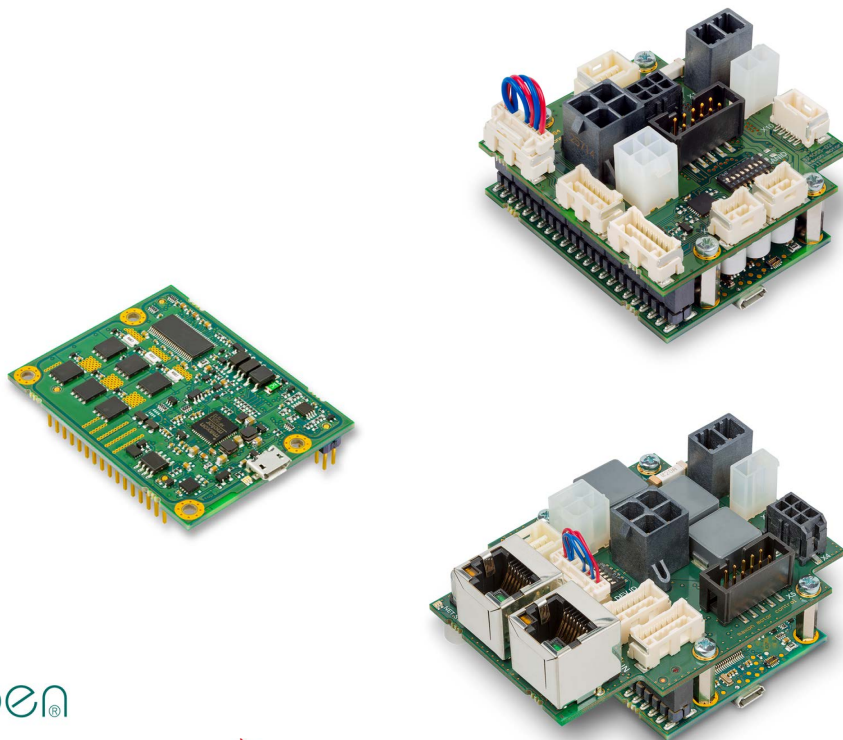


EPOS4 Module 50/8

EPOS4 Compact 50/8

Hardware Reference



CANopen

EtherCAT



epos.maxongroup.com

TABLE OF CONTENTS

| | | |
|----------|---|-----------|
| 1 | ABOUT | 5 |
| 1.1 | About this Document. | 5 |
| 1.2 | About the Devices. | 8 |
| 1.3 | About the Safety Precautions | 10 |
| 2 | SPECIFICATIONS | 11 |
| 2.1 | Technical Data | 11 |
| 2.2 | Thermal Data | 14 |
| 2.3 | Limitations. | 15 |
| 2.4 | Dimensional Drawings | 16 |
| 2.5 | Standards | 19 |
| 3 | SETUP | 21 |
| 3.1 | Generally applicable Rules | 21 |
| 3.2 | Pin Assignment for Module Version | 22 |
| 3.3 | Pin Assignment for Connector Boards & Compact Versions | 25 |
| 3.3.1 | EPOS4 CB Power CAN (520884) / EPOS4 Compact 50/8 CAN (520885). | 25 |
| 3.3.2 | EPOS4 CB Power EtherCAT (604594) / EPOS4 Compact 50/8 EtherCAT (605298) | 25 |
| 3.3.3 | Cabling | 26 |
| 3.3.4 | Tools | 27 |
| 3.3.5 | Connections | 28 |
| 3.3.5.1 | Power Supply (X1) | 29 |
| 3.3.5.2 | Logic Supply (X2) | 30 |
| 3.3.5.3 | Motor (X3a) (X3b). | 31 |
| 3.3.5.4 | Hall Sensor (X4) | 33 |
| 3.3.5.5 | Encoder (X5) | 34 |
| 3.3.5.6 | Sensor (X6) | 35 |

READ THIS FIRST

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

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

EPOS4 Module 50/8 and EPOS4 Compact 50/8 positioning controllers are considered as partly completed machinery according to EU Directive 2006/42/EC, Article 2, Clause (g) and are intended to be incorporated into or assembled with other machinery or other partly completed machinery or equipment.

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

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

| | | |
|------------|--|-----------|
| 3.3.5.7 | Digital I/O (X7) | 36 |
| 3.3.5.8 | Analog I/O (X8) | 37 |
| 3.3.5.9 | STO (X9) | 38 |
| 3.3.5.10 | RS232 (X10) | 39 |
| 3.3.5.11 | CAN 1 (X11) & CAN 2 (X12) | 40 |
| 3.3.5.12 | EtherCAT IN (X14) & EtherCAT OUT (X15) | 41 |
| 3.3.6 | DIP Switch Configuration (SW1) | 43 |
| 3.3.6.1 | CAN ID (Node-ID) / DEV ID | 43 |
| 3.3.6.2 | CAN automatic Bit Rate Detection (Compact CAN) | 44 |
| 3.3.6.3 | CAN Bus Termination (Compact CAN) | 45 |
| 3.3.6.4 | Digital Input Level | 45 |
| 3.3.7 | Spare Parts | 45 |
| 3.4 | Connection Specifications | 46 |
| 3.4.1 | Power Supply | 46 |
| 3.4.2 | Logic Supply | 47 |
| 3.4.3 | Motor | 48 |
| 3.4.4 | Hall Sensor | 49 |
| 3.4.5 | Encoder | 50 |
| 3.4.6 | Sensor | 53 |
| 3.4.6.1 | Incremental Encoder | 53 |
| 3.4.6.2 | SSI Absolute Encoder | 59 |
| 3.4.6.3 | High-speed Digital I/Os | 61 |
| 3.4.7 | Digital I/Os | 64 |
| 3.4.7.1 | Module | 64 |
| 3.4.7.2 | Compact | 65 |
| 3.4.8 | Safe Torque Off I/Os | 68 |
| 3.4.9 | Analog I/Os | 70 |
| 3.4.10 | Serial Communication Interface (SCI) / RS232 | 72 |
| 3.4.10.1 | Module | 72 |
| 3.4.10.2 | Compact CAN | 73 |
| 3.4.11 | CAN Interface / ID Setting | 74 |
| 3.4.11.1 | Connection | 74 |
| 3.4.11.2 | Configuration | 75 |
| 3.4.12 | Serial Peripheral Interface (SPI) | 77 |
| 3.4.13 | USB (X13) | 78 |
| 3.5 | Status Indicators | 79 |
| 4 | MOTHERBOARD DESIGN GUIDE | 83 |
| 4.1 | Requirements for Components of Third-party Suppliers | 84 |
| 4.1.1 | Socket Headers | 84 |
| 4.1.2 | Supply Voltage | 84 |
| 4.1.3 | Logic Supply Voltage | 85 |
| 4.1.4 | Motor Cables and Motor Chokes | 86 |
| 4.1.5 | RS232 Transceiver | 87 |
| 4.1.6 | Recommended Components and Manufacturers | 88 |
| 4.2 | Design Guidelines | 90 |

| | | |
|----------|--|------------|
| 4.2.1 | Ground | 90 |
| 4.2.2 | Layout | 90 |
| 4.3 | THT Footprint | 91 |
| 5 | WIRING | 93 |
| 5.1 | Possible Combinations to connect a Motor | 94 |
| 5.2 | Main Wiring Diagrams | 96 |
| 5.3 | Excerpts | 98 |
| | LIST OF FIGURES | 101 |
| | LIST OF TABLES | 103 |
| | INDEX | 107 |

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 Module 50/8 and EPOS4 Compact 50/8 positioning controllers. It will highlight the tasks for safe and adequate installation and/or commissioning. Follow the described instructions ...

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

The present document is part of a documentation set and contains performance data and specifications, information on fulfilled standards, details on connections and pin assignment, and wiring examples. The below overview shows the documentation hierarchy and the interrelationship of its individual parts:

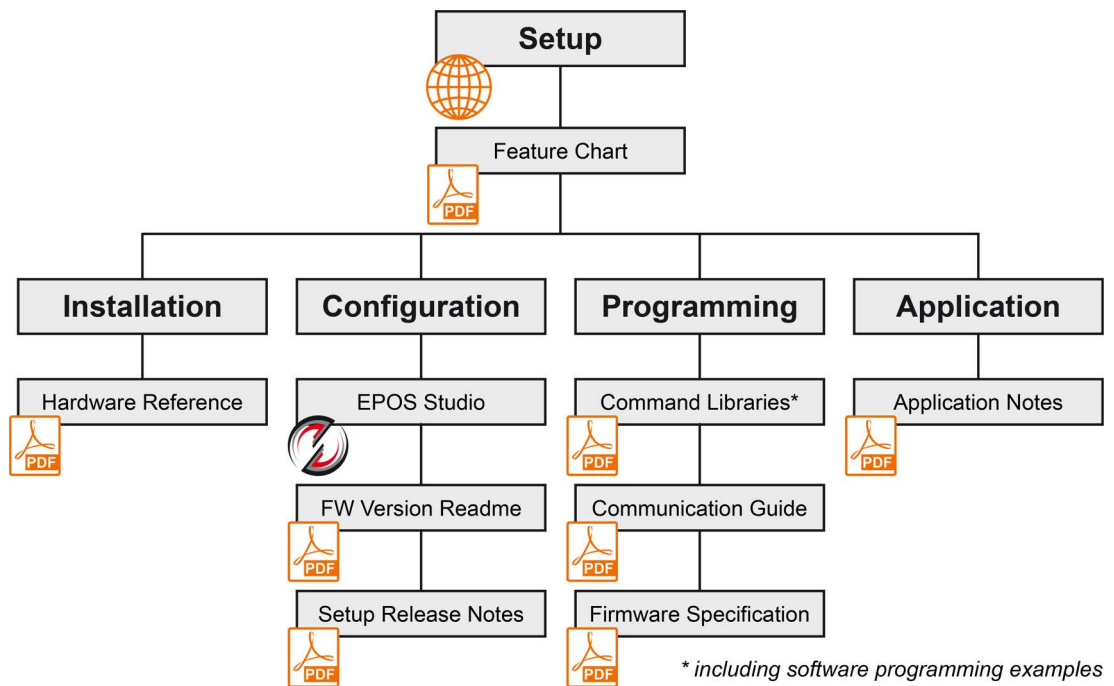


Figure 1-1 Documentation structure

1.1.2 Target Audience

The present document is intended for trained and skilled personnel. It conveys information on how to understand and fulfill the respective work and duties.

1.1.3 How to use

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

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

| Notation | Meaning |
|----------|--|
| (n) | refers to an item (such as part numbers, list items, etc.) |
| → | denotes “see”, “see also”, “take note of” or “go to” |

Table 1-1 Notation used

1.1.4 Symbols & Signs

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







| Type | Symbol | Meaning | |
|-------------------|--|---|--|
| Safety alert |  (typical) | DANGER | Indicates an imminent hazardous situation . If not avoided, it will result in death or serious injury . |
| | | WARNING | Indicates a potential hazardous situation . If not avoided, it 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) |
| Littelfuse® SMD NANO2® | © Littelfuse Inc., USA-Chicago, IL |
| Windows® | © Microsoft Corporation, USA-Redmond, WA |

Table 1-3 Brand names and trademark owners

1.1.6 Copyright

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CCMC | EPOS4 Module/Compact 50/8 Hardware Reference | Edition 2023-07 | DocID rel11749

1.2 About the Devices

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

maxon's EPOS4 Module 50/8 and EPOS4 Compact 50/8 are small-sized, full digital, smart positioning control units. Their high power density allow flexible use for brushed DC and brushless EC (BLDC) motors up to approximately 400 Watts with various feedback options, such as Hall sensors, incremental encoders as well as absolute sensors in a multitude of drive applications.

The devices are specially designed to be commanded and controlled as a slave node in a CANopen or EtherCAT network. In addition, the units can be operated via any USB or RS232 communication port of a Windows or Linux workstation (the Module thereby requires an external transceiver). Moreover, the integrated extension interface of the Module allows pooling with optionally available communication interfaces 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.

Thanks to its smart design, the EPOS4 Module 50/8 can either be used in combination with EPOS4 CB Power connector boards as a compact, integrated solution or be incorporated into customer-specific motherboards for single axis or multi axes motion control systems. The controller is available in the following configurations:

- **EPOS4 Module 50/8 (504384)**
Plug-in module for use with EPOS4 connector boards or customer-specific motherboards
- **EPOS4 CB Power CAN (520884)**
Connector board for initial commissioning or combination to a compact solution providing all connectors, including CANopen and RS232 interface
- **EPOS4 CB Power EtherCAT (604594)**
Connector board for initial commissioning or combination to a compact solution providing all connectors, including EtherCAT interface
- **EPOS4 Compact 50/8 CAN (520885)**
Fully integrated, compact, ready-to-use assembly of plug-in module and CANopen connector board
- **EPOS4 Compact 50/8 EtherCAT (605298)**
Fully integrated, compact, ready-to-use assembly of plug-in module and EtherCAT connector board

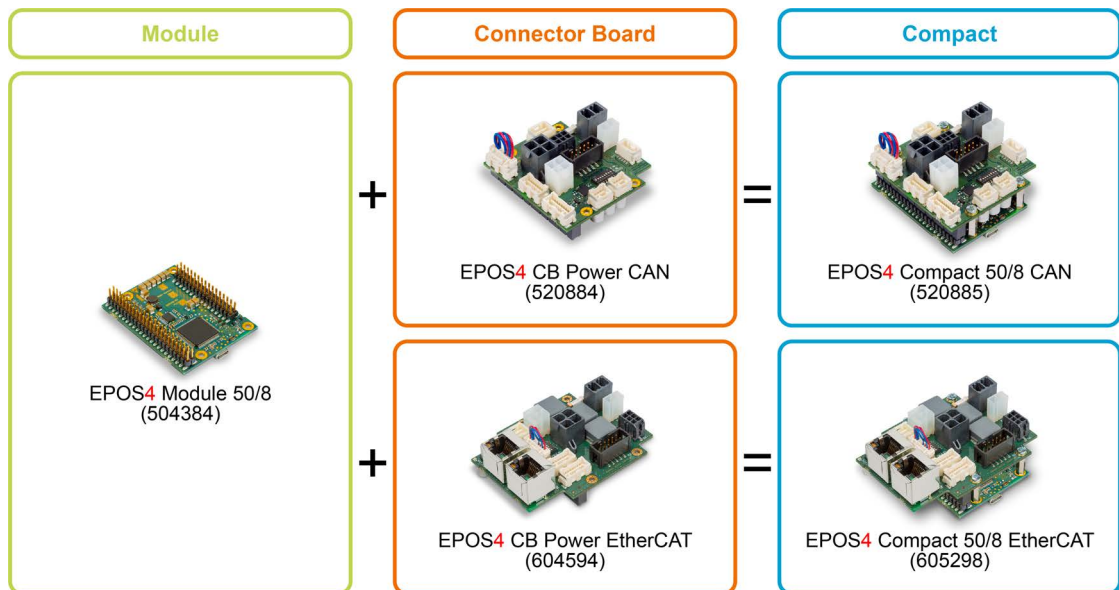


Figure 1-2 Configuration overview

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

| Short form | Meaning |
|------------------|--|
| CB | a connector board (EPOS4 CB Power CAN, EPOS4 CB Power EtherCAT) |
| Compact | any type of Compact 50/8 version |
| Compact CAN | EPOS4 Compact 50/8 CAN |
| Compact EtherCAT | EPOS4 Compact 50/8 EtherCAT |
| EPOS4 | all controller versions (Module and Compact) as well as other EPOS4 positioning controllers as a whole |
| Module | EPOS4 Module 50/8 |

Table 1-4 Abbreviations



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

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

1.3 About the Safety Precautions

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 can not be considered fail-safe. Therefore, you must make sure that any machine/apparatus has been fitted with independent monitoring and safety equipment. If the machine/apparatus should break down, if it is operated incorrectly, if the control unit breaks down or if the cables break or get disconnected, etc., the complete drive system must return – and be kept – in a safe operating mode.
- Be aware that you are not entitled to perform any repair on components supplied by maxon.



Electrostatic sensitive device (ESD)

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

2 SPECIFICATIONS

2.1 Technical Data

| EPOS4 Module 50/8 (504384) EPOS4 Compact 50/8 CAN (520885) EPOS4 Compact 50/8 EtherCAT (605298) | | | |
|---|--|--|---|
| Electrical Rating | Nominal power supply voltage +V _{CC} | 10...50 VDC | |
| | Nominal logic supply voltage +V _C | Module | 10...50 VDC |
| | | Compact | 10...50 VDC, optional |
| | 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} (<5 s) | 8 A / 30 A | |
| | Pulse Width Modulation frequency | 50 kHz | |
| | Sampling rate PI current controller | 25 kHz (40 μs) | |
| | Sampling rate PI speed controller | 2.5 kHz (400 μs) | |
| | Sampling rate PID positioning controller | 2.5 kHz (400 μs) | |
| | Sampling rate analog input | 2.5 kHz (400 μs) | |
| | Max. efficiency | 98% (→Figure 2-4) | |
| | Max. speed DC motor | limited by max. permissible speed (motor) 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 | Module | — | |
| | Compact | 3 x 2.2 μH; 15 A | |
| Inputs & Outputs | Digital Input 1 (general purpose) Digital Input 2 (general purpose) Digital Input 3 (general purpose) Digital Input 4 (general purpose) | Module Compact | +2.1...+36 VDC 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 |

Continued on next page.

| EPOS4 Module 50/8 (504384) EPOS4 Compact 50/8 CAN (520885) EPOS4 Compact 50/8 EtherCAT (605298) | | | | |
|---|---|---|----------------------------------|--|
| Inputs & Outputs (continued) | 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) <ul style="list-style-type: none"> Digital incremental encoder Analog incremental encoder SinCos SSI absolute encoder High-speed digital input 1...4 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, 0.4...2 MHz EIA RS422, max. 6.25 MHz EIA RS422, max. 6.25 MHz | | |
| Voltage Outputs | Sensor supply voltage V_{Sensor} | +5 VDC / $I_L \leq 100$ mA | | |
| | Auxiliary output voltage V_{Aux} | +5 VDC / $I_L \leq 145$ mA | | |
| Motor Connections | DC motor | + Motor, - Motor | | |
| | EC motor | Motor winding 1, Motor winding 2, Motor winding 3 | | |
| Interfaces | | Module | Compact CAN | Compact EtherCAT |
| | USB 2.0 / USB 3.0 | Full Speed | Full Speed | Full Speed |
| | RS232 | max. 115'200 bit/s; external transceiver necessary | max. 115'200 bit/s | — |
| | CAN | max. 1 Mbit/s | max. 1 Mbit/s | — |
| | EtherCAT | Full duplex (100 Mbit/s) as to IEE 802.3 100 Base Tx; optional «EPOS4 EtherCAT Card» required | — | Full duplex (100 Mbit/s) as to IEE 802.3 100 Base Tx |
| Status Indicators | | Module | Compact CAN | Compact EtherCAT |
| | Device status | Operation (green) Error (red) | Operation (green) Error (red) | Operation (green) Error (red) |
| | NET status | — | — | RUN state (green) Error (red) |
| | NET port | — | — | Link activity (green) |

Continued on next page.

| EPOS4 Module 50/8 (504384) EPOS4 Compact 50/8 CAN (520885) EPOS4 Compact 50/8 EtherCAT (605298) | | | | | |
|---|-----------------------------|--------------------|--|--------------------------------|--------------------------------|
| Physical | | | Module | Compact CAN | Compact EtherCAT |
| | Weight | | approx. 23 g | approx. 86 g | approx. 100 g |
| | Dimensions (L x W x H) [mm] | | 59.5 x 46.0 x 14.1 | 59.5 x 58.5 x 33.0 | 59.5 x 79.5 x 35.7 |
| | Mounting | | pluggable female headers 2.54 mm or mounting holes for M2.5 screws | mounting holes for M2.5 screws | mounting holes for M2.5 screws |
| Environment | Temperature | Operation | -30...+45 °C | -30...+45 °C | -30...+45 °C |
| | | Extended range [a] | +45...+77 °C Derating -0.250 A/°C (→ Figure 2-3) | | |
| | | Storage | -40...+85 °C | | |
| | Altitude [b] | Operation | 0...6'000 m MSL | | |
| | | Extended range [a] | 6'000...10'000 m MSL Derating → Figure 2-3 | | |
| | Humidity | | 5...90% (condensation not permitted) | | |

