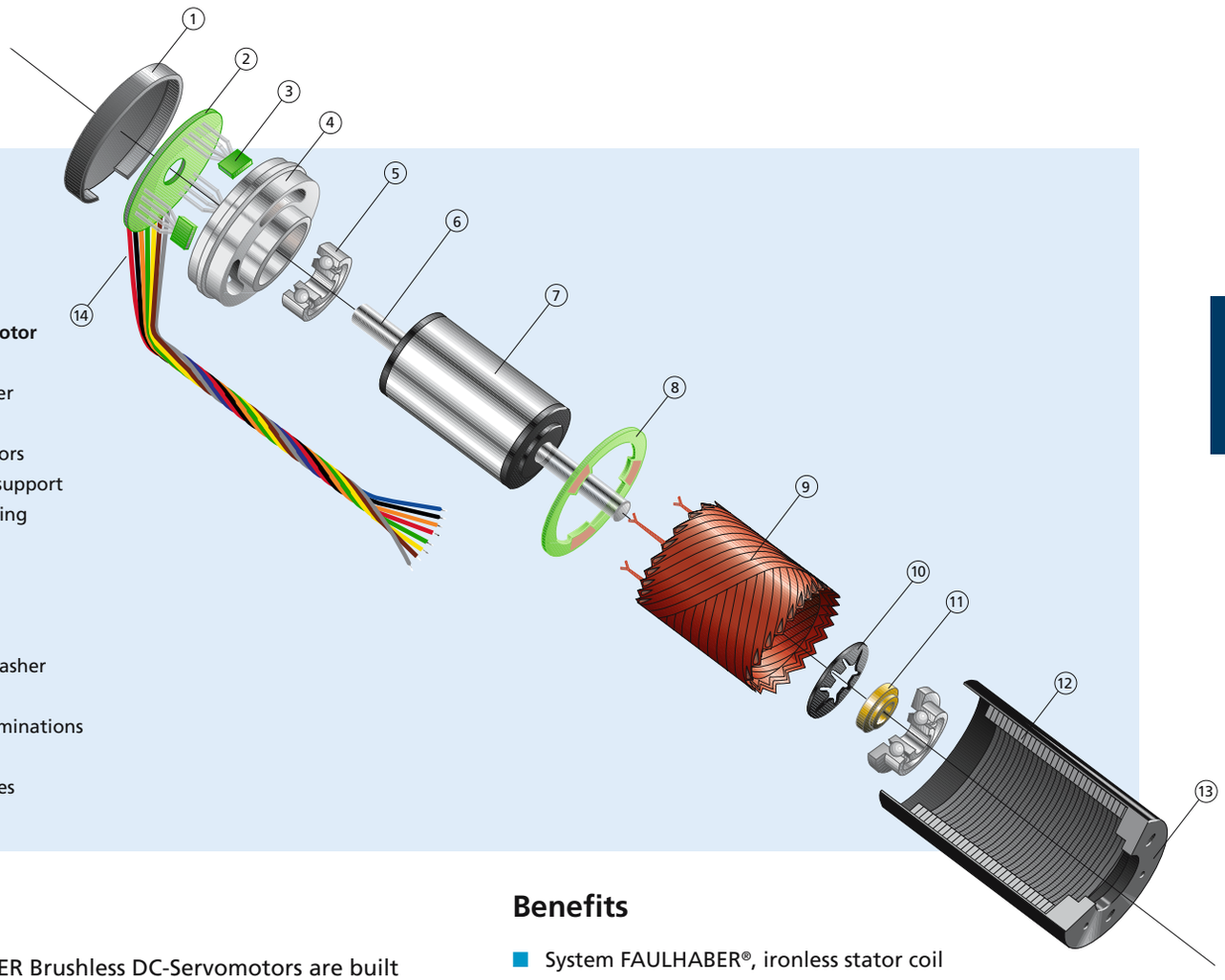
Brushless DC-Servomotors



Brushless DC-Servomotor

① Rear cover
② PCB
③ Hall sensors
④ Bearing support
⑤ Ball bearing
⑥ Shaft
⑦ Magnet
⑧ PCB
⑨ Coil
⑩ Spring washer
⑪ Spacer
⑫ Stator laminations
⑬ Housing
⑭ Lead wires

Features

The FAULHABER Brushless DC-Servomotors are built for extreme operating conditions. They are precise, have extreme long lifetimes and are highly reliable. Exceptional qualities such as smooth running and especially low noise level are of particular note. The rare-earth magnet as rotor, and FAULHABER skew winding technology ensure that these motors deliver top performance dynamics within minimum overall dimensions.

This series is also available in an autoclavable version and is ideally suited for application in laboratory and medical equipment.

Sterilizing conditions

- Temperature 134 °C ± 2 °C
- Water vapour pressure 2,1 bar
- Relative humidity 100 %
- Duration of cycle 20 min.
- Rated for a minimum of 100 cycles

Benefits

- System FAULHABER®, ironless stator coil
- High reliability and operational lifetime
- Wide range of linear torque / speed performance
- No sparking
- No cogging
- Dynamically balanced rotor
- Simple design
- Standard with digital hall sensors with optional analog hall sensors

Product Code

24	Motor diameter [mm]
44	Motor length [mm]
S	Shaft type
024	Nominal voltage [V]
B	Type of commutation (brushless)

2444 S 024 B

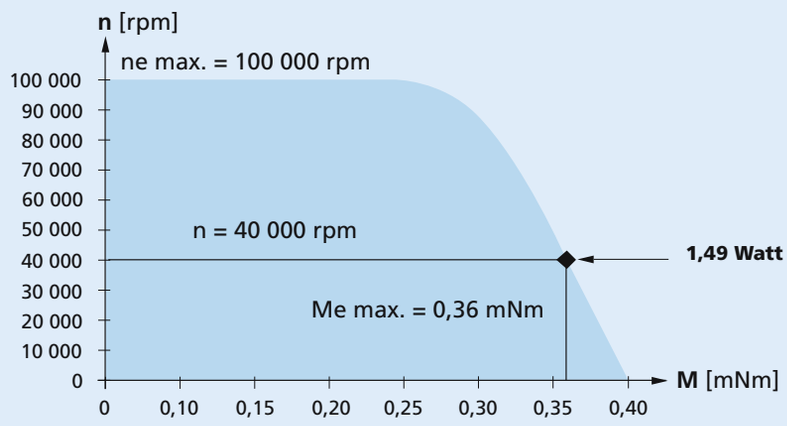
Brushless DC-Servomotors 0,36 mNm

For combination with
Gearheads:
06/1
Encoder:
PA2-50, HXM3-64
Drive Electronics:
Speed Controller, Motion Controller

Series 0620 ... B

		0620 K		006 B	012 B	
1	Nominal voltage	U_N		6	12	Volt
2	Terminal resistance, phase-phase	R		9,1	59,0	Ω
3	Output power [1]	$P_{2\ max.}$		1,47	1,49	W
4	Efficiency	$\eta_{max.}$		52	50	%
5	No-load speed	n_o		46 500	35 600	rpm
6	No-load current (with shaft ø 1,0 mm)	I_o		0,062	0,020	A
7	Stall torque	M_H		0,73	0,57	mNm
8	Friction torque, static	C_o		0,023	0,023	mNm
9	Friction torque, dynamic	C_v		$1,0 \cdot 10^{-6}$	$1,0 \cdot 10^{-6}$	mNm/rpm
10	Speed constant	k_n		8 451	3 282	rpm/V
11	Back-EMF constant	k_E		0,118	0,305	mV/rpm
12	Torque constant	k_M		1,13	2,91	mNm/A
13	Current constant	k_I		0,885	0,344	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		68 054	66 533	rpm/mNm
15	Terminal inductance, phase-phase	L		26	187	µH
16	Mechanical time constant	τ_m		6	6	ms
17	Rotor inertia	J		0,0095	0,0095	gcm^2
18	Angular acceleration	$\alpha_{max.}$		768	601	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	14 / 88,0			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	1 / 149			s
21	Operating temperature range:					
	– motor		– 20 ... +100			°C
	– coil, max. permissible		+125			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 10 000/50 000 rpm (3,7 mm from mounting flange)		2,0 / 1,5			N
	– axial at 10 000/50 000 rpm (push-on only)		0,6 / 0,2			N
	– axial at standstill (push-on only)		10			N
24	Shaft play:					
	– radial	≤	0,012			mm
	– axial	=	0			mm
25	Housing material		aluminium, black anodized			
26	Weight		2,5			g
27	Direction of rotation		electronically reversible			
Recommended values - mathematically independent of each other						
28	Speed up to [2]	$n_{e\ max.}$		100 000	100 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$		0,351	0,356	mNm
30	Current up to [1] [2]	$I_{e\ max.}$		0,367	0,144	A

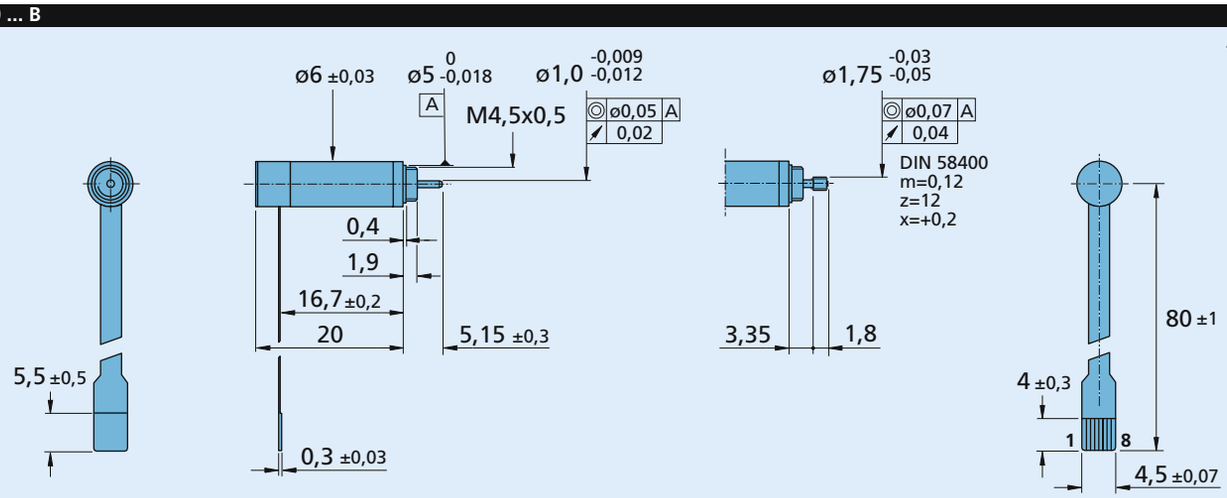
[1] at 40 000 rpm
[2] thermal resistance $R_{th\ 2}$ by 55% reduced



Recommended area for continuous operation

Options
K1855:
Motors for operation with Motion Controllers
MCBL 3003 S/C, MCBL 3006 S/C.

0620 ... B



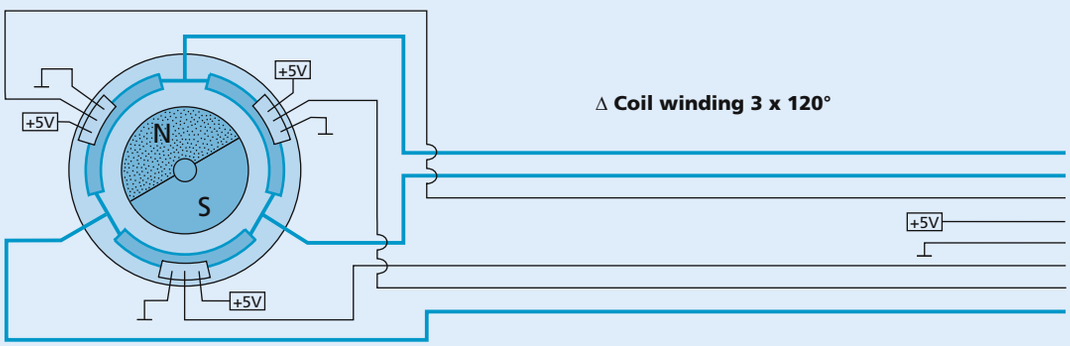
0620 K

0620 C for Gearheads 06/1

Cable and connection information

Recommended connector
Molex - ZIF Connector,
No. 52745-0896.

Flexboard
8 circuits; 0,5mm pitch,
Top Contact Style.



Δ Coil winding 3 x 120°

Connection

No.	Function
1	Phase C
2	Phase B
3	Hall sensor C
4	+5V
5	GND
6	Hall sensor A
7	Hall sensor B
8	Phase A

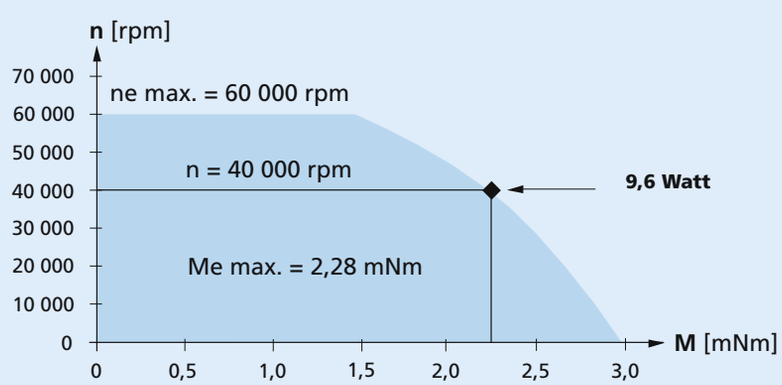
Brushless DC-Servomotors 2,2 mNm

For combination with
Gearheads:
10/1, 12/3, 12/4, 12/5
Drive electronics:
Speed Controller, Motion Controller

Series 1226 ... B

		1226 S		006 B	012 B	
1	Nominal voltage	U_N		6	12	Volt
2	Terminal resistance, phase-phase	R		2,30	5,30	Ω
3	Output power [1]	$P_{2\ max.}$		9,6	9,3	W
4	Efficiency	$\eta_{max.}$		68	69	%
5	No-load speed	n_o		20 100	27 200	rpm
6	No-load current (with shaft ø 1,2 mm)	I_o		0,088	0,074	A
7	Stall torque	M_H		7,19	9,21	mNm
8	Friction torque, static	C_o		0,079	0,079	mNm
9	Friction torque, dynamic	C_v		$8{,}2 \cdot 10^{-6}$	$8{,}2 \cdot 10^{-6}$	mNm/rpm
10	Speed constant	k_n		3 447	2 335	rpm/V
11	Back-EMF constant	k_E		0,290	0,428	mV/rpm
12	Torque constant	k_M		2,77	4,09	mNm/A
13	Current constant	k_I		0,361	0,244	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		2 862	3 026	rpm/mNm
15	Terminal inductance, phase-phase	L		35	80	µH
16	Mechanical time constant	τ_{m}		4	4	ms
17	Rotor inertia	J		0,145	0,145	gcm^2
18	Angular acceleration	$\alpha_{max.}$		496	635	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	7 / 38,0			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	3 / 186			s
21	Operating temperature range:					
	– motor		– 20 ... +100			°C
	– coil, max. permissible		+125			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 10 000/30 000 rpm (3,7 mm from mounting flange)		4,9 / 4,0			N
	– axial at 10 000/30 000 rpm (push-on only)		2,6 / 1,1			N
	– axial at standstill (push-on only)		11			N
24	Shaft play:					
	– radial	≤	0,012			mm
	– axial	=	0			mm
25	Housing material		aluminium, black anodized			
26	Weight		13			g
27	Direction of rotation		electronically reversible			
Recommended values - mathematically independent of each other						
28	Speed up to [2]	$n_{e\ max.}$		60 000	60 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$		2,28	2,21	mNm
30	Current up to [1] [2]	$I_{e\ max.}$		0,97	0,64	A

[1] at 40 000 rpm
[2] thermal resistance $R_{th\,2}$ by 55% reduced

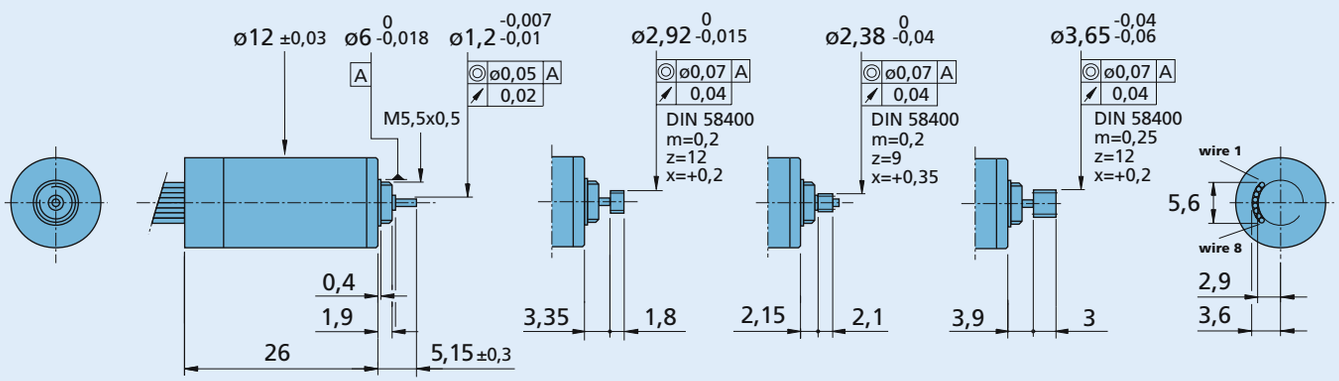


Recommended area for continuous operation

For notes on technical data and lifetime performance refer to „Technical Information".
Edition 2011 – 2012

Options
K1855:
Motors for operation with Motion Controllers
MCBL 3003 S/C, MCBL 3006 S/C.

1226 ... B



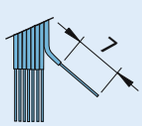
1226 S

1226 M
for Gearhead 10/1

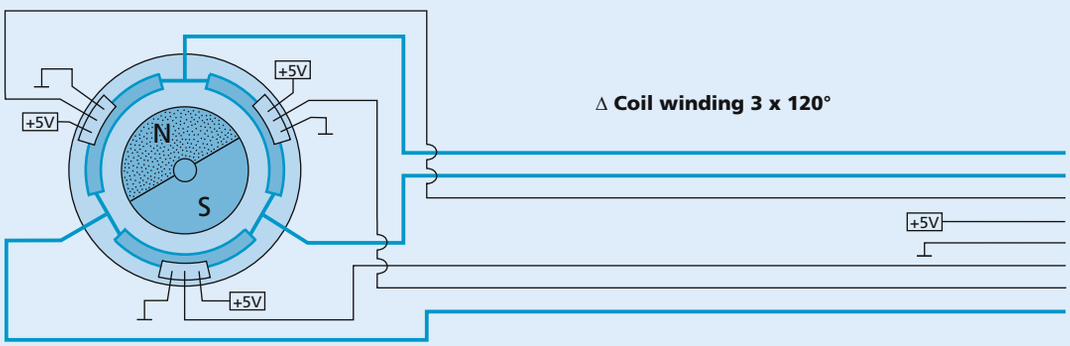
1226 E
for Gearheads 12/3, 12/5

1226 A
for Gearhead 12/4

Cable and connection information



Cable
Single wires, material PTFE
Length 80 mm ± 3 mm
8 conductors, AWG 30



Δ Coil winding 3 x 120°

Connection

No.	Function	Colour
1	Phase C	yellow
2	Phase B	orange
3	Hall sensor C	grey
4	Logical supply +5V	red
5	Logical GND	black
6	Hall sensor A	green
7	Hall sensor B	blue
8	Phase A	brown

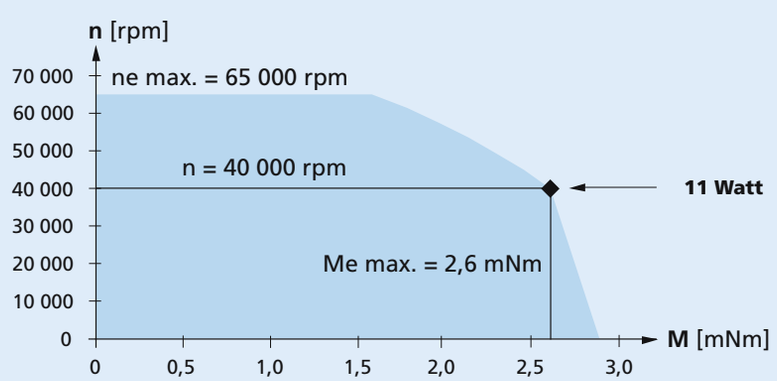
Brushless DC-Servomotors 2,6 mNm

For combination with
Gearheads:
16/7
Encoders:
IE2-1024
Drive Electronics:
Speed Controller, Motion Controller

Series 1628 ... B

			1628 T		012 B	024 B	
1	Nominal voltage	U_N			12	24	Volt
2	Terminal resistance, phase-phase	R			4,3	15,1	Ω
3	Output power [1]	$P_{2\ max.}$			10	11	W
4	Efficiency	$\eta_{max.}$			68	68	%
5	No-load speed	n_o			28 650	29 900	rpm
6	No-load current (with shaft ø 1,5 mm)	I_o			0,098	0,052	A
7	Stall torque	M_H			11	12	mNm
8	Friction torque, static	C_o			0,15	0,15	mNm
9	Friction torque, dynamic	C_v			$8{,}0 \cdot 10^{-6}$	$8{,}0 \cdot 10^{-6}$	mNm/rpm
10	Speed constant	k_n			2 474	1 287	rpm/V
11	Back-EMF constant	k_E			0,404	0,777	mV/rpm
12	Torque constant	k_M			3,86	7,42	mNm/A
13	Current constant	k_I			0,259	0,135	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$			2 737	2 610	rpm/mNm
15	Terminal inductance, phase-phase	L			141	525	µH
16	Mechanical time constant	τ_m			15	14	ms
17	Rotor inertia	J			0,54	0,54	gcm²
18	Angular acceleration	$\alpha_{max.}$			198	217	$\cdot 10^3$rad/s²
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	7,8 / 30,1				K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	8 / 379				s
21	Operating temperature range		– 30 ... +125				°C
22	Shaft bearings		ball bearings, preloaded				
23	Shaft load max.:						
	– radial at 3 000/20 000 rpm (4,5 mm from mounting flange)		17 / 10				N
	– axial at 3 000/20 000 rpm (push-on only)		10 / 6				N
	– axial at standstill (push-on only)		20				N
24	Shaft play:						
	– radial	≤	0,015				mm
	– axial	=	0				mm
25	Housing material		aluminium, black anodized				
26	Weight		31				g
27	Direction of rotation		electronically reversible				
Recommended values - mathematically independent of each other							
28	Speed up to [2]	$n_{e\ max.}$			65 000	65 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$			2,5	2,6	mNm
30	Current up to [1] [2]	$I_{e\ max.}$			0,77	0,41	A

[1] at 40 000 rpm
[2] thermal resistance $R_{th\,2}$ by 55% reduced

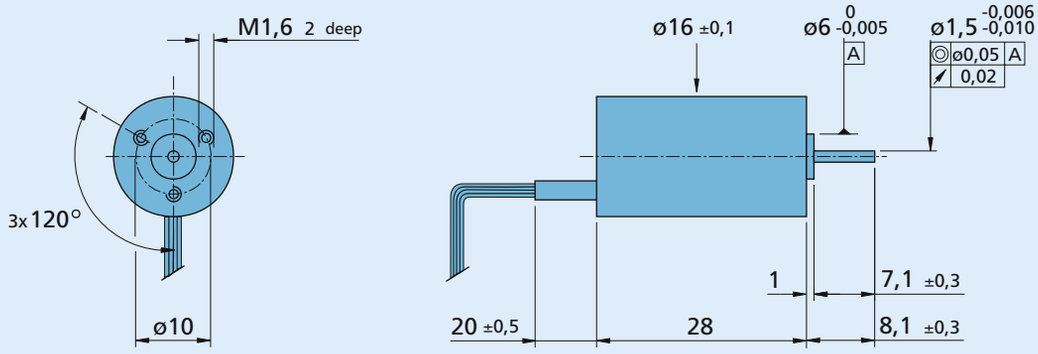


Recommended area for continuous operation

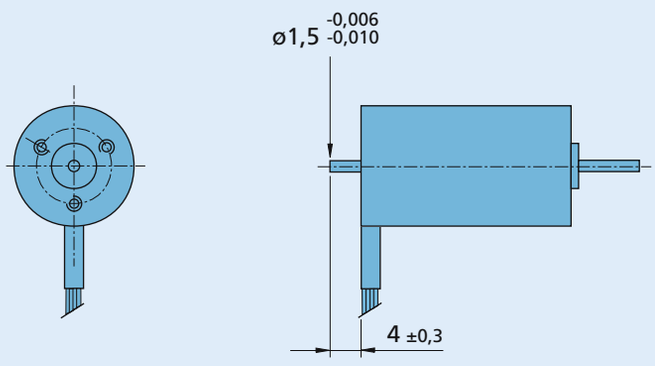
Brushless DC-Motors

Options
K1000:
Motors in autoclavable version.
K1155:
Motors for operation with Motion Controllers
MCBL 3003 S/C, MCBL 3006 S/C.

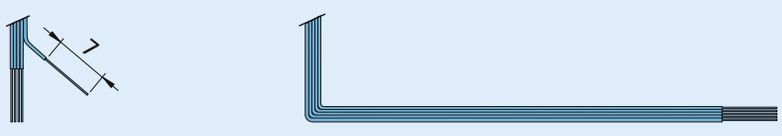
1628 T ... B



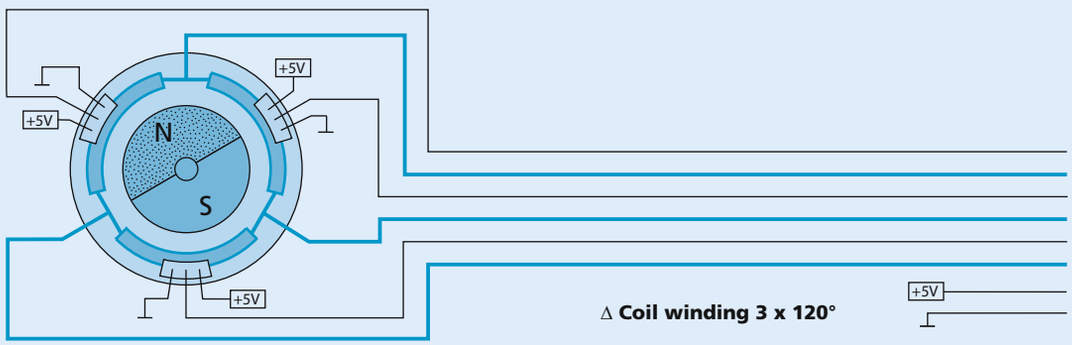
1628 T ... B - K312 with rear end shaft



Cable and connection information



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
8 conductors, AWG 26



Connection

	Function	Colour
A	Hall sensor	green
A	Phase	brown
B	Hall sensor	blue
B	Phase	orange
C	Hall sensor	grey
C	Phase	yellow
+5V	Logical supply	red
GND	Logical	black

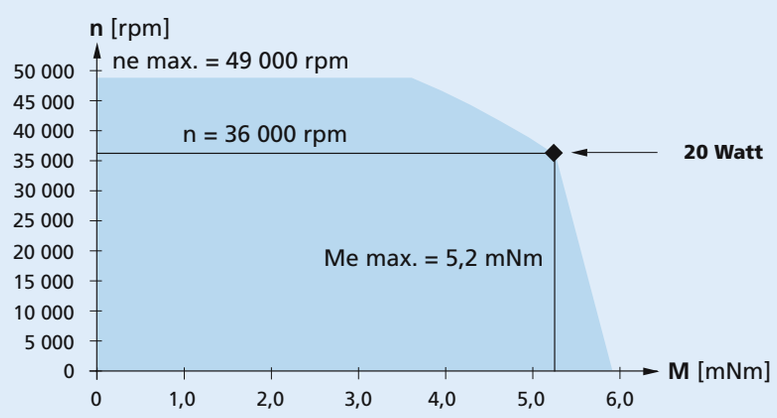
Brushless DC-Servomotors 5,2 mNm

For combination with
Gearheads:
20/1
Encoders:
IE2-1024, 5500, 5540
Drive Electronics:
Speed Controller, Motion Controller

Series 2036 ... B

		2036 U		012 B	024 B	036 B	048 B	
1	Nominal voltage	U_N		12	24	36	48	Volt
2	Terminal resistance, phase-phase	R		3,4	14,0	27,9	62,2	Ω
3	Output power [1]	$P_{2\ max.}$		20	19	18	18	W
4	Efficiency	$\eta_{max.}$		70	69	69	69	%
5	No-load speed	n_o		17 600	18 000	19 500	17 400	rpm
6	No-load current (with shaft ø 2,0 mm)	I_o		0,102	0,053	0,040	0,025	A
7	Stall torque	M_H		22	21	22	20	mNm
8	Friction torque, static	C_o		0,27	0,27	0,27	0,27	mNm
9	Friction torque, dynamic	C_v		$2{,}14 \cdot 10^{-5}$	$2{,}14 \cdot 10^{-5}$	$2{,}14 \cdot 10^{-5}$	$2{,}14 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		1 506	773	557	374	rpm/V
11	Back-EMF constant	k_E		0,664	1,294	1,796	2,677	mV/rpm
12	Torque constant	k_M		6,34	12,36	17,15	25,56	mNm/A
13	Current constant	k_I		0,158	0,081	0,058	0,039	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		808	875	906	909	rpm/mNm
15	Terminal inductance, phase-phase	L		148	600	1 160	2 500	µH
16	Mechanical time constant	τ_m		16	18	18	18	ms
17	Rotor inertia	J		1,95	1,95	1,95	1,95	gcm²
18	Angular acceleration	$\alpha_{max.}$		114	107	113	100	$\cdot 10^3$rad/s²
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	5,7 / 19,9					K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	9 / 577					s
21	Operating temperature range		– 30 ... +125					°C
22	Shaft bearings		ball bearings, preloaded					
23	Shaft load max.:							
	– radial at 3 000/20 000 rpm (4,5 mm from mounting flange)		14 / 7					N
	– axial at 3 000/20 000 rpm (push-on only)		8 / 4					N
	– axial at standstill (push-on only)		30					N
24	Shaft play:							
	– radial	≤	0,015					mm
	– axial	=	0					mm
25	Housing material		aluminium, black anodized					
26	Weight		50					g
27	Direction of rotation		electronically reversible					
Recommended values - mathematically independent of each other								
28	Speed up to [2]	$n_{e\,max.}$		49 000	49 000	49 000	49 000	rpm
29	Torque up to [1] [2]	$M_{e\,max.}$		5,2	4,9	4,8	4,8	mNm
30	Current up to [1] [2]	$I_{e\,max.}$		0,98	0,48	0,34	0,23	A

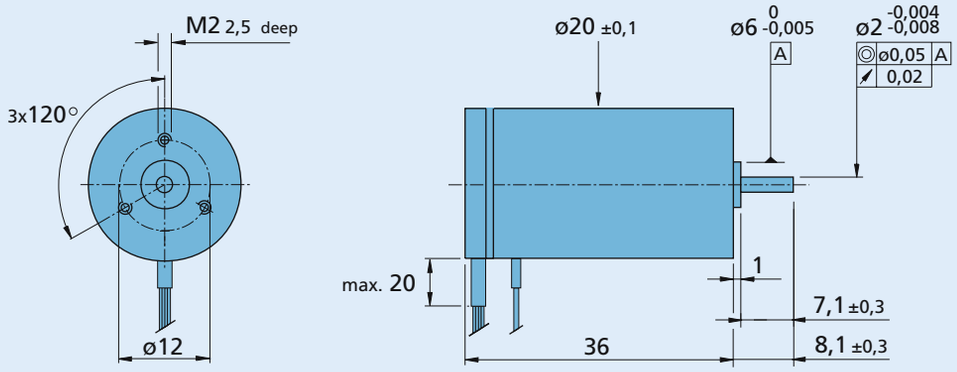
[1] at 36 000 rpm
[2] thermal resistance $R_{th\,2}$ by 55% reduced



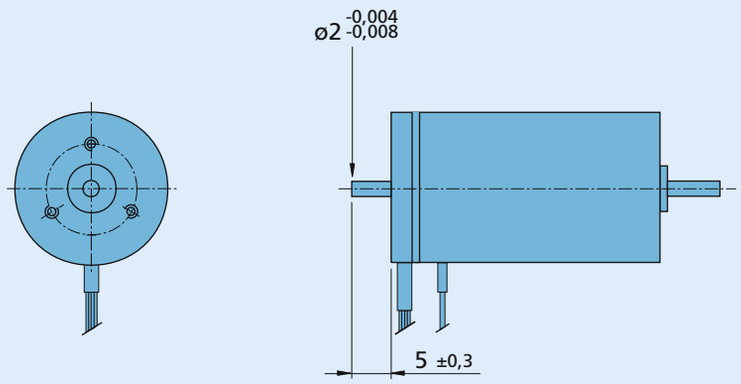
Recommended area for continuous operation

Options
K1000:
Motors in autoclavable version.
K1155:
Motors for operation with Motion Controllers MCBL 3003 S/C, MCBL 3006 S/C.

