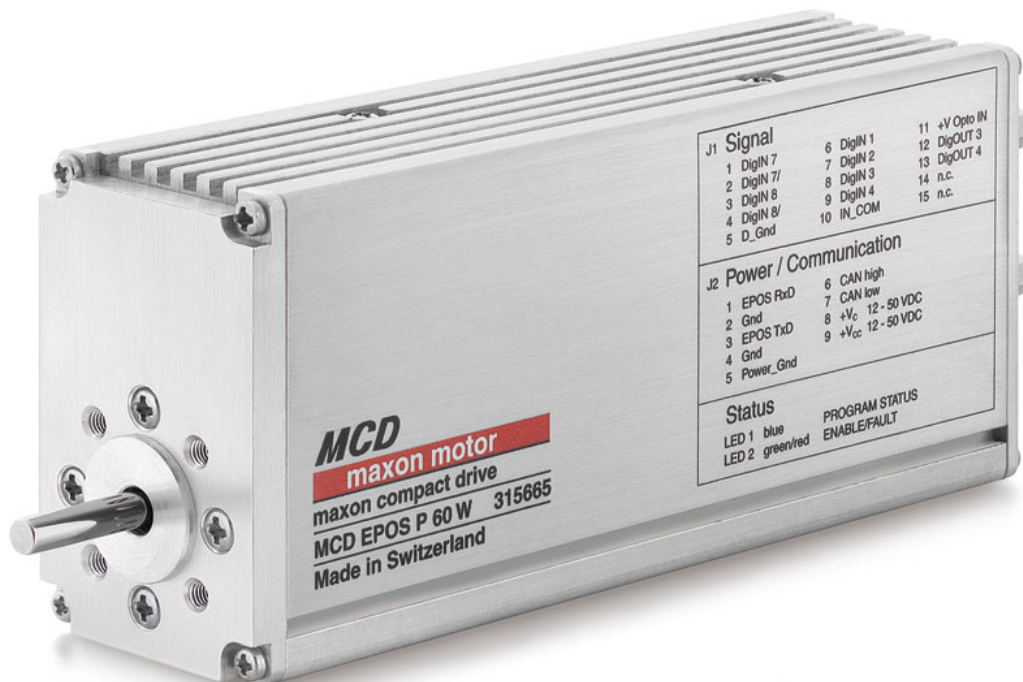


MCD EPOS P 60 W

Programmable Positioning Compact Drive

Documentation

Hardware Reference



maxon document number: 787218-04

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3 Introduction

This documentation “Hardware Reference” provides the hardware details of the maxon compact drive MCD EPOS P 60 W. It contains performance data, connections, specification, pin assignment and wiring examples.

The maxon MCD EPOS P 60 W is a small-sized free programmable compact drive. It contains a brushless EC motor with Hall-sensors, digital Encoder and a digital position control unit. The optimized commutation by space vector control offers to drive the integrated brushless EC motor with minimal torque ripple and low noise. The integrated position-, velocity- and current control functionality allows sophisticated positioning applications. The MCD EPOS P 60 W is programmable with a very efficient software tool. The programming languages are according to IEC 61131-3 standard. The built-in CANopen interface allows the design of an easy-to-use standalone multiple axis system, particularly with standard maxon MCD EPOS controllers or standard maxon EPOS controllers. In addition the unit can be operated through any RS-232 communication port.

The latest edition of these “Hardware Reference”, additional documentation and software to the MCD EPOS compact drive may also be found on the internet under <http://www.maxonmotor.com> category <Service & Downloads> or in the maxon motor e-shop <http://shop.maxonmotor.com>.



