

# **ESCON 70/10**

**Servo Controller**

**P/N 422969**

## **Hardware Reference**



escon.maxonmotor.com

**Document ID: rel5543**

## TABLE OF CONTENTS

1	About	3
1.1	About this Document	3
1.2	About the Device	4
1.3	About the Safety Precautions	5
2	Specifications	7
2.1	Technical Data	7
2.2	Standards	10
3	Setup	11
3.1	Generally applicable Rules	11
3.2	Determination of Power Supply	12
3.3	Connections	13
3.4	Potentiometers	26
3.5	Status Indicators	26
3.6	External Motor Chokes	28
4	Wiring	29
4.1	DC Motors	30
4.2	EC Motors	33
5	Spare Parts	35

## 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 ESCON 70/10 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 fully complies with the EU directive's requirements!
- unless the other machinery fulfills all relevant health and safety aspects!
- unless all respective interfaces have been established and fulfill the herein stated requirements!

# 1 About

## 1.1 About this Document

### 1.1.1 Intended Purpose

The purpose of the present document is to familiarize you with the ESCON 70/10 Servo Controller. It will highlight the tasks for safe and adequate installation and/or commissioning. Follow the described instructions ...

- to avoid dangerous situations,
- to keep installation and/or commissioning time at a minimum,
- to increase reliability and service life of the described equipment.

The document contains performance data and specifications, information on fulfilled standards, details on connections and pin assignment, and wiring examples.

### 1.1.2 Target Audience

The present document is intended for trained and skilled personnel. It conveys information on how to understand and fulfill the respective work and duties.

### 1.1.3 How to use




Take note of the following notations and codes which will be used throughout the document.

Notation	Meaning
(n)	refers to an item (such as order number, list item, etc.)
→	denotes “see”, “see also”, “take note of” or “go to”

Table 1-1 Notation used

### 1.1.4 Symbols & Signs

In the course of the present document, the following symbols and signs will be used.

Type	Symbol	Meaning	
Safety Alert	 (typical)	DANGER	Indicates an <b>imminent hazardous situation</b> . If not avoided, it <b>will result in death or serious injury</b> .
		WARNING	Indicates a <b>potential hazardous situation</b> . If not avoided, it <b>can result in death or serious injury</b> .
		CAUTION	Indicates a <b>probable hazardous situation</b> or calls the attention to unsafe practices. If not avoided, it <b>may result in injury</b> .
Prohibited Action	 (typical)	Indicates a dangerous action. Hence, <b>you must not!</b>	
Mandatory Action	 (typical)	Indicates a mandatory action. Hence, <b>you must!</b>	




Type	Symbol	Meaning	
Information		Requirement / Note / Remark	Indicates an activity you must perform prior continuing, or gives information on a particular item you need to observe.
		Best Practice	Indicates an advice or recommendation on the easiest and best way to further proceed.
		Material Damage	Indicates information particular to possible damage of the equipment.

Table 1-2 Symbols & Signs

## 1.1.5 Trademarks and Brand Names

For easier legibility, registered brand names are listed below and will not be further tagged with their respective trademark. It must be understood that the brands (the list below is not necessarily concluding) are protected by copyright and/or other intellectual property rights even if their legal trademarks are omitted in the later course of this document.

Brand Name	Trademark Owner
Windows®	© Microsoft Corporation, USA-Redmond, WA

Table 1-3 Brand Names and Trademark Owners

## 1.1.6 Copyright

© 2015 maxon motor. All rights reserved.

The present document – including all parts thereof – is protected by copyright. Any use (including reproduction, translation, microfilming, and other means of electronic data processing) beyond the narrow restrictions of the copyright law without the prior approval of maxon motor ag, is not permitted and subject to prosecution under the applicable law.

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

Phone +41 41 666 15 00  
Fax +41 41 666 16 50  
Web [www.maxonmotor.com](http://www.maxonmotor.com)

## 1.2 About the Device

The ESCON 70/10 is a small-sized, powerful 4-quadrant PWM servo controller for the highly efficient control of permanent magnet-activated brushed DC motors or brushless EC motors up to approximately 700 Watts.

The featured operating modes – speed control (closed loop), speed control (open loop), and current control – meet the highest requirements. The ESCON 70/10 is designed being commanded by an analog set value and features extensive analog and digital I/O functionality.

The device is designed to be configured via USB interface using the graphical user interface «ESCON Studio» for Windows PCs.

You can download the latest ESCON software version (as well as the latest edition of the documentation) from the internet under → <http://escon.maxonmotor.com>.

### 1.3 About the Safety Precautions

- Make sure that you have read and understood the note “READ THIS FIRST” on page A-2!
- Do not engage with any work unless you possess the stated skills (→chapter “1.1.2 Target Audience” on page 1-3)!
- Refer to →chapter “1.1.4 Symbols & Signs” on page 1-3 to understand the subsequently used indicators!
- You must 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!



#### DANGER

##### **High Voltage and/or Electrical Shock**

##### **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!



#### Requirements

- Make sure that all associated devices and components are installed according to local regulations.
- 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.
- Be aware that you are not entitled to perform any repair on components supplied by maxon motor.



#### Electrostatic Sensitive Device (ESD)

- Make sure to wear working cloth in compliance with ESD.
- Handle device with extra care.

*••page intentionally left blank••*

## 2 Specifications

### 2.1 Technical Data

ESCON 70/10 (422969)		
Electrical Rating	Nominal operating voltage $+V_{CC}$	10...70 VDC
	Absolute operating voltage $+V_{CC \min} / +V_{CC \max}$	8 VDC / 76 VDC
	Output voltage (max.)	$0.95 \times +V_{CC}$
	Output current $I_{cont} / I_{max}$ (<20 s)	10 A / 30 A
	Pulse Width Modulation frequency	53.6 kHz
	Sampling rate PI current controller	53.6 kHz
	Sampling rate PI speed controller	5.36 kHz
	Max. efficiency	98%
	Max. speed DC motor	limited by max. permissible speed (motor) and max. output voltage (controller)
	Max. speed EC motor	150'000 rpm (1 pole pair)
	Built-in motor choke	3 x 15 $\mu$ H; 10 A
Inputs & Outputs	Analog Input 1 Analog Input 2	resolution 12-bit; -10...+10 V; differential
	Analog Output 1 Analog Output 2	resolution 12-bit; -4...+4 V; referenced to GND
	Digital Input 1 Digital Input 2	+2.4...+36 VDC ( $R_i = 38.5 \text{ k}\Omega$ )
	Digital Input/Output 3 Digital Input/Output 4	+2.4...+36 VDC ( $R_i = 38.5 \text{ k}\Omega$ ) / max. 36 VDC ( $I_L < 500 \text{ mA}$ )
	Hall sensor signals	H1, H2, H3
	Encoder signals	A, A\, B, B\, (max. 1 MHz)
Voltage Outputs	Auxiliary output voltage	+5 VDC ( $I_L \leq 10 \text{ mA}$ )
	Hall sensor supply voltage	+5 VDC ( $I_L \leq 30 \text{ mA}$ )
	Encoder supply voltage	+5 VDC ( $I_L \leq 70 \text{ mA}$ )
Potentiometers	Potentiometer P1 (on board) Potentiometer P2 (on board)	240°; linear
Motor Connections	DC motor	+ Motor, - Motor
	EC motor	Motor winding 1, Motor winding 2, Motor winding 3
Interface	USB 2.0 / USB 3.0	full speed
Status Indicators	Operation	green LED
	Error	red LED

ESCON 70/10 (422969)			
Physical	Weight	approx. 259 g	
	Dimensions (L x W x H)	125 x 78.5 x 27 mm	
	Mounting holes	for M4 screws	
Environmental Conditions	Temperature	Operation	-30...+45 °C
		Extended range <sup>*1)</sup>	+45...+82 °C Derating → Figure 2-1
		Storage	-40...+85 °C
	Altitude <sup>*2)</sup>	Operation	0...10'000 m MSL
	Humidity	5...90% (condensation not permitted)	

\*1) Operation within the extended range (temperature and altitude) is permitted. However, a respective derating (declination of output current  $I_{cont}$ ) as to the stated values will apply.

\*2) Operating altitude in meters above Mean Sea Level, MSL.

