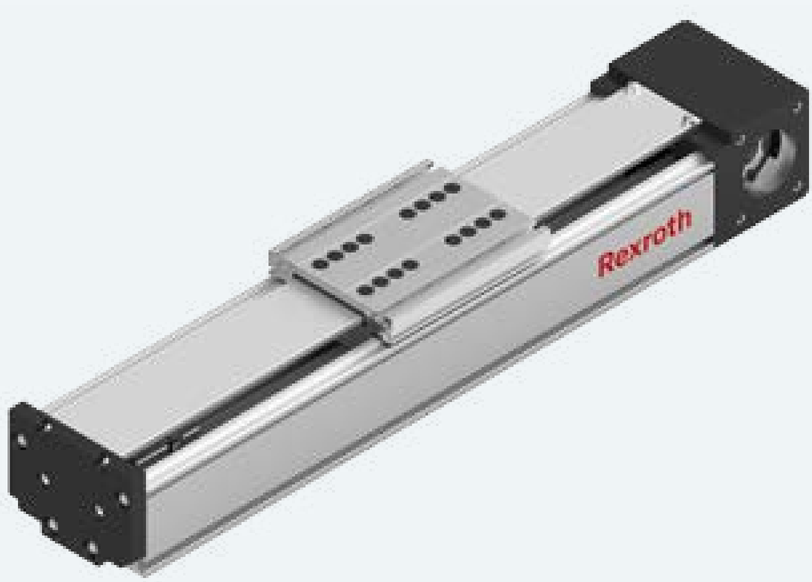
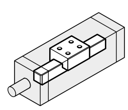
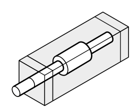
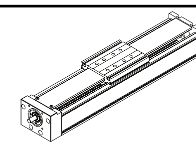
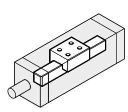
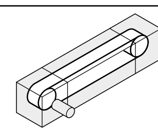
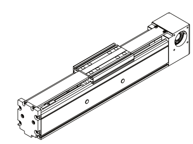
Function Modules FMS, FMB





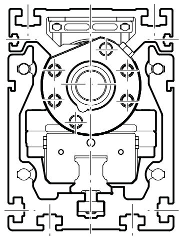
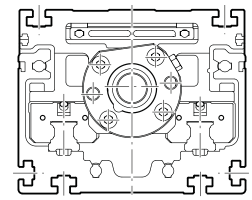

Identification system for short product names

Example		**FM**	**S**	-	**080**	-	**SN**	-	**1**
System	=	**F**unction **M**odule							
Drive	=	**S**crew drive (Ball Screw Assembly) **B**elt drive							
Size	=	**080**/**110**							
Version	=	**SN** single-rail (one Ball Rail System) **DN** dual-rail (two Ball Rail Systems)							
Generation	=	Product generation **1**							

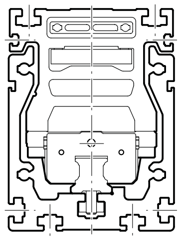
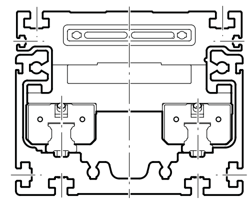
Type	Guideway	Drive	Function Module
FMS	 **Ball Rail System**	 **Ball Screw Assembly**	
FMB	 **Ball Rail System**	 **Belt drive**	

Product overview

Function Modules with Ball Screw Assembly (FMS)

Versions with one Ball Rail System (single-rail) FMS-xxx-SN-x	**Versions with two Ball Rail Systems (dual-rail) FMS-xxx-DN-x**
	
Without motor attachment	
	
Motor attachment with timing belt side drive	
	
Motor attachment with mount and coupling	
	

Function Modules with belt drive (FMB)

Versions with one Ball Rail System (single-rail) FMB-xxx-<u>S</u>N-x	**Versions with two Ball Rail Systems (dual-rail) FMB-xxx-<u>D</u>N-x**
	
Without motor attachment	
	
Motor attachment with ancillary gear	
	

FMS/FMB product description

Characteristic features

Rexroth Function Modules meet the precision and load-bearing capacity requirements of numerous popular applications in mechanical engineering, and complement the tried-and-tested portfolio of high-performance linear axes. Rexroth Function Modules are available in single-rail and dual-rail versions, as well as with belt drive or Ball Screw Assembly.

Structural design

- Ready-to-install Function Modules in any length up to L_{max}
- Extremely compact extruded aluminum frame with integrated Rexroth Ball Rail Systems
- Identical outer dimensions between FMS and FMB Function Modules
- Aluminum carriage with T-slots
- Single-rail and dual-rail versions available
- Mounted parts protected by aluminum cover plate (optional)

Attachments (accessories program)

- Matching drive controllers for servo and pulse train technology
- Sensors and extension cables
- Matching sensors (magnetic and optical sensors)
- Switching cams
- Clamping fixtures and sliding blocks

Further highlights

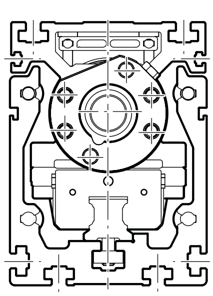
- Selectable options for flexible configuration
- No assembly required
- Magnetic and optical sensors can be mounted directly on the frame
- Planetary gearbox with various gear ratios
- Servo motors

Applications

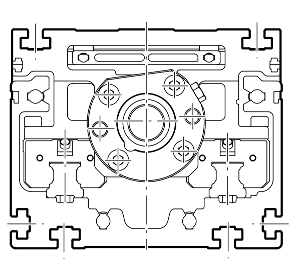
- Pick and place
- Handling
- Placement systems, palletizers
- Feed units
- Inspection and analysis systems
- Feed units in transfer lines
- Motion units

FMS Function Module with Ball Rail System and Ball Screw Assembly

- Realization of long travel distances of up to 1,500 mm
- Travel speeds up to 1 m/s
- Repeatability of up to +/- 0.015 mm



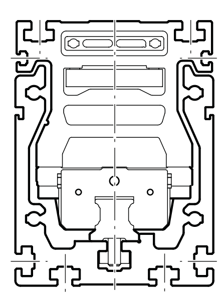
Single-rail version (FMS-xxx-SN-1)



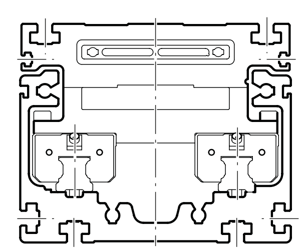
Dual-rail version (FMS-xxx-DN-1)

FMB Function Module with Ball Rail System and belt drive

- Realization of long travel distances of up to 3,800 mm
- Travel speeds up to 3 m/s
- Repeatability of up to +/- 0.05 mm



Single-rail version (FMB-xxx-SN-1)



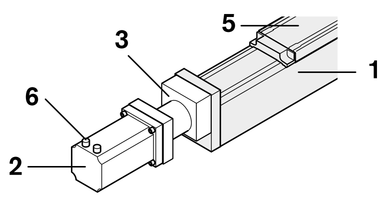
Dual-rail version (FMB-xxx-DN-1)

Function Module delivery details

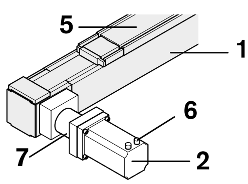
Function Modules with Ball Screw Assembly or belt drive come fully assembled.

Gear/motor attachment interface:
If a combination of attachment interface, gear and motor has been selected, the attachment of the components is done as shown in the figure below. When ordering Function Modules only with attachment interface (without gear and motor!), not all parts can be assembled. Assembly must then be completed by the customer. All necessary instructions and parameters for professional assembly are included. The installation variant is selected and determined during product configuration and is a part of the order key.

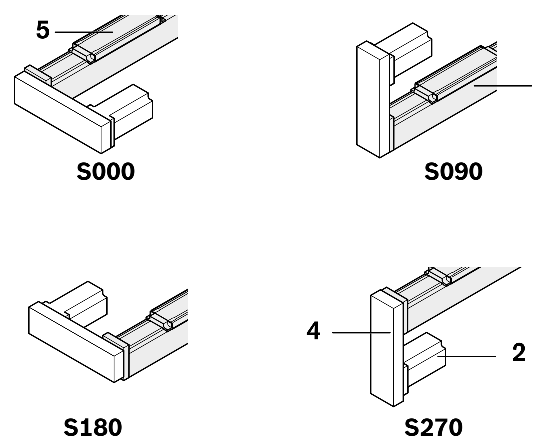
FMS with mount and coupling (F001)



FMB with planetary gearbox (G010, G011)

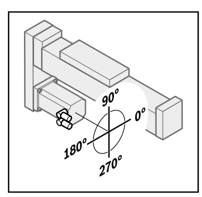


FMS with timing belt side drive (S000–S270)



Motor connector position

- Function Module in horizontal installation position (carriage on top)
- View toward the motor from the rear
- Selectable motor connector locations, see section "Configuration and ordering"



Example:
Timing belt side drive S270
Motor connector position 180°

Switching system

Magnetic and optical sensors can be ordered from the accessories program.
Multiple sensors can be installed to suit the application.
See the section titled "Switching system".

Lubrication

Function Modules come with initial greasing.

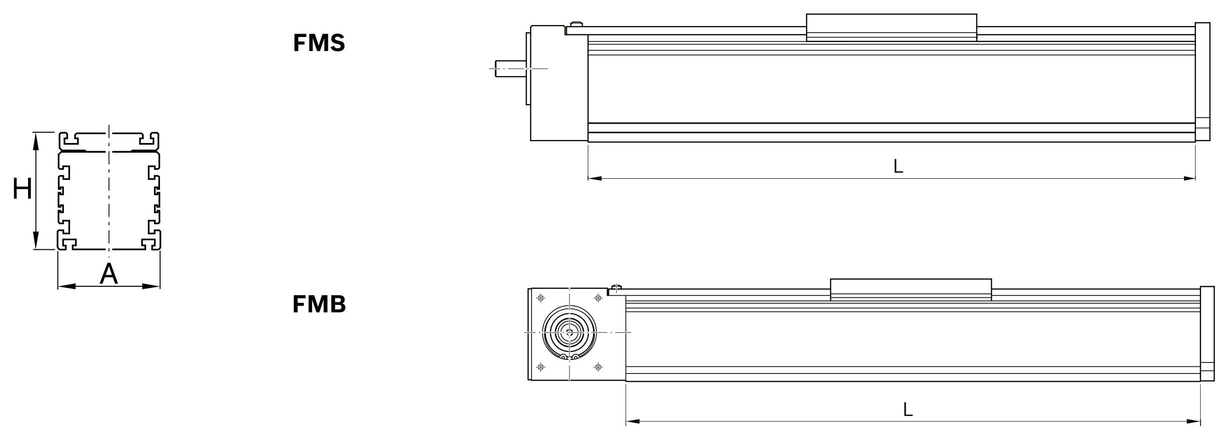
Documentation

Each Function Module comes with appropriate documentation.

1 Function Module
2 Motor
3 Mount and coupling
4 Timing belt side drive
5 Carriage
6 Motor connector
7 Gear

Overview of types with load ratings

Read the section below titled “General technical instructions”.
For dimensions and values for calculations, see the technical data for the desired Function Module.
For abbreviations, see the section titled “Abbreviations”.



Type	Size	-065		-080		-110		-145	
	Dimensions (mm)			A	H	A	H	A	H
				80	107	110	89		
FMS	L_{max} (mm)	In preparation		1,695		1,675		In preparation	
	$C^{1)}$ (N)			23,700		24,000			
FMB	L_{max} (mm)			4,031		4,013			
	$C^{1)}$ (N)			23,700		24,000			

1) Maximum permitted values. Depending on design, the load ratings for the dual-rail version are virtually identical when using a smaller Ball Rail System.

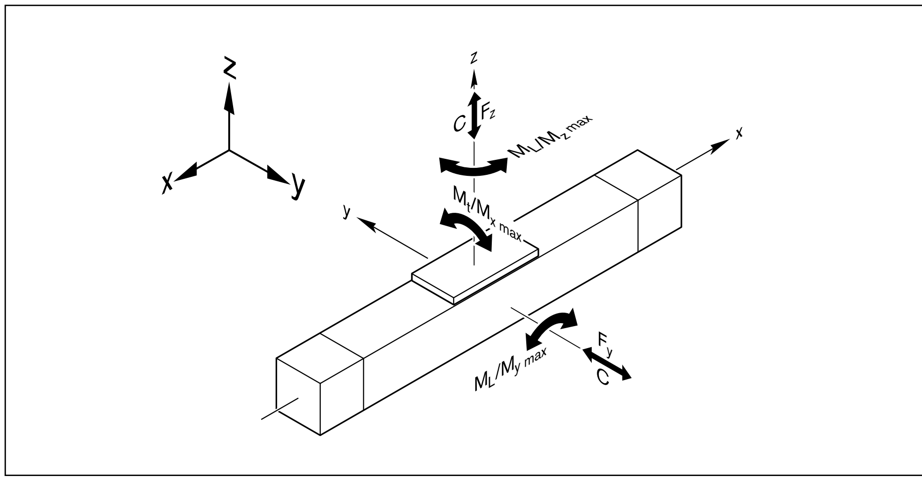
General technical instructions

Note on dynamic load ratings and load moments

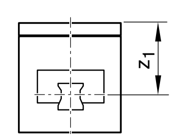
Determination of the dynamic load ratings and load moments is based on a travel life of 100,000 m. However, figures often are only based on 50,000 m.
For comparison:
Multiply values C, M_t and M_L from the table by 1.26.
Load ratings for the Screw Drive as per ISO 3408-5.
Load ratings for the Ball Rail System verified in testing
(above the DIN ISO 14728-1 ratings).

Suitable loads

With respect to the desired nominal life, loads for F_{comb}, F_m up to approx. 20% of the dynamic characteristics (**C**, $\mathbf{M_t}$, $\mathbf{M_L}$) have generally proven suitable.
See the section titled “Basis of calculations”.
Do not exceed the technical data for the Linear Motion System.



Application point of the effective force (Z_1)



FMS/FMB

Modulus of elasticity E

E = 70,000 N/mm^2

Maximum permissible load

When selecting Linear Motion Systems, it is essential to consider the maximum permissible load and force tolerances. The values depend on the system. In other words, the toleranc es are determined not only by the load ratings of the bearing points but also tolerances based on design and material.

Conditions for combined loads:

$$\frac{|F_y|}{F_{y\,max}} + \frac{|F_z|}{F_{z\,max}} + \frac{|M_x|}{M_{x\,max}} + \frac{|M_y|}{M_{y\,max}} + \frac{|M_z|}{M_{z\,max}} \leq 1$$

Combined equivalent load on guideway bearing

$$F_{comb} = |F_y| + |F_z| + C \cdot \frac{|M_x|}{M_t} + C \cdot \frac{|M_y|}{M_L} + C \cdot \frac{|M_z|}{M_L}$$

Life

Nominal life of the guideway in meters:

$$L = \left(\frac{C}{f_w \cdot F_{comb}} \right)^3 \cdot 10^5 \text{ m}$$

Nominal life of the guideway in hours:

$$L_h = \frac{L}{3600 \cdot v_m}$$

Ball Screw Assembly (BASA) loading and life

When the load and rotary speed vary, the following applies for the average load F_m

$$F_m = \sqrt[3]{|F_{eff\,1}|^3 \cdot \frac{|n_1|}{n_m} \cdot \frac{q_{t1}}{100\%} + |F_{eff\,2}|^3 \cdot \frac{|n_2|}{n_m} \cdot \frac{q_{t2}}{100\%} + \ldots + |F_{eff\,n}|^3 \cdot \frac{|n_n|}{n_m} \cdot \frac{q_{tn}}{100\%}}$$

Life

Nominal life (BASA) in revolutions:

$$L = \left(\frac{C_{bs}}{F_m} \right)^3 \cdot 10^6$$

Nominal life (BASA) in hours:

$$L_h = \frac{L}{n_m \cdot 60}$$

Linear Motion System weight m_s
Weight calculation:

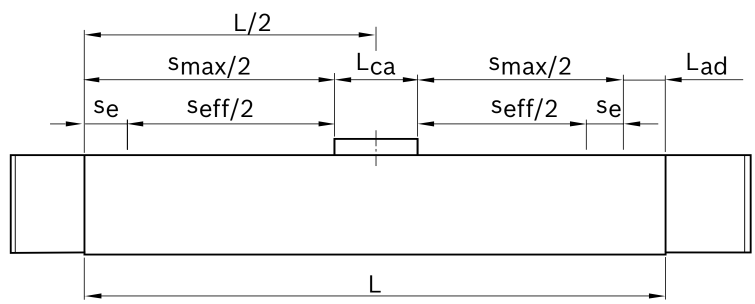
- without motor
- without sensor attachment
- without motor attachment

$$m_s = k_{g\,fix} + k_{g\,var} \cdot L + m_{ca}$$

Length calculation of the Linear Motion System

$$L = s_{eff} + 2 \cdot s_e + L_{ca} + L_{ad}$$

$$s_{max} = s_{eff} + 2 \cdot s_e$$



For length calculation values, see the section titled “Technical data” for the desired Function Module (FMS/FMB).

Function Modules FMS

Product description

Features

- Ready-to-install Function Modules in any length up to L_{max}
- Extremely compact aluminum frame with integrated Rexroth Ball Rail System (one or two Ball Rail Systems)
- Ball Rail System with moderate pre-tensioning (pre-tensioning class C1)
- Driven by a low-backlash Ball Screw Assembly (BASA) in rolled design, tolerance grade T9 as per ISO 3408-3 with Single Nut
- High travel speeds thanks to large leads with high precision over long distances
- Aluminum carriage with T-slots
- Guideway and drive components protected by aluminum cover plate (optional)
- Low-cost maintenance thanks to in-service lubrication option (grease lubrication)
- Repeatability of up to +/– 0.015 mm

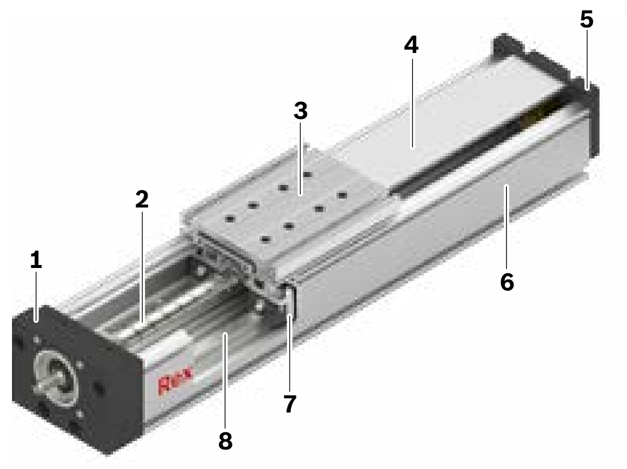
Further highlights

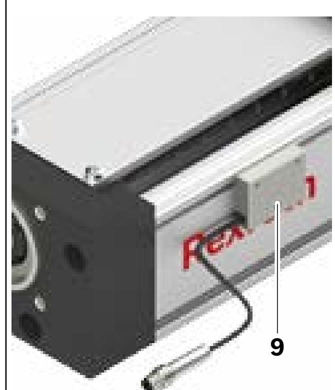
- Standard with integrated solenoid switch for magnetic field sensors
- Nameplate with parameters for easy start-up
- Fastening elements

Attachments

- Motor attachment via mount and coupling or via timing belt side drive
- Maintenance-free servo motors with optional holding brake
- Magnetic field sensors
- Optical sensors
- Extensive sensor accessories

Structural design/versions





Magnetic sensor

Optical sensor

Structural design

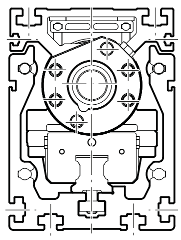
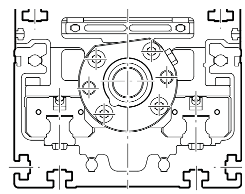
1 Drive-side end block
2 Ball Screw Assembly (covered)
3 Carriage with T-slots
4 Cover plate
5 End plate
6 Frame
7 Runner Block
8 Guide Rail

Attachments/accessories

9 Magnetic sensor
10 Optical sensor

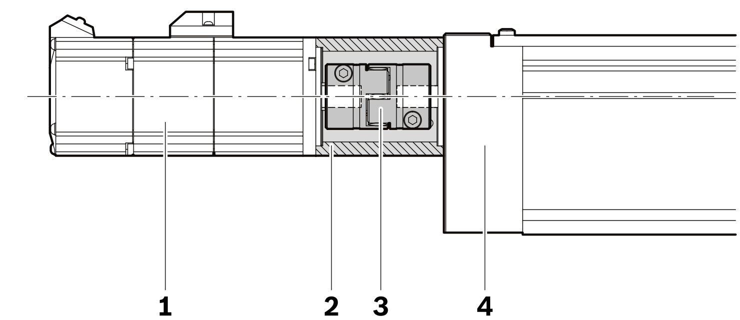
For further information, see the section titled “Accessories”.

Versions

Versions with one Ball Rail System (single-rail) FMS-xxx-SN-x	**Versions with two Ball Rail Systems (dual-rail) FMS-xxx-DN-x**
	
Without motor attachment	
	
Motor attachment with timing belt side drive	
	
Motor attachment with mount and coupling	
	

Structural design

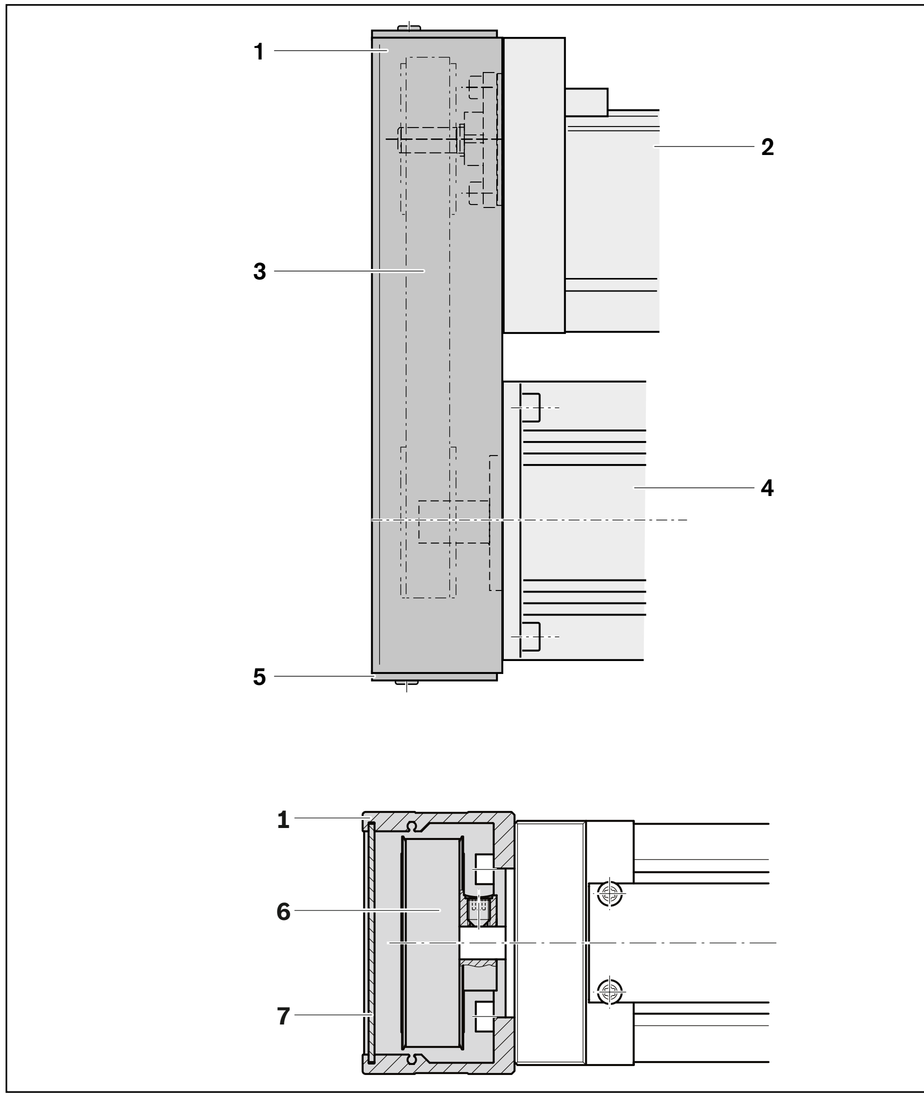
Motor attachment with mount and coupling
A motor can be attached via a mount and coupling to all Function Modules with a Ball Screw Assembly.
The mount fastens the motor to the Function Module and acts as a closed housing for the coupling.
The coupling transmits the motor drive torque to the Function Module drive shaft without distortive stresses.
Our standard couplings compensate for the system's thermal expansion.



1 Motor
2 Mount
3 Coupling
4 Function Module

Motor attachment via timing belt side drive

A motor can be attached via a timing belt side drive to all Function Modules with a Ball Screw Assembly.
This makes the overall length shorter than when attaching the motor with a mount and coupling.
The space-saving, closed pulley housing serves as protection for the belt and as a motor bracket.
Various gear ratios are also available.
The timing belt side drive can be mounted in four different directions.



- **1** Pulley housing made of anodized aluminum
- **2** Function Module
- **3** Belt drive with gear ratio
- **4** Motor
- **5** Cover
- **6** Belt pulley
- **7** Cover plate

Technical data

General technical data

Read the sections titled “Calculation” and “General technical instructions”.