Figure 1: MCD EPOS P 60 W

4 How to use this guide

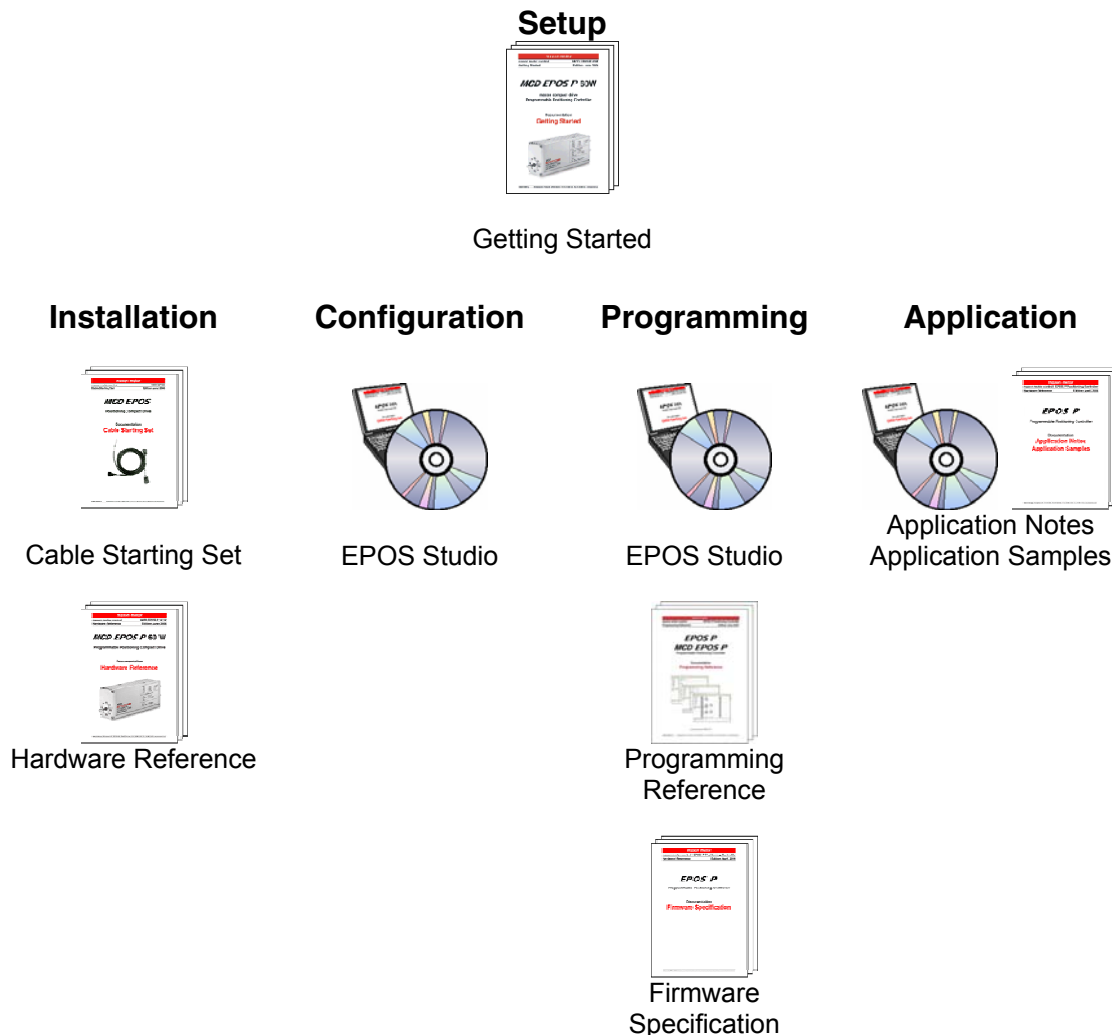


Figure 2: EPOS documentation hierarchy

5 Safety Instructions

**Skilled Personnel**

Installation and starting of the equipment shall only be performed by experienced, skilled personnel.

**Statutory Regulations**

The user must ensure that the compact drive and the components belonging to it are assembled and connected according to local statutory regulations.

**Load Disconnected**

For primary operation the compact drive should be free running, i.e. with the load disconnected.

**Additional Safety Equipment**

Any electronic apparatus is, in principle, not fail-safe. Machines and apparatus must therefore be fitted with independent monitoring and safety equipment. If the equipment breaks down, if it is operated incorrectly, if the control unit breaks down or if the cables break, etc., it must be ensured that the drive or the complete apparatus is kept in a safe operating mode.

**Repairs**

Repairs may be made by authorized personnel only or by the manufacturer. Improper repairs can result in substantial dangers for the user.

**Danger**

During installation of the MCD EPOS P 60 W, make sure to disconnect all apparatus from the electrical supply.
After switch-on, do not touch any life parts!

**Max. Supply Voltage**

Make sure that the supply voltage is between 12 and 50 VDC. Voltages higher than 55 VDC or of wrong polarity will destroy the unit.

**Electrostatic Sensitive Device (ESD)**

6 Performance Data

6.1 Motor data

Nominal torque (max. continuous torque)	54 mNm ($T_a=25^\circ\text{C}$, 5000 rpm) ¹⁾
Max. torque	218 mNm
Max. permissible speed (restricted by Encoder)	12000 rpm
Max. efficiency	70 %
Torque constant	24.3 mNm/A
Speed constant	393 rpm/V
Speed / Torque gradient	20.6 rpm/mNm
Rotor inertia	21.9 gcm ²
Axial play at axial load	< 6 N 0 mm > 6 N 0.14 mm
Radial play	preloaded
Max. axial load (dynamic)	5.5 N
Max. force for press fits (static)	100 N
Max. radial loading, 5 mm from flange	25 N