Table 2-4 Technical Data

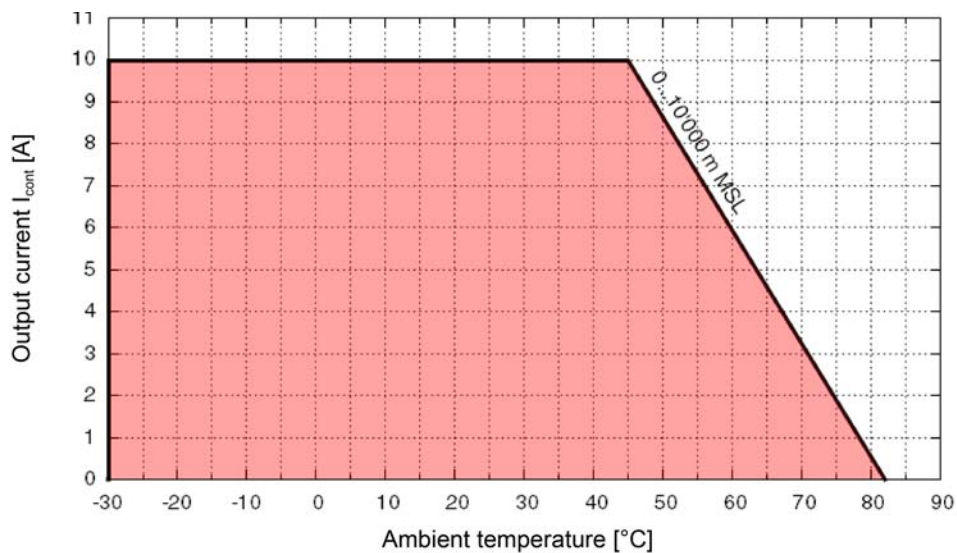


Figure 2-1 Derating Output Current



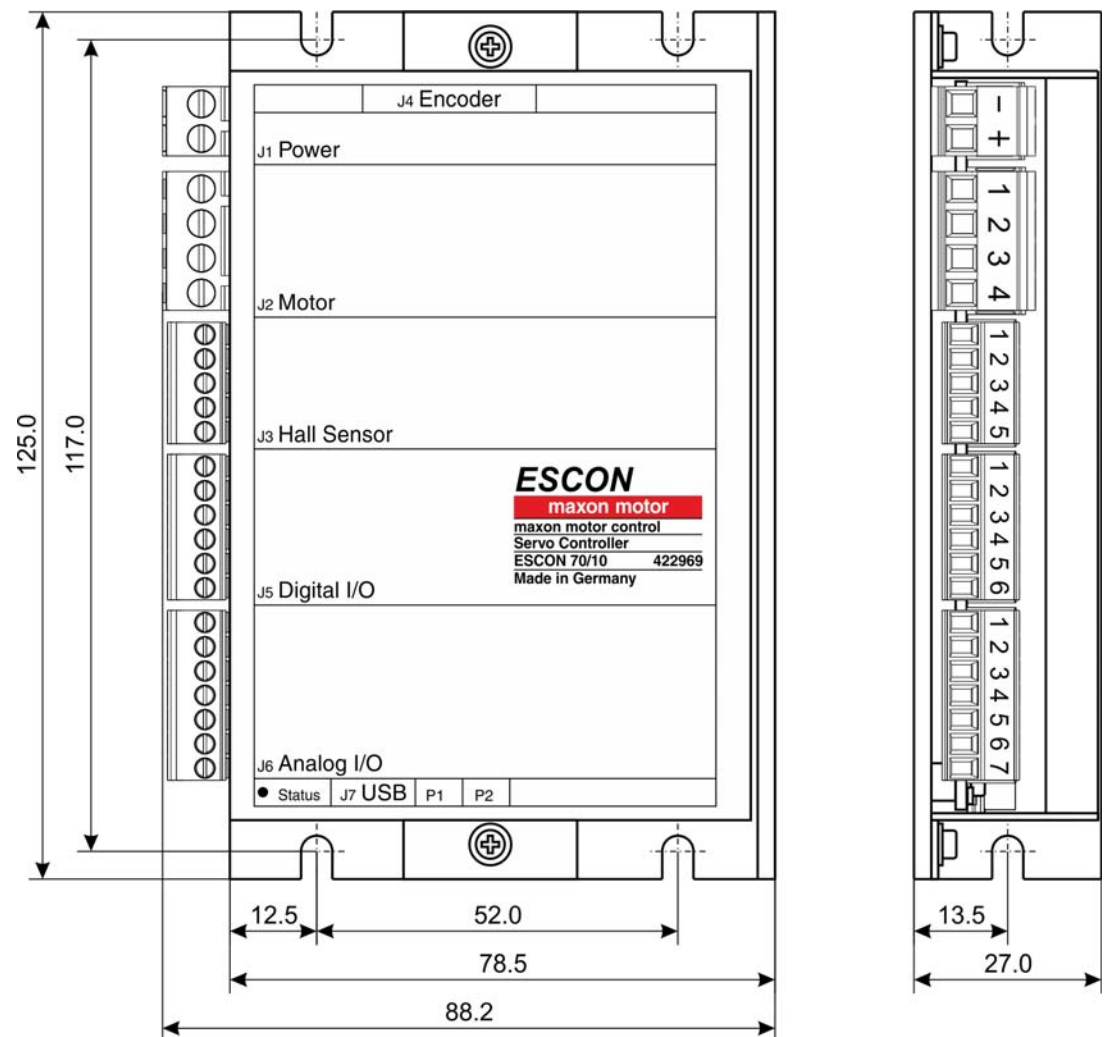


Figure 2-2 Dimensional Drawing [mm]

## 2.2 Standards

The described device has been successfully tested for compliance with the below listed standards. In practical terms, only the complete system (the fully operational equipment comprising all individual components, such as motor, servo controller, power supply unit, EMC filter, cabling etc.) can undergo an EMC test to ensure interference-free operation.



### Important Notice

*The device's compliance with the mentioned standards does not imply its compliance within the final, ready to operate setup. In order to achieve compliance of your operational system, you must perform EMC testing of the involved equipment as a whole.*

Electromagnetic Compatibility		
Generic Standards	IEC/EN 61000-6-2	Immunity for industrial environments
	IEC/EN 61000-6-3	Emission standard for residential, commercial and light-industrial environments
Applied Standards	IEC/EN 61000-6-3 IEC/EN 55022 (CISPR22)	Radio disturbance characteristics / radio interference
	IEC/EN 61000-4-2	Electrostatic discharge immunity test 8 kV/6 kV
	IEC/EN 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test >10 V/m
	IEC/EN 61000-4-4	Electrical fast transient/burst immunity test $\pm 2$ kV
	IEC/EN 61000-4-6	Immunity to conducted disturbances, induced by radio-frequency fields 10 Vrms
Others		
Environmental Standards	IEC/EN 60068-2-6	Environmental testing – Test Fc: Vibration (sinusoidal, 10...500 Hz, 20 m/s <sup>2</sup> )
	MIL-STD-810F	Random transport (10...500 Hz up to 2.53 g <sub>rms</sub> )
Safety Standards	UL File Number E207844; unassembled printed circuit board	
Reliability	MIL-HDBK-217F	Reliability prediction of electronic equipment Environment: Ground, benign (GB) Ambient temperature: 298 K (25 °C) Component stress: In accordance with circuit diagram and nominal power Mean Time Between Failures (MTBF): 280'383 hours

Table 2-5 Standards

### 3 Setup

**IMPORTANT NOTICE: PREREQUISITES FOR PERMISSION TO COMMENCE INSTALLATION**

The **ESCON 70/10** 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.**

**WARNING****Risk of Injury**

**Operating the device without the full compliance of the surrounding system with EU Directive 2006/42/EC may cause serious injuries!**

- Do not operate the device, unless you have made completely sure that the other machinery fully complies with the EU directive's requirements!
- Do not operate the device, unless the other machinery fulfills all relevant health and safety aspects!
- Do not operate the device, unless all respective interfaces have been established and fulfill the requirements stated in this document!

#### 3.1 Generally applicable Rules

**Maximal permitted Supply Voltage**

- Make sure that supply power is between 10...70 VDC.
- Supply voltages above 76 VDC, or wrong polarity will destroy the unit.
- Note that the necessary output current is depending on the load torque. Yet, the output current limits of the ESCON 70/10 are as follows; continuous max. 10 A / short-time (acceleration) max. 30 A.

**Built-in Motor Chokes**

In a setup with low-inductive motor winding combined with high continuous current and high supply voltage, an additional external 3-phase motor choke will probably be necessary (for details →chapter "3.6 External Motor Chokes" on page 3-28).

### 3.2 Determination of Power Supply

Basically, any power supply may be used, provided it meets the minimal requirements stated below.

Power Supply Requirements	
Output voltage	+V <sub>CC</sub> 10...70 VDC
Absolute output voltage	min. 8 VDC; max. 76 VDC
Output current	Depending on load <ul style="list-style-type: none"> <li>• continuous max. 10 A</li> <li>• short-time (acceleration, &lt;20 s) max. 30 A</li> </ul>

- 1) Use the formula below to calculate the required voltage under load.
- 2) Choose a power supply according to the calculated voltage. Thereby consider:
  - a) During braking of the load, the power supply must be capable of buffering the recovered kinetic energy (for example, in a capacitor).
  - b) If you are using an electronically stabilized power supply, make sure that the overcurrent protection circuit is configured inoperative within the operating range.



#### Note

The formula already takes the following into account:

- Maximum PWM duty cycle of 95%
- Controller's max. voltage drop of 1 V @ 10 A

#### KNOWN VALUES:

- Operating torque M [mNm]
- Operating speed n [rpm]
- Nominal motor voltage U<sub>N</sub> [Volt]
- Motor no-load speed at U<sub>N</sub>, n<sub>0</sub> [rpm]
- Speed/torque gradient of the motor Δn/ΔM [rpm/mNm]

#### SOUGHT VALUE:

- Supply voltage +V<sub>CC</sub> [Volt]

#### SOLUTION:

$$V_{CC} \geq \left[ \frac{U_N}{n_0} \cdot \left( n + \frac{\Delta n}{\Delta M} \cdot M \right) \cdot \frac{1}{0.95} \right] + 1 [V]$$

### 3.3 Connections

The actual connection will depend on the overall configuration of your drive system and the type of motor you will be using.