FMS	Carriage	BASA d_0 x P		Dynamic characteristics					Maximum permissible loads					
				Dyn. load ratings			Dyn. load moments		Max. permissible moments			Max. permissible forces		
	L_{ca}	d_0	P	C	C_{bs}	C_{fb}	M_t	M_L	$M_{x\ max}$	$M_{y\ max}$	$M_{z\ max}$	$F_{y\ max}$	$F_{z1\ max}$	$F_{z2\ max}$
	(mm)	(mm)	(mm)	(N)	(N)	(N)	(Nm)	(Nm)	(Nm)	(Nm)	(Nm)	(N)	(N)	(N)
-065-SN-1	In preparation													
-080-SN-1	160	16	5	23,700	8,900	13,050	240	910	35	135	135			3,500
			10		8,600									
			16		6,000									
-110-DN-1	140	16	5	24,000	8,900	13,050	970	940	140	140	140	2,200	3,600	3,600
			10		8,600									
			16		6,000									
-145-DN-1	In preparation													

[1] Minimum required travel to ensure a reliable lubrication distribution.
For operating conditions, see the section titled “Additional information”.
If values are not met, please contact Bosch Rexroth.

For short product names, see the section titled “Additional information”.

	Additional length L_{ad} (mm)	Min. travel range s_{min} 1) (mm)	Max. travel range s_{max} (mm)	Max. length L_{max} (mm)	Application point of the effective force z_1 (mm)	Moved system mass m_{ca} (kg)	Constant mass calculation $k_{g\ fix}$ (kg)	 $k_{g\ var}$ (kg/mm)	Planar moment of inertia I_y (cm⁴)	 I_z (cm⁴)
						1.85				
	35	150	1,500	1,695	78.2	1.88	1.31	0.009	154.42	184.96
						1.93				
						1.76				
	35	120	1,500	1,675	59.3	1.78	1.38	0.010	89.07	349.08
						1.83				

Technical data

Drive data

Read the sections titled “Calculation” and “General technical instructions”.

FMS	BASA	Moved system mass	Constant mass moment of inertia			Frictional torque[1]	Max. acceleration	Max. drive torque M_P (Nm)	Max. permissible speed v_{max} (m/s)
	d_0 x P (mm)	m_{ca} (kg)	$k_{J\ fix}$ (kgmm²)	$k_{J\ var}$ (kgmm)	$k_{J\ m}$ (mm²)	M_{Rs} (Nm)	a_{max} (m/s²)		
-065-SN-1	In preparation							See graphs	See graphs
-080-SN-1	16 x 5	1.85	11.461	0.031	0.630	0.8	40		
	16 x 10	1.88	15.045	0.031	2.530				
	16 x 16	1.93	22.768	0.034	6.480				
-110-DN-1	16 x 5	1.76	11.402	0.031	0.630	0.8	40		
	16 x 10	1.78	14.805	0.031	2.530				
	16 x 16	1.83	22.152	0.034	6.480				
-145-DN-1	In preparation								

[1] at 200 rpm

For short product names, see the section titled “Additional information”.

Drive data for motor attachment via timing belt side drive

FMS	BASA	Length	Permissible torque M_{sd} (Nm) Motor				Reduced mass moment of inertia		Frictional torque	Mass	
	d_0 x P	up to L[1)]	MSM 031C		ECMA-C10604 ECMA-C20604			J_{sd}	M_{Rsd}		m_{sd}
	(mm)	(mm)						(10^{-6} kgm²)	(Nm)		(kg)
-065-SN-1	In preparation										
-080-SN-1			i = 1	i = 1.5	i = 1	i =1.5	i = 1	i = 1.5		i = 1	i = 1.5
	16 x 5	900	7.07	7.07	7.07	7.07	60.1	105.2	0.15	1.02	1.12
	16 x 10	1,150									
	16 x 16	1,400									
-110-DN-1			i =1	i =1.5	i = 1	i =1.5	i = 1	i =1.5		i = 1	i =1.5
	16 x 5	900	7.07	7.07	7.07	7.07	60.1	105.2	0.15	1.02	1.12
	16 x 10	1,150									
	16 x 16	1,400									
-145-DN-1	In preparation										

1) For greater lengths, the permissible drive torque is determined from the length-variable value M_p of the Linear Motion System in accordance with the graph. See the section titled “Basis of calculation”.

Drive data for motor attachment via mount and coupling

FMS	Coupling			Mount and coupling
	M_{cN}	J_c	m_c	m_{fc}
	(Nm)	(10^{-6} kgm²)	(kg)	(kg)
-065-SN-1	In preparation			
-080-SN-1	12.5	40	0.2	0.4
-110-DN-1	12.5	40	0.2	0.4
-145-DN-1	In preparation			

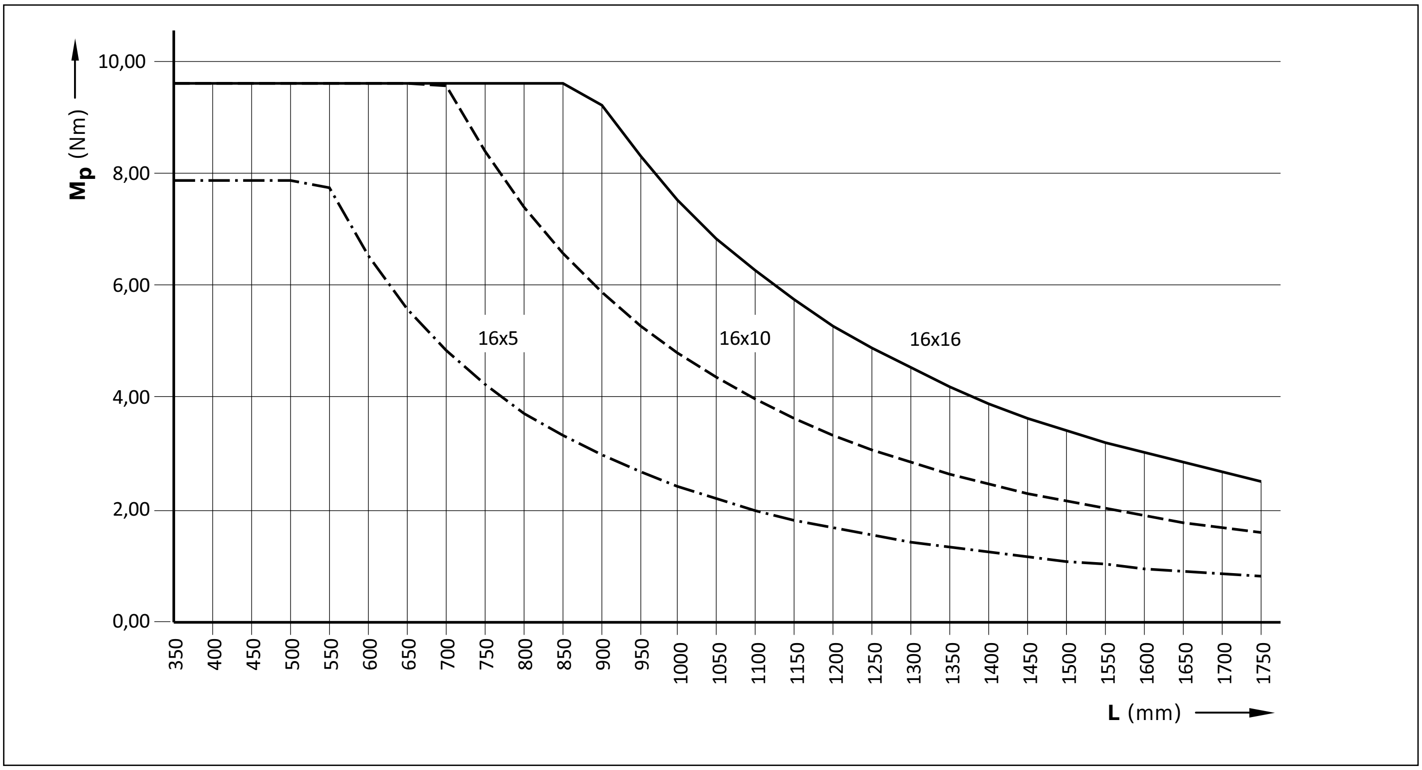
Maximum permissible drive torque for mechanical group M_p

The values for M_p apply under the following conditions:

- Horizontal operation
- No radial load on screw journal

Factor in the rated torque of the coupling being used.

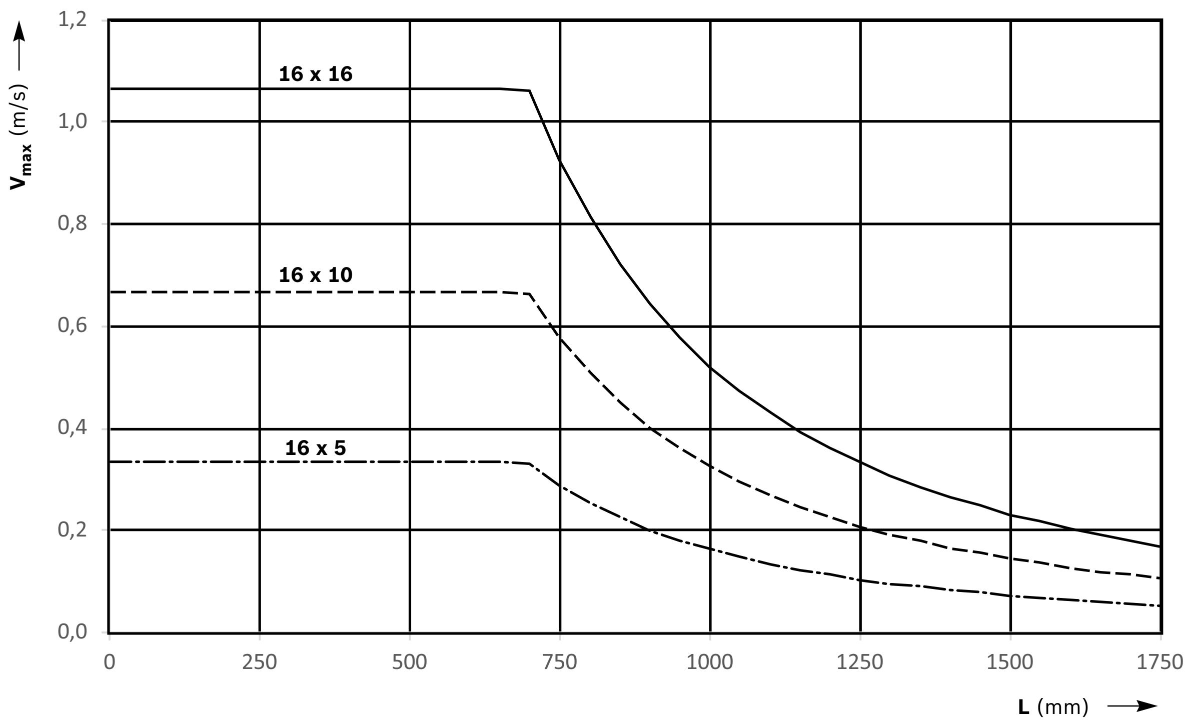
FMS-080-SN-1/-110-DN-1



Maximum permissible speed of mechanical system v_{max}

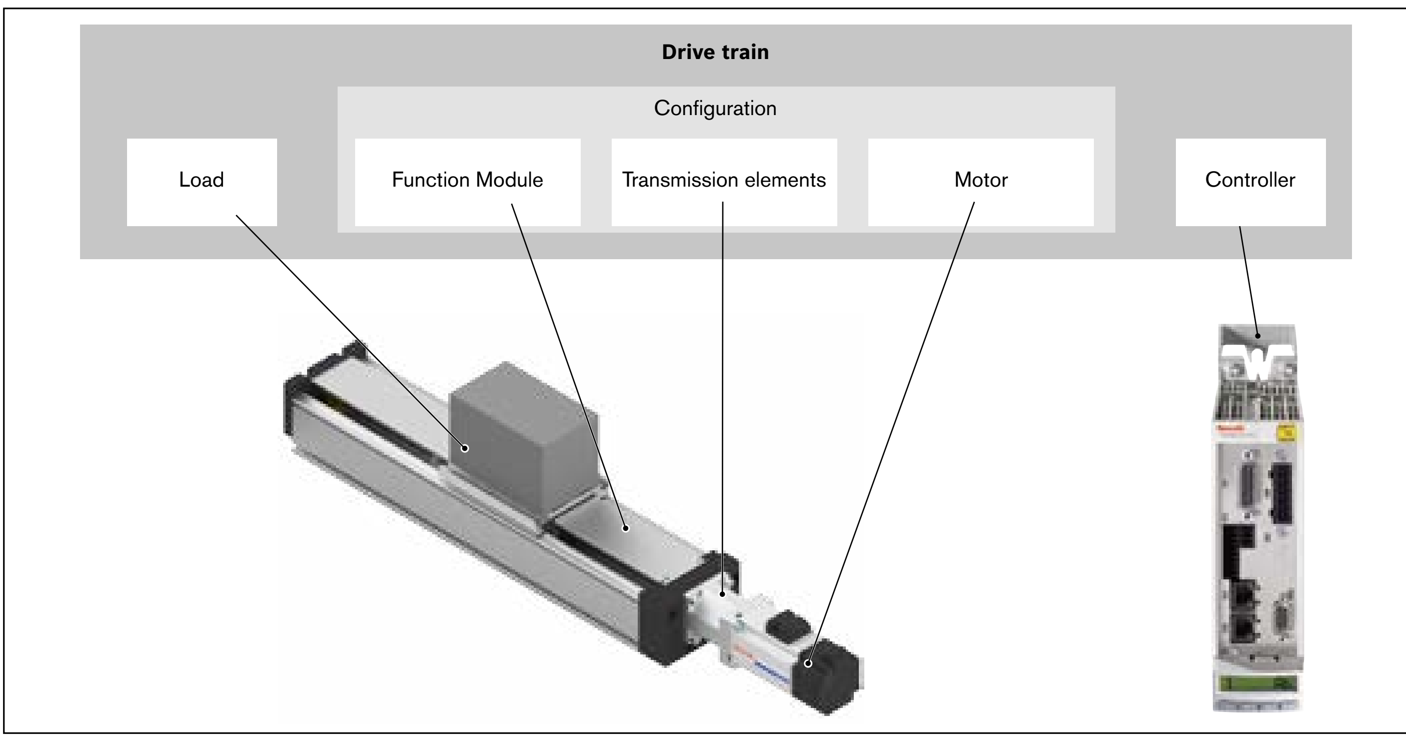
Observe motor speed!

FMS-080-SN-1/-110-DN-1



Calculation

Calculation principles



The correct dimensioning and assessment of an application requires structured consideration of the drive train as a whole. The basic element of the drive train is the configuration – made up of the Linear Motion System, the transmission element (coupling or timing belt side drive) and the motor – which can be ordered in that constellation in the catalog.

Maximum permissible loads

When selecting a Linear Motion System, the maximum permissible loads and forces must be taken into account and can be found in the section “Technical Data”. The values specified there depend on the system. In other words, the tolerances are determined not only by the load ratings of the bearing points but also include tolerances depending on design and material.

Conditions for combined loads

$$\frac{|F_y|}{F_{y\ max}} + \frac{|F_z|}{F_{z\ max}} + \frac{|M_x|}{M_{x\ max}} + \frac{|M_y|}{M_{y\ max}} + \frac{|M_z|}{M_{z\ max}} \leq 1$$

Linear guideway life

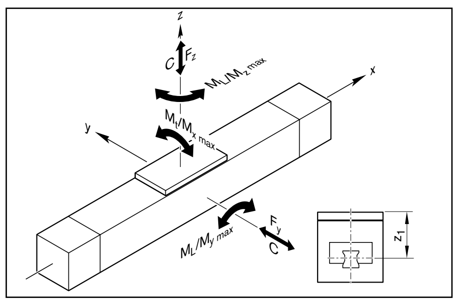
The life of the rolling bearing points contained in a Linear Motion System can be calculated using the formulas given below. The roller bearings that determine the life of a Linear Motion System with Ball Screw Assembly are the linear guideway, the Ball Screw Assembly (nut) and the fixed bearing.

⚠ **The life of the Linear Motion System is the separately calculated life that is the shortest (for linear guideway, Ball Screw Assembly or fixed bearing).**

The linear guideway in the Linear Motion System must withstand the load as well as any process forces that occur.

Combined equivalent load on bearing of the guideway

$$F_{comb} = F_y + F_z + C \cdot \frac{|M_x|}{M_t} + C \cdot \frac{|M_y|}{M_L} + C \cdot \frac{|M_z|}{M_L}$$



Nominal life in meters

$$L = \left(\frac{C}{f_w \cdot F_{comb}} \right)^3 \cdot 10^5 \text{ m}$$

Impact loads and vibrations cause additional loads on the contact point between ball and running track. Determining the exact conditions of use is difficult. However, the additional loads increase as travel velocity increases. The load factor f_w (see table) factors in the effects of impacts and vibrations on life.

Conditions of use	Travel velocity	Load factor f_w
No impact loads and vibrations	$v < 0.25$ m/s	1.0 ... 1.2
Low impact loads and vibrations	0.25 m/s $\le v < 1$ m/s	1.2 ... 1.5
Moderate impact loads and vibrations	1 m/s $\le v < 2$ m/s	1.5 ... 2.0
High impact loads and vibrations	$v \ge 2$ m/s	2.0 ... 3.5

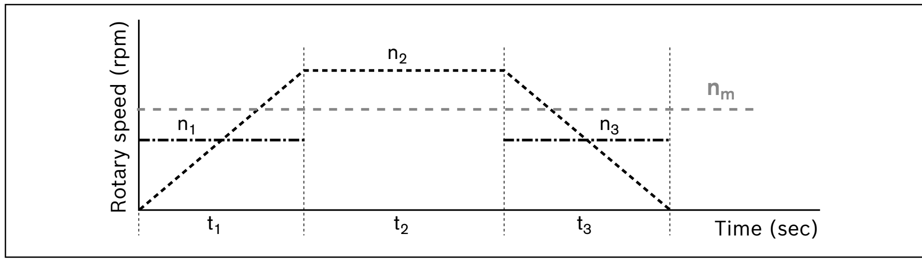
Nominal life in hours

$$L_h = \frac{L}{3\,600 \cdot v}$$

Ball Screw Assembly/fixed bearing life

Under variable operating conditions (variable rotary speed and load), the means $\mathbf{F_m}$ and $\mathbf{n_m}$ have to be used when calculating life.

If rotary speed varies, average rotary speed $\mathbf{n_m}$ is calculated as follows:



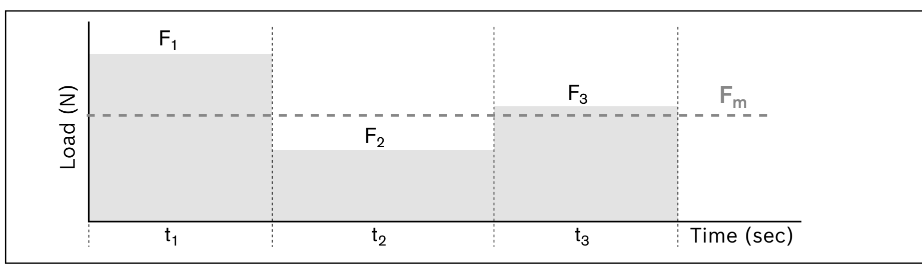
$$n_m = \frac{|n_1| \cdot t_1 + |n_2| \cdot t_2 + \ldots + |n_n| \cdot t_n}{t_{total}}$$

$$t_{total} = t_1 + t_2 + \ldots + t_n$$

Rotary speed in acceleration and braking phases $\mathbf{n_{1 \ldots n}}$:

$$n_{1 \ldots n} = \frac{n_{A1 \ldots n} + n_{E1 \ldots n}}{2}$$

When both the load and the rotary speed vary, the average load $\mathbf{F_m}$ is calculated as follows:



$$F_m = \sqrt[3]{|F_1|^3 \cdot \frac{|n_1|}{n_m} \cdot \frac{t_1}{t_{ges}} + |F_2|^3 \cdot \frac{|n_2|}{n_m} \cdot \frac{t_2}{t_{ges}} + \ldots + |F_n|^3 \cdot \frac{|n_n|}{n_m} \cdot \frac{t_n}{t_{ges}}}$$

Nominal life

Nominal life in revolutions:

$$L = \left(\frac{C}{F_m}\right)^3 \cdot 10^6$$

Nominal life in hours:

$$L_h = \frac{L}{n_m \cdot 60}$$

Drive dimensioning

Principles

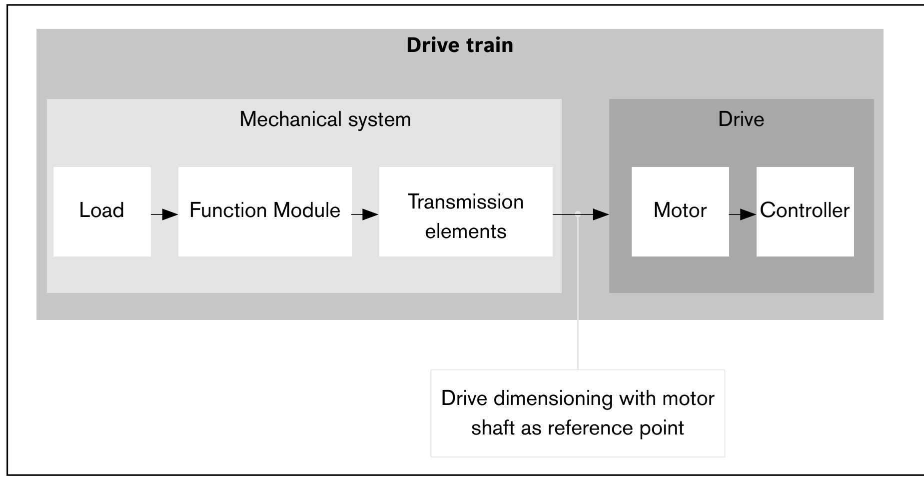
For drive dimensioning, the drive train can be divided into the mechanical system and the drive system.

The **mechanical** system includes the physical components – Linear Motion System and the transmission elements (timing belt side drive, coupling) – and the load to be carried.

The electric **drive** is a motor/controller combination with corresponding performance data.

The dimensioning of the electric drive is done taking the motor shaft as a reference point.

For drive dimensioning, limits must be taken into account as well as base values. The limits must not be exceeded in order to avoid damaging the mechanical components.



Technical data and formula symbols for the mechanical system

For every component (Linear Motion System, coupling, timing belt side drive), the corresponding maximum permissible limits for drive torque and speed, and the base values for friction moment and mass moment of inertia have to be used.
The following technical data with the associated formula symbols are used when considering the basic **mechanical** system requirements in the design calculations for dimensioning the drive. The data listed in the table below can be found in the section titled "Technical Data" or is determined using formulas based on the descriptions on the following pages.

		Mechanical system			
		Load	Linear Motion System	Transmission elements	
				Coupling	Timing belt side drive
Weight moment	(Nm)	M_g[6]	–	–	–
Frictional torque	(Nm)	–[5]	M_{Rs}[3]	–	M_{Rsd}[3]
Mass moment of inertia	(kgm^2)	J_t[1]	J_s[2]	J_c[3]	J_{sd}[3]
Max. permissible speed	(m/s)	–	v_{max}[4]	–	–
Max. permissible drive torque	(Nm)	–	M_p[4]	M_{cN}[3]	M_{sd}[3]

1) Determine the value using the appropriate formula
2) Length-dependent value, determined using the appropriate formula
3) Use the value from the table
4) Length-dependent value, to be read off the graph
5) Any additional process forces are to be taken into consideration as load moments
6) For vertical mounting position: Determine the value using the appropriate formula

Drive dimensioning with motor shaft as reference point

When dimensioning the drive, all relevant design calculation values for the mechanical components in the drive train have to be determined and be expressed/reduced to the motor shaft. For a combination of mechanical components within the drive train, this will result in one value for each of the following:

- Frictional torque M_R
- Mass moment of inertia J_{ex}
- Maximum permissible speed v_{mech} (maximum permissible rotary speed n_{mech})
- Max. permissible drive torque M_{mech}

Determination of the values for each mechanical component in the drive train based on the motor shaft as a reference point

Frictional torque M_R

For motor attachment via mount and coupling

$$M_R = M_{Rs}$$

For motor attachment via timing belt side drive

$$M_R = M_{Rsd} + \frac{M_{Rs}}{i}$$

Mass moment of inertia J_{ex}

For motor attachment via mount and coupling

$$J_{ex} = J_s + J_t + J_c$$

For motor attachment via timing belt side drive

$$J_{ex} = J_{sd} + \frac{(J_s + J_t)}{i^2}$$

Determination of mass moment of inertia of Linear Motion System components

$$J_s = (k_{J\,fix} + k_{J\,var} \cdot L) \cdot 10^{-6}$$

Determination of translatory mass moment of inertia of external load

$$J_t = m_{ex} \cdot k_{J\,m} \cdot 10^{-6}$$

Maximum permissible speed v_{mech}

The lowest of all the values for the maximum permissible speed of all mechanical components contained in the drive train determines the maximum permissible speed of the mechanical system which has to be taken into consideration as the upper limit for the drive when dimensioning the motor. Depending on the system, the maximum permissible speed/rotary speed of the Linear Motion System with Ball Screw Assembly is always below the limits for the coupling or timing belt side drive components, meaning it determines the maximum permissible speed of the mechanical system.

