

PD2-E CANopen



Short instructions

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Introduction

The *PD2-E* is a brushless motor with integrated controller in two versions in protection classes IP30 and IP65, respectively. The integrated absolute encoder (single-turn and multi-turn variants available) makes immediate operation possible in *closed-loop* mode without homing.

This instruction describes the installation and commissioning of the motor. You can find the detailed documentation for the product and motor data sheets on **us.nanotec.com**. The short instructions do not replace the *technical manual* of the motor.

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Intended use

The *PD2-E* motor with integrated controller is used as a component of drive systems in a range of industrial applications.

Use the product as intended within the limits defined in the technical data (in particular, see **Permissible operating voltage**) and the approved **Environmental conditions**. This Nanotec product may not be integrated as a safety component in a product or system under any circumstances.

All products containing a component manufactured by Nanotec must, upon delivery to the end user, be provided with corresponding warning notices including instructions for safe use and safe operation. All warning notices provided by Nanotec must be passed on directly to the end user.

Warranty and disclaimer

Nanotec shall not be liable for damage and malfunctions attributable to installation errors, failure to observe this document or improper repair. The plant engineer, operating company and user shall be responsible for the selection, operation and use of our products. Nanotec shall not take responsibility for integration of the product in the end system. The general terms and conditions listed at www.nanotec.de shall apply. **Comment:** Modifications/changes to the product as well as opening the product are prohibited.

Target group and qualification

The product and this documentation are directed towards technically trained specialists staff such as: development engineers, plant engineers, installers/ service personnel, and application engineers.

Only specialists may install, program and commission the product. Specialist staff are persons who

- have appropriate training and experience in working with motors and their controller,
- are familiar with and understand the content of this technical manual,
- know the applicable regulations.

EU directives for product safety

The following EU directives were observed:

- RoHS directive (2011/65/EU, 2015/863/EU)
- EMC directive (2014/30/EU)

Other applicable regulations

In addition to this technical manual, the following regulations are to be observed:

- Accident-prevention regulations
- Local regulations on occupational safety

Safety and warning notices



CAUTION!

Risk of burning from hot surfaces!

The motor can become very hot during operation. If touched, this could result in burns.

- During use, make certain that the environmental conditions are ensured and that operation takes place within the limits defined by the technical data.
- Install the motor in such a way that heat dissipation and passive cooling are possible.
- After switching off, wait until all components have cooled before you touch them.

NOTICE

Damage to the controller!

Changing the wiring during operation may damage the controller.

- Only change the wiring in a de-energized state. After switching off, wait until the capacitors have discharged.

NOTICE

Damage to the controller due to excitation voltage of the motor!

Voltage peaks during operation may damage the controller.

- Install suitable circuits (e. g., charging capacitor) that reduce voltage peaks.

NOTICE

Damage to the electronics through improper handling of ESD-sensitive components!

The device contains components that are sensitive to electrostatic discharge. Improper handling can damage the device.

- Observe the basic principles of ESD protection when handling the device.

NOTICE

Damage to the electronics if the supply voltage is connected with reversed polarity!

Polarity reversal results in a short-circuit between supply voltage and GND (earth) via the power diode.

- Install a line protection device (fuse) in the supply line.

Technical details and pin assignment

Environmental conditions

Environmental condition	Value
Protection class	- PD2-E...-30-...: IP30 - PD2-E...-65-...: IP65 (IP54 at the shaft output)
Degree of contamination	2
Ambient temperature (operation)	-10 ... +40°C
Ambient temperature (storage and transport)	-20 ... +85°C
Relative humidity (operation), non-condensing	0 ... 85%
Relative humidity (storage and transport), non-condensing	0 ... 85%
Absolute humidity (storage and transport), non-condensing	30 g/m ³
Max. altitude of site above <i>sea level</i> / (without drop in performance in operation)	1500 m (drop in performance above 1000 m: -1%/100 m)
Max. altitude of site above <i>sea level</i> / (storage and transport)	3000 m

Electrical properties and technical data

Electrical data

Operating voltage of motor (rated value)

48 V DC

Except for variants PD2-EB...**B**-...: 24 V DC

Permissible range of the operating voltage

11.4...57.6 V DC

Logic voltage (rated value)

