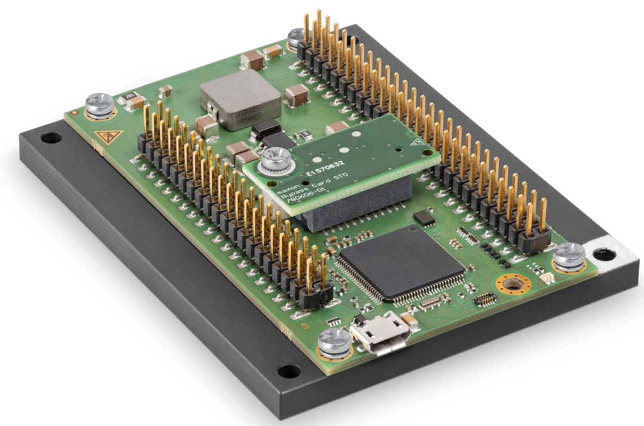
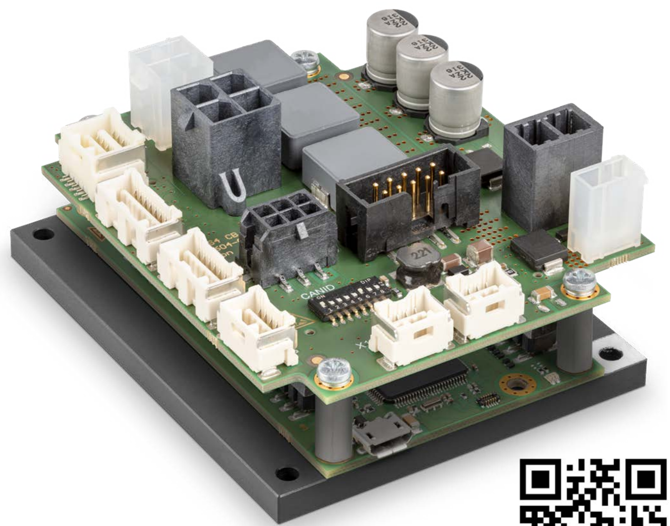
maxon

EPOS4 Module 60/20
EPOS4 Compact 60/20

Hardware Reference





CANopen

epos.maxongroup.com

EPOS4 Module/Compact 60/20 Positioning Controller | P/Ns 833716 / 894249 / 894250 / 833726
Hardware Reference
CCMC | Edition 2025-06 | DocID rel12744

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.*

EPOS4 Module 60/20 and EPOS4 Compact 60/20 *positioning controllers are 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!*

1 ABOUT

1.1 About this Document

1.1.1 Intended Purpose

The purpose of the present document is to familiarize you with the EPOS4 Module 60/20 and EPOS4 Compact 60/20 positioning controllers. 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 present document is part of a documentation set and contains performance data and specifications, information on fulfilled standards, details on connections and pin assignment, and wiring examples. The below overview shows the documentation hierarchy and the interrelationship of its individual parts:

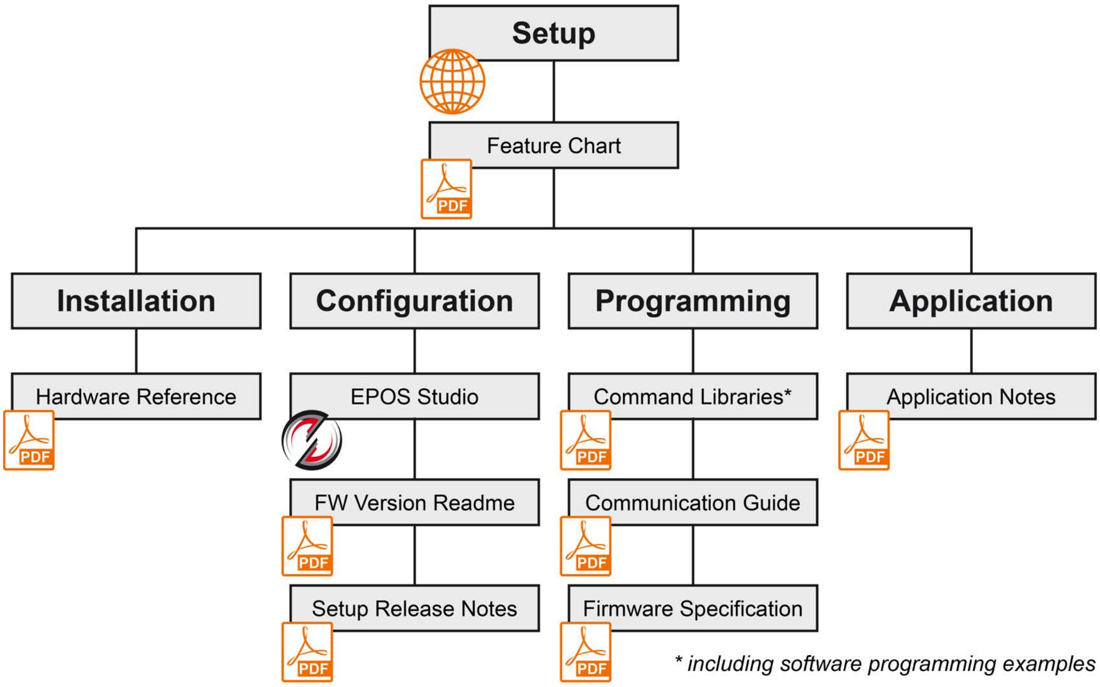


Figure 1-1 Documentation structure

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

If not stated otherwise, the described details are valid for both the plug-in module and the stand-alone compact version (➔Chapter "1.2 About the Devices" on page 1-8).

Throughout the document, the following notations and codes will be used.

Notation	Meaning
(n)	refers to an item (such as part numbers, list items, etc.)
➔	denotes "see", "see also", "take note of" or "go to"

Table 1-1 Notation used

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 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
Adobe® Reader®	© Adobe Systems Incorporated, USA-San Jose, CA
Bourns®	© Bourns, Inc., Riverside, California, United States
CANopen® CiA®	© CiA CAN in Automation e.V, Nuremberg, Germany
CLIK-Mate™ Micro-Fit™ Mini-Fit Jr.™ Mega-Fit®	© Molex, Lisle, Illinois, United States
E-tec Interconnect®	© E-tec Interconnect AG, Lengnau, Switzerland
Laird Smart Technology®	© Laird Smart Technology, London, United Kingdom
Linux®	© Linus Torvalds, The Linux Foundation, San Francisco, California, United States
Littelfuse®	© Littelfuse, Chicago, Illinois, United States
Nippon Chemi-Con®	© Nippon Chemi-Con Corporation, Osaki, Shinagawa-ku, Tokyo, Japan
Panasonic®	© Panasonic Corporation, Kadoma, Ōsaka, Japan
Rubycon®	© Rubycon Corporation, Nishi-Minowa, Ina, Nagano Prefecture, Japan
Samtec®	© Samtec Europe GmbH, Germering, Germany
Texas Instruments®	© Texas Instruments Inc., Dallas, Texas, United States
Vishay®	© Vishay Precision Group, Malvern, Pennsylvania, United States
Windows®	© Microsoft Corporation, Redmond, Washington, United States
Würth Elektronik®	© Würth Elektronik ICS GmbH & Co. KG, Niedernhall-Waldzimmern, Germany

Table 1-3 Brand names and trademark owners

1.1.6 Copyright

CCMC | EPOS4 Module/Compact 60/20 Hardware Reference | Edition 2025-06 | DocID rel12744

1.2 About the Devices

maxon's EPOS4 Module 60/20 and EPOS4 Compact 60/20 are small-sized, full digital, smart positioning control units. Their high power density allow flexible use for brushed DC and brushless EC (BLDC) motors up to approximately 1´200 Watts with various feedback options, such as Hall sensors, incremental encoders as well as absolute sensors in a multitude of drive applications.

The devices are specially designed to be commanded and controlled as a slave node in a CANopen network. In addition, the units can be operated via any USB or RS232 communication port of a Windows or Linux workstation (the Module thereby requires an external transceiver). Moreover, the devices can be ordered with STO (Safe Torque Off) functionality. Optionally, an EtherCAT card is available for the Modules.

Latest technology, such as field-oriented control (FOC), acceleration/velocity feed forward, or dual loop, in combination with highest control cycle rates allow sophisticated, ease-of-use motion control.

Thanks to its smart design, the EPOS4 Module 60/20 can either be used in combination with EPOS4 CB 60/20 CAN connector board as a compact, integrated solution or be incorporated into customer-specific motherboards for single axis or multi axes motion control systems. The controller is available in the following configurations:

- **EPOS4 Module 60/20 (833716)**
  Plug-in module for use with maxon EPOS4 connector board or customer-specific motherboard
- **EPOS4 Module 60/20 STO (894249)**
  Plug-in module with STO (Safe Torque Off) Safety Card for use with maxon EPOS4 connector board or customer-specific motherboard
- **EPOS4 CB 60/20 CAN (833713)**
  Connector board for initial commissioning or combination to a compact solution providing all connectors, including CANopen and RS232 interface
- **EPOS4 Compact 60/20 CAN (894250)**
  Fully integrated, compact, ready-to-use assembly of plug-in module and CANopen connector board
- **EPOS4 Compact 60/20 CAN STO (833726)**
  Fully integrated, compact, ready-to-use assembly of plug-in module with STO (Safe Torque Off) Safety Card and CANopen connector board

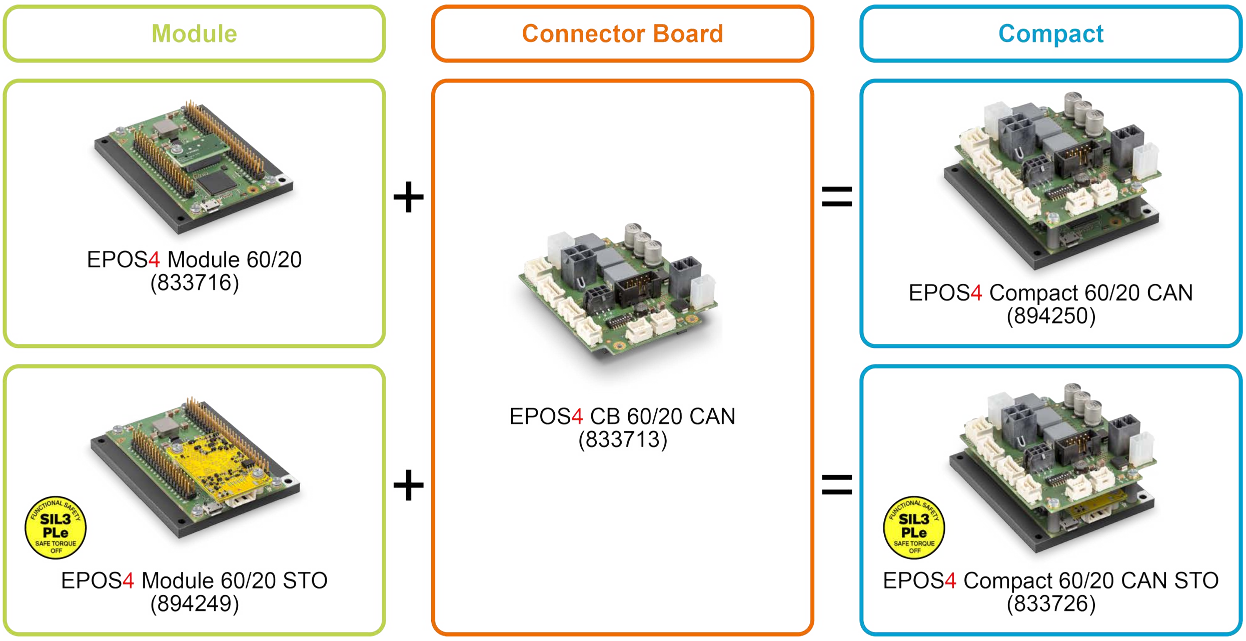


Figure 1-2 Configuration overview

For easier legibility, in the later course of this document naming of components will be as follows:

Short form	Meaning
CB	a connector board (EPOS4 CB 60/20 CAN)
Compact	any type of Compact 60/20 version
Compact CAN	EPOS4 Compact 60/20 CAN
EPOS4	all controller versions (Module and Compact) as well as other EPOS4 positioning controllers as a whole
Module	EPOS4 Module 60/20

Table 1-4 Abbreviations

Find the latest edition of the present document as well as additional documentation and software for EPOS4 positioning controllers also on the Internet: ➔http://epos.maxongroup.com.

In addition, you may wish to browse the EPOS video library. It features video tutorials that provide easy to follow instructions on how to get started with «EPOS Studio» and shows you tips and tricks on how to setup communication interfaces, and so on. Explore on Vimeo: ➔https://vimeo.com/album/4646388

1.3 About the Safety Precautions

- Make sure that you have read and understood the note “READ THIS FIRST” on page A-2!
- Do not engage with any work unless you possess the stated skills (➔Chapter “1.1.2 Target Audience” on page 1-5)!
- Refer to ➔Chapter “1.1.5 Trademarks and Brand Names” on page 1-7 to understand the subsequently used indicators!
- You must observe any regulation applicable in the country and/or at the site of implementation with regard to health and safety/accident prevention and/or environmental protection!

DANGER

High voltage and/or electrical shock
Touching live wires causes death or serious injuries!

- *Consider any power cable as connected to live power, unless having proven the opposite!*
- *Make sure that neither end of cable is connected to live power!*
- *Make sure that power source cannot be engaged while work is in process!*
- *Obey lock-out/tag-out procedures!*
- *Make sure to securely lock any power engaging equipment against unintentional engagement and tag it with your name!*
- *Install touch protection on the motor connection.*
  If the motor connection is not protected, it can cause electric shock or serious injury.

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)

- *Wear working cloth and use equipment in compliance with ESD protective measures.*
- *Handle device with extra care.*

WARNING

Check EPOS4 for damage before installation

- *Check the packaging and the EPOS4 for visible damage.*
- *Visually inspect the EPOS4 before installation.*
- *Damage to the EPOS4 can cause hazardous malfunctions.*

WARNING

Operate the EPOS4 only in environments with a pollution degree of 2 or lower.

- *INSTRUCTION:*
  Make sure that the pollution degree of the environment does not exceed level 2.

WARNING

Use a power supply that meets the specified input values of the EPOS4 Positioning Controller.
The power supply must meet the SELV or PELV requirements and comply with protection class III.
Make sure that voltage fluctuations in the system do not exceed the compatibility levels defined in IEC 61000-2-4.

2 SPECIFICATIONS

2.1 Technical Data

EPOS4 Module 60/20 (833716) / EPOS4 Module 60/20 STO (894249) EPOS4 Compact 60/20 CAN (894250) / EPOS4 Compact 60/20 CAN STO (833726)			
Electrical Rating	Nominal power supply voltage $+V_{CC}$	10…60 VDC, SELV/PELV (protection class III) voltage proof	
	Nominal logic supply voltage $+V_C$	Module	10…60 VDC, SELV/PELV (protection class III) voltage proof
		Compact	10…60 VDC, SELV/PELV (protection class III) voltage proof
	Absolute supply voltage $+V_{min}$ / $+V_{max}$	9 VDC / 72 VDC	
	Output voltage (max.)	0.9 × $+V_{CC}$	
	Output current I_{cont} / I_{max} (<15 s)	20 A / 40 A	
	Pulse Width Modulation frequency	50 kHz	
	Sampling rate PI current controller	25 kHz (40 µs)	
	Sampling rate PI speed controller	2.5 kHz (400 µs)	
	Sampling rate PID positioning controller	2.5 kHz (400 µs)	
	Sampling rate analog input	2.5 kHz (400 µs)	
	Max. efficiency	98% (➔Figure 2-4)	
	Max. speed DC motor	limited by max. permissible speed (motor)	
	Max. speed EC motor (block)	100’000 rpm (1 pole pair)	
	Max. speed EC motor (sinusoidal)	50’000 rpm (1 pole pair)	
	Built-in motor choke	Module	—
		Compact CAN	3 × 1 µH; 20 A
Inputs & Outputs	Digital Input 1 (general purpose) Digital Input 2 (general purpose) Digital Input 3 (general purpose) Digital Input 4 (general purpose)	Module	+2.1…+36 VDC
		Compact CAN	DIP switch-selectable levels: • Logic: +2.0…+30 VDC • PLC: +9.0…+30 VDC
	Digital Output 1 (general purpose) Digital Output 2 (general purpose)	Module	max. 60 VDC / 1’000 mA (open drain with internal pull-up, configurable for "Holding Brake" functionality)
		Compact CAN	max. 60 VDC / 500 mA (open drain with internal pull-up, configurable for "Holding Brake" functionality)
	STO Input 1 STO Input 2	Requires an optionally available extension card, for details refer to ➔ «Safety Card STO User Manual»	
	Analog Input 1 Analog Input 2	Resolution 12-bit, −10…+10 V, 10 kHz, differential	
	Analog Output 1 Analog Output 2	Resolution 12-bit, −4…+4 V, 25 kHz, referenced to GND	

Continued on next page.

<table>
<tr><th colspan="5">EPOS4 Module 60/20 (833716) / EPOS4 Module 60/20 STO (894249)
EPOS4 Compact 60/20 CAN (894250) / EPOS4 Compact 60/20 CAN STO (833726)</th></tr>
<tr><td rowspan="3">Inputs & Outputs (continued)</td><td colspan="2">Digital Hall sensor signals H1, H2, H3</td><td colspan="2">+2.0…+24 VDC (internal pull-up)</td></tr>
<tr><td colspan="2">Digital incremental encoder signals
A, A\, B, B\, I, I\</td><td colspan="2">EIA RS422, max. 6.25 MHz</td></tr>
<tr><td colspan="2">Sensor signals
(choice between multiple functions)
Digital incremental encoder
Analog incremental encoder SinCos
SSI absolute encoder
High-speed digital input 1…4
High-speed digital output 1</td><td colspan="2">

3-channel, EIA RS422, max. 6.25 MHz
3-channel, resolution 12-bit, ±1.8 V, differential
configurable, EIA RS422, 0.4…2 MHz
EIA RS422, max. 6.25 MHz
EIA RS422, max. 6.25 MHz</td></tr>
<tr><td rowspan="2">Voltage Outputs</td><td colspan="2">Sensor supply voltage V_{Sensor}</td><td colspan="2">+5 VDC / I_L ≤100 mA</td></tr>
<tr><td colspan="2">Auxiliary output voltage V_{Aux}</td><td colspan="2">+5 VDC / I_L ≤145 mA</td></tr>
<tr><td rowspan="2">Motor Connections</td><td colspan="2">DC motor</td><td colspan="2">+ Motor, − Motor</td></tr>
<tr><td colspan="2">EC motor</td><td colspan="2">Motor winding 1, Motor winding 2, Motor winding 3</td></tr>
<tr><td rowspan="4">Interfaces</td><th colspan="2"></th><th>Module</th><th>Compact CAN</th></tr>
<tr><td colspan="2">USB 2.0 / USB 3.0</td><td colspan="2">Full Speed</td></tr>
<tr><td colspan="2">RS232</td><td>max. 115’200 bit/s;
external transceiver necessary</td><td>max. 115’200 bit/s</td></tr>
<tr><td colspan="2">CAN</td><td colspan="2">max. 1 Mbit/s</td></tr>
<tr><td>Status Indicators</td><td colspan="2">Device status</td><td colspan="2">Operation (green)
Error (red)</td></tr>
<tr><td rowspan="3">Physical</td><td colspan="2">Weight</td><td>approx. 96 g</td><td>approx. 171 g</td></tr>
<tr><td colspan="2">Dimensions (L × W × H) [mm]</td><td>80 × 64 × 17.9</td><td>80 × 69 × 35</td></tr>
<tr><td colspan="2">Mounting</td><td>pluggable female headers 2.54 mm
or
mounting holes for M3 screws</td><td>mounting holes for M3 screws</td></tr>
<tr><td rowspan="6">Environment</td><td rowspan="3">Temperature</td><td>Operation</td><td colspan="2">−30…+30 °C</td></tr>
<tr><td>Extended range</td><td colspan="2">+30...+72 °C
Derating −0.488 A/°C (➔Figure 2-3)</td></tr>
<tr><td>Storage</td><td colspan="2">−40...+85 °C</td></tr>
<tr><td rowspan="2">Altitude [b]</td><td>Operation</td><td colspan="2">0…500 m MSL</td></tr>
<tr><td>Extended range [a]</td><td colspan="2">500…10’000 m MSL
Derating ➔Figure 2-3</td></tr>
<tr><td colspan="2">Humidity</td><td colspan="2">5…90% (condensation not permitted)</td></tr>
</table>

[a] If you use the Safety Card STO, the extended range is restricted.
For more information, refer to the Safety Card STO User Manual.

[b] Operating altitude in meters above Mean Sea Level, MSL.

