CONTROL OPTIONS FOR PLUG & DRIVE MOTORS AND MOTOR CONTROLLERS

Just as our motor controllers, our Plug & Drive motors can be controlled via a wide variety of methods. Dip switches, configuration files or software enable the user to switch between the different methods. Information on which control version can be used in each case is provided in the data sheets.

Our motor controllers are divided into two device generations: SMCI, PD-N: motor controllers that can be easily configured with NanoPro and NanoCAN; for use with USB, RS485 and CANopen; programmable with NanoJ.
C, N, PD-C: real-time motor controllers and PD motors with a large variety of field bus options; programmable with NanoJ V2

Clock & direction
- Microstep to one 64th of a step
- Step multiplication/microstep emulation so that the smooth running of the microstep can also be used with older higher-level controllers that only output full or half steps.

Control via digital and analog inputs
- Motor controllers that are configurable with NanoPro: Up to 32 movement sequences (position or speed profiles) can be stored in the motor controller, selected using digital inputs, started and stopped. Also speed, position or torque can be controlled via the analog input. For additional functions (e.g. reference switch, enable) Inputs are freely configurable.
- Motor controllers that are programmable with NanoJ V2: digital and analog I/Os can be read out every millisecond and processed in a sequence program.

Control via fieldbus
- Open protocol via RS232/RS485 with an adjustable baud rate of 9.6–115 Kbit for motor controllers configurable with NanoPro
- Diverse fieldbus options for Controller with NanoJ V2:
  - EtherCAT
  - Modbus
  - EtherNet/IP

Sequence control with NanoJ/NanoJ V2
- C-based programming language; these programs run autonomously (without a connected PC or master) directly on the motor controller or Plug & Drive motor
- Access to all controller parameters and inputs/outputs
- Variables, branches, loops, logical and mathematical functions
- Programs can be stored in the motor controller via Fieldbus/USB

PLUG & DRIVE® MOTORS
A stepper motor is used wherever movement to fixed positions is required. The classic stepper motor transfers electric energy into precise mechanical movements as long as the motor’s torque is not exceeded. Since there is no position feedback or control present, the motor loses steps if unexpec-
ted load jumps or resonance occurs and it no longer moves to the desired position. A closed-loop step motor can adjust in those instances and reach the specified position reliably. Using an open loop, a standard step-
ner motor is always operated with the same current regardless of the load and it therefore becomes relatively hot in many applications. By controlling current in a closed loop, the current level can be adapted to the required torque; no unnecessary lost heat is produced and energy consumption drops accordingly.

Advantages over servo motors

In many cases, closed-loop stepper motors from Nanotec are an alternative to servo drives, such as in winding applications or belt drives. The speed and position, and even the torque, can be controlled with precision. This not only achieves the highest maximum torque, the best efficiency and the best dynamics, it also achieves the lowest torque rip-
ple and excellent running smoothness.

Applications for closed loop systems:

- Dosing pumps, filler systems, semi-conductor mounting, wafer production, industrial sewing machines, and more.
- Textile machines, industrial sewing machines
- Applications that require smooth operation, short settling times and precision positioning.

What is closed loop?

Sinusoidal commutation via encoder with field-oriented control is re-
f erred to as the closed-loop process. The rotor position is detected us-
ing the encoder’s signals and sinusoidal phase currents are generated in the motor windings. Controlling the vector of the magnet-
ic field ensures that the stator magnetic field is vertical relative to the rotor magnetic field and the field strength corresponds exact-
tly to the desired torque. The controlled current level in the wind-
ings provides uniform motor force and leads to a particularly quiet-running motor that can be controlled precisely.

True/pseudo closed loop

There are stepper motors that dress themselves up as being closed loops and work with encoders but do not provide any field-oriented control with sinusoidal commutated current control. They only check the step position, and cannot correct step losses during operation. True closed loop with field-oriented regulation compensates step losses during the run or prevents them from occurring by increasing the motor current.

Advantages over standard stepper motors

Energy efficiency

Closed loop-capable stepper motors merge the benefits of stepper and servo motor technology. They are smooth-running with less reso-
nance than stepper motors. They offer position feedback and control, short setting and release times and no longer exhibit step loss. They are an alternative to a stepper motor if energy efficiency, smooth run-
ning and load tolerance are required. Compared to servo motors, they have advantages due to high torque at low speeds, short setting times and correct positioning without back swing.

