25.1 Overview

Synchronous servo motor for screw drive (direct drive for threaded nut)

Axial forces of motors with convection cooling

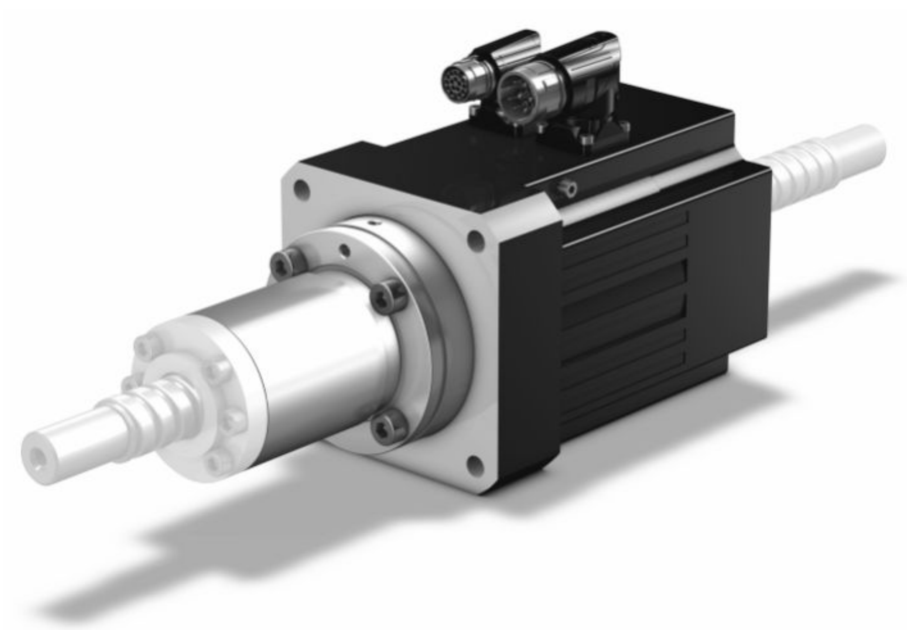
F_{ax}	751 – 21375 N

Axial forces of motors with water cooling

F_{ax}	919 – 30649 N

Features

Designed for ball threaded nut drive of ball screws in accordance with DIN 69051-2.	✓
Axial angular ball bearing acting on two sides for direct absorption of the threaded spindle forces	✓
Super compact due to tooth winding technology with the highest possible copper fill factor	✓
Backlash-free holding brake (optional)	✓
Convection cooling or water cooling (optional)	✓
Inductive EnDat absolute value encoder	✓
Multiturn absolute value encoders (optional) eliminate the need for referencing	✓
Electronic nameplate for fast and reliable commissioning	✓
Rotating plug connectors with quick lock	✓



EZM

25.2 Selection tables

The technical data specified in the selection tables applies for:

- Installation altitudes up to 1000 m above sea level
- Surrounding temperatures from 0° C to 40° C
- Operation on a STOBER drive controller
- DC link voltage U_{ZK} = DC 540 V
- Paint black matte as per RAL 9005

In addition the technical data apply to an uninsulated design with the following thermal mounting conditions:

Motor type	Steel mounting flange dimensions (thickness x width x height)	Convection surface Steel mounting flange
EZM5	23 x 210 x 275 mm	0.16 m^2
EZM7	28 x 300 x 400 mm	0.3 m^2

Formula symbols	Unit	Explanation
F_{ax}	N	Permitted axial force on the output
I_0	A	Standstill current: RMS value of the line-to-line current with standstill torque M_0 generated (Tolerance ±5 %)
I_{max}	A	Maximum current: RMS value of the maximum permitted line-to-line current with maximum torque M_{max} generated (tolerance ±5 %).
		Exceeding I_{max} may lead to irreversible damage (demagnetization) of the rotor.
I_N	A	Nominal current: RMS value of the line-to-line current with nominal torque M_N generated (tolerance ±5 %)
J	10^{-4}kgm^2	Mass moment of inertia
K_{EM}	V/rpm	Voltage constant: peak value of the induced motor voltage at a speed of 1000 rpm and a winding temperature $\Delta\vartheta$ = 100 K (tolerance ±10 %)
K_{M0}	Nm/A	Torque constant: ratio of the standstill torque and frictional torque to the standstill current; $K_{M0} = (M_0 + M_R) / I_0$ (tolerance ±10 %)
$K_{M,N}$	Nm/A	Torque constant: ratio of the nominal torque M_N to the nominal current I_N; $K_{M,N} = M_N / I_N$ (tolerance ±10 %)
L_{U-V}	mH	Winding inductance of a motor between two phases (determined in the oscillating circuit)
m	kg	Weight
M_0	Nm	Standstill torque: the torque the motor is able to deliver long term at a speed of 10 rpm (tolerance ±5 %)
M_{max}	Nm	Maximum torque: the maximum permitted torque the motor is able to deliver briefly (when accelerating or decelerating) (tolerance ±10 %)
M_N	Nm	Nominal torque: the maximum torque of a motor in S1 mode at nominal speed n_N (tolerance ±5 %)
		You can calculate other torques as follows: $M_{N*} = K_{M0} \cdot I^* - M_R$.
M_R	Nm	Frictional torque (of the bearings and sealings) of a motor at winding temperature $\Delta\vartheta$ = 100 K
n_N	rpm	Nominal speed: the speed for which the nominal torque M_N is specified

Formula symbols	Unit	Explanation
P_N	kW	Nominal output: the output the motor is able to deliver long term in S1 mode at the nominal point (tolerance ±5 %)
R_{U-V}	Ω	Winding resistance of a motor between two phases at a winding temperature of 20 °C
T_{el}	ms	Electrical time constant: ratio of the winding inductance to the winding resistance of a motor: $T_{el} = L_{U-V} / R_{U-V}$
U_{ZK}	V	DC link voltage: characteristic value of a drive controller

25.2.1 EZM motors with convection cooling

Type	K_{EM} [V/1000 rpm]	n_N [rpm]	M_N [Nm]	I_N [A]	$K_{M,N}$ [Nm/A]	P_N [kW]	M_0 [Nm]	I_0 [A]	K_{M0} [Nm/A]	M_R [Nm]	M_{max} [Nm]	I_{max} [A]	R_{U-V} [Ω]	L_{U-V} [mH]	T_{el} [ms]
EZM511U	97	3000	3.65	3.55	1.03	1.2	4.25	4.00	1.19	0.49	16.0	22.0	3.80	23.50	6.18
EZM512U	121	3000	6.60	5.20	1.27	2.1	7.55	5.75	1.40	0.49	31.0	33.0	2.32	16.80	7.24
EZM513U	119	3000	8.80	6.55	1.34	2.8	10.6	7.60	1.46	0.49	43.0	41.0	1.25	10.00	8.00
EZM711U	95	3000	6.35	6.60	0.96	2.0	7.30	7.40	1.07	0.65	20.0	25.0	1.30	12.83	9.87
EZM712U	133	3000	10.6	7.50	1.41	3.3	13.0	8.90	1.53	0.65	41.0	36.0	1.00	11.73	11.73
EZM713U	122	3000	14.7	10.4	1.41	4.6	18.9	13.0	1.50	0.65	65.0	62.0	0.52	6.80	13.08

25.2.2 EZM motors with water cooling

Type	K_{EM} [V/1000 rpm]	n_N [rpm]	M_N [Nm]	I_N [A]	$K_{M,N}$ [Nm/A]	P_N [kW]	M_0 [Nm]	I_0 [A]	K_{M0} [Nm/A]	M_R [Nm]	M_{max} [Nm]	I_{max} [A]	R_{U-V} [Ω]	L_{U-V} [mH]	T_{el} [ms]
EZM511W	97	3000	4.95	4.75	1.04	1.6	5.20	4.85	1.18	0.49	16.0	22.0	3.80	23.50	6.18
EZM512W	121	3000	9.75	7.70	1.27	3.1	10.6	7.85	1.41	0.49	31.0	33.0	2.32	16.80	7.24
EZM513W	119	3000	13.1	10.2	1.28	4.1	14.8	11.3	1.35	0.49	43.0	41.0	1.25	10.00	8.00
EZM711W	95	3000	9.80	9.95	0.98	3.1	10.0	10.0	1.06	0.65	20.0	25.0	1.30	12.83	9.87
EZM712W	133	3000	16.7	12.2	1.37	5.3	18.8	13.1	1.49	0.65	41.0	36.0	1.00	11.73	11.73
EZM713W	122	3000	22.0	17.0	1.29	6.9	27.1	19.6	1.42	0.65	65.0	62.0	0.52	6.80	13.08

25.2.3 Mass moments of inertia and weights

	df [mm]	ef [mm]	ef2 [mm]	J [10^{-4} kgm²]	m [kg]
EZM511	40	51	65	20,3	9,9
EZM512	40	51	65	23,6	11,5
EZM513	40	51	65	26,8	13,1
EZM711	50	65	78	53,7	17,4
EZM711	56	71	78	60,3	17,6
EZM712	50	65	78	63,1	19,9
EZM712	56	71	78	69,7	20,1
EZM713	50	65	78	72,4	22,5
EZM713	56	71	78	79,0	22,7

25.3 Torque/speed characteristic curves

Torque/speed characteristic curves depend on the nominal speed and/or winding version of the motor and the DC link voltage of the drive controller that is used. The following torque/speed characteristic curves apply to the DC link voltage DC 540 V.

