EPOS4 50/5

Positioning Controller
P/N 546047

Hardware Reference

epos.maxonmotor.com

Document ID: rel7692

TABLE OF CONTENTS

READ THIS FIRST

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

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

***The EPOS4 50/5** 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!*

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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 50/5 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:

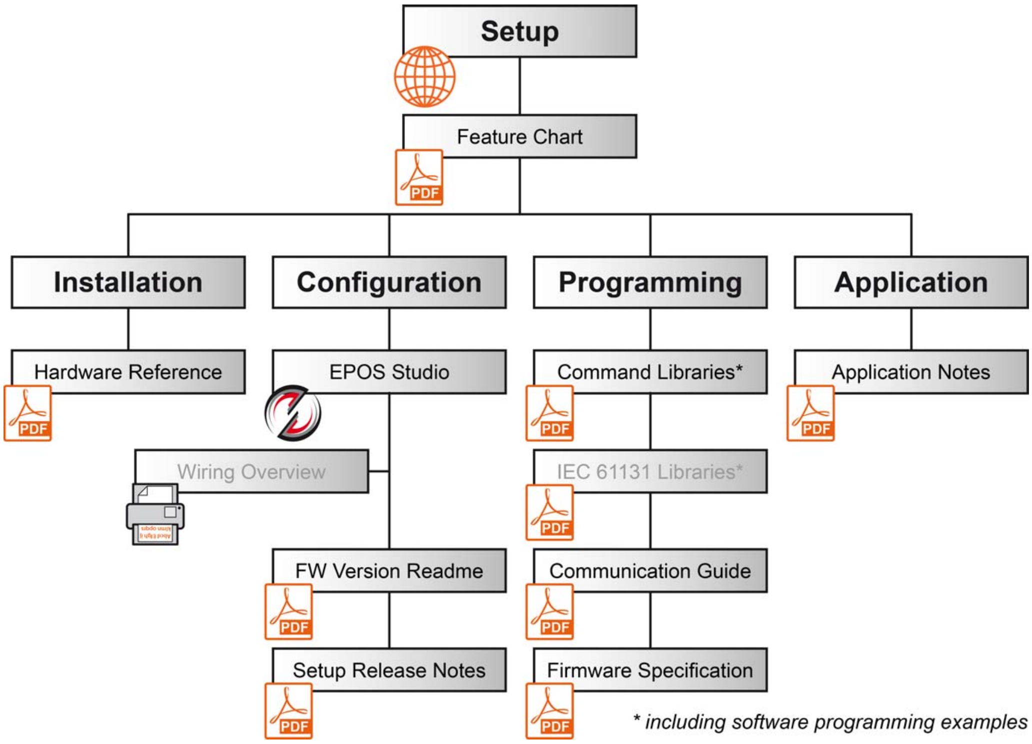

Figure 1-1 Documentation structure

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 sings will be used.

Type	Symbol	Meaning	
Safety alert	 (typical)	DANGER	Indicates an **imminent hazardous situation**. If not avoided, it **will result in death or serious injury**.
		WARNING	Indicates a **potential hazardous situation**. If not avoided, it **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**!	
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® PCIe®	© 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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Brünigstrasse 220
P.O.Box 263
CH-6072 Sachseln

Phone +41 41 666 15 00
Fax +41 41 666 16 50
Web www.maxonmotor.com

1.2 About the Device

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

maxon motor control's EPOS4 50/5 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 250 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) and acceleration/velocity feed forward 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.maxonmotor.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

EPOS Tutorials on Vimeo

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 motor.*

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 50/5 (546047)		
Electrical Rating	Nominal power supply voltage $+V_{CC}$	10…50 VDC
	Nominal logic supply voltage $+V_C$	10…50 VDC
	Absolute supply voltage $+V_{min}$ / $+V_{max}$	8 VDC / 56 VDC
	Output voltage (max.)	0.9 x $+V_{CC}$
	Output current I_{cont} / I_{max} (<15 s)	5 A / 15 A
	Pulse Width Modulation frequency	50 kHz
	Sampling rate PI current controller	25 kHz (40 µs)
	Sampling rate PID speed controller	2.5 kHz (400 µs)
	Sampling rate PID positioning controller	2.5 kHz (400 µs)
	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 µH; 5 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 ≤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 ≤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
	Sensor signals (choice between multiple functions) • Digital incremental encoder • Analog incremental encoder* • SSI absolute encoder • High-speed digital input 1…4 and High-speed digital output 1	 3-channel, EIA RS422, max. 6.25 MHz 3-channel, resolution 12-bit, ±1.8 V, differential configurable, EIA RS422, 5 MHz EIA RS422, max. 6.25 MHz

Continued on next page.

EPOS4 50/5 (546047)			
Voltage Outputs	Sensor supply voltage V_{Sensor}	+5 VDC / $I_L \leq$100 mA	
	Auxiliary output voltage V_{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 [3]	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. 206 g	
	Dimensions (L x W x H)	105.0 x 83.0 x 38.7 mm	
	Mounting	mounting holes for M4 screws	
Environ-mental Conditions	Temperature	Operation	−30…+50 °C
		Extended range [1]	+50…+80 °C; Derating: −0.167 A/°C (➔Figure 2-2) Additional derating with inserted extension card: Ambient temperature less 5 °C (➔Figure 2-2) [4]
		Storage	−40…+85 °C
	Altitude [2]	Operation	0…10'000 m MSL
	Humidity	5…90% (condensation not permitted)	

Legend

- * Available with an upcoming firmware release.
- 1) Operation within the extended range is permitted. However, a respective derating (declination of output current I_{cont}) as to the stated values will apply.
- 2) Operating altitude in meters above Mean Sea Level, MSL.
- 3) Available with optional EPOS4 EtherCAT Card.
- 4) 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

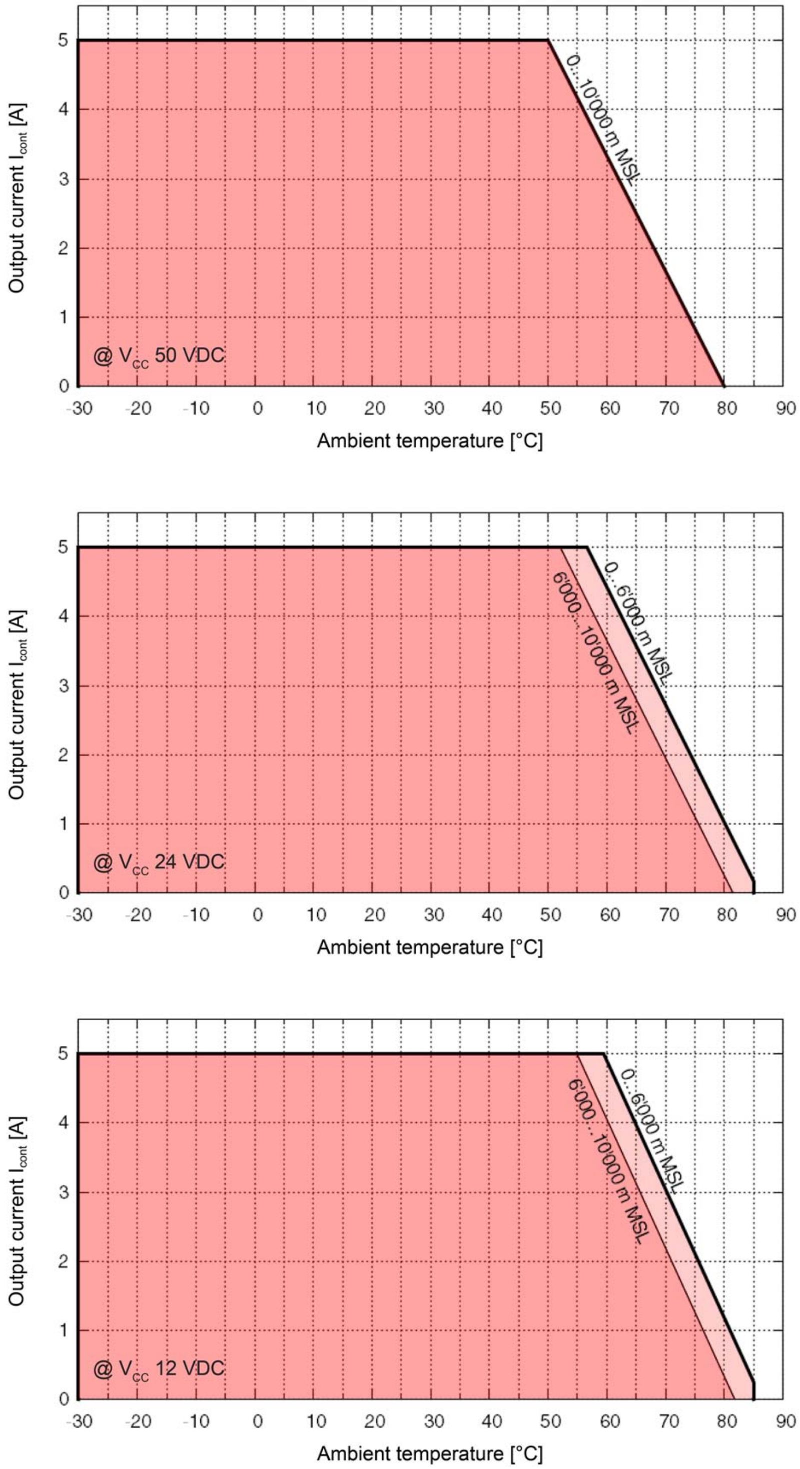


Figure 2-2 Derating of output current

2.2.2 Power Dissipation and Efficiency

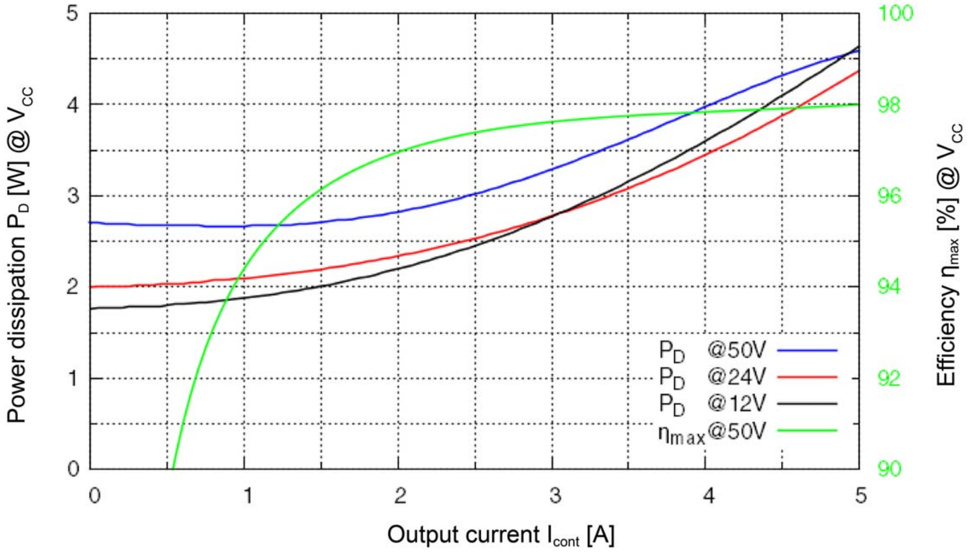


Figure 2-3 Power dissipation and efficiency

2.3 Limitations

Protection functionality	Switch-off threshold	Recovery threshold
Undervoltage	8.0 V	8.5 V
Overvoltage	58 V	56 V
Overcurrent	20 A	—
Thermal overload	100 °C	90 °C