Service life

Overload

In an open loop, the stepper motor is dimensioned such that it is certain to move the maximum required load. For this reason, normally a safety factor of 20% is calculated, which amounts to wasted energy in the application. When the load is reduced, the open loop motor cannot react and waste even more energy.

Resonances

With a 20% safety reserve and a design for a continuous load of 25 kg, an additional load of only 5 kg exceeds the power reserve and the open loop drive stops without an error message. By contrast, with its overload reserve the closed loop stepper motor can handle this load increase easily.

Resonance frequencies occurring in the open loop depend on external loads (the greater the torque reserve, the greater is the resonance stimulation) and can bring the motor to a stop. In closed loop mode, the motor receives only as much energy as needed for the external load; the torque reserve and its resonance elimination do not exist, so there is practically no resonance behaviour.

Applications for closed loop systems:

- Dosing pumps, filter systems, semi-conductor mounting, wafer production, industrial sewing machines, and more.
- Textile machines, industrial sewing machines
- Applications that require smooth operation, short settling times and precision positioning.

Advantages over standard stepper motors

There are stepper motors that dress themselves up as being closed loops and work with encoders but do not provide any field-oriented control with sinusoidal commutated current control. They only check the step position, and cannot correct step losses during operation. True closed loop with field-oriented regulation compensates step losses during the run or prevents them from occurring by increasing the motor current.
Plug & Drive® Motors

COMPREHENSIVE SOFTWARE FUNCTIONALITY

dspDrive® – Software-based current control with high resolution in the open loop

In the newest generation of Nanotec hardware, the current in the motor is no longer controlled by an integrated component but directly by a digital signal processor. Compared to commercially available ICs, which only provide a resolution of 6 or 8 bits for measuring current in the winding and specifying the target current, the entire control process can be carried out using 12-bit resolution with the new dspDrive. The parameters of the PI current controller are adjusted depending on speed.

This has the following application advantages:

- Very quiet, low-resonance operation with sinusoidal current waveform in the windings. Jumps and noise, which encourage the motor towards resonance, no longer occur thanks to the high resolution of the control.

- Even more flexible: Now 3-phase stepper motors and BLDC motors can be controlled by the direct activation of half-bridges using DSP, just like their 2-phase counterparts.

Sinusoidal commutation with encoder in operation

In contrast to conventional stepper motor controllers where only the motor is actuated or the position adjusted via the encoder, sinusoidal commutation controls the stator magnetic field via the encoder as in a servo motor. The stepper motor behaves different than a multi-pole servo motor in this operating type, i.e. classic stepper motor noises and resonance are gone. The motor is capable of no longer loosing steps up to its maximum torque. The current level is always adjusted to the currently needed torque by the control; as a result, current consumption and heat generation are reduced significantly compared to a classic stepper motor controller if the maximum torque is not used continuously. Especially with speeds up to 1500 rpm or torques up to 10 Nm, the sinus commutated stepper motor presents an economic alternative to conventional servo systems as, in contrast to these, a direct drive without gears is often possible.

Application programs with NanoJ

The integrated Java-based NanoJ programming language can be used to implement complete autonomous application programs on the motor controllers. Querying and setting digital and analog I/Os and accessing all of the parameters for a movement program turns the motor controller into a full-fledged device controller in conjunction with variables, loops and mathematical functions and everything that distinguishes a full-fledged higher language. The programs can be created, compiled directly and written to the motor controller with the free NanoJEasy editor.

Application programs with NanoIP

The second generation of our NanoJ programming language features two major improvements:

1. The internal operating system of the new control generation ensures that the program will run with a stable timing of 1 ms with minimal jitter. The mapped objects, such as the inputs or controller sizes, are updated every millisecond and can be processed by the NanoJ program. This makes it possible to employ user programs to create solutions for dynamic applications, which until now often required firmware adjustments.

2. Byte code is no longer executed in a virtual machine. Instead, real machine code is used, which accelerates execution several times over.

