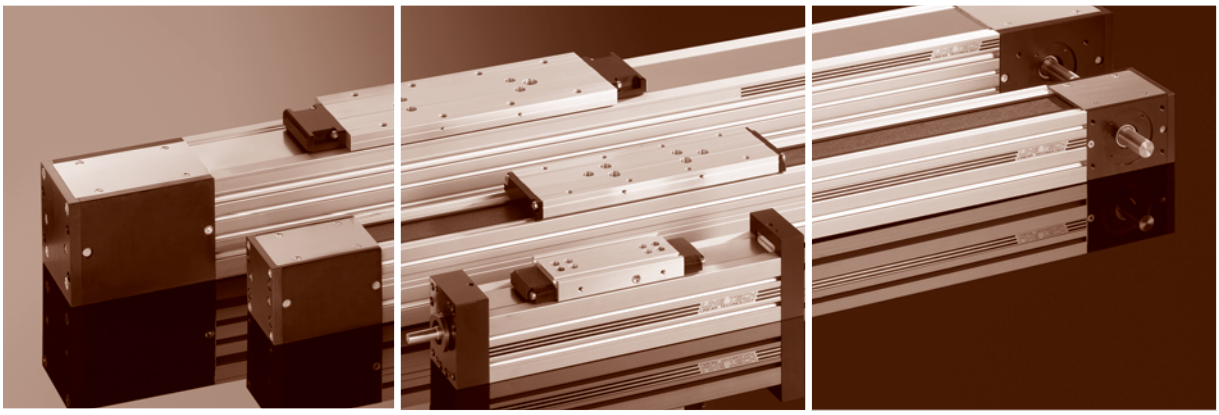
EXTRAK



Modular Rodless Belt-Driven Actuators

EXLAR

Exlar, the leading supplier of industrial servo controlled actuators, now offers a complete line of rodless actuators. Exlar's new Extrak™ rodless actuators complement Exlar's "long life" line of rod style actuators and create, in one source, the broadest offering of electric linear actuators anywhere. This addition makes Exlar your one-stop solution center for all your linear and rotary actuator needs.

Exlar's products are designed for heavy duty [continuous motion] applications and are ideal for industrial positioning or material handling applications with their high speed and long stroke length capabilities. Electric actuators from Exlar will perform millions of operations over the life span of the machine where they are applied. Like Exlar's rod style actuator, Exlar's rodless actuators use components which are designed for extreme robustness and long life. The belt drive actuators employ Gates PowerGrip premium glide belts which make them virtually indestructible.

By choosing Exlar you can be sure you have the most robust mechanical drive possible in your rodless actuator application. This commitment to quality and long life makes Exlar your sure choice for rodless actuators in industrial applications.

There are numerous advantages to the Extrak design:

►Speed of over 16 feet per second (5 m/sec) with linear guide rails is achievable depending on the load, driving motor, and actuator drive type. These higher speeds greatly increase the application versatility of the actuator. With the innovative roller guide system, speeds of over 32 feet per second are achievable.

►Stroke lengths are available up to 22 feet (6.7 m). Optional limit switch packages allow the stroke length limits and homing reference positions to be set within the physical limits of the actuator.

►Flexible – The rodless actuators utilize a close-coupled motor mounting flange for mounting your choice of NEMA or metric dimension motors, gearboxes, clutches, and brakes. This allows the unit to be customized to specific application requirements with the smallest possible package.

►Shorter overall length – Unlike the rod-style actuator, the extended and retracted lengths are the same. This permits a smaller envelope for the actuator and allows it to be applied in more size restricted applications.

Profile Size

Exlar's Extrak actuators are available in three different profile [frame] sizes; 65 mm, 80 mm, and 110 mm. This allows you to conveniently match the physical size allowed by your application with the required performance. Stroke lengths are available up to 24.9 feet (7.6 m) of usable stroke. These rugged actuators can carry heavy loads up to 1,650 pounds in high duty applications – even higher loads are possible for intermittent duty service.

Frame/Enclosure

Exlar rodless actuators consist of a precision aluminum frame/housing with a movable platen. The extruded housing acts at the frame of the unit and provides for the mounting of a bearings guide and the driving motor. The moving platen rides on one of the two different types of guiding system. The first type incorporates a linear guide system offering the highest load capacity and also the highest offset load, or moment capability. Linear guide rails also assure high radial stiffness and vibration free operation. These criteria are important to assure both precise execution of motion profiles and extremely long life.

An alternative guiding system uses roller guides. Roller guides are designed for a lower payload capacity than the linear guide rails, but allow operation at very high speeds exceeding 30 feet per second.

Protection

An optional stainless steel metallic band seal is available for protection. The steel band is held to the case magnetically and covers the screw and guides. This helps to keep debris out of the drive system which may eventually adversely affect the operation of the belt and guides.

All Extrak actuators can be supplied with pressure ports for applying positive air pressure to the actuator in extreme environments. This feature, when employed, will provide additional protection against obstacles and debris from penetrating the housing and affecting operational mechanisms.

Motors

Exlar Extrak actuators are modular in design thus allowing the user to mount any IEC 60, 90, or 115 mm frame or Nema 23, 34, or 42 frame motors. Motors are available from Exlar and can be mounted prior to shipment from the factory and one designed as a plug & play component with your choice of a servo amplifier. Alternatively the user can readily mount his own motor. In this case Exlar will manufacture the adapter flange to the required dimensions for simple, close-couple of the user's motor to the actuator.

Toothed Belt Drive

Exlar's belt drive rodless actuator employs a tooth Power Grip™ premium belt from Gates to convert the rotary motion of the driving motion to the high speed linear motion of the platen. The "long-life" belts provide the higher possible speed of up to 32 ft/sec, 9 m/sec) and due to their composition allow long life. Please be aware that belt drives exhibit high rotational inertia and that proper matching of the driving motor and actuator is important. A planetary gear reducer is an option to assure proper inertia matching.

Mounting

Mounting of the Extrak actuator to your machine frame is simple. The profile of the Extrak includes multiple sized T-slots which allow mounting to other commercially available extruded machine frame products. These also offer mounting of multiple Extrak modules to each other for multi-axis systems.

Accessories

Accessories are available assuring that you can adapt the actuators to perform specific control functions necessary for each application you encounter.

1. Limit switches
2. Limit switch cables
3. T-Nuts
4. Mounting screws
5. Additional travelers

Table of Contents page/s

Extrak Rodless Actuator Ordering Information

LM 3 . 2 . 0500 B R 016 . 1 . 02 . 0 F

Design
LM = linear guides
RM = roller guides

Size
3 = size 65
4 = size 80
5 = size 110

Construction
2 = with 2 guiding carriages
4 = with 4 guide rollers
6 = with 6 guide rollers

Stroke (mm)

Protection
N = without protection
B = with steel strapping

Drive (see page 6/7)
N = without drive
Z = toothed belt

Stroke length per revolution [mm] (see page 6)

Limit switches (see page 9)
0 = without limit switch
1 = with limit switch and reference pos. at front (drive mount)
2 = with limit switch and reference pos. at rear (drive mount opposite)
3 = with 2 limit switches and additional reference position

Mounting conditions (see page 8)
00 = without drive

11 = free shaft end right*
12 = free shaft end left*
13 = shaft end right with coupling and intermediate plate*
14 = shaft end left with coupling and intermediate plate*
15 = shaft end right with lateral drive mount*
16 = shaft end left with lateral drive mount*
17 = free screw noses on both sides (passing screw)
18 = screw noses on both sides, one side with coupling and intermediate plate
21 = special design

Gear reduction
0 = without reduction
1 = reduction 2:1
2 = reduction 2,5 : 1
} available for lateral drive mount only

Motor mount
N = without mounting plate
F = mounting plate for Exlar motor
S = mounting plate for special motor

* seen from motor opposite side towards motor

Product Selection

Drive

In order to simplify the selection of the optimal drive, you'll find below the various drive solutions in line with the most important performance data.

This allows for the comparison of the different drives and the selection of the drive solution appropriate to the customer's individual need.

In case of any specific or higher requirements to the positioning system we ask you to get in contact with Exlar customer service.

Rodless Belt Drive Specifications	Size	Belt Type/Pitch/Width Travel per rev (mm)	Stroke range [mm]	Positioning accuracy [µm/mm]
	LM3	GT5MR/25-	≤ 7600	200/1000
	RM3	155mm/rev	≤ 7600	200/1000
	LM4	GT5MR/40-	≤ 7500	200/1000
	RM4	205mm/rev	≤ 7500	200/1000
	LM5	STD8M/50-	≤ 7400	200/1000
	RM5	296 mm/rev	≤ 7400	200/1000

[1] max. strength of extension at 1.6 m/sec

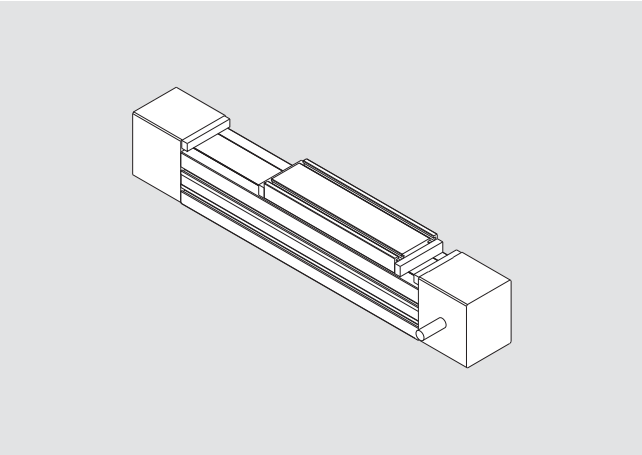
[2] no mechanical delimitation, depending on motor capacity

Accuracy * [+/- mm]	Backlash [mm]	Speed max. [m/s]	Acceleration max. [m/s^2]	Axial load rate C_0 [N]
0.1	zero backlash	1.6 (optional 5.0)	2)	1560 1)
0.1	zero backlash	1.6 (optional 5.0)	2)	1560 1)
0.1	zero backlash	1.6 (optional 5.0)	2)	2200 1)
0.1	zero backlash	1.6 (optional 5.0)	2)	2200 1)
0.1	zero backlash	1.6 (optional 5.0)	2)	3720 1)
0.1	zero backlash	1.6 (optional 5.0)	2)	3720 1)

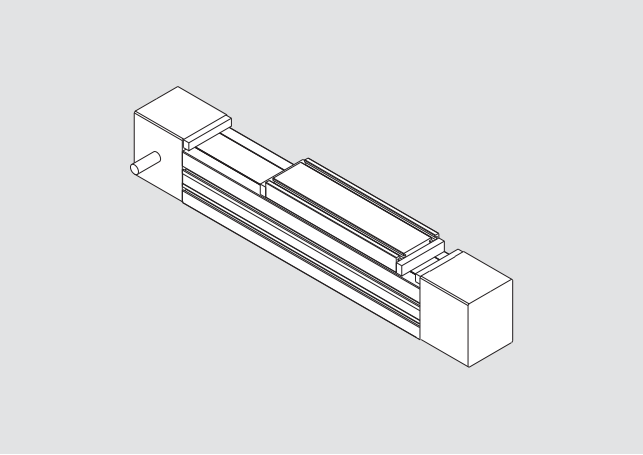
* without considering reversal backlash

Mounting Condition

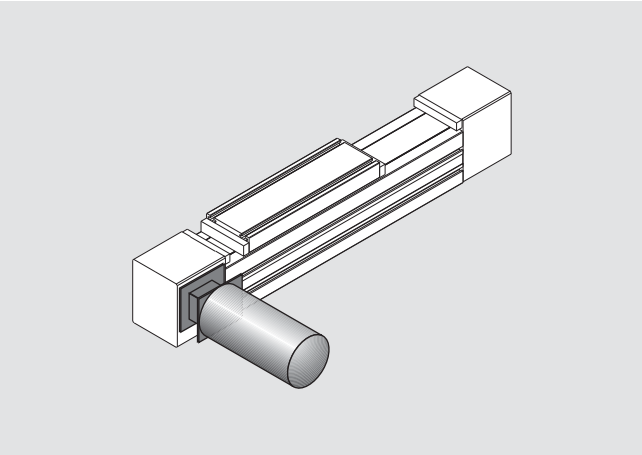
The Exlar positioning systems can be purchased in various mounting conditions. For the dimensions see page 32 .



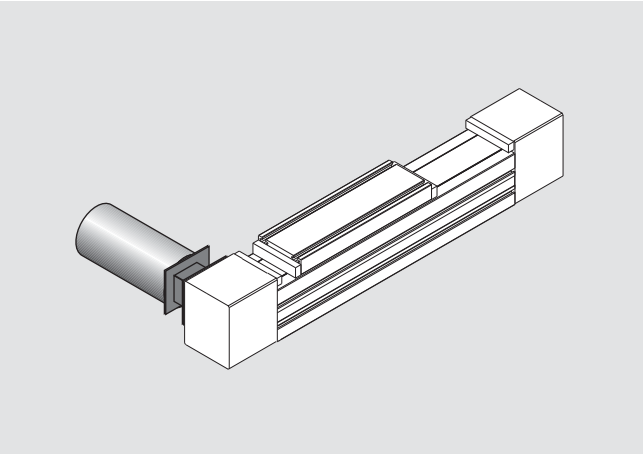
Picture 2: Free shaft end right hand side
(Mounting condition 11)



Picture 3: Free shaft end left hand side
(Mounting condition 12)



Picture 9: Belt drive left with coupling and intermediate plate
(Mounting condition 14)



Picture 10: Belt drive right with coupling and intermediate plate
(Mounting condition 13)

Limit Switches

The limit switches are used in conjunction with a control unit to limit the stroke (prevent overrunning of the carriage) and to define the reference position.
The standard inductive limit switches are PNP-break contact type and show the following characteristics:

Supply: 10…30 VDC
Current consumption off-load: < 10 mA
Load: max. 200 mA

Mechanical switch-ratio: ≤ 0.4mm

On request the following non standard limit switches are available:
– PNP-normally open (PNP-NO)
– NPN-normally closed (NPN-NC)
– NPN-normally open (NPN-NO)
– Mechanical limit switch

The Exlar product range includes continuous- and linear path control systems as well as step motors, AC- and DC servo drives. The individual components are tuned together and complete Exlar elements to custom made positioning systems.