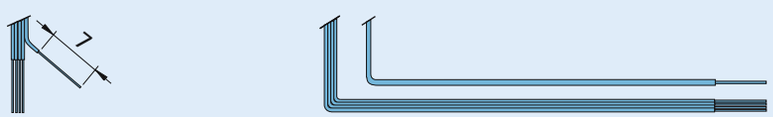
2036 U ... B



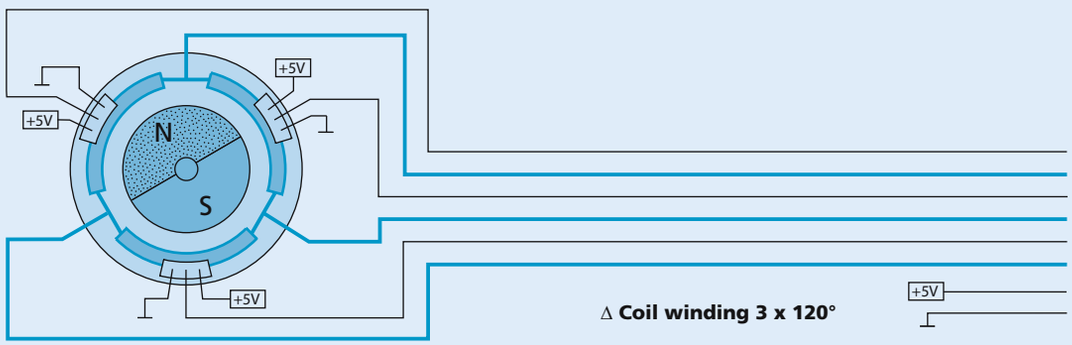
2036 U ... B - K312 with rear end shaft



Cable and connection information



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 24
5 conductors, AWG 26



Connection

	Function	Colour
A	Hall sensor	green
A	Phase	brown
B	Hall sensor	blue
B	Phase	orange
C	Hall sensor	grey
C	Phase	yellow
+5V	Logical supply	red
GND	Logical	black

Brushless DC-Servomotors 16,5 mNm

For combination with
Gearheads:
20/1, 23/1
Encoders:
IE2-1024, 5500, 5540
Drive Electronics:
Speed Controller, Motion Controller

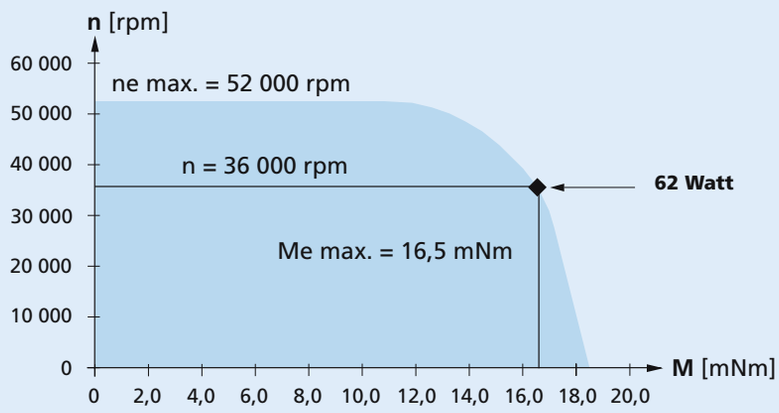
Series 2057 ... B

		2057 S		012 B	024 B	
1	Nominal voltage	U_N		12	24	Volt
2	Terminal resistance, phase-phase	R		0,55	1,42	Ω
3	Output power [1]	$P_{2\ max.}$		61	62	W
4	Efficiency	$\eta_{max.}$		82	83	%
5	No-load speed	n_o		21 900	26 500	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,210	0,147	A
7	Stall torque	M_H		113	144	mNm
8	Friction torque, static	C_o		0,28	0,28	mNm
9	Friction torque, dynamic	C_v		$3{,}70 \cdot 10^{-5}$	$3{,}70 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		1 840	1 116	rpm/V
11	Back-EMF constant	k_E		0,543	0,896	mV/rpm
12	Torque constant	k_M		5,19	8,56	mNm/A
13	Current constant	k_I		0,193	0,117	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		195	185	rpm/mNm
15	Terminal inductance, phase-phase	L		68	117	µH
16	Mechanical time constant	τ_m		8	8	ms
17	Rotor inertia	J		3,95	3,95	gcm²
18	Angular acceleration	$\alpha_{max.}$		286	365	$\cdot 10^3$rad/s²
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	2,8 / 11,5			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	10 / 590			s
21	Operating temperature range		– 30 ... +125			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000/20 000 rpm (4,5 mm from mounting flange)		28 / 14			N
	– axial at 3 000/20 000 rpm (push-on only)		17 / 11			N
	– axial at standstill (push-on only)		75			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		aluminium, black anodized			
26	Weight		95			g
27	Direction of rotation		electronically reversible			

Recommended values - mathematically independent of each other

28	Speed up to [2]	$n_{e\ max.}$		52 000	52 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$		16,1	16,5	mNm
30	Current up to [1] [2]	$I_{e\ max.}$		3,41	2,12	A

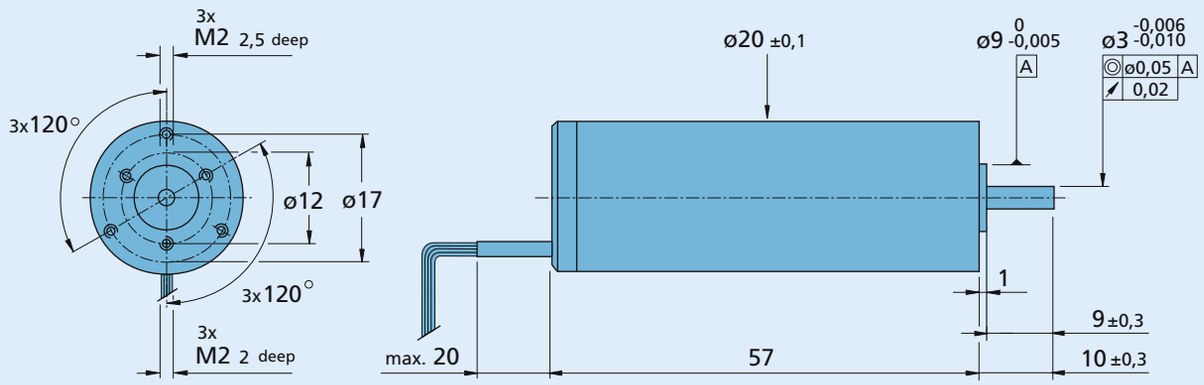
[1] at 36 000 rpm
[2] thermal resistance $R_{th\,2}$ by 55% reduced



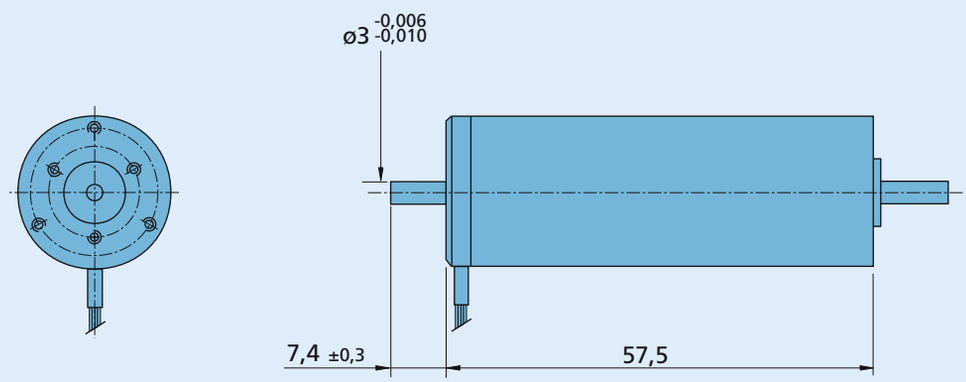
Recommended area for continuous operation

Options
K1000:
Motors in autoclavable version.
K1155:
Motors for operation with Motion Controllers
MCBL 3003 S/C, MCBL 3006 S/C.

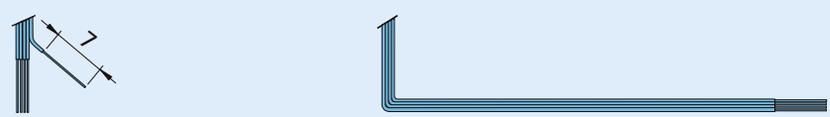
2057 S ... B



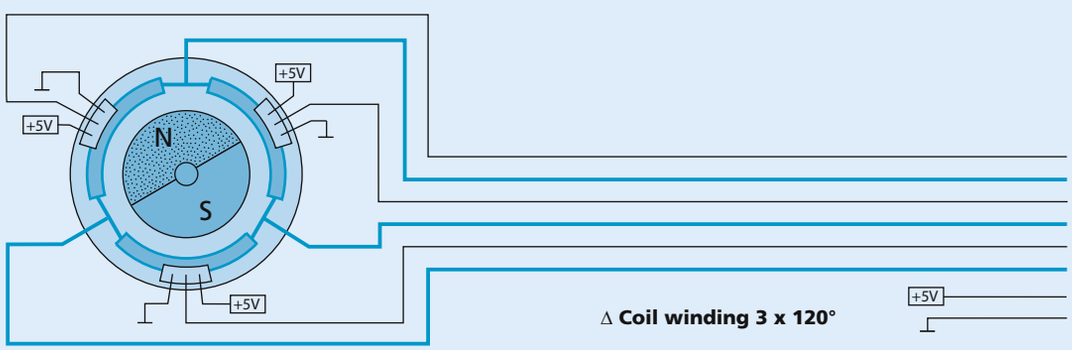
2057 S ... B - K312 with rear end shaft



Cable and connection information



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
5 conductors, AWG 26
3 conductors, AWG 24



Connection

	Function	Colour
A	Hall sensor	green
A	Phase	brown
B	Hall sensor	blue
B	Phase	orange
C	Hall sensor	grey
C	Phase	yellow
+5V	Logical supply	red
GND	Logical	black

Brushless DC-Servomotors 11,8 mNm

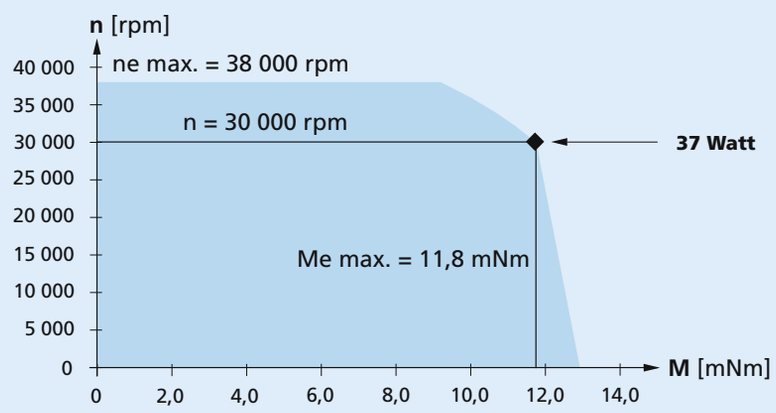
For combination with
Gearheads:
23/1, 26/1, 26/1 S, 30/1, 30/1 S, 38/3
Encoders:
IE2-1024, IE3-1024, IE3-1024 L, 5500, 5540
Drive Electronics:
Speed Controller, Motion Controller

Series 2444 ... B

		2444 S		024 B	048 B	
1	Nominal voltage	U_N		24	48	Volt
2	Terminal resistance, phase-phase	R		2,1	8,4	Ω
3	Output power [1]	$P_{2\ max.}$		36	37	W
4	Efficiency	$\eta_{max.}$		77	77	%
5	No-load speed	n_o		23 000	22 500	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,184	0,088	A
7	Stall torque	M_H		111	115	mNm
8	Friction torque, static	C_o		1,00	1,00	mNm
9	Friction torque, dynamic	C_v		$3,5 \cdot 10^{-5}$	$3,5 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		974	473	rpm/V
11	Back-EMF constant	k_E		1,026	2,115	mV/rpm
12	Torque constant	k_M		9,8	20,2	mNm/A
13	Current constant	k_I		0,102	0,050	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		209	197	rpm/mNm
15	Terminal inductance, phase-phase	L		180	760	µH
16	Mechanical time constant	τ_m		14	13	ms
17	Rotor inertia	J		6,5	6,5	gcm²
18	Angular acceleration	$\alpha_{max.}$		171	177	$\cdot 10^3$rad/s²
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	4,1 / 14,8			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	16 / 680			s
21	Operating temperature range		– 30 ... +125			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000/20 000 rpm (6 mm from mounting flange)		30 / 17			N
	– axial at 3 000/20 000 rpm (push-on only)		16 / 10			N
	– axial at standstill (push-on only)		57			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		aluminium, black anodized			
26	Weight		100			g
27	Direction of rotation		electronically reversible			

Recommended values - mathematically independent of each other						
28	Speed up to [2]	$n_{e\ max.}$		38 000	38 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$		11,4	11,8	mNm
30	Current up to [1] [2]	$I_{e\ max.}$		1,37	0,69	A

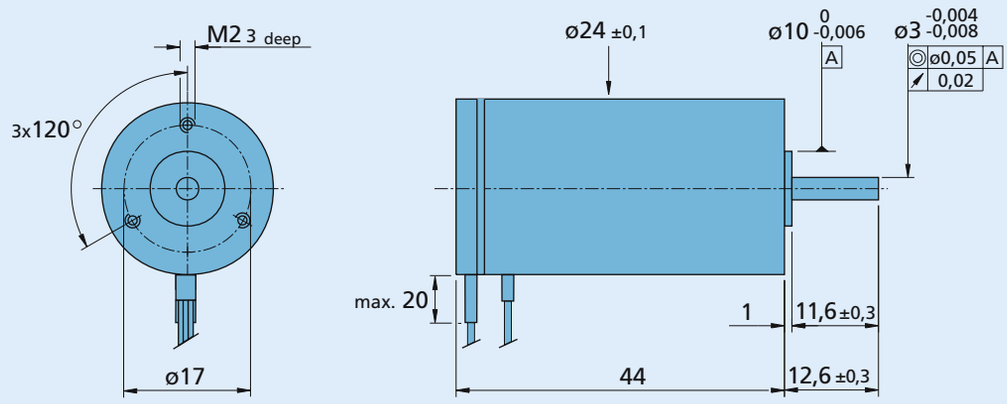
[1] at 30 000 rpm
[2] thermal resistance $R_{th\,2}$ by 55% reduced



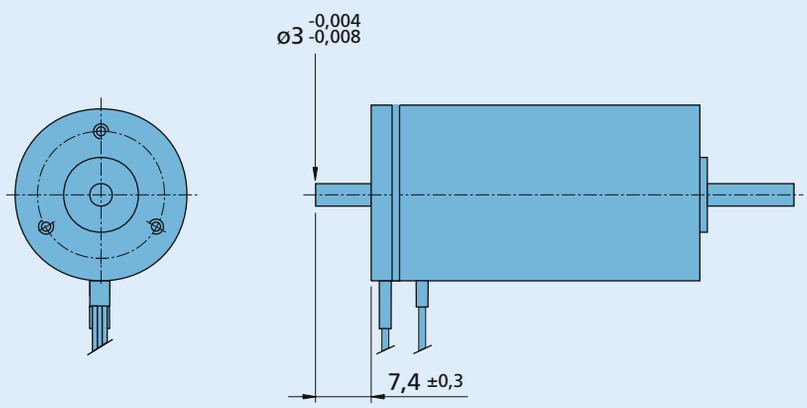
Recommended area for continuous operation

Options
K1000:
Motors in autoclavable version.
K1155:
Motors for operation with Motion Controllers MCBL 3003 S/C, MCBL 3006 S/C.

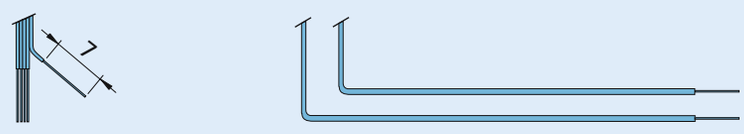
2444 S ... B



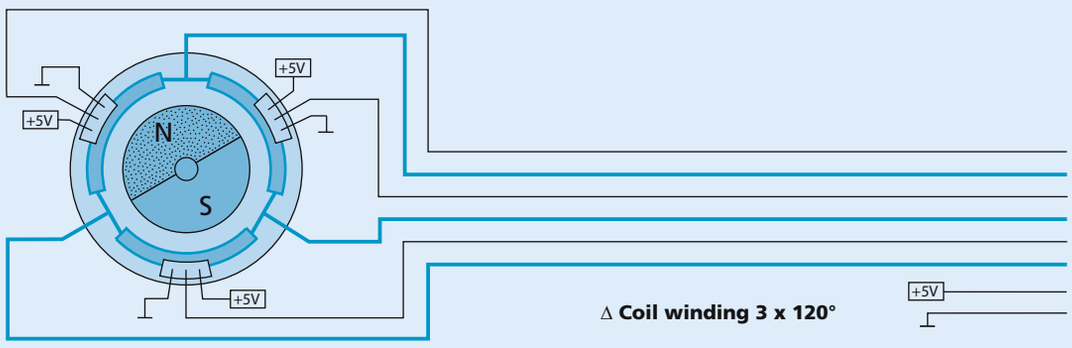
2444 S ... B - K312 with rear end shaft



Cable and connection information



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 24
5 conductors, AWG 26



Connection

	Function	Colour
A	Hall sensor	green
A	Phase	brown
B	Hall sensor	blue
B	Phase	orange
C	Hall sensor	grey
C	Phase	yellow
+5V	Logical supply	red
GND	Logical	black

Brushless DC-Servomotors 22,1 mNm

For combination with
Gearheads:
30/1, 30/1 S, 38/1, 38/1 S, 38/2, 38/2 S
Encoders:
IE3-1024, IE3-1024 L, 5500, 5540
Drive Electronics:
Speed Controller, Motion Controller

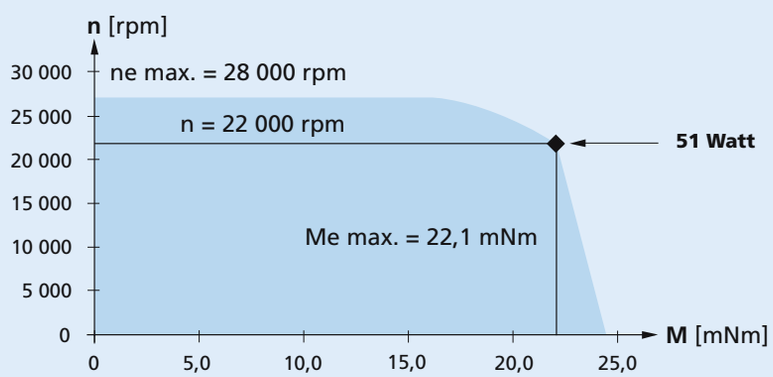
Series 3056 ... B

		3056 K		012 B	024 B	036 B	048 B	
1	Nominal voltage	U_N		12	24	36	48	Volt
2	Terminal resistance, phase-phase	R		1,6	6,6	13,7	26,5	Ω
3	Output power [1]	$P_{2\ max.}$		48	51	49	49	W
4	Efficiency	$\eta_{max.}$		73	74	74	74	%
5	No-load speed	n_o		8 790	8 200	8 840	8 740	rpm
6	No-load current (with shaft ø 4,0 mm)	I_o		0,168	0,075	0,056	0,042	A
7	Stall torque	M_H		95	98	99	100	mNm
8	Friction torque, static	C_o		0,91	0,91	0,91	0,91	mNm
9	Friction torque, dynamic	C_v		$1,4 \cdot 10^{-4}$	$1,4 \cdot 10^{-4}$	$1,4 \cdot 10^{-4}$	$1,4 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		750	350	251	186	rpm/V
11	Back-EMF constant	k_E		1,334	2,861	3,981	5,374	mV/rpm
12	Torque constant	k_M		12,74	27,32	38,02	51,32	mNm/A
13	Current constant	k_I		0,078	0,037	0,026	0,019	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		94	84	91	89	rpm/mNm
15	Terminal inductance, phase-phase	L		160	720	1 400	2 520	µH
16	Mechanical time constant	τ_m		13	12	13	12	ms
17	Rotor inertia	J		13,6	13,6	13,6	13,6	gcm^2
18	Angular acceleration	$\alpha_{max.}$		70	72	73	73	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	3,3 / 9,4					K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	19 / 1 034					s
21	Operating temperature range		– 30 ... +125					°C
22	Shaft bearings		ball bearings, preloaded					
23	Shaft load max.:							
	– radial at 3 000/20 000 rpm (7,4 mm from mounting flange)		72 / 51					N
	– axial at 3 000/20 000 rpm (axial push-on only)		18 / 12					N
	– axial at standstill (axial push-on only)		62					N
24	Shaft play:							
	– radial	≤	0,015					mm
	– axial	=	0					mm
25	Housing material		aluminium, black anodized					
26	Weight		190					g
27	Direction of rotation		electronically reversible					

Recommended values - mathematically independent of each other

28	Speed up to [2]	$n_{e\ max.}$		28 000	28 000	28 000	28 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$		20,7	22,1	21,2	21,5	mNm
30	Current up to [1] [2]	$I_{e\ max.}$		1,94	0,96	0,66	0,50	A

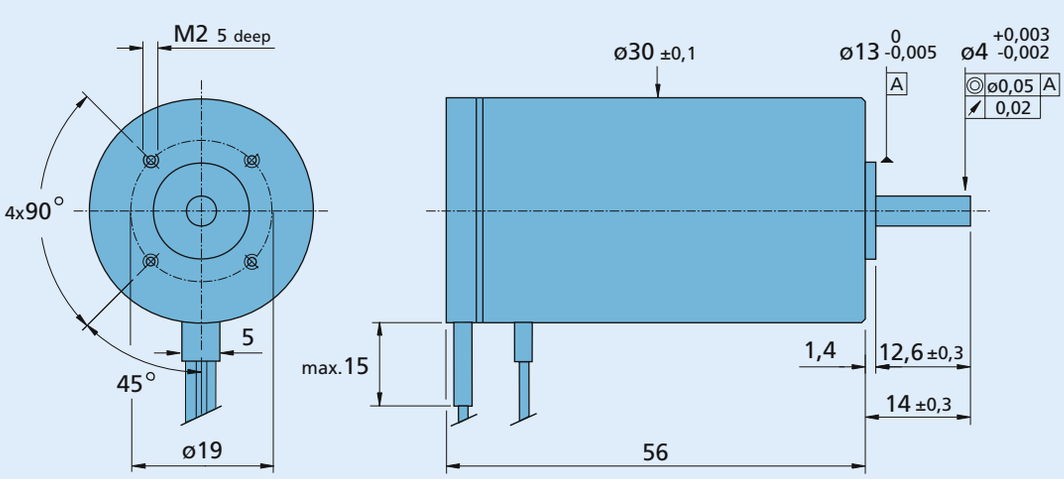
[1] at 22 000 rpm
[2] thermal resistance $R_{th\,2}$ by 55% reduced



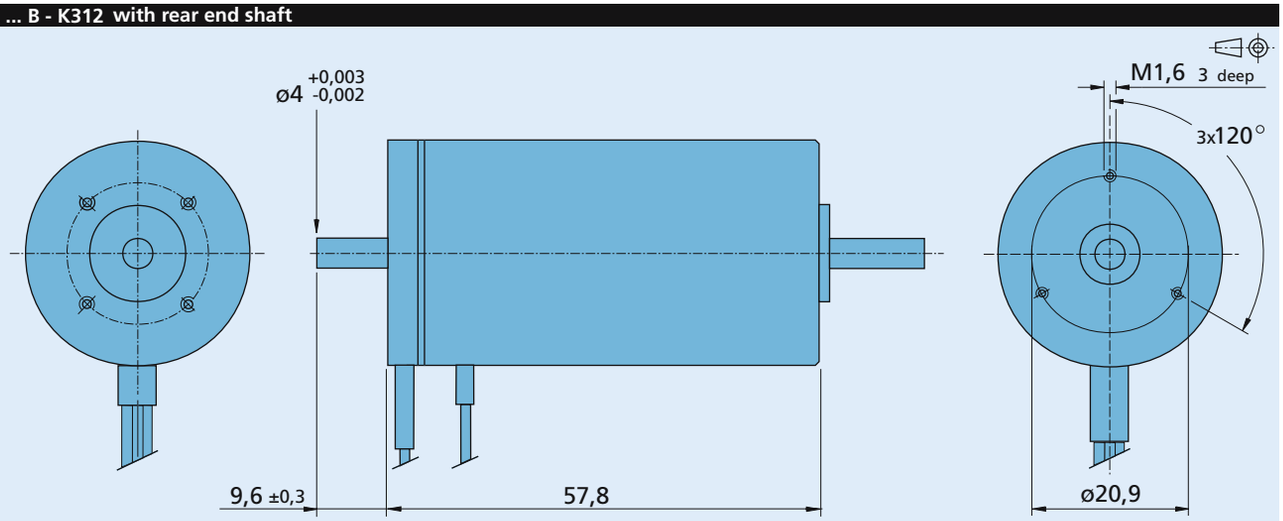
Recommended area for continuous operation

Options
K1000:
Motors in autoclavable version.
K1155:
Motors for operation with Motion Controllers MCBL 3003 S/C, MCBL 3006 S/C.

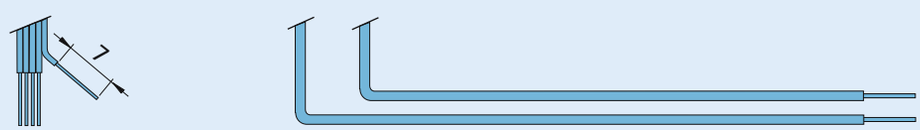
3056 K ... B



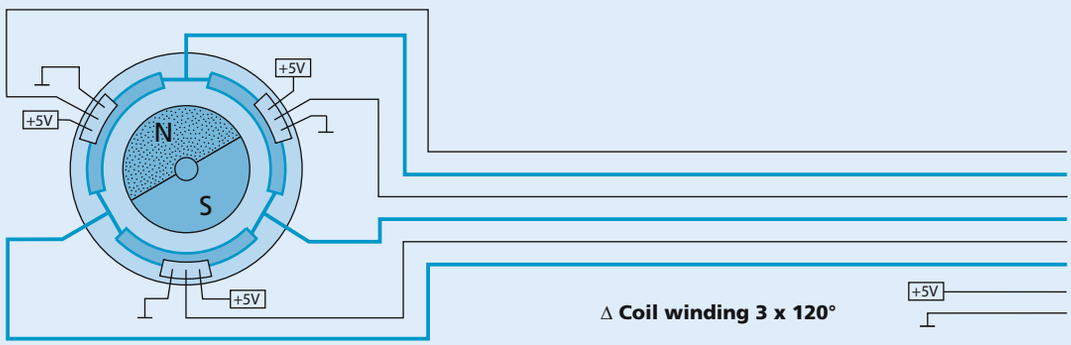
3056 K ... B - K312 with rear end shaft



Cable and connection information



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 20
5 conductors, AWG 26



Connection

	Function	Colour
A	Hall sensor	green
A	Phase	brown
B	Hall sensor	blue
B	Phase	orange
C	Hall sensor	grey
C	Phase	yellow
+5V	Logical supply	red
GND	Logical	black

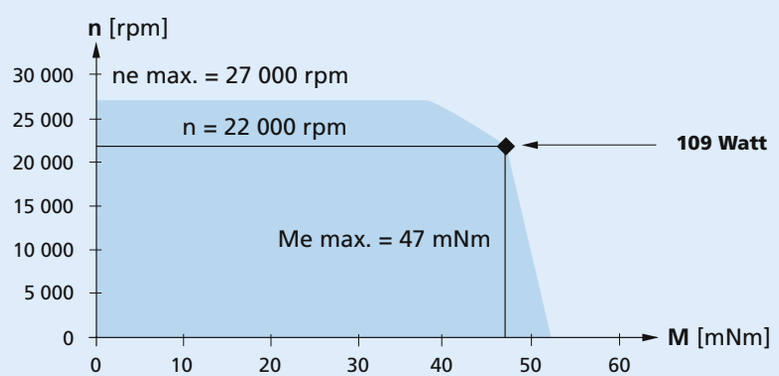
Brushless DC-Servomotors 47,1 mNm

For combination with
Gearheads:
30/1, 30/1 S, 32/3, 32/3 S, 38A, 38/1, 38/1 S, 38/2, 38/2 S
Encoders:
IE3-1024, IE3-1024 L, 5500, 5540
Drive Electronics:
Speed Controller, Motion Controller

Series 3564 ... B

		3564 K		012 B	024 B	036 B	048 B	
1	Nominal voltage	U_N		12	24	36	48	Volt
2	Terminal resistance, phase-phase	R		0,6	1,2	2,8	4,4	Ω
3	Output power [1]	$P_{2\ max.}$		109	101	101	101	W
4	Efficiency	$\eta_{max.}$		81	81	81	82	%
5	No-load speed	n_o		7 850	11 300	11 550	12 200	rpm
6	No-load current (with shaft ø 4,0 mm)	I_o		0,206	0,189	0,131	0,109	A
7	Stall torque	M_H		291	371	379	401	mNm
8	Friction torque, static	C_o		1,10	1,10	1,10	1,10	mNm
9	Friction torque, dynamic	C_v		$2{,}4 \cdot 10^{-4}$	$2{,}4 \cdot 10^{-4}$	$2{,}4 \cdot 10^{-4}$	$2{,}4 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		658	475	324	258	rpm/V
11	Back-EMF constant	k_E		1,521	2,107	3,089	3,877	mV/rpm
12	Torque constant	k_M		14,52	20,12	29,50	37,02	mNm/A
13	Current constant	k_I		0,069	0,050	0,034	0,027	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		27	31	31	31	rpm/mNm
15	Terminal inductance, phase-phase	L		96	194	427	678	µH
16	Mechanical time constant	τ_m		10	11	11	11	ms
17	Rotor inertia	J		34	34	34	34	gcm^2
18	Angular acceleration	$\alpha_{max.}$		86	109	111	118	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	2,5 / 6,3					K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	23 / 1 175					s
21	Operating temperature range		– 30 ... +125					°C
22	Shaft bearings		ball bearings, preloaded					
23	Shaft load max.:							
	– radial at 3 000/20 000 rpm (7,4 mm from mounting flange)		108 / 73					N
	– axial at 3 000/20 000 rpm (push-on only)		50 / 30					N
	– axial at standstill (push-on only)		131					N
24	Shaft play:							
	– radial	≤	0,015					mm
	– axial	=	0					mm
25	Housing material		aluminium, black anodized					
26	Weight		310					g
27	Direction of rotation		electronically reversible					
Recommended values - mathematically independent of each other								
28	Speed up to [2]	$n_{e\ max.}$		27 000	27 000	27 000	27 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$		47,1	44,0	43,9	44,0	mNm
30	Current up to [1] [2]	$I_{e\ max.}$		3,68	2,50	1,71	1,36	A

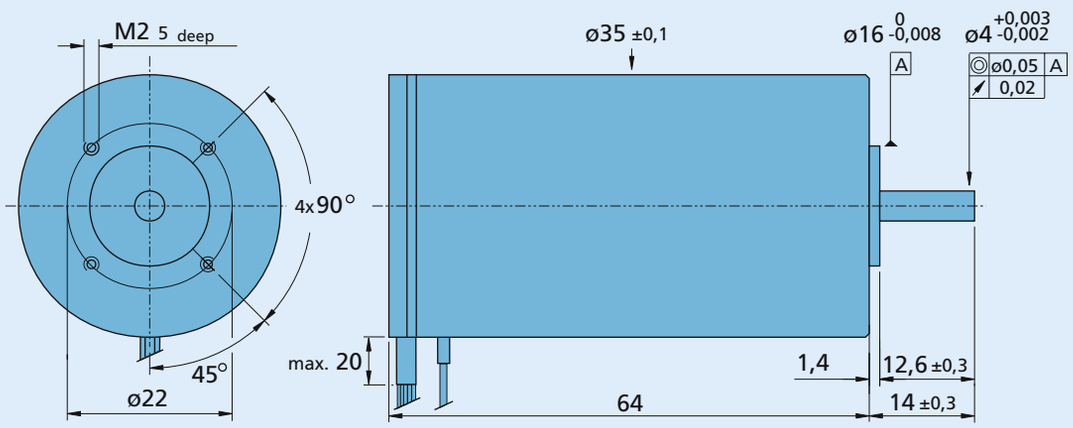
[1] at 22 000 rpm
[2] thermal resistance $R_{th\,2}$ by 55% reduced



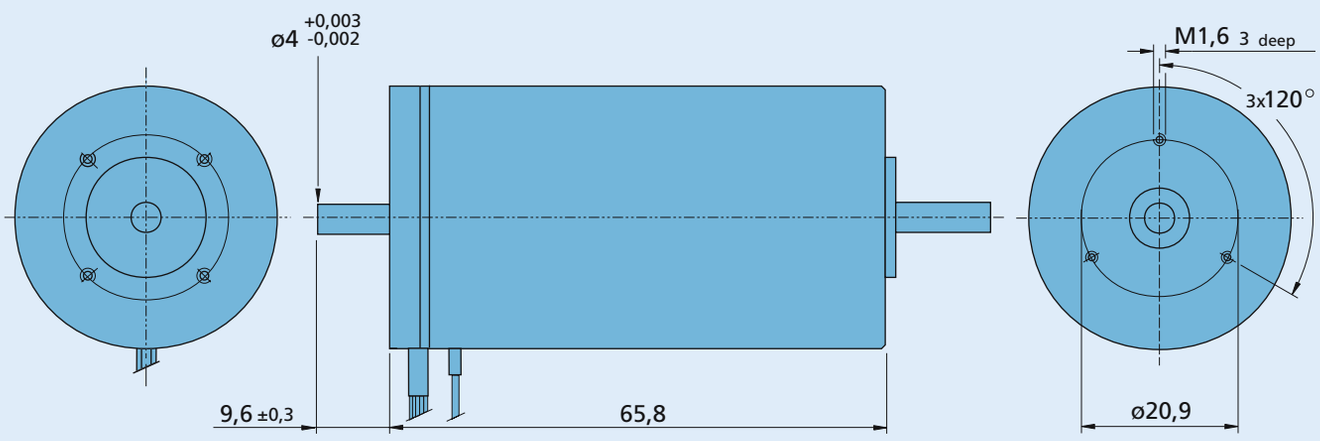
Recommended area for continuous operation

Options
K1000:
Motors in autoclavable version.
K1155:
Motors for operation with Motion Controllers MCBL 3003 S/C, MCBL 3006 S/C.

