

# EPOS4 70/15

## Hardware Reference



CANopen®

EtherCAT®



epos.maxongroup.com

## TABLE OF CONTENTS

<b>1</b>	<b>ABOUT</b>	<b>5</b>
1.1	About this Document. . . . .	5
1.2	About the Device. . . . .	8
1.3	About the Safety Precautions . . . . .	8
<b>2</b>	<b>SPECIFICATIONS</b>	<b>9</b>
2.1	Technical Data . . . . .	9
2.2	Thermal Data . . . . .	11
2.3	Limitations. . . . .	12
2.4	Dimensional Drawing . . . . .	13
2.5	Standards . . . . .	14
<b>3</b>	<b>SETUP</b>	<b>15</b>
3.1	Generally applicable Rules . . . . .	15
3.2	Cabling . . . . .	16
3.3	Connections . . . . .	18
3.3.1	Power Supply (X1) . . . . .	19
3.3.2	Logic Supply (X2) . . . . .	21
3.3.3	Motor (X3a) (X3b) . . . . .	22
3.3.4	Hall Sensor (X4) . . . . .	24
3.3.5	Encoder (X5) . . . . .	26
3.3.6	Sensor (X6) . . . . .	29
3.3.6.1	Incremental Encoder . . . . .	30
3.3.6.2	SSI Absolute Encoder . . . . .	36
3.3.6.3	High-speed Digital I/Os. . . . .	37
3.3.7	Digital I/O (X7) . . . . .	40
3.3.8	Analog I/O (X8) . . . . .	44

### READ THIS FIRST

***These instructions are intended for qualified technical personnel. Prior commencing with any activities...***

- you must carefully read and understand this manual and
- you must follow the instructions given therein.

***The EPOS4 70/15 positioning controller is considered as partly completed machinery according to EU Directive 2006/42/EC, Article 2, Clause (g) and is intended to be incorporated into or assembled with other machinery or other partly completed machinery or equipment.***

***Therefore, you must not put the device into service,...***

- unless you have made completely sure that the other machinery fully complies with the EU directive's requirements!
- unless the other machinery fulfills all relevant health and safety aspects!
- unless all respective interfaces have been established and fulfill the herein stated requirements!

3.3.9	STO (X9) .....	47
3.3.10	RS232 (X10) .....	50
3.3.11	CAN 1 (X11) & CAN 2 (X12) .....	51
3.3.12	USB (X13) .....	53
3.3.13	Extension IN (X14) & Extension OUT (X15) .....	54
3.3.14	Extension Signal (X16) .....	55
3.3.15	Extension Slots (EXT1 & EXT2).....	56
3.3.16	DIP Switch Configuration (SW1) .....	58
3.3.16.1	CAN ID (Node-ID) / DEV ID .....	58
3.3.16.2	CAN automatic Bit Rate Detection .....	59
3.3.16.3	CAN Bus Termination .....	59
3.3.16.4	Digital Input Level .....	60
3.3.17	Spare Parts .....	60
3.4	Status Indicators .....	61
<b>4</b>	<b>WIRING</b> .....	<b>63</b>
4.1	Possible Combinations to connect a Motor .....	64
4.2	Main Wiring Diagram .....	66
4.3	Excerpts .....	67
	<b>LIST OF FIGURES</b> .....	<b>71</b>
	<b>LIST OF TABLES</b> .....	<b>73</b>
	<b>INDEX</b> .....	<b>75</b>

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## 1 ABOUT

### 1.1 About this Document

#### 1.1.1 Intended Purpose

Use the document to...  
**–stay safe,**  
**–be fast,**  
**–end up with set up and ready-to-go equipment.**

The purpose of the present document is to familiarize you with the EPOS4 70/15 positioning controller. It will highlight the tasks for safe and adequate installation and/or commissioning. Follow the described instructions ...

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

The 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:

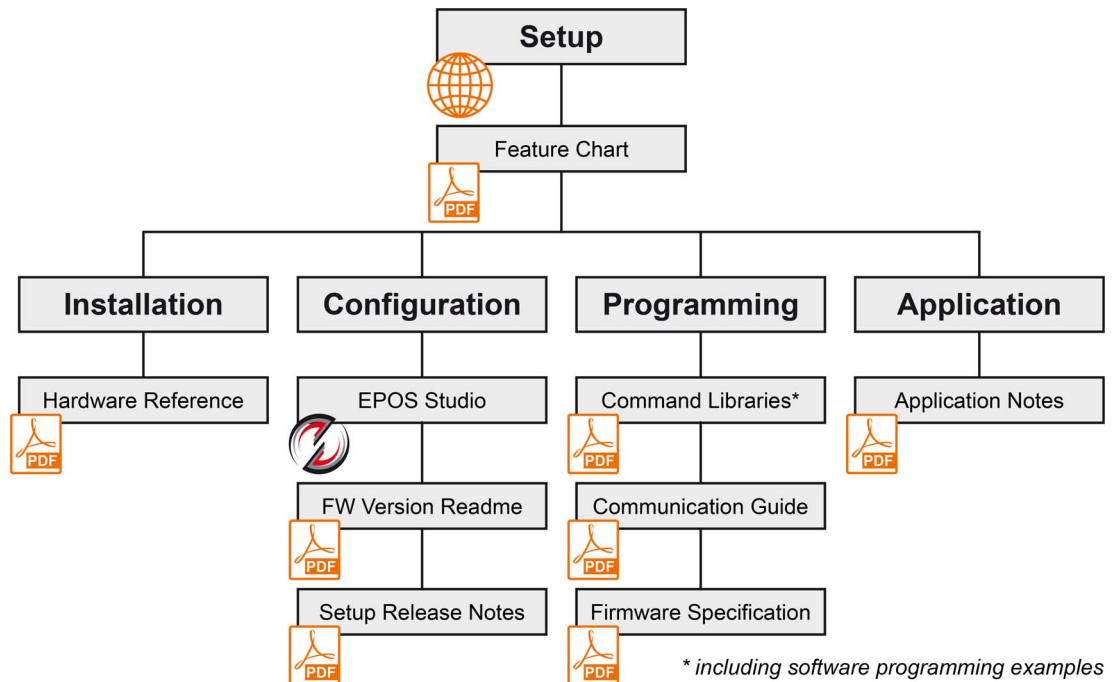


Figure 1-1 Documentation structure

#### 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

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

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







Type	Symbol	Meaning	
Safety alert	 (typical)	DANGER	Indicates an <b>imminent hazardous situation</b> . If not avoided, it <b>will result in death or serious injury</b> .
		WARNING	Indicates a <b>potential hazardous situation</b> . If not avoided, it <b>can result in death or serious injury</b> .
		CAUTION	Indicates a <b>probable hazardous situation</b> or calls the attention to unsafe practices. If not avoided, it <b>may result in injury</b> .
Prohibited action	 (typical)	Indicates a dangerous action. Hence, <b>you must not!</b>	
Mandatory action	 (typical)	Indicates a mandatory action. Hence, <b>you must!</b>	
Information		Requirement / Note / Remark	Indicates an activity you must perform prior continuing, or gives information on a particular item you need to observe.
		Best practice	Indicates an advice or recommendation on the easiest and best way to further proceed.
		Material Damage	Indicates information particular to possible damage of the equipment.

Table 1-2 Symbols 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
BiSS	© iC-Haus GmbH, DE-Bodenheim
CANopen® CiA®	© CiA CAN in Automation e.V, DE-Nuremberg
CLIK-Mate™ Micro-Fit™ Mini-Fit Jr.™ Mega-Fit®	© Molex, USA-Lisle, IL
EnDat	© DR. JOHANNES HEIDENHAIN GmbH, DE-Traunreut
EtherCAT®	© EtherCAT Technology Group, DE-Nuremberg, licensed by Beckhoff Automation GmbH, DE-Verl
Linux®	© Linus Torvalds (The Linux Foundation, USA-San Francisco CA)
PCI Express® PCle®	© PCI-SIG, USA-Beaverton, OR
TwinCAT®	© Beckhoff Automation GmbH, DE-Verl
Windows®	© Microsoft Corporation, USA-Redmond, WA

Table 1-3 Brand names and trademark owners

### 1.1.6 Copyright

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## 1.2 About the Device

*Capabilities of the device, included features, and supported motors.*

maxon's EPOS4 70/15 is a small-sized, full digital, smart positioning control unit. Its high power density allows flexible use for brushed DC and brushless EC (BLDC) motors up to approximately 1050 Watts with various feedback options, such as Hall sensors, incremental encoders as well as absolute sensors in a multitude of drive applications.

The device is specially designed to be commanded and controlled as a slave node in a CANopen network. In addition, the unit can be operated via any USB or RS232 communication port of a Windows or Linux workstation. Moreover, the integrated extension interface allows pooling with optionally available communication interfaces, such as EtherCAT or other additional functionalities.

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.



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

*Keep in mind:  
Safety first!  
Always!*

- 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 “1.1.4 Symbols & Signs” on page 1-6 to understand the subsequently used indicators!
- You must observe any regulation applicable in the country and/or at the site of implementation with regard to health and safety/accident prevention and/or environmental protection!



### DANGER

#### **High voltage and/or electrical shock**

#### **Touching live wires causes death or serious injuries!**

- *Consider any power cable as connected to live power, unless having proven the opposite!*
- *Make sure that neither end of cable is connected to live power!*
- *Make sure that power source cannot be engaged while work is in process!*
- *Obey lock-out/tag-out procedures!*
- *Make sure to securely lock any power engaging equipment against unintentional engagement and tag it with your name!*



### Requirements

- *Make sure that all associated devices and components are installed according to local regulations.*
- *Be aware that, by principle, an electronic apparatus cannot 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.*



## 2 SPECIFICATIONS

### 2.1 Technical Data

EPOS4 70/15 (594385)		
Electrical Rating	Nominal power supply voltage $+V_{CC}$	10...70 VDC
	Nominal logic supply voltage $+V_C$	10...70 VDC
	Absolute supply voltage $+V_{min} / +V_{max}$	8 VDC / 75 VDC
	Output voltage (max.)	$0.9 \times +V_{CC}$
	Output current $I_{cont} / I_{max}$ (<60 s)	15 A / 30 A
	Pulse Width Modulation frequency	50 kHz
	Sampling rate PI current controller	25 kHz (40 $\mu$ s)
	Sampling rate PI speed controller	2.5 kHz (400 $\mu$ s)
	Sampling rate PID positioning controller	2.5 kHz (400 $\mu$ s)
	Sampling rate analog input	2.5 kHz (400 $\mu$ s)
	Max. efficiency	98% (→Figure 2-3)
	Max. speed DC motor	limited by max. permissible speed (motor) and max. output voltage (controller)
	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	3 x 15 $\mu$ H; 15 A
Inputs & Outputs	Digital Input 1 (general purpose) Digital Input 2 (general purpose) Digital Input 3 (general purpose) Digital Input 4 (general purpose)	DIP switch-selectable levels: • Logic: +2.0...+30 VDC • PLC: +9.0...+30 VDC
	Digital Output 1 (general purpose) Digital Output 2 (general purpose)	max. 36 VDC / $I_L \leq 500$ mA (open collector with internal pull-up)
	STO Input 1 STO Input 2	+4.5...+30 VDC (optically isolated)
	STO Output	max. 30 VDC / $I_L \leq 15$ mA (optically isolated with self-resetting short-circuit protection)
	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
	Digital Hall sensor signals H1, H2, H3	+2.0...+24 VDC (internal pull-up)
	Digital incremental encoder signals A, A', B, B', I, I'	EIA RS422, max. 6.25 MHz

Continued on next page.

EPOS4 70/15 (594385)			
Inputs & Outputs (continued)	Sensor signals (choice between multiple functions)	3-channel, EIA RS422, max. 6.25 MHz	
	<ul style="list-style-type: none"> <li>Digital incremental encoder</li> <li>Analog incremental encoder SinCos</li> <li>SSI absolute encoder</li> <li>High-speed digital input 1...4</li> <li>High-speed digital output 1</li> </ul>	3-channel, resolution 12-bit, $\pm 1.8$ V, differential configurable, EIA RS422, 0.4...2 MHz EIA RS422, max. 6.25 MHz EIA RS422, max. 6.25 MHz	
Voltage Outputs	Sensor supply voltage $V_{\text{Sensor}}$	+5 VDC / $I_L \leq 100$ mA	
	Auxiliary output voltage $V_{\text{Aux}}$	+5 VDC / $I_L \leq 150$ mA	
Motor Connections	DC motor	+ Motor, – Motor	
	EC motor	Motor winding 1, Motor winding 2, Motor winding 3	
Interfaces	RS232	max. 115'200 bit/s	
	USB 2.0 / USB 3.0	Full Speed	
	CAN	max. 1 Mbit/s	
	EtherCAT [c]	Full duplex (100 Mbit/s) as to IEEE 802.3 100 Base T	
Status Indicators	Device Status	Operation	green LED
		Error	red LED
	NET Status	RUN state	green LED
		Error	red LED
NET Port	Link activity	green LED	
Physical	Weight	approx. 372 g	
	Dimensions (L x W x H)	125.0 x 94.5 x 38.7 mm	
	Mounting	mounting holes for M4 screws	
Environment	Temperature	Operation	-30...+50 °C
		Extended range [a]	+50...+85 °C; Derating: -0.429 A/°C (→Figure 2-2) Additional derating with inserted extension card: Ambient temperature less 5 °C (→Figure 2-2) [d]
		Storage	-40...+85 °C
	Altitude [b]	Operation	0...10'000 m MSL
	Humidity	5...90% (condensation not permitted)	

[a] Operation within the extended range is permitted. However, a respective derating (declination of output current  $I_{\text{cont}}$ ) as to the stated values will apply.

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

[c] Available with optional EPOS4 EtherCAT Card.

[d] Derating further increases with an inserted extension card. For the actual value, consult →Figure 2-2 and shift the graph horizontally to the left by the specified value.

