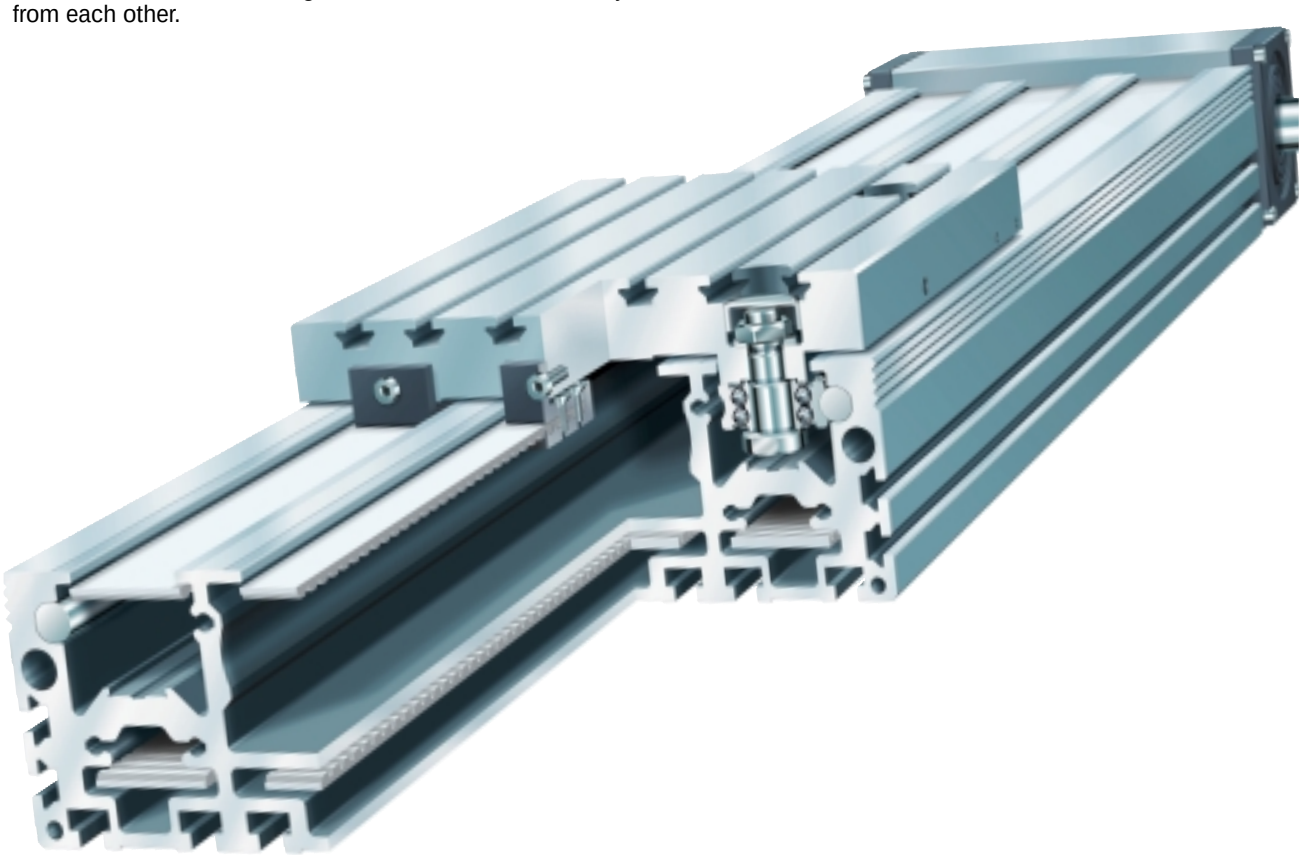
Linear actuators with toothed belt drive

The linear actuators in this MAI supplement the range of actuators in *INA publication* ALE, "Driven linear units". All these series were developed within the framework of special applications and have since proven themselves in numerous volume applications.

The basic elements of the actuators are made from anodised profiled aluminium sections and the actuators themselves are designed according to a modular concept. Due to their integrated construction, they are very compact and can therefore be used to achieve significant space savings across the handling equipment sector. These ready-to-fit linear actuators give particularly cost-effective complete solutions, in contrast to expensive, time-consuming customer designs.

The linear actuators are driven by wear-resistant toothed belts and are fitted with various guidance systems. Dependent on the guidance system fitted, they can be used to move heavy loads at high speed and can achieve high positioning and repeat accuracies. For synchronised opposing motion, two of the series have carriages that move towards or away from each other.

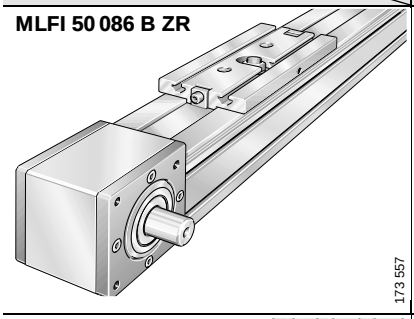
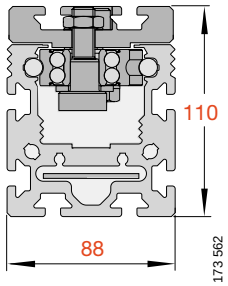
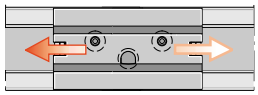
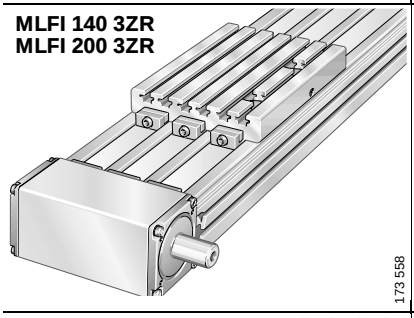
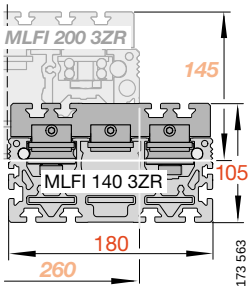
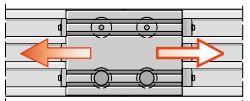
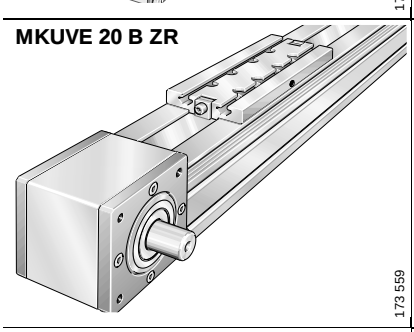
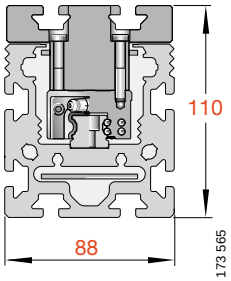
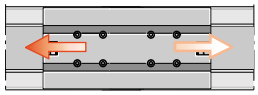
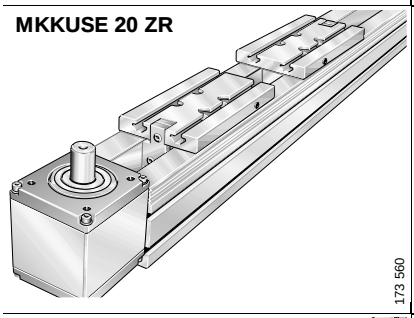
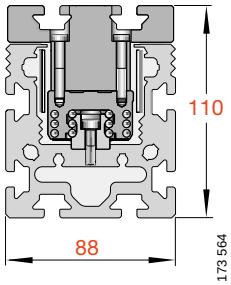
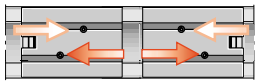
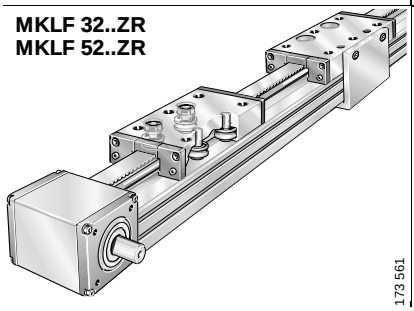
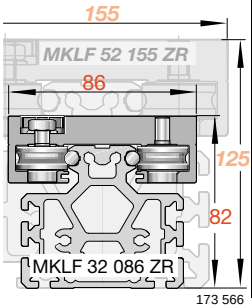
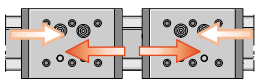
In its role as a system supplier, INA offers the appropriate couplings, gearboxes and motors for these actuators as well as a user-friendly control system. These components are matched to the various series and complete the range of linear actuators.

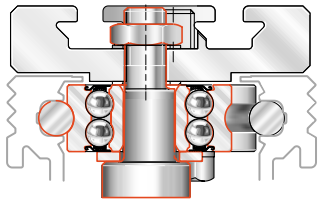
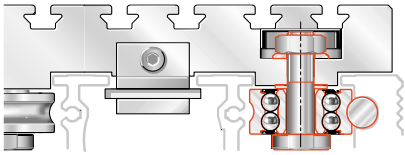
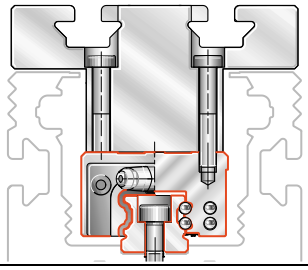
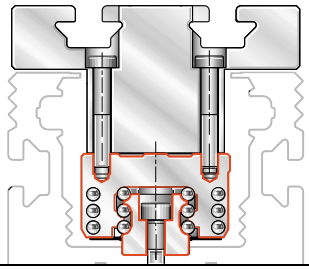
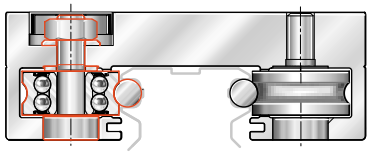


200 231b

Product range

Overview

Features / Linear actuator	Characteristics	Dimensions $B_7 \times H$	Standard carriage/ motion
MLFI 50 086 B ZR  173 557	■ comprising support rail, carriage, toothed belt drive, return units ■ can support loads from all directions ■ one toothed belt ■ clearance-free track roller guidance system ■ for horizontal and vertical mounting positions ■ can be fitted with additional carriages ■ positional deviation ≦ ±0,1 mm	 173 562	 173 571
MLFI 140 3ZR **MLFI 200 3ZR**  173 558	■ comprising support rail, carriage, toothed belt drive, return units ■ can support loads from all directions ■ three toothed belts ■ clearance-free track roller guidance system ■ highly suitable for vertical mounting position due to high security provided by three belts ■ can be fitted with additional carriages ■ positional deviation ≦ ±0,1 mm	 173 563	 173 567
MKUVE 20 B ZR  173 559	■ comprising support rail, carriage, toothed belt drive, return units ■ can support loads from all directions ■ one toothed belt ■ clearance-free, preloaded KUVE guidance system ■ can be fitted with additional carriages ■ positional deviation ≦ ±0,1 mm	 173 565	 173 570
MKKUSE 20 ZR  173 560	■ comprising support rail, carriage, toothed belt drive, return units ■ can support loads from all directions ■ for synchronised, opposing motion of the carriages ■ two vertical toothed belts ■ clearance-free, preloaded KUSE guidance system ■ positional deviation ≦ ±0,1 mm per carriage	 173 564	 173 568
MKLF 32..ZR **MKLF 52..ZR**  173 561	■ comprising support rail, carriage, toothed belt drive, return units ■ can support loads from all directions ■ for synchronised, opposing motion of the carriages ■ one toothed belt ■ clearance-free track roller guidance system ■ lubrication and wiper units on end faces ■ positional deviation ≦ ±0,1 mm per carriage	 173 566	 173 569

Guidance system			Load	Acceleration max.	Travel speed max.	Features
System	clearance-free	clearance-free facility		m/s^2	m/s	See page
LF  173 574	–	❑	moderate	40	8	4
LF  173 573	–	❑	moderate to heavy	40	8	14
KUVE  173 576	❑	–	moderate to heavy	30	3	24
KUSE  173 575	❑	–	moderate to heavy	30	3	34
LF  173 572	–	❑	light to moderate	40	8	44

Linear actuator with track roller guidance system and toothed belt drive

Series MLFI 50 086 B ZR

Page

Design and safety guidelines 6

Accuracy 9

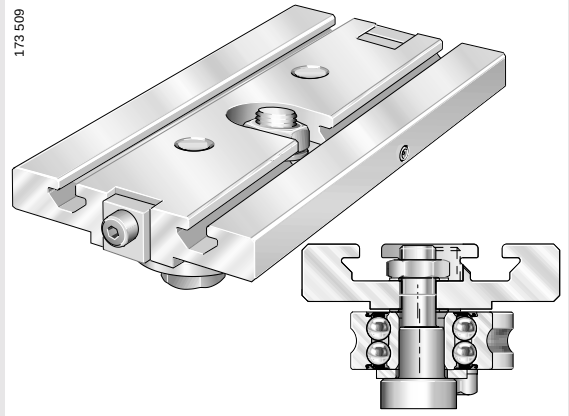
Ordering example and ordering designation 10

Features

Linear actuators with track roller guidance system and toothed belt drive

- are complete units comprising:
  - a support rail – the supporting profiled section is extremely rigid and suitable for spanning large gaps; it has two high alloy steel shafts arranged in parallel
  - one carriage running in the support rail – guidance by three track rollers
  - a toothed belt drive
  - two return units
- can support forces from all directions and moments about all axes
- are suitable for moderate loads
- can also be fitted with more than one driven carriage
- have a clearance-free guidance system
  - the track rollers are adjusted against the raceways by means of eccentric bolts
- run with high positional accuracy
  - if the servo controller COMPAX is used, the positional accuracy is ≦±0,1 mm
- are suitable for:
  - accelerations up to 40 m/s^2
  - speeds up to 8 m/s
  - operating temperatures from –20 °C to +80 °C
- are easy to fit
  - the carriage and support rail have T-slots for standard T-nuts or fixing lugs. The components can therefore be easily screwed to the adjacent construction
- are particularly suitable, due to the T-slots, for modular constructions
- are maintenance-free and the raceways can be relubricated
  - the carriage, toothed belt drive and return units require no maintenance
  - the raceways of the track rollers are lubricated via lubrication holes in the carriage
- are versatile in application due to a comprehensive range of accessories.

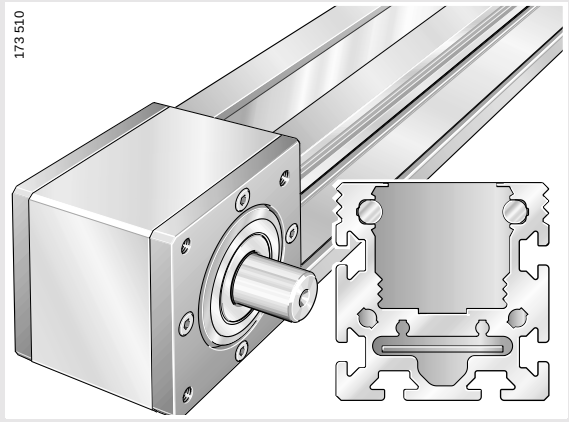
Carriage



- anodised aluminium saddle plate with T-slots
- three track rollers
- eccentric bolts for clearance-free adjustment of the track rollers against the raceway
- driven by one toothed belt
- integral clamping devices for toothed belt on both sides
- lubrication holes in the longitudinal faces, closed off by stud bolts
- lubrication and wiper unit

12

Support rail with return unit

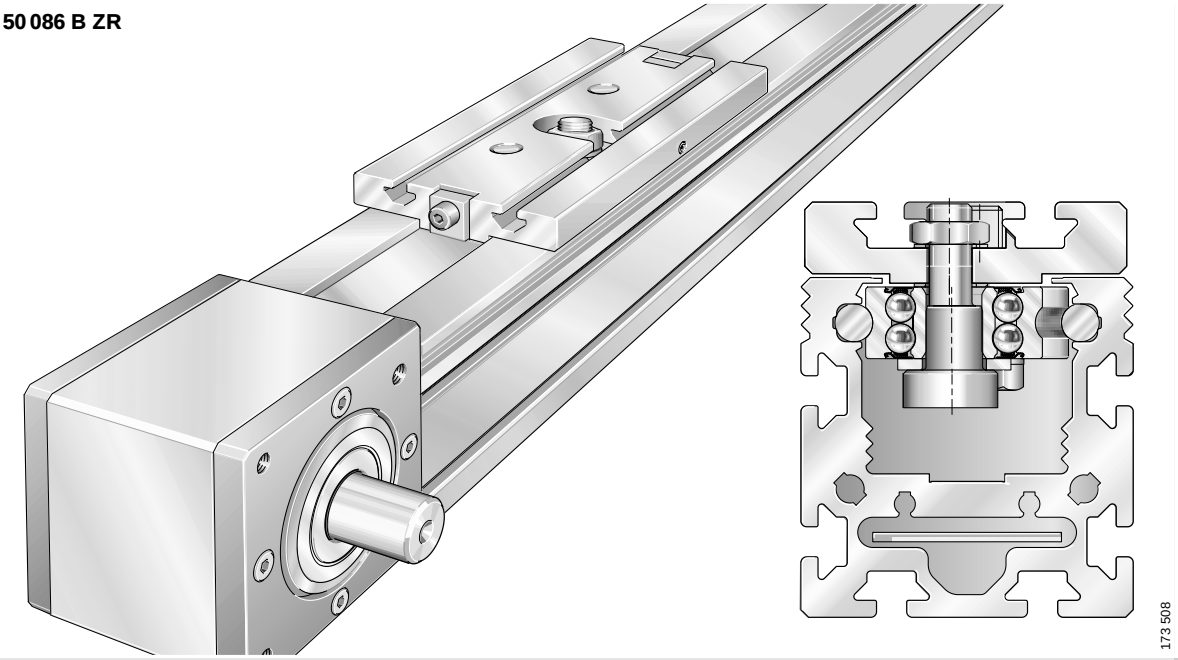


- support rail
  - composite rail made from anodised profiled aluminium supporting section
- return unit
  - housing made from anodised profiled aluminium
  - return shaft with maintenance-free ball bearings
  - wiper brushes to protect the return area from contamination

12

Linear actuator – scope of basic delivery

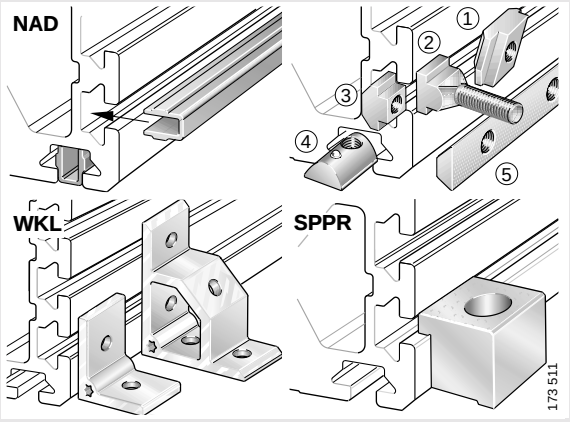
MLFI 50 086 B ZR



173 508

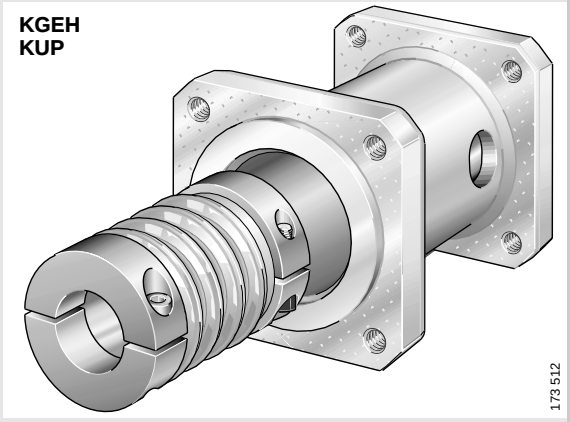
12

Accessories



173 511

- NAD
  - plastic slot seal
- SPPR
  - fixing lug
- WKL
  - fixing brackets
- ①, ②, ③, ④, ⑤
  - fixing screws, T-bolts and T-strips



173 512

- KGEH
  - coupling housing made from anodised aluminium
  - flange with fixing holes at both ends
- KUPs
  - metallic bellows coupling
  - fixing hubs made from anodised aluminium
  - metallic bellows made from thin-walled alloy steel
  - clamping to motor, drive or gearbox shaft

Design and safety guidelines

Idling drive torque

With constant drive speed and a horizontally mounted actuator, the drive torque does not vary significantly as a function of the mass to be moved.

With increasing speed, the drive torque also increases (Figure 1).

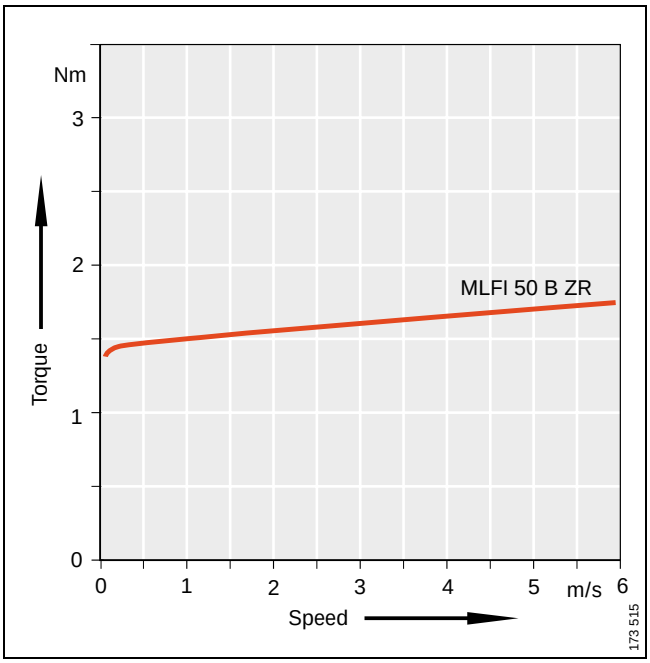


Figure 1 · Idling drive torque in horizontal mounting position of linear actuator MLFI 50 086 B ZR

Combination with actuator components

In its role as a system supplier, INA offers not only actuators but also the appropriate components including coupling housings, couplings, gearboxes and motors (Table 1). These components are precisely matched to the actuators and thus complement the range of linear actuators in an optimum manner.

