

N5-1-3, N5-2-3



Short instructions
Original: de

Version 1.0.0

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Introduction

The N5 is a controller for the *open loop* or *closed loop* operation of stepper motors and the *closed loop* operation of BLDC motors.

This document describes the installation and commissioning of the controller. You can find the detailed documentation for the product on the Nanotec website us.nanotec.com. The short instructions do not replace the technical manual of the product.

Copyright, marking and contact

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Intended use

The N5 controller is used to control stepper and BLDC motors and is designed for use under the approved **Environmental conditions**.

Any other use is considered unintended use.



Note

Changes or modification to the controller are not permitted.

Warranty and disclaimer

Nanotec produces component parts that are used in a wide range of industrial applications. The selection and use of Nanotec products is the responsibility of the system engineer and end user. Nanotec accepts no responsibility for the integration of the products in the end system.

Under no circumstances may a Nanotec product be integrated as a safety controller in a product or construction. All products containing a component part manufactured by Nanotec must, upon delivery to the end user, be provided with corresponding warning notices and instructions for safe use and safe operation. All warning notices provided by Nanotec must be passed on directly to the end user.

Our general terms and conditions apply: en.nanotec.com/service/general-terms-and-conditions/.

Specialist staff

Only specialists may install, program and commission the device:

- Persons who have appropriate training and experience in work with motors and their control.
- Persons who are familiar with and understand the content of this technical manual.
- Persons who 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

Note

- 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.

Note

- Fault of 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.

Note

- There is no polarity reversal protection.
- 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.

Note

- 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.

Technical details and pin assignment

Environmental conditions

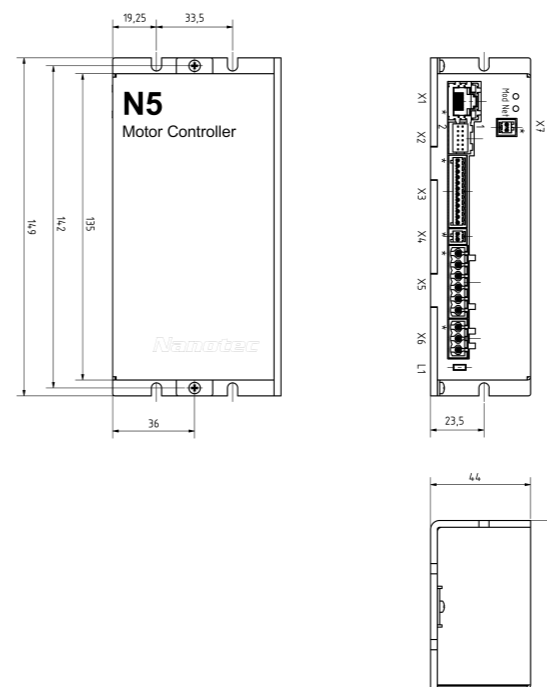
Environmental condition	Value
Protection class	IP20
Ambient temperature (operation)	-10 ... +40°C
Air humidity (non-condensing)	0 ... 95 %
Altitude of site above sea level (without drop in performance)	1500 m
Ambient temperature (storage)	-25 ... +85°C

Electrical properties and technical data

Property	Description / value
Operating voltage	<ul style="list-style-type: none"> 12 V -5% ... 72 V +4% DC for <i>low-current version</i> with designation N5-1-3 12 V - 48 V +/-5% DC for the <i>high-current version</i> with designation N5-2-3 and up to hardware version w007 12 V -5% ... 57.4 V DC for the <i>high-current version</i> with designation N5-2-3 and from hardware version w007b
Rated current	N5-1-3 (<i>low current</i>): 10 A _{rms} N5-2-3 (<i>high current</i>): 18 A _{rms}
Peak current	N5-1-3 (<i>low current</i>): 10 A _{rms} N5-2-3 (<i>high current</i>): 40 A _{rms} for 5 seconds
Commutation	Stepper motor – open loop, stepper motor – closed loop with encoder, BLDC motor – closed loop with Hall sensor, and BLDC motor – closed loop with encoder
Operating modes	<i>Profile Position Mode, Profile Velocity Mode, Profile Torque Mode, Velocity Mode, Homing Mode, Clock-Direction Mode</i>
Set value setting / programming	<i>EtherNet/IP, Ethernet (REST with the NanoIP user interface), clock-direction, analog, NanoJ program</i>
Interfaces	EtherNet/IP

