Active Grid Manual

Atli Vikar Ingimundarson, Elmar Atli Arnarsson,Jakob Daníelsson og Sæór Orrason

May 16, 2024

Contents

1 Introduction

Welcome to the user manual for your new Active Grid system. This manual is designed to guide you through the installation, operation, and maintenance of the Active Grid in your wind tunnel setup. The Active Grid is a versatile tool that helps in controlling airflow patterns during testing.

Purpose of this Manual:

This manual provides the necessary information to ensure you can effectively use your Active Grid. It covers everything from setup to regular maintenance, helping you to maintain optimal performance.

How to Use This Manual:

The manual is divided into several sections:

- **Installation:** Instructions for setting up your Active Grid in the wind tunnel.
- **Operation:** Guidelines on how to operate the system.
- **Maintenance:** Tips for maintaining the Active Grid to ensure it continues to work effectively.
- **Safety Guidelines:** Important safety information to follow during use.

Please read this manual carefully before using your Active Grid and refer to it as needed for guidance on specific functions and troubleshooting. If you need further assistance, our customer service team is here to help.

2 Installation

2.1 Requirements

Below is the list of hardware required for setting up the Active Grid system. Ensure all components are gathered before proceeding with the installation.

- 16x PD4-C5918L4204-E-08 motors
- 16x ZK-PD4-C-CAN-4-500-S
- 5 meters of TF-BUS cable 2X0.8+2X2X0.5MM: TFB-200-T01
- CANopen to USB converter (recommended): ZK-USB-CAN-1
- Power supply 24-48 V (recommended): PRO BAS 120W 24V 5A 1X230VAC/50HZ from Weidmüller
- A computer with an operating system capable of running Python (recommended: Windows 10 or above)
- It is recommended to have extra wires on hand to accommodate your specific project needs

Specific Use Information This hardware list is specifically for a system that uses one motor on each axle in a structure frame measuring 1m x 1m. It should only be used for such configurations. Please contact HönX-1 if you need to make any changes to the system.

2.2 Step-by-Step Installation Procedure of Frame and shafts

Step 1: Bearings

Insert bearings on the frame, the total number of bearings is 32. The bearing type is SKF 6002. The design is press fit so the bearings need to be pressed in by a hydraulic press

Figure 1: Bearings in the Frame

Step 2: Shafts

There are two types of shafts, horizontal and vertical shafts. But it is the same procedure to install them. Bolt the flaps in the middle of the shaft, each shaft should have 7 whole shafts and 2 half shafts. Use 4x10 countersunk bolts stainless steel. In total, the number of shafts is 16, and there are 8 each time.

Figure 2: Flaps bolted in the middle of the shaft

Step 3: The frame

Insert the shafts into the bearing and put the frame together. Bolt the frame together with under-sink 6x30 stainless steel bolts. Make sure the sides match and the bearings are on the outside and the bearings are in line.

Step 3: The Motor flange

Bolt the motor flange onto the frame, they are bolted on using 8 mm threaded shaft. Each motor flange has room for 4 motors.