Table 2-5 Limitations

2.4 Dimensional Drawing

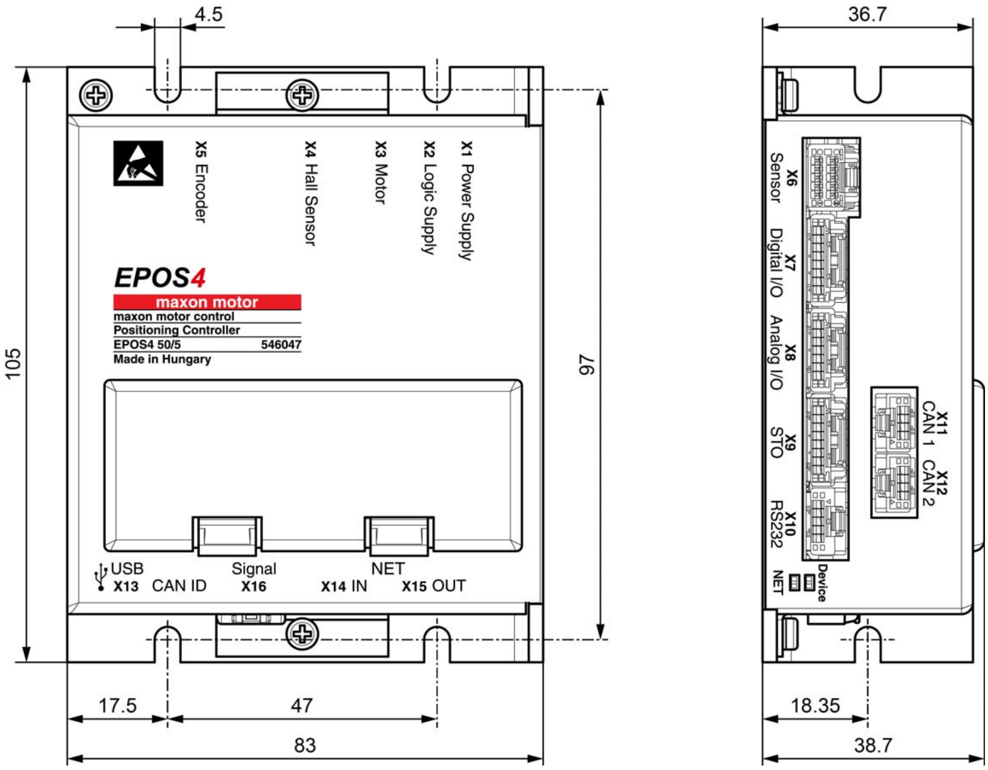


Figure 2-4 Dimensional drawing [mm]

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 ±2 kV
	IEC/EN 61000-4-6	Immunity to conducted disturbances, induced by radio-frequency fields 10 Vrms

Others		
Environment	IEC/EN 60068-2-6	Environmental testing – Test Fc: Vibration (sinusoidal, 10…500 Hz, 20 m/s^2)
	MIL-STD-810F	Random transport (10…500 Hz up to 2.53 g_{rms})
Safety	UL File Number	Unassembled printed circuit board: E229342
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): 296'741 hours

Table 2-6 Standards

3 Setup

IMPORTANT NOTICE: PREREQUISITES FOR PERMISSION TO COMMENCE INSTALLATION

The EPOS4 50/5 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…50 VDC.*
- *Supply voltages above 56 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. 5 A
  – short-time (acceleration) max. 15 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	275829	3-19
X2	Power Cable	275829	3-19
X3	Motor Cable	275851	3-22
X4	Hall Sensor Cable	275878	3-23
X5	Encoder Cable	275934	3-26
X6	Sensor Cable 5x2core	520852	3-29
X7	Signal Cable 8core	520853	3-38
X8	Signal Cable 7core	520854	3-42
X9	Signal Cable 8core	520853	3-38
X10	RS232-COM Cable	520856	3-46
X11	CAN-COM Cable CAN-CAN Cable	520857 520858	3-47 3-48
X12	CAN-COM Cable CAN-CAN Cable	520857 520858	3-47 3-48
X13	USB Type A - micro B Cable	403968	3-49
X14	Ethernet Cable	422827	3-51
X15	Ethernet Cable	422827	3-51
X16	Sensor Cable 5x2core	520852	3-29

Table 3-7 Prefab maxon cables

Make&Bake your Own

If you decide not to employ maxon motor'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		
	Molex Mega-Fit, 2 poles (171692-0102)	1
X1 / X2	Molex Mini-Fit Jr., 2 poles (39-01-2020)	2
X3	Molex Mini-Fit Jr., 4 poles (39-01-2040)	1
	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
Crimp Terminals		
	Molex Mega-Fit, female crimp terminal (172063-0311)	7
X1 / X2 / X3	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
Accessories		
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 Mini-Fit crimp terminals	Molex	63819-0900

Table 3-9 Recommended tools

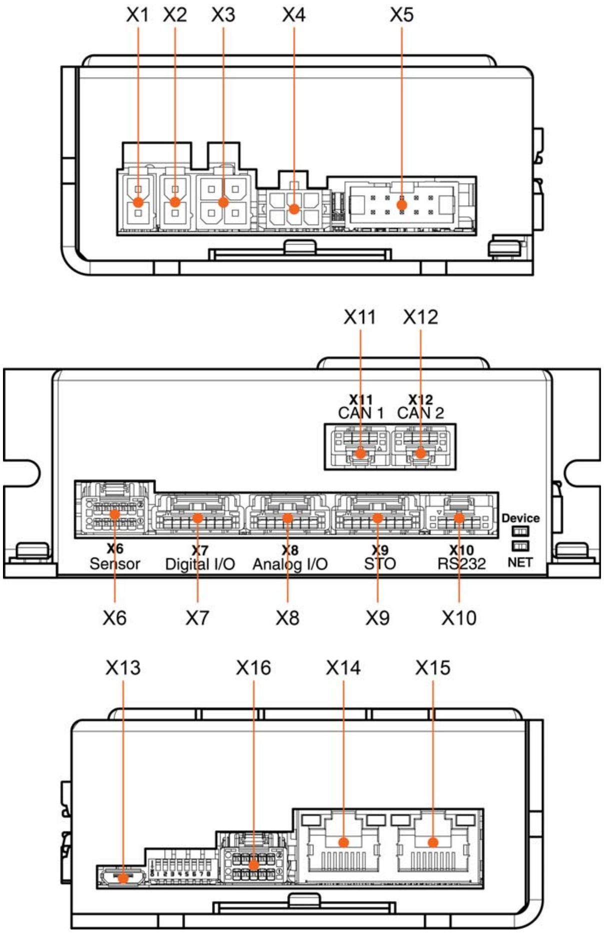
3.3 Connections

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 4-61) that best suits the components you are using.



X1	Power Supply ➔page 3-19
X2	Logic Supply ➔page 3-21
X3	Motor ➔page 3-22
X4	Hall Sensor ➔page 3-23
X5	Encoder ➔page 3-25
X6	Sensor ➔page 3-28
X7	Digital I/O ➔page 3-38
X8	Analog I/O ➔page 3-42
X9	STO ➔page 3-44
X10	RS232 ➔page 3-46
X11	CAN 1 ➔page 3-47
X12	CAN 2 ➔page 3-47
X13	USB ➔page 3-49
X14 5)	Extension NET IN ➔page 3-50
X15 5)	Extension NET OUT ➔page 3-50
X16 5)	Extension Signal ➔page 3-52

5) 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.

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

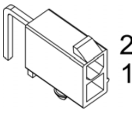


Figure 3-6 Power supply connector X1

X1 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	black	–	GND	Ground
2	black	+	$+V_{CC}$	Nominal power supply voltage (+10…+50 VDC)

Table 3-10 Power supply connector X1 – Pin assignment

Power Cable (275829)		
		
Cross-section	2 x 0.75 mm², 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 mm²	

Table 3-11 Power Cable

Power supply requirements	
Output voltage	$+V_{CC}$ 10…50 VDC
Absolute output voltage	min. 8 VDC; max. 56 VDC
Output current	Depending on load • continuous max. 5 A • short-time (acceleration, <15 s) max. 15 A

Continued on next page.

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 @ 5 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]

SOUGHT VALUE:

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

SOLUTION:

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

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.

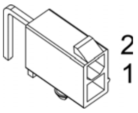


Figure 3-7 Logic supply connector X2

X2 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	black	–	GND	Ground
2	black	+	$+V_C$	Nominal logic supply voltage (+10…+50 VDC)

Table 3-12 Logic supply connector X2 – Pin assignment

For the matching prefab cable assembly ➔Table 3-11.

Power supply requirements	
Output voltage	$+V_C$ 10…50 VDC
Absolute supply voltage	min. 8 VDC; max. 56 VDC
Min. output power	P_C min. 3.5 W

3.3.3 Motor (X3)

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

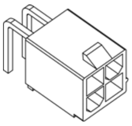


Figure 3-8 Motor connectors X3

X3 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 3-13 Motor connector X3 – Pin assignment for maxon DC motor

X3 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 3-14 Motor connector X3– Pin assignment for maxon EC motor

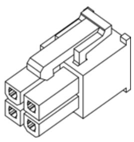
Motor Cable (275851)		
A 		B
Cross-section	3 x 0.75 mm², shielded, grey	
Length	3 m	
Head A	Plug	Molex Mini-Fit Jr., 4 poles (39-01-2040)
	Contacts	Molex Mini-Fit Jr. female crimp terminals (45750)
Head B	Wire end sleeves 0.75 mm²	

Table 3-15 Motor Cable

3.3.4 Hall Sensor (X4)

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

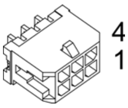


Figure 3-9 Hall sensor connector X4

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_{Sensor}	Sensor supply voltage (+5 VDC; I_L ≤100 mA)
6	black		Hall shield	Cable shield

Table 3-16 Hall sensor connector X4 – Pin assignment

Hall Sensor Cable (275878)		
		
Cross-section	5 x 0.14 mm², 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 mm²	

Table 3-17 Hall Sensor Cable

Continued on next page.

