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Product pictures are for illustrative purposes only and must not be used for design work.

Designs must only be prepared in accordance with the technical information, dimension tables and dimension drawings in this edition. In case of doubt, please consult the INA engineering service.

Due to constant development of the product range, we reserve the right to make modifications.

The sales and delivery conditions in force are those which form the basis of the invoices and contracts.

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HYDREL flat cage guidance systems

Linear recirculating roller guidance systems

Nowadays the performance of a linear guidance system is no longer determined simply by its load carrying capacity, rigidity and accuracy. In addition to these “basic virtues”, there is a demand for customised guidance system solutions. These are solutions that are precisely matched to the requirements of the application and thus have a positive influence on the overall design concept of the machine or installation. As a result, technically accomplished and particularly cost-effective complete designs can be achieved that fulfil the requirements of the market. In practice, therefore, various classes of guidance systems have gained acceptance whose suitability is often confined to particular applications.

Where linear locating or non-locating bearings with extremely high load carrying capacity and very smooth running are required for *limited* stroke lengths, *flat cage guidance systems* can be used. These guidance systems comprise a guideway arrangement separated by needle roller, cylindrical roller or ball flat cages. Flat cage guidance systems have extremely high rigidity, high accuracy and low friction and require significantly less space than other linear guidance systems.

Where locating/locating or locating/non-locating bearing arrangements with very high load carrying capacity are required for *unlimited* displacement distances, *linear recirculating roller guidance systems* can be used. These guidance systems comprise INA linear recirculating roller bearings with cylindrical rollers as rolling elements and HYDREL guideways with up to four raceways for the recirculating bearings. Linear recirculating roller guidance systems are preloaded and have extremely high rigidity, high accuracy and low friction; they allow compact designs that fulfil the requirements of the specific application.

Publication FRF gives information on the standard range of these HYDREL flat cage guidance systems and INA/HYDREL linear recirculating roller guidance systems. It supersedes the publications FKF and RUF. Any information in previous editions that does not concur with the data in this edition is therefore invalid.

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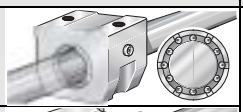
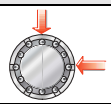
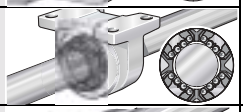
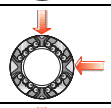
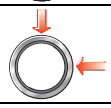
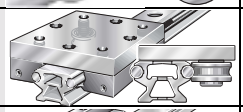
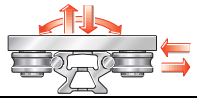
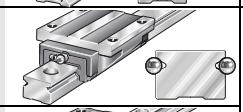
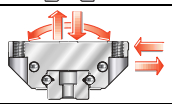
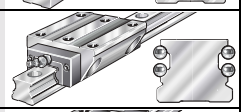
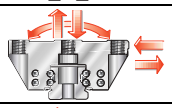
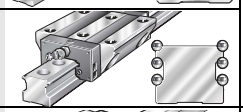
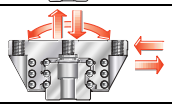
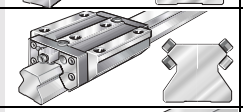
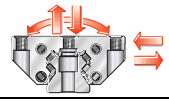
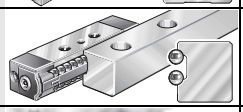
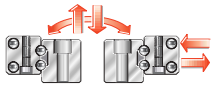
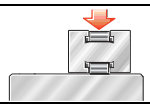
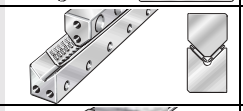
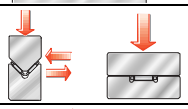
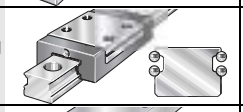
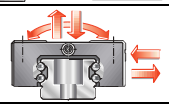
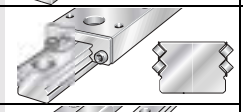
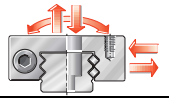
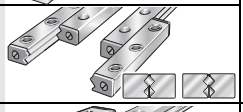
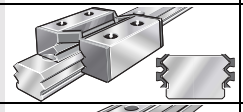
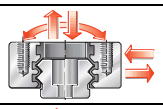
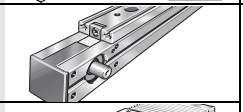
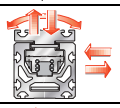
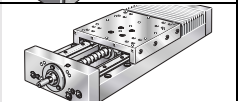
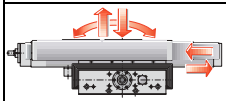
Linear guidance systems

Overview

Linear guidance systems		Applications	Load directions
Linear ball bearings **KH**		■ Machine building ■ Machine housings ■ Packaging machines ■ Handling equipment ■ Jigs and fixtures ■ For compensation of angular misalignment.	
Linear ball bearings **KS, KB**			
Linear plain bearings **PAB**		■ Hydrodynamically lubricated linear guidance systems with low noise levels.	
Track roller guidance systems **LF**		■ Machine building, packaging machines ■ Handling equipment.	
Two-row linear ball bearing and guideway assemblies **KUE**		■ Machine building ■ Sheet metalworking machines ■ Plastics injection moulding machines ■ Packaging machines ■ Handling equipment ■ Machine tools ■ For high load carrying capacity, rigidity and accuracy.	
Four-row linear ball bearing and guideway assemblies **KUVE**			
Six-row linear ball bearing and guideway assemblies **KUSE**			
Linear roller bearing and guideway assemblies **RUE**		■ Machine tools ■ For very high load carrying capacity, rigidity and accuracy.	
Linear recirculating ball bearing units **KUVS**		■ Machine building, handling equipment ■ Linear guidance systems adaptable to individual requirements.	
Linear recirculating roller bearings **RUS, PR**		■ Machine tools ■ Adaptable locating/non-locating systems with very high load carrying capacity, rigidity and accuracy.	
Flat cage guidance systems **M, V, ML, J, S**		■ Machine tools ■ For very high load carrying capacity, rigidity and accuracy ■ Very low friction with limited stroke length.	
Miniature linear recirculating ball bearing and guideway assemblies		■ Precision engineering, manufacture of electronic components ■ For low-friction applications.	
Miniature carriage units with flat cages **RMWE**		■ Precision engineering, manufacture of electronic components, microscope focussing systems ■ For high demands for ease of movement and low wear.	
Miniature linear guidance sets with flat cages **RWS**			
Plain guidance systems **GFS**		■ Operating and handling equipment ■ For maintenance-free applications.	
Actuators		■ Operating and handling equipment ■ Complete driven linear systems comprising mechanical components, electric motor and controller.	
Tables			

Load carrying capacity C/C_0 N	Bearing type/ Friction	Acceleration a_{max} m/s^2	Travel speed v_{max} m/min	Operating temperature °C	Information
up to 6 800/ up to 7 000	Ball recirculation	50	120	to +120	Catalogue 801
up to 8 000/ up to 10 600	Ball recirculation	100	120 to 300	to +120	Catalogue 801
up to 1 000 000	Plain bearing	50	180	to +80	Catalogue 801
up to 4 800/ up to 8 000	Track roller	50	600	–20 to +120	Catalogue 801
up to 28 000/ up to 37 000	Ball recirculation	150	180	–10 to +100	Catalogue 605
up to 82 000/ up to 181 000	Ball recirculation	150	300	–10 to +100	Catalogue 605
up to 125 400/ up to 312 000	Ball recirculation	150	300	–10 to +100	Catalogue 605
up to 270 000/ up to 640 000	Roller recirculation	100	120 to 180	–10 to +100	Catalogue 605
up to 26 000/ up to 46 500	Ball recirculation	150	180	–10 to +100	Available by agreement
up to 620 000/ up to 790 000	Needle cage	100	50 to 120	–10 to +100	Publication FRF
dependent on cage length	Needle cage	250	50 to 100	to +150	Publication FRF
up to 4 800/ up to 9 600	Ball recirculation	150	–	–10 to +100	MAI 81
up to 17 500/ up to 45 700	Roller cage	250	50 to 100	to +120	MAI 77
dependent on cage length	Roller cage	250	50 to 100	to +120	MAI 79
to 480	Plain bearing	–	60	–40 to +80	MAI 78
–	–	–	–	–	Publication ALE
–	–	–	–	–	Publication ALE

Zwischentitel

HYDREL flat cage guidance systems

HYDREL flat cage guidance systems

- comprise HYDREL/EGIS guideways of various types with appropriate flat or angled flat cages. The cage type depends on the guideway design
- have high precision raceways and cages with a large number of precision rolling elements – needle rollers, cylindrical rollers or balls
- are particularly suitable for limited stroke applications due to the relative movement between the cage and the two raceways
- are used as locating or non-locating bearings depending on their design
- give uniformly high accuracy over a wide range of loads
- have high load carrying capacity and rigidity with low friction coefficients
- are suitable for high accelerations
- do not involve recirculation of rolling elements and are characterised by smooth, quiet running
- differ from plain guidance systems in that accuracy is practically unaffected by the lubricant film
- require very little space compared to other linear guidance systems.

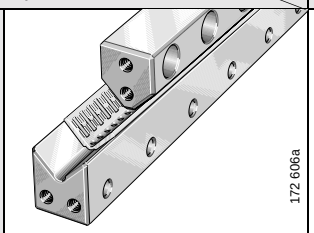
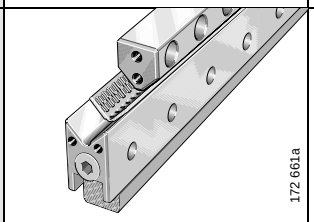
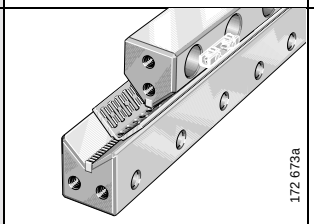
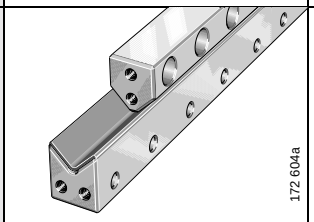
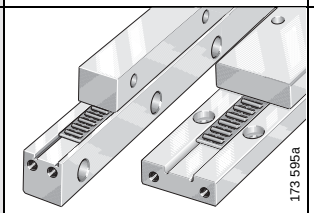
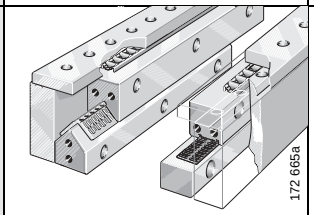
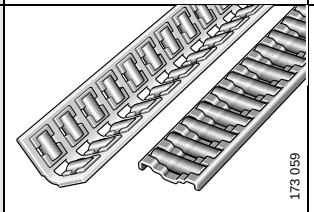
In addition to the individual components described, HYDREL can also supply complete, ready-to-fit flat cage guidance systems.
Due to its engineering expertise, HYDREL is also an ideal choice as a manufacturer of special parts to meet specific customer requirements with integral functional elements of a flat cage guidance system.

INA-Schaeffler KG
Linear Technology Division
Homburg (Saar)

HYDREL AG
Romanshorn (Switzerland)

Product range

Overview / selection scheme

Guidance system / Characteristic		Locating bearing arrangement	Non-locating bearing arrangement	Accuracy[2] Q2	Accuracy[2] Q6	Accuracy[2] Q10	Rigidity	Load carrying capacity	Friction	Operating temperature
M / V	 172 606a	■		■	■	■				to +150 °C to +120 °C[1]
ML / V	 172 661a	■			■	■				to +150 °C to +120 °C[1]
MVZ	 172 673a	■		■	■	■				to +100 °C
M with plain sliding layer / V	 172 604a	■			■	■				to +80 °C
J / S	 173 595a		■	■	■	■				to +150 °C to +120 °C[1]
L counter stay	 172 665a	■	■	■						to +150 °C
Angled flat cage **Flat cage**	 173 059	■	■							to +150 °C to +120 °C[1]

■ Design of flat cage guidance system. [1]) Temperature for operation with plastic cage. [2]) Optional.

Positive cage control	Preload by adjusting gib	Accessories[2]			Flat cage[2]			Anti-corrosion protection[2]	max. Acceleration	Features see Page
		End pieces	Wipers	sealing strips	Metal cage	Plastic cage	With friction damping			
		■	■	■	■	■	■	■	to 250 m/s²	 50
	■	■	■	■	■	■	■	■	to 250 m/s²	 56
■	■		■	■	■			■	to 100 m/s²	 62
	■		■						to 250 m/s²	 68
		■	■		■	■	■	■	to 250 m/s²	 74
		■	■		■	■	■	■	to 250 m/s²	 88
■					■	■	■	■	to 250 m/s²	 100

Contents

Product index

sorted alphanumerically

Page	Type	Description
95	HW	Angled needle roller flat cage made from light metal, double row, shanks at right angles to each other
95	H..ZW	Needle roller flat cage made from light metal, double row
97	HR..ZW	Cylindrical roller flat cage, double row, light metal carrier with plastic retainer inserts
74	J	Guideway for needle roller flat cages, matched to S guideway
82	LU	U counterstay for L counterstay system LUE
82	LUE	L counterstay system, comprising M, V, J and S guideways, one L counterstay, angled needle roller flat cages and needle roller flat cages
50	M	Guideway for angled needle roller and angled cylindrical roller flat cages, optionally with sliding layer, matched to V guideway
56	ML	M guideway with adjusting gib for preloading system, for angled needle roller flat cages, matched to V guideway
62	MVZ	Set of M and V guideways with integral toothed rack and pinion in cage for positive cage control, dimensionally identical to M and V guideways, with angled needle roller flat cage
74	S	Guideway for needle roller flat cages, matched to J guideway
50	V	Guideway for angled needle roller and angled cylindrical roller flat cages, matched to M or ML guideway

Index of suffixes

Sorting criteria:
A–Z

Suffix	Definition
BK	Metal flat cage made from aluminium or steel, protected against corrosion by plating on all surfaces
BR	Metal flat cage made from aluminium or steel, sliding surfaces with friction-reducing coating
DSV	Anti-corrosion protection by thin layer chromium plating
E1	No threaded holes in end faces of guideways
E2	Guideways with raceway lead zones on end faces
F	Cage made from unhardened steel
G..	Flat cage: other grades of rolling elements
L	Hole pattern on left, mirror image of R
LA../..	Indication of end distances if these are outside the limit values in the publication and/or are asymmetrical. Indication of C_5/C_6 by: C_5 distance between start of guideway and first hole C_6 distance between last hole and end of guideway
LB1	Raceway lined with TURCITE® B (standard)
LP21	Raceway lined with Permaglide® P21
MS	Cage made from brass
PP	M guideways sealed on all sides. Longitudinal surfaces with contact lip seals. End faces fitted with wipers EAM
..P	Restricted positional tolerance for hole pattern in guideways. Allows fitting to predrilled hole pattern. The suffix P is immediately after the grade
Q2	Accuracy class, high precision
Q6	Accuracy class, precision
Q10	Accuracy class, normal
R	Hole pattern on right, mirror image of L
..RS	Damping force differs from standard in needle roller flat cages with friction damping
US	M/V guideways with restricted tolerance for dimensions A_1 and A_2. US parts can be used in any combination
..ZZ	M guideways sealed on all sides. Longitudinal sealing by gap seals, end faces fitted with wipers EAM
2SX	X in the sort suffix indicates that linear guidance systems of non-identical design are sorted together. Example: M..2SX with ML..2SX or V../15..2SX with V../03..2SX
4SX	Matching in sets for combinations of M/V, J/S guideways in open designs

Symbols and units

Unless stated otherwise in the text, the values used in this catalogue have the following symbols, units and definitions.

b	mm	Distance between guidance systems
C	N	Basic dynamic load rating for a cage length of 100 mm
C_w	N	Effective dynamic load rating
C_L	N/mm	Rigidity of flat cage guidance system
C_{DIN}	N	Basic dynamic load rating C for a rating life of 100000 m
C_0	N	Basic static load rating for a cage length of 100 mm
C_{0w}	N	Effective static load rating
C_4	mm	Hole pitch
C_5, C_6	mm	Distance between start or end of guideway and nearest hole
C_{5min}, C_{6min}	mm	Minimum value for C_5 and C_6
C_{50000}	N	Basic dynamic load rating C for a rating life of 50000 m
D_w	mm	Ball diameter
e	mm	Distance between centre of first or last cage pocket and end of cage
f_H	–	Dynamic hardness factor
f_{H0}	–	Static hardness factor
f_α	–	Dynamic load direction factor
$f_{\alpha 0}$	–	Static load direction factor
F	N	Operating load, load on guidance system
F_i	N	Variable load
F_R	N	Displacement resistance
F_{RV}	N	Table displacement friction
F_w	–	Limiting load for effective cage length
F_{perm}	max.	Permissible limiting load for reference length of 100 mm
H	mm	Distance between end points of stroke
k_F	–	Dynamic load factor
k_{0F}	–	Static load factor
K	–	Factor for calculating elastic deformation, dependent on the product type
K_P	–	Load correction factor
K_U	–	Environmental correction factor
K_W	–	Stroke correction factor
K_{LF}	–	Bearing factor

L	m	Basic rating life in 100000 m
L	mm	Length of guideway
L_A	mm	Length of guideway with allowance for wiper
L_h	h	Basic rating life in hours
L_w	mm	Rolling element length
L_K	mm	Length of cage
M_A	–	Tightening torque for pressure screws
n	–	Maximum possible number of hole pitches
n_{osc}	min^{-1}	Number of return strokes per minute
p	–	Life exponent
p	N/mm^2	Contact pressure
P	N	Equivalent dynamic load
P_0	N	Maximum equivalent static load
q_i	%	Proportion of total duration
RS	N	Damping force of flat cages with friction damping in direction of movement
S_0	–	Static load safety factor
t	mm	Pocket pitch in basic cage element
t_f	h	Basic lubrication interval in hours
t_{fG}	h	Guide value for lubricant operating life in hours
t_{fR}	h	Guide value for relubrication interval in hours
v_i	m/min	Variable speed
$\overline{v}$	m/min	Equivalent dynamic speed
x	–	Number of holes
Z	–	Number of rolling elements per row
α	°	Load direction angle deviating from main load direction
δ	µm	Elastic deformation at contact points
μ	–	Coefficient of friction
μ_R	–	Coefficient of rolling friction
Δh	µm	Permissible height offset
Σ_R	N	Total frictional force

Load carrying capacity and life

The dimensioning of a flat cage guidance system is based on the basic dynamic and static load ratings of the flat cage fitted.

The basic load ratings of linear guidance systems without rolling element recirculation are defined in accordance with DIN 636-3. Basic dynamic load ratings in accordance with DIN 636 are calculated on a basic rating life of 100000 m.

Basic load ratings to DIN, basic load ratings as used in Far East

Suppliers from the Far East often give basic load ratings based on a rating life of 50000 m. The resulting basic load ratings are up to 20% higher than those calculated to DIN 636.
The basic load rating values are converted in accordance with Tables 1 and 2.

Table 1 · Converting basic load ratings to DIN to basic load ratings as used in the Far East

Flat cage guidance system	Conversion factor
Ball cage	$C_{50000} = \mathbf{1,26} \cdot C_{DIN}$
Cylindrical roller cage	$C_{50000} = \mathbf{1,23} \cdot C_{DIN}$

Table 2 · Converting basic load ratings as used in the Far East into basic load ratings to DIN

Flat cage guidance system	Conversion factor
Ball cage	$C_{DIN} = \mathbf{0,79} \cdot C_{50000}$
Cylindrical roller cage	$C_{DIN} = \mathbf{0,81} \cdot C_{50000}$

C_{50000} N
Basic dynamic load rating C for basic rating life of 50000 m

C_{DIN} N
Basic dynamic load rating C for basic rating life of 100000 m – definition in accordance with DIN 636.

Dynamic load carrying capacity and life

The dynamic load carrying capacity of the flat cage guidance system is determined by the fatigue behaviour of the material. The life, i.e. the fatigue life, depends on:

- the load acting on the guidance system
- the traverse speed of the guidance system
- the statistical probability of the first appearance of failure.

Basic rating life

The basic rating life is reached or exceeded by 90% of a sufficiently large group of apparently identical flat cage guidance systems before the first evidence of material fatigue occurs (*Calculation example*, page 24).

$$L = \left(\frac{C_w}{P}\right)^p$$

$$L_h = \frac{8{,}33 \cdot 10^5}{H \cdot n_{osc}} \cdot \left(\frac{C_w}{P}\right)$$

$$L_h = \frac{1666}{\bar{v}} \cdot \left(\frac{C_w}{P}\right)^l$$

L m
Basic rating life in 100000 m

L_h h
Basic rating life in hours

C_w N
Effective dynamic load rating (page 21)

P N
Equivalent dynamic load

p –
Life exponent:
flat cage guidance systems based on rollers: p = 10/3
flat cage guidance systems based on balls: p = 3

H mm
Distance between ends of stroke

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

$\bar{v}$ m/min
Equivalent dynamic velocity.

⚠ According to DIN 636-3, the equivalent dynamic load should not exceed $P = 0{,}5 \cdot C_w$!

Operating life

The operating life is defined as the life actually achieved by a flat cage guidance system. The operating life may deviate from the calculated life (basic rating life).

Possible reasons are wear and/or fatigue due to:

- misalignment between the guideways
- contamination of the guidance system
- inadequate lubrication
- reciprocating motion with very small stroke length (false brinelling)
- vibration during stoppage (false brinelling).

Since there is a wide range of possible installation and operating conditions, it is not possible to calculate the operating life of a flat cage guidance system precisely in advance. The most reliable method of achieving a good estimate of the operating life is by comparison with similar applications.

Equivalent load and speed

The life calculation formulae are based on the assumption that the load and speed remain constant. Non-constant operating conditions can be taken into consideration by means of equivalent operating values. These have the same effect on the life as the loads occurring in practice.

Equivalent dynamic load

General formula

$$P = \sqrt[p]{\left(\int_0^T |v(t) \cdot F^p(t)| dt\right) \left(\int_0^T |v(t)| dt\right)}$$

Load varying in steps

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

Load and speed varying in steps

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

Equivalent dynamic speed

General formula

$$\bar{v} = \frac{1}{T} \int_0^T |v(t)| dt$$

Speed varying in steps

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

P N
Equivalent dynamic load

p –
Life exponent:
flat cage guidance systems based on rollers: p = 10/3
flat cage guidance systems based on balls: p = 3

q_i %
Proportion of total duration

F_i N
Variable load

v_i m/min
Variable speed

$\bar{v}$ m/min
Equivalent dynamic velocity.

Static load carrying capacity

Permissible load

The static load carrying capacity of a flat cage guidance system is limited by

- the permissible load on the flat cage guidance system
- the load carrying capacity of the raceways
- the permissible load on the screw connections
- the permissible load on the adjacent construction.

⚠ Attention must also be paid to the static load safety factor required for the application!

Basic static load ratings

The basic static load ratings (*dimension tables*) are the loads under which a permanent deformation of the raceways and rolling elements occurs which corresponds to 1/10 000 of the rolling element diameter.

Static load safety factor

The static load safety factor S_0 indicates the security with regard to permissible permanent deformation in the bearing without affecting the guidance accuracy and smooth running of the bearing.

$$S_0 = \frac{C_{0w}}{P_0}$$

S_0 –
Static load safety factor

C_{0w} N
Effective static load rating (page 21)

P_0 N
Maximum equivalent static load.

If high demands are placed on accuracy and smoothness of running, the static load safety factor should not be less than $S_0 = 3$.

⚠ If $S_0 < 3$ for tensile and moment loading, the screw connections must be checked!

Calculation of effective load ratings

The basic dynamic and static load ratings C and C_0 given in the dimension tables are valid for a cage with a theoretical reference length of 100 mm. It is thus possible to make a direct comparison of the load carrying capacity of flat cages of various types and sizes.

For the effective cage lengths, the effective dynamic and static load ratings C_w and C_{0w} must be calculated using the formulae below.

Needle roller flat cages:

$$C_w = C \cdot \left(\frac{L_K - 2e + t}{100}\right)^{7/}$$

$$C_{0w} = C_0 \cdot \frac{L_K - 2e + t}{100}$$

Ball flat cages:

$$C_w = C \cdot \left(\frac{L_K - 2e + t}{100}\right)^{0,}$$

$$C_{0w} = C_0 \cdot \frac{L_K - 2e +}{100}$$

C N
Basic dynamic load rating for cage length of 100 mm (*dimension table*)

C_0 N
Basic static load rating for cage length of 100 mm (*dimension table*)

C_w N
Effective dynamic load rating

C_{0w} N
Effective static load rating

L_K mm
Length of cage (Figure 1)

e mm
Distance between first or last pocket centre and end of cage (Figure 1, *dimension table*)

t mm
Pocket pitch in basic cage element (Figure 1, *dimension table*)

Z –
Number of rolling elements per row.

⚠ The formulae for the effective load ratings will only give reliable results if the cage length $L_K = (Z\text{-}1)\,t + 2e$ is based on a whole number of rolling elements per row.

Formula for checking Z:

$$Z = \frac{L_K - 2e}{t} + 1 = \text{whole number!}$$

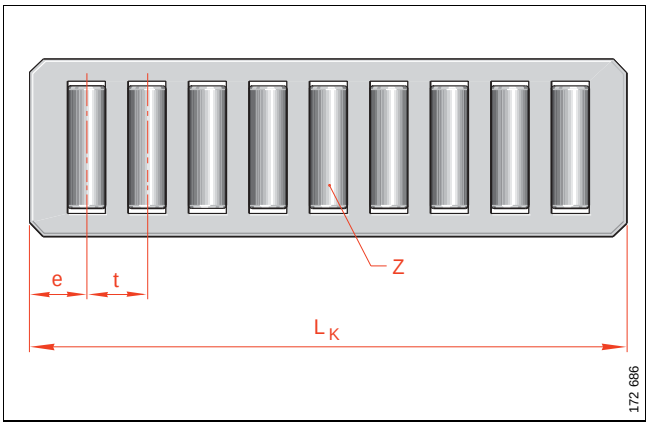


Figure 1 · Dimensions for calculating the effective load rating

Factors influencing the load carrying capacity

The basic load ratings given in the dimension tables are only valid under certain conditions. Correction factors should be used to take account of:

- deviating raceway hardness
- offset loading.

Hardness – correction factor

If flat cages are used on raceways with a surface hardness <670 HV (58 HRC), the basic load ratings must be multiplied by the hardness factor f_H or f_{H0} (Figure 2).

Load direction – correction factor

The effective basic load ratings of double row angled flat cages are dependent on the load angle α at which the load acts on the guidance system.

The basic load ratings in the dimension tables are valid on condition that the load acts symmetrical to the cage shanks ($\alpha = 0°$). For other load directions, the effective load ratings can be calculated using the formulae below and Figure 3.

Basic dynamic load rating

$$C_w = f_\alpha \cdot f_H \cdot C \cdot \left(\frac{L_K - 2e + t}{100}\right)^p$$

C_w N
Effective dynamic load rating

f_α –
Dynamic load direction factor

f_H –
Dynamic hardness factor

C N
Basic dynamic load rating for cage length of 100 mm (*dimension table*)

p -
Life exponent
for needle roller and cylindrical roller flat cages: p = 7/9
for ball flat cages: p = 0,7.

Basic dynamic load rating

$$C_{0w} = f_{\alpha 0} \cdot f_{H0} \cdot C_0 \cdot \left(\frac{L_K - 2e + t}{100}\right)$$

C_{0w} N
Effective static load rating

$f_{\alpha 0}$ –
Static load direction factor

f_{H0} –
Static hardness factor

C_0 N
Basic static load rating for cage length of 100 mm (*dimension table*)

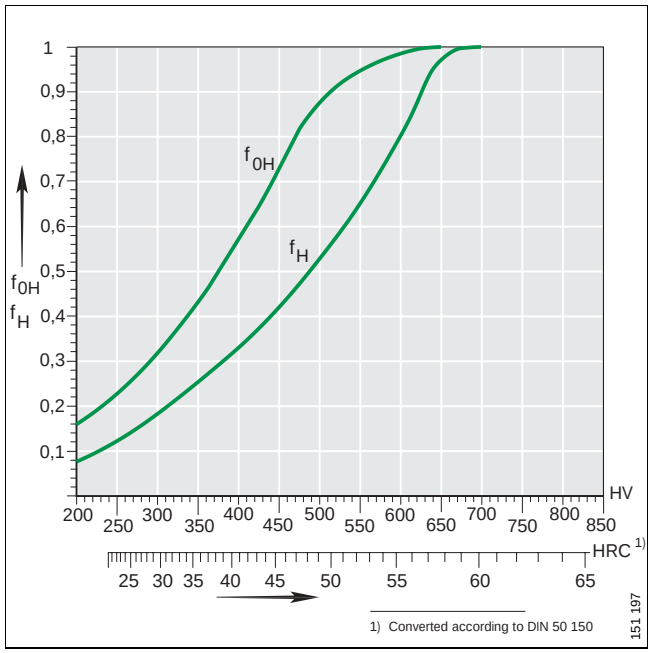


Figure 2 · Hardness factors for raceway

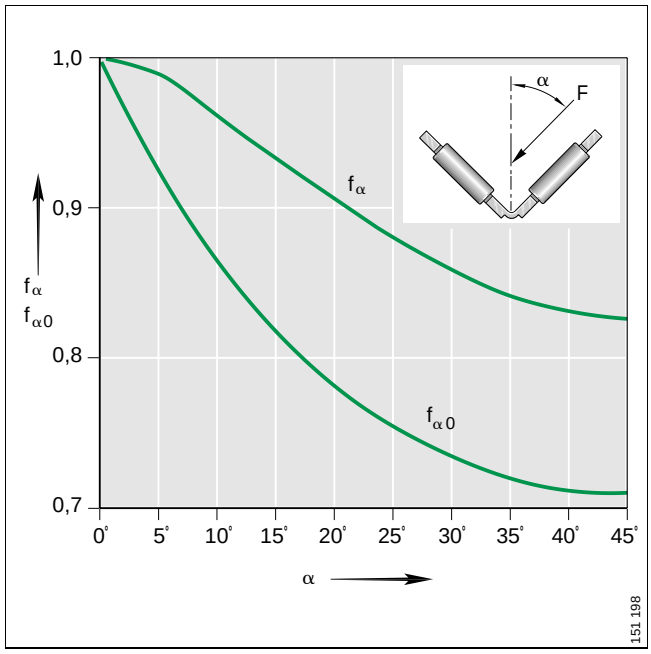


Figure 3 · Load direction factors for angled flat cages

Offset loading of guideways in open arrangement

Flat cages always travel half the distance of the moving guideway. They are therefore not subjected to uniform load in most cases.

The basic load ratings given in the dimension tables are only valid for uniform load distribution and concentric loading. If the cages are subjected to offset loading, the load carrying capacity and life can be calculated on the basis of the equivalent static or dynamic cage load (Figure 4). If the defined operating limits are exceeded, the cages are only subjected to partial load. This impairs the load carrying capacity and rigidity of the guidance system.

Open arrangement (*Design of bearing arrangements*, page 40, Figure 1).

Offset loading of guideways in closed arrangement

Guidance systems in a closed arrangement can be subjected to additional load and tilting moments.

Calculation of the equivalent cage load is a highly complex task. It is carried out by the INA engineering service using appropriate calculation programs (*Data sheet*, page 26).

Closed arrangement (*Design of bearing arrangements*, page 40, Figure 2).

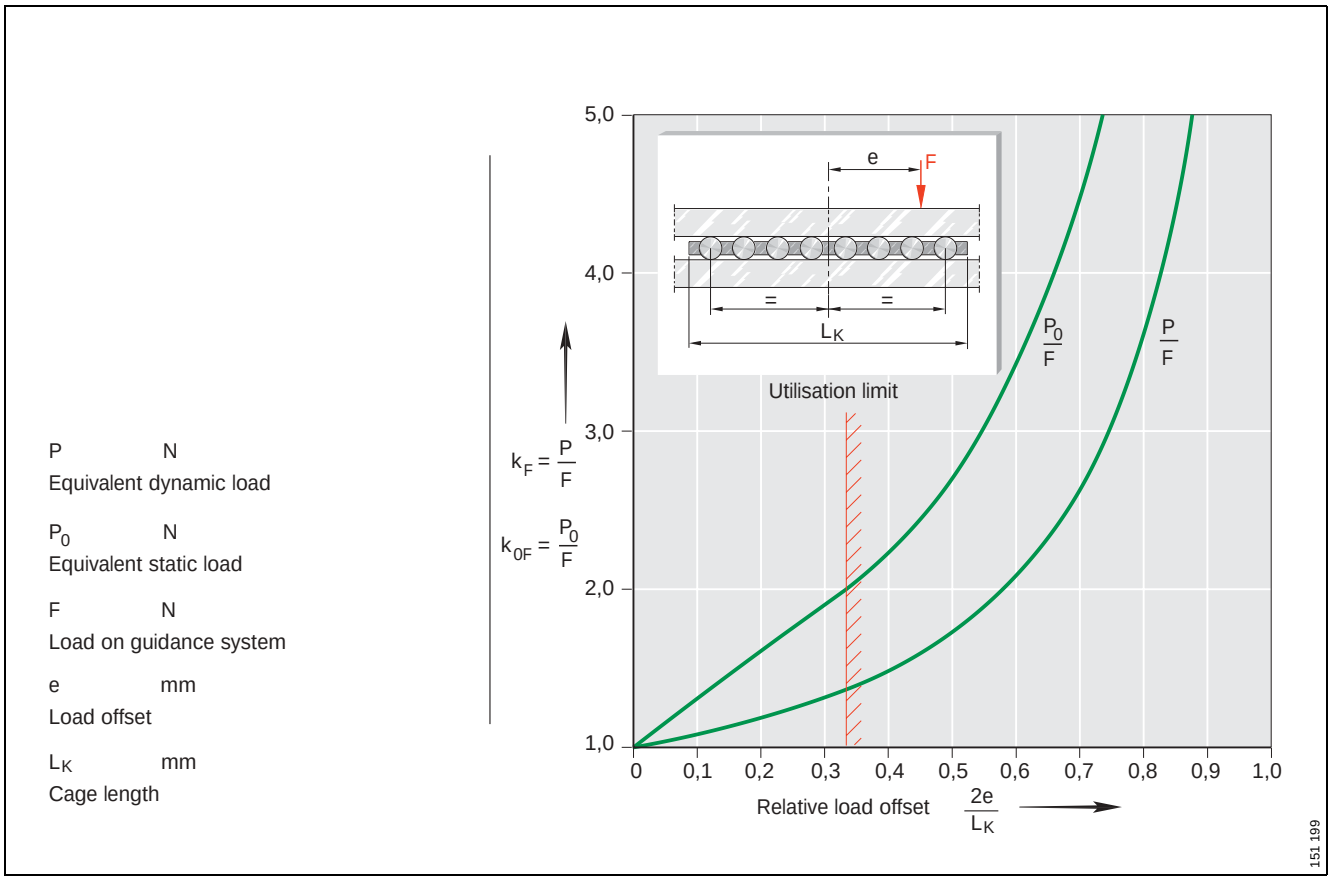


Figure 4 · Equivalent load for flat cages subjected to offset loading with open arrangement

Calculation example

Given data

Guideway			M 6035 and V 6035
Flat cage			HW 20
Basic dynamic load rating for a cage length of 100 mm	C	=	40300 N
Basic static load rating for a cage length of 100 mm	C_0	=	139500 N
Operating load, acting concentrically on the guidance system (factors f_α, $f_{\alpha 0}$, k_F, k_{0F} = 1)	F_B	=	25000 N
Distance between ends of stroke	H	=	200 mm
Number of return strokes per minute	n_{osc}	=	18 min^{-1}
Cage length	L_K	=	500 mm

Required

Basic rating life	L and L_h
Static load safety factor	S_0

Calculation

Checking the number of rolling elements per row (t, e, *dimension table*, page 104)

$$Z = \frac{L_K - 2e}{t} + 1$$

$$Z = \frac{500 - 8}{5,5} + 1 = 90 \text{ (rounded whole number)}$$

Effective dynamic load rating C_w

$$C_w = C \cdot \left(\frac{L_K - 2e + t}{100}\right)^{7/9}$$

$$C_w = 40300 \cdot \left(\frac{497,5}{100}\right)^{7/9} = 140000$$

Basic rating life L

$$L = \left(\frac{C_w}{P}\right)^{10/3}$$

$$L = \left(\frac{140000}{25000}\right)^{10/3} = 310 \cdot 10^5 \text{ r}$$

Basic rating life L_h

$$L_h = \frac{8,33 \cdot 10^5}{H \cdot n_{osc}} \cdot \left(\frac{C_w}{P}\right)^{10/3}$$

$$L_h = \frac{8,33 \cdot 10^5 \cdot 310}{200 \cdot 18} = 72000$$

Static load safety factor S_0

$$C_{0w} = C_0 \cdot \frac{L_K - 2e + t}{100}$$

$$C_{0w} = 133500 \cdot \frac{497,5}{100} = 664000 \text{ N}$$

$$S_0 = \frac{C_{0w}}{P_0}$$

$$S_0 = \frac{664000}{25000} = 26,6$$

Computer program

The calculation method on pages 21 to 24 is intended mainly for the preliminary selection of flat cage guidance systems. It allows only an approximate calculation of the equivalent bearing load, since:

- the formulae for calculating the element loads assume a system supported at two points.

Complex influencing factors

The system is not in fact supported at two points and cannot be calculated by simple means.

A precise calculation of the equivalent load requires precise knowledge of the internal load distribution. This means that the loads on the individual rolling elements must be known.

In principle, the internal load distribution could be taken into consideration by means of load factors. Due to the large number of possible load combinations, however, an impracticably large number of diagrams would be required.

In many applications, not only the load carrying capacity and life of the system but also the rigidity and displacement under combined load are important. The latter values can only be calculated by simple manual means for very simple load cases.

INA calculation program

INA has therefore developed a calculation program that can be used to calculate the load carrying capacity and rigidity under any combined load. The program takes into consideration the non-linear deflection curves of the rolling elements.
The adjacent construction is assumed to be rigid.

INA offers the calculation of linear guidance systems using this program as a service.

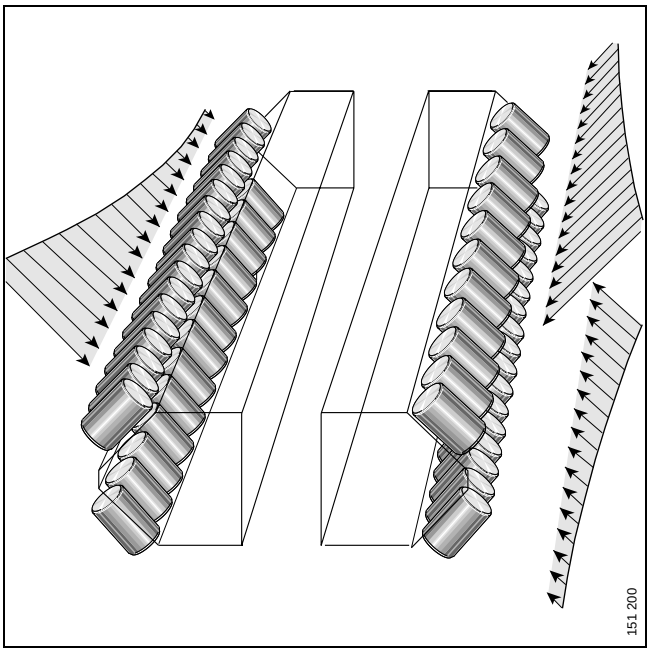


Figure 5 · Internal load distribution under combined load

The INA computer program for linear guidance systems calculates values such as:

- the static load safety factor
- the basic rating life
- the displacement resulting from the elasticity of the bearing arrangement.

For calculation, the following data must be given for each load case in a co-ordinate system with a freely selectable origin (Figure 6):

- the geometry and position of the monorail guidance system including the position of the drive axis
- the external load components (any number) and the positions of their loading points in the co-ordinate system
- the components of shear-free moments
- the masses (any number) and the positions of their centres of gravity in the co-ordinate system
- the kinetic values
- the durations of particular steps.

Data sheet

The geometry and loads can be easily described using the data sheet below (Figure 6):

- two masses and two loads are given in the data sheet as an example. The other masses and loads should be entered on the same basis
- if there are several planes, please complete a separate data sheet for each plane
- if there are planes or guideways at an angle to the planes of the co-ordinate system, please provide a diagram showing the positions of the planes
- the data must be given separately for each load case.

Calculation can also be carried out on the basis of a technical drawing containing the required dimensions and loads.

Guidance geometry			Position of guidance system			Kinetic values			Duration of particular step		
L_K		mm	x_{LF}		mm	a_{max}		m/s^2	q		%
b_1		mm	y_{LF}		mm	v_{max}		m/min	Shear-free moments		
b_2		mm	z_{LF}		mm	v		m/min	M_x		Nm
h_1		mm				H		mm	M_y		Nm
h_2		mm				n_{osc}		min^{-1}	M_z		Nm

Mass 1			Mass 2			Load 1			Load 2		
m_1		kg	m_2		kg	$F_{1\,x}$		N	$F_{2\,x}$		N
						$F_{1\,y}$		N	$F_{2\,y}$		N
						$F_{1\,z}$		N	$F_{2\,z}$		N

Centre of gravity 1			Centre of gravity 2			Loading point 1			Loading point 2		
$x_{m\,1}$		mm	$x_{m\,2}$		mm	$x_{F\,1}$		mm	$x_{F\,2}$		mm
$y_{m\,1}$		mm	$y_{m\,2}$		mm	$y_{F\,1}$		mm	$y_{F\,2}$		mm
$z_{m\,1}$		mm	$z_{m\,2}$		mm	$z_{F\,1}$		mm	$z_{F\,2}$		mm

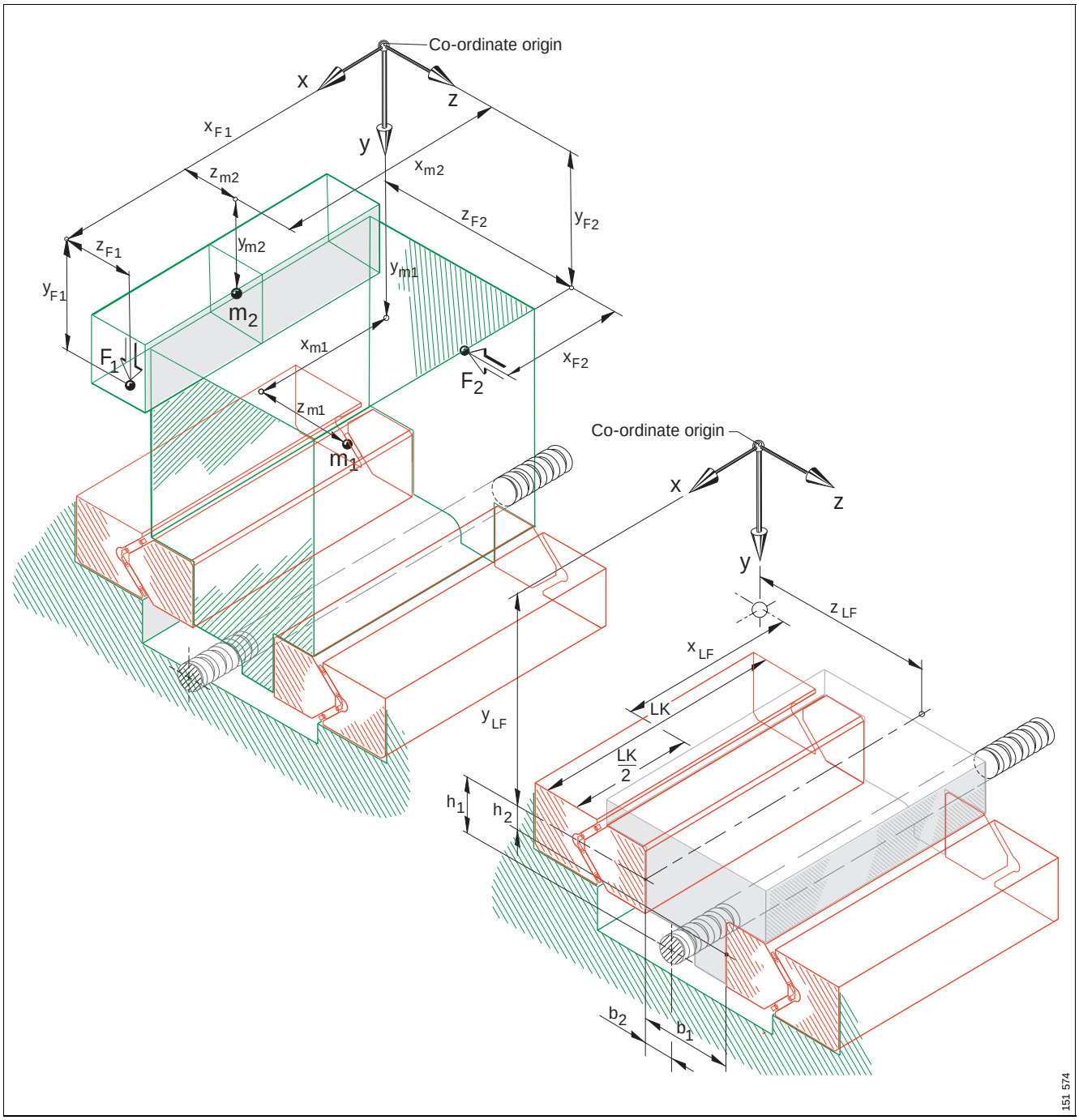


Figure 6 · Loading data for flat cage guidance systems

Preload

Preload:

- increases the rigidity and guidance accuracy of flat cage guidance systems
- reduces the high loads on the rolling elements at the ends of cages under moment load; this increases the moment load carrying capacity of the guidance system
- affects the displacement resistance and the operating life.

Preload value

Preload generally has a positive effect at a level of 0,02 to 0,03 · C_0. The optimum preload can be determined using the calculation programs of the INA data service.

If the preload is too low or too high, it can lead to uncontrolled displacement of the flat cage (cage creep).

Influence of the adjacent construction

If the rigidity is to be fully utilised, the adjacent construction must have sufficient rigidity and geometrical accuracy (*Design of bearing arrangements*). If the adjacent construction can be easily deformed or is not accurate, angular defects can occur between the raceways. The rolling elements may then be subjected to load at the ends only. In these cases, the rigidity of the system is not increased. Furthermore, the operating life may be reduced due to edge loads and cage creep may be induced.

Setting the preload

The preload can be measured and set by various methods:

- by pressure screws with a defined tightening torque (Table 1, page 29)
- by the table displacement friction F_{RV} (formula) when using pressure screws or guideways with an adjusting gib (page 29)
- by measuring the deformation of the adjacent construction once the correct deformation has been determined using the hydraulic adjustment rail (page 30).

$$F_{RV} = \frac{C_{0w}}{40000}$$

F_{RV} N
Table displacement friction

C_{0w} N
Effective static load rating

The formula is correct under the following conditions:

- preload 2,5% C_0
- guidance system lubricated, no operating load
- movement of approx. 0,05 m/s.

Pressure screws

Under low load ($S_0 > 5$), the preload can be applied by pressure screws on the back face of the guideway. The pressure screws (Figure 1, Table 1) should:

- have an even contact surface (dowel screw to ISO 4 026, DIN 913)
- be arranged in the spaces between the fixing screws and at the ends of the guideways.

Table 1 · Sizes of pressure screws / Tightening torques

Guideway	Pressure screw		Tightening torque[1])
	Size	Spacing mm	M_A Nm
M / V 3015	M 4	40	0,34
M / V 4020/5025	M 6	80	1,2
M / V 4525	M 6	80	1
M / V 6035	M 8	100	2,9
M / V 6535	M 8	100	3,5
M / V 7040	M10	100	5,7
M / V 8050	M12	100	7,7
M / V 8550	M12	100	7,3

[1]) Preload = 2,5% C_0 (*dimension table*).

Guideways with adjusting gib

Under high loads ($S_0 < 5$), or where high requirements are placed on rigidity, it is advantageous to use guideways ML with an adjusting gib. With these guideways, the preload is applied evenly over the whole length of the guidance system and precise adjustment is achieved.

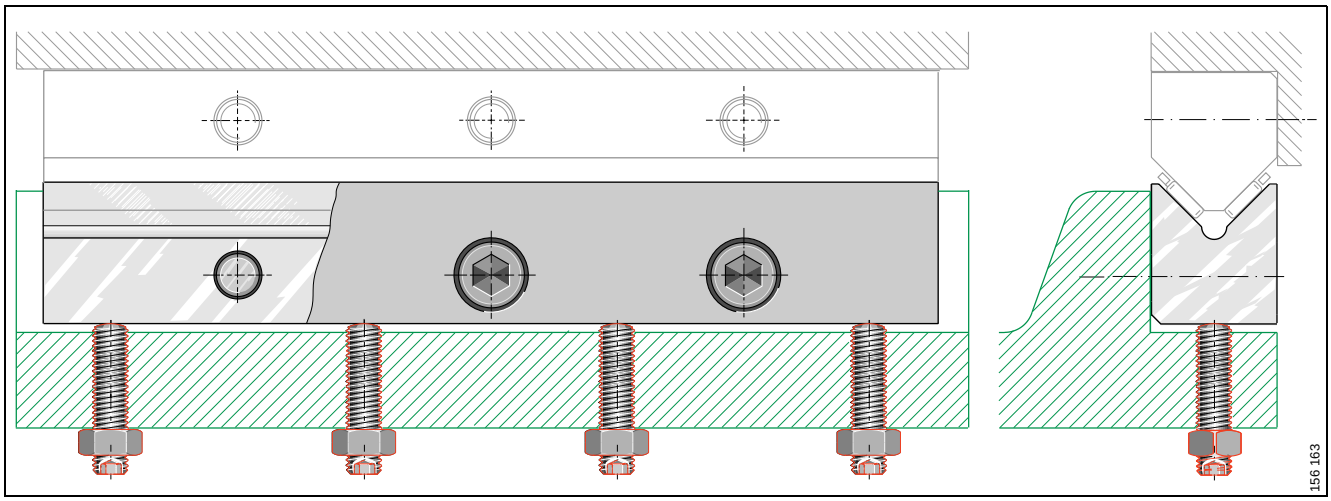


Figure 1 · Arrangement of pressure screws

Hydraulic adjustment rail

This rail can be used to determine the deformation of the adjacent construction and the preload of M, ML and V guideways in closed arrangements. The deformation is specific to the particular design and must only be determined once for a machine type (Figure 2).

Hydraulic adjustment rails are of a modular construction and can be matched to practically any application.
Such measurements are offered by INA as a service.

Description of the principle

- At initial assembly, replace one guideway and one flat cage by the hydraulic adjustment rail.
- Apply the necessary preload using the hydraulic adjustment rail.
- Measure the deformation (deflection) of the adjacent construction under the preload.
- Set the preload of the completely reassembled guidance system in accordance with the measured deformation.

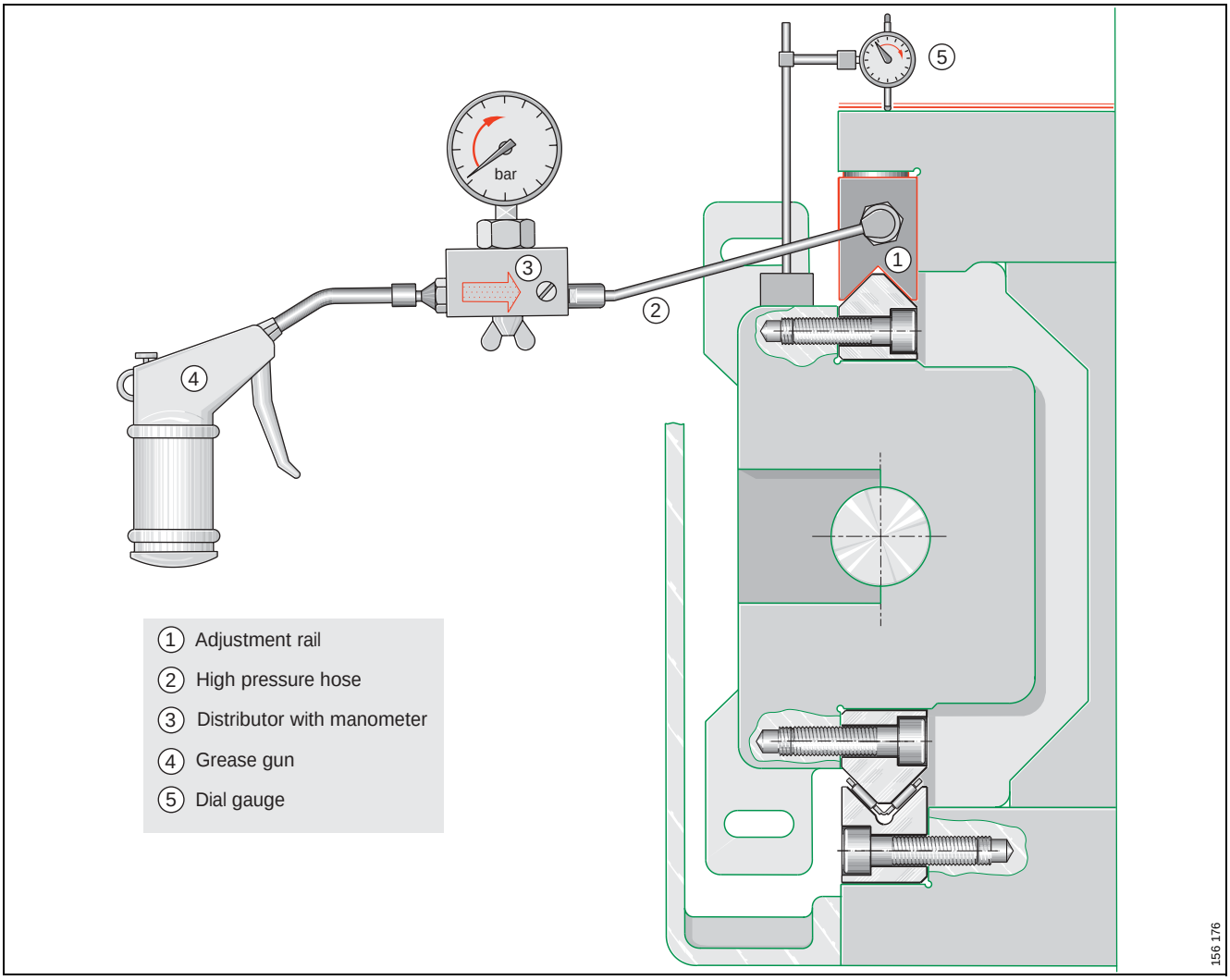


Figure 2 · Preload with hydraulic adjustment rail

Friction

At all traverse speeds, flat cage guidance systems have a low friction coefficient. The friction curve is uniform and the starting friction is slight. As a result, flat cage guidance systems run without stick-slip.

Friction coefficient

The total friction consists of:

- rolling and sliding friction in rolling contacts
- lubricant friction
- seal friction.

The friction coefficient is dependent on:

- the load
- the preload
- the traverse speed
- the lubricant
- the lubrication condition
- the temperature
- the installation accuracy.

The influence of these factors may be reciprocal, act in a single direction or counteract each other. The friction coefficient is characterised by the ratio of displacement force to normal load. Under normal conditions, the friction coefficient of rolling element guidance systems is between 0,001 and 0,004.

Fresh grease will cause a temporary increase in the friction coefficient. However, the friction coefficient returns to its original lower value after a short running-in period. This applies to both initial operation and regreasing.

Seal friction

The total friction is increased by contact type seals.

The seal friction is at its greatest with new guidance systems.

During the running-in phase, the seal lip geometry becomes worn at particular locations and adapts to the guideway; the seal friction decreases as a result.

Displacement resistance

The displacement resistance is defined as follows:

$$F_R = \mu \cdot F$$

F_R N
Displacement resistance

F N
Load on the guidance system

μ –
Friction coefficient.

The friction coefficient is dependent on the ratio C/P and is therefore a function of the load (Figure 1).

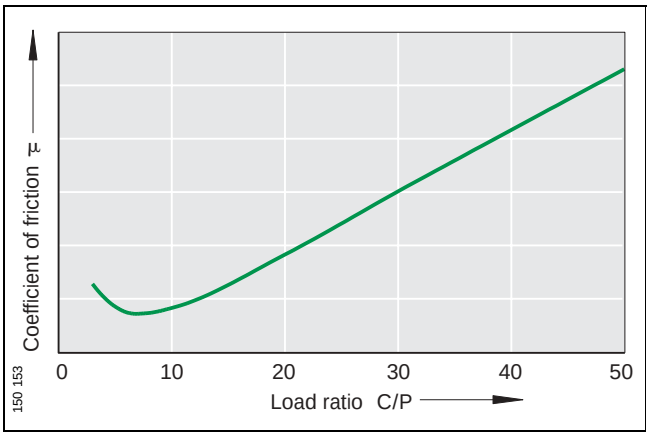


Figure 1 · Relationship between friction coefficient and load ratio C/P

Rigidity

In flat cage guidance systems, the load-bearing rolling elements are needle rollers, cylindrical rollers or balls.

Contact geometry

In guidance systems with needle or cylindrical rollers, the rolling elements are in line contact, while the rolling elements in guidance systems with balls are in four point contact. Due to the larger contact surface, guidance systems with needle or cylindrical rollers are significantly more rigid than guidance systems with balls (Figure 1).

Needle and cylindrical rollers have profiled ends, i.e. the outside surface of the roller curves has a curved surface running towards the ends. This reduces the edge stresses at the ends of the rolling elements. This has practically no effect on the load carrying capacity since the effective contact length between the roller and raceway is hardly reduced.

Elastic deformation

Flat cage guidance systems have extremely high rigidity. However, the operating load does lead to elastic deformation at the contact points. The deformation and rigidity are subject to the formulae on page 33.

⚠ This does not take account of elastic deformation of the adjacent construction and screw connections or of settling effects, etc. Since the adjacent construction is not completely rigid, the elastic deformation can in practice be somewhat higher.

In closed arrangements with M and V guideways, the rigidity of the guidance system can be further increased by preload (*Preload*, page 28).

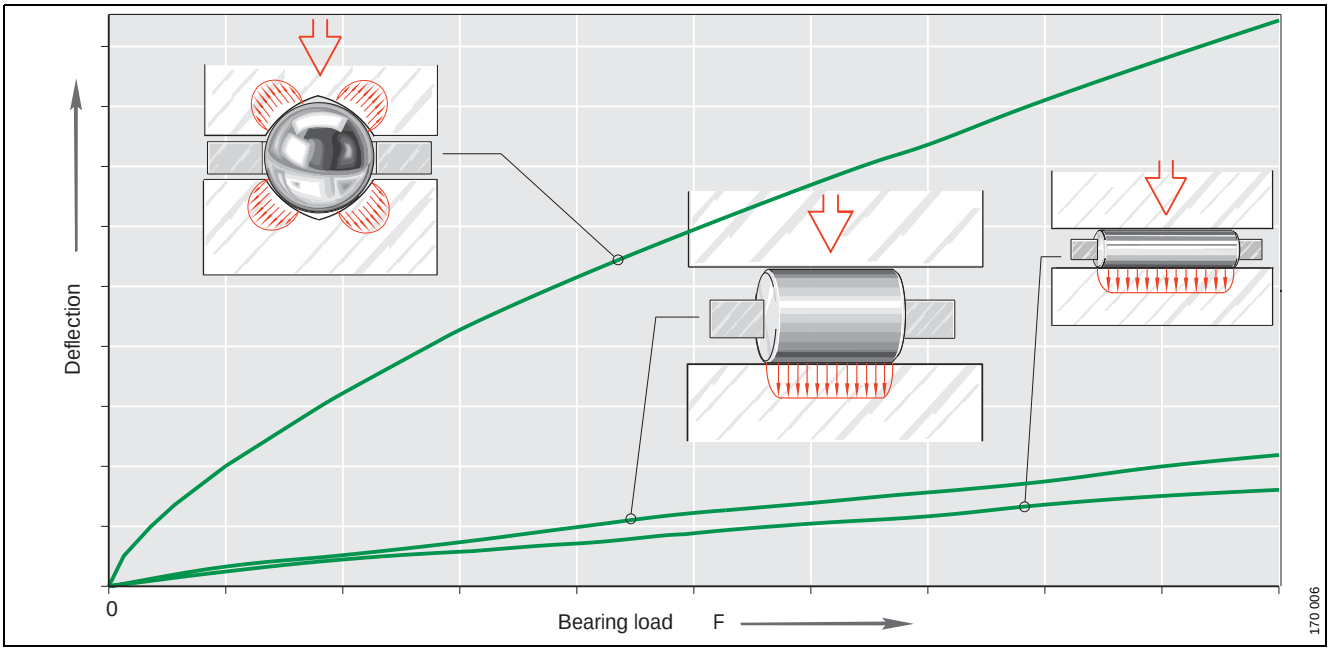


Figure 1 · Rolling element type and elastic deformation - deflection (rigidity)

Rigidity of flat cage guidance systems

The rigidity of a flat cage guidance system is determined by the ratio between the load and elastic deformation.

$$C_L = \frac{F}{\delta}$$

C_L N/µm
Rigidity of flat cage guidance system

F N
Operating load

δ µm
Elastic deformation at contact points.

Calculation of rigidity

The elastic deformation depends on the load, number, length and geometry of the rolling elements.

Flat cage guidance systems with line contact

$$\delta = K \cdot \frac{(F / Z)^{0,838}}{L_w^{0,605}}$$

$$C_L = \frac{1}{K} \cdot F^{0,162} \cdot Z^{0,838} \cdot L_w^{0,605}$$

Flat cage guidance systems with four point contact

$$\delta = K \cdot \frac{(F / Z)^{2/3}}{D_w^{1/3}}$$

$$C_L = \frac{1}{K} \cdot F^{1/3} \cdot Z^{2/3} \cdot D_w^{1/3}$$

δ µm
Elastic deformation at contact points.
Convergence of two raceway planes

K –
Factor for calculating elastic deformation, dependent on the product type (Table 1)

F N
Operating load

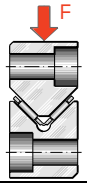
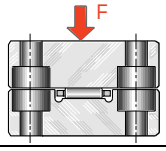
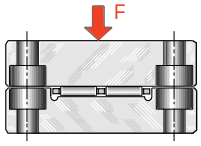
Z –
Number of rolling elements per row

L_w mm
Length of rolling element

C_L N/µm
Rigidity of flat cage guidance systems

D_w mm
Ball diameter.

Table 1 · Type factor for calculating elastic deformation

Guideway Type	Type factor K
	0,092
	0,087
	0,049

Calculation example

Guideway	M 6035 and V 6035
Flat cage	HW 20×500.
Operating load	25000 N
Number of rolling elements per row Z	90
Rolling element length L_w	9,8
Type factor K (Table 1)	0,092.

Calculation of elastic deformation:

$$\delta = K \cdot \frac{(F / Z)^{0,838}}{L_w^{0,605}}$$

$$\delta = 0,092 \cdot \frac{(25000 / 90)^{0,838}}{9,8^{0,605}} = 2,6 \text{ µm}$$

Calculation of rigidity:

$$C_L = \frac{25000}{2,6} = 9600 \text{ N/µm}$$

Lubrication

The performance capability of a machine is determined to a considerable extent by the flat cage guidance systems used. Lubrication constitutes an important component of the flat cage guidance system.

Lubricants (either grease or oil) perform the following functions:

- they reduce friction
- they minimise wear
- they prevent corrosion
- they give protection against contamination
- they increase the operating life of the guidance system.

Early selection

Lubrication is a design element! The lubricant and lubrication method must therefore be selected in the development phase of the machine. Experience has shown that considerable problems occur if the lubrication of the guidance system is only selected when the design is complete.

The lubricant requirement has an increasingly important role in guidance systems. A carefully considered lubrication concept is therefore indicative of a modern flat cage guidance system. The lubricant consumption should be as small as possible, especially in the case of oil lubrication.

It will be determined on the basis of technical and economic considerations whether oil or grease should be used and which lubrication method should be applied.

Advantages of grease lubrication

- Very little design work is required for relubrication devices if a central lubrication plant is not required
- Relubrication intervals up to one year
- Emergency running characteristics due to the thickener in the grease
- Good support to the seal.

Advantages of oil lubrication

- Heat dissipation
- Very good lubricant distribution
- Almost complete replacement of the lubricant when relubrication is carried out
- Contaminant particles are washed out.

Furthermore, oil lubrication is advisable where the adjacent machine elements are already supplied with oil.

Ensuring correct function

Flat cage guidance systems must be relubricated at appropriate intervals. The length of the interval is essentially dependent on:

- the speed
- the load
- the temperature
- the stroke length
- the environmental conditions.

The shorter the lubrication intervals, the easier it is to justify substantial expenditure on lubrication devices on economic grounds. Where the intervals are long, lubrication by hand or using semi-automatic devices can be advantageous.

Environmental protection

Any lubrication method involves loss of lubricant.
The lubricant consumed must be collected and disposed of by methods which help to protect the environment.

⚠ The handling and use of lubricants is governed by national regulations for environmental protection and health and safety at work as well as information from lubricant manufacturers. These specifications must be observed.

Flat cage guidance systems

Flat cage guidance systems require only small quantities of lubricant. They are supplied with a preservative as standard. The preservative is compatible with oils and greases.

The guidance systems operate almost exclusively under mixed friction conditions, especially at low speeds. Doped lubricants (type P to DIN 51502) should be used in preference.

⚠ Drilling oils or other coolant emulsions must not be used for lubrication. These have the effect of thinning the lubricating oils and can lead to corrosion in certain circumstances.

Lubricants with solid additives must not be used.

With M and V guideways, lubricant is generally introduced through the lateral gap between the upper and lower guideway. If this is not possible, for example if the guidance system is fitted in a vertical position, guideways with a relubrication facility can be supplied (special design).

Oil lubrication

Lubricating oils CLP to DIN 51517 and HLP to DIN 51524 should be used in preference. For operating temperatures between 0 °C and +70 °C, the viscosity should be between ISO VG 32 and ISO VG 68. For low-temperature operation, oils to ISO VG 10 or ISO VG 22 should be used.
Slideway oils CGLP up to ISO VG 220 may be used.

Oil impulse or oil drop lubrication is recommended. In highly contaminated environments, pneumatic oil lubrication is particularly advantageous. It creates a slight pressure in the guidance system, reinforcing the effectiveness of the seals.

The feed mechanism for the lubricating oil must be selected with reference to the installation position (Figure 1) such that all the rows of rolling elements are provided with lubricant.

Compatibility and miscibility

Before lubricating oils are used, their behaviour with respect to plastics, elastomers, light metals and non-ferrous metals must be checked under dynamic conditions at operating temperature if no past experience or data from the manufacturer is available.

In general, oils with a mineral oil base and with the same classification are miscible with each other. However, the viscosities should be within one ISO VG class of each other.

Synthetic oils should always be checked for their miscibility and compatibility before use. If there is any doubt, please consult the INA engineering service.

Initial operation

The raceway and cage of the flat cage guidance system should be oiled before initial operation and protected against solid and liquid contaminants.

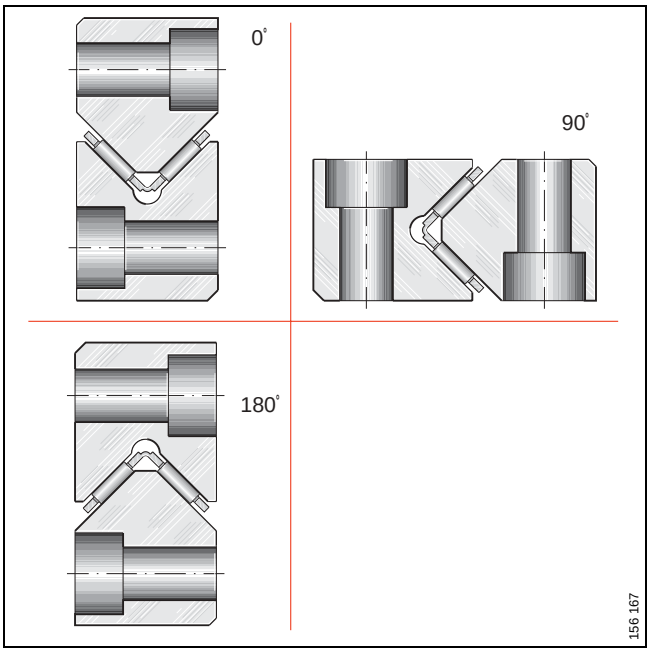


Figure 1 · Installation position of flat cage guidance systems

Grease lubrication

INA recommends lithium soap greases with a mineral oil base. The base oil viscosity should be between:

- ISO VG 150 and ISO VG 220.

For high loads ($S_0 < 8$), the following are absolutely necessary:

- EP doped greases with a base oil viscosity of ISO VG 220.

A lubricating grease KP2N-20 to DIN 51825 is recommended for initial greasing.

Miscibility

Greases may be mixed providing the following preconditions are met:

- they have the same base oil type
- their thickener types must match
- they must have similar base oil viscosities (the difference must be no more than one ISO VG class)
- their consistencies (NLGI class) must match.

If there is any doubt, please consult the INA engineering service.

Storage

Experience shows that lubricating greases with a mineral oil base can be stored for up to 3 years.
The following preconditions apply:

- the storage room is protected against outside influences
- the temperature is between 0 °C and +40 °C
- the relative humidity is less than 65%
- the lubricants are protected against chemical agents (vapours, gases, fluids).

After long storage periods, friction may be considerably higher for a short time compared to freshly greased flat cage guidance systems. The lubricity of the grease may also have deteriorated.

It is the user's responsibility to follow the directions given by the lubricant manufacturer.

Initial operation and initial grease quantity

Without relubrication device

The initial grease quantity according to Table 1 should be introduced evenly from both sides into the cage pockets and distributed over the cage surfaces. A thin film of grease should also be applied to the guideway raceways.

The guidance system must be protected against solid and liquid contaminants before and during fitting.

With relubrication device

Before fitting, a thin film of grease must be applied to the cage and raceways. The guidance system is then fitted and the feed pipe is filled with grease before the initial grease quantity according to Table 1 is introduced.

During greasing, guidance systems must be moved the whole stroke length several times to ensure uniform grease distribution.

Table 1 · Initial grease quantity for flat cages – guide values

Flat cage Series	Initial grease quantity g per 100 mm cage length[1])
HW 10	0,2 to 0,6
HW 15[2]) / FFW 2025 / FF 2025 ZW	0,2 to 0,6
HW 20[2]) / FFW 2535 / FF 2535 ZW	0,2 to 1
HW 25[2]) / FFW 3045 / FF 3045 ZW	0,3 to 1,3
HW 30[2]) / FFW 3555 / FF 3555 ZW	0,3 to 2,1
HRW 08	0,2 to 0,6
HRW 50	0,2 to 1,5
HRW 70	0,2 to 3,5
HRW 100	0,2 to 6,6
H 10[2])	0,1 to 0,3
H 15[2])	0,1 to 0,5
H 20[2])	0,2 to 0,7
H 25[2])	0,2 to 1,1
FF 2010	0,1 to 0,3
FF 2515	0,1 to 0,5
FF 3020	0,2 to 0,7
FF 3525	0,2 to 1,1

[1]) For high speeds, the lower value should be selected; for low speeds, the quantity should be close to the higher value.

[2]) For cages with damping, use 80% of the stated value.

Relubrication

The relubrication quantity is approximately 50% of the initial grease quantity. Relubrication should be carried out with several partial quantities at shorter intervals in preference to a single regreasing at the end of the relubrication interval.

Relubrication interval

The relubrication interval and quantity can only be determined precisely under operating conditions since it is not possible to calculate all the influences in advance. An observation period of adequate length must be allowed.

The relubrication interval t_{fR} should be no more than 1 year even if the formula gives a value greater than this:

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

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

t_f h
Basic lubrication interval in hours (Figure 2)

K_P, K_W, K_U
Correction factors for load, stroke and environmental influences (page 38).

Basic lubrication interval

The basic lubrication interval t_f (Figure 2) is valid under the following conditions:

- bearing temperature t <+70 °C
- load ratio $C_0/P = 20$
- lubrication with high quality lithium soap grease
- no disruptive environmental influences
- stroke ratio between 1 and 10.

The speed parameter is defined as follows:

$$\text{Speed parameter: } \frac{60}{\bar{v}} \cdot K_{LF}$$

$\bar{v}$ m/min
Equivalent dynamic speed

K_{LF} –
Bearing factor (Table 2).

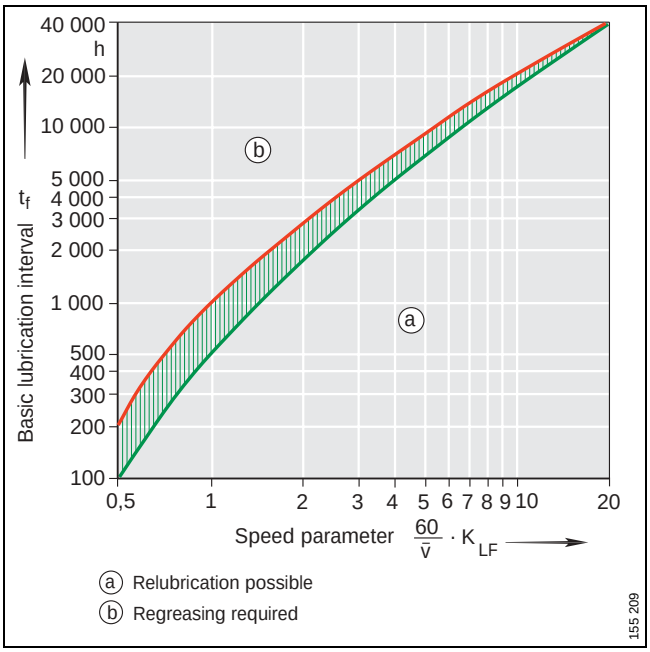


Figure 2 · Calculation of basic lubrication interval

Table 2 · Bearing factor K_{LF}

Flat cage	HW, HRW, FFW	H, HR, FF
Bearing factor K_{LF}	1,5	1

Load correction factor K_P

The correction factor K_P takes into consideration the greater strain on the lubricating grease at a load ratio of $C_0/P < 20$.

⚠ The values given in Figure 3 are valid only for high quality lithium soap grease. The preload must be taken into consideration.

Stroke ratio correction factor K_W

The correction factor K_W (Figure 4) takes into consideration the raceway length to be provided with grease. It is dependent on the stroke ratio.

If the stroke ratio is <1 or >10, the relubrication interval must be shortened in order to reduce possible fretting corrosion.

If the stroke is very short, the relubrication interval t_{fR} may be shorter than the calculated value. In such cases, the use of special lubricating greases is recommended. Please consult the INA engineering service.

The stroke ratio is defined as follows:

$$\text{Stroke ratio: } \frac{L_K}{H}$$

L_K mm
Length of cage

H mm
Distance between ends of stroke.

Environmental correction factor K_U

The correction factor K_U (Table 3) takes into consideration the effect of oscillations, vibration (leading to fretting corrosion) and shocks. These subject the grease to additional strain.

All calculations are invalid if cooling lubricants or moisture penetrate the bearing.

Lubricating grease operating life

If a linear system cannot be relubricated, the operating life of the lubricating grease is then the decisive factor.
In most applications, the guide value is:

$$t_{fG} = 2 \cdot t_{fR}$$

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

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

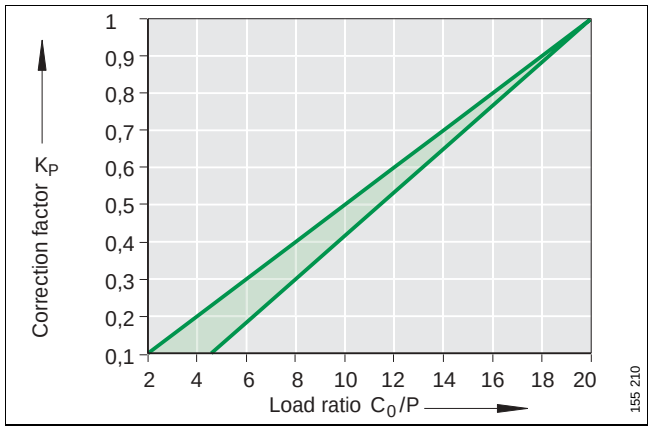


Figure 3 · Correction factor K_P

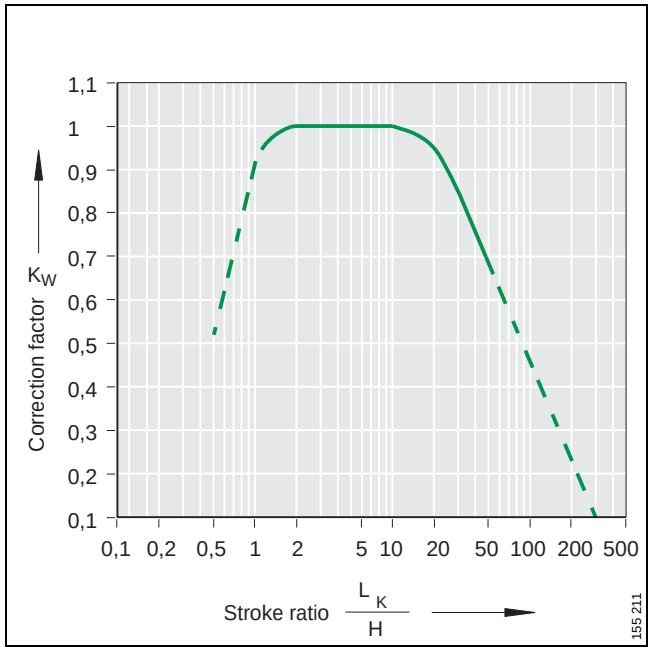


Figure 4 · Stroke ratio correction factor K_W

Table 3 · Environmental correction factor K_U

Environmental influences	K_U
slight	1
moderate	0,8
severe	0,5

Sealing
Operating limits

Sealing

The type of sealing or shielding is of decisive importance in ensuring problem-free operation and a long operating life of flat cage guidance systems.

Depending on the operating conditions and requirements, the following sealing arrangements can be used:

- wipers (*Accessories*, page 90)
- sealing strips
- a complete solution for M and V guideways with conventional wipers and integral sealing strips (suffix ..ZZ, ..PP)
- seals in the adjacent construction.