Table 1 · Possible combinations with actuator components

Linear actuator	Coupling housings	Couplings	Gearboxes	Motors
MLFI 50 086 B ZR	KGEH MLFI 50 B ZR-80/100/M6	KUP 560-56 20H7-20H7	GETR PL 90-..	MOT SMH 82 MOT SMHA 82-BR
	KGEH MLFI 50 B ZR-60/ 75/M5	KUP 560-56 20H7-16H7	GETR PL 70-..	MOT SMH 60 MOT SMHA 60-BR

Drive variants

The possible positions of the drive are shown in Figure 2.
Description of the suffixes: see Table 2.

Table 2 · Drive variants – suffixes

Drive system Suffix	Designs
OA	Without drive
AR	Drive shaft on right side
AL	Drive shaft on left side
RL	Drive shaft on both sides (right and left)

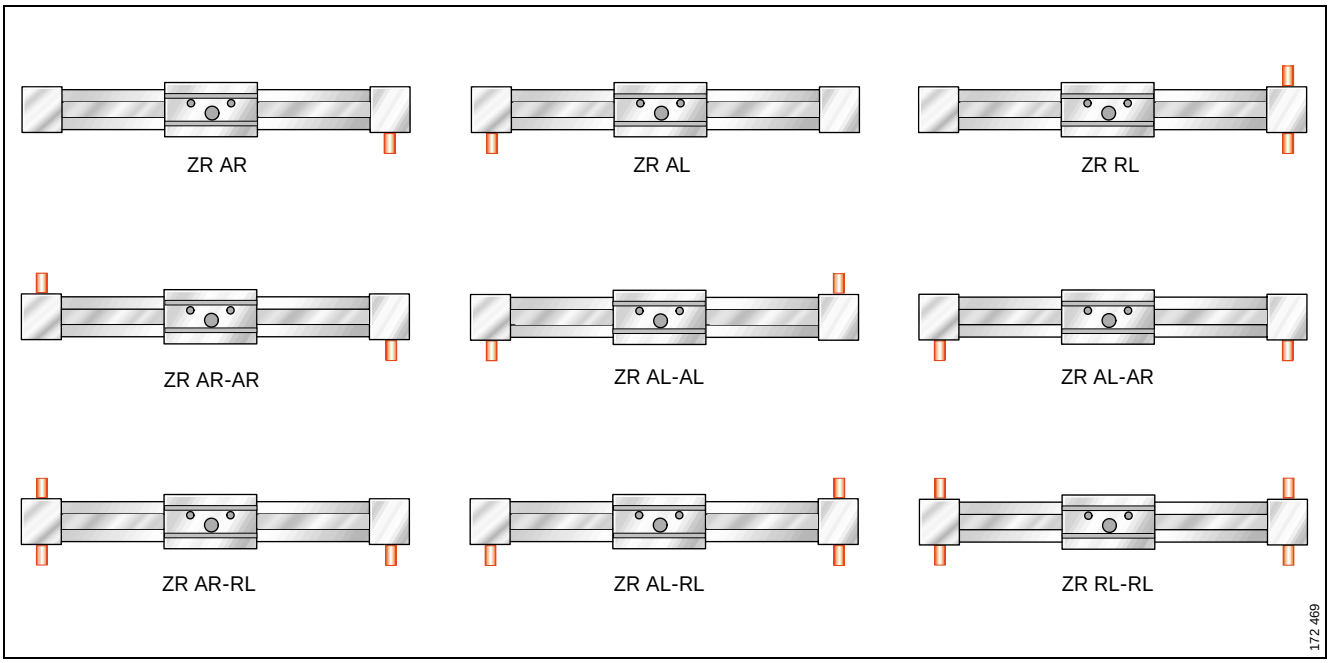


Figure 2 · Positions of the drive – schematic

Lubrication

Track rollers

The track rollers in the carriages are greased with a high quality lithium complex soap grease in accordance with DIN 51825–K3K–30 and are maintenance-free.

Raceways

The raceways for the track rollers must be lubricated at particular intervals.

The relubrication intervals are essentially dependent on:

- the travel speed
- the load
- the operating temperature
- the stroke length
- the environmental conditions; the cleaner the operating environment, the lower the lubricant consumption.

Since it is not possible to calculate all the influencing factors, the time at which relubrication must be carried out and the quantity of lubricant which must be used can only be determined under actual operating conditions. If no precise data are available, the values according to Table 3 are valid for many applications.

Relubrication must be carried out at the latest when fretting corrosion first occurs – this can be identified by a reddish discolouration of the raceways or the outside surface of the track rollers. Subsequent lubrication intervals must be shortened!

The support rail raceways are lubricated by a felt insert which is soaked with oil by means of lubrication nipples in the side. Oils of type CL and CLP to DIN 51 517 with a viscosity of ISO VG 220 are recommended.

Relubrication should preferably be carried out with several partial quantities at various times instead of the complete quantity at the time of the relubrication interval. The support rail raceway is lubricated by an oil-soaked felt insert. Relubrication is carried out via two lubrication holes ① on the longitudinal faces of the carriages ② (Figure 3). Relubrication can therefore be carried out from either the left or right side of the carriage.

⚠ The area around the lubrication holes and the lubricant must be clean!

Lubrication should only be carried out on linear actuators still warm from operation!

Move the carriage during lubrication!

Further information on lubricant quantities is given in *INA publication "ALE"*!

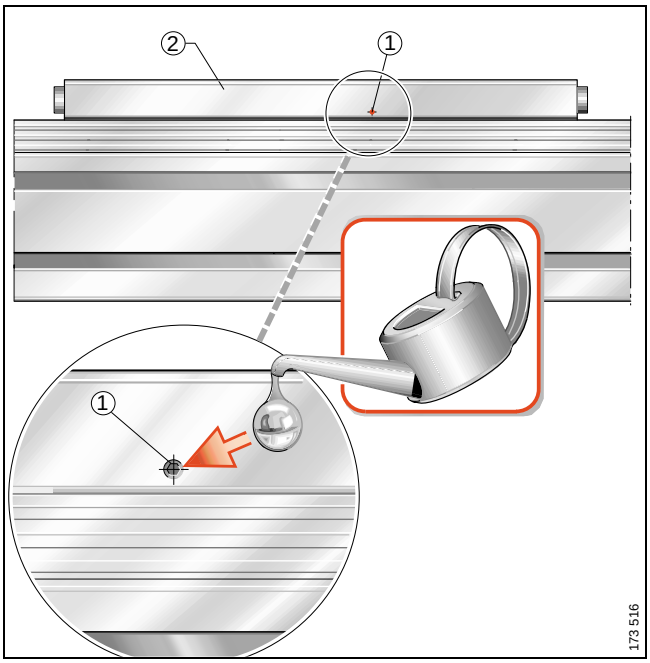


Figure 3 · Lubrication points – MLFI 50 086 B ZR

Table 3 · Relubrication quantities – guide values

Linear actuator	Oil quantity per carriage ml
MLFI 50 086 B ZR	2 to 3

Accuracy

The linear actuators are precision straightened and the tolerances are better than those to DIN 17 615 (Table 4 and Table 5). The tolerances are arithmetic mean values.

The method for determining the straightness of the support rail is shown in Figure 4. For lengths in excess of 6 000 mm, the straightness tolerance t_2, t_3 may show a linear increase of 0,5 mm per 1000 mm.

Table 4 · Length tolerance of linear actuators

Length of actuator L_{tot} mm	Tolerance mm
L_{tot} <1000	±2
1000 ≦L_{tot} <2 000	±3
2000 ≦L_{tot} <4 000	±4
4000 ≦L_{tot}	±5

Table 5 · Straightness tolerance of support rail

Length of support rail mm	MLFI 50 086 B ZR		
	t_2 mm	t_3 mm	Torsion mm
<1000	0,4	0,3	0,8
1000 ≦2000	0,8	0,5	1
2000 ≦3000	1,2	0,7	1,2
3000 ≦4000	1,5	1	1,6
4000 ≦5000	1,9	1,2	1,8
5000 ≦6000	2,5	1,5	2
6000 ≦7000	2,9	1,8	2,2
over 7000	3,4	2,1	2,4

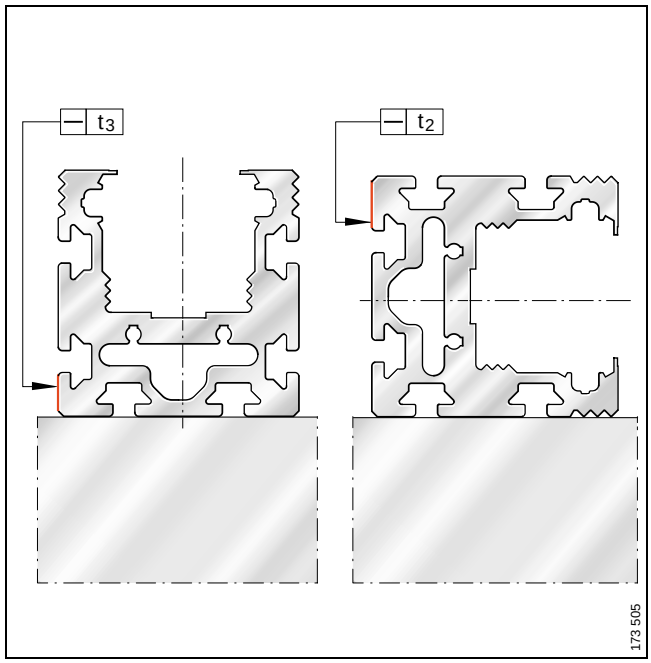


Figure 4 · Straightness tolerance of support rail for MLFI 50 086 B ZR

Ordering example and ordering designation

Ordering example

Linear actuator MLFI 50 086 B ZR

Linear actuator with enclosed track roller guidance system	MLFI
Size	50 B
Width of carriage	86 mm
Drive type: one toothed belt	ZR
Drive shaft on left side	AL
Total length L_{tot}	4 000 mm
Total stroke (effective stroke + 2×S)	3 534 mm

Ordering designation:

1 off MLFI 50 086 B ZR AL/4 000-3 534 (Figure 5).

Note

Note total length of carriage!

For a second carriage, use the suffix W2!

If two or more carriages are arranged in series, the distance between the carriages must be stated in the order!

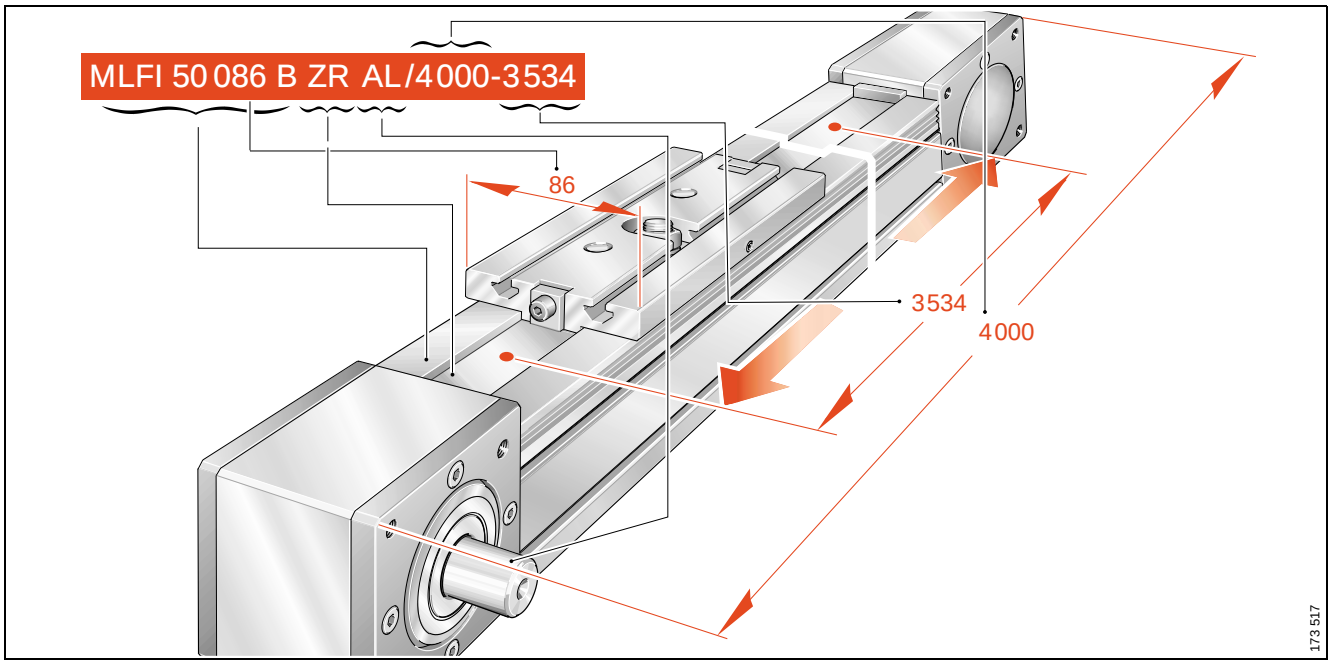
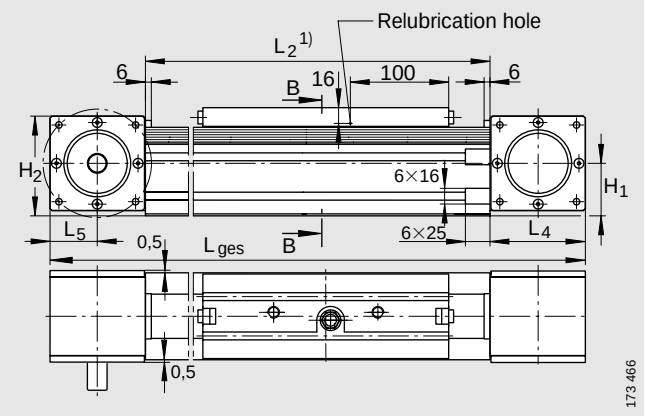


Figure 5 · Ordering example and ordering designation – linear actuator MLFI 50 086 B ZR AL/4 000-3 534

Linear actuator with track roller guidance system and toothed belt drive

Series MLFI 50 086 B ZR



MLFI 50 086 B ZR

Dimension table · Dimensions in mm

Designation	Mass		Dimensions			Mounting dimensions								
	G_{tot} ≈kg	G_{Law} 2) ≈kg	H	B	L	L_1	B_1	B_4	B_7	B_8 P_9	D	L_4	H_1	H_2
MLFI 50 086 B ZR	$(L_{tot} - 194) \times 0{,}0124 + 6$	2	110	86	250	260	40	40	88	6	110	97	53,4	101,4

1) L_2 = total stroke + L_1 + 12
L_{tot} = total stroke + L_1 + 12 + 2×L_4.
Total stroke = effective stroke + 2×S (mm).

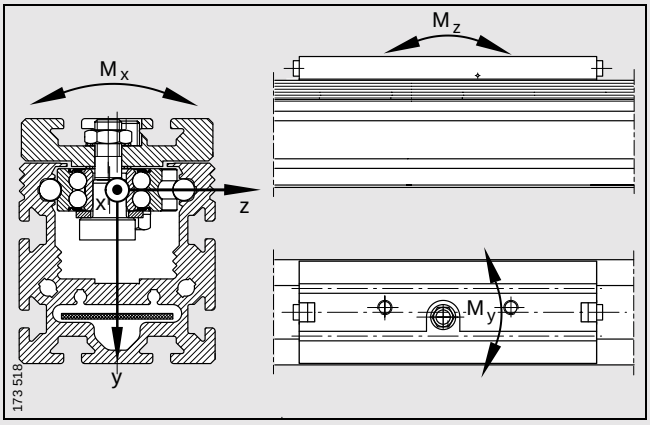
⚠ The allowance S designates a safety range suitable for the particular application and should be at least 85 mm; total stroke in mm.

Maximum single-piece support rail length L2 = 8 000 mm.

2) G_{Law} = mass of carriage.

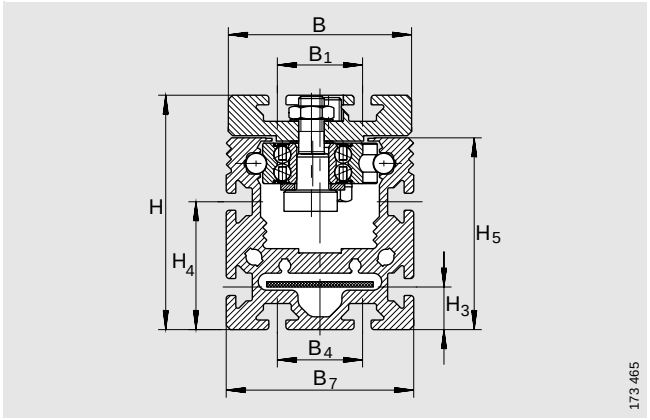
3) The values are single loads and apply when the underside of the actuator is fully supported.
These must be reduced for combined loads. For design criteria of linear guidance system, see *INA Catalogue 801*.

4) Utilisation of the T-slots is restricted by the holes.



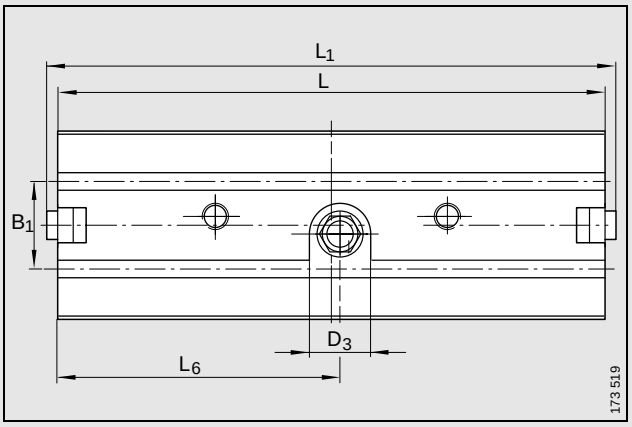
Load directions

Linear actuator	**Toothed belt/gears**					
Designation	Toothed belt	Permissible toothed belt operating force	Maximum drive torque	Mass of toothed belt	Feed	Mass moment of inertia of both gears
	Type	N	Nm	kg/m	mm/rev.	kg · m^2
MLFI 50 086 B ZR	50 AT 10	1880	68,8	0,315	200	5×10^{-4}

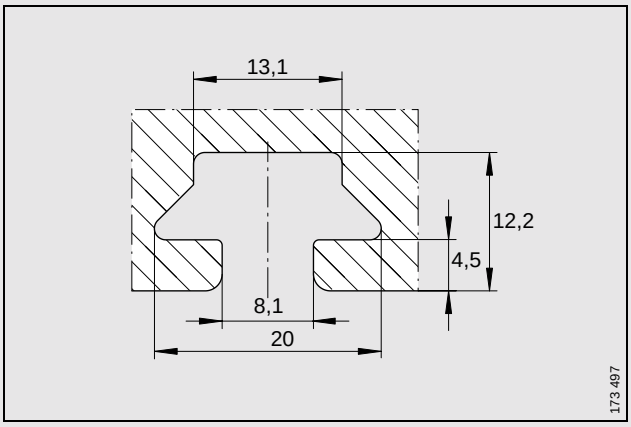


MLFI 50 086 B ZR

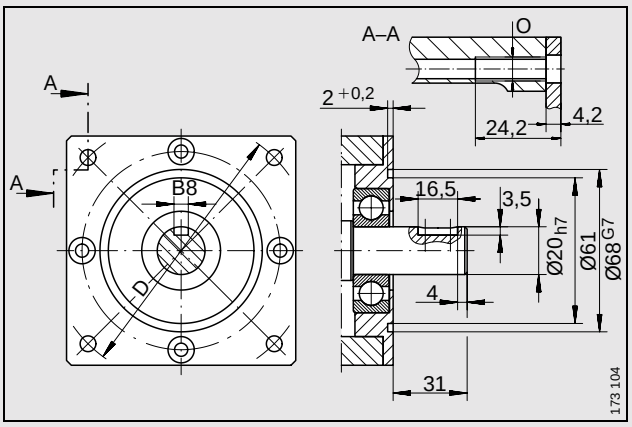
							Permissible load on carriage guidance system[3]				Permissible torque on carriage guidance system[3]			Geometrical moment of inertia of support rail	
H_3	H_4	H_5	L_5	O	L_6[4]	D_3[4]	$F_{y\,perm}$ N	$F_{0y\,perm}$ N	$F_{z\,perm}$ N	$F_{0z\,perm}$ N	$M_{0x\,perm}$ Nm	$M_{0y\,perm}$ Nm	$M_{0z\,perm}$ Nm	I_y cm^4	I_z cm^4
20	60	90	48	M6	129	28	1800	2 700	3 250	3 250	62	150	100	300	198



Carriage



T-slots



Drive flange/drive shaft

Linear actuator with track roller guidance system and toothed belt drive

Series MLFI..3ZR

Page

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Accuracy 19

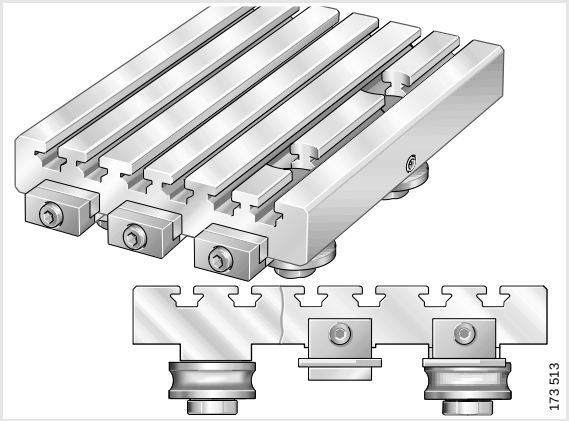
Ordering example and ordering designation 20

Features

Linear actuators with track roller guidance system and toothed belt drive

- are complete units comprising:
  - a support rail – the supporting profiled section is extremely rigid and suitable for spanning large gaps; it has two high alloy steel shafts arranged in parallel
  - a carriage running in the support rail – guidance by four track rollers, with integral lubrication and wiper unit
  - a toothed belt drive with three parallel toothed belts
  - two return units
- can support forces from all directions and moments about all axes
- are suitable for moderate and heavy loads
- are highly suitable for vertical mounting, since the three toothed belts allow very high operating forces
- can also be fitted with a second driven carriage
- have a clearance-free guidance system
  - the track rollers are adjusted against the raceways by means of eccentric bolts
- run with high positional accuracy
  - if the servo controller COMPAX is used, the positional accuracy is $\leqq \pm 0{,}1$ mm
- are suitable for:
  - accelerations up to 40 m/s^2
  - speeds up to 8 m/s
  - operating temperatures from –20 °C to +80 °C
- are easy to fit
  - the carriage and support rail have T-slots for standard T-nuts or fixing lugs. The components can therefore be easily screwed to the adjacent construction
- are particularly suitable, due to the T-slots, for modular constructions
- are maintenance-free and the raceways can be relubricated
  - the toothed belt drive and return units require no maintenance
  - the raceways of the track rollers are lubricated by means of funnel type lubrication nipples and oil-soaked felt inserts in the carriage
- are versatile in application due to a comprehensive range of accessories.

