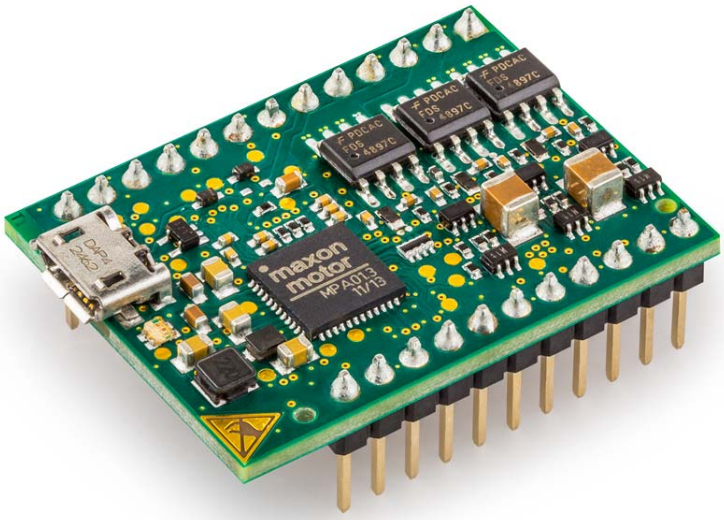
maxon

ESCON Module 24/2

Hardware Reference



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ESCON Module 24/2 Servo Controller | P/N 466023
Hardware Reference
CCMC | Edition 2021-08 | DocID rel9004

TABLE OF 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 ESCON Module 24/2 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!*

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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 Module 24/2 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. In addition, the document also includes a Motherboard Design Guide and detailed information on the optionally available «ESCON Module 24/2 Motherboard».

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 **imminent hazardous situation**. If not avoided, it **will result in death or serious injury**.
		WARNING	Indicates a **potential hazardous situation**. If not avoided, it **may result in death or serious injury**.
		CAUTION	Indicates a **probably hazardous situation** or calls the attention to unsafe practices. If not avoided, it **may result in injury**.
Prohibited Action	 (typical)	Indicates a dangerous action. Hence, **you must not**!	
Mandatory Action	 (typical)	Indicates a mandatory action. Hence, **you must**!	
Information		Requirement / Note / Remark	Indicates an activity you must perform prior to continuing, or gives information on a particular item you need to observe.
		Best Practice	Indicates advice or a recommendation on the easiest and best way to proceed.
		Material Damage	Indicates instructions on how to prevent damage to 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
Littelfuse® SMD NANO2®	© Littelfuse, USA-Chicago, IL
Windows®	© Microsoft Corporation, USA-Redmond, WA

Table 1-3 Brand Names and Trademark Owners

1.1.6 Copyright

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, is not permitted and subject to prosecution under the applicable law.
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1.2 About the Device

The ESCON Module 24/2 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 48 Watts.

The featured operating modes – speed control (closed loop), speed control (open loop), and current control – meet the highest requirements. The ESCON Module 24/2 is designed being commanded by an analog set value and features extensive analog and digital I/O functionality.

The miniaturized OEM plug-in module can be seamlessly integrated in complex customer applications. A suitable motherboard is available for the initial commissioning.

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.maxongroup.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 in any work unless you possess the stated skills (➔chapter “1.1.2 Target Audience” on page 1-5)!
- Refer to ➔chapter “1.1.4 Symbols & signs” on page 1-6 for explanations of the symbols used in the following!
- 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.*

Electrostatic Sensitive Device (ESD)

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

2 SPECIFICATIONS

2.1 Technical Data

ESCON Module 24/2 (466023)		
Electrical Rating	Nominal operating voltage $+V_{CC}$	10…24 VDC
	Absolute operating voltage $+V_{CC\ min}/+V_{CC\ max}$	8 VDC / 28 VDC
	Output voltage (max.)	$+V_{CC}$
	Output current I_{cont}/I_{max} (<4 s)	2 A / 6 A
	Pulse width modulation frequency	53.6 kHz
	Sampling rate of PI current controller	53.6 kHz
	Sampling rate of PI speed controller	5.36 kHz
	Max. efficiency	92%
	Max. speed of 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	–
Inputs & Outputs	Analog input 1 Analog input 2	12-bit resolution; −10…+10 V; differential
	Analog output 1 Analog output 2	12-bit resolution ; −4…+4 V; referenced to GND
	Digital input 1 Digital input 2	+2.4…+36 VDC (R_i = 38.5 kΩ)
	Digital input/output 3 Digital input/output 4	+2.4…+36 VDC (R_i = 38.5 kΩ)/max. 36 VDC (I_L <50 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 ≤10 mA)
	Hall sensor supply voltage	+5 VDC (I_L ≤30 mA)
	Encoder supply voltage	+5 VDC (I_L ≤70 mA)
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 Module 24/2 (466023)			
Physical	Weight	approx. 7 g	
	Dimensions (L x W x H)	35.6 x 26.7 x 12.7 mm	
	Connection	Plugs into socket headers with 2.54 mm pitch	
Environmental Conditions	Temperature	Operation	−30…+60 °C
		Extended range *1)	+60…+80 °C Derating ➔Figure 2-1
		Storage	−40…+85 °C
	Altitude *2)	Operation	0…6'000 m MSL
		Extended range *1)	6'000…10'000 m MSL Derating ➔Figure 2-1
	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

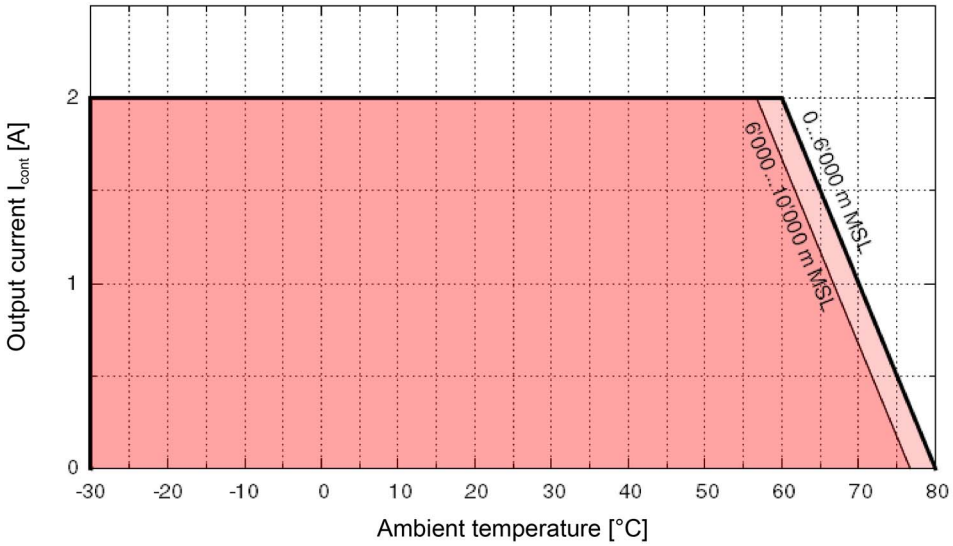

Figure 2-1 Derating Output Current

Protection functionality	Switch-off threshold	Recovery threshold
Undervoltage	7.2 V	7.4 V
Overvoltage	31 V	29 V
Overcurrent	9.6 A	—
Thermal overload	95 °C	85 °C

Table 2-5 Limitations

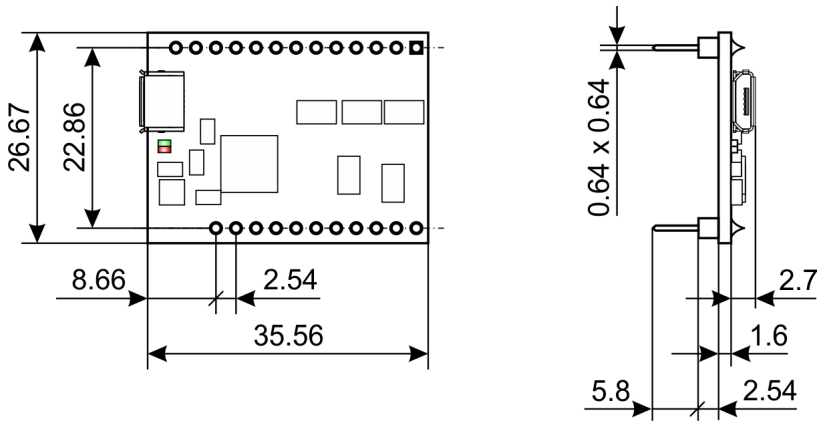

Figure 2-2 Dimensional Drawing [mm]

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 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test >10 V/m
	IEC/EN 61000-4-4	Electrical fast transient/burst immunity test ±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^2)
	MIL-STD-810F	Random transport (10…500 Hz up to 2.53 g_{rms})
Safety standards	UL File Number E148881; 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): 1'044'089 hours

Table 2-6 Standards

3 SETUP

IMPORTANT NOTICE: PREREQUISITES FOR PERMISSION TO COMMENCE INSTALLATION

The ESCON Module 24/2 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 operating voltage is between 10…24 VDC.*
- *Supply voltages above 28 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 Module 24/2 are as follows; continuous max. 2 A / short-time (acceleration) max. 6 A.*

Hot plugging the USB interface may cause hardware damage

If the USB interface is being hot-plugged (connecting while the power supply is on), the possibly high potential differences of the two power supplies of controller and PC/Notebook can lead to damaged hardware.

- *Avoid potential differences between the power supply of controller and PC/Notebook or, if possible, balance them.*
- *Insert the USB connector first, then switch on the power supply of the controller.*

3.2 Configuration of Power Supply

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

Power Supply Requirements	
Output voltage	$+V_{CC}$ 10…24 VDC
Absolute output voltage	min. 8 VDC; max. 28 VDC
Output current	Depending on load • continuous max. 2 A • short-time (acceleration, <4 s) max. 6 A

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 100%*
- *Controller's max. voltage drop of 1 V @ 2 A*

KNOWN VALUES:
- Operating torque M [mNm]
- Operating speed n [rpm]
- Nominal motor voltage U_N [Volt]
- 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 $+V_{CC}$ [Volt]

SOLUTION:

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

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 the given order and choose the wiring diagram that best suits the components you are using. For corresponding wiring diagrams ➔chapter “4 Wiring” on page 4-27.