Follow the description in given order and choose the connection scheme that suits the respective components you are using. For corresponding wiring diagrams → chapter “4 Wiring” on page 4-29.

#### 3.3.1 Power (J1)



Figure 3-3 Power Plug J1

J1 Pin	Signal	Description
-	Power_GND	Ground of supply voltage
+	+V <sub>CC</sub>	Power supply voltage (+10...+70 VDC)

Table 3-6 Power Plug J1 – Pin Assignment

Specification / Accessories	
Type	Pluggable screw-type terminal block, 2 poles, pitch 5.0 mm
Suitable cables	0.2...2.5 mm <sup>2</sup> multi-core, AWG 24-12 0.2...2.5 mm <sup>2</sup> single wire, AWG 24-12

Table 3-7 Power Plug J1 – Specification & Accessories

### 3.3.2 Motor (J2)

The servo controller is set to drive either maxon DC motor (brushed) or maxon EC motor (brushless).

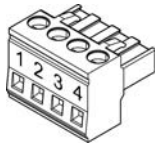


Figure 3-4 Motor Plug J2

J2 Pin	Signal	Description
1	Motor (+M)	DC motor: Motor +
2	Motor (-M)	DC motor: Motor -
3	not connected	–
4	Motor shield	Cable shield

Table 3-8 Motor Plug J2 – Pin Assignment for maxon DC motor (brushed)

J2 Pin	Signal	Description
1	Motor winding 1	EC motor: Winding 1
2	Motor winding 2	EC motor: Winding 2
3	Motor winding 3	EC motor: Winding 3
4	Motor shield	Cable shield

Table 3-9 Motor Plug J2 – Pin Assignment for maxon EC motor (brushless)

Specification / Accessories	
Type	Pluggable screw-type terminal block, 4 poles, pitch 5.0 mm
Suitable cables	0.2...2.5 mm <sup>2</sup> multi-core, AWG 24-12 0.2...2.5 mm <sup>2</sup> single wire, AWG 24-12

Table 3-10 Motor Plug J2 – Specification & Accessories

### 3.3.3 Hall Sensor (J3)

Suitable Hall effect sensors IC use «Schmitt trigger» with open collector output.

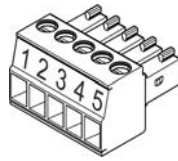


Figure 3-5 Hall Sensor Plug J3

J3 Pin	Signal	Description
1	Hall sensor 1	Hall sensor 1 input
2	Hall sensor 2	Hall sensor 2 input
3	Hall sensor 3	Hall sensor 3 input
4	+5 VDC	Hall sensor supply voltage (+5 VDC; $I_L \leq 30$ mA)
5	GND	Ground

Table 3-11 Hall Sensor Plug J3 – Pin Assignment

Specification / Accessories	
Type	Pluggable screw-type terminal block, 5 poles, pitch 3.5 mm
Suitable cables	0.14...1.5 mm <sup>2</sup> multi-core, AWG 28-14 0.14...1.5 mm <sup>2</sup> single wire, AWG 28-14

Table 3-12 Hall Sensor Plug J3 – Specification & Accessories

Hall sensor supply voltage	+5 VDC
Max. Hall sensor supply current	30 mA
Input voltage	0...24 VDC
Max. input voltage	+24 VDC
Logic 0	typically <1.0 V
Logic 1	typically >2.4 V
Internal pull-up resistor	2.7 k $\Omega$ (against +5.45 V – 0.6 V)

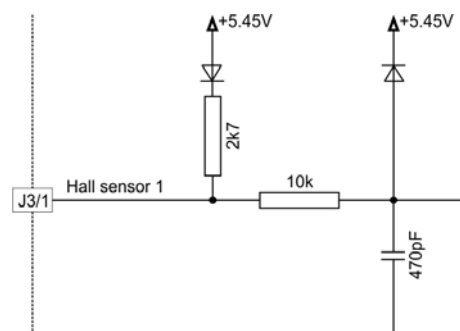


Figure 3-6 Hall Sensor 1 Input Circuit (analogously valid also for Hall Sensors 2 & 3)

### 3.3.4 Encoder (J4)

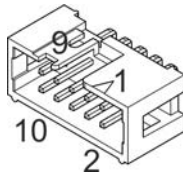


Figure 3-7 Encoder Socket J4

J4 Pin	Signal	Description
1	not connected	–
2	+5 VDC	Encoder supply voltage (+5 VDC; ≤70 mA)
3	GND	Ground
4	not connected	–
5	Channel A\	Channel A complement
6	Channel A	Channel A
7	Channel B\	Channel B complement
8	Channel B	Channel B
9	not connected	–
10	not connected	–

Table 3-13 Encoder Socket J4 – Pin Assignment

Accessories		
Suitable strain relief	Retainer	For sockets with strain relief: 1 retainer clip, height 13.5 mm, 3M (3505-8110)
		For sockets without strain relief: 1 retainer clip, height 7.9 mm, 3M (3505-8010)
	Latch	For sockets with strain relief: 2 pieces, 3M (3505-33B)

Table 3-14 Encoder Socket J4 – Accessories



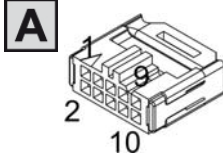
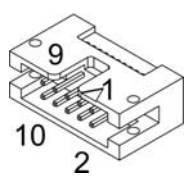
Encoder Cable (275934)	
<b>A</b>	<b>B</b>
	
Cable cross-section	10 x AWG28, round-jacket, twisted pair flat cable, pitch 1.27 mm
Length	3.20 m
Head A	DIN 41651 female, pitch 2.54 mm, 10 poles, with strain relief
Head B	DIN 41651 Plug, pitch 2.54 mm, 10 poles, with strain relief

Table 3-15 Encoder Cable



#### Best Practice

- Because of its resistance against electrical interferences, **we recommend using differential scheme**. Nevertheless, the controller supports both schemes – differential and single-ended.
- The controller does not require an index impulse (Ch I, Ch II).
- For best performance, **we strongly recommend using encoders with line driver**. Otherwise, speed limitations may apply due to slow switching edges.

Differential	
Min. differential input voltage	±200 mV
Max. input voltage	+12 VDC / –12 VDC
Line receiver (internal)	EIA RS422 Standard
Max. input frequency	1 MHz

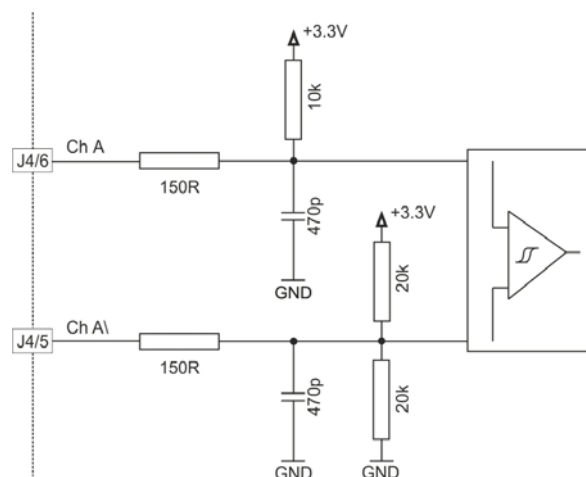


Figure 3-8 Encoder Input Circuit Ch A “Differential” (analogously valid also for Ch B)

Single-ended	
Input voltage	0...5 VDC
Max. input voltage	+12 VDC / -12 VDC
Logic 0	<1.0 V
Logic 1	>2.4 V
Input high current	$I_{IH}$ = typically +420 $\mu$ A @ 5 V
Input low current	$I_{IL}$ = typically -170 $\mu$ A @ 0 V
Max. input frequency	100 kHz

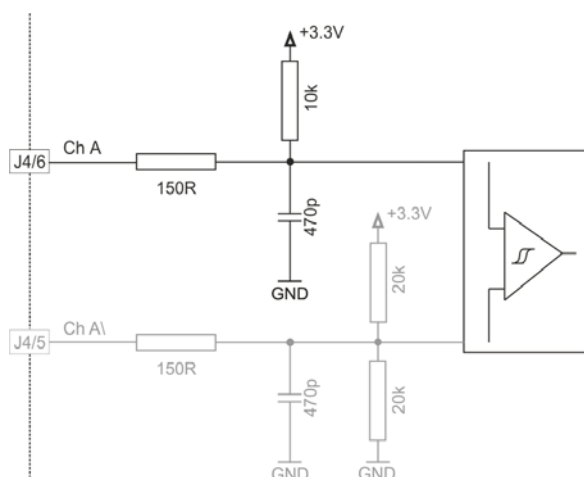


Figure 3-9 Encoder Input Circuit Ch A "Single-ended" (analogously valid also for Ch B)

## 3.3.5 Digital I/Os (J5)

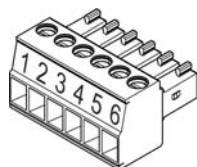


Figure 3-10 Digital I/Os Plug J5

J5 Pin	Signal	Description
1	DigIN1	Digital input 1
2	DigIN2	Digital input 2
3	DigIN/DigOUT3	Digital input/output 3
4	DigIN/DigOUT4	Digital input/output 4
5	GND	Signal ground
6	+5 VDC	Auxiliary output voltage (+5 VDC; ≤10 mA)