Maximum permissible speed

$$v_{mech} = v_{max}$$

Maximum permissible rotary speed

For motor attachment via mount and coupling

$$n_{mech} = \frac{v_{mech} \cdot 1{,}000 \cdot 60}{P}$$

For motor attachment via timing belt side drive

$$n_{mech} = \frac{v_{mech} \cdot i \cdot 1{,}000 \cdot 60}{P}$$

Max. permissible drive torque M_{mech}

The lowest (minimum) of all the values for permissible drive torque of all mechanical components contained in the drive train determines the maximum permissible drive torque of the mechanical system which has to be taken into consideration as the upper limit for the drive when sizing the motor.

For motor attachment via mount and coupling

$$M_{mech} = \text{minimum}\ (M_{cN};\ M_p)$$

For motor attachment via timing belt side drive

$$M_{mech} = \text{minimum}\ \left(M_{sd}\ ;\ \frac{M_p}{i}\right)$$

⚠ **When considering the complete drive train (mechanical system + motor/controller), the maximum torque of the motor can lie below the maximum value for the mechanical system (M_{mech}) and thus limit the maximum permissible drive torque of the overall drive train.**
If the maximum torque of the motor lies above the upper limit for the mechanical system (M_{mech}), the maximum motor torque must be limited to the permitted value for the mechanical system.

General motor preselection

The motor can be generally preselected using the following conditions:

Condition 1:

The rotary speed of the motor must be greater than or equal to the rotary speed required for the mechanical system (but not exceeding the maximum permissible limit value).

$$n_{max} \geq n_{mech}$$

Condition 2:

Consideration of the ratio of mass moments of inertia of the mechanical system and the motor. The ratio of the mass moments of inertia serves as an indicator for the control performance of a motor/controller combination. The mass moment of inertia of the motor is directly related to the motor size.

Ratio of mass moments of inertia

$$V = \frac{J_{ex}}{J_m + J_{br}}$$

For pre-selection, past experience has shown the values opposite will result in high control performance.
These are not rigid limits, but values exceeding them will require closer consideration of the specific application.

Application area	**V**
Handling	≤ 6.0
Processing	≤ 1.5

Condition 3:

Estimation of the ratio of the static load moment to the continuous torque of the motor. The torque ratio must be less than or equal to an empirical value of 0.6. This condition roughly factors in the missing dynamic characteristics of an exact motion profile with the required motor torques.

Torque ratio

$$\frac{M_{stat}}{M_0} \leq 0.6$$

Static load moment

$$M_{stat} = M_R + M_g$$

Weight moment

For vertical mounting only!

For motor attachment via mount and coupling: i = 1

$$M_g = \frac{P \cdot (m_{ex} + m_{ca}) \cdot g}{2{,}000 \cdot \pi \cdot i}$$

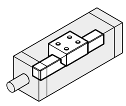
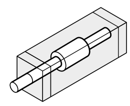
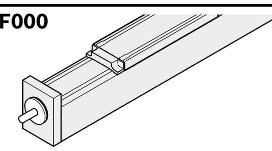
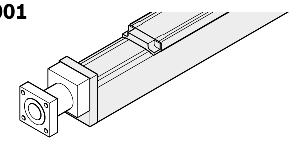
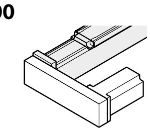
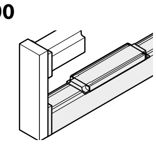
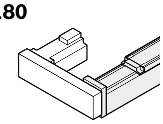
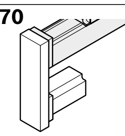
In the section titled “Configuration and ordering”, users can put together standard configurations, including motor attachment and motor, for the various Linear Motion System sizes by selecting the appropriate options. By checking the above conditions, it is possible to see whether a standard motor selected in a particular configuration will generally be of a suitable size for the specific application.

Precise drive dimensioning

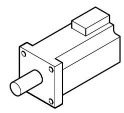
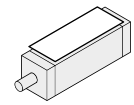
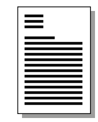
Preselecting the motor according to this rough guide is no substitute for the required precise design calculations for the drive, taking all moments/torques and rotary speed levels into account. For precise calculation of the electric drive, including consideration of the specific motion profile, please refer to the performance data in the catalog “Rexroth Drive technology”.
When dimensioning the drive, the maximum permitted values for linear speed, drive torque and acceleration must not be exceeded, in order to avoid damaging the mechanical system.

Configuration and ordering

FMS-080-SN-1

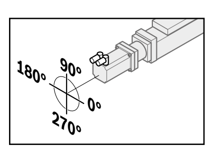
$s_{max.}$ [1] (mm)	Carriage	Guideway	Drive				Version	
								
	L_{ca} = 160 mm			BASA size d_0 x P				
			Screw journal	16x5	16x10	16x16		
s_{max}=	002	001	Ø 11	001	011	021	F000 	
							F001 	
							S000  S090  S180  S270 	

[1] Travel range s_{max} dependent on length L and option selection. ➠ Section "General technical instructions".
[2] Coverage up to a length L = 1,500 m available.

Mounting interface		Motor				Cover[2)]		Documentation
								
Ratio i =	Mechanical interface	Motor code	without	with	Motor connector position	without	with	Standard report
			Brake			Cover plate		
–	000	–	000			000	010	001
i = 1	011	**MSM031C-0300**	138	139	000 090 180 270			
		ECMA-C20604	182	183				
		ECMA-C10604	192	193				
i = 1	021	**MSM031C-0300**	138	139				
		ECMA-C20604	182	183				
		ECMA-C10604	192	193				
i = 1.5	031	**MSM031C-0300**	138	139				
		ECMA-C20604	182	183				
		ECMA-C10604	192	193				

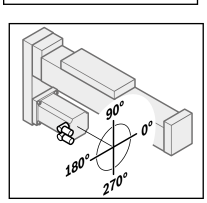
Length calculation ➠ Section “General technical instructions”

Mount	Motor connector position			
	0°	90°	180°	270°
F001	✔	✔ ★	✔	✔



Example:
Mount F001
Motor connector position 90°

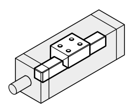
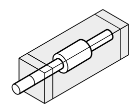
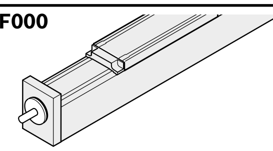
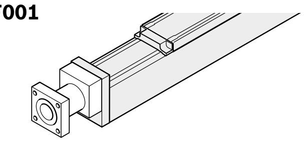
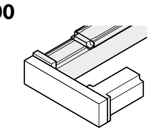
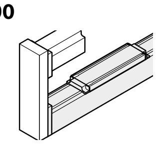
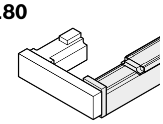
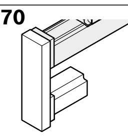
Timing belt side drive	Motor connector position			
	0°	90°	180°	270°
S000	–	090	180 ★	270
S090	000	090 ★	180	–
S180	000 ★	090	–	270
S270	000	–	180	270 ★



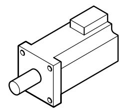
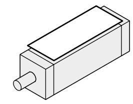
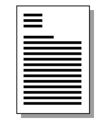
Example:
Timing belt side drive S270
Motor connector position 180°

★ standard delivery (connector orientation)

FMS-110-DN-1

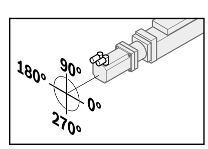
$s_{max.}$[1] (mm)	Carriage	Guideway	Drive				Version	
								
	L_{ca} = 140 mm		Screw journal	BASA size d_0 x P				
				16x5	16x10	16x16		
s_{max}=	002	001	Ø 11	001	011	021	F000  F001  S000  S090  S180  S270 	

1) Travel range s_{max} dependent on length L and option selection. ➠ Section “General technical instructions”.
2) Coverage up to a length L = 1,500 m available.

Mounting interface		Motor				Cover[2)]		Documentation
								
Ratio i =	**Mechanical interface**	**Motor code**	**without** (Brake)	**with** (Brake)	**Motor connector position**	**without** (Cover plate)	**with** (Cover plate)	**Standard report**
–	000	–	000			000	010	001
i = 1	011	**MSM031C-0300**	138	139	000 090 180 270			
		ECMA-C20604	182	183				
		ECMA-C10604	192	193				
i = 1	021	**MSM031C-0300**	138	139				
		ECMA-C20604	182	183				
		ECMA-C10604	192	193				
i = 1.5	031	**MSM031C-0300**	138	139				
		ECMA-C20604	182	183				
		ECMA-C10604	192	193				

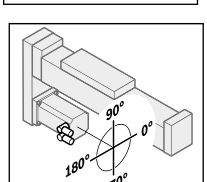
Length calculation ➟ Section “General technical instructions”

Mount	**Motor connector position**			
	0°	**90°**	**180°**	**270°**
F001	✔	✔ ★	✔	✔



Example:
Mount F001
Motor connector position 90°

Timing belt side drive	**Motor connector position**			
	0°	**90°**	**180°**	**270°**
S000	–	090	180 ★	270
S090	000	090 ★	180	–
S180	000 ★	090	–	270
S270	000	–	180	270 ★

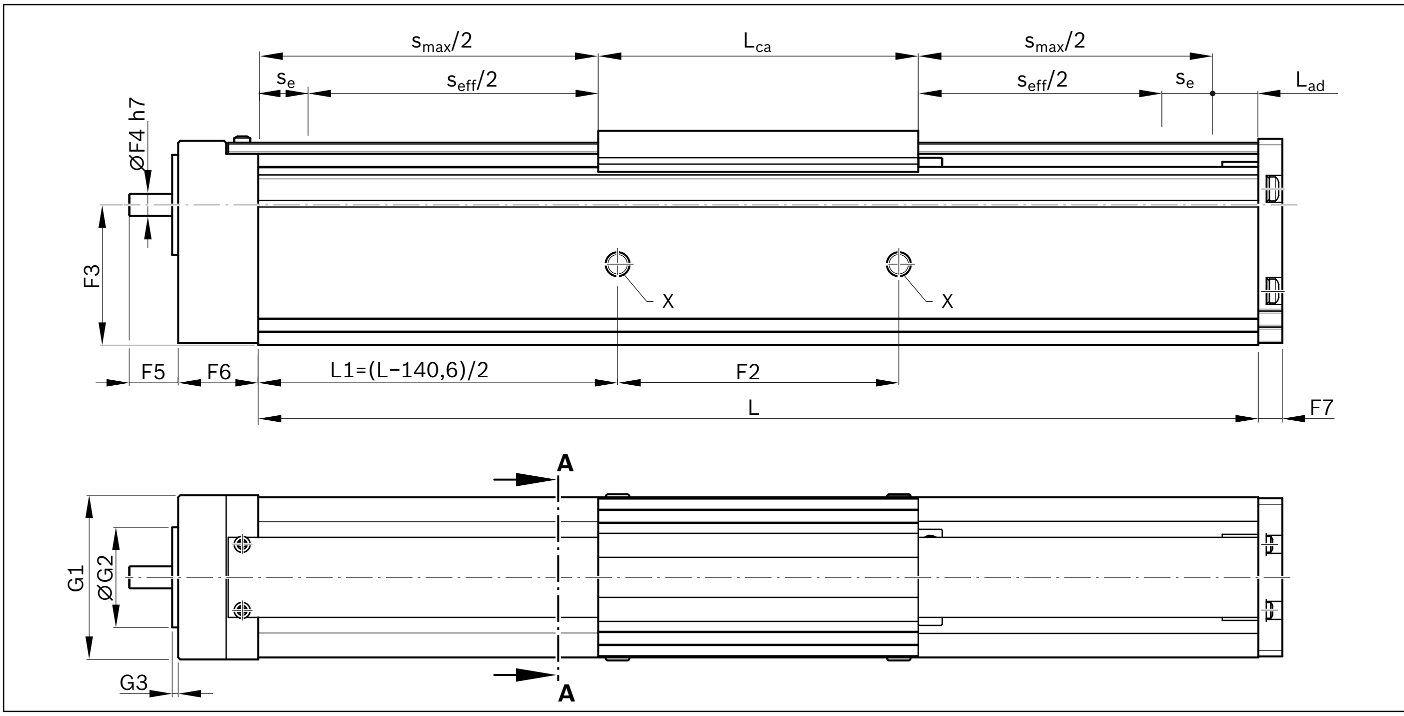


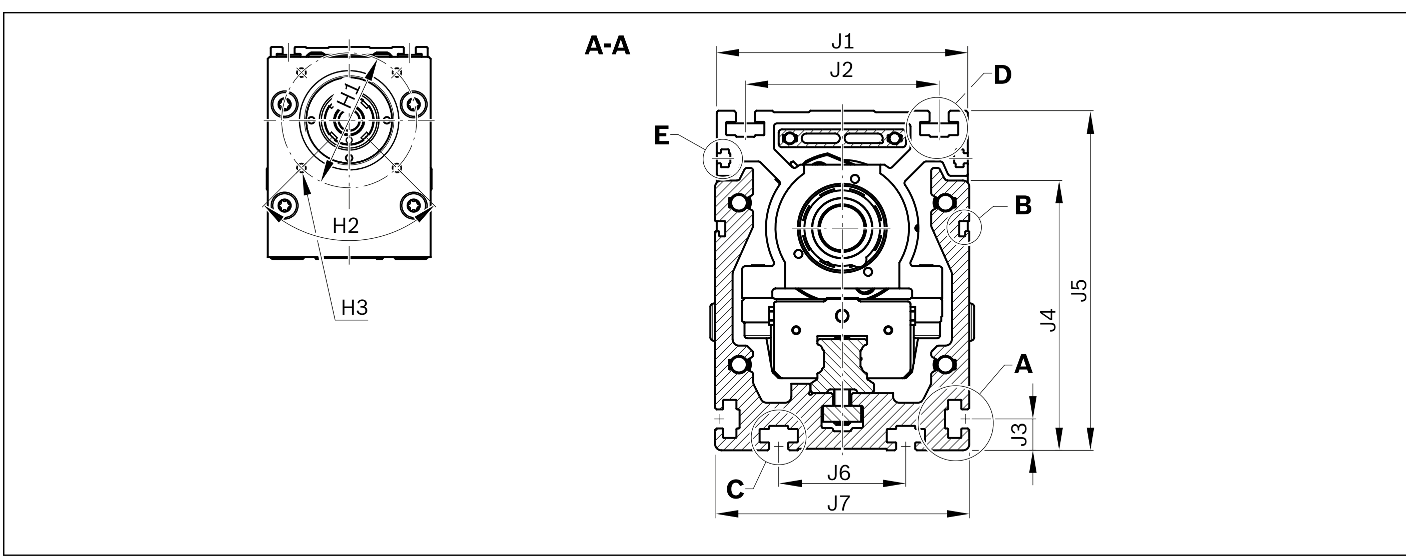
Example:
Timing belt side drive S270
Motor connector position 180°

★ standard delivery (connector orientation)

Frame dimension drawings

FMS-xxx-SN-1 (single-rail)

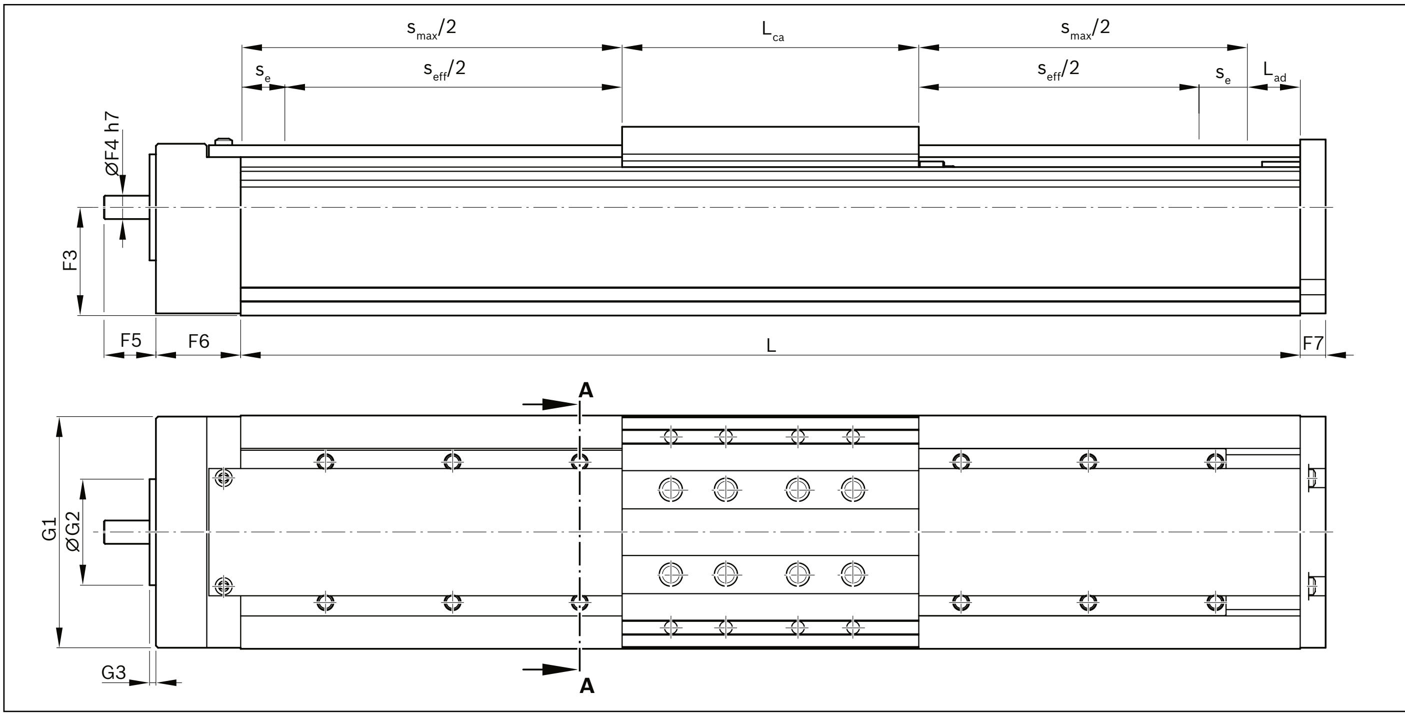


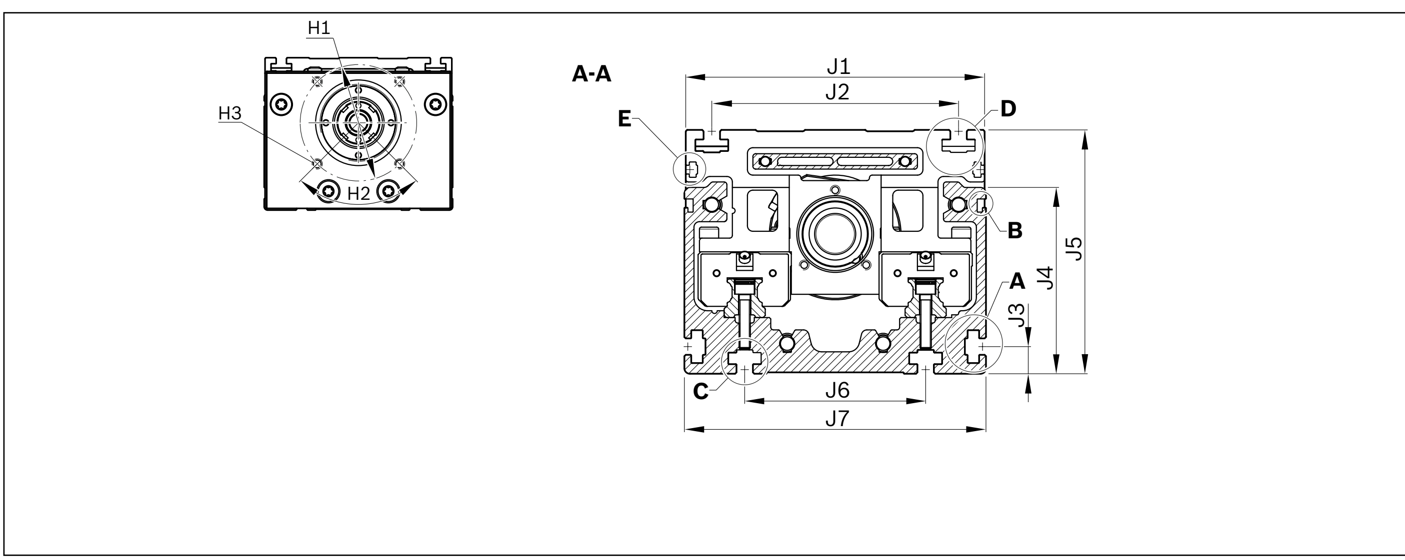


FMS	Dimensions (mm)																			
	F2	**F3**	**F4**	**F5**	**F6**	**F7**	**G1**	**G2**	**G3**	**H1**	**H2**	**H3**	**J1**	**J2**	**J3**	**J4**	**J5**	**J6**	**J7**	**L_{ca}**	**L_{ad}**
-080-SN-1	140.6	70	11	24.5	40	12	82	50	3	68	90°	M5–10 deep (4x)	79	61	9.9	85	107	40	80	160	35

X: Lube fittings (DIN 3405-A funnel-type lube nipple) on both sides for Runner Block grease lubrication.
For Ball Screw Assembly lubrication and further information on lubrication, see the section titled “Lubrication”.

FMS-xxx-SN-1 (dual-rail)

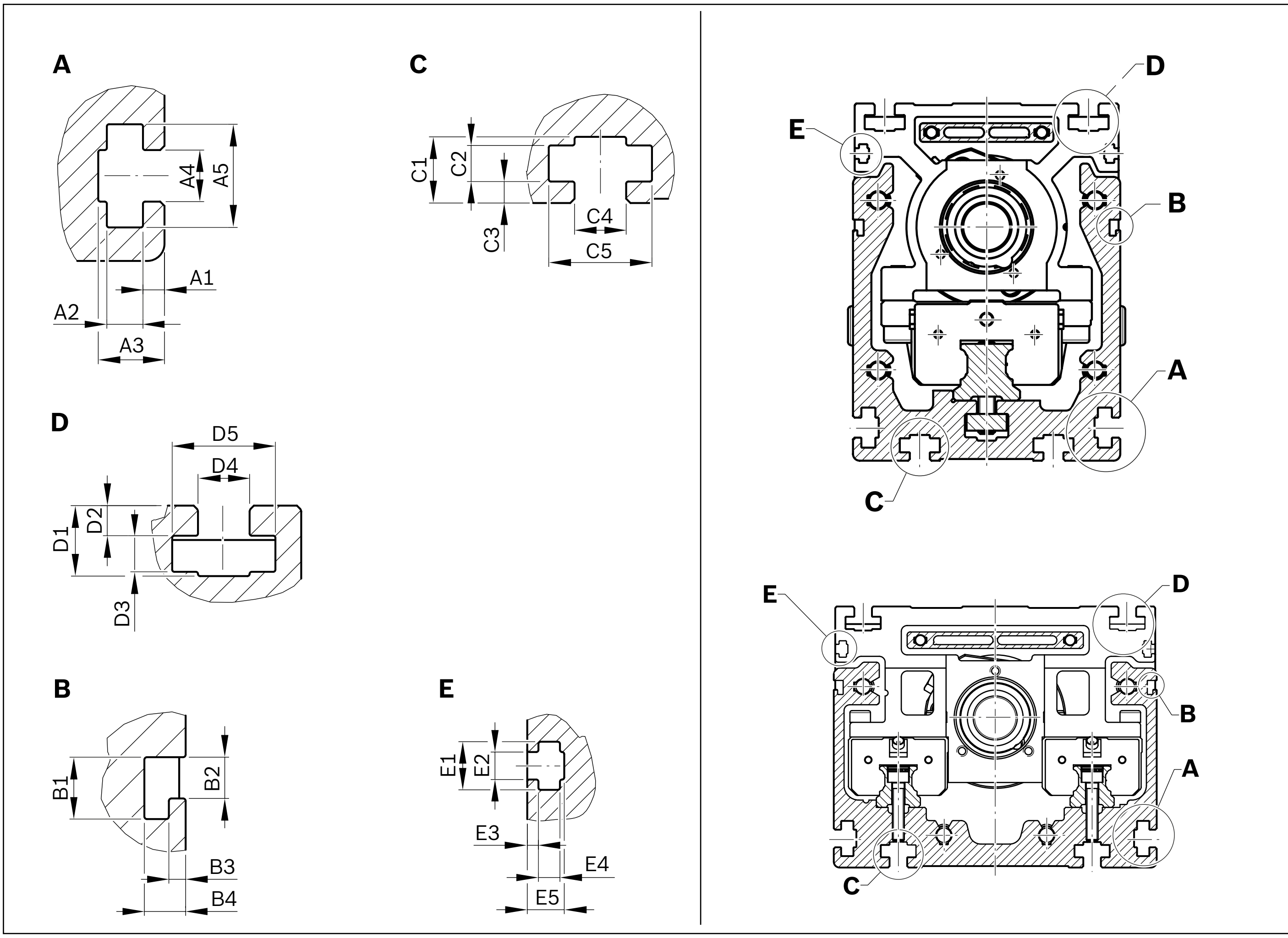




FMS	Dimensions (mm)																		
	F3	F4	F5	F6	F7	G1	G2	G3	H1	H2	H3	J1	J2	J3	J4	J5	J6	J7	L_{ca}	L_{ad}
-110-DN-1	51	11	24.5	40	12	109	50	3	68	90°	M5–10 deep (4x)	109	90	9.9	68	89	66	110	140	35

Notes: Diagrams use different scales. Exact contours and dimensions can be found in the CAD model. CAD configurator available on the Internet at www.boschrexroth.com “Product configurators”.
See below for dimension drawings for motor attachment and details. For short product names, see the section titled “Additional information”. For lubrication, see the section titled “Lubrication”.