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

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

Table 2-5 Technical data

2.2 Thermal Data

2.2.1 Derating of Output Current

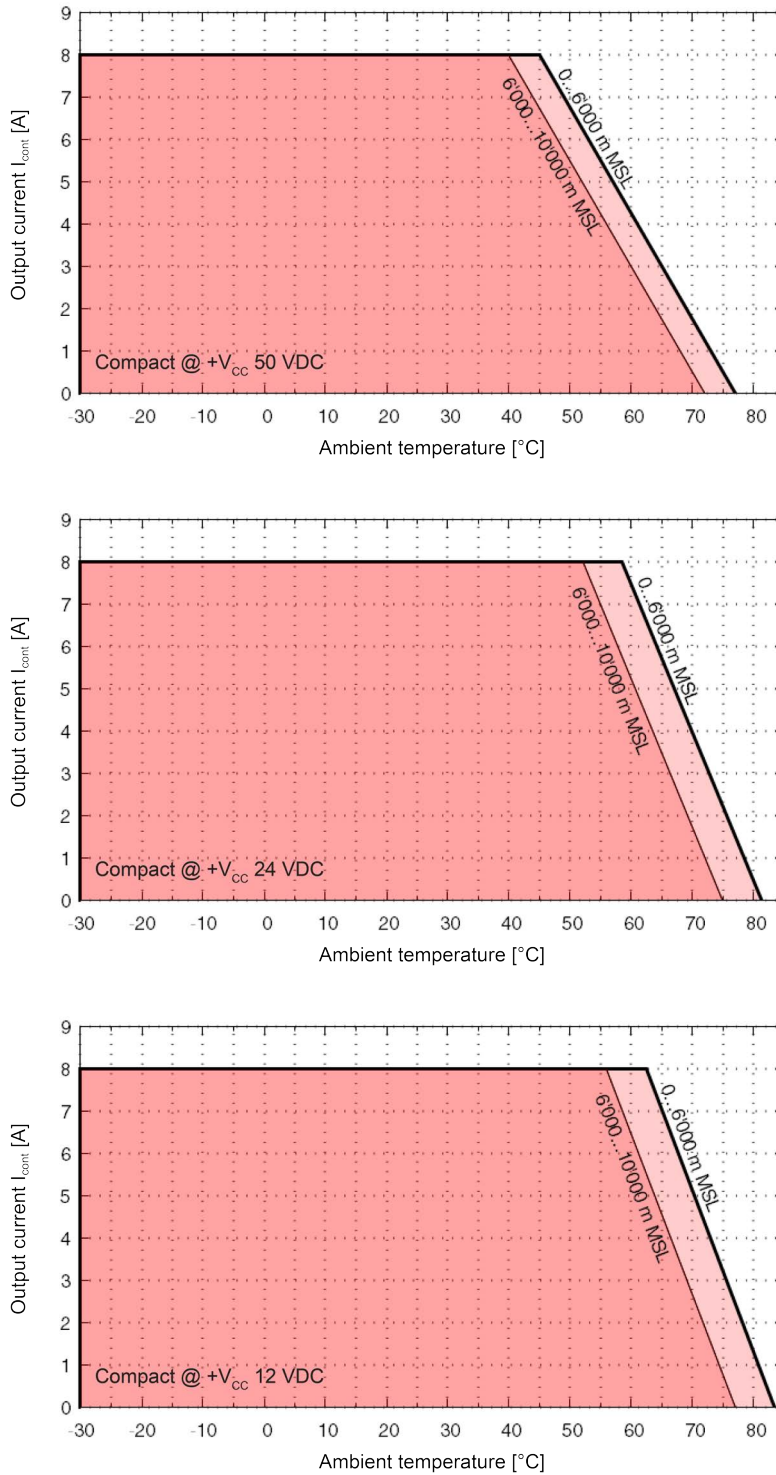


Figure 2-3 Derating of output current

2.2.2 Power Dissipation and Efficiency

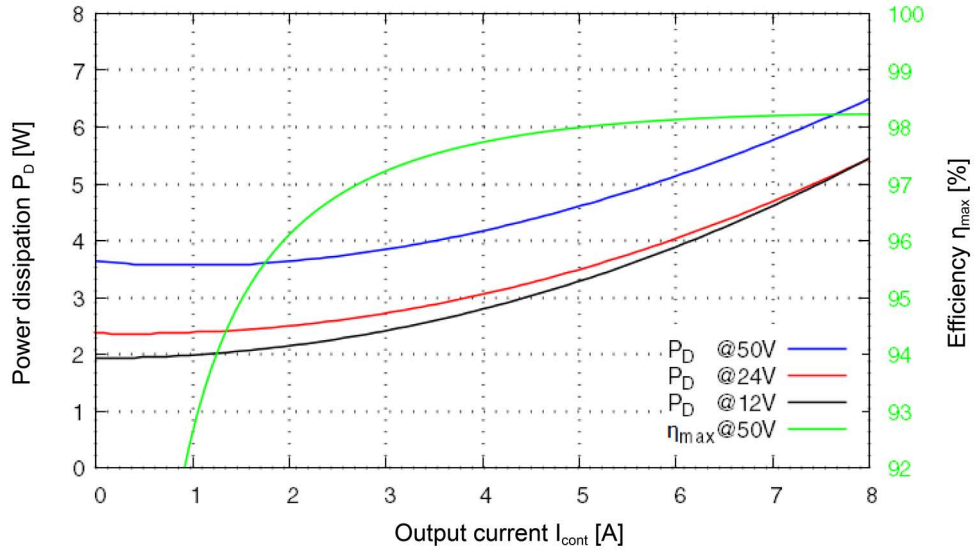


Figure 2-4 Power dissipation and efficiency – EPOS4 Module/Compact 50/8 CAN

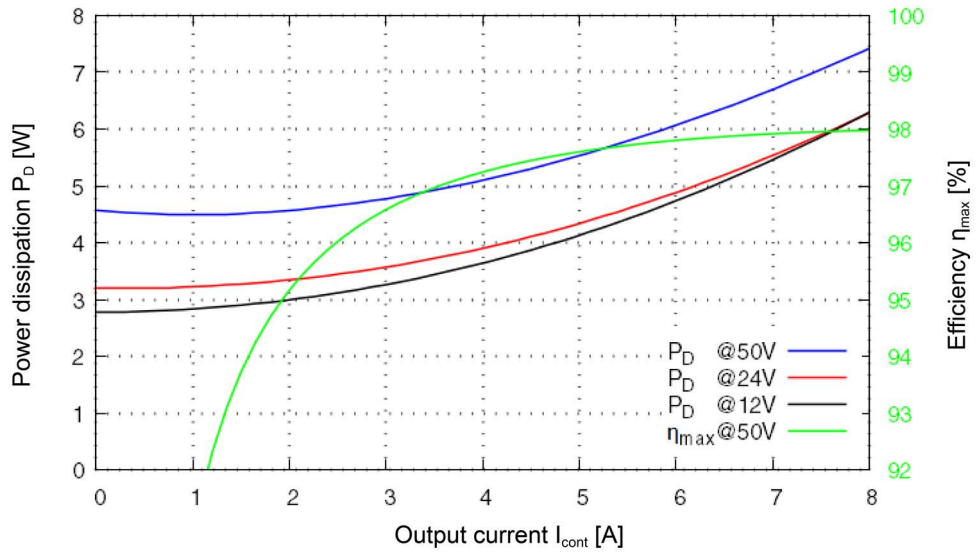


Figure 2-5 Power dissipation and efficiency – EPOS4 Compact 50/8 EtherCAT

2.3 Limitations

| Protection functionality | Switch-off threshold | Recovery threshold |
|--------------------------|----------------------|--------------------|
| Undervoltage | 8.0 V | 8.5 V |
| Overvoltage | 58 V | 56 V |
| Overcurrent | 40 A | — |
| Thermal overload | 100 °C | 90 °C |

Table 2-6 Limitations

2.4 Dimensional Drawings

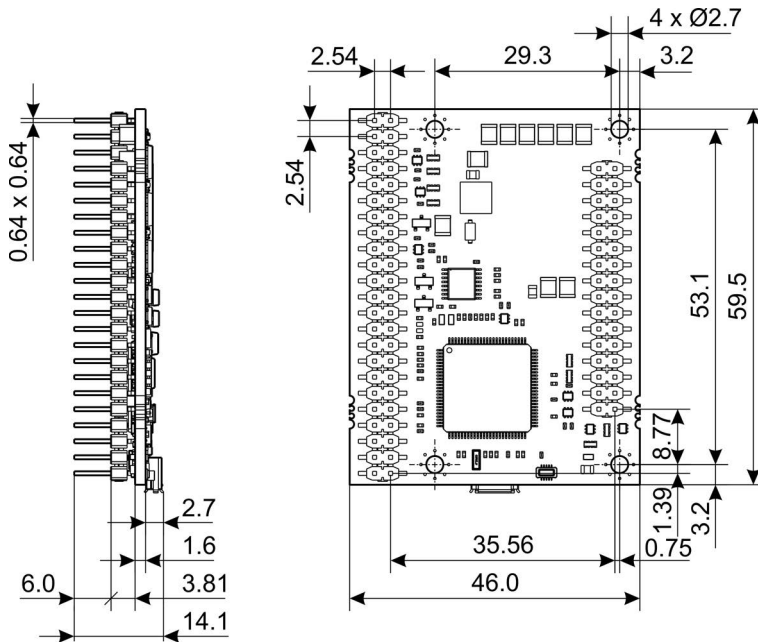


Figure 2-6 EPOS4 Module 50/8 – Dimensional drawing [mm]

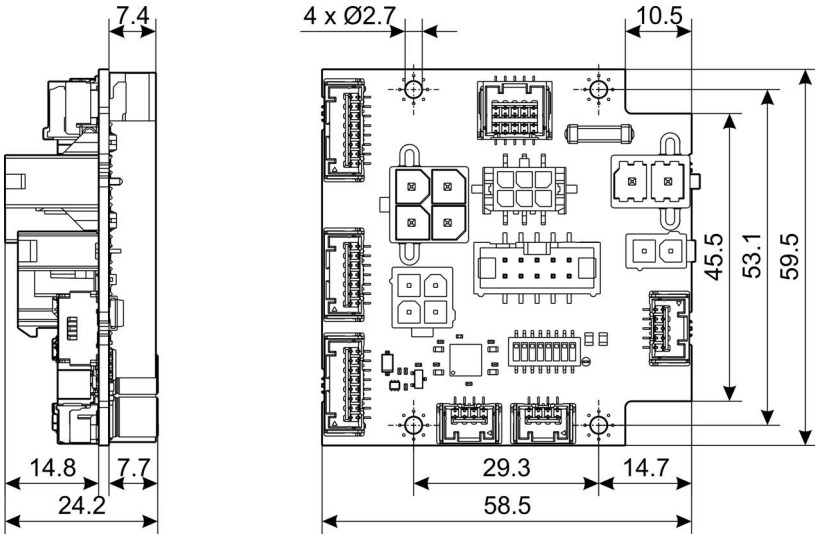


Figure 2-7 EPOS4 CB Power CAN – Dimensional drawing [mm]

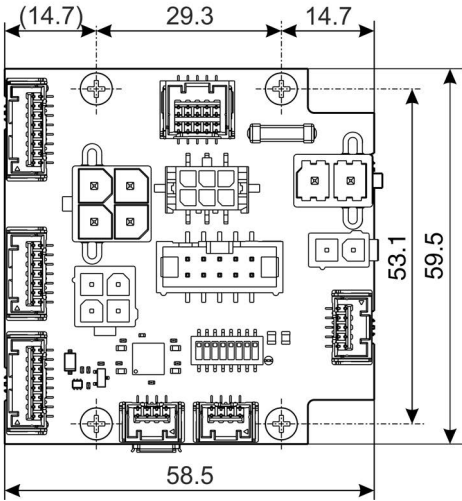
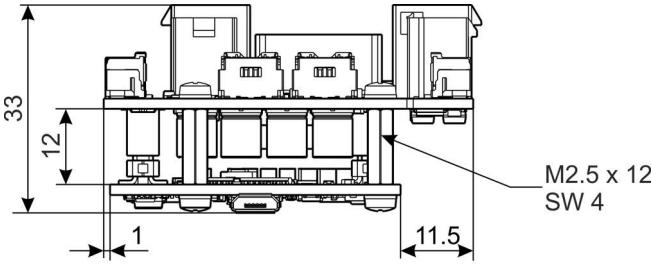


Figure 2-8 EPOS4 Compact 50/8 CAN – Dimensional drawing [mm]

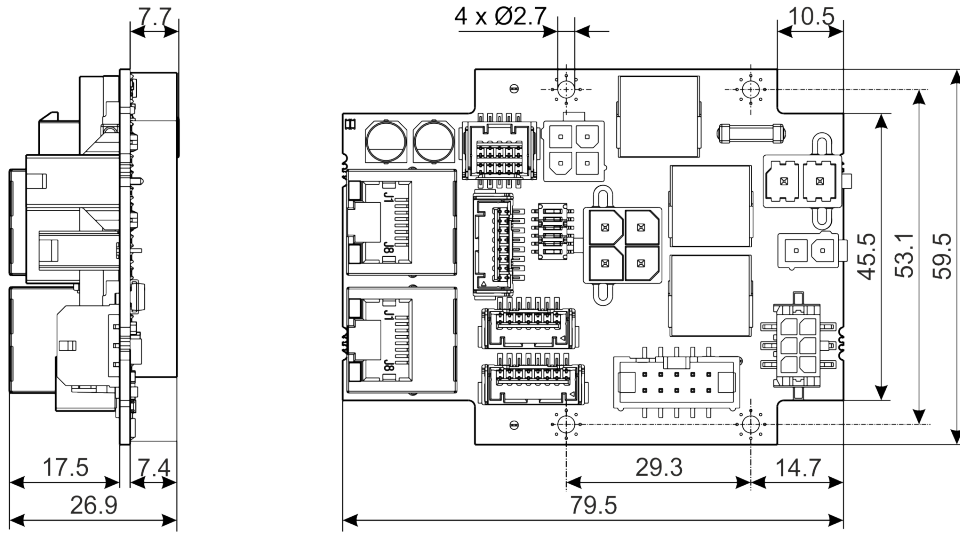


Figure 2-9 EPOS4 CB Power EtherCAT – Dimensional drawing [mm]

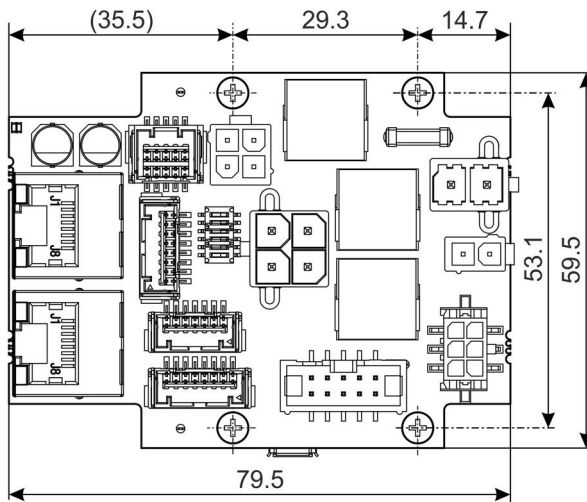
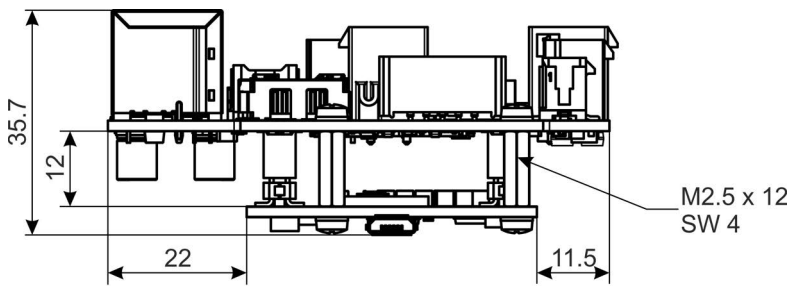


Figure 2-10 EPOS4 Compact 50/8 EtherCAT – Dimensional drawing [mm]

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 <ul style="list-style-type: none"> • Module: E76251; E133472; E207844; E337862 • Compact CAN: E76251; E116354; E133472; E207844; E337862 • Compact EtherCAT: E76251; E133472; E207844; E337862 |
| 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) <ul style="list-style-type: none"> • Module: 245'451 hours • Compact CAN: 210'109 hours • Compact EtherCAT: 197'129 hours |

Table 2-7 Standards

••page intentionally left blank••

3 SETUP

IMPORTANT NOTICE: PREREQUISITES FOR PERMISSION TO COMMENCE INSTALLATION

EPOS4 Module 50/8 and EPOS4 Compact 50/8 positioning controllers are considered as partly completed machinery according to EU Directive 2006/42/EC, Article 2, Clause (g) and **are intended to be incorporated into or assembled with other machinery or other partly completed machinery or equipment.**



WARNING

Risk of injury

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

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

3.1 Generally applicable Rules



Maximal permitted supply voltage

- *Make sure that supply power is between 10...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. 8 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.*

3.2 Pin Assignment for Module Version

For in-depth details on connections → chapter “3.4 Connection Specifications” on page 3-46.

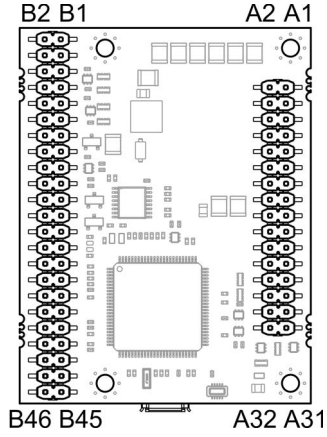


Figure 3-11 Pin assignment

| Pin | Signal | Description |
|-------------|---------------------|---|
| A1...A4** | Motor (+M) | DC motor: Motor + |
| | Motor winding 1 | EC motor: Winding 1 |
| A5...A8** | Motor (-M) | DC motor: Motor - |
| | Motor winding 2 | EC motor: Winding 2 |
| A9...A12** | Motor winding 3 | EC motor: Winding 3 |
| A13...A16** | +V _{CC} | Power supply voltage (+10...+50 VDC) |
| A17 | +V _C | Logic supply voltage (+10...+50 VDC) |
| A18...A22** | GND | Ground |
| A23 | Hall sensor 1 | Hall sensor 1 input |
| A24 | Hall sensor 2 | Hall sensor 2 input |
| A25 | Hall sensor 3 | Hall sensor 3 input |
| A26 | V _{Sensor} | Sensor supply voltage (+5 VDC; I _L ≤ 100 mA) |
| A27 | Channel A | Digital incremental encoder channel A |
| A28 | Channel A\ | Digital incremental encoder channel A complement |
| A29 | Channel B | Digital incremental encoder channel B |
| A30 | Channel B\ | Digital incremental encoder channel B complement |
| A31 | Channel I | Digital incremental encoder channel I |
| A32 | Channel I\ | Digital incremental encoder channel I complement |

** Connect all pins in respect to the individual pin current rating.

Table 3-8 Pin assignment A1...A32 (X1...X5)

| Pin | Signal | Description |
|-----|------------------|---|
| B1 | DigIN1 | Digital input 1 |
| B2 | DigIN2 | Digital input 2 |
| B3 | DigIN3 | Digital input 3 |
| B4 | DigIN4 | Digital input 4 |
| B5 | DigOUT1 | Digital output 1 |
| B6 | DigOUT2 | Digital output 2 |
| B7 | Channel A | Digital/analog incremental encoder channel A |
| | HsDigIN1 | High-speed digital input 1 |
| B8 | Channel A\ | Digital/analog incremental encoder channel A complement |
| | HsDigIN1\ | High-speed digital input 1 complement |
| B9 | Channel B | Digital/analog incremental encoder channel B |
| | HsDigIN2 | High-speed digital input 2 |
| B10 | Channel B\ | Digital/analog incremental encoder channel B complement |
| | HsDigIN2\ | High-speed digital input 2 complement |
| B11 | Channel I | Digital/analog incremental encoder channel I |
| | HsDigIN3 | High-speed digital input 3 |
| | Clock | Clock (SSI) |
| | HsDigOUT1 | High-speed digital output 1 |
| B12 | Channel I\ | Digital/analog incremental encoder channel I complement |
| | HsDigIN3\ | High-speed digital input 3 complement |
| | Clock\ | Clock (SSI) complement |
| | HsDigOUT1\ | High-speed digital output 1 complement |
| B13 | Data | Data (SSI) |
| | HsDigIN4 | High-speed digital input 4 |
| B14 | Data\ | Data (SSI) complement |
| | HsDigIN4\ | High-speed digital input 4 complement |
| B15 | V _{Aux} | Auxiliary output voltage (+5 VDC; I _L ≤145 mA) |
| B16 | GND | Ground |
| B17 | STO-IN1+ | Safe Torque Off input 1, positive signal |
| B18 | STO-IN1- | Safe Torque Off input 1, negative signal |
| B19 | STO-IN2+ | Safe Torque Off input 2, positive signal |
| B20 | STO-IN2- | Safe Torque Off input 2, negative signal |
| B21 | STO-OUT+ | Safe Torque Off output, positive signal |
| B22 | STO-OUT- | Safe Torque Off output, negative signal |
| B23 | AnIN1+ | Analog input 1, positive signal |
| B24 | AnIN1- | Analog input 1, negative signal |
| B25 | AnIN2+ | Analog input 2, positive signal |
| B26 | AnIN2- | Analog input 2, negative signal |
| B27 | AnOUT1 | Analog output 1 |
| B28 | AnOUT2 | Analog output 2 |
| B29 | ID 1 | CAN ID / DEV ID 1 (valence = 1) |
| B30 | ID 2 | CAN ID / DEV ID 2 (valence = 2) |

Continued on next page.

| Pin | Signal | Description |
|-----------|---|--|
| B31 | ID 3 | CAN ID / DEV ID 3 (valence = 4) |
| B32 | ID 4 | CAN ID / DEV ID 4 (valence = 8) |
| B33 | ID 5 | CAN ID / DEV ID 5 (valence = 16) |
| B34 | Auto bit rate | Automatic bit rate detection of CAN bus |
| B35 | CAN high | CAN high bus line |
| B36 | CAN low | CAN low bus line |
| B37...B38 | GND | Ground |
| B39 [c] | DSP_RxD | Serial communication interface receive (UART) |
| B40 | DSP_TxD | Serial communication interface transmit (UART) |
| B41 [d] | SPI_CLK | Serial Peripheral Interface clock |
| B42 [d] | SPI_IRQ | Serial Peripheral Interface interrupt request |
| B43 [d] | SPI_SOMI | Serial Peripheral Interface Slave output, Master input |
| B44 [d] | SPI_SIMO | Serial Peripheral Interface Slave input, Master output |
| B45 [d] | SPI_CS2 | Serial Peripheral Interface chip select 2 |
| B46 [d] | SPI_CS1 | Serial Peripheral Interface chip select 1 |
| [c] | connect to sensor supply voltage V_{Sensor} (A26) when RS232 is not in use | |
| [d] | only used for maxon extension modules | |

Table 3-9 Pin assignment B1...B46 (X6...X12)

3.3 Pin Assignment for Connector Boards & Compact Versions

As an alternative to developing an own motherboard, ready-made connector boards are available to combine the Module to Compact versions. They comprise all required connections.

