Morskate®

Programmable
Stepper Motor Controller for Two Axes

Contents

Manual MCC-2

1 The MCC-2 Stepper Motor Controller

1.1 Overview

MCC-2, the intelligent motion controller, is a user-friendly and compact stepper motor control unit for two-phase stepper motors up to 3.5 A_{PEAK} motor current with 24 to 48 V motor voltage.
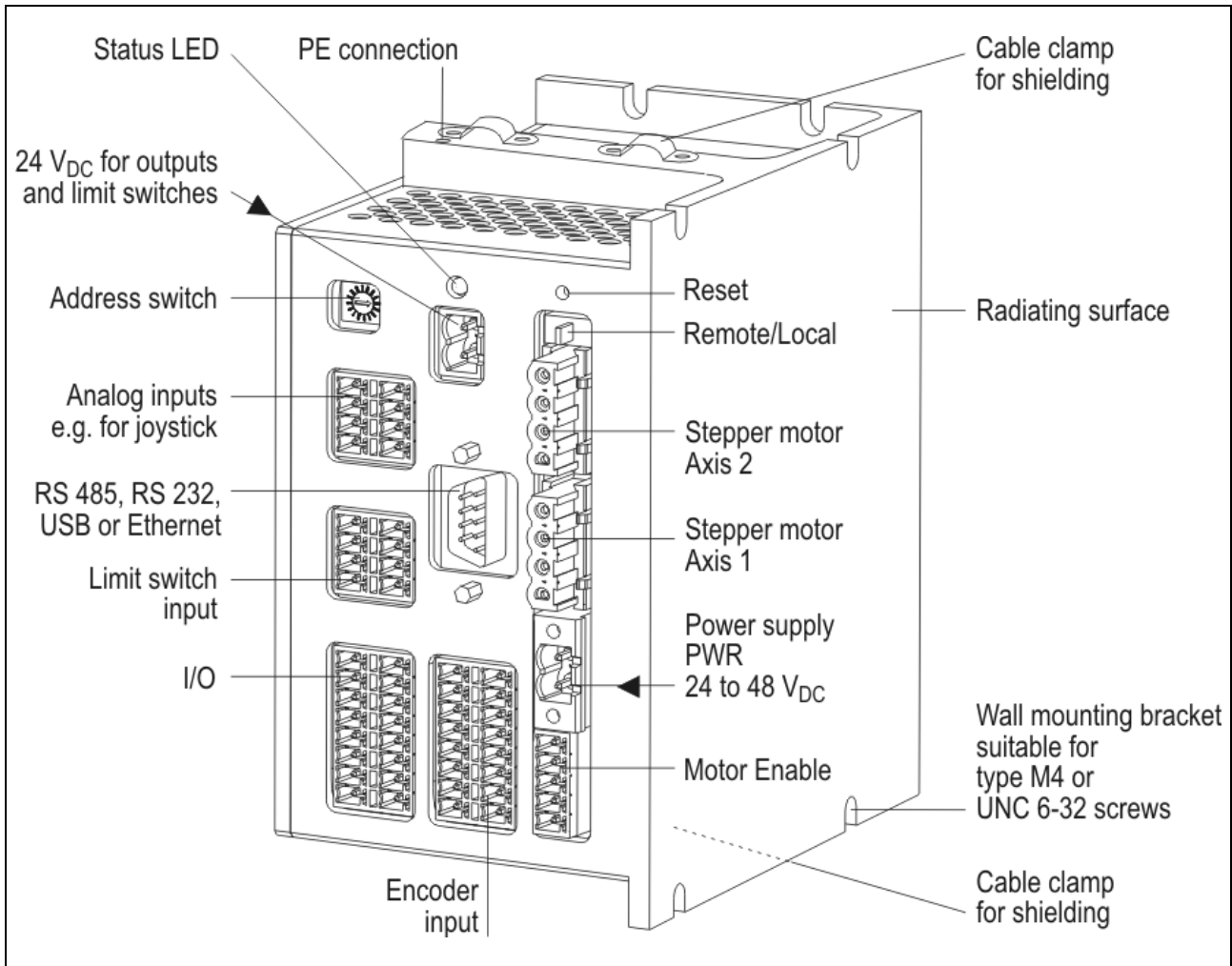
Fig. 1: Front view

At the front side you'll find connectors for wiring supply voltages, stepper motors, inputs and outputs.

Machine sequence controls can be programmed on PC by the MiniLog-Comm communication software. The ready program can be transmitted to the controller via X5 communication interface. The program will be stored and can be locally started by the REMOTE/LOCAL switch.

MCC-2 and stepper motors need a DC power supply from 24 to 48 V_{DC}.

A separate 24 V_{DC} supply voltage is required for the outputs and limit switches.

The MCC-2 housing contains mounting brackets for different mounting positions. A clip for rail mounting is mounted on the rear side.
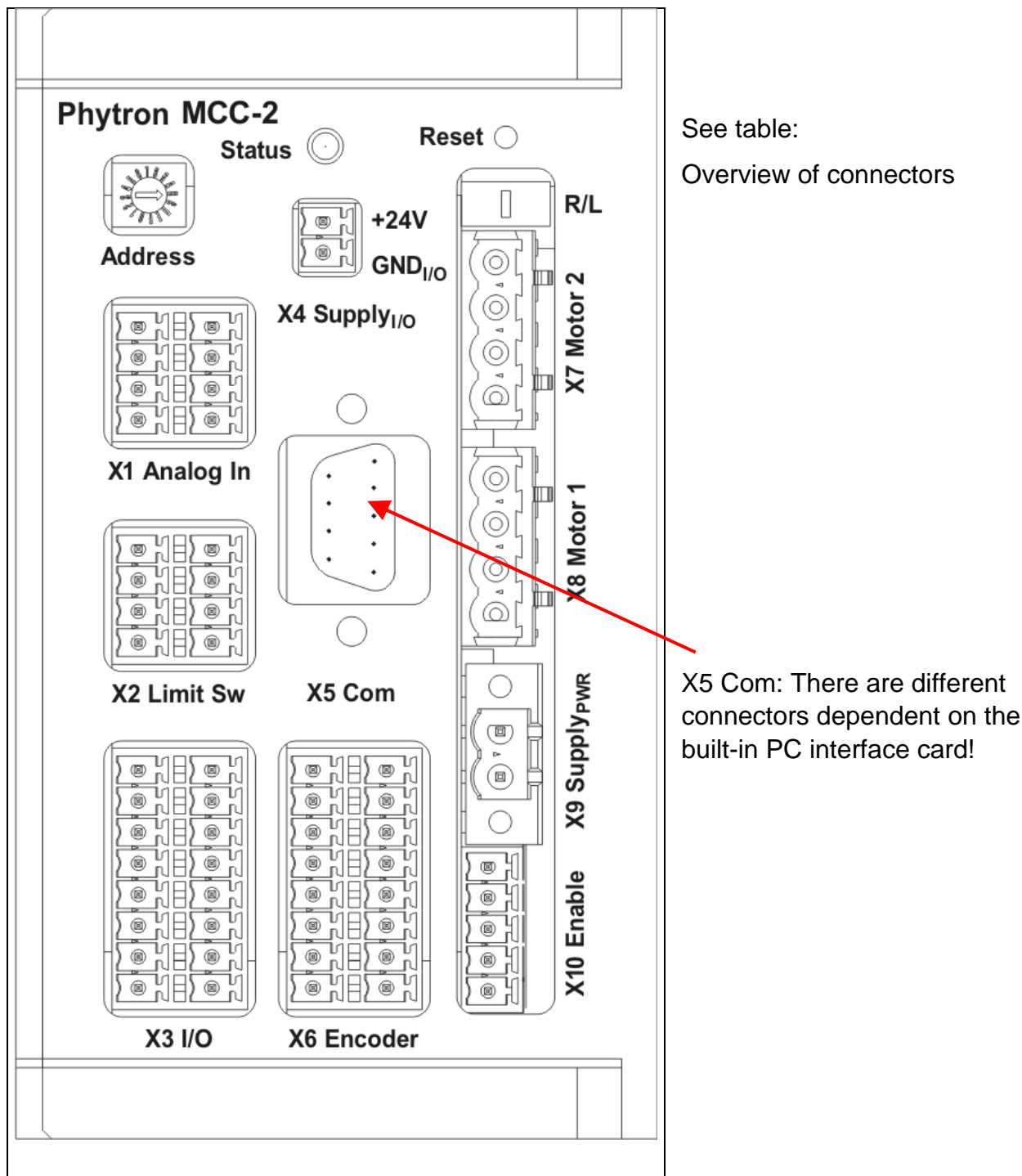
1.2.1 Stepper Motor Power Stages

A power stage is built-in for each axis. The power stages are used for bipolar control of two-phase stepper motors with Phytron's welltried technology, the patented SYNCHROCHOP precision current control.

For smooth stepper motor movement, the power stages solve the motor full step into increments up to 1/256 step.

Run current, stop current and Boost current (acceleration) can be programmed independently up to 3.5 A_{PEAK} at 48 V_{DC} nominal voltage.

The following errors will switch off the power stage:

- Short circuit: between phase and power supply
  between both motor phases
  within a motor phase
  against ground

- Overtemperature

- Undervoltage: e. g. if the voltage drops due to a weak power supply and dynamic motor movements

1.2.2 Inputs and Outputs

MCC-2 can be regarded as independent machine controller because of eight digital inputs, which are electrically separated from the sequential controller, and eight overload-safe outputs.

Two signal inputs of each axis can be used for connecting type pnp-NCC (default) or pnp-NOC limit switches.

A joystick can be connected to the analog input X1.

Additional safety requirement was considered during development, because the MCC-2 was designed for applications in the domain of medical devices:

The motors can be activated by the Enable input – independent of the incoming control pulse signals (X10).

The encoder inputs for step failure monitoring allow the interpretation of the encoder signals. Incremental encoder or absolute encoder acc. to SSI-standard can be connected to the same connector (X6).

1.2.3 Interfaces and Bus Mode

The X5 Com communication interface is available with USB, RS 485(4-wire), RS 232, Ethernet or ProfiBus layout. The following possibilities are accessible by interface:

- Controller and motor parameter programming

- Controller configuration by software

- Online diagnostics for safe operation and easy maintenance

- Test mode and status information

- Firmware update

- Controller communication via Ethernet

- Integration in Fieldbus system by Profibus interface

The MCC-2 can be programmed user-friendly by MiniLog-Comm for Windows (see manual MiniLog-Comm).

1.2.4 REMOTE/LOCAL-Switch R/L

You can select the controller's operating mode with the REMOTE/LOCAL switch:

REMOTE: The controller is connected to the PC via interface. In this operating mode, programs edited by the customer can be transmitted from PC to controller and back. In the REMOTE mode it is also possible to test single instructions or to test the motor run using the MiniLog-Comm communication software.

LOCAL: When switching to LOCAL the stored program will be started. The program should be stored in the auto start register.

    a)   The program runs **without** connection to the PC.

    b)   Program run **with** connection to an external computer: The PC can be called by the sequential program in order to exchange actual data.

1.2.5 Reset Push-Button

The Reset push-button above the REMOTE/LOCAL switch is mounted recessed in order to inhibit accidental operation.
Reset cancels possibly error messages.
Delay time after end of Reset signal: about 3 sec.

Manual MCC-2

1.2.6 Address Switch

The logic device address can be selected by the address switch and set from 0…F.

This rotary switch is only read after power on or after a reset, i.e. later changes remain without effect during the regular operation.

