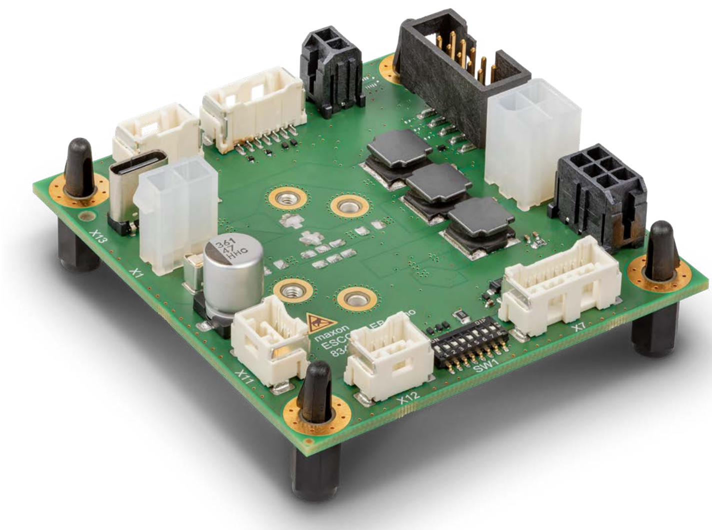
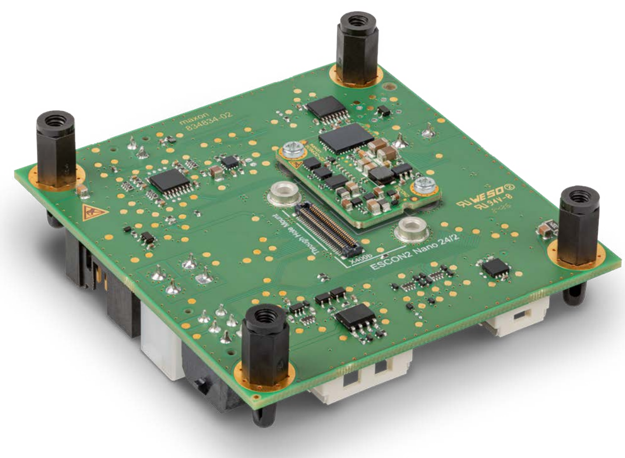
maxon

Evaluation Board

ESCON2 EB Nano with ESCON2 Nano 24/2

Hardware Reference





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ESCON2 EB Nano Evaluation Board with ESCON2 Nano 24/2 | P/N 834838
Hardware Reference
CCMC | Edition 2024-12 | DocID rel12672

TABLE OF CONTENTS

1 ABOUT 5

1.1 About this document . . . 5
1.2 About the devices . . . 7
1.3 About the safety precautions . . . 8

2 SPECIFICATIONS 9

2.1 Technical data . . . 9
2.2 Thermal data . . . 10
2.2.1 Test setup for data collection . . . 10
2.2.4 Thermal accessories . . . 12
2.3 Limitations and protections . . . 14
2.4 Dimensional drawing . . . 14
2.5 Standards . . . 15

3 SETUP 17

3.1 Generally applicable rules . . . 17
3.2 Connections . . . 18
3.2.1 Cabling . . . 18
3.3 Connection specifications . . . 20
3.3.1 Power supply (X1) . . . 20
3.3.2 Motor (X3) . . . 22
3.3.3 Sensor 1 Hall sensor (X4) . . . 23
3.3.4 Sensor 2 Encoder / I/Os (X5) . . . 24
3.3.5 Digital I/Os (X7) . . . 31
3.3.6 Analog I/Os (X8) . . . 35
3.3.7 RS232 (X10) . . . 37
3.3.8 CAN 1 (X11) & CAN 2 (X12) . . . 38
3.3.9 USB (X13) . . . 39
3.3.10 Motor temperature sensor (X16) (future release) . . . 40

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 ESCON2 EB Nano with ESCON2 Nano 24/2** is considered as partly completed machinery according to EU Directive 2006/42/EC, Article 2, Clause (g) and **are 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!*

3.4 DIP switch configuration (SW1) . . . 42
3.4.1 CAN ID (Node-ID) . . . 42
3.4.2 CAN automatic bit rate detection . . . 44
3.4.3 CAN bus termination . . . 44
3.5 Status indicators . . . 44

4 WIRING 47

4.1 Possible combinations to connect a motor . . . 47
4.2 Main wiring diagram . . . 49
4.3 Excerpts . . . 50
4.3.1 Power supply . . . 50
4.3.2 DC motor . . . 50
4.3.3 EC (BLDC) motor . . . 50
4.3.4 Sensor 1 Hall sensor . . . 50
4.3.5 Sensor 2 Encoder / I/Os . . . 51
4.3.6 Digital I/Os . . . 52
4.3.7 Analog I/Os . . . 52
4.3.8 RS232 . . . 53
4.3.9 CAN . . . 53
4.3.10 USB . . . 54
4.3.11 Motor temperature sensor (future release) . . . 54

LIST OF FIGURES 55

LIST OF TABLES 57

INDEX 59

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1 ABOUT

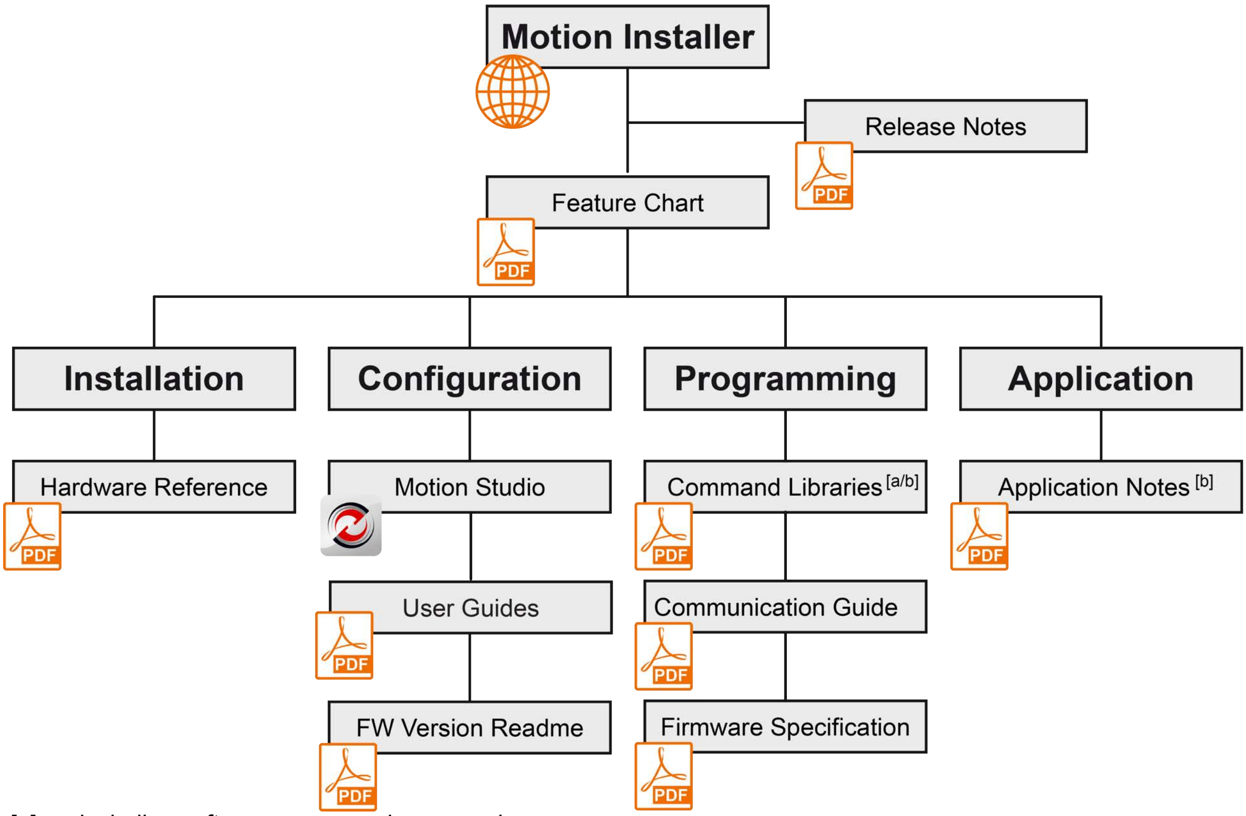
1.1 About this document

1.1.1 Intended purpose

This document familiarizes you with the ESCON2 EB Nano Evaluation Board, with the ESCON2 Nano 24/2 Servo Controller installed on it. It describes the tasks for safe and proper installation and commissioning. Follow the 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.

This document is part of a documentation set. It includes performance data, specifications, standards information, connection details, pin assignments, and wiring examples. The overview below shows the documentation hierarchy and how its parts are related:



[a] including software programming examples
[b] will be available with upcoming release

Figure 1-1 Documentation structure

Find the latest edition of this document, along with additional documentation and software for ESCON2 Servo Controllers, at: http://escon.maxongroup.com

1.1.2 Target audience

This document is intended for trained and skilled personnel. It provides information on how to understand and perform the respective tasks and duties.

1.1.3 How to use

Follow these notations and codes throughout the document.

Notation	Meaning
ESCON2	stands for «ESCON2 Servo Controller»
«Abcd»	indicating a title or a name (such as of document, product, mode, etc.)
(n)	refers to an item (such as a part number, list items, etc.)
*****	refers to an internal value
➔	denotes “check”, “see”, “see also”, “take note of” or “go to”

Table 1-1 Notations used in this document

1.1.4 Symbols & signs

This document uses the following symbols and signs:

Type	Symbol	Meaning
Safety alert 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 **can result in death or serious injury.**
CAUTION		Indicates a **probable 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!**
Requirement, Note, Remark		Indicates an activity you must perform prior to continuing, or gives information on a particular point that must be observed.
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 and signs

1.1.5 Trademarks and brand names

For easier reading, the registered brand names below are not marked with their trademarks. Understand that these brands are protected by copyright and other intellectual property rights, even if trademarks are not shown later in this document.

Brand Name	Trademark Owner
Adobe® Reader®	© Adobe Systems Incorporated, USA-San Jose, CA
BiSS	© iC-Haus GmbH, DE-Bodenheim
CANopen® CiA®	© CiA CAN in Automation e.V, DE-Nuremberg
Windows®	© Microsoft Corporation, USA-Redmond, WA

Table 1-3 Brand names and trademark owners

1.1.6 Copyright

CCMC | ESCON2 EB Nano with ESCON2 Nano 24/2 Hardware Reference | Edition 2024-12 | DocID rel12672

1.2 About the devices

The ESCON2 EB Nano Evaluation Board is for commissioning and evaluating the ESCON2 Nano 24/2 Servo Controller. It has industrial connectors compatible with maxon prefab cables.

The ESCON2 Nano 24/2 (P/N 809635) is a small, powerful 4-quadrant PWM Servo Controller. Its high power density allows flexible use for brushed DC motors and brushless EC (BLDC) motors up to 48 Watts. It supports various feedback options, such as Hall sensors, incremental encoders, and absolute sensors for many drive applications.

The device is designed to be controlled by analog and digital set values, or as a slave node in a CANopen network. You can also operate it via any USB or RS232 communication port of a Windows workstation. It has extensive analog and digital I/O functions.

It uses the latest technology, such as field-oriented control (FOC) and acceleration/velocity feed forward, with high control cycle rates for easy and advanced motion control.

1.3 About the safety precautions

- Read and understand the note ➔«READ THIS FIRST»!
- Do not start any work unless you have the required skills ➔Chapter “1.1.2 Target audience” on page 1-5!
- Refer to ➔Chapter “1.1.4 Symbols & signs” on page 1-6 to understand the subsequently used indicators!
- Follow all applicable health, safety, accident prevention, and environmental protection regulations for your country and work site.

DANGER

High voltage and/or electrical shock
Touching live wires can cause death or serious injuries.

- *Treat all power cables as live unless proven otherwise.*
- *Ensure neither end of the cable is connected to live power.*
- *Ensure the power source cannot be turned on while you work.*
- *Follow lock-out/tag-out procedures.*

Requirements

- *Install all devices and components according to local regulations.*
- *Electronic devices are not fail-safe. Ensure any machine has independent monitoring and safety equipment. If the machine breaks down, is operated incorrectly, or if the control unit or cables fail, etc. the drive system must return to and stay in a safe mode.*
- *Do not repair any components supplied by maxon.*

Electrostatic sensitive device (ESD)

- *Observe precautions for handling Electrostatic sensitive devices.*
- *Handle the device with care.*

2 SPECIFICATIONS

2.1 Technical data

ESCON2 EB Nano (P/N 834838) with ESCON2 Nano 24/2 (P/N 809635)		
Electrical data	Nominal power supply voltage V_{CC}	5…24 VDC 6...24 VDC (with use of sensor supply voltage output)
	Nominal logic supply voltage V_C	—
	Absolute supply voltage V_{min} / V_{max}	4.75 VDC / 28 VDC 5.8 VDC / 28 VDC (with use of sensor supply voltage output)
	Output voltage (max.)	0.90 × V_{CC}
	Output current I_{cont} / I_{max} (< 6.5 s)	2 A / 6 A
	Pulse Width Modulation (PWM) frequency	50 kHz
	Sampling rate PI current controller	50 kHz
	Sampling rate PI speed controller	10 kHz
	Sampling rate analog input	50 kHz
	Max. efficiency	92 % →Figure 2-5
	Max. speed DC motor	limited by max. permissible motor speed and max. output voltage (controller)
	Max. speed EC motor (FOC)	120'000 rpm (1 pole pair)
	Built-in motor choke per phase	33 uH / 2.3 A
Inputs & outputs	Sensor 1 Digital Hall sensor H1, H2, H3	0...24 VDC (internal pull-up)
	Sensor 2 (choice between multiple functions): • Digital incremental encoder • SSI absolute encoder [a] • BISS C unidirectional absolute encoder [a] • High-speed digital inputs 1…2 • High-speed digital inputs 3…4 • High-speed digital output 1	 2-channel, EIA/RS422, max. 6.67 MHz 0.1...2 MHz (single-ended, configurable) 0.1...4 MHz (single-ended, configurable) EIA/RS422, max. 6.67 MHz Logic: 0...12 VDC, max. 6.25 MHz 3.3 VDC / I_L ≤ 24 mA / R_i = 75 Ω
	Digital Inputs 1...4	Logic: 0…25 VDC, inputs 1…2 PWM capable
	Digital Outputs 1...2	max. 36 VDC / I_L ≤ 500 mA (open drain with internal pull-up)
	Analog Inputs 1...2	Resolution 12-bit, 0...5 VDC (referenced to GND), 10 kHz
	Analog Outputs 1...2	Resolution 12-bit, 0...3.3 VDC (referenced to GND), 25 kHz
	Motor temperature sensor [a]	Resolution 12-bit, 0...3.3 VDC (internal pull-up)
Voltage outputs	Sensor supply voltage V_{Sensor}	5 VDC / I_L ≤ 145 mA
	Peripheral supply voltage $V_{Peripheral}$	–
Motor connections	DC motor	+ Motor, − Motor
	EC motor	Motor winding 1, Motor winding 2, Motor winding 3

Continued on next page.

