FAULHABER

Series
2610…B SC
2622…B SC

Instruction Manual

EN

WE CREATE MOTION

Imprint

Version:
1st issue, 06.11.2009

This instruction manual has been prepared with care. Dr. Fritz Faulhaber GmbH & Co. KG cannot accept any liability for any errors in this instruction manual or for the consequences of such errors. Equally, no liability can be accepted for direct or consequential damages resulting from improper use of the equipment.

The pertinent regulations regarding safety engineering and interference suppression as well as the specifications in this instruction manual must be complied with when using the equipment.

Subject to modifications.

The respective current version of this instruction manual is available on FAULHABER's internet site:
www.faulhaber.com

Table of Contents

1 Important Information

This instruction manual describes the handling and operation of the following FAULHABER brushless flat-frame (pancake) motors:

2610…B SC

2622…B SC

- Please read through the complete instruction manual before using the software.
- Keep this instruction manual in a safe place for later use.

The information given in this instruction manual refers to the standard version of the motors. Please refer to any additional information sheet provided in the event of differences in information due to a customer-specific motor modification.

1.1 Symbols used in this instruction manual

WARNING! ***Warning!***

This pictogram with the wording "Warning!" indicates an potential danger which can result in physical injuries.

► *This arrow points out the appropriate action to take to prevent the potential danger.*

CAUTION! ***Caution!***

This pictogram with the wording "Caution!" indicates an potential danger which can result in slight physical injuries or material damage.

► *This arrow points out the appropriate precautions.*

REGULATION! ***Regulations, guidelines and directives***

This pictogram with the wording "Regulation" indicates a statutory regulation, guideline or directive which must be observed in the respective context of the text.

NOTE ***Note***

This "Note" pictogram provides tips and recommendations for use and handling of the component.

1 Important Information

1.2 Safety instructions

Observance of the following safety instructions is prerequisite for trouble-free and safe operation of the products. Therefore, please carefully read through all the notes and follow them when using the motors.

Intended use

The servomotor is designed as a drive for small mechanical systems, and for applications with speed control in a minimum space.

- The motor contains magnetic and electromagnetic components. Any effects as well as the specific relevant national regulations must be taken into account when using the motor.
- The motor may not be used in environments where contact with water, chemicals and/or dust is possible or in potentially explosive atmospheres!
- The forces, torques and accelerations acting on the motor are limited.
  See Chapter 7 "Technical Data".
- Please ask the manufacturer for information about individual use under special ambient conditions.

2 Description

2.1 General product description

Product information

With this instruction manual, you receive instructions on installation and use of the Series 26…B SC drives, and the drives' technical data.

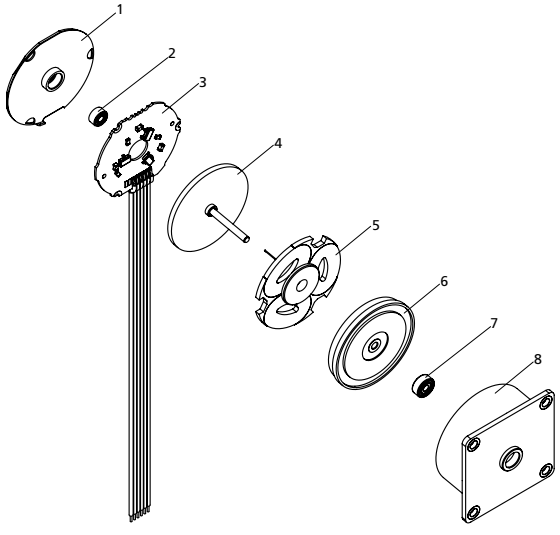
26 … T … B SC

SC:	Integrated Speed Controller
B:	Brushless motor
…	Supply voltage of the motor
T:	Shaft diameter 1.5 mm
10:	Motor length 10 mm
22:	Motor length 22 mm
26:	Motor diameter 26 mm

The flat brushless DC motor described in this manual comes equipped with integrated commutation electronics (speed controller) which provides many motor control possibilities.

The motor offers the following functions:

- Control of the speed through command value input or control of the speed through the motor voltage.
- The direction of rotation is reversable with the use of the given control signal input.
- The speed signal can be monitored at the frequency output.



1 Cover
2 Ball bearing
3 Electronic printed circuit board
4 Steel yoke Part 1
5 Coil form
6 Steel yoke Part 2 and rotor magnet
7 Ball bearing
8 Motor housing

CAUTION! ***Risk of damage***

The control input for direction of rotation is not intended for dynamic (4 quadrant) control. Reversing direction quickly over an extended period of time will damage the controller.

► *Do not reverse the motor dynamically.*

3 Installation

3.1 Assembly

The flat brushless DC servomotor must be installed according to certain specifications to prevent malfunctions and damage.

CAUTION!

Material damage!

Incorrect installation or installation using the wrong fixing materials can disrupt the motor's function and/or damage the motor.

► *Observe the following assembly instructions.*

Ambient conditions

Depending on the method of use the flat brushless DC servomotor can become hot. Appropriate cooling must be provided.

Shaft loads

When mounting parts on the motor shaft it may have to be supported on the opposite side. Otherwise the maximum allowable load values (axial at a standstill) must be noted and observed. See Chapter 7 "Technical Data".

Mounting flange

The drive may only be fixed using the screw bushings on the front flange. We recommend locking the screws. Due to the square front flange the drive is not suited for assembly in a cylinder.

Electrical connection

It is necessary to ensure that the ribbon cable is laid without risk of damage during installation and operation, e.g. through chafing, squeezing or bending. The maximum load of the cable must be noted and observed. See Chapter 7 "Technical Data".

Specialised staff

These products are intended for use by trained professionals or experts in the use of small motors who are familiar with the relevant regulations and directives: **EMC Directive**, **Low Voltage Directive**, **Machinery Directive**, **VDE Regulations** or accident prevention regulations. This user's manual should be carefully read before powering on the drive.

3 Installation

3.2 EMC compatible installation

CAUTION! ***Length of the connection leads!***

The maximum length of the connection leads is limited.

