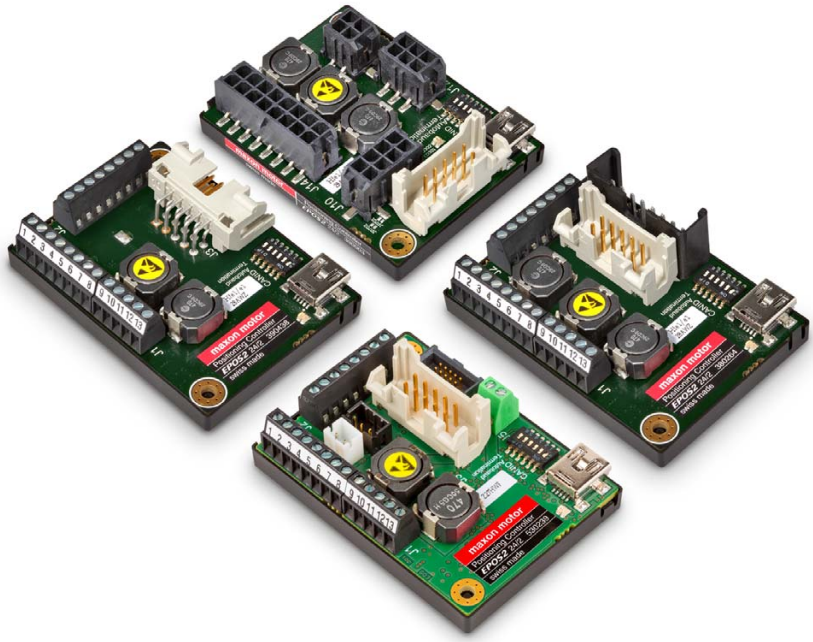
maxon motor control **EPOS2 Positioning Controller**

Hardware Reference **Edition November 2017**

EPOS2 24/2

Positioning Controller

Hardware Reference



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PLEASE 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.*

We have tried to provide you with all information necessary to install and commission the equipment in a **secure**, **safe** and **time-saving** manner. Our main focus is …

- to familiarize you with all relevant technical aspects,
- to let you know the easiest way of doing,
- to alert you of any possibly dangerous situation you might encounter or that you might cause if you do not follow the description,
- to **write as little** and to **say as much** as possible and
- not to bore you with things you already know.

Likewise, we tried to skip repetitive information! Thus, you will find things **mentioned just once**. If, for example, an earlier mentioned action fits other occasions you then will be directed to that text passage with a respective reference.

Follow any stated reference – observe respective information – then go back and continue with the task!

PREREQUISITES FOR PERMISSION TO COMMENCE INSTALLATION

The EPOS2 24/2 is considered as partly completed machinery according to EU directive 2006/42/EC, Article 2, Clause (g) and therefore **is intended to be incorporated into or assembled with other machinery or other partly completed machinery or equipment**.

You must not put the device into service, …

- *unless you have made completely sure that the other machinery – the surrounding system the device is intended to be incorporated to – fully complies with the requirements stated in EU directive 2006/42/EC!*
- *unless the surrounding system fulfills all relevant health and safety aspects!*
- *unless all respective interfaces have been established and fulfill the stated requirements!*

TABLE OF CONTENTS

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1 About this Document

1.1 Intended Purpose

The purpose of the present document is to familiarize you with the described equipment and the tasks on safe and adequate installation and/or commissioning.

Observing the described instructions in this document will help you …

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

Use for other and/or additional purposes is not permitted. maxon motor, the manufacturer of the equipment described, does not assume any liability for loss or damage that may arise from any other and/or additional use than the intended purpose.

1.2 Target Audience

This document is meant for trained and skilled personnel working with the equipment described. It conveys information on how to understand and fulfill the respective work and duties.

This document is a reference book. It does require particular knowledge and expertise specific to the equipment described.

1.3 How to use

Take note of the following notations and codes which will be used throughout the document.

Notation	Explanation
(n)	referring to an item (such as order number, list item, etc.)
➔	denotes “see”, “see also”, “take note of” or “go to”

Table 1-1 Notations used in this Document

1.4 Symbols and Signs

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

Type	Symbol	Meaning	
Safety Alert	 (typical)	DANGER	Indicates an **imminent hazardous situation**. If not avoided, it **will result in death or serious injury**.
		WARNING	Indicates a **potential hazardous situation**. If not avoided, it **can result in death or serious injury**.
		CAUTION	Indicates a **probable hazardous situation** or calls the attention to unsafe practices. If not avoided, it **may result in injury**.
Prohibited Action	 (typical)	Indicates a dangerous action. Hence, **you must not**!	
Mandatory Action	 (typical)	Indicates a mandatory action. Hence, **you must**!	

Type	Symbol	Meaning	
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 & Signs

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 below list 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.

The brand name(s) …	… is/are a registered trademark(s) of …
Adobe® Reader®	© Adobe Systems Incorporated, USA-San Jose, CA
Micro-Fit™ Mini-Fit Jr.™	© Molex, USA-Lisle, IL
Pentium®	© Intel Corporation, USA-Santa Clara, CA
Windows®	© Microsoft Corporation, USA-Redmond, WA

Table 1-3 Brand Names and Trademark Owners

1.6 Copyright

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Switzerland

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www.maxonmotor.com

2 Introduction

The present document provides you with information on the EPOS2 24/2 Positioning Controller's hardware. It contains…

- performance data and specifications,
- information on connections and pin assignment and
- wiring examples.

The EPOS2 24/2 Positioning Controller is available in different variants possessing an identical basic setup, however, their individual configuration varies slightly. The present document covers the entire scope on all variants, thus providing you with all relevant information regardless of the actual type of controller you are using.

maxon motor control's EPOS2 24/2 is a small-sized, full digital, smart motion controller. Due to its flexible and high efficient power stage, the EPOS2 24/2 drives brushed DC motors with digital encoder as well as brushless EC motors with digital Hall sensors and encoder.

The sinusoidal current commutation by space vector control offers the possibility to drive brushless EC motors with minimal torque ripple and low noise. The integrated position, velocity and current control functionality allows sophisticated positioning applications. The EPOS2 24/2 is especially designed being commanded and controlled as a slave node in a CANopen network. In addition, the unit can be operated via any USB or RS232 interface.

Find the latest edition of the present document, as well as additional documentation and software to the EPOS2 24/2 Positioning Controller also on the Internet: ➔www.maxonmotor.com

2.1 Documentation Structure

The present document is part of a documentation set. Please find below an overview on the documentation hierarchy and the interrelationship of its individual parts:

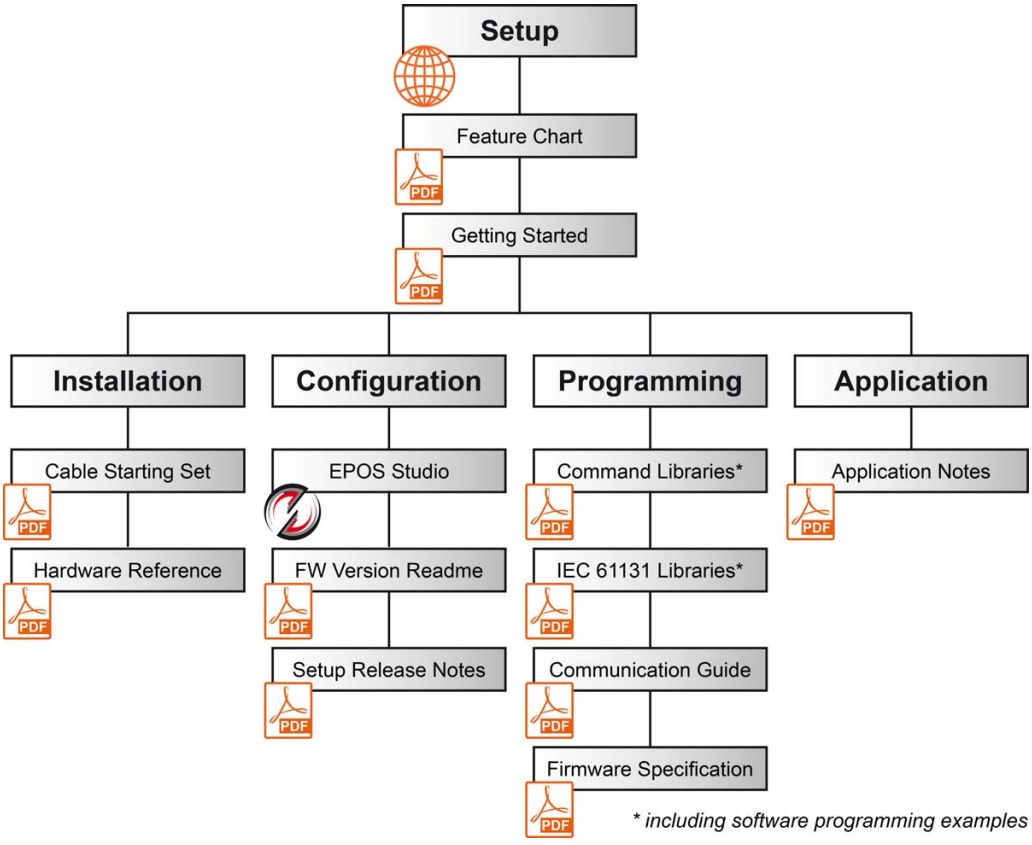

Figure 2-1 Documentation Structure

2.2 Safety Precautions

Prior continuing …

- make sure you have read and understood chapter " PLEASE READ THIS FIRST" on page A-2,
- do not engage with any work unless you possess the stated skills (➔chapter "1.2 Target Audience" on page 1-5),
- refer to ➔chapter "1.4 Symbols and Signs" on page 1-5 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,
- take note of the subsequently used indicators and follow them at all times.