Dimensional drawings of details

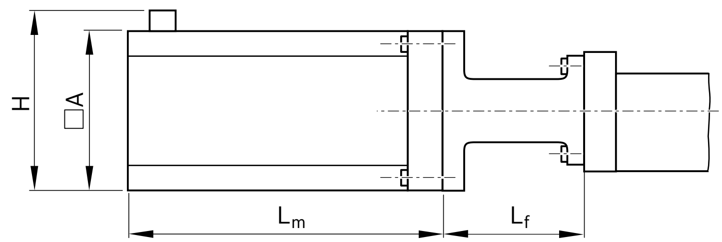


FMS	Dimensions (mm)																								
	A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**C1**	**C2**	**C3**	**C4**	**C5**	**D1**	**D2**	**D3**	**D4**	**D5**	**E1**	**E2**	**E3**	**E4**	**E5**
-080-SN-1	2.5	4.2	7.7	6	12	4.8	3.2	1.3	3.2	7.7	4.2	2.5	6	12	8.2	3.5	4.2	6	12	5.6	3.2	1.3	2.5	4.3
-110-DN-1	2.5	4.2	7.7	6	12	4.8	3.2	1.3	3.2	8.7	4.2	3.5	6	12	8.2	3.5	4.2	6	12	5.6	3.2	1.3	2.5	4.3

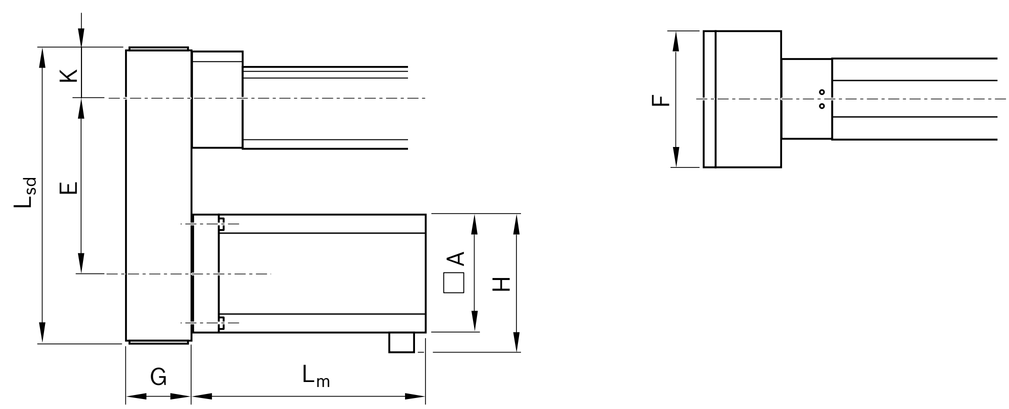
A For fastening with clamping fixtures.
B For sensor plate (for magnetic/optical sensors).
C For fastening with sliding blocks
D For customer's attachment
E For switching cam (for optical sensor).

Dimension drawings for motor attachment

Motor attachment via mount and coupling



Motor attachment via timing belt side drive



FMS	Motor	i	Dimensions (mm) A	E	F	G	H	K	L_m Without brake	L_m With brake	L_{sd}	L_f
-080-SN-1	MSM031C	1	60	125	88	51	73	47.4	98.5	135.0	227.8	72
		1.5		122								–
	ECMA-C20604 ECMA-C10604	1		125					130.7	166.8		72
		1.5		122								–
-110-DN-1	MSM031C	1		125			73		98.5	135.0		72
		1.5		122								–
	ECMA-C20604 ECMA-C10604	1		125					130.7	166.8		72
		1.5		122								–

Function Modules FMB

Product description

Features

- Ready-to-install Function Modules in any length up to L_{max}
- Extremely compact aluminum frame with integrated Rexroth Ball Rail System (one or two Ball Rail Systems) Ball Rail System with moderate pre-tensioning (pre-tensioning class C1)
- Pre-tensioned belt drive (HTD 5M)
- High travel speed of up to 3 m/s
- Aluminum carriage with T-slots
- Guideway and drive components protected by aluminum cover plate (up to a length of 1,500 m)
- Low-cost maintenance thanks to in-service lubrication option (grease lubrication)
- Repeatability of up to +/- 0.05 mm

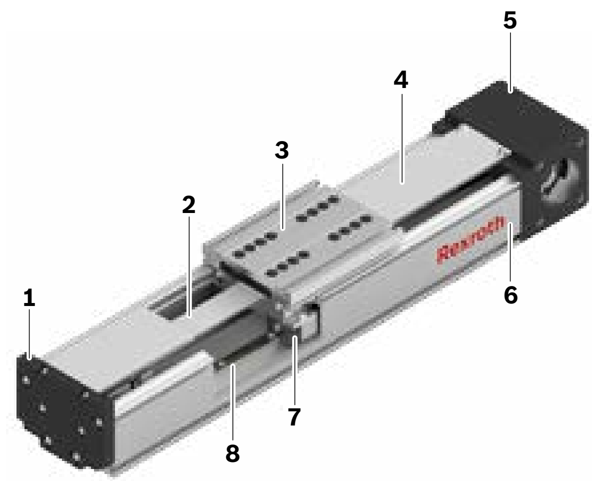
Further highlights

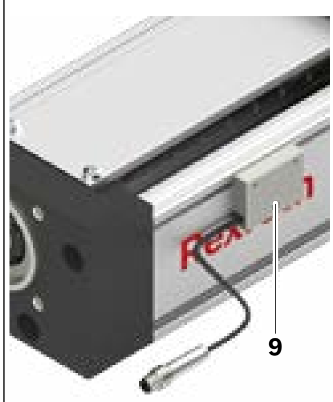
- Standard with integrated solenoid switch for magnetic field sensors
- Nameplate with parameters for easy start-up
- Fastening elements

Attachments

- Motor attachment via mount and coupling
- Planetary gearbox with various gear ratios
- Maintenance-free servo motors with optional holding brake
- Magnetic sensor
- Optical sensors
- Extensive sensor accessories

Structural design/versions





Magnetic sensor

Optical sensor

Structural design

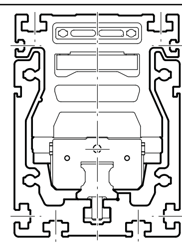
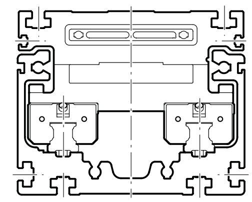
1 Idler end end plate
2 Toothed belt (covered)
3 Carriage with T-slots
4 Cover plate
5 Drive end enclosure
6 Frame
7 Runner Block
8 Guide Rail

Attachments/accessories

9 Magnetic sensor
10 Optical sensor

For further information, see the section titled “Accessories”.

Versions

Versions with one Ball Rail System (single-rail) FMB-xxx-SN-x	Versions with two Ball Rail Systems (dual-rail) FMB-xxx-DN-x
	
Without motor attachment	
	
Motor attachment with ancillary gear	
	

Technical Data

Read the sections titled “Calculation” and “General technical instructions”.

General technical data

FMB	Carriage length	Dyn. characteristics			Maximum permissible loads						Moved system mass
		Dyn. load ratings	Dyn. load moments		Max. permissible moments			Max. permissible forces			
	L_{ca}	C	M_t	M_L	$M_{x\,max}$	$M_{y\,max}$	$M_{z\,max}$	$F_{y\,max}$	$F_{z1\,max}$	$F_{z2\,max}$	m_{ca}
	(mm)	(N)	(Nm)	(Nm)	(Nm)	(Nm)	(Nm)	(N)	(N)	(N)	(kg)
-065-SN-1	In preparation										
-080-SN-1	160	23,700	240	910	35	135	135	3,500	3,500	3,500	1.72
-110-DN-1	140	24,000	970	940	140	140	140	2,200	3,600	3,600	1.71
-145-DN-1	In preparation										

Drive data/gear unit data

FMB	Gear ratio	Max. acceleration torque (at the gear output)	Base frictional torque	Max. drive speed	Mass moment of inertia	Weight
	i	M_{ge} [2)]	M_{Rge}	n_{ge} [2)]	J_{ge}	m_{ge}
	(–)	(Nm)	(Nm)	(rpm)	(kgm^2)	(kg)
-065-SN-1	In preparation					
-080-SN-1	3	24	0.15	4,500	0.0000135	0.9
	5	32			0.0000078	
	10	24			0.0000054	
-110-DN-1	3	24	0.15	4,500	0.0000135	0.9
	5	32			0.0000078	
	10	24			0.0000054	
-145-DN-1	In preparation					

FMB	Gear ratio	Max. drive torque	Lead constant	Max. speed	Carriage
	i	M_P	u	v_{max}	L_{ca}
	(–)	(Nm)	(mm/rev)	(m/s)	(mm)
-065-SN-1	In preparation				
-080-SN-1	1	7.79	110.00	3.00	160.00
	3	2.60	36.67	2.75	
	5	1.56	22.00	1.65	
	10	0.78	11.00	0.83	
-110-DN-1	1	11.48	130.00	3.00	140.00
	3	3.83	43.33	3.00	
	5	2.30	26.00	1.95	
	10	1.15	13.00	0.98	
-145-DN-1	In preparation				

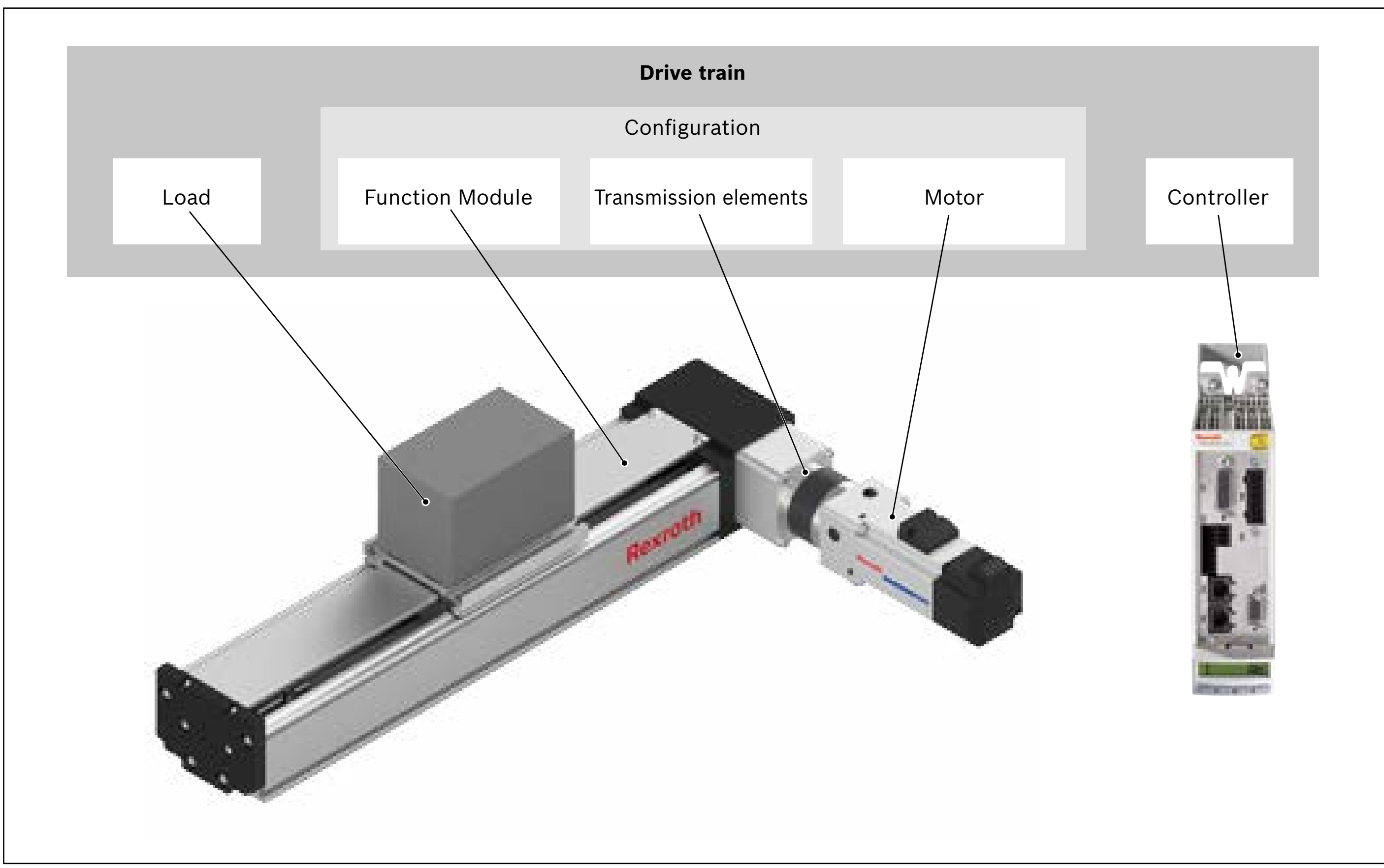
1) Minimum required travel to ensure a reliable lubrication distribution. For operating conditions, see the section titled “Additional information”. If values are not met, please contact Bosch Rexroth.
2) The limits of the Linear Motion System must not be exceeded. For more information about calculations, see the section titled “Basis of calculations”.
3) Maximum force that can be transmitted via the teeth meshing with the belt pulley.
4) The maximum permitted tensile load on the belt cross section (belt elasticity limit) is given here for easier comparability. This value represents the load limit in terms of plastic deformation and may not be used to calculate the maximum permissible drive torque.

Constant mass calculation		Additional length	Min. travel range	Max. travel range	Max. length	Application point of the effective force	Planar moments of inertia	
$k_{g\ fix}$ (kg)	$k_{g\ var}$ (kg)/mm	L_{ad} (mm)	s_{min} 1) (mm)	s_{max} (mm)	L_{max} (mm)	z_1 (mm)	I_y (cm^4)	I_z (cm^4)
1.822	0.008	71	150	3,800	4,031	78.2	154.42	184.96
2.302	0.009	73	120	3,800	4,013	59.3	89.09	349.08

Constants – mass moment of inertia			Frictional torque	Belt pulley diameter	Belt type	Max. belt driving force	Belt elasticity limit	Specific spring rate	Max. acceleration
$k_{J\ fix}$ ($kgmm^2$)	$k_{J\ var}$ (kgmm)	$k_{J\ m}$ (mm^2)	M_{Rs} (Nm)	d_3 (mm)	B_t	F_{max} 3) (N)	$F_{t\ perm}$ 4) (N)	c_{spe} (N)	a_{max} (m/s^2)
567.787	0.050	306.497	1.40	35.01	25 - MTD5	445	1700	0.425×10^6	40
819.880	0.082	428.082	1.90	41.38	30 - MTD5	555	2000	0.5×10^6	

Calculation

Basis of calculations



The correct dimensioning and assessment of an application requires structured consideration of the drive train as a whole. The basic element of the drive train is the configuration – made up of the Linear Motion System, the transmission element (gears or directly without transmission element) and the motor – which can be ordered in that constellation in the catalog.

Maximum permissible loads
When selecting a Linear Motion System, the maximum permissible loads and forces must be taken into account and can be found in the section “Technical Data”. The values specified there depend on the system. In other words, the tolerances are determined not only by the load ratings of the bearing points but also include tolerances depending on design and material.

Conditions for combined loads

$$\frac{|F_y|}{F_{y\,max}} + \frac{|F_z|}{F_{z\,max}} + \frac{|M_x|}{M_{x\,max}} + \frac{|M_y|}{M_{y\,max}} + \frac{|M_z|}{M_{z\,max}} \leq 1$$

Linear guideway life

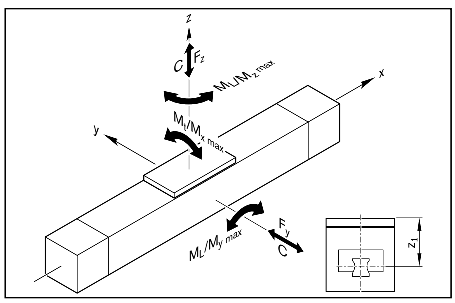
The life of the rolling bearing points contained in a Linear Motion System can be calculated using the formulas given below. The rolling bearing point that is relevant to the life in a Linear Motion System with geared belt drive is generally the linear guideway.

⚠ **The computed life specification for the Linear Motion System is determined by the life specification of the linear guide.**

The linear guideway in the Linear Motion System must withstand the load as well as any process forces that occur.

Combined equivalent load on bearing of the guideway

$$F_{comb} = F_y + F_z + C \cdot \frac{|M_x|}{M_t} + C \cdot \frac{|M_y|}{M_L} + C \cdot \frac{|M_z|}{M_L}$$



Nominal life in meters

$$L = \left(\frac{C}{f_w \cdot F_{comb}}\right)^3 \cdot 10^5\,m$$

Impact loads and vibrations cause additional loads on the contact point between ball and running track. Determining the exact conditions of use is difficult. However, the additional loads increase as travel velocity increases. The load factor f_w (see table) factors in the effects of impacts and vibrations on life.

Conditions of use	**Travel velocity**	**Load factor f_w**
No impact loads and vibrations	$v < 0.25$ m/s	1.0 ... 1.2
Low impact loads and vibrations	0.25 m/s $\leq v < 1$ m/s	1.2 ... 1.5
Moderate impact loads and vibrations	1 m/s $\leq v < 2$ m/s	1.5 ... 2.0
High impact loads and vibrations	$v \geq 2$ m/s	2.0 ... 3.5

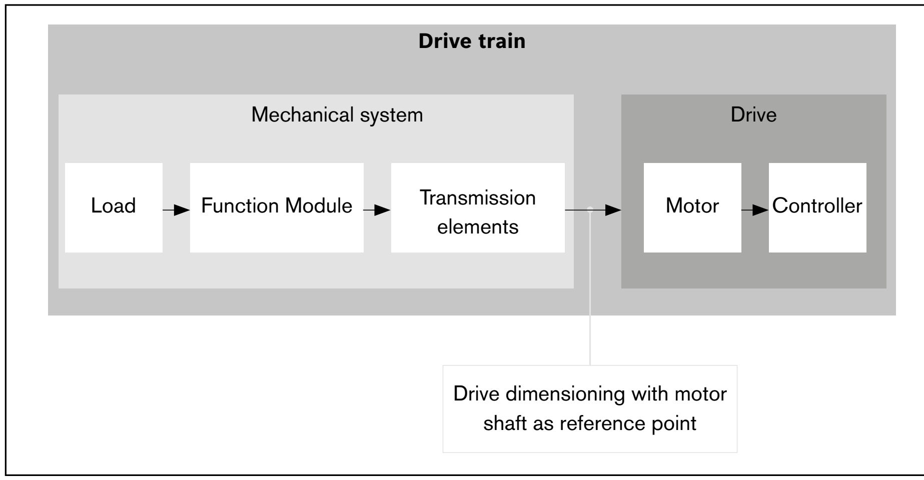
Nominal life in hours

$$L_h = \frac{L}{3\,600 \cdot v}$$

Drive dimensioning

Principles

For drive dimensioning, the drive train can be divided into the mechanical system and the drive system.
The **mechanical system** includes the physical components – Linear Motion System and the transmission elements (gears or directly without transmission element) – and the load to be carried.
The electric **drive** is a motor/controller combination with the appropriate performance data.
The dimensioning of the electric drive is done taking the motor shaft as a reference point.
For drive dimensioning, limits must be taken into account as well as base values. The limits must not be exceeded in order to avoid damaging the mechanical components.



Technical data and formula symbols for the mechanical system

For each component (Linear Motion System, gears), the relevant maximum permissible values must be identified for the drive torque and travel speed, as well as the basic values for frictional torque and mass moment of inertia ➠ "Drive data".
The following technical data with the associated formula symbols are used when considering the basic **mechanical system** requirements in the design calculations for dimensioning the drive. The data listed in the table below can be found in the section titled "Technical Data" or is determined using formulas based on the descriptions on the following pages.

		Mechanical system		
		Load	Linear Motion System	Transmission element Gear
Weight moment	(Nm)	M_g 5)	–	–
Frictional torque	(Nm)	– 4)	M_{Rs} 3)	M_{Rge} 3)
Mass moment of inertia	(kgm²)	J_t 1)	J_s 2)	J_{ge} 3)
Max. permissible speed	(m/s)	–	v_{max} 3)	–
Max. permissible rotary speed	(rpm)	–	n_p 1)	n_{ge} 3)
Max. permissible drive torque	(Nm)	–	M_p 3)	M_{ge} 3)

1) Determine the value using the appropriate formula
2) Length-dependent value, determined using the appropriate formula
3) Use the value from the table
4) Any additional process forces are to be taken into consideration as load moments
5) For vertical mounting position: Determine the value using the appropriate formula

Drive dimensioning with motor shaft as reference point

When dimensioning the drive, all relevant design calculation values for the mechanical components in the drive train have to be determined and be expressed/reduced to the motor shaft. For a combination of mechanical components within the drive train, this will result in one value for each of the following:

- Frictional torque M_R
- Mass moment of inertia J_{ex}
- Maximum permissible speed v_{mech} (maximum permissible rotary speed n_{mech})
- Max. permissible drive torque M_{mech}

Determination of the values for the mechanical system in the drive train, based on the motor shaft as reference point

Frictional torque M_R:

For direct motor attachment (without gear)

$$M_R = M_{Rs}$$

For motor attachment via gear

$$M_R = M_{Rge} + \frac{M_{Rs}}{i}$$

Mass moment of inertia J_{ex}

For direct motor attachment (without gear)

$$J_{ex} = J_s + J_t$$

For motor attachment via gear

$$J_{ex} = J_{ge} + \frac{(J_s + J_t)}{i^2}$$

Determination of mass moment of inertia of Linear Motion System components

$$J_s = (k_{J\,fix} + k_{J\,var} \cdot L) \cdot 10^{-6}$$

Determination of translatory mass moment of inertia of external load

$$J_t = m_{ex} \cdot k_{J\,m} \cdot 10^{-6}$$

Maximum permissible speed v_{mech} (max. permissible rotary speed n_{mech})

The lowest of all the values for maximum permissible speed or rpm of all mechanical components contained in the drive train determines the maximum permissible speed of the mechanical system which has to be taken into consideration as the upper limit for the drive when sizing the motor.

Maximum permissible speed

For direct motor attachment (without gear)

$$v_{mech} = v_{max}$$

$$v_{mech} = \frac{n_{mech} \cdot p \cdot d_3}{1{,}000 \cdot 60}$$

For motor attachment via gear

$$v_{mech} = \frac{n_{mech} \cdot p \cdot d_3}{i \cdot 1000 \cdot 60}$$

Maximum permissible rotary speed

For direct motor attachment (without gear)

$$n_{mech} = \frac{v_{mech} \cdot i \cdot 1{,}000 \cdot 60}{p \cdot d_3}$$

$$n_{mech} = n_p$$

For motor attachment via gear

$$n_{mech} = \text{minimum } (n_p \cdot i \ ; \ n_{ge})$$

$$n_p = \frac{v_{max} \cdot 1{,}000 \cdot 60}{p \cdot d_3}$$

Maximum permissible drive torque M_{mech}

The lowest (minimum) of all the values for permissible drive torque of all mechanical components contained in the drive train determines the maximum permissible drive torque of the mechanical system which has to be taken into consideration as the upper limit for the drive when sizing the motor.

For direct motor attachment (without gear)

$$M_{mech} = M_p$$

For motor attachment via gear

$$M_{mech} = \text{Minimum } \left(\frac{M_{ge}}{i} \ ; \ \frac{M_p}{i}\right)$$

⚠ **When considering the complete drive train (mechanical system + motor/controller) the maximum torque of the motor can lie below the maximum value for the mechanical system (M_{mech}) and thus limit the maximum permissible drive torque of the overall drive train.**
If the maximum torque of the motor lies above the upper limit for the mechanical system (M_{mech}), the maximum motor torque must be limited to the permitted value for the mechanical system.

General motor preselection

The motor can be generally preselected using the following conditions:

Condition 1:

The rotary speed of the motor must be greater than or equal to the rotary speed required for the mechanical system (but not exceeding the maximum permissible limit value).

$$n_{max} \geq n_{mech}$$

Condition 2:

Consideration of the ratio of mass moments of inertia of the mechanical system and the motor. The ratio of the mass moments of inertia serves as an indicator for the control performance of a motor/controller combination. The mass moment of inertia of the motor is directly related to the motor size.

Ratio of mass moments of inertia

$$V = \frac{J_{ex}}{J_m + J_{br}}$$

For preselection, experience has shown that the following ratios will result in high control performance. These are not rigid limits, but values exceeding them will require closer consideration of the specific application.

Application area	V
Handling	≤ 6.0
Processing	≤ 1.5

Condition 3:

Estimation of the ratio of the static load moment to the continuous torque of the motor. The torque ratio must be less than or equal to an empirical value of 0.6. This condition roughly factors in the missing dynamic characteristics of an exact motion profile with the required motor torques.