Our new motor controllers with an Ethernet interface can be comfortably configured using the browser-based NanoIP application. The motor controllers can be parameterized and started up using an Internet browser (e.g. Firefox, Chrome) without requiring additional software or plugins. Data can be read out or written to the object dictionary and configurations can be saved independently from (or in parallel to) the field bus. NanoIP programs can be uploaded and started as well.

The motor controllers integrate a webserver with which the NanoIP running in the browser exchanges data via the HTTP-based REST interface. This interface can also be used by customers to control the controller from their own applications if real-time capability is not required. In this case, the standard Ethernet interface is a simple alternative to the field bus interface, above all when it comes to integrating IT-oriented applications.

A closed-loop assistant determines the necessary motor and encoder parameters for the closed loop. The load angle values are determined by an automatic calibration run.

The control can be optimized further by autotuning and the option to adjust PID parameters manually.

Easy switching between open- and closed-loop operation to compare operating behavior, performance, positioning times, etc.

Machine settings make the parameters more transparent for the operator, thereby simplifying setup and installation. Thus, the travel and speed for a linear axis can be configured in mm and m/s and the user does not have to deal with converting to steps and Hz.

Nanotec® – Software-based current control with high resolution in the open loop

PLUG & DRIVE
PD2-O41
High-Pole Plug & Drive DC Servo Motor - NEMA 17

TECHNICAL DATA

- **Operating voltage**: 12 to 48 VDC
- **Phase current**: Max. 2.7 A (1% increments) = 150%, 1.8 A = 100%
- **Interface**: RS485 or CANopen
- **Operating type**: Clock-direction, position, speed, flag position, analog, joystick CANopen: profile positioning, velocity, homing
- **Step frequency**: Up to 1 MHz at 1/64
- **Inputs**: 6 digital inputs (5 V TTL), 1 analog input max +10 V, min -10 V adjustable
- **Outputs**: 3 open collectors, 24 V/0.5 A max.
- **Current reduction**: Adjustable in 1% increments
- **Protective circuit**: Overvoltage, undervoltage and temperature >80 °C, integrated ballast switching
- **Temperature range**: -10 to +40 °C
- **New functions**: dspDrive/easily programmable as sequential controller using NanoJ easy (RS485)

SOFTWARE

- NameMicro
- NameCAN
- NameJ

OPTION

- Icon

CAUTION

For stabilizing the operating voltage, we recommend using a sufficiently dimensioned decoupling capacitor.

ORDER IDENTIFIER

- PD2-O4118S1404-2 = RS485 Interface
- PD2-O4118L1804-3 = CANopen Interface

ACCESSORIES

- ZK-RS485-USB Converters
- ZK4700/50 Charging Capacitor
- ZK-SMCI12, ZK-SMCI12-3 CANopen Cable
- ZK-SMCI12-4I IO Cable

VERSIONS

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DIMENSIONS (IN MM)

- Front view and mounting
- Side view
- Rear view

TORQUE CURVES

- PD2-O4118S1404
- PD2-O4118L1804
**PD2-N41**

High-Pole Plug & Drive DC Servo Motor - NEMA 17

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**TECHNICAL DATA**

- **Operating voltage**: 12 to 48 V DC
- **Max. phase current**: Adjustable via software up to 2.7 A (1% increments), 100% = 1.8 A
- **Interface**: RS485 or CANopen
- **Operating type**: RS485 interface: position, speed, reference run, flag position, clock-direction, analog and joystick, analog position, torque CANopen interface: profile position, speed, reference run, interpolated position, torque
- **Operating mode**: 1/1, 1/2, 1/4, 1/5, 1/8, 1/10, 1/16, 1/32, 1/64, adaptive microstep, feed constant
- **Step angle**: 1.8 °C
- **Step frequency**: 0 to 50 kHz in clock-direction mode, 0 to 25 kHz in all other modes
- **Encoder**: Integrated magnetic encoder, 1024 pulses/rev.
- **Inputs**: 6 digital inputs (5–24 V), 1 analog input (+-10 V)
- **Outputs**: 3 outputs in open drain circuit (0 switching, max. 24 V/0.5 A)
- **Position monitoring**: Automatic error correction up to 0.9 °
- **Current reduction**: Adjustable in 1% increments
- **Protective circuit**: Overvoltage and heat sink temperature >80 °C
- **Temperature range**: -10 to +40 °C
- **Connection type**: Plug connection with JST connectors
- **New functions**: Closed loop/sinusoidal commutation/dspDrive/programmable as sequential controller using NanoJ easy (RS485)

**ACCESSORIES**

- **ZK-PD2N**: Connection cable
- **ZK-PD2N-3**: Connection cable
- **ZK-RS485-USB**: Converters
- **ZK-K4700/50**: Charging Capacitor

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**SOFTWARE**

- **OPTION**

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**CAUTION**

For stabilizing the operating voltage, we recommend using a sufficiently dimensioned decoupling capacitor.