ESCON2 EB Nano (P/N 834838) with ESCON2 Nano 24/2 (P/N 809635)			
Communication interfaces	CAN		Max. 1 Mbit/s
	RS232		Max. 115'200 bit/s
	USB		12 Mbit/s (Full Speed)
Status indicators	Device status		Operation (green) Warning/Error (red)
Mechanical data	Dimensions (L × W × H)		70 × 67 × 24.4 mm
	Weight (approx.)	Evaluation Board	35 g
		with Controller	38 g
	Mounting		mounting holes ø4 mm with mounted spacers
Environmental conditions	Temperature	Operation	−30…+45 °C
		Extended range [b]	45…70 °C Derating: approx. −0.077 A/°C ➔Figure 2-2 with additional heatsink: ➔Figure 2-3
		Storage	−40…+85 °C
	Altitude [c]	Operation	0…500 m MSL
		Extended range [b]	500...10'000 m MSL Derating ➔Figure 2-2
	Humidity		5…90 % (condensation not permitted)

[a] The functionality will be available with a future firmware release.
[b] Operation within the extended range is permitted. However, a respective derating (declination of output current I_{cont}) as to the stated values will apply.
[c] Operating altitude in meters above Mean Sea Level, MSL.

Table 2-4 Technical data

2.2 Thermal data

Mandatory operation within the specified limits

- *Operation within the specified thermal limits is mandatory.*
- *If the ambient temperature exceeds the specified limits, thermal overload can occur even at low output currents.*

2.2.1 Test setup for data collection

Unless stated otherwise, maxon generated the thermal data using the ESCON2 EB Nano (P/N 834838) with the ESCON2 Nano 24/2 (P/N 809635) installed. This configuration simulates mounting on a customer-specific motherboard. The assembly is positioned upright with the connections of the Evaluation Board facing upward and the Nano on the bottom. It was placed on thermally poorly conductive holders, effectively floating in air.

2.2.2 Derating of output current (operation without additional heat sink)

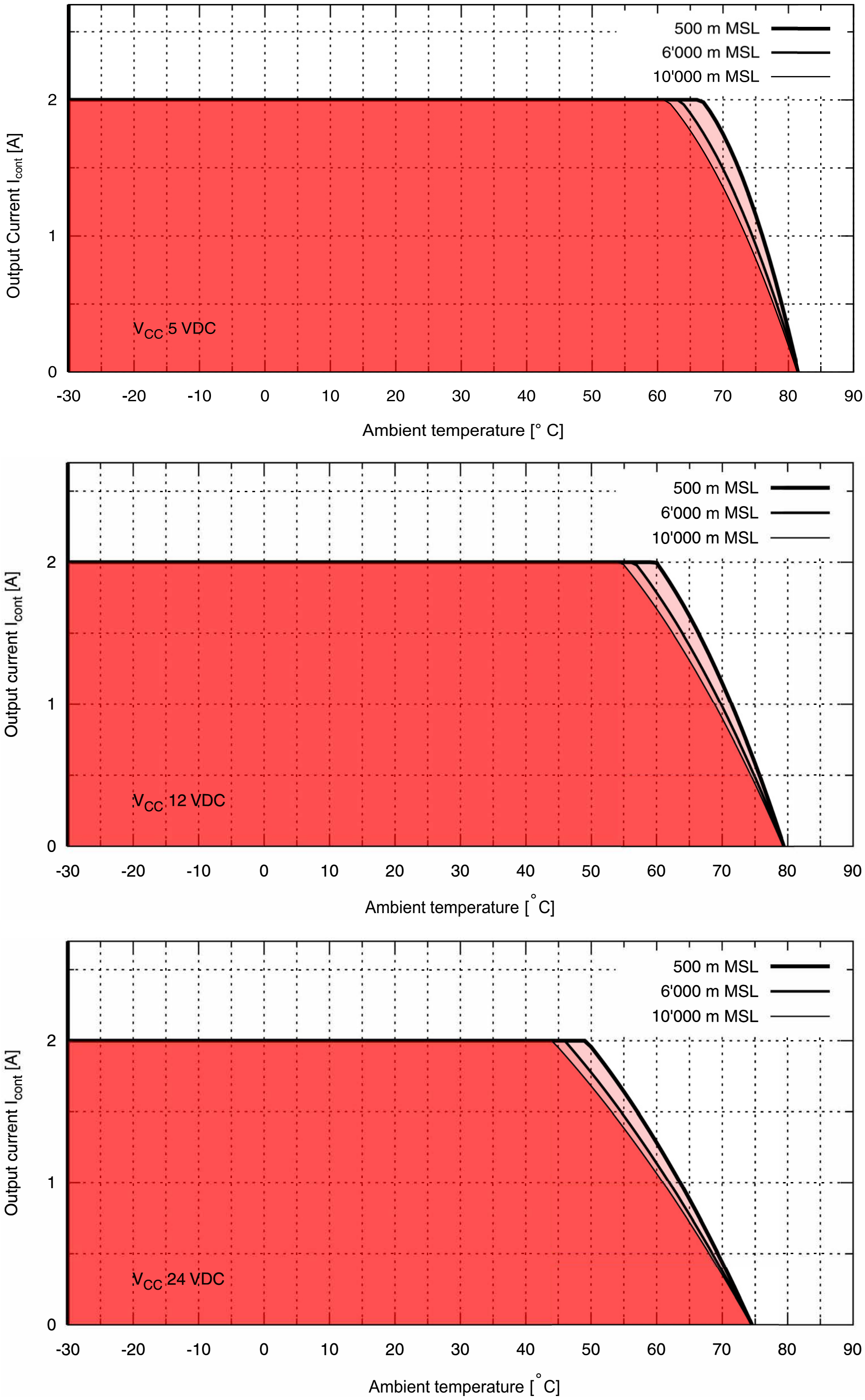


Figure 2-2 Derating of output current (operation without additional heatsink)

2.2.3 Operation with additional heatsink

During data collection in this chapter, the assembly was placed on its side. This position allows heat to flow upward from the additional heatsink, promoting effective passive cooling at the top.

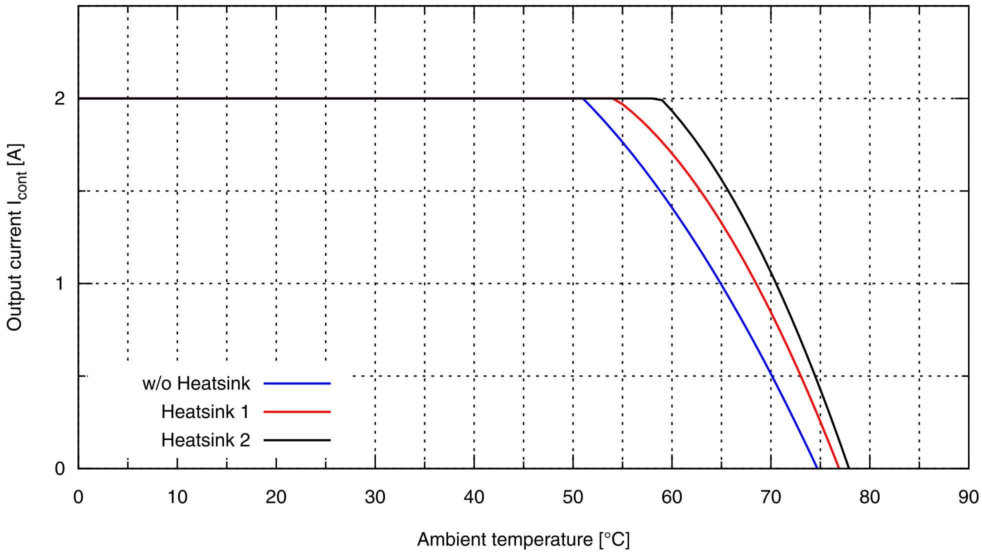


Figure 2-3 Extended operation @ V_{CC} 24 VDC with additional heatsink

Heatsink	Manufacturer	Type	Dimensions [mm]	Thermal resistance R_{th} [K/W]
1	Fischer Elektronik GmbH	SK 631 25 SA	25 × 19 × 6	27.5
2	Fischer Elektronik GmbH	SK 633 25 SA	25 × 19 × 14	18

Table 2-5 Heatsink – tested components

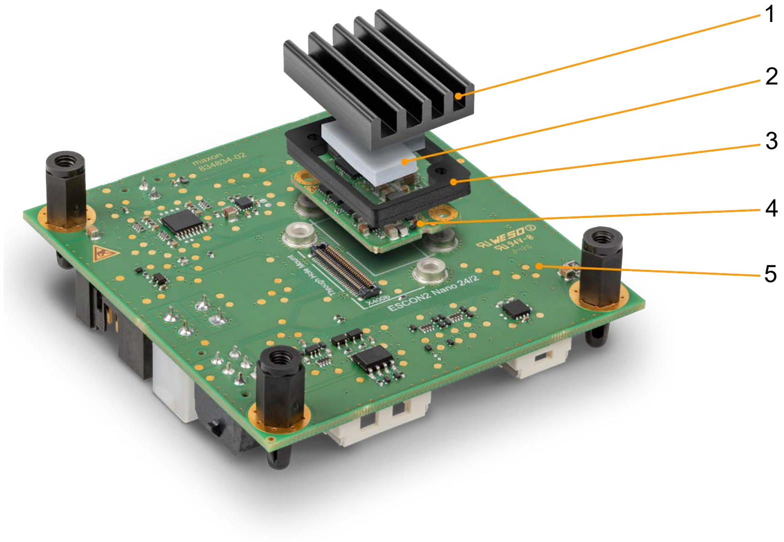
2.2.4 Thermal accessories

maxon offers the ESCON2 Nano 24/2 Thermal Accessory Kit (P/N 876085), consisting of a thermal pad and a mounting frame. Both fit the ESCON2 Nano 24/2 perfectly.

Specifications		
ESCON2 Nano 24/2 Thermal Pad	Dimensions (L × W × H)	20 × 13 × 2.54 mm (with two cutouts at diagonally opposite corners of size 4.5 × 4.5 mm)
	Mounting	n/a (placed between controller and structure)
	Thermal conductivity	2.4 W/(mK)
ESCON2 Nano 24/2 Mounting Frame	Dimensions (L × W × H)	25.6 × 18.6 × 3.7 mm
	Mounting	2 holes ø2.2 mm

Table 2-6 Thermal accessories – specification

CAD files are available on the maxon website as part of the ESCON2 Nano 24/2 Thermal Accessory Kit (P/N 876085).



1	Heatsink [a]	2	Thermal Pad
3	Mounting Frame	4	ESCON2 Nano 24/2
5	ESCON2 EB Nano		

[a] The heatsink is not part of the accessory kit and shown for illustration purposes only.

Figure 2-4 Assembly with thermal accessories

2.2.5 Power dissipation and efficiency

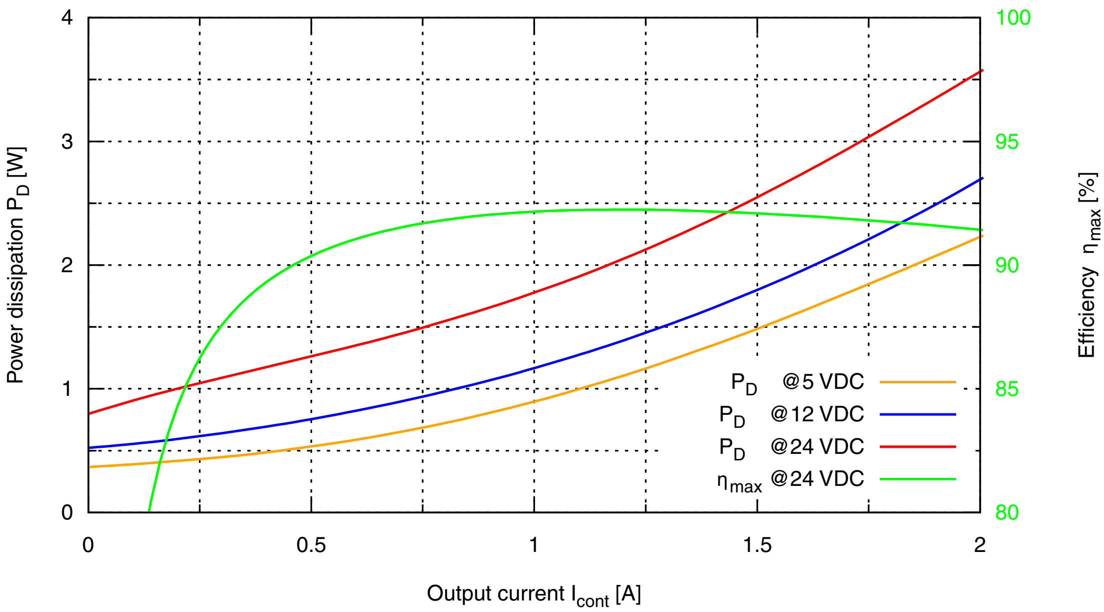


Figure 2-5 Power dissipation and efficiency

2.3 Limitations and protections

Functionality		Switch-off threshold	Recovery threshold
Undervoltage		4.5 VDC	4.55 VDC
Overvoltage		31 VDC	29 VDC
Thermal overload	logic	108 °C	98 °C
	power stage	90 °C	—

Table 2-7 Limitations and protections

The device has a configurable output current limit and an overcurrent protection function. This protects the controller in case of a short circuit in a motor winding or a damaged power stage. The undervoltage, overvoltage, and thermal overload power stage protection limits are also configurable. For more information, see the «ESCON2 Firmware Specification».

2.4 Dimensional drawing

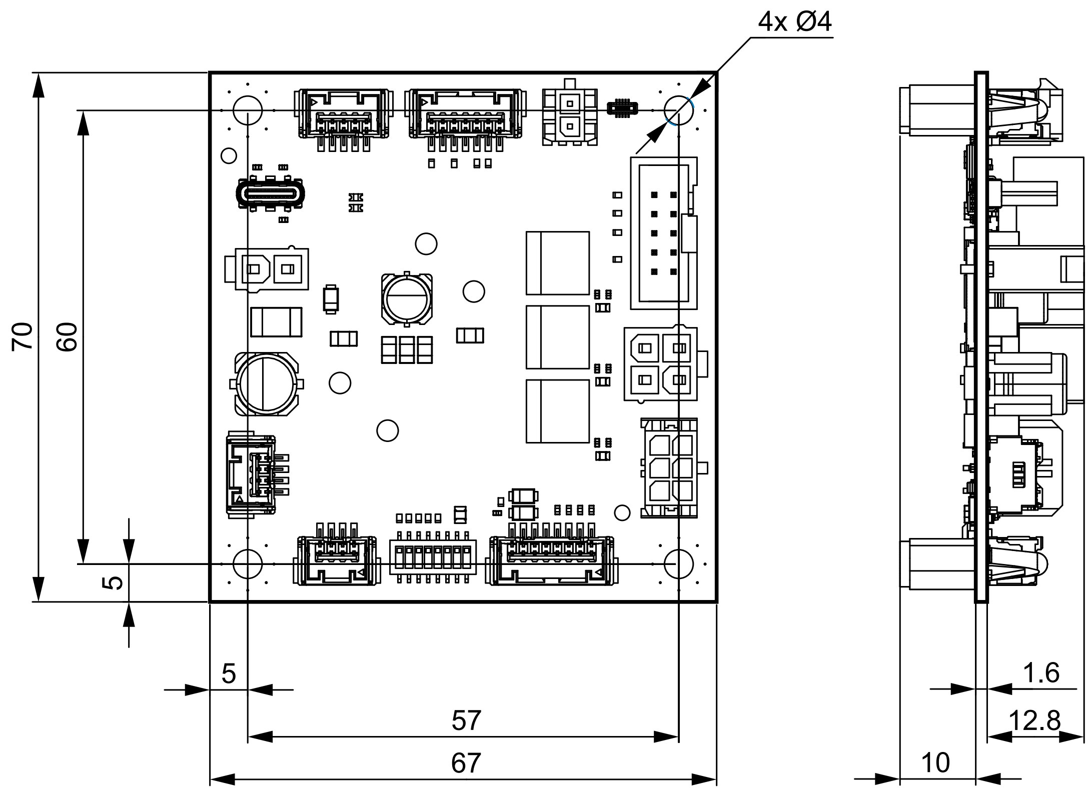


Figure 2-6 Dimensional drawing [mm]

2.5 Standards

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

Important Notice
Compliance of the device with the mentioned standards does not guarantee compliance in the final, ready-to-operate setup. To achieve compliance for your operational system, you must perform EMC testing on the complete equipment as a whole.