For most applications, wipers will be sufficient to keep the raceways clean.

⚠ The wipers must be in contact with raceways over the whole stroke length of the system.

If the guideways are subjected to severe contamination or aggressive media, special measures must be used.

Operating limits

Acceleration

The permissible acceleration of flat cage guidance systems depends on:

- the load
- the lubrication
- the accuracy achieved in fitting.

For high accelerations, HYDREL flat cages made from light metal are particularly suitable.
These cages:

- have low mass and high strength
- are suitable for accelerations up to 250 m/s^2
- are suitable for speeds up to 15 m/s.

For accelerations of more than 100 m/s^2, one guideway should be extended by the amount of the stroke length and both end pieces should be fixed to the shorter guideway. The cage will therefore be guided between the raceways in all positions. If wipers are used, an end piece should be fitted between the wiper and guideway.

Operating temperatures

Guideways without wipers in conjunction with metal flat cages are suitable for continuous temperatures up to +150 °C if appropriate lubrication is used.

Guideways which operate continuously at higher temperatures must be heat stabilised. In such cases, please consult the INA engineering service.

Needle roller and cylindrical roller flat cages made from plastic can be used at temperatures up to +120 °C.

Guideways with wipers must not be subjected to operating temperatures above +100 °C.

Design of bearing arrangements

Installation arrangements

Guideways can be fitted in open or closed arrangements.

Open arrangements

The open arrangement is a locating/non-locating bearing arrangement. It comprises (Figure 1):

- M and V guideways with the associated angled flat cage
- J and S guideways with the associated flat cage.

This arrangement:

- is mainly used for applications with loads acting concentric and vertical to the guidance plane and a large guidance base
- is very easy to install.

Closed arrangement M/V

The closed arrangement is a locating/locating bearing arrangement. It comprises (Figure 2):

- two M and two V guideways with the associated angled flat cages.

This arrangement:

- is mainly used for applications with all types of load directions and moment loads
- allows a small guidance system base
- allows all types of operating positions
- can be preloaded (*Preload*, page 28).

Closed arrangement LUE

The closed arrangement LUE is a locating/non-locating bearing arrangement. It comprises (Figure 3):

- one M and one V guideway
- one J and one S guideway
- the associated flat cages
- counterstay parts matched to the guidance systems.

This arrangement:

- is mainly used for applications with all types of load directions and moment loads and very high accuracy requirements
- is intrinsically preloaded
- can compensate for thermal expansion of the adjacent construction without distortion.

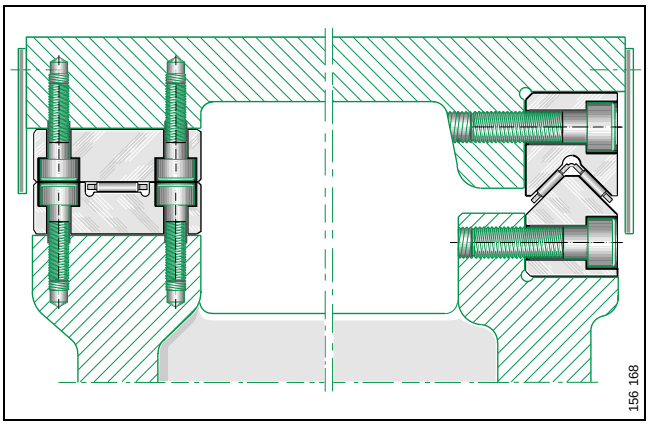


Figure 1 · Open arrangement M/V, J/S

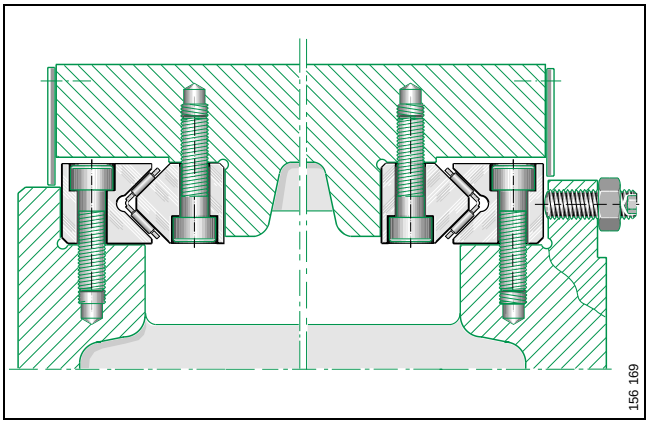


Figure 2 · Closed arrangement M/V

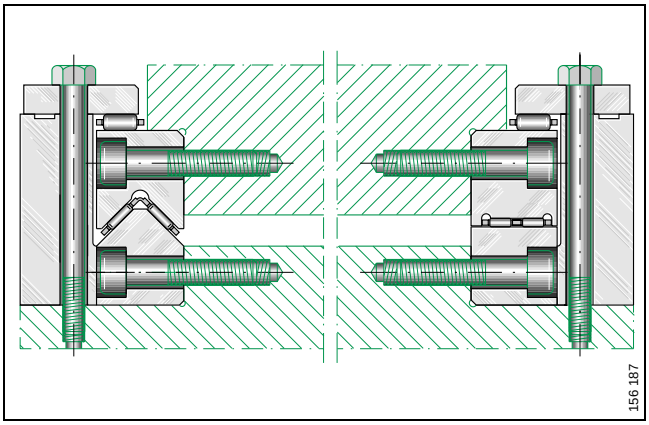


Figure 3 · Closed arrangement LUE

Calculation of length

When selecting the dimensions of guideways and cages, the technical requirements or design features can be decisive. In both cases, the stroke H is an important factor.

Calculation in accordance with technical requirements

Cage length

The load carrying capacity and rigidity of the guidance system are determined by the cage size and cage length.

For concentric loading, the size and length of the flat cages can theoretically be selected within wide limits. As a guide value for determining the cage length L_K, the following principles have proved appropriate in both technical and economic terms:

- for an open arrangement
  - cage length $L_K \geqq 1{,}5\ H$
- for a closed arrangement
  - cage length $L_K \geqq H$

For offset loading and moment loads, the largest possible cage lengths and distances between the guideways should be selected. This gives more uniform load distribution.

Guideway length

For the guideway length L, the cage length L_K and stroke H are decisive. It must be taken into consideration that:

- for kinematic reasons, the flat cage always travels half the distance of the moving guideway (Figure 4)
- the whole length of the cage remains between the two guideways irrespective of the position of the moving guideway
- the wipers must remain in contact with the raceway (Figure 5).

Guideway without wipers (Figure 4).

$$L = L_K + \frac{H}{2}$$

L mm
Guideway length

L_K mm
Cage length

H mm
Distance between end points of stroke.

Guideways with wipers (Figure 5).

$$L_A = L_K + 3 \cdot \frac{H}{2} + 10\,\text{mm}$$

L_A mm
Length of guideway with allowance for wipers.

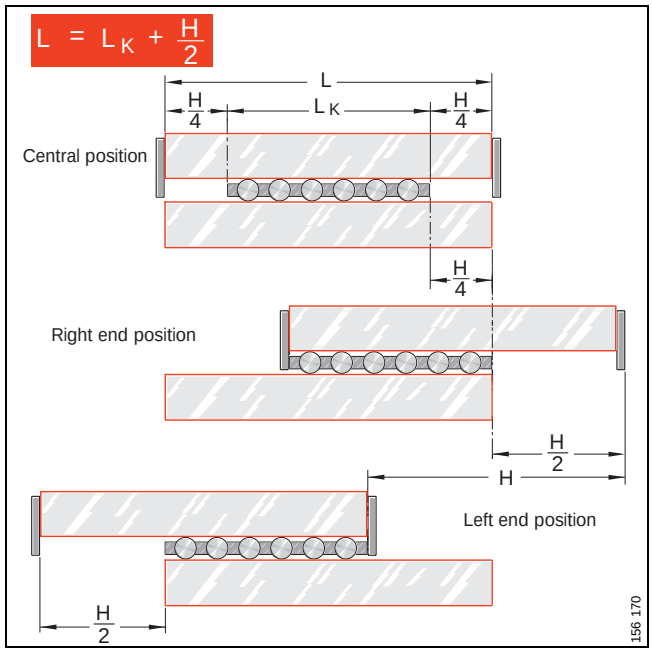


Figure 4 · Movement of guideway and cage

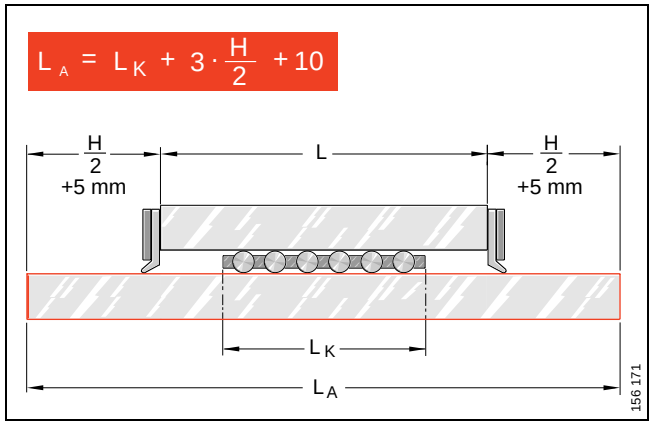


Figure 5 · Length of guideway with wipers

Calculation in accordance with design features

The maximum possible guideway length L, L_A and the stroke H are often predetermined by the design. The possible cage length L_K is therefore already defined.

Cage length

Kinematically possible cage length in guidance systems without wipers (Figure 6).

$$L_K = L - \frac{H}{2}$$

Kinematically possible cage length in guidance systems with wipers (Figure 7).

$$L_K = L_A - 3 \cdot \frac{H}{2} - 10\,mm$$

L mm
Guideway length

L_A mm
Guideway length

L_K mm
Cage length

H mm
Distance between ends of stroke.

⚠ If a guidance system is designed for long strokes such that the whole length of the flat cage does not remain between the guideways, the formulae are not valid!

In such cases, single-piece metal flat cages should be used and raceway lead areas should be provided on the shorter guideway (suffix E2). If necessary, cages with positive control can be used or, alternatively, it should be checked whether a monorail guidance system with rolling element recirculation would be more suitable!

End pieces / wipers

End pieces or wipers retain the cage in its nominal position at the ends of the stroke.

Two end pieces or wipers should be fitted per cage. If this is not possible, the function of the end pieces must be fulfilled by elements of the adjacent construction.

⚠ End pieces or wipers must not be fitted as shown in Figure 8 (due to the risk of collision)!

Under special operating conditions, for example where the stroke length changes but remains constant over the long term or where extreme loads are applied at the ends of the stroke, the normal end pieces can no longer fulfil the cage positioning function. Such applications can be fulfilled by the use of integral positive control of the cage (series MVZ, page 62).

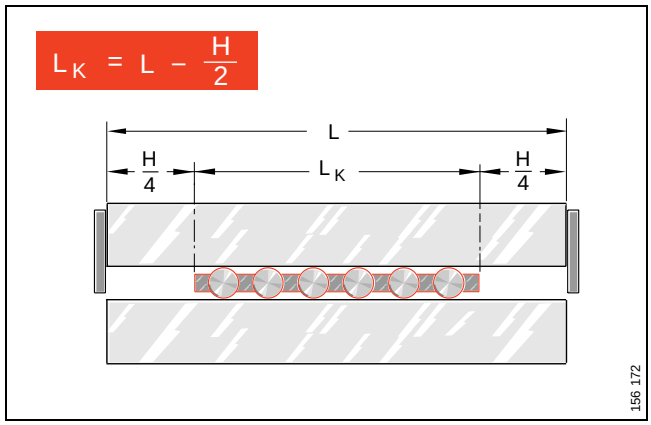


Figure 6 · Cage length of guideways without wipers

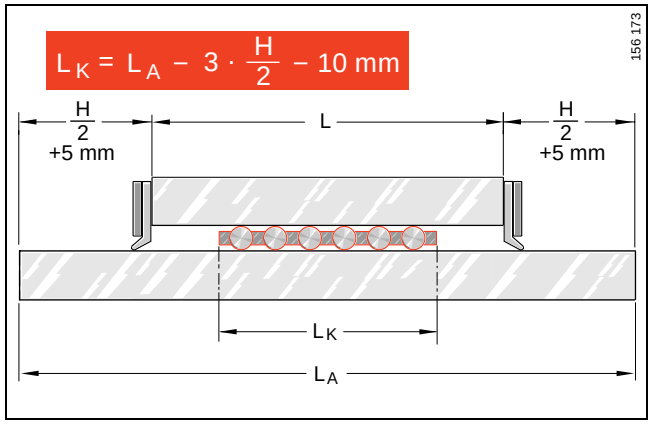


Figure 7 · Cage length of guideways with wipers

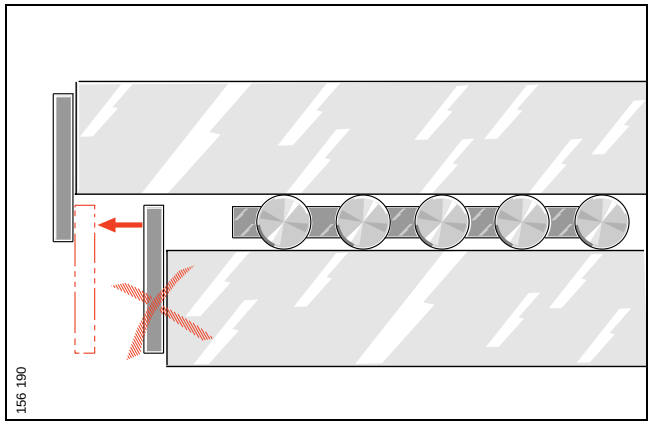


Figure 8 · Impermissible arrangement of end pieces or wipers

Location of guideways

The guideways are fixed to the adjacent construction using fixing screws. The possible guideway hole types are shown in Figure 9 and the *dimension tables*. Hole patterns are shown on page 44.

Guideways of series M and V of standard lengths held in stock have holes of type 15. Insert nuts ESM can be used to allow screw mounting of these guideways on the basis of hole type 03 (Figure 10).

The insert nuts must be ordered separately (*Accessories*, page 93). They are included loose in the delivery and must be fixed in the counterbore by means of adhesive (Figure 10).

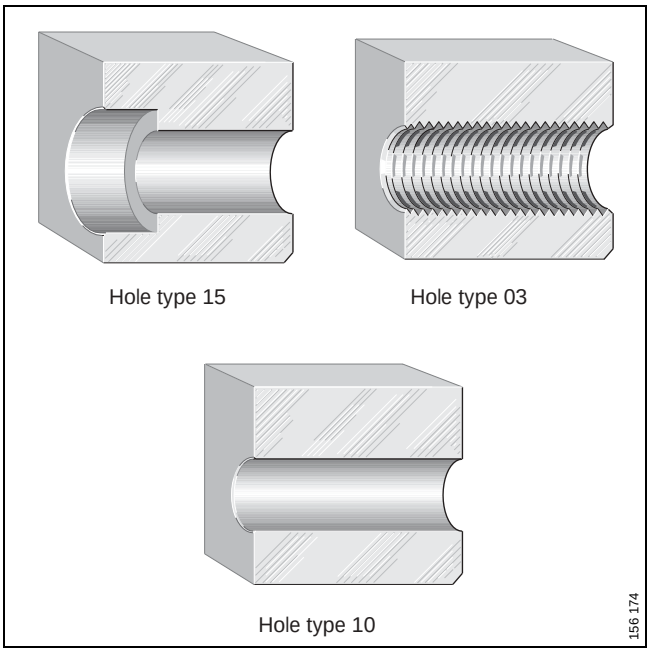


Figure 9 · Hole types

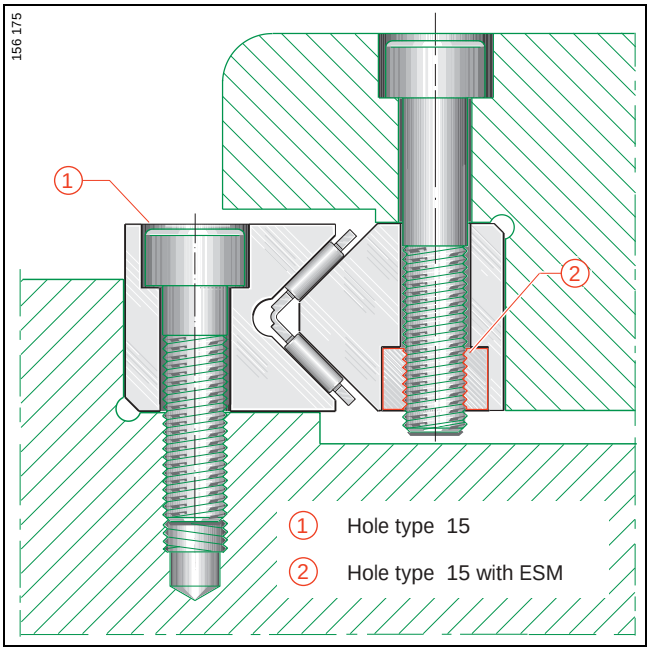


Figure 10 · Location of M and V guideway from one side

Hole patterns

Unless stated otherwise, guideways are supplied with a symmetrical hole pattern. On request, an asymmetrical hole pattern is also possible where $C_5 \geqq C_{5min}$ and $C_6 \geqq C_{6min}$.

For a symmetrical hole pattern, $C_5 = C_6$ (Figure 11a).

For an asymmetrical hole pattern, $C_5 \neq C_6$ (Figure 11b).

⚠ Note the position of the spacing C_5!
Definition of the position of C_5: see Figure 12.
Suffix LA (C_5/C_6)

Calculation of hole patterns

The number of pitches between holes is the nearest whole number equivalent to

$$n = \frac{L - (2 \cdot C_{5min})}{C_4}$$

Dimensions C_5 and C_6

$$C_5 + C_6 = L - n \cdot C_4$$

Guideways with symmetrical hole pattern

$$C_5 = C_6 = \frac{1}{2} \cdot (L - n \cdot C_4)$$

Number of holes

$$x = n + 1$$

L mm
Guideway length

C_4 mm
Hole pitch

C_5, C_6 mm
Distance between start or end of guideway and nearest hole

$C_{5\,min}$, $C_{6\,min}$ mm
Minimum value for C_5 and C_6 (*dimension table*)

n –
Maximum possible number of hole pitches

x –
Number of holes.

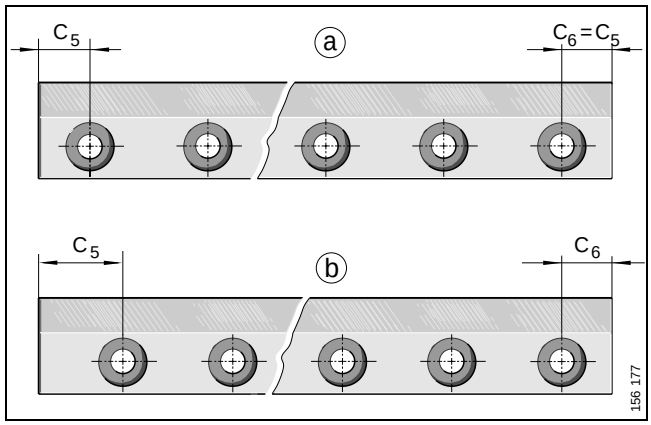


Figure 11 · Symmetrical (a) and asymmetrical (b) hole pattern for guideway with one row of holes

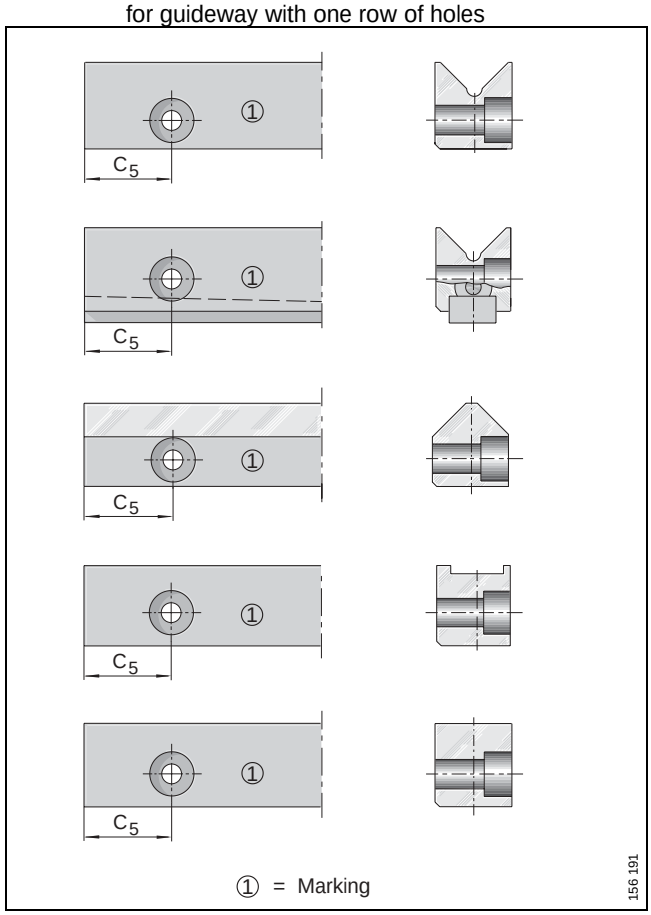


Figure 12 · Position of distance between first hole and start of guideway C_5

Accuracy of adjacent components

The correct function of flat cage guidance systems is decisively determined by the accuracy of the adjacent surfaces. The requirements for geometrical and positional accuracy increase with those for accuracy and smooth running.

Parallelism and perpendicularity

Any parallelism defects in the adjacent surfaces should not be greater than those in the corresponding guideways. The adjacent and rear face surfaces of the adjacent components for M and V guideways must be machined perpendicular to each other.

⚠ The deviation must not exceed ±0,3 mrad!

Height variation of adjacent surfaces

In order to ensure uniform load distribution over the length of the rolling elements, the height variation Δh must not be exceeded (Figure 13 and 14 and formulae).

In an open arrangement, the height variation Δh can be matched to the non-locating bearing side using an intermediate layer or set to the locating bearing side using the adjusting gib guideway ML (Figure 14).

Permissible height variation for needle roller flat cages

$$\Delta h < 0{,}1 \cdot b$$

Δh μm
Permissible height variation

b mm
Distance between guidance systems.

Permissible height variation for cylindrical roller flat cages

$$\Delta h < 0{,}3 \cdot b$$

Surface roughness

In order to achieve the required geometrical accuracy, the necessary measurement basis as well as good location of the guideways, the surfaces should be precision machined.

In order to avoid location defects, the holes must be carefully deburred.

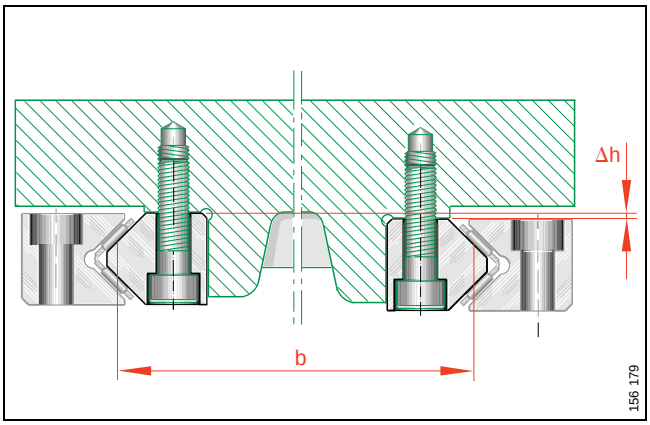


Figure 13 · Height variation in closed arrangement

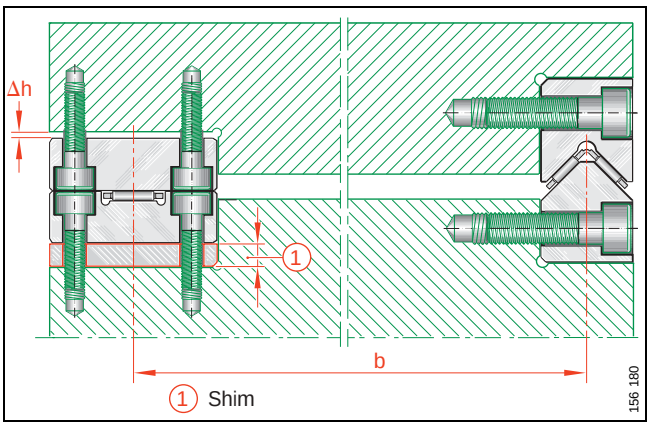


Figure 14 · Adjustment of the height variation in open arrangement

Fitting

Guideways are high precision machine elements. These products must be handled very carefully before and during fitting. Their trouble-free operation depends largely on the care taken during fitting.

Delivered condition and storage

- Guideways
  - are supplied with a preservative and are packed in anticorrosion paper.
  - parts dimensionally matched to each other are packed together. If the parts must be packed in several units due to weight, these are marked accordingly.
- Flat cages
  - are supplied with a preservative and packed with anticorrosion protection.

Storage

- Packaging must be kept closed
- Parts must be stored in dry, clean rooms with the temperature as constant as possible
- The maximum relative humidity is 65%.

Removal from packaging

- Perspiration from handling leads to corrosion. Hands must be kept clean and dry; protective gloves should be worn if necessary.

Guideways

- Guideways should only be removed from their packaging immediately before fitting
- They should be lightly oiled in order to prevent corrosion during fitting
- Guideways matched to each other are supplied as sets. Attention must be paid to the marking:
  - parts with the same set number must be fitted in the same guidance system
  - where the arrangement of guideways within a set having the same set number must be defined more specifically, this is indicated using letters (Figure 1).

Flat cages

When unpacking and fitting metal cages, especially longer cages, it must be ensured that they are not bent.

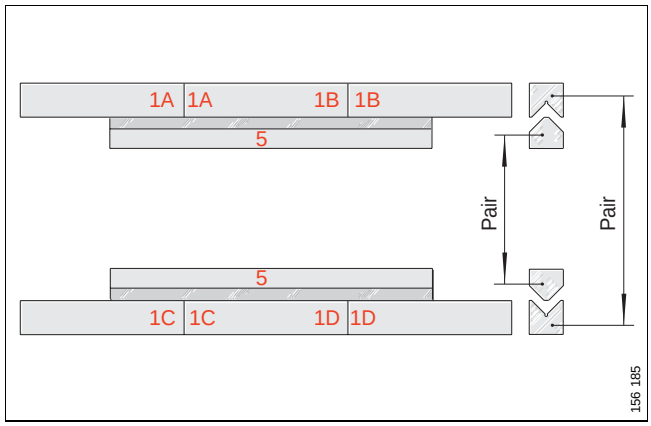


Figure 1 · Marking of single and multi/piece guideways

Closed arrangements

⚠ Guideways packed in pairs and marked with the same number must only be fitted in the same guidance unit.

The locating faces of the guideways are not marked and can be identified by the larger edge break.

Guideways must be clamped against the back locating face before the fixing screws are fully tightened.

Fitting of closed arrangements

⚠ The sequence of work steps must be adhered to.

- Screw the guideway pair ① rigidly in place (Figure 2)
- Check the parallelism of the guideway pair (Figure 3)
- Locate the opposing guideway ② (Figure 4)
- Locate the adjustment guideway ③ (Figure 4). In order to allow adjustment of the guideway, do not fully tighten the fixing screws
- Push the guidance system in longitudinally (Figure 4)
- Push the cages between the guideways and position precisely
- Preload the adjustment guideway ③ using pressure screws ④ (Figure 4) or an adjusting gib (ML guideway, Figure 5 to 7) to approximately twice the required value and loosen again, in order to preempt settling effects
- Set the preload to the required value
- Tighten the fixing screws fully
- Fit the wipers and/or end pieces.

Preloading using pressure screws

- Tighten the pressure screws to the required tightening torque in two stages
- Secure the pressure screws by means of a locknut or screw lock.

⚠ The movable part must be moved such that each pressure screw is supported by the flat cage when the screws are fully tightened.

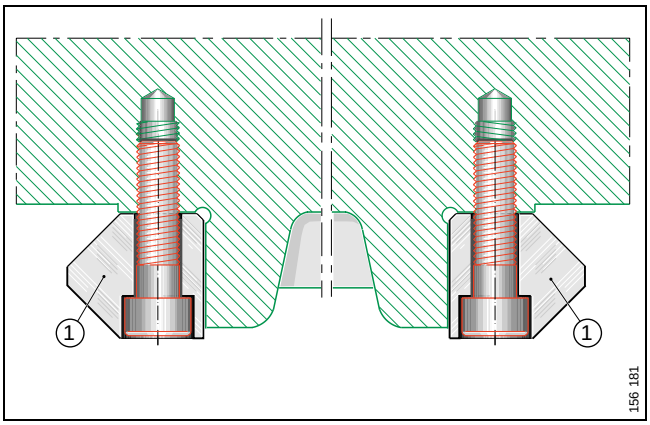


Figure 2 · Fitting the guideway pair to the table

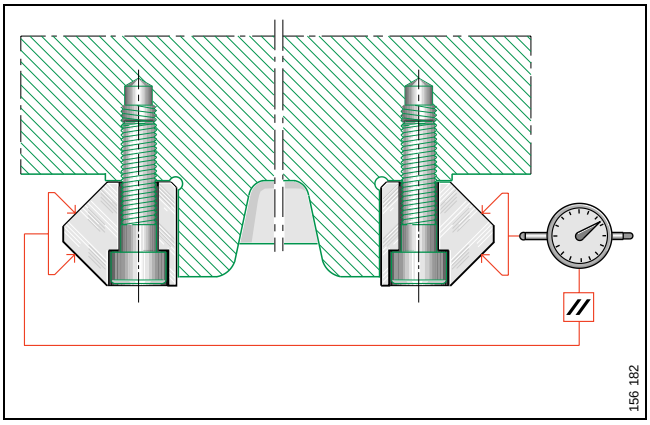


Figure 3 · Checking the parallelism

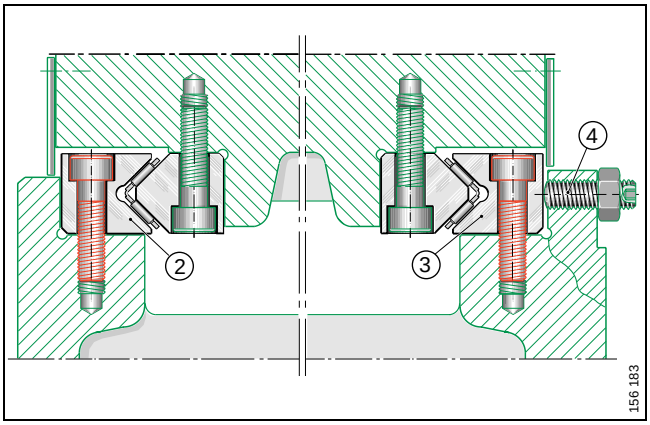


Figure 4 · Fitting of closed arrangements

Setting the preload on guideways with an adjusting gib

Setting

- Push the unhardened, ground gib under the guideway ML and set the guidance system free from clearance (Figure 5)
  - the gib protrudes approximately 30 mm from each end of the guideway.
- Shorten the gib on the adjustment side of the guideway such that it is recessed about 3 mm from the end face of the guideway (Figure 5).
- Shorten the gib on the other side such that it is flush with the end of the guideway.
- Drive in the gib using a copper drift and light hammer blows in order to preload the system (Figure 6)
  - moving the gib by 1 mm changes the adjustment by 15 µm.
- Check the preload.
- After setting, fix the position of the gib using the hexagonal socket screw on the end face of the guideway (Figure 7).

Open arrangements

Fitting should be carried out by a procedure similar to that for *Closed arrangements*. However, it is not necessary to adhere strictly to the sequence of steps.

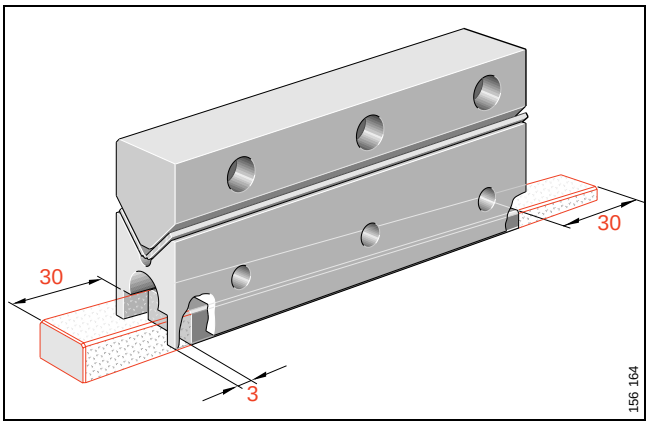


Figure 5 · Inserting and shortening the gib

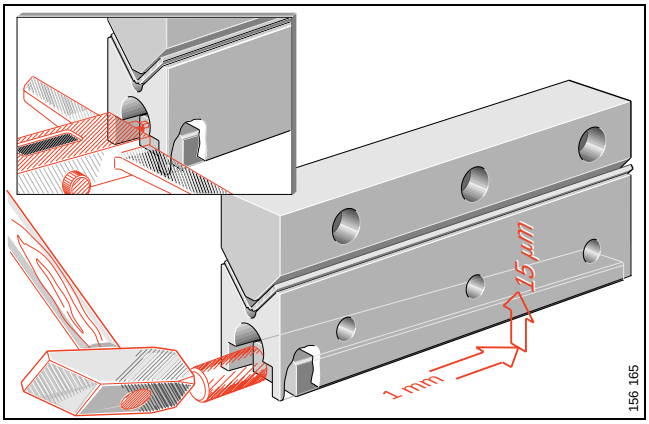


Figure 6 · Preloading the system

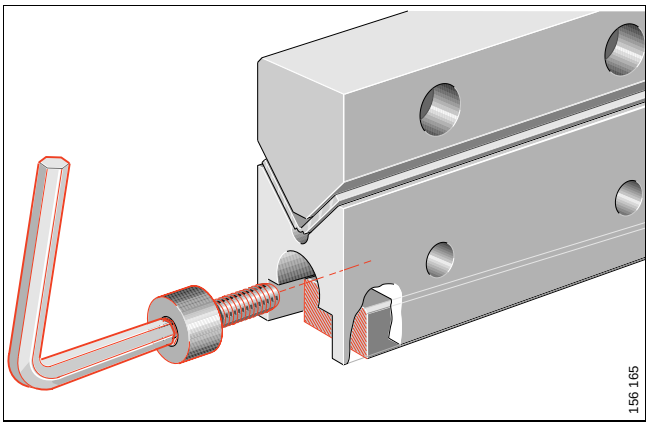


Figure 7 · Fixing the setting device

Product range

Flat cage guidance systems

HYDREL/EGIS M and V guideways with angled needle roller flat cage or angled cylindrical roller flat cage

Features

Flat cage guidance systems

- consist of:
  - guideways of type M and V
  - angled flat cages with a large number of rolling elements
- are used as linear locating bearings
- are highly suitable for limited stroke lengths
- have high rigidity and load carrying capacity whilst requiring very little space
- have low, uniform friction
- have high, consistent accuracy throughout their operating life
- can be supplemented by accessories
- are also available with sealing strips (*dimension table*).

Guideways M, V

- are made from through hardened steel with a minimum hardness of 670 HV
- have precision ground raceways and locating faces
- are produced with various hole types
- have threaded holes on the end faces for fitting end pieces or wipers.

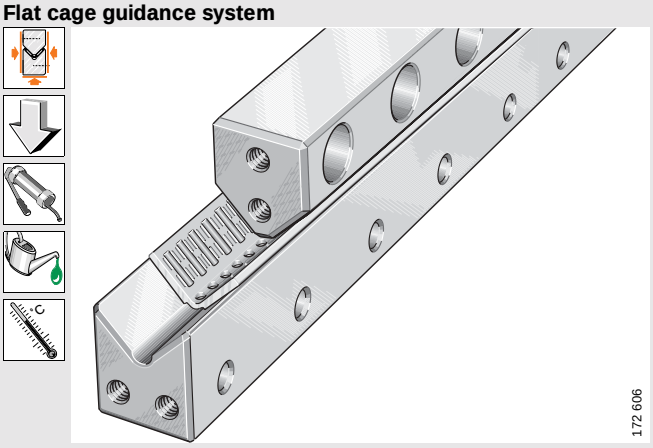
Angled needle roller and angled cylindrical roller flat cages

- are double row cages with the shanks at right angles to each other
- are made from metal or plastic
  - metal cages are lightweight components with high strength. They are suitable for more demanding conditions such as high acceleration, high temperatures and where the ends of the cage are exposed at some point in operation
  - plastic cages are an economical solution for less demanding operating conditions.

Accessories

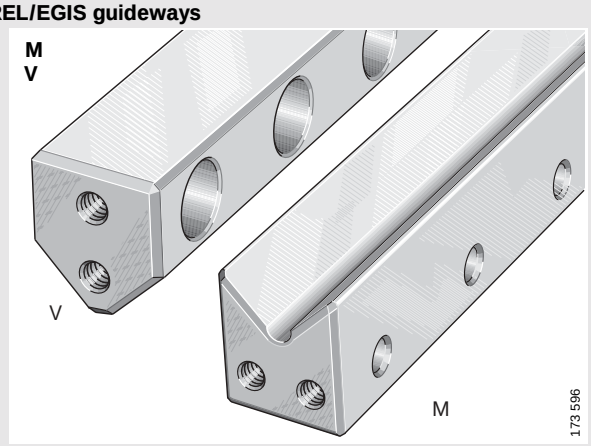
- end pieces prevent the cage creeping out of the load zone
- wipers protect the raceways against contamination under normal operating conditions
- insert nuts allow the conversion of holes of type 15 to threaded holes.

Flat cage guidance system



- basic design comprising:
  - guideways M, V
  - angled needle roller flat cages FFW, HW or HGW or angled cylindrical roller flat cages HRW

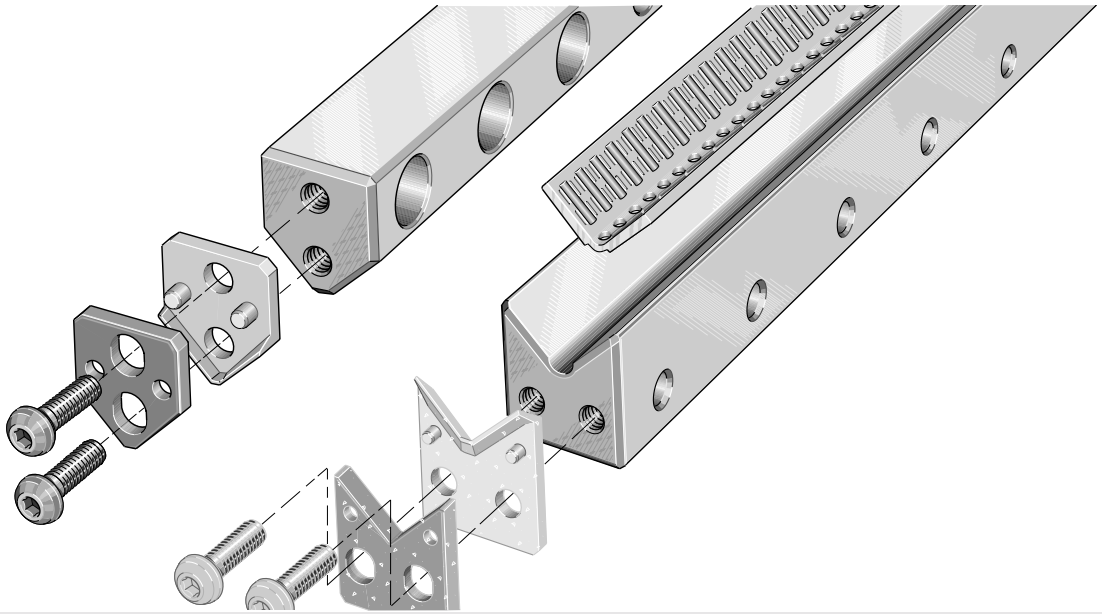
HYDREL/EGIS guideways



- for angled needle roller and angled cylindrical roller flat cages
- standard lengths from 100 to 1000 mm in steps of 100 mm; hole type 15 for fixing
- available in any custom length up to the maximum length
- hole types 03, 10 and 15

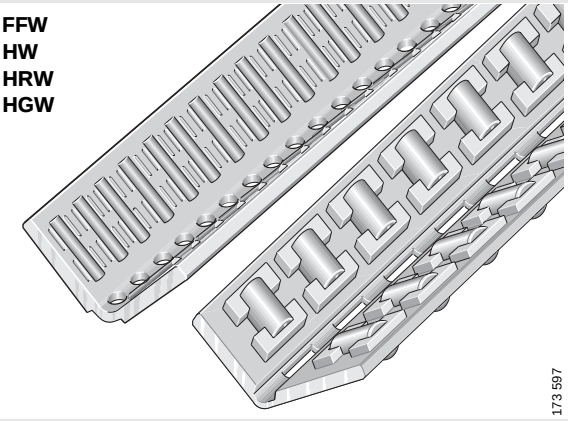
Flat cage guidance system with accessories

M/V



Angled needle roller and angled cylindrical roller flat cages

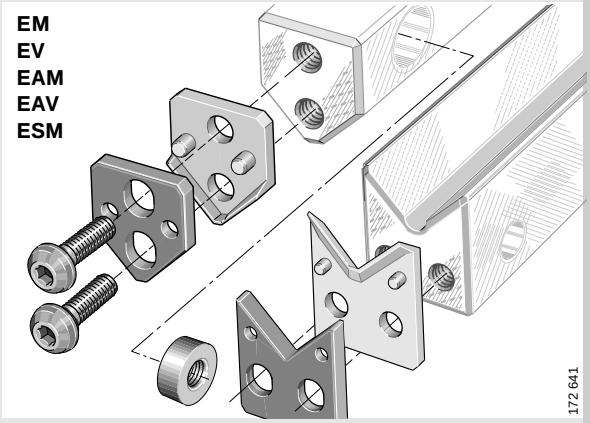
FFW
HW
HRW
HGW



- FFW and HW: needle roller flat cage
- HRW: cylindrical roller flat cage
- needle rollers and cylindrical rollers in grade G2
- FFW made from plastic. HRW made from light metal with plastic inserts. For temperatures up to +120 °C
- HW made from metal. For temperatures up to +150 °C
- HGW: angled needle roller flat cage with friction damping

Accessories

EM
EV
EAM
EAV
ESM



- end pieces EM, EV made from steel
- wipers EAM, EAV made from polyurethane, with steel end piece. For temperatures up to +100 °C
- end pieces and wipers are supplied with fixing screws
- insert nuts ESM

Design and safety guidelines

- In a closed arrangement, two V guideways and two M guideways with identical dimensions A_1 and A_2 should always be used in order to ensure correct function.
  The guideways are matched accordingly and are marked with the same set number.
- Guideway pairs should be fitted in accordance with the set numbers (Figure 1). This ensures that the installation width is within tolerance.
- Guideways with a restricted tolerance of ± 0,005 for dimensions A_1 and A_2 (suffix US) can be used in any combination if normal requirements apply.
  Where accuracy requirements are higher, they can be matched in accordance with the marking on the guideway:

marking US-1: deviation A_1 and A_2 $+0{,}005$ / 0

marking US-2: deviation A_1 and A_2 0 / $-0{,}005$.

Further information Page

Accuracy

Quality, positional and profile tolerances

Guideways are available in three quality grades (Figure 2):

- Q2
  For exacting requirements in high precision machines. This grade should only be used if the adjacent construction can be produced to equally high accuracy.
- Q6
  Conforms to the requirements of precision table guidance systems in machine tool construction.
- Q10
  Standard quality grade. For requirements in general machine building
- Geometrical and positional tolerances (Figure 2).
- Profile tolerances (Figure 1).

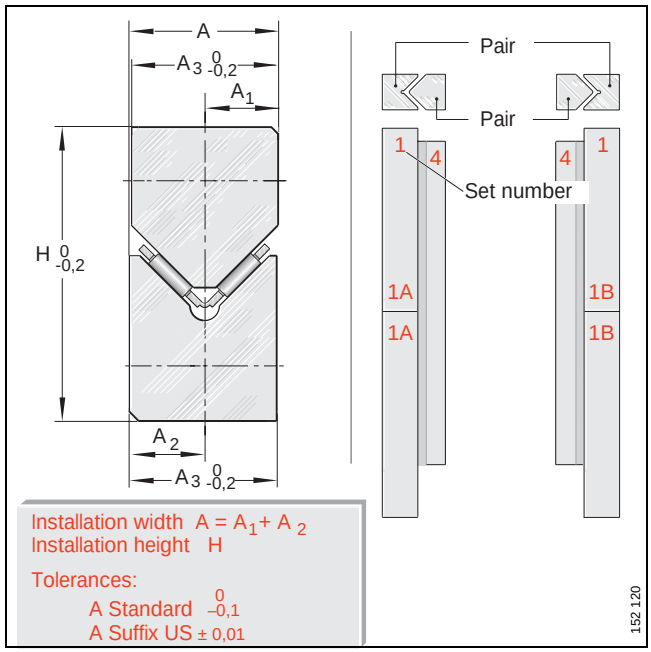


Figure 1 · Profile tolerances, marking

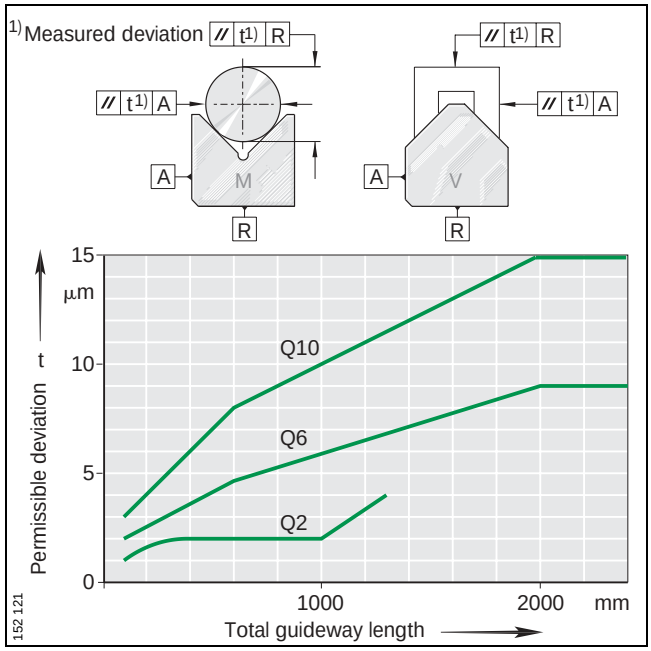


Figure 2 · Positional accuracy and quality of guideways

Tolerances for hole pitches

The positional tolerance of the hole pattern ∅ X is 1‰ of the guideway length L (Figure 3).

If the guideway length is less than 80% of the maximum length given in the dimension table, it can be fitted to a predrilled hole pattern; a positional tolerance of ∅ 0,2 must be achieved in this case.

If longer guideways are to fulfil this requirement, they must be ordered using the suffix P (positional tolerance).

Special designs

Guideways

- with different cross-sections, fixing holes, hole pitches and lengths
- guidance system heights A_1 or A_2 with restricted tolerance ±0,005 mm
  – suffix US
- anti-corrosion protection by thin layer chromium plating
  – suffix DSV
- raceway lead chamfers at ends of guideway
  – suffix E2
- without holes on end faces
  – suffix E1
- needle roller flat cage with friction damping
  – series HGW.

Ordering example and ordering designation

For four machines:

M and V guideways in standard length for closed arrangement, stroke 90 mm, end pieces with wipers, angled flat cage made from metal.

Profile size	5025
Hole type	15
Length of V guideways	500 mm
Length of M guideways	400 mm
Quality grade	Q6

Insert nuts ESM for V guideway.

Angled flat cage HW and end pieces with wipers

Ordering designation:

8 off V 5025/15×500 Q6
8 off M 5025/15×400 Q6
8 off HW 16×355
16 off EAM 5025
48 off ESM M6 (Figure 4).

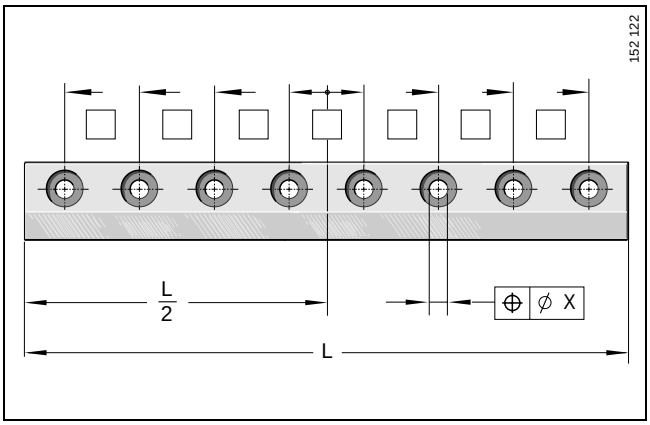


Figure 3 · Hole pattern of guideway

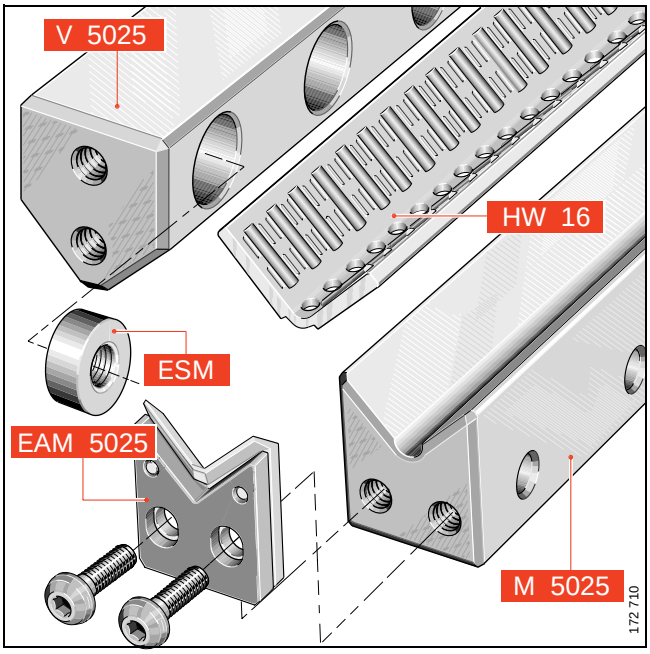


Figure 4 · Ordering example, ordering designation

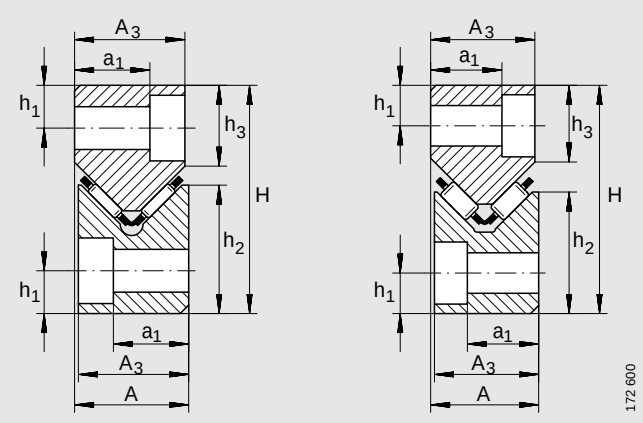
Flat cage guidance systems

HYDREL/EGIS guideways
with angled needle roller flat cage or
angled cylindrical roller flat cage

Series M
V

M guideways also available with sealing strips
– gap or lip seal –
(only in conjunction with V guideways).

Suffix for M guideways with gap seals: ..ZZ
Suffix for M guideways with lip seals: ..PP



Needle roller flat cage | Cylindrical roller flat cage

Dimension table · Dimensions in mm

Designation		Dimensions					Fixing holes							Holes in end faces
		H –0,2	A –0,1	A_3 –0,2	h_2	h_3	K_1 For screws DIN 912-8.8	h_1	a_1	t min.	C_4[1]	C_5[2] min.	C_6[2] min.	K_3
M 3015	**–**	30	15	15	15,5	–	M4	5,5	10,5	15	40	15	15	M3
–	**V 3015**	30	15	15	–	10,5	M4	5,5	10,5	15	40	15	15	M3
M 4020	**–**	40	20	20	22,5	–	M6	7,5	13,2	20	80	15	15	M5
–	**V 4020**	40	20	20	–	13,5	M6	7,5	13,2	20	80	15	15	M5
M 4525	**–**	45	25	25	22,5	–	M6	7,5	18,2	15	80	20	20	M6
–	**V 4525**	45	25	25	–	14	M6	7,5	18,2	15	80	20	20	M6
M 5025	**–**	50	25	25	28	–	M6	10	18,2	15	80	20	20	M6
–	**V 5025**	50	25	25	–	17	M6	10	18,2	15	80	20	20	M6
M 6035	**–**	60	35	35	35	–	M8	11	26	20	100	20	20	M6
–	**V 6035**	60	35	35	–	20	M8	11	26	20	100	20	20	M6
M 6535	**–**	65	35	35	33	–	M8	11	26	20	100	20	20	M6
–	**V 6535**	65	35	35	–	20	M8	11	26	20	100	20	20	M6
M 7040	**–**	70	40	40	40	–	M10	13	29	25	100	20	20	M6
–	**V 7040**	70	40	40	–	24	M10	13	29	25	100	20	20	M6
M 8050	**–**	80	50	50	45	–	M12	14	37	30	100	20	20	M6
–	**V 8050**	80	50	50	–	26	M12	14	37	30	100	20	20	M6
M 8550	**–**	85	50	50	42	–	M12	14	37	30	100	20	20	M6
–	**V 8550**	85	50	50	–	26	M12	14	37	30	100	20	20	M6

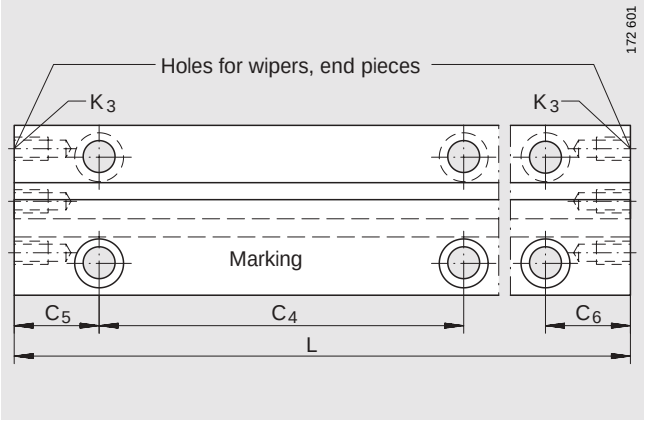
[1]) M/V 3015: For L = 100 mm to 109 mm, C_4 = 35 mm (3 holes).
Other sizes: For $L < C_4 + C_{5\,min.} + C_{6\,min.}$ C_4 = 50 mm.

[2]) C_5 and C_6 are dependent on the guideway length and must be identical at both ends of a guideway: C_5 and $C_6 = \frac{L - \Sigma C_4}{2}$;
$C_{5\,min.}$ and $C_{6\,min.}$ are minimum values.

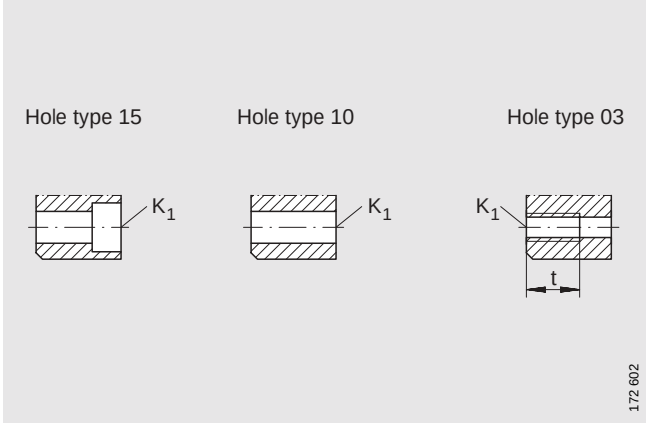
[3]) Guideways longer than the stated maximum length are available as multi-piece units.
The total length of a multi-piece unit must be stated in the order.
Single-piece extra-long guideways may be available by agreement.

[4]) End pieces: see page 88; wipers: see page 90; insert nuts: see page 93.

[5]) Hole pattern for M/V 3015 = 15 + 2 × 35 + 15.
Hole pattern for other sizes = 25 + 50 + 25.



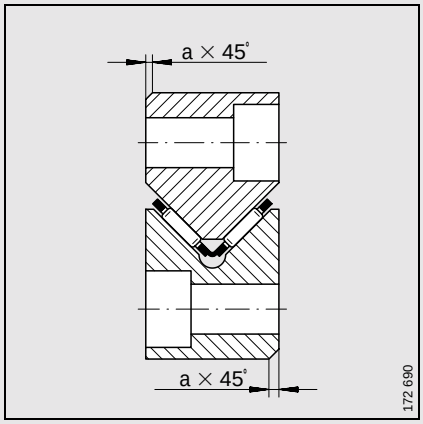
M and V



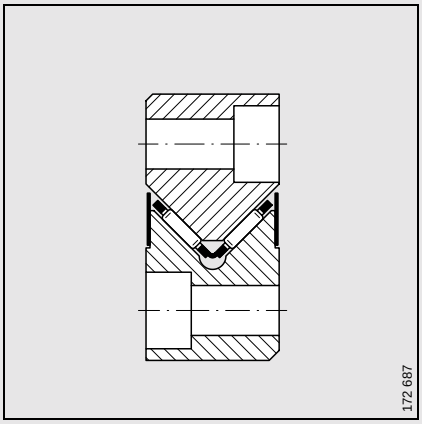
Hole types

Available standard lengths											Custom lengths up to L[3])	Appropriate angled flat cages			Accessories[4])		
100[5])	150	200	300	400	500	600	700	800	900	1000	max.	Plastic needle roller cage	Cylindrical roller cage	Metal needle roller cage	End pieces	End pieces with wipers	Insert nuts
•	•	•	•	•	•	•					600	–	–	**HW 10**	**EM 3015**	**EAM 3015**	**ESM M4**
•	•	•	•	•	•	•					600	–	–	**HW 10**	**EV 3015**	**EAV 3015**	**ESM M4**
•	•	•	•	•	•	•					1000	**FFW 2025**	–	**HW 15**	**EM 4020**	**EAM 4020**	**ESM M6**
•	•	•	•	•	•	•					1000	**FFW 2025**	–	**HW 15**	**EV 4020**	**EAV 4020**	**ESM M6**
•		•	•	•	•	•	•	•	•	•	1000	–	**HRW 50**	–	**EM 4525**	**EAM 4525**	**ESM M6**
•		•	•	•	•	•	•	•	•	•	1000	–	**HRW 50**	–	**EV 4525**	**EAV 4525**	**ESM M6**
•		•	•	•	•	•	•	•	•	•	1300	**FFW 2025**	–	**HW 16**	**EM 5025**	**EAM 5025**	**ESM M6**
•		•	•	•	•	•	•	•	•	•	1300	**FFW 2025**	–	**HW 16**	**EV 5025**	**EAV 5025**	**ESM M6**
		•	•	•	•	•	•	•	•	•	1300	**FFW 2535**	–	**HW 20**	**EM 6035**	**EAM 6035**	**ESM M8**
		•	•	•	•	•	•	•	•	•	1300	**FFW 2535**	–	**HW 20**	**EV 6035**	**EAV 6035**	**ESM M8**
		•	•	•	•	•	•	•	•	•	1300	–	**HRW 70**	–	**EM 6535**	**EAM 6535**	**ESM M8**
		•	•	•	•	•	•	•	•	•	1300	–	**HRW 70**	–	**EV 6535**	**EAV 6535**	**ESM M8**
		•	•	•	•	•	•	•	•	•	1300	**FFW 3045**	–	**HW 25**	**EM 7040**	**EAM 7040**	**ESM M10**
		•	•	•	•	•	•	•	•	•	1300	**FFW 3045**	–	**HW 25**	**EV 7040**	**EAV 7040**	**ESM M10**
			•	•	•	•	•	•	•	•	1300	**FFW 3555**	–	**HW 30**	**EM 8050**	**EAM 8050**	**ESM M12**
			•	•	•	•	•	•	•	•	1300	**FFW 3555**	–	**HW 30**	**EV 8050**	**EAV 8050**	**ESM M12**
			•	•	•	•	•	•	•	•	1300	–	**HRW 100**	–	**EM 8550**	**EAM 8550**	**ESM M12**
			•	•	•	•	•	•	•	•	1300	–	**HRW 100**	–	**EV 8550**	**EAV 8550**	**ESM M12**

Series	a_{min}
M and V 3015	0,7×45°
M and V 4020 to M and V 8550	1,3×45°



Chamfer dimensions



Design with sealing strips

Flat cage guidance systems

HYDREL/EGIS ML and V guideways with adjusting gib and angled needle roller flat cage

Features

Flat cage guidance systems

- consist of:
  - guideways of type ML with adjusting gib and guideways of type V
  - angled flat cages with a large number of rolling elements
- are used as linear locating bearings
- are preloaded using the adjusting gib
  - the gib applies the preload evenly over the whole length of the guidance system
- are extremely rigid and support loads very uniformly due to the preload
- are highly suitable for limited stroke lengths
- have high rigidity and load carrying capacity whilst requiring very little space
- have low, uniform friction
- have high, consistent accuracy throughout their operating life
- can be supplemented by accessories
- are also available with sealing strips (*dimension table*).

Guideways ML, V

- are made from through hardened steel with a minimum hardness of 670 HV (the adjusting gib is unhardened)
- have precision ground raceways and locating faces
- are produced with various hole types
- have threaded holes on the end faces for fitting end pieces or wipers.

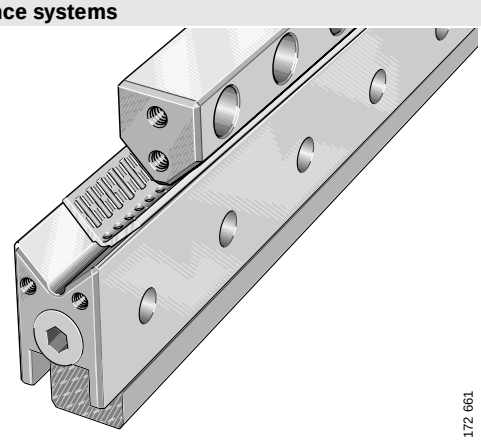
Angled needle roller flat cages

- are double row cages with the shanks at right angles to each other
- are made from metal or plastic
  - metal cages are high strength lightweight components. They are suitable for demanding conditions such as high acceleration, high temperatures and where the cage ends are exposed at some point in operation
  - plastic cages are an economical solution for less demanding operating conditions.

Accessories

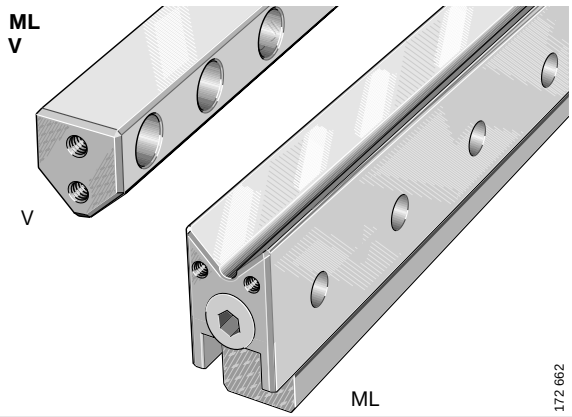
- end pieces prevent the cage creeping out of the load zone
- wipers protect the raceways against contamination under normal operating conditions.
- insert nuts allow the conversion of holes of type 15 to threaded holes.

Flat cage guidance systems



- basic design comprising:
  - guideways ML with adjusting gib and guideway V. The pitch of the gib surface is 1,5%. When the gib is moved by 1 mm, the height changes by 15 µm
  - angled needle roller flat cages FFW, HW or HGW

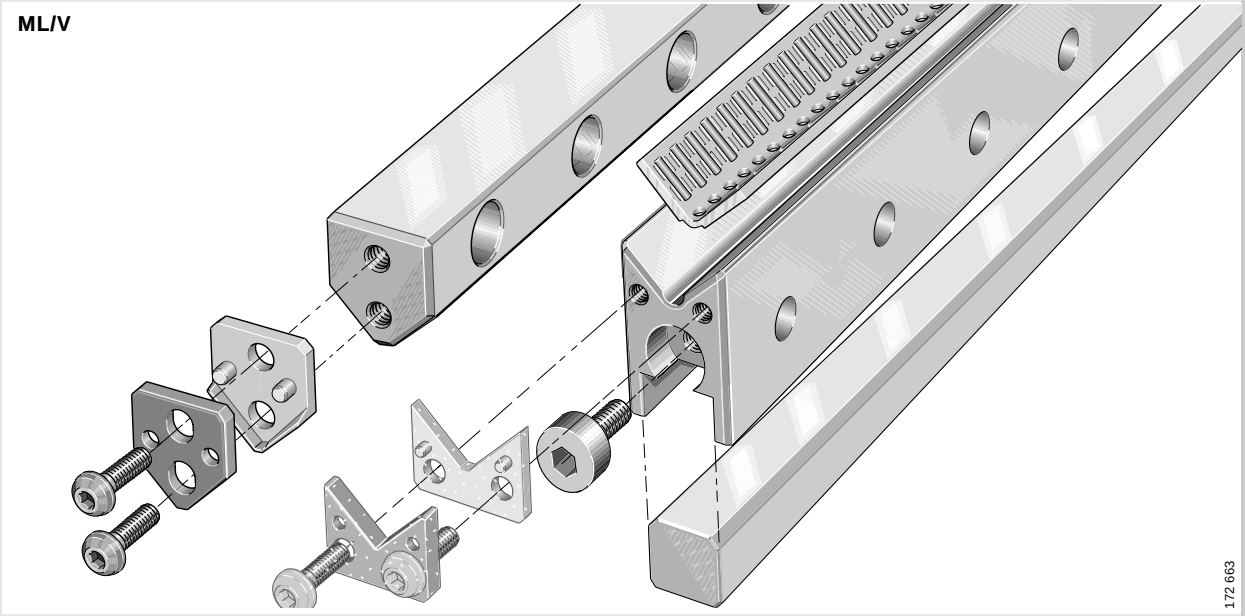
HYDREL/EGIS guideways



- with adjusting gib for preloading the system
- for angled needle roller flat cages
- custom lengths according to dimension table
- hole type 03 and 15

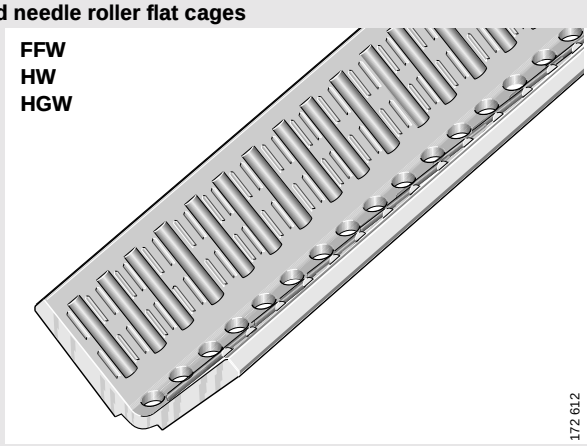
Flat cage guidance system with accessories

ML/V



Angled needle roller flat cages

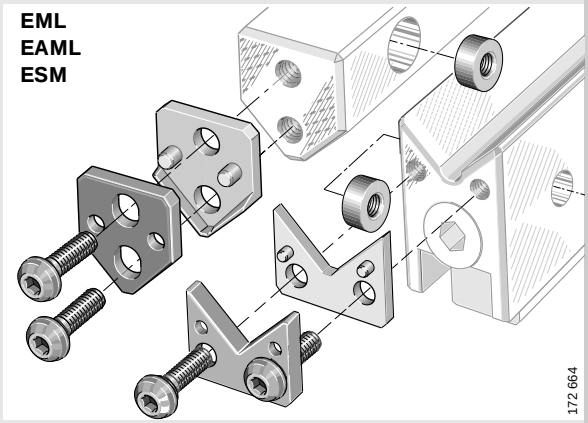
FFW
HW
HGW



- needle rollers in grade G2
- FFW made from plastic. For temperatures up to +120 °C
- HW made from metal. For temperatures up to +150 °C
- HGW: angled needle roller flat cage with friction damping

Accessories

EML
EAML
ESM



- end pieces EML made from steel
- wipers EAML made from polyurethane, with steel end piece. For temperatures up to +100 °C
- end pieces and wipers are supplied with fixing screws
- insert nuts ESM

Design and safety guidelines

- In a closed arrangement, two V guideways and one ML and one M guideway with identical dimensions A_1 and A_2 should always be used in order to ensure correct function. The guideways are matched accordingly and are marked with the same set number (suffix 2SX for ML and M guideway).
- Guideway pairs should be fitted in accordance with the set numbers (Figure 1). This ensures that the installation width is within tolerance.
- Guideways with a restricted tolerance of ± 0,005 for dimensions A_1 and A_2 (suffix US) can be used in any combination if normal requirements apply. Where accuracy requirements are higher, they can be matched in accordance with the marking on the guideway:

  Marking US-1: deviation A_1 and A_2 $^{+0,005}_{0}$

  Marking US-2: deviation A_1 and A_2 $^{0}_{-0,005}$.

Further information Page

Accuracy

Quality, positional and profile tolerances

Guideways are available in two quality grades (Figure 2):

- Q6
  Conforms to the requirements of precision table guidance systems in machine tool design.
- Q10
  Standard quality grade for requirements in general machine building.
- Geometrical and positional tolerances (Figure 2).
- Profile tolerances (Figure 1).

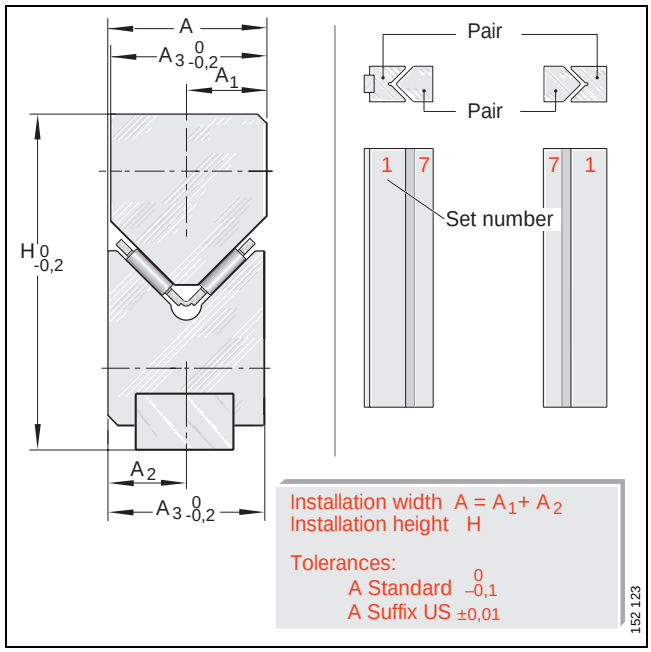


Figure 1 · Profile tolerances, marking

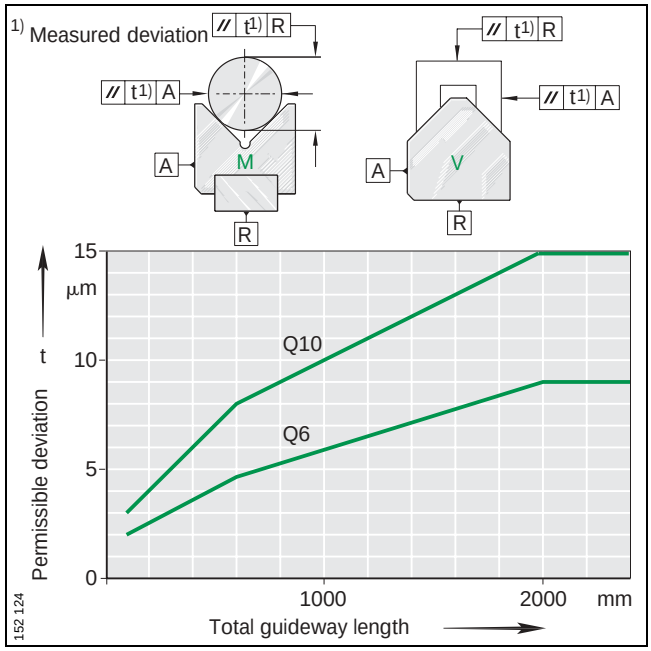


Figure 2 · Positional accuracy and quality of guideways

Tolerances for hole pitches

The positional tolerance of the hole pattern ∅ X is 1‰ of the guideway length L (Figure 3).

If the guideway length is less than 80% of the maximum length given in the dimension table, it can be fitted to a predrilled hole pattern; a positional tolerance of ∅ 0,2 must be achieved in this case.

If longer guideways are to fulfil this requirement, they must be ordered using the suffix P (positional tolerance).

Special designs

Guideways

- with different cross-sections, fixing holes, hole pitches and lengths
- guidance system heights A_1 or A_2 with restricted tolerance ±0,005 mm
  – suffix US
- anti-corrosion protection by thin layer chromium plating
  – suffix DSV
- raceway lead chamfers at ends of guideway
  – suffix E2
- without holes on end faces
  – suffix E1
- needle roller flat cage with friction damping
  – series HGW.

Ordering example and ordering designation

For four machines:

ML and V guideways and M and V guideways in custom length for closed arrangement

Stroke length	150 mm
Profile width	25 mm
Hole type	15, counterbore on right
Length of ML and M guideways	450 mm
Length of V guideways	600 mm
Quality grade	Q6.

Ordering designation:

4 off ML 6025/15 L×450 Q6 2SX
4 off M 5025/15 ×450 Q6 2SX
8 off V 5025/15 ×600 Q6
8 off HW 16×375
8 off EM 5025
8 off EML 25 (Figure 4).

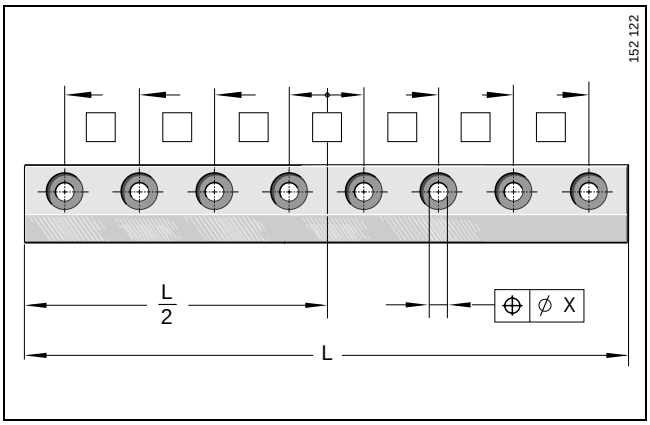


Figure 3 · Hole pattern of guideway

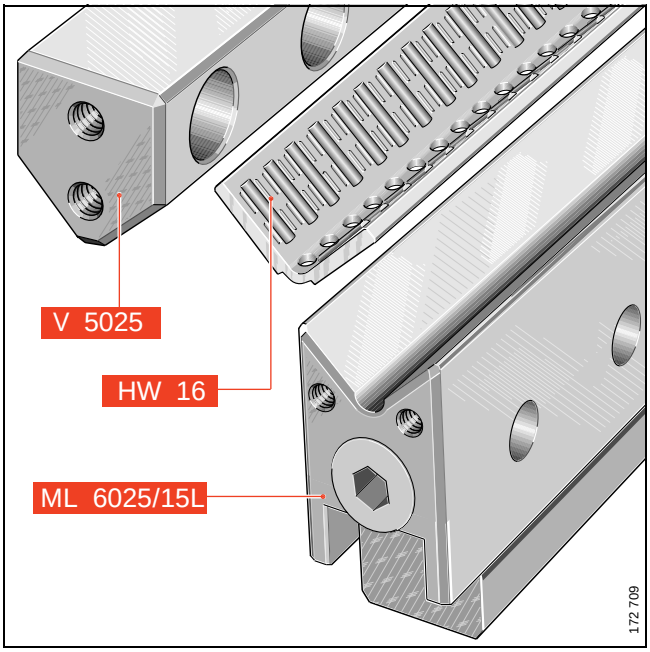


Figure 4 · Ordering example, ordering designation

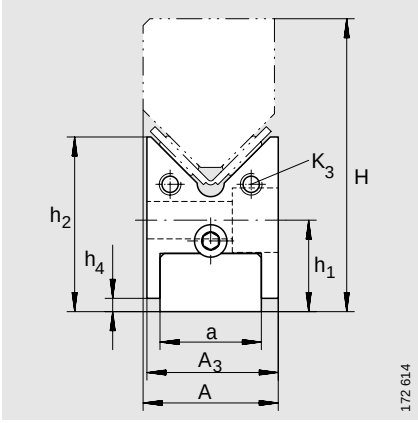
Flat cage guidance systems

HYDREL/EGIS guideways
with adjusting gib and
angled needle roller flat cage

Series ML

ML guideways also available with sealing strips
– gap or lip seal –
(only in conjunction with V guideways).

