# *MCD EPOS* 60 W

## Positioning Compact Drive

## Documentation

# Hardware Reference

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# 3 Introduction

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

The maxon MCD EPOS 60 W is a small-sized 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. It is specially designed being commanded and controlled as a slave node in the CANopen network. In addition the unit can be operated through any RS-232 communication port.

*Figure 1: MCD EPOS 60 W*

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.

# 4 How to use this guide

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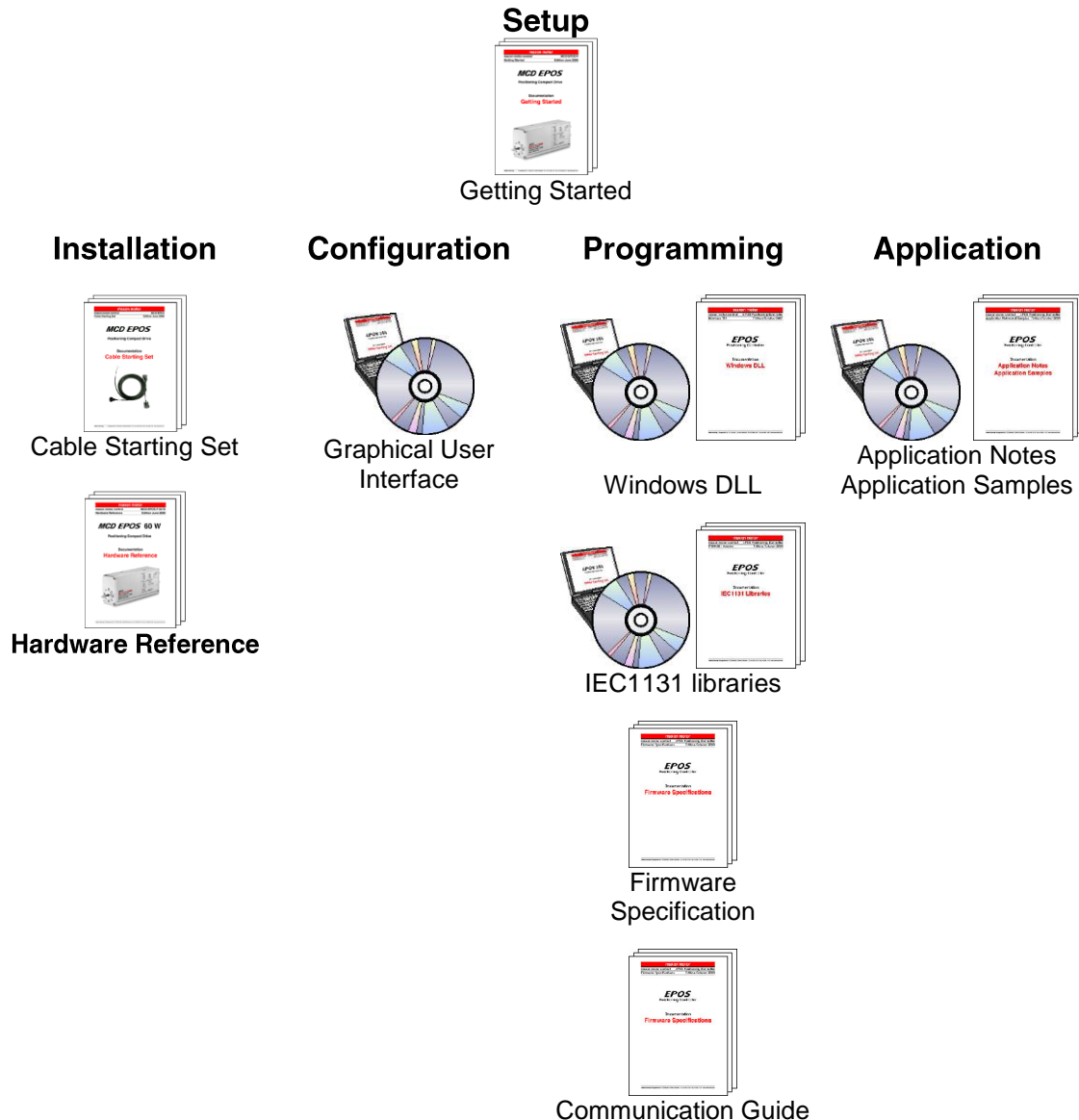
*Figure 2: EPOS documentation hierarchy*