1.2.7 Status LED

The two-color LED shows the status of the device:

- green
  - = ready, no error

- red
  - = Error (see status window in the MiniLog-Comm software)

- orange
  - = Busy (update of the indexer firmware)

1.3 Block Diagram

This block diagram shows a simplified layout. You'll find details, e. g. pin assignments in the corresponding chapters.
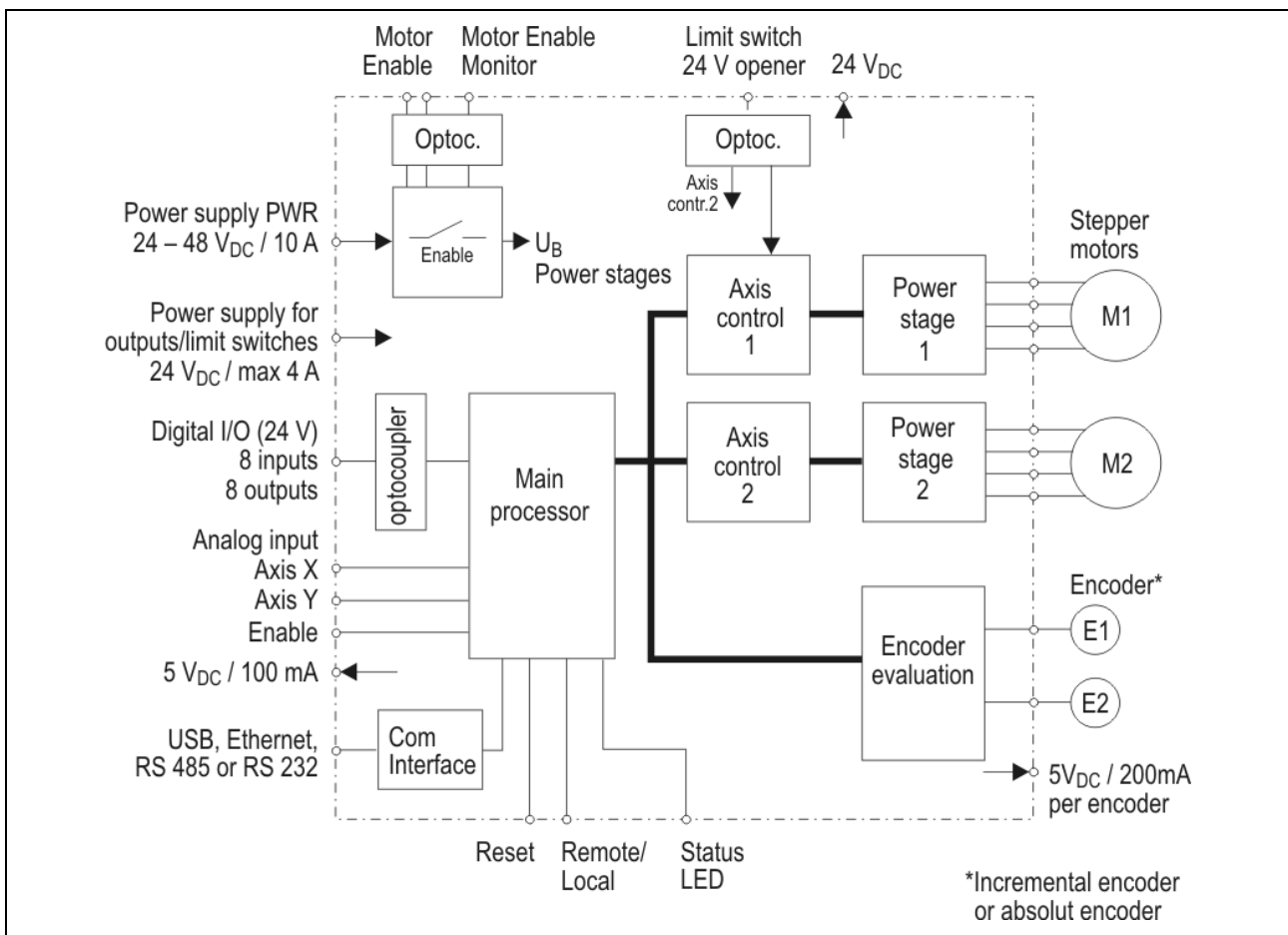
Fig. 3: Block diagram

1.4 Extent of Supply

The MCC is available in the following **options** (#: Ident number):

- MCC-2 Motion-Controller with mating connector kit

with USB interface for wall mounting (W)	#10008144
with USB interface for rail mounting (H)	#10008145
with RS 485 interface for wall mounting	#10008142
with RS 485 interface for rail mounting	#10008143
with RS 232 interface for wall mounting	#10008140
with RS 232 interface for rail mounting	#10008141
with RS 232 interface for wall mounting with RS 232 adaptor	#10008788
with USB converter for wall mounting (cable A-A 20 cm included)	#10008146
with USB converter for rail mounting (cable A-A 20 cm included)	#10008147
with Ethernet connection for wall mounting	#10012343
with Ethernet connection for rail mounting	#10012342
mit Profibus interface for wall mounting	?
mit Profibus interface for rail mounting	?

Included in delivery:

- MCC-2 Manual
- MiniLog Programming Manual
- MiniLog-Comm Manual
- Phytron CD with MiniLog-Comm software
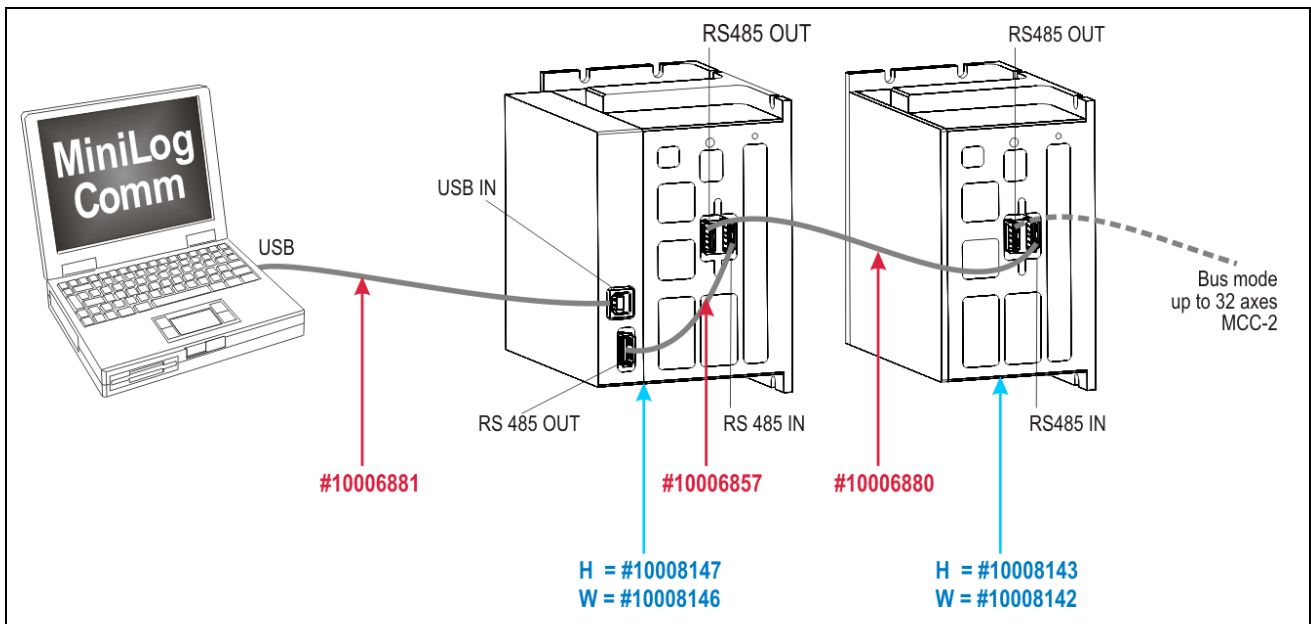
Fig. 4:   MCC-2 with USB converter and RS 485 interface

Supplementary parts are available:

- Rail mounting kit   #02005659

- Mating connector kit (X1 to X4, X6 to X10)   #10005871

- Cable (connection A-A) 20 cm   #10006857

- Cable (connection A-A) 100 cm   #10006880

- USB cable (connection A-B) 200 cm   #10006881

- USB-485 converter stick   #10012292

- Power supply unit SPH240-4805 (5 A, 48 V) for wall mounting   #10015426

- Power supply unit SPH240-4805 (5 A, 48 V) for rail mounting   #10015427

- Power supply unit SPH240-2410 (10 A, 24 V) for wall mounting   #10015394

- Power supply unit SPH240-2410 (10 A, 24 V) for rail mounting   #10015320

1.5 Accessories: Operator Panel

A MCC-2 with RS 232 adaptor is used for operator panel connection (e.g. BT 5). The terminal is connected to the RS 232 connector of the adaptor.

You'll find the description of the operator panel in Phytron's manual 'Operator Panel BT 5'.
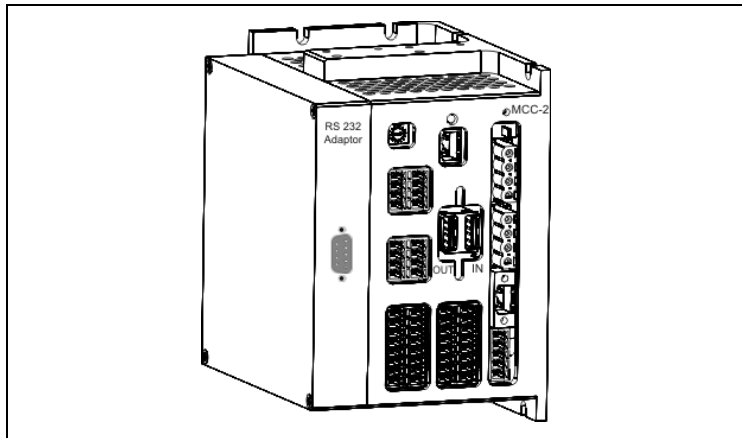
Fig. 5:   MCC-2 with RS 232 adaptor

Then, enabled functions can be used by the operator personnel without PC: for example: selection of another program or change of the piece numbers, length.

The operator panel can display textual data or error messages on demand. The function keys on the operator panel are labeled individually and defined by the controller's programmer.

More functions can be added in the expert mode like input of drive instructions, setting of outputs or display of status messages.

Fig. 6:   MCC-2 cable → BT 5

The MCC-2's baud rate should be scaled down to 38400 for using the operator panel.

