STÖBER

22 EZ synchronous servo motors

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22.1 Overview

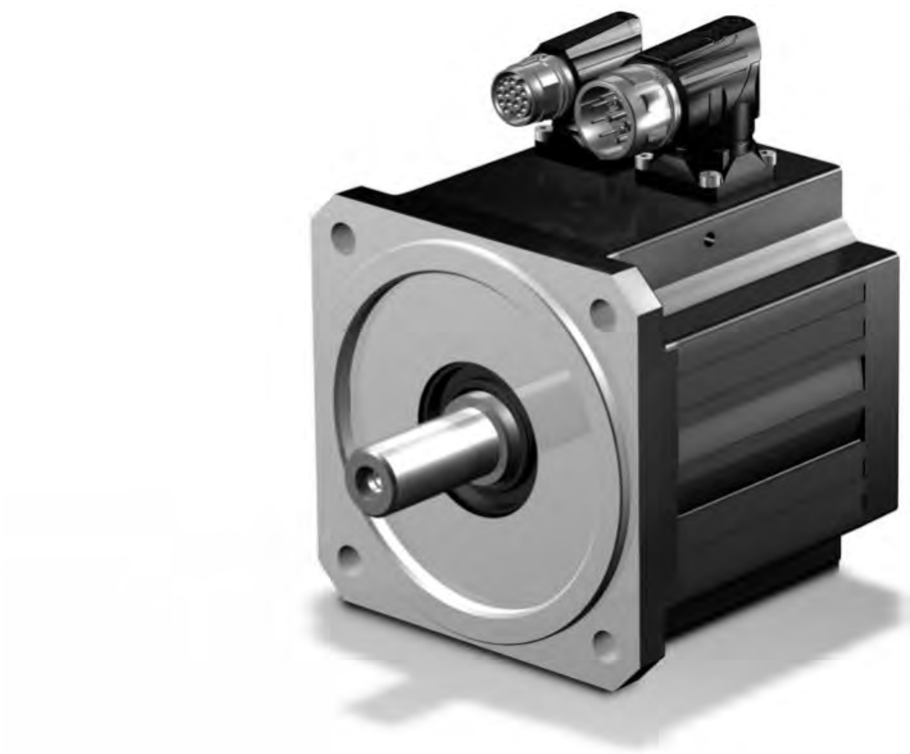
Synchronous servo motors with single tooth winding

Torques

M_N	0.89 – 77.2 Nm
M_0	0.95 – 94 Nm

Features

High dynamics	✓
Short length	✓
Super compact due to tooth-coil winding method with the highest possible copper fill factor	✓
Backlash-free holding brake (optional)	✓
Electronic nameplate for fast and reliable commissioning	✓
Convection cooling or forced ventilation (optional)	✓
Optical, inductive EnDat absolute encoders or resolvers	✓
Elimination of referencing with multi-turn absolute encoders (optional)	✓
One Cable Solution (OCS) with HIPERFACE DSL encoder (optional)	✓
Rotating plug connectors with quick lock	✓



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22.2 Selection tables

The technical data specified in the selection tables applies to:

- 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
- Black matte paint as per RAL 9005

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

Motor type	Steel mounting flange dimensions (thickness x width x height)	Convection surface area Steel mounting flange
EZ3 − EZ5	23 x 210 x 275 mm	0.16 m^2
EZ7 − EZ8	28 x 300 x 400 mm	0.3 m^2

Note the differing ambient conditions in Chapter [▷ 22.7.3]

Formula symbol	Unit	Explanation
I_0	A	Stall current: RMS value of the line-to-line current when the stall torque M_0 is generated (tolerance ±5%)
I_{max}	A	Maximum current: RMS value of the maximum permitted line-to-line current when maximum torque M_{max} is 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 when nominal torque M_N is generated (tolerance ±5%)
J_{dyn}	10^{-4} kgm^2	Mass moment of inertia of a motor in dynamic operation
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 stall torque and frictional torque to the stall 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 a resonant circuit)
m_{dyn}	kg	Weight of a motor in dynamic operation
M_0	Nm	Stall torque: The continuous torque the motor is able to deliver at a speed of 10 rpm (tolerance ±5%)
M_{max}	Nm	Maximum torque: the maximum permitted torque the motor is able to deliver over a short period (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 torque values as follows: $M_{N^*} = K_{M0} \cdot I^* - M_R$.
M_R	Nm	Frictional torque (of the bearings and seals) 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 symbol	Unit	Explanation
P_N	kW	Nominal power: the power 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

22.2.1 EZ 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_{dyn} [10^{-4} kgm²]	m_{dyn} [kg]
EZ301U	40	6000	0.89	1.93	0.46	0.56	0.95	2.02	0.49	0.04	2.80	12.7	11.70	39.80	3.40	0.19	1.50
EZ301U	40	3000	0.93	1.99	0.47	0.29	0.95	2.02	0.49	0.04	2.80	12.7	11.70	39.80	3.40	0.19	1.50
EZ302U	42	6000	1.50	3.18	0.47	0.94	1.68	3.48	0.49	0.04	5.00	17.8	4.50	18.70	4.16	0.29	2.10
EZ302U	86	3000	1.59	1.60	0.99	0.50	1.68	1.67	1.03	0.04	5.00	8.55	17.80	75.00	4.21	0.29	2.10
EZ303U	55	6000	1.96	3.17	0.62	1.2	2.25	3.55	0.65	0.04	7.00	16.9	4.90	21.10	4.31	0.40	2.60
EZ303U	109	3000	2.07	1.63	1.27	0.65	2.19	1.71	1.30	0.04	7.00	8.25	13.10	68.70	5.24	0.40	2.60
EZ401U	47	6000	2.30	4.56	0.50	1.4	2.80	5.36	0.53	0.04	8.50	33.0	1.94	11.52	5.94	0.93	4.00
EZ401U	96	3000	2.80	2.74	1.02	0.88	3.00	2.88	1.06	0.04	8.50	16.5	6.70	37.70	5.63	0.93	4.00
EZ402U	60	6000	3.50	5.65	0.62	2.2	4.90	7.43	0.66	0.04	16.0	43.5	1.20	8.88	7.40	1.63	5.10
EZ402U	94	3000	4.70	4.40	1.07	1.5	5.20	4.80	1.09	0.04	16.0	26.5	3.00	21.80	7.26	1.63	5.10
EZ404U	78	6000	5.80	7.18	0.81	3.6	8.40	9.78	0.86	0.04	29.0	51.0	0.89	7.07	7.94	2.98	7.20
EZ404U	116	3000	6.90	5.80	1.19	2.2	8.60	6.60	1.31	0.04	29.0	35.0	1.85	15.00	8.11	2.98	7.20
EZ501U	68	6000	3.40	4.77	0.71	2.1	4.40	5.80	0.77	0.06	16.0	31.0	2.10	12.10	5.76	2.90	5.00
EZ501U	97	3000	4.30	3.74	1.15	1.4	4.70	4.00	1.19	0.06	16.0	22.0	3.80	23.50	6.18	2.90	5.00
EZ502U	72	6000	5.20	7.35	0.71	3.3	7.80	9.80	0.80	0.06	31.0	59.0	0.76	5.60	7.37	5.20	6.50
EZ502U	121	3000	7.40	5.46	1.36	2.3	8.00	5.76	1.40	0.06	31.0	33.0	2.32	16.80	7.24	5.20	6.50
EZ503U	84	6000	6.20	7.64	0.81	3.9	10.6	11.6	0.92	0.06	43.0	63.5	0.62	5.00	8.06	7.58	8.00
EZ503U	119	3000	9.70	6.90	1.41	3.1	11.1	7.67	1.46	0.06	43.0	41.0	1.25	10.00	8.00	7.58	8.00
EZ505U	103	4500	9.50	8.94	1.06	4.5	15.3	13.4	1.15	0.06	67.0	73.0	0.50	4.47	8.94	12.2	10.9
EZ505U	141	3000	13.5	8.80	1.53	4.2	16.0	10.0	1.61	0.06	67.0	52.0	0.93	8.33	8.96	12.2	10.9
EZ701U	76	6000	5.20	6.68	0.78	3.3	7.90	9.38	0.87	0.24	20.0	31.0	0.87	8.13	9.34	8.50	8.30
EZ701U	95	3000	7.40	7.20	1.03	2.3	8.30	8.00	1.07	0.24	20.0	25.0	1.30	12.83	9.87	8.50	8.30
EZ702U	82	6000	7.20	8.96	0.80	4.5	14.3	16.5	0.88	0.24	41.0	60.5	0.34	3.90	11.47	13.7	10.8
EZ702U	133	3000	12.0	8.20	1.46	3.8	14.4	9.60	1.53	0.24	41.0	36.0	1.00	11.73	11.73	13.7	10.8
EZ703U	99	4500	12.1	11.5	1.05	5.7	20.0	17.8	1.14	0.24	65.0	78.0	0.36	4.42	12.28	21.6	12.8
EZ703U	122	3000	16.5	11.4	1.45	5.2	20.8	14.0	1.50	0.24	65.0	62.0	0.52	6.80	13.08	21.6	12.8
EZ705U	106	4500	16.4	14.8	1.11	7.7	30.0	25.2	1.20	0.24	104	114	0.22	2.76	12.55	34.0	18.3
EZ705U	140	3000	21.3	14.2	1.50	6.7	30.2	19.5	1.56	0.24	104	87.0	0.33	4.80	14.55	34.0	18.3
EZ802U	90	4500	10.5	11.2	0.94	5.0	34.5	33.3	1.05	0.30	100	135	0.13	1.90	14.60	58.0	26.6
EZ802U	136	3000	22.3	13.9	1.60	7.0	37.1	22.3	1.68	0.30	100	84.0	0.30	5.00	16.66	58.0	26.6
EZ803U	131	3000	26.6	17.7	1.50	8.4	48.2	31.1	1.56	0.30	145	124	0.18	2.79	15.50	83.5	32.7
EZ805U	142	2000	43.7	25.9	1.69	9.2	66.1	37.9	1.75	0.30	205	155	0.13	2.22	17.08	133	45.8

22.2.2 EZ 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_{dyn} [10^{-4} kgm²]	m_{dyn} [kg]
EZ401B	47	6000	2.90	5.62	0.52	1.8	3.50	6.83	0.52	0.04	8.50	33.0	1.94	11.52	5.94	0.93	5.40
EZ401B	96	3000	3.40	3.40	1.00	1.1	3.70	3.60	1.04	0.04	8.50	16.5	6.70	37.70	5.63	0.93	5.40
EZ402B	60	6000	5.10	7.88	0.65	3.2	6.40	9.34	0.69	0.04	16.0	43.5	1.20	8.88	7.40	1.63	6.50
EZ402B	94	3000	5.90	5.50	1.07	1.9	6.30	5.80	1.09	0.04	16.0	26.5	3.00	21.80	7.26	1.63	6.50
EZ404B	78	6000	8.00	9.98	0.80	5.0	10.5	12.0	0.88	0.04	29.0	51.0	0.89	7.07	7.94	2.98	8.60
EZ404B	116	3000	10.2	8.20	1.24	3.2	11.2	8.70	1.29	0.04	29.0	35.0	1.85	15.00	8.11	2.98	8.60
EZ501B	68	6000	4.50	6.70	0.67	2.8	5.70	7.50	0.77	0.06	16.0	31.0	2.10	12.10	5.76	2.90	7.00
EZ501B	97	3000	5.40	4.70	1.15	1.7	5.80	5.00	1.17	0.06	16.0	22.0	3.80	23.50	6.18	2.90	7.00
EZ502B	72	6000	8.20	11.4	0.72	5.2	10.5	13.4	0.79	0.06	31.0	59.0	0.76	5.60	7.37	5.20	8.50
EZ502B	121	3000	10.3	7.80	1.32	3.2	11.2	8.16	1.38	0.06	31.0	33.0	2.32	16.80	7.24	5.20	8.50
EZ503B	84	6000	10.4	13.5	0.77	6.5	14.8	15.9	1.07	0.06	43.0	63.5	0.62	5.00	8.06	7.58	10.0
EZ503B	119	3000	14.4	10.9	1.32	4.5	15.9	11.8	1.35	0.06	43.0	41.0	1.25	10.00	8.00	7.58	10.0
EZ505B	103	4500	16.4	16.4	1.00	7.7	22.0	19.4	1.14	0.06	67.0	73.0	0.50	4.47	8.94	12.2	12.9
EZ505B	141	3000	20.2	13.7	1.47	6.4	23.4	14.7	1.60	0.06	67.0	52.0	0.93	8.33	8.96	12.2	12.9
EZ701B	76	6000	7.50	10.6	0.71	4.7	10.2	12.4	0.84	0.24	20.0	31.0	0.87	8.13	9.34	8.50	13.3
EZ701B	95	3000	9.70	9.50	1.02	3.1	10.5	10.0	1.07	0.24	20.0	25.0	1.30	12.83	9.87	8.50	13.3
EZ702B	82	6000	12.5	16.7	0.75	7.9	19.3	22.1	0.89	0.24	41.0	60.5	0.34	3.90	11.47	13.7	15.8
EZ702B	133	3000	16.6	11.8	1.41	5.2	19.3	12.9	1.51	0.24	41.0	36.0	1.00	11.73	11.73	13.7	15.8
EZ703B	99	4500	19.8	20.3	0.98	9.3	27.2	24.2	1.13	0.24	65.0	78.0	0.36	4.42	12.28	21.6	17.8
EZ703B	122	3000	24.0	18.2	1.32	7.5	28.0	20.0	1.41	0.24	65.0	62.0	0.52	6.80	13.08	21.6	17.8
EZ705B	106	4500	27.7	25.4	1.09	13	39.4	32.8	1.21	0.24	104	114	0.22	2.76	12.55	34.0	23.3
EZ705B	140	3000	33.8	22.9	1.48	11	41.8	26.5	1.59	0.24	104	87.0	0.33	4.80	14.55	34.0	23.3
EZ802B	90	4500	30.6	30.5	1.00	14	47.4	45.1	1.06	0.30	100	135	0.13	1.90	14.60	58.0	31.6
EZ802B	136	3000	34.3	26.5	1.29	11	47.9	28.9	1.67	0.30	100	84.0	0.30	5.00	16.66	58.0	31.6
EZ803B	131	3000	49.0	35.9	1.37	15	66.7	42.3	1.58	0.30	145	124	0.18	2.79	15.50	83.5	37.7
EZ805B	142	2000	77.2	45.2	1.71	16	94.0	53.9	1.75	0.30	205	155	0.13	2.22	17.08	133	51.8

22.3 Torque/speed curves

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

Formula symbol	Unit	Explanation
ED	%	Duty cycle based on 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_{max}	Nm	Maximum torque: the maximum permitted torque the motor is able to deliver over a short period (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

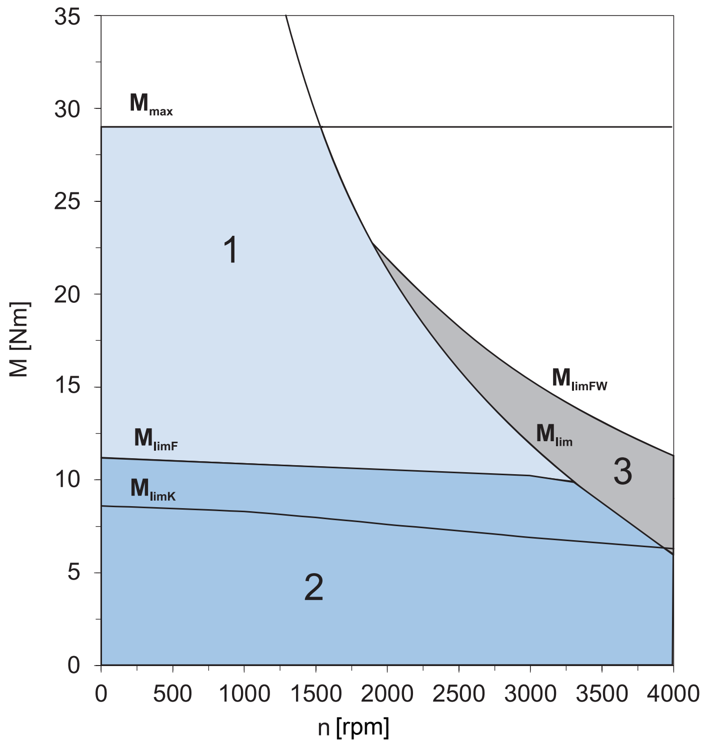
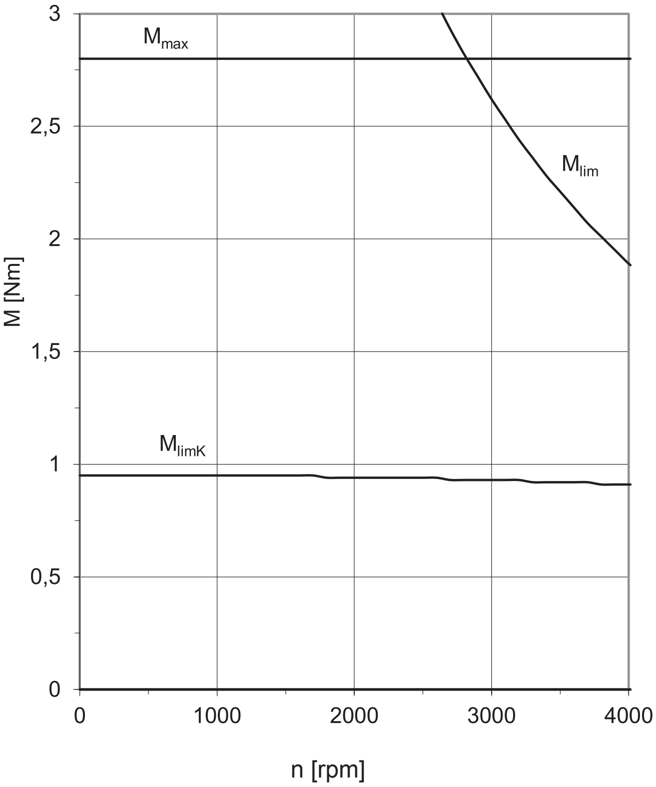