Suffix for ML guideways with gap seals: ..ZZ
Suffix for ML guideways with lip seals: ..PP



ML and V

Dimension table · Dimensions in mm

Designation	Dimensions							Fixing holes						
	H[1]	A –0,1	A_3 –0,2	h_2[1]	h_4	h_5	a	K_1 For screws DIN 912-8.8	h_1	a_1	t min.	C_4[2]	C_5[3] min.	C_6 min.
ML 5020	50	20	20	32,5	5,5	15	15	M6	17,5	13,2	20	80	30	15
ML 5520	55	20	20	37,5	6	20	15	M6	22,5	13,2	20	80	30	15
ML 5525	55	25	25	32,5	2,5	11,5	20	M6	15	18,2	15	80	30	20
ML 6025	60	25	25	37,5	3,5	16,5	20	M6	20	18,2	15	80	30	20
ML 6525	65	25	25	42,5	5	21,5	20	M6	25	18,2	15	80	30	20
ML 7025	70	25	25	47,5	6,5	26,5	20	M6	30	18,2	15	80	30	20
ML 7035	70	35	35	45	3	15,5	25	M8	21	26	20	100	32	20
ML 8035	80	35	35	55	5	25,5	25	M8	31	26	20	100	32	20
ML 8040	80	40	40	50	3	16	30	M10	23	29	25	100	32	20
ML 9040	90	40	40	60	5	26	30	M10	33	29	25	100	32	20
ML 9050	90	50	50	55	3	15,5	40	M12	24	37	30	100	32	20
ML 10050	100	50	50	65	5	25,5	40	M12	34	37	30	100	32	20

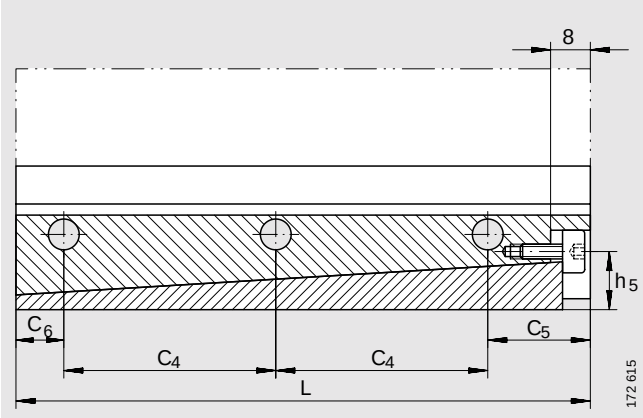
[1]) The various guideway heights H and h_2 of a profile are determined by the gib heights dependent on the gib length.
Setting range for H: –0,5 to +0,3 mm.

[2]) For length L $< C_4 + C_{5\,min.} + C_{6\,min.}$ C_4 = 50 mm.

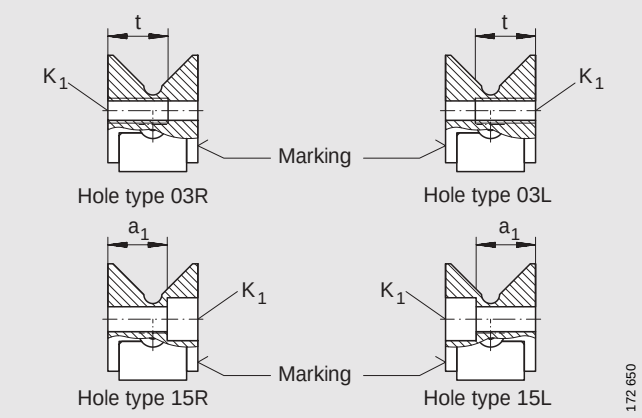
[3]) C_5 is always on the adjusting gib side.

[4]) The dimensions C_5 and C_6 are dependent on the guideway length:
$C_6 + C_5 = L - \sum C_4$; $C_{6\,min.}$ and $C_{5\,min.}$ are minimum values;
for $L - \sum C_4 \geq 2\ C_{5\,min}$ $C_6 = C_5$.

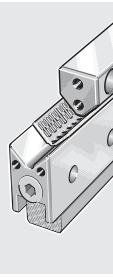
[5]) End pieces: see page 88; wipers: see page 90; insert nuts: see page 93.



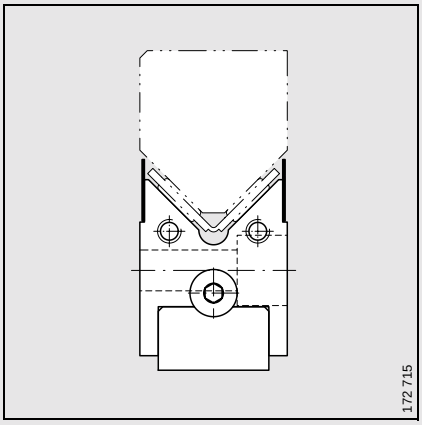
ML and V



Hole types



Holes in end faces K_3	Design length L[4)]	Appropriate guideway	Appropriate angled flat cages		Accessories[5)]		
			Plastic	Metal	End pieces	End pieces with wipers	Insert nuts
M4	100– 300	**V 4020**	**FFW 2025**	**HW 15**	**EML 20**	**EAML 20**	**ESM M6**
M4	301– 600	**V 4020**	**FFW 2025**	**HW 15**	**EML 20**	**EAML 20**	**ESM M6**
M5	100– 250	**V 5025**	**FFW 2025**	**HW 16**	**EML 25**	**EAML 25**	**ESM M6**
M5	251– 500	**V 5025**	**FFW 2025**	**HW 16**	**EML 25**	**EAML 25**	**ESM M6**
M5	501– 750	**V 5025**	**FFW 2025**	**HW 16**	**EML 25**	**EAML 25**	**ESM M6**
M5	751–1000	**V 5025**	**FFW 2025**	**HW 16**	**EML 25**	**EAML 25**	**ESM M6**
M6	100– 500	**V 6035**	**FFW 2535**	**HW 20**	**EML 35**	**EAML 35**	**ESM M8**
M6	501–1000	**V 6035**	**FFW 2535**	**HW 20**	**EML 35**	**EAML 35**	**ESM M8**
M6	100– 500	**V 7040**	**FFW 3045**	**HW 25**	**EML 40**	**EAML 40**	**ESM M10**
M6	501–1000	**V 7040**	**FFW 3045**	**HW 25**	**EML 40**	**EAML 40**	**ESM M10**
M6	100– 500	**V 8050**	**FFW 3555**	**HW 30**	**EML 50**	**EAML 50**	**ESM M12**
M6	501–1000	**V 8050**	**FFW 3555**	**HW 30**	**EML 50**	**EAML 50**	**ESM M12**



Design with sealing strips

Flat cage guidance systems

HYDREL/EGIS M and V guideways with integral toothed rack for positive control of angled needle roller flat cage

Features

Flat cage guidance systems

- consist of:
  - guideways of type M and V with an integral toothed rack
  - angled flat cages with an integral gear and a large number of rolling elements
- are used where there is a risk of cage creep, for example:
  - in designs with non-uniform rigidity in the guidance area
  - if the cage does not regularly move to the end positions
- are used as linear locating bearings
- have high rigidity and load carrying capacity whilst requiring very little space
- have low, uniform friction
- have high, consistent accuracy throughout their operating life
- are only supplied in sets (designation MVZ)
  - two M and two V guideways, two needle roller flat cages and a positive control device comprising a rack and pinion
- can be supplemented by accessories
- are also available with sealing strips (*dimension table*).

Guideways with positive cage control

- are made from through hardened tool steel with a minimum hardness of 670 HV (the toothed rack is unhardened)
- have precision ground raceways and locating faces
- have the same mounting dimensions as guideways M/ML and V
- are produced with various hole types
- have threaded holes on the end faces for fitting wipers.

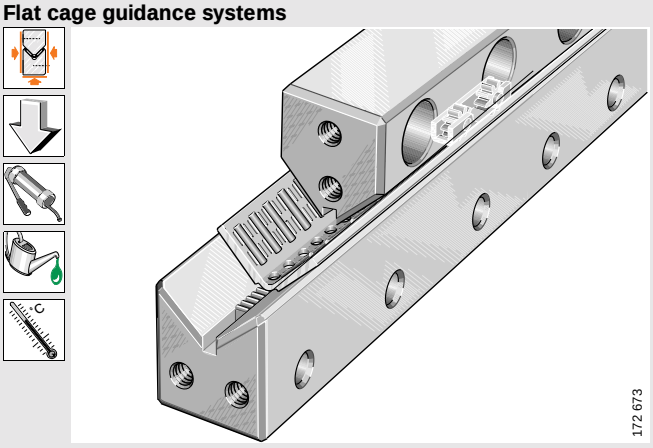
Angled needle roller flat cages

- are subjected to positive control by means of an integral gear
- are double row cages with the shanks at right angles to each other
- are made from metal.

Accessories

- wipers protect the raceways against contamination under normal operating conditions
- insert nuts allow the conversion of holes of type 15 to threaded holes.

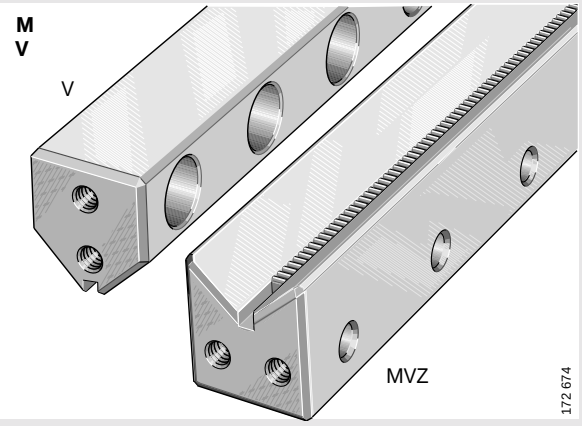
Flat cage guidance systems



172 673

- basic design comprising:
  - guideway M with integral toothed rack and guideway V with integral toothed rack
  - angled needle roller flat cage HW with integral gear

HYDREL/EGIS guideways

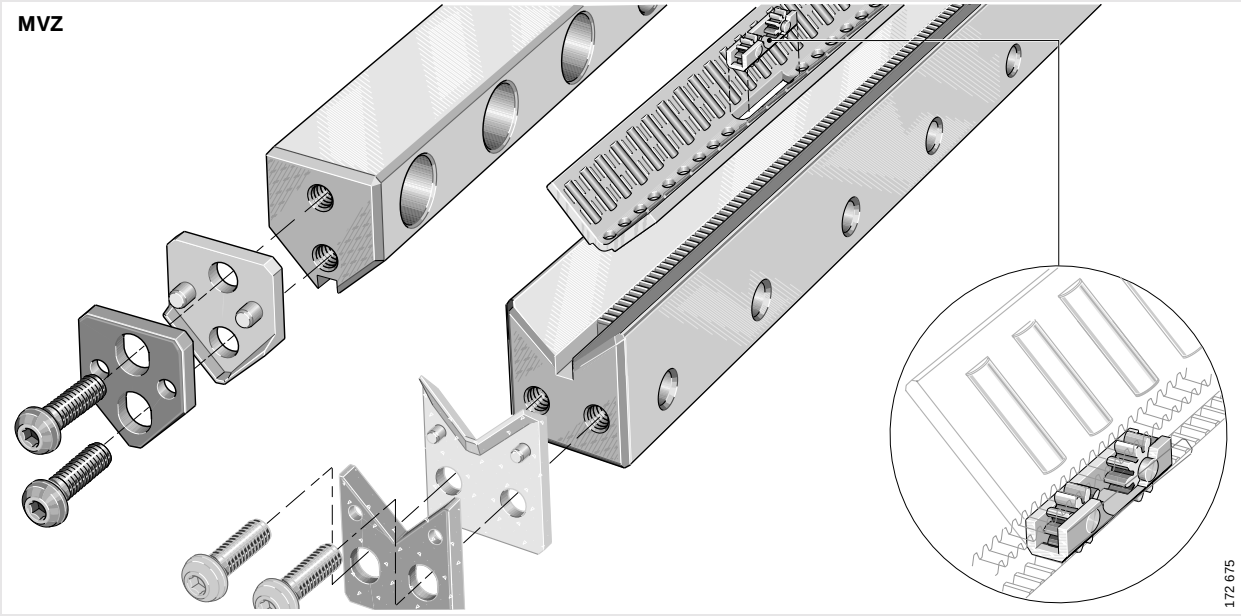


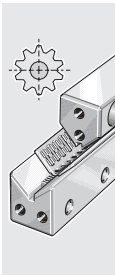
172 674

- M guideway and V guideway with integral toothed rack
- custom length according to dimension table
- hole types 03, 10 and 15

Flat cage guidance system with accessories

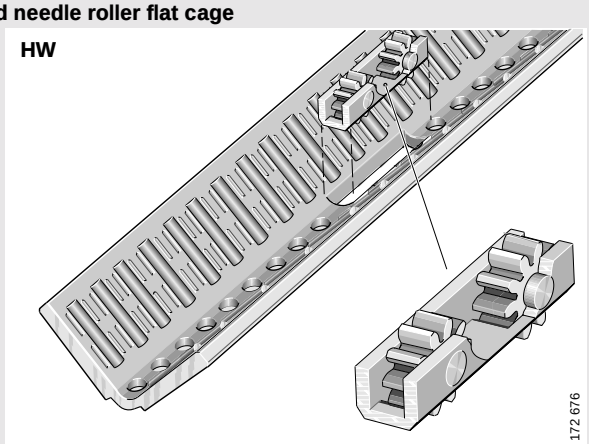
MVZ





Angled needle roller flat cage

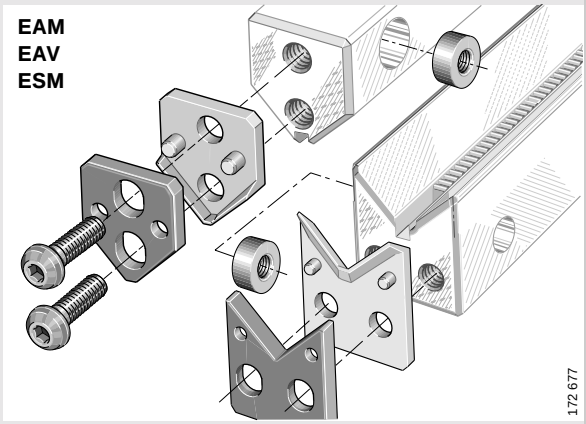
HW



- made from metal
- needle rollers in grade G2
- gear unit

Accessories

EAM
EAV
ESM



- wipers EAM/EAV made from polyurethane, with steel end piece. For temperatures up to +100 °C
- wipers are supplied with fixing screws
- insert nuts ESM

Design and safety guidelines

- The guideways and cages of MVZ guidance systems are supplied in sets. The parts are matched and marked on the basis of the dimensions A_1 and A_2 and the cages.

Fitting

- Guideways must be fitted in sets. This must be carried out in accordance with the set number.
- During fitting, it must be ensured that the guideway and cage are correctly positioned relative to each other in order to prevent the cage colliding with the wipers or points on the adjacent construction.
  - Note the marking x-x indicating the correct relative position of the guideways and cages in the central stroke position (Figure 1).

Further information

Accuracy

Quality, positional and profile tolerances

Guideways are available in three quality grades (Figure 2):

- Q2
  For exacting requirements in high precision machines. This grade should only be used if the adjacent construction can be produced to equally high accuracy.
- Q6
  Conforms to the requirements of precision table guidance systems in machine tool design.
- Q10
  Standard quality grade for requirements in general machine building.
- Geometrical and positional tolerances (Figure 2).
- Profile tolerances (Figure 1).

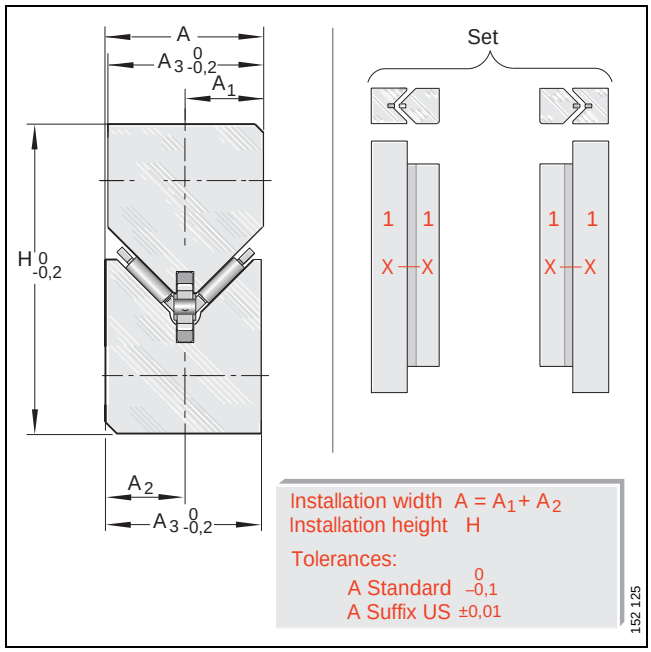


Figure 1 · Profile tolerances, marking

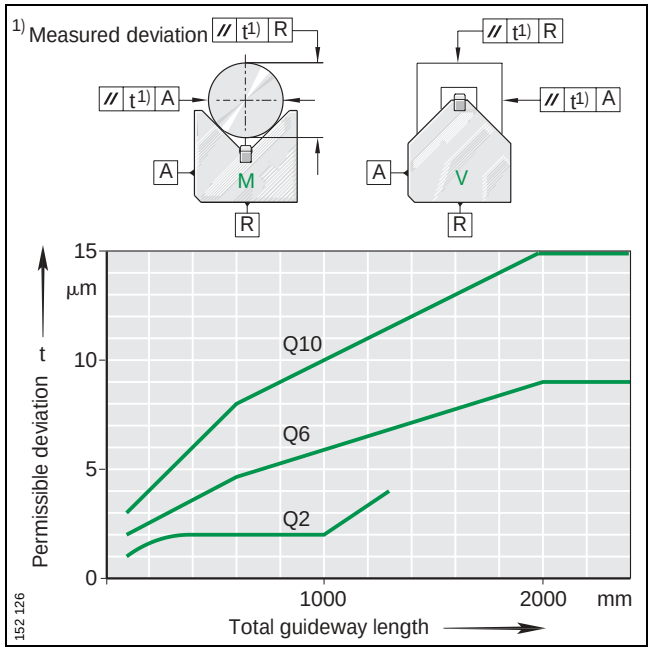


Figure 2 · Positional accuracy and quality of guideways

Tolerances for hole pitches

The positional tolerance of the hole pattern ∅ X is 1‰ of the guideway length L (Figure 3).

If the guideway length is less than 80% of the maximum length given in the dimension table, it can be fitted to a predrilled hole pattern; a positional tolerance of ∅ 0,2 must be achieved in this case.

If longer guideways are to fulfil this requirement, they must be ordered using the suffix P (positional tolerance).

Special designs

Guideways

- with different cross-sections, fixing holes, hole pitches and lengths
- anti-corrosion protection by thin layer chromium plating
  – suffix DSV
- raceway lead chamfers at ends of guideway
  – suffix E2
- without holes on end faces
  – suffix E1.

Ordering example and ordering designation

4 sets of M and V guideways with integral positive cage control, closed arrangement

Profile size	4020
M guideways	400 mm, hole type 03
V guideways	600 mm, hole type 15
Cage length	305 mm
Stroke	190 mm
End wipers on M guideway	
Quality grade	Q10.

Ordering designation:

4 sets MVZ 4020×400/600/305 Q10

each comprising:

2 off M	4020/03×400 Q10
2 off V	4020/15×600 Q10
2 off HW	15×305
4 off EAM	4020 (Figure 4).

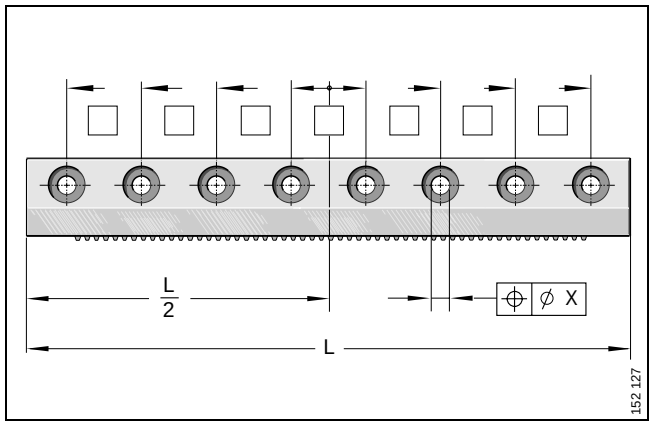


Figure 3 · Hole pattern of guideway

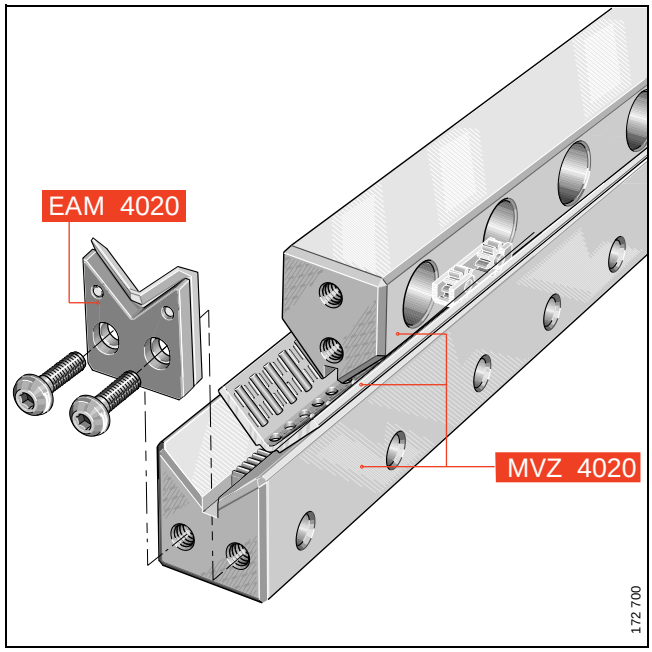


Figure 4 · Ordering example, ordering designation

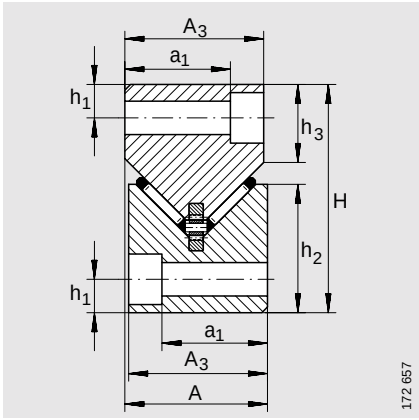
Flat cage guidance systems

HYDREL/EGIS guideways
with integral toothed rack for positive
control of angled needle roller flat cage

Series MVZ

M guideways also available with sealing strips
– gap or lip seal –
(only in conjunction with V guideways).

Suffix for M guideways with gap seals: ..ZZ
Suffix for M guideways with lip seals: ..PP



MVZ

Dimension table · Dimensions in mm

Designation		Dimensions					Fixing holes							Holes in end faces
		H –0,2	A –0,1	A_3 –0,2	h_2	h_3	K_1 For screws DIN 912-8.8	h_1	a_1	t	C_4[1]	C_5[2] min.	C_6[2] min.	K_3
M 3015	**–**	30	15	15	15,5	–	M4	5,5	10,5	15	40	15	15	M3
–	**V 3015**	30	15	15	–	10,5	M4	5,5	10,5	15	40	15	15	M3
M 4020	**–**	40	20	20	22,5	–	M6	7,5	13,2	20	80	15	15	M5
–	**V 4020**	40	20	20	–	13,5	M6	7,5	13,2	20	80	15	15	M5
M 5025	**–**	50	25	25	28	–	M6	10	18,2	15	80	20	20	M6
–	**V 5025**	50	25	25	–	17	M6	10	18,2	15	80	20	20	M6
M 6035	**–**	60	35	35	35	–	M8	11	26	20	100	20	20	M6
–	**V 6035**	60	35	35	–	20	M8	11	26	20	100	20	20	M6
M 7040	**–**	70	40	40	40	–	M10	13	29	35	100	20	20	M6
–	**V 7040**	70	40	40	–	24	M10	13	29	35	100	20	20	M6
M 8050	**–**	80	50	50	45	–	M12	14	37	30	100	20	20	M6
–	**V 8050**	80	50	50	–	26	M12	14	37	30	100	20	20	M6

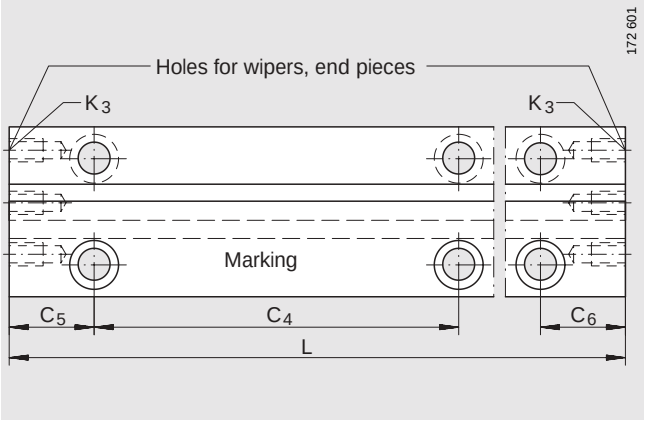
[1]) M/V 3015: For L = 100 mm to 109 mm, C_4 = 35 mm (3 holes).
Other sizes: For $L < C_4 + C_{5\,min.} + C_{6\,min.}$ C_4 = 50 mm.

[2]) C_5 and C_6 are dependent on the guideway length and must be identical at both ends of a guideway: C_5 and $C_6 = \frac{L - \Sigma C_4}{2}$; $C_{5\,min.}$ and $C_{6\,min.}$ are minimum values.

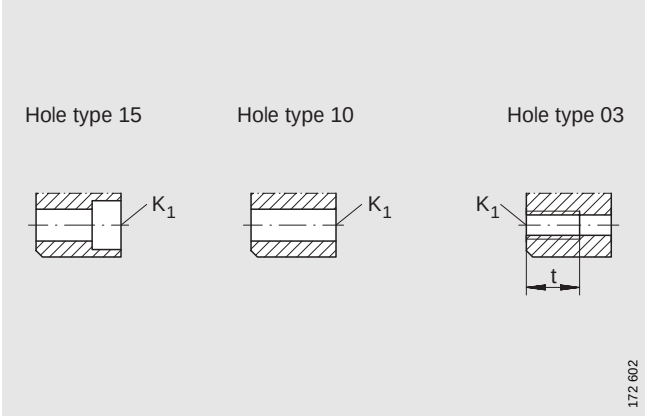
[3]) Extra-long guideways available by agreement.

[4]) End pieces with wipers: see page 90; insert nuts: see page 93.

[5]) Hole pattern for M/V 3015 = 15 + 2 × 35 + 15.
Hole pattern for other sizes = 25 + 50 + 25.

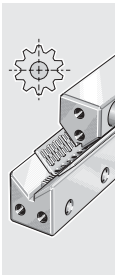


MVZ

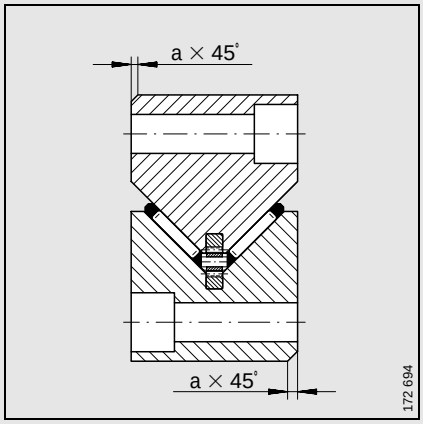


Hole types

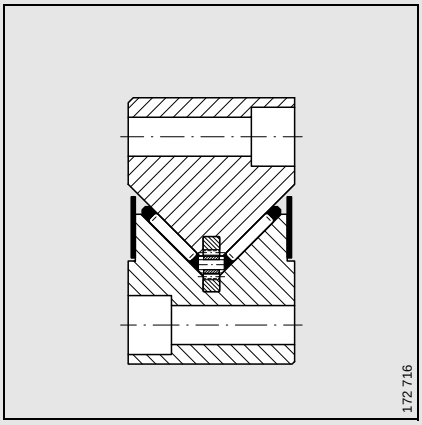
Available standard lengths											Custom lengths up to L[3]	Appropriate angled flat cages	Accessories[4]	
													End pieces with wipers	Insert nuts
100[5]	150	200	300	400	500	600	700	800	900	1000	max.			
•	•	•	•	•	•	•					600	**HW 10**	**EAM 3015**	**ESM M4**
•	•	•	•	•	•	•					600	**HW 10**	**EAV 3015**	**ESM M4**
•	•	•	•	•	•	•					1000	**HW 15**	**EAM 4020**	**ESM M6**
•	•	•	•	•	•	•					1000	**HW 15**	**EAV 4020**	**ESM M6**
•		•	•	•	•	•	•	•	•	•	1300	**HW 16**	**EAM 5025**	**ESM M6**
•		•	•	•	•	•	•	•	•	•	1300	**HW 16**	**EAV 5025**	**ESM M6**
		•	•	•	•	•	•	•	•	•	1300	**HW 20**	**EAM 6035**	**ESM M8**
		•	•	•	•	•	•	•	•	•	1300	**HW 20**	**EAV 6035**	**ESM M8**
		•	•	•	•	•	•	•	•	•	1300	**HW 25**	**EAM 7040**	**ESM M10**
		•	•	•	•	•	•	•	•	•	1300	**HW 25**	**EAV 7040**	**ESM M10**
			•	•	•	•	•	•	•	•	1300	**HW 30**	**EAM 8050**	**ESM M12**
			•	•	•	•	•	•	•	•	1300	**HW 30**	**EAV 8050**	**ESM M12**



Series	a_{min}
M and V 3015	0,7×45°
M and V 4020 to M and V 8050	1,3×45°



Chamfer dimensions



Design with sealing strips

Flat guidance systems

HYDREL/EGIS M guideways with sliding layer and V guideways

Features

Flat guidance systems

- consist of
  - guideways of type M with a plain sliding layer and guideways of type V as a mating raceway
- are used especially
  - for supporting static or pulsating loads
  - where lubrication is not possible or only initial lubrication can be provided (plain sliding material LB1, *Design and safety guidelines*, page 70). However, they can also be used with oil or grease lubrication
  - where an increased friction level is required in order to provide damping
- are used as linear locating bearings
- have hardly any stick-slip.

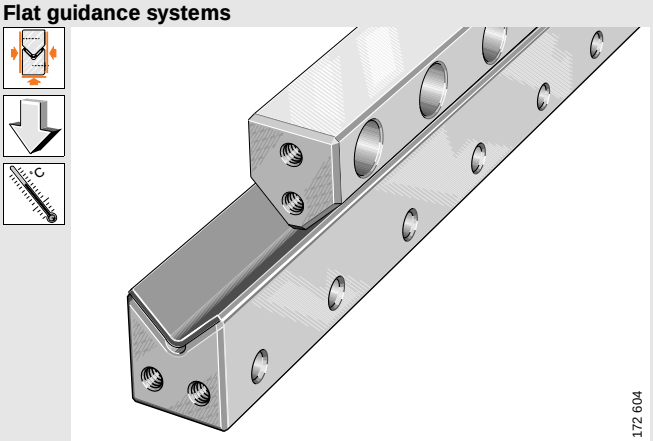
Guideways M with plain sliding layer

- comprise a guideway made from unhardened steel with a plain sliding layer attached by adhesive
- are available with various plain sliding materials
  - Turcite® B, suffix LB1
  - Permaglide® P21, suffix LP21
- have the same mounting dimensions as guideways M and V with flat cages
- are produced with various hole types
- have threaded holes on the end faces for fitting wipers.

Accessories

- insert nuts allow the conversion of holes of type 15 to threaded holes.

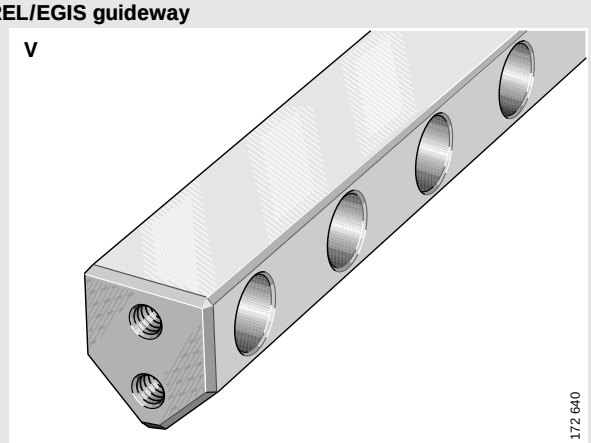
Flat guidance systems



- basic design comprising:
  - guideway M with plain sliding layer and guideway V

HYDREL/EGIS guideway

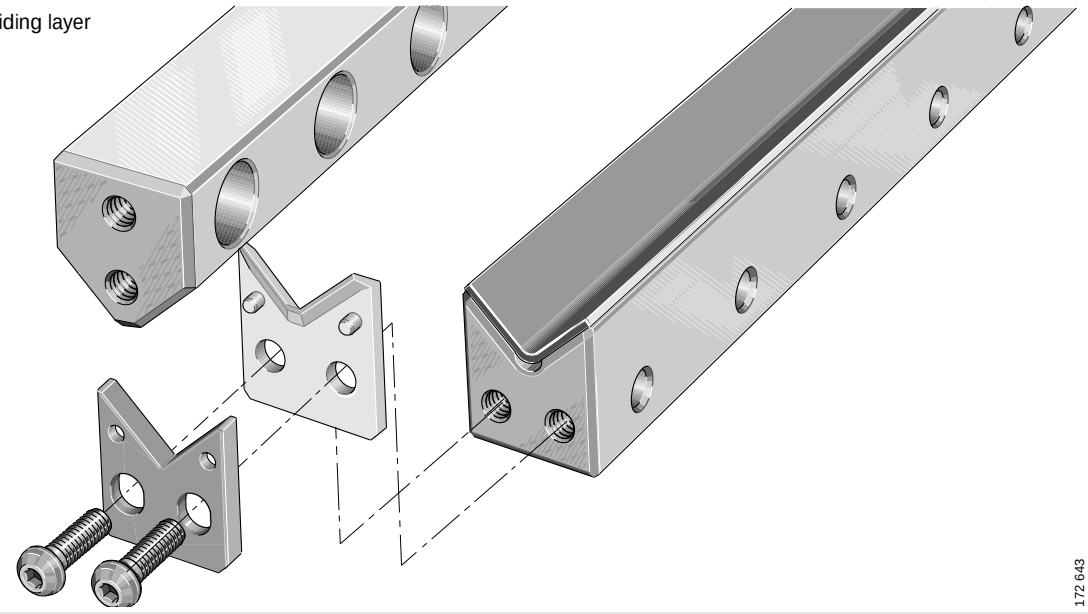
V

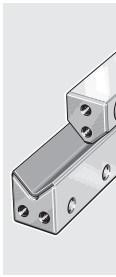


- guideway without plain sliding layer, dimensionally identical to design for flat cages
- standard and custom lengths according to dimension table
- hole types 03, 10 and 15

Flat guidance system with accessories

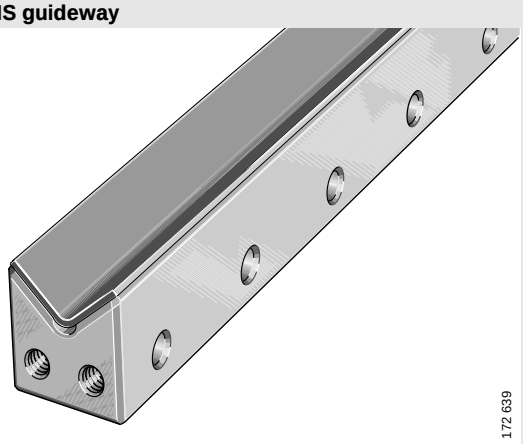
M with plain sliding layer
V





HYDREL/EGIS guideway

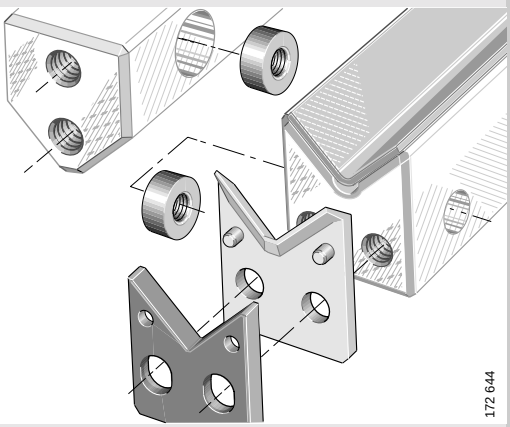
M



- with sliding layer
- for temperatures up to +80 °C
- custom lengths according to dimension table
- hole types 03, 10 and 15

Accessories

EAM
ESM



- wipers EAM made from polyurethane, with steel end piece
- insert nuts ESM

Design and safety guidelines

- Guide values for selection of plain sliding material

		Turcite® B	Permaglide® P21
	Suffix	LB1	LP21
Maximum specific load p_{max} static	[N/mm²]	6	250
p · v max	[N/mm² · m/s]	1	3
Maximum temperature	[°C]	–40 to +80	–40 to +110
Coefficient of friction, dry		0,15 to 0,26	not suitable
Coefficient of friction, lubricated		0,04 to 0,08	0,02 to 0,2

- In a closed arrangement, two V guideways and two M guideways with identical dimensions A_1 and A_2 should always be used in order to ensure correct function. The guideways are matched accordingly and are marked with the same set number.
- Guideway pairs should be fitted in accordance with the set numbers (Figure 1). This ensures that the installation width is within tolerance.

⚠ Plain guidance systems must not be set free from clearance or preloaded in a rigid environment, since even slight thermal expansion can lead to uncontrolled friction conditions.

- The screw connections should be checked.

Further information Page

Design of bearing arrangements 40
Fitting 46

Accuracy

Quality, positional and profile tolerances

Guideways are available in two quality grades (Figure 2):

- Q6
  Conforms to the requirements of precision table guidance systems in machine tool design.
- Q10
  Standard quality grade for requirements in general machine building.
- Geometrical and positional tolerances (Figure 2).
- Profile tolerances (Figure 1).

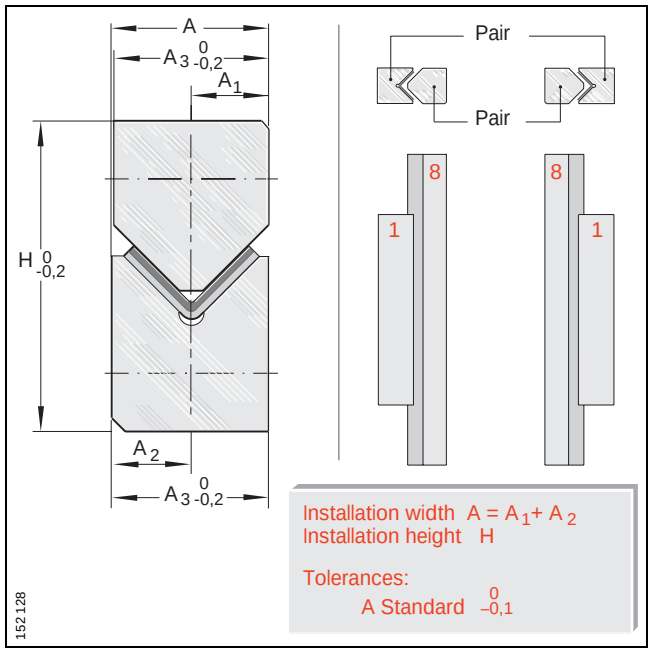


Figure 1 · Profile tolerances, marking

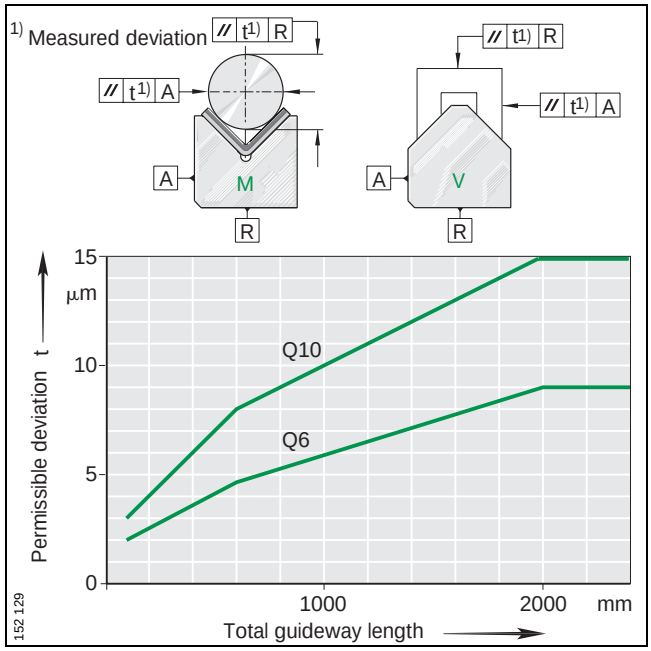


Figure 2 · Positional accuracy and quality of guideways

Tolerances for hole pitches

The positional tolerance of the hole pattern ∅ X is 1‰ of the guideway length L (Figure 3).

If the guideway length is less than 80% of the maximum length given in the dimension table, it can be fitted to a predrilled hole pattern; a positional tolerance of ∅ 0,2 must be achieved in this case.

If longer guideways are to fulfil this requirement, they must be ordered using the suffix P (positional tolerance).

Special designs

Guideways

- with different cross-sections, fixing holes, hole pitches and lengths
- without holes on end faces
  – suffix E1.

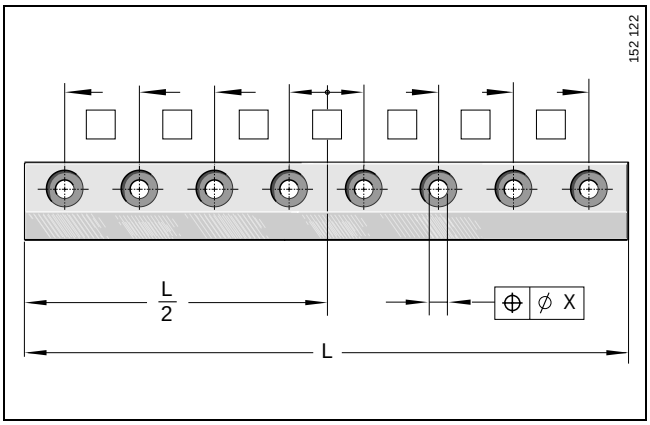
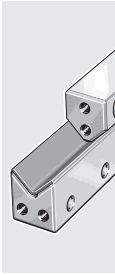


Figure 3 · Hole pattern of guideway



Ordering example and ordering designation

For four machines:

M guideways with plain sliding layer in standard length and V guideways in standard length, for closed arrangement, stroke 100 mm

Profile size	5025
Hole type	15
Length of V guideways	500 mm
Length of M guideways with plain sliding layer	400 mm
Quality grade	Q6
Plain sliding layer	LB1.

Ordering designation:

8 off M 5025/15×400 Q6 LB1
8 off V 5025/15×500 Q6 (Figure 4).
Intended for four sets.

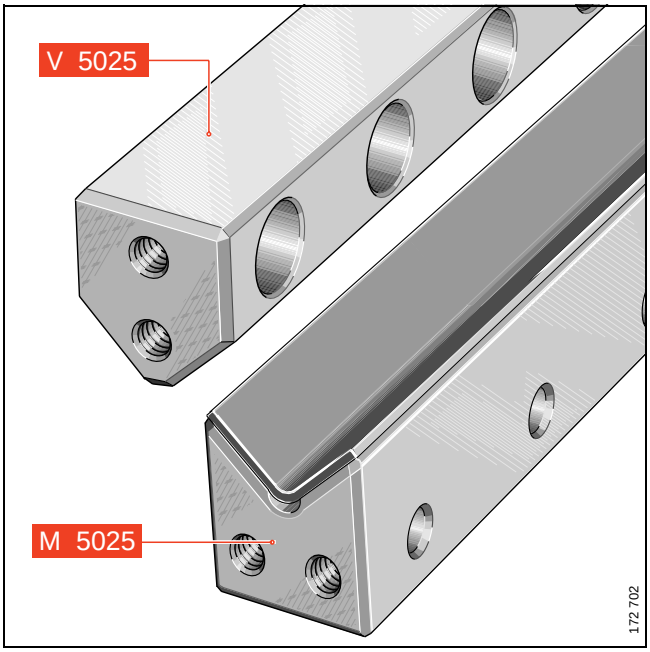
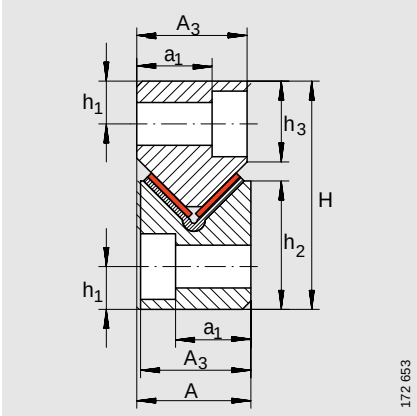


Figure 4 · Ordering example, ordering designation

Flat guidance systems

HYDREL/EGIS guideways
with plain sliding layer

Series M
V



M with plain sliding layer and V

Dimension table · Dimensions in mm

Designation		Dimensions					Fixing holes						
		H –0,2	A –0,1	A_3 –0,2	h_2	h_3	K_1 For screws DIN 912-8.8	h_1	a_1	t min.	C_4 [1]	C_5 [2] min.	C_6 [2] min.
M 3015	**–**	30	15	15	15,5	–	M4	5,5	10,5	15	40	15	15
–	**V 3015**	30	15	15	–	10,5	M4	5,5	10,5	15	40	15	15
M 4020	**–**	40	20	20	22,5	–	M6	7,5	13,2	20	80	15	15
–	**V 4020**	40	20	20	–	13,5	M6	7,5	13,2	20	80	15	15
M 5025	**–**	50	25	25	28	–	M6	10	18,2	15	80	20	20
–	**V 5025**	50	25	25	–	17	M6	10	18,2	15	80	20	20
M 6035	**–**	60	35	35	35	–	M8	11	26	20	100	20	20
–	**V 6035**	60	35	35	–	20	M8	11	26	20	100	20	20
M 7040	**–**	70	40	40	40	–	M10	13	29	25	100	20	20
–	**V 7040**	70	40	40	–	24	M10	13	29	25	100	20	20
M 8050	**–**	80	50	50	45	–	M12	14	37	30	100	20	20
–	**V 8050**	80	50	50	–	26	M12	14	37	30	100	20	20

[1] M/V 3015: For L = 100 mm to 109 mm, C_4 = 35 mm (3 holes).
Other sizes: For $L < C_4 + C_{5\,min.} + C_{6\,min.}$ C_4 = 50 mm.

[2] C_5 and C_6 are dependent on the guideway length and must be identical at both ends of a guideway: C_5 and $C_6 = \frac{L - \Sigma C_4}{2}$; $C_{5\,min.}$ and $C_{6\,min.}$ are minimum values.

[3] Guideways longer than the stated maximum length are available as multi-piece units. The total length of a multi-piece unit must be stated in the order.

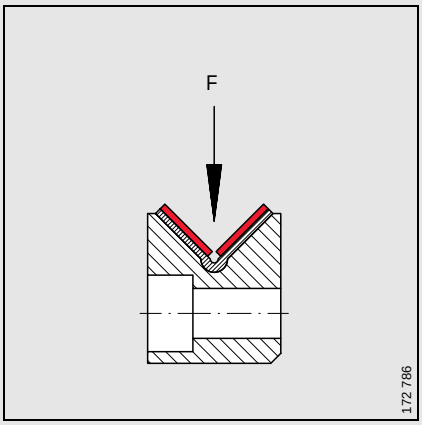
[4] End pieces with wipers: see page 90; insert nuts: see page 93.

[5] Hole pattern for M/V 3015 = 15 + 2 × 35 + 15.
Hole pattern for other sizes = 25 + 50 + 25.

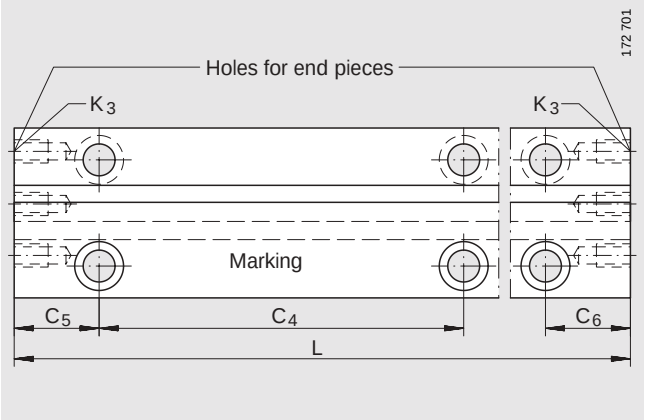
Maximum static load [6]

Designation	$F_{0\,perm}$ N Turcite® B	$F_{0\,perm}$ N Permaglide® P21
M 3015	3 600	150 000
V 3015	–	–
M 4020	6 600	275 000
V 4020	–	–
M 5025	8 400	350 000
V 5025	–	–
M 6035	12 000	500 000
V 6035	–	–
M 7040	13 800	575 000
V 7040	–	–
M 8050	16 200	675 000
V 8050	–	–

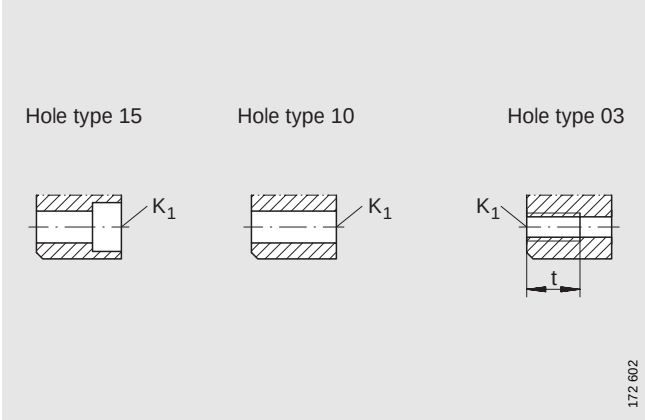
[6] For a guideway length of 100 mm in *Load direction* according to the figure.



Load direction

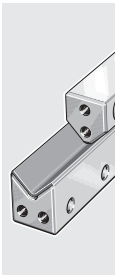


M with plain sliding layer and V

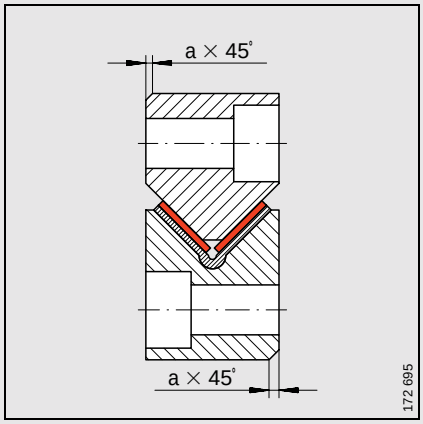


Hole types

Holes in end faces K_3	Standard lengths											Design lengths up to L^3)	Accessories[4])	
	100[5])	150	200	300	400	500	600	700	800	900	1000	max.	End pieces with wipers	Insert nuts
M3	•	•	•	•	•	•	•					600	**EAM 3015**	**ESM M4**
M3	•	•	•	•	•	•	•					600	**–**	**ESM M4**
M5	•	•	•	•	•	•	•					1000	**EAM 4020**	**ESM M6**
M5	•	•	•	•	•	•	•					1000	**–**	**ESM M6**
M6	•		•	•	•	•	•	•	•	•	•	1300	**EAM 5025**	**ESM M6**
M6	•		•	•	•	•	•	•	•	•	•	1300	**–**	**ESM M6**
M6			•	•	•	•	•	•	•	•	•	1300	**EAM 6035**	**ESM M8**
M6			•	•	•	•	•	•	•	•	•	1300	**–**	**ESM M8**
M6			•	•	•	•	•	•	•	•	•	1300	**EAM 7040**	**ESM M10**
M6			•	•	•	•	•	•	•	•	•	1300	**–**	**ESM M10**
M6				•	•	•	•	•	•	•	•	1300	**EAM 8050**	**ESM M12**
M6				•	•	•	•	•	•	•	•	1300	**–**	**ESM M12**



Series	a_{min}
M and V 3015	0,7×45°
M and V 4020 to M and V 8050	1,3×45°



Chamfer dimensions

Flat cage guidance systems

HYDREL/EGIS J and S guideways with needle roller flat cage

Features

Flat cage guidance systems

- consist of:
  - guideways of type J and S
  - flat cages with a large number of rolling elements
- are used as linear non-locating bearings
- are highly suitable for limited stroke lengths
- have high rigidity and load carrying capacity whilst requiring very little space
- have low, uniform friction
- have high, consistent accuracy throughout their operating life
- can be supplemented by accessories.

Guideways J, S

- are made from through hardened steel with a minimum hardness of 670 HV
- have precision ground raceways and locating faces
- the J guideway guides the flat cage between ribs
- are produced with various hole types
- have threaded holes on the end faces for fitting end pieces or wipers.

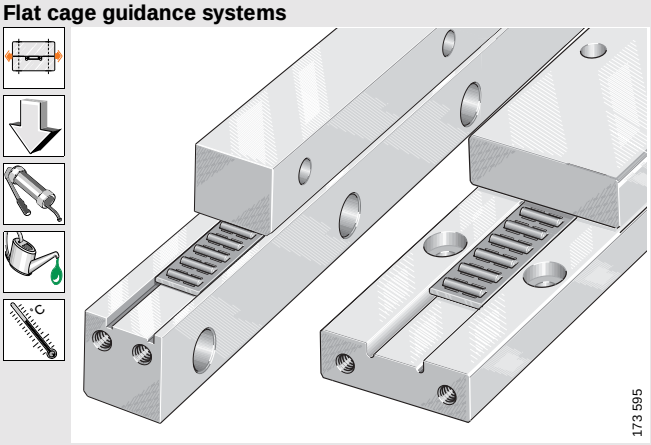
Needle roller flat cages

- are single or double row cages depending on the housing
- are made from metal or plastic
  - metal cages are lightweight components with high strength. They are suitable for more demanding conditions such as high acceleration, high temperatures and where the ends of the cage are exposed at some point in operation.

Accessories

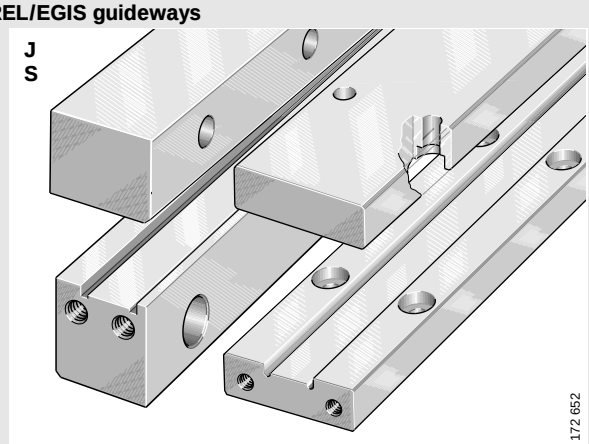
- end pieces prevent the cage creeping out of the load zone
- wipers protect the the raceways against contamination under normal operating conditions.
- insert nuts allow the conversion of holes of type 15 to threaded holes.

Flat cage guidance systems



- basic design comprising:
  - guideways J, S
  - needle roller flat cages FF or H
  - high or flat design

HYDREL/EGIS guideways

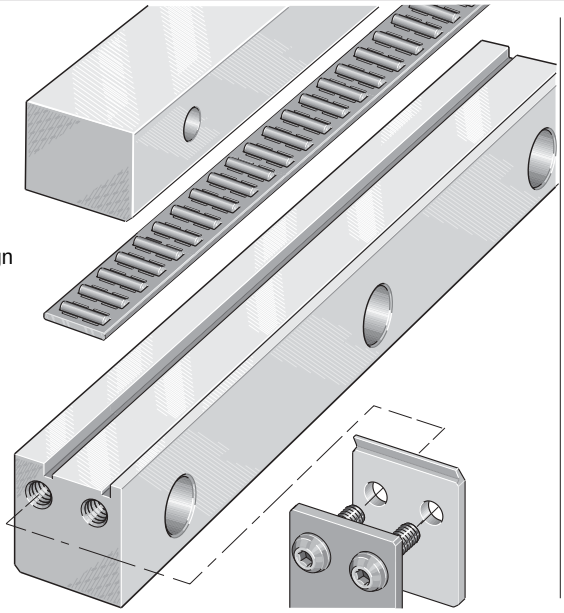


- for needle roller flat cages
- flat and high designs
- available in any custom length up to the maximum length given in the dimension table
- hole type 03 and 15

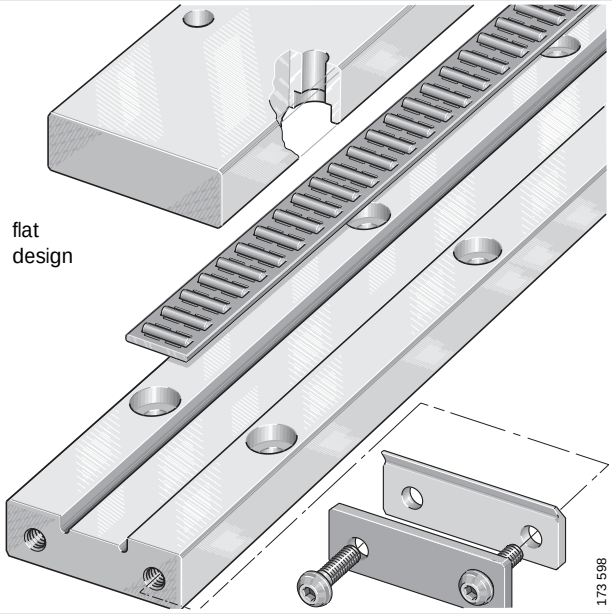
Flat cage guidance system with accessories

J/S

high design

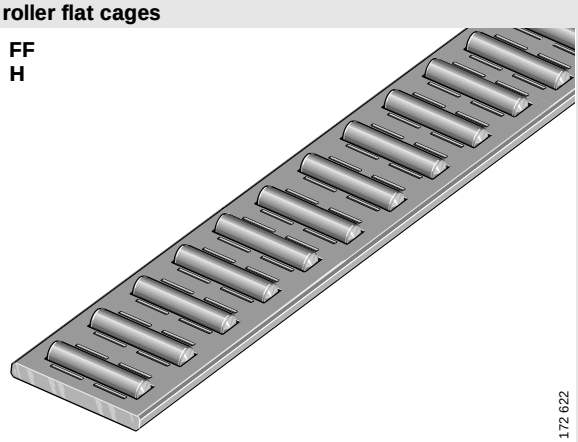


flat design



Needle roller flat cages

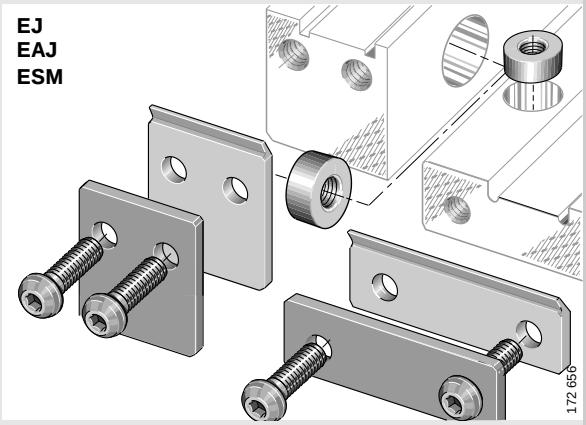
FF
H



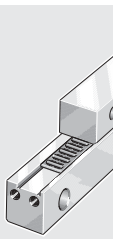
- single row
- needle roller flat cage FF made from plastic.
  Needle rollers in grade G2.
  For temperatures up to +120 °C
- needle roller flat cages H made from metal.
  Needle rollers in grade G2.
  For temperatures up to +150 °C

Accessories

EJ
EAJ
ESM



- end pieces EJ made from steel
- wipers EAJ made from polyurethane, with steel end piece.
  For temperatures up to +100 °C
- end pieces and wipers are supplied with fixing screws
- insert nuts ESM



Design and safety guidelines

- When using J and S guideways in conjunction with M and V guideways in an open arrangement, the heights must be carefully matched in order to prevent edge loads (page 45, Figure 14).
- Matched sets of combinations of M/V and J/S guideways in an open arrangement (suffix 4SX) allows installation without the need for a shim or an ML guideway. It must be ensured that the nominal value for the height difference of the adjacent parts conforms to the tolerance Δh (page 45).

Fitting

- Parts supplied in sets are matched to each other and must be fitted in sets in accordance with the set number. This must be carried out in accordance with the set number.

Further information

Accuracy

Quality and positional tolerances

Guideways are available in three quality grades (Figure 2):

- Q2
  For exacting requirements in high precision machines. This grade should only be used if the adjacent construction can be produced to equally high accuracy.
- Q6
  Conforms to the requirements of precision table guidance systems in machine tool design.
- Q10
  Standard quality grade for requirements in general machine building.
- Geometrical and positional tolerances (Figure 2).
- Profile tolerances (Figure 1).

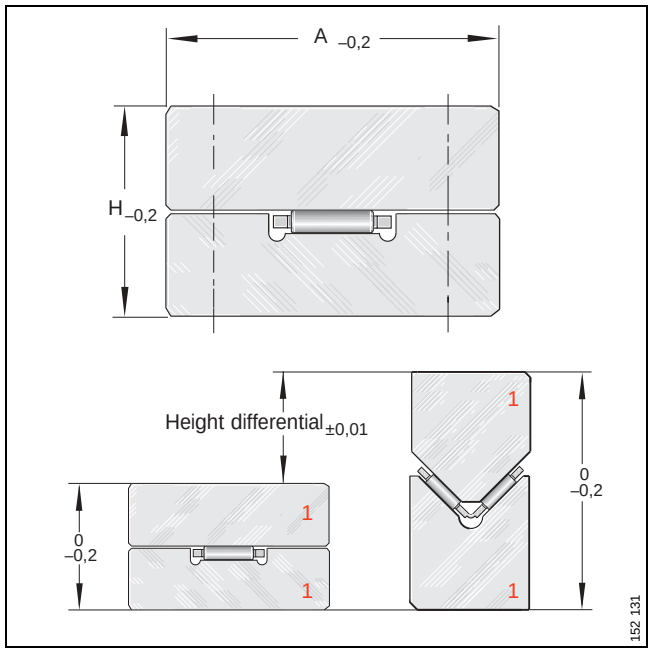


Figure 1 · Profile tolerances, 4SX sorting, marking

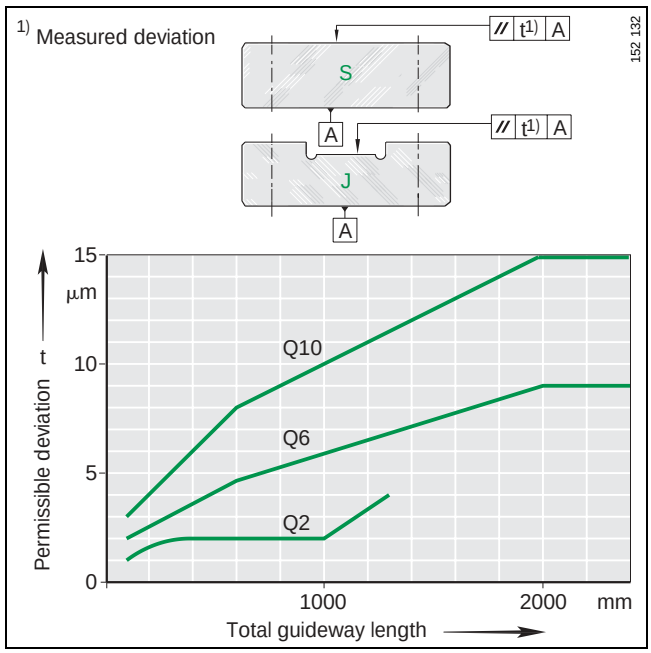


Figure 2 · Positional accuracy and quality of guideways

Tolerances for hole pitches

The positional tolerance of the hole pattern ∅ X is 1‰ of the guideway length L (Figure 3).

If the guideway length is less than 80% of the maximum length given in the dimension table, it can be fitted to a predrilled hole pattern; a positional tolerance of ∅ 0,2 must be achieved in this case.

If longer guideways are to fulfil this requirement, they must be ordered using the suffix P (positional tolerance).

Special designs

Guideways

- with different cross-sections, fixing holes, hole pitches and lengths
- anti-corrosion protection by thin layer chromium plating
  – suffix DSV
- raceway lead chamfers at ends of guideway
  – suffix E2
- without holes on end faces
  – suffix E1
- matching in sets for combinations of M/V and J/S guideways
  – suffix 4SX
- needle roller flat cage with friction damping
  – series HGW, HG.

Ordering example and ordering designation

For five machines:

J/S guideways and M/V guideways in custom length, for open arrangement, stroke length 200 mm, matched in sets (height difference = 25 mm)

J and S profile size	4025
M and V profile size	5025
Hole type	15
Length of guideways	750 mm
Quality grade	Q10.

Ordering designation:

5 off J	4025/15×750 Q10 4SX
5 off S	4025/15×750 Q10 4SX
5 off V	5025/15×750 Q10 4SX
5 off M	5025/15×750 Q10 4SX
5 off H	15×650
5 off HW	16×650
10 off EJ	40
10 off EM	5025 (Figure 4).

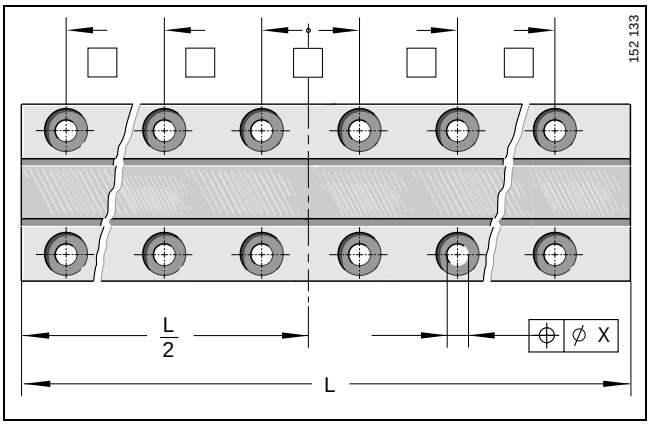


Figure 3 · Hole pattern of guideway

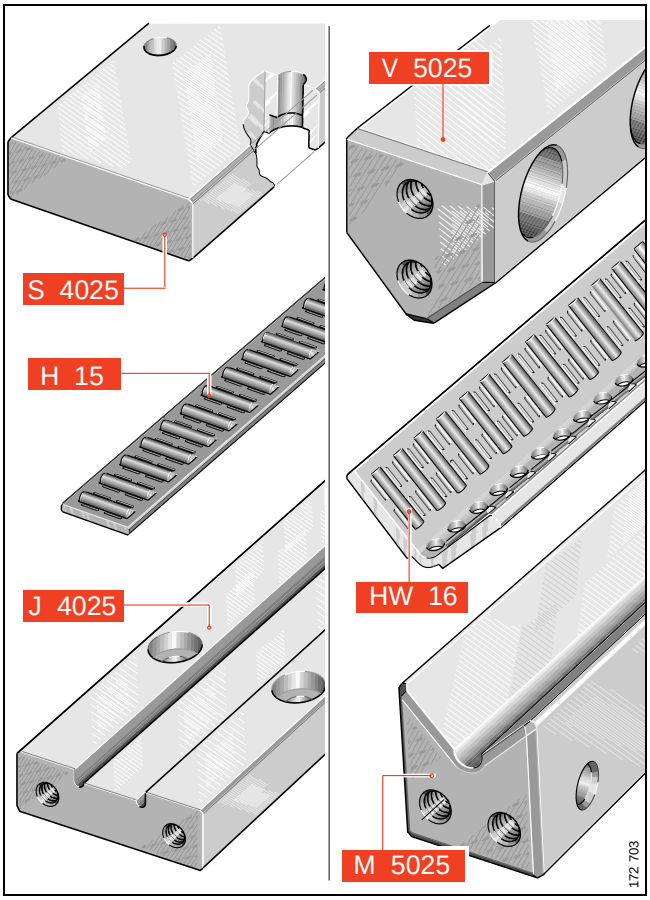


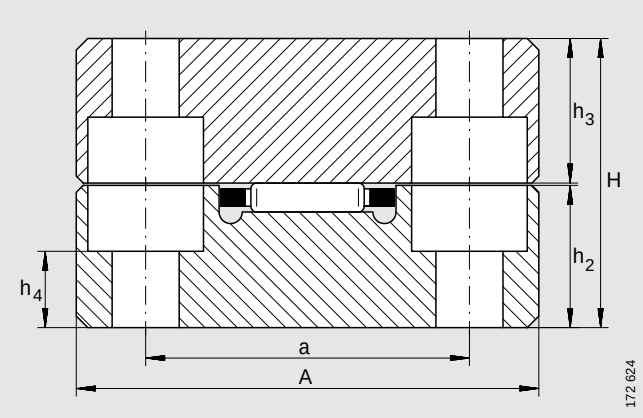
Figure 4 · Ordering example, ordering designation

Flat cage guidance systems

HYDREL/EGIS guideways with needle roller flat cage

Flat design

Series J
S



J and S

Dimension table · Dimensions in mm

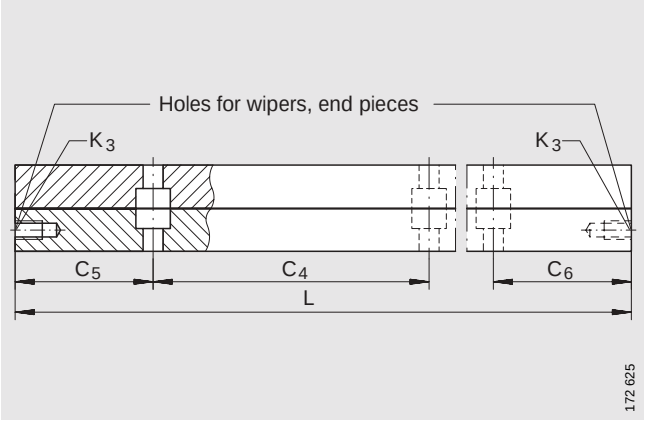
Designation		Dimensions				Fixing holes					
		H –0,2	A –0,2	h_2	h_3	K_1 For screws DIN 912-8.8	a	h_4	C_4[1)]	C_5 min.	C_6 min.
J 3525	**–**	25	35	11,8	–	M5	22	6	80	15	15
–	**S 3525**	25	35	–	13	M5	22	–	80	15	15
J 4025	**–**	25	40	12,3	–	M5	28	6,5	80	15	15
–	**S 4025**	25	40	–	12,5	M5	28	–	80	15	15
J 5030	**–**	30	50	14,8	–	M6	35	8	100	15	15
–	**S 5030**	30	50	–	15	M6	35	–	100	15	15
J 5530	**–**	30	55	15,3	–	M6	40	8,5	100	15	15
–	**S 5530**	30	55	–	14,5	M6	40	–	100	15	15

1) For length $L < C_4 + 2 \cdot C_{5\,min.}$ C_4 = 50 mm.

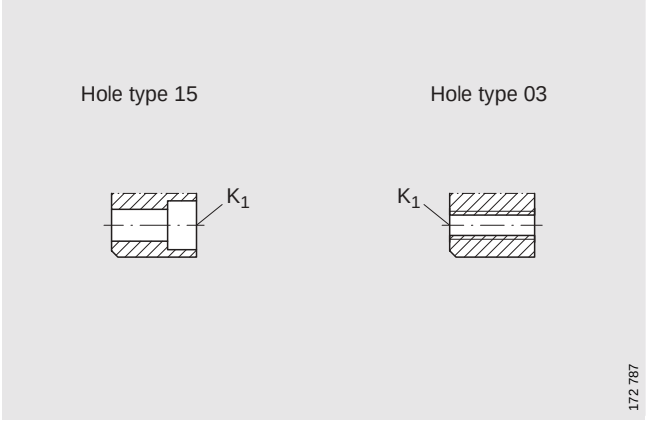
2) Guideways longer than the stated maximum length are available as multi-piece units. The total length of a multi-piece unit must be stated in the order.

3) Associated flat cages: see page 94.

4) End pieces: see page 88; wipers: see page 90.

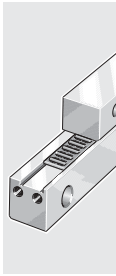


J and S

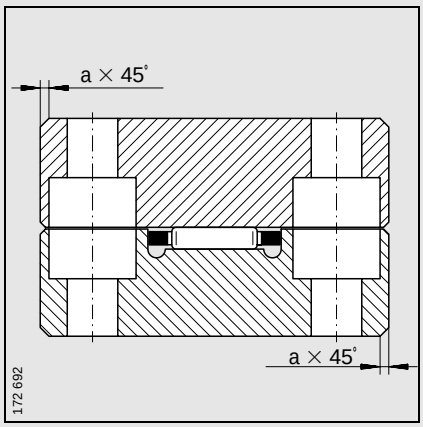


Hole types

Holes in end faces K_3	Custom length $L^{2)}$	Appropriate flat cages[3)]		Accessories[4)]		
				End pieces	End pieces with wipers	Insert nuts
M5	80–1000	**FF 2010**	**H 10**	**EJ 35**	**EAJ 35**	**ESM M5 D10**
–	80–1000	**FF 2010**	**H 10**	**–**	**–**	**ESM M5 D10**
M5	80–1000	**FF 2515**	**H 15**	**EJ 40**	**EAJ 40**	**ESM M5 D10**
–	80–1000	**FF 2515**	**H 15**	**–**	**–**	**ESM M5 D10**
M6	80–1000	**FF 3020**	**H 20**	**EJ 50**	**EAJ 50**	**ESM M6**
–	80–1000	**FF 3020**	**H 20**	**–**	**–**	**ESM M6**
M6	80–1000	**FF 3525**	**H 25**	**EJ 55**	**EAJ 55**	**ESM M6**
–	80–1000	**FF 3525**	**H 25**	**–**	**–**	**ESM M6**



Series	a_{min}
J and S 3525 to J and S 5530	1×45°



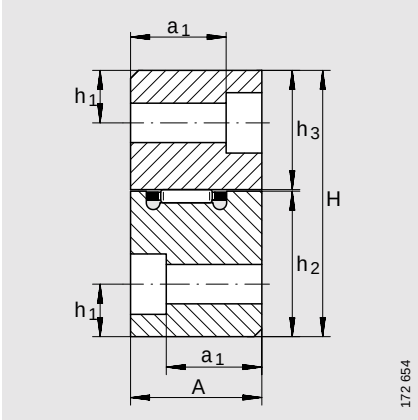
Chamfer dimensions

Flat cage guidance systems

HYDREL/EGIS guideways with needle roller flat cage

High design

Series J
S



J and S

Dimension table · Dimensions in mm

Designation		Dimensions				Fixing holes						
		H	A	h_2	h_3	K_1 For screws DIN 912-8.8	h_1	a_1	t min.	C_4[1]	C_5[2] min.	C_6[2] min.
J 5025	**–**	50	25	27,7	–	M6	10	18,2	15	80	20	20
–	**S 5025**	50	25	–	22	M6	10	18,2	15	80	20	20
J 6035	**–**	60	35	34,7	–	M8	11	26	20	100	20	20
–	**S 6035**	60	35	–	25	M8	11	26	20	100	20	20
J 7040	**–**	70	40	39,7	–	M10	13	29	25	100	20	20
–	**S 7040**	70	40	–	30	M10	13	29	25	100	20	20
J 8050	**–**	80	50	44,7	–	M12	14	37	30	100	20	20
–	**S 8050**	80	50	–	35	M12	14	37	30	100	20	20

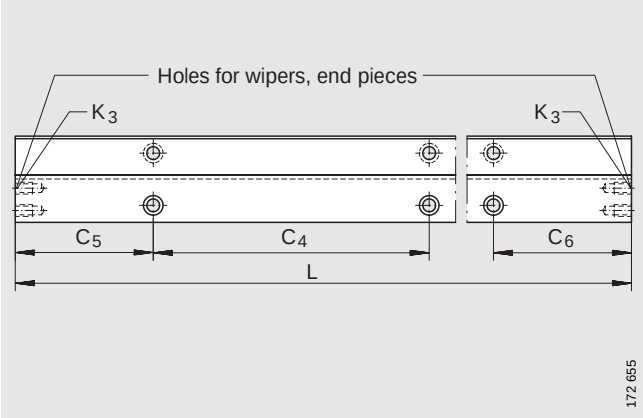
[1]) For length $L < C_4 + C_{5\,min.} + C_{6\,min.}$ $C_4 = 50$ mm.

[2]) C_5 and C_6 are dependent on the guideway length and must be identical at both ends of a guideway: C_5 and $C_6 = \frac{L - \Sigma C_4}{2}$; $C_{5\,min.}$ and $C_{6\,min.}$ are minimum values.

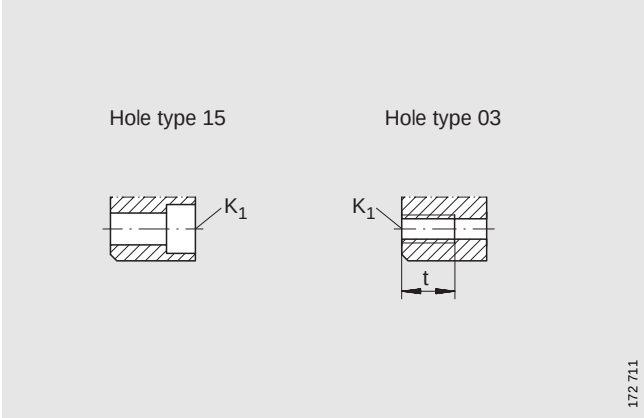
[3]) Guideways longer than the stated maximum length are available as multi-piece units. The total length of a multi-piece unit must be stated in the order.

[4]) Associated flat cages: see page 94.

[5]) End pieces: see page 88; wipers: see page 90.

