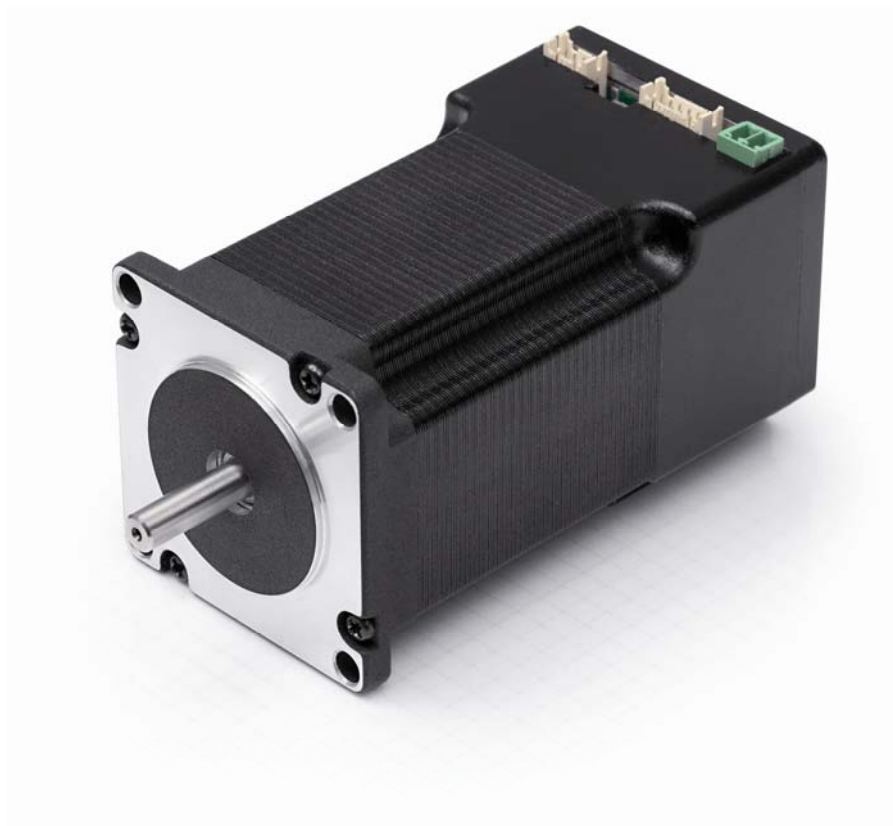


# Technical manual



## Plug & Drive motors **PD4-N5918**

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## Editorial

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### Version/Change overview

Version	Date	Changes
1.0	2009-11-16	New issue C+P
1.1	2010-04-12	Operating voltage; CANopen firmware
1.2	2010-04-23	Wire colors ZK-PD4N

## About this manual

### Target group

This technical manual is aimed at designers and developers who need to operate a Nanotec stepper motor without much experience in stepper motor technology.

### Important information

This technical manual must be carefully read before installation and commissioning of the Plug & Drive motor.

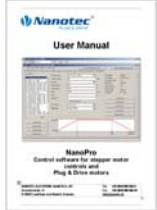



Nanotec<sup>®</sup> reserves the right to make technical alterations and further develop hardware and software in the interests of its customers to improve the function of this product without prior notice.

This manual was created with due care. It is exclusively intended as a technical description of the product and as commissioning instructions. The warranty is exclusively for repair or replacement of defective equipment, according to our general terms and conditions, liability for subsequent damage or errors is excluded. Applicable standards and regulations must be complied with during installation of the device.

For criticisms, proposals and suggestions for improvement, please contact the above address or send an email to: [info@nanotec.com](mailto:info@nanotec.com)

### Additional manuals

Please also note the following manuals from Nanotec:

<b>NanoPro User Manual</b>	Configuration of controllers with the NanoPro software	
<b>NanoCAN User Manual</b>	Configuration of the CAN communication for CANopen-capable controllers with the NanoCAN software	
<b>Nanotec CANopen reference</b>	Detailed documentation of the CANopen functions	
<b>Programming manual</b>	Controller programming <ul style="list-style-type: none"> <li>• Command reference</li> <li>• NanoJ</li> <li>• COM interface</li> </ul>	

The manuals are available for download on [www.nanotec.com](http://www.nanotec.com).

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# 1 Overview

## Introduction

The Plug & Drive motor PD4-N5918 includes, in addition to the integrated power end stage, a complete, network-capable Closed-Loop speed and positioning control.

The PD4-N5918 not only significantly reduces development and installation outlay, but also space and component requirements. It also increases flexibility, system properties and the availability of a complete drive unit. Replacement of existing drive solutions is easy with the mechanical and electrical compatibility with standard motors.

