Linear actuator with integral planetary gearbox and servomotor

Series MLF 52155 ZR .. GTRI/.., MKUSE 25 ZR .. GTRI/..

Linear actuators with an integral gearbox and motor are ready-to-fit, driven linear units for unlimited stroke lengths. They are driven by means of a servomotor, planetary gearbox and toothed belt.

The gearbox is integrated in the return unit. Since there is no coupling or coupling housing, the design is very compact with a reduced number of components; this gives clear economic advantages for the customer.

These linear actuators are available with:

- a track roller guidance system for light to moderate loads

- a ball monorail guidance system for moderate to heavy loads

- two gearbox sizes/reduction ratios

- a servomotor with two power classes.
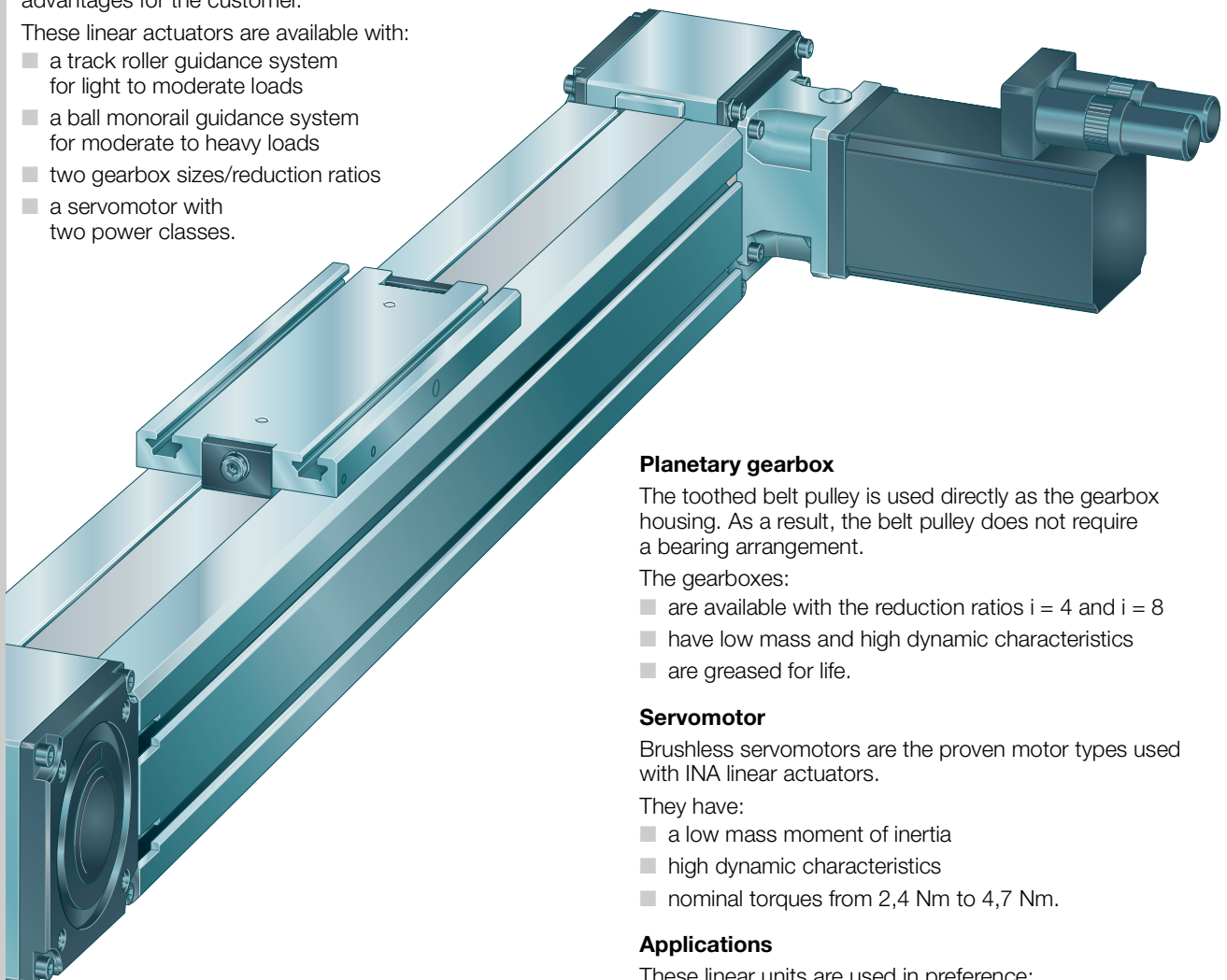
Planetary gearbox

The toothed belt pulley is used directly as the gearbox housing. As a result, the belt pulley does not require a bearing arrangement.

The gearboxes:

- are available with the reduction ratios $i = 4$ and $i = 8$

- have low mass and high dynamic characteristics

- are greased for life.

Servomotor

Brushless servomotors are the proven motor types used with INA linear actuators.

They have:

- a low mass moment of inertia

- high dynamic characteristics

- nominal torques from 2,4 Nm to 4,7 Nm.

Applications

These linear units are used in preference:

- in applications with high traverse speeds

- where forces and moments occur in all three axes

- in the handling equipment sector.

173 728

Linear actuator with track roller guidance system, planetary gearbox and servomotor

Features

Linear actuators with track roller guidance system

- are complete units comprising:
  - an aluminium support rail with rolled-in steel shafts
  - a carriage guided on the support rail
  - a toothed belt drive with return units
  - a planetary gearbox
  - a servomotor with two power classes
- can support loads and moments about all axes
- are suitable for light to moderate loads
- have lubrication and wiper units on the carriage to protect the raceways
- have track rollers that are greased for life.
  The raceways of the support rails can be lubricated via four lubrication nipples on the end faces of the carriages
- are suitable for:
  - accelerations up to 40 m/s^2
  - speeds up to 8 m/s
 - operating temperatures from –20 °C to +80 °C.

Planetary gearboxes

- are designed such that the toothed belt pulley is used as the gearbox housing
- are not restricted to particular mounting positions
- are supplied lubricated with grease
- are single-stage gearboxes
- are available with the reduction ratio i = 4:1 and i = 8:1
- have a torsional backlash of $\leqq$ 3 angular minutes.

Servomotors

- have a low mass moment of inertia and high dynamic characteristics
- have a resolver feedback facility
- are available with a holding brake
- have a nominal speed of 3 000 min^{-1} to 3 300 min^{-1} – depending on the motor size.
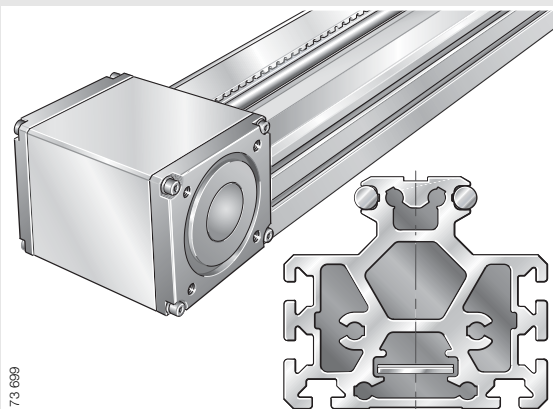
Carriage
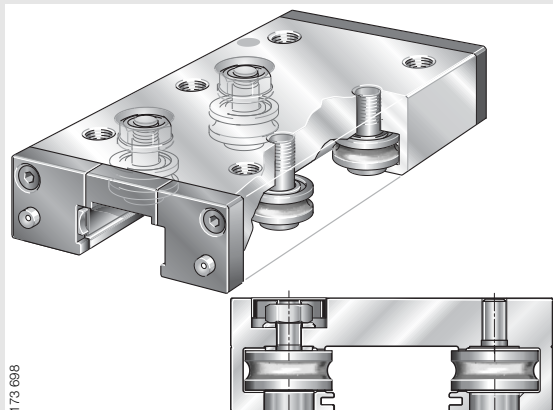
173 698