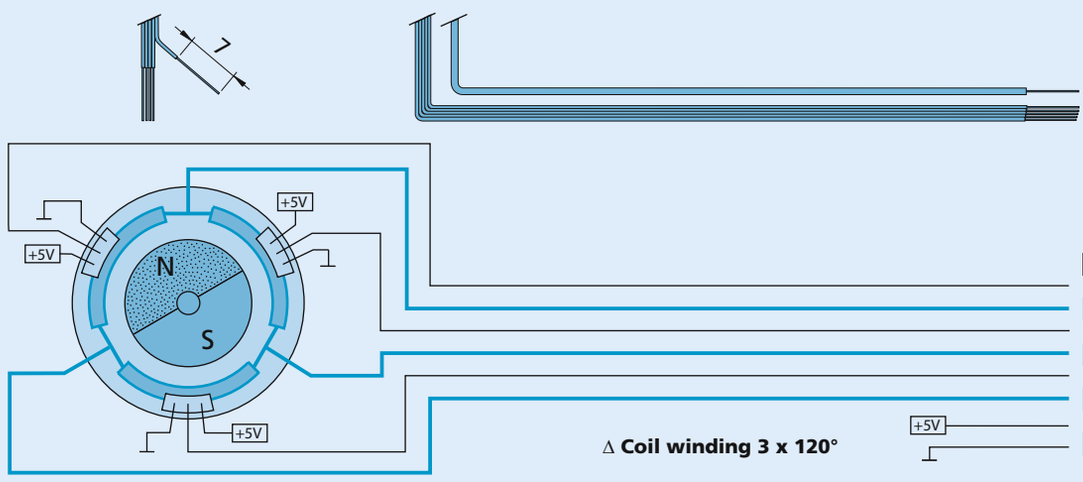
3564 K ... B



3564 K ... B - K312 with rear end shaft



Cable and connection information



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 20
5 conductors, AWG 26

Connection

	Function	Colour
A	Hall sensor	green
A	Phase	brown
B	Hall sensor	blue
B	Phase	orange
C	Hall sensor	grey
C	Phase	yellow
+5V	Logical supply	red
GND	Logical	black

Δ Coil winding 3 x 120°

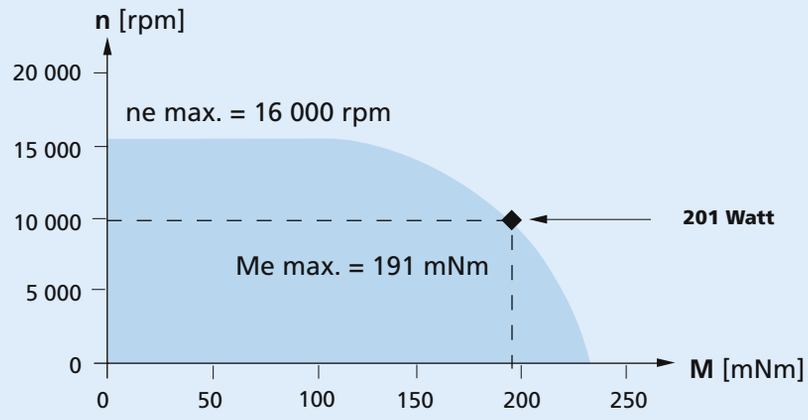
Brushless DC-Servomotors 191 mNm

For combination with
Gearheads:
38A, 44/1
Encoders:
IE3-1024, IE3-1024 L, 40B
Drive Electronics:
Speed Controller, Motion Controller

Series 4490 ... B

			4490 H		024 B	036 B	048 B	
1	Nominal voltage	U_N			24	36	48	Volt
2	Terminal resistance, phase-phase	R			0,237	0,445	0,720	Ω
3	Output power [1]	$P_{2\ max.}$			201	201	200	W
4	Efficiency	$\eta_{max.}$			86	86	86	%
5	No-load speed	n_o			9 550	10 450	11 000	rpm
6	No-load current (with shaft ø 6,0 mm)	I_o			0,554	0,432	0,354	A
7	Stall torque	M_H			2 406	2 637	2 758	mNm
8	Friction torque, static	C_o			3,65	3,65	3,65	mNm
9	Friction torque, dynamic	C_v			$1,0 \cdot 10^{-3}$	$1,0 \cdot 10^{-3}$	$1,0 \cdot 10^{-3}$	mNm/rpm
10	Speed constant	k_n			401	292	231	rpm/V
11	Back-EMF constant	k_E			2,495	3,422	4,335	mV/rpm
12	Torque constant	k_M			23,83	32,68	41,40	mNm/A
13	Current constant	k_I			0,042	0,031	0,024	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$			4,0	4,0	4,0	rpm/mNm
15	Terminal inductance, phase-phase	L			76	143	236	µH
16	Mechanical time constant	τ_m			5	5	5	ms
17	Rotor inertia	J			130	130	130	gcm^2
18	Angular acceleration	$\alpha_{max.}$			185	203	212	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	1,35 / 3,94					K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	29 / 1 756					s
21	Operating temperature range		– 30 ... +125					°C
22	Shaft bearings		ball bearings, preloaded					
23	Shaft load max.:							
	– radial at 3 000/10 000 rpm (13,5 mm from mounting flange)		103 / 66					N
	– axial at 3 000/10 000 rpm (push-on only)		45 / 30					N
	– axial at standstill (push-on only)		135					N
24	Shaft play:							
	– radial	≤	0,015					mm
	– axial	=	0					mm
25	Housing material		aluminium, black anodized					
26	Weight		750					g
27	Direction of rotation		electronically reversible					
	Coil connection		Δ Delta-circuit					
Recommended values - mathematically independent of each other								
28	Speed up to [2]	$n_{e\ max.}$			16 000	16 000	16 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$			191,8	191,9	191,1	mNm
30	Current up to [1] [2]	$I_{e\ max.}$			8,62	6,29	4,95	A

[1] at 10 000 rpm
[2] thermal resistance $R_{th\ 2}$ by 55% reduced

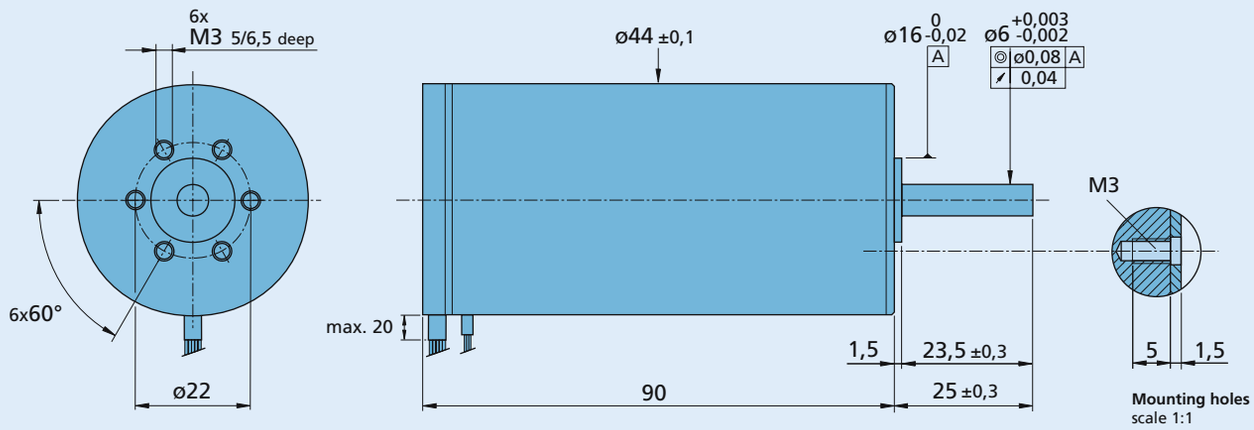


Recommended area for continuous operation

Options
K1155:
Motors with linear Hall sensors.

4490 H ... B

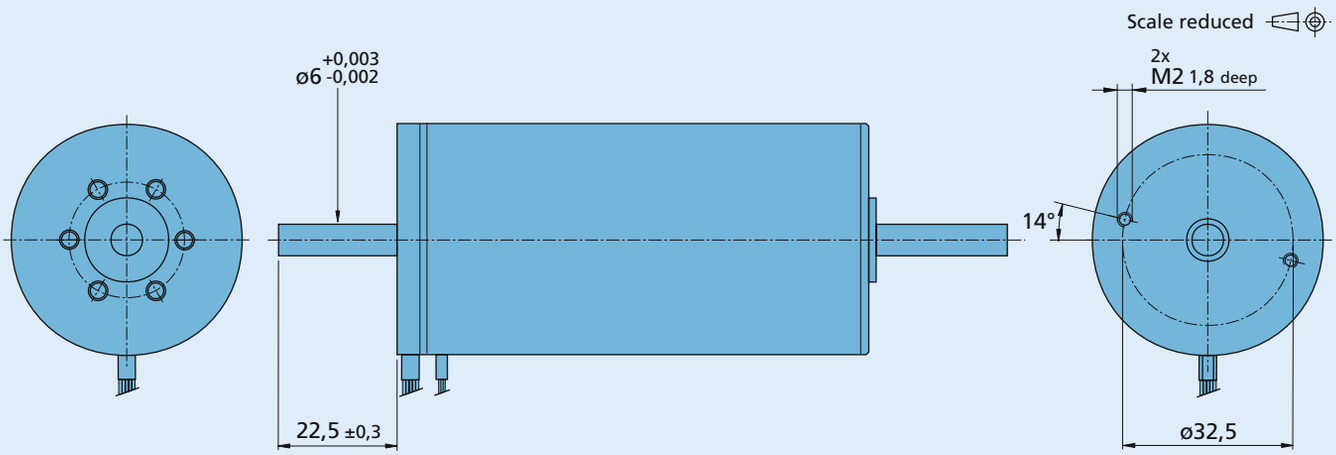
Scale reduced



4490 H ... B

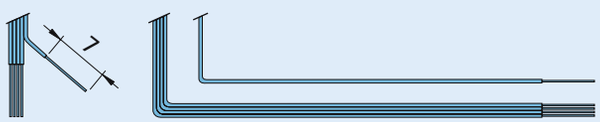
4490 H ... B - K312 with rear end shaft

Scale reduced

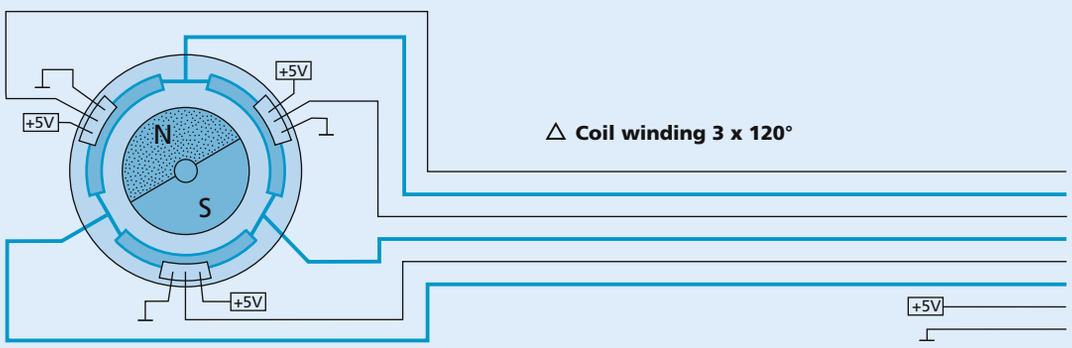


4490 H ... B - K312

Cable and connection information



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 16
5 conductors, AWG 26



△ **Coil winding 3 x 120°**

Connection

	Function	Colour
A	Hall sensor	green
A	Phase	brown
B	Hall sensor	blue
B	Phase	orange
C	Hall sensor	grey
C	Phase	yellow
+5V	Logical supply	red
GND	Logical	black

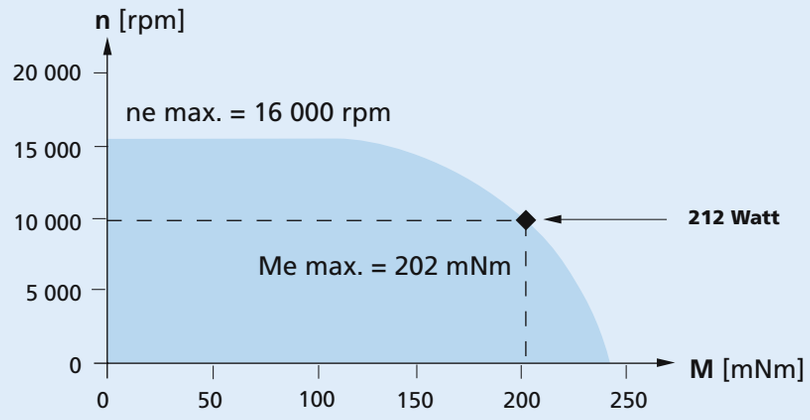
Brushless DC-Servomotors 202 mNm

For combination with
Gearheads:
38A, 44/1
Encoders:
IE3-1024, IE3-1024 L, 40B
Drive Electronics:
Speed Controller, Motion Controller

Series 4490 ... BS

		4490 H		024 BS	036 BS	048 BS	
1	Nominal voltage	U_N		24	36	48	Volt
2	Terminal resistance, phase-phase	R		0,690	1,340	2,130	Ω
3	Output power [1]	$P_{2\ max.}$		207	210	212	W
4	Efficiency	$\eta_{max.}$		85	85	86	%
5	No-load speed	n_o		5 450	5 790	6 060	rpm
6	No-load current (with shaft ø 6,0 mm)	I_o		0,217	0,160	0,129	A
7	Stall torque	M_H		1 455	1 584	1 689	mNm
8	Friction torque, static	C_o		3,65	3,65	3,65	mNm
9	Friction torque, dynamic	C_v		$1{,}0 \cdot 10^{-3}$	$1{,}0 \cdot 10^{-3}$	$1{,}0 \cdot 10^{-3}$	mNm/rpm
10	Speed constant	k_n		228	162	127	rpm/V
11	Back-EMF constant	k_E		4,384	6,185	7,871	mV/rpm
12	Torque constant	k_M		41,86	59,06	75,16	mNm/A
13	Current constant	k_I		0,024	0,017	0,013	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		3,8	3,7	3,6	rpm/mNm
15	Terminal inductance, phase-phase	L		220	435	720	µH
16	Mechanical time constant	τ_m		5	5	5	ms
17	Rotor inertia	J		130	130	130	gcm^2
18	Angular acceleration	$\alpha_{max.}$		112	122	130	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	1,35 / 3,94				K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	29 / 1 756				s
21	Operating temperature range		– 30 ... +125				°C
22	Shaft bearings		ball bearings, preloaded				
23	Shaft load max.:						
	– radial at 3 000/10 000 rpm (13,5 mm from mounting flange)		103 / 66				N
	– axial at 3 000/10 000 rpm (push-on only)		45 / 30				N
	– axial at standstill (push-on only)		135				N
24	Shaft play:						
	– radial	≤	0,015				mm
	– axial	=	0				mm
25	Housing material		aluminium, black anodized				
26	Weight		750				g
27	Direction of rotation		electronically reversible				
	Coil connection		Y Star-circuit				
Recommended values - mathematically independent of each other							
28	Speed up to [2]	$n_{e\ max.}$		16 000	16 000	16 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$		197,8	200,4	202,4	mNm
30	Current up to [1] [2]	$I_{e\ max.}$		5,05	3,63	2,88	A

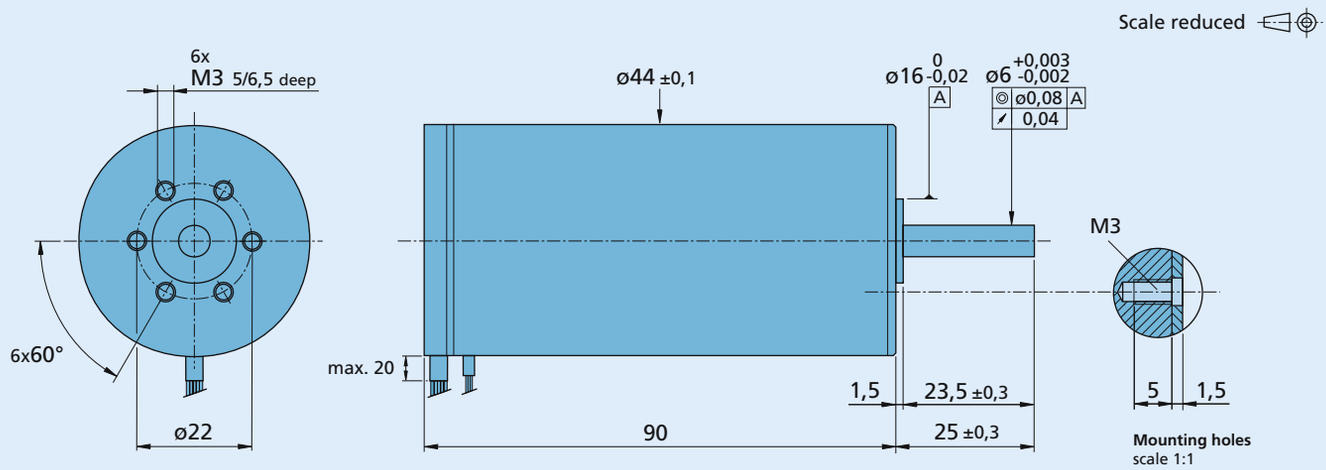
[1] at 10 000 rpm
[2] thermal resistance $R_{th\ 2}$ by 55% reduced



Recommended area for continuous operation

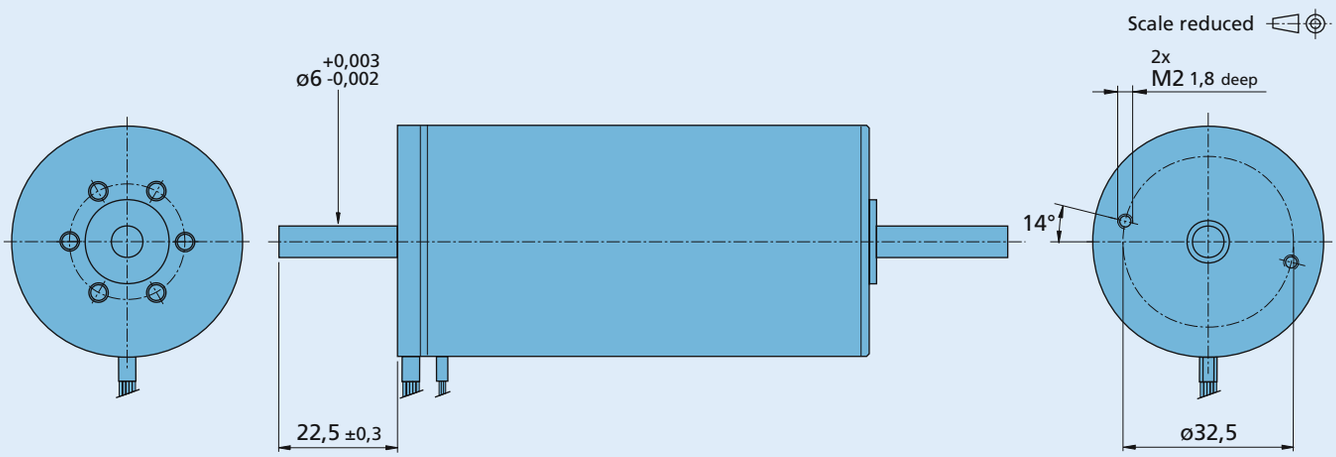
Options
K1155:
Motors with linear Hall sensors.

4490 H ... BS



4490 H ... BS

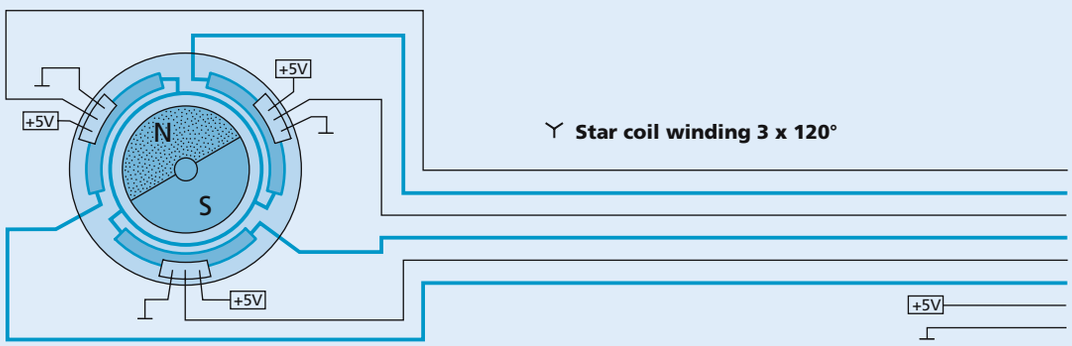
4490 H ... BS - K312 with rear end shaft



4490 H ... BS - K312

Cable and connection information

Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 16
5 conductors, AWG 26



Y Star coil winding 3 x 120°

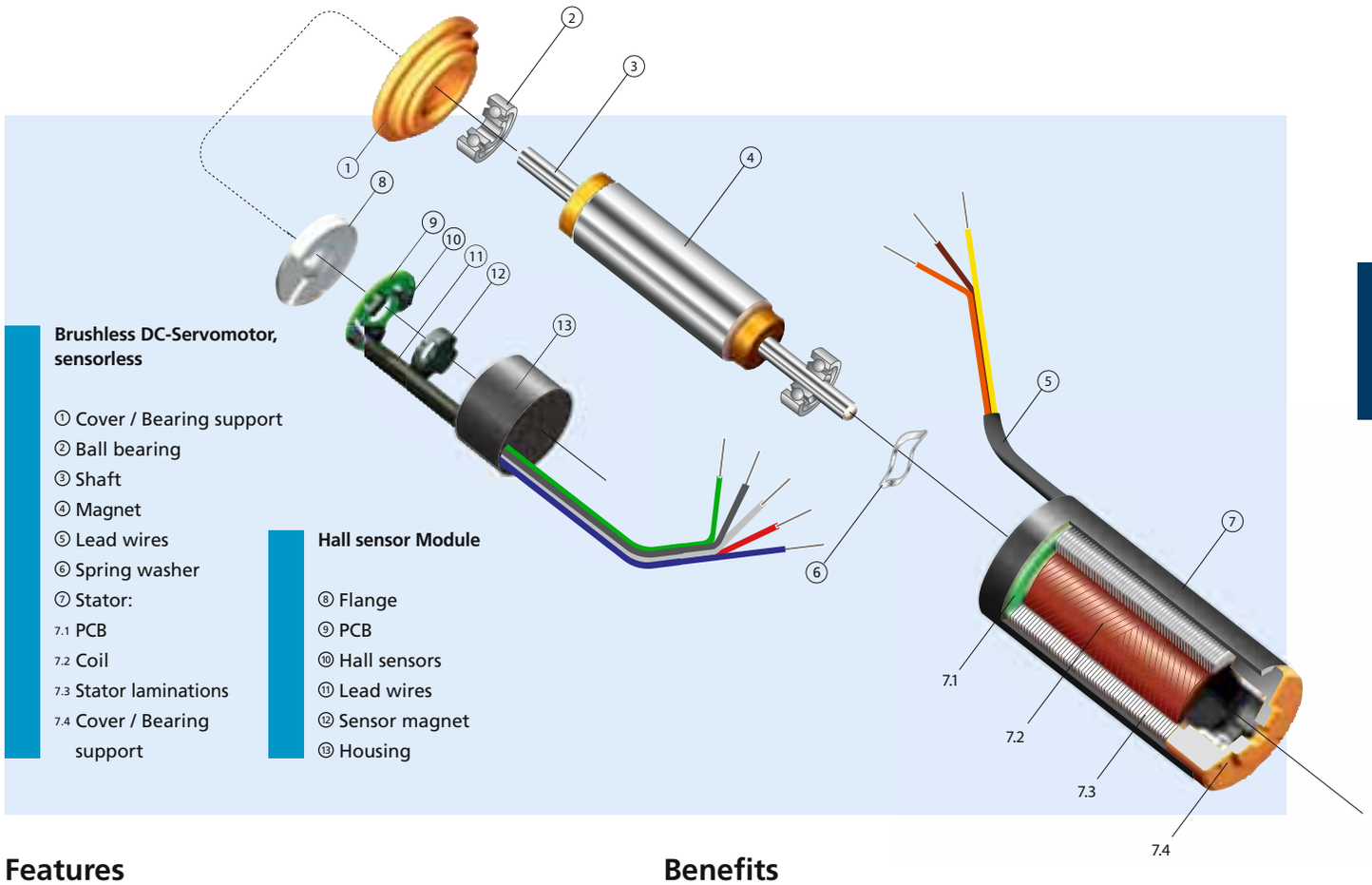
Connection

	Function	Colour
A	Hall sensor	green
A	Phase	brown
B	Hall sensor	blue
B	Phase	orange
C	Hall sensor	grey
C	Phase	yellow
+5V	Logical supply	red
GND	Logical	black

Notes

Brushless DC-Servomotors

Sensorless, SMARTSHELL® Technology



Brushless DC-Servomotor, sensorless

① Cover / Bearing support
② Ball bearing
③ Shaft
④ Magnet
⑤ Lead wires
⑥ Spring washer
⑦ Stator:
7.1 PCB
7.2 Coil
7.3 Stator laminations
7.4 Cover / Bearing support

Hall sensor Module

⑧ Flange
⑨ PCB
⑩ Hall sensors
⑪ Lead wires
⑫ Sensor magnet
⑬ Housing

Features

The skew-wound self-supporting coil, System FAULHABER®, the printed circuit board, the laminated stack and the front-end bearing cover are all encapsulated and meshed together with a mould-injected LCP (Liquid Crystal Polymer), exhibiting outstanding mechanical and thermal features.

The modular design concept of the SMARTSHELL® motors offers two Hall sensor modules for precise speed and position control. With these modules assembled to the rear end of the motors, the BDS (Brushless Digital Sensors) and BAS (Brushless Analog Sensors) options are available for use with the appropriate drive electronics.

Benefits

- System FAULHABER®, ironless stator coil
- High reliability and operational lifetime
- Wide range of linear torque / speed performance
- No sparking
- No cogging
- Dynamically balanced rotor
- Simple design
- Available with optional digital or analog hall sensors

Product Code

22	Motor diameter [mm]
32	Motor length [mm]
S	Shaft type
048	Nominal voltage [V]
B	Type of commutation (brushless)
SL	Version (sensorless)

2232 S 048 BSL

Brushless DC-Servomotors

sensorless, with optional Hall Sensors
SMARTSHELL® Technology

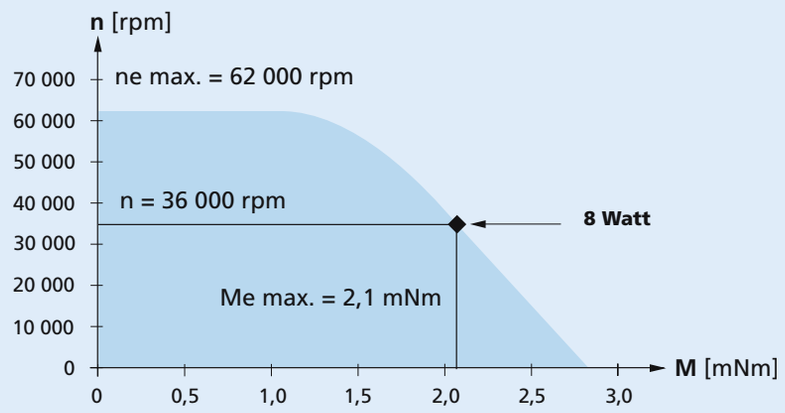
2,1 mNm

For combination with
Gearheads:
15/5, 15/5 S, 15/8, 16/7
Drive Electronics:
Speed Controller

Series 1524 ... BSL

		1524 U		006 BSL	009 BSL	012 BSL	
1	Nominal voltage	U_N		6	9	12	Volt
2	Terminal resistance, phase-phase	R		4,30	9,7	15,3	Ω
3	Output power [1]	$P_{2\ max.}$		8	8	8	W
4	Efficiency	$\eta_{max.}$		54	53	54	%
5	No-load speed	n_o		18 500	19 200	19 900	rpm
6	No-load current (with shaft ø 2,0 mm)	I_o		0,110	0,078	0,062	A
7	Stall torque	M_H		4	4	4	mNm
8	Friction torque, static	C_o		0,140	0,140	0,140	mNm
9	Friction torque, dynamic	C_v		$9{,}5 \cdot 10^{-6}$	$9{,}5 \cdot 10^{-6}$	$9{,}5 \cdot 10^{-6}$	mNm/rpm
10	Speed constant	k_n		3 339	2 318	1 805	rpm/V
11	Back-EMF constant	k_E		0,299	0,431	0,554	mV/rpm
12	Torque constant	k_M		2,86	4,12	5,29	mNm/A
13	Current constant	k_I		0,350	0,243	0,189	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		5 020	5 457	5 221	rpm/mNm
15	Terminal inductance, phase-phase	L		82	169	273	µH
16	Mechanical time constant	τ_m		15	16	16	ms
17	Rotor inertia	J		0,30	0,30	0,30	gcm^2
18	Angular acceleration	$\alpha_{max.}$		129	123	133	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	2,6 / 29,0				K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	1 / 326				s
21	Operating temperature range		– 30 ... +125				°C
22	Shaft bearings		ball bearings, preloaded				
23	Shaft load max.:						
	– radial at 3 000/20 000 rpm (4,5 mm from mounting flange)		5 / 4 for series 1524 U ... B ..				N
	– radial at 3 000/20 000 rpm (2,0 mm from mounting flange)		5,5 / 4,5 for series 1524 E ... B ..				N
	– axial at 3 000/20 000 rpm (push-on only)		4 / 3,5				N
	– axial at standstill (push-on only)		17				N
24	Shaft play:						
	– radial	≤	0,015				mm
	– axial	=	0				mm
25	Housing material		mounting face in aluminium, housing in plastic				
26	Weight		20				g
27	Direction of rotation		electronically reversible				
Recommended values - mathematically independent of each other							
28	Speed up to [2]	$n_{e\ max.}$		62 000	62 000	62 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$		2,1	2,0	2,1	mNm
30	Current up to [1] [2]	$I_{e\ max.}$		0,91	0,61	0,48	A

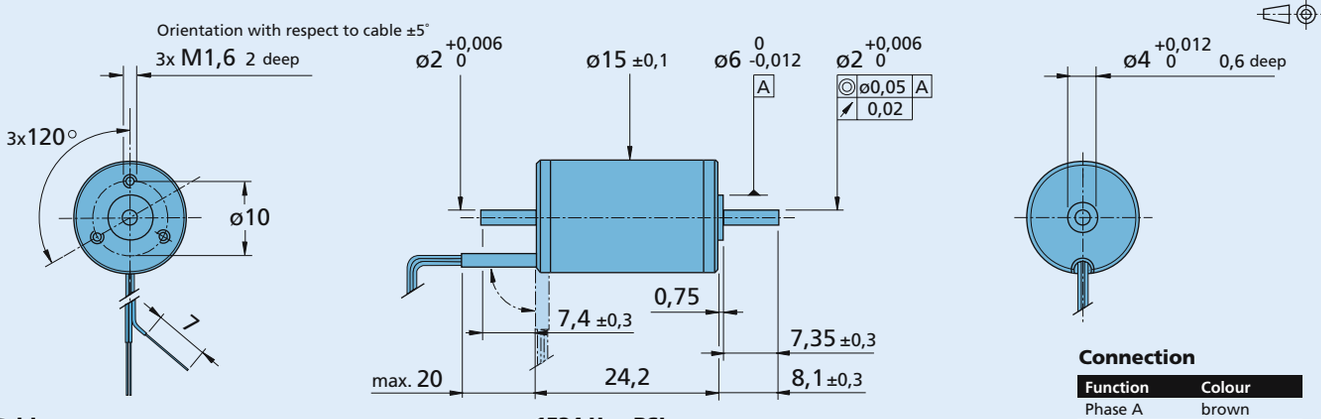
[1] at 36 000 rpm
[2] thermal resistance $R_{th\,2}$ by 55% reduced



Recommended area for continuous operation

Options
Motors with digital sensors:
1524 U ... BDS, 1524 E ... BDS
Motors with analog sensors:
1524 U ... BAS, 1524 E ... BAS

1524 U ... BSL sensorless



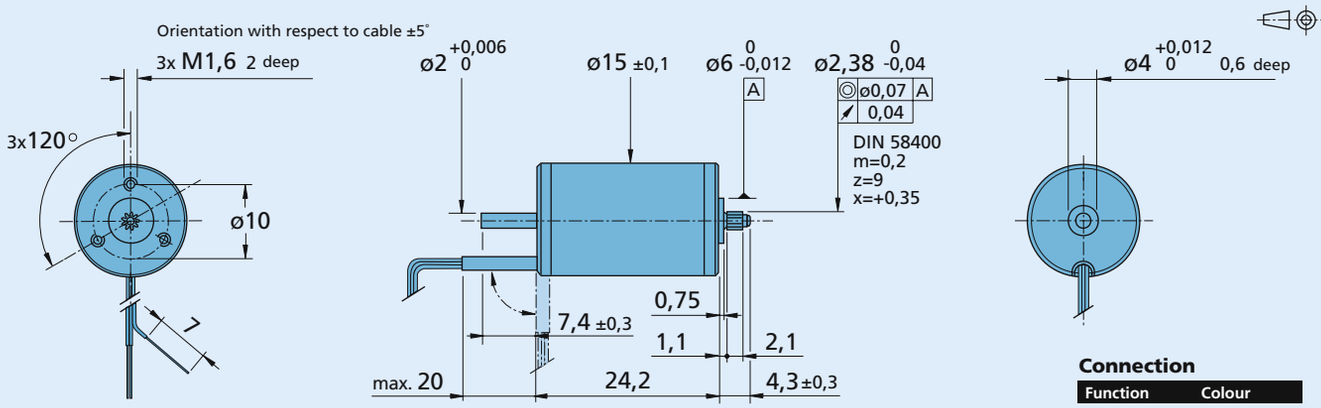
Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 26

1524 U ... BSL
for combination with:
Gearheads 16/7
Drive Electronics Speed Controller

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow

1524 E ... BSL sensorless



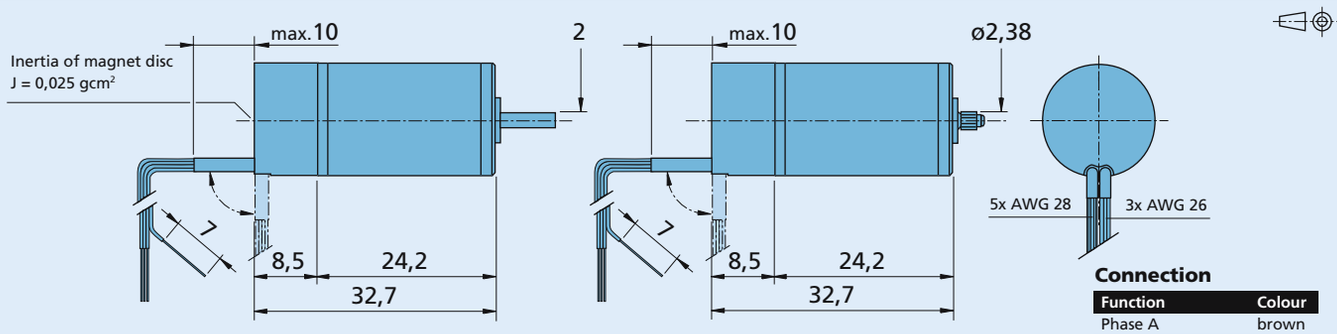
Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 26