1.6 Directives and Standards

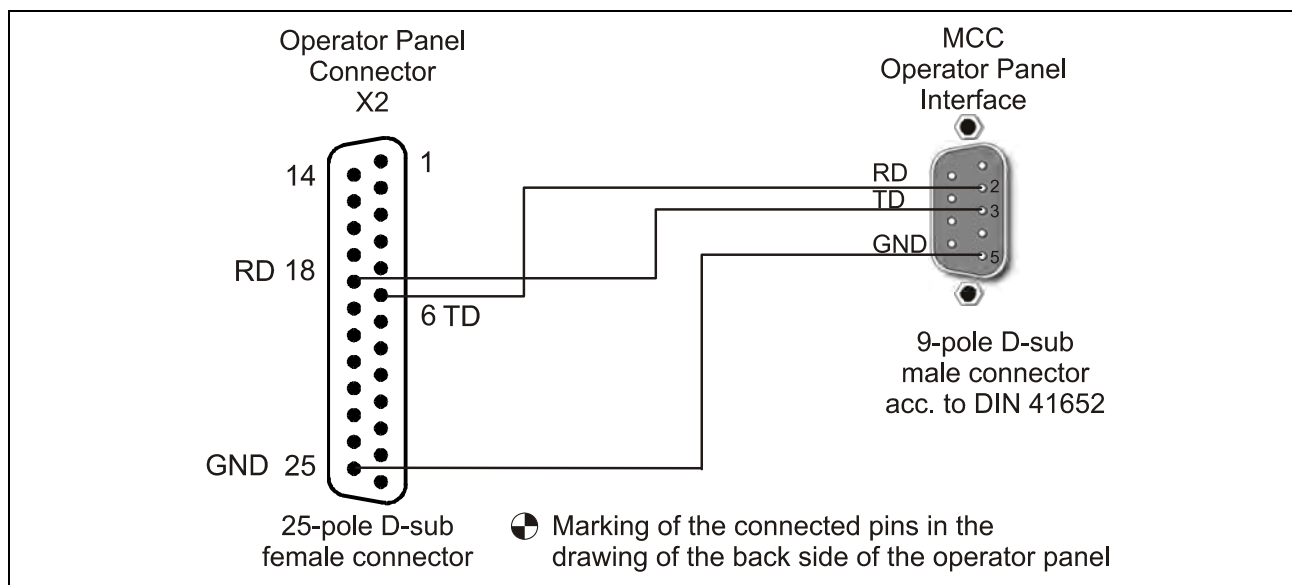|	
CE Mark	With the declaration of conformity and the CE Mark on the product the manufacturer certifies that the product complies with the requirements of the relevant EC directives. The unit, described here, can be used anywhere in the world.
EC Machine Directive	The drive system, described here, isn´t a machine in the sense of the EC machine directive (2006/42/EC), but a component of a machine for installation. They have no functional moving parts. But they can be part of a machine or equipment. The conformity of the complete system in accordance with the machine guideline is to be certified by the manufacturer with the CE marking.
EC EMC Directive	The EC Directives on electromagnetic compatibility (89/336/EEC) applies to products, which can cause electromagnetic interference or whose operation can be impaired by such interference. The controller's compliance with the EMC Directive cannot be assessed until it has been installed into a machine or installation. The instructions provided in "Installation" must be complied with to guarantee that the MCC-2 is EMC compliant when fitted in the machine or installation and before use of the device is permitted.
Standards for safe operation	EN 60204-1: 1998-11: Electrical equipment of machines, degree of pollution 2 must be observed EN 60529: IP Degree of protection
Standards for observing the EMC limit values	EN 61000-3-2: EMC EN 61000-6-1, 3, 4: Emission standard EN 61000-6-2:2005: EMC Immunity for industrial environments
Standards for measuring methods of observing EMC limit values	EN 55011 class B: Noise field and voltage measuring EN 61000-4-2...6,11: Emission standard test

1.7 Declaration of Incorporation

phytron
Beyond Steppers

Declaration of Incorporation
according to EC directive 2006/42/EC on machinery (Annex II B)
for partly completed machinery

Name and address of the manufacturer:
Phytron-Elektronik GmbH,
Industriestr. 12
82194 Gröbenzell

Representative in EU, authorized to compile the relevant technical documentation:
Rainer Gareis
Phytron-Elektronik GmbH,
Industriestr. 12
82194 Gröbenzell

Description of the partly completed machinery:
Product denomination: Programmable Stepper Motor Controller for one or two Axis
Model/Type: MCC-1, MCC-2 und MCC-LIN

From serial number 1001xxxxx

We declare that the product complies with the following essential requirements of the Machinery Directive2006/42/EC:
1.1.2.; 1.1.5.; 1.3.1.; 1.3.4.; 1.5.1.; 1.5.2.; 1.5.4.; 1.5.5.; 1.5.6.; 1.5.16.; 1.6.3.; 1.6.4; 1.7.2.; 1.7.3.; 1.7.4.

In addition the partly completed machinery is in conformity with the following EC Directives:
EC Directives 2004/108/EC relating to electromagnetic compatibility.

We declare that the relevant technical documentation is compiled in accordance with part B of Annex VII.

We commit to transmit, in response to a reasoned request by the market surveillance authorities, relevant documents on the partly completed machinery.

Important note! The partly completed machinery must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of Directive 2006/42/EC on Machinery, where appropriate, and until the EC Declaration of Conformity according to Annex II A is issued.

Gröbenzell, 2010-02-24

Johannes Schmid
Technical Director

2   To Consider Before Installation

Read this manual very carefully before installing and operating the MCC-2. Observe the safety instructions in the following chapter!

2.1   Qualified Personnel

Design, installation and operation of systems using the MCC-2 may only be performed by qualified and trained personnel.

These persons should be able to recognize and handle risks emerging from electrical, mechanical or electronic system parts.

The qualified personnel must know the content of this manual and be able to understand all documents belonging to the product. Safety instructions are to be planned.

The trained personnel must know all valid standards, regulations and rules for the accident prevention, which are necessary for working with the product.

WARNING

Without proper training and qualifications damages to devices and injury might result!

2.2 Safety Instructions

● The MCC-2 is designed for operating as a wall or rail mounting device.
An installation is only allowed, if the requirement of the EC Machine Directive and EMC are conformed with. See chap. 1.6.

This product is used as a part of a complete system, therefore risk evaluations must be made before the use of the product regarding the concrete application. According to the results safety measures have to be taken and verified.

Personnel safety must be ensured by the concept of this complete system (e.g. machine concept).

WARNING

Injury or damage by overvoltage!
The MCC-2 must only be operated in accordance with the protective measures in chap. 3.

CAUTION

Risk of damage by false motor current setting!
In case of motor voltages > 24 V:
The controller must only be operated if the unit and the motor housing both are connected to protective ground.

CAUTION

Risk of damage by not fixed cables!
Motor cables and motor supply cables should be fixed to the device by the cable clamps at the front side.

DANGER

Danger of electric shock!
Be careful handling the screw connectors X7/X8.
As long as the power stage is connected to supply voltage, a hazardous voltage level is present at these components, even if the motor is not wired. Up to 3 minutes after turning off the supply voltage, dangerous voltages may still exist at the connectors.

The instrument setting (e. g. motor current) must **only** be done while separated from the power supply with a special instrument.

DANGER

Danger of electric arching!
Always switch off the supply voltage before connecting or disconnecting any wires or connectors at the MCC-2.
Do not unplug the connector while powered!

ℹ Please consider when connecting the X10 Enable connector:
Both Enable inputs must be wired for activation!

⚠ **DANGER**

Danger of touch voltage!
To avoid dangerous touch voltages, all voltages should be safely separated from the mains. The maximum voltage limits are the specified values of the corresponding chapters.

⚠ **WARNING**

Danger of injury if touching the surface!
The surface of the MCC-2 reaches temperatures more than 75 °C during operation.
The controller has to be deactvated at temperatures more than 75 °C.

2.3 Ambient Conditions

Installation	wall or rail mounting
Permissible ambient temperature	operation: 5 to 50 °C storage: −10 to +60 °C transport: −10 to +60 °C
Permissible heat sink temperature	max. 75 °C heating curve see chap. 9
Relative humidity	ambient conditions: class 3K3 acc. to EN 60721-3-3:1995: 5% ... 85%, no condensation permissible
Degree of pollution	stage 2
Device protection	degree of protection acc. to DIN EN 60529:1991 IP 20

3   Protective Measure Options

The control unit must be operated by the protective measure PELV acc. to VDE 0100. Board and motor housing have to be grounded and/or connected to 0 V.

Various options are possible to achieve the protective measure PELV:
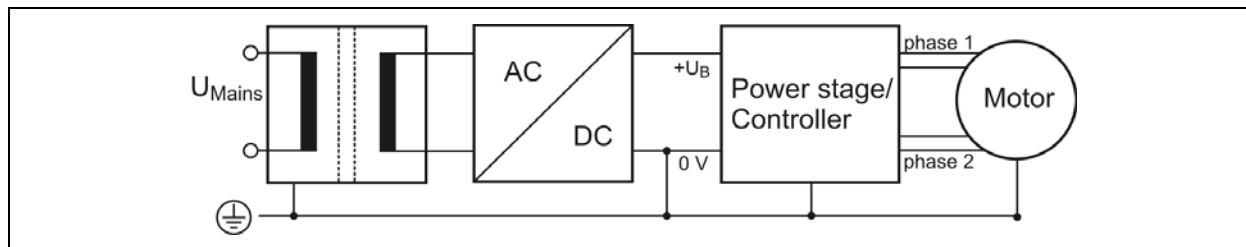

Fig. 7:   PELV – Grounding: total
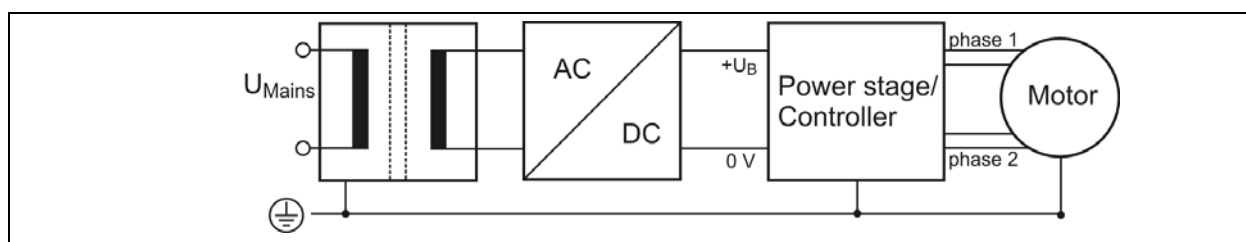
Fig. 8:   PELV – Grounding: Power Stage and Motor.
The secondary winding of the transformer (SELV supply) must not be grounded because the equipment is grounded.
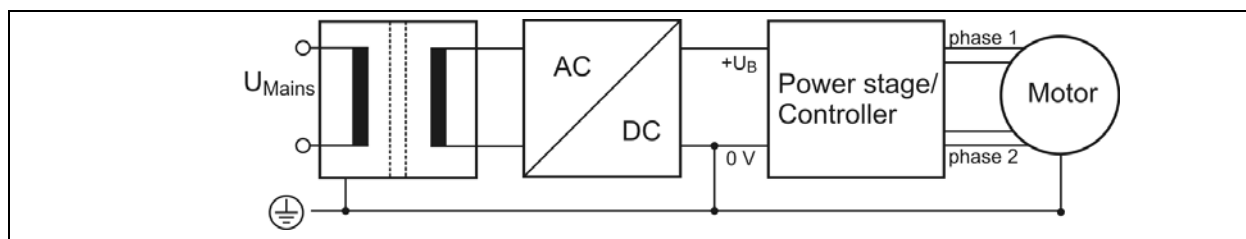
Fig. 9:   PELV – Grounding: 0 V and Motor

If there is no PE clamp on the motor, the 0 V wire **must** be grounded to complete the protective measure PELV (Fig. 10 and Fig.11):
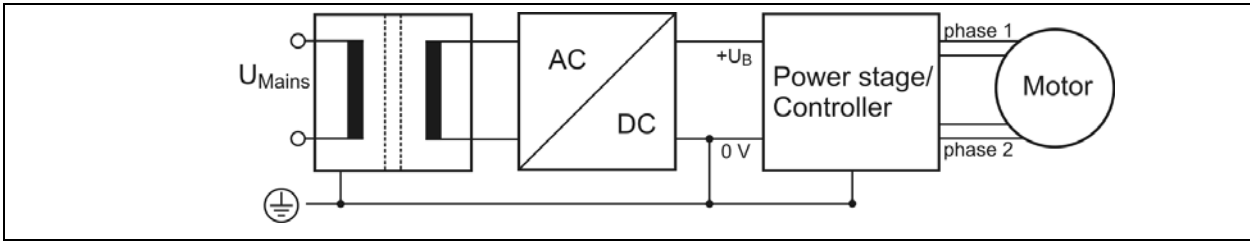
Fig. 10: PELV – Grounding: 0 V and Controller
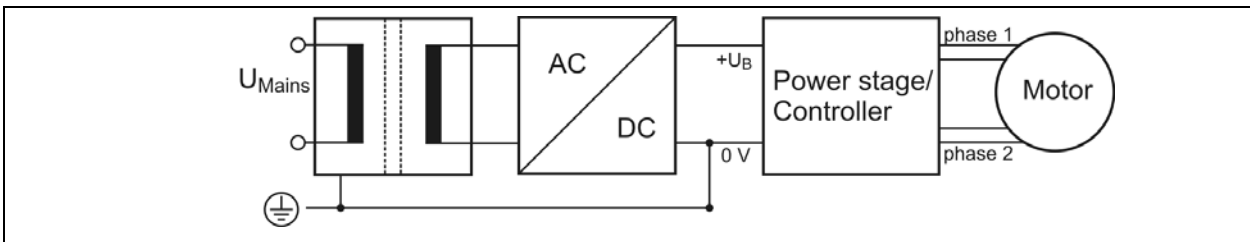
Fig. 11: PELV – Grounding: 0 V

Protective measure PELV for application of the $+U_B$ should not exceed 70 V_{DC} or 50 V_{AC} at dry environment (environmental conditions 3 acc. to IEC 61201). It is essential for MCC: $+U_B \leq 48\,V_{DC}$.