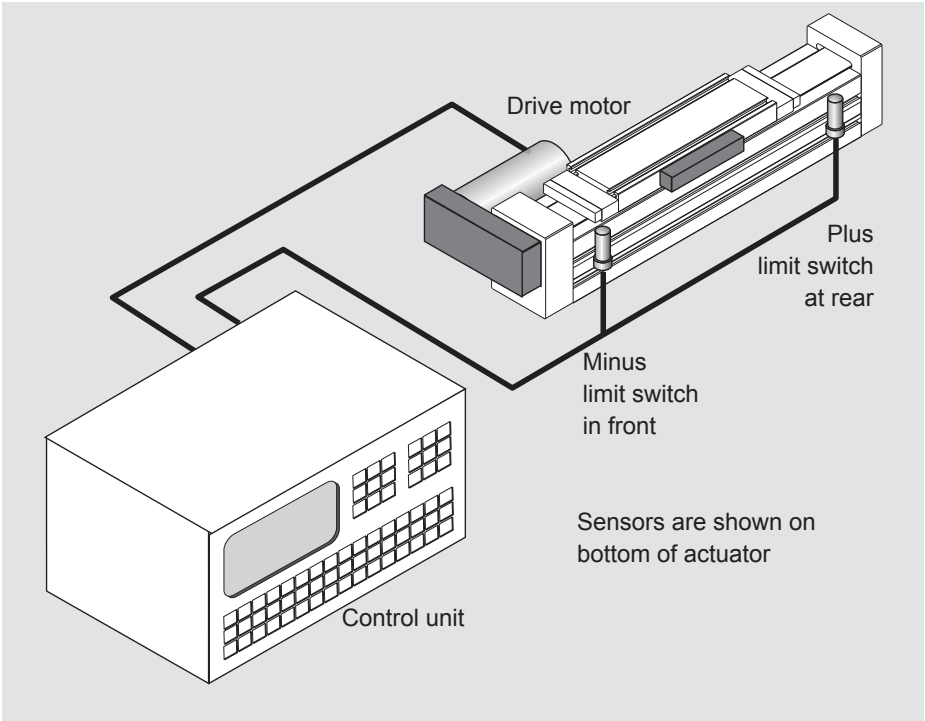
Mounting of the Limit Switches

The mounting position of the limit switches is shown in picture 11a. The reference position can be located either to the plus (+) or to the minus (-) limit switch.

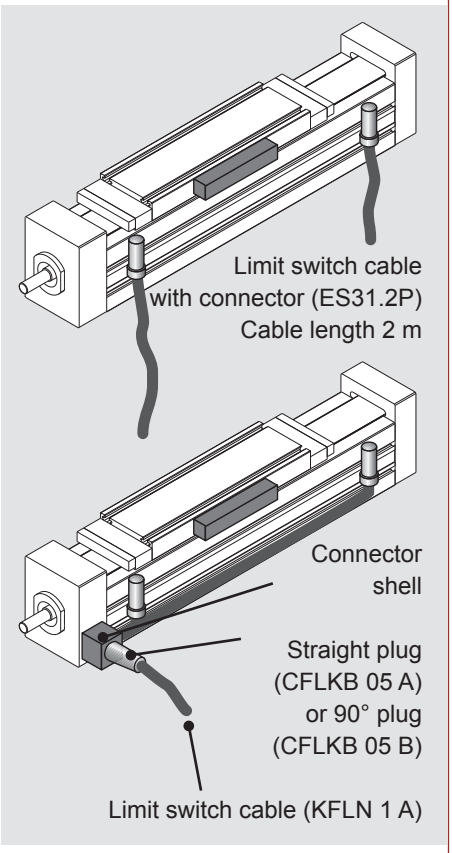
Limit switch cables are not included in the delivery. However they can be ordered separately (picture 11b).

On request the limit switches can be connected to a connector shell (picture 11b).

The limit switch cable (PN ES31.2P) is equipped with a plug on one side.



Picture 11a: Fitting position of the limit switches



Picture 11b: Connector shell and cable

Load Capacity

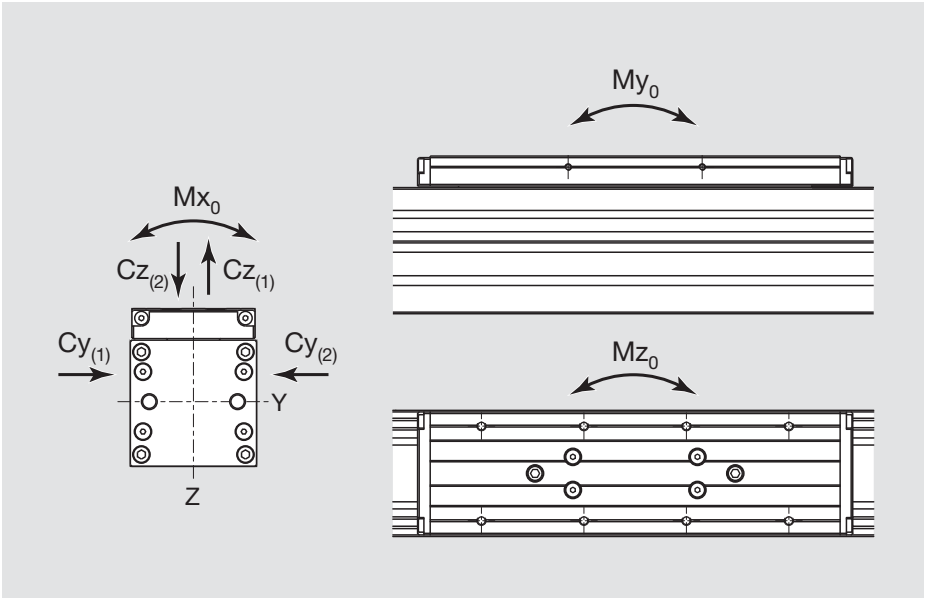
The load capacity is determined by the selected guiding system. We recommend to applying max. 20% of the dynamic load rate to the unit.

Applied Moment Load

The allowable values for applied moments are determined by the selected guiding system. The illustration at the right (picture 12) shows the descriptions of moment loads as depicted in the table below.

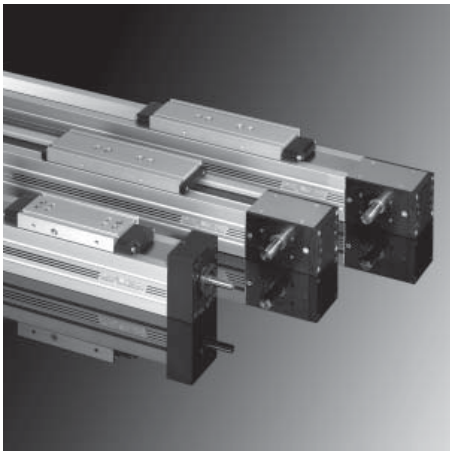
Deflection

For positioning units the maximum allowed deflection angle is of 5°. Exceeding this value will decrease the unit's life.



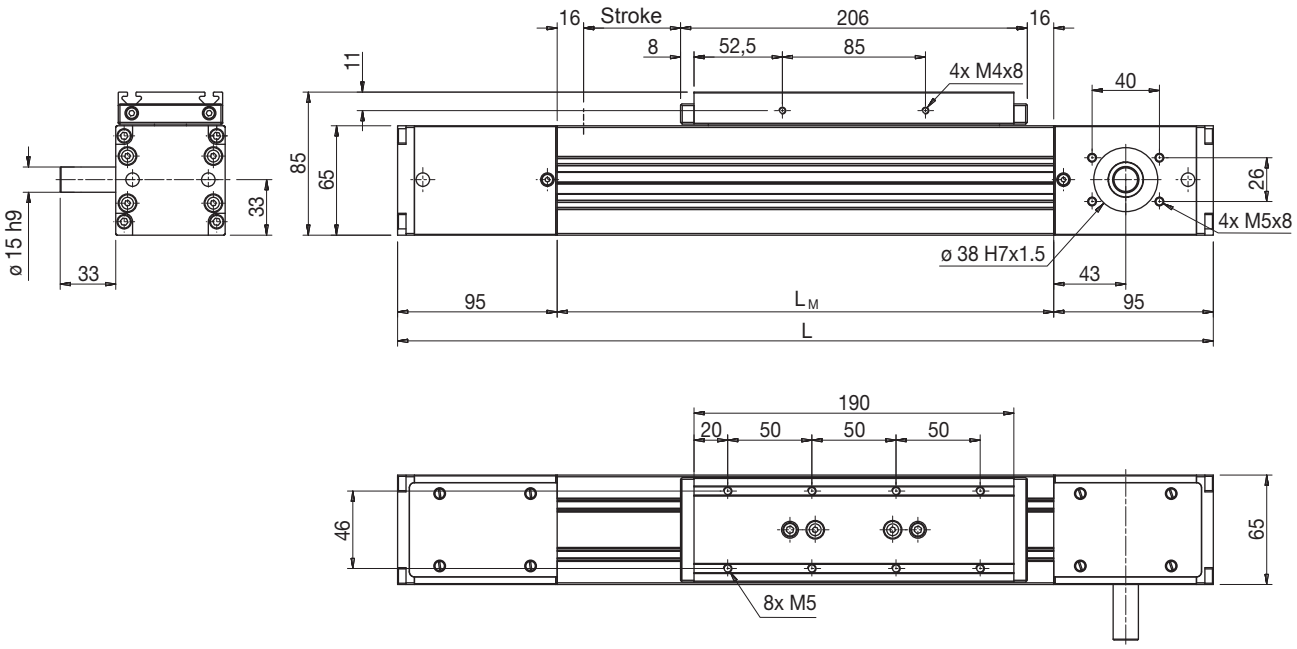
Picture 12: Directions of possible torque application

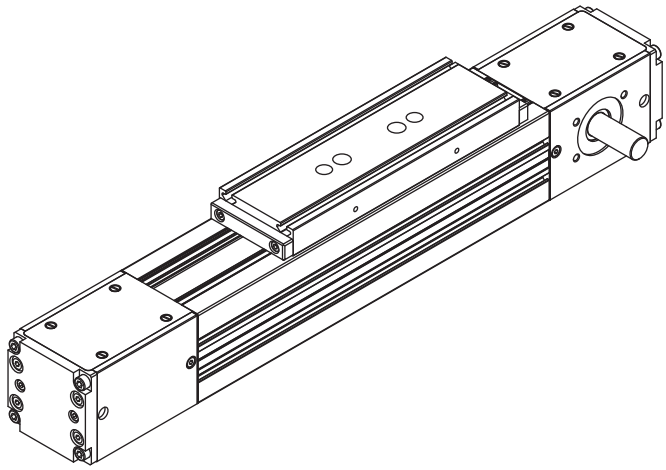
Type	Drive	Load rates dynamic				Load rates static				Torques static			Area momentum	
		$Cy_{(1)}$ [kN]	$Cy_{(2)}$	$Cz_{(1)}$	$Cz_{(2)}$	$Cy_{0\,(1)}$ [kN]	$Cy_{0\,(2)}$	$Cz_{0\,(1)}$	$Cz_{0\,(2)}$	Mx_0 [Nm]	My_0	Mz_0	Iy_s [cm^4]	Iz_s
LM3	Toothed belt	14.6	14.6	16.7	16.7	21.2	21.2	25.3	33.8	170	1,330	1,117	66.9	82.4
RM3.4	Toothed belt	7.3	7.3	2.1	2.1	4.5	4.5	1.1	1.1	16	82	169	67.2	87.0
RM3.6	Toothed belt	11.0	11.0	3.2	3.2	6.8	6.8	1.6	1.6	24	118	184	67.2	87.0
LM4	Toothed belt	20.5	20.5	23.4	23.4	29.6	29.6	35.2	47.0	320	2,590	2,176	131.2	197.8
RM4.4	Toothed belt	17.1	17.1	5.0	5.0	10.2	10.2	2.4	2.4	31	233	484	134.2	209.1
RM4.6	Toothed belt	25.7	25.7	7.5	7.5	15.3	15.3	3.6	3.6	47	344	533	134.2	209.1
LM5	Toothed belt	33.0	33.0	37.6	37.6	45.9	45.9	54.7	73.0	572	5,803	4,874	451.9	623.9
RM5.4	Toothed belt	31.2	31.2	9.1	9.1	18.2	18.2	4.3	4.3	22	529	1,000	451.9	669.6
RM5.6	Toothed belt	46.8	46.8	13.6	13.6	27.3	27.3	6.5	6.5	32	983	1,528	451.9	669.6



– Dimension drawings LM3/RM3 (size 65):
  - LM3.2 with linear rail guiding system and toothed belt drive
  - RM3.4 with roller guides (with 4 rolls) and toothed belt drive
  - RM3.6 with roller guides (with 6 rolls) and toothed belt drive

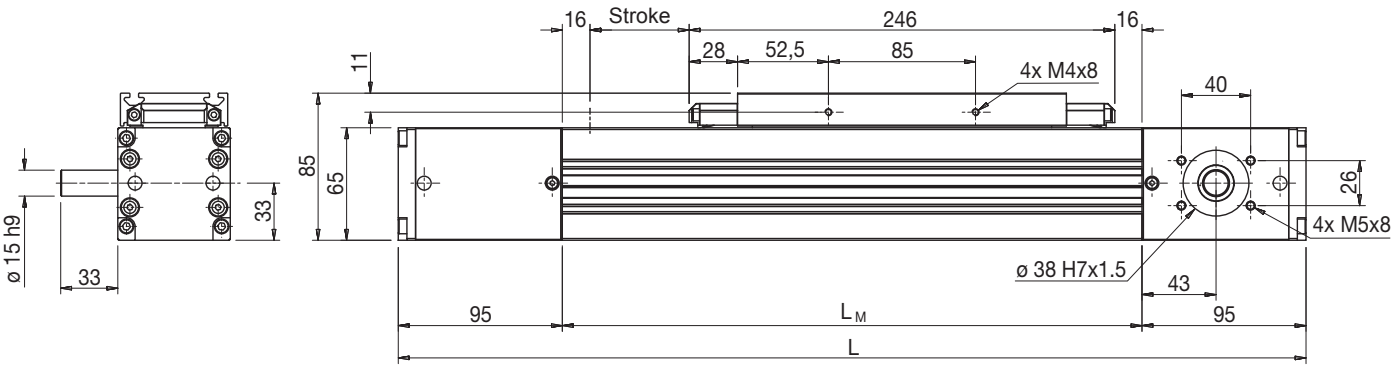
LM3.2 with linear rail guiding system and toothed belt drive (without protection)