- saddle plate made from anodised profiled aluminium
- four track rollers
- driven by toothed belt
- lubrication holes on the end faces

6

Support rail with return unit

173 699

- support rail
  - composite guideway comprising anodised aluminium support rail and rolled-in shafts made from high alloy steel
- return unit
  - housing made from anodised profiled aluminium
  - return shaft with maintenance-free ball bearings
  - wiper brushes to protect the return area from contamination
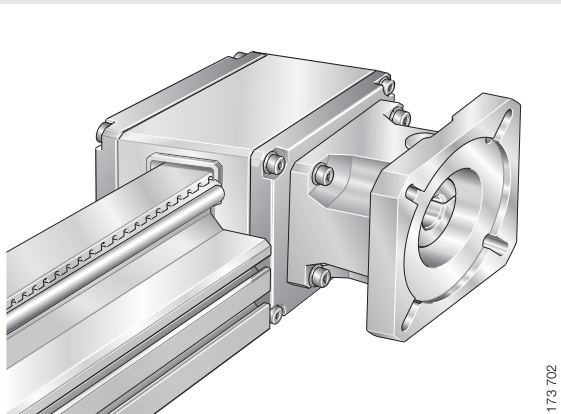
6

Linear actuator – scope of basic delivery

MLF 52155 ZR .. GTRI/..
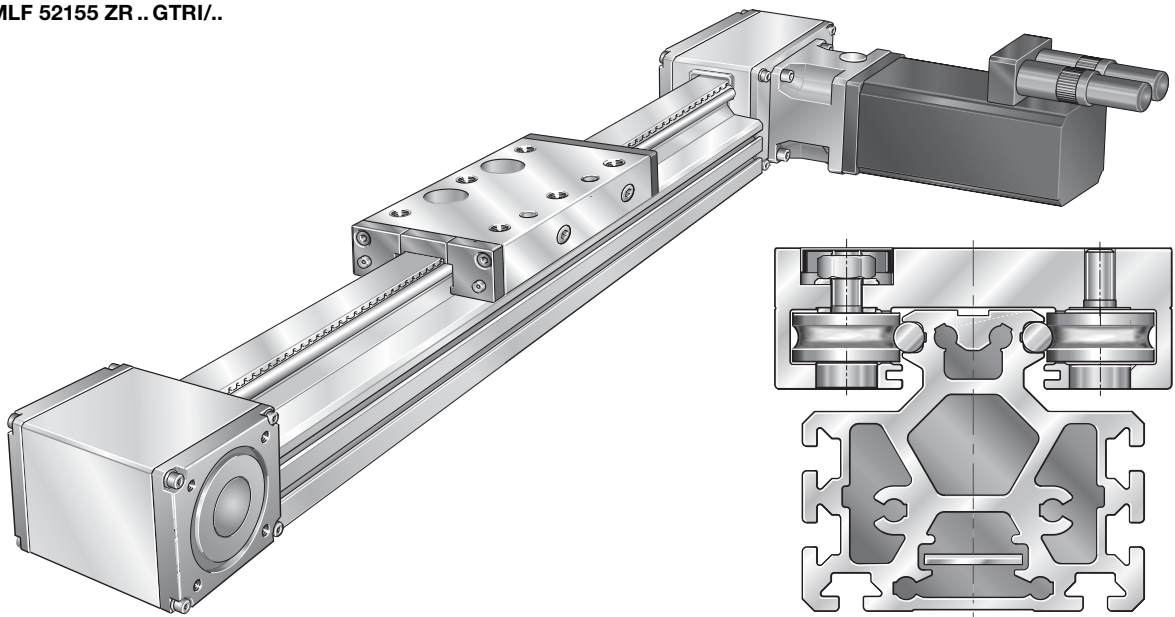
173 700

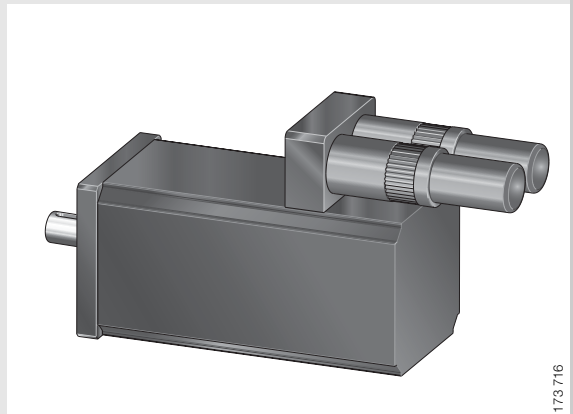## Planetary gearbox

173 702

☐ two mounting flange sizes
☐ two reduction ratios possible

6

Servomotor

173 716

☐ brushless
☐ sine wave magnetisation and resolver feedback
☐ uniform torque curve
☐ with or without holding brake

6

Linear actuator with track roller guidance system, planetary gearbox and servomotor

Figure 1 · Positions of the drive – schematic

Design and safety guidelines

The positions of the drive are shown in Figure 1.
Description of the suffixes: see Table 1.

Table 1 · Drive variants – suffixes

Drive system Suffix	Design
AR	Drive from right side
AL	Drive from left side

Power values of actuators/gearboxes and motors

Table 2 gives the maximum possible load that can be moved using the linear actuator and the positional controller. The table is valid for vertical and horizontal mounting of the actuators.

⚠ The bearing load must always be checked for the specific actuator.

Table 2 · Power values for linear actuators

Max. mass m kg	Max. speed v_{max} m/s	Mean speed[1] v m/s	Acceleration a m/s^2	Gear reduction ratio i	Actuator[2]	Servocontroller
20	3,1	2,25	10	4	MLF 52155 ZR-AR (AL)-GTRI/4-1(2)/3 173-2 670	STUNG COMPAX 2500 S
	1,75	1,4	10	8	MLF 52155 ZR-AR (AL)-GTRI/8-1(2)/3 173-2 670	STUNG COMPAX 1000 SL[3]
30	1,75	1,4	10	8	MLF 52155 ZR-AR (AL)-GTRI/8-1(2)/3 173-2 670	STUNG COMPAX 2500 S

[1] Relative to effective stroke of 2,5 m.

[2] Servomotor with brake.

[3] STUNG COMPAX 1000 SL: see *INA Catalogue ALE* (page 126).

Table 3 · Available gearboxes and motors

Linear actuator	Gearbox		Motor			
	Gear ratio reduction	Nominal output torque Nm	Nominal torque M_N Nm	Rated current I_N A	Nominal speed n_N min^{-1}	Stationary torque M_0 Nm
MLF 52155 ZR .. GTRI/4	4:1	72	4,7	4,6	3 000	6
MLF 52155 ZR .. GTRI/8	8:1	60	2,4	2,8	3 300	3
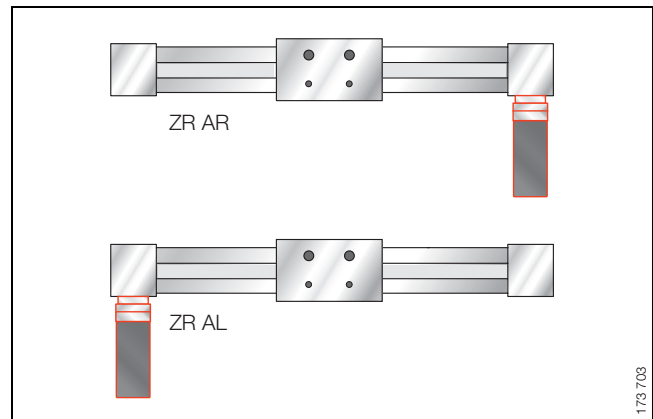
Ordering example and ordering designation

Ordering example

Linear actuator with track roller guidance system	MLF
Size	52
Width of carriage	155 mm
Toothed belt drive	ZR
Drive shaft on right side	AR
Integral gearbox	GTRI
Gear ratio reduction	i = 8
Motor with holding brake	-2
Total length L_{tot}	3 003 mm
Total stroke (effective stroke + 2×S)	2 500 mm