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**VERSIONS**

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**DIMENSIONS (IN MM)**

- **PD2-N4118**
- **TORQUE CURVES**

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**ORDER IDENTIFIER**

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<th>ACCESSORIES</th>
<th>CAUTION</th>
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</table>
PLUG & DRIVE®

**PD4-N59/N60**
High-Pole Plug & Drive DC Servo Motor - NEMA 23/24

### TECHNICAL DATA

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<th>Parameter</th>
<th>Details</th>
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<td>Operating voltage</td>
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<tr>
<td>Max. phase current</td>
<td>Adjustable via software up to 4.8 A (1% increments), 100% = 3.2 A</td>
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<tr>
<td>Interface</td>
<td>RS485 or CANopen</td>
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<tr>
<td>Operating type</td>
<td>Position, speed, flag position, clock-direction, analog, analog position, torque</td>
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<tr>
<td>Operating mode</td>
<td>1/1, 1/2, 1/4, 1/5, 1/8, 1/10, 1/32, 1/64, adaptive (1/128)</td>
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<tr>
<td>Step frequency</td>
<td>0 to 50 kHz in clock-direction mode, 0 to 25 kHz in all other modes</td>
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<tr>
<td>Inputs</td>
<td>6 opto-coupler inputs (5 - 24 V)</td>
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<tr>
<td>Outputs</td>
<td>Open drain (0 switching, max. 24 V/0.5 A)</td>
</tr>
<tr>
<td>Position monitoring</td>
<td>Automatic error correction up to 0.9 °</td>
</tr>
<tr>
<td>Current reduction</td>
<td>Adjustable in 1% increments</td>
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<tr>
<td>Temperature range</td>
<td>-10 to +40 °</td>
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<td>Protective circuit</td>
<td>Overvoltage and heat sink temperature &gt;80 °C</td>
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<tr>
<td>Connection type</td>
<td>Plug connection with JST connectors</td>
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<tr>
<td>New features</td>
<td>Closed loop/sinusoidal commutation/dspDrive/programmable as sequential controller using NanoJ easy (RS485)</td>
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### VERSIONS

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### ORDER IDENTIFIER

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<td>ZK-P4700/50</td>
<td>ZK-PD4N</td>
<td>Charging Capacitor</td>
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<tr>
<td>ZK-RS485-USB</td>
<td>ZK-RS485-USB</td>
<td>Connection cable</td>
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### CAUTION

For stabilizing the operating voltage, we recommend using a sufficiently dimensioned decoupling capacitor.

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**PD4-N5918**

**PD4-N6018**
PD4-N59/N60
High-Pole Plug & Drive DC Servo Motor - NEMA 23/24

TORQUE CURVES

PD4-N5918X4204

PD4-N5918M4204

PD4-N5918L4204

PD4-N6018L4204

Notes
PD4-C
High-Pole Plug & Drive DC Servo Motor - NEMA 23/24

TECHNICAL DATA

Operating voltage 12 - 48 VDC
Phase current eff. 4.2 A
RMS for 1 S max. 6.3 A
Version 01 (USB)
Operating types Torque, speed, position, homing
Target value specification/programming Clock-direction, analog input/NanoJ V2, USB
Inputs Single/differential, clock/direction/enable (+5 V/+24 V), 3 digital inputs (+24 V), 1 analog input (0-10 V)
Outputs 1 Output, max. 0.5 A, open drain
Integrated encoder Single turn, magnetic absolute encoder, 1024 CPR
Version 08 (CAN)
Operating types Torque, speed, position, homing
Target value specification/programming CANopen, analog input
Inputs 4 digital inputs (+5 V/+24 V), 1 analog input (0-10 V)
Outputs 2 outputs, max. 0.5 A, open drain
Integrated encoder Single turn, magnetic absolute encoder, 1024 CPR