► *All connection leads may not exceed a length of 3 m.*

Additional EMC measures are necessary to optimise the performance with respect to emission and immunity:

3.3 Connector pin assignment

The 26…B SC motor is equipped with a six position connection cable (AWG 28).

CAUTION! ***Electronic damage/ESD protection***

Electrostatic discharges at the connection pin assignment of the ribbon cable can result in irreparable damage to the motor.

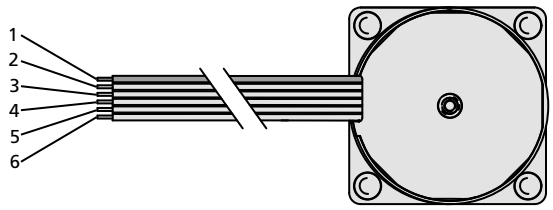
► *It may only be processed in ESD protected workplaces.*
Incorrect connection of the cores can cause damage to or destruction of the electronics.

► *Connect the connections in accordance with the connector pin assignment, see table.*

Please also note and follow the supplementary installation instructions on electromagnetic compatibility in Chapter 8 "EMC".

Connection pin assignment of the ribbon cable

Core	Function	Value
1 (red)	U_P electronic supply	4 V DC – 18 V DC
2	U_{mot} coil supply	1.7 V DC – 18 V DC
3	GND earth	
4	$U_{ntarget}$ target velocity	0 – 10 V DC / > 10 V DC – max. 18 V DC
5	DIR rotational direction	to earth or U < 0.5 V = anti-clockwise, U > 3 V = clockwise
6	FG frequency output	(max. U_P, I_{max} 15 mA) 6 pulses per revolution



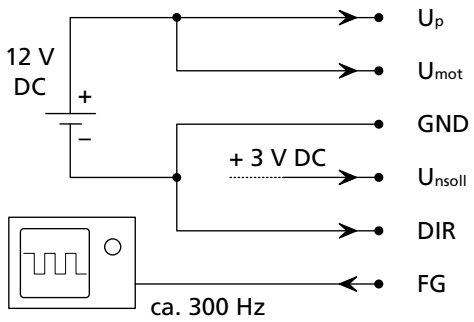
3 Installation

3.4 Connection diagram

Flat brushless DC motor with integrated SC speed controller

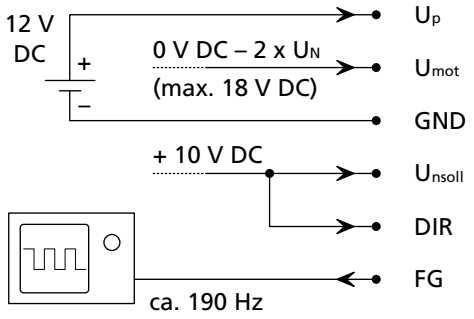
Two examples are given and are intended to clearly explain the operating modes of the brushless flat-frame motor with SC Speed controller. The figures given refer to a motor with a nominal voltage of 12 V.

Electronic speed control



The motor rotates counter-clockwise with approx. 3000 rpm. The speed is electronically controlled.

External speed control



The motor rotates, e.g. with approx. 1900 rpm in a clockwise direction. The speed is controlled via the motor voltage (U_{mot}). Approx. 190 Hz (6 pulses per revolution) is measured at the frequency output (FG).

190 pulses/sec. = 31.6 U/sec.

31.6 U/sec. = 1900 rpm

4 Function

4.1 Connection functions

The flat brushless DC motor with integrated SC speed controller supports the following functions and/or operating modes:

- Control of the speed through the voltage at the command value input.
- Control of the speed through the coil voltage.
- Control of the direction of rotation at the switch input.
- Reading out the speed signal at the frequency output.

U_P (core 1, red)

Supply voltage for the electronics.

For voltage range, see Chapter 7 "Technical Data".

U_{mot} (core 2)

Supply voltage for the motor winding.

For voltage range, see Chapter 7 "Technical Data".

GND (core 3)

Common ground.

$U_{nsetpoint}$ (core 4)

Control voltage for the target velocity.

Voltage range: 0-10 V DC/10 V DC – max. 18 V DC.

Resolution: See Chapter 7 "Technical Data".

The defined control range for Unsetpoint lies between 0 - 10 V DC. If the motor's nominal voltage is applied, the maximum speed can be reached before the control limit of 10 V. In this case, the actual speed is limited by the motor properties. Full modulation occurs.

If, at Unsetpoint = 10 V, the motor voltage is increased to such an extent that a higher speed than the set target velocity results, the Speed Controller limits the speed to the set value. In these cases the maximum speed value can be adjusted, as described in Chapter 4.3 "Special Configurations".

The input impedance of this cable is approx. 8.9 kΩ.

DIR (core 5)

Switch input for the motor's direction of rotation.

To earth or U < 0.5 V anti-clockwise, U > 3.0 V = clockwise.

FG (core 6)

Digital output

The digital output is a switch which switches to GND (open collector with integrated pull-up resistance of 22 kΩ).

Error output

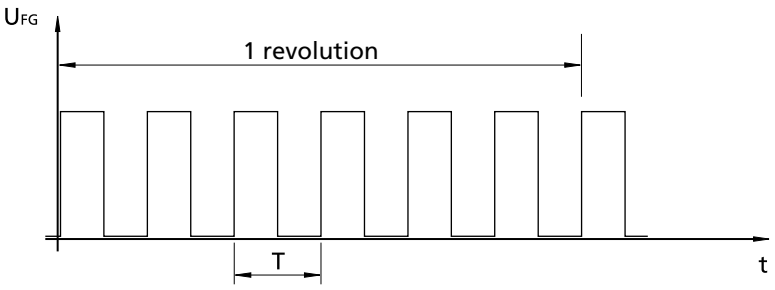
- Output switches to high level if current limiting is activated. The delay between activation of current limiting and activation of the output can be adjusted.
- Output switches to low level if current limiting is deactivated

4 Function

4.1 Connection functions

Frequency output

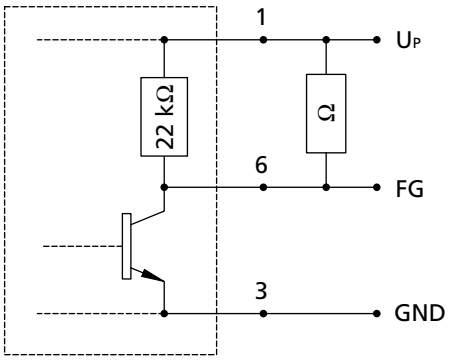
Frequency output for reading out the actual motor speed. Signal setup: 6 pulses per motor revolution.



