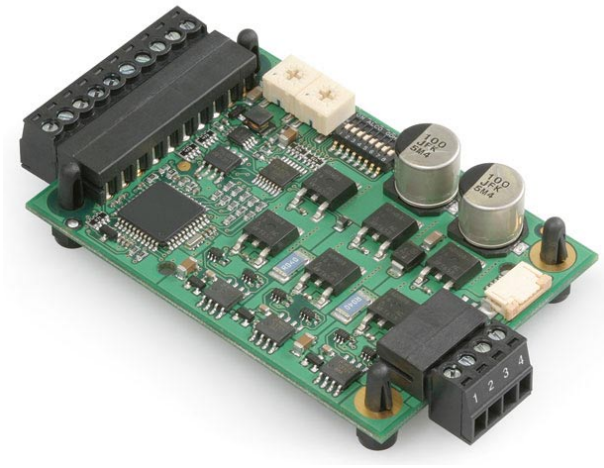
maxon motor control 1-Q-EC Amplifier DECS 50/5

Order number 343253

Operating Instructions June 2009 Edition

The DECS 50/5 (**D**igital **E**C **C**ontroller **S**ensorless) is a 1-quadrant digital controller for the control of brushless DC motors (**E**lectronic **C**ommutated motors) up to 250 W. Rotor position sensors (Hall sensors) are not required. The actual rotor position is evaluated by using the Back-EMF sensing technique.



Features:

- Digital speed control
- Maximum speed 80000 rpm (motor with 1 pole pair)
- Set value input by built-in potentiometer or by analogue set value input (0 ... +5 V)
- «Brake», «Direction» and «Enable» input
- Maximum current limit adjustable
- Selectable start-up modes
- Adjustable speed regulator gain
- Motor speed can be monitored with the speed monitor output
- Status indication with «Ready» output and LED
- Motor connection either by using plug-in screw connector or flex print connector (FPC)

Thanks to the wide input power supply range of 10-50 VDC, the DECS 50/5 is very versatile and can be used with various power supplies. Pluggable PCB screw connectors and a robust controller design make the amplifier ideal for immediate use.

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The latest edition of these operating instructions may be downloaded from the internet as a PDF-file under www.maxonmotor.com, category «Service & Downloads», order number 343253 or in the e-shop http://shop.maxonmotor.com.

1. Safety Instructions

Skilled Personnel
Installation and starting of the equipment shall only be performed by experienced, skilled personnel.

Statutory Regulations
The user must ensure that the amplifier and the components belonging to it are assembled and connected according to local statutory regulations.

Load Disconnected
For primary operation the motor should be free running, i.e. with the load disconnected.

Additional Safety Equipment
Any electronic apparatus is, in principle, not fail-safe. Machines and apparatus must therefore be fitted with independent monitoring and safety equipment. If the equipment breaks down, if it is operated incorrectly, if the control unit breaks down or if the cables break, etc., it must be ensured that the drive or the complete apparatus is kept in a safe operating mode.

Repairs
Repairs may be made by authorised personnel only or by the manufacturer. Improper repairs can result in substantial dangers for the user.

Danger
Do ensure that during the installation of the DECS 50/5 no apparatus is connected to the electrical supply. After switching on, do not touch any live parts!

Wiring Procedure
All cable connections should only be connected or disconnected when the power is switched off.

Max. Supply Voltage
Make sure that the supply voltage is between 10 and 50 VDC. Voltage higher than 55 VDC or wrong polarity will destroy the unit.

Short Circuit and Earth Fault
The DECS 50/5 amplifier is not protected against winding short circuits against ground safety earth and/or GND!

Flex Print Connector Current Limitation
If the motor flex print connector J2 is used, the maximum allowed continuous output current must be limited to 1.2A because of connector specifications.

Start-up Procedure
The principle of sensorless commutation may cause start-up problems in unfavourable conditions such as applications with high friction or with high moment of inertia in combination with low friction.

Electrostatic sensitive device (ESD)

2. Performance Data

2.1 Electrical data

Nominal supply voltage $+V_{CC}$ ..... 10 ... 50 VDC
Absolute minimum supply voltage $+V_{cc\ min}$ ..... 10 VDC
Absolute maximum supply voltage $+V_{cc\ max}$ ..... 55 VDC
Max. output voltage ..... $0.8 \cdot V_{CC}$
Continuous output current I_{cont} ..... 5 A[1]
Max. output current I_{max} ..... 8 A
Switching frequency ..... 50 kHz
Max. speed (motor with 1 pole pair) ..... 80 000 rpm

2.2 Inputs

«Set value speed» ..... Analogue input (0...5 V); Resolution: 1024 steps
«Enable» ..... +3.5...+50 VDC, (R_i = 47 kΩ), or switch against «+5 VDC OUT»
«Direction» ..... +3.5...+50 VDC, (R_i = 47 kΩ), or switch against «+5 VDC OUT»
«Brake» ..... +3.5...+50 VDC, (R_i = 47 kΩ), or switch against «+5 VDC OUT»

2.3 Outputs

Motor rotation speed «Monitor n» ..... Digital output signal (+5 VDC / R_O = 470 Ω)
Status indication «Ready» ..... Digital output signal, open drain, max. +50 VDC (I_L < 100 mA)

2.4 Voltage outputs

Auxiliary voltage «+5 VDC OUT» ..... 5 VDC, (R_O = 235 Ω)

2.5 Motor connections

«Motor winding 1», «Motor winding 2», «Motor winding 3»