Table 2-5 Technical data

2.2 Thermal Data

2.2.1 Derating of Output Current

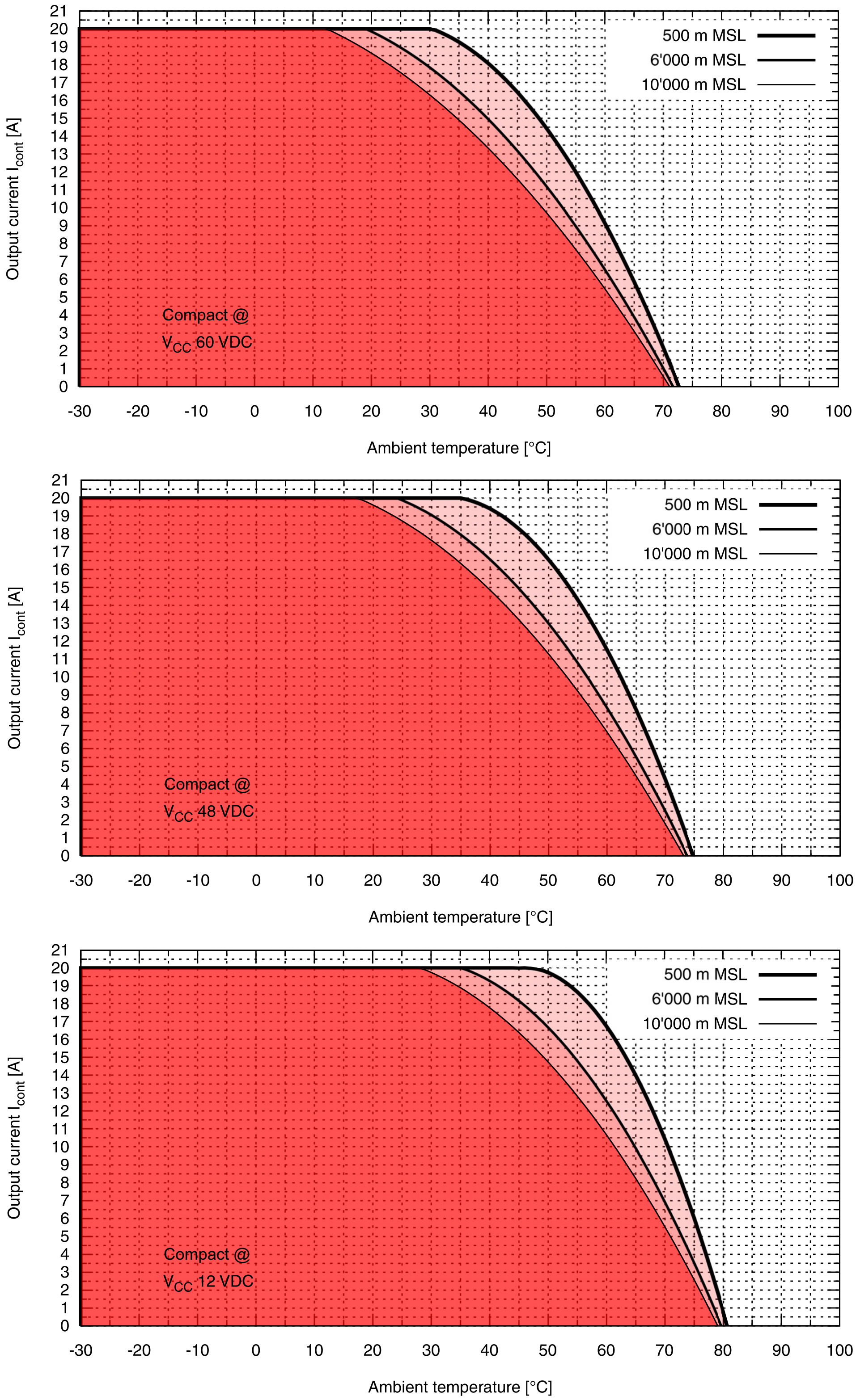


Figure 2-3 Derating of output current

2.2.2 Power Dissipation and Efficiency

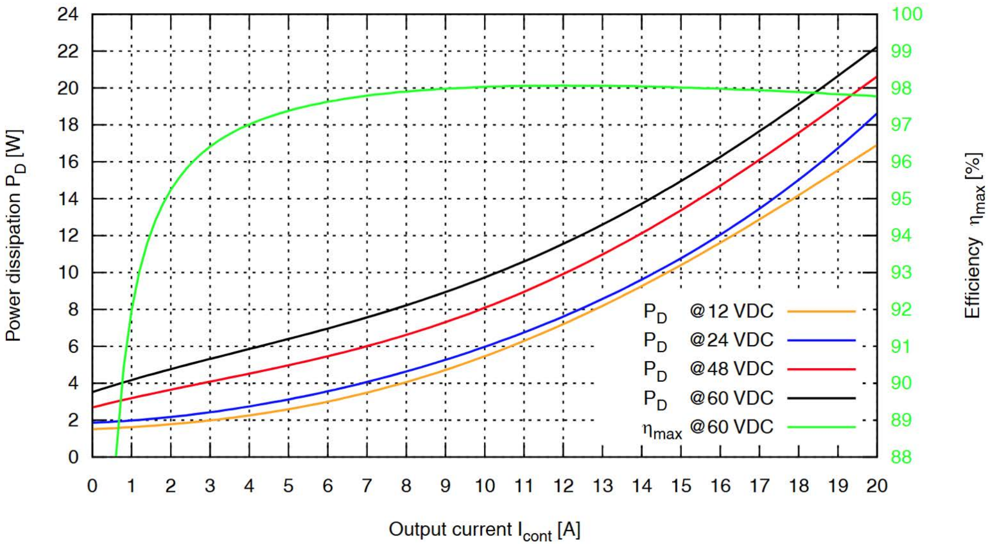


Figure 2-4 Power dissipation and efficiency – EPOS4 Module/Compact 60/20 CAN

2.3 Limitations

Protection functionality	Switch-off threshold	Recovery threshold
Undervoltage	9 V	10 V
Overvoltage	74 V	72 V
Overcurrent	60 A	—
Thermal overload	95 °C	90 °C

Table 2-6 Limitations

2.4 Dimensional Drawings

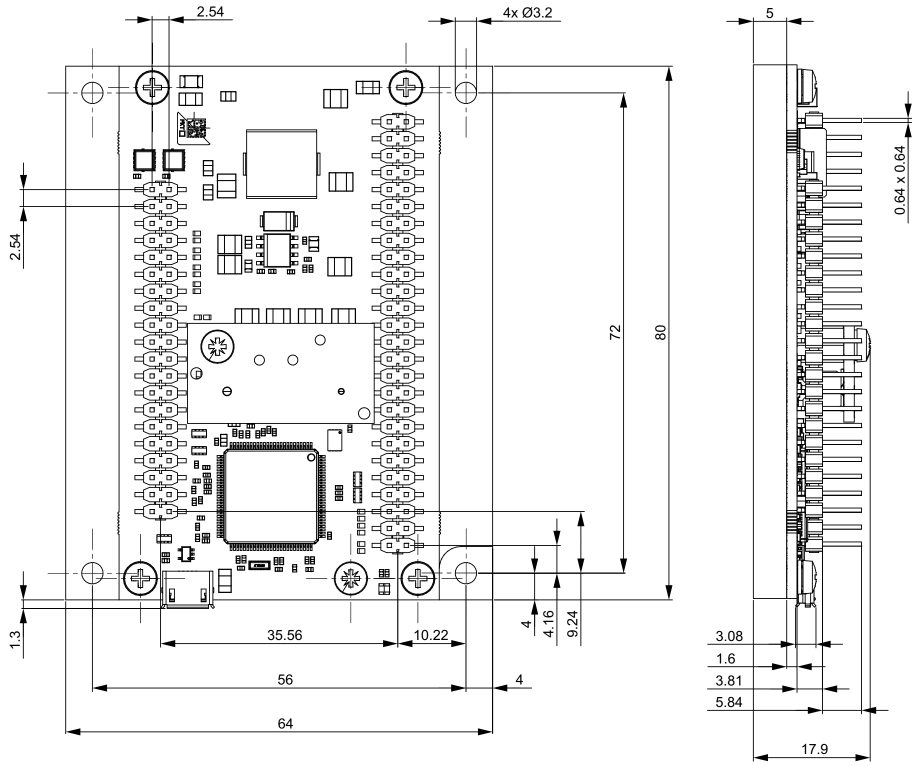


Figure 2-5 EPOS4 Module 60/20 – Dimensional drawing [mm]

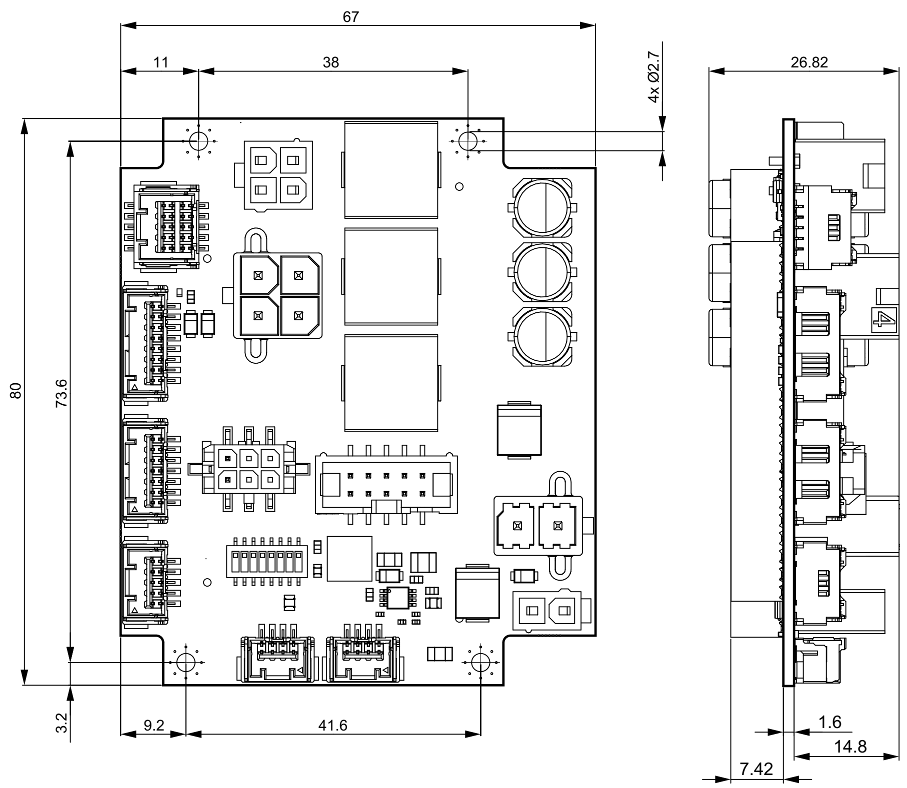


Figure 2-6 EPOS4 CB 60/20 CAN – Dimensional drawing [mm]

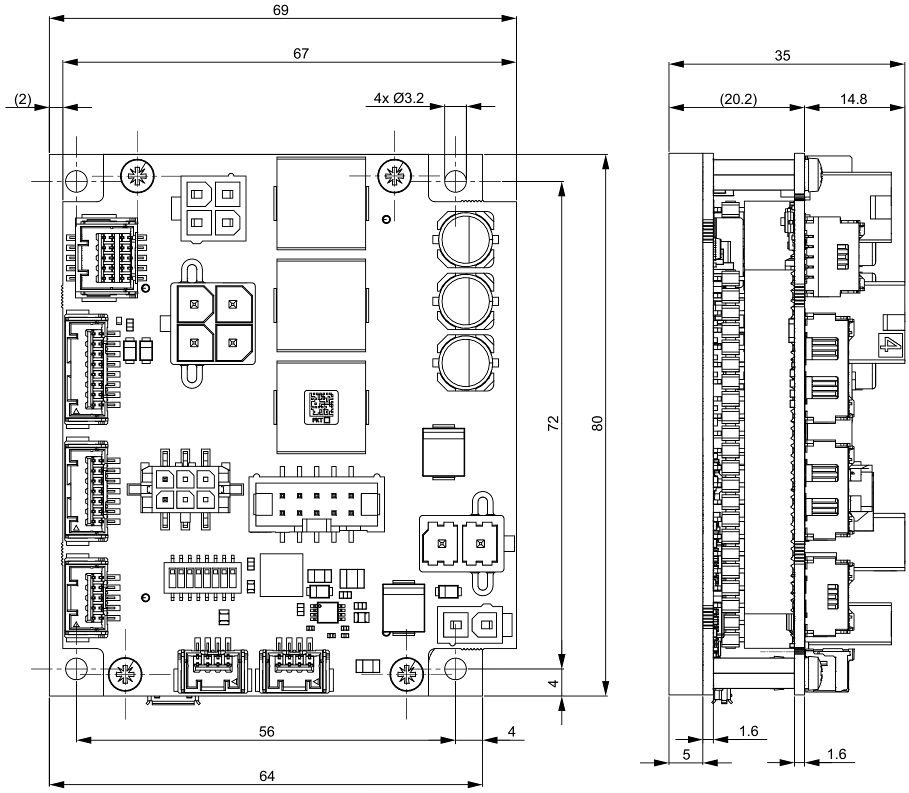


Figure 2-7 EPOS4 Compact 60/20 CAN – Dimensional drawing [mm]

2.5 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	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 (CISPR22)	Radio disturbance characteristics / radio interference
	IEC/EN 61000-4-2	Electrostatic discharge, restricted to connectors only (no housing) • 6 kV contact discharge or 8 kV air discharge
	IEC/EN 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test • 80 MHz to 1 GHz 20 V/m, 80% AM (1 kHz) • 1.4 GHz to 2.0 GHz 10 V/m, 80% AM (1 kHz) • 2.0 GHz bis 6.0 GHz 3 V/m, 80% AM (1 kHz)
	IEC/EN 61000-4-4	Electrical fast transient/burst immunity test ± 4 kV (power ports), ± 2 kV (signal ports)
	IEC/EN 61000-4-6	Immunity to conducted disturbances, induced by radio-frequency fields • 0.15 MHz bis 80 MHz 20 V/m, 80% AM (1 kHz)

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 board • Module: E207844 • Compact CAN: E207844
	IEC/EN 61800-5-1	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
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) • Module: 151'757 hours • Compact CAN: 123'439 hours

Table 2-7 Standards

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3 SETUP

IMPORTANT NOTICE: PREREQUISITES FOR PERMISSION TO COMMENCE INSTALLATION

EPOS4 Module 60/20 and EPOS4 Compact 60/20 positioning controllers are 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**.

WARNING

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

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

3.1 Generally applicable Rules

Maximal permitted supply voltage

- *Make sure that supply power is between 10…60 VDC.*
- *Supply voltages above 72 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 are as follows:*
  – continuous max. 20 A
  – short-time (acceleration) max. 40 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 Pin Assignment for Module Version

For in-depth details on connections ➔Chapter “3.4 Connection Specifications” on page 3-40.

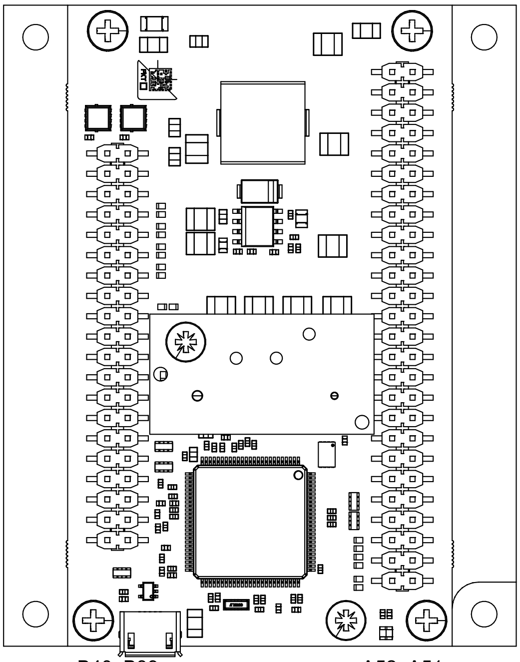


Figure 3-8 Pin assignment

Pin	Signal	Description
A1…A8**	Motor (+M)	DC motor: Motor +
	Motor winding 1	EC motor: Winding 1
A9…A16**	Motor (−M)	DC motor: Motor −
	Motor winding 2	EC motor: Winding 2
A17…A24**	Motor winding 3	EC motor: Winding 3
A25…A32**	$+V_{CC}$	Power supply voltage (+10…+60 VDC)
A34	$+V_C$	Logic supply voltage (+10…+60 VDC)
A33, A35…A42**	GND	Ground
A43	Hall sensor 1	Hall sensor 1 input
A44	Hall sensor 2	Hall sensor 2 input
A45	Hall sensor 3	Hall sensor 3 input
A46	V_{Sensor}	Sensor supply voltage (+5 VDC; $I_L \leq 100$ mA)
A47	Channel A	Digital incremental encoder channel A
A48	Channel A\	Digital incremental encoder channel A complement
A49	Channel B	Digital incremental encoder channel B
A50	Channel B\	Digital incremental encoder channel B complement
A51	Channel I	Digital incremental encoder channel I
A52	Channel I\	Digital incremental encoder channel I complement
** Connect all pins in respect to the individual pin current rating.		

Table 3-8 Pin assignment A1…A52 (X1…X5)

Pin	Signal	Description
B1	DigIN1	Digital input 1
B2	DigIN2	Digital input 2
B3	DigIN3	Digital input 3
B4	DigIN4	Digital input 4
B5	DigOUT1	Digital output 1
B6	DigOUT2	Digital output 2
B7	Channel A	Digital/analog incremental encoder channel A
	HsDigIN1	High-speed digital input 1
B8	Channel A\	Digital/analog incremental encoder channel A complement
	HsDigIN1\	High-speed digital input 1 complement
B9	Channel B	Digital/analog incremental encoder channel B
	HsDigIN2	High-speed digital input 2
B10	Channel B\	Digital/analog incremental encoder channel B complement
	HsDigIN2\	High-speed digital input 2 complement
B11	Channel I	Digital/analog incremental encoder channel I
	HsDigIN3	High-speed digital input 3
	Clock	Clock (SSI)
	HsDigOUT1	High-speed digital output 1
B12	Channel I\	Digital/analog incremental encoder channel I complement
	HsDigIN3\	High-speed digital input 3 complement
	Clock\	Clock (SSI) complement
	HsDigOUT1\	High-speed digital output 1 complement
B13	Data	Data (SSI)
	HsDigIN4	High-speed digital input 4
B14	Data\	Data (SSI) complement
	HsDigIN4\	High-speed digital input 4 complement
B15	V_{Aux}	Auxiliary output voltage (+5 VDC; $I_L \leq$145 mA)
B16	GND	Ground
B17	AnIN1+	Analog input 1, positive signal
B18	AnIN1−	Analog input 1, negative signal
B19	AnIN2+	Analog input 2, positive signal
B20	AnIN2−	Analog input 2, negative signal
B21	AnOUT1	Analog output 1
B22	AnOUT2	Analog output 2
B23	ID 1	CAN ID / DEV ID 1 (valence = 1)
B24	ID 2	CAN ID / DEV ID 2 (valence = 2)
B25	ID 3	CAN ID / DEV ID 3 (valence = 4)
B26	ID 4	CAN ID / DEV ID 4 (valence = 8)
B27	ID 5	CAN ID / DEV ID 5 (valence = 16)
B28	Auto bit rate	Automatic bit rate detection of CAN bus
B29	CAN high	CAN high bus line
B30	CAN low	CAN low bus line
B31…B32	GND	Ground

Continued on next page.

Pin	Signal	Description
B33 [c]	DSP_RxD	Serial Communication Interface Receive (UART)
B34	DSP_TxD	Serial Communication Interface Transmit (UART)
B35 [d]	SPI_CLK	Serial Peripheral Interface Clock
B36 [d]	SPI_IRQ	Serial Peripheral Interface Interrupt request
B37 [d]	SPI_SOMI	Serial Peripheral Interface Slave output, Master input
B38 [d]	SPI_SIMO	Serial Peripheral Interface Slave input, Master output
B39 [d]	SPI_CS2	Serial Peripheral Interface Chip select 2
B40 [d]	SPI_CS1	Serial Peripheral Interface Chip select 1

[c] connect to sensor supply voltage V_{Sensor} (A46) when RS232 is not in use
[d] only used for maxon extension modules

Table 3-9 Pin assignment B1…B40 (X6…X11)

3.3 Pin Assignment for Connector Boards & Compact Versions

As an alternative to developing an own motherboard, ready-made connector boards are available to combine the Module to Compact versions. They comprise all required connections.
For in-depth details on connections ➔Chapter “3.4 Connection Specifications” on page 3-40.

3.3.1 EPOS4 CB 60/20 CAN (833713) / EPOS4 Compact 60/20 CAN (894250)

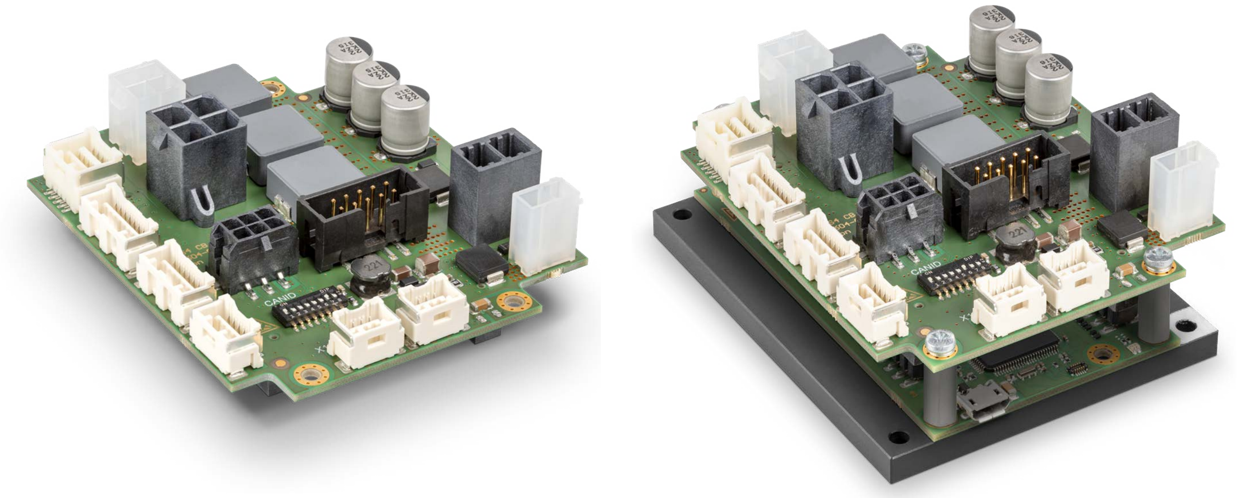


Figure 3-9 EPOS4 CB 60/20 CAN (left) / EPOS4 Compact 60/20 CAN (right)

3.3.2 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.