# 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 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 °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 · $V_{CC}$
Max. output current $I_{max}$ .................................................................... 9 A
Continuous output current $I_{cont}$ ..................................... 2.6 A ($T_a$=25 °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 ± 1°
Position reproducibility ........................................................................ typical ± 0.09°
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)

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[1]     Valid at $T_a$ =25°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    LED indicator

Bi-colour LED ......................................................... green = ENABLE, red = FAULT
Blue LED ........................................................ is not used with MCD EPOS 60 W

## 6.7    Ambient temperature- / Humidity range

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

## 6.8    Mechanical data

Weight ....................................................................................... approx. 528 g
Dimensions (L x W x H) ............................................................. 120 x 33 x 53 mm
Mounting plate .......................................................................... for M3x4.5 screws

## 6.9    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)

## 6.10  Order number

MCD EPOS 60 W ....................................................................................... **326343**

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[1]     Valid at $T_a$ =25°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
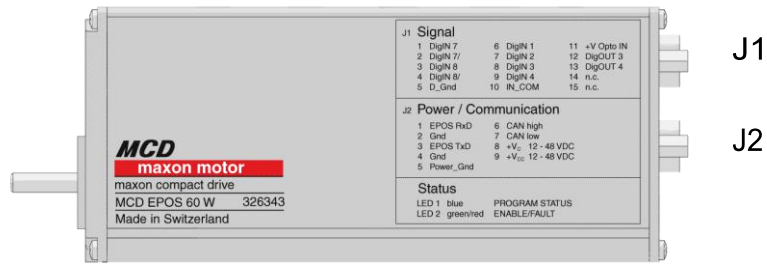        -    lower speed

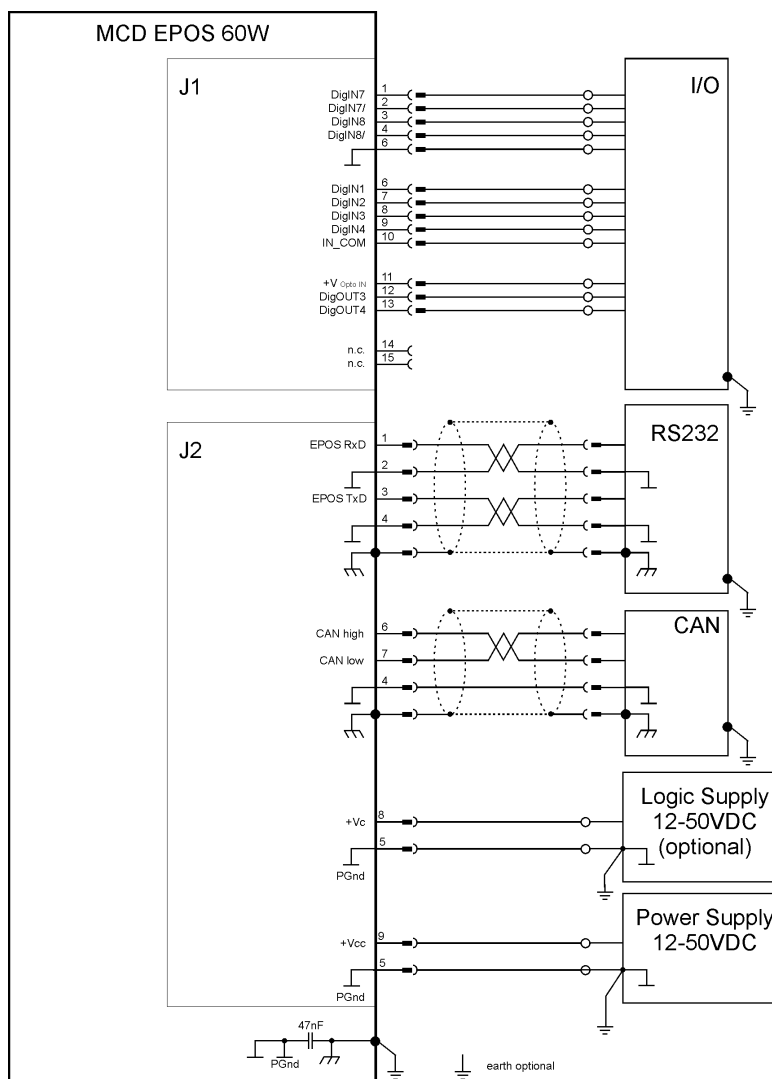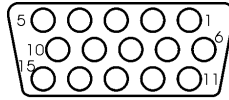# 7 Connections