For in-depth details on connections → chapter “3.4 Connection Specifications” on page 3-46.

3.3.1 EPOS4 CB Power CAN (520884) / EPOS4 Compact 50/8 CAN (520885)

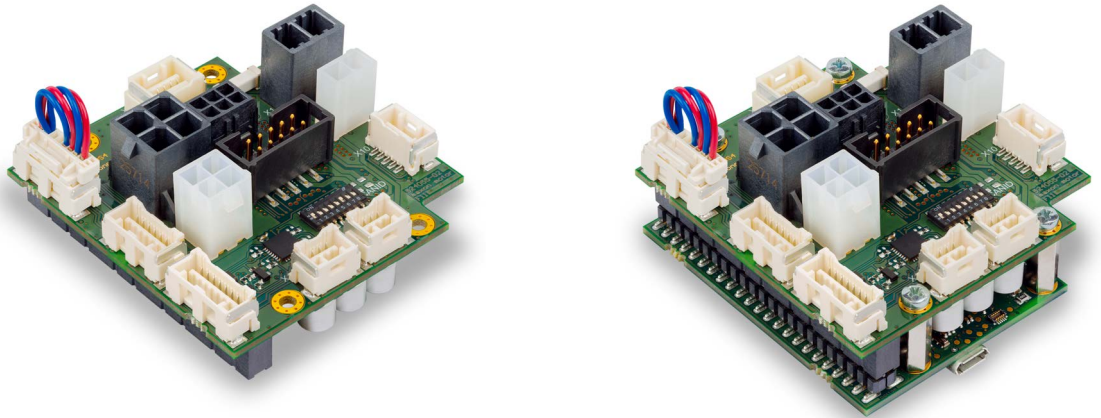


Figure 3-12 EPOS4 CB Power CAN (left) / EPOS4 Compact 50/8 CAN (right)

3.3.2 EPOS4 CB Power EtherCAT (604594) / EPOS4 Compact 50/8 EtherCAT (605298)

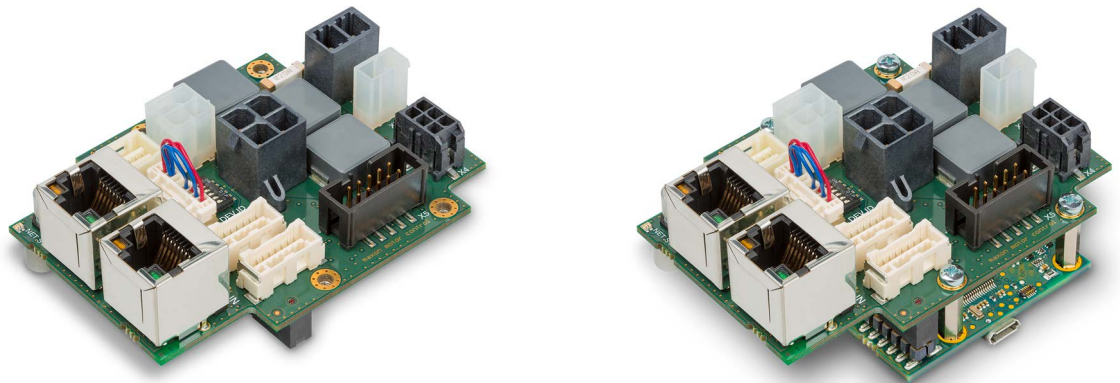


Figure 3-13 EPOS4 CB Power EtherCAT (left) / EPOS4 Compact 50/8 EtherCAT (right)

3.3.3 Cabling

PLUG&PLAY

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

- a) Check the following table and find the part number of the cable assembly that matches the setup you will be using.
- b) Follow the cross-reference to get the cable's pin assignment.

| Connector | | Prefab Cable Assembly | | |
|-------------|------------------|---|------------------|--------------|
| Compact CAN | Compact EtherCAT | Designation | Part Number | →Page |
| X1 | | Power Cable High Current Mandatory for supply of power stage! | 520850 | 3-29 |
| X2 | | Power Cable Optional for separate logic supply! | 275829 | 3-30 |
| X3a | | Motor Cable | 275851 | 3-32 |
| X3b | | Motor Cable High Current | 520851 | 3-32 |
| X4 | | Hall Sensor Cable | 275878 | 3-33 |
| X5 | | Encoder Cable | 275934 | 3-34 |
| X6 | | Sensor Cable 5x2core | 520852 | 3-36 |
| X7 | | Signal Cable 8core | 520853 | 3-36 |
| X8 | | Signal Cable 7core | 520854 | 3-37 |
| X9 | | Signal Cable 8core | 520853 | 3-36 |
| X10 | — | RS232-COM Cable | 520856 | 3-39 |
| X11 | — | CAN-COM Cable CAN-CAN Cable | 520857 520858 | 3-40 3-40 |
| X12 | — | CAN-COM Cable CAN-CAN Cable | 520857 520858 | 3-40 3-40 |
| X13 | | USB Type A - micro B Cable (located at the Module) | 403968 | 3-78 |
| — | X14 | Ethernet Cable | 422827 | 3-42 |
| — | X15 | Ethernet Cable | 422827 | 3-42 |

Table 3-10 Prefab maxon cables

MAKE&BAKE YOUR OWN

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

| EPOS4 Connector Set (520859) | | |
|------------------------------|---|----------|
| Connector | Specification | Quantity |
| Connectors | | |
| X1 | Molex Mega-Fit, 2 poles (171692-0102) | 1 |
| X2 | Molex Mini-Fit Jr., 2 poles (39-01-2020) | 2 |
| X3a | Molex Mini-Fit Jr., 4 poles (39-01-2040) | 1 |
| X3b | Molex Mega-Fit, 4 poles (171692-0104) | 1 |
| X4 | Molex Micro-Fit 3.0, 6 poles (430-25-0600) | 1 |
| X6 | Molex CLIK-Mate, dual row, 10 poles (503149-1000) | 1 |
| X7 / 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 | | |
| 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 | Molex CLIK-Mate crimp terminal (502579-0100) | 44 |
| Accessories | | |
| X5 | 3M Retainer Clip with strain relief, height 13.5 mm (3505-8110) | 1 |

Table 3-11 EPOS4 Connector Set – Content

3.3.4 Tools

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

Table 3-12 Recommended tools

3.3.5 Connections

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

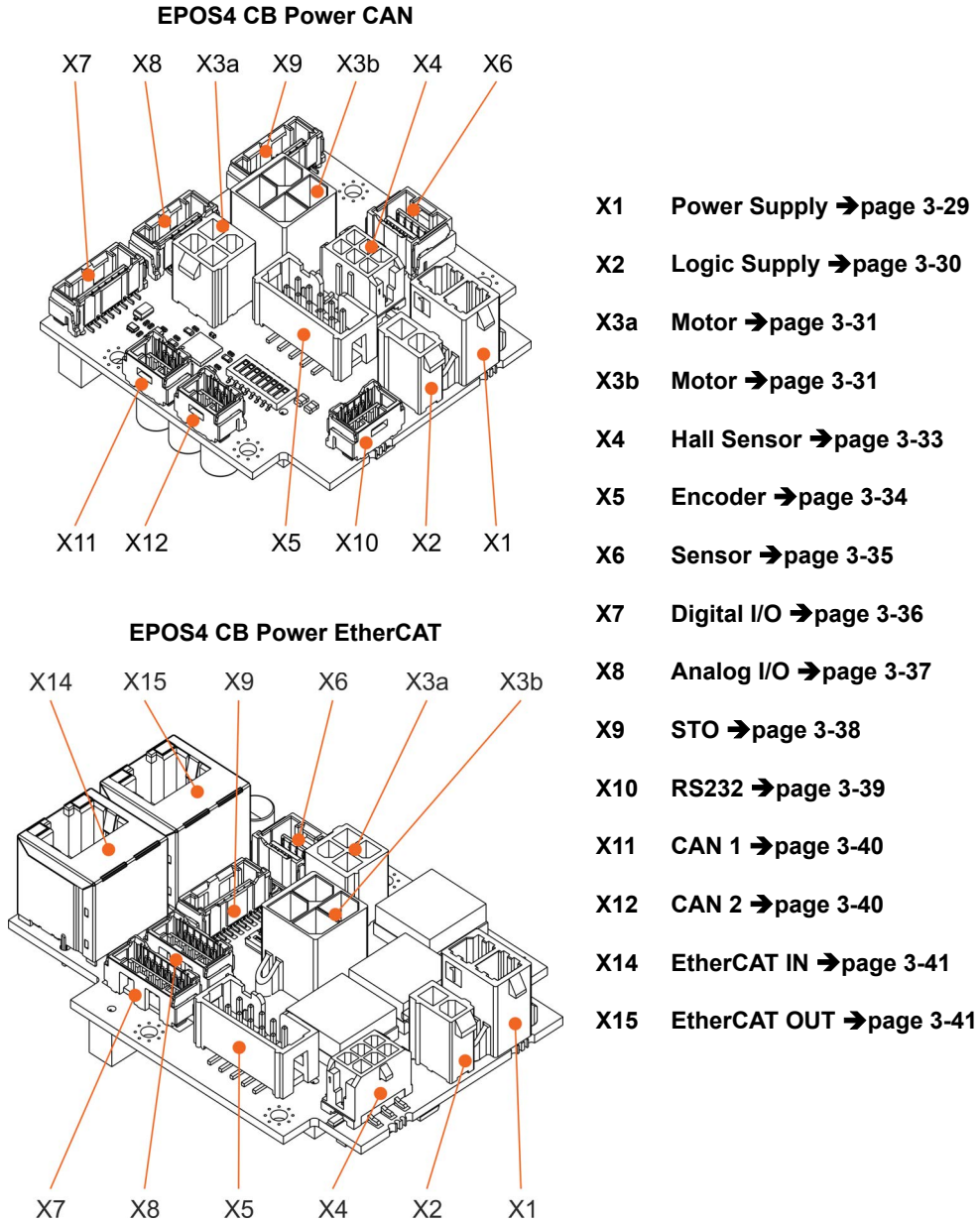


Figure 3-14 Connector Boards – Connectors



How to read pin assignment tables

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

3.3.5.1 Power Supply (X1)



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.

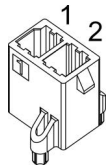


Figure 3-15 Power supply connector X1

| X1 Head A Pin | Prefab Cable Color | Head B Pin | Signal | Description |
|---------------|--------------------|------------|------------------|--------------------------------------|
| 1 | black | - | GND | Ground |
| 2 | black | + | +V _{CC} | Power supply voltage (+10...+50 VDC) |

Table 3-13 Power supply connector X1 – Pin assignment

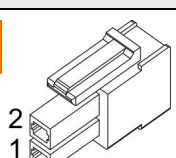
| Power Cable High Current (520850) | | | |
|-----------------------------------|---|---|----------|
| A |  | | B |
| Cross-section | 2 x 2.5 mm ² , grey | | |
| Length | 3 m | | |
| Head A | Plug | Molex Mega-Fit, 2 poles (171692-0102) | |
| | Contacts | Molex Mega-Fit, female crimp terminals (172063)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

Table 3-14 Power Cable High Current

3.3.5.2 Logic Supply (X2)

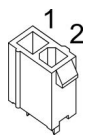


Figure 3-16 Logic supply connector X2

| X2 Head A Pin | Prefab Cable Color | Head B Pin | Signal | Description |
|---------------|--------------------|------------|-----------------|--------------------------------------|
| 1 | black | - | GND | Ground |
| 2 | black | + | +V _C | Logic supply voltage (+10...+50 VDC) |

Table 3-15 Logic supply connector X2 – Pin assignment

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

Table 3-16 Power Cable

3.3.5.3 Motor (X3a) (X3b)

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



Maximum permitted current

The connectors are designed for the following output currents:

- X3a: $I_{cont} \leq 11 A$
- X3b: $I_{cont} \leq 15 A$

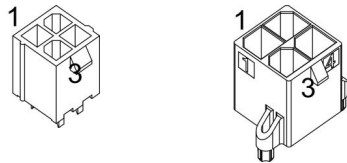


Figure 3-17 Motor connectors X3a (left) and X3b (right)

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

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

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

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

Continued on next page.

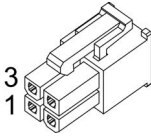
| Motor Cable for X3a (275851) | | | |
|------------------------------|---|---|----------|
| A |  | | B |
| Cross-section | 3 x 0.75 mm ² , shielded, grey | | |
| Length | 3 m | | |
| Head A | Plug | Molex Mini-Fit Jr., 4 poles (39-01-2040) | |
| | Contacts | Molex Mini-Fit Jr. female crimp terminals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

Table 3-19 Motor Cable

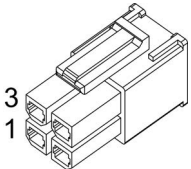
| Motor Cable High Current for X3b (520851) | | | |
|---|--|---|----------|
| A |  | | B |
| Cross-section | 3 x 2.5 mm ² , shielded, grey | | |
| Length | 3 m | | |
| Head A | Plug | Molex Mega-Fit, 4 poles (171692-0104) | |
| | Contacts | Molex Mega-Fit, female crimp terminals (172063) | |
| Head B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

Table 3-20 Motor Cable High Current

3.3.5.4 Hall Sensor (X4)

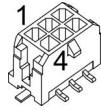


Figure 3-18 Hall sensor connector X4

| 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 3-21 Hall sensor connector X4 – Pin assignment

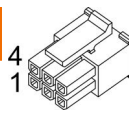
| Hall Sensor Cable (275878) | | |
|----------------------------|---|--|
| A |  | B |
| Cross-section | 5 x 0.14 mm ² , shielded, grey | |
| Length | 3 m | |
| Head A | Plug | Molex Micro-Fit 3.0, 6 poles (430-25-0600) |
| | Contacts | Molex Micro-Fit 3.0 female crimp terminals (430-30-xxxx) |
| Head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

Table 3-22 Hall Sensor Cable

3.3.5.5 Encoder (X5)

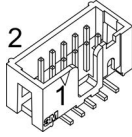


Figure 3-19 Encoder connector X5

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

Table 3-23 Encoder connector X5 – Pin assignment

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

Table 3-24 Encoder connector X5 – Accessories

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

Table 3-25 Encoder Cable

3.3.5.6 Sensor (X6)

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

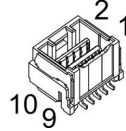


Figure 3-20 Sensor connector X6

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

Table 3-26 Sensor connector X6 – Pin assignment

Continued on next page.

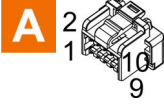
| Sensor Cable 5x2core (520852) | | |
|---|---|---|
|  | | B |
| Cross-section | 5 x 2 x 0.14 mm ² , twisted pair, grey | |
| Length | 3 m | |
| Head A | Plug | Molex CLIK-Mate, dual row, 10 poles (503149-1000) |
| | Contacts | Molex CLIK-Mate crimp terminals (502579) |
| Head B | Wire end sleeves 0.14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

Table 3-27 Sensor Cable 5x2core

3.3.5.7 Digital I/O (X7)

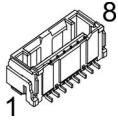


Figure 3-21 Digital I/O connector X7

| 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 ≤145 mA) |

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


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

Table 3-29 Signal Cable 8core

3.3.5.8 Analog I/O (X8)

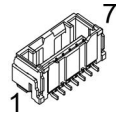


Figure 3-22 Analog I/O connector X8

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

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

| Signal Cable 7core (520854) | | |
|-----------------------------|---------------------------------------|--|
| | | |
| Cross-section | 7 x 0.14 mm ² , 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 ² | |

Table 3-31 Signal Cable 7core

3.3.5.9 STO (X9)

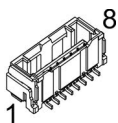


Figure 3-23 STO connector X9



Activation of power stage

In order to activate the power stage, either **both** STO inputs must be powered or the «STO Idle Connector» (→Table 3-33; included with every Compact version delivery) 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 3-32 STO connector X9 – Pin assignment

For the matching prefab cable assembly →Table 3-29 on page 3-36.

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

Table 3-33 STO Idle Connector

3.3.5.10 RS232 (X10)

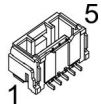


Figure 3-24 RS232 connector X10

| 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 3-34 RS232 connector X10 – Pin assignment


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

Table 3-35 RS232-COM Cable

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

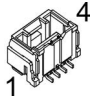


Figure 3-25 CAN 1 connector X11/CAN 2 connector X12

| 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 3-36 CAN 1 connector X11/CAN 2 connector X12 – Pin assignment

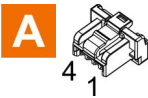
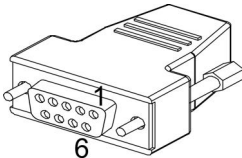
| CAN-COM Cable (520857) | | |
|---|---|--|
|   | | |
| Cross-section | 2 x 2 x 0.14 mm ² , twisted pair, shielded | |
| Length | 3 m | |
| Head A | Plug | Molex CLIK-Mate, single row, 4 poles (502578-0400) |
| | Contacts | Molex CLIK-Mate crimp terminals (502579) |
| Head B | Female D-Sub connector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

Table 3-37 CAN-COM Cable

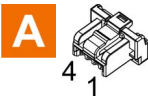
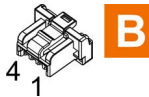
| CAN-CAN Cable (520858) | | |
|---|---|--|
|   | | |
| Cross-section | 2 x 2 x 0.14 mm ² , twisted pair, shielded | |
| Length | 3 m | |
| Head A | Plug | Molex CLIK-Mate, single row, 4 poles (502578-0400) |
| | Contacts | Molex CLIK-Mate crimp terminals (502579) |
| Head B | Plug | Molex CLIK-Mate,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

Table 3-38 CAN-CAN Cable

3.3.5.12 EtherCAT IN (X14) & EtherCAT OUT (X15)



Wrong plugging may cause hardware damage

Even though both EtherCAT 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 EtherCAT IN (X14) as «Input».
- Use EtherCAT OUT (X15) as «Output».

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

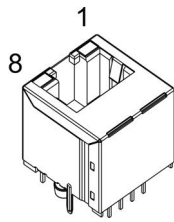


Figure 3-26 EtherCAT IN & EtherCAT OUT connectors X14 & X15

| 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 3-39 EtherCAT IN & EtherCAT OUT connectors X14 & X15 – Pin assignment

Continued on next page.