Carriage



- saddle plate made from anodised profiled aluminium with T-slots
- four maintenance-free track rollers
- eccentric bolts for clearance-free adjustment of the track rollers against the raceway
- driven by three toothed belts
- integral clamping devices for toothed belt on both sides
- lubrication and wiper unit
- funnel type lubrication nipples on longitudinal faces

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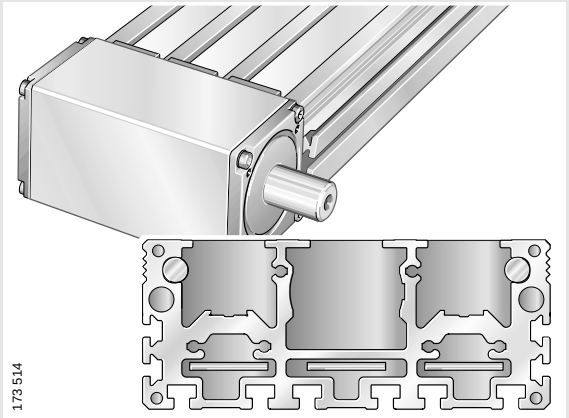
Support rail with return unit

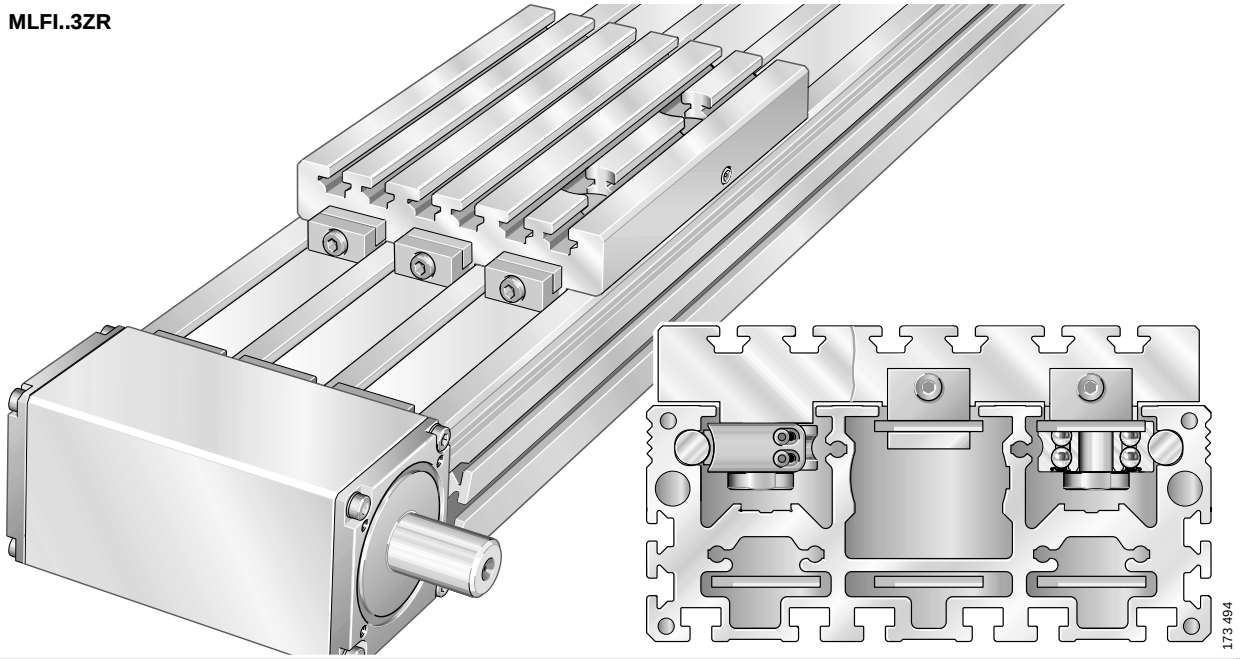


- support rail
  - composite rail made from anodised profiled aluminium supporting section
- return unit
  - housing made from anodised profiled aluminium
  - return shaft with maintenance-free tapered roller bearings
  - wiper brushes to protect the return area from contamination

22

Linear actuator – scope of basic delivery

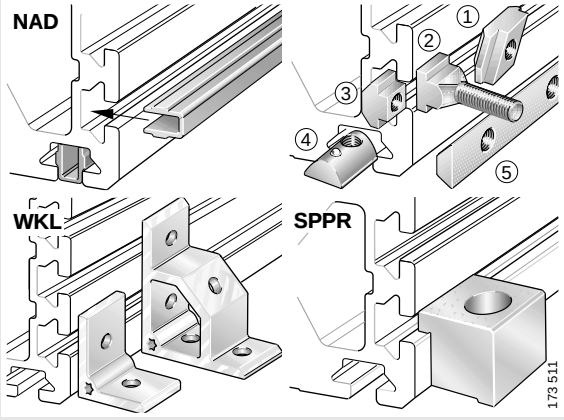
MLFI..3ZR



22

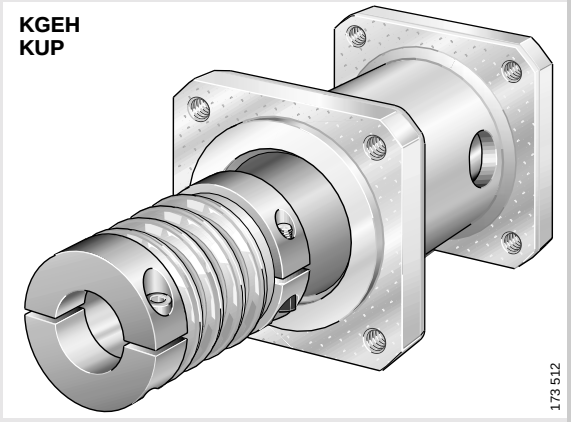
Accessories

NAD



- NAD
  - plastic slot seal
- SPPR
  - fixing lug
- WKL
  - fixing brackets
- ①, ②, ③, ④, ⑤
  - fixing screws, T-bolts and T-strips

KGEH
KUP



- KGEH
  - coupling housing made from anodised aluminium
  - flange with fixing holes at both ends
- KUP
  - metallic bellows coupling
  - fixing hubs made from anodised aluminium
  - metallic bellows made from thin-walled alloy steel
  - clamping to motor, drive or gearbox shaft

Design and safety guidelines

Idling drive torque

With constant drive speed and a horizontally mounted actuator, the drive torque does not vary significantly as a function of the mass to be moved.

With increasing speed, the drive torque also increases (Figure 1).

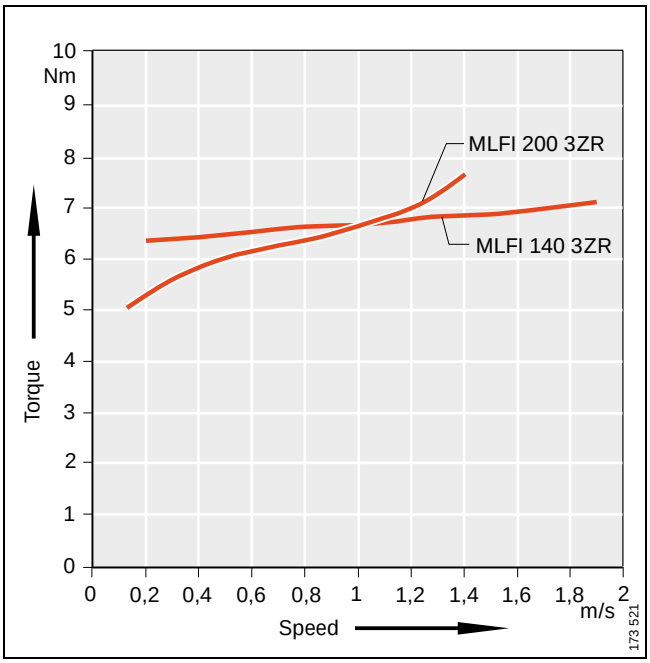


Figure 1 · Idling drive torque in horizontal mounting position of actuators MLFI..3ZR

Combination with actuator components

In its role as a system supplier, INA offers not only actuators but also the appropriate components including coupling housings, couplings, gearboxes and motors (Table 1). These components are precisely matched to the actuators and thus complement the range of linear actuators in an optimum manner.

Table 1 · Possible combinations with actuator components

Linear actuator	Coupling housings	Couplings	Gearboxes	Motors
MLFI 140 3ZR	KGEH MDKUE 15 3ZR-110/130/M8	KUP KM 170 25H7-25H7	GETR PL 115-..	MOT SMH 100
			GETR PLE 120/115	MOT SMHA 100-BR
	KGEH MDKUE 15 ZR-110/130/M8	KUP 560-66 25H7-25H7	GETR PL 115-..	MOT MH 105
			GETR PLE 120/115	MOT MHA 105-BR
	KGEH MLF 32 ZR-80/100/M6	KUP 560-56 20H7-25H7	GETR PL 90	MOT SMH 82
			GETR PLE 80/90	MOT SMHA 82-BR
			MOGE AS2-STI..	
MLFI 200 3ZR	KGEH MDKUE 25 ZR-110/130/M8	KUP KM 400 32H7-25H7	GETR PL 115-..	MOT SMH 100
				MOT SMHA 100-BR
				MOT MH 105
				MOT MHA 105-BR

Drive variants

The possible positions of the drive are shown in Figure 2.
Description of the suffixes: see Table 2.

Table 2 · Drive variants – suffixes

Drive system Suffix	Designs
OA	Without drive
AR	Drive shaft on right side
AL	Drive shaft on left side
RL	Drive shaft on both sides (right and left)

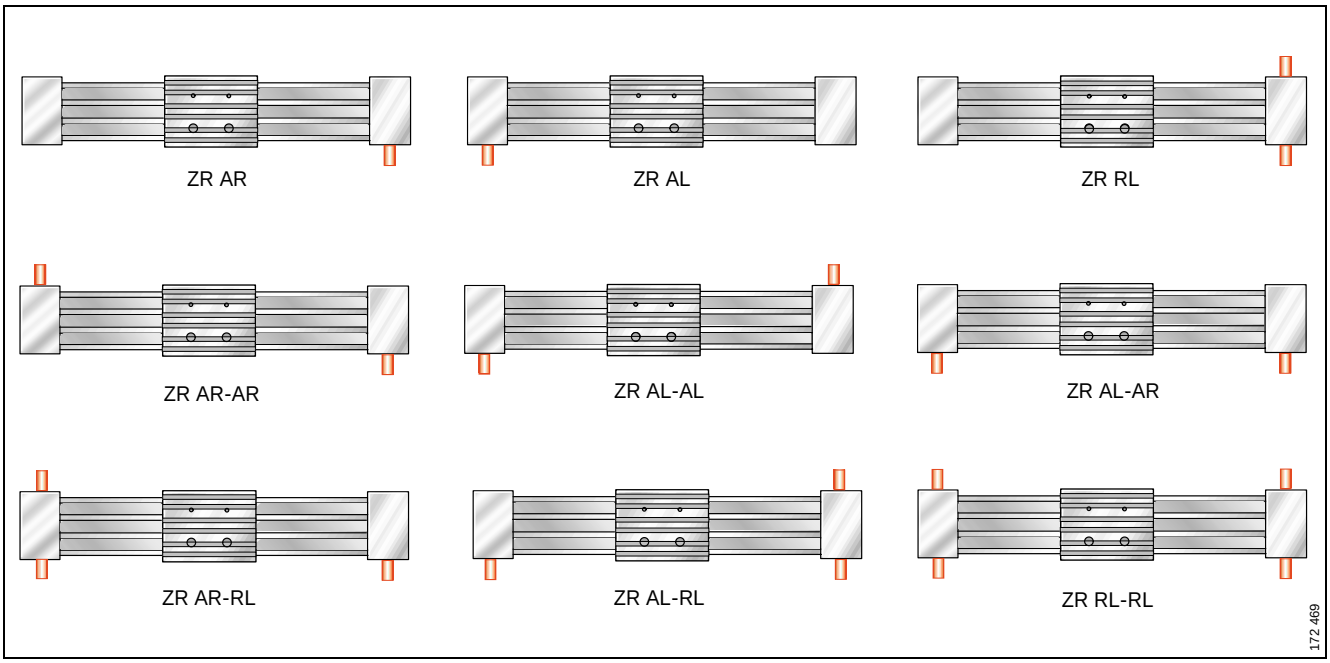


Figure 2 · Positions of the drive – schematic

Lubrication

Track rollers

The track rollers in the carriages are greased with a high quality lithium complex soap grease in accordance with DIN 51825–K3K–30 and are maintenance-free.

Raceways

The raceways for the track rollers must be lubricated at particular intervals.

The relubrication intervals are essentially dependent on:

- the travel speed
- the load
- the operating temperature
- the stroke length
- the environmental conditions; the cleaner the operating environment, the lower the lubricant consumption.

Since it is not possible to calculate all the influencing factors, the time at which relubrication must be carried out and the quantity of lubricant which must be used can only be determined under actual operating conditions. If no precise data are available, the values according to Table 3 are valid for many applications.

Relubrication must be carried out at the latest when fretting corrosion first occurs – this can be identified by a reddish discolouration of the raceways or the outside surface of the track rollers. Subsequent lubrication intervals must be shortened!

The support rail raceways are lubricated by a felt insert which is soaked with oil by means of lubrication nipples in the side. Oils of type CL and CLP to DIN 51 517 with a viscosity of ISO VG 220 are recommended.

Relubrication should preferably be carried out with several partial quantities at various times instead of the complete quantity at the time of the relubrication interval. The support rail raceway is lubricated by an oil-soaked felt insert. Relubrication is carried out via two funnel type lubrication nipples to DIN 3405-D6 ① on the longitudinal faces of the carriages ② (Figure 3). Relubrication can therefore be carried out from either the left or right side of the carriage.

⚠ The area around the lubrication holes and the lubricant must be clean!

Lubrication should only be carried out on linear actuators still warm from operation!

Move the carriage during lubrication!

Further information on lubricant quantities is given in *INA publication "ALE"!*

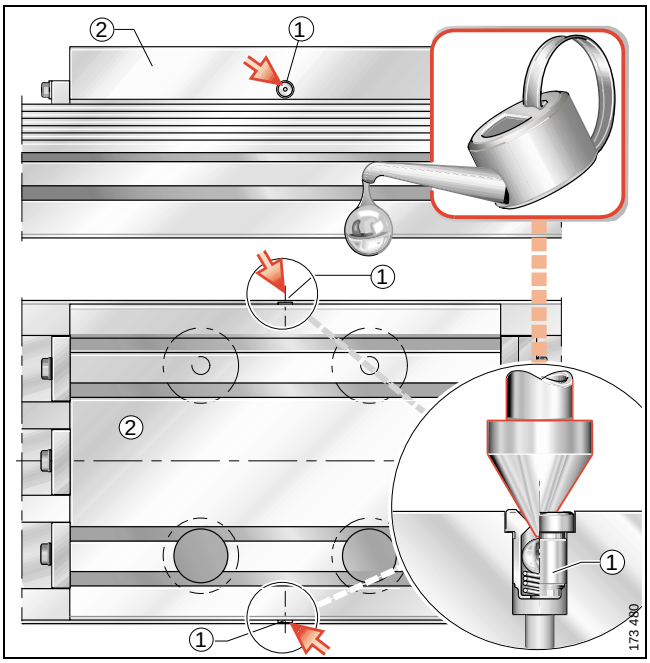


Figure 3 · Lubrication points – MLFI 140 3ZR, MLFI 200 3ZR

Table 3 · Relubrication quantities – guide values

Linear actuator	Oil quantity per carriage ml
MLFI 140 3ZR	2 to 3
MLFI 200 3ZR	4 to 5

Accuracy

The linear actuators are precision straightened and the tolerances are better than those to DIN 17 615 (Table 4 and Table 5). The tolerances are arithmetic mean values.

The method for determining the straightness of the support rail is shown in Figure 4. For lengths in excess of 6 000 mm, the straightness tolerance t_2, t_3 may show a linear increase of 0,5 mm per 1000 mm.

Table 4 · Length tolerance of linear actuators

Length of actuator L_{tot} mm	Tolerance mm
L_{tot} <1000	±2
1000 ≦L_{tot} <2 000	±3
2000 ≦L_{tot} <4 000	±4
4000 ≦L_{tot}	±5

Table 5 · Straightness tolerance of support rail

Length of support rail	MLFI 140 3ZR			MLFI 200 3ZR		
	t_2	t_3	Torsion	t_2	t_3	Torsion
mm	mm	mm	mm	mm	mm	mm
<1000	0,6	0,5	0,5	0,8	0,7	0,5
1000 ≦2000	1	0,7	1	1,2	0,9	1
2000 ≦3000	1,4	0,9	1,5	1,6	1,1	1,5
3000 ≦4000	1,7	1,2	2	1,9	1,4	2
4000 ≦5000	2,1	1,4	2,5	2,3	1,6	2,5
5000 ≦6000	2,7	1,7	3	2,9	1,9	3
6000 ≦7000	3,1	2	3,5	3,3	2,2	3,5
over 7000	3,6	2,3	4	3,8	2,5	4

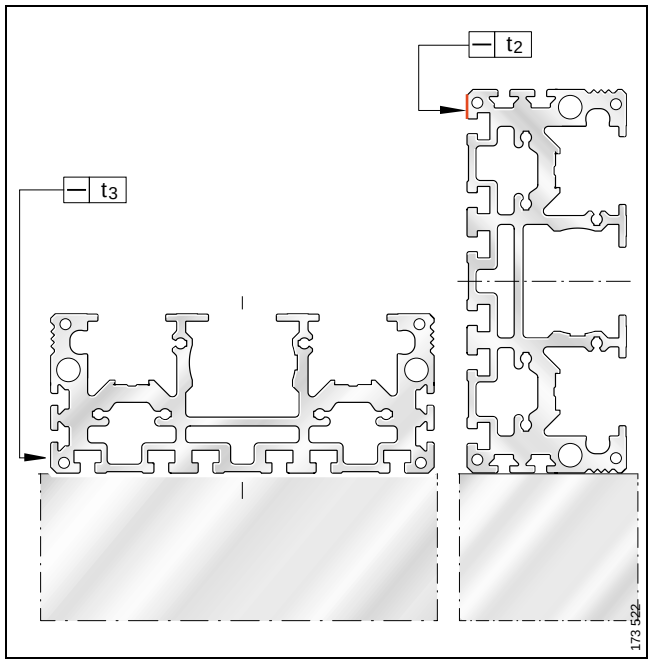


Figure 4 · Straightness tolerance of support rail for MLFI 140 3ZR, MLFI 200 3ZR

Ordering example and ordering designation

Ordering example

Linear actuator MLFI 200 3ZR

Linear actuator with	
enclosed track roller guidance system	MLFI
Size	200
Drive type: three toothed belts	3ZR
Drive shaft on left side	AL
Total length L_{tot}	4 648 mm
Total stroke (effective stroke + 2×S)	4 000 mm

Ordering designation:

1 off MLFI 200 3ZR AL/4 648-4 000 (Figure 5).

Note

Note total length of carriage!

For a second carriage, use the suffix W2!

If two or more carriages are arranged in series, the distance between the carriages must be stated in the order!