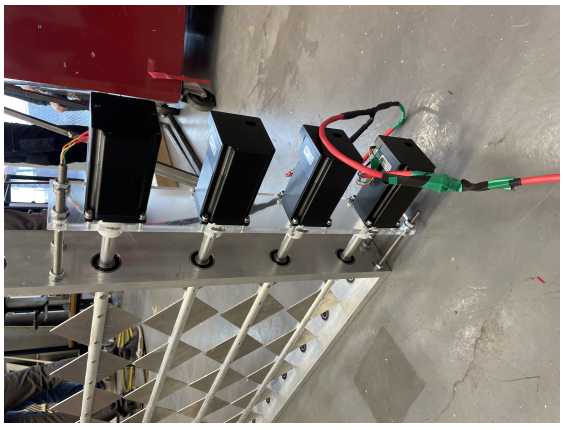


Figure 3: The motor flange on the frame

2.3 Step-by-Step Installation Procedure of Motors

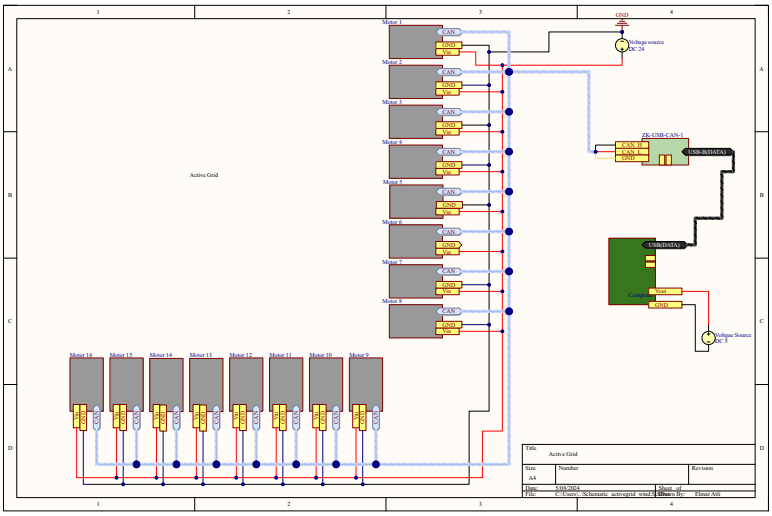


Figure 4: The wiring of the system

This section outlines the step-by-step procedure for installing and setting up your Active Grid system. Please follow each step carefully to ensure proper setup.

Step 1: Connect Motors to Each Axle

Start by attaching each of the 16 PD4-C5918L4204-E-08 motors to their respective axles in the structural frame.

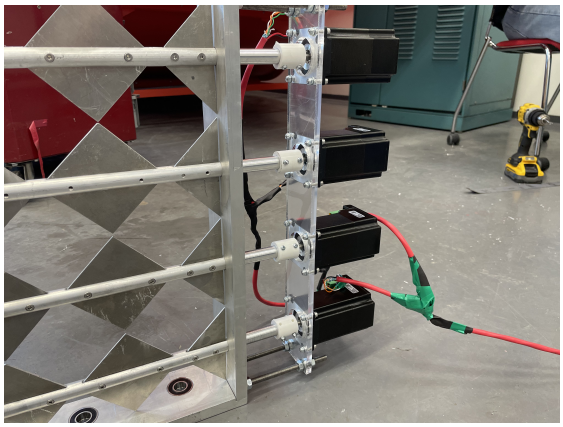


Figure 5: Motors connected via motor coupling and the bolted on the motor flange

Step 2: Set Unique Node IDs for Each Motor

Each motor must have a unique Node ID. Adjust the ID dial on each motor as shown in figure 1 in S2 below.

Connector	Function	Pin assignment / description
X1	CANopen IN/OUT and external logic supply The contacts of both connector are connected to each other.	1. +UB Logik (24 V DC/approx. 32 mA, external logic supply for the communication) 2. CAN+ 3. CAN- 4. GND
X2	Digital and analog inputs and outputs Switching thresholds for digital **inputs 1 - 4**: **5 V (factory setting)**: On: >3 V; Off: <1 V **24 V**: On: >16 V; Off: <8 V	1. **GND** 2. **Analog input**: 10 Bit, 0-10 V 3. **12V output**: +12 VDC, max. 100 mA 4. **Digital output 1**: Open drain, max 24 V/100 mA 5. **Digital output 2**: Open drain, max 24 V/100 mA 6. **Digital input 1**; 5 V / 24 V Signal, switchable with object **3240**$_h$ 7. **Digital input 2**; 5 V / 24 V Signal, switchable with object **3240**$_h$ 8. **Digital input 3**: 5 V / 24 V, switchable with object **3240**$_h$, max. 1 MHz; *direction input* in clock/direction mode 9. **Digital input 4**: 5 V / 24 V, switchable with object **3240**$_h$, max. 1 MHz; *clock input* in clock/direction mode 10. **GND**
X3	Voltage supply PD4-C: 12-48 V DC ±5% PD4-CB: 12-24 V DC±5%	1. **+UB** 2. **GND**
S2	Hex coding switch for setting the *Node-ID* and baud rate. 	**Value of the switch** / **Node-ID** / **Baud rate** 0_h / Objekt **2009**$_h$ / 1MBd $1\text{-}7_h$ / Value of the switch / 1MBd 8_h / Object **2009**$_h$ / Object **2005**$_h$ $9_h\text{-}F_h$ / (Number of the switch)-8 / Object **2005**$_h$
S3	DIP switch for 120 Ω termination for CAN-Bus.	**OFF**: The CAN bus termination is off. **ON (up)**: The CAN bus termination is on.