Property	Description / value
Inputs	<ul style="list-style-type: none"> 4 inputs, 5 V/24 V (inputs 1 to 4) individually switchable by means of software, factory setting: 5 V 2 inputs, wide range 5-24 V (inputs 5 and 6); 2 analog inputs -10 to +10 V or 0–20 mA (switchable by means of software)
Outputs	2 outputs, (open drain, 0 switching, max. 24 V and 500 mA)
Encoder input	5 V or 24 V signal, differential or single-ended (switchable by means of software), max. resolution 65536 increments per revolution (16-bit)
Protection circuit	<p>Overvoltage and undervoltage protection</p> <p>Overtemperature protection (> 75° Celsius on the power board)</p> <p>Polarity reversal protection: In the event of a polarity reversal, a short-circuit will occur between supply voltage and GND over a power diode; a line protection device (fuse) is therefore necessary in the supply line. The values of the fuse are dependent on the application and must be dimensioned</p> <ul style="list-style-type: none"> greater than the maximum current consumption of the controller less than the maximum current of the voltage supply. <p>If the fuse value is very close to the maximum current consumption of the controller, a medium / slow tripping characteristics should be used.</p>

Dimensioned drawings



Overtemperature protection

Above a temperature of approx. 75°C on the power board (corresponds to 65–72°C outside on the cover), 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

Normal operation

In normal operation, the green power LED L1 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

Flash rate	Error
3	Temperature
4	Overcurrent
5	Controller
6	Watchdog-Reset

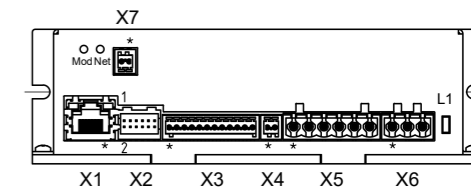


Note

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

Pin assignment

Pin 1 is marked with an asterisk "**".



Connector	Function	Pin assignment / description
X1	EtherNet/IP	
X2	Encoder and Hall sensor 5 V / 24 V DC signal Max. 1 MHz Switching thresholds: 5 V (factory setting): On: >3.8 V; Off: <0.26 V 24 V: On: >14.42 V; Off: <4.16 V	<ol style="list-style-type: none"> GND Vcc: +5 V (factory setting) / 24 V DC output, switchable with object 2059_n A B A' B' I I' Hall 1 Hall 2 Hall 3 Shielding
X3	Inputs and outputs Switching thresholds for digital inputs 1 - 4: 5 V (factory setting): On: >3.8 V; Off: <0.26 V 24 V: On: >14.42 V; Off: <4.16 V Switching thresholds for digital inputs 5 - 6: On: >3.25 V; Off: <2 V	<ol style="list-style-type: none"> GND Digital input 1; 5 V / 24 V Signal, switchable with object 3240_n Digital input 2; 5 V / 24 V Signal, switchable with object 3240_n Digital input 3; 5 V / 24 V, switchable with object 3240_n, max. 1 MHz; <i>direction input</i> in clock/direction mode Digital input 4; 5 V / 24 V, switchable with object 3240_n, max. 1 MHz; <i>clock input</i> in clock/direction mode Digital input 5; 5...24 V signal, not switchable Digital input 6; 5...24 V signal, not switchable Analog input 1: 10 Bit, 0-10 V oder 0-20 mA, switchable with object 3221_n Analog input 1: 10 Bit, 0-10 V oder 0-20 mA, switchable with object 3221_n Digital output 1: Open drain, max 24 V/500 mA Digital output 2: Open drain, max 24 V/500 mA Shielding
X4	Brake 24V Brakes have to be connected using an appropriate circuit if +UB>24 V!	<ol style="list-style-type: none"> Brake+: internally connected to +UB Brake -: PWM-controlled open-drain output, max 1.5 A
X5	Motor	<ol style="list-style-type: none"> Shielding A (Stepper) U (BLDC) A' (Stepper) V (BLDC) B (Stepper) W (BLDC) B' (Stepper) Shielding

Connector	Function	Pin assignment / description
X6	Voltage supply Permissible operating voltage: <i>See Electrical properties and technical data</i>	1. Shielding 2. +UB 3. GND
X7	Supply for Encoder/ Hall sensor, external logic supply To be connected if 24V encoder is used or logic supply of the controller desired.	1. +UB Logic / Encoder: +24 V 2. GND

Note

- 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* software offers you an option for performing the configuration and adapting the controller to the connected motor. You can find further information in document *Plug & Drive Studio: Quick Start Guide* at us.nanotec.com.

Observe the following note:

Note

- EMC: Current-carrying cables – particularly around supply and motor cables – produce electromagnetic alternating fields.
- These can interfere with the motor and other devices. Nanotec recommends the following measures:
- Use shielded cables and earth the cable shielding on both ends over a short distance.
- Use cables with cores in twisted pairs.
- Keep power supply and motor cables as short as possible.
- Earth motor housing with large contact area over a short distance.
- Lay supply, motor and control cables physically separate from one another.