Formula symbols	Unit	Explanation
ED	%	Duty cycle relative to 10 minutes
M_{lim}	Nm	Torque limit without compensating for field weakening
M_{limFW}	Nm	Torque limit with compensation for field weakening (applies to operation on STOBER drive controllers only)
M_{limK}	Nm	Torque limit of the motor with convection cooling
M_{limW}	Nm	Torque limit of the motor with water cooling
M_{max}	Nm	Maximum torque: the maximum permitted torque the motor is able to deliver briefly (when accelerating or decelerating) (tolerance ±10 %)
n_N	rpm	Nominal speed: the speed for which the nominal torque M_N is specified
$\Delta\vartheta$	K	Temperature difference

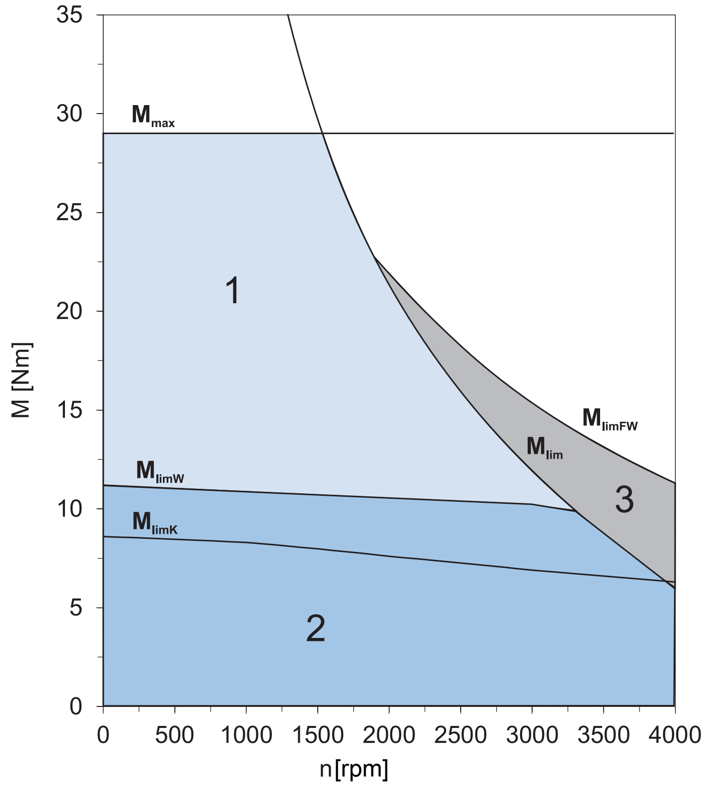
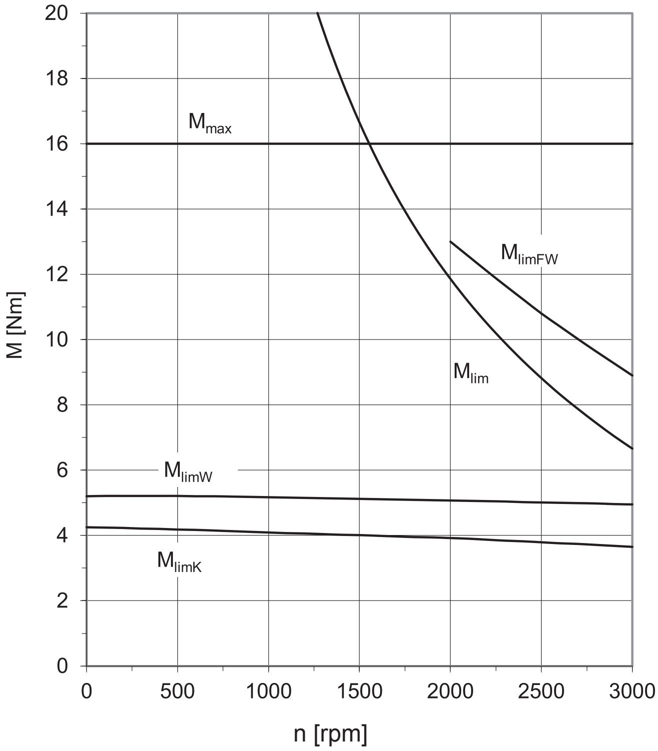


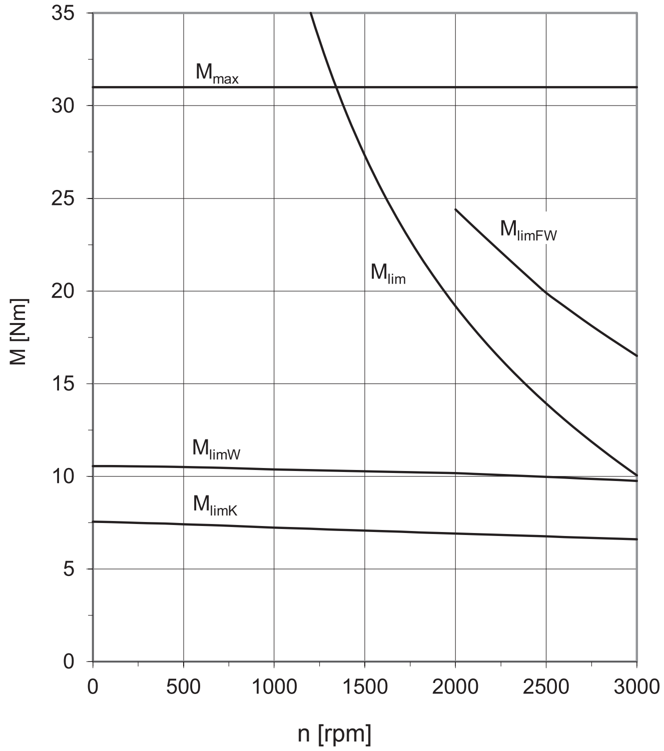
Illustration 1: Explanation of a torque/speed characteristic curve

1	Torque range for brief operation (duty cycle < 100%) with ϑ = 100 K	2	Torque range for continuous operation at a constant load (S1 mode, duty cycle = 100%) with ϑ = 100 K
3	Field weakening range (can only be used with operation on STOBER drive controllers)		

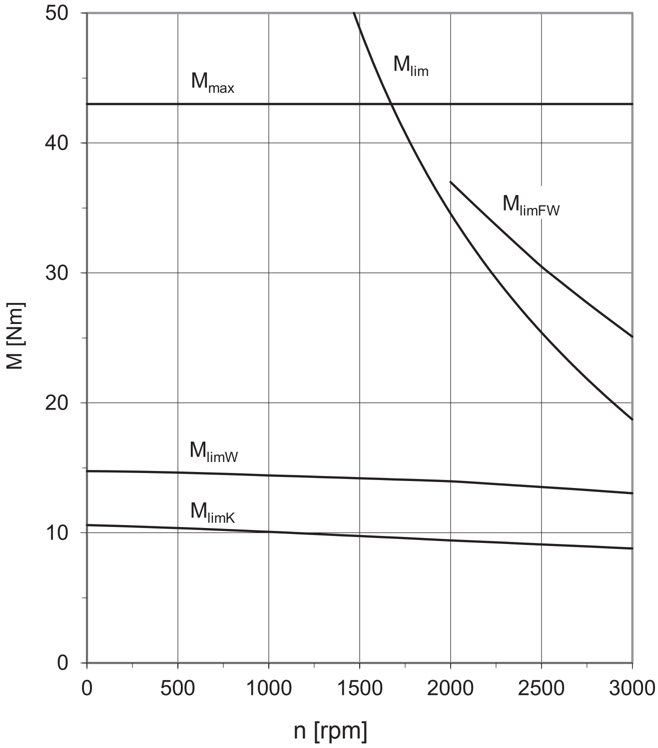
EZM511 (n_N=3000 rpm)



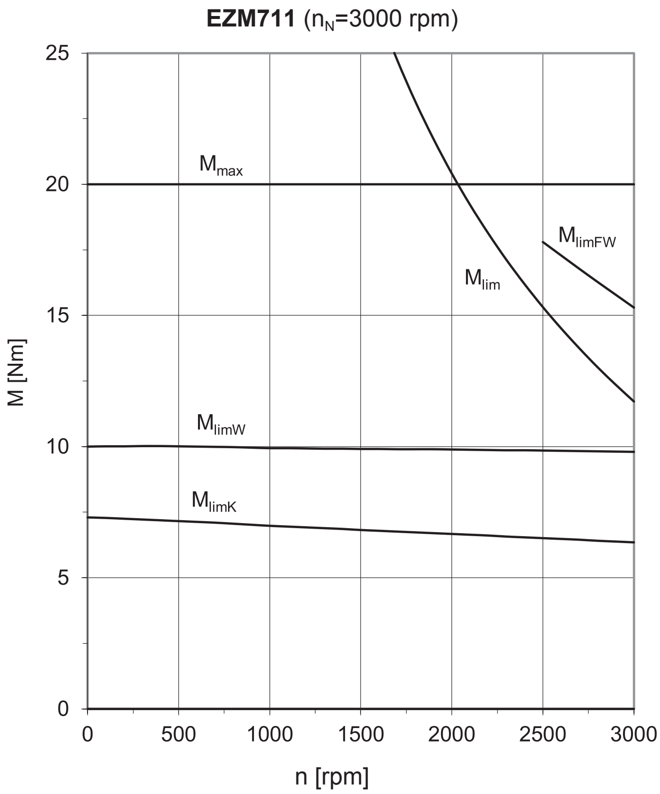
EZM512 (n_N=3000 rpm)