6.2 Electrical data

Power supply voltage V_{CC} (Ripple < 10%)	12 ... 50 VDC
Logic supply voltage V_C (Ripple < 10%) (optional)	12 ... 50 VDC
Max. output voltage	$0.9 \cdot V_{CC}$
Max. output current I_{max}	9 A
Continuous output current I_{cont}	2.6 A ($T_a=25^\circ\text{C}$, 5000 rpm) ¹⁾
Switching frequency	50 kHz
Max. efficiency	93 %
Sample rate PI - current controller	10 kHz
Sample rate PI - speed controller	1 kHz
Sample rate PID - positioning controller	1 kHz
Position resolution	0.09°
Position accuracy	typical $\pm 1^\circ$
Position reproducibility	typical $\pm 0.09^\circ$
Hall sensor signals	Hall sensor 1, Hall sensor 2, Hall sensor 3
Encoder signals	1000 Increments A, A\, B, B\, I, I\ (max. 200 KHz)

6.3 Inputs

Digital input 1 ("General Purpose")	opto-isolated	+9 ... +24 VDC
Digital input 2 ("Home Switch")	opto-isolated	+9 ... +24 VDC
Digital input 3 ("Positive Limit Switch")	opto-isolated	+9 ... +24 VDC
Digital input 4 ("Negative Limit Switch")	opto-isolated	+9 ... +24 VDC
Digital input 7 ("High Speed Command")	line receiver EIA standard RS-422	
Digital input 8 ("High Speed Command")	line receiver EIA standard RS-422	
+V Opto IN		+12 ... +24 VDC

6.4 Outputs

Digital output 3 ("General Purpose")	opto-isolated	max. 24 VDC ($I_L < 350$ mA)
Digital output 4 ("General Purpose")	opto-isolated	max. 24 VDC ($I_L < 350$ mA)

¹⁾ Valid at $T_a=25^\circ\text{C}$, thermally isolated, no convection and 5000 rpm
Higher value (I_{cont} max.3A) possible with better ambient conditions for example:

- free convection or forced air cooling
- thermal coupling
- lower speed

6.5 Interfaces

RS-232	RxD; TxD	max. 115 200 bit/s
CAN (high speed)	CAN_H (high); CAN_L (low)	max.1 MBit/s
CAN-ID, no mechanical switch, configured according to		LSS CiA DSP-305

6.6 Memory Data

Total memory	512 kByte
Application memory (free programmable)	256 kByte
Non-volatile memory	512 Byte

6.7 LED indicator

Bi-colour LED	green = ENABLE, red = FAULT
Blue LED	PROGRAM STATUS

6.8 Ambient temperature- / Humidity range

Protection class	IP42 (optional IP54)
Operating	-20 ... +85°C
.....	power derating 1.4%/K above $T_a=25^\circ\text{C}^{1)}$
Storage	-40 ... +85°C
Non condensating	20 ... 80 %
Max. case temperature	< 100°C

6.9 Mechanical data

Weight	approx. 495 g
Dimensions (L x W x H)	120 x 33 x 53 mm
Mounting plate	for M3x4.5 screws

6.10 Connections

J1 Signal	D-Sub connector High-Density 15 poles (female)
Suitable plug:	D-Sub connector High-Density 15 poles (male)
J2 Power / Communication	D-Sub connector 9 poles (male)
Suitable plug:	D-Sub connector 9 poles (female)

6.11 Order number

MCD EPOS P 60 W	315665
-----------------------	---------------

¹⁾ Valid at $T_a=25^\circ\text{C}$, thermally isolated, no convection and 5000 rpm
 Higher value (I_{cont} max.3A) possible with better ambient conditions for example:

