26.1 Overview

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

Axial forces of motors with convection cooling

F_{ax}	760 – 22280 N

Axial forces of motors with forced ventilation

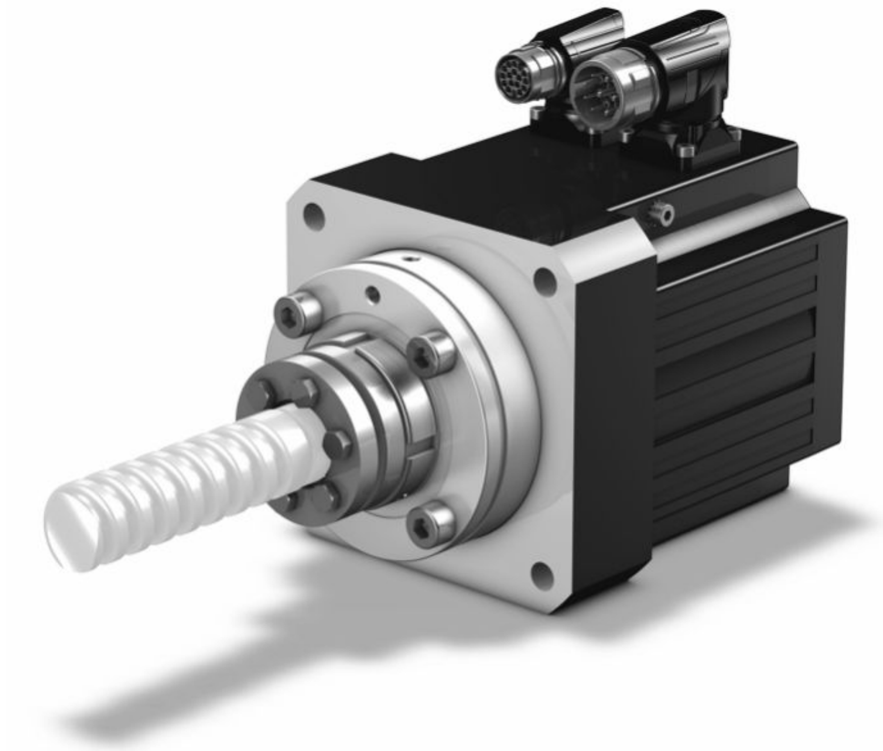
F_{ax}	963 – 31271 N

Axial forces of motors with water cooling

F_{ax}	937 – 30649 N

Features

Backlash-free connection with the threaded spindle via clamping unit	✓
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, forced ventilation (optional) or water cooling (optional)	✓
Optical, inductive EnDat absolute value encoder or resolver	✓
Multiturn absolute value encoders (optional) eliminate the need for referencing	✓
Electronic nameplate for fast and reliable commissioning	✓
Rotating plug connectors with quick lock	✓



26.2 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
EZS5	23 x 210 x 275 mm	0.16 m^2
EZS7	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

26.2.1 EZS 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]	J [10^{-4} kgm²]	m [kg]
EZS501U	97	3000	3.85	3.65	1.05	1.2	4.30	3.95	1.19	0.40	16.0	22.0	3.80	23.50	6.18	6.50	7.10
EZS502U	121	3000	6.90	5.30	1.30	2.2	7.55	5.70	1.40	0.40	31.0	33.0	2.32	16.80	7.24	8.80	8.50
EZS503U	119	3000	9.10	6.70	1.36	2.9	10.7	7.60	1.46	0.40	43.0	41.0	1.25	10.00	8.00	11.1	10.0
EZS701U	95	3000	6.65	6.80	0.98	2.1	7.65	7.70	1.07	0.59	20.0	25.0	1.30	12.83	9.87	20.3	12.6
EZS702U	133	3000	11.0	7.75	1.42	3.5	13.5	9.25	1.53	0.59	41.0	36.0	1.00	11.73	11.73	25.6	14.9
EZS703U	122	3000	15.3	10.8	1.42	4.8	19.7	13.5	1.50	0.59	65.0	62.0	0.52	6.80	13.08	30.8	17.2

26.2.2 EZS motors with forced ventilation

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]	J [10^{-4} kgm²]	m [kg]
EZS501B	97	3000	5.10	4.70	1.09	1.6	5.45	5.00	1.17	0.40	16.0	22.0	3.80	23.50	6.18	6.50	7.10
EZS502B	121	3000	10.0	7.80	1.28	3.1	10.9	8.16	1.38	0.40	31.0	33.0	2.32	16.80	7.24	8.80	8.50
EZS503B	119	3000	14.1	10.9	1.29	4.4	15.6	11.8	1.35	0.40	43.0	41.0	1.25	10.00	8.00	11.1	10.0
EZS701B	95	3000	9.35	9.50	0.98	2.9	10.2	10.0	1.07	0.59	20.0	25.0	1.30	12.83	9.87	20.3	12.6
EZS702B	133	3000	16.3	11.8	1.38	5.1	19.0	12.9	1.51	0.59	41.0	36.0	1.00	11.73	11.73	25.6	14.9
EZS703B	122	3000	23.7	18.2	1.30	7.4	27.7	20.0	1.41	0.59	65.0	62.0	0.52	6.80	13.08	30.8	17.2

26.2.3 EZS 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]	J [10^{-4} kgm²]	m [kg]
EZS501W	97	3000	5.10	4.75	1.07	1.6	5.30	4.85	1.18	0.40	16.0	22.0	3.80	23.50	6.18	6.50	7.10
EZS502W	121	3000	9.90	7.70	1.29	3.1	10.7	7.85	1.41	0.40	31.0	33.0	2.32	16.80	7.24	8.80	8.50
EZS503W	119	3000	13.2	10.2	1.29	4.2	14.9	11.3	1.35	0.40	43.0	41.0	1.25	10.00	8.00	11.1	10.0
EZS701W	95	3000	9.85	9.95	0.99	3.1	10.0	10.0	1.06	0.59	20.0	25.0	1.30	12.83	9.87	20.3	12.6
EZS702W	133	3000	16.8	12.2	1.37	5.3	18.9	13.1	1.49	0.59	41.0	36.0	1.00	11.73	11.73	25.6	14.9
EZS703W	122	3000	22.1	17.0	1.30	6.9	27.1	19.6	1.42	0.59	65.0	62.0	0.52	6.80	13.08	30.8	17.2

26.3 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_{limF}	Nm	Torque limit of the motor with forced ventilation
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