Torque ratio

$$\frac{M_{stat}}{M_0} \leq 0.6$$

Static load moment

$$M_{stat} = M_R + M_g$$

Weight moment
For vertical mounting only!

$$M_g = \frac{d_3 \cdot (m_{ex} + m_{ca}) \cdot g}{2{,}000 \cdot i}$$

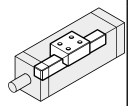
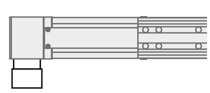
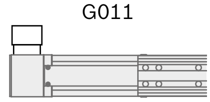
In the section titled ➟”Configuration and ordering”, users can put together standard configurations, including gears and motor, for the various Linear Motion System sizes by selecting the appropriate options. By checking the above conditions, it is possible to see whether a standard motor selected in a particular configuration will generally be of a suitable size for the specific application.

Precise drive dimensioning

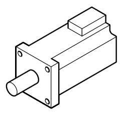
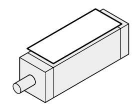
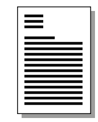
Preselecting the motor according to this rough guide is no substitute for the required precise design calculations for the drive, taking all moments/torques and rotary speed levels into account. For precise calculation of the electric drive, including consideration of the specific motion profile, please refer to the performance data in the catalog “Rexroth drive technology”. When dimensioning the drive, the maximum permitted values for linear speed, drive torque and acceleration must not be exceeded, in order to avoid damaging the mechanical system.

Configuration and ordering

FMB-080-SN-1

$s_{max.}$ [1] (mm)	Carriage L_{ca} = 160 mm	Guideway 	Version	Drive	Gear Ratio i =	Mechanical interface
s_{max}=	002	001	H001 	001	–	00
			G010 	011	3	011
					5	012
			G011 		10	013

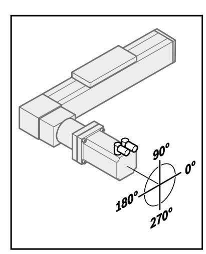
[1] Travel distance s_{max} depends on length L and option selection ➠ Section “General technical instructions”.
[2] Coverage up to a length L = 1,500 m available.

Motor				Cover[2)]		Documentation
						
Motor code	**without**	**with**	**Motor connector position**	**without**	**with**	**Standard report**
	Brake			**Cover plate**		
–	000			000	010	001
MSM031C-0300	138	139	000 090 180 270			
ECMA-C20604	182	183				
ECMA-C10604	192	193				

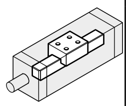
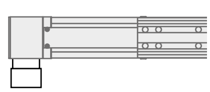
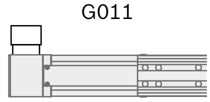
Length calculation ➠ Section “General technical instructions”

Version	Motor connector position			
	0°	**90°**	**180°**	**270°**
G010/G011	000	090 ★	180	270

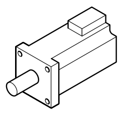
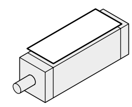
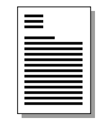
★ standard delivery (connector orientation)



FMB-110-DN-1

$s_{max.}$[1)] (mm)	Carriage L_{ca} = 140 mm	Guideway 	Version	Drive	Gear Ratio i =	Mechanical interface	
s_{max}=	002	001	H001 	001	–	00	
			G010 	011	3	011	
					5	012	
			G011 		10	013	

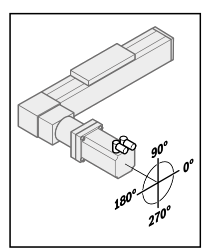
1) Travel distance s_{max} depends on length L and option selection ➠ Section "General technical instructions".
2) Coverage up to a length L = 1,500 m available.

Motor				Cover[2]		Documentation
						
Motor code	**without**	**with**	**Motor connector position**	**without**	**with**	**Standard report**
	Brake			**Cover plate**		
–	000			000	010	001
MSM031C-0300	138	139	000 090 180 270			
ECMA-C20604	182	183				
ECMA-C10604	192	193				

Length calculation ➠ Section “General technical instructions”

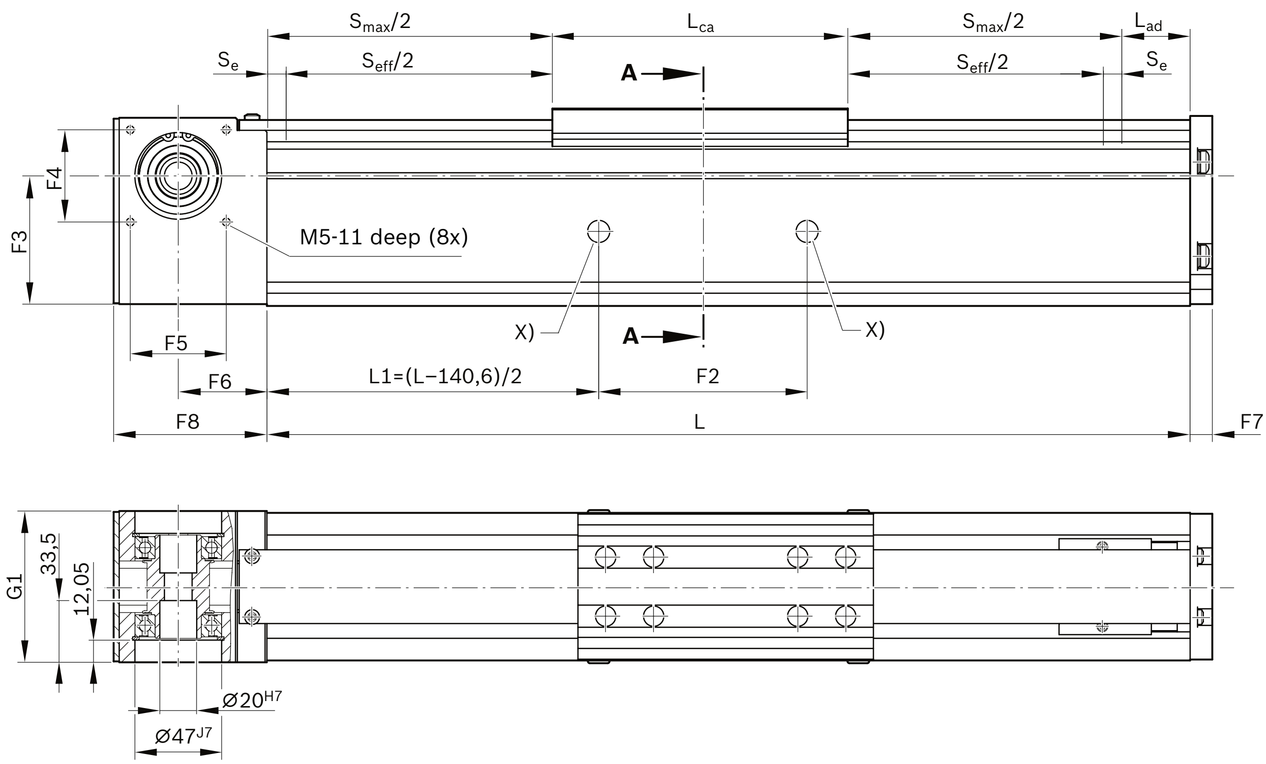
Version	**Motor connector position**			
	0°	**90°**	**180°**	**270°**
G010/G011	000	090 ★	180	270

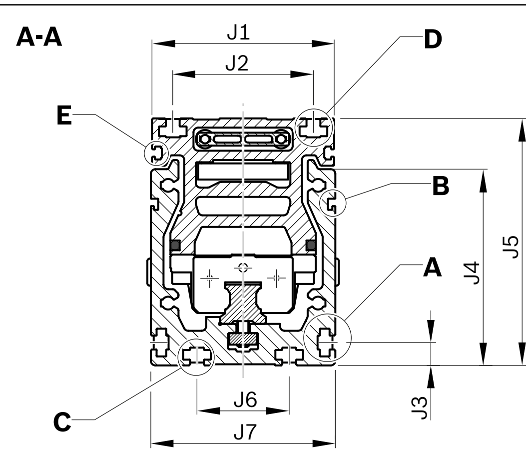
★ standard delivery (connector orientation)



Frame dimension drawings

FMB-xxx-SN-1 (single-rail)

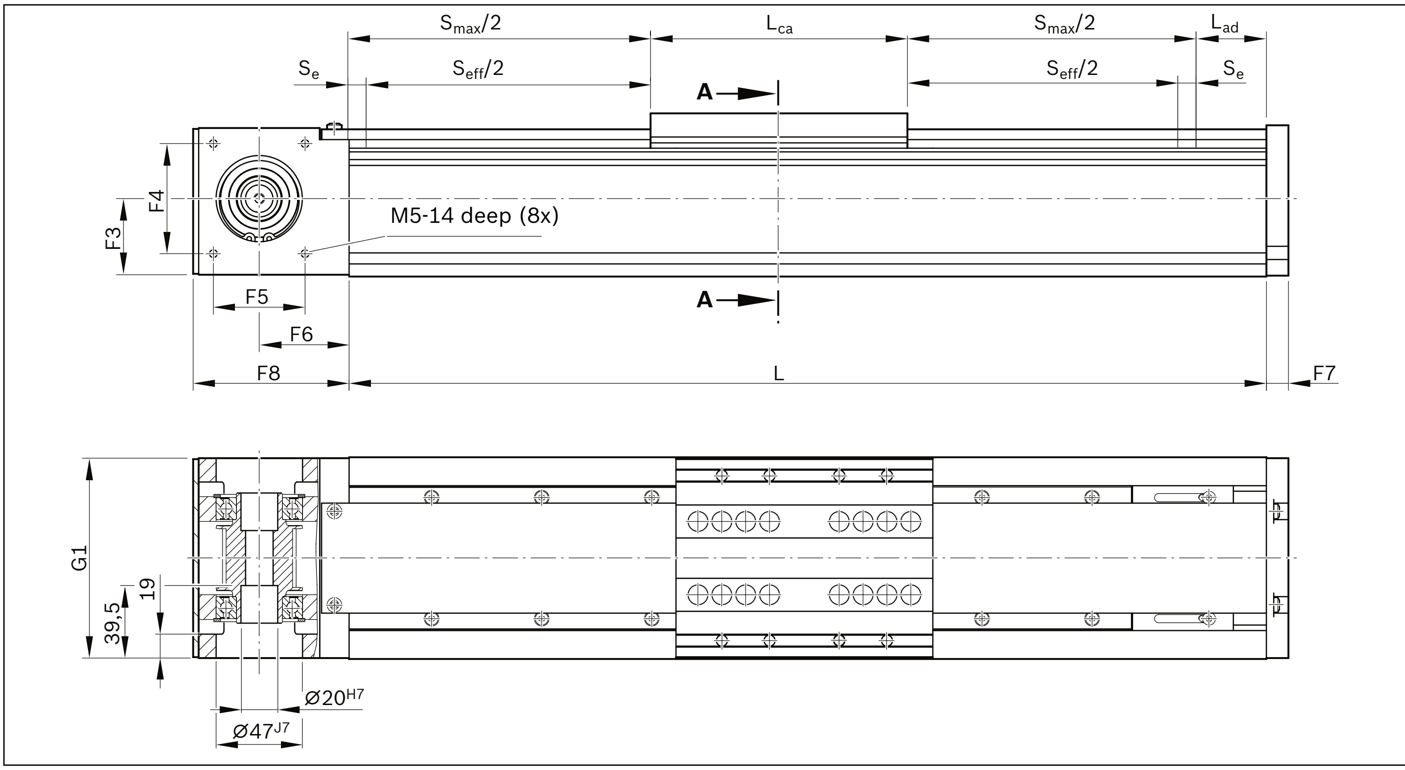


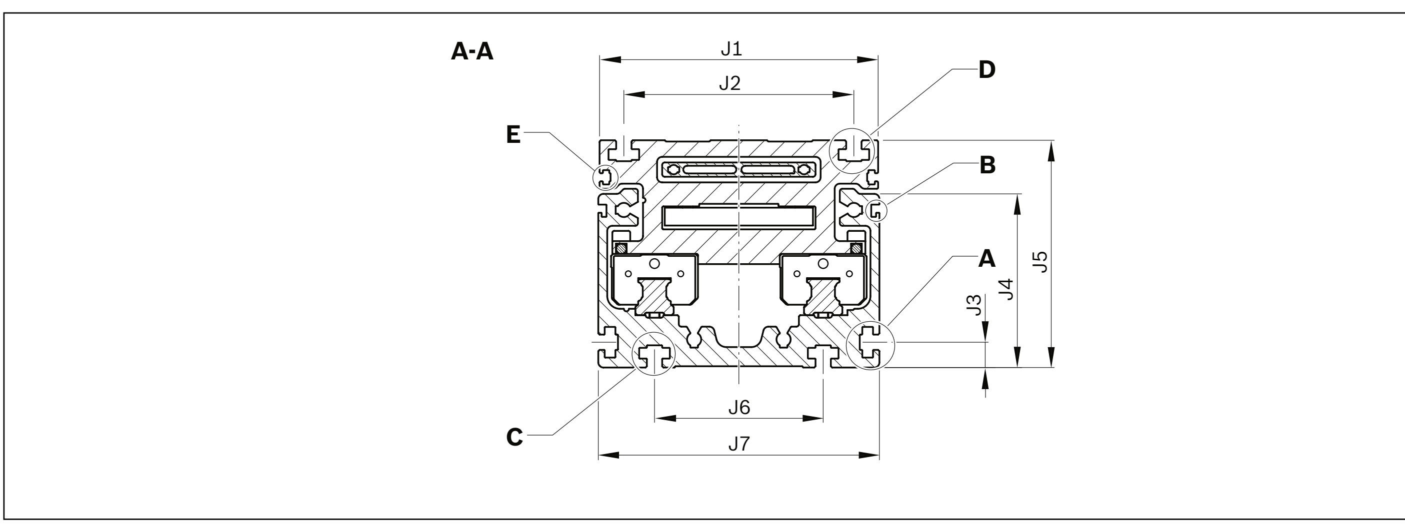


FMB	Dimensions (mm)																	
	F1	F2	F3	F4	F5	F6	F7	F8	G1	J1	J2	J3	J4	J5	J6	J7	L_{ca}	L_{ad}
-080-SN-1	160	140.6	69.5	50	52	48	12	83	82	79	61	9.9	85	107	40	80	160	71

X: Lube fittings (DIN 3405-A funnel-type lube nipple) on both sides for Runner Block grease lubrication.
For further information, see the section titled “Lubrication”.

FMB-xxx-DN-1 (dual-rail)

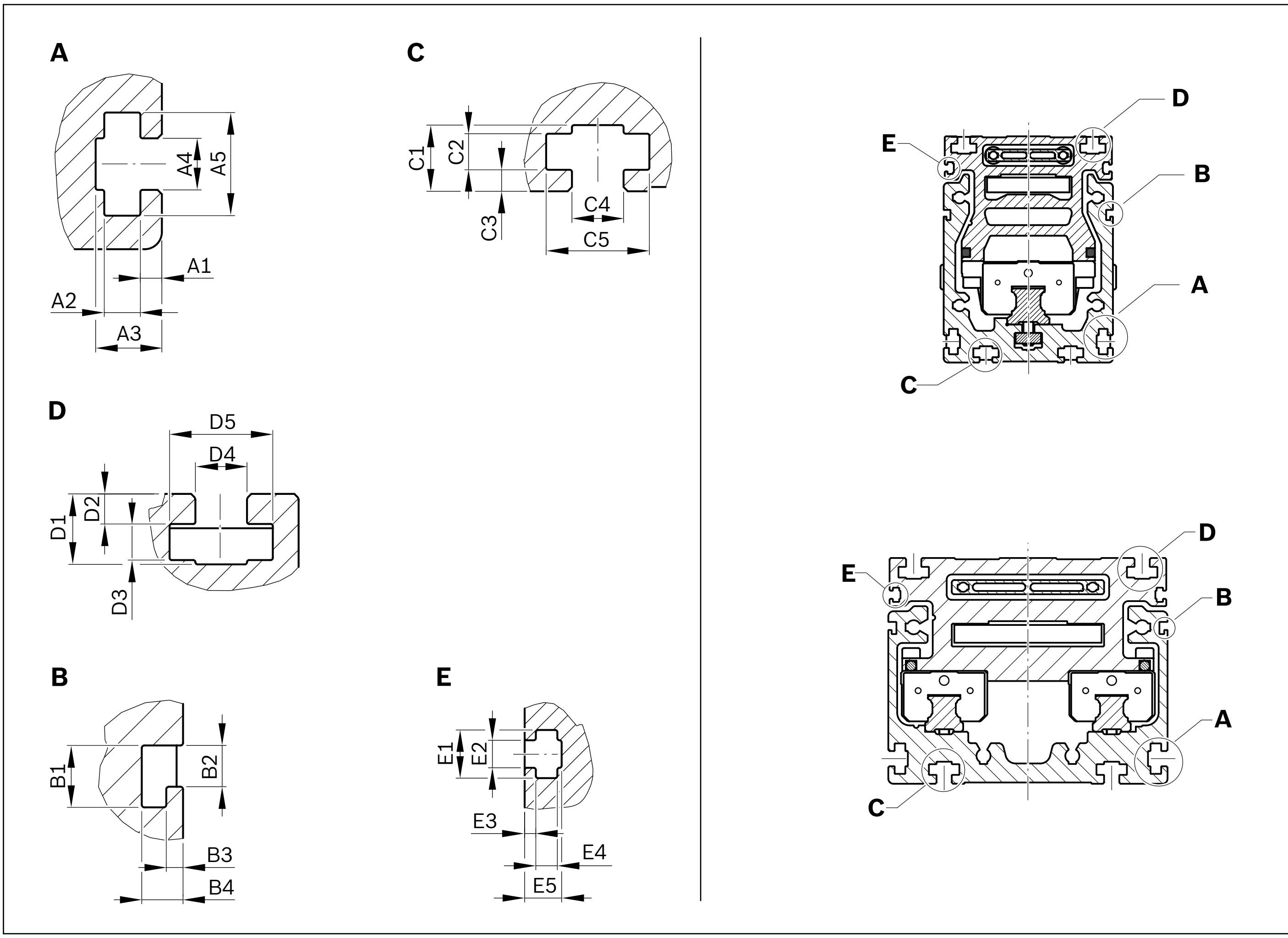




FMB	Dimensions (mm)																	
	F1	F2	F3	F4	F5	F6	F7	F8	G1	J1	J2	J3	J4	J5	J6	J7	L_{ca}	L_{ad}
-110-DN-1	140	–	41.5	60	50	49	12	85	109	109	90	9.9	68	89	66	110	140	73

Notes: Diagrams use different scales. Exact contours and dimensions can be found in the CAD model.
CAD configurator available on the Internet at www.boschrexroth.com “Product configurators”.
See below for dimension drawings for motor attachment and details. For short product names, see the section titled “Additional information”. For lubrication, see the section titled “Lubrication”.

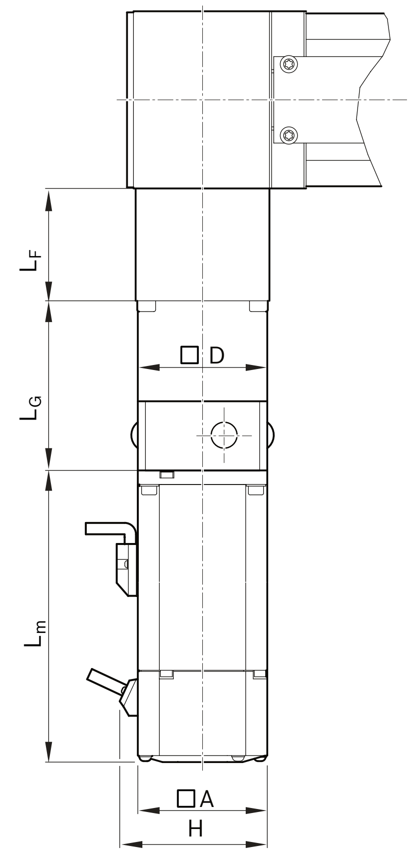
Dimensional drawings of details



FMB	Dimensions (mm)																							
	A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**C1**	**C2**	**C3**	**C4**	**C5**	**D1**	**D2**	**D3**	**D4**	**D5**	**E1**	**E2**	**E3**	**E4**	**E5**
-080-SN-1	2.5	4.2	7.7	6	12	4.8	3.2	1.3	3.2	7.7	4.2	2.5	6	12	8.2	3.5	4.2	6	12	5.6	3.2	1.3	2.5	4.3
-110-DN-1	2.5	4.2	7.7	6	12	4.8	3.2	1.3	3.2	8.7	4.2	3.5	6	12	8.2	3.5	4.2	6	12	5.6	3.2	1.3	2.5	4.3

A For fastening with clamping fixtures.
B For sensor plate (for magnetic/optical sensors).
C For fastening with sliding blocks
D For customer's attachment
E For switching cam (for optical sensor).

Motor attachment dimension drawings



FMB	i	Motor	Dimensions (mm)					
			L_m		L_G	L_F	A/D	H
			Without brake	With brake				
-080-SN-1 **-110-DN-1**	3/5/10	MSM 031C-0300	98.5	135.0	78.5	52	60	73
		ECMA-C20604 ECMA-C10604	130.7	166.8		46		73

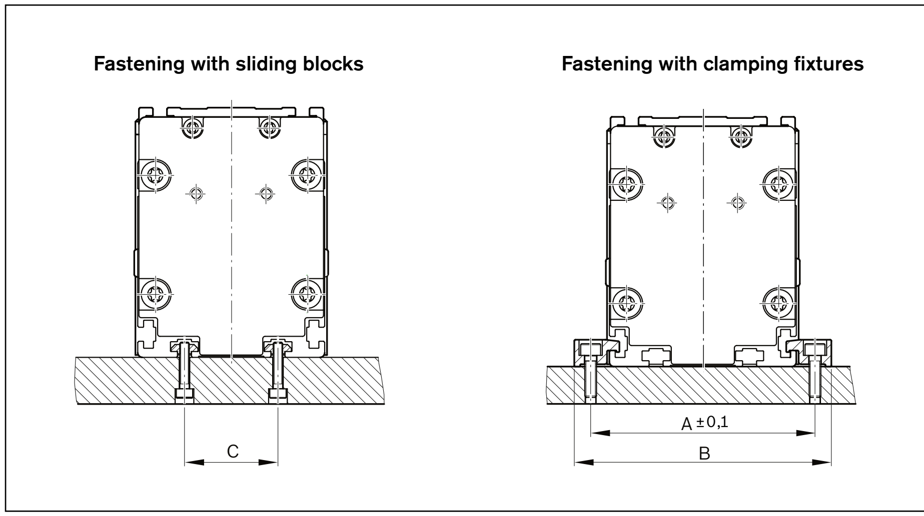
Mounting

General information

The Function Modules are mounted using various fastening elements:

- Sliding blocks
- Square nuts
- Spring nuts
- Screws for T-slots as per DIN 787 (no picture).
  Length depends on base.