Configuration via Ethernet

Establishing connection with the controller

Setting the IP address

Each of the connected devices (controller and communication partners) in an Ethernet network or with a point-to-point Ethernet connection requires a unique IP address. This can either be obtained automatically (DHCP) or assigned statically. In the following, "communication partner" refers to a PC or laptop.

You can integrate the controller in an existing Ethernet network. To do this, you only need to establish the physical connection with a standard Ethernet cable. Provided DHCP is activated on the controller (factory setting), the controller is also automatically detected on the network and can immediately be operated via a PC located on the network.

Setting DHCP

IP addresses can be obtained dynamically in a network from a DHCP server. DHCP are preset in the controller at the factory for automatically obtaining an IP address from a DHCP server. To establish the connection to the controller, it may only be necessary to make a few settings on the communication partner (e.g., PC or laptop). Settings using the Windows 7 operating system as an example:

- Press the Windows Start button and select *Control Panel*.
- Select *Network and Sharing Center*.
- Select *Change adapter settings*.
- A list of the available network adapters is displayed. Open the properties on the adapter to which the controller is connected (e.g., click with the right mouse button).
- Select *Internet Protocol version 4 (TCP/IPv4)* and press the *Properties* button.
- Select the *Obtain an IP address automatically* option.
- Confirm acceptance of the entries with the *OK* button.

Commissioning EtherNet/IP

This controller is equipped with an EtherNet/IP interface. Read chapter **EtherNet/IP** in the technical manual of the controller for further details.

Note

Nanotec controllers are always based on CANopen standard CiA402. All attributes are therefore stored in a so-called *object dictionary*. These can be addressed with an index and a subindex, e.g., 1018_h;01_h. The index is a 16-bit value and the subindex is an 8-bit value.

The controller offers EtherNet/IP, but this protocol uses a different procedure: all attributes are stored on the basis of objects. For this reason, the *N5* uses an assignment to create a bridge between EtherNet/IP and CANopen. As a consequence, the configuration of this controller is somewhat different that with normal EtherNet/IP devices.

The following commissioning procedure requires the use of a *CompactLogix* PLC and *Studio 5000* software from Rockwell.

Connection

- Connect the supply voltage to connector X6.
- Connect the Rockwell *CompactLogix* PLC to connection X1 of the controller.

Software connection

By default, the controller is in DHCP mode. A DHCP server is therefore needed in the network. If no DHCP server is available or if the controller is to operate with a fixed IP address, the *BOOTP/DHCP* tool from Rockwell can be used. With this tool, it is possible to either assign an IP address to the controller by means of DHCP or to assign a static address and deactivate DHCP. BOOTP is not supported by the controller.

If you have your own DHCP server and wish to ascertain the IP address, this can be accomplished most easily with the *ping* tool. To do this, the NetBIOS service must be activated on the PC and the MAC address of the controller must be known.

You must perform the next steps in the Rockwell *Logix Designer*:

- Use the *RSLinx Classic* software to create an EtherNet/IP driver. Refer to the corresponding manual for help.
- Select the project path of the PLC.
- Import the EDS file of the controller: Click on *Tools\EDS Hardware Installation Tool*, select *Register an EDS file(s)*. Then select the correct EDS file and import it.

- Right-click on *Ethernet* in the *Controller Organizer* and select *New Module...*

Select the *Catalog* tab, find entry *N5* and select the device with which you would like to work.

The *New Module* input mask then opens. Select the *General* tab and enter a name and the IP address for the device. Use of the *Host Name* is not supported.

Select the *Connection* tab and enter an RPI value for the *I/O Common* data as shown in the following figure. The *input type* can also be changed to *unicast* or *multicast*.

Lastly, close the mask by clicking on *OK*.

- Right-click on *Add-On Instruction* in the *Controller Organizer* and then on *Import Add-On Instruction...* to import the add-ons that have been made available, which will simplify work with the controller (see chapter **Add-on instructions** in the technical manual of the controller).
- Right-click on *Data Types\User-Defined* in the *Controller Organizer* and then on *Import Data Type...* to import the *user-defined* data that have been made available. After importing, the message objects in the various AOLs should be checked to determine whether the correct communication path is still set.
- Select the *Communications* menu item followed by the *Go Online* submenu item to go online. To do this, you must download the program to the PLC.
- Once you are online, go to *Run Mode* via the *Communications* menu and the *Run Mode* submenu item. If the fields are green for *Run Mode*, *Controller OK* and *I/O OK*, configuration was successful and you can begin work with the controller.

Setting the motor data

Prior to commissioning, the motor controller requires a number of values from the motor data sheet.

