N5-1-5, N5-2-5

Nanotec®
PLUG & DRIVE

Short instructions
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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*.

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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

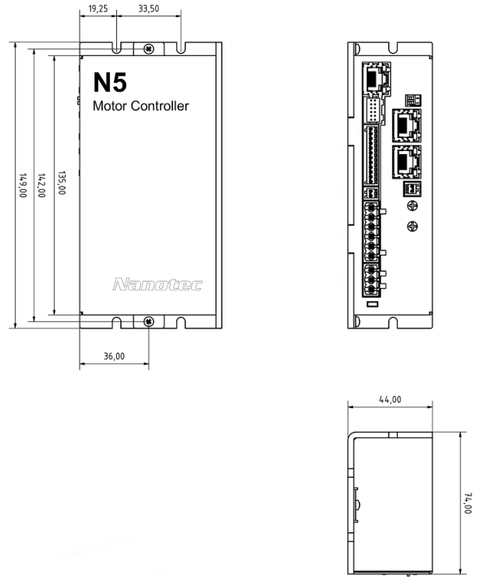
Environmental conditions

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

Property	Description / value
Operating voltage	• 12 V -5%…72 V +4% DC for *low-current version* with designation N5-1-5 • 12 V - 48 V ±5% DC for the *high-current version* with designation N5-2-5 and up to **hardware version** w007 • 12 V -5%…57,4 V DC for the *high-current version* with designation N5-2-5 and from **hardware version** w007b
Rated current	N5-1-5 (*low current*): 10 A_{rms} N5-2-5 (*high current*): 18 A_{rms}
Peak current	N5-1-5 (*low current*): 10 A_{rms} N5-2-5 (*high current*): 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	*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*
Set value setting / programming	*Modbus RTU (RS-485)*, *Ethernet*, *clock-direction*, *analog*, *NanoJ program*
Interfaces	RS-485 (Modbus RTU), Ethernet
Inputs	• 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	Overvoltage and undervoltage protection Overtemperature protection (> 75° Celsius on the power board) 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 • greater than the maximum current consumption of the controller • less than the maximum current of the voltage supply. If the fuse value is very close to the maximum current consumption of the controller, a medium / slow tripping characteristics should be used.

Dimensioned drawings



Overtemperature protection

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

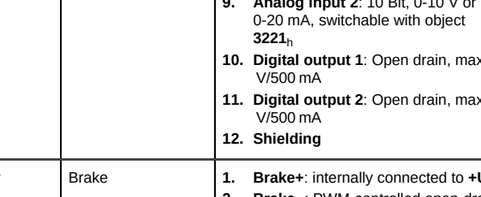
Flash rate	Error
1	General
2	Voltage
3	Temperature
4	Overcurrent
5	Controller
6	Watchdog-Reset

Note

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

Pin assignment

Pin 1 is marked with an asterisk "*".



Connector	Function	Pin assignment / description
X1	Ethernet	Configuration interface
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	**1.** GND **2.** Vcc: +5 V (factory setting) /24 V DC output, switchable with object 2059$_h$ **3.** A **4.** B **5.** A\ **6.** B\ **7.** I **8.** I\ **9.** Hall 1 **10.** Hall 2 **11.** Hall 3 **12.** 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	**1. GND** **2. Digital input 1**; 5 V / 24 V signal, switchable with object **3240**$_h$ **3. Digital input 2**; 5 V / 24 V signal, switchable with object **3240**$_h$ **4. Digital input 3**: 5 V / 24 V, switchable with object **3240**$_h$, max. 1 MHz; *direction input* in clock-direction mode **5. Digital input 4**: 5 V / 24 V, switchable with object **3240**$_h$, max. 1 MHz; *clock input* in clock-direction mode **6. Digital input 5**; 5 V…24 V signal, not switchable **7. Digital input 6**; 5 V…24 V signal, not switchable **8. Analog input 1**: 10 Bit, 0-10 V or 0-20 mA, switchable with object **3221**$_h$ **9. Analog input 2**: 10 Bit, 0-10 V or 0-20 mA, switchable with object **3221**$_h$ **10. Digital output 1**: Open drain, max 24 V/500 mA **11. Digital output 2**: Open drain, max 24 V/500 mA **12. Shielding**
X4	Brake 24V Brakes have to be connected using an appropriate circuit if **+UB**>24 V!	**1. Brake+**: internally connected to **+UB** **2. Brake -**: PWM-controlled open-drain output, max 1.5 A

Connector	Function	Pin assignment / description
X5	Motor	**1. Shielding** **2. A** (Stepper) **U** (BLDC) **3. A** (Stepper) **V** (BLDC) **4. B** (Stepper) **W** (BLDC) **5. B** (Stepper) **6. Shielding**
X6	Voltage supply Permissible operating voltage: See *Electrical properties*	**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**
X8	RS-485 IN	**1.** n.c **2.** n.c **3.** n.c **4.** RS-485 + **5.** RS-485 - **6.** n.c. **7.** n.c. **8.** Common
X9	RS-485 OUT	
S1 und S2	Two hex coding swithces for setting the slave address and baud rate: • *S1*: 16^1 • *S2*: 16^0	**Value of the switches** / **address** / **baud rate / parity** 0_h / Object **2028_h** / Object **202A / $202D_h$** $1\text{-}F7_h$ / Value of the switches / Object **202A / $202D_h$** $F8_h\text{-}FF_h$ / 5 / 19200, even parity
S3	DIP switch for 150 Ω termination for RS-485.	**OFF**: No termination **ON**: Termination on.