Electromagnetic compatibility		
Generic	IEC/EN 61000-6-2	Immunity for industrial environments
	IEC/EN 61000-6-3	Emission standard for residential, commercial and light-industrial environments
Applied	IEC/EN 55022 (CISPR32)	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		
Environment	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	UL File Number	Unassembled printed circuit boards: E207844
Reliability	MIL-HDBK-217F [a]	Only ESCON2 Nano 24/2: 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): 988'899 hours

[a] The reliability calculation is based on MIL-HDBK-217F. Since component manufacturer data is more accurate, it has been used whenever possible.

Table 2-8 Standards

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3 SETUP

IMPORTANT NOTICE: PREREQUISITES FOR INSTALLATION PERMISSION

The **ESCON2 EB Nano Evaluation Board with ESCON2 Nano 24/2** is considered partly completed machinery according to EU Directive 2006/42/EC, Article 2, Clause (g). **It is intended to be incorporated into or assembled with other machinery or partly completed machinery or equipment.**

WARNING

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

- *Do not operate the device unless you are certain 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!*

CAUTION

Burn hazard
Hot surfaces can cause burns.

- *During operation, some parts of the device become very hot. Contact with these parts can burn your skin.*
- *Disconnect the power supply and secure it. Wait for the surface to cool before you do maintenance.*

3.1 Generally applicable rules

Maximum permitted supply voltage

- *Make sure that the supply power is between 5...24 VDC, respectively 6...24 VDC if sensor supply voltage output is used.*
- *Supply voltages above 31 VDC or incorrect polarity will destroy the unit.*
- *The necessary output current depends on the load torque. The output current limits are:*
  – continuous max. 2 A
  – short-time (acceleration) max. 6 A (< 6.5 s)

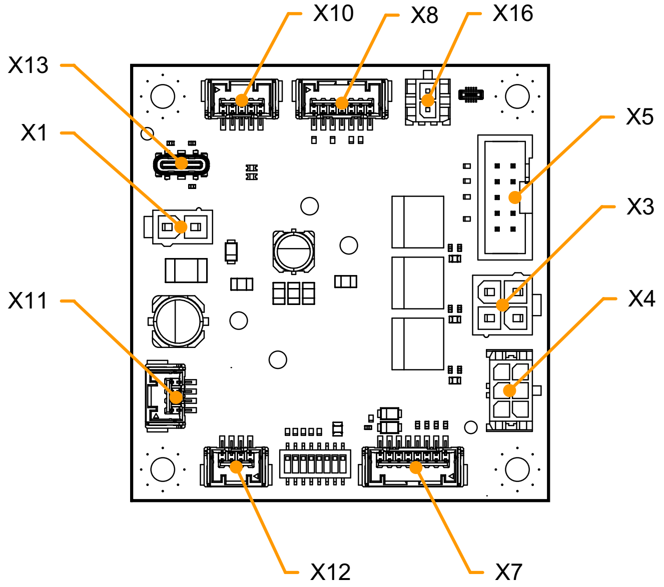
Hot plugging the USB interface may cause hardware damage
If the USB interface is being hot-plugged (connecting while the power supply is on), the possibly high potential differences of the two power supplies of controller and PC/Notebook can lead to damaged hardware.

- *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.*

Best practice
Keep the motor mechanically disconnected during the setup and adjustment phase.

3.2 Connections

For in-depth details on connections ➔Chapter “3.3 Connection specifications” on page 3-20.



X1	Power supply ➔page 3-20
X3	Motor ➔page 3-22
X4	Sensor 1 Hall sensor ➔page 3-23
X5	Sensor 2 ➔page 3-24
X7	Digital I/Os ➔page 3-31
X8	Analog I/Os ➔page 3-35
X10	RS232 ➔page 3-37
X11	CAN 1 ➔page 3-38
X12	CAN 2 ➔page 3-38
X13	USB ➔page 3-39
X16	Motor temperature sensor ➔page 3-40

Figure 3-7 Connections

3.2.1 Cabling

PLUG&PLAY

Take advantage of maxon’s prefab cable assemblies. They come as ready-to-use parts and will help to reduce commissioning time to a minimum.

a) Check the following table and find the part number of the cable assembly that matches the setup you will be using.

b) Follow the cross-reference to get the cable’s pin assignment.

Prefab cable assembly			
Connector	Designation	Part Number	➔Page
X1	Power cable	275829	3-19
X3	Motor cable	275851	3-22
X4	Hall sensor cable	275878	3-23
X5	Encoder cable	275934	3-29
X7	Signal cable 8core	520853	3-32
X8	Signal cable 7core	520854	3-35
X10	RS232-COM cable	520856	3-37
X11	CAN-CAN cable CAN-COM cable	520858 520857	3-38 3-39
X12	CAN-CAN cable CAN-COM cable	520858 520857	3-38 3-39
X13	USB Type C – Type C cable USB Type A – Type C cable	845854 838461	3-40 3-40
X16	NTC cable	847301	3-41

Table 3-9 Prefab maxon cables

MAKE&BAKE YOUR OWN

If you decide not to employ maxon's prefab cable assemblies, you might wish to use the prepackaged kit that contains all connectors required to make up your own cabling.

Motion connector set (P/N 846644)		
Connector	Specification	Quantity
Connectors		
X1	Molex Mini-Fit Jr., 2 poles (39012020)	2
X3	Molex Mini-Fit Jr., 4 poles (39012040)	1
X4	Molex Micro-Fit 3.0, 6 poles (430250600)	1
X7	Molex CLIK-Mate, 8 poles (5025780800)	1
X8	Molex CLIK-Mate, 7 poles (5025780700)	1
X10	Molex CLIK-Mate, 5 poles (5025780500)	1
X11 / X12	Molex CLIK-Mate, 4 poles (5025780400)	2
X16	Molex Micro-Fit 3.0, 2 poles (430250200)	1
Crimp Terminals		
X1 / X3	Molex Mini-Fit Plus, AWG16 (457503112 / 457503111)	8
X4 / X16	Molex Micro-Fit 3.0, AWG26-30 (430300010 / 430300004)	8
X7 / X8 / X10 / X11 / X12	Molex CLIK-Mate, AWG24-28 (5025790100 / 5025790000)	30

Table 3-10 Motion connector set – Content

TOOLS

Tool	Manufacturer	Part Number
Hand crimper for Mini-Fit Jr. crimp terminals	Molex	2002182200
Hand crimper for Micro-Fit 3.0 crimp terminals	Molex	0638190000
Hand crimper for CLIK-Mate crimp terminals	Molex	2002187400

Table 3-11 Recommended tools

3.3 Connection specifications

The actual connection depends on your drive system configuration and the type of motor you are using. Follow the description in the given order and choose the wiring diagram (➔see page 4-49) that best suits your components.

How to read pin assignment tables
In the subsequent sections of the document, you will come across tables outlining the pin assignments. These tables provide information about the hardware connectors, their corresponding wired signals, the assigned pins, and details regarding the prefab cables that are available.

- *The initial column provides the pin numbers for the connectors.*
- *The second column specifies the pin numbers for the corresponding end (Head A) of the prefab cable.*
- *The third column describes the core color of the prefab cable.*
- *The fourth column indicates the pin numbers for the other end (Head B) of the prefab cable.*

3.3.1 Power supply (X1)

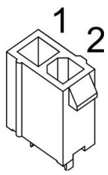


Figure 3-8 Power supply connector X1

X1	Prefab cable			Signal	Description
Pin	Head A Pin	Cable color	Head B Pin		
1	1	black	–	GND	Ground
2	2	black	+	V_{CC}	Power supply voltage input (5...24 VDC / 6...24 VDC with use of V_{Sensor})

Table 3-12 Power supply connector X1 – Pin assignment

Power cable (P/N 275829)		
		
Cross-section	2 × 0.75 mm^2, grey	
Length	3 m	
Head A	Plug	Molex Mini-Fit Jr., 2 poles (39012020)
	Contacts	Molex Mini-Fit Jr. female crimp terminals (457501112)
Head B	Wire end sleeves 0.75 mm^2	

Table 3-13 Power cable

Power supply requirements	
Nominal output voltage V_{CC}	5…24 VDC 6...24 VDC (with use of sensor supply voltage output)
Absolute output voltage V_{CC}	min. 4.75 VDC / max. 28 VDC min. 5.8 VDC / max. 28 VDC (with use of sensor supply voltage output)
Output current	Depending on load • continuous max. 2 A • short-time (acceleration) max. 6 A (< 6.5 s)

Table 3-14 Power supply requirements

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 over current protection circuit is configured inoperative within the operating range.

The formula already takes the following into account:
- *Maximum PWM duty cycle of 90 %*
- *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_O [rpm]
- Speed/torque gradient of the motor $\Delta n/\Delta M$ [rpm/mNm]

SOUGHT VALUE:
- Supply voltage V_{CC} [Volt]

SOLUTION:

$$V_{CC} \geq \left[\frac{U_N}{n_O} \cdot \left(n + \frac{\Delta n}{\Delta M} \cdot M\right) \cdot \frac{1}{0.90}\right] + 1[V]$$

3.3.2 Motor (X3)

The controller is set to drive either maxon EC motor (BLDC, brushless DC motor) or maxon DC motor (brushed DC motor) with separated motor/encoder cable.

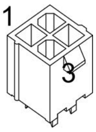


Figure 3-9 Motor connector X3

Best practice
Keep the motor mechanically disconnected during the setup and adjustment phase.

X3 Pin	Prefab cable Head A Pin	Prefab cable Cable color	Prefab cable Head B Pin	Signal	Description
1	1	black		Motor winding 1	EC motor: Winding 1
				Motor (+M)	DC motor: Motor +
2	2	black		Motor winding 2	EC motor: Winding 2
				Motor (−M)	DC motor: Motor −
3	3	black		Motor winding 3	EC motor: Winding 3
				–	DC motor: DO NOT CONNECT
4	4	black		Motor shield	Cable shield

Table 3-15 Motor connector X3 – Pin assignment for maxon EC & DC motor

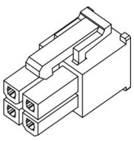
Motor cable (P/N 275851)		
A 		B
Cross-section	3 × 0.75 mm², shielded, grey	
Length	3 m	
Head A	Plug	Molex Mini-Fit Jr., 4 poles (39012040)
	Contacts	Molex Mini-Fit Jr. female crimp terminals (45750)
Head B	Wire end sleeves 0.75 mm²	

Table 3-16 Motor cable

3.3.3 Sensor 1 Hall sensor (X4)

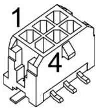


Figure 3-10 Sensor 1 Hall sensor connector X4

X4 Pin	Prefab cable Head A Pin	Prefab cable Cable color	Prefab cable Head B Pin	Signal	Description
1	1	green		Hall sensor 1	Hall sensor 1 input
2	2	brown		Hall sensor 2	Hall sensor 2 input
3	3	white		Hall sensor 3	Hall sensor 3 input
4	4	yellow		GND	Ground
5	5	grey		V_{Sensor}	Sensor supply voltage output (5 VDC / $I_L \leq$ 145 mA)
6	6	black		Hall shield	Cable schield

Table 3-17 Hall sensor connector X4 – Pin assignment

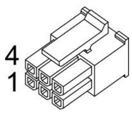
Hall sensor cable (P/N 275878)		
A 		B
Cross-section	5 × 0.14 mm^2, shielded, grey	
Length	3 m	
Head A	Plug	Molex Micro-Fit 3.0, 6 poles (430250600)
	Contacts	Molex Micro-Fit 3.0 female crimp terminals (430300010)
Head B	Wire end sleeves 0.14 mm^2	

Table 3-18 Hall sensor cable

Important Notice

The maximum supply current of the sensor supply voltage output V_{Sensor} is in total 145 mA. It can be used for:

- *Hall sensors ➔Chapter "3.3.3 Sensor 1 Hall sensor (X4)" on page 3-23*
- *Incremental encoders ➔Chapter "3.3.4.1 Incremental encoder" on page 3-26*
- *SSI / BiSS C encoders ➔Chapter "3.3.4.2 SSI / BiSS C unidirectional absolute encoder (future release)" on page 3-27*
- *High-speed digital I/Os ➔Chapter "3.3.5 Digital I/Os (X7)" on page 3-31*
- *Digital I/Os ➔Chapter "3.3.5 Digital I/Os (X7)" on page 3-31*
- *Other peripherals which need a 5 VDC supply.*

All currents resulting from parts connected to the sensor supply voltage output V_{Sensor} must not exceed 145 mA in total.

Hall sensor	
Sensor supply voltage output V_{Sensor}	5 VDC
Max. sensor supply current	145 mA (➔refer to Important Notice)
Input voltage	0…24 VDC
Max. input voltage	24 VDC
Low-level input voltage	< 0.8 VDC
High-level input voltage	> 2.0 VDC
Internal pull-up resistor	2.7 kΩ (referenced to 5 VDC - 0.6 VDC)

Table 3-19 Sensor 1 Hall sensor specification

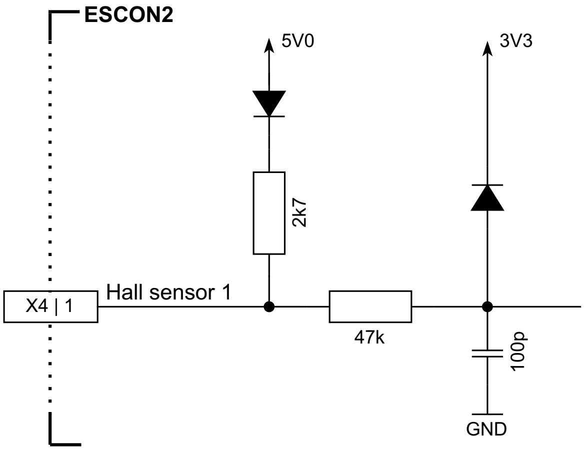


Figure 3-11 Sensor 1 Hall sensor input circuit (analogously valid for Hall sensors 2 & 3)

3.3.4 Sensor 2 Encoder / I/Os (X5)

Additional sensors, both incremental and serial encoders, or digital inputs and outputs can be connected. Only one sensor/function can be used at a time, i.e. either an incremental encoder, or an absolute encoder, or high-speed digital I/Os.