1524 E ... BSL
for combination with:
Getriebe 15/5, 15/5 S, 15/8
Drive Electronics Speed Controller

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow

1524 U ... BAS, 1524 U ... BDS, 1524 E ... BAS, 1524 E ... BDS with Hall sensors



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 26
5 conductors, AWG 28

1524 U ... BDS
for combination with:
Drive Electronics Speed Controller

1524 U ... BAS
for combination with:
Drive Electronics Motion Controllers

1524 E ... BDS
for combination with:
Drive Electronics Speed Controller

1524 E ... BAS
for combination with:
Drive Electronics Motion Controllers

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow
Hall sensor A	green
Hall sensor B	blue
Hall sensor C	grey
+5V - Logical supply	red
GND - Logical	black

Brushless DC-Servomotors

sensorless, with optional Hall Sensors
SMARTSHELL® Technology

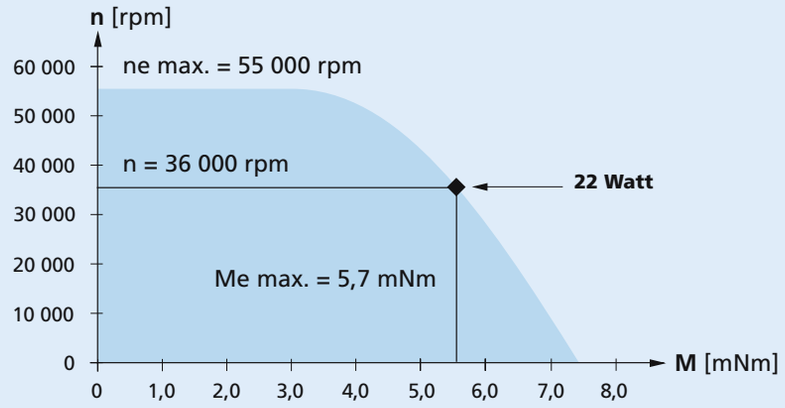
5,7 mNm

For combination with
Gearheads:
15/5, 15/5 S, 15/8, 16/7
Drive Electronics:
Speed Controller

Series 1536 ... BSL

		1536 U		009 BSL	012 BSL	024 BSL	
1	Nominal voltage	U_N		9	12	24	Volt
2	Terminal resistance, phase-phase	R		3,28	5,48	21,42	Ω
3	Output power [1]	$P_{2\ max.}$		22	21	21	W
4	Efficiency	$\eta_{max.}$		69	69	69	%
5	No-load speed	n_o		15 100	15 900	16 200	rpm
6	No-load current (with shaft ø 2,0 mm)	I_o		0,086	0,069	0,036	A
7	Stall torque	M_H		15	15	15	mNm
8	Friction torque, static	C_o		0,230	0,230	0,230	mNm
9	Friction torque, dynamic	C_v		$1{,}61 \cdot 10^{-5}$	$1{,}61 \cdot 10^{-5}$	$1{,}61 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		1 739	1 364	698	rpm/V
11	Back-EMF constant	k_E		0,575	0,733	1,433	mV/rpm
12	Torque constant	k_M		5,49	7,00	13,68	mNm/A
13	Current constant	k_I		0,182	0,143	0,073	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		1 039	1 068	1 093	rpm/mNm
15	Terminal inductance, phase-phase	L		102	170	654	µH
16	Mechanical time constant	τ_m		6	6	6	ms
17	Rotor inertia	J		0,55	0,55	0,55	gcm^2
18	Angular acceleration	$\alpha_{max.}$		269	275	274	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	1,9 / 20,9				K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	2 / 430				s
21	Operating temperature range		– 30 ... +125				°C
22	Shaft bearings		ball bearings, preloaded				
23	Shaft load max.:						
	– radial at 3 000/20 000 rpm (4,5 mm from mounting flange)		5,5 / 4,5 for series 1536 U ... B ..				N
	– radial at 3 000/20 000 rpm (2,0 mm from mounting flange)		6 / 5 for series 1536 E ... B ..				N
	– axial at 3 000/20 000 rpm (push-on only)		4 / 3,5				N
	– axial at standstill (push-on only)		17				N
24	Shaft play:						
	– radial	≤	0,015				mm
	– axial	=	0				mm
25	Housing material		mounting face in aluminium, housing in plastic				
26	Weight		33				g
27	Direction of rotation		electronically reversible				
Recommended values - mathematically independent of each other							
28	Speed up to [2]	$n_{e\ max.}$		55 000	55 000	55 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$		5,7	5,6	5,6	mNm
30	Current up to [1] [2]	$I_{e\ max.}$		1,19	0,92	0,47	A

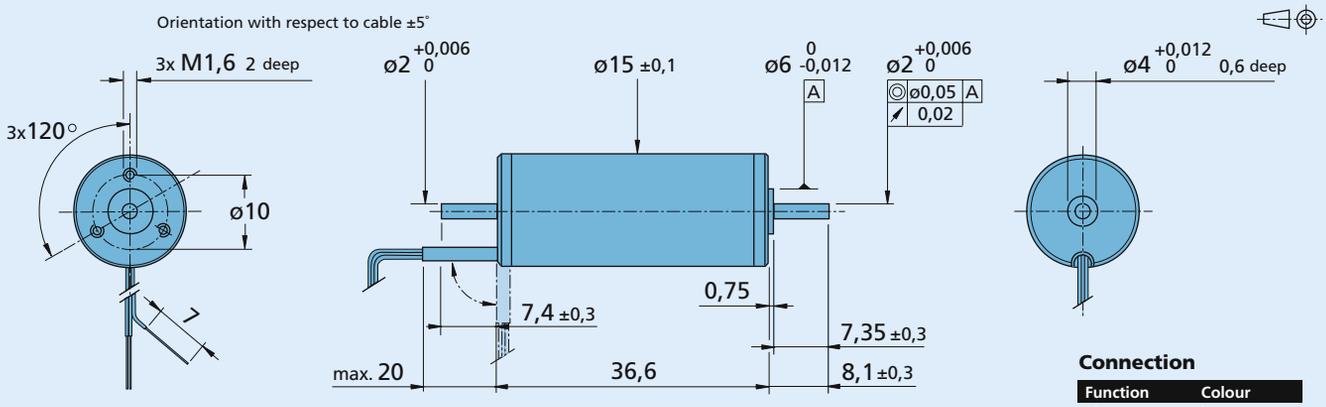
[1] at 36 000 rpm
[2] thermal resistance $R_{th\,2}$ by 55% reduced



Recommended area for continuous operation

Options
Motors with digital sensors:
1536 U ... BDS, 1536 E ... BDS
Motors with analog sensors:
1536 U ... BAS, 1536 E ... BAS

1536 U ... BSL sensorless



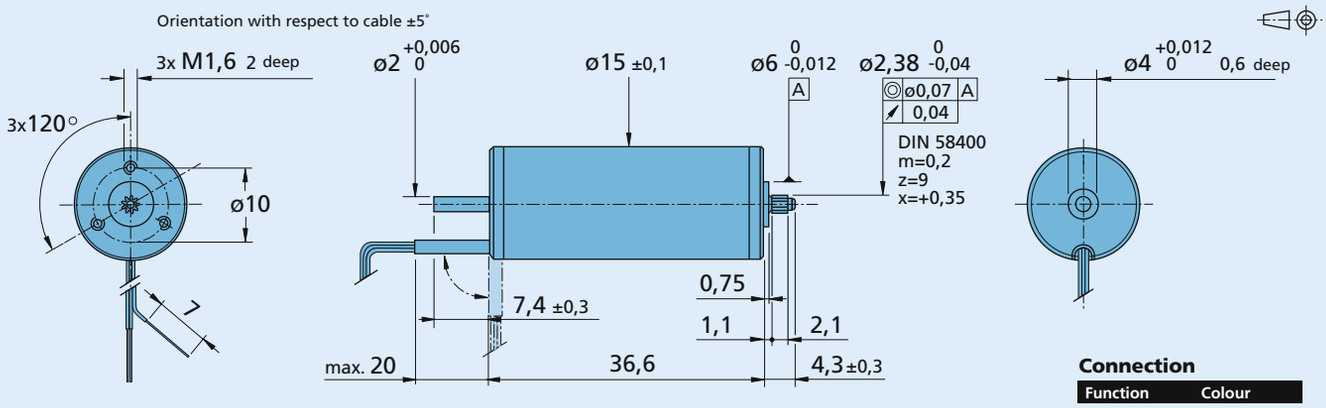
Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 26

1536 U ... BSL
for combination with:
Gearheads 16/7
Drive Electronics Speed Controller

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow

1536 E ... BSL sensorless



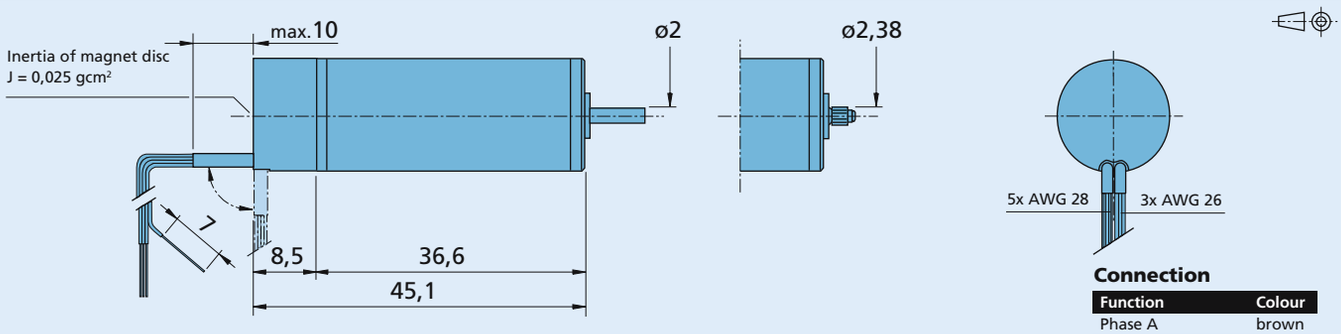
Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 26

1536 E ... BSL
for combination with:
Getriebe 15/5, 15/5 S, 15/8
Drive Electronics Speed Controller

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow

1536 U ... BAS, 1536 U ... BDS, 1536 E ... BAS, 1536 E ... BDS with Hall sensors



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 26
5 conductors, AWG 28

1536 U ... BDS
for combination with:
Drive Electronics Speed Controller

1536 U ... BAS
for combination with:
Drive Electronics Motion Controllers

1536 E ... BDS
for combination with:
Drive Electronics Speed Controller

1536 E ... BAS
for combination with:
Drive Electronics Motion Controllers

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow
Hall sensor A	green
Hall sensor B	blue
Hall sensor C	grey
+5V - Logical supply	red
GND - Logical	black

Brushless DC-Servomotors

6,5 mNm

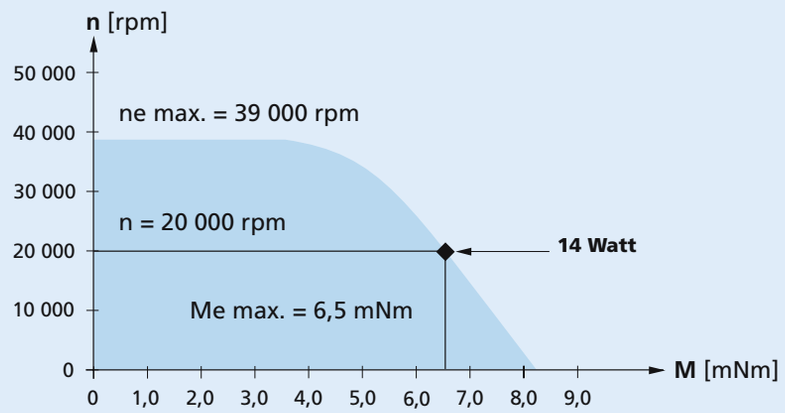
sensorless, with optional Hall Sensors
SMARTSHELL® Technology

For combination with
Gearheads:
20/1, 22/2, 22/5, 22/7, 23/1, 26/1, 26/1 S, 30/1, 30/1 S, 38/3
Drive Electronics:
Speed Controller

Series 2232 ... BSL

		2232 S		006 BSL	012 BSL	024 BSL	048 BSL	
1	Nominal voltage	U_N		6	12	24	48	Volt
2	Terminal resistance, phase-phase	R		1,11	4,33	14,46	41,20	Ω
3	Output power [1]	$P_{2\ max.}$		13	14	14	13	W
4	Efficiency	$\eta_{max.}$		61	61	62	62	%
5	No-load speed	n_o		15 600	15 600	17 100	20 950	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,294	0,146	0,085	0,060	A
7	Stall torque	M_H		18	19	21	24	mNm
8	Friction torque, static	C_o		0,389	0,389	0,389	0,389	mNm
9	Friction torque, dynamic	C_v		$4{,}05 \cdot 10^{-5}$	$4{,}05 \cdot 10^{-5}$	$4{,}05 \cdot 10^{-5}$	$4{,}05 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		2 752	1 370	751	460	rpm/V
11	Back-EMF constant	k_E		0,363	0,730	1,331	2,175	mV/rpm
12	Torque constant	k_M		3,47	6,97	12,71	20,77	mNm/A
13	Current constant	k_I		0,288	0,143	0,079	0,048	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		880	851	855	912	rpm/mNm
15	Terminal inductance, phase-phase	L		38	153	509	1 337	µH
16	Mechanical time constant	τ_m		17	17	17	18	ms
17	Rotor inertia	J		1,92	1,92	1,92	1,92	gcm^2
18	Angular acceleration	$\alpha_{max.}$		96	99	108	124	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	3,56 / 17,2					K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	3 / 645					s
21	Operating temperature range		– 30 ... +125					°C
22	Shaft bearings		ball bearings, preloaded					
23	Shaft load max.:							
	– radial at 3 000/20 000 rpm (6 mm from mounting flange)		28 / 24 for series 2232 S ... B ..					N
	– radial at 3 000/20 000 rpm (4,5 mm from mounting flange)		29 / 25 for series 2232 U ... B ..					N
	– axial at 3 000/20 000 rpm (push-on only)		21 / 16					N
	– axial at standstill (push-on only)		45					N
24	Shaft play:							
	– radial	≤	0,015					mm
	– axial	=	0					mm
25	Housing material		mounting face in aluminium, housing in plastic					
26	Weight		60					g
27	Direction of rotation		electronically reversible					
Recommended values - mathematically independent of each other								
28	Speed up to [2]	$n_{e\ max.}$		39 000	39 000	39 000	39 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$		6,3	6,5	6,5	6,2	mNm
30	Current up to [1] [2]	$I_{e\ max.}$		2,17	1,10	0,60	0,36	A

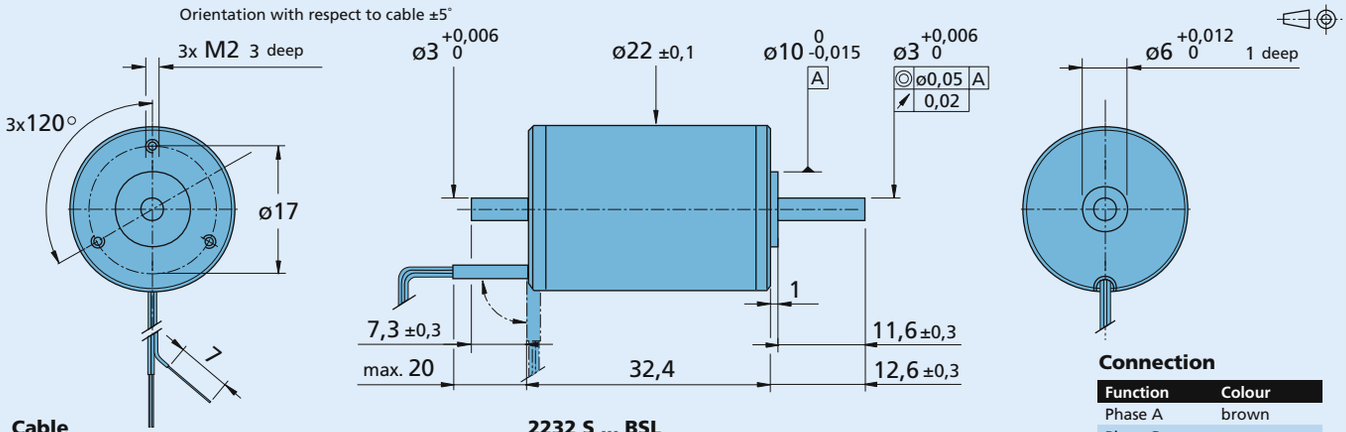
[1] at 20 000 rpm
[2] thermal resistance $R_{th\,2}$ by 55% reduced



Recommended area for continuous operation

Options
Motors with digital sensors:
2232 S ... BDS, 2232 U ... BDS
Motors with analog sensors:
2232 S ... BAS, 2232 U ... BAS

2232 S ... BSL sensorless



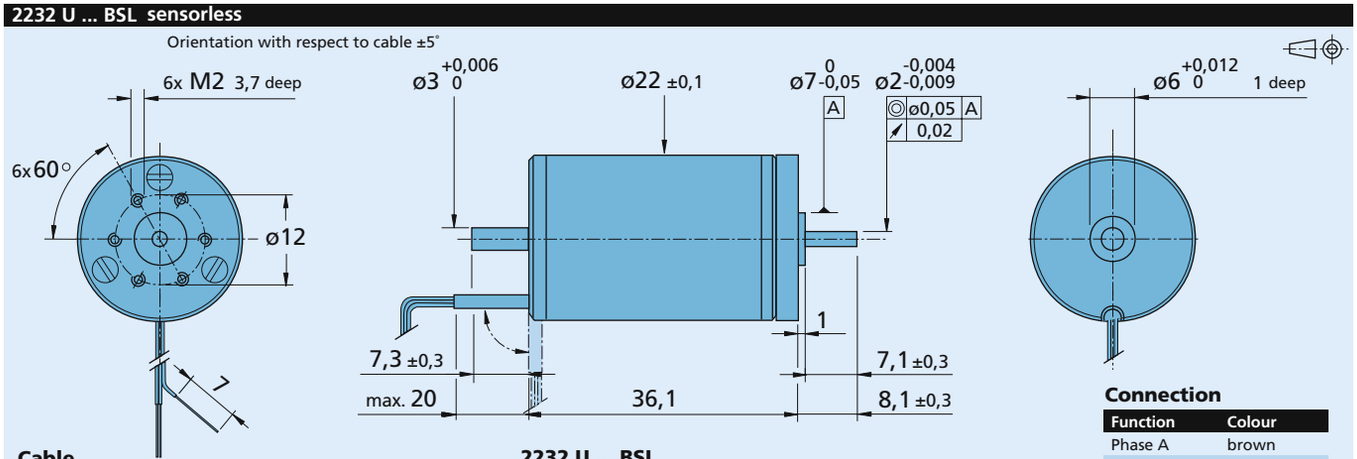
Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 24

2232 S ... BSL
for combination with:
Gearheads 22/7, 23/1, 26/1, 26/1 S, 30/1, 30/1 S, 38/3
Drive Electronics Speed Controller

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow

2232 U ... BSL sensorless



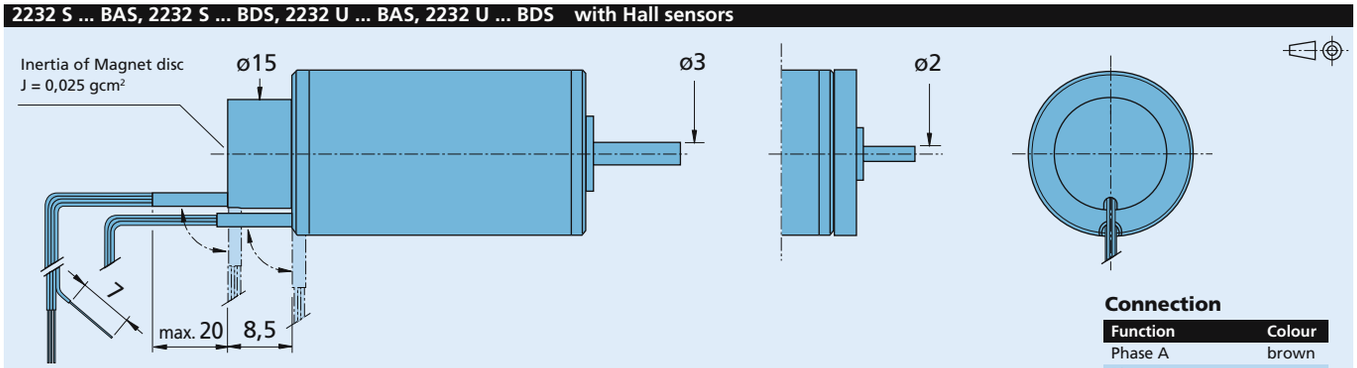
Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 24

2232 U ... BSL
for combination with:
Gearheads 20/1, 22/2, 22/5
Drive Electronics Speed Controller

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow

2232 S ... BAS, 2232 S ... BDS, 2232 U ... BAS, 2232 U ... BDS with Hall sensors



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 24
5 conductors, AWG 26

2232 S ... BDS
for combination with:
Drive Electronics Speed Controller

2232 S ... BAS
for combination with:
Drive Electronics Motion Controllers

2232 U ... BDS
for combination with:
Drive Electronics Speed Controller

2232 U ... BAS
for combination with:
Drive Electronics Motion Controllers

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow
Hall sensor A	green
Hall sensor B	blue
Hall sensor C	grey
+5V - Logical supply	red
GND - Logical	black

Brushless DC-Servomotors

15,5 mNm

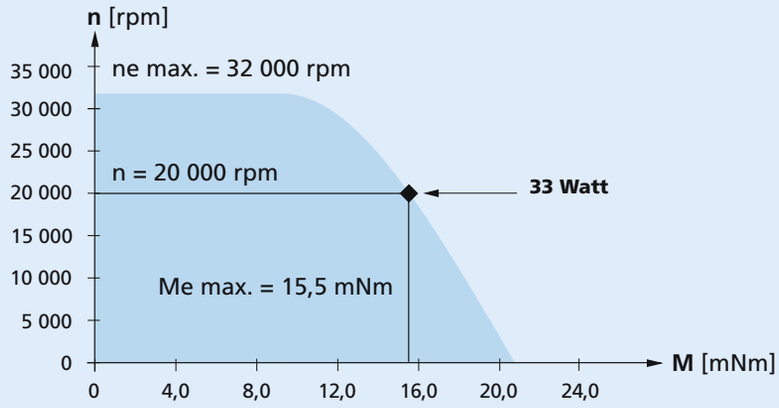
sensorless, with optional Hall Sensors
SMARTSHELL® Technology

For combination with
Gearheads:
20/1, 22/2, 22/5, 22/7, 23/1, 26/1, 26/1 S, 30/1, 30/1 S, 38/3
Drive Electronics:
Speed Controller

Series 2248 ... BSL

		2248 S		012 BSL	024 BSL	048 BSL	
1	Nominal voltage	U_N		12	24	48	Volt
2	Terminal resistance, phase-phase	R		1,15	4,20	17,00	Ω
3	Output power [1]	$P_{2\ max.}$		32	33	31	W
4	Efficiency	$\eta_{max.}$		74	75	74	%
5	No-load speed	n_o		13 700	14 100	14 600	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,217	0,114	0,060	A
7	Stall torque	M_H		85	90	86	mNm
8	Friction torque, static	C_o		0,640	0,640	0,640	mNm
9	Friction torque, dynamic	C_v		$8{,}31 \cdot 10^{-5}$	$8{,}31 \cdot 10^{-5}$	$8{,}31 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		1 167	599	311	rpm/V
11	Back-EMF constant	k_E		0,857	1,668	3,215	mV/rpm
12	Torque constant	k_M		8,18	15,93	30,70	mNm/A
13	Current constant	k_I		0,122	0,063	0,033	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		164	158	172	rpm/mNm
15	Terminal inductance, phase-phase	L		71	276	1 048	µH
16	Mechanical time constant	τ_m		6	5	6	ms
17	Rotor inertia	J		3,36	3,36	3,36	gcm^2
18	Angular acceleration	$\alpha_{max.}$		252	269	256	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	4,5 / 12,6				K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	7 / 710				s
21	Operating temperature range		– 30 ... +125				°C
22	Shaft bearings		ball bearings, preloaded				
23	Shaft load max.:						
	– radial at 3 000/20 000 rpm (6 mm from mounting flange)		31 / 23 for series 2248 S ... B ..				N
	– radial at 3 000/20 000 rpm (4,5 mm from mounting flange)		32 / 24 for series 2248 U ... B ..				N
	– axial at 3 000/20 000 rpm (push-on only)		18 / 13				N
	– axial at standstill (push-on only)		45				N
24	Shaft play:						
	– radial	≤	0,015				mm
	– axial	=	0				mm
25	Housing material		mounting face in aluminium, housing in plastic				
26	Weight		95				g
27	Direction of rotation		electronically reversible				
Recommended values - mathematically independent of each other							
28	Speed up to [2]	$n_{e\ max.}$		32 000	32 000	32 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$		15,2	15,5	14,8	mNm
30	Current up to [1] [2]	$I_{e\ max.}$		2,14	1,12	0,56	A

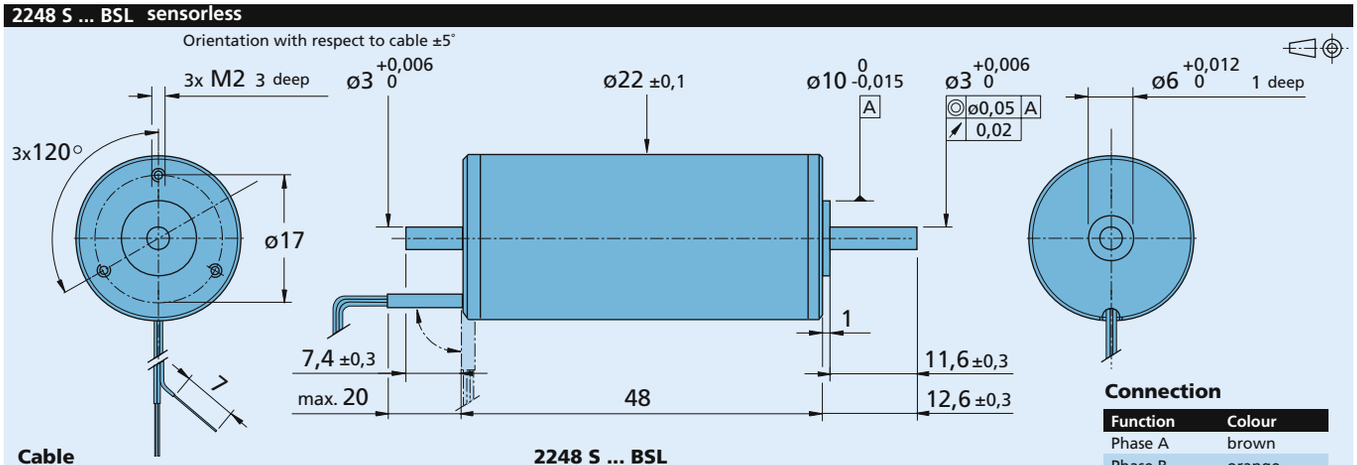
[1] at 20 000 rpm
[2] thermal resistance $R_{th\,2}$ by 55% reduced



Recommended area for continuous operation

Options
Motors with digital sensors:
2248 S ... BDS, 2248 U ... BDS
Motors with analog sensors:
2248 S ... BAS, 2248 U ... BAS

2248 S ... BSL sensorless



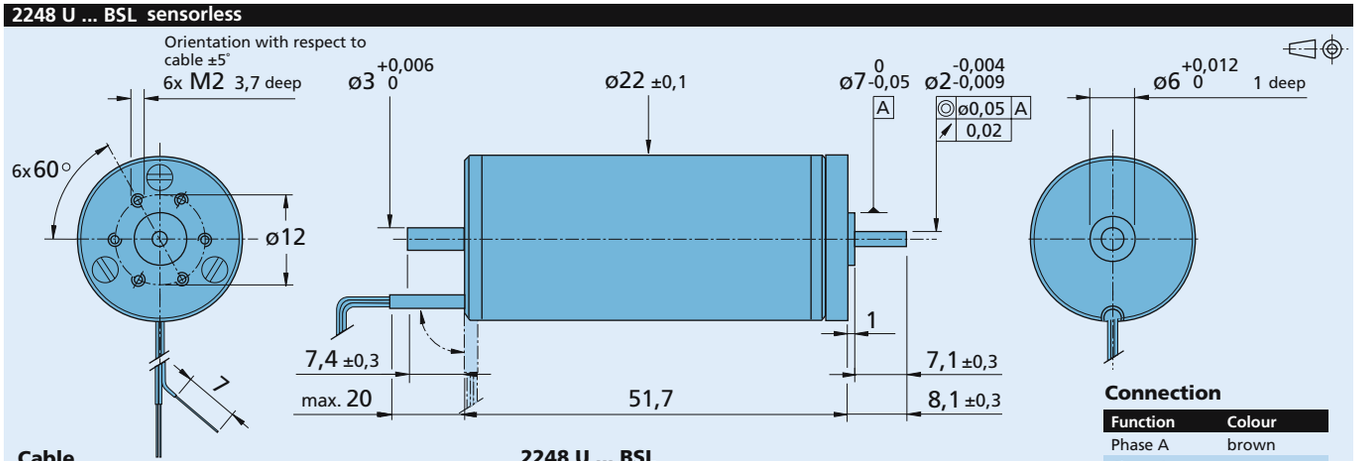
Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 24

2248 S ... BSL
for combination with:
Gearheads 22/7, 23/1, 26/1, 26/1 S, 30/1, 30/1 S, 38/3
Drive Electronics Speed Controller

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow

2248 U ... BSL sensorless



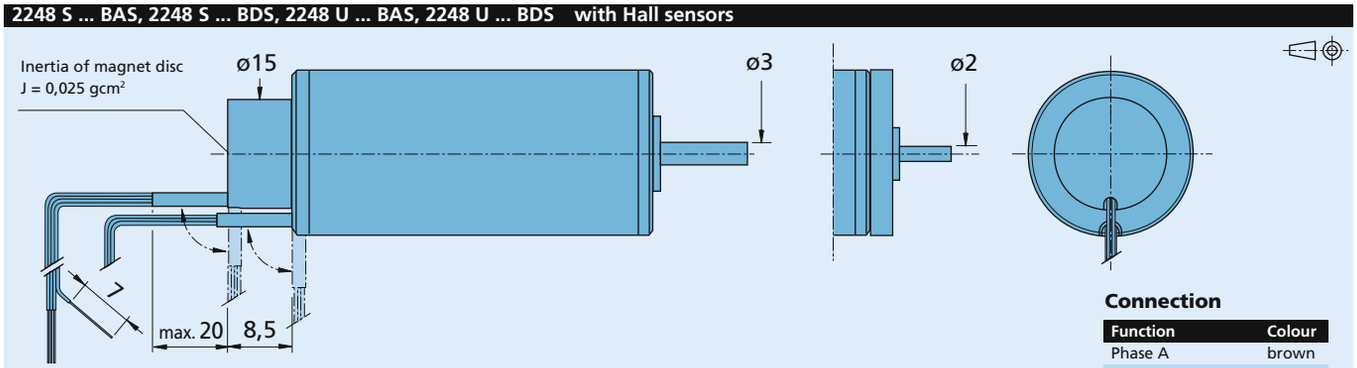
Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 24

2248 U ... BSL
for combination with:
Gearheads 20/1, 22/2, 22/5
Drive Electronics Speed Controller

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow

2248 S ... BAS, 2248 S ... BDS, 2248 U ... BAS, 2248 U ... BDS with Hall sensors



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 24
5 conductors, AWG 26

2248 S ... BDS
for combination with:
Drive Electronics Speed Controller

2248 S ... BAS
for combination with:
Drive Electronics Motion Controllers

2248 U ... BDS
for combination with:
Drive Electronics Speed Controller

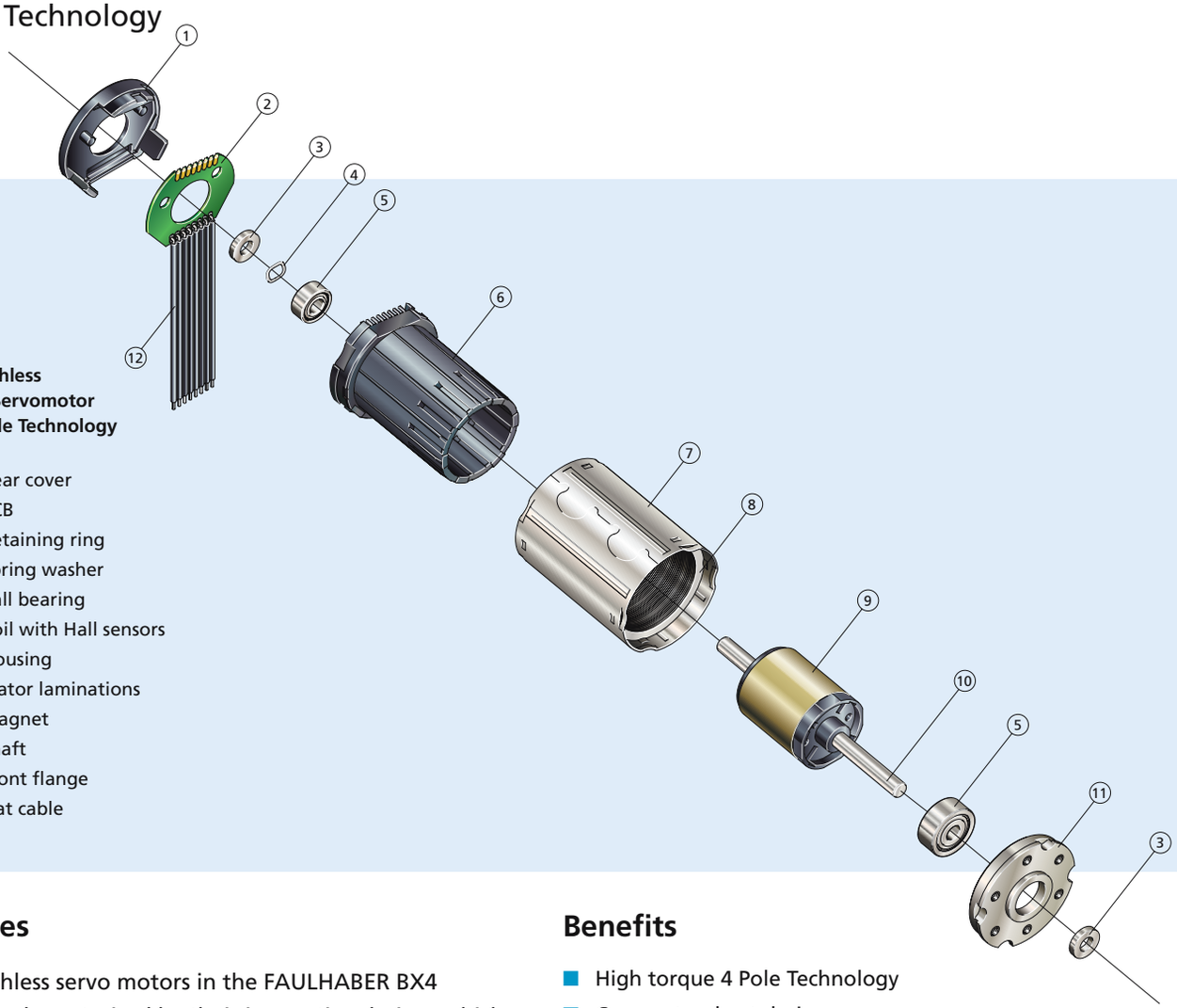
2248 U ... BAS
for combination with:
Drive Electronics Motion Controllers

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow
Hall sensor A	green
Hall sensor B	blue
Hall sensor C	grey
+5V - Logical supply	red
GND - Logical	black

Brushless DC-Servomotors

4 Pole Technology



Brushless DC-Servomotor 4 Pole Technology

① Rear cover
② PCB
③ Retaining ring
④ Spring washer
⑤ Ball bearing
⑥ Coil with Hall sensors
⑦ Housing
⑧ Stator laminations
⑨ Magnet
⑩ Shaft
⑪ Front flange
⑫ Flat cable

Features

The brushless servo motors in the FAULHABER BX4 series are characterised by their innovative design, which comprises just a few individual components.

