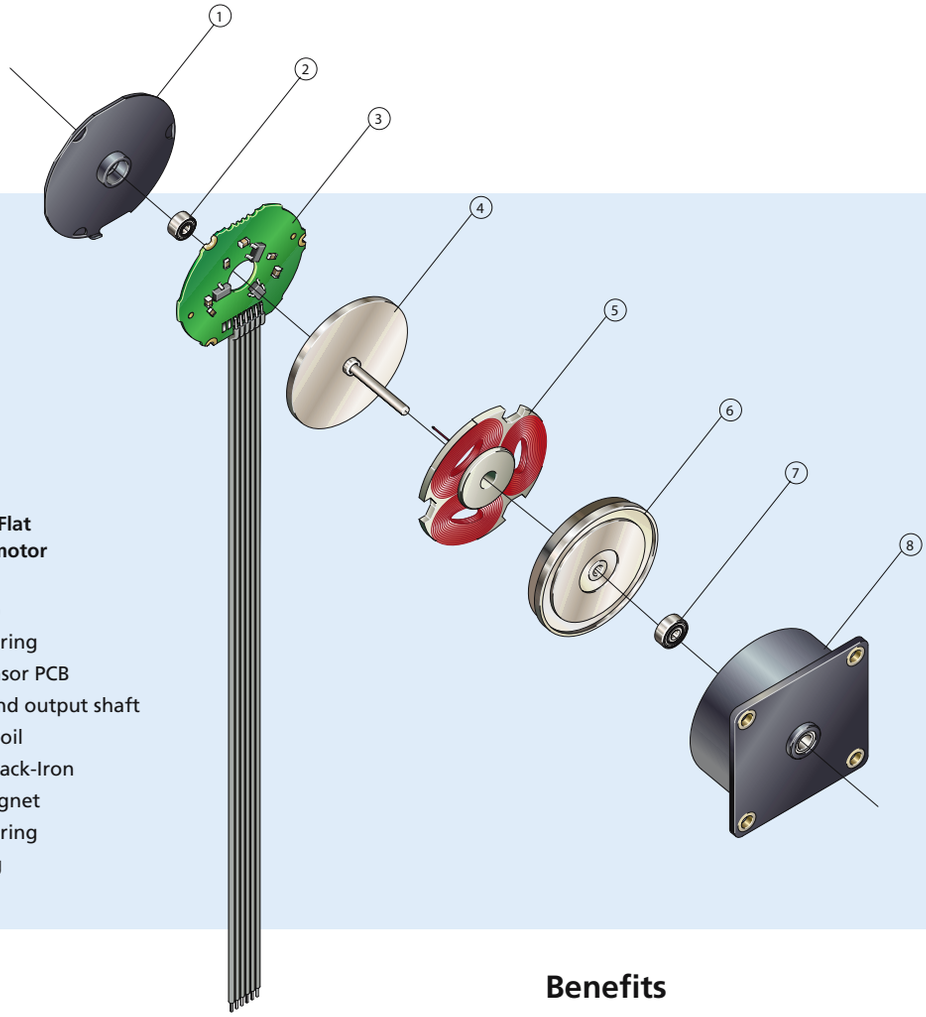
Brushless Flat DC-Micromotors



Brushless Flat DC-Micromotor

① End cap
② Ball bearing
③ Hall Sensor PCB
④ Rotor and output shaft
⑤ Stator Coil
⑥ Rotor, Back-Iron and Magnet
⑦ Ball bearing
⑧ Housing

Features

The heart of each brushless flat DC motor consists of the flat stator coils. The rotor is constructed of a high power rare earth magnet and two rotating discs which provide the back iron for an optimal use of the magnetic flux. The rotating back iron also serves to eliminate any cogging, or so-called detent torque which improves the inherent speed control properties of the motor drastically.

Thanks to the brushless commutation the motors can reach much higher operational lifetimes than conventional mechanically commutated DC motors.

Motor torque can be increased and motor speed reduced by the addition of an integrated reduction gearhead. The revolutionary integrated design provides for a wide variety of reduction ratios while maintaining a very flat profile.