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 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 motor.*

Best Practice
- *For initial operation, make sure that the motor is free running. If not the case, mechanically disconnect the motor from the load.*

Maximal permitted Supply Voltage
- *Make sure that supply power is between 9…24 VDC.*
- *Supply voltages above 30 VDC will destroy the unit.*
- *Wrong polarity will destroy the unit.*

Electrostatic Sensitive Device (ESD)
- *Make sure to wear working cloth in compliance with ESD.*
- *Handle device with extra care.*

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 Technical Data

3.1 Electrical Data

Rating	
Nominal power supply voltage V_{CC}	9…24 VDC
Absolute min. supply voltage V_{CC}	8 VDC
Absolute max. supply voltage V_{CC}	28 VDC
Max. output voltage	0.9 • V_{CC}
Max. output current I_{max} (<1 sec)	4 A
Continuous output current I_{cont}	2 A
Switching frequency	100 kHz
Max. efficiency	90%
Sample rate PI – current controller	10 kHz
Sample rate PI – speed controller	1 kHz
Sample rate PID – positioning controller	1 kHz
Max. speed @ sinusoidal commutation (motors with 1 pole pair)	25 000 rpm
Max. speed @ block commutation (motors with 1 pole pair)	100 000 rpm
Built-in motor choke per phase	47 µH / 2 A

Table 3-4 Electrical Data – Rating

Inputs	
Hall sensor signals (380264 and 390003 only)	Hall sensor 1, Hall sensor 2 and Hall sensor 3 for Hall effect sensor ICs (Schmitt trigger with open collector output)
Encoder signals	A, A\, B, B\, I, I\ (max. 5 MHz) internal line receiver EIA RS422 Standard
Digital Input 1 (“General Purpose”)	+2.4…+24 VDC (Ri = 11 kΩ)
Digital Input 2 (“General Purpose”)	+2.4…+24 VDC (Ri = 11 kΩ)
Digital Input 3 (“General Purpose”)	+2.4…+24 VDC (Ri = 11 kΩ)
Digital Input 4 (“Home Switch”)	+2.4…+24 VDC (Ri = 11 kΩ)
Digital Input 5 (“Positive Limit Switch”)	+2.4…+24 VDC (Ri = 11 kΩ)
Digital Input 6 (“Negative Limit Switch”)	+2.4…+24 VDC (Ri = 11 kΩ)
Analog Input 1	resolution 12-bit 0…+5 V (Ri = 47 kΩ)
Analog Input 2	resolution 12-bit 0…+5 V (Ri = 47 kΩ)
CAN ID (CAN identification)	ID 1…15 configurable via DIP switch 1…4

Table 3-5 Electrical Data – Inputs

Outputs	
Digital Output 3 (“General Purpose”), open drain	max. 24 VDC (I_L <50 mA)
Digital Output 4 (“General Purpose”), open drain	max. 24 VDC (I_L <50 mA)

Table 3-6 Electrical Data – Outputs

Voltage Outputs	
Encoder supply voltage	+5 VDC (I_L <100 mA)
Hall sensors supply voltage (380264 and 390003 only)	+5 VDC (I_L <30 mA)
Auxiliary output voltage	+5 VDC (I_L <10 mA)

Table 3-7 Electrical Data – Voltage Outputs

Motor Connections	
maxon EC motor (380264 and 390003 only)	**maxon DC motor**
Motor winding 1	+ Motor
Motor winding 2	− Motor
Motor winding 3	

Table 3-8 Electrical Data – Motor Connections

Connections					
DC (390438)	DC/EC (390003)	DC(X) (530239)	EC (380264)	Purpose	Connector Type
J1	–	J1	J1	Supply / Control Signals	PCB screw clamps, 13 poles, pitch 2.54 mm
J2	–	J2	J2	Communication / Analog Inputs	PCB screw clamps, 8 poles, pitch 2.54 mm
J3	–	–	–	Motor*1) / Encoder	DIN41651; 10 poles for ribbon cable, pitch 1.27 mm, AWG 28 *Suitable clip: Tyco C42334-A421-C42 (right); C42334-A421-C52 (left)*
–	–	J4	–	Encoder	Half pitch box header, 2 x 5 poles, pitch 1.27/1.27 mm
–	–	J5	–	Motor	PCB screw clamps, 2 poles, pitch 2.54 mm
–	–	J6	–	Motor	Hirose DF3-3P-2DSA *Suitable plug/terminal: Hirose DF3-3S-2C / Hirose DF3-22SC*
–	–	J7	–	Motor	JST B2B-PH-K-S *Suitable plug/terminal: JST PHR-2 / JST SPH-002T*
–	–	–	J8	Motor / Hall Sensors	Lumberg 2.5 MSF/O 08, 8 poles, pitch 2.5 mm
–	J11	J3	J9	Encoder	DIN41651; 10 poles for ribbon cable, pitch 1.27 mm, AWG 28 *Suitable clip: Tyco C42334-A421-C42 (right); C42334-A421-C52 (left)*
–	J10	–	–	DC Motor / EC Motor with Hall Sensors	Dual row male header (8 poles) Molex Micro-Fit 3.0 *Suitable plug/terminal: Molex Micro-Fit 3.0 430-25-0800 / female crimp terminal 43030-xxxx (AWG 20-30)*
–	J12	–	–	RS232	Dual row male header (6 poles) Molex Micro-Fit 3.0 *Suitable plug/terminal: Molex Micro-Fit 3.0 430-25-0600 / female crimp terminal 43030-xxxx (AWG 20-30)*
–	J13	–	–	CAN	Dual row male header (4 poles) Molex Micro-Fit 3.0 *Suitable plug/terminal: Molex Micro-Fit 3.0 430-25-0400 / female crimp terminal 43030-xxxx (AWG 20-30)*
–	J14	–	–	Supply / Control Signals	Dual row male header (16 poles) Molex Micro-Fit 3.0 *Suitable plug/terminal: Molex Micro-Fit 3.0 430-25-1600 / female crimp terminal 43030-xxxx (AWG 20-30)*
J15	J15	J15	J15	USB	USB connector type mini-B jack (5 poles) *Suitable plug: Standard USB cable with type mini-B plug connector (5 poles)*

*1) with interface according to MR Encoder Type S with Line Driver and MR Encoder Type M with Line Driver.

Table 3-9 Electrical Data – Connections

Interfaces		
RS232	RxD; TxD	max. 115 200 bit/s
USB 2.0 / USB 3.0	Data+; Data−	full speed
CAN 1	CAN_H (high); CAN_L (low)	max.1 Mbit/s
CAN 2	CAN_H (high); CAN_L (low)	max.1 Mbit/s

Table 3-10 Electrical Data – Interfaces

Status Indicators	
Operation	green LED
Error	red LED

Table 3-11 Electrical Data – LEDs

3.2 Mechanical Data

Mechanical Data	DC (390438)	DC/EC (390003)	DCX (530239)	EC (380264)
Weight	approx. 27 g	approx. 28 g	approx. 27 g	approx. 30 g
Dimensions (L x W x H)	55 x 40 x 15.6 mm	55 x 40 x 18.2 mm	55 x 40 x 18.2 mm	55 x 40 x 19.6 mm
Mounting plate	for M2.5 screws *1)	for M2.5 screws *1)	for M2.5 screws *1)	for M2.5 screws *1)

*1) Max. tightening torque 0.16 Nm.

Table 3-12 Mechanical Data

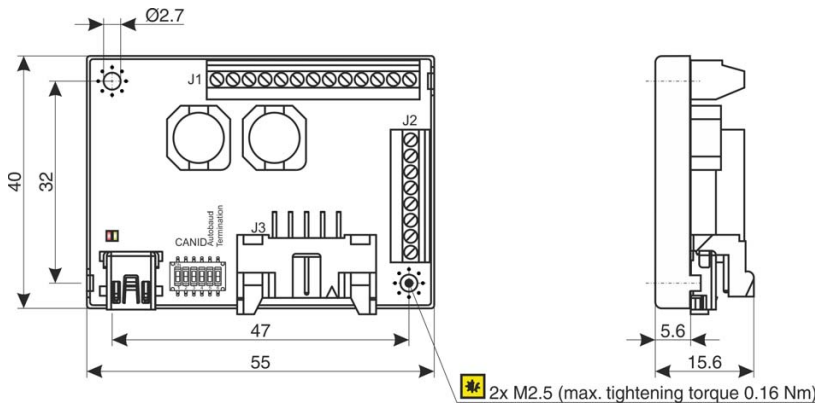

Figure 3-2 Dimensional Drawing [mm] – DC (390438)

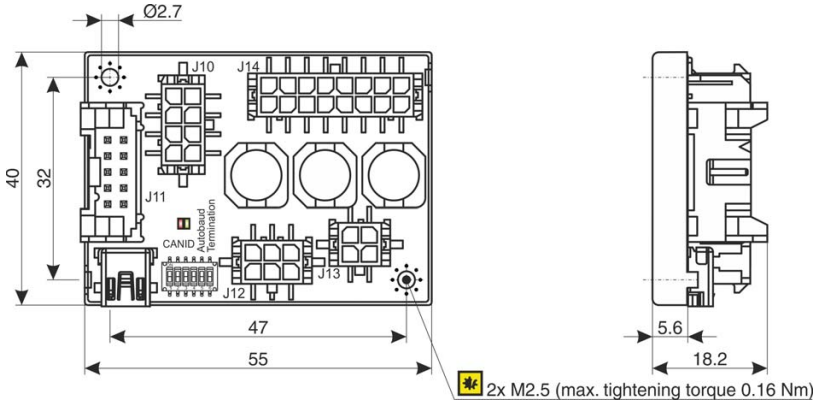

Figure 3-3 Dimensional Drawing [mm] – DC/EC (390003)

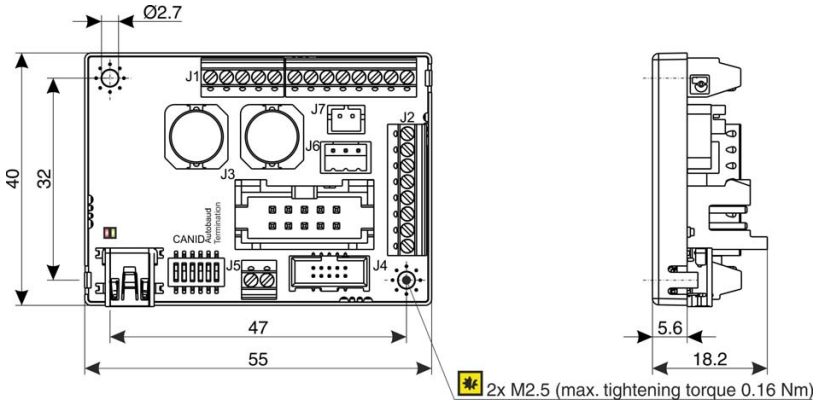

Figure 3-4 Dimensional Drawing [mm] – DCX (530239)