Best practice
For best performance and good resistance against electrical interference, ***we recommend using encoders with a line driver (differential scheme).*** *Otherwise, limitations may apply due to slow switching edges. Nevertheless, the controller supports both schemes – differential and single-ended (unsymmetrical).*

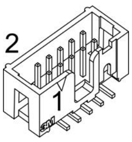
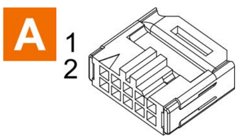


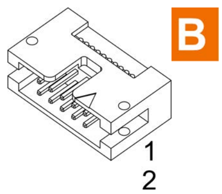
Figure 3-12 Sensor 2 connector X5

X5 Pin	Prefab cable Head A Pin	Prefab cable Cable color	Prefab cable Head B Pin	Signal	Description
1	1	brown	1	Data	Data (SSI, BiSS C)
				HsDigIN4	High-speed digital input 4
2	2	white	2	V_{Sensor}	Sensor supply voltage output (5 VDC / $I_L \leq$ 145 mA)
3	3	red	3	GND	Ground
4	4	white	4	Clock	Clock (SSI, BiSS C)
				HsDigOUT1	High-speed digital output 1
5	5	orange	5	Channel A\	Digital incremental encoder channel A complement
				HsDigIN1\	High-speed digital input 1 complement
6	6	white	6	Channel A	Digital incremental encoder channel A
				HsDigIN1	High-speed digital input 1
7	7	yellow	7	Channel B\	Digital incremental encoder channel B complement
				HsDigIN2\	High-speed digital input 2 complement
8	8	white	8	Channel B	Digital incremental encoder channel B
				HsDigIN2	High-speed digital input 2
9	9	green	9	–	not connected
10	10	white	10	HsDigIN3	High-speed digital input 3

Table 3-20 Sensor 2 connector X5 – Pin assignment

Encoder cable (P/N 275934)





Cross-section	10 × AWG28, round-jacket, flat cable, pitch 1.27 mm
Length	3 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 3-21 Encoder cable

Important Notice

The maximum supply current of the sensor supply voltage output V_{Sensor} is in total 145 mA. It can be used for:

- *Hall sensors ➔Chapter "3.3.3 Sensor 1 Hall sensor (X4)" on page 3-23*
- *Incremental encoders ➔Chapter "3.3.4.1 Incremental encoder" on page 3-26*
- *SSI / BiSS C encoders ➔Chapter "3.3.4.2 SSI / BiSS C unidirectional absolute encoder (future release)" on page 3-27*
- *High-speed digital I/Os ➔Chapter "3.3.5 Digital I/Os (X7)" on page 3-31*
- *Digital I/Os ➔Chapter "3.3.5 Digital I/Os (X7)" on page 3-31*
- *Other peripherals which need a 5 VDC supply.*

All currents resulting from parts connected to the sensor supply voltage output V_{Sensor} must not exceed 145 mA in total.

3.3.4.1 Incremental encoder

Digital incremental encoder (differential)	
Sensor supply voltage output V_{Sensor}	5 VDC
Max. sensor supply current	145 mA (➔refer to Important Notice)
Min. differential input voltage	± 200 mV
Max. input voltage	−9...+13 VDC
Line receiver (internal)	EIA/RS422 standard
Max. input frequency	6.67 MHz

Table 3-22 Differential digital incremental encoder specification

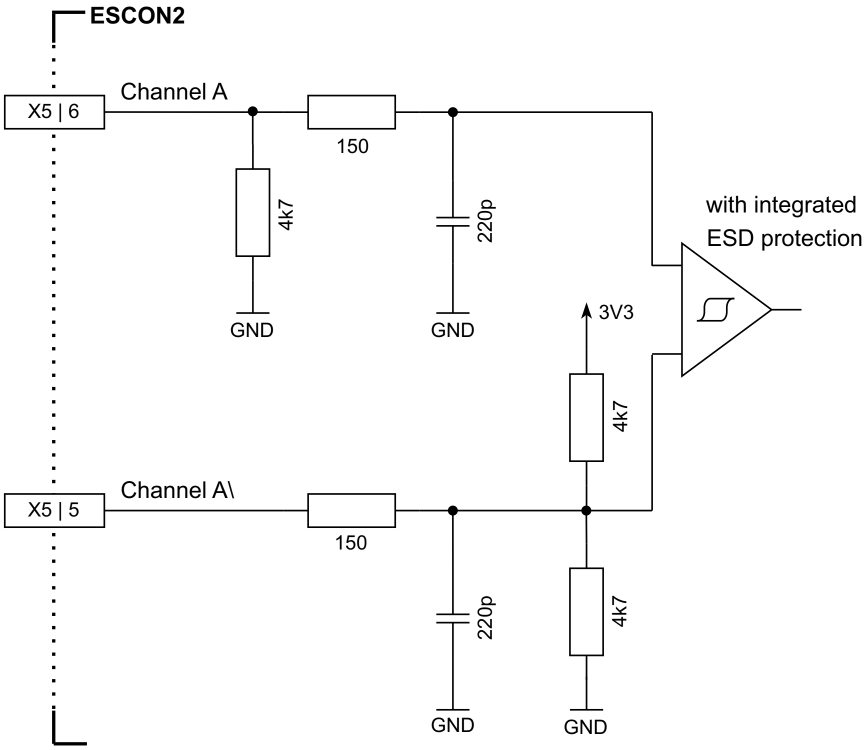


Figure 3-13 Digital incremental encoder input circuit Ch A “differential” (analogously valid for Ch B)

Digital incremental encoder (single-ended)		
Sensor supply voltage output V_{Sensor}		5 VDC
Max. sensor supply current		145 mA (➔refer to Important Notice)
Input voltage		0...5 VDC
Max. input voltage		−9...+13 VDC
Low-level input voltage		< 1 VDC
High-level input voltage		> 2.4 VDC
Input high current		I_{IH} = typically 1.25 mA @ 5 VDC
Input low current		I_{IL} = typically −0.18 mA @ 0 VDC
Max. input frequency	Push-pull	6.25 MHz
	Open collector	100 kHz (additional external 3k3 pull-up)

Table 3-23 Single-ended digital incremental encoder specification

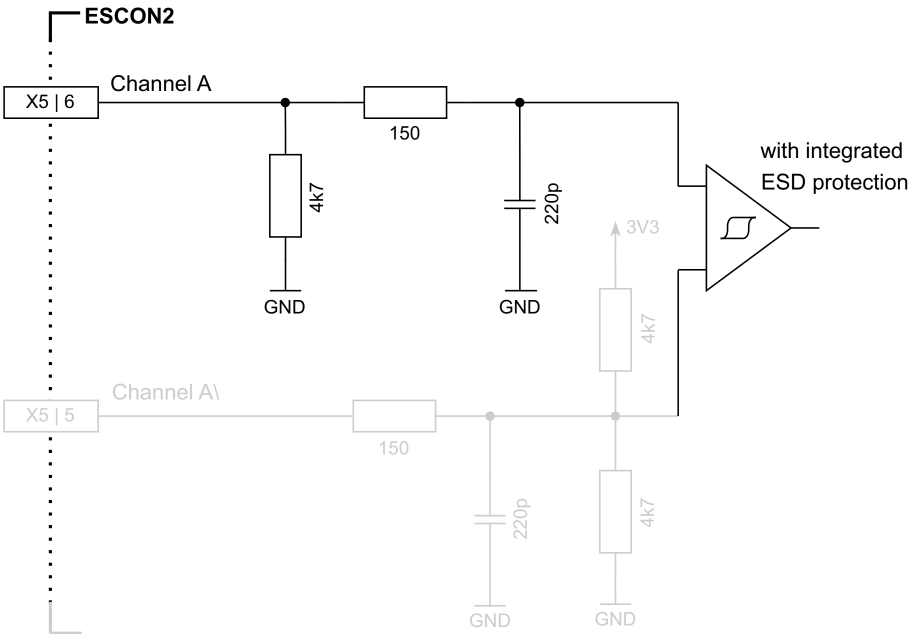


Figure 3-14 Digital incremental encoder input circuit Ch A "single-ended" (analogously valid for Ch B)

3.3.4.2 SSI / BiSS C unidirectional absolute encoder (future release)

The functionality will only be available with a future firmware release.

SSI / BiSS C unidirectional absolute encoder (single-ended)		
Sensor supply voltage output V_{Sensor}		5 VDC
Max. sensor supply current		145 mA (➔refer to Important Notice)
Clock frequency	SSI	0.1...2 MHz
	BiSS C	0.1...4 MHz

Table 3-24 SSI / BiSS C unidirectional absolute encoder specification

SSI / BiSS C unidirectional absolute encoder data channel	
Input voltage	0…5 VDC
Max. input voltage	± 12 VDC
Low-level input voltage	< 1.0 VDC
High-level input voltage	> 2.4 VDC
Input high current	I_{IH} = typically 0.33 mA @ 5 VDC (➔refer to Important Notice)
Input low current	I_{IL} = typically 0 mA @ 0 VDC (➔refer to Important Notice)
Max. input frequency	6.25 MHz
Total reaction time	< 1.5 ms

Table 3-25 Single-ended SSI / BiSS C unidirectional absolute encoder data channel specification

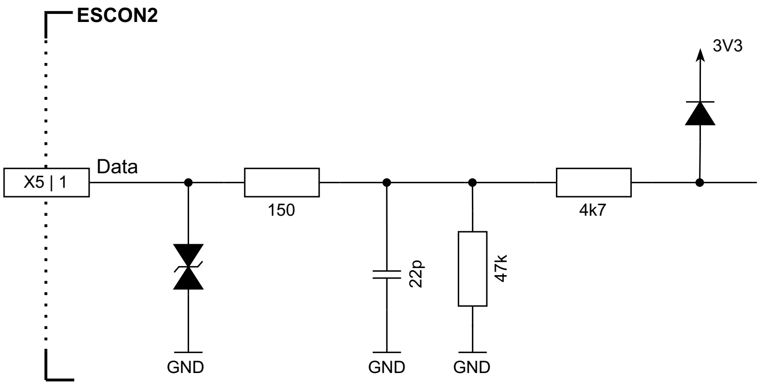


Figure 3-15 SSI absolute encoder data input (analogously valid for BiSS C)

SSI / BiSS C unidirectional absolute encoder clock channel		
Output voltage		3.3 VDC
Output resistance	Total	75 Ω (47 Ω + 28 Ω)
	Gate internal	28 Ω
Max. output current		24 mA
Clock frequency	SSI	0.1...2 MHz
	BiSS C	0.1...4 MHz

Table 3-26 Single-ended SSI / BiSS C unidirectional absolute encoder clock channel specification

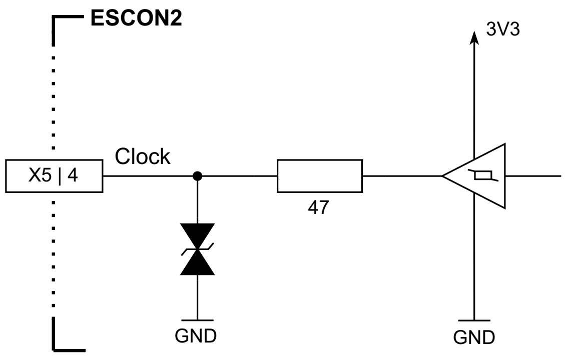


Figure 3-16 SSI absolute encoder clock output (analogously valid for BiSS C)

3.3.4.3 High-speed digital I/Os

Alternatively, the sensor interface can be used for high-speed digital I/O operation.

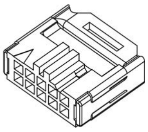
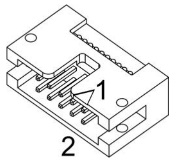
Encoder cable (P/N 275934)	
 A 1 2	 B 1 2
Cross-section	10 × AWG28, round-jacket, flat cable, pitch 1.27 mm
Length	3 m
Head A	DIN 41651 female, pitch 2.54 mm, 10 poles, with strain relief
Head B	DIN 41651 plug, pitch 2.54 mm, 10 poles, with strain relief

Table 3-27 Encoder cable

High-speed digital input 1…2 (differential)	
Max. input voltage	−9...+13 VDC
Min. differential input voltage	± 200 mV
Line receiver (internal)	EIA/RS422 standard
Max. input frequency	6.67 MHz
Total reaction time	< 1.5 ms

Table 3-28 Differential high-speed digital input specification

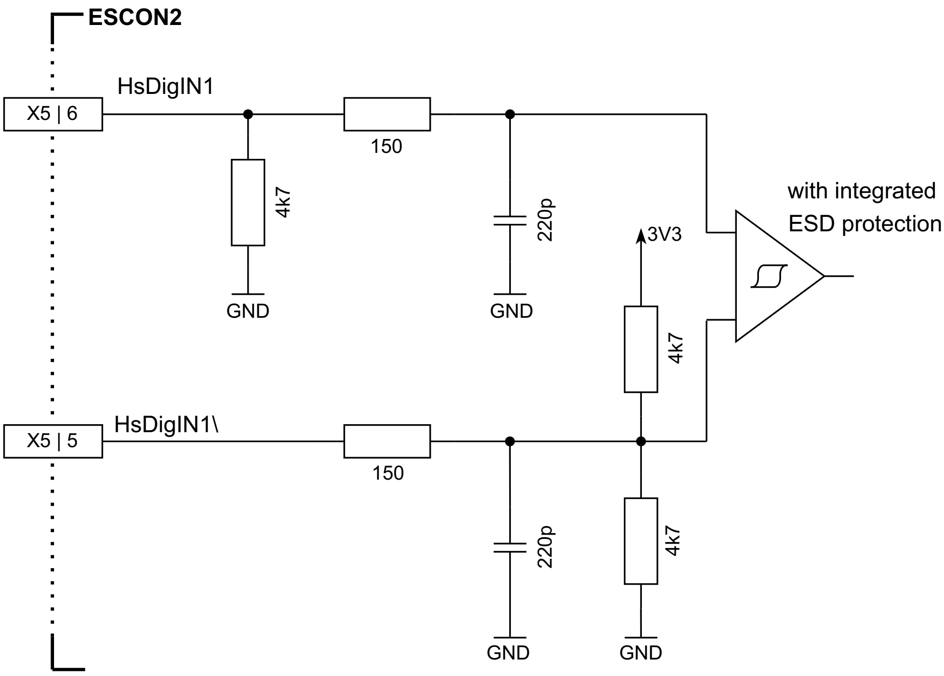


Figure 3-17 HsDigIN1 circuit “differential” (analogously valid for HsDigIN2)

High-speed digital input 1…4 (single-ended)		
Input voltage		0…5 VDC
Max. input voltage		−9...+13 VDC
Low-level input voltage		< 1.0 VDC
High-level input voltage		> 2.4 VDC
Input high current	HsDigIN1...3	I_{IH} = typically 1.25 mA @ 5 VDC (→refer to Important Notice)
	HsDigIN4	I_{IH} = typically 0.33 mA @ 5 VDC (→refer to Important Notice)
Input low current	HsDigIN1...3	I_{IL} = typically −0.18 mA @ 0 VDC (→refer to Important Notice)
	HsDigIN4	I_{IL} = typically 0 mA @ 0 VDC (→refer to Important Notice)
Max. input frequency		6.25 MHz
Total reaction time		< 1.5 ms

Table 3-29 Single-ended high-speed digital input specification

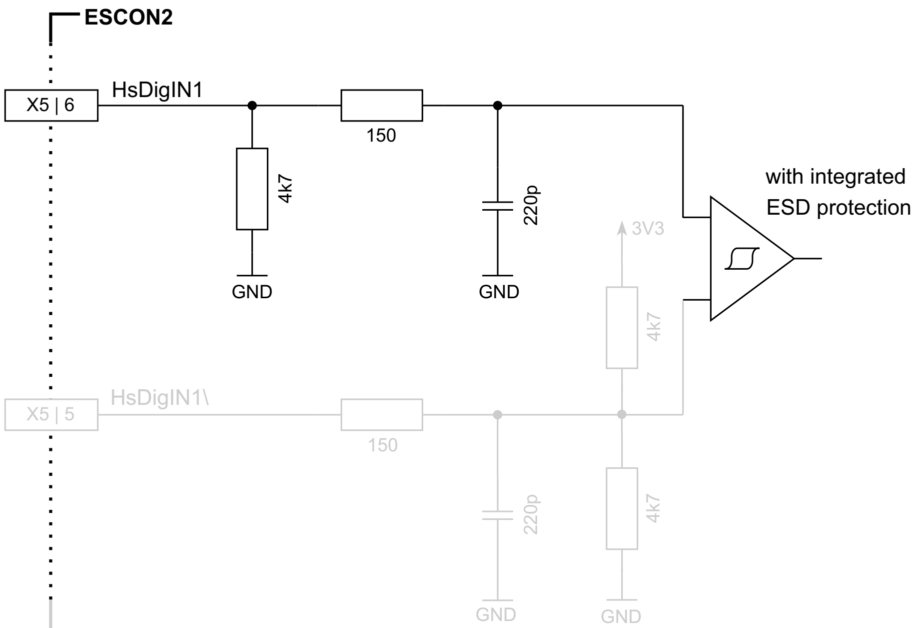


Figure 3-18 HsDigIN1 circuit “single-ended” (analogously valid for HsDigIN2…3)