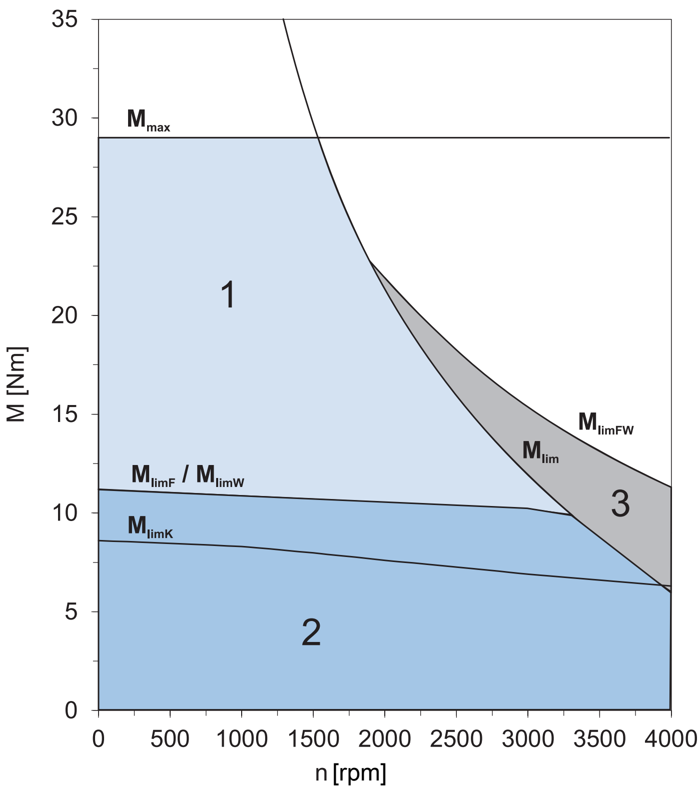
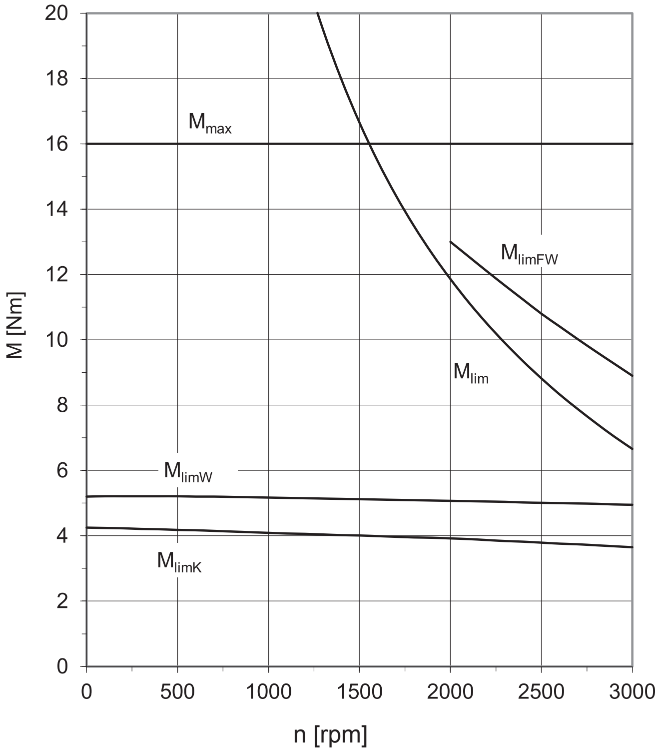


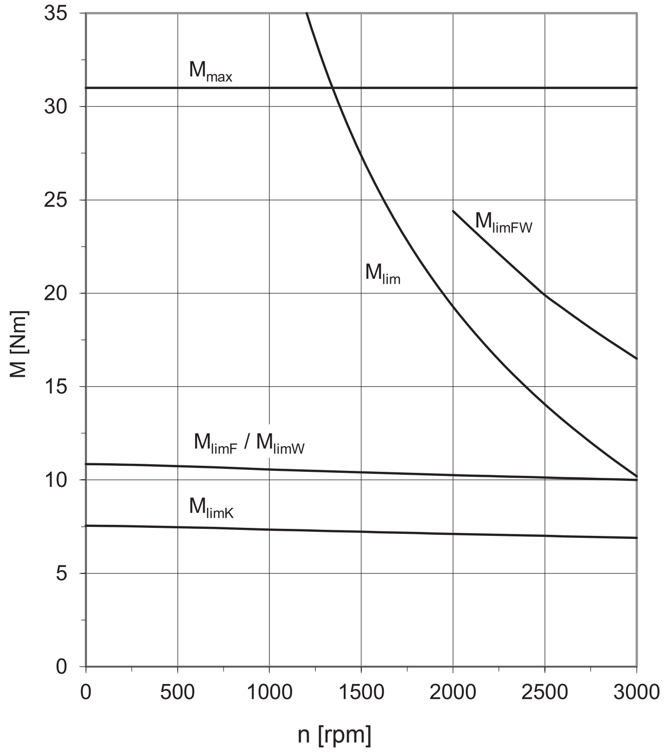
Illustration 1: Explanation of a torque/speed characteristic curve

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)		

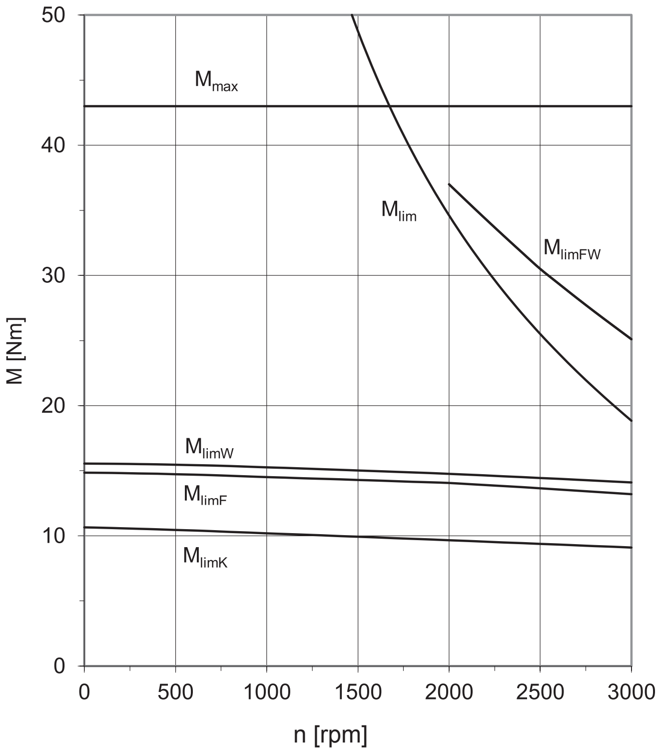
EZS501 (n_N=3000 rpm)



EZS502 (n_N=3000 rpm)