Fig. 1: Explanation of a torque/speed curve

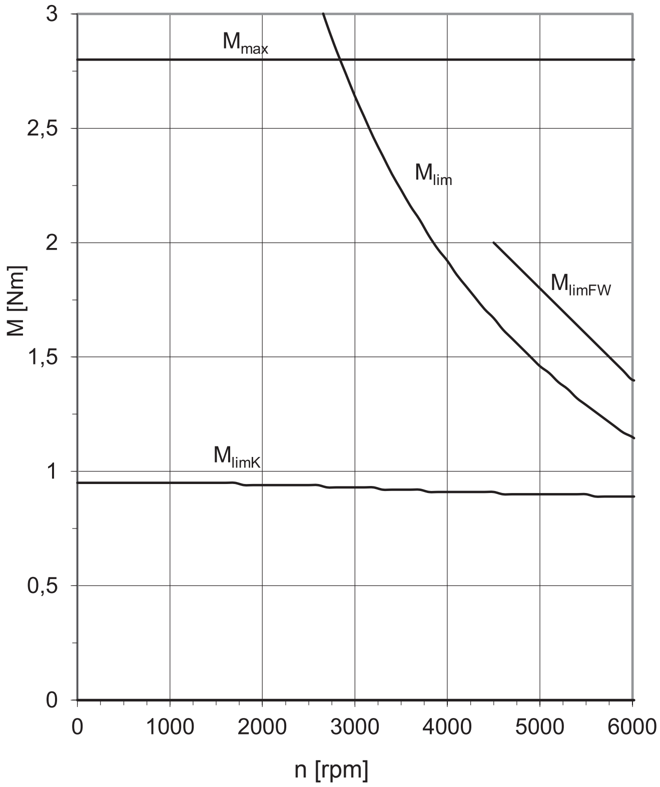
1	Torque range for brief operation (duty cycle < 100%) with Δϑ = 100 K	2	Torque range for continuous operation at a constant load (S1 mode, duty cycle = 100%) with ϑ = 100 K
3	Field weakening range (can be used only with operation on STOBER drive controllers)		

EZ

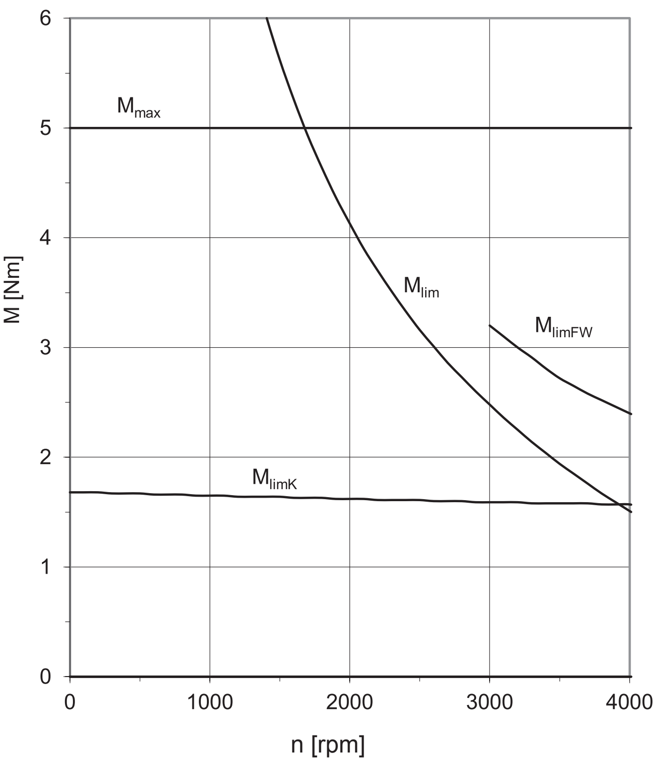
EZ301 (n_N=3000 rpm)



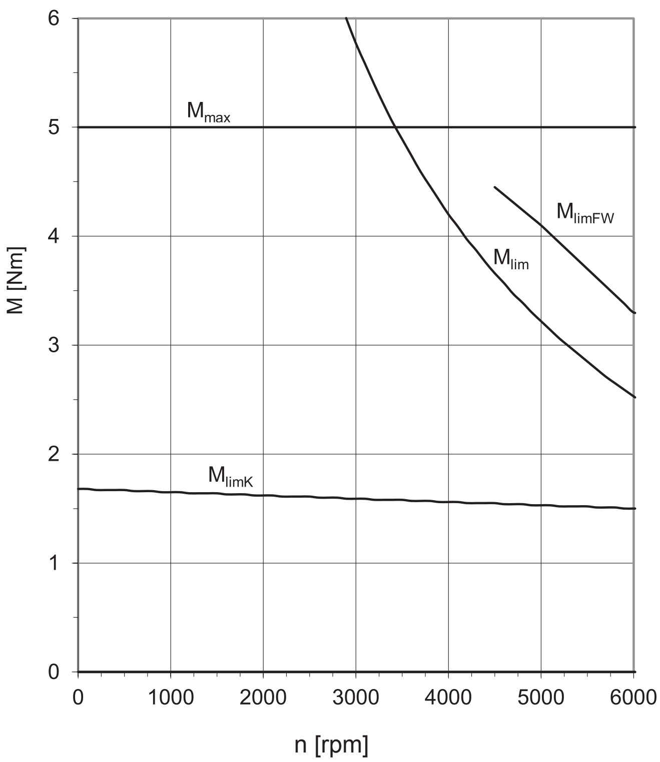
EZ301 (n_N=6000 rpm)



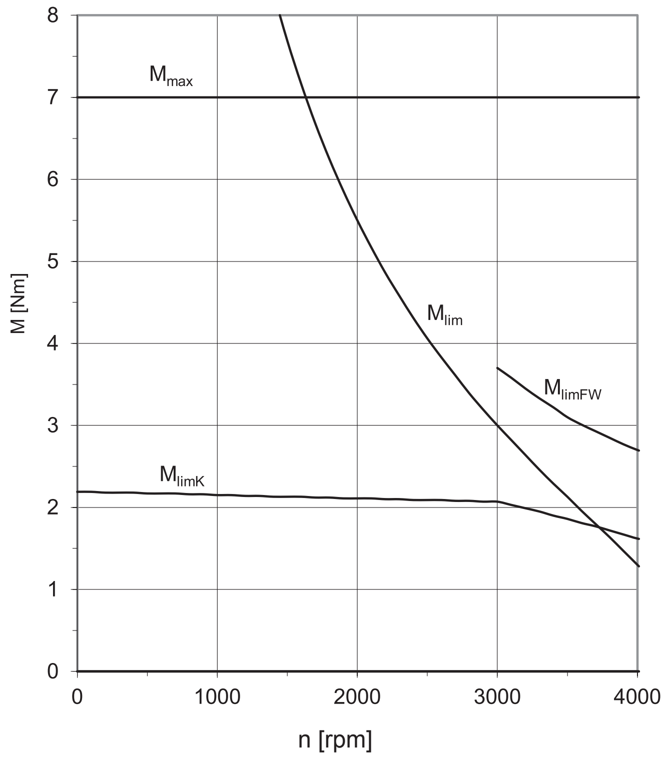
EZ302 (n_N=3000 rpm)



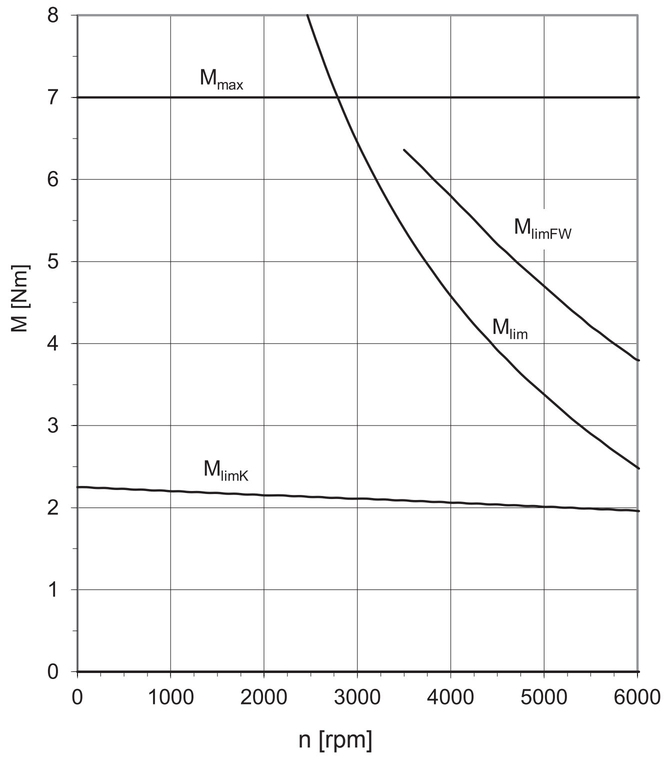
EZ302 (n_N=6000 rpm)



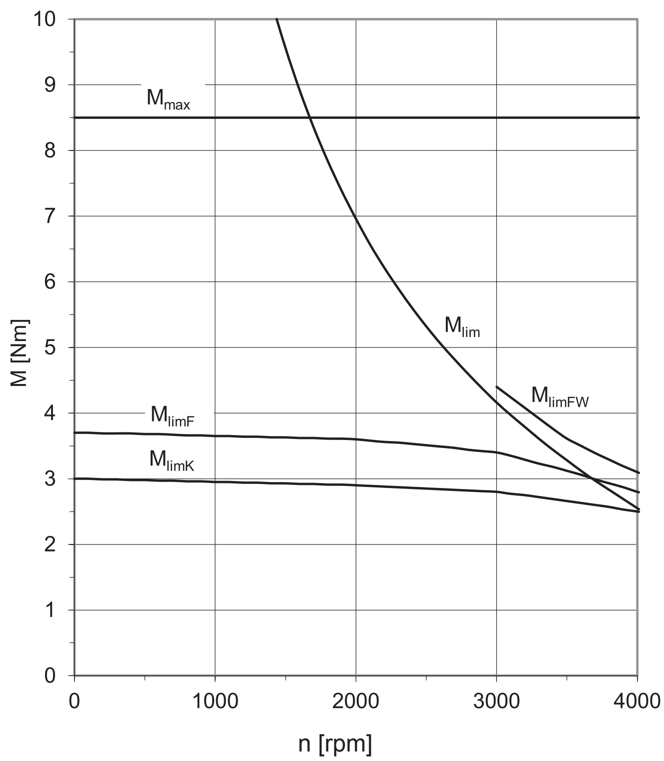
EZ303 (n_N=3000 rpm)



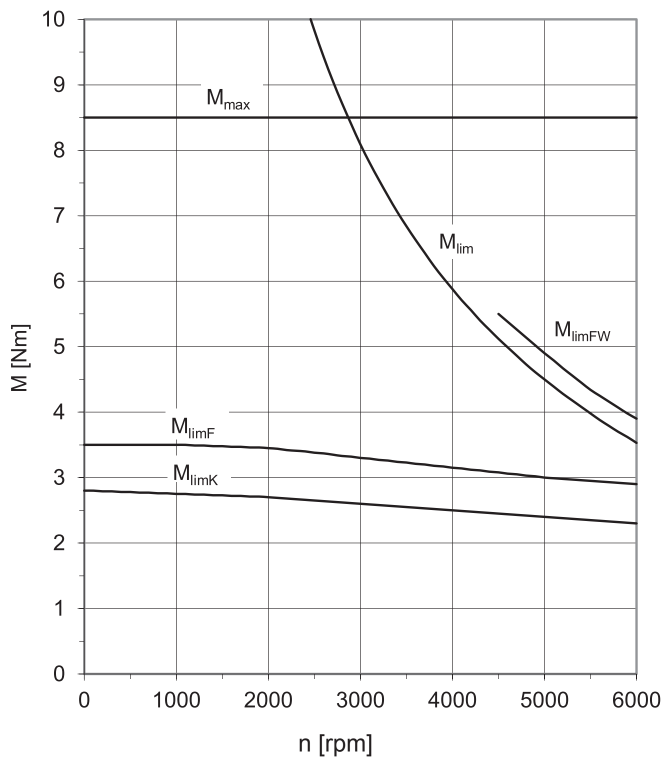
EZ303 (n_N=6000 rpm)



EZ401 (n_N=3000 rpm)



EZ401 (n_N=6000 rpm)



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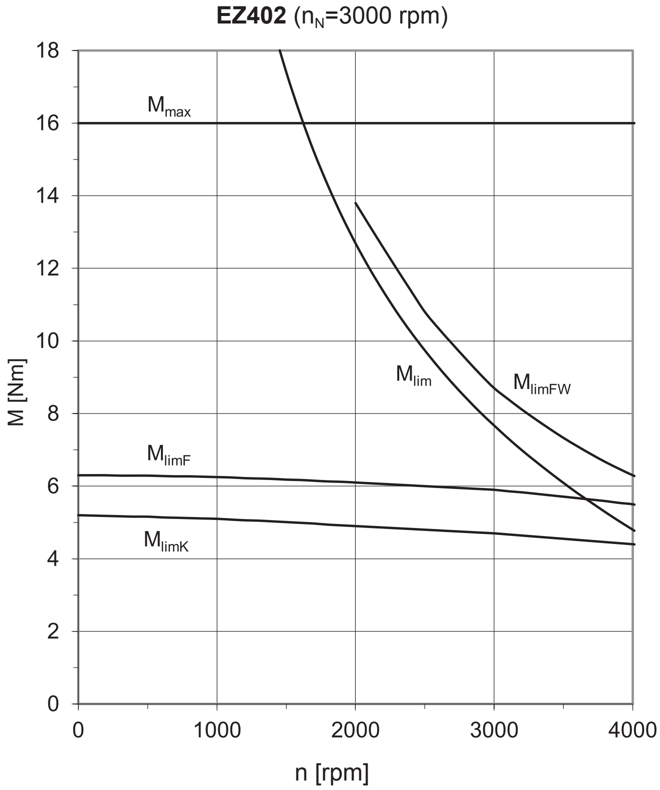
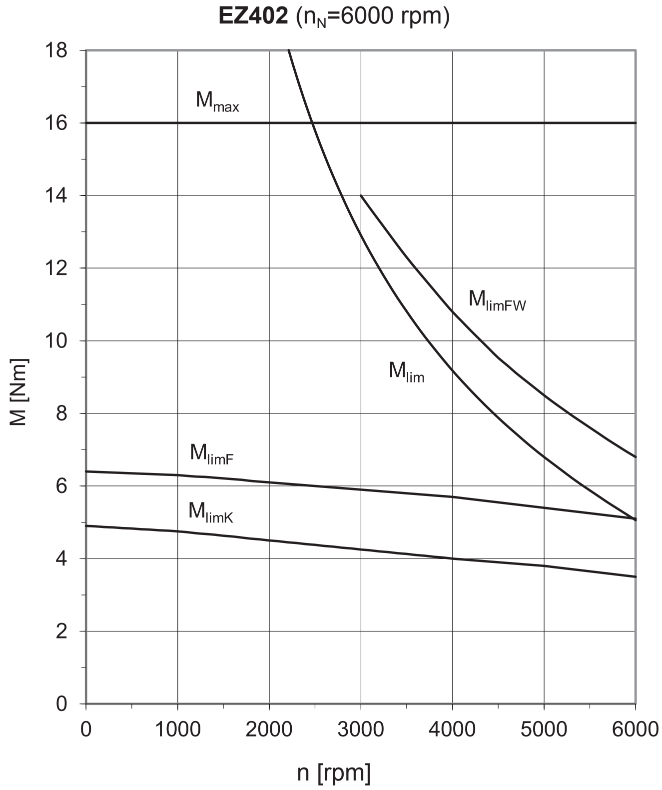
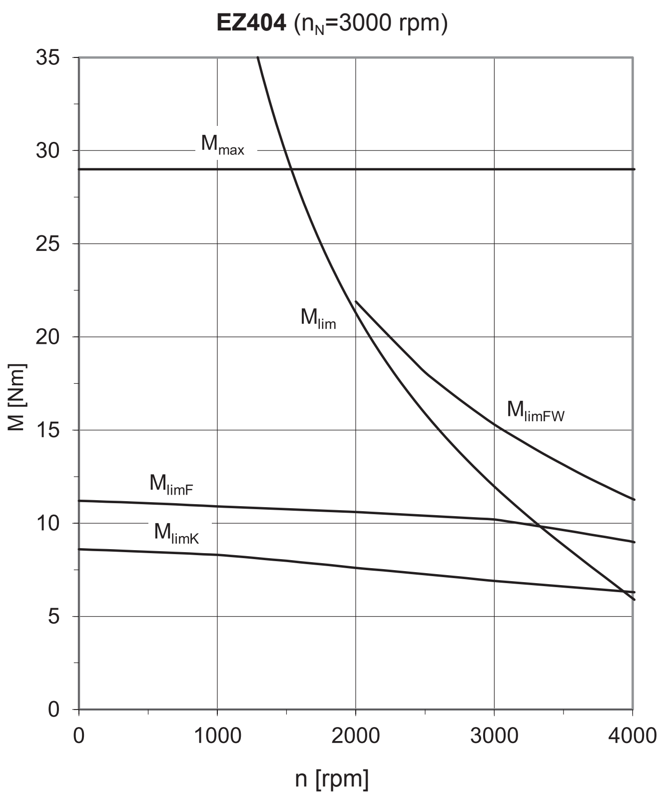
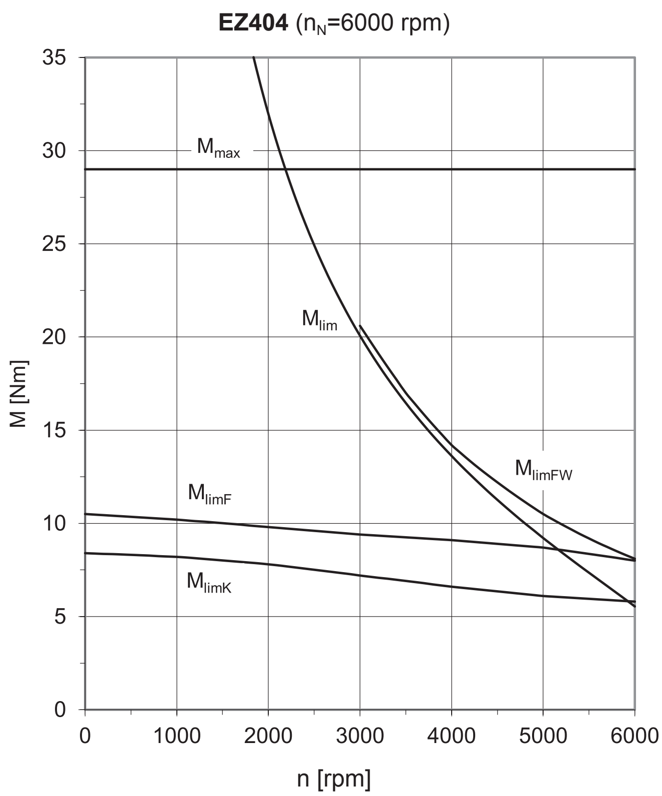

