling element contact. The integral analysis method can be used to investigate the influence of nearly all parameters relating to the complete system on relevant results.

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INA calculation program

Taking account of elasticities in the system

This sophisticated calculation model takes account of all the elasticities in the system, ranging from the rigidity of the saddle plates and guideways through to the non-linear deflection behaviour of the rolling elements.

In order to determine even more precisely the pressure between the rolling elements and raceway in linear recirculating roller bearing and guideway assemblies, the end profiling of the rolling elements is also taken into consideration. The adjacent construction is assumed to be rigid in the first instance but can, if necessary, be modelled on an elastic basis by means of reduced rigidity matrices (e.g. from FE calculation).

Very precise results

This model gives significantly more precise results than calculation programs that only take account of elasticity in rolling contact. This means an increased level of security in the design.

BEARINX allows the calculation of systems with any number of: traverse axes, linear guidance elements and linear drives, load situations, loads and masses.

The results provided by BEARINX include the static load safety factor, the basic rating life and the displacements that arise from the elasticity of the bearing arrangement.

Calculation using BEARINX is available as a service.

Linear BEARINX online

The linear calculation program BEARINX-online assists in the calculation and design of the linear guidance system, *Figure 2*.
A fee will be charged for usage.

Information and registration ➤ *https://www.schaeffler.de/std/1F2D*.

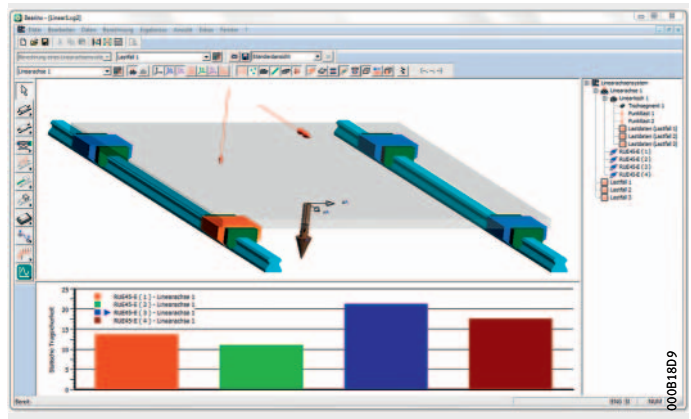


Figure 2
Example from the online program

BEARINX-online Easy Linear

For calculation of an axis, the linear calculation program BEARINX-online Easy Linear is available on the Internet and is free of charge. The user guide simplifies access to the calculation of linear axes.

➤ *https://bearinx-online-easy-linear.schaeffler.com*

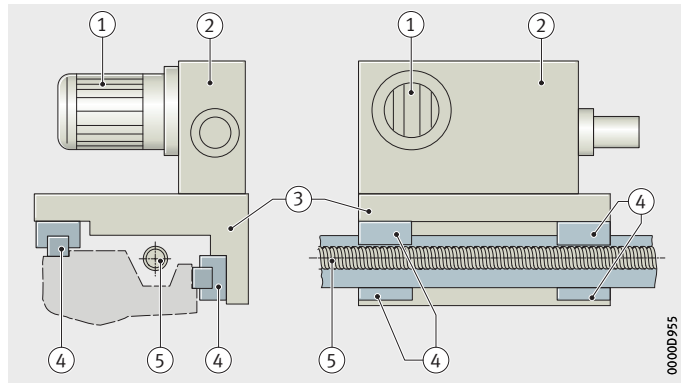
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Calculation program – Example of input data for a design brief

The input data for the calculation program should be compiled from the design brief (with clearly dimensioned drawings or diagrams in at least two views). Here is a step-by-step guide based on a simple example to show the dimensioning process.

Step 1
Define the components

The relevant factors for calculation, apart from the linear guidance elements and the drive system for the table, are those components that induce loads on the linear guidance elements (the inherent mass of the components or their inertia forces), *Figure 3*.



① Motor
② Headstock
③ Base plate
④ Linear guidance elements
⑤ Drive

Figure 3
Defining the components

Step 2
Define the table co-ordinate system

The table co-ordinate system is a Cartesian, right hand co-ordinate system.

The directions in the table co-ordinate system are defined as follows, *Figure 4*:

- X axis: traverse direction of the table
- Y axis: main load direction on the system (direction of weight)
- Z axis: derived from the right hand rule (lateral direction).

The (translational) position of the table co-ordinate system is freely selectable. It is recommended that this should be located centrally between the carriages for the X and Y directions.

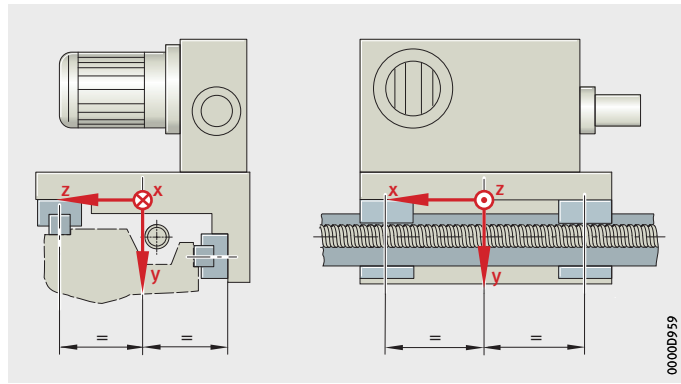


Figure 4
Defining the table co-ordinate system

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Step 3
Define the position of the linear guidance elements

The translational position of the linear guidance elements is stated in relation to the table co-ordinate system. In order to determine the torsion angle of the linear guidance elements, their co-ordinate system is rotated about the X axis into the table co-ordinate system, *Figure 5*.

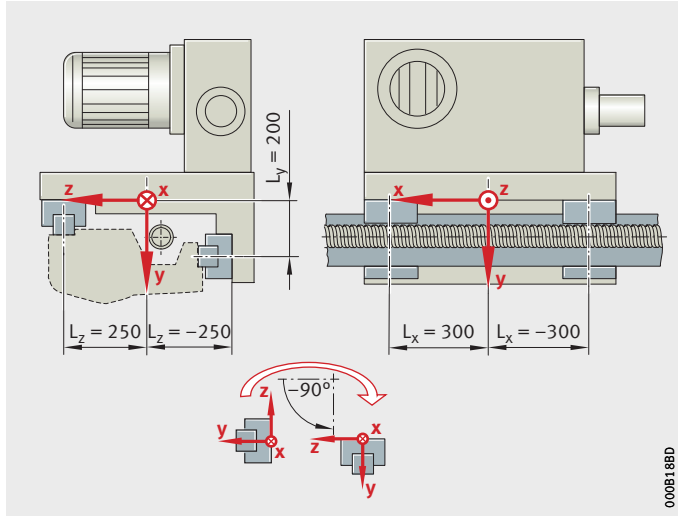


Figure 5
Defining the position of the linear guidance elements

Step 4
Define the position of the drives

The translational position of the drives (support function in the traverse direction) is stated in relation to the table co-ordinate system as Y and Z co-ordinates, *Figure 6*.

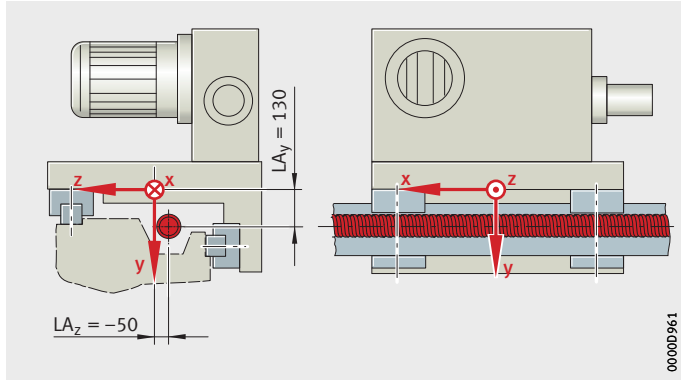


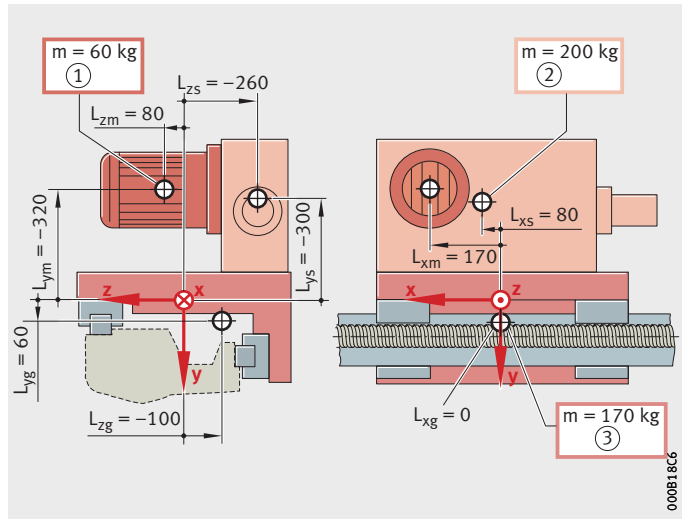
Figure 6
Defining the position of the drives

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Step 5
Define the centres of gravity of the components

The mass of the components is concentrated at a mass point at its centre.