## Variants

The PD4-N5918 is available in the following variants that differ in holding torque, weight and length (see Section 6 "Technical data"):

- PD4-N5918X4204
- PD4-N5918L4204

## Functions of the PD4-N5918

The Plug & Drive motor PD4-N5918 has the following functions:

- Microstep 1/1 – 1/64 final output stage (0.014° step resolution)
- Closed-Loop current control (sinusoidal commutation via the encoder)
- Powerful DSP microprocessor for flexible I/O
- Sequence programs with NanoJ
- Integrated encoder for rotation monitoring and Closed-Loop current control
- RS485/CANopen interface for parameterization and control (USB connection possible via converter cable ZK-RS485-USB)
- Network capability with up to 254 motors (RS485) or 127 motors (CANopen)
- Easy programming with the NanoPro Windows software



Closed-Loop current control (sinusoidal commutation via the encoder):

In contrast to conventional stepper motor controls where only the motor is actuated or the position adjusted via the encoder, sinusoidal commutation controls the stator magnetic field as in a servomotor via the rotary encoder. The stepper motor acts in this operating mode as nothing more than a high pole servomotor, i.e. the classic stepper motor noises and resonances vanish. As the current is controlled, the motor can no longer lose any steps up to its maximum torque.

If the controller recognizes that the rotor is falling behind the stator field due to overload, adjustments are made with optimal field angle and increased current. In the opposite case, i.e. if the rotor is running forward due to the torque, the current is automatically reduced so that current consumption and heat development in the motor and controller are much lower compared to normal controlled operation.

### **dspDrive**<sup>®</sup>

With dspDrive<sup>®</sup>, the motor current is controlled directly by a digital signal processor. Unlike conventional ICs, which resolve the winding current measurement and the target current value with only 6 or 8 bit, the new dspDrive<sup>®</sup> performs the entire control with a resolution of 12 bit. The parameters of the PI current controller can be adjusted to the motor and by the user as a function of the rpm.

This has the following application advantages:

- Very smooth, low-resonance operation with a sinusoidal current in the windings.
- Very good step angle accuracy and synchronization, even in open-loop operation.
- Three-phase stepper motors and BLDC motors can be controlled as well.

### **NanoJ**

With the integrated NanoJ programming language based on the Java standard, complete sequencing programs can be implemented that can be run autonomously without a superordinate controller.

The programs can be created, compiled directly and written to the controller with the free NanoJEasy editor.

More detailed information can be found in the separate programming manual.

## **Activation via CANopen**

### **CANopen**

It is possible to include the stepper motor control in a CANopen environment with the PD4-N5918. The connection can be established either via 2 wires of the I/O connection cable or in a customer-specific version also via an M12 connector (5-pole).

More detailed information on this can be found in the CANopen reference and in the NanoCAN user manual.

In addition, the Plug & Drive motor via CANopen has another safety function: Even when the voltage supply of the PD4-N5918 is interrupted, the processor continues to be supplied with power via the communication line and the position data cannot be lost so that the machine does not need to be referenced after being switched on.

## **Settings**

The operating behavior of the motor can be set and optimized according to individual requirements by setting the motor-related parameters. The parameters can be set using the NanoPro software and significantly reduce commissioning time.

More detailed information on this can be found in the separate NanoPro user manual.

## **Rotation monitoring**

Even if stepper motors do not lose steps during normal operation, the integrated speed control provides additional security in all operating modes, e.g. against motor stalling or other external sources of error. The monitoring function detects a stalled motor or step loss after tenth of a step at the most (for 1.8° stepper motors with 500 pulses/rotation).

Automatic error correction is possible after the drive profile is ended or during the drive.