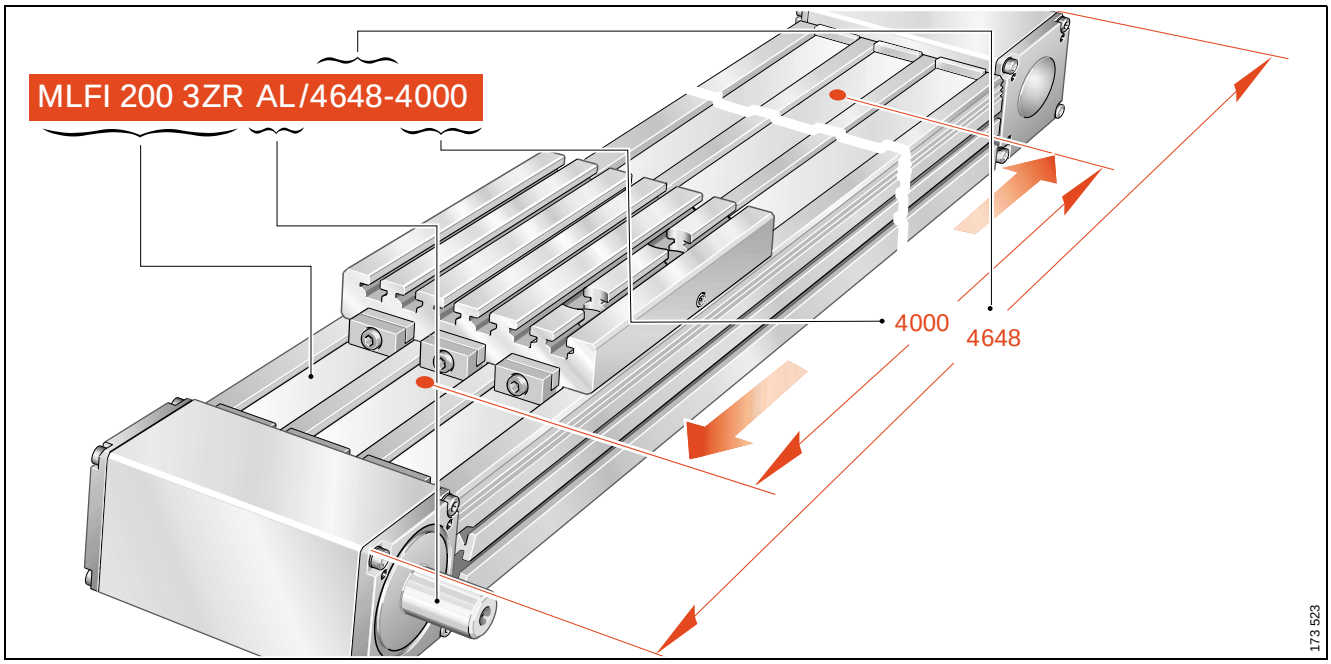
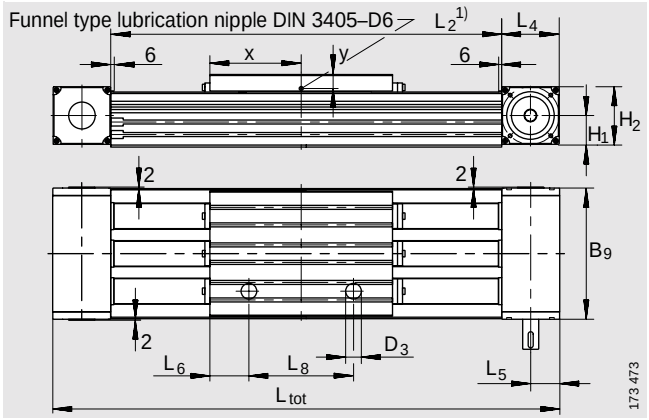


Figure 5 · Ordering example and ordering designation – linear actuator MLFI 200 3ZR AL/4 648-4 000

Linear actuator with track roller guidance system and toothed belt drive

Series MLFI..3ZR



MLFI .. 3ZR

Dimension table · Dimensions in mm

Designation	Mass		Dimensions			Mounting dimensions											
	G_{tot} ≈kg	G_{Law} 2) ≈kg	H	B	L	L_1	B_1 4)	B_2 4)	B_3 4)	B_4 3)	B_5 3)	B_6 3)	B_7	B_8 P9	B_9	D	L_4
MLFI 140 3ZR	$(L_{tot} - 160) \times 0{,}0138 + 12{,}7$	5,5	105	176	240	282	–	80	130	–	70	140	180	8	195	80	80
MLFI 200 3ZR	$(L_{tot} - 231) \times 0{,}0300 + 29{,}2$	13,3	145	250	365	405	35	115	185	50	110	210	260	10	263	115	115,5

1) L_2 = total stroke + L_1 + 12
L_{tot} = total stroke + L_1 + 12 + 2×L_4.
Total stroke = effective stroke + 2×S (mm).

⚠ The allowance S designates a safety range suitable for the particular application and should be at least 85 mm; total stroke in mm.

Maximum single-piece support rail length L2 = 8 000 mm.

2) G_{Law} = mass of carriage.

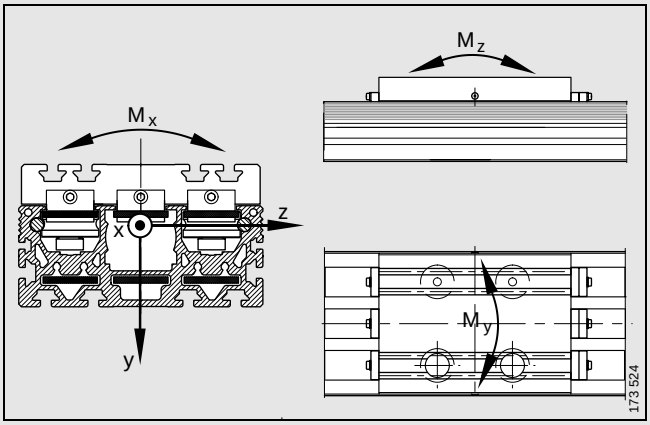
3) On MLFI 140: slot width 8 mm.
On MLFI 200: slot width 10 mm.

4) On MLFI 140: slot width 8 mm.
On MLFI 200: slot width 8 mm.

5) On MLFI 140: slot width 5 mm.
On MLFI 200: slot width 8 mm.

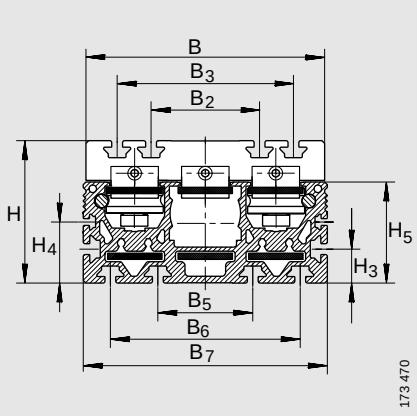
6) The values are single loads and apply when the underside of the actuator is fully supported.
These must be reduced for combined loads. For design criteria of the linear guidance system, see *INA Catalogue 801*.

7) Utilisation of the T-slots is restricted by the holes.

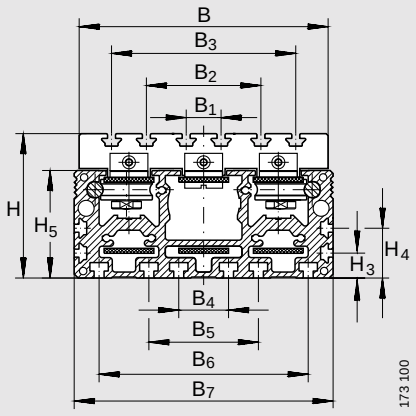


Load directions

Linear actuator	**Toothed belt/gears**					
Designation	Toothed belt	Permissible toothed belt operating force	Maximum drive torque	Mass of toothed belts	Feed	Mass moment of inertia of both gears
	Type	N	Nm	kg/m	mm/rev.	kg · m^2
MLFI 140 3ZR	3×40 AT 10	4 500	115	0,75	160	$8{,}2 \times 10^{-4}$
MLFI 200 3ZR	3×50 AT 10	5 640	207	0,95	230	$35{,}2 \times 10^{-4}$

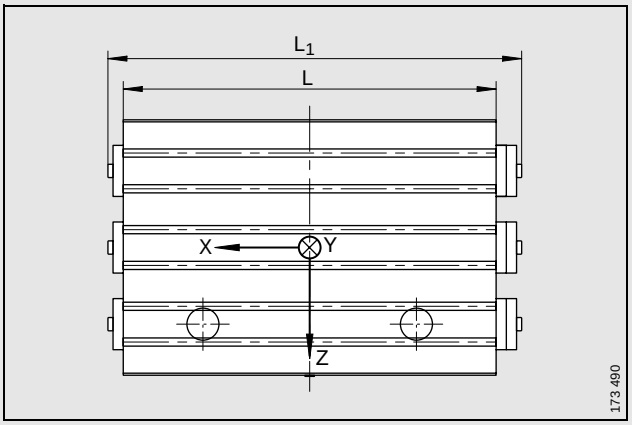


MLFI 140 3ZR

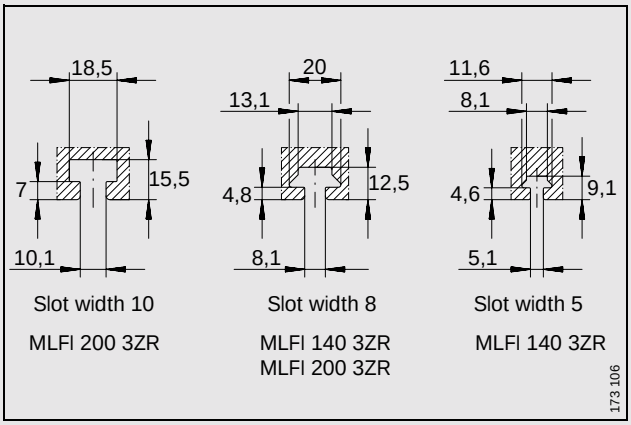


MLFI 200 3ZR

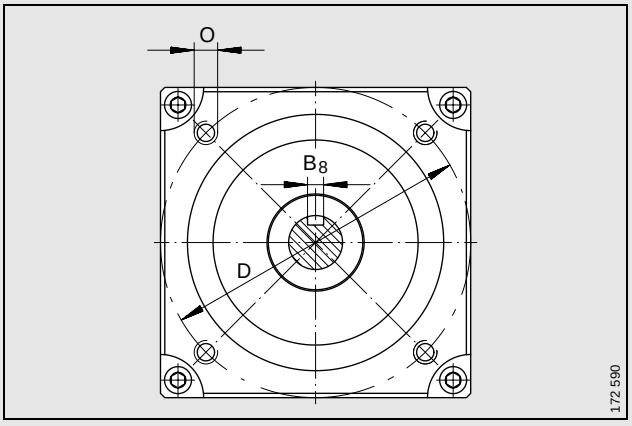
												Permissible load on carriage guidance system[6]				Permissible torque on carriage guidance system[6]			Geometrical moment of inertia of support rail	
H_1	H_2	H_3[4]	H_5[5]	H_4	L_5	O	L_6[7]	L_8	D_3[7]	X	Y	$F_{y\,perm}$ N	$F_{0y\,perm}$ N	$F_{z\,perm}$ N	$F_{0z\,perm}$ N	$M_{0x\,perm}$ Nm	$M_{0y\,perm}$ Nm	$M_{0z\,perm}$ Nm	I_y cm^4	I_z cm^4
44	84	25	74,5	45	40	M6	73	94	30	120	24	2 400	4 000	4 500	4 500	320	210	180	1 636	200
63	120,5	25	108	50	57,75	M8	78	209	36,5	182,5	28	4 800	8 000	10 000	10 000	750	1 100	788	7 068	899



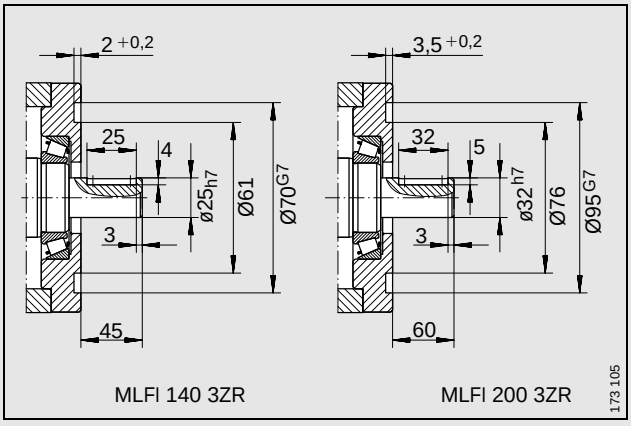
Carriage MLFI 200 3ZR with 6 slots
Carriage MLFI 140 3ZR with 4 slots



T-slots



Drive flange/drive shaft



Drive flange/drive shaft

Linear actuator with ball bearing and guideway assembly and toothed belt drive

Series MKUVE 20 B ZR

Page

Design and safety guidelines 26

Accuracy 29

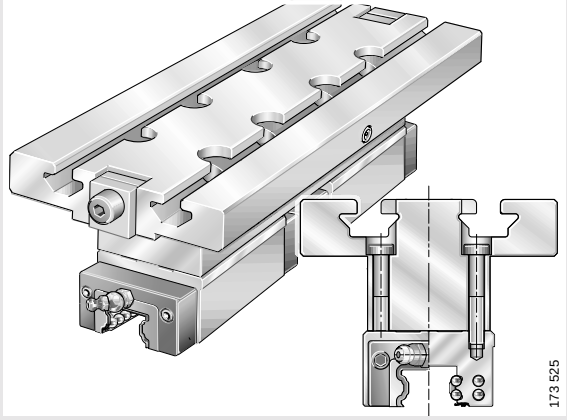
Ordering example and ordering designation 30

Features

Linear actuators with ball bearing and guideway assembly and toothed belt drive

- are complete units comprising:
  - a support rail – the supporting profiled section is extremely rigid and suitable for spanning large gaps
  - one carriage running in the support rail – guidance by two KUVE carriages
  - a toothed belt drive
  - two return units
- can support forces from all directions and moments about all axes
- are suitable for moderate to heavy loads
- can also be fitted with more than one driven carriage
- have a clearance-free, preloaded guidance system
- run with high positional accuracy and free from stick-slip
  - if the servo controller COMPAX is used, the positional accuracy is $\leqq \pm 0{,}1$ mm
- are suitable for:
  - accelerations up to 30 m/s^2
  - speeds up to 3 m/s
  - operating temperatures from –10 °C to +80 °C
- are easy to fit
  - the carriage and support rail have T-slots for standard T-nuts or fixing lugs. The components can therefore be easily screwed to the adjacent construction
- are particularly suitable, due to the T-slots, for modular constructions
- are fitted with carriages with a relubrication facility
  - the carriages are lubricated via lubrication nipples in the longitudinal sides of the carriages
  - the carriage, toothed belt drive and return units require no maintenance
- are versatile in application due to a comprehensive range of accessories.

Carriage



- saddle plate made from anodised profiled aluminium with T-slots
- two KWVE carriages
- driven by one toothed belt
- integral clamping devices for toothed belt on both sides
- funnel type lubrication nipples on longitudinal faces

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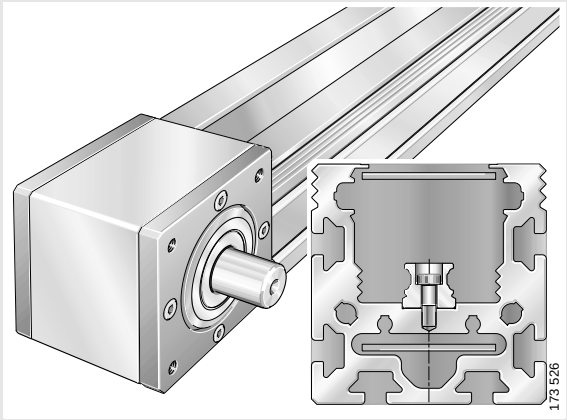
Support rail with return unit



- support rail
  - composite rail made from anodised aluminium profiled supporting section, combined with guideway of linear guidance system KUVE
- return unit
  - housing made from anodised profiled aluminium
  - return shaft with maintenance-free ball bearings
  - wiper brushes to protect the return area from contamination

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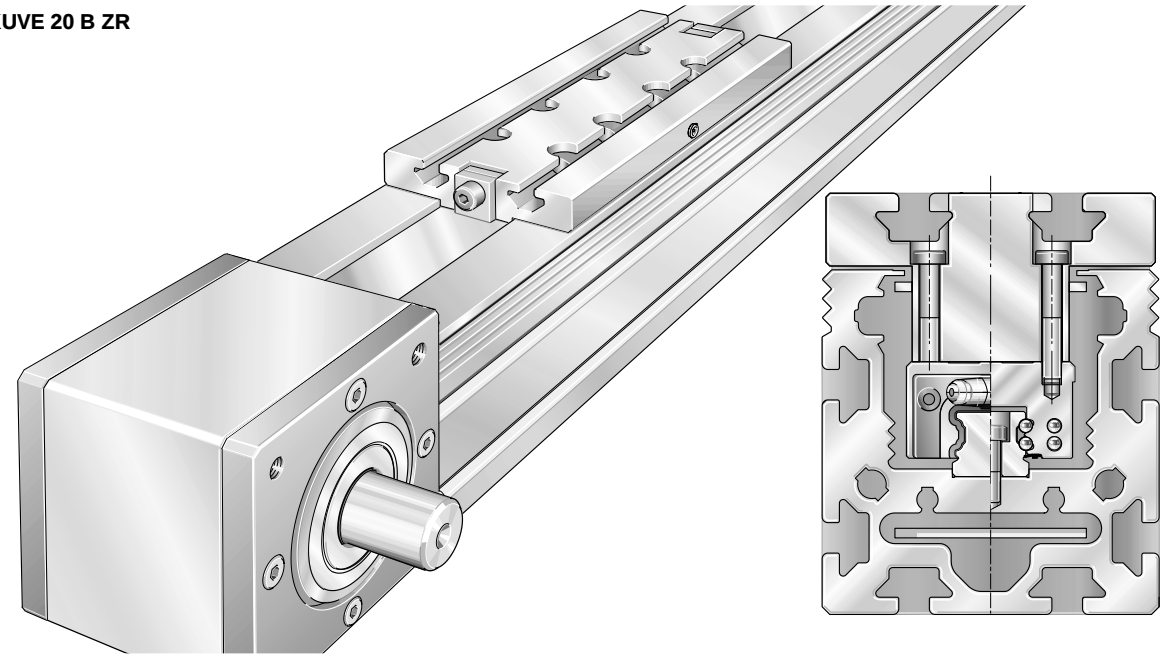
Linear actuator – scope of basic delivery

MKUVE 20 B ZR



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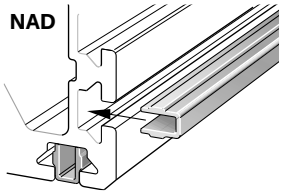
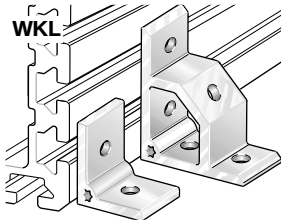
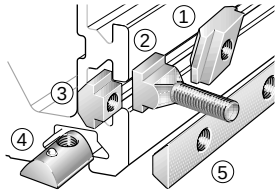
Accessories

NAD

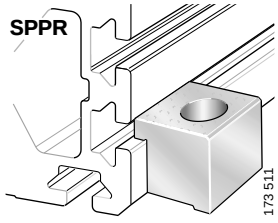


WKL





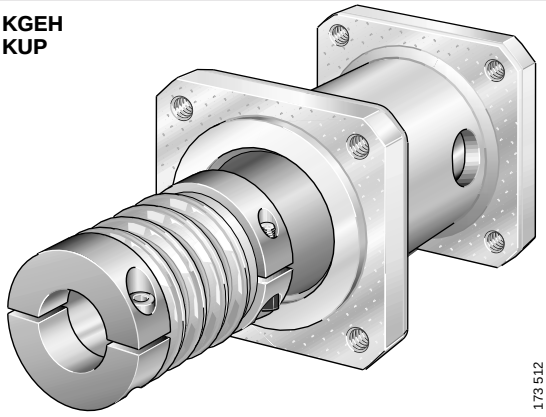
SPPR



173 511

- NAD
  - plastic slot seal
- SPPR
  - fixing lug
- WKL
  - fixing brackets
- ①, ②, ③, ④, ⑤
  - fixing screws, T-bolts and T-strips

KGEH
KUP



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- KGEH
  - coupling housing made from anodised aluminium
  - flange with fixing holes at both ends
- KUP
  - metallic bellows coupling
  - fixing hubs made from anodised aluminium
  - metallic bellows made from thin-walled alloy steel
  - clamping to motor, drive or gearbox shaft

Design and safety guidelines

Idling drive torque

With constant drive speed and a horizontally mounted actuator, the drive torque does not vary significantly as a function of the mass to be moved.

With increasing speed, the drive torque also increases (Figure 1).

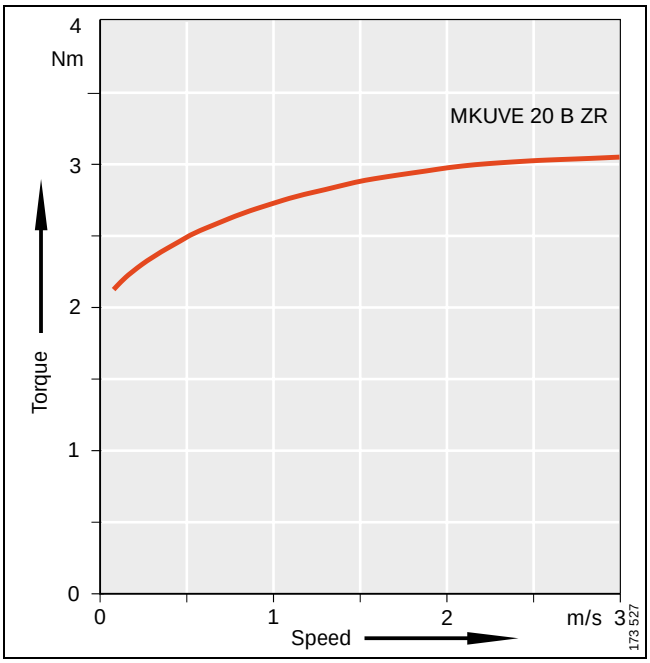


Figure 1 · Idling drive torque in horizontal mounting position of linear actuator MKUVE 20 B ZR

Combination with actuator components

In its role as a system supplier, INA offers not only actuators but also the appropriate components including coupling housings, couplings, gearboxes and motors (Table 1). These components are precisely matched to the actuators and thus complement the range of linear actuators in an optimum manner.

Table 1 · Possible combinations with actuator components

Linear actuator	Coupling housings	Couplings	Gearboxes	Motors
MKUVE 20 B ZR	KGEH MLFI 50 B ZR-60/ 75/M5	KUP 560-56 20H7-20H7	GETR PL 70-..	MOT SMH 60 MOT SMHA 60-BR
	KGEH MLFI 50 B ZR-80/100/M6	KUP 560-56 20H7-20H7	GETR PL 90-..	MOT SMH 82 MOT SMHA 82-BR

Drive variants

The possible positions of the drive are shown in Figure 2.
Description of the suffixes: see Table 2.