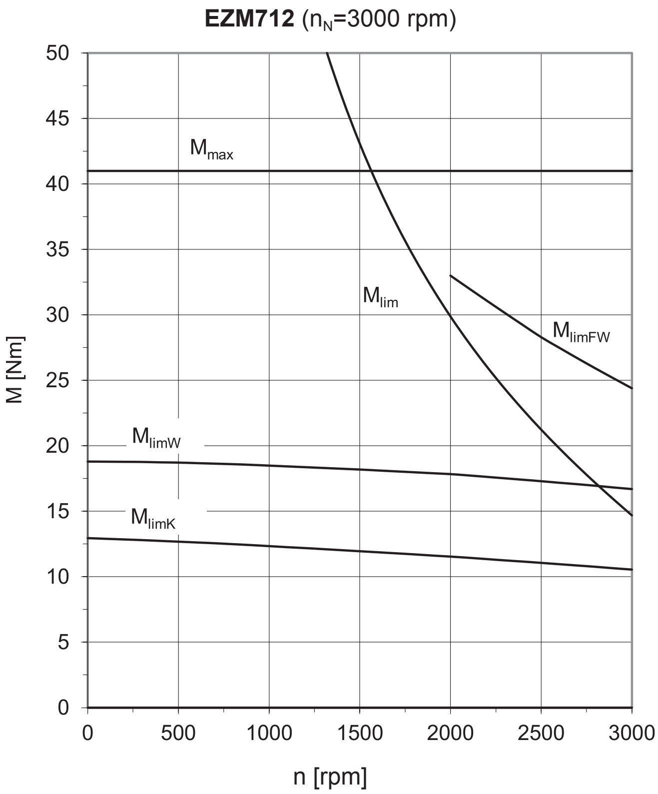


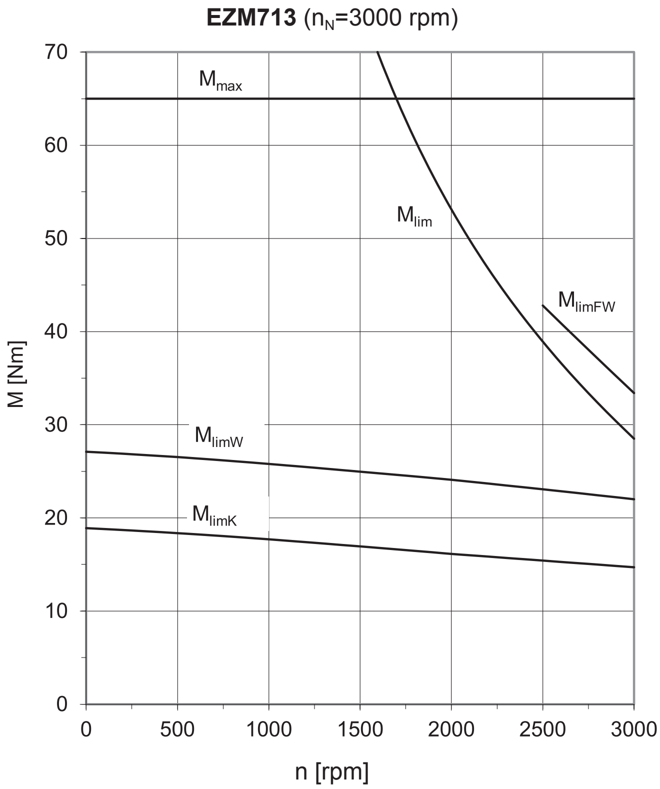
EZM513 (n_N=3000 rpm)



EZM


EZM711 (n_N=3000 rpm)
M [Nm]
n [rpm]
M_{max}
M_{lim}
M_{limFW}
M_{limW}
M_{limK}


EZM712 (n_N=3000 rpm)
M [Nm]
n [rpm]
M_{max}
M_{lim}
M_{limFW}
M_{limW}
M_{limK}


EZM713 (n_N=3000 rpm)
M [Nm]
n [rpm]
M_{max}
M_{lim}
M_{limFW}
M_{limW}
M_{limK}

STÖBER

25.4 Dimensional drawings

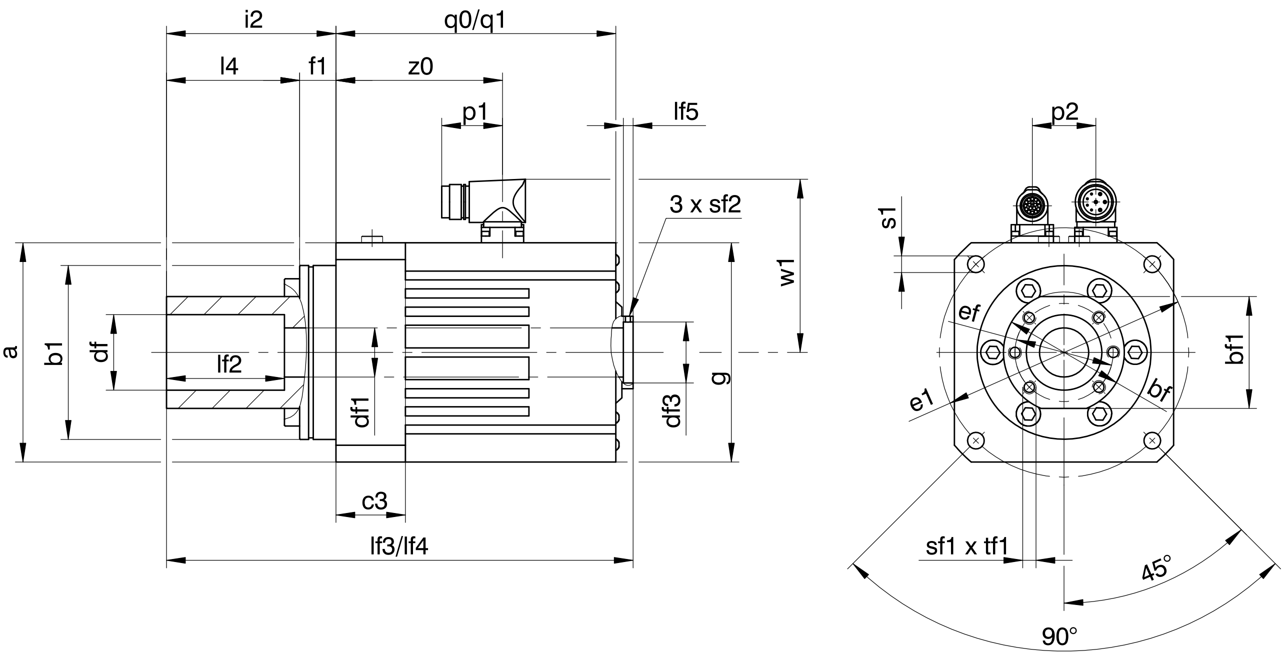
In this chapter you can find the dimensions of the motors.

Dimensions may exceed the requirements of ISO 2768-mK due to casting tolerances or the sum of additional tolerances.

We reserve the right to make modifications to the dimensions due to technical advances.

You can download CAD model of our standard drives from http://cad.stoeber.de.

25.4.1 EZM motors with convection cooling

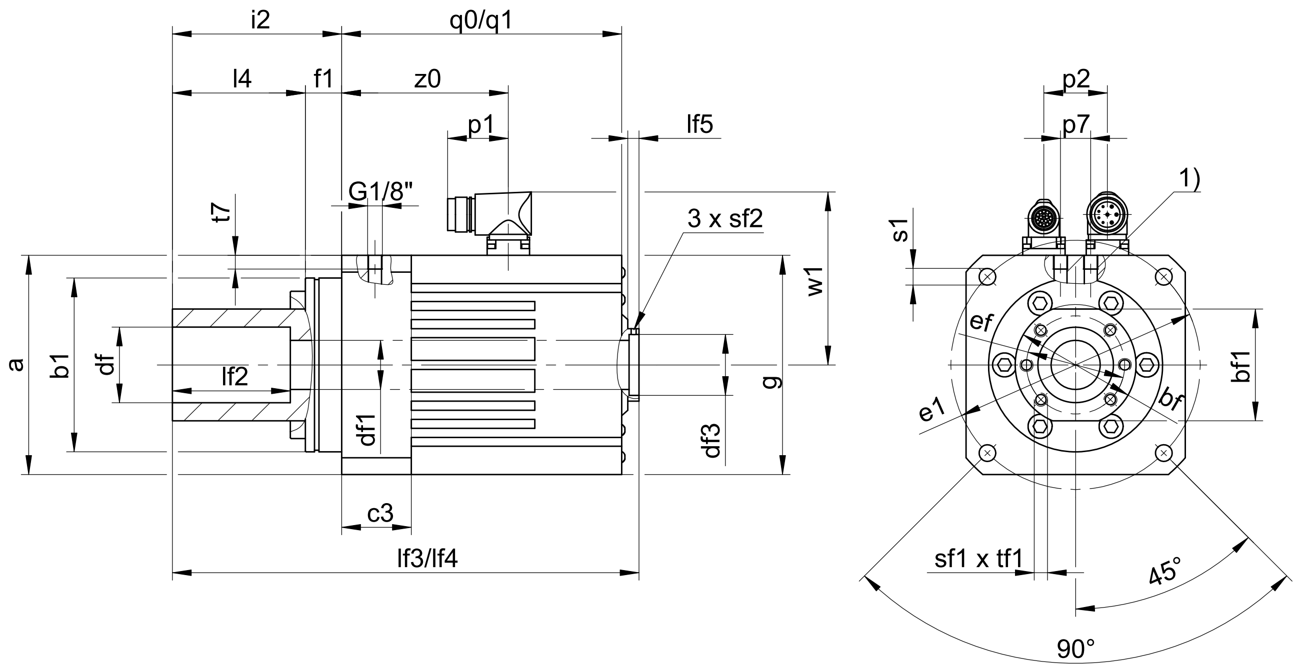


q0, lf3	Applies to motors without holding brake.	q1, lf4	Applies to motors with holding brake.

Type	□a	∅b1	∅bf	bf1	c3	∅df	∅df1	∅df3	∅e1	∅ef	f1	□g	i2	l4	lf2	lf3	lf4	lf5	p1	p2	q0	q1	∅s1	sf1	sf2	tf1	w1	z0
EZM511U	115	$90_{-0,01}$	62	59	37	40^{JS6}	25.5	32.3	130	51	24	115	98	74	66	279.0	333.0	4.4	40	36	170.1	225.4	9	M6	M3	12	100	95.5
EZM512U	115	$90_{-0,01}$	62	59	37	40^{JS6}	25.5	32.3	130	51	24	115	98	74	66	304.0	358.3	4.4	40	36	195.1	250.4	9	M6	M3	12	100	120.5
EZM513U	115	$90_{-0,01}$	62	59	37	40^{JS6}	25.5	32.3	130	51	24	115	98	74	66	329.0	383.3	4.4	40	36	220.1	275.4	9	M6	M3	12	100	145.5
EZM711U	145	$115_{-0,01}$	80	74	46	50^{JS6}	32.5	40.3	165	65	24	145	112	88	79	308.6	368.6	5.2	40	42	185.2	245.2	11	M8	M4	14	115	110.2
EZM712U	145	$115_{-0,01}$	80	74	46	50^{JS6}	32.5	40.3	165	65	24	145	112	88	79	333.6	393.6	5.2	40	42	210.2	270.2	11	M8	M4	14	115	135.2
EZM713U	145	$115_{-0,01}$	80	74	46	50^{JS6}	32.5	40.3	165	65	24	145	112	88	79	358.6	418.6	5.2	40	42	235.2	295.2	11	M8	M4	14	115	160.2
EZM711U	145	$115_{-0,01}$	86	80	46	56^{JS6}	32.5	40.3	165	71	24	145	112	88	79	308.6	368.6	5.2	40	42	185.2	245.2	11	M8	M4	14	115	110.2
EZM712U	145	$115_{-0,01}$	86	80	46	56^{JS6}	32.5	40.3	165	71	24	145	112	88	79	333.6	393.6	5.2	40	42	210.2	270.2	11	M8	M4	14	115	135.2
EZM713U	145	$115_{-0,01}$	86	80	46	56^{JS6}	32.5	40.3	165	71	24	145	112	88	79	358.6	418.6	5.2	40	42	235.2	295.2	11	M8	M4	14	115	160.2

EZM

25.4.2 EZM motors with water cooling



1)	The supply or return line of the cooling system can be connected to both connections for water cooling. The flange with the connections for water cooling can be rotated 180°.
q0, lf3	Applies to motors without holding brake.
q1, lf4	Applies to motors with holding brake.