The supply transformer must be constructed with reinforced or double insulation between supply and secondary winding (acc. to EN 61558).

Only use motors which are checked acc. to EN 60034-1 (500 V_{AC}/1 minute).

4   Design Requirements

4.1   Electromagnetic Compatibility (EMC)

4.1.1 Remarks

⚠️ **WARNING**

Risk of injury by interference of signals and devices!

Perturbed signals can cause equipment to react unexpectedly.

• Connect the controller to the EMC requirements.

• In electrically noisy environments ensure the correct execution of the EMC measures. Disregarding these precautions can cause death, serious injuries or material damages.

4.1.2 EMC Measures

	EMC Measures	Effect
Device Mounting	Use cable clamps for shielding, connect metallic parts at a large area.	Good conductivity due to planar contacts.
	Connect the housing via cable diameter more than 2 mm^2 with potential equalisation.	Reduction of mutual interference.
	Fit switching devices such as contactors, relays or solenoids with interference or spark suppressors (e. g. diodes, varistors, RC elements).	
Cabling	Keep cables as short as possible. No "safety loops".	Avoidance of capacitive and inductive interference
	Connect the shielding of all shielded cables to the housing by the cable clamps to a large area.	Reduction of EMC emissions.
	Lay the cables spatially separated from each other (distance at least 20 cm): • signal and power cables • power and master cables • line filter input and output cable	Avoidance of mutual interference

	Ground a large surface area of the shieldings of digital signal cables.	Stray interference on control cables, reduction of emissions.
Power Supply	Protective circuit to mitigate over voltage or lightning strikes.	Protection of damage by over voltage.

Preset for EMC: Motor cable

The motor cable is a source of interference and must be carefully laid.

Use the cables recommended by Phytron. They are tested for EMC safety and are suitable for movement.

The motor and the encoder cable of the driving system must be connected to a large surface area of the output of the control cabinet and the motor with a low resistance.

- The PE lead (green/yellow) of the motor cable should be fixed at the earthing screw below the MCC-2 motor connector.

- The PE lead at the motor side of the cable should be fixed at the motor's earthing screw.

- For EMC compliant wiring it is important to conductively connect the motor cable shielding mesh with the controller housing. Use the cable clamps at the bottom and the top side of the MCC-2. Remove the external cable sheath in that range of the cable where you fix it with one of the cable clamps.

- The cables connecting motor and controller should not be interrupted (e.g. by connectors).

- At the motor side the cable's shielding mesh should be connected to the motor housing at a large area. We recommend to use special EMC type conduit fittings.

- In case of motors without adapted conduit fittings the cable shielding must be connected as near to the motor as possible and has to be applied to PE.

Potential equalization cables

Connect the shielding on all sides for protection from interference.

The difference of potential can cause incorrect currents on the shielding and must be avoided by potential equalization cables.

4.2 Cables

	maximum cable length [m]	minimum cross section [mm²]	shielded, grounded on all sides
Motor cable	The length depends on the cable resistance: $R_{cable} < 0.2x$ R_{phase}	Dependent on the maximum current of the motor and the motor cable length is suitable:	
	25	0.1 per 1 Ampere motor current	X
	50	0.2 per 1 Ampere motor current	X
USB	5	⎯	X
Signal line (digital)	100	0.14	X

5 Technical Data

5.1 Mechanical Data

| Device protection	IP 20
Dimensions WxHxD	72x127x110 (mm)
Weight with heat sink	about 930 g
Mounting	The MCC-2 housing is constructed with mounting brackets at two side panels. We recommend a vertical mounting (labeling readable) because of a better heat dissipation. The clip for rail mounting is mounted on the rear side.
Accessories (optional)	MCC-2 with additional RS 232 port for connecting a BT 5 operator panel MCC-2 with attached USB converter
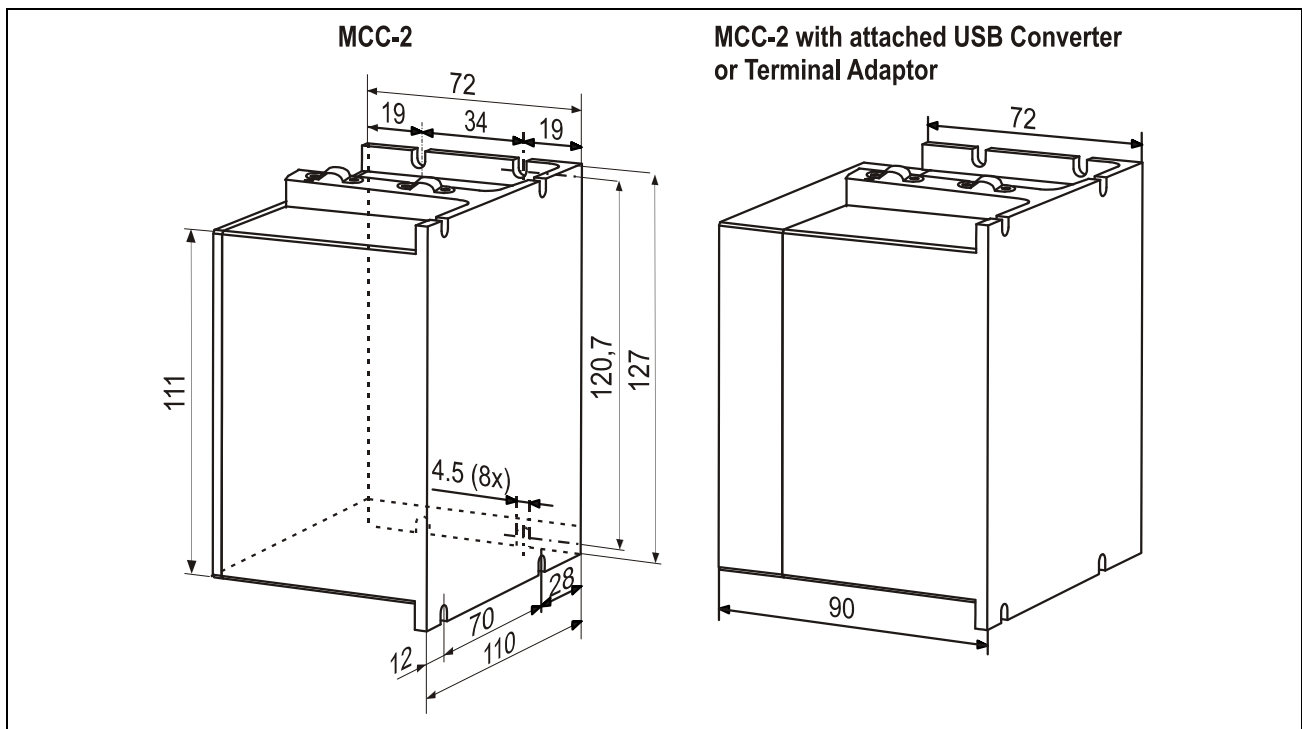
Fig. 12: Dimensions in mm

- Wall mounting: screws type M4 or UNC 6-32.

- Required space at the front side: about 35 mm for connectors and cables

5.2 Electrical Data

Technical Characteristics	
Supply voltage	Unregulated filtered DC voltage Admissible voltage range for • Controller and motor: 24 to 48 V_{DC} (X9) • Limit switch and outputs: 24 V_{DC} (X4) Reinforced or double insulation between mains and secondary circuit is required.
Stepper motor	Two-phase stepper motors in 4, 6 or 8 lead wiring scheme at X7/X8 Winding resistance between 0.1 and 10 Ohm Winding inductance 0.5 to 10 mH per phase
Phase current	up to 3.5 A_{Peak}
Step resolution	1/1, 1/2, 1/4, 1/5, 1/8, 1/10, 1/20 of a full step, enhanced setting range up to 1/256 step for smoother motor run
Max. run frequency	40 kHz for full step, 20 kHz for half step
Interfaces	RS 485, RS 232, USB Ethernet or ProfiBus (X5)
Connectors	2 Analog inputs (X1) 2 Limit switch inputs (X2) 8 Digital inputs / 8 digital outputs (X3) 1 Encoder per axis (incremental or SSI) (X6)
Fuse	6.3 A fast
Ambient temperatures	Operation: 5 to 50 °C Storage: -10 to 60 °C Transport: -10 to 60 °C
Temperature behaviour	Heating curve see chap. 9
Error detection	The MCC shuts down in case of undervoltage 17 V ±1 V. The error is set by the status bit and is indicated by the status LED which can be reset by a hardware or software reset (power stage reset). The power stage is deactivated in case of an error.

6   Installation

6.1   Mechanical Installation

	DANGER
⚡	**Danger of electric shock in case of foreign particles or damage!**

Make sure during the installation that not fixed particles, such as pieces of wire or assembly parts, can fall into the device. Conductive foreign materials in the product can endanger persons in case of parasitic voltage and destroy the device by short circuit.

Rail or Wall Mounting

- The controller should be vertically mounted.

- Mount the controller to a plane surface with appropriate load capacity.

- The wall mounting brackets on two sides of the device allow different mounting positions.

- The rail mounting clip is fixed with screws on the rear side.

- The rap holes can also be used for individual mounting solutions on the rear side.

  ⚠ The mounting screws used must intrude not more than 1 mm into the device's inner parts (housing thickness: 4mm).

- Minimum free space above and below the controller: 100 mm
  Keep the air slots free to allow convective air exchange.

- Minimum free space to other devices besides the controller: 30 mm

- Recommended free space before the controller for connectors and cables: about 35 mm.

- The heated air flow from other devices and components doesn't result in excessive heating of the cooling air.