Ordering designation:

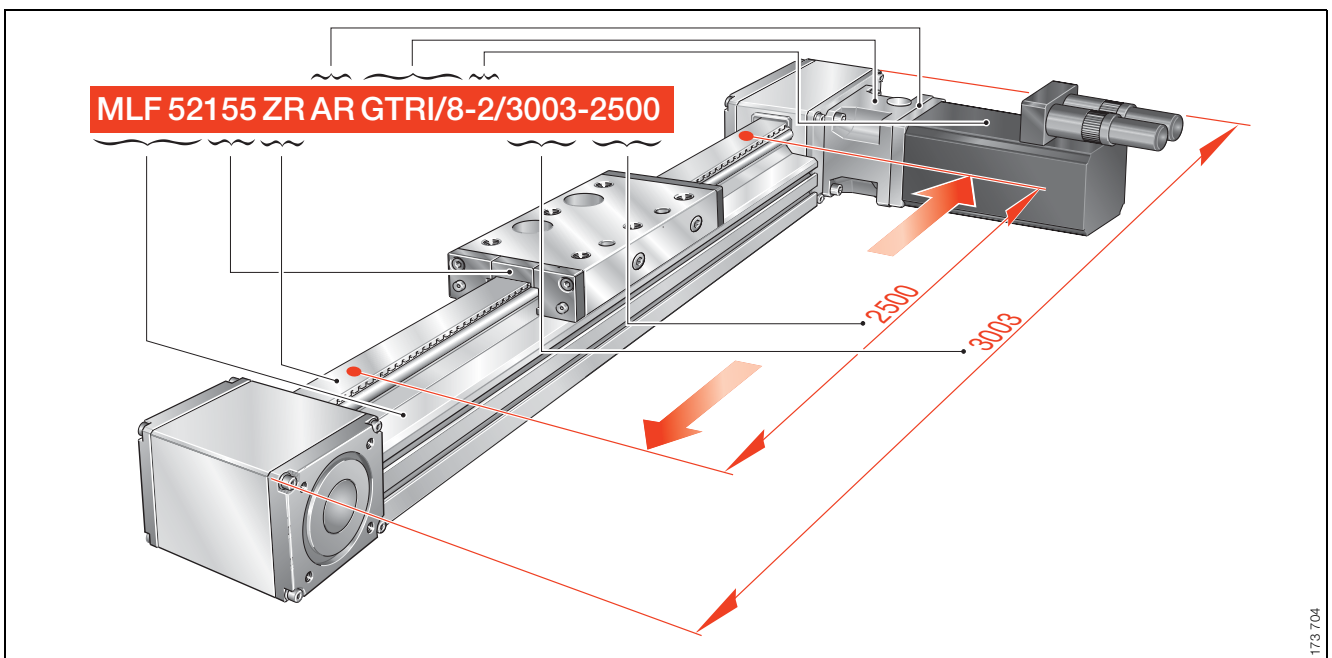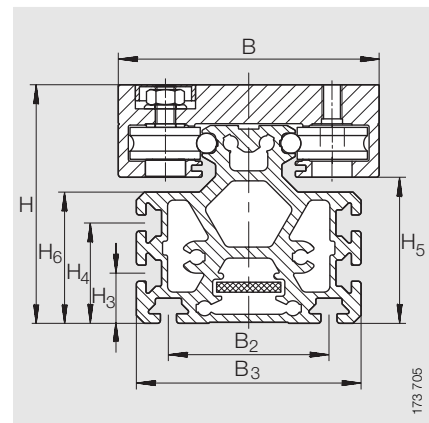MLF 52155 ZR AR GTRI/8-2/3 003-2 500 (Figure 2).

Figure 2 · Ordering example and ordering designation – linear actuator MLF 52155 ZR AR GTRI/8-2/3 003-2 500

Linear actuator with track roller guidance system, planetary gearbox and servomotor

Series MLF 52155 ZR .. GTRI/..

MLF 52155 ZR .. GTRI/..

Dimension table · Dimensions in mm

Designation	Mass				Dimensions			Mounting dimensions							
	G_{tot}[4] $\approx$kg	G_{Law}[2] $\approx$kg	Gear ratio reduction i		B	H	L	B_1 $\pm0,2$	B_2	B_3	H_1 $\pm0,5$	H_2	H_3	H_4	H_5
MLF 52155 ZR .. GTRI/4	$(L_{tot} - 231)\times0,0128 +20,5$ [21,1]	5	4		155	125	260	115	80	112	60,5	118,3	25	50	70
MLF 52155 ZR .. GTRI/8	$(L_{tot} - 231)\times0,0128 +20,2$ [20,8]	5	8		155	125	260	115	80	112	60,5	118,3	25	50	70

[1] $\overline{L_2}$ = total stroke + L +12.
L_{tot} = total stroke + L + 12 + 231.
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 support rail length L_2 = 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 for the linear guidance system, see *INA Catalogue 801*.

[4] Values in [ ] for motor version with motor holding brake.

[5] Version with motor holding brake.

[6] Max. drive speed: 4 000 min⁻¹
Tightening torque M_A of clamping screw: 23,5 Nm.

[7] Max. drive speed: 4 000 min⁻¹
Tightening torque M_A of clamping screw: 17,3 Nm.
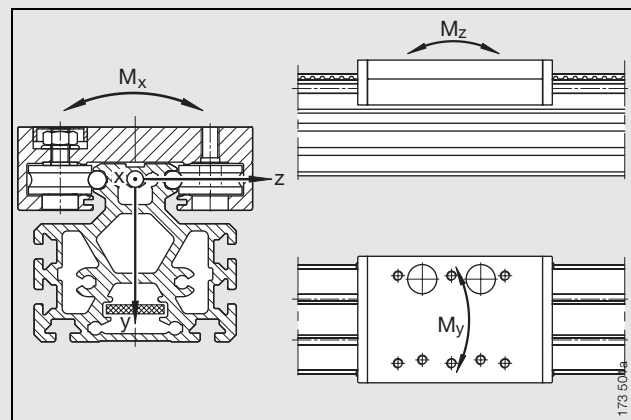
Load directions

Linear actuator	Toothed belt/drive			
Designation	Toothed belt Type	Permissible toothed belt operating force N	Maximum input torque (gearbox) Nm	Feed mm/rev.
MLF 52155 ZR .. GTRI/4	32 AT 10	1750	18	67,5
MLF 52155 ZR .. GTRI/8	32 AT 10	1750	7,5	33,75
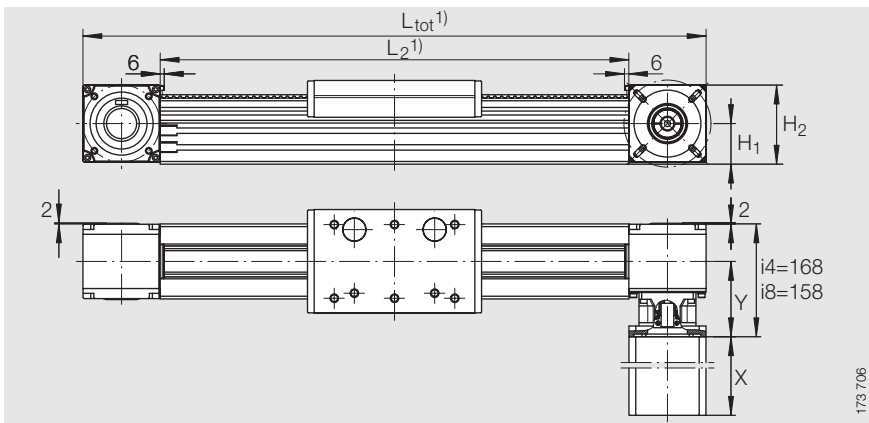
MLF 52155 ZR AR GTRI/..