3.3.1 Pin Assignment

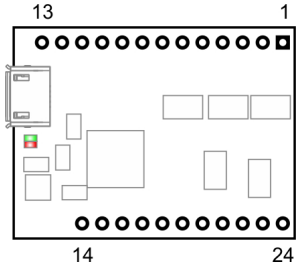

Figure 3-3 Pin Assignment

Pin	Signal	Description
1	Motor (+M) Motor winding 1	DC motor: Motor + EC motor: Winding 1
2	Motor (−M) Motor winding 2	DC motor: Motor − EC motor: Winding 2
3	Motor winding 3	EC motor: Winding 3
4	$+V_{CC}$	Nominal operating voltage (+10…+24 VDC)
5	Power_GND GND	Ground of operating voltage Ground
6	+5 VDC	Hall sensor supply voltage (+5 VDC; ≤30 mA) Encoder supply voltage (+5 VDC; ≤70 mA) Auxiliary output voltage (+5 VDC; ≤10 mA)
7	Hall sensor 1	Hall sensor 1 input
8	Hall sensor 2	Hall sensor 2 input
9	Hall sensor 3	Hall sensor 3 input
10	Channel A	Encoder channel A
11	Channel A\	Encoder channel A complement
12	Channel B	Encoder channel B
13	Channel B\	Encoder channel B complement

Table 3-7 Pin Assignment (Pins 1-13)

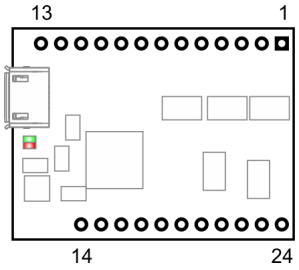

Figure 3-4 Pin Assignment

Pin	Signal	Description
14	DigIN/DigOUT4	Digital input/output 4
15	DigIN/DigOUT3	Digital input/output 3
16	DigIN2	Digital input 2
17	DigIN1	Digital input 1
18	GND	Ground
19	AnOUT2	Analog output 2
20	AnOUT1	Analog output 1
21	AnIN2−	Analog input 2, negative signal
22	AnIN2+	Analog input 2, positive signal
23	AnIN1−	Analog input 1, negative signal
24	AnIN1+	Analog input 1, positive signal

Table 3-8 Pin Assignment (Pins 14-24)

3.3.2 Hall Sensor

Hall sensor supply voltage	+5 VDC
Max. Hall sensor supply current	30 mA
Input voltage	0…5.5 VDC
Max. input voltage	±5.5 VDC
Logic 0	typically <1.0 V
Logic 1	typically >2.4 V
Internal pull-up resistor	10 kΩ (referenced to +5.45 V)

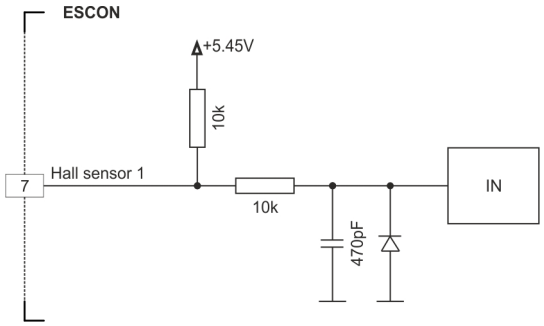

Figure 3-5 Hall Sensor 1 Input Circuit (analogously valid also for Hall Sensors 2 & 3)

3.3.3 Encoder

Best practice

- *Differential signals offer good resistance against electrical interference. Therefore we **recommend using a differential scheme**. Nevertheless, the controller supports both schemes – differential and single-ended (unsymmetrical).*
- *The controller does not require an index impulse (Ch I, Ch I\).*
- *For best performance, **we strongly recommend using encoders with a 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

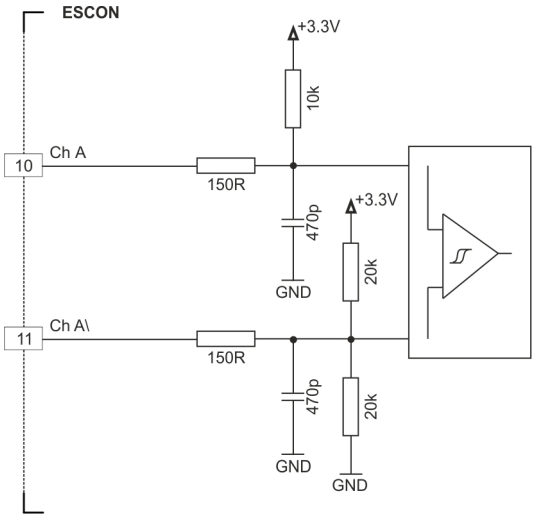

Figure 3-6 Encoder Input Circuit Ch A “Differential” (analogously valid also for Ch B)

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 µA @ 5 V
Input low current	I_{IL} = typically −170 µA @ 0 V
Max. input frequency	100 kHz

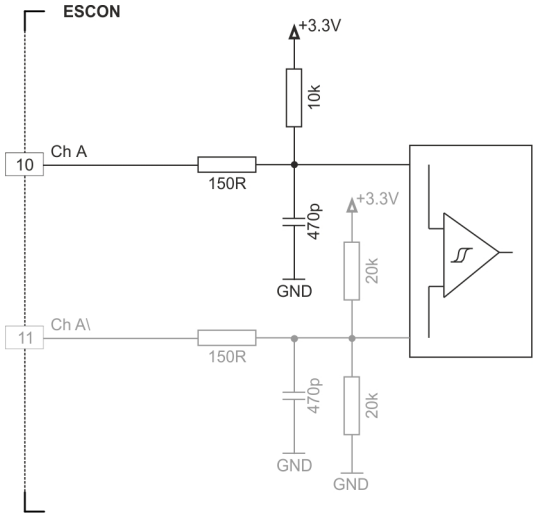

Figure 3-7 Encoder Input Circuit Ch A “Single-ended” (analogously valid also for Ch B)

3.3.4 Digital I/Os

3.3.4.1 Digital Input 1

Input voltage	0…28 VDC
Max. input voltage	+36 VDC/−36 VDC
Logic 0	typically <1.0 V
Logic 1	typically >2.4 V
Input resistance	typically 47 kΩ (<3.3 V) typically 38.5 kΩ (@ 5 V) typically 25.5 kΩ (@ 24 V)
Input current at logic 1	typically 130 µA @ +5 VDC
Switching delay	<8 ms

PWM frequency range	10 Hz…5 kHz
PWM duty cycle range (resolution)	10...90%
PWM accuracy	typically 0.1% @ 10 Hz typically 0.5% @ 1 kHz typically 2.5% @ 5 kHz
RC Servo cycle duration	3…30 ms
RC Servo pulse length	1…2 ms

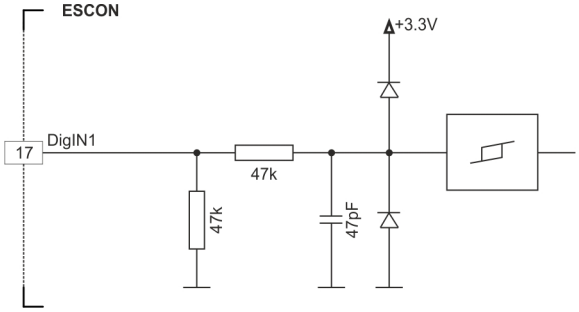

Figure 3-8 DigIN1 Circuit

3.3.4.2 Digital Input 2

Input voltage	0…28 VDC
Max. input voltage	+36 VDC/−36 VDC
Logic 0	typically <1.0 V
Logic 1	typically >2.4 V
Input resistance	typically 47 kΩ (<3.3 V) typically 38.5 kΩ (@ 5 V) typically 25.5 kΩ (@ 24 V)
Input current at logic 1	typically 130 µA @ +5 VDC
Switching delay	<8 ms

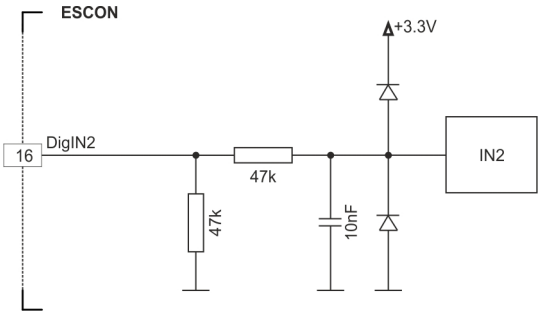

Figure 3-9 DigIN2 Circuit

3.3.4.3 Digital Inputs/Outputs 3 and 4

DigIN	
Input voltage	0…28 VDC
Max. input voltage	+36 VDC
Logic 0	typically <1.0 V
Logic 1	typically >2.4 V
Input resistance	typically 47 kΩ (<3.3 V) typically 38.5 kΩ (@ 5 V) typically 25.5 kΩ (@ 24 V)
Input current at logic 1	typically 130 µA @ +5 VDC
Switching delay	<8 ms

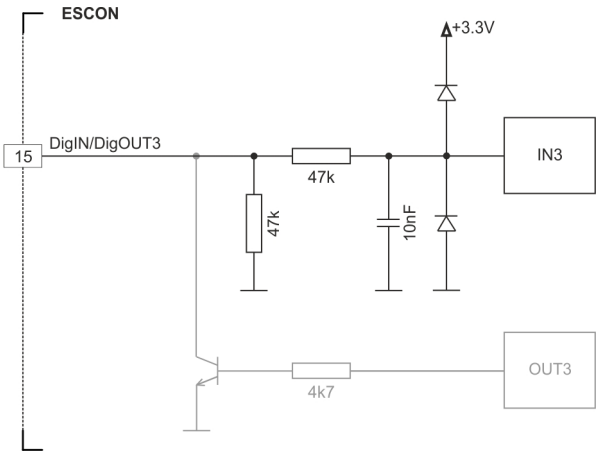

Figure 3-10 DigIN3 Circuit (analogously valid also for DigIN4)

DigOUT	
Max. input voltage	+36 VDC
Max. load current	50 mA
Max. voltage drop	0.5 V @ 50 mA
Max. load inductance	Only possible with external protective circuitry (free-wheeling diode)

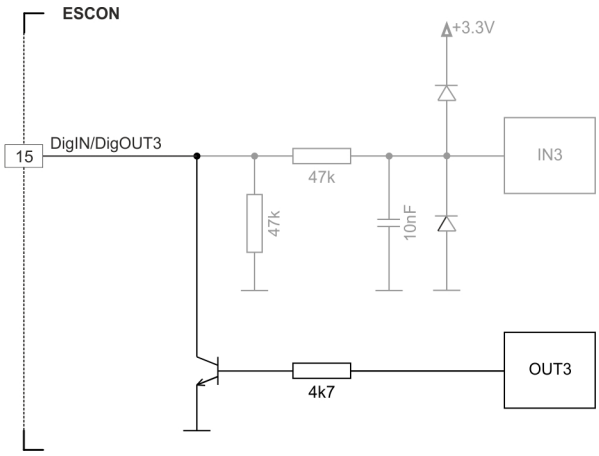

Figure 3-11 DigOUT3 Circuit (analogously valid also for DigOUT4)

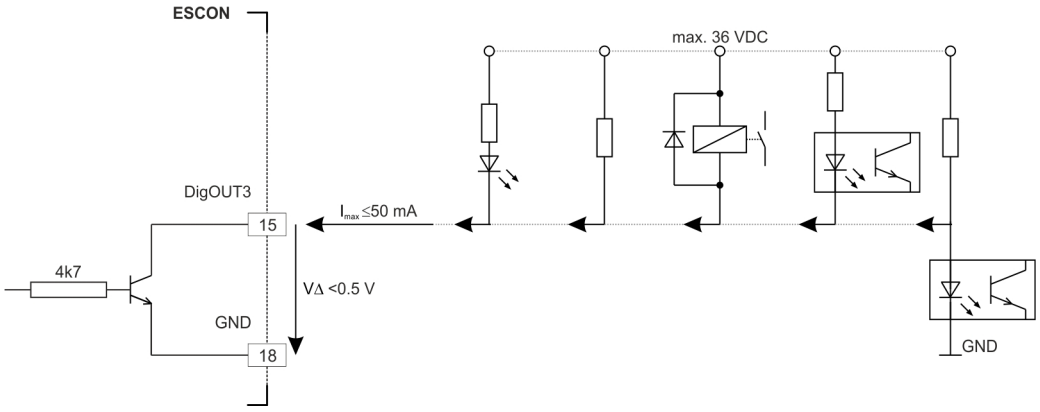

Figure 3-12 DigOUT3 Wiring Examples (analogously valid also for DigOUT4)

