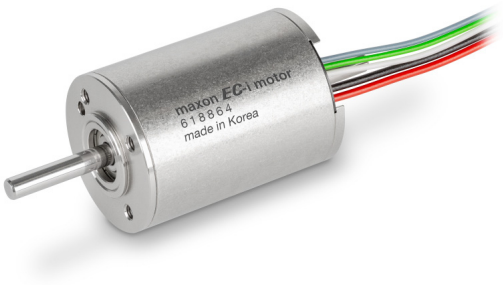
The EC-i30 with integrated electronics is a brushless, speed-controlled 4-quadrant drive with four pole pairs. It is available as 55 Watt version with two shaft ends:

Order number	Variant	Nominal speed [rpm]	Output [W]
618864	5-wire, CW «Enable»	6'000	20
619301	5-wire, CW «Direction»	6'000	20



Functions

- Commutation with Hall sensors
- Digital speed control
- Speed range: 250…6'000 rpm
- Current limitation, non-adjustable
- Overvoltage and undervoltage switch-off
- Short-term overcurrent with I^2T limitation possible
- Temperature monitoring of electronics
- Protection against reverse polarity of supply voltage
- Set value speed via analog signal 0…10 V
- Speed monitor delivers speed-proportional frequency signal
- Parameter setting via power line communication (optional, by factory setting)
- Variants with control input «Enable» or «Direction»

Contents

READ THIS FIRST

These instructions are intended for qualified technical personnel.

Prior commencing with any activities…

- you must carefully read and understand this manual and
- you must follow the instructions given therein.

The EC-i30 with integrated electronics is considered as partly completed machinery according to EU Directive 2006/42/EC, Article 2, Clause (g) and **is intended to be incorporated into or assembled with other machinery or other partly completed machinery or equipment**.

Therefore, you must not put the device into service,…

- unless you have made completely sure that the other machinery – the surrounding system the device is intended to be incorporated to – fully complies with the requirements stated in the EU directive 2006/42/EC!
- unless the surrounding system fulfills all relevant health and safety aspects!
- unless all respective interfaces have been established and fulfill the stated requirements!

Safety Guidelines

Qualified personnel
Do not engage with any work unless you possess the necessary skills.

Legal requirements
Observe any regulation applicable in the country and/or at the site of implementation with regard to health and safety/accident prevention and/or environmental protection.

Make sure that all associated devices and components are installed according to local regulations.

Additional safety equipment
Be aware that, by principle, an electronic apparatus can not be considered fail-safe. Therefore, you must make sure that any machine/apparatus has been fitted with independent monitoring and safety equipment. If the machine/apparatus should break down, if it is operated incorrectly, if the control unit breaks down or if the cables break or get disconnected, etc., the complete drive system must return – and be kept – in a safe operating mode.

Repairs
Be aware that you are not entitled to perform any repair on components supplied by maxon motor.

Danger to life
Touching live wires causes death or serious injuries!

- Consider any power cable as connected to live power, unless having proven the opposite!
- Make sure that neither end of cable is connected to live power!
- Make sure that power source cannot be engaged while work is in process!
- Obey lock-out/tag-out procedures!
- Make sure to securely lock any power engaging equipment against unintentional engagement and tag it with your name!

Max. supply voltage
The connected supply voltage must be between 8 VDC and 28 VDC. Permanently applied voltages above 30 VDC will destroy the unit.

Electrostatic sensitive components
The built-in electronics can be destroyed by externally applied electronic discharges during transport, installation, and during operation.

- Make sure to wear working cloth in compliance with ESD.
- Handle the device with extra care.
- Limit the voltage between flange and any live parts to 500 VDC

Temperature
During operation, the temperature of housing, flange, or other components may exceed 60°C.

Terms used

4-Q speed controller

The motor produces positive torque in the selected or programmed direction. When the speed set value is reduced or the direction changed (direction preselection version) the load is actively decelerated as to the factory-set speed ramp.A load can be permanently decelerated.

Remark

When the load is decelerated, energy is fed back to the operating voltage supply. Thereby, the operating voltage can undesirably increase and can damage in parallel connected consumers. Use an operating voltage supply with feed-in possibility or a brake choppers to prevent excessive voltage surges.

Brake chopper

Limits the operating voltage to a preset value as soon as its feed-in should rise above the threshold value.

Direction CW/CCW

As seen towards the mounting flange:

- CW = shaft turns to the right (clockwise)
- CCW = shaft turns to the left (counterclockwise)

IP40

Protected against access to dangerous parts with a wire, tool, or similar ≥Ø 1 mm and against solid foreign bodies ≥Ø 1 mm. No protection against water.

Max. torque M_{max} [mNm]

The maximum torque the motor can produce for a short term. It is limited by the overload protection of the electronics.

Max. current I_{max} [A]

Supply current with which the peak torque is generated at nominal voltage. With an active speed controller, the supply current is not proportional to the torque, but also depends on the supply voltage. As a result, this value only applies at nominal voltage.