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)

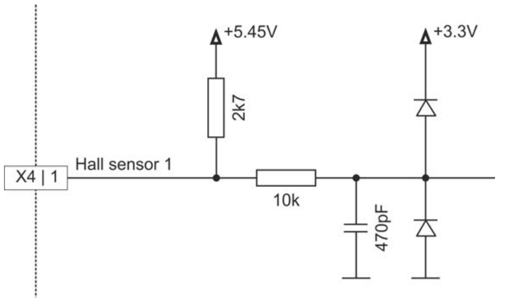


Figure 3-10 Hall sensor 1 input circuit (analogously valid for Hall sensors 2 & 3)

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****.*

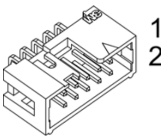


Figure 3-11 Encoder connector X5

X5 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	brown	1	–	not connected
2	white	2	V_{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 3-18 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 3-19 Encoder connector X5 – Accessories

Continued on next page.

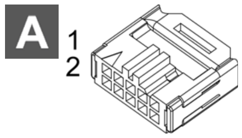
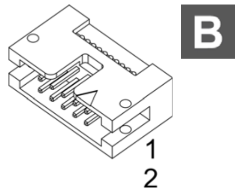
Encoder Cable (275934)	
	
Cross-section	10 x AWG28, round-jacket, twisted pair flat cable, pitch 1.27 mm, grey
Length	3.2 m
Head A	DIN 41651 female, pitch 2.54 mm, 10 poles, with strain relief
Head B	DIN 41651 plug, pitch 2.54 mm, 10 poles, with strain relief

Table 3-20 Encoder Cable

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

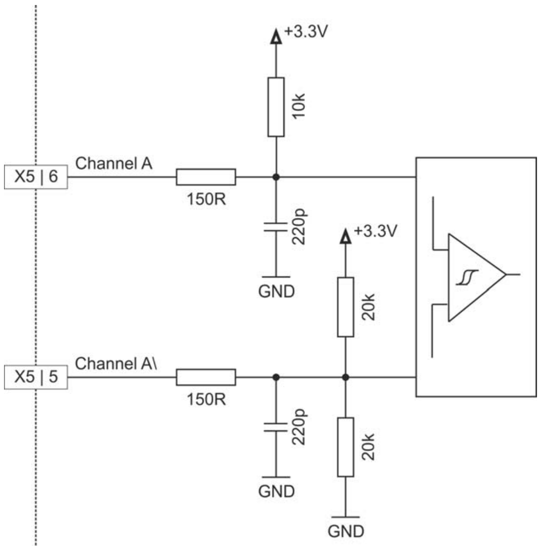


Figure 3-12 Encoder input circuit Ch A “differential” (analogously valid for Ch B & Ch I)

Continued on next page.

Encoder (single-ended)		
Sensor supply voltage (V_{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 +420 µA @ 5 V	
Input low current	I_{IL} = typically −170 µA @ 0 V	
Max. input frequency	Push-pull	Open collector
	6.25 MHz	40 kHz (internal pull-up only)
		150 kHz (additional external 3k3 pull-up)

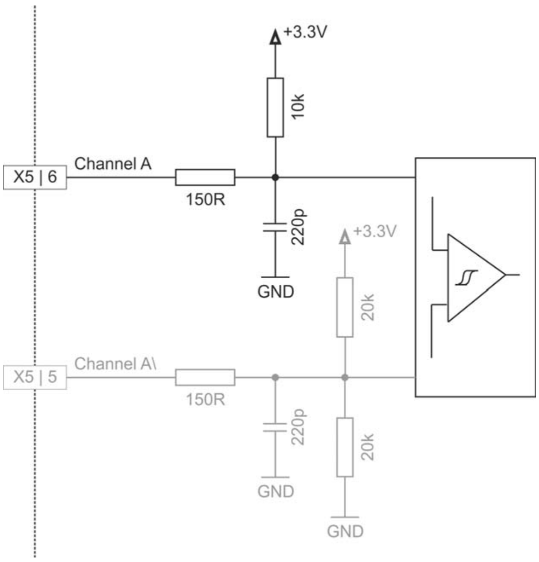


Figure 3-13 Encoder input circuit Ch A “single-ended” (analogously valid for Ch B & Ch I)

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}).

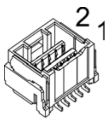


Figure 3-14 Sensor connector X6

X6 Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	white	1	Channel A HsDigIN1	Digital/analog incremental encoder channel A High-speed digital input 1
2	brown	2	Channel A\ HsDigIN1\	Digital/analog incremental encoder channel A complement High-speed digital input 1 complement
3	green	3	Channel B HsDigIN2	Digital/analog incremental encoder channel B High-speed digital input 2
4	yellow	4	Channel B\ HsDigIN2\	Digital/analog incremental encoder channel B complement High-speed digital input 2 complement
5	grey	5	Channel I HsDigIN3 Clock HsDigOUT1	Digital/analog incremental encoder channel I High-speed digital input 3 Clock (SSI) High-speed digital output 1
6	pink	6	Channel I\ HsDigIN3\ Clock\ HsDigOUT1\	Digital/analog incremental encoder channel I complement High-speed digital input 3 complement Clock (SSI) complement High-speed digital output 1 complement
7	blue	7	Data HsDigIN4	Data (SSI) High-speed digital input 4
8	red	8	Data\ HsDigIN4\	Data (SSI) complement High-speed digital input 4 complement
9	black	9	GND	Ground
10	violet	10	V_{Aux}	Auxiliary output voltage (+5 VDC; I_L ≤150 mA)

Table 3-21 Sensor connector X6 – Pin assignment

Continued on next page.

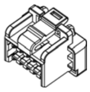
Sensor Cable 5x2core (520852)		
A 2 1 		B
Cross-section	5 x 2 x 0.14 mm², twisted pair, grey	
Length	3 m	
Head A	Plug	Molex CLIK-Mate, dual row, 10 poles (503149-1000)
	Contacts	Molex CLIK-Mate crimp terminals (502579)
Head B	Wire end sleeves 0.14 mm²	

Table 3-22 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	±200 mV
Max. input voltage	+12 VDC
Line receiver (internal)	EIA RS422 standard
Max. input frequency	6.25 MHz

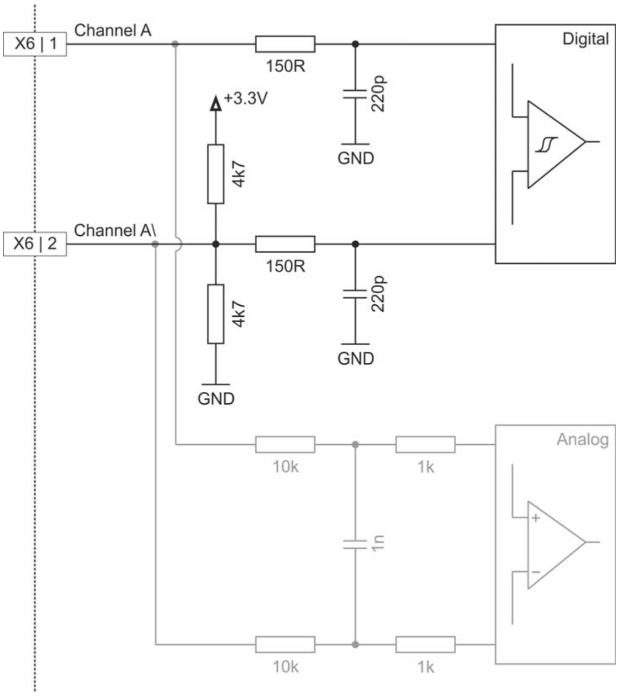


Figure 3-15 Digital incremental encoder input circuit Ch A “differential” (analogously valid for Ch B)

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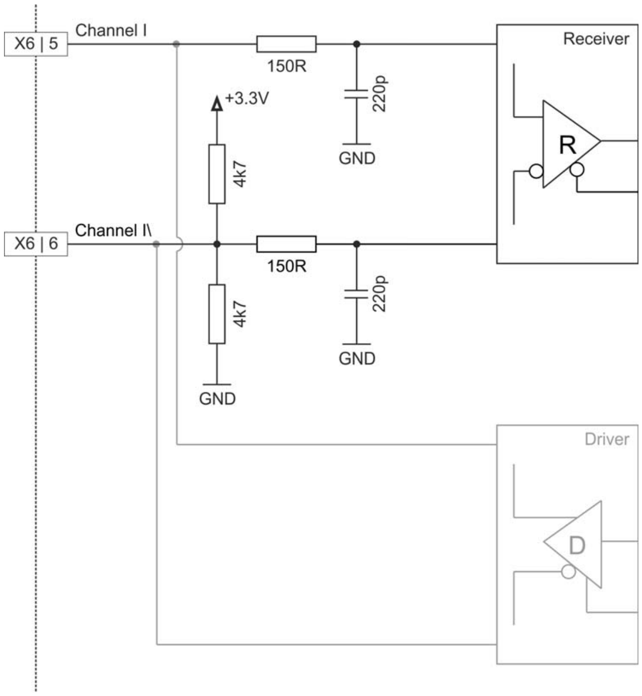

Figure 3-16 Digital incremental encoder input circuit Ch I

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	±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	Open collector
	6.25 MHz	100 kHz (additional external 3k3 pull-up)

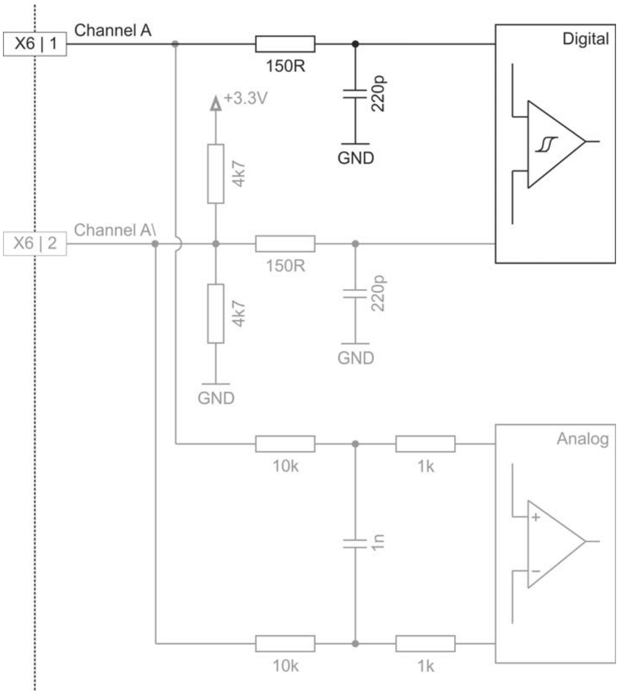

Figure 3-17 Digital incremental encoder input circuit Ch A “single-ended” (analogously valid for Ch B)

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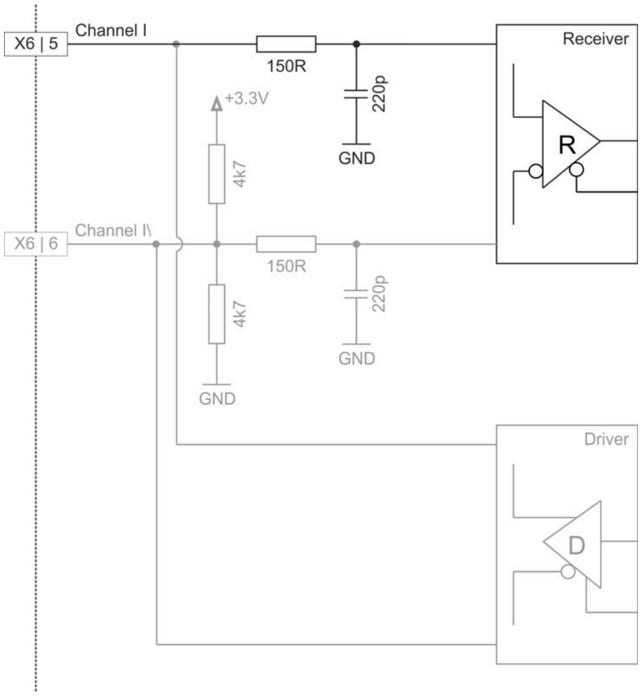

Figure 3-18 Digital incremental encoder input circuit Ch I

Continued on next page.

