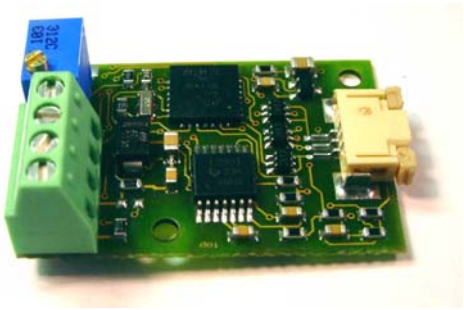
maxon motor

maxon motor control 1-Q-EC Amplifier DECS 5/0.05

Order number 274645

Operating Instructions November 2006 Edition

The DECS (**D**igital **E**C **C**ontroller **S**ensorless) is a sensorless 1-quadrant EC amplifier specially designed for use with maxon EC 6 flat motors. Rotor position sensors (Hall sensors) are not required.



- Motor speed is regulated and can be adjusted by the built-in potentiometer or by an external control voltage.
- Exact adjustment and observance of motor speed can be implemented by monitoring the output "Monitor n"
- The "Direction" input sets motor rotational direction.
- The current rotor position is evaluated by using the back-EMF sensing technology
- Plug and run: The motor connector is suited to the Flex-PCB of the maxon EC 6 flat motor

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The latest edition of these operating instructions may be found on the internet under http://www.maxonmotor.com category <Service & Downloads>.

maxon document number: 567464 - 02

1 Safety Instructions

Skilled Personnel
Only experienced, skilled personnel should install and start the equipment.

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 initial 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 only be carried out by authorised personnel or the manufacturer. It is dangerous for the user to carry out any repairs.

Danger
Ensure that no apparatus is connected to the electrical supply during installation of the DECS 5/0.05. 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 4.5 and 5.5 VDC. Voltages higher than 6 VDC or of wrong polarity will destroy the unit.

Start-up procedure
Start-up problems may occur in unfavourable applications through the principle of brushless commutation. This is the case with high friction torque, a very high load moment of intertia and in general.

Electrostatic sensitive device (ESD)

2 Performance Data

2.1 Electrical data

Supply voltage V_{cc}	4.5 – 5.5 VDC
Continuous output current I_{cont}	50 mA
Max. output current I_{max}	100 mA
Max. output voltage	3.5 V
Current consumption (no load at rotor shaft)	n= 1 000 min^{-1}: typ. 8 mA [1]
	n= 15 000 min^{-1}: typ. 11 mA [1]
Speed range	1000 ... 15 000 min^{-1}

2.2 Inputs

Direction	logic signal (5 V) or switch against Gnd

2.3 Outputs

Monitor n	logic signal (5 V)

2.4 Motor connections

Motor winding 1
Motor winding 2
Motor winding 3

2.5 Ambient temperature / humidity range

Operation	-0 ... +60°C
Storage	-40 ... +85°C
No condensation	20 ... 80 %

2.6 Mechanical data

Weight	approx. 3 g
Dimensions (L x W x H)	20 x 29.7 x 12 mm
Mounting	2 mounting holes, diameter 2 mm
Mounting hole distance	15.6 x 16.2 mm

2.7 Terminals

Power / Signal

Screw terminals J1	4 poles
Pitch	2.54 mm
AWG 26-20	0.14 ... 0.5 mm^2

Motor terminal

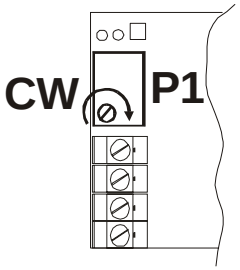
Flex print connector J2	3 poles
Pitch	1.0 mm
Suitable for	maxon EC 6 flat motor

[1] technical data are only valid for use with maxon EC 6 flat motors, order number #263800

3 Operating Instructions

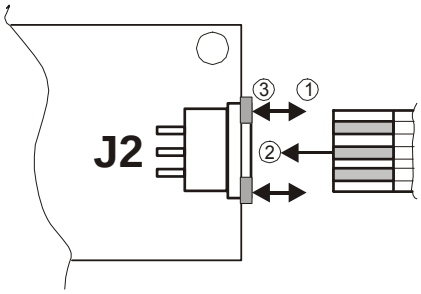
3.1 Step 1 "Pre-adjusting potentiometer P1"

By pre-adjusting the set value potentiometer P1 starting conditions are established.
Turn set value potentiometer P1 fully right (CW).
This adjustment complies with approximately 1'000 rpm motor speed.



3.2 Step 2 "Connect maxon EC 6 flat motor"

Pull out the slider of the Flex-to-PCB plug.
Plug in the Flex-PCB of the maxon EC 6 flat motor carefully.
Make sure copper surface is facing up.
Pull in the slider of the Flex-to-PCB plug again.

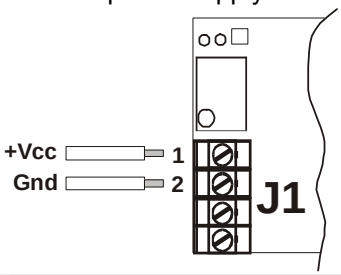


3.3 Step 3 "Connect power supply"

Any available power supply can be used, as long as it meets the minimum requirements set out below.