Connector	Prefab Cable Assembly		
Compact CAN	Designation	Part Number	➔Page
X1	Power Cable High Current **Mandatory for supply of power stage!**	520850	3-26
X2	Power Cable **Mandatory for supply of logic part!**	275829	3-27
X3a	Motor Cable	275851	3-29
X3b	Motor Cable High Current	520851	3-29
X4	Hall Sensor Cable	275878	3-30
X5	Encoder Cable	275934	3-31
X6	Sensor Cable 5×2core	520852	3-33
X7	Signal Cable 8core	520853	3-33
X8	Signal Cable 7core	520854	3-34
X10	RS232-COM Cable	520856	3-35
X11	CAN-COM Cable CAN-CAN Cable	520857 520858	3-36 3-36
X12	CAN-COM Cable CAN-CAN Cable	520857 520858	3-36 3-36
X13	USB Type A - micro B Cable (located at the Module)	403968	3-71

Table 3-10 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.

EPOS4 Connector Set (520859)		
Connector	**Specification**	**Quantity**
Connectors		
X1	Molex Mega-Fit, 2 poles (171692-0102)	1
X2	Molex Mini-Fit Jr., 2 poles (39-01-2020)	2
X3a	Molex Mini-Fit Jr., 4 poles (39-01-2040)	1
X3b	Molex Mega-Fit, 4 poles (171692-0104)	1
X4	Molex Micro-Fit 3.0, 6 poles (430-25-0600)	1
X6	Molex CLIK-Mate, dual row, 10 poles (503149-1000)	1
X7	Molex CLIK-Mate, single row, 8 poles (502578-0800)	2
X8	Molex CLIK-Mate, single row, 7 poles (502578-0700)	1
X10	Molex CLIK-Mate, single row, 5 poles (502578-0500)	1
X11 / X12	Molex CLIK-Mate, single row, 4 poles (502578-0400)	2
Crimp Terminals		
X1 / X3b	Molex Mega-Fit, female crimp terminal (172063-0311)	7
X2 / X3a	Molex Mini-Fit Jr. female crimp terminal (45750-1111)	9
X4	Molex Micro-Fit 3.0 female crimp terminal (43030-0010)	7
X6...X8 X10…X12	Molex CLIK-Mate crimp terminal (502579-0100)	44
Accessories		
X5	3M Retainer Clip with strain relief, height 13.5 mm (3505-8110)	1

Table 3-11 EPOS4 Connector Set – Content

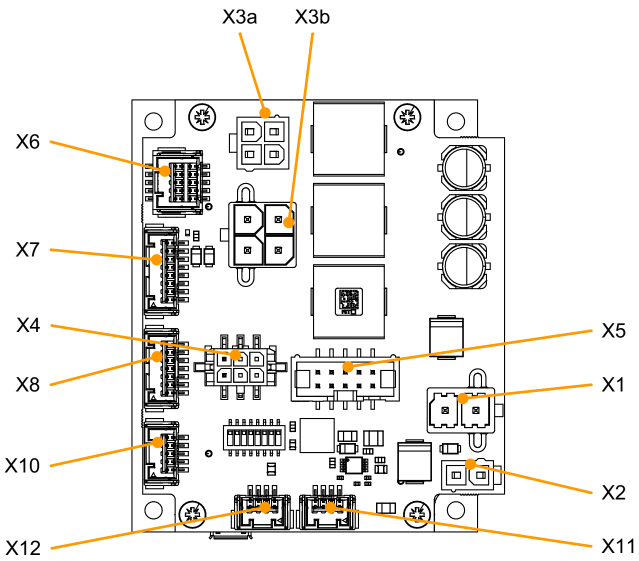
3.3.3 Tools

Tool	Manufacturer	Part Number
Hand crimper for CLIK-Mate crimp terminals	Molex	63819-4600
Hand crimper for Micro-Fit 3.0 crimp terminals	Molex	63819-0000
Hand crimper for Mega-Fit crimp terminals	Molex	63825-7100
Hand crimper for Mini-Fit crimp terminals	Molex	63819-0900

Table 3-12 Recommended tools

3.3.4 Connections

The USB interface (X13) is located at the Module.



X1	**Power Supply ➔Page 3-26**
X2	**Logic Supply ➔Page 3-27**
X3a	**Motor ➔Page 3-28**
X3b	**Motor ➔Page 3-28**
X4	**Hall Sensor ➔Page 3-30**
X5	**Encoder ➔Page 3-31**
X6	**Sensor ➔Page 3-32**
X7	**Digital I/O ➔Page 3-33**
X8	**Analog I/O ➔Page 3-34**
X10	**RS232 ➔Page 3-35**
X11	**CAN 1 ➔Page 3-36**
X12	**CAN 2 ➔Page 3-36**

Figure 3-10 Connector Boards – Connectors

How to read pin assignment tables
- *The first column describes both the pin number of the connector and of the matching prefab maxon cable's Head A.*
- *The second column describes the cable core color of the prefab maxon cable.*
- *The third column describes the pin number of the prefab maxon cable's Head B.*

3.3.4.1 Power Supply (X1)

Use of X1 is mandatory
You must employ X1 to connect the power stage of the controller to the electrical supply. Use of X2 is also mandatory.

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

WARNING

Use a power supply that meets SELV (Safety Extra Low Voltage) or PELV (Protective Extra Low Voltage) requirements.
The power supply must also comply with protection class III.

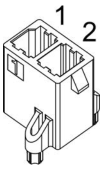


Figure 3-11 Power supply connector X1

X1 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	black	–	GND	Ground
2	black	+	$+V_{CC}$	Power supply voltage (+10…+60 VDC)

Table 3-13 Power supply connector X1 – Pin assignment

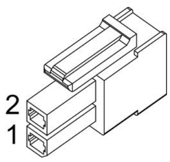
<table>
<tr><th colspan="3">Power Cable High Current (520850)</th></tr>
<tr><td colspan="3">A  B</td></tr>
<tr><td>Cross-section</td><td colspan="2">2 × 2.5 mm^2, grey</td></tr>
<tr><td>Length</td><td colspan="2">3 m</td></tr>
<tr><td rowspan="2">Head A</td><td>Plug</td><td>Molex Mega-Fit, 2 poles (171692-0102)</td></tr>
<tr><td>Contacts</td><td>Molex Mega-Fit, female crimp terminals (172063)</td></tr>
<tr><td>Head B</td><td colspan="2">Wire end sleeves 2.5 mm^2</td></tr>
</table>

Table 3-14 Power Cable High Current

3.3.4.2 Logic Supply (X2)

Use of X2 is mandatory
You must employ X2 to connect the logic part of the controller to the electrical supply.

WARNING

Use a power supply that meets SELV (Safety Extra Low Voltage) or PELV (Protective Extra Low Voltage) requirements.
The power supply must also comply with protection class III.

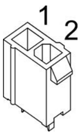


Figure 3-12 Logic supply connector X2

X2 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	black	–	GND	Ground
2	black	+	$+V_C$	Logic supply voltage (+10…+60 VDC)

Table 3-15 Logic supply connector X2 – Pin assignment

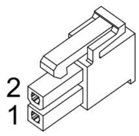
Power Cable (275829)		
A 		B
Cross-section	2 × 0.75 mm^2, grey	
Length	3 m	
Head A	Plug	Molex Mini-Fit Jr., 2 poles (39-01-2020)
	Contacts	Molex Mini-Fit Jr. female crimp terminals (45750)
Head B	Wire end sleeves 0.75 mm^2	

Table 3-16 Power Cable

3.3.4.3 Motor (X3a) (X3b)

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.

Maximum permitted current

The connectors are designed for the following output currents:

- *X3a: $I_{cont} \leq 11$ A*
- *X3b: $I_{cont} \leq 20$ A*

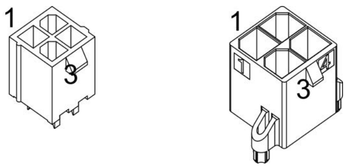


Figure 3-13 Motor connectors X3a (left) and X3b (right)

X3a X3b Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	white		Motor (+M)	DC motor: Motor +
2	brown		Motor (−M)	DC motor: Motor −
3	green		–	not connected
4	black		Motor shield	Cable shield

Table 3-17 Motor connector X3a / X3b – Pin assignment for maxon DC motor

X3a X3b Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	white		Motor winding 1	EC motor: Winding 1
2	brown		Motor winding 2	EC motor: Winding 2
3	green		Motor winding 3	EC motor: Winding 3
4	black		Motor shield	Cable shield

Table 3-18 Motor connector X3a / X3b – Pin assignment for maxon EC motor

Continued on next page.

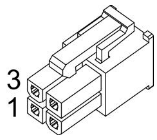
Motor Cable for X3a (275851)		
A 	B	
Cross-section	3 × 0.75 mm^2, shielded, grey	
Length	3 m	
Head A	Plug	Molex Mini-Fit Jr., 4 poles (39-01-2040)
	Contacts	Molex Mini-Fit Jr. female crimp terminals (45750)
Head B	Wire end sleeves 0.75 mm^2	

Table 3-19 Motor Cable

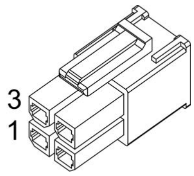
Motor Cable High Current for X3b (520851)		
A 	B	
Cross-section	3 × 2.5 mm^2, shielded, grey	
Length	3 m	
Head A	Plug	Molex Mega-Fit, 4 poles (171692-0104)
	Contacts	Molex Mega-Fit, female crimp terminals (172063)
Head B	Wire end sleeves 2.5 mm^2	

Table 3-20 Motor Cable High Current

maxon

3.3.4.4 Hall Sensor (X4)

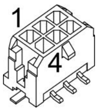


Figure 3-14 Hall sensor connector X4

X4 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	green		Hall sensor 1	Hall sensor 1 input
2	brown		Hall sensor 2	Hall sensor 2 input
3	white		Hall sensor 3	Hall sensor 3 input
4	yellow		GND	Ground
5	grey		V_{Sensor}	Sensor supply voltage (+5 VDC; $I_L \leq$100 mA)
6	black		Hall shield	Cable shield

Table 3-21 Hall sensor connector X4 – Pin assignment

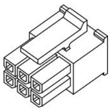
Hall Sensor Cable (275878)		
A 		B
Cross-section	5 × 0.14 mm^2, shielded, grey	
Length	3 m	
Head A	Plug	Molex Micro-Fit 3.0, 6 poles (430-25-0600)
	Contacts	Molex Micro-Fit 3.0 female crimp terminals (430-30-xxxx)
Head B	Wire end sleeves 0.14 mm^2	

Table 3-22 Hall Sensor Cable

3.3.4.5 Encoder (X5)

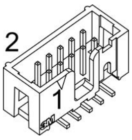


Figure 3-15 Encoder connector X5

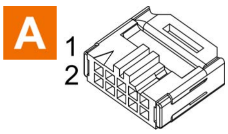
X5 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	brown	1	–	not connected
2	white	2	V_{Sensor}	Sensor supply voltage (+5 VDC; $I_L \leq 100$ mA)
3	red	3	GND	Ground
4	white	4	–	not connected
5	orange	5	Channel A\	Channel A complement
6	white	6	Channel A	Channel A
7	yellow	7	Channel B\	Channel B complement
8	white	8	Channel B	Channel B
9	green	9	Channel I\	Channel I complement
10	white	10	Channel I	Channel I

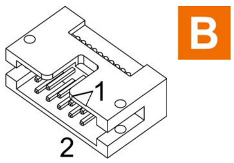
Table 3-23 Encoder connector X5 – Pin assignment

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

Table 3-24 Encoder connector X5 – Accessories

Encoder Cable (275934)





Encoder Cable (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 3-25 Encoder Cable

3.3.4.6 Sensor (X6)

Additional sensors, both incremental and serial encoders, can be connected.

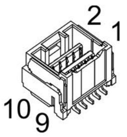


Figure 3-16 Sensor connector X6

X6 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	white	1	Channel A	Digital/analog incremental encoder channel A
			HsDigIN1	High-speed digital input 1
2	brown	2	Channel A\	Digital/analog incremental encoder channel A complement
			HsDigIN1\	High-speed digital input 1 complement
3	green	3	Channel B	Digital/analog incremental encoder channel B
			HsDigIN2	High-speed digital input 2
4	yellow	4	Channel B\	Digital/analog incremental encoder channel B complement
			HsDigIN2\	High-speed digital input 2 complement
5	grey	5	Channel I	Digital/analog incremental encoder channel I
			HsDigIN3	High-speed digital input 3
			Clock	Clock (SSI)
			HsDigOUT1	High-speed digital output 1
6	pink	6	Channel I\	Digital/analog incremental encoder channel I complement
			HsDigIN3\	High-speed digital input 3 complement
			Clock\	Clock (SSI) complement
			HsDigOUT1\	High-speed digital output 1 complement
7	blue	7	Data	Data (SSI)
			HsDigIN4	High-speed digital input 4
8	red	8	Data\	Data (SSI) complement
			HsDigIN4\	High-speed digital input 4 complement
9	black	9	GND	Ground
10	violet	10	V_{Aux}	Auxiliary output voltage (+5 VDC; $I_L \leq 145$ mA)

Table 3-26 Sensor connector X6 – Pin assignment

Continued on next page.

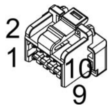
Sensor Cable 5x2core (520852)		
A 		B
Cross-section	5 × 2 × 0.14 mm^2, twisted pair, grey	
Length	3 m	
Head A	Plug	Molex CLIK-Mate, dual row, 10 poles (503149-1000)
	Contacts	Molex CLIK-Mate crimp terminals (502579)
Head B	Wire end sleeves 0.14 mm^2	

Table 3-27 Sensor Cable 5×2core

3.3.4.7 Digital I/O (X7)

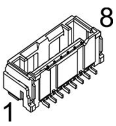


Figure 3-17 Digital I/O connector X7

X7 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	white	1	DigIN1	Digital input 1
2	brown	2	DigIN2	Digital input 2
3	green	3	DigIN3	Digital input 3
4	yellow	4	DigIN4	Digital input 4
5	grey	5	DigOUT1	Digital output 1
6	pink	6	DigOUT2	Digital output 2
7	blue	7	GND	Ground
8	red	8	$V_{I/O}$	$V_{I/O}$ (+5 VDC - 0.75 VDC = 4.25 VDC; $I_L \leq 145$ mA)

Table 3-28 Digital I/O connector X7 – Pin assignment

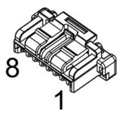
Signal Cable 8core (520853)		
A 		B
Cross-section	8 × 0.14 mm^2, grey	
Length	3 m	
Head A	Plug	Molex CLIK-Mate, single row, 8 poles (502578-0800)
	Contacts	Molex CLIK-Mate crimp terminals (502579)
Head B	Wire end sleeves 0.14 mm^2	

Table 3-29 Signal Cable 8core

3.3.4.8 Analog I/O (X8)

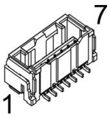


Figure 3-18 Analog I/O connector X8

X8 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	white	1	AnIN1+	Analog input 1, positive signal
2	brown	2	AnIN1−	Analog input 1, negative signal
3	green	3	AnIN2+	Analog input 2, positive signal
4	yellow	4	AnIN2−	Analog input 2, negative signal
5	grey	5	AnOUT1	Analog output 1
6	pink	6	AnOUT2	Analog output 2
7	blue	7	GND	Ground

Table 3-30 Analog I/O connector X8 – Pin assignment

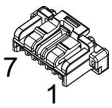
Signal Cable 7core (520854)		
A 		B
Cross-section	7 × 0.14 mm², grey	
Length	3 m	
Head A	Plug	Molex CLIK-Mate, single row, 7 poles (502578-0700)
	Contacts	Molex CLIK-Mate crimp terminals (502579)
Head B	Wire end sleeves 0.14 mm²	

Table 3-31 Signal Cable 7core

3.3.4.9 RS232 (X10)

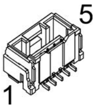


Figure 3-19 RS232 connector X10

X10 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	white	3	EPOS_RxD	EPOS RS232 receive
2	brown	5	GND	Ground
3	green	2	EPOS_TxD	EPOS RS232 transmit
4	yellow	5	GND	Ground
5	Shield	Housing	Shield	Cable shield

Table 3-32 RS232 connector X10 – Pin assignment

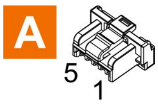
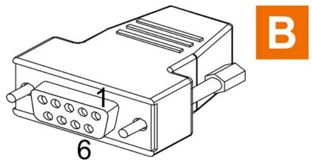
RS232-COM Cable (520856)		
		
Cross-section	2 × 2 × 0.14 mm^2, twisted pair, shielded	
Length	3 m	
Head A	Plug	Molex CLIK-Mate, single row, 5 poles (502578-0500)
	Contacts	Molex CLIK-Mate crimp terminals (502579)
Head B	Female D-Sub connector DIN 41652, 9 poles, with mounting screws	

Table 3-33 RS232-COM Cable

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

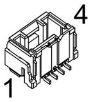
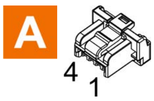


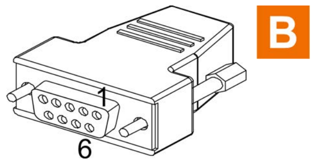
Figure 3-20 CAN 1 connector X11/CAN 2 connector X12

X11/X12 Head A Pin	Prefab Cable Color	520857 Head B Pin	520858 Head B Pin	Signal	Description
1	white	7	1	CAN high	CAN high bus line
2	brown	2	2	CAN low	CAN low bus line
3	green	3	3	GND	Ground
4	Shield	5	4	Shield	Cable shield

Table 3-34 CAN 1 connector X11/CAN 2 connector X12 – Pin assignment

CAN-COM Cable (520857)

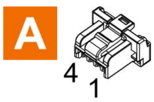


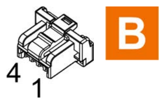


Cross-section	2 × 2 × 0.22 mm^2, twisted pair, shielded	
Length	3 m	
Head A	Plug	Molex CLIK-Mate, single row, 4 poles (502578-0400)
	Contacts	Molex CLIK-Mate crimp terminals (502579)
Head B	Female D-Sub connector DIN 41652, 9 poles, with mounting screws	

Table 3-35 CAN-COM Cable

CAN-CAN Cable (520858)





Cross-section	2 × 2 × 0.22 mm^2, twisted pair, shielded	
Length	3 m	
Head A	Plug	Molex CLIK-Mate, single row, 4 poles (502578-0400)
	Contacts	Molex CLIK-Mate crimp terminals (502579)
Head B	Plug	Molex CLIK-Mate, single row, 4 poles (502578-0400)
	Contacts	Molex CLIK-Mate crimp terminals (502579)

Table 3-36 CAN-CAN Cable

3.3.5 DIP Switch Configuration (SW1)

EPOS4 CB 60/20 CAN

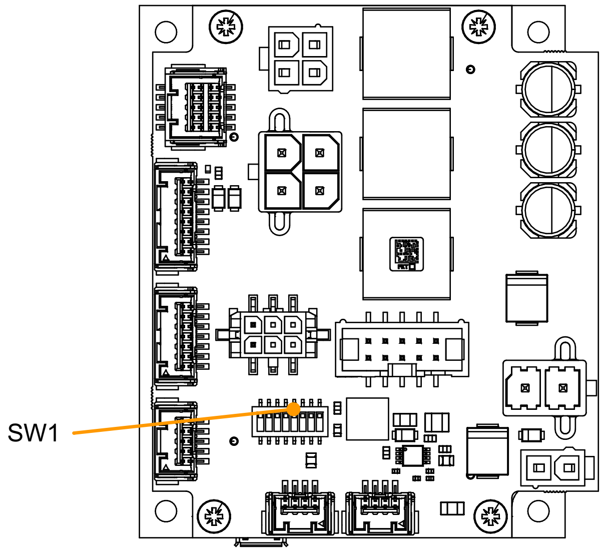


Figure 3-21 DIP switch SW1

3.3.5.1 CAN ID (Node-ID) / DEV ID

The device's identification (subsequently called "ID") is set by means of DIP switches 1…5. The ID (1…31) may be coded using binary code.