- The controller has to be mounted and operated at a place free of shocks and vibrations.
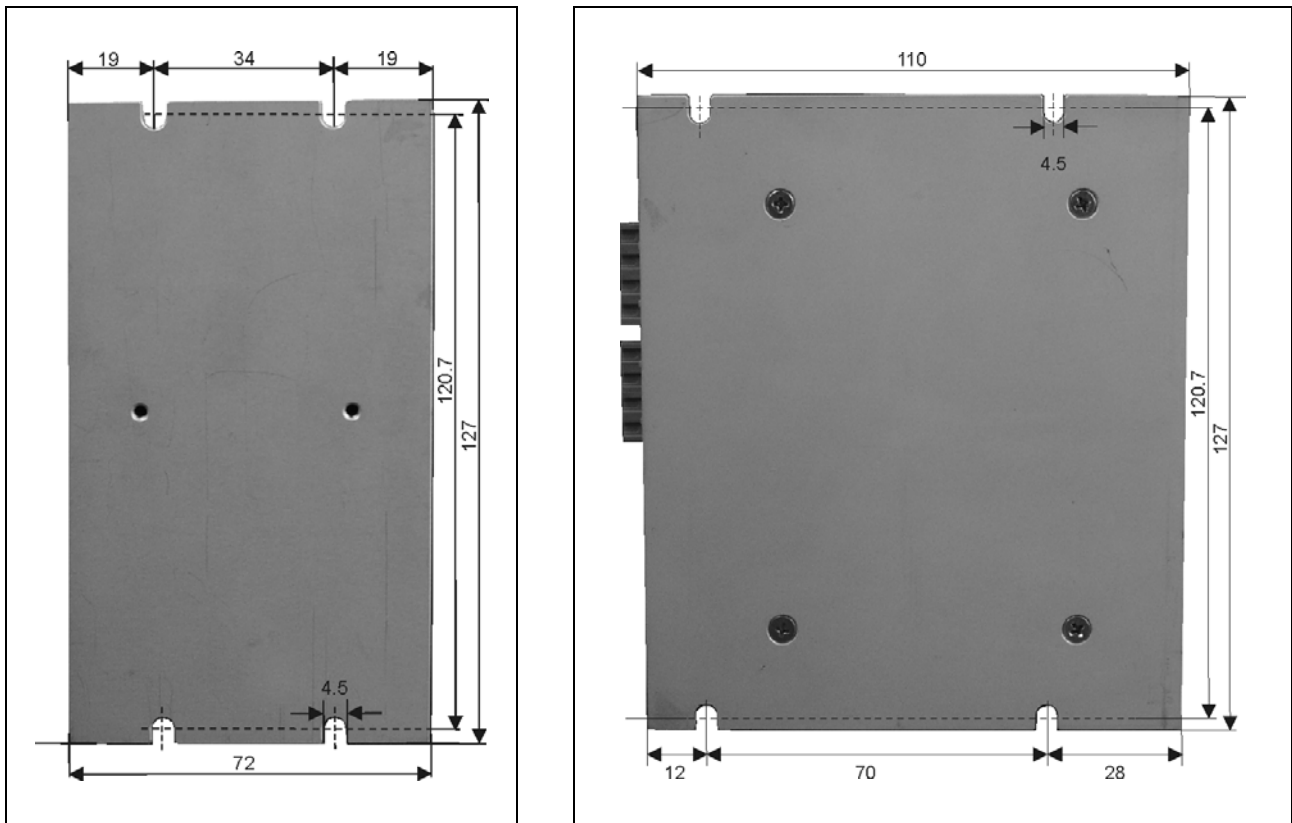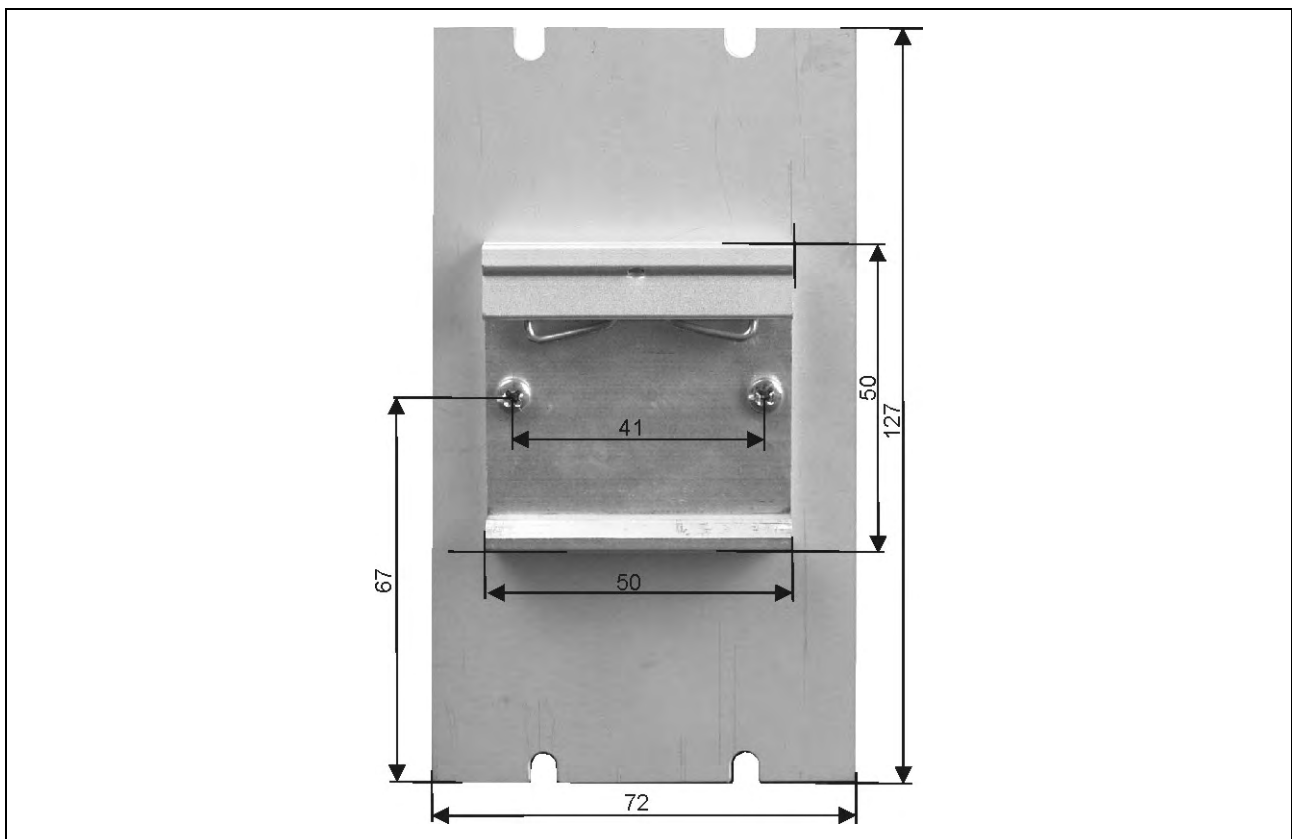
Fig. 13: Wall mounting MCC-2, dimensions

Fig. 14: Rail mounting MCC-2, dimensions

6.2 Electrical Installation

Connectors - Overview

Connector	Number of poles	Phoenix connector type	Phoenix mating connectors	Material number (mating connector)
X1 / X2	2 x 4	MCDN 1,5/4-G1-3,5 P26THR	FMC 1,5/4-ST-3,5	#10005880
X3 / X6	2 x 8	MCDN 1,5/8-G1-3,5 P26THR	FMC 1,5/8-ST-3,5	#10005881
X4	2	MC 1,5/2-G-3,5 THT	FMC 1,5/2-ST-3,5	#10007077
X7 / X8	4	IC 2,5/4-G-5,08	IC 2,5/4-ST-5,08	#10005390
X9	2	MSTB 2,5/2-GF-5,08	MSTB 2,5/2-STF-5,08	#02005267
X10	5	MC 1,5/5-G-3,5	FMC 1,5/5-ST-3,5	#10006540

6.3 Connection of the Power Supply

6.3.1 X4 Power Supply I/O

Fig. 15: X4 Connector Supply I/O

DANGER

Danger of electric arcing!
Do not plug or unplug any connector when powered!

The 24 V_{DC} (absolute limit values: 19.2 to 30 V_{DC}) supply voltage I/O is connected to the X4 connector and supplies outputs and limit switches.

The power requirement depends on the connected outputs and limit switches. 3 A are allowed.
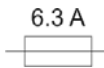
6.3.2 X9 Supply Voltage PWR

The controller and motor supply voltage is connected to the X9 connector.
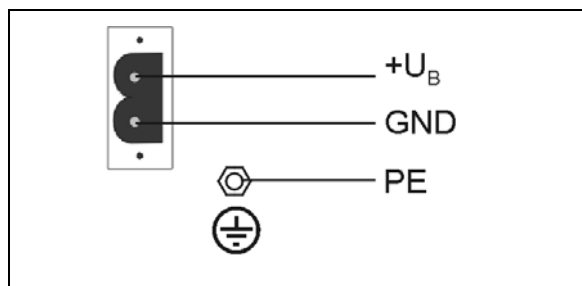
Permissible supply voltage range:

24 to 48 V_{DC}

Fig. 16: X9 Connector Supply PWR

- When the MCC-2 is supplied by means of an unregulated filtered DC voltage (e.g. transformer), a load capacitor of min. 3,000 μF should be used.

- Protective ground of the supply voltage should be connected to the earthing screw on the upper or lower side of the device.

- For strain relief the cable should be fixed with one of the cable clamps at the bottom or the top side of the device.

- Motor voltage is fused with 6.3 A fast.

⚠ **DANGER**

Danger of electric arcing!
Never plug or unplug the screw connectors when powered!

Remark: The maximum motor current is only reached when the supply voltage exceeds 40 V_{DC}.

⚠ The MCC shuts down in case of undervoltage 17 V ± 1 V. The error is set by the status bit and is indicated by the status LED which can be reset by a hardware or software reset (power stage reset). The power stage is deactivated in case of an error.
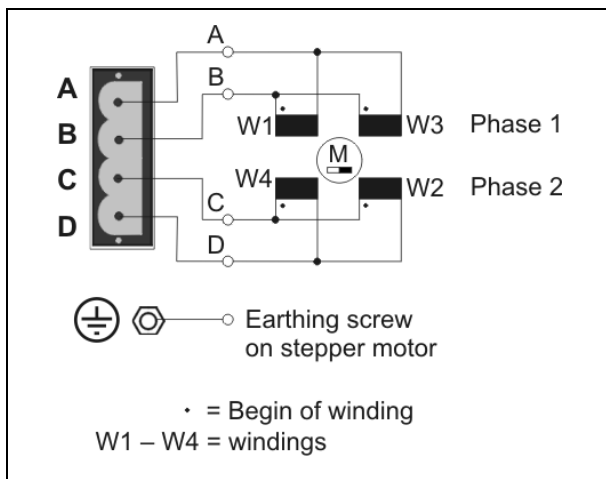
6.4 X7/X8 Motor Connector

6.4.1 Stepper Motor Connection

Suitable stepper motor types for operation with MCC-2:

- Two-phase stepper motors with 4, 6 or 8 lead wiring scheme and up to 3.5 A_{Peak} phase current

- Winding resistance below 10 Ohms

- Winding inductivity of one motor phase 0.5 to 10 mH

- To ensure electromagnetic compatibility (EMC), all parts of the motor housing should be conductively connected with each other.

The figure below shows the connection of a two-phase stepper motor with 4-lead wiring scheme and parallel connected windings:

DANGER

Danger of electric arcing!
Do not plug or unplug any connector when powered!

Fig. 17: Motor connection to X7 or X8 connector

Depending on application and stepper motor design, other wiring modes are possible, e.g. serial connected windings. See next chap 6.4.2.

WARNING

Power stage damage in case of faulty connection!
- Before running the motor, the motor currents should be set to suitable values! See chap. 6, Putting into service.
- 5-phase stepper motors **must not** be operated with MCC-2 controllers. Connecting 5-phase stepper motors **would result in damaging the power stage**.

The supply voltage value affects the setting accuracy of the motor current. In addition the setting accuracy depends on inductance and resistance of the motor. The current can be set less exactly, if the current value is smaller than 600 mA.