3.3.5 Analog I/Os

3.3.5.1 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 kΩ (differential) 65 kΩ (referenced to GND)
A/D converter	12-bit
Resolution	5.64 mV
Bandwidth	10 kHz

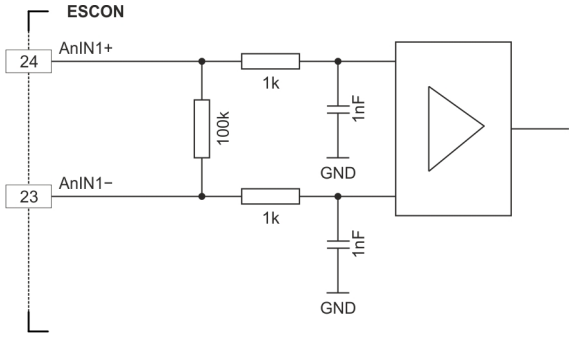

Figure 3-13 AnIN1 Circuit (analogously valid also for AnIN2)

3.3.5.2 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 **Note:** The rate of the increase is limited in proportion to the capacitive load (e.g. 5 V/ms @300 nF).
Max. output current limit	1 mA

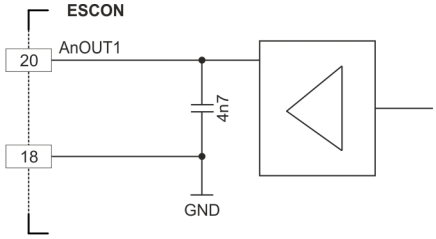

Figure 3-14 AnOUT1 Circuit (analogously valid also for AnOUT2)

3.3.6 USB (J7)

Hot plugging the USB interface may cause hardware damage
If the USB interface is being hot-plugged (connecting while the power supply is on), the possibly high potential differences of the two power supplies of controller and PC/Notebook can lead to damaged hardware.
- *Avoid potential differences between the power supply of controller and PC/Notebook or, if possible, balance them.*
- *Insert the USB connector first, then switch on the power supply of the controller.*

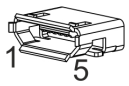

Figure 3-15 USB Socket J7

Note
Column "Head B" (➔Table 3-9) refers to USB terminals of your PC.

J7 & Head A Pin	Head B Pin	Signal	Description
1	1	V_{BUS}	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 3-9 USB Socket J7 – Pin Assignment & Cabling

USB Type A - micro B Cable (403968)	
	
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 3-10 USB Type A - micro B Cable

USB standard	USB 2.0 / USB 3.0 (full speed)
Max. bus operating voltage	+5.25 VDC
Typical input current	60 mA
Max. DC data input voltage	−0.5…+3.8 VDC

3.4 Status Indicators

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

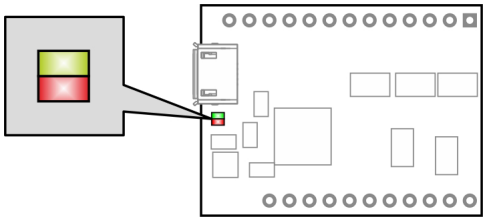

Figure 3-16 LEDs – Location

LED		Status/Error	
Green	Red		
off	off	INIT	
slow	off	DISABLE	
on	off	ENABLE	
2x	off	STOPPING; STOP STANDSTILL	
off	1x	ERROR	• +Vcc Overvoltage Error • +Vcc Undervoltage Error • +5 VDC Undervoltage Error
off	2x	ERROR	• Thermal Overload Error • Overcurrent Error • Power Stage Protection Error • Internal Hardware Error
off	3x	ERROR	• Encoder Cable Break Error • Encoder Polarity Error • DC Tacho Cable Break Error • DC Tacho Polarity Error
off	4x	ERROR	• PWM Set Value Input out of Range Error
off	5x	ERROR	• Hall Sensor Pattern Error • Hall Sensor Sequence Error • Hall Sensor Frequency too high Error
off	on	ERROR	• Auto Tuning Identification Error • Internal Software Error

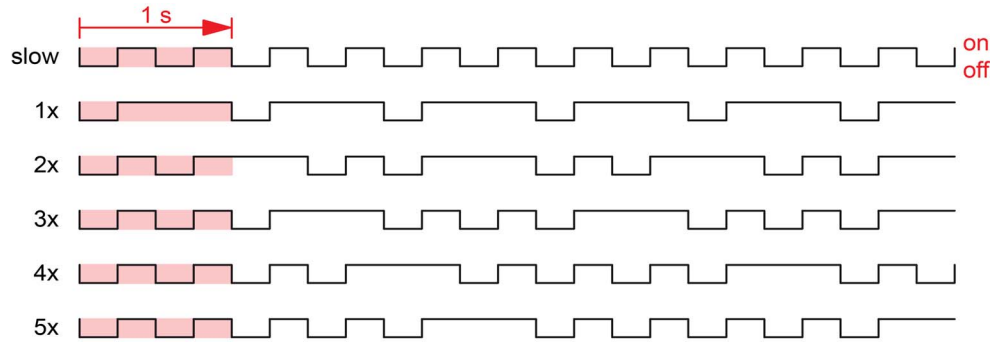

Table 3-11 LEDs – Interpretation of Condition

4 WIRING

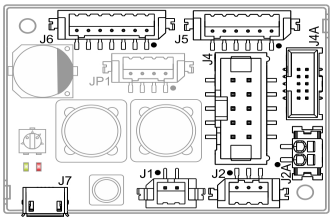

Figure 4-17 Interfaces – Designations and Location

Note

The subsequent diagrams feature this symbol:

- ⏚ *Ground safety earth connection (optional)*

4.1 DC Motors

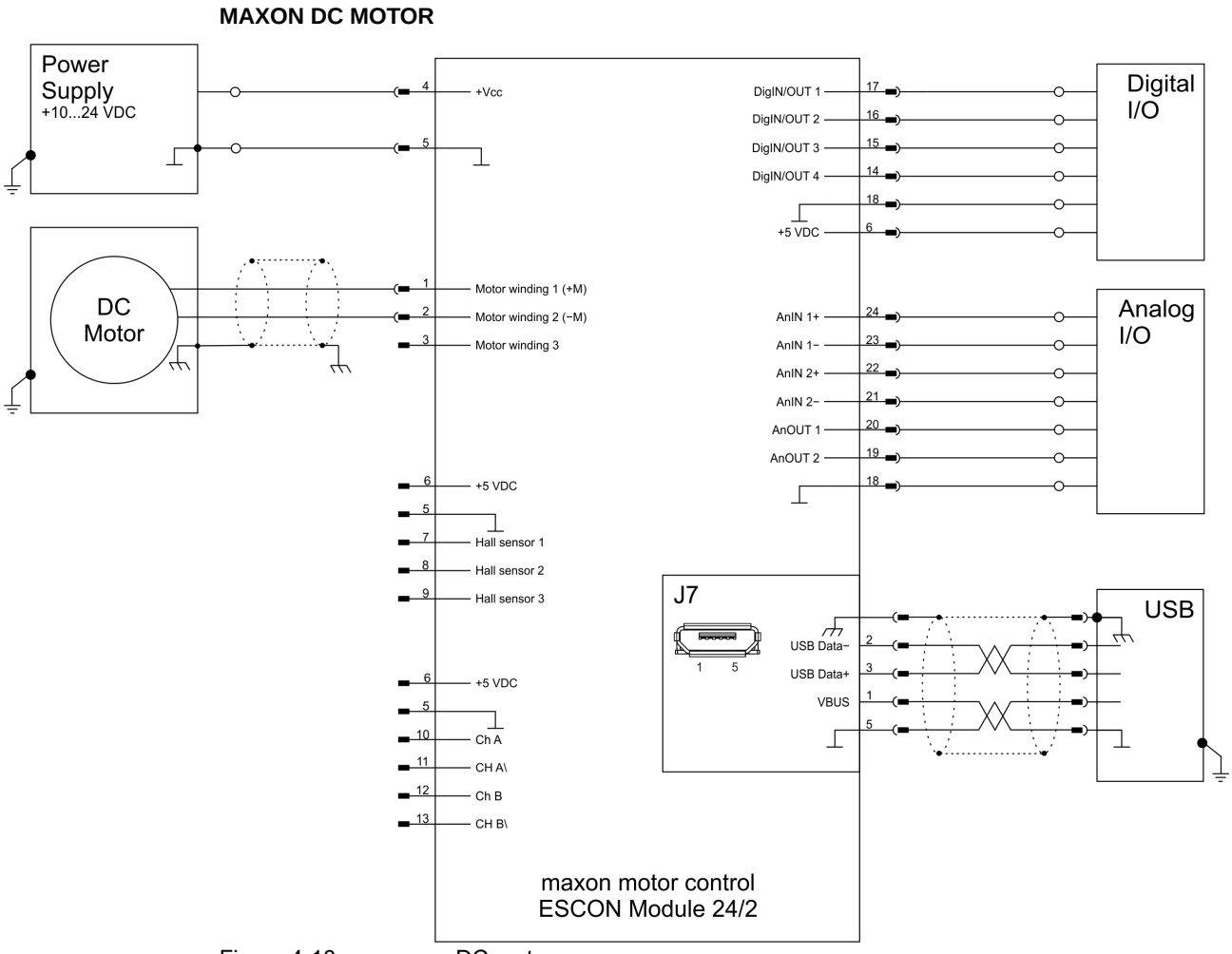

Figure 4-18 maxon DC motor

MAXON DC MOTOR WITH DC TACHO

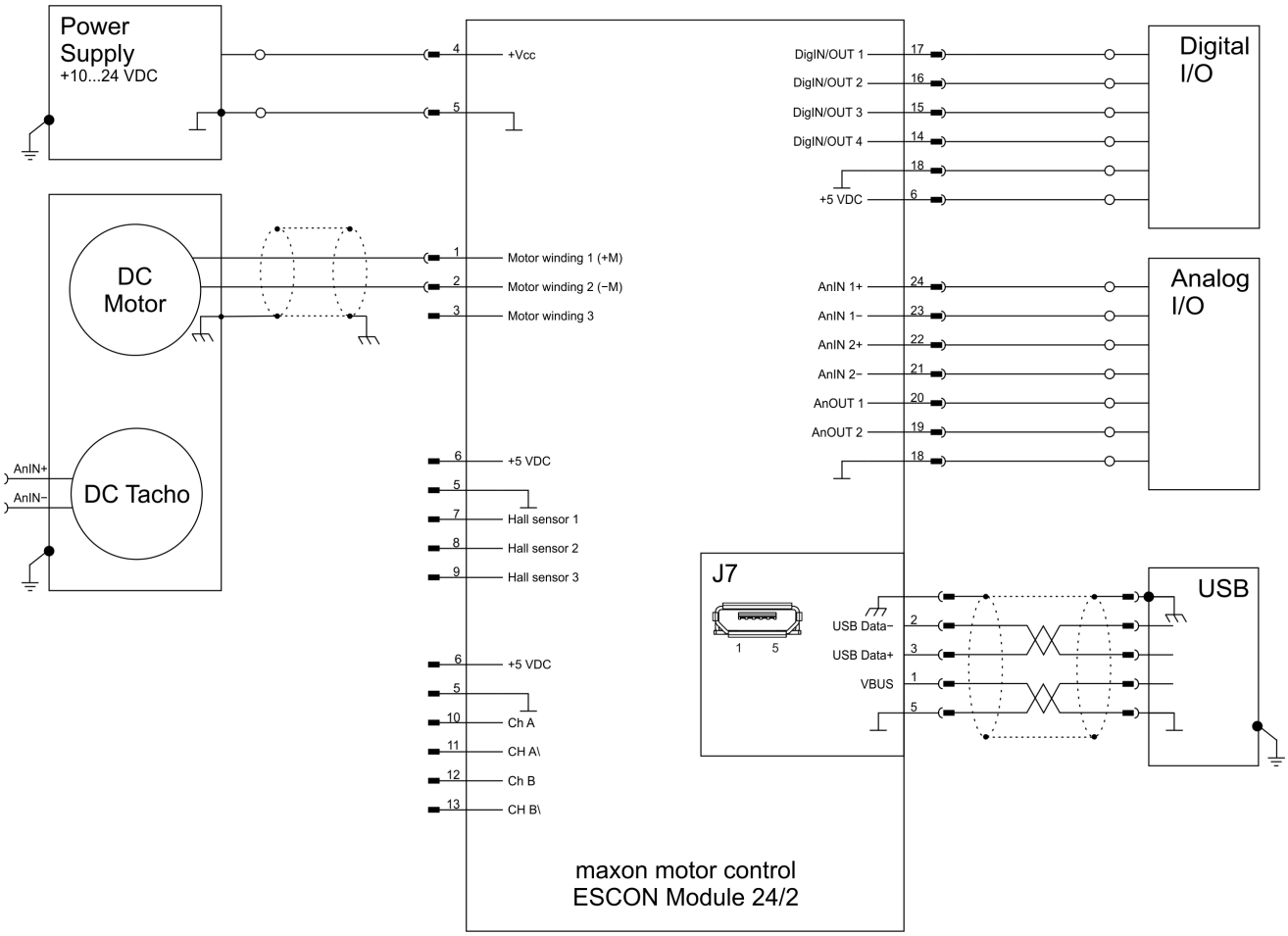

Figure 4-19 maxon DC motor with DC Tacho

MAXON DC MOTOR WITH ENCODER

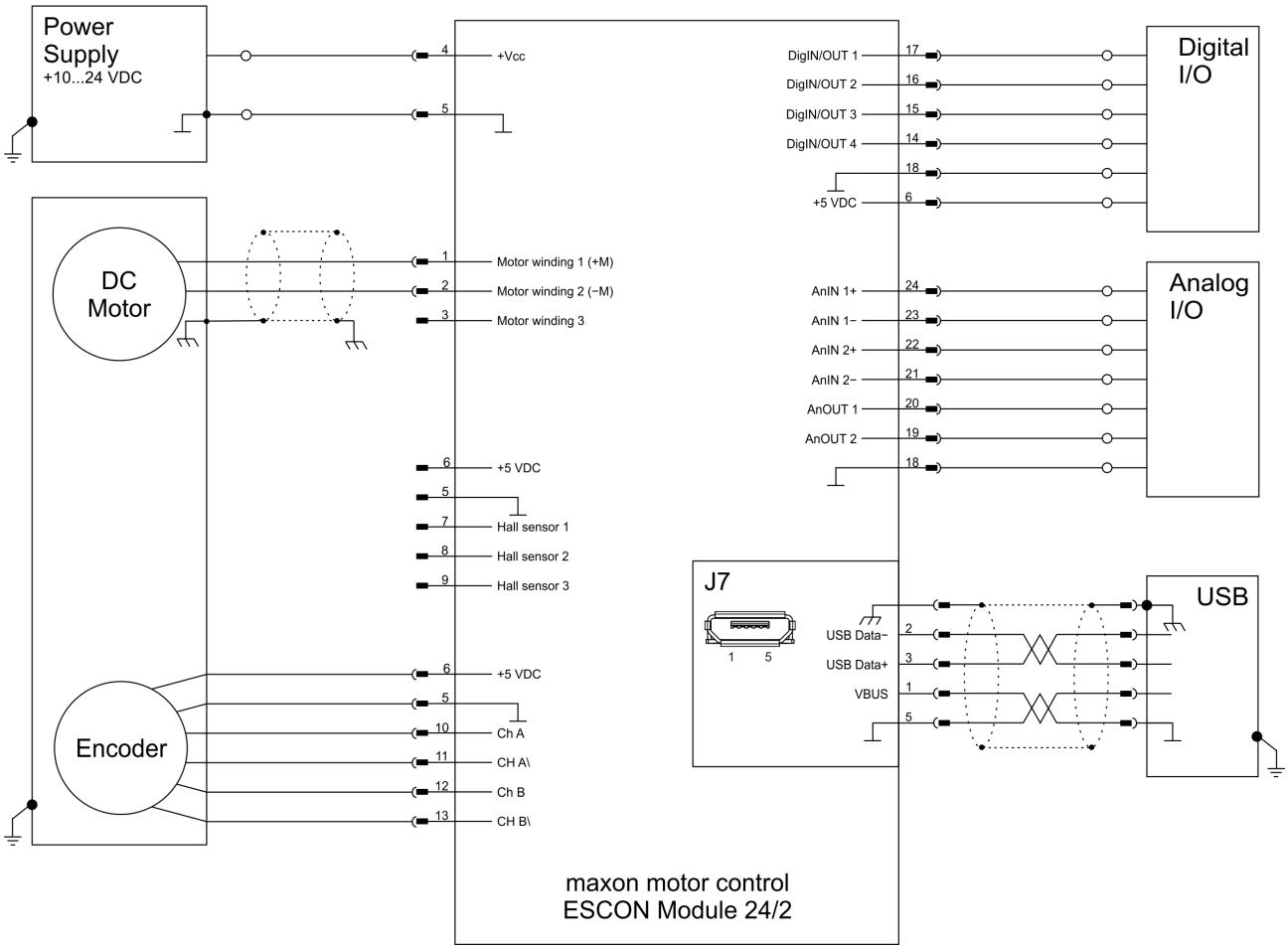

Figure 4-20 maxon DC motor with Encoder

4.2 EC Motors

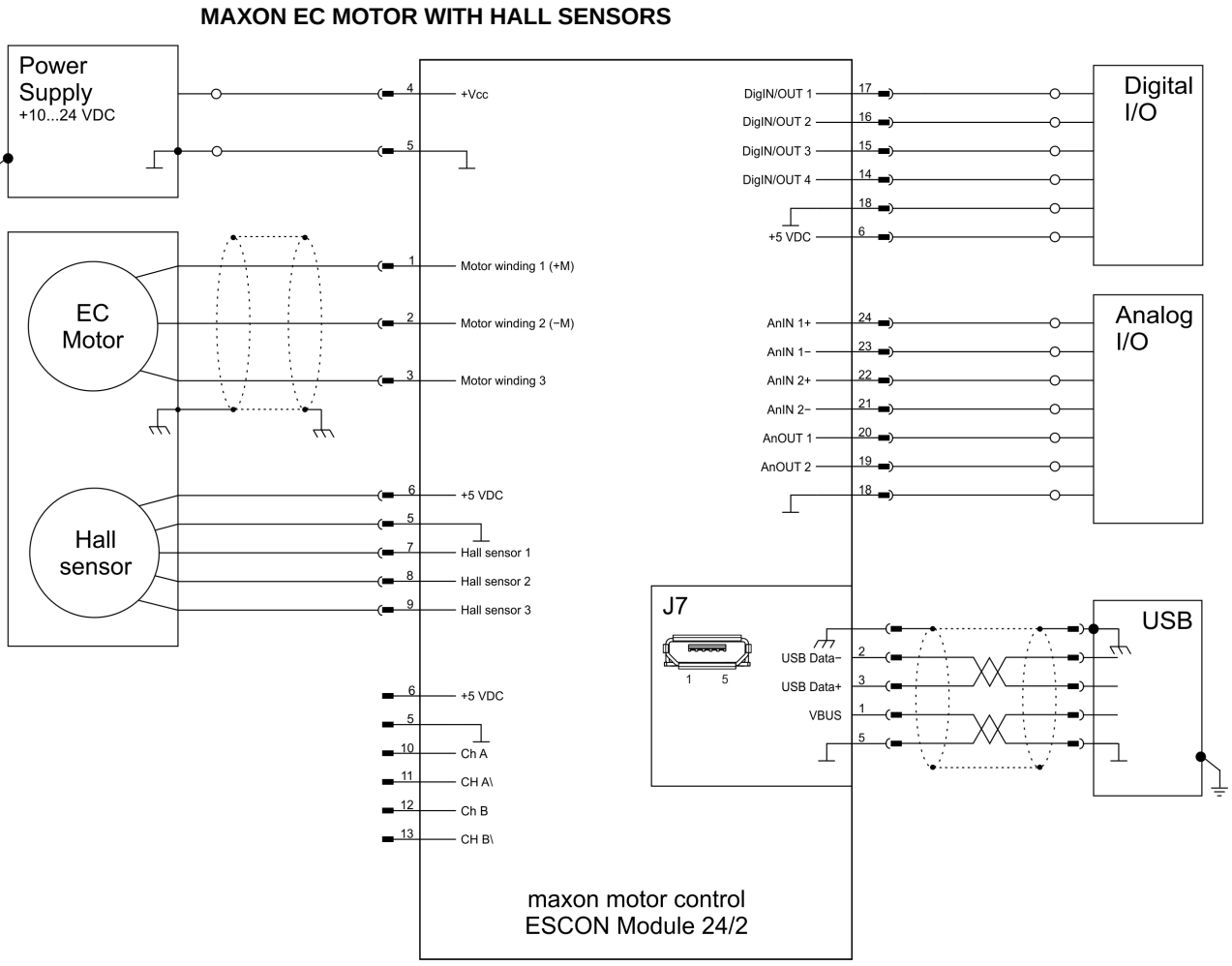

Figure 4-21 maxon EC motor with Hall Sensors

MAXON EC MOTOR WITH HALL SENSORS & ENCODER

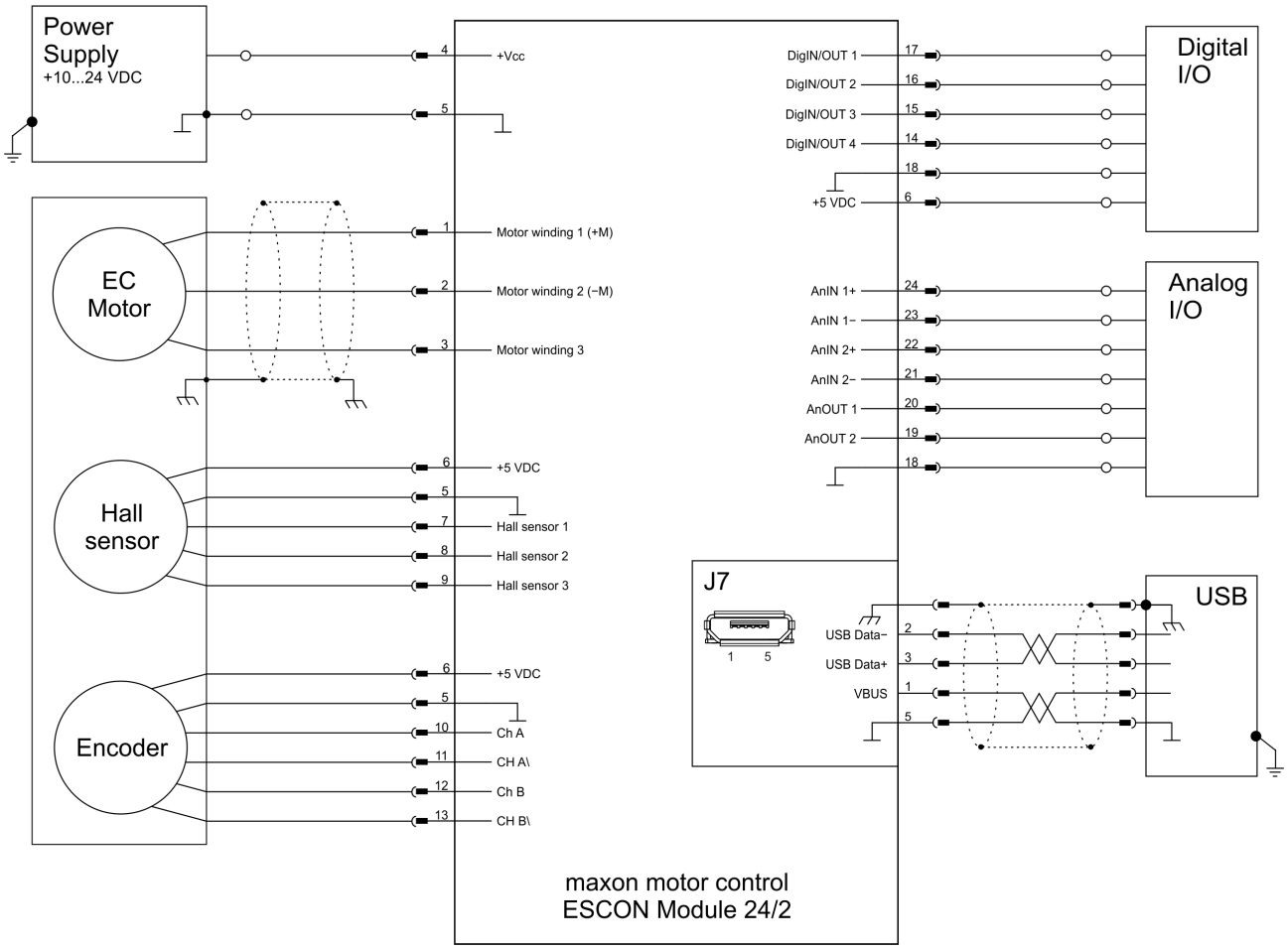

Figure 4-22 maxon EC motor with Hall Sensors & Encoder

maxon

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5 MOTHERBOARD DESIGN GUIDE

The following provides helpful information on integrating the ESCON Module 24/2 on a printed circuit board. The «Motherboard Design Guide» contains recommendations for the layout of the motherboard and specifies external components that may be required, pin assignments, and connection examples.

CAUTION

Dangerous Action
Errors in implementing the Design can result in serious Injury!
- *Only proceed if you are skilled in electronics design!*
- *Designing a printed circuit board requires special skills and knowledge and may only be performed by experienced electronic developers!*
- *This quick guide is only intended as an aid, does not make any claim to completeness, and will not automatically result in a functional component!*

Bring in additional Support:
If you are not trained in the design and development of printed circuit boards, you will need additional support for this point.
maxon will be happy to provide you with a quote for designing and manufacturing a motherboard for your specific application.

5.1 Requirements for Components of Third-party Suppliers

5.1.1 Socket Headers

The ESCON Module 24/2's implementation with pin headers permits mounting in two different ways. The module can either be plugged onto a socket header (➔Table 5-12) or be directly soldered to a printed circuit board.

5.1.2 Supply Voltage

To protect the ESCON Module 24/2, we recommend using an external circuit breaker, a TVS diode, and a capacitor in the voltage supply cable. In this regard, please note the following recommendations:

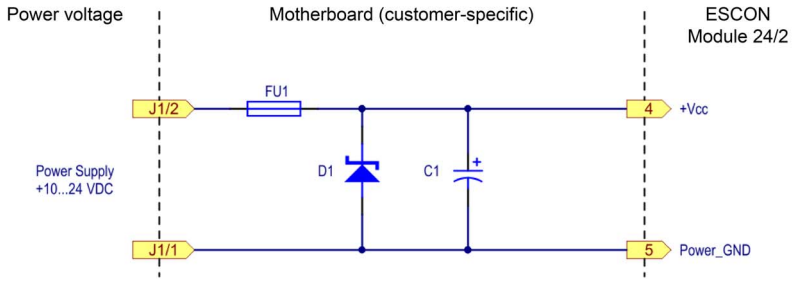

Figure 5-23 Wiring of Voltage Supply Cable

INPUT FUSE (FU1)

An input fuse (FU1) is necessary in order to provide reverse polarity protection. Together with an unipolar TVS diode (D1), this prevents current from flowing in the wrong direction.

TVS DIODE (D1)