|							Permissible load on carriage guidance system[3]				Permissible static torque of carriage guidance system[3]						Geometrical moment of inertia of support rail	
H_6	L_1	L_5	0	X	$X^{5)}$	Y	$F_{y\,perm}$	$F_{0y\,perm}$	$F_{z\,perm}$	$F_{0z\,perm}$	$M_{x\,perm}$	$M_{0x\,perm}$	$M_{y\,perm}$	$M_{0y\,perm}$	$M_{z\,perm}$	$M_{0z\,perm}$	I_y	I_z
	±0,1						Nm	Nm	Nm	Nm	Nm	Nm	Nm	Nm	Nm	Nm	cm^4	cm^4
65,4	90	24	M12	191,5	238,5	112,5	4 800	7 900	8 000	8 000	101	166	480	480	288	474	386	301
65,4	90	24	M12	163,5	206,5	102,5	4 800	7 900	8 000	8 000	101	166	480	480	288	474	386	301
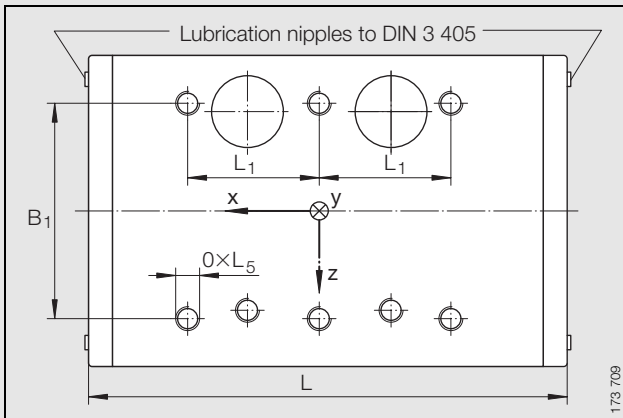
Carriage
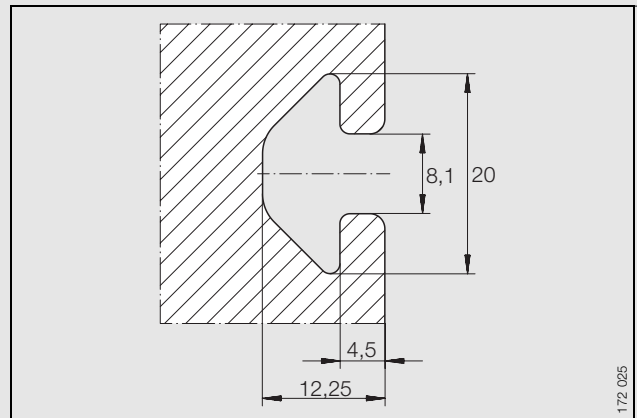
T-slots
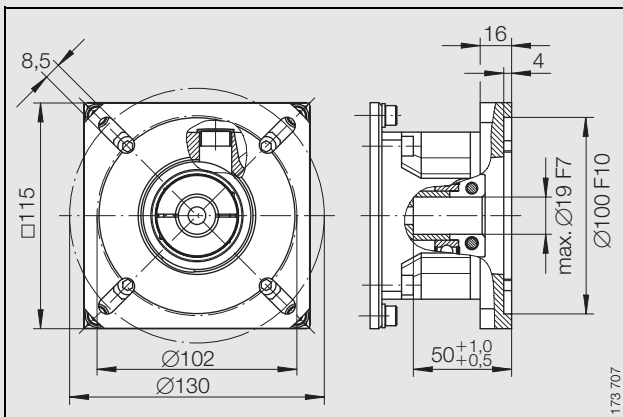
Planetary gearbox with reduction ratio i = 4[6]
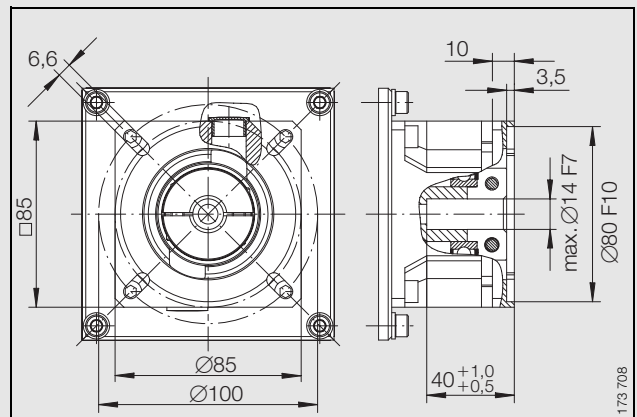
Planetary gearbox with reduction ratio i = 8[7]

Linear actuator with ball monorail guidance system, planetary gearbox and servomotor

Features

Linear actuators with ball monorail guidance system

- are complete units comprising:
  - a support rail – the supporting profiled section is extremely rigid and suitable for spanning large gaps
  - a carriage guided in the support rail by a KUSE guidance system with two carriages
  - a toothed belt drive with return units
  - a planetary gearbox
  - a servomotor with two power classes
- can support loads and moments about all axes
- are suitable for moderate to heavy loads
- can be relubricated; the guidance systems can be lubricated via lubrication nipples on the longitudinal faces of the carriages
- are suitable for:
  - accelerations up to 30 m/s^2
  - speeds up to 5 m/s
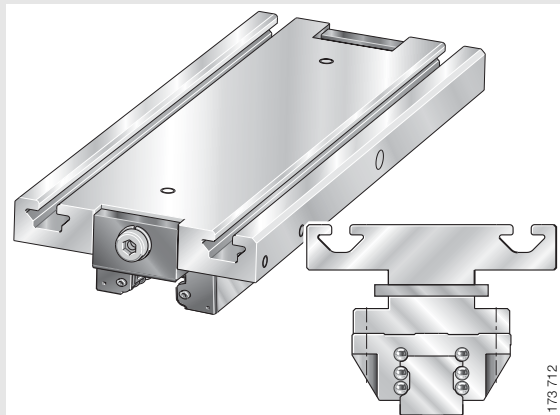 - operating temperatures from –20 °C to +80 °C.

Planetary gearboxes

- are designed such that the toothed belt pulley is used as the gearbox housing
- are not restricted to particular mounting positions
- are supplied lubricated with grease
- are single-stage gearboxes
- are available with the reduction ratio i = 4:1 and i = 8:1
- have a torsional backlash of $\leqq$ 3 angular minutes.

Servomotors

- have a low mass moment of inertia and high dynamic characteristics
- have a resolver feedback facility
- are available with a holding brake
- have a nominal speed of 3 000 min^{-1} to 3 300 min^{-1} – depending on the motor size.
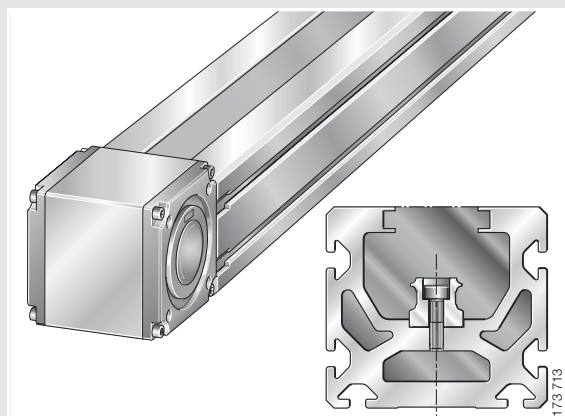
Carriage

- saddle plate made from anodised profiled aluminium with T-slots
- two KUSE carriages
- driven by toothed belt
- funnel type lubrication nipples on longitudinal faces