Setting the ID by DIP switch SW1

- *By setting the DIP switch (1…5) address 0 ("OFF"), the ID may be set by software (object 0x2000 «Node-ID», range 1…127).*
- *The ID results in the summed values of DIP switch addresses 1 ("ON").*
- *With EPOS4 CB 60/20 CAN, DIP switches 6…8 do not have any impact on the ID.*

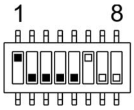
Controller Compact CAN	Switch	Binary Code	Valence
1 8  ON OFF (factory setting)	1	2^0	1
	2	2^1	2
	3	2^2	4
	4	2^3	8
	5	2^4	16

Table 3-37 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:

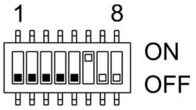
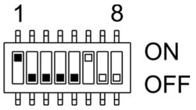
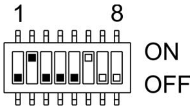
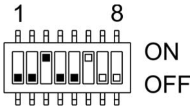
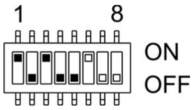
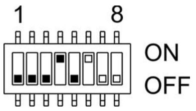
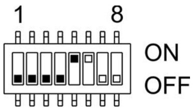
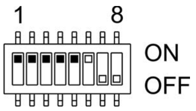
Controller Compact CAN	Switch 1	Switch 2	Switch 3	Switch 4	Switch 5	ID
	0	0	0	0	0	–
	**1**	0	0	0	0	1
	0	**1**	0	0	0	2
	0	0	**1**	0	0	4
	**1**	0	**1**	0	0	5
	0	0	0	**1**	0	8
	0	0	0	0	**1**	16
	**1**	**1**	**1**	**1**	**1**	31
0 = Switch "OFF" 1 = Switch "ON"						

Table 3-38 DIP switch SW1 – Examples

3.3.5.2 CAN automatic Bit Rate Detection (Compact CAN)

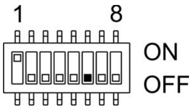
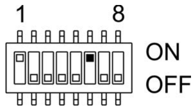
Controller	Switch	OFF	ON
Compact CAN	6	 Automatic bit rate detection deactivated	 Automatic bit rate detection activated (factory setting)

Table 3-39 DIP switch SW1 – CAN automatic bit rate detection

3.3.5.3 CAN Bus Termination (Compact CAN)

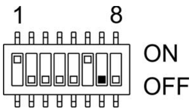
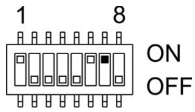
Controller	Switch	OFF	ON
Compact CAN	7	 Without bus termination (factory setting)	 Bus termination with 120 Ω

Table 3-40 DIP switch SW1 – CAN bus termination

3.3.5.4 Digital Input Level

For details ➔Chapter “3.4.7 Digital I/Os” on page 3-59.

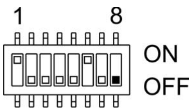
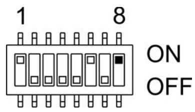
Controller	Switch	OFF	ON
Compact CAN	8	 Logic level (factory setting)	 PLC level

Table 3-41 DIP switch SW1 – Digital input level

3.4 Connection Specifications

The actual connection will depend on the overall configuration of your drive system and the type of motor you will be using. Follow the description in given order and choose the wiring diagram (➔as of Page 5-85) that best suits the components you are using.

WARNING

Use a power supply that meets SELV (Safety Extra Low Voltage) or PELV (Protective Extra Low Voltage) requirements.
The power supply must also comply with protection class III.

How to read the following data

The following tables feature, where applicable, connection details for both versions the Module and the Compact. Thereby,…

- *the column «Module Header Pin» refers to the Module's header pin number.*
  Example: **A13…A16** *means header A, pins 13 thru 16*
- *the column «Compact/CB Connector Pin» refers to the Compact's or CB's connector pin number.*
  Example: **X1 | 2** *means connector X1, pin 2*

For easier legibility, the subsequently used circuit diagrams refer to the Module. For the corresponding Compact's circuitry take the second column «Connector Pin» into account.

3.4.1 Power Supply

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

Module Header Pin	Compact/CB Connector Pin	Signal	Description
A25…A32**	X1 | 2	$+V_{CC}$	Power supply voltage (+10…+60 VDC)
A33, A35…A42**	X1 | 1	GND	Ground
** Connect all pins in respect to the individual pin current rating.			

Table 3-42 Power supply – Pin assignment

Power supply requirements	
Output voltage	$+V_{CC}$ 10…60 VDC
Absolute output voltage	min. 9 VDC; max. 72 VDC
Output current	Depending on load • continuous max. 20 A • short-time (acceleration, <15 s) max. 40 A

Table 3-43 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 overcurrent protection circuit is configured inoperative within the operating range.

Continued on next page.

The formula already takes the following into account:
- *Maximum PWM duty cycle of 90%*
- *Controller's max. voltage drop of 1 V @ 20 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 Δn/ΔM [rpm/mNm]

SOLUTION:

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

$$V_{CC} \geq \left[\frac{U_N}{n_O} \cdot \left(n + \frac{\Delta n}{\Delta M} \cdot M\right) \cdot \frac{1}{0.9}\right] + 1\,[V]$$

3.4.2 Logic Supply

WARNING

Use a power supply that meets SELV (Safety Extra Low Voltage) or PELV (Protective Extra Low Voltage) requirements.
The power supply must also comply with protection class III.

Separate power supply
The logic part of the controller must be supplied by a voltage supply that meets the below stated minimum requirements.
- *You will need to provide both, logic supply and power supply.*
- ***Use** two cables, the «Power Cable» (275829) to provide the logic supply and the «Power Cable High Current» (520850) to provide the power supply.*

Module Header Pin	Compact/CB Connector Pin	Signal	Description
A34	X2 | 2	$+V_C$	Logic supply voltage (+10…+60 VDC)
A33, A35…A42**	X2 | 1	GND	Ground
** Connect all pins in respect to the individual pin current rating.			

Table 3-44 Logic supply – Pin assignment

Power supply requirements	
Output voltage	$+V_C$ 10…60 VDC
Absolute supply voltage	min. 9 VDC; max. 72 VDC
Min. output power	P_C min. 3.5 W

Table 3-45 Logic supply requirements

3.4.3 Motor

The EPOS4 is set to drive either maxon DC motors (brushed) or maxon EC motors (brushless).

Module Header Pin	Compact/CB Connector Pin	Signal	Description
A1…A8**	X3a | 1 X3b | 1	Motor (+M)	Motor +
A9…A16**	X3a | 2 X3b | 2	Motor (−M)	Motor −
–	X3a | 3 X3b | 3	–	not connected
–	X3a | 4 X3b | 4	Motor shield	Cable shield
** Connect all pins in respect to the individual pin current rating.			

Table 3-46 DC motor – Pin assignment

Module Header Pin	Compact/CB Connector Pin	Signal	Description
A1…A8**	X3a | 1 X3b | 1	Motor winding 1	Winding 1
A9…A16**	X3a | 2 X3b | 2	Motor winding 2	Winding 2
A17…A24**	X3a | 3 X3b | 3	Motor winding 3	Winding 3
–	X3a | 4 X3b | 4	Motor shield	Cable shield
** Connect all pins in respect to the individual pin current rating.			

Table 3-47 EC motor – Pin assignment

3.4.4 Hall Sensor

Module Header Pin	Compact/CB Connector Pin	Signal	Description
A33, A35…A42	X4 | 4	GND	Ground
A43	X4 | 1	Hall sensor 1	Hall sensor 1 input
A44	X4 | 2	Hall sensor 2	Hall sensor 2 input
A45	X4 | 3	Hall sensor 3	Hall sensor 3 input
A46	X4 | 5	V_{Sensor}	Sensor supply voltage (+5 VDC; I_L ≤100 mA)
–	X4 | 6	Hall shield	Cable shield

Table 3-48 Hall sensor – Pin assignment

Hall sensor	
Sensor supply voltage (V_{Sensor})	+5 VDC
Max. Hall sensor supply current	30 mA
Input voltage	0…24 VDC
Max. input voltage	+24 VDC
Logic 0	typically <0.8 V
Logic 1	typically >2.0 V
Internal pull-up resistor	10 kΩ (referenced to +5.45 V)

Table 3-49 Hall sensor specification

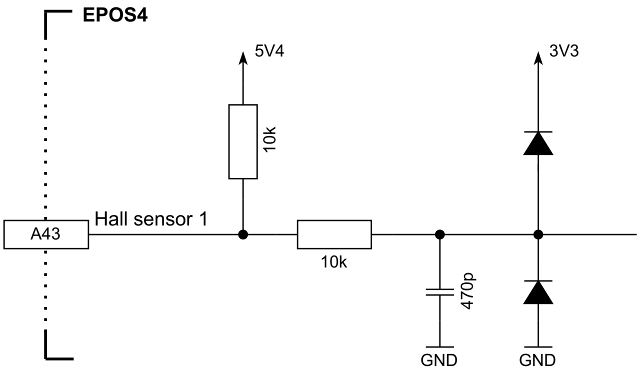


Figure 3-22 Hall sensor 1 input circuit (analogously valid for Hall sensors 2 & 3)

3.4.5 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).*
- *For best performance,* ***we strongly recommend using encoders with a line driver****. Otherwise, limitations may apply due to slow switching edges.*
- *Even though 2-channel will do,* ***we strongly recommend to use only 3-channel versions****.*

Module Header Pin	Compact/CB Connector Pin	Signal	Description
–	X5 | 1	–	not connected
A33, A35…A42	X5 | 3	GND	Ground
A46	X5 | 2	V_{Sensor}	Sensor supply voltage (+5 VDC; I_L ≤100 mA)
–	X5 | 4	–	not connected
A47	X5 | 6	Channel A	Digital incremental encoder channel A
A48	X5 | 5	Channel A\	Digital incremental encoder channel A complement
A49	X5 | 8	Channel B	Digital incremental encoder channel B
A50	X5 | 7	Channel B\	Digital incremental encoder channel B complement
A51	X5 | 10	Channel I	Digital incremental encoder channel I
A52	X5 | 9	Channel I\	Digital incremental encoder channel I complement

Table 3-50 Encoder – Pin assignment

Encoder (differential)	
Sensor supply voltage (V_{Sensor})	+5 VDC
Max. encoder supply current	70 mA
Min. differential input voltage	±200 mV
Max. input voltage	±12 VDC
Line receiver (internal)	EIA RS422 standard
Max. input frequency	6.25 MHz

Table 3-51 Differential encoder specification

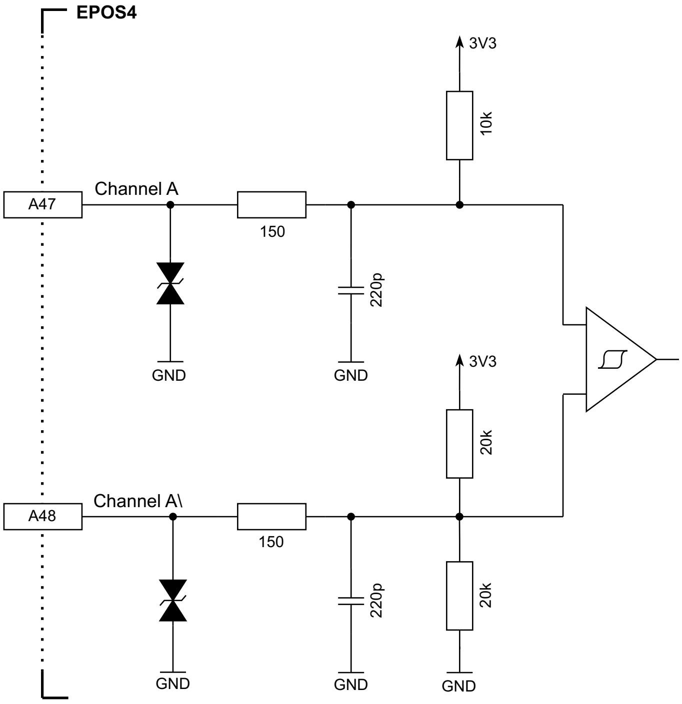


Figure 3-23 Encoder input circuit Ch A “differential” (analogously valid for Ch B & Ch I)

Encoder (single-ended)		
Sensor supply voltage (V_{Sensor})		+5 VDC
Max. encoder supply current		70 mA
Input voltage		0…5 VDC
Max. input voltage		±12 VDC
Logic 0		<1.0 V
Logic 1		>2.4 V
Input high current		I_{IH} = typically +250 µA @ 5 V
Input low current		I_{IL} = typically −330 µA @ 0 V
Max. input frequency	Push-pull	6.25 MHz
	Open collector	40 kHz (internal pull-up only) 150 kHz (additional external 3k3 pull-up)

Table 3-52 Single-ended encoder specification

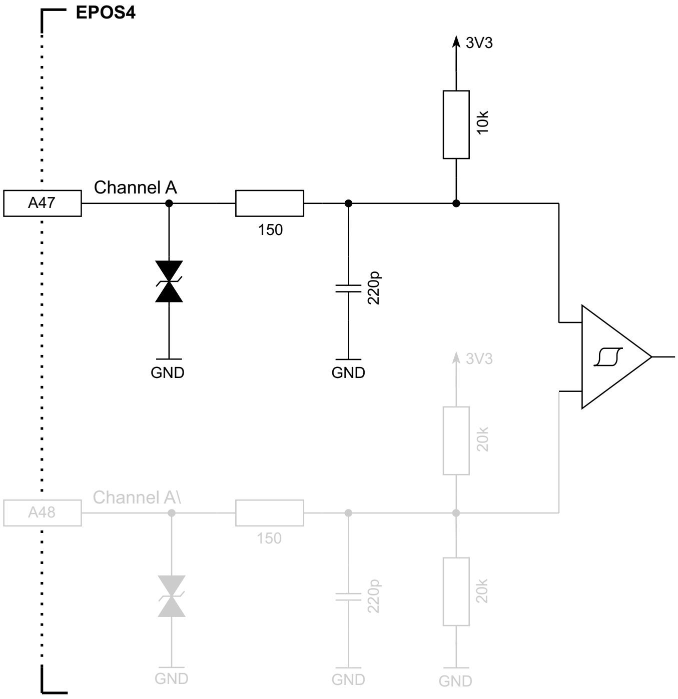


Figure 3-24 Encoder input circuit Ch A "single-ended" (analogously valid for Ch B & Ch I)

3.4.6 Sensor

Check on the applied sensor's data sheet
If the specified inrush current or the maximum continuous current of the sensor should exceed 145 mA, you can connect the sensor supply voltage (V_{Sensor}) in parallel to the auxiliary output voltage (V_{Aux}).

3.4.6.1 Incremental Encoder

Module Header Pin	Compact/CB Connector Pin	Signal	Description
B7	X6 | 1	Channel A	Digital/analog incremental encoder channel A
B8	X6 | 2	Channel A\	Digital/analog incremental encoder channel A complement
B9	X6 | 3	Channel B	Digital/analog incremental encoder channel B
B10	X6 | 4	Channel B\	Digital/analog incremental encoder channel B complement
B11	X6 | 5	Channel I	Digital/analog incremental encoder channel I
B12	X6 | 6	Channel I\	Digital/analog incremental encoder channel I complement
B13	X6 | 7	–	not used
B14	X6 | 8	–	not used
B15	X6 | 10	V_{Aux}	Auxiliary output voltage (+5 VDC; $I_L \leq$145 mA)
B16	X6 | 9	GND	Ground

Table 3-53 Incremental encoder – Pin assignment

Digital incremental encoder (differential)	
Auxiliary output voltage (V_{Aux})	+5 VDC
Max. auxiliary supply current	145 mA
Min. differential input voltage	±200 mV
Max. input voltage	+12 VDC
Line receiver (internal)	EIA RS422 standard
Max. input frequency	6.25 MHz

Table 3-54 Differential digital incremental encoder specification

Continued on next page.

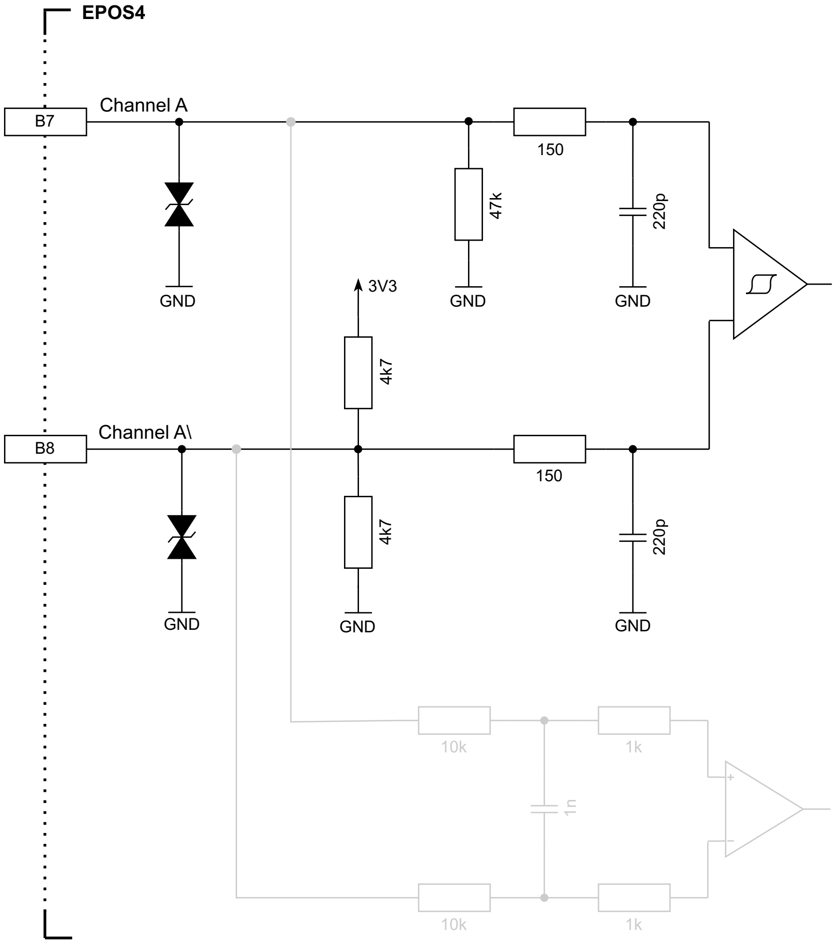


Figure 3-25 Digital incremental encoder input circuit Ch A “differential” (analogously valid for Ch B)

Continued on next page.

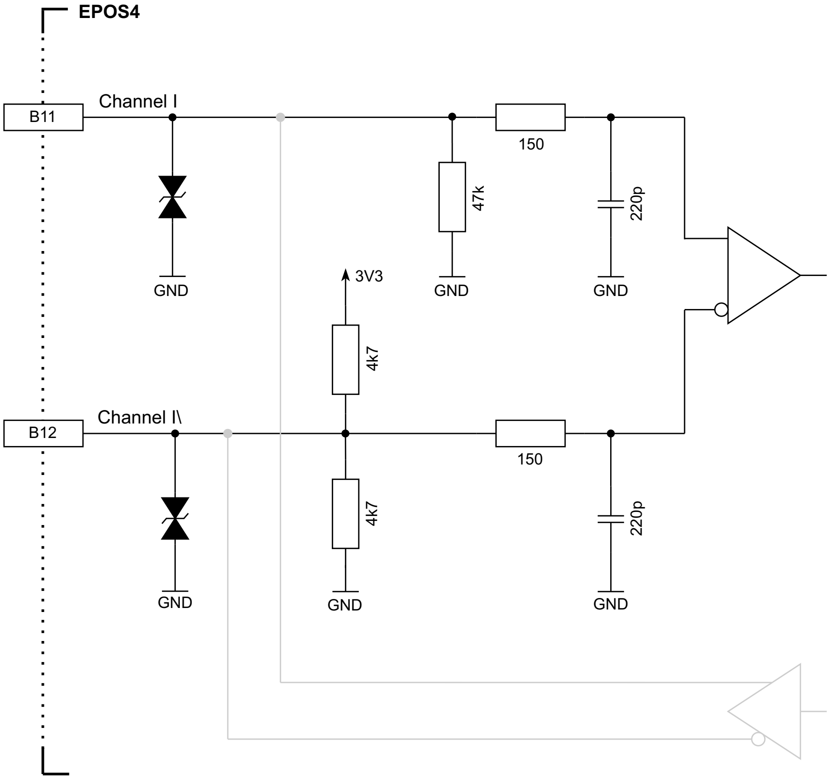


Figure 3-26 Digital incremental encoder input circuit Ch I “differential”

Digital incremental encoder (single-ended)		
Auxiliary output voltage (V_{Aux})		+5 VDC
Max. auxiliary supply current		145 mA
Input voltage		0…5 VDC
Max. input voltage		±12 VDC
Logic 0		<1.0 V
Logic 1		>2.4 V
Input high current		typically 210 µA @ +5 VDC (channel A, B) typically 60 µA @ +5 VDC (channel I)
Input low current		typically −80 µA @ 0 VDC (channel A, B) typically −7 µA @ 0 VDC (channel I)
Max. input frequency	Push-pull	6.25 MHz
	Open collector	100 kHz (additional external 3k3 pull-up)

Table 3-55 Single-ended digital incremental encoder specification

Continued on next page.

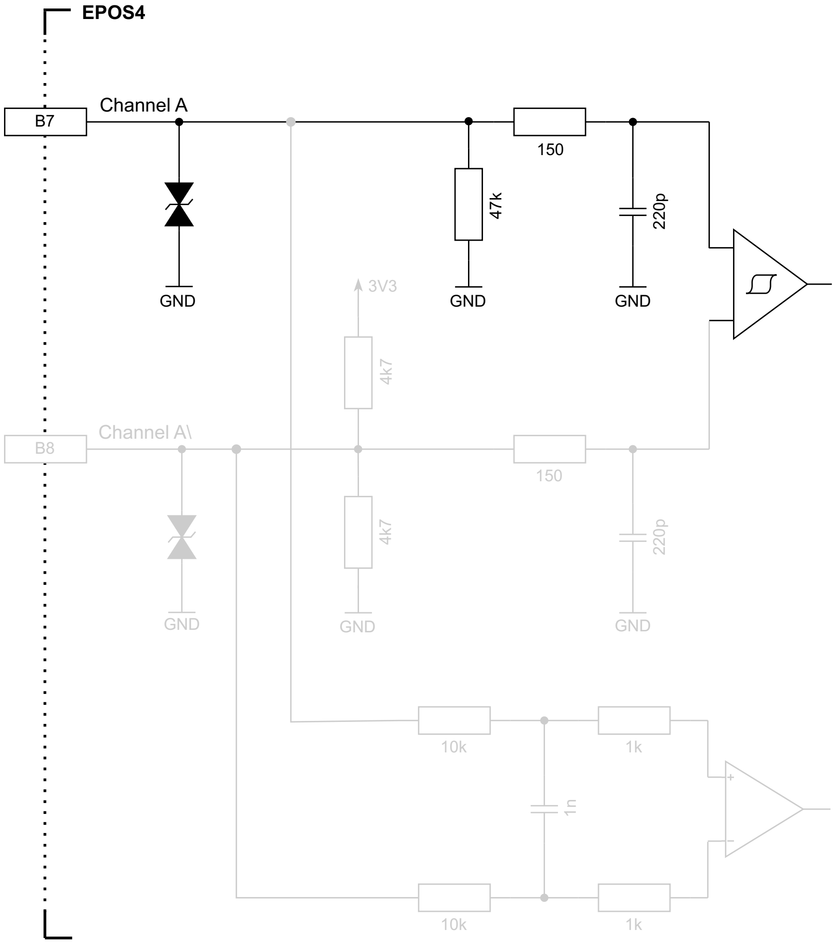


Figure 3-27 Digital incremental encoder input circuit Ch A “single-ended” (analogously valid for Ch B)

Continued on next page.