Table 2-4 Technical data

## 2.2 Thermal Data

### 2.2.1 Derating of Output Current

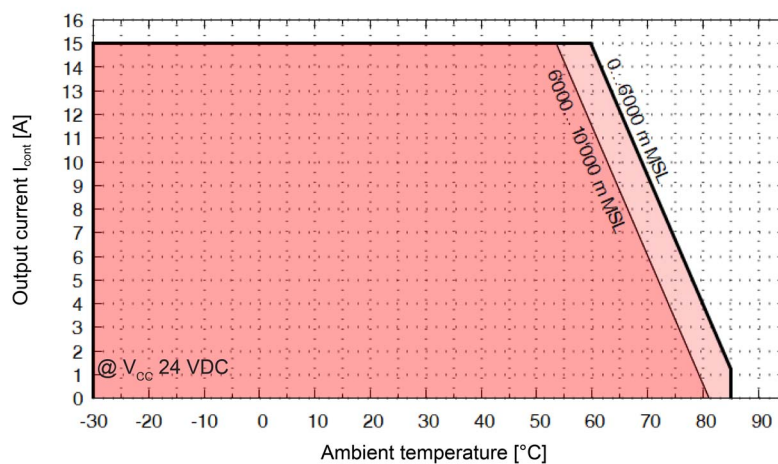
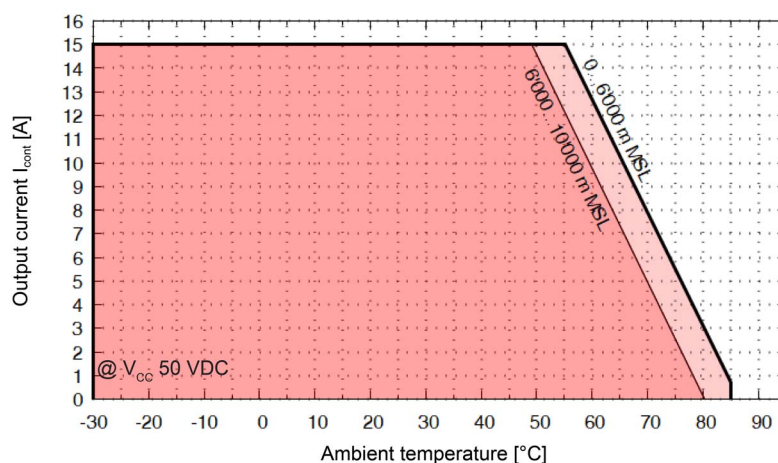
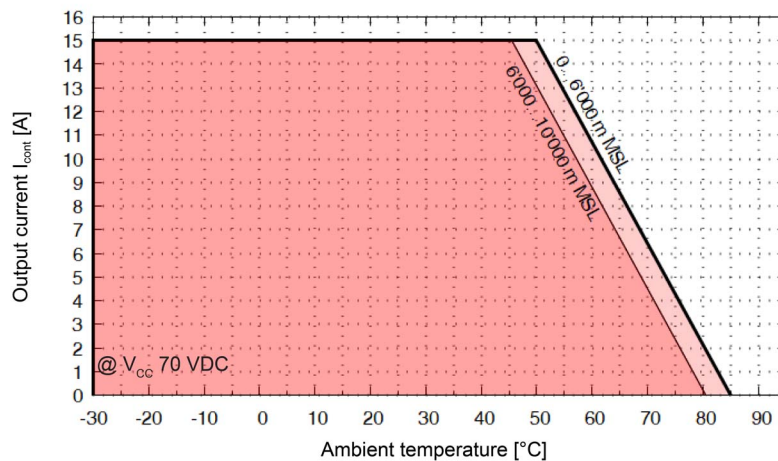


Figure 2-2 Derating of output current

### 2.2.2 Power Dissipation and Efficiency

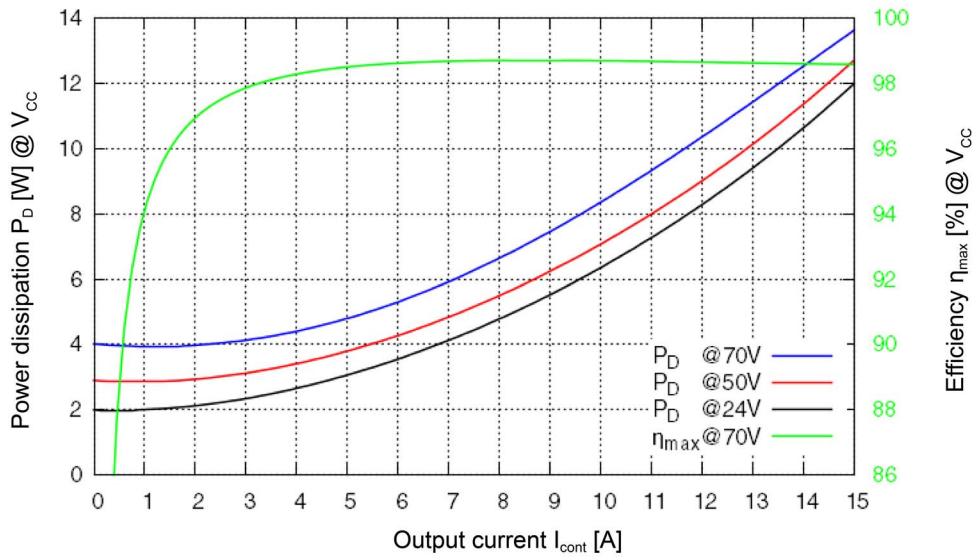


Figure 2-3 Power dissipation and efficiency

## 2.3 Limitations

Protection functionality	Switch-off threshold	Recovery threshold
Undervoltage	8.0 V	8.5 V
Overvoltage	78 V	75 V
Overcurrent	40 A	—
Thermal overload	95 °C	85 °C

Table 2-5 Limitations

## 2.4 Dimensional Drawing

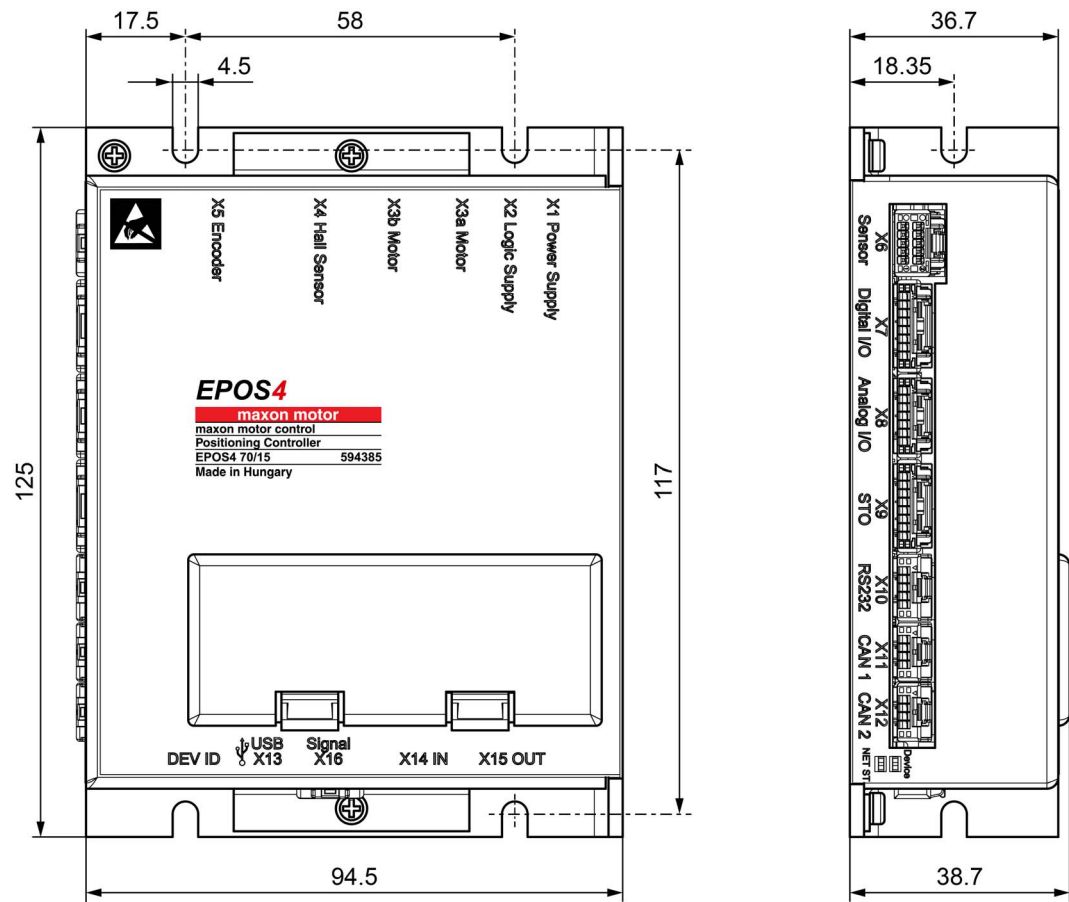


Figure 2-4 Dimensional drawing [mm]

## 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 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test >10 V/m
	IEC/EN 61000-4-4	Electrical fast transient/burst immunity test $\pm 2$ kV
	IEC/EN 61000-4-6	Immunity to conducted disturbances, induced by radio-frequency fields 10 Vrms
Others		
Environment	IEC/EN 60068-2-6	Environmental testing – Test Fc: Vibration (sinusoidal, 10...500 Hz, 20 m/s <sup>2</sup> )
	MIL-STD-810F	Random transport (10...500 Hz up to 2.53 g <sub>rms</sub> )
Safety	UL File Number	Unassembled printed circuit board: E207844
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): 254'446 hours

Table 2-6 Standards

## 3 SETUP

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

The EPOS4 70/15 positioning controller is considered as partly completed machinery according to EU Directive 2006/42/EC, Article 2, Clause (g) and **is intended to be incorporated into or assembled with other machinery or other partly completed machinery or equipment.**



#### WARNING

##### **Risk of injury**

**Operating the device without the full compliance of the surrounding system with 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...70 VDC.
- Supply voltages above 75 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. 15 A
  - short-time (acceleration) max. 30 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.



#### **Hot plugging/hot swapping the extension slots may cause hardware damage**

Switch off the controller's power supply before removing or inserting an extension card.

## 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		
	Designation	Part Number	→Page
X1	Power Cable High Current <b>Mandatory for supply of power stage!</b>	520850	3-19
X2	Power Cable <b>Optional for separate logic supply!</b>	275829	3-21
X3a	Motor Cable	275851	3-23
X3b	Motor Cable High Current	520851	3-23
X4	Hall Sensor Cable	275878	3-24
X5	Encoder Cable	275934	3-27
X6	Sensor Cable 5x2core	520852	3-30
X7	Signal Cable 8core	520853	3-40
X8	Signal Cable 7core	520854	3-44
X9	Signal Cable 8core	520853	3-40
X10	RS232-COM Cable	520856	3-50
X11	CAN-COM Cable CAN-CAN Cable	520857	3-51
		520858	3-52
X12	CAN-COM Cable CAN-CAN Cable	520857	3-51
		520858	3-52
X13	USB Type A - micro B Cable	403968	3-53
X14	Ethernet Cable	422827	3-55
X15	Ethernet Cable	422827	3-55
X16	Sensor Cable 5x2core	520852	3-30

Table 3-7 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
<b>Connectors</b>		
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 / X16	Molex CLIK-Mate, dual row, 10 poles (503149-1000)	1
X7 / X9	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
<b>Crimp Terminals</b>		
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...X12 / X16	Molex CLIK-Mate crimp terminal (502579-0100)	44
<b>Accessories</b>		
X5	3M Retainer Clip with strain relief, height 13.5 mm (3505-8110)	1

Table 3-8 EPOS4 Connector Set – Content

## 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 3-9 Recommended tools

### 3.3 Connections

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

For each connector you will find detailed information on the pin assignment, the available accessories and prefab cable assemblies, the requirements that must be met, if any, and the circuitry.

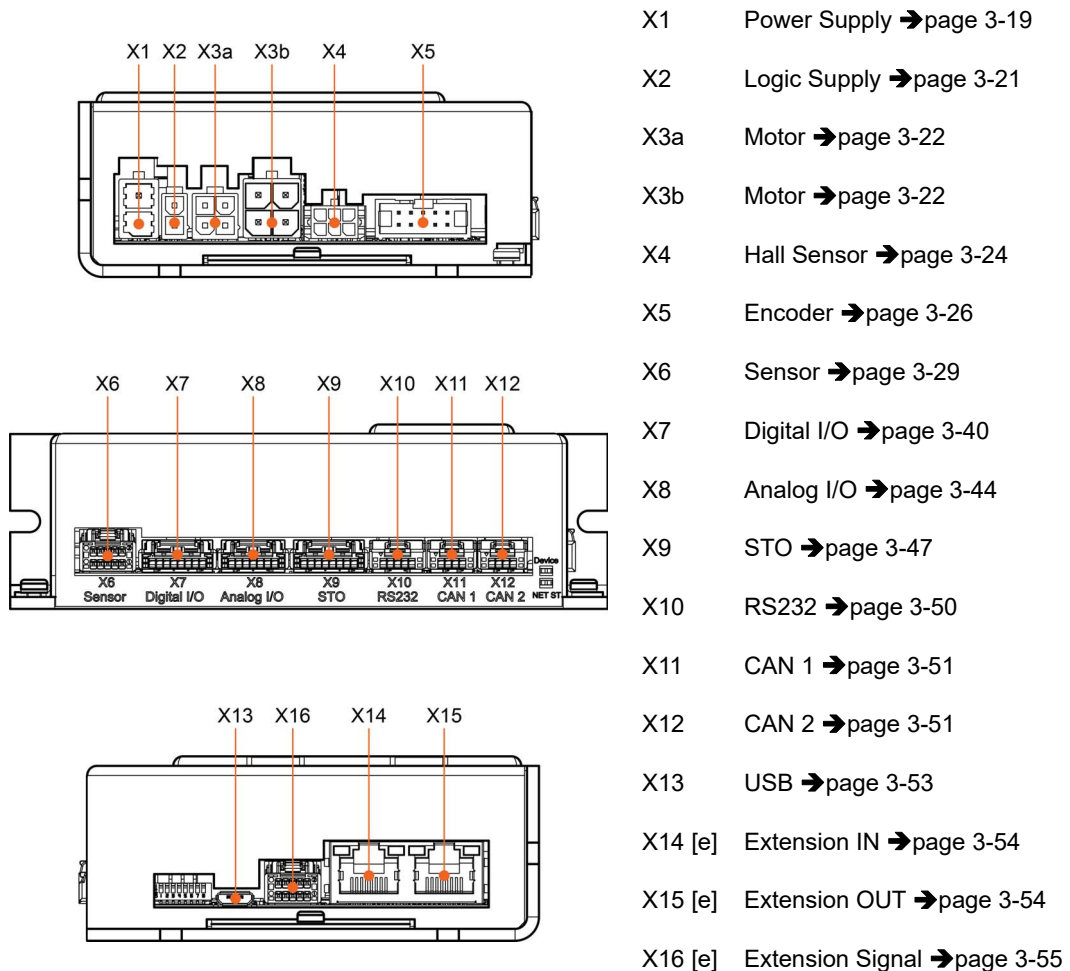


#### How to read pin assignment tables

In the later course of the document you will find tables containing information on the EPOS4's hardware connectors, their wired signals and assigned pins as well as details on the available prefab cables.

- 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.

Follow the description in given order and choose the wiring diagram (→as of page 4-63) that best suits the components you are using.



[e] Requires an optionally available maxon Extension Card

Figure 3-5 Connectors

**3.3.1 Power Supply (X1)**

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



**Use of X1 is mandatory**

You must employ X1 to connect the controller to the electrical supply. Use X2 only if you wish to connect an optional, separately wired logic supply.