The translational position of the centres of gravity is in turn stated in relation to the table co-ordinate system, *Figure 7*.



① Mass of motor
② Mass of headstock
③ Mass of base plate

Figure 7
Defining the centres of gravity of the components

Step 6
Define the external loads

External loads, such as machining forces on the linear table, are stated in relation to the table co-ordinate system.

The following must be stated, *Figure 8*:

- in which of the defined load cases the load acts on the table co-ordinate system
- the position of its loading point
- the force and moment components.

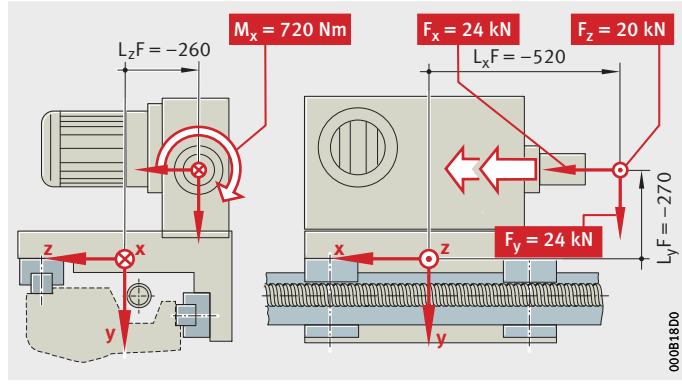


Figure 8
Defining the external loads

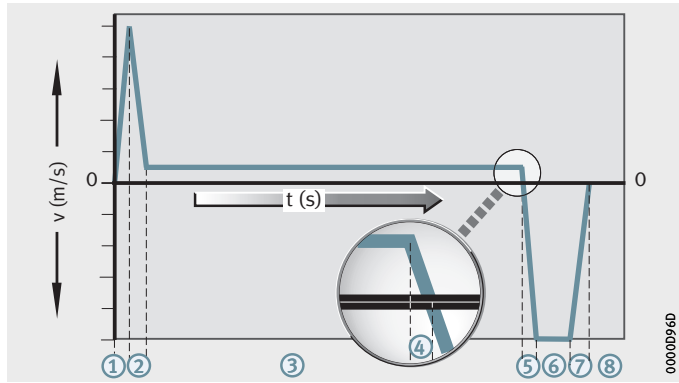
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Step 7
Define the duty cycle

In order to depict the working cycle of the machine, a duty cycle must be described. This is composed of the motion parameters of the machine and their loading due to external loads (e. g. machining forces).

On the basis of a velocity/time diagram, the working cycle should be subdivided logically into individual load cases, *Figure 9*, ① to ⑧.

With the aid of the basic motion equations for uniform motion (v = const.) or uniform acceleration (a = const.) as appropriate, the missing values (travel, acceleration) can then be determined.



① – ⑧ = load cases

Figure 9
Defining the duty cycle

Travel

$$s(t) = s_0 + \left(\frac{v + v_0}{2} \cdot t \right)$$

Velocity

$$v(t) = v_0 + a \cdot t$$

Acceleration

$$a(t) = \frac{\Delta v}{\Delta t}$$

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Example of the motion pattern of a linear table

The following simplified example describes the motion of a linear table. The analysis covers eight load cases, *Figure 9*, page 32, circled numbers ① to ⑧.

Complex traverse cases can in certain circumstances be usefully reduced by combination. In such cases, please consult the Schaeffler engineering service.

Rapid traverse to machining position

Acceleration

In t_1 (0,05 s) to v_1 (0,5 m/s), *Figure 9*, page 32, ①.

$$a(t) = \frac{\Delta v}{\Delta t}$$

$$a_1 = \frac{0,5}{0,05} = 10\,m/s^2$$

$$s_1 = \frac{v_1 \cdot t_1}{2}$$

$$s_1 = \frac{0,5 \cdot 0,05}{2} = 0,0125\,m = 12,5\,mm$$

Deceleration

In t_2 (0,045 s) to v_2 (0,05 m/s), *Figure 9*, page 32, ②.

$$a_2 = \frac{v_2 - v_1}{t_2}$$

$$a_2 = \frac{0,05 - 0,5}{0,045} = -10\,m/s^2$$

$$s_2 = s_1 + \frac{v_2 + v_1}{2} \cdot t_2$$

$$s_2 = 0,0125 + \frac{0,05 + 0,5}{2} \cdot 0,045 = 0,0249\,m = 24,9\,mm$$

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Machining

Constant velocity

v_3 (0,05 m/s) for t_3 (1,105 s); additional effect of machining force, *Figure 9*, page 32, ③.

$$a_3 = 0\,m/s^2$$

$$s_3 = s_2 + \frac{v_3 + v_2}{2} \cdot t_3$$

$$s_3 = 0{,}0249 + \frac{0{,}05 + 0{,}05}{2} \cdot 1{,}105 = 0{,}0801\,m = 80{,}1\,mm$$

Machining force

Position:

- x = –520 mm
- y = –270 mm
- z = –260 mm.

Size:

- M_x = 720 Nm
- F_x = 24 kN
- F_y = 24 kN
- F_z = 20 kN.

Deceleration

In t_4 (0,0025 s) to v_4 (0 m/s), *Figure 9*, page 32, ④.

$$a_4 = \frac{v_4 - v_3}{t_4}$$

$$a_4 = \frac{0{,}0 - 0{,}05}{0{,}0025} = -20\,m/s^2$$

$$s_4 = s_3 + \frac{v_4 + v_3}{2} \cdot t_4$$

$$s_4 = 0{,}0801 + \frac{0{,}0 + 0{,}05}{2} \cdot 0{,}0025 = 0{,}0802\,m = 80{,}2\,mm$$

Rapid traverse back to original position

Acceleration

In t_5 (0,025) to v_5 (–0,5 m/s); opposing direction, *Figure 9*, page 32, ⑤.

$$a_5 = \frac{v_5 - v_4}{t_5}$$

$$a_5 = \frac{-0{,}5 - 0{,}0}{0{,}025} = -20\,m/s^2$$

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$$s_5 = s_4 + \frac{v_5 + v_4}{2} \cdot t_5$$

$$s_5 = 0{,}0802 + \frac{-0{,}5 + 0{,}0}{2} \cdot 0{,}025 = 0{,}0739\,\text{m} = 73{,}9\,\text{mm}$$

Constant velocity

v_6 (–0,5 m/s) for t_6 (0,135 s); opposing direction, *Figure 9*, page 32, ⑥.

$$a_6 = 0\,\text{m/s}^2$$

$$s_6 = s_5 + \frac{v_6 + v_5}{2} \cdot t_6$$

$$s_6 = 0{,}0739 + \frac{-0{,}5 + (-0{,}5)}{2} \cdot 0{,}135 = 0{,}0064\,\text{m} = 6{,}4\,\text{mm}$$

Deceleration

In t_7 (0,0257 s) to v_7 (0 m/s), *Figure 9*, page 32, ⑦.

$$a_7 = \frac{v_7 - v_6}{t_7}$$

$$a_7 = \frac{0 - (-0{,}5)}{0{,}0257} = 19{,}46\,\text{m/s}^2$$

$$s_7 = s_6 + \frac{v_7 + v_6}{2} \cdot t_7$$

$$s_7 = 0{,}064 + \frac{0{,}0 + (-0{,}5)}{2} \cdot 0{,}0257 \approx 0\,\text{m}$$

Standstill in original position

Duration

t_8 (1,5 s), v_8 (0 m/s), *Figure 9*, page 32, ⑧.

$$a_8 = 0\,\text{m/s}^2$$

$$s_8 = 0\,\text{mm}$$

t_i s
Duration of time interval i

s_i mm
Travel position at end of interval i

v_i m/s
Velocity at end of interval i

a_i m/s²
Acceleration during interval i.