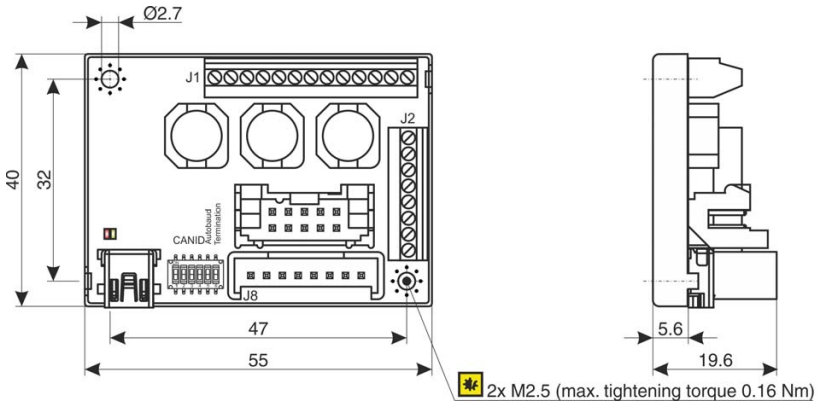

Figure 3-5 Dimensional Drawing [mm] – EC (380264)

3.3 Environmental Conditions

Environmental Condition		
Temperature	Operation	−10…+55 °C
	Extended Range *1)	+55…+74 °C / Derating ➔Figure 3-6
	Storage	−40…+85 °C
Altitude *2)	Operation	0…10'000 m MSL
Humidity		5…90% (condensation not permitted)

*1) 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.
*2) Operating altitude in meters above Mean Sea Level, MSL.

Table 3-13 Environmental Conditions

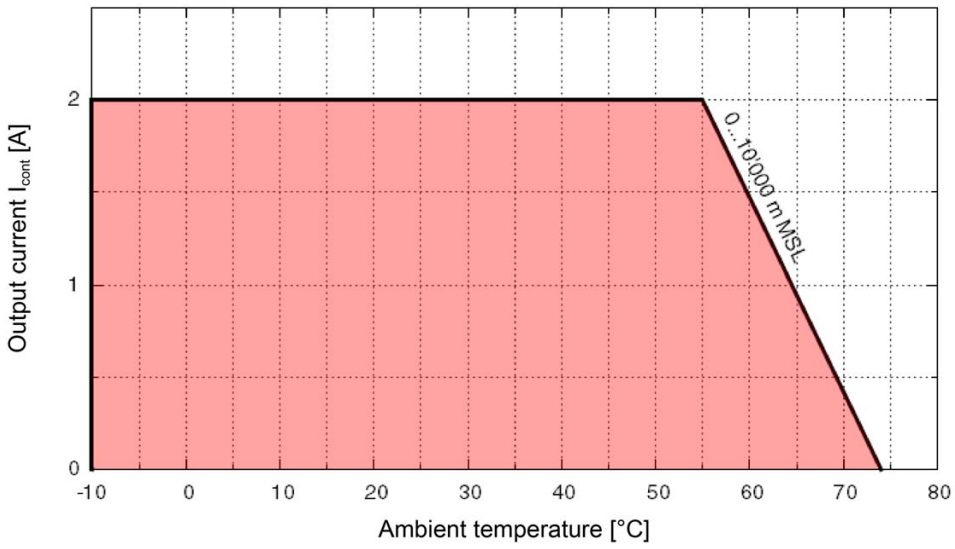

Figure 3-6 Derating Output Current

3.4 Order Details

Order #	Order Details	
380264	EPOS2 24/2	for maxon **EC** motors
390003	EPOS2 24/2	for maxon **DC** motors for maxon **EC** motors
390438	EPOS2 24/2	for maxon **DC** motors
530239	EPOS2 24/2	for maxon **DC** motors for maxon **DCX** motors

Table 3-14 Order Details

3.5 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 Standards	IEC/EN 61000-6-2	Immunity for industrial environments
	IEC/EN 61000-6-3	Emission standard for residential, commercial and light-industrial environments
Applied Standards	IEC/EN 61000-6-3 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
	IEC/EN 61000-4-8	Power frequency magnetic field 30 A/m

Others		
Environmental Standards	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 Standards	UL File Numbers E76332, E174311; unassembled printed circuit board	
Reliability	MIL-HDBK-217F	Reliability prediction of electronic equipment Environment: Ground, benign Ambient temperature: 298 K (25 °C) Component stress: In accordance with circuit diagram and nominal power Mean Time Between Failures (MTBF) • DC (390438): 912'810 hours • DC/EC (390003): 751'966 hours • DCX (530239): 912'810 hours • EC (380264): 750'015 hours

Table 3-15 Standards

4 Connections

4.1 Wiring Diagrams

4.1.1 EPOS2 24/2 for maxon DC motors (390438)

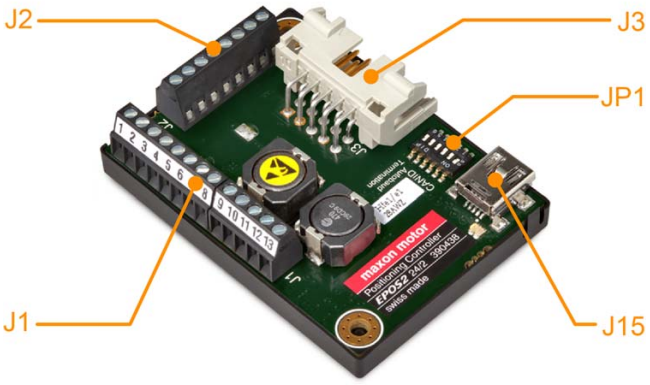

Figure 4-7 Interfaces – Designations and Location «DC» (390438)

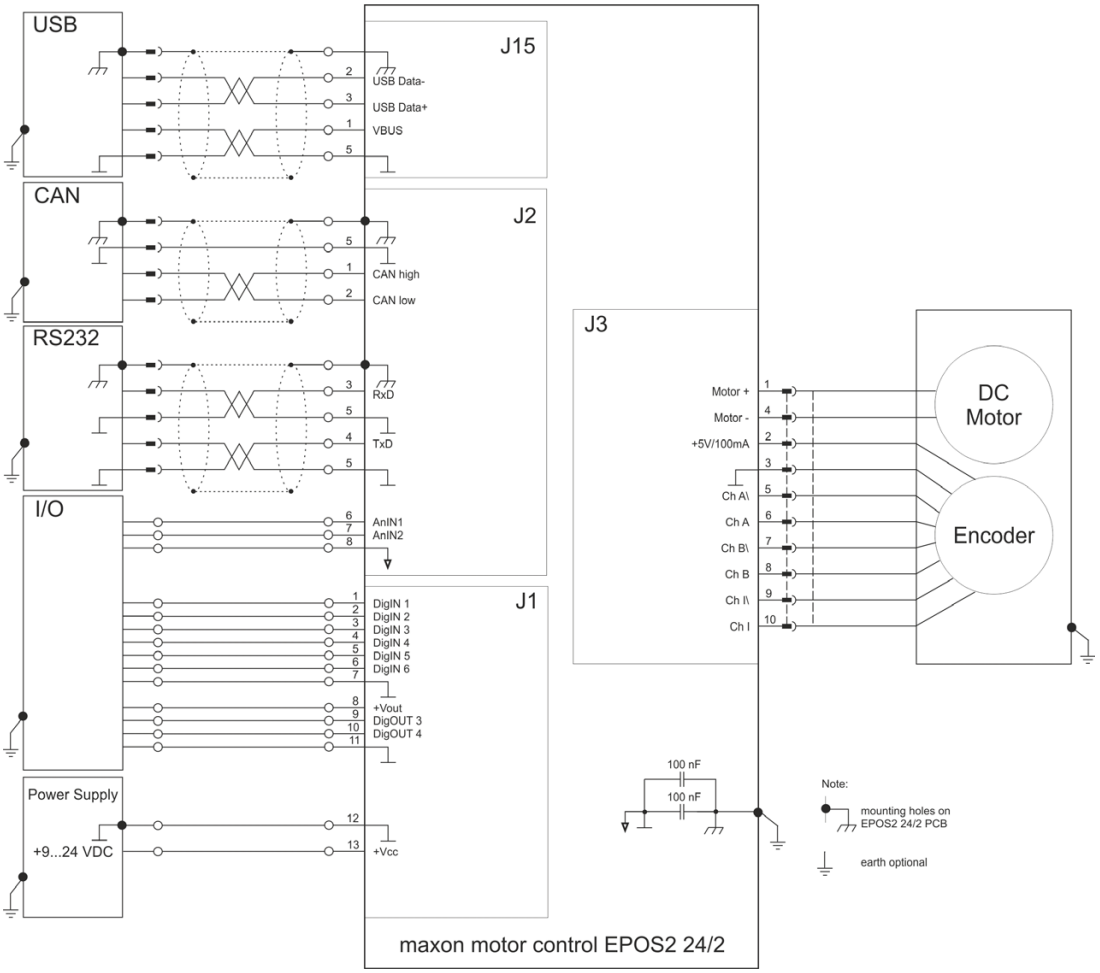

Figure 4-8 Wiring Diagram «DC» (390438)