**Best practice**

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

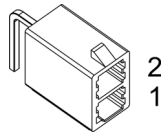


Figure 3-6 Power supply connector X1

X1 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	black	-	GND	Ground
2	black	+	+V <sub>CC</sub>	Power supply voltage (+10...+70 VDC)

Table 3-10 Power supply connector X1 – Pin assignment

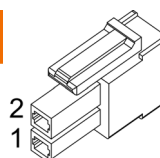
Power Cable High Current (520850)			
<b>A</b>			<b>B</b>
Cross-section	2 x 2.5 mm <sup>2</sup> , grey		
Length	3 m		
Head A	Plug	Molex Mega-Fit, 2 poles (171692-0102)	
	Contacts	Molex Mega-Fit, female crimp terminals (172063)	
Head B	Wire end sleeves 2.5 mm <sup>2</sup>		

Table 3-11 Power Cable High Current

Continued on next page.

Power supply requirements	
Output voltage	+V <sub>CC</sub> 10...70 VDC
Absolute output voltage	min. 8 VDC; max. 75 VDC
Output current	Depending on load <ul style="list-style-type: none"> <li>• continuous max. 15 A</li> <li>• short-time (acceleration, &lt;60 s) max. 30 A</li> </ul>

Table 3-12 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.



**The formula already takes the following into account:**

- Maximum PWM duty cycle of 90%
- Controller's max. voltage drop of 1 V @ 15 A

**KNOWN VALUES:**

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

**SOUGHT VALUE:**

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

**SOLUTION:**

$$V_{CC} \geq \left[ \frac{U_N}{n_0} \cdot \left( n + \frac{\Delta n}{\Delta M} \cdot M \right) \cdot \frac{1}{0.9} \right] + 1 [V]$$

### 3.3.2 Logic Supply (X2)



#### Separate power supply

The logic part of the controller may be supplied by a separate supply voltage provided that it meets the below stated minimum requirement:

If not supplied separately, the logic supply is internally connected to the power supply.

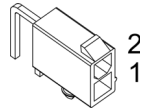


Figure 3-7 Logic supply connector X2

X2 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	black	-	GND	Ground
2	black	+	+V <sub>C</sub>	Logic supply voltage (+10...+70 VDC)

Table 3-13 Logic supply connector X2 – Pin assignment

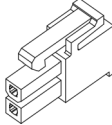
Power Cable (275829)		
<b>A</b>		<b>B</b>
Cross-section	2 x 0.75 mm <sup>2</sup> , grey	
Length	3 m	
Head A	Plug	Molex Mini-Fit Jr., 2 poles (39-01-2020)
	Contacts	Molex Mini-Fit Jr. female crimp terminals (45750)
Head B	Wire end sleeves 0.75 mm <sup>2</sup>	

Table 3-14 Power Cable

Power supply requirements	
Output voltage	+V <sub>C</sub> 10...70 VDC
Absolute supply voltage	min. 8 VDC; max. 75 VDC
Min. output power	P <sub>C</sub> min. 3.5 W

Table 3-15 Logic supply requirements

### 3.3.3 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:  $I_{cont} \leq 11\text{ A}$
- X3b:  $I_{cont} \leq 15\text{ A}$

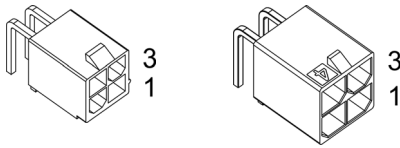


Figure 3-8 Motor connectors X3a (left) and X3b (right)

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 3-16 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 3-17 Motor connector X3a / X3b – Pin assignment for maxon EC motor

Continued on next page.

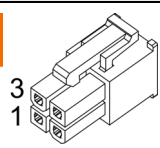
Motor Cable for X3a (275851)			
<b>A</b>			<b>B</b>
Cross-section	3 x 0.75 mm <sup>2</sup> , shielded, grey		
Length	3 m		
Head A	Plug	Molex Mini-Fit Jr., 4 poles (39-01-2040)	
	Contacts	Molex Mini-Fit Jr. female crimp terminals (45750)	
Head B	Wire end sleeves 0.75 mm <sup>2</sup>		

Table 3-18 Motor Cable

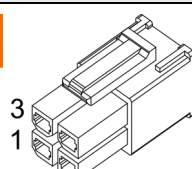
Motor Cable High Current for X3b (520851)			
<b>A</b>			<b>B</b>
Cross-section	3 x 2.5 mm <sup>2</sup> , shielded, grey		
Length	3 m		
Head A	Plug	Molex Mega-Fit, 4 poles (171692-0104)	
	Contacts	Molex Mega-Fit, female crimp terminals (172063)	
Head B	Wire end sleeves 2.5 mm <sup>2</sup>		

Table 3-19 Motor Cable High Current

### 3.3.4 Hall Sensor (X4)

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

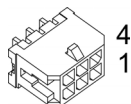


Figure 3-9 Hall sensor connector X4

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		$V_{\text{Sensor}}$	Sensor supply voltage (+5 VDC; $I_L \leq 100$ mA)
6	black		Hall shield	Cable shield

Table 3-20 Hall sensor connector X4 – Pin assignment

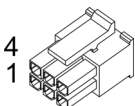
Hall Sensor Cable (275878)		
<b>A</b>		<b>B</b>
Cross-section	5 x 0.14 mm <sup>2</sup> , shielded, grey	
Length	3 m	
Head A	Plug	Molex Micro-Fit 3.0, 6 poles (430-25-0600)
	Contacts	Molex Micro-Fit 3.0 female crimp terminals (430-30-xxxx)
Head B	Wire end sleeves 0.14 mm <sup>2</sup>	

Table 3-21 Hall Sensor Cable

Continued on next page.



Hall sensor	
Sensor supply voltage ( $V_{\text{Sensor}}$ )	+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	2.7 k $\Omega$ (referenced to +5.45 V - 0.6 V)

Table 3-22 Hall sensor specification

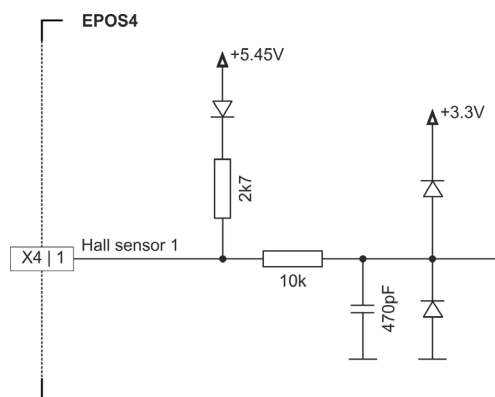


Figure 3-10 Hall sensor 1 input circuit (analogously valid for Hall sensors 2 & 3)

### 3.3.5 Encoder (X5)



#### 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**.

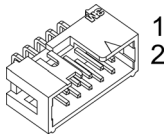


Figure 3-11 Encoder connector X5

X5 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	brown	1	–	not connected
2	white	2	$V_{\text{Sensor}}$	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

Continued on next page.

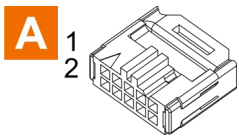
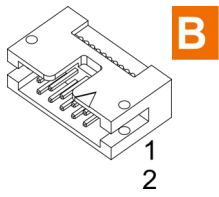
Encoder Cable (275934)	
	
Cross-section	10 x AWG28, round-jacket, flat cable, pitch 1.27 mm
Length	3.2 m
Head A	DIN 41651 female, pitch 2.54 mm, 10 poles, with strain relief
Head B	DIN 41651 plug, pitch 2.54 mm, 10 poles, with strain relief

Table 3-25 Encoder Cable

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

Table 3-26 Differential encoder specification

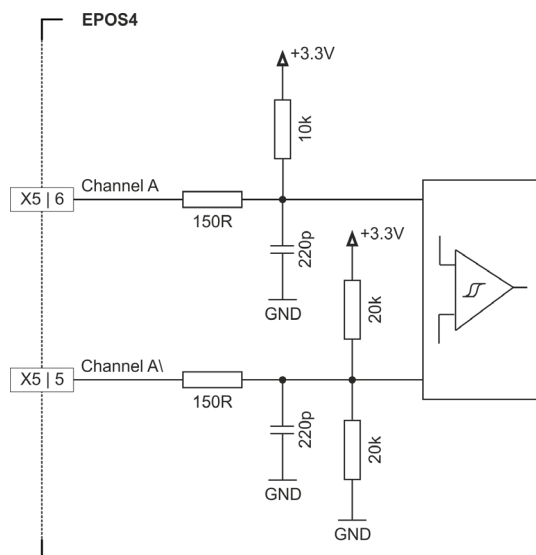


Figure 3-12 Encoder input circuit Ch A “differential” (analogously valid for Ch B & Ch I)

Continued on next page.

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

Table 3-27 Single-ended encoder specification

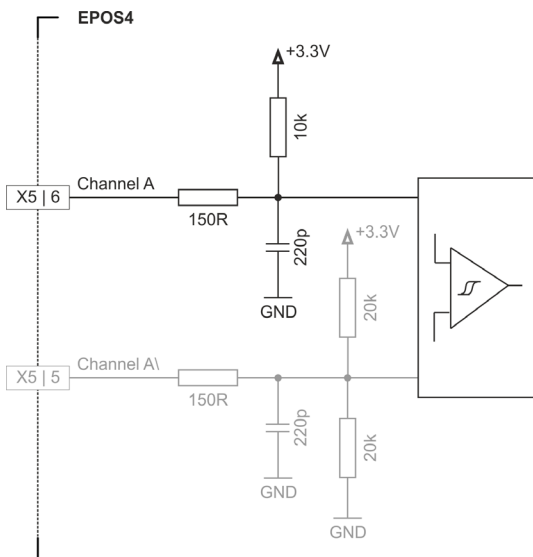


Figure 3-13 Encoder input circuit Ch A "single-ended" (analogously valid for Ch B & Ch I)

### 3.3.6 Sensor (X6)

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



#### **Check on the applied sensor's data sheet**

If the specified inrush current or the maximum continuous current of the sensor should exceed 150 mA, you can connect the sensor supply voltage ( $V_{Sensor}$ ) in parallel to the auxiliary output voltage ( $V_{Aux}$ ).

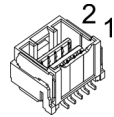


Figure 3-14 Sensor connector X6

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)
6	pink	6	HsDigOUT1	High-speed digital output 1
			Channel I\	Digital/analog incremental encoder channel I complement
			HsDigIN3\	High-speed digital input 3 complement
7	blue	7	Clock\	Clock (SSI) complement
			HsDigOUT1\	High-speed digital output 1 complement
			Data	Data (SSI)
8	red	8	HsDigIN4	High-speed digital input 4
			Data\	Data (SSI) complement
9	black	9	HsDigIN4\	High-speed digital input 4 complement
			GND	Ground
10	violet	10	$V_{Aux}$	Auxiliary output voltage (+5 VDC; $I_L \leq 150$ mA)

Table 3-28 Sensor connector X6 – Pin assignment

Continued on next page.

Sensor Cable 5x2core (520852)		
<b>A</b>	2 1	<b>B</b>
Cross-section	5 x 2 x 0.14 mm <sup>2</sup> , 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 <sup>2</sup>	

Table 3-29 Sensor Cable 5x2core

### 3.3.6.1 Incremental Encoder

Digital incremental encoder (differential)	
Auxiliary output voltage ( $V_{Aux}$ )	+5 VDC
Max. auxiliary supply current	150 mA
Min. differential input voltage	$\pm 200$ mV
Max. input voltage	+12 VDC
Line receiver (internal)	EIA RS422 standard
Max. input frequency	6.25 MHz

Table 3-30 Differential digital incremental encoder specification

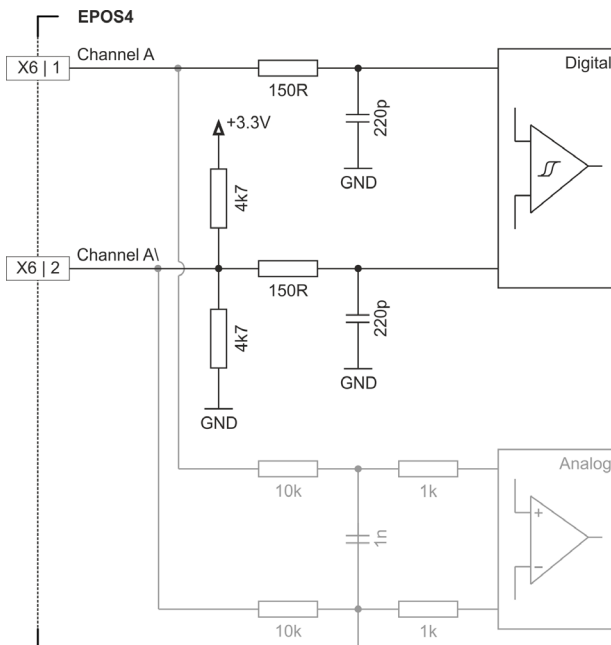


Figure 3-15 Digital incremental encoder input circuit Ch A “differential” (analogously valid for Ch B)

Continued on next page.

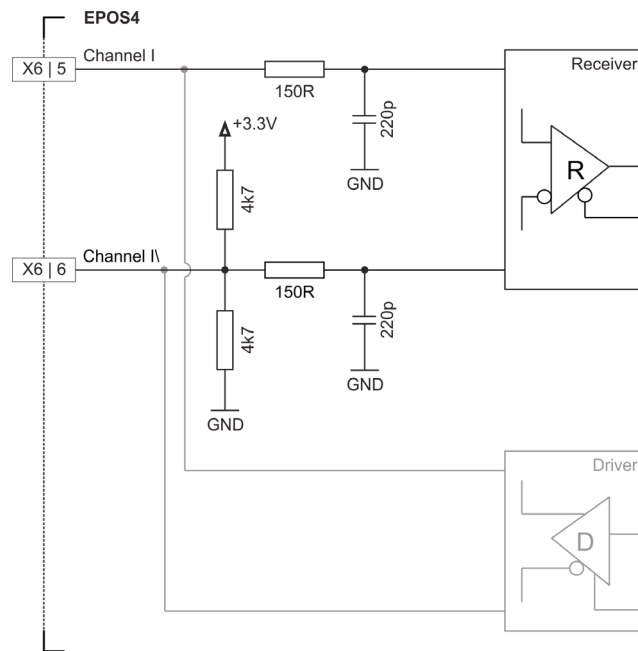


Figure 3-16 Digital incremental encoder input circuit Ch I

Continued on next page.

