

**NEW**

# Brushless DC-Servomotors

with integrated Encoder  
4 Pole Technology

11 / 22 mNm

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

## Series 2232 ... BX4 IE3

	2232 S	012 BX4 S	024 BX4 S	012 BX4	024 BX4	IE3
1 Nominal voltage	U <sub>N</sub>	12	24	12	24	Volt
2 Terminal resistance, phase-phase	R	3,5	12,4	3,5	12,4	Ω
3 Output power <sup>1)</sup>	P <sub>2 max.</sub>	4,4	4,5	8,8	8,9	W
4 Efficiency	η <sub>max.</sub>	60,9	61,7	66,9	67,6	%
5 No-load speed	n <sub>0</sub>	13 200	14 000	6 600	7 000	rpm
6 No-load current (with shaft ø 3,0 mm)	I <sub>0</sub>	0,163	0,088	0,112	0,061	A
7 Stall torque	M <sub>H</sub>	27,3	29,4	55,7	59,9	mNm
8 Friction torque, static	C <sub>0</sub>	0,6	0,6	0,85	0,85	mNm
9 Friction torque, dynamic	C <sub>v</sub>	5,5 · 10 <sup>-5</sup>	5,5 · 10 <sup>-5</sup>	1,5 · 10 <sup>-4</sup>	1,5 · 10 <sup>-4</sup>	mNm/rpm
10 Speed constant	k <sub>n</sub>	1 173	616	579	304	rpm/V
11 Back-EMF constant	k <sub>E</sub>	0,852	1,623	1,728	3,288	mV/rpm
12 Torque constant	k <sub>M</sub>	8,14	15,50	16,50	31,40	mNm/A
13 Current constant	k <sub>I</sub>	0,123	0,065	0,061	0,032	A/mNm
14 Slope of n-M curve	Δn/ΔM	504	493	123	120	rpm/mNm
15 Terminal inductance, phase-phase	L	130	470	120	440	μH
16 Mechanical time constant	τ <sub>m</sub>	22	22	6,7	6,5	ms
17 Rotor inertia	J	4,2	4,2	5,2	5,2	gcm <sup>2</sup>
18 Angular acceleration	α <sub>max.</sub>	65	70	107	115	·10 <sup>3</sup> rad/s <sup>2</sup>
19 Thermal resistance	R <sub>th 1</sub> / R <sub>th 2</sub>	2 / 13		2 / 13		K/W
20 Thermal time constant	τ <sub>w1</sub> / τ <sub>w2</sub>	4,1 / 274		4,1 / 283		s
21 Operating temperature range		- 40 ... + 100		- 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				
<b>Recommended values - mathematically independent of each other</b>						
29 Speed up to	n <sub>e max.</sub>	40 000	40 000	25 000	20 000	rpm
30 Torque up to <sup>1) 2)</sup>	M <sub>e max.</sub>	7 / 11	7 / 11	14 / 22	14 / 22	mNm
31 Current up to <sup>1) 2)</sup>	I <sub>e max.</sub>	1,06 / 1,61	0,58 / 0,86	1,05 / 1,60	0,56 / 0,85	A

<sup>1)</sup> at 5 000 rpm

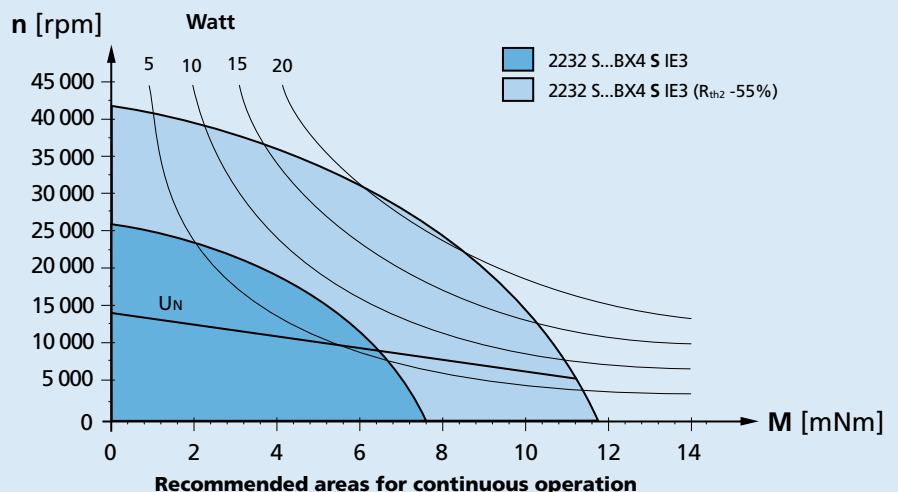
<sup>2)</sup> thermal resistance R<sub>th 2</sub> not reduced / thermal resistance R<sub>th 2</sub> by 55% reduced

**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<sub>th 2</sub> 55% reduced).

The nominal voltage (U<sub>N</sub>) 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.