NOTE

Pull-up resistance

An additional, external pull-up resistance can be connected to increase the edge steepness. The maximum loadability of the digital output must be noted and observed. See circuit diagram:



Due to the coupling of the internal pull-up resistance between FG and the supply voltage U_P, conducted electromagnetic RF interference, which affect the supply voltage, can drastically worsen the frequency signal.

If operated properly and as intended, the speed and direct of rotation of the motor are not impaired by this interference.

PWM mode

If $U_{nsetpoint}$ is specified as the voltage at the motor it is operated with speed control. The speed is controlled by pulse width modulation (PWM), i.e. the motor tries to achieve a constant speed under fluctuating load.

Due to the technical requirements for a motor with SC speed controller, if the allowable maximum housing temperature is adhered to, the maximum possible continuous torque in PWM mode may be lower than under full modulation. The maximum thermally allowable continuous current reduces accordingly.

4 Function

4.2 Configuration

The control parameters of the SC speed controller integrated in the motor can be individually adjusted to the respective application via a PC. This requires a programming adapter which can be ordered separately as well as a version of the FAULHABER Motion Manager PC software suitable for the speed controller.

The software is available on request or from the FAULHABER homepage www.faulhaber.com/MotionManager.

CAUTION! ***Risk of damage***

Before starting up, the parameters configured in the control must be checked and if necessary adjusted. Incorrectly set values can cause irreparable damage to the motor and/or the speed controller. In particular, the following parameters must be correctly set:

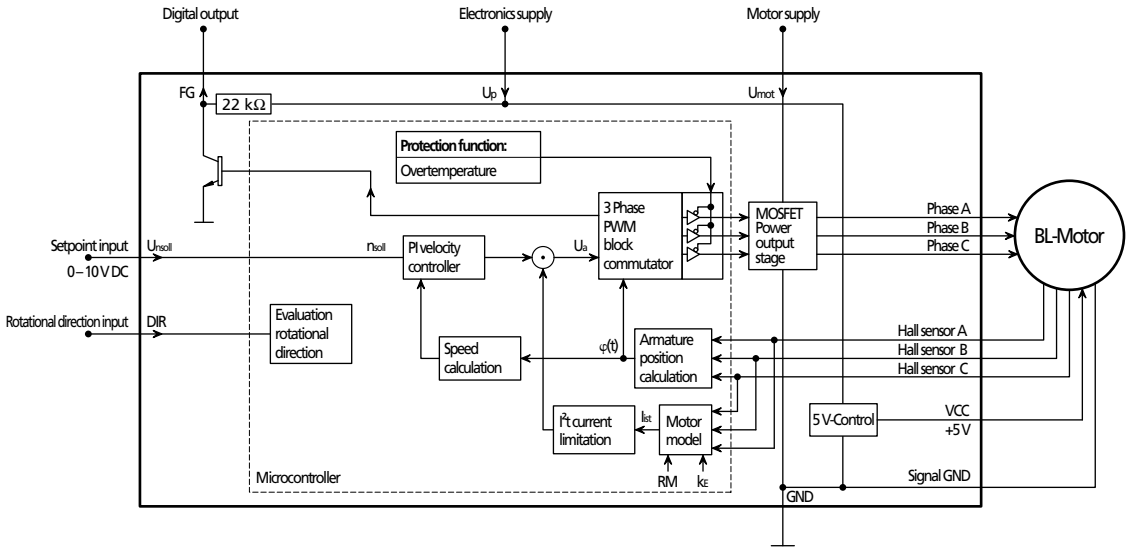
- *Duration and maximum current value*
- *Generator voltage constant ke and connected resistance R,*
- *Controller parameter*

The flat brushless DC motor is equipped with digital Hall sensors, with which the commutation signals can be determined. The actual speed value is determined via the time interval between the edges of the hall sensor signals.

Preset default basic parameters:

- Due to the resolution of the digital hall sensors, speeds from approx. 500 rpm can be stably controlled.
- PWM frequency at the power output stage approx. 96 kHz.
- 2-quadrant operation with function for quick speed reduction.

  The motor windings are short-circuited for faster transition from higher to lower speeds.



4 Function

4.2 Configuration

Setting options

- Pure 2-quadrant operation without active braking option.

  If problems occur with the braking function in the default setting it can be deactivated.
- Filtering (averaging) of the hall sensor signals.

  If problems occur with the default setting the time of a complete electrical (half) motor revolution is evaluated to obtain a continuous speed signal. This can cause instable motor running at low speeds as the control dynamics worsen.
- Configuration of the digital output as error output.
- Frequency output can be configured to 6 or 2 pulses.
- Speed setpoint value input via PWM signal at the speed setpoint value input. See Chapter 4.3 "Special Configurations".
- Operation with fixed speed (fixed speed mode). See Chapter 4.3 "Special Configurations".
- Operation as voltage controller (volt mode). See Chapter 4.3 "Special Configurations".

4.3 Special configurations

Further setting options exist in addition to the configurations described in Chapter 4.2.