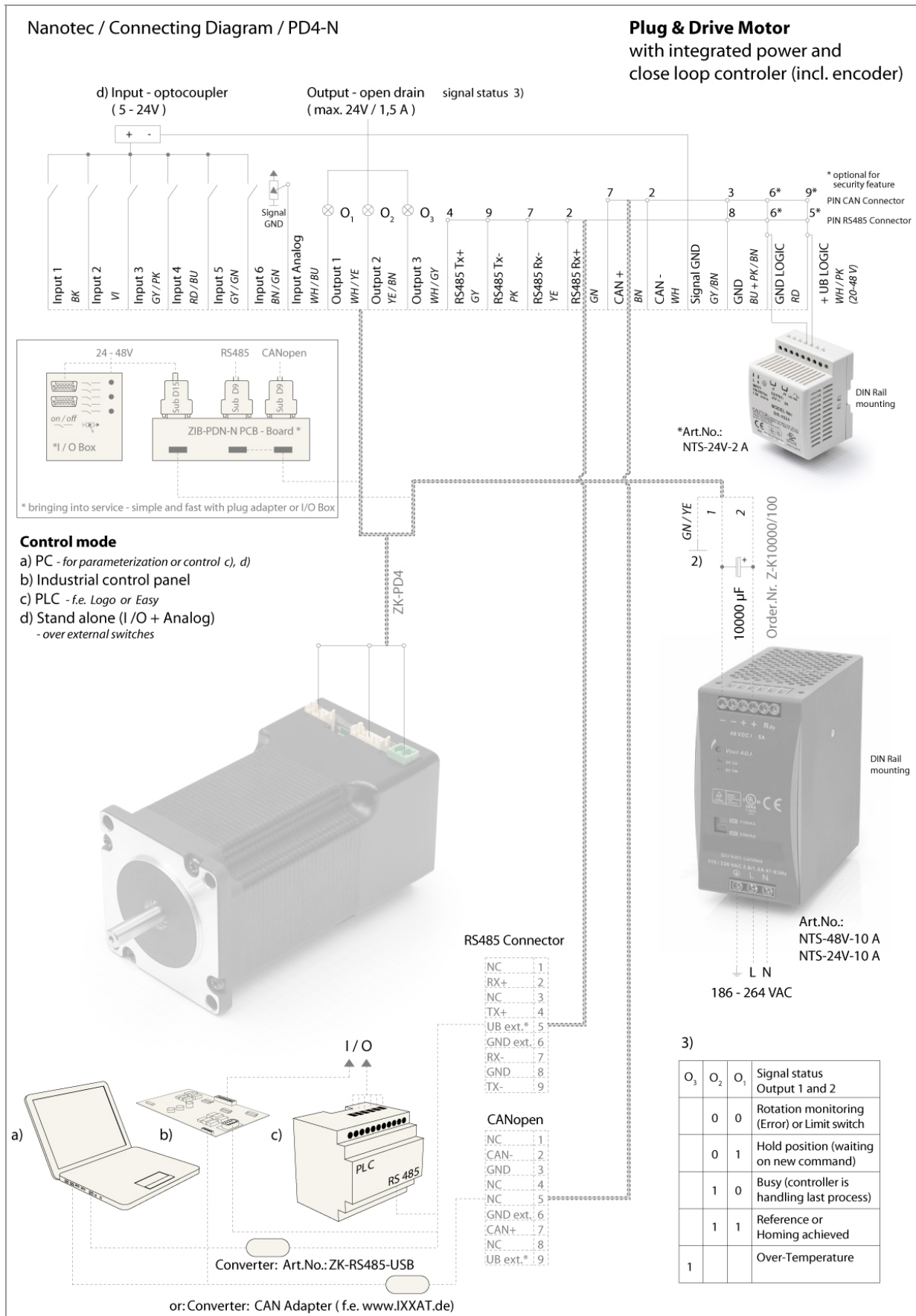
## 2 Connection and commissioning

### 2.1 Connection diagram

#### Introduction

To operate the Plug & Drive motor, you must implement the wiring according to the following connection diagram.

**Connection diagram PD4-N5918**





## 2.2 Commissioning

### Provisions

The connection and commissioning of the PD4-N5918 Plug & Drive motor are described below.

This section describes the main first steps you need to take to be able to quickly begin working with the PD4-N5918 if you want to work with the NanoPro software from a PC. You will find more detailed information in the separate NanoPro manual.

If you want to work at a later time with a PLC or your own program, you will find the necessary information in the separate "Command Reference".

Familiarize yourself with the PD4-N5918 Plug & Drive motor and the relevant NanoPro control software before configuring the Plug & Drive Motor for your application.

### Operation with CANopen interface

For the operation and configuration of the Plug & Drive motors with a CANopen interface, you require the CANopen firmware and the NanoCAN software, which you can download from the Nanotec website.

The PD4-N motors are delivered as standard with firmware that is optimized for RS485. If you want to use CANopen, you must install the NanoPro software and connect the motor to the PC over the serial interface.


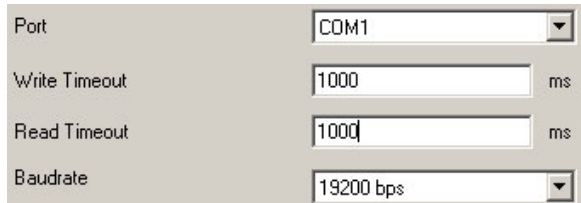
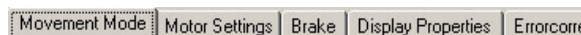
A firmware update can then be carried out via NanoPro:


1. Call up the <System / Firmware change / select firmware> menu.
2. Select the required CANopen firmware in the "open Firmware file" window.



## Procedure

Proceed as follows to commission the Plug & Drive motor:

Step	Action	Note
1	Install the NanoPro control software on your PC. See the separate manual on NanoPro.	Download von <a href="http://www.nanotec.com/downloads">www.nanotec.com/downloads</a> .
2	Connect the Plug & Drive motor according to the connection diagram.	Connection diagram, see Section 2.1. Detailed information on connections can be found in Chapter 3 „Connections and circuits“.
3	Apply the operating voltage (12 V DC ... 48 V DC).	The green LED lights up.
4	Connect the Plug & Drive motor with your PC. Use the converter cable ZK-RS485-USB for connection to the USB interface. Connection via the RS232 interface is not possible.	Order number: <ul style="list-style-type: none"> <li>ZK-RS485-USB (download the necessary controller from <a href="http://www.nanotec.com">www.nanotec.com</a> under the menu item Accessories/Converter)</li> </ul>
5	Start the NanoPro software.	The NanoPro main menu appears.
6	Select the "Communication" tab. 	
7	In the "Port" field, select the COM port to which the PD4-N5918 is connected. 	The number of the COM port to which the Plug & Drive motor is connected can be found in the device manager of your Windows PC (System Supervision/System/Hardware).
8	Select the "115200 bps" entry in the "Baudrate" selection field.	
9	Select the "Movement" tab. 	