Digital incremental encoder (single-ended)		
Auxiliary output voltage ( $V_{Aux}$ )	+5 VDC	
Max. auxiliary supply current	150 mA	
Input voltage	0...5 VDC	
Max. input voltage	$\pm 12$ VDC	
Logic 0	<1.0 V	
Logic 1	>2.4 V	
Input high current	typically 210 $\mu$ A @ +5 VDC (channel A, B) typically 60 $\mu$ A @ +5 VDC (channel I)	
Input low current	typically -80 $\mu$ A @ 0 VDC (channel A, B) typically -7 $\mu$ A @ 0 VDC (channel I)	
Max. input frequency	Open collector	6.25 MHz
	Push-pull	100 kHz (additional external 3k3 pull-up)

Table 3-31 Single-ended digital incremental encoder specification

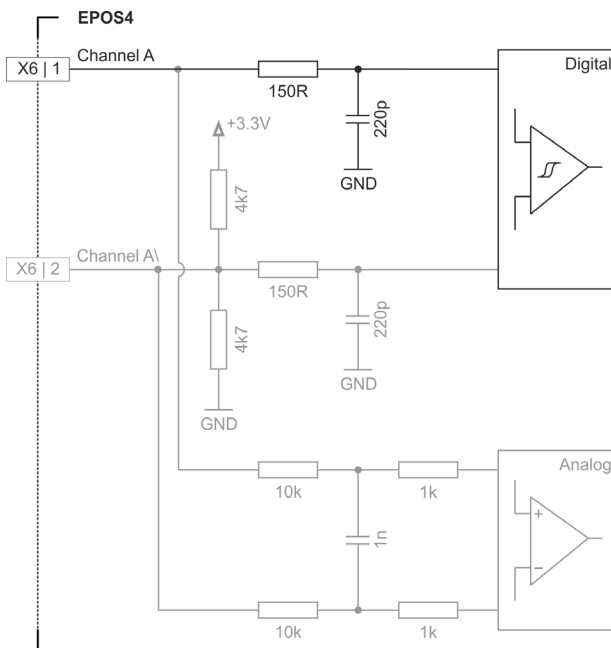


Figure 3-17 Digital incremental encoder input circuit Ch A “single-ended” (analogously valid for Ch B)

Continued on next page.



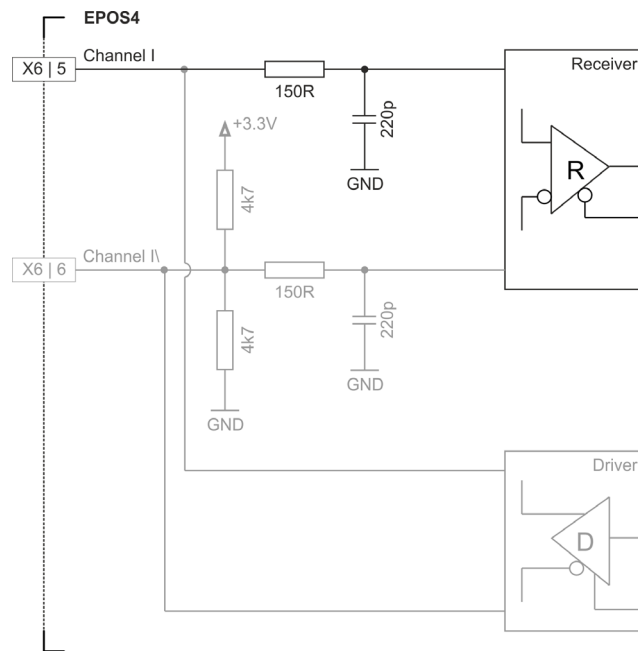


Figure 3-18 Digital incremental encoder input circuit Ch I

Continued on next page.

Analog incremental encoder SinCos (differential)	
Auxiliary output voltage ( $V_{Aux}$ )	+5 VDC
Max. auxiliary supply current	150 mA
Input voltage	$\pm 1.8$ V (differential)
Max. input voltage	$\pm 12$ VDC
Common mode voltage	-9...+4 VDC (referenced to GND)
Input resistance	typically 10 k $\Omega$
A/D converter	12-bit
Resolution	0.88 mV
Bandwidth	10 kHz

Table 3-32 Differential analog incremental encoder specification

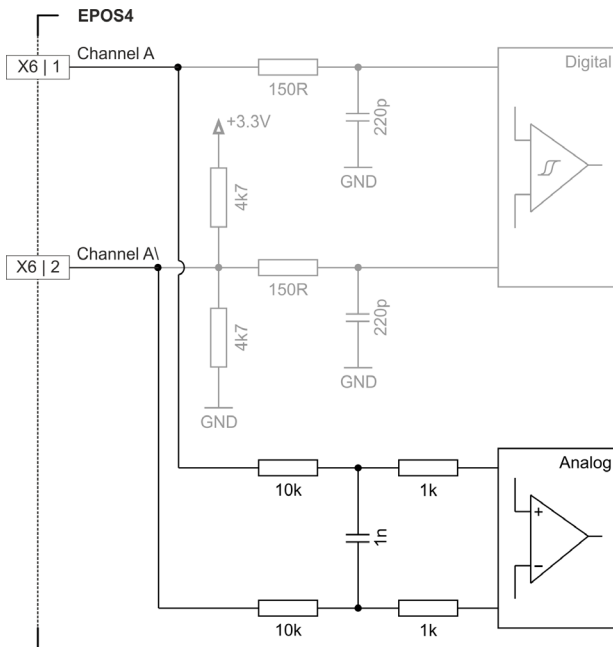


Figure 3-19 Analog incremental encoder input circuit Ch A “differential” (analogously valid for Ch B)

Continued on next page.

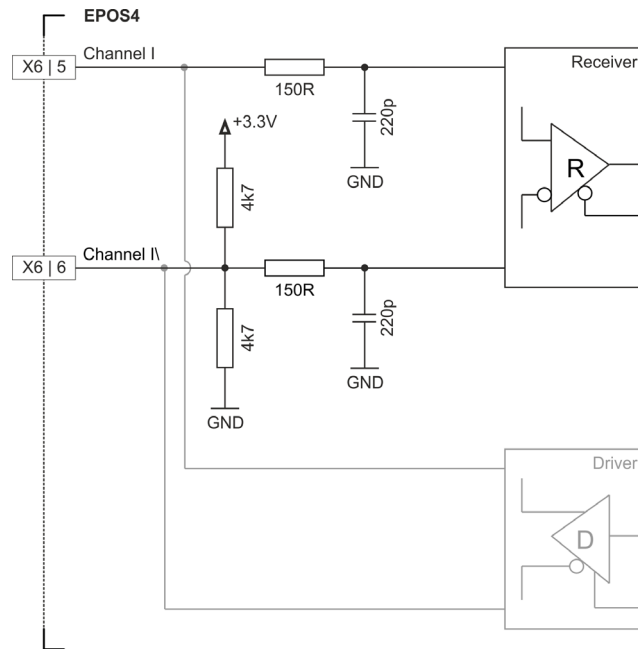


Figure 3-20 Analog incremental encoder input circuit Ch I (digital evaluation)

Continued on next page.

**3.3.6.2 SSI Absolute Encoder**

SSI absolute encoder	
Auxiliary output voltage ( $V_{Aux}$ )	+5 VDC
Max. auxiliary supply current	150 mA
Min. differential input voltage	$\pm 200$ mV
Min. differential output voltage	$\pm 1.8$ V @ external load $R=54 \Omega$
Max. output current	40 mA
Line receiver (internal)	EIA RS422 standard
Encoder input/output frequency	0.4... 2 MHz

Table 3-33 SSI absolute encoder specification

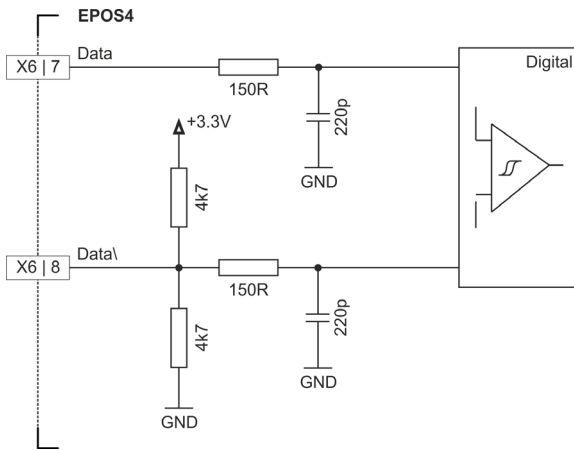


Figure 3-21 SSI absolute encoder data input

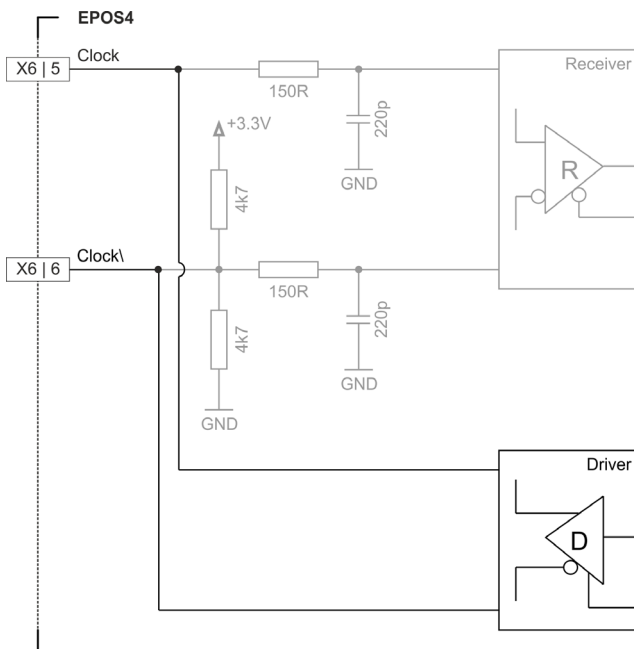


Figure 3-22 SSI absolute encoder clock output

### 3.3.6.3 High-speed Digital I/Os

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

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 3-34 Differential high-speed digital input specification

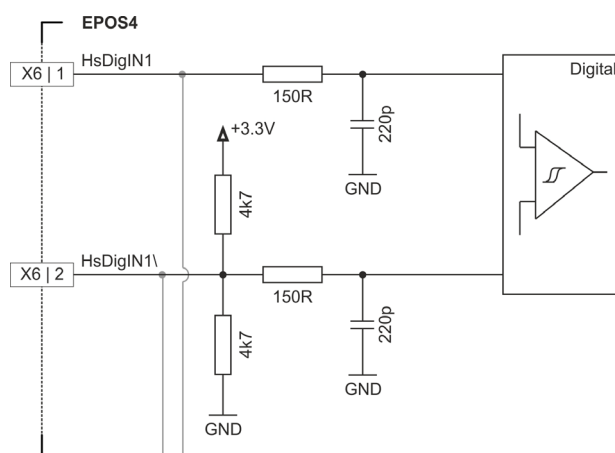


Figure 3-23 HsDigIN1 circuit “differential” (analogously valid for HsDigIN2...4)

Continued on next page.

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 $\mu\text{A}$ @ +5 VDC (HsDigIN1, 2) typically 60 $\mu\text{A}$ @ +5 VDC (HsDigIN3, 4)
Input low current	typically -80 $\mu\text{A}$ @ 0 VDC (HsDigIN1, 2) typically -7 $\mu\text{A}$ @ 0 VDC (HsDigIN3, 4)
Max. input frequency	6.25 MHz

Table 3-35 Single-ended high-speed digital input specification

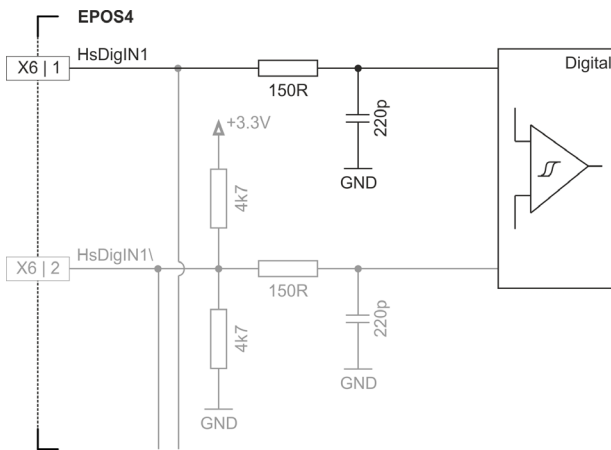


Figure 3-24 HsDigIN1 circuit “single-ended” (analogously valid for HsDigIN2...4)

Continued on next page.

High-speed digital output 1	
Min. differential output voltage	$\pm 1.8 \text{ V @ external load } R=54 \Omega$
Max. output current	40 mA
Line transceiver (internal)	EIA RS422 standard
Max. output frequency	6.25 MHz

Table 3-36 High-speed digital output specification

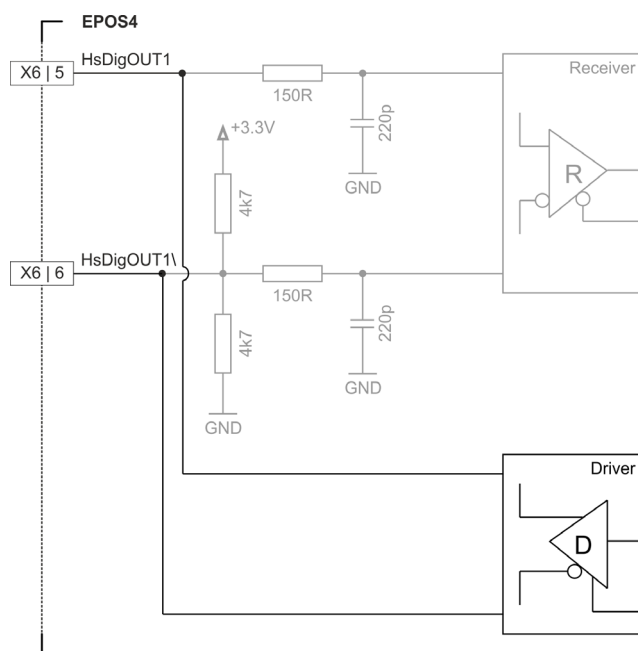


Figure 3-25 HsDigOUT1 output circuit

**3.3.7 Digital I/O (X7)**

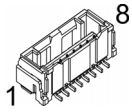


Figure 3-26 Digital I/O connector X7

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 <sub>Aux</sub>	Auxiliary output voltage (+5 VDC; I <sub>L</sub> ≤150 mA)

Table 3-37 Digital I/O connector X7 – Pin assignment

Signal Cable 8core (520853)		
Cross-section	8 x 0.14 mm <sup>2</sup> , 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 <sup>2</sup>	

Table 3-38 Signal Cable 8core

Continued on next page.



Digital inputs 1...4 (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 3-39 Digital input specification – Logic level setting

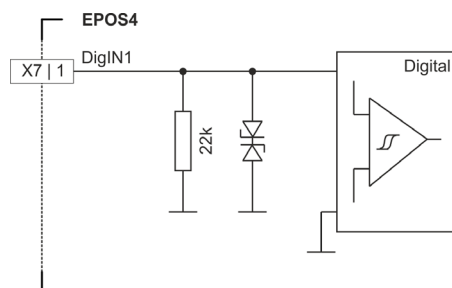


Figure 3-27 DigIN1 circuit (analogously valid for DigIN2...4) – Logic level setting

Digital inputs 1...4 (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 3-40 Digital input specification – PLC level setting

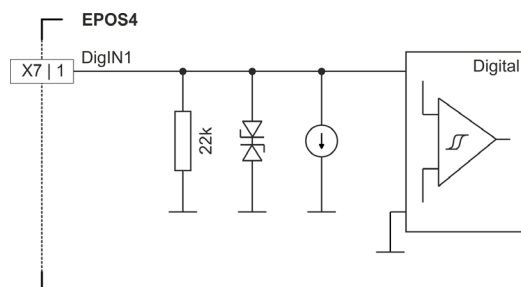


Figure 3-28 DigIN1 circuit (analogously valid for DigIN2...4) – PLC level setting

Continued on next page.