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Preload

Influence of preload

Increasing the preload increases the rigidity of the guidance system. The preload influences not only the rigidity but also the displacement force of the guidance system. The higher the preload, the larger the displacement force. Furthermore, preload also influences the operating life of the guidance system.

Preload and damping

The damping of linear guidance systems based on rolling elements is not influenced by preload. A significant level of damping is only achieved by means of additional design measures, for example using the damping carriage RUDS..-D for RUE or the hydrostatic compact guidance system HLE.

The approximate calculation of the equivalent static and dynamic load is based on the standard preload.

Under low load and high preload, the values for the rating life and static load safety factor may be lower than those calculated using the approximation equations for the equivalent static and dynamic load.

The correct preload is only achieved once the guidance system is completely assembled (due to deflection of the back of the carriage).

Preload classes

Preload class	Preload setting
Linear recirculating roller bearing and guideway assemblies RUE..-E	
V1	0,04 · C
V2	0,08 · C
V3[1)]	0,1 · C
V4	0,13 · C
V5	0,15 · C
Linear recirculating ball bearing and guideway assemblies KUSE	
V0	Very small clearance to clearance-free
V1[1)]	0,04 · C_{II}[2)]
V2	0,13 · C_{II}[2)]
Linear recirculating ball bearing and guideway assemblies KUVE..-B, KUVE..-W	
V0	Very small clearance to clearance-free
V1[1)]	0,04 · C
V2	0,1 · C

1) Standard preload class.

2) Basic dynamic load rating C_{II} in tensile direction.

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Friction

Influencing factors

Linear guidance systems have a low, uniform resistance to displacement.

The factors influencing friction are:

- load
- preload
- travel velocity
- lubricant (viscosity and quantity)
- temperature
- misalignment
- the sliding motion components of the seals.

Influence of grease on friction

During commissioning and relubrication, the coefficient of friction increases temporarily due to the fresh grease. After a short running-in period, however, the coefficient of friction returns to its original lower value.

The friction behaviour is determined significantly by the characteristics of the grease used. The consistency and base oil viscosity serve as approximate guide values.

Systems have an increased resistance to displacement after initial greasing.

Influence of seals on friction

Contact seals increase the total friction of the linear guidance system.

The seal friction is at its highest in new guidance systems. It decreases after the running-in period.

Additional wiper variants (accessories) increase the friction to differing extents depending on the seal design.

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Lubrication in general

Oil or grease lubrication

Monorail guidance systems must be lubricated. Technical, economic and ecological factors will determine whether oil or grease should be used and which lubrication method should be applied.

A significant factor in selecting the type of lubrication is the environmental conditions, such as contamination. If extreme conditions are anticipated, it is recommended that Schaeffler External Sales is consulted in the design phase.

Accessories for lubrication:

- Lubricant quantity metering valves SMDS, see page 144
- KIT series 500 with minimal lubricant quantity metering unit, see page 142
- KIT series 400 with long term lubrication unit
  - RWU, see page 140
  - KWVE..-B, see page 370
  - KWVE..-W, see page 370
- KIT series 600 with lubrication adapter plate, see page 145
- Lubrication connectors
  - RWU, see page 164
  - KWSE, see page 254
  - KWVE..-B, see page 384
  - KWVE..-W, see page 394.

Delivered condition, suitable lubricants

RUE..-E and KUSE are protected by a preservative. The preservative is compatible with oils and greases having a mineral oil base.

The series KUVE..-B and KUVE..-W are supplied with basic greasing. Nevertheless, the series KUVE..-B and KUVE..-W must be relubricated with the minimum oil quantity or initial grease quantity before commissioning.

Initial greasing is possible by agreement, in order to supplement the basic greasing. Initial grease quantities, see tables, page 47. The basic greasing is not a substitute for initial greasing. It is only suitable for bridging the period for commissioning, until the carriages are provided with an initial greasing or are connected to a central lubrication system.

KUVE25-B..-HS (design High-Speed) and KUVS are supplied as standard with an initial greasing (greasing ready for operation).

Monorail guidance systems run exclusively under mixed friction conditions. Doped lubricants should therefore be used in preference (type P to DIN 51502).

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Overview of lubricating oils

Linear guidance system	Lubricating oil to ISO VG			
	68	100	150	220
Linear recirculating roller bearing and guideway assemblies				
RUE..-E	●	●	●	●
Minimal lubricant quantity metering unit				
KIT series 500	●	●	●	●
Linear recirculating ball bearing and guideway assemblies				
KUSE	●	●	●	●
KUVE..-B KUVE..-W	●	●	●	●
KUVS	●	●	●	●

● Suitable.

Overview of lubricating greases

Linear guidance system	Grease and flowable grease									
	NLGI grade (consistency)						Base oil ISO VG			
	000	00	0	1	2	3	68	100	150	220
Linear recirculating roller bearing and guideway assemblies										
RUE..-E	●	●	●	●	●	●	–	–	●	●
Minimal lubricant quantity metering unit										
KIT series 500	●	●	–	–	–	–	–	–	●	●
Linear recirculating ball bearing and guideway assemblies										
KUSE	●	●	●	●	●	●	●	●	●	–
KUVE..-B KUVE..-W	●	●	●	●	●	●	●	●	●	–
KUVS	●	●	●	●	●	●	●	●	●	–

● Suitable.

Used lubricants

Used lubricants should be disposed of by environmentally-friendly methods. The use of lubricants is governed by national regulations for environmental protection and occupational safety as well as guidance from the lubricant manufacturers. These regulations must be observed.

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Oil lubrication

The advantage of oil lubrication is the flushing effect. The rolling elements are coated with oil, excess oil flows away and any particles are flushed out of the carriage.

Preference should be given to the use of lubricating oils CLP or CGLP to DIN 51517 and HLP to DIN 51524.

At operating temperatures between +10 °C and +80 °C, the viscosity should be between ISO VG 68 and ISO VG 220, see table, page 39.

If the temperatures are outside the range stated above, oils with appropriate suitability must be used.

For highly dynamic applications, lubricating oils to ISO VG 100 are recommended.

Compatibility

If it is possible to draw upon practical experience or guidelines from the oil manufacturer, oils must not be used until their behaviour in relation to plastics, elastomers and non-ferrous metals has been tested.

The compatibility of oils must always be checked.

This must only be checked under dynamic conditions and at operating temperature.

In case of doubt, the lubricant manufacturer must be consulted.

Miscibility

Oils with a mineral oil base of the same classification are miscible with each other. However, the viscosities should not differ by more than one ISO VG grade.

The miscibility of synthetic oils must always be checked.
In case of doubt, the lubricant manufacturer must be consulted.

Compatibility with process materials (e.g. cooling lubricants) must be checked.

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Lubricant quantities

All the values given are guide values, see tables, page 43.

They are valid for the following conditions:

- operating duration 100%
- $C_0/P = 8$
- v = 0,8 m/s
- stroke 500 mm to 1000 mm
- irrespective of mounting positions, 0° to 90°, *Figure 1*.

Precise values can only be determined in practice. Adequate provision of lubricant is indicated by a visible, unbroken oil film at the profile of the wipers.

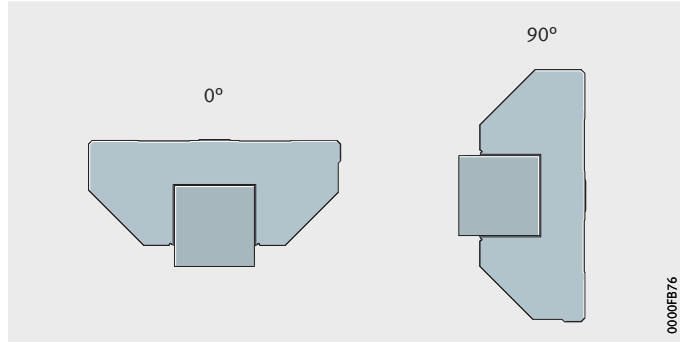


Figure 1
Mounting position

Minimum oil quantity Q_{min}

The minimum oil quantity Q_{min} is valid for commissioning or recommissioning after machine downtime of more than 8 hours, see tables, page 43.