Presetting of target velocity value via PWM signal

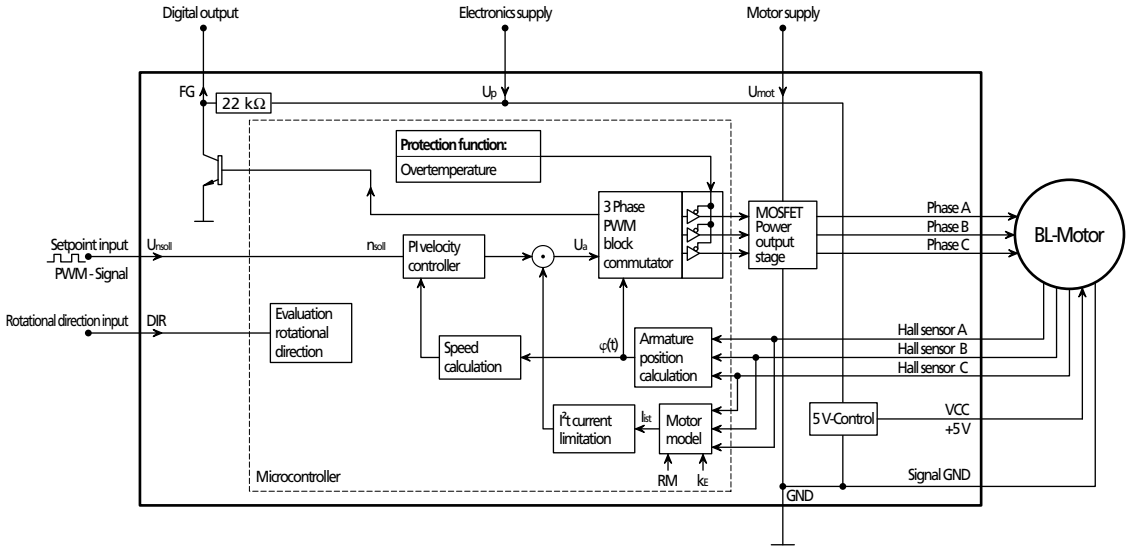
The speed setpoint value input can take place via a PWM signal if the speed setpoint value input $U_{nsetpoint}$ is appropriately configured. The speed setpoint value is proportional to the duty cycle.

Basic parameter for the duty cycle

- PWM frequency range: 500 Hz – 18 kHz.
- Motor stops at duty cycle < 2.0 %.
- Motor runs at duty cycle > 3.0 %.
- The target velocity is proportional to the duty cycle. The maximum target velocity at 100% can be configured. See Chapter 4.4 "Operating Data".

4 Function

4.3 Special configuration



Setting options

- The TTL and PLC levels can be configured as switching levels.

Mode	high level	low level
TTL	> 3.0 V DC	< 0.5 V DC
PLC	> 7.5 V DC	< 2.0 V DC

Operation with fixed speed (fixed speed mode)

Fixed speed mode is possible for applications in which the flat brushless DC motor is to be operated with a specific speed only. The target velocity to be set is fixed via a parameter (see Chapter 4.4 "Parameter Settings").

Setting options via speed setpoint value input $U_{nsetpoint}$

- Quick stop input (low level)

  Motor stops at $U_{nsetpoint}$ < 0.1 V.

  Motor stops if connection is open.

  Motor runs at $U_{nsetpoint}$ > 0.2 V.
- Quick stop input inverted (high level)

  Motor runs at $U_{nsetpoint}$ > 2.0 V.

  Motor runs if connection is open.
- No function

  The motor always runs.

Operation as voltage controller (voltage mode).

The integrated speed controller can be configured for function as a voltage controller. The motor voltage is then output proportionally to the voltage at the speed setpoint value input $U_{nsetpoint}$. The current limitation remains active. With this configuration it is possible to use a master controller. The speed controller is then only used as a power amplifier and for commutation only.

4 Function

4.3 Special configuration

Digital output (FG)

The digital output is a switch which switches to GND (open collector with integrated pull-up resistance of 22 kΩ). It can be configured for different tasks:

- Error output
- Frequency output

The detailed properties of the configurations are described in Chapter 4.1 "Connection Functions".

4.4 Parameter settings

The following parameters can be used to adjust the integrated speed controller to the respective application.

Several parameters have a function in certain configurations only or with specific settings only.

Current limiting values

For I^2t current limiting, the peak current (I_{max}) and the motor current (I_{cont}) must be specified (see also Chapter 4.5 "Technical Information"). The allowable values of the speed controller used as well as of the connected motor must be noted and observed.

Parameter	Meaning	max. value	Units
Peak current (I_{max})	Value for the maximum current allowed for a short time (transient maximum current).	2 600*	mA
Motor continuous current (I_{cont})	Value for the continuous current which is the limit value.	1 300*	mA

* Values depend on motor type. The given values correspond to the default values used by the Motion Manager if a motor-specific parameter set has not been loaded.

Fixed speed value

For operation with a fixed speed the speed setpoint value is input via an adjustable parameter (see Chapter 4.3 "Special Configurations").

Parameter	Meaning	max. value	Units
Fixed speed value (N_{setFix})	Speed setpoint value, which is input in operation with fixed speed.	120 000	rpm

Pulses per motor revolution

It is possible to configure the digital output FG as a frequency output (this is the default configuration).

Parameter	Meaning	Possible values	Units
Pulses per revolution	Number of pulses per revolution at the digital output.	2, 6	1/rev

4 Function

4.4 Parameter settings

Maximum speed value

When inputting the speed setpoint value (as an analog voltage or as a PWM signal) the speed value, which is input at 10 V DC or at 100 % duty cycle, can be set. The maximum speed value can therefore be adjusted to the application.

Different resolutions of the maximum speed value and different maximum values are possible, depending on the operating mode and motor type.

Parameter	Meaning	Possible values	Units
Maximum speed value (N_{setMax})	Maximum speed setpoint value at 10 V or 100 % duty cycle at the speed setpoint value input $U_{nsetpoint}$.	60 000	rpm

Controller parameter

The integrated speed controller is set in the factory so that problem free operation is usually possible. The speed controller has an integrated feature for specifying appropriate parameters if adjustment of the drive to the controlled system is necessary for special applications (see Chapter 4.5 "Technical Information").

The targets set for the control's properties also depend on the application. Above all, a differentiation is made between the stiffness of the control, the uniformity of the speed within a revolution, the allowed system deviation, the allowed overswing and the required stability reserves.

The control circuit must also satisfy these requirements to that the controller parameters must also be adjusted with respect to these.

The PI speed controller used here enables two parameters to be set (proportional and integral component).

Parameter	Meaning	max. value	Units
V	Proportional component	32 767	Digit
VI	Proportional component multiplied by the integral-action component	65 535	Digit

Delayed Current Error (with error output only)

Activation of the output can be delayed. Even if the current is already limited the output is not activated until after the time input with DCE. As a result, short-term exceeding of the limit current can be ignored.