Benefits

- No cogging torque
- Electronic commutation using three digital hall sensors
- Precise speed control
- Flat, light, and very compact

Product Code

26 10 T 012 B

26	Motor diameter [mm]
10	Motor length [mm]
T	Shaft type
012	Nominal voltage [V]
B	Type of commutation (electronic)

Brushless Flat DC-Micromotors 0,6 mNm

For combination with
Drive Electronics:
Speed Controller

Series 1509 ... B

		1509 T		006 B	012 B	
1	Nominal voltage	U_N		6	12	Volt
2	Terminal resistance, phase-phase	R		22,0	92,8	Ω
3	Output power [1]	$P_{2\ max.}$		0,31	0,30	W
4	Efficiency	$\eta_{max.}$		56	55	%
5	No-load speed	n_o		14 700	14 700	rpm
6	No-load current	I_o		0,0174	0,0087	A
7	Stall torque	M_H		0,97	0,92	mNm
8	Friction torque, static	C_o		0,025	0,025	mNm
9	Friction torque, dynamic	C_v		$2,6 \cdot 10^{-6}$	$2,6 \cdot 10^{-6}$	mNm/rpm
10	Speed constant	k_n		2 623	1 312	rpm/V
11	Back-EMF constant	k_E		0,381	0,762	mV/rpm
12	Torque constant	k_M		3,64	7,28	mNm/A
13	Current constant	k_I		0,275	0,137	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		15 856	16 721	rpm/mNm
15	Terminal inductance, phase-phase	L		590	2 350	µH
16	Mechanical time constant	τ_m		115	121	ms
17	Rotor inertia	J		0,69	0,69	gcm^2
18	Angular acceleration	$\alpha_{max.}$		14	13	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	65 / 45			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	10 / 130			s
21	Operating temperature range		-25 ... +80			°C
22	Shaft bearings		ball bearing, preloaded			
23	Shaft load max.:					
	– radial at 3 000/16 000 rpm (3 mm from mounting flange)		2,0 / 0,5			N
	– axial at 3 000/16 000 rpm (push-on only)		2,0 / 1,7			N
	– axial at standstill (push-on only)		15			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		plastic			
26	Weight		6,9			g
27	Direction of rotation		electronically reversible			

Recommended values - mathematically independent of each other

28	Speed up to	$n_{e\ max.}$		16 000	16 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$		0,52 / 0,60	0,51 / 0,58	mNm
30	Current up to [1] [2]	$I_{e\ max.}$		0,174 / 0,198	0,085 / 0,096	A

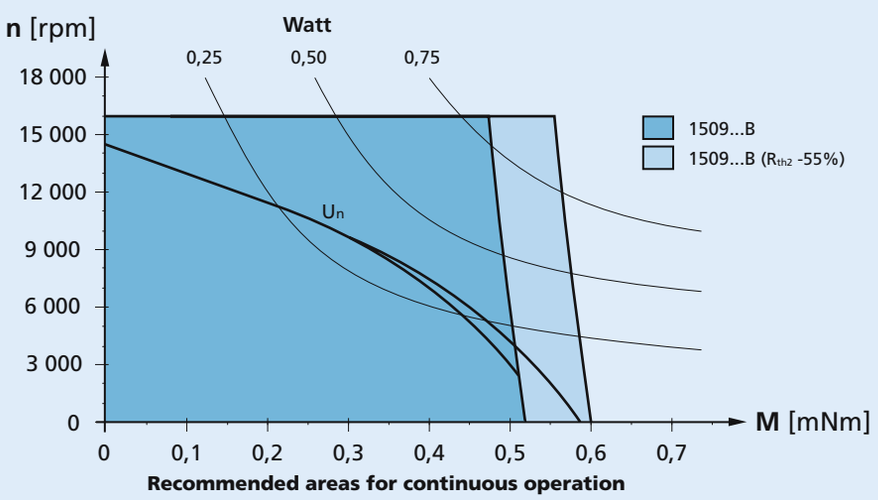
[1] at 5 000 rpm
[2] thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

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.