Analog incremental encoder (differential)	
Auxiliary output voltage (V_{Aux})	+5 VDC
Max. auxiliary supply current	150 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

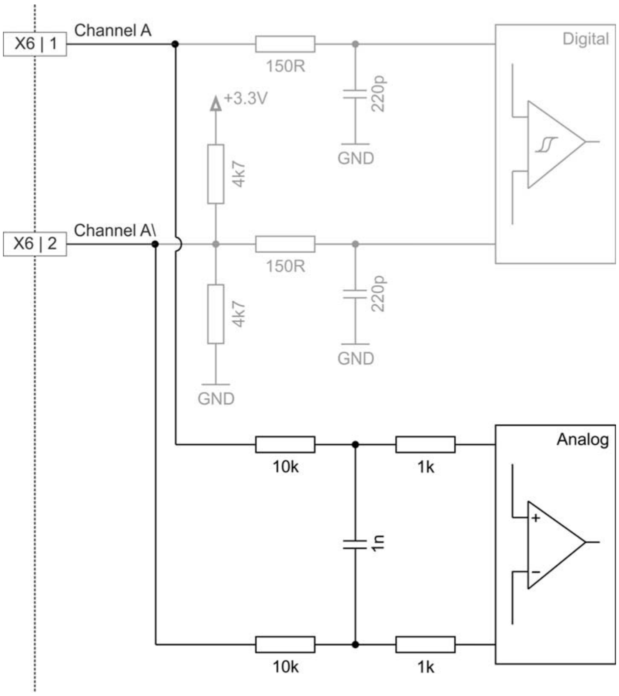

Figure 3-19 Analog incremental encoder input circuit Ch A “differential” (analogously valid for Ch B)

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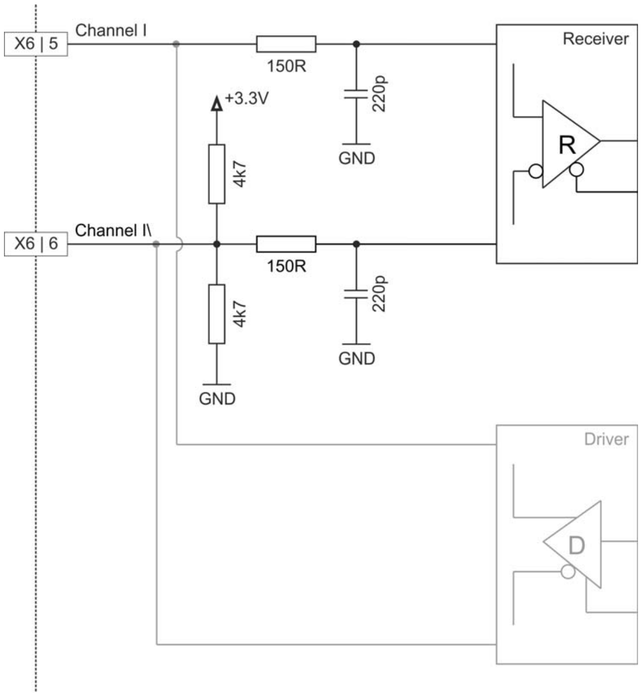


Figure 3-20 Analog incremental encoder input circuit Ch I (digital evaluation)

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	±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
Max. encoder input/output frequency	5 MHz

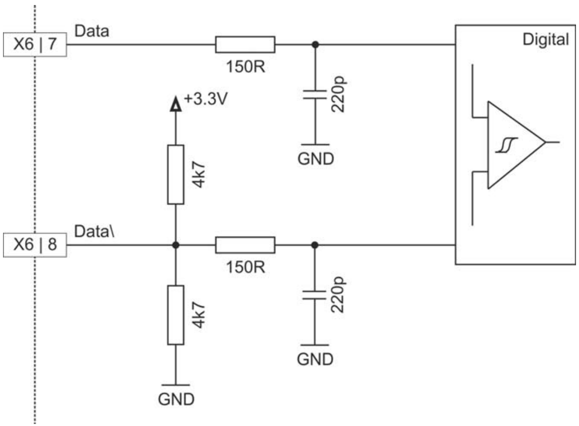


Figure 3-21 SSI absolute encoder data input

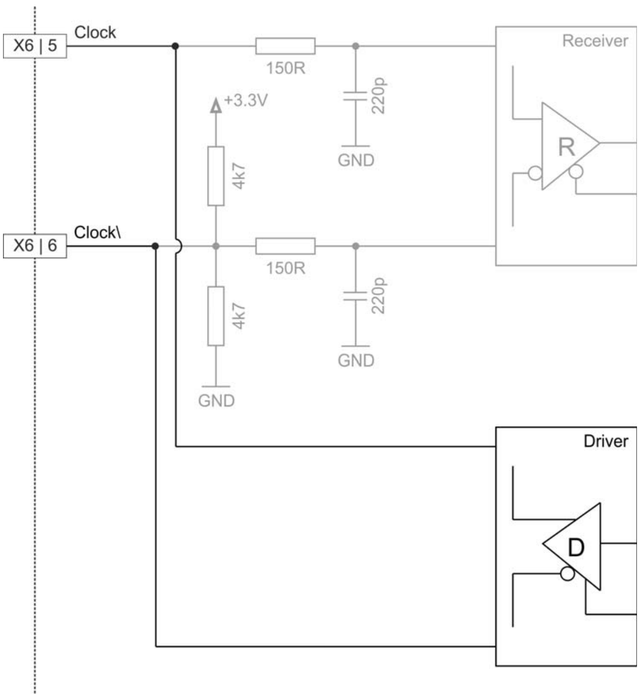


Figure 3-22 SSI absolute encoder clock output

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

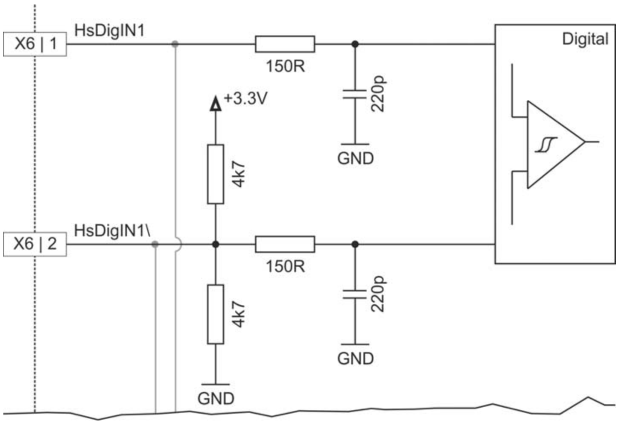


Figure 3-23 HsDigIN1 circuit "differential" (analogously valid for HsDigIN2…4)

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

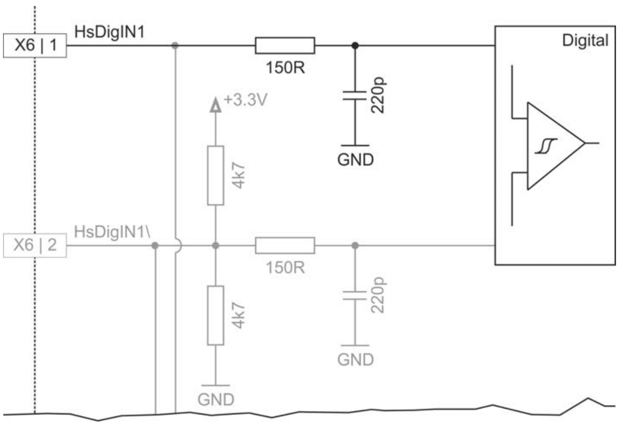


Figure 3-24 HsDigIN1 circuit "single-ended" (analogously valid for HsDigIN2…4)

Continued on next page.

High-speed digital output 1	
Min. differential output voltage	±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

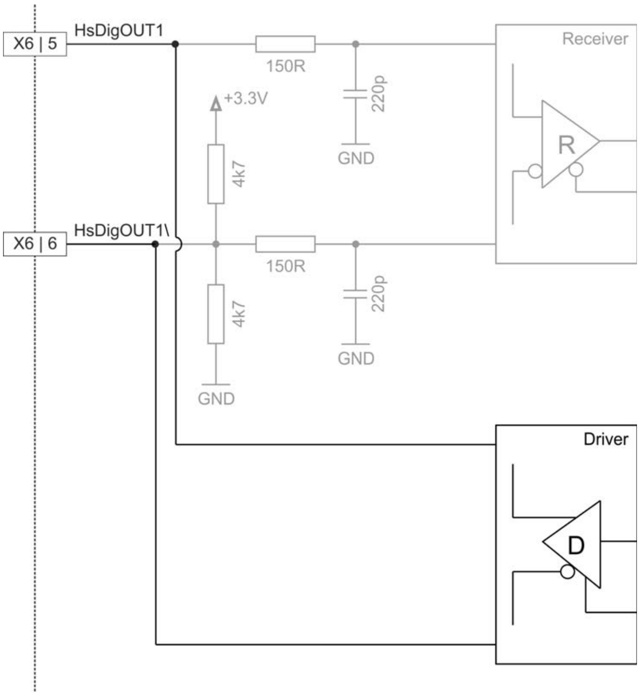


Figure 3-25 HsDigOUT1 output circuit

3.3.7 Digital I/O (X7)

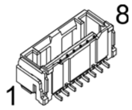


Figure 3-26 Digital I/O connector X7

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_{Aux}	Auxiliary output voltage (+5 VDC; $I_L \leq$150 mA)

Table 3-23 Digital I/O connector X7 – Pin assignment

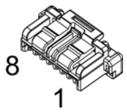
Signal Cable 8core (520853)		
A 		B
Cross-section	8 x 0.14 mm², grey	
Length	3 m	
Head A	Plug	Molex CLIK-Mate, single row, 8 poles (502578-0800)
	Contacts	Molex CLIK-Mate crimp terminals (502579)
Head B	Wire end sleeves 0.14 mm²	

Table 3-24 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

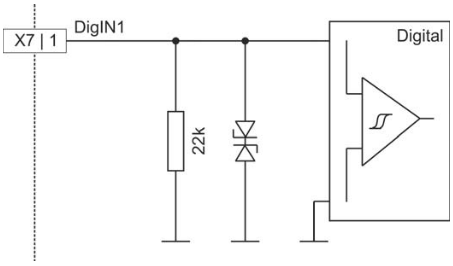


Figure 3-27 DigIN1 circuit (analogously valid for DigIN2…4) – Logic level setting

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

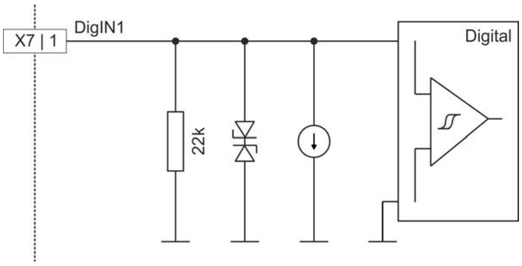


Figure 3-28 DigIN1 circuit (analogously valid for DigIN2…4) – PLC level setting

Continued on next page.