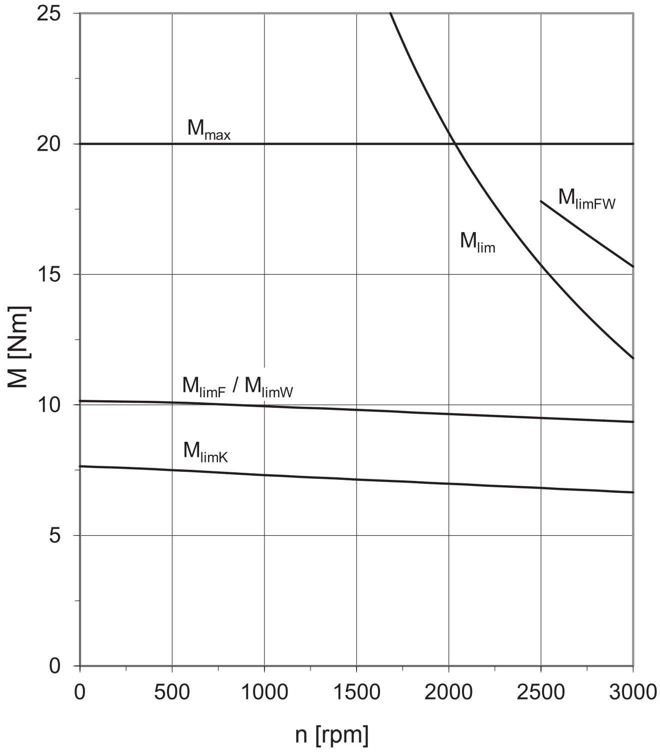


EZS503 (n_N=3000 rpm)

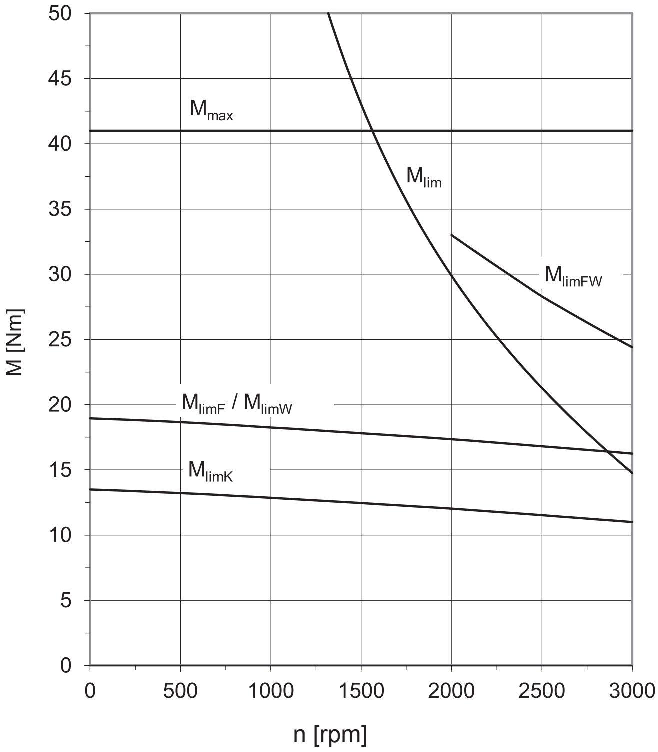


EZS

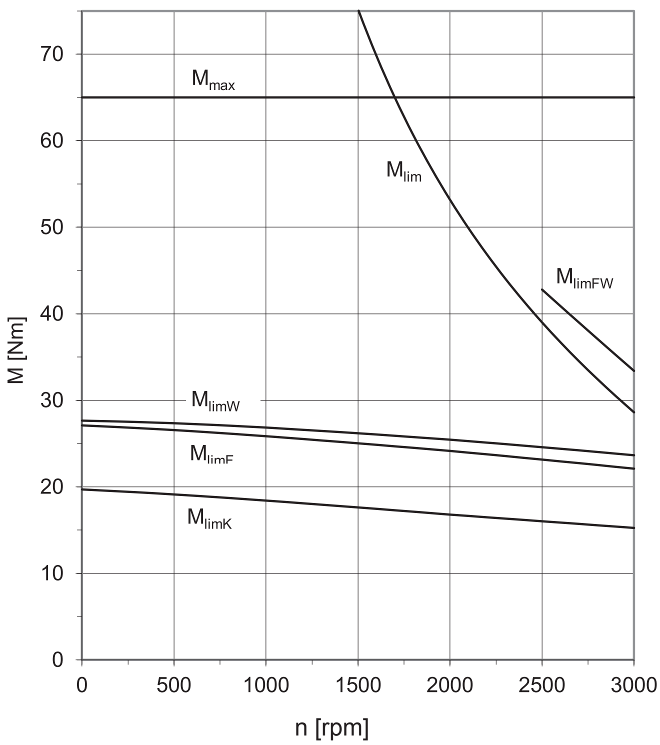
EZS701 (n_N=3000 rpm)



EZS702 (n_N=3000 rpm)



EZS703 (n_N=3000 rpm)



26.4 Dimensional drawings

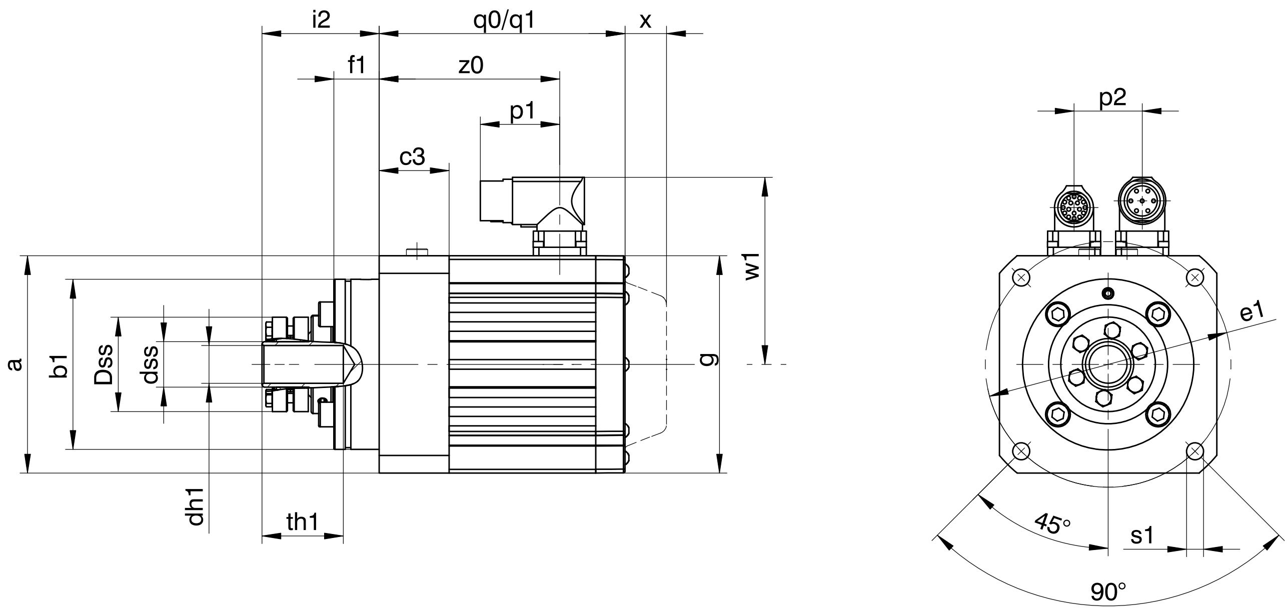
In this chapter you can find the dimensions of the motors.