We recommend to use the linear MCC-2 LIN controller if the accuracy of the motor current setting must be improved.
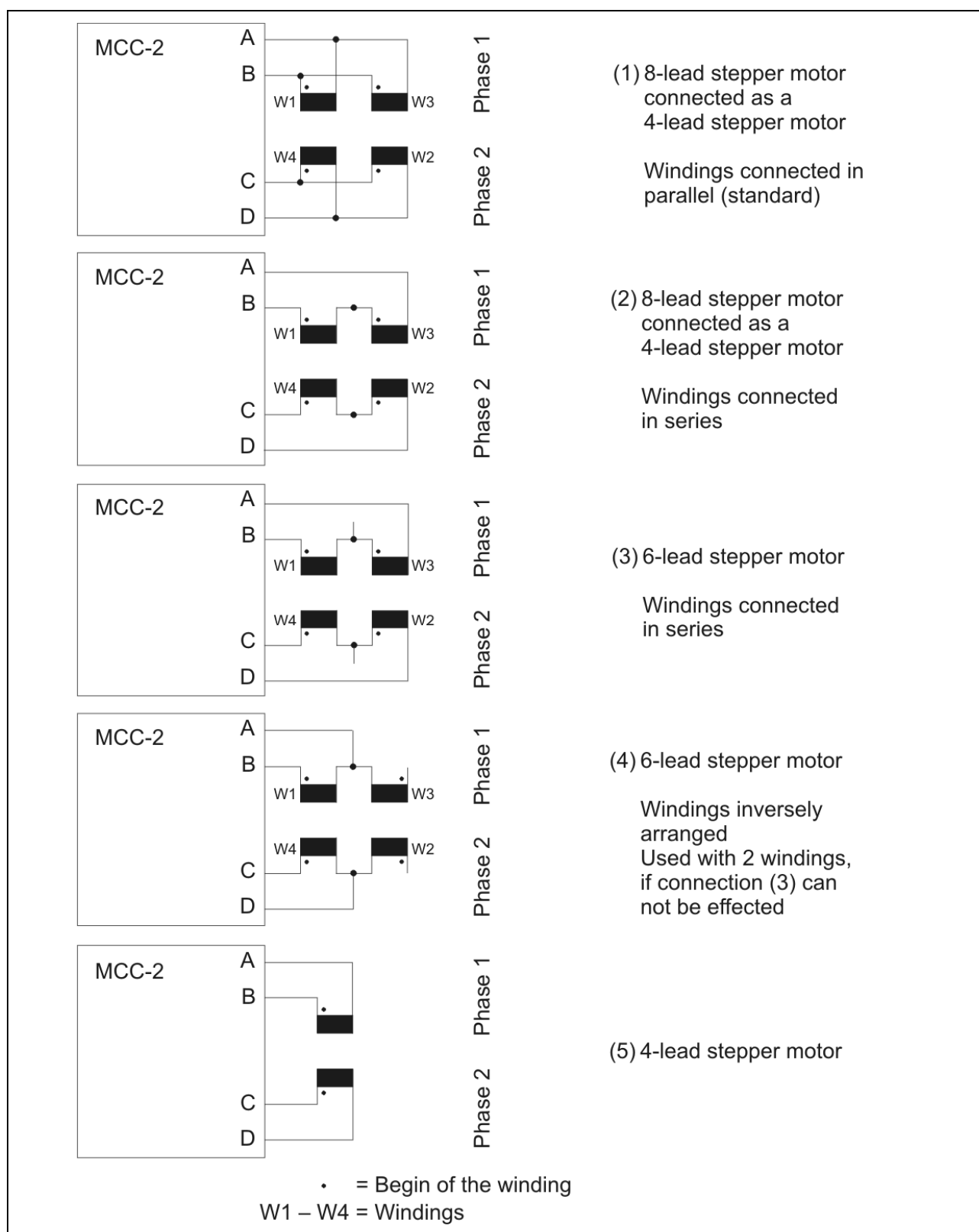
6.4.2 Wiring Schemes for 2-Phase Stepper Motors

Fig. 18: Wiring schemes for 2-phase stepper motors

⚠️ **WARNING**

Motor leads not used should be individually isolated (e.g. 6-lead motors)!

6.4.3 Motor Cable

Recommendations for Motor Cable Design:

Cable type: 5-pole with shielding mesh
(for stepper motors without earthing screw: 4-pole with shielding mesh)

Lead cross section: 1 mm² recommended, a smaller lead cross section can be used dependent on the maximum motor current and the motor cable length.

Acceptable motor cable length: dependent on power stage current setting and motor winding resistance
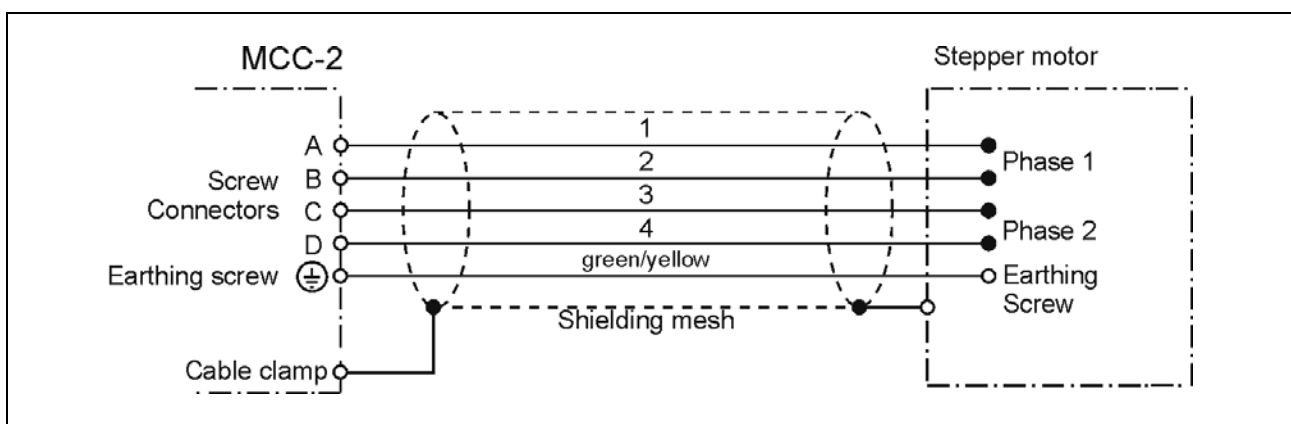

Fig. 19: EMC compliant motor cable wiring

⚡ **DANGER**

Danger of electric arcing!
Do not plug in or plug out motor cable leads when motor supply voltage is on!

- The PE lead (green/yellow) of the motor cable should be fixed at the earthing screw below the MCC-2 motor connector.

- The PE lead at the motor side of the cable should be fixed at the motor's earthing screw.

- For EMC compliant wiring it is important to conductively connect the motor cable shielding mesh with the controller housing. Use the cable clamps at the bottom and the top side of the MCC-2. Remove the external cable sheath in that range of the cable where you fix it with one of the cable clamps.

- The cables connecting motor and controller should not be interrupted (e.g. by connectors).

- At the motor side the cable's shielding mesh should be connected to the motor housing at a large area. We recommend to use special EMC type conduit fittings.

- In case of motors without adapted conduit fittings the cable shielding must be connected as near to the motor as possible and has to be applied to PE.

6.5 X5 Com Communication Interface

The X5 Com communication interface is available as USB, RS 232(4-wire), RS 485, Ethernet or ProfiBus-connection.

<u>**Factory setting:**</u>

57 600 Baud
8 Data bits
1 Stop bit
No parity

Protocol:: <small><STX></small> | Address | Data | Separator | Checksum <small>|<ETX></small>

Baud rate and **Interface parameters** can be modified after installation of MiniLog-Comm in the menu item *Options/Interface Parameters.*

i   If the MCC-2 is connected via Ethernet, the **IP address**

- **is created by DHCP** (dynamic IP configuration) or
- is assigned via Minilog Comm or *phy***LOGIC**® ToolBox (Interface parameter/Eth-MCM menu).

i   When the MCC-2 is connected to the PC by USB-interface, USB drivers have to be installed on the PC.

i   An USB converter is needed, if several controller should be connected by USB. It is mounted either external or at the first MCC-2 with RS 485 interface. See chapter 6.5.3 RS 485 interface.

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USB Interface

MCC-2 and PC can be directly connected by the USB cable type A-B. The USB port of the PC (type A) is directly connected to the USB port of the controller (type B). The MCC-2 operates in the stand-alone mode.
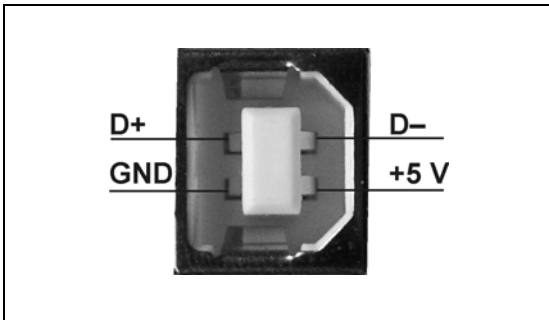

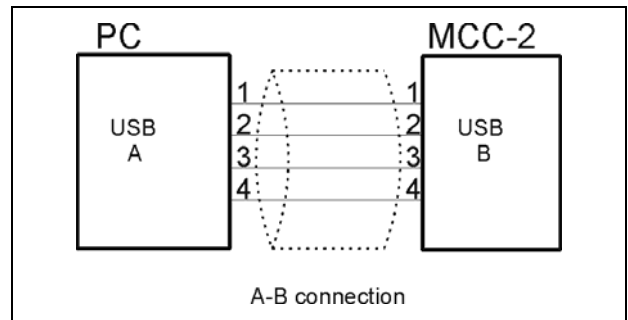Fig. 20: X5 Com: USB port type B (DIN IEC 61076-3-108)

Fig. 21: Wiring scheme PC ←→ MCC-2 by cable A-B

USB-Driver Installation (Windows)

- Insert the Phytron-CD and open the folder **USB Driver** by the Windows Explorer. Select the .**exe**-program which goes with your system software and start it by double click. The following window is shown on desktop after a successful installation:

- Connect the MCC-2 directly or via USB converter to the USB port of your PC by USB cable.

- For checking the correct USB-driver installation, continue as follows:

  Start the device manager by clicking **Start→Settings→System control** and double-click on **System**. Then select the **Device manager** tab. The USB components can be found in **Computer→ Ports** and in **Universal Serial Bus Controller**. Here the new USB-component is shown: **USB Serial Port (Com X)**

- You'll find information about the driver installation for the chip FT232R and more drivers for Linux and MAC on http://www.ftdichip.com

⚠ • When the MCC-2 is connected to the PC by USB-interface, USB drivers have to be installed on the PC.

- Administrator authorizations are required for the driver installation.

- Use a USB cable with a maximum length of 2 m!

- If you want to test several USB devices, which are identical in construction, you should use the same USB port on the PC. Thus, you avoid to change the COM port number.

6.5.1 Ethernet Interface

The MCC-2 can be integrated into the firm's network by the Ethernet adaptor.

The port number of the MCC-2 controller is fixed to 22222 by Phytron.
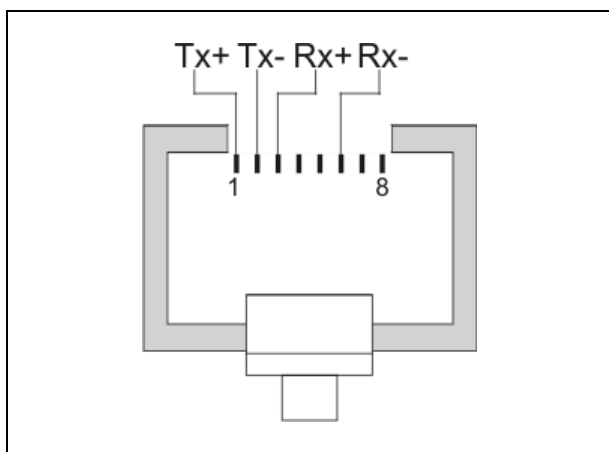
The Ethernet connection via RJ 45 connector (X5 Com):

Fig. 22:   X5: RJ 45 Ethernet connector

6.5.2 RS 485 Interface

When up to 16 MCC-2 are connected together in bus mode (RS 485/4-wire), an individual address has to be set on the rotary switch 'Address' for each MCC-2.