*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.



Front view

*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

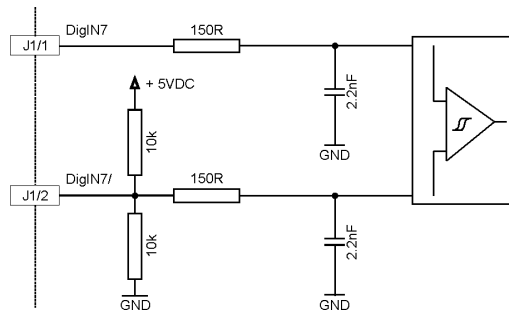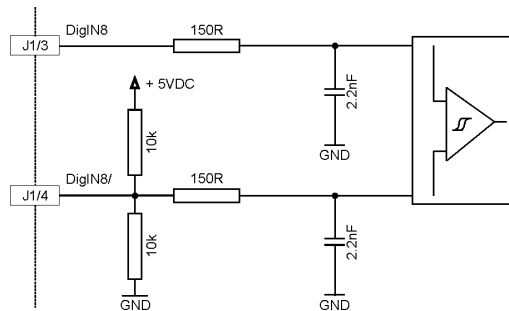| Connector No. and Pin No. | Connector [J1] Pin number [1] |
| | Connector [J1] Pin number [2] |
| Min. differential input voltage | ±200 mV |
| Line receiver (internal) | EIA standards RS-422 |
| Max. input frequency | 500 kHz |

*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) |
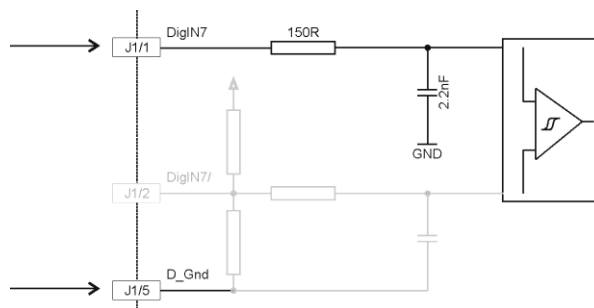
*Figure 7: Digital input 7 "Single-ended" circuit*

**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]<br>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 kΩ<br>(referenced to D_Gnd) |
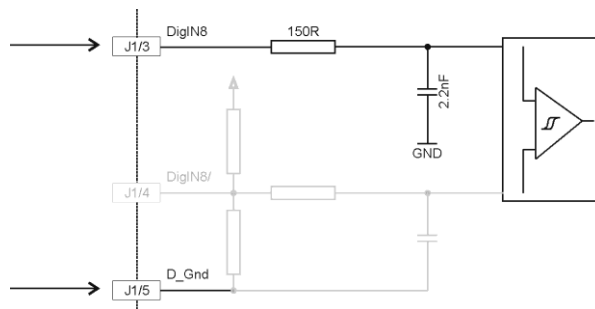