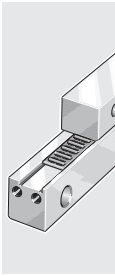


J and S

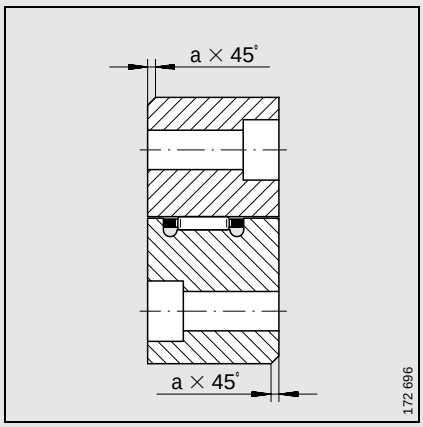


Hole types

Holes in end faces K_3	Custom lengths up to L[3] max.	Appropriate flat cages[4]	Accessories[5]		
			End pieces	End pieces with Wipers	Insert nuts
M6	800	**H 15, FF 2515**	**EJ 5025**	**EAJ 5025**	**ESM M6**
M6	800	**H 15, FF 2515**	**–**	**–**	**ESM M6**
M6	1000	**H 24 ZW**	**EJ 6035**	**EAJ 6035**	**ESM M8**
M6	1000	**H 24 ZW**	**–**	**–**	**ESM M8**
M6	1200	**H 34 ZW**	**EJ 7040**	**EAJ 7040**	**ESM M10**
M6	1200	**H 34 ZW**	**–**	**–**	**ESM M10**
M6	1200	**H 44 ZW**	**EJ 8050**	**EAJ 8050**	**ESM M12**
M6	1200	**H 44 ZW**	**–**	**–**	**ESM M12**



Series	a_{min}
J and S 5025 to J and S 8050	1,5×45°



Chamfer dimensions

Flat cage guidance systems

HYDREL/EGIS L counterstay system with needle roller and cylindrical roller flat cages

Locating/non-locating bearing units

Features

HYDREL/EGIS L counterstay systems

- are complete units comprising:
  - a locating bearing arrangement comprising guideways of type M and V
  - a non-locating bearing arrangement comprising guideways of type J and S
  - needle roller and cylindrical roller flat cages
  - an L counterstay in each case which preloads the two guidance systems
- are used as linear locating/non-locating bearing units
  - due to the subdivision into locating and non-locating bearing arrangements, the system is not distorted by thermal expansion
- are used where guidance systems must have high accuracy, rigidity and load carrying capacity and the adjacent construction must not be distorted by preload forces or thermal expansion
  - the highest load carrying capacity and rigidity are achieved when the principal load acts in load direction I or II (*dimension table*, page 86)
- have the highest accuracy of any rolling element type linear guidance system
- are easy to fit. No adjustment work is required after fitting
  - the ready-to-fit guidance system is fitted using the specified tightening torques. This gives a precise preload
- have particularly low friction
- can only be replaced in their entirety
  - all parts of the system are matched to each other
- can be supplemented by accessories.

Guideways

- correspond to the standard range of M, V, J and S guideways in grade Q2.

Needle roller and cylindrical roller flat cages

- guide the rolling elements exactly parallel to the axis and retain them at a specified distance from each other.

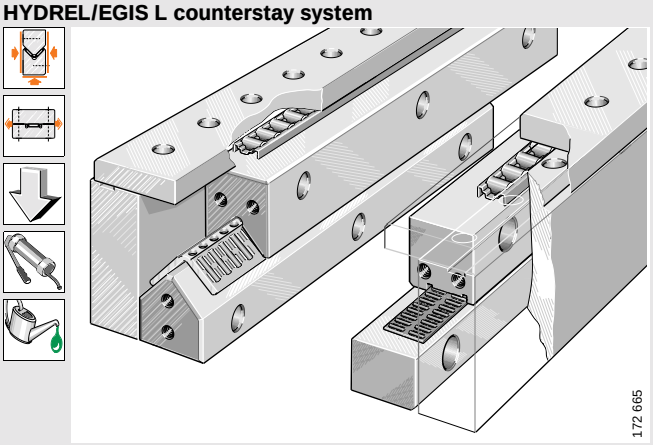
LU counterstay arrangements

- comprise an unhardened spacer and a hardened counterstay

Accessories

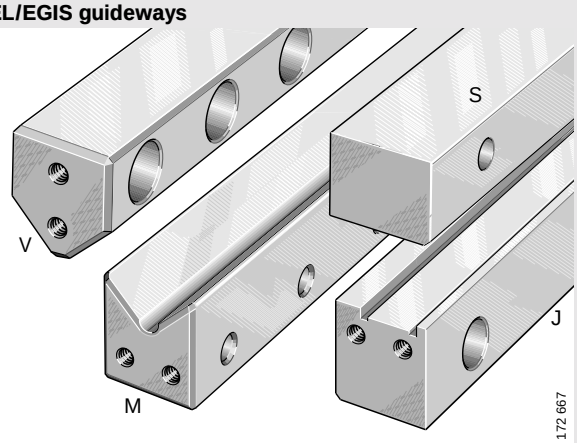
- end pieces prevent the cage creeping out of the load zone
  - end pieces should be selected in accordance with the guideway arrangement.

HYDREL/EGIS L counterstay system



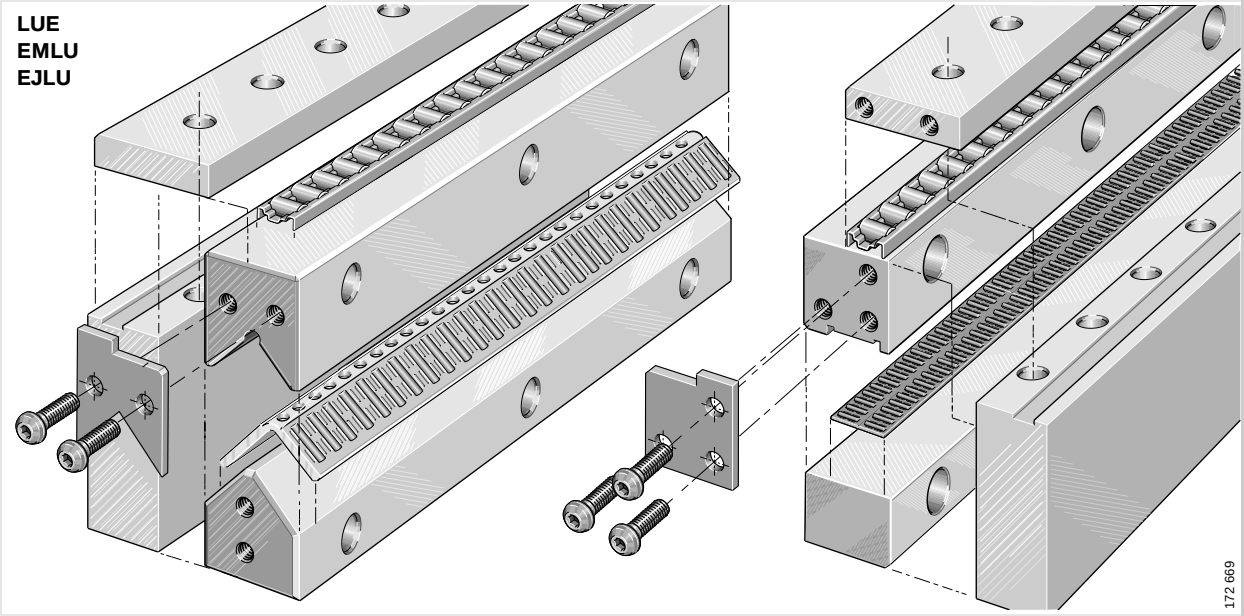
- basic design

HYDREL/EGIS guideways

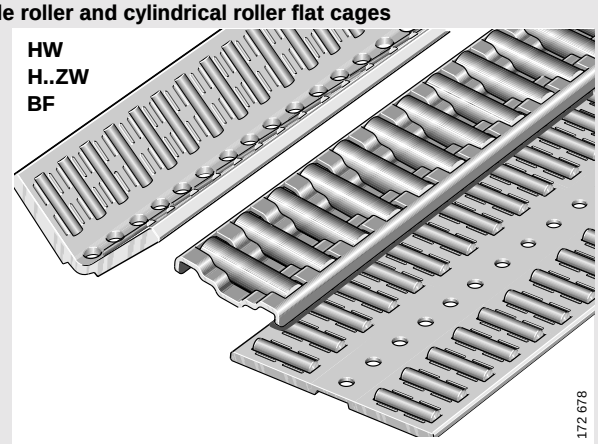


- guideways M, V, J, S
- hole type 15 for fixing

HYDREL/EGIS L counterstay system with accessories

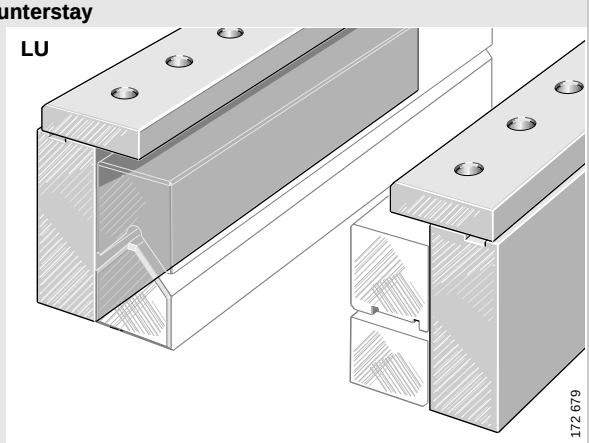


Needle roller and cylindrical roller flat cages



- HW: angled needle roller flat cage, double row, shanks at right angles to each other, light metal
- H..ZW: needle roller flat cage, double row, light metal
- BF: needle roller flat cage, single row, profiled steel strip
- needle rollers in grade G1

LU counterstay



- hole type 10 or 03 for fixing

Design and safety guidelines

- LUE counterstay systems are supplied in sets (Figure 1). The parts are matched to each other in terms of dimensions and preload and are marked with set numbers.

Fitting

- The parts must be fitted as sets (Figure 1). This must be carried out in accordance with the set number.
- The fixing screws for the counterstays must be tightened to the specified tightening torque.

Accuracy

Quality and positional tolerances

Guideways are supplied in quality grade Q2 (Figure 2):

- For exacting requirements in high precision machines.
- Geometrical and positional tolerances (Figure 2).

Tolerances for hole pitches

The positional tolerance of the hole pattern ∅ X is 1‰ of the guideway length L (Figure 3).

If the guideway length is less than 80% of the maximum length given in the dimension table, it can be fitted to a predrilled hole pattern; the positional tolerance of ∅ 0,2 applies in this case.

Further information

Special designs

Available by agreement:

Needle roller and cylindrical roller flat cages

- flat cages with friction damping
  – series HG, HGW
- anti-corrosion protection by thin layer chromium plating
  – suffix DSV.

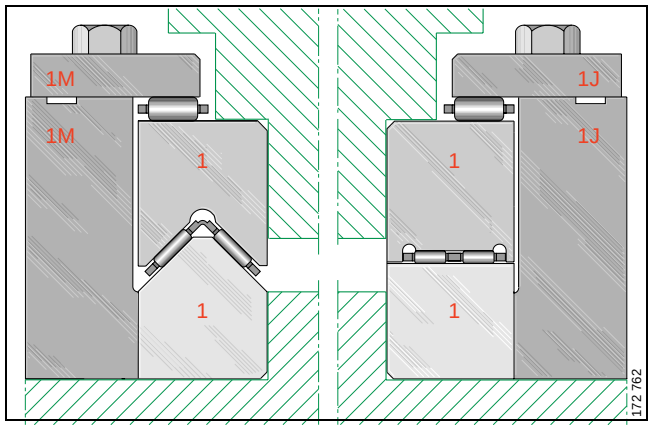


Figure 1 · Marking of sets for LUE unit

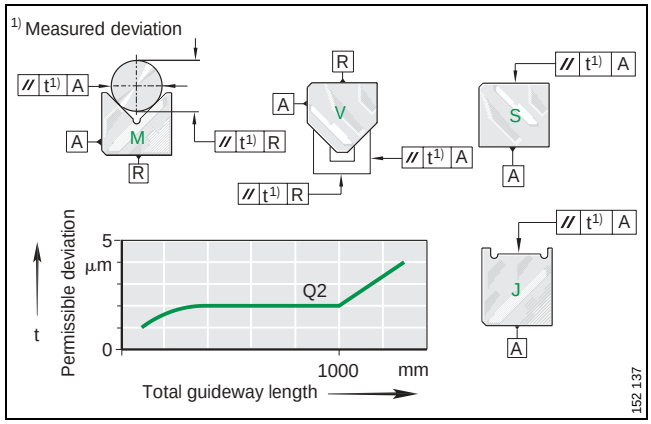


Figure 2 · Positional accuracy and quality of guideways

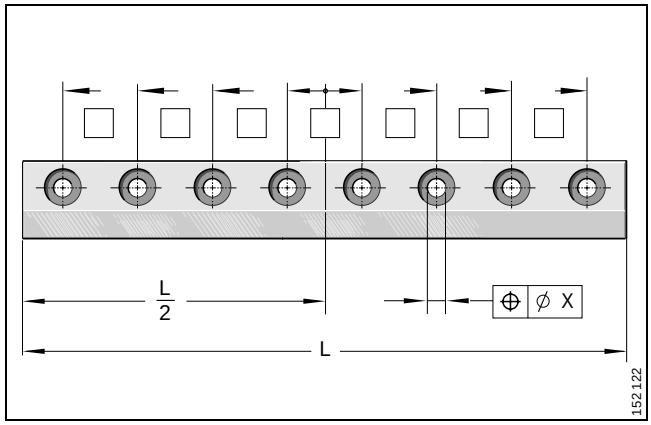


Figure 3 · Hole pattern of guideway

Ordering example and ordering designation

For four machines:
LUE units to custom length

Profile size	6035
Counterstay with hole type	10
Length of V and S guideways	800 mm
Length of M and J guideways	620 mm
Stroke	180 mm

End pieces.

Ordering designation:

8 sets LUE 6035×800[1])
each comprising:

2 off Counterstay	LU	6035/10×800
1 off Guideway	M	6035/15×620 Q2
1 off Guideway	V	6035/15×800 Q2
1 off Guideway	J	6035/15×620 Q2
1 off Guideway	S	6035/15×800 Q2
1 off Angled flat cage	HW	20 G1×530
1 off Flat cage	H	24 ZW G1×530
2 off Flat cages	BF	5015 G1×530
4 off End pieces	ELU	6035
2 off End pieces	EM	6035
2 off End pieces	EJ	6035 (Figure 4).

[1]) Length of longest part.

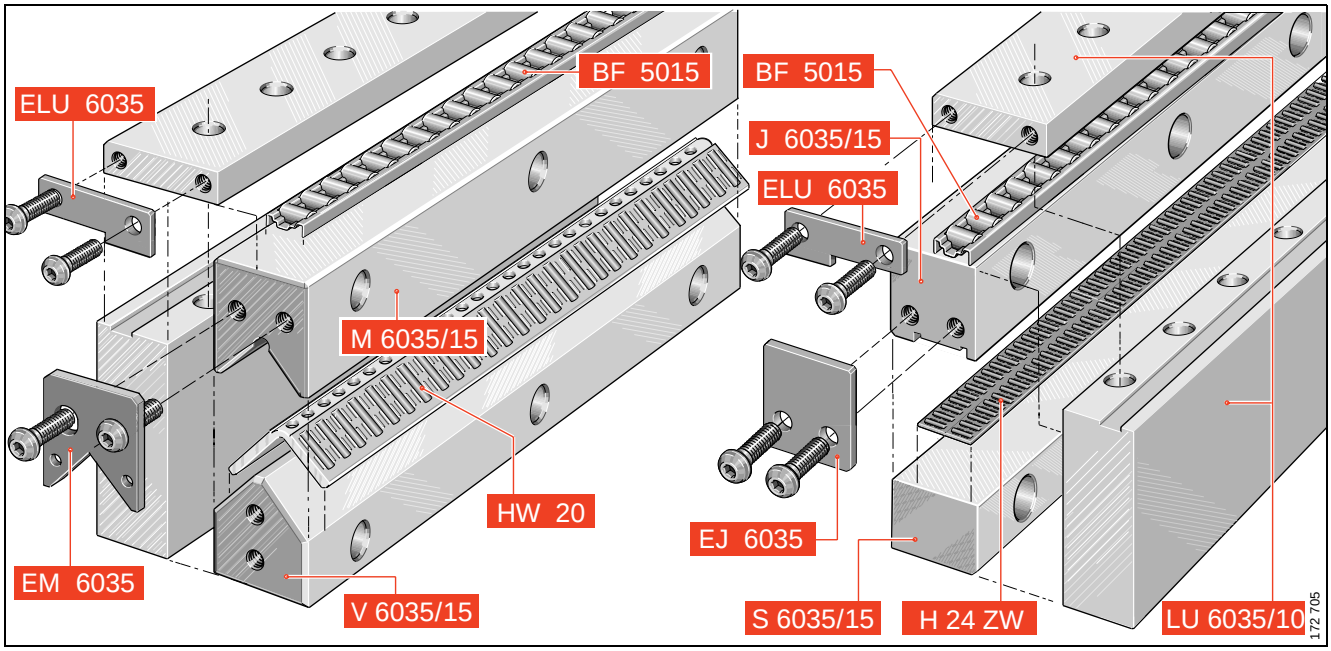
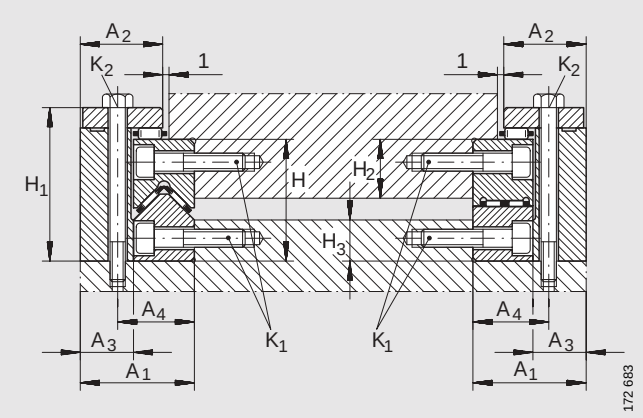


Figure 4 · Ordering example, ordering designation

Flat cage guidance systems

HYDREL/EGIS L counterstay system with needle roller and cylindrical roller flat cages

Series LUE



L counterstay system

Dimension table · Dimensions in mm

Designation	Dimensions					Mounting dimensions								
Unit	H 0 –0,2	H_1	A_1	A_2	A_3	A_4	K_1 [1]	K_2 [1]	C_4	C_5 min.	C_6 min.	L [2] max.	H_2	H_3
LUE 5025	50	62	45	30	20	31	M 6	M 6	50	20	20	800	27,5	17
LUE 6035	60	77	60	40	25	42	M 8	M 8	50	20	20	1000	34,5	20
LUE 7040	70	89	65	40	25	47	M10	M 8	50	20	20	1000	39,5	24
LUE 8050	80	100	86	51	36	61	M12	M12	50	20	20	1000	44,5	26

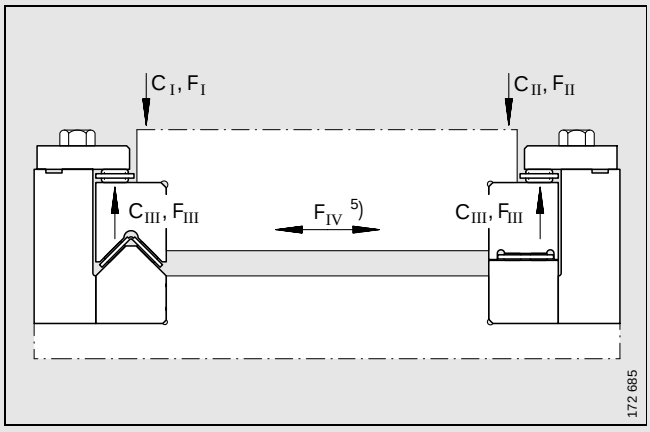
[1]) Screws of grade 10.9 should be used.

[2]) $L > L_{max}$ by agreement.

[3]) For a theoretical cage length of 100 mm in the load direction according to the figure. Calculation of basic load ratings for effective cage lengths and calculation of safety factors and life: see page 18ff.

[4]) For a theoretical cage length of 100 mm in the load direction according to the figure. Calculation of limit loads for effective cage lengths:

$$F_{w\,I,\,II,\,III} = F_{I,\,II,\,III} \cdot \frac{L_K - 2e + t}{100} \text{ where } Z = \frac{L_K - 2e}{100} + 1 = \text{whole number.}$$



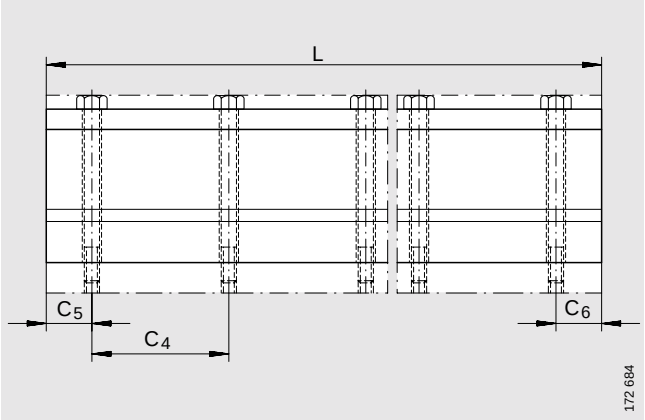
Main load directions

[5]) Limited by system preload.

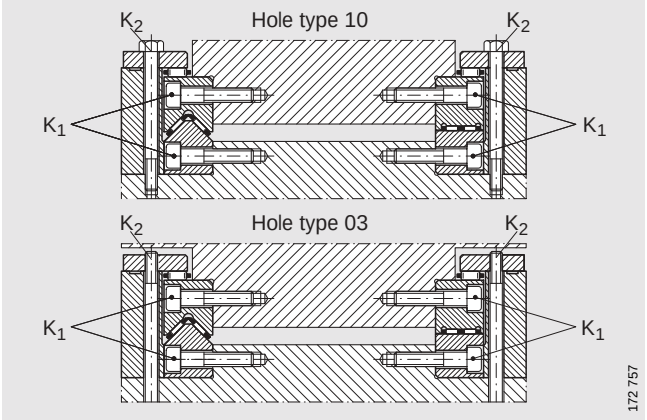
[6]) Limited by load carrying capacity/friction locking effect of fixing screws.

Tightening torque for fixing screws [7])	
for screws K_1, K_2 Grade 10.9	Tightening torque Nm
M 6	12
M 8	29
M10	58
M12	101

[7]) Coefficient of friction μ = 0,1.



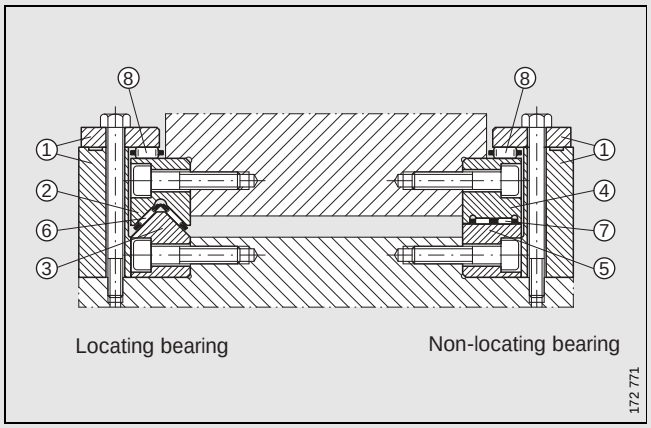
L counterstay system



Hole types

Load carrying capacity

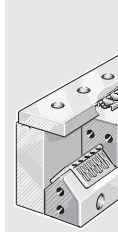
Basic dynamic load ratings[3]			Limiting loads[4]			
C_I	C_{II}	C_{III}	$F_{I\ perm}$[5]	$F_{II\ perm}$[5]	$F_{III\ perm}$[6]	$F_{IV\ perm}$[6]
N	N	N	N	N	N	N
26200	35800	21600	13840	15630	1200	7500
40300	37000	69900	38690	58620	1500	10000
62900	57000	69900	42500	61720	2500	16000
82700	88900	69900	43150	69540	4000	23000



LUE unit

Components of LUE unit

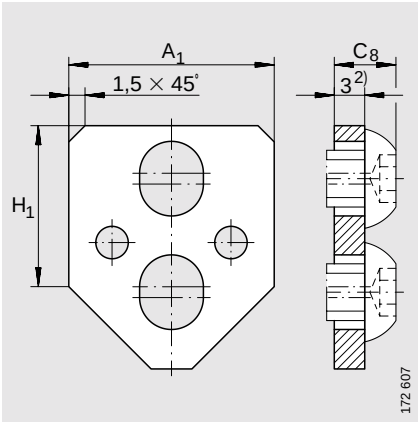
Unit designation	Counterstay	Guideways		Cages		
	①	M/V ②③	J/S ④⑤	⑥	⑦	⑧
LUE 5025	LU 5025/10	5025/15	5025/15	HW 15	H 15	H 10
	LU 5025/03	5025/15	5025/15	HW 15	H 15	H 10
LUE 6035	LU 6035/10	6035/15	6035/15	HW 20	H 24 ZW	BF 5015
	LU 6035/03	6035/15	6035/15	HW 20	H 24 ZW	BF 5015
LUE 7040	LU 7040/10	7040/15	7040/15	HW 25	H 34 ZW	BF 5015
	LU 7040/03	7040/15	7040/15	HW 25	H 34 ZW	BF 5015
LUE 8050	LU 8050/10	8050/15	8050/15	HW 30	H 44 ZW	BF 5015
	LU 8050/03	8050/15	8050/15	HW 30	H 44 ZW	BF 5015



Accessories

End pieces for HYDREL/EGIS guideways

Series EV
EM
EML
EJ



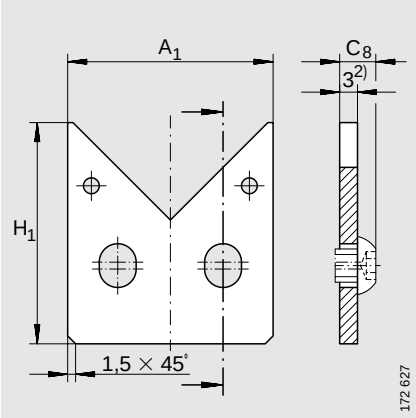
EV

Dimension table · Dimensions in mm

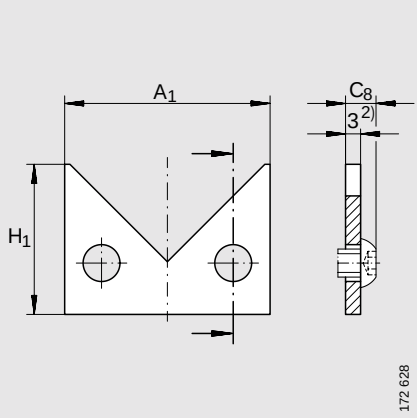
Guideway	Designation[1])			
	EV	EM	EML	EJ
V 3015	**EV 3015**	**–**	**–**	**–**
M 3015	**–**	**EM 3015**	**–**	**–**
V 4020	**EV 4020**	**–**	**–**	**–**
M 4020	**–**	**EM 4020**	**–**	**–**
ML 5020, ML 5520	**–**	**–**	**EML 20**	**–**
V 4525	**EV 4525**	**–**	**–**	**–**
M 4525	**–**	**EM 4525**	**–**	**–**
V 5025	**EV 5025**	**–**	**–**	**–**
M 5025	**–**	**EM 5025**	**–**	**–**
ML 5525 to ML 7025	**–**	**–**	**EML 25**	**–**
V 6035	**EV 6035**	**–**	**–**	**–**
M 6035	**–**	**EM 6035**	**–**	**–**
ML 7035, ML 8035	**–**	**–**	**EML 35**	**–**
V 6535	**EV 6535**	**–**	**–**	**–**
M 6535	**–**	**EM 6535**	**–**	**–**
V 7040	**EV 7040**	**–**	**–**	**–**
M 7040	**–**	**EM 7040**	**–**	**–**
ML 8040, ML 9040	**–**	**–**	**EML 40**	**–**
V 8050	**EV 8050**	**–**	**–**	**–**
M 8050	**–**	**EM 8050**	**–**	**–**
ML 9050, ML 10050	**–**	**–**	**EML 50**	**–**
V 8550	**EV 8550**	**–**	**–**	**–**
M 8550	**–**	**EM 8550**	**–**	**–**
J 3525	**–**	**–**	**–**	**EJ 35**
J 4025	**–**	**–**	**–**	**EJ 40**
J 5030	**–**	**–**	**–**	**EJ 50**
J 5530	**–**	**–**	**–**	**EJ 55**
J 5025	**–**	**–**	**–**	**EJ 5025**
J 6035	**–**	**–**	**–**	**EJ 6035**
J 7040	**–**	**–**	**–**	**EJ 7040**
J 8050	**–**	**–**	**–**	**EJ 8050**

[1]) The end pieces are supplied with fixing screws to ISO 7380.

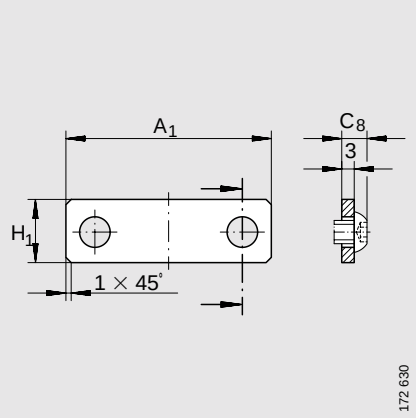
[2]) Profile size 3015 = 2 mm.



EM

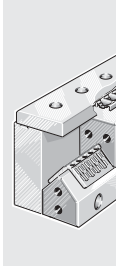


EML



EJ

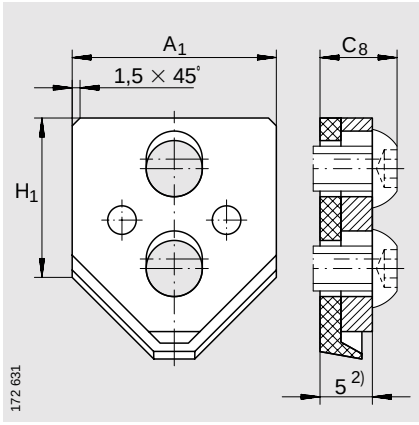
Dimensions					Fixing screws
A_1	H_1			C_8 max.	K_1
14	12,6	–	–	5	–
14	–	16,7	–	5	–
19	15,6	–	–	6	–
19	–	23	–	6	–
19	–	12	–	6,5	–
24	18,5	–	–	6,5	–
24	–	26,5	–	6,5	–
24	19,1	–	–	6,5	–
24	–	30	–	6,5	–
24	–	15	–	6,5	–
34	22,8	–	–	6,5	–
34	–	35	–	6,5	–
34	–	23	–	6,5	–
34	27,5	–	–	6,5	–
34	–	40,5	–	6,5	–
39	27,5	–	–	6,5	–
39	–	40	–	6,5	–
39	–	28,5	–	6,5	–
49	30,3	–	–	6,5	–
49	–	45	–	6,5	–
49	–	35	–	6,5	–
49	37,5	–	–	6,5	–
49	–	54,5	–	6,5	–
34	–	–	11	6	–
39	–	–	12	6	–
49	–	–	14	6,5	–
54	–	–	15	6,5	–
24	–	–	16,6	6,5	–
34	–	–	17	6,5	–
39	–	–	16,8	6,5	–
49	–	–	18,2	6,5	–



Accessories

Wipers for HYDREL/EGIS guideways

Series EAV
EAM
EAML
EAJ



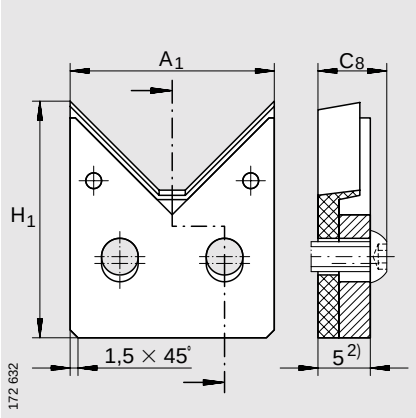
EAV

Dimension table · Dimensions in mm

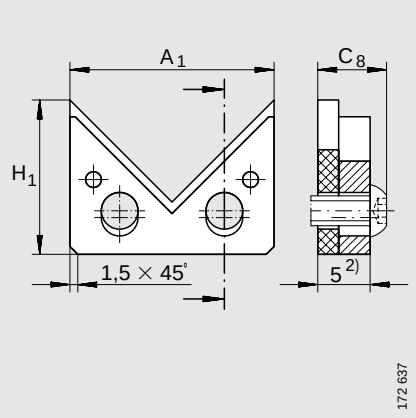
Guideway	Designation[1]			
	EAV	EAM	EAML	EAJ
V 3015	**EAV 3015**	**–**	**–**	**–**
M 3015	**–**	**EAM 3015**	**–**	**–**
V 4020	**EAV 4020**	**–**	**–**	**–**
M 4020	**–**	**EAM 4020**	**–**	**–**
ML 5020, ML 5520	**–**	**–**	**EAML 20**	**–**
V 4525	**EAV 4525**	**–**	**–**	**–**
M 4525	**–**	**EAM 4525**	**–**	**–**
V 5025	**EAV 5025**	**–**	**–**	**–**
M 5025	**–**	**EAM 5025**	**–**	**–**
ML 5525 to ML 7025	**–**	**–**	**EAML 25**	**–**
V 6035	**EAV 6035**	**–**	**–**	**–**
M 6035	**–**	**EAM 6035**	**–**	**–**
ML 7035, ML 8035	**–**	**–**	**EAML 35**	**–**
V 6535	**EAV 6535**	**–**	**–**	**–**
M 6535	**–**	**EAM 6535**	**–**	**–**
V 7040	**EAV 7040**	**–**	**–**	**–**
M 7040	**–**	**EAM 7040**	**–**	**–**
ML 8040, ML 9040	**–**	**–**	**EAML 40**	**–**
V 8050	**EAV 8050**	**–**	**–**	**–**
M 8050	**–**	**EAM 8050**	**–**	**–**
ML 9050, ML 10050	**–**	**–**	**EAML 50**	**–**
V 8550	**EAV 8550**	**–**	**–**	**–**
M 8550	**–**	**EAM 8550**	**–**	**–**
J 3525	**–**	**–**	**–**	**EAJ 35**
J 4025	**–**	**–**	**–**	**EAJ 40**
J 5030	**–**	**–**	**–**	**EAJ 50**
J 5530	**–**	**–**	**–**	**EAJ 55**
J 5025	**–**	**–**	**–**	**EAJ 5025**
J 6035	**–**	**–**	**–**	**EAJ 6035**
J 7040	**–**	**–**	**–**	**EAJ 7040**
J 8050	**–**	**–**	**–**	**EAJ 8050**

[1]) The end pieces are supplied with fixing screws to ISO 7380.

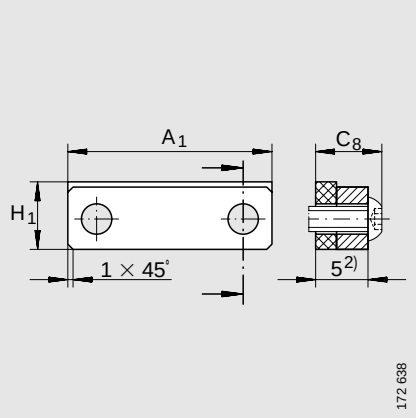
[2]) Profile size 3015 = 4 mm.



EAM



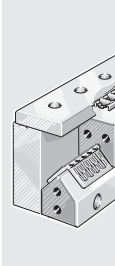
EAML



EAJ

Dimensions

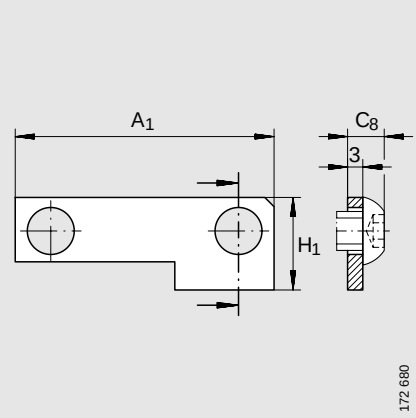
A_1	H_1			C_8 max.
14	13,4	–	–	6
14	–	18,6	–	6
19	16,7	–	–	8
19	–	25,7	–	8
19	–	14	–	8
24	21,2	–	–	8,5
24	–	30,2	–	8,5
24	19,9	–	–	8,5
24	–	32,2	–	8,5
24	–	18,4	–	8,5
34	23,7	–	–	8,5
34	–	39,2	–	8,5
34	–	25,7	–	8,5
34	30,2	–	–	8,5
34	–	44,2	–	8,5
39	28,4	–	–	8,5
39	–	45,2	–	8,5
39	–	31,2	–	8,5
49	31,2	–	–	8,5
49	–	53,2	–	8,5
49	–	39,6	–	8,5
49	40,2	–	–	8,5
49	–	58,2	–	8,5
34	–	–	11,6	8,5
39	–	–	12,3	8,5
49	–	–	14,3	8,5
54	–	–	14,8	8,5
24	–	–	16,9	8,5
34	–	–	17,3	8,5
39	–	–	17,1	8,5
49	–	–	18,7	8,5



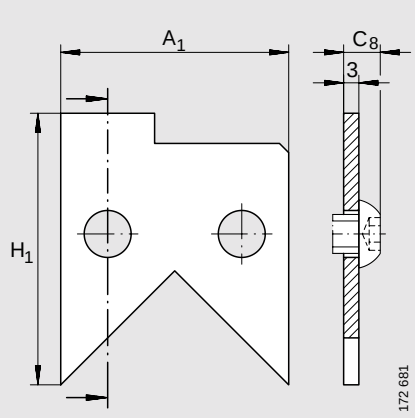
Accessories

End pieces for HYDREL/EGIS L counterstay system

Series ELU
EMLU
EJLU



ELU

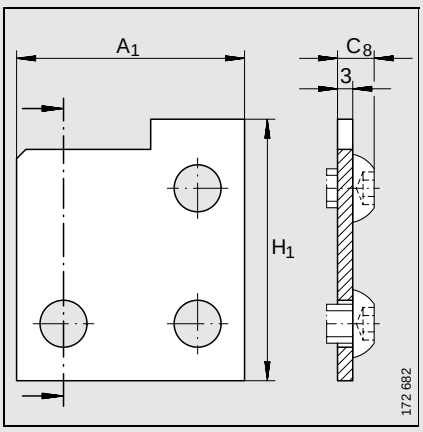


EMLU

Dimension table · Dimensions in mm

Designation Unit	Designation[1])			Dimensions		
	ELU	EMLU	EJLU	A_1	H_1	C_8 max.
LUE 5025	**ELU 5025**	**–**	**–**	28,6	11,3	6,5
	–	**EMLU 5025**	**–**	24	31,1	6,5
	–	**–**	**EJLU 5025**	24	29,2	6,5
LUE 6035	**ELU 6035**	**–**	**–**	38,6	13,8	6,5
	–	**EMLU 6035**	**–**	34	40,5	6,5
	–	**–**	**EJLU 6035**	34	39	6,5
LUE 7040	**ELU 7040**	**–**	**–**	38,6	15,8	6,5
	–	**EMLU 7040**	**–**	39	46,5	6,5
	–	**–**	**EJLU 7040**	39	44	6,5
LUE 8050	**ELU 8050**	**–**	**–**	49,6	18,8	6,5
	–	**EMLU 8050**	**–**	49	53,5	6,5
	–	**–**	**EJLU 8050**	49	49	6,5

[1]) The end pieces are supplied with fixing screws to ISO 7380.

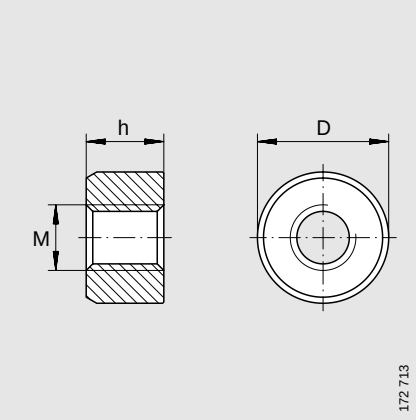


EJLU

Accessories

Insert nuts for guideways

Series ESM



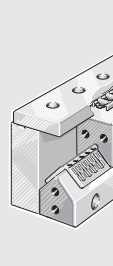
ESM

Dimension table · Dimensions in mm

Designation[1])	Dimensions			Appropriate guideway
	M	$D^{-0,05}_{-0,1}$	h	
ESM M4	M4	8,5	4,3	**M 3015, V 3015**
ESM M5 / D10	M5	10	5,5	**J 3525, S 3525, J 4025, S 4025**
ESM M6	M6	11,5	6,5	**M 4020, V 4020, M 4525, V 4525, M 5025, V 5025, J 5025, S 5025, J 5030, S 5030, J 5530, S 5530, ML..20, ML..25**
ESM M8	M8	15	8,5	**M 6035, V 6035, M 6535, V 6535, J 6035, S 6035, ML..35**
ESM M10	M10	18,5	10,5	**M 7040, V 7040, J 7040, S 7040, ML..40**
ESM M12	M12	20	12,5	**M 8050, V 8050, J 8050, S 8050, M 8550, V 8550, ML..50**

[1]) Insert nuts must be ordered separately. They are included loose in the delivery and must be fixed in the counterbore by means of adhesive (page 43, Figure 10).

⚠ Insert nuts ESM for screws to grade 8.8.



Flat cages

Needle roller flat cages

Features

Flat cages

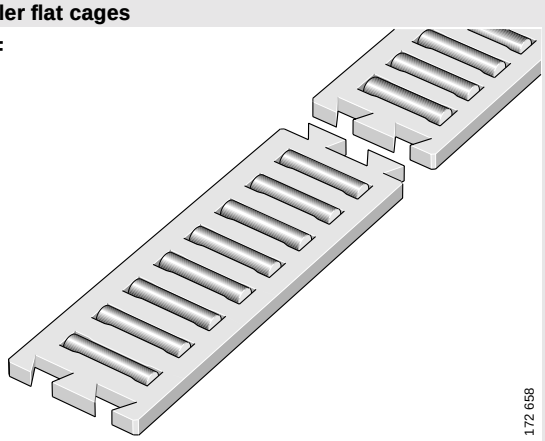
- consist of:
  - a basic cage made from metal or plastic – depending on the series
  - a large number of rolling elements guided precisely in pockets
- have a low section height
- have high load carrying capacity
- have high rigidity
- require hardened and ground surfaces for use as raceways
- are supplied as individual parts and in combination with guideways.

Needle roller flat cages

- have needle rollers as rolling elements
  - the needle rollers have profiled ends, i.e. the outside surface of the roller has a curved surface running towards the ends. This reduces the edge stresses at the ends of the rolling elements
- have the highest rigidity of any flat cage type
- are available as flat cages or angled flat cages.

Needle roller flat cages

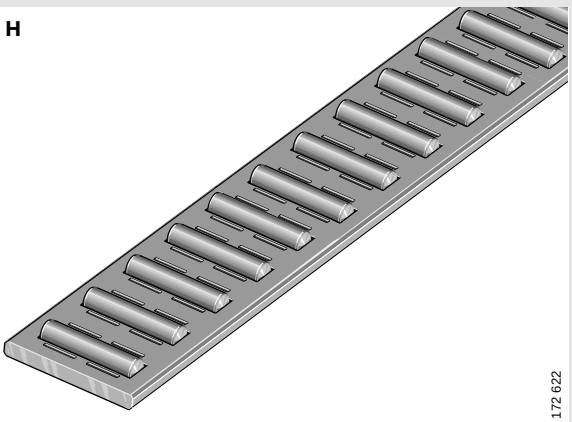
FF



100

- needle roller flat cage, single row, basic cage made from plastic
- dovetail slots at the ends for easy linking of any number of elements
- for temperatures up to +120 °C

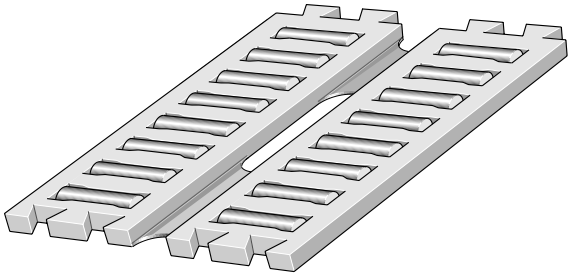
H



100

- needle roller flat cage, single row, basic cage made from light metal (as standard), steel or brass
- high strength with low mass
- for more exacting requirements such as high loads and accelerations
- for temperatures up to +150 °C

FF..ZW

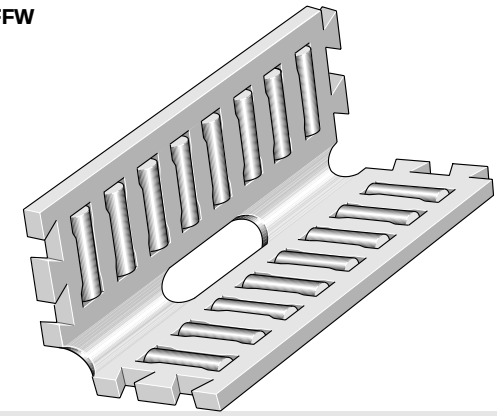


172 668

102

- needle roller flat cage, double row, plastic basic cage
  - the rows can be bent at any angle to each other. The cage is heated to between +70 °C and +90 °C, bent to the required angle and allowed to cool in this position
  - snap cage FF 2025 ZW can only be set at 0° and 90°
- dovetail slots at the ends for easy linking of any number of elements for temperatures up to +120 °C

FFW

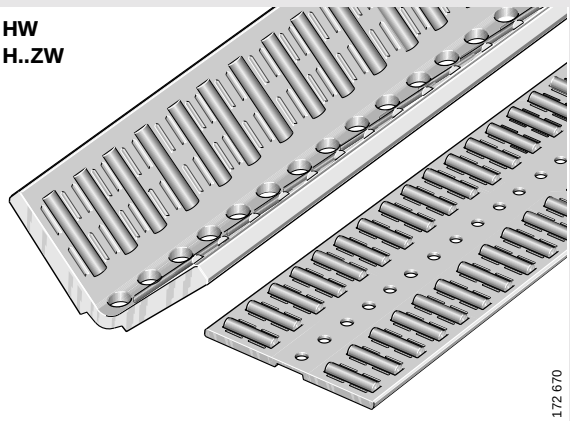


172 697

104

- angled needle roller flat cage based on series FF..ZW
- shanks bent at right angles to each other (FFW 2025 snapped into place)
- for use in conjunction with M and V guideways
- for temperatures up to +120 °C

HW
H..ZW

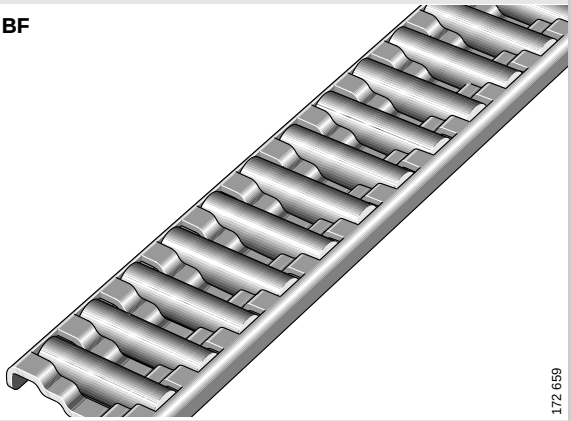


172 670

102
104

- needle roller flat cage, double row, basic cage made from light metal, high strength, for more exacting requirements
- HW as H..ZW, but shanks bent at right angles to each other; HW for M and V guideways
- HW 10 and H 19 ZW made from steel
- cages >HW 10 made from light metal (standard), steel, brass
- for temperatures up to +150 °C

BF



172 659

100

- needle roller flat cage, single row, basic cage made from profiled steel strip
- for temperatures up to +150 °C

Flat cages

Cylindrical roller flat cages
Ball flat cages

Features

Cylindrical roller flat cages

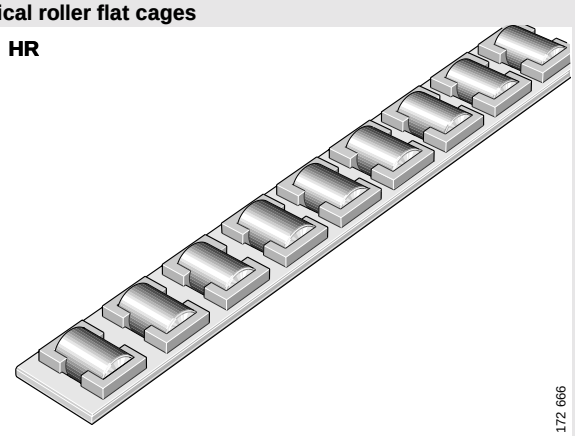
- have cylindrical rollers as rolling elements
  - the needle rollers have profiled ends, i.e. the outside surface of the roller has a curved surface running towards the ends. This reduces the edge stresses at the ends of the rolling elements
- have a load carrying capacity similar to that of needle roller flat cages
- have a slightly lower rigidity than needle roller flat cages
- are available as flat cages or angled flat cages.

Ball flat cages HB

- have balls as rolling elements arranged in several rows in two point contact with the raceways
- have a high static load carrying capacity due to the large number of small balls
- have the lowest friction of any flat cage type.

Cylindrical roller flat cages

HR

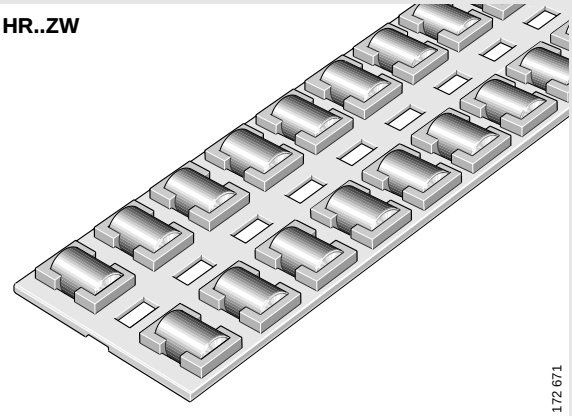


172 666

100

- cylindrical roller flat cage, single row
- – basic cage made from light metal with plastic guidance and retention inserts
- for temperatures up to +150 °C

HR..ZW

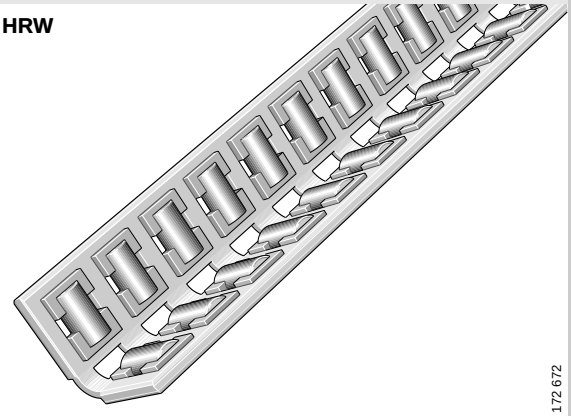


172 671

102

- cylindrical roller flat cage, double row
- – basic cage made from light metal with plastic guidance and retention inserts
- for temperatures up to +120 °C

HRW

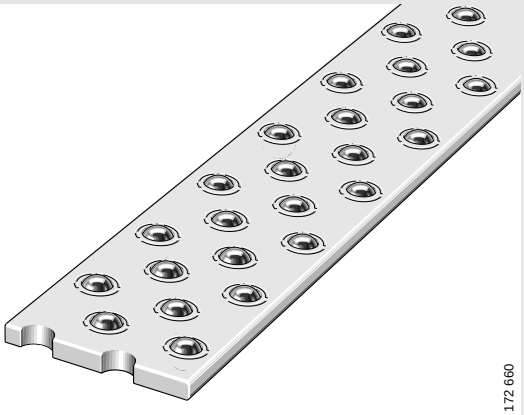


172 672

104

- cylindrical roller flat cage, double row
- – basic cage made from light metal with plastic guidance and retention inserts
- shanks bent at right angles to each other
- for use in conjunction with M and V guideways
- for temperatures up to +120 °C

HB



172 660

106

- ball flat cage, multi-row, basic cage made from light metal, giving high strength with low mass
- for temperatures up to +150 °C

Design and safety guidelines

⚠ The raceways for the cages must be produced in accordance with the requirements for rolling bearing raceways; alternatively, HYDREL/EGIS guideways must be used.

Design of raceways

- HYDREL/EGIS guideways are suitable as raceways. If these guideways cannot be used, machine parts with appropriate characteristics can be used as raceways instead. It must be ensured that:
  - the raceway roughness does not exceed R_a 0,3
  - the raceway hardness is at least 670 HV (58 HRC). If the hardness is below this value, the basic load ratings (*dimension table*) must be multiplied by the hardness factors (*Load carrying capacity and life*, Figure 2, page 22).
- The cage must be in the correct longitudinal position before preloading and initial operation.
- The cages must not be deformed during unpacking and fitting.
- The cages must be protected against contamination during fitting.

Further information Page

Accuracy

- Needle rollers in quality grade G2 in accordance with DIN 5402-3
- Cylindrical rollers in quality grade GN in accordance with DIN 5402-1
- Balls in quality grade in accordance with DIN 5401-1
  - G5 for flat cages of series HB
- Excerpt from DIN 5402: see table.

Rolling elements	to DIN		Roundness µm	Sort tolerance µm
Needle rollers	DIN 5402-3	G2	1	2
		G1[1)]	0,5	1
Cylindrical rollers	DIN 5402-1	GN	1	2
		G1	0,5	1
Balls	DIN 5401	G20	0,5	2
		G5	0,13	1

[1)] Not included in DIN 5402.

Special designs

Available by agreement:

- cages made from different materials
  - steel, suffix F
  - brass, suffix MS
- higher accuracy of rolling elements
- cages with anti-corrosion protection
  - suffix BK
- coating for reduced friction
  - suffix BR
- cages bent into circular shapes.

Ordering example and ordering designation

Two H needle roller flat cages
Rolling element diameter 3 mm
Cage width 20 mm
Cage length 400 mm

Ordering designation:

2 off H 20×400 (Figure 1).

Two HW angled needle roller flat cages for closed arrangement, steel cage
Rolling element diameter 3 mm
Cage shank length 25 mm
Cage length 280 mm

Ordering designation:

2 off HW 25×280 F (Figure 2).

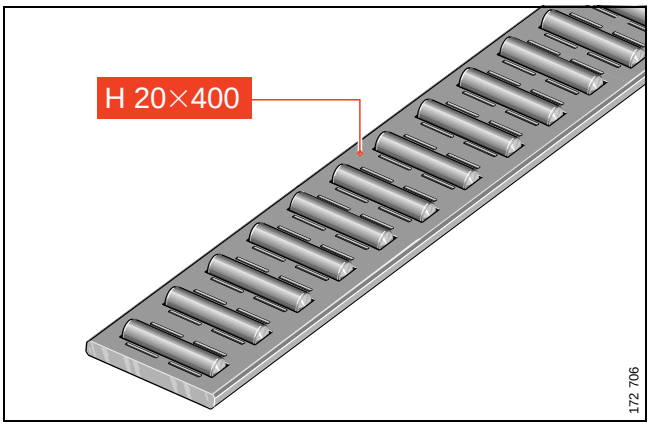


Figure 1 · Ordering example, ordering designation

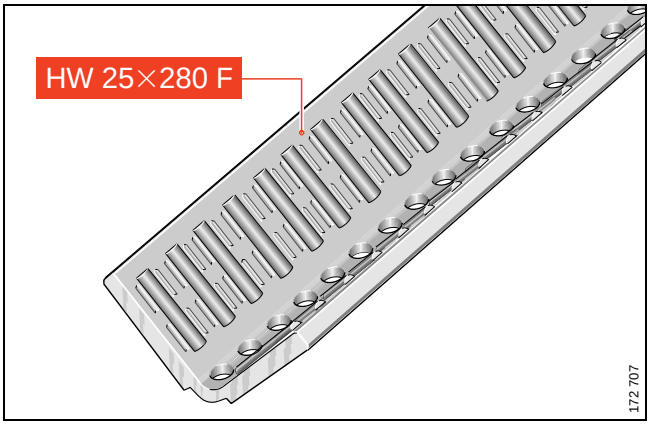
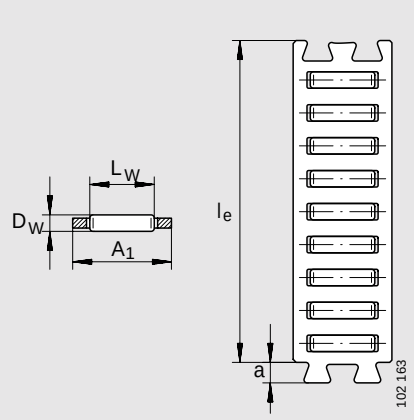


Figure 2 · Ordering example, ordering designation

Flat cages

Single row

Series FF
H
BF
HR



FF

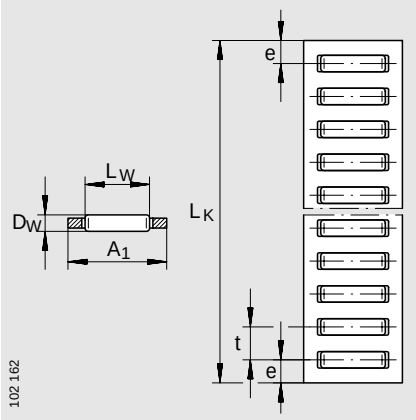
Dimension table · Dimensions in mm

Rolling element diameter	Designation				Mass for L_K = 1000 mm	Dimensions								
	FF	H	BF	HR	g	A_1	D_W	L_w	t	e	a	L_K [3] max.	l_e	Z_e [1]
2	**FF 2010**	**–**	**–**	**–**	46	10	2	6,8	–	–	2	–	32	7
	–	**H 10**	**–**	**–**	63	10	2	6,8	4,5	3,5	–	3 000	–	–
2,5	**FF 2515**	**–**	**–**	**–**	84	15	2,5	9,8	–	–	2,5	–	45	8
	–	**H 15**	**–**	**–**	120	15	2,5	9,8	5	3,5	–	3 000	–	–
3	**FF 3020**	**–**	**–**	**–**	148	20	3	13,8	–	–	3	–	60	9
	–	**H 20**	**–**	**–**	202	20	3	13,8	6	4,5	–	3 000	–	–
	–	**–**	**BF 3020**	**–**	342	20	3	15,8	6	4,5	–	2 000	–	–
3,5	**FF 3525**	**–**	**–**	**–**	221	25	3,5	17,8	–	–	3	–	75	10
	–	**H 25**	**–**	**–**	294	25	3,5	17,8	7	5	–	3 000	–	–
5	**–**	**–**	**–**	**HR 50**	105	10,5	5	5	10	6,5	–	3 000	–	–
	–	**–**	**BF 5015**	**–**	375	15	5	11,8	8	5,5	–	2 000	–	–
	–	**–**	**BF 5023**	**–**	530	23	5	19,8	8	5,5	–	2 000	–	–
	–	**–**	**BF 5032**	**–**	722	32	5	27,8	8	5,5	–	2 000	–	–
7	**–**	**–**	**–**	**HR 70**	295	17	7	10	13	8,5	–	3 000	–	–
	–	**–**	**BF 7028**	**–**	875	28	7	24	11	7,5	–	2 000	–	–
	–	**–**	**BF 7035**	**–**	1080	35	7	30	11	7,5	–	2 000	–	–
10	**–**	**–**	**–**	**HR 100**	598	24	10	14	17	10	–	3 000	–	–
12	**–**	**–**	**BF 12022**	**–**	1220	22	12	18	16	10	–	2 000	–	–
	–	**–**	**BF 12040**	**–**	1970	40	12	36	16	10	–	2 000	–	–

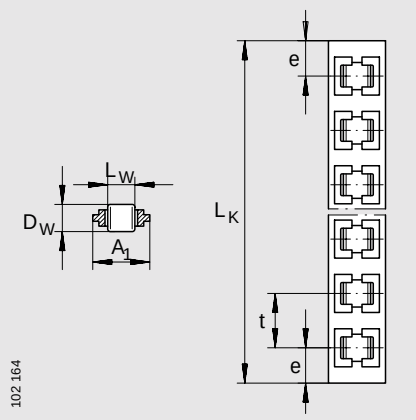
[1]) Number of rolling elements in one cage element.

[2]) For a theoretical cage length of 100 mm in the load direction according to the figure. Calculation of basic load ratings for effective cage lengths and calculation of safety factors and life: see page 18ff.

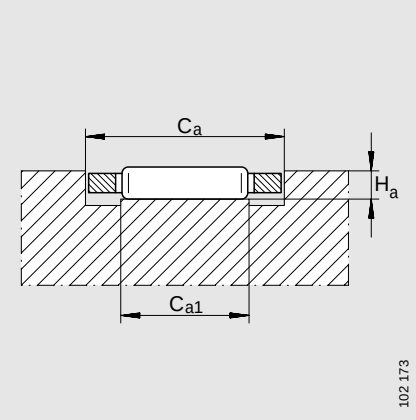
[3]) Length tolerance: $+0/-1 \times t$.



H, BF

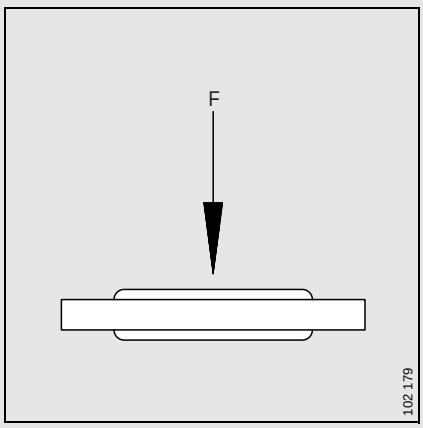


HR



Mounting dimensions

Basic load ratings[2]		Mounting dimensions			Appropriate guideways
C	C_0	C_a	C_{a1}	H_a	
N	N		min.		
21 300	61 900	$10{,}3^{+0{,}2}$	7	1,7	**J 3525, S 3525**
21 600	62 800	$10{,}3^{+0{,}2}$	7	1,7	**J 3525, S 3525**
32 700	92 300	$15{,}3^{+0{,}2}$	10	2,2	**J 4025, S 4025, J 5025, S 5025**
35 800	103 800	$15{,}3^{+0{,}2}$	10	2,2	**J 4025, S 4025, J 5025, S 5025**
47 800	133 200	$20{,}4^{+0{,}2}$	14	2,7	**J 5030, S 5030**
51 900	148 000	$20{,}4^{+0{,}2}$	14	2,7	**J 5030, S 5030**
57 800	170 100	$20{,}4^{+0{,}2}$	16	2,7	**J 5030, S 5030**
64 700	177 300	$25{,}4^{+0{,}2}$	18	3,2	**J 5530, S 5530**
68 200	190 000	$25{,}4^{+0{,}2}$	18	3,2	**J 5530, S 5530**
29 400	50 800	$10{,}9^{+0{,}2}$	5	3,4	**–**
69 900	154 700	$15{,}3^{+0{,}2}$	12	4,6	**–**
106 400	265 100	$23{,}4^{+0{,}2}$	20	4,6	**–**
139 500	375 600	$32{,}5^{+0{,}3}$	28	4,6	**–**
65 800	114 200	$17{,}4^{+0{,}2}$	10	4,8	**–**
150 800	331 800	$28{,}4^{+0{,}2}$	24	6,5	**–**
179 800	416 200	$35{,}6^{+0{,}3}$	30	6,5	**–**
109 900	174 200	$24{,}4^{+0{,}2}$	14	6,5	**–**
178 800	288 300	$22{,}4^{+0{,}2}$	18	11	**–**
447 600	938 600	$40{,}5^{+0{,}3}$	36	11	**–**

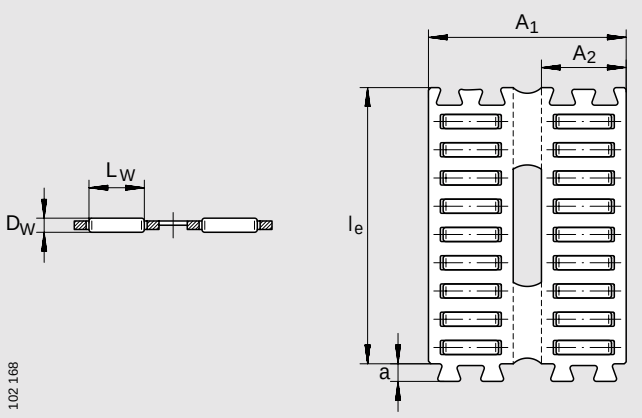


Load direction

Flat cages

Double row

Series FF..ZW
H..ZW
HR..ZW



FF..ZW, excluding FF 2025 ZW

Dimension table · Dimensions in mm

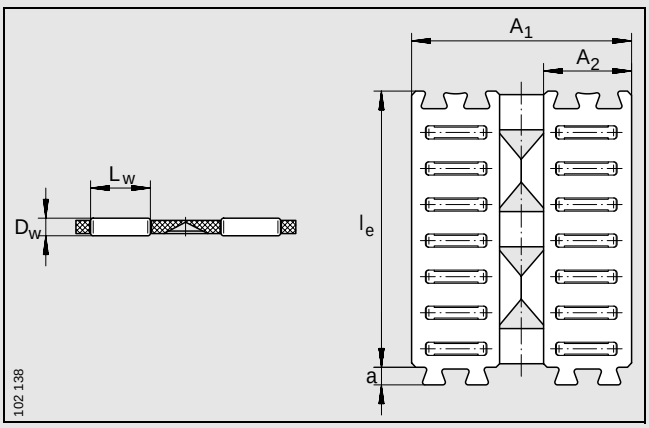
Rolling element diameter	Designation			Mass for L_K = 1000 mm	Dimensions									
	FF..ZW	H..ZW	HR..ZW	g	A_1	A_2	D_w	L_w	t	e	a	L_K[3] max.	l_e	Z_e[1]
2	**–**	**H 19 ZW**[4]	**–**	219	19,2	8	2	4,8	4	3	–	1000	–	–
	FF 2025 ZW	**–**	**–**	94	25	10	2	6,8	–	–	2	–	32	7
	–	**H 24 ZW**	**–**	138	24	10,5	2	6,8	4,5	3,5	–	3000	–	–
2,5	**FF 2535 ZW**	**–**	**–**	182	35	15	2,5	9,8	–	–	2,4	–	45	8
	–	**H 34 ZW**	**–**	239	33,5	14,3	2,5	9,8	5,5	4	–	3000	–	–
3	**FF 3045 ZW**	**–**	**–**	315	45	20	3	13,8	–	–	3	–	60	9
	–	**H 44 ZW**	**–**	408	44	19	3	13,8	6	4,5	–	3000	–	–
3,5	**FF 3555 ZW**	**–**	**–**	464	55	25	3,5	17,8	–	–	3,2	–	75	10
	–	**H 55 ZW**	**–**	598	55	24	3,5	17,8	7	5	–	3000	–	–
5	**–**	**–**	**HR 50 ZW**	215	24	10,5	5	5	10	6,5	–	3000	–	–
7	**–**	**–**	**HR 70 ZW**	602	40	17	7	10	13	8,5	–	3000	–	–
10	**–**	**–**	**HR 100 ZW**	1233	55	24	10	14	17	10	–	3000	–	–

[1]) Number of rolling elements per row in one cage element.

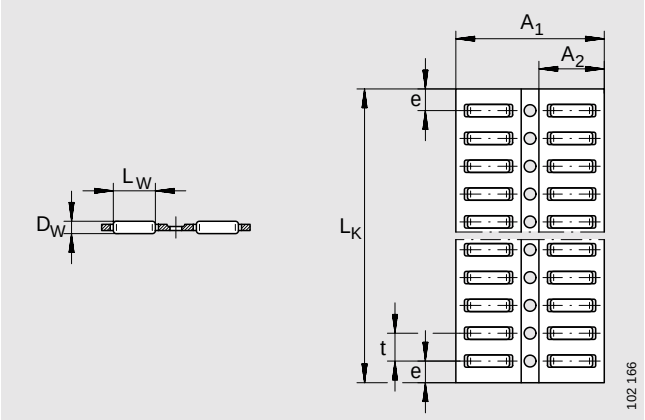
[2]) For a theoretical cage length of 100 mm in the load direction according to the figure. Calculation of basic load ratings for effective cage lengths and calculation of safety factors and life: see page 18ff.

[3]) Length tolerance: $+0/-1 \times t$.

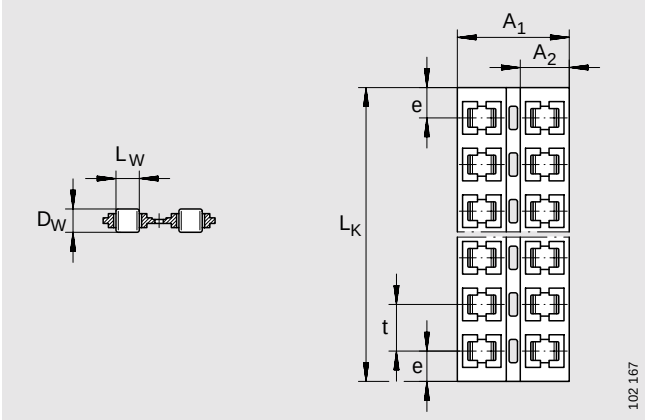
[4]) Steel basic cage.



FF 2025 ZW

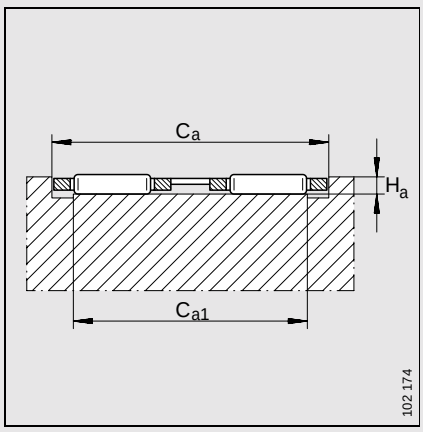


H..ZW

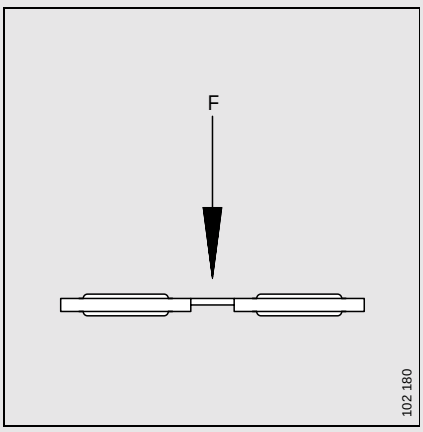


HR..ZW

Basic load ratings[2]		Mounting dimensions			Appropriate guideways
C N	C_0 N	C_a	C_{a1} min.	H_a	
30 300	97 200	$19{,}6^{+0{,}2}$	17	1,7	–
36 600	123 700	$25{,}4^{+0{,}2}$	22	1,7	–
37 000	125 700	$24{,}4^{+0{,}2}$	21	1,7	**J 6035, S 6035**
56 000	184 600	$35{,}5^{+0{,}2}$	30	2,2	–
57 000	188 800	$34{,}0^{+0{,}2}$	28,5	2,2	**J 7040, S 7040**
81 900	266 500	$45{,}5^{+0{,}2}$	39	2,7	–
88 900	296 100	$44{,}5^{+0{,}2}$	38	2,7	**J 8050, S 8050**
110 900	354 700	$55{,}5^{+0{,}2}$	48	3,2	–
117 000	380 000	$55{,}5^{+0{,}2}$	48	3,2	–
50 500	101 600	$24{,}4^{+0{,}2}$	19,5	3,4	–
112 800	228 400	$40{,}5^{+0{,}2}$	34	4,8	–
188 400	348 300	$55{,}5^{+0{,}2}$	46	6,5	–



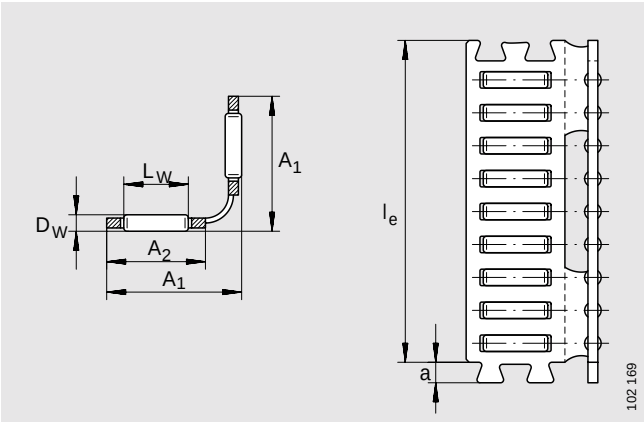
Mounting dimensions



Load direction

Angled flat cages

Series FFW
HW
HRW



FFW

Dimension table · Dimensions in mm

Rolling element diameter	Designation			Mass for L_K = 1000 mm	Dimensions									
					A_1	A_2	D_w	L_w	t	e	a	L_K[5])	l_e	Z_e[1])
	FFW	HW	HRW	g								max.		
2	**–**	**HW 10**[3])	**–**	219	10	8	2	4,8	4	3	–	1000	–	–
	FFW 2025	**–**	**–**	94	15	10	2	6,8	–	–	2	–	32	7
	–	**HW 15**[4])	**–**	138	14	10,5	2	6,8	4,5	3,5	–	3000	–	–
	–	**HW 16**	**–**	190	16	13,5	2	8,8	3,8	2,8	–	3000	–	–
2,5	**FFW 2535**	**–**	**–**	182	20,5	15	2,5	9,8	–	–	2,4	–	45	8
	–	**HW 20**[4])	**–**	239	20	14,3	2,5	9,8	5,5	4	–	3000	–	–
3	**FFW 3045**	**–**	**–**	315	26	20	3	13,8	–	–	3	–	60	9
	–	**HW 25**	**–**	408	25	19	3	13,8	6	4,5	–	3000	–	–
3,5	**FFW 3555**	**–**	**–**	464	31,5	25	3,5	17,8	–	–	3,2	–	75	10
	–	**HW 30**	**–**	598	30	24	3,5	17,8	7	5	–	3000	–	–
5	**–**	**–**	**HRW 50**	215	15,5	10,5	5	5	10	6,5	–	3000	–	–
7	**–**	**–**	**HRW 70**	602	25	17	7	10	13	8,5	–	3000	–	–
10	**–**	**–**	**HRW 100**	1233	34	24	10	14	17	10	–	3000	–	–

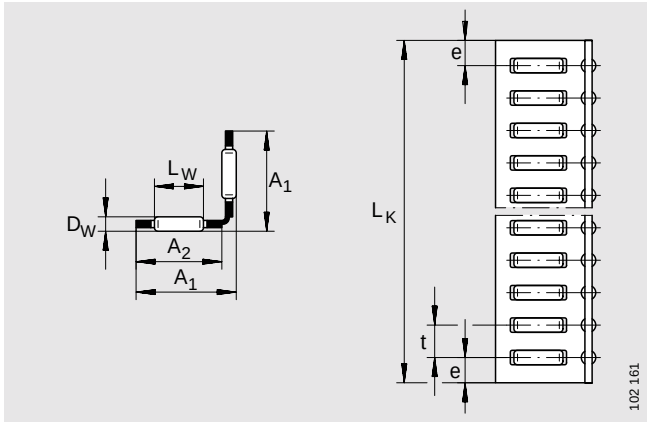
[1]) Number of rolling elements per row in one cage element.

[2]) For a theoretical cage length of 100 mm in the load direction according to the figure. Calculation of basic load ratings for effective cage lengths and calculation of safety factors and life: see page 18ff.

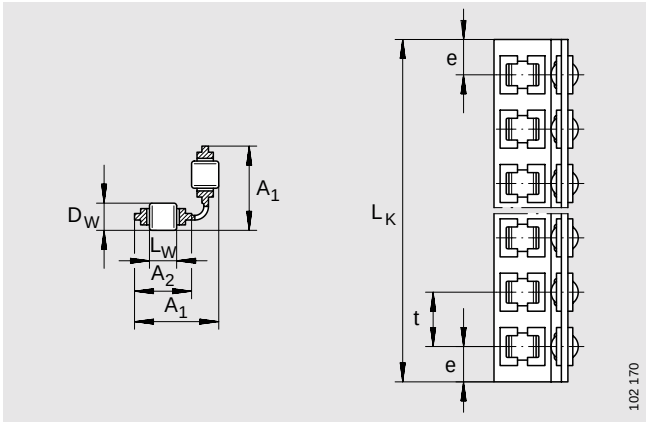
[3]) Steel basic cage.

[4]) Higher basic load ratings by agreement.

[5]) Length tolerance: $+0/-1 \times t$.

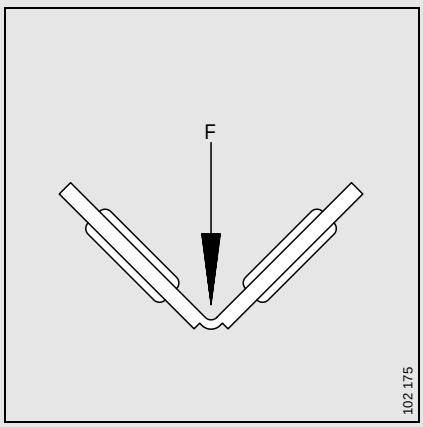


HW



HRW

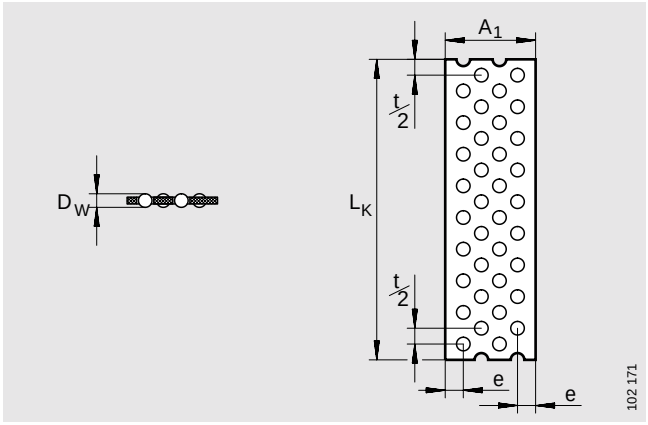
Basic load ratings[2]		Appropriate guideways
C N	C_0 N	
21 400	68 700	**M 3015, V 3015**
25 900	87 500	**M 4020, V 4020, ML 5020, ML 5520, M 5025, V 5025, ML 5525 to ML 7025**
26 200	88 900	**M 4020, V 4020, ML 5020, ML 5520, M 5025, V 5025, ML 5525 to ML 7025**
36 900	138 100	**M 5025, V 5025, ML 5525 bis ML 7025**
39 600	130 500	**M 6035, V 6035, ML 7035, ML 8035**
40 300	133 500	**M 6035, V 6035, ML 7035, ML 8035**
57 900	188 400	**M 7040, V 7040, ML 8040, ML 9040**
62 900	209 400	**M 7040, V 7040, ML 8040, ML 9040**
78 400	250 800	**M 8050, V 8050, ML 9050, ML 10050**
82 700	268 700	**M 8050, V 8050, ML 9050, ML 10050**
35 700	71 900	**M 4525, V 4525**
79 700	161 500	**M 6535, V 6535**
133 200	246 300	**M 8550, V 8550**



Load direction

Ball flat cages

Series HB

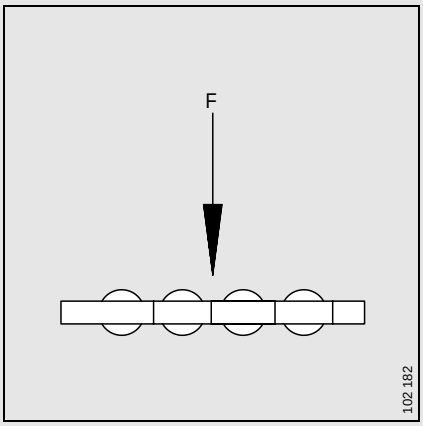


HB

Dimension table · Dimensions in mm

Ball diameter	Designation	Mass for L_K = 1000 mm g	Dimensions					Basic load ratings[1]		Appropriate guideway
			A_1	D_w	e	t/2	L_K max.	dyn. C N	stat. C_0 N	
2,5	**HB 2515**	95	15	2,5	4,5	3	3000	3330	3040	**J 4025, S 4025, J 5025, S 5025**
3	**HB 3020**	167	20	3	4	3,5	3000	5350	5000	**J 5030, S 5030**
3	**HB 3023**	187	23	3	5,5	3,5	3000	5350	5000	**–**
4	**HB 4025**	250	25	4	5	5	3000	7630	6220	**J 5530, S 5530**

[1]) For a theoretical cage length of 100 mm in the load direction according to the figure. Calculation of basic load ratings for effective cage lengths and calculation of safety factors and life: see page 18ff.