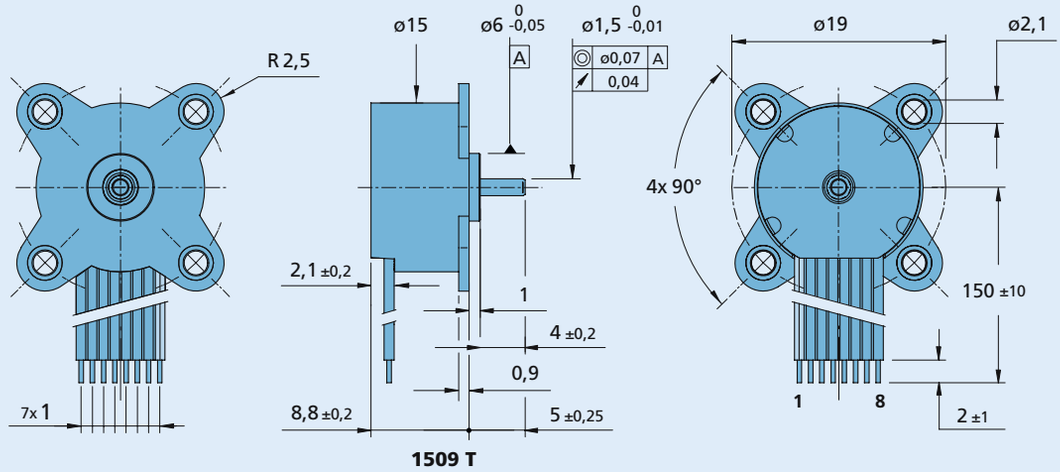
The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

The nominal voltage 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.



1509 T ... B

Scale enlarged



1509 T

Connection

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

Brushless Flat DC-Micromotors 3,8 mNm

For combination with
Drive Electronics:
Speed Controller

Series 2610 ... B

		2610 T		006 B	012 B	
1	Nominal voltage	U_N		6	12	Volt
2	Terminal resistance, phase-phase	R		7,0	28,2	Ω
3	Output power [1]	$P_{2\ max.}$		1,92	1,91	W
4	Efficiency	$\eta_{max.}$		78	78	%
5	No-load speed	n_o		6 200	6 200	rpm
6	No-load current	I_o		0,012	0,006	A
7	Stall torque	M_H		7,73	7,68	mNm
8	Friction torque, static	C_o		0,025	0,025	mNm
9	Friction torque, dynamic	C_v		$1,35 \cdot 10^{-5}$	$1,35 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		1 055	528	rpm/V
11	Back-EMF constant	k_E		0,948	1,895	mV/rpm
12	Torque constant	k_M		9,05	18,1	mNm/A
13	Current constant	k_I		0,111	0,055	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		816	822	rpm/mNm
15	Terminal inductance, phase-phase	L		480	1 940	µH
16	Mechanical time constant	τ_m		69	70	ms
17	Rotor inertia	J		8,1	8,1	gcm^2
18	Angular acceleration	$\alpha_{max.}$		9,5	9,5	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	33 / 27			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	20 / 230			s
21	Operating temperature range		-25 ... +80			°C
22	Shaft bearings		ball bearing, preloaded			
23	Shaft load max.:					
	– radial at 3 000/7 000 rpm (3 mm from mounting flange)		4,0 / 3,5			N
	– axial at 3 000/7 000 rpm (push-on only)		3,5 / 3,4			N
	– axial at standstill (push-on only)		17,5			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		plastic			
26	Weight		20,1			g
27	Direction of rotation		electronically reversible			

Recommended values - mathematically independent of each other					
28	Speed up to	$n_{e\ max.}$	7 000	7 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$	3,24 / 3,77	3,23 / 3,75	mNm
30	Current up to [1] [2]	$I_{e\ max.}$	0,416 / 0,481	0,207 / 0,240	A