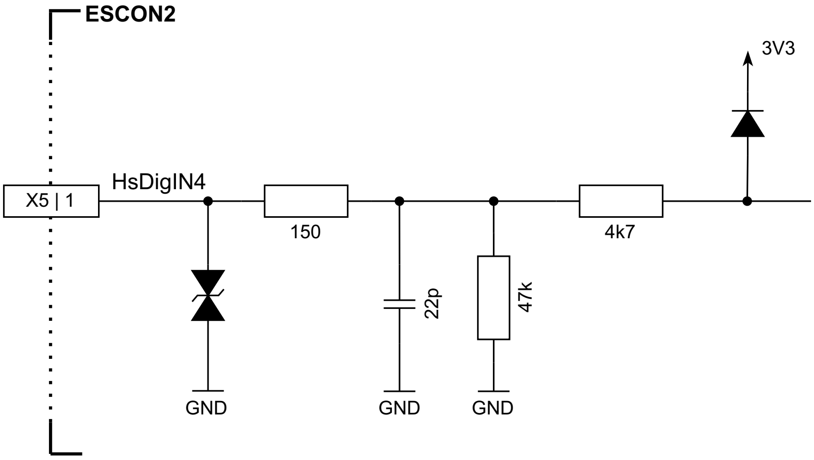


Figure 3-19 HsDigIN4 circuit “single-ended”

High-speed digital output 1		
Output voltage		3.3 VDC
Output resistance	Total	75 Ω (47 Ω + 28 Ω)
	Gate internal	28 Ω
Max. output current		24 mA
Max. output frequency		25 kHz

Table 3-30 High-speed digital output specification

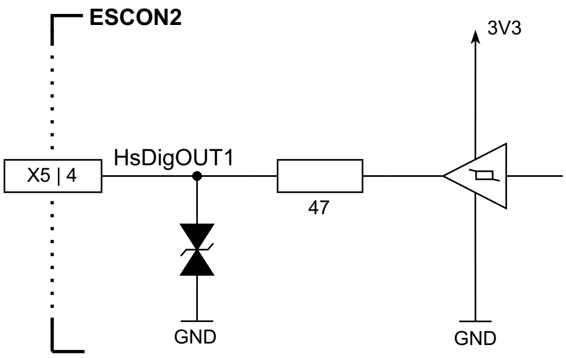


Figure 3-20 HsDigOUT1 circuit

3.3.5 Digital I/Os (X7)

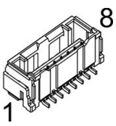


Figure 3-21 Digital I/Os connector X7

X7 Pin	Prefab cable Head A Pin	Cable color	Head B Pin	Signal	Description
1	1	white		DigIN1	Digital input 1
2	2	brown		DigIN2	Digital input 2
3	3	green		DigIN3	Digital input 3
4	4	yellow		DigIN4	Digital input 4
5	5	grey		DigOUT1	Digital output 1
6	6	pink		DigOUT2	Digital output 2
7	7	blue		GND	Ground
8	8	red		$V_{I/O}$	$V_{I/O}$ = 5 VDC - 0.75 VDC = 4.25 VDC

Table 3-31 Digital I/Os connector X7 – Pin assignment

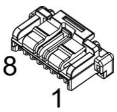
Signal cable 8core (P/N 520853)		
A  8 1		B
Cross-section	8×0.14 mm^2, grey	
Length	3 m	
Head A	Plug	Molex CLIK-Mate, single row, 8 poles (5025780800)
	Contacts	Molex CLIK-Mate crimp terminals (5025790000)
Head B	Wire end sleeves 0.14 mm^2	

Table 3-32 Signal cable 8core

Digital inputs 1…2	
Input voltage	0…25 VDC
Max. input voltage	± 25 VDC
Low-level input voltage	< 0.8 VDC
High-level input voltage	> 2.1 VDC
Input resistance	typically 47 kΩ < 3.3 VDC typically 37 kΩ @ 5 VDC typically 25 kΩ @ 24 VDC
Input current at logic 1	typically 135 μA @ 5 VDC
Hardware switching delay	< 6 μs
Total reaction time	< 2.3 ms
PWM duty cycle (resolution)	10...90 % (0.1 %)
PWM frequency	50 Hz...10 kHz
PWM accuracy	typically +0.1 % absolute @ 50 Hz / 5 VDC typically +1.5 % absolute @ 10 kHz / 5 VDC

Table 3-33 Digital inputs 1...2 specification

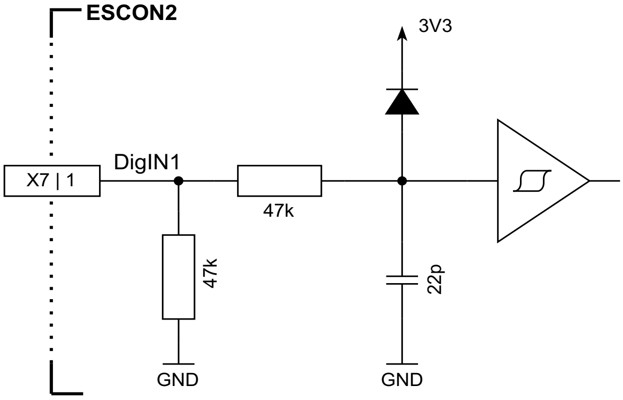


Figure 3-22 DigIN1 circuit (analogously valid for DigIN2)

Digital inputs 3…4	
Input voltage	0…25 VDC
Max. input voltage	± 25 VDC
Low-level input voltage	< 0.8 VDC
High-level input voltage	> 2.1 VDC
Input resistance	typically 47 kΩ < 3.3 VDC typically 37 kΩ @ 5 VDC typically 25 kΩ @ 24 VDC
Input current at logic 1	typically 135 µA @ 5 VDC
Hardware switching delay	< 300 µs
Total reaction time	< 2.3 ms

Table 3-34 Digital inputs 3...4 specification

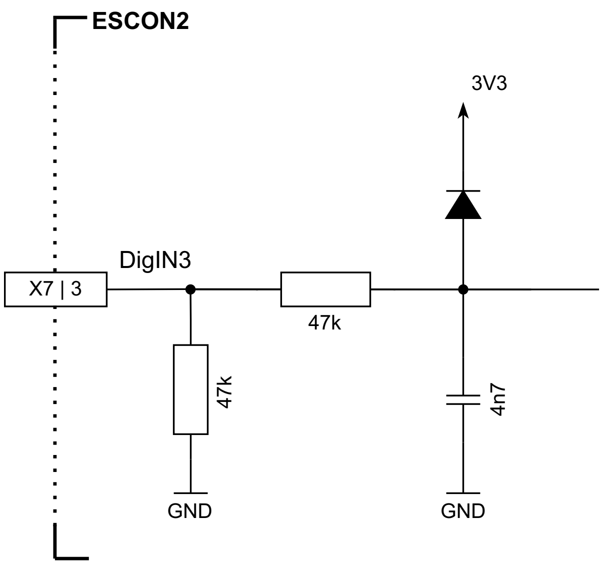


Figure 3-23 DigIN3 circuit (analogously valid for DigIN4)

Digital outputs 1…2 "sink"	
Max. input voltage	36 VDC
Max. load current	500 mA
Max. voltage drop	0.25 VDC @ 500 mA
Max. load inductance	100 mH @ 24 VDC; 500 mA with internal clamping typically 45 VDC
Max. output frequency	25 kHz

Table 3-35 Digital outputs specification – Sinks

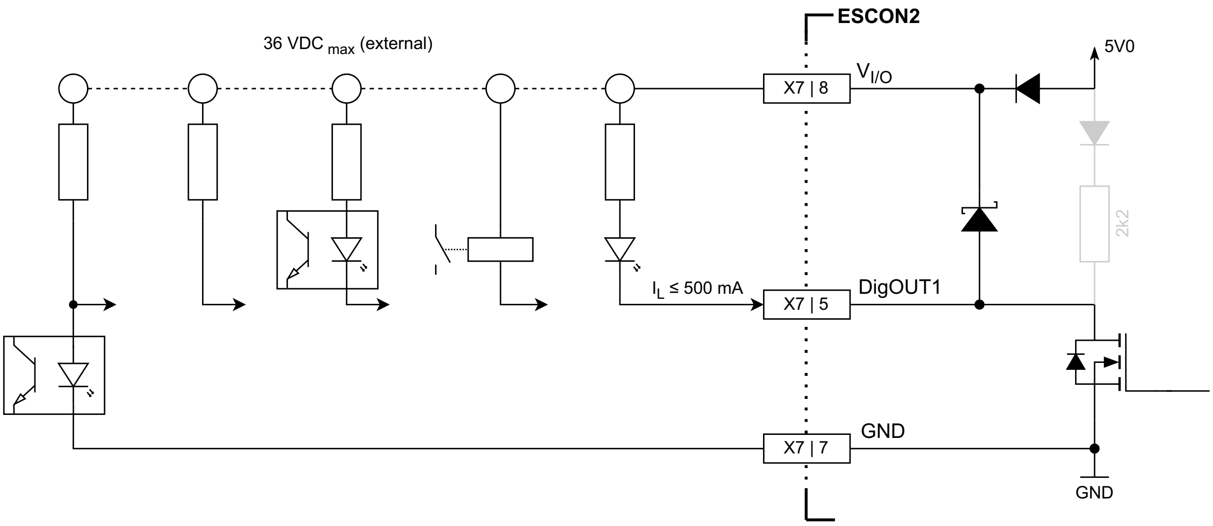


Figure 3-24 DigOUT1 "sinks" (analogously valid for DigOUT2)

Freewheeling diode for inductive loads
When utilizing the digital output load switch for the operation of inductive loads, such as relays, and $V_{I/O}$ is not uses, it is essential to confirm the presence of a freewheeling diode to prevent potential harm to the hardware. If possible, install the freewheeling diode at the load.

Digital outputs 1…2 "source"	
Output voltage	V_{Out} = 5 VDC − 0.75 VDC − (I_L × 2´200 Ω)
Max. load current	$I_L \leq 2$ mA

Table 3-36 Digital outputs specification – Sources

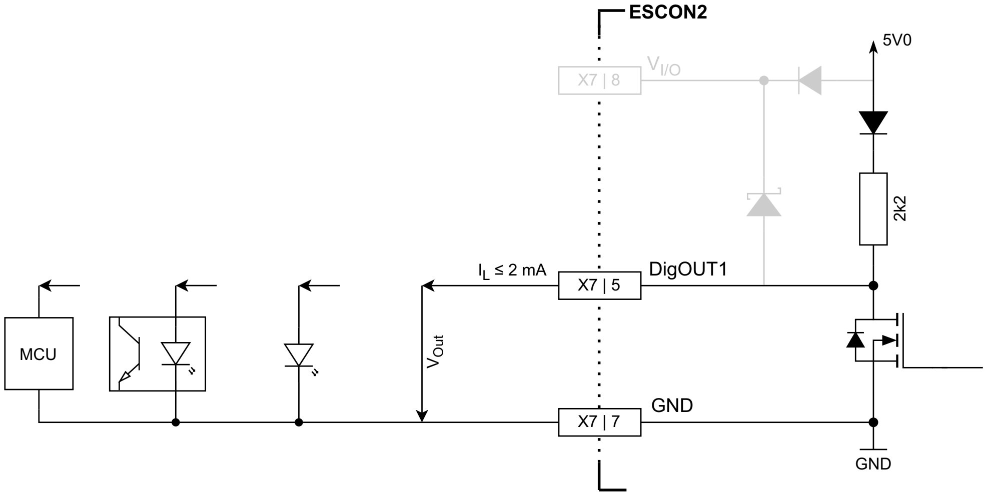


Figure 3-25 DigOUT1 “source” (analogously valid for DigOUT2)

3.3.6 Analog I/Os (X8)

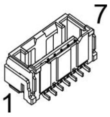


Figure 3-26 Analog I/Os connector X8

X8 Pin	Prefab cable Head A Pin	Prefab cable Cable color	Prefab cable Head B Pin	Signal	Description
1	1	white		AnIN1	Analog input 1
2	2	brown		-	not connected
3	3	green		AnIN2	Analog input 2
4	4	yellow		-	not connected
5	5	grey		AnOUT1	Analog output 1
6	6	pink		AnOUT2	Analog output 2
7	7	blue		GND	Ground

Table 3-37 Analog I/Os connector X8 – Pin assignment

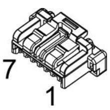
Signal cable 7core (P/N 520854)		
A  7 1		B
Cross-section	7 × 0.14 mm^2, grey	
Length	3 m	
Head A	Plug	Molex CLIK-Mate, single row, 7 poles (5025780700)
	Contacts	Molex CLIK-Mate crimp terminals (5025790000)
Head B	Wire end sleeves 0.14 mm^2	

Table 3-38 Signal cable 7core

Analog inputs 1…2	
Input voltage	0...5 VDC
Max. input voltage	± 7.5 VDC
Input resistance	5.9 kΩ
A/D converter	12-bit
Resolution	1.22 mV
Bandwidth	10 kHz

Table 3-39 Analog input specification

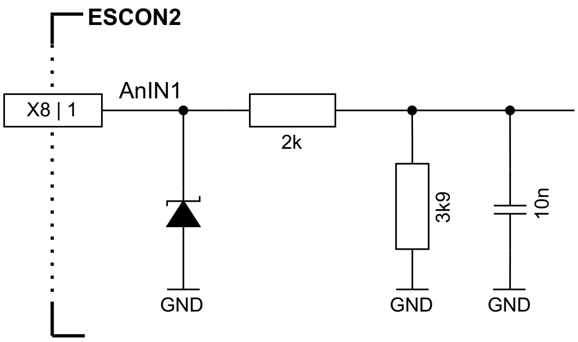


Figure 3-27 AnIN1 circuit (analogously valid for AnIN2)

Analog outputs 1…2	
Output voltage	0...+3.3 VDC
D/A converter	12-bit
Resolution	0.81 mV
Refresh rate	50 kHz
Analog bandwidth of output amplifier	25 kHz
Max. output current limit	1 mA

Table 3-40 Analog output specification

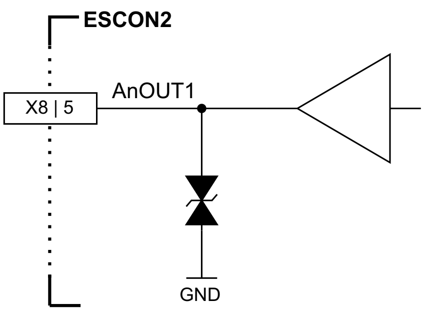


Figure 3-28 AnOUT1 circuit (analogously valid for AnOUT2)

3.3.7 RS232 (X10)

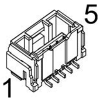
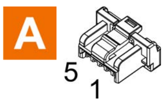


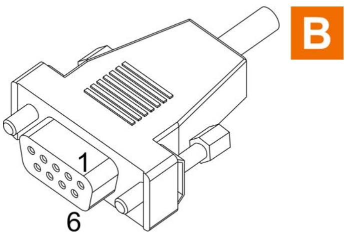
Figure 3-29 RS232 connector X10

X10 Pin	Prefab cable Head A Pin	Cable color	Head B Pin	Signal	Description
1	1	white	3	RS232_RxD	RS232 receive
2	2	brown	5	GND	Ground
3	3	green	2	RS232_TxD	RS232 transmit
4	4	yellow	5	GND	Ground
5	5	Shield	Housing	Shield	Cable shield

Table 3-41 RS232 connector X10 – Pin assignment

RS232-COM cable (P/N 520856)





Cross-section	2 × 2 × 0.14 mm^2, twisted pair, shielded	
Length	3 m	
Head A	Plug	Molex CLIK-Mate, single row, 5 poles (5025780500)
	Contacts	Molex CLIK-Mate crimp terminals (502579)
Head B	Female D-Sub connector DIN 41652, 9 poles, with mounting screws	

Table 3-42 RS232-COM cable

RS232 interface	
Max. input voltage	±30 VDC
Output voltage	typically ±9 V @ 3 kΩ to GND
Max. bit rate	115’200 bit/s
RS232 transceiver	EIA RS232 standard

Table 3-43 RS232 interface specification

Bit rate setting
- *Consider the master’s maximal bit rate.*
- *The standard bit rate setting (factory setting) is 115‘200 bit/s.*

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3.3.8 CAN 1 (X11) & CAN 2 (X12)

The ESCON2 is specially designed being commanded and controlled via a Controller Area Network (CAN), a highly efficient data bus very common in all fields of automation and motion control. It is preferably used as a slave node in the CANopen network.