EZ402 (nN=3000 rpm)
Mmax
Mlim
MlimFW
MlimF
MlimK
M [Nm]
n [rpm]
0
2
4
6
8
10
12
14
16
18
0
1000
2000
3000
4000

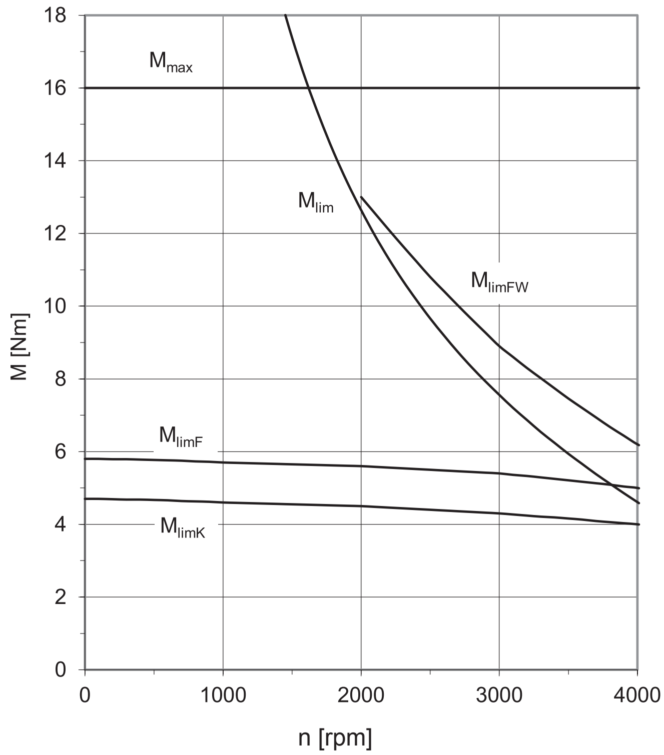

EZ402 (nN=6000 rpm)
Mmax
MlimFW
Mlim
MlimF
MlimK
M [Nm]
n [rpm]
0
2
4
6
8
10
12
14
16
18
0
1000
2000
3000
4000
5000
6000


EZ404 (nN=3000 rpm)
Mmax
Mlim
MlimFW
MlimF
MlimK
M [Nm]
n [rpm]
0
5
10
15
20
25
30
35
0
1000
2000
3000
4000

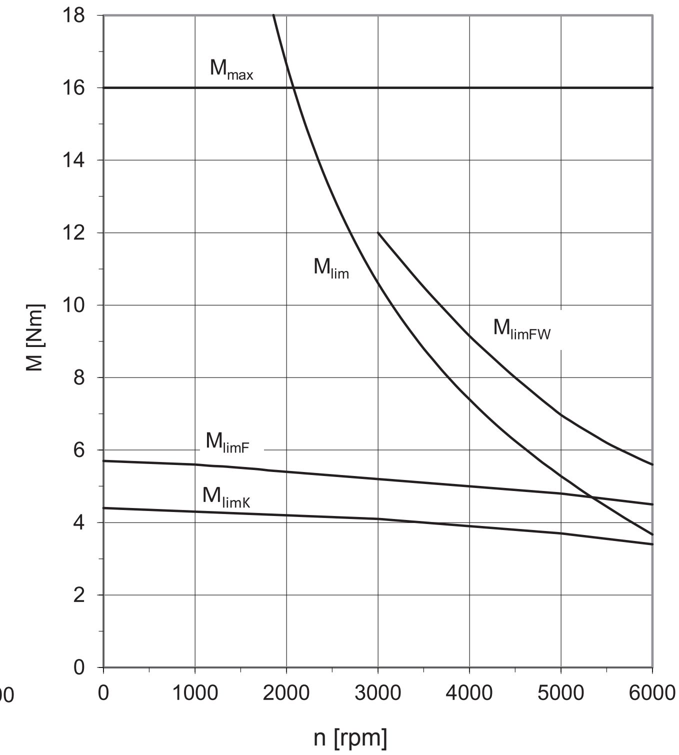

EZ404 (nN=6000 rpm)
Mmax
Mlim
MlimFW
MlimF
MlimK
M [Nm]
n [rpm]
0
5
10
15
20
25
30
35
0
1000
2000
3000
4000
5000
6000

STOBER

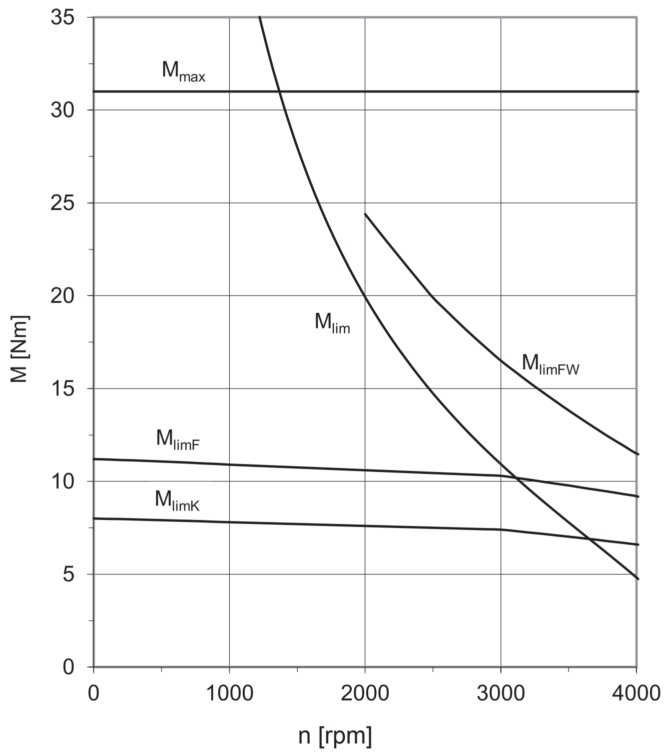
EZ501 (n_N=3000 rpm)



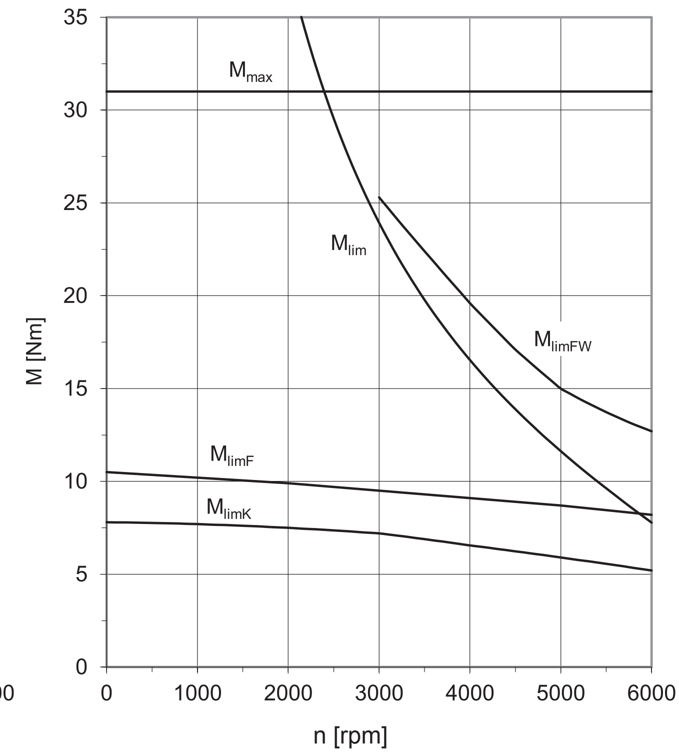
EZ501 (n_N=6000 rpm)



EZ502 (n_N=3000 rpm)

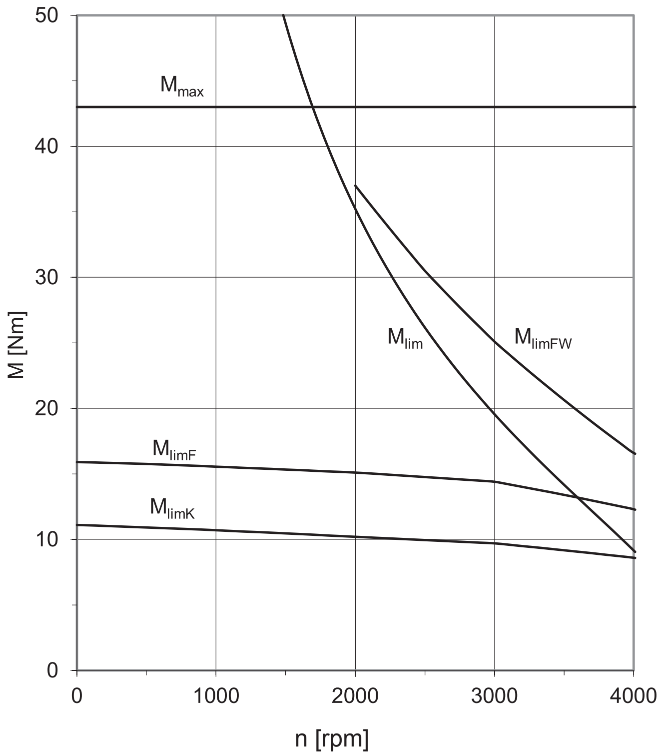


EZ502 (n_N=6000 rpm)

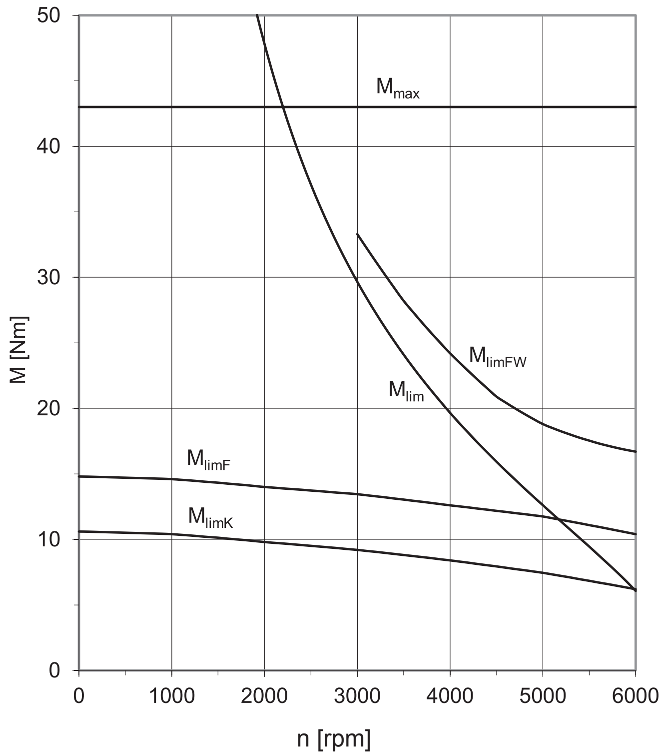


EZ

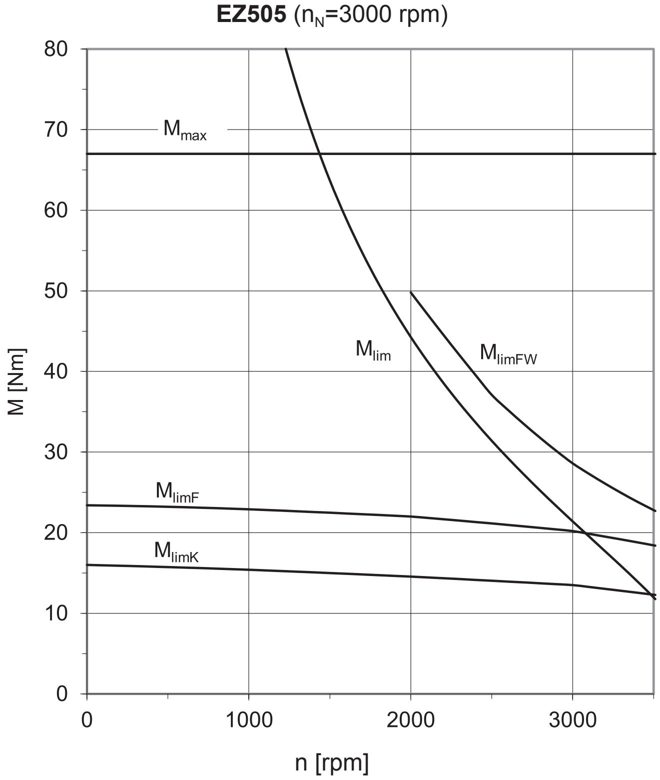
EZ503 (n_N=3000 rpm)



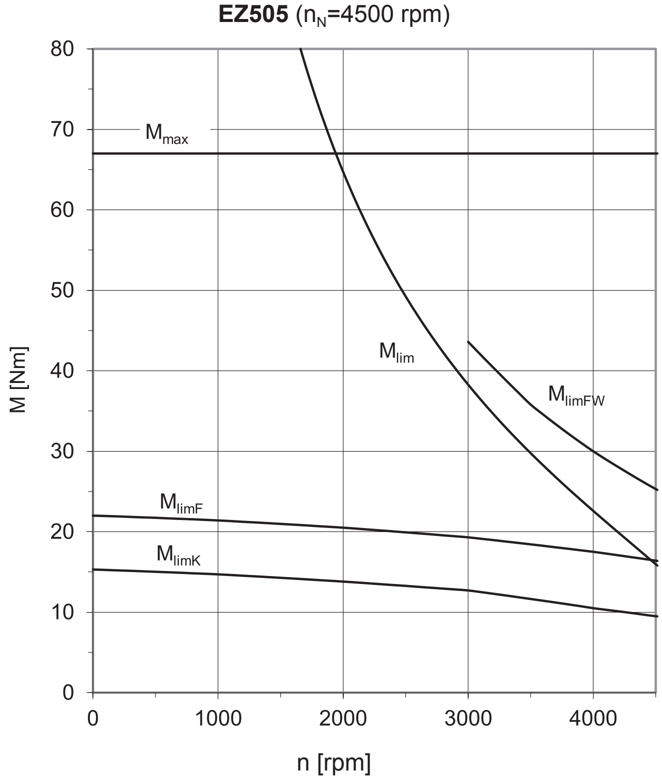
EZ503 (n_N=6000 rpm)



EZ505 (n_N=3000 rpm)

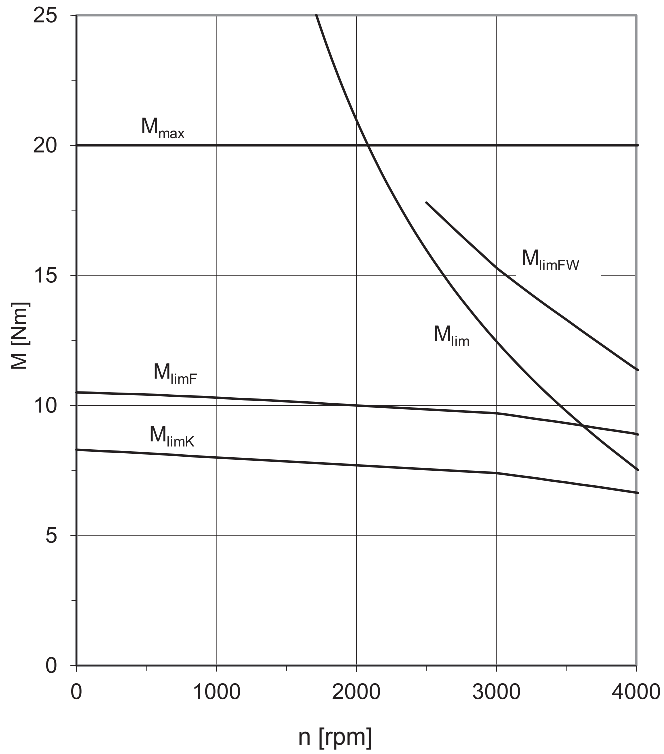


EZ505 (n_N=4500 rpm)

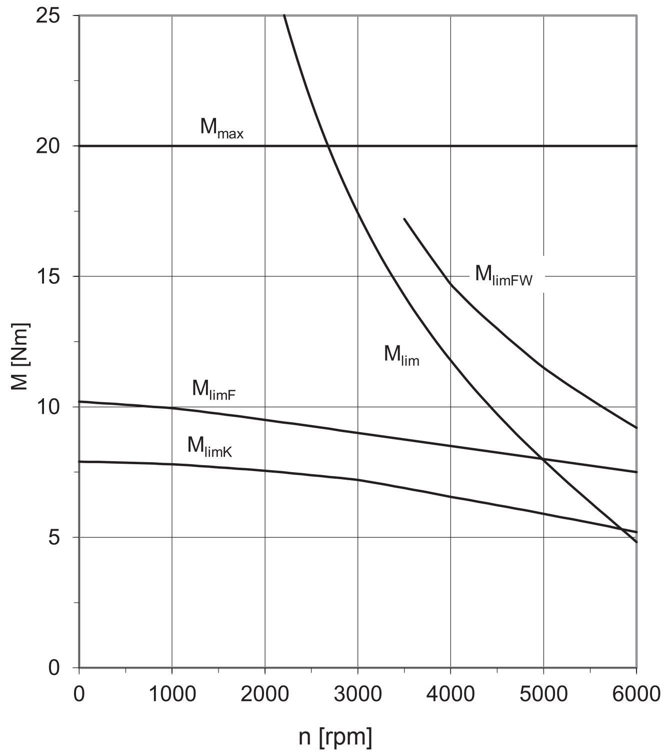


STOBER

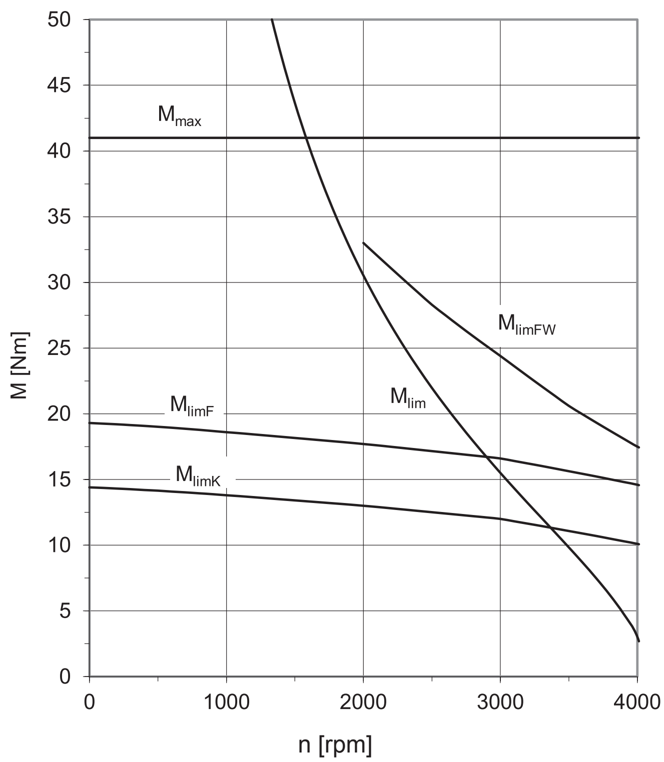
EZ701 (n_N=3000 rpm)



