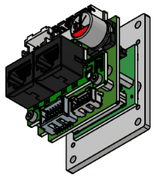
CLC-1-1... , CLC-2-1...



Short instructions
Original: de

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Introduction

The products of the *CLC* series are compact motor controllers without housing in three different sizes. The *CLC3-...* and *CLC6-...* variants can control both BLDC motors and stepper motors; the *CLC15* variant is suitable for BLDC motors only.

This manual describes the functions of the controller and the available operating modes. It also shows how you can address and program the controller via the communication interface.

You can find further information on the product on **us.nanotec.com**.

Copyright

CE

Intended use

The *CLC* serves to control stepper motors and BLDC motors and is used as a component in drive systems in a wide range of industrial applications.

Use the product as intended within the limits defined in the technical data (in particular, see **Permissible operating voltage**) and the approved **Environmental conditions**. This Nanotec product may not be integrated as a safety component in a product or system under any circumstances.

All products containing a component manufactured by Nanotec must, upon delivery to the end user, be provided with corresponding warning notices including instructions for safe use and safe operation. All warning notices provided by Nanotec must be passed on directly to the end user.

Target group and qualification

The product and this documentation are directed towards technically trained specialists staff such as: development engineers, plant engineers, installers/ service personnel, and application engineers.

Only specialists may install, program and commission the product. Specialist staff are persons who

- have appropriate training and experience in working with motors and their controller,
- are familiar with and understand the content of this technical manual,
- know the applicable regulations.

Warranty and disclaimer

Nanotec shall not be liable for damage and malfunctions attributable to installation errors, failure to observe this document or improper repair. The plant engineer, operating company and user shall be responsible for the selection, operation and use of our products. Nanotec shall not take responsibility for integration of the product in the end system. The general terms and conditions listed at www.nanotec.de shall apply. **Comment:** Modifications/changes to the product as well as opening the product are prohibited.

Other applicable regulations

In addition to this technical manual, the following regulations are to be observed:

- Accident-prevention regulations
- Local regulations on occupational safety

EU directives for product safety

The following EU directives were observed:

- RoHS directive (2011/65/EU, 2015/863/EU)

Safety and warning notices

HINWEIS

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.

HINWEIS

Damage to 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.

HINWEIS

Damage to the electronics through improper handling of ESD-sensitive components!

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.

HINWEIS

Damage to the electronics if the supply voltage is connected with reversed polarity!

► Install a line protection device (fuse) in the supply line.

Technical details and pin assignment

Environmental conditions

Environmental condition	Value
Protection class	No IP protection
Ambient temperature (operation)	-10 … +40°C
Ambient temperature (storage and transport)	-25 … +85°C
Relative humidity (operation), non-condensing	0 … 95 %
Relative humidity (storage and transport), non-condensing	0 … 90 %
Absolute humidity (storage and transport), non-condensing	30 g/m^3
Max. altitude of site above *sea level*	1500 m
Max. altitude of site above *sea level* (storage and transport)	3000 m

Dimensioned drawings and notes on mounting

All dimensions are in millimeters.

CLC3

CLC6

CLC15

- To optimize the heat dissipation, mount the product vertically.
- Fasten the product with suitable screws and nuts using the available holes (3.2 mm diameter). Do not cut a thread into the plate, to avoid producing metal chips.

Electrical properties and technical data

Property	Description / value
Operating voltage	12 … 57.6 V DC
Rated current @40°C	*CLC3-...*: 3 A_{rms}
	CLC6-...: 6 A_{rms}
	CLC15-...: 15 A_{rms}
Peak current @40°C	• *CLC3-1-...*: 3 A_{rms} • *CLC3-2-...*: 9 A_{rms} (for max. 5 seconds)
	• *CLC6-1-...*: 6 A_{rms} • *CLC6-2-...*: 18 A_{rms} (for max. 5 seconds)
	CLC15-...: 45 A_{rms} (for max. 5 seconds)
Commutation	*CLC3-...*, *CLC6-...*: Stepper motor *open-loop*, stepper motor *closed-loop* with encoder, BLDC sine commutated via Hall sensor, BLDC sine commutated via encoder *CLC15-…*: BLDC sine commutated via Hall sensor, BLDC sine commutated via 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	*Clock-direction*, *analog*, *NanoJ program*
Interfaces	USB, EtherCAT
Encoder/Hall	1x SSI encoder, 1x Hall sensor, 1x incremental encoder
I/O	6 digital inputs (5/24 V), 2 analog inputs (0-24 V), 2 digital outputs (5/UB_Logic V) 1 PWM brake output (level = UB_Logic)
Overtemperature	Shutdown at temperature > 75°C
Charging capacitor	For each ampere of rated current on the motor, Nanotec recommends a capacitance of approx. 1000 µF.