Type	□a	∅b1	∅bf	bf1	c3	∅df	∅df1	∅df3	∅e1	∅ef	f1	□g	i2	l4	lf2	lf3	lf4	lf5	p1	p2	p7	q0	q1	∅s1	sf1	sf2	t7	tf1	w1	z0
EZM511W	115	$90_{-0,01}$	62	59	37	40^{JS6}	25.5	32.3	130	51	24	115	98	74	66	279.0	333.0	4.4	40	36	20	170.1	225.4	9	M6	M3	8	12	100	95.5
EZM512W	115	$90_{-0,01}$	62	59	37	40^{JS6}	25.5	32.3	130	51	24	115	98	74	66	304.0	358.3	4.4	40	36	20	195.1	250.4	9	M6	M3	8	12	100	120.5
EZM513W	115	$90_{-0,01}$	62	59	37	40^{JS6}	25.5	32.3	130	51	24	115	98	74	66	329.0	383.3	4.4	40	36	20	220.1	275.4	9	M6	M3	8	12	100	145.5
EZM711W	145	$115_{-0,01}$	80	74	46	50^{JS6}	32.5	40.3	165	65	24	145	112	88	79	308.6	368.6	5.2	40	42	20	185.2	245.2	11	M8	M4	9	14	115	110.2
EZM712W	145	$115_{-0,01}$	80	74	46	50^{JS6}	32.5	40.3	165	65	24	145	112	88	79	333.6	393.6	5.2	40	42	20	210.2	270.2	11	M8	M4	9	14	115	135.2
EZM713W	145	$115_{-0,01}$	80	74	46	50^{JS6}	32.5	40.3	165	65	24	145	112	88	79	358.6	418.6	5.2	40	42	20	235.2	295.2	11	M8	M4	9	14	115	160.2
EZM711W	145	$115_{-0,01}$	86	80	46	56^{JS6}	32.5	40.3	165	71	24	145	112	88	79	308.6	368.6	5.2	40	42	20	185.2	245.2	11	M8	M4	9	14	115	110.2
EZM712W	145	$115_{-0,01}$	86	80	46	56^{JS6}	32.5	40.3	165	71	24	145	112	88	79	333.6	393.6	5.2	40	42	20	210.2	270.2	11	M8	M4	9	14	115	135.2
EZM713W	145	$115_{-0,01}$	86	80	46	56^{JS6}	32.5	40.3	165	71	24	145	112	88	79	358.6	418.6	5.2	40	42	20	235.2	295.2	11	M8	M4	9	14	115	160.2

25.5 Type designation

Sample code

EZM	5	1	1	U	S	AD	B1	O	097

Explanation

Code	Designation	Design
EZM	Type	Synchronous servo motor for screw drive
5	Motor size	5 (example)
1	Generation	1
1	Length	1 (example)
U W	Cooling	Convection cooling Water cooling
S	Design	Standard
AD	Drive controller	SD6 (example)
B1	Encoder	EBI 135 EnDat 2.2 (example)
O P	Brake	Without holding brake Permanent magnet holding brake
097	Electromagnetic constant (EMC) K_{EM}	97 V/1000 rpm (example)

Instructions

- You can find information about available encoders in section [▹ 25.6.6].
- In section [▹ 25.6.6.3], you can find information about connecting synchronous servo motors to other STOBER drive controllers.
- In section [▹ 27], you can find information about connecting STOBER synchronous servo motors to drive controllers of third-party manufacturers.

25.6 Product description

25.6.1 General features

Feature	EZM5	EZM7
Maximum threaded spindle diameter ∅kg [mm]	25.00	32.00
Pitch of threaded spindle P_{st}	5 – 25	5 – 32
Pilot ∅kg [mm]	40	50/56
Pitch circle ∅ekg [mm]	51	65/71
Nominal speed n_N [rpm]	3000	3000
Bearing type[1]	INA ZKLF 3590-2Z[2]	INA ZKLF 50115-2Z[3]
Maximum bearing speed n_{la} [rpm]	3800	3000
Axial bearing load rating, dynamic C_{dyn} [N]	41000	46500
Axial rigidity C_{ax} [N/µm]	500	770
Protection class	IP40	IP40

EZM

[1] Axial angular ball bearing for screw drives, grease lubricated, can be relubricated
[2] Or comparable products of other providers
[3] Or comparable products of other providers

Feature	EZM5	EZM7
Thermal class	155 (F) as per EN 60034-1 (155°C, heating $\Delta\vartheta$ = 100 K)	
Surface[4]	Black matte as per RAL 9005	
Noise level	Limit values as per EN 60034-9/A1	
Cooling	IC 410 convection cooling or water cooling in the A-side flange (optional)	

25.6.2 Electrical features

General electrical features of the motor are described in this section. For details see the selection tables section.

Feature	Description
DC-link-voltage	DC 540 V (max. 620 V) on STOBER drive controllers
Winding	Three-phase, single-tooth design
Circuit	Star, center not led out
Protection class	I (protective grounding) as per EN 61140/A1
Number of pole pairs	7

25.6.3 Ambient conditions

Standard ambient conditions for transport, storage and operation of the motor are described in this section.

Feature	Description
Transport/storage surrounding temperature[5]	-30 °C to +85 °C
Surrounding operating temperature	−15 °C to +40 °C (without water cooling) +10 °C to +40 °C (with water cooling)
Installation altitude	≤ 1000 m above sea level
Shock load	≤ 50 m/s^2 (5 g), 6 ms as per EN 60068-2-27

Instructions

- STOBER synchronous servo motors are not suitable for use in potentially explosive atmospheres according to ATEX-Richtlinie2014/34/EU.
- Brace the motor connection cables close to the motor so that vibrations of the cable do not place unpermitted loads on the motor plug connector.
- Note that the braking torques of the holding brake (optional) may be reduced due to shock loading.

25.6.4 Threaded nut

The driven threaded nut (threaded spindle mounted stationary) has the following advantages compared to the driven threaded spindle (threaded nut mounted stationary):

- Higher axial velocity can be achieved with long threaded spindles because swinging of the threaded spindle is less problematic.
- Drastic reduction in the power loss of the threaded spindle bearing because the stretching forces do not have to be directed through the bearing.
- Liquid cooling of the threaded spindle is easier.

[4] Repainting will change the thermal properties and therefore the performance limits of the motor.
[5] If you will be storing or transporting the system in which a motor with water cooling is installed below +3 °C, drain the water completely out of the cooling circuit in advance.

- Increased axial rigidity and torsional rigidity of the threaded spindle (especially with a high pitch/diameter ratio) because the \axial forces and torques at both ends of the threaded spindle can be channeled to the surrounding structure.

25.6.4.1 Lubrication of the threaded nut

Because lubricant supply to the driven threaded nut is made difficult due to the system, it should be lubricated via the threaded spindle. The following options are available.

- For threaded nut with axial motion: Through a lubrication channel in the threaded spindle, which is arranged axially parallel up to the tool change position of the threaded nut. Lubricant can be injected into the threaded nut through a cross-hole if it is exactly in that position. As a rule, the amount of lubricant is adequate without problem until the next tool change.
- For threaded spindle with axial motion: By lubrication brushes attached on the machine, which are connected to the lubrication supply and dispense the lubricant to the threaded spindle as it moves axially.

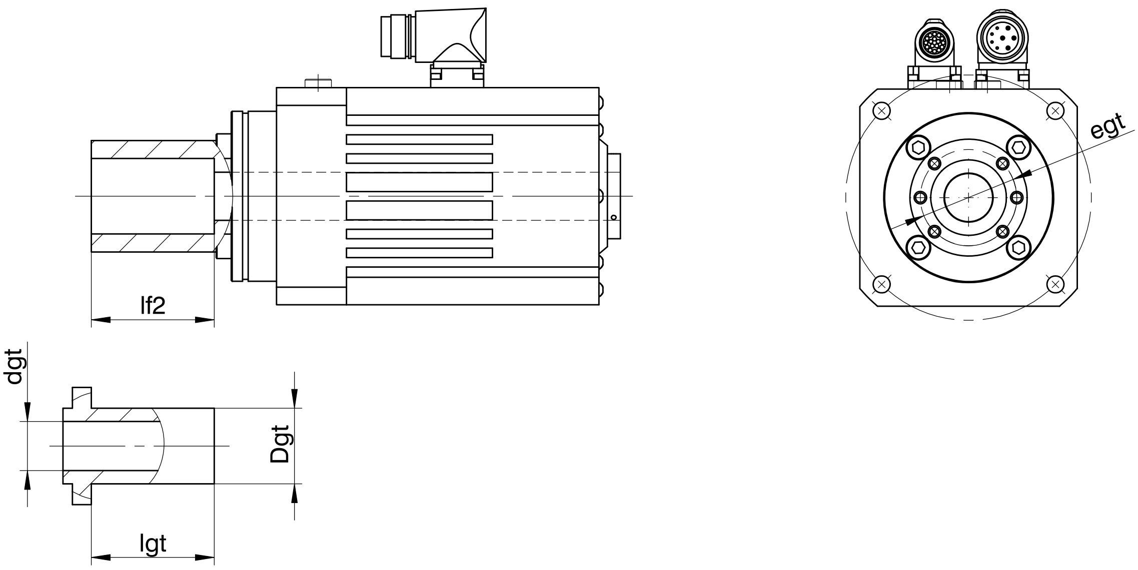
Lubricants that penetrate into the inside of the motor can impair the function of the holding brake and encoder. Therefore take into consideration the protection class of the synchronous servo motor during projecting planning for your screw drive, especially for vertical installation of the synchronous servo motor with the A side on top. For detailed information about lubrication of the screw drive, contact the manufacturer of your screw drive.