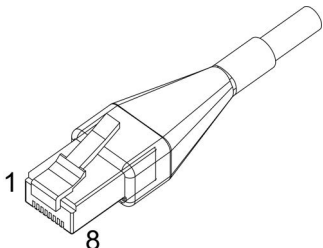
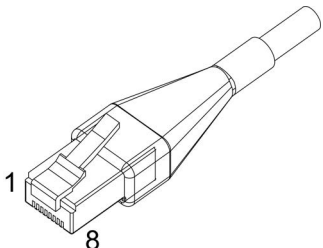
| Ethernet Cable (422827) | |
|---|---|
| A | B |
|  |  |
| Cross-section | Cat. 5e SF/UTP (ISO/IEC 11801), 1:1 patch cable, green |
| Length | 2 m |
| Head A | RJ45 (8P8CS) EIA/TIA-568B |
| Head B | RJ45 (8P8CS) EIA/TIA-568B |

Table 3-40 Ethernet Cable

3.3.6 DIP Switch Configuration (SW1)

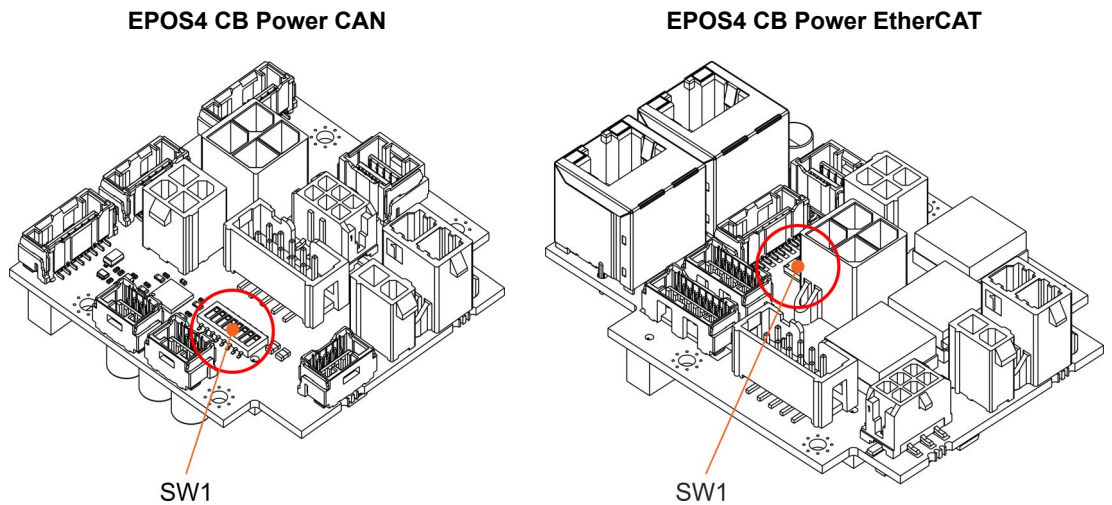


Figure 3-27 DIP switch SW1

3.3.6.1 CAN ID (Node-ID) / DEV ID



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").
- With EPOS4 CB Power CAN, DIP switches 6...8 do not have any impact on the ID.
- With EPOS4 CB Power EtherCAT, DIP switch 6 does not have any impact on the ID.

| Controller | | Switch | Binary Code | Valence |
|--------------------------|--------------------------|--------|----------------|---------|
| Compact CAN | Compact EtherCAT | | | |
| <p>(factory setting)</p> | <p>(factory setting)</p> | 1 | 2 ⁰ | 1 |
| | | 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 ID can be observed by adding the valence of all activated switches. Use the following table as a (non-concluding) guide:

| Controller | | Switch | | | | | ID |
|-------------|------------------|--------|---|---|---|---|----|
| Compact CAN | Compact EtherCAT | 1 | 2 | 3 | 4 | 5 | |
| | | 0 | 0 | 0 | 0 | 0 | – |
| | | 1 | 0 | 0 | 0 | 0 | 1 |
| | | 0 | 1 | 0 | 0 | 0 | 2 |
| | | 0 | 0 | 1 | 0 | 0 | 4 |
| | | 1 | 0 | 1 | 0 | 0 | 5 |
| | | 0 | 0 | 0 | 1 | 0 | 8 |
| | | 0 | 0 | 0 | 0 | 1 | 16 |
| | | 1 | 1 | 1 | 1 | 1 | 31 |

0 = Switch "OFF" 1 = Switch "ON"

Table 3-42 DIP switch SW1 – Examples

3.3.6.2 CAN automatic Bit Rate Detection (Compact CAN)

| Controller | Switch | OFF | ON |
|-------------|--------|---|---|
| Compact CAN | 6 | <p>Automatic bit rate detection deactivated</p> | <p>Automatic bit rate detection activated (factory setting)</p> |

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

3.3.6.3 CAN Bus Termination (Compact CAN)

| Controller | Switch | OFF | ON |
|-------------|--------|--|-----------------------------------|
| Compact CAN | 7 | <p>Without bus termination (factory setting)</p> | <p>Bus termination with 120 Ω</p> |

Table 3-44 DIP switch SW1 – CAN bus termination

3.3.6.4 Digital Input Level

For details → chapter “3.4.7 Digital I/Os” on page 3-64.

| Controller | Switch | OFF | ON |
|------------------|--------|--------------------------------------|------------------|
| Compact CAN | 8 | <p>Logic level (factory setting)</p> | <p>PLC level</p> |
| Compact EtherCAT | 6 | <p>Logic level (factory setting)</p> | <p>PLC level</p> |

Table 3-45 DIP switch SW1 – Digital input level

3.3.7 Spare Parts

| Order number | Description |
|--------------|-----------------------|
| 520860 | STO Idle Connector X9 |

Table 3-46 Spare parts list

3.4 Connection Specifications

The actual connection will depend on the overall configuration of your drive system and the type of motor you will be using. Follow the description in given order and choose the wiring diagram (→ as of page 5-93) that best suits the components you are using.



How to read the following data

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

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

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

3.4.1 Power Supply

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

| Module Header Pin | Compact/CB Connector Pin | Signal | Description |
|-------------------|--------------------------|------------------|--------------------------------------|
| A13...A16** | X1 2 | +V _{CC} | Power supply voltage (+10...+50 VDC) |
| A18...A22** | X1 1 | GND | Ground |

** Connect all pins in respect to the individual pin current rating.

Table 3-47 Power supply – Pin assignment

| Power supply requirements | |
|---------------------------|---|
| Output voltage | +V _{CC} 10...50 VDC |
| Absolute output voltage | min. 8 VDC; max. 56 VDC |
| Output current | Depending on load <ul style="list-style-type: none"> • continuous max. 8 A • short-time (acceleration, <5 s) max. 30 A |

Table 3-48 Power supply requirements

- 1) Use the formula below to calculate the required voltage under load.
- 2) Choose a power supply according to the calculated voltage. Thereby consider:
 - a) During braking of the load, the power supply must be capable of buffering the recovered kinetic energy (for example, in a capacitor).
 - b) If you are using an electronically stabilized power supply, make sure that the overcurrent protection circuit is configured inoperative within the operating range.

Continued on next page.



The formula already takes the following into account:

- Maximum PWM duty cycle of 90%
- Controller's max. voltage drop of 1 V @ 8 A

KNOWN VALUES:

- Operating torque M [mNm]
- Operating speed n [rpm]
- Nominal motor voltage U_N [Volt]
- Motor no-load speed at U_N ; n_0 [rpm]
- Speed/torque gradient of the motor $\Delta n/\Delta M$ [rpm/mNm]

SOUGHT VALUE:

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

SOLUTION:

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

3.4.2 Logic Supply



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 requirements.

For the voltage supply observe the following:

- Module: You will need to provide both, logic supply and power supply.
- Compact:

Either use two cables, the «Power Cable» (275829) to provide the logic supply and the «Power Cable High Current» (520850) to provide the power supply.

Or use just one cable, the «Power Cable High Current» (520850) to provide the power supply. In this case, the logic supply is internally connected to the power supply voltage.

| Module Header Pin | Compact/CB Connector Pin | Signal | Description |
|-------------------|--------------------------|--------|--------------------------------------|
| A17 | X2 2 | $+V_C$ | Logic supply voltage (+10...+50 VDC) |
| A18...A22** | X2 1 | GND | Ground |

** Connect all pins in respect to the individual pin current rating.

Table 3-49 Logic supply – Pin assignment

| 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 |

Table 3-50 Logic supply requirements

3.4.3 Motor

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

| Module Header Pin | Compact/CB Connector Pin | Signal | Description |
|-------------------|--------------------------|--------------|---------------|
| A1...A4** | X3a 1 X3b 1 | Motor (+M) | Motor + |
| A5...A8** | X3a 2 X3b 2 | Motor (-M) | Motor - |
| - | X3a 3 X3b 3 | - | not connected |
| - | X3a 4 X3b 4 | Motor shield | Cable shield |

** Connect all pins in respect to the individual pin current rating.

Table 3-51 DC motor – Pin assignment

| Module Header Pin | Compact/CB Connector Pin | Signal | Description |
|-------------------|--------------------------|-----------------|--------------|
| A1...A4** | X3a 1 X3b 1 | Motor winding 1 | Winding 1 |
| A5...A8** | X3a 2 X3b 2 | Motor winding 2 | Winding 2 |
| A9...A12** | X3a 3 X3b 3 | Motor winding 3 | Winding 3 |
| - | X3a 4 X3b 4 | Motor shield | Cable shield |

** Connect all pins in respect to the individual pin current rating.

Table 3-52 EC motor – Pin assignment

3.4.4 Hall Sensor

| Module Header Pin | Compact/CB Connector Pin | Signal | Description |
|-------------------|--------------------------|---------------------|---|
| A18...A22 | X4 4 | GND | Ground |
| A23 | X4 1 | Hall sensor 1 | Hall sensor 1 input |
| A24 | X4 2 | Hall sensor 2 | Hall sensor 2 input |
| A25 | X4 3 | Hall sensor 3 | Hall sensor 3 input |
| A26 | X4 5 | V_{Sensor} | Sensor supply voltage (+5 VDC; $I_L \leq 100$ mA) |
| – | X4 6 | Hall shield | Cable shield |

Table 3-53 Hall sensor – Pin assignment

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

Table 3-54 Hall sensor specification

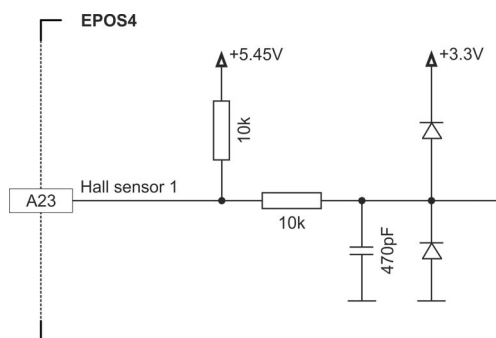


Figure 3-28 Hall sensor 1 input circuit (analogously valid for Hall sensors 2 & 3)

3.4.5 Encoder



Best practice

- *Differential signals offer good resistance against electrical interference. Therefore, **we recommend using a differential scheme**. Nevertheless, the controller supports both schemes – differential and single-ended (unsymmetrical).*
- *For best performance, **we strongly recommend using encoders with a line driver**. Otherwise, limitations may apply due to slow switching edges.*
- *Even though 2-channel will do, **we strongly recommend to use only 3-channel versions**.*

| Module Header Pin | Compact/CB Connector Pin | Signal | Description |
|-------------------|--------------------------|---------------------|--|
| A18...A22 | X5 3 | GND | Ground |
| A26 | X5 2 | V _{Sensor} | Sensor supply voltage (+5 VDC; I _L ≤100 mA) |
| A27 | X5 6 | Channel A | Digital incremental encoder channel A |
| A28 | X5 5 | Channel A\ | Digital incremental encoder channel A complement |
| A29 | X5 8 | Channel B | Digital incremental encoder channel B |
| A30 | X5 7 | Channel B\ | Digital incremental encoder channel B complement |
| A31 | X5 10 | Channel I | Digital incremental encoder channel I |
| A32 | X5 9 | Channel I\ | Digital incremental encoder channel I complement |

Table 3-55 Encoder – Pin assignment

Continued on next page.

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

Table 3-56 Differential encoder specification

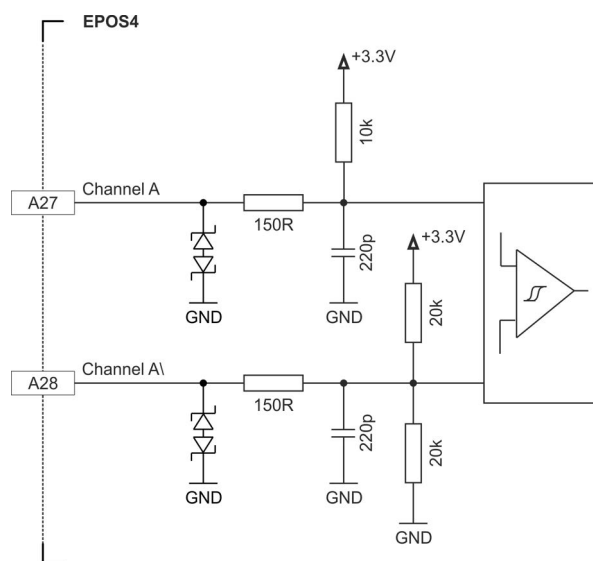


Figure 3-29 Encoder input circuit Ch A “differential” (analogously valid for Ch B & Ch I)

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

Table 3-57 Single-ended encoder specification

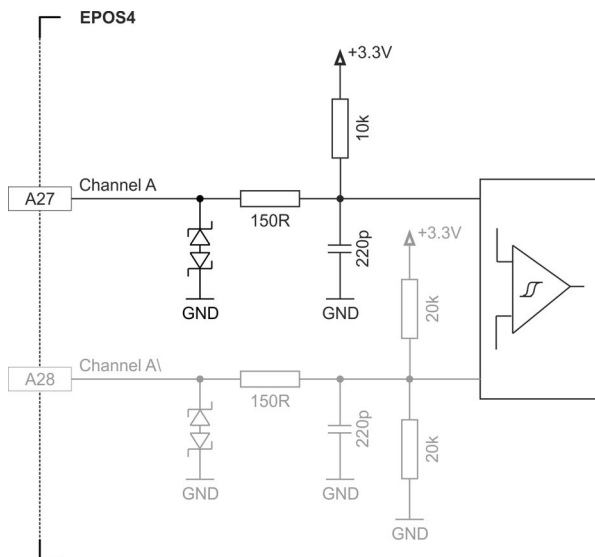


Figure 3-30 Encoder input circuit Ch A "single-ended" (analogously valid for Ch B & Ch I)

3.4.6 Sensor



Check on the applied sensor's data sheet

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

3.4.6.1 Incremental Encoder

| Module Header Pin | Compact/CB Connector Pin | Signal | Description |
|-------------------|--------------------------|------------|---|
| B7 | X6 1 | Channel A | Digital/analog incremental encoder channel A |
| B8 | X6 2 | Channel A\ | Digital/analog incremental encoder channel A complement |
| B9 | X6 3 | Channel B | Digital/analog incremental encoder channel B |
| B10 | X6 4 | Channel B\ | Digital/analog incremental encoder channel B complement |
| B11 | X6 5 | Channel I | Digital/analog incremental encoder channel I |
| B12 | X6 6 | Channel I\ | Digital/analog incremental encoder channel I complement |
| B15 | X6 10 | V_{Aux} | Auxiliary output voltage (+5 VDC; $I_L \leq 145$ mA) |
| B16 | X6 9 | GND | Ground |

Table 3-58 Incremental encoder – Pin assignment

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

Table 3-59 Differential digital incremental encoder specification

Continued on next page.

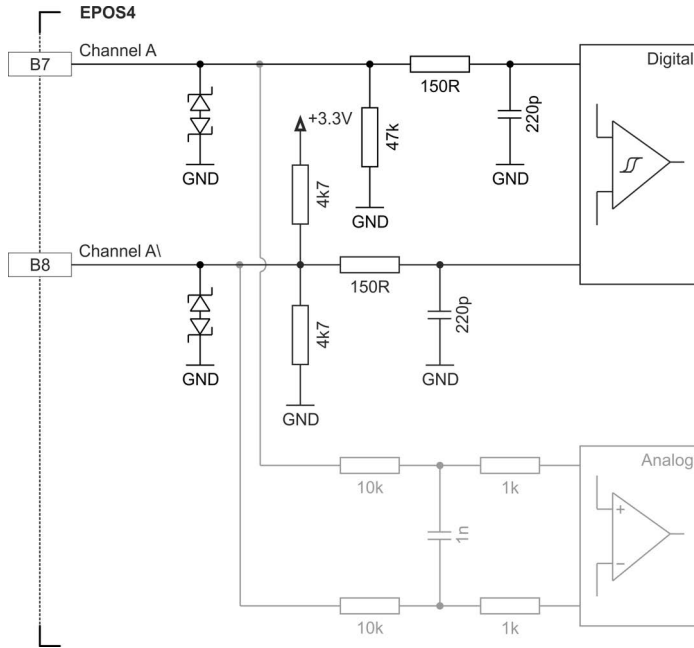


Figure 3-31 Digital incremental encoder input circuit Ch A “differential” (analogously valid for Ch B)

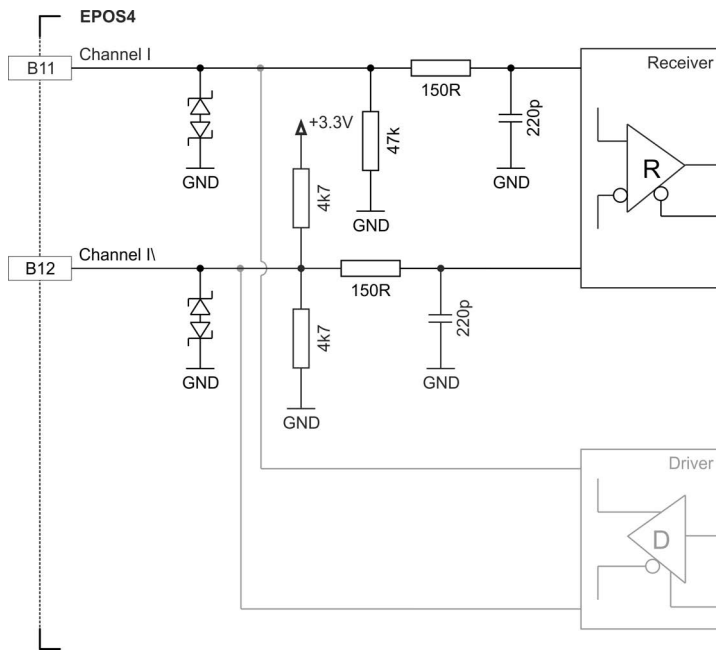


Figure 3-32 Digital incremental encoder input circuit Ch I

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

Table 3-60 Single-ended digital incremental encoder specification

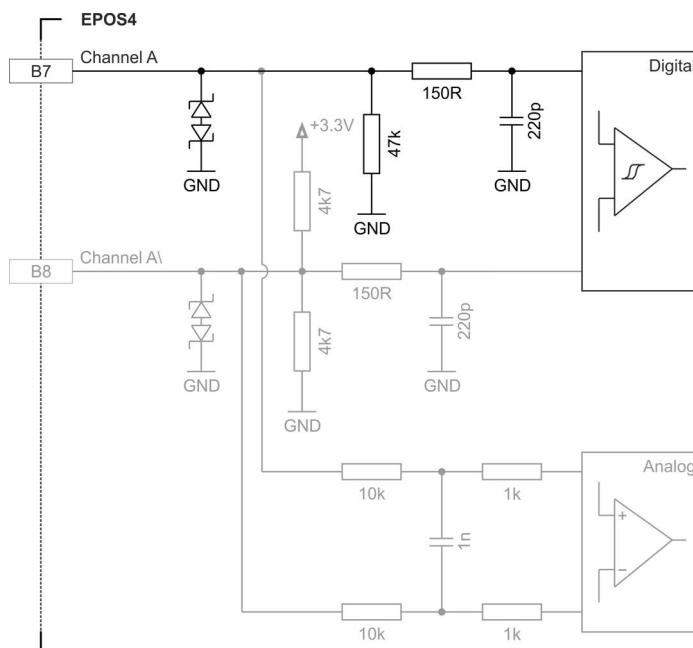


Figure 3-33 Digital incremental encoder input circuit Ch A "single-ended" (analogously valid for Ch B)

Continued on next page.

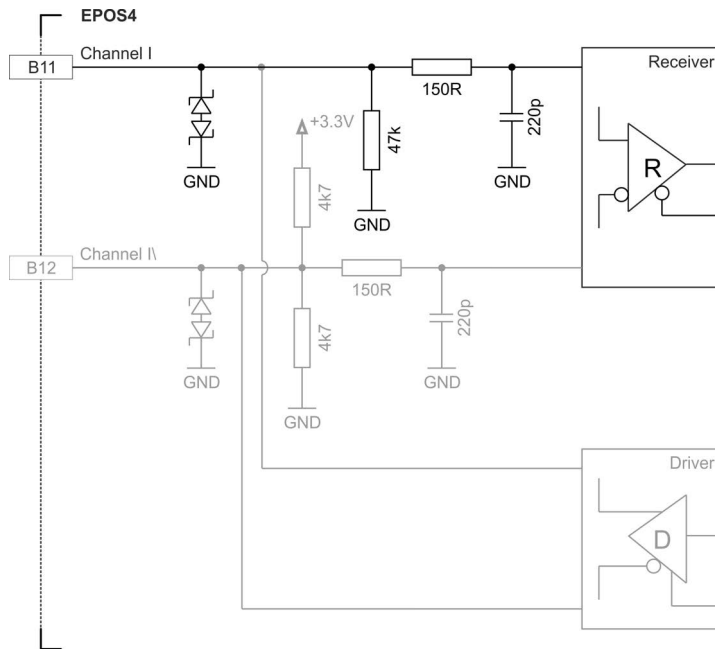


Figure 3-34 Digital incremental encoder input circuit Ch I

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

Table 3-61 Differential analog incremental encoder specification

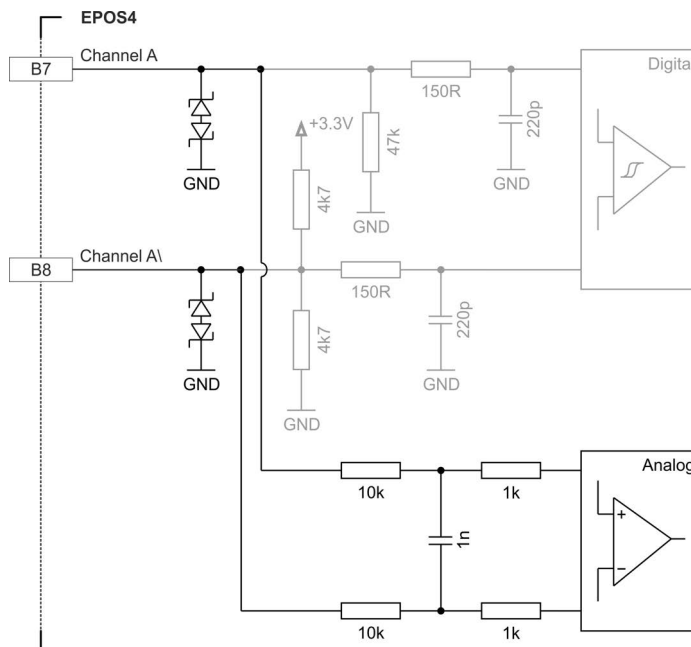


Figure 3-35 Analog incremental encoder input circuit Ch A “differential” (analogously valid for Ch B)

Continued on next page.