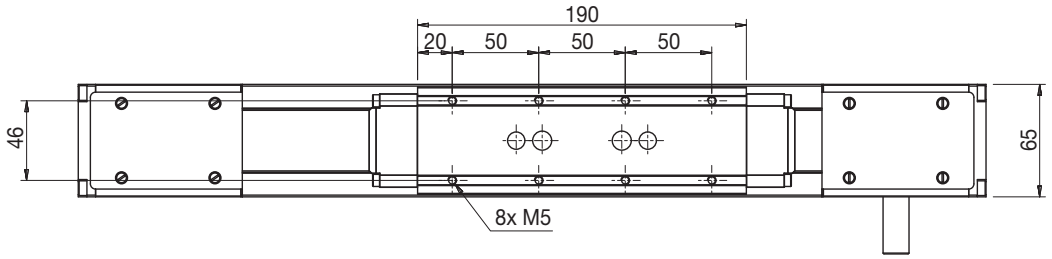


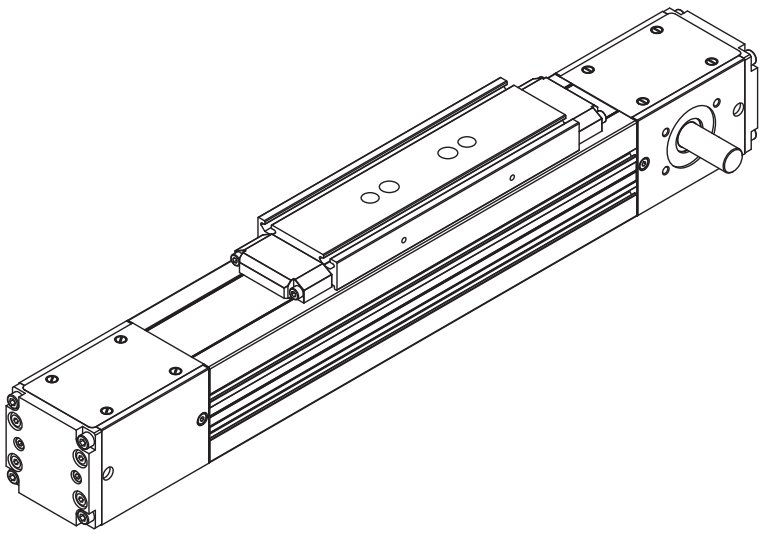


Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Weight [kg]
LM3.2.____NZ	Stroke + 435	L – 190	2 x Stroke + 730	4.5 kg + 0.60 kg/100 mm Stroke

LM3.2 with linear rail guiding system and toothed belt drive (with steel strapping)

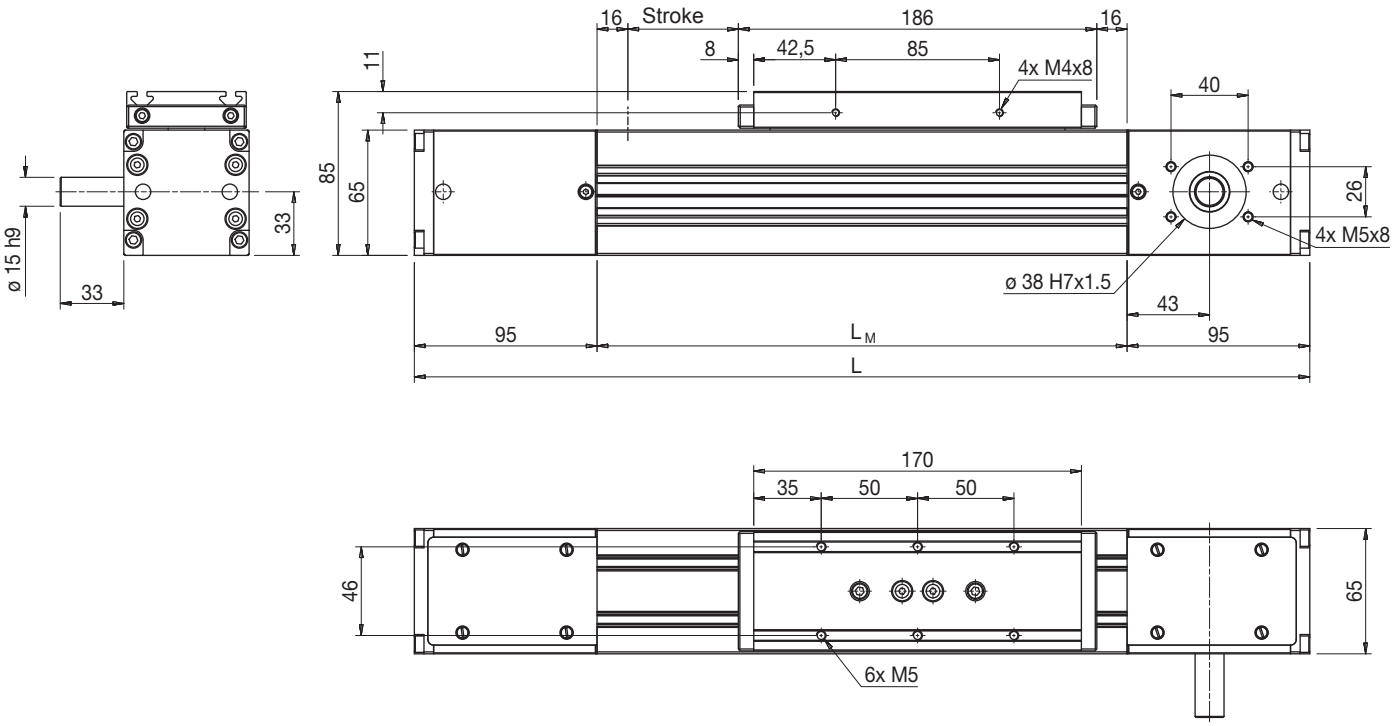


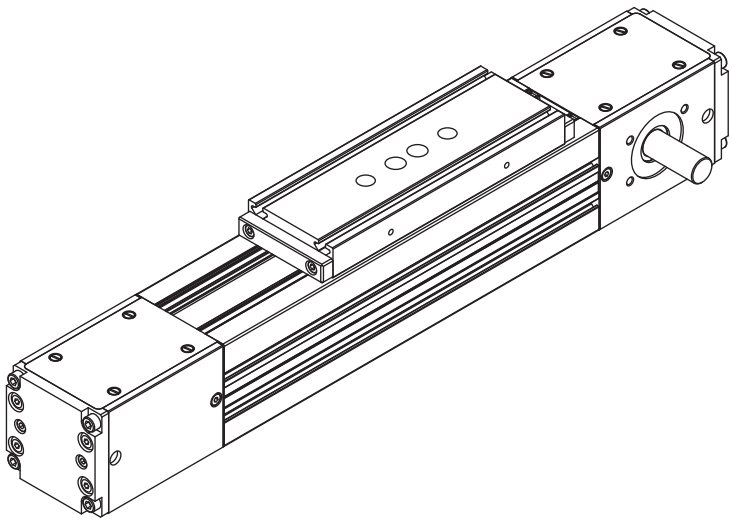




Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Length steel strapping	Weight [kg]
LM3.2.____BZ	Stroke + 475	L – 190	2 x Stroke + 810	L – 10	4.8 kg + 0.60 kg/100 mm Stroke

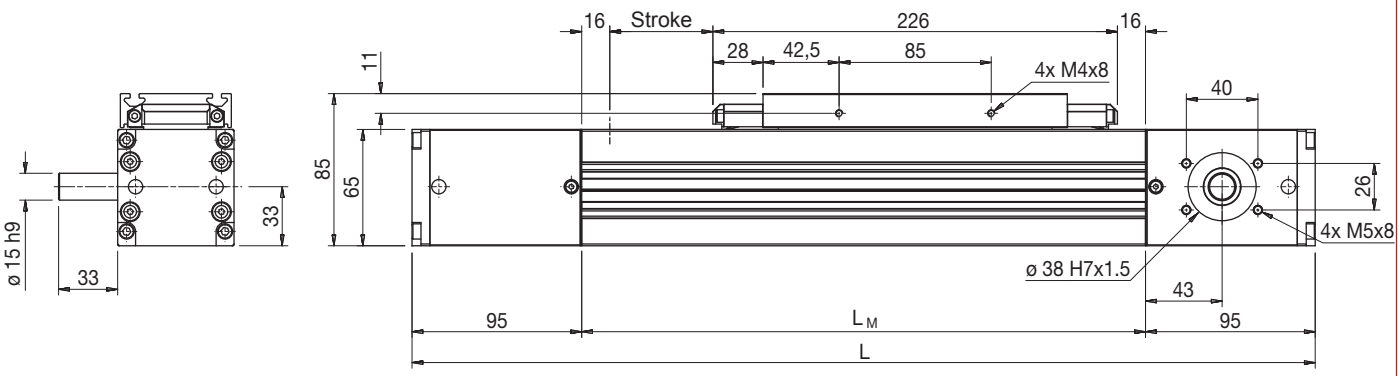
RM3.4 with roller guides (with 4 rolls) and toothed belt drive (without protection)

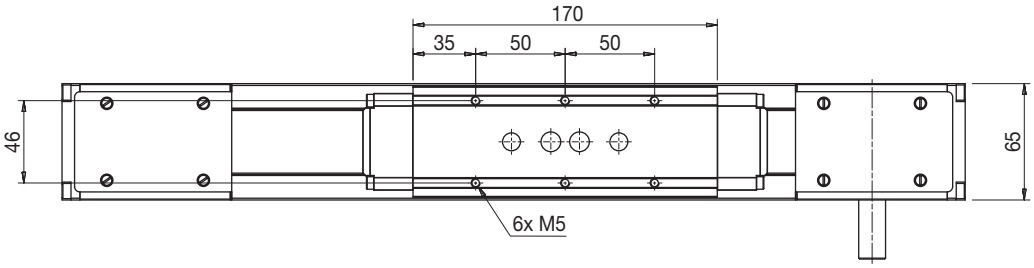


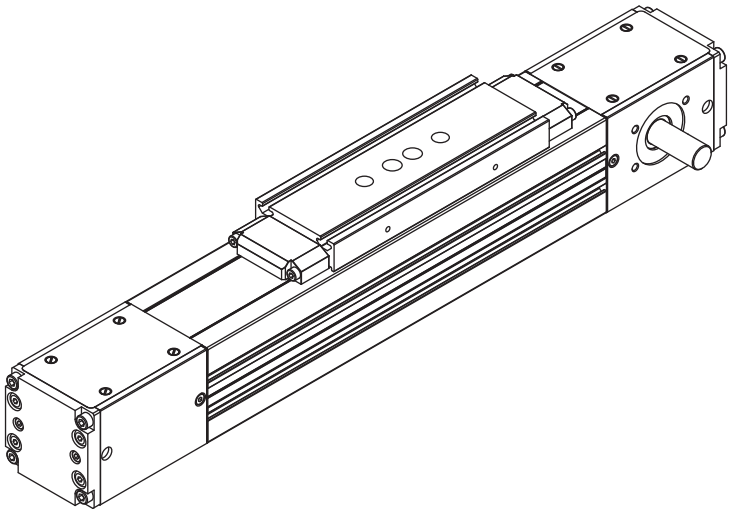


Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Weight [kg]
RM3.4.____NZ	Stroke + 415	L – 190	2 x Stroke + 710	3.9 kg + 0.53 kg/100 mm Stroke

RM3.4 with roller guides (with 4 rolls) and toothed belt drive (with steel strapping)

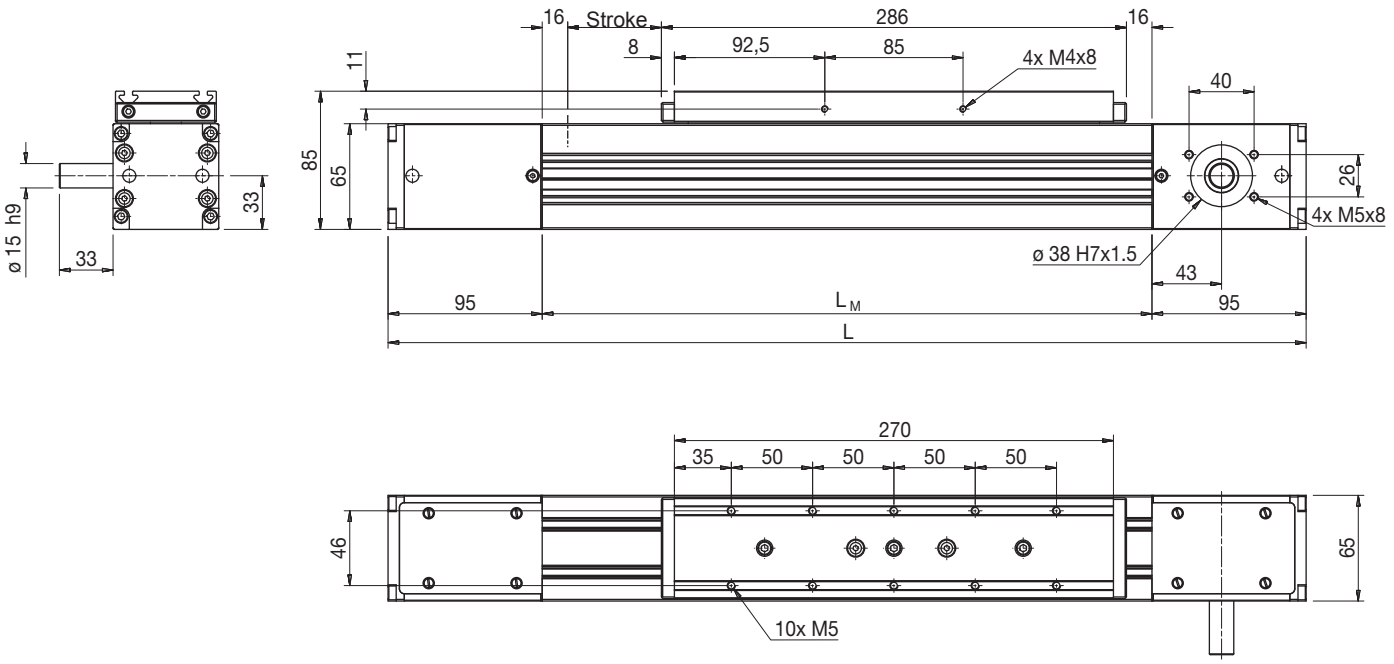


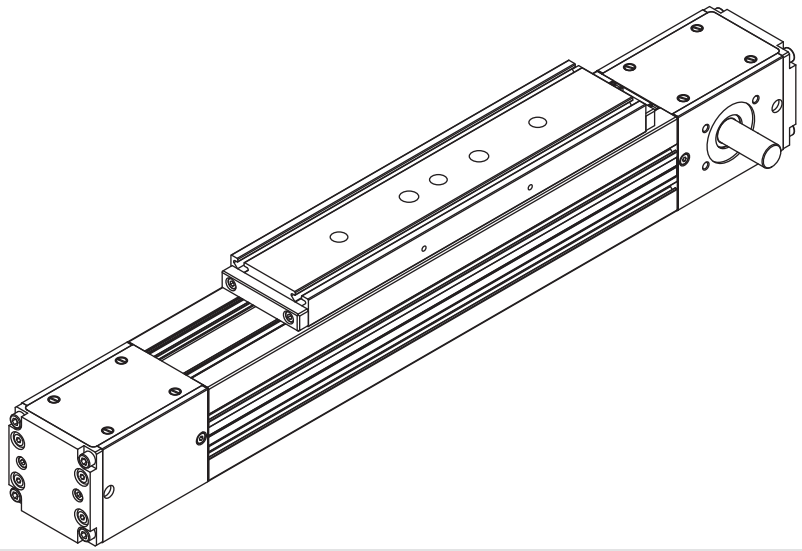




Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Length steel strapping	Weight [kg]
RM3.4.____BZ	Stroke + 455	L – 190	2 x Stroke + 890	L – 10	4.7 kg + 0.54 kg/100 mm Stroke