Digital outputs 1...2	
Circuit	Open drain (internal pull-up resistor 2k2 and diode to +5.45 VDC

Table 3-41 Digital output specification

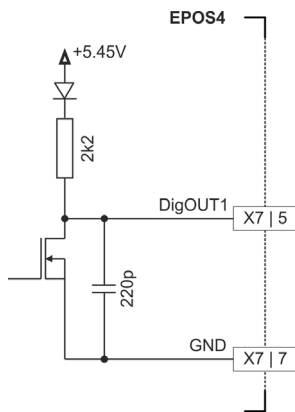


Figure 3-29 DigOUT1 circuit (analogously valid for DigOUT2)

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WIRING EXAMPLES

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

Table 3-42 Digital output – Sinks

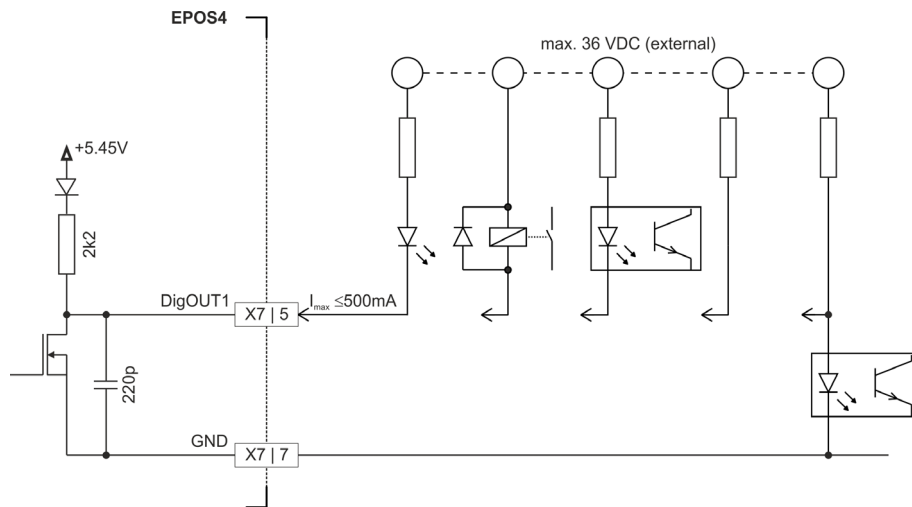


Figure 3-30 DigOUT1 "sinks" (analogously valid for DigOUT2)

DigOUT "source"	
Output voltage	$U_{Out} = 5.45\text{ V} - 0.75\text{ V} - (I_{Load} \times 2200\ \Omega)$
Max. load current	$I_{Load} \leq 2\text{ mA}$

Table 3-43 Digital output – Source

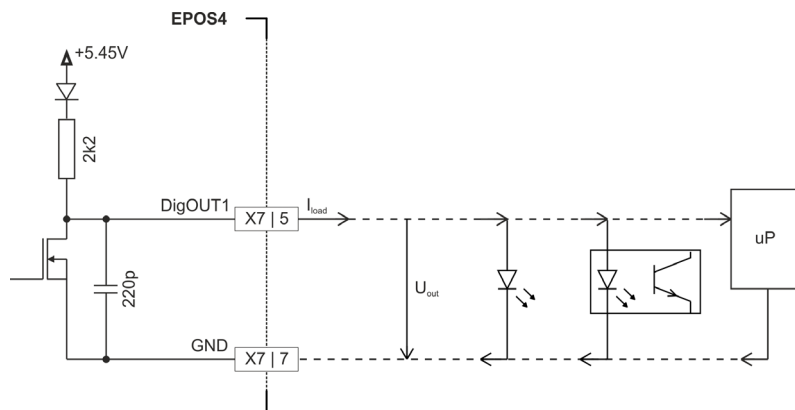


Figure 3-31 DigOUT1 "source" (analogously valid for DigOUT2)

**3.3.8 Analog I/O (X8)**

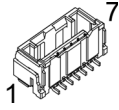


Figure 3-32 Analog I/O connector X8

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 3-44 Analog I/O connector X8 – Pin assignment

Signal Cable 7core (520854)		
Cross-section	7 x 0.14 mm <sup>2</sup> , 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 mm <sup>2</sup>	

Table 3-45 Signal Cable 7core

Continued on next page.

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 3-46 Analog input specification

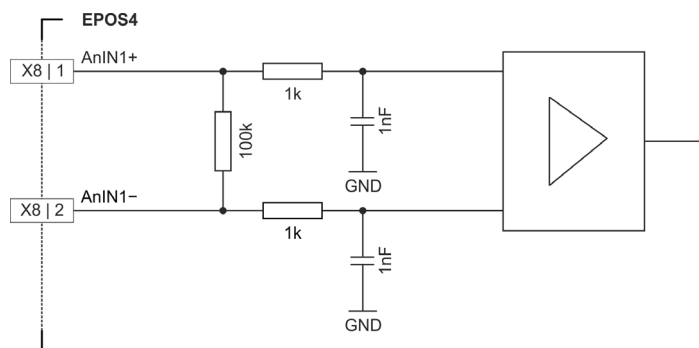


Figure 3-33 AnIN1 circuit (analogously valid for AnIN2)

Continued on next page.

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 <b>Note:</b> 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 3-47 Analog output specification

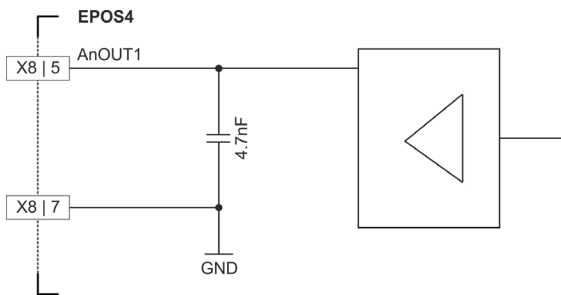


Figure 3-34 AnOUT1 circuit (analogously valid for AnOUT2)

### 3.3.9 STO (X9)

The STO (Safe Torque Off) function can be utilized to bring the drive to a torque-free, safe condition via two independent inputs. The drive output power stage is switched off if either one of the inputs is not powered.

For in-depth details on the STO functionality see separate document → «EPOS4 Application Notes».



#### **Non-certified STO functionality**

*The implemented STO functionality will not be certified.*

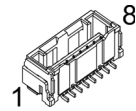


Figure 3-35 STO connector X9



#### **Activation of power stage**

*In order to activate the power stage, either **both** STO inputs must be powered or the «STO Idle Connector» (→Table 3-49) must be plugged.*

X9 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	white	1	STO-IN1+	Safe Torque Off input 1, positive signal
2	brown	2	STO-IN1-	Safe Torque Off input 1, negative signal
3	green	3	STO-IN2+	Safe Torque Off input 2, positive signal
4	yellow	4	STO-IN2-	Safe Torque Off input 2, negative signal
5	grey	5	STO-OUT+	Safe Torque Off output, positive signal
6	pink	6	STO-OUT-	Safe Torque Off output, negative signal
7	blue	7	GND	Ground
8	red	8	V <sub>STO</sub>	Activation voltage for STO inputs (+5 VDC) <b>Note:</b> Do not use this voltage for any other purpose

Table 3-48 STO connector X9 – Pin assignment

For the matching prefab cable assembly →Table 3-38 on page 3-40.

STO Idle Connector (520860) —included with every delivery—	
Plug	Molex CLIK-Mate, single row, 8 poles (502578-0800) with cable bridges

Table 3-49 STO Idle Connector

Continued on next page.

Safe Torque Off inputs 1...2	
Circuit type	Optically isolated input
Input voltage	0...+30 VDC
Max. input voltage	±30 VDC
Logic 0	<1.0 VDC
Logic 1	>4.5 VDC
Input current at logic 1	>2 mA @ 5 VDC typically 3.2 mA @ 24 VDC
Reaction time	<25 ms

Table 3-50 STO input specification

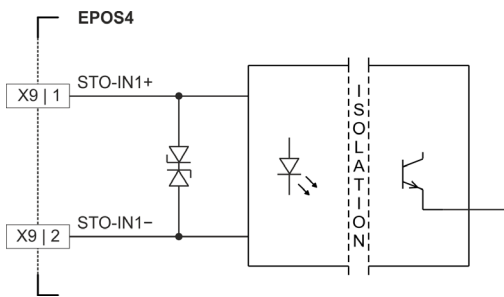


Figure 3-36 STO-IN1 circuit (analogously valid for STO-IN2)

Safe Torque Off output	
Circuit type	Optically isolated output with self-resetting short-circuit protection
Max. input voltage	±30 VDC
Max. load current	15 mA
Leakage current	<10 µA @ +30 VDC
Max. voltage drop	1.3 V @ 2 mA 2.5 V @ 15 mA

Table 3-51 STO output specification

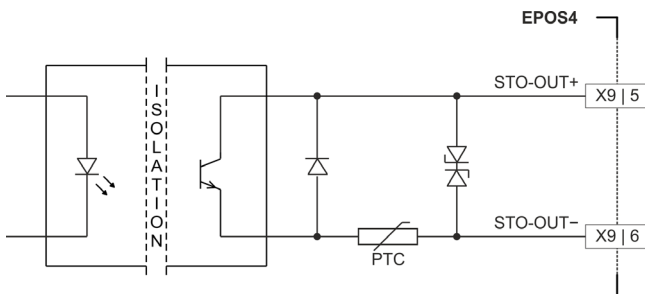


Figure 3-37 STO-OUT circuit

Continued on next page.



STO Logic State			
STO-IN1	STO-IN2	STO-OUT	Power Stage
0	0	open	inactive
1	0	closed	inactive
0	1	closed	inactive
1	1	closed	active

Table 3-52 STO logic state

**3.3.10 RS232 (X10)**

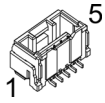


Figure 3-38 RS232 connector X10

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 3-53 RS232 connector X10 – Pin assignment

RS232-COM Cable (520856)		
Cross-section	2 x 2 x 0.14 mm <sup>2</sup> , 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 3-54 RS232-COM Cable

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

Table 3-55 RS232 interface specification

**3.3.11 CAN 1 (X11) & CAN 2 (X12)**

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.

For the CAN configuration → “DIP Switch Configuration (SW1)” on page 3-58.

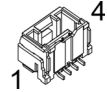


Figure 3-39 CAN 1 connector X11/CAN 2 connector X12

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 3-56 CAN 1 connector X11/CAN 2 connector X12 – Pin assignment


CAN-COM Cable (520857)		
<b>A</b>		<b>B</b>
Cross-section	2 x 2 x 0.14 mm <sup>2</sup> , 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 3-57 CAN-COM Cable

Continued on next page.

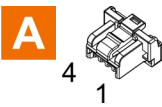
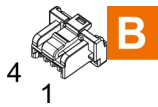
CAN-CAN Cable (520858)		
		
Cross-section	2 x 2 x 0.14 mm <sup>2</sup> , twisted pair, shielded	
Length	3 m	
Head A	Plug	Molex CLIK-Mate, single row, 4 poles (502578-0400)
	Contacts	Molex CLIK-Mate crimp terminals (502579)
Head B	Plug	Molex CLIK-Mate, single row, 4 poles (502578-0400)
	Contacts	Molex CLIK-Mate crimp terminals (502579)

Table 3-58 CAN-CAN Cable

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	By DIP switch or software

Table 3-59 CAN interface specification



**Note**

- Consider the CAN master's maximal bit rate.
- The standard bit rate setting (factory setting) is 1 Mbit/s, 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».

3.3.12 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.

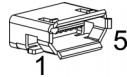


Figure 3-40 USB connector X13

X13 Head A Pin	PC's USB Terminal Head B Pin	Signal	Description
1	1	V <sub>BUS</sub>	USB bus supply voltage input +5 VDC
2	2	USB_D-	USB Data- (twisted pair with Data+)
3	3	USB_D+	USB Data+ (twisted pair with Data-)
4	–	ID	not connected
5	4	GND	USB ground

Table 3-60 USB connector X13 – Pin assignment

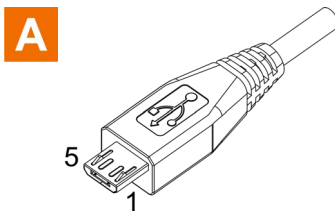
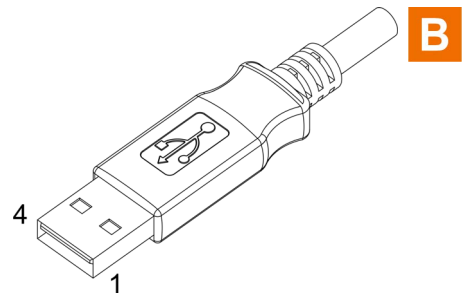
USB Type A - micro B Cable (403968)	
	
Cross-section	According to USB 2.0 / USB 3.0 specification
Length	1.5 m
Head A	USB Type "micro B", male
Head B	USB Type "A", male

Table 3-61 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 3-62 USB interface specification

### 3.3.13 Extension IN (X14) & Extension OUT (X15)

The EPOS4 70/15 features two NET connectors for extension communication interfaces, such as Ether-CAT. One serves for NET input, the other for NET output. Both sockets are identical in respect to their external wiring.



**Wrong plugging may cause hardware damage**

Even though both NET sockets are prepared for identical external wiring, make sure to always connect them as follows.

- Use only standard Cat5 cables with RJ45 plug, such as maxon's «Ethernet Cable» (422827).
- Use IN (X14) as «Input».
- Use OUT (X15) as «Output».

For detailed information see separate document →«EPOS4 Communication Guide».

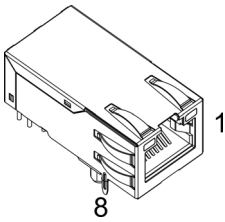


Figure 3-41 Extension IN & OUT connectors X14 & X15

X14 X15 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	white/ orange	1	TX+	Transmission Data+
2	orange	2	TX-	Transmission Data-
3	white/ green	3	RX+	Receive Data+
4	blue	4	–	not applicable
5	white/ blue	5	–	not applicable
6	green	6	RX-	Receive Data-
7	white/ brown	7	–	not applicable
8	brown	8	–	not applicable

Table 3-63 Extension IN & OUT connectors X14 & X15 – Pin assignment

Continued on next page.