Load direction

Needle roller flat cages with friction damping

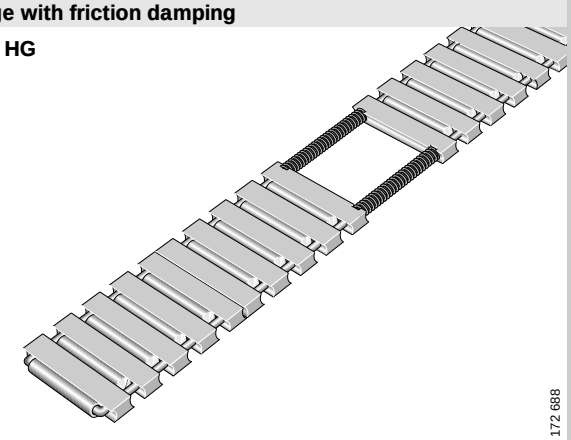
Features

Needle roller flat cages with friction damping

- consist of:
  - a large number of rolling elements
  - special metal intermediate elements which are arranged in a row by means of tie rods. The assembly is preloaded longitudinally by spring elements. This preload leads to the frictional damping force between the rolling elements and intermediate elements in the direction of movement
- are used where table systems are designed for very high positional accuracy and the table must not oscillate about its nominal position
- prevent internally or externally induced oscillations in the direction of movement or rapidly dissipate these oscillations
- eliminate the need for additional damping elements
  - they have the advantage that the damping force acts directly on the moving parts
  - they prevent hysteresis effects due to the use of transmission elements
- are free from stick slip even at very low speeds
  - due to the minimal surface pressure on the sliding surfaces of the rolling elements and the intermediate elements
- have a damping force RS of 0,1‰ of the basic static load rating C_0 as standard – related to one row of rolling elements.

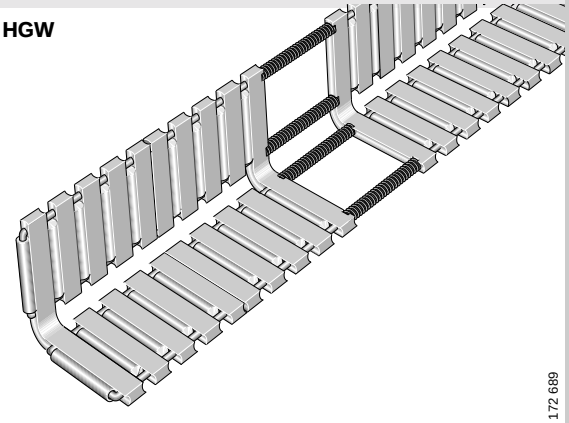
Flat cage with friction damping

HG



- needle roller flat cage with friction damping, single row and double row
- mounting dimensions identical to H and H..ZW
- for J/S guideways

HGW



- needle roller flat cage with friction damping, double row
- mounting dimensions identical to HW and FFW
- for M, ML and V guideways

Design and safety guidelines

Design of raceways

- M, ML, V, J and S guideways are suitable as raceways. If these guideways cannot be used, machine parts with appropriate characteristics can be used as raceways instead. It must be ensured that:
  - the raceway roughness does not exceed R_a 0,3
  - the raceway hardness is at least 670 HV (58 HRC). If the hardness is below this value, the basic load ratings (*dimension table*) must be multiplied by the hardness factors (*Load carrying capacity and life*, Figure 2, page 22).

Cage length

- For optimum load distribution under eccentric loading or moment loads, the longest possible cage should be selected.

⚠ Cages with friction damping must always be located over their whole length between the guideways. If this is not the case, please consult the INA engineering service.

The information on cage length given in the section *Design of bearing arrangements*, page 40 must be noted!

Damping force and preload

- If a damping force other than the standard value is required, this must be stated in the order. The permissible range is between 0 and 2 RS.
- In order to make full use of the damping force, the guidance system must be subjected to a minimal preload
  - preload approx. 0,005 C_0.

Total friction

- The total frictional torque consists of the rolling friction due to the load and the damping force independent of the load. If the cage is correctly installed, the coefficient of rolling friction μ_R is approximately 0,001.

$$\Sigma R = RS + \mu_R \cdot F$$

ΣR N
Total frictional force

RS N
Damping force

μ_R –
Coefficient of rolling friction

F N
Load on the guidance system.

Operating temperature

- Cages with friction damping can be used at temperatures up to +150 °C.

Accuracy

Needle rollers in quality grade G2 in accordance with DIN 5402-3.

Special designs

- Differing damping forces RS
  - suffix ..RS
- Special designs by agreement
- Needle rollers in higher quality grades.

Ordering example and ordering designation

Needle roller flat cage for a flat cage guidance system with M and V guideways:
Guideway sizes M 4020 and V 4020
Angled needle roller flat cage with friction damping HGW 15
Cage length 400 mm.

Ordering designation:

1 off HGW 15×400 (Figure 1).

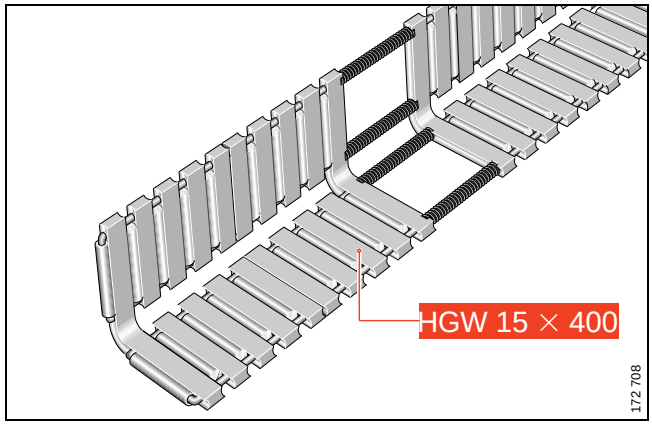
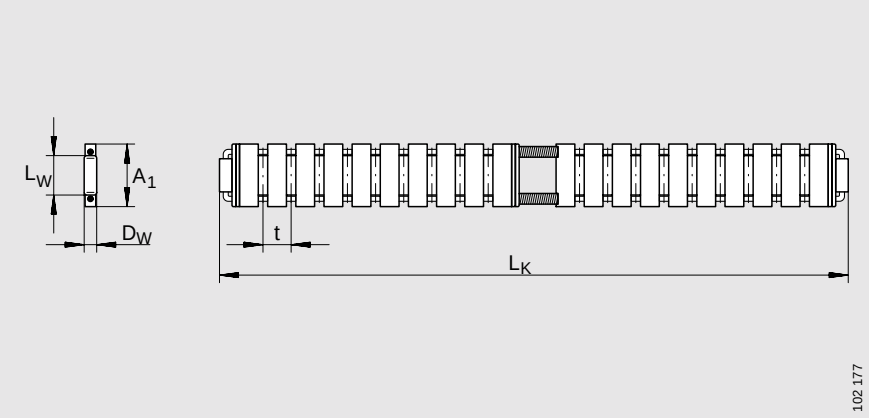


Figure 1 · Ordering example, ordering designation

Needle roller flat cages with friction damping

Series HG
HGW



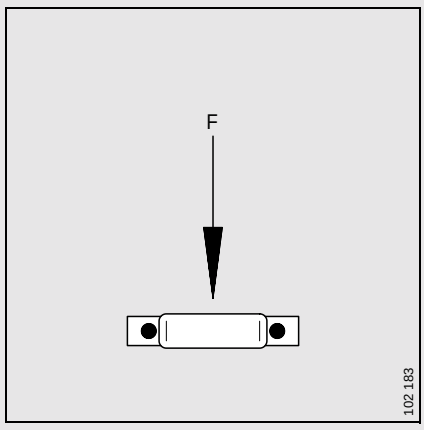
HG

Dimension table · Dimensions in mm

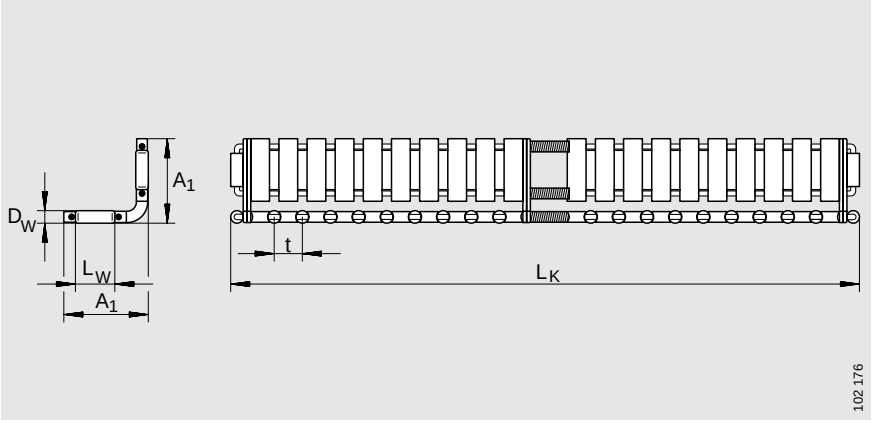
Needle roller diameter	Designation		Mass for L_K = 1000 mm	Dimensions				
	HG	HGW	g	A_1	A_2	D_w	L_w	t
2	**HG 10**	**–**	130	10	–	2	6,3	4,5
	–	**HGW 15**	265	13,5	10	2	6,3	4,5
2,5	**HG 15**	**–**	230	15	–	2,5	9,8	5
	–	**HGW 20**	470	19,5	15	2,5	9,8	5
3	**HG 20**	**–**	375	20	–	3	13,8	6
	–	**HGW 25**	760	25	20	3	13,8	6
3,5	**HG 25**	**–**	560	25	–	3,5	17,8	7
	–	**HGW 30**	1150	30,5	25	3,5	17,8	7

[1]) For a theoretical cage length of 100 mm in the load direction according to the figure. Calculation of basic load ratings for effective cage lengths and calculation of safety factors and life: see page 18ff.

[2]) For a cage length of 100 mm.
Calculation of damping force for effective cage lengths $RS_w = RS \cdot \frac{L_K}{100}$.

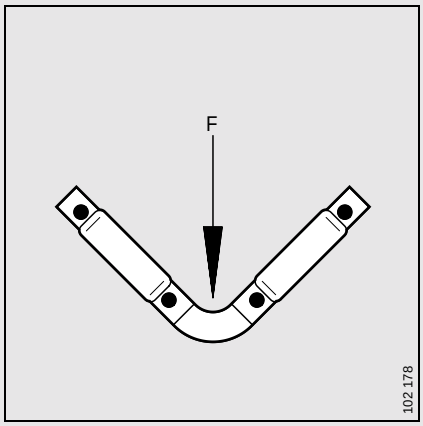


Load direction



HGW

Basic load ratings[1]		Standard damping force RS[2]	Appropriate guideway
dyn. C N	stat. C_0 N	N	
18 300	50 800	4,5	**J 3525, S 3525**
21 900	70 500	9	**M 4020, M 5025, ML 5020, ML 5520, ML 5525 to ML 7025, V 4020, V 5025**
31 700	88 700	8	**J 4025, S 4025, J 5025, S 5025**
38 000	123 800	16	**M 6035, ML 7035, ML 8035, V 6035**
47 700	132 800	11	**J 5030, S 5030**
57 200	185 500	22	**M 7040, ML 8040, ML 9040, V 7040**
61 300	165 700	14	**J 5530, S 5530**
73 800	232 100	28	**M 8050, ML 9050, ML 10050, V 8050**



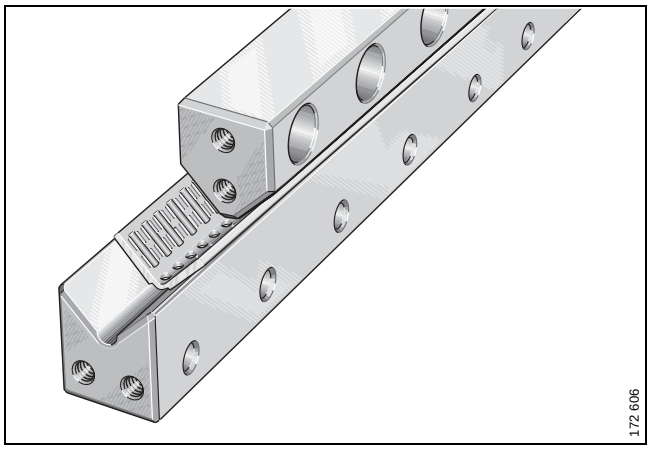
Load direction

Order form

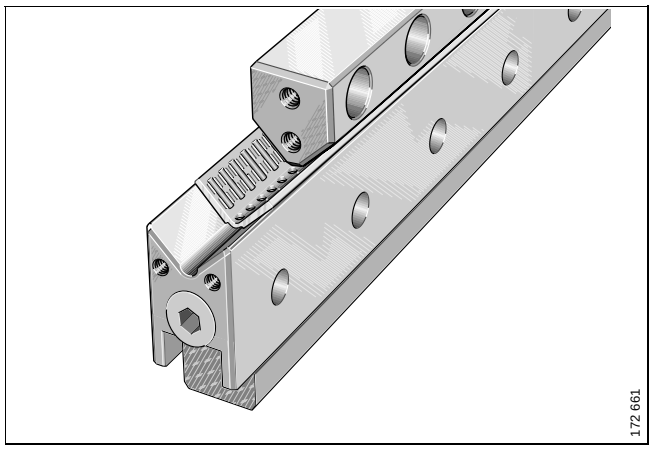
Flat cage guidance systems

Closed arrangement M/V, ML/V

M/V guidance system



ML/V guidance system



Quantity	Designation (see dimension tables)				Hole pitches (see dimension tables) $C_5 + i \times C_4 + C_6$
_____	Guideway	V	_____/_____	× _____	_____ + _____ × _____ + _____ = _____
_____	Guideway	V	_____/_____	× _____	_____ + _____ × _____ + _____ = _____
_____	Guideway	M	_____/_____	× _____	_____ + _____ × _____ + _____ = _____
_____	Guideway	M	_____/_____	× _____	_____ + _____ × _____ + _____ = _____
	or	ML	_____/_____	× _____	_____ + _____ × _____ + _____ = _____
_____	Flat cage	FFW	_____	× _____	
	or	HW/HRW	_____	× _____	Grade _____
_____	End piece	EM	_____		Intended for _____ set/sets
_____	End piece	EV	_____		
_____	Wiper	EAM	_____		Stroke of guidance system H_____ mm
_____	Wiper	EAV	_____		Comments _____
_____	End piece	EML	_____		_____
_____	Wiper	EAML	_____		_____
					Delivery date _____
					Order no. _____

Date Company stamp and signature

HYDREL AG

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E-Mail info@hydrel.ch
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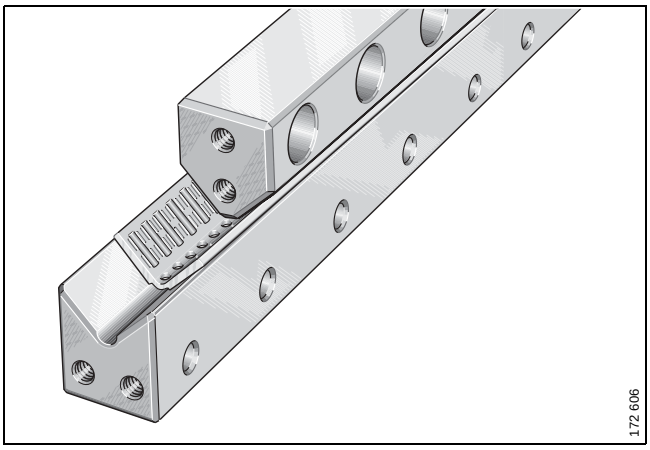
Order form

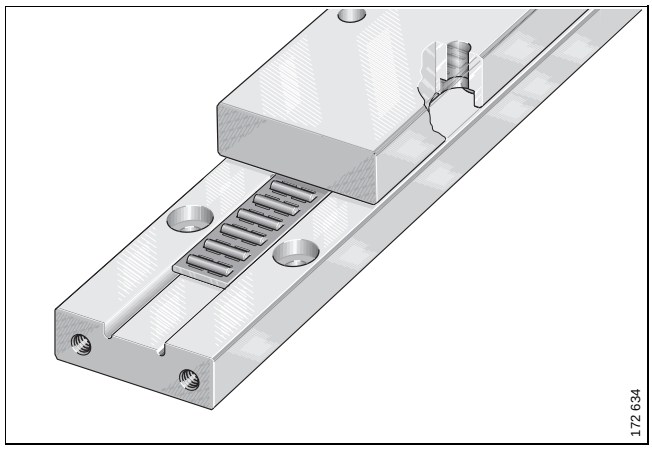
Flat cage guidance systems

Open arrangement M/V, J/S

M/V guidance system



J/S guidance system



Quantity	Designation (see dimension tables)			Hole pitches (see dimension tables) $C_5 + i \times C_4 + C_6$
_____	Guideway	J	_____/_____ × _____	_____ + _____ × _____ + _____ = _____
_____	Guideway	S	_____/_____ × _____	_____ + _____ × _____ + _____ = _____
_____	Guideway	M	_____/_____ × _____	_____ + _____ × _____ + _____ = _____
_____	Guideway	M	_____/_____ × _____	_____ + _____ × _____ + _____ = _____
	or	ML	_____/_____ × _____	_____ + _____ × _____ + _____ = _____
_____	Flat cage	FF	_____ × _____	
	or	H	_____ × _____	Grade _____
_____	Flat cage	FFW	_____ × _____	Intended for _____ set/sets
	or	HW/HRW	_____ × _____	Stroke of guidance system H_____ mm
_____	End piece	EJ	_____	
_____	End piece	EV	_____	Comments _____
_____	End piece	EM	_____	_____
_____	End piece	EM	_____	_____
	or	EML	_____	
_____	Wiper	EAV	_____	Delivery date _____
_____	Wiper	EAM	_____	Order no. _____
	or	EAML	_____	

Date Company stamp and signature

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Zwischentitel

Linear recirculating roller guidance systems

Linear recirculating roller guidance systems comprise a bearing arrangement system for linear motion with unlimited stroke. Since the guidance elements have a versatile range of possible arrangements, linear recirculating roller guidance systems are suitable for numerous applications in general machine building, especially for linear guidance systems in machine tools where high guidance and positioning accuracies are required over long traverse distances.

Linear recirculating roller guidance systems consist of:

- INA linear recirculating roller bearings with cylindrical rollers as rolling elements and
- HYDREL guideways with up to four raceways for the bearings. In combination with the bearings, the guideways give high precision linear guidance systems.

Linear recirculating roller guidance systems:

- have very high load carrying capacity
- can be preloaded by means of adjusting gibs
- have extremely high rigidity under preload
- have high accuracy throughout their operating life
- have consistently low friction
- can be used to achieve compact designs matched to the specific application
- are suitable for locating/locating and locating/non-locating bearing arrangements
- can in a locating/locating bearing arrangement support loads from all directions and moments about all axes.

The range of recirculating guidance systems is complemented by:

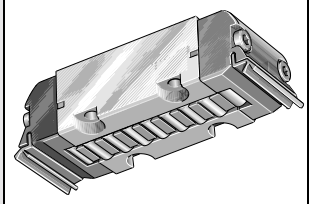
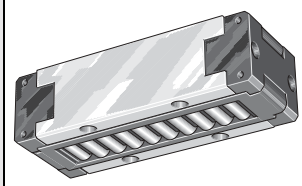
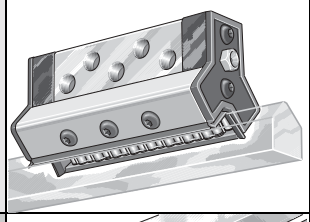
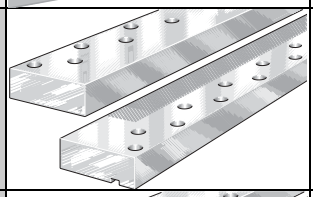
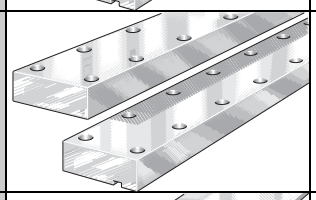
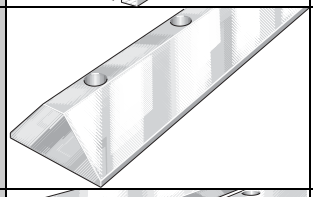
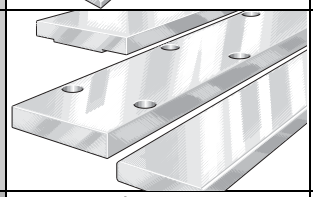
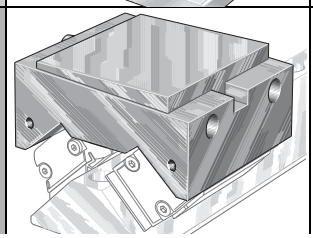
- INA adjusting gibs for precise setting of preload
- INA setting devices for measuring the deformation of the adjacent construction where preload forces must be supported
- HYDREL adapters. These adapters
  - provide a simple means of installing the linear recirculating roller bearings in 45° arrangements
  - are suitable for both open and closed arrangements.

INA-Schaeffler KG
Linear Technology Division
Homburg (Saar)

HYDREL AG
Romanshorn (Switzerland)

Product range

Overview / selection scheme

Characteristic / Guidance system		Accuracy Q2	Accuracy Q6	Accuracy Q10	Load carrying capacity	Rigidity	Friction	Travel velocity max
RUS / RUS..KS								50 m/min to 100 m/min[2)]
PR								120 m/min
RUSW								100 m/min
UG, UGN, UGS, UGSN		❑	■	❑				
UZ, UZN, UZS, UZSN		❑	■	❑				
UV		❑	❑	■				
UFA, UFB, UFK		❑	❑	■				
APUV, AUV, AUVL, AV, AVL								

■ Standard design.

❑ Optional.

[1)] Without seals: –40 °C to +120 °C.

[2)] Dependent on series.

Operating temperature	Raceways Quantity	Relubrication via end piece	Accessories Adjusting gib	Setting device	Wipers	Features See page
–30 °C to +90 °C[1)]		■ (RUS..KS)	❑	❑		 174
–40 °C to +120 °C			❑	❑	❑	 175
–30 °C to +90 °C		■				 175
	4					 190 191
	3					 190 191
	2					 191
	1					 191
		❑			❑	 202

Contents

Product index

sorted alphanumerically

Page	Type	Description
191	UFA	Guideway with one raceway, recesses for adhesive bonding to adjacent construction
191	UFB	Guideway with one raceway, through holes and counterbores for fixing screws
191	UFK	Guideway with one raceway, for clamping to adjacent construction by means of clamping strip UKB
190	UG	Guideway, rectangular cross-section, with four raceways, through holes and counterbores for fixing screws
190	UGN	Guideway, rectangular cross-section, with four raceways, milled continuous slot for square steel bar in order to support high lateral loads, through holes and counterbores for fixing screws
191	UGS	Guideway, rectangular cross-section, with four raceways, threaded blind holes
191	UGSN	Guideway, rectangular cross-section, with four raceways, milled continuous slot for square steel bar in order to support high lateral loads, threaded blind holes
201	UKB	Clamping strip for locating guideways UFK
191	UV	Guideway, trapezoidal cross-section, with two raceways arranged at an angle of 45° to the mounting face, through holes and counterbores for fixing screws
191	UZ	Guideway, rectangular cross-section, with three raceways, through holes and counterbores for fixing screws
191	UZN	Guideway, rectangular cross-section, with three raceways, milled continuous slot for square steel bar in order to support high lateral loads, through holes and counterbores for fixing screws
190	UZS	Guideway, rectangular cross-section, with three raceways, threaded blind holes
190	UZSN	Guideway, rectangular cross-section, with three raceways, milled continuous slot for square steel bar in order to support high lateral loads, threaded blind holes
176	VUS	Adjusting gib for linear recirculating roller bearings RUS, metric dimensions
176	VUSZ	Adjusting gib for linear recirculating roller bearings PR, inch dimensions

Index of suffixes

Sorting criteria:
A–Z

Suffix	Definition
KL 02	Guideway UFA with adhesive bonding gap 0,02 mm
L	Asymmetrical hole pattern for guideways of series UG – left handed design
LA../..	Indication of end distances if these are outside the limit values in the dimension table and/or are asymmetrical. Indication of C_5/C_6 by: C_5 first distance C_6 last distance
Q..H	Guideways UG.., UZ.. with raceway accuracy only in relation to dimension H. Lateral surfaces preground only
Q2	Accuracy class, high precision
Q6	Accuracy class, precision
Q10	Accuracy class, normal
R	Asymmetrical hole pattern for guideways of series UG – right handed design
S	Linear recirculating roller bearings or guideways matched and sorted together
VGS	Preground guideways, all surfaces with grinding allowance
VQ	Preground guideways, mounting face finish ground, other surfaces with grinding allowance
X	Non-identical guideway designs in guideways matched and sorted together

Symbols and units

Unless stated otherwise in the text, the values used in this catalogue have the following symbols, units and definitions.

A_K	cm^2	Total piston surface
C	N	Basic dynamic load rating
C_H	N	Effective dynamic load rating at reduced hardness
c_S	N/µm	Rigidity of guidance system
C_0	N	Basic static load rating
C_{0H}	N	Effective static load rating at reduced hardness
C_1	mm	Effective saddle plate length
C_4	mm	Hole pitch
C_5, C_6	mm	Distance between start/end of guideway and nearest hole
f_H	–	Dynamic hardness factor
f_{0H}	–	Static hardness factor
F	N	Operating load
F_i	N	Variable load
F_B	N	Operating load
F_R	N	Displacement resistance
F_{RV}	N	Displacement resistance of table
F_v	N	Calculated preload
H	mm	Stroke
k_F	–	Load correction factor under misalignment
K_p, K_w, K_u		Correction factors for load, stroke and environmental influences
K_{LF}	–	Bearing factor
L	m	Basic rating life in 100 000 m displacement of guideway or of movable table
L	mm	Length of guideway
L_h	h	Basic rating life in hours
n	–	Maximum possible number of hole pitches
n_{osc}	min^{-1}	Frequency of reciprocating motion
p	–	Life exponent
p	bar	Pressure required
P	N	Equivalent dynamic load
P_0	N	Maximum equivalent static load
q_i	%	Proportion of total duration
S_0	–	Static load safety factor
t_f	h	Basic lubrication interval in hours
t_{fG}	h	Guide value for lubricant operating life in hours
t_{fR}	h	Guide value for relubrication interval in hours
v	m/min	Mean traverse speed
v_i	m/min	Variable speed
$\overline{v}$	m/min	Equivalent dynamic speed
X	–	Number of holes
δ_B	µm	Deflection under operating load
µ	–	Coefficient of friction

Load carrying capacity and life

The size of the linear recirculating roller guidance system required is dependent on the demands made on its:

- load carrying capacity
- life
- operational reliability.

The load carrying capacity is described using:

- the basic static load rating C_0 according to the *dimension table* and the
- basic dynamic load rating C according to the *dimension table*.

Basic load ratings according to DIN and to Japanese industrial practice

The calculation of basic load ratings for linear recirculating roller guidance systems is based on DIN 636/ISO 281.

Basic dynamic load ratings in accordance with DIN 636 are calculated on a basic rating life of 100 000 m. Suppliers from the Far East often give basic load ratings based on a rating life of 50 000 m. This results in basic load ratings that may appear to be more than 20% higher than those according to DIN 636.

Table 1 and Table 2 show how the basic load ratings should be converted.

Table 1 · Conversion of basic load ratings according to DIN into basic load ratings according to Japanese industrial practice

Linear recirculating roller bearing Designation	Conversion factor
RUS, RUS..KS, PR, RUSW	$C_{50\,000} = 1{,}23 \cdot C_{DIN}$

Table 2 · Conversion of basic load ratings according to Japanese industrial practice to basic load ratings according to DIN

Linear recirculating roller bearing Designation	Conversion factor
RUS, RUS..KS, PR, RUSW	$C_{DIN} = 0{,}81 \cdot C_{50\,000}$

Dynamic load carrying capacity and life

The dynamic load carrying capacity of the linear recirculating roller guidance system is determined by the fatigue behaviour of the material.

The dynamic load carrying capacity is described in terms of:

- the basic dynamic load rating (*dimension table*)
- the basic rating life.

The rating life as a fatigue period depends on:

- the load acting on the guidance system
- the traverse speed of the guidance system
- the statistical probability of the first appearance of failure.

Basic rating life

The basic rating life is reached or exceeded by 90% of a sufficiently large group of apparently identical linear recirculating roller guidance systems before the first evidence of material fatigue occurs (*Calculation example*, page 131).

The basic rating life is determined using the following formulae. The life calculation formulae are based on the assumption that the load and speed remain constant. If the load and speed are not constant, see *Equivalent load and speed*, page 127.

$$L = \left(\frac{C}{P}\right)^{10/3}$$

$$L_h = \frac{8{,}33 \cdot 10^5}{H \cdot n_{osc}} \cdot \left(\frac{C}{P}\right)^{10/3}$$

$$L_h = \frac{1\,666}{\bar{v}} \cdot \left(\frac{C}{P}\right)^{10/3}$$

L m
Basic rating life in 100 000 m displacement of guideway or of movable table

L_h h
Basic rating life in hours

C N
Basic dynamic load rating according to *dimension table*

P N
Equivalent dynamic load.

⚠ According to DIN 636, the equivalent dynamic load should not exceed P = 0,5 · C!

H mm
Single stroke length of reciprocating motion

n_{osc} min^{-1}
Frequency of reciprocating motion

$\bar{v}$ m/min
Mean travel speed equivalent dynamic speed.

Equivalent load and speed

Non-constant operating conditions can be taken into consideration by means of equivalent operating values. These have the same effect on the life as the loads occurring in practice.

Equivalent dynamic load

General formula

$$P = \sqrt[p]{\left(\int_0^T |v(t) \cdot F^p(t)|\,dt\right) \Big/ \left(\int_0^T |v(t)|\,dt\right)}$$

Load varying in steps

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

Load and speed varying in steps

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

Equivalent dynamic speed

General formula

$$\bar{v} = \frac{1}{T} \int_0^T |v(t)|\,dt$$

Speed varying in steps

$$\bar{v} = \frac{q_1 \cdot v_1 + q_2 \cdot v_2 + \ldots + q_z \cdot v}{100}$$

P N
Equivalent dynamic load

p –
Life exponent = 10/3

q_i %
Proportion of total duration

F_i N
Variable load

v_i m/min
Variable speed

$\bar{v}$ m/min
Equivalent dynamic speed.

Operating life

The operating life is defined as the life actually achieved by a linear recirculating roller guidance system. The operating life may deviate from the calculated life (basic rating life).

Possible reasons are wear and/or fatigue due to:

- misalignment between the guideways and guidance elements
- contamination of the guidance system
- inadequate lubrication
- excessive preload
- reciprocating motion with very small stroke length (false brinelling)
- vibration during stoppage (false brinelling).

Since there is a wide range of possible installation and operating conditions, it is not possible to calculate the operating life of a linear recirculating roller guidance system precisely in advance. The most reliable method of achieving a good estimate of the operating life is by comparison with similar applications.

Static load carrying capacity

Basic static load rating

The basic static load rating (*dimension table*) is the load under which a permanent deformation of the raceways and rolling elements occurs which corresponds to 1/10 000 of the rolling element diameter.

Static load carrying capacity

The static load carrying capacity is limited by:

- the permissible loading of the linear recirculating roller bearings
- the hardness of the raceways
- the permissible load on the screw connections
- the permissible load on the adjacent construction.

⚠ Attention must also be paid to the static load safety factor required for the application!

Check the frictional location of the fixing screws if lateral forces are present!

Static load safety factor

The static load safety factor S_0 indicates the security with regard to permissible permanent deformation in the rolling contact without affecting the guidance accuracy and smooth running of the bearing.

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

S_0 –
Static load safety factor

C_0 N
Basic static load rating according to *dimension table*

P_0 N
Maximum equivalent static load.

If high demands are placed on accuracy and smoothness of running, for example in machine tools, the static load safety factor should not be less than $S_0 = 3$.

Factors influencing the load carrying capacity

The basic load ratings *(dimension tables)* are only valid under certain conditions. Correction factors must be applied in order to take account of:

- deviating raceway hardness
- misalignment.

Hardness factor

The basic load ratings in the *dimension tables* are defined for a raceway hardness of ≧670 HV (≧58 HRC) with the fine structure characteristic of rolling bearing parts. If the raceway hardness is lower, the basic load rating is reduced to the value C_H or C_{0H}. The reduced basic load ratings can be calculated using the correction factor formula.

⚠ The hardness factors are only valid for rolling bearing steels or similar alloy steels with corresponding purity and structure! The correction factors must not be used for other materials such as cast and non-ferrous metals!

Correction factor formula for effective dynamic load rating at reduced hardness

$$C_H = f_H \cdot C$$

Correction factor formula for effective static load rating at reduced hardness

$$C_{0H} = f_{0H} \cdot C$$

C_H, C_{0H} N
Effective dynamic or static load rating at reduced hardness

f_H, f_{0H} –
Dynamic or static hardness factor (Figure 1)

C, C_0 N
Basic dynamic or static load rating according to *dimension table*.

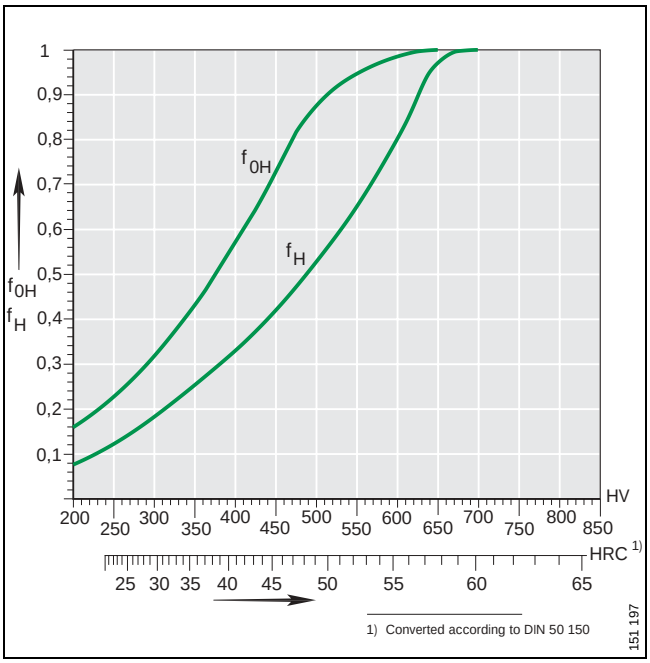


Figure 1 · Dynamic and static hardness factors

Reduction in life due to misalignment

The life calculation formulae (page 126) are based on the assumption that the guidance elements are positioned correctly. If misalignment occurs, for example due to elastic deformation of the counterstay, the rolling elements are subjected to non-uniform load along the contact line.

Correction factor formula for load under misalignment

$$P = k_F \cdot F$$

P N
Equivalent dynamic load

k_F –
Correction factor for load under misalignment (Figure 2)

F N
Bearing load.

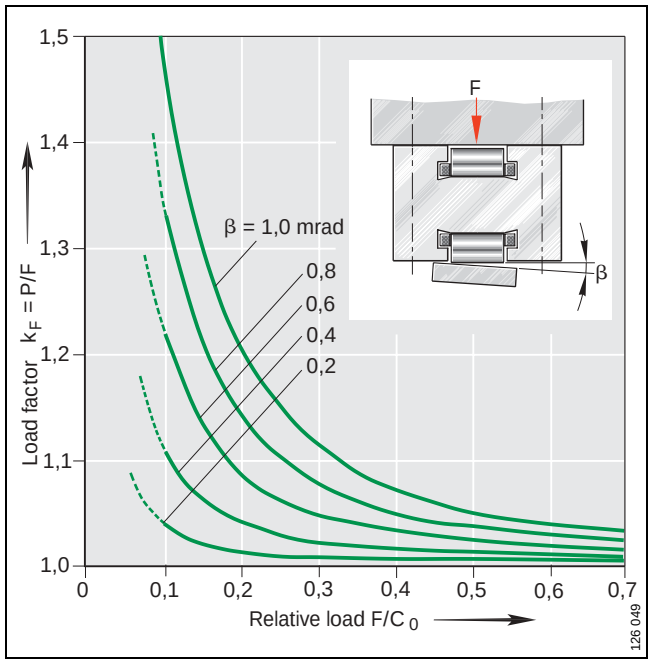


Figure 2 · Correction factor for load under misalignment

Calculation example

Given data

Linear recirculating roller bearing	RUS 26 102
Basic dynamic load rating	C = 95 000 N
Basic static load rating	C_0 = 75 000 N
Operating load at most highly loaded point	F_B = 15 000 N
Single stroke length of reciprocating motion	H = 500 mm
Frequency of reciprocating motion	n_{osc} = 8 min^{-1}
Preload force	F_V = 8 000 N

Calculate the load on the linear recirculating roller bearings from the preload diagram (Figure 3). Deduct the operating load F_B and read off F_1, F_2 on the Y axis:

Load on linear recirculating roller bearing	1 F_1 = 20 000 N
Load on linear recirculating roller bearing	2 F_2 = 5 000 N

Required

Basic rating life	L and L_h
Static load safety factor	S_0

Life calculation

$$L = \left(\frac{C}{P}\right)^{10/3}$$

For P, use the equivalent load F_1.

$$L = \left(\frac{95\,000}{20\,000}\right)^{10/3} = 180 \cdot 10^5 \text{ m}$$

$$L_h = \frac{8{,}33 \cdot 10^5}{H \cdot n_{osc}} \cdot \left(\frac{C}{P}\right)^{10/3}$$

$$L_h = \frac{8{,}33 \cdot 10^5 \cdot 180}{500 \cdot 8} = 37\,500 \text{ h}$$

The life is sufficient for the more highly load bearing.

Calculation of static load safety factor

$$S_0 = \frac{C_0}{F_1}$$

$$S_0 = \frac{75\,000}{20\,000} = 3{,}75$$

The static load safety factor is sufficient.

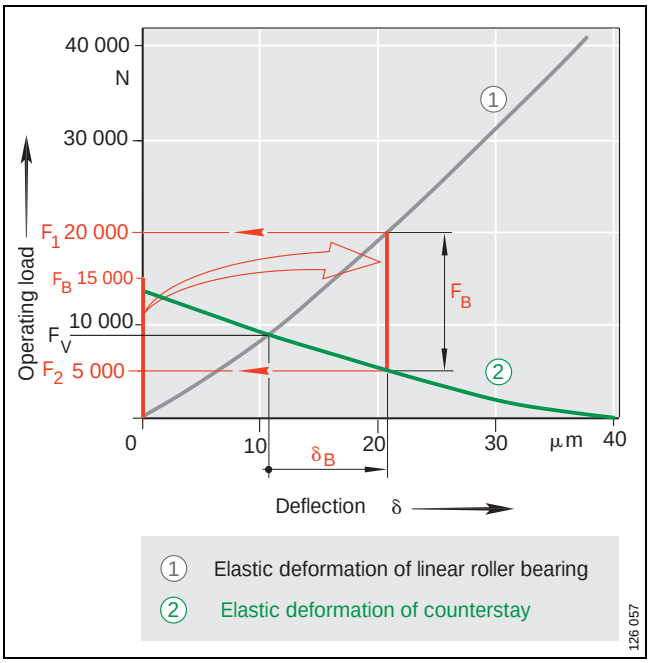


Figure 3 · Preload diagram for counterstay guidance system with two linear recirculating roller bearings RUS 26 102

Preload

Preload

- increases the rigidity and guidance accuracy of the guidance system
- gives favourable load distribution under moment loading
- prevents clearance occurring in the guidance system in all operating conditions
- prevents slippage of the cylindrical rollers, thus ensuring correct rolling of the rolling elements
- affects the displacement resistance and the life of the guidance system.

Influence of the adjacent construction

In order to ensure optimum conversion of preload into rigidity, the adjacent construction must be rigid and geometrically accurate (see *Design of bearing arrangements*, page 148).

Preload – guide value

As a guide value, the preload force may be taken as between 10% and 20% of the basic dynamic load rating C (*dimension table*) of the linear recirculating roller bearing used.

If the preload is too low, the rigidity of the system will be reduced and the guidance system may lift under load!

If the preload is too high, the life is reduced and the friction is increased!

Calculation of preload force

In order to calculate the preload force precisely, the following must be known:

- the deflection of the adjacent construction
- the operating load (see *Rigidity*, page 136).

Setting the preload

The preload can be set by means of:

- adjusting gibs VUS / VUSZ
- shims
- pressure screws.

Setting preload by means of adjusting gibs

These elements can be used to set the preload easily and precisely to the required preload dimension (Figure 1).

The gibs transmit the preload uniformly over the whole length of the linear recirculating roller bearing.

Shims

Shims are preground, economical design elements. They are finish ground to the calculated preload dimension when the guidance system is fitted.

Further information on the production of shims can be obtained from INA.

Pressure screws

Guidance systems with linear recirculating roller bearings RUSW can be preloaded by means of pressure screws (Figure 2).

The pressure screws should:

- have an even contact surface (dowel screw to DIN 913, ISO 4 026)
- be arranged between the fixing screws.

For pressure screws M6, the tightening torque M_A is 1,1 Nm (preload 0,1 · C).

Calculation of preload using the setting device EUS

The setting device EUS can be used to measure the deformation of the adjacent construction under preload forces. This deformation, when added to the deflection of the linear recirculating roller bearing under the preload force F_V (see deflection curves, page 138 and page 139), gives the required preload dimension.

The core of the setting device is the setting block with a pressure piston. This block has the same dimensions as the linear recirculating roller bearing to be fitted.

The setting block can be connected via a pressure pipe and an intermediate distributor block and integral manometer to a conventional grease gun.

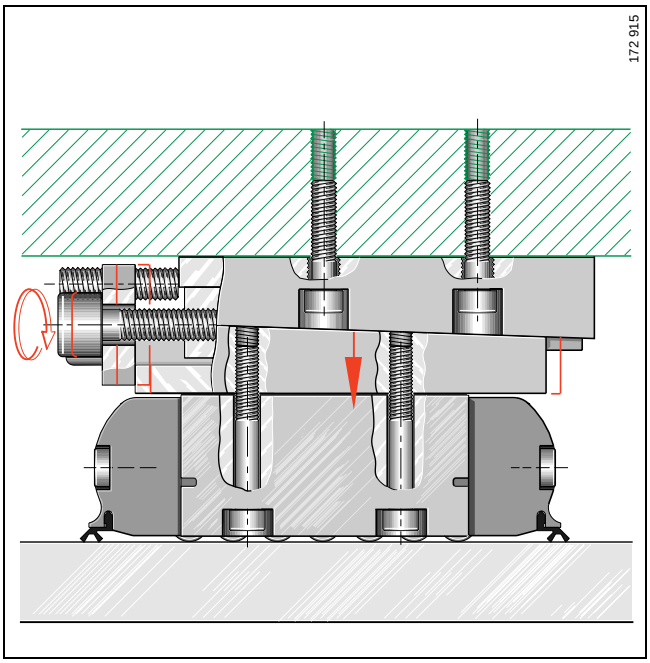


Figure 1 · Preloading the guidance system using an adjusting gib

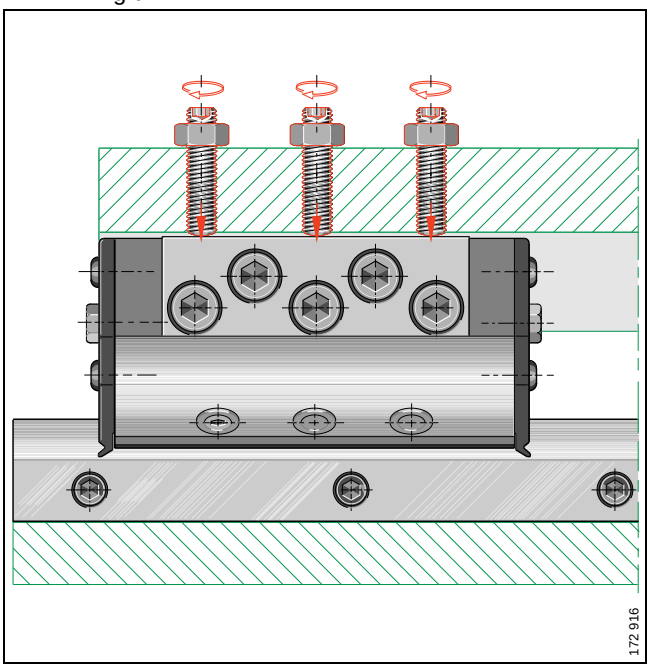


Figure 2 · Preloading the guidance system using pressure screws

Measuring the preload dimension using the setting device EUS and setting the preload (Figure 3)

- Fit the setting device EUS ① in place of the linear recirculating roller bearing.
- Connect the grease gun ⑤ to the distributor block with the manometer ③ and pressure pipe ④.
- Position a dial gauge ⑥ at a suitable point in order to measure the deformation.
- Calculate the required pressure using the formula.
- Apply pressure using a conventional grease gun ⑤ continuously until the required pressure is reached on the manometer ③.
- Read of and note the deformation travel on the dial gauge ⑥.
- Determine the deflection of the linear recirculating roller bearing under the preload force F_V (deflection curves, page 138 and page 139).
- Add the deflection of the adjacent construction to that of the linear recirculating roller bearing to give the required preload dimension
- Detach the setting device and fit the linear recirculating roller bearing.
- Set the adjusting gib to the preload dimension or finish grind the shim to the preload dimension.

Required pressure

$$p = \frac{F_v}{10 \cdot A_K}$$

p bar
Required pressure

F_v N
Calculated preload force

A_K cm^2
Total piston area (*dimension table*).

Influence of preload on displacement resistance

$$F_{RV} = \mu \cdot \Sigma F_V$$

F_{RV} N
Displacement resistance of table

μ –
Coefficient of friction (*Friction*, page 135, Table 1)

F_V N
Preload.

⚠ Influences due to lubrication or seals and the mass of the table are not taken into consideration!

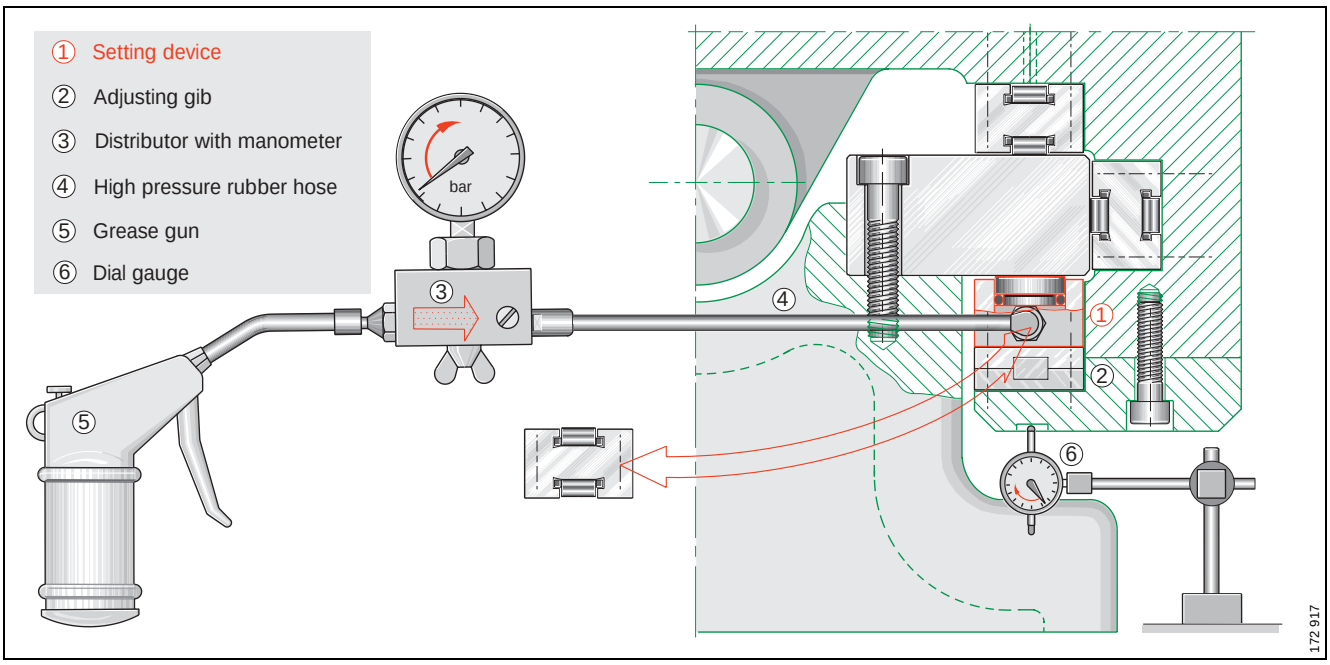


Figure 3 · Measuring the deformation travel using the setting device EUS / setting the preload dimension

Friction

Linear recirculating roller guidance systems have a consistently low coefficient of friction throughout their operating life. They are therefore free from stick-slip in contrast to plain guidance systems. The displacement force of linear recirculating roller guidance systems is only about 2% up to a maximum of 10% of the displacement force of plain guidance systems (Figure 1).

Since the rolling elements are guided in parallel, the coefficient of friction is very low (Table 1)!

Due to the lower displacement resistance, linear recirculating roller guidance systems have:

- lower drive power requirements
- reduced deformation in the elastic machine parts
- higher positional accuracy.

The friction is temporarily increased by fresh grease at initial operation and during regreasing. However, the friction coefficient returns to its original lower value after a short running-in period.

Seal friction

In linear recirculating roller guidance systems with wipers, the seal friction is at its highest with new guidance systems.

During the running-in phase, the geometry of the seal lips gradually becomes matched to the profile of the guideway. As a result, the seal friction decreases again.

Displacement resistance – calculation

The displacement resistance of linear recirculating roller bearings can be approximated using the following formula:

$$F_R = F \cdot \mu$$

F_R N
Displacement resistance

F N
Operating load of linear recirculating roller bearing

μ –
Coefficient of friction (Table 1).

Table 1 · Coefficient of friction

Linear recirculating roller guidance system Series	Coefficient of friction μ
RUS	0,003
RUS..KS	0,0025
RUSW	0,0035
PR	0,004

⚠ The values given in Table 1 are only valid if the required accuracy is achieved and if the lubrication is appropriate to the application!

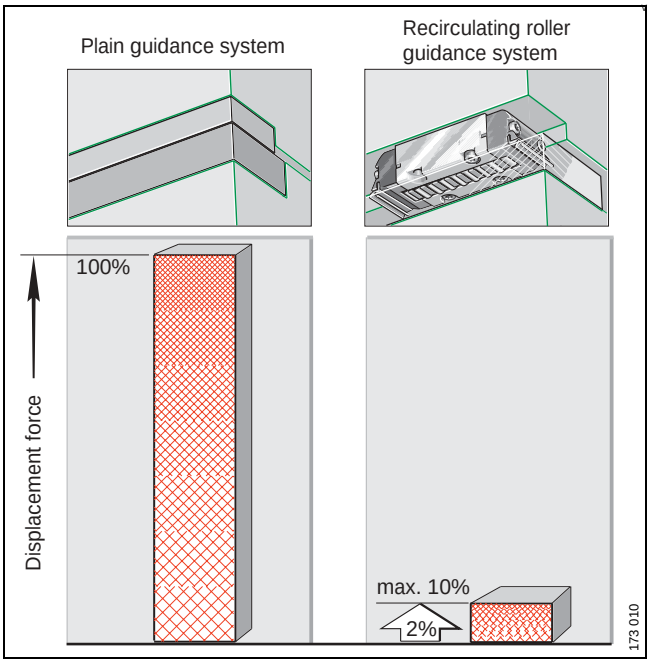


Figure 1 · Comparison of displacement force – linear recirculating roller guidance system/plain guidance system

Rigidity

Rigidity of the guidance system

If a linear recirculating roller bearing is subjected to an operating load F_B, it undergoes elastic deformation of a magnitude δ_B (Figure 1). The measured deflection curves of linear roller bearings are shown in Figure 7, page 138 and Figure 8, page 139.

The rigidity c_S of the guidance system is derived from the ratio between the operating load and deflection (formula).

$$c_S = \frac{F_B}{\delta_B}$$

c_S N/µm
Rigidity of the guidance system

F_B N
Operating load

δ_B µm
Deflection under operating load.

⚠ The formula does not take into consideration the elastic deformation of the adjacent construction, screw connections, settling effects, etc! Since the adjacent construction is not completely rigid, the deformation of the complete structure can be higher in practice!

Elastic deformation of linear recirculating roller bearings acting in opposition

Linear recirculating bearings installed clearance-free without preload

Where two linear recirculating roller bearings set clearance-free without preload act in opposition to each other, only one linear roller bearing is subjected to load and elastically deformed. The linear roller bearing without load has clearance corresponding to the deflection of the load bearing (deflection curve, Figure 2).

Linear recirculating bearings installed clearance-free with preload

If two linear recirculating roller bearings acting in opposition are subjected to a preload force F_V of magnitude δ_V, this gives the preload diagram in Figure 3.

If the system is subjected to an operating load F_B, it undergoes deformation of magnitude δ_B (Figure 3). The linear roller bearing R_1 is deformed by δ_1 and the linear roller bearing R_2 by δ_2. The system remains clearance-free up to the maximum operating load $F_{B\,max}$. In this range, the rigidity remains approximately twice that of the individual linear recirculating roller bearing.

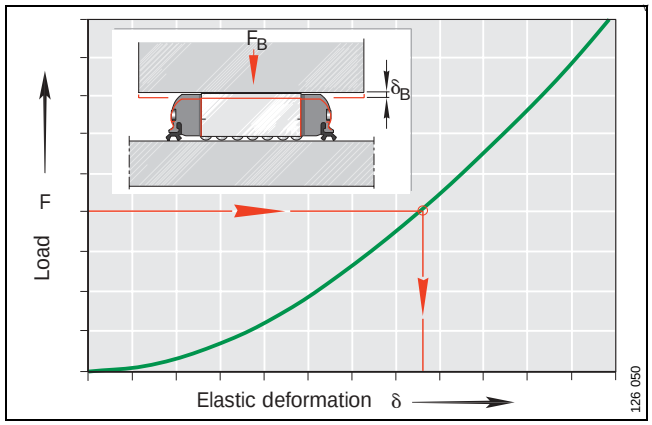


Figure 1 · Deflection curve of a linear roller bearing

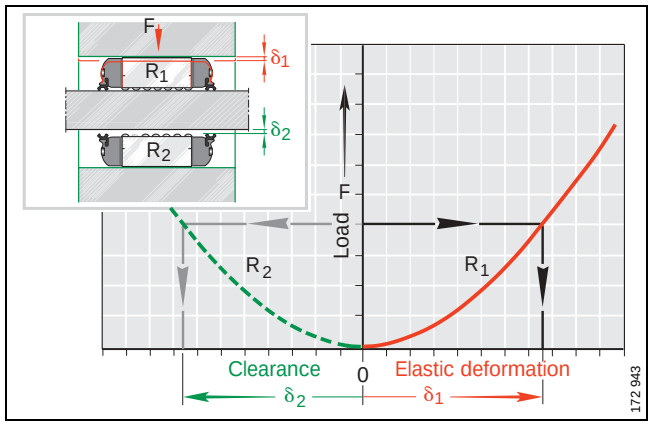


Figure 2 · Deflection curve of linear roller bearings without preload

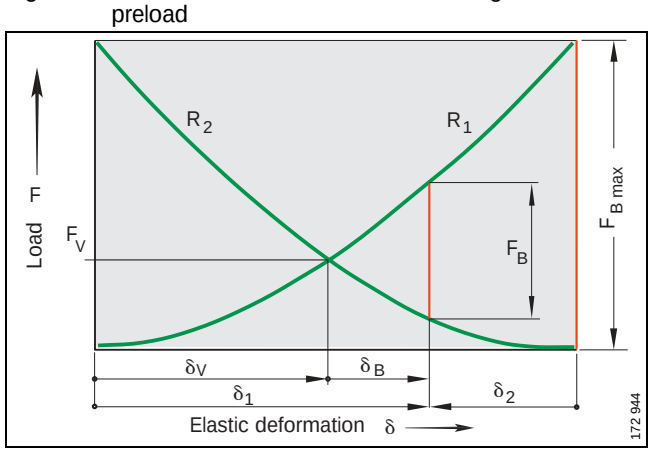


Figure 3 · Preload diagram of linear roller bearings with preload

Influence of the adjacent construction on rigidity for linear recirculating roller bearings acting in opposition

Since the counterstay and the screw connections are elastic, the deflection curve becomes shallower in the opposing direction.

The deflection characteristics of the counterstay can be determined by measuring its elastic deformation, e.g.:

- with the setting device EUS (*Preload*, page 134).

The deflection curve for the counterstay (Figure 4, red) is derived from adding together the elastic deformation of the linear roller bearing R_2 and the counterstay (Figure 4, red).

The deflection curve for the linear roller bearing R_1 is shown in green (Figure 4).

With operating loads in the opposite direction ($F_{B\,II}$) – e.g. due to moment loads – it is possible that even under relatively small loads ($F_{B\,II} > F_{B\,II\,max}$) clearance will occur on the linear roller bearing R_1. This clearance can be prevented by increased preload or higher rigidity of the counterstay (Figure 5).

⚠ If the rigidity is to be fully utilised, the adjacent construction must have sufficient rigidity and geometrical accuracy (*Design of bearing arrangements*, page 148).

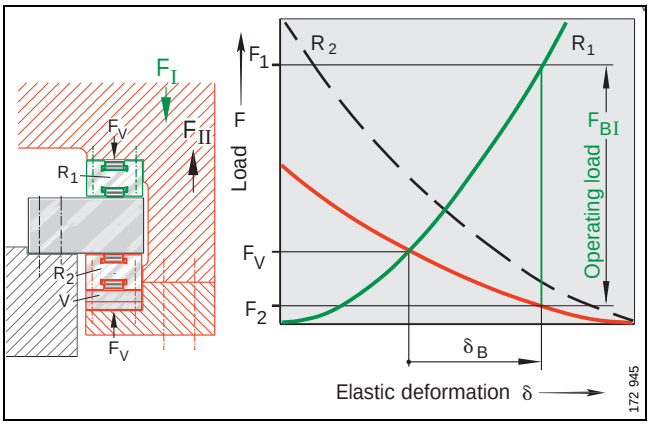


Figure 4 · Linear recirculating roller bearing preloaded, with counterstay

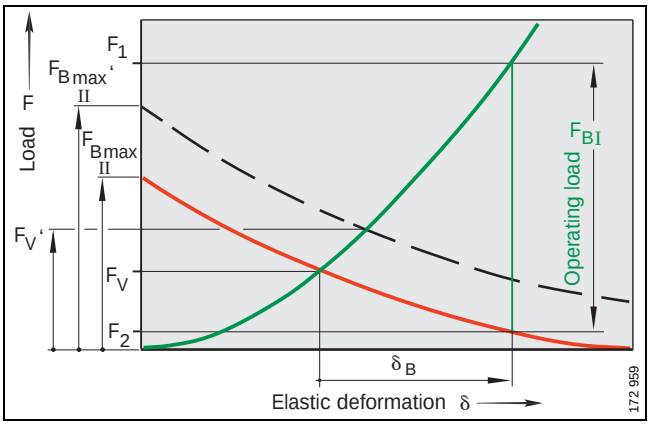


Figure 5 · Rigidity of a system with counterstay under different preloads

Calculation example

Given data

Linear recirculating roller bearing		RUS 26102
Operating load at most highly loaded point	F_B	= 15 000 N
Preload force	F_V	= 8 000 N
Deflection under operating load (derived from Figure 6)	δ_B	= 10 µm

Reference to Figure 6:

- the deflection curve for the linear roller bearing intersects the curve for the counterstay at the point for the preload F_V
- the operating load F_B between the deflection curves is deducted
- the deflection δ_B is derived from the distance between the intersection of the deflection curves for the bearing and counterstay and the points at which the operating load F_B is in contact with the deflection curves.

Required

Rigidity of the guidance system in the load direction.

Calculation

$$c_S = \frac{F_B}{\delta_B}$$

$$c_S = \frac{15\,000\ \text{N}}{10\,\mu\text{m}} = 1500\ \text{N/}\mu\text{m}$$

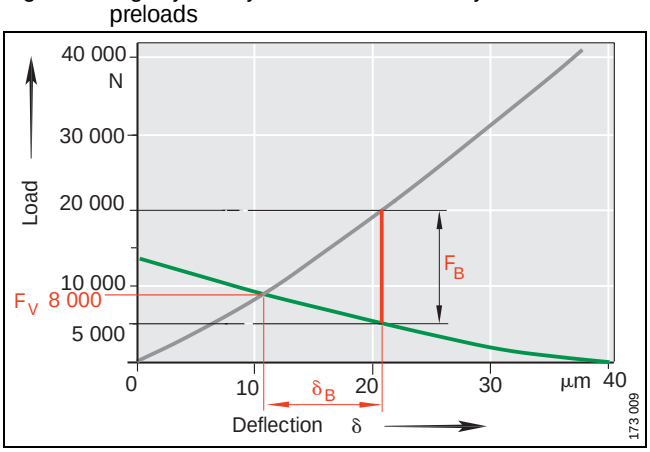


Figure 6 · Preload diagram for counterstay guidance system

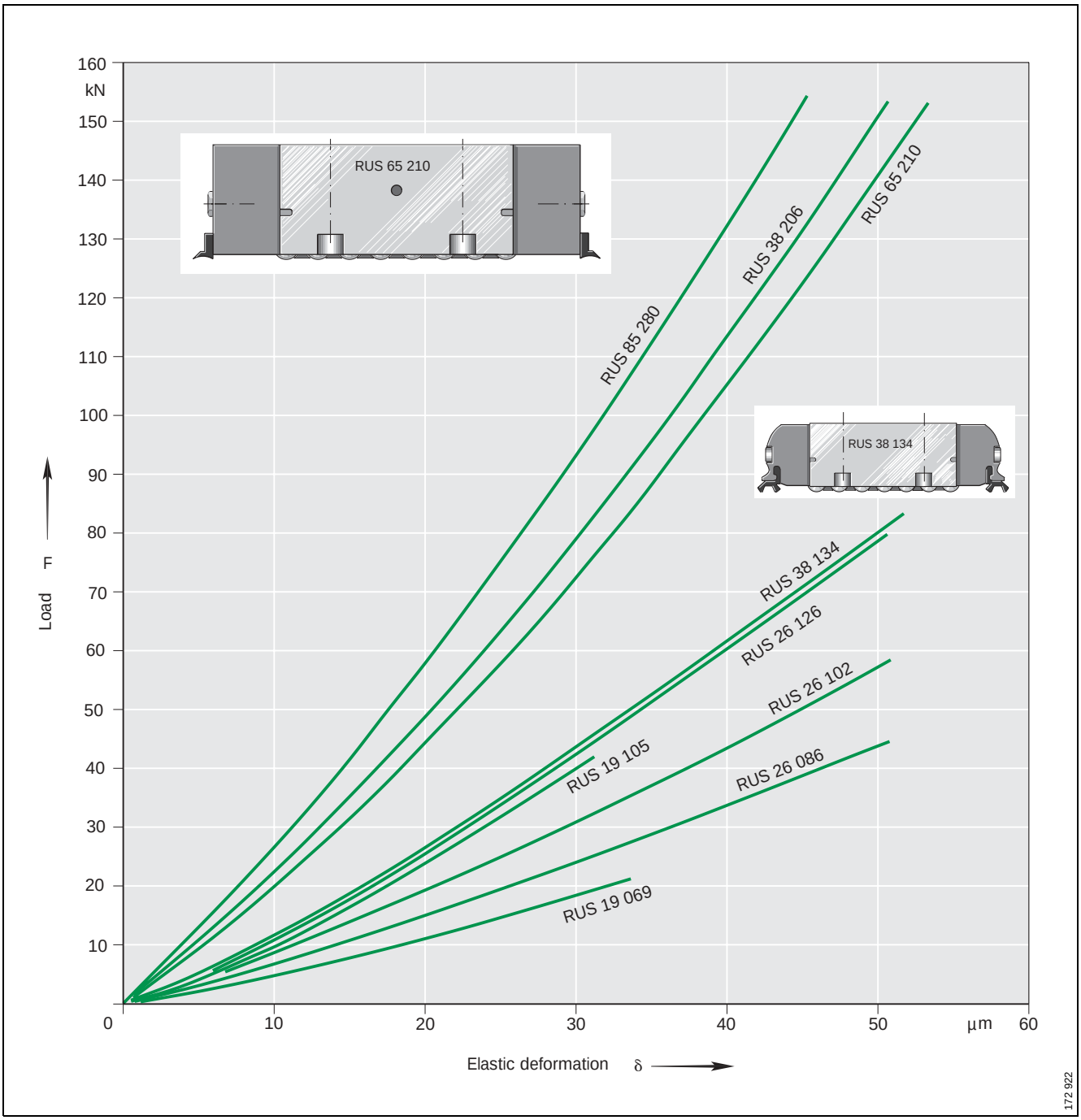


Figure 7 · Measured deflection curve for linear recirculating roller bearings RUS

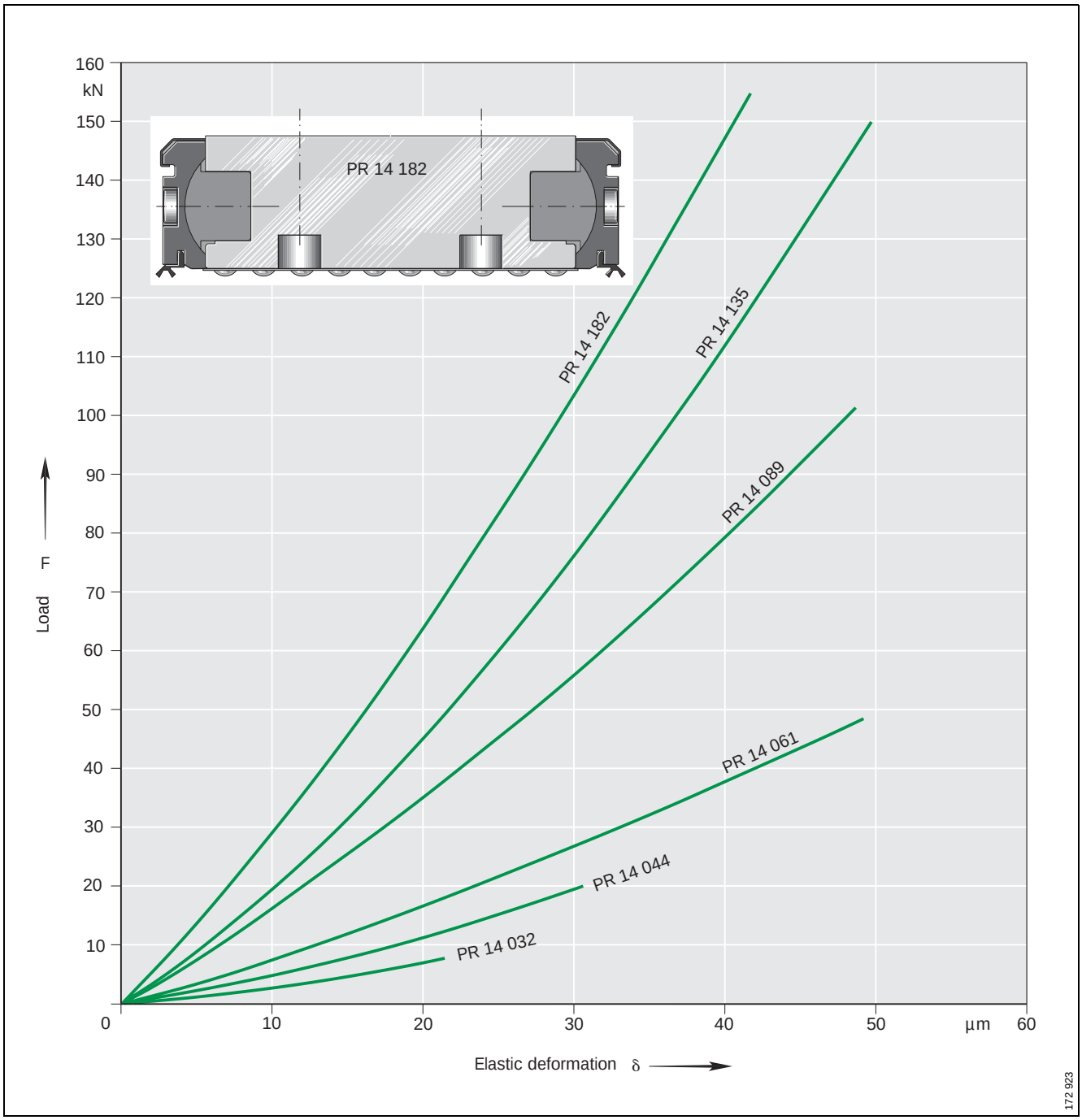


Figure 8 · Measured deflection curve for linear recirculating roller bearings PR

Lubrication

Lubrication is an important element for the reliable function and long operating life of the linear recirculating roller guidance system.

Lubricants (either grease or oil) perform the following functions:

- they reduce friction
- they minimise wear
- they prevent corrosion
- they give protection against contamination
- they increase the operating life of the guidance system.

Lubrication as a design element

Lubrication is a design element. The lubricant and lubrication method must therefore be selected in the development phase of the machine. If lubrication of the guidance system is only determined once the design is complete, experience shows that considerable problems are likely to occur.

The lubricant requirement has an increasingly important role. The lubricant consumption should be as small as possible, especially in the case of oil lubrication. A carefully considered lubrication concept is therefore indicative of a modern linear guidance system.

Environmental protection

Any lubrication method involves loss of lubricant. The lubricant consumed must be collected and disposed of by methods which help to protect the environment.

⚠ The handling and use of lubricants is governed by national regulations for environmental protection and health and safety at work as well as information from lubricant manufacturers. These specifications must be observed.

Doped lubricants

Linear recirculating roller bearings operate almost exclusively under mixed friction conditions, especially at low speeds. Doped oils and greases (type P to DIN 51502) should be used in preference.

Oil lubrication

Advantages of oil lubrication

Oil:

- dissipates heat from the bearing
- is distributed more evenly in the lubrication area than grease
- is replaced almost completely when relubrication is carried out
- carries contaminant particles out of the bearing.

Furthermore, oil lubrication is advisable where the adjacent machine elements are already supplied with oil.

Oils

Lubricating oils CLP to DIN 51517 and HLP to DIN 51524 should be used in preference.

For operating temperatures between 0 °C and +70 °C, the viscosity should be between ISO VG 32 and ISO VG 68.

For low-temperature operation, oils to ISO VG 10 or ISO VG 22 should be used.

Slideway oils CGLP can also be used up to ISO VG 220.

⚠ Do not use drilling oils or other coolant emulsions for lubrication! These have the effect of thinning the lubricants and can lead to corrosion in certain circumstances.

The preservative applied to linear roller bearings is compatible with the oils.

Lubrication methods

Oil impulse or oil drop lubrication is recommended.

In highly contaminated environments, pneumatic oil lubrication is particularly advantageous. This generates a slight excess pressure within the guidance system. The effectiveness of the seals is reinforced as a result.

Note the installation position of the guidance system (Figure 1). The lubricant feed arrangement should be selected such that all the moving parts of the linear roller bearings are supplied with oil:

- e.g. in the return zone of the linear roller bearings (Figure 2) or
- the oil pipe should, in place of the lubrication nipple, lead directly into the end piece (Figure 3).

Compatibility and miscibility

Before lubricating oils are used, their behaviour with respect to plastics, elastomers, light metals and non-ferrous metals must be checked under dynamic conditions at operating temperature if no past experience or data from the manufacturer is available.

In general, oils with a mineral oil base and with the same classification are miscible with each other. However, the viscosities should be within one ISO VG class of each other.

If synthetic oils are to be used, their miscibility and compatibility must always be checked.

If in any doubt, please consult the INA engineering service.

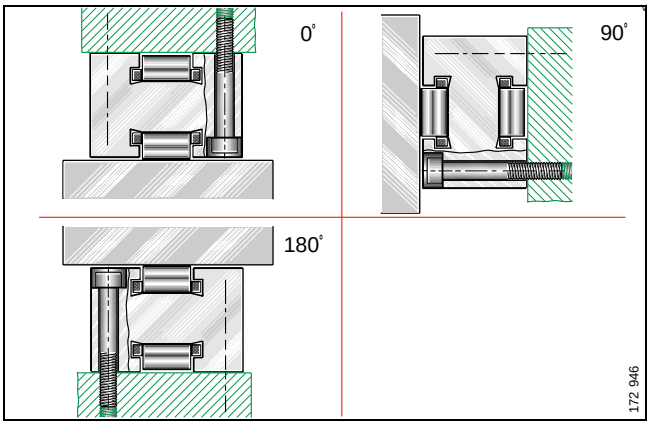


Figure 1 · Installation position of linear recirculating roller bearings

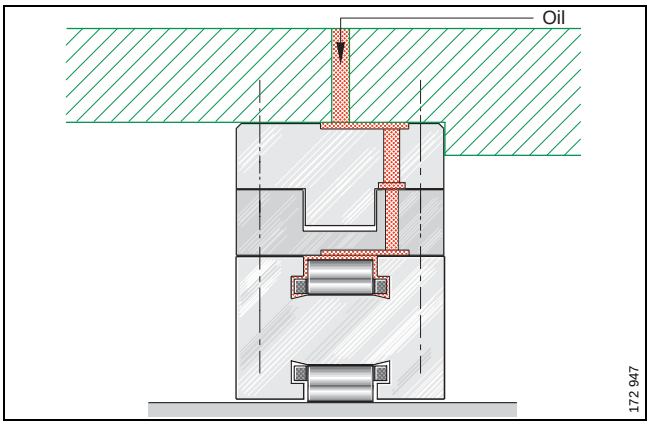


Figure 2 · Oil feed through the adjusting gib

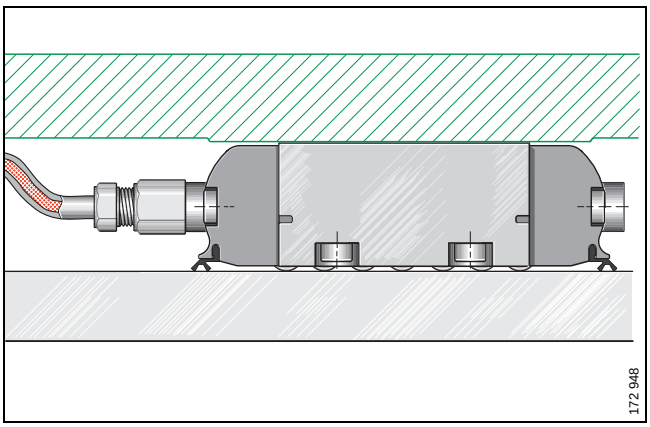


Figure 3 · Oil feed through the end piece

Initial operation / minimum oil quantities

⚠ Protect the bearing and guideway system against solid and fluid contaminants!

Linear recirculating roller bearings and guideways should be oiled before initial operation. During this process, linear roller bearings should be moved several times consecutively without load by at least four times the length of the bearing.

The minimum oil quantities according to Table 1 are valid under the following standardised conditions:

- 100% operating duration
- $C_0/P = 8$
- v = 0,8 m/s
- stroke = 500 mm to 1000 mm.

⚠ The values are guide values only. Precise values can only be determined under operating conditions.

Minimum oil quantity Q_{min} – Table 1:

- the minimum oil quantity is measured such that the oil ducts, rolling elements and raceways will be supplied with sufficient quantities of lubricant.

Oil impulse lubrication – Table 1:

- the oil impulse quantity applies when the recirculating lubrication system is connected to a central lubrication system. It is recommended that the stated quantity should be spread over several impulses.

Pneumatic oil lubrication:

- Pneumatic oil lubrication may allow smaller quantities of oil to be used than oil impulse lubrication. It is not possible to state definitive quantities since these are essentially dependent on the design of the central lubrication system. The necessary oil quantity must therefore be determined under operating conditions.

Table 1 · Minimum oil quantities – guide values

Linear recirculating roller bearing Series	Minimum oil quantity for initial operation Q_{min} cm^3	Oil impulse quantity Q_{imp} cm^3/h
RUS 19 069	0,35 to 0,5	0,25
RUS 19 105	0,35 to 0,5	0,25
RUS 26 086	0,35 to 0,5	0,25
RUS 26 102	0,35 to 0,5	0,25
RUS 26 126	0,6 to 0,8	0,5
RUS 38 134	0,6 to 0,8	0,5
RUS 38 206	1,5 to 2	1
RUS 65 210	0,8 to 1,2	1
RUS 85 280	2,8 to 3	2
PR 14 032	0,25 to 0,4	0,25
PR 14 044	0,25 to 0,4	0,25
PR 14 061	0,25 to 0,4	0,25
PR 14 089	0,6 to 0,8	0,5
PR 14 135	0,8 to 1,2	1
PR 14 182	2,5 to 2,8	2
RUSW 4020	0,35 to 0,5	0,25

Grease lubrication

Advantages of grease lubrication

Grease:

- requires very little design work on relubrication devices if a central lubrication system is not used
- allows relubrication intervals of up to one year
- has emergency running characteristics due to the thickener in the lubricant
- gives additional support to the seals.