To protect against overvoltage resulting from voltage transients or brake energy feedback, we recommend connecting a TVS (transient voltage suppressor) diode (D1) to the voltage supply cable.

CAPACITOR (C1)

The function of the ESCON Module 24/2 does not necessarily require the use of an external capacitor (C1). To further reduce voltage ripple and feedback currents, an electrolytic capacitor can be connected to the voltage supply cable.

5.1.3 Encoder Inputs

To protect the encoder inputs of the ESCON Module 24/2 against overcurrent, we recommend using an external TVS diode network.

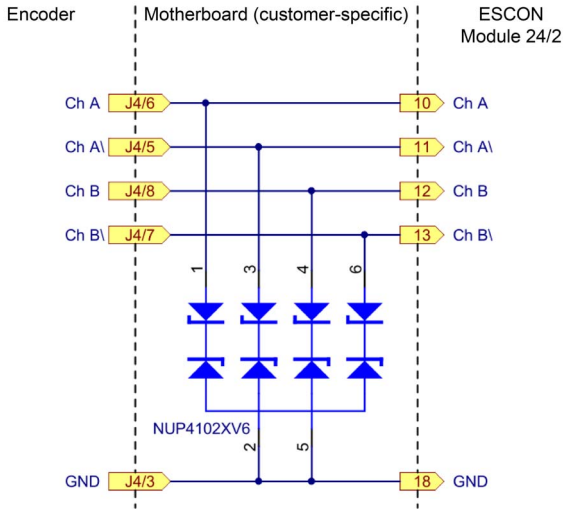

Figure 5-24 Encoder Inputs – Protective Circuitry

5.1.4 Analog Inputs and Outputs

To protect the analog inputs and outputs of the ESCON Module 24/2 against overcurrent, we recommend using an external TVS diode network.

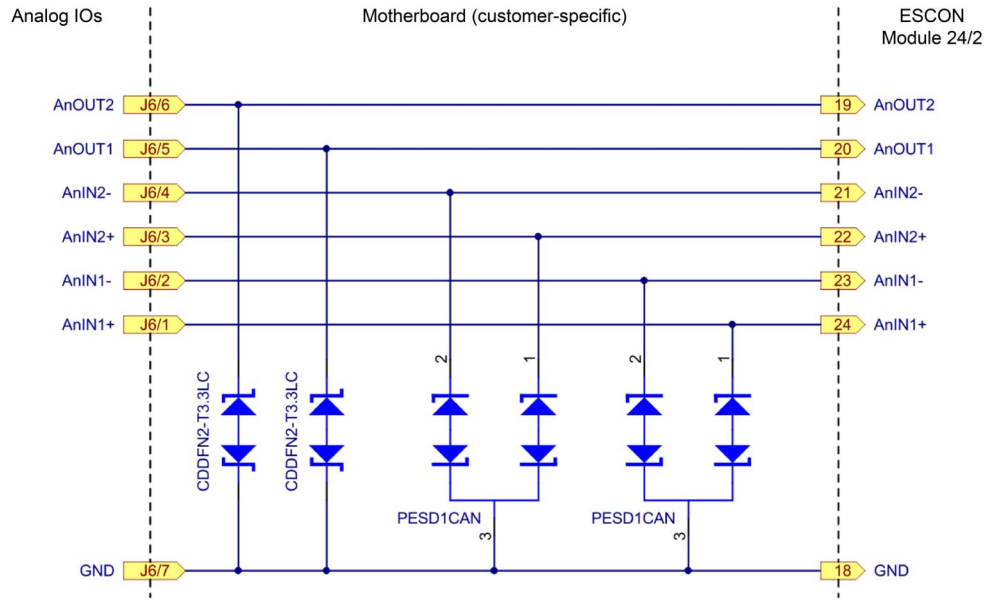

Figure 5-25 Analog Inputs and Outputs – Protective Circuitry

5.1.5 Motor Cables/Motor Chokes

The ESCON Module 24/2 is not equipped with internal motor chokes.
The majority of motors and applications do not require additional chokes. However, in the case of high supply voltage with very low terminal inductance, the ripple of the motor current can reach an unacceptably high value. This causes the motor to heat up unnecessarily and causes instable control behavior. The minimum terminal inductance required per phase can be calculated using the following formula:

$$L_{phase} \geq \frac{1}{2} \cdot \left(\frac{V_{cc}}{6 \cdot f_{PWM} \cdot I_N} - (0.3 \cdot L_{motor}) \right)$$

$L_{phase}[H]$	Additional external inductance per phase
$V_{cc}[V]$	Operating voltage $+V_{CC}$
$f_{PWM}[Hz]$	Switching frequency of the power stage = 53 600 Hz
$I_N[A]$	Nominal current of the motor (➔line 6 in the maxon catalog)
$L_{motor}[H]$	Terminal inductance of the motor (➔line 11 in the maxon catalog)

If the result of the calculation is negative, no additional chokes are necessary. Nevertheless, the use of chokes in combination with additional filter components can be useful to reduce the emission of electromagnetic interference.

An additional choke must feature electromagnetic shielding, a high saturation current, minimal losses, and a nominal current greater than the continuous current of the motor. The below wiring example refers to an additional inductance of 150 µH. If a different additional inductance is required, also the filter components must be adapted accordingly. Should you need further help with the filter design, contact maxon Support at ➔http://support.maxongroup.com.