For the CAN configuration check ➔Chapter “3.4 DIP switch configuration (SW1)” on page 3-42.

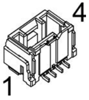


Figure 3-30 CAN 1 connector X11/CAN 2 connector X12

X11/12 Pin	Prefab cable				Signal	Description
	Head A Pin	Cable color	P/N 520858 Head B Pin	P/N 520857 Head B Pin		
1	1	white	1	7	CAN high	CAN bus high line
2	2	brown	2	2	CAN low	CAN bus low line
3	3	green	3	3	GND	Ground
4	4	yellow	4	5	CAN shield	Cable shield

Table 3-44 CAN 1 connector X11/CAN 2 connector X12 – Pin assignment

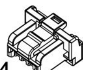
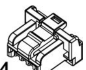
CAN-CAN cable (P/N 520858)		
A  4 1		 4 1 B
Cross-section	2 × 2 × 0.14 mm^2, twisted pair, shielded	
Length	3 m	
Head A	Plug	Molex CLIK-Mate, single row, 4 poles (5025780400)
	Contacts	Molex CLIK-Mate crimp terminals (5025790000)
Head B	Plug	Molex CLIK-Mate, single row, 4 poles (5025780400)
	Contacts	Molex CLIK-Mate crimp terminals (5025790000)

Table 3-45 CAN-CAN cable

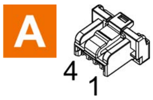
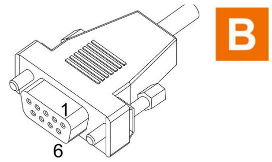
CAN-COM cable (P/N 520857)		
		
Cross-section	2 × 2 × 0.14 mm^2, twisted pair, shielded	
Length	3 m	
Head A	Plug	Molex CLIK-Mate, single row, 4 poles (5025780400)
	Contacts	Molex CLIK-Mate crimp terminals (5025790000)
Head B	Female D-Sub connector DIN 41652 9 poles, with mounting screws	

Table 3-46 CAN-COM cable

CAN interface	
Standard	ISO 11898-2:2003
Max. bit rate	1 Mbit/s
Max. number of CAN nodes	31/127 (via hardware/software setting)
Protocol	CiA 301 version 4.2.0
Node-ID setting	By DIP switch or software

Table 3-47 CAN interface specification

Note
- *Consider the CAN master’s maximal bit rate.*
- *The standard bit rate setting (factory setting) is 1 Mbit/s.*
- *Use 120 Ω termination resistor at both ends of the CAN bus.*
- *For detailed CAN information see separate document ➔«ESCON2 Communication Guide».*

3.3.9 USB (X13)

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.*

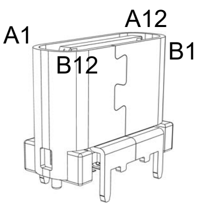


Figure 3-31 USB connector X13

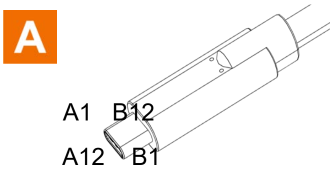
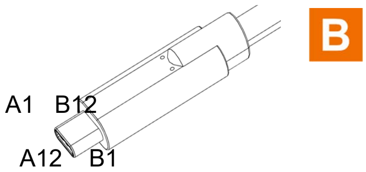
USB Type C - Type C cable (P/N 845854)	
	
USB standard	USB 3.2
Length	1.5 m
Head A	USB Type C
Head B	USB Type C

Table 3-48 USB Type C – Type C cable

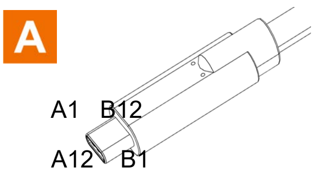
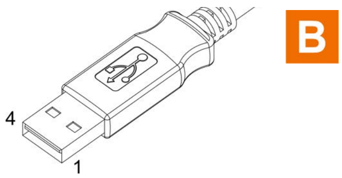
USB Type A - Type C cable (P/N 838461)	
	
USB standard	USB 2.0 / USB 3.0
Length	1.5 m
Head A	USB Type C
Head B	USB Type A

Table 3-49 USB Type A – Type C cable

USB	
Data signaling rate	12 Mbit/s (Full speed)
Max. bus supply voltage V_{Bus}	5.25 VDC
Max. DC data input voltage	−0.3…+3.8 VDC

Table 3-50 USB interface specification

3.3.10 Motor temperature sensor (X16) (future release)

The functionality will only be available with a future firmware release.

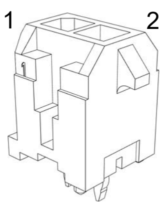


Figure 3-32 Motor temperature sensor connector X16

X16 Pin	Prefab cable Head A Pin	Prefab cable Cable color	Prefab cable Head B Pin	Signal	Description
1	1	black		GND	Ground
2	2	red		MotorTemp	Motor temperature sensor input

Table 3-51 Motor temperature sensor connector X16 – Pin assignment

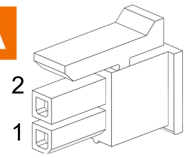
NTC cable (P/N 847301)		
A 		B
Cross-section	2 × 0.5 mm^2, grey	
Length	3 m	
Head A	Plug	Molex Micro-Fit 3.0, 2 poles (430250200)
	Contacts	Molex Micro-Fit 3.0 female crimp terminals (0430300001)
Head B	Wire end sleeves 0.5 mm^2	

Table 3-52 NTC cable

Motor temperature sensor input	
Input voltage	0...3.3 VDC
Max. input voltage	+24 VDC
A/D converter	12-bit
Internal pull-up resistor	3.3 kΩ (referenced to 3.3 VDC)

Table 3-53 Motor temperature sensor – specifications

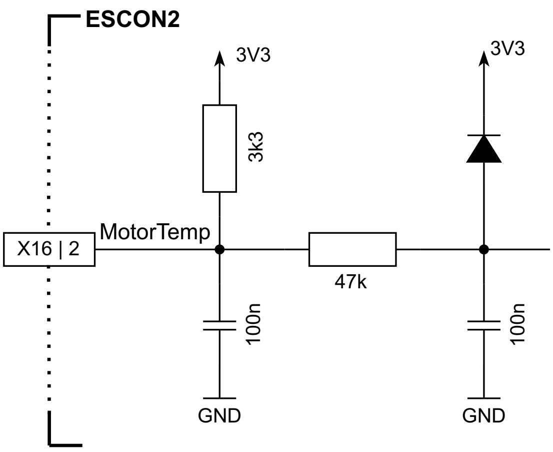


Figure 3-33 Motor temperature circuit

3.4 DIP switch configuration (SW1)

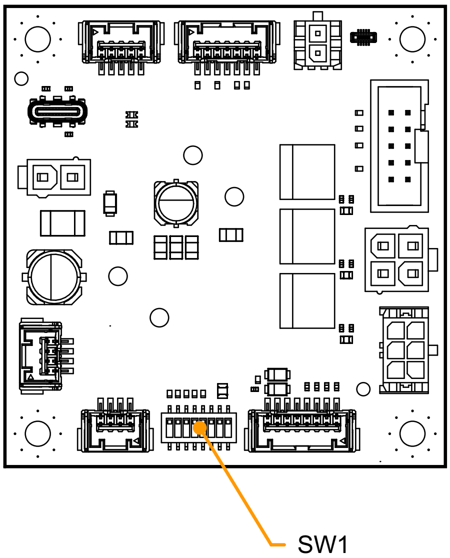


Figure 3-34 DIP switch SW1

DIP switch 8 has no functionality assigned and is not connected.

3.4.1 CAN ID (Node-ID)

The device’s identification (subsequently called “ID”) can be set by means of DIP switches 1...5 or software using binary code.

Setting the ID by DIP switch SW1

- *DIP switches 6…8 do not have any impact on the ID.*

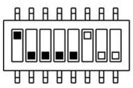
Setting	Switch	Binary Code	Valence
1 8  ON OFF (factory setting)	1	2^0	1
	2	2^1	2
	3	2^2	4
	4	2^3	8
	5	2^4	16

Table 3-54 DIP switch SW1 – Binary code values

Continued on next page.

The set ID can be observed by adding the valence of all activated switches. Use the following table as a (non-concluding) guide:

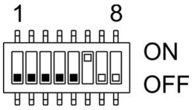
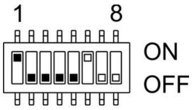
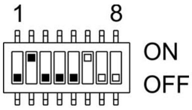
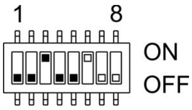
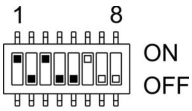
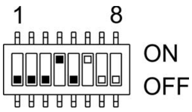
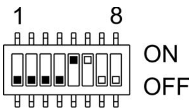
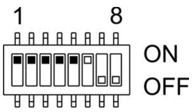
Setting	Switch					ID
	1	2	3	4	5	
	0	0	0	0	0	–
	**1**	0	0	0	0	1
	0	**1**	0	0	0	2
	0	0	**1**	0	0	4
	**1**	0	**1**	0	0	5
	0	0	0	**1**	0	8
	0	0	0	0	**1**	16
	**1**	**1**	**1**	**1**	**1**	31
0 = Switch “OFF” 1 = Switch “ON”						

Table 3-55 DIP switch SW1 – Examples

SETTING THE ID BY MEANS OF «MOTION STUDIO»

- The ID may be set by software (changing object 0×2000 «Node-ID», range 1…127).
- The ID set by software is valid if the ID is set to “0” (DIP switches 1...5 set to OFF).

3.4.2 CAN automatic bit rate detection

With this function, the CANopen interface can be put in a “listen only” mode. For further details see separate document ➔«ESCON2 Firmware Specification». Automatic bit rate detection is activated with DIP switch 6.

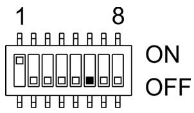
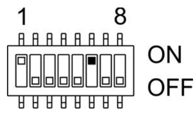
Switch	OFF	ON
6	 Automatic bit rate detection deactivated	 Automatic bit rate detection activated (factory setting)

Table 3-56 DIP switch SW1 – CAN automatic bit rate detection

3.4.3 CAN bus termination

A 120 Ω termination resistor can be "activated" with DIP switch 7.

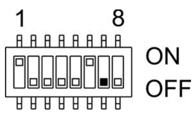
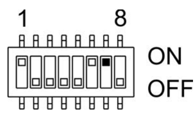
Switch	OFF	ON
7	 Without bus termination (factory setting)	 Bus termination with 120 Ω

Table 3-57 DIP switch SW1 – CAN bus termination

3.5 Status indicators

The Evaluation Board features a set of LED indicators to display the controller's condition.

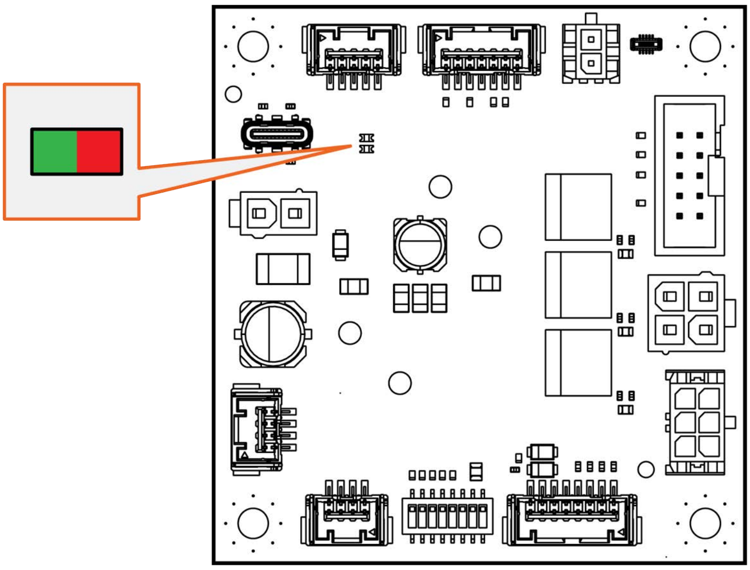


Figure 3-35 LEDs – Location

The LEDs display the actual status and possible warnings and errors of the ESCON2:

- Green LED shows the operation status
- Red LED indicates warnings and errors

LED		Warning / Error	Description
Green	**Red**		
Slow	OFF	No warning/error active.	Power stage is disabled. The ESCON2 is in status • Switch on disabled • Ready to switch on • Switched on
Slow	Slow	At least one warning is active.	
ON	OFF	No warning/error active.	Power stage is enabled. The ESCON2 is in status • Operation enabled • Quick stop active
ON	Slow	At least one warning is active.	
ON	ON	At least one error has occurred.	Power stage is enabled. The ESCON2 is in temporary status • Fault reaction active
OFF	ON	At least one error has occurred.	Power stage is disabled. The ESCON2 is in status • Fault
Flash	ON	n/a	Firmware update in progress or invalid application
Slow = LED is slowly blinking (0.5 s OFF, 0.5 s ON) Flash = LED is flashing (0.9 s OFF, 0.1 s ON)			

Table 3-58 Device status LEDs

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4 WIRING

This section provides wiring information for your setup. You can either use the consolidated wiring diagrams (see ➔Figure 4-37) featuring the full scope of interconnectivity and pin assignments, or you may use the connection overviews for either DC motor or EC (BLDC) motor to determine the wiring for your particular motor type and the appropriate feedback signals.

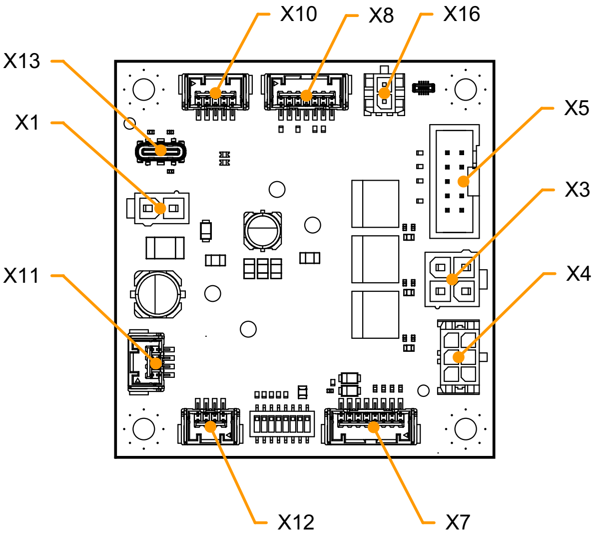

Figure 4-36 Interfaces – Designations and location

Signs and abbreviations used

The subsequent diagrams feature these signs and abbreviations:

- *«EC motor» stands for brushless EC motor (BLDC).*
- ⏚ *Ground safety earth connection (optional).*

4.1 Possible combinations to connect a motor

The following tables show feasible ways to connect the motor with its respective feedback signals or possible combinations thereof. To find the wiring that best suits your setup, proceed as follows:

1) Decide on the type of motor you are using and go to the respective subsection; ➔Chapter “4.1.1 DC motor” on page 4-48 or ➔Chapter “4.1.2 EC (BLDC) motor” on page 4-48.
2) Connect the power supply and the logic supply as shown in the referenced figure.
3) Check-out the listing for the combination that best suits your setup. Pick the wiring method # and go to the respective table; for DC motor see ➔Table 4-59, for EC (BLDC) motor see ➔Table 4-60.
4) Pick the row with the corresponding wiring method # and refer to the listed figure(s) to find the relevant wiring information.