Figure 6: Setting the Node ID on a Motor

Step 3: Connect Controllers to the Bus Cable and Power

1. Connect each ZK-PD4-C-CAN-4-500-S controller to the bus cable.
2. Insert the bus cable into Plug X1 on each motor. A visual representation can be seen in figure 2.
3. Connect power cables to Plug X3 on each motor as shown in figure 2 below.

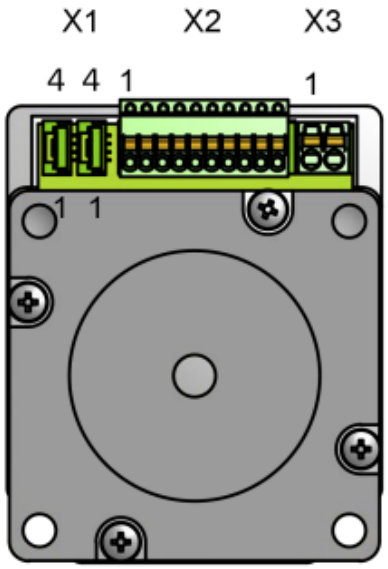


Figure 7: Connecting Controllers and Power Cables

Step 4: Connect the Bus Cable to the CAN to USB Converter and Power Supply

1. Connect the bus cable from the last motor or controller to the CANopen to USB converter.
2. Connect the power supply to the power inputs as previously installed.
3. Before powering on, ensure all connections are correct by referring to Figure 1.

Step 5: Power On and Start Programming

1. Turn on the power supply to activate the grid.

3 Operation

This section provides detailed instructions on how to operate the Active Grid system within your wind tunnel, with a focus on controlling motor velocity and position. Follow these guidelines to effectively manage and configure motor settings through your control software.

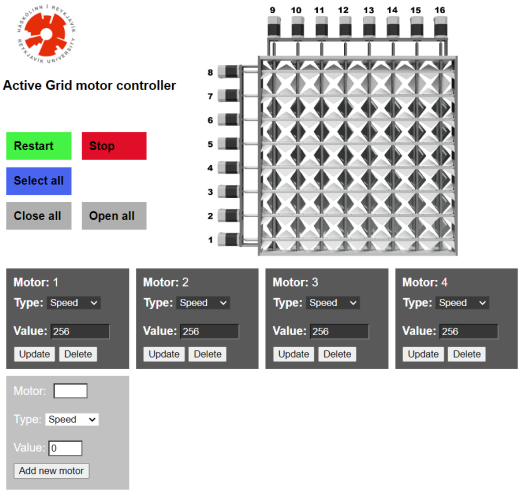


Figure 8: User interface for Active Grid

3.1 General Setup

Before adjusting motor settings, ensure that the system is properly initialized:

- Power up the system and ensure all connections are secure.
- Open the control software on the connected computer.
- Perform a system check to confirm all components are communicating and functional.

3.2 Controlling Motor Velocity and Position

Controlling the velocity and position of motors is crucial for precise aerodynamic testing. These settings can be adjusted for individual motors or synchronously for groups of motors.

3.2.1 Controlling a Single Motor

To adjust the velocity and position of a single motor:

1. Find the motor you want to control in the motorbox view.
2. Select either position or speed from the type options.
3. **Set Velocity:** Select type "speed" in the motor box. Change the value input field to your desired value in revolutions per minute. To update the motor press the update button.
4. **Set Position:** Select type "position" in the motor box. Change the value input field to your desired value in degrees. To update the motor press the update button.