24 V DC

Voltage range of the logic supply

11.4...30 V DC

Rated current

- PD2-EB42MB-... : 3.1 A rms
- PD2-EB42MD-... : 1.5 A rms
- PD2-EB42LB-... : 4.8 A rms
- PD2-EB42LD -... : 2.4 A rms
- PD2-EB42CD -... : 3.66 A rms
- PD2-E421... (steppers) : 1.8 A rms

Peak current (for max. 1 s)

- PD2-EB42MB-... : 9.3 A rms
- PD2-EB42MD-... : 4.6 A rms
- PD2-EB42LB-... : 14.4 A rms
- PD2-EB42LD -... : 7.2 A rms
- PD2-EB42CD -... : 11 A rms
- PD2-E421... (steppers) : 3 A rms

Technical data

Operating modes	<i>Profile Position Mode, Profile Velocity Mode, Profile Torque Mode, Velocity Mode, Homing Mode, Interpolated Position Mode, Cyclic Sync Position Mode, Cyclic Sync Velocity Mode, Cyclic Synchronous Torque Mode, Clock-Direction Mode</i>
Set value setting / programming	<i>CANopen, analog input, NanoJ program</i>
Inputs	4 digital inputs (+5 V/+24 V (V+Logic) DC), switchable by means of software, factory settings: 5 V 2 analog inputs 0...24 V
Outputs	2 digital outputs, <i>Push-Pull</i> , (+5 V/+24 V (V +Logic) DC) max. 100 mA 1 PWM brake output for external holding brake
Integrated encoder	- PD2-...-E-x(x): Magnetic, single-turn absolute encoder, 16 bits - PD2-...-M-x(x): Magnetic, multi-turn absolute encoder, 16 bits multi-turn, 17 bits single-turn resolution
Protection circuit	Overvoltage and undervoltage protection Overtemperature protection (> 80 °C on the power board)

Overtemperature protection

Above a temperature of approx. 80 °C on the power board the power part of the controller switches off and the error bit is set. After cooling down and confirming the error , the controller again functions normally.

LED signaling

Power LED

The power LED indicates the current status.

Normal operation

In normal operation, the green power LED flashes briefly once per second.

Case of an error

If an error has occurred, the LED turns red and signals an error number.

The following table shows the meaning of the error numbers.

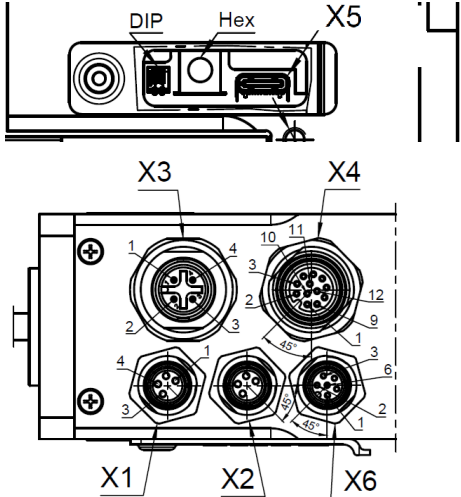
Flash rate	Error
1	General
2	Voltage
3	Temperature
4	Overcurrent
5	Controller
6	Watchdog-Reset



NOTICE

For each error that occurs, a more precise error code is stored in object **1003_h**.