Parameter	Meaning	max. value	Units
Delayed Current Error (DCE)	Delay of activation of the error output	5 100	ms

4 Function

4.5 Technical information

I²t current limiting

The flat brushless DC motor with integrated SC speed controller is equipped with current limiting which enables certain motor protection to be achieved.

- Peak current (I_{max})

  The current is limited to the peak current, provided that the thermal current model calculates a non-critical temperature.

- Continuous current (I_{cont})

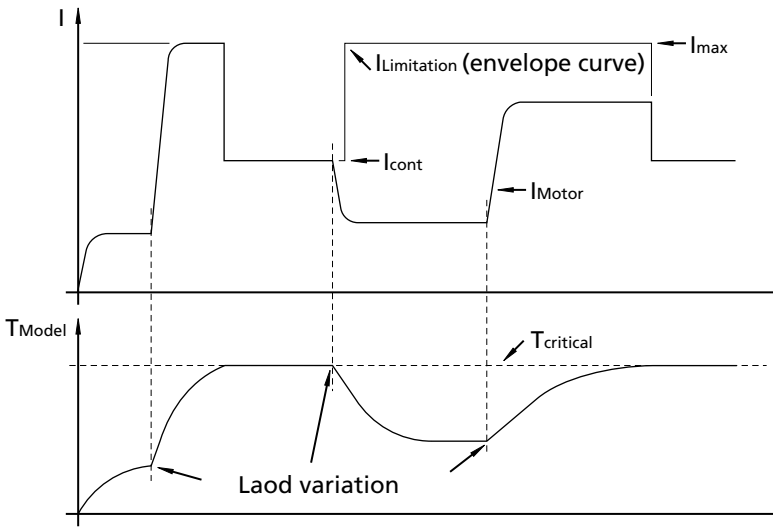
  If the thermal current model reaches a critical temperature, continuous current is switched to.

How the current limiting works:

When the motor starts, the peak current is preset as the set-point value for the current controller. As the load increases, the current in the motor constantly increases until it finally reaches the peak current. The current controller then comes into operation and limits the current to this set-point.

A thermal current model operating in parallel calculates a temperature from the actual flowing current. If this model temperature exceeds a critical value, continuous current is switched to and the motor current is regulated to this. Only when the load becomes so small that the temperature falls below the critical model temperature is peak current permitted again.

The following diagram shows how the current limiting functions by means of an envelope curve ($I_{limiting}$). The current may not rise above the values along this envelope curve The aim of this so-called I²t current limiting is not to heat the motor above the thermally allowable temperature by selecting a suitable continuous current. On the other hand, a high load should be temporarily possible in order to enable very dynamic movements.



Overtemperature cut-off

The motor is deactivated if the temperature of the electronics exceeds the limit value of 100 °C.

The following condition must be fulfilled to reactivate the motor:

- Temperature below the specified limit value.

4 Function

4.5 Technical information

Adjustment of the controller parameters

The controller parameters are already preset for common applications. However, the controller parameters can be optimised to optimally adjust the controller to the respective application.

The digital controller operates with a sampling rate of approx. 500 µs.

Example of controller setting:

1. Set the initial configuration.
2. Increase controller gain (proportional component V).
3. Speed jump from 1/3 of the maximum speed to 2/3 specified.
4. Speed jump from 2/3 to 1/3 and observe behaviour.
5. Repeat steps 2 to 4, until the controller becomes unstable. Then reduce controller amplification until stability is reliably ensured.
6. Repeat steps 2 to 5 with proportional integral-action component (VI).

Effect of pulse width modulation (PWM)

The power output stage of the integrated speed controller operates with so-called pulse width modulation (PWM). At a fixed frequency (the PWM frequency) the duty cycle is set between the on time and the off time depending on the controller output value. The advantage of this procedure is that the losses in the drive electronics are very low.

In contrast, the losses in a linear output stage can be very large and it becomes hot.

When the PWM is used the motor's inductance is used as a filter for the current. Therefore, the PWM frequency should be high enough to adequately filter the current.

NOTE

Pulse duty factor

The PWM frequency of the speed controller is optimally matched to the connected motor. Nevertheless, it must be noted that with a low PWM duty cycle and larger motor load caused by short-term high current flow in the motor, substantially higher losses can occur than with a large duty cycle.

- ▶ *As large a duty cycle as possible should set in at the operating point. The required control reserve must also be noted and observed!*
- ▶ *To achieve this, if necessary, the motor operating voltage can be reduced.*

NOTE

Efficiency

It is necessary to note that a reduction in the efficiency at the motor also reduces the maximum allowable current and therefore the maximum continuous torque too.

5 Operation

5.1 Powering on

Before starting up the flat brushless DC motor together with a mechanism, the following points must be checked:

- The drive has been installed according to the specifications.
- The ribbon cable of the motor is connected according to the requirements (risk of polarity reversal!) and is laid so that it cannot be damaged during operation. The maximum load values must be noted and observed (see Chapter 7 "Technical Data").
- Lengthening the connection leads can affect the function and properties with respect to EMC. All connection leads may not exceed a length of 3 m.
- The connected mechanism is installed free of blockages.
- The loads and stresses on the shaft (axial, radial and torques) are within the specified values (see Chapter 7 "Technical Data").

CAUTION! ***Risk of injuries***

A risk of injuries can result from protruding rotating or moving parts of the driven mechanism.

► *Cover rotating and moving parts with appropriate devices.*

CAUTION! ***Risk of injuries***

Depending on the load and ambient temperature, very high temperatures can occur on the surface of the unit.

► *Contact protection must be provided if necessary.*

6 Maintenance

6.1 Service / Maintenance

The flat brushless DC motors are designed to be maintenance-free, however, dust contamination should be avoided.

6.2 Troubleshooting

If operated as indicated in this manual, the flat brushless DC motors will function trouble free. Should a malfunction occur in spite of this please contact the manufacturer.