Table 3-16 Digital I/Os Plug J5 – Pin Assignment &amp; Cabling

Specification / Accessories	
Type	Pluggable screw-type terminal block, 6 poles, pitch 3.5 mm
Suitable cables	0.14...1.5 mm <sup>2</sup> multi-core, AWG 28-14 0.14...1.5 mm <sup>2</sup> single wire, AWG 28-14

Table 3-17 Digital I/Os Plug J5 – Specification &amp; Accessories



### 3.3.5.3 Digital Inputs/Outputs 3 and 4

DigIN	
Input voltage	0...36 VDC
Max. input voltage	+36 VDC
Logic 0	typically <1.0 V
Logic 1	typically >2.4 V
Input resistance	typically 47 k $\Omega$ (<3.3 V) typically 38.5 k $\Omega$ (@ 5 V) typically 25.5 k $\Omega$ (@ 24 V)
Input current at logic 1	typically 130 $\mu$ A @ +5 VDC
Switching delay	<8 ms

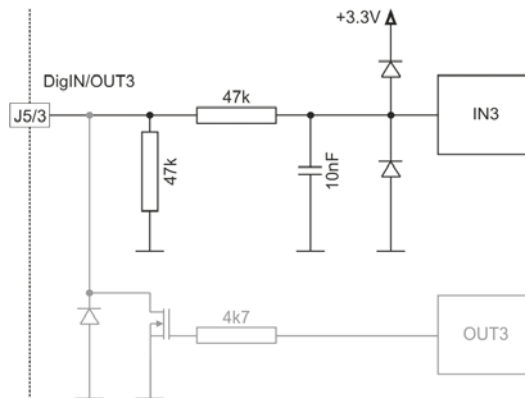


Figure 3-13 DigIN3 Circuit (analogously valid also for DigIN4)

DigOUT	
Max. input voltage	+36 VDC
Max. load current	500 mA
Max. voltage drop	0.5 V @ 500 mA
Max. load inductance	100 mH @ 24 VDC; 500 mA

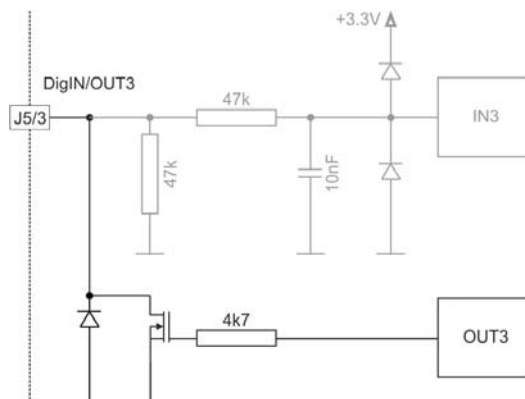


Figure 3-14 DigOUT3 Circuit (analogously valid also for DigOUT4)

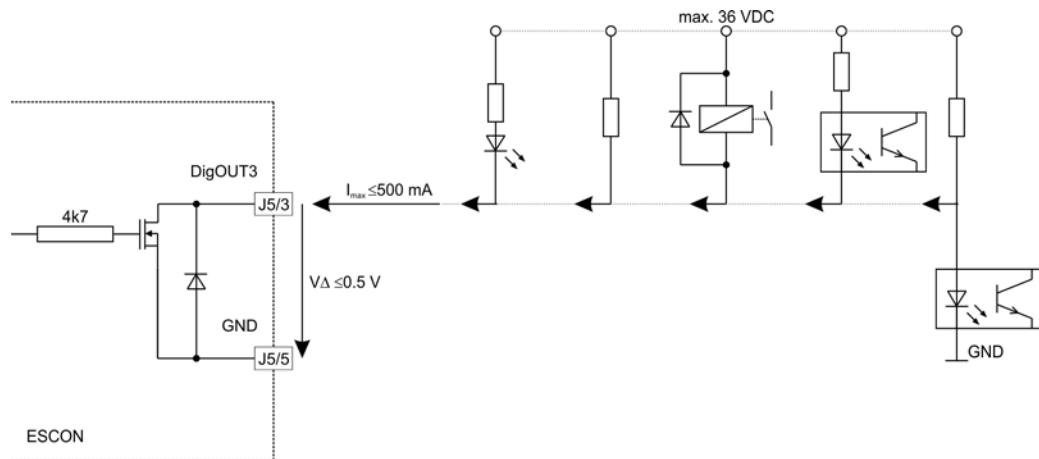


Figure 3-15 DigOUT3 Wiring Examples (analogously valid also for DigOUT4)

## 3.3.6 Analog I/Os (J6)

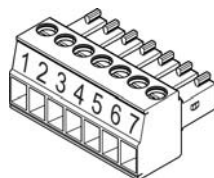


Figure 3-16 Analog I/Os Plug J6

J6 Pin	Signal	Description
1	AnIN1+	Analog input 1, positive signal
2	AnIN1–	Analog input 1, negative signal
3	AnIN2+	Analog input 2, positive signal
4	AnIN2–	Analog input 2, negative signal
5	AnOUT1	Analog output 1
6	AnOUT2	Analog output 2
7	GND	Signal ground

Table 3-18 Analog I/Os Plug J6 – Pin Assignment &amp; Cabling

Specification / Accessories	
Type	Pluggable screw-type terminal block, 7 poles, pitch 3.5 mm
Suitable cables	0.14...1.5 mm <sup>2</sup> multi-core, AWG 28-14 0.14...1.5 mm <sup>2</sup> single wire, AWG 28-14

Table 3-19 Analog I/Os Plug J6 – Specification &amp; Accessories

### 3.3.6.1 Analog Inputs 1 and 2

Input voltage	-10...+10 VDC (differential)
Max. input voltage	+24 VDC / -24 VDC
Common mode voltage	-5...+10 VDC (referenced to GND)
Input resistance	80 k $\Omega$ (differential) 65 k $\Omega$ (referenced to GND)
A/D converter	12-bit
Resolution	5.64 mV
Bandwidth	10 kHz

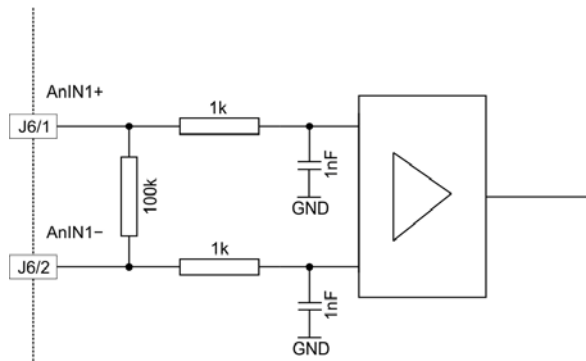


Figure 3-17 AnIN1 Circuit (analogously valid also for AnIN2)

### 3.3.6.2 Analog Outputs 1 and 2

Output voltage	-4...+4 VDC
D/A converter	12-bit
Resolution	2.42 mV
Refresh rate	AnOUT1: 26.8 kHz AnOUT2: 5.4 kHz
Analog bandwidth of output amplifier	50 kHz
Max. capacitive load	300 nF <b>Note:</b> The slew rate will be limited proportional to the capacitive load (e.g. 5 V/ms @300 nF).
Max. output current	1 mA

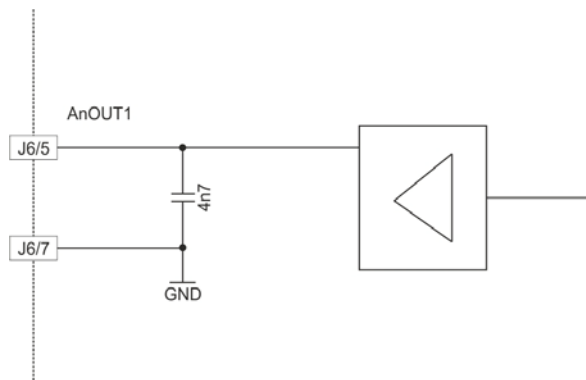


Figure 3-18 AnOUT1 Circuit (analogously valid also for AnOUT2)



### 3.3.7 USB (J7)

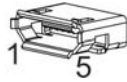


Figure 3-19 USB Socket J7


**Note**

Column "Head B" (→Table 3-20) refers to USB terminals of your PC.