Connections



Connection	Function	Pin assignment / description															
X1	CANopen IN and external logic supply	V+Logic: 12 - 30 V DC CAN_SHLD: connection for shield CAN_H CAN_L GND: internally connected to all GND pins															
X2	CANopen OUT and external logic supply																
X3	Connection for the power supply 12 - 57.6 V DC	V+ V+ GND GND															
X4	In- / Outputs and external logic supply Thresholds for the digital inputs: 5 V (factory setting) : On: >4.09 V; Off: <0.95 V 24 V : On: >14.74 V; Off: <3.78 V	GND Digital input 1: 5 V / 24 V, switchable with object 323A_h, max. 1 MHz Digital input 2: 5 V / 24 V, switchable with object 323A_h, max. 1 MHz Digital input 3: 5 V / 24 V, switchable with object 323A_h, max. 1 MHz Digital input 4: 5 V / 24 V, switchable with object 323A_h, max. 1 MHz Analog input 1: 12 Bit, 0 V...+24 V Analog input 2: 12 Bit, 0 V...+24 V Digital output 1: Push-Pull, switchable 5 V / V+ Logic with 323A_h, max. 100 mA Digital output 2: Push-Pull, switchable 5 V / V+ Logic with 323A_h, max. 100 mA V+ Logic: 12 - 30 V DC Brake +: PWM controlled output for optional external holding brake, max. V + Logic, 400 mA, 20 kHz Brake -															
X5	USB, Typ C	Configuration interface															
X6 (only with PD2-E(B)42x(x)-xS-...)	STO (<i>Safe Torque Off</i>) Detailed description in the document <i>Functional description STO</i> at us.nanotec.com .	STO-A-IN STO-A-RTN b2: STO-FBH STO-FBL STO-B-IN STO-B-RTN															
Hex	Hex coding switch for setting the <i>Node-ID</i> und baud rate: 	<table><tr><th>Value of the switch</th><th>Node-ID</th><th>Baud rate</th></tr><tr><td>0_h</td><td>Object 2009_h</td><td>1MBd</td></tr><tr><td>1_h-7_h</td><td>Value of the switch</td><td>1MBd</td></tr><tr><td>8_h</td><td>Object 2009_h</td><td>Object 2005_h</td></tr><tr><td>9_h-F_h</td><td>(Number of the switch)-8</td><td>Object 2005_h</td></tr></table>	Value of the switch	Node-ID	Baud rate	0 _h	Object 2009_h	1MBd	1 _h -7 _h	Value of the switch	1MBd	8 _h	Object 2009_h	Object 2005_h	9 _h -F _h	(Number of the switch)-8	Object 2005_h
Value of the switch	Node-ID	Baud rate															
0 _h	Object 2009_h	1MBd															
1 _h -7 _h	Value of the switch	1MBd															
8 _h	Object 2009_h	Object 2005_h															
9 _h -F _h	(Number of the switch)-8	Object 2005_h															

Connection	Function	Pin assignment / description
DIP	DIP switches for 120 Ω termination for CAN-Bus.	OFF: The CAN bus termination is off. ON (under): The CAN bus termination is on.



NOTICE

- EMC: For a DC power supply line longer than 30 m or when using the motor on a DC bus, additional interference-suppression and protection measures are necessary.
- An EMI filter is to be inserted in the DC supply line as close as possible to the controller/motor.
- Long data or supply lines are to be routed through ferrites.

Commissioning

The *Plug & Drive Studio 3* software offers you an option for performing the configuration and adapting the motor parameters to your application. You can find further information in the document *Plug & Drive Studio 3: User Manual* at us.nanotec.com.

Observe the following notes:



CAUTION!

Moving parts can cause hand injuries!
If you touch moving parts during running operation, hand injuries may result.
► Do not reach for moving parts during operation. After switching off, wait until all movements have ended.



CAUTION!

In free-standing operation, motor movements are uncontrolled and can cause injuries.
If the motor is unsecured, it can, e. g., fall down. Foot injuries or damage to the motor could occur.
► If you operate the motor free-standing, observe the motor, switch it off immediately in the event of danger and make certain that the motor cannot fall down.



CAUTION!

Moving parts can catch hair and loose clothing.
During running operation, moving parts can catch hair or loose clothing, which may lead to injuries.
► If you have long hair, wear a hairnet or take other suitable protective measures when near moving parts. Do not work with loose clothing or ties near moving parts.



NOTICE

EMC: Current-carrying cables – particularly around supply cables – produce electromagnetic alternating fields. These can interfere with the motor and other devices.
Suitable measures may be:
► Use shielded cables and earth the cable shielding on both ends over a short distance.
► Keep power supply cables as short as possible.
► Use cables with cores in twisted pairs.
► Earth motor housing with large contact area over a short distance.
► Lay supply and control cables separately.
► Connect a charging capacitor of approx. 1000 µF per ampere rated current parallel to the supply voltage.