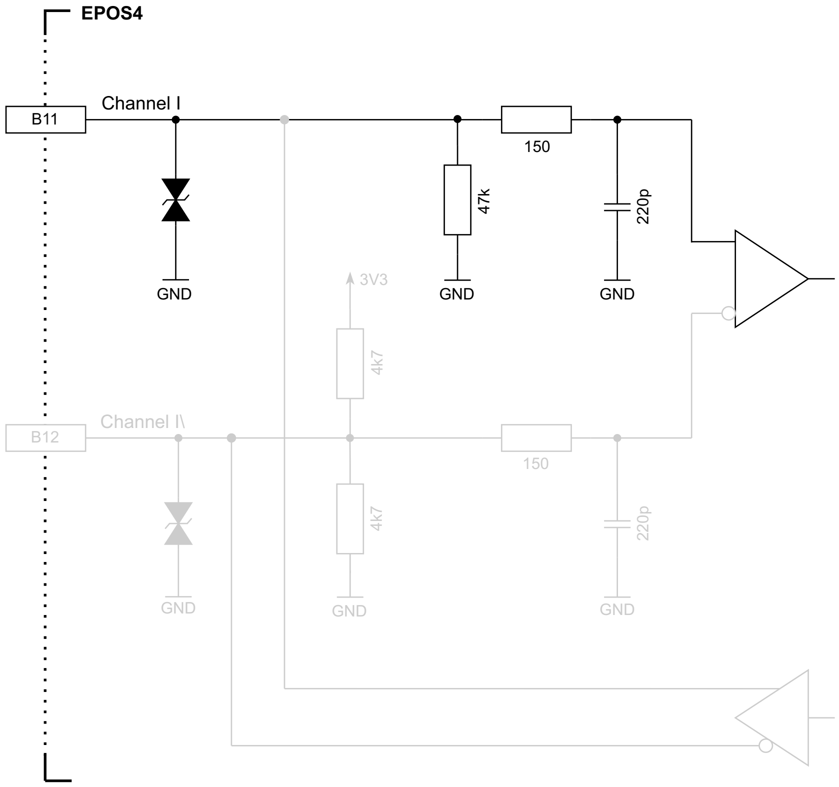


Figure 3-28 Digital incremental encoder input circuit Ch I “single-ended”

Analog incremental encoder SinCos (differential)	
Auxiliary output voltage (V_{Aux})	+5 VDC
Max. auxiliary supply current	145 mA
Input voltage	±1.8 V (differential)
Max. input voltage	±12 VDC
Common mode voltage	−9…+4 VDC (referenced to GND)
Input resistance	typically 10 kΩ
A/D converter	12-bit
Resolution	0.88 mV
Bandwidth	10 kHz

Table 3-56 Differential analog incremental encoder specification

Continued on next page.

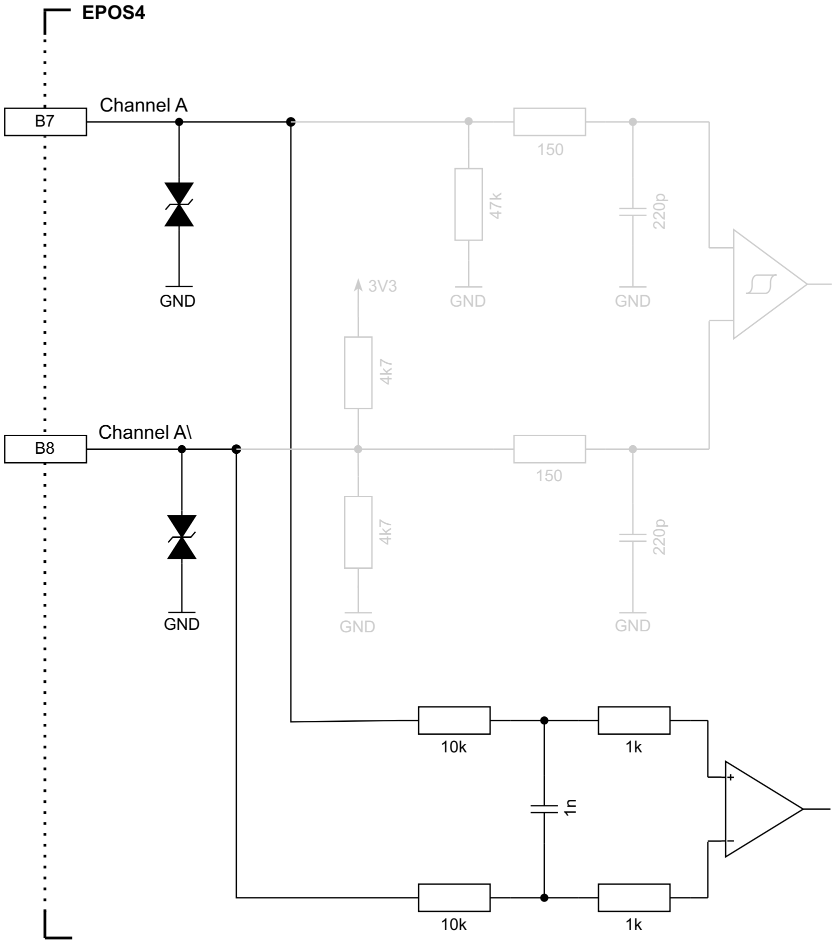


Figure 3-29 Analog incremental encoder input circuit Ch A “differential” (analogously valid for Ch B)

Continued on next page.

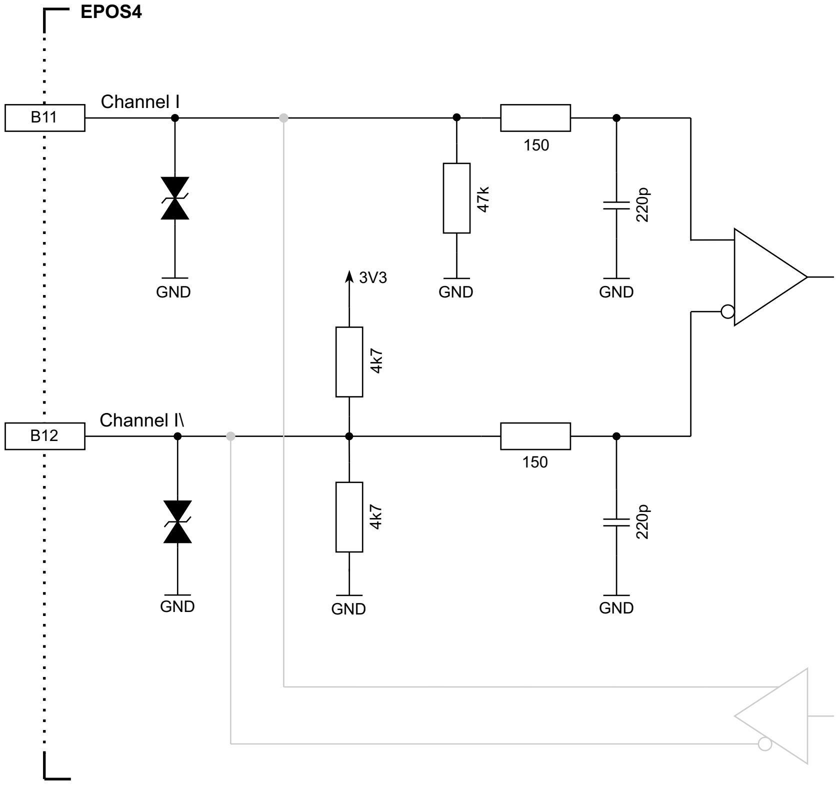


Figure 3-30 Analog incremental encoder input circuit Ch I (digital evaluation)

3.4.6.2 SSI Absolute Encoder

Module Header Pin	Compact/CB Connector Pin	Signal	Description
B7	X6 | 1	–	not used
B8	X6 | 2	–	not used
B9	X6 | 3	–	not used
B10	X6 | 4	–	not used
B11	X6 | 5	Clock	Clock (SSI)
B12	X6 | 6	Clock\	Clock (SSI) complement
B13	X6 | 7	Data	Data (SSI)
B14	X6 | 8	Data\	Data (SSI) complement
B15	X6 | 10	V_{Aux}	Auxiliary output voltage (+5 VDC; I_L ≤145 mA)
B16	X6 | 9	GND	Ground

Table 3-57 SSI absolute encoder – Pin assignment

SSI absolute encoder	
Auxiliary output voltage (V_{Aux})	+5 VDC
Max. auxiliary supply current	145 mA
Min. differential input voltage	±200 mV
Min. differential output voltage	±1.8 V @ external load R=54 Ω
Max. output current	40 mA
Line receiver (internal)	EIA RS422 standard
Encoder input/output frequency	0.4… 2 MHz

Table 3-58 SSI absolute encoder specification

Continued on next page.

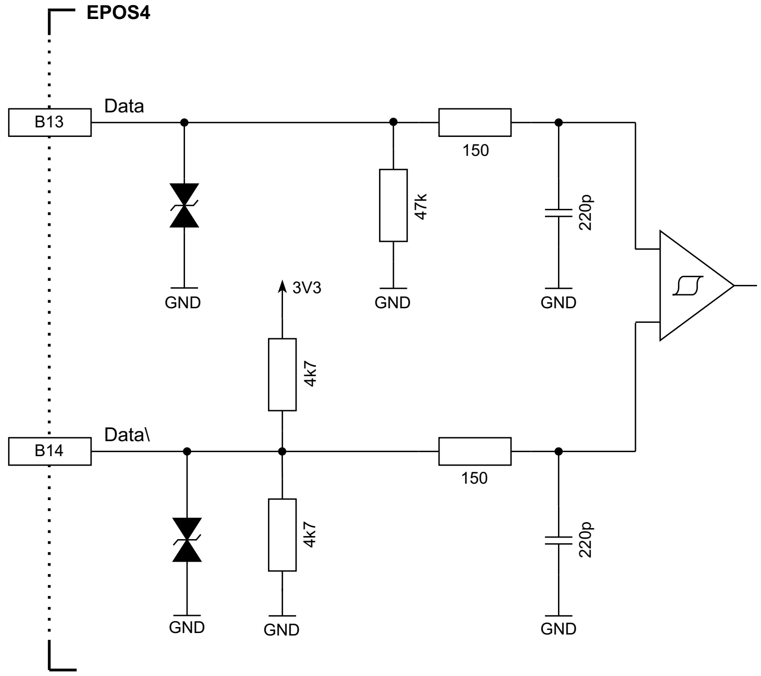


Figure 3-31 SSI absolute encoder data input

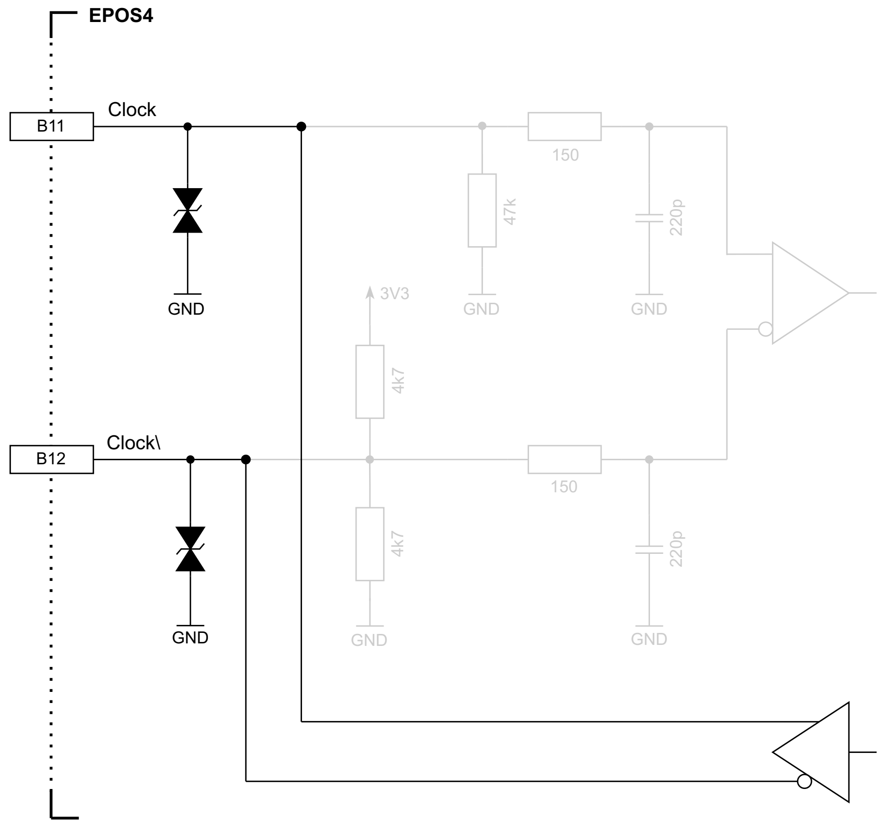


Figure 3-32 SSI absolute encoder clock output

maxon

3.4.6.3 High-speed Digital I/Os

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

Module Header Pin	Compact/CB Connector Pin	Signal	Description
B7	X6 | 1	HsDigIN1	High-speed digital input 1
B8	X6 | 2	HsDigIN1\	High-speed digital input 1 complement
B9	X6 | 3	HsDigIN2	High-speed digital input 2
B10	X6 | 4	HsDigIN2\	High-speed digital input 2 complement
B11	X6 | 5	HsDigIN3	High-speed digital input 3
		HsDigOUT1	High-speed digital output 1
B12	X6 | 6	HsDigIN3\	High-speed digital input 3 complement
		HsDigOUT1\	High-speed digital output 1 complement
B13	X6 | 7	HsDigIN4	High-speed digital input 4
B14	X6 | 8	HsDigIN4\	High-speed digital input 4 complement
B15	X6 | 10	V_{Aux}	Auxiliary output voltage (+5 VDC; $I_L \leq$145 mA)
B16	X6 | 9	GND	Ground

Table 3-59 High-speed digital I/Os – Pin assignment

High-speed digital input 1…4 (differential)	
Max. input voltage	±12 VDC
Min. differential input voltage	±200 mV
Line receiver (internal)	EIA RS422 standard
Max. input frequency	6.25 MHz

Table 3-60 Differential high-speed digital input specification

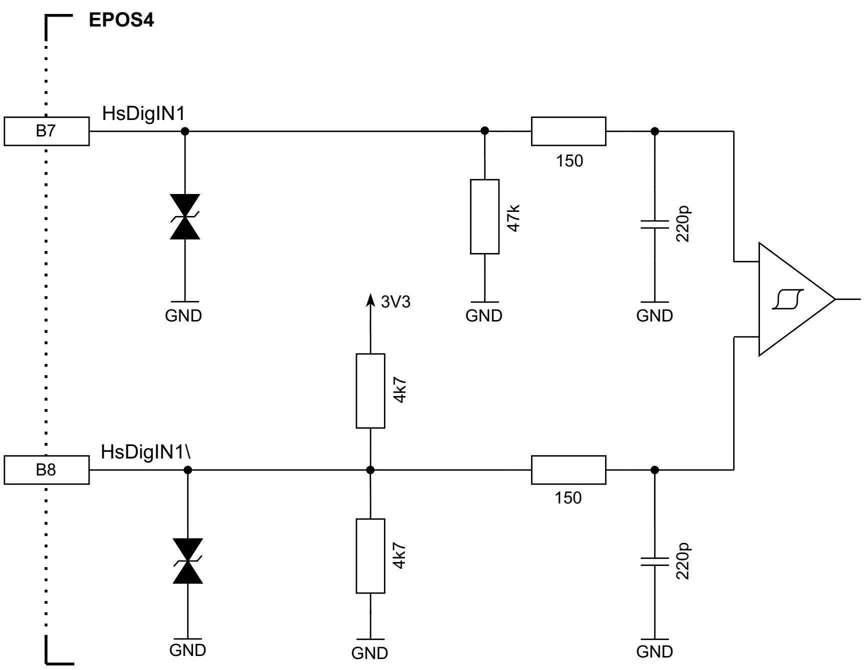


Figure 3-33 HsDigIN1 circuit “differential” (analogously valid for HsDigIN2…4)

High-speed digital input 1…4 (single-ended)	
Input voltage	0…5 VDC
Max. input voltage	±12 VDC
Logic 0	<1.0 V
Logic 1	>2.4 V
Input high current	typically 210 µA @ +5 VDC (HsDigIN1, 2) typically 60 µA @ +5 VDC (HsDigIN3, 4)
Input low current	typically −80 µA @ 0 VDC (HsDigIN1, 2) typically −7 µA @ 0 VDC (HsDigIN3, 4)
Max. input frequency	6.25 MHz

Table 3-61 Single-ended high-speed digital input specification

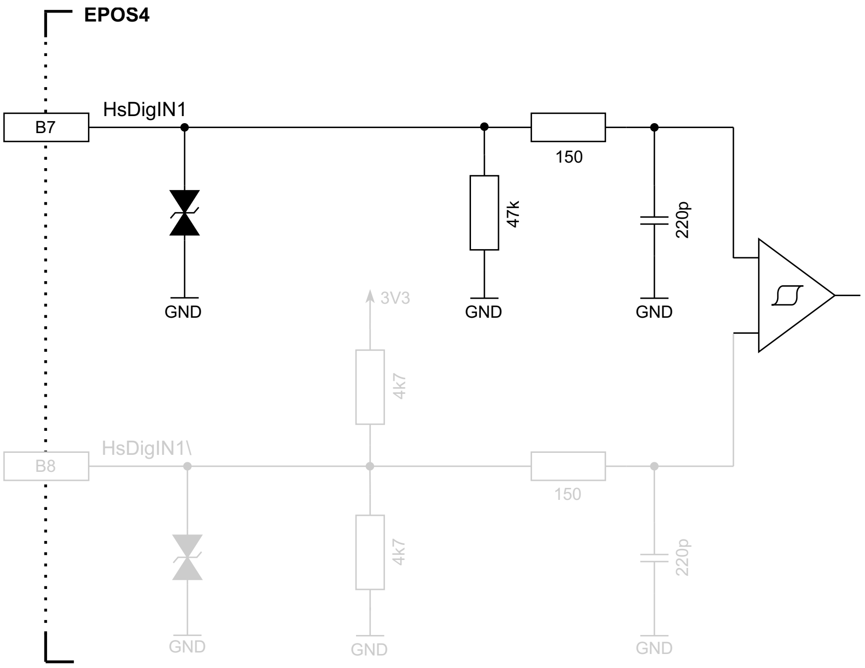


Figure 3-34 HsDigIN1 circuit “single-ended” (analogously valid for HsDigIN2…4)

High-speed digital output 1	
Min. differential output voltage	±1.8 V @ external load R=54 Ω
Max. output current	40 mA
Line transceiver (internal)	EIA RS422 standard
Max. output frequency	6.25 MHz

Table 3-62 High-speed digital output specification

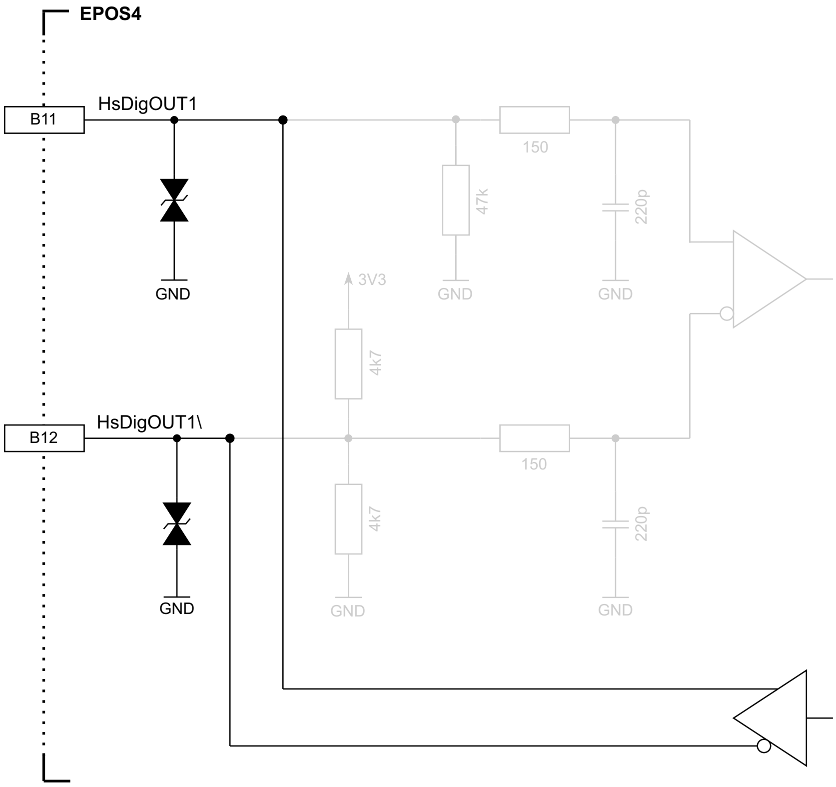


Figure 3-35 HsDigOUT1 output circuit

3.4.7 Digital I/Os

3.4.7.1 Module

Module Header Pin	Signal	Description
B1	DigIN1	Digital input 1
B2	DigIN2	Digital input 2
B3	DigIN3	Digital input 3
B4	DigIN4	Digital input 4
B5	DigOUT1	Digital output 1
B6	DigOUT2	Digital output 2
B15	V_{Aux}	Auxiliary output voltage (+5 VDC; I_L ≤145 mA)
B16	GND	Ground