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

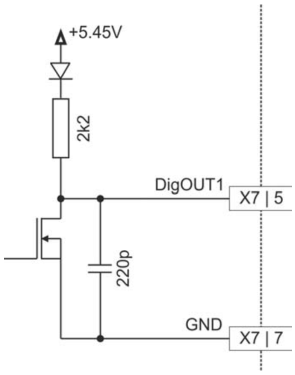


Figure 3-29 DigOUT1 circuit (analogously valid for DigOUT2)

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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

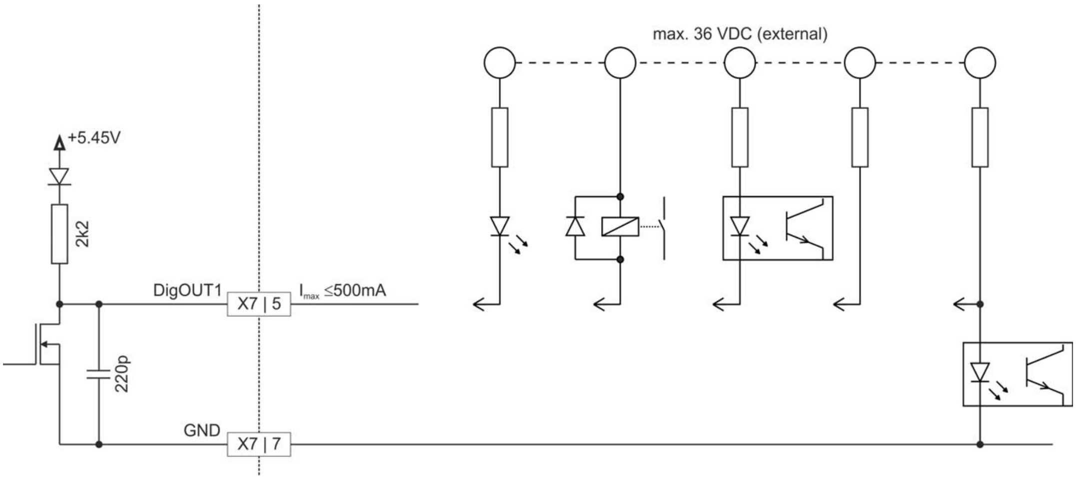


Figure 3-30 DigOUT1 "sinks" (analogously valid for DigOUT2)

DigOUT "source"	
Output voltage	U_{Out} = 5.45 V − 0.75 V − (I_{Load} x 2200 Ω)
Max. load current	I_{Load} ≤2 mA

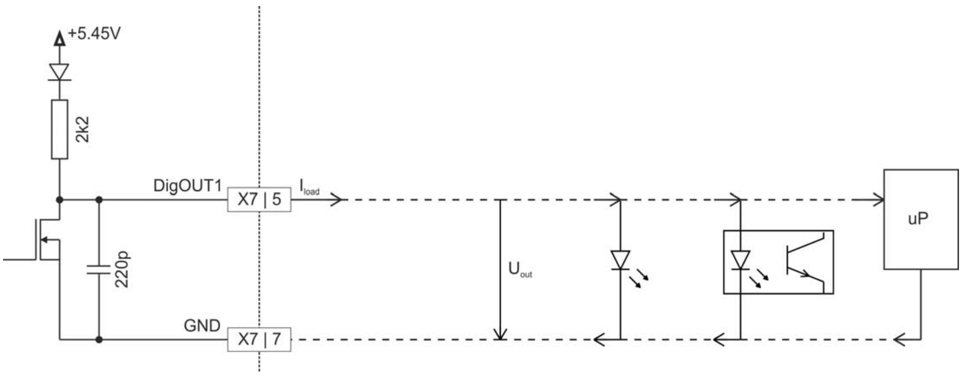


Figure 3-31 DigOUT1 "source" (analogously valid for DigOUT2)

3.3.8 Analog I/O (X8)

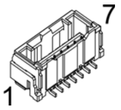


Figure 3-32 Analog I/O connector X8

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 3-25 Analog I/O connector X8 – Pin assignment

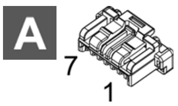
<table>
<tr><th colspan="3">Signal Cable 7core (520854)</th></tr>
<tr><td colspan="3"> B</td></tr>
<tr><td>Cross-section</td><td colspan="2">7 x 0.14 mm², grey</td></tr>
<tr><td>Length</td><td colspan="2">3 m</td></tr>
<tr><td rowspan="2">Head A</td><td>Plug</td><td>Molex CLIK-Mate, single row, 7 poles (502578-0700)</td></tr>
<tr><td>Contacts</td><td>Molex CLIK-Mate crimp terminals (502579)</td></tr>
<tr><td>Head B</td><td colspan="2">Wire end sleeves 0.14 mm²</td></tr>
</table>

Table 3-26 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

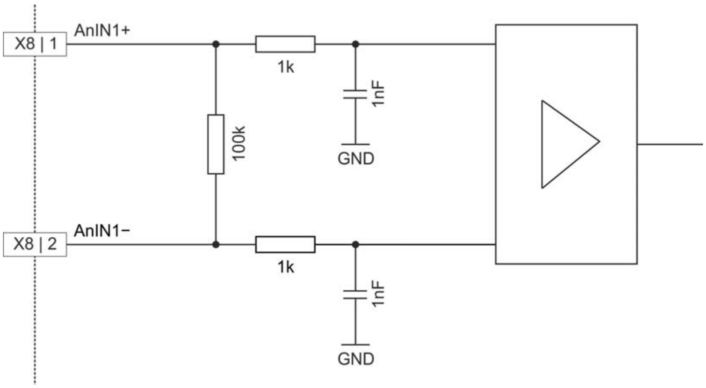


Figure 3-33 AnIN1 circuit (analogously valid for AnIN2)

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

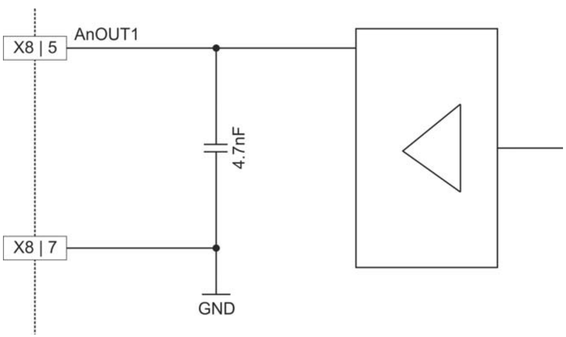


Figure 3-34 AnOUT1 circuit (analogously valid for AnOUT2)

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 ➔separate document «EPOS4 Application Notes».

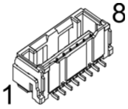


Figure 3-35 STO connector X9

Activation of power stage
In order to activate the power stage, either ***both*** *STO inputs must be powered or the «STO Idle Connector» (➔Table 3-28) 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_{STO}	Activation voltage for STO inputs (+5 VDC) ***Note:*** *Do not use this voltage for any other purpose*

Table 3-27 STO connector X9 – Pin assignment

For the matching prefab cable assembly ➔Table 3-24 on page 3-38.

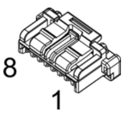
STO Idle Connector (520860) —included with every delivery—	
	
Plug	Molex CLIK-Mate, single row, 8 poles (502578-0800) with cable bridges

Table 3-28 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

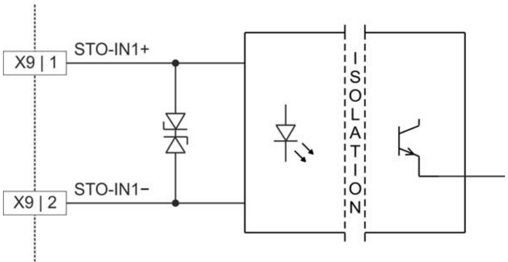


Figure 3-36 STO-IN1 circuit (analogously valid for STO-IN2)

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

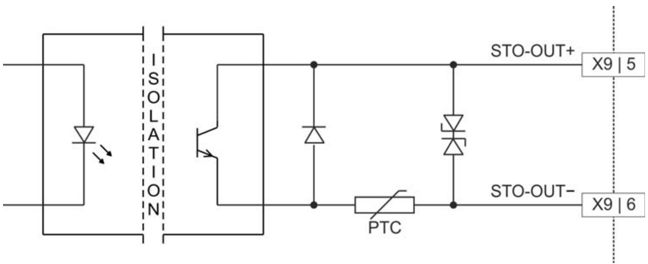


Figure 3-37 STO-OUT circuit

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 3-29 STO logic state

3.3.10 RS232 (X10)

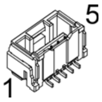


Figure 3-38 RS232 connector X10

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 3-30 RS232 connector X10 – Pin assignment

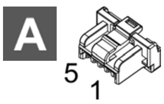
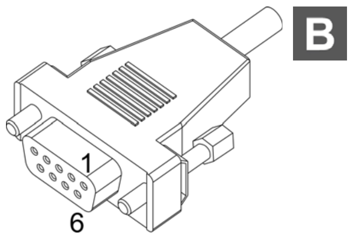
RS232-COM Cable (520856)		
		
Cross-section	2 x 2 x 0.14 mm², twisted pair, shielded	
Length	3 m	
Head A	Plug	Molex CLIK-Mate, single row, 5 poles (502578-0500)
	Contacts	Molex CLIK-Mate crimp terminals (502579)
Head B	Female D-Sub connector DIN 41652, 9 poles, with mounting screws	

Table 3-31 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

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 3-55.