Despite their compact dimensions, the 4 pole magnet technology gives these drives a high continuous torque with smooth running characteristics and a particularly low noise level. The modular rotor system makes it possible to tune the performance of the motor to the higher torque or higher speed needs of the application.

Thanks to the electronic commutation of the drives, the lifetime is much longer in comparison with mechanically commutated motors. Alongside the basic version in which the commutation is provided by an external control, the highly flexible BX4 series also includes advanced specifications with integrated speed controller or integrated encoder.

The motors come standard with digital Hall sensors.

Benefits

- High torque 4 Pole Technology
- Compact, robust design
- Modular concept
- Available with integrated encoders and speed controllers
- High reliability and operational lifetime
- No sparking
- No cogging
- Dynamically balanced rotor
- Simple design

Product Code

22	Motor diameter [mm]
32	Motor length [mm]
S	Shaft type
012	Nominal voltage [V]
BX4	Type of commutation (brushless), 4 Pole Technology

2232 S 012 BX4

Brushless DC-Servomotors

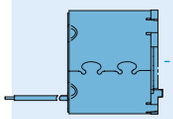
4 Pole Technology
overview of combinations

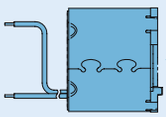
Series 22 ... BX4

Controller	Encoders	Motors	Gearheads

SC
Speed Controller
Ø 22 mm, integrated
400 – 50.000 rpm
Page 192 – 203

CSD/CCD
Motion Controller
Ø 22 mm, integrated
RS232 / CAN
Page 226 – 229

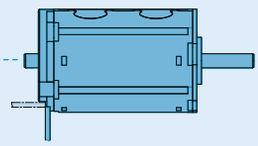




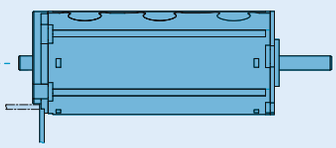
IE3(L)
Magnetic Encoder
3 Channel, Ø 22 mm
1024 Lines
Page 136 – 158

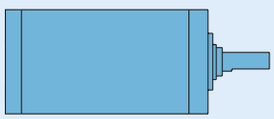
AES
Absolute Encoder
Ø 22 mm, 4096 Lines
Page 136 – 158

Series 2232 ... BX4



Series 2250 ... BX4





Series 22F, 22/7
Planetary Gearheads
Ø 22 mm
0,7 – 1,0 Nm
Page 318, 321

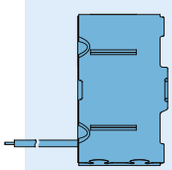
Series 26A
Planetary Gearheads
Ø 26 mm
1,0 Nm
Page 323

Series 32 ... BX4

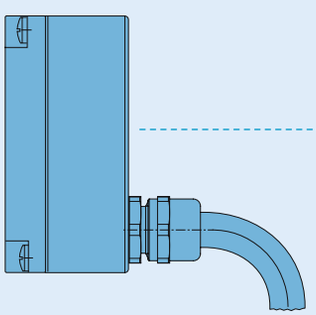
Controller	Encoders	Motors	Gearheads

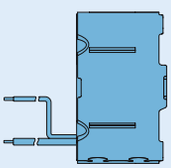
SC
Speed Controller
Ø 32 mm, integrated
400 – 50.000 rpm
Page 204, 210

SCDC
Speed Controller
Ø 32 mm, 2-wire
400 – 50.000 rpm
Page 207, 213



CS/CC
Motion Controller
integrated
RS232 / CAN
Page 230 – 233

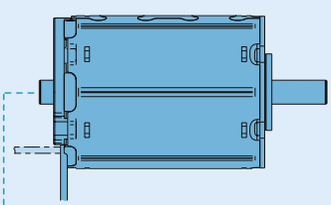




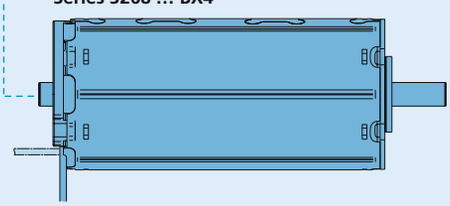
IE3(L)
Magnetic Encoder
3 Channel, Ø 32 mm
1024 Lines
Page 160 – 170

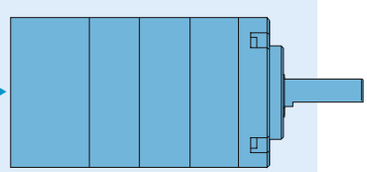
AES
Absolute Encoder
Ø 32 mm
4096 Lines
Page 160 – 170

Series 3242 ... BX4



Series 3268 ... BX4





Series 30/1(S)
Planetary Gearheads
Ø 30 mm
4,5 Nm
Page 326 – 327

Series 32A, 32/3(S)
Planetary Gearheads
Ø 32 mm
4,5 - 7 Nm
Page 328, 329 – 330

Series 38/1(S), 38/2(S)
Planetary Gearheads
Ø 38 mm
10 Nm
Page 332 – 335

Brushless DC-Servomotors 10 mNm

4 Pole Technology

For combination with
Gearheads:
22F, 22/7, 26A
Encoders:
2232...BX4S + Encoder
Drive Electronics:
Speed Controller

Series 2232 ... BX4 S

		2232 S		012 BX4 S	024 BX4 S	
1	Nominal voltage	U_N		12	24	Volt
2	Terminal resistance, phase-phase	R		3,5	12,4	Ω
3	Output power [1]	$P_{2\ max.}$		3,8	3,9	W
4	Efficiency	$\eta_{max.}$		60,9	61,7	%
5	No-load speed	n_o		13 200	14 000	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,163	0,088	A
7	Stall torque	M_H		27,3	29,4	mNm
8	Friction torque, static	C_o		0,6	0,6	mNm
9	Friction torque, dynamic	C_v		$5,5 \cdot 10^{-5}$	$5,5 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		1 173	616	rpm/V
11	Back-EMF constant	k_E		0,852	1,623	mV/rpm
12	Torque constant	k_M		8,14	15,50	mNm/A
13	Current constant	k_I		0,123	0,065	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		504	493	rpm/mNm
15	Terminal inductance, phase-phase	L		130	470	µH
16	Mechanical time constant	τ_{m}		22	22	ms
17	Rotor inertia	J		4,2	4,2	gcm^2
18	Angular acceleration	$\alpha_{max.}$		65	70	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	2 / 17			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,1 / 360			s
21	Operating temperature range		– 40 ... + 100			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4 mm from mounting flange)		20			N
	– axial at 3 000 rpm		2			N
	– axial at standstill		20			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		70			g
27	Direction of rotation		electronically reversible			
28	Number of pole pairs		2			
Recommended values - mathematically independent of each other						
29	Speed up to	$n_{e\ max.}$		34 000	34 000	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$		6 / 10	6 / 10	mNm
31	Current up to [1] [2]	$I_{e\ max.}$		0,94 / 1,42	0,50 / 0,75	A

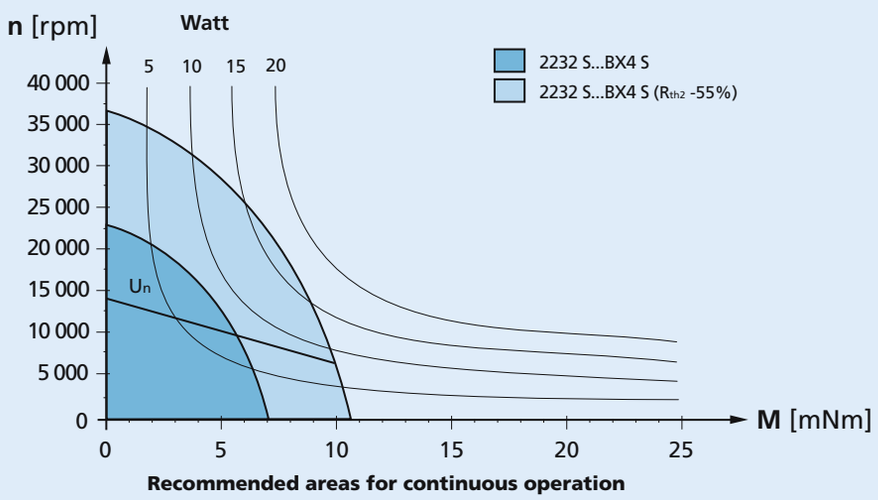
[1] at 5 000 rpm
[2] thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

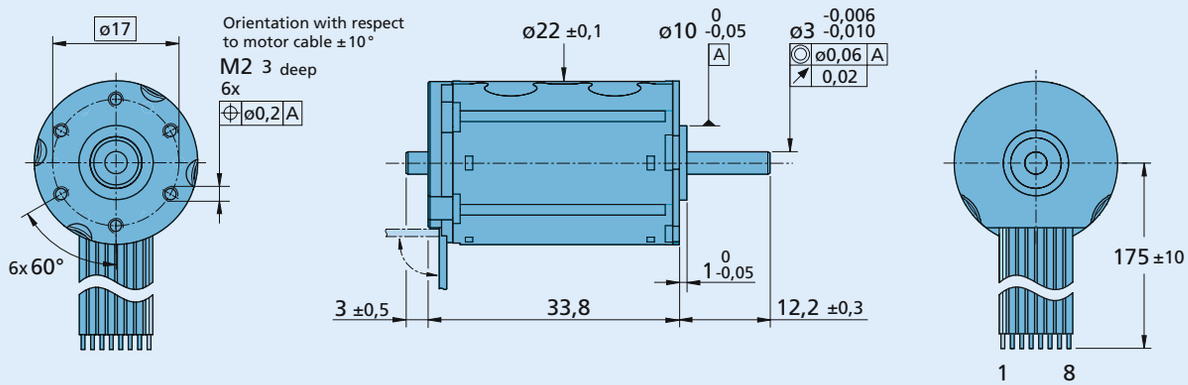
The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Dimensional drawing

M 1:1



2232 S ... BX4 S

Options

- Connector variant (Option no. 3830)

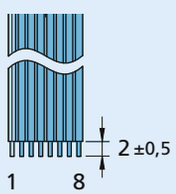
  Motor:
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit

Full product description

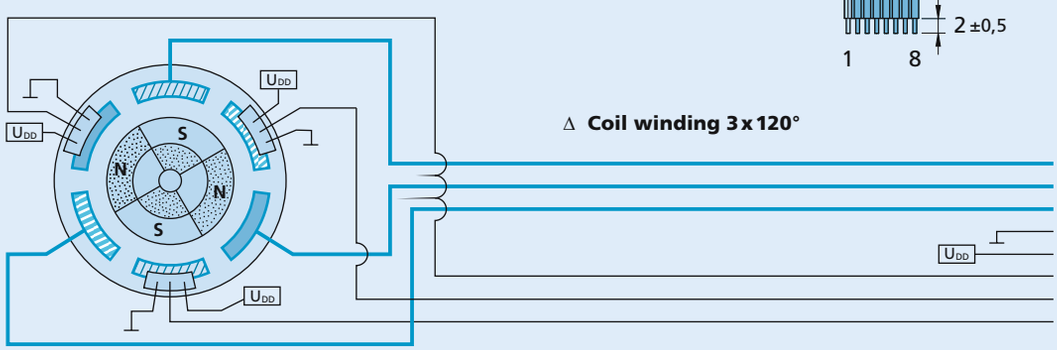
- Examples:

  2232S012BX4S

Cable and connection information



Cable
Jacket Material: PVC
8 conductors, AWG 26
grid 1,27 mm
wires tinned



Δ **Coil winding 3 x 120°**

Connection

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Brushless DC-Servomotors 19 mNm

4 Pole Technology

For combination with
Gearheads:
22F, 22/7, 26A
Encoders:
2232...BX4 + Encoder
Drive Electronics:
Speed Controller

Series 2232 ... BX4

		2232 S		012 BX4	024 BX4	
1	Nominal voltage	U_N		12	24	Volt
2	Terminal resistance, phase-phase	R		3,5	12,4	Ω
3	Output power [1]	$P_{2\ max.}$		7,6	7,7	W
4	Efficiency	$\eta_{max.}$		66,9	67,6	%
5	No-load speed	n_o		6 600	7 000	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,112	0,061	A
7	Stall torque	M_H		55,7	59,9	mNm
8	Friction torque, static	C_o		0,85	0,85	mNm
9	Friction torque, dynamic	C_v		$1,5 \cdot 10^{-4}$	$1,5 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		579	304	rpm/V
11	Back-EMF constant	k_E		1,728	3,288	mV/rpm
12	Torque constant	k_M		16,50	31,40	mNm/A
13	Current constant	k_I		0,061	0,032	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		123	120	rpm/mNm
15	Terminal inductance, phase-phase	L		120	440	µH
16	Mechanical time constant	τ_m		6,7	6,5	ms
17	Rotor inertia	J		5,2	5,2	gcm^2
18	Angular acceleration	$\alpha_{max.}$		107	115	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	2 / 17			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,1 / 370			s
21	Operating temperature range		– 40 ... + 100			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4 mm from mounting flange)		20			N
	– axial at 3 000 rpm		2			N
	– axial at standstill		20			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		70			g
27	Direction of rotation		electronically reversible			
28	Number of pole pairs		2			
Recommended values - mathematically independent of each other						
29	Speed up to	$n_{e\ max.}$		22 000	22 000	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$		12 / 19	12 / 19	mNm
31	Current up to [1] [2]	$I_{e\ max.}$		0,90 / 1,40	0,48 / 0,74	A

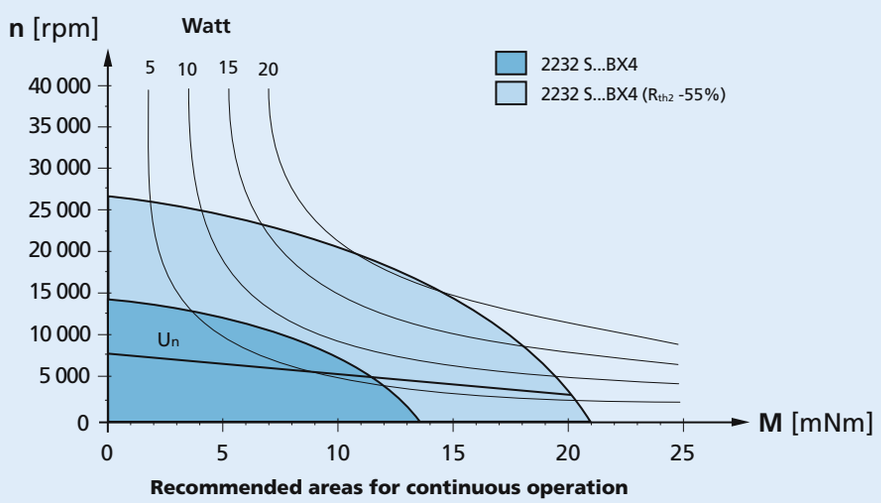
[1] at 5 000 rpm
[2] thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

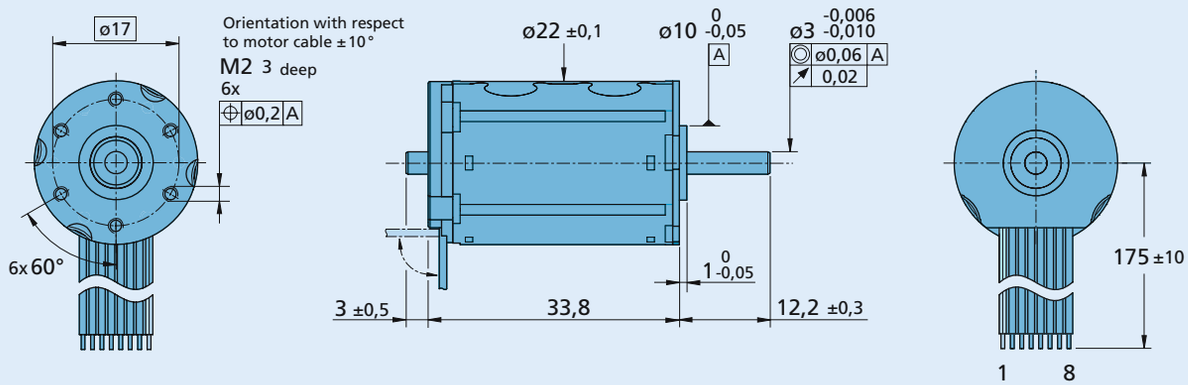
The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Dimensional drawing

M 1:1



2232 S ... BX4

Options

- Connector variant (Option no. 3830)

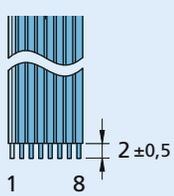
  Motor:
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit

Full product description

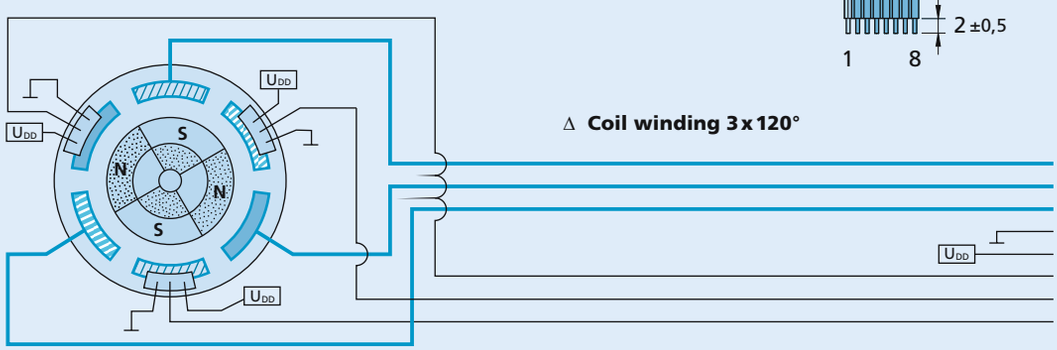
- Examples:

  2232S024BX4

Cable and connection information



Cable
Jacket Material: PVC
8 conductors, AWG 26
grid 1,27 mm
wires tinned



Δ **Coil winding 3 x 120°**

Connection

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Brushless DC-Servomotors 22 mNm

4 Pole Technology

For combination with
Gearheads:
22F, 22/7, 26A
Encoders:
2250...BX4S + Encoder
Drive Electronics:
Speed Controller

Series 2250 ... BX4 S

		2250 S		024 BX4 S	
1	Nominal voltage	U_N		24	Volt
2	Terminal resistance, phase-phase	R		5,9	Ω
3	Output power [1]	$P_{2\ max.}$		8,8	W
4	Efficiency	$\eta_{max.}$		70,4	%
5	No-load speed	n_o		10 500	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,105	A
7	Stall torque	M_H		84,7	mNm
8	Friction torque, static	C_o		0,75	mNm
9	Friction torque, dynamic	C_v		$1,4 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		451	rpm/V
11	Back-EMF constant	k_E		2,218	mV/rpm
12	Torque constant	k_M		21,1	mNm/A
13	Current constant	k_I		0,047	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		125,6	rpm/mNm
15	Terminal inductance, phase-phase	L		250	µH
16	Mechanical time constant	τ_m		6,97	ms
17	Rotor inertia	J		5,3	gcm^2
18	Angular acceleration	$\alpha_{max.}$		160	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	1,2 / 14		K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,2 / 443		s
21	Operating temperature range		– 40 ... + 100		°C
22	Shaft bearings		ball bearings, preloaded		
23	Shaft load max.:				
	– radial at 3 000 rpm (4 mm from mounting flange)		20		N
	– axial at 3 000 rpm		2		N
	– axial at standstill		20		N
24	Shaft play:				
	– radial	≤	0,015		mm
	– axial	=	0		mm
25	Housing material		stainless steel		
26	Weight		90		g
27	Direction of rotation		electronically reversible		
28	Number of pole pairs		2		
Recommended values - mathematically independent of each other					
29	Speed up to	$n_{e\ max.}$		25 000	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$		14 / 22	mNm
31	Current up to [1] [2]	$I_{e\ max.}$		0,79 / 1,20	A

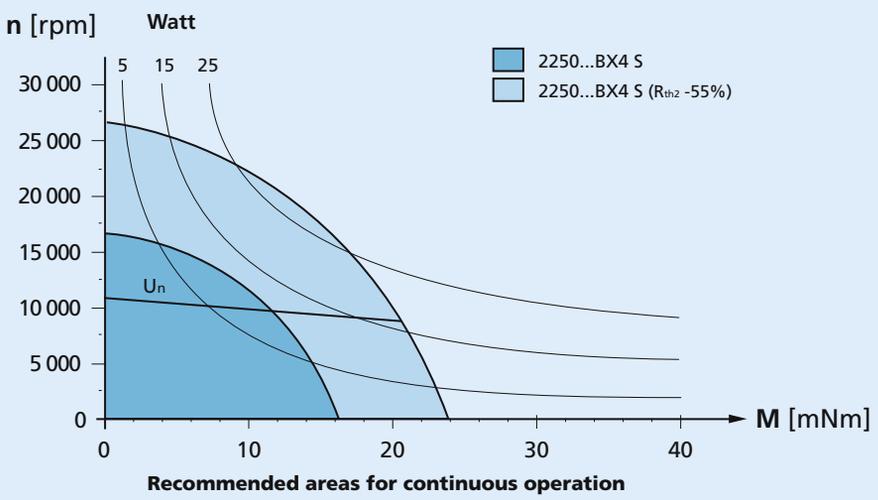
[1] at 5 000 rpm
[2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

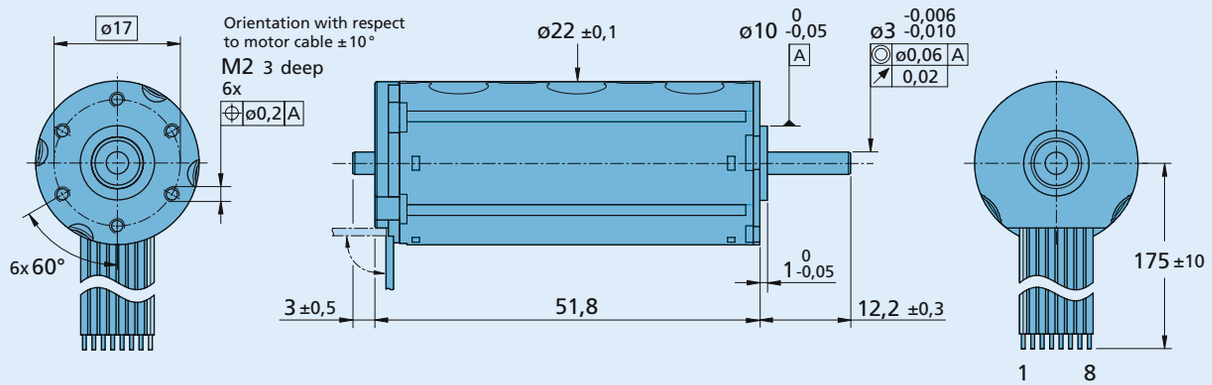
The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Dimensional drawing

M 1:1



2250 S ... BX4 S

Options

- Connector variant (Option no. 3830)

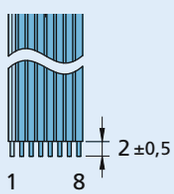
  Motor:
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit

Full product description

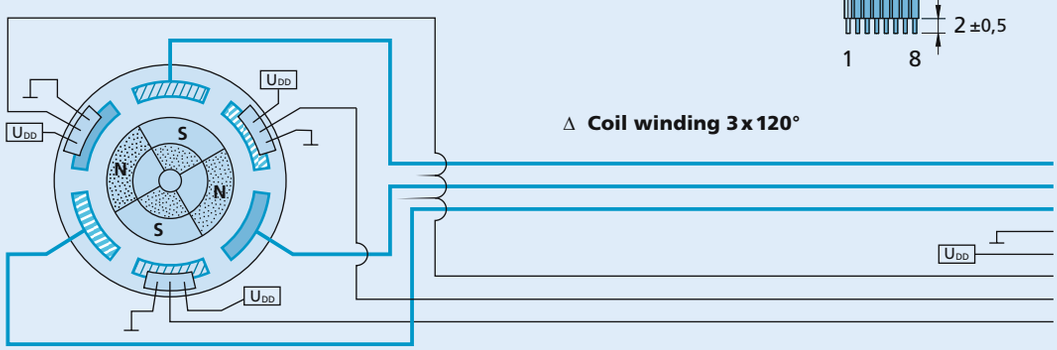
- Examples:

  2250S024 BX4S

Cable and connection information



Cable
Jacket Material: PVC
8 conductors, AWG 26
grid 1,27 mm
wires tinned



Δ **Coil winding 3 x 120°**

Connection

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Brushless DC-Servomotors

4 Pole Technology

37 mNm

For combination with
Gearheads:
22F, 22/7, 26A
Encoders:
2250...BX4 + Encoder
Drive Electronics:
Speed Controller

Series 2250 ... BX4

		2250 S		024 BX4	
1	Nominal voltage	U_N		24	Volt
2	Terminal resistance, phase-phase	R		5,9	Ω
3	Output power [1]	$P_{2\ max.}$		14,6	W
4	Efficiency	$\eta_{max.}$		75,0	%
5	No-load speed	n_o		6 000	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,072	A
7	Stall torque	M_H		149,0	mNm
8	Friction torque, static	C_o		1,20	mNm
9	Friction torque, dynamic	C_v		$2{,}4 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		259	rpm/V
11	Back-EMF constant	k_E		3,860	mV/rpm
12	Torque constant	k_M		36,9	mNm/A
13	Current constant	k_I		0,027	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		41,4	rpm/mNm
15	Terminal inductance, phase-phase	L		240	µH
16	Mechanical time constant	τ_m		4,30	ms
17	Rotor inertia	J		10,0	gcm^2
18	Angular acceleration	$\alpha_{max.}$		149	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	1,2 / 14		K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,2 / 566		s
21	Operating temperature range		– 40 ... + 100		°C
22	Shaft bearings		ball bearings, preloaded		
23	Shaft load max.:				
	– radial at 3 000 rpm (4 mm from mounting flange)		20		N
	– axial at 3 000 rpm		2		N
	– axial at standstill		20		N
24	Shaft play:				
	– radial	≤	0,015		mm
	– axial	=	0		mm
25	Housing material		stainless steel		
26	Weight		106		g
27	Direction of rotation		electronically reversible		
28	Number of pole pairs		2		
Recommended values - mathematically independent of each other					
29	Speed up to	$n_{e\ max.}$		18 000	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$		23 / 37	mNm
31	Current up to [1] [2]	$I_{e\ max.}$		0,74 / 1,18	A

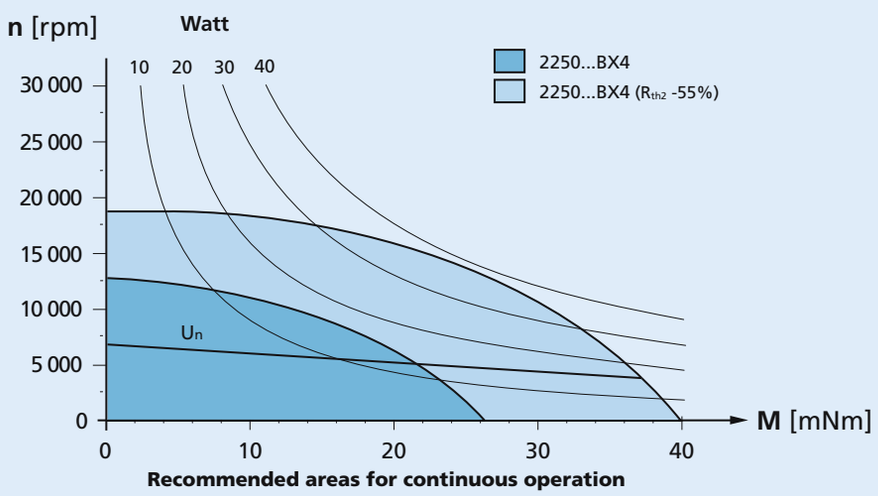
[1] at 5 000 rpm
[2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

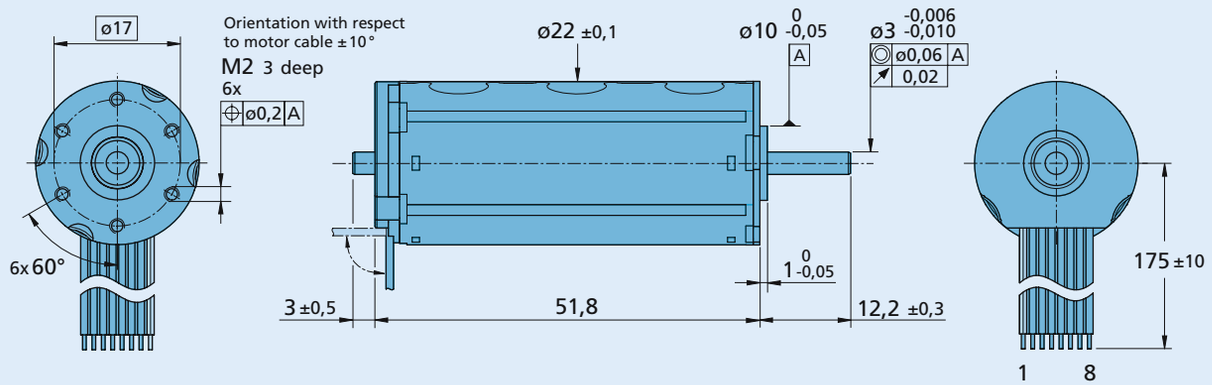
The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Dimensional drawing

M 1:1



2250 S ... BX4

Options

- Connector variant (Option no. 3830)

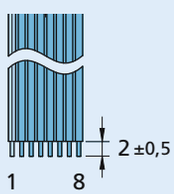
  Motor:
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit

Full product description

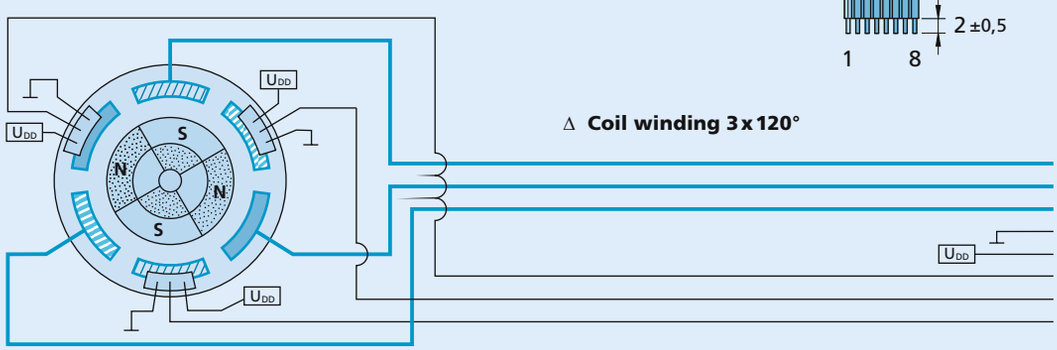
- Examples:

  2250S024 BX4

Cable and connection information



Cable
Jacket Material: PVC
8 conductors, AWG 26
grid 1,27 mm
wires tinned



Δ Coil winding 3 x 120°

Connection

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Brushless DC-Servomotors 56 mNm

4 Pole Technology

For combination with
Gearheads:
30/1, 32A, 32/3, 32/3 S, 38/1, 38/1 S, 38/2, 38/2 S
Encoders:
3242...BX4 + Encoder
Drive Electronics:
Speed Controller