3.2.2 Controlling a Group of Motors

To batch update settings for a group of motors:

1. In the control software, select the motor you want to include in the batch update by pressing on the motor boxes. The motor box changes color to black when selected.
2. Use the global type options list and the global slider to change the values of the batch.
3. To update the selected motors press the batch update button. The values and type can be previewed in each motor box.

3.3 Tips for Effective Motor Management

- Regularly update the firmware of each motor to ensure compatibility with the latest software enhancements.
- Perform calibration checks after significant adjustments to motor settings to ensure accuracy in tests.
- Always ensure that the motor limits set in the software match the physical capabilities of the motors to prevent mechanical overruns.

Note: Precision in setting velocities and positions is critical for achieving reliable test results. Make adjustments based on test requirements and monitor the system continuously for any discrepancies.

4 Maintenance

This section provides guidelines on maintaining the Active Grid system. Proper maintenance ensures the system's longevity and optimal performance.

4.1 Structural Issues

The structural frame of the Active Grid has been designed and manufactured by Stálorka. If you encounter any issues with the structural components, please do not attempt to fix them yourself. Contact Stálorka directly for support:

```
Stálorka Support
Phone: 565-0399
Email: stalorka@stalorka.is
```

4.2 Motor Replacement Procedure

In the event that a motor needs to be replaced, follow these steps to ensure safe and correct handling:

1. **Disconnect Power:** Safety first! Always unplug all power sources to the machine before attempting any repairs or replacements.
2. **Unplug the Motor:** Disconnect the motor from the electrical system.
3. **Loosen the Motor from the Axle:** Before fully removing the motor, ensure it is securely loosened from the axle. As the motors are somewhat heavy, incorrect handling could lead to them sliding and potentially damaging the cables or other components.
4. **Replace the Motor:** Install the new motor by reversing the removal process. Secure it to the axle and reconnect it to the electrical system.
5. **Set the Node ID:** Assign the same node ID to the new motor that the old motor had. This is crucial for maintaining the correct operation of the system.

Note: Our system is designed to be plug-and-play, so replacing a motor is straightforward and does not require re-calibration of the entire system. Follow these steps carefully to minimize downtime and ensure a smooth transition.

5 Common mistakes

5.1 Motor nodes not addressed

If motors are not responding or wrong motors are responding to your requests, make sure all motors are assigned to the correct node. That is done under the motors by turning the variable wheel to the correct node, (see 6). Also make sure all CANbus connection heads are inserted properly.

5.2 No power on motors

Make sure all connections are inserted properly into the motors. Also make sure that the Emergency stop button is resetted by pulling hard on it. See figure 4

5.3 Incorrect replacement parts

For full effect and usage of the grid all replacement parts must be the correct parts as we can not gurantee proper functionality of the grid unless it has been stated in this manual. All parts are built with Stálorka, please contact them regarding extra flaps, and please see the BOM 1 when ordering spare parts.

5.4 Motor Truning but shaft stuck

The most likely reason for this is broken pin in the motor coupling or the motor coupling itself is broken, order a new one or build it yourself using Cad drawing.

6 Disposal

Proper disposal of equipment is crucial to ensure environmental sustainability and safety compliance. This chapter outlines the appropriate steps to dispose of such apparatus responsibly.

6.1 Assessment of Components:

Before disposal, assess the equipment thoroughly to identify all its components. Follow the list of materials, including aluminum shafts, bars, wires, motors, the E-Stop button, and the small computer. This inventory will guide the disposal process and help determine the appropriate recycling or disposal methods for each component.

6.2 Dismantling:

Disassemble the equipment carefully, separating different components according to material type. Remove aluminum shafts, bars, and wires from the assembly. Extract the motors, E-Stop button, and small computer unit from their respective housings. Take precautions to avoid damage to any reusable or recyclable parts during this process.

6.3 Recycling Aluminum Components:

Aluminum is highly recyclable and retains its properties indefinitely. Collect all aluminum parts, including shafts, and bars, and ensure they are clean and free from contaminants. Contact local recycling facilities (Sorpa) or scrap metal yards that accept aluminum for recycling. Follow their guidelines for proper preparation and delivery of the aluminum materials.