Greases

Lithium soap greases with a mineral oil base should be used in preference. The base oil viscosity should be between:

- ISO VG 150 and ISO VG 220.

For high loads ($S_0 < 8$), the following are absolutely necessary:

- EP doped greases with a base oil viscosity of ISO VG 220.

A lubricating grease KP2N-20 to DIN 51825 is recommended for initial greasing.

⚠ Lubricants with solid additives must not be used.

The preservative applied to linear roller bearings is compatible with greases having a mineral oil base.

Miscibility

Greases may be mixed providing the following preconditions are met:

- they have the same base oil type
- their thickener types must match
- they must have similar base oil viscosities (the difference must be no more than one ISO VG class)
- their consistencies (NLGI class) must match.

If in any doubt, please consult the INA engineering service.

Storage

Experience shows that lubricating greases having a mineral oil base can be stored for up to three years. The following preconditions apply:

- the storage room is protected against outside influences
- the temperature is between 0 °C and +40 °C
- the relative humidity is less than 65%
- the lubricants are protected against chemical agents (vapours, gases, fluids).

After long storage periods, the frictional torque may temporarily be higher than that of freshly greased linear recirculating roller bearings. The lubricity of the grease may also have deteriorated.

It is the user's responsibility to follow the directions given by the lubricant manufacturer.

Initial operation / initial grease quantity

⚠ Protect the bearing and guideway system against solid and fluid contaminants!

Linear recirculating roller bearings and guideways should be greased before initial operation. In order to ensure uniform distribution of the grease in the bearing, the linear roller bearings should be moved several times consecutively without load by at least four times the length of the bearing! Regreasing should be carried out continuously during this time!

The initial grease quantities are listed in Table 2.

On very long guidance systems, the guideways should be coated with lubricant before initial operation so that the grease reservoir from initial greasing is not used up prematurely.

If the guidance system is not connected to a central lubrication system, the linear roller bearings should be charged with the initial grease quantity before fitting.

Where central lubrication systems are used, the linear roller bearings should be charged with the initial grease quantity and the feed pipes filled with grease.

Relubrication

Linear recirculating roller bearings can be relubricated via the rolling element return zone or via lubrication nipples (Figure 4).

Relubrication should be carried out with several partial quantities at shorter intervals in preference to a single regreasing at the end of the relubrication interval.

During relubrication, linear roller bearings should be moved several times without load by at least four times the length of the bearing.

The relubrication quantities are listed in Table 2.

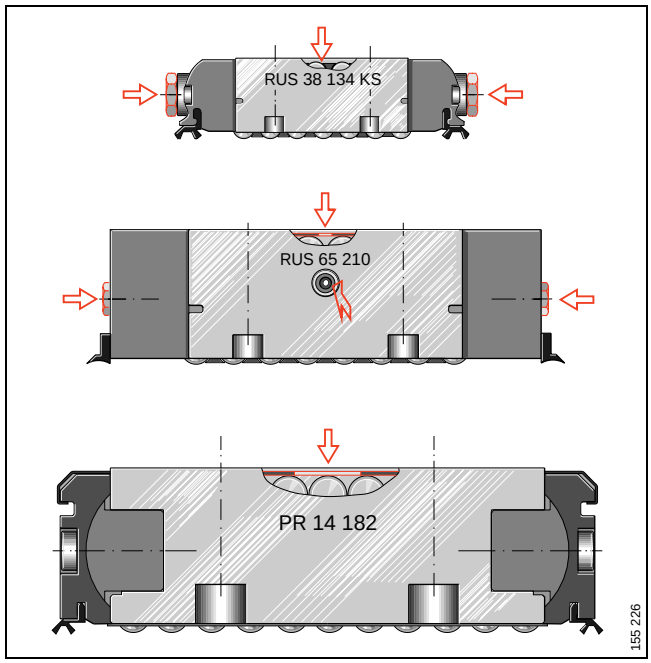


Figure 4 · Relubrication of linear recirculating roller bearings

Table 2 · Initial grease and relubrication quantities – guide values

Linear recirculating roller bearing Series	Initial grease quantity g	Relubrication quantity g
RUS 19 069	2,5	0,75
RUS 19 105	3,5	1,05
RUS 26 086	7	2
RUS 26 102	7,5	2,2
RUS 26 126	8	2,4
RUS 38 134	18	5,4
RUS 38 206	25	7,5
RUS 65 210	26	8,6
RUS 85 280	27	9
PR 14 032	1	0,3
PR 14 044	2	0,6
PR 14 061	7	2,1
PR 14 089	15	4,5
PR 14 135	16	5,2
PR 14 182	25	8,3
RUSW 4020	2,5	0,75

Relubrication interval

Linear recirculating roller bearings must be relubricated at appropriate intervals. The relubrication interval is essentially dependent on:

- the speed
- the load
- the temperature
- the stroke length
- the environmental conditions.

The relubrication interval and relubrication quantity can only be determined under operating conditions, since it is not possible to quantify all the influencing factors in advance. An observation period of adequate length must be allowed.

The relubrication interval t_{fR} should be no more than 1 year even if the formula gives a value greater than this.

$$t_{fR} = tf \cdot K_p \cdot K_w \cdot K_u$$

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

t_f h
Basic lubrication interval in hours (Figure 5)

K_p, K_w, K_u –
Correction factors for load, stroke and environmental influences (page 146).

Basic lubrication interval

The basic lubrication interval t_f is valid under the following conditions (Figure 5):

- bearing temperature $<$+70 °C
- load ratio $C_0/P = 20$
- lubrication with high quality lithium soap grease
- no disruptive environmental influences
- stroke ratio between 1 and 10.

The speed parameter is defined as follows:

$$\text{Speed parameter: } \frac{60}{\bar{v}} \cdot K_{LF}$$

$\bar{v}$ m/min
Mean traverse speed

K_{LF} –
Bearing factor

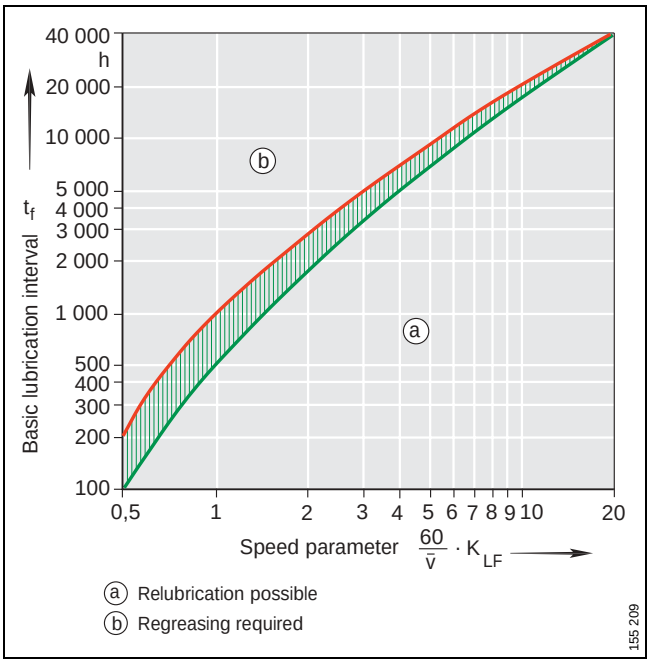


Figure 5 · Determining the basic lubrication interval

Table 3 · Bearing factor K_{LF}

Linear guidance system	RUS... RUSW...	PR...
Bearing factor K_{LF}	1,5	1

Load correction factor K_p

The correction factor K_p takes into consideration the greater strain on the lubricating grease at a load ratio of $C_0/P < 20$.

⚠ The values given in Figure 6 are valid only for high quality lithium soap grease. The preload must be taken into consideration.

Stroke ratio correction factor K_w

The correction factor K_w (Figure 7) takes into consideration the raceway length to be provided with grease. It is dependent on the stroke ratio.

If the stroke ratio is <1 or >10, the relubrication interval must be shortened in order to reduce possible fretting corrosion.

If the stroke is very short, the relubrication interval t_{fR} may be shorter than the calculated value. In such cases, the use of special lubricating greases is recommended. Please consult the INA engineering service.

The stroke ratio is defined as follows:

$$\text{Stroke ratio: } \frac{C_1 \cdot 10}{H}$$

C_1 mm
Effective saddle plate length C_1 (*dimension table*)

H mm
Stroke length.

Environmental correction factor K_u

The correction factor K_u (Table 4) takes into consideration the effect of oscillations, vibration (leading to fretting corrosion) and shocks. These subject the grease to additional strain.

All calculations are invalid if cooling lubricants or moisture penetrate the system.

Lubricating grease operating life

If a linear system cannot be relubricated, the operating life of the lubricating grease is then the decisive factor. In most applications, the guide value is:

$$t_{fG} = 2 \cdot t_{fR}.$$

t_{fG} h
Guide value for grease operating life

t_{fR} h
Guide value for relubrication interval.

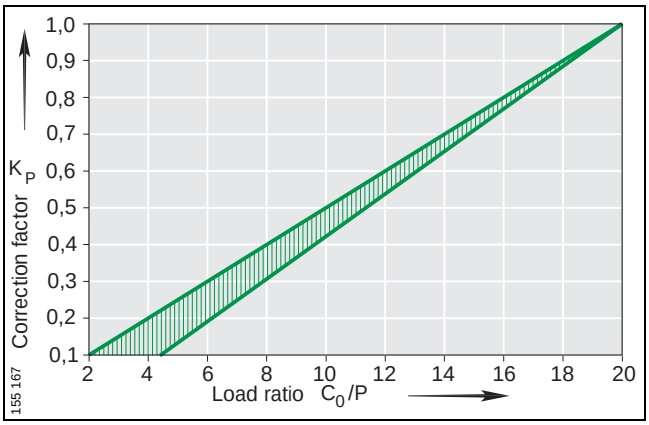


Figure 6 · Load correction factor K_p

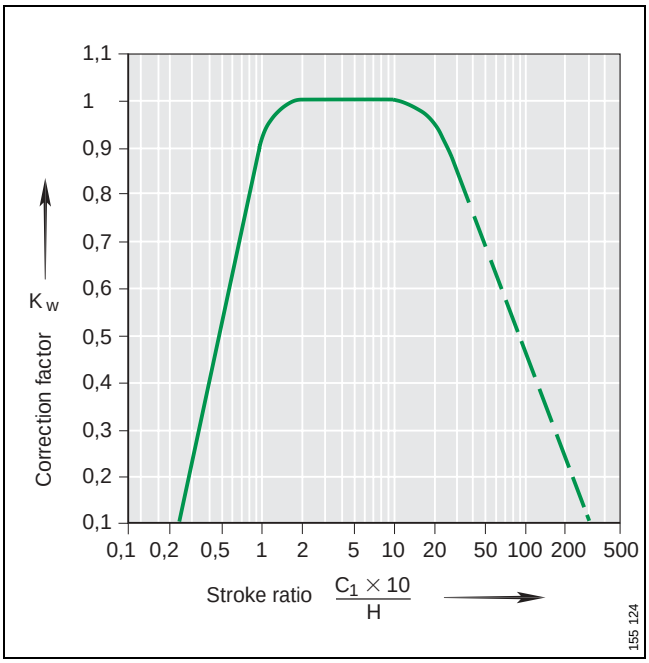


Figure 7 · Stroke ratio correction factor K_w

Table 4 · Environmental correction factor K_u

Environmental influences	K_u
Slight	1
Moderate	0,8
Severe	0,5

Sealing
Operating limits

Sealing

The type of sealing or shielding is of decisive importance in ensuring problem-free operation and a long operating life of linear recirculating roller bearings.

Linear recirculating roller bearings RUS have interchangeable, elastic, double lip wipers on the end pieces. The wipers ensure that:

- no contaminants enter the bearing
- no lubricant escapes from the bearing.

In most applications, linear recirculating roller bearings are protected reliably against contamination by the wipers and the narrow gap between the saddle plate and raceway. In special cases, additional measures may be taken to cover the raceway.

⚠ If linear recirculating roller bearings are exposed to severe contamination (e.g. swarf, grinding dust, etc.) or aggressive media, and in the case of linear roller bearings PR, separate raceway wipers should be fitted!

Operating limits

Linear recirculating roller bearings are suitable for numerous applications. In appropriate arrangements, they can support loads from all directions and moments about all axes. They also have high load carrying capacity while requiring little space.

Traverse speed

The maximum traverse speeds of guidance systems with linear recirculating roller bearings are shown in Table 1.

Table 1 · Maximum traverse speed

Linear recirculating roller bearing	Traverse speed v_{max} m/min
PR...	120
RUS 19..., RUS 19...KS, RUSW 4020	100
RUS 26..., RUS 26...KS	80
RUS 38..., RUS 38...KS	60
RUS 65..., RUS 85...	50

⚠ If a guidance system is to be designed for very high speeds, please consult the INA engineering service.

Acceleration

If very high accelerations (shocks) occur and the linear roller bearings are fixed to the moving part (e.g. in a ram guidance system), additional support must be provided to the linear roller bearings. The inertia forces must not be supported by the friction lock on the screw connections.

The maximum accelerations of guidance systems with linear recirculating roller bearings are shown in Table 2.

Table 2 · Maximum acceleration

Linear recirculating roller bearing	Linear roller bearing on moving part Acceleration a_{max} m/s²	Linear roller bearing on stationary part Acceleration a_{max} m/s²
PR	70	160
RUS RUS..KS	50	110

⚠ If a guidance system is to be designed for very high speeds, please consult the INA engineering service.

Load carrying capacity

The load carrying capacity of linear recirculating roller bearings is limited by:

- the required life L and L_h
- the required static load safety factor S_0.

For applications where high demands are placed on accuracy and smoothness of running, the static load safety factor should not be less than $S_0 = 3$.

Operating temperatures

Linear recirculating roller bearings RUS/RUSW are suitable for temperatures from –30 °C to +90 °C.

Linear recirculating roller bearings PR can be used at temperatures between –40 °C and +120 °C.

Design of bearing arrangements

The adjacent construction has a significant influence on:

- the load carrying capacity
- the rigidity
- the accuracy
- the smoothness of running
- the operating life

of a guidance system with linear recirculating roller bearings.

When designing the adjacent construction, particular attention must therefore be paid to:

- the design of the raceways
- the geometrical and positional accuracy of the mounting surfaces
- the location of the guidance elements
- the sealing of the bearing arrangement.

Design of raceways

Linear recirculating roller bearings require hardened and ground guideways for use as raceways.

HYDREL guideways (page 190 and *dimension table*) are matched to the requirements of linear recirculating roller bearings. They can be used to achieve high precision, rigid linear recirculating guidance systems with high load carrying capacity and low friction.

If these guideways cannot be used, machine parts with appropriate characteristics can be used as raceways instead. Values for the effective hardness depth, hardness and roughness are given in Table 1.

In order to ensure that the high load carrying capacity and rigidity of the linear recirculating roller bearings can be used to the full, the raceways must conform to the accuracies of the guideways.

Table 1 · Design of raceways

Linear recirculating roller bearing	Raceway		
	Effective hardness depth	Hardness	Roughness
Series	Rht	HV	R_a (R_z)
RUS 19 069 to RUS 38 206 PR 14 032 to PR 14 089 RUSW 4020	Rht ≧0,6 mm	≥670 HV (58 HRC) +170 HV	R_a0,6 (R_z2,5)
RUS 65 210 RUS 85 280 PR 14 135 PR 14 182	Rht ≧2 mm	≥670 HV (58 HRC) +170 HV	R_a0,8 (R_z4)

Geometrical and positional accuracy of the mounting surfaces

The higher the requirements for accuracy and smooth running of the guidance system, the more attention must be paid to the geometrical and positional accuracy. The mounting surfaces, i.e. the support and locating surfaces, should be designed according to the tolerances in Figure 1 and Figure 2. The surfaces can be ground or precision milled. The objective should be to achieve a mean roughness of R_a1,6.

If the tolerances are not met, this will impair the overall accuracy of the guidance system and will influence the operating life. This applies despite the fact that linear recirculating roller guidance systems can partially compensate for inaccuracies.

Maximum permissible deviation

The differences ΔH_Q and ΔH_L (Figure 1 and Figure 2, page 149) indicate the maximum permissible deviation from the theoretically precise position of the mounting surfaces in the longitudinal and transverse axes.

The permissible values for linear recirculating roller guidance systems are:

$$\Delta H_L = a_L \cdot b$$

$$\Delta H_Q = a_Q \cdot b$$

ΔH_L µm
Maximum permissible deviation in a longitudinal axis from the theoretically precise position

ΔH_Q µm
Maximum permissible deviation in a transverse axis from the theoretically precise position

a_L, a_Q –
Factor dependent on the series (Table 2)

b mm
Centre distance between guidance elements.

If larger deviations are present, please consult the INA engineering service.

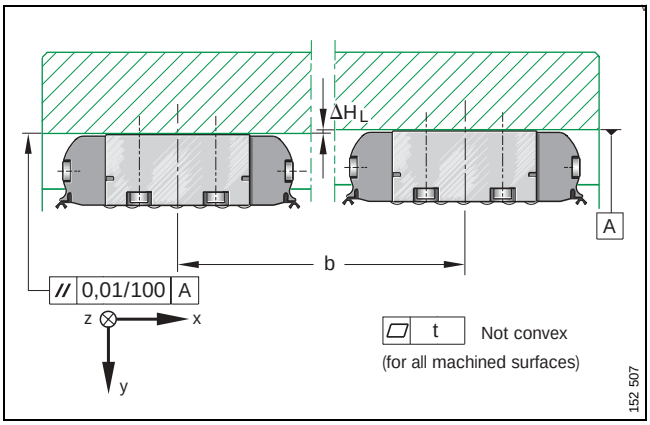


Figure 1 · Geometrical and positional accuracy of the mounting surfaces in the longitudinal direction

Table 2 · Factor dependent on series

Series	Factor	
	a_L	a_Q
RUS, RUS..KS, PR	0,1	0,15

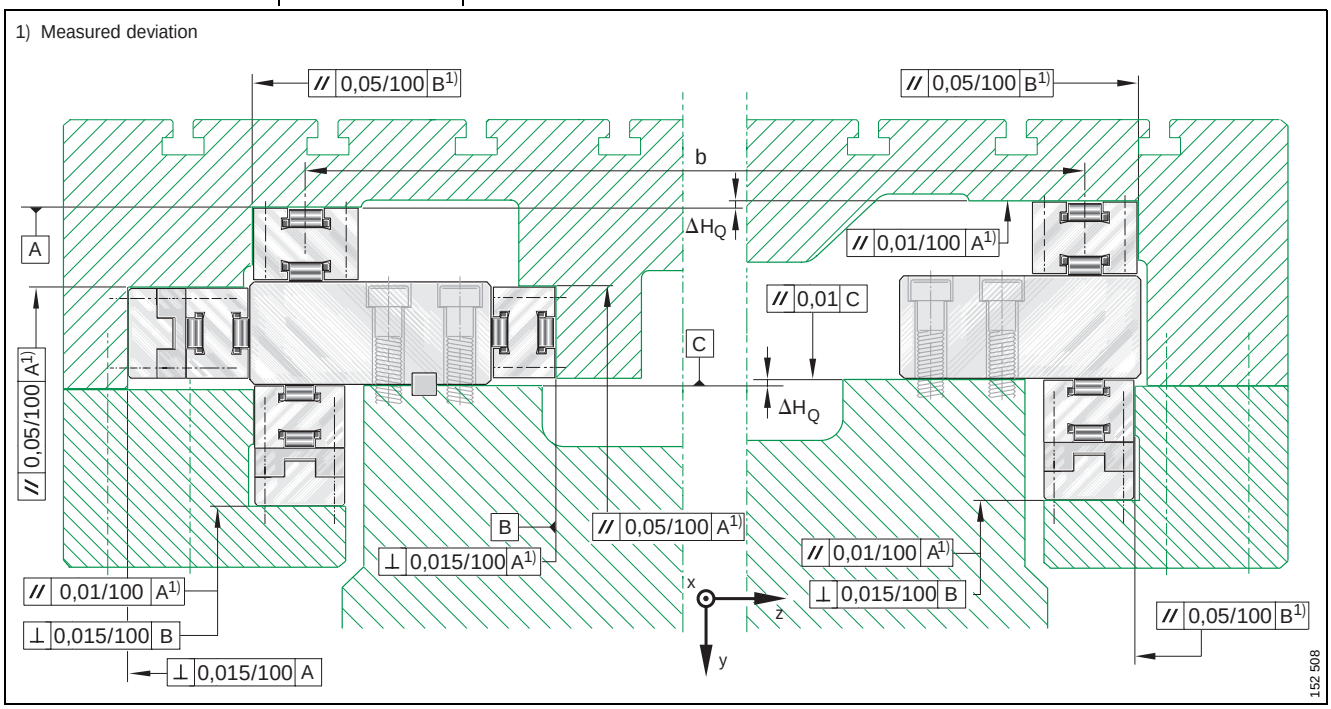


Figure 2 · Geometrical and positional accuracy of the mounting surfaces

Connection to the adjacent construction

The connection between the guidance elements and the adjacent construction influences the effective load carrying capacity of the guidance system. When designing the adjacent construction, particular attention must therefore be paid to:

- the direction of the forces
- the direction of the moments
- the position of the locating faces
- the size of the locating faces
- the load carrying capacity and number of fixing screws.

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

Support of lateral guidance forces in one direction

If the friction lock of the screw connections cannot support the lateral guidance forces, the guideways must be laterally supported against a locating edge (Figure 3).

Support of lateral guidance forces in two directions

If high lateral forces occur in both directions, the guideways UZ, UZS, UV can be screw mounted in a slot (Figure 4).

After fitting, the lateral gaps must be filled with castable resin (page 151, Figure 6, Figure 7).

Guideways UGN, UGSN, UZN and UZSN with longitudinal slot

These guideways have a continuous slot (Figure 5).

The guideways are linked to the adjacent construction by means of square steel bars to DIN 178. These transmit the lateral forces into the machine part.

After fitting, the lateral gaps must be filled with castable resin.

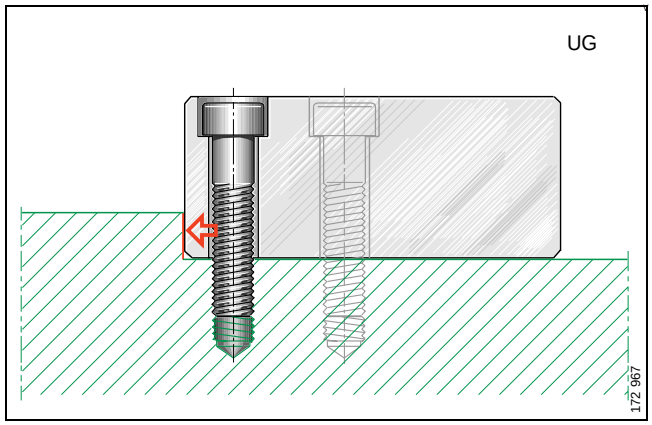


Figure 3 · Lateral locating face

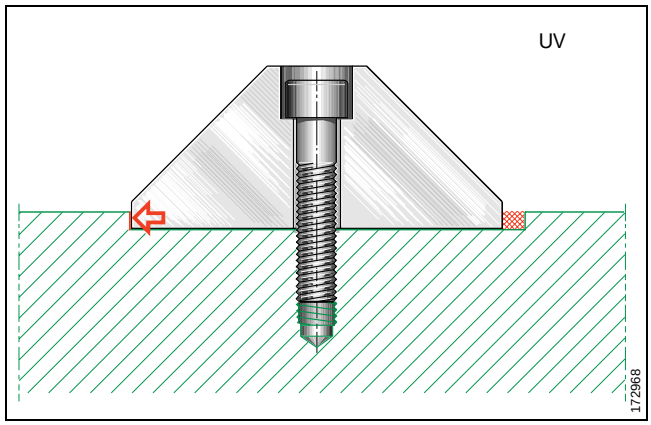


Figure 4 · Guideway UV located in slot

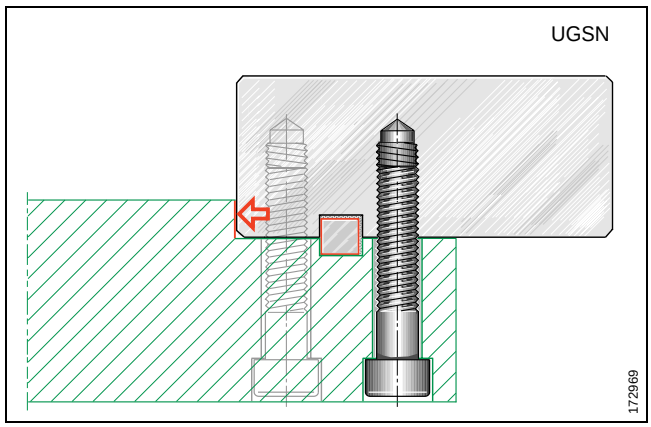


Figure 5 · Guideway with longitudinal slot

Hollow filling screws

For filling with resin, hollow filling screws HS (Table 3) can be used (*Fitting*, page 162). Recesses should be milled 500 mm apart in the adjacent construction.

In order that the castable resin can reach these recesses, holes must be made in the adjacent construction (Figure 6, Figure 7, Table 4). Due to the combination of the recess and hole, the castable resin flows into the gap between the square steel bar and the adjacent construction.

Table 3 · Allocation of hollow screw to guideway

Guideway Designation	Hollow screw Designation
UGN/UGSN/UZN / UZSN 6628	HS 6628
UGN/UGSN/UZN / UZSN 9741	HS 9741
UGN/UGSN/UZN / UZSN 12553	HS 12553
UGN/UGSN/UZN / UZSN 16260	HS 16260

Table 4 · Recommended design of recesses in adjacent construction for hollow filling screws

Guideway Designation	Dimensions		
	D_a mm	E_a mm	H_a mm
UGN/UGSN 6628 / UZN/UZSN 6628	18	4	3,5
UGN/UGSN 9741 / UZN/UZSN 9741	25	6	6
UGN/UGSN 12553 / UZN/UZSN 12553	30	8	7
UGN/UGSN 16260 / UZN/UZSN 16260	30	7	9

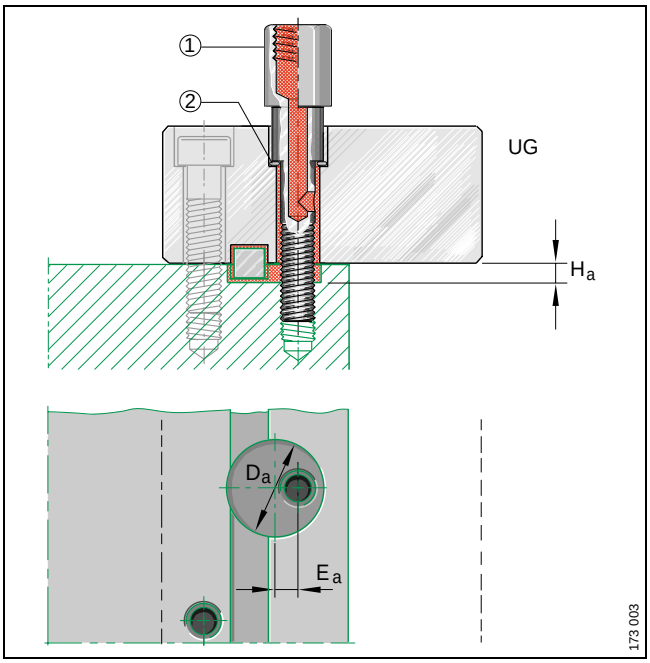


Figure 6 · Hollow screws for guideways UGN/UZN

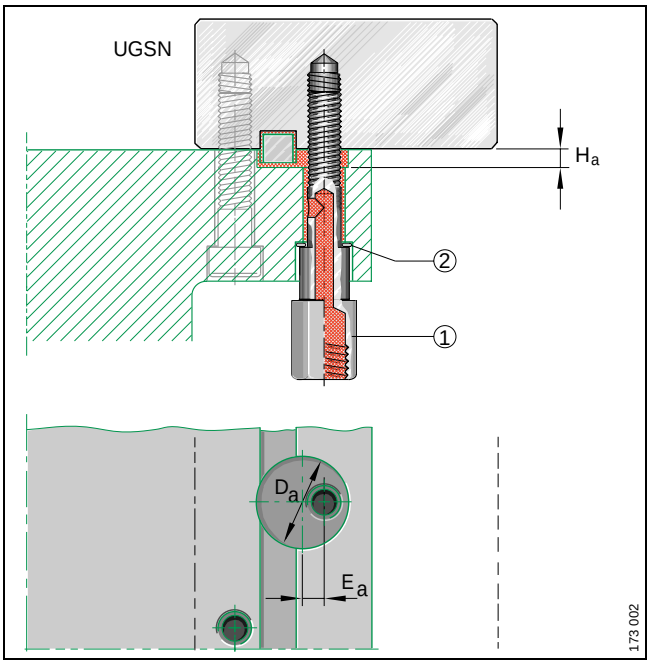


Figure 7 · Hollow screws for guideways UGSN/UZSN

Location of guideways

⚠ The adjacent construction must have sufficient strength – see VDI guideline 2230!

HYDREL guideways are located by means of:

- through holes with cylindrical counterbores for screws to DIN 912
  - series UG, UGN, UZ, UZN, UV, UFB
- threaded blind holes
  - series UGS, UGSN, UZS, UZSN
- adhesive bonding
  - series UFA (*Fitting*, page 166)
- clamping strip
  - series UFK (*Fitting*, page 167).

Location of guideways UG, UGN, UZ, UZN, UV, UFB

These guideways have through holes with cylindrical counterbores for the screw heads. They are located from the guideway side (Figure 8).

⚠ The cylindrical counterbores have sharp edges! Risk of injury!

When the counterbores are closed off flush using closing plugs (*dimension table*) or castable resin, this gives a smooth guideway surface (Figure 9). This protects the wipers against damage. Contamination, coolants, etc. can not collect in the counterbores.

Location of guideways UGS, UGSN, UZS, UZSN

These guideways have threaded blind holes.

The guideways are located from the machine part (Figure 10). The guideway surface is completely unbroken as a result. The entire width of the guideway can therefore be used as a raceway. There is also no need to close off the cylindrical counterbores.

⚠ In order to transmit the tightening torque M_A of the screw connections, the screws must be embedded in the holes to a length of approximately 2 · d!

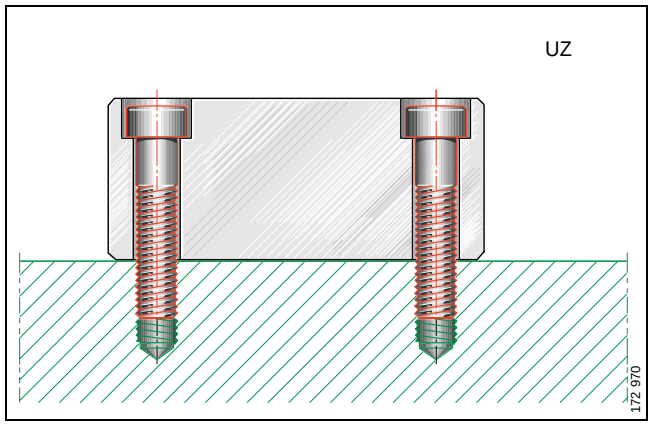


Figure 8 · Location from the guideway side

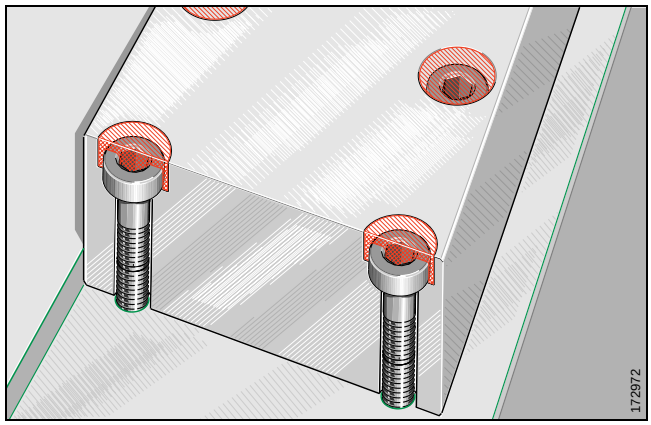


Figure 9 · Closing off the counterbore

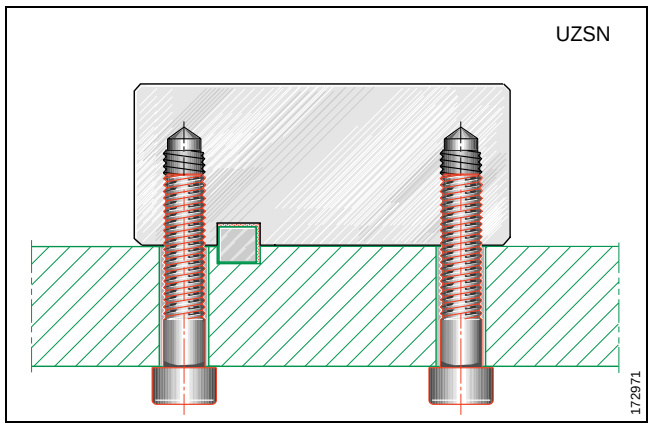


Figure 10 · Location from the machine part side

Adhesive bonding of guideway UFA

Guideways of this series are bonded by adhesive to the adjacent construction (Figure 11). Conventional metal adhesives are suitable for bonding (*Fitting*, page 166).

The standard bond gap of 0,15 mm is matched to two-component adhesives. Anaerobic single-component adhesives that harden in the absence of air give satisfactory adhesion and higher accuracy with thin adhesive layers. For these applications, guideways UFA are available with a bond gap of 0,02 mm (suffix KL 02).

Location of guideways UFK with clamping strip

Guideways of this series are retained in the slot by means of a special clamping strip made from spring steel (accessory) – slot widths for the guideways (Table 5, Figure 12).

The clamping strip can be fitted using a shim (*Fitting*, page 167).

Table 5 · Slot width for guideways

Guideway Designation	Clamping strip Designation	Slot width B_1 +0,15 mm
UFK 3210	UKB 10	32,65
UFK 4710	UKB 10	47,65
UFK 6412	UKB 12	64,65
UFK 8815	UKB 14	88,65
UFK 11518	UKB 14	115,65

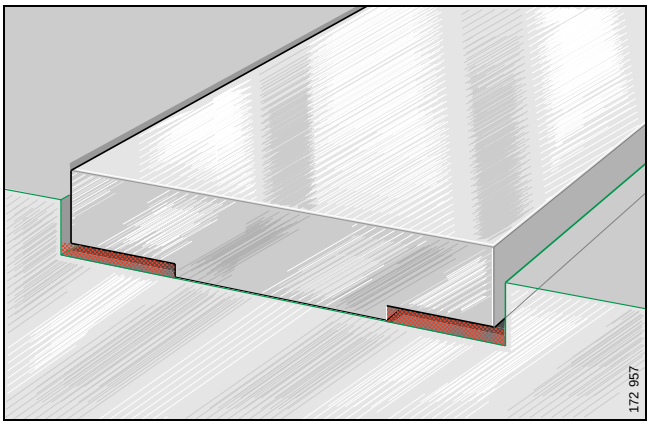


Figure 11 · Adhesive bonding of guideway UFA

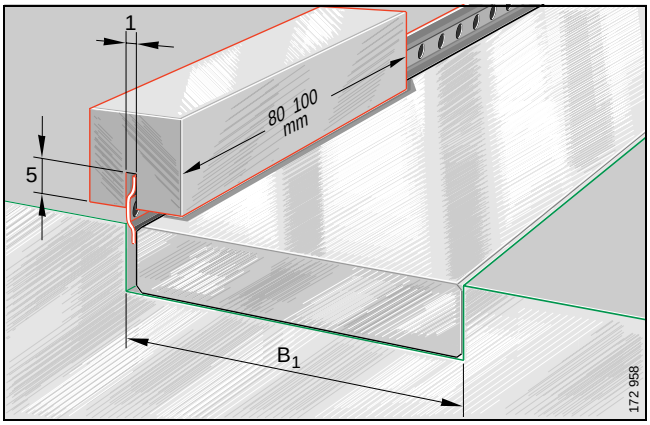


Figure 12 · Slot width for guideways UFK

Multi-piece guideways

If the length required exceeds the maximum guideway length L for single-piece guideways (*dimension table*), guideways can be assembled from individual sections matched to each other and marked accordingly (*Fitting*, page 162).

The matching of the sections avoids significant differences in height at the joints in the guideways and thereby ensures the acceptable functioning of linear recirculating roller bearings.

⚠ In order to avoid impaired function of the bearings, the maximum height difference and gap width due to errors in assembly and in the adjacent construction must not be exceeded (Table 6, Figure 14).

The guideways matched to each other form a set. All parts of the same set have the same set number. In addition, the joints are marked consecutively by means of letters (Figure 13).

⚠ The guideways should be assembled such that the ends with the same set numbers and letters are adjacent to each other)!

Table 6 · Height difference and gap width

Guideway grade	Height difference ΔH µm max.	Gap width ΔS µm max.
Q2 and Q6	2	0,05
Q10	3	0,05

Overgrinding of preground guideways

In order to achieve acceptable results even when the adjacent construction is of reduced accuracy, preground guideways (suffix VQ) can be used.

⚠ These guideways must be overground with extreme care once they have been fitted!

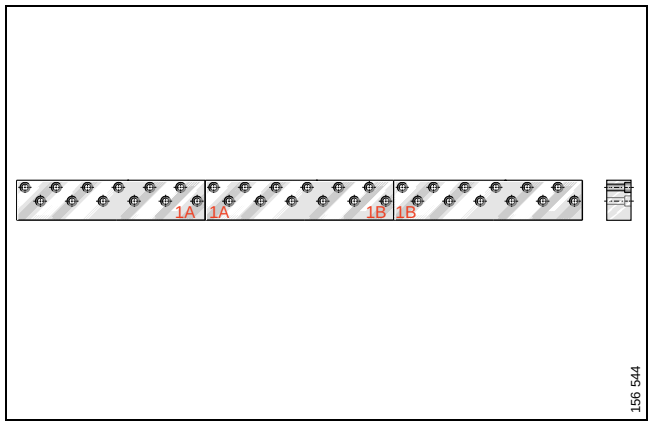


Figure 13 · Marking of multi-piece guideways

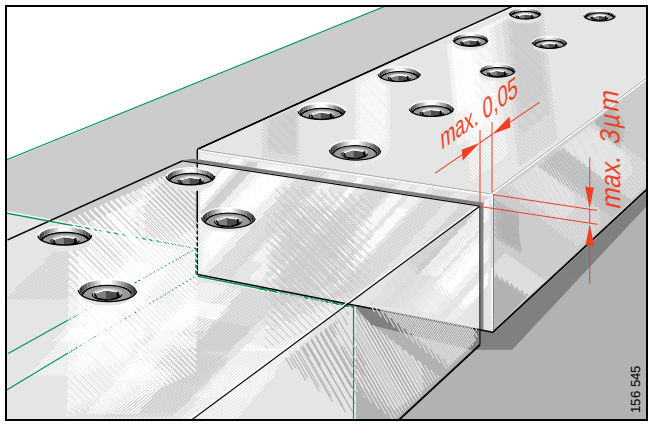


Figure 14 · Height difference and gap width

Hole patterns for guideways

Unless specified otherwise, guideways are supplied with a hole pattern having identical end dimensions ($C_5 = C_6$, Figure 15ⓐ). On customer request, a hole pattern with non-identical end dimensions is also possible ($C_5 \neq C_6$, Figure 15ⓑ). Suffix L_A C_5/C_6.

⚠ Note the position of the dimension C_5 (definition of C_5 according to Figure 16)!

Note $C_{5min/max}$, $C_{6min/max}$!

Guideways UG, UGN, UGS, UGSN have offset holes (Figure 16). The position of the holes depends on the length of the guideway (*dimension table*).

Calculation of hole patterns

The number of hole pitches is the rounded down whole number equivalent to:

$$n = \frac{L - (C_{5min} + C_{6min})}{C_4}$$

Dimensions C_5, C_6:

$$C_5 + C_6 = L - n \cdot C_4$$

Guideway with identical end dimensions for holes

$$C_5 = C_6 = \frac{1}{2} \cdot (L - n \cdot C_4)$$

Number of holes:

$$X = n + 1$$

n – Maximum possible number of hole pitches

L mm Guideway length

C_5, C_6 mm Distance between start or end of guideway and nearest hole (*dimension table*)

C_4 mm Hole pitch (*dimension table*)

X – Number of holes

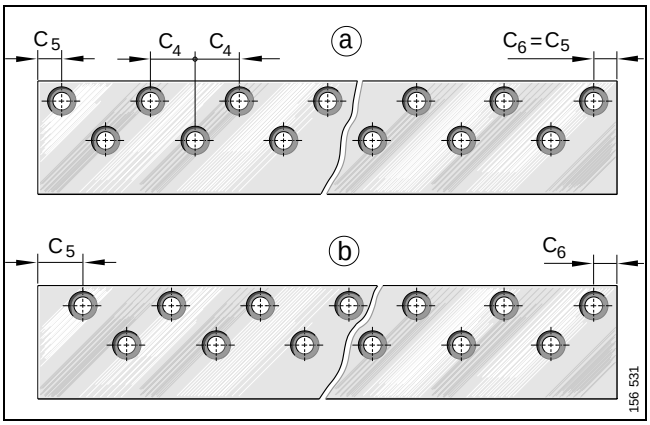


Figure 15 · Hole patterns with identical and non-identical end dimensions

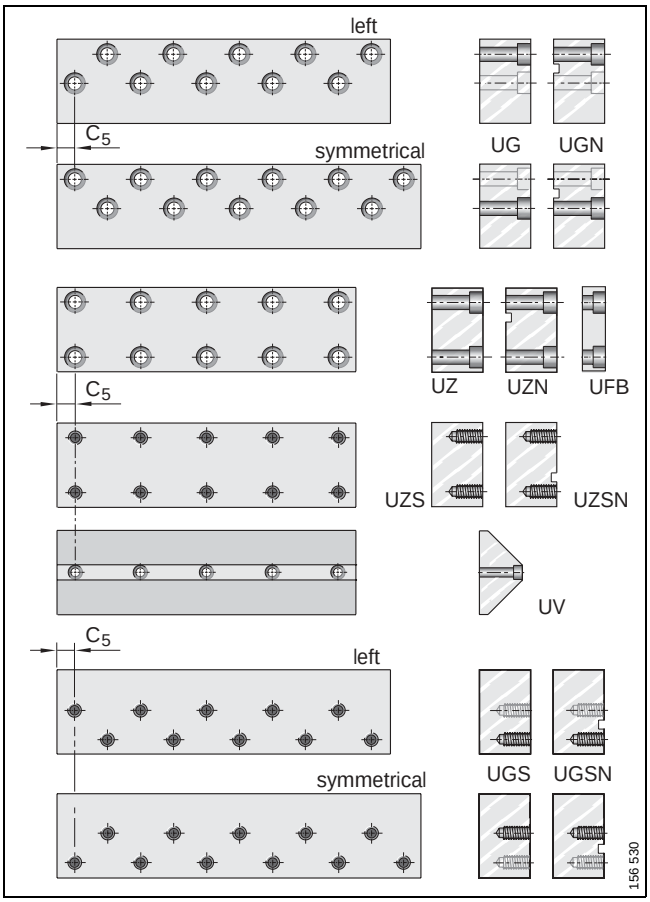


Figure 16 · Position of distance between first hole and start of guideway C_5

Location of linear recirculating roller bearings

Linear recirculating roller bearings are fixed to the machine part by means of hexagon socket cap screws to DIN 912 – screws dimensions according to *dimension table*. Location is possible from either the linear roller bearing or the machine part.

⚠ The adjacent construction must have sufficient strength – see VDI guideline 2230!

Location from the linear roller bearing side

For this type of location, the machine part has threaded holes. The linear roller bearings are aligned on the machine part and screwed to the machine part from the bearing side using fixing screws (Figure 17).

This type of location can be used for:

- linear recirculating roller bearings RUS, PR and RUSW.

Location from the machine part side

For this type of location, the machine part has through holes and counterbores for the screw heads.

The linear roller bearings are aligned on the machine part and screwed to the machine part from the adjacent construction side using fixing screws (Figure 18).

This type of location can be used for:

- linear recirculating roller bearings RUS and PR.

Location of linear recirculating roller bearing/adjusting gib assembly

Adjusting gibs can be located from the gib side or adjacent construction side (Figure 19):

- adjusting gibs VUS from the gib side or adjacent construction side (①, ②)
- adjusting gibs from the gib side only (①).

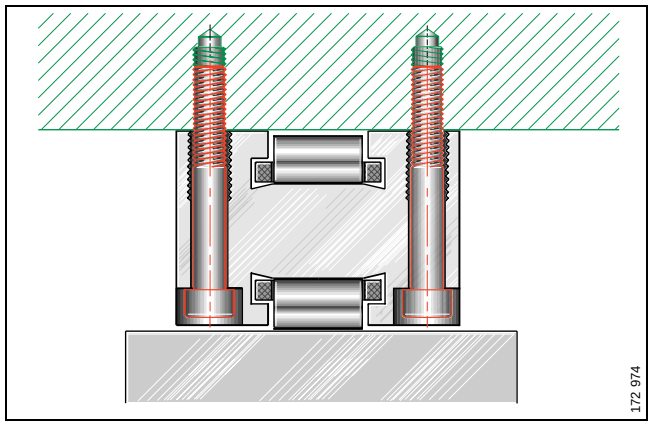


Figure 17 · Location from the linear roller bearing side

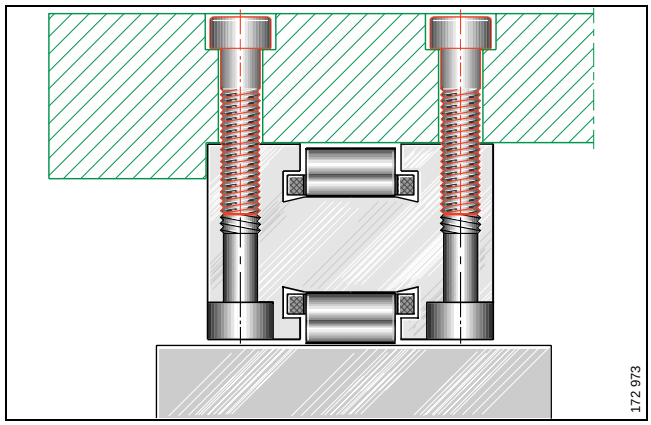


Figure 18 · Location from the adjacent construction side

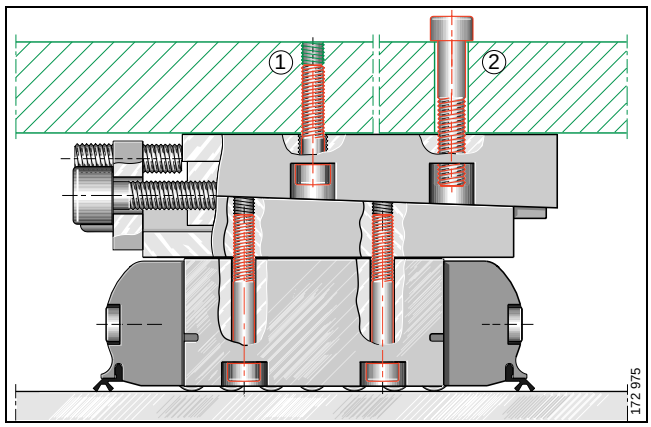


Figure 19 · Location of linear recirculating roller bearing/ adjusting gib assembly

Location of adapter/linear recirculating roller bearing assembly

Adapters are screw mounted on the adjacent construction using hexagon socket cap screws to DIN 912 (Figure 20 and Figure 21):

- APUV through the locating face on the top (Figure 20)
  - high lateral forces can be supported by means of an additional dowel. The adapter has a predrilled dowel hole.
- AUV, AUVL, AV, AVL through the lateral locating face (Figure 21)
  - this type of location can support high lateral forces by means of force lock.

⚠ For the location of adapters and for sorting, note the guidelines in the sections *Features* and *Design and safety guidelines*!

Location of linear recirculating roller bearings on adjusting gib or adapter

Linear recirculating roller bearings are aligned and fixed to the the adjusting gib or adapter from the bearing side using hexagon socket cap screws to DIN 912.

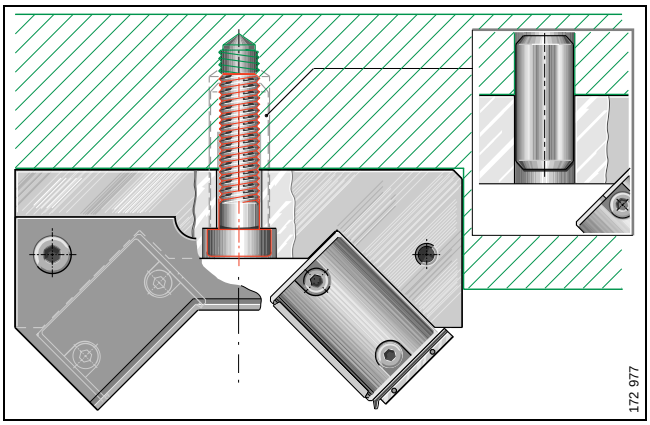


Figure 20 · Location of adapters APUV

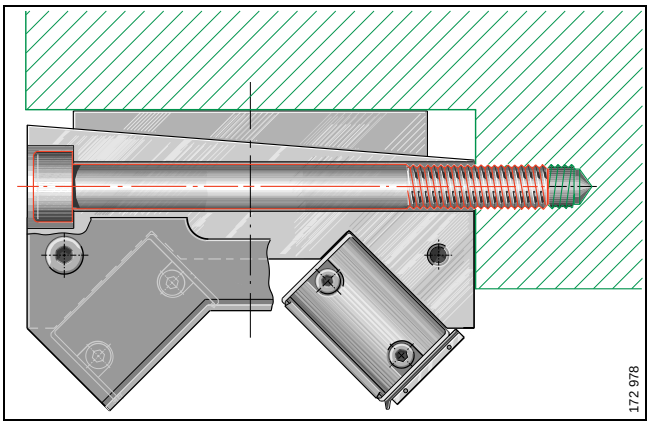


Figure 21 · Location of adapters AUV, AUVL, AV, AVL

Sealing of the bearing arrangement

⚠ In order to prevent damage to the running system of the linear recirculating roller bearings, the raceways must be kept clean!

The elastic wipers on the end pieces of the linear roller bearings give effective protection of the guidance systems against contamination.

In order to prevent damage to the wiper lips, the counterbores of the fixing screw holes must be closed off (*Fitting*, page 166).

The function and effectiveness of the wipers also depends on correct fitting of the linear recirculating roller bearings (*Fitting*, page 168).

⚠ If guidance systems are exposed to severe contamination or aggressive media, additional seals must be provided to protect the running system (example, Figure 22)!

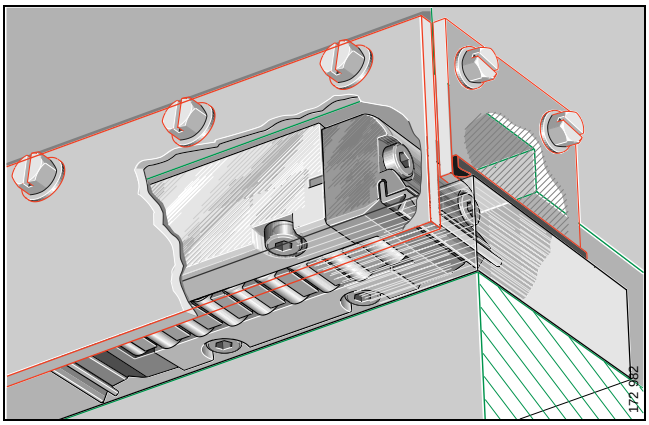


Figure 22 · Sealing of the bearing arrangement – example

Sealing of adapters

If severe contamination is present in the application, the rolling system can be provided with additional protection by fitting the adapters with additional wipers on the end faces and sides (Figure 23).

The wipers are supplied with fasteners.

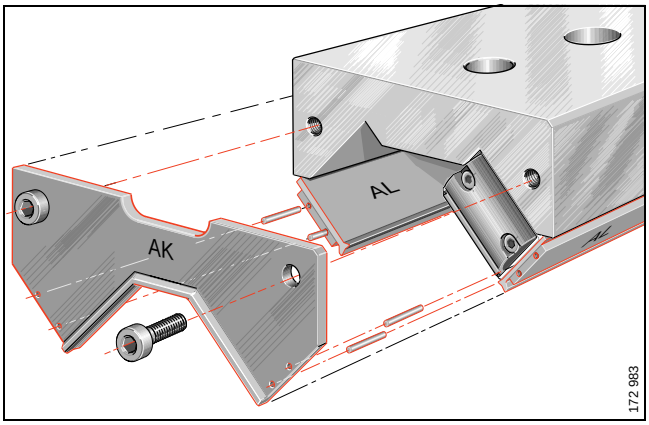


Figure 23 · Sealing of adapters

Design examples

HYDREL guideways are supplied in various designs (*Features*, page 190). These guideways can be used to achieve open and closed arrangements (*Open arrangements*, page 160, *Closed arrangements*, page 161).

Typical designs with HYDREL guideways and linear recirculating roller bearings are shown in Figure 24.

Examples

- Guideways UG, UGN:
  - have four raceways
  - support forces in the main load direction and opposing direction with a counterstay as well as lateral forces in two directions.
- Guideways UZ, UZN:
  - have three raceways
  - support forces in the main load direction and lateral forces in two directions
- Guideways UV:
  - have two raceways arranged at an angle of 45° to the mounting surface
  - support forces in the main load direction in two directions
- Guideways UFA, UFB, UFK:
  - have one raceway
  - support forces in the main load direction only.

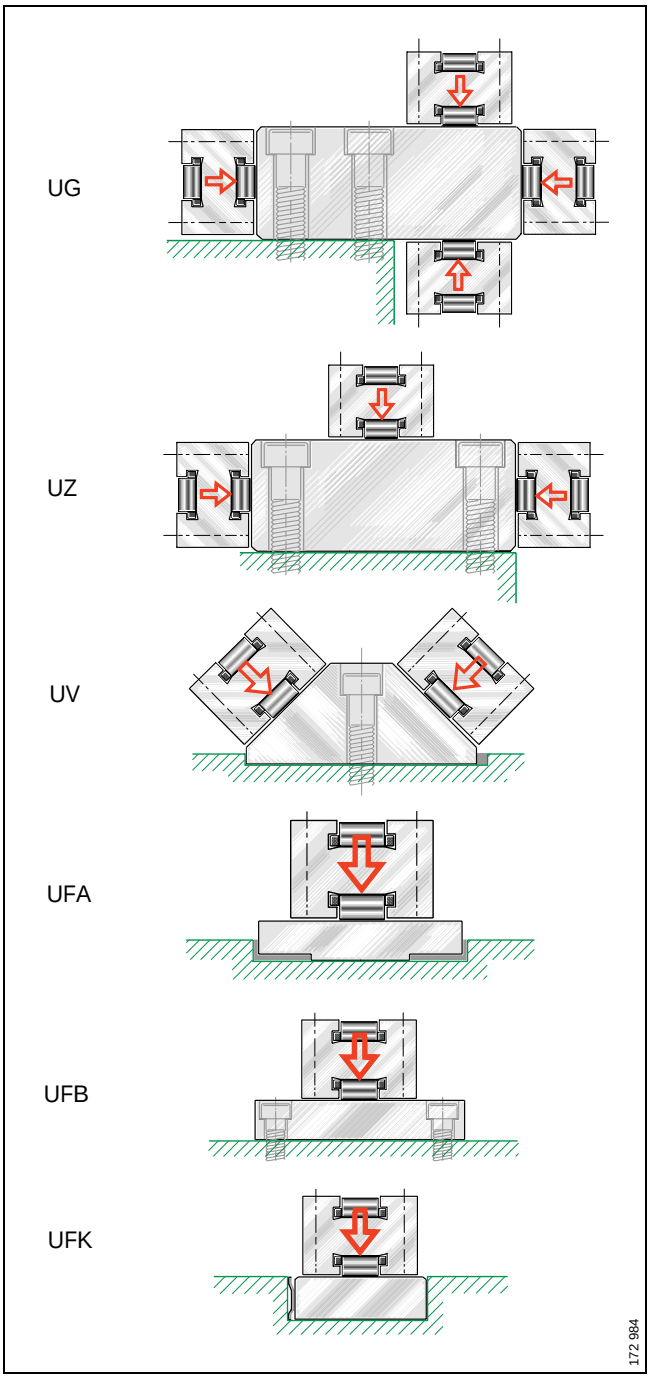


Figure 24 · Guideways/linear roller bearings/load directions

Open arrangements

This arrangement (Figure 25):

- has one locating bearing side and one or more non-locating bearing sides
- is mainly used for applications with loads acting concentric and vertical to the guidance plane
- allows a large guidance base
- is very easy to fit, since the machine part can simply be placed on and lifted off.

⚠ Open arrangements are bearing arrangements without a counterstay!

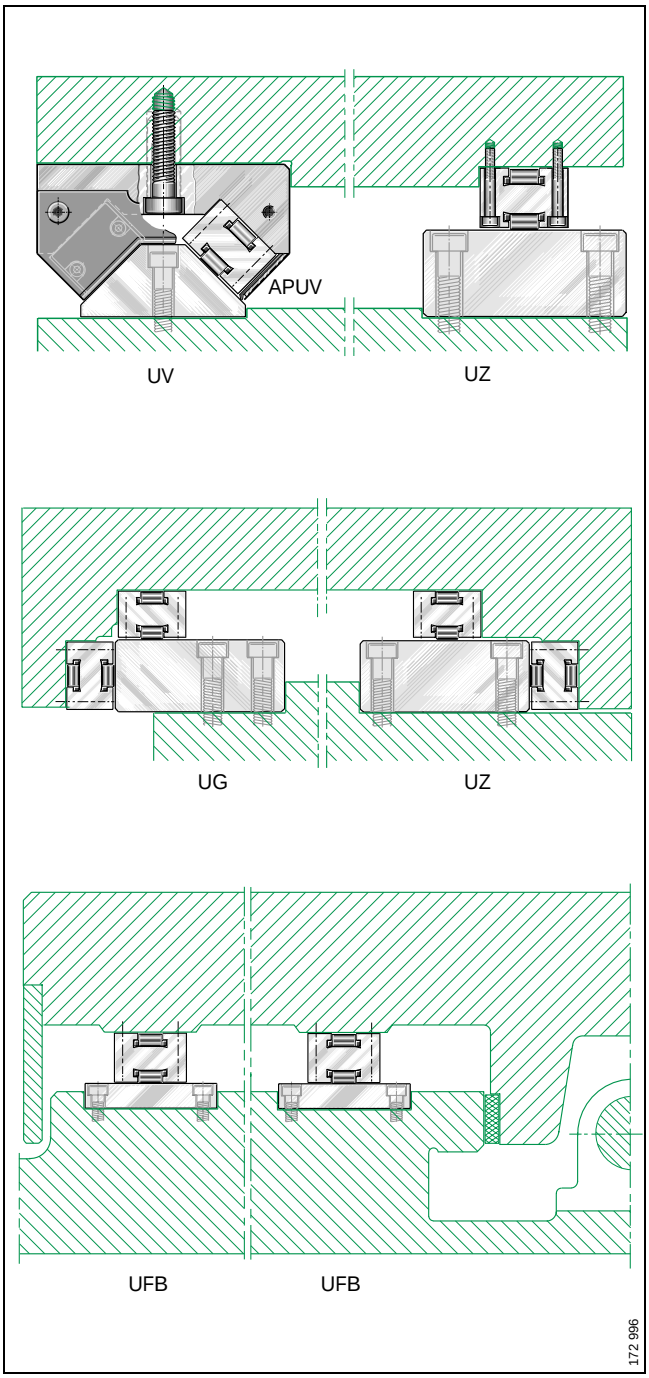


Figure 25 · Open arrangements – examples

Closed arrangements

This arrangement (Figure 26):

- has one or two locating bearing sides
- has a counterstay on both sides
- is mainly used for applications with all types of load directions and moment loads
- is preloaded. This increases the rigidity and accuracy.

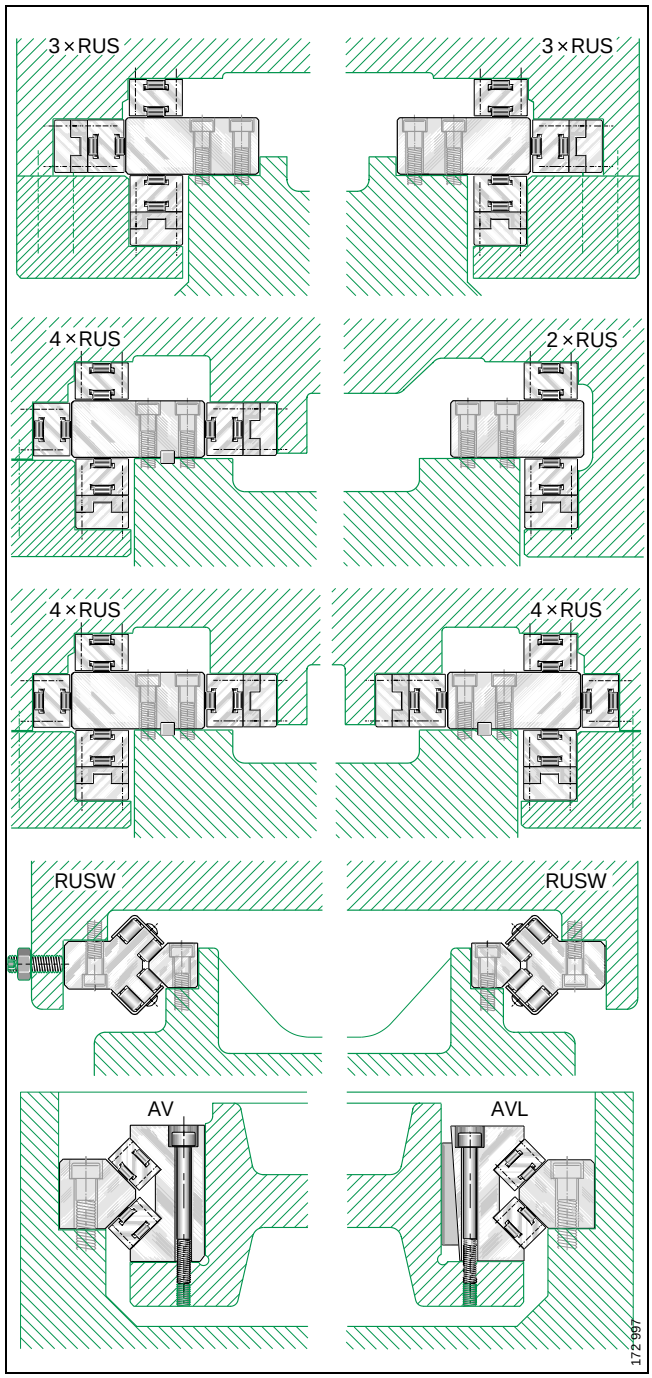


Figure 26 · Closed arrangements – examples

Fitting

Linear recirculating roller bearings and guideways are high precision machine elements. These products must be handled very carefully before and during fitting. Their trouble-free operation depends largely on the care taken during fitting.

Delivered condition and storage

Delivered condition of linear recirculating roller bearings

Linear recirculating roller bearings are supplied coated with an oil-based preservative.

⚠ Do not remove the preservative! If it is washed out, foreign bodies can enter the bearing and damage the running system!

The bearings are supplied in groups with a height sorting of dimension H of 5 µm or 10 µm.

The group is marked by a coloured sticker on the packaging. Unless specified otherwise in the order, the group GR 3 (yellow) is supplied in preference.

The suffix S with a number indicates linear recirculating roller bearings sorted to half the group tolerance (*Accuracy*, page 177).

Delivered condition of HYDREL guideways

- Guideways
  - are supplied with a preservative and are packed in anti-corrosion paper
  - guideways matched to each other form a set. All the individual parts in a set have the same set number, and the joints are marked consecutively with letters. All the parts of a set are packed together. If the parts must be packed in several units due to weight, these are marked accordingly.

⚠ Parts with the same set number must be fitted in the same guidance system! The guideways should be assembled such that the ends with the same set numbers and letters are adjacent to each other!

Storage of linear recirculating roller bearings and guideways

Linear recirculating roller bearings and guideways should only be stored:

- in the original packaging. Packaging must be kept closed
- in dry, clean rooms with the temperature as constant as possible
- at a relative humidity of 65% max.

⚠ Contamination impairs the accuracy and reduces the operating life of the guidance elements!

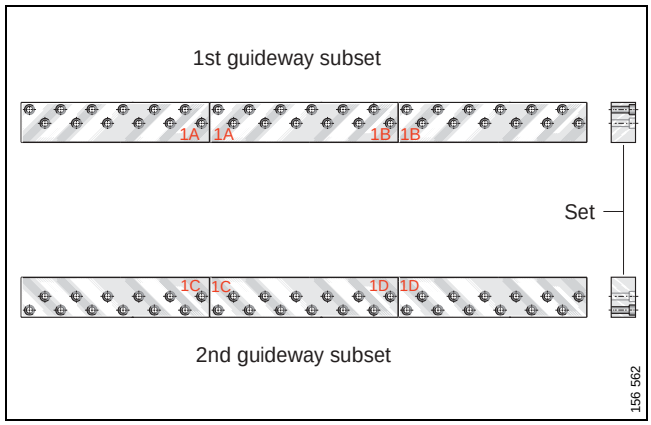


Figure 1 · Marking of multi-piece guideways

Unpacking of guidance elements

Perspiration from handling leads to corrosion. Hands must be kept clean and dry; protective gloves should be worn if necessary.

Guideways should only be removed from their packaging immediately before fitting. If the fitting procedure is very time-consuming – for example with complex fitting processes – or fitting is interrupted, bearings should be protected against contamination by appropriate measures. Parts should be held covered in a clean, dry area.

⚠ Wire wool or fluff-forming cloths must not be used!

The bearings and guideways should be lightly oiled in order to prevent corrosion during fitting. The preservative present on the parts when supplied need not be removed.

Design of the assembly area

It must be ensured that work surfaces are bright, clean and free from fibres (e.g. plastic) and that lighting conditions are good (Figure 2).

⚠ Machines or equipment that produce swarf or generate dust must not be used in the immediate vicinity of the bearings!

The guidance systems must be protected against dust, contamination, swarf, moisture, adhesives, etc! Contaminants affect the operation and operating life of the guidance elements!

Cleaning the adjacent construction

In order to prevent mounting defects, the holes and edges of the adjacent parts must be free of burrs.

The mounting surfaces for the guideways and the locating faces for the linear roller bearings must be clean.

⚠ Legal specifications relating to the handling and use of cleaning agents (manufacturer's guidance and regulations covering health and safety at work and environmental protection) must be complied with! Cleaning agents must be disposed of correctly after use!

Suitable cleaning agents are:

- conventional grease solvents (isopropanol, petroleum, diesel oil).

Cleaning (Figure 3)

- Apply cleaning agents using a brush or suitable cloth.
- Clean and dry the surfaces.

⚠ Ensure that the adjacent components and lubrication holes are free from cleaning agents, solvents and washing emulsions! The fit surfaces can rust or the raceway system can become contaminated!

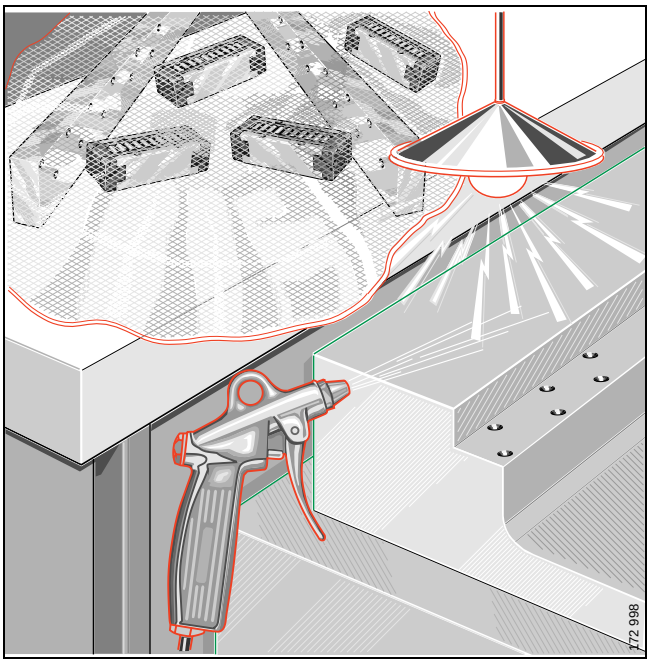


Figure 2 · Design of assembly area

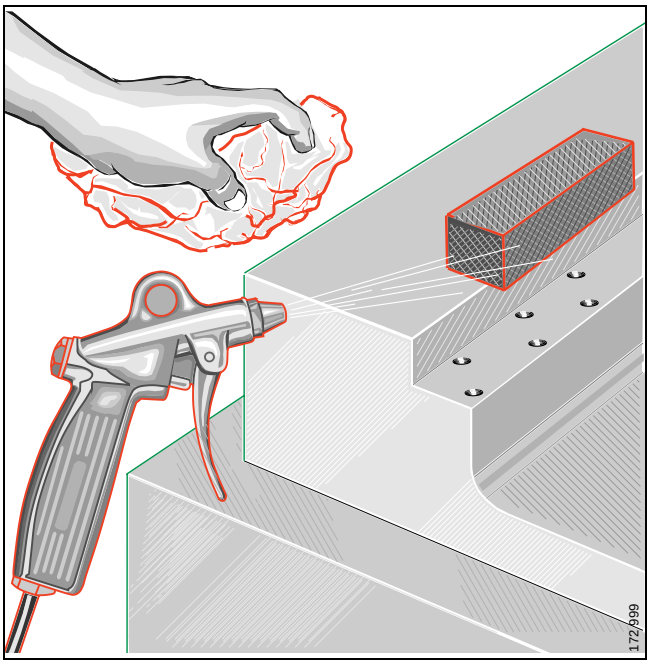


Figure 3 · Cleaning the adjacent construction

Checking the dimensional and geometrical tolerances of the adjacent construction

The measurement method depends on:

- the measuring equipment used (e.g. Figure 4)
- the geometry of the adjacent components
- the requirements for running accuracy. If high running accuracy is required, it may be necessary to check the measuring machine.

Checking the mounting surfaces

⚠ The accuracy of the adjacent construction should not be checked if the adjacent components have been refrigerated or heated!

The mounting surfaces of the adjacent construction should not exceed the permissible dimensional and geometrical tolerances (*Design of bearing arrangements*, page 148 and page 149)!

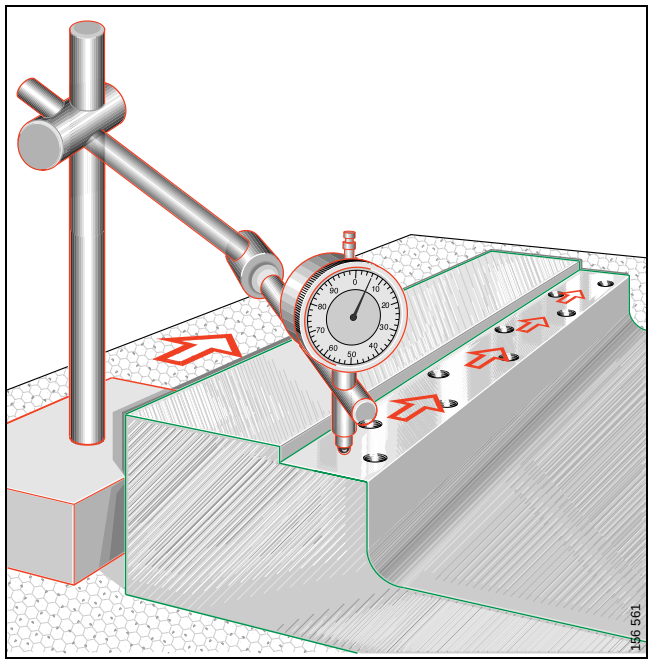


Figure 4 · Checking the adjacent construction

Handling of fasteners

Screws, square steel bar

Linear recirculating roller bearings and guideways should only be located using the screws specified. The definitive information is given in the *dimension tables*.

⚠ The specifications relating to the fasteners must be adhered to! Any deviations will affect the security of the screw connections as well as the accuracy, load carrying capacity, rigidity and operating life of guidance systems!

Adequate strength of the adjacent construction in accordance with VDI guideline 2230 must be ensured!

Fixing screws are not included in the delivery.

For guideways UGN, UGSN, UZN and UZSN, a square steel bar to DIN 178 should be provided (*dimension table*, page 196).

Adhesives, clamping strips

Conventional metal adhesives of two-component types or single-component adhesives are suitable. If anaerobic single-component adhesives are used, the guideways should have a reduced bonding gap – suffix KL-02.

Adhesives are not included in the delivery.

A clamping strip UKB in accordance with Table 5, page 153 should be provided.

Fitting of guideways

Alignment and screw mounting of guideways UG, UGN, UGS, UGSN, UZ, UZN, UZS, UZSN, UV and UFB

⚠ In order that the load carrying capacity, rigidity, accuracy and smooth running of the linear recirculating roller guidance systems can be used to the full, the guideways must be precisely aligned!

The cylindrical counterbores of the fixing holes have sharp edges! Risk of injury!

- Guideways UGN, UGSN, UZN, UZSN
  Fitting of the square steel bar (Figure 5):
  – Place the square steel bar in the centre of the slot in the adjacent construction
  – Fix the square steel bar in place using at least two dowel pins ① or screws.
- Lightly oil the mounting and locating faces for the guideways ② on the adjacent construction
  – this prevents fretting corrosion.
- Insert the fixing screws ③ in the holes in the guideways and tighten finger tight (Figure 6).
- Position the guideways ② (Figure 6)
  – press the guideways against the lateral locating faces if necessary and clamp rigidly against the lateral locating faces by means of suitable devices (screw clamps or clamping fixtures).

⚠ All the holes for fixing screws should be used! If a smaller number of fixing screws is used, this will reduce the load carrying capacity of the screw connections and the rigidity of the guidance system!

- If locating faces are not present, align the guideways precisely using a plastic hammer ④ and optical measuring device (e.g. light alignment device or laser) (Figure 7).

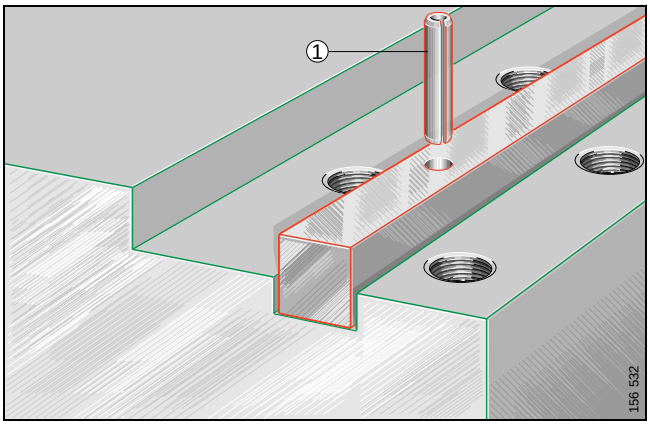


Figure 5 · Fitting the square steel bar

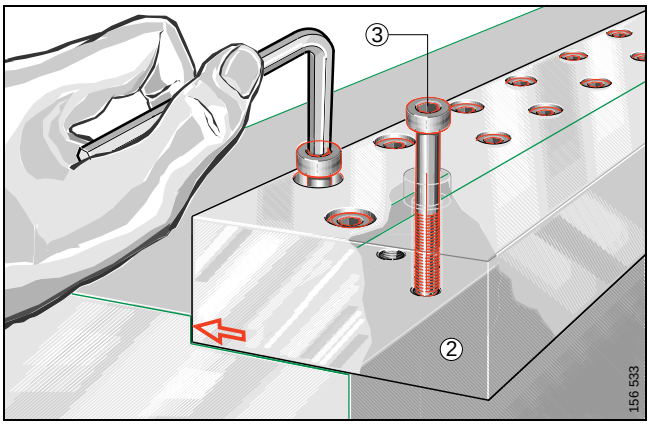


Figure 6 · Positioning of guideways on the adjacent construction

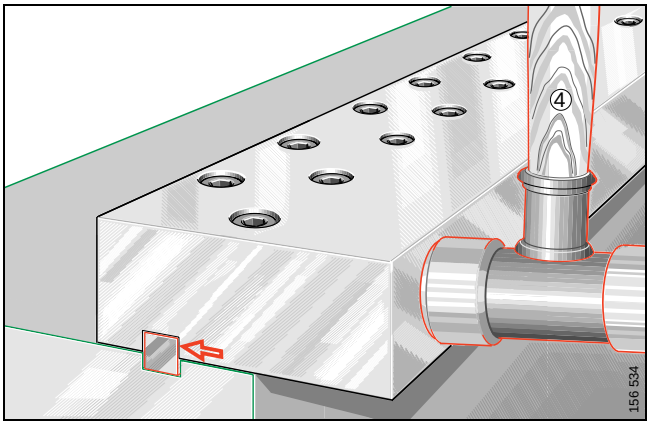


Figure 7 · Aligning the guideways

- Tighten the fixing screws using a torque wrench ⑤ in three stages to the specified tightening torque M_A (Figure 8):
  - Stage 1 40% of M_A
  - Stage 2 70% of M_A
  - Stage 3 100% of M_A

⚠ In order to prevent the occurrence of unacceptable stresses, the location sequence must be adhered to!

Tighten the screws in the guideways from the centre in both directions!

If the screws are lubricated, the tightening torque M_A should be reduced!

Check the alignment of the guideways after each stage!

- Guideways UGN, UGSN, UZN, UZSN: fill the space between the square steel bar and the slot with castable resin, ensuring that no bubbles are present. Allow the mass to harden.