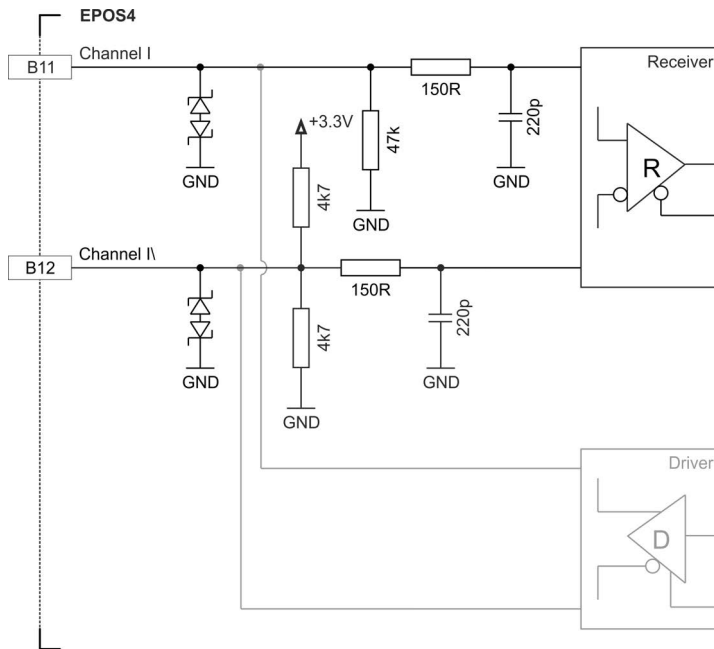


Figure 3-36 Analog incremental encoder input circuit Ch I (digital evaluation)

3.4.6.2 SSI Absolute Encoder

| Module Header Pin | Compact/CB Connector Pin | Signal | Description |
|-------------------|--------------------------|------------------|---|
| B11 | X6 5 | Clock | Clock (SSI) |
| B12 | X6 6 | Clock\ | Clock (SSI) complement |
| B13 | X6 7 | Data | Data (SSI) |
| B14 | X6 8 | Data\ | Data (SSI) complement |
| B15 | X6 10 | V _{Aux} | Auxiliary output voltage (+5 VDC; I _L ≤145 mA) |
| B16 | X6 9 | GND | Ground |

Table 3-62 SSI absolute encoder – Pin assignment

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

Table 3-63 SSI absolute encoder specification

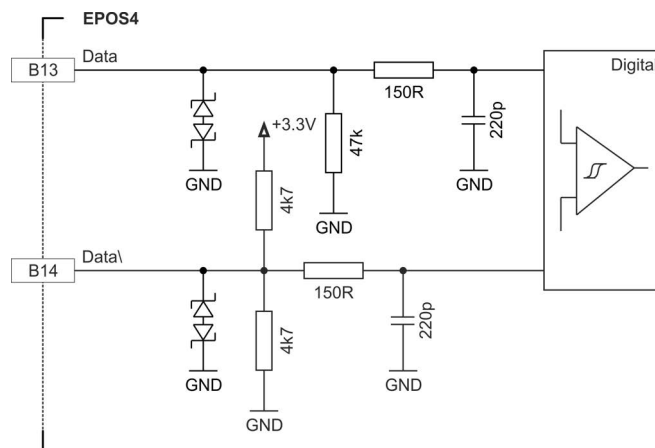


Figure 3-37 SSI absolute encoder data input

Continued on next page.

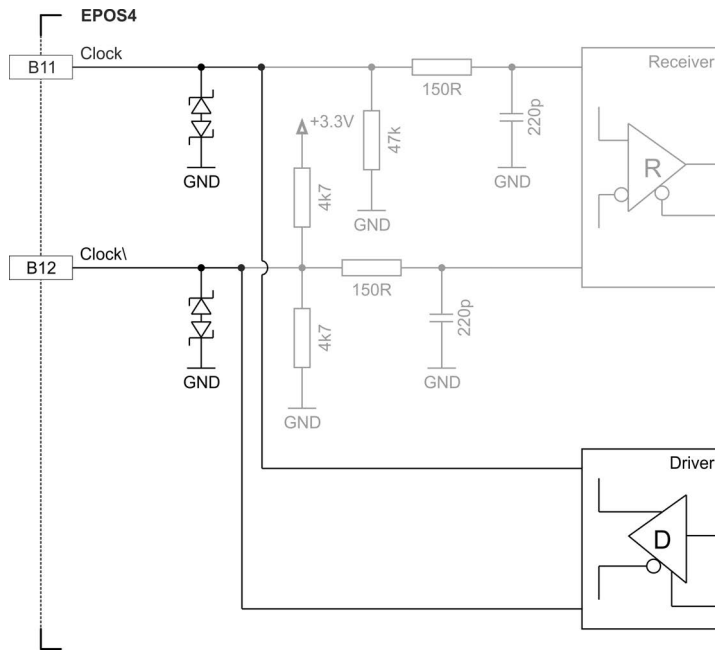


Figure 3-38 SSI absolute encoder clock output

3.4.6.3 High-speed Digital I/Os

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

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

Table 3-64 High-speed digital I/Os – Pin assignment

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

Table 3-65 Differential high-speed digital input specification

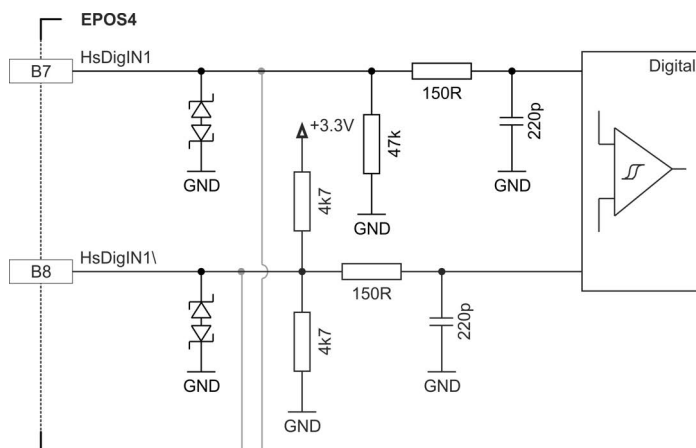


Figure 3-39 HsDigIN1 circuit “differential” (analogously valid for HsDigIN2...4)

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

Table 3-66 Single-ended high-speed digital input specification

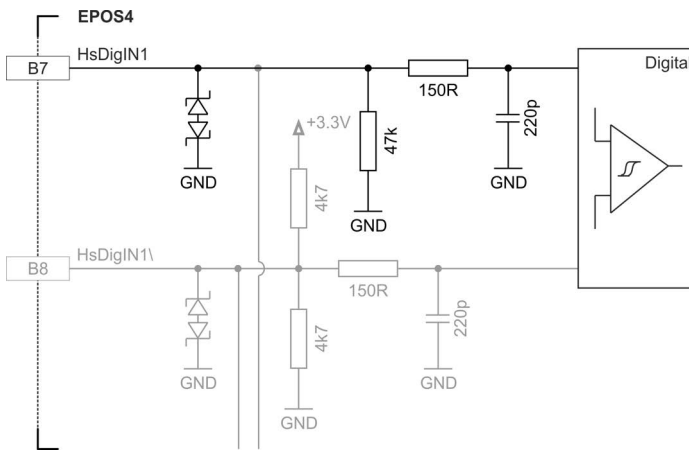


Figure 3-40 HsDigIN1 circuit “single-ended” (analogously valid for HsDigIN2...4)

| 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 3-67 High-speed digital output specification

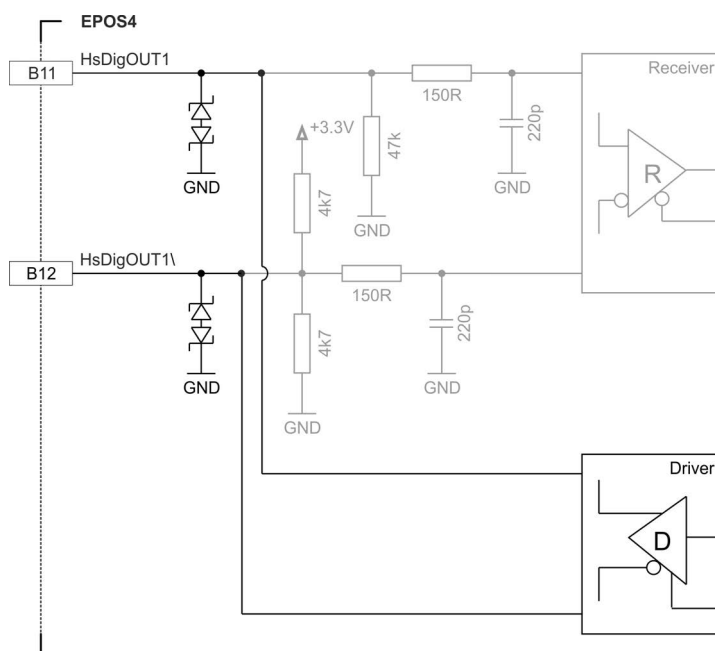


Figure 3-41 HsDigOUT1 output circuit

3.4.7 Digital I/Os

3.4.7.1 Module

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

Table 3-68 Digital I/Os – Pin assignment – Module

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

Table 3-69 Digital input specification

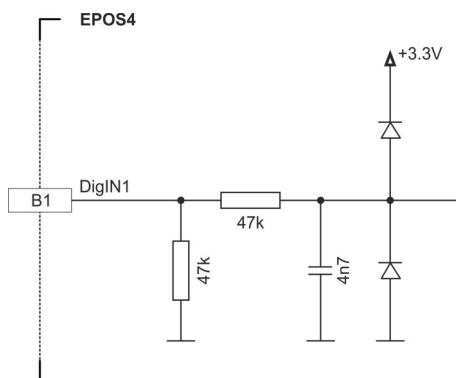


Figure 3-42 DigIN1 circuit (analogously valid for DigIN2...4) – Module

3.4.7.2 Compact

| Compact/CB Connector Pin | Signal | Description |
|--------------------------|------------------|--|
| X7 1 | DigIN1 | Digital input 1 |
| X7 2 | DigIN2 | Digital input 2 |
| X7 3 | DigIN3 | Digital input 3 |
| X7 4 | DigIN4 | Digital input 4 |
| X7 5 | DigOUT1 | Digital output 1 |
| X7 6 | DigOUT2 | Digital output 2 |
| X7 7 | GND | Ground |
| X7 8 | V _{Aux} | Auxiliary output voltage (+5 VDC; I _L ≤ 145 mA) |

Table 3-70 Digital I/Os – Pin assignment – Compact

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

Table 3-71 Digital input specification – Logic level setting

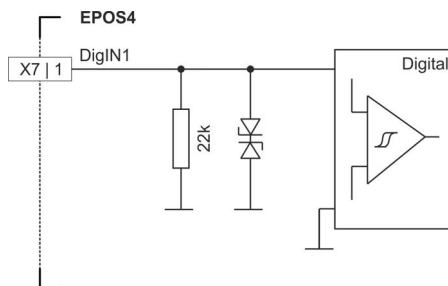


Figure 3-43 DigIN1 circuit (analogously valid for DigIN2...4) – Compact / Logic level setting

Continued on next page.

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

Table 3-72 Digital input specification – PLC level setting

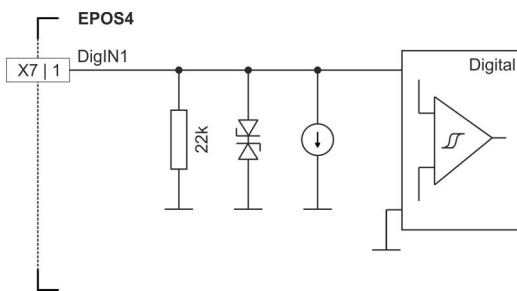


Figure 3-44 DigIN1 circuit (analogously valid for DigIN2...4) – Compact / PLC level setting

For pin assignment of digital outputs → Table 3-68 and Table 3-70.

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

Table 3-73 Digital output specification

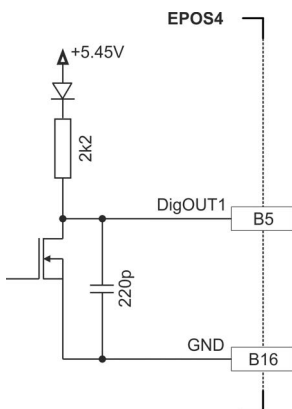


Figure 3-45 DigOUT1 circuit (analogously valid for DigOUT2 and Compact)

Continued on next page.

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 3-74 Digital output – Sinks

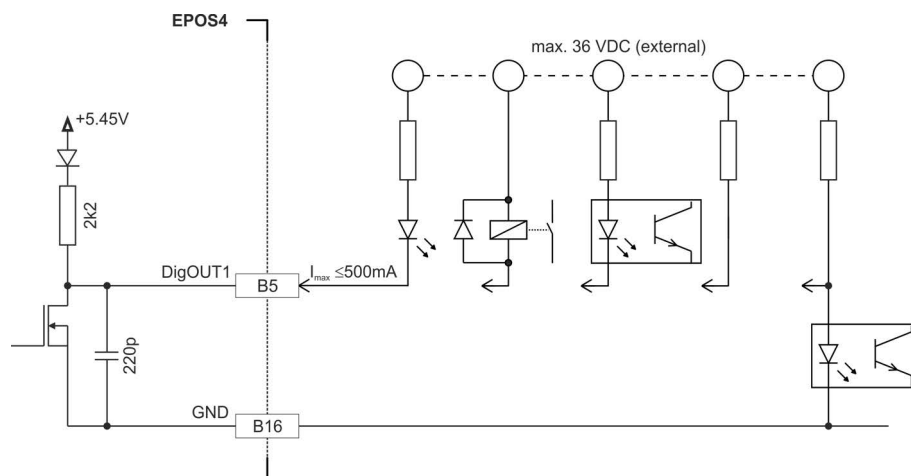


Figure 3-46 DigOUT1 "sinks" (analogously valid for DigOUT2 and Compact)

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

Table 3-75 Digital output – Source

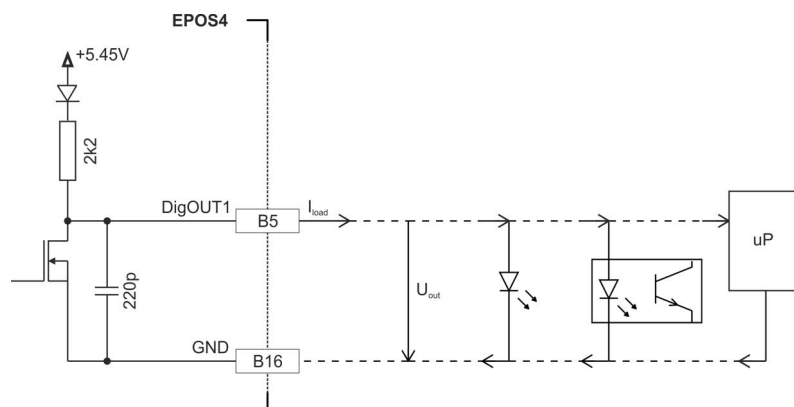


Figure 3-47 DigOUT1 "source" (analogously valid for DigOUT2 and Compact)

3.4.8 Safe Torque Off I/Os

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.



Activation of power stage

*In order to activate the power stage, **both** STO inputs must be powered.*

| Module Header Pin | Compact/CB Connector Pin | Signal | Description |
|-------------------|--------------------------|-----------|--|
| – | X9 8 | V_{STO} | Activation voltage for STO inputs (+5 VDC) Note: Do not use this voltage for any other purpose |
| B15 | – | V_{Aux} | Auxiliary output voltage (+5 VDC; $I_L \leq 145$ mA) |
| B16 | X9 7 | GND | Ground |
| B17 | X9 1 | STO-IN1+ | Safe Torque Off input 1, positive signal |
| B18 | X9 2 | STO-IN1– | Safe Torque Off input 1, negative signal |
| B19 | X9 3 | STO-IN2+ | Safe Torque Off input 2, positive signal |
| B20 | X9 4 | STO-IN2– | Safe Torque Off input 2, negative signal |
| B21 | X9 5 | STO-OUT+ | Safe Torque Off output, positive signal |
| B22 | X9 6 | STO-OUT– | Safe Torque Off output, negative signal |

Table 3-76 STO I/Os – Pin assignment

| 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 3-77 STO input specification

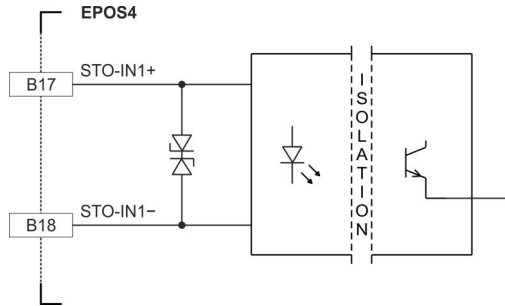


Figure 3-48 STO-IN1 circuit (analogously valid for STO-IN2)

| 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 3-78 STO output specification

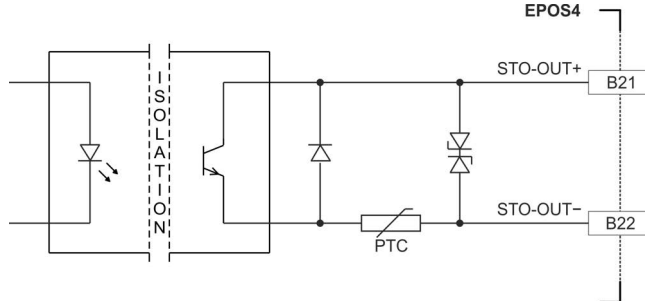


Figure 3-49 STO-OUT circuit

| 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 3-79 STO logic state

3.4.9 Analog I/Os

| Module Header Pin | Compact/CB Connector Pin | Signal | Description |
|-------------------|--------------------------|--------|---------------------------------|
| B16 | X8 7 | GND | Ground |
| B23 | X8 1 | AnIN1+ | Analog input 1, positive signal |
| B24 | X8 2 | AnIN1- | Analog input 1, negative signal |
| B25 | X8 3 | AnIN2+ | Analog input 2, positive signal |
| B26 | X8 4 | AnIN2- | Analog input 2, negative signal |
| B27 | X8 5 | AnOUT1 | Analog output 1 |
| B28 | X8 6 | AnOUT2 | Analog output 2 |

Table 3-80 Analog I/Os – Pin assignment

| Analog inputs 1...2 | |
|---------------------|---|
| Input voltage | ±10 VDC (differential) |
| Max. input voltage | ±24 VDC |
| Common mode voltage | -5...+10 VDC (referenced to GND) |
| Input resistance | 80 kΩ (differential) 65 kΩ (referenced to GND) |
| A/D converter | 12-bit |
| Resolution | 5.64 mV |
| Bandwidth | 10 kHz |

Table 3-81 Analog input specification

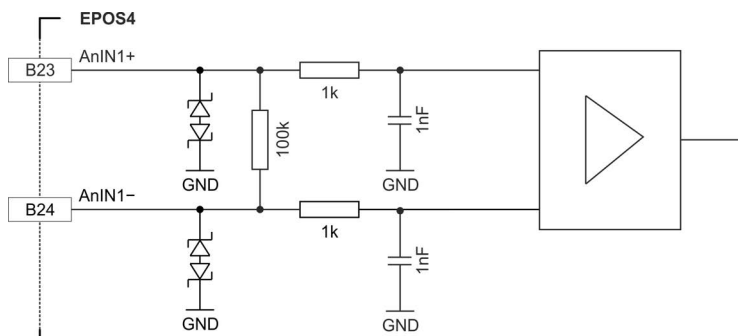


Figure 3-50 AnIN1 circuit (analogously valid for AnIN2)

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

Table 3-82 Analog output specification

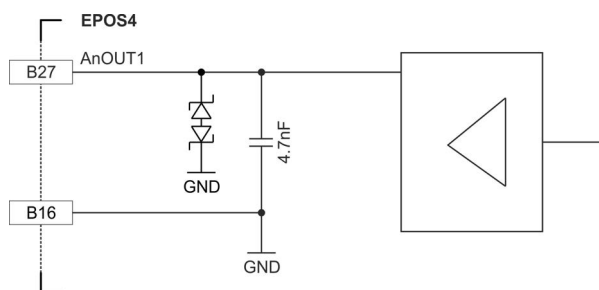


Figure 3-51 AnOUT1 circuit (analogously valid for AnOUT2)

3.4.10 Serial Communication Interface (SCI) / RS232

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

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



Bit rate settings

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

3.4.10.1 Module

| Module Header Pin | Signal | Description |
|-------------------|---|--|
| B38 | GND | Ground |
| B39 [e] | DSP_RxD | Serial communication interface receive (UART) |
| B40 | DSP_TxD | Serial communication interface transmit (UART) |
| [e] | connect to sensor supply voltage V_{Sensor} (A26) when RS232 is not in use | |

Table 3-83 SCI – Pin assignment

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

Table 3-84 SCI specification

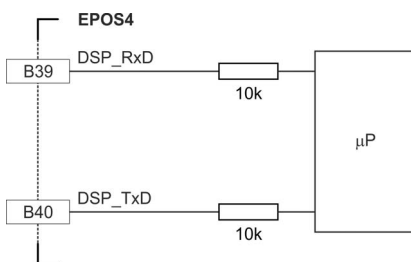


Figure 3-52 SCI circuit

3.4.10.2 Compact CAN

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

Table 3-85 RS232 – Pin assignment

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

Table 3-86 RS232 interface specification

3.4.11 CAN Interface / ID Setting

3.4.11.1 Connection

The EPOS4 is specially designed being commanded and controlled via a Controller Area Network (CAN), a highly efficient data bus very common in all fields of automation and motion control. It is preferably used as a slave node in the CANopen network.

| Module Header Pin | Compact/CB Connector Pin | Signal | Description |
|-------------------|--------------------------|----------|-------------------|
| B35 | X11 1 X12 1 | CAN high | CAN high bus line |
| B36 | X11 2 X12 2 | CAN low | CAN low bus line |
| B37 | X11 3 X12 3 | GND | Ground |
| – | X11 4 X12 4 | Shield | Cable shield |

Table 3-87 CAN bus line / CAN 1 / CAN 2 – Pin assignment

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

Table 3-88 CAN interface specification



Note

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

3.4.11.2 Configuration

**Setting the ID is currently available for CAN only!**

The device's identification (subsequently called "ID") can be set by different means:

- For configuration on **Compact** versions → "DIP Switch Configuration (SW1)" on page 3-43.
- For configuration on **Module** versions, the ID is set using the input lines ID1...ID5. The ID (1...31) may be coded using binary code.

| Module Header Pin | Signal | Description | Binary Code | Valence |
|-------------------|--------|-------------------|----------------|---------|
| B29 | ID 1 | CAN ID / DEV ID 1 | 2 ⁰ | 1 |
| B30 | ID 2 | CAN ID / DEV ID 2 | 2 ¹ | 2 |
| B31 | ID 3 | CAN ID / DEV ID 3 | 2 ² | 4 |
| B32 | ID 4 | CAN ID / DEV ID 4 | 2 ³ | 8 |
| B33 | ID 5 | CAN ID / DEV ID 5 | 2 ⁴ | 16 |
| B37 | GND | Ground | | |

Table 3-89 ID – Pin assignment

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

Table 3-90 CAN ID / DEV ID specification

**Important**

The internal circuit of the ID pins (B29...B33) is based on an analog voltage measurement. Ensure a proper ground connection (0.0 V) when Logic 1 state is intended and a high impedance for Logic 0 state.