25.6.4.2 Possible combinations with ball screw nuts in accordance with DIN 69051-5

As the screw drive is not included in the scope of delivery from STOBER, you can find information in the following sections about possible combinations of the EZM motor with ball screw nuts in accordance with DIN 69051-5 from a few well known manufacturers. Information about EZM motors for other types of threaded nuts is available on request.

Formula symbols	Unit	Explanation
P_{st}	mm	Pitch of the screw drive

Dimensions of the ball screw nut



Manufacturer	Type	∅dgt	P_{st}	∅Dgt	∅egt	lgt	Motor type	lf2
HIWIN	FSC/DEB	25	10	40	51	51/55	EZM5	66
HIWIN	FSC/DEB	25	25	40	51	60	EZM5	66
HIWIN	FSC/DEB	32	10	50	65	65	EZM7	79

EZM

Manufac-turer	Type	∅dgt	P_{st}	∅Dgt	∅egt	lgt	Motor type	lf2
HIWIN	FSC/DEB	32	20	50	65	76	EZM7	79
HIWIN	FSC/DEB	32	32	50	65	68	EZM7	79
Steinmeyer	Series 2426	25	10	40	51	52	EZM5	66
Steinmeyer	Series 2426	25	20	40	51	40	EZM5	66
Steinmeyer	Series 2426	25	20	40	51	60	EZM5	66
Steinmeyer	Series 2426	25	25	40	51	49	EZM5	66
Steinmeyer	Series 3426	32	10	50	65	65	EZM7	79
Steinmeyer	Series 3426	32	10	50	65	76	EZM7	79
Steinmeyer	Series 3426	32	20	56	71	47	EZM7	79
Steinmeyer	Series 3426	32	20	56	71	67	EZM7	79
Steinmeyer	Series 3426	32	30	56	71	67	EZM7	79
THK	EBA	25	10	40	51	65	EZM5	66
THK	EBA	32	10	50	65	65	EZM7	79
THK	EBA	32	10	50	65	77	EZM7	79
Kammerer	FM	25	10	40	51	50	EZM5	66
Kammerer	FM	25	20	40	51	60	EZM5	66
Kammerer	FM	32	10	50	65	68	EZM7	79
Kammerer	FM	32	10	56	71	66	EZM7	79
NSK	PR	25	10	40	51	48	EZM5	66
NSK	LPR	25	25	40	51	51	EZM5	66
NSK	PR	32	10	50	65	47	EZM7	79
NSK	LPR	32	32	50	65	78	EZM7	79
Neff	KGF-D	25	10	40	51	45	EZM5	66
Neff	KGF-D	25	20	40	51	25	EZM5	66
Neff	KGF-D	25	25	40	51	45	EZM5	66
Neff	KGF-D	32	5	50	65	43	EZM7	79
Neff	KGF-D	32	10	50	65	57	EZM7	79
Rodriguez	SFU	25	5	40	51	40	EZM5	66
Rodriguez	SFS*	25	6	40	51	50	EZM5	66
Rodriguez	SFS*	25	6	40	51	50	EZM5	66
Rodriguez	SFS*	32	6	50	65	39	EZM7	79
Rodriguez	SFS*	31	8	50	65	50	EZM7	79
Rodriguez	FK*	25	5	40	51	33	EZM5	66
Rodriguez	FK*	32	5	50	65	39	EZM7	79
Rodriguez	FK*	32	10	50	65	55	EZM7	79
Rodriguez	FH*	25	10	40	51	25	EZM5	66
Rodriguez	FH*	25	25	40	51	45.5	EZM5	66
Rodriguez	FH*	32	20	56	71	52	EZM7	79
Rodriguez	FH*	32	32	56	71	57.5	EZM7	79

*Design does not correspond to DIN 69051-5.

25.6.5 Threaded spindle

The concept of the EZM motor states that the threaded spindle of the screw drive can be guided through the entire length of the motor. Contact between the threaded spindle and motor shaft during operation is not permitted. The dimensions of the EZM motor are designed so that they can incorporate the threaded spindles whose maximum outer diameter does not exceed the nominal diameter. Note when selecting your screw drive that there are spindle nut/threaded spindle combinations for which the maximum threaded spindle diameter exceeds the nominal diameter of the threaded nut or spindle nut. In this case, the attachment of the screw drive to the EZM motor is not permitted (see also [▸ 25.6.1] section, maximum threaded spindle diameter Ødkg feature).

25.6.6 Encoder

STOBER synchronous servo motors are available in versions with different encoder types. The following sections include information for choosing the optimal encoder for your application.

25.6.6.1 Selection tool for EnDat interface

The following table provides you with a selection tool for the EnDat interface of absolute value encoders.

Feature	EnDat 2.1	EnDat 2.2
Short cycle times	★★☆	★★★
Additional information transferred with the position value	–	✓
Expanded power supply range	★★☆	★★★
Key: ★★☆ = good, ★★★ = very good		

25.6.6.2 EnDat encoder

In this chapter you can find detailed technical data of the encoder types that can be selected with EnDat interface.

Encoder with EnDat 2.2 interface

Encoder type	Type code	Measuring principle	Recordable revolutions	Resolution	Position values per revolution
EBI 135	B1	Inductive	65536	19 bits	524288
ECI 119-G2	C9	Inductive	–	19 bits	524288

Encoder with EnDat 2.1 interface

Encoder type	Type code	Measuring principle	Recordable revolutions	Resolution	Position values per revolution	Periods per revolution
ECI 119	C4	Inductive	–	19 bits	524288	Sin/cos 32

Instructions

- The type code of the encoder is a part of the type designation of the motor.
- Several revolutions of the motor shaft can only be recorded with multiturn encoders.
- The encoder EBI 135 requires an external buffer battery so that the absolute position information will be retained after the power supply is turned off.

25.6.6.3 Possible combinations with drive controllers

The following table shows combination options of STOBER drive controllers with selectable encoder types.

Drive controller		**SDS 5000**	**MDS 5000**	**SDS 5000 sin/cos MDS 5000 sin/cos**	**SD6**	**SD6 sin/cos**
Drive controller type code		AA	AB	AC	AD	AE
ID connection plan		442305	442306	442307	442450	442451
Encoder	**Encoder type code**					
EBI 135	B1	✓	✓	–	✓	–
ECI 119-G2	C9	✓	✓	–	✓	–
ECI 119	C4	–	–	✓	–	✓

Instructions

- The type code of the drive controller and the encoder are a part of the type designation of the motor (see type designation chapter).
- In section [▸ 27], you can find information about connecting STOBER synchronous servo motors to drive controllers of third-party manufacturers.

25.6.7 Temperature sensor

In this chapter you can find technical data of the temperature sensors that are installed in STOBER synchronous servo motors for the realization of the thermal winding protection. To prevent damage to the motor, always monitor the temperature sensor with appropriate devices that will turn off the motor if the maximum permitted winding temperature is exceeded.

Some encoders have their own internal analysis electronics with warning and off limits that may overlap with the corresponding values set in the drive controller for the temperature sensor. In some cases this may result in an encoder with internal temperature monitoring forcing the motor to shut down even before the motor has reached its nominal data.

You can find information about the electrical connection of the temperature sensor in the connection technology chapter.

25.6.7.1 PTC thermistor

The PTC thermistor is installed as a standard temperature sensor in STOBER synchronous servo motors. The PTC thermistor is a drilling thermistor as per DIN 44082, so that the temperature of each winding phase can be monitored.

The resistance values in the following table and characteristic curve refer to a single thermistor as per DIN 44081. These values must be multiplied by 3 for a drilling thermistor in accordance with DIN 44082.

Feature	Description
Nominal response temperature ϑ_{NAT}	145 °C ± 5 K
Resistance R −20 °C up to ϑ_{NAT} − 20 K	≤ 250 Ω
Resistance R with ϑ_{NAT} − 5 K	≤ 550 Ω
Resistance R with ϑ_{NAT} + 5 K	≥ 1330 Ω
Resistance R with ϑ_{NAT} + 15 K	≥ 4000 Ω
Operating voltage	≤ DC 7,5 V
Thermal response time	< 5 s
Thermal class	155 (F) as per EN 60034-1 (155 °C, heating $\Delta\vartheta$ = 100 K)