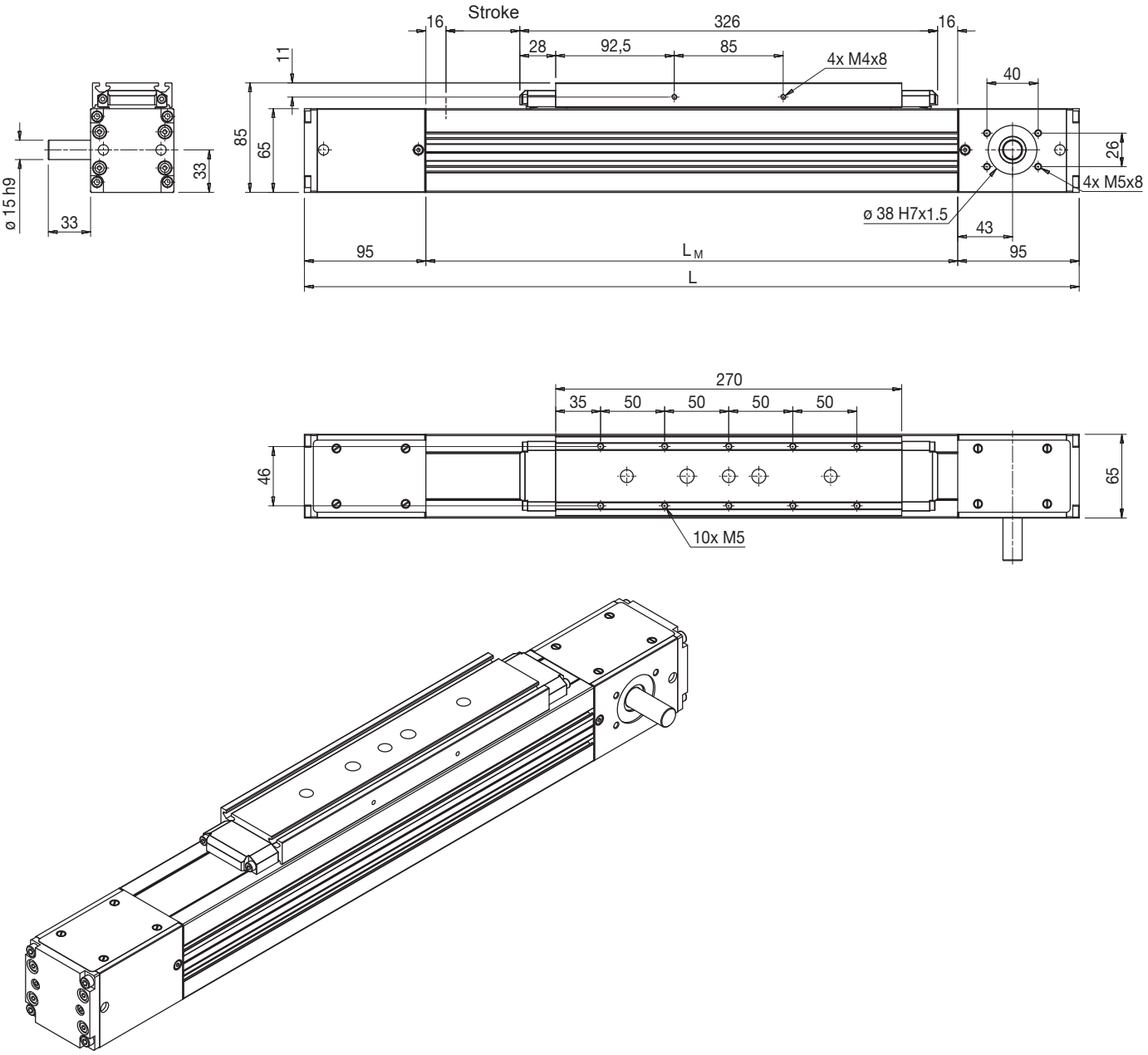
RM3.6 with roller guides (with 6 rolls) and toothed belt drive (without protection)





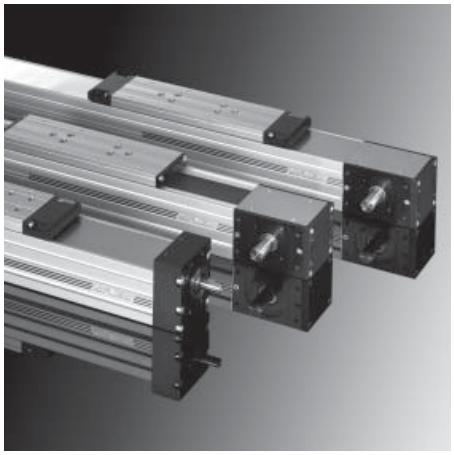
Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Weight [kg]
RM3.6.____NZ	Stroke + 515	L – 190	2 x Stroke + 810	4.9 kg + 0.53 kg/100 mm Stroke

RM3.6 with roller guides (with 6 rolls) and toothed belt drive (with steel strapping)



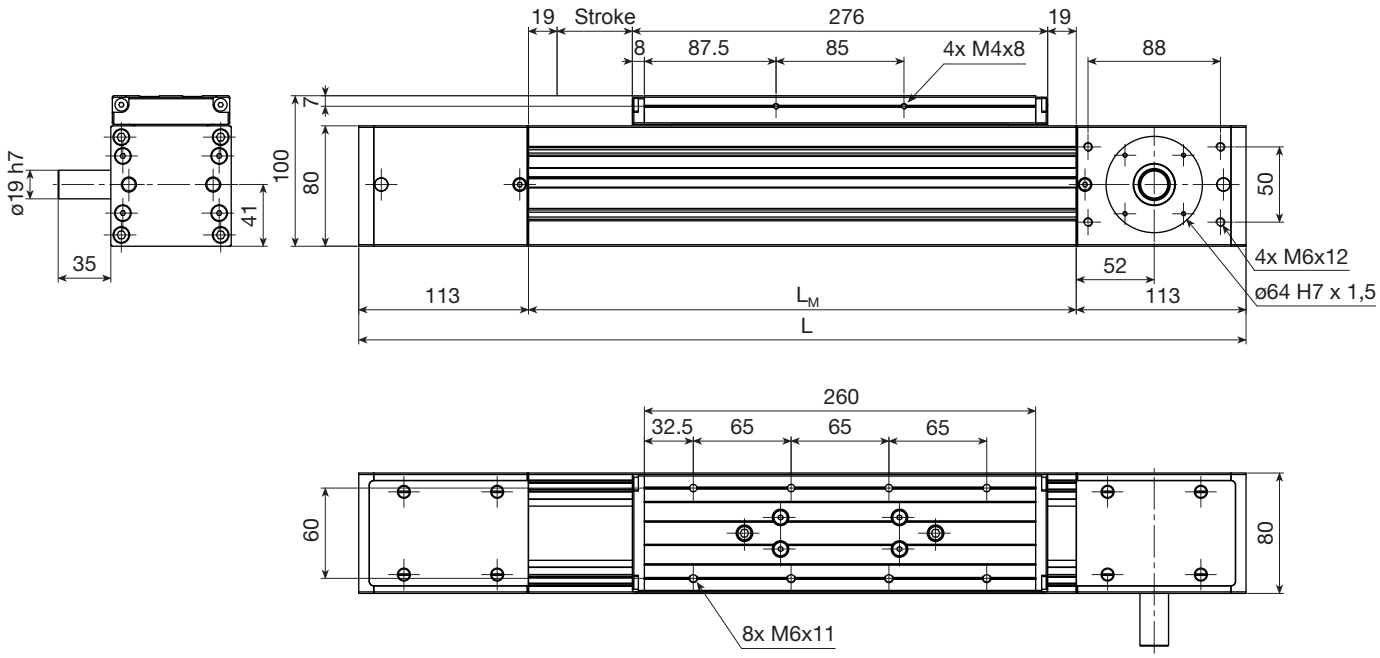
Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Length steel strapping	Weight [kg]
RM3.6.____BZ	Stroke + 555	L – 190	2 x Stroke + 890	L – 10	5.2 kg + 0.54 kg/100 mm Stroke

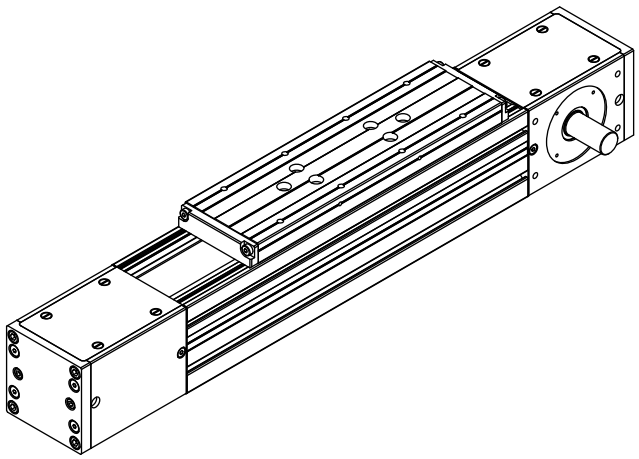
LM4/RM4 Size 80



– Dimension drawings LM4/RM4 (size 80):
  - LM4.2 with linear rail guiding system and toothed belt drive
  - RM4.4 with roller guides (with 4 rolls) and toothed belt drive
  - RM4.6 with roller guides (with 6 rolls) and toothed belt drive

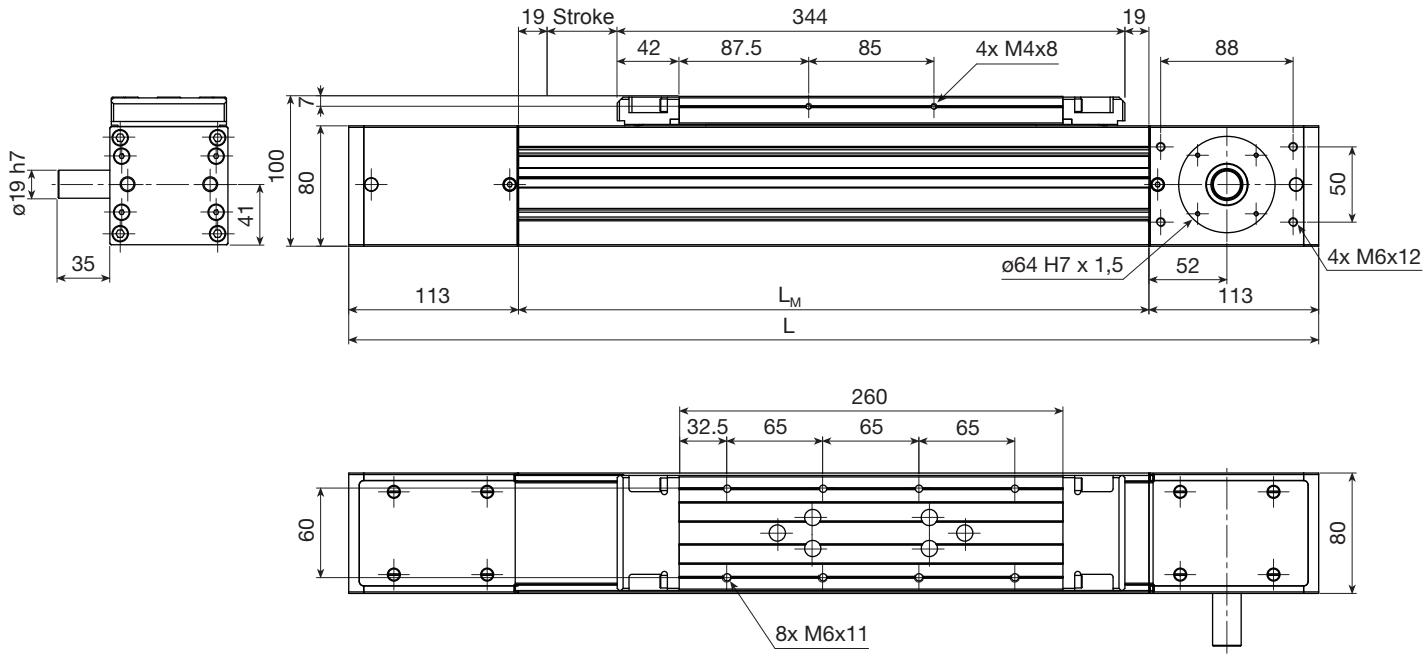
LM4.2 with linear rail guiding system and toothed belt drive (without protection)

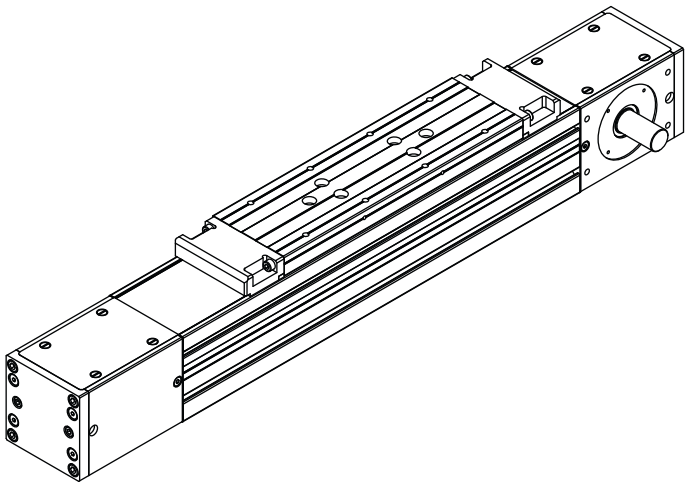




Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Weight [kg]
LM4.2.____NZ	Stroke + 540	L – 226	2 x Stroke + 900	8.4 kg + 0.93 kg/100 mm Stroke