12

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
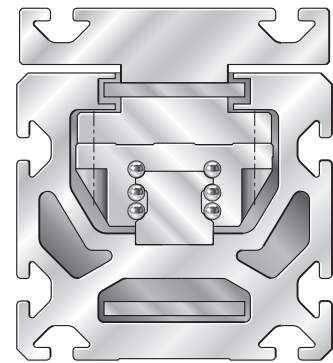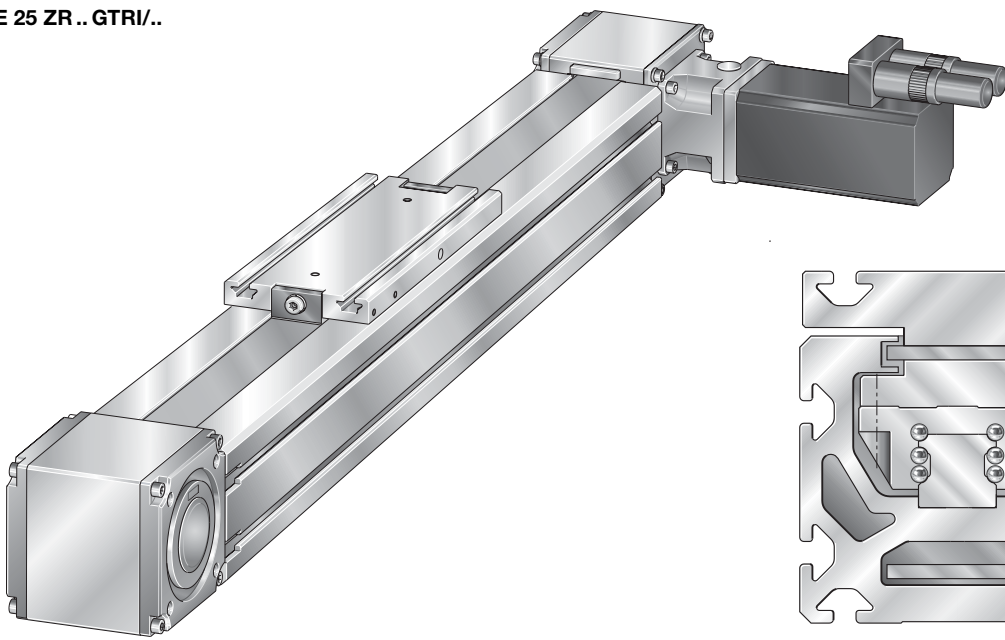- return unit

12

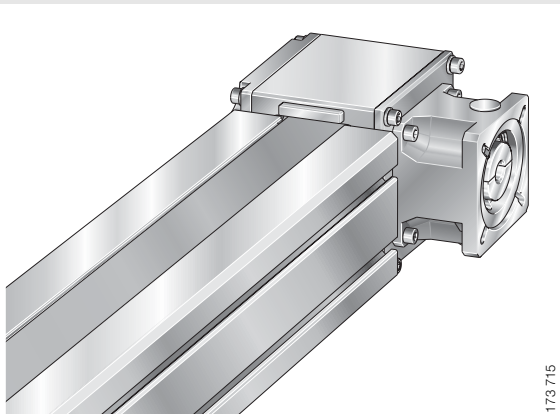## Linear actuator – scope of basic delivery

MKUSE 25 ZR .. GTRI/..
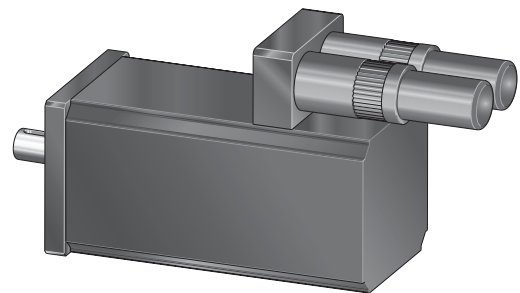
173 714

12

Planetary gearbox

173 715

- two mounting flange sizes
- two reduction ratios possible

12

Servomotor

173 716

- brushless
- sine wave magnetisation and resolver feedback
- uniform torque curve
- with or without holding brake

12

Linear actuator with ball monorail guidance system, planetary gearbox and servomotor

![Design and safety guidelines icon] **Design and safety guidelines**

The positions of the drive are shown in Figure 1.
Description of the suffixes: see Table 1.

Table 1 · Drive variants – suffixes

Drive system Suffix	Design
AR	Drive from right side
AL	Drive from left side

Power values of actuators/gearboxes and motors

Table 2 gives the maximum possible load that can be moved using the linear actuator and the positional controller. The table is valid for vertical and horizontal mounting of the actuators.

⚠ The bearing load must always be checked for the specific actuator.

Figure 1 · Positions of the drive – schematic

Table 2 · Power values for linear actuators

Max. mass m kg	Max. speed v_{max} m/s	Mean speed[1] v m/s	Acceleration a m/s^2	Gear reduction ratio i	Actuator[2]	Servocontroller
20	3,1	2,25	10	4	MKUSE 25 ZR-AR (AL) N-GTRI/4-1 (2)/3176-2670	STUNG COMPAX 2500 S
	1,75	1,4	10	8	MKUSE 25 ZR-AR (AL) N-GTRI/8-1 (2)/3176-2670	STUNG COMPAX 1000 SL[3]
30	1,75	1,4	10	8	MKUSE 25 ZR-AR (AL) N-GTRI/8-1 (2)/3176-2670	STUNG COMPAX 2500 S

[1] Relative to effective stroke of 2,5 m.

[2] Servomotor with brake.

[3] STUNG COMPAX 1000 SL: see *INA Catalogue ALE* (page 126).

Table 3 · Available gearboxes and motors

Linear actuator	Gearbox		Motor			
	Gear ratio reduction	Nominal output torque Nm	Nominal torque M_N Nm	Rated current I_N A	Nominal speed n_N min^{-1}	Stationary torque M_0 Nm
MKUSE 25 ZR .. GTRI/4	4:1	72	4,7	4,6	3000	6
MKUSE 25 ZR .. GTRI/8	8:1	60	2,4	2,8	3300	3
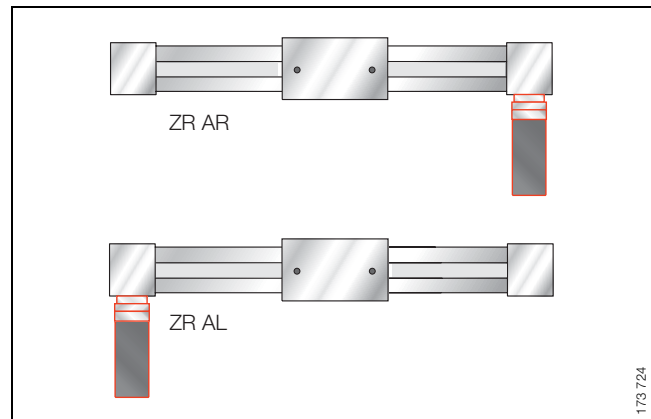
Ordering example and ordering designation

Ordering example

Linear actuator with six-row linear ball bearing and guideway assembly	MKUSE
Size	25
Toothed belt drive	ZR
Drive shaft on right side	AR
Carriage with T-slots (note total length $L_1 = 263$ mm)	N
Integral gearbox	GTRI
Gear ratio reduction	i = 4
Motor without holding brake	-1
Total length L_{tot}	3 506 mm
Total stroke (effective stroke + 2×S)	3 000 mm

Ordering designation:

1 off **MKUSE 25 ZR AR N GTRI/4-1/3 506-3 000** (Figure 2).