1 Technical Data

All data in the document are typical values.

For detailed information consult the data sheet at the end of this document.

Motor Data		
Nominal voltage	VDC	24
No load speed	rpm	6’000
No load current	mA	107
Nominal speed	rpm	6’000
Nominal torque	mNm	32.6
Nominal current	A	1.19
Max. torque	mNm	105
Max. current	A	6.5
Max. efficiency	%	75.4

Mechanical Data			
Rotor inertia		$g \cdot cm^2$	6.69
Radial play		—	preloaded bearings
Max. axial load	dynamic	N	9
	statistic	N	48.8
	supported	N	2’510
Max. radial load	10 mm from flange	N	30
Weight		g	160

Thermal Data		
Thermal resistance housing/ambient air	K/W^{-1}	5.89
Thermal resistance winding/housing	K/W^{-1}	13
Thermal time constant winding	s	34.1
Thermal time constant motor	s	1’030
Max. winding temperature	°C	155
Max. temperature of electronics	°C	100

Connections	
Operating voltage $+V_{IN}$	red AWG 20 / 0.52 mm^2
Operating voltage GND	black AWG 20 / 0.52 mm^2
Speed setpoint «Set value speed»	white AWG 24 / 0.20 mm^2
Speed monitor «Monitor speed»	green AWG 24 / 0.20 mm^2
Control input «Enable» or «Direction»	grey AWG 24 / 0.20 mm^2

Controller Data			
Operating voltage $+V_{IN}$		VDC	+8…+28
Max. output voltage		V	($+V_{IN}$ x 0.97) − 0.5
Output current, continuous I_{cont}		A	4.5
Max. output current I_{max}	Firmware	A	6.5
	Hardware	A	8.0
Clock frequency of power stage		kHz	50
Sampling rate of speed controller		Hz	1’000
Velocity range		rpm	250…6'000
Direction version «Enable»		—	CW
Direction version «Direction»		—	CCW / CW

Inputs	
Speed set value «Set value speed»	Analog input 0…10.0 V (10.1 V); 101 kΩ Resolution: 4’096 steps

Outputs	
Speed monitor «Monitor speed»	Digital output 3.3 V; 4.1 kΩ

Protective Functions	
Inverse polarity protection	up to max. −30 VDC
Undervoltage protection	cuts off at V_{CC} <7.5 VDC engages at V_{CC} >7.7 VDC
Overvoltage protection	cuts off at V_{CC} >29.5 VDC engages at V_{CC} <28.5 VDC
Temperature monitoring	cuts off at T >100 °C (typical) engages at T <90 °C (typical)
Overvoltage protection (transient)	bipolar Transzorb diode 400 W·ms

Ambient Conditions			
Temperature range	Operation	°C	−40…+40
	Operation with reduced power output	°C	+40…+85
	Storage	°C	−40…+35
Humidity (condensation not permitted)		%	20…80

Voltage Supply			
Ripple		%	<5
Load-dependent output current (recommended)		A	≥3
Output current	min	VDC	8.5
	max	VDC	28
Safe against forced supply if load is being decelerated. With additional brake chopper if operating voltage rises too high due to active feed-in.			

1.1 Speed / Torque / Operating Voltage Diagram

Provisional, calculated data. Measurement pending.