- free convection or forced air cooling
- thermal coupling
- lower speed

7 Connections

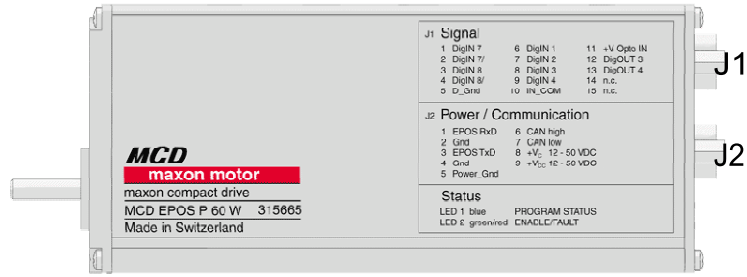


Figure 3: Connector location

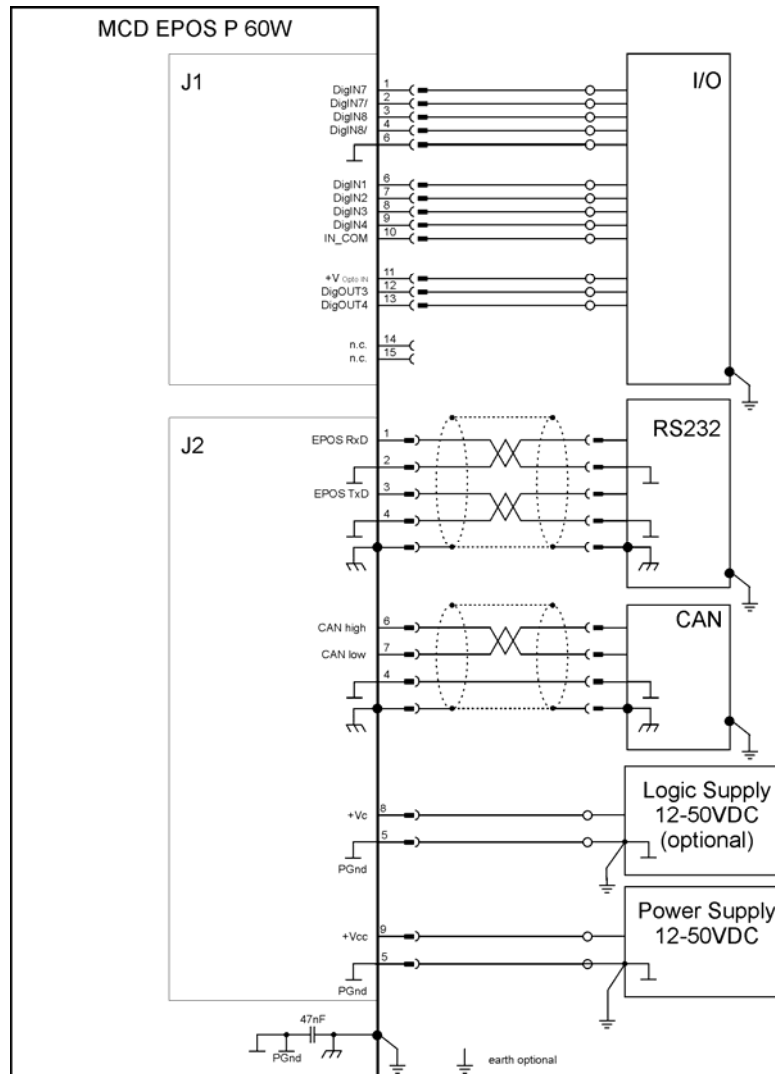


Figure 4: Wiring diagram (overview)

7.1 Signal connector (J1)

Signal connector contains smart multi-purpose digital I/O's preconfigured as: "Positive- and Negative Limit Switches" and "Home Switch". Additionally "General Purpose" digital I/O's are provided.

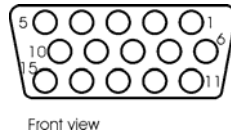


Figure 5: Signal connector (J1) D-Sub connector High-Density 15 poles (female)

Pin No.	Signal	Description
1	DigIN 7	Digital input 7 "High Speed Command" signal
2	DigIN 7/	Digital input 7 "High Speed Command" complement signal
3	DigIN 8	Digital input 8 "High Speed Command" signal
4	DigIN 8/	Digital input 8 "High Speed Command" complement signal
5	D_Gnd	Digital signal ground
6	DigIN 1	Digital input 1 "General Purpose"
7	DigIN 2	Digital input 2 "Home Switch"
8	DigIN 3	Digital input 3 "Positive Limit Switch"
9	DigIN 4	Digital input 4 "Negative Limit Switch"
10	IN_COM	Common signal for DigIN 1...4
11	+V Opto IN	External supply Input voltage for Digital Outputs (+12 ... 24VDC)
12	DigOUT 3	Digital output 3 "General Purpose"
13	DigOUT 4	Digital output 4 "General Purpose"
14	n.c.	Not connected
15	n.c.	Not connected

Accessories: MCD EPOS signal cable

maxon order number: **326923**

Suitable connector: D-Sub connector High-Density 15 poles (male)

7.1.1 Digital input 7 “High Speed Command”

“High Speed Command” differential input by default and can be configured via software setting.