2.6 Trim potentiometers

Speed, I_{max}

2.7 LED indicator

Operating display ..... green LED
Error display ..... red LED

2.8 Ambient temperature / humidity range

Operating ..... -10 ... +45°C
Storage ..... -40 ... +85°C
Non condensating ..... 20 ... 80%

2.9 Protective functions

Start-up observation ..... shutdown after 5 unsuccessful start trials in series
Current limitation ..... 0.5 ... 8A
Under voltage shutdown ..... shutdown if $+V_{CC}$ < 9.5 VDC
Over voltage shutdown ..... shutdown if $+V_{CC}$ > 59 VDC
Thermal overload protection of power stage ..... shutdown if $T_{power\ stage}$ > 90°C

2.10 Mechanical data

Weight ..... approx. 40 g
Dimensions (LxWxH) ..... 73.4 x 50.8 x 21.9 mm
Mounting ..... 4 hexagonal M3 distance pins with inside thread
Mounting hole separation ..... 63.2 x 40.6 mm

2.11 Terminals

Power / Signal

Pluggable PCB screw connector J1 ..... 10 poles, pitch 3.5 mm
suitable for wire cross section ..... 0.14... 1.50 mm² (AWG 26 ... 16)

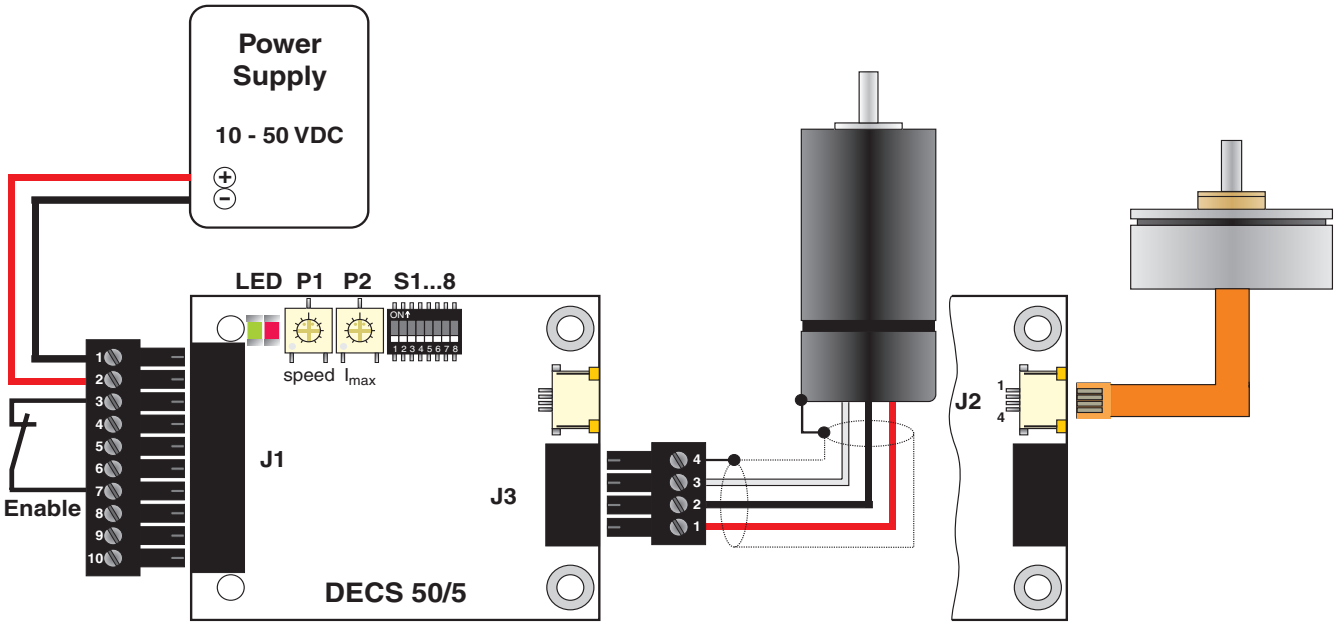
Motor

Pluggable PCB screw connector J3 ..... 4 poles, pitch 3.5 mm
suitable for wire cross section ..... 0.14... 1.50 mm² (AWG 26 ... 16)

Flex print connector J2 ..... 4 poles, pitch 1.0 mm
suitable for maxon EC flat motors (sensorless) with flex print ..... top contact style

1 Has to be limited to 1.2A in use with motor flex print connector (FPC) J2

3. Minimum External Wiring



Pin assignment J1:

1	Power GND
2	+Vcc 10...50 VDC
3	Enable
4	Direction
5	Brake
6	Set value speed
7	+5 VDC OUT
8	Gnd
9	Monitor n
10	Ready

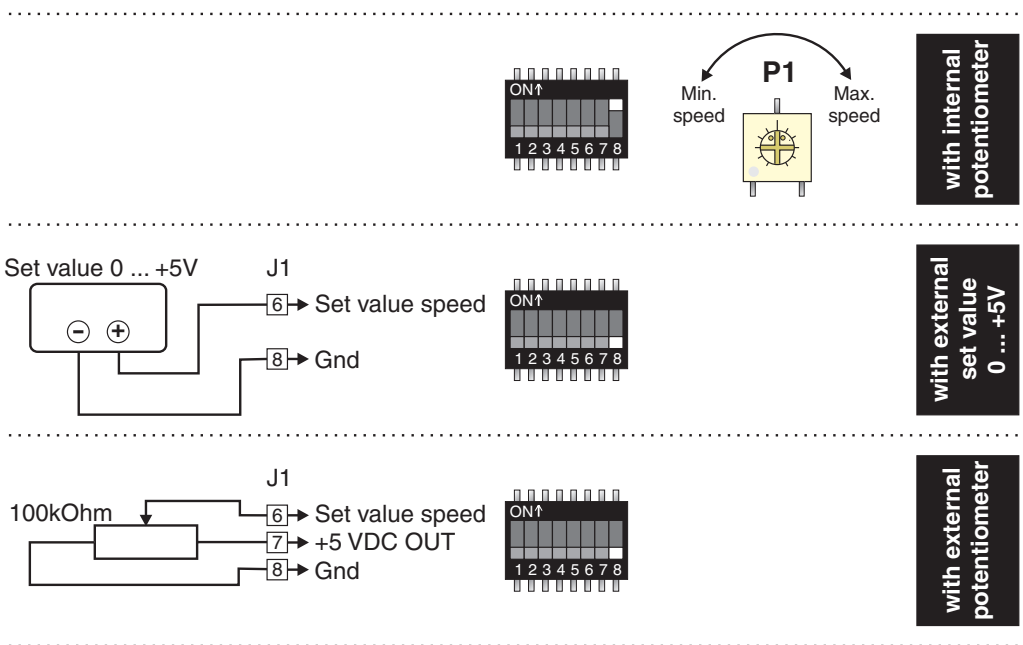
Pin assignment J3:

4	Cable shield
3	Motor winding 3
2	Motor winding 2
1	Motor winding 1

Pin assignment J2:

1	Motor winding 1
2	Motor winding 2
3	Motor winding 3
4	Neutral point Y (not used)

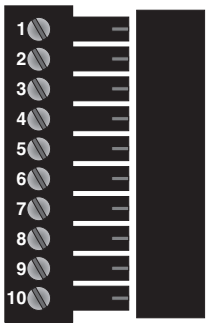
Set value speed input selection



3.1. Pin assignment

3.1.1. Power and signal

Connector J1



pluggable PCB screw connector
10-poles

Pin-No.	Signal	Description
1	Power GND	Ground for power supply
2	$+V_{CC}$	Supply voltage +10 ... 50 VDC
3	Enable	Enable input
4	Direction	Direction input
5	Brake	Brake input
6	Set value speed	Set value speed input
7	+5 VDC OUT	Auxiliary voltage output 5 VDC
8	Gnd	Digital Ground
9	Monitor n	Speed monitor output
10	Ready	Status indication output

3.1.2. Connector for maxon EC motors

Connector J3

pluggable PCB screw connector
4-poles

Pin-No.	Signal	Description
4	Cable shield	Cable shield
3	Motor winding 3	Motor winding 3
2	Motor winding 2	Motor winding 2
1	Motor winding 1	Motor winding 1

3.1.3. Connector for maxon flat motors with flex print

Connector J2

FPC-FFC Flex print connector
4-poles

Pin-No.	Signal	Description
1	Motor winding 1	Motor winding 1
2	Motor winding 2	Motor winding 2
3	Motor winding 3	Motor winding 3
4	Neutral point Y	Neutral point Y (not used)

4. Operating Instructions

4.1. Power supply layout

Any available power supply can be used, as long as it meets the minimum requirements shown below.
During set up and adjustment phases, we recommend separating the motor mechanically from the machine to prevent damage due to uncontrolled motion!

Power supply requirements

Output voltage	10 VDC < V_{CC} < 50 VDC
Output current	depending on load, continuous max. 5 A acceleration, short-time max. 8 A

The required supply voltage can be calculated as follows:

Known values

- ⇨ Operating torque M_B [mNm]
- ⇨ Operating speed n_B [rpm]
- ⇨ Nominal motor voltage U_N [V]
- ⇨ Motor no-load speed at U_N, n_0 [rpm]
- ⇨ Speed/torque gradient of the motor $\Delta n/\Delta M$ [rpm/mNm]

Sought value

- ⇨ Supply voltage V_{CC} [V]

Solution

$$V_{CC} = \frac{U_N}{n_0} \cdot (n_B + \frac{\Delta n}{\Delta M} \cdot M_B) \cdot \frac{1}{0.80} + 1.0V$$

Select a power supply capable of supplying this calculated voltage under load. The formula takes into account a maximum PWM duty cycle of 80% and a 1.0 V maximum voltage drop (at maximum output current) of the power stage.

What speed can be reached with a given power supply V_{CC}:

$$n_B = 0.80 \cdot \left[(V_{CC} - 1.0\,V) \cdot \frac{n_0}{U_N} \right] - \left[\frac{\Delta n}{\Delta M} \cdot M_B \right]$$

Note

- ⇨ The power supply must be able to buffer the back-fed energy e.g. in a capacitor.
- ⇨ The under voltage protection switches off the DECS 50/5, as soon as the supply voltage V_{CC} falls below 9.5 V. Therefore, at low supply voltage V_{CC} attention has to be payed to the voltage drop over the supplying cables.

4.2. Start-up Description

A successful sensorless start-up procedure consists of two phases:
The alignment phase and the acceleration phase.

Alignment Phase
The alignment phase sets the motor shaft into a defined rotor position and stabilizes it before starting. This is achieved by supplying a motor current ramp at a fixed step configuration (non rotating stator field).
During the alignment phase the motor current rises up to I_{Start}.