6.4 Electric Disposal:

Motors and wires may contain hazardous materials such as copper wiring and rare earth magnets. Contact local recycling centers or electronic waste (e-waste) recycling facilities that accept motors for proper disposal or recycling. Some facilities specialize in the recycling of electronic components and can ensure environmentally friendly handling of motor components.

6.5 Disposal of E-Stop Button and Small Computer:

The E-Stop button and small computer unit may contain electronic components and batteries. These should be disposed of separately from regular waste to prevent environmental contamination. Contact e-waste recycling facilities or electronic disposal services in your area to safely

dispose of these items. Ensure that any sensitive data stored on the small computer is securely erased before disposal.

6.6 Environmental Considerations:

Throughout the disposal process, prioritize environmental protection by choosing recycling options whenever possible and ensuring that hazardous materials are handled responsibly. Minimize the generation of waste and strive to maximize the reuse and recycling of equipment components to reduce environmental impact.

By following these steps, you can ensure the responsible disposal of equipment containing aluminum shafts, bars, wires, motors, an E-Stop button, and a computer, contributing to environmental sustainability and safety compliance.

Appendices

Motor data sheet

https://www.nanotec.com/fileadmin/files/Handbuecher/Kurzanleitungen/EN/pd4c-canopen-quick-guide.pdf?1656012586 Jakob!!

Hex Values and Their Meanings

Node Control Commands

- **0x60FF**: This hex value is used to specify the target object dictionary index for controlling the motor node.
- **0x6040**: This hex value represents the object dictionary index for accessing the control-word, which is used to control the state of the motor.
- **0x6060**: This hex value is the object dictionary index for setting the mode of operation for the motor.
- **0x607A**: This hex value represents the target position for absolute positioning mode.
- **0x6081**: This hex value is used to set the profile velocity in velocity mode.

Controlword Values

- **6**: This value indicates the "Ready to switch on" state of the motor.
- **7**: This value signifies the "Switched on" state of the motor.
- **15**: This value represents the "Operation enabled" state of the motor.
- **31**: This value is used for setting absolute positioning mode.
- **95**: This value is used for setting relative positioning mode.

Bill of Material

Table 1: Bill of material for Active Grid

Top of Frame	1	Aluminium Plate 150x12 mm
Side Frame	2	Aluminium Plate 150x12 mm
Bottom Frame	1	Aluminium Plate 150x12 mm
DIN 7991 - M6x30	8	Hexagon socket countersunk head cap screws
SKF - SKF 6002-2Z	32	Deep groove ball bearings single row with two Z shields SKF
Flaps half	36	Aluminium Plate 2 mm
Flaps whole	126	Aluminium Plate 2 mm
Shaft Vertical	8	Aluminum Shaft 18 mm
AS 1420 - 1973 - M4 x 10	288	ISO metric hexagon socket head cap screws
PD4-C5918L4204-E-08	16	BRUSHLESS DC SERVO MOTOR – NEMA 23
Shaft Horizontal	8	Aluminum Shaft 18 mm
Motor Flange	4	Aluminum Plate 3 mm
AS 1420 - 1973 - M4 x 25	64	ISO metric hexagon socket head cap screws
Motor Coupling	16	PLA 3D print
Wiring loom	1	Wiring loom for Data and Power
E-stop	1	Estop button
USB-CAN adapter	1	Adapter for CAN open
M4 Nuts	64	Locking nut for motor flange
Threaded shaft	16	M8 * 115 mm

PD4-C/CB CANopen

Short instructions
Original: de

Nanotec Electronic GmbH & Co. KG
Kapellenstraße 6
85622 Feldkirchen, Germany

Phone: +49 (0)89-900 686-0
Fax: +49 (0)89-900 686-50
info@nanotec.de

Version 1.0.0

Introduction

The *PD4-C* is a brushless motor with integrated controller. The integrated absolute encoder makes immediate operation possible in *closed loop* mode without homing.

This document describes the installation and commissioning of the motor.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

CE

Intended use

The *PD4-C* motor with integrated controller is designed for use under the approved **Environmental conditions**.

Any other use is considered unintended use.