Table 2 · Drive variants – suffixes

Drive system Suffix	Designs
OA	Without drive
AR	Drive shaft on right side
AL	Drive shaft on left side
RL	Drive shaft on both sides (right and left)

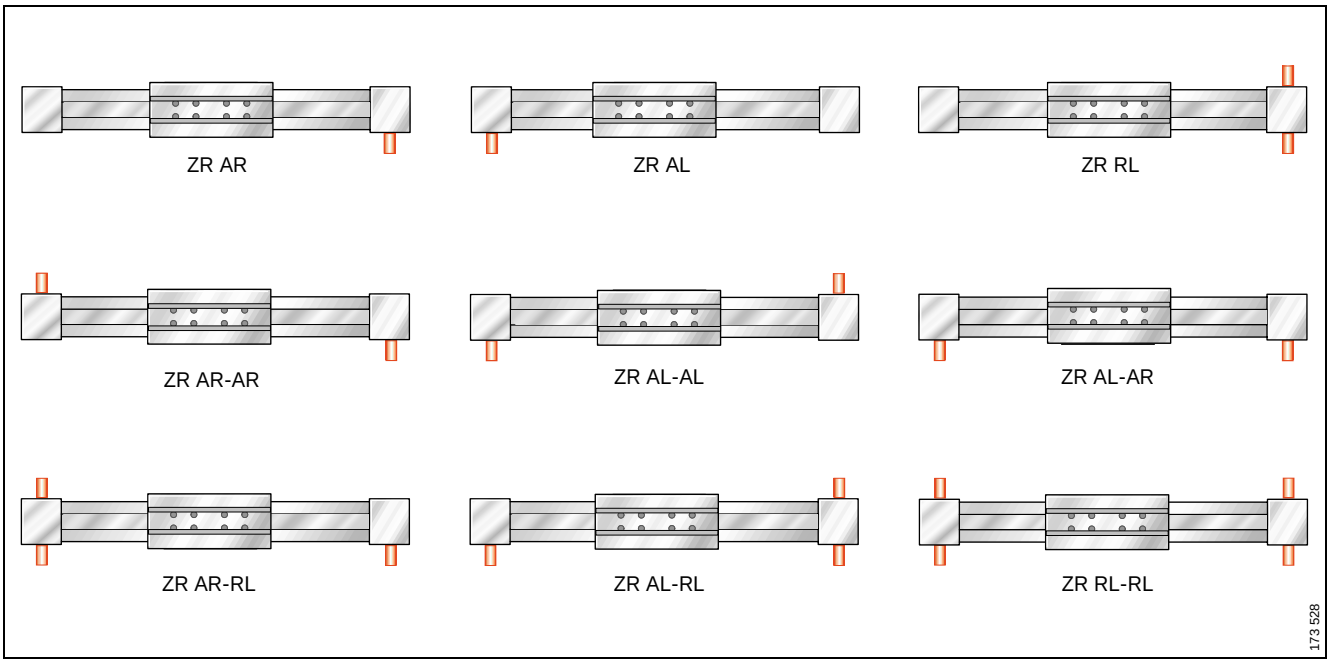


Figure 2 · Positions of the drive – schematic

Lubrication

Raceways

The rolling system (the contact zone between the rolling element and raceways) must be lubricated.

The relubrication intervals are essentially dependent on:

- the travel speed
- the load
- the operating temperature
- the stroke length
- the environmental conditions; the cleaner the operating environment, the lower the lubricant consumption.

Since it is not possible to calculate all the influencing factors, the time at which relubrication must be carried out and the quantity of lubricant which must be used can only be determined under actual operating conditions. If no precise data are available, the values according to Table 3 are valid for many applications.

Relubrication must be carried out at the latest when fretting corrosion first occurs – this can be identified by a reddish discolouration of the raceways or the outside surface of the track rollers. Subsequent lubrication intervals must be shortened!

Relubrication should be carried out using a lithium complex soap grease with a mineral oil base. The viscosity of the base oil should be between ISO VG 68 and ISO VG 100.

Relubrication should preferably be carried out with several partial quantities at various times instead of the complete quantity at the time of the relubrication interval. Relubrication is carried out via two funnel type lubrication nipples to DIN 3405-D6 ① on the longitudinal faces of the carriages ② (Figure 3). Relubrication can therefore be carried out from either the left or right side of the carriage.

⚠ The grease gun, the lubrication nipple, the area around the lubrication nipple and the grease must be clean!

Lubrication should only be carried out on linear actuators still warm from operation!

Move the carriage during lubrication!

Further information on lubricant quantities is given in *INA publication "ALE"*!

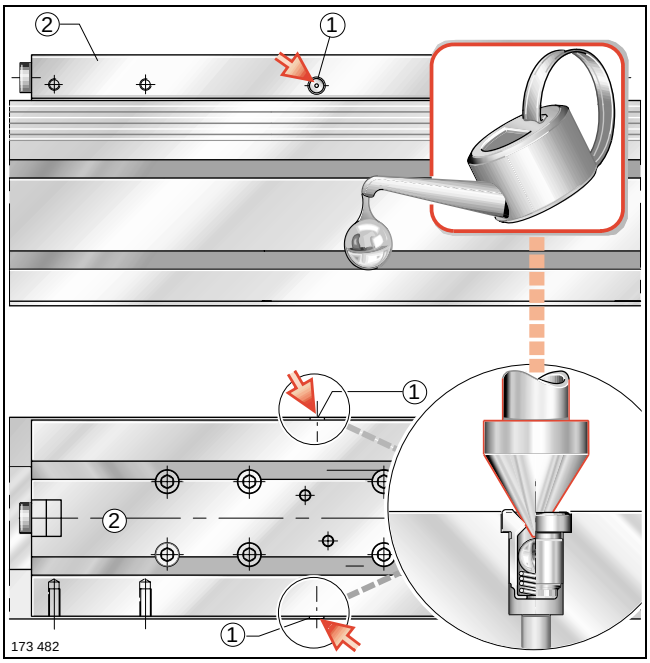


Figure 3 · Lubrication points – MKUVE 20 B ZR

Table 3 · Relubrication quantities – guide values

Linear actuator	Grease quantity per carriage g
MKUVE 20 B ZR	approx. 4 to 5

Accuracy

The linear actuators are precision straightened and the tolerances are better than those to DIN 17 615 (Table 4 and Table 5). The tolerances are arithmetic mean values.

The method for determining the straightness of the support rail is shown in Figure 4. For lengths in excess of 6 000 mm, the straightness tolerance t_2, t_3 may show a linear increase of 0,5 mm per 1000 mm.

Table 4 · Length tolerance of linear actuators

Length of actuator L_{tot} mm	Tolerance mm
L_{tot} <1000	±2
1000 ≦L_{tot} <2 000	±3
2000 ≦L_{tot} <4 000	±4
4000 ≦L_{tot}	±5

Table 5 · Straightness tolerance of support rail

Length of support rail mm	MKUVE 20 B ZR		
	t_2 mm	t_3 mm	Torsion mm
<1000	0,4	0,3	0,8
1000 ≦2000	0,8	0,5	1
2000 ≦3000	1,2	0,7	1,2
3000 ≦4000	1,5	1	1,6
4000 ≦5000	1,9	1,2	1,8
5000 ≦6000	2,5	1,5	2
6000 ≦7000	2,9	1,8	2,2
over 7000	3,4	2,1	2,4

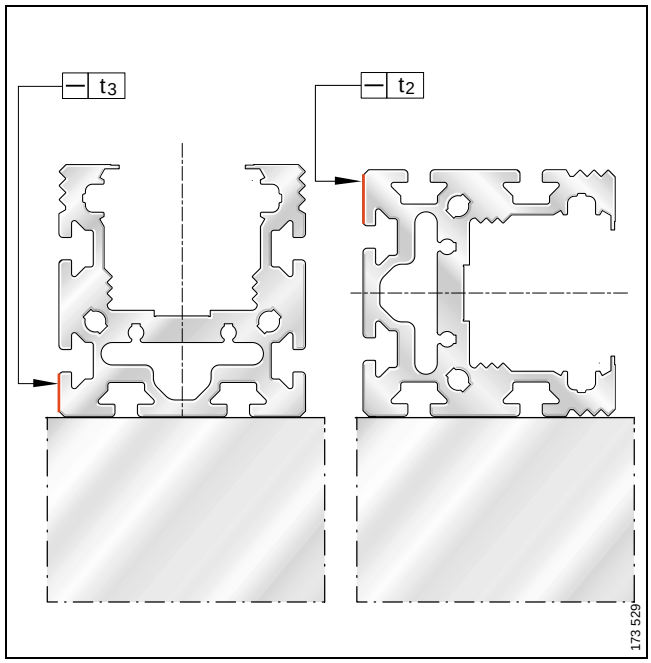


Figure 4 · Straightness tolerance of support rail for MKUVE 20 B ZR

Ordering example and ordering designation

Ordering example

Linear actuator MKUVE 20 B ZR

Linear actuator with	
enclosed ball bearing and guideway assembly	MKUVE
Size	20 B
Drive type: one toothed belt	ZR
Drive shaft on both sides	RL
Carriage with T-slots	N
Total length L_{tot}	3 000 mm
Total stroke (effective stroke + 2×S)	2 534 mm

Ordering designation:

1 off MKUVE 20 B ZR RL N/3 000-2 534 (Figure 5).

Note

Note total length of carriage!

For a second carriage, use the suffix W2!

If two or more carriages are arranged in series, the distance between the carriages must be stated in the order!

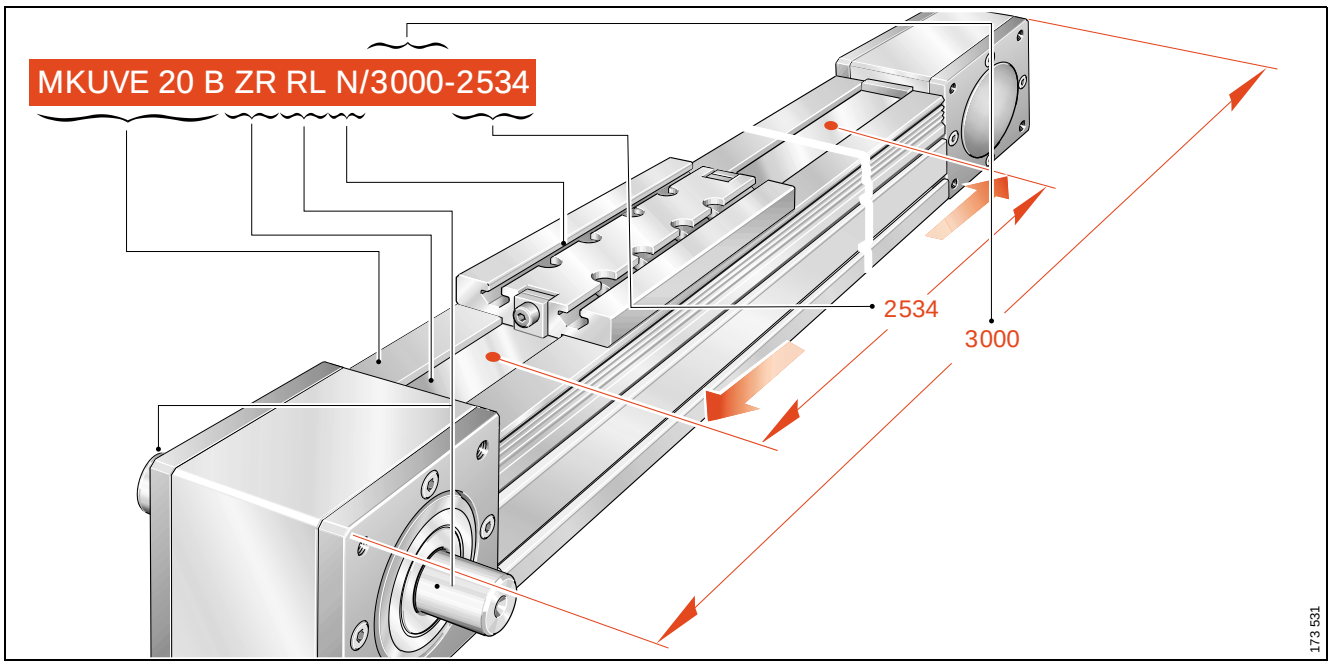
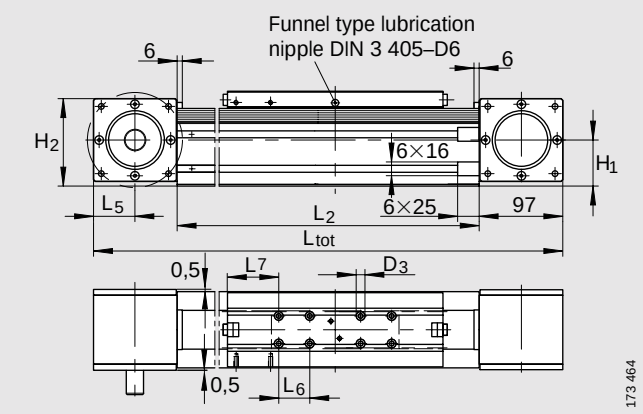


Figure 5 · Ordering example and ordering designation – linear actuator MKUVE 20 B ZR

Linear actuator with ball bearing and guideway assembly and toothed belt drive

Series MKUVE 20 B ZR



MKUVE 20 B ZR

Dimension table · Dimensions in mm

Designation	Mass		Dimensions			Mounting dimensions								
	G_{tot} ≈kg	G_{Law} [3] ≈kg	H	B	L	L_1	B_1	B_4	B_7	B_8 P9	D	L_4	H_1	H_2
MKUVE 20 B ZR	$(L_{tot} - 194)\times 0{,}0124 + 6$	2	110	86	250	260	40	40	88	6	110	97	53,4	101,4

[1] L_2 = total stroke + L_1 + 12
L_{tot} = total stroke + L_1 + 12 + 2×L_4.
Total stroke = effective stroke + 2×S (mm).

⚠ The allowance S designates a safety range suitable for the particular application and should be at least 85 mm; total stroke in mm.

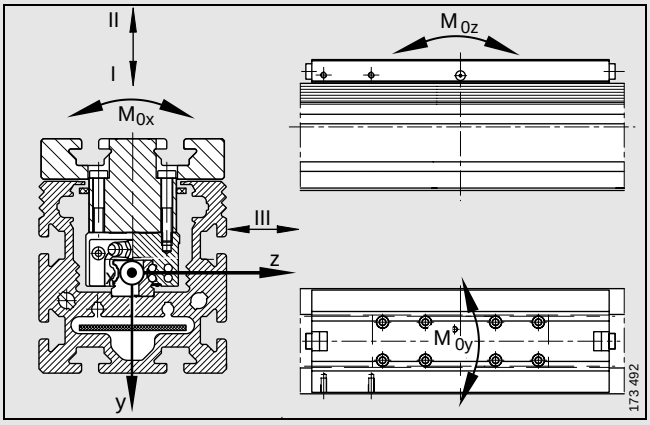
Maximum single-piece support rail length L2 = 8 000 mm.

[2] ⚠ Values are valid for calculating L_h only.

[3] G_{Law} = mass of carriage.

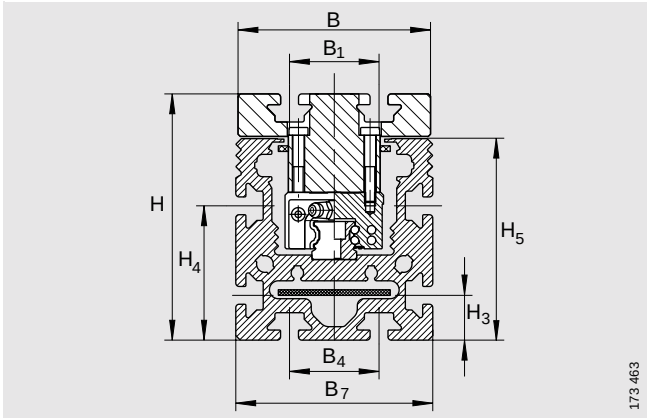
[4] The values are single loads and apply when the underside of the actuator is fully supported.
These must be reduced for combined loads. For design criteria of the linear guidance system, see *INA Catalogue 605*.

[5] Utilisation of the T-slots is restricted by the holes.



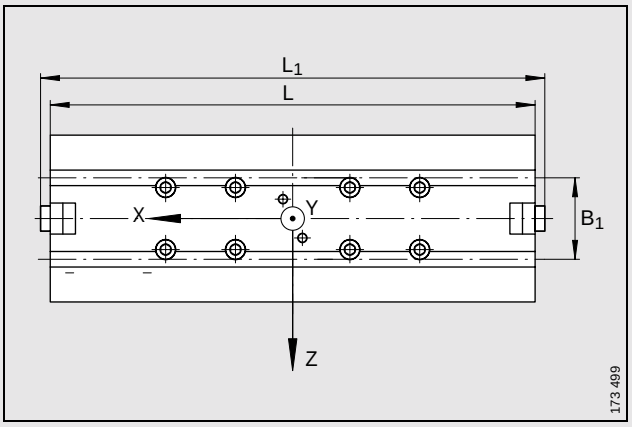
Load directions

Linear actuator	Toothed belt/gears					
Designation	Toothed belt	Permissible toothed belt operating force	Maximum drive torque	Mass of toothed belt	Feed	Mass moment of inertia of both gears
	Type	N	Nm	kg/m	mm/rev.	kg · m^2
MKUVE 20 B ZR	50 AT 10	1880	68,8	0,315	200	5×10^{-4}

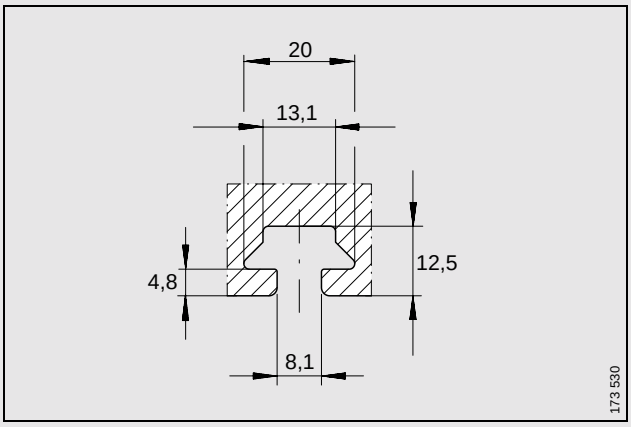


MKUVE 20 B ZR

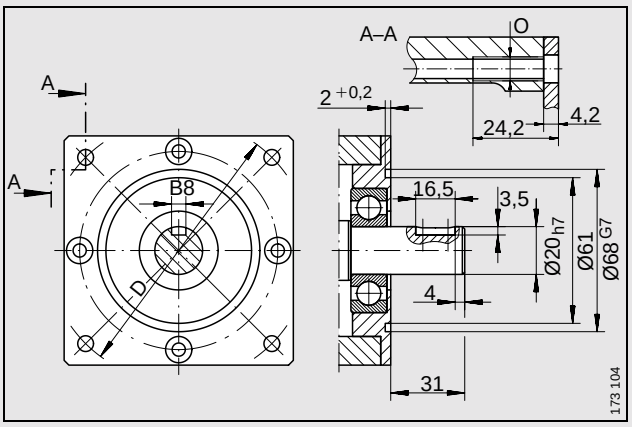
								Basic load ratings of carriage guidance system[2]		Permissible torque on carriage guidance system[4]			Geometrical moment of inertia of support rail	
H_3	H_4	H_5	L_5	O	L_6[5]	L_7[5]	D_3[5]	C	C_0	M_{0x}	M_{0y}	M_{0z}	I_y	I_z
								kN	kN	Nm	Nm	Nm	cm^4	cm^4
20	60	90	48	M6	36	59,5	10	21,3	54	664	1900	1700	300	198



Carriage



T-slots



Drive flange/drive shaft

Linear actuator with ball monorail guidance system and two opposing carriages

Series MKKUSE 20 ZR

Page

Design and safety guidelines 36

Accuracy 39

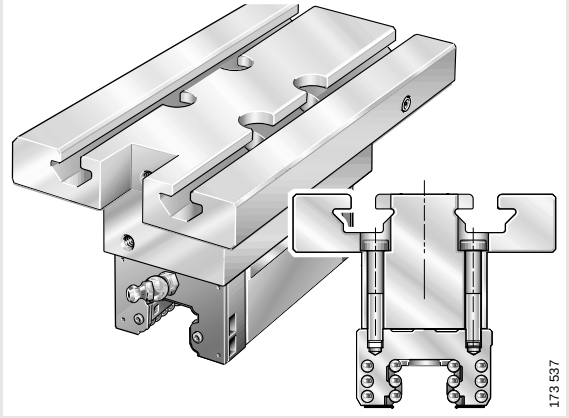
Ordering example and ordering designation 40

Features

Linear actuators with ball monorail guidance system and two opposing carriages

- are complete units comprising:
  - a support rail – the supporting profiled section is extremely rigid and suitable for spanning large gaps
  - two opposing carriages running in the support rail – guidance by KUSE carriages
  - a toothed belt drive with a vertical arrangement
  - two return units
- allow synchronised opposing motion of the carriages due to the vertical arrangement and linkage of the toothed belts
- can support forces from all directions and moments about all axes
- are suitable for moderate to heavy loads
- have a clearance-free, preloaded guidance system
- run with high positional accuracy and free from stick-slip
  - if the servo controller COMPAX is used, the positional accuracy per carriage is $\leqq \pm 0{,}1$ mm
- are suitable for:
  - accelerations up to 30 m/s^2
  - speeds up to 3 m/s
  - operating temperatures from –10 °C to +80 °C
- are easy to fit
  - the carriages and support rail have T-slots for standard T-nuts or fixing lugs. The components can therefore be easily screwed to the adjacent construction
- are particularly suitable, due to the T-slots, for modular constructions
- are maintenance-free and the running system can be relubricated
  - the carriages, toothed belt drive and return units require no maintenance
  - the running system is relubricated via lubrication nipples in the longitudinal sides of the carriages
- are versatile in application due to a comprehensive range of accessories.