Configuration via USB

General

The following options are available for configuring the controller via USB:

Configuration file

This file can be saved to the controller via the USB connection. For further information, read chapters **USB connection** and **Configuration file**.

NanoJ program

This program can be programmed, compiled and then transferred to the controller with *NanoJ* via USB. *NanoJ* is integrated in the *Plug & Drive Studio 3* software. You can find further information in document *Plug & Drive Studio 3: User manual* at us.nanotec.com.

After connecting to a voltage supply, the controller reads out the configuration in the following order:

- The configuration file is read out and processed.

- The NanoJ program is started.

USB connection



NOTICE

Damage to the product and/or external hardware caused by differences in potential at the USB.
Connecting the USB cable while the electronics are being supplied (hot plugging) may result in damage.
► Connect USB before switching on the supply voltage.
► If possible, equalize differences in potential between PC and product or use USB isolator.
► First connect the USB cable to the product, then to the PC.

If the controller is connected to a PC via a USB cable, an MTP device with the exact *device name* of the product variant is created in the Windows file explorer that contains a data carrier.

Up to three files are displayed, the configuration file (`cfg*.txt`), the firmware (`*.fw`) and the *NanoJ program* (`nanoj*.usz`), which is stored internally immediately after restarting the controller and is no longer displayed.

You can thereby store the configuration file or the *NanoJ program* on the controller. The voltage supply of the controller must also be connected during USB operation.

Configuration file

General

The `cfg.txt` configuration file is used to preset values for the object dictionary to a certain value during startup. This file uses a special syntax to make accessing the objects of the object dictionary as easy as possible. The controller evaluates all assignments in the file from top to bottom.

Reading and writing the file

How to access the file:

- Connect the controller to your PC using the USB cable.
- Connect and switch on the voltage supply.
- After the PC has detected the device as a removable storage device, navigate in the Explorer to the directory of the controller. File `cfg*.txt` is stored there.
- Open this file with a simple text editor, such as Notepad or Vi. Do not use any programs that use markup (LibreOffice or similar).

After you have made changes to the file, proceed as follows to apply the changes through a restart:

- Save the file if you have not yet already done so.
- Disconnect the voltage supply from the controller for approx. 1 second until the power LEDs stop flashing.
- Reconnect the voltage supply. When the controller is now restarted, the values in the configuration file are read out and applied.

Communication settings

CANopen

Described in the following chapters is how you can change the communication settings.

The controller is configured per default for node-ID 127 and a baud rate of 1 Mbaud.

Setting node-ID and baud rate

Node-ID and baud rate are dependent on the position of the *rotary switch* and, if applicable, on objects **2005h CANopen Baudrate**, **2006h CANopen WheelConfig** and **2009h CANopen NodeID**.

Rotary switch

The product is equipped with one **hex coding switch**. This can be used to set the source for the node-ID and the baud rate.

General

- If the rotary switch is set to the value "1", the node-ID is set to "1" and the baud rate is permanently set to 1 MbD. In the event of problems with the configuration, communication can thereby always be established with the controller and any errors reversed.
- The changes in objects **2005_h** and **2009_h** must be stored by writing value "65766173_h" in object **1010_h:0A_h**.
 - The changes are not accepted until either
 - the voltage supply is briefly disconnected or
 - the controller is restarted via **2800_h** or
 - the CANopen message "RESET COMM" (NMT) is sent to the motor.
 - The load sequence for objects **2005_h** and **2009_h** is as follows (each successive value overwrites the previous):
 - The default value is loaded.
 - A stored value – if present – is loaded.
 - The configuration file is used if the controller has one.
 - The settings of the rotary switches are taken over.

Node-ID and baud rate

The following table shows a summary of the adjustment options available with the rotary switch.

Value of the rotary switch	Node-ID	Baud rate
0 _h	Object 2009_h	1 MBd fixed
1 _h -7 _h	Value of the rotary switch	1 MBd fixed
8 _h	Object 2009_h	Object 2005_h
9 _h -F _h	(Number of the rotary switch)-8	Object 2005_h

The value of object **2005_h** can be found in the following table.