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.

26.4.1 EZS motors with convection cooling

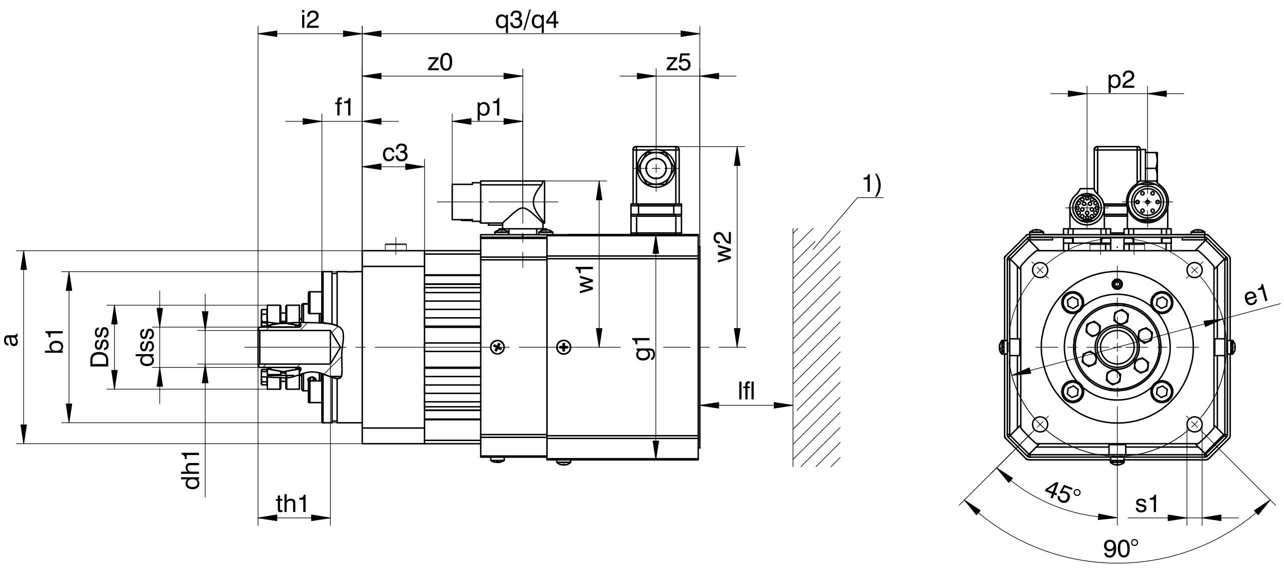


q0	Applies to motors without holding brake.	q1	Applies to motors with holding brake.
x	Applies to encoders based on optical measuring principle.		

Type	□a	∅b1	c3	∅dh1	∅dss	∅Dss	∅e1	f1	□g	i2	p1	p2	q0	q1	∅s1	th1	w1	x	z0
EZS501U	115	$90_{-0,01}$	37	20^{H6}	24_{h7}	50	130	24	115	62.0	40	36	130	184.5	9	41	100	22	95.5
EZS502U	115	$90_{-0,01}$	37	20^{H6}	24_{h7}	50	130	24	115	62.0	40	36	155	209.5	9	41	100	22	120.5
EZS503U	115	$90_{-0,01}$	37	20^{H6}	24_{h7}	50	130	24	115	62.0	40	36	180	234.5	9	41	100	22	145.5
EZS701U	145	$115_{-0,01}$	46	25^{H6}	30_{h7}	60	165	24	145	66.5	40	42	148	206.7	11	45	115	22	110.2
EZS702U	145	$115_{-0,01}$	46	25^{H6}	30_{h7}	60	165	24	145	66.5	40	42	173	231.7	11	45	115	22	135.2
EZS703U	145	$115_{-0,01}$	46	25^{H6}	30_{h7}	60	165	24	145	66.5	40	42	198	256.7	11	45	115	22	160.2

EZS

26.4.2 EZS motors with forced ventilation



q3	Applies to motors without holding brake.	q4	Applies to motors with holding brake.
1)	Machine wall		

Type	□a	∅b1	c3	∅dh1	∅dss	∅Dss	∅e1	f1	□g1	i2	lfl_{min}	p1	p2	q3	q4	∅s1	th1	w1	w2	z0	z5
EZS501B	115	$90_{-0,01}$	37	20^{H6}	24_{h7}	50	130	24	134.5	62.0	20	40	36	200	265.0	9	41	100	120	95.5	25
EZS502B	115	$90_{-0,01}$	37	20^{H6}	24_{h7}	50	130	24	134.5	62.0	20	40	36	225	280.0	9	41	100	120	120.5	25
EZS503B	115	$90_{-0,01}$	37	20^{H6}	24_{h7}	50	130	24	134.5	62.0	20	40	36	250	305.0	9	41	100	120	145.5	25
EZS701B	145	$115_{-0,01}$	46	25^{H6}	30_{h7}	60	165	24	164.5	66.5	30	40	42	240	298.7	11	45	115	134	110.2	40
EZS702B	145	$115_{-0,01}$	46	25^{H6}	30_{h7}	60	165	24	164.5	66.5	30	40	42	265	321.7	11	45	115	134	135.2	40
EZS703B	145	$115_{-0,01}$	46	25^{H6}	30_{h7}	60	165	24	164.5	66.5	30	40	42	290	348.7	11	45	115	134	160.2	40

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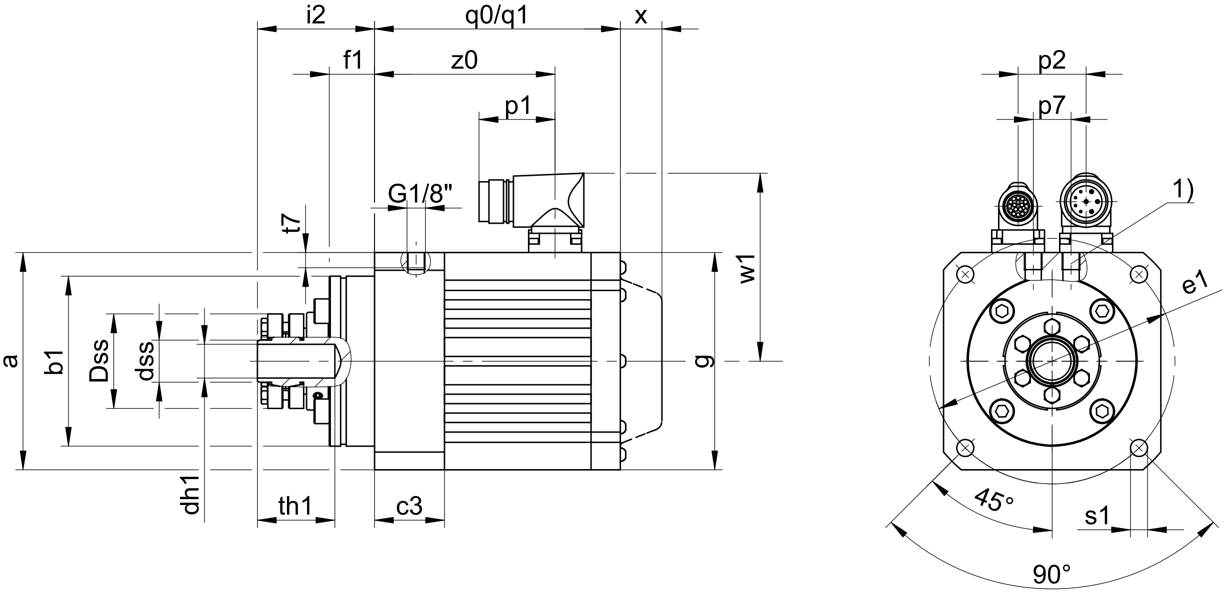
26.4.3 EZS motors with water cooling



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	Applies to motors without holding brake.
q1	Applies to motors with holding brake.
x	Applies to encoders based on optical measuring principle.