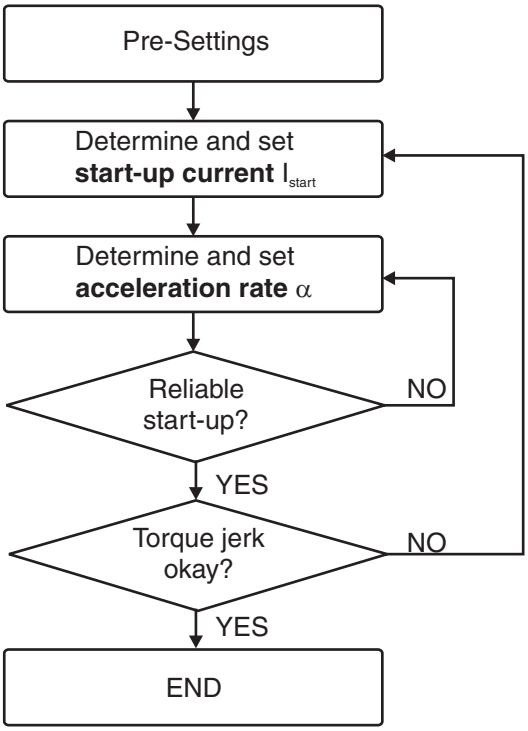
Acceleration Phase
During the acceleration phase, a synchronous rotation is forced on the motor at a fixed acceleration rate α until the motor speed is high enough for the Back-EMF sensing. The motor current is limited to I_{Start}.

Note

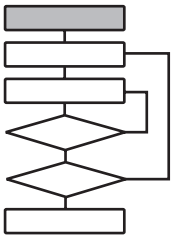
- ⇨ The principle of sensorless commutation can cause start-up problems in unfavourable conditions.
- ⇨ Operation with motors with inductance greater than approx. 2mH is not recommended, due to unsymmetrical commutation.
- ⇨ The following aspects are detrimental to a reliable start-up:
  High friction or high moment of inertia in combination with low friction or improperly selected start-up strategy.
- ⇨ The appropriate start-up strategy can be selected by DIP switches. The new DIP switch settings are adopted by a disable-enable procedure.

During the start-up procedure, the motor shaft may temporarily make righ-left rotary motions!

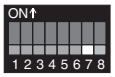
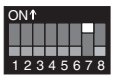
4.3. Setting-up Procedure



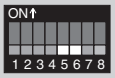
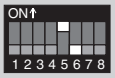
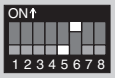
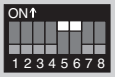
4.4. Pre-Settings



1. Set the desired motor speed range with DIP switch **S7**.

	Motor type		
DIP switch S7	**1 pole pair**	**4 pole pairs**	**8 pole pairs**
	1’000...20‘000 rpm	250...5‘000 rpm	125...2‘500 rpm
	1’000...80‘000 rpm	250...20‘000 rpm	125...10‘000 rpm

2. Set the appropriate speed regulator gain by DIP switches **S5** and **S6**.

DIP switches S5 and S6	**Gain setting**	**Recommended setting for motor with speed constant k_n (1 pole pair)**
	very low gain	> 2’000 rpm/V
	low gain	2’000...1‘000 rpm/V
	medium gain	1’000...200 rpm/V
	high gain	< 200 rpm/V

The recommendations are for guidance only and depend on the load characteristic.

Note

Select a lower gain if the motor is oscillating or not running smoothly. Select the gain setting <very low gain> if the commutation gets lost at higher motor currents, particularly with maxon flat motors (multi pole motors).

3. Apply a set value at the «Set value speed» input or with potentiometer **P1** depending on set value mode selected so that required speed is reached.

Note

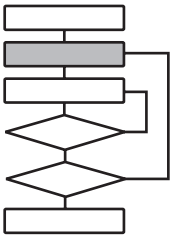
At 0 V set value, the speed is **NOT** 0 rpm. The minimum speed depends on the pole pair number of the connected motor (see table under point 1).

4. Adjust the maximum current I_{max} to the required limiting value.
With potentiometer **P2 I_{max}** the output current can be adjusted linearly in the range of 0.5 … 8 A.

Note

The limiting value I_{max} should be below the rated motor current (max. continuous current) as shown on the motor data sheet (corresponds to line 6 in maxon catalogue).

4.5 Determine and set start-up current



The start-up current I_{Start} influences the alignment phase, the acceleration phase and the torque jerk at start-up.

As a recommendation the startup-current should be equal to the rated motor current (max. continuous current) as shown on the motor data sheet (corresponds to line 6 in the maxon catalogue).

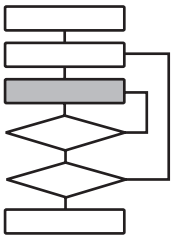
Set the start-up current with DIP switches **S1** and **S2**.

DIP switches S1 and S2	Start-up torque jerk	Recommended for	Start-up current I_{Start}
	low	very smooth start-up required	1 A
	medium	standard application	2 A
	high	standard application	4 A
	highest	high initial breakaway torque	8 A

Note
The maximal available startup-current is limited by the supply voltage and the terminal resistance. During alignment and acceleration phase, the motor voltage is reduced to half the supply voltage. The maximum possible startup-current is, therefore:

$$I_{Start} = \frac{+V_{CC}}{2 \cdot R_{Ph-Ph}} \quad [A]$$

4.6. Determine and set acceleration rate



The acceleration rate α depends on the produced torque and the total moment of inertia. It should be adapted to the application as follows:

Known values

⇨ Number of pole pairs of motor z_{POL}

⇨ Motor torque constant k_m [mNm/A]

⇨ Start-up current I_{Start} [A]

⇨ Rotor inertia J_R [gcm²]

⇨ Load inertia J_L [gcm²]

Sought value

⇨ Acceleration rate α [Hz/s]

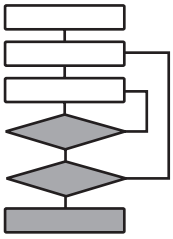
Solution

$$\alpha = z_{POL} \cdot \frac{10'000}{2 \cdot \pi} \cdot \frac{k_m \cdot I_{Start}}{J_R + J_L} \quad [Hz/s]$$

Select the start-up characteristic with DIP switches **S3** and **S4**.