Table 3-63 Digital I/Os – Pin assignment – Module

Digital inputs 1…4 (Module)	
Input voltage	0…36 VDC
Max. input voltage	±36 VDC
Logic 0	<0.8 V
Logic 1	>2.1 V
Input resistance	typically 47 kΩ (<3.3 V) typically 37.5 kΩ (@ 5 V) typically 25.5 kΩ (@ 24 V)
Input current at logic 1	typically 135 µA @ +5 VDC
Switching delay	<300 µs

Table 3-64 Digital input specification

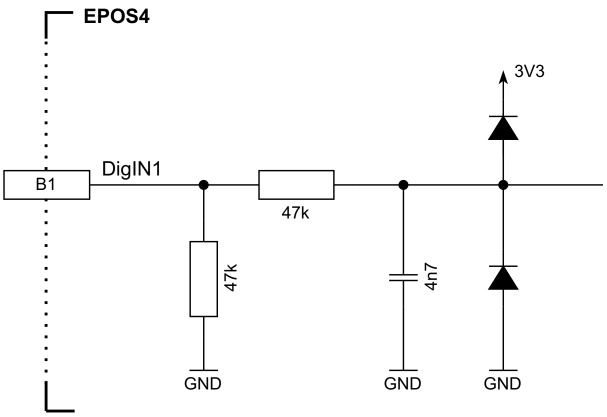


Figure 3-36 DigIN1 circuit (analogously valid for DigIN2…4) – Module

DigOUT “sinks”	
Max. input voltage	+60 VDC
Max. load current	1 A
Max. voltage drop	0.5 V @ 1 A

Table 3-65 Digital output – Sinks

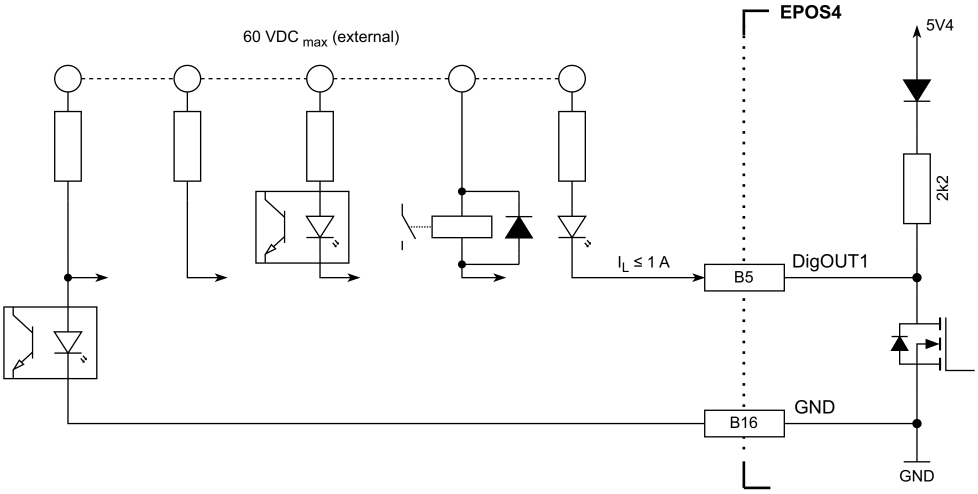


Figure 3-37 DigOUT1 “sinks” (analogously valid for DigOUT2) – Module

DigOUT “source”	
Output voltage	U_{Out} = 5.4 V − 0.75 V − (I_{Load} x 2200 Ω)
Max. load current	I_{Load} ≤2 mA

Table 3-66 Digital output – Source

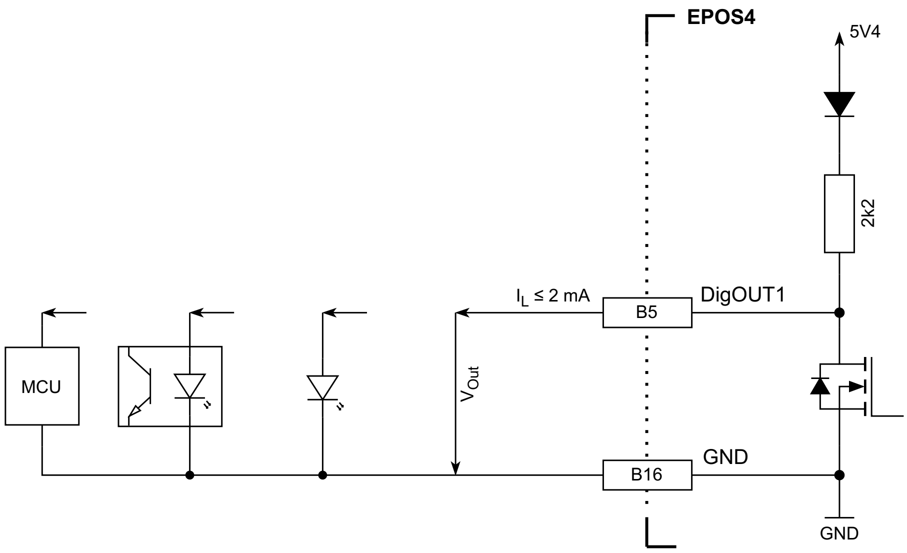


Figure 3-38 DigOUT1 “source” (analogously valid for DigOUT2) – Module

3.4.7.2 Compact

Compact/CB Connector Pin	Signal	Description
X7 | 1	DigIN1	Digital input 1
X7 | 2	DigIN2	Digital input 2
X7 | 3	DigIN3	Digital input 3
X7 | 4	DigIN4	Digital input 4
X7 | 5	DigOUT1	Digital output 1
X7 | 6	DigOUT2	Digital output 2
X7 | 7	GND	Ground
X7 | 8	$V_{I/O}$	$V_{I/O}$ (+5 VDC - 0.75 VDC = 4.25 VDC; $I_L \leq$145 mA)

Table 3-67 Digital I/Os – Pin assignment – Compact

Digital inputs 1…4 (Compact / Logic level setting)	
Input voltage	0…30 VDC
Max. input voltage	±30 VDC
Logic 0	<0.8 V
Logic 1	>2.0 V
Input current at logic 1	250 μA @ 5 VDC
Switching delay	<300 μs @ 5 VDC

Table 3-68 Digital input specification – Logic level setting

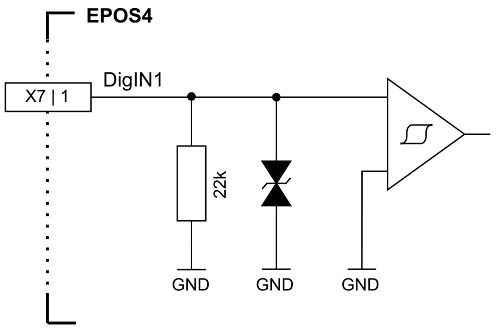


Figure 3-39 DigIN1 circuit (analogously valid for DigIN2…4) – Compact / Logic level setting

Continued on next page.

Digital inputs 1…4 (Compact / PLC level setting)	
Input voltage	0…30 VDC
Max. input voltage	±30 VDC
Logic 0	<5.5 V
Logic 1	>9 V
Input current at logic 1	>2 mA @ 9 VDC typically 3.5 mA @ 24 VDC
Switching delay	<300 μs @ 24 VDC

Table 3-69 Digital input specification – PLC level setting

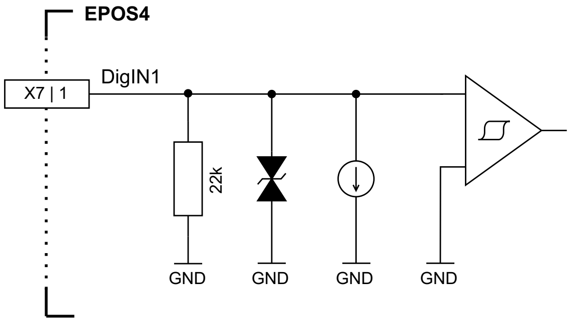


Figure 3-40 DigIN1 circuit (analogously valid for DigIN2…4) – Compact / PLC level setting

DigOUT “sinks”	
Max. input voltage	+60 VDC
Max. load current	1 A
Max. voltage drop	0.5 V @ 1 A

Table 3-70 Digital output – Sinks

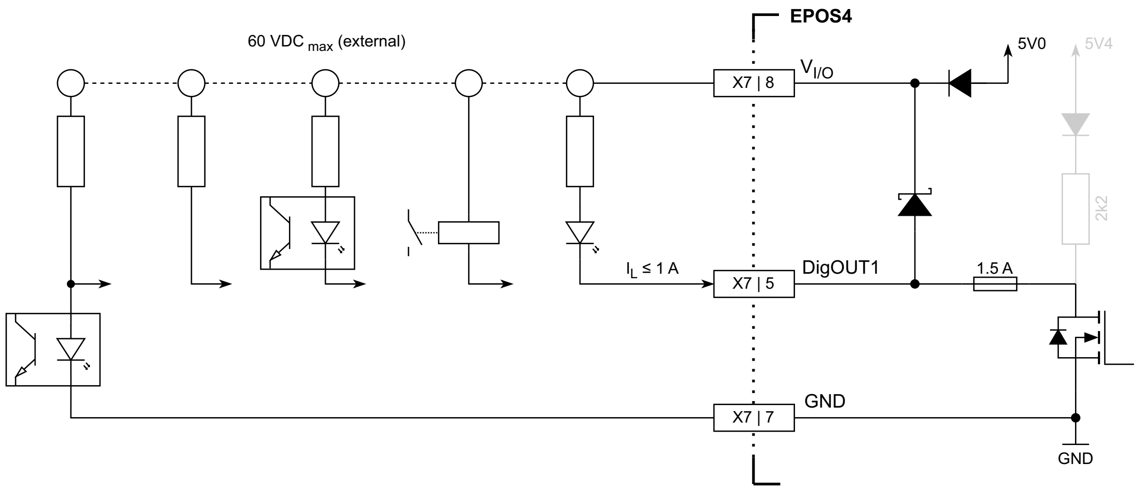


Figure 3-41 DigOUT1 “sinks” (analogously valid for DigOUT2) – Compact

DigOUT “source”	
Output voltage	U_{Out} = 5.4 V – 0.75 V – (I_{Load} x 2200 Ω)
Max. load current	I_{Load} ≤2 mA

Table 3-71 Digital output – Source

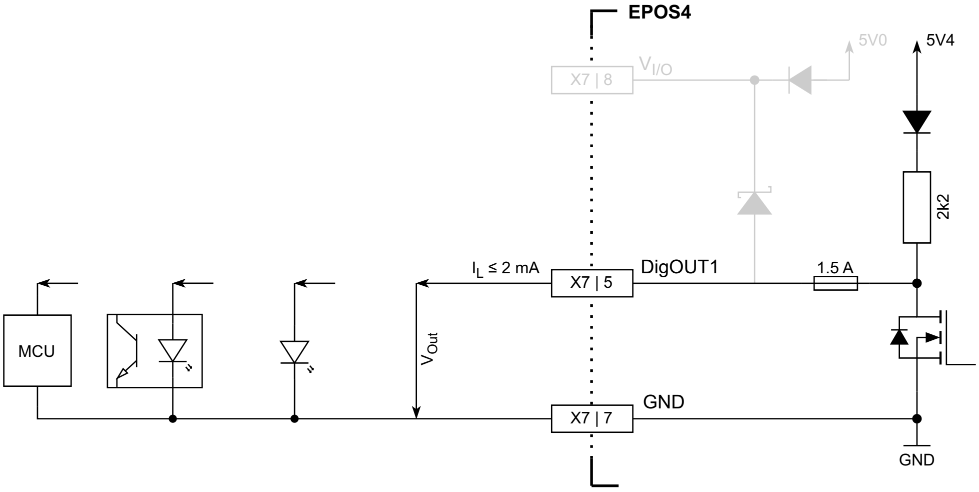


Figure 3-42 DigOUT1 “source” (analogously valid for DigOUT2) – Compact

3.4.8 Analog I/Os

Module Header Pin	Compact/CB Connector Pin	Signal	Description
B16	X8 | 7	GND	Ground
B17	X8 | 1	AnIN1+	Analog input 1, positive signal
B18	X8 | 2	AnIN1−	Analog input 1, negative signal
B19	X8 | 3	AnIN2+	Analog input 2, positive signal
B20	X8 | 4	AnIN2−	Analog input 2, negative signal
B21	X8 | 5	AnOUT1	Analog output 1
B22	X8 | 6	AnOUT2	Analog output 2

Table 3-72 Analog I/Os – Pin assignment

Analog inputs 1…2	
Input voltage	±10 VDC (differential)
Max. input voltage	±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

Table 3-73 Analog input specification

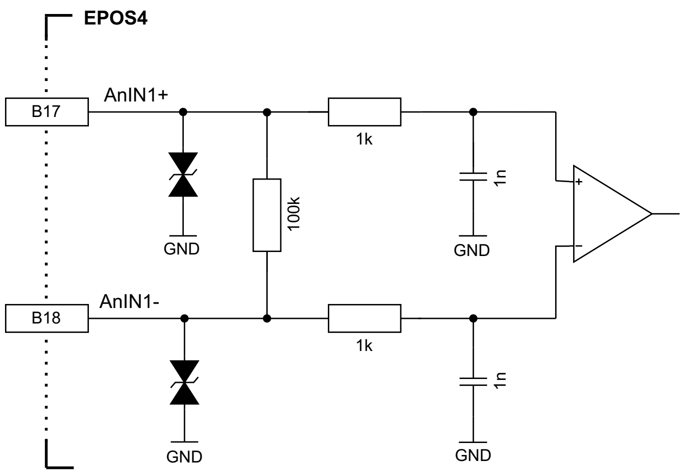


Figure 3-43 AnIN1 circuit (analogously valid for AnIN2)

Analog outputs 1…2	
Output voltage	±4 VDC
D/A converter	12-bit
Resolution	2.42 mV
Refresh rate	2.5 kHz
Analog bandwidth of output amplifier	25 kHz
Max. capacitive load	300 nF ***Note:*** *The increase rate is limited in proportion to the capacitive load (e.g. 5 V/ms @ 300 nF)*
Max. output current limit	1 mA

Table 3-74 Analog output specification

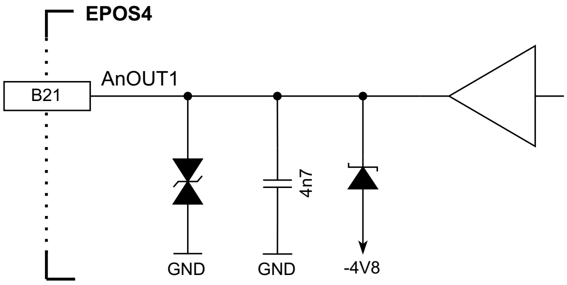


Figure 3-44 AnOUT1 circuit (analogously valid for AnOUT2)

3.4.9 Serial Communication Interface (SCI) / RS232

The SCI is a two-wire asynchronous serial port, commonly known as a UART. The SCI modules support digital communication between the CPU and other asynchronous peripherals that use the standard non-return-to-zero (NRZ) format.

A common use of the Module's SCI is to build an RS232 interface by wiring it to an RS232 transceiver. Alternatively, using any of the Compact versions does not require an external transceiver.

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

3.4.9.1 Module

Module Header Pin	Signal	Description
B32	GND	Ground
B33 [e]	DSP_RxD	Serial communication interface receive (UART)
B34	DSP_TxD	Serial communication interface transmit (UART)
[e] connect to sensor supply voltage V_{Sensor} (A46) when RS232 is not in use		

Table 3-75 SCI – Pin assignment

Serial Communication Interface (SCI)	
Input voltage	0…3.3 VDC
Max. input voltage	5 VDC
High-level input voltage	>2.0 VDC
Low-level input voltage	<0.8 VDC
High-level output voltage	>2.4 VDC
Low-level output voltage	<0.4 VDC
Series resistance (both lines)	10 kΩ
Max. bit rate	115'200 bit/s
Data format	NRZ (non-return-to-zero)

Table 3-76 SCI specification

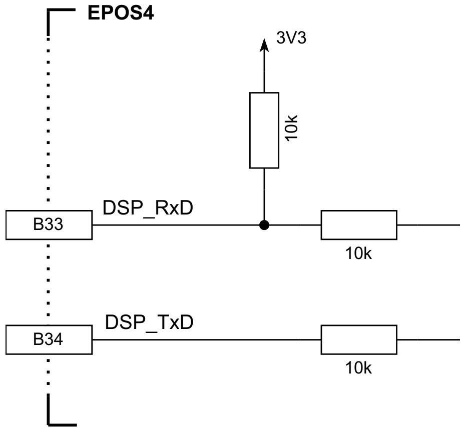


Figure 3-45 SCI circuit

3.4.9.2 Compact CAN

Compact/CB Connector Pin	Signal	Description
X10 | 1	EPOS_RxD	EPOS RS232 receive
X10 | 2	GND	Ground
X10 | 3	EPOS_TxD	EPOS RS232 transmit
X10 | 4	GND	Ground
X10 | 5	Shield	Cable shield

Table 3-77 RS232 – Pin assignment

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 3-78 RS232 interface specification

3.4.10 CAN Interface / ID Setting

3.4.10.1 Connection

The EPOS4 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.

Module Header Pin	Compact/CB Connector Pin	Signal	Description
B29	X11 | 1 X12 | 1	CAN high	CAN high bus line
B30	X11 | 2 X12 | 2	CAN low	CAN low bus line
B31	X11 | 3 X12 | 3	GND	Ground
–	X11 | 4 X12 | 4	Shield	Cable shield

Table 3-79 CAN bus line / CAN 1 / CAN 2 – Pin assignment

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

Table 3-80 CAN interface specification

Note

- *Consider the CAN master’s maximal bit rate.*
- *The standard bit rate setting (factory setting) is 1 Mbit/s. For connector boards and Compact CAN versions, automatic bit rate detection is set.*
- *Use 120 Ω termination resistor at both ends of the CAN bus.*
- *For detailed CAN information see separate document ➔«EPOS4 Communication Guide».*

3.4.10.2 Configuration

Setting the ID is currently available for CAN only!

The device’s identification (subsequently called “ID”) can be set by different means:

- For configuration on **Compact** versions ➔“DIP Switch Configuration (SW1)” on page 3-37.
- For configuration on **Module** versions, the ID is set using the input lines ID1…ID5. The ID (1…31) may be coded using binary code.

Module Header Pin	Signal	Description	Binary Code	Valence
B23	ID 1	CAN ID / DEV ID 1	2^0	1
B24	ID 2	CAN ID / DEV ID 2	2^1	2
B25	ID 3	CAN ID / DEV ID 3	2^2	4
B26	ID 4	CAN ID / DEV ID 4	2^3	8
B27	ID 5	CAN ID / DEV ID 5	2^4	16
B31	GND	Ground		

Table 3-81 ID – Pin assignment

CAN ID / DEV ID	
Max. input voltage	3.3 VDC
Logic 1	connected to GND
Logic 0	not connected

Table 3-82 CAN ID / DEV ID specification

Important
The internal circuit of the ID pins (B23…B27) is based on an analog voltage measurement. Ensure a proper ground connection (0.0 V) when Logic 1 state is intended and a high impedance for Logic 0 state.

The set ID can be observed by adding the valences of all inputs connected externally to GND. Use the following table as a (non-concluding) guide:

CAN ID / DEV ID					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* = ID input line not connected		1** = ID input line externally connected to GND			

Table 3-83 ID – Examples

Setting the ID by means of «EPOS Studio»

- *The ID may be set by software (changing object 0x2000 «Node-ID», range 1…127).*
- *The ID set by software is valid if the ID is set to “0” (none of the ID input lines connected).*

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 ➔«EPOS4 Firmware Specification». Automatic bit rate detection is activated when the input line is externally connected to GND.

Bit rate detection	
Auto Bit Rate GND	Pin B28 Pin B31
Max. input voltage	3.3 VDC
Logic 1	connected to GND
Logic 0	not connected

Table 3-84 Bit rate detection specification

3.4.11 Serial Peripheral Interface (SPI)

The SPI is a high-speed synchronous serial input/output port allowing the use of optional maxon extension modules.

Note

Do not connect any other signals to the SPI apart from those for the maxon extension modules!