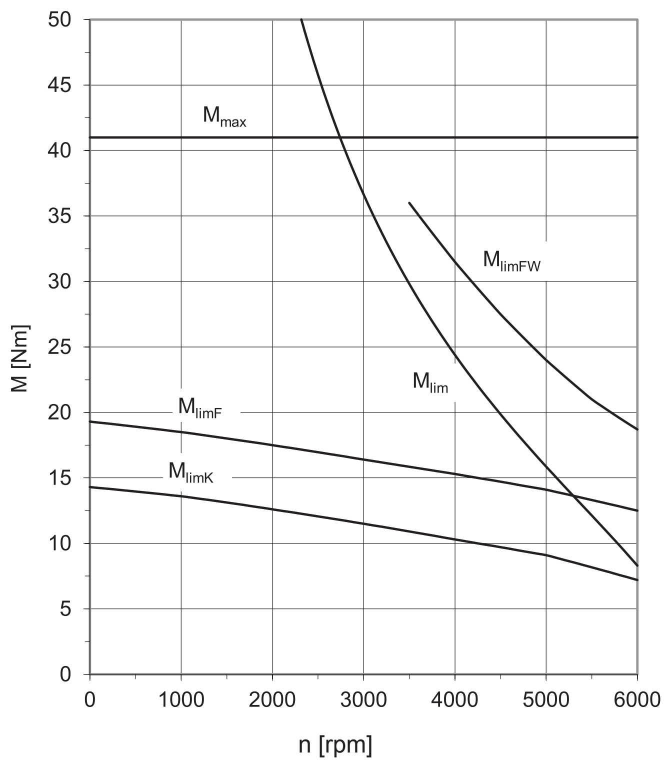
EZ701 (n_N=6000 rpm)



EZ702 (n_N=3000 rpm)

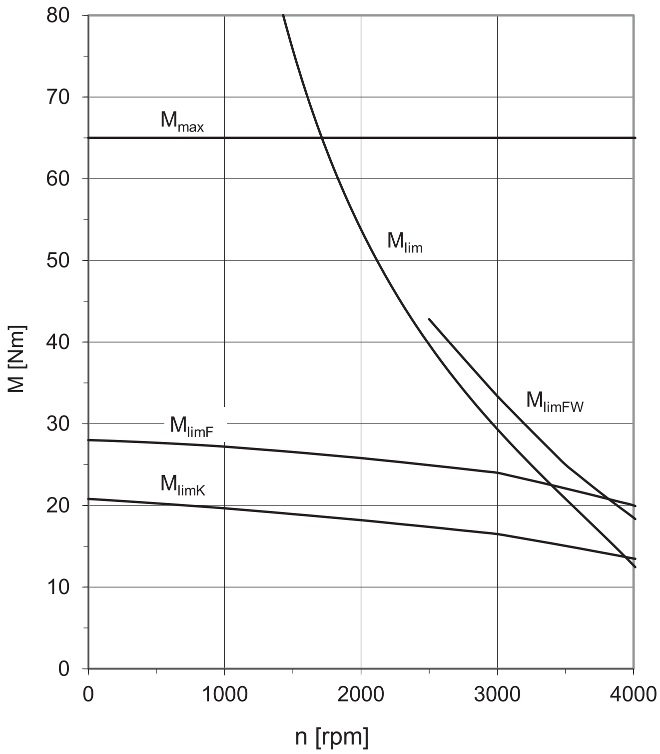


EZ702 (n_N=6000 rpm)

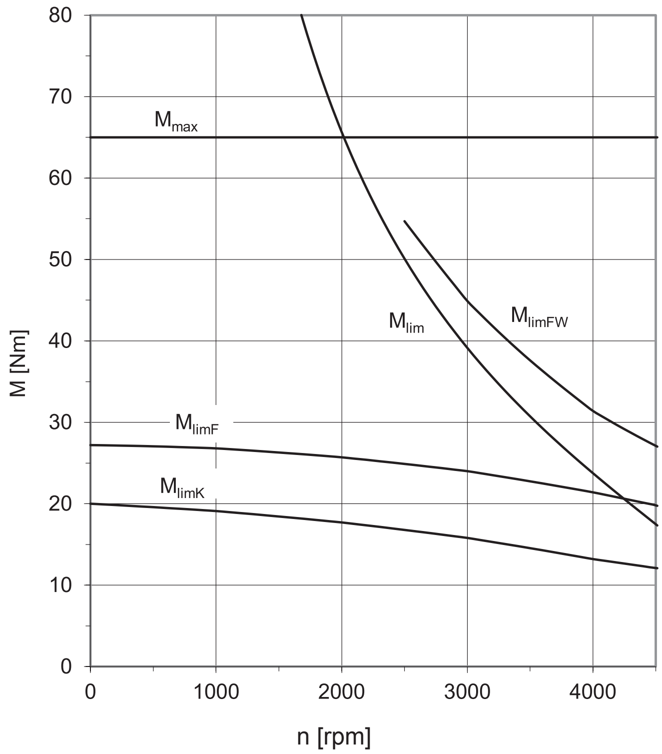


EZ

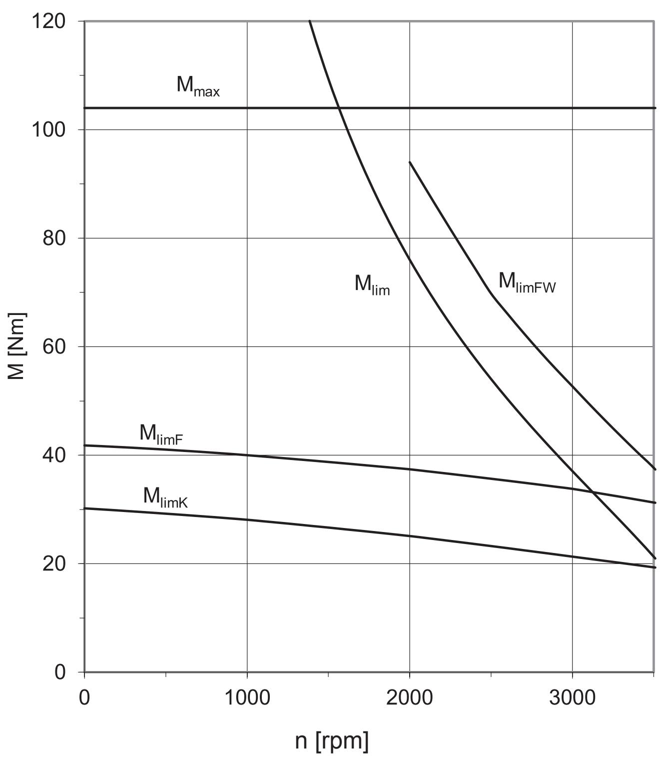
EZ703 (n_N=3000 rpm)



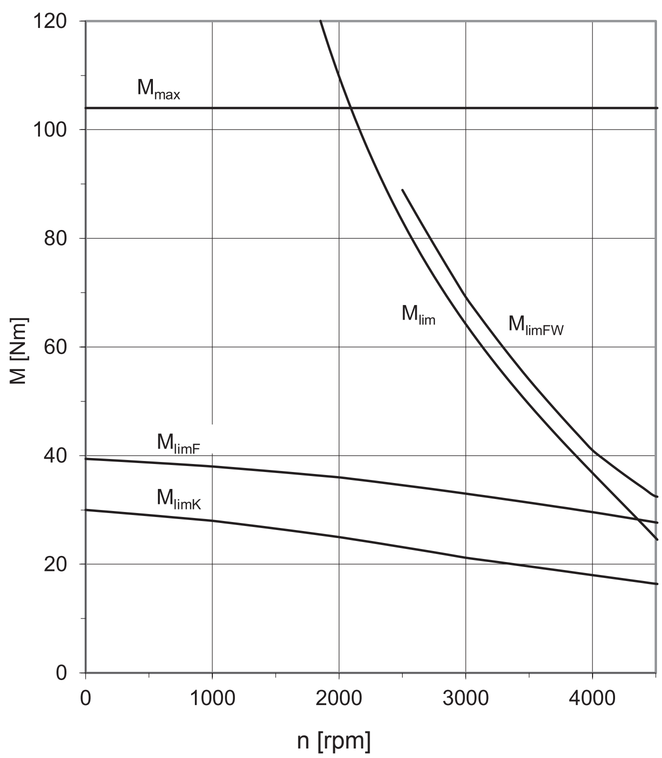
EZ703 (n_N=4500 rpm)



EZ705 (n_N=3000 rpm)

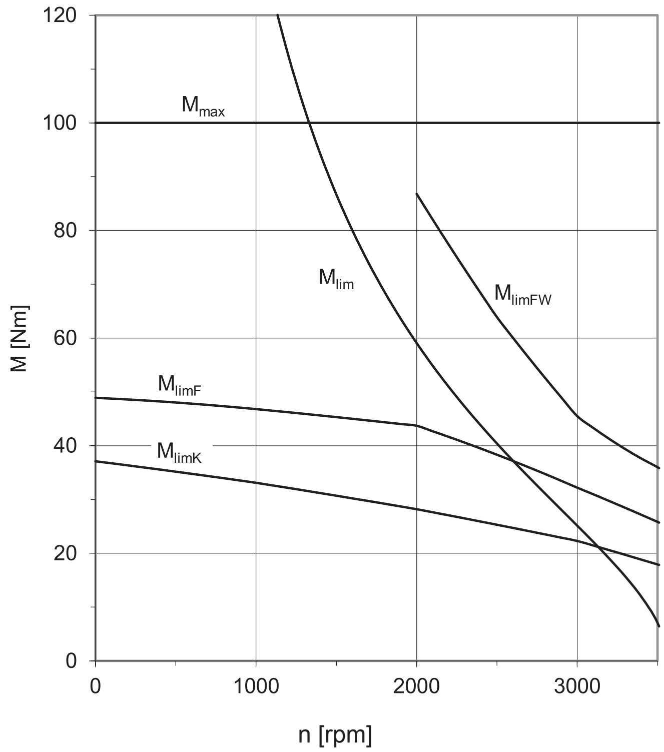


EZ705 (n_N=4500 rpm)

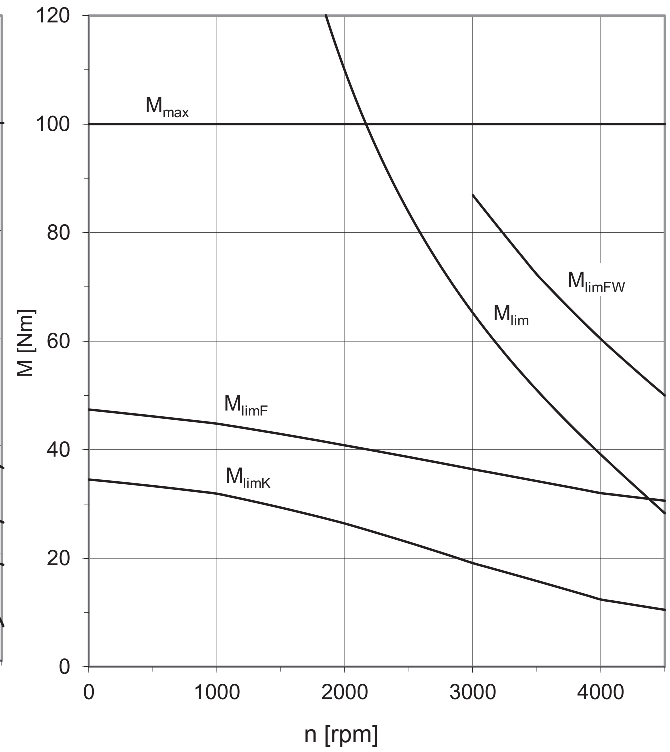


STOBER

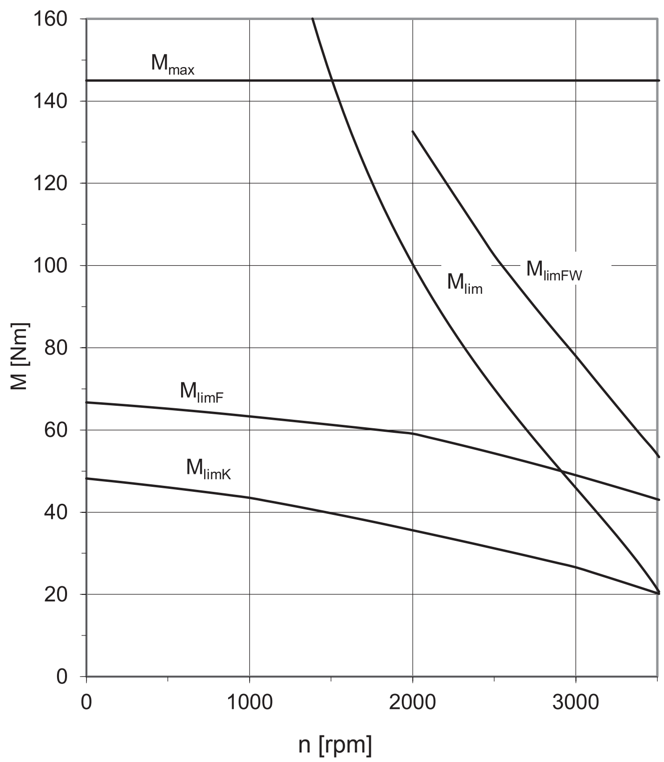
EZ802 (n_N=3000 rpm)



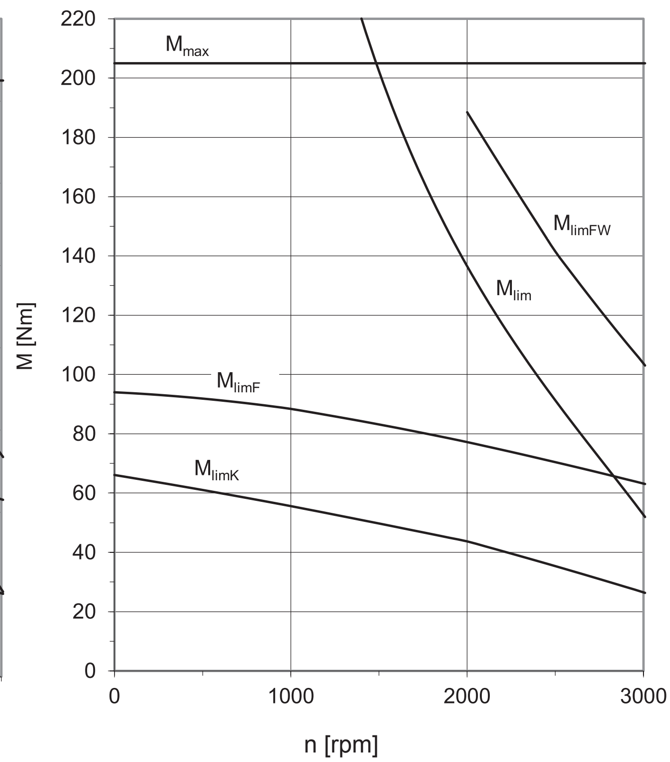
EZ802 (n_N=4500 rpm)



EZ803 (n_N=3000 rpm)



EZ805 (n_N=2000 rpm)



EZ

22.4 Dimensional drawings

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

Dimensions can exceed the specifications of ISO 2768-mK due to casting tolerances or accumulation of individual tolerances.

We reserve the right to make dimensional changes due to ongoing technical development.

You can download CAD models of our standard drives at http://cad.stoeber.de.