ACCESSORIES

Z-K4700/50 Charging Capacitor
ZK-MICROUSB USB Cable
ZK-PD4-C-CAN-4-500-S CANopen/RS485 Cable

ORDER IDENTIFIER

PD4-C5918M4204-E-01 = USB Interface
PD4-C5918M4204-E-08 = CANopen Interface

VERSIONS

<table>
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DIMENSIONS (IN MM)

For stabilizing the operating voltage, we recommend using a sufficiently dimensioned decoupling capacitor.

CAUTION

Accessories

PD4-C5918M4204-E-01
PD4-C5918L4204-E-01
PD4-C6018L4204-E-01
High-Pole Plug & Drive DC Servo Motor - NEMA 23/24

DIMENSIONS (IN MM)

PD4-C5918L4204-E-01

PD4-C6018L4204-E-08

PD4-C6018L4204-E-01
**TECHNICAL DATA**

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<td>Phase current eff.</td>
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<td>RMS for 1 s</td>
<td>max. 20 A</td>
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<td>Version</td>
<td>01 (USB)</td>
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<tr>
<td>Operating types</td>
<td>Torque, speed, position, homing</td>
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<tr>
<td>Target value specification/programming</td>
<td>Clock-direction, analog input, NanoJ V2, USB</td>
</tr>
<tr>
<td>Inputs</td>
<td>Single/differential, clock/direction/enable (+5 V/+24 V), 3 digital inputs (+24 V), 1 Analog Input (0-10 V)</td>
</tr>
<tr>
<td>Outputs</td>
<td>1 output, max. 0.5 A, open drain</td>
</tr>
<tr>
<td>Integrated encoder</td>
<td>Single turn, magnetic absolute encoder, 1024 CPR</td>
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<tr>
<td>Version</td>
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<td>Operating types</td>
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<td>Target value specification/programming</td>
<td>CANopen, analog input</td>
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<tr>
<td>Inputs</td>
<td>4 digital inputs (+5 V/+24 V), 1 analog input (0-10 V)</td>
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<td>Outputs</td>
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<td>Integrated encoder</td>
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**ORDER IDENTIFIER**

<table>
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**ACCESSORIES**

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<th>Accessory</th>
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<td>ZK-MICROUSB</td>
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<td>ZK:PD4-C-CAN4-600-5</td>
<td>CANopen/RS485 Cable</td>
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**CAUTION**

For stabilizing the operating voltage, we recommend using a sufficiently dimensioned decoupling capacitor.
PD6-N89
High-Pole Plug & Drive DC Servo Motor - NEMA 34

TECHNICAL DATA

Operating voltage: 24 to 48 VDC
Max. phase current: Adjustable up to max. 10.5 A/phase, 7 A nominal current
Interface: RS485, or CANopen
Operating mode: Position, speed, flag position, clock-direction, analog, analog position, torque
Position monitoring: Automatic error correction up to 0.9°
Operating mode: 1/1, 1/2, 1/4, 1/5, 1/8, 1/10, 1/32, 1/64 adaptive (1/128)
Step frequency: 0 to 50 kHz in clock-direction mode, 0 to 25 kHz in all other modes
Inputs: 6 opto-coupler inputs (5–24 V), analog input
Outputs: Open drain (0 switching, max. 24 V/0.5 A)
Current reduction: Adjustable in 1% increments
Protective circuit: Overvoltage and heat sink temperature >80 °C
Temperature range: 0 to +40 °C
Connection type: 2x2 m cable
New functions: Closed loop/sinusoidal commutation programmable as sequential controller using NanoJ easy (RS485)

ORDER IDENTIFIER

PD6-N8918S6404

ACCESSORIES

Z-K4705/50 Charging Capacitor
Z-K10000/100 Charging Capacitor
ZK-RS485-USB Converters
ZIB-PDx-N Additional Board

CAUTION

For stabilizing the operating voltage, we recommend using a sufficiently dimensioned decoupling capacitor.

VERSIONS

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<td>IP 65</td>
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DIMENSIONS (IN MM)

PD6-N8918...