J7 & Head A Pin	Head B Pin	Signal	Description
1	1	V <sub>BUS</sub>	USB BUS supply voltage input +5 VDC
2	2	D-	USB Data- (twisted pair with Data+)
3	3	D+	USB Data+ (twisted pair with Data-)
4	–	ID	not connected
5	4	GND	USB_Ground

Table 3-20 USB Socket J7 – Pin Assignment & Cabling

USB Type A - micro B Cable (403968)	
<div style="border: 1px solid black; padding: 2px; display: inline-block; font-weight: bold;">A</div>	<div style="border: 1px solid black; padding: 2px; display: inline-block; font-weight: bold;">B</div>
Cable cross-section	According to USB 2.0 / USB 3.0 specification
Length	1.5 m
Head A	USB Type "micro B", male
Head B	USB Type "A", male

Table 3-21 USB Type A - micro B Cable

USB Standard	USB 2.0 / USB 3.0 (full speed)
Max. bus supply voltage	+5.25 VDC
Typical input current	60 mA
Max. DC data input voltage	–0.5...+3.8 VDC

## 3.4 Potentiometers

### POTENTIOMETERS P1 & P2

Adjustment angle	240°
Type	Linear

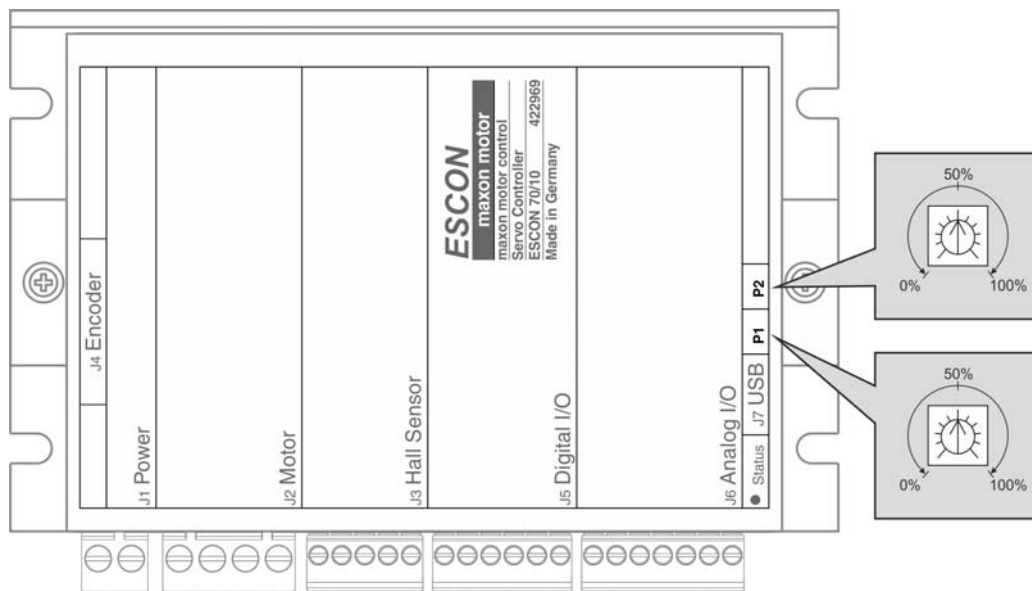


Figure 3-20 Potentiometers – Location & Adjustment Range

## 3.5 Status Indicators

Light-emitting diodes (LEDs) indicate the actual operating status (green) and possible errors (red).

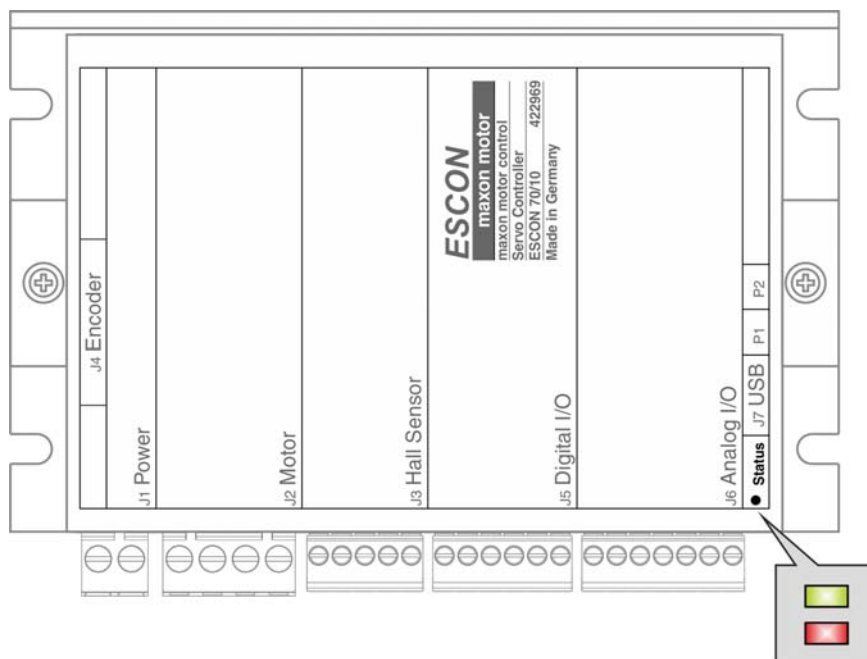


Figure 3-21 LEDs – Location

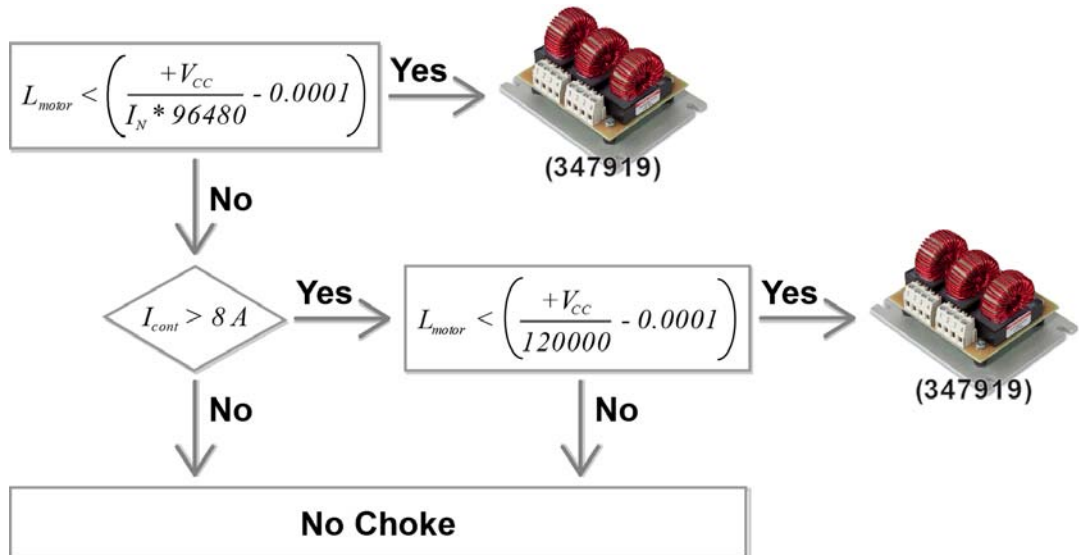
LED		Status / Error	
Green	Red		
off	off	INIT	
slow	off	DISABLE	
on	off	ENABLE	
2x	off	STOPPING; STOP STANDSTILL	
off	1x	ERROR	<ul style="list-style-type: none"> <li>• +Vcc Overvoltage Error</li> <li>• +Vcc Undervoltage Error</li> <li>• +5 VDC Undervoltage Error</li> </ul>
off	2x	ERROR	<ul style="list-style-type: none"> <li>• Thermal Overload Error</li> <li>• Overcurrent Error</li> <li>• Power Stage Protection Error</li> <li>• Internal Hardware Error</li> </ul>
off	3x	ERROR	<ul style="list-style-type: none"> <li>• Encoder Cable Break Error</li> <li>• Encoder Polarity Error</li> <li>• DC Tacho Cable Break Error</li> <li>• DC Tacho Polarity Error</li> </ul>
off	4x	ERROR	<ul style="list-style-type: none"> <li>• PWM Set Value Input out of Range Error</li> </ul>
off	5x	ERROR	<ul style="list-style-type: none"> <li>• Hall Sensor Pattern Error</li> <li>• Hall Sensor Sequence Error</li> <li>• Hall Sensor Frequency too high Error</li> </ul>
off	on	ERROR	<ul style="list-style-type: none"> <li>• Auto Tuning Identification Error</li> <li>• Internal Software Error</li> </ul>

Table 3-22 LEDs – Interpretation of Condition

### 3.6 External Motor Chokes

The ESCON 70/10 features built-in motor chokes that are suitable for most motors and applications. Nevertheless, in case of high power supply voltage  $+V_{cc}$  in combination with high continuous output current and a motor with very low inductance, the current ripple will become too high. This will cause unnecessary motor heating and unstable control behavior. In this case, an additional, external 3-phase motor choke will be necessary.