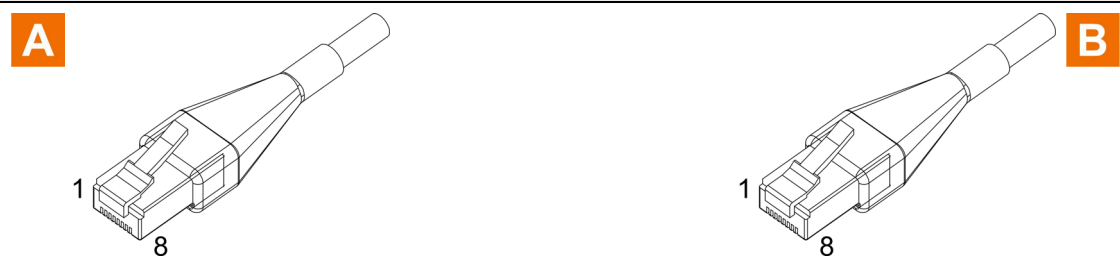
Ethernet Cable (422827)	
	
Cross-section	Cat. 5e SF/UTP (ISO/IEC 11801), 1:1 patch cable, green
Length	2 m
Head A	RJ45 (8P8CS) EIA/TIA-568B
Head B	RJ45 (8P8CS) EIA/TIA-568B

Table 3-64 Ethernet Cable

### 3.3.14 Extension Signal (X16)

The connector provides direct access to the signal extension slot EXT2 (→chapter “3.3.15 Extension Slots (EXT1 & EXT2)” on page 3-56) thus allowing the use of signal extension cards (such as for additional absolute sensors or customized signal extensions). The pin assignment is directly related to the corresponding extension card.

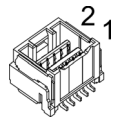


Figure 3-42 Extension Signal connector X16

X16 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	white	1	EXT-1	Depending on signal extension card inserted in extension slot EXT2 (→Table 3-66)
2	brown	2	EXT-2	
3	green	3	EXT-3	
4	yellow	4	EXT-4	
5	grey	5	EXT-5	
6	pink	6	EXT-6	
7	blue	7	EXT-7	
8	red	8	EXT-8	
9	black	9	EXT-9	
10	violet	10	EXT-10	

Table 3-65 Extension Signal connector X16 – Pin assignment

For the matching prefab cable assembly →Table 3-29 on page 3-30.

### 3.3.15 Extension Slots (EXT1 & EXT2)

The controller provides two extension slots (→ Figure 3-43) located underneath the plastic lid at the controller housing's top face. They host optionally available extension cards (→ Table 3-66) and thereby expand the controller's comprehensive motion control functionality even further.

- **EXT1** provides connectivity for a communication extension card, such as for EtherCAT. With the optionally available «EPOS4 EtherCAT Card», the controller serves as slave in an EtherCAT network, provides access for EtherCAT master control (such as Beckhoff TwinCAT), and offers real-time operation in an Ethernet master/slave network. For further details see separate document → «EPOS4 Communication Guide».
- **EXT2** provides connectivity for advanced signal extension cards, such as for additional absolute sensors or customized signal extensions. Using the respective optionally available EPOS4 cards, additional functions can be directly accessed via the connector → “Extension Signal (X16)” on page 3-55.

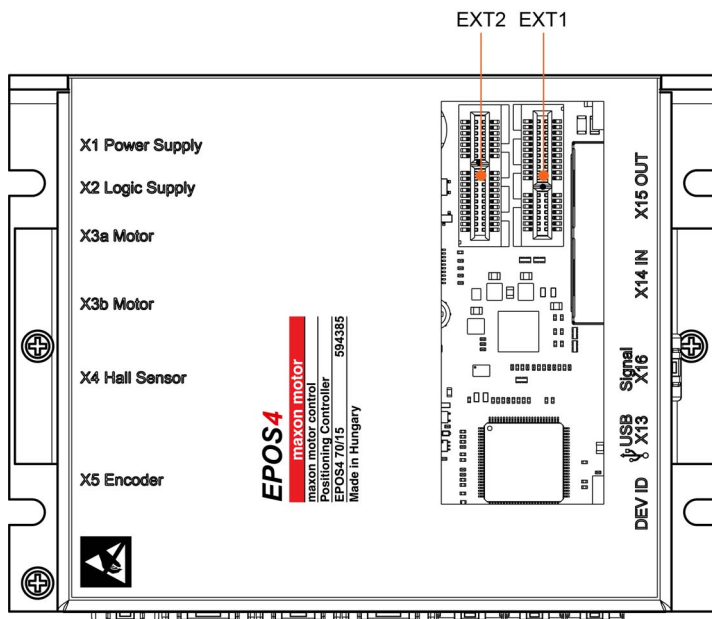


Figure 3-43 Extension slots

An inserted extension card mechanically interlocks in both horizontal and vertical direction.

To insert or remove an extension card, proceed as follows (explained using an «EPOS4 EtherCAT Card»):



**Hot plugging/hot swapping the card may cause hardware damage**

Switch off the controller's power supply before removing or inserting an extension card.



**Electrostatic sensitive device (ESD)**

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

Continued on next page.



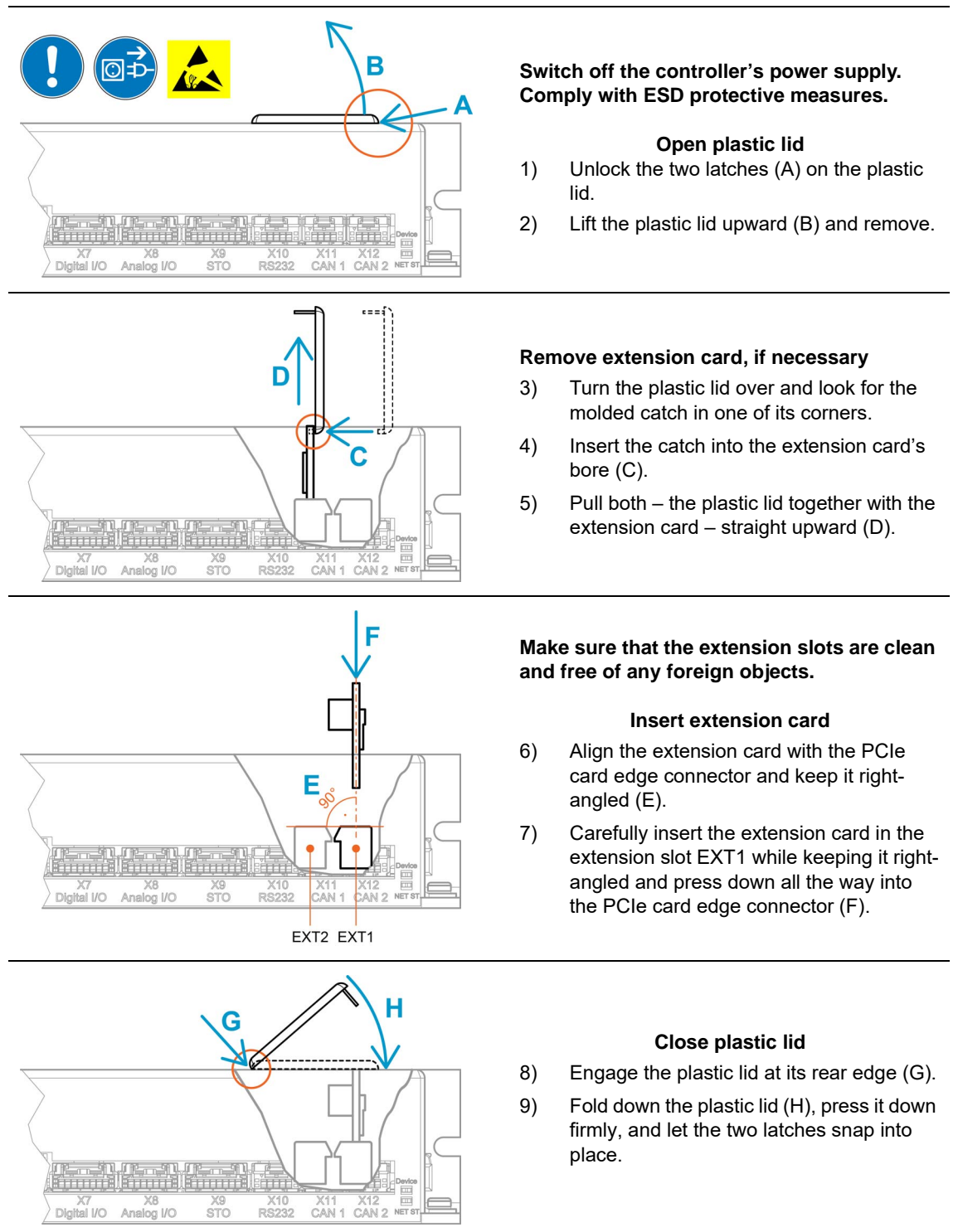


Figure 3-44 Installation & removal of an extension card

Continued on next page.

Extension Cards		
Slot	Description	Part number
EXT1	EPOS4 EtherCAT Card	581245
EXT2	—	—

Table 3-66 Extension cards (optional)

### 3.3.16 DIP Switch Configuration (SW1)

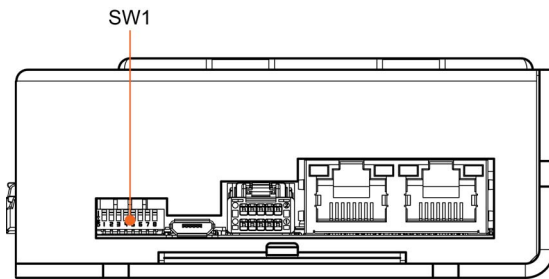


Figure 3-45 DIP switch SW1

#### 3.3.16.1 CAN ID (Node-ID) / DEV ID



**NOTE:** Setting the ID by means of DIP switches is currently available for CAN only!

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").
- DIP switches 6...8 do not have any impact on the ID.

Switch	Binary Code	Valence	Setting
1	2 <sup>0</sup>	1	<p>(factory setting)</p>
2	2 <sup>1</sup>	2	
3	2 <sup>2</sup>	4	
4	2 <sup>3</sup>	8	
5	2 <sup>4</sup>	16	

Table 3-67 DIP switch SW1 – Binary code values

Continued on next page.

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









Setting	Switch					ID
	1	2	3	4	5	
 ↑OFF ↓ON	0	0	0	0	0	–
 ↑OFF ↓ON	1	0	0	0	0	1
 ↑OFF ↓ON	0	1	0	0	0	2
 ↑OFF ↓ON	0	0	1	0	0	4
 ↑OFF ↓ON	1	0	1	0	0	5
 ↑OFF ↓ON	0	0	0	1	0	8
 ↑OFF ↓ON	0	0	0	0	1	16
 ↑OFF ↓ON	1	1	1	1	1	31
0 = Switch "OFF"      1 = Switch "ON"						

Table 3-68      DIP switch SW1 – Examples

### 3.3.16.2      CAN automatic Bit Rate Detection

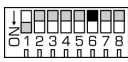
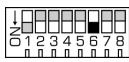
Switch	OFF	ON
6	 ↑OFF ↓ON Automatic bit rate detection deactivated	 ↑OFF ↓ON Automatic bit rate detection activated (factory setting)

Table 3-69      DIP switch SW1 – CAN automatic bit rate detection

### 3.3.16.3      CAN Bus Termination

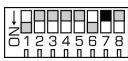
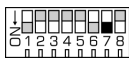
Switch	OFF	ON
7	 ↑OFF ↓ON Without bus termination (factory setting)	 ↑OFF ↓ON Bus termination with 120 Ω

Table 3-70      DIP switch SW1 – CAN bus termination

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**3.3.16.4 Digital Input Level**

For details → chapter “3.3.7 Digital I/O (X7)” on page 3-40.

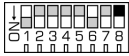
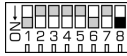
Switch	OFF	ON
8	 <p>Logic level (factory setting)</p>	 <p>PLC level</p>

Table 3-71 DIP switch SW1 – Digital input level

**3.3.17 Spare Parts**

Order number	Description
520860	STO Idle Connector X9

Table 3-72 Spare parts list

## 3.4 Status Indicators

The EPOS4 features three sets of LED indicators to display the device condition.

- A NET Status;** the LEDs display communication RUN states and errors conditions
- B Device Status;** the LEDs display the device's operation status and error conditions
- C NET Port;** the LED displays the NET link activity

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

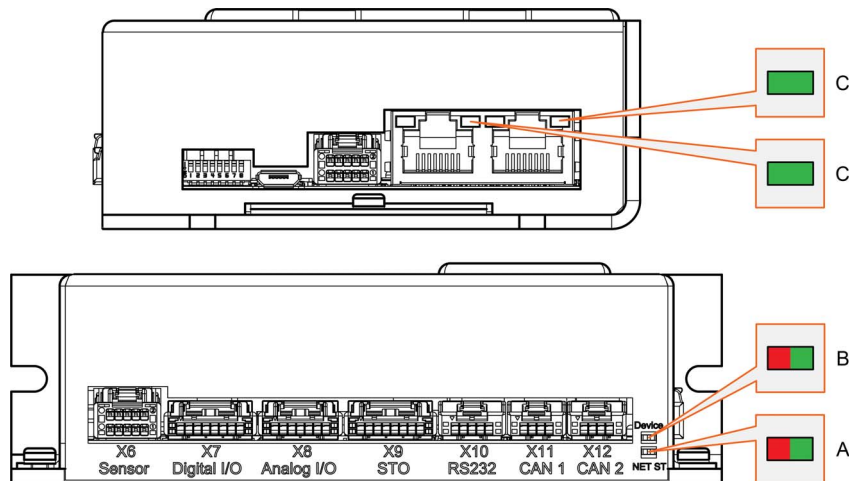


Figure 3-46 LEDs – Location

### 3.4.1 NET Status

The LEDs (→Figure 3-46; **A**) display the actual status and possible errors of the EPOS4 in respect to the NET network:

- Green LED shows the RUN state
- Red LED indicates errors

LED		Description
Green	Red	
OFF	—	EPOS4 is in state INIT
Blink	—	EPOS4 is in state PRE-OPERATIONAL
Single flash	—	EPOS4 is in state SAFE-OPERATIONAL
ON	—	EPOS4 is in state OPERATIONAL
Flicker	—	EPOS4 is in state BOOTSTRAP
—	OFF	EPOS4 is in operating condition
—	Double flash	An application watchdog timeout has occurred <i>Example: Timeout of Sync Manager Watchdog</i>
—	Single flash	EPOS4 has changed the COM state due to an internal error <i>Example: Change of state "Op" to "SafeOpError" due to Sync Error</i>
—	Blink	General Configuration Error <i>Example: State change commanded by master is not possible due to actual settings (register, object, hardware configuration)</i>

Blink = continuous blinking (≈2.5 Hz)  
Flash = flashing (≈0.2 s), followed by pause of 1 s  
Flicker = continuous flickering (≈10Hz)

Table 3-73 NET Status LEDs

### 3.4.2 Device Status

The LEDs (→Figure 3-46; **B**) 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... <ul style="list-style-type: none"> <li>• “Switch ON Disabled”</li> <li>• “Ready to Switch ON”</li> <li>• “Switched ON”</li> </ul>
ON	OFF	Power stage is enabled. The EPOS4 is in status... <ul style="list-style-type: none"> <li>• “Operation Enable”</li> <li>• “Quick Stop Active”</li> </ul>
OFF	ON	FAULT state. The EPOS4 is in status... <ul style="list-style-type: none"> <li>• “Fault”</li> </ul>
ON	ON	Power stage is enabled. The EPOS4 is in temporary status... <ul style="list-style-type: none"> <li>• “Fault Reaction Active”</li> </ul>
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 3-74 Device Status LEDs

### 3.4.3 NET Port

The LED (→Figure 3-46; **C**) displays the link activity of the NET port (applies for both ports, X14 “IN” and X15 “OUT”):

- Green LED indicates link activity

LED	Description
Green	
OFF	Port is closed
Flicker	Port is open / activity is present
ON	Port is open
—	Data rate is 100 Mbit/s
Flicker = continuous flickering (≈10 Hz)	

Table 3-75 NET Port LED

## 4 WIRING

In this section you will find the wiring information for the setup you are using. You can either use the consolidated wiring diagram (→ Figure 4-48) 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.