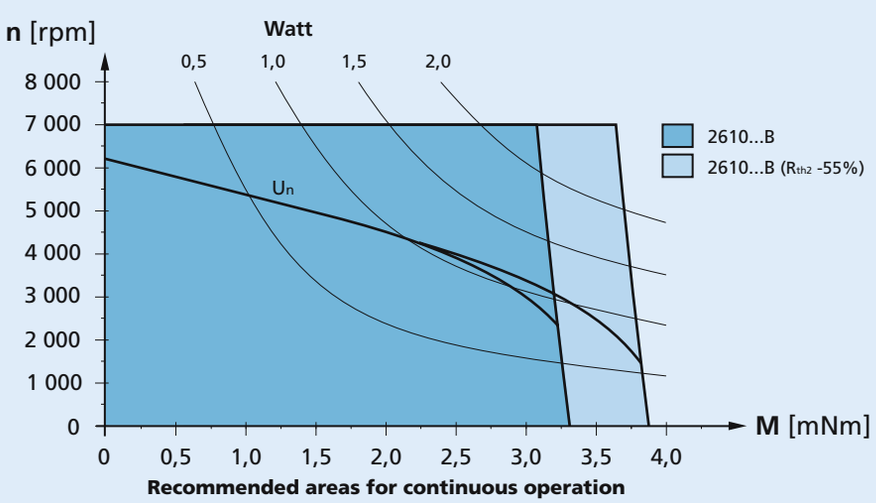
[1] at 5 000 rpm
[2] thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

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.

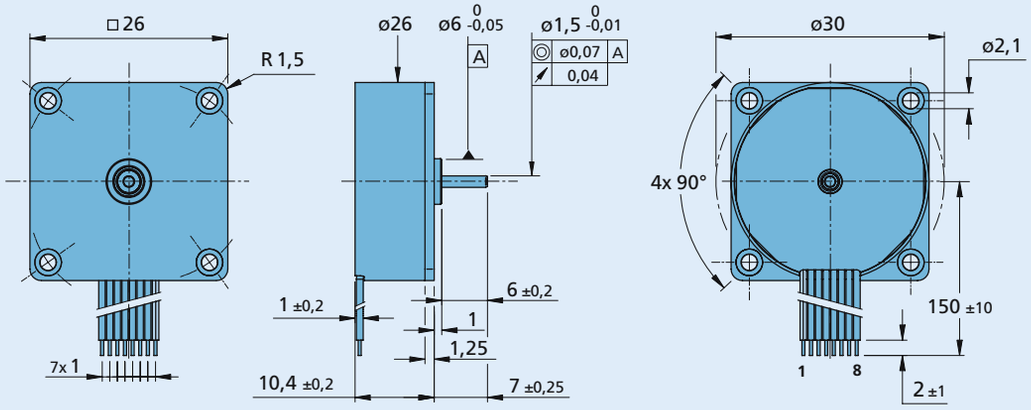
The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

The nominal voltage 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.