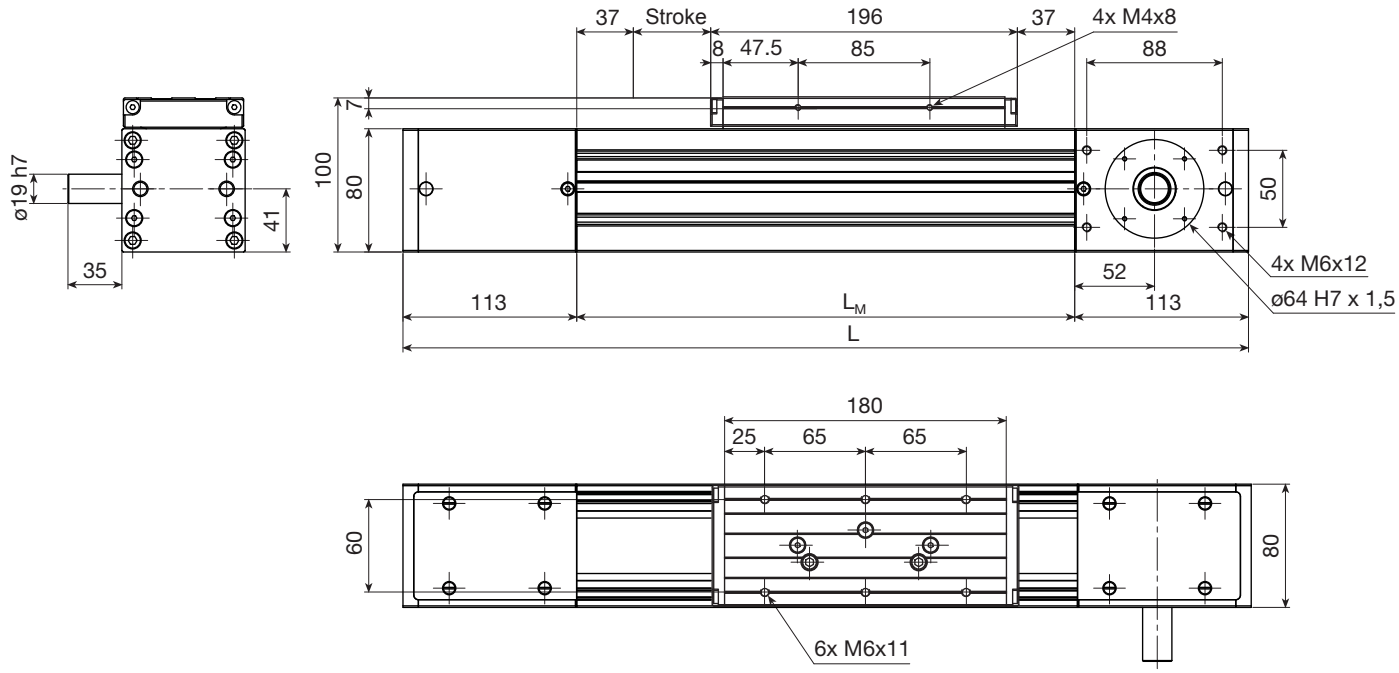
LM4.2 with linear rail guiding system and toothed belt drive (with steel strapping)

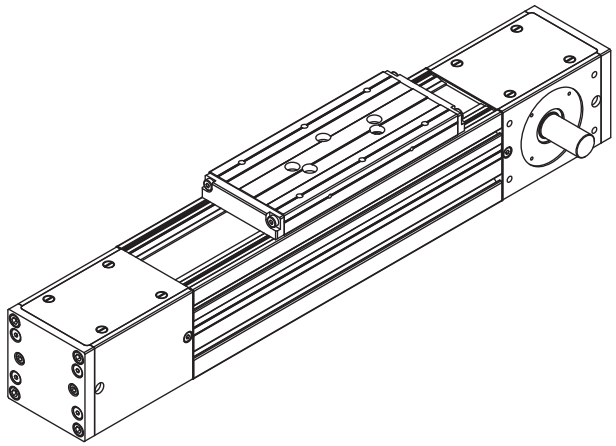




Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Length steel strapping	Weight [kg]
LM4.2.____BZ	Stroke + 608	L – 226	2 x Stroke + 1040	L – 12	9.1 kg + 0.95 kg/100 mm Stroke

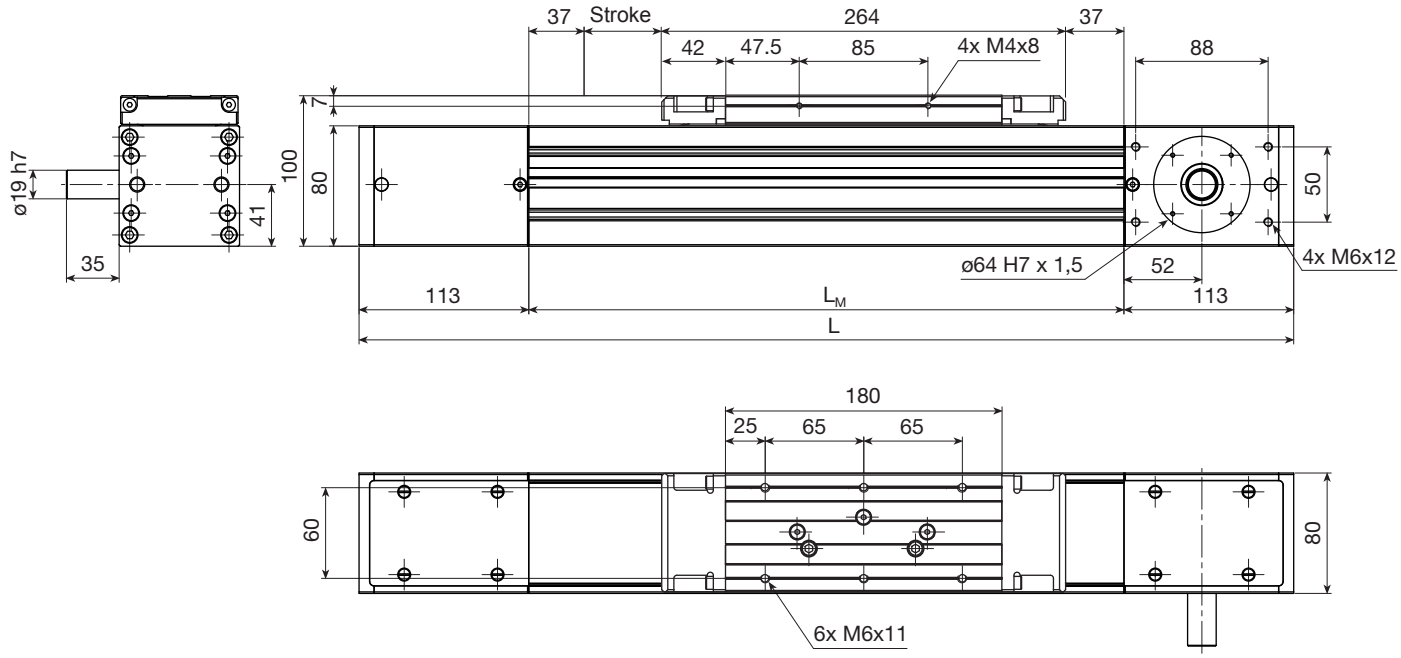
RM4.4 with roller guides (with 4 rollers) and toothed belt drive (without protection)

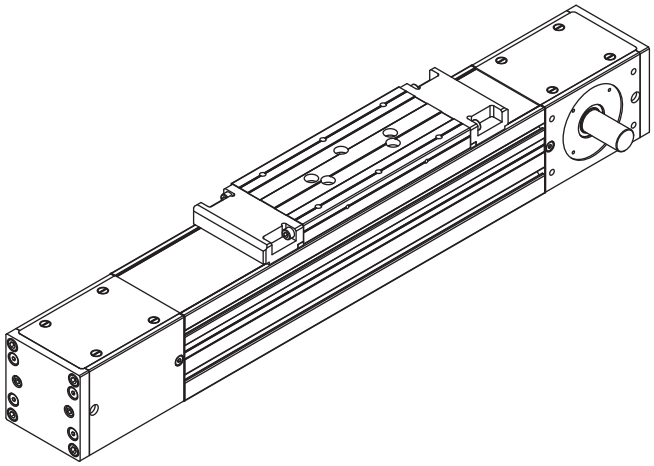




Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Weight [kg]
RM4.4.____NZ	Stroke + 496	L – 226	2 x Stroke + 860	7.4 kg + 0.81 kg/100 mm Stroke

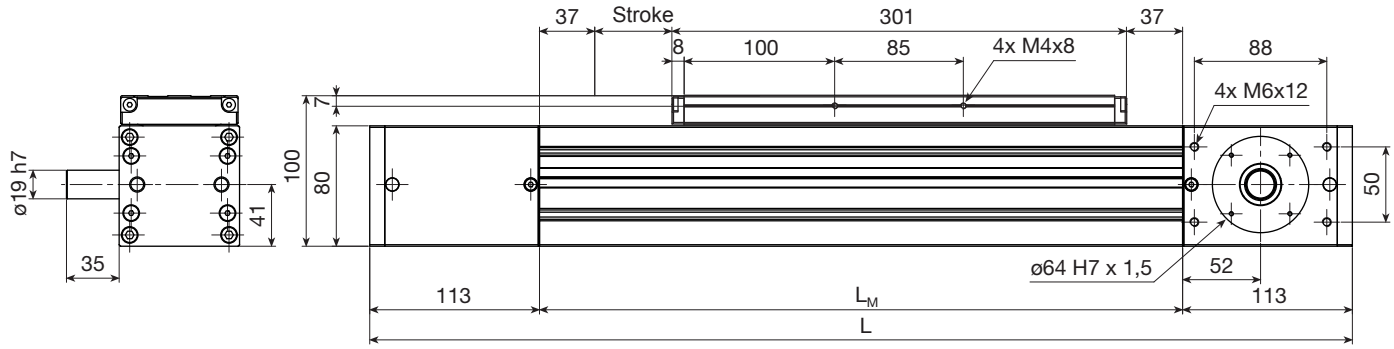
RM4.4 with roller guides (with 4 rollers) and toothed belt drive (with steel strapping)

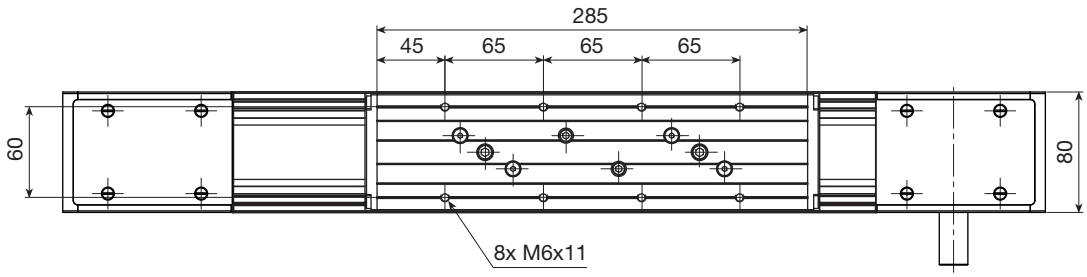


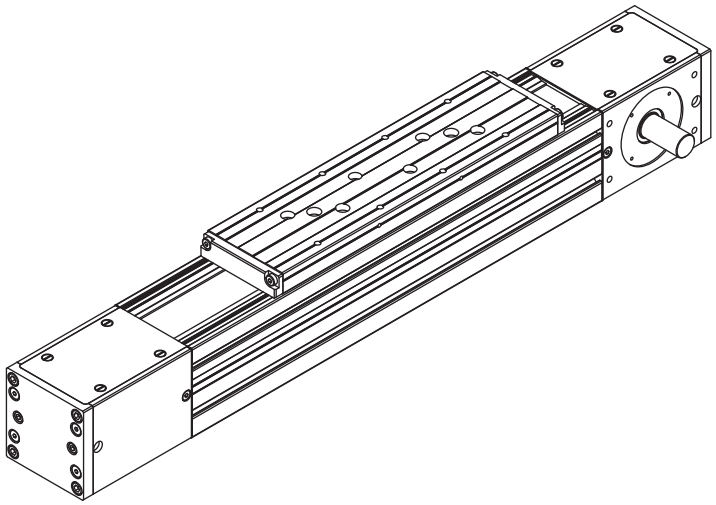


Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Length steel strapping	Weight [kg]
RM4.4.____BZ	Stroke + 564	L – 226	2 x Stroke + 995	L – 12	8.2 kg + 0.83 kg/100 mm Stroke

RM4.6 with roller guides (with 6 rollers) and toothed belt drive (without protection)

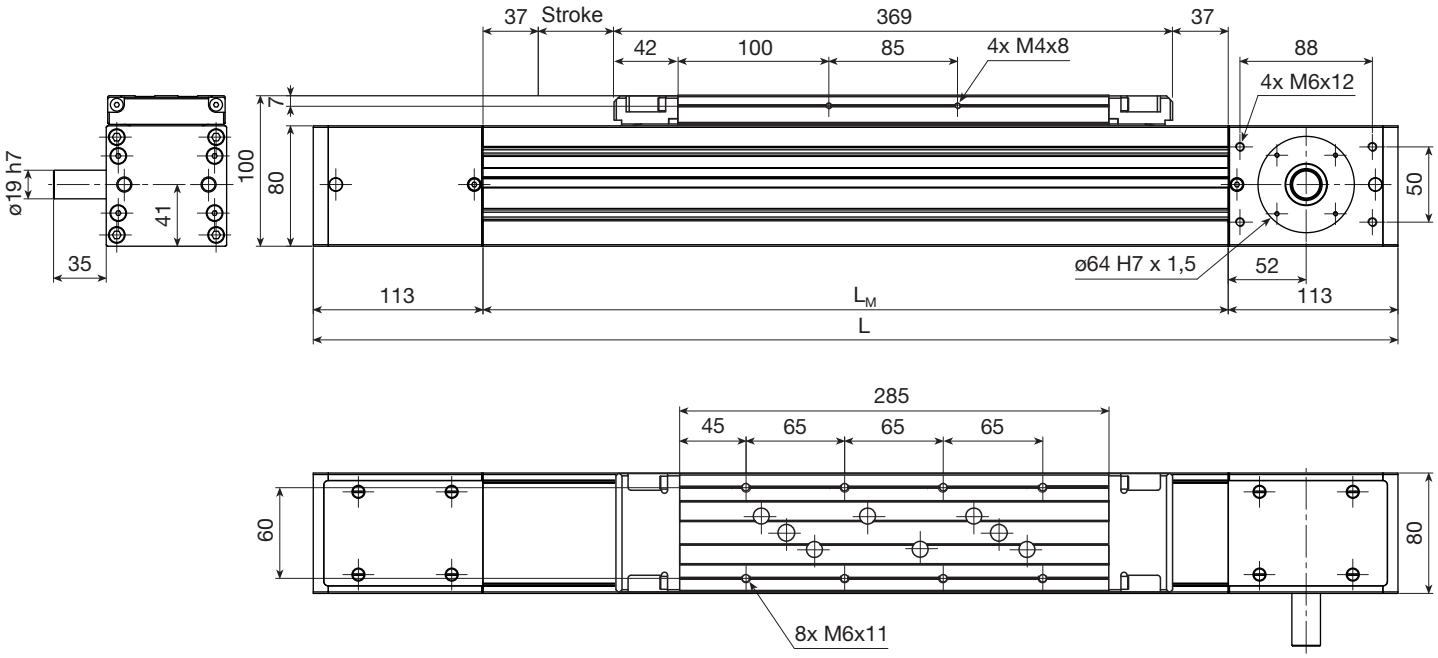


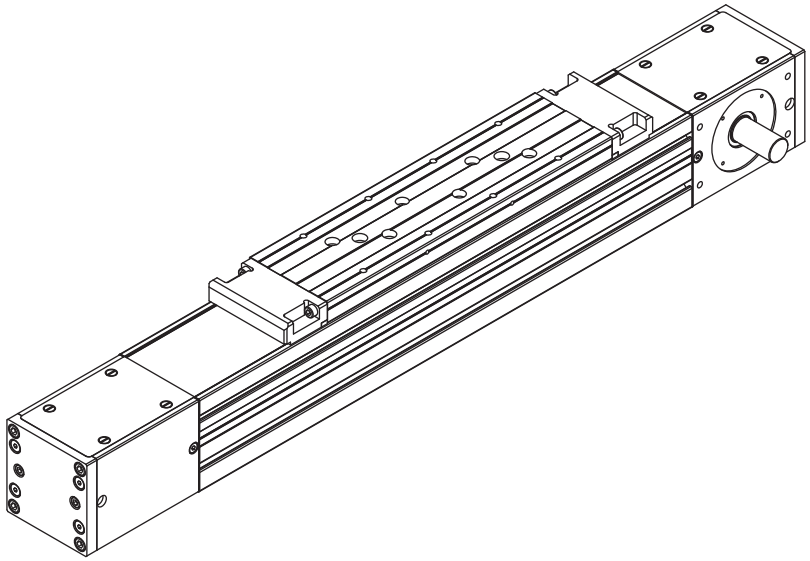




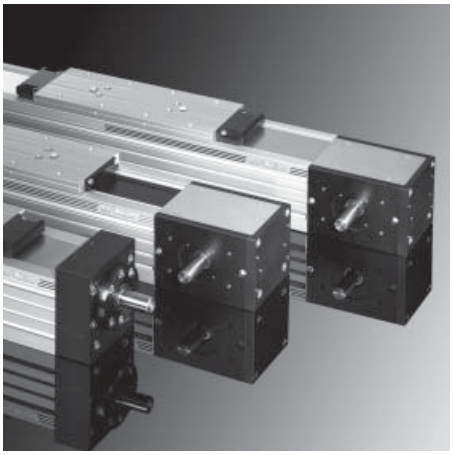
Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Weight [kg]
RM4.6.____NZ	Stroke + 601	L – 226	2 x Stroke + 965	9.2 kg + 0.81 kg/100 mm Stroke