Differential

Connector No. and Pin No.	Connector [J1] Pin number [1] Connector [J1] Pin number [2]
Min. differential input voltage	±200 mV
Line receiver (internal)	EIA standards RS-422
Max. input frequency	500 kHz

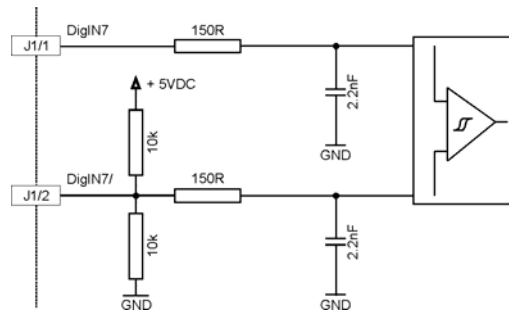


Figure 6: Digital input 7 “Differential” circuit

Single-ended DigIN 7

Connector No. and Pin No.	Connector [J1] Pin number [1]
Input voltage	0...5 VDC
Max. input voltage	± 24 VDC
Logic 0	< 2.0 V
Logic 1	> 3.0 V
Input resistance	typical 48 kΩ (referenced to D_Gnd)

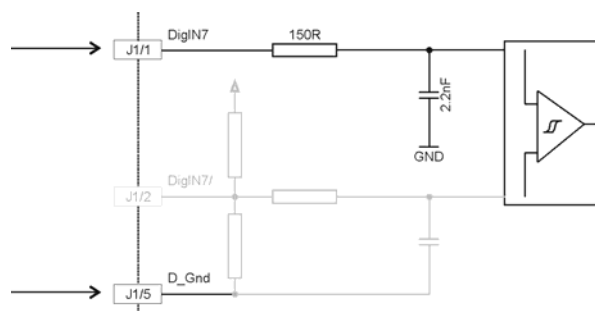


Figure 7: Digital input 7 “Single-ended” circuit

Note

Using the Digital Input as single ended, apply the input signal between DigIN7 [J1/1] and D_Gnd [J1/5] and let DigIN7/ [J1/2] unconnected.

7.1.2 Digital input 8 “High Speed Command”

“High Speed Command” differential input by default and can be configured via software setting.

Connector No. and Pin No.	Connector [J1] Pin number [3] Connector [J1] Pin number [4]
Min. differential Input voltage	± 200 mV
Line receiver	EIA standards RS-422
Max. input frequency	500 kHz

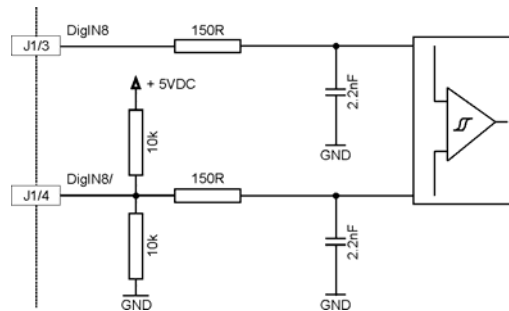


Figure 8: Digital input 8 “Differential” circuit

Single-ended DigIN 8

Connector No. and Pin No.	Connector [J1] Pin number [3]
Input voltage	0...5 VDC
Max. input voltage	± 24 VDC
Logic 0	< 2.0 V
Logic 1	> 3.0 V
Input resistance	typical 48 k Ω (referenced to D_Gnd)

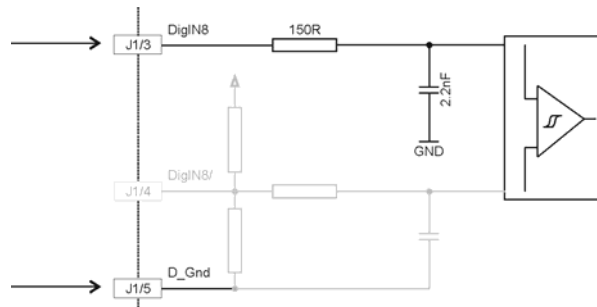


Figure 9: Digital input 8 “Single-ended” circuit

Note

Using the Digital Input as single ended, apply the input signal between DigIN 8 [J1/3] and D_Gnd [J1/5] and let DigIN 8/ [J1/4] unconnected.

7.1.3 Digital input 1, 2, 3, 4 “General Purpose”

These opto-isolated inputs are defined as:

Digital input 1: “General Purpose”

Digital input 2: “Home Switch”

Digital input 3: “Positive Limit Switch”

Digital input 4: “Negative Limit Switch”

by default and can be configured via software setting.

Digital input 1	[DigIN 1]	Connector [J1] Pin number [6]
Digital input 2	[DigIN 2]	Connector [J1] Pin number [7]
Digital input 3	[DigIN 3]	Connector [J1] Pin number [8]
Digital input 4	[DigIN 4]	Connector [J1] Pin number [9]
Common signal	[IN_COM]	Connector [J1] Pin number [10]

Type of Input	Optical isolated Single ended
Input voltage	0...+24 VDC
Max. input voltage	± 30 VDC
Logic 0	$ I_{in} < 1 \text{ mA}$ $ U_{in} < 5 \text{ VDC}$
Logic 1	$ I_{in} > 2 \text{ mA}$ $ U_{in} > 9 \text{ VDC}$