Step	Action	Note
10	<p>Click on the &lt;Test Record&gt; button to carry out the pre-set travel profile.</p> 	<p>The connected motor operates with the pre-set travel profile (default travel profile after new installation).</p>
11	<p>You can now enter your required settings. For instance, you can enter a new travel profile.</p>	<p>See the separate manual on NanoPro.</p>

## 3 Connections and circuits

### 3.1 Overview

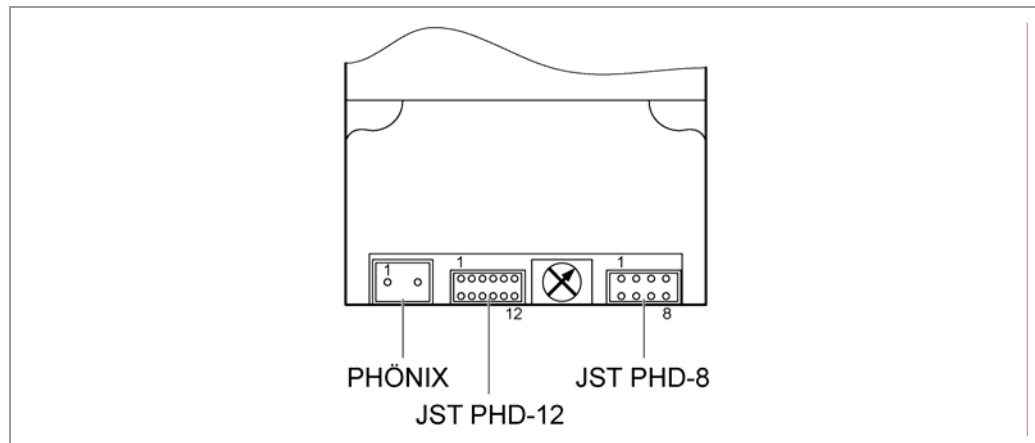
#### Plug connections

Plug & Drive motor PD4-N5918 is equipped with the following plug connections:

- JST PHD-12: inputs and outputs
- JST PHD-8: RS-485/CANopen
- Phoenix connector: power supply

#### Configuration

The following figure shows the configuration of the plug connections.



#### Connection cable

For making the connection, you need the PD4-N cable set (order number: ZK-PD4N).

## 3.2 Inputs and outputs (JST PHD-12)

### Introduction

An overview of the assignments can be found in the connection diagram in Section 2.1. This section looks in detail at the assignment, functions and circuits of the connections.

### Pin assignment JST PHD-12

Pin no.	Name	Wire color ZK-PD4N
1	Signal GND (Com)	GY/BN
2	GND	RD
3	Input 1	BK
4	Input 2	VT
5	Input 3	GY/PK
6	Input 4	RD/BU
7	Input 5	GY/GN
8	Input 6	BN/GN
9	Analog input	WH/BU
10	Output 1	WH/YE
11	Output 2	YE/BN
12	Output 3	WH/GY

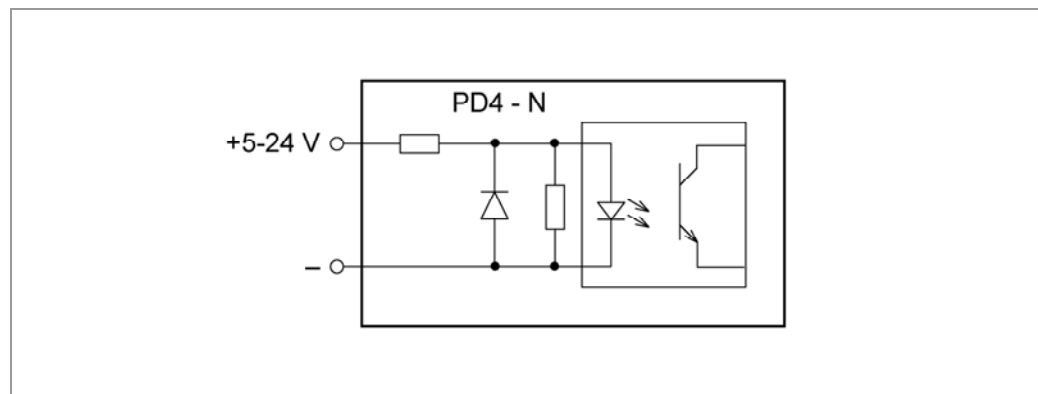
### Input circuits

All inputs (apart from the "Analog In" input) are electrically isolated by optocouplers from the voltage supply of the PD4-N5918 and designed for 5-24 V input signals at an input current of 8 mA.

The digital inputs 1 to 6 can be configured with the aid of the NANOPRO software for "active-high" or "active-low". In addition, these can be freely programmed there (e.g. as limit switch, enable, etc.) and can be used for sequential control with NanoJ.

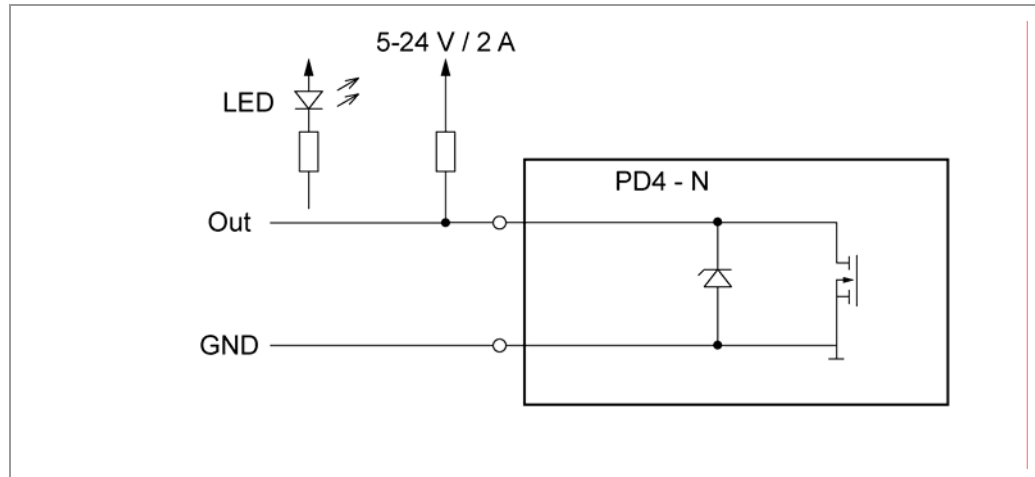
#### Note:

The voltage should drop below 2 V for safe switching off and be at least 4.5 V for safe switching on.



### Output circuits

The outputs are MosFET outputs in an Open-Drain circuit (0 switching, max. 24 V/2 A). An LED can be integrated to test the output. The LED lights up when the output is active.




### 3.3 Power supply (Phoenix connector)

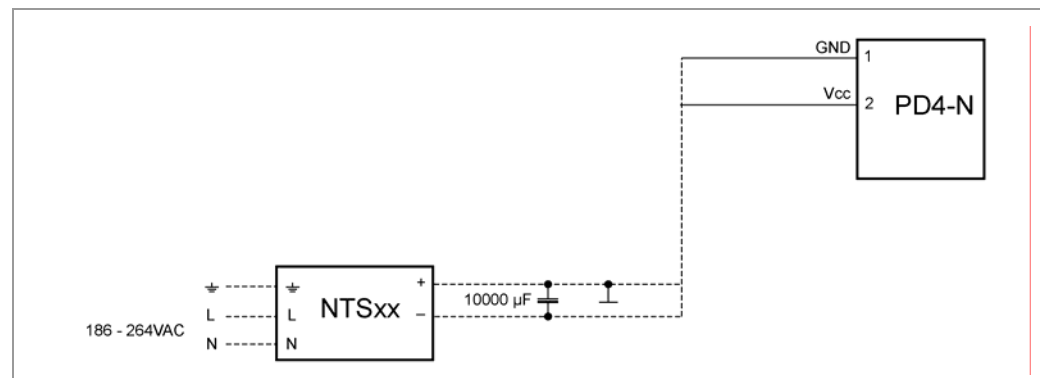
#### Permissible operating voltage

The permissible operating voltage of the Plug & Drive motor PD4-N5918 lies within the range +12 to +48 V DC and must not exceed 50 V or undershoot 11 V.

A charging condenser with minimum 4700  $\mu\text{F}$  (10000  $\mu\text{F}$ ) must be provided for the operating voltage to prevent exceeding the permissible operating voltage (e.g. during braking).

	<p><b>Danger of electrical surges</b></p> <p>Connect charging condenser with minimum 4700 <math>\mu\text{F}</math>!</p> <p>An operating voltage &gt; 50 V will destroy the output stage!</p> <p>Mixing up the connections can destroy the output stage!</p> <p>Never disconnect the link when operating voltage is applied!</p> <p><b>Never</b> disconnect lines when live!</p>
---	---

#### Voltage supply connection diagram



**Note:**  
Complete connection diagram - see Section 2.1.

#### Pin assignment

Pin no.	Name	Wire no. ZK-PD4N
1	GND	1
2	Vcc	2

#### Accessories for voltage supply

Appropriate power packs and charging condensers are available as accessories:

Name	Order number
Power pack	NTS-xxV-xA
Charging condenser	Z-K4700 or Z-K10000

**Note:**  
Further information about accessories can be found on the Nanotec website:  
[www.nanotec.com](http://www.nanotec.com)

### 3.4 RS485 network/CANopen (JST PHD-8)

#### RS485 network

Up to 254 (RS485) or 127 (CANopen) Plug & Drive motors can be actuated in a network from a PC or PLC.

These network connections are set up via the RS485/CANopen interface.

If you use the Plug & Drive motor with CANopen, you can use the additional safety function of the separate logic supply: Even when the voltage supply of the PD4-N5918 is interrupted, the processor continues to be supplied with power via the communication line and the position data cannot be lost so that the machine does not need to be referenced after being switched on.

More detailed information on this can be found in the CANopen reference and in the NanoCAN user manual.

#### Pin assignment

Pin no.	Name	Wire color ZK-PD4N
1	GND	BU
2	+Vb external	WH/PK
3	RS-485 Rx-	YE
4	RS-485 Rx+	GN
5	RS-485 Tx-	PK
6	RS-485 Tx+	GY
7	CAN+	BN
8	CAN-	WH

#### Two-wire operation

To enable RS485 two-wire transmission capability, all bus stations must have a direction control.

An "intelligent" converter enables two-wire operation of the PD4-N5918 as it automatically switches to transmit operation when receiving a start bit at the RS232 interface and returns to reception standby at the end of the stop bit. This solution does not require software support.

We can recommend the ICP-7520 converter, for example, that is available from Schuricht.

Talk to our Technical Hotline if you require support for this.