  For filling the gap, hollow filling screws HS can be used (*Design of bearing arrangements,* page 151) – comprehensive instructions can be requested.
- Close off the counterbores in the guideways flush with the surface by means of closing plugs (*dimension table*) or castable resin.

Adhesive bonding of guideways UFA

Conventional metal adhesives are suitable for adhesive bonding.

The standard bond gap of 0,15 mm is matched to two-component adhesives.

⚠ Anaerobic single-component adhesives that harden in the absence of air generally only give satisfactory results with thin adhesive layers!

For these applications, guideways UFA are available with a bond gap of 0,02 mm (suffix KL 02).

- Protect the mounting surfaces of the guideway against fretting corrosion by means of a thin layer of white fitting paste ① (Figure 9)
- Two-component adhesives should be prepared in accordance with the manufacturer's instructions.
- Apply adhesive ② to the appropriate surface of the guideway (Figure 10)
- Locate and align the guideways ③ (Figure 10)
  - repeat the procedure for multi-piece guideways.
- Apply sufficient load to the guideways ④ or use clamping methods and allow the adhesive to harden in accordance with the adhesive manufacturer's guidance (Figure 10).

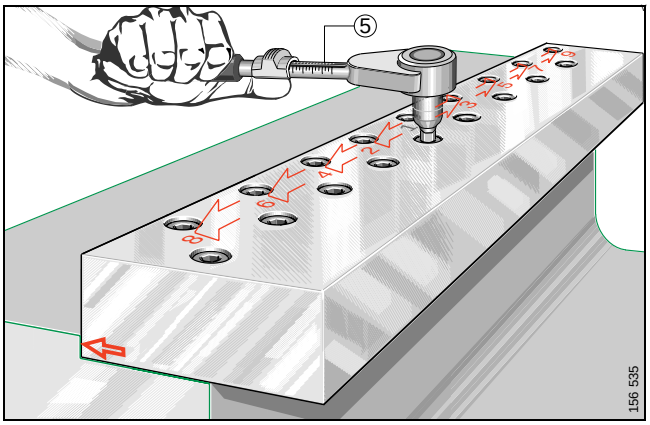


Figure 8 · Tightening of guideway to tightening torque M_A

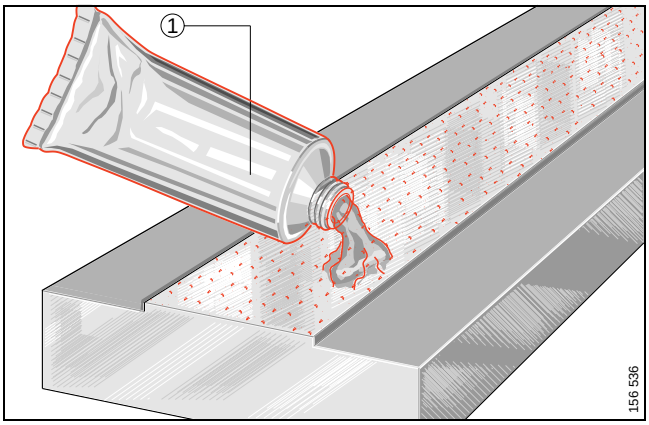


Figure 9 · Protecting the mounting surface using fitting paste

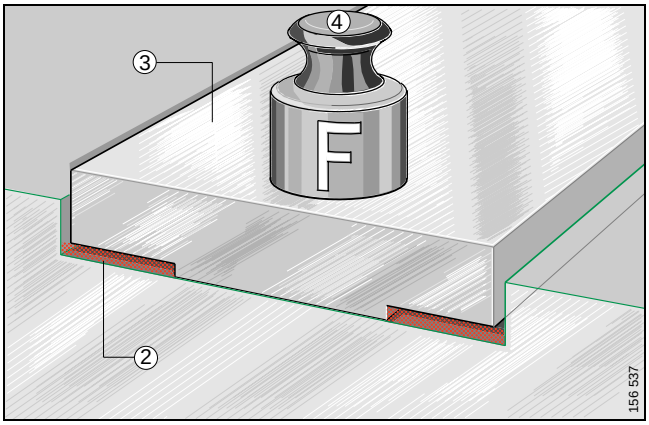


Figure 10 · Adhesive bonding of guideways/hardening of adhesive

Location of guideways UFK with clamping strip

- Lightly oil the mounting surfaces for the guideways on the adjacent construction
  - this prevents fretting corrosion.
- Position the guideways ① in the slot in the adjacent construction (Figure 11)
  - use the entire length of the clamping strip.
- Press in the clamping strip ② using a shim ③ (Figure 11).

Fitting of guideway sets

Guideways matched to each other form a set. All parts of the same set have the same set number. In addition, the joints are marked consecutively by means of letters.

⚠ Parts with the same set number must be fitted in the same guidance system! The guideways should be assembled such that the ends with the same set numbers and letters are adjacent to each other!

- Fitting of guideways (see section *Fitting*, page 162)
  - note the height difference and gap width (Figure 13, Table 1).

Table 1 · Height difference and gap width

Guideway grade	Height difference ΔH µm max.	Gap width ΔS mm max.
Q 2 and Q 6	2	0,05
Q 10	3	0,05

Overgrinding of preground guideways after fitting

Experience shows that an acceptable grinding result can only be achieved by taking considerable care. Particular attention must be paid to:

- careful contact grinding
- low feed levels
- plentiful and correct supply of coolant.

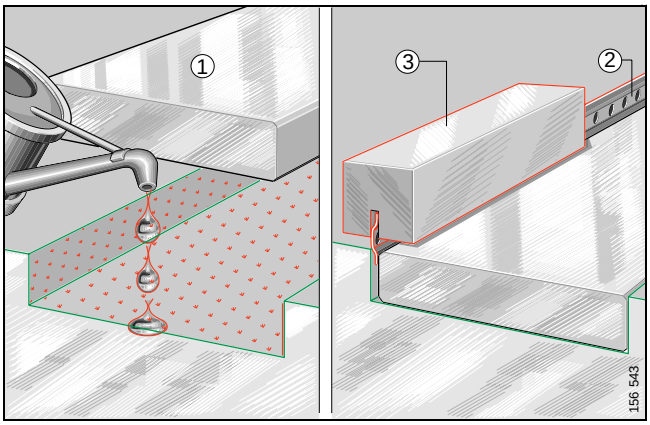


Figure 11 · Location of guideways using clamping strip

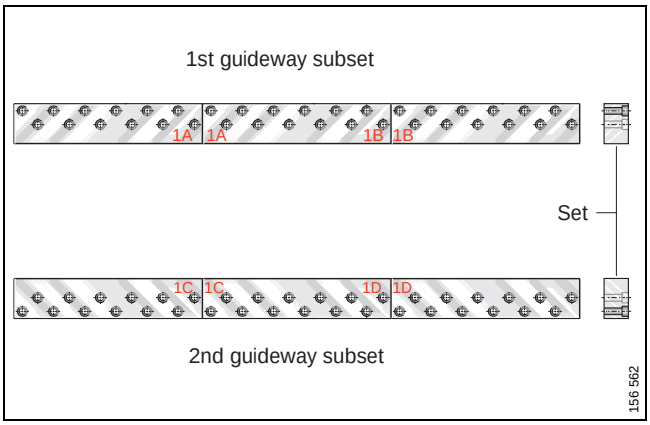


Figure 12 · Marking/fitting of multi-piece guideways

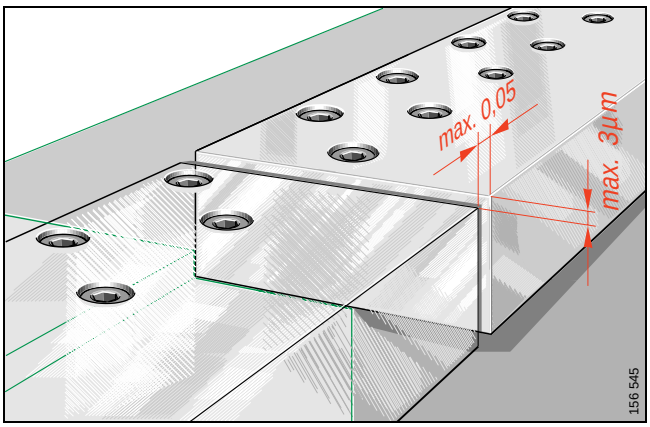


Figure 13 · Height difference and gap width

Oiling/greasing of linear recirculating roller bearings

Linear roller bearings should be oiled or greased depending on the lubrication method.

⚠ The guidance in the section *Lubrication*, page 140 must be observed!

Fitting of linear recirculating roller bearings

⚠ Direct blows and shocks on the linear roller bearings must be avoided! Fitting forces must never be directed through the rolling elements!

Linear recirculating roller bearings must never be fitted by force – e.g. by direct blows – in preloaded guidance systems!

It must be ensured that the seal lips are not damaged.

- Lightly oil the locating faces for the linear recirculating roller bearings on the adjacent construction
  – this prevents fretting corrosion.
- Insert the fixing screws ① in the holes in the linear roller bearings, tighten finger tight and align the bearings (Figure 14).
- Press the datum side of the linear recirculating roller bearings ② against the locating face of the adjacent construction (Figure 14)
  – the datum side is the unmarked side; it is on the opposite side to the marked side.

⚠ Check the parallelism (Figure 15); rework the adjacent construction if necessary!

- Tighten the fixing screws in crosswise sequence using a torque wrench in three stages to the specified tightening torque M_A (Figure 16):
  – Stage 1 40% of M_A
  – Stage 2 70% of M_A
  – Stage 3 100% of M_A

⚠ In order to prevent the occurrence of unacceptable stresses, the location sequence must be adhered to!

Check the alignment of the guideways after each stage!

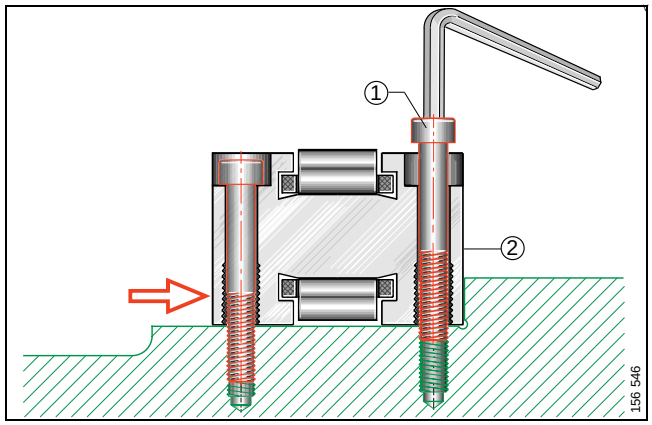


Figure 14 · Prefitting of linear recirculating roller bearings

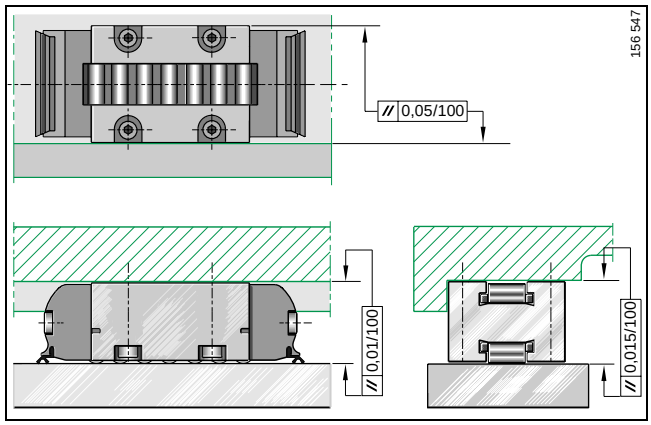


Figure 15 · Checking of parallelism

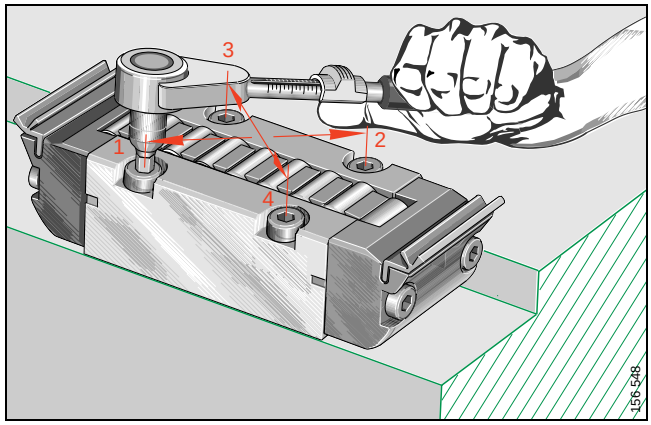


Figure 16 · Tightening of linear roller bearings to tightening torque M_A

Fitting of adjusting gibs

If assemblies comprising a linear recirculating roller bearing and adjusting gib are to be fitted, the linear roller bearing and not the adjusting gib should be aligned against the locating face. For this purpose, the adjusting gibs are slightly narrower than the associated linear roller bearings.

The fitting guidelines in the section *Fitting of linear recirculating roller bearings* must be followed (page 168)!

Fitting of gib to linear recirculating roller bearing

- Separate the gib halves
- Screw the gib ① to the linear recirculating roller bearing ② and tighten the screws finger tight (Figure 17).
- Align the gib to the linear roller bearing.
- Tighten the fixing screws in crosswise sequence using a torque wrench ③ in three stages to the specified tightening torque M_A (Figure 17)
  - Stage 1 40% of M_A
  - Stage 2 70% of M_A
  - Stage 3 100% of M_A

In order to prevent the occurrence of unacceptable stresses, the location sequence must be adhered to!

Check the alignment of the guideways after each stage!

Fitting of gib to adjacent construction

- Screw the gib ① to the adjacent construction ⑤ and tighten the screws finger tight (Figure 18).
- Align the gib to the adjacent construction.
- Tighten the fixing screws using a torque wrench ⑥ to the specified tightening torque M_A (Figure 18):
  - Stage 1 40% of M_A
  - Stage 2 70% of M_A
  - Stage 3 100% of M_A.
- Assemble the two gib halves carefully.

Setting the preload

- Determine the preload dimension (*Preload*, page 132).
- Set the calculated preload dimension using the adjusting screw ⑦ (Figure 19).
- Secure the setting by means of a locking screw ⑧ (Figure 19).

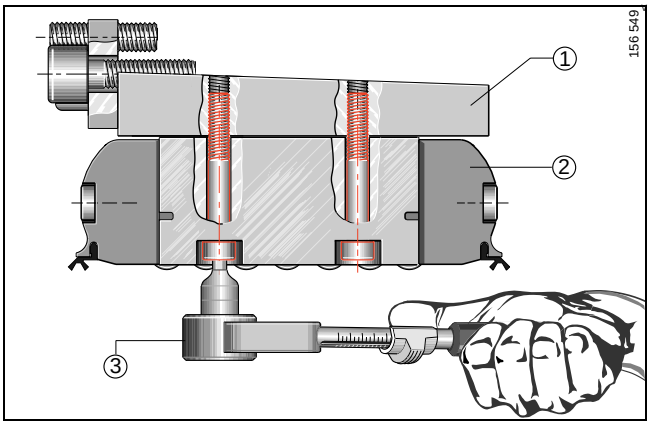


Figure 17 · Fitting of gib to linear recirculating roller bearing

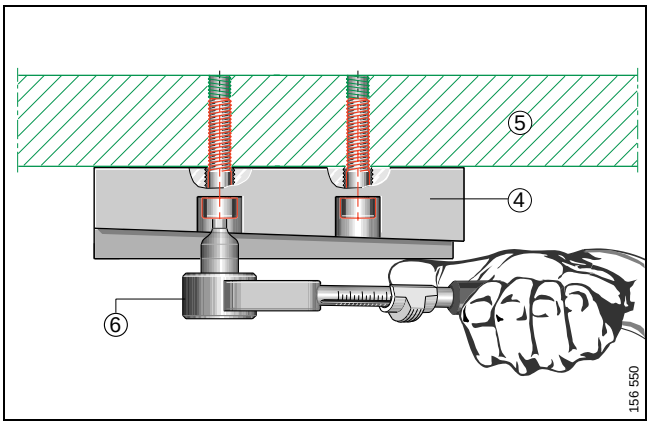


Figure 18 · Fitting of gib to adjacent construction

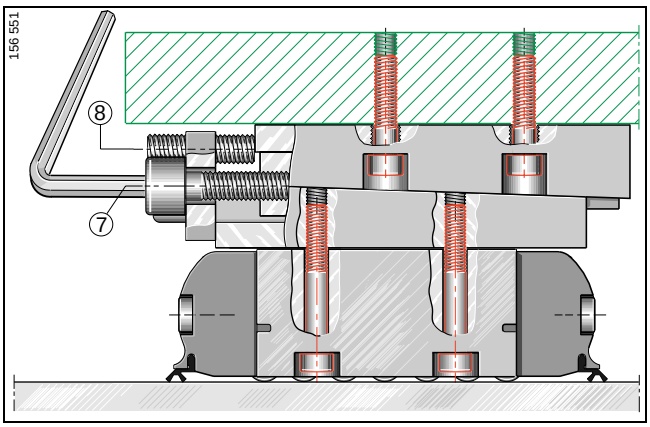


Figure 19 · Setting/securing the preload

Fitting of adapter APUV and linear recirculating roller bearing

- Lightly oil the mounting and support surfaces for the adapter and linear recirculating roller bearing
  – this prevents fretting corrosion.

Fitting of adapters

- Adapters with the same set number must be fitted in the same guidance system. Adapters with additional marking by means of letters must be fitted in line.
- Press the adapter ① against the locating faces on the adjacent construction (Figure 20).
- Insert the fixing screws ② in the holes and tighten finger tight (Figure 20).
- Tighten the fixing screws ② in three stages to the specified tightening torque M_A (Figure 20)
  – For the stages, see *Fitting of linear recirculating roller bearings*, page 168
- Fix the adapter to the adjacent construction by means of dowels using the dowel hole ③ (Figure 21)
  – Dimensions of dowel pins according to *dimension table*.

Fitting of linear recirculating roller bearings

- Press the datum side of the linear recirculating roller bearing ④ against the locating face of the adapter (Figure 22).
- Insert the fixing screws ⑤ and tighten finger tight.
- Tighten the fixing screws ⑤ in three stages to the specified tightening torque M_A (Figure 22)
  – Stage 1 40% of M_A
  – Stage 2 70% of M_A
  – Stage 3 100% of M_A.

⚠ In order to prevent the occurrence of unacceptable stresses, the location sequence must be adhered to!

Check the alignment of the guideways after each stage!

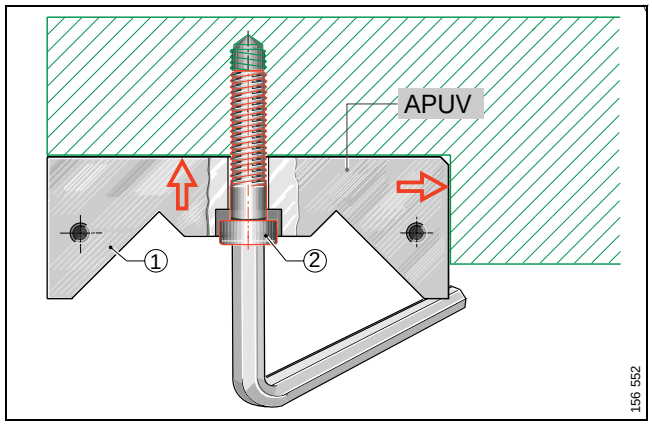


Figure 20 · Fitting of adapters

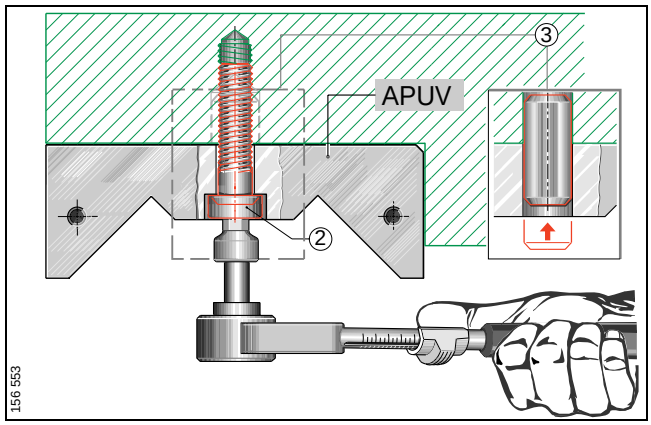


Figure 21 · Location of adapters using dowels

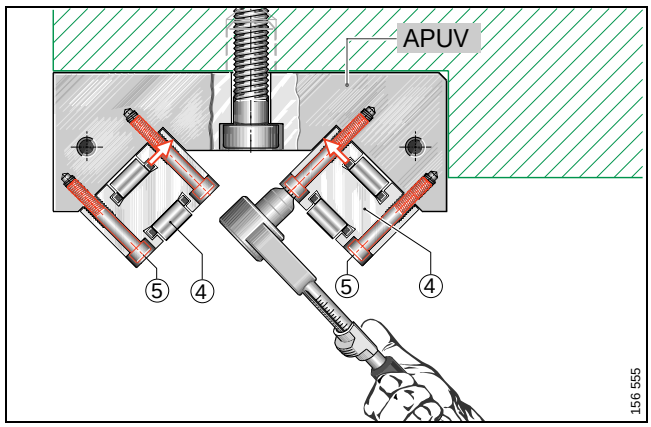


Figure 22 · Fitting of linear recirculating roller bearings

Fitting of adapters AUVL, AVL and linear recirculating roller bearing

- Lightly oil the mounting and support surfaces for the adapter and linear recirculating roller bearing
  - this prevents fretting corrosion.
- Treat the gib surfaces with fitting paste
  - this facilitates setting of the preload.

Fitting of linear recirculating roller bearings

This process can be omitted where completely assembled adapters are used (suffix KM).

- Press the datum side of the linear recirculating roller bearing ① against the locating face of the adapter (Figure 23).
- Insert the fixing screws ② and tighten finger tight (Figure 23).
- Tighten the fixing screws ② in three stages (see *Fitting of adapters*) to the specified tightening torque M_A (Figure 23).

Fitting of adapters

- Press the adapter ③ against the locating faces on the adjacent construction (Figure 24).
- Insert the fixing screws ④ in the holes and tighten finger tight (Figure 24).
- Determine the preload dimension (see *Preload*, page 132).
  - on the same basis as calculation of an individual bearing (see *Preload*, page 132)
- Set the calculated preload dimension (see *Preload*, page 132) using the adjusting screw ⑤ (Figure 24).
- Tighten the fixing screws ④ in three stages to the specified tightening torque M_A (Figure 24)
  - Stage 1 40% of M_A
  - Stage 2 70% of M_A
  - Stage 3 100% of M_A

Reference to dismantling of adapter

- Loosen the fixing screws ④ (Figure 24)
- Loosen the adjusting screw ⑤ for the adjusting gib by several turns (Figure 25).
- Carefully release the preload of the adjusting gib using a hammer ⑥ and metal plate ⑦ (Figure 25).
- Continue the dismantling process by apply the fitting process in reverse.

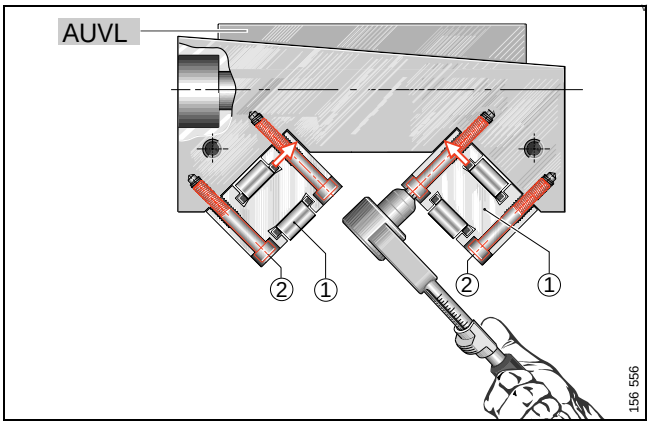


Figure 23 · Fitting of linear recirculating roller bearings

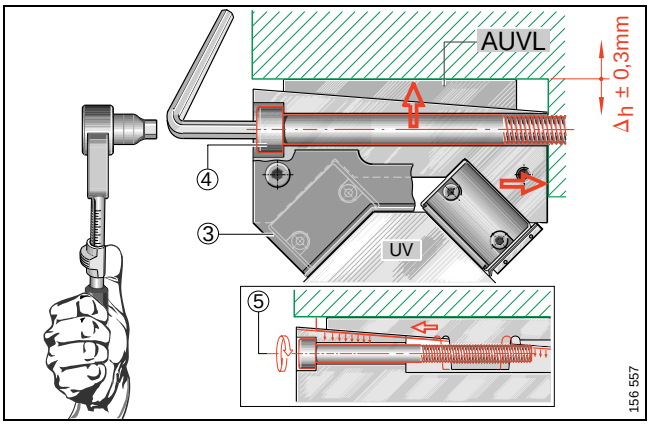


Figure 24 · Fitting of adapters

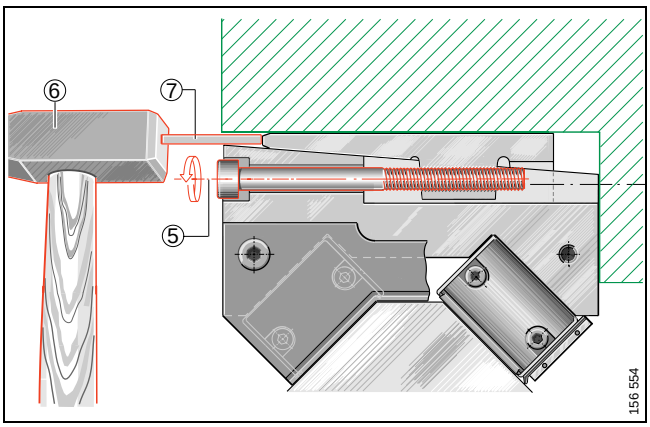


Figure 25 · Dismantling of adapters

Fitting of adapters AV, AUV

- Lightly oil the mounting and support surfaces for the adapter and linear recirculating roller bearing
  – this prevents fretting corrosion.

Fitting of linear recirculating roller bearings

This process can be omitted where completely assembled adapters are used (suffix KM).

- Press the datum side of the linear recirculating roller bearing ① against the locating face of the adapter (arrows, Figure 26).
- Insert the fixing screws ② and tighten finger tight (Figure 26).
- Tighten the fixing screws ② in three stages (see *Fitting of adapters*) to the specified tightening torque M_A (Figure 26).

Fitting of adapters

- Press the adapter ③ against the locating faces on the adjacent construction (arrows, Figure 27).
- Insert the fixing screws ④ in the holes in the adapter and tighten finger tight (Figure 27).
- Tighten the fixing screws ④ in three stages to the specified tightening torque M_A (Figure 27)
  – Stage 1 40% of M_A
  – Stage 2 70% of M_A
  – Stage 3 100% of M_A

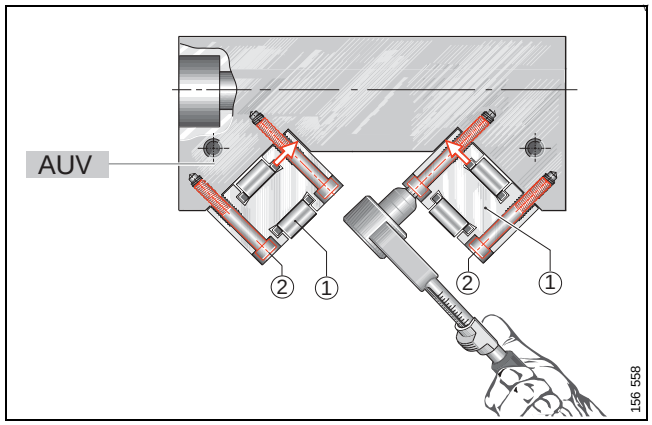


Figure 26 · Fitting of linear recirculating roller bearings

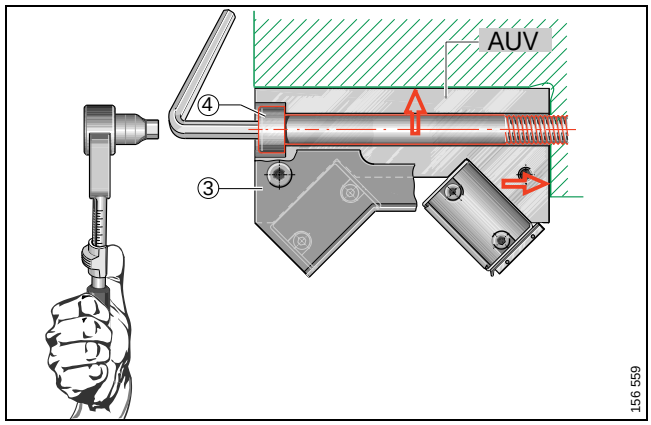
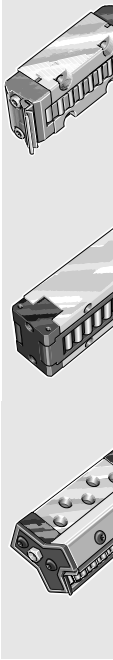


Figure 27 · Fitting of adapters



Linear recirculating roller guidance systems

INA linear recirculating roller bearings

Features

Linear recirculating roller guidance systems

- consist of:
  - INA linear recirculating roller bearings
  - HYDREL guideways
  - HYDREL adapters.
- are suitable for locating/locating and locating/non-locating bearing arrangements
- can in a closed arrangement support loads from all directions and moments about all axes (*Design of bearing arrangements*, page 161)
- have a very high load carrying capacity while requiring little space
- have extremely high rigidity under preload
- can be preloaded by means of adjusting gibs. These give particularly uniform distribution of the preload over the whole length of the linear recirculating roller bearing and allow the preload to be set very easily
- have high accuracy throughout their operating life
- have low, uniform friction
- can be lubricated with oil or grease.

Linear recirculating roller bearings RUS, RUS..KS

- run particularly smoothly and with very little noise
- are sealed on their end faces
- can be lubricated through the end piece – in the case of RUS..KS only.

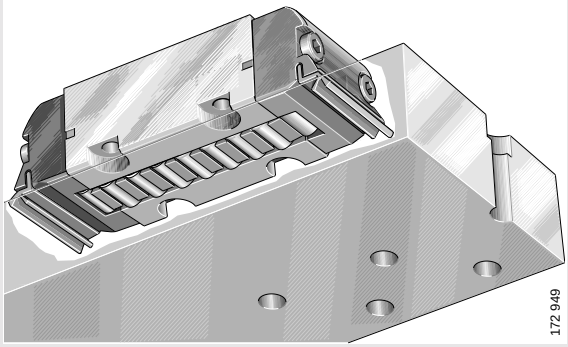
Linear recirculating roller bearings PR

- have a full complement cylindrical roller set
- are suitable for high temperatures
- are suitable for high speeds and accelerations.

Linear recirculating roller bearings RUSW

- are particularly suitable, due to their arrangement of two rows of recirculating rollers at 90° to each other, for closed arrangements (see *Design of bearing arrangements*, page 161)
- are sealed on all sides.

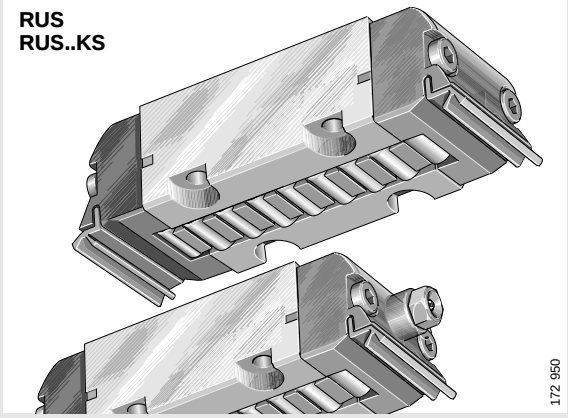
Linear recirculating roller guidance system



- basic design comprising:
  - linear recirculating roller bearing RUS.., RUS..KS
  - HYDREL guideway UG
- metric mounting dimensions

Linear recirculating roller bearings

RUS
RUS..KS



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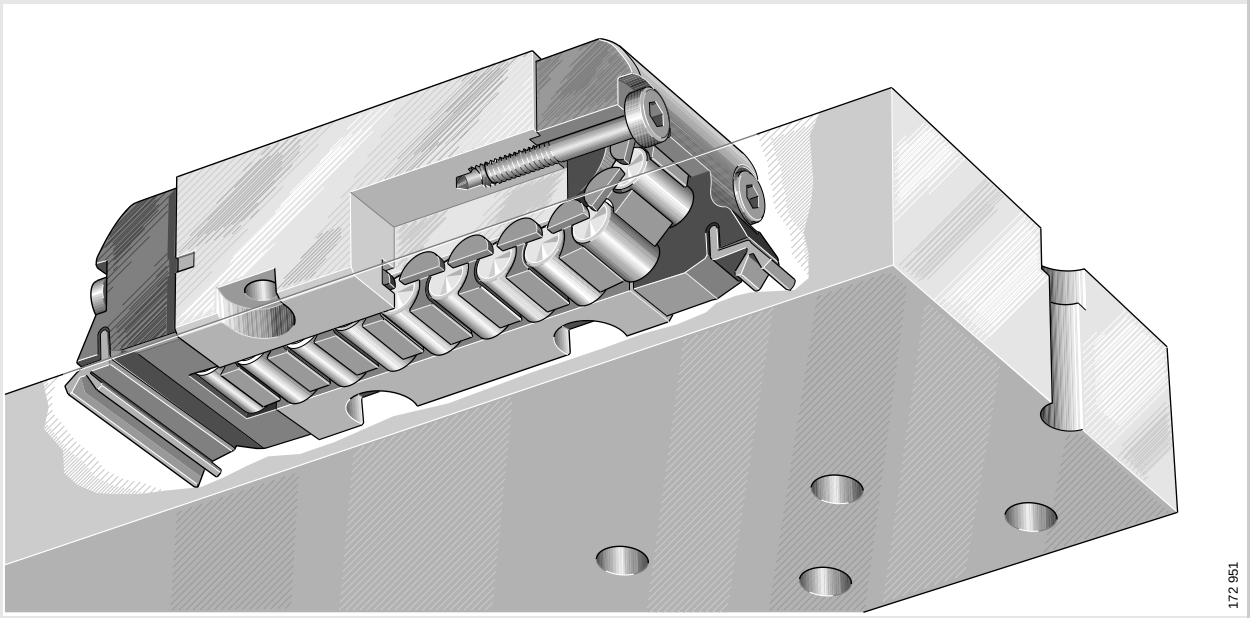
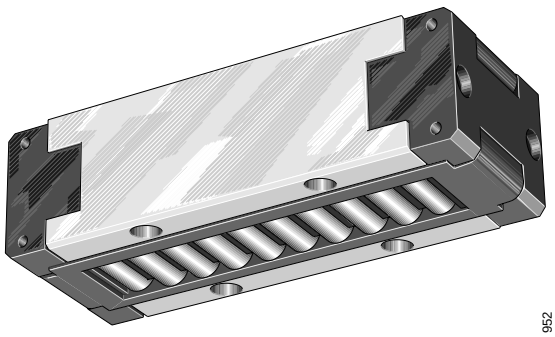
- cylindrical rollers kept apart by spacers
  - rollers guided between the ribs in the saddle plate
- elastic, interchangeable wipers on the end pieces
- metric mounting dimensions
- RUS..KS with relubrication facility via the end pieces
- for operating temperatures from –30 °C to +90 °C



PR



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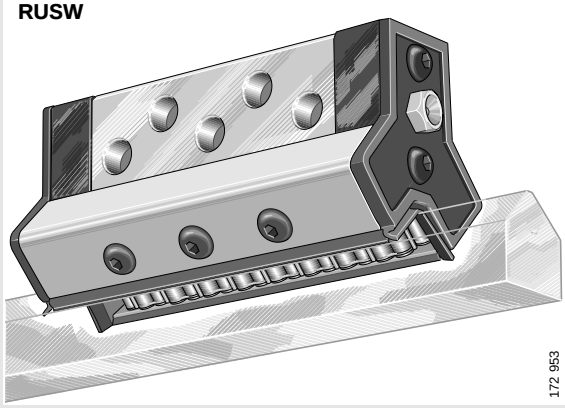
- full complement cylindrical roller set
- completely made from metal
- inch mounting dimensions
- for operating temperatures from –40 °C to +120 °C

RUSW



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- two rows of recirculating rollers arranged at right angles to each other, with preloaded roller chain, roller chain axially guided by formed metal plates, funnel type lubrication nipple to DIN 3405–AM6
- sealed on all sides by:
  - wipers on the end faces
  - longitudinal wipers vulcanised on to metal covers
- for operating temperatures from –30 °C to +90 °C

Linear recirculating roller guidance systems

Accessories for INA linear recirculating roller bearings

Features

Adjusting gibs

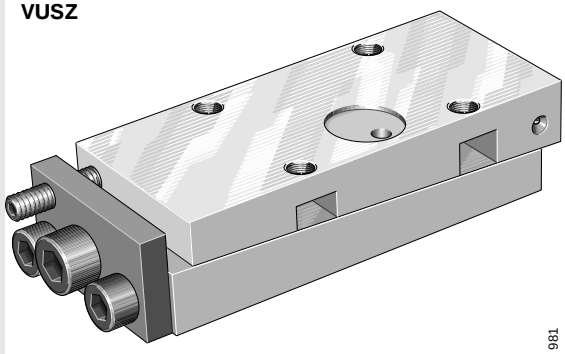
- are used where:
  - the guidance system must have a precisely defined preload
- increase the rigidity of the linear recirculating roller guidance system by preload
- give particularly uniform distribution of the preload over the whole length of the linear recirculating roller bearing
- are easy to fit
  - the adjusting gibs are screw mounted on the linear recirculating roller bearings and the adjacent construction
  - the preload is set by means of an adjusting screw and secured by means of a locking screw
- can be easily maintained
  - integral ducts feed the lubricant into the return zone of the linear recirculating roller bearings.
  - treat the sliding surfaces with oil or grease in order to reduce the friction.

Setting devices

- are used where the deformation of the adjacent construction under preload forces is to be measured
  - this deformation, when added to the deflection of the linear recirculating roller bearing under preload (see *Rigidity*, page 136), gives the required preload dimension
- have a setting block that has the same dimensions as the linear recirculating roller bearing to be fitted
  - the setting block is fitted in place of the linear roller bearing. It can be connected via the pressure pipe and an intermediate distribution block with manometer to a conventional grease gun (*Measuring with setting device EUS and setting the preload*, page 134).
  - after measurement of deformation, the setting block is replaced by the linear recirculating roller bearing and the preload dimension determined is set by means of adjusting gibs or shims.

Adjusting gib

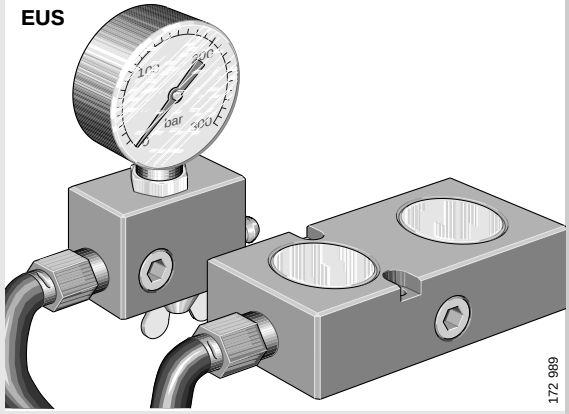
VUS
VUSZ



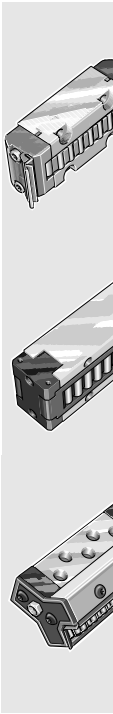
- consisting of:
  - two ground gibs
  - central fitting key which guides the gibs together
  - end support plate for the setting and locking screws
- VUSZ, inch dimensions

Setting device

EUS



- consisting of:
  - setting block with two hydraulic pistons
  - distribution block with manometer
  - high-pressure rubber hose



Design and safety guidelines

In order to achieve high guidance and positional accuracy and constant displacement resistance, note the fitting guidelines in the sections *Fitting* and *Design of bearing arrangements*!

If funnel type lubrication nipples to DIN 3405–AM6 are replaced by tube or hose connectors, the maximum screw length cannot be more than 6 mm.

Further information

Accuracy

Sorting and tolerances

Linear recirculating roller bearings are sorted by height into 5 groups (Table 1). If no group is indicated in the order, group GR 3 is supplied in preference.

Linear recirculating roller bearings have tolerances according to Table 2, adjusting gibs have tolerances according to Table 3.

Where two or more linear recirculating roller bearings are arranged in parallel or in series and particularly uniform load distribution is required, linear recirculating roller bearings can be supplied sorted within the same group tolerance (Table 4).

Linear recirculating roller bearings sorted together must be indicated in the order by stating the number of sorted bearings and the suffix S.

Special designs

Available by agreement:

- linear recirculating roller bearings PR with wipers on the end faces
  - suffix PP.
- linear recirculating roller bearings PR with a lubrication nipple on the end face
  - suffix KS.

Table 1 · Sorting of linear recirculating roller bearings – groups

Group	Colour of packaging sticker	Tolerance for H	
		RUS 19 069 to RUS 38 206 PR 14 032 to PR 14 089 Group tolerance 5 µm	RUS 65 210 RUS 85 280 PR 14 135, PR 14 182 Group tolerance 10 µm
GR1	red	0 / –5	0 / –10
GR2	blue	–5 / –10	0 / –10
GR3[1)]	**yellow**	**–10 / –15**	**–10 / –20**
GR4	green	–15 / –20	–20 / –30
GR5	black	–20 / –25	–20 / –30

1) Preferred series.

Table 2 · Tolerances of linear recirculating roller bearings

Linear recirculating roller bearing	Tolerance		
	Height µm	Width µm	Parallelism/ flatness µm
RUS 19 069 to RUS 38 206 PR 14 032 to PR 14 089	–25	–100	2
RUS 65 210 to RUS 85 280 PR 14 135 to PR 14 182	–30	–100	4

Table 3 · Tolerances of adjusting gibs

Adjusting gib	Tolerance Parallelism/flatness µm
VUS 19 069 to VUS 38 134 VUSZ 12 044 to VUSZ 24 084	3
RUS 65 210 to RUS 85 280 PR 14 135 to PR 14 182	8

Table 4 · Half group tolerance and width tolerance

Series Designation	Group tolerance H µm	Width tolerance A_4 µm
RUS 19069 to RUS 38 206	2,5	–
RUS 65 210 to RUS 85 280	5	–
RUSW 4020	5	5

Ordering example and ordering designation

Linear recirculating roller bearings RUS/RUS..KS

Linear recirculating roller bearing RUS 26 102
Height sorting of dimension H –10 µm to –15 µm.

Linear recirculating roller bearing RUS 38 134 KS
Height sorting of dimension H –10 µm to –15 µm.

Sorting to group 3 according to Table 1, page 177.

Ordering designation: RUS 26 102 GR 3 (Figure 1)
RUS 38 134 KS GR 3 (Figure 1).

Linear recirculating roller bearings sorted together

For eight linear recirculating roller bearings RUS 26 102 sorted together, the bearings are supplied with the restricted height tolerance 2,5 µm.

When ordering, state only the total quantity and not the number of sets, e.g.:

8 off RUS 26 102 8S.

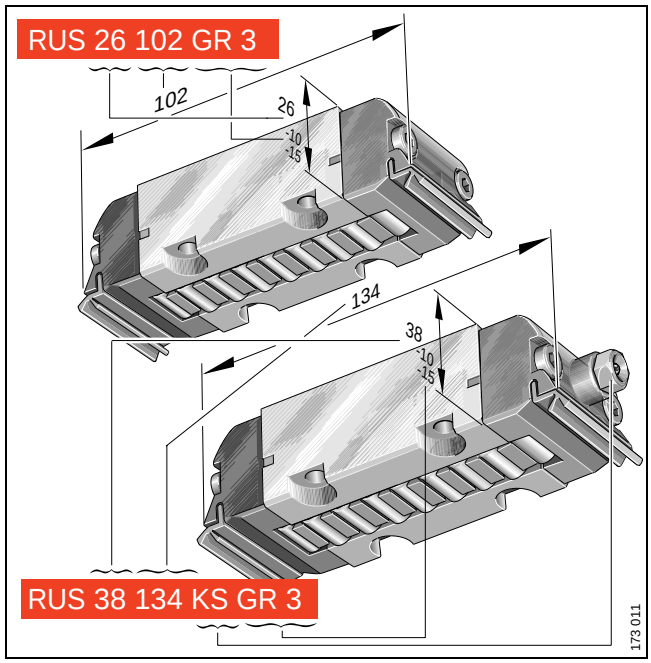


Figure 1 · Ordering example, ordering designation – RUS/RUS..KS

Linear recirculating roller bearings PR

Linear recirculating roller bearing PR 14 061
Height sorting of dimension H GR 3.

Linear recirculating roller bearing PR 14 135
Height sorting of dimension H GR 3.

Sorting to group 3 according to Table 1, page 177.

Ordering designation: PR 14 061 GR 3 (Figure 2)
PR 14 135 GR 3 (Figure 2).

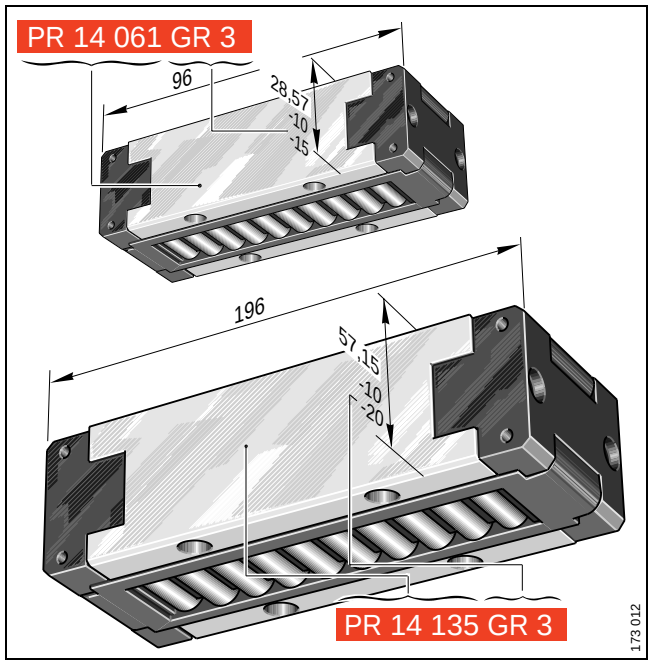


Figure 2 · Ordering example, ordering designation – PR

Adjusting gib

Adjusting gib for linear recirculating roller bearing RUS 26 102, metric dimensions.

Ordering designation: VUS 26 102 (Figure 3)

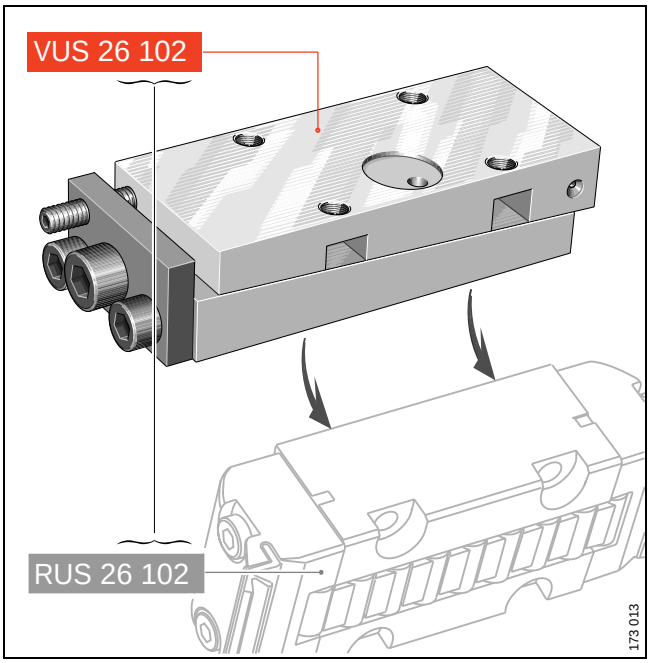


Figure 3 · Ordering example, ordering designation – adjusting gib VUS

Setting device

One setting block for linear recirculating roller bearing RUS 26 102 and two setting blocks for linear recirculating roller bearings 19 069

Distributor with manometer VBM 01 (article no. 126 361-7)

High-pressure rubber hose HDS 01/250 (article no. 126 358-7)

Ordering designation: 1 off EUS 26 (article no. 126 352-8)
2 off EUS 19 (article no. 126 350-1)
1 off VBM 01 (article no. 126 361-7)
2 off HDS 01/250
(article no. 126 358-7) (Figure 4)

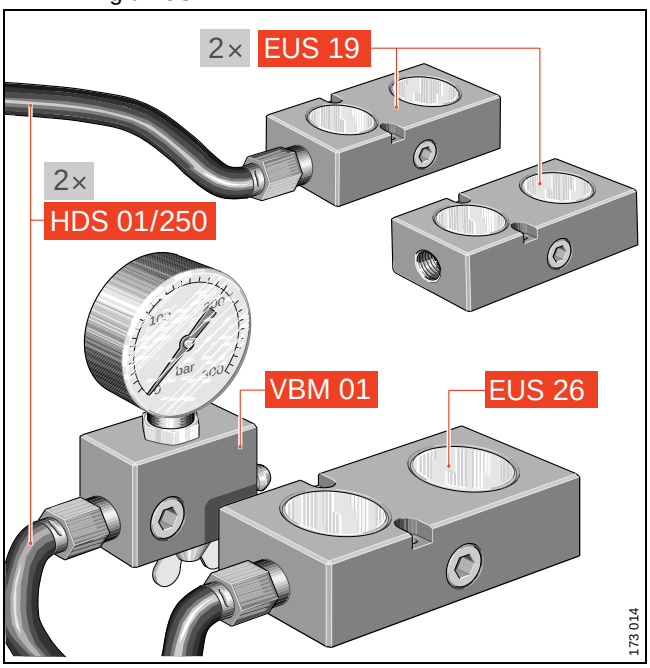
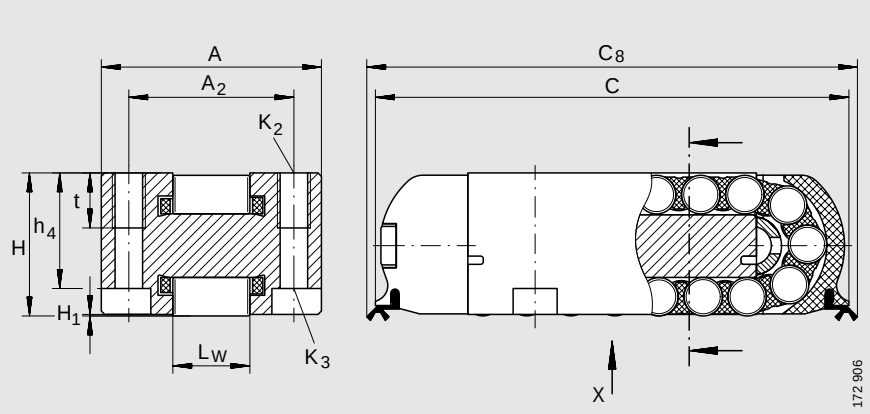


Figure 4 · Ordering example, ordering designation – setting device

INA linear recirculating roller bearings

Series RUS
RUS..KS



RUS 19 069 to RUS 38 206

Dimension table · Dimensions in mm

Designation		Mass	Dimensions			Mounting dimensions					
			A	C_8	H	A_2	C	C_2	C_3	C_1	C_9[2]
		kg		≈		±0,1		±0,1			
RUS 19 069	**–**	0,16	27	75	19	20,6	69	25,5	–	44	50
–	**RUS 19 069 KS**	0,19	27	–	19	20,6	–	25,5	76	44	50
RUS 19 105	**–**	0,27	27	111	19	20,6	105	50	–	78,5	85
–	**RUS 19 105 KS**	0,29	27	–	19	20,6	–	50	112	78,5	85
RUS 26 086	**–**	0,41	40	92	26	30	86	28	–	53	63
–	**RUS 26 086 KS**	0,49	40	–	26	30	–	28	92	53	63
RUS 26 102	**–**	0,53	40	108	26	30	102	44	–	69	79
–	**RUS 26 102 KS**	0,61	40	–	26	30	–	44	108	69	79
RUS 26 126	**–**	0,7	40	132	26	30	126	68	–	93	103
–	**RUS 26 126 KS**	0,78	40	–	26	30	–	68	132	93	103
RUS 38 134	**–**	1,27	52	133	38	41	133	51	–	85	100
–	**RUS 38 134 KS**	1,53	52	–	38	41	–	51	136	85	100
RUS 38 206	**–**	2,28	52	206	38	41	206	102	–	158	172
–	**RUS 38 206 KS**	2,53	52	–	38	41	–	102	209	158	172
RUS 65 210	**–**	7,5	76	234	65	62	211	76	–	134	–
RUS 85 280[4]	**–**	16	104	303	85	82,5	281	101,5	–	185	–

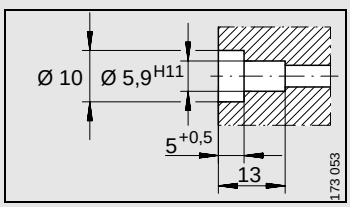
1) If the lubrication nipple is replaced by a tube or hose connector, the maximum screw length cannot be more than 6 mm.

2) Minimum support length.

3) UG guideway for RUS 85 280 available by agreement.

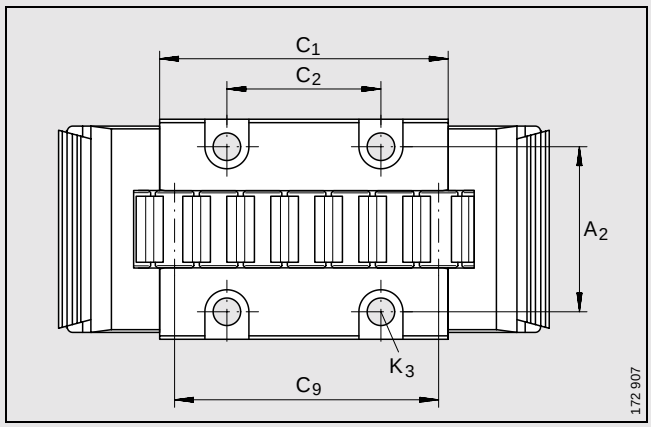
4) Available by agreement.

5) Hole connectors on both sides for optional funnel type lubrication nipples to DIN 3405-D6 (supplied loose) or tube or hose connectors. The holes should be closed off using lubrication nipples if a lubrication feed connector is not used.

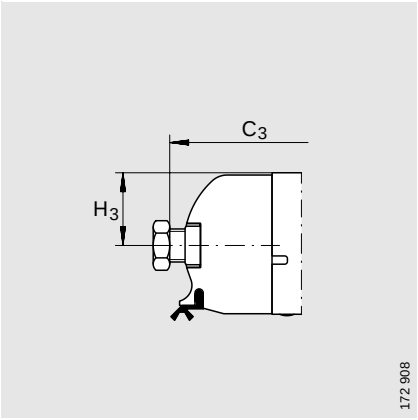


6) Adjusting gibs, page 186.

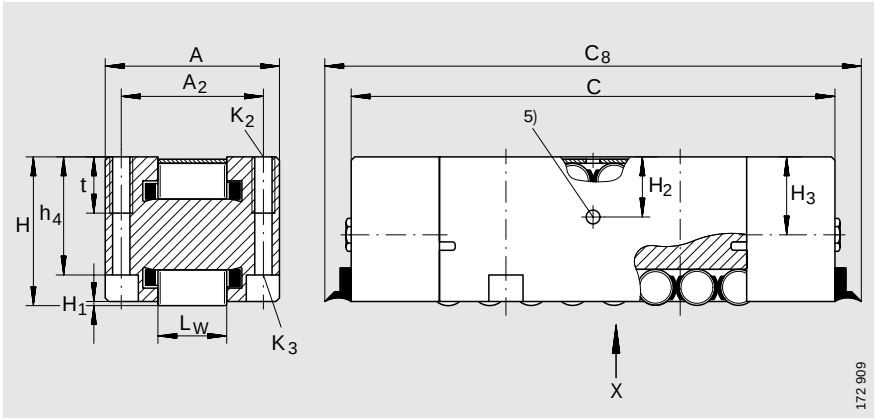
7) Guideways from page 196.



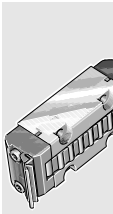
View X

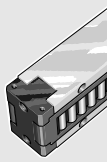


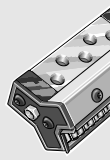
RUS 19 069 KS to RUS 38 206 KS



RUS 65 210 and RUS 85 280





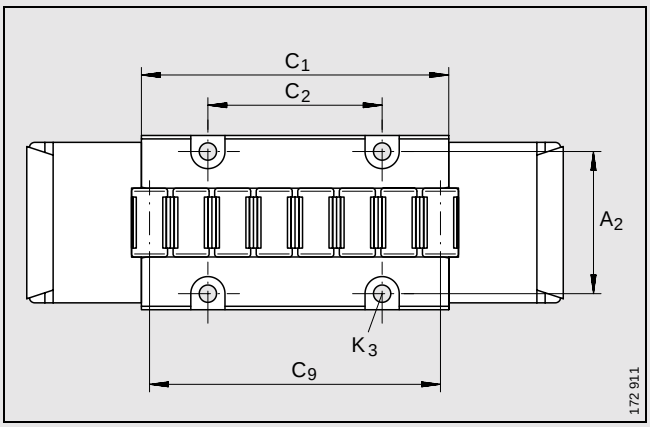


H_1	H_2	H_3	h_4	K_2[8] to DIN 912-12.9	L_W	t	Funnel type lubrication nipple[1]	Basic load ratings dyn. C N	Basic load ratings stat. C_0 N	K_3[8] to DIN 912-12.9	Suitable adjusting gib[6]	Suitable guideway[7]
0,2	–	–	15,5	M4	10	6		42 000	33 000	M3	**VUS 19 069**	**UG 6628** **UV 5323** **UFA 3210** **UFK 3210** **UFB 4710**
0,2	–	10	15,5	M4	10	6	DIN 3 405-AM6	42 000	33 000	M3	**VUS 19 069**	
0,2	–	–	15,5	M4	10	6		68 000	61 000	M3	**VUS 19 105**	
0,2	–	10	15,5	M4	10	6	DIN 3 405-AM6	68 000	61 000	M3	**VUS 19 105**	
0,2	–	–	21	M6	14	10		76 000	56 000	M4	**VUS 26 086**	**UG 9741** **UV 7532** **UFA 4710** **UFK 4710** **UFB 6412**
0,2	–	13,5	21	M6	14	10	DIN 3 405-AM6	76 000	56 000	M4	**VUS 26 086**	
0,2	–	–	21	M6	14	10		95 000	75 000	M4	**VUS 26 102**	
0,2	–	13,5	21	M6	14	10	DIN 3 405-AM6	95 000	75 000	M4	**VUS 26 102**	
0,2	–	–	21	M6	14	10		122 000	103 000	M4	**VUS 26 126**	
0,2	–	13,5	21	M6	14	10	DIN 3 405-AM6	122 000	103 000	M4	**VUS 26 126**	
0,2	–	–	31	M8	20	14		179 000	133 000	M6	**VUS 38 134**	**UG 12 553** **UV 9542** **UFA 6412** **UFK 6412** **UFB 7812**
0,2	–	19,5	31	M8	20	14	DIN 3 405-AM6	179 000	133 000	M6	**VUS 38 134**	
0,2	–	–	31	M8	20	14		305 000	265 000	M6	**VUS 38 206**	
0,2	–	19,5	31	M8	20	14	DIN 3 405-AM6	305 000	265 000	M6	**VUS 38 206**	
0,5	26	34	55	M10	30	22	DIN 3 405-AM8×1[4]	465 000	345 000	M8	**VUS 65 210**	**UG 16 260** **UV 13 863** **UFA 8815** **UFK 8815** **UFB 10 615**
0,5	33	45	73	M14	40	30	DIN 3 405-AM8×1[4]	840 000	620 000	M10	**VUS 85 280**	**UG....[3]** **UV 16 977** **UFA 11 518** **UFK 11 518** **UFB 14 0185**

Fixing screws	
Size	Tightening torque[8] Nm max.
M3	1,8
M4	5
M5	10
M6	17
M8	41
M10	83

[8] The values apply to screws with a preservative. If there is a possibility of settling, the screws should be secured against rotation.

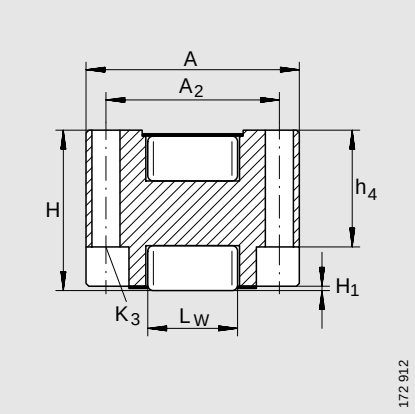
⚠ Ensure that the adjacent construction has adequate strength! See VDI guideline 2230!



View X

INA linear recirculating roller bearings

Series PR



PR

Dimension table · Dimensions in mm

Designation	Mass	Dimensions			Mounting dimensions						
		A	C	H	A_2	C_2	C_1	C_9	H_1	h_4	L_W
	kg				±0,1	±0,1			min.		
PR 14 032	0,095	22,23	51	14,285	17,1	19	37,8	31	0,05	10	9
PR 14 044	0,2	25,4	69	19,05	20,6	25,5	54,5	42	0,05	14	10
PR 14 061	0,65	38,1	96	28,57	31	38	77,5	58,5	0,05	20,8	16
PR 14 089	1,75	50,8	142	38,1	41	51	121,5	90	0,05	28	20
PR 14 135	5,65	76,2	198	57,15	62	76,2	158	126	0,05	42	30
PR 14 182	13,25	101,6	264	76,2	82,5	101,6	211	167	0,05	56	40

1) UG guideways for PR 14 182 available by agreement.

2) Delivery not ex stock. Delivery times on request.

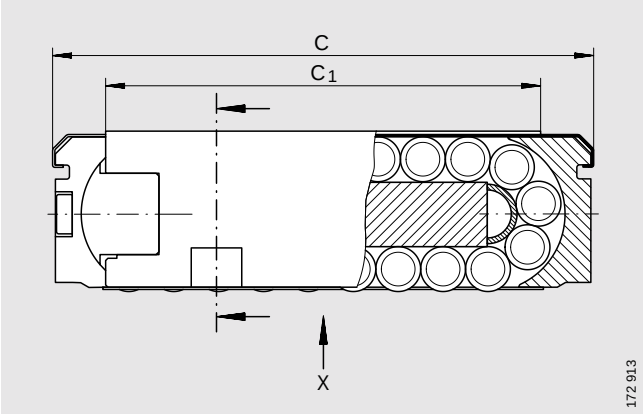
3) Adjusting gibs, page 186.

4) Guideways from page 196.

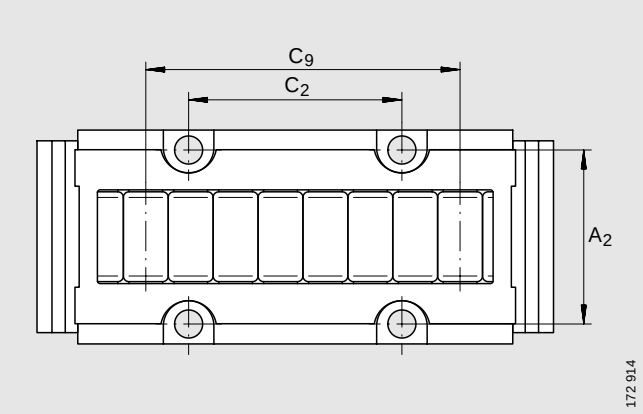
5) The values apply to screws with a preservative. If there is a possibility of settling, the screws should be secured against rotation.

⚠ Ensure that the adjacent construction has adequate strength! See VDI guideline 2230!

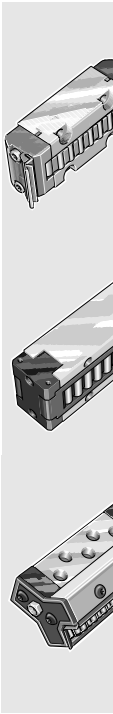
Fixing screws	
Size	Tightening torque[5] Nm max.
M2,5	1
M3	1,8
M4	5
M5	10
M6	17
M8	41



PR



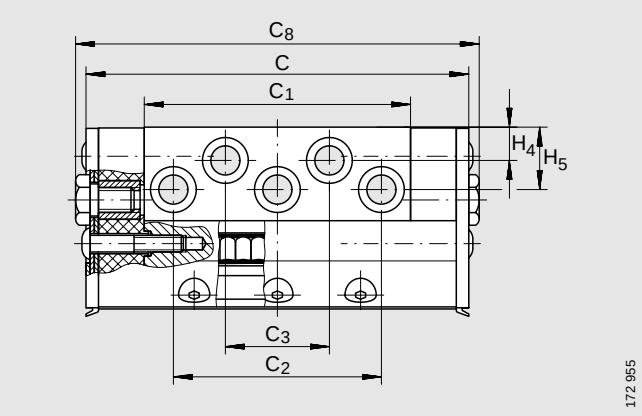
View X



Basic load ratings		K_3[5] to DIN 912-12.9	Suitable adjusting gib[3]	Suitable guideway[4]	
dyn. C N	stat. C_0 N				
21 700	17 600	M2,5	–	**UG 6628** **UV 5323**	**UFA 3210** **UFK 3210**
44 000	37 500	M3	**VUSZ 12 044**	**UG 6628** **UV 5323**	**UFA 3210** **UFK 3210** **UFB 4710**
107 000	86 000	M4	**VUSZ 18 059**	**UG 9741** **UV 7532**	**UFA 4710** **UFK 4710** **UFB 6412**
205 000	171 000	M5	**VUSZ 24 084**	**UG 12 553** **UV 9542**	**UFA 6412** **UFK 6412** **UFB 7812**
435 000	345 000	M6	**VUSZ 36 135**[2]	**UG 16 260** **UV 13 863**	**UFA 8815** **UFK 8815** **UFB 10 615**
790 000	620 000	M8	**VUSZ 48 182**[2]	**UG....**[1] **UV 16 977**	**UFA 11 518** **UFK 11 518** **UFB 14 018**

HYDREL linear recirculating roller bearing as angled element

Series RUSW



RUSW

Dimension table · Dimensions in mm

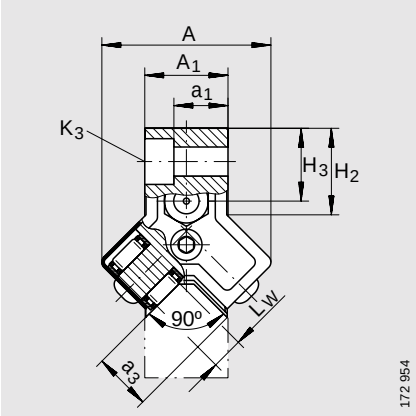
Designation	Mass	Dimensions			Mounting dimensions							
		A	C_8	H[1]	A_1	A_4[1]	a_1	a_3	C	C_2	C_3	C_1
	kg					±0,05				±0,1	±0,1	
RUSW 4020	0,47	42	97	60	20	10	13	13	92	50	25	64

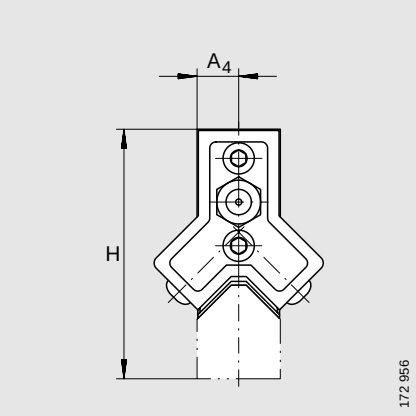
1) If a set RUSW 4020 is ordered with the suffix .S, the dimensions H and A_4 are supplied within a tolerance of 5 µm.

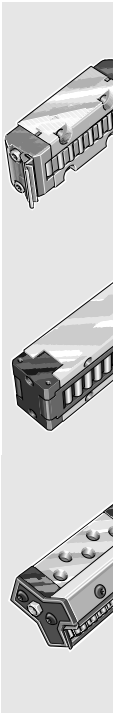
2) Guideways from page 54.

3) The values apply to screws with a preservative. If there is a possibility of settling, the screws should be secured against rotation.
⚠ Ensure that the adjacent construction has adequate strength! See VDI guideline 2230!

Fixing screws	
Size	Tightening torque[3] Nm max.
M6	17





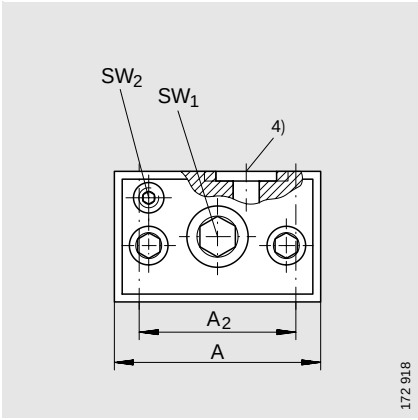


						Basic load ratings		Suitable guideway[2]
H_2	H_3	H_4 ±0,1	H_5 ±0,1	K_3[3] to DIN 912-12.9	L_W	dyn. C N	stat. C_0 N	
21,5	17,5	8	15	M6	8	50 000	125 000	**V 4020**

Adjusting gibs

Series VUS
metric

Series VUSZ
inch



VUS

Dimension table · Dimensions in mm

Designation	Mass	Dimensions			Mounting dimensions								
		A	C	H	A_2	A_3	A_4	C_{10}	C_2	C_{11}	C_{12}	C_{13}	C_{14}
	kg		max.	min.	±0,1			max.	±0,1			max.	
VUS 19 069	0,24	26,5	78	16	20,6	14,9	–	73	25,5	62	16,5	7	16,5
VUS 19 105	0,32	26,5	123	16	20,6	14,9	–	119	50	100	25	15	29
VUS 26 086	0,6	39,5	97	25	30	20,5	–	89	28	75	20,5	8	19,5
VUS 26 102	0,71	39,5	113	25	30	20,5	–	105	44	91	20,5	8	27,5
VUS 26 126	0,9	39,5	137	25	30	20,5	–	129	68	115	20,5	8	39,5
VUS 38 134	1,47	51,5	141	30	41	28,25	–	131	51	115	28	8	30,5
VUS 38 206	2,1	51,5	250	25	41	28,25	–	240	102	200	49	30	61
VUS 65 210[2)]	4,7	75	234	38	62	30,9	21,6	220	76	200	62	10	40,5
VUS 85 280[2)]	8,8	100	314	38	82,5	41,25	25	300	101,5	280	89	10	53,5

Dimension table · Dimensions in mm

Designation	Mass	Dimensions			Mounting dimensions								
		A	C	H	A_2	A_3	A_4	C_1	C_2	C_{11}	C_{12}	C_{13}	C_{14}
	kg		max.	min.	±0,1			max.	±0,1			max.	
VUSZ 12 044	0,19	25	78	16	19[1)]	14,2	–	73	25,5	62	16,5	7	16,5
VUSZ 18 059	0,63	37,6	107	25	31	22,3	–	99	38	85	20,5	8	20
VUSZ 24 084	1,38	50	141	30	41	28,5	–	131	51	115	28	8	30,5
VUSZ 36 135[2)]	4,7	75	234	38	62	30,9	21,6	220	76,2	200	62	10	40,5
VUSZ 48 182[2)]	8,8	100	314	38	82,5	41,25	25	300	101,5	280	89	10	53,5

1) Distance between fixing holes in the upper gib half, differing from the lower gib half.

2) Delivery not ex stock. Delivery times on request.

3) Linear recirculating roller bearings, page 180 and page 182.

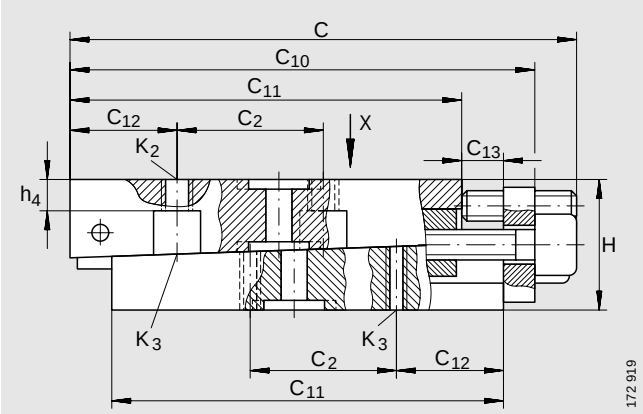
4) Through lubrication hole.

5) The values apply to screws with a preservative. If there is a possibility of settling, the screws should be secured against rotation.

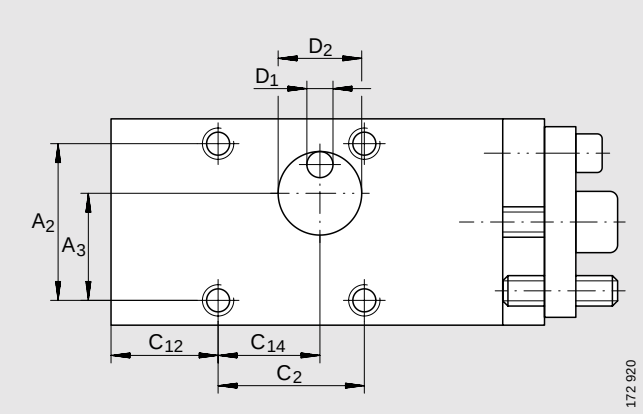
⚠ Ensure that the adjacent construction has adequate strength! See VDI guideline 2230!

6) Depending on the size, screws to DIN 912 or set screws to DIN 913 are used.

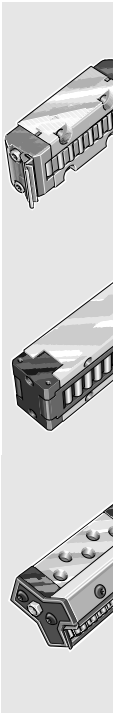
Fixing screws	
Size	Tightening torque[5)] Nm max.
M3	1,8
M4	5
M5	10
M6	17
M8	41
M10	83
M14	220



VUSZ

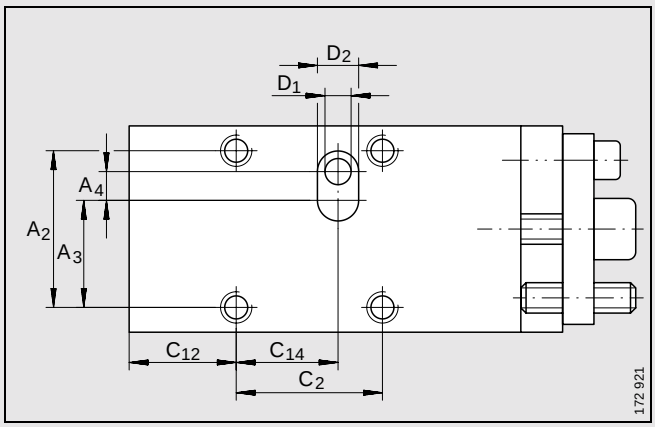


View X



D_1	D_2	h_4	K_2[5] to DIN 912-12.9	K_3[5] to DIN 912-12.9	Feed ΔH max.	Feed per screw revolution	Adjusting screw A/F_1	Locking and extraction screw[6] A/F_2	Suitable linear recirculating roller bearing[3]
3,5	12	4	M4	M3	0,35	0,035	3	2	**RUS 19 069**
3,5	12	3,5	M4	M3	0,5	0,023	3	2,5	**RUS 19 105**
5	16	6	M6	M4	0,4	0,05	6	3	**RUS 26 086**
5	16	6	M6	M4	0,4	0,05	6	3	**RUS 26 102**
5	16	6	M6	M4	0,4	0,05	6	3	**RUS 26 126**
5	22	7	M8	M6	0,4	0,062	8	4	**RUS 38 134**
5	22	5	–	M6	1	0,05	8	5	**RUS 38 206**
8	8	7	M10	M8	0,5	0,075	12	5	**RUS 65 210**
8	10	6	M14	M10	0,5	0,075	12	4	**RUS 85 280**

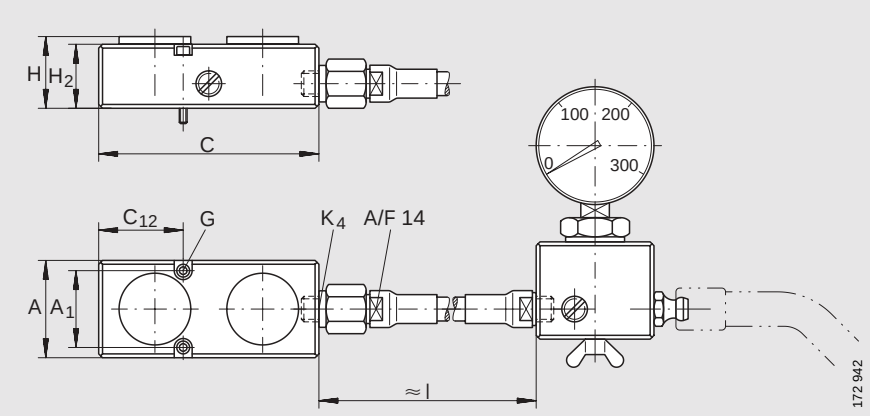
D_1	D_2	h_4	K_3[5] to DIN 912-12.9	Feed ΔH max.	Feed per screw revolution	Adjusting screw A/F_1	Locking and extraction screw[6] A/F_2	Suitable linear recirculating roller bearing[3]
3,5	12	4	M3	0,35	0,035	3	2	**PR 14 044**
5	16	6	M4	0,4	0,05	6	3	**PR 14 061**
5	22	7	M5	0,4	0,062	8	4	**PR 14 089**
8	8	7	M6	0,5	0,075	12	5	**PR 14 135**
8	10	6	M8	0,5	0,075	12	4	**PR 14 182**



View X
VUS 65 210, VUSZ 36 135, VUS 85 280, VUSZ 48 182

Setting device

Series EUS

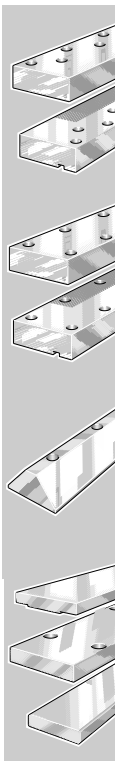


EUS

Dimension table · Dimensions in mm

Setting block	for linear recirculating roller bearing[1)]	Dimensions			Mounting dimensions						Article no.	High-pressure rubber hose HDS 01/....	Distributor with pressure gauge VBM
		A_K cm²	C	H max.	A	A_1	C_{12}	H_2	G	K_4			
EUS 19	**RUS 19069**	5	72	19,5	25,4	20,6	28	18	M3×20	$R^1/_8$“	126 350-1	l = 250 01/250 Article no. 126 358-7	01 Article no. 126 361-7
	RUS 19105	5	72	19,5	25,4	20,6	28	18	M3×20	$R^1/_8$“	126 350-1		
	RUSZ 12044	5	72	19,5	25,4	20,6	28	18	M3×20	$R^1/_8$“	126 350-1		
	PR 14044	5	72	19,5	25,4	20,6	28	18	M3×20	$R^1/_8$“	126 350-1		
EUS 26	**RUS 26086**	10	86	28	38	30	33	25	M4×30	$R^1/_8$“	126 352-8	l = 400 01/400 Article no. 126 359-5	
	RUS 26102	10	86	28	38	30	33	25	M4×30	$R^1/_8$“	126 352-8		
EUS 14061	**RUSZ 18059**	10	85	30	38	31	33	27,5	M4×30	$R^1/_8$“	152 704-5		
	PR 14061	10	85	30	38	31	33	27,5	M4×30	$R^1/_8$“	152 704-5		
EUS 26126	**RUS 26126**	15	115	28	38	30	33	25	M4×30	$R^1/_8$“	126 353-6	l = 1000 01/1000 Article no. 126 360-9	
EUS 38	**RUS 38134**	20	115	40	50,8	41	44	36	M6×40	$R^1/_8$“	126 354-4		
	RUSV 24084	20	115	40	50,8	41	44	36	M6×40	$R^1/_8$“	126 354-4		
	PR 14089	20	115	40	50,8	41	44	36	M6×40	$R^1/_8$“	126 354-4		
EUS 38206	**RUS 38206**	30	200	40	50,8	41	59	36	M6×40	$R^1/_8$“	126355-2		
EUS 65	**RUS 65210**	60	200	70	75	62	37	60	M8 ×70	$R^1/_8$“	126 356-0		
EUS 85	**RUS 85280**	100	250	90	100	82,5	89	80	M10×90	$R^1/_8$“	126 357-0		

[1)] Linear recirculating roller bearings, page 180 and page 182.