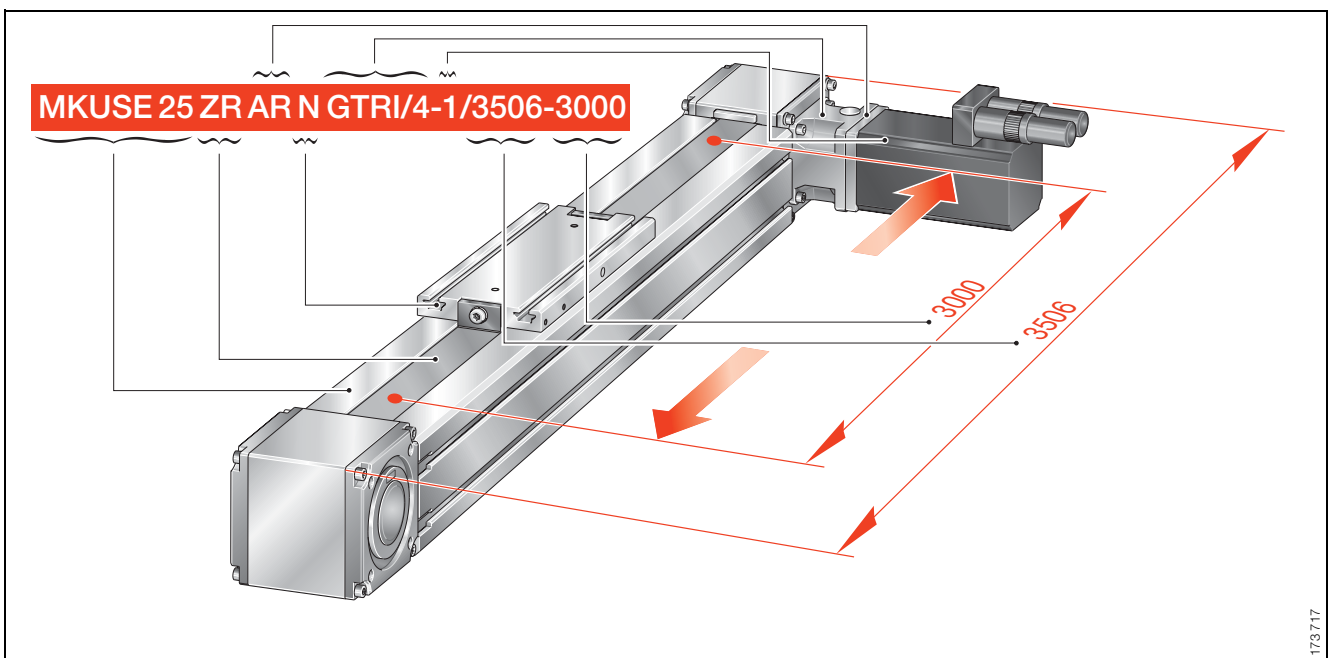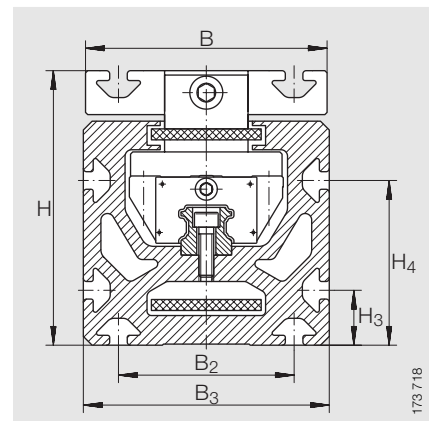MKUSE 25 ZR AR N GTRI/4-1/3506-3000

3000

3506

Figure 2 · Ordering example and ordering designation – linear actuator MKUSE 25 ZR AR N GTRI/4-1/3 506-3 000

Linear actuator with ball monorail guidance system, planetary gearbox and servomotor

Series MKUSE 25 ZR .. GTRI/..

MKUSE 25 ZR .. GTRI/..

Dimension table · Dimensions in mm

Designation	Mass			Dimensions			Mounting dimensions					
	G_{tot}[4] ≈kg	G_{Law}[2] ≈kg	Gear ratio reduction i	B	H	L	B_1 ±0,2	B_2	B_3	H_1 ±0,5	H_2	H_3
MKUSE 25 ZR .. GTRI/4	$(L_{tot} - 231) \times 0,0169 + 19,9$ [20,5]	3,8	4	110	125	250	80	80	112	58	115,7	25
MKUSE 25 ZR .. GTRI/8	$(L_{tot} - 231) \times 0,0169 + 18,4$ [19,1]	3,8	8	110	125	250	80	80	112	58	115,7	25

[1] L_2 = total stroke + L_1 + 12.
   L_{tot} = total stroke + L_1 + 12 + 231.

   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 L_2 = 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 for the linear guidance system, see *INA Catalogue 605*.

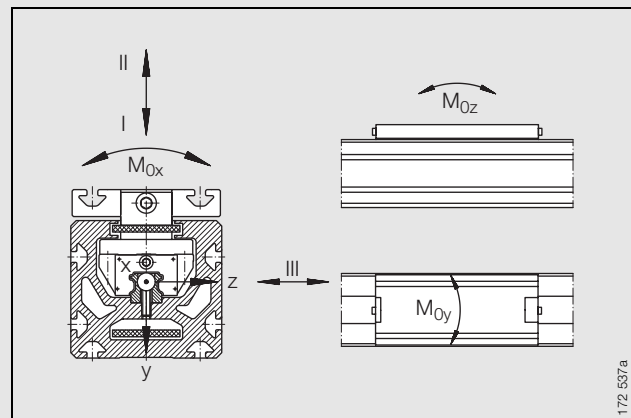[4] Values in [ ] for motor version with motor holding brake.

[5] Version with motor holding brake.

[6] Max. drive speed: 4 000 min^{-1}
   Tightening torque M_A of clamping screw: 23,5 Nm.

[7] Max. drive speed: 4 000 min^{-1}
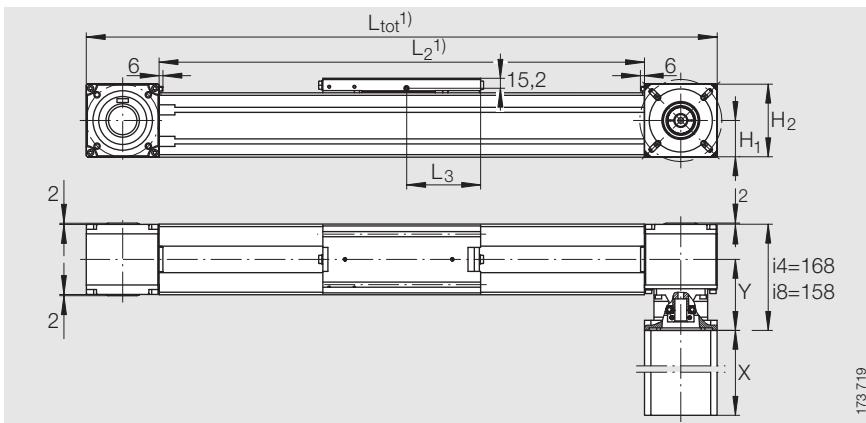   Tightening torque M_A of clamping screw: 17,3 Nm.

Load directions

Linear actuator	Toothed belt/drive			
Designation	Toothed belt Type	Permissible toothed belt operating force N	Maximum input torque (gearbox) Nm	Feed mm/rev.
MKUSE 25 ZR .. GTRI/4	50 AT 10	1880	18	62,5
MKUSE 25 ZR .. GTRI/8	50 AT 10	1880	7,5	31,25

Basic load ratings of carriage guidance system[3]					
Designation	Load direction I Compressive load		Load direction II Tensile load		Load direction III Lateral load	
	C kN	C_0 kN	C kN	C_0 kN	C kN	C_0 kN
MKUSE 25 ZR .. GTRI/4	45,5	134	37,2	86	34,6	92
MKUSE 25 ZR .. GTRI/8	45,5	134	37,2	86	34,6	92

MKUSE 25 ZR AR N-GTRI/..