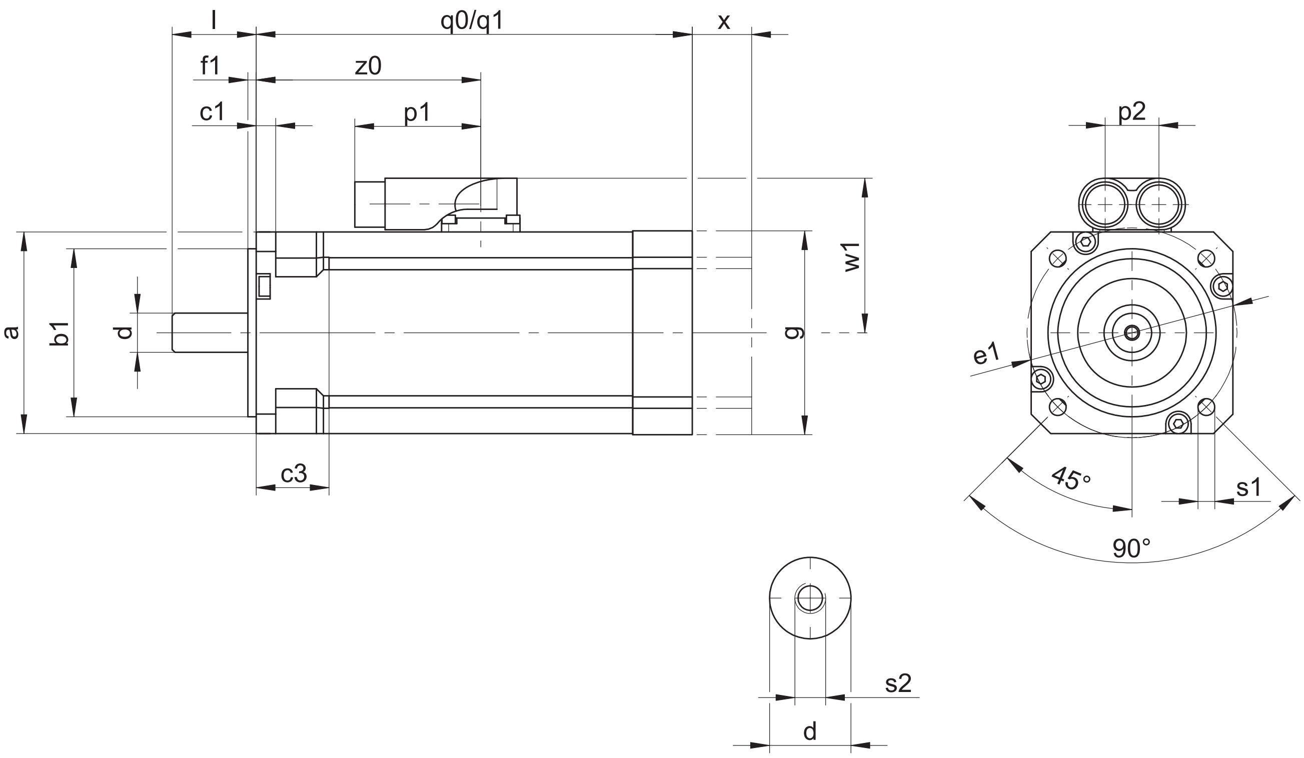
Tolerances

Solid shaft	Tolerance
Fit of shaft end Ø ≤ 50 mm	DIN 748-1, ISO k6
Fit of shaft end ∅ > 50 mm	DIN 748-1, ISO m6

Centering holes in solid shafts in accordance with DIN 332-2, DR form

Thread size	M4	M5	M6	M8	M10	M12	M16	M20	M24
Gewindetiefe	10	12.5	16	19	22	28	36	42	50

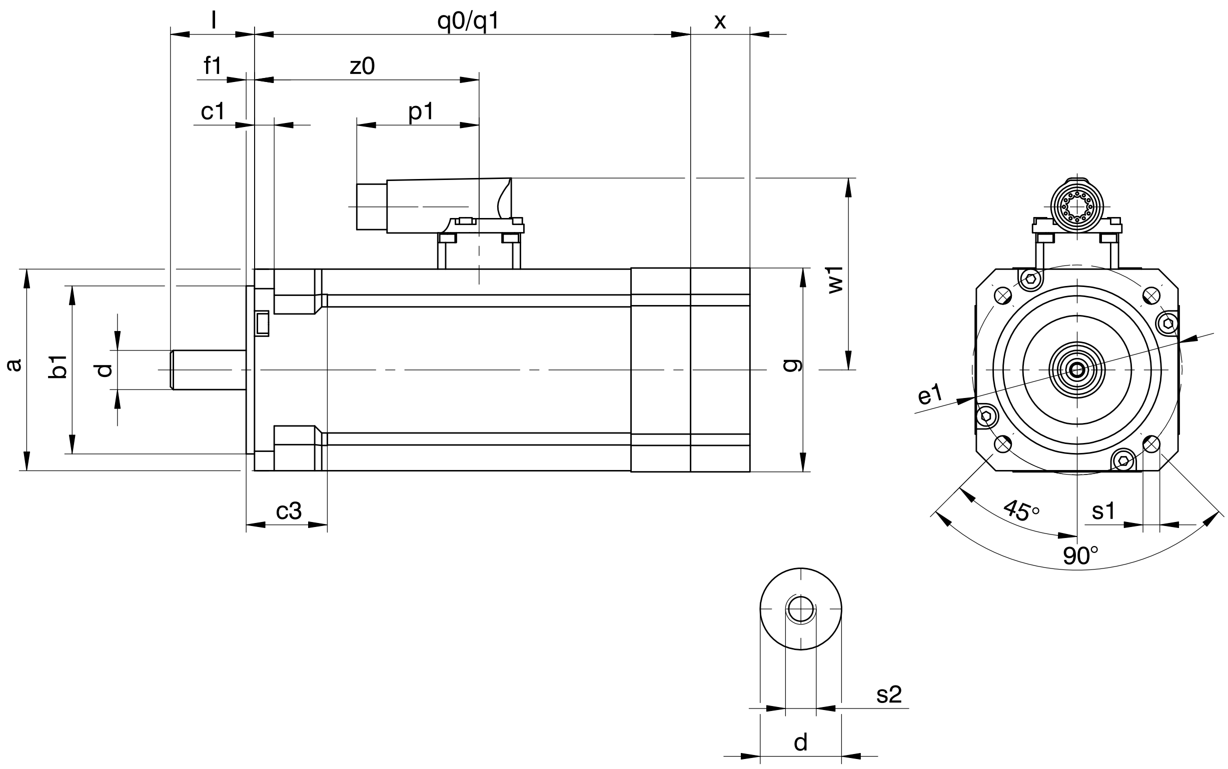
22.4.1 EZ3 motors



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

Type	□a	∅b1	c1	c3	∅d	∅e1	f1	□g	l	p1	p2	q0	q1	∅s1	s2	w1	x	z0
EZ301U	72	60_{j6}	7	26	14_{k6}	75	3	72	30	45	19	116	156	6	M5	55.5	21	80.5
EZ302U	72	60_{j6}	7	26	14_{k6}	75	3	72	30	45	19	138	178	6	M5	55.5	21	102.5
EZ303U	72	60_{j6}	7	26	14_{k6}	75	3	72	30	45	19	160	200	6	M5	55.5	21	124.5

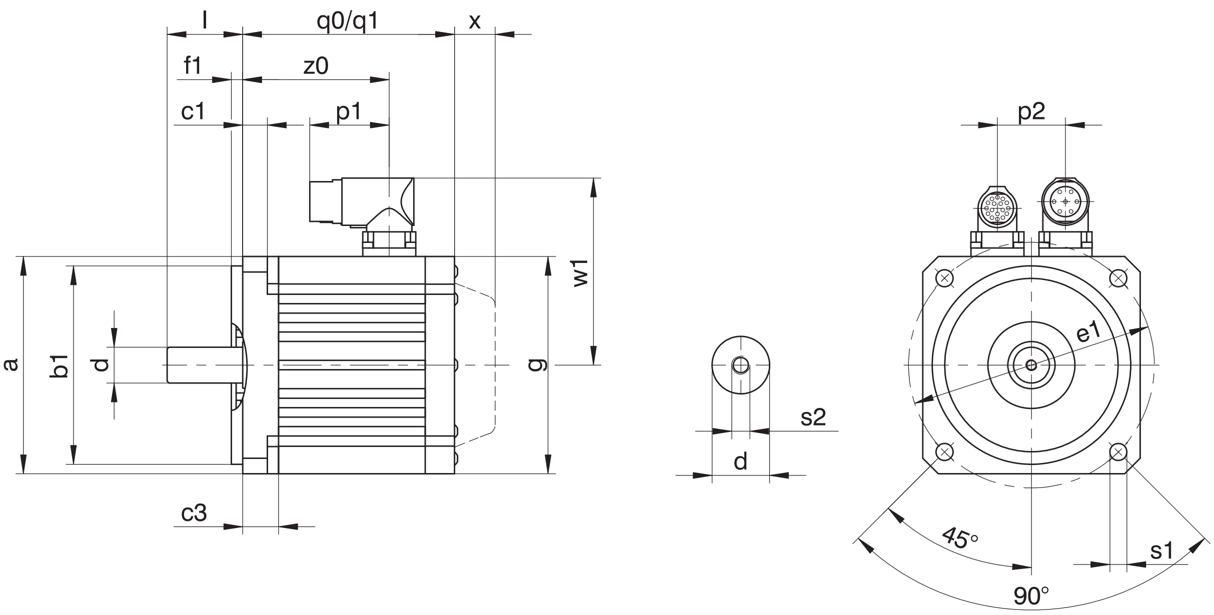
22.4.2 EZ3 motors (One Cable Solution)



q0	Applies to motors without holding brake	q1	Applies to motors with holding brake

Type	□a	∅b1	c1	c3	∅d	∅e1	f1	□g	l	p1	q0	q1	∅s1	s2	w1	x	z0
EZ301U	72	60_{j6}	7	26	14_{k6}	75	3	72	30	45	116	156	6	M5	69	21	80.5
EZ302U	72	60_{j6}	7	26	14_{k6}	75	3	72	30	45	138	178	6	M5	69	21	102.5
EZ303U	72	60_{j6}	7	26	14_{k6}	75	3	72	30	45	160	200	6	M5	69	21	124.5

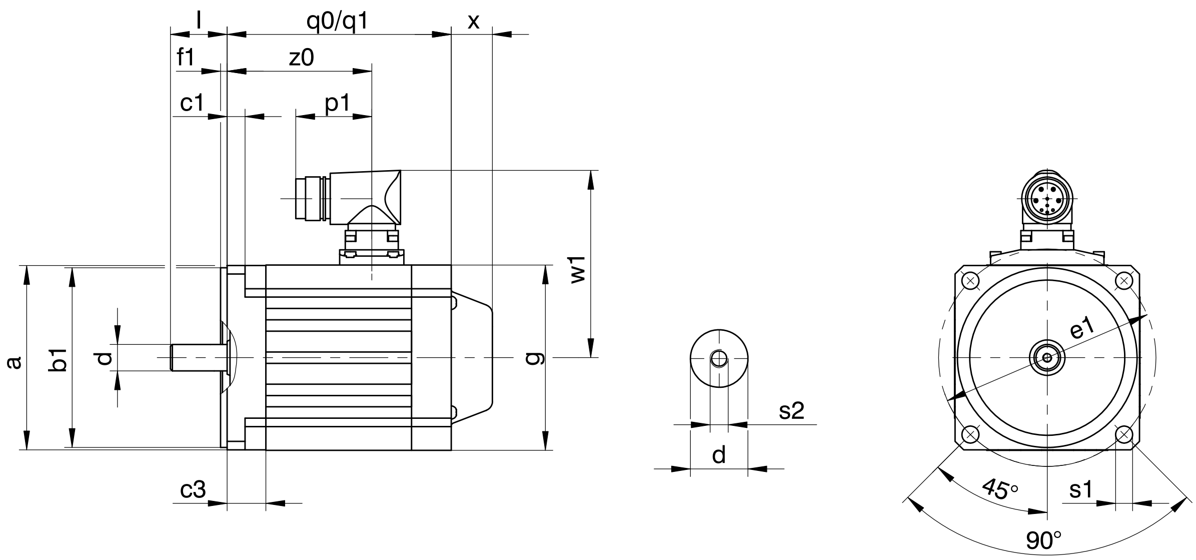
22.4.3 EZ4 – EZ8 motors with convection cooling



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

Type	□a	∅b1	c1	c3	∅d	∅e1	f1	□g	l	p1	p2	q0	q1	∅s1	s2	w1	x	z0
EZ401U	98	95_{j6}	9.5	20.5	14_{k6}	115	3.5	98	30	40	32	118.5	167.0	9	M5	91.0	22	76.5
EZ402U	98	95_{j6}	9.5	20.5	19_{k6}	115	3.5	98	40	40	32	143.5	192.0	9	M6	91.0	22	101.5
EZ404U	98	95_{j6}	9.5	20.5	19_{k6}	115	3.5	98	40	40	32	193.5	242.0	9	M6	91.0	22	151.5
EZ501U	115	110_{j6}	10.0	16.0	19_{k6}	130	3.5	115	40	40	36	109.0	163.5	9	M6	100.0	22	74.5
EZ502U	115	110_{j6}	10.0	16.0	19_{k6}	130	3.5	115	40	40	36	134.0	188.5	9	M6	100.0	22	99.5
EZ503U	115	110_{j6}	10.0	16.0	24_{k6}	130	3.5	115	50	40	36	159.0	213.5	9	M8	100.0	22	124.5
EZ505U	115	110_{j6}	10.0	16.0	24_{k6}	130	3.5	115	50	40	36	209.0	263.5	9	M8	100.0	22	174.5
EZ701U	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	145	50	40	42	121.0	180.0	11	M8	115.0	22	83.0
EZ702U	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	145	50	40	42	146.0	205.0	11	M8	115.0	22	108.0
EZ703U	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	145	50	40	42	171.0	230.0	11	M8	115.0	22	133.0
EZ705U	145	130_{j6}	10.0	19.0	32_{k6}	165	3.5	145	58	71	42	226.0	285.0	11	M12	134.0	22	184.0
EZ802U	190	180_{j6}	15.0	25.0	32_{k6}	215	3.5	190	58	71	60	222.0	299.0	13.5	M12	156.5	22	168.0
EZ803U	190	180_{j6}	15.0	25.0	38_{k6}	215	3.5	190	80	71	60	263.0	340.0	13.5	M12	156.5	22	209.0
EZ805U	190	180_{j6}	15.0	25.0	38_{k6}	215	3.5	190	80	71	60	345.0	422.0	13.5	M12	156.5	22	277.0

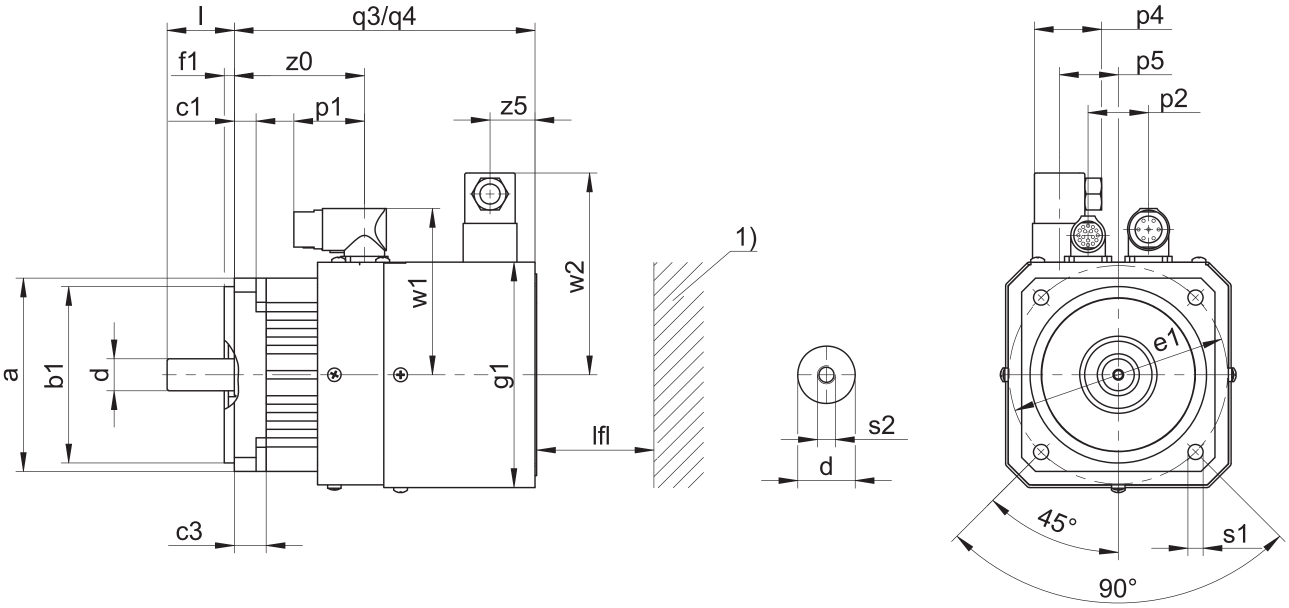
22.4.4 EZ4 – EZ8 motors with convection cooling (One Cable Solution)



q0	Applies to motors without holding brake	q1	Applies to motors with holding brake

Type	□a	Øb1	c1	c3	Ød	Øe1	f1	□g	l	p1	q0	q1	Øs1	s2	w1	x	z0
EZ401U	98	95_{j6}	9.5	20.5	14_{k6}	115	3.5	98	30	40	118.5	167.0	9	M5	99	22	76.5
EZ402U	98	95_{j6}	9.5	20.5	19_{k6}	115	3.5	98	40	40	143.5	192.0	9	M6	99	22	101.5
EZ404U	98	95_{j6}	9.5	20.5	19_{k6}	115	3.5	98	40	40	193.5	242.0	9	M6	99	22	151.5
EZ501U	115	110_{j6}	10.0	16.0	19_{k6}	130	3.5	115	40	40	109.0	163.5	9	M6	110	22	74.5
EZ502U	115	110_{j6}	10.0	16.0	19_{k6}	130	3.5	115	40	40	134.0	188.5	9	M6	110	22	99.5
EZ503U	115	110_{j6}	10.0	16.0	24_{k6}	130	3.5	115	50	40	159.0	213.5	9	M8	110	22	124.5
EZ505U	115	110_{j6}	10.0	16.0	24_{k6}	130	3.5	115	50	40	209.0	263.5	9	M8	110	22	174.5
EZ701U	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	145	50	40	121.0	180.0	11	M8	125	22	83.0
EZ702U	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	145	50	40	146.0	205.0	11	M8	125	22	108.0
EZ703U	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	145	50	40	171.0	230.0	11	M8	125	22	133.0
EZ705U	145	130_{j6}	10.0	19.0	32_{k6}	165	3.5	145	58	71	226.0	285.0	11	M12	125	22	184.0
EZ802U	190	180_{j6}	15.0	25.0	32_{k6}	215	3.5	190	58	71	222.0	299.0	13.5	M12	–	22	168.0
EZ803U	190	180_{j6}	15.0	25.0	38_{k6}	215	3.5	190	80	71	263.0	340.0	13.5	M12	–	22	209.0
EZ805U	190	180_{j6}	15.0	25.0	38_{k6}	215	3.5	190	80	71	345.0	422.0	13.5	M12	–	22	277.0

22.4.5 EZ4 – EZ8 motors with forced ventilation

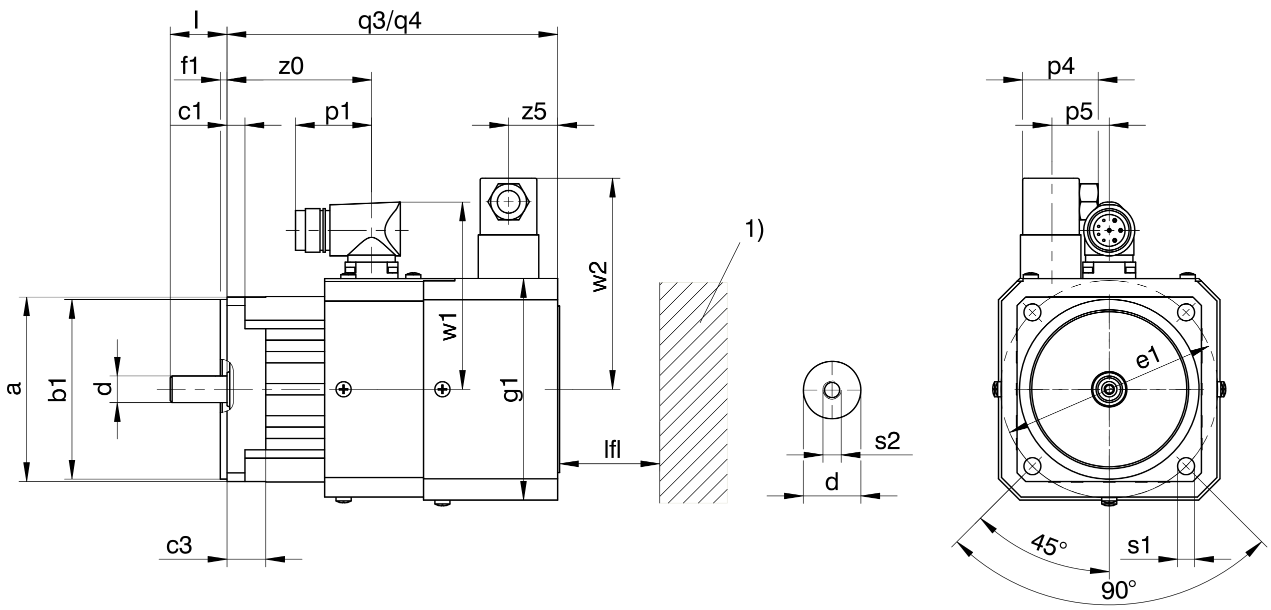


q3	Applies to motors without holding brake	q4	Applies to motors with holding brake
1)	Machine wall		