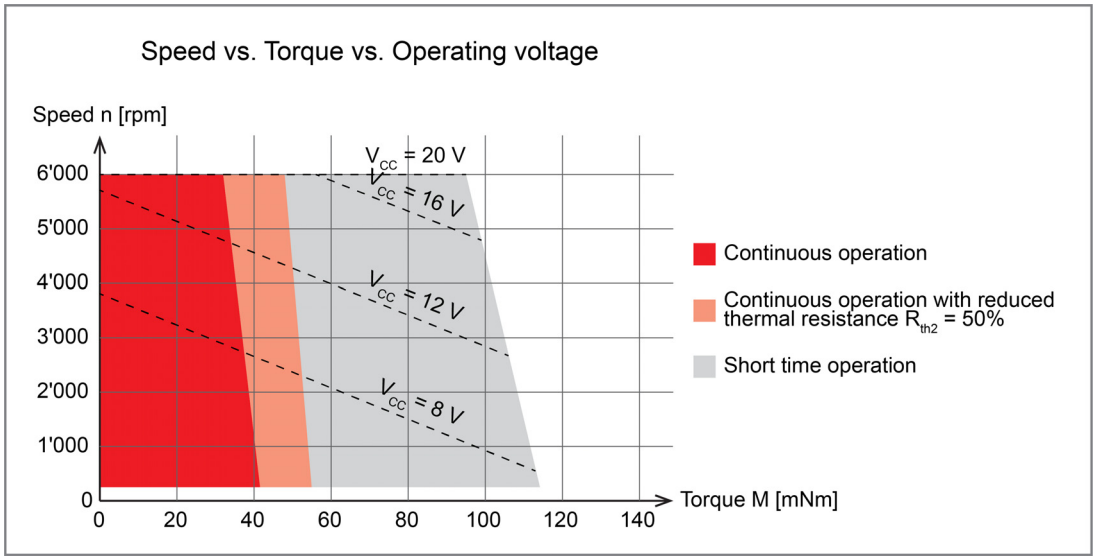


Figure 1 Speed / Torque / Operating voltage diagram

1.2 Dimensional Drawing

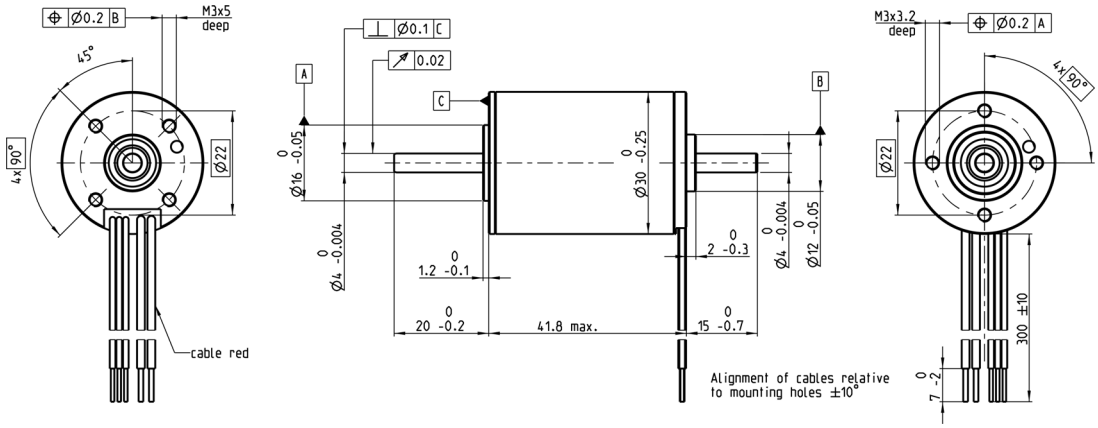


Figure 2 Dimensional drawing [mm]

2 Installation

Electrostatic Sensitive Devices (ESD)

The built-in electronics can be destroyed by externally applied electronic discharges during transport, installation, and during operation.

- *Make sure to wear working cloth in compliance with ESD.*
- *Handle the device with extra care.*
- *Limit the voltage between flange and any live parts to 500 VDC.*

Possible irreversible Damage of Motor

- *Until completion of the installation, individual components can be permanently damaged by improper handling. Therefore, handle the components with particular care.*
- *Max. torque of flange screws is 1.1 Nm (grade 8.8 screws).*
- *A high heat dissipation by mounting to a large-scale metallic structural element permits higher power output of the motor. However, in turn, the circuit board temperature protection can no longer adequately protect the winding.*
- *Cable outlet preferably downwards.*

2.1 EMC-compliant Installation

Cable length ≤300 mm:

- Usually, no shielding is required.
- Star wiring recommended if several EC-i30 with integrated electronics are supplied by a common power supply.

Cable length >300 mm:

- The voltage drop in the connection cable must be minimized by choosing a sufficiently large wire cross section.
- In electromagnetically harsh environments, use of shielded cables connected to ground at both ends can improve immunity against interferences.
- Release cable shielding on one side if 50/60 Hz interference problems occur.
- The incidence surface for interferences can be reduced by shortening the unshielded original connection cable.
- Immunity against interferences and speed stability in case of fluctuating loads can be accomplished by routing the set speed value signal separately in a shielded cable that is put to ground on both sides. In addition to the set speed value signal, a second ground (GND) line must also be carried in this separate cable, but only connected on the motor side. The external set value speed signal must be potential-free.