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4.1.1 DC motor

Power supply

Power supply . . . . Figure 4-38

Motor & feedback signals

Without sensor . . . . Method # DC1 [a]

Digital incremental encoder . . . . Method # DC2

SSI / BiSS C unidirectional absolute encoder . . . . Method # DC3 [b]

Method #	Sensor 2		➔Figure(s)
	Digital incremental encoder	SSI / BiSS C unidirectional absolute encoder [b]	
DC1 [a]			4-39
DC2	✓		4-39 4-42
DC3 [b]		✓	4-39 4-43

[a] For method # DC1, only the operating mode current control can be used.
[b] The functionality will be available with a future firmware release.

Table 4-59 Possible combinations of feedback signals for DC motor

4.1.2 EC (BLDC) motor

Power supply

Power supply . . . . Figure 4-38

Motor & feedback signals

Hall sensors . . . . Method # EC1

Hall sensors & Digital incremental encoder . . . . Method # EC2

Hall sensors & SSI / BiSS C unidirectional absolute encoder . . . . Method # EC3 [a]

SSI / BiSS C unidirectional absolute encoder . . . . Method # EC4 [a]

Method #	Sensor 1	Sensor 2		➔Figure(s)
	Hall sensors	Digital incremental encoder	SSI / BiSS C unidirectional absolute encoder [a]	
EC1	✓			4-40 4-41
EC2	✓	✓		4-40 4-41 4-42
EC3 [a]	✓		✓	4-40 4-41 4-43
EC4 [a]			✓	4-40 4-43

[a] The functionality will be available with a future firmware release.

Table 4-60 Possible combinations of feedback signals for EC (BLDC) motor

4.2 Main wiring diagram

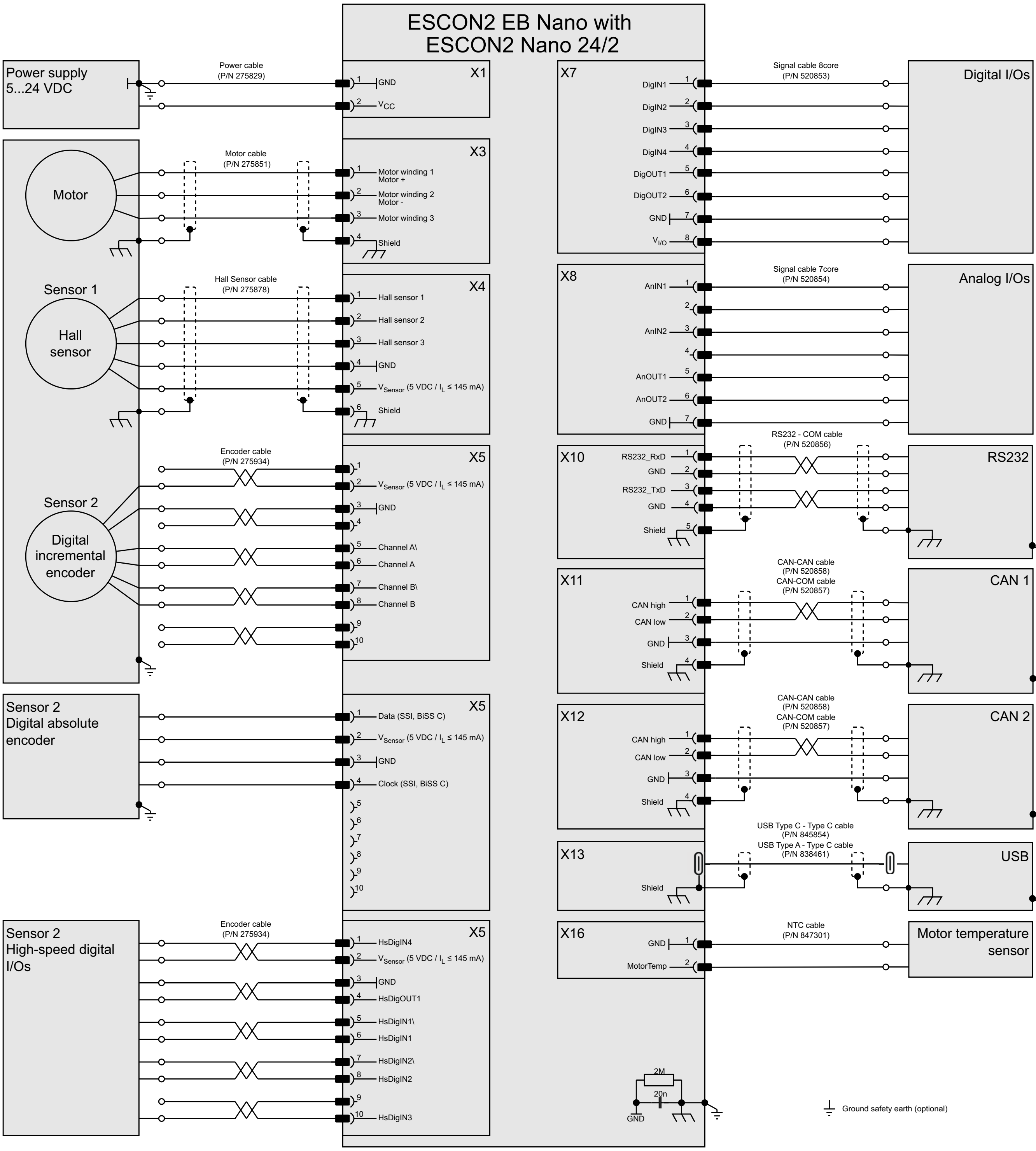

Figure 4-37 Main wiring diagram

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4.3 Excerpts

4.3.1 Power supply

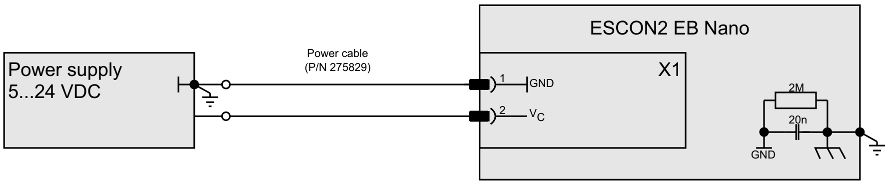

Figure 4-38 Power supply

4.3.2 DC motor

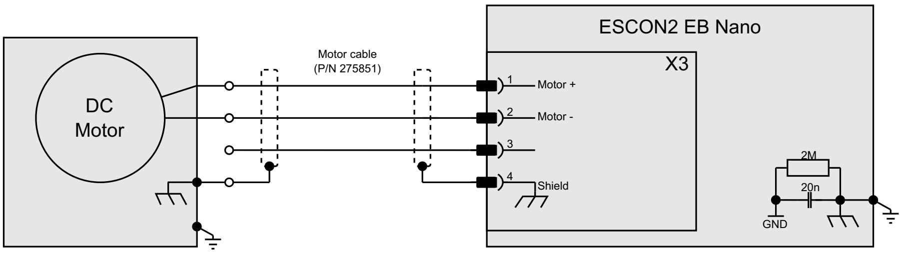

Figure 4-39 DC motor

4.3.3 EC (BLDC) motor

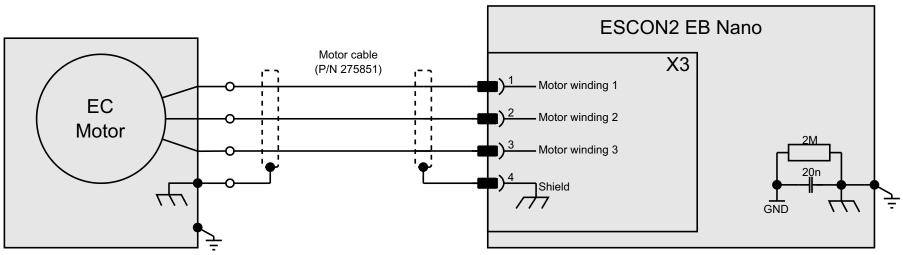

Figure 4-40 EC (BLDC) motor

4.3.4 Sensor 1 Hall sensor

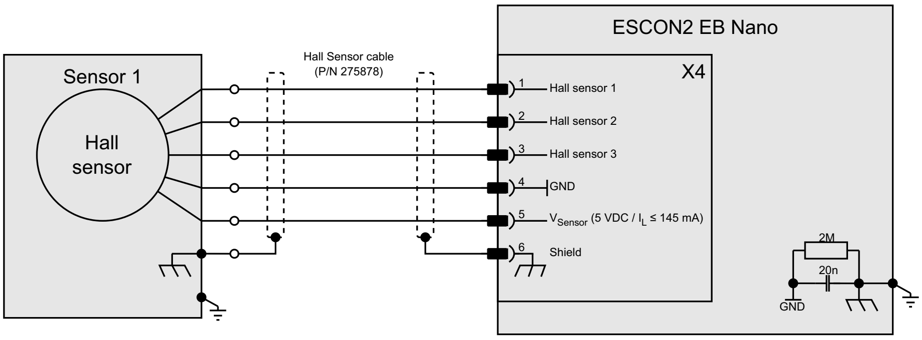

Figure 4-41 Sensor 1 Hall sensor

4.3.5 Sensor 2 Encoder / I/Os

4.3.5.1 Digital incremental encoder

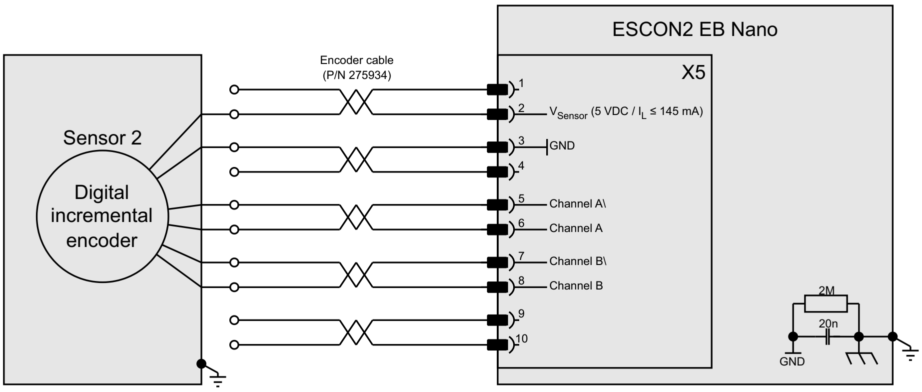

Figure 4-42 Digital incremental encoder

This interface can handle a digital incremental encoder, an SSI / BiSS C digital unidirectional absolute encoder or high-speed digital I/O's. Only one out of these three functions can be used at the same time.

4.3.5.2 SSI / BiSS C unidirectional absolute encoder (future release)

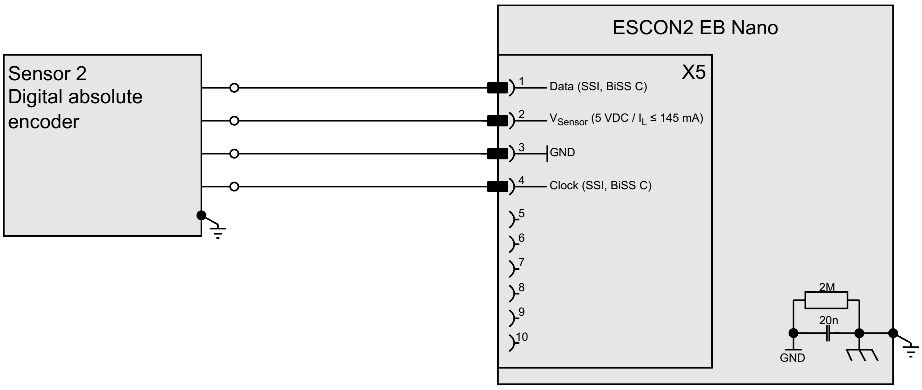

Figure 4-43 SSI / BiSS C unidirectional absolute encoder

This interface can handle a digital incremental encoder, an SSI / BiSS C digital unidirectional absolute encoder or high-speed digital I/O's. Only one out of these three functions can be used at the same time.

4.3.5.3 High-speed digital I/Os

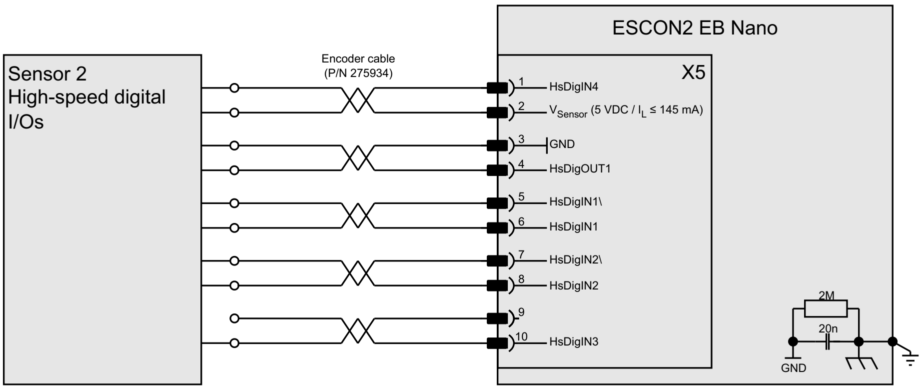

Figure 4-44 High-speed digital I/Os

This interface can handle a digital incremental encoder, an SSI / BiSS C digital unidirectional absolute encoder or high-speed digital I/O's. Only one out of these three functions can be used at the same time.