For initial operation, it is measured such that the oil ducts, rolling elements and raceways will be adequately provided with oil.

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Oil lubrication

Oil impulse quantity Q_{imp}

The oil impulse quantity Q_{imp} is valid if the linear guidance system is connected to a central lubrication system and the stroke ratio is less than 200, see tables, page 43 and *Figure 3*, page 52.

The lubricant quantities are valid for all mounting positions.

If heavy contamination is present, it may be necessary to increase the oil relubrication quantity.

The lubrication impulses must be carried out in direct succession.

Carriages with a minimal lubricant quantity metering unit have integral piston distributors. These inject 0,12 cm^3 of lubricant per impulse into the carriages. A separate piston distributor cannot be used with these guidance systems.

KIT series 500 with minimal lubricant quantity metering unit, see page 142.

The oil quantity for the damping carriage RUDS is dependent on the size of the recirculating roller guidance system RUE..-E.

Damping carriages RUDS, see page 192.

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Guide values for lubricant quantities

The guide values are valid under the stated conditions, see page 41.

Oil quantities for RUE and RUDS

Designation[1]	Commissioning quantity	Relubrication quantities			
	Minimum oil quantity Q_{min} cm³	Number of impulses	Oil impulse quantity Q_{imp} cm³	Relubrication interval h	Consumption cm³/h
RUE25-E (-H, -L, -HL)	0,8	1	0,2	5	0,04
RUE35-E (-H, -L, -HL)	1,3	2	0,6	12	0,1
RUE45-E (-H)	1,6	3	0,6	7	0,25
RUE45-E-L (-HL)	2,1	3	0,6	7	0,25
RUE55-E (-H)	2,8	3	0,6	9	0,2
RUE55-E-L (-HL)	3,2	3	0,6	9	0,2
RUE65-E (-H)	5,2	4	0,6	2	1,2
RUE65-E-L (-HL)	5,8	4	0,6	2	1,2
RUE100-E-L	17,6	4	0,6	1	2,4

[1] The oil quantity for the damping carriage RUDS is dependent on the size of the linear recirculating roller bearing and guideway assembly RUE.

Oil quantities for RUE..-E with minimal lubricant quantity metering unit

Designation	Number of impulses	Oil impulse quantity Q_{imp} cm³	Relubrication interval h	Consumption cm³/h
RUE35-E (-E-H)	1	0,12	2,4	0,05
RUE35-E (-E-L, -E-HL)	1	0,12	2,4	0,05
RUE45-E (-E-H)	1	0,12	1,5	0,08
RUE45-E-L (-E-HL)	1	0,12	1,2	0,1
RUE55-E (-E-H)	1	0,12	0,9	0,13
RUE55-E-L (-E-HL)	1	0,12	0,8	0,15
RUE65-E (-E-H)	1	0,12	0,5	0,25
RUE65-E-L (-E-HL)	1	0,12	0,4	0,28

RUE..-E systems with a minimal lubricant quantity metering unit have integral piston distributors. A separate piston distributor cannot be used with this combination.

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Oil lubrication

Oil quantities for RUE..-E with lubricant quantity metering valves SMDS

Designation	Number of impulses	Oil impulse quantity Q_{imp} cm^3	Relubrication interval h	Consumption cm^3/h
RUE35-E-SMDS (-H)	1	0,1	1,3	0,075
RUE35-E-L-SMDS (-HL)	1	0,1	1,3	0,075
RUE45-E-SMDS (-H)	1	0,1	0,6	0,165
RUE45-E-L-SMDS (-HL)	1	0,1	0,6	0,175
RUE55-E-SMDS (-H)	1	0,2	1,2	0,165
RUE55-E-L-SMDS (-HL)	1	0,2	1,1	0,175
RUE65-E-SMDS (-H)	1	0,2	0,3	0,725
RUE65-E-L-SMDS (-HL)	1	0,2	0,3	0,74

The functionality of the lubricant quantity metering valve is already integrated in the RUE25-E. The use of a lubricant quantity metering valve is therefore unnecessary in the case of RUE25-E.

Oil quantities for KUSE

Designation	Minimum oil quantity for commissioning Q_{min} cm^3	Oil impulse quantity Q_{imp} cm^3/h
KUSE20 (-H)	1,2	0,03
KUSE20-L (-HL)	1,6	0,04
KUSE25 (-H)	1,2	0,03
KUSE25-L (-HL)	2	0,05
KUSE30 (-H)	1,6	0,04
KUSE30-L (-HL)	2,8	0,07
KUSE35	2,2	0,04
KUSE35-L	3,2	0,08
KUSE45	2,8	0,07
KUSE45-L	5,2	0,12

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Oil quantities for KUVE

Designation	Minimum oil quantity for commissioning Q_{min} cm^3	Oil impulse quantity Q_{imp} cm^3/h
KUVE15-B (-S, -H, -E, -ES)	0,6	0,02
KUVE15-B-EC (-ESC)	0,6	0,02
KUVE15-W	0,6	0,02
KUVE20-B (-S, -H, -SN, -N, -E, -ES)	0,9	0,03
KUVE20-B-L (-SL, -SNL, -NL)	0,9	0,03
KUVE20-B-EC (-ESC)	0,6	0,02
KUVE20-W	0,9	0,03
KUVE20-WL	0,9	0,03
KUVE25-B (-S, -H, -SN, -N, -E, -ES)	0,9	0,03
KUVE25-B (-S, -H, -SN, -N, -E, -ES) -HS	0,9	0,03
KUVE25-B-L (-SL, -HL, -SNL, -NL)	1,2	0,04
KUVE25-B-EC (-ESC)	0,9	0,02
KUVE25-W	0,9	0,03
KUVE25-WL	1,2	0,04
KUVE30-B (-S, -H, -SN, -N, -E, -ES)	0,9	0,03
KUVE30-B-L (-SL, -HL, -SNL, -NL)	1,5	0,05
KUVE30-B-EC (-ESC)	0,9	0,02
KUVE30-W	0,9	0,03
KUVE35-B (-S, -H, -SN, -N, -E, -ES)	1,4	0,04
KUVE35-B-L (-SL, -HL, -SNL, -NL)	1,8	0,06
KUVE35-B-EC (-ESC)	0,9	0,02
KUVE35-WL	1,8	0,06
KUVE45-B (-S, -H, -SN, -N)	2,2	0,05
KUVE45-B-L (-SL, -HL, -SNL, -NL)	3	0,09
KUVE45-B-EC (-ESC)	1,4	0,03
KUVE55-B (-S)	3	0,09
KUVE55-B-L (-SL)	4,2	0,12

Oil quantities for KUVS

Designation	Minimum oil quantity for commissioning Q_{min} cm^3	Oil impulse quantity Q_{imp} cm^3/h
KUVS10-B	0,5 – 0,6	0,3
KUVS13-B	0,5 – 0,6	0,3
KUVS17-B	0,8 – 0,9	0,5

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Grease lubrication

The advantages of grease lubrication are as follows:

- little requirement for design work;
  it may be possible to dispense with a central lubrication system
- the possibility of long term lubrication
- the use of reservoir lubrication.

Flowable grease lubrication

Due to the risk of increased lubricant egress, flowable greases of grades NLGI 00 and NLGI 000 should be used in accordance with the guide values for oil lubrication, see tables, page 43.

In the case of flowable greases of grade NLGI 0, the lubricant quantity and relubrication interval should be taken from the chapter Grease lubrication.

In clean environmental conditions, the impulse quantity can in certain circumstances be reduced to approx. 20% of the oil impulse quantity stated in the tables.

Minimal lubricant quantity metering unit

For the minimal lubricant quantity metering unit, only flowable greases of grades NLGI 00 and NLGI 000 are permissible.

Lithium soap and lithium complex soap greases with a mineral oil base and EP additives are recommended.

Base oil viscosity

The base oil viscosity is shown in the table:

Guidance system	Base oil viscosity
RUE..-E[1)]	ISO VG 150 to ISO VG 220
KUSE[2)] KUVE..-B[2)] KUVE..-W[2)]	ISO VG 68 to ISO VG 100
KUVS[2)]	ISO VG 68 to ISO VG 100

1) For initial greasing with grease KP2N–20 to DIN 51825.