Switchboard: +49(0)7031/638-0
E-Mail: info@faulhaber.de
Internet: www.faulhaber.com

7 Technical Data

7.1 Motor 2610...B with SC speed controller

7.1.1 Operating data

	2610 T		006 B	012 B	
Nominal voltage	U_N		6	12	Volt
Terminal resistance, phase-phase	R		7.0	28.2	V
Output power [1]	$P_{2\ max.}$		1.92	1.91	W
Efficiency	η max.		78	78	%
No-load speed	n_o		6 200	6 200	rpm
No-load current	I_o		0.012	0.006	A
Stall torque	M_H		7.73	7.68	mNm
Friction torque:					
– static	C_o		0.025	0.025	mNm
– dynamic	C_v		$1.35 \cdot 10^{-5}$	$1.35 \cdot 10^{-5}$	mNm/rpm
Speed constant	k_N		1 055	528	rpm/V
Back-EMF constant	k_E		0.948	1.895	mV/rpm
Torque constant	k_M		9.05	18.1	mNm/A
Current constant	k_I		0.111	0.055	A/mNm
Slope of n-M curve	$\Delta n/\Delta M$		816	822	rpm/mNm
Terminal inductance, phase-phase	L		480	1 940	µH
Mechanical time constant	τ_m		69	70	ms
Rotor inertia	J		8.1	8.1	gcm²
Angular acceleration	α max.		9.5	9.5	$\cdot 10^3$rad/s²
Thermal resistance	$R_{th\ 1}/R_{th\ 2}$	33/27			K/W
Thermal time constant	τ_{w1}/τ_{w2}	20/230			s
Operating temperature range		-25 … +80			°C
Shaft bearings		ball bearing, preloaded			
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
Shaft play:					
– radial	≤	0.015			mm
– axial	=	0			mm
Housing material		plastic			
Weight		20.1			g
Direction of rotation		electronically reversible			
Recommended values - mathematically independent of each other					
Speed up to	$n_{e\ max.}$		7 000	7 000	rpm
Torque up to [1] [2]	$M_{e\ max.}$		3.14/3.72	3.13/3.70	mNm
Current up to [1] [2]	$I_{e\ max.}$		0.403/0.475	0.201/0.236	A

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

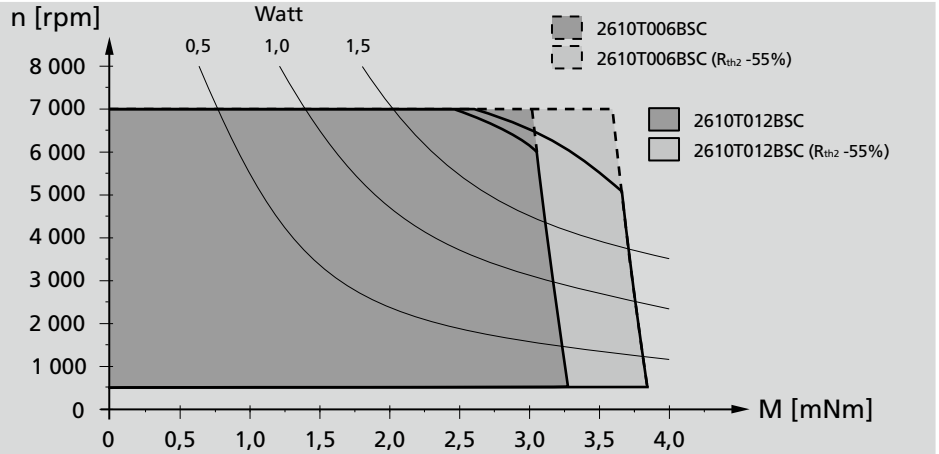
Recommended areas for continuous operation

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).

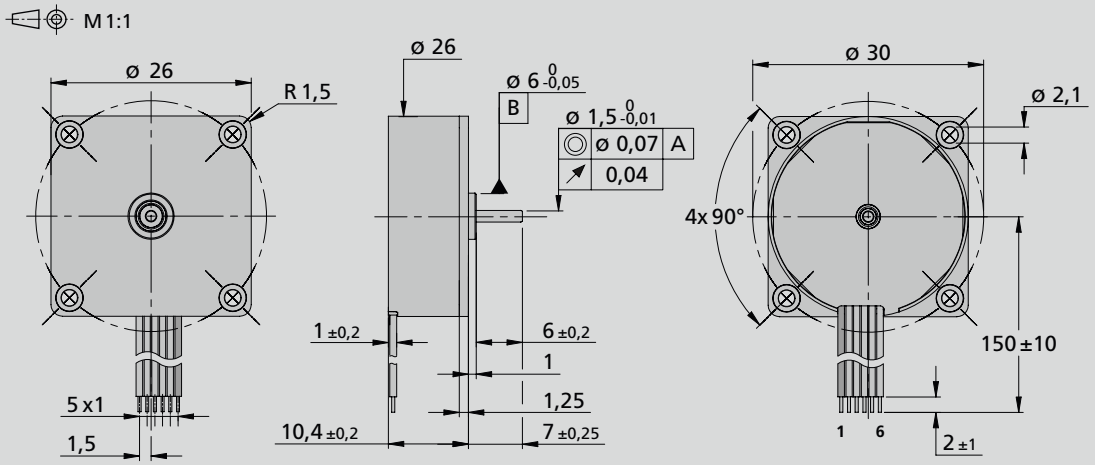
The area of the curve is defined by the maximum allowable supply voltage of the integrated speed controller as well as the control performance characteristics.



7 Technical Data

7.1 Motor 2610...B with SC speed controller

7.1.2 Product dimensions



Option

■ connector variants AWG 28 / PVC ribbon cable with connector Picoblade

connector pin assignment:

Connection

No.	Function
1	Up
2	Umot
3	GND
4	Unsoll
5	DIR
6	FG

7.1.3 Connection information

Speed Controller		006 B	012 B	SC
PWM switching frequency		96	96	kHz
Efficiency		95	95	%
Max. continuous output current [1]		0.8	0.8	A
Max. peak output current		1.6	1.6	A
Total standby current	0,020			A
Speed range electronic	500 … 60 000 [2]			rpm
Scanning range	500			µs

[1] at 22 °C ambient temperature and max. 60 °C motor temperature respectively
[2] speed depend on motor operating voltage