Continued on next page.

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

| CAN ID / DEV ID | | | | | ID |
|-----------------|---|---|---|---|----|
| 1 | 2 | 3 | 4 | 5 | |
| 0* | 0 | 0 | 0 | 0 | – |
| 1** | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | 0 | 0 | 0 | 2 |
| 0 | 0 | 1 | 0 | 0 | 4 |
| 1 | 0 | 1 | 0 | 0 | 5 |
| 0 | 0 | 0 | 1 | 0 | 8 |
| 0 | 0 | 0 | 0 | 1 | 16 |
| 1 | 1 | 1 | 1 | 1 | 31 |

0* = ID input line not connected 1** = ID input line externally connected to GND

Table 3-91 ID – Examples



Setting the ID by means of «EPOS Studio»

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

CAN AUTOMATIC BIT RATE DETECTION

With this function, the CANopen interface can be put in a “listen only” mode. For further details see separate document →«EPOS4 Firmware Specification». Automatic bit rate detection is activated when the input line is externally connected to GND.

| Bit rate detection | |
|----------------------|--------------------|
| Auto Bit Rate GND | Pin B34 Pin B38 |
| Max. input voltage | 3.3 VDC |
| Logic 1 | connected to GND |
| Logic 0 | not connected |

Table 3-92 Bit rate detection specification

3.4.12 Serial Peripheral Interface (SPI)

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

**Note**

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

| Module Header Pin | Signal | Description |
|-------------------|----------|--|
| B38 | GND | Ground |
| B41 | SPI_CLK | Serial Peripheral Interface clock |
| B42 | SPI_IRQ | Serial Peripheral Interface interrupt request |
| B43 | SPI_SOMI | Serial Peripheral Interface Slave output, Master input |
| B44 | SPI_SIMO | Serial Peripheral Interface Slave input, Master output |
| B45 | SPI_CS2 | Serial Peripheral Interface chip select 2 |
| B46 | SPI_CS1 | Serial Peripheral Interface chip select 1 |

Table 3-93 SPI – Pin assignment

3.4.13 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.

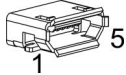


Figure 3-53 USB connector X13

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

Table 3-94 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 3-95 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 3-96 USB interface specification

3.5 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 EtherCAT Port;** the LED displays the NET link activity

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

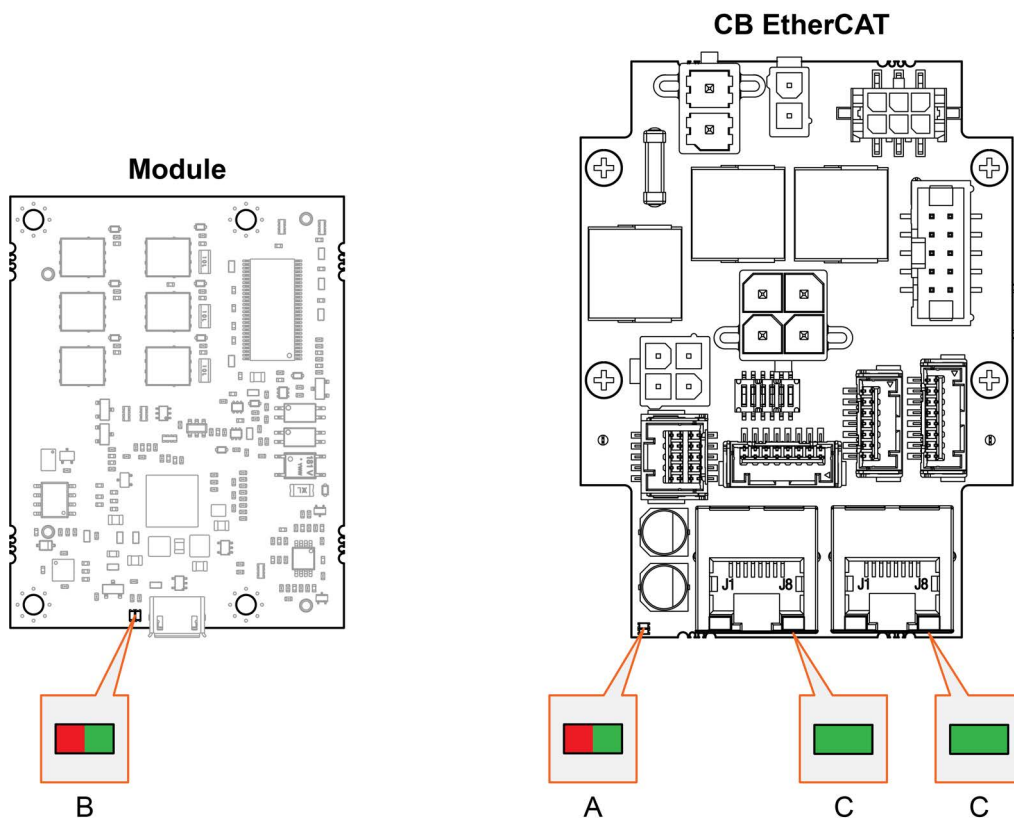


Figure 3-54 LEDs – Location

3.5.1 NET Status

The LEDs (→Figure 3-54; **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 3-97 NET Status LEDs

3.5.2 Device Status

The LEDs (→Figure 3-54; **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 3-98 Device Status LEDs

3.5.3 EtherCAT Port

The LED (→Figure 3-54; **C**) displays the link activity of the EtherCAT 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 3-99 EtherCAT Port LED

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4 MOTHERBOARD DESIGN GUIDE

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



CAUTION

Dangerous Action

Errors in implementing the design can result in serious injury!

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



Get help

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

4.1 Requirements for Components of Third-party Suppliers



Best practice

For references and recommended components consult →Table 4-100.

4.1.1 Socket Headers

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

4.1.2 Supply Voltage

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

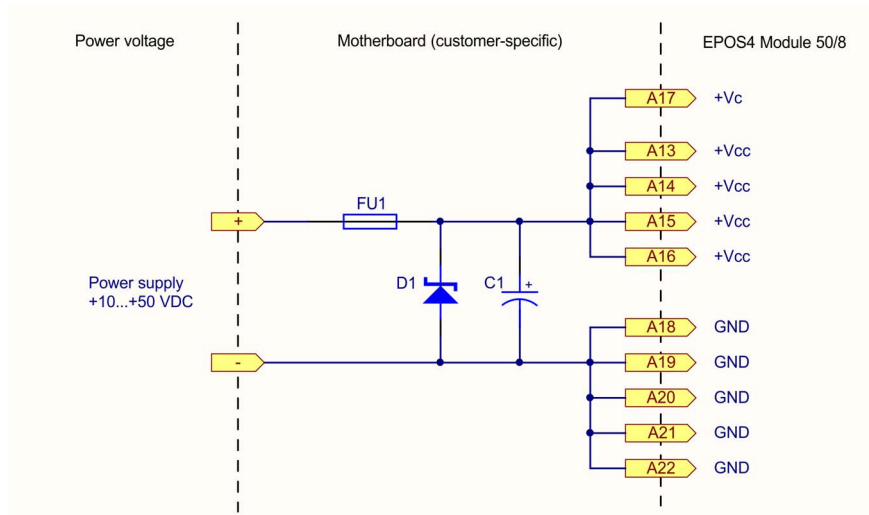


Figure 4-55 Wiring of power supply

INPUT FUSE (FU1)

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

TVS DIODE (D1)

To protect against overvoltage resulting from voltage transients, we recommend to connect a TVS (transient voltage suppressor) diode (D1) to the voltage supply line.

CAPACITOR (C1)

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

4.1.3 Logic Supply Voltage

The Module features a logic supply voltage input. Its voltage range is 10...50 V and must be either sourced separately or by the power supply voltage.

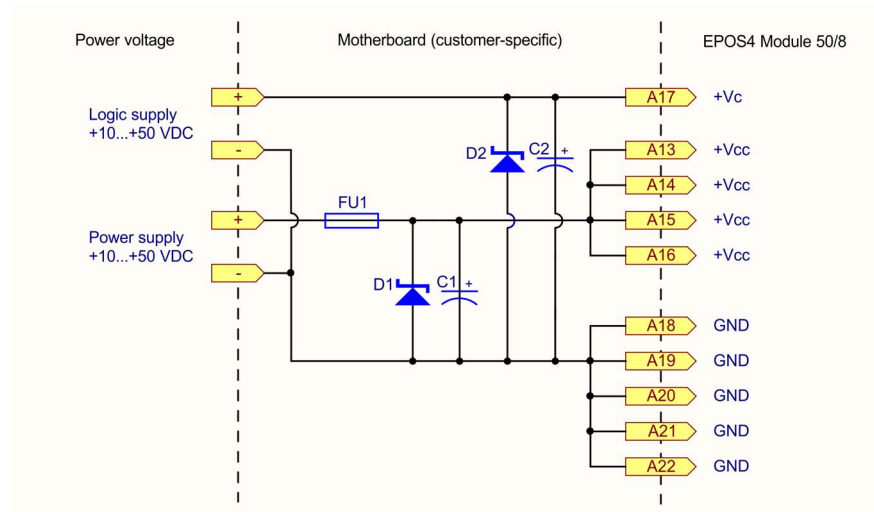


Figure 4-56 Wiring of logic supply

TVS DIODE (D2)

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

CAPACITOR (C2)

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

4.1.4 Motor Cables and Motor Chokes

The Module is not equipped with internal motor chokes.

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

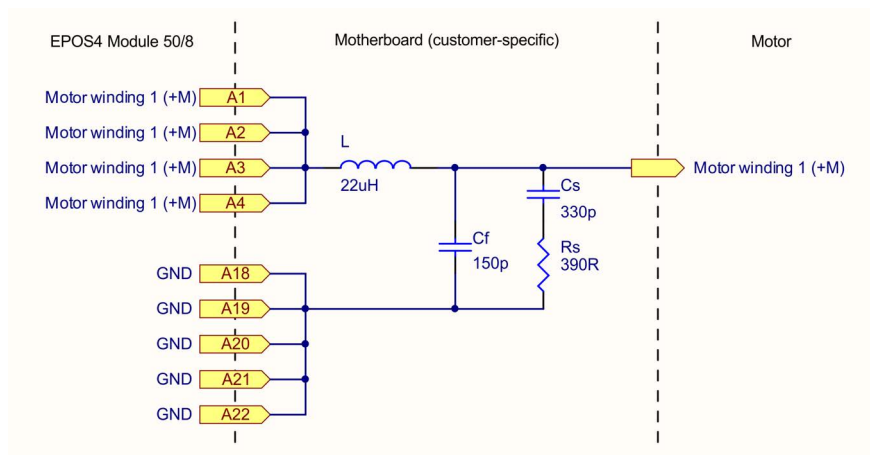
$$L_{Phase} \geq \frac{1}{2} \cdot \left(\frac{V_{CC}}{6 \cdot f_{PWM} \cdot I_N} - (0.3 \cdot L_{Motor}) \right)$$

| | |
|----------------|--|
| $L_{Phase}[H]$ | Additional external inductance per phase |
| $V_{CC}[V]$ | Operating voltage +V _{CC} |
| $f_{PWM}[Hz]$ | Switching frequency of the power stage = 50'000 Hz |
| $I_N[A]$ | Nominal current of the motor (→line 6 in the maxon catalog) |
| $L_{Motor}[H]$ | Terminal inductance of the motor (→line 11 in the maxon catalog) |

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

An additional choke must feature electromagnetic shielding, an adequate saturation current, minimal losses, and a nominal current greater than the continuous current of the motor. The below wiring example refers to an additional inductance of 2.2 μH or 22 μH. If a different additional inductance is required, also the filter components must be adapted accordingly. Should you need further help with the filter design, contact maxon Support at →<http://support.maxongroup.com>.

Example 1



Continued on next page.

Example 2

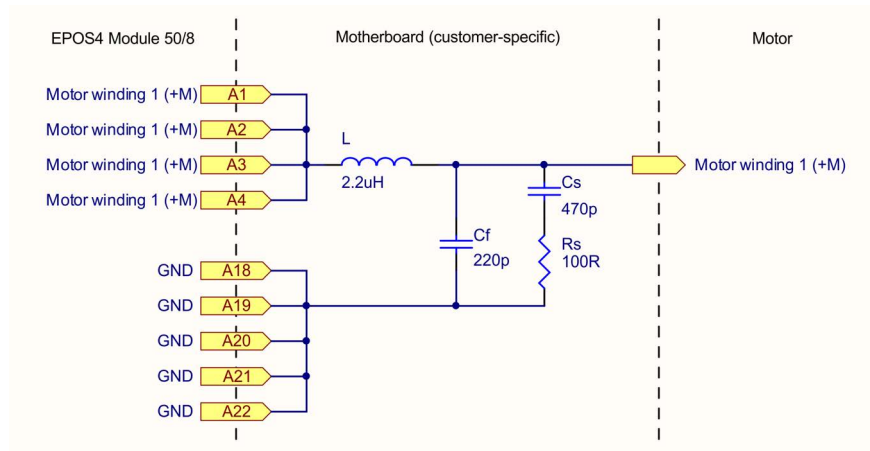


Figure 4-57 Wiring of motor winding 1 (analogously valid also for motor windings 2 & 3)

4.1.5 RS232 Transceiver

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

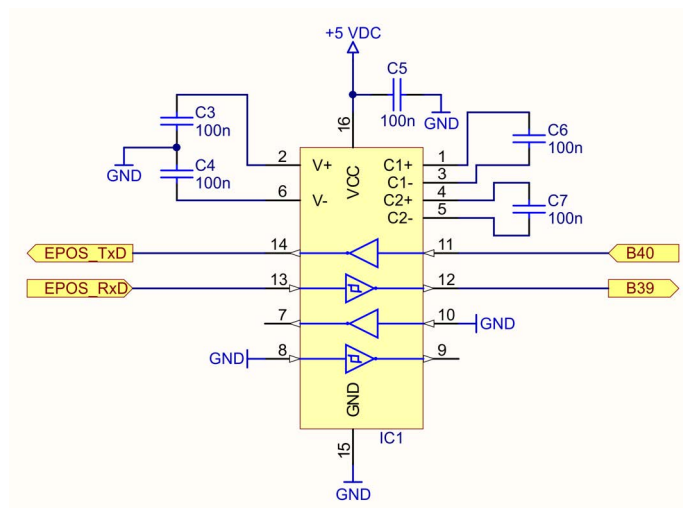


Figure 4-58 Wiring of RS232 transceiver



IMPORTANT

If you do not intend to use the RS232 interface, you must connect pin [B39] (DSP_RxD) with pin [A26] (sensor supply voltage V_{Sensor})!

4.1.6 Recommended Components and Manufacturers

| Recommended components | |
|------------------------|--|
| Socket header | <p>Straight socket header, pluggable with 0.64 x 0.64 mm pin headers, 2.54 mm pitch, contact length 6 mm, current rating per pin = $I_{cont} / 4$, contact material: gold</p> <p>16 poles, 2 rows:</p> <ul style="list-style-type: none"> Samtec (SSM-116-x-DV) SMT, 5.2 A per pin, 7.37 mm E-Tec (BS2-032-H750-55) SMT, 3 A per pin, 7.50 mm FCI (91618-316LF) SMT, 3 A per pin, 7.20 mm Samtec (SSW-116-0x-x-D) THT, 5.7 A per pin, 8.51 mm E-Tec (BL2-032-S842-55) THT, 3 A per pin, 8.50 mm FCI (87606-316LF) THT, 3 A per pin, 8.50 mm <p>23 poles, 2 rows:</p> <ul style="list-style-type: none"> Samtec (SSM-123-x-DV) SMT, 5.2 A per pin, 7.37 mm E-Tec (BS2-046-H750-55) SMT, 3 A per pin, 7.50 mm FCI (91618-323LF) SMT, 3 A per pin, 7.20 mm Samtec (SSW-123-0x-x-D) THT, 5.7 A per pin, 8.51 mm E-Tec (BL2-046-S842-55) THT, 3 A per pin, 8.50 mm FCI (87606-323LF) THT, 3 A per pin, 8.50 mm |
| | <p>Fuse (FU1)</p> <ul style="list-style-type: none"> Littelfuse 456 series, SMD NANO2 Fuse 20 A, 18 A²sec (0456 020) |
| TVS Diode (D1; D2) | <ul style="list-style-type: none"> Vishay (SMBJ54A) $U_R = 54 \text{ V}$, $U_{BR} = 60.0 \dots 66.3 \text{ V @ } 1 \text{ mA}$, $U_C = 87.1 \text{ V @ } 6.9 \text{ A}$ Fairchild (SMBJ54A) $U_R = 54 \text{ V}$, $U_{BR} = 60.0 \dots 66.6 \text{ V @ } 1 \text{ mA}$, $U_C = 87.1 \text{ V @ } 6.9 \text{ A}$ Littelfuse (SMBJ54A) $U_R = 54 \text{ V}$, $U_{BR} = 60.0 \dots 66.6 \text{ V @ } 1 \text{ mA}$, $U_C = 87.1 \text{ V @ } 6.9 \text{ A}$ |
| Capacitor (C1) | <p>The ripple current load for C1 depends on the motor's operating point and the power supply output capacity. Under worst case conditions however, the ripple current may reach $I_{cont} / 2$. Use capacitors with rated voltage $\geq 63 \text{ V}$ and adequate ripple current to avoid overheat or life time reduction.</p> <p>Remark: If there is an excessive amount of reversed energy present (for example during deceleration of loads with a high inertia or during a vertical movement downwards), there might be the need to add an additional capacitor with a much higher capacitance (for example up to 10'000...47'000 μF) and/or to add a brake chopper, for example maxon DSR 70/30 (235811).</p> <p>Example for C1 worst-case dimensioning: $I_{cont} = 12 \text{ A} \rightarrow 3x \text{ Panasonic (EEU-FR1J391); } 390 \mu\text{F, } 63 \text{ V, } 2000 \text{ mA r.m.s., } \varnothing xL \text{ } 12.5 \times 25 \text{ mm}$</p> |
| Capacitor (C2) | <p>To avoid voltage overshoot at power plug-in with a separately sourced logic supply, use an electrolytic capacitor covering the following requirements: 33 μF or 47 μF, 63 V, at least 265 mA r.m.s.</p> <ul style="list-style-type: none"> Rubicon (63ZLH47MEFCTA6.3X11) or (63YXJ47M6.3X11) Panasonic (EEU-FR1J470B) Nippon Chemicon (EKYB630ELL330MF11D) or (EKY-630 ELL330MF11D) |
| Motor Choke (L) | <p>Inductance: → "Motor Cables and Motor Chokes" on page 4-86</p> <p>Rated current: $I_{rms} \geq I_{cont}$; $I_{sat} \geq I_{peak}$</p> <p>Construction: shielded</p> <p>2.2 μH:</p> <ul style="list-style-type: none"> Bourns (SRP1265A-2R2M) $I_{rms} \text{ } 22 \text{ A}$, $I_{sat} \text{ } 37 \text{ A}$, 12.5 x 13.5 x 6.4 mm Vishay (IHLP5050FDER2R2M01) $I_{rms} \text{ } 22 \text{ A}$, $I_{sat} \text{ } 40 \text{ A}$, 12.9 x 13.2 x 6.5 mm Laird (MGV12072R2M-10) $I_{rms} \text{ } 22 \text{ A}$, $I_{sat} \text{ } 40 \text{ A}$, 12.6 x 13.5 x 6.5 mm <p>22 μH:</p> <ul style="list-style-type: none"> Würth (WE-PD-XXL / 7447709220) $I_{rms} \text{ } 5.3 \text{ A}$, $I_{sat} \text{ } 6.5 \text{ A}$, 12.5 x 12.5 x 10 mm |

Continued on next page.

| Recommended components | |
|-----------------------------|--|
| Motor Filter | Example 1 <ul style="list-style-type: none"> Motor Choke L 22 μH Filter Capacitor Cf 150 pF, 100 V Snubber Capacitor Cs 330 pF, 100 V Snubber Resistor Rs 390 Ω, 0.125 W |
| | Example 2 <ul style="list-style-type: none"> Motor Choke L 2.2 μH Filter Capacitor Cf 220 pF, 100 V Snubber Capacitor Cs 470 pF, 100 V Snubber Resistor Rs 100 Ω, 0.25 W |
| RS232 (IC1) (C3...C7) | RS232 transceiver (IC1) <ul style="list-style-type: none"> Texas Instruments (MAX202IPW) ST Microelectronics (ST202EBTR) |
| | Capacitors (C3...C7) <ul style="list-style-type: none"> 100 nF, X7R, 16 V |

Table 4-100 Motherboard Design Guide – Recommended components

4.2 Design Guidelines

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

While designing a motherboard, consider the following characteristics of the Module:

- Pin assignment (→page 3-22)
- Technical data (→page 2-11) and dimensional drawing (→page 2-16)

4.2.1 Ground

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

| Pin | Signal | Description |
|-----------|--------|-------------|
| A18...A22 | GND | Ground |
| B16 | GND | Ground |
| B37...B38 | GND | Ground |

Table 4-101 Motherboard Design Guide – Grounding

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

4.2.2 Layout

Guidelines for the layout of the motherboard:

- Connector pins [A13], [A14], [A15], and [A16] for +V_{CC} (nominal power supply voltage) should be connected to the fuse via wide conductive tracks.
- Connector pins [A18], [A19], [A20], [A21], [A22], [B16], [B37], and [B38] for GND (ground) should be connected with the operating voltage ground via wide conductive tracks.
- Connector pin [B39] (DSP_RxD) must be connected to [A26] (sensor supply voltage; V_{Sensor}) when RS232 is not in use.
- The width of the conductive tracks and the copper coating thickness of the conductors for supply voltage and motor depend on the current required in your application. A minimum track width of 75 mil and a minimum copper coating thickness of 35 μm are recommended.