Series 3242 ... BX4

		3242 G		012 BX4	024 BX4	
1	Nominal voltage	U_N		12	24	Volt
2	Terminal resistance, phase-phase	R		0,89	3,6	Ω
3	Output power [1]	$P_{2\ max.}$		21,7	21,7	W
4	Efficiency	$\eta_{max.}$		77,4	77,3	%
5	No-load speed	n_o		5 500	5 500	rpm
6	No-load current	I_o		0,206	0,103	A
7	Stall torque	M_H		282	279	mNm
8	Friction torque, static	C_o		1,3	1,3	mNm
9	Friction torque, dynamic	C_v		$5{,}2 \cdot 10^{-4}$	$5{,}2 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		455	227	rpm/V
11	Back-EMF constant	k_E		2,199	4,409	mV/rpm
12	Torque constant	k_M		21,0	42,1	mNm/A
13	Current constant	k_I		0,0476	0,0238	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		19,3	19,4	rpm/mNm
15	Terminal inductance, phase-phase	L		60	240	µH
16	Mechanical time constant	τ_m		6,1	6,1	ms
17	Rotor inertia	J		30	30	gcm^2
18	Angular acceleration	$\alpha_{max.}$		94	93	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	1,6 / 11,9			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	9 / 780			s
21	Operating temperature range		– 40 ... + 100			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4,5 mm from mounting flange)		50			N
	– axial at 3 000 rpm		5			N
	– axial at standstill		50			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		177			g
27	Direction of rotation		electronically reversible			
28	Number of pole pairs		2			
Recommended values - mathematically independent of each other						
29	Speed up to	$n_{e\ max.}$		14 500	14 500	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$		33 / 56	33 / 56	mNm
31	Current up to [1] [2]	$I_{e\ max.}$		1,95 / 3,19	0,97 / 1,59	A

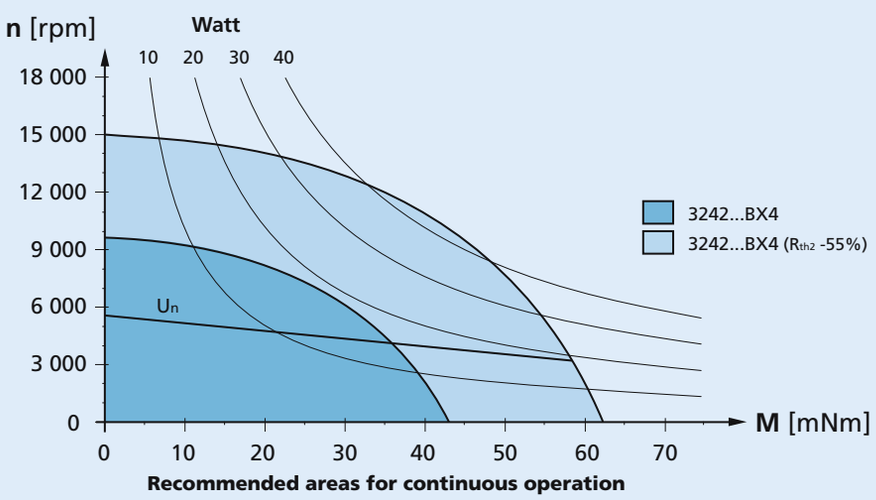
[1] at 5 000 rpm
[2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

Note:

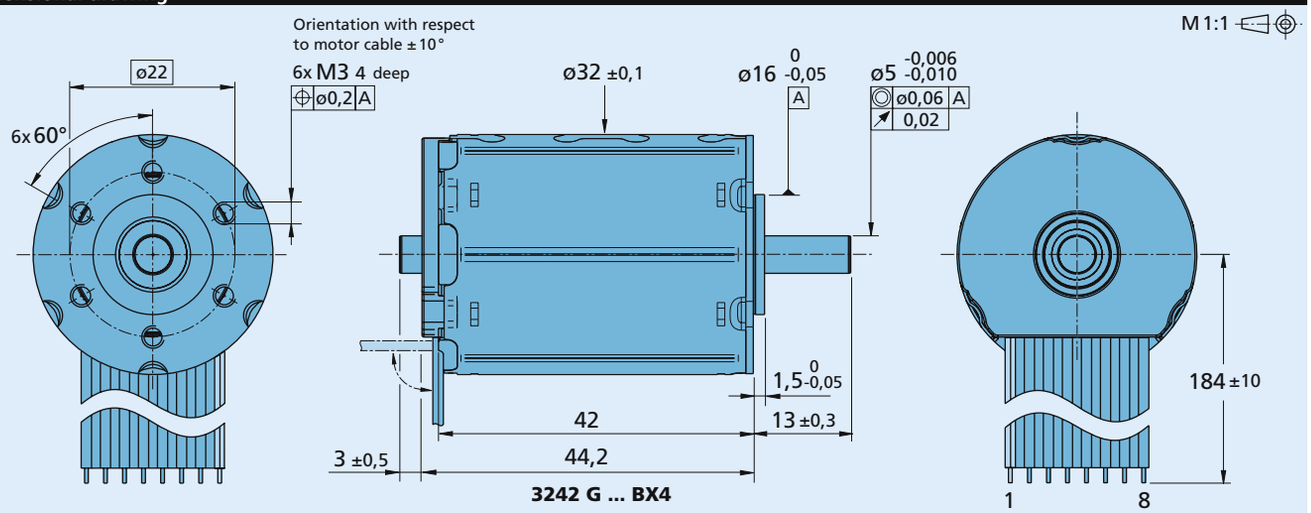
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Dimensional drawing



Options

- Connector variant (Option no. 3830)

  Motor:
  AWG 24 / PVC ribbon cable
  with connector Micro-Fit

- Analog Hall sensors (Option no. 3692)

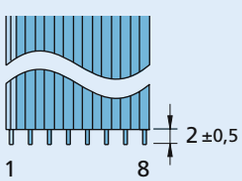
Full product description

- Examples:

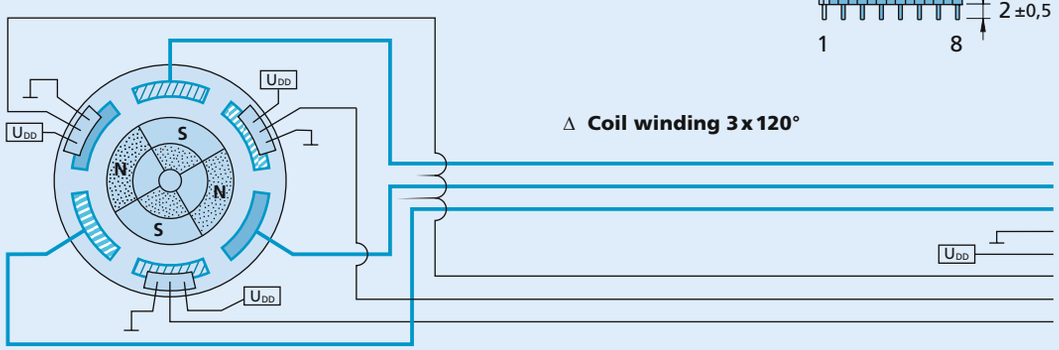
  3242G012BX4

  3242G024BX4

Cable and connection information



Cable
Insulation: PVC
8 conductors, AWG 24
pitch 2,54 mm
wires tinned



Δ **Coil winding 3 x 120°**

Connection

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Brushless DC-Servomotors

4 Pole Technology

97 mNm

For combination with
Gearheads:
30/1, 32A, 32/3, 32/3 S, 38/1, 38/1 S, 38/2, 38/2 S
Encoders:
3268...BX4 + Encoder
Drive Electronics:
Speed Controller

Series 3268 ... BX4

		3268 G		024 BX4	
1	Nominal voltage	U_N		24	Volt
2	Terminal resistance, phase-phase	R		1,45	Ω
3	Output power [1]	$P_{2\ max.}$		35,8	W
4	Efficiency	$\eta_{max.}$		79,5	%
5	No-load speed	n_o		5 500	rpm
6	No-load current	I_o		0,212	A
7	Stall torque	M_H		718	mNm
8	Friction torque, static	C_o		1,7	mNm
9	Friction torque, dynamic	C_v		$1,3 \cdot 10^{-3}$	mNm/rpm
10	Speed constant	k_n		220	rpm/V
11	Back-EMF constant	k_E		4,555	mV/rpm
12	Torque constant	k_M		43,5	mNm/A
13	Current constant	k_I		0,0230	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		7,3	rpm/mNm
15	Terminal inductance, phase-phase	L		110	µH
16	Mechanical time constant	τ_m		4,6	ms
17	Rotor inertia	J		60	gcm^2
18	Angular acceleration	$\alpha_{max.}$		120	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	1,9 / 8,6		K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	17 / 950		s
21	Operating temperature range		– 40 ... + 100		°C
22	Shaft bearings		ball bearings, preloaded		
23	Shaft load max.:				
	– radial at 3 000 rpm (4,5 mm from mounting flange)		50		N
	– axial at 3 000 rpm		5		N
	– axial at standstill		50		N
24	Shaft play:				
	– radial	≤	0,015		mm
	– axial	=	0		mm
25	Housing material		stainless steel		
26	Weight		290		g
27	Direction of rotation		electronically reversible		
28	Number of pole pairs		2		
Recommended values - mathematically independent of each other					
29	Speed up to	$n_{e\ max.}$		12 000	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$		54 / 97	mNm
31	Current up to [1] [2]	$I_{e\ max.}$		1,57 / 2,72	A

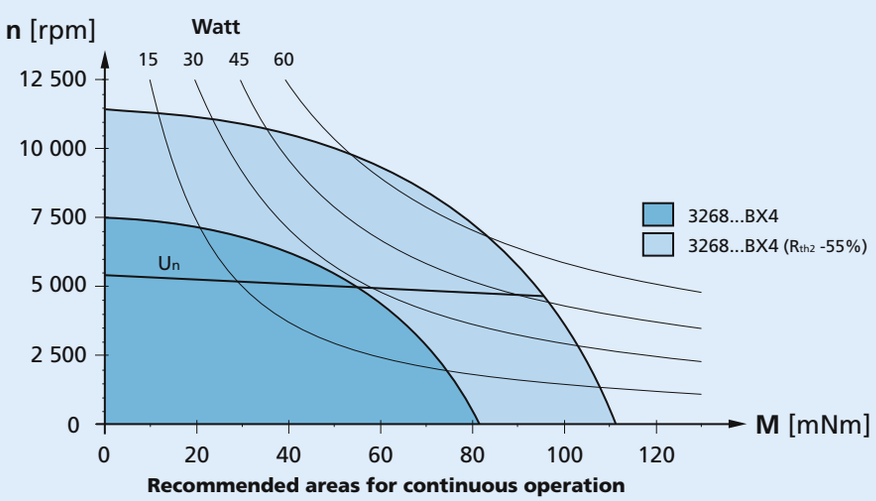
[1] at 5 000 rpm
[2] thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

Note:

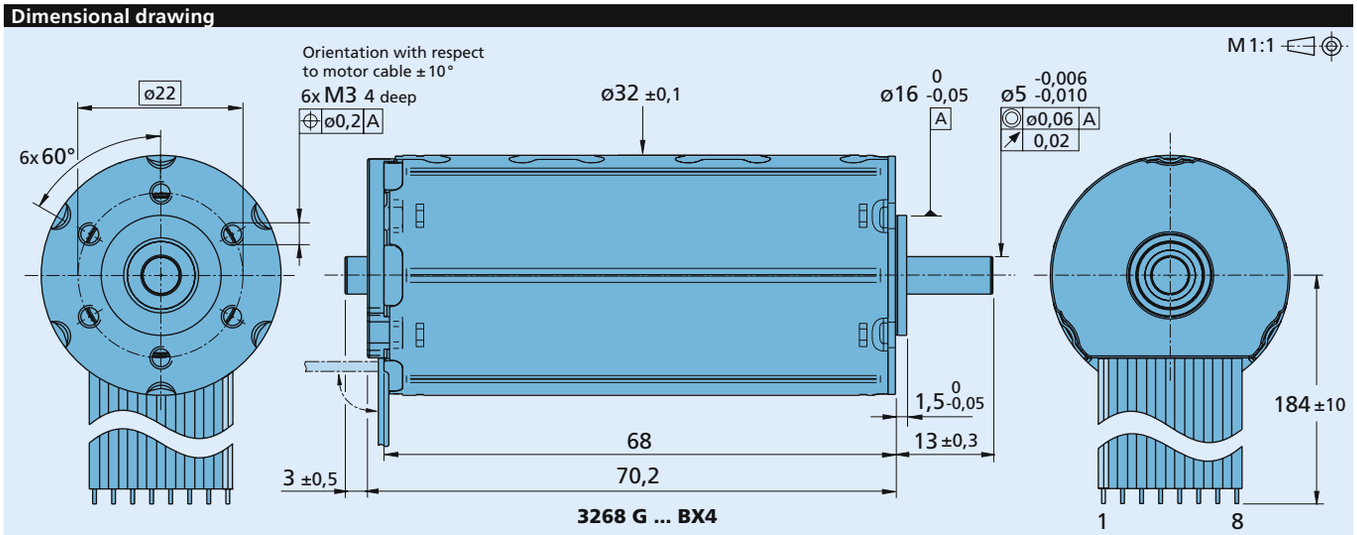
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Dimensional drawing



3268 G ... BX4

Options

- Connector variant (Option no. 3830)

  Motor:
  AWG 24 / PVC ribbon cable
  with connector Micro-Fit

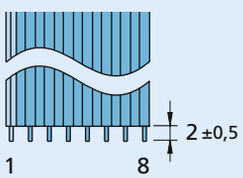
- Analog Hall sensors (Option no. 3692)

Full product description

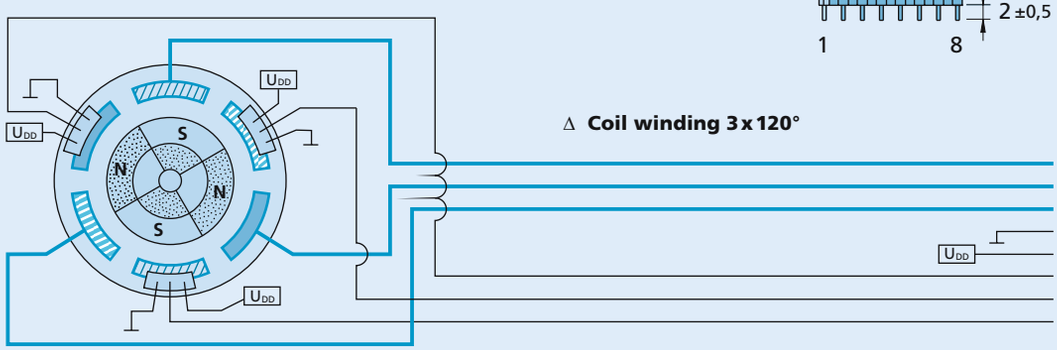
- Examples:

  3268G024BX4

Cable and connection information



Cable
Insulation: PVC
8 conductors, AWG 24
pitch 2,54 mm
wires tinned



Δ Coil winding 3 x 120°

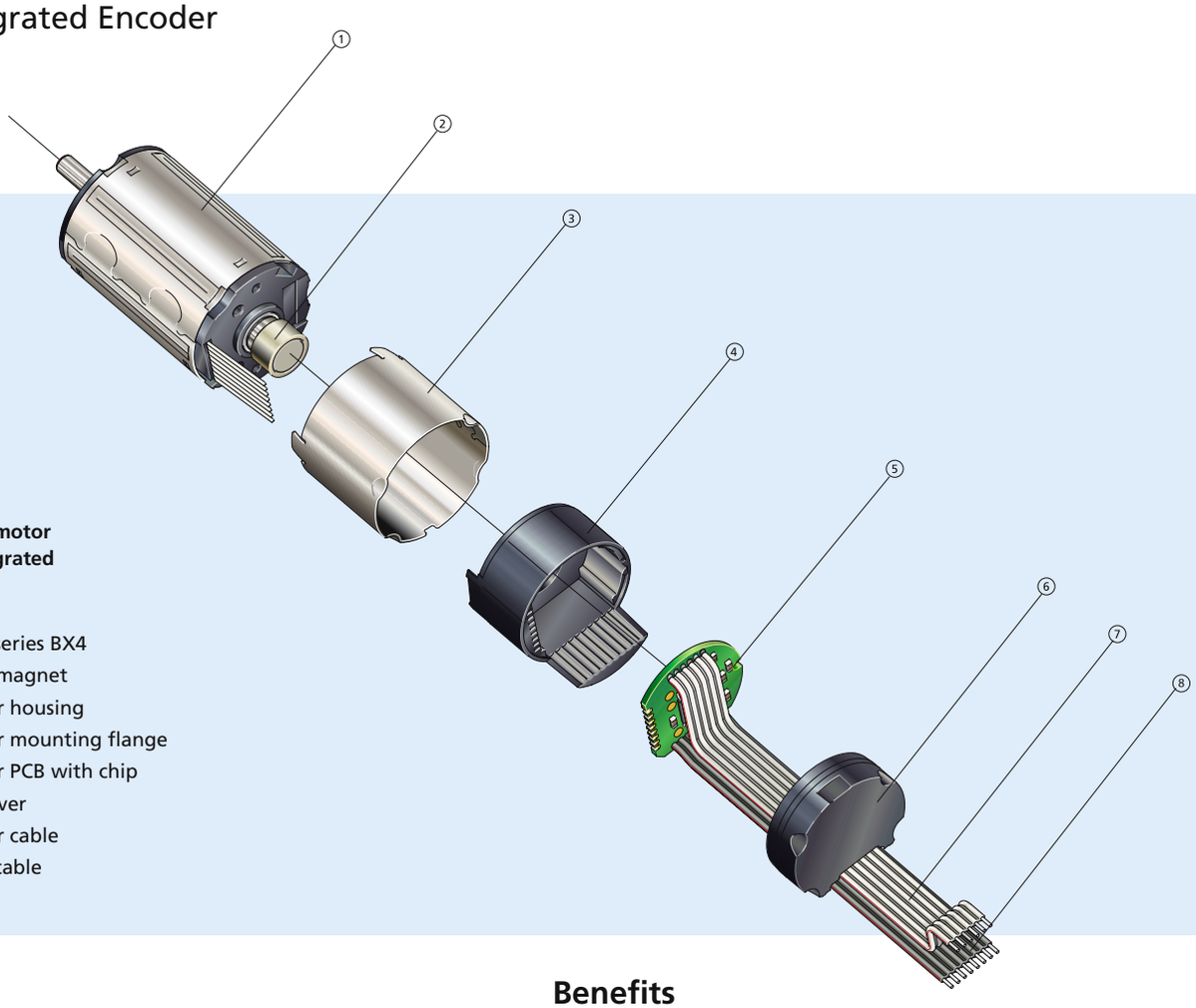
Connection

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Notes

Brushless DC-Servomotors

with integrated Encoder



Brushless DC-Servomotor with integrated Encoder

① Motor series BX4
② Sensor magnet
③ Encoder housing
④ Encoder mounting flange
⑤ Encoder PCB with chip
⑥ Rear cover
⑦ Encoder cable
⑧ Motor cable

Features

Encoders of the series IE3/IE3L and AES are designed with a diametrically magnetized code wheel which is pressed onto the motor shaft and provides the axial magnetic field to the encoder electronics. The electronics contain all the necessary functions of an encoder including Hall sensors, interpolation, and driver. The Hall sensors senses the rotational position of the sensor magnet and the signal is interpolated to provide a high resolution position signal.

At the encoder outputs, two 90° phase-shifted rectangular signals are available with up to 1024 impulses and an index impulse per motor revolution.

In the AES version, absolute position information is provided with a resolution of 4096 steps per revolution at the signal outputs and communicated via a serial (SSI) interface.

The absolute encoder is ideal for commutation, speed and position control of the motor.

Benefits

- Compact design in robust housing
- A wide range of resolutions are available
- Index channel
- Line Drivers are available
- Standardized encoder outputs
- Ideal for combination with FAULHABER Motion Controllers and FAULHABER Speed Controllers
- Custom modifications including custom resolution, index position and index pulse width are possible
- Available as absolute encoder with serial interface

Product Code

32	Motor diameter [mm]
42	Motor length [mm]
G	Shaft type
024	Nominal voltage [V]
BX4	Type of commutation (brushless), 4 Pole Technology
IE3	Integrated Encoder

32 42 G 024 BX4 IE3

Brushless DC-Servomotors

with integrated Encoder
4 Pole Technology

11 mNm

For combination with
Gearheads:
22F, 22/7, 26A

2232 ... BX4 S + Encoders

		2232 S		012 BX4 S	024 BX4 S	
1	Nominal voltage	U_N		12	24	Volt
2	Terminal resistance, phase-phase	R		3,5	12,4	Ω
3	Output power [1]	$P_{2\ max.}$		4,4	4,5	W
4	Efficiency	$\eta_{max.}$		60,9	61,7	%
5	No-load speed	n_o		13 200	14 000	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,163	0,088	A
7	Stall torque	M_H		27,3	29,4	mNm
8	Friction torque, static	C_o		0,6	0,6	mNm
9	Friction torque, dynamic	C_v		$5,5 \cdot 10^{-5}$	$5,5 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		1 173	616	rpm/V
11	Back-EMF constant	k_E		0,852	1,623	mV/rpm
12	Torque constant	k_M		8,14	15,50	mNm/A
13	Current constant	k_I		0,123	0,065	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		504	493	rpm/mNm
15	Terminal inductance, phase-phase	L		130	470	µH
16	Mechanical time constant	τ_m		22	22	ms
17	Rotor inertia	J		4,2	4,2	gcm^2
18	Angular acceleration	$\alpha_{max.}$		65	70	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	2 / 13			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,1 / 283			s
21	Operating temperature range		– 40 ... + 100			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4 mm from mounting flange)		20			N
	– axial at 3 000 rpm		2			N
	– axial at standstill		20			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		81			g
27	Direction of rotation		electronically reversible			
28	Number of pole pairs		2			
Recommended values - mathematically independent of each other						
29	Speed up to	$n_{e\ max.}$		40 000	40 000	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$		7 / 11	7 / 11	mNm
31	Current up to [1] [2]	$I_{e\ max.}$		1,06 / 1,61	0,58 / 0,86	A

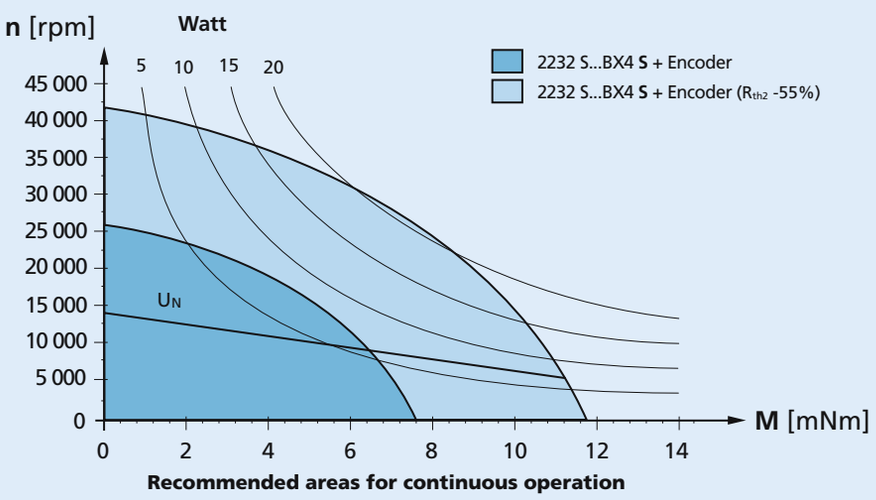
[1] at 5 000 rpm
[2] thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Features

The brushless DC-servomotors feature in this version an Encoder that is available with different interfaces. A permanent magnet on the shaft creates a moving magnetic field which is captured using a single-chip angular sensor and further processed.

In the **IE3** version, the brushless DC servomotors have an encoder with 3 output channels. At the encoder outputs, two 90° phase-shifted rectangular signals are available with up to 1 024 impulses and an index impulse per motor revolution. The encoder is available in a variety of different resolutions and is suitable for speed control and positioning applications.

The Line Driver **IE3L** version has differential signal outputs (TIA-422). Differential signals reduce ambient interference and are suitable for applications with high ambient interference. The line driver amplifies the encoder signal which means that long cables can be used without signal degradation. Differential signal outputs must be decoded by the appropriate receiver module. The motor and encoder cables are connected via separate ribbon cables.
Other resolutions of 1 - 127 impulses are available on request.

In the **AES** version (absolute encoder), absolute position information is provided with a resolution of 4096 steps per revolution at the signal outputs and communicated via a serial (SSI) interface. Absolute means, that each shaft position is assigned to a unique angular value within one revolution. This value is already available directly after power-on.

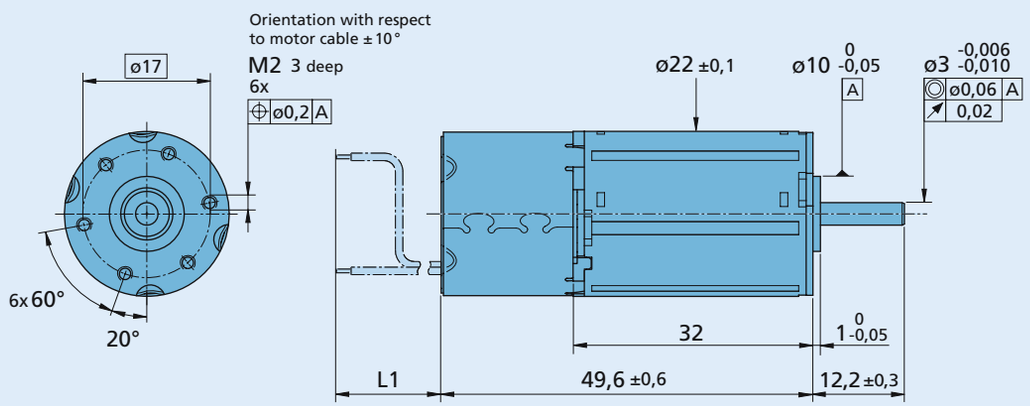
The absolute encoder is ideal for commutation, speed and position control of the motor. It can be used to create a sinusoidal commutation signal. The advantages are a reduced torque ripple, a higher efficiency, and reduced electrical noise generation.

Motor and encoder are connected via a common ribbon cable.

For more information about installation and setup a detailed instruction manual is included with the product or is available online at www.faulhaber.com

Dimensional drawing

M 1:1



Encoder		L1 mm
IE3	2 Cable	162 ±10
IE3 L	2 Cable	150 ±10
AES	1 Cable	162 ±10

2232 S ... BX4 S+ Encoder

Brushless DC-Servomotor 2232 ... BX4 S with Encoder		IE3-32	IE3-64	IE3-128	IE3-256	IE3-512	IE3-1024	
Lines per revolution	N	32	64	128	256	512	1024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2+1 Index						channels
Supply voltage Encoder	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 16, max. 23						mA
Output current, max. allowable [3]	I_{OUT}	4						mA
Index Pulse width [4]	P_0	90±45				90±75		°e
Phase shift, channel A to B [4]	Φ	90±45				90±75		°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	0,1/0,1						µs
Inertia of encoder magnet	J	0,08						gcm^2

Connection information Motor		IE3-32	IE3-64	IE3-128	IE3-256	IE3-512	IE3-1024	
Supply voltage Hallsensors [5]	U_{DD}	2,2 ...18				4,5 ... 5,5		V DC

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] $U_{DD\ Enc}$ = 5 V: low logic level < 0,4 V, high logic level > 4,5 V: CMOS- and TTL compatible
[4] at 5 000 rpm
[5] IE3-32/64/128/256 $U_{DD} \neq U_{DD\ ENC}$ (galvanically isolated)
IE3-512 / 1 024 $U_{DD} = U_{DD\ ENC}$

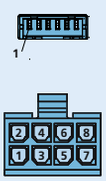
Features / Connector information

Options

- Connector variant (Option no. 3592)

Encoder:
AWG 28 / PVC ribbon cable
with connector PicoBlade (pitch 1,25 mm)

Motor:
AWG 26 / PVC ribbon cable
with connector Micro-Fit

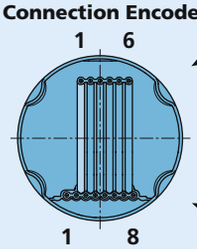


Full product description

- Examples:

2232S024BX4 S IE3-1024

Connection Encoder



No.	Function
1	n.c.
2	Channel I (Index)
3	GND Enc
4	$U_{DD\ Enc}$
5	Channel B
6	Channel A

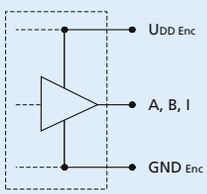
Connection Motor

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD}
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

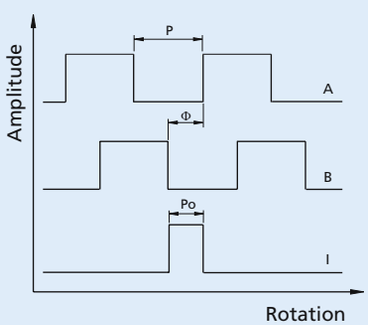
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_o = \left| 90° - \frac{P_o}{P} * 180° \right| \leq 75°$$

Brushless DC-Servomotor 2232 ... BX4 S with Encoder		IE3-32 L	IE3-64 L	IE3-128 L	IE3-256 L	IE3-512 L	IE3-1024 L	
Lines per revolution	N	32	64	128	256	512	1024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2+1 index and complementary outputs						channels
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 17, max. 25						mA
Index Pulse width [3]	P_0	90±45				90±75		°e
Phase shift, channel A to B [3]	Φ	90±45				90±75		°e
Inertia of encoder magnet	J	0,08						gcm^2

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] at 5 000 rpm

Notes: The output signals are TIA-422 compatible.
Examples of Line driver Receivers: ST26C32ABD (STM), ST26C32IP16 (EXAR), DS26C32AT (NSC).

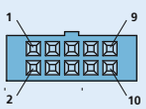
Features / Connector information

Options

- Connector variant (Option no.: 3589)

Motor:
AWG 26 / PVC ribbon cable
with connector Micro-Fit

Encoder:
AWG 28 / PVC ribbon cable
with connector DIN-41651 (pitch 2,54 mm)

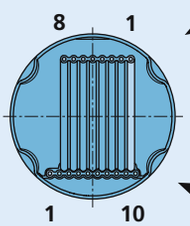


Full product description

- Examples:

2232S024BX4S IE3-1024 L

Connection Motor



No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

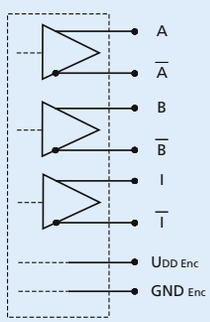
Connection Encoder

No.	Function
1	n.c.
2	$U_{DD\ Enc}$
3	GND_{Enc}
4	n.c.
5	Channel $\overline{A}$
6	Channel A
7	Channel $\overline{B}$
8	Channel B
9	Channel $\overline{I}$ (Index)
10	Channel I (Index)

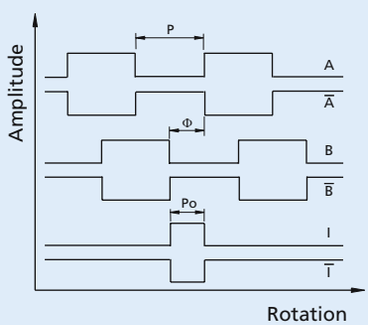
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_0 = \left| 90° - \frac{P_0}{P} * 180° \right| \leq 75°$$

Brushless DC-Servomotor 2232 ... BX4 S with Encoder		AES-4096	
Lines per revolution (resolution)	N	4 096	
Signal output		Synchronous Serial Interface (SSI)	
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5	V DC
Current consumption, typical [1]	$I_{DD\ Enc}$	typ. 16, max. 23	mA
Output current, max. (DATA) [2]		4	mA
Clock Frequency, max. (CLK)		2	MHz
Input low level (CLK)		0 ... 0,8	V
Input high level (CLK)		2 ... $U_{DD\ Enc}$	V
Setup time after power on, max.	t_{setup}	4	ms
Operating temperature range		– 40 ... +100	°C

[1] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[2] $U_{DD\ Enc}$ = 5 V: low logic level ≤ 0,4 V, high logic level ≥ 4,6 V

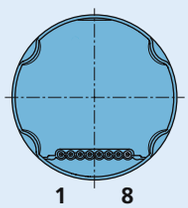
Features / Connector information

Options

- Connector variant (Option no. 3830)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit

Full product description

- Examples:
  2232S024BX4S AES-4096



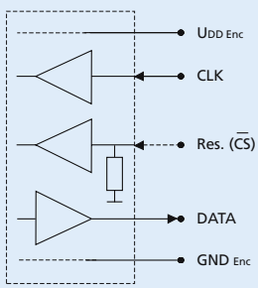
Connection Motor and Encoder

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND Enc
5	$U_{DD\ Enc}$
6	CLK
7	Res. ($\overline{CS}$)
8	DATA

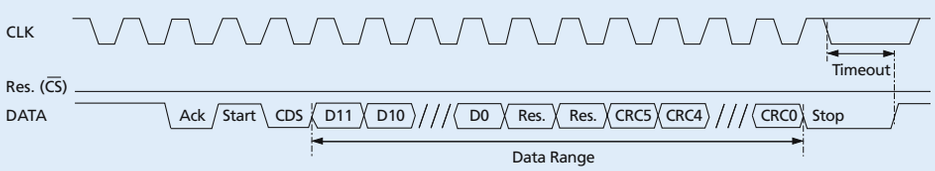
Caution:
Incorrect lead connection will damage the motor electronics!