			006 B	012 B	SC
Connection 1 „U_P“:	power supply electronic	U_P = 4 … 18			V
Connection 2 „U_{mot}“:	power supply electronic coil	U_{mot} = 1.7 … 18			V
Connection 3 „GND“:	ground	ground			
Connection 4 „U_{nsoll}“:					
– analog input	input voltage	U_{in} = 0 … 10 (max. U_P)			V
	input resistance	R_{in} ≥ 8			kΩ
	set speed value	per 1 V	1 000	1 000	rpm
		U_{in} < 0.15 V » motor stops			
		U_{in} > 0.3 V » motor starts			
Connection 5 „DIR“:					
– analog input	direction of rotation	to ground or level < 0.5 V » counterclockwise			
		open or level > 3 V » clockwise (max. U_P)			
	input resistance	R_{in} ≥ 10			kΩ
Connection 6 „FG“:		with max. U_P » I_{max} = 15 mA; open collector with 22 kΩ pull-up resistor			
– digital output	frequency output	6 lines per revolution			

7 Technical Data

7.2 Motor 2622...B with SC speed controller

7.2.1 Operating data

	2622 S		006 B	012 B	SC
Nominal voltage	U_N		6	12	Volt
Terminal resistance, phase-phase	R		7.0	28.2	Ω
Output power	$P_{2\ max.}$		1.92	1.91	W
Efficiency	η max.		78	78	%
No-load speed	n_o		6 200	6 200	rpm
No-load current	I_o		0.012	0.006	A
Stall torque	M_H		7.73	7.68	mNm
Friction torque:					
– static	C_o		0.025	0.025	mNm
– dynamic	C_v		$1.35 \cdot 10^{-5}$	$1.35 \cdot 10^{-5}$	mNm/rpm
Speed constant	k_N		1 055	528	rpm/V
Back-EMF constant	k_E		0.948	1.895	mV/rpm
Torque constant	k_M		9.05	18.1	mNm/A
Current constant	k_I		0.111	0.055	A/mNm
Slope of n-M curve	$\Delta n/\Delta M$		816	822	rpm/mNm
Terminal inductance, phase-phase	L		480	1 940	µH
Mechanical time constant	τ_m		69	70	ms
Rotor inertia	J		8.1	8.1	gcm²
Angular acceleration	α max.		9.5	9.5	$\cdot 10^3$rad/s²
Thermal resistance	$R_{th\ 1}/R_{th\ 2}$	33/27			K/W
Thermal time constant	τ_{w1}/τ_{w2}	20/230			s
Integrated Gearhead					
Housing material		plastic			
Geartrain material		metal			
Blacklash, at no-load	≤	4			°
Bearings on output shaft		ball bearing			
Shaft load max.:					
– radial (5 mm from mounting face)	≤	15			N
– axial	≤	5			N
Shaft press fit force, max.	≤	10			N
Shaft play:					
– radial (5 mm from mounting face)	≤	0.03			mm
– axial	≤	0.25			mm
Operating temperature range		-25 … +80			°C

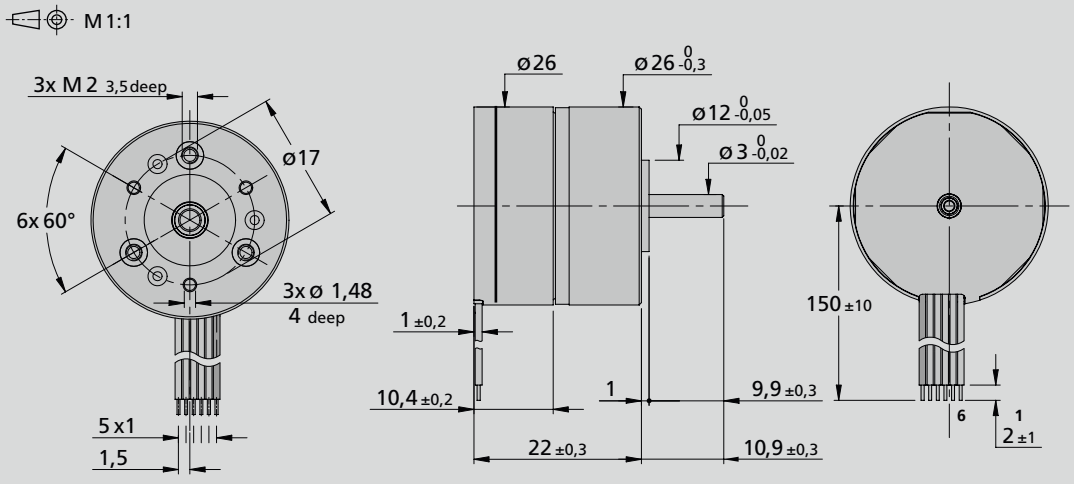
Technische Daten

reduction ratio (rounded)	output speed up to n_{max} (rpm)	weight with motor (g)	output torque (M_{max} mNm)		direction of rotation (reversible)	efficiency (%)
			continuous operation	intermittent operation		
8 : 1	635	25	9	30	=	81
22 : 1	223	26	23	75	≠	73
33 : 1	151	26	30	100	=	60
112 : 1	44	27	93	180	≠	59
207 : 1	24	27	100	180	=	53
361 : 1	14	27	100	180	=	53
814 : 1	6	28	100	180	=	43
1257 : 1	4	29	100	180	=	43

7 Technical Data

7.2 Motor 2622...B with SC speed controller

7.2.2 Product dimensions



Option

■ connector variants AWG 28 / PVC ribbon cable with connector Picoblade

connector pin assignment:

Connection

No.	Function
1	Up
2	Umot
3	GND
4	Unsoll
5	DIR
6	FG

7.2.3 Connection information

Speed Controller		006 B	012 B	SC
PWM switching frequency		96	96	kHz
Efficiency		95	95	%
Max. continuous output current [1]		0.8	0.8	A
Max. peak output current		1.6	1.6	A
Total standby current	0.020			A
Speed range electronic	500 … 60 000 [2]			rpm
Scanning range	500			µs

[1] at 22 °C ambient temperature and max. 60 °C motor temperature respectively
[2] speed depend on motor operating voltage

			006 B	012 B	SC
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Connection 3 „GND“:	ground	ground			
Connection 4 „U_{nsoll}“:					
– analog input	input voltage	U_{in} = 0 … 10 (max. U_P)			V
	input resistance	$R_{in} \geq 8$			kΩ
	set speed value	per 1 V	1 000	1 000	rpm
		U_{in} < 0.15 V » motor stops			
		U_{in} > 0.3 V » motor starts			
Connection 5 „DIR“:					
– analog input	direction of rotation	to ground or level < 0.5 V » counterclockwise			
		open or level > 3 V » clockwise (max. U_P)			
	input resistance	$R_{in} \geq 10$			kΩ
Connection 6 „FG“:		with max. U_P » I_{max} = 15 mA; open collector mit 22 kΩ pull-up resistor			
– digital output	frequency output	6 lines per revolution			

7 Technical Data

7.3 Ambient conditions

Shock loads

The noise emitted is increased and the life of the ball bearings and therefore of the motor becomes limited if they are exposed to impacts.