4.1.2 EPOS2 24/2 for maxon DC/EC motors (390003)

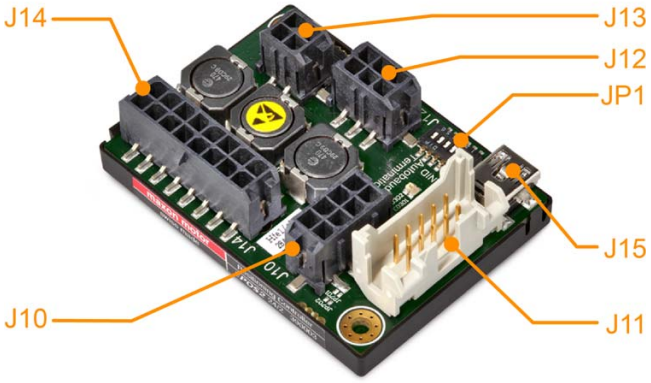

Figure 4-9 Interfaces – Designations and Location «DC/EC» (390003)

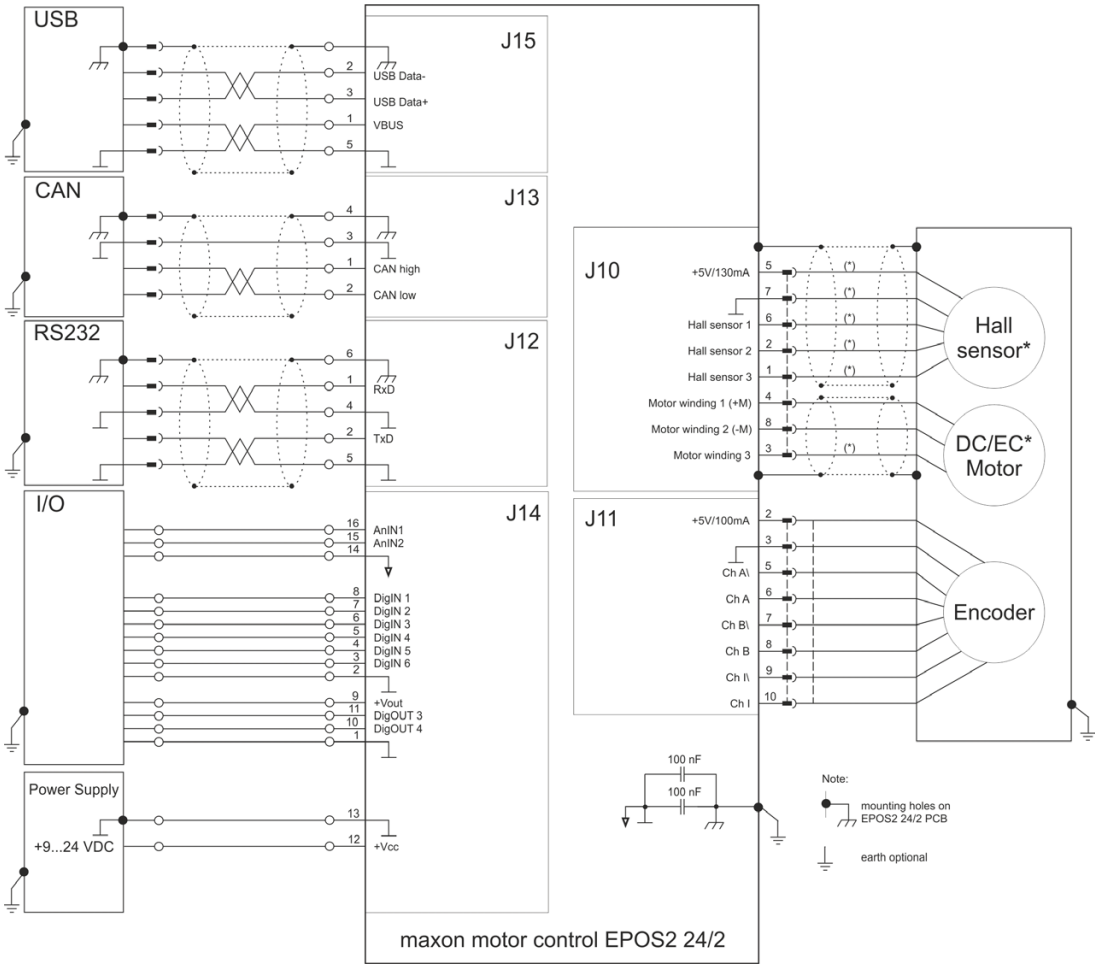

Figure 4-10 Wiring Diagram «DC/EC» (390003)

4.1.3 EPOS2 24/2 for maxon DCX motors (530239)

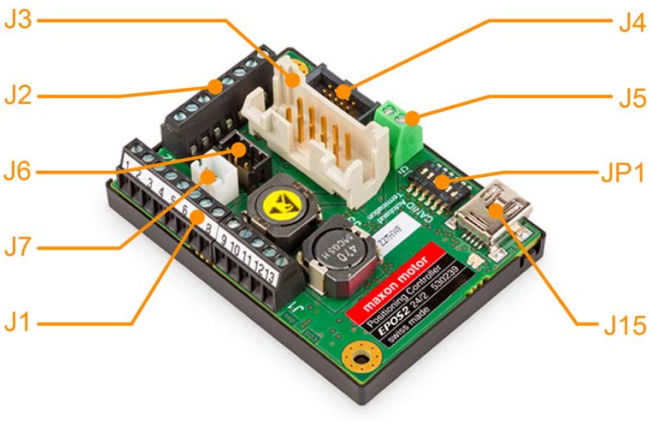

Figure 4-11 Interfaces – Designations and Location «DCX» (530239)

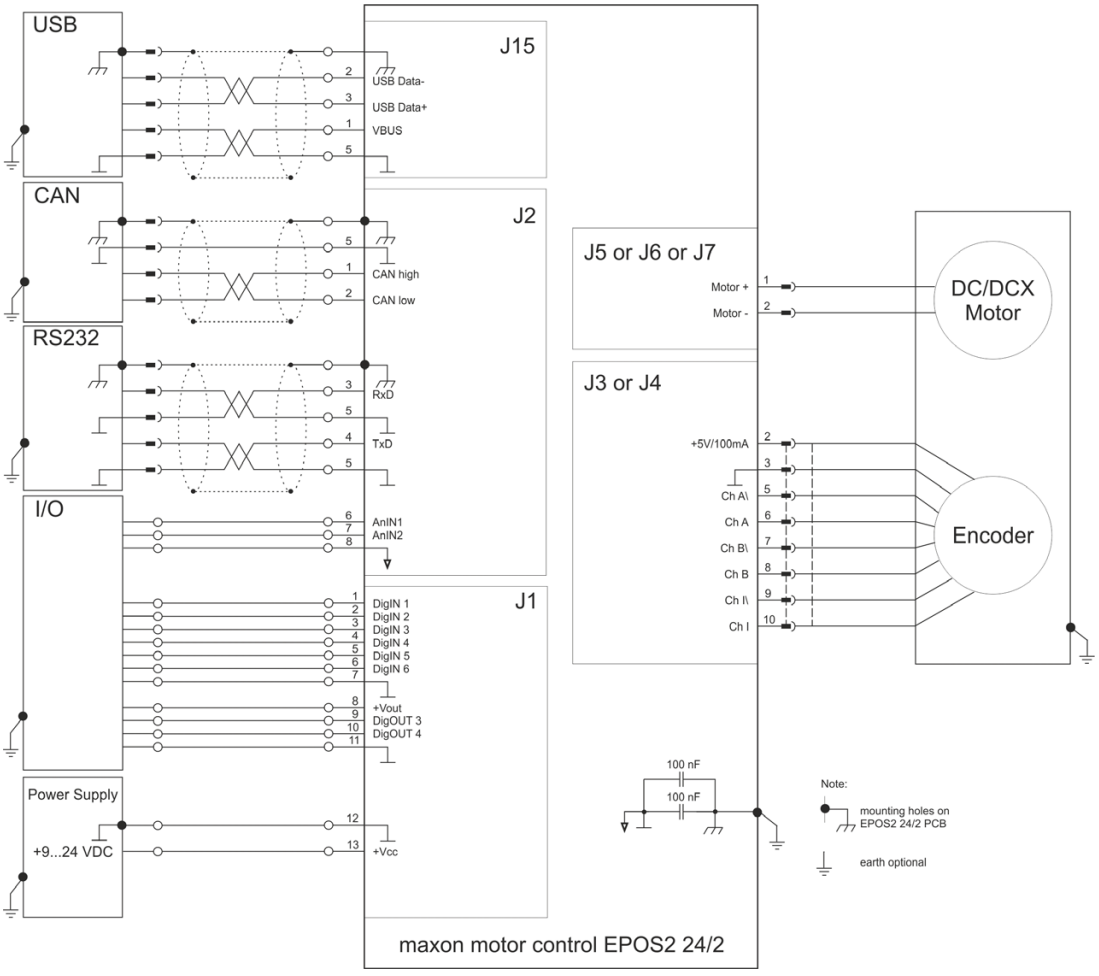

Figure 4-12 Wiring Diagram «DCX» (530239)

4.1.4 EPOS2 24/2 for maxon EC motors (380264)

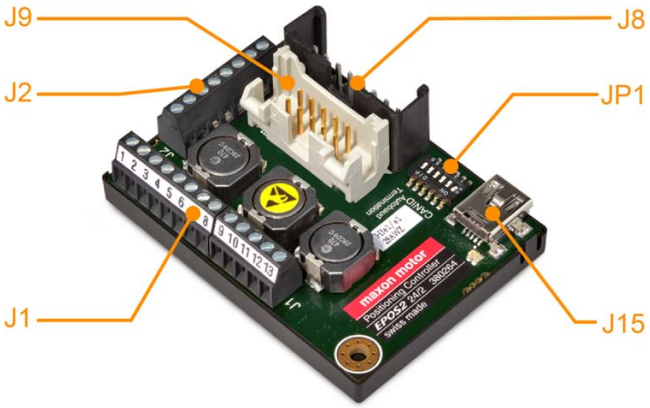

Figure 4-13 Interfaces – Designations and Location «EC» (380264)