2.2 Minimal Wiring

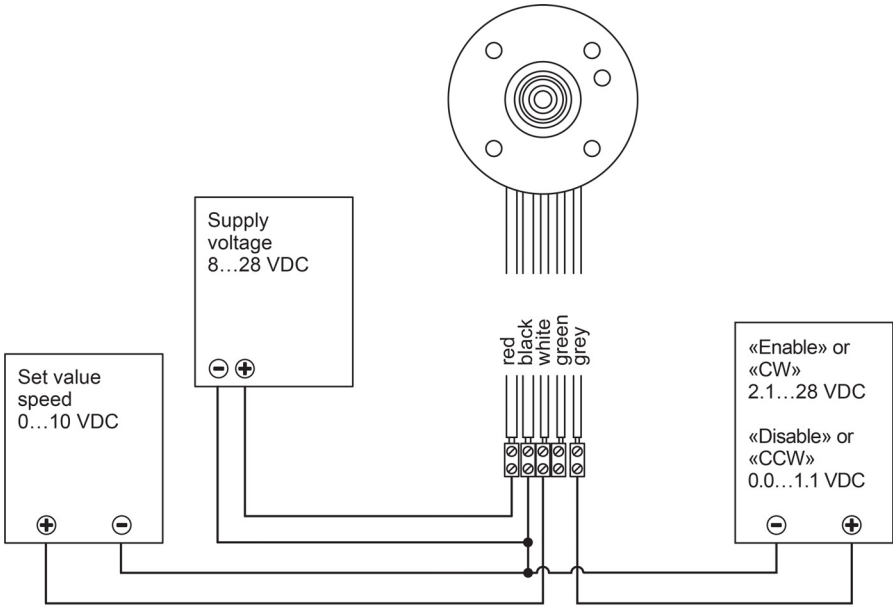


Figure 3 Set point «Set value speed» and (depending on version) activation «Enable» or direction preselection «Direction» from external power supply

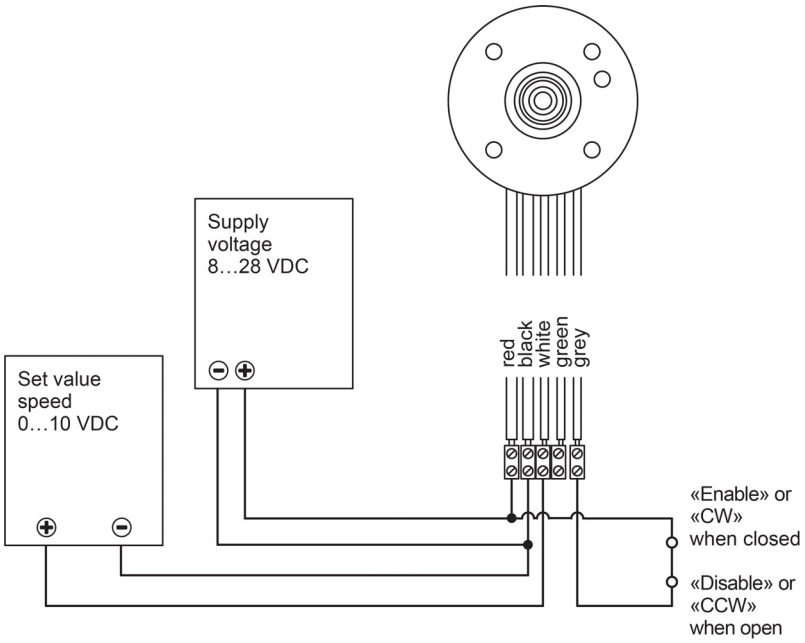


Figure 4 Set point «Set value speed» from external power supply and (depending on version) activation «Enable» or direction preselection «Direction» with potential-free contact

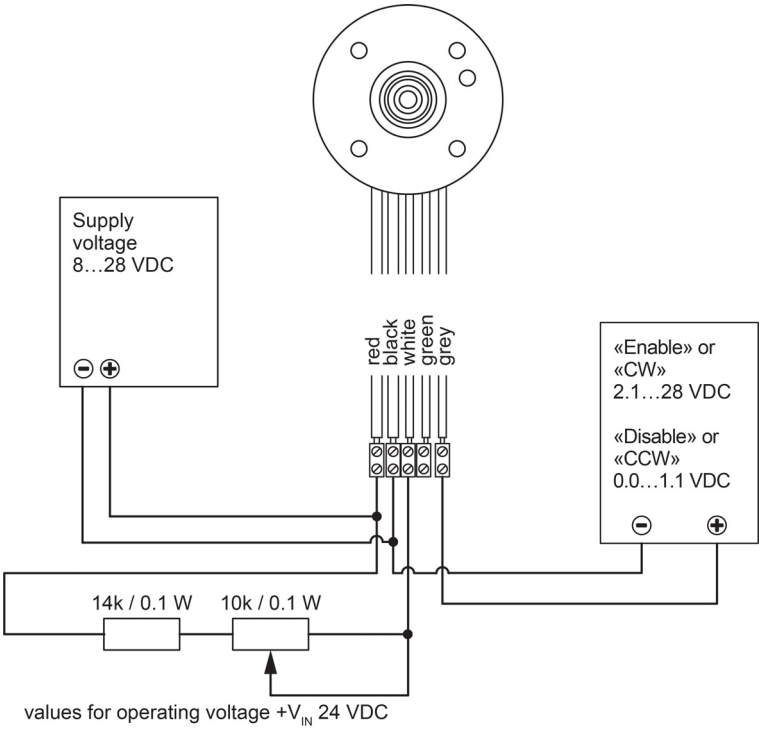


Figure 5 Set point «Set value speed» via external potentiometer and (depending on version) activation «Enable» or direction preselection «Direction» from external power supply