2) For initial greasing with grease KP2K–30 to DIN 51825.

Grease lubrication

Lithium soap and lithium complex soap greases with a mineral oil base are recommended.

Base oil viscosity

The base oil viscosity is shown in the table:

Guidance system	Base oil viscosity
RUE..-E	ISO VG 150 to ISO VG 220
KUSE KUVE..-B KUVE..-W	ISO VG 68 to ISO VG 150
KUVS	ISO VG 68 to ISO VG 150

For high loads, greases doped with EP additives are absolutely necessary.

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Miscibility

Greases may be mixed if:

- they have the same base oil type
- they have matching thickener types
- they have similar base oil viscosities:
  the difference must be no more than one ISO VG grade
- they have the same consistency (NLGI grade).

In case of doubt, please contact us.

If the grease quality differs from our specifications, this can lead to negative effects.

Initial grease quantity

Carriages that are not connected to a central lubrication system must be greased before mounting with the initial grease quantity, see tables.

Linear recirculating ball bearing and guideway assemblies KUVE..-B

- Standard designs are delivered with a basic greasing, which must be supplemented before commissioning.
- KUVE25-B..-HS (design High-Speed) systems are supplied with an initial greasing.
- KUVE..-B..-UG is supplied without basic greasing, which means that it only has a preservative (the suffix for this option is -UG).

If a linear guidance system not lubricated by a central lubrication system is not given an initial greasing, there is a risk of damage.

Initial grease quantities for RUE

Designation	Initial grease quantity ≈ g
RUE25-E (-H)	2,3
RUE25-E-L (-HL)	3,5
RUE35-E (-H)	6,9
RUE35-E-L (-HL)	8,1
RUE45-E (-H)	11,5
RUE45-E-L (-HL)	16,1
RUE55-E (-H)	20,7
RUE55-E-L (-HL)	25,3
RUE65-E (-H)	23
RUE65-E-L (-HL)	28,8
RUE100-E-L	92

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Grease lubrication

Initial grease quantities for KUSE

Designation	Initial grease quantity ≈ g
KUSE20-H	3,5
KUSE20-L (-HL)	4,4
KUSE25-H	4,6
KUSE25-L (-HL)	6,3
KUSE30-H	8,1
KUSE30-L (-HL)	10,4
KUSE35	12,7
KUSE35-L	17,3
KUSE45	20,7
KUSE45-L	26,5

Initial grease quantities for KUVE with basic greasing

Designation	Initial grease quantity ≈ g
KUVE15-B (-S, -H, -E, -ES)	0,6
KUVE15-B-EC (-ESC)	0,4
KUVE15-W	0,8
KUVE20-B (-S, -H, -SN, -N, -E, -ES)	0,9
KUVE20-B-L (-SL, -SNL, -NL)	1,1
KUVE20-B-EC (-ESC)	0,8
KUVE20-W	1,2
KUVE20-WL	1,4
KUVE25-B (-S, -H, -SN, -N, -E, -ES)	1,2
KUVE25-B (-S, -H, -SN, -N, -E, -ES) -HS[1)]	–
KUVE25-B-L (-SL, -HL, -SNL, -NL)	1,6
KUVE25-B-EC (-ESC)	1,0
KUVE25-W	1,8
KUVE25-WL	2,1
KUVE30-B (-S, -H, -SN, -N, -E, -ES)	3,1
KUVE30-B-L (-SL, -HL, -SNL, -NL)	3,4
KUVE30-B-EC (-ESC)	2,5
KUVE30-W	4,5
KUVE35-B (-S, -H, -SN, -N, -E, -ES)	4,9
KUVE35-B-L (-SL, -HL, -SNL, -NL)	5,7
KUVE35-B-EC (-ESC)	4,2
KUVE35-WL	6,6
KUVE45-B (-S, -H, -SN, -N)	7,9
KUVE45-B-L (-SL, -HL, -SNL, -NL)	8,6
KUVE45-B-EC (-ESC)	6,4
KUVE55-B (-S)	11,4
KUVE55-B-L (-SL)	13,1

1) KUVE25-B..-HS (design High-Speed) systems are supplied with an initial greasing.

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Initial grease quantities for KUVE..-UG with preservative (without basic greasing)

Designation	Initial grease quantity ≈ g
KUVE15-B (-S, -H, -E, -ES) ..-UG	0,9
KUVE15-B-EC (-ESC) ..-UG	0,6
KUVE15-W..-UG	0,9
KUVE20-B (-S, -H, -SN, -N, -E, -ES) ..-UG	1,7
KUVE20-B-L (-SL, -SNL, -NL) ..-UG	2,2
KUVE20-B-EC (-ESC) ..-UG	1,7
KUVE20-W..-UG	1,7
KUVE20-WL..-UG	2,2
KUVE25-B (-S, -H, -SN, -N, -E, -ES) ..-UG	2,5
KUVE25-B (-S, -H, -SN, -N, -E, -ES) -HS..-UG	2,5
KUVE25-B-L (-SL, -HL, -SNL, -NL) ..-UG	3,5
KUVE25-B-EC (-ESC) ..-UG	1,7
KUVE25-W..-UG	2,5
KUVE25-WL..-UG	3,5
KUVE30-B (-S, -H, -SN, -N, -E, -ES) ..-UG	4,8
KUVE30-B-L (-SL, -HL, -SNL, -NL) ..-UG	6,1
KUVE30-B-EC (-ESC) ..-UG	3,1
KUVE30-W..-UG	4,8
KUVE35-B (-S, -H, -SN, -N, -E, -ES) ..-UG	7,7
KUVE35-B-L (-SL, -HL, -SNL, -NL) ..-UG	9,9
KUVE35-B-EC (-ESC) ..-UG	4,8
KUVE35-WL..-UG	9,9
KUVE45-B (-S, -H, -SN, -N) ..-UG	13,8
KUVE45-B-L (-SL, -HL, -SNL, -NL) ..-UG	17,0
KUVE45-B-EC (-ESC) ..-UG	9,2
KUVE55-B (-S) ..-UG	16,7
KUVE55-B-L (-SL) ..-UG	21,9

Initial grease quantities for KUVS

Designation	Initial grease quantity[1] ≈ g
KUVS10-B	0,3
KUVS13-B	0,9
KUVS17-B	2,3

[1] KUVS systems are supplied with an initial greasing.

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Grease lubrication

Calculation of the lubrication interval Grease operating life

Since it is not possible to calculate all the influencing factors, the precise grease operating life can only be determined under operating conditions. The approximation equation below, however, can be used to determine a guide value for many applications:

$$t_{fG} = t_f \cdot K_P \cdot K_W \cdot K_U$$

t_{fG} h
Guide value for grease operating life in operating hours

t_f h
Factor for basic lubrication interval in operating hours, *Figure 1*

K_P, K_W, K_U –
Correction factors for load, stroke length and environment, see page 52.

The grease operating life is restricted to a maximum of three years due to the ageing resistance of the grease:

- for linear recirculating roller bearing and guideway assemblies RUE-E, to 18 000 h
- for linear recirculating ball bearing and guideway assemblies KUSE, KUVE..-B, KUVE..-W, KUVS, to 26 000 h.

Basic lubrication interval

The basic lubrication interval t_f is valid under the following conditions, *Figure 1*:

- bearing temperature < +80 °C
- load ratio $C_0/P = 20$
- no disruptive environmental influences
- stroke ratio between 10 and 50, *Figure 3*, page 52.