2610 T ... B

M 1:1



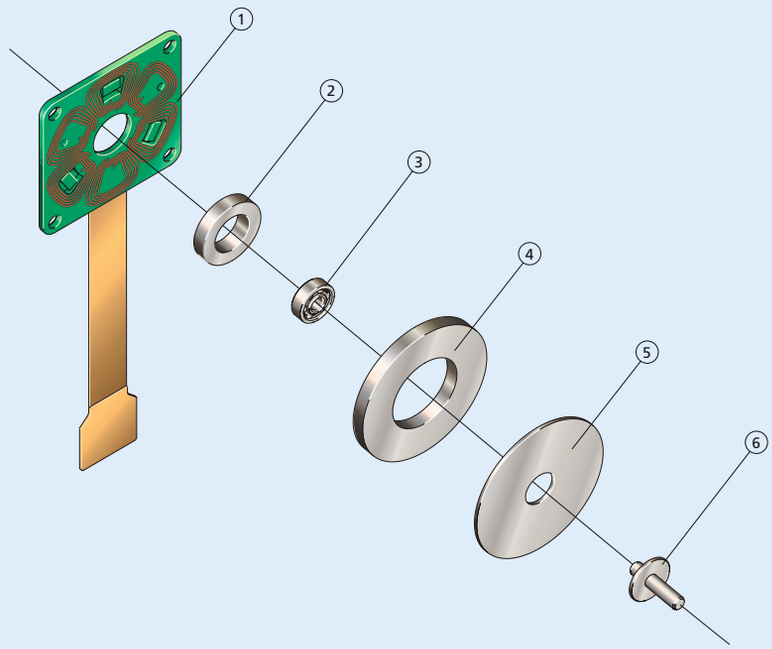
2610 T

Connection

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

Brushless Flat DC-Micromotors

penny-motor® Technology



Brushless Flat DC-Micromotor

① PCB with coil
② Bearing support
③ Ball bearing
④ Magnet
⑤ Rotor disc
⑥ Shaft

Features

The extremely flat design of the brushless penny-motor® is made possible by innovative coil design. Instead of being mechanically wound, it is fabricated by means of photo-lithographic processes. High power neodymium magnets (NdFeB) and a precise bearing system complete the motors for exceptional torque and smooth performance despite their extremely flat dimensions.

Motors with integrated spur gears are available with coaxial or eccentric shafts for higher torque in a compact form. The motors are electronically commutated for extremely long operational lifetime. They are particularly suited for applications where precise speed control and continuous duty operation are a must; for example in high precision optical filters, choppers or scanning devices.

Benefits

- Ultra flat design
- No cogging and precise speed control
- Exceptional power to volume ratio
- Very low current consumption
- High operational lifetime

Product Code

12	Motor diameter [mm]
02	Motor height [mm]
H	Shaft type
004	Nominal voltage [V]
B	Type of commutation (brushless)
H	Hall sensors

1202 H 004 BH

Brushless Flat DC-Micromotors

penny-motor® Technology

0,16 mNm

For combination with
Drive Electronics:
BLD 05002 S, SC 1801
each with adapter board