Linear recirculating roller guidance systems

HYDREL guideways

Features

HYDREL guideways

- are high precision elements that can be combined with INA linear recirculating roller bearings to give high precision linear recirculating guidance systems
- are made from through hardened tool steel (670 +170 HV)
- have precision ground raceways R_a0,4 (R_Z2)
- are supplied as single-piece elements up to the maximum length (*dimension table*)
  - longer guideways are made up from matched and marked sections.

Guideways UG, UGN, UGS, UGSN

- have four raceways for linear recirculating roller bearings
- support forces in the main load direction and opposing direction with a counterstay as well as lateral forces in two directions (*Design examples*, page 159)
  - UGN, UGSN have a continuous slot for a square steel bar to support high lateral forces in two directions.

Guideways UZ, UZN, UZS, UZSN

- have three raceways for linear recirculating roller bearings
  - the upper raceway is arranged between the holes for the fixing screws.
- support forces in the main load direction and lateral forces in two directions (*Design examples*, page 159)
  - UZN, UZSN have a continuous slot for a square steel bar to support high lateral forces in two directions.

Guideways UV

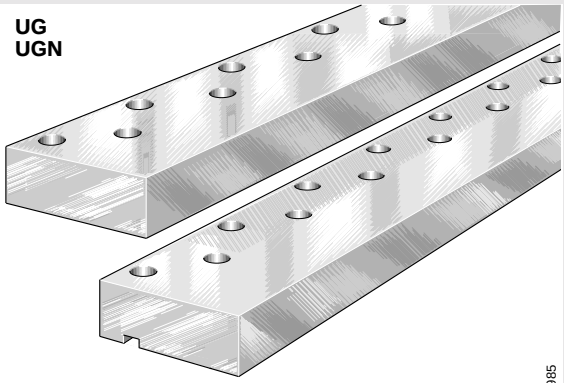
- have two raceways arranged at an angle of 45° to the mounting surface
- support forces in the main load direction and lateral forces in two directions (*Design examples*, page 159)
- allow simple adjacent construction designs when combined with HYDREL adapters.

Guideways UFA, UFB, UFK

- have only one raceway
- allow a low guidance height due to the low section height of the guideway
- support forces in the main load direction only (*Design examples*, page 159)
- are located by adhesive bonding (UFA), screw mounting (UFB) or a clamping strip in a slot (UFK).

HYDREL guideways

UG
UGN



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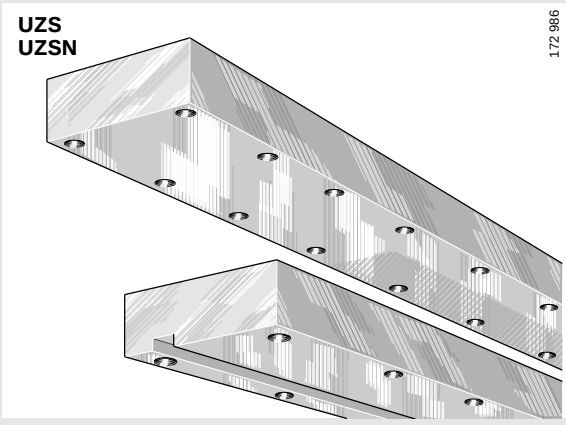
- rectangular cross-section with four raceways, offset hole pattern
- through holes with cylindrical counterbores for fixing screws to DIN 912
- UGN has a milled continuous slot for a square steel bar to DIN 178 in order to support high lateral forces

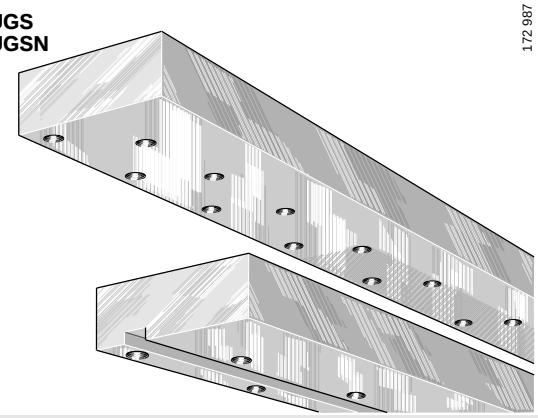
UZS
UZSN



198

- rectangular cross-section with three raceways, parallel hole pattern
- threaded blind holes
- UZSN has a milled continuous slot for a square steel bar to DIN 178 in order to support high lateral forces

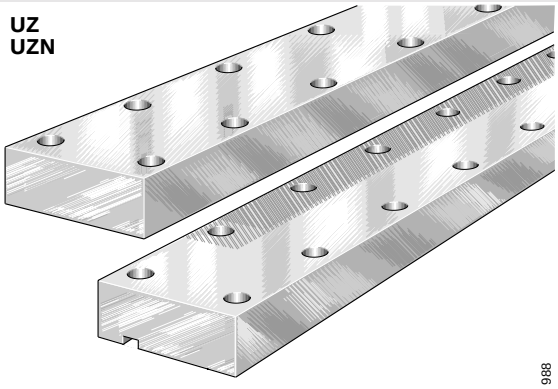
UGS
UGSN



196

- rectangular cross-section with four raceways, offset hole pattern
- threaded blind holes
- UGSN has a milled continuous slot for a square steel bar to DIN 178 in order to support high lateral forces

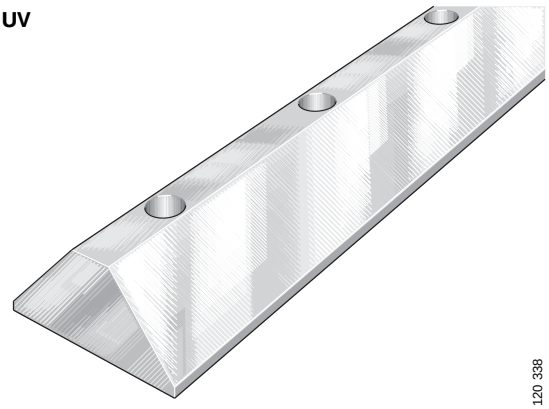
UZ
UZN



198

- rectangular cross-section with three raceways, parallel hole pattern
- through holes with cylindrical counterbores for fixing screws to DIN 912
- UZN has a milled continuous slot for a square steel bar to DIN 178 in order to support high lateral forces

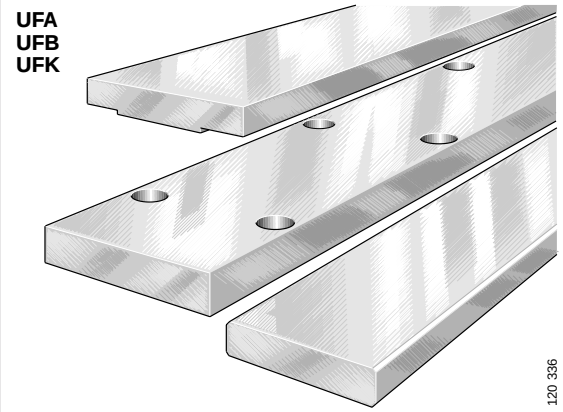
UV



200

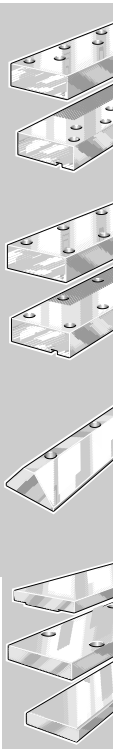
- trapezoidal cross-section, single row hole pattern
- through holes with cylindrical counterbores for fixing screws to DIN 912
- suitable for adapters AUV, AUVL, APUV

UFA
UFB
UFK



201

- UFA: for adhesive fixing
- UFB for screw mounting, through holes with cylindrical counterbores for fixing screws to DIN 912
- UFK: for clamping by means of clamping strip UKB



Design and safety guidelines

The running accuracy of the linear recirculating roller guidance system is determined to a significant extent by the accuracy and alignment of the guideways!

For guidance systems with a length greater than L_{max}, the guideway assembly is composed of several sections. Precise production and matching allow consistent accuracy and smooth running over the whole traverse distance.

The parts of multi-piece guideways are matched to each other, packed together and form a set. All parts of the same set have the same set number. The joints are additionally marked by means of consecutive letters (*Design of bearing arrangements*, page 148; *Fitting*, page 162).

Further information

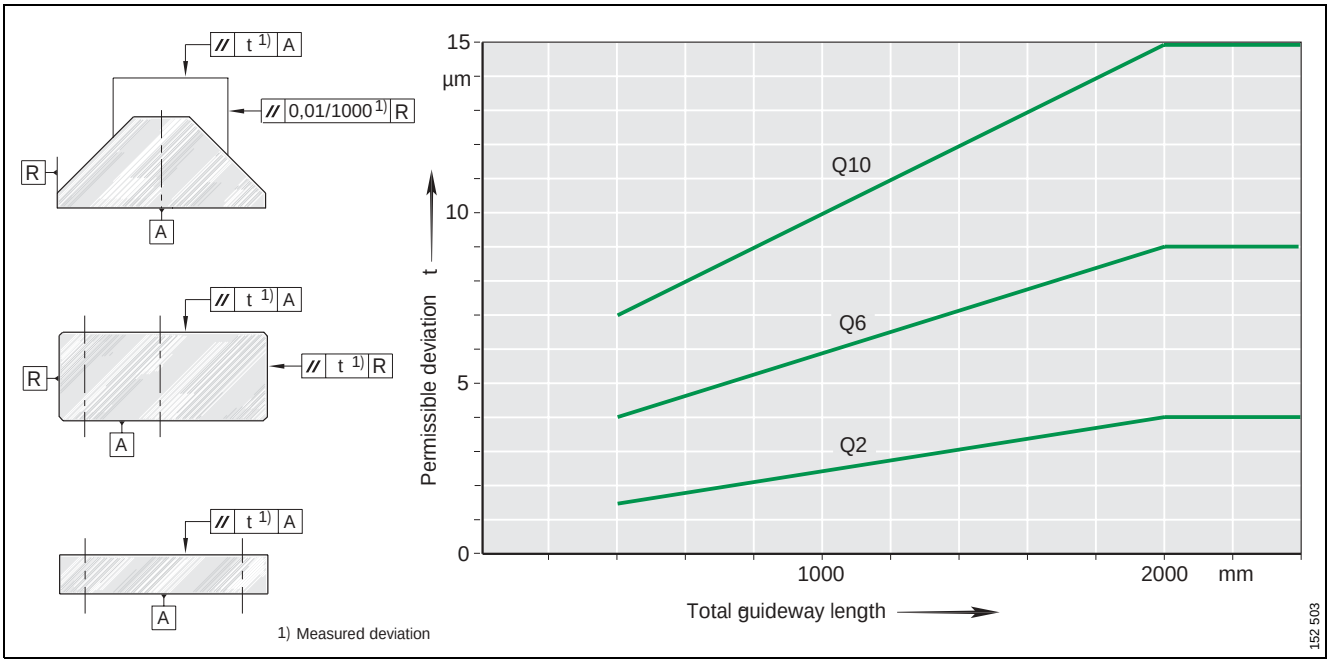


Figure 1 · Quality and parallelism of HYDREL guideways

Accuracy

HYDREL guideways

Guideways are available in three quality grades (Figure 1):

- Q2
  For exacting requirements in high precision machines. This grade should only be used if the adjacent construction is of correspondingly high accuracy.
- Q6
  For precision guidance systems in machine tool design. Standard grade for arrangements with counterstay.
- Q10
  For requirements in general machine building.

The guideways have length tolerances according to Table 1.

Table 1 · Length tolerances of HYDREL guideways

Guideway Designation	Length tolerances of guideways	
	Single-piece guideways	Multi-piece guideways
UG, UZ, UV UFA, UFB, UFK	L +2‰	L_{tot} ±2 mm

The positional tolerance of the hole pattern Ø X is 1‰ of the guideway length L (Figure 2). Guideways up to the maximum length according to Table 2 can be fitted to a predrilled hole pattern if a positional tolerance of Ø 0,2 can be achieved for the hole pattern.

If longer guideways are to fulfil this requirement, they must be ordered using the suffix P (positional tolerance).

Table 2 · Maximum length of guideways for fitting to a predrilled hole pattern

Fixing screw Size	Guideway length max. mm
M4 / M5	1 000
M6	1 200
M8 / M12	1 700
M10 / M16	2 200

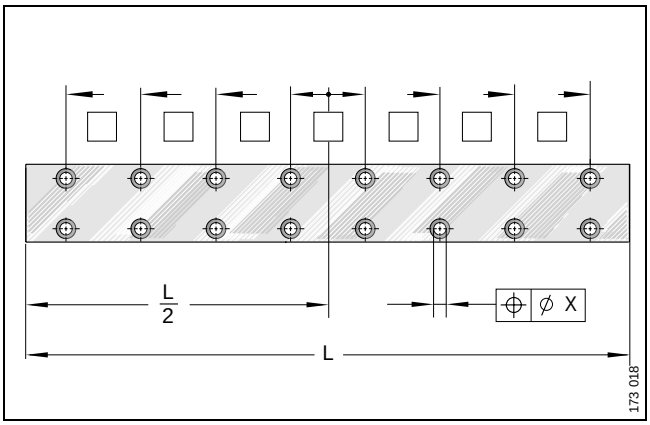
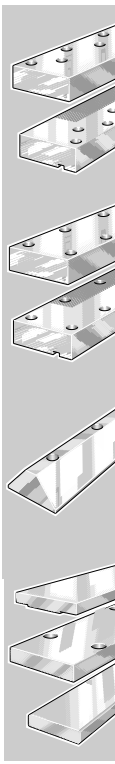


Figure 2 · Hole pattern of guideways



Multi-piece guideways

For multi-piece guideways, it is only necessary to state the total length. Further sorting information is not necessary.

The hole pitches over the joints are identical to those on single-piece guideways (dimension C_4, *dimension table*).

Example:

- 2 off UGN 9741×3600 Q6 each comprising two sections.

Sorted guideways

Guideways are sorted together if two or more guideways of the same profile are fitted in the same plane adjacent to each other or in series.

The sorting affects the positional accuracy of the raceways in relation to the mounting surfaces. The guideways are, within the respective quality grade, sorted and marked according to height and/or width. Sorting of the guideways is indicated by the suffix S and the number of sorted guideways.

Example:

- 2 off UG 9741×2000 Q6 2S.

Guideways for non-locating bearing side

If lateral guidance is only fulfilled by one guideway in a design solution, it is not necessary to machine the lateral surfaces of the second guideway to the raceway accuracy.

This more economical design is indicated by the suffix H after the grade symbol.

If various designs are to be used in the case of sorted guideways (suffix X), the ordering data must be marked by means of the suffix X.

Example:

- 5 off UG 9741×1600 Q6 2SX and
  5 off UG 9741×1600 Q6H 2SX.

Guideways with grinding allowance

If guideways are overground after fitting, guideways with preground raceways are used (suffix VQ).

The grade indicates the geometrical accuracy and surface quality of the mounting and locating surfaces.

The grinding allowance of the raceways is up to 0,1 mm

Example:

- 2 off UFB 4710×1200 VQ.

Special designs

Available by agreement:

- guideways in accordance with customer drawing
- lateral surfaces of guideways not machined to the raceway accuracy
  – suffix H
- all surfaces of guideways with grinding allowance
  – suffix VGS
- mounting surfaces of the guideways precision ground
  – suffix VQ
- mirror image hole pattern to hole pattern L
  – suffix R.

Ordering example and ordering designation

12 guideways for linear recirculating roller bearings RUS 26 126
Length 1000 mm (symmetrical hole pattern)
Sorted in matched pairs for 6 machines
Profile size UG 9741
Quality grade Q6.

Ordering designation: 12 off UG 9741×1000 Q6 2S (Figure 3).

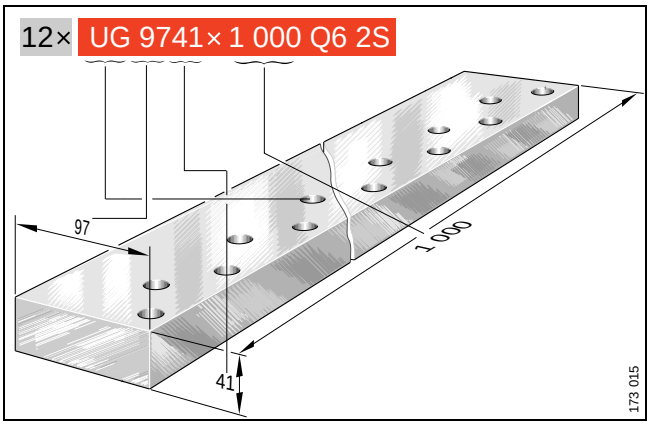


Figure 3 · Ordering example, ordering designation – UG

Sorted guideways

Guideways for linear recirculating roller bearings RUS 19 105
Length 1600 mm
Profile size UG 6628 (hole pattern on left side)
Profile size UZ 6628
Quality grade Q6.
Sorted for 10 machines

Ordering designation: 10 off UG 6628×1600 L Q6 2SX
10 off UZ 6628×1600 Q6 2SX
(Figure 4).

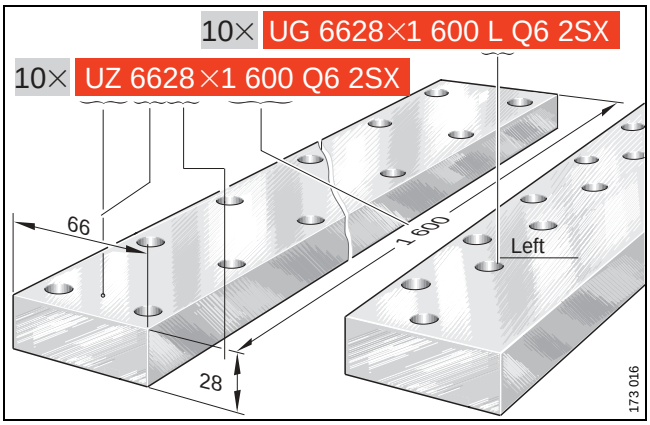


Figure 4 · Ordering example, ordering designation – UG/UZ

Multi-piece guideways

1 guideway for linear recirculating roller bearings RUS 19 069
Length 3200 mm (in two pieces)
Profile size UV 5323
Quality grade Q10.

Ordering designation: 1 off UV 5323×3200 Q10 (two pieces)
(Figure 5).

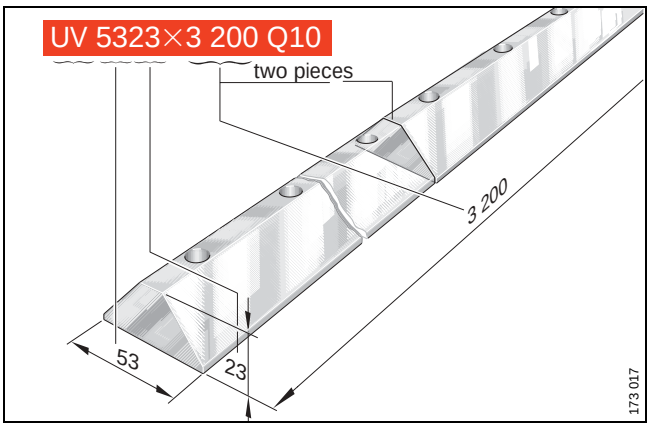
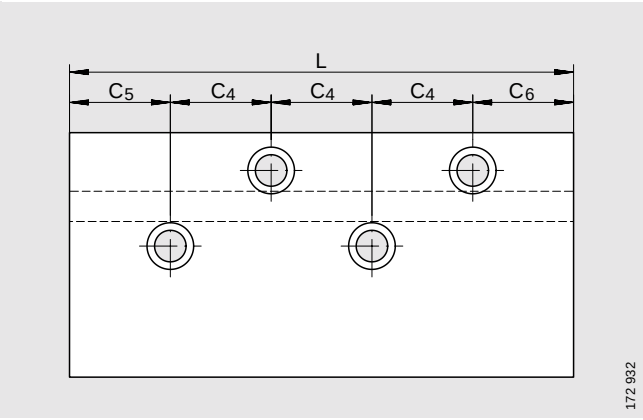


Figure 5 · Ordering example, ordering designation – UV

HYDREL guideways

Series UG
UGN
UGS
UGSN

Standard grade **Q6**



UG, UGN (view X)

Dimension table · Dimensions in mm

Designation	Dimensions			Mounting dimensions						
	A –0,1	H –0,1	L[1)] max.	A_1	A_2	C_4	C_5/C_6 min	C_5/C_6 max	C_a max.	h_4
UG 6628	66	28	2000	12	18	40	15	25	28	17
UGN 6628	66	28	2000	12	18	40	15	25	28	17
UGS 6628	66	28	2000	12	18	40	15	25	28	–
UGSN 6628	66	28	3000	12	18	40	15	25	28	–
UG 9741	97	41	3000	15	30	40	15	25	41	28
UGN 9741 A	97	41	3000	15	30	40	15	25	41	28
UGS 9741	97	41	3000	15	30	40	15	25	41	–
UGSN 9741 A	97	41	3000	15	30	40	15	25	41	–
UG 12553	125	53	3000	18	35	40	15	25	53	38
UGN 12553 A	125	53	3000	18	35	40	15	25	53	38
UGS 12553	125	53	3000	18	35	40	15	25	53	–
UGSN 12553 A	125	53	3000	18	35	40	15	25	53	–
UG 16260	162	60	3000	20	44	40	20	25	77	40
UGN 16260 A	162	60	3000	20	44	40	20	25	77	40
UGS 16260	162	60	3000	20	44	40	20	25	77	–
UGSN 16260 A	162	60	3000	20	44	40	20	25	77	–

1) L = available as single-piece guideways up to L_{max}; note alternating hole pattern.
Guideways longer than length L_{max} are supplied as multi-piece guideways.
The hole pattern of multi-piece guideways continues regularly over the joint.

2) The remaining gap is filled with castable resin after fitting.

3) Square steel bar to DIN 178 not included in delivery.

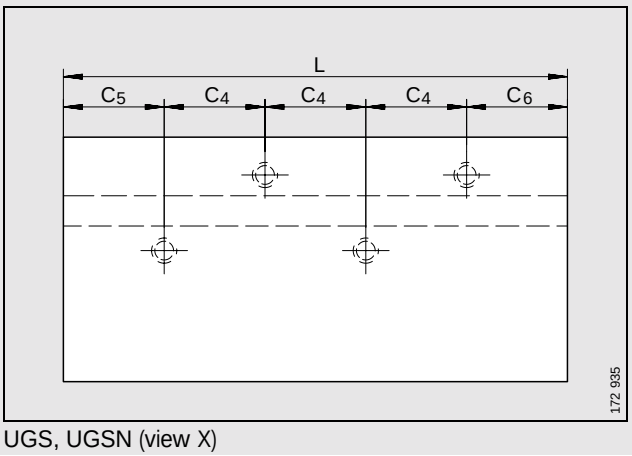
4) Indicate hole pattern and end pieces C_5/C_6 when ordering.

5) Linear recirculating roller bearings, page 180 and page 182.

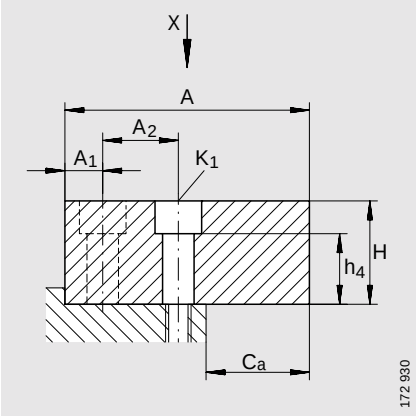
6) The values apply to screws with a preservative. If there is a possibility of settling, the screws should be secured against rotation.

⚠ Ensure that the adjacent construction has adequate strength! See VDI guideline 2230!

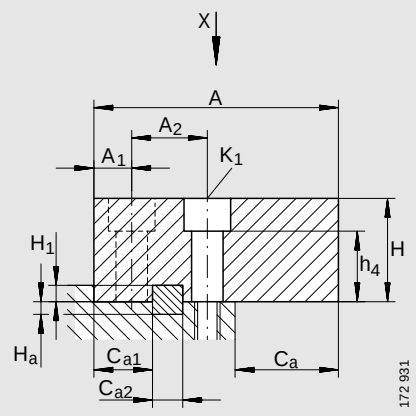
Fixing screws	
Size	Tightening torque[6)] Nm max.
M8	41
M10	83
M12	140
M16	350



UGS, UGSN (view X)

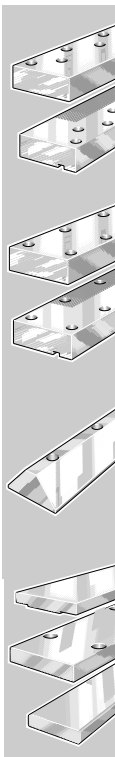


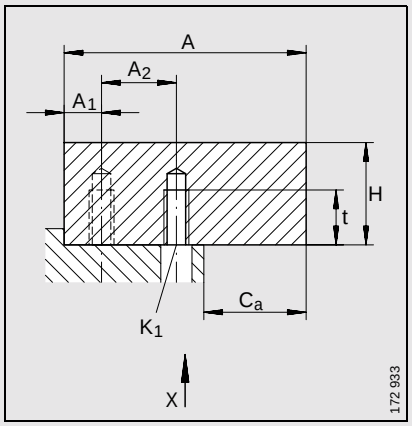
UG



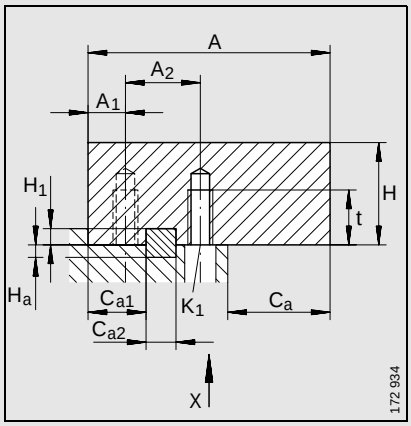
UGN

Fixing holes		Slots[2]				Square steel bar[3] DIN 178	Closing plugs	Suitable for linear recirculating roller bearing[5]	
K_1[6] to DIN 912-12.9	t	C_{a1}	C_{a2}	H_1	H_a				
M8	–	–	–	–	–	–	KVK 15	**RUS 19 069** **RUS 19 105**	**PR 14 032** **PR 14 044**
M8	–	17,75	6,5	3,5	2,5	5× 5	KVK 15		
M8	16	–	–	–	–	–	–		
M8	16	17,75	6,5	3,5	2,5	5× 5	–		
M10	–	–	–	–	–	–	KVK 18,5	**RUS 26 086** **RUS 26 102** **RUS 26 126**	**PR 14 061**
M10	–	23,25	12	6,5	5	10×10	KVK 18,5		
M10	22	–	–	–	–	–	–		
M10	22	23,25	12	6,5	5	10×10	–		
M12	–	–	–	–	–	–	KVK 20	**RUS 38 134** **RUS 38 206**	**PR 14 089**
M12	–	27	14	7,5	6	12×12	KVK 20		
M12	30	–	–	–	–	–	–		
M12	30	27	14	7,5	6	12×12	–		
M16	–	–	–	–	–	–	KA 26,5 M	**RUS 65 210**	**PR 14 135**
M16	–	31,25	18	9,5	8	16×16	KA 26,5 M		
M16	34	–	–	–	–	–	–		
M16	34	31,25	18	9,5	8	16×16	–		

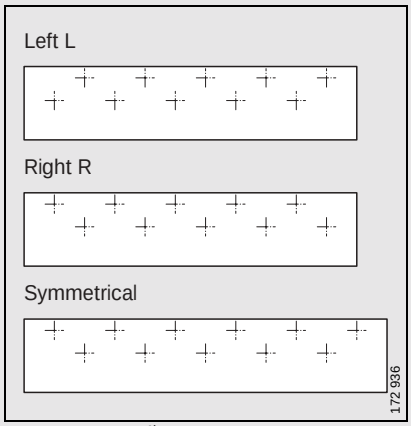




UGS



UGSN

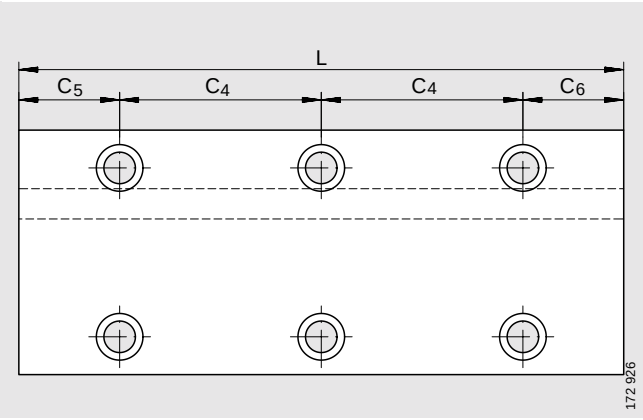


Hole patterns[4]

HYDREL guideways

Series UZ
UZN
UZS
UZSN

Standard grade **Q6**



UZ, UZN (view X)

Dimension table · Dimensions in mm

Designation	Dimensions			Mounting dimensions					
	A –0,1	H –0,1	L[1)] max.	A_1	A_2	C_4	C_5/C_6 min	C_5/C_6 max	h_4
UZ 6628	66	28	2 000	11	44	80	15	65	17
UZN 6628 A	66	28	2 000	11	44	80	15	65	17
UZS 6628	66	28	2 000	11	44	80	15	65	–
UZSN 6628 A	66	28	2 000	11	44	80	15	65	–
UZ 9741	97	41	2 960	15	67	80	15	65	28
UZN 9741 A	97	41	2 960	15	67	80	15	65	28
UZS 9741	97	41	2 960	15	67	80	15	65	–
UZSN 9741 A	97	41	2 960	15	67	80	15	65	–
UZ 12 553	125	53	2 960	18	89	80	15	65	38
UZN 12 553 A	125	53	2 960	18	89	80	15	65	38
UZS 12 553	125	53	2 960	18	89	80	15	65	–
UZSN 12 553 A	125	53	2 960	18	89	80	15	65	–
UZ 16 260	162	60	2 960	26	110	80	20	65	40
UZN 16 260 A	162	60	2 960	26	110	80	20	65	40
UZS 16 260	162	60	2 960	26	110	80	20	65	–
UZSN 16 260 A	162	60	2 960	26	110	80	20	65	–

1) L = available as single-piece guideways up to L_{max}.
Intermediate lengths available by agreement. Guideways longer than length L_{max} are supplied as multi-piece guideways.
The hole pattern of multi-piece guideways continues regularly over the joint.

2) The remaining gap is filled with castable resin after fitting.

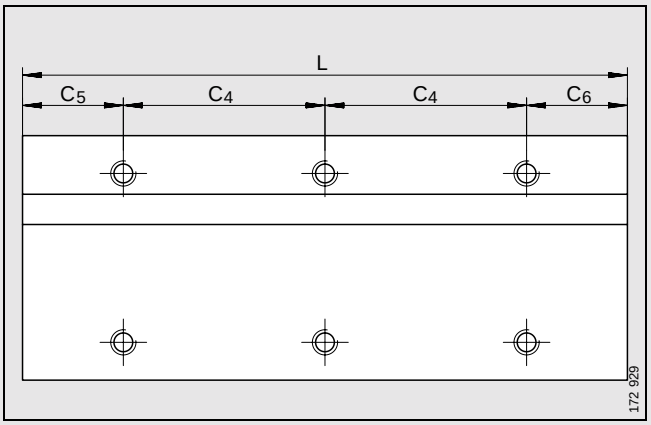
3) Square steel bar to DIN 178 not included in delivery.

4) Linear recirculating roller bearings, page 180 and page 182.

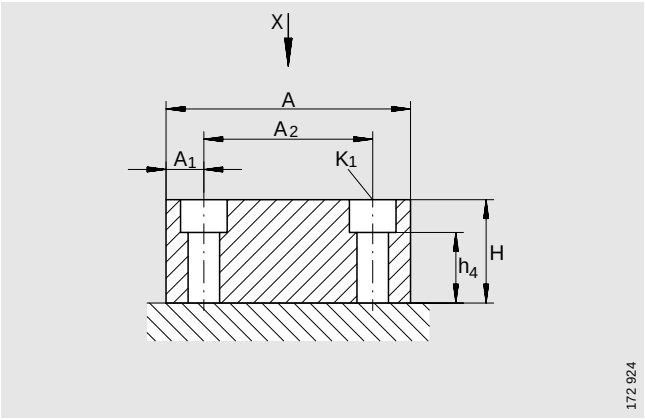
5) The values apply to screws with a preservative. If there is a possibility of settling, the screws should be secured against rotation.

⚠ Ensure that the adjacent construction has adequate strength! See VDI guideline 2230!

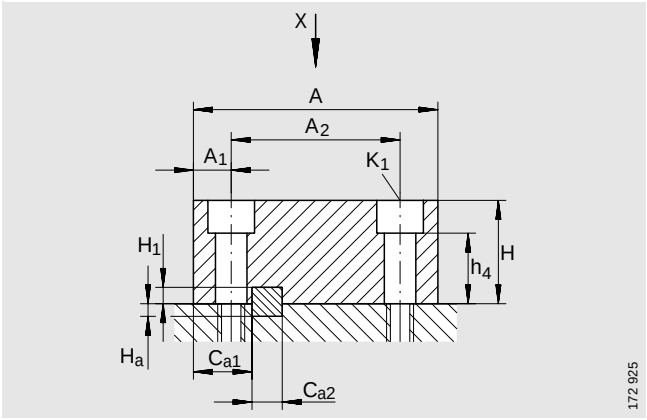
Fixing screws	
Size	Tightening torque[5)] Nm max.
M8	41
M10	83
M12	140
M16	350



UZS, UZSN (view X)

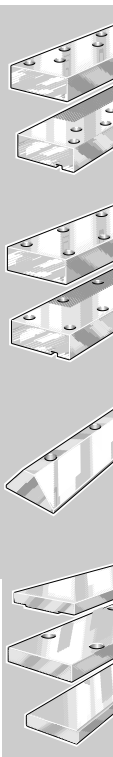


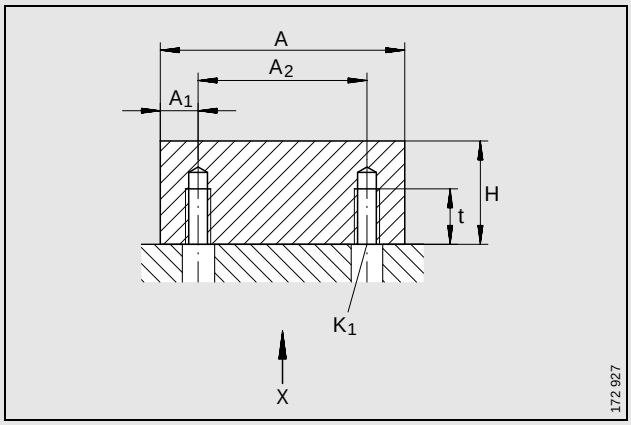
UZ



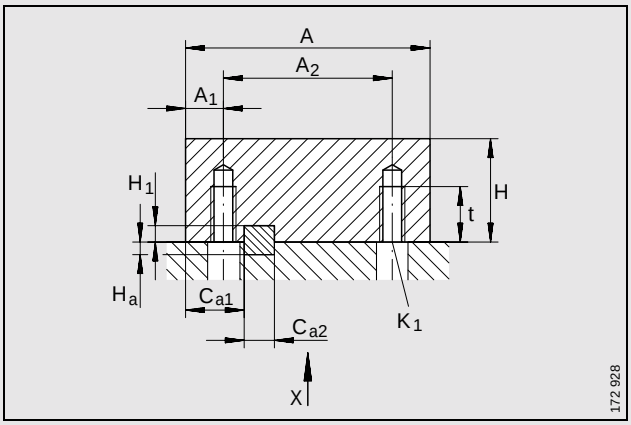
UZN

Fixing holes		Slots[2]				Square steel bar[3] DIN 178	Closing plugs	Suitable for linear recirculating roller bearing[4]	
K_1[5] to DIN 912-12.9	t	C_{a1}	C_{a2}	H_1	H_a				
M8	–	–	–	–	–	–	KVK 15	**RUS 19 069** **RUS 19 105**	**PR 14 032** **PR 14 044**
M8	–	17,75	6,5	3,5	2,5	5× 5	KVK 15		
M8	16	–	–	–	–	–	–		
M8	16	17,75	6,5	3,5	2,5	5× 5	–		
M10	–	–	–	–	–	–	KVK 18,5	**RUS 26 086** **RUS 26 102** **RUS 26 126**	**PR 14 061**
M10	–	23,25	12	6,5	5	10×10	KVK 18,5		
M10	22	–	–	–	–	–	–		
M10	22	23,25	12	6,5	5	10×10	–		
M12	–	–	–	–	–	–	KVK 20	**RUS 38 134** **RUS 38 206**	**PR 14 089**
M12	–	27	14	7,5	6	12×12	KVK 20		
M12	30	–	–	–	–	–	–		
M12	30	27	14	7,5	6	12×12	–		
M16	–	–	–	–	–	–	KA 26,5 M	**RUS 65 210**	**PR 14 135**
M16	–	37,25	18	9,5	8	16×16	KA 26,5 M		
M16	34	–	–	–	–	–	–		
M16	34	37,25	18	9,5	8	16×16	–		





UZS

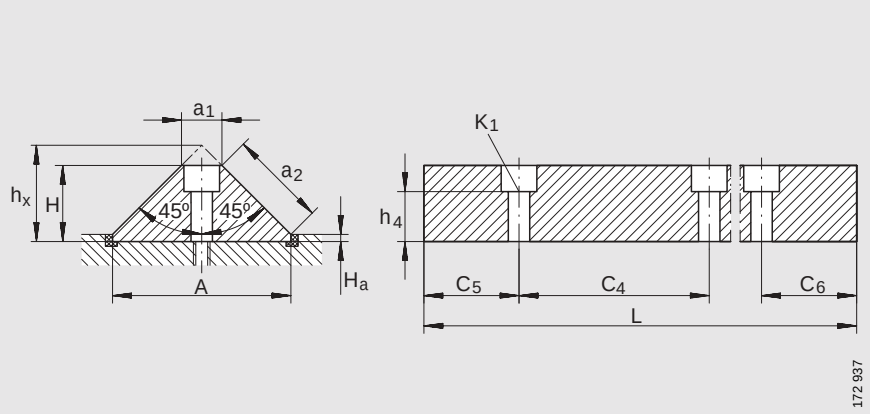


UZSN

HYDREL guideways

Series UV

Standard grade **Q10**



UV

Dimension table · Dimensions in mm

Designation	Dimensions				Mounting dimensions						Fixing holes		Closing plug	Suitable for linear recirculating roller bearing[2]	
	A –0,1	H –0,1	h_x –0,1	L[1] max.	a_1	a_2	C_4	C_5/C_6 min.	C_5/C_6 max.	H_a	h_4	K_1[3] to DIN 912-12.9			
UV 5323	53	23	29,5	2 000	13	28,3	80	10	70	3	15	M6	KVK 11,5	**RUS 19 069** **RUS 19 105**	**PR 14 032** **PR 14 044**
UV 7532	75	32	40,5	2 000	17	41	80	15	65	3	21	M8	KVK 15	**RUS 26 086** **RUS 26 102** **RUS 26 126**	**PR 14 061**
UV 9542	95	42	52	2 000	20	53	80	15	65	4,5	29	M10	KVK 18,5	**RUS 38 134** **RUS 38 206**	**PR 14 089**
UV 13 863	138	63,5	75	2 000	23	81	80	15	65	6	48,5	M12	KVK 20	**RUS 65 210**	**PR 14 135**
UV 16 977	169	77,5	92	2 000	29	99	80	20	60	7,5	57,5	M16	KA 26,5 M	**RUS 85 280**	**PR 14 182**

1) L = available as single-piece guideways up to L_{max}.
Intermediate lengths available by agreement. Guideways longer than length L_{max} are supplied as multi-piece guideways. The hole pattern of multi-piece guideways continues regularly over the joint.

2) Linear recirculating roller bearings, page 180 and page 182.

3) The values apply to screws with a preservative. If there is a possibility of settling, the screws should be secured against rotation.

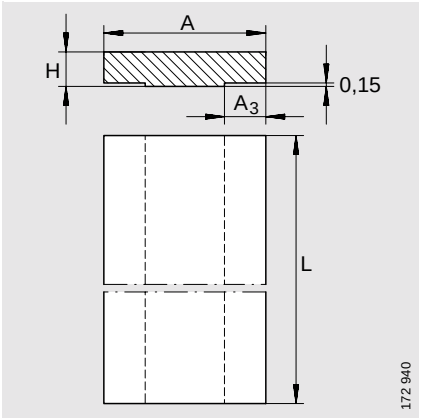
⚠ Ensure that the adjacent construction has adequate strength! See VDI guideline 2230!

Fixing screws	
Size	Tightening torque[3] Nm max.
M6	17
M8	41
M10	83
M12	140
M16	340

HYDREL guideways

Series UFA
UFB
UFK

Standard grade **Q10**



UFA, for adhesive bonding

Dimension table · Dimensions in mm

Designation	Dimensions			Mounting dimensions			Fixing holes				Bond width A_3	Suitable clamping strip[3]	Suitable for linear recirculating roller bearing[4]			
	A –0,1	H –0,1	L[1] max.	C_4	C_5 C_6 min.	C_5 C_6 max.	A_1	A_2	h_4	K1 to DIN 912-8.8						
UFA 3210	32	10	2000	–	–	–	–	–	–	–	8	–	**RUS 19 069**	**RUS 19 105**	**PR 14 032**	**PR 14 044**
UFK 3210	32	10	2000	–	–	–	–	–	–	–	–	UKB 10				
UFA 4710	47	10	2000	–	–	–	–	–	–	–	12	–	**RUS 26 086**	**RUS 26 102**	**RUS 26 126**	**PR 14 061**
UFB 4710	47	10	2000	80	10	70	5,5	36	4	M4	–	–	**RUS 19 069**	**RUS 19 105**	**PR 14 044**	
UFK 4710	47	10	2000	–	–	–	–	–	–	–	–	UKB 10	**RUS 26 086**	**RUS 26 102**	**RUS 26 126**	
UFA 6412	64	12	2000	–	–	–	–	–	–	–	15	–	**RUS 38 134**	**RUS 38 206**	**PR 14 089**	**PR 14 061**
UFB 6412	64	12	2000	80	10	70	6	52	5	M5	–	–	**RUS 26 086**	**RUS 26 102**	**RUS 26 126**	
UFK 6412	64	12	2000	–	–	–	–	–	–	–	–	UKB 12	**RUS 38 134**	**RUS 38 206**	**PR 14 089**	
UFB 7812	78	12	2000	80	10	70	7	64	5	M5	–	–	**RUS 38 134**	**RUS 38 206**	**PR 14 089**	
UFA 8815	88	15	2960	–	–	–	–	–	–	–	18	–	**RUS 65 210**		**PR 14 135**	
UFK 8815	88	15	2960	–	–	–	–	–	–	–	–	UKB 14				
UFB 10 615	106	15	2960	80	10	70	8	90	7	M6	–	–	**RUS 65 210**		**PR 14 135**	
UFA 11 518	115	18	2960	–	–	–	–	–	–	–	–	–	**RUS 85 280**		**PR 14 182**	
UFK 11 518	115	18	2960	–	–	–	–	–	–	–	–	UKB 14				
UFB 14 018	140	18	2960	80	15	65	11	118	7	M8	–	–	**RUS 85 280**		**RUS 14 182**	

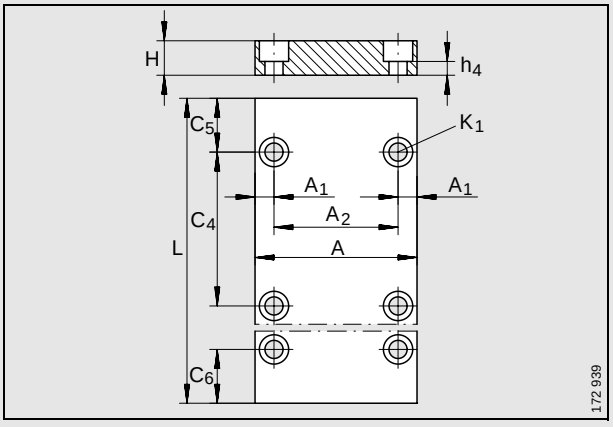
1) L = available as single-piece guideways up to L_{max}. Intermediate lengths available by agreement.
Guideways longer than length L_{max} are supplied as multi-piece guideways.
The hole pattern of multi-piece guideways continues regularly over the joint.

2) Slot width B_1 for clamping strip, see page 153, Table 5.

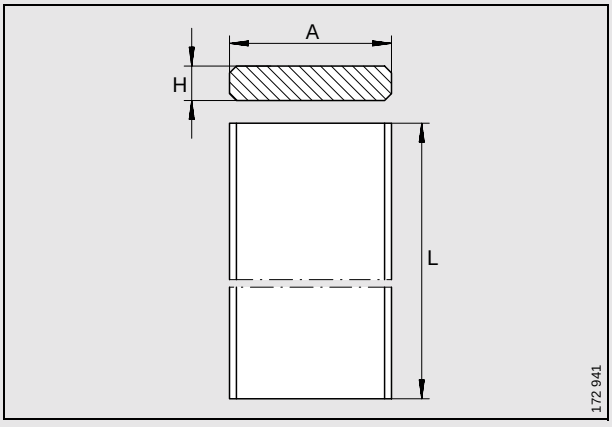
3) The clamping strip must be ordered separately.

4) Linear recirculating roller bearings, page 180 and page 182.

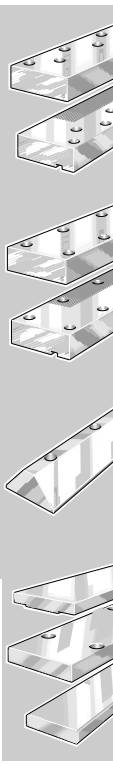
5) If anaerobic single-component adhesives are used, a reduced bonding gap of 0,02 mm should be used. Suffix KL 02.



UFB, for screw mounting



UFK, for clamping



Linear recirculating roller guidance systems

HYDREL adapters

Features

HYDREL adapters

- provide a simple means of installing the linear recirculating roller bearings in 45° arrangements
- are suitable for both open and closed arrangements
- can be provided with all-round sealing.

Adapters APUV

- are used for open arrangements and in conjunction with HYDREL UV guideways
- are predominantly used for loads in the main load direction
- can support additional lateral forces by means of a predrilled dowel hole.

Adapters AUV

- are used for closed arrangements and in conjunction with HYDREL UV guideways
- can also transmit high lateral forces due to the lateral screw connections.

Adapters AUVL

- are used for closed arrangements and in conjunction with HYDREL UV guideways
- have an adjusting gib that can be used to set the preload on the guidance system
- can also transmit high lateral forces due to the lateral screw connections.

Adapters AV

- are used for closed arrangements and in conjunction with HYDREL V guideways
- can also transmit high lateral forces due to the lateral screw connections (in the adapter and guideway).

Adapters AVL

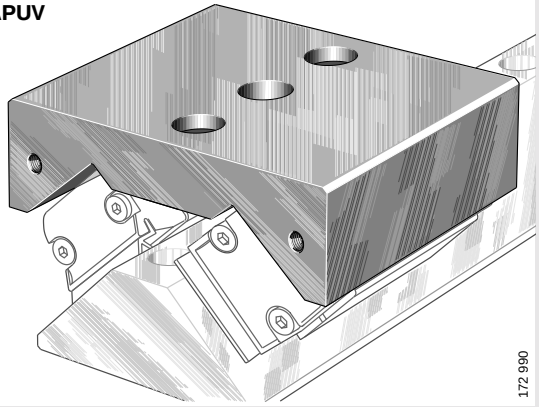
- are used for closed arrangements and in conjunction with HYDREL V guideways
- have an adjusting gib that can be used to set the preload on the guidance system
- can also transmit high lateral forces due to the lateral screw connections (in the adapter and guideway).

Wipers

- are end face and longitudinal wipers for HYDREL adapters.

HYDREL adapters

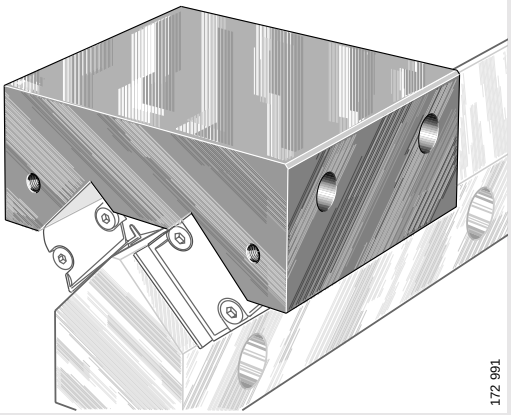
APUV



206

- for UV guideways
- predominantly for open arrangement systems
- screw connection on top
- with predrilled dowel hole

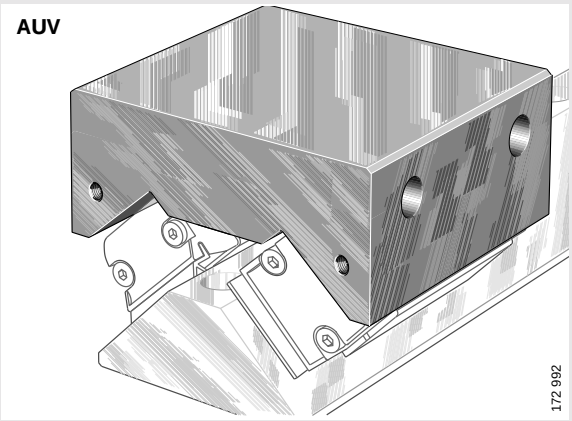
AV



208

- for V guideways
- predominantly for closed arrangement systems
- screw connection on side

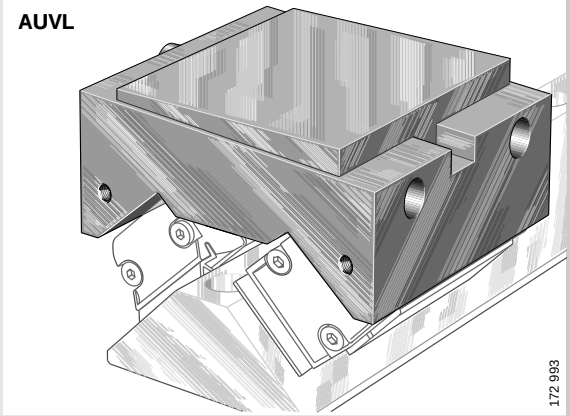
AUV



206

- for UV guideways
- predominantly for closed arrangement systems
- screw connection on side

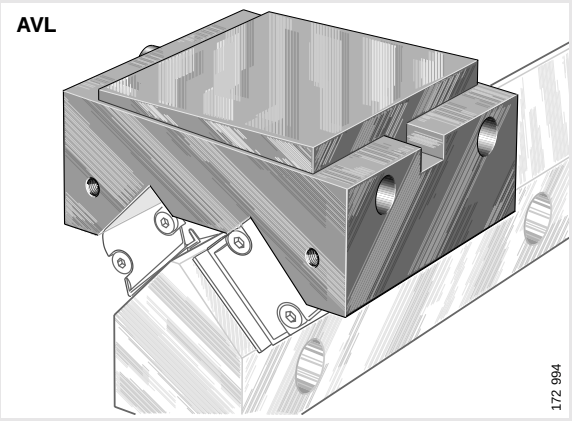
AUVL



206

- for UV guideways
- predominantly for closed arrangement systems
- with adjusting gib
- screw connection on side

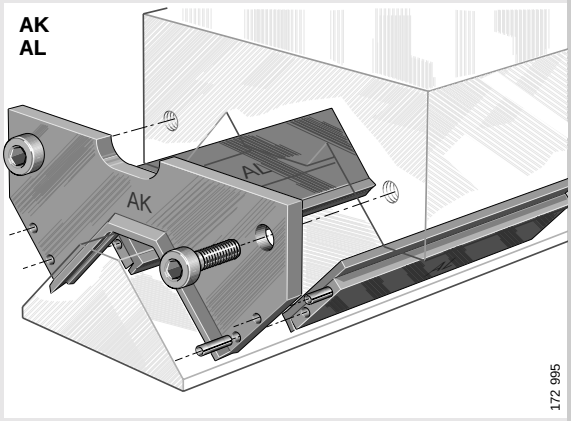
AVL



208

- for V guideways
- predominantly for closed arrangement systems
- with adjusting gib
- screw connection on side

AK
AL



207

- AK end face wipers for adapters
- AL longitudinal wipers for adapters
- suitable for screw mounting
- steel support element
- seal lips made from vulcanised NBR plastic
- lateral wipers AL supplied with fasteners

Design and safety guidelines

- The advantages of a preloaded guidance system should be utilised (see section *Preload*, page 132). Preload can be applied by means of adapters of series AUVL or AVL in closed arrangements (Figure 1).
- The adapters can be lubricated via the end piece in linear recirculating roller bearings of series RUS..KS.
- If adapters with end face seals are used, attention must be paid to the ordering designation
- The length of the fixing screws for linear roller bearings must not be exceeded (Table 1)
- Adapters must be fitted taking account of the set number.

Table 1 · Maximum length of fixing screws for linear recirculating roller bearings in adapters

Adapter APUV, AUV, AUVL, AV, AVL	Fixing screw	Length max.
19..	M3	22
26..	M4	30
38..	M6	40
14 032	M2,5	16
14 044	M3	20
14 061	M4	30

Further information Page

Design of bearing arrangements 148
Fitting 162

Accuracy

Adapters of type US – suffix US – are manufactured with a tolerance of 0,02 for dimension A_3 and are additionally sorted within 0,01 for dimension H. These are packed in units of two pieces and identified by a set number. With this sort, up to four adapters are used for the normal installation positions. For arrangements with more than four adapters, the arrangement must be stated when ordering.

Special designs

- Adapters completely assembled with linear recirculating roller bearings and wipers if necessary – suffix KM... (Figure 2).

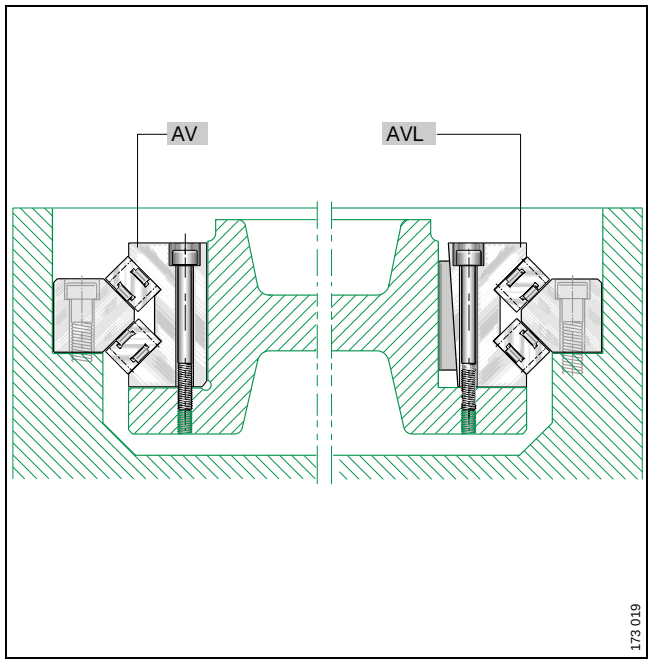


Figure 1 · Guidance system with adapter – preloaded

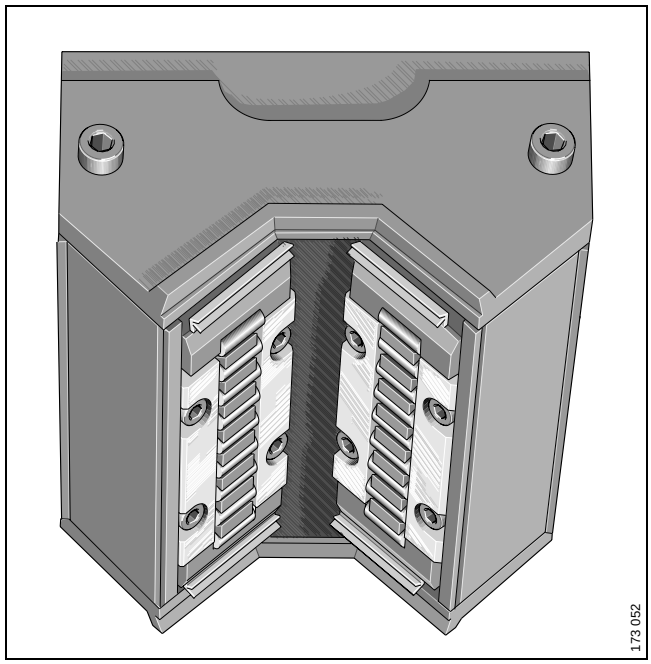


Figure 2 · Adapter completely assembled with linear recirculating roller bearings and wipers

Ordering example and ordering designation

Adapter without wipers

Adapter APUV for linear recirculating roller bearing RUS 19 069 and guideway UV 5323.

Ordering designation: 1 off APUV 19 069 (Figure 3).

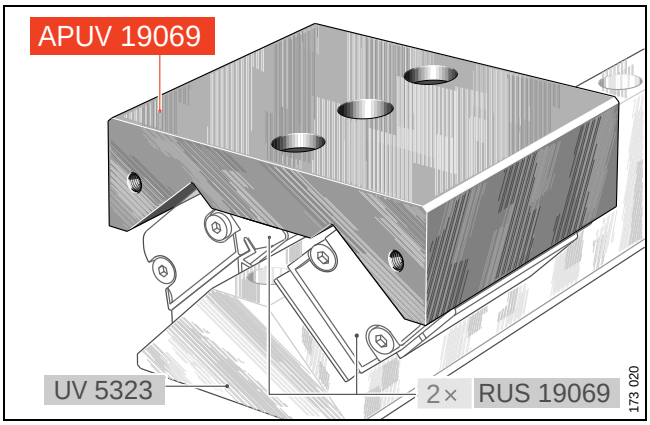


Figure 3 · Ordering example, ordering designation – adapter APUV

Adapter with all-round sealing

Adapter AUVL for linear recirculating roller bearing RUS 38 206 KS and guideway UV 9542.

Adapter sealed on longitudinal and end faces, relubrication facility via the end pieces ① of the linear recirculating roller bearings and a screwed pipe connection ②.

Ordering designation: 1 off AUVL 38 206
2 off AK 9542-021
2 off AL 38 206 (Figure 4).

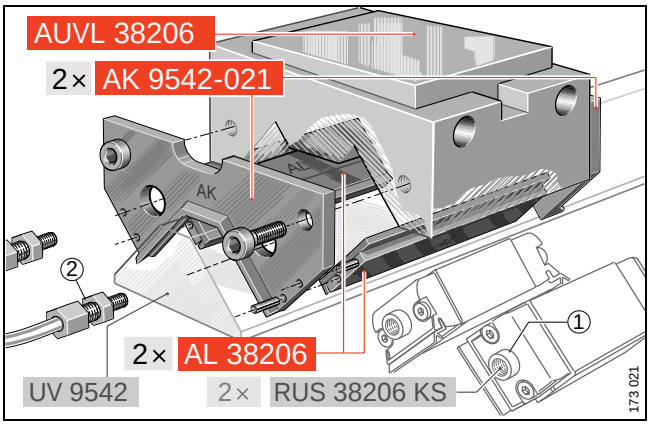


Figure 4 · Ordering example, ordering designation – AUVL

Adapter with end face seals

Adapter AUV for linear recirculating roller bearing PR 14 061 and guideway UV 7532.
Adapter sealed on end faces, no relubrication facility via the end pieces of the linear recirculating roller bearing, without lateral wipers.

Ordering designation: 1 off AUV 14 061
2 off AK 7532-100 (Figure 5).

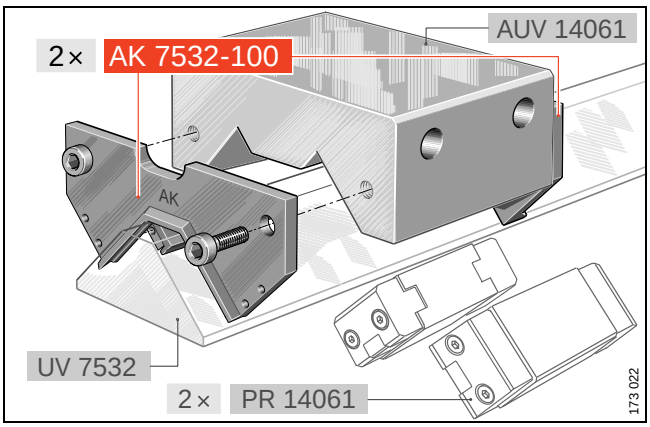
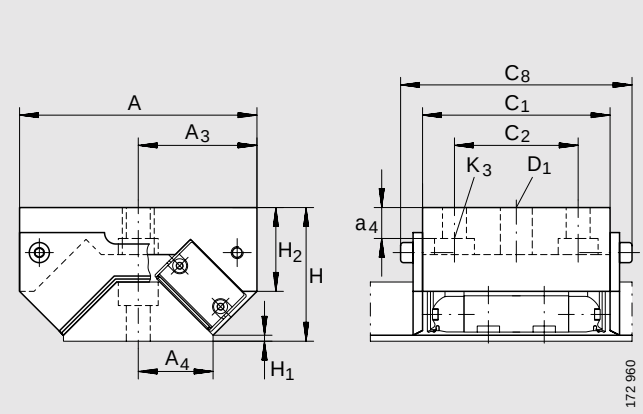


Figure 5 · Ordering example, ordering designation – wiper

HYDREL adapters

Series APUV
AUV
AUVL



APUV

Dimension table · Dimensions in mm

Adapter	Linear recirculating roller bearing	Dimensions					Mounting dimensions		
		C_1 –0,4	A	H[1] –0,2	A_3 –0,1	A_4 –0,1	H_2	H_1	C_8
APUV 19069 **AUV 19069** **AUVL 19069**	**RUS 19069** **RUS 19069 KS**	77	89	47 60 64	44,5	26,5	26,7 39,7 43,7	3	96
APUV 19105 **AUV 19105** **AUVL 19105**	**RUS 19105** **RUS 19105 KS**	113	89	47 60 64	44,5	26,5	26,7 39,7 43,7	3	132
APUV 14032 **AUV 14032** **AUVL 14032**	**PR 14032**	77	89	40,33 53,33 57,33	44,5	26,5	26,7 39,7 43,7	3	96
APUV 14044 **AUV 14044** **AUVL 14044**	**PR 14044**	83	89	47,07 60,07 64,07	44,5	26,5	26,7 39,7 43,7	3	102
APUV 26086 **AUV 26086** **AUVL 26086**	**RUS 26086** **RUS 26086 KS**	94	119	67 79 83	59,5	37,5	42 54 58	3	116
APUV 26102 **AUV 26102** **AUVL 26102**	**RUS 26102** **RUS 26102 KS**	110	119	67 79 83	59,5	37,5	42 54 58	3	132
APUV 26126 **AUV 26126** **AUVL 26126**	**RUS 26126** **RUS 26126 KS**	134	119	67 79 83	59,5	37,5	42 54 58	3	156
APUV 14061 **AUV 14061** **AUVL 14061**	**PR 14061**	102	119	70,63 82,63 86,63	59,5	37,5	42 54 58	3	124
APUV 38134 **AUV 38134** **AUVL 38134**	**RUS 38134** **RUS 38134 KS**	137	155	91 106 110	77,5	47,5	55,5 70,5 74,5	4,5	162
APUV 38206 **AUV 38206** **AUVL 38206**	**RUS 38206** **RUS 38206 KS**	210	155	91 106 110	77,5	47,5	55,5 70,5 74,5	4,5	235
APUV 14089 **AUV 14089** **AUVL 14089**	**PR 14089**	147	155	91,14 106,14 110,14	77,5	47,5	55,5 70,5 74,5	4,5	172

1) The height adjustment of the gib from the central position is ±0,3 mm.

2) For adapters AUV/AUVL 38206, only fixing screws of grade 10.9 can be used.

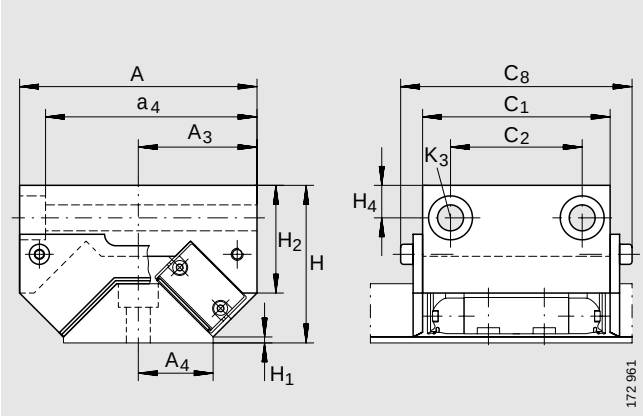
3) Drilling out of diameter D_1 H7 for dowel pins to DIN 6325 (tolerance m6).

4) Ordering example: see page 205.

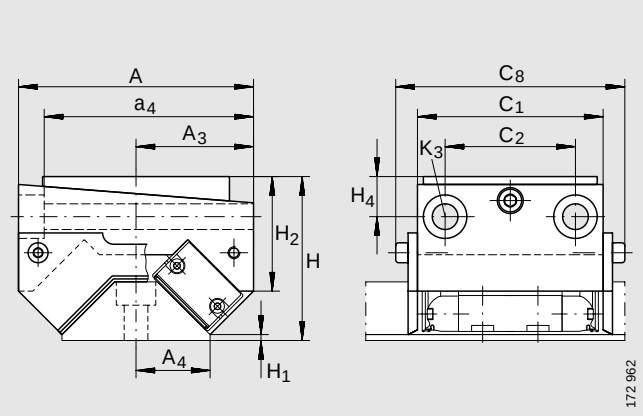
5) 00 No relubrication facility via end piece of RUS. For use without lateral wipers.
01 No relubrication facility via end piece of RUS. For use with lateral wipers.
10 Relubrication facility via end piece of linear recirculating roller bearing with lubrication nipple (RUS..KS). For use without lateral wipers.
11 Relubrication facility via end piece of linear recirculating roller bearing with lubrication nipple (RUS..KS). For use with lateral wipers.
20 Relubrication facility via end piece of linear recirculating roller bearing and screwed pipe connection, fitted to RUS..KS. For use without lateral wipers.
21 Relubrication facility via end piece of linear recirculating roller bearing and screwed pipe connection, fitted to RUS..KS. For use with lateral wipers.

6) The values apply to screws with a preservative. If there is a possibility of settling, the screws should be secured against rotation.

⚠ Ensure that the adjacent construction has adequate strength!
See VDI guideline 2230!



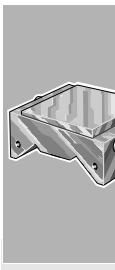
AUV



AUVL

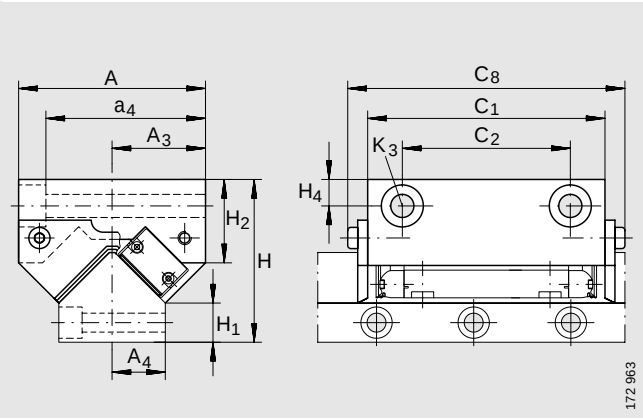
Fixing holes					Guideway	Wipers	
K_3[2)6)] to DIN 912-12.9	a_4	H_4	C_2	D_1[3)]		End face[4)]	Lateral[4)]
M8	7,8	–	44	10	**UV 5323**	**AK 5323-0**..[5)]	**AL 19 069**..[5)]
M10	78	12,6	43	–			
M10	78	16,6	43	–			
M8	7,8	–	85	16	**UV 5323**	**AK 5323-0**..[5)]	**AL 19 105**..[5)]
M10	78	12,6	80	–			
M10	78	16,6	80	–			
M8	7,8	–	44	10	**UV 5323**	**AK 5323-1..**[5)]	**AL 14 032**..[5)]
M10	78	12,6	43	–			
M10	78	16,6	43	–			
M8	7,8	–	44	10	**UV 5323**	**AK 5323-1**..[5)]	**AL 14 044**..[5)]
M10	78	12,6	43	–			
M10	78	16,6	43	–			
M10	15,5	–	62	16	**UV 7532**	**AK 7532-0**..[5)]	**AL 26 086**..[5)]
M12	106	16,3	66	–			
M12	106	20,3	66	–			
M10	15,5	–	62	16	**UV 7532**	**AK 7532-0**..[5)]	**AL 26 102**..[5)]
M12	106	16,3	66	–			
M12	106	20,3	66	–			
M10	15,5	–	98	16	**UV 7532**	**AK 7532-0**..[5)]	**AL 26 126**..[5)]
M12	106	16,3	84	–			
M12	106	20,3	84	–			
M10	15,5	–	62	16	**UV 7532**	**AK 7532-1**..[5)]	**AL 14 061**..[5)]
M12	106	16,3	66	–			
M12	106	20,3	66	–			
M12	25	–	105	16	**UV 9542**	**AK 9542-0**..[5)]	**AL 38 134**..[5)]
M16	138	21,4	90	–			
M16	138	25,4	90	–			
M12	25	–	168	14	**UV 9542**	**AK 9542-0**..[5)]	**AL 38 206**..[5)]
M16	138	21,4	140	–			
M16	138	25,4	140	–			
M12	25	–	105	20	**UV 9542**	**AK 9542-1**..[5)]	**AL 14 089**..[5)]
M16	138	21,4	90	–			
M16	138	25,4	90	–			

Fixing screws	
Size	Tightening torque[6)] Nm max.
M8	41
M10	83
M12	140
M16	350



HYDREL adapters

Series AV
AVL



AV

Dimension table · Dimensions in mm

Adapter		Linear recirculating roller bearing	Dimensions							Mounting dimensions			
			C_1 –0,4	A	H[1] –0,2		A_3 –0,1	A_4 –0,1		H_2	H_1		C_8
					V 7040	V 8050		V 7040	V 8050		V 7040	V 8050	
AV **19 069**		**RUS 19 069**	77	89	77,5	84,5	44,5	20	25	39,7	24	26	96
AVL **19 069**		**RUS 19 069 KS**			81,5	88,5				43,7			
AV **19 105**		**RUS 19 105**	113	89	77,5	84,5	44,5	20	25	39,7	24	26	132
AVL **19 105**		**RUS 19 105 KS**			81,5	88,5				43,7			
AV **14 032**		**PR 14 032**	77	89	70,9	77,9	44,5	20	25	39,7	24	26	96
AVL **14 032**					74,9	81,9				43,7			
AV **14 044**		**PR 14 044**	83	89	77,6	84,6	44,5	20	25	39,7	24	26	102
AVL **14 044**					81,6	88,6				43,7			

1) The height adjustment of the gib from the central position is ±0,3 mm.

2) Complete ordering designation: see page 205.

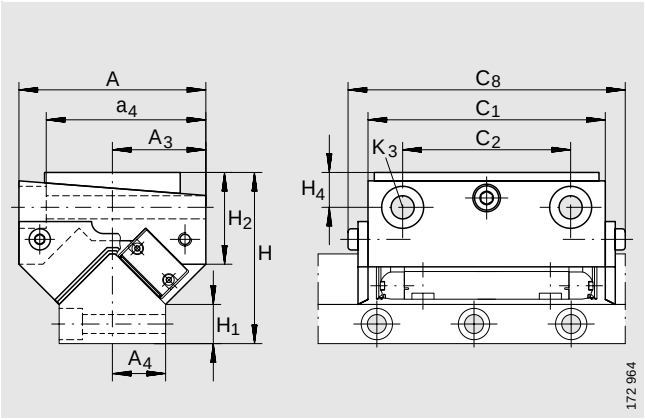
3) No wipers can be fitted in conjunction with guideway V 7040.

4) 00 No relubrication facility via end piece of RUS. For use without lateral wipers.
01 No relubrication facility via end piece of RUS. For use with lateral wipers.
10 Relubrication facility via end piece of linear recirculating roller bearing with lubrication nipple (RUS..KS). For use without lateral wipers.
11 Relubrication facility via end piece of linear recirculating roller bearing with lubrication nipple (RUS..KS). For use with lateral wipers.
20 Relubrication facility via end piece of linear recirculating roller bearing and screwed pipe connection, fitted to RUS..KS. For use without lateral wipers.
21 Relubrication facility via end piece of linear recirculating roller bearing and screwed pipe connection, fitted to RUS..KS. For use with lateral wipers.

5) The values apply to screws with a preservative. If there is a possibility of settling, the screws should be secured against rotation.

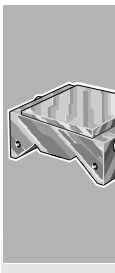
⚠ Ensure that the adjacent construction has adequate strength!
See VDI guideline 2230!

Fixing screws	
Size	Tightening torque[5] Nm max.
M10	83

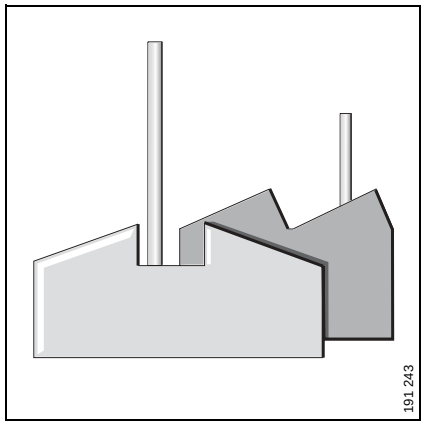


AVL

Fixing holes				Guideway	Wipers	
K_3[5] to DIN 912-12.9	a_4	H_4	C_2		End face[2]	Lateral[2]
					V 8050	V 8050
M10	78	12,6 16,6	43	**V 7040**[3] **V 8050**	**AK 8050-0**..[4]	**AL 19 069**..[4]
M10	78	12,6 16,6	80	**V 7040**[3] **V 8050**	**AK 8050-0**..[4]	**AL 19 105**..[4]
M10	78	12,6 16,6	43	**V 7040**[3] **V 8050**	**AK 8050-1**..[4]	**AL 14 032**..[4]
M10	78	12,6 16,6	43	**V 7040**[3] **V 8050**	**AK 8050-1**..[4]	**AL 14 044**..[4]



Manufacturing Plants



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Each section in the publication FRF begins with a description of the product series and their features.

The significant characteristics of the guidance systems are indicated by means of pictograms.

The advantages of this type of presentation include:

- the reading required is reduced
- the required information can be accessed more quickly
- a direct comparison between alternative bearings is possible.

Definition of pictograms

Pictogram	Description
	Linear locating bearing arrangement
	Linear non-locating bearing arrangement
	Main load direction
	Four raceways for linear roller bearings
	Three raceways for linear roller bearings
	Two raceways for linear roller bearings, arranged at 45° to the support face
	One raceway for linear roller bearings
	Can be lubricated with grease
	Can be lubricated with oil
	Note temperature
	This pictogram indicates the page number of the relevant dimension table
	If this information is not adhered to, there is a direct or indirect hazard to the product and/or adjacent construction
	Further information must be noted

CD

medias *professional*

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FRF · HYDREL flat cage guidance systems/Linear recirculating roller guidance systems