Type	□a	∅b1	c3	∅dh1	∅dss	∅Dss	∅e1	f1	□g	i2	p1	p2	p7	q0	q1	∅s1	t7	th1	w1	x	z0
EZS501W	115	$90_{-0,01}$	37	20^{H6}	24_{h7}	50	130	24	115	62.0	40	36	20	130	184.5	9	8	41	100	22	95.5
EZS502W	115	$90_{-0,01}$	37	20^{H6}	24_{h7}	50	130	24	115	62.0	40	36	20	155	209.5	9	8	41	100	22	120.5
EZS503W	115	$90_{-0,01}$	37	20^{H6}	24_{h7}	50	130	24	115	62.0	40	36	20	180	234.5	9	8	41	100	22	145.5
EZS701W	145	$115_{-0,01}$	46	25^{H6}	30_{h7}	60	165	24	145	66.5	40	42	20	148	206.7	11	9	45	115	22	110.2
EZS702W	145	$115_{-0,01}$	46	25^{H6}	30_{h7}	60	165	24	145	66.5	40	42	20	173	231.7	11	9	45	115	22	135.2
EZS703W	145	$115_{-0,01}$	46	25^{H6}	30_{h7}	60	165	24	145	66.5	40	42	20	198	256.7	11	9	45	115	22	160.2

EZS

26.5 Type designation

Sample code

EZS	**5**	**0**	**1**	**U**	**D**	**AD**	**M4**	**O**	**097**

Explanation

Code	Designation	Design
EZS	Type	Synchronous servo motor for screw drive
5	Motor size	5 (example)
0	Generation	0
1	Length	1 (example)
U B W	Cooling	Convection cooling Forced ventilation Water cooling
D	Design	Dynamic performance
AD	Drive controller	SD6 (example)
M4	Encoder	EQI 1131 FMA 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 [▷ 26.6.5].
- In section [▷ 26.6.5.5], 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.

26.6 Product description

26.6.1 General features

Feature	EZS5	EZS7
∅ Threaded spindle [mm]	25/32	32/40
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
Thermal class	155 (F) as per EN 60034-1 (155°C, heating $\Delta\vartheta$ = 100 K)	
Surface[4]	Black matte as per RAL 9005	

[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
[4] Repainting will change the thermal properties and therefore the performance limits of the motor.

Feature	EZS5	EZS7
Noise level	Limit values as per EN 60034-9/A1	
Cooling	IC 410 convection cooling (IC 416 convection cooling with forced ventilation or optionally water cooling in the A-side flange)	

26.6.2 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

26.6.3 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/s² (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.

26.6.4 Lubrication of the screw drive

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.

26.6.5 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.

[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.

26.6.5.1 Encoder measuring principle selection tool

The following table provides you with a selection tool for an encoder measuring principle that is optimally suited for your application.

Feature	Absolute value encoder		Resolver
Measuring principle	Optical	Inductive	Electromagnetic
Temperature resistance	★★☆	★★★	★★★
Vibration strength and shock resistance	★★☆	★★★	★★★
System accuracy	★★★	★★☆	★☆☆
Version with fault elimination for mechanical mounting FMA (option with EnDat interface)	✓	✓	–
The multiturn version (optional) eliminate the need for referencing	✓	✓	–
- Electronic nameplate ensures easy commissioning	✓	✓	–
Key: ★☆☆ = satisfactory, ★★☆ = good, ★★★ = very good			

26.6.5.2 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		

26.6.5.3 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
EQI 1131 FMA	M4	Inductive	4096	19 bits	524288
EQI 1131	Q6	Inductive	4096	19 bits	524288
EBI 1135	B0	Inductive	65536	18 bits	262144
EQN 1135 FMA	M3	Optical	4096	23 bits	8388608
EQN 1135	Q5	Optical	4096	23 bits	8388608
ECN 1123 FMA	M1	Optical	–	23 bits	8388608
ECN 1123	C7	Optical	–	23 bits	8388608
ECI 1118-G2	C5	Inductive	–	18 bits	262144

Encoder with EnDat 2.1 interface

Encoder type	Type code	Measuring principle	Recordable revolutions	Resolution	Position values per revolution	Periods per revolution
EQN 1125 FMA	M2	Optical	4096	13 bits	8192	Sin/cos 512
EQN 1125	Q4	Optical	4096	13 bits	8192	Sin/cos 512
ECN 1113 FMA	M0	Optical	–	13 bits	8192	Sin/cos 512
ECN 1113	C6	Optical	–	13 bits	8192	Sin/cos 512

Instructions

- The type code of the encoder is a part of the type designation of the motor.
- FMA = Version with fault elimination for mechanical mounting.
- The encoder EBI 1135 requires an external buffer battery so that the absolute position information will be retained after the power supply is turned off.
- Several revolutions of the motor shaft can only be recorded with multiturn encoders.

26.6.5.4 Resolver

In this chapter you can find detailed technical data of the resolver that can be installed as an encoder in a STOBER synchronous servo motor.

Feature	Description
Input voltage U_{1eff}	7 V ± 5 %
Input frequency f_1	10 kHz
Output voltage $U_{2,S1–S3}$	$K_{tr} \cdot U_{R1–R2} \cdot \cos \theta$
Output voltage $U_{2,S2–S4}$	$K_{tr} \cdot U_{R1–R2} \cdot \sin \theta$
Transformation ratio K_{tr}	0.5 ± 5 %
Electrical fault	±10 arcmin

26.6.5.5 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**					
EQI 1131 FMA	M4	✓	–	–	✓	–
EQI 1131	Q6	✓	✓	–	✓	–
EBI 1135	B0	✓	✓	–	✓	–
EQN 1135 FMA	M3	✓	–	–	✓	–
EQN 1135	Q5	✓	✓	–	✓	–
ECN 1123 FMA	M1	✓	–	–	✓	–
ECN 1123	C7	✓	✓	–	✓	–
ECI 1118-G2	C5	✓	✓	–	✓	–
EQN 1125 FMA	M2	✓	✓	✓	✓	✓
EQN 1125	Q4	✓	✓	✓	✓	✓
ECN 1113 FMA	M0	✓	✓	✓	✓	✓

EZS

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**					
ECN 1113	C6	✓	✓	✓	✓	✓
Resolver	R0	✓	✓	–	–	✓

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.