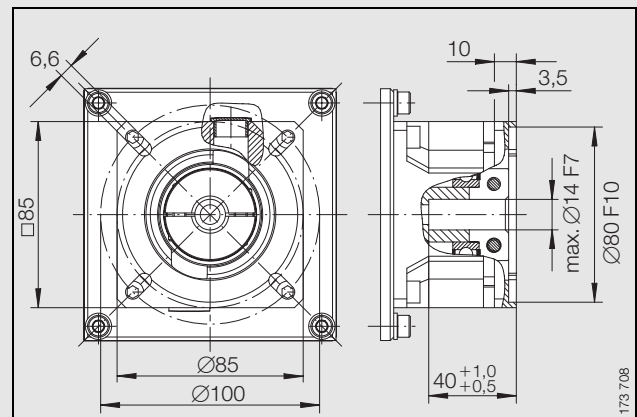| H$_4$	L$_1$	L$_3$	X	X[5]	Y	Permissible static torque of carriage guidance system[3]			Geometrical moment of inertia of support rail	
						M$_{0x\ perm}$	M$_{0y\ perm}$	M$_{0z\ perm}$	I$_y$	I$_z$
						Nm	Nm	Nm	cm^4	cm^4
75	263	117,5	191,5	238,5	112,5	1070	2 250	2 000	712	506
75	263	117,5	163,5	206,5	102,5	1070	2 250	2 000	712	506
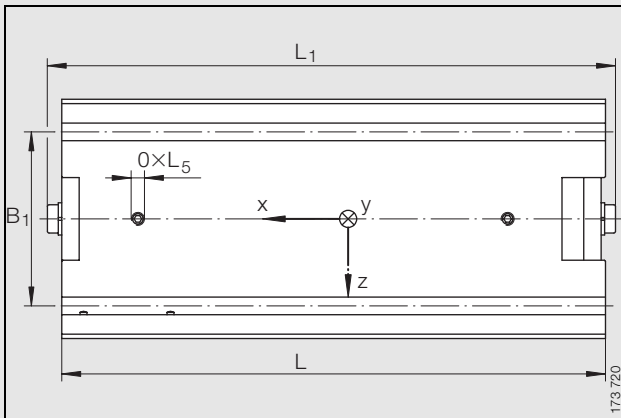
Carriage
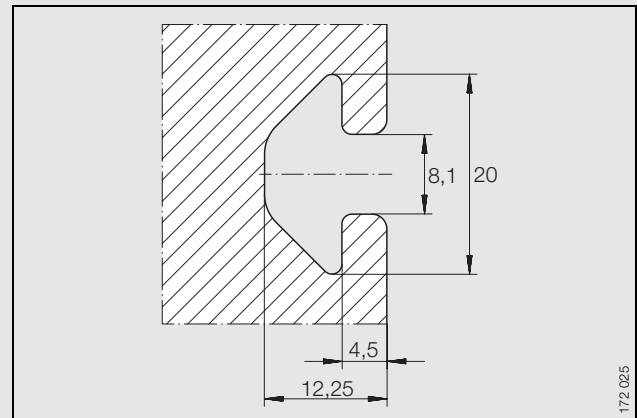
T-slots
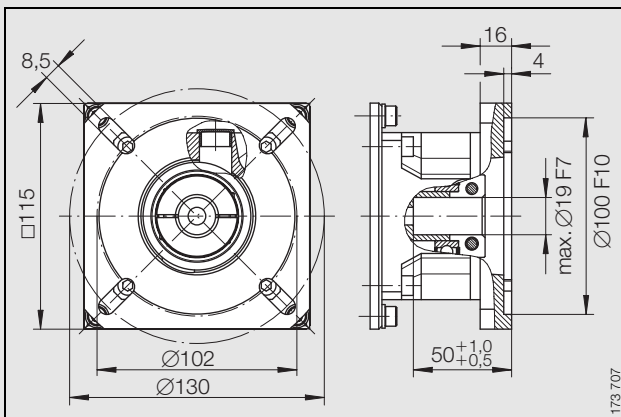
Planetary gearbox with reduction ratio i = 4[6]

Planetary gearbox with reduction ratio i = 8[7]

Drives and controls

![Drives and controls icon] **Drives and controls**

Servomotors

Brushless servomotors have long proven successful for driving INA linear actuators. These motors are based on neodymium magnets and achieve high power density.

In conjunction with digital positional controllers, the sine wave magnetisation and resolver feedback ensure a completely uniform torque curve even at low speeds.

The motors are available with or without an integral holding brake. With a holding brake, the motor is somewhat longer.

These motors have:

■ a low mass moment of inertia

■ high dynamic characteristics

■ nominal torques from 2,4 Nm to 4,7 Nm

■ anti-overload protection

■ connectors for power and resolver facility

■ three times the nominal torque for acceleration.

For all drives, shielded and customised power and resolver cables are available in stepped lengths up to 30 m.
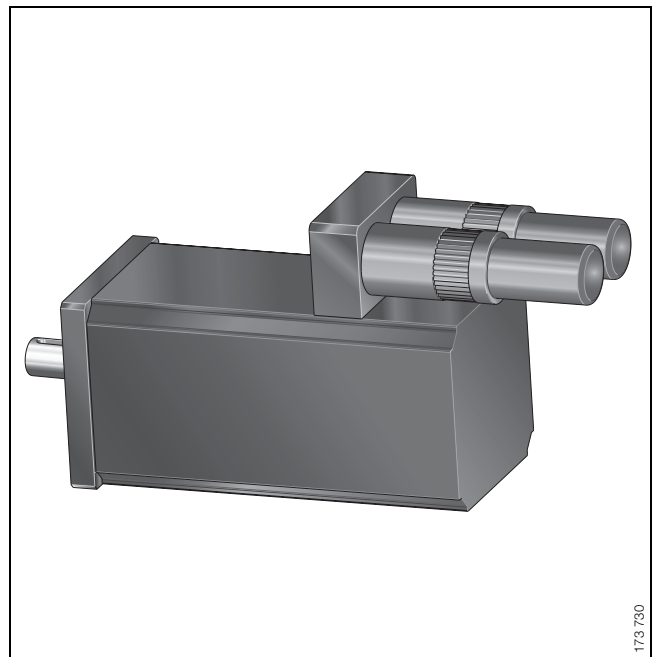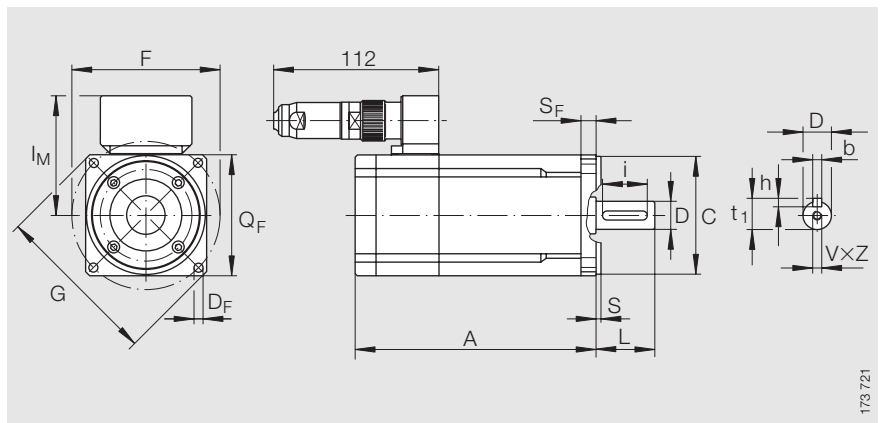

Figure 1 · Servomotor MOT SMH..

Drives and controls

Servomotors

Servomotor

Dimension table · Dimensions in mm

Designation	Dimensions															
	A	S_F	I_M	D_F $\varnothing$	F	D $j6$	L	b	h	i	t_1	V×Z	Q_F	C $\varnothing$	S	G
MOT SMH 82	163,5	10	81	6,5	100	14	30	5	5	25	16	M5×12,5	82	80h6	3,5	112
MOT SMHA 82-BR	206,5	10	81	6,5	100	14	30	5	5	25	16	M5×12,5	82	80h6	3,5	112
MOT SMH 100	191,5	10	91	9	115	19	40	6	6	30	21,5	M6×16	100	100h6	3,5	135
MOT SMHA 100-BR	238,5	10	91	9	116	19	40	6	6	30	21,5	M6×16	100	100h6	3,5	135

Technical data of servomotors

Designation	Stationary torque M_0 Nm	Nominal torque M_N Nm	Nominal speed n_N min^{-1}	Rated current I_N A	Mass m kg
MOT SMH 82	3	2,4	3 300	2,8	3,5
MOT SMHA 82-BR	3	2,4	3 300	2,8	4,2
MOT SMH 100	6	4,7	3 000	4,6	4,7
MOT SMHA 100-BR	6	4,7	3 000	4,6	5,3

Drives and controls

Digital servocontroller STUNG COMPAX 2500 S

Digital servocontroller STUNG COMPAX 2500 S

COMPAX 2500 S is a compact servocontroller for installation in control cabinets. The aluminium housing of the controller is screw mounted by means of two sheet metal fixing brackets to the control cabinet mounting plate. The controller can be used for all INA linear actuators, is user-friendly and easily put into operation. Since almost all the connectors are of the push-fit type, installation time is considerably reduced.