#### CANopen

With the PD4-N5918 it is also possible to control the motor via CANopen..

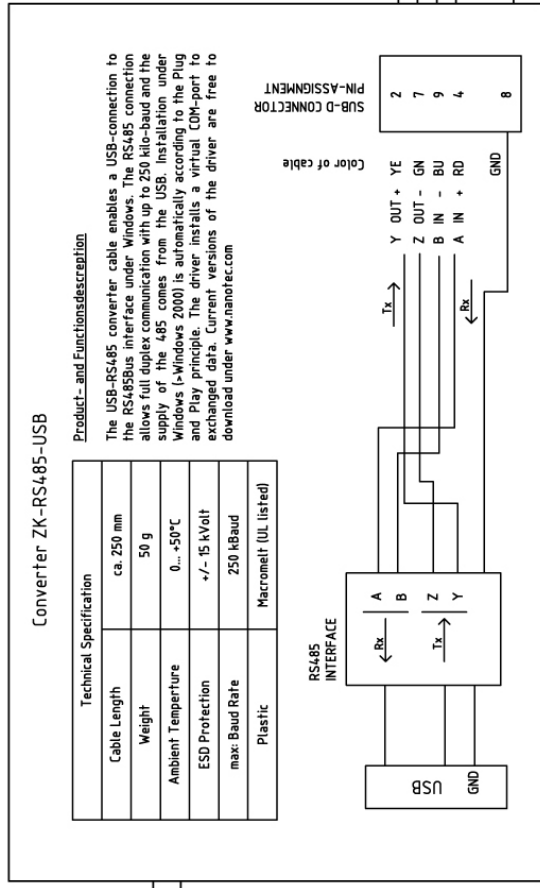
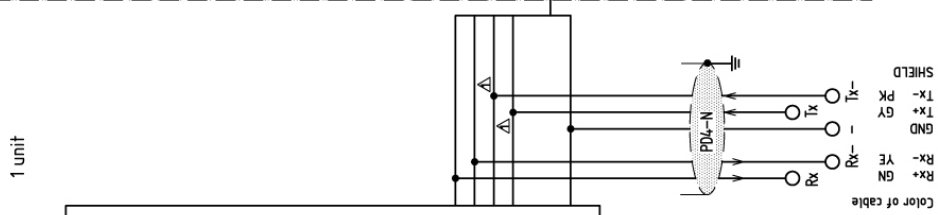
More detailed information on this can be found in the CANopen reference and in the NanoCAN user manual.



**Circuit diagram RS485 network**

**CONNECTION DIAGRAM RS485 NETWORK PD4-N**

- 2...254 units
- If there are more than two units Pin8 (GND) has to be connected to each unit.
  - GND and the shielding must be connected in each end.
- In disregard of the above points the controller could be destroyed
- If there are more than two units Pin8 (GND) has to be connected to each unit.
  - The last unit in each end of the line must be terminated with 120Ω.
  - the cable must be shielded twisted pair 6x0.2mm<sup>2</sup> (AWG24)
  - the max. cable length of the network cable is 5m.
- Disregard of the above points the controller could be not functional, because irregularity can be applied into the inputs and the communication lines and thus may be arise the considered errors in the processes .
- before connecting the unit to the network, every unit must get his own module number via Nanopro programm.



Converter ZK-RS485-USB

Product- and Functionsdescription

The USB-RS485 converter cable enables a USB-connection to the RS485bus interface under Windows. The RS485 connection allows full duplex communication with up to 250 kilo-baud and the supply of the 485 comes from the USB. Installation under Windows (Windows 2000) is automatically according to the Plug and Play principle. The driver installs a virtual COM-port to exchanged data. Current versions of the driver are free to download under [www.nanotec.com](http://www.nanotec.com)

Technical Specification	
Cable Length	ca. 250 mm
Weight	50 g
Ambient Temperature	0... +50°C
ESD Protection	+/- 15 kVolt
max: Baud Rate	250 kBaud
Plastic	Macromet (UL listed)

**Caution:**  
first read the connecting-description

Central Controller-f.e. PC

### Setting the RS485 module address

Max. 127 addresses can be set which can, however, only be used to the full extent via CANopen as the maximum number of stations in an RS485 network is limited to 32.

A rotary switch on the board can be used to adjust the RS485 module addresses 1 to 7 in the hardware. Depending on the position of the rotary switch, the baud rate is fixed at 1 MBaud or is read out from the EEPROM; see table:

Rotary switch value dec (hex)	Node ID	Baud rate
<b>0</b> (0x00)	From EEPROM	= 1MBaud
<b>1 - 7</b> (0x01 - 0x07)	= Rotary switch value	
<b>8</b> (0x08)	From EEPROM	From EEPROM
<b>9 - 15</b> (0x09 - 0x0F)	= Rotary switch value minus 8	

If the rotary switch is in position 0 or 8, the module address can be set in the software and read out from the EEPROM.

When the power supply is applied, the controller checks which address is set with the rotary switch on the hardware. This hardware address is then adopted. After the address is changed, the power supply must be briefly switched off and on again.

## 4 Operating modes

### Introduction

Depending on the drive profile, the motor can be operated using a total of 14 different operation modes. Due to the good performance and variety of functions available, they offer designers and developers a rapid and simple method of resolving numerous drive requirements with less programming effort.