Circuit diagram / Interface signals

Output circuit



Interface signals (SSI)



Angle position values are ascending for clockwise rotation.
Clockwise rotation as seen from the shaft end

Notes

Brushless DC-Servomotors

with integrated Encoder
4 Pole Technology

22 mNm

For combination with
Gearheads:
22F, 22/7, 26A

2232 ... BX4 + Encoders

		2232 S		012 BX4	024 BX4	
1	Nominal voltage	U_N		12	24	Volt
2	Terminal resistance, phase-phase	R		3,5	12,4	Ω
3	Output power [1]	$P_{2\ max.}$		8,8	8,9	W
4	Efficiency	$\eta_{max.}$		66,9	67,6	%
5	No-load speed	n_o		6 600	7 000	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,112	0,061	A
7	Stall torque	M_H		55,7	59,9	mNm
8	Friction torque, static	C_o		0,85	0,85	mNm
9	Friction torque, dynamic	C_v		$1,5 \cdot 10^{-4}$	$1,5 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		579	304	rpm/V
11	Back-EMF constant	k_E		1,728	3,288	mV/rpm
12	Torque constant	k_M		16,50	31,40	mNm/A
13	Current constant	k_I		0,061	0,032	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		123	120	rpm/mNm
15	Terminal inductance, phase-phase	L		120	440	µH
16	Mechanical time constant	τ_{m}		6,7	6,5	ms
17	Rotor inertia	J		5,2	5,2	gcm^2
18	Angular acceleration	$\alpha_{max.}$		107	115	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	2 / 13			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,1 / 283			s
21	Operating temperature range		– 40 ... + 100			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4 mm from mounting flange)		20			N
	– axial at 3 000 rpm		2			N
	– axial at standstill		20			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		81			g
27	Direction of rotation		electronically reversible			
28	Number of pole pairs		2			

Recommended values - mathematically independent of each other

29	Speed up to	$n_{e\ max.}$		25 000	20 000	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$		14 / 22	14 / 22	mNm
31	Current up to [1] [2]	$I_{e\ max.}$		1,05 / 1,60	0,56 / 0,85	A

[1] at 5 000 rpm
[2] thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

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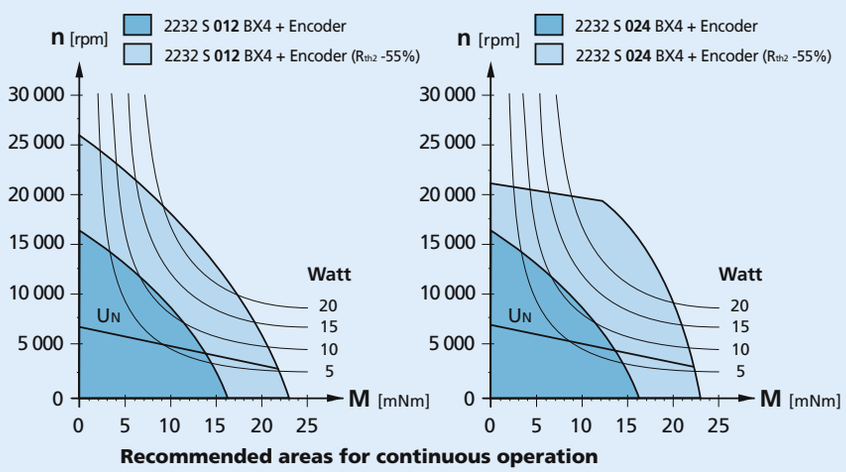

Recommended areas for continuous operation

Features

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In the **IE3** version, the brushless DC servomotors have an encoder with 3 output channels. At the encoder outputs, two 90° phase-shifted rectangular signals are available with up to 1 024 impulses and an index impulse per motor revolution. The encoder is available in a variety of different resolutions and is suitable for speed control and positioning applications.

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The absolute encoder is ideal for commutation, speed and position control of the motor. It can be used to create a sinusoidal commutation signal. The advantages are a reduced torque ripple, a higher efficiency, and reduced electrical noise generation.

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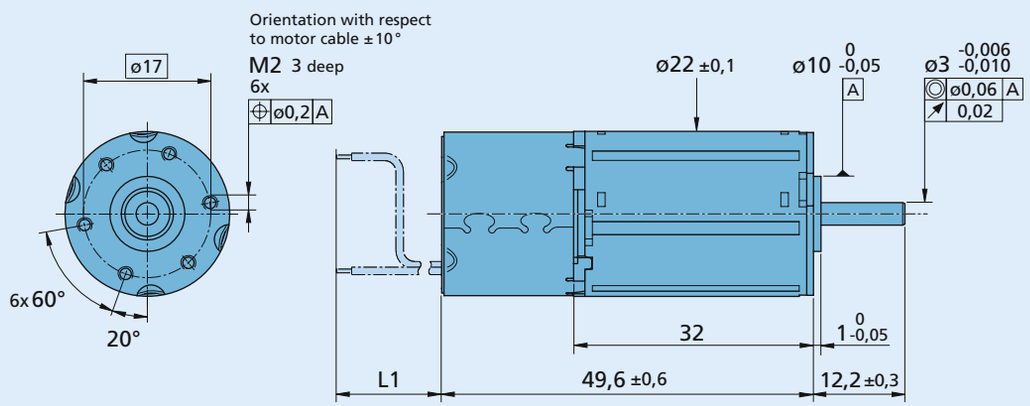
Dimensional drawing

M 1:1



Encoder		L1 mm
IE3	2 Cable	162 ±10
IE3 L	2 Cable	150 ±10
AES	1 Cable	162 ±10

2232 S ... BX4 + Encoder

Brushless DC-Servomotor 2232 ... BX4 with Encoder		IE3-32	IE3-64	IE3-128	IE3-256	IE3 - 512	IE3 - 1024	
Lines per revolution	N	32	64	128	256	512	1024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2+1 Index						channels
Supply voltage Encoder	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 16, max. 23						mA
Output current, max. allowable [3]	I_{OUT}	4						mA
Index Pulse width [4]	P_0	90±45				90±75		° e
Phase shift, channel A to B [4]	Φ	90±45				90±75		° e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	0,1/0,1						µs
Inertia of encoder magnet	J	0,08						gcm^2

Connection information Motor		IE3-32	IE3-64	IE3-128	IE3-256	IE3 - 512	IE3 - 1024	
Supply voltage Hallsensors [5]	U_{DD}	2,2 ...18				4,5 ... 5,5		V DC

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] $U_{DD\ Enc}$ = 5 V: low logic level < 0,4 V, high logic level > 4,5 V: CMOS- and TTL compatible
[4] at 5 000 rpm
[5] IE3-32/64/128/256 $U_{DD} \neq U_{DD\ ENC}$ (galvanically isolated)
IE3-512 / 1 024 $U_{DD} = U_{DD\ ENC}$

Features / Connector information

Options

- Connector variant (Option no. 3592)

Encoder:
AWG 28 / PVC ribbon cable
with connector PicoBlade (pitch 1,25 mm)

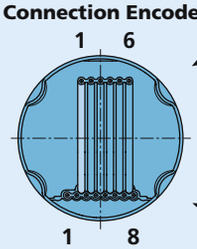
Motor:
AWG 26 / PVC ribbon cable
with connector Micro-Fit

Full product description

- Examples:

2232S024BX4 IE3-1024

Connection Encoder



No.	Function
1	n.c.
2	Channel I (Index)
3	GND Enc
4	$U_{DD\ Enc}$
5	Channel B
6	Channel A

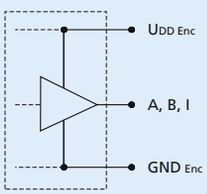
Connection Motor

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD}
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

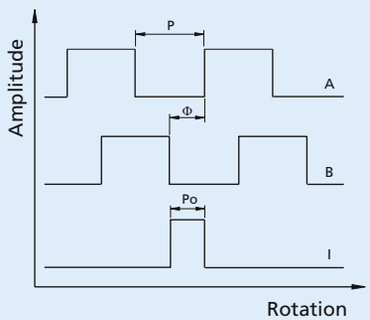
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_o = \left| 90° - \frac{P_o}{P} * 180° \right| \leq 75°$$

Brushless DC-Servomotor 2232 ... BX4 with Encoder		IE3-32 L	IE3-64 L	IE3-128 L	IE3-256 L	IE3-512 L	IE3-1024 L	
Lines per revolution	N	32	64	128	256	512	1024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2+1 index and complementary outputs						channels
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 17, max. 25						mA
Index Pulse width [3]	P_0	90±45				90±75		°e
Phase shift, channel A to B [3]	Φ	90±45				90±75		°e
Inertia of encoder magnet	J	0,08						gcm^2

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] at 5 000 rpm

Notes: The output signals are TIA-422 compatible.
Examples of Line driver Receivers: ST26C32ABD (STM), ST26C32IP16 (EXAR), DS26C32AT (NSC).

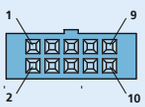
Features / Connector information

Options

- Connector variant (Option no.: 3589)

Motor:
AWG 26 / PVC ribbon cable
with connector Micro-Fit

Encoder:
AWG 28 / PVC ribbon cable
with connector DIN-41651 (pitch 2,54 mm)

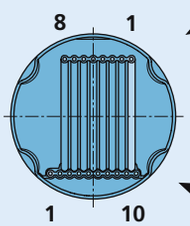


Full product description

- Examples:

2232S024BX4 IE3-1024 L

Connection Motor



No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

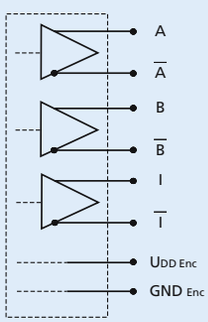
Connection Encoder

No.	Function
1	n.c.
2	$U_{DD\ Enc}$
3	GND_{Enc}
4	n.c.
5	Channel $\overline{A}$
6	Channel A
7	Channel $\overline{B}$
8	Channel B
9	Channel $\overline{I}$ (Index)
10	Channel I (Index)

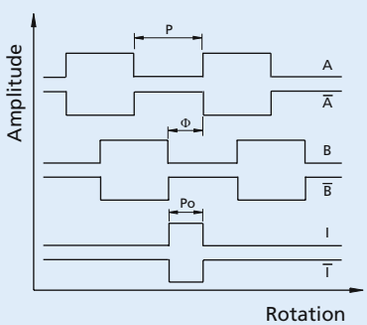
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_O = \left| 90° - \frac{P_O}{P} * 180° \right| \leq 75°$$

Brushless DC-Servomotor 2232 ... BX4 with Encoder		AES-4096	
Lines per revolution (resolution)	N	4 096	
Signal output		Synchronous Serial Interface (SSI)	
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5	V DC
Current consumption, typical [1]	$I_{DD\ Enc}$	typ. 16, max. 23	mA
Output current, max. (DATA) [2]		4	mA
Clock Frequency, max. (CLK)		2	MHz
Input low level (CLK)		0 ... 0,8	V
Input high level (CLK)		2 ... $U_{DD\ Enc}$	V
Setup time after power on, max.	t_{setup}	4	ms
Operating temperature range		– 40 ... +100	°C

[1] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[2] $U_{DD\ Enc}$ = 5 V: low logic level ≤ 0,4 V, high logic level ≥ 4,6 V

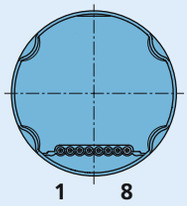
Features / Connector information

Options

- Connector variant (Option no. 3830)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit

Full product description

- Examples:
  2232S024BX4 AES-4096



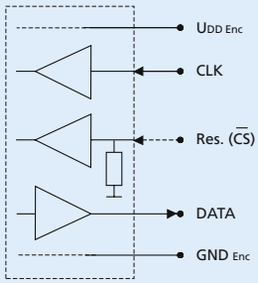
Connection Motor and Encoder

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND Enc
5	$U_{DD\ Enc}$
6	CLK
7	Res. ($\overline{CS}$)
8	DATA

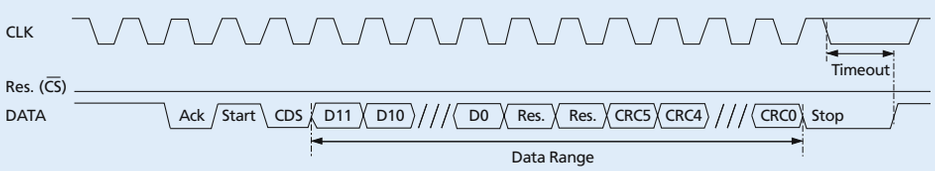
Caution:
Incorrect lead connection will damage the motor electronics!

Circuit diagram / Interface signals

Output circuit



Interface signals (SSI)



Angle position values are ascending for clockwise rotation.
Clockwise rotation as seen from the shaft end

Notes

Brushless DC-Servomotors

with integrated Encoder
4 Pole Technology

25 mNm

For combination with
Gearheads:
22F, 22/7, 26A

2250 ... BX4 S + Encoders

			2250 S		024 BX4 S	
1	Nominal voltage	U_N			24	Volt
2	Terminal resistance, phase-phase	R			5,9	Ω
3	Output power [1]	$P_{2\ max.}$			10,3	W
4	Efficiency	$\eta_{max.}$			70,4	%
5	No-load speed	n_o			10 500	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o			0,105	A
7	Stall torque	M_H			84,7	mNm
8	Friction torque, static	C_o			0,75	mNm
9	Friction torque, dynamic	C_v			$1{,}4 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n			451	rpm/V
11	Back-EMF constant	k_E			2,218	mV/rpm
12	Torque constant	k_M			21,1	mNm/A
13	Current constant	k_I			0,047	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$			125,6	rpm/mNm
15	Terminal inductance, phase-phase	L			250	µH
16	Mechanical time constant	τ_m			6,97	ms
17	Rotor inertia	J			5,3	gcm^2
18	Angular acceleration	$\alpha_{max.}$			160	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	1,2 / 10,5			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,2 / 332			s
21	Operating temperature range		– 40 ... + 100			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4 mm from mounting flange)		20			N
	– axial at 3 000 rpm		2			N
	– axial at standstill		20			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		101			g
27	Direction of rotation		electronically reversible			
28	Number of pole pairs		2			
Recommended values - mathematically independent of each other						
29	Speed up to	$n_{e\ max.}$			30 000	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$			16 / 25	mNm
31	Current up to [1] [2]	$I_{e\ max.}$			0,92 / 1,40	A

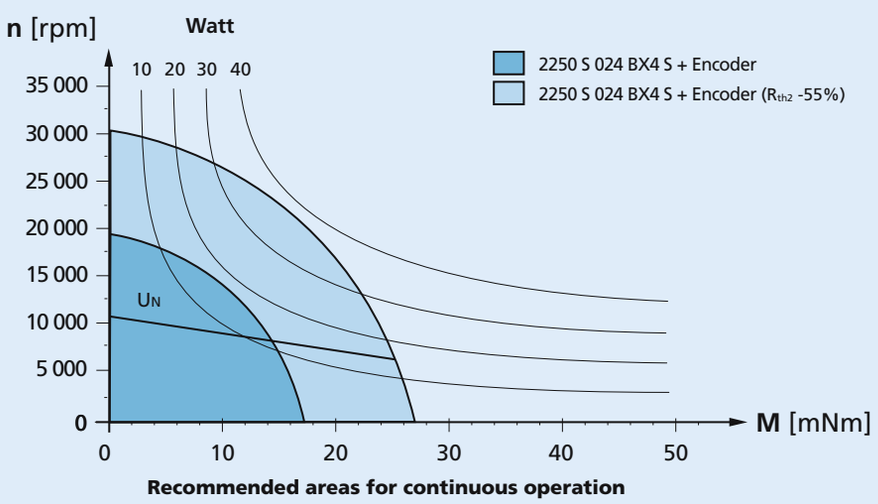
[1] at 5 000 rpm
[2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Features

The brushless DC-servomotors feature in this version an Encoder that is available with different interfaces. A permanent magnet on the shaft creates a moving magnetic field which is captured using a single-chip angular sensor and further processed.

In the **IE3** version, the brushless DC servomotors have an encoder with 3 output channels. At the encoder outputs, two 90° phase-shifted rectangular signals are available with up to 1 024 impulses and an index impulse per motor revolution. The encoder is available in a variety of different resolutions and is suitable for speed control and positioning applications.

The Line Driver **IE3L** version has differential signal outputs (TIA-422). Differential signals reduce ambient interference and are suitable for applications with high ambient interference. The line driver amplifies the encoder signal which means that long cables can be used without signal degradation. Differential signal outputs must be decoded by the appropriate receiver module. The motor and encoder cables are connected via separate ribbon cables.
Other resolutions of 1 - 127 impulses are available on request.

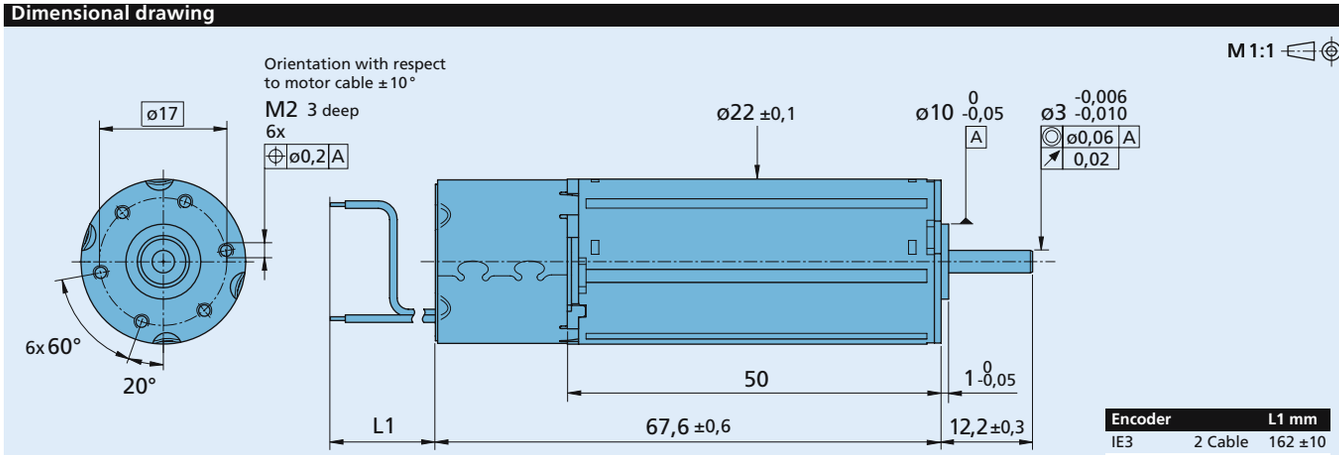
In the **AES** version (absolute encoder), absolute position information is provided with a resolution of 4096 steps per revolution at the signal outputs and communicated via a serial (SSI) interface. Absolute means, that each shaft position is assigned to a unique angular value within one revolution. This value is already available directly after power-on.

The absolute encoder is ideal for commutation, speed and position control of the motor. It can be used to create a sinusoidal commutation signal. The advantages are a reduced torque ripple, a higher efficiency, and reduced electrical noise generation.

Motor and encoder are connected via a common ribbon cable.

For more information about installation and setup a detailed instruction manual is included with the product or is available online at www.faulhaber.com

Dimensional drawing



Encoder		L1 mm
IE3	2 Cable	162 ±10
IE3 L	2 Cable	150 ±10
AES	1 Cable	162 ±10

2250 S ... BX4 S + Encoder

Brushless DC-Servomotor 2250 ... BX4 S with Encoder		IE3-32	IE3-64	IE3-128	IE3-256	IE3-512	IE3-1024	
Lines per revolution	N	32	64	128	256	512	1024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2+1 Index						channels
Supply voltage Encoder	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 16, max. 23						mA
Output current, max. allowable [3]	I_{OUT}	4						mA
Index Pulse width [4]	P_0	90±45				90±75		°e
Phase shift, channel A to B [4]	Φ	90±45				90±75		°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	0,1/0,1						µs
Inertia of encoder magnet	J	0,08						gcm^2
Connection information Motor								
Supply voltage Hallsensors [5]	U_{DD}	2,2 ...18				4,5 ... 5,5		V DC

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] $U_{DD\ Enc}$ = 5 V: low logic level < 0,4 V, high logic level > 4,5 V: CMOS- and TTL compatible
[4] at 5 000 rpm
[5] IE3-32/64/128/256 $U_{DD} \neq U_{DD\ ENC}$ (galvanically isolated)
IE3-512 / 1 024 $U_{DD} = U_{DD\ ENC}$

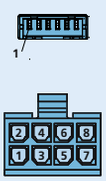
Features / Connector information

Options

- Connector variant (Option no. 3592)

Encoder:
AWG 28 / PVC ribbon cable
with connector PicoBlade (pitch 1,25 mm)

Motor:
AWG 26 / PVC ribbon cable
with connector Micro-Fit

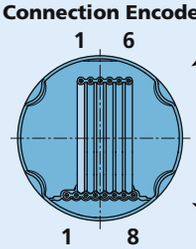


Full product description

- Examples:

2250S024BX4S IE3-1024

Connection Encoder



No.	Function
1	n.c.
2	Channel I (Index)
3	GND Enc
4	$U_{DD\ Enc}$
5	Channel B
6	Channel A

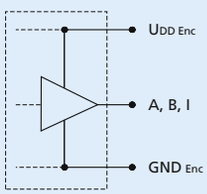
Connection Motor

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD}
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

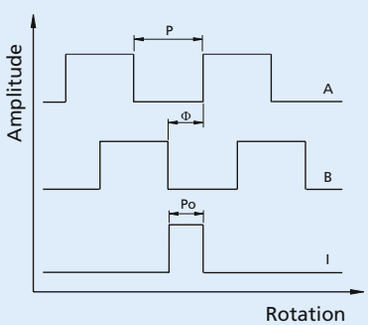
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_o = \left| 90° - \frac{P_o}{P} * 180° \right| \leq 75°$$

Brushless DC-Servomotor 2250 ... BX4 S with Encoder		IE3-32 L	IE3-64 L	IE3-128 L	IE3-256 L	IE3-512 L	IE3-1024 L	
Lines per revolution	N	32	64	128	256	512	1024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2+1 index and complementary outputs						channels
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 17, max. 25						mA
Index Pulse width [3]	P_0	90 ± 45				90 ± 75		°e
Phase shift, channel A to B [3]	Φ	90 ± 45				90 ± 75		°e
Inertia of encoder magnet	J	0,08						gcm^2

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] at 5 000 rpm

Notes: The output signals are TIA-422 compatible.
Examples of Line driver Receivers: ST26C32ABD (STM), ST26C32IP16 (EXAR), DS26C32AT (NSC).

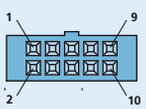
Features / Connector information

Options

- Connector variant (Option no.: 3589)

Motor:
AWG 26 / PVC ribbon cable
with connector Micro-Fit

Encoder:
AWG 28 / PVC ribbon cable
with connector DIN-41651 (pitch 2,54 mm)

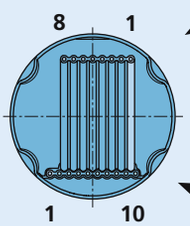


Full product description

- Examples:

2250S024BX4S IE3-1024 L

Connection Motor



No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

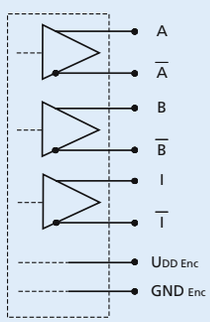
Connection Encoder

No.	Function
1	n.c.
2	$U_{DD\ Enc}$
3	GND_{Enc}
4	n.c.
5	Channel $\overline{A}$
6	Channel A
7	Channel $\overline{B}$
8	Channel B
9	Channel $\overline{I}$ (Index)
10	Channel I (Index)

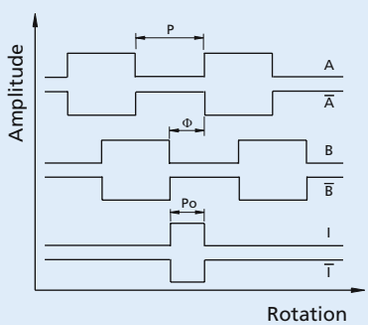
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_0 = \left| 90° - \frac{P_0}{P} * 180° \right| \leq 75°$$

Brushless DC-Servomotor 2250 ... BX4 S with Encoder		AES-4096	
Lines per revolution (resolution)	N	4 096	
Signal output		Synchronous Serial Interface (SSI)	
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5	V DC
Current consumption, typical [1]	$I_{DD\ Enc}$	typ. 16, max. 23	mA
Output current, max. (DATA) [2]		4	mA
Clock Frequency, max. (CLK)		2	MHz
Input low level (CLK)		0 ... 0,8	V
Input high level (CLK)		2 ... $U_{DD\ Enc}$	V
Setup time after power on, max.	t_{setup}	4	ms
Operating temperature range		– 40 ... +100	°C

[1] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[2] $U_{DD\ Enc}$ = 5 V: low logic level ≤ 0,4 V, high logic level ≥ 4,6 V

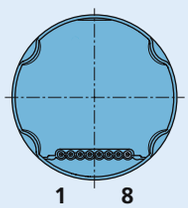
Features / Connector information

Options

- Connector variant (Option no. 3830)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit

Full product description

- Examples:
  2250S024BX4 S AES-4096



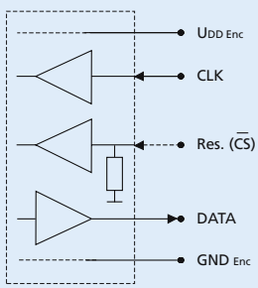
Connection Motor and Encoder

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND Enc
5	$U_{DD\ Enc}$
6	CLK
7	Res. ($\overline{CS}$)
8	DATA

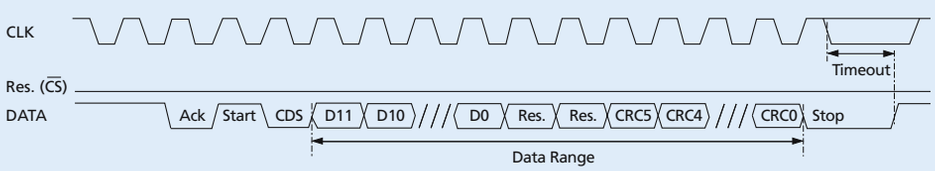
Caution:
Incorrect lead connection will damage the motor electronics!

Circuit diagram / Interface signals

Output circuit



Interface signals (SSI)



Angle position values are ascending for clockwise rotation.
Clockwise rotation as seen from the shaft end

Notes

Brushless DC-Servomotors

with integrated Encoder
4 Pole Technology

43 mNm

For combination with
Gearheads:
22F, 22/7, 26A

2250 ... BX4 + Encoder

		2250 S		024 BX4	
1	Nominal voltage	U_N		24	Volt
2	Terminal resistance, phase-phase	R		5,9	Ω
3	Output power [1]	$P_{2\ max.}$		17,3	W
4	Efficiency	$\eta_{max.}$		75	%
5	No-load speed	n_o		6 000	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,072	A
7	Stall torque	M_H		149	mNm
8	Friction torque, static	C_o		1,2	mNm
9	Friction torque, dynamic	C_v		$2{,}4 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		259	rpm/V
11	Back-EMF constant	k_E		3,860	mV/rpm
12	Torque constant	k_M		36,9	mNm/A
13	Current constant	k_I		0,027	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		41,4	rpm/mNm
15	Terminal inductance, phase-phase	L		240	µH
16	Mechanical time constant	τ_m		4,3	ms
17	Rotor inertia	J		10	gcm^2
18	Angular acceleration	$\alpha_{max.}$		149	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	1,2 / 10,5		K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,2 / 424		s
21	Operating temperature range		– 40 ... + 100		°C
22	Shaft bearings		ball bearings, preloaded		
23	Shaft load max.:				
	– radial at 3 000 rpm (4 mm from mounting flange)		20		N
	– axial at 3 000 rpm		2		N
	– axial at standstill		20		N
24	Shaft play:				
	– radial	≤	0,015		mm
	– axial	=	0		mm
25	Housing material		stainless steel		
26	Weight		117		g
27	Direction of rotation		electronically reversible		
28	Number of pole pairs		2		
Recommended values - mathematically independent of each other					
29	Speed up to	$n_{e\ max.}$		18 000	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$		27 / 43	mNm
31	Current up to [1] [2]	$I_{e\ max.}$		0,89 / 1,37	A

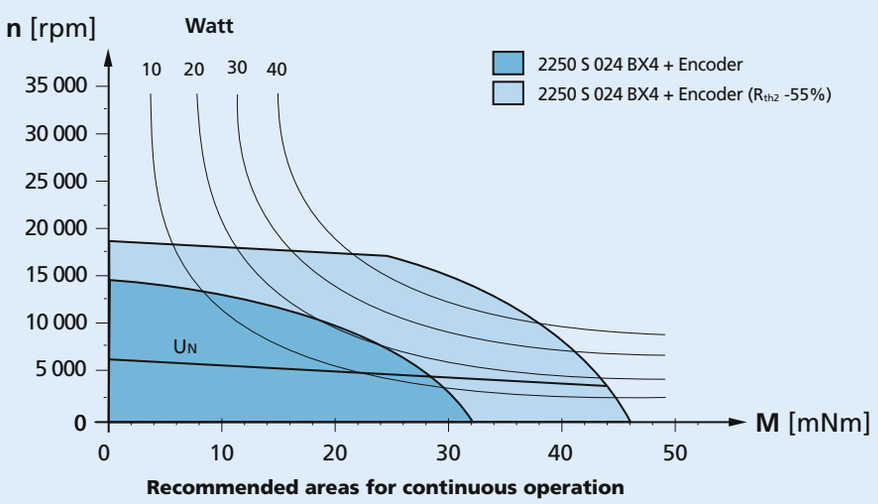
[1] at 5 000 rpm
[2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Features

The brushless DC-servomotors feature in this version an Encoder that is available with different interfaces. A permanent magnet on the shaft creates a moving magnetic field which is captured using a single-chip angular sensor and further processed.

In the **IE3** version, the brushless DC servomotors have an encoder with 3 output channels. At the encoder outputs, two 90° phase-shifted rectangular signals are available with up to 1 024 impulses and an index impulse per motor revolution. The encoder is available in a variety of different resolutions and is suitable for speed control and positioning applications.

The Line Driver **IE3L** version has differential signal outputs (TIA-422). Differential signals reduce ambient interference and are suitable for applications with high ambient interference. The line driver amplifies the encoder signal which means that long cables can be used without signal degradation. Differential signal outputs must be decoded by the appropriate receiver module. The motor and encoder cables are connected via separate ribbon cables.
Other resolutions of 1 - 127 impulses are available on request.

In the **AES** version (absolute encoder), absolute position information is provided with a resolution of 4096 steps per revolution at the signal outputs and communicated via a serial (SSI) interface. Absolute means, that each shaft position is assigned to a unique angular value within one revolution. This value is already available directly after power-on.

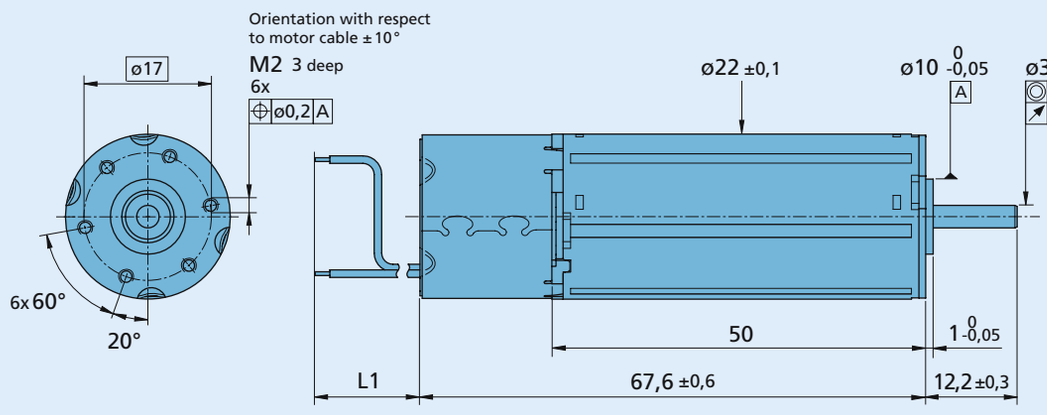
The absolute encoder is ideal for commutation, speed and position control of the motor. It can be used to create a sinusoidal commutation signal. The advantages are a reduced torque ripple, a higher efficiency, and reduced electrical noise generation.

Motor and encoder are connected via a common ribbon cable.

For more information about installation and setup a detailed instruction manual is included with the product or is available online at www.faulhaber.com

Dimensional drawing

M 1:1



Encoder		L1 mm
IE3	2 Cable	162 ±10
IE3 L	2 Cable	150 ±10
AES	1 Cable	162 ±10

2250 S ... BX4 + Encoder

Brushless DC-Servomotor 2250 ... BX4 with Encoder		IE3-32	IE3-64	IE3-128	IE3-256	IE3 - 512	IE3 - 1024	
Lines per revolution	N	32	64	128	256	512	1024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2+1 Index						channels
Supply voltage Encoder	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 16, max. 23						mA
Output current, max. allowable [3]	I_{OUT}	4						mA
Index Pulse width [4]	P_0	90 ± 45				90 ± 75		°e
Phase shift, channel A to B [4]	Φ	90 ± 45				90 ± 75		°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	0,1 / 0,1						µs
Inertia of encoder magnet	J	0,08						gcm^2

Connection information Motor				
Supply voltage Hallsensors [5]	U_{DD}	2,2 ...18	4,5 ... 5,5	V DC

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] $U_{DD\ Enc}$ = 5 V: low logic level < 0,4 V, high logic level > 4,5 V: CMOS- and TTL compatible
[4] at 5 000 rpm
[5] IE3-32/64/128/256 $U_{DD} \neq U_{DD\ ENC}$ (galvanically isolated)
IE3-512 / 1 024 $U_{DD} = U_{DD\ ENC}$

Features / Connector information

Options

- Connector variant (Option no. 3592)

Encoder:
AWG 28 / PVC ribbon cable
with connector PicoBlade (pitch 1,25 mm)

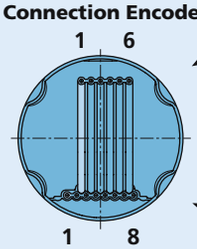
Motor:
AWG 26 / PVC ribbon cable
with connector Micro-Fit

Full product description

- Examples:

2250S024BX4 IE3-1024

Connection Encoder



No.	Function
1	n.c.
2	Channel I (Index)
3	GND Enc
4	$U_{DD\ Enc}$
5	Channel B
6	Channel A

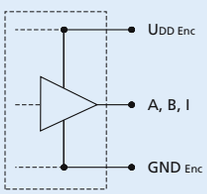
Connection Motor

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD}
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

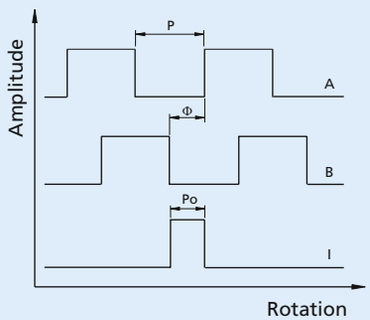
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_o = \left| 90° - \frac{P_o}{P} * 180° \right| \leq 75°$$

Brushless DC-Servomotor 2250 ... BX4 with Encoder		IE3-32 L	IE3-64 L	IE3-128 L	IE3-256 L	IE3-512 L	IE3-1024 L	
Lines per revolution	N	32	64	128	256	512	1024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2+1 index and complementary outputs						channels
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 17, max. 25						mA
Index Pulse width [3]	P_0	90±45				90±75		°e
Phase shift, channel A to B [3]	Φ	90±45				90±75		°e
Inertia of encoder magnet	J	0,08						gcm^2

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] at 5 000 rpm

Notes: The output signals are TIA-422 compatible.
Examples of Line driver Receivers: ST26C32ABD (STM), ST26C32IP16 (EXAR), DS26C32AT (NSC).