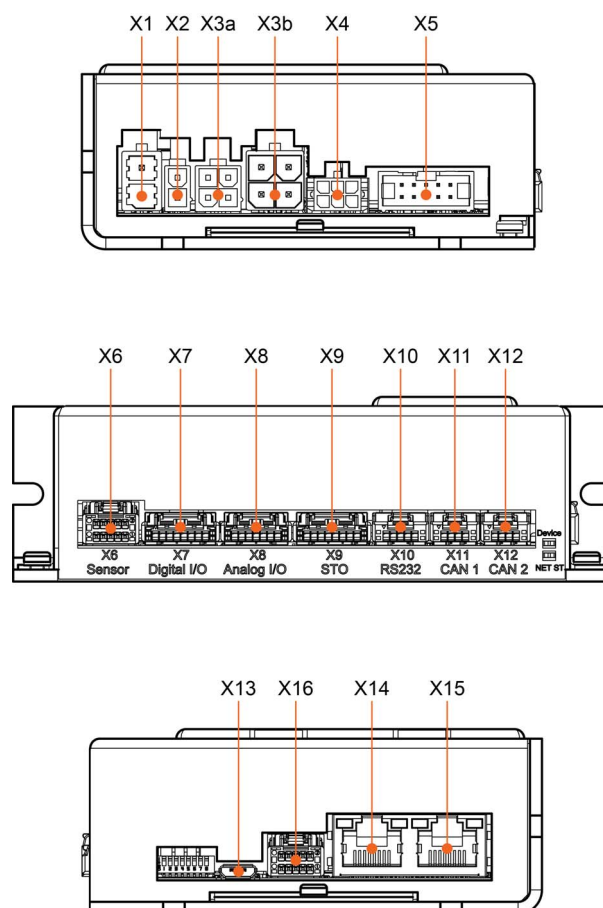



Figure 4-47 Interfaces – Designations and location



### Signs and abbreviations used

The subsequent diagrams feature these signs and abbreviations:

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

## 4.1 Possible Combinations to connect a Motor

The following tables show feasible ways 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 4-76, for EC (BLDC) motor → Table 4-77.
- 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.

### 4.1.1 DC Motor

**Power supply & optional logic supply** . . . . . Figure 4-49

#### 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					4-50
DC2	✓				4-50 4-53
DC3		✓			4-50 4-54
DC4			✓		4-50 4-55
DC5				✓	4-50 4-56
DC6	✓	✓			4-50 4-53 / 4-54
DC7	✓		✓		4-50 4-53 / 4-55
DC8	✓			✓	4-50 4-53 / 4-56

Table 4-76 Possible combinations of feedback signals for DC motor



**4.1.2 EC (BLDC) Motor**

**Power supply & optional logic supply** ..... Figure 4-49

**Motor & feedback signals**

- Hall sensors ..... Method # EC1
- Hall sensors & Digital incremental encoder ..... Method # EC2 or EC3
- Hall sensors & Analog incremental encoder SinCos ..... Method # EC4
- Hall sensors & SSI absolute encoder ..... Method # EC5
- Hall sensors & Digital incremental encoder & Digital incremental encoder ..... Method # EC6
- Hall sensors & Digital incremental encoder & Analog incremental encoder SinCos ..... Method # EC7
- Hall sensors & Digital encoder & SSI absolute encoder ..... Method # EC8
- Digital incremental encoder & SSI absolute encoder ..... Method # EC9
- SSI absolute encoder ..... Method # EC10

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	✓					4-51 4-52
EC2	✓	✓				4-51 4-52 / 4-53
EC3	✓		✓			4-51 4-52 / 4-54
EC4	✓			✓		4-51 4-52 / 4-55
EC5	✓				✓	4-51 4-52 / 4-56
EC6	✓	✓	✓			4-51 4-52 / 4-53 / 4-54
EC7	✓	✓		✓		4-51 4-52 / 4-53 / 4-55
EC8	✓	✓			✓	4-51 4-52 / 4-53 / 4-56
EC9		✓			✓	4-51 4-53 / 4-56
EC10					✓	4-51 4-56

Table 4-77 Possible combinations of feedback signals for EC (BLDC) motor

## 4.2 Main Wiring Diagram

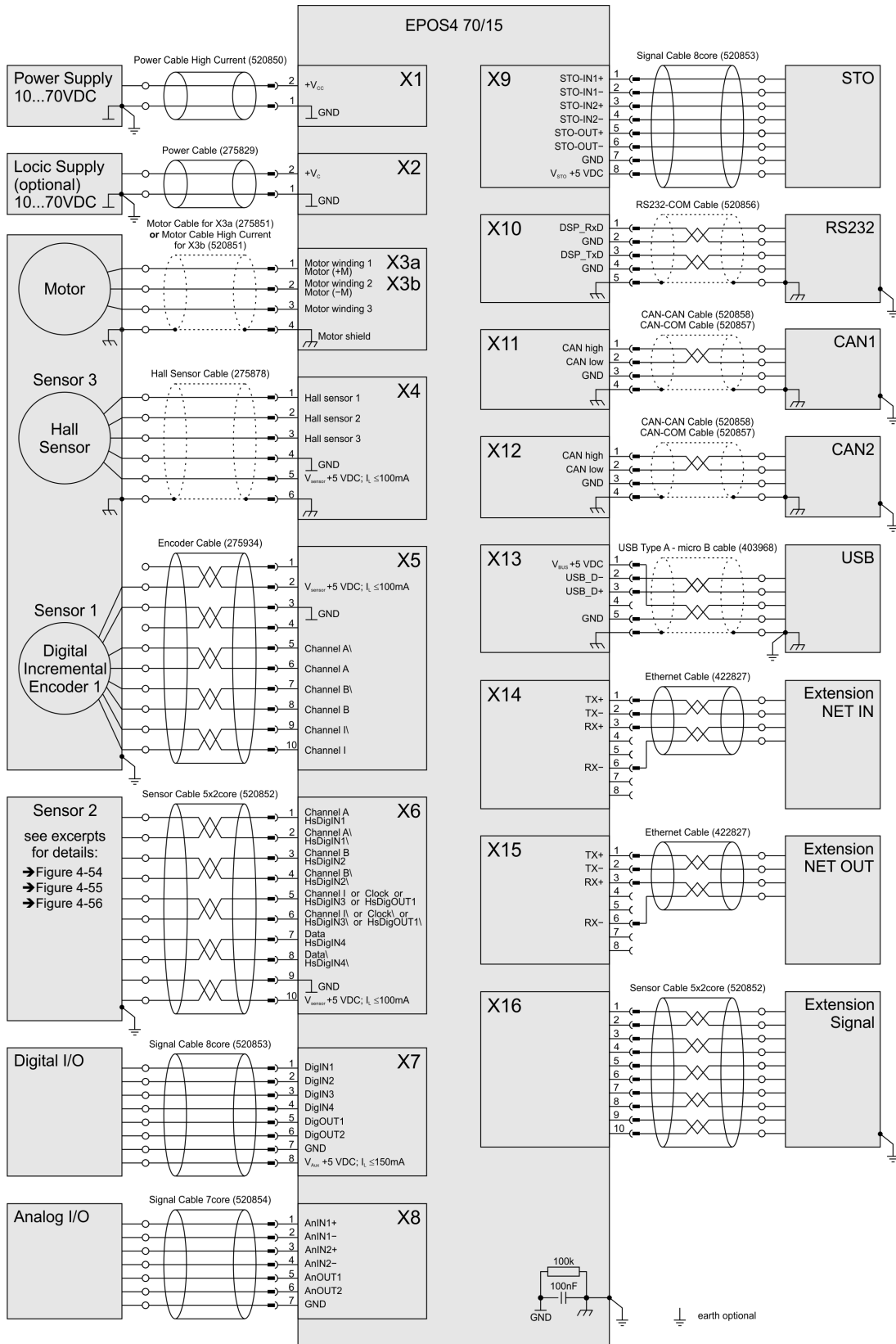


Figure 4-48 Main wiring diagram

## 4.3 Excerpts

### 4.3.1 Power & Logic Supply

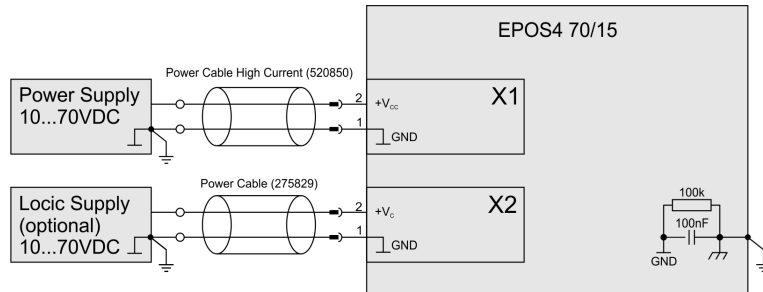


Figure 4-49 Power & logic supply

### 4.3.2 DC Motor

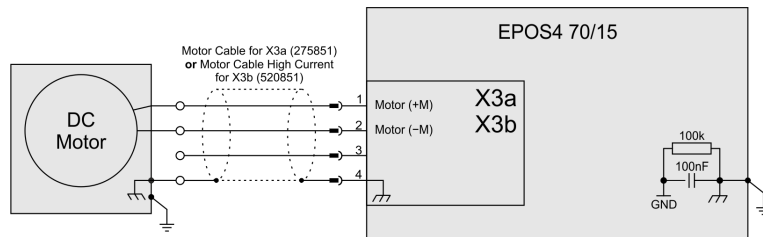


Figure 4-50 DC motor

### 4.3.3 EC (BLDC) Motor

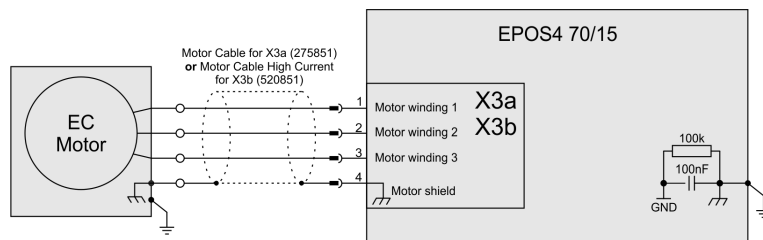


Figure 4-51 EC (BLDC) motor

### 4.3.4 Hall Sensors (Sensor 3)

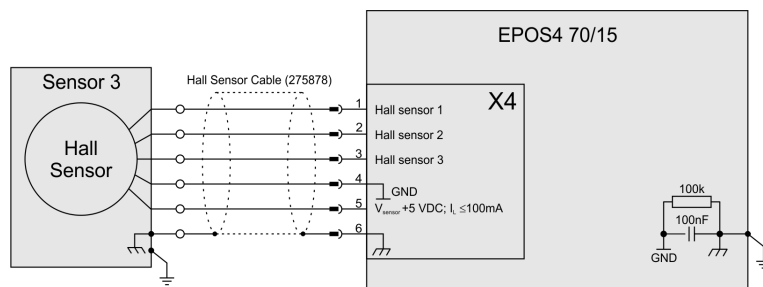


Figure 4-52 Hall sensors (Sensor 3)

**4.3.5 Digital Incremental Encoder 1 (Sensor 1)**

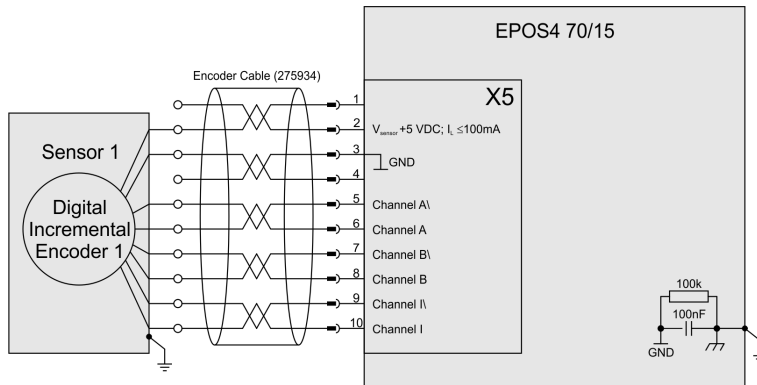


Figure 4-53 Digital incremental encoder 1 (Sensor 1)

**4.3.6 Digital Incremental Encoder 2 (Sensor 2)**

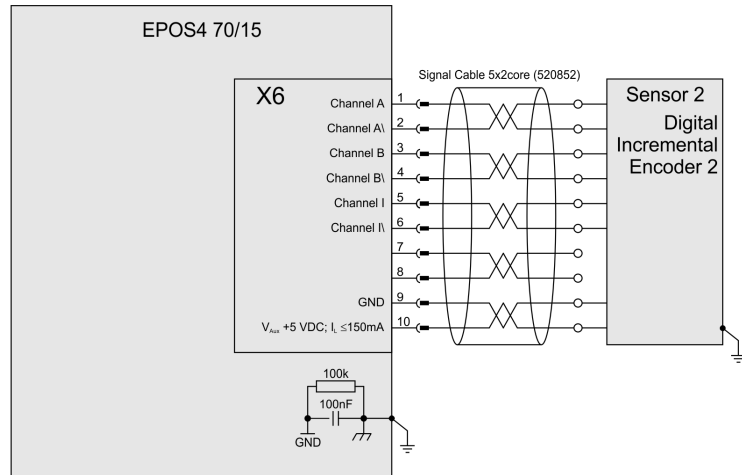


Figure 4-54 Digital incremental encoder 2 (Sensor 2)