Use the following formula to determine whether an additional motor choke will be required:



$L_{motor}[H]$  Motor terminal inductance (→Line 11 in maxon catalog)

$V_{cc}[V]$  Nominal operating voltage  $+V_{cc}$

$I_N[A]$  Motor nominal current (→Line 6 in maxon catalog)

$I_{cont}[A]$  System continuous current

Specification / Accessories		
Type	Choke Module (347919)	
	Rating	3 x 0.1 mH, 10.0 A nominal DC current, each
	Dimensions	90 x 70 x 49.7 mm (L x W x H)
	Connection	Screw-type terminal block

Table 3-23 External Motor Chokes – Specification & Accessories

## 4 Wiring

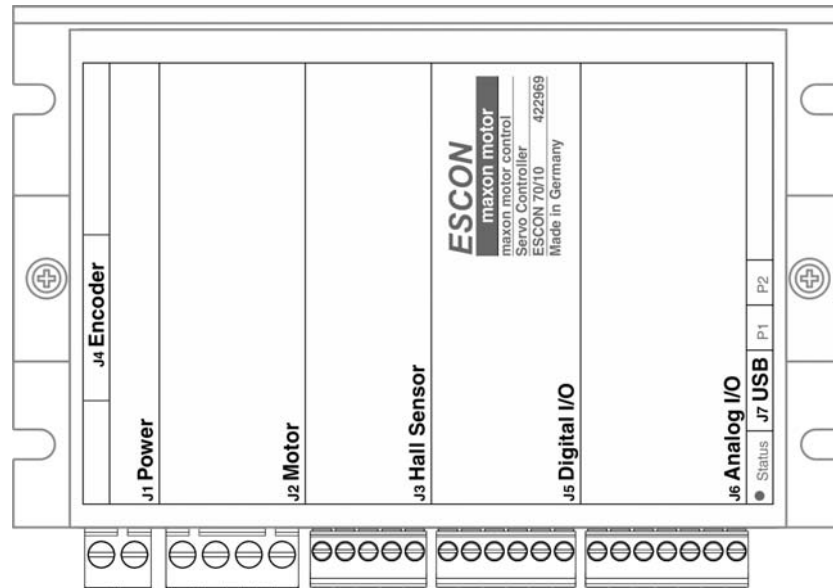



Figure 4-22 Interfaces – Designations and Location



### Remark

The subsequent diagrams feature this sign:

-  Ground safety earth connection (optional)

## 4.1 DC Motors

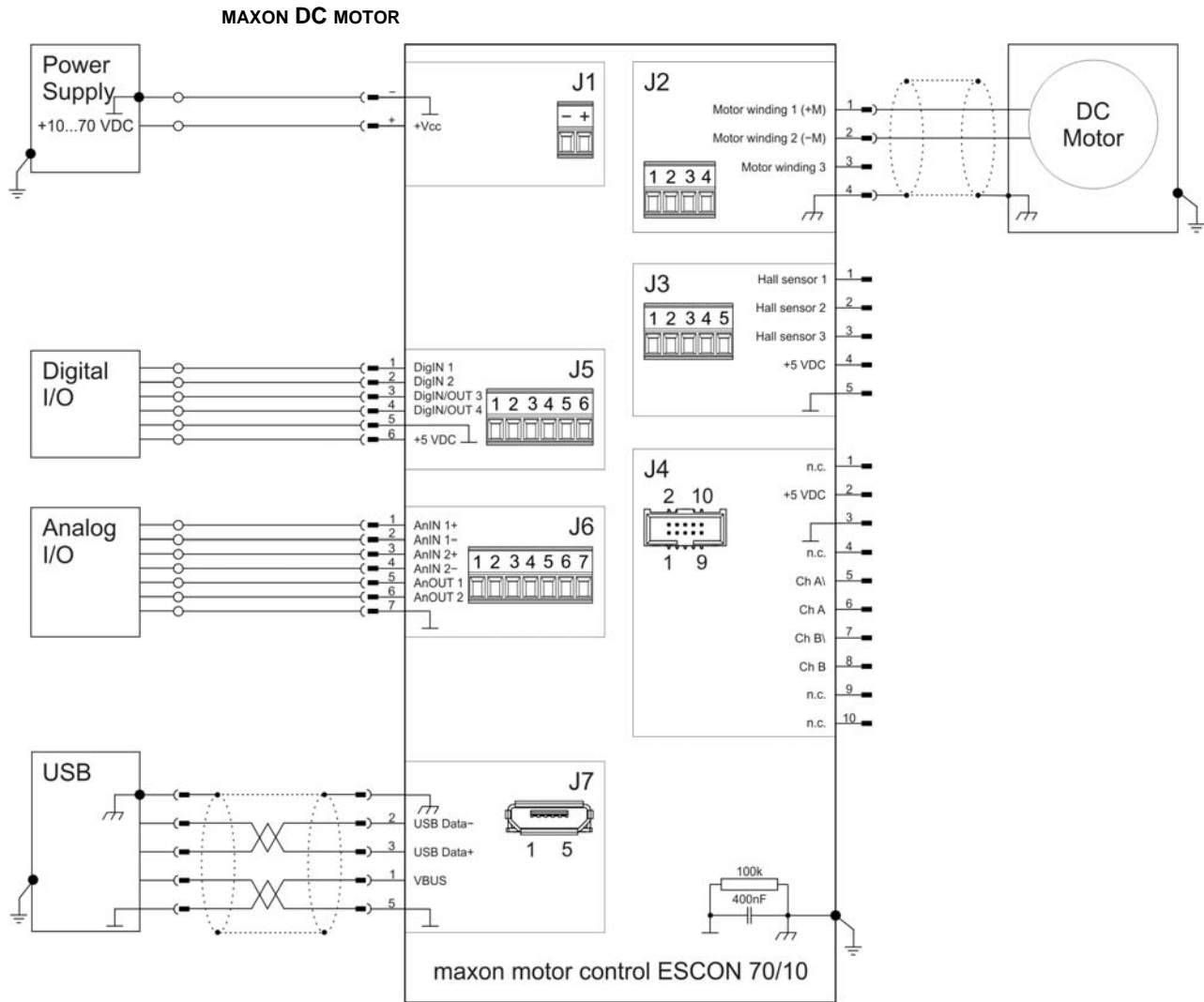


Figure 4-23 maxon DC motor (J2)

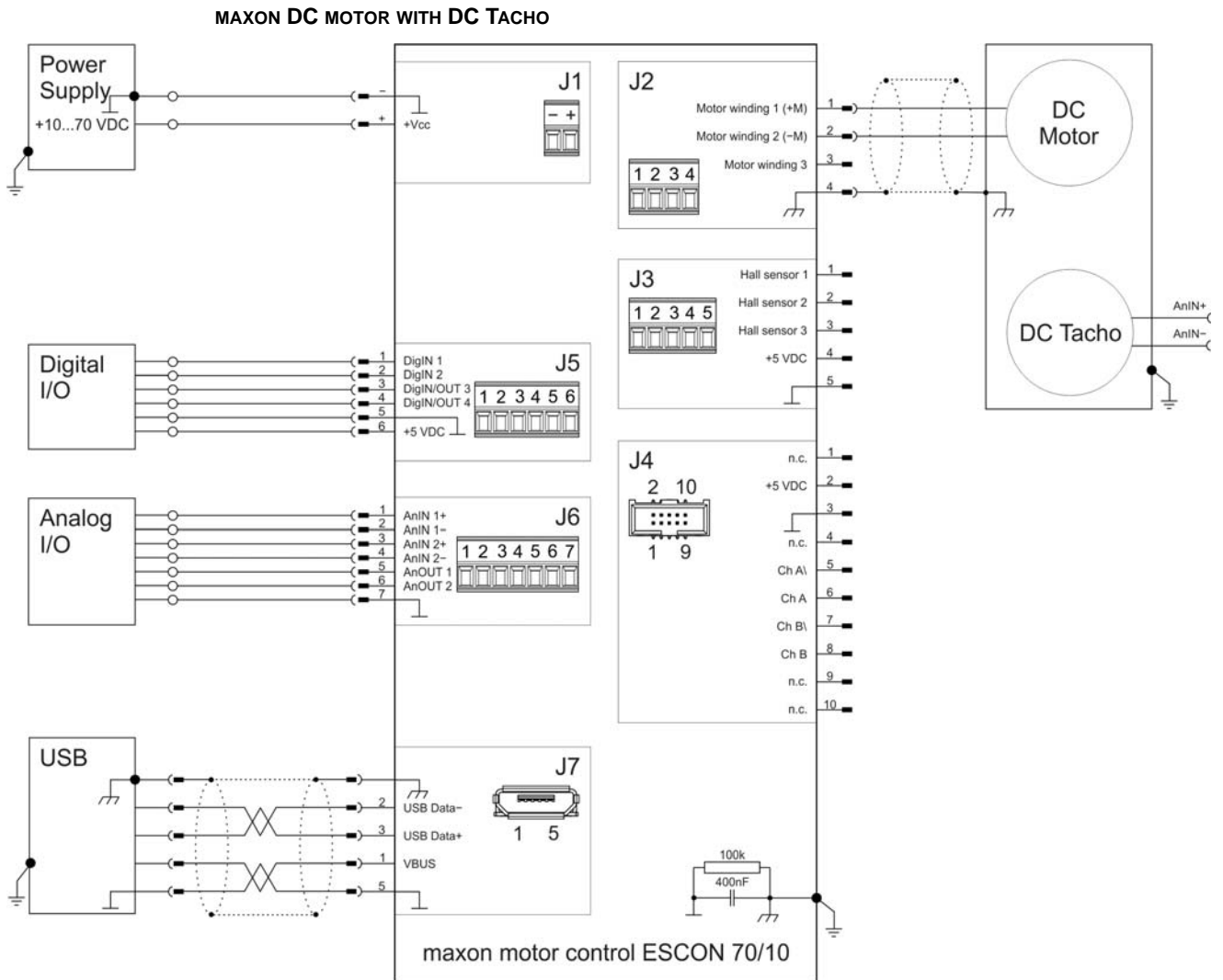


Figure 4-24 maxon DC motor with DC Tacho (J2)