- The motor can still function if it is not exposed to higher shock loads than defined according to EN 60068-2-27.
- The motor may not be exposed to higher vibratory stresses than defined according to EN 60068-2-6.

CAUTION! ***Risk of damage***

If the motor is installed on the mounting flange, the mounting flange can be damaged by high radial loads or stresses on the motor or by screws tightened with excessive torque.

► *Tighten the screws with maximum 40 Ncm. Note the strength of the screws!*

NOTE ***Service life***

The full life is reached if the motor is not exposed to shock or vibration loads.

CAUTION! ***Risk of damage***

The ribbon cables may be damaged if the static or dynamic load is too high.

► *The tension exerted on the cable may not exceed 20 N in each direction. If the cable is exposed to constant tensile loads the limit is 11 N.*

► *In case of frequent bending, the recommended minimum bending radius is 10 mm. The possible number of bending cycles increases with increasing bending radius.*

► *If the radii are small the cable may not be bent several times as otherwise the Litz wires will break. The bending radii if laid once must be larger than 1.2 mm.*

► *The cable may not be bent at temperatures < -10 °C.*

8 EC Directives

REGULATION! The following EC Directives are important for users of the described products:

§

Machinery Directive (98/37/EC):

It applies to independently functioning machines or a chain of machines forming whole plants or systems. For built in components, non-operational machines, a manufacturer's declaration is submitted according to Annex II B of the Machinery Directive 98/37/EC.

Low-Voltage Directive (2006/95/EC):

It applies to all electrical equipment with a nominal voltage from 75 to 1,500 V DC, or from 50 to 1,000 V AC. The products described in this instruction manual do not fall within the scope of this Directive as they are designed for smaller voltages.

EMC Directive (2004/108/EC):

The Electromagnetic Compatibility (EMC) Directive applies to all electronic and electrical equipment, plant and systems sold to end users (consumers). In addition, CE marking can be undertaken for built-in components according to the EMC Directive. Compliance is documented by the Declaration of Conformity.

9 Manufacturer's Declaration

Manufacturer's Declaration according to the Machinery Directive 98/37/EC, Annex II B

The manufacturer:

Dr. Fritz Faulhaber GmbH & Co. KG
Daimlerstr. 23/25
D-71101 Schönaich
Germany

herewith declares that the products named in the following are built in components and therefore, in the definition of Article 4 (2) of the Directive of the European Parliament and the Council dated 22 June 1998 on the harmonisation of the legal regulations of Member States for Machinery 98/37/EC – in short: the Machinery Directive – are not themselves functioning machines, and for this reason do not yet comply with all parts of the relevant provisions of the Machinery Directive.

Product name:

Micro drives, DC micro motors, step motors, motion control systems, precision gears, servo components, controls, micro-precision systems, linear DC servomotors, piezometric motors

Brand names:

FAULHABER, PRECIstep, FTB, penny-motor, smoovy, FAULHABER BX4, FAULHABER motion control, Quickshaft, Smartshell, PiezoMotor

It is prohibited to start up the motor until it has been established that the machine in which these components are to be installed is fully functional and conforms to the safety requirements of the Machinery Directive.

Schoenaich, 04/02/2008
(Place, Date)

Dr. Thomas Bertolini,
Executive Management

Signature

10 Warranty

Extract from our warranty conditions

Dr. Fritz Faulhaber GmbH & Co. KG products are produced to state of the art production methods and are subject to strict quality control.

Should, contrary to all expectations, defects occur, we undertake to find a remedy within the warranty period.

- We shall make good or replace defective goods, at our own discretion, within a reasonable period set by you and at our own cost. Replaced goods become our property and are to be returned to us.
- If improvement or replacement delivery is not possible or does not occur or fails for other reasons for which we are responsible within a period determined by you, you can opt to withdraw from the contract for the defective delivery or reduce the purchase price.
- We are not liable for damage to the goods caused by natural wear and tear, wear, unsuitable, improper or non-contractual use, incorrect assembly, installation or putting into service, excessive loading or improper change, improvement or repair work by you or third parties or incorrect or negligent treatment, provided these are not through our fault.
- Further claims, in particular claims for compensation instead of the performance and for compensation of other direct or indirect losses – including accompanying or consequential loss, for whatever legal reason – are excluded. This does not apply if
  a) we are maliciously silent with regard to a legal or material defect or have issued a guarantee for the nature of the goods,
  b) the loss is due to deliberate intent or gross negligence by us, our legal representatives or vicarious agents or are based on negligent breach of fundamental contract obligations by these persons, or
  c) culpable violation of duty by us, our legal representatives or vicarious agents which have resulted in physical injuries or damage to health.

  In the case of simple negligence, however, our obligation to pay damages is limited to the amount of typical, foreseeable losses for the type of contract.
- All defect claims including the claims for compensation covered by our terms and conditions of supply expire one year after delivery of the goods to your. The limitation period for replacements and improvements is 1 year but it expires at least when the original limitation period for the delivered object expires. The period for defects liability for a supplied object will be extended by the duration of the operational interruption caused by the making good work. Provisions concerning a shorter life of the object supplied within the scope of its intended use remain unaffected by this limitation provision.

For further information, please refer to our terms and conditions of supply, which we will pleased to make available on request.

Notes

Notes

FAULHABER

MA05026 English, 1st issue, 11.2009

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