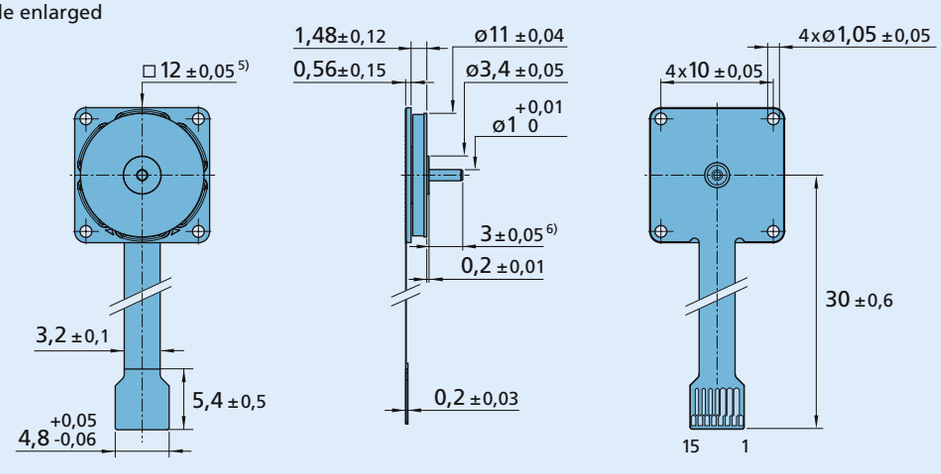
Series 1202 ... BH

	1202 H		004 BH	006 BH	
Nominal voltage	U_N		4	6	V
Terminal resistance, phase-phase	R		16	70	Ω
Output power [1]	$P_{2\,max.}$		0,652	0,492	W
Efficiency	$\eta_{max.}$		51	42	%
No-load speed	n_o		41 740	37 600	rpm
No-load current	I_o		0,028	0,015	A
Stall torque	M_H		0,222	0,124	mNm
Friction torque, static	C_o		0,003	0,003	mNm
Friction torque, dynamic	C_v		$0{,}52 \cdot 10^{-6}$	$0{,}52 \cdot 10^{-6}$	mNm/rpm
Speed constant	k_n		10 587	6 431	rpm/V
Back-EMF constant	k_E		0,094	0,156	mV/rpm
Torque constant	k_M		0,902	1,485	mNm/A
Current constant	k_I		1,109	0,673	A/mNm
Slope of n-M curve	$\Delta n/\Delta M$		187 793	303 121	rpm/mNm
Terminal inductance, phase-phase	L		26	58	µH
Mechanical time constant	τ_m		246	397	ms
Rotor inertia	J		0,125	0,125	gcm^2
Angular acceleration	$\alpha_{max.}$		$18 \cdot 10^3$	$10 \cdot 10^3$	rad/s^2
Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	0 / 94			K/W
Operating temperature range		-30 ... +85			°C
Shaft bearing		ball bearing			
Shaft load max.:					
– radial at 10 000 rpm (at shaft step ø3,4 mm)		0,6			N
– axial at 10 000 rpm (axial push-on only)		1			N
– axial at standstill (axial push-on only)		1			N
Shaft play:					
– radial	≤	0,011			mm
– axial	≤	0,060			mm
Number of pole pairs		4			
Weight		1,1			g
Direction of rotation		electronically reversible			

Recommended values - mathematically independent of each other					
Speed up to	$n_{e\,max.}$		40 000	40 000	rpm
Torque up to [2] [3]	$M_{e\,max.}$		0,16	0,12	mNm
Thermal current up to [3] [4]	$I_{e\,max.}$		0,199	0,095	A

[1] at 40 000 rpm [2] at 10 000 rpm [3] thermal resistance $R_{th\,2}$ not reduced [4] at standstill

Scale enlarged



1202 H

[5] also available with round stator ø12±0,05
[6] also available with 1 mm output shaft length

Connection

No.	Function
1	Star point
2	Phase A
3	Phase A
4	Phase B
5	Phase B
6	Phase C
7	Phase C
8	Hall sensor In +
9	Hall sensor In -
10	analog Hall A Out +
11	analog Hall A Out -
12	analog Hall B Out +
13	analog Hall B Out -
14	analog Hall C Out +
15	analog Hall C Out -

Connectors
15-pole; 0,3 mm pitch; e.g.:
Hirose: FH23-15S-0.3SHAW (05)