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Speed parameter

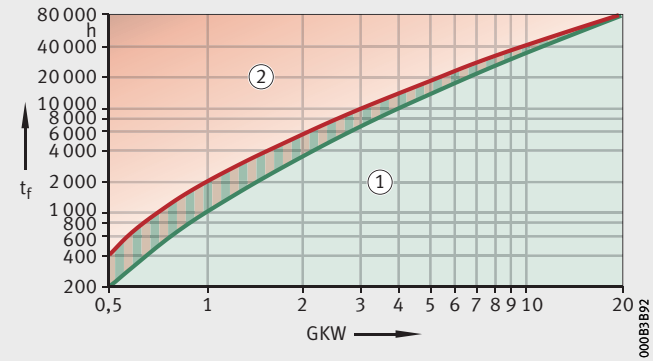
The speed parameter is defined as follows:

$$GKW = \frac{60}{v_m} \cdot K_{LF}$$

GKW –
Speed parameter, *Figure 1*

v_m m/min
Mean travel velocity

K_{LF} –
Bearing factor, see table, page 51.



t_f = basic lubrication interval
GKW = speed parameter
① Relubrication possible
② Regreasing necessary

Figure 1
Determining the basic lubrication interval

The bearing factor K_{LF} takes account of the internal and external structure of the bearing, such as lubricant reservoirs, wipers and additional lubrication devices that influence the grease operating life.

Bearing factor K_{LF} for delivered condition

Linear guidance system	Bearing factor K_{LF}		
	Carriage with initial greasing and		Long term lubrication unit KIT[1] (KIT series 400)
	single lip wipers	double lip wipers	
RUE..-E	0,8	1,2	2,5
KUSE	1,5	–	–
KUVE..-B	2,5	4,5	5,5
KUVE25-B..-HS	–	2,7	–
KUVE..-W	2,5	4,5	5,5
KUVS	1,5	–	–

[1] Valid only with mounting on both sides of the long term lubrication unit KIT on the carriage.

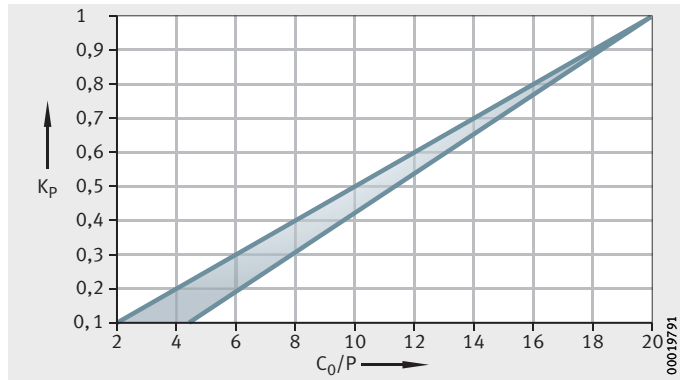
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Grease lubrication

Correction factor for load K_P

The correction factor K_P takes account of the strain on the grease at a load ratio of $C_0/P < 20$, *Figure 2*.

The factors are only valid for high quality lithium soap greases.

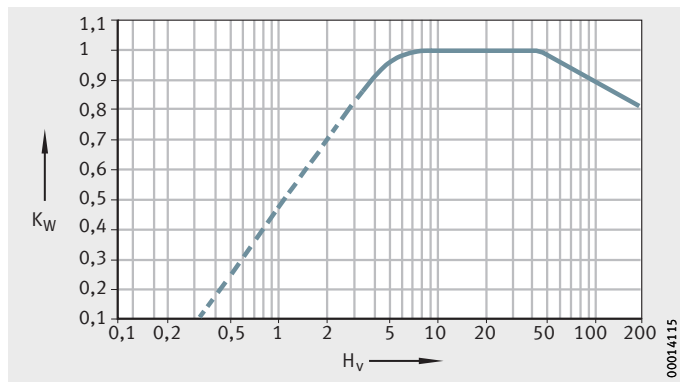


K_P = correction factor for load
C_0/P = load ratio

Figure 2
Correction factor for load

Correction factor for stroke K_W

The correction factor K_W takes account of the displacement distance to be lubricated, *Figure 3*. It is dependent on the stroke ratio.



K_W = correction factor for stroke length
H_v = stroke ratio

Figure 3
Correction factor for stroke length

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Stroke ratio

If the stroke ratio is < 10 or > 50, the grease operating life is reduced due to the risk of fretting corrosion or the loss of grease.

The stroke ratio is calculated as follows:

$$H_v = \frac{H \cdot 10}{L_1}$$

H_v – Stroke ratio

L_1 mm Effective saddle plate length, see dimension tables

H mm Stroke length.

If the stroke length is very small ($< 2 \cdot L_1$), the grease operating life may be shorter than the calculated guide value. In such cases, special greases are recommended.

Correction factor for environment K_U

The correction factor K_U takes account of shaking forces, vibrations (a cause of fretting corrosion) and shocks as well as environmental influences (contamination and operating media), see table.

These influences place an additional strain on the grease.

Cooling lubricants can wash greases out of the carriage. If cooling lubricant or moisture comes into contact with the linear system, calculation in approximate terms is possible but, for reasons of unpredictability, it must be regarded as a guide value only and requires monitoring and adjustment in practice. Where necessary, the grease operating life must be completely determined again.

Environmental influence and correction factor

Environmental influence	Correction factor K_U
light	1
moderate	0,8
heavy	0,5

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Grease lubrication

Relubrication interval

If the guide value for the grease operating life t_{fG} is less than the required operating duration of the linear unit, relubrication must be carried out.

Relubrication must be carried out at a time when the old grease can still be forced out of the carriage by the new grease.

A guide value for the relubrication interval for most applications is:

$$t_{fR} = 0{,}5 \cdot t_{fG};\ t_{fG} < t_{fE}$$

t_{fR} h
Guide value for relubrication interval in operating hours

t_{fG} h
Guide value for grease operating life in operating hours

t_{fE} h
Required operating duration in hours.

Relubrication of the guidance system

Relubrication should be carried out at a stage no later than half the grease operating life.

For the relubrication of monorail guidance systems, Schaeffler offers matched lubrication connectors, depending on the wiper KIT combination, RWU, see page 164, KWSE, see page 254, KWVE..-B, see page 384, KWVE..-W, see page 394.

Lubricating grease

Relubrication should be carried out using the same grease as for initial greasing; if different greases are to be used, the miscibility and compatibility of the greases must first be checked, see page 40.

Relubrication quantity

The relubrication quantity is approx. 50% of the initial grease quantity. In the case of KUVE, the relubrication quantity is 50% of the initial grease quantity without basic greasing, see page 49. Relubrication should be carried out wherever possible with several partial quantities at various times instead of the complete quantity at the time of the relubrication interval.

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Relubrication procedure

Relubrication should be carried out with the carriage still warm from operation and the carriage should be moved during relubrication. The minimum stroke is four times the saddle plate length; saddle plate length (L_1), see dimension tables.

If lubrication is carried out by hand, the grease gun, lubrication connector and the environment of the lubrication connector must first be cleaned thoroughly.

If long term lubrication units are used, these must always be mounted on both sides of the carriage in order to achieve the stated bearing factors K_{LF}.

Long term lubrication units are a component of the KIT series 400.

Influence of grease on friction behaviour

During commissioning and relubrication, the coefficient of friction increases temporarily due to the fresh grease. After a short running-in period, however, the coefficient of friction returns to its original lower value.

The friction behaviour is determined significantly by the characteristics of the grease used. The consistency and base oil viscosity serve as approximate guide values.

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Special coatings

In order that standard components can function for long periods, without maintenance and reliably even under extreme operating conditions, Schaeffler has developed various coatings for such requirements.

These coatings increase the corrosion resistance and/or wear resistance of the surface.

The selection of the coating is always dependent on the area of operation and the application.

Coatings have an effect on system accuracy. Tolerances for coated parts of linear recirculating roller bearing and guideway assemblies, see page 115, for six-row linear recirculating ball bearing and guideway assemblies, see page 225, for four-row linear recirculating ball bearing and guideway assemblies, see page 306.

Coated carriages and coated guideways must always be used in combination. If coated carriages are used with uncoated guideways, for example, this will lead to a reduction in preload.

Types of coatings

Components at risk of corrosion are protected by the:

- special coating Corrotect (RROC), see page 57
- thin dense chromium coating Protect A (KD), see page 59.