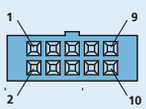
Features / Connector information

Options

- Connector variant (Option no.: 3589)

Motor:
AWG 26 / PVC ribbon cable
with connector Micro-Fit

Encoder:
AWG 28 / PVC ribbon cable
with connector DIN-41651 (pitch 2,54 mm)

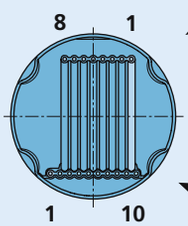


Full product description

- Examples:

2250S024BX4 IE3-1024 L

Connection Motor



No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

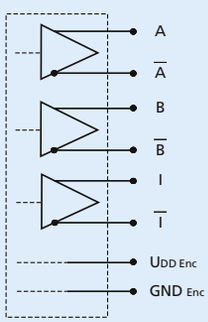
Connection Encoder

No.	Function
1	n.c.
2	$U_{DD\ Enc}$
3	GND_{Enc}
4	n.c.
5	Channel $\overline{A}$
6	Channel A
7	Channel $\overline{B}$
8	Channel B
9	Channel $\overline{I}$ (Index)
10	Channel I (Index)

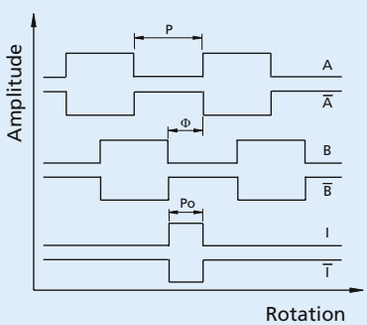
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_o = \left| 90° - \frac{P_o}{P} * 180° \right| \leq 75°$$

Brushless DC-Servomotor 2250 ... BX4 with Encoder		AES-4096	
Lines per revolution (resolution)	N	4 096	
Signal output		Synchronous Serial Interface (SSI)	
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5	V DC
Current consumption, typical [1]	$I_{DD\ Enc}$	typ. 16, max. 23	mA
Output current, max. (DATA) [2]		4	mA
Clock Frequency, max. (CLK)		2	MHz
Input low level (CLK)		0 ... 0,8	V
Input high level (CLK)		2 ... $U_{DD\ Enc}$	V
Setup time after power on, max.	t_{setup}	4	ms
Operating temperature range		– 40 ... +100	°C

[1] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[2] $U_{DD\ Enc}$ = 5 V: low logic level ≤ 0,4 V, high logic level ≥ 4,6 V

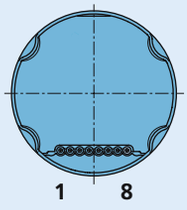
Features / Connector information

Options

- Connector variant (Option no. 3830)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit

Full product description

- Examples:
  2250S024BX4 AES-4096



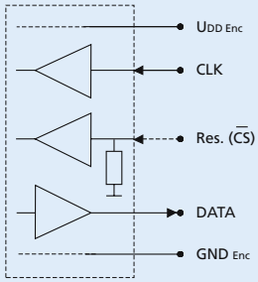
Connection Motor and Encoder

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND Enc
5	$U_{DD\ Enc}$
6	CLK
7	Res. ($\overline{CS}$)
8	DATA

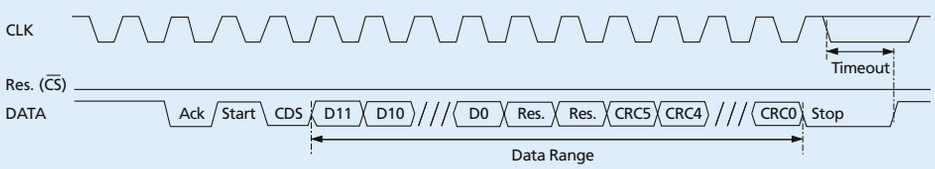
Caution:
Incorrect lead connection will damage the motor electronics!

Circuit diagram / Interface signals

Output circuit



Interface signals (SSI)



Angle position values are ascending for clockwise rotation.
Clockwise rotation as seen from the shaft end

Notes

Brushless DC-Servomotors

with integrated Encoder
4 Pole Technology

55 mNm

For combination with
Gearheads:
30/1, 32A, 32/3, 32/3 S, 38/1, 38/1 S, 38/2, 38/2 S

3242 ... BX4 + Encoders

		3242 G		012 BX4	024 BX4	
1	Nominal voltage	U_N		12	24	Volt
2	Terminal resistance, phase-phase	R		0,89	3,60	Ω
3	Output power [1]	$P_{2\ max.}$		21,2	21,1	W
4	Efficiency	$\eta_{max.}$		77,4	77,3	%
5	No-load speed	n_o		5 600	5 500	rpm
6	No-load current	I_o		0,206	0,103	A
7	Stall torque	M_H		282	279	mNm
8	Friction torque, static	C_o		1,3	1,3	mNm
9	Friction torque, dynamic	C_v		$5{,}2 \cdot 10^{-4}$	$5{,}2 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		455	227	rpm/V
11	Back-EMF constant	k_E		2,199	4,409	mV/rpm
12	Torque constant	k_M		21,0	42,1	mNm/A
13	Current constant	k_I		0,0476	0,0238	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		19,3	19,4	rpm/mNm
15	Terminal inductance, phase-phase	L		60	240	µH
16	Mechanical time constant	τ_m		6,1	6,1	ms
17	Rotor inertia	J		30	30	gcm^2
18	Angular acceleration	$\alpha_{max.}$		94	93	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	1,6 / 12,4			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	9 / 810			s
21	Operating temperature range		– 40 ... + 100			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4,5 mm from mounting flange)		50			N
	– axial at 3 000 rpm		5			N
	– axial at standstill		50			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		194			g
27	Direction of rotation		electronically reversible			
28	Number of pole pairs		2			
Recommended values - mathematically independent of each other						
29	Speed up to	$n_{e\ max.}$		14 000	14 000	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$		32 / 55	32 / 54	mNm
31	Current up to [1] [2]	$I_{e\ max.}$		1,89 / 3,12	0,94 / 1,55	A

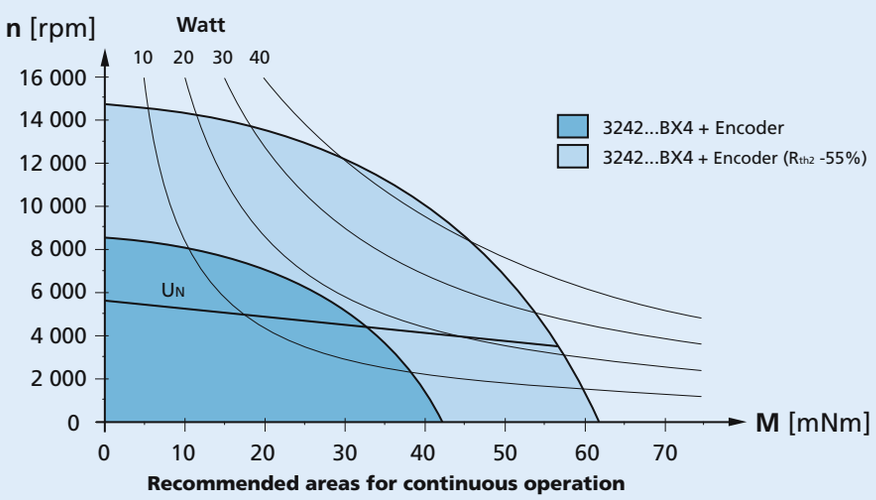
[1] at 5 000 rpm
[2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Features

The brushless DC-servomotors feature in this version an Encoder that is available with different interfaces. A permanent magnet on the shaft creates a moving magnetic field which is captured using a single-chip angular sensor and further processed.

In the **IE3** version, the brushless DC servomotors have an encoder with 3 output channels. At the encoder outputs, two 90° phase-shifted rectangular signals are available with up to 1 024 impulses and an index impulse per motor revolution. The encoder is available in a variety of different resolutions and is suitable for speed control and positioning applications.

The Line Driver **IE3L** version has differential signal outputs (TIA-422). Differential signals reduce ambient interference and are suitable for applications with high ambient interference. The line driver amplifies the encoder signal which means that long cables can be used without signal degradation. Differential signal outputs must be decoded by the appropriate receiver module. The motor and encoder cables are connected via separate ribbon cables.
Other resolutions of 1 - 127 impulses are available on request.

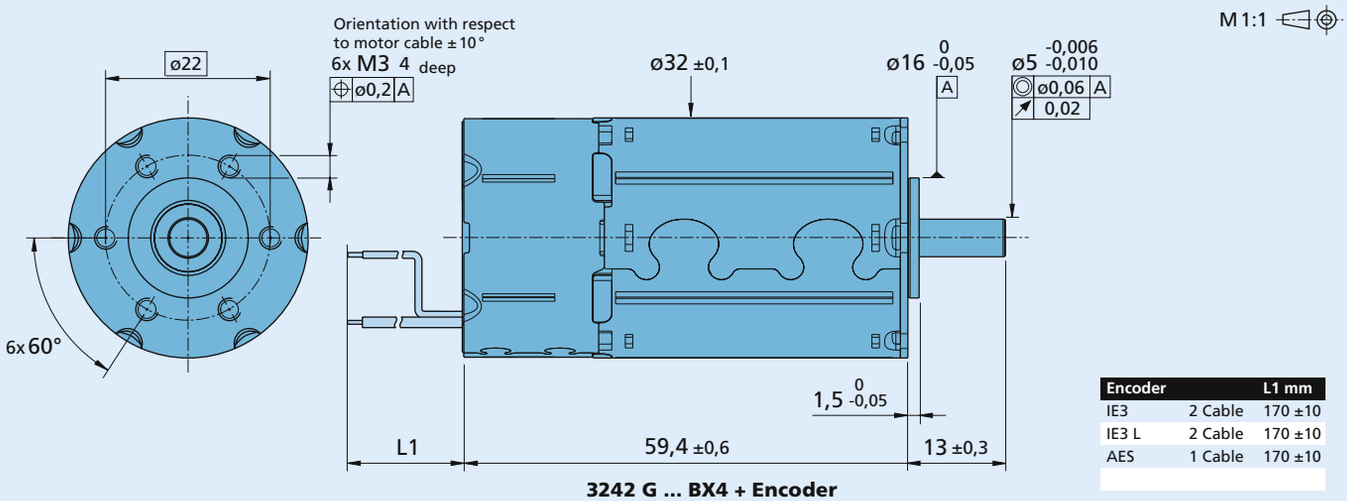
In the **AES** version (absolute encoder), absolute position information is provided with a resolution of 4096 steps per revolution at the signal outputs and communicated via a serial (SSI) interface. Absolute means, that each shaft position is assigned to a unique angular value within one revolution. This value is already available directly after power-on.

The absolute encoder is ideal for commutation, speed and position control of the motor. It can be used to create a sinusoidal commutation signal. The advantages are a reduced torque ripple, a higher efficiency, and reduced electrical noise generation.

Motor and encoder are connected via a common ribbon cable.

For more information about installation and setup a detailed instruction manual is included with the product or is available online at www.faulhaber.com

Dimensional drawing



3242 G ... BX4 + Encoder

Encoder		L1 mm
IE3	2 Cable	170 ±10
IE3 L	2 Cable	170 ±10
AES	1 Cable	170 ±10

Brushless DC-Servomotor 3242 ... BX4 with Encoder		IE3-32	IE3-64	IE3-128	IE3-256	IE3-512	IE3-1024	
Lines per revolution	N	32	64	128	256	512	1024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2+1 Index						channels
Supply voltage Encoder	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 16, max. 23						mA
Output current, max. allowable [3]	I_{OUT}	4						mA
Index Pulse width [4]	P_0	90±45				90±75		°e
Phase shift, channel A to B [4]	Φ	90±45				90±75		°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	0,1/0,1						µs
Inertia of encoder magnet	J	0,08						gcm^2

Connection information Motor				
Supply voltage Hallsensors [5]	U_{DD}	2,2 ...18	4,5 ... 5,5	V DC

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] $U_{DD\ Enc}$ = 5 V: low logic level < 0,4 V, high logic level > 4,5 V: CMOS- and TTL compatible
[4] at 5 000 rpm
[5] IE3-32/64/128/256 $U_{DD} \neq U_{DD\ ENC}$ (galvanically isolated)
IE3-512 / 1 024 $U_{DD} = U_{DD\ ENC}$

Features / Connector information

Options

- Connector variant (Option no. 3592)

Encoder:
AWG 28 / PVC ribbon cable
with connector PicoBlade (pitch 1,25 mm)

Motor:
AWG 24 / PVC ribbon cable
with connector Micro-Fit

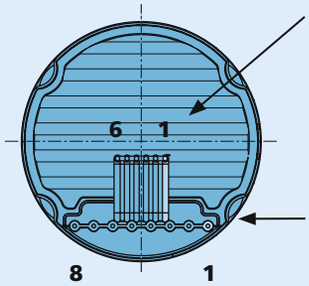
Full product description

- Examples:

3242G024BX4 IE3-1024

3242G012BX4 IE3-32

Connection Encoder



No.	Function
1	n.c.
2	Channel I (Index)
3	GND_{Enc}
4	$U_{DD\ Enc}$
5	Channel B
6	Channel A

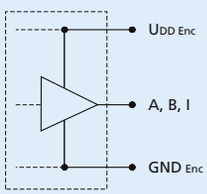
Connection Motor

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD}
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

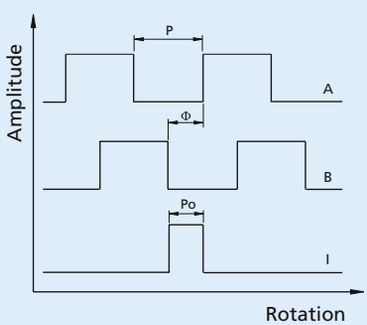
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen
from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_o = \left| 90° - \frac{P_o}{P} * 180° \right| \leq 75°$$

Brushless DC-Servomotor 3242 ... BX4 with Encoder		IE3-32 L	IE3-64 L	IE3-128 L	IE3-256 L	IE3-512 L	IE3-1024 L	
Lines per revolution	N	32	64	128	256	512	1024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2+1 index and complementary outputs						channels
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 17, max. 25						mA
Index Pulse width [3]	P_0	90±45				90±75		°e
Phase shift, channel A to B [3]	Φ	90±45				90±75		°e
Inertia of encoder magnet	J	0,08						gcm^2

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] at 5 000 rpm

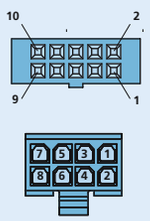
Notes: The output signals are TIA-422 compatible.
Examples of Line driver Receivers: ST26C32ABD (STM), ST26C32IP16 (EXAR), DS26C32AT (NSC).

Features / Connector information

Options

- Connector variant (Option no.: 3589)

Encoder:
AWG 28 / PVC ribbon cable
with connector DIN-41651 (pitch 2,54 mm)



Motor:
AWG 24 / PVC ribbon cable
with connector Micro-Fit

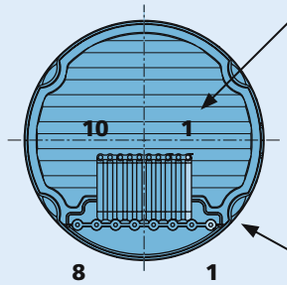
Full product description

- Examples:

3242G024BX4 IE3-1024 L

3242G012BX4 IE3-32 L

Connection Encoder



No.	Function
1	n.c.
2	$U_{DD\ Enc}$
3	GND_{Enc}
4	n.c.
5	Channel $\overline{A}$
6	Channel A
7	Channel $\overline{B}$
8	Channel B
9	Channel $\overline{I}$ (Index)
10	Channel I (Index)

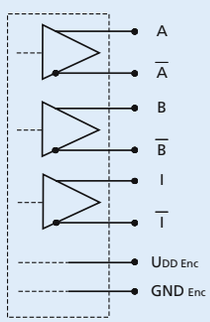
Connection Motor

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

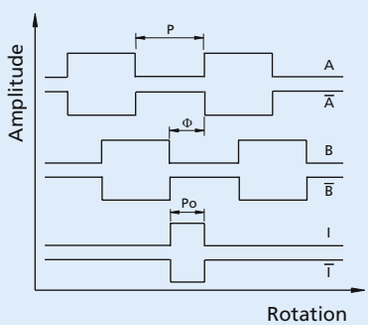
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_0 = \left| 90° - \frac{P_0}{P} * 180° \right| \leq 75°$$

Brushless DC-Servomotor 3242 ... BX4 with Encoder		AES-4096	
Lines per revolution (resolution)	N	4 096	
Signal output		Synchronous Serial Interface (SSI)	
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5	V DC
Current consumption, typical [1]	$I_{DD\ Enc}$	typ. 16, max. 23	mA
Output current, max. (DATA) [2]		4	mA
Clock Frequency, max. (CLK)		2	MHz
Input low level (CLK)		0 ... 0,8	V
Input high level (CLK)		2 ... $U_{DD\ Enc}$	V
Setup time after power on, max.	t_{setup}	4	ms
Operating temperature range		– 40 ... +100	°C

[1] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[2] $U_{DD\ Enc}$ = 5 V: low logic level ≤ 0,4 V, high logic level ≥ 4,6 V

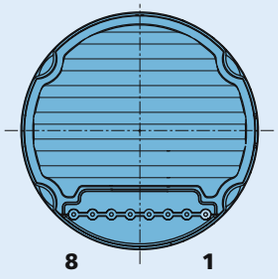
Features / Connector information

Options

- Connector variant (Option no. 3830)
  AWG 24 / PVC ribbon cable
  with connector Micro-Fit

Full product description

- Examples:
  3242G024BX4 AES-4096
  3242G012BX4 AES-4096



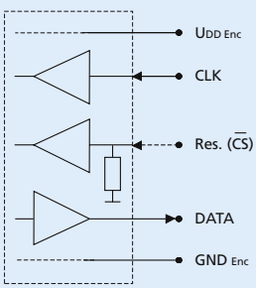
Connection Motor and Encoder

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND $_{Enc}$
5	$U_{DD\ Enc}$
6	CLK
7	Res. ($\overline{CS}$)
8	DATA

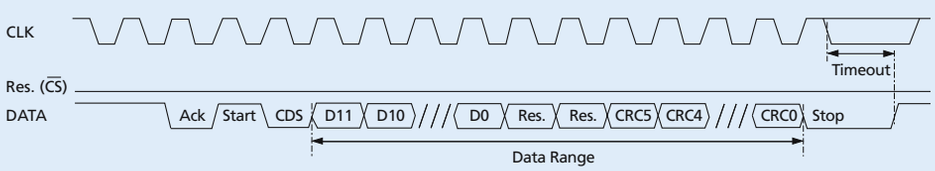
Caution:
Incorrect lead connection will damage the motor electronics!

Circuit diagram / Interface signals

Output circuit



Interface signals (SSI)



Angle position values are ascending for clockwise rotation.
Clockwise rotation as seen from the shaft end

Notes

Brushless DC-Servomotors

with integrated Encoder
4 Pole Technology

92 mNm

For combination with
Gearheads:
30/1, 32A, 32/3, 32/3 S, 38/1, 38/1 S, 38/2, 38/2 S

3268 ... BX4 + Encoders

			3268 G		024 BX4	
1	Nominal voltage	U_N			24	Volt
2	Terminal resistance, phase-phase	R			1,45	Ω
3	Output power [1]	$P_{2\ max.}$			32,7	W
4	Efficiency	$\eta_{max.}$			79,5	%
5	No-load speed	n_o			5 500	rpm
6	No-load current	I_o			0,215	A
7	Stall torque	M_H			718	mNm
8	Friction torque, static	C_o			1,7	mNm
9	Friction torque, dynamic	C_v			$1{,}3 \cdot 10^{-3}$	mNm/rpm
10	Speed constant	k_n			220	rpm/V
11	Back-EMF constant	k_E			4,555	mV/rpm
12	Torque constant	k_M			43,5	mNm/A
13	Current constant	k_I			0,0230	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$			7,3	rpm/mNm
15	Terminal inductance, phase-phase	L			110	µH
16	Mechanical time constant	τ_m			4,6	ms
17	Rotor inertia	J			60	gcm^2
18	Angular acceleration	$\alpha_{max.}$			120	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	1,9 / 9,6			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	17 / 1 060			s
21	Operating temperature range		– 40 ... +100			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4,5 mm from mounting flange)		50			N
	– axial at 3 000 rpm		5			N
	– axial at standstill		50			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		307			g
27	Direction of rotation		electronically reversible			
28	Number of pole pairs		2			
Recommended values - mathematically independent of each other						
29	Speed up to	$n_{e\ max.}$			11 000	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$			47 / 92	mNm
31	Current up to [1] [2]	$I_{e\ max.}$			1,41 / 2,59	A

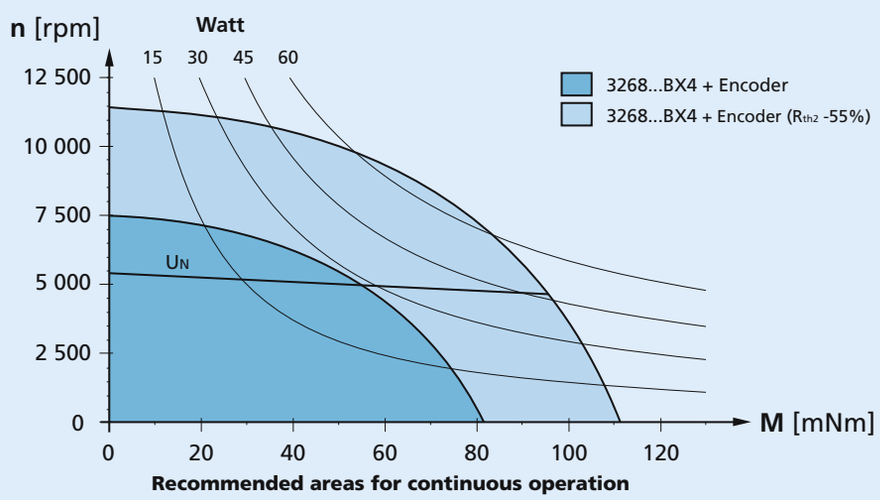
[1] at 5 000 rpm
[2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Features

The brushless DC-servomotors feature in this version an Encoder that is available with different interfaces. A permanent magnet on the shaft creates a moving magnetic field which is captured using a single-chip angular sensor and further processed.

In the **IE3** version, the brushless DC servomotors have an encoder with 3 output channels. At the encoder outputs, two 90° phase-shifted rectangular signals are available with up to 1 024 impulses and an index impulse per motor revolution. The encoder is available in a variety of different resolutions and is suitable for speed control and positioning applications.

The Line Driver **IE3L** version has differential signal outputs (TIA-422). Differential signals reduce ambient interference and are suitable for applications with high ambient interference. The line driver amplifies the encoder signal which means that long cables can be used without signal degradation. Differential signal outputs must be decoded by the appropriate receiver module. The motor and encoder cables are connected via separate ribbon cables.
Other resolutions of 1 - 127 impulses are available on request.

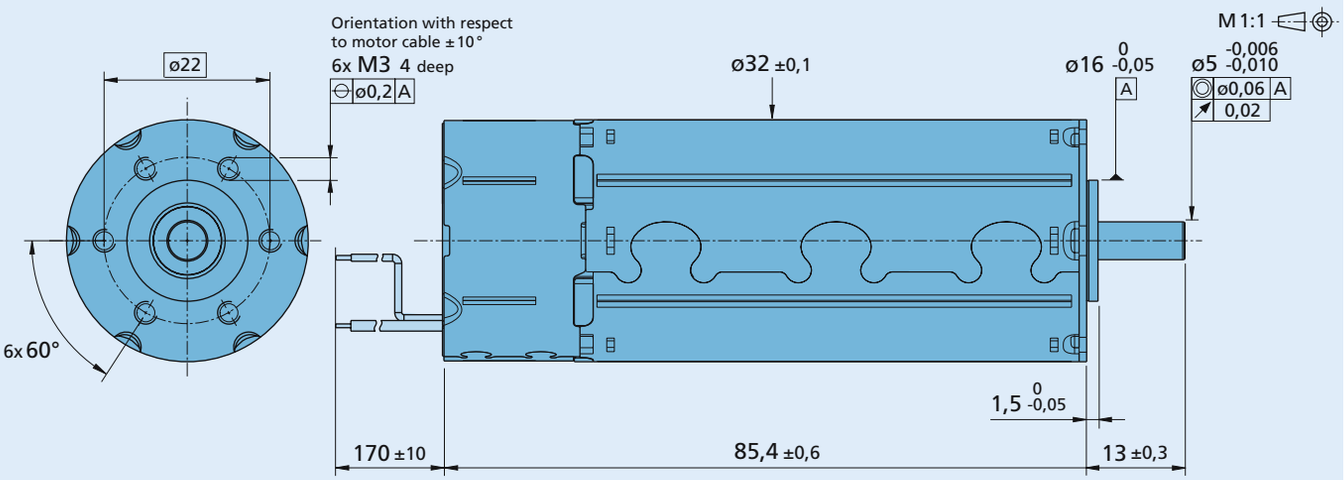
In the **AES** version (absolute encoder), absolute position information is provided with a resolution of 4096 steps per revolution at the signal outputs and communicated via a serial (SSI) interface. Absolute means, that each shaft position is assigned to a unique angular value within one revolution. This value is already available directly after power-on.

The absolute encoder is ideal for commutation, speed and position control of the motor. It can be used to create a sinusoidal commutation signal. The advantages are a reduced torque ripple, a higher efficiency, and reduced electrical noise generation.

Motor and encoder are connected via a common ribbon cable.

For more information about installation and setup a detailed instruction manual is included with the product or is available online at www.faulhaber.com

Dimensional drawing



3268 G ... BX4 + Encoder

Brushless DC-Servomotor 3268 ... BX4 with Encoder		IE3-32	IE3-64	IE3-128	IE3-256	IE3 - 512	IE3 - 1024	
Lines per revolution	N	32	64	128	256	512	1024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2+1 Index						
Supply voltage Encoder	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 16, max. 23						mA
Output current, max. allowable [3]	I_{OUT}	4						mA
Index Pulse width [4]	P_0	90 ± 45				90 ± 75		°e
Phase shift, channel A to B [4]	Φ	90 ± 45				90 ± 75		°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	0,1 / 0,1						µs
Inertia of encoder magnet	J	0,08						gcm^2

Connection information Motor				
Supply voltage Hallsensors [5]	U_{DD}	2,2 ...18	4,5 ... 5,5	V DC

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] $U_{DD\ Enc}$ = 5 V: low logic level < 0,4 V, high logic level > 4,5 V: CMOS- and TTL compatible
[4] at 5 000 rpm
[5] IE3-32/64/128/256 $U_{DD} \neq U_{DD\ ENC}$ (galvanically isolated)
IE3-512 / 1 024 $U_{DD} = U_{DD\ ENC}$

Features / Connector information

Options

- Connector variant (Option no. 3592)

Encoder:
AWG 28 / PVC ribbon cable
with connector PicoBlade (pitch 1,25 mm)

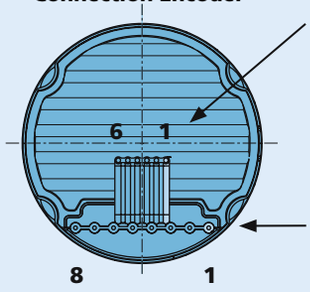
Motor:
AWG 24 / PVC ribbon cable
with connector Micro-Fit

Full product description

- Examples:

3268G024BX4 IE3-1024

Connection Encoder



No.	Function
1	n.c.
2	Channel I (Index)
3	GND Enc
4	$U_{DD\ Enc}$
5	Channel B
6	Channel A

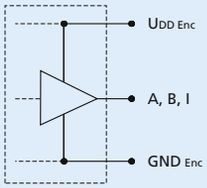
Connection Motor

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD}
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

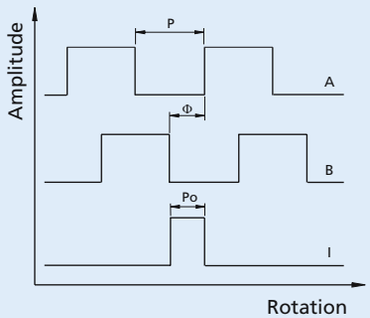
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_o = \left| 90° - \frac{P_o}{P} * 180° \right| \leq 75°$$

Brushless DC-Servomotor 3268 ... BX4 with Encoder		IE3-32 L	IE3-64 L	IE3-128 L	IE3-256 L	IE3-512 L	IE3-1024 L	
Lines per revolution	N	32	64	128	256	512	1 024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2+1 index and complementary outputs						channels
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 17, max. 25						mA
Index Pulse width [3]	P_0	90 ± 45				90 ± 75		°e
Phase shift, channel A to B [3]	Φ	90 ± 45				90 ± 75		°e
Inertia of encoder magnet	J	0,08						gcm^2

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] at 5 000 rpm

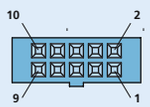
Notes: The output signals are TIA-422 compatible.
Examples of Line driver Receivers: ST26C32ABD (STM), ST26C32IP16 (EXAR), DS26C32AT (NSC).

Features / Connector information

Options

- Connector variant (Option no.: 3589)

Encoder:
AWG 28 / PVC ribbon cable
with connector DIN-41651 (pitch 2,54 mm)



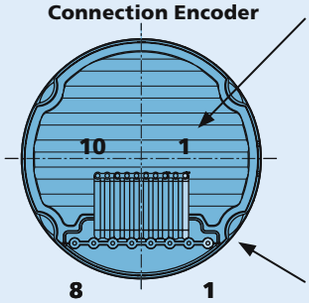
Motor:
AWG 24 / PVC ribbon cable
with connector Micro-Fit

Full product description

- Examples:

3268G024BX4 IE3-1024 L

Connection Encoder



Connection Motor

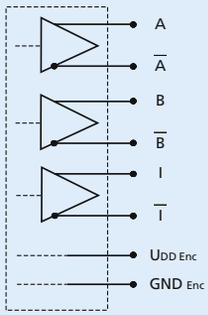
No.	Function
1	n.c.
2	$U_{DD\ Enc}$
3	GND_{Enc}
4	n.c.
5	Channel $\overline{A}$
6	Channel A
7	Channel $\overline{B}$
8	Channel B
9	Channel $\overline{I}$ (Index)
10	Channel I (Index)

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

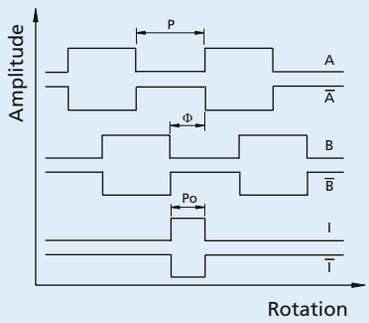
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_0 = \left| 90° - \frac{P_0}{P} * 180° \right| \leq 75°$$

Brushless DC-Servomotor 3268 ... BX4 with Encoder		AES-4096	
Lines per revolution (resolution)	N	4 096	
Signal output		Synchronous Serial Interface (SSI)	
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5	V DC
Current consumption, typical [1]	$I_{DD\ Enc}$	typ. 16, max. 23	mA
Output current, max. (DATA) [2]		4	mA
Clock Frequency, max. (CLK)		2	MHz
Input low level (CLK)		0 ... 0,8	V
Input high level (CLK)		2 ... $U_{DD\ Enc}$	V
Setup time after power on, max.	t_{setup}	4	ms
Operating temperature range		– 40 ... +100	°C

[1] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[2] $U_{DD\ Enc}$ = 5 V: low logic level ≤ 0,4 V, high logic level ≥ 4,6 V

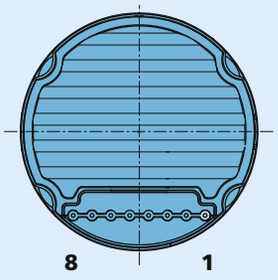
Features / Connector information

Options

- Connector variant (Option no. 3830)
  AWG 24 / PVC ribbon cable
  with connector Micro-Fit

Full product description

- Examples:
  3268G024BX4 AES-4 096



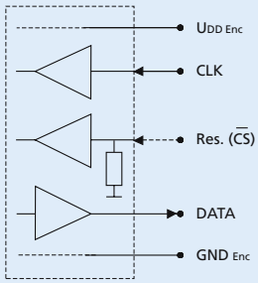
Connection Motor and Encoder

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND Enc
5	$U_{DD\ Enc}$
6	CLK
7	Res. ($\overline{CS}$)
8	DATA

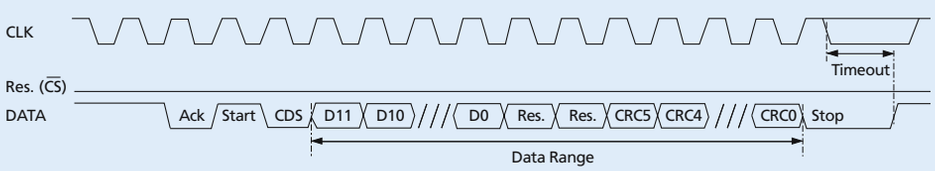
Caution:
Incorrect lead connection will damage the motor electronics!

Circuit diagram / Interface signals

Output circuit



Interface signals (SSI)



Angle position values are ascending for clockwise rotation.
Clockwise rotation as seen from the shaft end