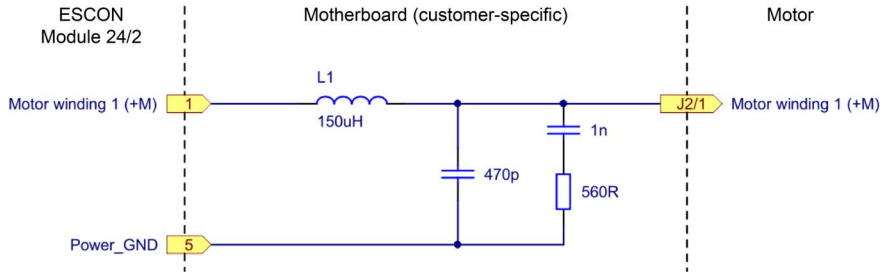

Figure 5-26 Wiring of Motor Winding 1 (analogously valid also for Motor Windings 2 & 3)

5.1.6 Recommended Components and Manufacturers

Recommended components		
Socket Header	Straight socket header, pluggable with 0.64 x 0.64 mm pin headers, 2.54 mm pitch, 3 A, contact material: gold	
	13 poles, 1 rows	Preci-Dip (801-87-013-10-005101) Würth (613 013 118 21) E-tec (BL1-013-S842-55)
	11 poles, 1 row	Preci-Dip (801-87-011-10-005101) Würth (613 011 118 21) E-tec (BL1-011-S842-55)
FU1 Fuse	Littelfuse 157 series, fuse holder incl. SMD NANO2 Fuse 4 A very fast-acting, 3.152 A^2sec (0157004.)	
TVS Diode D1	• Vishay (SMBJ33A) U_R=33 V, U_{BR} = 36.7…40.7 V @ 1 mA, U_C = 53.3 V @ 11.3 A • Diotec (P6SMBJ33A) U_R=33 V, U_{BR} = 36.7…40.7 V @ 1 mA, U_C = 53.3 V @ 11.3 A	
Capacitor C1	• United Chemi-Con (EKZE630E_ _820MJC5S) Rated voltage 63 V, Capacitance 82 µF, Ripple Current 690 mA • Rubycon (63ZLH120M10X12.5) Rated voltage 63 V, Capacitance 120 µF, Ripple Current 725 mA • Nichicon (UPM1J121MHD) Rated voltage 63 V, Capacitance 120 µF, Ripple Current 820 mA	
Motor Cable **Motor Choke**	• Würth Elektronik WE-PD (7447709151) L_N=150 µH, R_{DC}=151 mΩ, I_{DC}=2.1 A, I_{sat}=2.7 A, shielded • Bourns (SRR1210-151M) L_N=150 µH, R_{DC}=190 mΩ, I_{DC}=2.2 A, I_{sat}>1.8 A, shielded • Würth Elektronik WE-PD-XL (7447714470) L_N=47 µH, R_{DC}=83 mΩ, I_{DC}=2.2 A, I_{sat}=2.5 A, shielded	
TVS Diode for Encoder Inputs	• ON NUP4102XV6 • ST ESDA14V2BP6	
TVS Diode for analog Inputs	• NXP PESD1CAN • ON NUP2105	
TVS Diode for analog Outputs	• Bourns CDDFN2-T3.3B	

Table 5-12 Motherboard Design Guide – Recommended Components

5.2 Design Guidelines

The following instructions are intended to serve as an aid for designing an application-specific motherboard and ensuring the correct and reliable integration of the ESCON Module 24/2.

5.2.1 Ground

All ground connections (GND) should be internally connected to the ESCON Module 24/2 (equal potential). It is customary to equip the motherboard with a ground plane. All ground connections should be connected to the voltage supply ground via wide conductive tracks.

Pin	Signal	Description
5	Power_GND GND	Ground of operating voltage Ground
18	GND	Ground

Table 5-13 Motherboard Design Guide – Grounding

If an earth potential is in place or required, the ground plane should be connected to the earth potential via one or more capacitors. The use of ceramic capacitors with 100 nF and 100 V is recommended.

5.2.2 Layout

Guidelines for the layout of the motherboard:

- Connector pin [4] $+V_{CC}$ operating voltage:
  The pins should be connected to the fuse via wide conductive tracks.
- Connector pins [5] and [18] ground:
  All pins should be connected with the ground of the operating voltage via wide conductive tracks.
- The width of the conductive track and the copper coating thickness of the conductors for supply voltage and motor depend on the current required for the application. A minimum width of 75 mil is recommended for the track and a minimum thickness of 35 µm for the copper coating.

5.3 THT Footprint

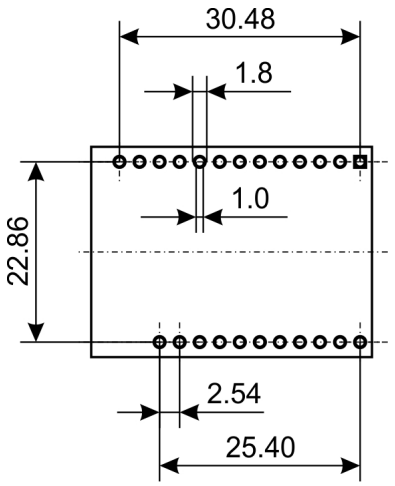

Figure 5-27 THT Footprint [mm] – View from above

5.4 Pin Assignment

For detailed specifications ➔chapter “3.3 Connections” on page 3-15.

5.5 Technical Data

For detailed specifications ➔chapter “2 Specifications” on page 2-9.

5.6 Dimensional Drawing

For the dimensional drawing ➔Figure 2-2 on page 2-11.

5.7 ESCON Module 24/2 Motherboard (486400)

The ESCON Module 24/2 Motherboard (subsequently named ESCON Module MoBo) is available as an alternative to developing an own motherboard. All required connections are already in place and designed as screw-type terminals.

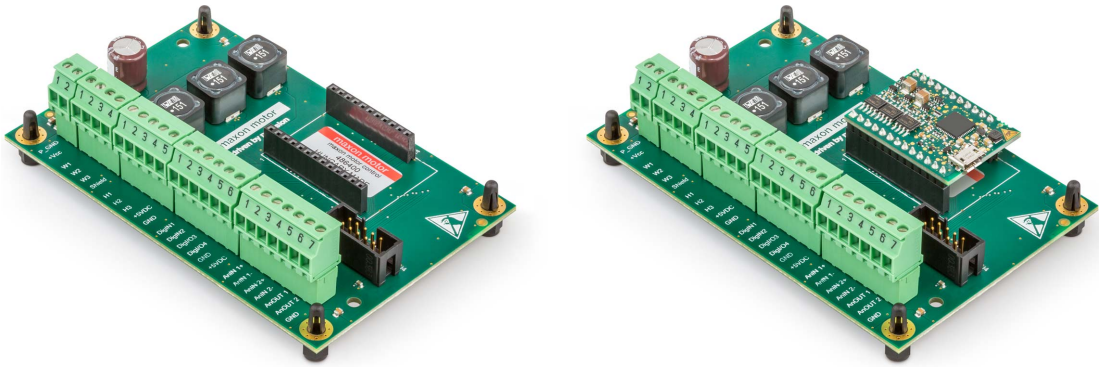

Figure 5-28 ESCON Module MoBo (left), with mounted ESCON Module 24/2 (right)

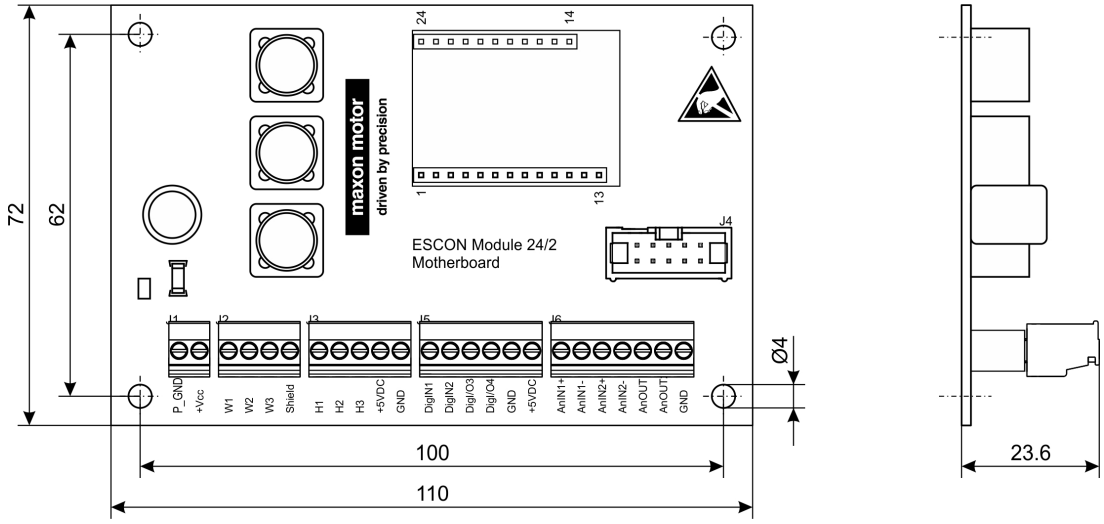

Figure 5-29 ESCON Module MoBo – Dimensional Drawing [mm]

5.7.1 Assembly

The ESCON Module MoBo is designed to easily be screw-mounted or integrated into standard rail systems. For ordering information for the components required ➔Figure 5-30 (only for illustrative purposes) and ➔Table 5-14.

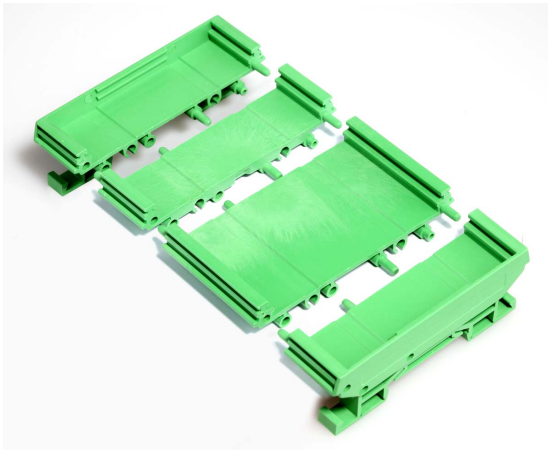

Figure 5-30 ESCON Module MoBo – Mounting on DIN Rail

Specification / Accessories	
Adapter for DIN rail	PHOENIX CONTACT 2 x panel mounting base element 11.25 mm UMK-SE11.25-1 (2970442) 2 x base element 45 mm UMK-BE45 (2970015) 2 x foot element UMK-FE (2970031)
	CamdenBoss 2 x end section with foot 22.5 mm (CIME/M/SEF2250S) 1 x base element 22.5 mm (CIME/M/BE2250SS) 1 x base element 45 mm (CIME/M/BE4500SS)

Table 5-14 ESCON Module MoBo, mounting on DIN Rail – Specification & Accessories

5.7.2 Connections

Note
The USB interface is located directly at the ESCON Module 24/2.

5.7.2.1 Power Supply (J1)

Figure 5-31 ESCON Module MoBo – Power Plug J1

J1 Pin	Signal	Description
1	Power_GND	Ground of operating voltage
2	$+V_{CC}$	Nominal operating voltage (+10…+24 VDC)

Table 5-15 ESCON Module MoBo – Power Plug J1 – Pin Assignment

Specification / Accessories	
Type	Pluggable screw-type terminal block, 2 poles, 3.5 mm pitch
Suitable cables	0.14…1.5 mm^2 multi-core, AWG 28-14 0.14…1.5 mm^2 single wire, AWG 28-14

Table 5-16 ESCON Module MoBo – Power Plug J1 – Specification & Accessories

5.7.2.2 Motor (J2)

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

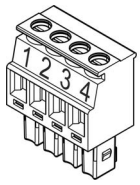

Figure 5-32 ESCON Module MoBo – Motor Plug J2

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 5-17 ESCON Module MoBo – 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 5-18 ESCON Module MoBo – Motor Plug J2 – Pin Assignment for maxon EC motor (brushless)

Specification / Accessories	
Type	Pluggable screw-type terminal block, 4 poles, 3.5 mm pitch
Suitable cables	0.14…1.5 mm² multi-core, AWG 28-14 0.14…1.5 mm² single wire, AWG 28-14

Table 5-19 ESCON Module MoBo – Motor Plug J2 – Specification & Accessories

5.7.2.3 Hall sensor (J3)

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

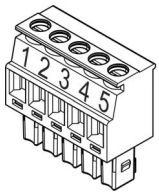

Figure 5-33 ESCON Module MoBo – Hall Sensor Plug J3

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 ≤30 mA)
5	GND	Ground

Table 5-20 ESCON Module MoBo – Hall Sensor Plug J3 – Pin Assignment

Specification / Accessories	
Type	Pluggable screw-type terminal block, 5 poles, 3.5 mm pitch
Suitable cables	0.14…1.5 mm² multi-core, AWG 28-14 0.14…1.5 mm² single wire, AWG 28-14