Power supply requirements	
Output voltage	V_{cc} min. 4.5 VDC; V_{cc} max. 5.5 VDC
Ripple	< 5 %
Output current	> 100mA

Switch off supply voltage.
Connect power supply at:



$+V_{cc}$	J1 terminal [1]
Gnd	J1 terminal [2]

Switch on supply voltage.

Caution!
Voltages higher than 6 VDC or of wrong polarity will destroy the unit.

3.4 Step 4 "Adjust motor speed"

The required motor speed is adjusted through the built-in potentiometer or by an external control voltage (see also chapter 4.3 "Set value selection, Solder bridge JP1" and chapter 5.1.2."Set value")

turn to the right (CW)	motor speed decreases fully right = approx. 1'000 rpm
turn to the left (CCW)	motor speed increases fully left = approx. 15'000 rpm
multi-turn (12) potentiometer	approx. 1'167 rpm / turn

4 Functions and Signals

4.1 Start-up procedure

Depending on the rotor start position and size of the coupled load, there is a start-up procedure prior to the motor's run-up.

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

Note:
A reliable start-up can be impossible with very high load inertia.

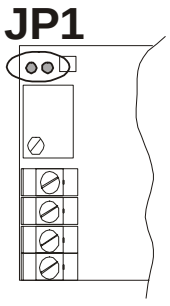
4.2 Current limitation

The power stage is internally current limited to approx. 100 mA. [2]

4.3 Set value selection, Solder bridge JP1

Closing the solder bridge JP1 activates the internal set value potentiometer.

Solder bridge JP1	Mode
open 	speed setting via external voltage
closed 	speed setting via internal potentiometer



[2] Due to the maximum output voltage of 3.5V and the maxon EC 6 flat motor (order number #263800) at a terminal resistance of 68 Ω the phase current is practically limited to approx. 50 mA.

5 Inputs and Output

5.1 Inputs

5.1.1 "Direction"

The motor shaft's direction is set by the "Direction" input at J1 terminal [3].

Input voltage range	0 ... +5 V
Input current	type -250 μA (internal current source to +5 V)
Continuous over voltage protection	-10 V ... +10 V
Clockwise (CW)	Set input to Gnd or input voltage < 0.8 V
Counter-clockwise (CCW)	Input open or input voltage > 2.4 V

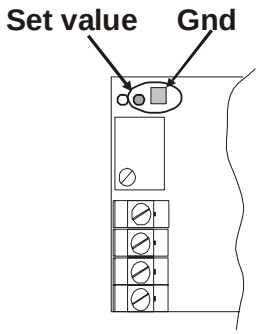
5.1.2 "Set value"

Use of internal potentiometer P1 (JP1 = closed)

Potentiometer	Function	Potentiometer – rotation direction	
		left ↺	right ↻
P1	Speed control with internal potentiometer	Motor speed higher	Motor speed lower

Use of external control voltage (JP1=open)
The voltage at the "Set value" solder pad sets the speed.
The speed changes proportionately to the set value.
The adjustable speed range is 1'000 min^{-1} (0 V) ... 15'000 min^{-1} (5 V)

Input voltage range	0 ... +5 V (reference against Gnd)
Input impedance	100 kΩ
Continuous over voltage protection	-10 V ... +10 V



5.2 Output

5.2.1 "Monitor n"

The motor shaft speed can be monitored at the "Monitor n" output J1 terminal [4]. The actual speed is available as a digital signal (high/low) and corresponds to the electrical rotational speed (= 4 times the mechanical rotational speed).[3]

Output voltage range	0 ... +5 V
Output resistance	100 Ohm
Output current	max. 10 mA against Gnd
Voltage value 'low'	max. 0.3 V (no load)
Voltage value 'high'	min. 4.5 V (no load)

Sought: frequency at the "Monitor n" output

$$f_{Monitor\ n} = \frac{n}{15} \quad [Hz]$$

n = Speed [rpm]

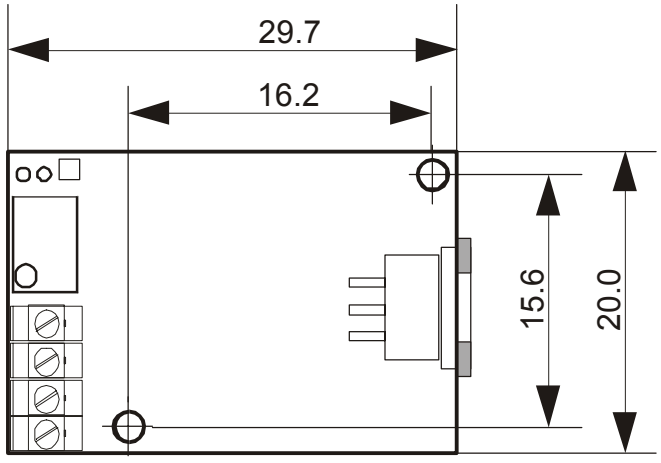
Sought: motor shaft speed

$$n_{set} = f_{Monitor\ n} \cdot 15 \qquad [rpm]$$

$f_{Monitor\ n}$ = Frequency at the "Monitor n" output [Hz]