Value		Baud rate in kBd
dec	hex	
120	78	100
129	81	10
130	82	20
131	83	50
132	84	125
133	85	250
134	86	500
135	87	1000

Using with node-ID offset

To activate this function, object **2006_h:01** must be set to the value "1". In this case, the following functions apply:

- If the number "0" is set with the rotary switch, the node-ID is read from object (default = 127), baud rate = 1 MBd.
- If a number between "1" and "F_h" is set, this number is added to **2006_h:02**. The baud rate corresponds to the setting in object **2005**.

Setting using LSS

The *Layer Setting Services* offers you the option to dynamically assign the node-ID and/or the baud rate via the CANopen bus. See chapter **LSS protocol**.

To do this, the **rotary switch** must be set to the position at which the node-ID and baud rate are read from the respective objects.

Special drive modes (clock-direction and analog speed)

You have the possibility to control the motor directly via the clock and direction input or the analog input by activating the *special drive modes*.

Digital input 3 serves here as an enable.

Activation

To activate the *special drive modes*, you must enter the value "2" in **4015_h:01_h**. In **4015_h:02_h**, set the mode by writing a value between "00"_h and "0F"_h.

The following table lists all possible modes and their value for **4015:02_h**:

Value	Mode			
00 _h /01 _h	Clock-direction	-	-	Open-Loop
02 _h	Test run	Test run with 30 rpm	Clockwise direction of rotation	Open-Loop
03 _h	Test run	Test run with 30 rpm	Counterclockwise direction of rotation	Open-Loop
04 _h	Analog speed	Direction via "Direction" input	Maximum speed 1000 rpm	Open-Loop
05 _h	Analog speed	Direction via "Direction" input	Maximum speed 100 rpm	Open-Loop
06 _h	Analog speed	Offset 5 V (joystick mode)	Maximum speed 1000 rpm	Open-Loop
07 _h	Analog speed	Offset 5 V (joystick mode)	Maximum speed 100 rpm	Open-Loop
08 _h /09 _h	Clock-direction	-	-	Closed-Loop
0A _h	Test run	Test run with 30 rpm	Clockwise direction of rotation	Closed-Loop
0B _h	Test run	Test run with 30 rpm	Counterclockwise direction of rotation	Closed-Loop
0C _h	Analog speed	Direction via "Direction" input	Maximum speed 1000 rpm	Closed-Loop
0D _h	Analog speed	Direction via "Direction" input	Maximum speed 100 rpm	Closed-Loop
0E _h	Analog speed	Offset 5 V (joystick mode)	Maximum speed 1000 rpm	Closed-Loop
0F _h	Analog speed	Offset 5 V (joystick mode)	Maximum speed 100 rpm	Closed-Loop

You must save object **4015_h** (*application category*); by writing the value "65766173_h" in **1010_h:03_h**, the changes do not take effect until after the controller is restarted.

Clock-direction

The controller internally sets the operating mode to **clock-direction**. You must connect the *enable*, *clock* and *direction* inputs.

Analog speed

The controller internally sets the operating mode to **Profile Velocity**. To preset the speed, the voltage on the analog input is used and the corresponding target speed is written in **60FF_h**.

Maximum speed

The maximum speed can be changed between 100 rpm and 1000 rpm.

If a different speed is necessary, it can be set using the scaling factor for the analog value (see **Analog inputs**).

Computation of the analog voltage

There are two modes for calculating the analog input voltage.

Normal mode

You must connect the *enable*, *direction* and *analog inputs*. The maximum analog voltage corresponds to the maximum speed. The direction is preset here via the direction input. If there is no signal at the direction input, the motor turns clockwise (when looking at the drive shaft). There is a dead zone from 0 V to 20 mV in which the motor does not move.

Joystick mode

You must connect the *release input* and the *analog input* The half of the maximum analog voltage corresponds to the speed 0; the controller automatically adapts the offset in **3321_h** here.

If the voltage drops below half, the speed increases in the negative direction. If the speed rises above half, the speed increases likewise in the positive direction. The dead zone here extends from U_{max}/2 ± 20 mV.

Test run with 30 rpm

The motor rotates at 30 rpm if the *enable input* is set.