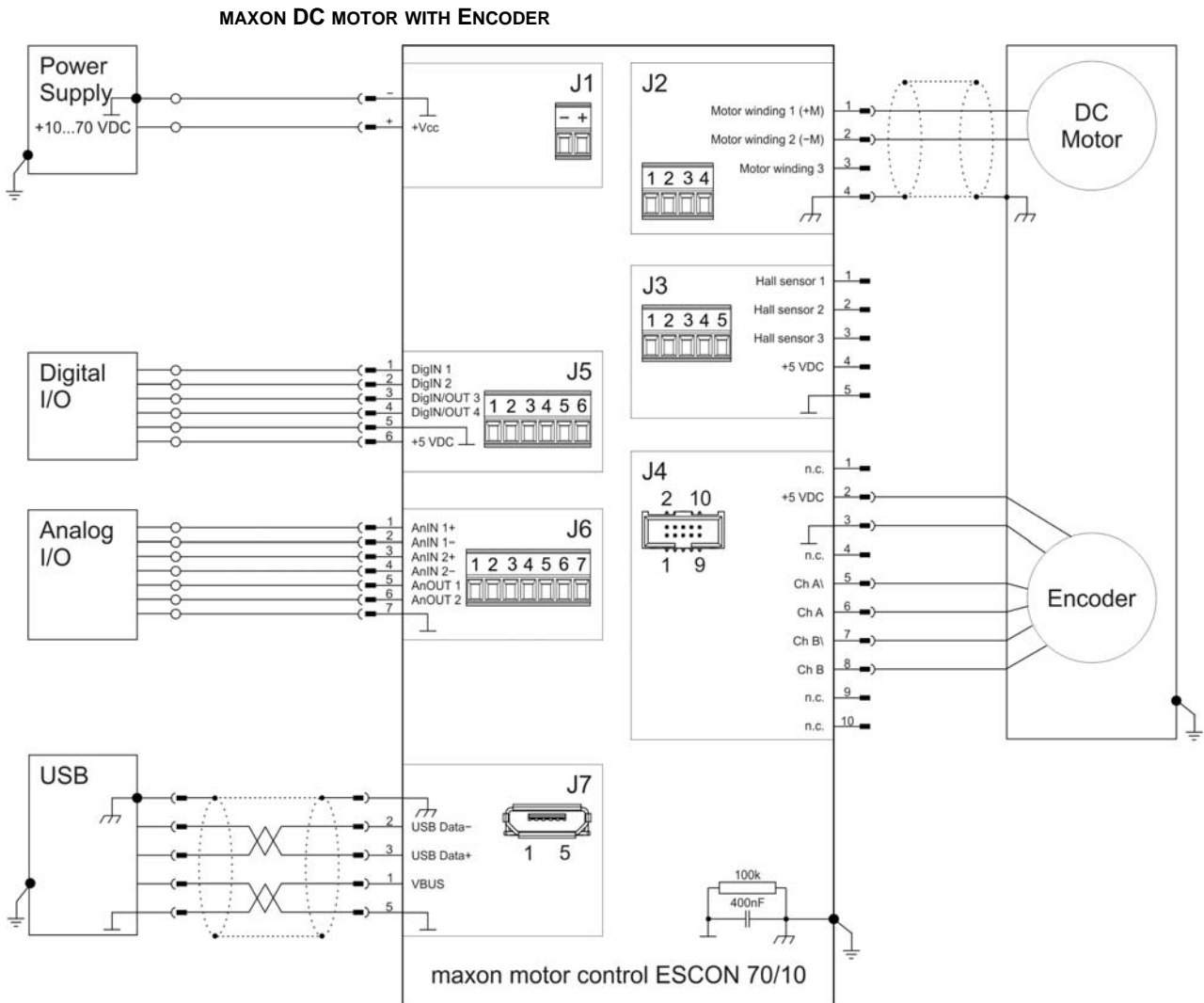


Figure 4-25 maxon DC motor with Encoder (J2 / J4)



## 4.2 EC Motors

### MAXON EC MOTOR WITH HALL SENSORS

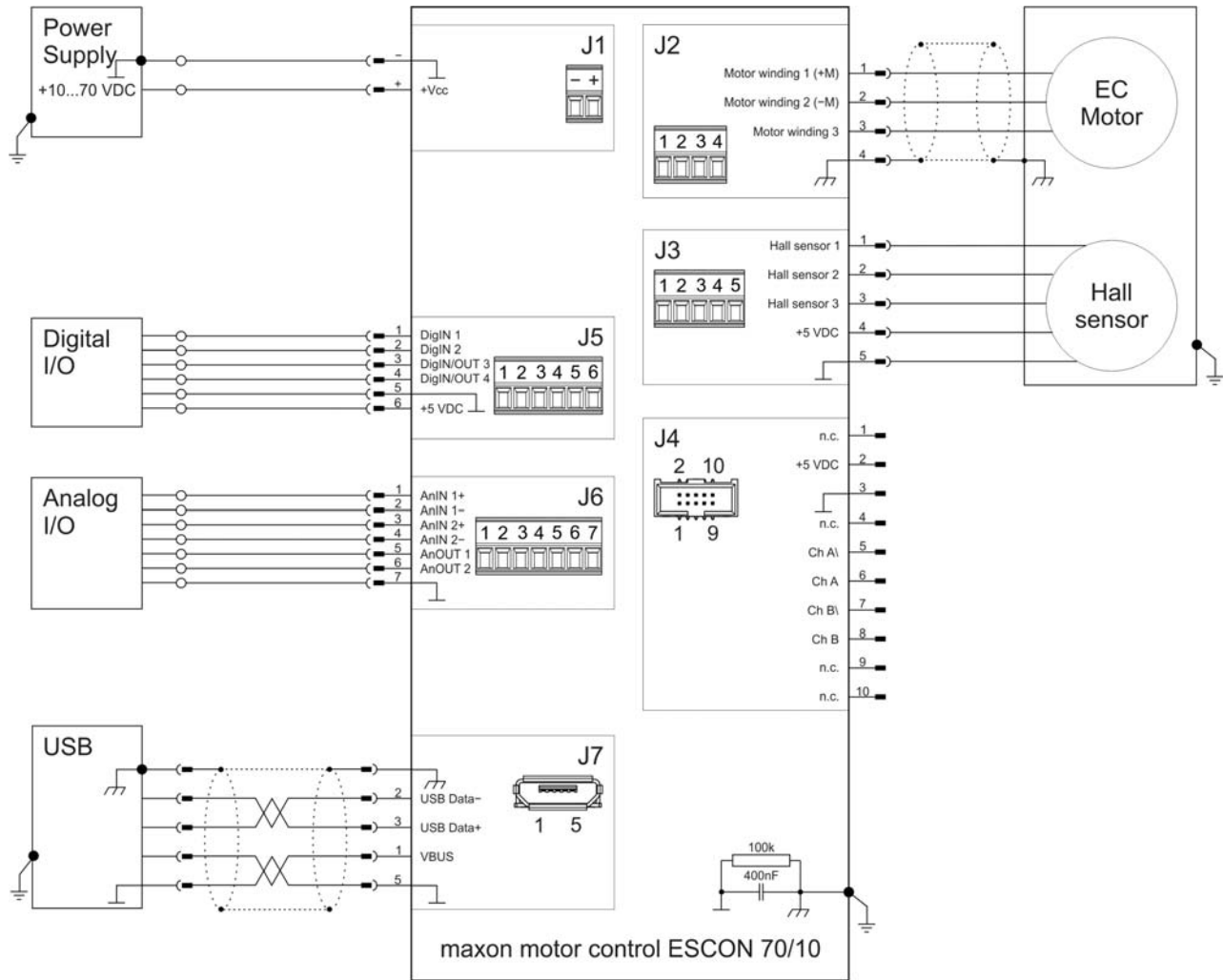


Figure 4-26 maxon EC motor with Hall Sensors (J2 / J3)