DIP switches S3 and S4	Start-up characteristic	Acceleration rate α
	slow	160 Hz/s
	medium	800 Hz/s
	fast	4’000 Hz/s
	very fast	20’000 Hz/s

4.7. Verify start-up settings



1. Verify the settings of the start-up current and the acceleration rate settings. Apply a set value at the «Set value speed» input or with potentiometer **P1** depending on set value mode selected so that required speed is reached. Enable the power stage.

2. Is the start-up behaviour reliable?
   YES: Continue with step 3.
   NO: Change the start-up characteristic with DIP switches **S3** and **S4**
   Note
   If the settings of DIP switches are changed, the new settings are adopted by a disable-enable procedure.

3. Check the torque jerk at start-up.
   Okay: Continue with step 4.
   Not okay: Change start-up current wit DIP switches S1 and S2.
   Note:
   If the settings of DIP switches are changed, the new settings are adopted by a disable-enable procedure.

4. The start-up settings procedure is finished.
   Note
   ⇨ If the speed setting is too low, the Back-EMF sensorless commutation can not properly detect the actual rotor position.
   ⇨ After 5 failed start-up trials the amplifier will be set into disable status automatically. New start-up trials are possible after a disable-enable procedure.

5. Functional Description of Inputs and Outputs

5.1. Inputs

5.1.1. «Enable»

The «Enable» input enables or disables the power stage.
If a voltage higher than 3.5 V is applied to the «Enable» input, the amplifier is activated (Enable). A speed ramp will be performed during acceleration.

Input voltage > 3.5 V	Motor running (Enable)

If the input is not connected (floating) or ground potential is applied to the «Enable» input, the power stage is high impedant and the motor shaft free-wheels and slows down (Disable).

Input not connected (floating) Input set to Gnd Input voltage < 1.5 V	Power stage switched off (Disable)

The «Enable» input is protected against over voltage.

Connector J1	Pin number [3] «Enable»
Input voltage range	0 ... +5 V
Input impedance	47 kΩ (in the range of 0 ... +5 V)
Continuous over voltage protection	-50 ... +50 V
Delay time	max. 25 ms

Do not enable the amplifier in case of the motor shaft is still rotating. Otherwise a high motor current can occur. The maximum permitted motor speed when activating the «Enable» function is limited by the maximum permitted brake current see chapter 5.1.3. «Brake».

5.1.2. «Direction»

The «Direction» input determines the rotational direction of the motor shaft. When the level changes, the motor shaft slows down with a ramp to standstill, (see also chapter 5.1.3. «Brake») and accelerates with a speed ramp in the opposite direction, until the nominal speed is reached again.

If the input is not connected (floating) or ground potential is applied to the «Direction» input, the motor shaft runs clockwise (CW).

Input not connected (floating) Input set to Gnd Input voltage < 1.5 V	Clockwise (CW)

If a voltage higher than 3.5 V is applied to the «Direction» input, the motor shaft runs counter-clockwise (CCW).

Input voltage > 3.5 V	Counter-clockwise (CCW)

The «Direction» input is protected against over voltage.

Connector J1	Pin number [4] «Direction»
Input voltage range	0 ... +5 V
Input impedance	47 kΩ (in the range of 0 ... +5 V)
Continuous over voltage protection	-50 ... +50 V

If the direction is changed with a rotating motor shaft, the limitations described in chapter 5.1.3. «Brake» must be observed, or the amplifier may be damaged.

5.1.3. «Brake»

Activating the «Brake» function short-circuits the motor winding. The motor shaft slows down in a fast but uncontrolled fashion to a standstill.

The motor shaft slows down in an uncontrolled fashion to a standstill by short-circuiting the motor windings.

If the input is not connected (floating) or ground potential is applied to the «Brake» input, the «Brake» function is inactive. The motor speed is not influenced.

Input not connected (floating) Input set to Gnd Input voltage < 1.5V	Brake function not active

If a voltage higher than 3.5 V is applied to the «Brake» input, the function is active.

Input voltage > 3.5 V	Brake function active (motor windings short-circuited)

The «Brake» input is protected against over voltage.

Connector J1	Pin number [5] «Brake»
Input voltage range	0 ... +5 V
Input impedance	47 kΩ (in the range of 0 ... +5V)
Continuous over voltage protection	-50 ... +50 V
Max. brake current	28 A
Delay time	max. 30 ms

Note

⇨ The motor windings remain short-circuited until the brake function is deactivated again.

The maximum permitted brake speed is limited by the maximum permitted brake current:

⇨ I <= 28 A (max. allowed brake current)

The value can be calculated as follows:

max. permitted brake speed limited by brake current (I = 28 A)

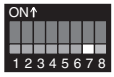
The maximum permitted brake speed can be calculated from the motor data:

$$n_{\max} = 28A \cdot k_n \cdot \left(R_{Ph-Ph} + 0.05\Omega\right) \qquad [rpm]$$

k_n = speed constant [rpm / V]
$R_{Ph\text{-}Ph}$ = terminal resistance phase-phase [Ω]

5.1.4. Set value «Set value speed»

The external analogue set value is predetermined at the «Set value speed» input. The «Set value speed» input sets the rotational speed of the motor shaft.The potentiometer P1 scales the maximum speed within the selected speed range (DIP switch S7).