Carriage



- saddle plate made from anodised profiled aluminium with T-slots
- one KWSE carriage
- driven by three toothed belts
- integral clamping devices for toothed belt on one side
- funnel type lubrication nipples on longitudinal faces

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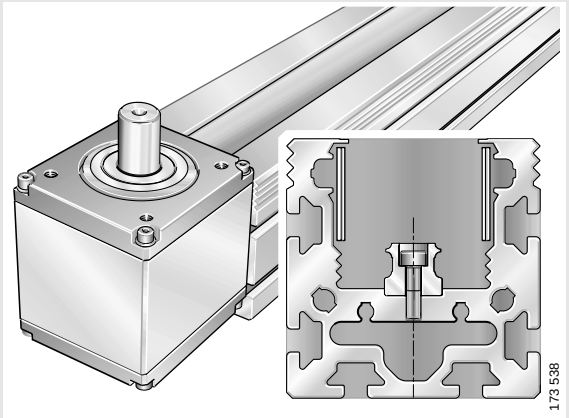
Support rail with return unit



- support rail
  - composite rail made from anodised aluminium profiled supporting section, combined with guideway of linear recirculating ball bearing and guideway assembly KUSE
- return unit
  - housing made from anodised profiled aluminium
  - return shaft with maintenance-free ball bearings

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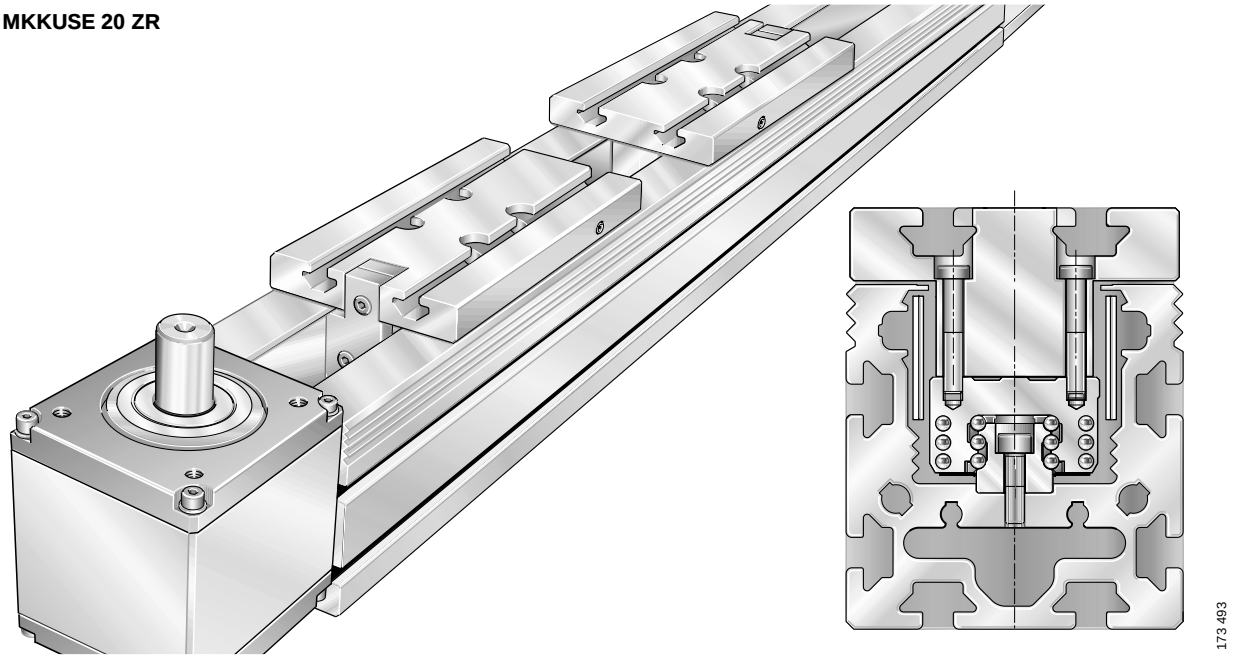
Linear actuator – scope of basic delivery

MKKUSE 20 ZR



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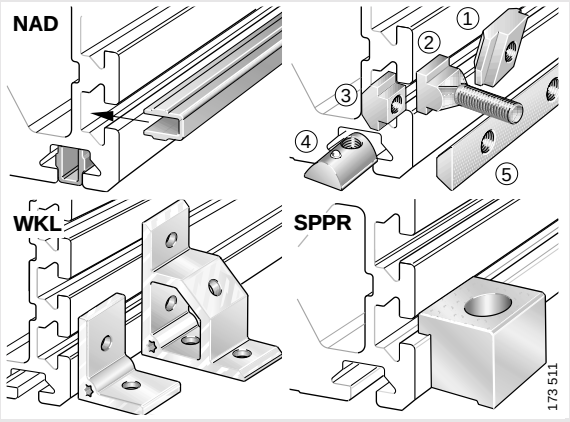
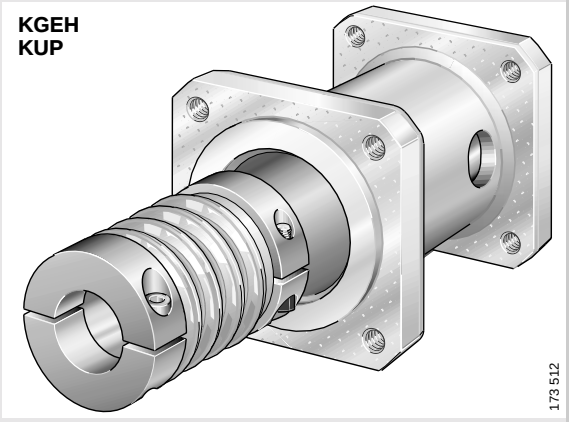
Accessories



- NAD
  - plastic slot seal
- SPPR
  - fixing lug
- WKL
  - fixing brackets
- ①, ②, ③, ④, ⑤
  - fixing screws, T-bolts and T-strips



- KGEH
  - coupling housing made from anodised aluminium
  - flange with fixing holes at both ends
- KUP
  - metallic bellows coupling
  - fixing hubs made from anodised aluminium
  - metallic bellows made from thin-walled alloy steel
  - clamping to motor, drive or gearbox shaft

Design and safety guidelines

Idling drive torque

With constant drive speed and a horizontally mounted actuator, the drive torque does not vary significantly as a function of the mass to be moved.

With increasing speed, the drive torque also increases (Figure 1).

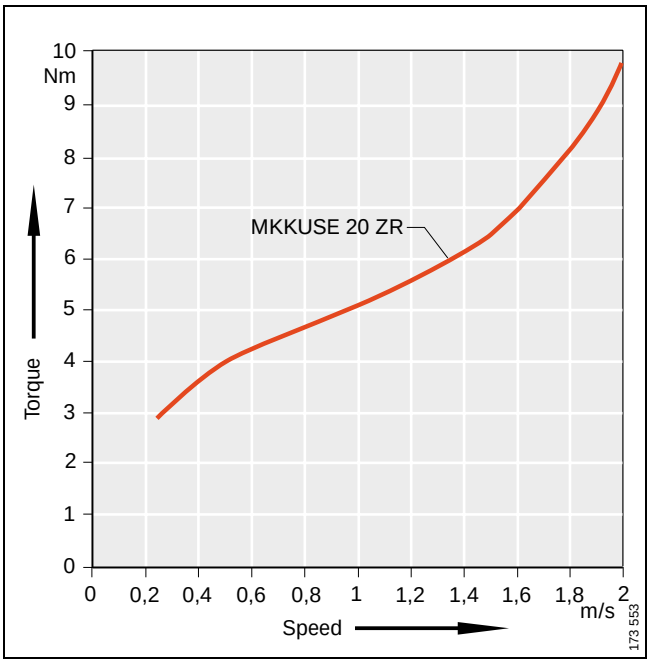


Figure 1 · Idling drive torque in horizontal mounting position of linear actuator MKKUSE 20 ZR

Combination with actuator components

In its role as a system supplier, INA offers not only actuators but also the appropriate components including coupling housings, couplings, gearboxes and motors (Table 1). These components are precisely matched to the actuators and thus complement the range of linear actuators in an optimum manner.

Table 1 · Possible combinations with actuator components

Linear actuator	Coupling housings	Couplings	Gearboxes	Motors
MKKUSE 20 ZR	KGEH MLF 32 ZR ZR-80/100/M6	KUP 560-56 20H7-20H7	GETR PL 90-..	MOT SMH 82 MOT SMHA 82-BR
			GETR PLE 80/90-..	
			MOGE AS2-STI..	
	KGEH MLF 32 ZR-45/70/75	KUP 50-40-2 20H7-14H7	MOGE AS1-PLE 60..	

Drive variants

The possible positions of the drive are shown in Figure 2.
Description of the suffixes: see Table 2.

Table 2 · Drive variants – suffixes

Drive system Suffix	Designs
AR	Drive shaft on right side
AL	Drive shaft on left side
RL	Drive shaft on both sides (right and left)

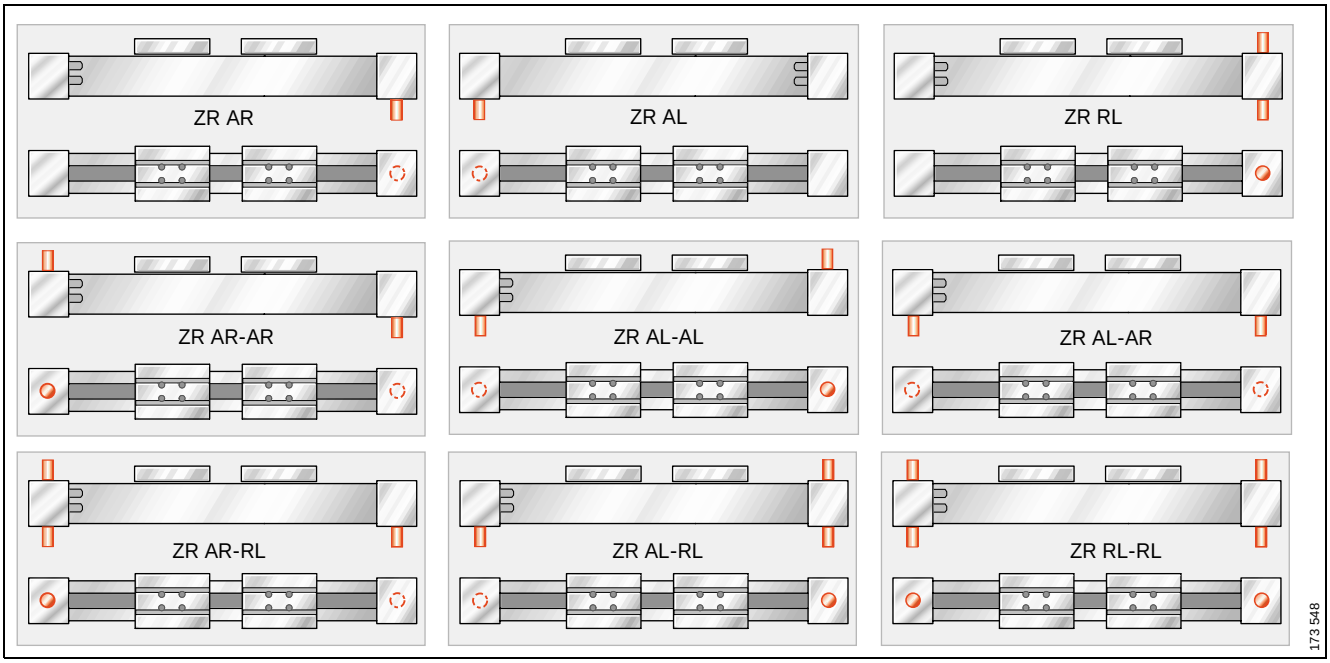


Figure 2 · Positions of the drive – schematic

Lubrication

Raceways

The rolling system (the contact zone between the rolling element and raceways) must be lubricated.

The relubrication intervals are essentially dependent on:

- the travel speed
- the load
- the operating temperature
- the stroke length
- the environmental conditions; the cleaner the operating environment, the lower the lubricant consumption.

Since it is not possible to calculate all the influencing factors, the time at which relubrication must be carried out and the quantity of lubricant which must be used can only be determined under actual operating conditions. If no precise data are available, the values according to Table 3 are valid for many applications.

Relubrication must be carried out at the latest when fretting corrosion first occurs – this can be identified by a reddish discolouration of the raceways or the outside surface of the track rollers. Subsequent lubrication intervals must be shortened!

Relubrication should be carried out using a lithium complex soap grease with a mineral oil base. The viscosity of the base oil should be between ISO VG 68 and ISO VG 100.

Relubrication should preferably be carried out with several partial quantities at various times instead of the complete quantity at the time of the relubrication interval. Relubrication is carried out via two funnel type lubrication nipples to DIN 3405-D6 ① on the longitudinal faces of the carriages ② (Figure 3). Relubrication can therefore be carried out from either the left or right side of the carriage.

⚠ The grease gun, the lubrication nipple, the area around the lubrication nipple and the grease must be clean!

Lubrication should only be carried out on linear actuators still warm from operation!

Move the carriage during lubrication!

Further information on lubricant quantities is given in *INA publication "ALE"*!

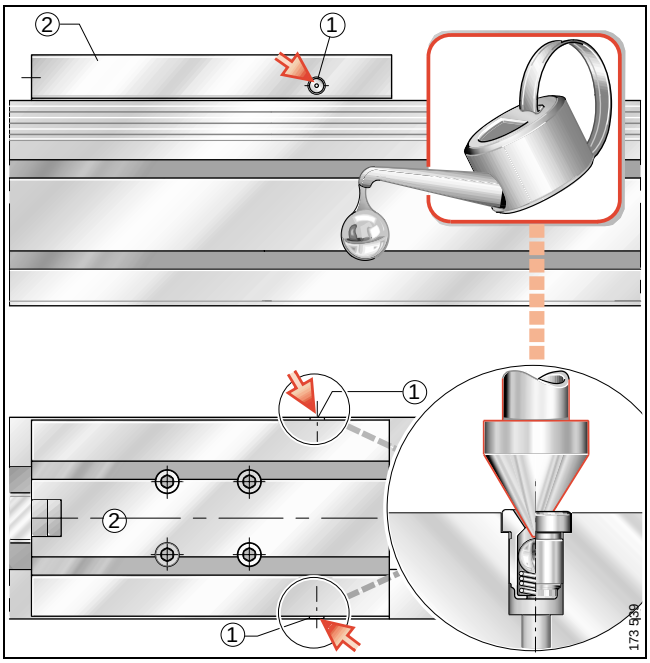


Figure 3 · Lubrication points – MKKUSE 20 ZR

Table 3 · Relubrication quantities – guide values

Linear actuator	Grease quantity per carriage g
MKKUSE 20 ZR	3 to 4

Accuracy

The linear actuators are precision straightened and the tolerances are better than those to DIN 17 615 (Table 4 and Table 5). The tolerances are arithmetic mean values.

The method for determining the straightness of the support rail is shown in Figure 4. For lengths in excess of 6 000 mm, the straightness tolerance t_2, t_3 may show a linear increase of 0,5 mm per 1000 mm.

Table 4 · Length tolerance of linear actuators

Length of actuator L_{tot} mm	Tolerance mm
L_{tot} <1000	±2
1000 ≦L_{tot} <2 000	±3
2000 ≦L_{tot} <4 000	±4
4000 ≦L_{tot}	±5

Table 5 · Straightness tolerance of support rail

Length of support rail mm	MKKUSE 20 ZR		
	t_2 mm	t_3 mm	Torsion mm
<1000	0,4	0,3	0,8
1000 ≦2000	0,8	0,5	1
2000 ≦3000	1,2	0,7	1,2
3000 ≦4000	1,5	1	1,6
4000 ≦5000	1,9	1,2	1,8
5000 ≦6000	2,5	1,5	2
6000 ≦7000	2,9	1,8	2,2
over 7000	3,4	2,1	2,4

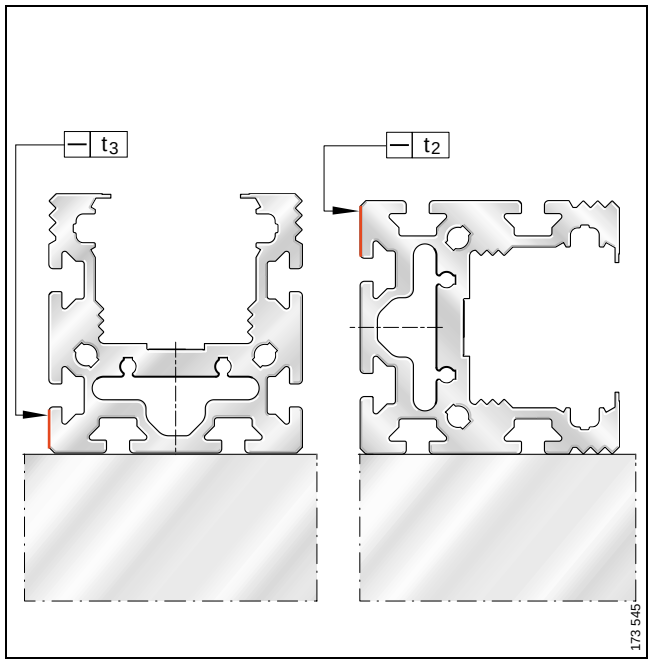


Figure 4 · Straightness tolerance of support rail for MKKUSE 20 ZR

Ordering example and ordering designation

Ordering example

Linear actuator MKKUSE 20 ZR

Linear actuator with opposing carriages and enclosed ball bearing and guideway assembly	MKKUSE
Size	20
Drive type: two toothed belts	ZR
Drive shaft on both sides	RL
Carriage with T-slots	N
Total length L_{tot}	3100 mm
Total stroke = 2×effective stroke +2×S (effective stroke per carriage in mm)	2530 mm

Ordering designation:

1 off MKKUSE 20 ZR RL N/3100-2530 (Figure 5).

Note

Note total length of each carriage!
Carriages with T-slots have the suffix N!

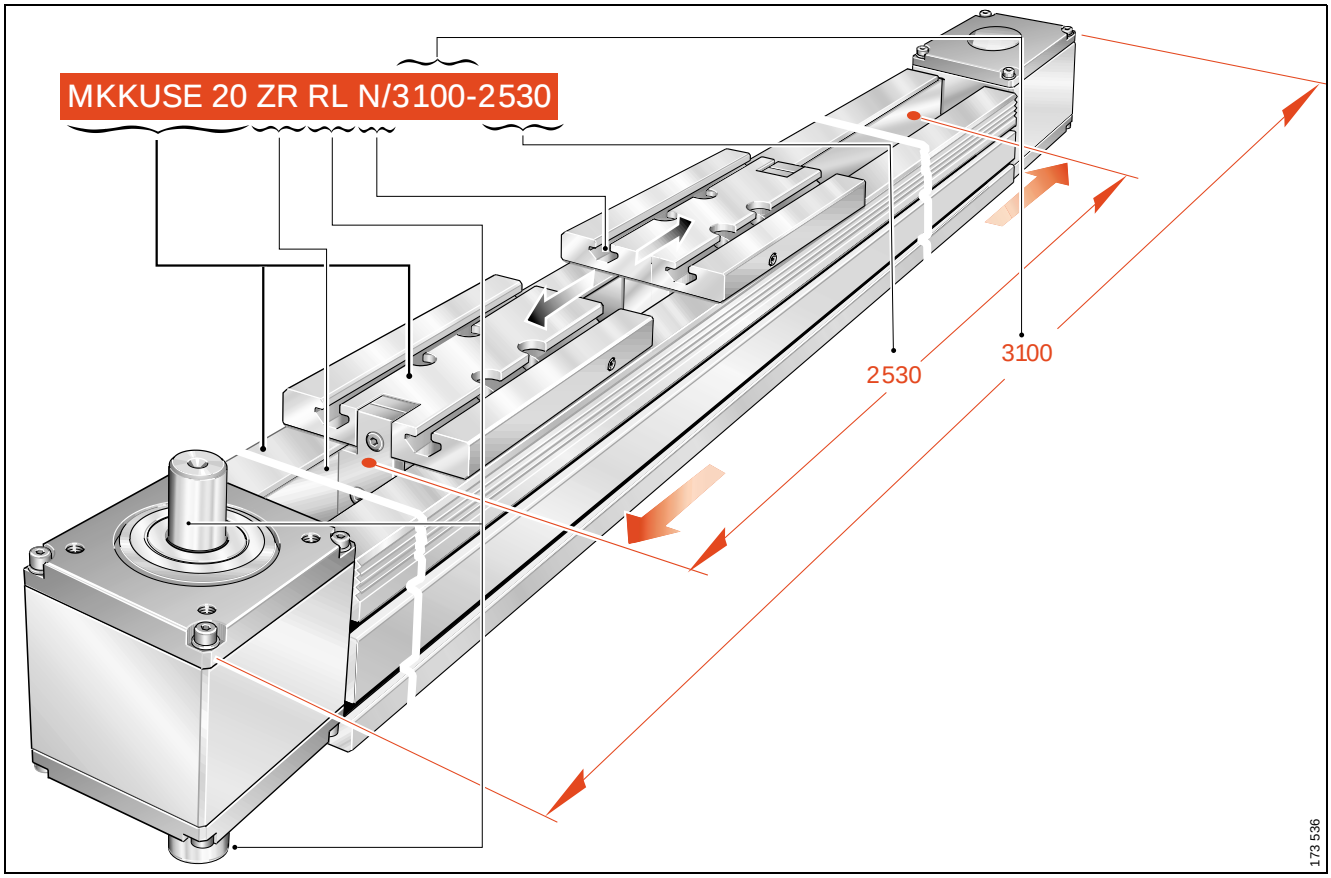
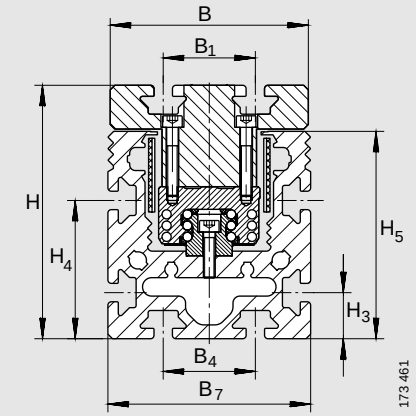


Figure 5 · Ordering example and ordering designation – linear actuator MKKUSE 20 ZR

Linear actuator with ball monorail guidance system and two opposing carriages

Series MKKUSE 20 ZR



MKKUSE 20 ZR

Dimension table · Dimensions in mm

Designation	Mass		Dimensions			Mounting dimensions											
	G_{tot} ≈kg	G_{Law} [3] ≈kg	B	H	L	B_1	B_4	B_7	B_8 P9	D	D_1 G7	D_2	D_3 [5]	L_4	L_5 [5]	H_2	H_3
MKKUSE 20 ZR	$(L_{tot} - 160)\times 0{,}0125 + 6$	1,5	86	110	155	40	40	88	6	80	70	61	10	80	36	80	20

[1] $\overline{L_2}$ = total stroke + $2\times L + L_{min}$ [6]
L_{tot} = total stroke + $2\times L + 2\times L_4 + L_{min}$ [6].
Total stroke = 2×effective stroke + 2×S
(effective stroke per carriage in mm).