Note

Changes or modifications to the product 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 … 85%
Altitude of site above *sea level* (without drop in performance)	1500 m
Ambient temperature (storage)	-25 … +85°C

Electrical properties and technical data

Technical data – motor

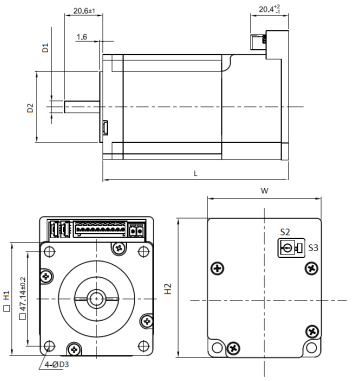
	PD4-C	PD4-CB
Type	High-pole DC servo (stepper motor)	Low-pole DC servo (BLDC)
Operating voltage	12 V to 48 V DC +/-5%	12 V to 24 V DC +/-5%
Rated current	4.2 A rms	8 A rms
Peak current for 1 s	Max. 6.3 A rms	Max. 20 A rms

Technical data

Property	Description / value
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	*CANopen*, *Clock-direction*, *analog*, *NanoJ program*
Inputs	4 digital inputs (+5 V/+24 V), individually switchable by means of software, factory settings: 5 V 1 analog input, 10-bit resolution, 0-10 V
Outputs	2 outputs, (open drain, 0 switching, max. 24 V and 100 mA)
Integrated encoder	Magnetic, single-turn absolute encoder, 1024 pulses/ revolution
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

All dimensions are in millimeters.



Dimension	Value
L	• PD4-C5918X4204-E: 65±1 • PD4-C5918M4204-E: 79±1 • PD4-C5918L4204-E: 100±1 • PD4-C6018L4204-E: 112.5±1 • PD4-CB59M024035-E: 94.9±1
W	• PD4-C5918X4204-E: 57 • PD4-C5918M4204-E: 57 • PD4-C5918L4204-E: 57 • PD4-C6018L4204-E: 60.5 • PD4-CB59M024035-E: 57
H1	• PD4-C5918X4204-E: 56.4 • PD4-C5918M4204-E: 56.4 • PD4-C5918L4204-E: 56.4 • PD4-C6018L4204-E: 60±0.5 • PD4-CB59M024035-E: 56.6±0.5
H2	• PD4-C5918X4204-E: 69.6 • PD4-C5918M4204-E: 69.6 • PD4-C5918L4204-E: 69.6 • PD4-C6018L4204-E: 71.3 • PD4-CB59M024035-E: 69.6
D1	• PD4-C5918X4204-E: $6.35^{+0}_{-0.013}$ • PD4-C5918M4204-E: $6.35^{+0}_{-0.013}$ • PD4-C5918L4204-E: $6.35^{+0}_{-0.013}$ • PD4-C6018L4204-E: $8^{+0}_{-0.015}$ • PD4-CB59M024035-E: $8^{+0}_{-0.013}$
D2	• PD4-C5918X4204-E: 38.1±0.025 • PD4-C5918M4204-E: 38.1±0.025 • PD4-C5918L4204-E: 38.1±0.025 • PD4-C6018L4204-E: 38.1±0.05 • PD4-CB59M024035-E: $38.1^{+0}_{-0.005}$
D3	• PD4-C5918X4204-E: 5 • PD4-C5918M4204-E: 5 • PD4-C5918L4204-E: 5 • PD4-C6018L4204-E: 4.5 • PD4-CB59M024035-E: 5.2±0.25

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 flashes briefly once per second.

Case of an error

If an error has occurred, the LED signals an error number..

The following table shows the meaning of the error numbers.

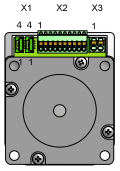
Flash rate	Error
1	General
2	Voltage
3	Temperature
4	Overcurrent
5	Controller
6	Watchdog-Reset

Note

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

Pin assignment

Pin 1 is marked.