Overtemperature protection

Above a temperature of approx. 75°C on the power board 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

The power LED indicates the current status.

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.

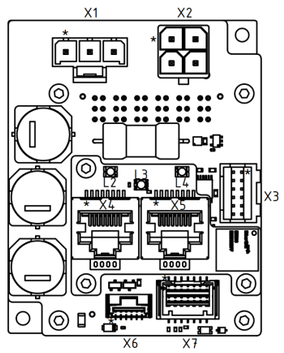
Flash rate	Error
1	General
2	Voltage
3	Temperature
4	Overcurrent
5	Controller
6	Watchdog-Reset

HINWEIS

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

Connections

Pin 1 is marked below.



Connection	Function	Pin assignment / description
X1 Molex 20024 11113	Power supply	1. **+UB**:12 V - 57.6 V DC 2. **+UB_Logic**:12 V - 30 V DC 3. **GND**
X2 Molex 7682 90104	Motor	1. **U** 2. **Not used** 3. **V** 4. **W**
X7 Molex 50315 41490	Inputs and outputs	1. **GND** 2. **Digital input 1**: 5 V / 24 V, switchable 3. **…2** 4. **…3** 5. **…4** 6. **…5** 7. **Digital input 6**: 5 V / 24 V, switchable 8. **Analog input 1**: 0 V…+24 V, 12-bit resolution 9. **Analog input 2**: 0 V…+24 V, 12-bit resolution 10. **Digital output 1**: 5 / 24 V (UB_Logic) switchable, 100 mA 11. **Digital output 2**: 5 / 24 V (UB_Logic) switchable, 100 mA 12. **Brake+**: PWM-controlled output, supplied by UB_Logic, up to 20 KHz, max. 1500 mA 13. **Brake-**: GND for brake 14. **+UB_Logic**:12 V - 30 V DC
X6 Molex 50238 20670	SSI encoder	1. **Vcc**: +10 V DC, output and supply voltage for SSI encoder, max. 350 mA 2. **CLCK A**: up to 10 MHz 3. **CLCK B**: up to 10 MHz 4. **DATA A** 5. **DATA B** 6. **GND**
X3 Type: JST S12B-PADSS-1	Incremental encoder and hall sensor Max. 1 MHz	1. **GND** 2. **Vcc**: +5 V DC, output and supply voltage for encoder / Hall sensor: max. 350 mA 3. **A** 4. **B** 5. **A** 6. **B** 7. **I** 8. **I** 9. **Hall 1** 10. **Hall 2** 11. **Hall 3** 12. **Shielding** Connection for the shielding
X5 / X4 RJ45 socket	EtherCAT IN / OUT	1. TD+ 2. TD- 3. RD+ 4. n.c. 5. n.c. 6. RD- 7. n.c. 8. n.c.

HINWEIS

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 (810911010 from Würth or equivalent) is to be inserted in the DC supply line(s) as close as possible to the controller/motor.

► Long data or supply lines are to be routed through ferrites.

► Motor cables are to be routed through ferrites (74271222 from Würth or equivalent).

Commissioning

The *Plug & Drive Studio 3* 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: User Manual* at **us.nanotec.com**.

Configuration via USB

General

The following options are available for configuring the controller via USB:

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 3* software. You can find further information in document *Plug & Drive Studio 3: User manual* 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 NanoJ program is started.

USB connection

HINWEIS

Damage to the product and/or external hardware caused by differences in potential at the USB.

Connecting the USB cable while the electronics are being supplied (hot plugging) may result in damage.

► Connect USB before switching on the supply voltage.

► If possible, equalize differences in potential between PC and product or use USB isolator.

► First connect the USB cable to the product, then to the PC.

If the controller is connected to a PC via a USB cable, an MTP device that contains a data carrier is created in the Windows file explorer.

Up to three files are displayed, the configuration file (`cfg*.txt`), the firmware (`*.fw`) and the *NanoJ program* (`nanoj*.usr`), which is stored internally immediately after restarting the controller and is no longer displayed.

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 the controller to your PC using the USB cable.
2. Connect and switch on the voltage supply.
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` 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).

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

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

Configuration via EtherCAT

Software connection

TIPP

The following description assumes that an EtherCAT master from Beckhoff with the *TwinCAT* software is used.