RM4.6 with roller guides (with 6 rollers) and toothed belt drive (with steel strapping)



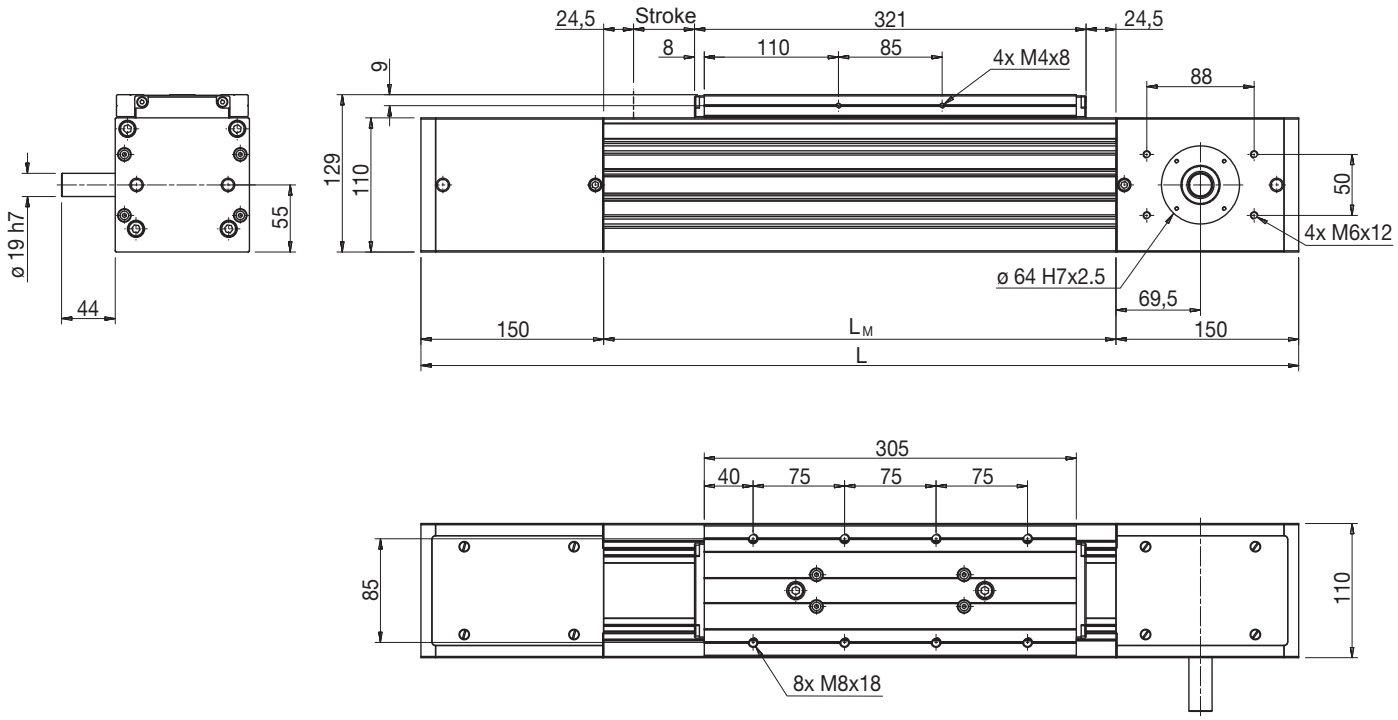


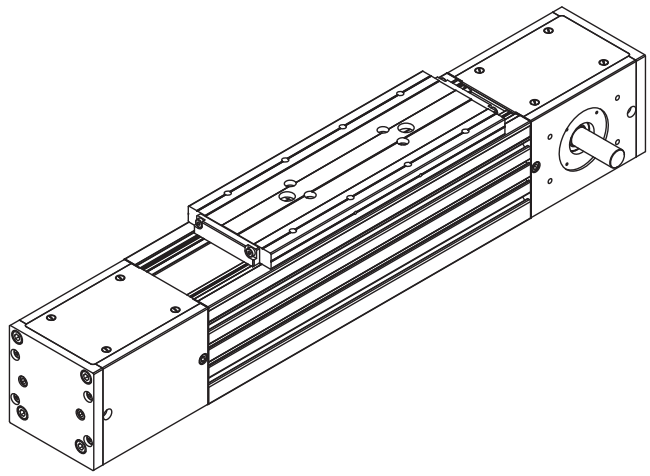
Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Length steel strapping	Weight [kg]
RM4.6.____BZ	Stroke + 669	L – 226	2 x Stroke + 1100	L – 12	10.0 kg + 0.83 kg/100 mm Stroke



– Dimension drawings LM5/RM5 (size 110):
  - LM5.2 with linear rail guiding system and toothed belt drive
  - RM5.4 with roller guides (with 4 rolls) and toothed belt drive
  - RM5.6 with roller guides (with 6 rolls) and toothed belt drive

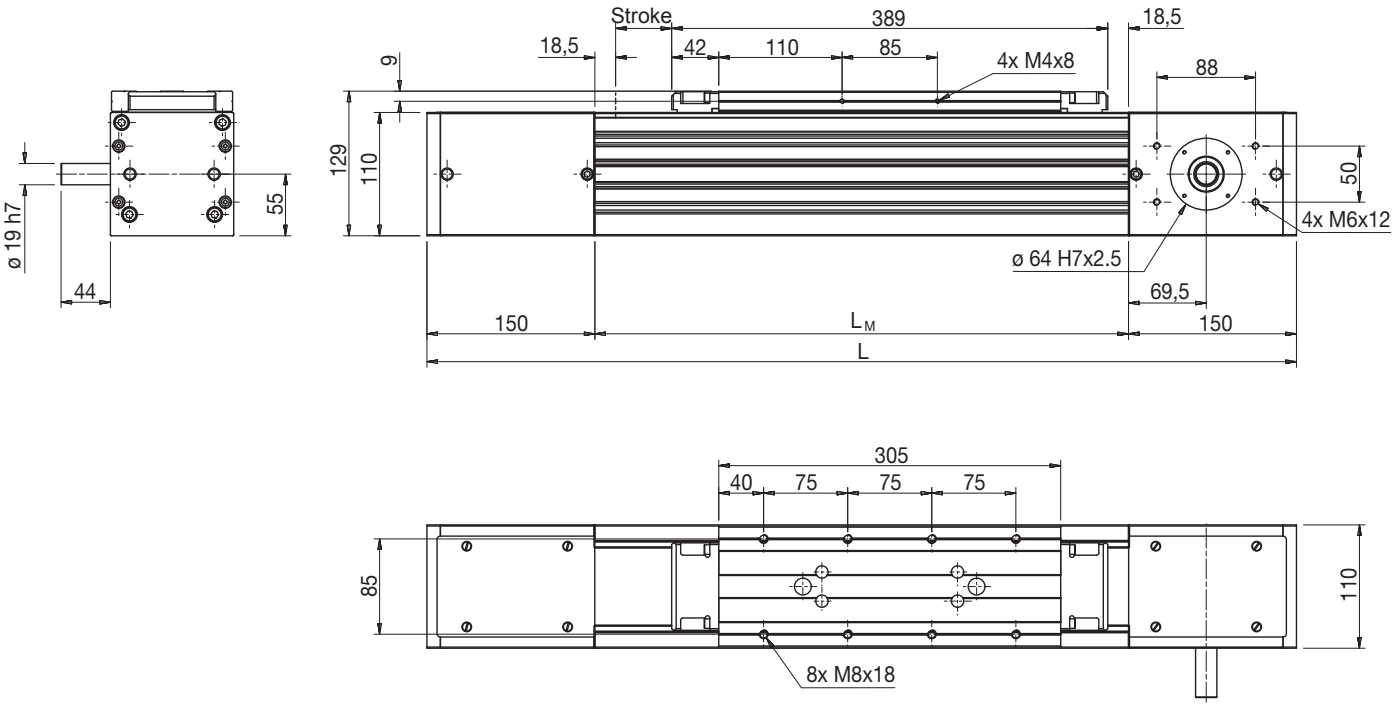
LM5.2 with linear rail guiding system and toothed belt drive (without protection)

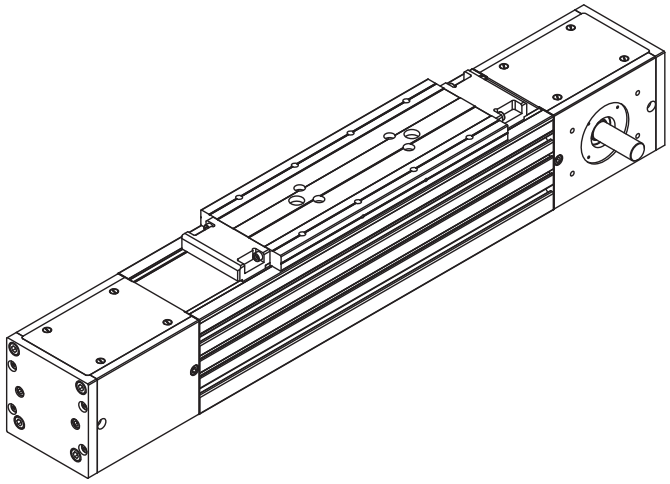




Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Weight [kg]
LM5.2.____NZ	Stroke + 670	L – 300	2 x Stroke + 1144	18.6 kg + 1.48 kg/100 mm Stroke

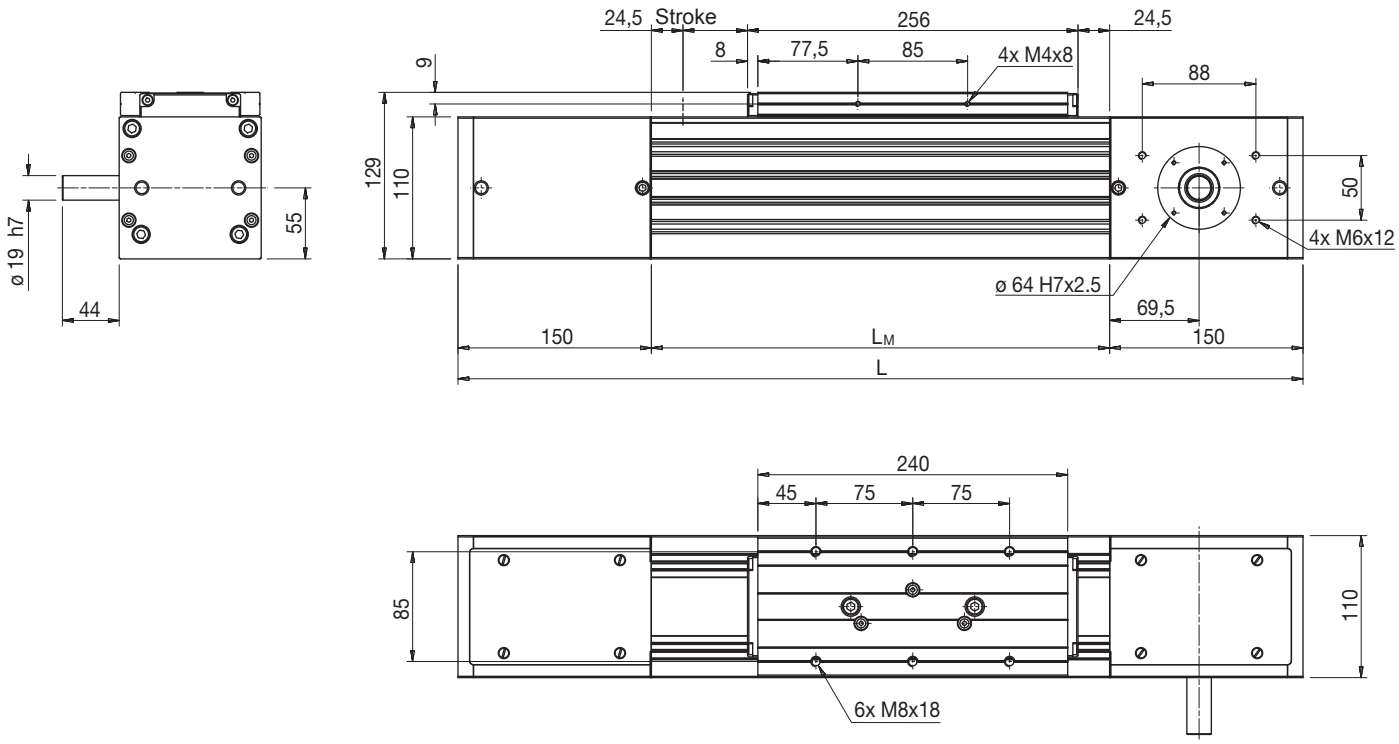
LM5.2 with linear rail guiding system and toothed belt drive (with steel strapping)