A USB/RS 485 converter has to be used for USB connection to the PC.
Alternatively, a PC with RS 422- or RS 485/4-wire interface can be the master.
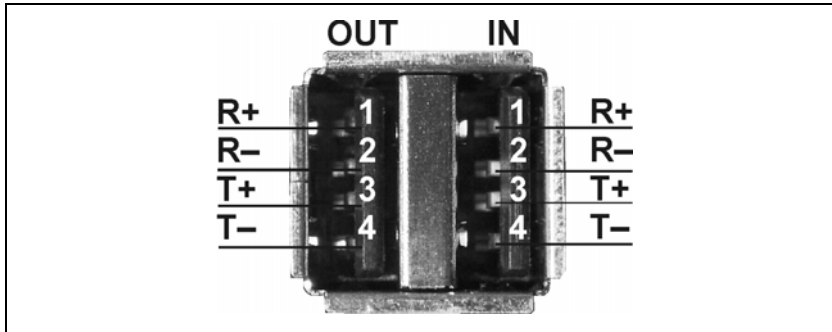

Fig. 23: X5 Com: connector, type A (DIN IEC 61076-3-107)

PC with RS 485/4-wire- or RS 422 interface ↔ RS 485 bus

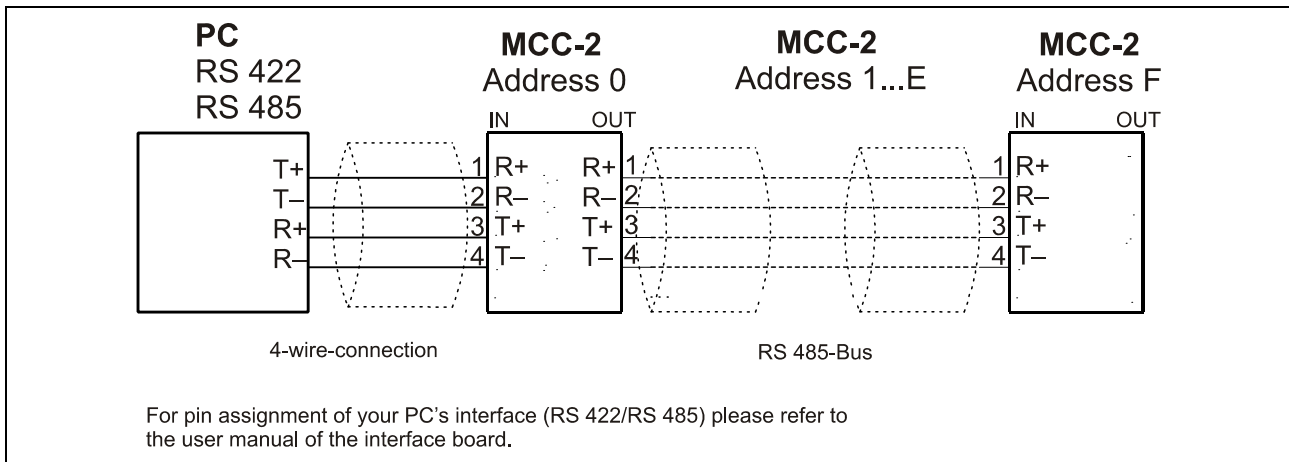The figure below shows the RS 485 bus connection to MCC-2 by a RS 422 or RS 485/4-wire interface on PC.

Fig. 24: Connection PC (RS 422/485 interface) → MCC-2 (RS 485 interface)

Remark:

- It is not necessary to use an external bus termination connector for RS 485 bus, because the bus termination resistors are already built-in the MCC-2.

- In the RS 485 bus mode the PC is the master. Therefore an interface type RS 422 or RS 485/4-wire is necessary.

The complete bus only operates, if all devices are supplied at X9 connector. If the supply voltage is disconnected on one MCC-2, all following devices on bus are without communication.

PC with USB interface ↔ Converter ↔ RS 485 bus

A USB/RS 485 converter has to be used for USB connection to the PC. An extra converter or a converter, which is installed on the first MCC-2 must be inserted.
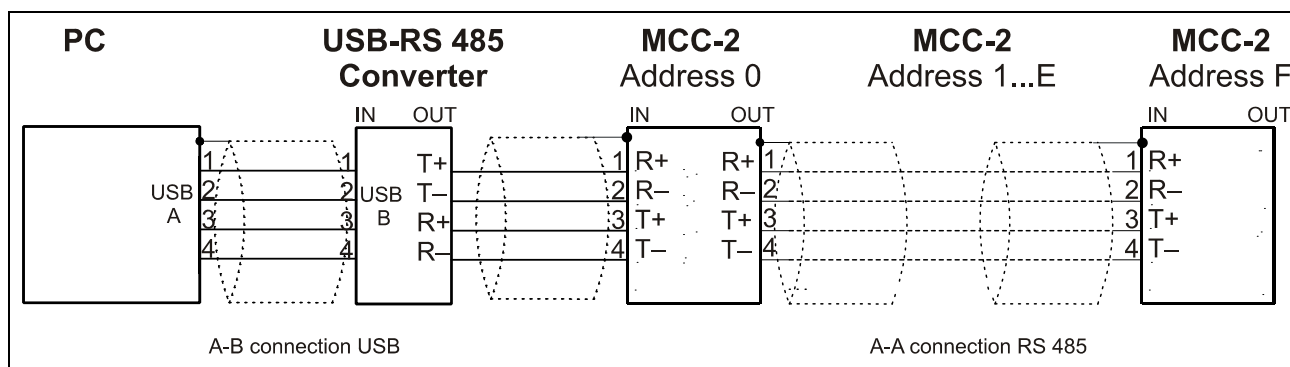

Fig. 25: Bus connection PC → MCC-2 with USB-RS 485 converter in RS 485 mode

The figure below shows the connection of the PC to MCC-2 by the Phytron USB-RS 485 converter.
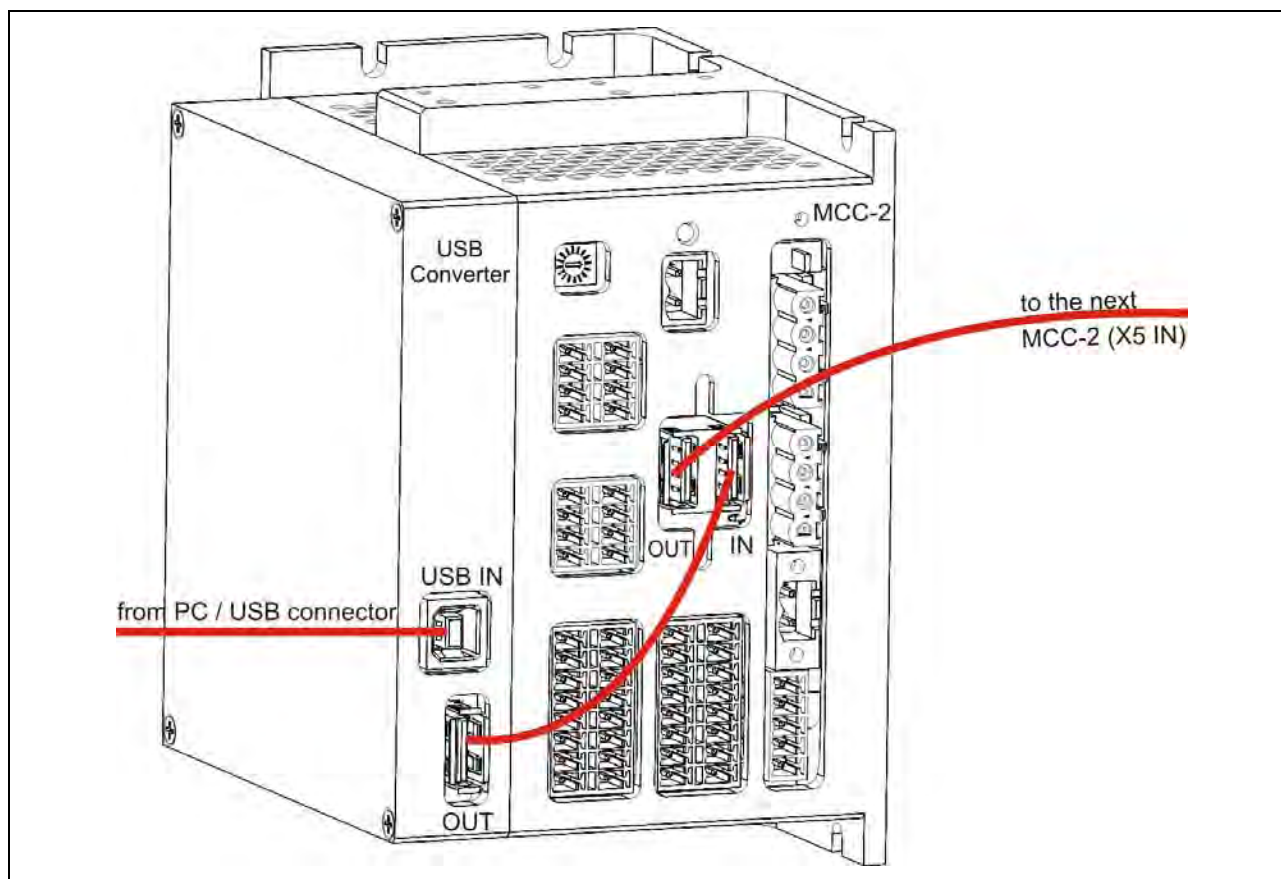

Fig. 26: Controller MCC-2 with Phytron USB-RS 485 converter

6.5.3 RS 232 Interface

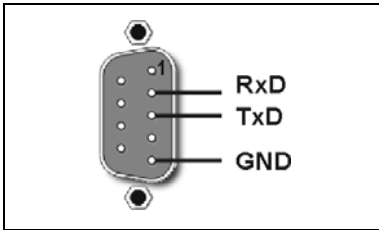The MCC-2 can be used as single device by RS 232 interface.

Fig. 27: 9 pole D-sub male connector acc. to DIN 41652

The following figures point out the cable connections to a PC with RS 232 interface. Depended on the type this can be a 9 pole or a 25 pole D-sub female connector.

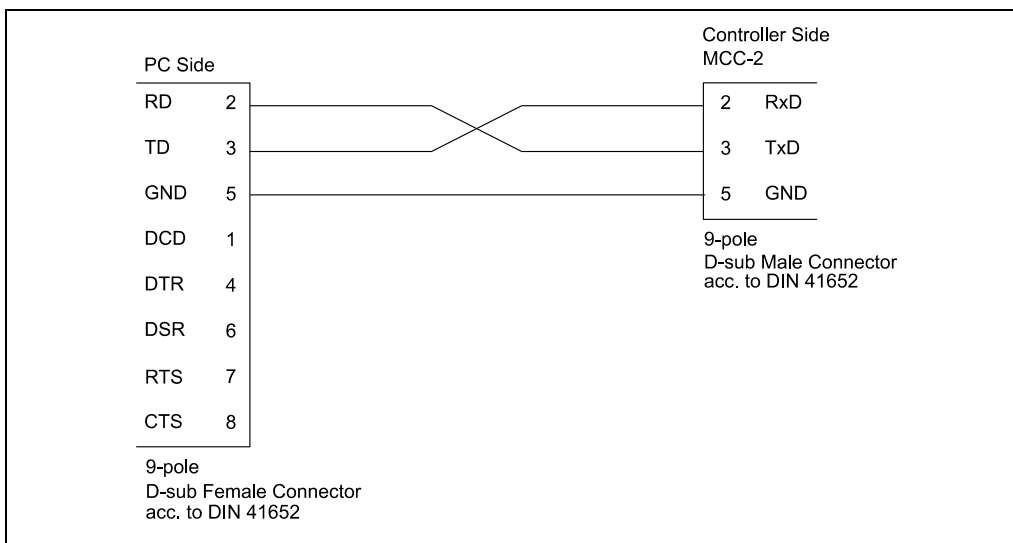## Connecting Cable PC – Controller:

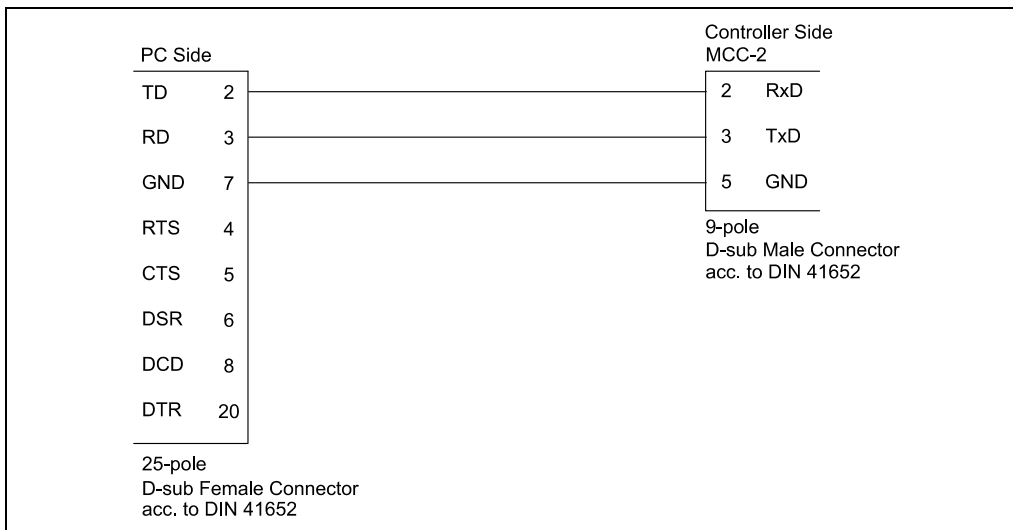Fig. 28: PC (9 pole female connector) <-> Controller MCC-2

Fig. 29: PC (25 pole female connector) <-> Controller MCC-2

⚠ 115 200 Baud are allowed as maximum baud rate to receive correct data.