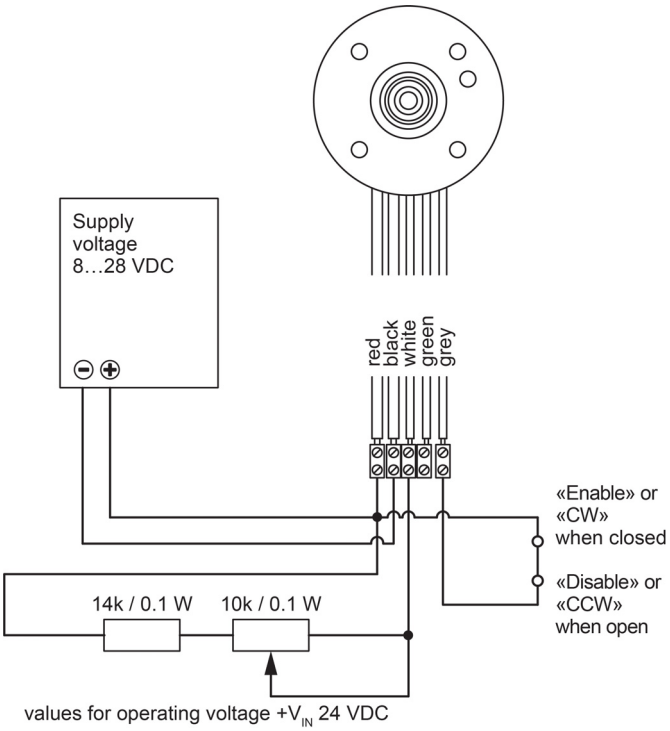


Figure 6 Set point «Set value speed» via external potentiometer and (depending on version) activation «Enable» or direction preselection «Direction» with potential-free contact

3 Functional Description

3.1 Inputs

3.1.1 Set point «Set value speed»

The motor speed is set with the analog input «Set value speed». The input is protected against overvoltage up to the maximum operating voltage.

Pin assignment	Connection wire «Set value speed», white
Input voltage range	0…+10.1 V (referenced to GND)
Input impedance	101 kΩ (in range of 0…+11.1 V) 68 kΩ (in range of +11.1 V…+V_{IN})
Continuous overvoltage protection	−30…+30 V
Nominal design point	10.0 VDC equals 6'000 rpm

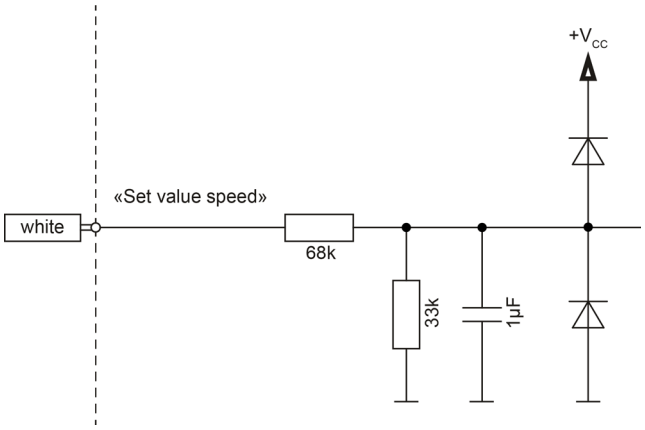


Figure 7 «Set value speed» – Input circuitry

The speed set value is set with the voltage at the set value input. The set speed is controlled by the controller. Changes to speed set value are executed by a delayed internal speed ramp.
A set value smaller a predefined minimum voltage (➔Table 1) disables the power stage, the motor shaft coasts.

Set Value	Function	Remarks
0.00…0.21 V	IDLE mode	Motor not engaged or coasts
0.21…0.42 V	Operation at minimal speed (250 rpm)	
0.42…10.0 V	Linear speed setting between 250 rpm and 6‘000 rpm	
10.0…10.1 V	Linear speed setting between 6‘000 rpm and 6‘060 rpm	