4.3 THT Footprint



Possible dimensional differences in STEP files

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

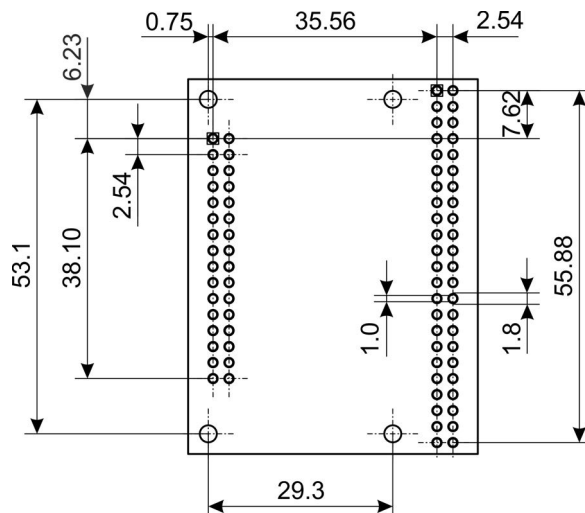


Figure 4-59 THT footprint [mm] – Top View

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5 WIRING

In this section you will find the wiring information for the setup you are using. You can either use the consolidated wiring diagrams (→Figure 5-61 and Figure 5-62) featuring the full scope of interconnectivity and pin assignment. Or you may wish to use the connection overviews for either DC motor or EC (BLDC) motor that will assist you in determining the wiring for your particular motor type and the appropriate feedback signals.

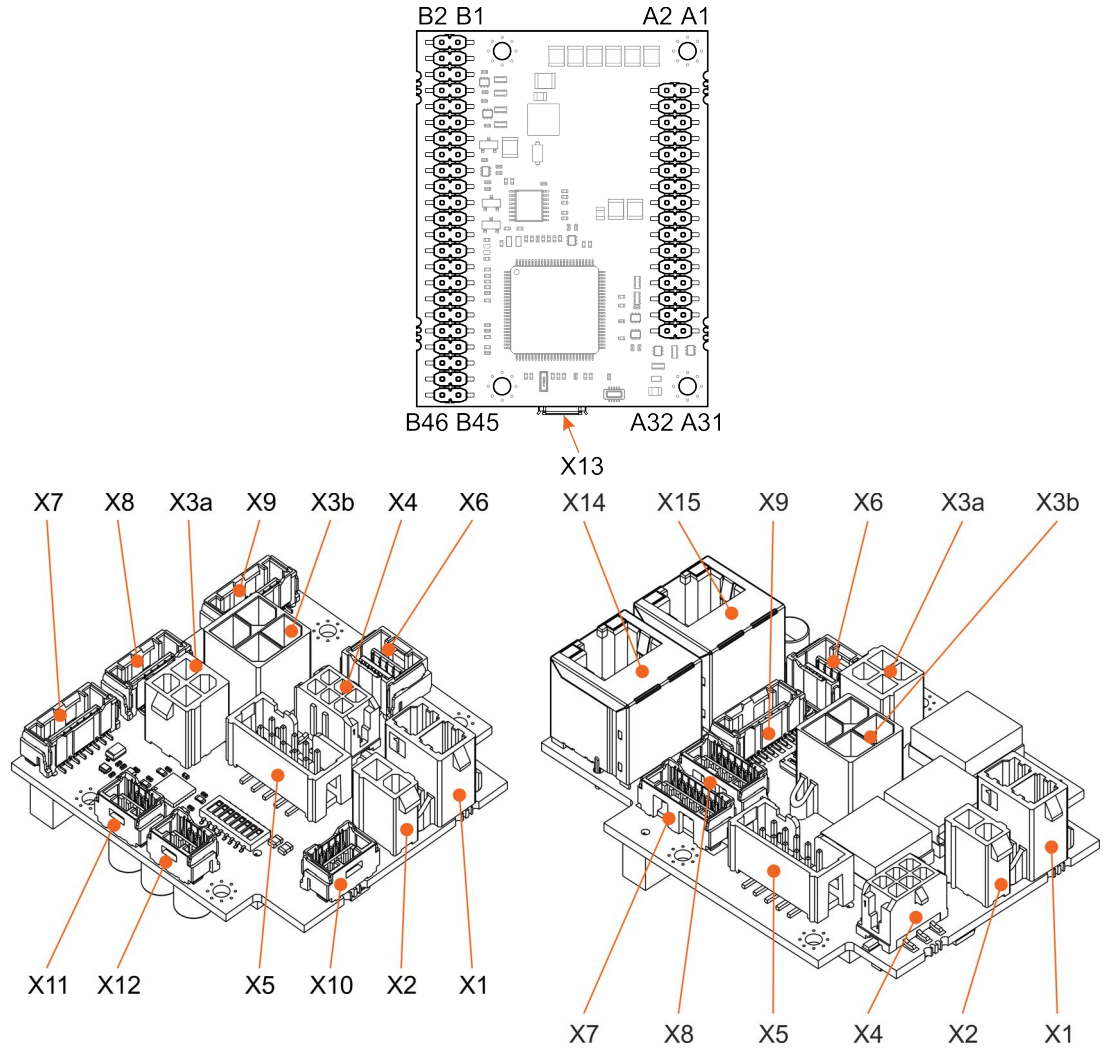



Figure 5-60 Interfaces – Designations and location



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).

5.1 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 5-102, for EC (BLDC) motor → Table 5-103.
- 4) Pick the row with the corresponding wiring method # and follow the link (or links) to the stated figure(s) to find the relevant wiring information.

5.1.1 DC Motor

Power supply & optional logic supply Figure 5-63

Motor & feedback signals

Without sensor Method # DC1
 Digital incremental encoder Method # DC2 or DC3
 Analog incremental encoder SinCos Method # DC4
 SSI absolute encoder Method # DC5
 Digital incremental encoder & Digital incremental encoder Method # DC6
 Digital incremental encoder & Analog incremental encoder SinCos Method # DC7
 Digital incremental encoder & SSI absolute encoder Method # DC8

| Method # | Digital Incremental Encoder 1 (Sensor 1) X5 | Digital Incremental Encoder 2 (Sensor 2) X6 | Analog Incremental Encoder (Sensor 2) X6 | SSI Absolute Encoder (Sensor 2) X6 | → Figure(s) |
|----------|--|--|---|---------------------------------------|---------------------|
| DC1 | | | | | 5-64 |
| DC2 | ✓ | | | | 5-64 5-67 |
| DC3 | | ✓ | | | 5-64 5-68 |
| DC4 | | | ✓ | | 5-64 5-69 |
| DC5 | | | | ✓ | 5-64 5-70 |
| DC6 | ✓ | ✓ | | | 5-64 5-67 / 5-68 |
| DC7 | ✓ | | ✓ | | 5-64 5-67 / 5-69 |
| DC8 | ✓ | | | ✓ | 5-64 5-67 / 5-70 |

Table 5-102 Possible combinations of feedback signals for DC motor

5.1.2 EC (BLDC) Motor

Power supply & optional logic supply Figure 5-63

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 | ✓ | | | | | 5-65 5-66 |
| EC2 | ✓ | ✓ | | | | 5-65 5-66 / 5-67 |
| EC3 | ✓ | | ✓ | | | 5-65 5-66 / 5-68 |
| EC4 | ✓ | | | ✓ | | 5-65 5-66 / 5-69 |
| EC5 | ✓ | | | | ✓ | 5-65 5-66 / 5-70 |
| EC6 | ✓ | ✓ | ✓ | | | 5-65 5-66 / 5-67 / 5-68 |
| EC7 | ✓ | ✓ | | ✓ | | 5-65 5-66 / 5-67 / 5-69 |
| EC8 | ✓ | ✓ | | | ✓ | 5-65 5-66 / 5-67 / 5-70 |
| EC9 | | ✓ | | | ✓ | 5-65 5-67 / 5-70 |
| EC10 | | | | | ✓ | 5-65 5-70 |

Table 5-103 Possible combinations of feedback signals for EC (BLDC) motor

5.2 Main Wiring Diagrams

5.2.1 Module & Compact CAN

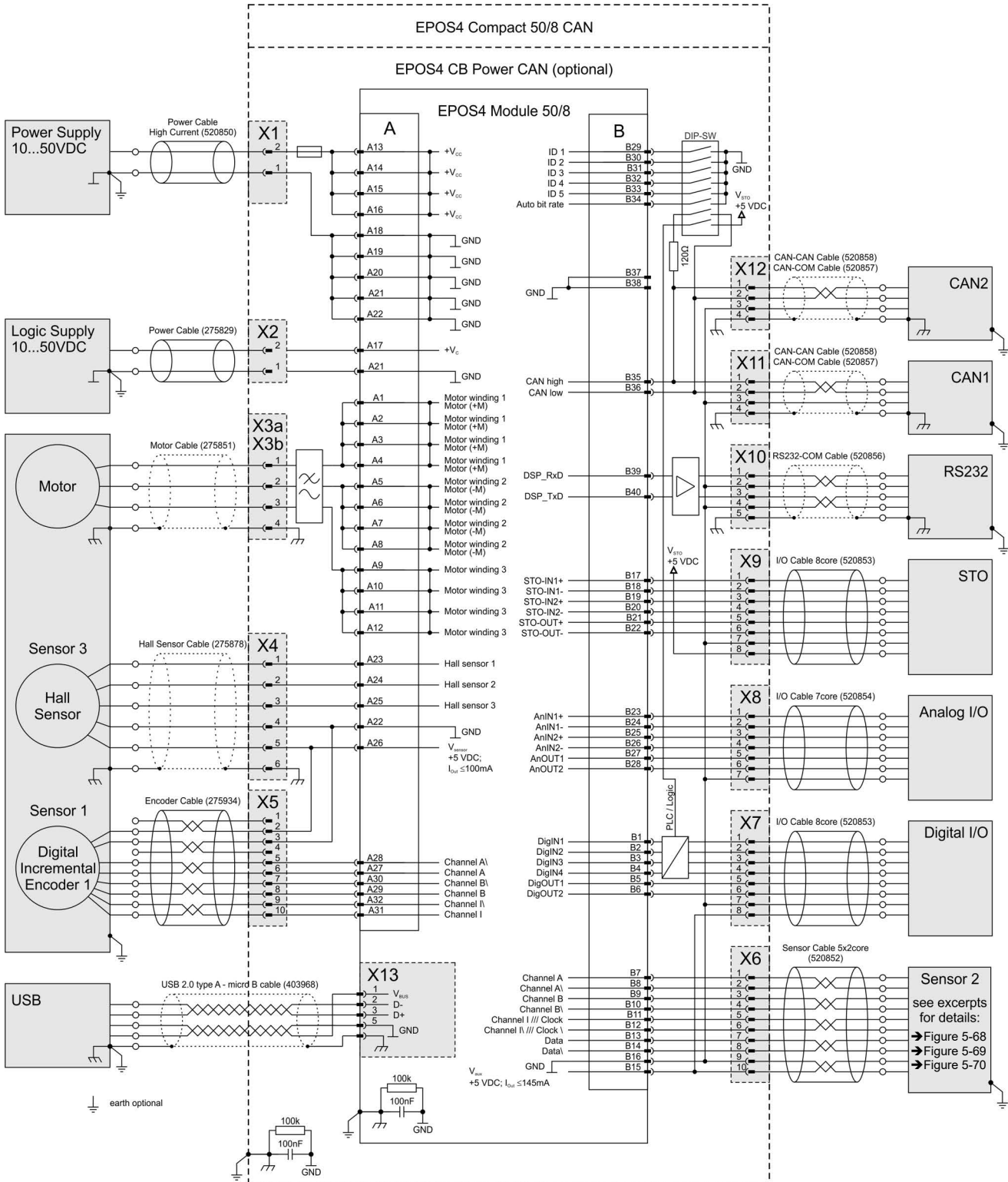


Figure 5-61 Main wiring diagram – Module & Compact CAN

5.2.2 Module & Compact EtherCAT

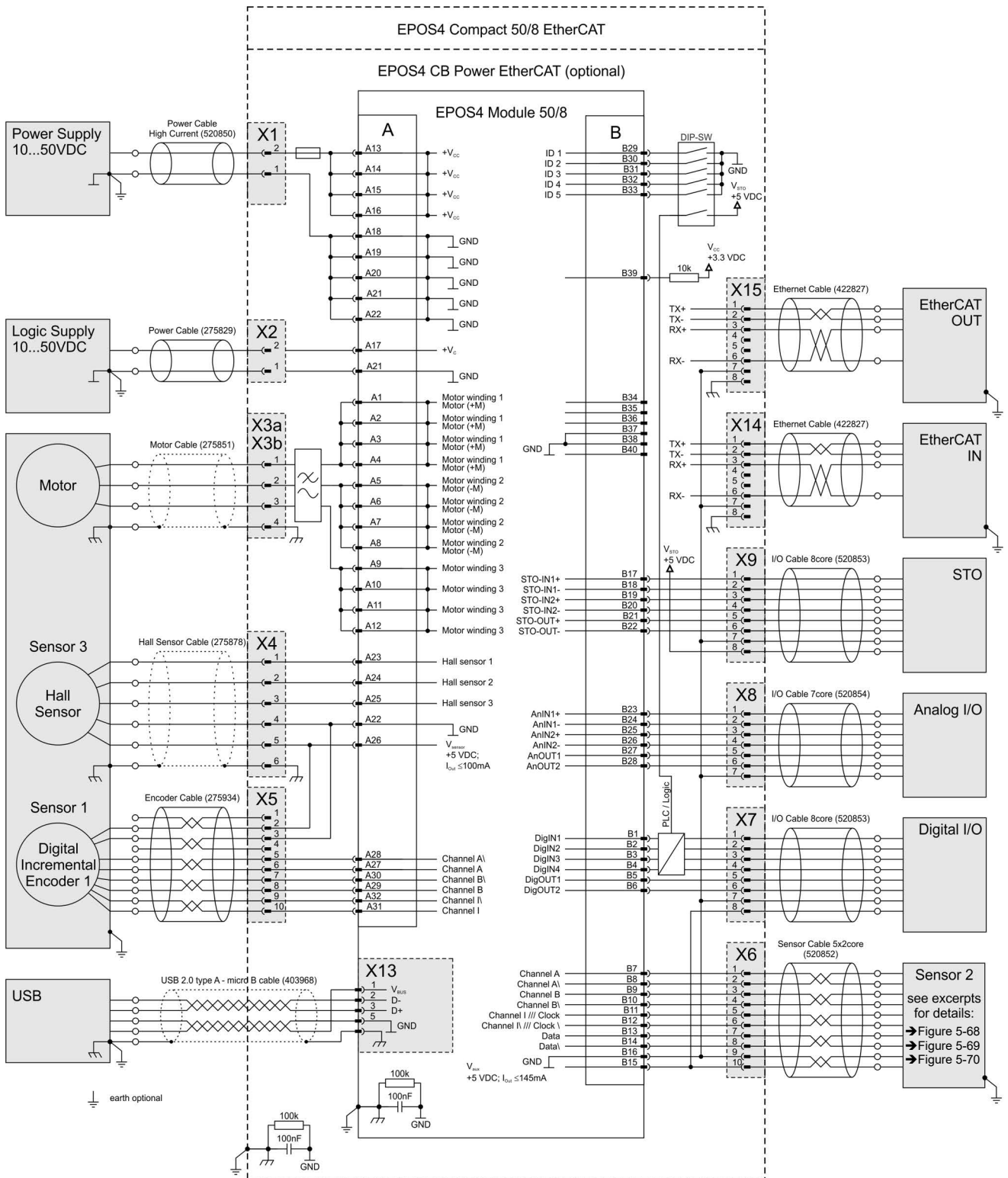


Figure 5-62 Main wiring diagram – Module & Compact EtherCAT

5.3 Excerpts

5.3.1 Power & Logic Supply

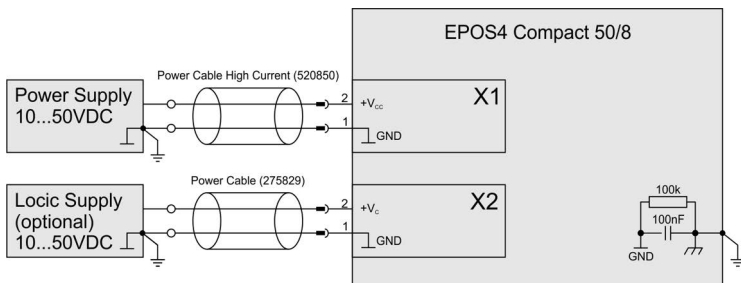


Figure 5-63 Power & logic supply

5.3.2 DC Motor

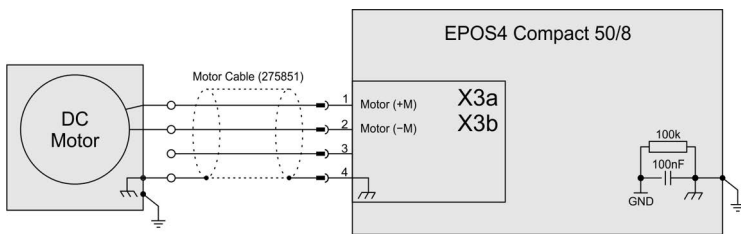


Figure 5-64 DC motor

5.3.3 EC (BLDC) Motor

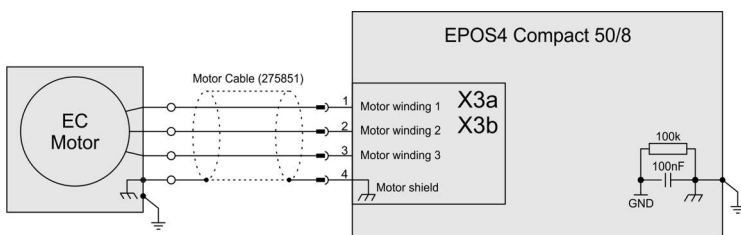


Figure 5-65 EC (BLDC) motor

5.3.4 Hall Sensors (Sensor 3)

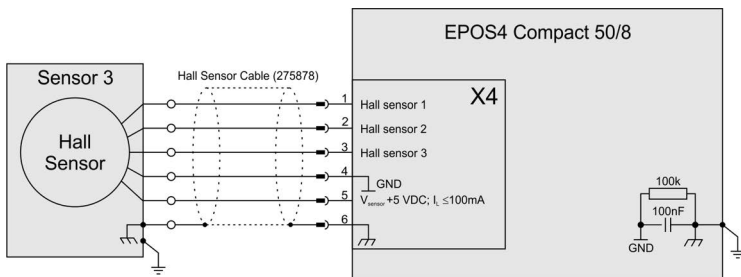


Figure 5-66 Hall sensors (Sensor 3)