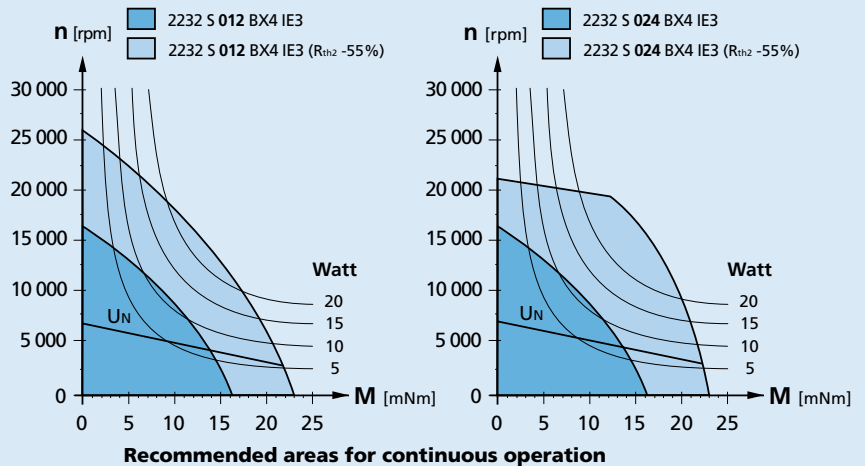


**Note:**

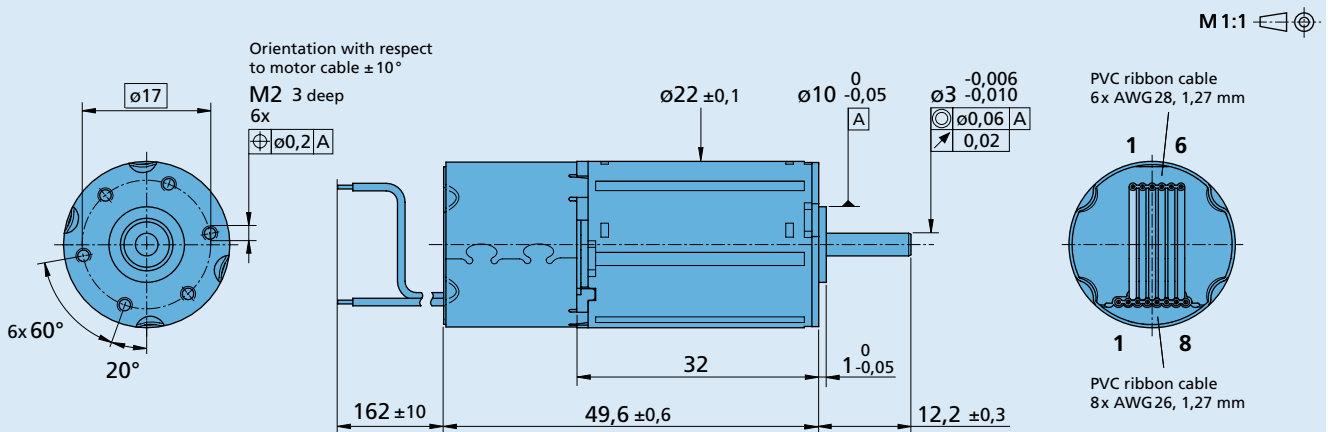
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ( $R_{th} \geq 55\%$  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**



<b>Magnetic Encoder</b>		<b>IE3-32</b>	<b>IE3-64</b>	<b>IE3-128</b>	<b>IE3-256</b>	<b>IE3-512</b>	<b>IE3-1024</b>	
Lines per revolution	N	32	64	128	256	512	1024	
Frequency range <sup>1)</sup> , 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 <sup>2)</sup>	$I_{DD\ Enc}$	typ. 16, max. 23						mA
Output current, max. allowable <sup>3)</sup>	$I_{OUT}$	4						mA
Index Pulse width <sup>4)</sup>	$P_0$	90 ± 45				90 ± 75		°e
Phase shift, channel A to B <sup>4)</sup>	$\Phi$	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 <sup>2</sup>

<b>Connection information Motor</b>		<b>IE3-32</b>	<b>IE3-64</b>	<b>IE3-128</b>	<b>IE3-256</b>	<b>IE3-512</b>	<b>IE3-1024</b>	
Supply voltage Hallsensors <sup>5)</sup>	$U_{DD}$	2,2 ... 18				4,5 ... 5,5		V DC

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

## Features

In this version, the brushless DC servomotors have an encoder with 3 output channels. A permanent magnet on the shaft creates a moving magnetic field which is captured using a single-chip angular sensor and further processed. At the encoder outputs, two 90° phase-shifted rectangular signals are available with up to 1024 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 motor and encoder cables are connected via separate ribbon cables.

A detailed instruction manual is included with the product or is available online at [www.faulhaber.com](http://www.faulhaber.com)

Other resolutions of 1 - 127 impulses are available on request.

## Options

- Connector variant (Option no. 3592)

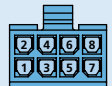
### Encoder:

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:

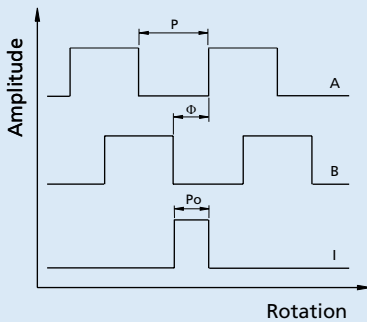
2232S024BX4 IE3-1 024

2232S012BX4S IE3-32

## Output signals / Circuit diagram / Connector information

### Output signals

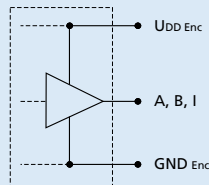
with clockwise rotation as seen from the shaft end



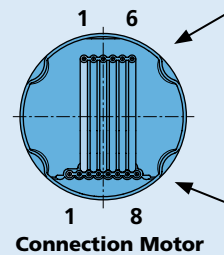
Admissible deviation of phase shift/Index pulse:

$$\Delta\Phi = \left| 90^\circ - \frac{\Phi}{P} * 180^\circ \right| \leq 75^\circ \quad \Delta P_0 = \left| 90^\circ - \frac{P_0}{P} * 180^\circ \right| \leq 75^\circ$$

### Output circuit



### Connection Encoder



No.	Function
1	n.c.
2	Channel I (Index)
3	GND Enc
4	UDD Enc
5	Channel B
6	Channel A

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

### Caution:

Incorrect lead connection will damage the motor electronics!