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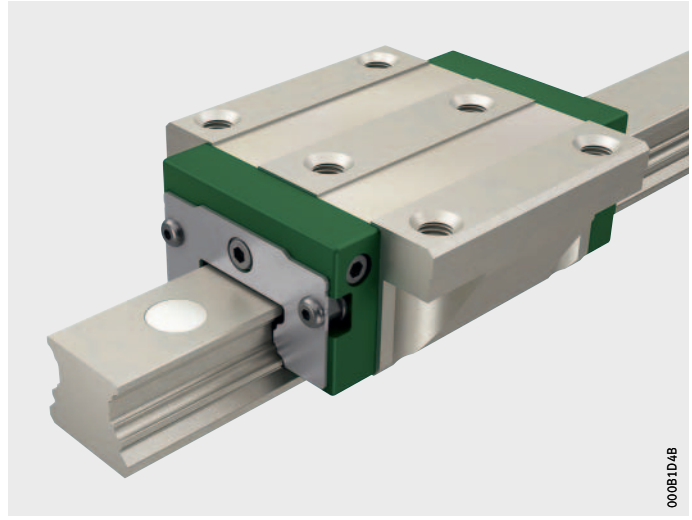
Corrotect special coating

Corrosion protection

Corrotect is a surface coating applied by electroplating, *Figure 1*. The coating gives cathodic corrosion protection and is extremely thin. Under load, it is compacted into the surface roughness profile and partially worn away.

In parts coated with Corrotect, running-in occurs in the area of the seal and an optically bright area develops as a result. Due to the remote cathodic protection mechanism, formation of rust in this area can also be prevented.

Parts with Corrotect coating have the suffix RROC.



KUVE..-B-RROC

Figure 1
Corrotect special coating – Cr(VI)-free

Advantages of RROC

The special coating Corrotect:

- is resistant to moisture, salt spray mist, contaminated water and weak alkaline or weak acidic cleaning agents
- does not impair the load carrying capacity, in contrast to the use of corrosion-resistant steels
- is extremely resistant to corrosion
- offers protection against rust on all surfaces
- gives protection against rust even on smaller bright spots due to the cathodic protection effect
- gives protection against EP additives
- has good thermal conductivity
- is free from Cr(VI) and fulfils the requirements relating to RoHS in accordance with EU Directive 2002/95/EC
- is suitable for use in the food industry.

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Special coatings

Applications

Components coated with Corrotect are particularly suitable where corrosion resistance is the most important factor.

The coating can also be used to prevent adhesion of weld spray.

Available products

The following products in the field of linear motion are available with the Corrotect coating:

- linear recirculating roller bearing and guideway assemblies RUE..-E
- linear recirculating ball bearing and guideway assemblies KUSE
- linear recirculating ball bearing and guideway assemblies KUVE..-B
- linear recirculating ball bearing and guideway assemblies KUVE..-W
- linear recirculating ball bearing units KUVS.

Suffixes

Components with the Corrotect Cr(VI)-free coating have the suffix RROC, see Ordering example.

Ordering designation

The ordering designation for a linear recirculating ball bearing and guideway assembly KUVE45-B with the Corrotect Cr(VI)-free coating is, for example:

- KUVE45-B-W1-V1-G3-RROC.

Technical/physical data for Corrotect

The table shows technical/physical data for the special coating Corrotect.

Data for Corrotect

Characteristics	Data
Suffix	RROC
Colour	Colourless, blue to iridescent
Layer thickness[1)]	0,5 µm – 3 µm
Number of layers	1
Composition	Zinc alloyed with iron
Layer hardness	300 HV
Corrosion protection[2)]	96 h
Coating resistance	The coating has reduced corrosion resistance for pH values < 6 and pH values > 8
Wear protection	–
Maximum single-piece length	3 500 mm
Cr(VI)-free	yes

1) Thickness in functional area.

2) Salt spray test in accordance with DIN EN ISO 9227.

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Protect A

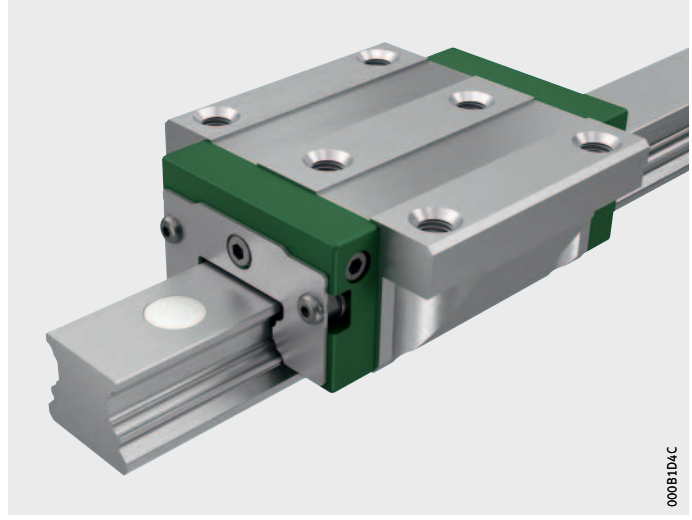
Wear and corrosion protection

Protect A is a pure chromium coating with a columnar surface structure, *Figure 2*.

The coating is applied by electroplating. The parts to be coated are heated to approx. +50 °C. Since no structural changes occur, the parts retain full dimensional stability.

The matt grey chromium layer retains a certain amount of lubricant in the recess between the Cr pearls. As a result, effective wear protection is achieved even under mixed friction or slippage conditions.

Parts with Protect A coating have the suffix KD.



KUVE..-B-KD

Figure 2
Thin dense chromium coating
Protect A

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Special coatings

Advantages of KD

The coating:

- is resistant to various chlorides, various oils, sulphur compounds, chlorine compounds and weak acidic media
- does not influence the load carrying capacity and operating life of the coated products
- has higher wear resistance due to its high hardness
- ensures effective wear protection even under mixed friction conditions
- offers good protection against EP additives
- has good thermal conductivity
- is moderately resistant to corrosion
- prevents false brinelling under vibration while stationary
- is Cr(VI)-free and, at the time of issue of this catalogue, is compliant with the RoHS Directive 2011/65/EU.

The high hardness of the thin dense chromium coating and the special surface structure give an anti-wear effect. The columnar structure has a certain capacity for storage of lubricant. This ensures adequate lubricant in the rolling element contact zone even under extreme environmental and operating conditions.



For use in the food industry, compliance with exacting environmental and health conditions must be achieved. The coating Protect A is free from Cr(VI) and can therefore also be used in this sector.

Operating temperature

The temperature range of the guidance system is between –10 °C and +80 °C.

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Applications

Protect A does not contain Cr(VI). Components with this coating are therefore particularly suitable for use in the food industry, medical equipment and similar areas.

The coating is recommended for particularly short stroke lengths and vibrations while stationary.

Available products

The following products in the field of linear motion are available with the Protect A coating:

- linear recirculating roller bearing and guideway assemblies RUE..-E
- linear recirculating ball bearing and guideway assemblies KUVE..-B
- linear recirculating ball bearing and guideway assemblies KUVE..-W
- linear recirculating ball bearing units KUVS.

Suffixes

Components coated with Protect A have the suffix KD, see Ordering designation.

Ordering designation

The ordering designation for a linear recirculating ball bearing and guideway assembly KUVE25-B with the Protect A coating is, for example:

- KUVE25-B-W2-V2-G3-KD.

Technical/physical data for Protect A

The table shows technical/physical data for the special coating Protect A.

Data for Protect A

Characteristics	Data
Suffix	KD
Colour	Matt grey
Layer thickness[1)]	0,5 µm – 4 µm
Number of layers	1
Composition	Pure chromium layer with pearly surface
Layer hardness	900 HV – 1 300 HV
Corrosion protection[2)]	8 h
Wear protection	Under mixed friction
Maximum single-piece length	4 000 mm
Cr(VI)-free[3)]	yes

1) Thickness in functional area.

2) Salt spray test in accordance with DIN EN ISO 9227.

3) Parts free from Cr(VI) are suitable for the food industry.

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Mounting variants

Mounting work – Influencing factors and assessment

The amount of work involved in mounting is essentially determined by:

- the arrangement of the screw mounting and locating surfaces for the guideways and carriages
- the accessibility of the fixing screws.