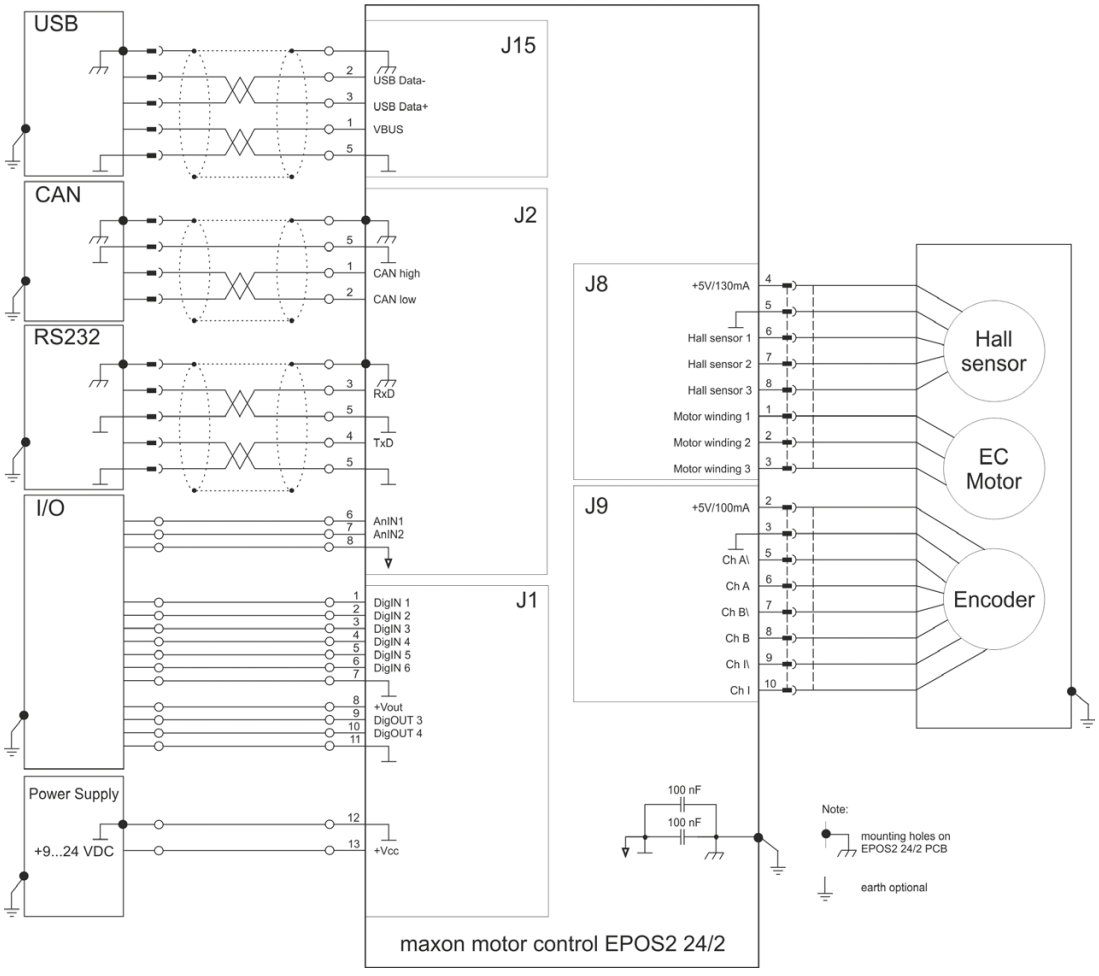

Figure 4-14 Wiring Diagram «EC» (380264)

4.2 Connectors

Use below table to determine the connectors installed on the type of controller you are using. Follow the respective hyperlink to receive detailed information and data on the respective connector.

EPOS2 24/2				Purpose	Find detailed information here:
DC (390438)	DC/EC (390003)	DCX (530239)	EC (380264)		
J1	–	**J1**	**J1**	Supply/Control Signals	➔page 4-20
J2	–	**J2**	**J2**	Communication/Analog Inputs	➔page 4-27
J3	–	–	–	Motor/Encoder	➔page 4-29
–	–	**J3**	–	Encoder	➔page 4-29
–	–	–	**J9**	Encoder	➔page 4-32
–	**J11**	–	–	Encoder	➔page 4-34
–	–	**J4**	–	Encoder	➔page 4-30
–	–	**J5**	–	Motor	➔page 4-30
–	–	**J6**	–	Motor	➔page 4-30
–	–	**J7**	–	Motor	➔page 4-30
–	–	–	**J8**	Motor/Hall Sensors	➔page 4-31
–	**J10**	–	–	Motor/Hall Sensors	➔page 4-33
–	**J12**	–	–	RS232	➔page 4-35
–	**J13**	–	–	CAN	➔page 4-36
–	**J14**	–	–	Supply/Control Signals	➔page 4-37
J15	**J15**	**J15**	**J15**	USB	➔page 4-38

Table 4-16 Controller Types and their Connectors

4.2.1 Supply/Control Signals Connector (J1)

Contains multi-purpose digital I/Os configurable as…

- “Home Switch”
- “Positive Limit Switch”
- “Negative Limit Switch”

Additionally available are “General Purpose” digital I/Os and supply voltage.

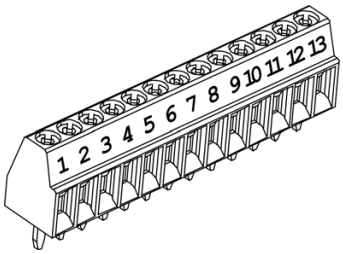

Figure 4-15 Supply/Control Signals Connector (J1)

Pin	Signal	Description
1	DigIN1	Digital Input 1 “General Purpose”
2	DigIN2	Digital Input 2 “General Purpose”
3	DigIN3	Digital Input 3 “General Purpose”
4	DigIN4	Digital Input 4 “Home Switch”
5	DigIN5	Digital Input 5 “Positive Limit Switch”
6	DigIN6	Digital Input 6 “Negative Limit Switch”
7	D_Gnd	Digital signal ground
8	$+V_{OUT}$	Auxiliary supply voltage Output (+5 VDC / 10 mA)
9	DigOUT3	Digital Output 3 “General Purpose”
10	DigOUT4	Digital Output 4 “General Purpose”
11	D_Gnd	Digital signal ground
12	Power_Gnd	Power ground
13	$+V_{CC}$	Power supply voltage (+9…24 VDC)

4.2.1.1 Digital Input 1

By default, the digital input is defined as “General Purpose” and may be configured via software.

DigIN1 “General Purpose” D_Gnd	Connector [J1] Pin [1] Connector [J1] Pin [7]
Input voltage	0…24 VDC
Max. input voltage	±30 VDC
Logic 0	U_{in} <0.7 VDC
Logic 1	U_{in} >2.4 VDC
Input resistance	typically 22 kΩ (<3.3 VDC) typically 11 kΩ (>3.3 VDC)
Input current at logic 1	typically 2 mA @ 24 VDC
Switching delay	<300 µs @ 5 VDC

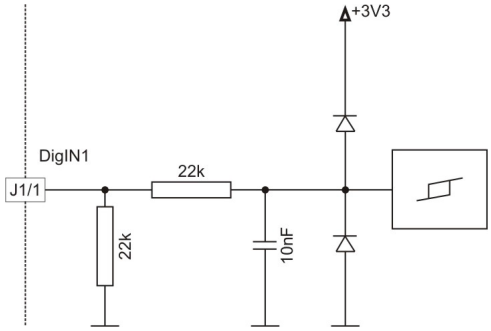

Figure 4-16 DigIN1

4.2.1.2 Digital Inputs 2 and 3

By default, the digital inputs are defined as “General Purpose” and may be configured via software.

DigIN2 “General Purpose” DigIN3 “General Purpose” D_Gnd	Connector [J1] Pin [2] Connector [J1] Pin [3] Connector [J1] Pin [7]
Input voltage	0…24 VDC
Max. input voltage	±30 VDC
Logic 0	U_{in} <0.7 VDC
Logic 1	U_{in} >2.4 VDC
Input resistance	typically 22 kΩ (<3.3 VDC) typically 11 kΩ (>3.3 VDC)
Input current at logic 1	typically 2 mA @ 24 VDC
Switching delay	<1 µs @ 5 VDC

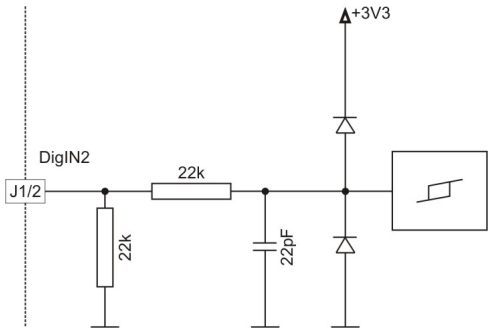

Figure 4-17 DigIN2 (analogously valid also for DigIN3)

4.2.1.3 Digital Inputs 4, 5 and 6

By default, the digital inputs are defined as follows and may be configured via software.