4.3.6 Digital I/Os

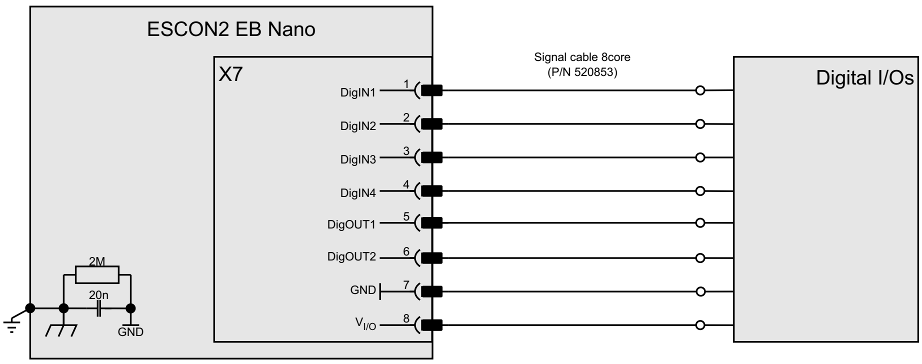

Figure 4-45 Digital I/Os

4.3.7 Analog I/Os

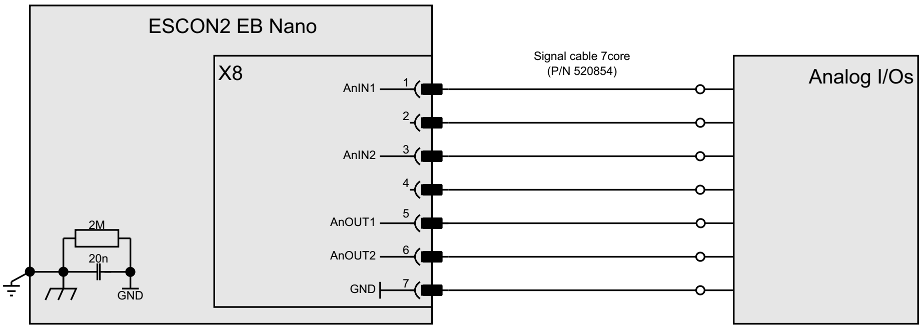

Figure 4-46 Analog I/Os

4.3.8 RS232

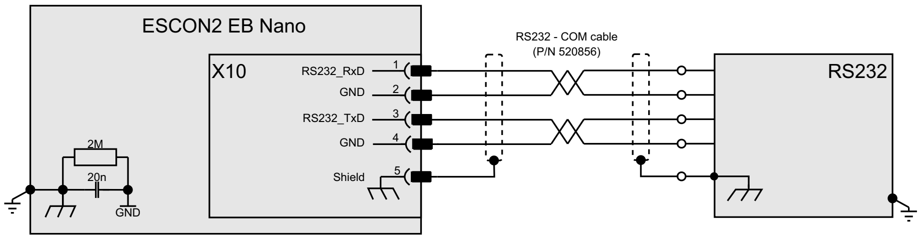

Figure 4-47 RS232

4.3.9 CAN

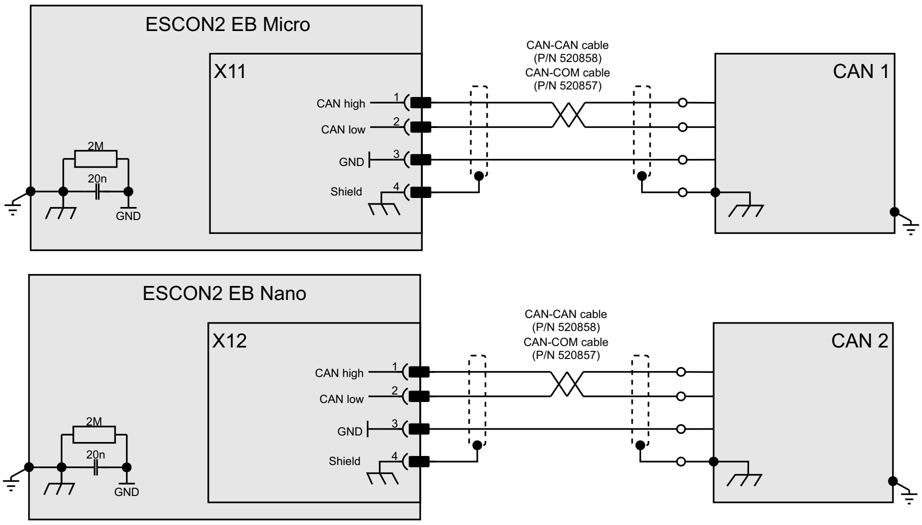

Figure 4-48 CAN

Depending on the preferred interface, one of the two prefab CAN cables can be used.

4.3.10 USB

4.3.10.1 USB-C

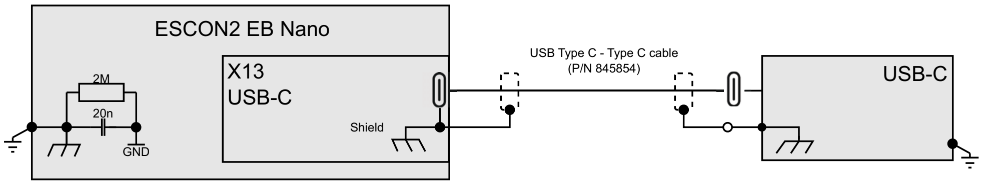

Figure 4-49 USB-C

4.3.10.2 USB-A

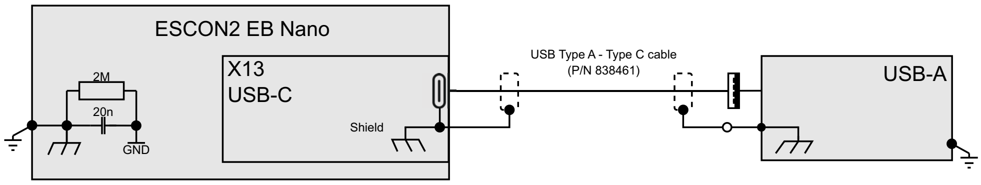

Figure 4-50 USB-A

4.3.11 Motor temperature sensor (future release)

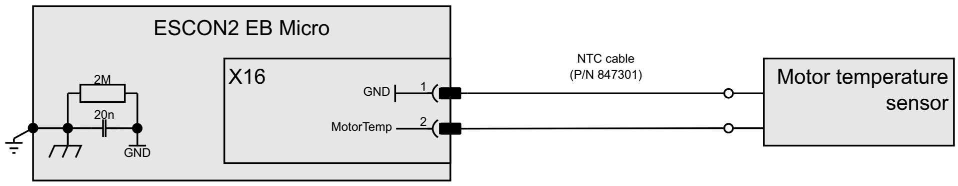

Figure 4-51 Motor temperature sensor

LIST OF FIGURES

Figure 1-1 Documentation structure . . . 5
Figure 2-2 Derating of output current (operation without additional heatsink) . . . 11
Figure 2-3 Extended operation @ VCC 24 VDC with additional heatsink . . . 12
Figure 2-4 Assembly with thermal accessories . . . 13
Figure 2-5 Power dissipation and efficiency . . . 13
Figure 2-6 Dimensional drawing [mm] . . . 14
Figure 3-7 Connections . . . 18
Figure 3-8 Power supply connector X1 . . . 20
Figure 3-9 Motor connector X3 . . . 22
Figure 3-10 Sensor 1 Hall sensor connector X4 . . . 23
Figure 3-11 Sensor 1 Hall sensor input circuit (analogously valid for Hall sensors 2 & 3) . . . 24
Figure 3-12 Sensor 2 connector X5 . . . 24
Figure 3-13 Digital incremental encoder input circuit Ch A “differential” (analogously valid for Ch B) . . . 26
Figure 3-14 Digital incremental encoder input circuit Ch A “single-ended” (analogously valid for Ch B) . . . 27
Figure 3-15 SSI absolute encoder data input (analogously valid for BiSS C) . . . 28
Figure 3-16 SSI absolute encoder clock output (analogously valid for BiSS C) . . . 28
Figure 3-17 HsDigIN1 circuit “differential” (analogously valid for HsDigIN2) . . . 29
Figure 3-18 HsDigIN1 circuit “single-ended” (analogously valid for HsDigIN2…3) . . . 30
Figure 3-19 HsDigIN4 circuit “single-ended” . . . 31
Figure 3-20 HsDigOUT1 circuit . . . 31
Figure 3-21 Digital I/Os connector X7 . . . 31
Figure 3-22 DigIN1 circuit (analogously valid for DigIN2) . . . 33
Figure 3-23 DigIN3 circuit (analogously valid for DigIN4) . . . 33
Figure 3-24 DigOUT1 “sinks” (analogously valid for DigOUT2) . . . 34
Figure 3-25 DigOUT1 “source” (analogously valid for DigOUT2) . . . 35
Figure 3-26 Analog I/Os connector X8 . . . 35
Figure 3-27 AnIN1 circuit (analogously valid for AnIN2) . . . 36
Figure 3-28 AnOUT1 circuit (analogously valid for AnOUT2) . . . 36
Figure 3-29 RS232 connector X10 . . . 37
Figure 3-30 CAN 1 connector X11/CAN 2 connector X12 . . . 38
Figure 3-31 USB connector X13 . . . 39
Figure 3-32 Motor temperature sensor connector X16 . . . 40
Figure 3-33 Motor temperature circuit . . . 41
Figure 3-34 DIP switch SW1 . . . 42
Figure 3-35 LEDs – Location . . . 44
Figure 4-36 Interfaces – Designations and location . . . 47
Figure 4-37 Main wiring diagram . . . 49
Figure 4-38 Power supply . . . 50
Figure 4-39 DC motor . . . 50
Figure 4-40 EC (BLDC) motor . . . 50
Figure 4-41 Sensor 1 Hall sensor . . . 50

Figure 4-42 Digital incremental encoder 51
Figure 4-43 SSI / BiSS C unidirectional absolute encoder 51
Figure 4-44 High-speed digital I/Os 52
Figure 4-45 Digital I/Os 52
Figure 4-46 Analog I/Os 52
Figure 4-47 RS232 53
Figure 4-48 CAN 53
Figure 4-49 USB-C 54
Figure 4-50 USB-A 54
Figure 4-51 Motor temperature sensor 54

LIST OF TABLES

Table 1-1	Notations used in this document	6
Table 1-2	Symbols and signs	6
Table 1-3	Brand names and trademark owners	7
Table 2-4	Technical data	10
Table 2-5	Heatsink – tested components	12
Table 2-6	Thermal accessories – specification	12
Table 2-7	Limitations and protections	14
Table 2-8	Standards	15
Table 3-9	Prefab maxon cables	19
Table 3-10	Motion connector set – Content	19
Table 3-11	Recommended tools	19
Table 3-12	Power supply connector X1 – Pin assignment	20
Table 3-13	Power cable	20
Table 3-14	Power supply requirements	21
Table 3-15	Motor connector X3 – Pin assignment for maxon EC & DC motor	22
Table 3-16	Motor cable	22
Table 3-17	Hall sensor connector X4 – Pin assignment	23
Table 3-18	Hall sensor cable	23
Table 3-19	Sensor 1 Hall sensor specification	24
Table 3-20	Sensor 2 connector X5 – Pin assignment	25
Table 3-21	Encoder cable	25
Table 3-22	Differential digital incremental encoder specification	26
Table 3-23	Single-ended digital incremental encoder specification	27
Table 3-24	SSI / BiSS C unidirectional absolute encoder specification	27
Table 3-25	Single-ended SSI / BiSS C unidirectional absolute encoder data channel specification	28
Table 3-26	Single-ended SSI / BiSS C unidirectional absolute encoder clock channel specification	28
Table 3-27	Encoder cable	29
Table 3-28	Differential high-speed digital input specification	29
Table 3-29	Single-ended high-speed digital input specification	30
Table 3-30	High-speed digital output specification	31
Table 3-31	Digital I/Os connector X7 – Pin assignment	32
Table 3-32	Signal cable 8core	32
Table 3-33	Digital inputs 1...2 specification	32
Table 3-34	Digital inputs 3...4 specification	33
Table 3-35	Digital outputs specification – Sinks	34
Table 3-36	Digital outputs specification – Sources	34
Table 3-37	Analog I/Os connector X8 – Pin assignment	35
Table 3-38	Signal cable 7core	35
Table 3-39	Analog input specification	36
Table 3-40	Analog output specification	36
Table 3-41	RS232 connector X10 – Pin assignment	37

Table 3-42 RS232-COM cable . . . 37
Table 3-43 RS232 interface specification . . . 37
Table 3-44 CAN 1 connector X11/CAN 2 connector X12 – Pin assignment . . . 38
Table 3-45 CAN-CAN cable . . . 38
Table 3-46 CAN-COM cable . . . 39
Table 3-47 CAN interface specification . . . 39
Table 3-48 USB Type C – Type C cable . . . 40
Table 3-49 USB Type A – Type C cable . . . 40
Table 3-50 USB interface specification . . . 40
Table 3-51 Motor temperature sensor connector X16 – Pin assignment . . . 41
Table 3-52 NTC cable . . . 41
Table 3-53 Motor temperature sensor – specifications . . . 41
Table 3-54 DIP switch SW1 – Binary code values . . . 42
Table 3-55 DIP switch SW1 – Examples . . . 43
Table 3-56 DIP switch SW1 – CAN automatic bit rate detection . . . 44
Table 3-57 DIP switch SW1 – CAN bus termination . . . 44
Table 3-58 Device status LEDs . . . 45
Table 4-59 Possible combinations of feedback signals for DC motor . . . 48
Table 4-60 Possible combinations of feedback signals for EC (BLDC) motor . . . 48

maxon

INDEX

A

alerts *6*
analog inputs *36*
analog outputs *36*
applicable EU directive *17*

B

bit rate detection *44*
bit rate, default *37*, *39*

C

cables (prefab)
  CAN-CAN cable *38*
  CAN-COM cable *39*
  Encoder cable *25*, *29*
  Hall sensor cable *23*
  Motor cable *22*
  NTC cable *41*
  Power cable *20*
  RS232-COM cable *37*
  Signal cable 7core *35*
  Signal cable 8core *32*
  USB Type A - Type C cable *40*
  USB Type C - Type C cable *40*
CAN bus termination *39*, *44*
CAN ID *42*
CAN interface *39*
codes (used in this document) *6*
Connections *18*
connector
  motor temperature sensor *40*
connectors
  X1 *20*
  X10 *37*
  X11 *38*
  X12 *38*
  X13 *39*
  X16 *40*
  X3 *22*
  X4 *23*
  X5 *24*
  X7 *31*
  X8 *35*
controller's *44*
country-specific regulations *8*

D

digital high-speed inputs (differential) *29*
digital high-speed inputs (single-ended) *30*
digital high-speed output *31*
digital incremental encoder (differential) *26*
digital incremental encoder (single-ended) *27*
digital inputs *32*, *33*
digital outputs *34*
DIP switch SW1 *42*

E

encoders
  absolute *27*
  absolute (single-ended) *27*
  incremental *26*
ESD *8*
EU directive, applicable *17*

H

Hall sensor *24*
how to
  calculate the required supply voltage *21*
  interpret icons (and signs) used in this document *6*

I

ID (of the device) *42*
incorporation into surrounding system *17*
informatory signs *6*
inputs
  analog *36*
  digital *32*, *33*
  high-speed digital *29*
interfaces
  CAN 1 *38*
  CAN 2 *38*
  location and designation *47*
  RS232 *37*
  USB *39*, *40*
  USB type A *40*
  USB Type C *40*
  USB type C *40*

L

LED *44*

M

mandatory action signs *6*
Motion connector set *19*

N

notations (used in this document) *6*

O

operating license *17*
outputs
  analog *36*
  digital *34*
  high-speed digital *31*

P

part numbers
  275829 *20*
  275851 *22*
  275878 *23*
  275934 *25*, *29*

520853 *32*
520854 *35*
520856 *37*
520857 *39*
520858 *38*
809635 *7*, *9*, *10*
834838 *9*, *10*
838461 *40*
845854 *40*
846644 *19*
847301 *41*
876085 *12*
performance data *9*
precautions *8*
prerequisites prior installation *17*
prohibitive signs *6*
protective measures (ESD) *8*
purpose
of the device *7*
of the document *5*

R

regulations, applicable *8*

S

safety alerts *6*
safety first! *8*
serial encoder *27*
signs used *6*
SSI absolute encoder *27*
standards, fulfilled *15*
status LEDs *44*
supply voltage, required *21*
SW1 *42*
symbols used *6*

T

technical data *9*
termination (CAN bus) *39*, *44*

U

USB port *39*

W

wiring examples
Analog I/Os *52*
CAN-CAN / CAN-COM cable *53*
DC motor *50*
Digital I/Os *52*
Digital incremental encoder *51*
EC (BLDC) motor *50*
High-speed digital I/Os *52*
Motor temperature sensor *54*
Power supply *50*
RS232 (future release) *53*
Sensor 1 Hall sensor *50*
Sensor 2 encoder I/Os *51*
SSI / BiSS C absolute encoder *51*
USB-A *54*
USB-C *54*

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