**4.3.7 Analog incremental encoder SinCos (Sensor 2)**

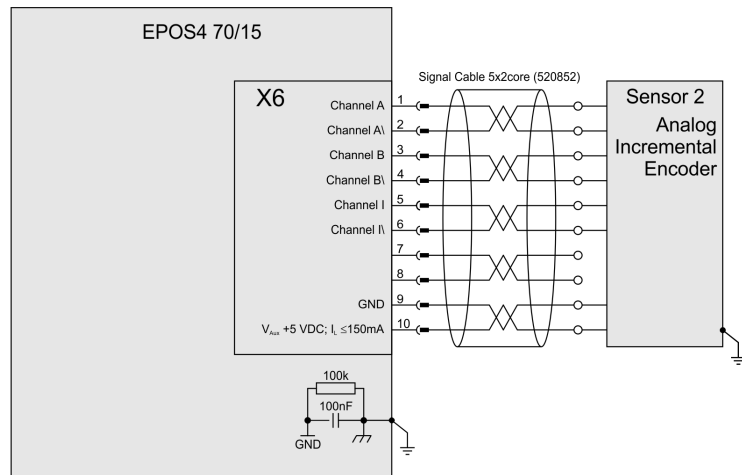


Figure 4-55 Analog incremental encoder (Sensor 2)

4.3.8 SSI Encoder (Sensor 2)

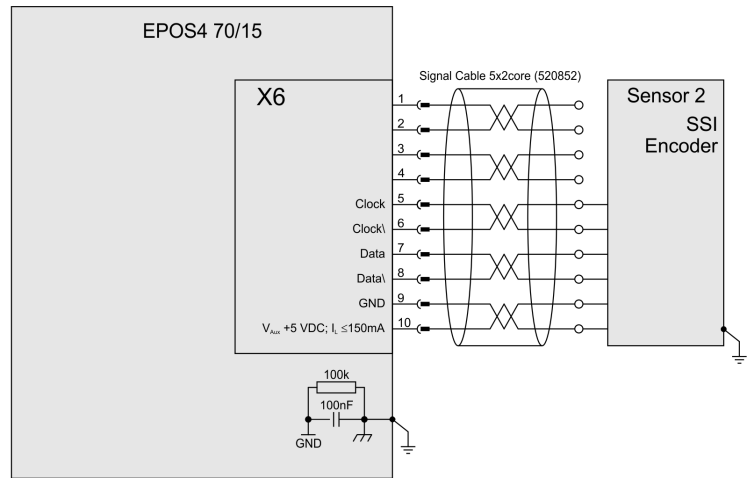


Figure 4-56 SSI encoder (Sensor 2)

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## LIST OF FIGURES

Figure 1-1	Documentation structure . . . . .	5
Figure 2-2	Derating of output current . . . . .	11
Figure 2-3	Power dissipation and efficiency . . . . .	12
Figure 2-4	Dimensional drawing [mm] . . . . .	13
Figure 3-5	Connectors . . . . .	18
Figure 3-6	Power supply connector X1. . . . .	19
Figure 3-7	Logic supply connector X2 . . . . .	21
Figure 3-8	Motor connectors X3a (left) and X3b (right) . . . . .	22
Figure 3-9	Hall sensor connector X4 . . . . .	24
Figure 3-10	Hall sensor 1 input circuit (analogously valid for Hall sensors 2 & 3) . . . . .	25
Figure 3-11	Encoder connector X5. . . . .	26
Figure 3-12	Encoder input circuit Ch A “differential” (analogously valid for Ch B & Ch I). . . . .	27
Figure 3-13	Encoder input circuit Ch A “single-ended” (analogously valid for Ch B & Ch I). . . . .	28
Figure 3-14	Sensor connector X6. . . . .	29
Figure 3-15	Digital incremental encoder input circuit Ch A “differential” (analogously valid for Ch B) . . . . .	30
Figure 3-16	Digital incremental encoder input circuit Ch I . . . . .	31
Figure 3-17	Digital incremental encoder input circuit Ch A “single-ended” (analogously valid for Ch B) . . . . .	32
Figure 3-18	Digital incremental encoder input circuit Ch I . . . . .	33
Figure 3-19	Analog incremental encoder input circuit Ch A “differential” (analogously valid for Ch B) . . . . .	34
Figure 3-20	Analog incremental encoder input circuit Ch I (digital evaluation). . . . .	35
Figure 3-21	SSI absolute encoder data input . . . . .	36
Figure 3-22	SSI absolute encoder clock output . . . . .	36
Figure 3-23	HsDigIN1 circuit “differential” (analogously valid for HsDigIN2...4) . . . . .	37
Figure 3-24	HsDigIN1 circuit “single-ended” (analogously valid for HsDigIN2...4) . . . . .	38
Figure 3-25	HsDigOUT1 output circuit . . . . .	39
Figure 3-26	Digital I/O connector X7 . . . . .	40
Figure 3-27	DigIN1 circuit (analogously valid for DigIN2...4) – Logic level setting. . . . .	41
Figure 3-28	DigIN1 circuit (analogously valid for DigIN2...4) – PLC level setting . . . . .	41
Figure 3-29	DigOUT1 circuit (analogously valid for DigOUT2). . . . .	42
Figure 3-30	DigOUT1 “sinks” (analogously valid for DigOUT2) . . . . .	43
Figure 3-31	DigOUT1 “source” (analogously valid for DigOUT2). . . . .	43
Figure 3-32	Analog I/O connector X8 . . . . .	44
Figure 3-33	AnIN1 circuit (analogously valid for AnIN2). . . . .	45
Figure 3-34	AnOUT1 circuit (analogously valid for AnOUT2). . . . .	46
Figure 3-35	STO connector X9. . . . .	47
Figure 3-36	STO-IN1 circuit (analogously valid for STO-IN2) . . . . .	48
Figure 3-37	STO-OUT circuit . . . . .	48
Figure 3-38	RS232 connector X10. . . . .	50
Figure 3-39	CAN 1 connector X11/CAN 2 connector X12 . . . . .	51
Figure 3-40	USB connector X13. . . . .	53
Figure 3-41	Extension IN & OUT connectors X14 & X15. . . . .	54

Figure 3-42	Extension Signal connector X16	55
Figure 3-43	Extension slots	56
Figure 3-44	Installation & removal of an extension card	57
Figure 3-45	DIP switch SW1	58
Figure 3-46	LEDs – Location	61
Figure 4-47	Interfaces – Designations and location	63
Figure 4-48	Main wiring diagram	66
Figure 4-49	Power & logic supply	67
Figure 4-50	DC motor	67
Figure 4-51	EC (BLDC) motor	67
Figure 4-52	Hall sensors (Sensor 3)	67
Figure 4-53	Digital incremental encoder 1 (Sensor 1)	68
Figure 4-54	Digital incremental encoder 2 (Sensor 2)	68
Figure 4-55	Analog incremental encoder (Sensor 2)	68
Figure 4-56	SSI encoder (Sensor 2)	69



## LIST OF TABLES

Table 1-1	Notation used . . . . .	6
Table 1-2	Symbols and signs . . . . .	6
Table 1-3	Brand names and trademark owners . . . . .	7
Table 2-4	Technical data . . . . .	10
Table 2-5	Limitations . . . . .	12
Table 2-6	Standards . . . . .	14
Table 3-7	Prefab maxon cables . . . . .	16
Table 3-8	EPOS4 Connector Set – Content . . . . .	17
Table 3-9	Recommended tools . . . . .	17
Table 3-10	Power supply connector X1 – Pin assignment . . . . .	19
Table 3-11	Power Cable High Current . . . . .	19
Table 3-12	Power supply requirements . . . . .	20
Table 3-13	Logic supply connector X2 – Pin assignment . . . . .	21
Table 3-14	Power Cable . . . . .	21
Table 3-15	Logic supply requirements . . . . .	21
Table 3-16	Motor connector X3a / X3b – Pin assignment for maxon DC motor . . . . .	22
Table 3-17	Motor connector X3a / X3b – Pin assignment for maxon EC motor . . . . .	22
Table 3-18	Motor Cable . . . . .	23
Table 3-19	Motor Cable High Current . . . . .	23
Table 3-20	Hall sensor connector X4 – Pin assignment . . . . .	24
Table 3-21	Hall Sensor Cable . . . . .	24
Table 3-22	Hall sensor specification . . . . .	25
Table 3-23	Encoder connector X5 – Pin assignment . . . . .	26
Table 3-24	Encoder connector X5 – Accessories . . . . .	26
Table 3-25	Encoder Cable . . . . .	27
Table 3-26	Differential encoder specification . . . . .	27
Table 3-27	Single-ended encoder specification . . . . .	28
Table 3-28	Sensor connector X6 – Pin assignment . . . . .	29
Table 3-29	Sensor Cable 5x2core . . . . .	30
Table 3-30	Differential digital incremental encoder specification . . . . .	30
Table 3-31	Single-ended digital incremental encoder specification . . . . .	32
Table 3-32	Differential analog incremental encoder specification . . . . .	34
Table 3-33	SSI absolute encoder specification . . . . .	36
Table 3-34	Differential high-speed digital input specification . . . . .	37
Table 3-35	Single-ended high-speed digital input specification . . . . .	38
Table 3-36	High-speed digital output specification . . . . .	39
Table 3-37	Digital I/O connector X7 – Pin assignment . . . . .	40
Table 3-38	Signal Cable 8core . . . . .	40
Table 3-39	Digital input specification – Logic level setting . . . . .	41
Table 3-40	Digital input specification – PLC level setting . . . . .	41
Table 3-41	Digital output specification . . . . .	42

Table 3-42	Digital output – Sinks	43
Table 3-43	Digital output – Source	43
Table 3-44	Analog I/O connector X8 – Pin assignment	44
Table 3-45	Signal Cable 7core	44
Table 3-46	Analog input specification	45
Table 3-47	Analog output specification	46
Table 3-48	STO connector X9 – Pin assignment	47
Table 3-49	STO Idle Connector	47
Table 3-50	STO input specification	48
Table 3-51	STO output specification	48
Table 3-52	STO logic state	49
Table 3-53	RS232 connector X10 – Pin assignment	50
Table 3-54	RS232-COM Cable	50
Table 3-55	RS232 interface specification	50
Table 3-56	CAN 1 connector X11/CAN 2 connector X12 – Pin assignment	51
Table 3-57	CAN-COM Cable	51
Table 3-58	CAN-CAN Cable	52
Table 3-59	CAN interface specification	52
Table 3-60	USB connector X13 – Pin assignment	53
Table 3-61	USB Type A - micro B Cable	53
Table 3-62	USB interface specification	53
Table 3-63	Extension IN & OUT connectors X14 & X15 – Pin assignment	54
Table 3-64	Ethernet Cable	55
Table 3-65	Extension Signal connector X16 – Pin assignment	55
Table 3-66	Extension cards (optional)	58
Table 3-67	DIP switch SW1 – Binary code values	58
Table 3-68	DIP switch SW1 – Examples	59
Table 3-69	DIP switch SW1 – CAN automatic bit rate detection	59
Table 3-70	DIP switch SW1 – CAN bus termination	59
Table 3-71	DIP switch SW1 – Digital input level	60
Table 3-72	Spare parts list	60
Table 3-73	NET Status LEDs	61
Table 3-74	Device Status LEDs	62
Table 3-75	NET Port LED	62
Table 4-76	Possible combinations of feedback signals for DC motor	64
Table 4-77	Possible combinations of feedback signals for EC (BLDC) motor	65

## INDEX

### A

alerts 6  
 analog incremental encoder (differential) 34  
 analog inputs 45  
 analog outputs 46  
 applicable EU directive 15  
 applicable regulations 8

### B

Beckhoff TwinCAT 56  
 BiSS encoder, wiring 69  
 bit rate detection 59  
 bit rate, default 52

### C

cables (prefab)  
   CAN-CAN Cable 52  
   CAN-COM Cable 51  
   Encoder Cable 27  
   Ethernet Cable 55  
   Hall Sensor Cable 24  
   Motor Cable 23  
   Motor Cable High Current 23  
   Power Cable 21  
   Power Cable High Current 19  
   RS232-COM Cable 50  
   Sensor Cable 5x2core 30  
   Signal Cable 7core 44  
   Signal Cable 8core 40  
   STO Idle Connector 47  
   USB Type A - micro B Cable 53  
 CAN bus termination 52, 59  
 CAN ID (see "ID")  
 CAN interface 52  
 connectors  
   EXT1 56  
   EXT2 56  
   X1 19  
   X2 21  
   X3a 22  
   X3b 22  
   X4 24  
   X5 26  
   X6 29  
   X7 40  
   X8 44  
   X9 47  
   X10 50  
   X11 51  
   X12 51  
   X13 53  
   X14 54

X15 54

X16 55

country-specific regulations 8

### D

DEV ID (see "ID")  
 device condition, display of 61  
 digital high-speed inputs (differential) 37  
 digital high-speed inputs (single-ended) 38  
 digital high-speed output 39  
 digital incremental encoder (differential) 30  
 digital incremental encoder (single-ended) 32  
 digital outputs 42  
 DIP switch SW1 58

### E

encoders  
   absolute 36  
   differential 27  
   incremental 30  
   serial 36  
   SinCos 34  
   single-ended 28  
 EnDat encoder, wiring 69  
 EPOS4 Connector Set 17  
 EPOS4 EtherCAT Card 58  
 ESD 8, 56  
 EtherCAT  
   network 56  
   option card 58  
 EU directive, applicable 15  
 extension card (insert/remove) 56

### H

Hall sensor 25  
 how to  
   calculate the required supply voltage 20  
   connect extension signals 55  
   interpret icons (and signs) used in this document 6  
   unplug an extension card 56

### I

ID (of the device) 58  
 incorporation into surrounding system 15  
 informative signs 6  
 inputs  
   analog 45  
   high-speed digital 37  
   STO 48

## interfaces

- CAN 51
- location and designation 63
- RS232 50
- USB 53

**L**

LEDs, interpretation of 61

**M**

mandatory action signs 6  
motor types, supported 8

**N**

node address (see "ID")  
Node-ID (see "ID")  
notations used 6

**O**

operating license 15  
outputs  

- analog 46
- digital 42
- high-speed digital 39
- STO 48

**P**

part numbers  

- 275829 21
- 275851 23
- 275878 24
- 275934 27
- 403968 53
- 422827 55
- 520850 19
- 520851 23
- 520852 30
- 520853 40
- 520854 44
- 520856 50
- 520857 51
- 520858 52
- 520859 17
- 520860 47
- 581245 58
- 594385 9

 performance data 9  
 power supply requirements 21  
 precautions 8  
 prerequisites prior installation 15  
 prohibitive signs 6  
 protective measures (ESD) 8, 56  
 purpose  

- of the device 8
- of the document 5

**R**

regulations, applicable 8  
Requirements of power supply 21

**S**

safety alerts 6  
 safety first! 8  
 signs used 6  
 SSI encoder  

- specification 36
- wiring 69

 standards, fulfilled 14  
 status LEDs 61  
 supply voltage, required 20  
 SW1 58  
 symbols used 6

**T**

technical data 9  
 termination (CAN bus) 52, 59  
 TwinCAT 56

**U**

USB port 53

**W**

wiring examples  

- analog incremental encoder 68
- DC motor 67
- digital & digital incremental encoder 68
- digital incremental encoder 68
- DigOUT 43
- EC (BLDC) motor 67
- Hall sensors 67
- power & logic supply 67
- SSI encoder 69

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