- Digital Input 4 “Home Switch”
- Digital Input 5 “Positive Limit Switch”
- Digital Input 6 “Negative Limit Switch”

DigIN4 “Home Switch” DigIN5 “Positive Limit Switch” DigIN6 “Negative Limit Switch” D_Gnd	Connector [J1] Pin [4] Connector [J1] Pin [5] Connector [J1] Pin [6] Connector [J1] Pin [7]
Input voltage	0…24 VDC
Max. input voltage	±30 VDC
Logic 0	U_{in} <0.7 VDC
Logic 1	U_{in} >2.4 VDC
Input resistance	typically 22 kΩ (<3.3 VDC) typically 11 kΩ (>3.3 VDC)
Input current at logic 1	typically 2 mA @ 24 VDC
Switching delay	<300 µs @ 5 VDC

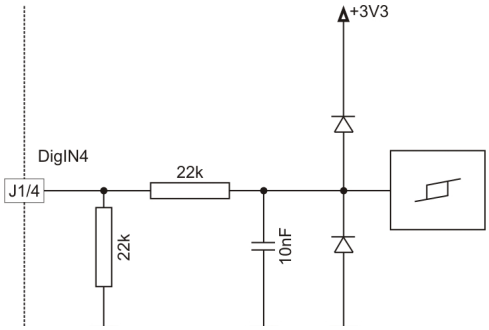

Figure 4-18 DigIN4 (analogously valid also for DigIN5/6)

WIRING EXAMPLE: “PROXIMITY SWITCH TYPE PNP”

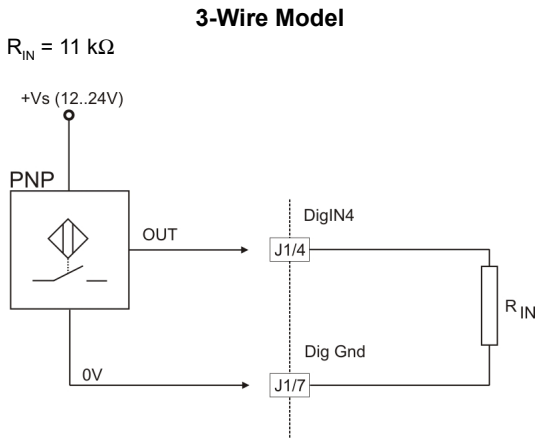

Figure 4-19 DigIN4 – Type PNP Proximity Switch (analogously valid also for DigIN5/6)

WIRING EXAMPLE: "PHOTOELECTRIC SENSOR"

3-Wire Model

R_{ext} = (12 V) = 20 kΩ (300 mW)
R_{ext} = (24 V) = 51 kΩ (150 mW)
R_{IN} = 11 kΩ

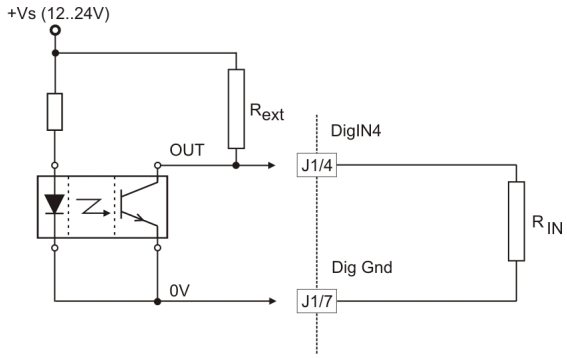

Figure 4-20 DigIN4 – Photoelectric Sensor (analogously valid also for DigIN5/6)

4.2.1.4 Auxiliary Output Voltage

Can be used as supply voltage for external loads connected to the digital inputs.

$+V_{OUT}$	Connector [J1] Pin [8]
Output voltage	+5 VDC (referenced to D_Gnd)
Output current	max. 10 mA

4.2.1.5 Digital Outputs 3 and 4

By default, the digital outputs are defined as “General Purpose” and may be configured via software.

DigOUT3 DigOUT4 D_Gnd	Connector [J1] Pin [9] Connector [J1] Pin [10] Connector [J1] Pin [11]
Circuit	Open drain (internal pull-up resistor 2k2 and diode to +5 VDC

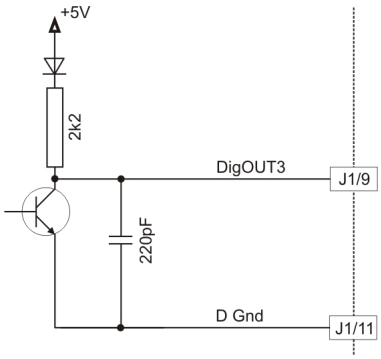

Figure 4-21 DigOUT3 Circuit (analogously valid also for DigOUT4)

WIRING EXAMPLES:

DigOUT “Sinks”	
Max. input voltage	+30 VDC
Max. load current	50 mA
Max. voltage drop	<1.0 V @ 50 mA

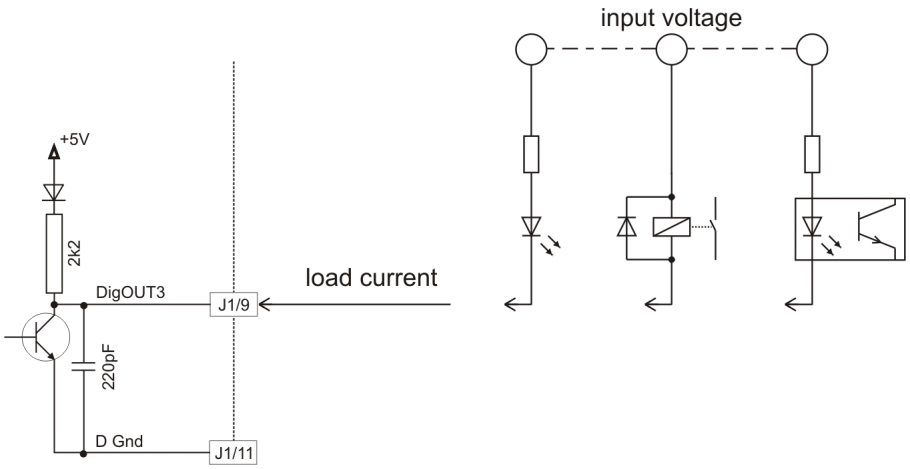

Figure 4-22 DigOUT3 “Sinks” Circuit (analogously valid also for DigOUT4)

DigOUT "Source"	
Output voltage	$U_{out} \approx 5V - 0.75\ V - (I_{load} \times 2200\ \Omega)$
Max. load current	$I_{load} \leq 2$ mA

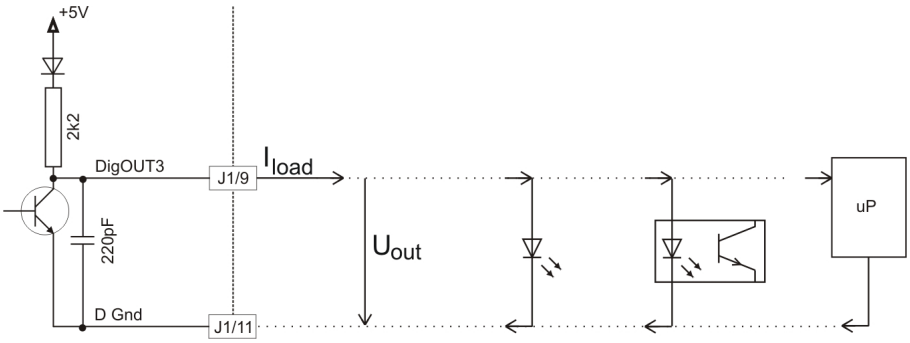

Figure 4-23 DigOUT3 "Source" Circuit (analogously valid also for DigOUT4)

4.2.1.6 Supply Voltage

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

DETERMINATION OF POWER SUPPLY

Basically, any power supply may be used, provided it meets below stated minimal requirements.

Power Supply Requirements	
Output voltage	V_{CC} min. 9 VDC; V_{CC} max. 24 VDC
Absolute output voltage	min. 8 VDC; max. 28 VDC
Output current	Depending on load (continuous max. 2 A / acceleration, short-time max. 4 A)

1) Calculate required voltage under load using following scheme (the formula takes a max. PWM cycle of 90% and a max. voltage drop of −1 V at EPOS2 24/2 into account):

KNOWN VALUES:

- Operating torque M_B [mNm]
- Operating speed n_B [min^{-1}]
- Nominal motor voltage U_N [Volt]
- Motor no-load speed at U_N, n_0 [min^{-1}]
- Speed/torque gradient of the motor $\Delta n/\Delta M$ [min^{-1} mNm^{-1}]

SOUGHT VALUE:

- Supply voltage V_{CC} [Volt]

SOLUTION:

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

2) Choose power supply capable as to above calculation. Thereby consider:
   a) During braking of the load, the power supply must be capable of buffering the fed back energy, e.g. in a capacitor.
   b) When using an electronically stabilized power supply, observe that the overcurrent protection must not be activated in any operating state.

$+V_{CC}$	Connector [J1] Pin [13]
Power_Gnd	Connector [J1] Pin [12]

4.2.2 Communication/Analog Inputs Connector (J2)

Contains CAN bus and RS232 communication signals.

Additionally available are multi-purpose analog inputs.

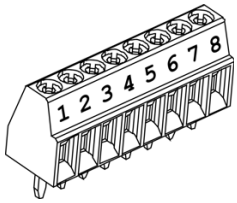

Figure 4-24 Communication/Analog Inputs Connector (J2)

Pin	Signal	Description
1	CAN high	CAN high bus line
2	CAN low	CAN low bus line
3	RS232 RxD	RS232 receive
4	RS232 TxD	RS232 transmit
5	GND	Ground
6	AnIN1	Analog Input 1
7	AnIN2	Analog Input 2
8	A_Gnd	Analog signal ground

4.2.2.1 CAN Communication

Standard	ISO 11898-2:2003
Max. bit rate	1 Mbit/s
Max. number of CAN nodes	127
Protocol	CANopen DS-301 V4.02
Identifier setting	DIP switch or software

CONNECTION OF POSITIONING CONTROLLER TO CAN BUS LINE CIA DS-102

EPOS2 24/2	CAN 9 pin D-Sub (DIN41652)
Connector [J2] Pin [1] “CAN high”	Pin 7 “CAN_H” high bus line
Connector [J2] Pin [2] “CAN low”	Pin 2 “CAN_L” low bus line”
Connector [J2] Pin [5] “GND”	Pin 3 “CAN_GND” Ground

Note

- *Consider CAN Master’s maximal baud rate.*
- *The standard baud rate setting (factory setting) is “Auto Bit Rate”.*
- *Use termination resistor at both ends of the CAN bus (➔chapter “4.3.2 CAN Bus Termination” on page 4-40).*
- *For detailed CAN information ➔separate document «EPOS2 Communication Guide».*

4.2.2.2 RS232 Communication

Max. input voltage	±30 V
Output voltage	typically ±9 V @ 3 kΩ to Ground
Max. bit rate	115 200 bit/s
Internal RS232 driver/receiver	EIA RS232 Standard

CONNECTION OF POSITIONING CONTROLLER TO PC

EPOS2 24/2	PC Interface (RS232), DIN41652
Connector [J2] Pin [3] “EPOS RxD”	Pin 3 “PC TxD”
Connector [J2] Pin [4] “EPOS TxD”	Pin 2 “PC RxD”
Connector [J2] Pin [5] “GND”	Pin 5 “CAN_GND” Ground

Note

- *Consider your PC's serial port maximal baud rate.*
- *The standard baud rate setting (factory setting) is 115'200 bauds.*

4.2.2.3 Analog Inputs 1 and 2

By default, the analog inputs are defined as “General Purpose” and may be configured via software.