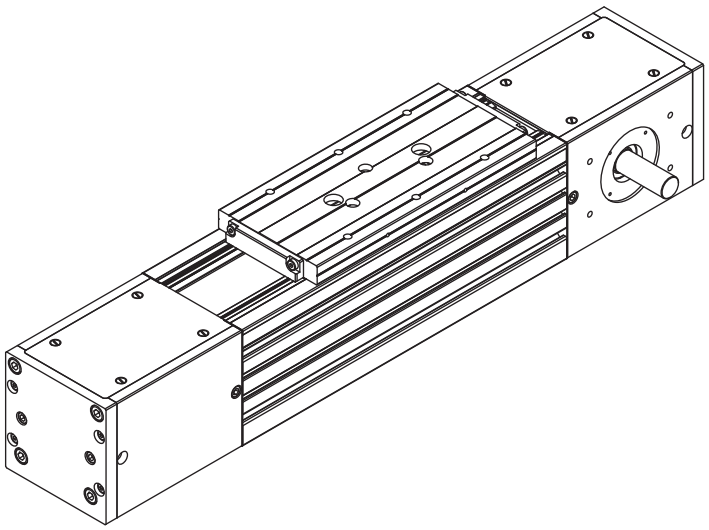




Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Length steel strapping	Weight [kg]
LM5.2.____BZ	Stroke + 726	L – 300	2 x Stroke + 1256	L – 14	19.5 kg + 1.50 kg/100 mm Stroke

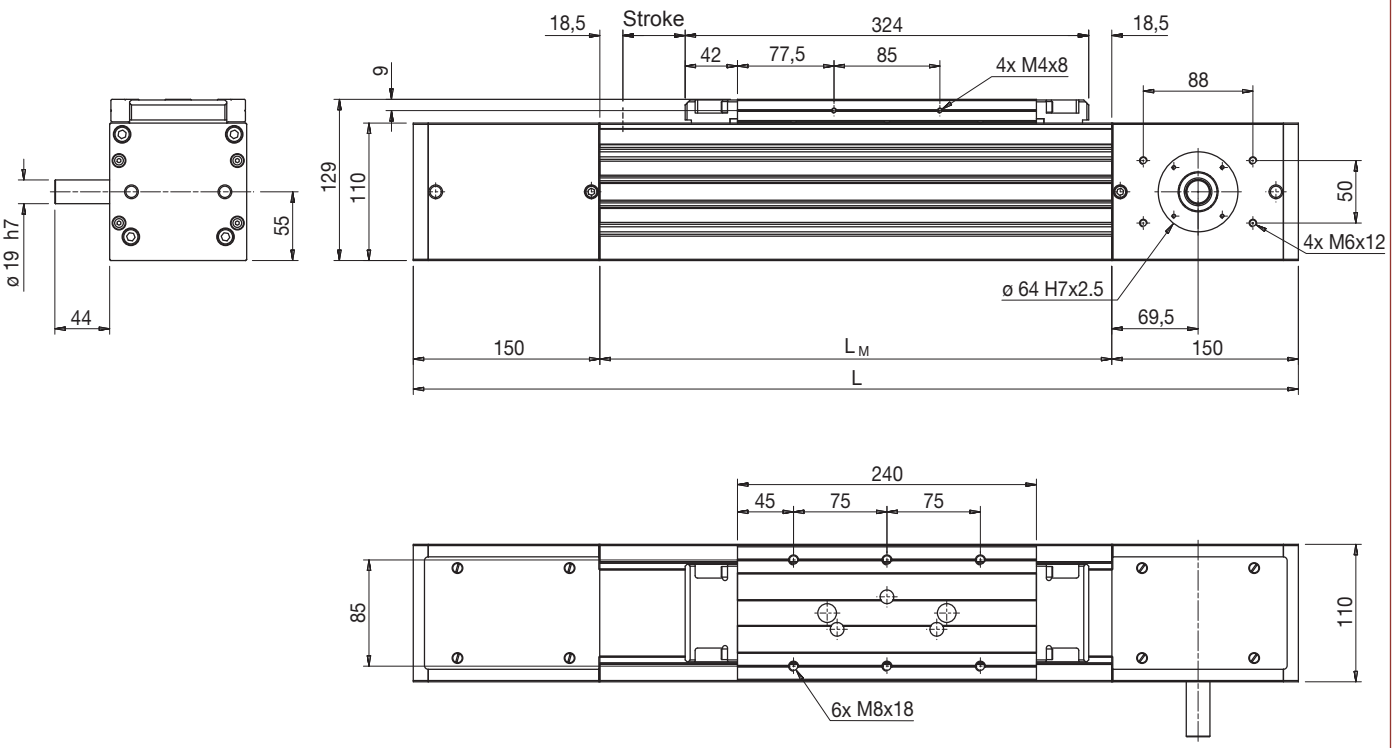
RM5.4 with roller guides (with 4 rollers) and toothed belt drive (without protection)

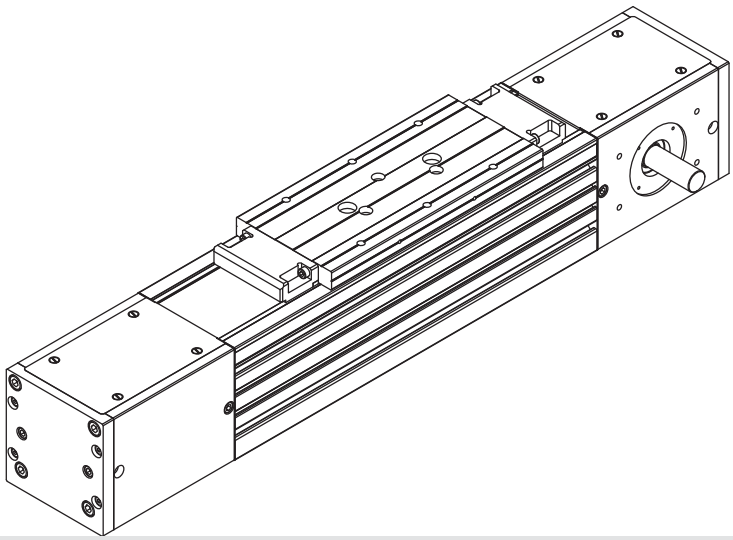




Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Weight [kg]
RM5.4.____NZ	Stroke + 605	L – 300	2 x Stroke + 1080	17.3 kg + 1.46 kg/100 mm Stroke

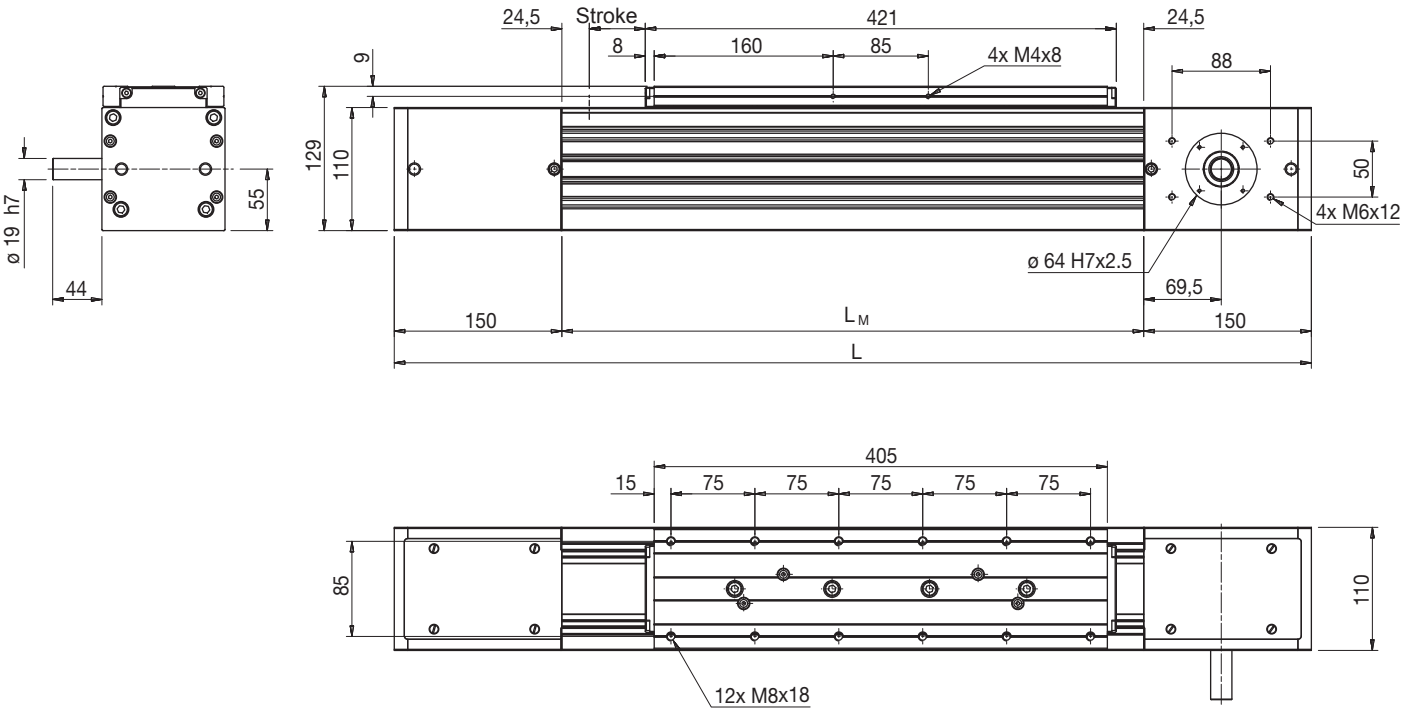
RM5.4 with roller guides (with 4 rollers) and toothed belt drive (with steel strapping)

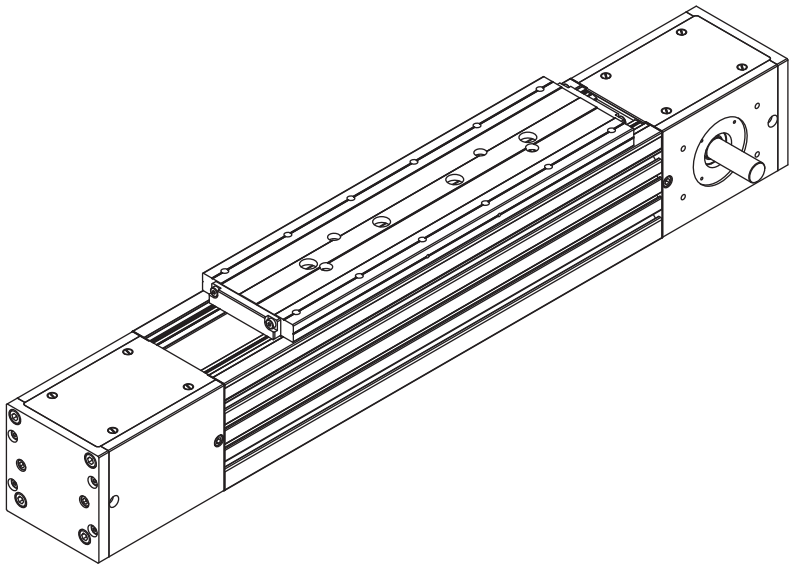




Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Length steel strapping	Weight [kg]
RM5.4.____BZ	Stroke + 661	L – 300	2 x Stroke + 1192	L – 14	18.4 kg + 1.48 kg/100 mm Stroke

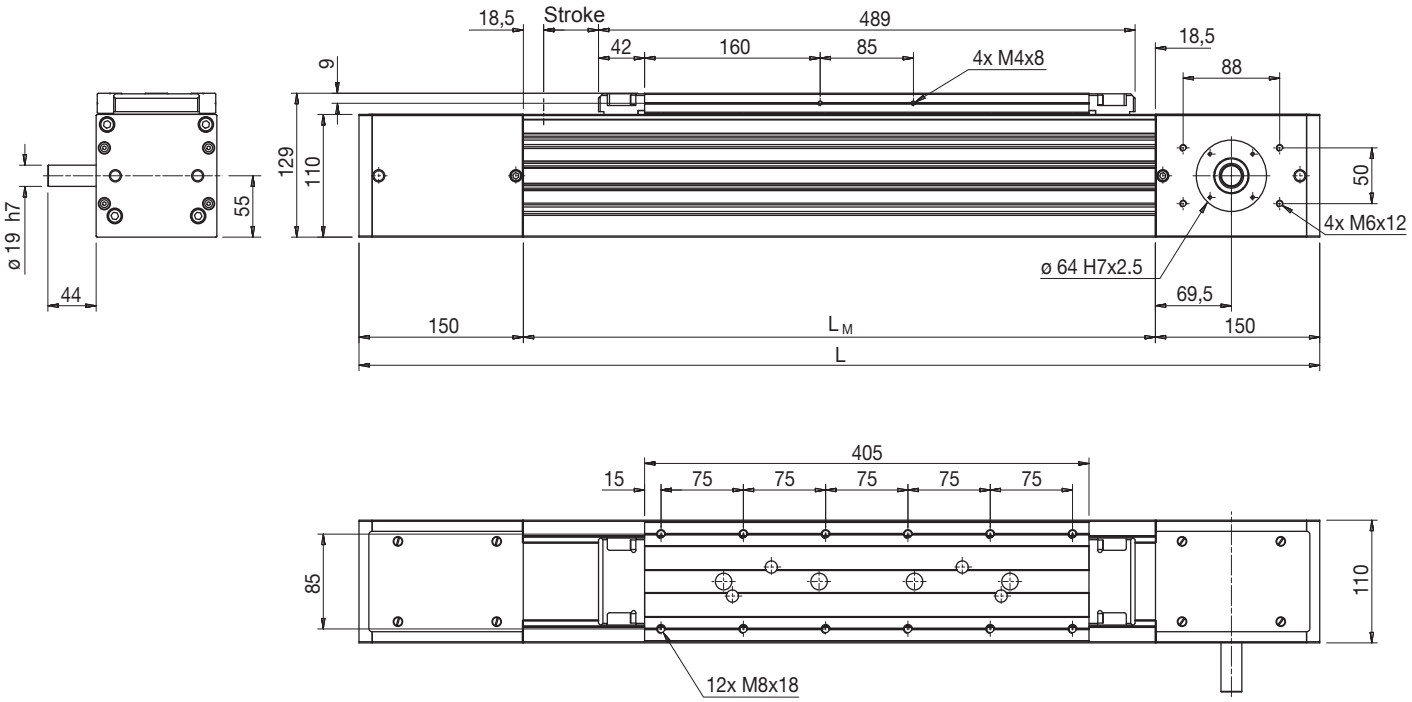
RM5.6 with roller guides (with 6 rollers) and toothed belt drive (without protection)

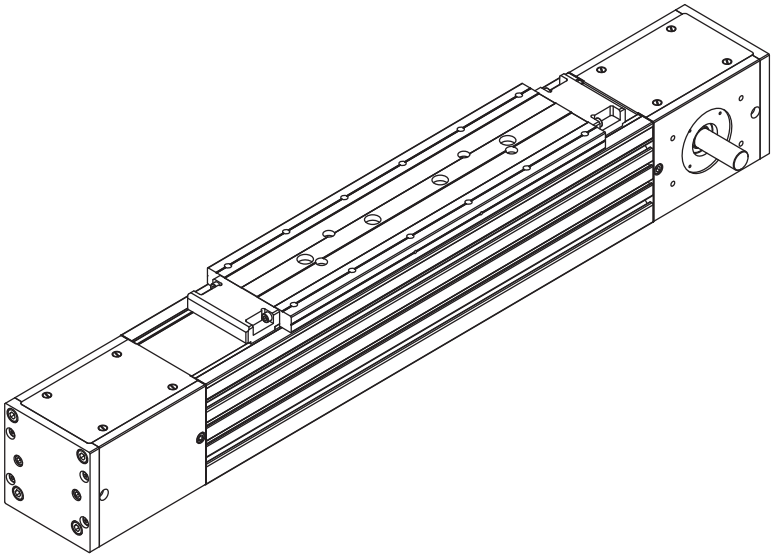




Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Weight [kg]
RM5.6.____NZ	Stroke + 770	L – 300	2 x Stroke + 1240	21.8 kg + 1.46 kg/100 mm Stroke

RM5.6 with roller guides (with 6 rollers) and toothed belt drive (with steel strapping)





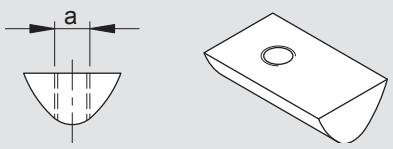
Nominal size Designation	**Dimensions** L [mm]	L_M	Belt length	Length steel strapping	Weight [kg]
RM5.6.____BZ	Stroke + 826	L – 300	2 x Stroke + 1352	L – 14	22.8 kg + 1.48 kg/100 mm Stroke

Mounting Grooves and Sliding Blocks

For all unit sizes the profiles, and often the carriages as well, come with grooves. The cradles of the linear modules LM4/RM4 and LM5/RM5 are not equipped with such. The attachment of those two types is made through threaded holes. The positions of the grooves as well as the maximum thread reach are shown in profile cross-sections.