*Figure 9: Digital input 8 "Single-ended" circuit*

**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 | $\| I_{in} \| < 1$ mA $\| U_{in} \| < 5$ VDC |
| Logic 1 | $\| I_{in} \| > 2$ mA $\| U_{in} \| > 9$ VDC |
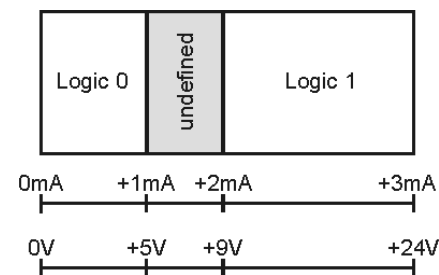


*Figure 10: Logic level*

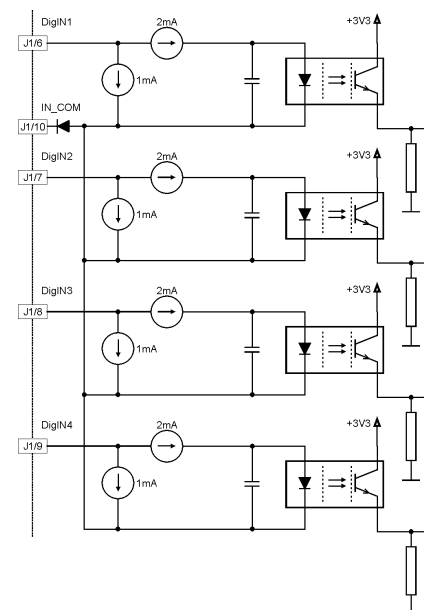| Input current at logic 1 | typical 3 mA @ 24 VDC |
| --- | --- |
| Switching delay | < 300 $\mu$s @ 24 VDC |



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

**Wiring examples:**

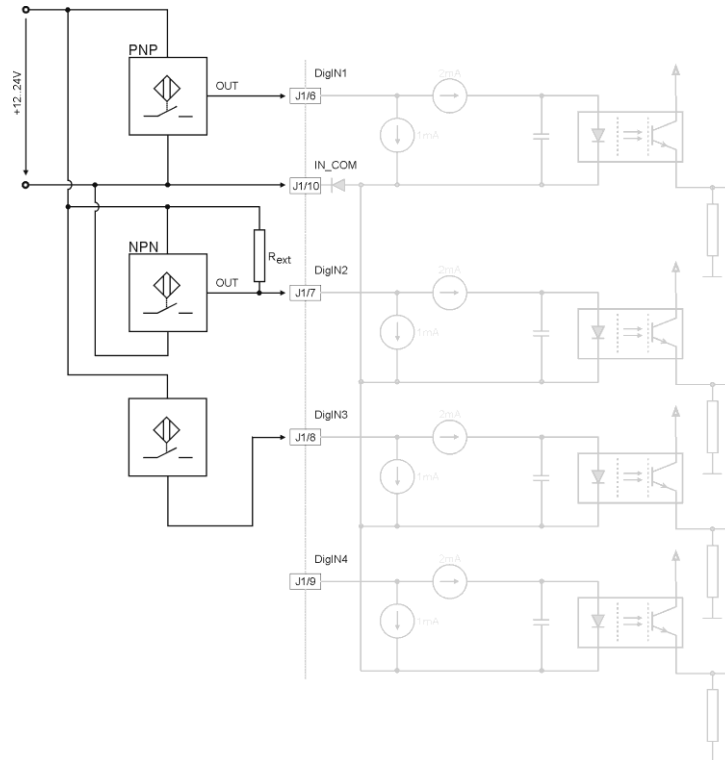Different types of proximity switches



*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 kΩ (150mW)
  $R_{ext}$ (24V) = 5 kΩ (120mW)
- 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] |