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 separately.

Configuring the Ethernet interface

Overview

Interface

The controller is equipped with a 10/100 MBit Ethernet interface. In this way it can be operated with all current Ethernet components (switches, PCs) and configured via the *Plug & Drive Studio* software.

IP address

The controller needs a valid IP address. This can be obtained in the following ways:

- DHCP: A DHCP server assigns the IP address to the controller (default setting).
- AutoIP: The controller automatically determines a suitable IP address. The prerequisite here is that the communication partners are in the same physical subnet and also use AutoIP.
- Static IP address: This is defined by the user.

Which method is used depends on the network environment and is defined by the network administrator.

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 generated (Auto-IP) 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/Auto-IP

IP addresses can be obtained dynamically in a network from a DHCP server or, for example, in the case of a PC direct connection, can be automatically self-generated without DHCP by the two communication devices (e.g., PC and controller). DHCP is preset in the controller at the factory for automatically obtaining an IP address from a DHPC server or for automatic IP address generation. 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:

1. Press the Windows Start button and select *Control Panel*.
2. Select *Network and Sharing Center*.
3. Select *Change adapter settings*.
4. 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).
5. *Select Internet Protocol version 4 (TCP/IPv4)* and press the *Properties* button.
6. Select the *Obtain an IP address automatically* option.
7. Confirm acceptance of the entries with the *OK* button.

Establishing network connection

Establish a physical connection between controller and communication partner using a standard Ethernet cable. If static IP addresses were assigned to the controller and the communication partner, they can communicate directly.

If you have a DHCP server and want to find out the IP address, you can use the tool Tool *ping*. In order to do this, the NetBIOS service on the PC must be acivated and dthe MAC address known.

Establishing communication via Modbus

1. Connect the *Modbus master* to the controller via the RS-485+ and RS-485- cables.
2. Supply the controller with voltage.
3. Change the configuration values if necessary.

   The controller is set to slave address 1 ex works, baud rate 19200 baud, even parity, 1 stop bit.
4. To test the interface, send bytes `01 65 55 00 2E 97` to the controller (you can find a detailed description of the Modbus function codes in chapter **Modbus RTU** of the *technical manual*).
   The object dictionary is read out.

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).
- 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, Nanotec recommends a value of 100 ms; 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 **2059_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**) 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

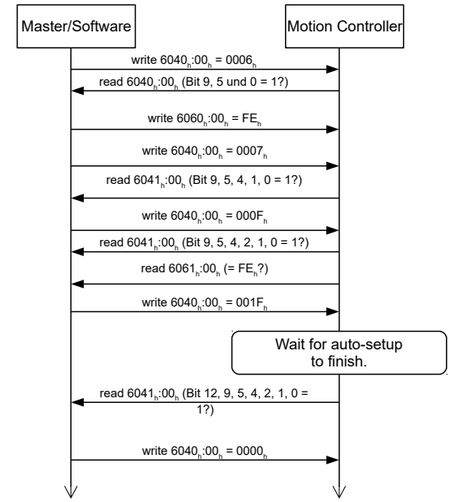
As long as the motor connected to the controller or the sensors for feedback (encoders/Hall sensors) are not changed, auto setup is only to be performed once during initial commissioning.

Execution

1. 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.
2. 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

Uncontrolled motor movements!

After the auto setup, the internal coordinate system is no longer valid. Unforeseen reactions can result.

► Restart the device after an auto setup. Homing alone does not suffice.

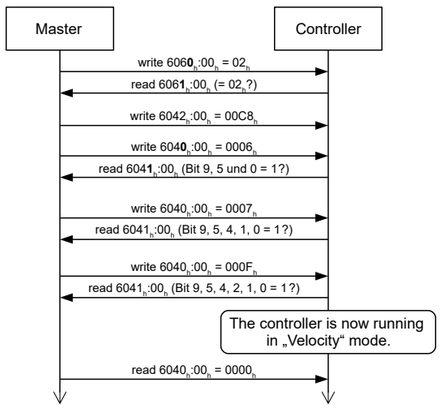
Test run

As an example, the **Velocity** operating mode is used.

The values are transferred from your *Modbus master* to the controller. After every transfer, the *master* should use the status objects of the controller to ensure successful parameterization.

1. Select the *Velocity* mode by setting object **6060_h** (Modes Of Operation) to the value "2".
2. Write the desired speed in **6042_h**.
3. Switch the *power state machine* to the *Operation enabled*.

   The following sequence starts *Velocity* mode; the motor turns at 200 rpm.



4. To stop the motor, set controlword (**6040_h**) to "0".