Table 1 «Set value speed» – Setpoint range

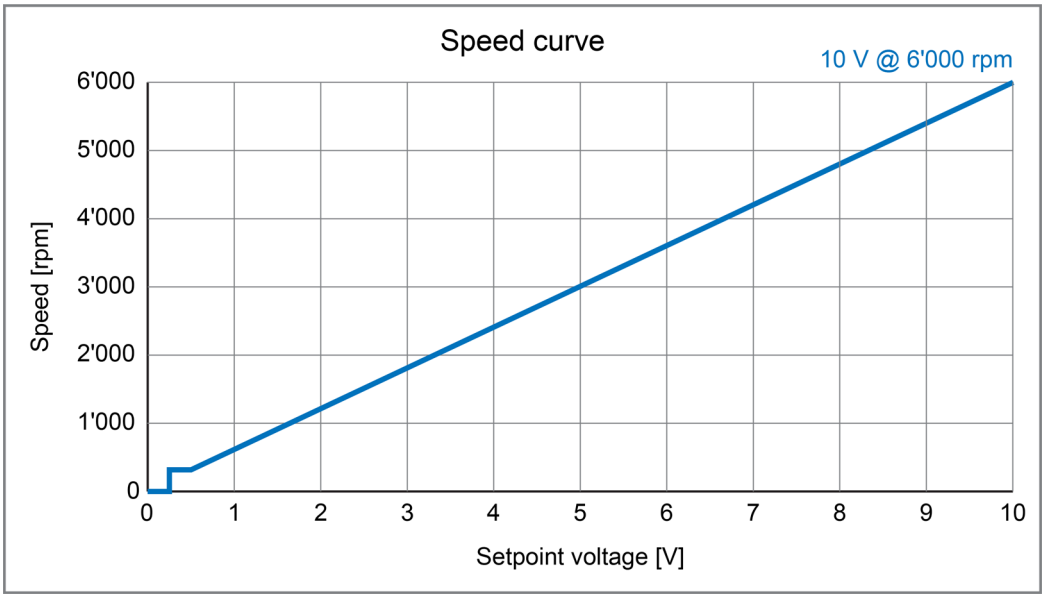


Figure 8 Speed as function of set value voltage

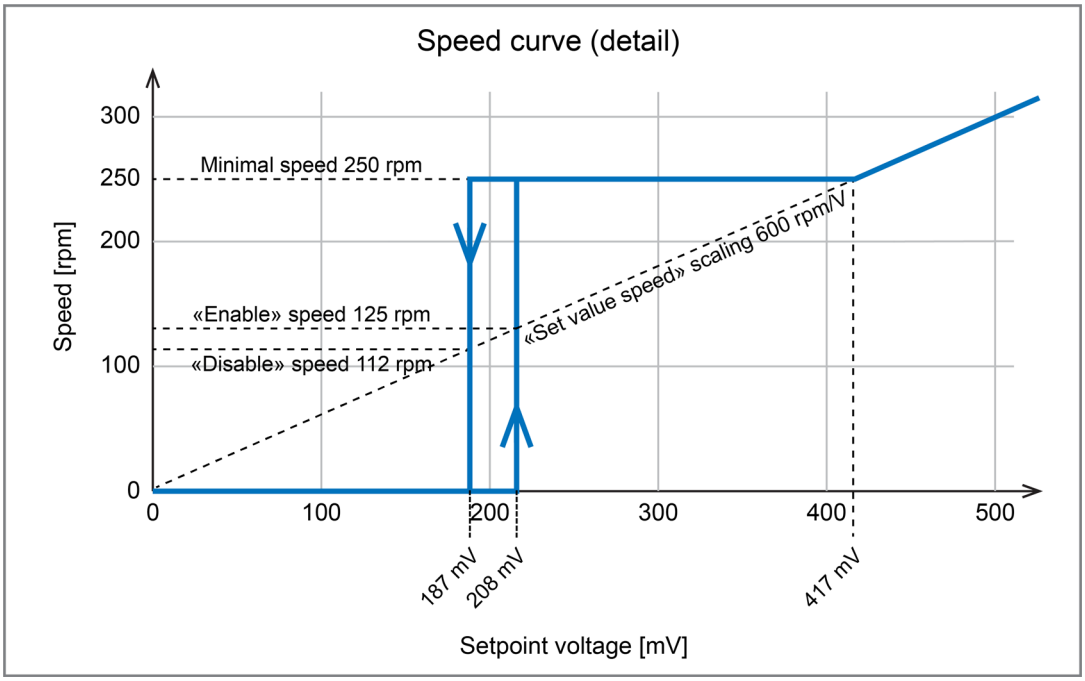


Figure 9 Speed as function of set value voltage – «Enable»

Setting Speed Set Value by PWM Signal

The speed set value can be preset by fixed frequency and amplitude.
The desired set speed value change is obtained by variation of the duty cycle in range of 0…100%.
Both, amplitude and duty cycle thereby have an effect on the resulting speed. The average of the applied PWM voltage corresponds to the analog input signal of the speed set value.

Remark
Depending on load and type of installation, low PWM frequencies can cause audible speed fluctuations.

Nominal value amplitude PWM set value	0…+10.1 VDC (referenced to GND)
Max. value amplitude PWM set value	−30…+30 VDC (referenced to GND)
Frequency range PWM set value	500 Hz…20 kHz
Modulation PWM set value	0…100%
Continuous overvoltage protection	−30…+30 V