According to the groove width, sliding blocks of the types NS5, NS6 and NS8 are available. The sliding blocks are available from Exlar. The order number must show type, material and thread size (e.q. NS5 St M5).

The available types are shown in the chart to the right.



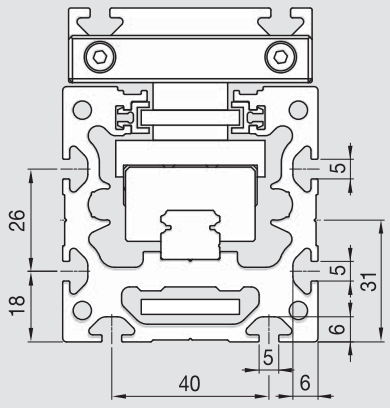
Groove width [mm]	Dimension „a“ [mm]	Material	Order number
5	M3 / M4 / M5	St / Inox	NS5 __ __
6	M4 / M5 / M6	St / Inox	NS6 __ __
8	M4 / M5 / M6 / M8	St / Inox	NS8 __ __

Material
Dim. „a“

Sample: NS5 St M5

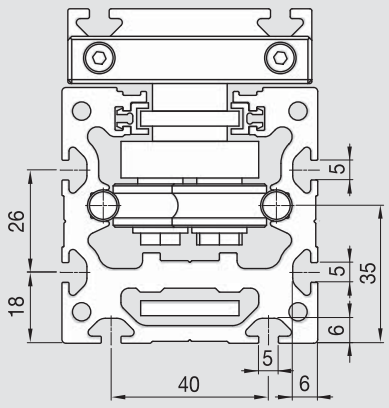
Profile cross-sections

LM3.2
with linear rail guiding system
and toothed belt drive



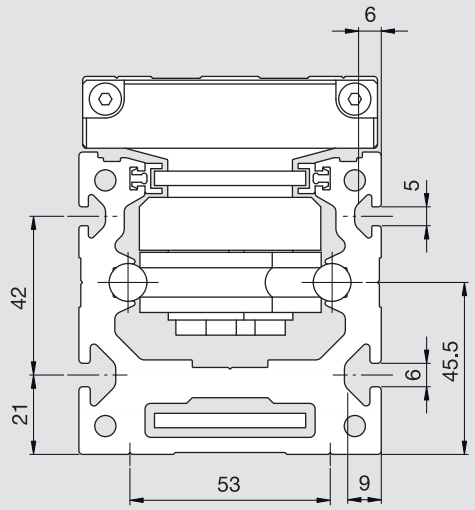
M1:2

RM3.4/6
with roller guides
and toothed belt drive



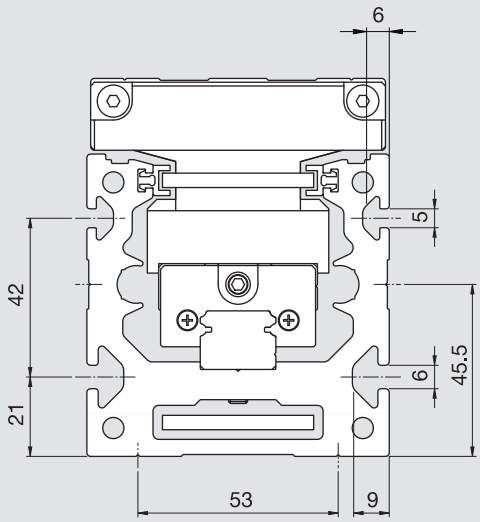
M1:2

RM4.4/6
with roller guides and toothed belt drive



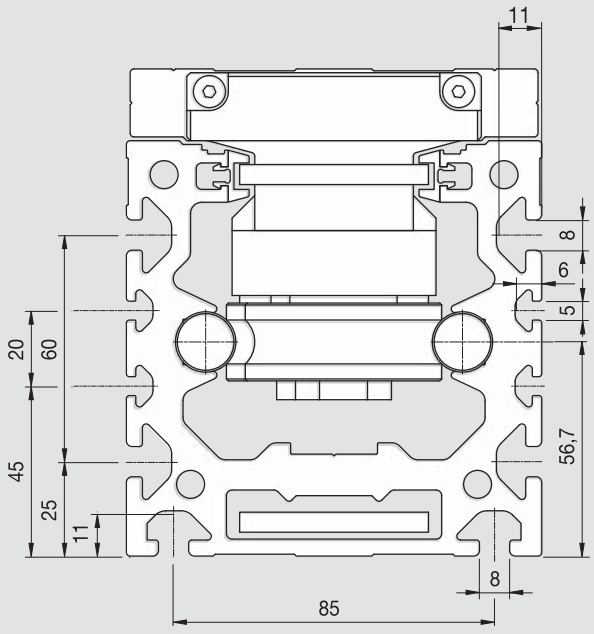
M1:2

LM4.2
with linear rail guiding system and toothed belt drive



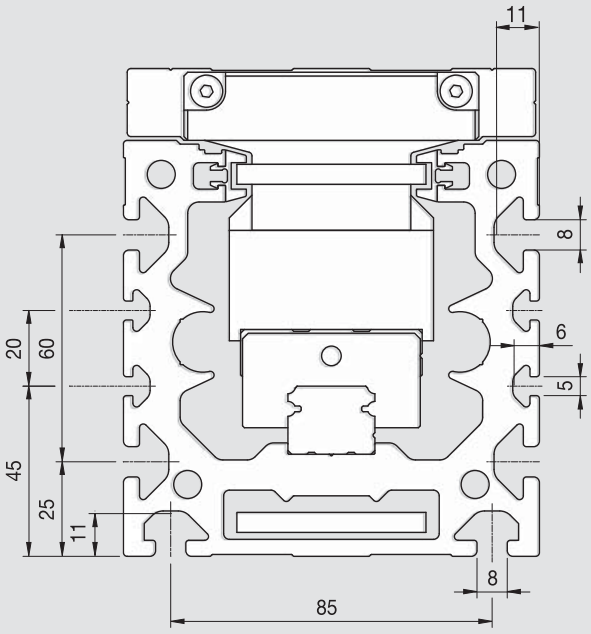
M1:2

RM5.4/6
with roller guides and toothed belt drive



M1:2

LM5.2
with linear rail guiding system and toothed belt drive



M1:2

Calculation guidelines

The determination of service life must be calculated based on the specifications of the linear guide system and the drive system.

It is the linear guide or guide roller system which normally determines the service life. Therefore the following equations can be used for an approximation of service life.

Dynamic load
The nominal service life L10 is being calculated from the dynamic load factor C_{dyn} [N] and the applied load F_r [N]:

$$L_{10} = \left(\frac{C_{dyn}}{F_r}\right)^3 \quad [10^5 \text{ m run}]$$

Static load
In cases where only static load is applied, the static load factor f_S is calculated in order to show that a module with an adequate load capacity has been selected. Taking into account the static load factor C_0 [N] and the load F_r [N] results:

$$f_S = \frac{C_0}{F_r}$$

If $f_S \geq 1$, the safety margin is sufficient

If $f_S \leq 1$, contact Exlar Applications Engineering for further advice.

The above formulas are applicable only in cases where all bearings are equally loaded, i.e. the load F_r F is applied at the center of the cradle. Especially in vertical arrangements of the linear modules, the drive (screw or belt) must be checked in addition to the guide capacity.

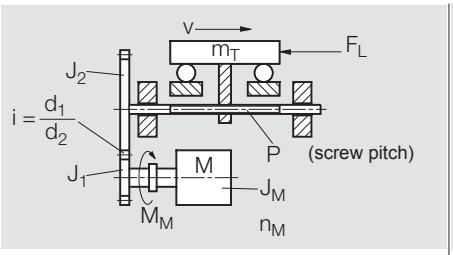
Definition of the drive motor
Size and type of the drive motor primarily depend on the load, the required displacement speed and the acceleration factor. Calculation and choice of a positioning unit shall be based on the worst case service conditions.

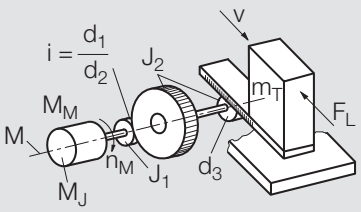
The linear modules can be configured to accept any type of motor includig brushless motors, gearmotors, or Tritex rotary actuators from Exlar.

The following formulas are provided for sizing assistance.

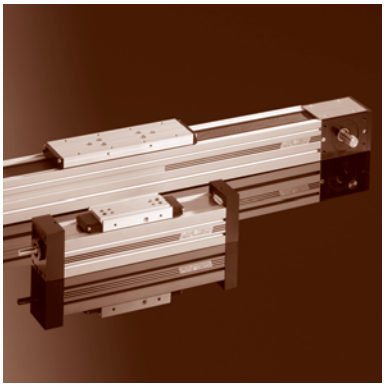
Key to the formulas at page 35:

d	[mm]	=	screw diameter
d_1	[mm]	=	diameter driving wheel
d_2	[mm]	=	diameter driven gear
d_3	[mm]	=	diameter pinion or belt pulley
F_L	[N]	=	feed power
i	[–]	=	gear reduction
J	[kgm^2]	=	mass moment of inertia
J_1	[kgm^2]	=	mass moment of inertia driving wheel
J_2	[kgm^2]	=	mass moment of inertia driven gear
J_M	[kgm^2]	=	mass moment of inertia drive motor
J_R	[kgm^2]	=	rotatory mass moment of inertia
J_T	[kgm^2]	=	translatory mass moment of inertia
l	[mm]	=	screw length
M_B	[Nm]	=	acceleration torque resp. breaking moment
M_d	[Nm]	=	motor – continuous torque (see motor spec.)
M_{eff}	[Nm]	=	motor – effective output torque
M_L	[Nm]	=	load moment
M_M	[Nm]	=	motor torque (see motor spec.)
M_{max}	[Nm]	=	motor torque peak
m_T	[kg]	=	external load (linear moving mass)
n_k	[min^{-1}]	=	critical speed for screw drive
n_M	[min^{-1}]	=	motor speed
p	[mm]	=	screw pitch
P_A	[W]	=	power output
s_B	[mm]	=	acceleration / brake path
t_B	[s]	=	acceleration / braking period
t_L	[s]	=	running time under load moment
t_0	[s]	=	stop period unloaded
v	[m/s]	=	rate of feed
η	[–]	=	mechanical efficiency on motor shaft





Motor speed	[min^{-1}]	$n_M = \frac{v \cdot 6 \cdot 10^4}{p \cdot i}$	$n_M = \frac{v \cdot 6 \cdot 10^4}{\pi \cdot d_3 \cdot i}$
Critical speed	[min^{-1}]	$n_k = 120 \cdot 10^6 \cdot \frac{d}{l^2}$	
Load moment	[Nm]	$M_L = p \cdot i \frac{F_L}{2000 \cdot \pi}$	$M_L = d_3 \cdot i \frac{F_L}{2000}$
Translatory mass moment of inertia	[kgm^2]	$J_T = m_T \left(\frac{p}{2 \cdot \pi}\right)^2 \cdot 10^{-6}$	$J_T = m_T \left(\frac{d_3}{2}\right)^2 \cdot 10^{-6}$
Rotatory mass moment of inertia (for steel)	[kgm^2]	$J_R = 7{,}7 \cdot d^4 \cdot l \cdot 10^{-13}$	
Total of reduced mass moments of inertia	[kgm^2]	$J = J_M + J_1 + i^2 (J_R + J_T + J_2)$ (at gear reduction 2:1 → i = 0,5)	
Acceleration torque resp. breaking moment $M_B = f(n_M)$	[Nm]	$M_B = \frac{n_M \cdot J}{9{,}55 \cdot t_B}$	
Acceleration torque resp. breaking moment $M_B = f(s_B)$	[Nm]	$M_B = \frac{4 \cdot \pi \cdot s_B \cdot J}{p \cdot i \cdot t_B^2}$	$M_B = \frac{4 \cdot s_B \cdot J}{d_3 \cdot i \cdot t_B^2}$
Acceleration- / braking period $t_B = f(n_m)$	[s]	$t_B = \frac{n_M \cdot J}{9{,}55 \cdot M_B}$	
Acceleration- / braking period $t_B = f(s_B)$	[s]	$t_B = \sqrt{\frac{4 \cdot \pi \cdot s_B \cdot J}{p \cdot i \cdot M_B}}$	$t_B = \sqrt{\frac{4 \cdot s_B \cdot J}{d_3 \cdot i \cdot M_B}}$
Resulting speed (rpm) after acceleration	[min^{-1}]	$n_M = \frac{120 \cdot s_B}{p \cdot i \cdot t_B}$	$n_M = \frac{120 \cdot s_B}{d_3 \cdot \pi \cdot i \cdot t_B}$
Resulting distance of acceleration	[mm]	$s_B = \frac{n_M \cdot t_B \cdot p \cdot i}{120}$	$s_B = \frac{n_M \cdot t_B \cdot d_3 \cdot \pi \cdot i}{120}$
Total of moments to override by the motor	[Nm]	$M_M = \frac{1}{\eta} (M_L + M_B)$	
Power output	[W]	$P_A = \frac{M_M \cdot n_M}{9{,}55}$	
Effective output torque of motor	[Nm]	$M_{eff} = \sqrt{\frac{\Sigma t_B (M/M_M)^2 + \Sigma t_L (M_L/M_M)^2}{\Sigma t_B + \Sigma t_L + t_0}} \cdot M_M$	



Exlar specializes in the manufacture of electric actuation solutions in addition to components. Please see Exlar's 140 page catalog containing seven product families of motors and actuators.

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