6 Dimension Drawing

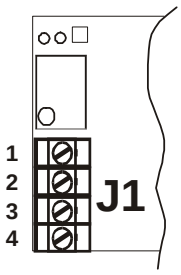
Dimensions in [mm]



[3] are only valid for use with maxon EC 6 flat motors (8 pole permanent magnet)

7 Pin assignment

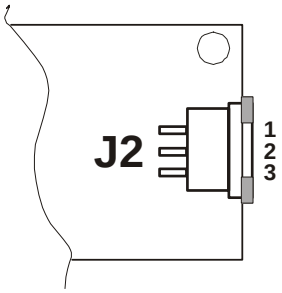
7.1 Pin assignment J1 Power / Signal



1	$+V_{cc}$ 4.5 - 5.5 VDC
2	Gnd
3	Direction
4	Monitor n

Screw terminal	4 poles
Pitch	2.54 mm
AWG 26-20	0.14 ... 0.5 mm^2

7.2 Pin assignment J2 Motor



1	Motor winding 3
2	Motor winding 2
3	Motor winding 1

Flex print connector	3 poles, top contact
Pitch	1.0 mm

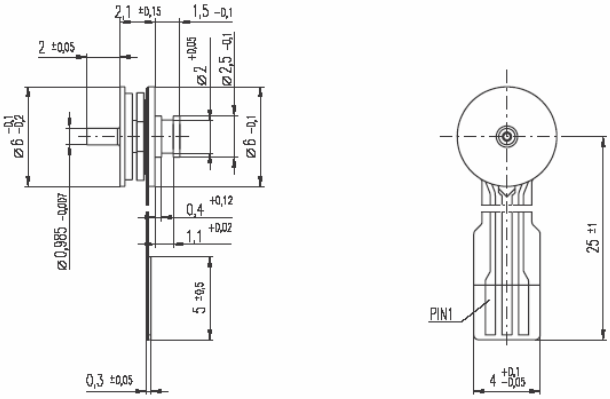
Note:

Motor terminals suited to	maxon EC 6 Flat motor sensorless

8 maxon EC 6 flat motor data

EC 6 flat ∅6 mm, brushless, 0.03 Watt

maxon flat motor



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Stock program
Standard program
Special program (on request)

			Order Number
		sensorless	263800
Motor Data (provisional)			
	Values at nominal voltage		
1	Nominal voltage	V	1.0
2	No load speed	rpm	15900
3	No load current	mA	6.59
4	Nominal speed	rpm	7950
5	Nominal torque	mNm	0.00206
6	Nominal current	A	0.0106
7	Stall torque	mNm	0.00486
8	Starting current	A	0.0147
9	Max. efficiency	%	22
	Characteristics		
10	Terminal resistance phase to phase	Ω	68.0
11	Terminal inductance phase to phase	mH	0.121
12	Torque constant	mNm / A	0.330
13	Speed constant	rpm / V	28900
14	Speed / torque gradient	rpm / mNm	5960000
15	Mechanical time constant	ms	393
16	Rotor inertia	gcm²	0.00630

Specifications

	Thermal data	
17	Thermal resistance housing-ambient	80 K / W
18	Thermal resistance winding-housing	75 K / W
19	Thermal time constant windings	1 s
20	Thermal time constant motor	14 s
21	Ambient temperature	-40 ... +85°C
22	Max. permissible winding temperature	+100°C
	Mechanical data (Ruby bearing)	
23	Max. permissible speed	20000 rpm
24	Axial play	0.5 mm
	Axial preload (> 0.03 N) defined through magnetic force between rotor and stator	
25	Radial play	0.007 mm
26	Max. axial load (dynamic)	0.03 N
27	Max. force for press fits (static)	2 N
	(static, shaft supported)	20 N
28	Max. radial loading, 1 mm from flange	0.02 N
	Other specifications	
29	Number of pole pairs	4
30	Number of phases	3
31	Weight of motor	0.35 g

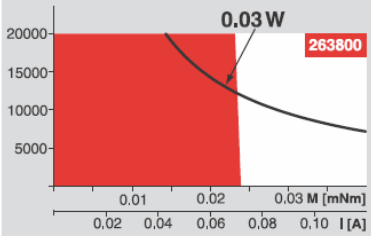
Ruby bearing with axial pivot bearing

Values listed in the table are nominal.

Connection

Pin 1	Motor winding 3
Pin 2	Motor winding 2
Pin 3	Motor winding 1
Connector	**Article number**
MOLEX	52207-0385

Operating Range



Comments

Continuous operation
In observation of above listed thermal resistance (lines 17 and 18) the maximum permissible winding temperature will be reached during continuous operation at 25°C ambient.
= Thermal limit.

Short term operation
The motor may be briefly overloaded (recurring).

Assigned power rating

Recommended Electronics:
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