	Motor type		
DIP switch S7	**1 pole pair**	**4 pole pairs**	**8 pole pairs**
	1'000...20'000 rpm	250...5'000 rpm	125...2'500 rpm
	1'000...80'000 rpm	250...20'000 rpm	125...10'000 rpm

Note

⇨ If the settings of DIP switches are changed, the new settings are adopted by a disable-enable procedure.

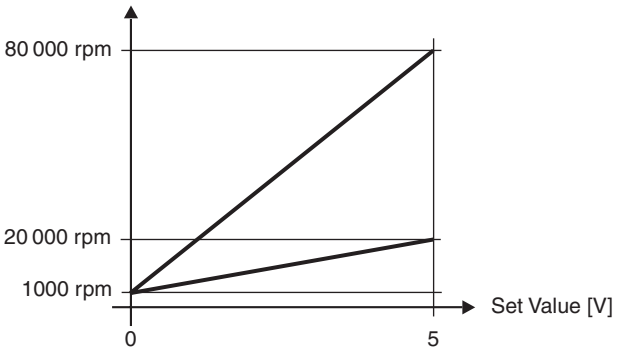
The actual speed value is calculated according the following formula:

$$a = Speed\ range - 1'000 \quad [rpm]$$

$$b = \frac{P1[\%]}{100[\%]}$$

$$c = \frac{Set\ value\ speed[V]}{5[V]}$$

$$Speed = (a \cdot b \cdot c) + 1'000 \quad [rpm]$$



Note

⇨ Formula and diagram valid for 1 pole pair.

The «Set value speed» input is protected against over voltage.

Connector J1	Pin number [6] «Set value speed»
Input voltage range	0 ... +5 V (referenced to Gnd)
Resolution	1024 steps (4.88 mV)
Input impedance	47 kΩ (in range 0...+5 V)
Continuous over voltage protection	-50...+50 V

Note

⇨ If the set value is applied using the «Set value speed» input, DIP switch **S8** has to be switched OFF.

5.2. Outputs

5.2.1. Auxiliary voltage «+5 VDC OUT»

An internal auxiliary voltage of +5 VDC is provided.

Used as reference voltage:

⇨ For external set value potentiometer (recommended value: 100 kΩ)

⇨ Gating the signals: «Enable», «Direction» and «Brake»

Connector J1	Pin number [7] «+5 VDC OUT» Pin number [8] «Gnd»
Output voltage	5 VDC ± 5%
Output resistance R_O	235Ω
Max. output current	5VDC/R_O

5.2.2. «Monitor n»

The «Monitor n» output gives information on the actual speed of the motor shaft. The actual speed is available as a digital frequency signal. Its frequency is equal to the electrical frequency of the motor (1 pulse per electrical turn).

Connector J1	Pin number [9] «Monitor n»
Output voltage range	0...+5 V
Output resistance R_O	470Ω
Maximum output current	5 VDC / R_O
Continuous over voltage protection	-0.8...+7 V

Sought values: Frequency at «Monitor n» output

$$f_{Monitor\ n} = \frac{n \cdot z_{Pol}}{60} \qquad [\mathrm{Hz}]$$

n = Speed [rpm]
z_{Pol} = Number of pole pairs

Sought values: Motor shaft speed

$$n = \frac{f_{Monitor\ n} \cdot 60}{z_{Pol}} \qquad [\mathrm{rpm}]$$

$f_{Monitor\ n}$ = Frequency at «Monitor n» output [Hz]
z_{Pol} = Number of pole pairs

5.2.3. «Ready»

The «Ready» output can be used to report the state of operational readiness or a fault condition to a master control unit.

In normal cases (no fault) the output is switched to Ground.

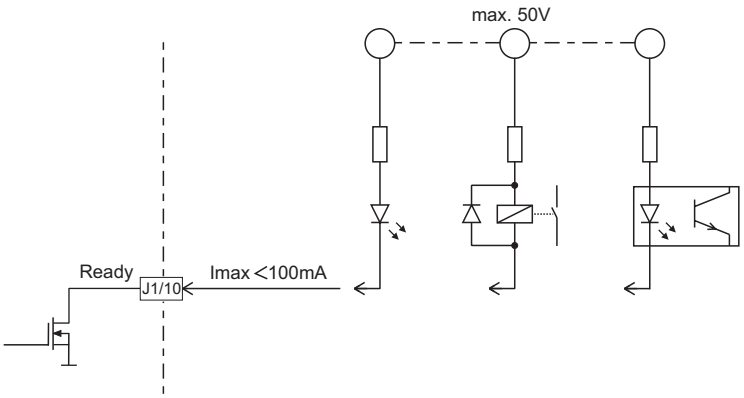
Ready (no fault)	Gnd

In case of a fault the output MOSFET is not conducting (high impedant)

Fault (not ready)	not conducting

The «Ready» output is not protected. Use additional resistance to limit the maximum load current.

Connector J1	Pin number [10] «Ready»
Maximum Input voltage	+50 VDC
Maximum load current	100 mA (not protected)
Type of Output	Open Drain



Note

⇨ All fault conditions are listed in chapter 8.

6. Functional Description of DIP Switches

Operating modes are adjusted using eight DIP switches:

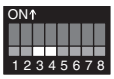
6.1. Setting start-up current

S1 and **S2** are used to predetermine the start-up current.

DIP switches S1 and S2	Start-up torque jerk	Recommended for	Start-up current I_{Start}
	low	very smooth start-up required	1 A
	medium	standard application	2 A
	high	standard application	4 A
	highest	high initial breakaway torque	8 A

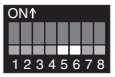
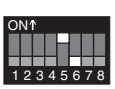
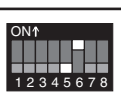
6.2. Setting acceleration rate

S3 and **S4** are used to predetermine the acceleration rate.