The speed and positional controller for controlling the servomotors are integrated in the controller. The controller can operate as a stand-alone system or can be incorporated in comprehensive control systems. Ten free inputs are available (total 16 I/O). It is connected to a 230 V mains supply.
The power level of the controller is 2,5 kW. The peak power during the acceleration phase of the motors can reach 5 kW.

COMPAX 2500 S can be connected to a computer using an RS-232 interface. The universal PLC data interface allows easy exchange of data with all PLC types. The only requirement is for 5 binary inputs and outputs. A profibus and other fieldbus interfaces are optional. One servoaxis can be controlled; connection to several axes is possible.

The simple programming language allows a sequential program to be created within a very short time. Acceleration times, speeds and positions can be programmed quickly. Furthermore, inputs can be polled, outputs allocated and subroutine techniques used.

The servocontroller COMPAX 2500 S provides the user with a complete, powerful and particularly economical automation solution for precise positioning tasks.

Designation and article number

Designation of controller:
■ STUNG COMPAX 2500 S.

Article number of controller:
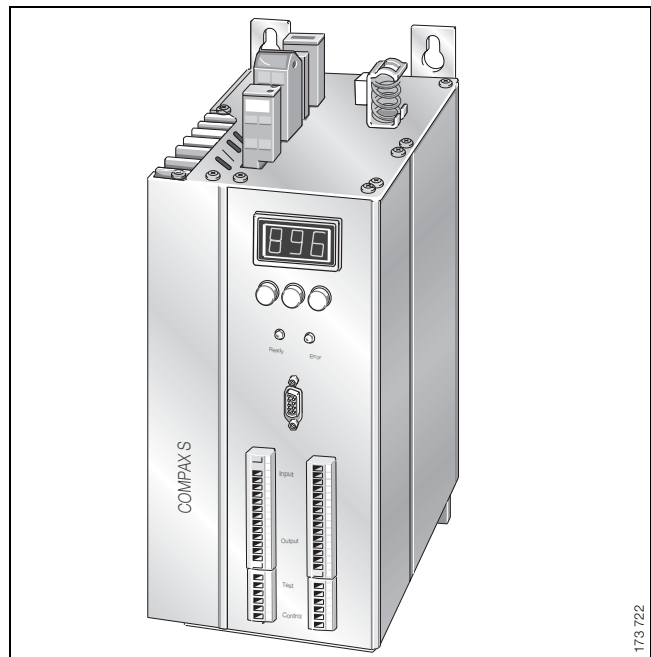■ 000-293-016.

Figure 2 · Digital servocontroller –
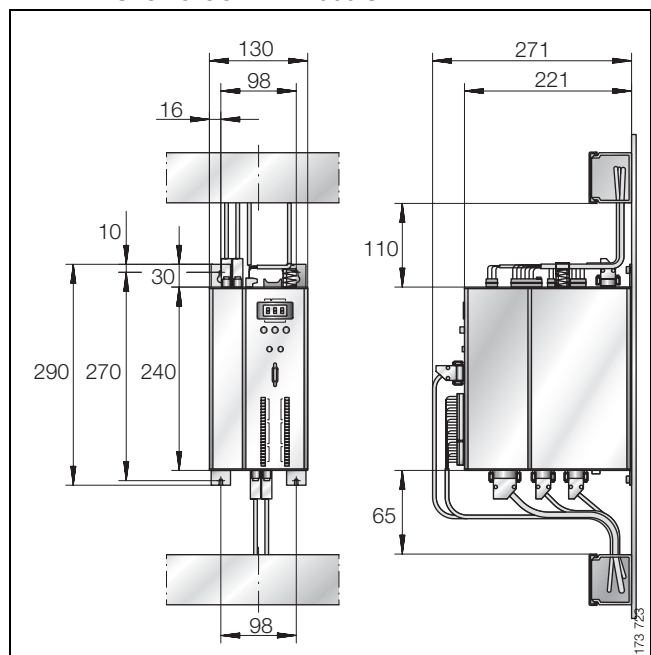STUNG COMPAX 2500 S

Figure 3 · Dimensions of servocontroller –
STUNG COMPAX 2500 S

Drives and controls

Technical data for STUNG COMPAX 2500 S

Performance characteristics

Range of functions

- Positional, speed and current controller
- IGBT output stage with short-circuit and short-to-earth protection
- Digital positional controller
- Motion control.

Output current

Device	Rated current A_{eff}	Peak current A_{eff} < 5 s	Power kVA
COMPAX 2500 S	6,3	12,6	2,5

Supply voltage

- 1*230 V AC + 10% – 15% 45 – 65 Hz.

Line-side fuse protection

- 16 A
- K automatic fuse or Neozed fuse-link.

Operating voltage

- 300 V DC.

Control voltage

- 24 V DC ±10%, waviness < 1 V_{SS} (must be provided by customer)

Required power

- 0,8 A for device
- 100 mA for each digital output
- For motor holding brake (0,5 – 0,67 A).

Accuracy

- Positioning on motor shaft
- Resolution 16 bit (= 0,3 angular minutes)
- Absolute accuracy: ±15 angular minutes.

Maximum power loss

- 80 W.

Block memory

- 250 blocks, powerfail-protected.

Block functions

- Positioning commands, I/O instructions, program commands ACCEL, SPEED, POSA, POSR, WAIT, GOTO, GOSUB, IF, OUTPUT, REPEAT, RETURN, END, WAIT START, GOTO EXT, GOSUB EXT, SPEED SYNC, OUTPUT A0, GOTO, POSR SPEED, POSR OUTPUT, +, –, *, /.

Setpoint generator

- Linear, quadratic, jerk-free ramp form
- Positional data in mm, inches and increments
- Variable by means of scaling factor.

Monitoring functions

- Power/auxiliary voltage range
- Motor final stage temperature/locking protection
- Monitoring of contouring errors.

CE conformity

- EMC interference immunity/emissions to EN 61800-3.

Safety

- VDE 0160/EN 50178.

Drives and controls

Technical data for STUNG COMPAX 2500 S

Interfaces

Control inputs
- 16
- 24 VDC/10 kOhm.

Control outputs
- 16
- Voltage level 24 V/100 mA
- Active HIGH
- Short-circuit protection.

RS 232
- 9600 baud, rigidly set
- Word length 8 bit, 1 start bit, 1 stop bit
- Software handshaking XON, XOFF.

Encoder – interface (option)
- Encoder simulator: 512/1024 increments/revolution
- Encoder input: RS-422 interface
- Power supply: 5 V 120-10 000 increments/revolution.

HEDA – interface (option)
- synchronous, serial real-time interface.

Bus connectors (optional)
Profibus (option)
- 1,5 Mbaud, Sinec L2-DP and FMS.

RS 485 (option)

Interbus-S (option)

CAN-Bus

Operation

Parameter input/status check
- Via COMPAX hand terminal BDF 2
- Via RS-232 interface
- Via bus interface.

Hardware

Housing
- Closed metal housing
- Insulated to VDE 0160
- Protection IP 20.

Connectors
- Motor, power, control inputs/control outputs via push-fit terminals, emitter cable, interfaces via sockets.

Standard delivery
- COMPAX with product manual
- Mating connectors for X8, X9, X10, X11
- Software Servomanager.

INA-Schaeffler KG