26.6.6 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.

26.6.6.1 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)

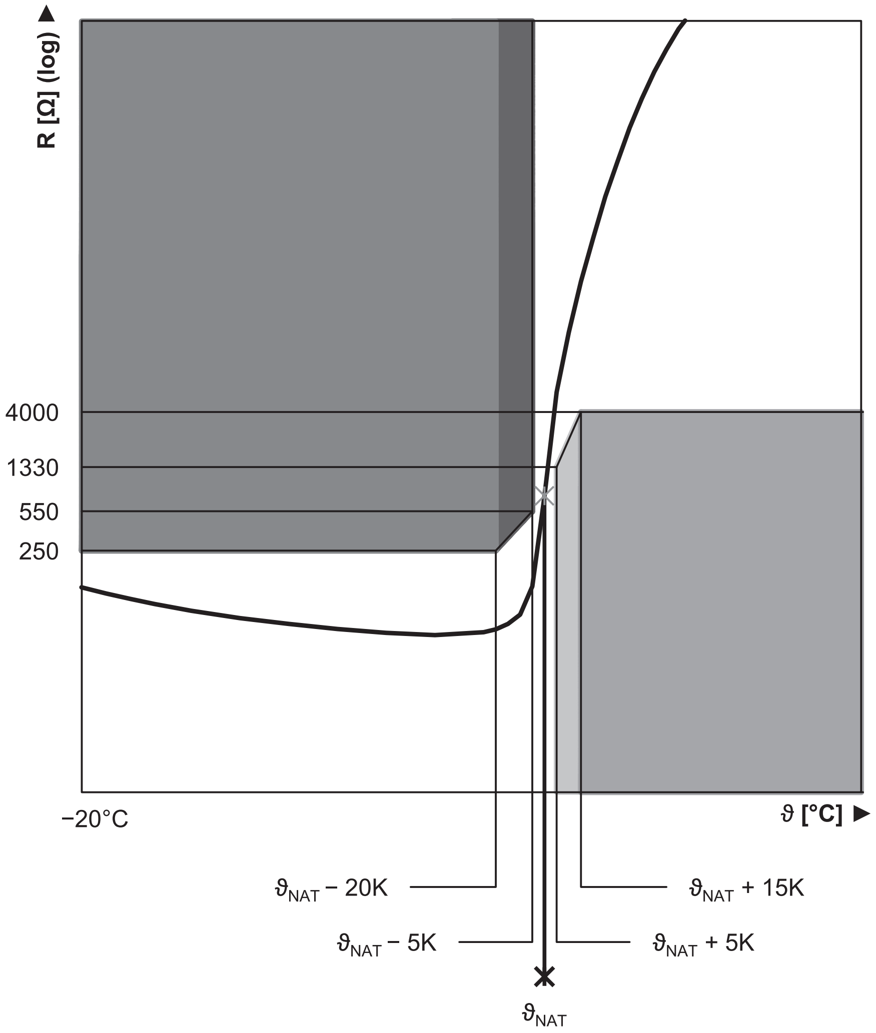


Illustration 2: Characteristic curve of PTC thermistor (single thermistor)

26.6.7 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 by an forced-cooling fan or with water.

26.6.7.1 Forced ventilation

STOBER synchronous servo motors can optionally be cooled with a forced-cooling fan to increase the performance data for the same size. Retrofitting with a forced-cooling fan is also possible to optimize the drive at a later date. When retrofitting, check whether the core cross-section of the power cable of the motor must be increased. Also take into account the dimensions of the forced-cooling fan.

The performance data of the motors with forced ventilation can be found in section [26.2.2], the dimensional drawings in section [26.4.2].

Formula symbols	Unit	Explanation
$I_{N,F}$	A	Nominal current of the forced-cooling fan
L_{pA}	dBA	Noise level of the forced-cooling fan in the optimum operating range
m_F	kg	Weight of the forced-cooling fan
$P_{N,F}$	W	Nominal output of the forced-cooling fan

Formula symbols	Unit	Explanation
q_{vF}	m³/h	Delivery capacity of the forced-cooling fan in open air
$U_{N,F}$	V	Nominal voltage of the forced-cooling fan

Technical Data

Motor	Forced-cooling fan	$U_{N,F}$ [V]	$I_{N,F}$ [V]	$P_{N,F}$ [W]	$q_{v,F}$ [m³/h]	$L_{p(A)}$ [dBA]	m_F [kg]	Protection class
EZS5_B	FL5	230 V ± 5 %, 50/60 Hz	0.10	14	160	45	1.9	IP54
EZS7_B	FL7		0.10	14	160	45	2.9	IP54

Connection assignment for forced-cooling fan plug connectors

Connection diagram	Pin	Connection
	1	L1 (phase)
	2	N (neutral conductor)
	3	
	⏚	PE (protective ground)

26.6.7.2 Water cooling

STOBER synchronous servo motors can optionally be cooled with water to increase the performance data for the same size. Water cooling represents an alternative to forced ventilation if it is not possible due to the surrounding area or space considerations. Water cooling cannot be retrofitted. It must be specified in the purchase order. Water cooling can not be combined with forced ventilation.

The performance data of the motors with water cooling can be found in section [▹ 26.2.3], the dimensional drawings in section [▹ 26.4.3].

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
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 (EZS5)
	Optimum 7.5 l/min, minimum 5 l/min (EZS7)

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.

26.6.8 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.

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: $J_{Bstop} = J_{dyn} \times 2$
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

Formula symbols	Unit	Explanation
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

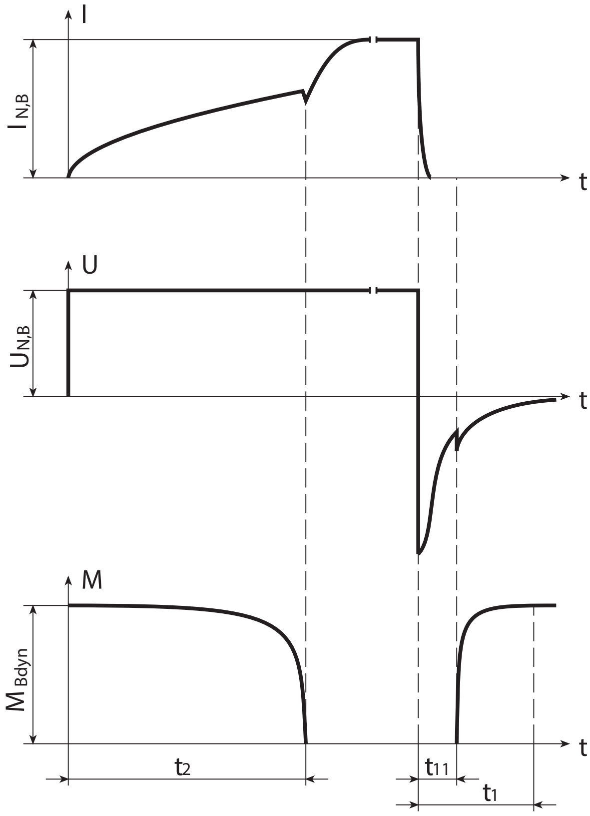
$$W_{B,R/B} = \frac{J_{tot} \cdot n^2}{182.4} \cdot \frac{M_{Bdyn}}{M_{Bdyn} \pm M_L}$$