Size	Dimensions (mm)		
	A	B	C
-080	96	110	40
-110	126	140	66

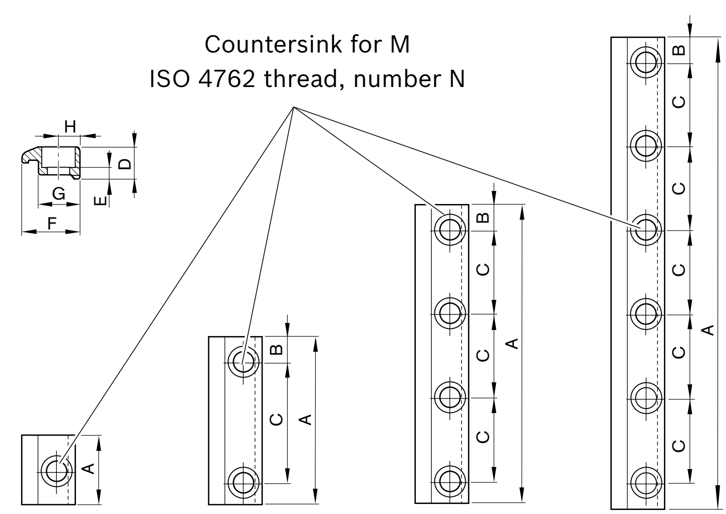


Clamping fixtures

Recommended number of clamping fixtures:

- Type 1: 6 per meter and side
- Type 2: 4 per meter and side
- Type 3: 3 per meter and side
- Type 4: 3 per meter and side

Clamping fixtures

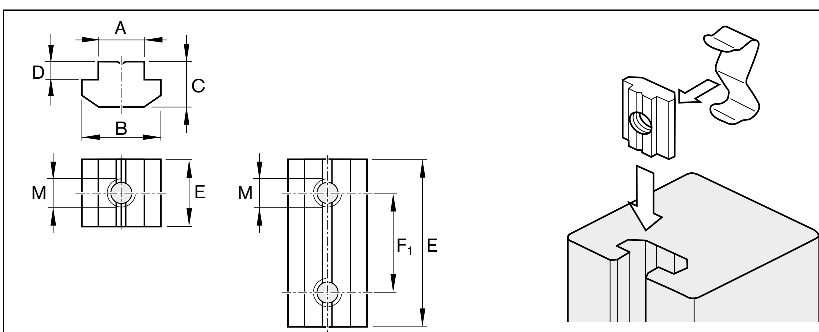


Size	For thread	Type	Number of holes N	Dimensions (mm)								Part number
				A	B	C	D	E	F	G	H	
-080/-110	M5	3	4	107	8.5	30	11.5	4.8	19.3	14.0	7.0	R037541002
		3	4	77	8.5	20						R037541026
		4	6	107	8.5	18						R037541041
	M6	1	1	25	–	–	11.5	5.3	19.3	14.0	7.0	R037551000
		3	4	142	11.0	40						R037551002
		2	2	72	11.0	50						R037551033
		2	2	62	11.0	40						R037551034
		2	2	47	8.5	30						R037551023
		4	6	142	8.5	25						R037551041

Sliding blocks, springs and strips

Recommended number at the sliding blocks: with one thread, six pieces per meter and side

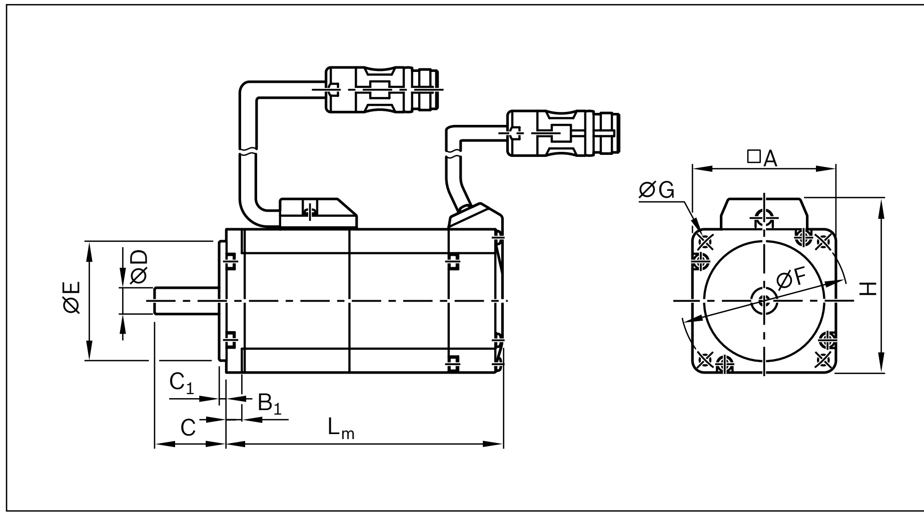
For fastening attachments on the connection plate.
The spring serves as a mounting and positioning aid.



Size	For thread	Dimensions (mm)						Sliding block part number	Spring part number
		A	B	C	D	E	F_1		
-080/-110	M4	6	11.5	4	1	12	–	R344701401	R341201002

Motor/controller

IndraDyn S MSM servo motors



Motor schematic

Motor code	**Dimensions** (mm)										
	A	**B_1**	**C**	**C_1**	**ØD h6**	**ØE h7**	**ØF**	**ØG**	**H**	**L_m Without holding brake**	**L_m With holding brake**
MSM031C-0300	60	6.5	30	3	14	50	70	4.5	73	98.5	135.0

Motor data

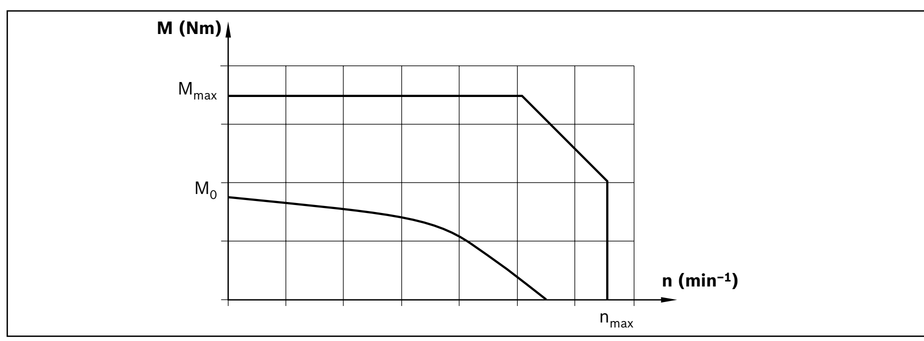
Motor code	**n_{max}** (rpm)	**M_0** (Nm)	**M_{max}** (Nm)	**M_{br}** (Nm)	**J_m** (kgm^2)	**J_{br}** (kgm^2)	**m_m** (kg)	**m_{br}** (kg)
MSM031C-0300	5,000	1.30	3.80	1.27	0.0000260	0.0000018	1.20	0.50

Motor code	Motor connection 1/2 cable(s)	Holding brake	Type code	Part number
MSM031C-0300-NN	2	Without	MSM031C-0300-NN-M5-MH0	R911344215
		With	MSM031C-0300-NN-M5-MH1	R911344216

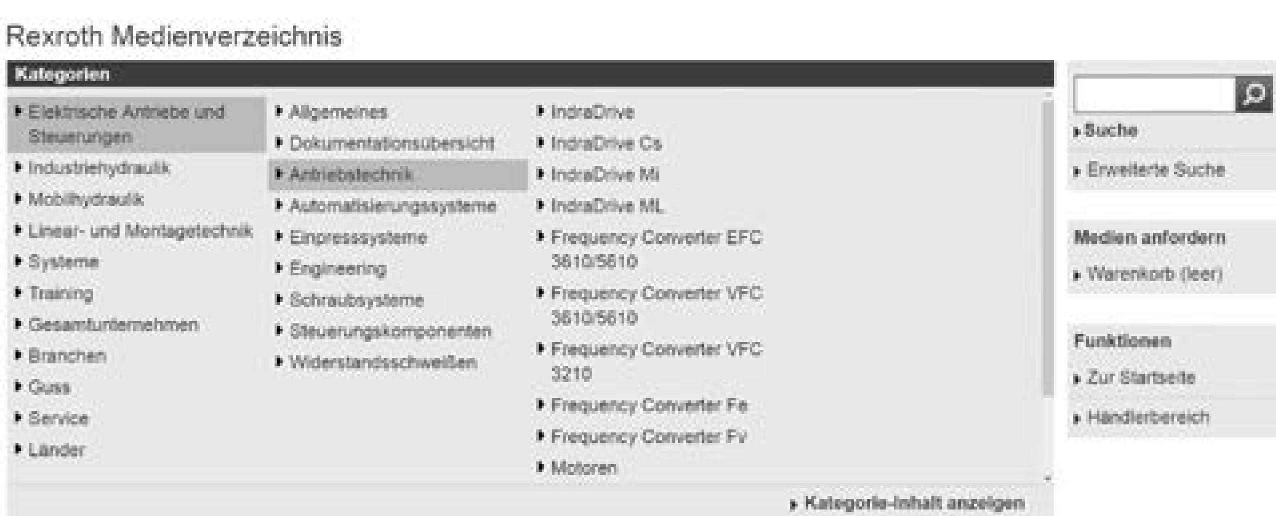
Versions:

- Plain shaft without shaft seal
- M5 multiturn absolute encoder (20-bit, absolute encoder function only available with backup battery)
- Cooling system: natural convection
- IP rating: IP54 (shaft: IP40)
- With or without holding brake
- M17 metal round connector

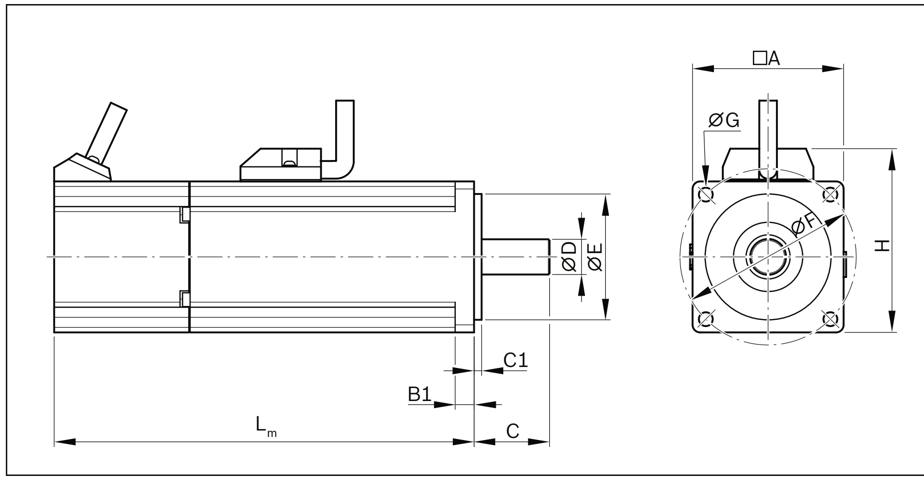
Torque/speed characteristic
(Schematic)



Note
Motors are available with control units and controllers. See the Rexroth Drive Technology catalog for other motor types and more information on motors, control units and controllers at www.boschrexroth.com/mediadirectory.



ECMA servo motors



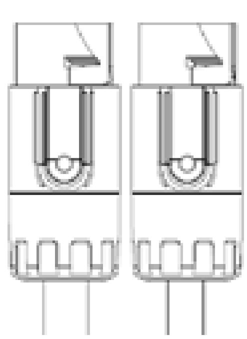
Motor schematic

Motor code	**Dimensions** (mm)									
	A	**B_1**	**C**	**C_1**	**ØD**	**ØE**	**ØF**	**ØG**	**H**	**L_m**
					h6	**h7**				
										Without holding brake	**With holding brake**
ECMA-C20604 ECMA-C10604	60	7.5	30	3	14	50	70	5.5	72.9	130.7	166.8

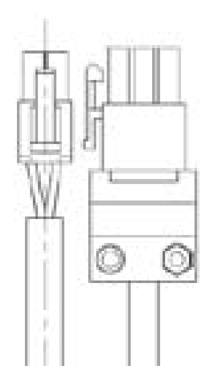
Motor data

Motor code	**n_{max}** (rpm)	**M_0** (Nm)	**M_{max}** (Nm)	**M_{br}** (Nm)	**J_m** (kgm^2)	**J_{br}** (kgm^2)	**m_m** (kg)	**m_{br}** (kg)
ECMA-C20604 ECMA-C10604	5,000	1.27	3.82	1.3	0.0000277	0.0000023	1.6	0.4

Connector variants



Round connector for ECMA-C20604 motor



Rectangular connector for ECMA-C10604 motor

Motor code	Motor connection 1/2 cable(s)	Holding brake	Type code	Part number
ECMA-C20604[1]	2	Without	ECMA-C20604CS	R913062732
		With	ECMA-C20604DS	R913062733
ECMA-C10604[2]	2	Without	ECMA-C10604YG	R913063450
		With	ECMA-C10604YK	R913063452

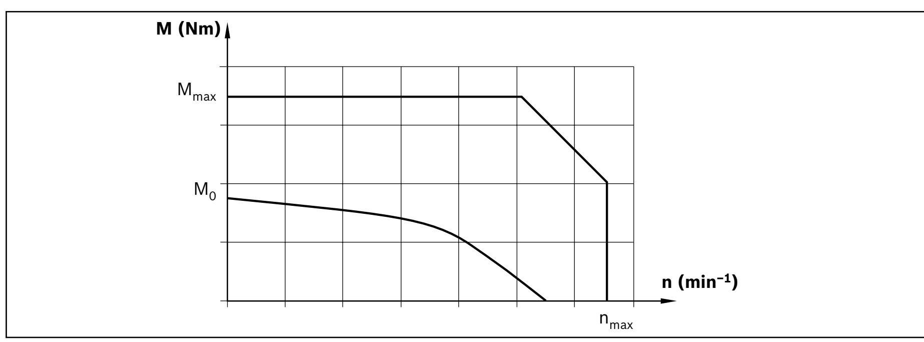
1) With rectangular connector
2) With IP67 round connector

Version

- Plain shaft
- With or without holding brake

Torque/speed characteristic

(Schematic)



Note

Motors are available with control units and controllers. More information below.

ASD-B2 drive controller

With step motor interface for ECMA servo motors

Part no.	Designation	Type	Characteristic(s)
Drive controller			
R913063556	Servo controller with step motor interface	ASD-B2-0421-B	400 W 200–230 V 1-phase/3-phase
Motor brake and encoder cables with rectangular connectors for ECMA-C2 motor			
R901490363	Motor brake cable	ASDBCAPW0305	Length 5 m
R901490374	Encoder cable	ASDBCAEN0005	Length 5 m
Accessories			
R911388169	CN1 connector with terminals	ASD-IF-DS4444	
R911388170	CN3 parameterization cable (for PC)	ASD-CNUS0A08	Length 3 m
R911266399	Mains filter	NFE02.1-230-008	8 A

Motor code	Motor connection 2 cables	Holding brake	Type code	Part number
ECMA-C20604	2	Without	ECMA-C20604CS	R913062732
		With	ECMA-C20604DS	R913062733

Note

Further information on control units, controllers and start-up software can be found in the Rexroth Media Directory at www.boschrexroth.com/mediadirectory.

ASD-A2 drive controller

With EtherCAT and CANopen interface for ECMA servo motors

Part no.	Designation	Type	Characteristic(s)
Drive controller			
R913063564	Servo controller with CANopen interface	ASD-A2-0421-M	400 W 200–230 V 1-phase/3-phase
R913063560	Servo controller with EtherCAT interface	ASD-A2-0421-E	
Motor brake and encoder cables with rectangular connectors for ECMA-C2 motor			
R901490568	Motor brake cable	ASD-ABPW0105	Length 5 m
R901490557	Encoder cable	ASD-ABEN0005	Length 5 m
Motor brake and encoder cables with (IP67 round connectors for ECMA-C1 motor			
R901490883	Motor cable with brake piloting	A2B-I67-.75-5	Length 5 m
R901490894		A2B-I67-.75-10	Length 10 m
R901490895		A2B-I67-.75-20	Length 20 m
R901490920	Encoder cable	A2I-03-05-A2-5	Length 5 m
R901490923		A2I-03-05-A2-10	Length 10 m
R901490925		A2I-03-05-A2-20	Length 20 m
Accessories			
R911388171	CN1 connector with terminals	ASD-IF-SC5020	
R901490926	CN4 parameterization cable (for PC)	UC-PRG015-02A	Length 1.5 m
R911266399	Mains filter	NFE02.1-230-008	8 A

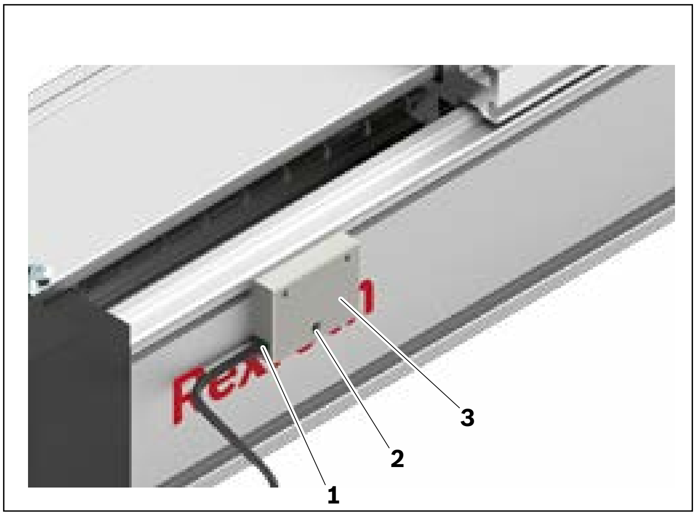
Motor code	Motor connection 2 cables	Holding brake	Type code	Part number
ECMA-C20604[1)]	2	Without	ECMA-C20604CS	R913062732
		With	ECMA-C20604DS	R913062733
ECMA-C10604[2)]	2	Without	ECMA-C10604YG	R913063450
		With	ECMA-C10604YK	R913063452

1) With rectangular connector
2) With IP67 round connector

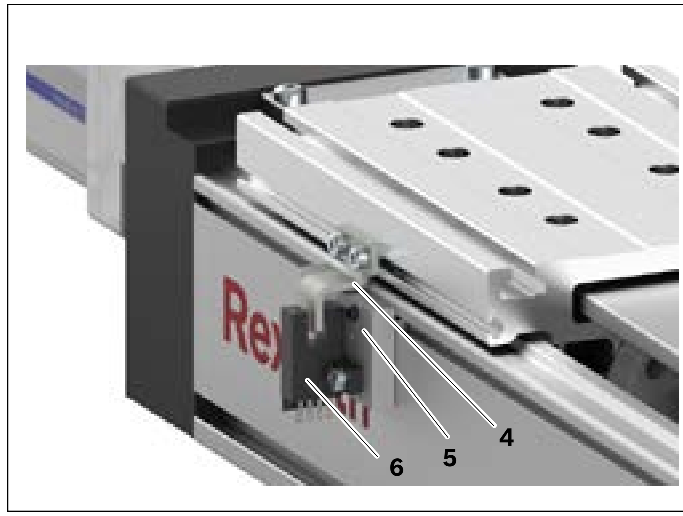
Switching system

Overview of switching system

Magnetic sensor



Optical sensor



1 Magnetic sensor
2 Clamping screw
3 Sensor plate

4 Switching cam
5 Sensor plate
6 Optical sensor

Ordering sensors and attachments

Assembly	Use	Designation
Magnetic sensor		
R114134020	Limit switch (PNP/NC)	MZT8-03VPO-KRDS14
R114134021	Reference switch (PNP/NO)	MZT8-03VPS-KRDS13
R114134022	Limit switch (NPN/NC)	MZT8-03VNO-KRDS16
R114134023	Reference switch (NPN/NO)	MZT8-03VNS-KRDS15
Optical sensor		
R116134020	Limit- Reference switch (PNP)	EE-SX672P
R116134021	Limit- Reference switch (NPN)	EE-SX672

Sensor mounting

Magnetic sensor

The switch activator is a magnet integrated in the carriage (no switching cam necessary). The switch activation points can be positioned anywhere along the stroke. Versions: Hall sensor

Optical sensor

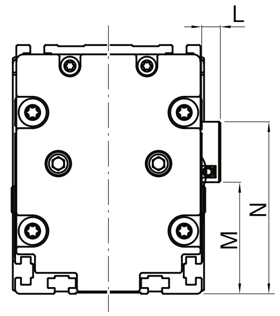
The switch activator is a switching cam. The switch activation points can be positioned anywhere along the stroke.

General mounting instructions:

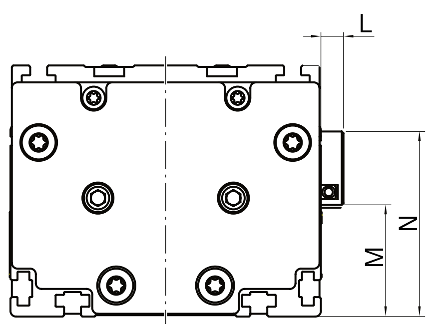
Sensors may only be mounted on one side (left or right) of the Function Module and should not be installed until the Function Module has been fastened to its base. For instructions on mounting and setting the switch activation points, see the Function Module manual.
See the section titled “Attachments and accessories” for technical data.

Sensor mounting

Magnetic sensor

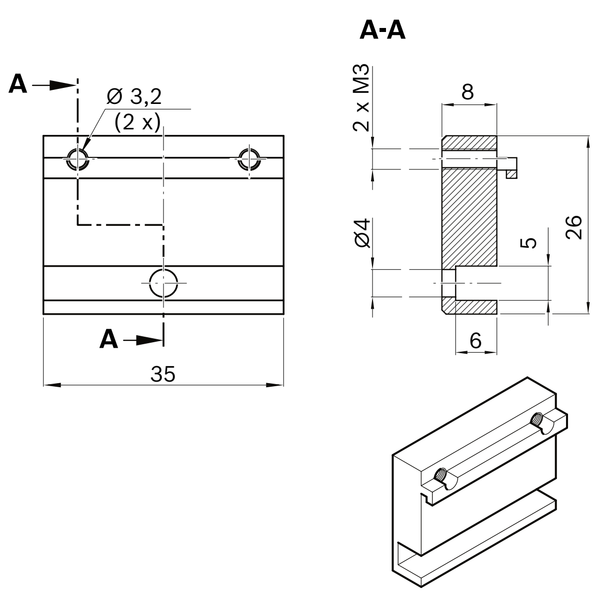


Single-rail version

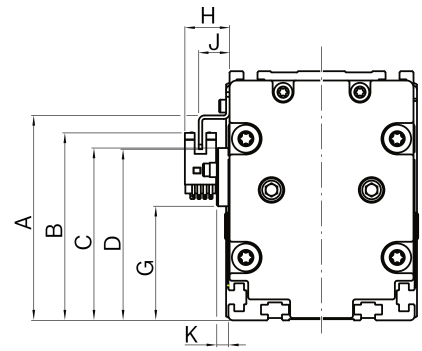


Dual-rail version

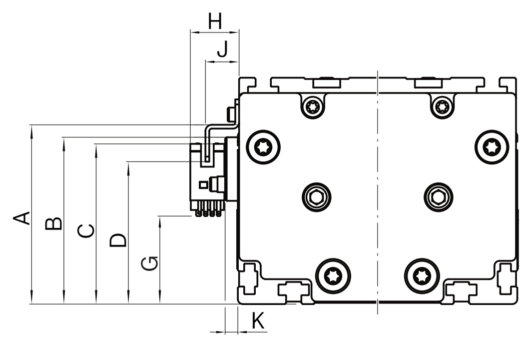
Sensor plate



Optical sensor

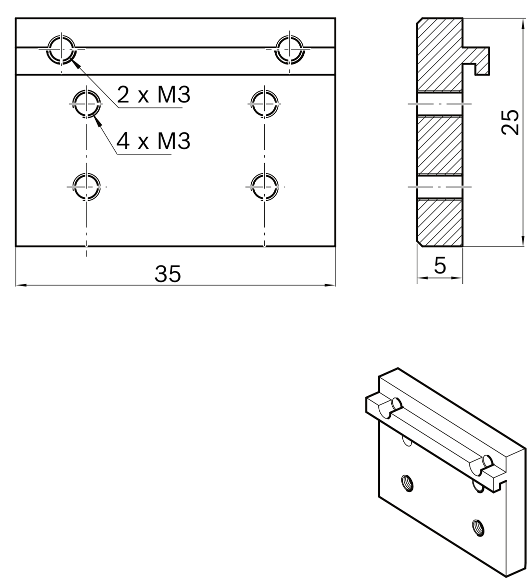


Single-rail version



Dual-rail version

Sensor plate



FMx	**Dimensions** (mm)												
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**
-080-SN-1	88.0	80.5	74	73.5	54.5	52.1	49.0	19.2	13.25	5	8	48.0	74.0
-110-DN-1	70.5	65.6	63	56.0	40.6	37.0	34.6	19.2	13.25	5	8	39.6	65.6

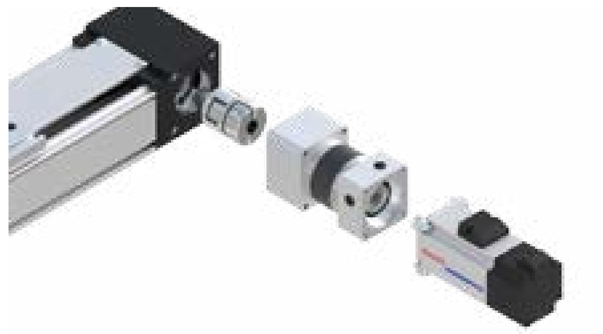
Attachments and accessories

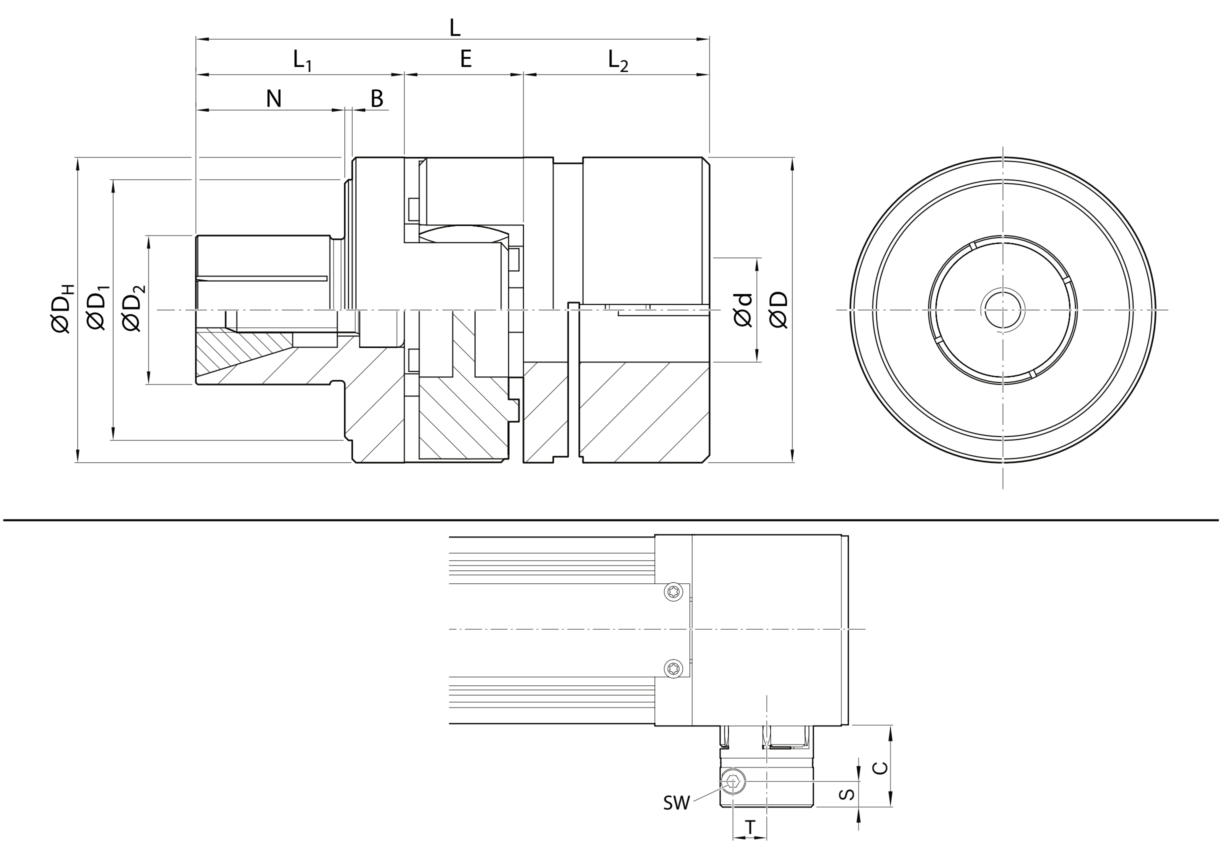
Coupling for FMB Function Modules

Couplings connect individual components such as motors, gears and linear axes, and transmit a rotary motion or torque.