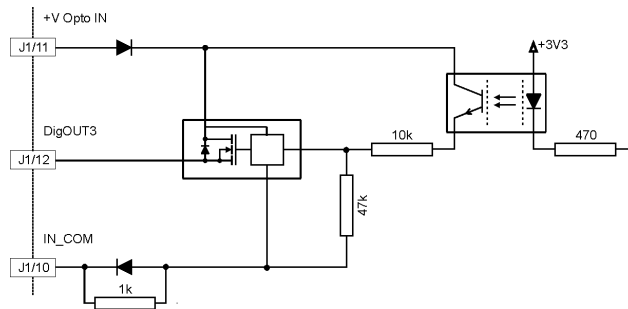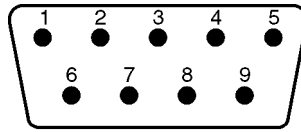| | |
|---|---|
| Type of Output | Optical isolated Open-Emitter |
| Output voltage | $U_{out} \geq$ (+V Opto IN – 1.5V) |
| Max. load current | $I_{load} \leq 350$ mA |
| Leakage current | $I_{leak} \leq 50$ µA |
| Switching delay | < 300 µs @ 24 VDC |
| Max. inductive load | 2 H @ 24VDC; 500mA |



*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 | $\pm$ 30 V |
| Output voltage | typical $\pm$ 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 38 400 bit/s.

Connection MCD - PC

| MCD EPOS 60 W | 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" |

## 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 60 W** | **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**
- Please consider your CAN Master port maximal baud rate.
- 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: $\Delta n/\Delta M$ = 20.6 rpm/mNm

**Sought value**
- ⇨  Supply voltage +$V_{CC}$ [Volt]

**Solution**

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

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

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

The green LED shows the operating status and the red LED indicates an error of the positioning controller MCD EPOS 60W. Detailed information may be found in the Firmware Specification document.

| Red LED | Green LED | Description |
|---------|-----------|-------------|
| OFF | Slow blinking (≈ 1Hz) | The EPOS is in state:<br>- *Switch ON Disabled*<br>- *Ready to Switch ON*<br>- *Switched ON*<br>The power stage is disabled |
| OFF | **ON** | The EPOS is in state:<br>- *Operation Enable*<br>- *Quick Stop Active*<br>The power stage is enabled |
| **ON** | OFF | The EPOS is in state:<br>- *Fault* |
| **ON** | **ON** | The EPOS is in temporary state:<br>- *Fault Reaction Active*<br>The power stage is enabled |
| **ON** | Flashing | There is no valid firmware on the EPOS (due to a failed firmware download) |

# 9 Dimension drawing

Dimensions in [mm]
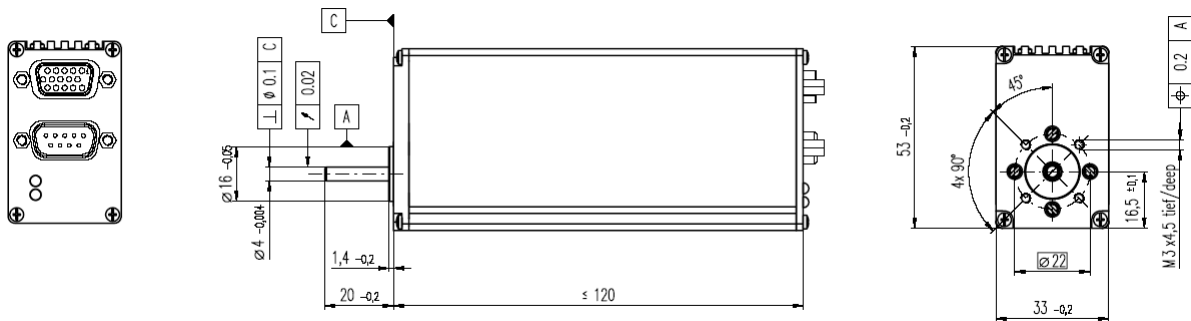


*Figure 15: Dimensions MCD EPOS 60 W*