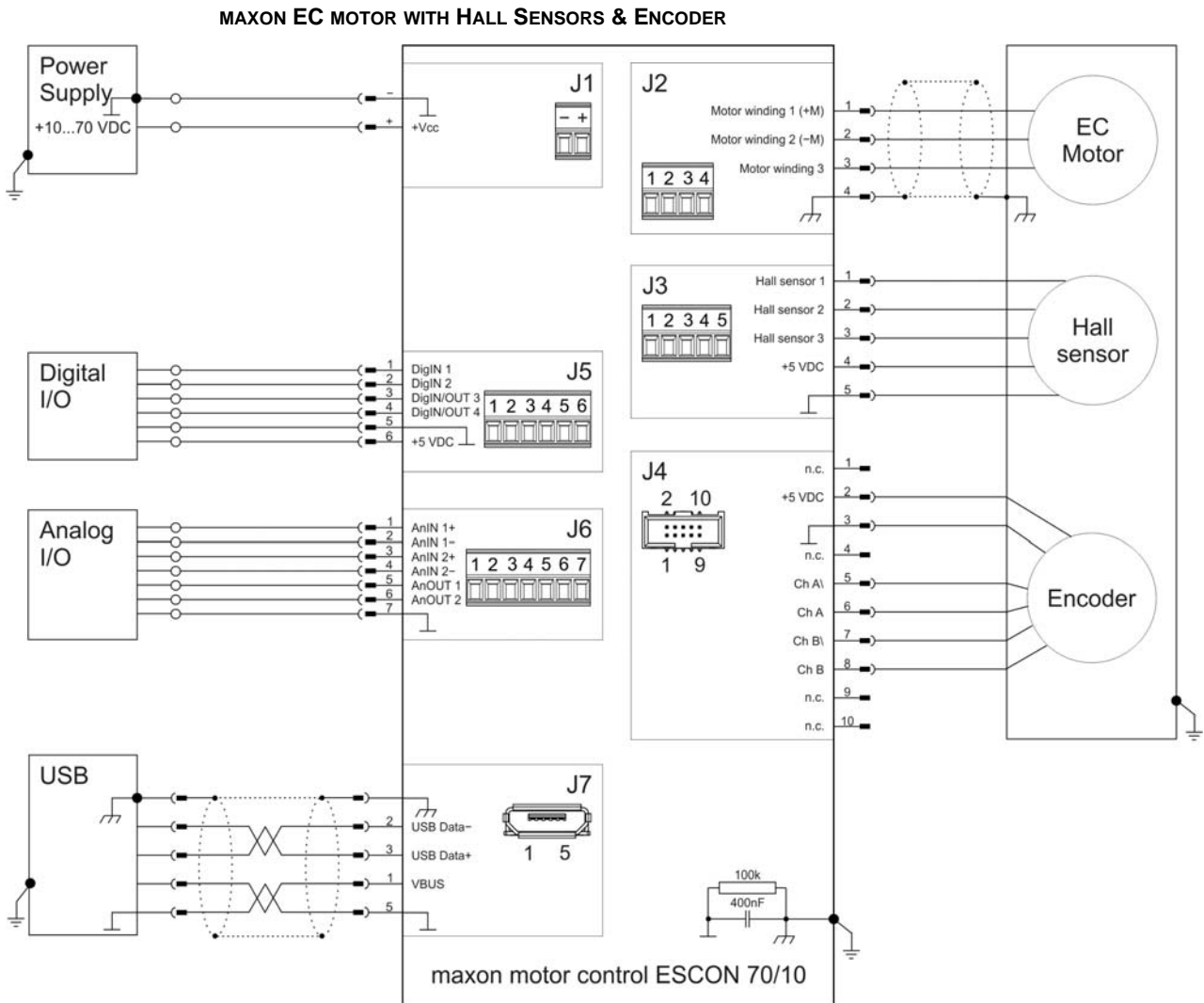


Figure 4-27 maxon EC motor with Hall Sensors & Encoder (J2 / J3 / J4)

## 5 Spare Parts

Order number	Description
432793	2 poles pluggable screw-type terminal block, pitch 5.0 mm, labeled 1...2
432794	4 poles pluggable screw-type terminal block, pitch 5.0 mm, labeled 1...4
425564	5 poles pluggable screw-type terminal block, pitch 3.5 mm, labeled 1...5
425565	6 poles pluggable screw-type terminal block, pitch 3.5 mm, labeled 1...6
425566	7 poles pluggable screw-type terminal block, pitch 3.5 mm, labeled 1...7

Table 5-24 Spare Parts List

---

*••page intentionally left blank••*

## LIST OF FIGURES

Figure 2-1	Derating Output Current . . . . .	8
Figure 2-2	Dimensional Drawing [mm]. . . . .	9
Figure 3-3	Power Plug J1 . . . . .	13
Figure 3-4	Motor Plug J2 . . . . .	14
Figure 3-5	Hall Sensor Plug J3 . . . . .	15
Figure 3-6	Hall Sensor 1 Input Circuit (analogously valid also for Hall Sensors 2 & 3) . . . . .	15
Figure 3-7	Encoder Socket J4 . . . . .	16
Figure 3-8	Encoder Input Circuit Ch A “Differential” (analogously valid also for Ch B) . . . . .	17
Figure 3-9	Encoder Input Circuit Ch A “Single-ended” (analogously valid also for Ch B) . . . . .	18
Figure 3-10	Digital I/Os Plug J5 . . . . .	19
Figure 3-11	DigIN1 Circuit . . . . .	20
Figure 3-12	DigIN2 Circuit . . . . .	20
Figure 3-13	DigIN3 Circuit (analogously valid also for DigIN4) . . . . .	21
Figure 3-14	DigOUT3 Circuit (analogously valid also for DigOUT4) . . . . .	21
Figure 3-15	DigOUT3 Wiring Examples (analogously valid also for DigOUT4). . . . .	22
Figure 3-16	Analog I/Os Plug J6 . . . . .	23
Figure 3-17	AnIN1 Circuit (analogously valid also for AnIN2) . . . . .	24
Figure 3-18	AnOUT1 Circuit (analogously valid also for AnOUT2) . . . . .	24
Figure 3-19	USB Socket J7 . . . . .	25
Figure 3-20	Potentiometers – Location & Adjustment Range . . . . .	26
Figure 3-21	LEDs – Location . . . . .	26
Figure 4-22	Interfaces – Designations and Location . . . . .	29
Figure 4-23	maxon DC motor (J2) . . . . .	30
Figure 4-24	maxon DC motor with DC Tacho (J2). . . . .	31
Figure 4-25	maxon DC motor with Encoder (J2 / J4). . . . .	32
Figure 4-26	maxon EC motor with Hall Sensors (J2 / J3) . . . . .	33
Figure 4-27	maxon EC motor with Hall Sensors & Encoder (J2 / J3 / J4) . . . . .	34

## LIST OF TABLES

Table 1-1	Notation used . . . . .	3
Table 1-2	Symbols & Signs . . . . .	4
Table 1-3	Brand Names and Trademark Owners. . . . .	4
Table 2-4	Technical Data . . . . .	8
Table 2-5	Standards. . . . .	10
Table 3-6	Power Plug J1 – Pin Assignment. . . . .	13
Table 3-7	Power Plug J1 – Specification & Accessories . . . . .	13
Table 3-8	Motor Plug J2 – Pin Assignment for maxon DC motor (brushed) . . . . .	14
Table 3-9	Motor Plug J2 – Pin Assignment for maxon EC motor (brushless) . . . . .	14
Table 3-10	Motor Plug J2 – Specification & Accessories. . . . .	14
Table 3-11	Hall Sensor Plug J3 – Pin Assignment. . . . .	15
Table 3-12	Hall Sensor Plug J3 – Specification & Accessories . . . . .	15
Table 3-13	Encoder Socket J4 – Pin Assignment . . . . .	16
Table 3-14	Encoder Socket J4 – Accessories . . . . .	16
Table 3-15	Encoder Cable . . . . .	17
Table 3-16	Digital I/Os Plug J5 – Pin Assignment & Cabling . . . . .	19
Table 3-17	Digital I/Os Plug J5 – Specification & Accessories. . . . .	19
Table 3-18	Analog I/Os Plug J6 – Pin Assignment & Cabling . . . . .	23
Table 3-19	Analog I/Os Plug J6 – Specification & Accessories . . . . .	23
Table 3-20	USB Socket J7 – Pin Assignment & Cabling . . . . .	25
Table 3-21	USB Type A - micro B Cable . . . . .	25
Table 3-22	LEDs – Interpretation of Condition . . . . .	27
Table 3-23	External Motor Chokes – Specification & Accessories. . . . .	28
Table 5-24	Spare Parts List . . . . .	35

---

**INDEX****A**

additionally applicable regulations 5  
alerts 3  
analog inputs 24  
applicable EU directive 11

**C**

cables (prefab)  
    Encoder Cable 17  
    USB Type A - micro B Cable 25  
country-specific regulations 5

**D**

digital inputs 20, 21

**E**

error display 26  
ESD 5  
EU directive, applicable 11  
external motor choke 28

**H**

how to  
    calculate required supply voltage 12  
    determine the need for external motor chokes 28  
    interpret icons (and signs) used in the document 3

**I**

incorporation into surrounding system 11  
informatory signs 4  
intended purpose of the device 4  
interfaces, location and designation 29

**L**

LEDs 26

**M**

mandatory action signs 3  
motor chokes, additional 28

**N**

notations used 3

**O**

operating license 11  
operating status, display 26

order numbers

275934 17  
347919 28  
403968 25  
422969 7  
425564 35  
425565 35  
425566 35  
432793 35  
432794 35

**P**

performance data 7  
potentiometers 26  
precautions 5  
prerequisites prior installation 11  
prohibitive signs 3  
purpose  
    of the device 4  
    of this document 3

**R**

regulations, additionally applicable 5

**S**

safety alerts 3  
safety first! 5  
signs used 3  
sockets  
    J1 13  
    J2 14  
    J3 15  
    J4 16  
    J5 19  
    J6 23  
    J7 25  
standards, fulfilled 10  
status display 26  
status LEDs 26  
supply voltage, required 12  
symbols used 3

**T**

technical data 7

**U**

USB interface 25

**W**

wiring diagrams for  
    DC motors 30  
    EC motors 33

© 2015 maxon motor. All rights reserved.

The present document – including all parts thereof – is protected by copyright. Any use (including reproduction, translation, microfilming, and other means of electronic data processing) beyond the narrow restrictions of the copyright law without the prior approval of maxon motor ag, is not permitted and subject to prosecution under the applicable law.

**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](http://www.maxonmotor.com)