C5-01

Nanotec PLUG & DRIVE

Short instructions
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Introduction

The *C5* is a controller for the *open loop* operation of stepper motors. The *C5* is delivered preconfigured in clock-direction mode. Via DIP switches, you can also use the analog velocity mode without any additional programming.

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 oft he product.

Copyright, marking and contact

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Intended use

The *C5 controller* is used to control stepper 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	12 V DC to 48 V DC +/-5%
Rated current	6 A$_{rms}$
Peak current	6 A$_{rms}$
Commutation	Stepper motor, open loop
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	*Clock-direction, analog, NanoJ program*
Interfaces	USB
Inputs	• 3 inputs 24 V (inputs 1 to 3) • 3 inputs switchable 5/24 V, single-ended or differential (inputs 4 to 6), factory settings are 5 V and single-ended • 1 analog input, switchable 0-10 V or 0-20 mA
Outputs	2 outputs, (open drain, 0 switching, max. 24 V / 100 mA for each output)

Property	Description / value
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
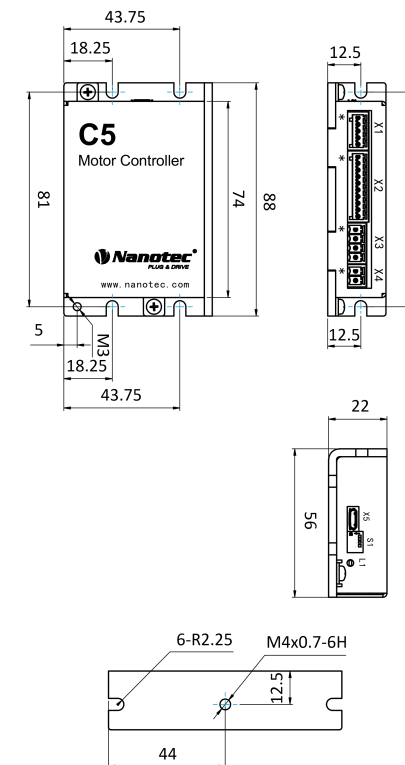
Overtemperature protection

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

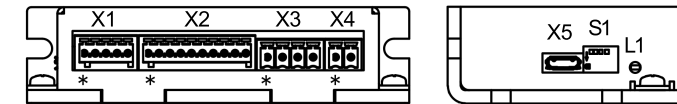| Flash rate	Error
1	General
2	Voltage
3	Temperature
4	Overcurrent
5	Controller
6	Watchdog-Reset

> **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	Analog input and outputs	1. **GND** 2. **Analog input**: 10 Bit, 0-10 V or 0-20 mA, switchable with object **3221**$_h$ 3. **Digital output 1**: Open drain, max 24 V/100 mA 4. **Digital output 2**: Open drain, max 24 V/100 mA 5. **10V output**: +10 VDC, max. 150 mA
X2	Digital inputs Switching thresholds for digital **inputs 1 - 3**: On >16 V; Off: <4 V Switching thresholds for digital **inputs 4 - 6 (Pins 4-9)**: **5 V (factory setting)**: On: >3 V; Off: <1 V **24 V**: On: >12 V; Off: <7 V	1. **Digital input 1**: 24 V, not switchable 2. **Digital input 2**: 24 V, not switchable 3. **Digital input 3**: 24 V, not switchable 4. **-Enable (-input 4)**: 5/24 V and *single-ended/differential* switchable, max. 1 MHz 5. **+Enable (+input 4)**: 5/24 V and *single-ended/differential* switchable, max. 1 MHz 6. **-Direction (-input 5)**: 5/24 V and *single-ended/differential* switchable, max. 1 MHz 7. **+Direction (+input 5)**: 5/24 V and *single-ended/differential* switchable, max. 1 MHz 8. **-Clock (-input 6)**: 5/24 V and *single-ended/differential* switchable, max. 1 MHz 9. **+Clock (+input 6)**: 5/24 V and *single-ended/differential* switchable, max. 1 MHz 10. **GND**
X3	Motor	1. **A** (Stepper) 2. **A** (Stepper) 3. **B** (Stepper) 4. **B** (Stepper)
X4	Voltage supply 12-48 V DC±5%	1. **+UB** 2. **GND**
X5	USB connector	Micro USB
S1	DIP switches for the selection of the *special drive modes* (Clock-direction / Analog-speed)	See *Comissioning*

> **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**.