Type	□a	∅b1	c1	c3	∅d	∅e1	f1	□g1	l	lfl_{min}	p1	p2	p4	p5	q3	q4	∅s1	s2	w1	w2	z0	z5
EZ401B	98	95_{j6}	9.5	20.5	14_{k6}	115	3.5	118	30	20	40	32	37.5	0	175	224	9.0	M5	91.0	111	76.5	25
EZ402B	98	95_{j6}	9.5	20.5	19_{k6}	115	3.5	118	40	20	40	32	37.5	0	200	249	9.0	M6	91.0	111	101.5	25
EZ404B	98	95_{j6}	9.5	20.5	19_{k6}	115	3.5	118	40	20	40	32	37.5	0	250	299	9.0	M6	91.0	111	151.5	25
EZ501B	115	110_{j6}	10.0	16.0	19_{k6}	130	3.5	135	40	20	40	36	37.5	0	179	234	9.0	M6	100.0	120	74.5	25
EZ502B	115	110_{j6}	10.0	16.0	19_{k6}	130	3.5	135	40	20	40	36	37.5	0	204	259	9.0	M6	100.0	120	99.5	25
EZ503B	115	110_{j6}	10.0	16.0	24_{k6}	130	3.5	135	50	20	40	36	37.5	0	229	284	9.0	M8	100.0	120	124.5	25
EZ505B	115	110_{j6}	10.0	16.0	24_{k6}	130	3.5	135	50	20	40	36	37.5	0	279	334	9.0	M8	100.0	120	174.5	25
EZ701B	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	165	50	30	40	42	37.5	0	213	272	11.0	M8	115.0	134	83.0	40
EZ702B	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	165	50	30	40	42	37.5	0	238	297	11.0	M8	115.0	134	108.0	40
EZ703B	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	165	50	30	40	42	37.5	0	263	322	11.0	M8	115.0	134	133.0	40
EZ705B	145	130_{j6}	10.0	19.0	32_{k6}	165	3.5	165	58	30	71	42	37.5	0	318	377	11.0	M12	134.0	134	184.0	40
EZ802B	190	180_{j6}	15.0	25.0	32_{k6}	215	3.5	215	58	30	71	60	37.5	62	322	399	13.5	M12	156.5	160	168.0	40
EZ803B	190	180_{j6}	15.0	25.0	38_{k6}	215	3.5	215	80	30	71	60	37.5	62	363	440	13.5	M12	156.5	160	209.0	40
EZ805B	190	180_{j6}	15.0	25.0	38_{k6}	215	3.5	215	80	30	71	60	37.5	62	445	522	13.5	M12	178.0	160	277.0	40

STOBER

22.4.6 EZ4 – EZ8 motors with forced ventilation (One Cable Solution)



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

Type	□a	∅b1	c1	c3	∅d	∅e1	f1	□g1	l	lfl_{min}	p1	p4	p5	q3	q4	∅s1	s2	w1	w2	z0	z5
EZ401B	98	95_{j6}	9.5	20.5	14_{k6}	115	3.5	118	30	20	40	37.5	0	175	224	9.0	M5	99	111	76.5	25
EZ402B	98	95_{j6}	9.5	20.5	19_{k6}	115	3.5	118	40	20	40	37.5	0	200	249	9.0	M6	99	111	101.5	25
EZ404B	98	95_{j6}	9.5	20.5	19_{k6}	115	3.5	118	40	20	40	37.5	0	250	299	9.0	M6	99	111	151.5	25
EZ501B	115	110_{j6}	10.0	16.0	19_{k6}	130	3.5	135	40	20	40	37.5	0	179	234	9.0	M6	110	120	74.5	25
EZ502B	115	110_{j6}	10.0	16.0	19_{k6}	130	3.5	135	40	20	40	37.5	0	204	259	9.0	M6	110	120	99.5	25
EZ503B	115	110_{j6}	10.0	16.0	24_{k6}	130	3.5	135	50	20	40	37.5	0	229	284	9.0	M8	110	120	124.5	25
EZ505B	115	110_{j6}	10.0	16.0	24_{k6}	130	3.5	135	50	20	40	37.5	0	279	334	9.0	M8	110	120	174.5	25
EZ701B	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	165	50	30	40	37.5	0	213	272	11.0	M8	125	134	83.0	40
EZ702B	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	165	50	30	40	37.5	0	238	297	11.0	M8	125	134	108.0	40
EZ703B	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	165	50	30	40	37.5	0	263	322	11.0	M8	125	134	133.0	40
EZ705B	145	130_{j6}	10.0	19.0	32_{k6}	165	3.5	165	58	30	71	37.5	0	318	377	11.0	M12	125	134	184.0	40
EZ802B	190	180_{j6}	15.0	25.0	32_{k6}	215	3.5	215	58	30	71	37.5	62	322	399	13.5	M12	–	160	168.0	40
EZ803B	190	180_{j6}	15.0	25.0	38_{k6}	215	3.5	215	80	30	71	37.5	62	363	440	13.5	M12	–	160	209.0	40

EZ

22.5 Type designation

Sample code

EZ	4	0	1	U	D	AD	M4	O	096

Explanation

Code	Designation	Design
EZ	Type	Synchronous servo motor
4	Size	4 (example)
0	Generation	0
1	Length	1 (example)
U B	Cooling[1]	Convection cooling Forced ventilation
D	Design	Dynamic
AD	Drive controller	SD6 (example)
M4	Encoder	EQI 1131 FMA EnDat 2.2 (example)
O P	Brake	Without holding brake Permanent magnet holding brake
096	Electromagnetic constant (EMC) K_{EM}	96 V/1000 rpm (example)

Notes

- In Chapter [▸ 22.6.4], you can find information about available encoders.
- In Chapter [▸ 22.6.4.6], you can find information about connecting synchronous servo motors to other drive controllers from STOBER.
- In Chapter [▸ 27], you can find information about options for connecting STOBER synchronous servo motors to drive controllers from other manufacturers.

22.6 Product description

22.6.1 General features

Feature	Description
Design	IM B5, IM V1, IM V3 in accordance with EN 60034-7
Protection class	IP56 / IP66 (option)
Thermal class	155 (F) in accordance with EN 60034-1 (155 °C, heating $\Delta\vartheta$ = 100 K)
Surface[2]	Matte black as per RAL 9005
Cooling	IC 410 convection cooling (IC 416 convection cooling with optional forced ventilation)
Bearing	Ball bearing with lifetime lubrication and non-contact sealing
Sealing	Radial shaft seal rings made of FKM (A side)
Shaft end	Shaft without feather key, diameter quality k6
Radial runout accuracy	Normal tolerance class in accordance with IEC 60072-1
Concentricity	Normal tolerance class in accordance with IEC 60072-1
Axial runout	Normal tolerance class in accordance with IEC 60072-1

[1] EZ3 motors only available with convection cooling
[2] Repainting the motor will change the thermal properties and therefore the performance limits.

Feature	Description
Vibration intensity	A in accordance with EN 60034-14
Noise level	Limit values in accordance with EN 60034-9

22.6.2 Electrical features

General electrical features of the motor are described in this chapter. Details can be found in the "Selection tables" chapter.

Feature	Description
DC link voltage	DC 540 V (max. 620 V) on STOBER drive controllers
Winding	Three-phase, single-tooth coil design
Circuit	Star, center not led through
Protection class	I (protective grounding) in accordance with EN 61140
Number of pole pairs	5 (EZ3) 7 (EZ4/EZ5/EZ7) 8 (EZ8)

22.6.3 Ambient conditions

Standard ambient conditions for transport, storage and operation of the motor are described in this chapter. Information about differing ambient conditions can be found in Chapter [▷ 22.7.3].

Feature	Description
Surrounding temperature for transport/storage	−30 °C to +85 °C
Surrounding temperature for operation	−15 °C to +40 °C
Installation altitude	≤ 1000 m above sea level
Shock load	≤ 50 m/s² (5 g), 6 ms in accordance with EN 60068-2-27

Notes

- STOBER synchronous servo motors are not suitable for potentially explosive atmospheres in accordance with (ATEX) Directive2014/34/EU.
- Secure 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 by shock loading.
- Also take into consideration the shock load of the motor due to output units (such as gear units and pumps) which are coupled with the motor.

22.6.4 Encoders

STOBER synchronous servo motors can be designed with different encoder types. The following chapters include information for choosing the optimal encoder for your application.

22.6.4.1 Encoder measuring method selection tool

The following table offers a selection tool for an encoder measuring method that is optimally suited for your application.

Feature	Absolute encoder		Resolver
Measuring method	Optical	Inductive	Electromagnetic
Temperature resistance	★★☆	★★★	★★★

Feature	Absolute encoder		Resolver
Vibration strength and shock resistance	★★☆	★★★	★★★
System accuracy	★★★	★★☆	★☆☆
FMA version with fault elimination for mechanical coupling (option with EnDat interface)	✓	✓	–
Elimination of referencing with multi-turn design (optional)	✓	✓	–
Simple commissioning with electronic nameplate	✓	✓	–
Key: ★☆☆ = satisfactory, ★★☆ = good, ★★★ = very good			

22.6.4.2 Selection tool for EnDat interface

The following table offers a selection tool for the EnDat interface of absolute encoders.

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

22.6.4.3 EnDat encoders

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

Encoders with EnDat 2.2 interface

Encoder type	Type code	Measuring method	Recordable revolutions	Resolution	Position values per revolution
EQI 1131 FMA	M4	Inductive	4096	19 bit	524288
EQI 1131	Q6	Inductive	4096	19 bit	524288
EBI 1135	B0	Inductive	65536	18 bit	262144
EQN 1135 FMA	M3	Optical	4096	23 bit	8388608
EQN 1135	Q5	Optical	4096	23 bit	8388608
ECN 1123 FMA	M1	Optical	–	23 bit	8388608
ECN 1123	C7	Optical	–	23 bit	8388608
ECI 1118-G2	C5	Inductive	–	18 bit	262144

Encoders with EnDat 2.1 interface

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

Notes

- The encoder type code is a part of the type designation of the motor.
- FMA = Version with fault elimination for mechanical coupling.

- The EBI 1135 encoder requires an external buffer battery so that absolute position information is retained after the power supply is turned off (AES option for STOBER drive controllers).
- Multiple revolutions of the motor shaft can be recorded only using multi-turn encoders.

22.6.4.4 HIPERFACE DSL encoders

HIPERFACE DSL is a robust, purely digital protocol that functions with minimal connection lines. HIPERFACE DSL facilitates the One Cable Solution, which allows the connection lines between the encoder and drive controller to be routed along in the motor's power cable.

The One Cable Solution offers the following advantages:

- Significantly reduced wiring effort by eliminating the encoder cable
- Significantly reduced space requirements by eliminating the encoder plug connector
- Transmission of measured values from the temperature sensor using the HIPERFACE DSL protocol

The encoder has the following features:

Encoder type	Type code	Measuring method	Recordable revolutions	Resolution	Position values per revolution
EKM36	H3	Optical	4096	20 bit	1048576

22.6.4.5 Resolver

In this chapter, you can find detailed technical data for 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

22.6.4.6 Possible combinations with drive controllers

The following table shows the options for combining STOBER drive controllers with selectable encoder types.

Drive controller		SDS 5000	MDS 5000	SDS 5000/ MDS 5000	SD6		SI6		
Drive controller type code		AA	AB	AC	AD	AE	AP	AQ	AS
Connection plan ID		442305	442306	442307	442450	442451	442771	442772	442788
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	✓	✓	–	✓	–	✓	–	–

EZ

Drive controller		SDS 5000	MDS 5000	SDS 5000/ MDS 5000	SD6		SI6		
Drive controller type code		AA	AB	AC	AD	AE	AP	AQ	AS
Connection plan ID		442305	442306	442307	442450	442451	442771	442772	442788
Encoder	**Encoder type code**								
EQN 1125 FMA	M2	✓	✓	✓	✓	✓	–	–	–
EQN 1125	Q4	✓	✓	✓	✓	✓	–	–	–
ECN 1113 FMA	M0	✓	✓	✓	✓	✓	–	–	–
ECN 1113	C6	✓	✓	✓	✓	✓	–	–	–
EKM36	H3	–	–	–	–	–	–	–	✓
Resolver	R0	✓	✓	–	–	✓	–	✓	–

Notes

- The drive controller and encoder type codes are a part of the type designation of the motor (see the "Type designation" chapter).
- In Chapter [▸ 27], you can find information about options for connecting STOBER synchronous servo motors to drive controllers from other manufacturers.

22.6.5 Temperature sensor

In this chapter, you can find technical data for the temperature sensors that are installed in STOBER synchronous servo motors for implementing 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 integrated analysis electronics for temperature monitoring with warning and shut-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 instance where an encoder with internal temperature monitoring forces 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.

22.6.5.1 PTC thermistor

The PTC thermistor is installed as a standard temperature sensor in STOBER synchronous servo motors. The PTC thermistor is a triple thermistor in accordance with DIN 44082 that allows the temperature of each winding phase to be monitored.

The resistance values in the following table and curve refer to a single thermistor in accordance with DIN 44081. These values must be multiplied by 3 for a triple 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) in accordance with EN 60034-1 (155 °C, heating $\Delta\vartheta$ = 100 K)

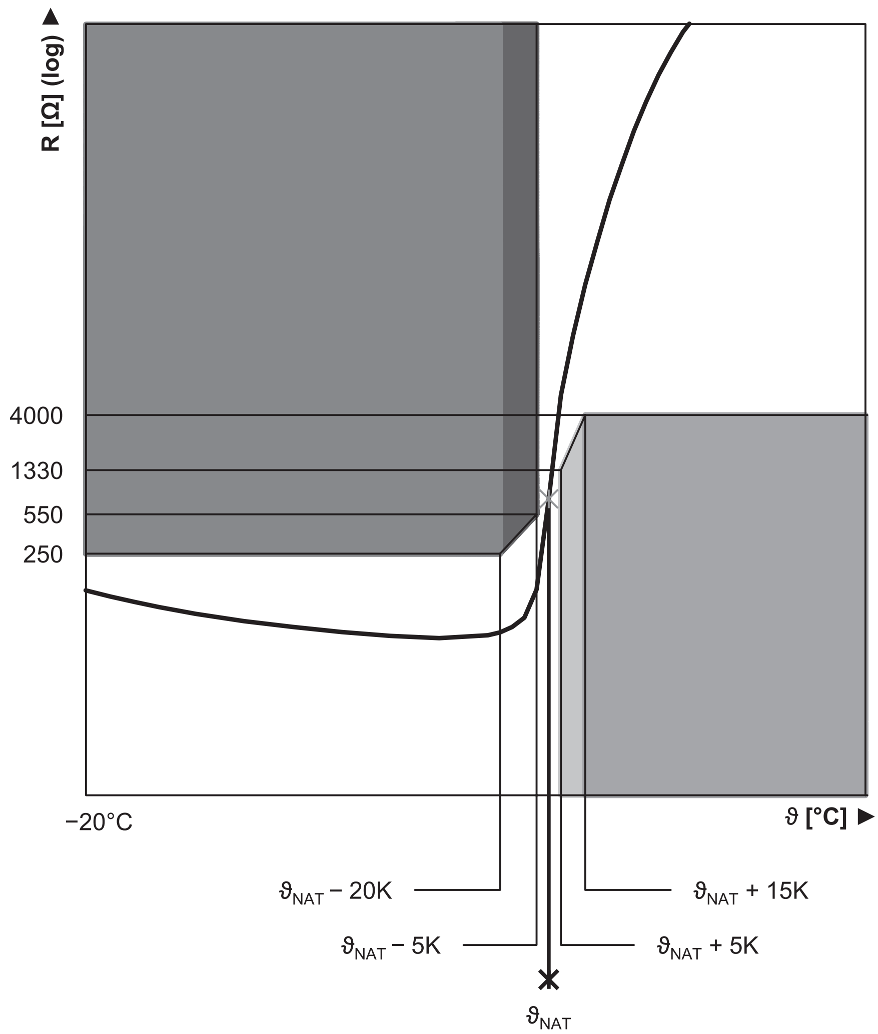


Fig. 2: PTC thermistor curve (single thermistor)

22.6.5.2 Pt1000 temperature sensor

STOBER synchronous servo motors are available in versions with a Pt1000 temperature sensor. The Pt1000 is a temperature-dependent resistor that has a resistance curve with a linear relationship with temperature. As a result, the Pt1000 allows for measurements of the winding temperature. These measurements are limited to one phase of the motor winding, however. In order to adequately protect the motor from exceeding the maximum permitted winding temperature, use a i^2t model in the drive controller to monitor the winding temperature.

Avoid exceeding the specified measurement current so that the measured values are not falsified due to self-heating of the temperature sensor.