- Number of pole pairs: Object 2030_h;00_h (pole pair count) The number of motor pole pairs is to be entered here. With a stepper motor, the number of pole pairs is calculated using the step angle, e.g., 1.8° = 50 pole pairs, 0.9° = 100 pole pairs (see step angle in motor data sheet). With BLDC motors, the number of pole pairs is specified directly in the motor data sheet.
- Setting the motor current / motor type:
 - Stepper motor only: Object 2031_h;00_h: Rated current (bipolar) in mA (see motor data sheet)
 - Object 2031_h;00_h: Rated current (bipolar) in mA (see motor data sheet)
 - Object 3202_h;00_h (Motor Drive Submode Select): Defines motor type stepper motor, activates current reduction on motor standstill: 0000008h.

- Object 2037_h (Open Loop Current Reduction Value/factor): the root mean square is specified to which the rated current is to be reduced if current reduction is activated in *Open Loop*.

BLDC motor only:

- Object 2031_h;00_h Peak current in mA (see motor data sheet)
- Object 203B_h;01_h Rated current in mA (see motor data sheet)
- Object 203B_h;02_h Maximum duration of the peak current in ms (for initial commissioning, a value of 100 ms is recommended; this value is to be adapted later to the specific application).
- Object 3202_h;00_h (Motor Drive Submode Select): Defines motor type BLDC: 00000041h

- Motor with encoder: Object 20592059_h;00_h (Encoder Configuration): Depending on the encoder version, one of the following values is to be entered (see motor data sheet):

- Supply voltage 5V, differential: 00000000h
- Supply voltage 24V, differential: 00000001h
- Supply voltage 5V, single-ended: 00000002h
- Supply voltage 24V, single-ended: 00000003h

- Motor with brake: Object 3202_h;00_h (Motor Drive Submode Select): The brake control is activated for the initial commissioning. Depending on the specific application, this configuration can be deactivated later if necessary. One of the following values is to be entered depending on the motor type:

- Stepper motor, brake control (and **current reduction** while at standstill) activated: 0000000Ch
- BLDC motor, brake control activated: 00000044h

Auto setup

To determine a number of parameters related to the motor and the connected sensors (encoders/Hall sensors), an auto setup is performed. **Closed Loop** operation requires a successfully completed auto setup.

Note

- Note the following prerequisites for performing the auto setup:
- The motor must be load-free.
- The motor must not be touched.
- The motor must be able to turn freely in any direction.
- No NanoJ programs may be running (object 2300_h;00_h bit 0 = "0", see **2300h NanoJ Control**).

Tip

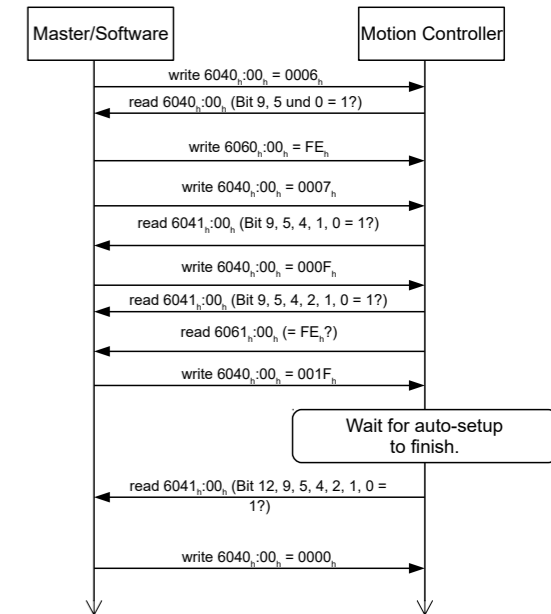
As long as the motor connected to the controller or the sensors for feedback (encoders/Hall sensors) are not changed, auto setup is only to be performed once during initial commissioning.

Execution

- To preselect the *auto setup* operating mode, enter the value "-2" ("FE_h") in object 6060_h;00_h. The *power state machine* must now switch to the *Operation enabled* state.
- Start *auto setup* by setting bit 4 *OMS* in object 6040_h;00_h (controlword). While the auto setup is running, the following tests and measurements are performed in succession:

To determine the values, the direction of the measurement method is reversed and edge detection re-evaluated.

Value 1 in bit 12 *OMS* in object 6041_h;00_h (statusword) indicates that the auto setup was completely executed and ended. In addition, bit 10 *TARG* in object 6041_h;00_h can be used to query whether (= "1") or not (= "0") an encoder index was found.



CAUTION

- After executing auto setup mode, the internal coordinate system is no longer valid.
- Homing* alone does not suffice! If the controller is not restarted, unexpected reactions may result.
- Restart the device after an auto setup!