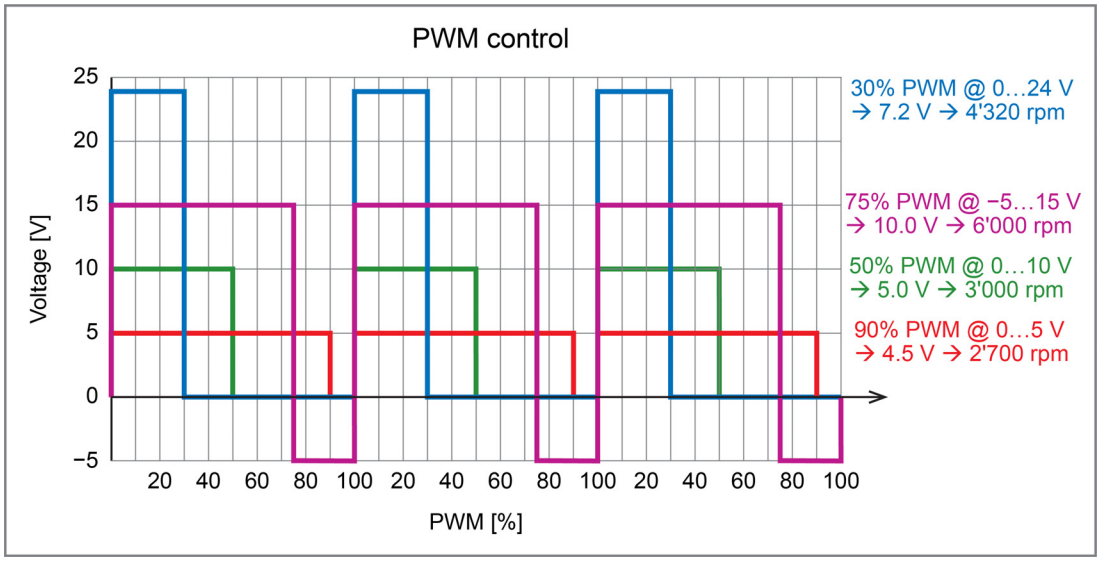


Figure 10 Examples for possible PWM activation for the input «Set value speed»

3.1.2 Version Power Stage Activation: Control Input «Enable»

The power stage is activated with digital input «Enable». The input is protected against overvoltage up to the maximum operating voltage.

Pin assignment	Connection wire «Enable», grey
Input voltage range	0…+3.3 V (referenced to GND)
Input impedance	130 kΩ (in range of 0…+4.4 V) 10 kΩ (in range of +4.4 V…+V_{IN})
Continuous overvoltage protection	−30…+30 V

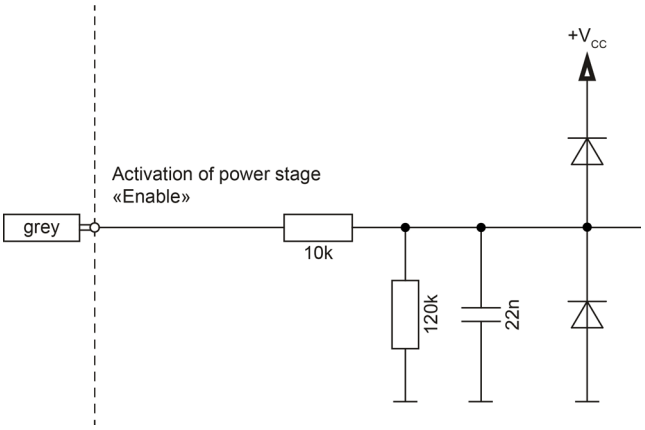


Figure 11 «Enable» – Input circuitry

The power stage is activated by a voltage above 2.1 V, the speed is dependent on the voltage applied on the input «Set value speed». The power stage is deactivated by voltage below 1.1 V, the motor shaft coasts independent on the voltage applied on the input «Set value speed».

Set Value	Function	Remarks
0.0…1.1 V	IDLE mode	Power stage not activated
2.1…3.3 V	RUN mode	Power stage activated if «Set value speed» higher than 0.21 V

Table 2 «Enable» – Setpoint range

3.1.3 Version Direction Preselection: Control Input «Direction»

The motor's rotational direction is set with digital input «Direction». The input is protected against overvoltage up to the maximum operating voltage.

Pin assignment	Connection wire «Direction», grey
Input voltage range	0…+3.3 V (referenced to GND)
Input impedance	130 kΩ (in range of 0…+4.4 V) 10 kΩ (in range of +4.4 V…+V_{IN})
Continuous overvoltage protection	−30…+30 V

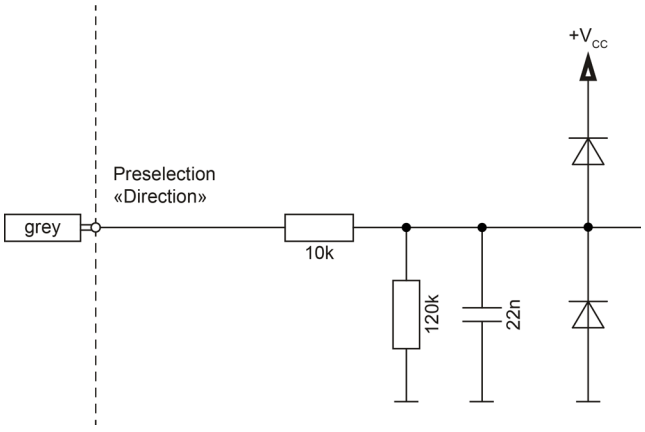


Figure 12 «Direction» – Input circuitry

The activation of the power stage is solely dependent on the setpoint voltage «Set value speed». Upon reversal of the direction with a rotating motor shaft, the internal set value is decreased by a preset ramp until the minimal speed is reached. The power stage is briefly deactivated until the motor shaft accelerates (with the set ramp) in the newly commanded direction up to the preset speed.