Version

- Vibration-reducing claw coupling
- Axially intermatable
- Maintenance-free



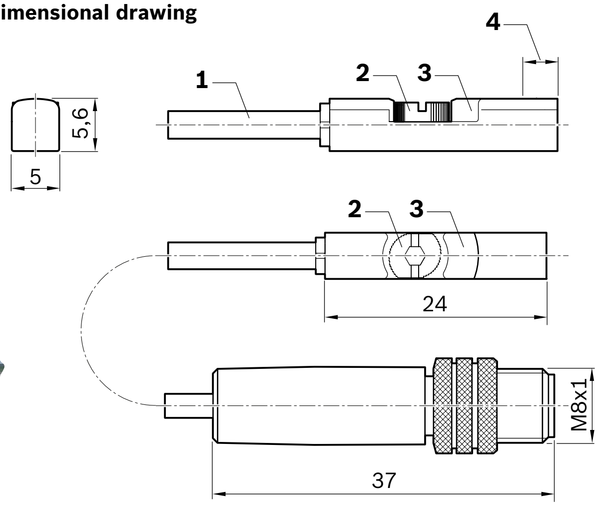


FMB	Part number (Coupling)	Dimensions (mm)													
		ØD	$ØD_H$	$ØD_1$	$ØD_2$	Ød	B	C	E	L	L_1	L_2	N	S	T
-080-SN-1	R345400219	41	41	35	20	14	1	37	16	69	28	25	20	11	14.5
-110-DN-1								31							

Sensors

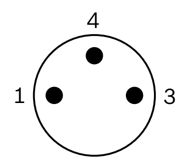
Magnetic sensor

Dimensional drawing



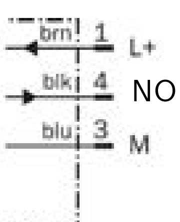
1) Connection
2) Fastening screw
3) LED display
4) Position of sensor element: 2 mm

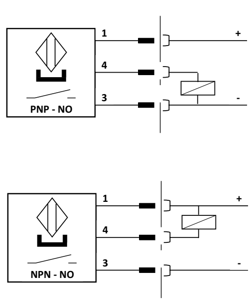
1 brown (+)
3 blue (-)
4 black (signal)



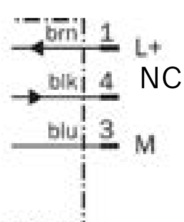
Connection diagram

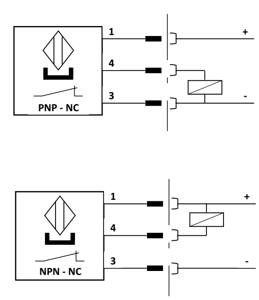
R913037444
R913037446





R913037443
R913037445





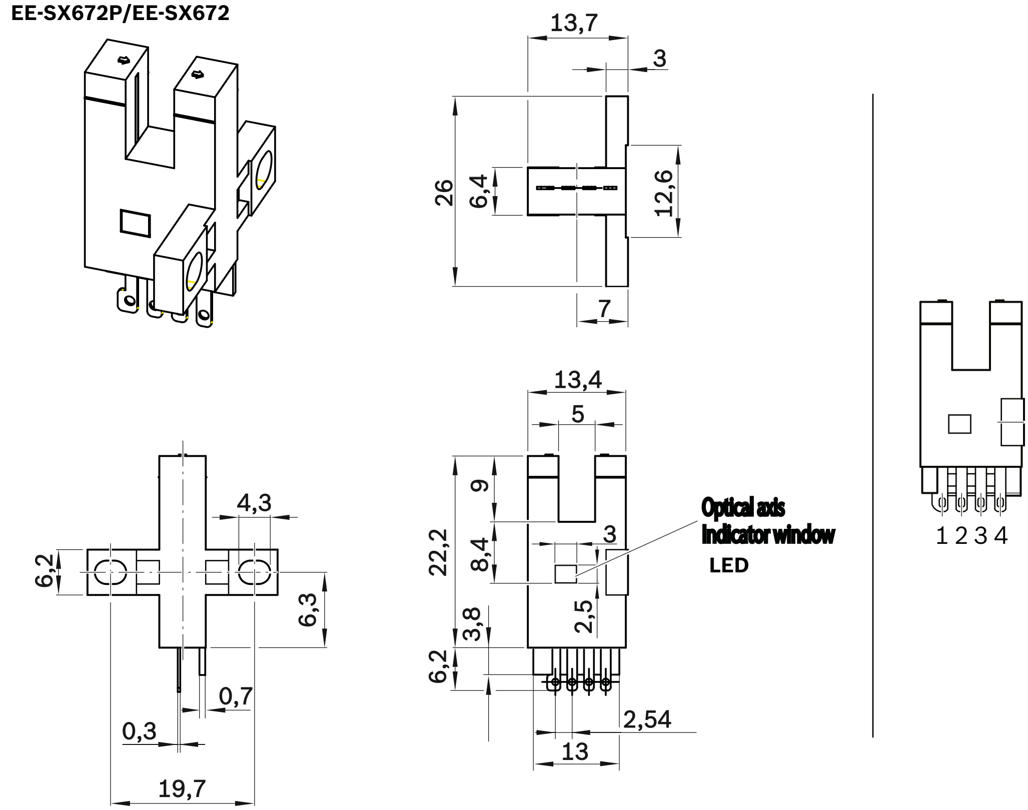
Part numbers/technical data

Use	Limit switch	Reference switch	Limit switch	Reference switch
Part number	R913037445	R913037444	R913037443	R913037446
Designation	MZT8-03VPO-KRDS14	MZT8-03VPS-KRDS13	MZT8-03VNO-KRDS16	MZT8-03VNS-KRDS15
Functional principle	Magnetic			
Operating voltage	10 - 30 VDC			
Load current	≦ 200 mA			
Switching function	PNP/NC	PNP/NO	NPN/NC	NPN/NO
Connection type	0.5 m cable and M8x1 connector, 3-pin with knurled screw connection			
Function indicator	✓			
Short-circuit protection	✓			
Reverse polarity protection	✓			
Switch-on suppression	✓			
Switching frequency	3 kHz			
Pulse elongation (off delay)	20 ms			
Max. permissible starting speed	5 m/s			
Suitable for drag chains[1]	✓			
Torsion-resistant[1]	✓			
Weld spark-resistant[1]	–			
Cable cross-section[1]	3x0.14 mm^2			
Cable diameter D[1]	2.9 ± 0.15 mm			
Static bending radius[1]	≧ 5xD			
Dynamic bending radius[1]	≧ 10xD			
Bending cycles[1]	> 2 mil.			
Maximum permissible travel speed[1]	5 m/s			
Max. permissible acceleration[1]	≦ 5 m/s^2			
Ambient temperature	-30 °C to +80 °C			
IP rating	IP68			
MTTFd (per EN ISO 13849-1)	MTTFd = 2339.0 years			
Certifications and approvals[2]				

[1] Technical data only for the cast-on connection cable (0.5 m) on the magnetic sensor. Available extension cables offer even more performance, e.g. for use in a cable drag chain (see below).
[2] For these products, no certificate is needed for launching on the Chinese market. Document “CCC sales information” available on request.

Optical sensor

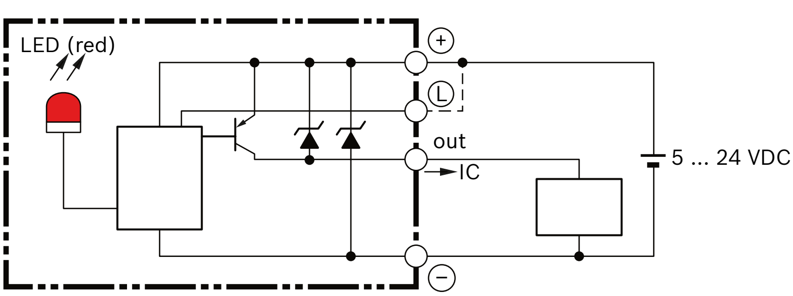
EE-SX672P/EE-SX672



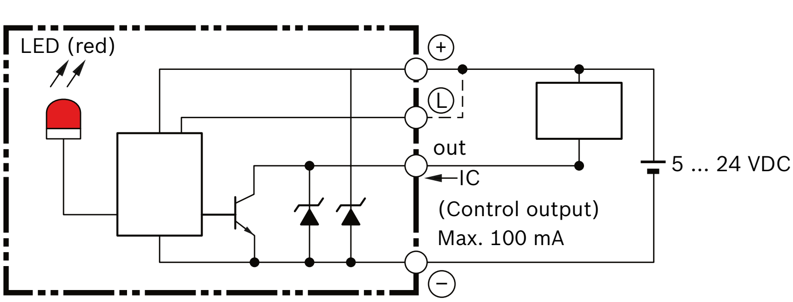
1	⊕	V_{CC}
2	**L**	L
3	**Out**	Output
4	⊖	GND (0 V)

Connection diagram

EE-SX672P



EE-SX672



Part numbers/technical data

Use	Limit switch/reference switch	
Part number	R901489850 (PNP)	R901489851 (NPN)
Designation	EE-SX672P optical sensor	EE-SX672 optical sensor
Sensor distance	5 mm (aperture width)	
Switching object	Opaque: min. 2 × 0.8 mm	
Differential distance	0.025 mm	
Light source	Infrared LED with peak wavelength of 940 nm	
Indicator	Light indicator (red; turns on when the light is broken in models ending in A or R)	
Power supply	5 to 24 VDC ± 10% residual ripple (p-p): max. 10%	
Current consumption	Max. 12 mA (connector models, L terminal open), max. 30 mA (prewired PNP models)	Max. 12 mA (connector models, L terminal open), max. 35 mA (prewired NPN models)
Control output	Open collector PNP: 5 to 24 VDC, max. 50 mA 50 mA load current with residual voltage of max. 1.3 V OFF current (leakage current): max. 0.5 mA	Open collector NPN 5 to 24 VDC, max. 100 mA 100 mA load current with residual voltage of max. 0.8 V 40 mA load current with residual voltage of max. 0.4 V OFF current (leakage current): max. 0.5 mA
Protective circuits	Load short-circuit protection (connector models), no circuit protection (prewired models)	
Response frequency	Min. 1 kHz (3 kHz average)	
Ambient lighting	Max. 1,000 lx with fluorescent light on receiver surface.	
Ambient temperature range	In operation: −25 °C to +55 °C; in storage: −30 °C to +80 °C (without freezing or condensation)	
Ambient humidity range	In operation: 5 to 85%; in storage: 5 to 95% (without freezing or condensation)	
Vibration resistance	Damage: 20 to 2000 Hz (peak acceleration: 100 m/s^2) 1.5 mm double amplitude for 2 h (4 min periods) in x-, y- and z-direction each	
Shock resistance	Damage: 500 m/s^2 3x in x-, y- and z-direction each	
IP rating	IP50 per IEC 60529	
Connection method	Connector models (direct soldering possible), prewired models (standard cable length: 1 m), models with connections (standard cable length: 0.1 m)	
Weight		
Connector models	Approx. 2.4 g	
Prewired models	Approx. 17.8 g	
Material		
Housing	Polybutylene terephthalate (PBT)	
Cover	Polycarbonate	
Transmitter/receiver		

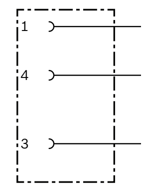
Connectors

Extensions for magnetic sensor

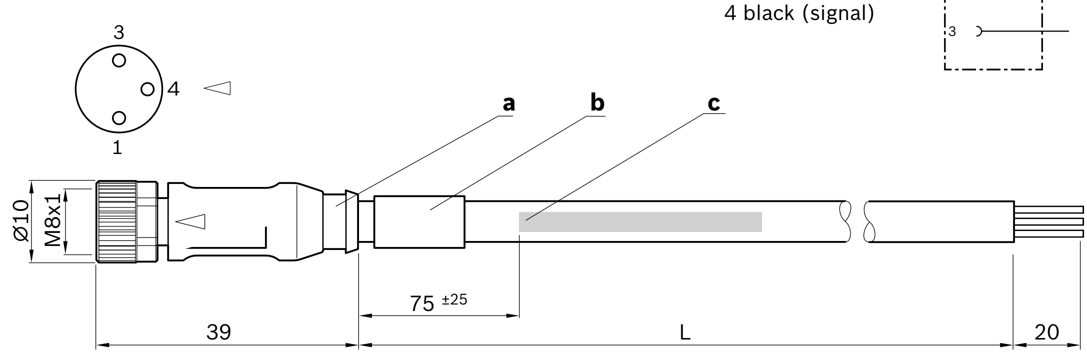
Assembled on one end

Connection diagram

1 brown (+)
3 blue (-)
4 black (signal)



Dimensional drawing



Part numbers

Use	Extension cable	
Part number	R911344602	R911344619
Designation	7000-08041-6500500	7000-08041-6501000
Length (L)	5.0 m	10.0 m
1. Connection type	M8x1 3-pin straight female connector	
2. Connection type	Unassembled cable end	

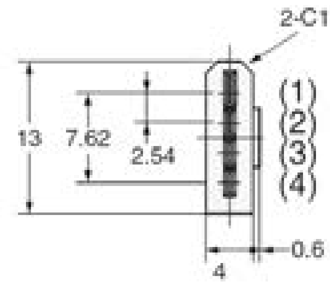
Technical data	
Function indicator	–
Operating voltage indicator	–
Operating voltage	10–30 V DC
Type of cable	PUR black
Suitable for drag chains	✓
Torsion-resistant	✓
Weld spark-resistant	✓
Cable cross-section	3 x 0.25 mm^2
Cable diameter D	4.1 ±0.2 mm
Static bending radius	≥ 5xD
Dynamic bending radius	≥ 10xD
Bending cycles	> 10 mill.
Max. permissible travel speed	3.3 m/s - at 5 m travel range (type) up to 5 m/s at 0.9 m travel range
Max. permissible acceleration	≤ 30 m/s^2
Ambient temperature when secured	–40 °C to +85 °C
Ambient temperature when loose	–25 °C to +85 °C
Protection class	IP68
Certifications and approvals	CE, cULus LISTED, CSA C US, PCT, RoHS

a) Contour for 6.5 mm corrugated tube (inner diameter)
b) Cable grommet
c) Cable label in accordance with labeling regulation

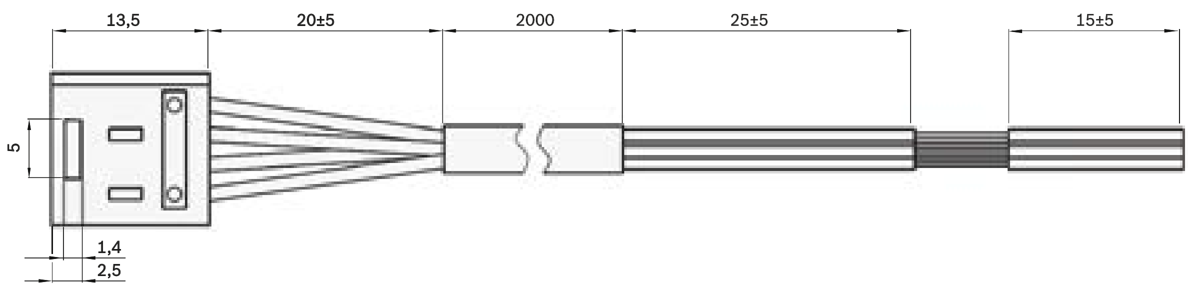
Extensions for optical sensor

Connection diagram

1	⊕	brown
2	**L**	pink
3	**Out**	black
4	⊖	blue



Dimensional drawing



Part numbers

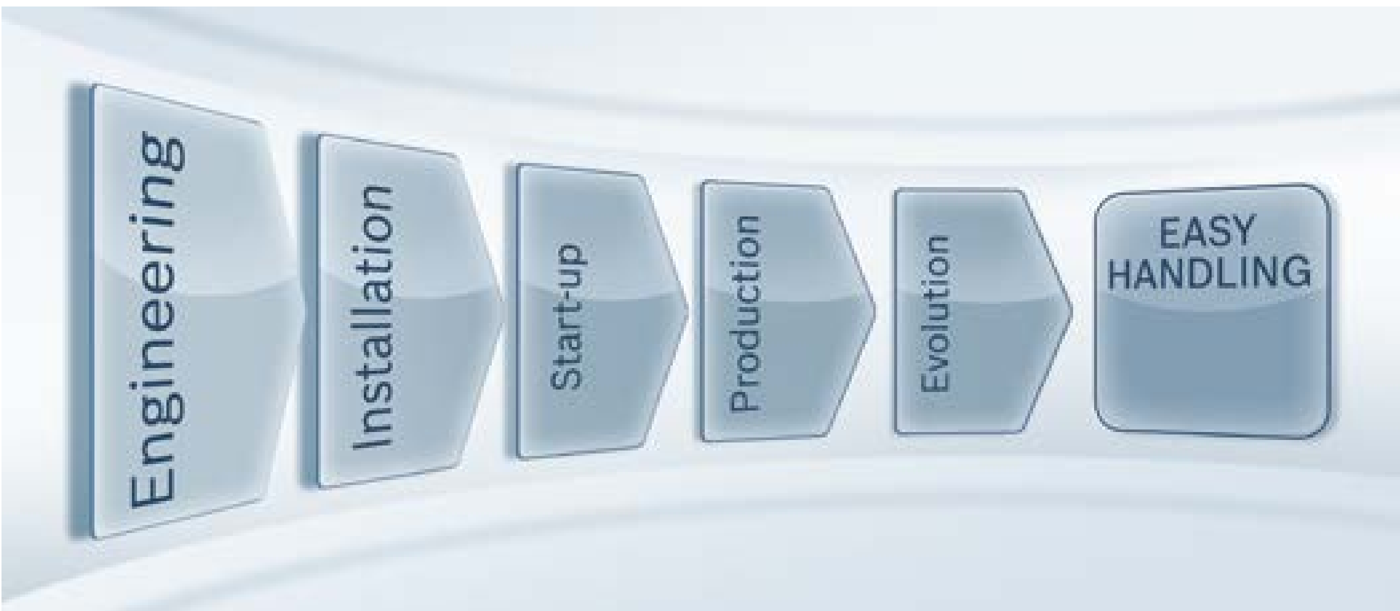
Use	Extension cable
Part number	R911388079
Designation	EE-1010 2M
Length (L)	2.0 m
1. Connection type	plug
2. Connection type	Unassembled cable end

EasyHandling

The perfect system solution for every application

Efficient production processes are the key to your success in the marketplace. Today's environment, defined by rapid change and short product cycles, demands flexible systems with an optimal design and configuration. EasyHandling gives you the tools you need to automate your handling tasks with greater ease, speed, and efficiency. EasyHandling is more than just a modular collection of mechanical components; it takes an evolutionary step forward by providing an all-inclusive system solution – our best solution for your requirements.

EasyHandling – Easier. Faster. More Economical.



Easier
to get results that fit
Tailor-made solutions just like that – with support all the way.

Faster route
to your ideal application
Effortless adaptation, even to future requirements – fast and flexible scalability.

More economical
thanks to built-in efficiency
Optimizes processes from planning to operation – while saving significantly on resources.

Planning – up to 70% faster
EasyHandling tools help users right from the component selection stage – by proposing solutions with all the necessary information on parts lists, technical data and CAD drawings.

Installation – saves up to 60% on time
Thanks to positive-locking interfaces, the mechanical components are perfectly aligned and accurately connected right away.

Start-up – reduces your effort by up to 90%
With the smart start-up assistant EasyWizard, parameterization and configuration take no time at all. Your handling system will be ready to go in just a few clicks.

Production – more economical and more efficient
Rexroth enhances the system effectiveness still further with smart application tools: The drive controller software sends maintenance-related messages to the user based on operating hours and travel to help schedule servicing at the right intervals. The result: longer life and reduced risk of failure.

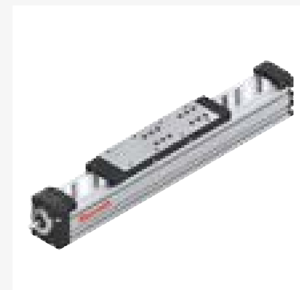
Future developments – continuous improvement
Prepare now for future market developments: One of the great features of EasyHandling systems is their openness. The flexibility of the mechanical and electrical components allows you to adapt quickly and efficiently to new production requirements.

EasyHandling – more than just a building system

The modular system concept for perfect scalability

basic – made-to-measure mechanics

EasyHandling basic includes all mechatronic components for complete, custom **single and multi-axis systems**.
All of the component interfaces are systematically standardized, making it possible to combine them with ease. Practical tools and aids make selection and configuration even easier.



comfort – get off to a faster start

EasyHandling comfort expands the basic component range by adding **powerful servo drives with multiple-protocol capability**. The universal, smart control units are ideally suited for a variety of handling tasks.
It also features the unique **EasyWizard start-up assistant**. Generate ready-to-use Linear Motion Systems in a snap by entering just a few application-specific parameters.

advanced – controls for demanding requirements

With its **individually scalable, high-performance Motion Logic solution**, EasyHandling advanced makes configuration and handling even easier. Predefined functions covering more than 90% of all handling applications eliminate the need for lengthy programming.

For more information about EasyHandling, see the brochure “EasyHandling – more than just a building system” R999000044.

Additional information

Operating conditions

Normal operating conditions

Ambient temperature with Rexroth servo motor	0 °C ... 40 °C, above 40 °C loss of performance
Ambient temperature for mechanical system (no dropping below dew point)	−10 °C ... 60 °C
Travel s_{min}[1)]	See “Technical data” tables
Soiling	Not permissible

1) Minimum travel to ensure a reliable lubrication distribution.

Required and supplementary documentation

For further instructions and information, please refer to the documentation for this product.

You can find PDF files of these documents on the Internet at www.boschrexroth.com/mediadirectory.

We would also be happy to send you the documents you want.

If you are unsure about using this product, please contact Bosch Rexroth.

Documentation

Standard report

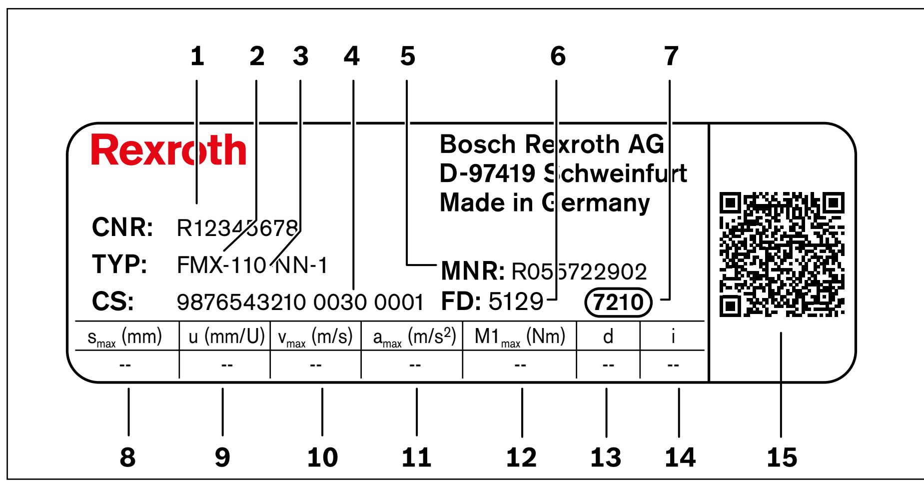
Option 001

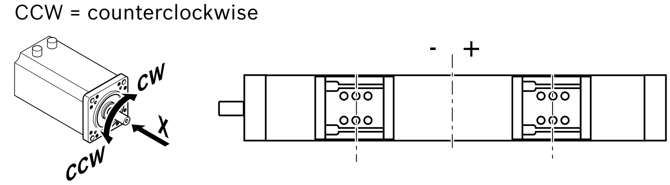
The standard report serves to confirm that the checks listed in the report have been carried out and that the measured values lie within the permissible tolerances.
Checks listed in the standard report:

- Functional checks of mechanical components
- Functional checks of electrical components
- Design as per order confirmation

Parameterization (start-up)

The nameplate contains reference information on the production of the Linear Motion System as well as technical start-up parameters.