Connector	Function	Pin assignment / description
X1	CANopen IN/OUT and external logic supply The contacts of both connector are connected to each other.	1. +UB Logik (24 V DC/approx. 32 mA, external logic supply for the communication) 2. CAN+ 3. CAN- 4. GND
X2	Digital and analog inputs and outputs Switching thresholds for digital **inputs 1 - 4**: **5 V (factory setting)**: On: >3 V; Off: <1 V **24 V**: On: >16 V; Off: <8 V	1. **GND** 2. **Analog input**: 10 Bit, 0-10 V 3. **12V output**: +12 VDC, max. 100 mA 4. **Digital output 1**: Open drain, max 24 V/100 mA 5. **Digital output 2**: Open drain, max 24 V/100 mA 6. **Digital input 1**; 5 V / 24 V Signal, switchable with object **3240**$_h$.01$_h$ 7. **Digital input 2**; 5 V / 24 V Signal, switchable with object **3240**$_h$.02$_h$ 8. **Digital input 3**: 5 V / 24 V, switchable with object **3240**$_h$.03$_h$, max. 1 MHz; *direction input* in clock/direction mode 9. **Digital input 4**: 5 V / 24 V, switchable with object **3240**$_h$.04$_h$, max. 1 MHz; *clock input* in clock/direction mode 10. **GND**
X3	Voltage supply PD4-C: 12-48 V DC ±5% PD4-CB: 12-24 V DC±5%	1. **+UB** 2. **GND**
S2	Hex coding switch for setting the *Node-ID* and baud rate. 	**Value of the switch** / **Node-ID** / **Baud rate** 0_h — Objekt **2009**$_h$ — 1MBd 1-7_h — Value of the switch — 1MBd 8_h — Object **2009**$_h$ — Object **2005**$_h$ 9_h-F_h — (Number of the switch)-8 — Object **2005**$_h$
S3	DIP switch for 120 Ω termination for CAN-Bus.	**OFF**: The CAN bus termination is off. **ON (up)**: The CAN bus termination is 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 motor parameters to your application. You can find further information in document *Plug & Drive Studio: Quick Start Guide* at **us.nanotec.com**.

Observe the following notes:

CAUTION

- Moving parts can cause hand injuries.
- If you touch moving parts during running operation, hand injuries may result.
- Do not reach for moving parts during operation. After switching off, wait until all movements have ended.

CAUTION

- In free-standing operation, motor movements are uncontrolled and can cause injuries.
- If the motor is unsecured, it can, e.g., fall down. Foot injuries or damage to the motor could occur.
- If you operate the motor free-standing, observe the motor, switch it off immediately in the event of danger and make certain that the motor cannot fall down.

CAUTION

- Moving parts can catch hair and loose clothing.
- During running operation, moving parts can catch hair or loose clothing, which may lead to injuries.
- If you have long hair, wear a hairnet or take other suitable protective measures when near moving parts. Do not work with loose clothing or ties near moving parts.

CAUTION

- Risk of overheating or fire if there is insufficient cooling.
- If cooling is insufficient or if the ambient temperature is too high, there is a risk of overheating or fire.
- During use, make certain that the cooling and ambient temperature conditions are ensured.

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.

Establishing communication via CANopen

1. Connect the CANopen master to the controller via the CAN- and CAN+ cables. Check the connection of your CAN-GND and that the necessary **120 ohm termination resistor** is present between CAN+ and CAN-.
2. Supply the controller with voltage.

   Note

   If you would like to use the logic supply instead of the main supply, you must set bit 0 in **4013**$_h$.01$_h$ and save this object (set 1010_h:03_h to "65766173_h").
3. Change the configuration values if necessary.

   The controller is set per default to node-ID 1, baud rate 1 Mbaud.
4. To test the interface, send bytes `40 41 60 00 00 00 00 00` to the controller.
   Statusword (6041$_h$) was read; you receive this response: `4B 41 60 00 XX XX 00 00`.

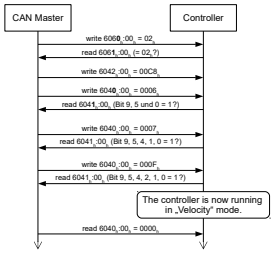
Test run

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

The values are transferred from your *CANopen master* or 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* state.

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



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