DIP switches S3 and S4	Start-up characteristic	Acceleration rate α
	slow	160 Hz/s
	medium	800 Hz/s
	fast	4’000 Hz/s
	very fast	20’000 Hz/s

6.3. Setting speed regulator gain

S5 and **S6** are used to predetermine the speed regulation gain.

DIP switches S5 and S6	Gain setting	Recommended setting for motor with speed constant k_n (1 pole pair)
	very low gain	> 2’000 rpm/V
	low gain	2’000...1‘000 rpm/V
	medium gain	1’000...200 rpm/V
	high gain	< 200 rpm/V

6.4. Setting speed range

S7 is used to predetermine the speed range.

	Motor type		
DIP switch S7	**1 pole pair**	**4 pole pairs**	**8 pole pairs**
	1’000...20‘000 rpm	250...5‘000 rpm	125...2‘500 rpm
	1’000...80‘000 rpm	250...20‘000 rpm	125...10‘000 rpm

6.5. Setting set value source

S8 is used to predetermine the set value source.

DIP switch S8	**Set value source**
	with external set value 0 ... +5 V or with external potentiometer
	with internal potentiometer **P1**

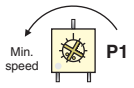
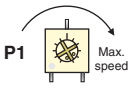
Note

⇨ If the settings of DIP switches are changed, the new settings are adopted by a disable-enable procedure.

7. Functional Description of Potentiometers

7.1. Potentiometer P1 «Speed»

If DIP switch **S8** is switched on, the set speed value is adjusted by potentiometer **P1** «Speed».

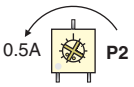
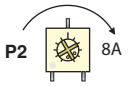
Potentiometer P1	Adjustment position	Value
	Left end stop	Minimal value (see chapter 6.4.)
	Right end stop	Maximum value (see chapter 6.4.)

Note

⇨ If set value is aplied using the «Speed set value» input (DIP switch S8 OFF) the potentiometer P1 scales the maximum speed within the selected speed range (DIP switch S7). See also chapter 5.1.4. Set value «Set value speed».

7.2. Potentiometer P2 «I_{max}»

Potentiometer **P2** «I_{max}» allows to adjust the current limitation in the range of approximately 0.5 … 8 A.

Potentiometer P2	Adjustment position	Value
	Left end stop	0.5 A
	Right end stop	8.0 A

Note

⇨ The maximum continuous output current should be limited to:
1.2 A for Flex print connector J2
5.0 A for pluggable PCB connector J3

⇨ The working principle of the current limitation is «cycle-by-cycle». As a consequence the motor winding current is limited to the peak current. Please note, especially with low impedance motor winding and / or high supply voltage the mean value of the motor winding current can be significantly lower than the peak current value.

Improper setting of P2 I_{max} in comparison to the rated motor current (maximum continuous current) as shown on the motor data sheet can lead to the loss of electronic commutation at high motor current. In worst case an enduring operation at wrong commutation pattern occurs. As a recommendation set I_{max} not higher than twice the rated motor current if a higher motor current is needed.

8. Operating Status Display

A green and a red LED show the operating status and the error condition.

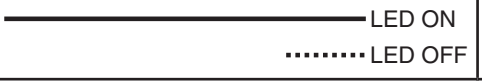
Definition


8.1. No LED

Reason

- No supply voltage $+V_{CC}$
- Wrong polarity of supply voltage $+V_{CC}$

8.2. Green LED (normal operation)

Blink pattern (green LED)	Operating status
	Amplifier enabled
	Amplifier disabled
	Brake function active
	Start-up running

8.3. Red LED (fault conditions)

According to the blink pattern of the red LED the following error messages can be identified:

Blink pattern (red LED)	Fault condition
① 	**Start-up Failure** More than 5 trials in series to start the motor were unsuccessful
② 	**Under voltage** Supply voltage $+V_{CC}$ falls below 9.5V
③ 	**Over voltage** Supply voltage $+V_{CC}$ rises above 59V
④ 	**Over temperature** Power stage temperature exceeds 90°C

Note

⇨ All fault conditions are checked in «Enable» state only.

⇨ To reset the fault condition (1) «Start-up Failure» the amplifier must be disabled.

⇨ To reset the fault condition (2) «Under voltage» the amplifier must be disabled and the supply voltage $+V_{CC}$ must be > 9.8 VDC.