Table 5-21 ESCON Module MoBo – Hall Sensor Plug J3 – Specification & Accessories

5.7.2.4 Encoder (J4)

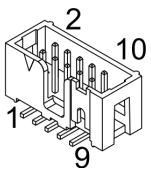

Figure 5-34 ESCON Module MoBo – Encoder Socket J4

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 5-22 ESCON Module MoBo – 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 5-23 ESCON Module MoBo – Encoder Socket J4 – Accessories

Encoder Cable (275934)	
	
Cable cross-section	10 x AWG28, round-jacket, flat cable, 1.27 mm pitch
Length	3 m
Head A	DIN 41651 female, 2.54 mm pitch, 10 pins, with strain relief
Head B	DIN 41651 connector, 2.54 mm pitch, 10 poles, with strain relief

Table 5-24 ESCON Module MoBo – 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 I\).*
- *For best performance, **we strongly recommend using encoders with line driver**. Otherwise, speed limitations may apply due to slow switching edges.*

5.7.2.5 Digital I/Os (J5)

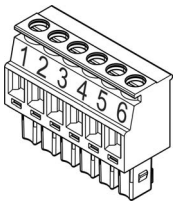

Figure 5-35 ESCON Module MoBo – Digital I/Os Plug J5

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	Ground
6	+5 VDC	Auxiliary output voltage (+5 VDC; ≤10 mA)

Table 5-25 ESCON Module MoBo – Digital I/Os Plug J5 – Pin Assignment

Specification / Accessories	
Type	Pluggable screw-type terminal block, 6 poles, 3.5 mm pitch
Suitable cables	0.14…1.5 mm² multi-core, AWG 28-14 0.14…1.5 mm² single wire, AWG 28-14

Table 5-26 ESCON Module MoBo – Digital I/Os Plug J5 – Specification & Accessories

5.7.2.6 Analog I/Os (J6)

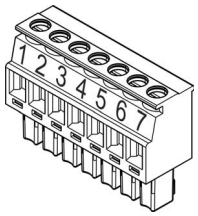

Figure 5-36 ESCON Module MoBo – Analog I/Os Plug J6

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	Ground

Table 5-27 ESCON Module MoBo – Analog I/Os Plug J6 – Pin Assignment

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

Table 5-28 ESCON Module MoBo – Analog I/Os Plug J6 – Specification & Accessories

5.7.3 Wiring

Note
The USB interface is located directly at the ESCON Module 24/2.

Note
The subsequent diagrams feature this symbol:

- ⏚ *Ground safety earth connection (optional)*

5.7.3.1 DC Motors

MAXON DC MOTOR

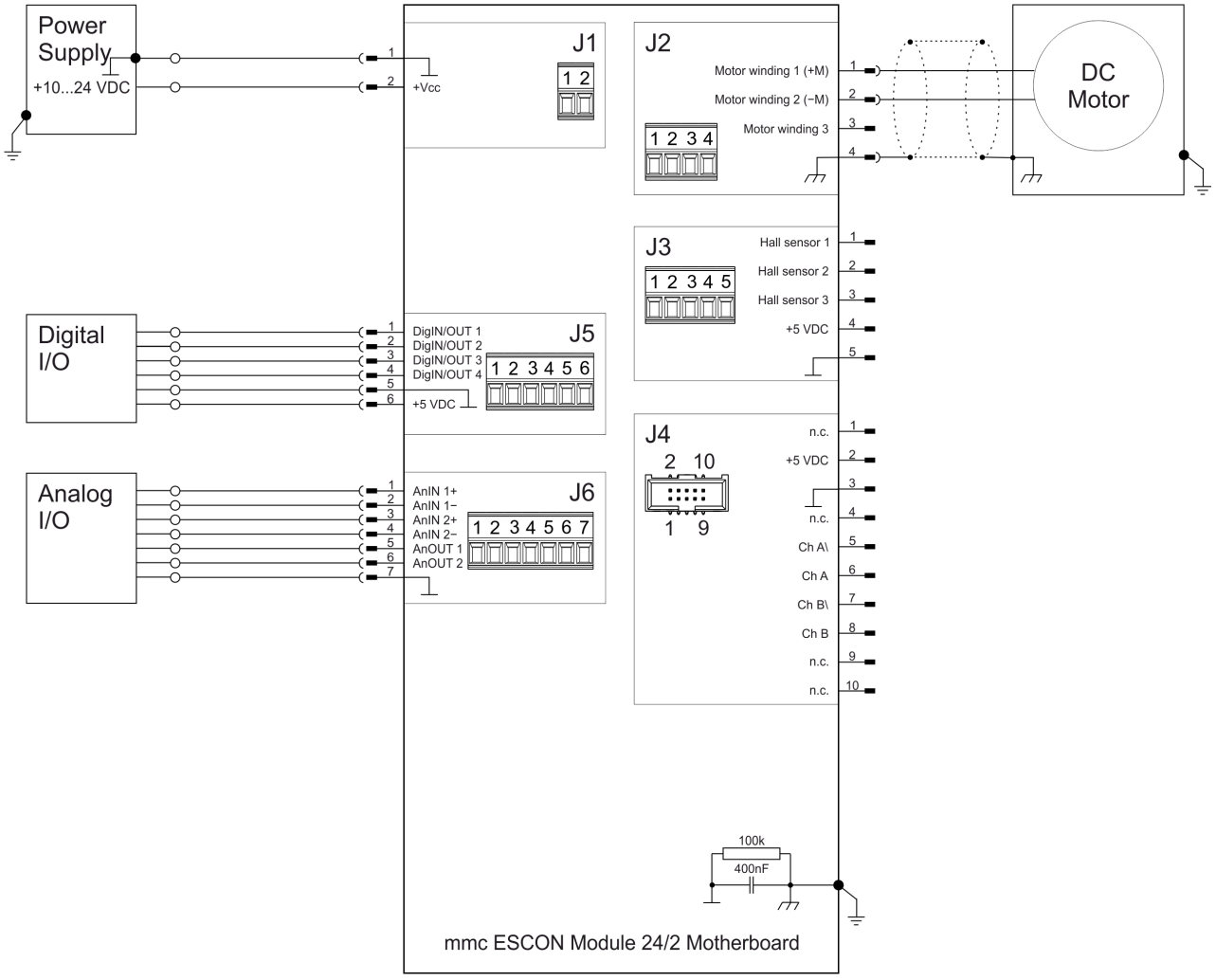

Figure 5-37 ESCON Module MoBo – maxon DC motor (J2)

MAXON DC MOTOR WITH DC TACHO

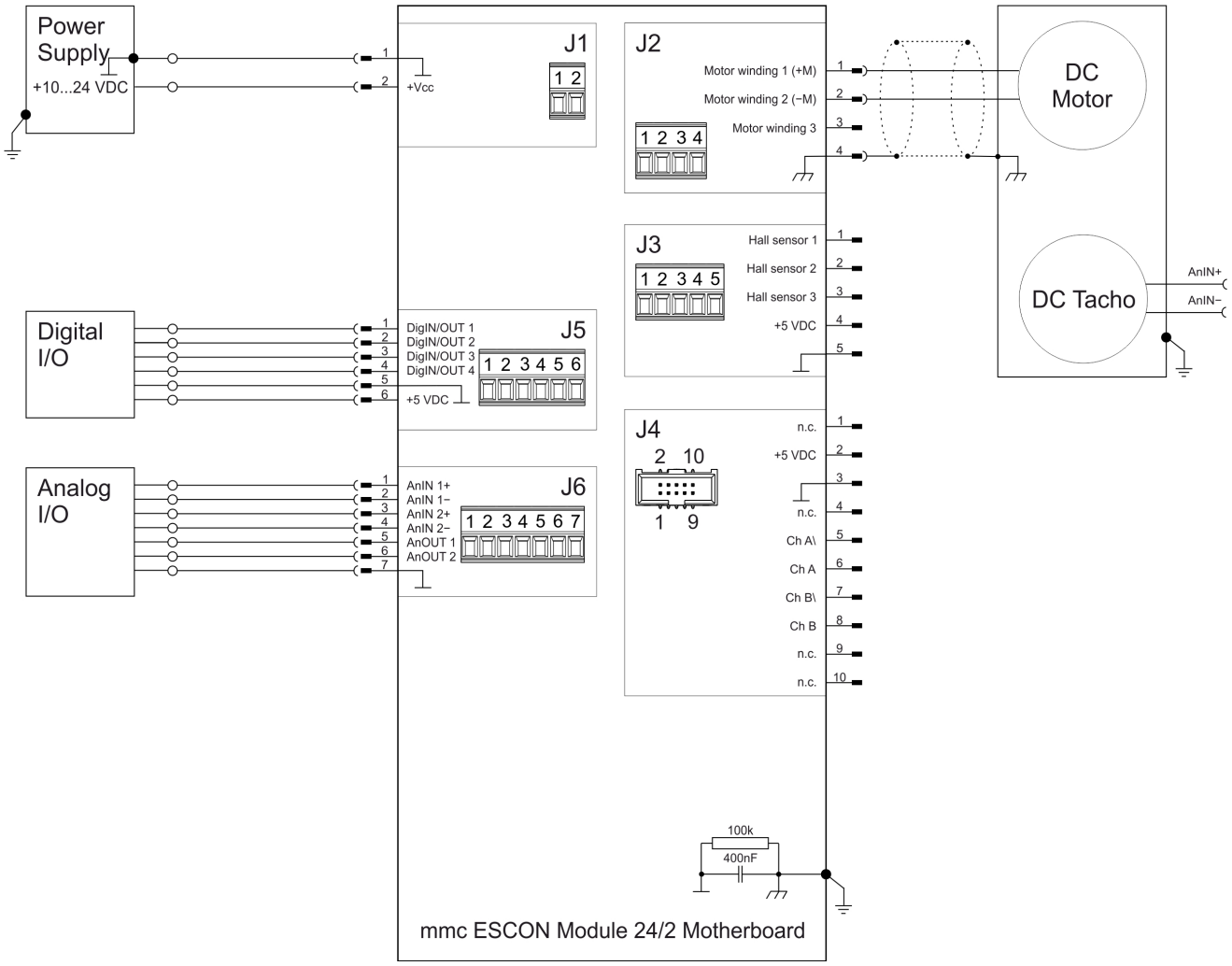

Figure 5-38 ESCON Module MoBo – maxon DC motor with DC Tacho (J2)