Feature	Description
Measurement current (constant)	2 mA
Resistance R for ϑ = 0 °C	1000 Ω
Resistance R for ϑ = 80 °C	1300 Ω
Resistance R for ϑ = 150 °C	1570 Ω

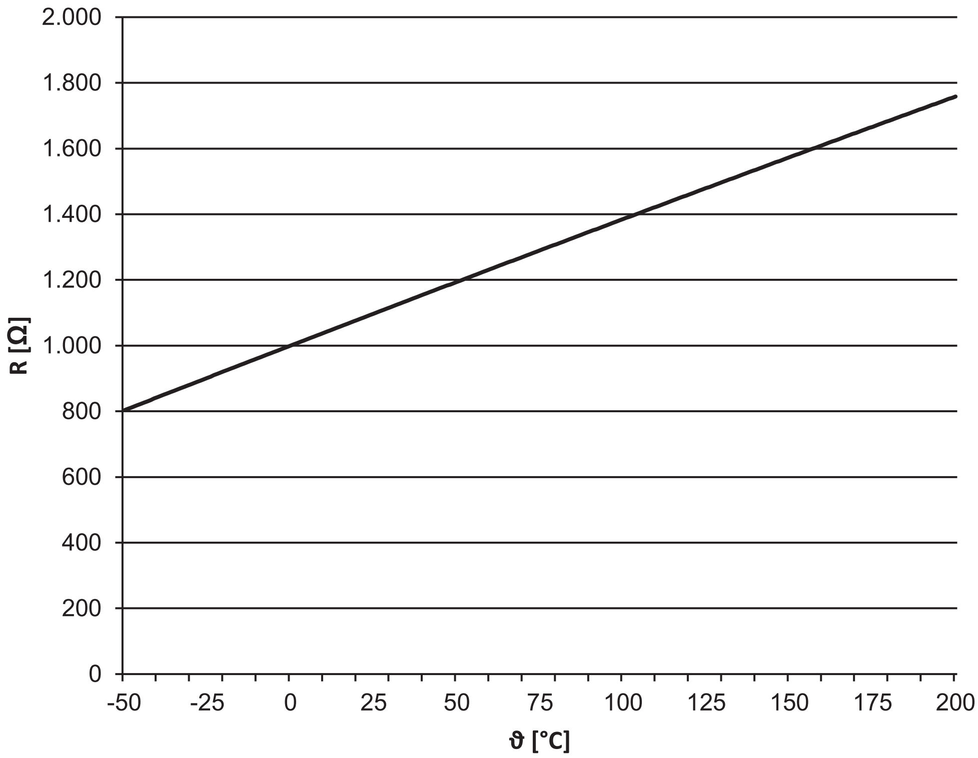


Fig. 3: Pt1000 temperature sensor characteristic curve

22.6.6 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. Optionally, forced ventilation can be used to cool the motor.

22.6.6.1 Forced ventilation

STOBER synchronous servo motors offer the option of being cooled with forced ventilation in order to increase performance data while maintaining the same size. Retrofitting with a forced ventilation unit is also possible in order 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 ventilation unit.

The performance data for motors with forced ventilation can be found in Chapter [▸ 22.2.2] and the dimensional drawings in Chapter [▸ 22.4.5].

Formula symbol	Unit	Explanation
$I_{N,F}$	A	Nominal current of the forced ventilation unit
$L_{pA,F}$	dBA	Noise level of the forced ventilation unit in the optimal operating range
m_F	kg	Weight of the forced ventilation unit
$P_{N,F}$	W	Nominal output of the forced ventilation unit
q_{vF}	m³/h	Delivery capacity of the forced ventilation unit in open air
$U_{N,F}$	V	Nominal voltage of the forced ventilation unit

Technical data

Motor	Forced ventilation unit	$U_{N,F}$ [V]	$I_{N,F}$ [V]	$P_{N,F}$ [W]	$q_{v,F}$ [m³/h]	$L_{p(A)}$ [dBA]	m_F [kg]	Protection class
EZ4_B	FL4	230 V ± 5%, 50/60 Hz	0.07	10	59	41	1.4	IP44
EZ5_B	FL5		0.10	14	160	45	1.9	IP54
EZ7_B	FL7		0.10	14	160	45	2.9	IP54
EZ8_B	FL8		0.20	26	420	54	5.0	IP55

Connection assignment for forced ventilation unit plug connectors

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

22.6.7 Holding brake

STOBER synchronous servo motors can be equipped with a backlash-free holding brake using permanent magnets in order to secure the motor shaft when at a standstill. The holding brake engages automatically if the voltage drops.

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

Observe the following during project configuration:

- In exceptional circumstances, the holding brake can be used for braking from full speed (following a power failure or when setting up the machine). The maximum permitted work done by friction $W_{B,Rmax/h}$ may not be exceeded. Activate other braking processes during operation using the corresponding brake functions of the drive controller to prevent premature wear on the holding brake.
- Note that the braking torque M_{Bdyn} may initially be up to 50% less when braking from full speed. As a result, the braking effect has a delayed action and braking distances become longer.
- Regularly perform a brake test to ensure the functional safety of the brakes. Details can be found in 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 controllers with BRS/BRM brake module).
- The holding brake of the synchronous servo motor does not offer adequate safety for persons in the hazardous area of 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" chapter.

Formula symbol	Unit	Explanation
$I_{N,B}$	A	Nominal current of the brake at 20 °C
ΔJ_B	10^{-4} kgm²	Additive mass moment of inertia of a motor with holding brake

EZ

Formula symbol	Unit	Explanation
J_{Bstop}	10^{-4} kgm²	Reference mass moment of inertia when braking from full speed: $J_{Bstop} = J_{dyn} \times 2$
J_{dyn}	10^{-4} kgm²	Mass moment of inertia of a motor in dynamic operation
J_{tot}	10^{-4} kgm²	Total mass moment of inertia (based on 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	Work done by friction for braking
$W_{B,Rlim}$	J	Work done by friction until wear limit is reached
$W_{B,Rmax/h}$	J	Maximum permitted work done by friction per hour with individual braking
$x_{B,N}$	mm	Nominal air gap of brake

Calculation of work done by friction per braking process

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

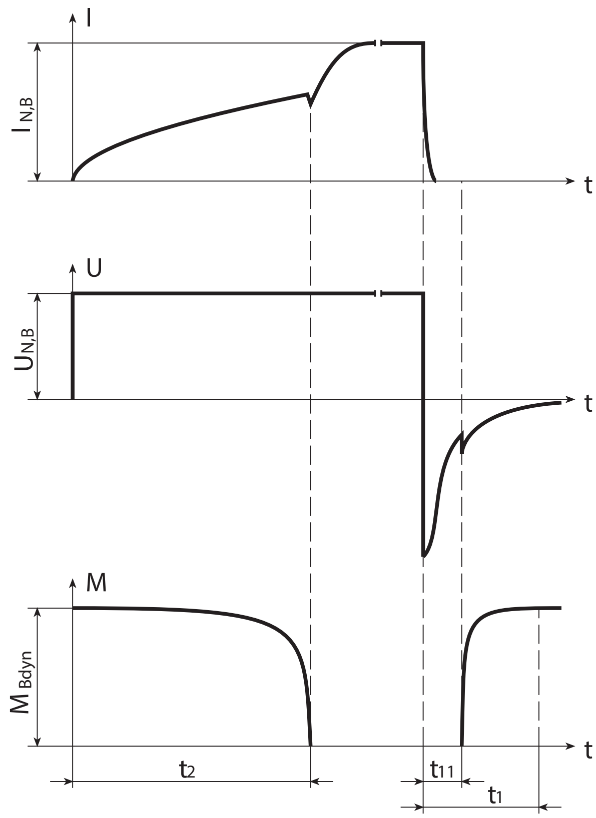
The sign of M_L is positive if the movement runs vertically upwards or horizontally and it is negative if the movement runs vertically down.

Calculation of the stop time

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

STOBER

Switching behavior



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]
EZ301	2.5	2.3	0.51	6.0	48000	0.752	180	25	3.0	20	0.2	0.186	0.55
EZ302	4.0	3.8	0.75	8.5	38000	0.952	180	44	4.0	26	0.3	0.186	0.55
EZ303	4.0	3.8	0.75	8.5	30000	1.17	180	44	4.0	26	0.3	0.186	0.55
EZ401	4.0	3.8	0.75	8.5	16000	2.24	180	44	4.0	26	0.3	0.192	0.76
EZ402	8.0	7.0	0.75	8.5	13500	4.39	300	40	2.0	20	0.3	0.566	0.97
EZ404	8.0	7.0	0.75	8.5	8500	7.09	300	40	2.0	20	0.3	0.566	0.97
EZ501	8.0	7.0	0.75	8.5	8700	6.94	300	40	2.0	20	0.3	0.571	1.19
EZ502	8.0	7.0	0.75	8.5	5200	11.5	300	40	2.0	20	0.3	0.571	1.19
EZ503	15	12	1.0	11.0	5900	18.6	550	60	5.0	30	0.3	1.721	1.62
EZ505	15	12	1.0	11.0	4000	27.8	550	60	5.0	30	0.3	1.721	1.62
EZ701	15	12	1.0	11.0	5400	20.5	550	60	5.0	30	0.3	1.743	1.94
EZ702	15	12	1.0	11.0	3600	30.9	550	60	5.0	30	0.3	1.743	1.94
EZ703	32	28	1.1	25.0	5200	54.6	1400	100	5.0	25	0.4	5.680	2.81
EZ705	32	28	1.1	25.0	3500	79.4	1400	100	5.0	25	0.4	5.680	2.81
EZ802	65	35	1.7	45.0	6000	149	2250	200	10	50	0.4	16.460	5.40
EZ803	65	35	1.7	45.0	4500	200	2250	200	10	50	0.4	16.460	5.40
EZ805	115	70	2.1	65.0	7000	376	6500	190	12	65	0.5	55.460	8.40

EZ

22.6.8 Connection method

The following chapters describe the connection technology of STOBER synchronous servo motors in the standard version on 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 Chapter [▸ 27], you can find information about options for connecting STOBER synchronous servo motors to drive controllers from other manufacturers.

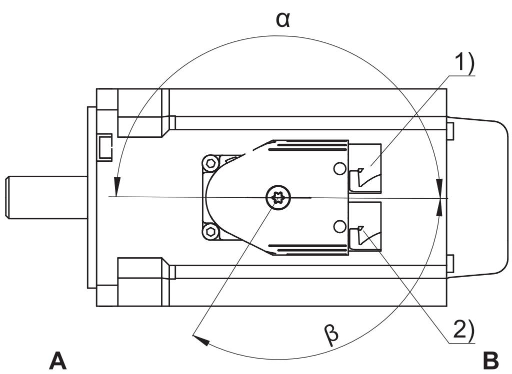
22.6.8.1 Plug connectors

STOBER synchronous servo motors are equipped with twistable quick-lock plug connectors in the standard version (except for plug connector size con.58). Details can be found in this chapter.

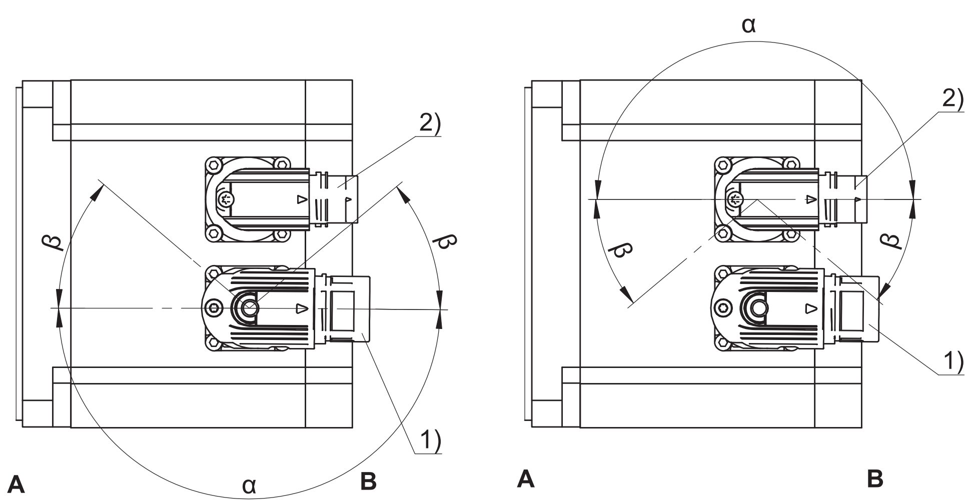
For motors with forced ventilation, avoid collisions between the motor connection cables and the plug connector of the forced ventilation unit. In the event of a collision, turn the motor plug connectors accordingly. Details regarding the position of the plug connector for the forced ventilation unit can be found in the "Dimensional drawings" chapter.

The figures represent the position of the plug connectors upon delivery.

Turning ranges of plug connectors (EZ3 motors)



Turning ranges of plug connectors (EZ4 – EZ8 motors)



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

Power plug connector features

Motor type	Size	Connection	Turning range	
			α	β
EZ3	con.15	Quick lock	180°	120°
EZ4, EZ5, EZ701, EZ703	con.23	Quick lock	180°	40°
EZ705, EZ802, EZ803, EZ805U	con.40	Quick lock	180°	40°
EZ805B	con.58	Screw thread[3]	0°	0°

[3] Specify alignment on side A or B in the purchase order.

Encoder plug connector features

Motor type	Size	Connection	Turning range α	Turning range β
EZ3	con.15	Quick lock	180°	120°
EZ4, EZ5, EZ7, EZ802, EZ803, EZ805U	con.17	Quick lock	180°	20°
EZ805B	con.17	Quick lock	180°	0°

Notes

- The number after "con." indicates the approximate 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 the β turning range, the power and encoder plug connectors can only be turned if they will not collide with each other by doing so.
- For the EZ3 motor, the power and encoder plug connectors are mechanically connected and can only be turned together.

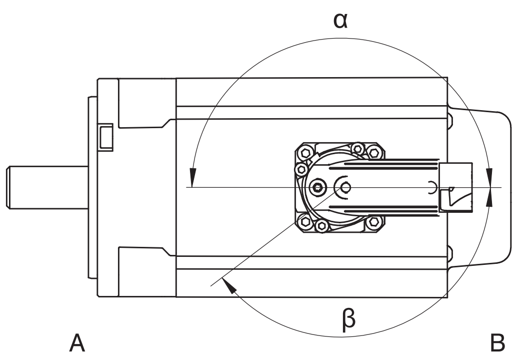
22.6.8.2 Plug connectors (One Cable Solution)

In the One Cable Solution design, the power and encoder lines are connected using a shared plug connector.

For motors with forced ventilation, avoid collisions between the motor connection cables and the plug connector of the forced ventilation unit. In the event of a collision, turn the motor plug connectors accordingly. Details regarding the position of the plug connector for the forced ventilation unit can be found in the "Dimensional drawings" chapter.

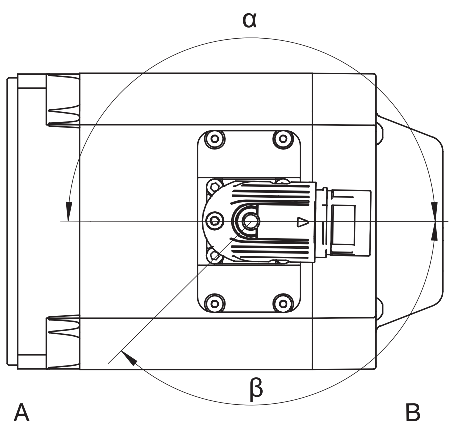
The figures represent the position of the plug connectors upon delivery.

Turning ranges of plug connectors (EZ3 motors)



A	Attachment or output side of the motor	B	Rear side of the motor

Turning ranges of plug connectors (EZ4 – EZ8 motors)



A	Attachment or output side of the motor	B	Rear side of the motor

Plug connector features

Motor type	Size	Connection	Turning range	
			α	β
EZ3	con.15	Quick lock	180°	135°
EZ4, EZ5, EZ701, EZ703	con.23	Quick lock	180°	135°
EZ705, EZ802, EZ803, EZ805U	con.40	Quick lock	180°	135°

Notes

- The number after "con." indicates the approximate 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).

22.6.8.3 Connection of the motor housing to the grounding conductor system

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

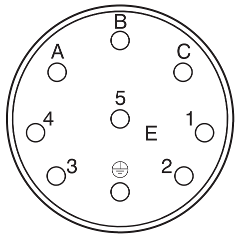
All attachment parts required for the connection of the grounding conductor to the motor housing are delivered with the motor. The grounding screw of the motor is identified with the symbol ⏚ in accordance with IEC 60417-DB. The minimum cross-section of the grounding conductor is specified in the following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

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

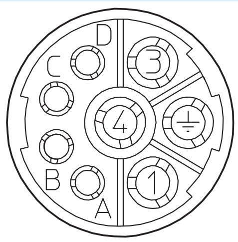
22.6.8.4 Connection assignment of the power plug connector

The size and connection plan of the power plug connector depend on the size of the motor. The colors of the connecting wires inside the motor are specified in accordance with IEC 60757.

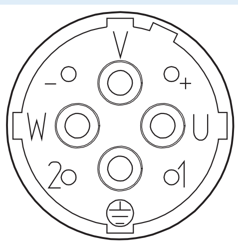
Plug connector size con.15

Connection diagram	Pin	Connection	Color
	A	1U1 (U phase)	BK
	B	1V1 (V phase)	BU
	C	1W1 (W phase)	RD
	1	1TP1/1K1 (temperature sensor)	
	2	1TP2/1K2 (temperature sensor)	
	3	1BD1 (brake +)	RD
	4	1BD2 (brake −)	BK
	⏚	PE (grounding conductor)	GNYE

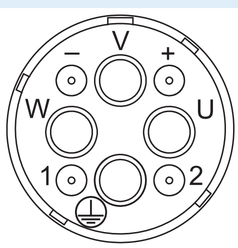
Plug connector size con.23 (1)

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

Plug connector size con.40 (1.5)

Connection diagram	Pin	Connection	Color
	U	1U1 (U phase)	BK
	V	1V1 (V phase)	BU
	W	1W1 (W phase)	RD
	+	1BD1 (brake +)	RD
	–	1BD2 (brake −)	BK
	1	1TP1/1K1 (temperature sensor)	
	2	1TP2/1K2 (temperature sensor)	
	⏚	PE (grounding conductor)	GNYE

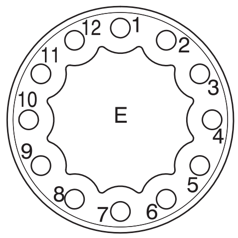
Plug connector size con.58 (3)

Connection diagram	Pin	Connection	Color
	U	1U1 (U phase)	BK
	V	1V1 (V phase)	BU
	W	1W1 (W phase)	RD
	+	1BD1 (brake +)	RD
	–	1BD2 (brake −)	BK
	1	1TP1/1K1 (temperature sensor)	
	2	1TP2/1K2 (temperature sensor)	
	⏚	PE (grounding conductor)	GNYE

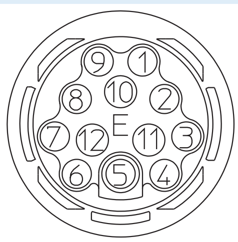
22.6.8.5 Connection assignment of the encoder plug connector

The size and connection assignment of the encoder plug connectors depend on the type of encoder installed and the size of the motor.