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

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

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]
EZS501	8,0	7,0	0,75	8,5	4300	14,1	300	40	2,0	20	0,3	0,550	1,19
EZS502	8,0	7,0	0,75	8,5	3200	18,7	300	40	2,0	20	0,3	0,550	1,19
EZS503	15	12	1,0	11,0	4300	25,6	550	60	5,0	30	0,3	1,700	1,62
EZS701	15	12	1,0	11,0	2500	44,0	550	60	5,0	30	0,3	1,700	1,94
EZS702	15	12	1,0	11,0	2000	54,6	550	60	5,0	30	0,3	1,700	1,94
EZS703	32	28	1,1	25,0	3800	72,8	1400	100	5,0	25	0,4	5,600	2,81

26.6.9 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.

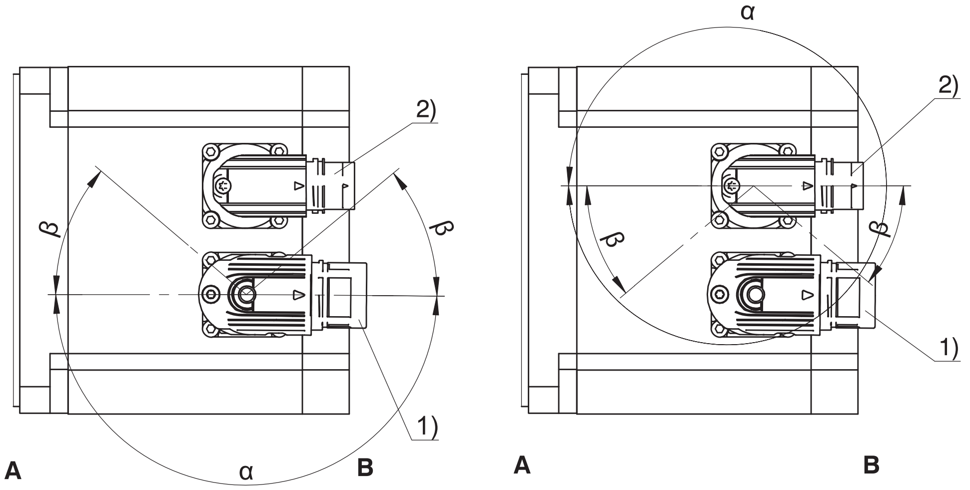
26.6.9.1 Plug connector

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

In motors with forced ventilation or water cooling, prevent collisions between the motor connection cables and the plug connector of the forced-cooling fan or the connecting lines of the cooling system. In the event of a collision, turn the motor plug connectors appropriately. For details on the position of the forced-cooling fan plug connector or the connections for water cooling, see 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
EZS	con.23	Quick lock	180°	40°

Encoder plug connector features

Motor type	Size	Connection	Turning range	
			α	β
EZS	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.

26.6.9.2 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.

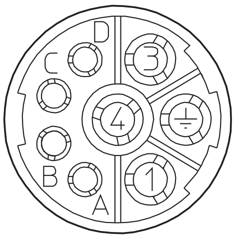
All attachment parts required for the connection of the protective ground to the motor housing are delivered with the motor. The grounding screw of the motor is identified with the symbol ⏚ as per IEC 60417-DB. The minimum cross-section of the protective ground is specified in the following table.

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

26.6.9.3 Connection assignment of the power plug connector

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

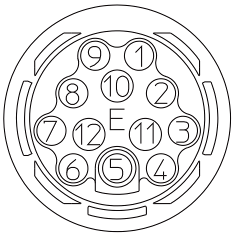
Plug connector size con.23 (1)

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

26.6.9.4 Connection assignment of encoder plug connector

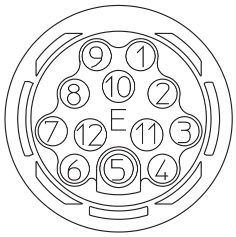
The size and connection assignment of the encoder plug connector depend on the type of the installed encoder and the size of the motor. The colors of the connection strands inside the motor and specified according to IEC 60757.

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

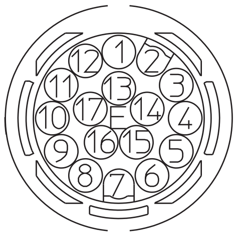
Connection diagram	Pin	Connection	Color
	1	Clock +	VT
	2	Up sense	BN GN
	3		
	4		
	5	Data −	PK
	6	Data +	GY
	7		
	8	Clock −	YE
	9		
	10	0 V GND	WH GN
	11		
	12	Up +	BN GN
	Pin 2 is connected with pin 12 in the built-in socket		

EZS

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

26.7 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.

26.7.1 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_{limF}	Nm	Torque limit of the motor with forced ventilation
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 $M_{eff*} \leq M_{limF}$ or $M_{eff*} \leq M_{limW}$

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

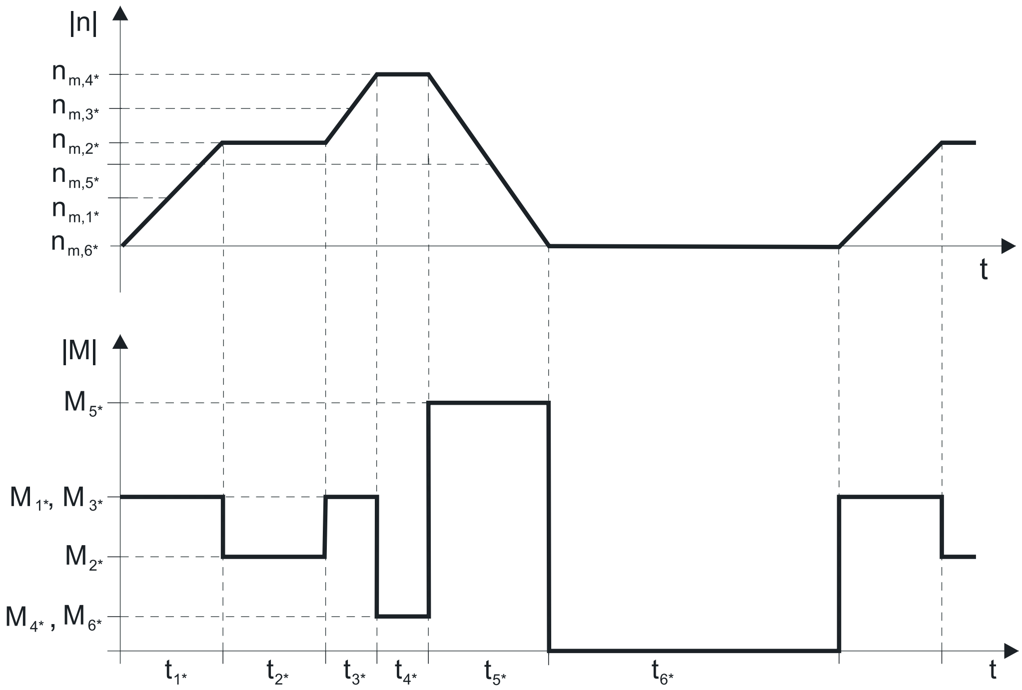
The values for M_N, n_N, M_{max} can be found in the selection tables.