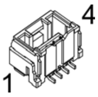


Figure 3-39 CAN 1 connector X11 and CAN 2 connector X12

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

Table 3-32 CAN 1 connector X11/CAN 2 connector X12 – Pin assignment

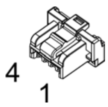
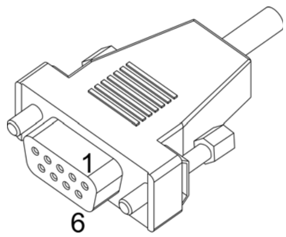
CAN-COM Cable (520857)		
A 		B 
Cross-section	2 x 2 x 0.14 mm², twisted pair, shielded	
Length	3 m	
Head A	Plug	Molex CLIK-Mate, single row, 4 poles (502578-0400)
	Contacts	Molex CLIK-Mate crimp terminals (502579)
Head B	Female D-Sub connector DIN 41652, 9 poles, with mounting screws	

Table 3-33 CAN-COM Cable

Continued on next page.

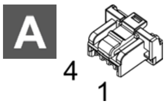
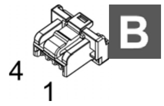
CAN-CAN Cable (520858)		
		
Cross-section	2 x 2 x 0.14 mm², twisted pair, shielded	
Length	3 m	
Head A	Plug	Molex CLIK-Mate, single row, 4 poles (502578-0400)
	Contacts	Molex CLIK-Mate crimp terminals (502579)
Head B	Plug	Molex CLIK-Mate, single row, 4 poles (502578-0400)
	Contacts	Molex CLIK-Mate crimp terminals (502579)

Table 3-34 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
Identifier setting	By DIP switch or software

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 ➔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.*

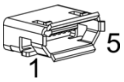


Figure 3-40 USB connector X13

X13 Head A Pin	PC's USB Terminal Head B Pin	Signal	Description
1	1	V_{BUS}	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 3-35 USB connector X13 – Pin assignment

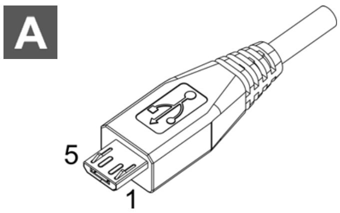
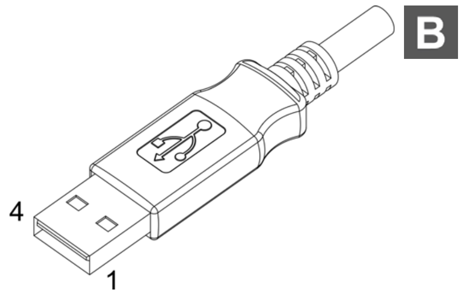
USB Type A - micro B Cable (403968)	
	
Cross-section	According to USB 2.0 / USB 3.0 specification
Length	1.5 m
Head A	USB Type "micro B", male
Head B	USB Type "A", male

Table 3-36 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

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

The EPOS4 50/5 features two NET connectors for extension communication interfaces, such as EtherCAT. 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 NET IN (X14) as «Input».*
- *Use NET OUT (X15) as «Output».*

For detailed information ➔separate document «EPOS4 Communication Guide».

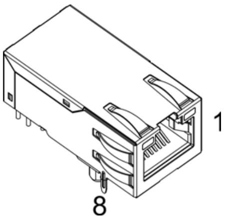


Figure 3-41 Extension NET IN & NET OUT connectors X14 & X15

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 3-37 Extension NET IN & NET 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 3-38 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 3-53) 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.

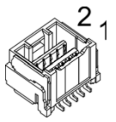


Figure 3-42 Extension Signal connector X16

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 3-40)
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 3-39 Extension Signal connector X16 – Pin assignment

For the matching prefab cable assembly ➔Table 3-22 on page 3-29.

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 3-40) 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 ➔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 3-52.

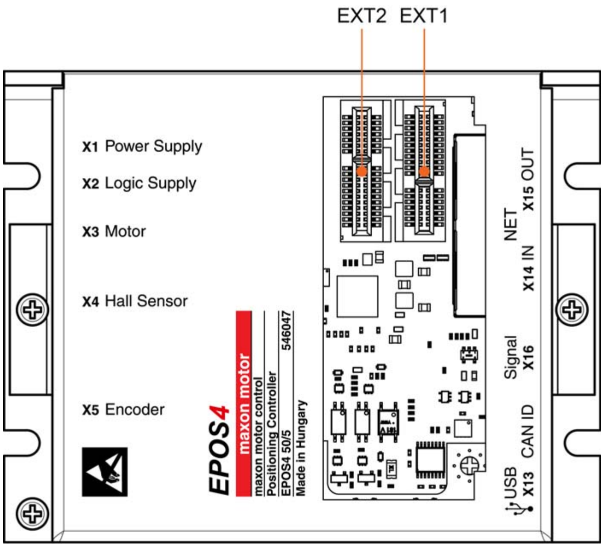


Figure 3-43 Extension slots

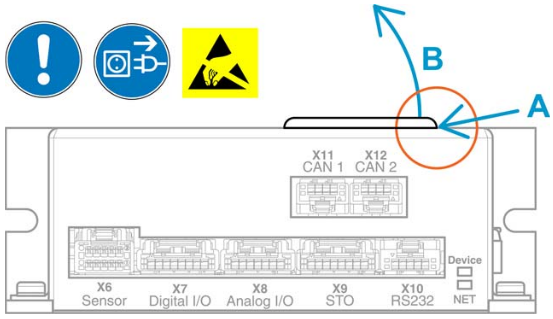
An inserted extension card mechanically interlocks in both horizontal and vertical direction.

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.

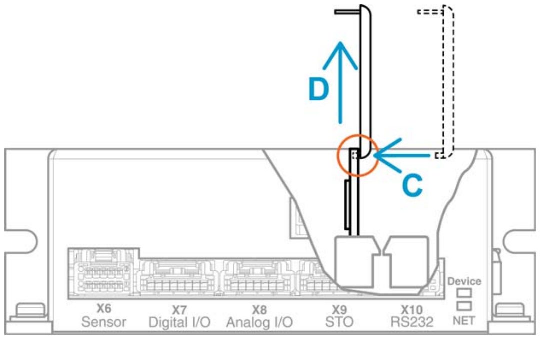


Switch off the controller's power supply. Comply with ESD protective measures.

Open plastic lid

3) Unlock the two latches (A) on the plastic lid.

4) Lift the plastic lid upward (B) and remove.

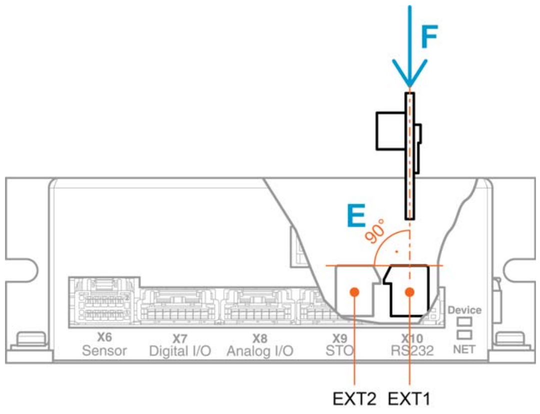


Remove extension card, if necessary

5) Turn the plastic lid over and look for the molded catch in one of its corners.

6) Insert the catch into the extension card's bore (C).

7) Pull both – the plastic lid together with the extension card – straight upward (D).

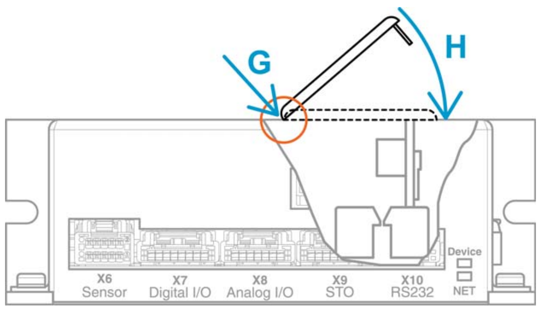


Make sure that the extension slots are clean and free of any foreign objects.

Insert extension card

8) Align the extension card with the PCIe card edge connector and keep it right-angled (E).

9) Carefully insert the extension card in the extension slot EXT1 while keeping it right-angled and press down all the way into the PCIe card edge connector (F).



Close plastic lid

10) Engage the plastic lid at its rear edge (G).

11) Fold down the plastic lid (H), press it down firmly, and let the two latches snap into place.

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 3-40 Extension cards (optional)

3.3.16 DIP Switch Configuration (SW1)

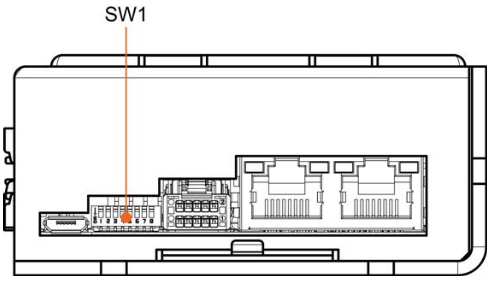


Figure 3-45 DIP switch SW1

3.3.16.1 CAN ID (Node Address)

The CAN ID is set with DIP switches 1…5. The node address (1…31) may be coded using binary code.

Setting the CAN ID by DIP switch SW1

- *By setting the DIP switch (1…5) address 0 (“OFF”), the CAN ID may be set by software (changing object “Node ID”, range 1…127).*
- *The CAN ID results in the summed values of DIP switch addresses 1 (“ON”).*
- *DIP switches 6…8 do not have any impact on the CAN ID.*

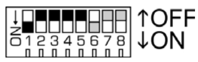
Switch	Binary Code	Valence	Setting
1	2^0	1	 (factory setting)
2	2^1	2	
3	2^2	4	
4	2^3	8	
5	2^4	16	

Table 3-41 DIP switch SW1 – Binary code values

Continued on next page.

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

Setting	Switch					Node Address
	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 3-42 DIP switch SW1 – Examples

3.3.16.2 CAN automatic Bit Rate Detection

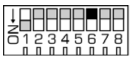
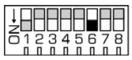
Switch	OFF	ON
6	 ↑OFF ↓ON Automatic bit rate detection deactivated	 ↑OFF ↓ON Automatic bit rate detection activated (factory setting)

Table 3-43 DIP switch SW1 – CAN automatic bit rate detection

3.3.16.3 CAN Bus Termination

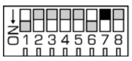
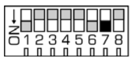
Switch	OFF	ON
7	 ↑OFF ↓ON Without bus termination (factory setting)	 ↑OFF ↓ON Bus termination with 120 Ω

Table 3-44 DIP switch SW1 – CAN bus termination

Continued on next page.

3.3.16.4 Digital Input Level

For details ➔chapter “3.3.7 Digital I/O (X7)” on page 3-38.

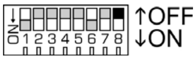
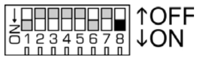
Switch	OFF	ON
8	 Logic level (factory setting)	 PLC level

Table 3-45 DIP switch SW1 – Digital input level

3.3.17 Spare Parts

Order number	Description
520860	STO Idle Connector X9

Table 3-46 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 ➔separate document «EPOS4 Firmware Specification».