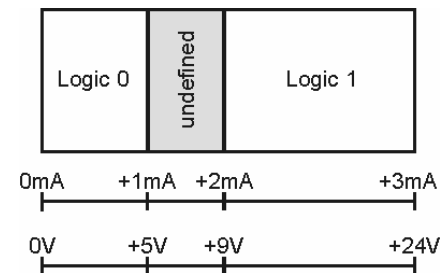


Figure 10: Logic level

Input current at logic 1	typical 3 mA @ 24 VDC
Switching delay	< 300 μs @ 24 VDC

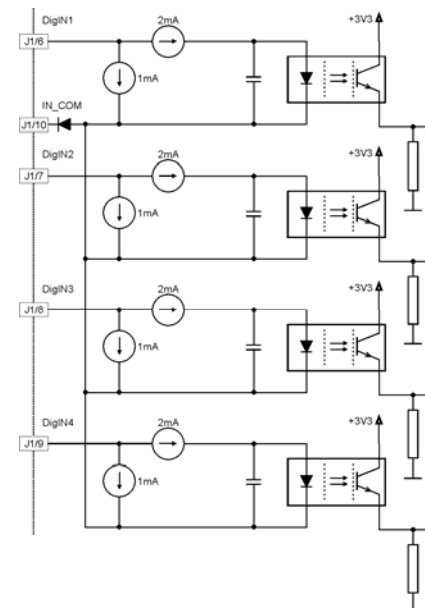


Figure 11: Digital input 1,2,3,4

Wiring examples:

Different types of proximity switches

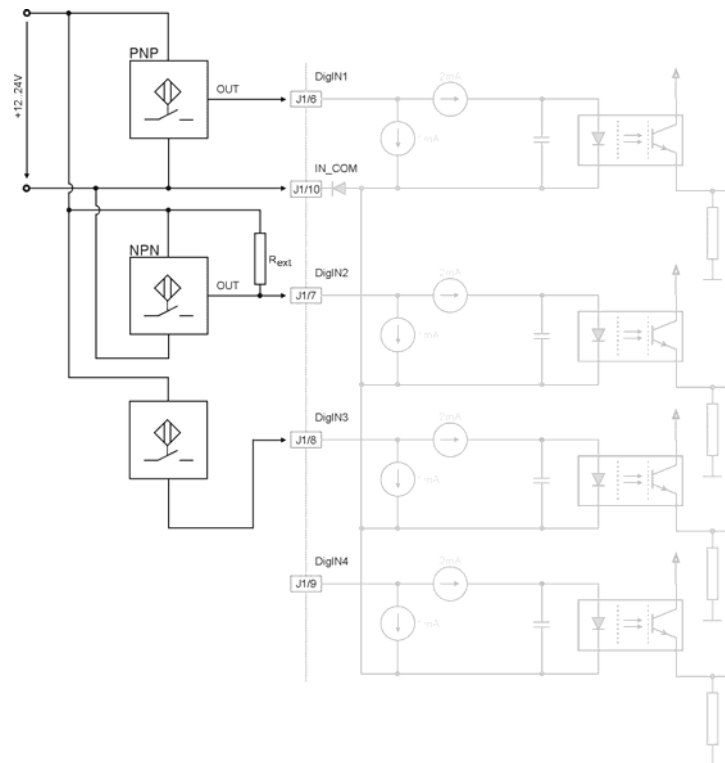


Figure 12: Digital input 1,2,3,4 external wiring examples

Notes

- Use of 3-wire PNP proximity switches is preferred.
- Use of 3-wire NPN proximity switches needs an additional external pull-up resistor
 $R_{ext} (12V) = 1 \text{ k}\Omega (150\text{mW})$
 $R_{ext} (24V) = 5 \text{ k}\Omega (120\text{mW})$
- Use of 2-wire proximity switches is possible.
 Consider a minimal load current of approximately 5mA should be complied. Depending on 2-wire proximity switch an additional parallel resistor is necessary.

7.1.4 “+V Opto IN” external supply Input voltage for Digital Outputs

An external supply voltage has to be applied for supplying the digital optical-isolated outputs.

+V Opto IN	[+V Opto IN]	Connector [J1] Pin number [11]
Common signal	[IN_COM]	Connector [J1] Pin number [10]

Any available power supply can be used, provided it meets the minimal requirements set below.

Supply voltage	+12...+24 VDC
Min. current *	700 mA

* If maximum load of digital outputs is required

7.1.5 Digital output 3 and 4 “General Purpose”

These opto-isolated outputs are defined as “General Purpose” by default and can be configured via software setting.