1. Connect the EtherCAT master to the controller, see .
2. Supply the controller with voltage.
3. Obtain the *ESI file* that corresponds exactly to the used **firmware version** from the following sources:
   a. From the Nanotec website **us.nanotec.com**. The current version of the firmware and the *ESI file* can be found in the *Plug & Drive Studio* download folder.
   b. From Nanotec support.
4. Close the *TwinCAT* system manager if it is open.
5. Then copy the *ESI file* to the *TwinCAT* subfolder:
   - If you use *TwinCAT* version 2, use folder `<TWINCAT INSTALL DIR>/Io/EtherCAT`
   - If you use *TwinCAT* version 3, use folder `<TWINCAT INSTALL DIR>/3.1/Config/Io/EtherCAT`

   Example

   Example: If *TwinCAT* 2 is installed on your computer under path `C:\TwinCAT\`, copy the *ESI file* to path `C:\TwinCAT\Io\EtherCAT\`.

6. Open the *ESI file* with an editor. Find the *AddInfo* parameter. Enter:
   - the value "2" if you would like to integrate the controller as *Box* (factory settings)
   - the value "0" if you would like to integrate the controller as *NC-Axis*

   Save and close the file.
7. Now restart the *TwinCAT* system manager. The *ESI files* are read in again following a restart.

HINWEIS

The cycle time of the sync signal must always be set to 1 ms. You can set the bus cycle time (and, consequently, the interpolation time in **60C2**$_h$) to integer multiples of 1 ms.

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.
- Object **6075**$_h$:00$_h$: rated current of the motor in mA (see motor data sheet
- Object **6073**$_h$:00$_h$: maximum current (for a stepper motor, generally corresponds to the rated current, bipolar) in tenths of a percent of the set rated current (see motor data sheet). Factory settings: "1000", which corresponds to 100% of the value in **6075**$_h$.
- Object **3219**$_h$:01$_h$ Maximum duration of the maximum current (**6073**$_h$) in ms (for initial commissioning, Nanotec recommends a value of 100 ms; this value is to be adapted later to the specific application).
- Setting the motor type:
  - Stepper motor:
    - Object **3202**$_h$ (Motor Drive Submode Select): Set bit 6 to "0" for stepper motor and use bit 0 to select between open- and closed-loop: value 0$_h$ or 1$_h$.
    - Object **3219**$_h$:03$_h$ (Open Loop Idle State Current): Specify the root mean square in tenths of a percent to which the rated current is to be reduced if current reduction is activated in *open-loop*.
  - BLDC motor:
    - Object **3202**$_h$ (Motor Drive Submode Select): Bit 6 for BLDC, bit 0 for the recommended *closed-loop*: 00000041$_h$
- Motor with encoder without index: You must set the encoder parameters after the **Auto setup**, see chapter **Configuring the sensors** in the technical manual.
- Stepper motor, brake control activated: 00000004$_h$
- BLDC motor, brake control activated, *closed-loop*: 00000045$_h$

HINWEIS

Due to the sine commutation and the sinusoidal current flow, the current of a motor winding can achieve an alternating current value that is briefly greater (by max. √2 times) than the set current.

At especially slow speeds or while at a standstill with full load, one of the windings can therefore be supplied with overcurrent for a longer period of time. Take this into account when dimensioning the motor and select a motor with larger torque reserve if necessary if required by the application.

Connecting the motor

After setting the motor parameters, see **Setting the motor data**, connect the motor and, if applicable, the present sensors (encoders / Hall sensors) and the brake.

HINWEIS

Damage to the electronics if motor is connected incorrectly!

► Observe the PIN assignment in chapter *Pin assignment* and the motor data sheet.

- Connect the motor:
  - to connection **Motor connection**
- Connect encoders / Hall sensors:
  - to connection **Incremental encoder/Hall sensors**
  - or to **SSI encoder**
- Connect the brake:
  - to connection **Inputs and outputs**

How the automatic brake control can be activated is described in chapter **Automatic brake control**.

Auto setup

To determine a number of parameters related to the motor and the connected sensors (encoders/Hall sensors), you must perform an auto setup.

TIPP

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.

HINWEIS

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.

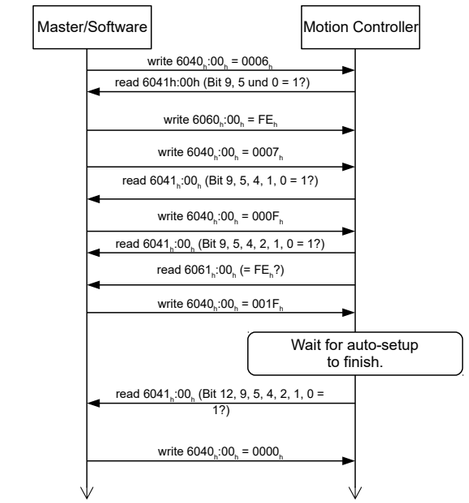
► No NanoJ programs may be running (object 2300$_h$:00$_h$ bit 0 = "0", see **2300h NanoJ Control**).

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).

   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.



VORSICHT!

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.