Select the required operating mode for each drive profile and configure the controller according to your requirements.

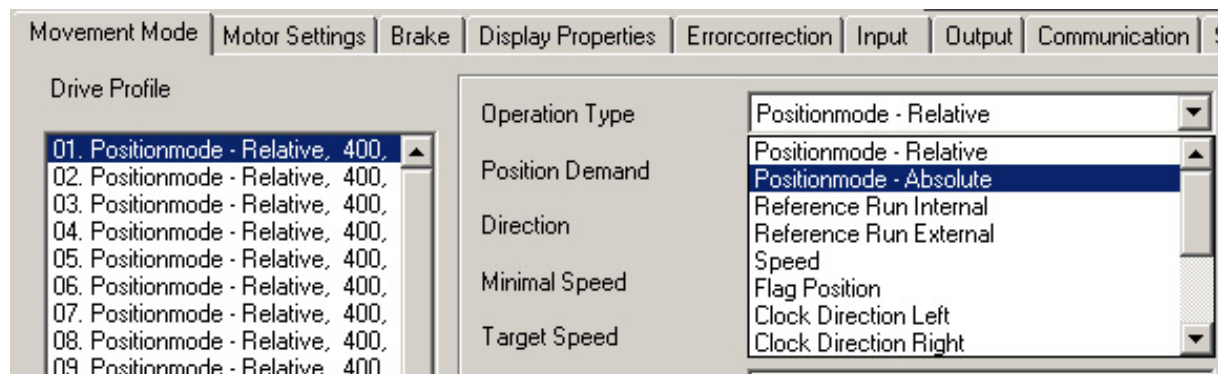
More detailed information can be found in the separate NanoPro manual.

### Overview of operating modes and their areas of application

Operation mode	Application
Relative	Use this mode when you wish to travel to a specific position. The motor travels according to a specified drive profile from a Position A to a Position B.
Absolute	
Internal Homing	During the internal reference run, the motor travels to an internal reference point at the set minimum speed.
External Homing	During an external reference run, the motor travels to a switch connected to the reference input.
Speed mode	Use this mode when you wish to travel with a specific speed (e.g. a conveyor belt or pump speed). In the speed mode, the motor accelerates with a specified ramp from the starting speed (start frequency "V Start") to the specified maximum speed (maximum frequency "V Normal"). Several inputs enable the speed to be changed on-the-fly to different speeds.
Flag positioning mode	The flag positioning mode offers a combination of the speed and positioning modes. The motor is initially operated in speed mode; when a trigger point is reached, it changes to the positioning mode and the specified setpoint position (relative to the trigger position) is approached. This operating mode is used for labeling, for example: the motor first travels with the set ramp to the synchronous speed of the conveyed goods. When the labels are detected, the preset distance (position) is traveled to apply the labels.

Operation mode	Application
Clock direction mode, left	Use this mode when you wish to operate the motor with a superordinate controller (e.g. CNC controller). In the clock direction mode, the motor is operated via two inputs with a clock and a direction signal from a superordinate positioning control (indexer). Depending on the mode selected (Int. Ref. / Ext. Ref.), the internal and external reference runs are supported.
Clock direction mode, right	
Clock direction mode, Int. Ref.	
Clock direction mode, Ext. Ref.	
Analog and Joystick mode	The motor is controlled in this operating mode simply with a potentiometer or a joystick (–10 V to +10 V). Use this mode if you want to use the motor in a simple application: <ul style="list-style-type: none"> <li>• Setting a specific speed, e.g. via an external potentiometer,</li> <li>• Traveling synchronously with a superordinate controller with analog output (–10 V to +10 V).</li> </ul>
Analog positioning mode	Use this mode when you wish to travel to a specific position. The voltage level on the analog input is proportional to the required position, thus enabling servo behavior.
Torque mode	Use this mode when you require a specific output torque independent of the speed as is the case in typical winding and unwinding applications. The maximum torque is specified via the analog input.


### Selecting the operating mode in NanoPro



## 5 Troubleshooting

### Troubleshooting procedure

Proceed with care during troubleshooting and error rectification to avoid damaging the Plug & Drive Motor.

	<p><b>Danger of electrical surges</b></p> <p>An operating voltage &gt; 50 V and incorrect connections can destroy the end stage. Never disconnect the link when operating voltage is applied! Never disconnect lines when live!</p>
---	---

### Possible error

Error	Possible cause	Rectification
Plug & Drive Motor is not ready	Data transfer to PD4-N5918 is not possible (communication error): Incorrect COM port selected.	In the "Communication" tab, select the PC port to which you have connected the PD4-N5918 (e.g. "COM-1"). The port used can be found in the device manager of your PC.
	Communication cable not connected or interrupted (incorrect RS485 converter used).	Function is not guaranteed with third-party 4-wire cables and 2-wire Nanotec converters do not function. Use the recommended RS485 converter from Nanotec: <ul style="list-style-type: none"> <li>Order number: ZK-RS485-USB</li> </ul>
	A non-existent motor number (module number) is set.	Set the correct module address. See the separate manual on NanoPro.
	The voltage supply to the PD4-N5918 is interrupted.	Check voltage supply, switch on if necessary.
	Another open program is blocking the COM port to which the PD4-N5918 is connected.	Close down other programs on your PC.
	Inadmissible data was sent to the Plug & Drive Motor during the output of a travel profile.	Click on the <Yes> button to stop the travel profile. The PD4-N5918 switches to the "Ready" status. The data can then be resent to the Plug & Drive Motor.
Transmission error	The data transfer to the PD4-N5918 is disturbed (transmitter or receiver are disturbed).	Check the possible causes for the transmission error and rectify the cause of the error.