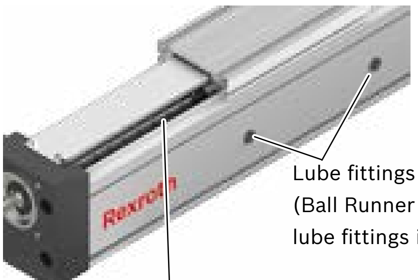


1	CNR	Customer's part number
2	TYP	Short product name
3	110	Size
4	CS	Customer information
5	MNR	Part number
6	FD	Manufacturing date
7	7210	Manufacturing location
8	s_{max}	Max. travel range
9	u	Lead constant without motor attachment
10	v_{max}	Maximum speed
11	a_{max}	Max. acceleration
12	$M1_{max}$	Maximum drive torque at motor journal
13	d	Direction of motor rotation to move in positive (+) direction CW = clockwise CCW = counterclockwise 
14	i	Gear ratio
15		QR code

Lubrication

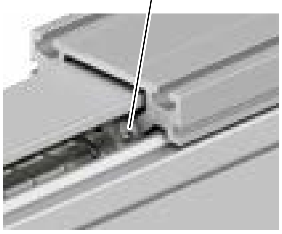
Function Module FMS

Lube fittings for single-rail version



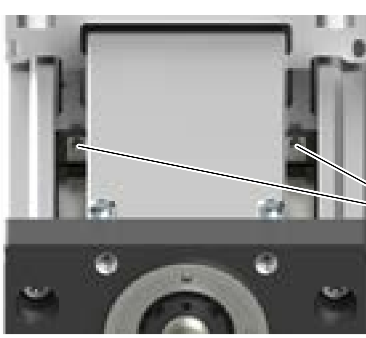
Lube fittings for Ball Rail System (Ball Runner Block) via the side lube fittings in the frame.

The Ball Screw Assembly is lubricated by the open access between the cover plate and frame.



Lube fittings for dual-rail version

Ball Rail Systems (Ball Runner Block) and Ball Screw Assembly are lubricated by the open access between the cover plate and frame.

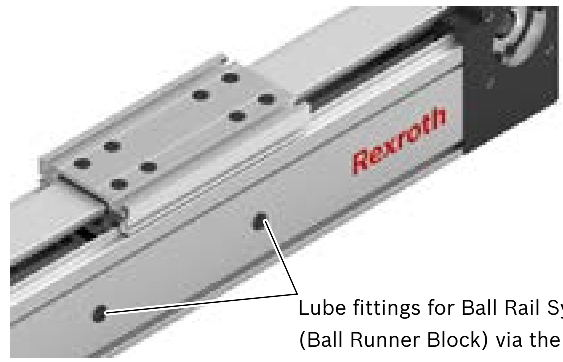


Lubrication of the Ball Rail Systems (Ball Runner Block) (lubricate four Runner Blocks).

Lubrication of the Ball Screw Assembly (FMS only)

Function Module FMB

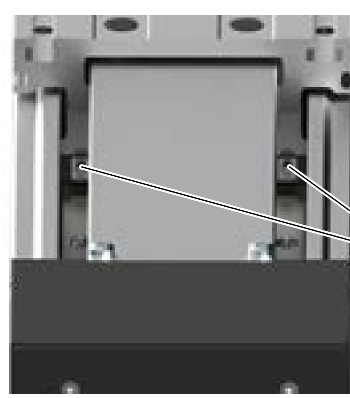
Lube fittings for single-rail version



Lube fittings for Ball Rail System (Ball Runner Block) via the side lube fittings in the frame.

Lube fittings for dual-rail version

Ball Rail Systems (Ball Runner Block) are lubricated by the open access between the cover plate and frame.



Lubrication of the Ball Rail Systems (Ball Runner Block) (lubricate four Runner Blocks).

Recommended lubricants

Note on lubrication

Function Modules come lubricated with Dynalub 510 and are only designed for grease lubrication using a manual grease gun.
Maintenance is limited to relubrication of the integrated Ball Rail System and the Ball Screw Assembly (on FMS Function Modules).

⚠ **Do not use lubricants with solid particles (e.g. graphite or MoS_2 additives).**

Recommended lubricants

For relubrication quantity and relubrication intervals, see the Function Module manual.

FMS/FMB	Grease (DIN)	Consistency class DIN 51818	Recommended grease
-080/-110	KP2K-20 (DIN 51825)	NLGI 2	Dynalub 510

Grease

Consistency class NLGI 2
as per DIN 51818
We recommend
Dynalub 510 (Bosch Rexroth)
Cartridge (400 g) R341603700
Hobbok (25 kg) R341603500

Can still be used

Elkalub GLS 135 / N2 (Chemie-Technik)
Castrol Longtime PD2 (Castrol)

Sample calculation

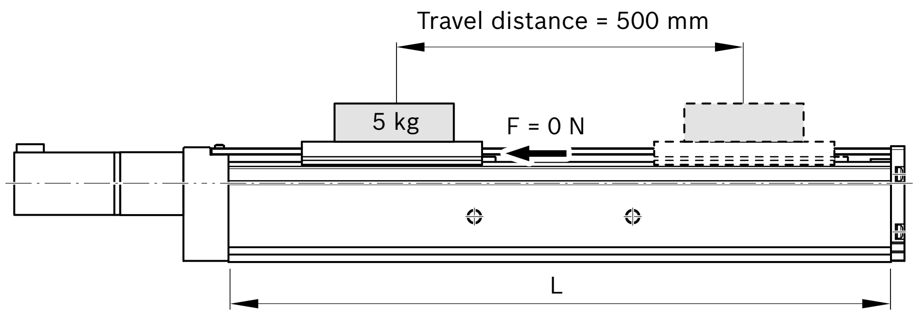
FMS with mount and coupling

Given data

An object weighing 5 kg needs to be moved horizontally 500 mm at a max. speed of 0.5 m/s. The following was selected based on the technical data and the installation space:

FMS-080-SN-1 Function Module

- Motor attachment with mount and coupling
- With MSM 031C servo motor without brake



Estimation of length L

The initial estimate assumes a large lead (P = 16 mm) and therefore length, since the permissible speed can decrease as length increases.

	L	$= s_{max} + L_{ca} + L_{ad}$
Excess travel:	s_e	$= 2 \cdot P = 2 \cdot 16 = 32$ mm
Max. travel distance:	s_{max}	$= s_{eff} + 2 \cdot s_e$
		$= 500 + 2 \cdot 32 = 564$ mm
Length:	L	$= 564 + 160 + 35 = 759$ mm

Selection of Ball Screw Assembly

(Better to choose the lowest lead as this is favorable in terms of resolution, braking distance, length.)

Acceptable Ball Screw Assemblies according to “max. permissible speed” graph given v = 0.5 m/s and L = 759 mm:

BASA 16 x 16 and BASA 16 x 10

Selected Ball Screw Assembly (lower lead):

BASA 16 x 10

Maximum permissible speed for BASA 16 x 10 as read off from graph:

$V_{max} = 0.58$ m/s

Calculation of length L

(For selected BASA)

Excess travel:	s_e	$= 2 \cdot P = 2 \cdot 10 = 20$ mm
Max. travel distance:	s_{max}	$= s_{eff} + 2 \cdot s_e$
		$= 500 + 2 \cdot 20 = 540$ mm
Length:	L	$= 540 + 160 + 35 = 735$ mm

Frictional torque M_R:

(Motor attachment with mount and coupling)

	M_R	=	M_{Rs}
Function Module:	M_{Rs}	=	0.8 Nm
Frictional torque:	M_R	=	0.80

Mass moment of inertia J_{ex}
(Motor attachment with mount and coupling)

	J_{ex}	=	$J_s + J_t + J_c$
Coupling:	J_c	=	$40 \cdot 10^{-6}$ kgm^2
Drive Unit:	J_s	=	$(k_{J\ fix} + k_{J\ var} \cdot L) \cdot 10^{-6}$
		=	$(15.045 + 0.031 \cdot 735) \cdot 10^{-6}$
		=	$37.83 \cdot 10^{-6}$ kgm^2
External load:	J_t	=	$m_{ex} \cdot k_{J\ m} \cdot 10^{-6}$
		=	$5 \cdot 2.53 \cdot 10^{-6}$
		=	$12.65 \cdot 10^{-6}$ kgm^2
Mass moment of inertia:	J_{ex}	=	$40 \cdot 10^{-6} + 37.83 \cdot 10^{-6} + 12.65 \cdot 10^{-6}$
		=	$90.48 \cdot 10^{-6}$ kgm^2

Maximum permissible rotary speed n_{mech}
(Motor attachment with mount and coupling)
Limit for mechanical system

	n_{mech}	=	$\frac{(v_{mech} \cdot 1{,}000 \cdot 60)}{P}$
Max. permissible speed:	v_{mech}	=	$v_{max} = 0.58$ m/s
Max. permissible rotary speed:	n_{mech}	=	$\frac{(0.58 \cdot 1{,}000 \cdot 60)}{10}$
		=	3,480 rpm

Maximum rotary speed of application n_{mech}
(Motor attachment with mount and coupling)
Application tolerance

Speed:	v_{mech}	=	0.5 m/s
Rotary speed:	n_{mech}	=	$\frac{0.5 \cdot 1{,}000 \cdot 60}{10}$
		=	3,000 rpm

Maximum permissible drive torque M_{mech}
(Motor attachment with mount and coupling)
Limit for mechanical system

	M_{mech}	=	Minimum (M_{cN}; M_p)
Coupling:	M_{cN}	=	12.5 Nm
Function Module:	M_p	=	7.8 Nm
Drive torque:	M_{mech}	=	minimum (12.5; 7.8)
		=	7.8 Nm

FMS with mount and coupling (continued)

Motor preselection check

Selected motor:
MSM 031C with brake

Condition 1:

Rotary speed: $n_{max} \geq n_{mech}$

$5{,}000 \geq 3{,}000$ Condition met – motor selection OK

Condition 2:

Mass moment of inertia ratio: $V = \dfrac{J_{ex}}{J_m + J_{br}}$

Motor moment of inertia: $J_m = 26.0 \cdot 10^{-6}$ kgm^2

Brake moment of inertia: $J_{br} = 0$ kgm^2 (without brake)

Moment of inertia ratio: $V = \dfrac{90.48 \cdot 10^{-6}}{(26 \cdot 10^{-6} + 0 \cdot 10^{-6})}$

$= 3.48$

Handling condition: $V \leq 6$

$3.48 \leq 6$ Condition met – motor size OK

Result

FMS-080-SN-1 Function Module

L = 735 mm, s_{max} = 540 mm, L_{ca} = 160 mm; BASA: d_0 = 60 mm, P = 10 mm; motor attachment with mount and coupling;
Motor preselection: MSM 031C without brake.
For precise dimensioning of the electric drive, the motor/controller combination must always be considered, as the performance data (e.g. max. useful speed and max. torque) will depend on the controller used.
When doing this, the following data must be considered:

Frictional torque:	M_R	= 0.80 Nm
Mass moment of inertia:	J_{ex}	= $90.48 \cdot 10^{-6}$ kgm^2
Speed:	v_{mech}	= 0.5 m/s (n_{mech} = 3,000 rpm)
Drive torque limit:	M_{mech}	= 7.8 Nm

➠ The motor torque must be limited to 7.8 Nm on the drive side.

Limit for acceleration:	a_{max}	= 40 m/s^2
Limit value for speed:	v_{mech}	= 0.58 m/s (n_{mech} = 3,480 rpm)

Besides the preferred type MSM 031C, other motors with identical mounting dimensions can be adapted while taking care not to exceed tolerances.

Abbreviations

Code/ index	Designation	Unit
a	Acceleration	(m/s²)
$\mathbf{a_{max}}$	Max. acceleration	(m/s²)
BASA	Ball Screw Assembly	(–)
$\mathbf{B_t}$	Belt type	(–)
cspe	Specific spring rate	(N)
C	Dynamic load capacity, guideway	(N)
$\mathbf{C_{bs}}$	Dynamic load rating for Ball Screw Assembly	(N)
$\mathbf{C_{fb}}$	Dynamic load rating for fixed bearing	(N)
$\mathbf{d_0}$	Nominal diameter of Ball Screw Assembly	(mm)
$\mathbf{d_3}$	Belt pulley diameter	(mm)
$\mathbf{f_w}$	Load factor	(–)
$\mathbf{F_1, F_2, \ldots F_n}$	Axial load during phases 1 ... n	(N)
Fbp	Max. belt driving force	(N)
$\mathbf{F_{comb}}$	Combined equivalent load on bearing	(N)
$\mathbf{F_m}$	Equivalent dynamic axial load	(N)
$\mathbf{F_{pr}}$	Preload force on motor	(N)
Ft perm	Belt elasticity limit	(N)
$\mathbf{F_y}$	Load from a resulting force in y-direction	(N)
$\mathbf{F_{y\ max}}$	Max. dynamic load in y-direction	(N)
$\mathbf{F_z}$	Load from a resulting force in z-direction	(N)
$\mathbf{F_{z\ max}}$	Max. dynamic load in z-direction	(N)
g	Gravity (= 9.81)	(m/s²)
i	Gear ratio	(–)
Iy	Planar moment of inertia about the y-axis	
Iz	Planar moment of inertia about the z-axis	
$\mathbf{J_{br}}$	Mass moment of inertia of motor brake	(kgm²)
$\mathbf{J_c}$	Mass moment of inertia of coupling	(kgm²)
$\mathbf{J_{dc}}$	Mass moment of inertia of drive train	(kgm²)
$\mathbf{J_{ex}}$	Mass moment of inertia of the mechanical system	(kgm²)
$\mathbf{J_{ge}}$	Mass moment of inertia of gear about the motor journal	(kgm²)
$\mathbf{J_m}$	Mass moment of inertia of motor	(kgm²)
$\mathbf{J_s}$	Mass moment of inertia of Linear Motion System	(kgm²)
$\mathbf{J_{sd}}$	Mass moment of inertia of belt timing belt side drive about the motor journal	(kgm²)
$\mathbf{J_t}$	Translatory mass moment of inertia of external load about the Linear Motion System screw journal	(kgm²)
$\mathbf{k_{g\ fix}}$	Constant for fixed portion of mass	(kg)
$\mathbf{k_{g\ var}}$	Constant for variable-length portion of mass	(kg/mm)
$\mathbf{k_{J\ fix}}$	Constant for fixed portion of mass moment of inertia	(kgmm²)
$\mathbf{k_{J\ m}}$	Constant for mass-specific portion of mass moment of inertia	(mm²)
$\mathbf{k_{J\ var}}$	Constant for variable-length portion of mass moment of inertia	(kgmm)

Code/ index	Designation	Unit
L	Length of Linear Motion System	(mm)
L	Nominal life – in revolutions – in meters	 (rpm) (m)
$\mathbf{L_{ad}}$	Additional length	(mm)
$\mathbf{L_{ca}}$	Carriage length	(mm)
$\mathbf{L_h}$	Nominal life	(h)
$\mathbf{L_m}$	Motor length	(mm)
$\mathbf{L_{max}}$	Max. length	(mm)
$\mathbf{L_W}$	Center-to-center distance between carriages	(mm)
$\mathbf{m_{br}}$	Brake mass	(kg)
$\mathbf{m_{ca}}$	Moved system mass of carriage	(kg)
$\mathbf{m_{ex}}$	Moved external mass	(kg)
$\mathbf{m_{fc}}$	Mass of mount and coupling	(kg)
$\mathbf{m_m}$	Motor mass	(kg)
$\mathbf{m_s}$	Mass of Linear Motion System (without attachments)	(kg)
$\mathbf{m_{sd}}$	Mass of timing belt side drive	(kg)
$\mathbf{M_0}$	Continuous motor torque	(Nm)
$\mathbf{M_{cN}}$	Nominal coupling torque	(Nm)
$\mathbf{M_g}$	Weight moment at motor journal	(Nm)
$\mathbf{M_{ge}}$	Maximum permissible acceleration torque of the gear (on the output drive)	(Nm)
$\mathbf{M_L}$	Dynamic longitudinal moment load capacity	(Nm)
$\mathbf{M_m}$	Equivalent dynamic torque	(Nm)
$\mathbf{M_{max}}$	Max. possible motor torque	(Nm)
$\mathbf{M_{mech} = Mp}$	Maximum permissible drive torque of mechanical system	(Nm)
$\mathbf{M_p}$	Maximum permissible drive torque (at drive journal)	(Nm)
$\mathbf{M_R}$	Frictional torque at motor journal	(Nm)
$\mathbf{M_{Rge}}$	Frictional torque of gear at motor journal	(Nm)
$\mathbf{M_{Rs}}$	Frictional torque of system	(Nm)
$\mathbf{M_{Rsd}}$	Frictional torque of timing belt side drive at motor journal	(Nm)
$\mathbf{M_{sd}}$	Maximum permissible drive torque of the timing belt side drive	(Nm)
$\mathbf{M_{stat}}$	Static load moment	(Nm)
$\mathbf{M_t}$	Dynamic torsional moment load capacity	(Nm)
$\mathbf{M_x}$	Dynamic torsional moment around the x-axis	(Nm)
$\mathbf{M_{x\ max}}$	Maximum permissible torsional moment around the x-axis	(Nm)
$\mathbf{M_y}$	Dynamic torsional moment around the y-axis	(Nm)
$\mathbf{M_{y\ max}}$	Maximum permissible torsional moment around the y-axis	(Nm)
$\mathbf{M_z}$	Dynamic torsional moment around the z-axis	(Nm)

Code/ index	Designation	Unit
$\mathbf{M_{z\,max}}$	Maximum permissible torsional moment around the z-axis	(Nm)
$\mathbf{n_1, n_2, \dots n_n}$	Rotary speed in acceleration and braking phases	(rpm)
$\mathbf{n_{A1-n}}$	Starting speed in Phase 1–n	(rpm)
$\mathbf{n_{E1-n}}$	Ending speed in Phase 1–n	(rpm)
$\mathbf{n_{ge}}$	Maximum permissible rotary speed of the gear	(rpm)
$\mathbf{n_m}$	Mean speed	(rpm)
$\mathbf{n_{mech}}$	Maximum permissible speed of mechanical system	(rpm)
$\mathbf{n_{max}}$	Max. motor speed	(rpm)
$\mathbf{n_P}$	Maximum permissible rotary speed of the Linear Motion System	(rpm)
P	Screw lead	(mm)
$\mathbf{P_{app}}$	Effective power in application	(W)
Keyway	Keyway	(–)
$\mathbf{s_a}$	Acceleration travel	(mm)
$\mathbf{s_e}$	Excess travel (excess travel s_e should be greater than breaking distance. The acceleration travel can be used as a guideline for braking distance.)	(mm)
$\mathbf{s_{eff}}$	Effective stroke	(mm)
$\mathbf{s_{min}}$	Min. travel distance	(mm)
$\mathbf{s_{max}}$	Max. travel distance	(mm)
SPU	Screw support	
$\mathbf{t_a}$	Acceleration time, braking time	(s)
$\mathbf{t_1, t_2, \dots t_n}$	Time for Phase 1 ... n	(s)
u	Lead constant	(mm/ rev)
$\mathbf{v_1, v_2, \dots v_n}$	Speed in phase 1 ... n	(m/s)
$\mathbf{v_{max}}$	Maximum permissible speed	(m/s)
$\mathbf{v_{mech}}$	Maximum permissible speed for mechanical system	(m/s)
$\mathbf{v_m}$	Mean speed	(m/s)
V	Ratio of mass moments of inertia of drive train and motor	(–)
$\mathbf{z_1}$	Application point of the effective force	(mm)
p	Pi	(–)

Sample order for FMS-080-SN-1

Ordering data	Option	Description
Function Module	FMS-080-SN-1	Function Module with Size 80 Ball Screw Assembly
Travel distance	500 mm	Required travel distance
Carriage	002	Carriage length = 160 mm
Guideway	001	Ball Rail System
Drive		
BASA (Ball Screw Assembly d_0 x P)	011	Nominal diameter = 16 mm, lead = 10 mm
Version	F001	With mount and coupling
Mounting interface		
Gear ratio	i = 1	Gear ratio i = 1
Mechanical interface	011	Motor attachment for MSM031C servo motor
Motor		
Motor code	MSM031C-0300	Motor code
Motor brake	139	With brake
Motor connector position	180	Motor connector position = 180°
Cover		
Cover plate	010	With cover plate
Documentation	001	Standard report

Inquiry/order form for FMx-xxx-xN-1

Ordering data	Option	Description
Function Module		
Travel distance		
Carriage		
Guideway		
Drive		
BASA (Ball Screw Assembly d_o x P)		
Version		
Mounting interface		
Gear ratio		
Mechanical interface		
Motor		
Motor code		
Motor brake		
Motor connector position		
Cover		
Cover plate		
Documentation		

Quantity Acceptance of: ______ unit(s), _______ per month, _______ per year, per order, or ___________________

Comments:

From

Company: ____________________ Name: ____________________

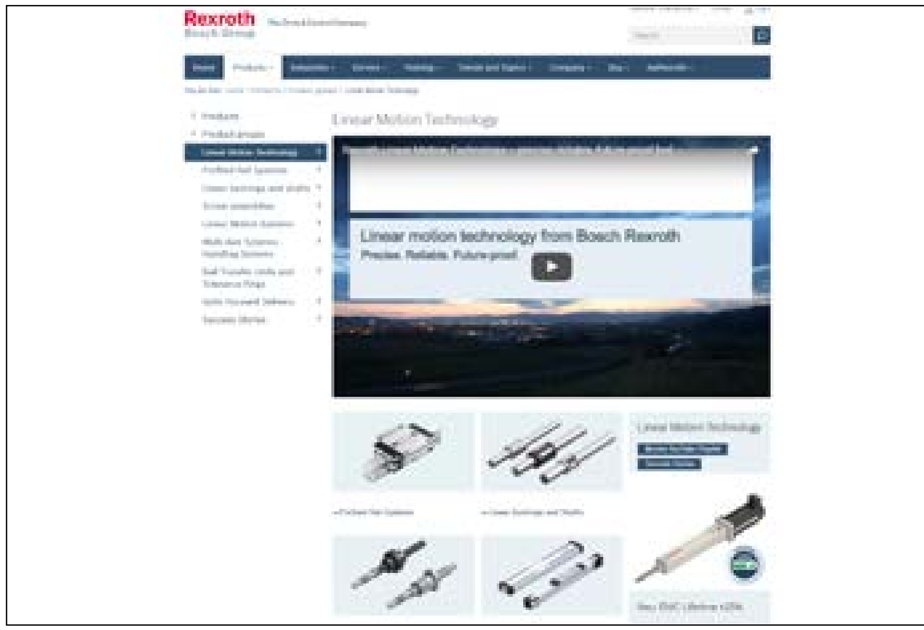
Address: ____________________ Department: ____________________

____________________ Telephone: ____________________

____________________ Telefax: ____________________

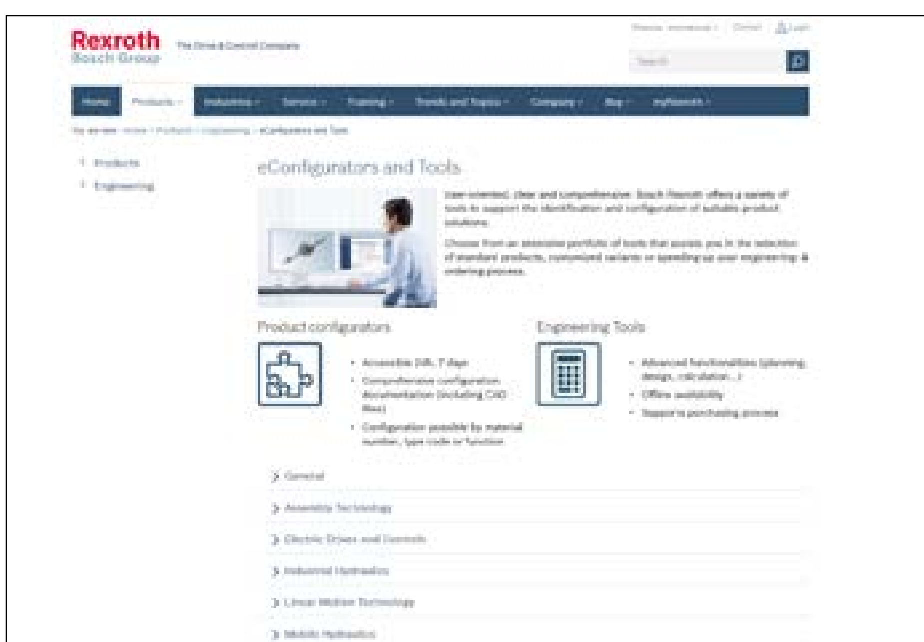
Further information

Bosch Rexroth Linear Motion Technology homepage:
https://www.boschrexroth.com/en/xc/products/product-groups/linear-motion-technology/index



Configurators and tools

https://www.boschrexroth.com/en/xc/products/engineering/econfigurators-and-tools/econfigurators



Bosch Rexroth AG
Ernst-Sachs-Straße 100
97424 Schweinfurt, Germany
Tel. +49 9721 937-0
Fax +49 9721 937-275
www.boschrexroth.com

Find your local contact person here:
www.boschrexroth.com/contact

R999001418/2018-08