MAXON DC MOTOR WITH ENCODER

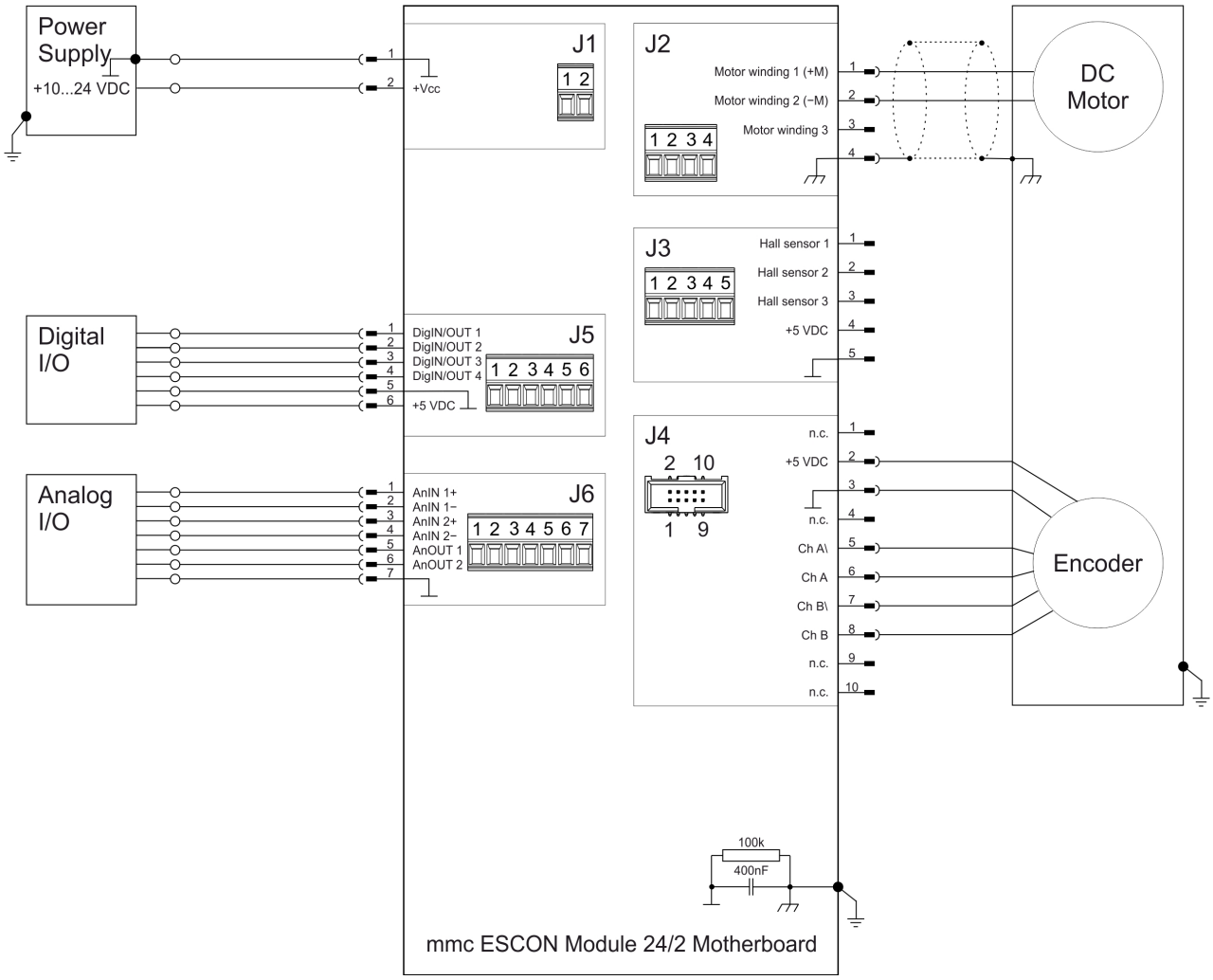

Figure 5-39 ESCON Module MoBo – maxon DC motor with Encoder (J2 / J4)

5.7.3.2 EC motors

MAXON EC MOTOR WITH HALL SENSORS

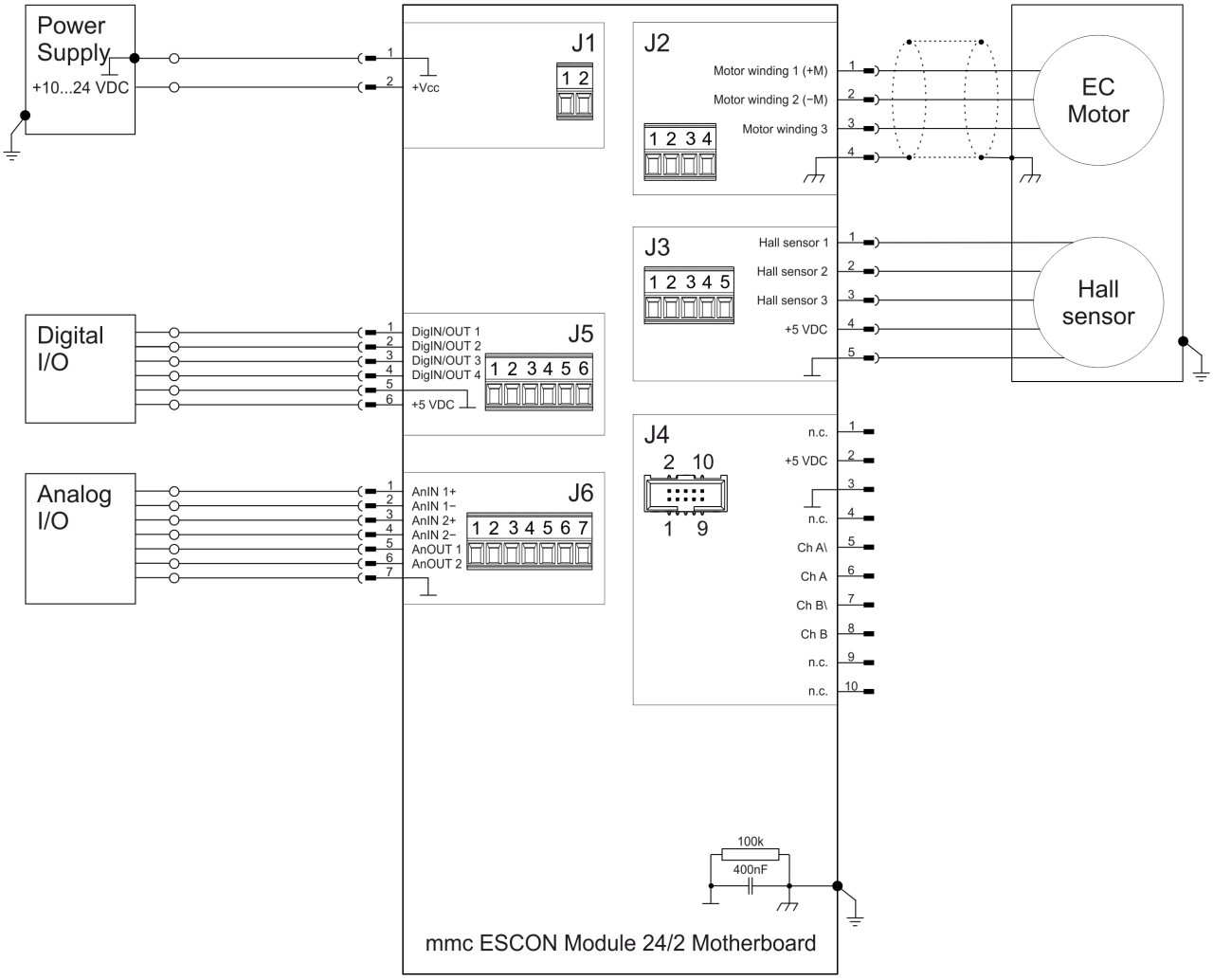

Figure 5-40 ESCON Module MoBo – maxon EC motor with Hall Sensors (J2 / J3)

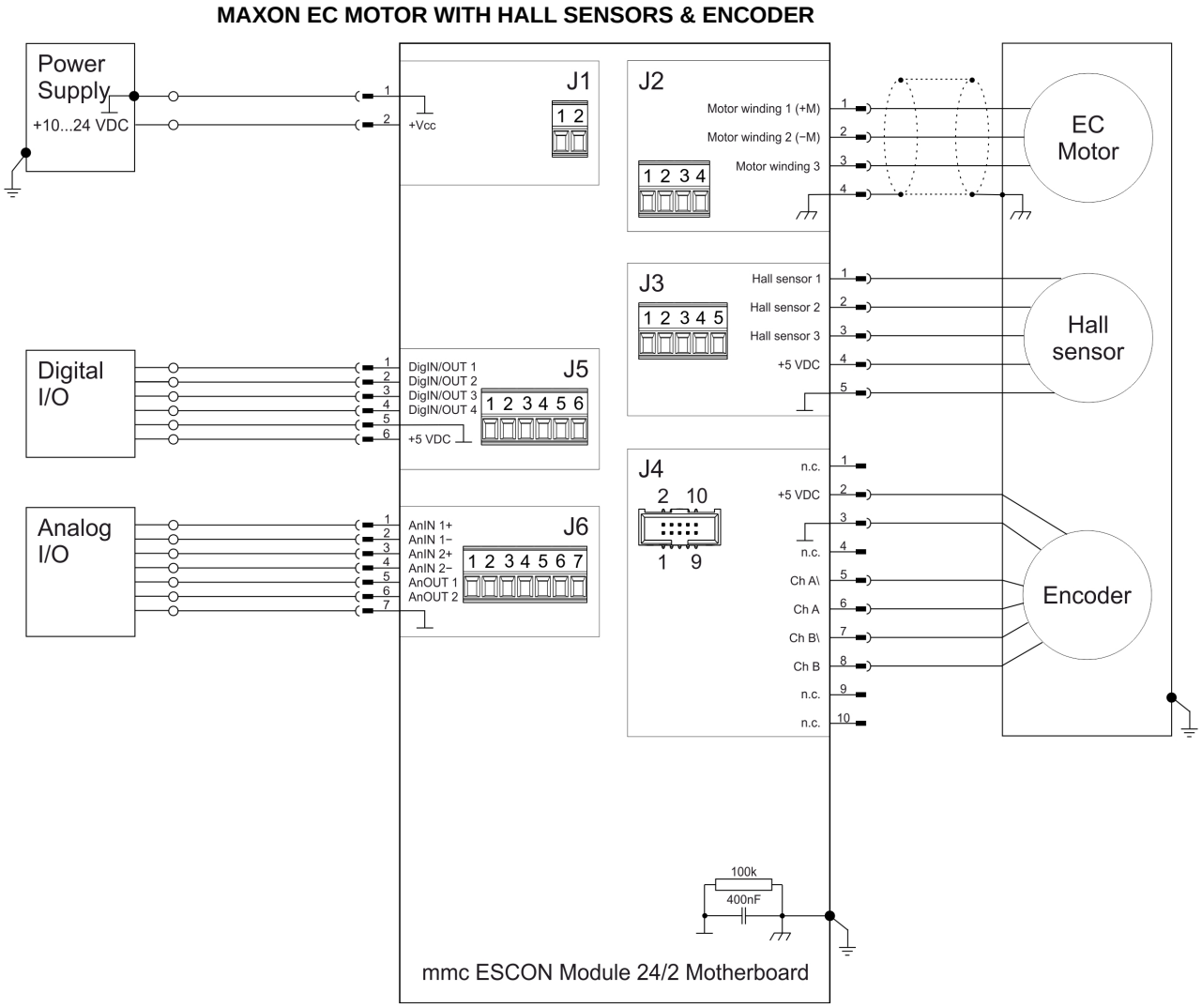

Figure 5-41 ESCON Module MoBo – maxon EC motor with Hall Sensors & Encoders (J2 / J3 / J4)

5.8 Spare Parts

Order number	Description
444144	2-pole pluggable screw-type terminal block, 3.5 mm pitch, labeled 1…2
444145	4-pole pluggable screw-type terminal block, 3.5 mm pitch, labeled 1…4
444146	5-pole pluggable screw-type terminal block, 3.5 mm pitch, labeled 1…5
444147	6-pole pluggable screw-type terminal block, 3.5 mm pitch, labeled 1…6
444148	7-pole pluggable screw-type terminal block, 3.5 mm pitch, labeled 1…7

Table 5-29 Spare Parts List

LIST OF FIGURES

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LIST OF TABLES

INDEX

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CCMC | ESCON Module 24/2 Hardware Reference | Edition 2021-08 | DocID rel9004

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