Error	Possible cause	Rectification
Position error	The motor cannot reach the position or the limit switch was overrun.	Click the <Yes> button in the error message; the error is reset.
Red LED on the PD4-N5918 lit up.	Overtemperature of power electronics > 75 °C	Switch off Plug & Drive Motor and allow to cool. The error is reset when the PD4-N5918 is disconnected from the power supply unit.
	Undervoltage	Check voltage supply.

## 6 Technical data

### Electrical connections

Operating voltage $V_b$	DC 12 V to 48V $\pm 4\%$ Lower voltage limit: 11 V (undervoltage protection) Upper voltage limit: 50 V (overvoltage protection)
Max. phase current	Adjustable up to max. 4 A/phase Continuous current 3.2 A/phase
Current drop	Adjustable 0 to 150% of max. phase current
Interfaces	RS-485 (4-wire) <ul style="list-style-type: none"> <li>• 115200 Baud (adjustable)</li> <li>• 1 start bit, 8 data bits, 1 stop bit</li> <li>• No parity</li> </ul> CAN bus (CANopen) <ul style="list-style-type: none"> <li>• Extended functionality</li> <li>• Separate circuit for supply and processor</li> <li>• Closed-Loop capable</li> </ul>

### Motor settings

Step resolution	Full step Half step Quarter step Fifth step Eighth step Tenth step 16th step 32th step Adaptive microstep (1/64)
Step angle	1.8°
Operating modes	Position Speed Flag position Clock direction Analogue Analog positioning mode Joystick Torque
Step frequency	0 to 50 kHz in clock direction mode 0 to 25 kHz in all other modes
Position monitoring	Automatic error correction up to 0.18° (depending on encoder resolution)

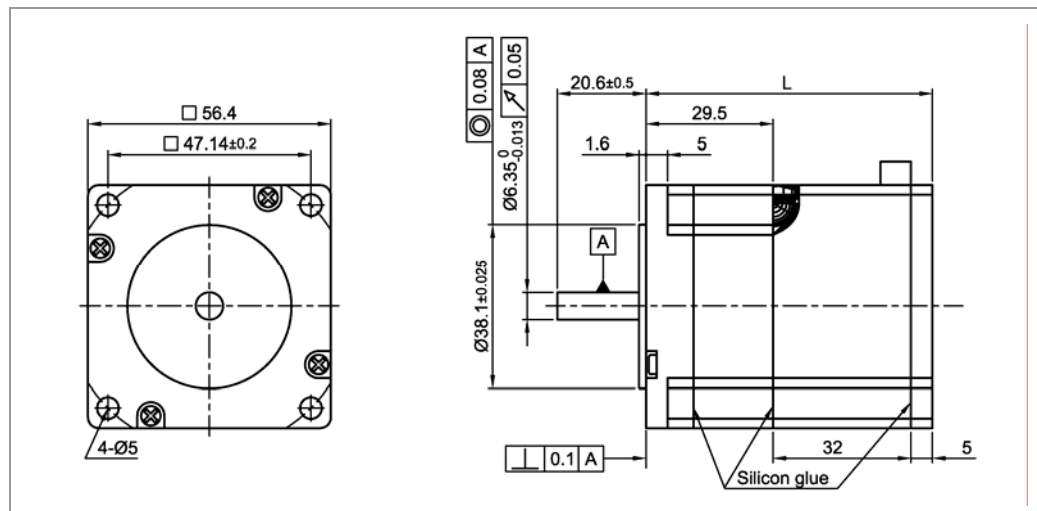
**Inputs and outputs**

Inputs	6 optocouplers, 5 – 24 V <ul style="list-style-type: none"> <li>• Safe switch off: max. 2 V</li> <li>• Safe switch on: min. 4.5 V</li> </ul> Signal delay time: <ul style="list-style-type: none"> <li>• Inputs 1 to 5: 120 µs</li> <li>• Input 6: 10 µs</li> </ul>
Outputs	3 MosFET outputs <ul style="list-style-type: none"> <li>• Open-Drain (0 switching, max. 24 V/2 A)</li> <li>• Signal delay time: output 1/2: ≈ 12 µs (with 10 kΩ-Pull-Up at 24 V)</li> </ul>

**Protective circuits**

Overvoltage and undervoltage	Protective circuit for voltages > 50 V or < 21 V
Max. heatsink temperature	Approx. 67 °C External ventilation may be required in full step operation, depending on the switch-on duration, current drop set and external cooling area.
Ambient temperature	-10 °C to 40 °C

**Dimensions PD4-N5918**



A complete set of datasheets is available for downloading at [www.nanotec.de](http://www.nanotec.de).

**Variants**

Variants	Holding torque (Nm)	Weight (kg)	Length "L" (mm)
PD4-N5918X4204	0.537	0.49	66.5
PD4-N5918L4204	1.98	1.22	101



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