5.3.5 Digital Incremental Encoder 1 (Sensor 1)

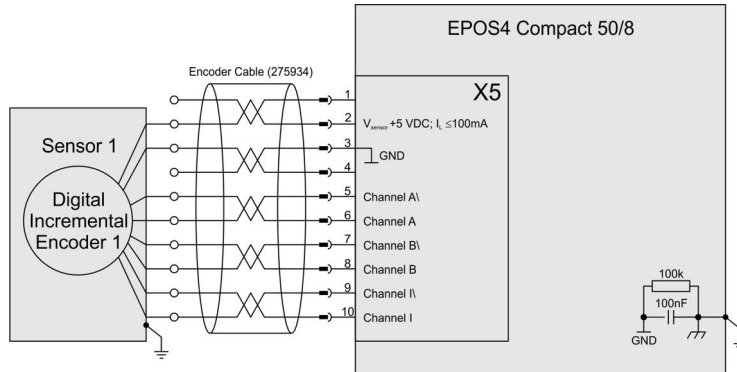


Figure 5-67 Digital incremental encoder 1 (Sensor 1)

5.3.6 Digital Incremental Encoder 2 (Sensor 2)

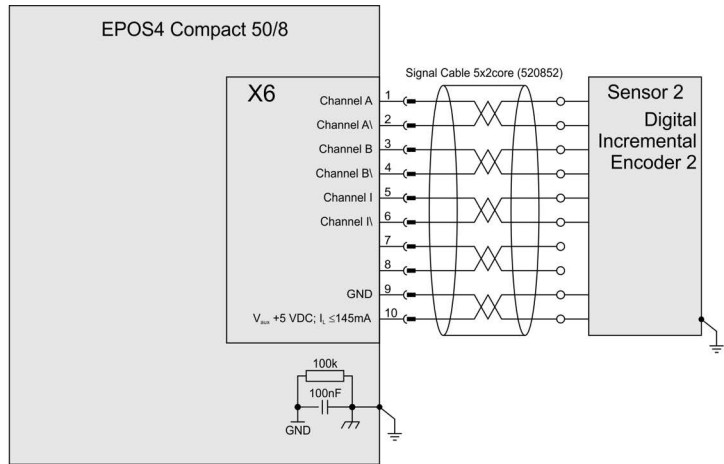


Figure 5-68 Digital incremental encoder 2 (Sensor 2)

5.3.7 Analog incremental encoder SinCos (Sensor 2)

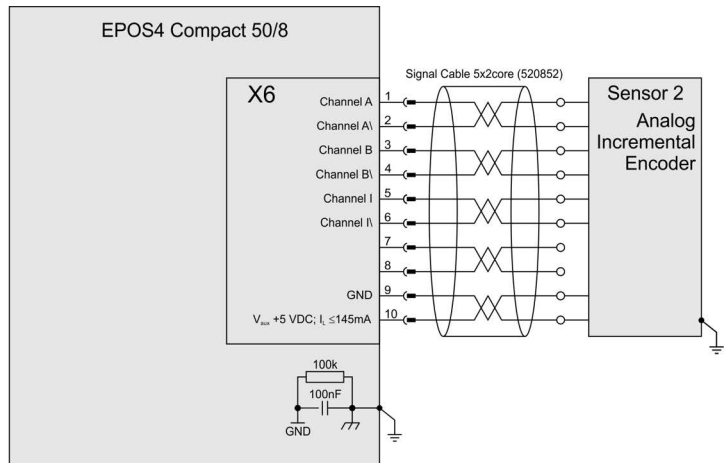


Figure 5-69 Analog incremental encoder (Sensor 2)

5.3.8 SSI Encoder (Sensor 2)

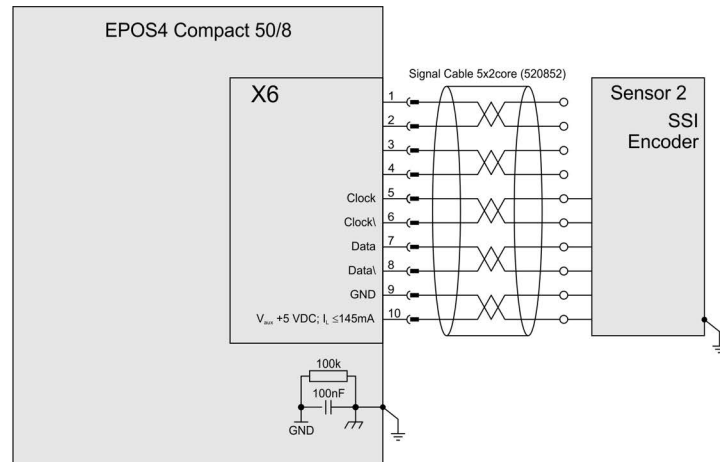


Figure 5-70 SSI encoder (Sensor 2)

LIST OF FIGURES

| | | |
|-------------|--|----|
| Figure 1-1 | Documentation structure | 5 |
| Figure 1-2 | Configuration overview | 8 |
| Figure 2-3 | Derating of output current | 14 |
| Figure 2-4 | Power dissipation and efficiency – EPOS4 Module/Compact 50/8 CAN | 15 |
| Figure 2-5 | Power dissipation and efficiency – EPOS4 Compact 50/8 EtherCAT | 15 |
| Figure 2-6 | EPOS4 Module 50/8 – Dimensional drawing [mm] | 16 |
| Figure 2-7 | EPOS4 CB Power CAN – Dimensional drawing [mm] | 17 |
| Figure 2-8 | EPOS4 Compact 50/8 CAN – Dimensional drawing [mm] | 17 |
| Figure 2-9 | EPOS4 CB Power EtherCAT – Dimensional drawing [mm] | 18 |
| Figure 2-10 | EPOS4 Compact 50/8 EtherCAT – Dimensional drawing [mm] | 18 |
| Figure 3-11 | Pin assignment | 22 |
| Figure 3-12 | EPOS4 CB Power CAN (left) / EPOS4 Compact 50/8 CAN (right) | 25 |
| Figure 3-13 | EPOS4 CB Power EtherCAT (left) / EPOS4 Compact 50/8 EtherCAT (right) | 25 |
| Figure 3-14 | Connector Boards – Connectors | 28 |
| Figure 3-15 | Power supply connector X1 | 29 |
| Figure 3-16 | Logic supply connector X2 | 30 |
| Figure 3-17 | Motor connectors X3a (left) and X3b (right) | 31 |
| Figure 3-18 | Hall sensor connector X4 | 33 |
| Figure 3-19 | Encoder connector X5 | 34 |
| Figure 3-20 | Sensor connector X6 | 35 |
| Figure 3-21 | Digital I/O connector X7 | 36 |
| Figure 3-22 | Analog I/O connector X8 | 37 |
| Figure 3-23 | STO connector X9 | 38 |
| Figure 3-24 | RS232 connector X10 | 39 |
| Figure 3-25 | CAN 1 connector X11/CAN 2 connector X12 | 40 |
| Figure 3-26 | EtherCAT IN & EtherCAT OUT connectors X14 & X15 | 41 |
| Figure 3-27 | DIP switch SW1 | 43 |
| Figure 3-28 | Hall sensor 1 input circuit (analogously valid for Hall sensors 2 & 3) | 49 |
| Figure 3-29 | Encoder input circuit Ch A “differential” (analogously valid for Ch B & Ch I) | 51 |
| Figure 3-30 | Encoder input circuit Ch A “single-ended” (analogously valid for Ch B & Ch I) | 52 |
| Figure 3-31 | Digital incremental encoder input circuit Ch A “differential” (analogously valid for Ch B) | 54 |
| Figure 3-32 | Digital incremental encoder input circuit Ch I | 54 |
| Figure 3-33 | Digital incremental encoder input circuit Ch A “single-ended” (analogously valid for Ch B) | 55 |
| Figure 3-34 | Digital incremental encoder input circuit Ch I | 56 |
| Figure 3-35 | Analog incremental encoder input circuit Ch A “differential” (analogously valid for Ch B) | 57 |
| Figure 3-36 | Analog incremental encoder input circuit Ch I (digital evaluation) | 58 |
| Figure 3-37 | SSI absolute encoder data input | 59 |
| Figure 3-38 | SSI absolute encoder clock output | 60 |
| Figure 3-39 | HsDigIN1 circuit “differential” (analogously valid for HsDigIN2...4) | 61 |
| Figure 3-40 | HsDigIN1 circuit “single-ended” (analogously valid for HsDigIN2...4) | 62 |
| Figure 3-41 | HsDigOUT1 output circuit | 63 |

| | | |
|-------------|---|-----|
| Figure 3-42 | DigIN1 circuit (analogously valid for DigIN2...4) – Module | 64 |
| Figure 3-43 | DigIN1 circuit (analogously valid for DigIN2...4) – Compact / Logic level setting | 65 |
| Figure 3-44 | DigIN1 circuit (analogously valid for DigIN2...4) – Compact / PLC level setting | 66 |
| Figure 3-45 | DigOUT1 circuit (analogously valid for DigOUT2 and Compact) | 66 |
| Figure 3-46 | DigOUT1 “sinks” (analogously valid for DigOUT2 and Compact) | 67 |
| Figure 3-47 | DigOUT1 “source” (analogously valid for DigOUT2 and Compact) | 67 |
| Figure 3-48 | STO-IN1 circuit (analogously valid for STO-IN2) | 69 |
| Figure 3-49 | STO-OUT circuit | 69 |
| Figure 3-50 | AnIN1 circuit (analogously valid for AnIN2) | 70 |
| Figure 3-51 | AnOUT1 circuit (analogously valid for AnOUT2) | 71 |
| Figure 3-52 | SCI circuit | 72 |
| Figure 3-53 | USB connector X13 | 78 |
| Figure 3-54 | LEDs – Location | 79 |
| Figure 4-55 | Wiring of power supply | 84 |
| Figure 4-56 | Wiring of logic supply | 85 |
| Figure 4-57 | Wiring of motor winding 1 (analogously valid also for motor windings 2 & 3) | 87 |
| Figure 4-58 | Wiring of RS232 transceiver | 87 |
| Figure 4-59 | THT footprint [mm] – Top View | 91 |
| Figure 5-60 | Interfaces – Designations and location | 93 |
| Figure 5-61 | Main wiring diagram – Module & Compact CAN | 96 |
| Figure 5-62 | Main wiring diagram – Module & Compact EtherCAT | 97 |
| Figure 5-63 | Power & logic supply | 98 |
| Figure 5-64 | DC motor | 98 |
| Figure 5-65 | EC (BLDC) motor | 98 |
| Figure 5-66 | Hall sensors (Sensor 3) | 98 |
| Figure 5-67 | Digital incremental encoder 1 (Sensor 1) | 99 |
| Figure 5-68 | Digital incremental encoder 2 (Sensor 2) | 99 |
| Figure 5-69 | Analog incremental encoder (Sensor 2) | 99 |
| Figure 5-70 | SSI encoder (Sensor 2) | 100 |

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 1-4 | Abbreviations. | 9 |
| Table 2-5 | Technical data | 13 |
| Table 2-6 | Limitations | 15 |
| Table 2-7 | Standards | 19 |
| Table 3-8 | Pin assignment A1...A32 (X1...X5). | 22 |
| Table 3-9 | Pin assignment B1...B46 (X6...X12). | 24 |
| Table 3-10 | Prefab maxon cables. | 26 |
| Table 3-11 | EPOS4 Connector Set – Content | 27 |
| Table 3-12 | Recommended tools | 27 |
| Table 3-13 | Power supply connector X1 – Pin assignment | 29 |
| Table 3-14 | Power Cable High Current | 29 |
| Table 3-15 | Logic supply connector X2 – Pin assignment | 30 |
| Table 3-16 | Power Cable | 30 |
| Table 3-17 | Motor connector X3a / X3b – Pin assignment for maxon DC motor | 31 |
| Table 3-18 | Motor connector X3a / X3b – Pin assignment for maxon EC motor | 31 |
| Table 3-19 | Motor Cable. | 32 |
| Table 3-20 | Motor Cable High Current | 32 |
| Table 3-21 | Hall sensor connector X4 – Pin assignment | 33 |
| Table 3-22 | Hall Sensor Cable | 33 |
| Table 3-23 | Encoder connector X5 – Pin assignment | 34 |
| Table 3-24 | Encoder connector X5 – Accessories | 34 |
| Table 3-25 | Encoder Cable. | 34 |
| Table 3-26 | Sensor connector X6 – Pin assignment | 35 |
| Table 3-27 | Sensor Cable 5x2core. | 36 |
| Table 3-28 | Digital I/O connector X7 – Pin assignment | 36 |
| Table 3-29 | Signal Cable 8core | 36 |
| Table 3-30 | Analog I/O connector X8 – Pin assignment. | 37 |
| Table 3-31 | Signal Cable 7core | 37 |
| Table 3-32 | STO connector X9 – Pin assignment | 38 |
| Table 3-33 | STO Idle Connector. | 38 |
| Table 3-34 | RS232 connector X10 – Pin assignment. | 39 |
| Table 3-35 | RS232-COM Cable | 39 |
| Table 3-36 | CAN 1 connector X11/CAN 2 connector X12 – Pin assignment | 40 |
| Table 3-37 | CAN-COM Cable. | 40 |
| Table 3-38 | CAN-CAN Cable | 40 |
| Table 3-39 | EtherCAT IN & EtherCAT OUT connectors X14 & X15 – Pin assignment | 41 |
| Table 3-40 | Ethernet Cable | 42 |
| Table 3-41 | DIP switch SW1 – Binary code values | 43 |

| | | |
|------------|--|----|
| Table 3-42 | DIP switch SW1 – Examples | 44 |
| Table 3-43 | DIP switch SW1 – CAN automatic bit rate detection | 44 |
| Table 3-44 | DIP switch SW1 – CAN bus termination | 45 |
| Table 3-45 | DIP switch SW1 – Digital input level | 45 |
| Table 3-46 | Spare parts list | 45 |
| Table 3-47 | Power supply – Pin assignment | 46 |
| Table 3-48 | Power supply requirements | 46 |
| Table 3-49 | Logic supply – Pin assignment | 47 |
| Table 3-50 | Logic supply requirements | 47 |
| Table 3-51 | DC motor – Pin assignment | 48 |
| Table 3-52 | EC motor – Pin assignment | 48 |
| Table 3-53 | Hall sensor – Pin assignment | 49 |
| Table 3-54 | Hall sensor specification | 49 |
| Table 3-55 | Encoder – Pin assignment | 50 |
| Table 3-56 | Differential encoder specification | 51 |
| Table 3-57 | Single-ended encoder specification | 52 |
| Table 3-58 | Incremental encoder – Pin assignment | 53 |
| Table 3-59 | Differential digital incremental encoder specification | 53 |
| Table 3-60 | Single-ended digital incremental encoder specification | 55 |
| Table 3-61 | Differential analog incremental encoder specification | 57 |
| Table 3-62 | SSI absolute encoder – Pin assignment | 59 |
| Table 3-63 | SSI absolute encoder specification | 59 |
| Table 3-64 | High-speed digital I/Os – Pin assignment | 61 |
| Table 3-65 | Differential high-speed digital input specification | 61 |
| Table 3-66 | Single-ended high-speed digital input specification | 62 |
| Table 3-67 | High-speed digital output specification | 63 |
| Table 3-68 | Digital I/Os – Pin assignment – Module | 64 |
| Table 3-69 | Digital input specification | 64 |
| Table 3-70 | Digital I/Os – Pin assignment – Compact | 65 |
| Table 3-71 | Digital input specification – Logic level setting | 65 |
| Table 3-72 | Digital input specification – PLC level setting | 66 |
| Table 3-73 | Digital output specification | 66 |
| Table 3-74 | Digital output – Sinks | 67 |
| Table 3-75 | Digital output – Source | 67 |
| Table 3-76 | STO I/Os – Pin assignment | 68 |
| Table 3-77 | STO input specification | 68 |
| Table 3-78 | STO output specification | 69 |
| Table 3-79 | STO logic state | 69 |
| Table 3-80 | Analog I/Os – Pin assignment | 70 |
| Table 3-81 | Analog input specification | 70 |
| Table 3-82 | Analog output specification | 71 |
| Table 3-83 | SCI – Pin assignment | 72 |
| Table 3-84 | SCI specification | 72 |
| Table 3-85 | RS232 – Pin assignment | 73 |

| | | |
|-------------|---|----|
| Table 3-86 | RS232 interface specification | 73 |
| Table 3-87 | CAN bus line / CAN 1 / CAN 2 – Pin assignment | 74 |
| Table 3-88 | CAN interface specification | 74 |
| Table 3-89 | ID – Pin assignment | 75 |
| Table 3-90 | CAN ID / DEV ID specification | 75 |
| Table 3-91 | ID – Examples | 76 |
| Table 3-92 | Bit rate detection specification. | 76 |
| Table 3-93 | SPI – Pin assignment | 77 |
| Table 3-94 | USB connector X13 – Pin assignment | 78 |
| Table 3-95 | USB Type A - micro B Cable. | 78 |
| Table 3-96 | USB interface specification | 78 |
| Table 3-97 | NET Status LEDs | 80 |
| Table 3-98 | Device Status LEDs | 80 |
| Table 3-99 | EtherCAT Port LED. | 81 |
| Table 4-100 | Motherboard Design Guide – Recommended components | 89 |
| Table 4-101 | Motherboard Design Guide – Grounding | 90 |
| Table 5-102 | Possible combinations of feedback signals for DC motor | 94 |
| Table 5-103 | Possible combinations of feedback signals for EC (BLDC) motor | 95 |

INDEX

A

abbreviations used 9
 alerts 6
 analog incremental encoder (differential) 57
 analog inputs 70
 analog outputs 71
 applicable EU directive 21
 applicable regulations 10

B

BiSS encoder, wiring 100
 bit rate detection 44, 76
 bit rate, default 74
 BLDC motor, connection 22, 48

C

C1 (capacitor) 84
 C2 (capacitor) 85
 cables (prefab)
 CAN-CAN Cable 40
 CAN-COM Cable 40
 Encoder Cable 34
 Ethernet Cable 42
 Hall Sensor Cable 33
 Motor Cable 32
 Motor Cable High Current 32
 Power Cable 30
 Power Cable High Current 29
 RS232-COM Cable 39
 Sensor Cable 5x2core 36
 Signal Cable 7core 37
 Signal Cable 8core 36
 STO Idle Connector 38
 USB Type A - micro B Cable 78

CAN bus termination 45, 74

CAN ID (see "ID")

CAN interface 74

choke, motor 86

connectors

X1 29
 X10 39
 X11 40
 X12 40
 X13 78
 X14 41
 X15 41
 X2 30
 X3a 31
 X3b 31
 X4 33
 X5 34
 X6 35
 X7 36
 X8 37
 X9 38

country-specific regulations 10

D

D1 (DVS diode) 84
 D2 (DVS diode) 85
 DC motor, connection 22, 48
 DEV ID (see "ID")
 device condition, display of 79
 digital high-speed inputs (differential) 61
 digital high-speed inputs (single-ended) 62
 digital high-speed output 63
 digital incremental encoder (differential) 53
 digital incremental encoder (single-ended) 55
 digital inputs 64
 digital outputs 66
 DIP switch SW1 43

E

EC motor, connection 22, 48
 encoders

 absolute 59
 differential 51
 incremental 53
 serial 59
 SinCos 57
 single-ended 52

EnDat encoder, wiring 100

EPOS4 Connector Set 27

ESD 10

EU directive, applicable 21

F

FU1 (input fuse) 84

H

Hall sensor 49

how to

 calculate the required supply voltage 46
 get help in designing the motherboard 83
 interpret icons (and signs) used in this document 6

I

ID (of the device) 43

incorporation into surrounding system 21

incremental encoder 53

informatory signs 6

inputs

 analog 70
 digital 64
 high-speed digital 61
 STO 68

interfaces

 CAN 40, 74
 EtherCAT 41
 location and designation 93
 RS232 39, 72
 SCI 72
 SPI 77

USB 78
 internal motor chokes 86

L

LEDs, interpretation of 79
 logic supply 47

M

mandatory action signs 6
 motor choke 86
 motor types, supported 8

N

naming of components 9
 node address (see "ID")
 Node-ID (see "ID")
 notations used 6

O

operating license 21
 outputs
 analog 71
 digital 66
 high-speed digital 63
 STO 69

P

part numbers
 275829 30
 275851 32
 275878 33
 275934 34
 403968 78
 422827 42
 504384 8
 520850 29
 520851 32
 520852 36
 520853 36
 520854 37
 520856 39
 520857 40
 520858 40
 520859 27
 520860 38
 520884 8, 25
 520885 8, 25
 604594 8, 25
 605298 8, 25

performance data 11
 pin assignment 22
 power supply 46
 precautions 10
 prerequisites prior installation 21
 prohibitive signs 6
 protective measures (ESD) 10
 purpose
 of the device 8
 of the document 5

R

regulations, applicable 10

RS232 transceiver 87

S

Safe Torque Off (STO) 68
 safety alerts 6
 safety first! 10
 SCI (Serial Communication Interface) 72
 Serial Communication Interface (SCI) 72
 serial encoder 59
 signs used 6
 SPI (Serial Peripheral Interface) 77
 SSI absolute encoder 59
 SSI encoder, wiring 100
 standards, fulfilled 19
 status LEDs 79
 STO (Safe Torque Off) 68
 supply voltage, required 46
 SW1 43
 symbols used 6

T

technical data 11
 termination (CAN bus) 45, 74

U

USB port 78

W

wiring examples
 additional inductance on Motherboard 86
 analog incremental encoder 99
 DC motor 98
 digital & digital incremental encoder 99
 digital incremental encoder 99
 DigOUT 67
 EC (BLDC) motor 98
 Hall sensors 98
 power & logic supply 98
 SSI encoder 100



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