Set Value	Function	Remarks
0.0…1.1 V	CCW	Motor shaft turns counterclockwise
2.1…3.3 V	CW	Motor shaft turns clockwise

Table 3 «Direction» – Setpoint range

3.2 Outputs

3.2.1 Speed monitor «Monitor speed»

The actual motor velocity can be monitored using the output «Monitor speed» of the electronics. Thereby, the actual motor velocity is available as digital signal (High/Low) and delivers 6 output pulses per mechanical turn of a motor with 4 pole pairs.

Remark
The output «Monitor speed» is also available in condition «Disable».

Pin assignment	Connection wire «Monitor speed», green
Output voltage range	0…+3.3 VDC
Output resistance	4.1 kΩ
Low level, no load	max. 0.5 VDC
High level, no load	min. 2.8 VDC
Duty cycle	50%
Continuous overvoltage protection	−30…+30 V

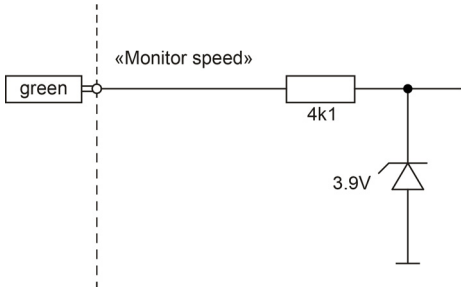


Figure 13 «Monitor speed» – Output circuitry

Sought: Frequency at output «Monitor speed»

$$f_{MonitorSpeed} = \frac{n_{actual} \cdot Z_{Polepairs} \cdot 2}{80} \quad [Hz]$$

Sought: Speed of motor shaft

$$n_{actual} = \frac{f_{MonitorSpeed} \cdot 80}{Z_{Polepairs} \cdot 2} \quad [rpm]$$

n_{actual}	Speed [rpm]
$Z_{Polepairs}$	Number of magnetic pole pairs of motor (4 for the maxon EC-i 30)
$f_{MonitorSpeed}$	Frequency at output «Monitor speed» [Hz]

4 Protective Functions

Inverse polarity protection	The amplifier is protected against polarity reversal of the supply voltage $+V_{IN}$ is protected. Thereby, the negative input voltage must not exceed the maximum permitted supply voltage $+V_{IN}$.
Undervoltage switch-off	The motor is switched off when the supply voltage $+V_{IN}$ drops below approx. 7.5 V to prevent operation beyond the specified range. If the supply voltage $+V_{IN}$ exceeds the restart threshold of approx. 7.7V, the amplifier will be again ready for operation.
Overvoltage switch-off	The motor is switched off when the supply voltage $+V_{IN}$ exceeds approx. 29.5 V to prevent operation beyond the specified range. If the supply voltage $+V_{IN}$ drops below the restart threshold of approx. 28.5 V, the amplifier will be again ready for operation.
Overvoltage protection	The overvoltage protection comprises a bidirectional Transzorb diode (overvoltage protection diode) capable of receiving a maximum peak energy of 400 mWs. Threshold voltage is a minimum of 31.1 V, independent of polarity.
Temperature monitoring	The motor is switched off if the PCB temperature exceeds approx. 100°C. As soon as the PCB temperature has dropped below approx. 90°C, the amplifier will be again ready for operation.
Current limiting	The winding current is electronically limited to approx. 2.56 A (short-term 8.0 A). Thereby, the maximum load torque is limited accordingly.

5 Troubleshooting

- Is the supply voltage $+V_{IN}$ between 8.0 VDC and 28.0 VDC?
- Is the supply voltage $+V_{IN}$ connected to red and black wires and switched on?
- Is the voltage at the red motor connection positive compared to black connection?
- Is the speed set value voltage between 0.42 VDC and 10.0 VDC
- Is the speed set value voltage connected to white and black wires and switched on
- Is the voltage at the white motor connection positive compared to black connection?
- Is the power source not in current limiting?
- Is the motor not mechanically blocked? Can it turn freely?
- The green wire does not have to be connected.

••page intentionally left blank••

maxon motor ag
Brünigstrasse 220
P.O.Box 263
CH-6072 Sachseln
Switzerland

Phone +41 41 666 15 00
Fax +41 41 666 16 50

www.maxonmotor.com