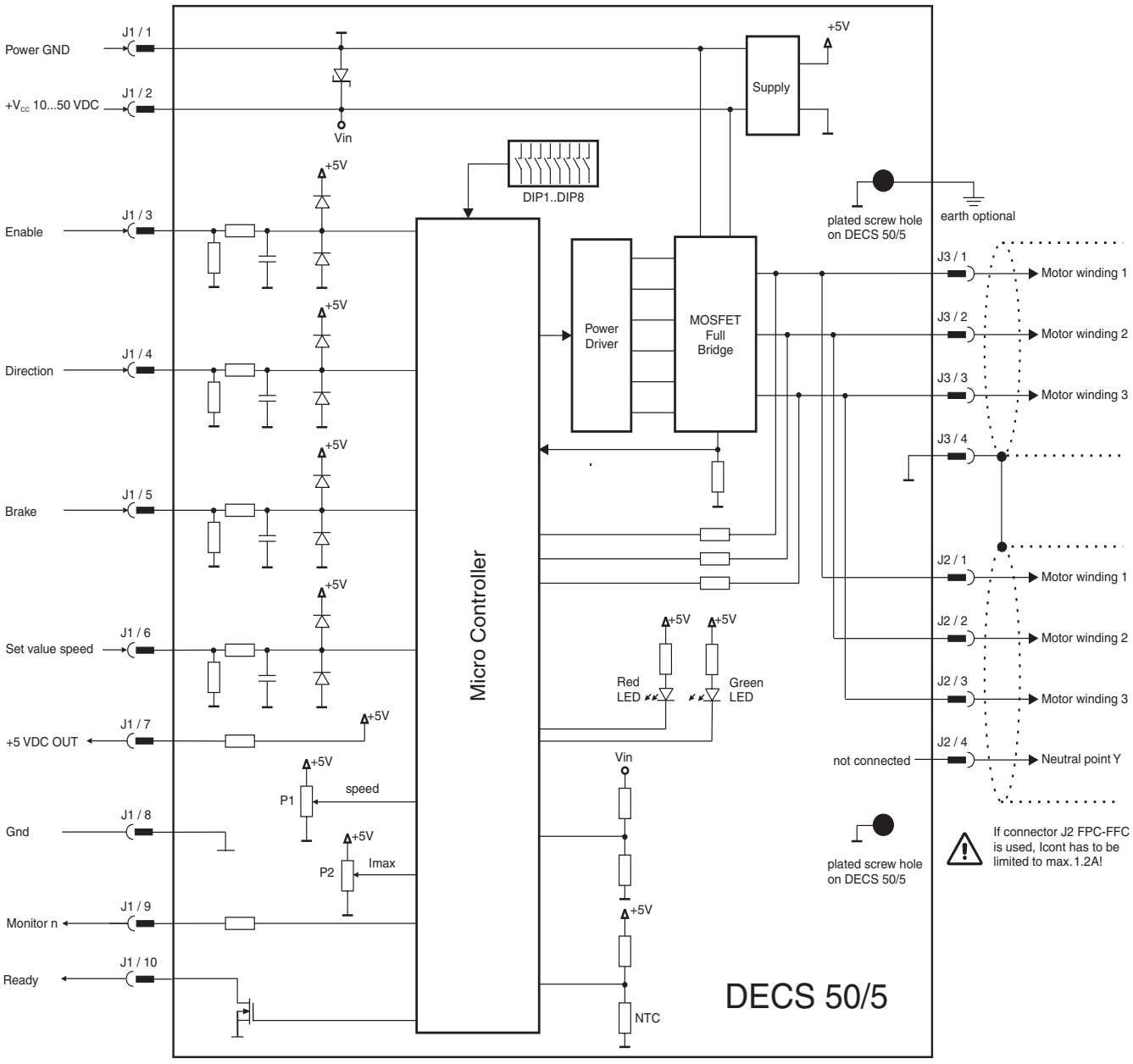
⇨ To reset the fault condition (3) «Over voltage» the amplifier must be disabled and the supply voltage $+V_{CC}$ must be < 55 VDC

⇨ To reset the fault condition (4) «Over temperature» the amplifier must be disabled and the power stage temperature must fall below 80°C

Possible reason for a fault message:

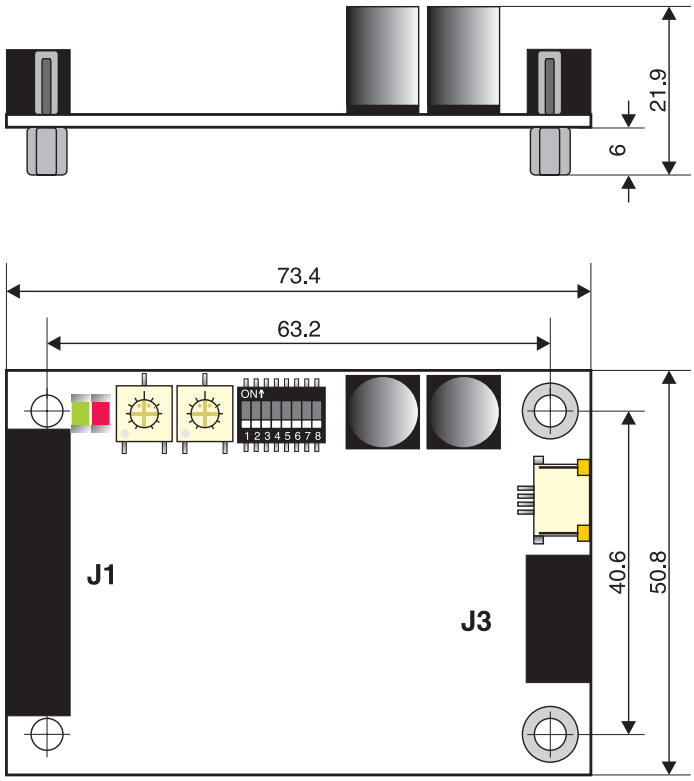
Blink pattern	Possible reason for fault messages
①	**Start-up Failure** High friction Broken motor cable
②	**Under voltage** The power supply limits the DC current The power supply lines have a high voltage drop
③	**Over voltage** The power supply is not capable to buffer the fed back energy at fast deceleration
④	**Over temperature** To high ambient temperature Insufficient thermal convection

9. Block Diagram



10. Dimension Drawing

Dimensions in [mm]



11. Spare Parts List

maxon motor order number	Designation
345470	10 poles pluggable PCB connector pitch 3.5 mm (suitable to J1 «Power/Signal»)
345469	4 poles pluggable PCB connector pitch 3.5 mm (suitable to J3 «Motor»)