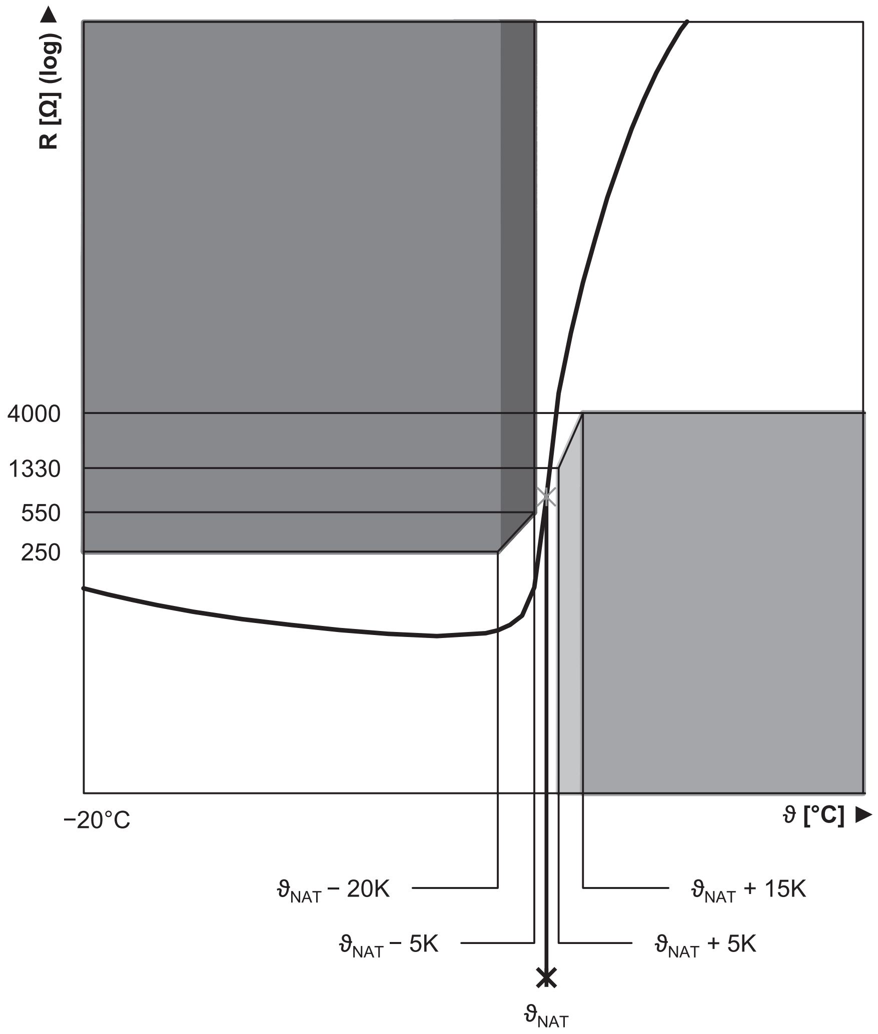


Illustration 2: Characteristic curve of PTC thermistor (single thermistor)

25.6.8 Cooling

A synchronous servo motor in the standard version is cooled by convection cooling (IC 410 in accordance with EN 60034-6). The air flowing around the motor is heated by the radiated motor heat and rises. The motor can optionally be cooled with water.

25.6.8.1 Water cooling

The EZM synchronous servo motors can optionally be cooled with water to increase the performance data for the same size. Water cooling cannot be retrofitted. It must be specified in the purchase order.

The performance data of the motors with water cooling can be found in section [▷ 25.2.2], the dimensional drawings in section [▷ 25.4.2].

Cooling circuit specification

Feature	Description
Coolant	Water
Temperature at inlet	+5 °C to +40 °C (max. 5 K below the surrounding temperature)
Cooling circuit	Closed, with recooling unit
Cleanliness	Clear, with no suspended matter or dirt, use particle filter ≤ 100 µm if necessary
pH value	6.5 – 7.5

Feature	Description
Hardness	1.43 – 2.5 mmol/l
Salinity	NaCl < 100 ppm, demineralized
Anticorrosive	Maximum percentage 25 %, neutral relative to AlCuMgPb F38, GG-220HB
Operating pressure	≤ 3.5 bar (provide a pressure relief valve in the supply line if necessary)
Flow rate	Optimum 6 l/min, minimum 4.5 l/min (EZM5)
	Optimum 7.5 l/min, minimum 5 l/min (EZM7)

Instructions

- The nominal data for synchronous servo motors with water cooling refers to water as a coolant. If another coolant is used, the nominal data must be determined again.
- For detailed information about the cooling system or coolants and coolant additives, please contact the manufacturer of your cooling system.
- Coolant with fresh water from the public supply grid with coolants, lubricants or cutting agents from the machining process is not permitted.
- If the temperature of the coolant is lower than the surrounding temperature, interrupt the supply of coolant when the motor is stopped for extended times to prevent condensation water from forming.
- If you will be storing or transporting the system in which a motor is installed below +3 °C, drain the water completely out of the cooling circuit in advance.
- Further information on water cooling can be found in the operating manual for the motor.

25.6.9 Holding brake

STOBER synchronous servo motors can by equipped with a backlash-free permanent magnet holding brake to keep the motor shaft still when stopped. The holding brake engages automatically if the voltage drops.

Nominal voltage of permanent magnet holding brake: DC 24 V ± 5 %, smoothed. Take into account the voltage losses in the connection lines of the holding brake.

Observe the following for the configuration:

- The holding brake can be used for braking from full speed (following a power failure or when setting up the machine). Activate other braking processes during operation via corresponding brake functions of the drive controller to prevent prematurely wear on the holding brake.
- Note that when braking from full speed the braking torque M_{Bdyn} may initially be up to 50 % less. This causes the braking effect to be introduced later and braking distances will be longer.
- Regularly perform a brake test to ensure the functional safety of the brakes. For further details see the documentation of the motor and the drive controller.
- Connect a varistor of type S14 K35 (or comparable) in parallel to the brake coil to protect your machine from switching surges. (Not necessary for connecting the holding brake to STOBER drive controller with BRS/BRM brake module).
- The holding brake of the synchronous servo motor does not provide adequate safety for person in the hazardous area around gravity-loaded vertical axes. Therefore take additional measures to minimize risk, e.g. by providing a mechanical substructure for maintenance work.
- Take into consideration voltage losses in the connection cables that connect the voltage source to the holding brake connections.
- The braking torque of the brake can be reduced by shock loading. Information about shock loading can be found in the ambient conditions section.

STÖBER

Formula symbols	Unit	Explanation
$I_{N,B}$	A	Nominal current of the brake at 20 °C
ΔJ_B	10^{-4}kgm^2	Additive mass moment of inertia of a motor with holding brake
J	10^{-4}kgm^2	Mass moment of inertia
J_{Bstop}	10^{-4}kgm^2	Reference mass moment of inertia with braking from full speed: J_{Bstop} = J × 2
J_{tot}	10^{-4}kgm^2	Total mass moment of inertia (relative to the motor shaft)
Δm_B	kg	Additive weight of a motor with holding brake
M_{Bdyn}	Nm	Dynamic braking torque at 100 °C (Tolerance +40 %, −20 %)
M_{Bstat}	Nm	Static braking torque at 100 °C (Tolerance +40 %, −20 %)
M_L	Nm	Load torque
N_{Bstop}	–	Permitted number of braking processes from full speed (n = 3000 rpm) with J_{Bstop} (M_L = 0). The following applies if the values of n and J_{Bstop} differ: $N_{Bstop} = W_{B,Rlim} / W_{B,R/B}$.
n	rpm	Speed
t_1	ms	Linking time: time from when the current is turned off until the nominal braking torque is reached
t_2	ms	Disengagement time: time from when the current is turned on until the torque begins to drop
t_{11}	ms	Response delay: time from when the current is turned off until the torque increases
t_{dec}	ms	Stop time
$U_{N,B}$	V	Nominal voltage of brake (DC 24 V ±5 % (smoothed))
$W_{B,R/B}$	J	Friction work per braking
$W_{B,Rlim}$	J	Friction work until wear limit is reached
$W_{B,Rmax/h}$	J	Maximum permitted friction work per hour per individual braking
$x_{B,N}$	mm	Nominal air gap of brake

Calculation of friction work per braking process

$$W_{B,R/B} = \frac{J_{tot} \cdot n^2}{182.4} \cdot \frac{M_{Bdyn}}{M_{Bdyn} \pm M_L}$$

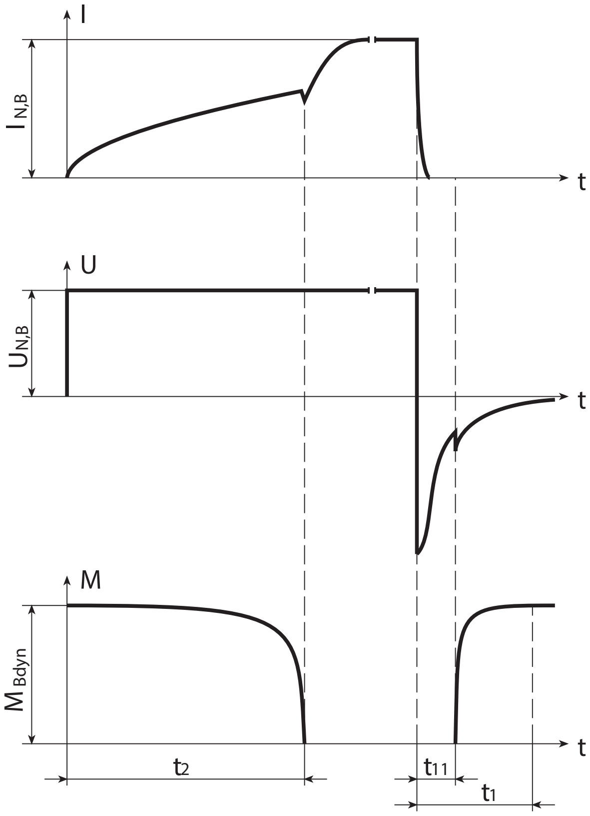
The sign of M_L is positive if the movement runs vertically up or horizontally and negative if the movement runs vertically down.

Calculation of the stop time

$$t_{dec} = 2.66 \cdot t_1 + \frac{n \cdot J_{tot}}{9.55 \cdot M_{Bdyn}}$$

EZM

Switching characteristics



Technical Data

	M_{Bstat} [Nm]	M_{Bdyn} [Nm]	$I_{N,B}$ [A]	$W_{B,Rmax/h}$ [kJ]	$N_{B,stop}$	$J_{B,stop}$ [10^{-4}kgm²]	$W_{B,Rlim}$ [kJ]	t_2 [ms]	t_{11} [ms]	t_1 [ms]	$x_{B,N}$ [mm]	ΔJ_B [10^{-4}kgm²]	Δm_B [kg]
EZM511	18	15	1,1	11,0	2100	52,5	550	55	3,0	30	0,3	5,970	2,50
EZM512	18	15	1,1	11,0	1850	59,1	550	55	3,0	30	0,3	5,970	2,50
EZM513	18	15	1,1	11,0	1700	65,5	550	55	3,0	30	0,3	5,970	2,50
EZM711	28	25	1,1	25,0	1900	149	1400	120	4,0	40	0,4	14,100	4,33
EZM712	28	25	1,1	25,0	1650	168	1400	120	4,0	40	0,4	14,100	4,33
EZM713	28	25	1,1	25,0	1500	186	1400	120	4,0	40	0,4	14,100	4,33

25.6.10 Connection method

The following sections describe the connection technology of STOBER synchronous servo motors in the standard version of STOBER drive controllers. You can find further information relating to the drive controller type that was specified in your order in the connection plan that is delivered with every synchronous servo motor.