First view and mounting
Side view
Rear view
Top view A

DIMENSIONS (IN MM)

PD6-N8918...

First view and mounting
Side view
Rear view
Top view A

Accessories:

Z-K4705/50 Charging Capacitor
Z-K10000/100 Charging Capacitor
ZK-RS485-USB Converters
ZIB-PDx-N Additional Board
PLUG & DRIVE®
High-Pole Plug & Drive DC Servo Motor - NEMA 34

TORQUE CURVES

PD6-N8918S6404

PD6-N8918M9504

PD6-N8918L9504

Notes

PLUG & DRIVE
PD2-N4118-IP
High-Pole Plug & Drive DC Servo Motor in Protection Class IP65 - NEMA 17

TECHNICAL DATA

- Operating voltage: 12 to 48 VDC
- Max. phase current: Adjustable via software up to 2.7 A (1% increments), 100% = 1.8 A
- Interface: RS485 or CANopen
- Operating type: Position, speed, flag position, clock-direction, analog, analog position, torque
- Operating mode: 1/1, 1/2, 1/4, 1/5, 1/8, 1/10, 1/16, 1/32, 1/64, adaptive (1/128)
- Step frequency: 0 to 50 kHz in clock-direction mode, 0 to 25 kHz in all other modes
- Inputs: 6 digital inputs (5-24 V), 1 analog input (+/-10 V)
- Outputs: Open drain (0 switching, max. 24 V/0.5 A)
- Position monitoring: Automatic error correction up to 0.9 °
- Current reduction: Adjustable in 1% increments
- Protective circuit: Overvoltage and heat sink temperature >80 °C
- Temperature range: -10 to +40 °C
- Connection type: Plug connection with 2 x M12
- New functions: Closed loop/sinusoidal commutation/dspDrive/programmable as sequential controller using NanoJ easy (RS485)

ACCESSORIES

- ZK-RS485-USB
- Z-K4700/50 Charging Capacitor
- ZK-M12-17-1M-2-S-PIN M12 Cable
- ZK-M12-17-1M-2-PUR-S M12 Cable
- ZK-M12-17-3M-2-PUR-S M12 Cable

ORDER IDENTIFIER

PD2-N4118L1804-IP
- 2 = RS485 Interface
- 3 = CANopen Interface

TORQUE CURVES

PD2-N4118L1804-IP

For stabilizing the operating voltage, we recommend using a sufficiently dimensioned decoupling capacitor.
**TECHNICAL DATA**

Operating voltage: 12 to 48 VDC

Max. phase current: Adjustable via software up to 4.8 A (1% increments), 100% = 3.2 A

Interface: RS485 or CANopen

Operating type: Position, speed, flag position, clock-direction, analog, analog position, torque

Operating mode: 1/1, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, adaptive (1/128)

Step frequency: 0 to 50 kHz in clock-direction mode, 0 to 25 kHz in all other modes

Inputs: 6 opto-coupler inputs (5–24 V)

Outputs: Open drain (0 switching, max. 24 V/0.5 A)

Position monitoring: Automatic error correction up to 0.9°

Current reduction: Adjustable in 1% increments

Protective circuit: Overvoltage and heat sink temperature >80 °C

Temperature range: -10 to +40 °C

Connection type: M12

New functions: Closed loop/sinusoidal commutation/dspDrive/programmable as sequential controller using NanoJeasy (RS485)

**ACCESSORIES**

Z-K4700/S: Charging Capacitor

ZK-RS485-USB: Converters

ZIB-Pdx-N: Additional Board

**ORDER IDENTIFIER**

PD4-N5918X4204-IP-2 = RS485 Interface

PD4-N5918X4204-IP-3 = CANopen Interface

**CAUTION**

For stabilizing the operating voltage, we recommend using a sufficiently dimensioned decoupling capacitor.

**SOFTWARE**

**VERSIONS**

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<th>Weight kg</th>
<th>Length &quot;A&quot; mm</th>
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**DIMENSIONS (IN MM)**

**PD4-N5918-IP**

**PD4-N6018-IP**
Torque curves for PLUG & DRIVE® PD4-N59/N60-IP high-pole plug & drive DC servo motor in protection class IP64 - NEMA 23/24.
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Bestellingen doorsturen naar : sales@motion.nl