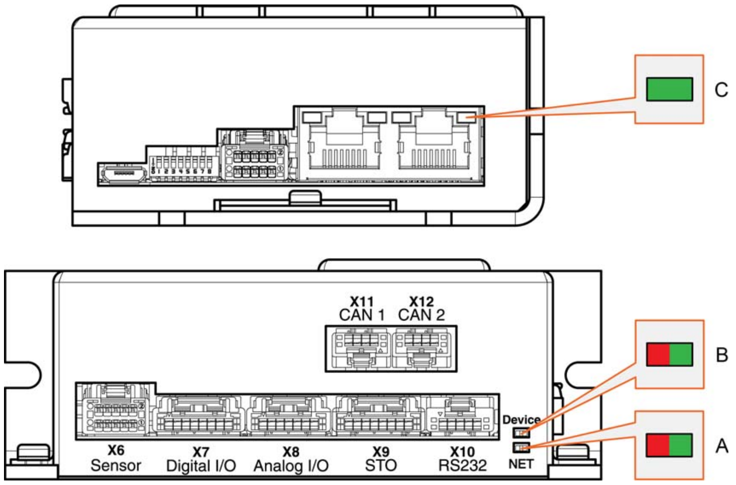


Figure 3-46 LEDs – Location

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
—	OFF	EPOS4 is in operating condition
—	Double flash	An application watchdog timeout has occurred *Example: Timeout of Sync Manager Watchdog*
—	Single flash	EPOS4 has changed the COM state due to an internal error *Example: Change of state "Op" to "SafeOpError" due to Sync Error*
—	Blink	General Configuration Error *Example: State change commanded by master is not possible due to actual settings (register, object, hardware configuration)*
Blink = continuous blinking (≈2.5 Hz)		Flash = Flashing (≈0.2 s), followed by pause of 1 s

Table 3-47 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… • “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 3-48 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 Green	Description
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 3-49 NET Port LED

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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.

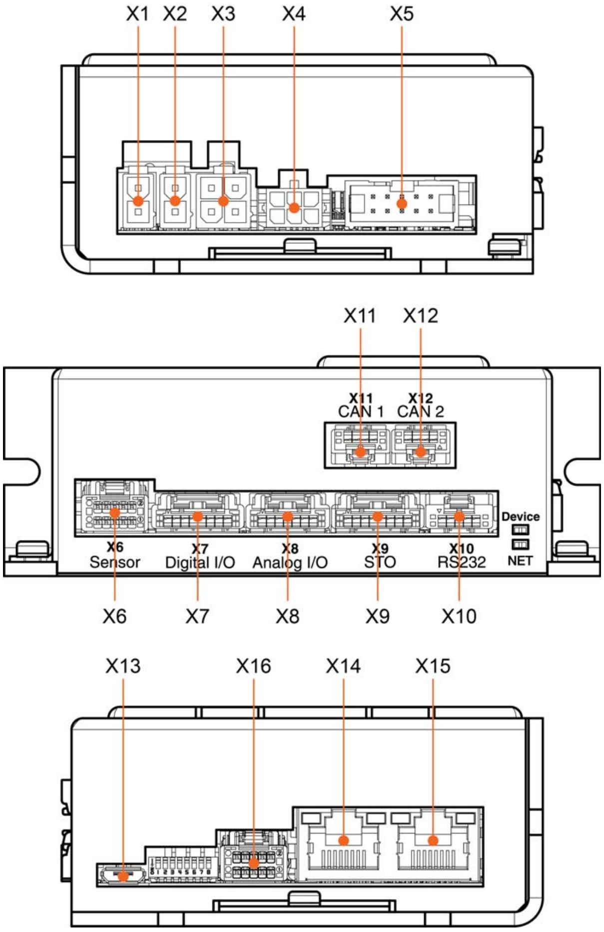

Figure 4-47 Interfaces – Designations and location

Signs and abbreviations used

The subsequent diagrams feature this signs and abbreviations:

- *Items marked with an asterisk (*) will be available with an upcoming firmware release.*
- *«EC Motor» stands for brushless EC motor (BLDC).*
- ⏚ *Ground safety earth connection (optional).*

CONTENTS

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 links 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 4-50, for EC (BLDC) motor ➔Table 4-51.
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

Digital incremental encoder & Digital incremental encoder . . . . Method # DC3

Digital incremental encoder & Analog incremental encoder. . . . . Method # DC4

Digital incremental encoder & SSI absolute encoder . . . . Method # DC5

Analog incremental encoder. . . . . Method # DC6

SSI absolute encoder . . . . Method # DC7

Method #	Encoders				➔ Figure(s)
	Digital Incremental 1 X5	Digital Incremental 2 X6	Analog Incremental X6	SSI Absolute X6	
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 / 4-57
DC7				✓	4-50 / 4-58

Table 4-50 Possible combinations of feedback signals for DC motor

4.1.2 EC (BLDC) Motor

Motor & feedback signals

Method #	Hall sensors X4	Encoders: Digital Incremental 1 X5	Encoders: Digital Incremental 2 X6	Encoders: Analog Incremental X6	Encoders: SSI Absolute X6	➔ Figure(s)
EC1	✓					4-51 / 4-52
EC2	✓	✓				4-51 / 4-52 / 4-53
EC3	✓			✓*		4-51 / 4-52 / 4-57
EC4	✓				✓	4-51 / 4-52 / 4-58
EC5	✓	✓	✓*			4-51 / 4-52 / 4-54
EC6	✓	✓		✓*		4-51 / 4-52 / 4-55
EC7	✓	✓			✓	4-51 / 4-52 / 4-56
EC8		✓				4-51 / 4-53
EC9		✓	✓*			4-51 / 4-54
EC10		✓		✓*		4-51 / 4-55
EC11		✓			✓	4-51 / 4-56
EC12				✓*		4-51 / 4-57
EC13					✓	4-51 / 4-58