Brushless Flat DC-Micromotors

penny-motor® Technology

0,2 mNm

For combination with
Gearheads:
16A
Drive Electronics:
SC 1801 F

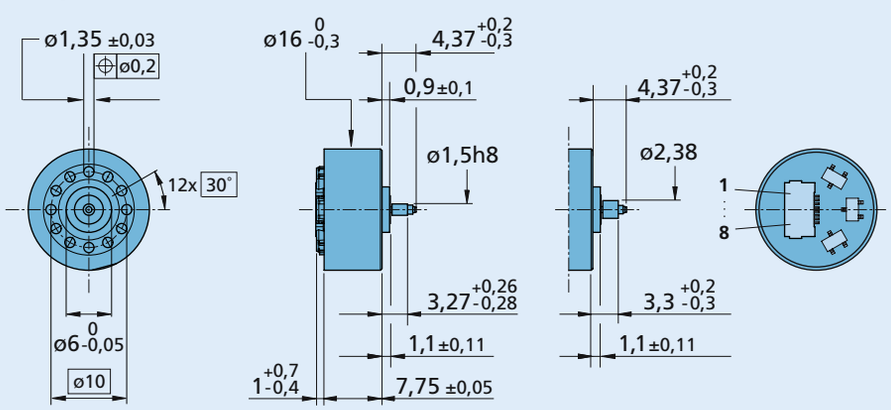
Series 1608 ... BH

		1608 H	003 BH	
Nominal voltage	U_N		3	V
Terminal resistance, phase-phase	R		18,6	Ω
Output power [1]	$P_{2\ max.}$		0,116	W
Efficiency	$\eta_{max.}$		38	%
No-load speed	n_o		17 872	rpm
No-load current	I_o		0,032	A
Stall torque	M_H		0,203	mNm
Friction torque, static	C_o		0,005	mNm
Friction torque, dynamic	C_v		$2 \cdot 10^{-6}$	mNm/rpm
Speed constant	k_n		7 407	rpm/V
Back-EMF constant	k_E		0,135	mV/rpm
Torque constant	k_M		1,289	mNm/A
Current constant	k_I		0,776	A/mNm
Slope of n-M curve	$\Delta n/\Delta M$		106 746	rpm/mNm
Terminal inductance, phase-phase	L		21	µH
Mechanical time constant	τ_m		702	ms
Rotor inertia	J		0,628	gcm^2
Angular acceleration	$\alpha_{max.}$		$3 \cdot 10^3$	rad/s^2
Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	0 / 80		K/W
Operating temperature range		-30 ... +85		°C
Shaft bearing		sintered sleeve bearings		
Shaft load max.:				
– radial at 10 000 rpm (at shaft step ø 3,4 mm)		0,5		N
– axial at 10 000 rpm (axial push-on only)		0,1		N
– axial at standstill (axial push-on only)		20		N
Shaft play:				
– radial	≤	0,05		mm
– axial	≤	0,12		mm
Number of pole pairs		4		
Weight		4,1		g
Direction of rotation		electronically reversible		

Recommended values - mathematically independent of each other			
Speed up to	$n_{e\ max.}$	12 000	rpm
Torque up to [1] [2]	$M_{e\ max.}$	0,205	mNm
Thermal current up to [1] [2]	$I_{e\ max.}$	0,184	A

[1] at 5000 rpm [2] thermal resistance $R_{th\ 2}$ not reduced

Scale enlarged



1608 N **1608 E**

Connection

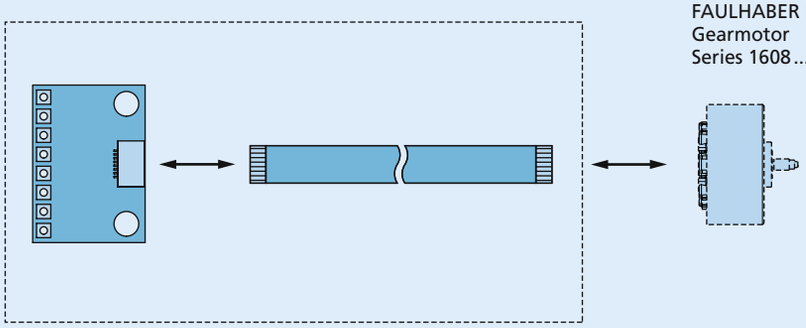
No.	Function
1	Hall sensor A
2	Hall sensor B
3	Hall sensor C
4	UDD (2.2 ... 18V DC)
5	GND
6	Phase A
7	Phase B
8	Phase C

Connectors
8-pole; 0,5 mm pitch;
thickness 0,3 mm

Accessory - optional

Adapter board with ribbon cable
Part number: 6611.00017

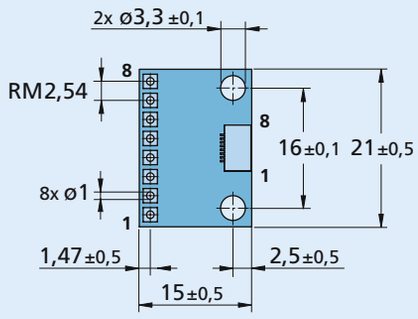
FAULHABER Brushless
Gearmotor
Series 1608 ... BH



Note: The conector on the adapter board has contacts on both sides. The pin out of the adapter board depends on the orientation of the ribbon cable and motor conector.

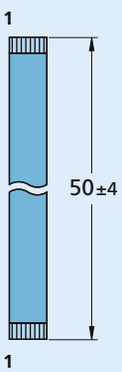
Accessory - Dimensional drawing

M 1:1



Adapter board

Connector Information
FFC/FPC Connector; 8-pole;
0,5 mm pitch; thickness: 0,3 mm
Connector has contacts on both sides



Ribbon cable