Module Header Pin	Signal	Description
B32	GND	Ground
B35	SPI_CLK	Serial Peripheral Interface clock
B36	SPI_IRQ	Serial Peripheral Interface interrupt request
B37	SPI_SOMI	Serial Peripheral Interface Slave output, Master input
B38	SPI_SIMO	Serial Peripheral Interface Slave input, Master output
B39	SPI_CS2	Serial Peripheral Interface chip select 2
B40	SPI_CS1	Serial Peripheral Interface chip select 1

Table 3-85 SPI – Pin assignment

3.4.12 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.*

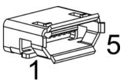
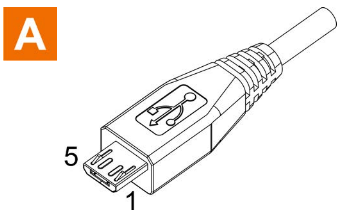


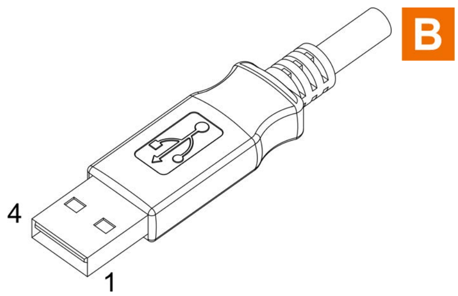
Figure 3-46 USB connector X13

Compact Connector Pin	PC's USB Terminal	Signal	Description
X13 | 1	1	V_{BUS}	USB bus supply voltage input +5 VDC
X13 | 2	2	USB_D−	USB Data− (twisted pair with Data+)
X13 | 3	3	USB_D+	USB Data+ (twisted pair with Data−)
X13 | 4	–	ID	not used
X13 | 5	4	GND	USB ground

Table 3-86 USB connector X13 – Pin assignment

USB Type A - micro B Cable (403968)





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 3-87 USB Type A - micro B Cable

USB	
USB Standard	USB 2.0 / USB 3.0 (full speed)
Max. bus supply voltage	+5.25 VDC
Max. DC data input voltage	−0.5…+3.8 VDC

Table 3-88 USB interface specification

3.5 Status Indicators

The EPOS4 features one set of LED indicators to display the device condition.

A **Device Status**; the LEDs display the device's operation status and error conditions

For detailed information see separate document ➔«EPOS4 Firmware Specification».

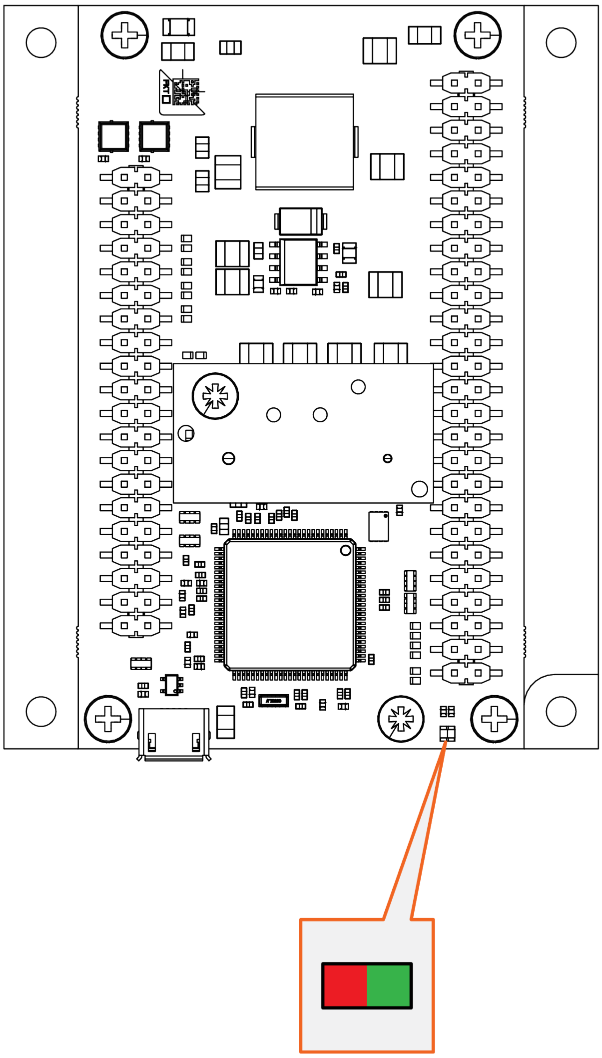


Figure 3-47 LEDs – Location

3.5.1 Device Status

The LEDs (➔Figure 3-47; **A**) display the actual status and possible errors of the EPOS4:

- Green LED shows the status
- Red LED indicates errors

LED		Description
Green	**Red**	
Slow	OFF	Power stage is disabled. The EPOS4 is in status… • “Switch ON Disabled” • “Ready to Switch ON” • “Switched ON”
ON	OFF	Power stage is enabled. The EPOS4 is in status… • “Operation Enable” • “Quick Stop Active”
OFF	ON	FAULT state. The EPOS4 is in status… • “Fault”
ON	ON	Power stage is enabled. The EPOS4 is in temporary status… • “Fault Reaction Active”
Flash	ON	No valid firmware or firmware download in progress
Flash = flashing (≈0.9 s OFF/≈0.1 s ON) Slow = slow blinking (≈1 Hz)		

Table 3-89 Device Status LEDs

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4 MOTHERBOARD DESIGN GUIDE

The «Motherboard Design Guide» provides helpful information on integrating the Module on a printed circuit board. It contains recommendations for the motherboard layout 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!*

Get help
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.

4.1 Requirements for Components of Third-party Suppliers

Best practice
For references and recommended components consult ➔Table 4-90.

4.1.1 Socket Headers

The Module's implementation with pin headers permits mounting in two different ways. It can either be plugged onto a socket header or be directly soldered to a printed circuit board.

4.1.2 Supply Voltage

To protect the Module, 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:

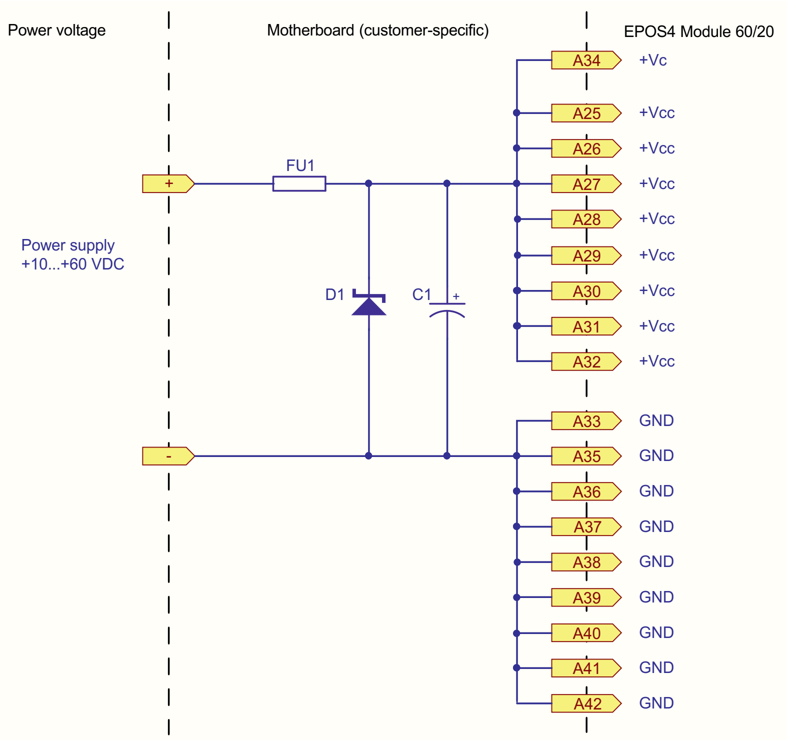


Figure 4-48 Wiring of power supply

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, we recommend to connect a TVS (transient voltage suppressor) diode (D1) to the voltage supply line.

CAPACITOR (C1)

The function of the Module does not necessarily require the use of an external capacitor. Nevertheless, to further reduce voltage ripple or to buffer feedback currents (typically present during motor deceleration), an electrolytic capacitor (C1) can be connected to the voltage supply line. Use of an electrolytic capacitor is also recommended to avoid oscillations caused by supply cable inductance or by the Module's built-in capacitors that could lead to a voltage overshoot at power plug-in.

4.1.3 Logic Supply Voltage

The Module features a logic supply voltage input. Its voltage range is 10…60 V and must be either sourced separately or by the power supply voltage.

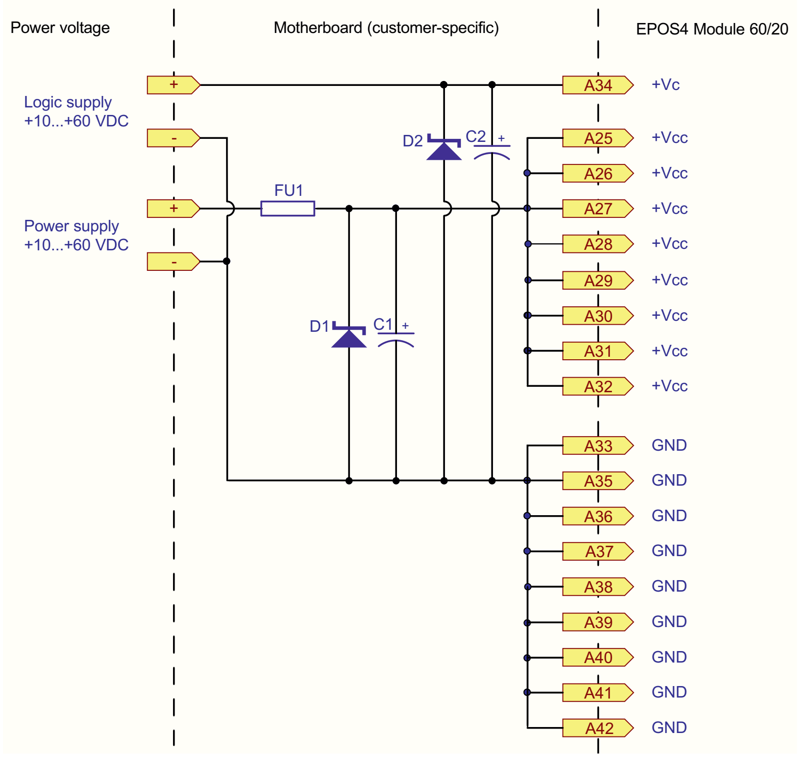


Figure 4-49 Wiring of logic supply

TVS DIODE (D2)

If the logic supply voltage is sourced separately, a transient voltage suppressor diode (D2) at the logic supply voltage input can be connected to protect the module against overvoltage.

CAPACITOR (C2)

Use an electrolytic capacitor (C2) if the logic supply is sourced separately. This will avoid oscillations caused by supply cable inductance or the Module’s built-in capacitors that could lead to a voltage overshoot at power plug-in.

4.1.4 Motor Cables and Motor Chokes

The Module is not equipped with internal motor chokes.
The majority of motors and applications do not require additional chokes. However, in 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:

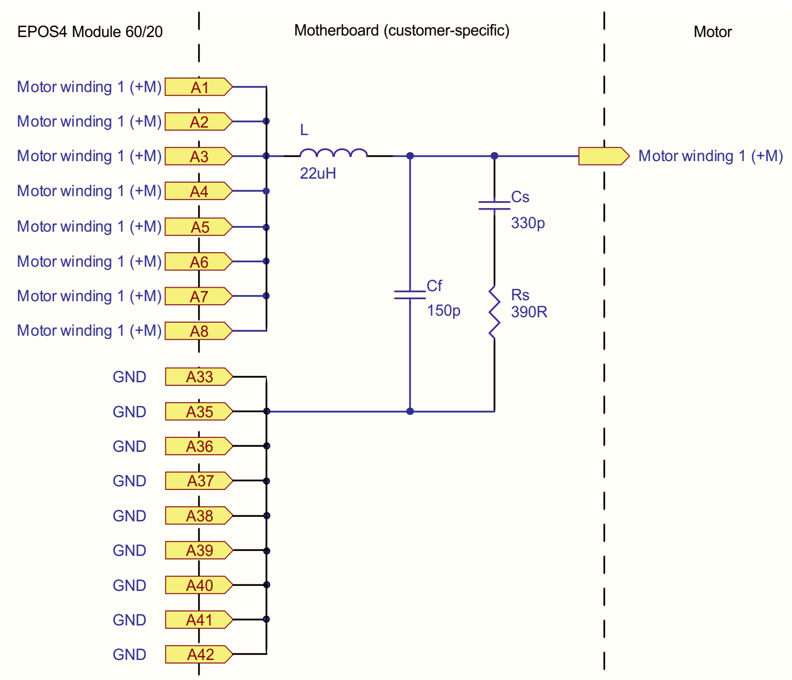
$$L_{Phase} \geq \frac{1}{2} \cdot \left(\frac{V_{CC}}{6 \cdot f_{PWM} \cdot I_N} - (0.3 \cdot L_{Motor})\right)$$

$L_{Phase}[H]$	Additional external inductance per phase
$V_{CC}[V]$	Operating voltage $+V_{CC}$
$f_{PWM}[Hz]$	Switching frequency of the power stage = 50’000 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, an adequate 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 2.2 µH or 22 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.

Example 1



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Example 2

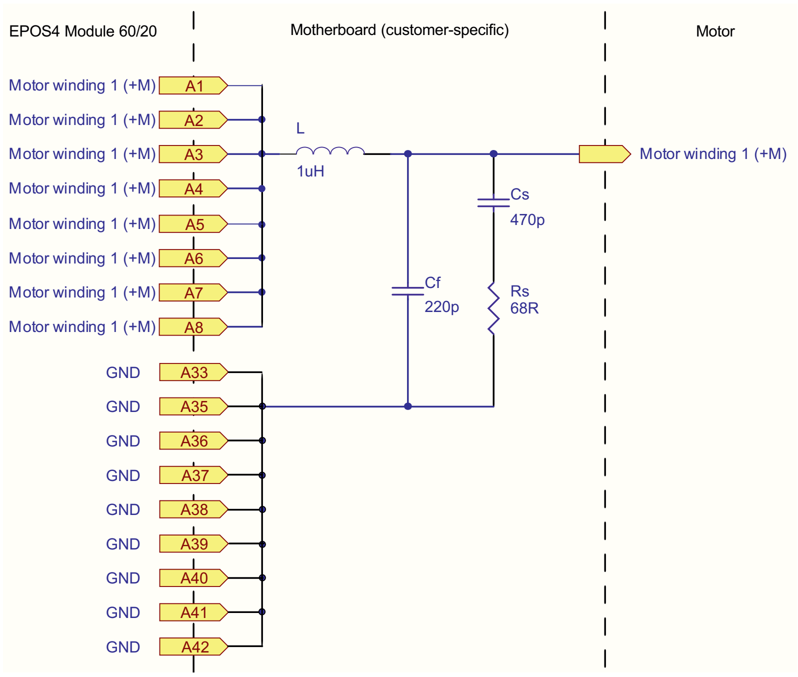

Figure 4-50 Wiring of motor winding 1 (analogously valid also for motor windings 2 & 3)

4.1.5 RS232 Transceiver

If you intend to use an RS232 interface, an external transceiver is necessary.

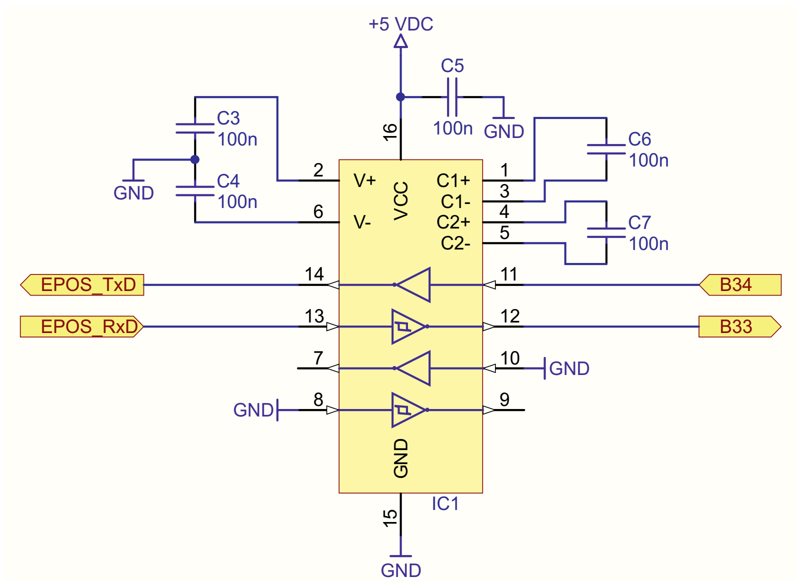

Figure 4-51 Wiring of RS232 transceiver

IMPORTANT

If you do not intend to use the RS232 interface, you must connect pin [B33] (DSP_RxD) with pin [A46] (sensor supply voltage V_{Sensor})!

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4.1.6 Recommended Components and Manufacturers

Recommended components	
Socket header	Straight socket header, pluggable with 0.64 × 0.64 mm pin headers, 2.54 mm pitch, contact length 6 mm, current rating per pin = I_{cont} / 8, contact material: gold **52 poles, 2 rows:** • Samtec (SSM-126-F-DV-A-x) SMT, 5.2 A per pin, 7.37 mm • E-Tec (BS2-052-HH750/2-55/x-W01) SMT, 3 A per pin, 7.50 mm **40 poles, 2 rows:** • Samtec (SSM-120-F-DV-A-x) SMT, 5.2 A per pin, 7.37 mm • E-Tec (BS2-040-HH750/2-55/x-W01) SMT, 3 A per pin, 7.50 mm
Fuse (FU1)	• Littelfuse (0456 025.xx) Fuse 25 A, 45 A^2sec • Eaton (1025HC25-RTR) Fuse 25 A, 50 A^2sec • Bourns, Inc. (SF-3812FG2500T-2) Fuse 25 A, 45 A^2sec
TVS Diode (D1; D2)	• Littelfuse (SMDJ75A) U_R = 75 V, U_{BR} = 83.3…92.1 V @ 1 mA, U_C = 121 V @ 24.8 A • Eaton (SMDJ75A) U_R = 75 V, U_{BR} = 83.3…92.1 V @ 1 mA, U_C = 121 V @ 24.8 A
Capacitor (C1)	The ripple current load for C1 depends on the motor's operating point and the power supply output capacity. Under worst case conditions however, the ripple current may reach I_{cont} / 2. Use capacitors with rated voltage ≥ 80 V and adequate ripple current to avoid overheat or life time reduction. Remark: If there is an excessive amount of reversed energy present (for example during deceleration of loads with a high inertia or during a vertical movement downwards), there might be the need to add an additional capacitor with a much higher capacitance (for example up to 10'000…47'000 µF) and/or to add a brake chopper, for example maxon DSR 70/30 (235811). **Example for C1 worst-case dimensioning:** I_{cont} = 20 A → 6 × Panasonic (EEHZA1K220P); 22 µF, 80 V, 1550 mA r.m.s., Ø×L 8 × 10.2 mm
Capacitor (C2)	To avoid voltage overshoot at power plug-in with a separately sourced logic supply, use an electrolytic capacitor covering the following requirements: 33 µF or 47 µF, 80 V, at least 265 mA r.m.s. • Panasonic (EEHZA1K330P) • Panasonic (EEHZA1K470P)
Motor Choke (L)	Inductance: ➔"Motor Cables and Motor Chokes" on page 4-78 Rated current: $I_{rms} \geq I_{cont}$; $I_{sat} \geq I_{peak}$ Construction: shielded **22 µH:** • Würth (WE-PD-XXL / 7447709220) I_{rms} 5.3 A, I_{sat} 6.5 A, 12.5 × 12.5 × 10 mm **1 µH:** • Bourns (SRP1265A-1R0M) I_{rms} 30 A, I_{sat} 48 A, 12.6 × 13.5 × 6.5 mm • Vishay (IHLP5050FDER1R0M01) I_{rms} 32 A, I_{sat} 49 A, 12.9 × 13.2 × 6.4 mm • Laird (MGV12071R0M-10) I_{rms} 30 A, I_{sat} 48 A, 12.6 × 13.5 × 6.5 mm

Continued on next page.

Recommended components	
Motor Filter	**Example 1** • Motor Choke L — 22 µH • Filter Capacitor Cf — 150 pF, 100 V • Snubber Capacitor Cs — 330 pF, 100 V • Snubber Resistor Rs — 390 Ω, 0.125 W **Example 2** • Motor Choke L — 1 µH • Filter Capacitor Cf — 220 pF, 100 V • Snubber Capacitor Cs — 470 pF, 100 V • Snubber Resistor Rs — 68 Ω, 0.5 W
RS232 (IC1) (C3…C7)	**RS232 transceiver (IC1)** • Texas Instruments (MAX202IPW) • ST Microelectronics (ST202EBTR)
	Capacitors (C3…C7) • 100 nF, X7R, 16 V

Table 4-90 Motherboard Design Guide – Recommended components

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4.2 Design Guidelines

The following instructions are intended to serve as an aid when designing an application-specific motherboard and ensures the correct and reliable integration of the Module.

While designing a motherboard, consider the following characteristics:

- Pin assignment (➔Page 3-20)
- Technical data (➔Page 2-11) and dimensional drawing (➔Page 2-15)

4.2.1 Ground

All ground connections (GND) should be internally connected to the Module (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
A33, A35 ... A42	GND	Ground
B16, B31, B32	GND	Ground

Table 4-91 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 10 nF and 100 V is recommended.

4.2.2 Layout

Guidelines for the layout of the motherboard:

- Connector pins [A25], [A26], [A27], [A28], [A29], [A30], [A31] and [A32] for $+V_{CC}$ (nominal power supply voltage) should be connected to the fuse via wide conductive tracks.
- Connector pins [A33], [A35], [A36], [A37], [A38], [A39], [A40], [A41], [A42], [B16], [B31] and [B32] for GND (ground) should be connected with the operating voltage ground via wide conductive tracks.
- Connector pin [B33] (DSP_RxD) must be connected to [A46] (sensor supply voltage; V_{Sensor}) when RS232 is not in use.
- The width of the conductive tracks and the copper coating thickness of the conductors for supply voltage and motor depend on the current required in your application. A minimum track width of 500 mil and a minimum copper coating thickness of 35 µm are recommended.

4.3 Footprint

Possible dimensional differences in STEP files
For conversion reasons, the below stated dimensions may slightly differ from the dimensions specified in the downloadable STEP file. Use only the below stated dimensions for your design.