The controller also offers you the possibility to switch *special drive modes* on/off via the DIP switch. You can thereby control the motor directly via the inputs (analog input/clock-direction). See chapter **Special drive modes (clock-direction and analog speed)** for details.

Observe the following note:

Configuration

General

The following options are available for configuring the controller:

Configuration file

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

NanoJ program

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

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

1. The configuration file is read out and processed.
2. The DIP switches for selecting the *special drive modes* is/are read out and used as configuration. See chapter **Special drive modes (clock-direction and analog speed)**.
3. The NanoJ program is started.

USB connection

If the controller is connected to a PC via a USB cable, the controller behaves like a removable storage device. No further drivers are required.

Three files are displayed: the configuration file (`cfg.txt`), the NanoJ program (`vmmcode.usr`) and the information file (`info.bin`), where the serial numbers and firmware version of the product can be found.

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

Configuration file

General

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

Reading and writing the file

How to access the file:

1. Connect and switch on the voltage supply.
2. Connect the controller to your PC using the USB cable.
3. After the PC has detected the device as a removable storage device, navigate in the Explorer to the directory of the controller. File `cfg.txt` (for a PD4C, the file is named `pd4ccfg.txt`) is stored there.
4. Open this file with a simple text editor, such as Notepad or Vi. Do not use any programs that use markup (LibreOffice or similar).

Tip

💡
To be able to connect the controller with *Plug & Drive Studio* via the *virtual COM port* mit verbinden zu können, insert the following line:

```
2102:00=0x190001
```

```
DD4C=1
```

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

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

Structure of the configuration file

Comments

Lines that begin with a semicolon are ignored by the controller.

Assignments

Values in the object dictionary can be set with the following syntax:

```
<Index>:<Subindex>=<Value>
```

Example

Set object 2031$_h$:00 (rated current) to the value "258$_h$" (600 mA):

```
2031:00=0x258
```

Set object 3202$_h$:00 to the value "8" (activate current reduction while at a standstill in *open loop* mode):

```
3202:00=8
```

Set object 2057$_h$:00 to the value "512" and object 2058$_h$ to the value "4" (*quarter step* step mode in clock-direction mode):

```
2057:00=512
```

```
2058:00=4
```

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*.

Special drive modes (clock-direction and analog speed)

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

Digital input 4 serves here as an enable.

Activation

You can configure the controller via the DIP switches on the rear side and choose one of the *special drive modes*.

The configuration via the DIP switches is activated on delivery, you can completely deactivate it by inseting this line in the configuration file:

```
dd4c=1
```

The following graphic shows the position of the switches on delivery.

Following combination of the switches are possible (switch 4 has no function):

1	2	3	Modus		
Off	Off	Off	Clock-direction		
Off	Off	On	Clock-direction		
Off	On	Off	test run	Test run with 30 rpm	Clockwise direction of rotation
Off	On	On	test run	Test run with 30 rpm	Counterclockwise direction of rotation
On	Off	Off	Analog speed	Direction via "Direction" input	Maximum speed 1000 rpm

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1	2	3	Modus		
On	Off	On	Analog speed	Direction via "Direction" input	Maximum speed 100 rpm
On	On	Off	Analog speed	Offset 5 V (joystick mode)	Maximum speed 1000 rpm
On	On	On	Analog speed	Offset 5 V (joystick mode)	Maximum speed 100 rpm

Note

ⓘ
A change to the switches does not take effect until after the controller is restarted.

Clock-direction

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

Analog speed

The controller internally sets the operating mode to **Velocity**. To preset the speed, the voltage on the analog input is used and the corresponding target speed is written in **6042**$_h$.

Maximum speed

The maximum speed can be changed between 100 rpm and 1000 rpm. If a different speed is necessary, it can be set using the scaling factor (object **604C**$_h$ subindices 01$_h$ and 02$_h$).

Computation of the analog voltage

There are two modes for calculating the analog input voltage.

Normal mode

You must connect the *enable*, *direction* and *analog inputs*. The maximum analog voltage corresponds to the maximum speed. The direction is preset here via the direction input. There is a dead zone from 0 V to 20 mV in which the motor does not move.

Joystick mode

You must connect the *enable input* and the *analog input*. Half of the maximum analog voltage corresponds to the speed 0. If the voltage drops below half, the speed increases in the negative direction. If the speed rises above half, the speed increases likewise in the positive direction. The dead zone here extends from $U_{max}/2 \pm 20$ mV.

Test run with 30 rpm

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