In section [▸ 27], you can find information about connecting STOBER synchronous servo motors to drive controllers of third-party manufacturers.

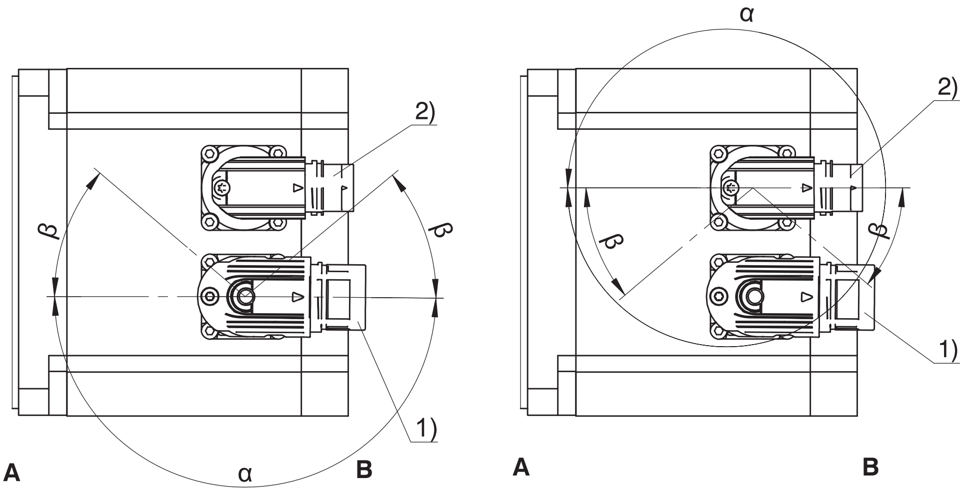
25.6.10.1 Plug connector

STOBER synchronous servo motors are equipped with twistable quick lock plug connectors in the standard version. For details see this section.

In motors with water cooling, prevent collisions between the motor connection cables and the connecting lines of the cooling system. In the event of a collision, turn the motor plug connectors appropriately. Details regarding the position of the connections for water cooling can be found in the dimensional drawings section.

The illustrations represent the position of the plug connectors when delivered.

Turning ranges of plug connectors



1	Power plug connector	2	Encoder plug connector
A	Attachment or output side of the motor	B	Rear of the motor

Power plug connector features

Motor type	Size	Connection	Turning range	
			α	β
EZM	con.23	Quick lock	180°	40°

Encoder plug connector features

Motor type	Size	Connection	Turning range	
			α	β
EZM	con.17	Quick lock	180°	20°

Instructions

- The number after "con." indicates approximately the external thread diameter of the plug connector in mm (for example con.23 designates a plug connector with an external thread diameter of about 23 mm).
- In turning range β the power and encoder plug connectors can only be turned if they will not collide with each other by doing so.

25.6.10.2 Connection of the motor housing to the protective ground system

Connect the motor housing to the protective ground system to protect persons and to prevent the false triggering of fault current protection devices.

All attachment parts required for the connection of the protective ground to the motor housing are delivered with the motor. The grounding screw of the motor is identified with the symbol ⏚ as per IEC 60417-DB. The minimum cross-section of the protective ground is specified in the following table.

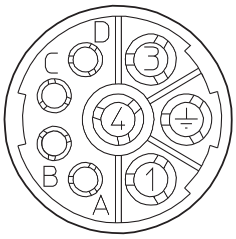
Cross-section of the copper protective grounding in the power cable (A)	Cross-section of the copper protective ground for motor housing (A_E)
A < 10 mm²	A_E = A
A ≥ 10 mm²	A_E ≥ 10 mm²

25.6.10.3 Connection assignment of the power plug connector

The colors of the connection strands inside the motor and specified according to IEC 60757.

EZM

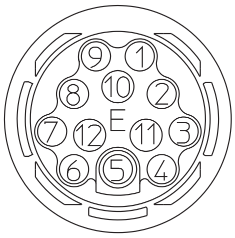
Plug connector size con.23 (1)

Connection diagram	Pin	Connection	Color
	1	1U1 (phase U)	BK
	3	1V1 (phase V)	BU
	4	1W1 (phase W)	RD
	A	1BD1 (brake +)	RD
	B	1BD2 (brake −)	BK
	C	1TP1/1K1 (temperature sensor)	
	D	1TP2/1K2 (temperature sensor)	
	⏚	PE (protective ground)	GNYE

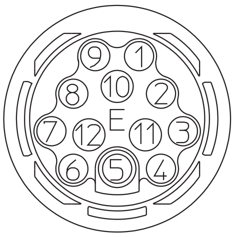
25.6.10.4 Connection assignment of encoder plug connector

The size and connection assignment of the encoder plug connector depend on the type of the installed encoder and the size of the motor. The colors of the connection strands inside the motor and specified according to IEC 60757.

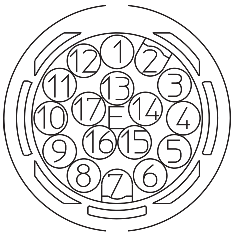
Encoder EnDat 2.1/2.2 digital, plug connector size con.17

Connection diagram	Pin	Connection	Color
	1	Clock +	VT
	2	Up sense	BN GN
	3		
	4		
	5	Data −	PK
	6	Data +	GY
	7		
	8	Clock −	YE
	9		
	10	0 V GND	WH GN
	11		
	12	Up +	BN GN
	Pin 2 is connected with pin 12 in the built-in socket		

Encoder EnDat 2.2 digital with battery buffering, plug connector size con.17

Connection diagram	Pin	Connection	Color
	1	Clock +	VT
	2	UBatt +	BU
	3	UBatt −	WH
	4		
	5	Data −	PK
	6	Data +	GY
	7		
	8	Clock −	YE
	9		
	10	0 V GND	WH GN
	11		
	12	Up +	BN GN
	UBatt+ = DC 3.6 V for encoder type EBI in combination with the AES option of STOBER-drive controllers		

Encoder EnDat 2.1 with sin/cos incremental signals, plug connector size con.17

Connection diagram	Pin	Connection	Color
	1	Up sense	BU
	2		
	3		
	4	0 V sense	WH
	5		
	6		
	7	Up +	BN GN
	8	Clock +	VT
	9	Clock −	YE
	10	0 V GND	WH GN
	11		
	12	B + (sin +)	BU BK
	13	B − (sin −)	RD BK
	14	Data +	GY
	15	A + (cos +)	GN BK
	16	A − (cos −)	YE BK
	17	Data −	PK

25.7 Projecting

You can project your drives with our SERVOsoft design software. SERVOsoft is available at no cost from your consultant in one of our sales centers. Note the limit conditions in this section for a safe design of your drives.

25.7.1 Calculation of the operating point

In this chapter you can find information that is necessary for the calculation of the operating point.

The formula symbols for values actually present in the application are identified by a *.

Formula symbols	Unit	Explanation
ED	%	Duty cycle relative to 10 minutes
M_{op}	Nm	Torque of motor in the operating point from the motor characteristics for n_{1m*}
M_{1*} – M_{6*}	Nm	Existing motor torque in the relevant time segment (1 to 6)
M_{eff*}	Nm	Existing effective torque of the motor
M_{limK}	Nm	Torque limit of the motor with convection cooling
M_{limW}	Nm	Torque limit of the motor with water cooling
M_{max}	Nm	Maximum torque: the maximum permitted torque the motor is able to deliver briefly (when accelerating or decelerating) (tolerance ±10 %)
M_{max*}	Nm	Existing maximum torque
M_{n*}	Nm	Existing torque of the motor in the n-th time segment
M_N	Nm	Nominal torque of the motor
n_{m*}	rpm	Existing average motor speed
$n_{m,1*}$ – $n_{m,6*}$	rpm	Existing average speed of the motor in the respective time segment (1 to 6)
$n_{m,n*}$	rpm	Existing average speed of the motor in the n-th time segment
n_N	rpm	Nominal speed: the speed for which the nominal torque M_N is specified
t	s	Time
t_{1*} – t_{6*}	s	Duration of the relevant time segment (1 to 6)
t_{n*}	s	Duration of the n-th time segment

Check the following conditions for operating points other than the nominal point specified in the selection tables M_N:

$n_{m*} \leq n_N$

$M_{eff*} \leq M_{limK}$ or $M_{eff*} \leq M_{limW}$

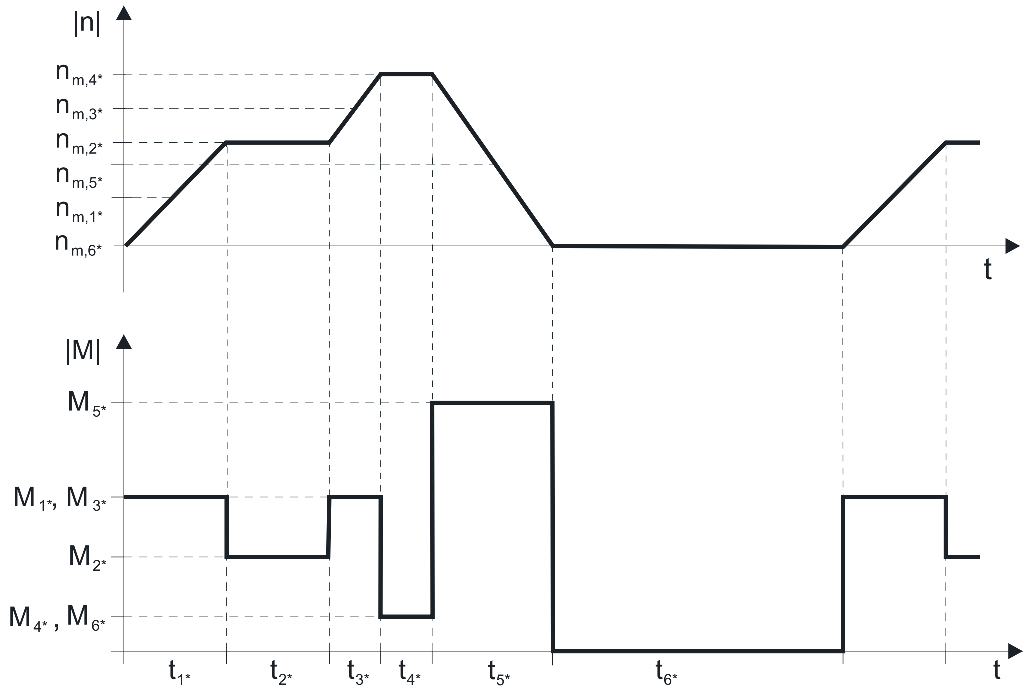
$M_{max*} < M_{max}$

The values for M_N, n_N, M_{max} can be found in the selection tables.