⚠ The allowance S designates a safety range suitable for the particular application and should be at least 85 mm; total stroke in mm.

Maximum single-piece support rail length L2 = 4 000 mm
(longer support rails may be available by agreement).

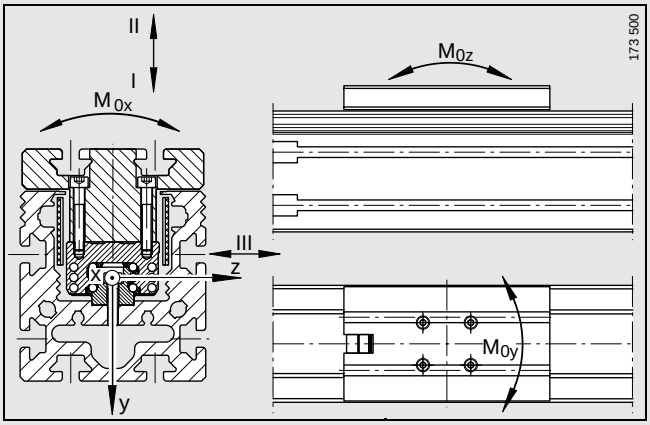
[2] Values are valid for calculating L_h only.

[3] G_{Law} = mass of carriage.

[4] The values are single loads and apply when the underside of the actuator is fully supported.
They relate to the individual carriages.
For design criteria of the linear guidance system, see *INA Catalogue 605.*

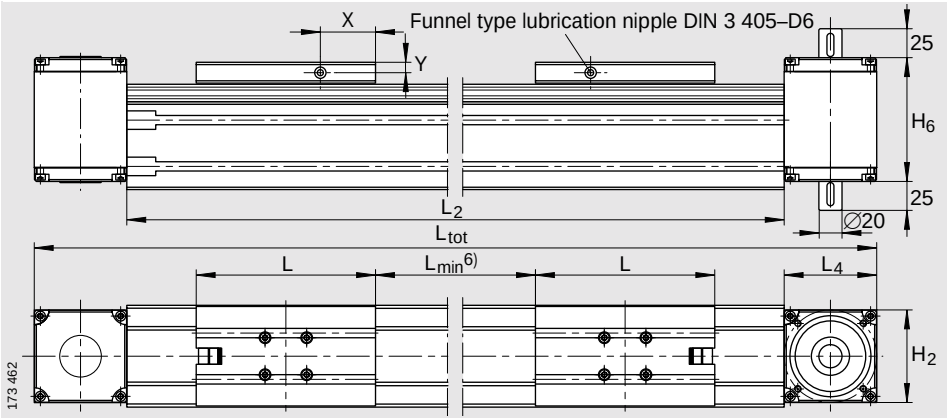
[5] Utilisation of the T-slots is restricted by the holes.

[6] The minimum spacing between the carriages L_{min} is dependent on the application and should be at least 20 mm.



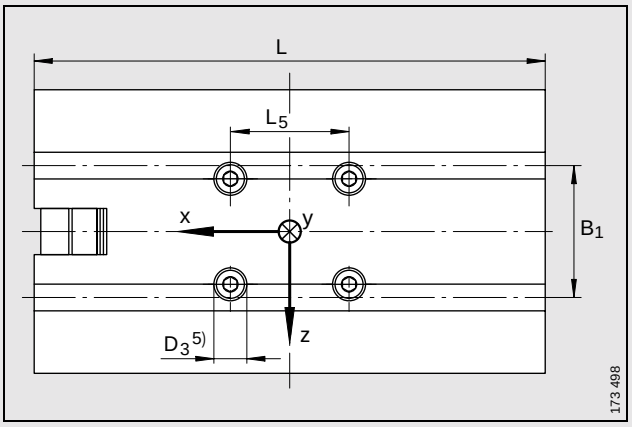
Load directions

Linear actuator	**Toothed belt/gears**					
Designation	Toothed belt Type	Permissible toothed belt operating force N	Maximum drive torque Nm	Mass of toothed belt kg/m	Feed mm/rev.	Mass moment of inertia of both gears kg · m^2
MKKUSE 20 ZR	32 AT 5	650	18	0,068	175	$2{,}2\times 10^{-4}$

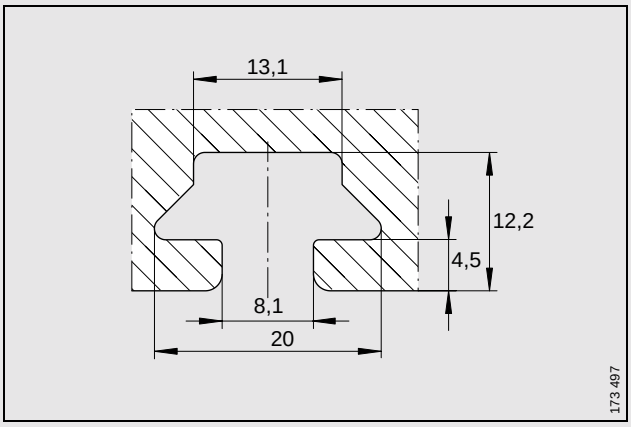


MKKUSE 20 ZR RL

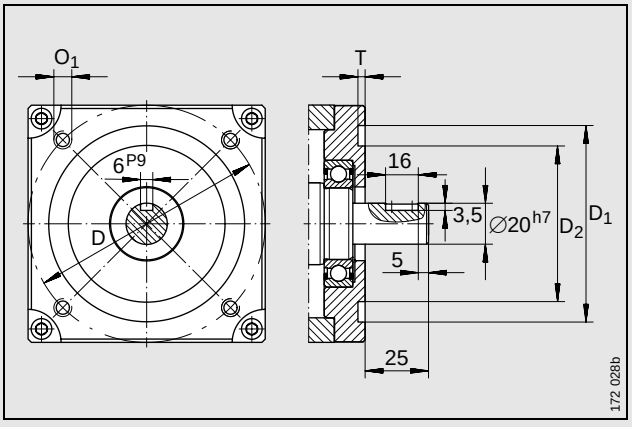
							Basic load ratings of carriage guidance system 2)4)						Permissible torque on carriage guidance system 2)4)		
							Load direction I: Compressive load		Load direction II: Tensile load		Load direction III: Lateral load				
H_4	H_5	H_6	O_1	T	X	Y	C	C_0	C	C_0	C	C_0	$M_{0x\,perm}$	$M_{0y\,perm}$	$M_{0z\,perm}$
							kN	kN	kN	kN	kN	kN	Nm	Nm	Nm
60	90	107	M6	$2^{+0,2}$	47,7	13	22	52	17,5	33,5	16,3	36	330	250	240



Carriage



T-slots



Drive flange/drive shaft

Linear actuator with track roller guidance system and two opposing carriages

Series MKLF..ZR

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Accuracy 49

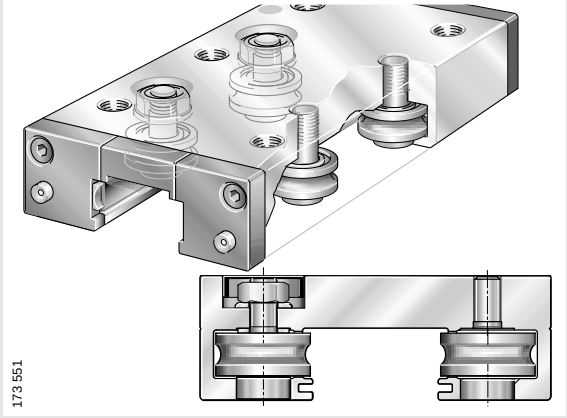
Ordering example and ordering designation 50

Features

Linear actuators with track roller guidance system and two opposing carriages

- are complete units comprising:
  - a support rail – the supporting profiled section is extremely rigid and suitable for spanning large gaps
  - two carriages running on the support rail (one carriage with a counterstay arrangement) – guidance by means of four track rollers
  - a toothed belt drive
  - two return units
  - plastic lubrication and wiper units on the end faces of the carriages
- allow synchronised opposing motion of the carriages due to the toothed belt linkage of the carriages
- can support forces from all directions and moments about all axes
- are suitable for light to moderate loads
- have a clearance-free guidance system
  - the track rollers are adjusted against the raceways by means of eccentric bolts
- run with high positional accuracy
  - if the servo controller COMPAX is used, the positional accuracy per carriage is $\leqq \pm 0{,}1$ mm
- are suitable for:
  - accelerations up to 40 m/s^2
  - speeds up to 8 m/s
  - operating temperatures from –20 °C to +80 °C
- are easy to fit
  - the carriages have threaded holes and the support rail has T-slots for standard T-nuts or fixing lugs
- are particularly suitable, due to the T-slots, for modular constructions
- are sealed by means of lubrication and wiper units on the end faces
- are also available in a corrosion-resistant design
- are maintenance-free and the raceways can be relubricated
  - the toothed belt drive and return units require no maintenance
  - the raceways and track rollers are lubricated by means of funnel type lubrication nipples in the carriages
- are versatile in application due to a comprehensive range of accessories.

Carriage



- saddle plate made from anodised profiled aluminium, with and without counterstay arrangement; the toothed belt passes through the carriage with the counterstay
- four maintenance-free track rollers
- eccentric bolts for clearance-free adjustment of the track rollers against the raceway
- driven by toothed belt
- integral clamping devices for toothed belt on both sides
- funnel type lubrication nipples on end faces

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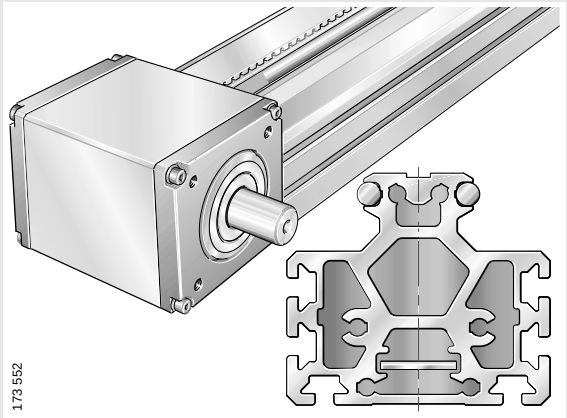
Support rail with return unit



- support rail
  - composite rail made from anodised profiled aluminium supporting section
  - on the counterstay carriage side, the underside is milled out to the centre point
- return unit
  - housing made from anodised profiled aluminium
  - return shaft with maintenance-free ball bearings
  - wiper brushes to protect return area from contamination

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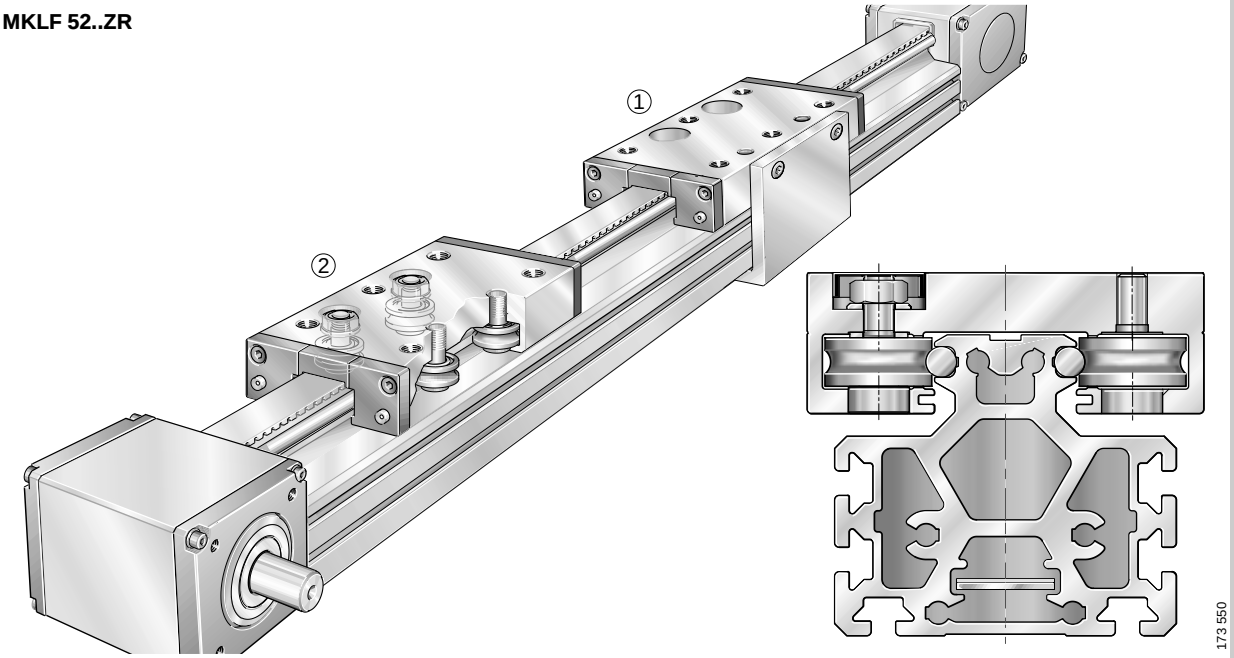
Linear actuator – scope of basic delivery

MKLF 52..ZR



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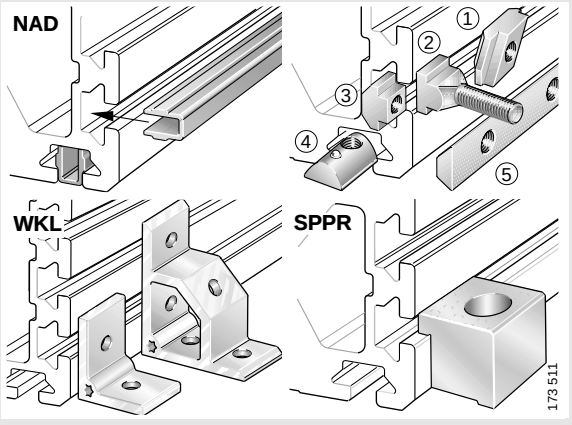
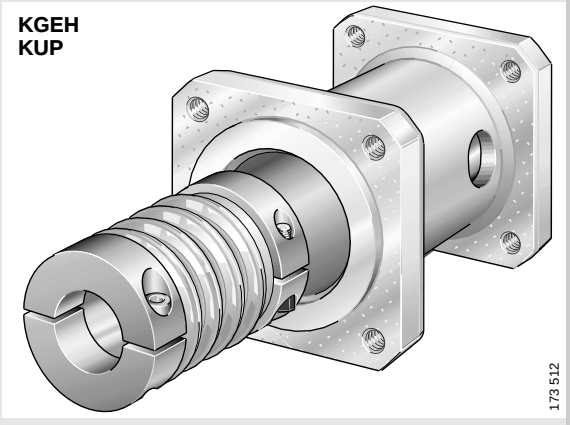
Accessories



- NAD
  - plastic slot seal
- SPPR
  - fixing lug
- WKL
  - fixing bracket
- ①, ②, ③, ④, ⑤
  - fixing screws, T-bolts and T-strips



- KGEH
  - coupling housing made from anodised aluminium
  - flange with fixing holes at both ends
- KUP
  - metallic bellows coupling
  - fixing hubs made from anodised aluminium
  - metallic bellows made from thin-walled alloy steel
  - clamping to motor, drive or gearbox shaft

Design and safety guidelines

Idling drive torque

With constant drive speed and a horizontally mounted actuator, the drive torque does not vary significantly as a function of the mass to be moved.

With increasing speed, the drive torque also increases (Figure 1).

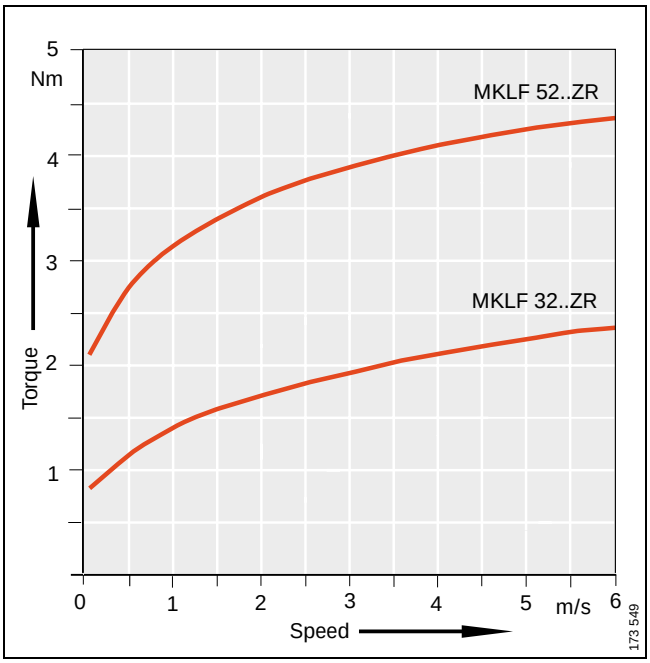


Figure 1 · Idling drive torque in horizontal mounting position of linear actuator MKLF..ZR

Combination with actuator components

In its role as a system supplier, INA offers not only actuators but also the appropriate components including coupling housings, couplings, gearboxes and motors (Table 1). These components are precisely matched to the actuators and thus complement the range of linear actuators in an optimum manner.

Table 1 · Possible combinations with actuator components

Linear actuator	Coupling housings	Couplings	Gearboxes	Motors
MKLF 52..ZR	KGEH MLF 52 ZR-110/130/M8	KUP 560-66 20H7-25H7	GETR PL 115-..	MOT SMH 100
			GETR PL 120/115	MOT SMHA 100-BR
				MOT MH 105
				MOT MHA 105-BR
	KGEH MLF 52 ZR-80/100/M6	KUP 560-56 20H7-20H7	GETR PL 90-..	MOT SMH 82
			GETR PLE 80/90-..	MOT SMHA 82-BR
MKLF 32 086 ZR	KGEH MLF 32 ZR-80/100/M6	KUP 560-56 20H7-20H7	GETR PL 90-..	
			GETR PLE 80/90-..	
			MOGE AS2-STI..	
	KGEH MLF 32 ZR-45/70/75	KUP 50-40-2 20H7-14H7	MOGE AS1-PLE 60..	

Drive variants

The possible positions of the drive are shown in Figure 2.
Description of the suffixes: see Table 2.

Table 2 · Drive variants – suffixes

Drive system Suffix	Designs
AR	Drive shaft on right side
AL	Drive shaft on left side
RL	Drive shaft on both sides (right and left)

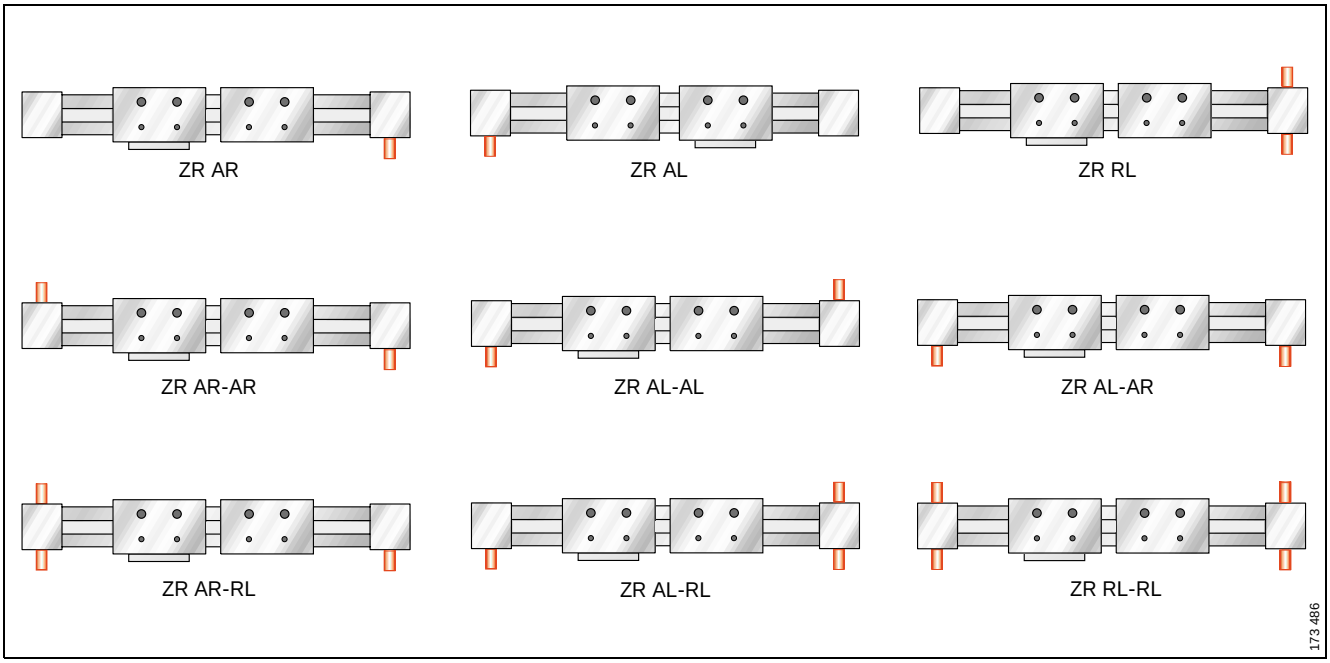


Figure 2 · Positions of the drive – schematic

Lubrication

Track rollers

The track rollers in the carriage are greased with a high quality lithium complex soap grease in accordance with DIN 51825–K3K–30 and are maintenance-free.