AnIN1 AnIN2 A_Gnd	Connector [J2] Pin [6] Connector [J2] Pin [7] Connector [J2] Pin [8]
Input voltage	0…5 VDC
Max. input voltage	±30 VDC
Input resistance	typically 47 kΩ (referenced to A_Gnd)
A/D converter	12-bit
Resolution	0.0012 V
Bandwidth	5 kHz

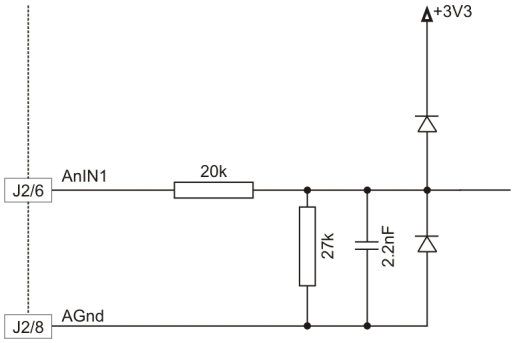

Figure 4-25 AnIN1 Circuit (analogously valid also for AnIN2)

4.2.3 Motor/Encoder Connector (J3)

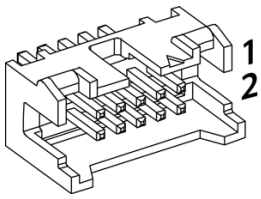

Figure 4-26 Motor/Encoder Connector (J3)

Pin	Signal	Description
1	Motor+	Motor terminal “+” DC version (390438) only
2	+5 VDC / 100 mA	Encoder supply voltage
3	GND	Ground
4	Motor−	Motor terminal “−” DC version (390438) only
5	Channel A\	Channel A complement
6	Channel A	Channel A
7	Channel B\	Channel B complement
8	Channel B	Channel B
9	Channel I\	Index complement
10	Channel I	Index

Accessories	Cable	Encoder Cable (275934)
Notes	Suitable connector	DIN 41651 Plug, pitch 2.54 mm, 10 poles, strain relief

Best Practice
The use of encoder with built-in line driver is mandatory.
Even though 2-channel will do, we strongly recommend to use only 3-channel versions!

By default, the controller is set for a 500 count per turn encoder. For other encoders, you will need to adjust respective settings via software.

Encoder supply voltage	+5 VDC
Max. encoder supply current	100 mA
Min. differential Input voltage	± 200 mV
Line receiver (internal)	EIA RS422 Standard
Max. encoder input frequency	5 MHz

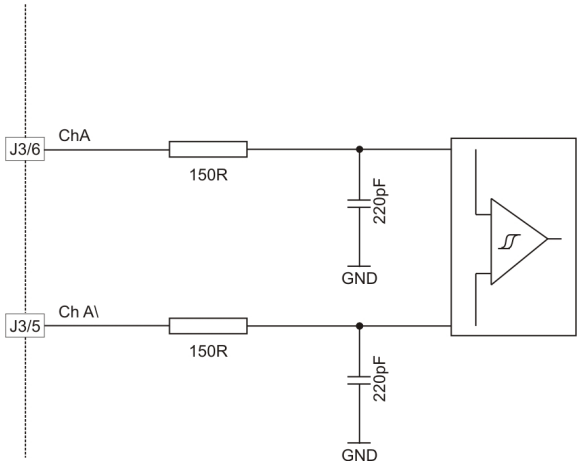

Figure 4-27 Encoder Input Circuit Channel A (analogously valid also for Channel B/Index)

4.2.4 Encoder Connector (J4)

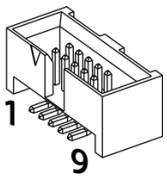

Figure 4-28 Encoder Connector (J4)

Pin	Signal	Description
1	not connected	
2	+5 VDC / 100 mA	Encoder supply voltage
3	GND	Ground
4	not connected	
5	Channel A\	Channel A complement
6	Channel A	Channel A
7	Channel B\	Channel B complement
8	Channel B	Channel B
9	Channel I\	Index complement
10	Channel I	Index

Accessories	Suitable cable	Flat ribbon cable AWG 30
Notes	Suitable plugs	Samtec: FFSD series W+P Products: 376 series Elcotron: IDC32 series

For further details ➔page 4-29.

4.2.5 Motor Connectors (J5 / J6 / J7)

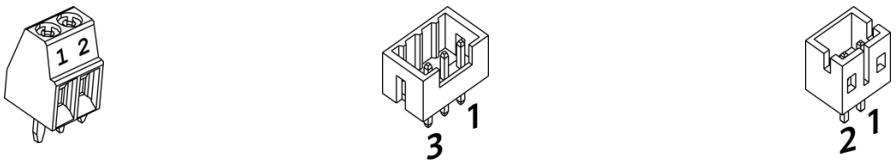

Figure 4-29 Motor Connectors (J5, left) / (J6, center) / (J7, right)

Pin	Signal	Description
1	Motor+	Motor terminal “+”
2	Motor−	Motor terminal “−”
3	not connected	–

4.2.6 Motor/Hall Sensors Connector (J8)

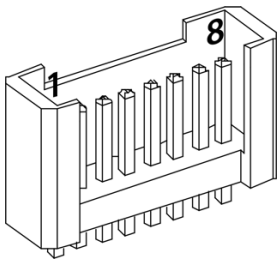

Figure 4-30 Motor/Hall Sensors Connector (J8)

Pin	Signal	Description
1	Motor winding 1	Winding 1
2	Motor winding 2	Winding 2
3	Motor winding 3	Winding 3
4	$+V_{Hall}$	Hall sensor supply voltage +5 VDC / 30 mA
5	GND	Ground of Hall sensor supply
6	Hall Sensor 1	Hall sensor 1 Input
7	Hall Sensor 2	Hall sensor 2 Input
8	Hall Sensor 3	Hall sensor 3 Input

Notes	Suitable connector	MKF 13268-6-0-808 STOCKO Elektronik GmbH

Hall sensor supply voltage	+5 VDC
Max. Hall sensor supply current	30 mA
Input voltage	0…+24 VDC
Logic 0	typically <0.8 VDC
Logic 1	typically >2.4 VDC
Internal pull-up resistor	2.7 kΩ (against +5 VDC)

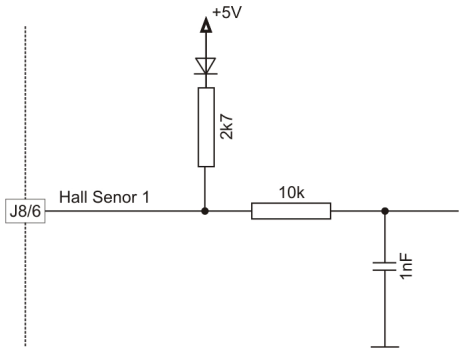

Figure 4-31 Hall Sensor Input Circuit

4.2.7 Encoder Connector (J9)

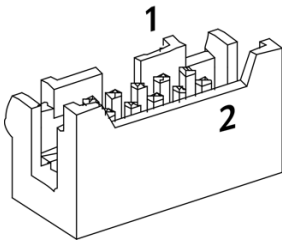

Figure 4-32 Encoder Connector (J9)

Pin	Signal	Description
1	not connected	–
2	+5 VDC / 100 mA	Encoder supply voltage
3	GND	Ground
4	not connected	–
5	Channel A\	Channel A complement
6	Channel A	Channel A
7	Channel B\	Channel B complement
8	Channel B	Channel B
9	Channel I\	Index complement
10	Channel I	Index

Accessories	Cable	Encoder Cable (275934)
Notes	Suitable connector	DIN 41651 Plug, pitch 2.54 mm, 10 poles, plug strain relief

For further details ➔page 4-29.

4.2.8 Motor/Hall Sensors Connector (J10)

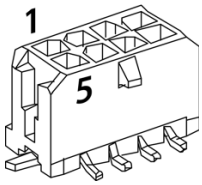

Figure 4-33 Motor/Hall Sensors Connector (J10)

4.2.8.1 DC Motor

Pin	Signal	Description
1	not connected	–
2	not connected	–
3	not connected	–
4	Motor+	Motor terminal “+”
5	not connected	–
6	not connected	–
7	not connected	–
8	Motor−	Motor terminal “−”

Accessories	Cable	DC Motor Cable (303490)
Notes	Suitable connector Suitable crimp terminals Suitable hand crimper	Molex Micro-Fit 8 poles (430-25-0800) Molex Micro-Fit female crimp terminals (43030-xxxx) Molex hand crimper (63819-0000)

4.2.8.2 EC Motor

Pin	Signal	Description
1	Hall Sensor 3	Hall sensor 3 Input
2	Hall Sensor 2	Hall sensor 2 Input
3	Motor winding 3	Winding 3
4	Motor winding 1	Winding 1
5	$+V_{Hall}$	Hall sensor supply voltage +5 VDC / 30 mA
6	Hall Sensor 1	Hall sensor 1 Input
7	GND	Ground
8	Motor winding 2	Winding 2

Accessories	Cable	Motor/Hall Sensor Cable (302948)
Notes	Suitable connector Suitable crimp terminals Suitable hand crimper	Molex Micro-Fit 8 poles (430-25-0800) Molex Micro-Fit female crimp terminals (43030-xxxx) Molex hand crimper (63819-0000)

For further details ➔page 4-31.

4.2.9 Encoder Connector (J11)

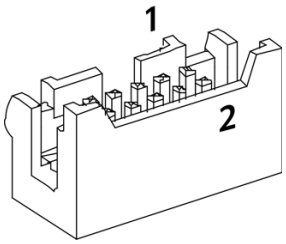

Figure 4-34 Encoder Connector (J11)

The use of the connector depends on the type of DC motor (respectively its connecting cable) you are using. Possible configurations are:

A maxon DC motor **with separated motor/encoder cable**
For further details ➔"Motor/Encoder Connector (J3)" on page 4-29.