Digital output 3	[DigOUT3]	Connector [J1] Pin number [12]
Digital output 4	[DigOUT4]	Connector [J1] Pin number [13]
+V Opto IN	[+V Opto IN]	Connector [J1] Pin number [11]
Common signal	[IN_COM]	Connector [J1] Pin number [10]

Type of Output	Optical isolated Open-Emitter
Output voltage	$U_{out} \geq (+V \text{ Opto IN} - 1.5V)$
Max. load current	$I_{load} \leq 350 \text{ mA}$
Leakage current	$I_{leak} \leq 50 \mu\text{A}$
Switching delay	$< 300 \mu\text{s @ 24 VDC}$
Max. inductive load	2 H @ 24VDC; 500mA

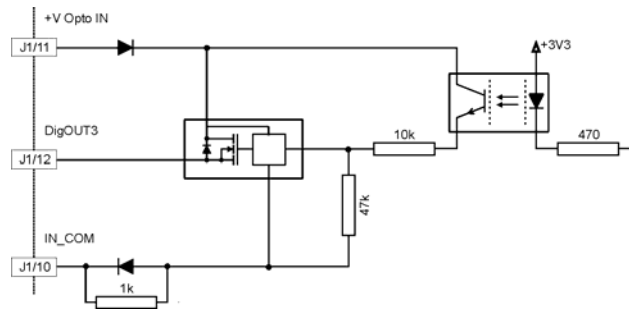
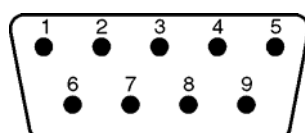


Figure 13: Digital output 3

7.2 Power / Communication connector (J2)



Front view

Figure 14: Power / Communication connector (J2) D-Sub connector 9 poles (male)

Pin No.	Signal	Description
1	EPOS RxD	EPOS RS232 receive
2	Gnd	Ground
3	EPOS TxD	EPOS RS232 transmit
4	Gnd	Ground
5	Power_Gnd	Ground of supply voltage
6	CAN high	CAN high bus line
7	CAN low	CAN low bus line
8	+V _C 12-50 VDC	Logic supply voltage (optional) +12...+50 VDC
9	+V _{CC} 12-50 VDC	Power supply voltage +12...+50 VDC

Accessories:	MCD EPOS Power / RS232-CAN cable	maxon order number: 325939
	MCD EPOS Power / CAN-CAN cable	maxon order number: 325235
	MCD EPOS CAN termination plug	maxon order number: 326923

Suitable connector: D-Sub connector 9 poles (female)

7.2.1 RS-232 communication

RxD receive line	[EPOS RxD]	Connector [J2] Pin number [1]
Ground	[Gnd]	Connector [J2] Pin number [2]
TxD transmit line	[EPOS TxD]	Connector [J2] Pin number [3]
Ground	[Gnd]	Connector [J2] Pin number [4]

Maximum input voltage	± 30 V
Output voltage	typical ± 9 V @ $3k\Omega$ to Ground
Maximum bit rate	115 200 bit/s
Internal RS232 driver/receiver	EIA RS232 standard

Notes

- Please consider your PC's serial port maximal baud rate.
- The standard baud rate setting (factory setting) is 115 200 bit/s.

Connection MCD - PC

MCD EPOS P 60W	PC Interface (RS232), DIN41652
Connector J2 pin 2 + 4 "GND"	Pin 5 "GND"
Connector J2 pin 1 "EPOS RxD"	Pin 3 "PC TxD"
Connector J2 pin 3 "EPOS TxD"	Pin 2 "PC RxD"

Note

The RS-232 interface is used as programming interface by the maxon programming tool EPOS Studio. It can not be used by the application program.

7.2.2 CAN communication

CAN high bus line	[CAN high]	Connector [J2] Pin number [6]
CAN low bus line	[CAN low]	Connector [J2] Pin number [7]
Ground	[Gnd]	Connector [J2] Pin number [4]

Standard type	CAN high-speed ISO 11898 compatible
Maximum bit rate	1 MBit/s
Max. number of CAN nodes	127
Protocol	CANopen DS-301 V4.02
CAN ID	LSS CiA DSP-305

Connection EPOS - CAN
bus line CiA DS-102

MCD EPOS P 60W	CAN 9 pin D-Sub (DIN41652)
Connector J2 pin 6 "CAN high"	Pin 7 "CAN_H" high bus line
Connector J2 pin 7 "CAN low"	Pin 2 "CAN_L" low bus line
Connector J2 pin 4 "Gnd"	Pin 3 "CAN_GND" Ground

Notes

- The standard baud rate setting (factory setting) is 1 MBit/s.
- Further CAN information may be found in the "Communication Guide" documentation.
- Use termination resistors on both ends of the CAN bus.

7.2.3 Logic supply (optional)

Logic supply voltage	[+V _C 12-50 VDC]	Connector [J2] Pin number [8]
Ground of supply voltage	[Power_Gnd]	Connector [J2] Pin number [5]

Optionally, the logic supply voltage can be sourced separately. This allows a safe and economical power backup feature.