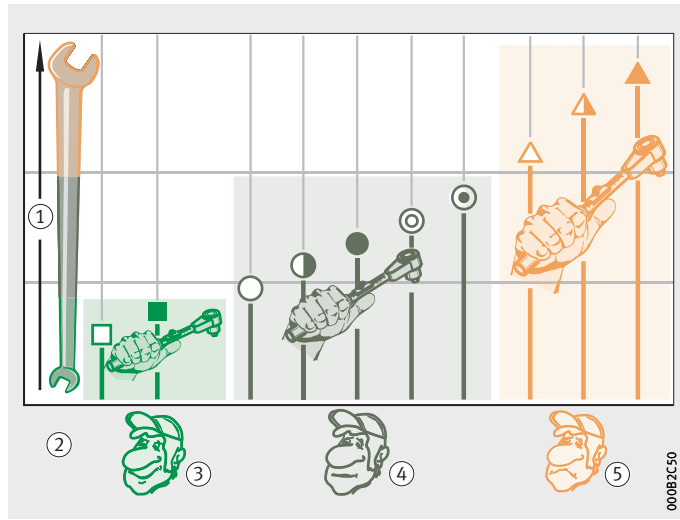
Based on these points, the mounting work can be assessed.

The structure, *Figure 1*, is ascending and describes the work according to the following criteria:

- simple mounting without fitting aids ③
- simple mounting with fitting aids ④
- demanding, time-consuming mounting with fitting aids ⑤.

For reasons of time and cost (reduced mounting work) only variants corresponding to ③ and ④ should be selected.

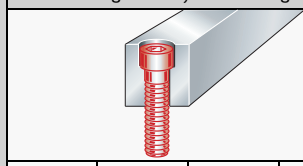
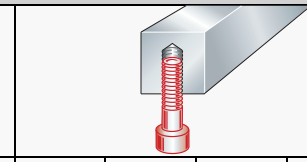
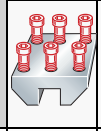
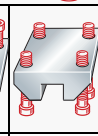
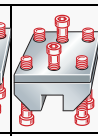
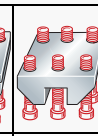
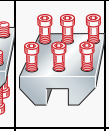
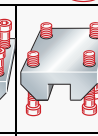
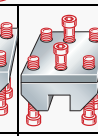
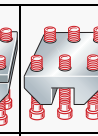
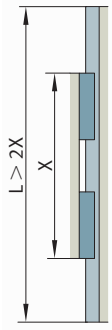
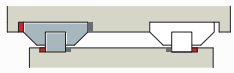
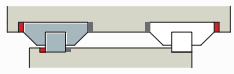
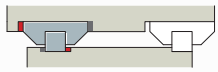
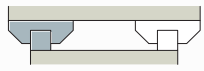
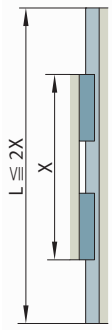
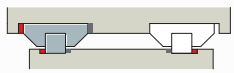
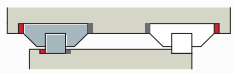
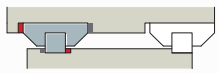
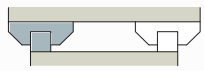
For the assessment of mounting work, see table, page 63.



① Mounting work
② Fitting variant
③ Simple mounting without aids
④ Simple mounting with aids
⑤ Demanding, time-consuming mounting with aids

Figure 1
Relationship between mounting work and mounting variant

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Mounting work as a function of the adjacent construction									
Ratio of table length to guideway length	Design of adjacent construction	Location of guideway and carriage							
									
									
		□	□	□	○	□	□	□	○
		□	□	□	○	□	□	□	○
		■	■	■	◎	■	■	■	◎
		◑	◑	◑	◉	◑	◑	◑	◉
		●	●	●	△	□	□	□	○
		●	●	●	△	□	□	□	○
		■	■	■	◭	■	■	■	◎
		◑	◑	◑	▲	◑	◑	◑	◉

□■○◑●◎◉△◭▲ From left to right: increasing mounting work

■ Pressure and fixing elements

■ Locating faces

Datum side

Adjustment side

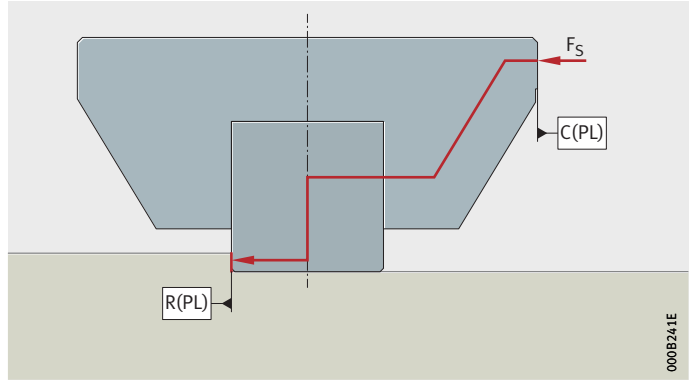
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Connection to the adjacent construction

The connection between the guidance elements and the adjacent construction influences the effective load carrying capacity.
The direction of the forces and moments, the position and arrangement of the locating faces as well as the load carrying capacity and the number of screws must be taken into consideration.

The better supported the guidance system is in relation to the forces occurring, the greater the extent to which the load carrying capacity can be used, *Figure 2*.

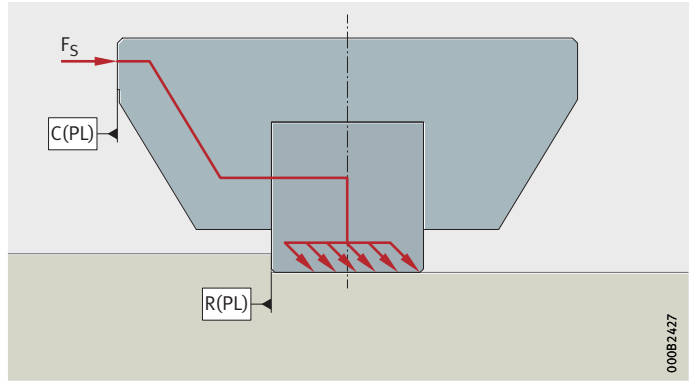
Locating faces must be provided.



F_S = lateral force

Figure 2
Favourable application of force

If no locating faces are present, the maximum lateral load that can be transmitted is dependent on the screw connection between the guideway and adjacent construction, *Figure 3*. This must be taken into consideration in the design process at the customer.



F_S = lateral force

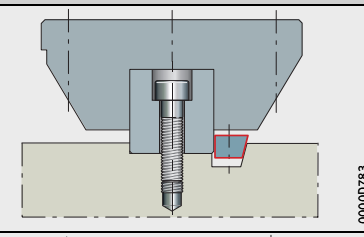
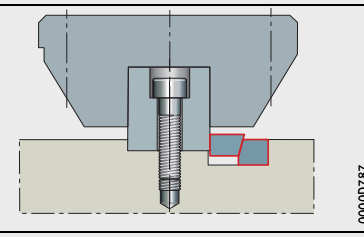
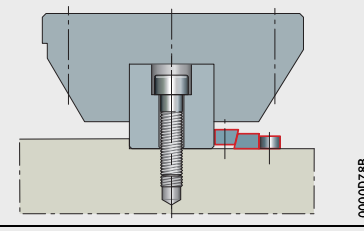
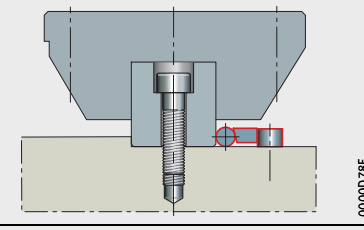
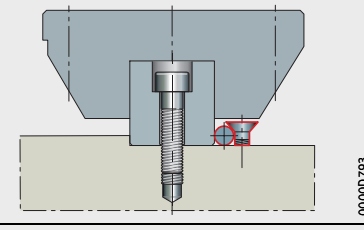
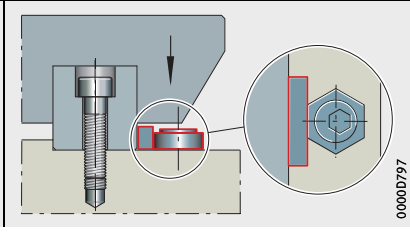
Figure 3
Unfavourable application of force

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Pressure and fixing elements

For guideways and carriages, pressure and fixing elements should be provided, see table.

Fixing method

Element	
Vee strip, integrated in a slot in the machine bed	 0000D783
Double vee strip in a slot in the machine bed	 0000D787
Double vee strip screw mounted to the machine bed	 0000D78B
Vee strip with integral shaft, screw mounted to the machine bed	 0000D78F
Shaft screw mounted to the machine bed	 0000D793
Square section rail, adjusted using eccentric screw	 0000D797

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