B maxon DC motor **with integrated motor/encoder ribbon cable**
Proceed as follows:

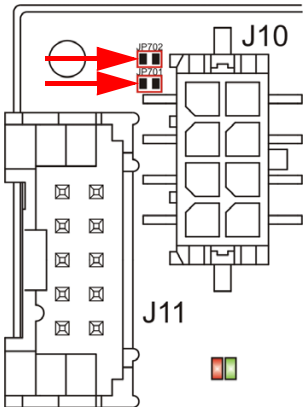

Figure 4-35 Controller PCB – Solder Pads (JP701 & JP702

1) Find solder pads (➔Figure 4-35, arrows) on controller PCB.
2) Bridge **both** solder pad pairs.
3) Connect motor/encoder ribbon cable to connector J11.

Note
*With maxon DC motor **with integrated motor/encoder ribbon cable**, connector J10 will not be used!*

Accessories	Cable	Encoder Cable (275934)

For further details ➔page 4-29.

4.2.10 RS232 Connector (J12)

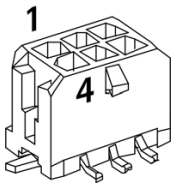

Figure 4-36 RS232 Connector (J12)

Pin	Signal	Description
1	EPOS RxD	EPOS RS232 receive
2	EPOS TxD	EPOS RS232 transmit
3	not connected	–
4	GND	RS232_Ground
5	GND	RS232_Ground
6	Shield	Cable shield

Accessories	Cable	RS232-COM Cable (275900)
Notes	Suitable connector Suitable crimp terminals Suitable hand crimper	Molex Micro-Fit 3.0 6 poles (430-25-0600) Molex Micro-Fit 3.0 female crimp terminals (43030-xxxx) Molex hand crimper (63819-0000)

Max. input voltage	±30 V
Output voltage	typically ±9 V @ 3 kΩ to Ground
Max. bit rate	115 200 bit/s
Internal RS232 driver/receiver	EIA RS232 Standard

Connection of Positioning Controller to PC

EPOS2 24/2	PC Interface (RS232), DIN41652
Connector [J12] Pin [1] “EPOS RxD”	Pin 3 “PC TxD”
Connector [J12] Pin [2] “EPOS TxD”	Pin 2 “PC RxD”
Connector [J12] Pins [4] + [5] “GND”	Pin 5 “GND”

Note

- *Consider your PC's serial port maximal baud rate.*
- *The standard baud rate setting (factory setting) is 115'200 bauds.*

4.2.11 CAN Connector (J13)

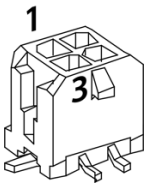

Figure 4-37 CAN Connector (J13)

Pin	Signal	Description
1	CAN high	CAN high bus line
2	CAN low	CAN low bus line
3	CAN GND	CAN Ground
4	CAN Shield	Cable shield

Accessories	Cable	CAN-COM Cable (275908) CAN-CAN Cable (275926) CAN-Y Cable (319471)
Notes	Suitable connector Suitable crimp terminals Suitable hand crimper	Molex Micro-Fit 3.0 4 poles (430-25-0400) Molex Micro-Fit 3.0 female crimp terminals (43030-xxxx) Molex hand crimper (63819-0000)

4.2.11.1 CAN Communication

Standard	ISO 11898-2:2003
Max. bit rate	1 Mbit/s
Max. number of CAN nodes	127
Protocol	CANopen DS-301 V4.02
Identifier setting	DIP switch or software

CONNECTION OF POSITIONING CONTROLLER TO CAN BUS LINE CIA DS-102

EPOS2 24/2	CAN 9 pin D-Sub (DIN41652)
Connector [J13] Pin [1] “CAN high”	Pin 7 “CAN_H” high bus line
Connector [J13] Pin [2] “CAN low”	Pin 2 “CAN_L” low bus line”
Connector [J13] Pin [3] “GND”	Pin 3 “CAN_GND” Ground
Connector [J13] Pin [4] “CAN Shield”	Pin 5 “CAN_Shield” Cable shield

Note

- *Consider CAN Master’s maximal baud rate.*
- *The standard baud rate setting (factory setting) is “Auto Bit Rate”.*
- *Use termination resistor at both ends of the CAN bus (➔chapter “4.3.2 CAN Bus Termination” on page 4-40).*
- *For detailed CAN information ➔separate document «EPOS2 Communication Guide».*

4.2.12 Supply/Control Signals Connector (J14)

Contains multi-purpose digital I/Os configurable as…

- "Home Switch"
- "Positive Limit Switch"
- "Negative Limit Switch"

Additionally available are "General Purpose" digital I/Os and supply voltage.

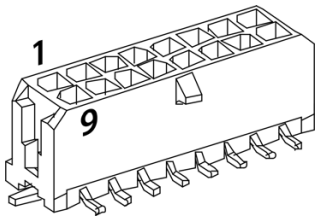

Figure 4-38 Supply/Control Signals Connector (J14)

Pin	Signal	Description
1	D_Gnd	Digital signal ground
2	D_Gnd	Digital signal ground
3	DigIN6	Digital Input 6 "Negative Limit Switch"
4	DigIN5	Digital Input 5 "Positive Limit Switch"
5	DigIN4	Digital Input 4 "Home Switch"
6	DigIN3	Digital Input 3 "General Purpose"
7	DigIN2	Digital Input 2 "General Purpose"
8	DigIN1	Digital Input 1 "General Purpose"
9	$+V_{OUT}$	Auxiliary supply voltage Output (+5 VDC / 10 mA)
10	DigOUT4	Digital Output 4 "General Purpose"
11	DigOUT3	Digital Output 3 "General Purpose"
12	$+V_{CC}$	Power supply voltage (+9…24 VDC)
13	Power_Gnd	Power ground
14	A_Gnd	Analog signal ground
15	AnIN2	Analog Input 2
16	AnIN1	Analog Input 1

Accessories	Cable	Signal Cable 16core (275932)
Notes	Suitable connector Suitable crimp terminals Suitable hand crimper	Molex Micro-Fit 3.0 16 poles (430-25-1600) Molex Micro-Fit 3.0 female crimp terminals (43030-xxxx) Molex hand crimper (63819-0000)

Find detailed information, electrical data and circuits in below listed sections:

- ➔"Digital Input 1" on page 4-21
- ➔"Digital Inputs 2 and 3" on page 4-21
- ➔"Digital Inputs 4, 5 and 6" on page 4-22
- ➔"Analog Inputs 1 and 2" on page 4-28
- ➔"Auxiliary Output Voltage" on page 4-24
- ➔"Digital Outputs 3 and 4" on page 4-24
- ➔"Supply Voltage" on page 4-26

4.2.13 USB Connector (J15)

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 4-39 USB Connector (J15)

Pin	Signal	Description
1	V_{BUS}	USB bus supply input voltage +5 VDC
2	USB D−	USB Data−
3	USB D+	USB Data+
4	not connected	–
5	GND	USB Ground
	Shield	Cable Shield

Accessories	Cable	USB Type A - mini B Cable (370513)
Notes	Suitable connector	Standard USB cable with type mini B plug (5 poles)

USB Standard	USB 2.0 / USB 3.0 (full speed)
Max. bus supply voltage	+5.25 VDC
Typical input current	15 mA
Max. DC data input voltage	−0.5…+3.8 VDC

Connection of Positioning Controller to PC

EPOS2 24/2	PC Interface (USB 2.0 / USB 3.0)
Connector [J15] Pin [1] “V_{BUS}”	Pin 1 “V_{BUS}”
Connector [J15] Pin [2] “USB D−”	Pin 2 “USB D−”
Connector [J15] Pin [3] “USB D+”	Pin 3 “USB D+”
Connector [J15] Pin [5] “GND”	Pin 4 “GND”
Connector [J15] Housing “Shield”	Housing “Shield”

4.3 CAN Node Identification (JP1)

4.3.1 CAN ID (Node Address)

The CAN ID is set with DIP switches 1…4. Addresses (1…15) may be coded using binary code.

Note

- *By setting the DIP switch (1…4) address 0 ("OFF"), the CAN ID may be configured by software (changing object "Node ID", range 1…15).*
- *The CAN ID results in the summed values of DIP switch addresses 1 ("ON").*
- *DIP switches 5 and 6 do not have any impact on the CAN ID.*

Switch	Binary Code	Valence	DIP Switch
1	2^0	1	
2	2^1	2	
3	2^2	4	
4	2^3	8	

Table 4-17 CAN ID – Binary Code Values

EXAMPLES:

Use following table as a (non-concluding) guide:

	CAN ID/Switch	1	2	3	4	
	Valence	1	2	4	8	
CAN ID	**DIP Setting**					**Calculation**
1		1	0	0	0	1
2		0	1	0	0	2
8		0	0	0	1	8
11		1	1	0	1	1 + 2 + 8
15		1	1	1	1	1 + 2 + 4 + 8

Table 4-18 CAN ID – DIP Switch Settings (Example)

4.3.2 CAN Bus Termination

The CAN bus must be terminated at both ends by a termination resistor of 120 Ω, typically. Depending on utilization of the controller, individual CAN bus termination settings must be performed.

Using DIP switch 6, the controller-internal bus termination resistor can be activated/deactivated. By default, bus termination is “OFF”, nevertheless, the bus is **not** terminated.

Figure 4-40 DIP Switch (JP1 [6]) – CAN Bus Termination (left “OFF” / right “ON”)

4.4 CAN Bit Rate Detection

Automatic bit rate detection may be forced by DIP switch 5.

Figure 4-41 DIP Switch (JP1 [5]) – Auto Bit Rate (left “OFF” / right “ON”)

4.5 Status LEDs

The LEDs display the current status of the EPOS2 24/2 as well as possible errors:

- Green LED shows the operating status
- Red LED indicates errors

For detailed information ➔separate document «EPOS2 Firmware Specification».

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

Table 4-19 LEDs – Interpretation of Condition

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