The values for M_{limK} or M_{limF} 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:

EZS



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

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

26.7.2 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.

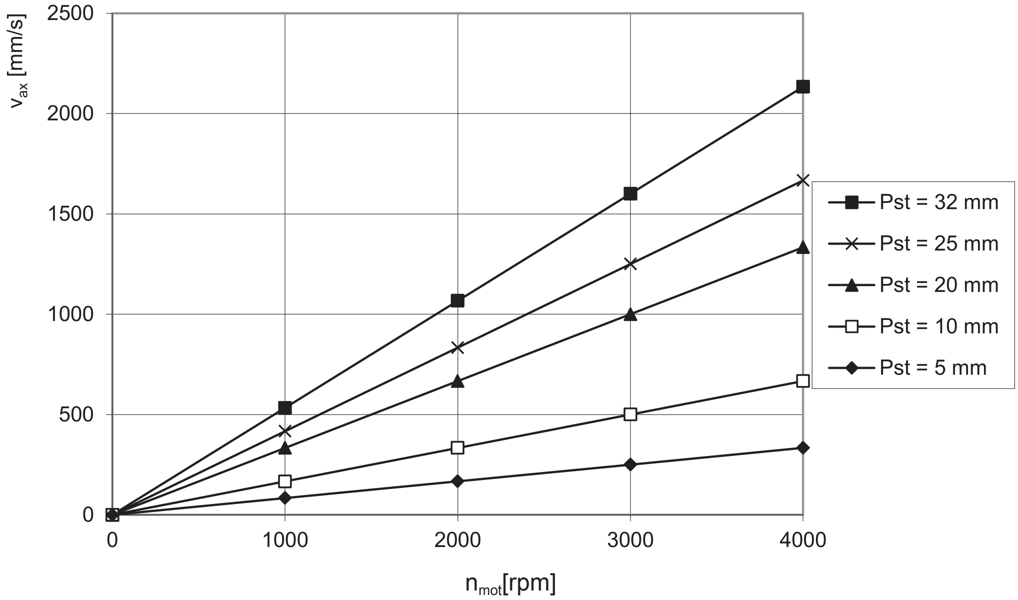
Formula symbols	Unit	Explanation
C_{dyn}	N	Dynamic bearing load rating
η_{gt}	%	Efficiency of the screw drive
F_{ax}	N	Permitted axial force on the output
F_{ax0}	N	Axial force required when the motor is at a standstill to hold the load due to the motor torque
L_{10}		Nominal bearing service life for 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

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]
EZS501U	4.3	4863	2432	1621	1216	973	760
EZS501B	5.5	6164	3082	2055	1541	1233	963
EZS501W	5.3	5994	2997	1998	1499	1199	937
EZS502U	7.6	8539	4269	2846	2135	1708	1334
EZS502B	10.9	12271	6136	4090	3068	2454	1917
EZS502W	10.7	12045	6022	4015	3011	2409	1882
EZS503U	10.7	12045	6022	4015	3011	2409	1882
EZS503B	15.6	17587	8793	5862	4397	3517	2748
EZS503W	14.9	16795	8397	5598	4199	3359	2624
EZS701U	7.7	8652	4326	2884	2163	1730	1352
EZS701B	10.2	11479	5740	3826	2870	2296	1794

	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]
EZS701W	10.0	11310	5655	3770	2827	2262	1767
EZS702U	13.5	15268	7634	5089	3817	3054	2386
EZS702B	19.0	21432	10716	7144	5358	4286	3349
EZS702W	18.9	21375	10688	7125	5344	4275	3340
EZS703U	19.7	22280	11140	7427	5570	4456	3481
EZS703B	27.7	31271	15636	10424	7818	6254	4886
EZS703W	27.1	30649	15325	10216	7662	6130	4789

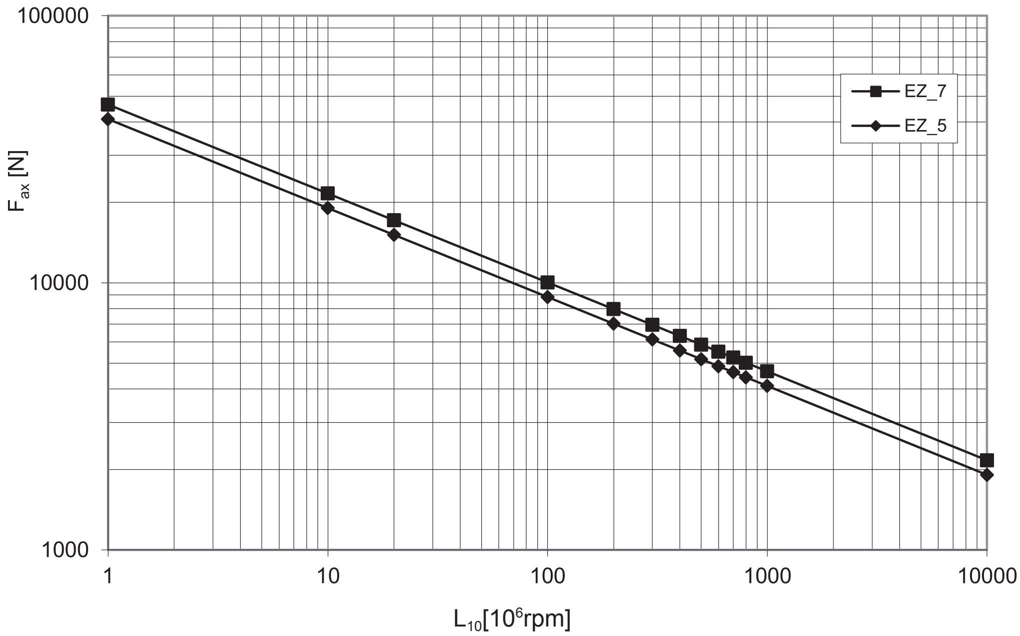
Bearing service life

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}.



26.8 Further information

26.8.1 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

26.8.2 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 the UL number E182088 (N) with Underwriters Laboratories USA (optional).

26.8.3 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

EZS