The values for M_{limK} or M_{limW} can be found in the torque/speed characteristic curves.

Example of cycle sequence

The following calculations refer to a representation of the power consumed on the motor shaft based on the following example:



Calculation of the existing average input speed

$$n_{m^*} = \frac{|n_{m,1^*}| \cdot t_{1^*} + \ldots + |n_{m,n^*}| \cdot t_{n^*}}{t_{1^*} + \ldots + t_{n^*}}$$

If t_{1^*} + ... + t_{5^*} ≥ 10 min, determine n_{m^*} without pause t_{6^*}.

Calculation of the existing effective torque

$$M_{eff^*} = \sqrt{\frac{t_{1^*} \cdot M_{1^*}^2 + \ldots + t_{n^*} \cdot M_{n^*}^2}{t_{1^*} + \ldots + t_{n^*}}}$$

25.7.2 Design of the screw drive

You can use the information below to select a suitable synchronous servo motor for your screw drive. For a detailed design of th screw drive please contact the screw drive manufacturer.

Formula symbols	Unit	Explanation
C_{dyn}	N	Dynamic bearing load rating
η_{gt}	%	Efficiency of the screw drive
F_{ax}	N	Permitted axial force on the output
F_{ax0}	N	Axial force required when the motor is at a standstill to hold the load due to the motor torque
L_{10}		Nominal bearing service life for a survival probability of 90% in 10^6 rollovers
L_{10h}	h	Bearing service life
M_0	Nm	Standstill torque: the torque the motor is able to deliver long term at a speed of 10 rpm (tolerance ±5 %)
n_{mot}	rpm	Speed of the motor
P_{st}	mm	Pitch of the screw drive
v_{ax}	mm/s	Axial velocity

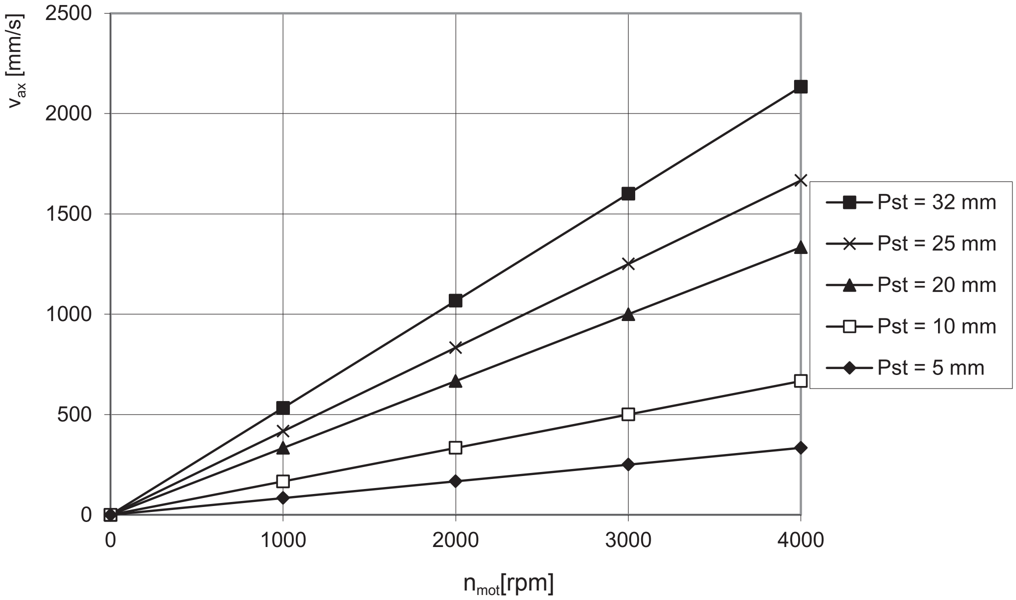
EZM

Axial velocity

The axial velocity of a screw drive can be calculated as follows:

$$v_{ax} = \frac{n_{mot} \cdot P_{st}}{60}$$

The following diagram represents the characteristic curves of screw drives with commonly used pitches which can be implemented with STOBER synchronous servo motors for screw drive.



Axial force

The axial force of a screw drive can be calculated as follows:

$$F_{ax} = \frac{2000 \cdot M_0 \cdot \pi \cdot \eta_{gt}}{P_{st}}$$

If the synchronous servo motor must hold the load due to its torque, the following formula defines the required axial force:

$F_{ax0} \leq 0.6 \cdot F_{ax}$.

You can use the following table to select the matching motor type / screw drive pitch combination for your application. The axial forces are calculated in the table for $_{gt}$ = 0.9.

	M_0 [Nm]	F_{ax} P_{st}=5 [N]	F_{ax} P_{st}=10 [N]	F_{ax} P_{st}=15 [N]	F_{ax} P_{st}=20 [N]	F_{ax} P_{st}=25 [N]	F_{ax} P_{st}=32 [N]
EZM511U	4.3	4807	2403	1602	1202	961	751
EZM511W	5.2	5881	2941	1960	1470	1176	919
EZM512U	7.6	8539	4269	2846	2135	1708	1334
EZM512W	10.6	11932	5966	3977	2983	2386	1864
EZM513U	10.6	11988	5994	3996	2997	2398	1873
EZM513W	14.8	16682	8341	5561	4170	3336	2607
EZM711U	7.3	8256	4128	2752	2064	1651	1290
EZM711W	10.0	11310	5655	3770	2827	2262	1767
EZM712U	12.9	14590	7295	4863	3647	2918	2280
EZM712W	18.8	21262	10631	7087	5316	4252	3322

	M_0 [Nm]	F_{ax} P_{st}=5 [N]	F_{ax} P_{st}=10 [N]	F_{ax} P_{st}=15 [N]	F_{ax} P_{st}=20 [N]	F_{ax} P_{st}=25 [N]	F_{ax} P_{st}=32 [N]
EZM713U	18.9	21375	10688	7125	5344	4275	3340
EZM713W	27.1	30649	15325	10216	7662	6130	4789

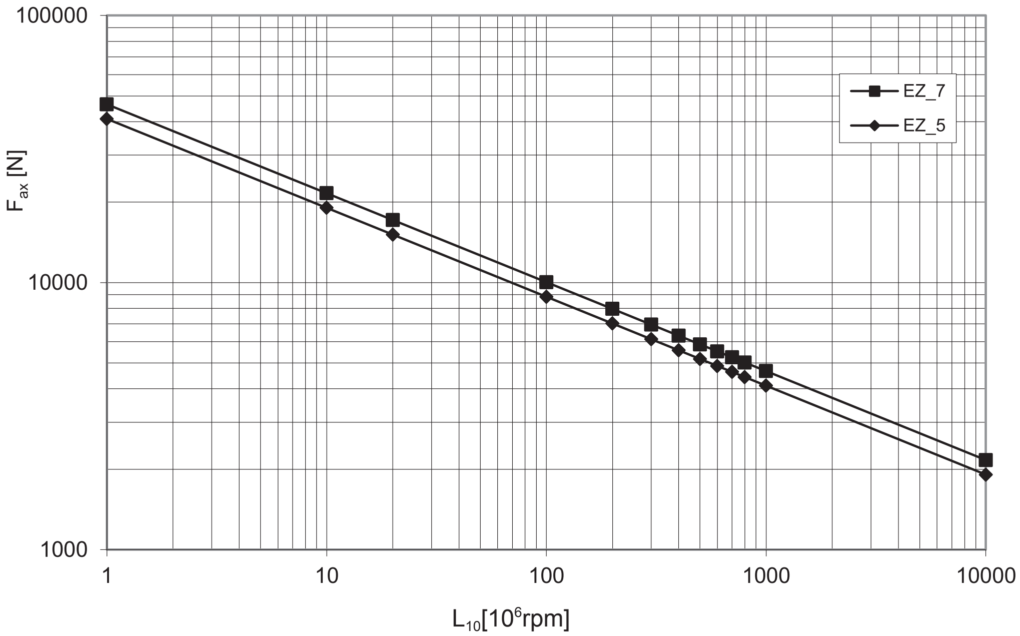
Bearing service life

You can calculate the service life of the axial angular ball bearing of a STOBER synchronous servo motor for screw drive as follows (for the value of C_{dyn} see Technical features section)

$$L_{10} = \left(\frac{C_{dyn}}{F_{ax}}\right)^3 \cdot 10^6$$

$$L_{10h} = \frac{L_{10}}{n \cdot 60}$$

The following diagram shows the bearing service life L_{10}.



25.8 Further information

25.8.1 Directives and Standards

STOBER synchronous servo motors meet the requirements of the following directives and standards:

- Niederspannungsrichtlinie 2014/35/EU
- EMV-Richtlinie 2014/30/EU
- EN 60204-1:2006-06
- EN 60034-1:2010-10
- EN 60034-5/A1:2007-01
- EN 60034-6:1993-11
- EN 60034-9/A1:2007-04
- EN 60034-14/A1:2007-06

EZM

25.8.2 Identifiers and test symbols

STOBER synchronous servo motors have the following identifiers and test symbols:

CE mark: the product meets the requirements of EU directives.

cURus test symbol "Recognized Component Class 155(F)"; registered under UL number E182088 (N) with Underwriters Laboratories USA (optional).

25.8.3 More documentation

More documentation concerning the product can be found online at:

http://www.stoeber.de/de/stoeber_global/service/downloads/downloadcenter.html

Enter the ID of the documentation in the Search... field.

Documentation	ID
Operating manual synchronous servo motors EZ	442585