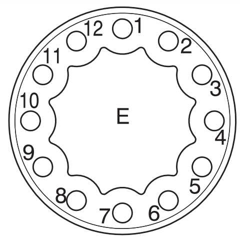
EnDat 2.1/2.2 digital encoders, plug connector size con.15

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		

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

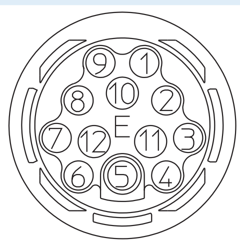
Connection diagram	Pin	Connection	Color
	1	Clock +	VT
	2	Up sense	BN GN
	3		
	4		
	5	Data –	PK
	6	Data +	GY
	7		
	8	Clock –	YE
	9		
	10	0 V GND	WH GN
	11		
	12	Up +	BN GN
	Pin 2 is connected with pin 12 in the built-in socket		

EnDat 2.2 digital encoder with battery buffering, plug connector size con.15



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		

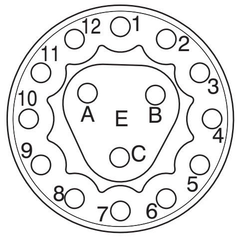
EnDat 2.2 digital encoder with battery buffering, plug connector size con.17



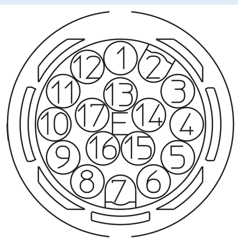
Connection diagram	Pin	Connection	Color
	1	Clock +	VT
	2	UBatt +	BU
	3	UBatt −	WH
	4		
	5	Data −	PK
	6	Data +	GY
	7		
	8	Clock −	YE
	9		
	10	0 V GND	WH GN
	11		
	12	Up +	BN GN
	UBatt+ = DC 3.6 V for encoder type EBI in combination with the AES option of STOBER drive controllers		

EZ

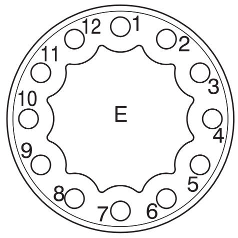
EnDat 2.1 encoder with sin/cos incremental signals, plug connector size con.15

Connection diagram	Pin	Connection	Color
	1	Up sense	BU
	2	0 V sense	WH
	3	Up +	BN GN
	4	Clock +	VT
	5	Clock –	YE
	6	0 V GND	WH GN
	7	B + (Sin +)	BU BK
	8	B – (Sin –)	RD BK
	9	Data +	GY
	10	A + (Cos +)	GN BK
	11	A – (Cos –)	YE BK
	12	Data –	PK
	A		
	B		
	C		

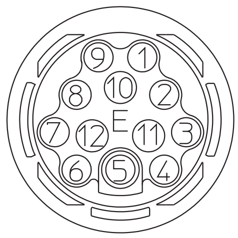
EnDat 2.1 encoder with sin/cos incremental signals, plug connector size con.17

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

Resolver, plug connector size con.15

Connection diagram	Pin	Connection	Color
	1	S3 Cos +	BK
	2	S1 Cos −	RD
	3	S4 Sin +	BU
	4	S2 Sin −	YE
	5		
	6		
	7	R2 Ref +	YE WH
	8	R1 Ref −	RD WH
	9		
	10		
	11		
	12		

Resolver, plug connector size con.17

Connection diagram	Pin	Connection	Color
	1	S3 Cos +	BK
	2	S1 Cos −	RD
	3	S4 Sin +	BU
	4	S2 Sin −	YE
	5		
	6		
	7	R2 Ref +	YE WH
	8	R1 Ref −	RD WH
	9		
	10		
	11		
	12		

22.6.8.6 Connection assignment of the plug connector (One Cable Solution)

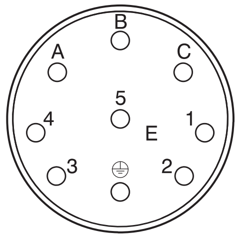
In the One Cable Solution design, the power and encoder lines are connected using a shared plug connector.

The temperature sensor of the motor is connected to the encoder internally. The measured values from the temperature sensor are transmitted via the HIPERFACE DSL log of the encoder.

The size of the plug connector depends on the size of the motor.

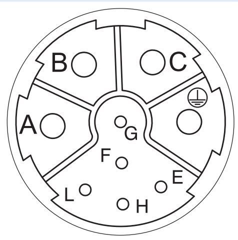
EZ

Plug connector size con.15



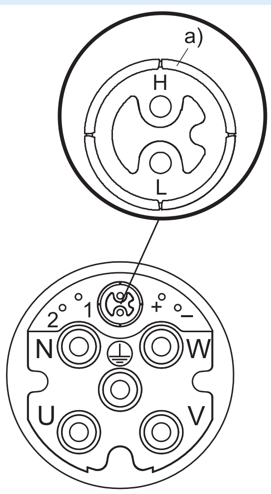
Connection diagram	Pin	Connection	Color
	A	1U1 (U phase)	BK
	B	1W1 (W phase)	RD
	C	1V1 (V phase)	BU
	1	1BD1 (brake +)	
	2	1BD2 (brake −)	
	3	DSL+ (H)	GY
	4	DSL− (L)	GN
	5	DSL shield	
	⏚	PE (grounding conductor)	GNYE

Plug connector size con.23 (1)



Connection diagram	Pin	Connection	Color
	A	1U1 (U phase)	BK
	B	1V1 (V phase)	BU
	C	1W1 (W phase)	RD
	E	DSL− (L)	GN
	F	DSL shield	
	G	1BD1 (brake +)	
	H	DSL+ (H)	GY
	L	1BD2 (brake −)	
	⏚	PE (grounding conductor)	GNYE

Plug connector size con.40 (1.5)



Connection diagram	Pin	Connection	Color
	U	1U1 (U phase)	BK
	V	1V1 (V phase)	BU
	W	1W1 (W phase)	RD
	N		
	+	1BD1 (brake +)	
	−	1BD2 (brake −)	
	F		
	G		
	H	DSL+ (H)	GY
	L	DSL− (L)	GN
	⏚	PE (grounding conductor)	GNYE

a) Coaxial shield to which the DSL shield is connected

22.7 Project configuration

Project your drive using our SERVOsoft designing software. You can receive SERVOsoft for free from your adviser at one of our sales centers. Observe the limit conditions in this chapter to ensure a safe design for your drives.

22.7.1 Calculation of the operating point

In this chapter, you can find information needed to calculate the operating point.

The formula symbols for values actually present in the application are marked with *.

Formula symbol	Unit	Explanation
ED	%	Duty cycle based on 10 minutes
M_{op}	Nm	Torque of motor at the operating point from the motor characteristic curve at n_{1m^*}
$M_{1^*} – M_{6^*}$	Nm	Actual torque of the motor in the respective time segment (1 to 6)
M_{eff^*}	Nm	Actual 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_{max}	Nm	Maximum torque: the maximum permitted torque the motor is able to deliver over a short period (when accelerating or decelerating) (tolerance ±10%)
M_{max^*}	Nm	Actual maximum torque
M_{n^*}	Nm	Actual torque of the motor in the n-th time segment
M_N	Nm	Nominal torque of the motor
n_{m^*}	rpm	Actual average motor speed
$n_{m,1^*} – n_{m,6^*}$	rpm	Actual average speed of the motor in the respective time segment (1 to 6)
n_{m,n^*}	rpm	Actual 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 respective 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 M_N specified in the selection tables:

$n_{m^*} \leq n_N$

$M_{eff^*} \leq M_{limK}$ and $M_{eff^*} \leq M_{limF}$

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

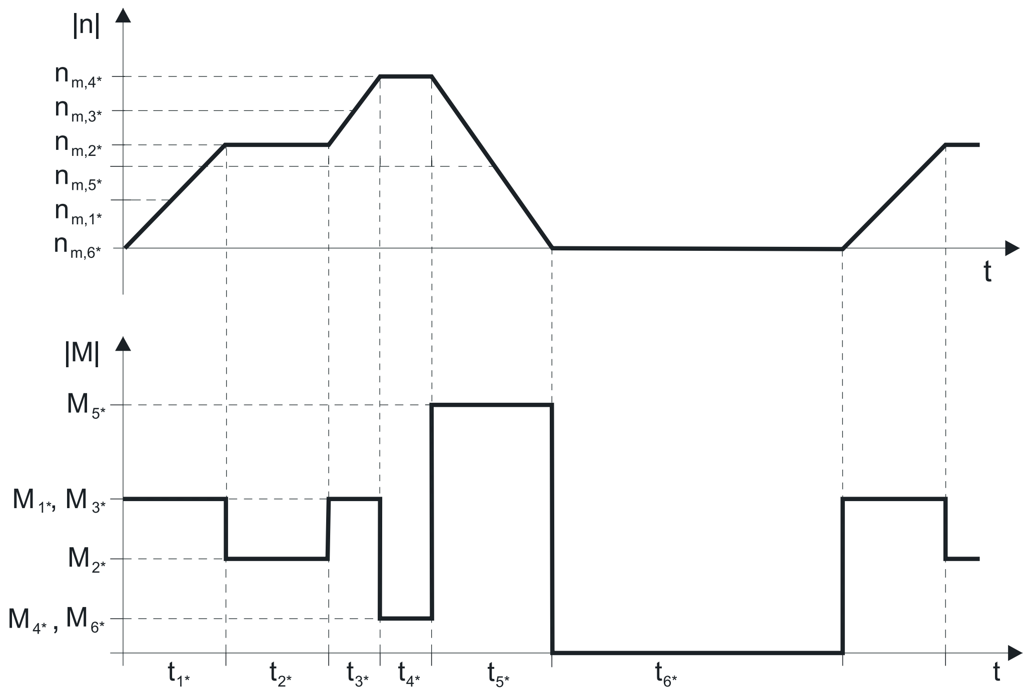
The values for M_N, n_N, M_{max} can be found in the selection tables.

The values for M_{limK} and M_{limF} can be found in the torque/speed curves.

Example of cycle sequence

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

EZ



Calculation of the actual average input speed

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

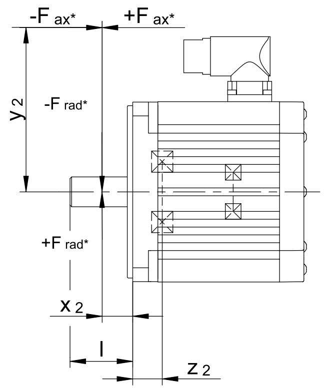
If $t_{1^*} + \ldots + t_{5^*} \geq 10$ min, determine n_{m^*} without the rest phase t_{6^*}.

Calculation of the actual effective torque

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

22.7.2 Permitted shaft loads

Formula symbol	Unit	Explanation
F_{ax^*}	N	Actual axial force on the output
F_{ax100}	N	Permitted axial force on the output for $n_{m^*} \leq 100$ rpm
F_{ax}	N	Permitted axial force on the output
F_{rad^*}	N	Actual radial force on the output
F_{rad100}	N	Permitted radial force on the output for $n_{m^*} \leq 100$ rpm
F_{rad}	N	Permitted radial force on the output
l	mm	Length of the output shaft
M_{k^*}	Nm	Actual breakdown torque on the output
M_{k100}	Nm	Permitted breakdown torque on the output for $n_{m^*} \leq 100$ rpm
M_k	Nm	Permitted breakdown torque on the output
n_{m^*}	rpm	Actual average motor speed
x_2	mm	Distance of the shaft shoulder to the force application point
y_2	mm	Distance of the shaft axis to the axial force application point
z_2	mm	Distance of the shaft shoulder to the middle of the output bearing



Permitted shaft loads

	z_2 [mm]	F_{ax100} [N]	F_{rad100} [N]	M_{k100} [Nm]
EZ301	24.0	350	1000	39
EZ302	24.0	350	1000	39
EZ303	24.0	350	1000	39
EZ401	19.5	550	1800	62
EZ402	19.5	550	1800	71
EZ404	19.5	550	1800	71
EZ501	19.5	750	2000	79
EZ502	19.5	750	2400	95
EZ503	19.5	750	2400	107
EZ505	19.5	750	2400	107
EZ701	24.5	1300	3500	173
EZ702	24.5	1300	4200	208
EZ703	24.5	1300	4200	208
EZ705	24.5	1300	4200	225
EZ802	28.5	1750	5600	384
EZ803	28.5	1750	5600	384
EZ805	28.5	1750	5600	384

The values specified in the tables apply to the permitted shaft loads:

- For shaft dimensions in accordance with the catalog
- If force is applied at the center of the output shaft: $x_2 = l / 2$ (shaft dimensions can be found in Chapter [▸ 22.4]).
- Output speed $n_{m^*} \leq 100$ rpm ($F^{ax} = F_{ax100}$; $F_{rad} = F_{rad100}$; $M_k = M_{k100}$)

The following applies for output speeds $n_{m^*} > 100$ rpm:

$$F_{ax} = \frac{F_{ax100}}{\sqrt[3]{\frac{n_{m^*}}{100\text{ rpm}}}} \qquad F_{rad} = \frac{F_{rad100}}{\sqrt[3]{\frac{n_{m^*}}{100\text{ rpm}}}} \qquad M_k = \frac{M_{k100}}{\sqrt[3]{\frac{n_{m^*}}{100\text{ rpm}}}}$$

The following applies to other force application points:

$$M_{k^*} = \frac{2 \cdot F_{ax^*} \cdot y_2 + F_{rad^*} \cdot (x_2 + z_2)}{1000} \leq M_{k100}$$

$$F_{rad^*} \leq F_{rad100}$$

$F_{ax*} \leq F_{ax100}$

For applications with multiple axial and/or radial forces, you must add the forces as vectors.

22.7.3 Derating

If you use the motor under ambient conditions that differ from the standard ambient conditions, the nominal torque M_N of the motor is reduced. In this chapter, you can find information for calculating the reduced nominal torque.

Formula symbol	Unit	Explanation
H	m	Installation altitude above sea level
K_H	–	Derating factor for installation altitude
K_ϑ	–	Derating factor for surrounding temperature
M_N	Nm	Nominal torque of the motor
M_{N*}	Nm	Reduced nominal torque of the motor
ϑ_{amb}	°C	Surrounding temperature

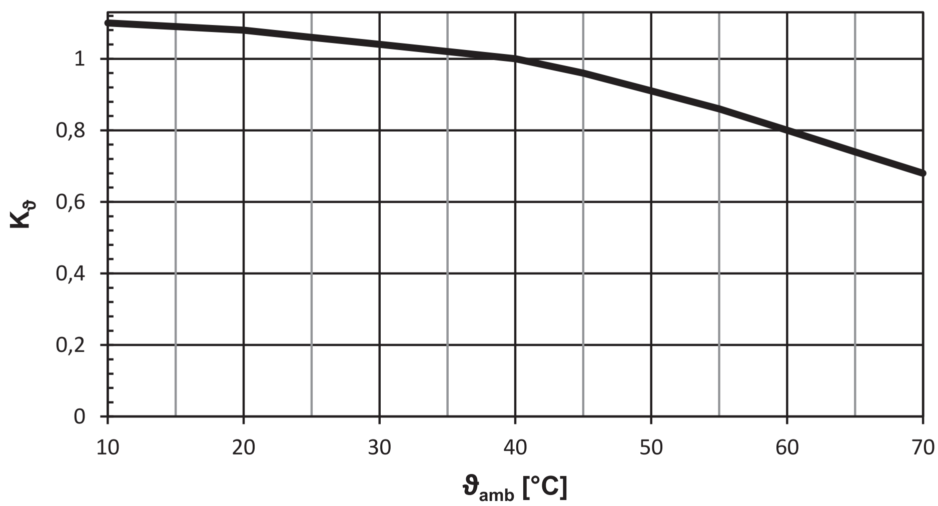


Fig. 4: Derating depending on the surrounding temperature

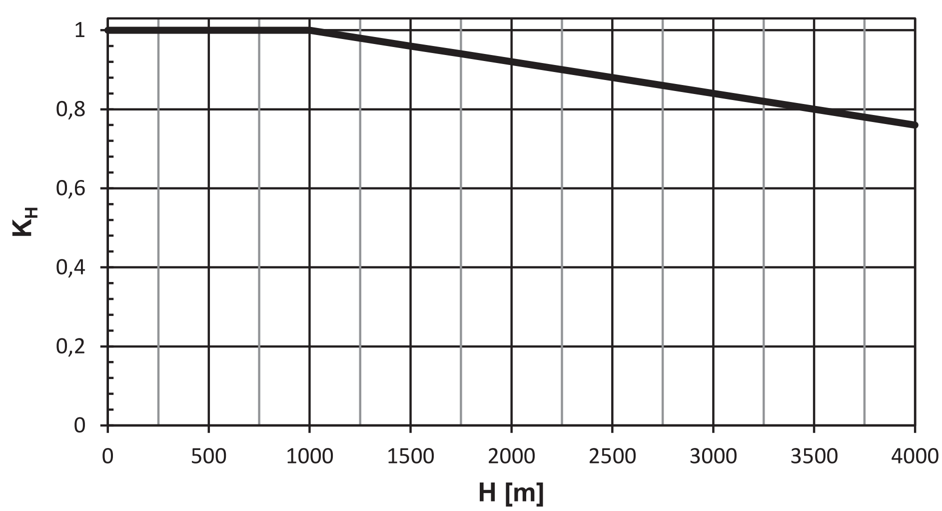


Fig. 5: Derating depending on the installation height

Calculation

If surrounding temperature ϑ_{amb} > 40 °C:

$M_{N^*} = M_N \cdot K_\vartheta$

If installation altitude H > 1000 m above sea level:

$M_{N^*} = M_N \cdot K_H$

If the surrounding temperature ϑ_{amb} > 40 °C and installation altitude H > 1000 m above sea level:

$M_{N^*} = M_N \cdot K_H \cdot K_\vartheta$

22.8 Further information

22.8.1 Directives and standards

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

- (Low Voltage) Directive 2014/35/EU
- (EMC) Directive 2014/30/EU
- EN 61000-6-2:2005
- EN 61000-6-4:2007 + A1:2011
- EN 60034-1:2010 + Cor.:2010
- EN 60034-5:2001 + A1:2007
- EN 60034-6:1993

22.8.2 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 "COMPONENT - SERVO AND STEPPER MOTORS"; registered under UL number E488992 with Underwriters Laboratories USA (optional).

22.8.3 Additional documentation

Additional documentation related to the product can be found at http://www.stoeber.de/en/download

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

Documentation	ID
Operating manual for EZ synchronous servo motors	442585