In case of no separate Logic supply is applied, the Logic supply will be sourced by the Power supply voltage automatically.

Any available power supply can be used, provided it meets the minimal requirements set out below.

Logic supply requirements

Output voltage	V _C min. 12 VDC; V _C max. 50 VDC
Ripple	< 10 %
Min. Output power	P _C min. 3 W

7.2.4 Power supply

Power supply voltage	[+V _{CC} 12-50 VDC]	Connector [J2] Pin number [9]
Ground of supply voltage	[Power_Gnd]	Connector [J2] Pin number [5]

Any available power supply can be used, provided it meets the minimal requirements set out below.

During set up and adjustment phases, we recommend separating the unit mechanically from the machine to prevent damage due to uncontrolled motion.

Power supply requirements

Output voltage	V _{CC} min. 12 VDC; V _{CC} max. 50 VDC
Ripple	< 10 %
Output current	Depending on load, continuous min. 2.6 A acceleration, short-time min. 9 A

The required voltage can be calculated as follows:

Known values

- ⇒ Operating torque M_B [mNm]
- ⇒ Operating speed n_B [rpm]
- ⇒ Speed constant: k_n = 393 rpm/V
- ⇒ Speed/torque gradient: Δn/ΔM = 20.6 rpm/mNm

Sought value

- ⇒ Supply voltage +V_{CC} [Volt]

Solution

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

$$V_{CC} = \frac{1}{393 \left[\frac{rpm}{V} \right]} \cdot \left(n_B + 20.6 \left[\frac{rpm}{mNm} \right] \cdot M_B \right) \cdot \frac{1}{0.9} + 1 [V]$$

Choose a power supply capable of supplying this calculated voltage under load. The formula takes a max. PWM cycle of 90 % and a 1 V max. voltage drop at power stage into account.

Consider

During braking of the load, the power supply must be capable of buffering the feed back energy, e.g. in a capacitor or shunt regulator.

When using an electronically stabilized power supply observe that the over current protection shall not be activated in any operating state

8 LED status

Three LED's are showing the actual state of the MCD EPOS P 60W:

- Green LED Shows the operating status
- Red LED Indicates an error
- Blue LED Shows the status of the application program

Detailed information may be found in the Firmware Specification document.

Red LED	Green LED	Blue LED	Description
OFF	Slow blinking ($\approx 1\text{Hz}$)	X	The EPOS is in state: - <i>Switch ON Disabled</i> - <i>Ready to Switch ON</i> - <i>Switched ON</i> The power stage is disabled
OFF	ON	X	The EPOS is in state: - <i>Operation Enable</i> - <i>Quick Stop Active</i> The power stage is enabled
ON	OFF	X	The EPOS is in state - <i>Fault</i>
ON	ON	X	The EPOS is in temporary state - <i>Fault Reaction Active</i> The power stage is enabled
ON	Flashing	X	There is no valid firmware on the EPOS (due to a failed firmware download)
X	X	fast blinking ($\approx 4\text{Hz}$)	There is no valid application program on the EPOS P
X	X	slow blinking ($\approx 1\text{Hz}$)	The application program on the EPOS P is stopped
X	X	ON	The application program on the EPOS P is running
X	X	Flashing	The application program on the EPOS P is in Error state

X: Don't care (ON or OFF)

9 Dimension drawing

Dimensions in [mm]

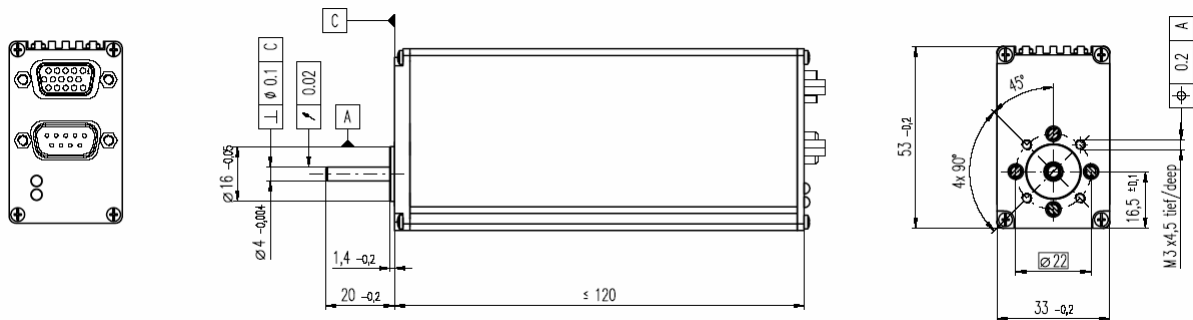


Figure 15: Dimensions MCD EPOS P 60 W