Raceways

The raceways for the track rollers must be lubricated at particular intervals.

The relubrication intervals are essentially dependent on:

- the travel speed
- the load
- the operating temperature
- the stroke length
- the environmental conditions; the cleaner the operating environment, the lower the lubricant consumption.

Since it is not possible to calculate all the influencing factors, the time at which relubrication must be carried out and the quantity of lubricant which must be used can only be determined under actual operating conditions. If no precise data are available, the values according to Table 3 are valid for many applications.

Relubrication must be carried out at the latest when fretting corrosion first occurs – this can be identified by a reddish discolouration of the raceways or the outside surface of the track rollers. Subsequent lubrication intervals must be shortened!

The support rail raceways are lubricated by a felt insert which is soaked with oil by means of lubrication nipples in the side. Oils of type CL and CLP to DIN 51 517 with a viscosity of ISO VG 220 are recommended.

⚠ If lubrication by means of lubricating varnish is used, it must be borne in mind that this only provides effective lubrication for a significantly shorter time than oils!

Relubrication should preferably be carried out with several partial quantities at various times instead of the complete quantity at the time of the relubrication interval. Relubrication is carried out via lubrication nipples on the end faces of the carriages ①, ② (Figure 3). The oil quantity according to Table 3 should be distributed evenly to all four lubrication points!

⚠ The grease gun, the lubrication nipple, the area around the lubrication nipple and the oil must be clean!

Lubrication should only be carried out on linear actuators still warm from operation!

Move the carriage during lubrication!

Further information on lubricant quantities is given in *INA publication "ALE"*!

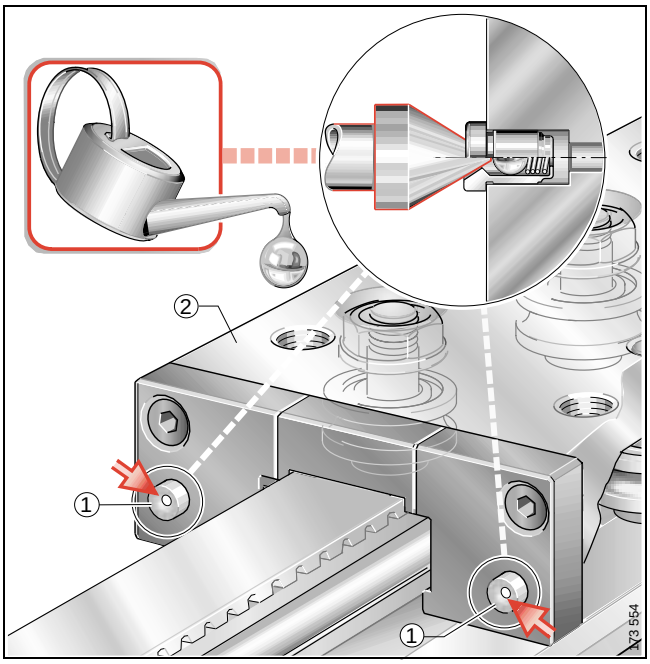


Figure 3 · Lubrication points

Table 3 · Relubrication quantities – guide values

Linear actuator	Oil quantity per carriage ml
MKLF 32..ZR	1 to 2
MKLF 52130 ZR	2 to 3
MKLF 52145 ZR	2 to 3
MKLF 52155 ZR	2 to 3

Accuracy

The linear actuators are precision straightened and the tolerances are better than those to DIN 17 615 (Table 4 and Table 5). The tolerances are arithmetic mean values.

The method for determining the straightness of the support rail is shown in Figure 4. For lengths in excess of 6 000 mm, the straightness tolerance t_2, t_3 may show a linear increase of 0,5 mm per 1000 mm.

Table 4 · Length tolerance of linear actuators

Length of actuator L_{tot} mm	Tolerance mm
L_{tot} <1000	±2
1000 ≦L_{tot} <2 000	±3
2000 ≦L_{tot} <4 000	±4
4000 ≦L_{tot}	±5

Table 5 · Straightness tolerance of support rail

Length of support rail mm	MKLF 32..ZR, MKLF 52..ZR		
	t_2 mm	t_3 mm	Torsion mm
<1000	0,6	0,5	0,8
1000 ≦2000	0,8	0,6	1
2000 ≦3000	1,2	0,7	1,5
3000 ≦4000	1,5	1	2
4000 ≦5000	1,9	1,2	2,5
5000 ≦6000	2,5	1,5	3
6000 ≦7000	2,9	1,8	3,5
over 7000	3,4	2,1	4

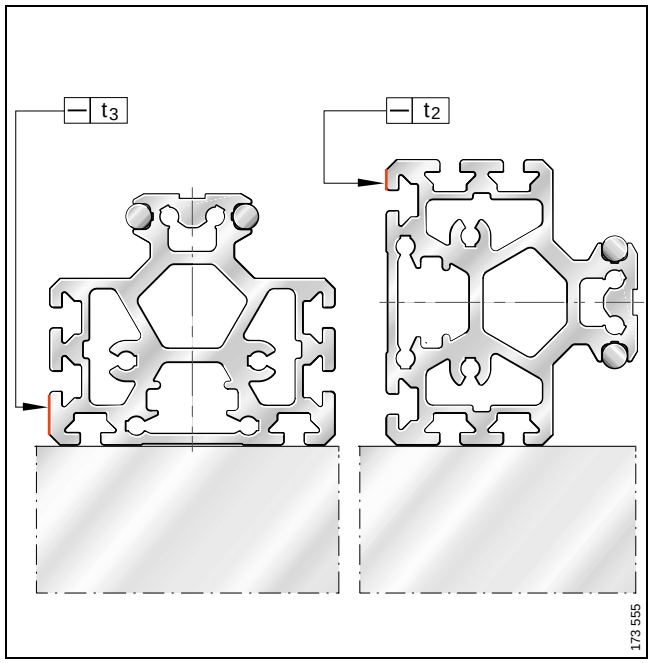


Figure 4 · Straightness tolerance of support rail for MKLF 32..ZR, MKLF 52..ZR

Ordering example and ordering designation

Ordering example

Linear actuator MKLF 32 ZR

Linear actuator with track roller guidance system and two opposing carriages	MKLF
Size	32
Width of carriage	86 mm
Drive type: one toothed belt	ZR
Drive shaft on left side	AL
Total length L_{tot}	5100 mm
Total stroke (2×effective stroke + 2×S)	4518 mm

Ordering designation:

1 off MKLF 32 086 ZR AL/5100-4518 (Figure 5).

Note

Note total length of each carriage!

The corrosion-resistant design has the suffix VA!

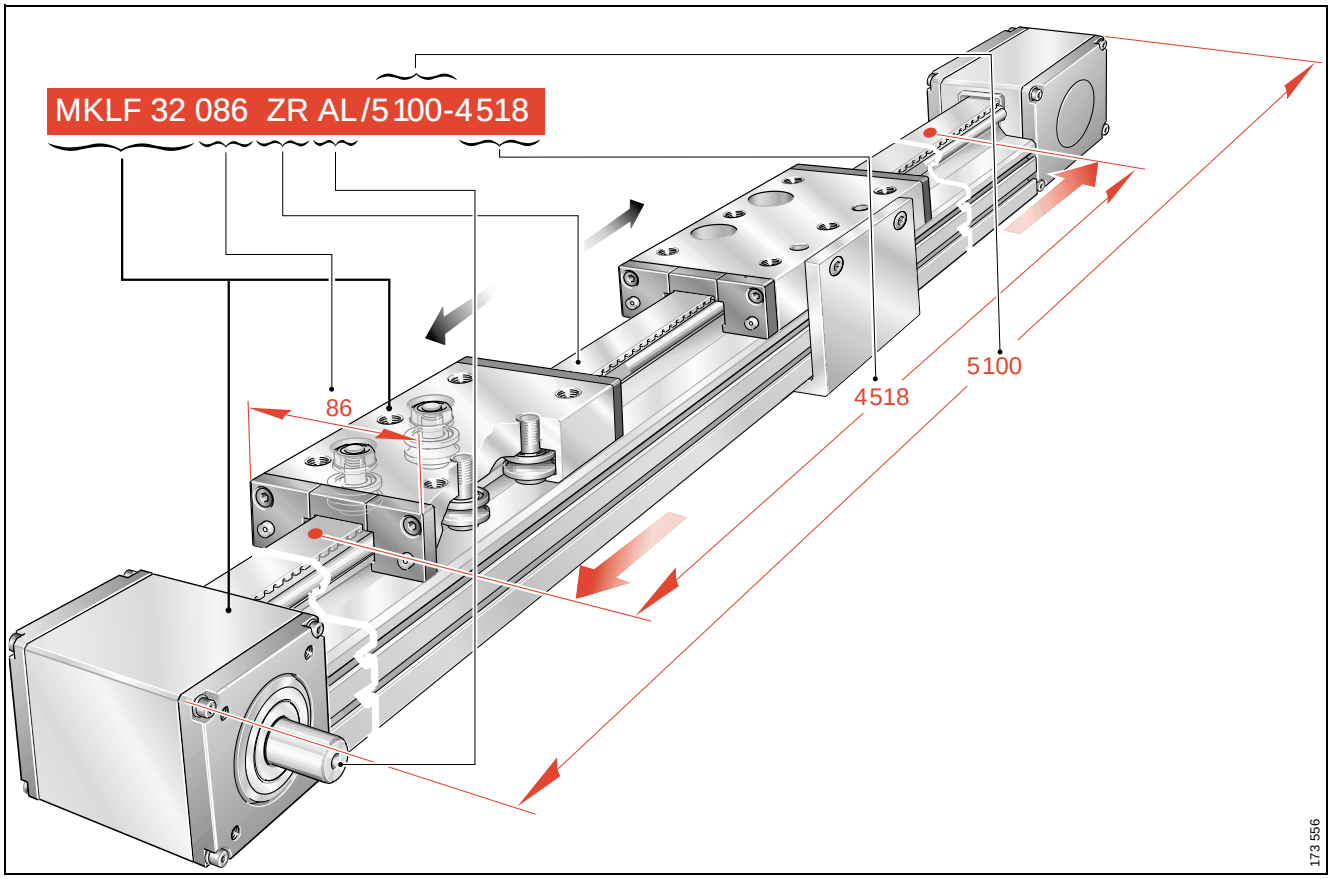
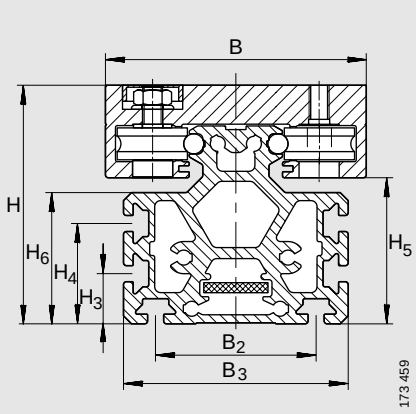


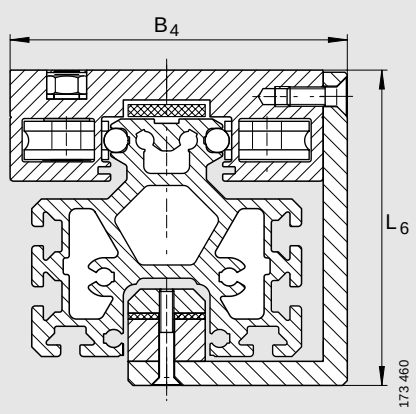
Figure 5 · Ordering example and ordering designation – linear actuator MKLF 32 ZR

Linear actuator with track roller guidance system and two opposing carriages

Series MKLF..ZR



MKLF..ZR



MKLF..ZR

Dimension table · Dimensions in mm

Designation	Mass			Dimensions			Mounting dimensions											
	G_{tot}	G_{Law} 2)	G_{Law} 2) counterstay	H	B	L	B_1	B_2	B_3	B_4	D	D_1	D_2	H_1	H_2	H_3	H_4	H_5	H_6
	≈kg	≈kg	≈kg				±0,1					G7		±0,5					
MKLF 32 086 ZR	$(L_{tot} - 160) \times 0{,}0060 + 5{,}1$	0,8	1,2	82	86	155	59	43	75	94	80	70	61	41,5	81,3	25	–	50	47
MKLF 52 130 ZR	$(L_{tot} - 231) \times 0{,}0128 + 12{,}25$	2	2,75	119	130	200	90	80	112	140	115	95	76	60,5	117,7	25	50	72,8	65,4
MKLF 52 145 ZR	$(L_{tot} - 231) \times 0{,}0128 + 14{,}85$	3,2	4,05	125	145	245	105	80	112	155	115	95	76	60,5	117,7	25	50	71,2	65,4
MKLF 52 155 ZR	$(L_{tot} - 231) \times 0{,}0128 + 18{,}35$	5	5,95	125	155	260	115	80	112	165	115	95	76	60,5	117,7	25	50	70	65,4

1) L_2 = total stroke + 2×L + 12 + L_{min} 5)
L_{tot} = total stroke + 2×L + 2×L_4 + 12 + L_{min} 5).
Total stroke = 2×effective stroke + 2×S
(effective stroke per carriage in mm).

⚠ The allowance S designates a safety range suitable for the particular application and should be at least 85 mm; total stroke in mm.

Maximum single-piece support rail length L2 = 8 000 mm.

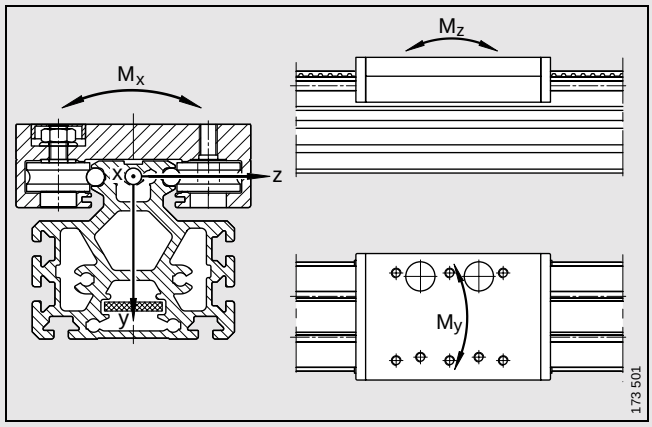
2) G_{Law} = mass of carriage.

3) The values are single loads and apply as values for the individual carriages. For design criteria of linear guidance system, see *INA Catalogue 801*.

4) Geometrical moments of inertia of support rail on the open side.

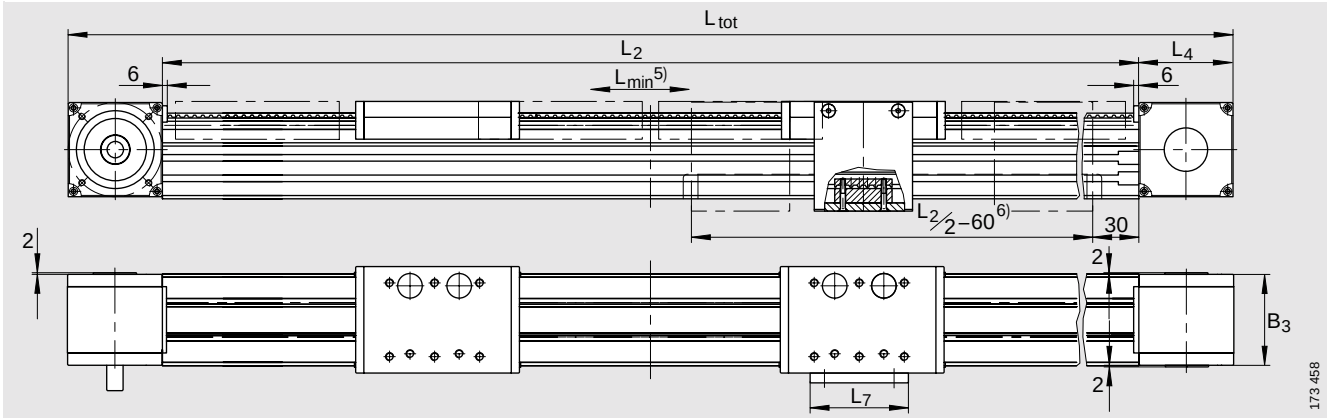
5) The minimum spacing L_{min} (of the carriages) is dependent on the application and should be at least 20 mm.

6) The underside of the support rail is open over this length.



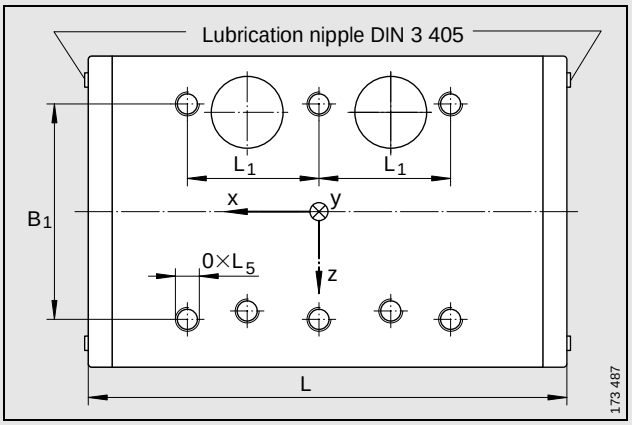
Load directions

Linear actuator	**Toothed belt/gears**					
Designation	Toothed belt	Permissible toothed belt operating force	Maximum drive torque	Mass of toothed belt	Feed	Mass moment of inertia of both gears
	Type	N	Nm	kg/m	mm/rev.	kg · m^2
MKLF 32 086 ZR	20 AT 5	640	18	0,068	175	$2{,}2 \times 10^{-4}$
MKLF 52 130 ZR	32 AT 10	1750	73,5	0,2	270	$12{,}6 \times 10^{-4}$
MKLF 52 145 ZR	32 AT 10	1750	73,5	0,2	270	$12{,}6 \times 10^{-4}$
MKLF 52 155 ZR	32 AT 10	1750	73,5	0,2	270	$12{,}6 \times 10^{-4}$

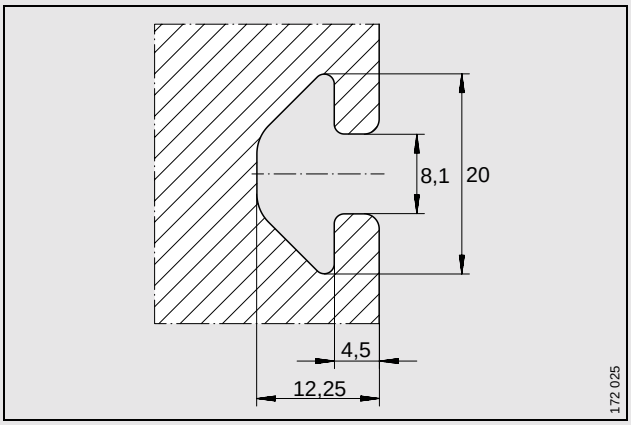


MKLF..ZR

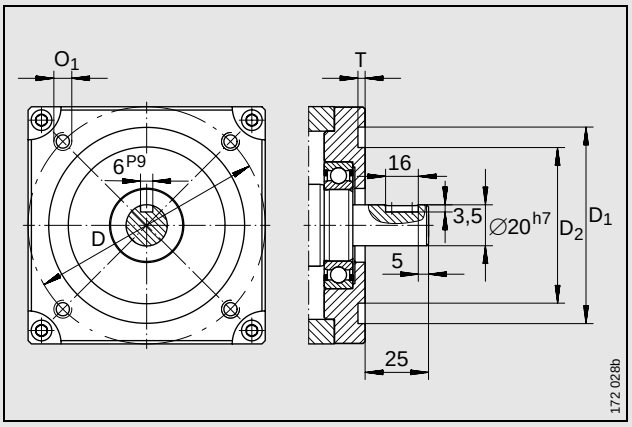
								Permissible load on carriage guidance system 3)				Permissible torque on carriage guidance system 3)						Geometrical moment of inertia of support rail 4)	
L_1	L_4	L_5	L_6	L_7	O	O_1	T	$F_{y\,perm}$	$F_{0y\,perm}$	$F_{z\,perm}$	$F_{0z\,perm}$	$M_{x\,perm}$	$M_{0x\,perm}$	$M_{y\,perm}$	$M_{0y\,perm}$	$M_{z\,perm}$	$M_{0z\,perm}$	I_y	I_z
±0,1							+0,2	N	N	N	N	Nm	Nm	Nm	Nm	Nm	Nm	cm^4	cm^4
50	80	14	102	80	M 8	M6	2	850	1400	1000	1000	11	18	30	30	26	43	104	76
55	115,5	19	131	120	M10	M8	3,5	1500	2500	3500	3500	33	52	105	105	47	78	381	272
80	115,5	19	137	120	M10	M8	3,5	2400	4000	4500	4500	51	84	236	236	126	210	381	272
90	115,5	24	137	120	M12	M8	3,5	4800	7900	8000	8000	101	166	480	480	288	474	381	272



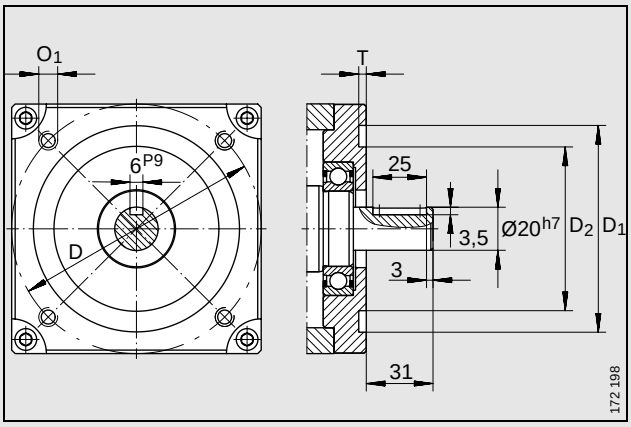
Carriage



T-slots



Drive flange/drive shaft for MKLF 32..ZR



Drive flange/drive shaft for MKLF 52..ZR

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