Table 4-51 Possible combinations of feedback signals for EC (BLDC) motor

4.2 Main Wiring Diagram

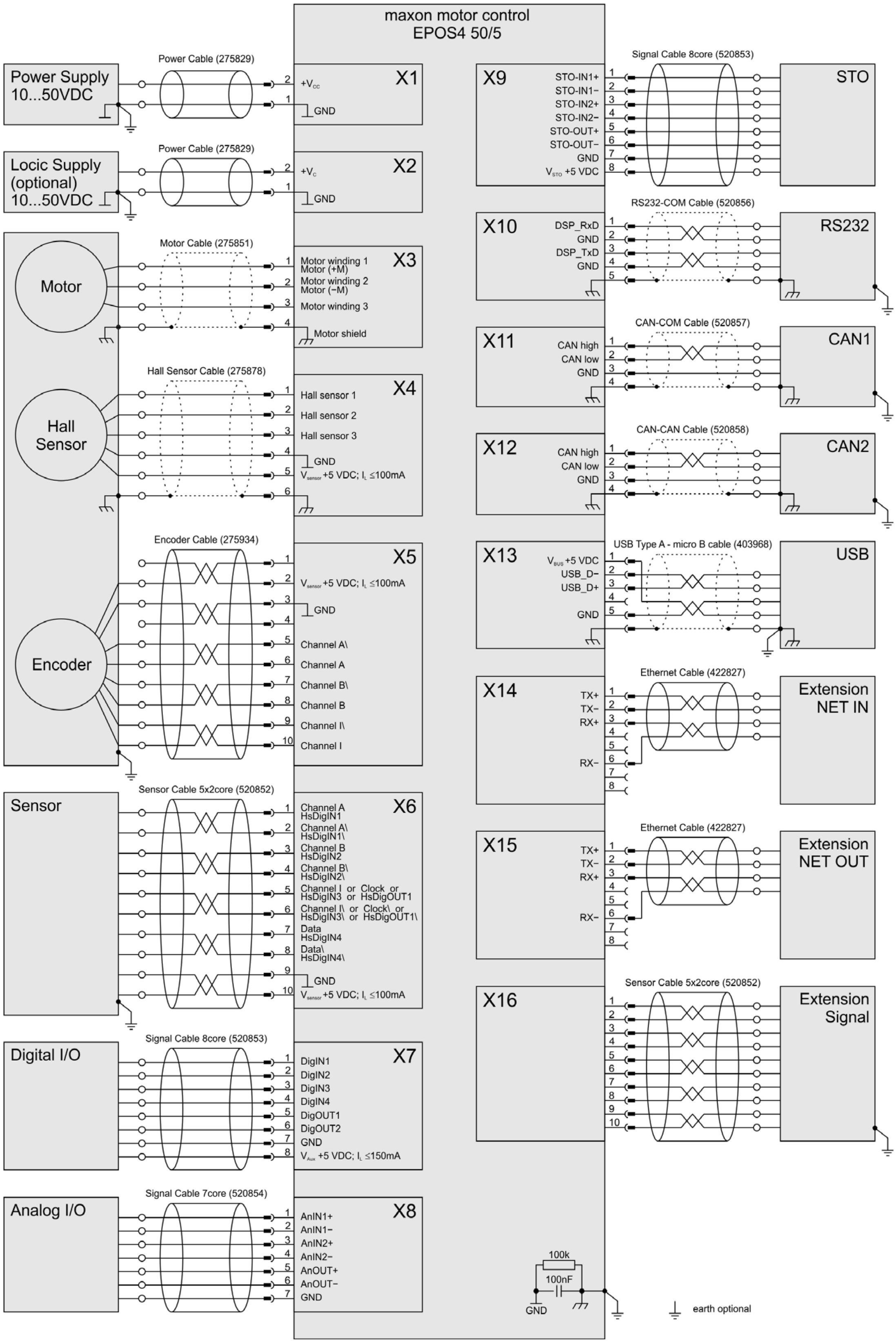

Figure 4-48 Main wiring diagram

4.3 Excerpts

4.3.1 Power & Logic Supply

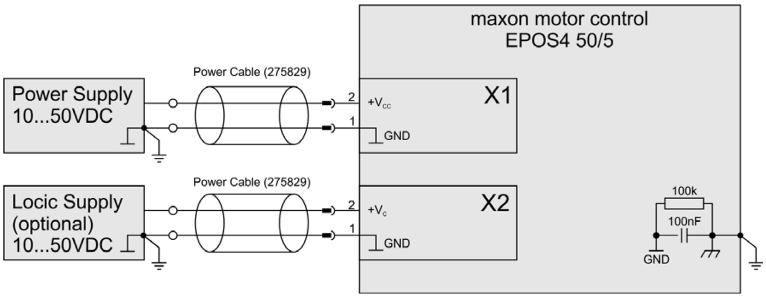

Figure 4-49 Power & logic supply

4.3.2 DC Motor

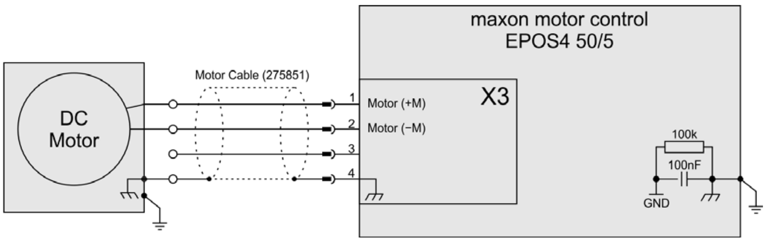

Figure 4-50 DC motor

4.3.3 EC (BLDC) Motor

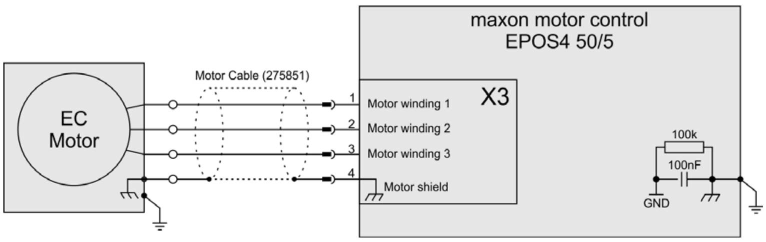

Figure 4-51 EC (BLDC) motor

4.3.4 Hall Sensors

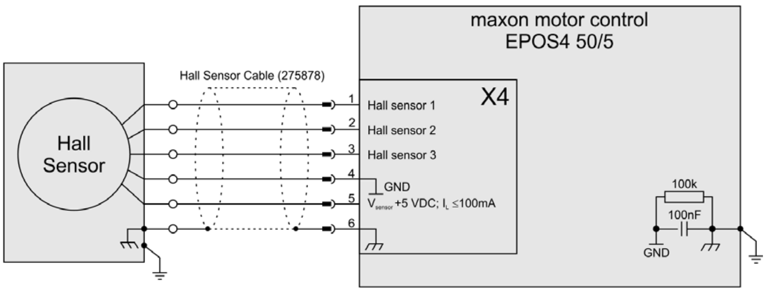

Figure 4-52 Hall sensors

4.3.5 Digital Incremental Encoder

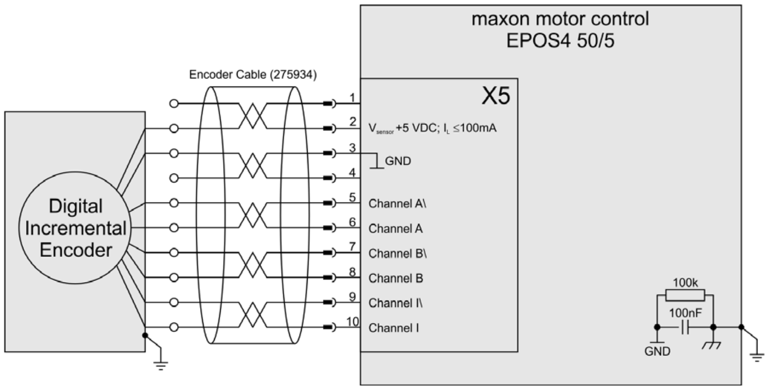

Figure 4-53 Digital incremental encoder

4.3.6 Digital & Digital Incremental Encoder

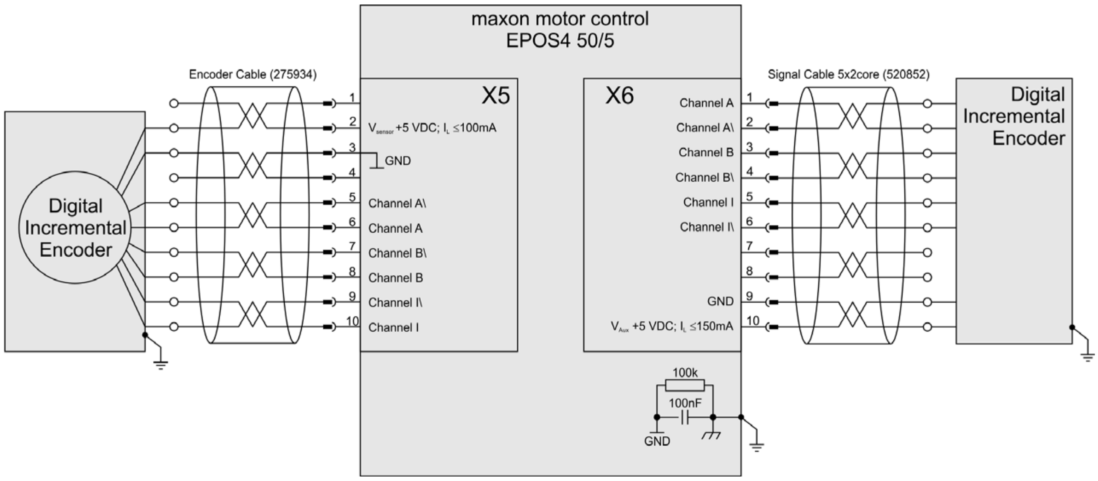

Figure 4-54 Digital & Digital incremental encoder

4.3.7 Digital & Analog Incremental Encoder

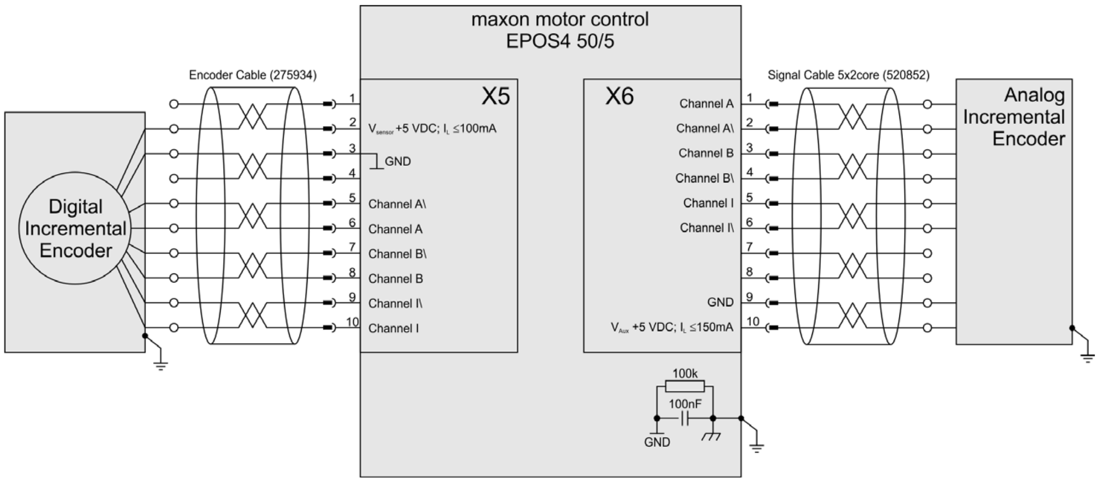

Figure 4-55 Digital & Analog incremental encoder

4.3.8 Digital Incremental & SSI Encoder

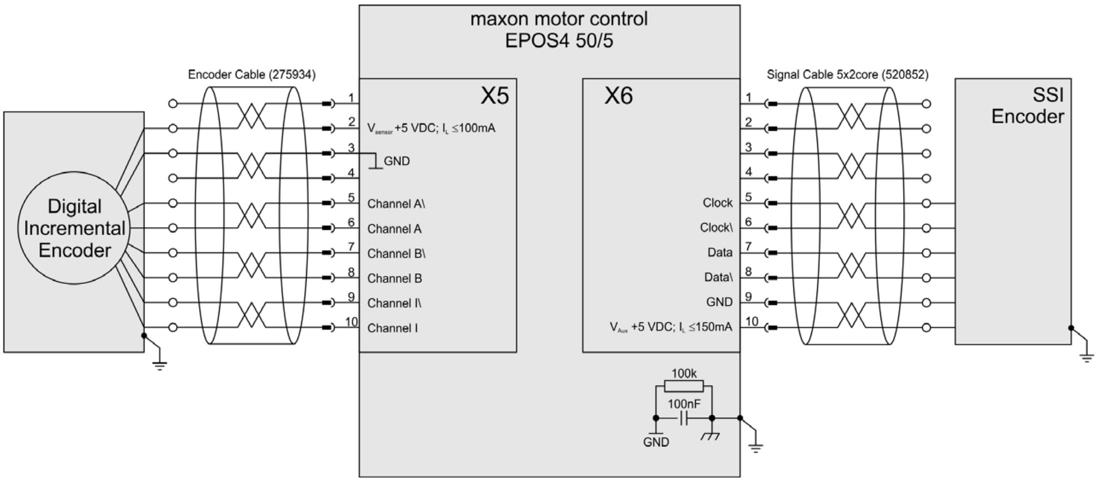

Figure 4-56 Digital incremental & SSI encoder

4.3.9 Analog Incremental Encoder

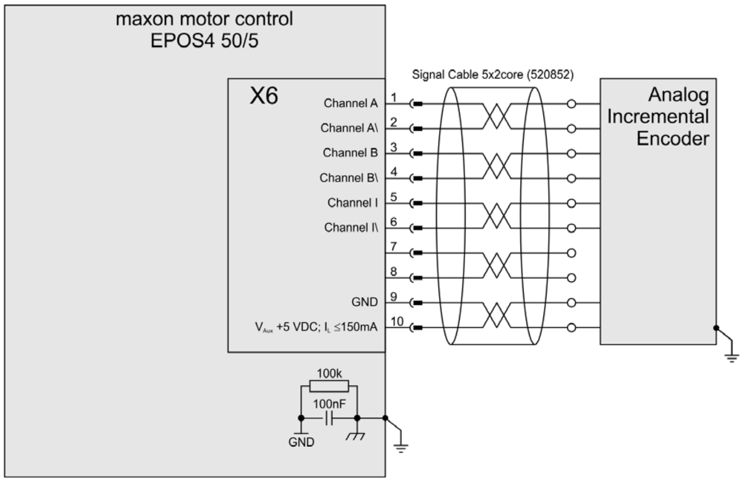

Figure 4-57 Analog incremental encoder

4.3.10 SSI Encoder

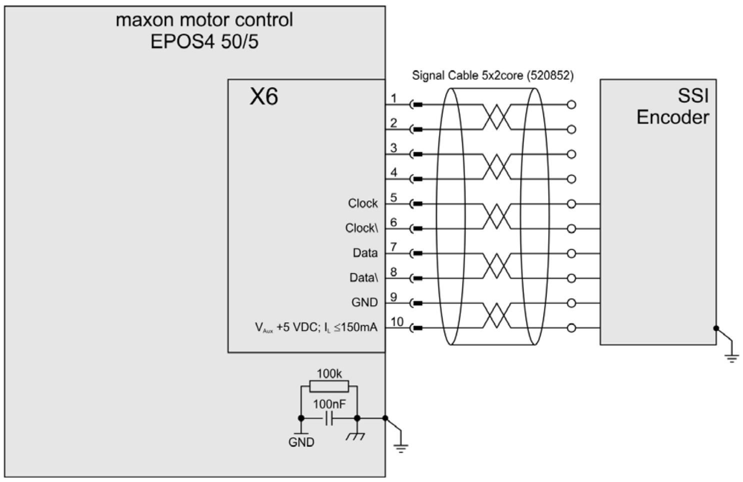

Figure 4-58 SSI encoder

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