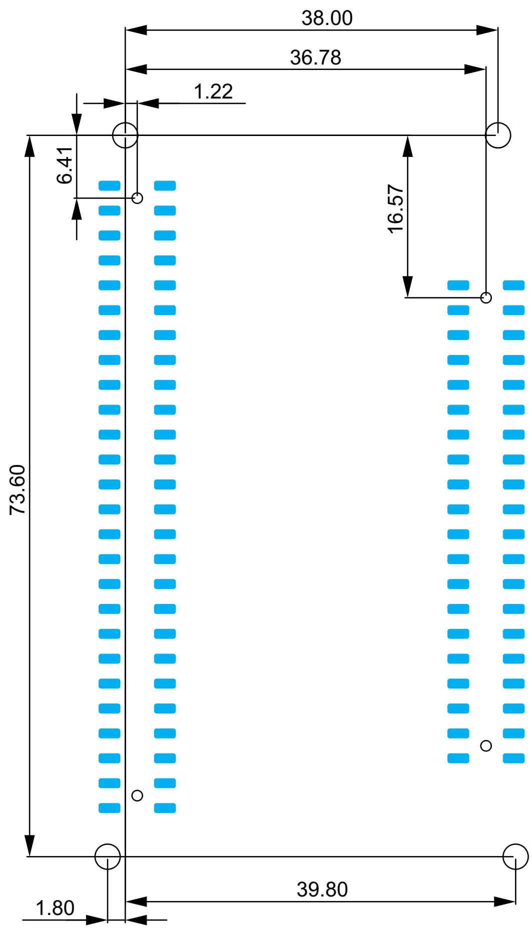

Figure 4-52 Footprint [mm] – Top View

••page intentionally left blank••

5 WIRING

In this section you will find the wiring information for the setup you are using. You can either use the consolidated wiring diagrams (➔Figure 5-54) featuring the full scope of interconnectivity and pin assignment. Or you may wish to use the connection overviews for either DC motor or EC (BLDC) motor that will assist you in determining the wiring for your particular motor type and the appropriate feedback signals.

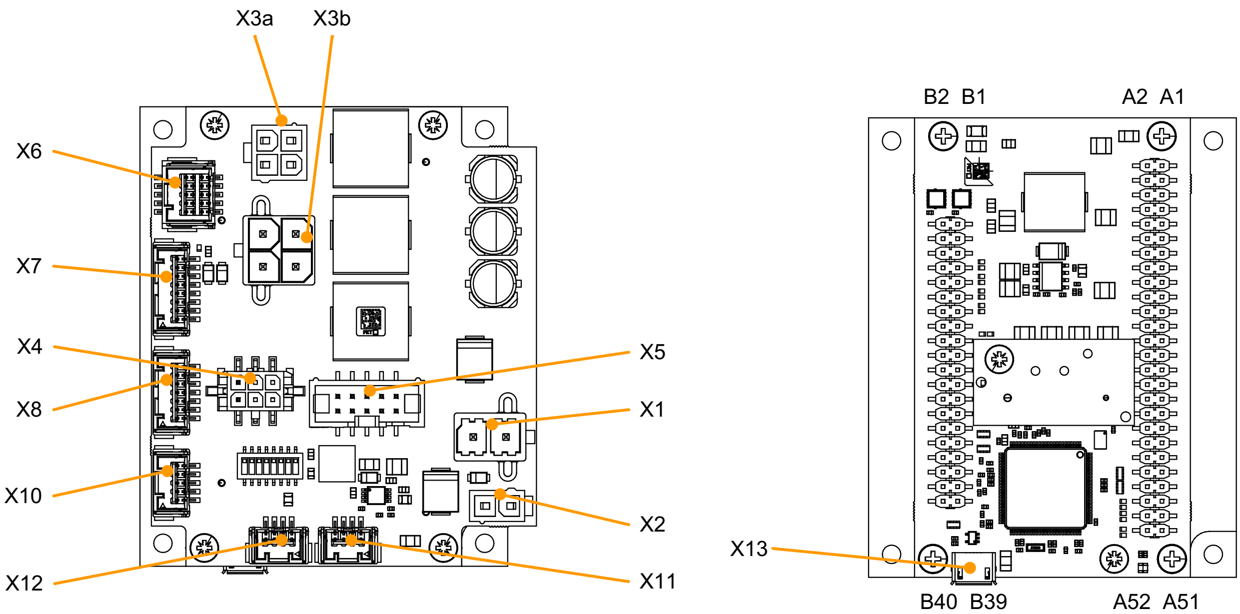

Figure 5-53 Interfaces – Designations and location

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).*

Information

To avoid electrical noise, install signal wires separately from power wires.

INSTRUCTION

If the monitoring function position sensor index error is active (➔see EPOS4 Firmware Specification), use a shielded cable for the incremental encoder.
Connect the shield at both ends.

5.1 Maximum Cable Lengths per Connection

WARNING

Long cables can cause dangerous malfunctions due to electrical noise.

Maximum Cable Lengths per Connection			
Connector	**Designation**	**max. Cabling length [m]**	**➔Page**
X1	Power Supply	30	3-40
X2	Logic Supply	30	3-41
X3a/X3b	Motor	30	3-42
X4	Hall Sensor	30	3-43
X5	Encoder	30	3-44
X6	Sensor	30	3-47
X7	Digital I/Os	3	3-59
X8	Analog I/Os	3	3-64
X10	Serial Communication Interface (SCI) / RS232	3	3-66
X11/X12	CAN 1 (X11) & CAN 2 (X12)	not limited	3-36
X13	USB (X13)	3	3-71

Table 5-92 Maximum Cable Lengths per Connection

5.2 Possible Combinations to connect a Motor

The following tables show feasible ways on how 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; either DC or EC (BLDC) motor.
2) Connect the power supply and the logic supply by following the link to the stated 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 ➔Table 5-93, for EC (BLDC) motor ➔Table 5-94.
4) Pick the row with the corresponding wiring method # and follow the link (or links) to the stated figure(s) to find the relevant wiring information.

5.2.1 DC Motor

Power supply & logic supply . . . . Figure 5-55

Motor & feedback signals

Without sensor . . . . Method # DC1

Digital incremental encoder. . . . . Method # DC2 or DC3

Analog incremental encoder SinCos . . . . Method # DC4

SSI absolute encoder . . . . Method # DC5

Digital incremental encoder & Digital incremental encoder. . . . . Method # DC6

Digital incremental encoder & Analog incremental encoder SinCos . . . . Method # DC7

Digital incremental encoder & SSI absolute encoder . . . . Method # DC8

Method #	Digital Incremental Encoder 1 (Sensor 1) X5	Digital Incremental Encoder 2 (Sensor 2) X6	Analog Incremental Encoder (Sensor 2) X6	SSI Absolute Encoder (Sensor 2) X6	➔ Figure(s)
DC1					5-56
DC2	✓				5-56 5-59
DC3		✓			5-56 5-60
DC4			✓		5-56 5-61
DC5				✓	5-56 5-62
DC6	✓	✓			5-56 5-59 / 5-60
DC7	✓		✓		5-56 5-59 / 5-61
DC8	✓			✓	5-56 5-59 / 5-62

Table 5-93 Possible combinations of feedback signals for DC motor

5.2.2 EC (BLDC) Motor

Method #	Hall sensors (Sensor 3) X4	Digital Incremental Encoder 1 (Sensor 1) X5	Digital Incremental Encoder 2 (Sensor 2) X6	Analog Incremental Encoder (Sensor 2) X6	SSI Absolute Encoder (Sensor 2) X6	➔ Figure(s)
EC1	✓					5-57 5-58
EC2	✓	✓				5-57 5-58 / 5-59
EC3	✓		✓			5-57 5-58 / 5-60
EC4	✓			✓		5-57 5-58 / 5-61
EC5	✓				✓	5-57 5-58 / 5-62
EC6	✓	✓	✓			5-57 5-58 / 5-59 / 5-60
EC7	✓	✓		✓		5-57 5-58 / 5-59 / 5-61
EC8	✓	✓			✓	5-57 5-58 / 5-59 / 5-62
EC9		✓			✓	5-57 5-59 / 5-62
EC10					✓	5-57 5-62

Table 5-94 Possible combinations of feedback signals for EC (BLDC) motor

5.3 Main Wiring Diagrams

5.3.1 Module & Compact CAN

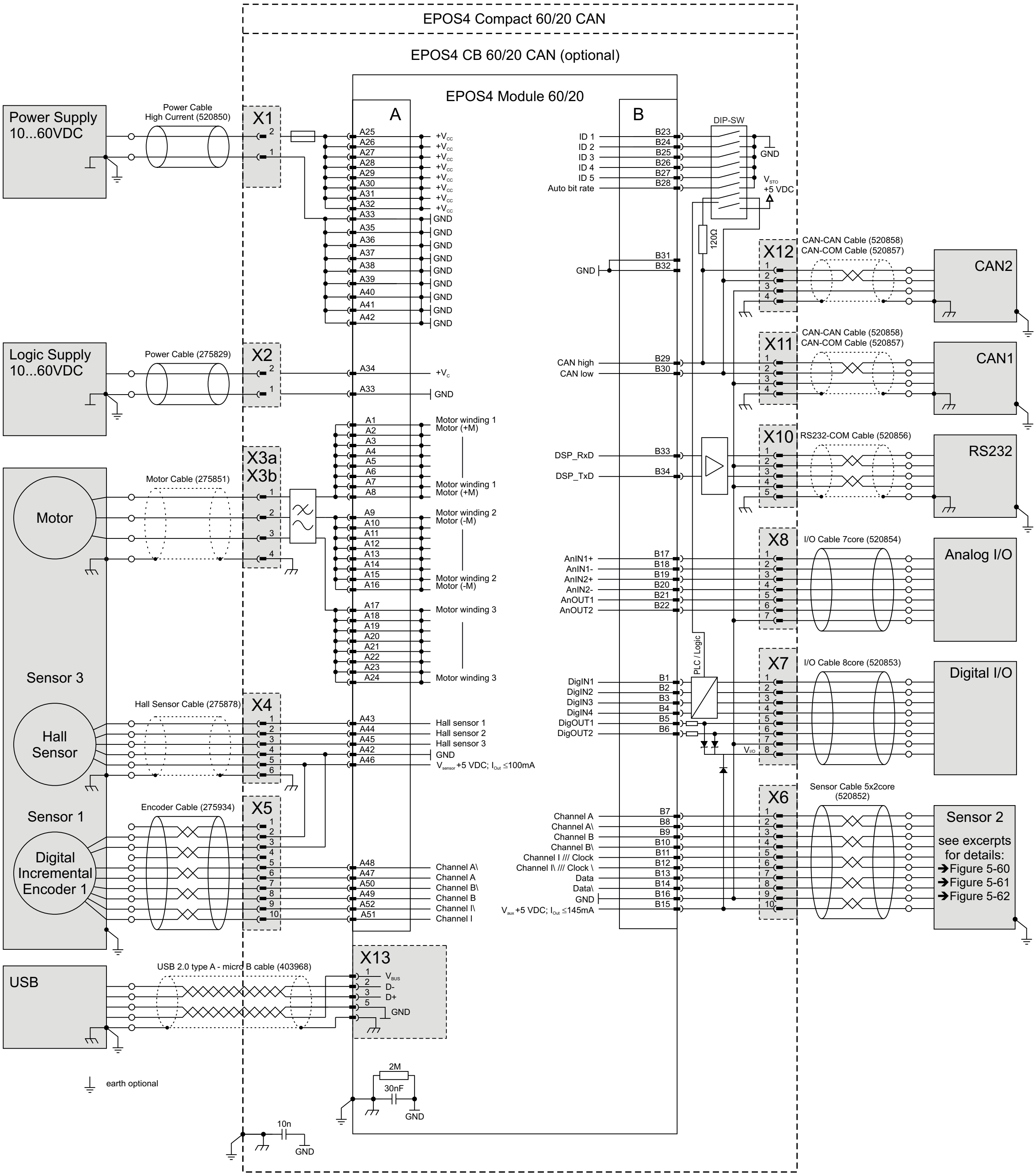

Figure 5-54 Main wiring diagram – Module & Compact CAN

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5.4 Excerpts

5.4.1 Power & Logic Supply

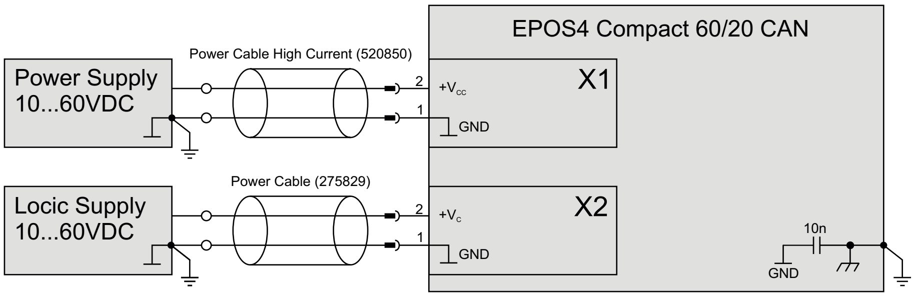

Figure 5-55 Power & logic supply

5.4.2 DC Motor

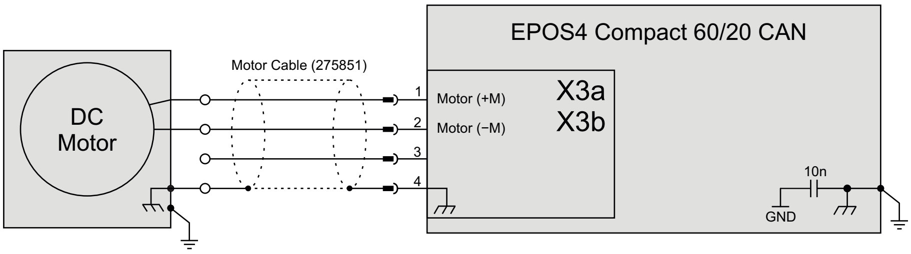

Figure 5-56 DC motor

5.4.3 EC (BLDC) Motor

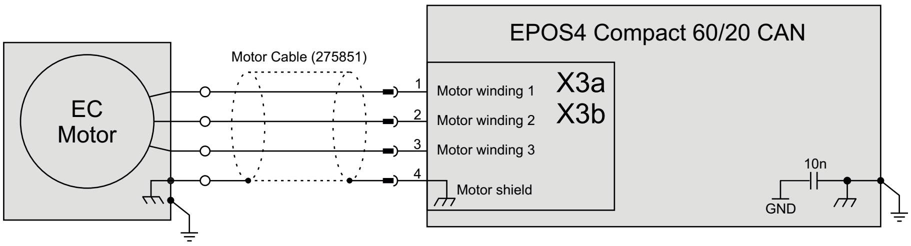

Figure 5-57 EC (BLDC) motor

5.4.4 Hall Sensors (Sensor 3)

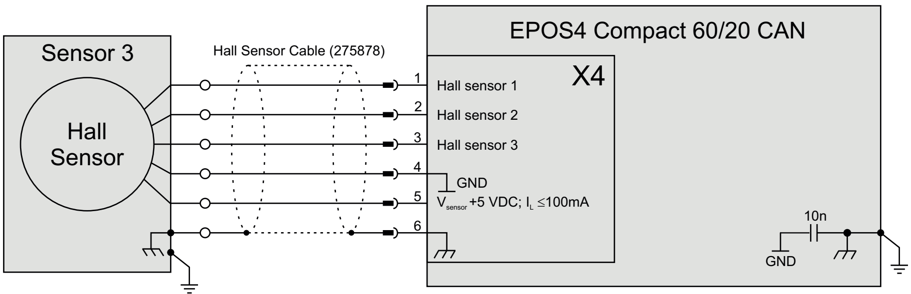

Figure 5-58 Hall sensors (Sensor 3)

5.4.5 Digital Incremental Encoder 1 (Sensor 1)

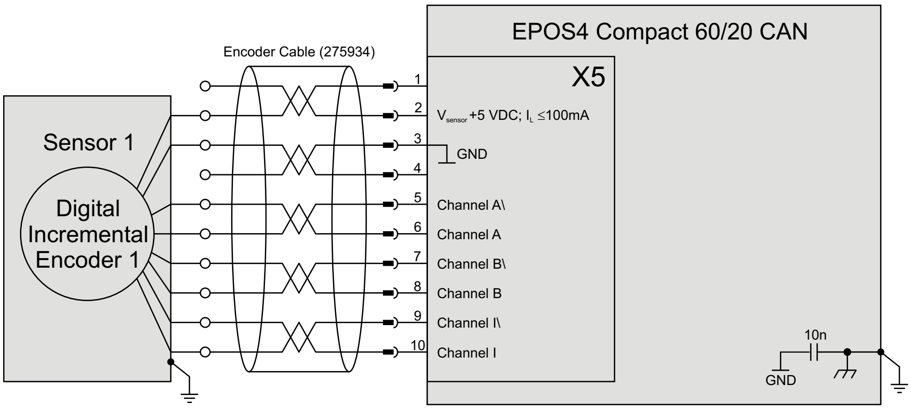

Figure 5-59 Digital incremental encoder 1 (Sensor 1)

5.4.6 Digital Incremental Encoder 2 (Sensor 2)

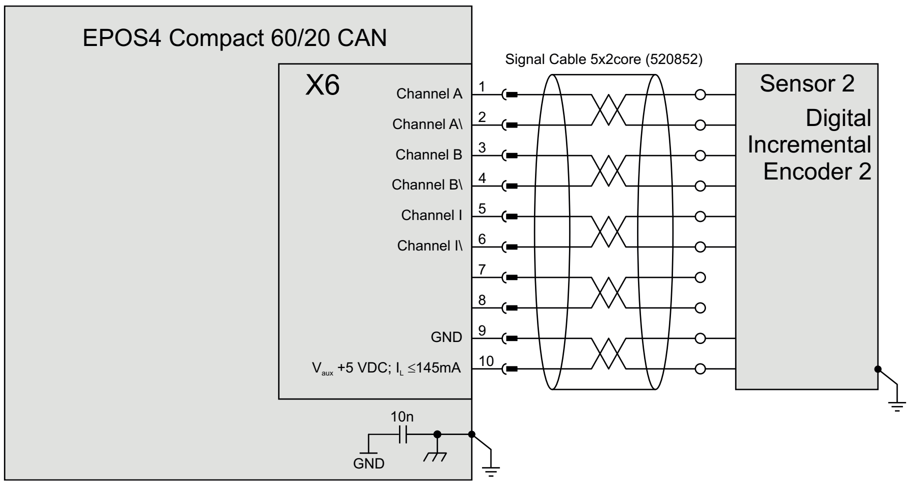

Figure 5-60 Digital incremental encoder 2 (Sensor 2)

5.4.7 Analog incremental encoder SinCos (Sensor 2)

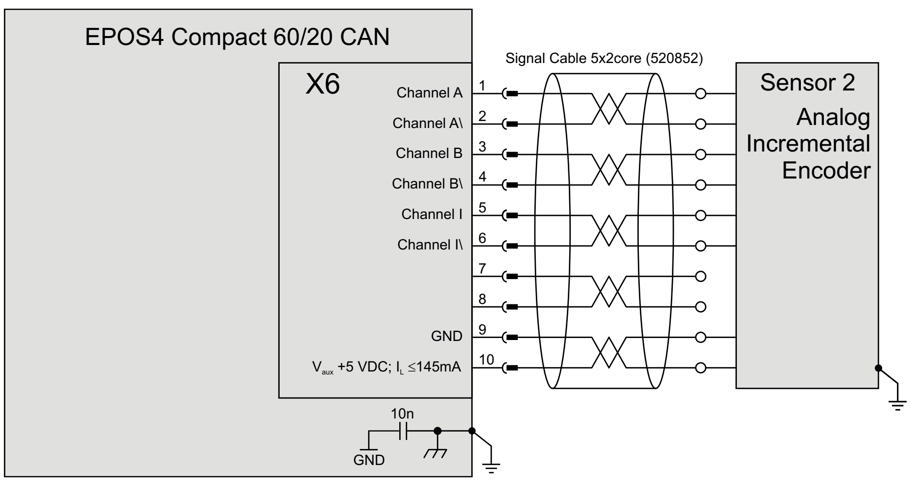

Figure 5-61 Analog incremental encoder (Sensor 2)

5.4.8 SSI Encoder (Sensor 2)

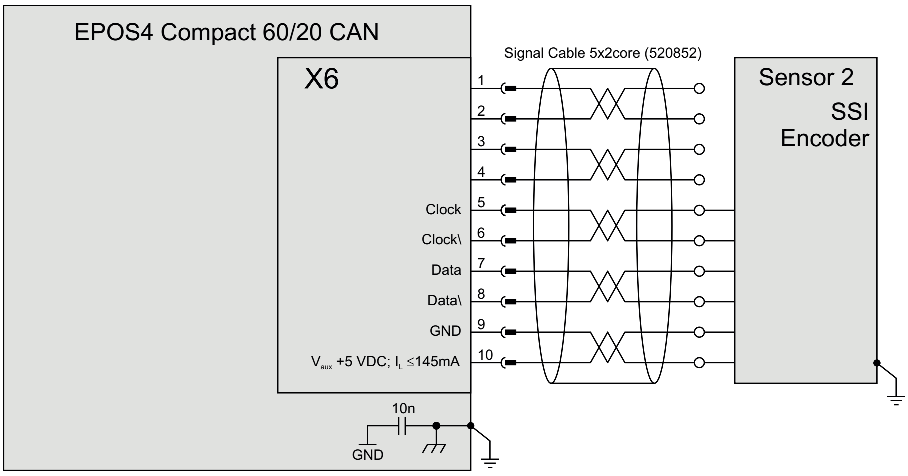

Figure 5-62 SSI encoder (Sensor 2)

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