6.5.4 Profibus Interface

The stepper motor controller is connected to the ProfiBus via internal device ProfiBus module (X5 Com connector).

Please perform the commissioning as follows:

Set the Profibus address on the rotary switch of the MCC:
  Address = switch position +1
    i.e. rotary switch 0 → address 1
       rotary switch 9 → address 10
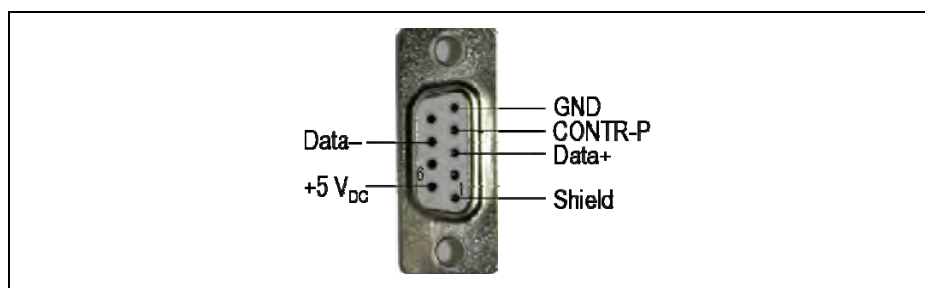   rotary switch F → address 16

Fig. 30: 9-pole D-SUB connector female acc. to DIN 41652

Further manual

Detailed information on this subject is in a supporting manual:

"*ProfiBus/ProfiNet Interface for MCC controllers*"

6.6 Signal Interface Connection

6.6.1 X1 AD Converter

The X1 analog inputs can be used for voltage measurement, as well as e.g. for a joystick as AD converter.

The 5 V_{DC} ±3 % / max. 100 mA voltage is supplied by the MCC-2.

Input voltage: 0 to 5 V

Resolution: 10 Bit

A/D conversion time: about 15 µs

Input resistance: 47 kΩ

The input A/D ENABLE is a digital input (max. 5 V), which can be used e.g. as joystick Enable. This input is only analyzed by software (see MiniLog-Comm).

Specific information for processing the input signals you'll find in the programming manual MiniLog-Comm.
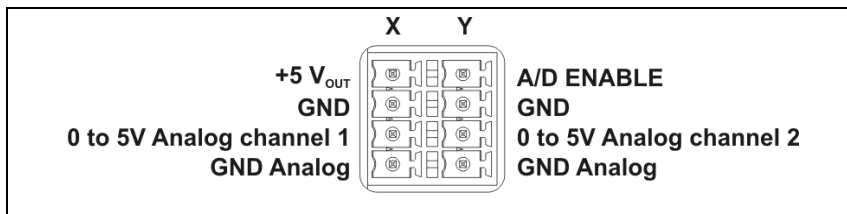
Fig. 31: X1 Pin assignment

⚠ **CAUTION**

Danger of device damage!
Do not exchange X1 and X2!

To improve the accuracy of measurement of the AD converter, use a shielded cable. We recommend using the shielding as GND analog. With PELV Grounding (except for SELV supply, see chap. 3) this can be additionally wired to PE. Make sure that no reverse current couple into the GND Analog shielding. GND Analog should not be connected to PE, if there is SELV supply.

6.6.2 X2 Limit Switch Input

The controller is designed for connecting two limit switches type PNP NCC or PNP NOC per axis.

This type has the advantage that cable breaks can be recognized.

Mechanical opening limit switches may be also connected.

The supply voltage for the limit switches and outputs has to be supplied on connector X4.
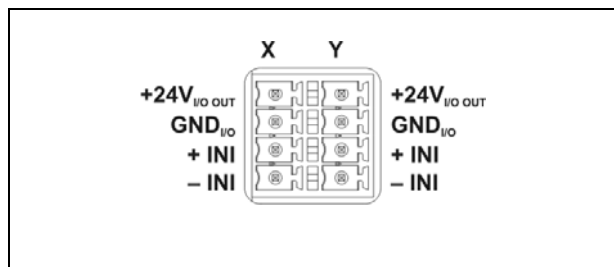
Fig. 32: X2 Pin assignment

⚠	**CAUTION**
	Danger of device damage!
	Do not exchange X1 and X2!

6.6.3 X3 Digital Inputs/Outputs

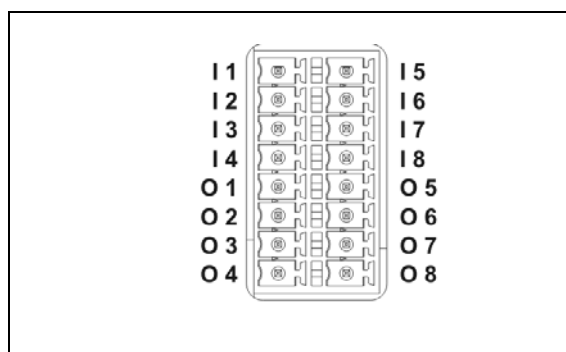MCC-2 controllers have each eight digital electrically insulated inputs and outputs.
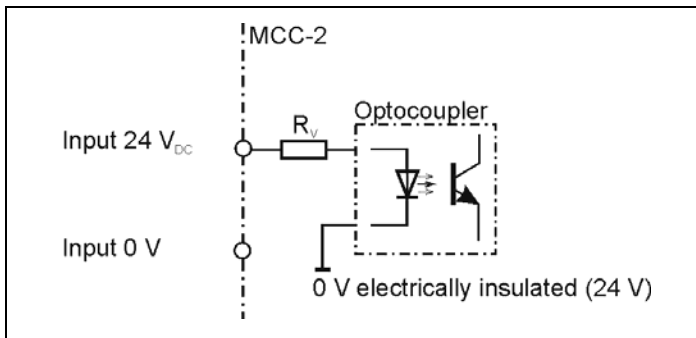

Fig. 33: X3 Pin assignment

⚠	**CAUTION**
	Danger of device damage!
	Do not exchange X3 and X6!

Manual MCC-2

Inputs

The inputs are connected to a common ground connection ($GND_{I/O}$ at X2, X4 or GND at X9).

Fig. 34: Input circuit diagram

Input level: 24 V_{DC}

The input circuit protective resistor of 3.3 kΩ corresponds to 7 mA nominal driver current at 24 V_{DC}.

Signal level Low: < 0.4 V_{DC}
Signal level High: 20 – 30 V_{DC}

Outputs

The overload-safe outputs are equipped with protective diodes to protect the internal circuitry. In the case of inductive loads (e.g. relay) each output should be additionally wired with a protective diode mounted near the load in order to avoid EMC problems.

Fig. 35: Output wiring example
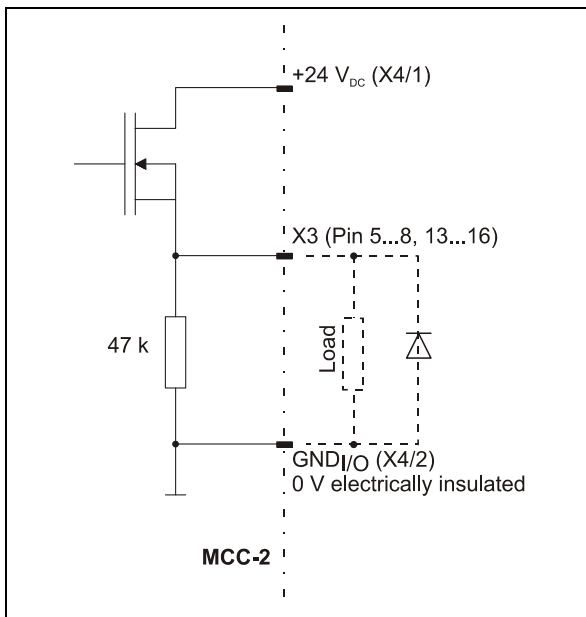
Max. 1 A current each output

Up to 3 A for all outputs

6.6.4 X6 Encoder Connector

- Connection of one encoder per axis.

- Incremental encoder with quadrature signals or absolute encoder acc. to SSI-standard.

- The incremental encoder supply voltage, 5.3 V_{DC} / max. 200 mA each encoder, is generated by the controller.

- Use shielded twisted pair wise cables for encoder connection. The transmission mode includes no protection against faulty transmission values.
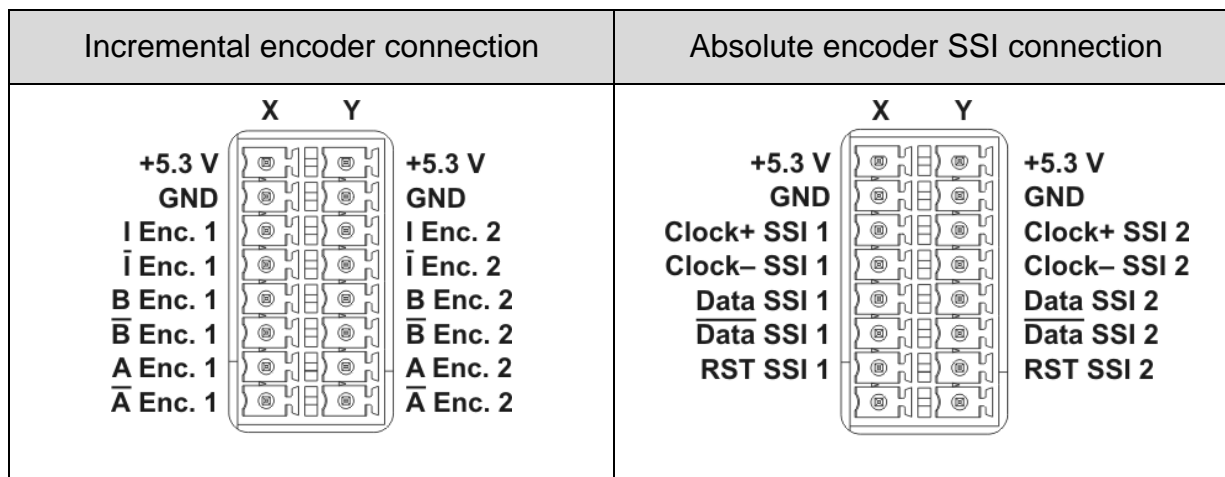
Incremental encoder connection	Absolute encoder SSI connection
X Y +5.3 V +5.3 V GND GND I Enc. 1 I Enc. 2 Ī Enc. 1 Ī Enc. 2 B Enc. 1 B Enc. 2 B̄ Enc. 1 B̄ Enc. 2 A Enc. 1 A Enc. 2 Ā Enc. 1 Ā Enc. 2	X Y +5.3 V +5.3 V GND GND Clock+ SSI 1 Clock+ SSI 2 Clock– SSI 1 Clock– SSI 2 Data SSI 1 Data SSI 2 Datā SSI 1 Datā SSI 2 RST SSI 1 RST SSI 2

Fig. 36:   Encoder connector X6

- When using encoders, the parameters P34 to P39 should be checked and adapted (MiniLog-Comm communication software):

  P34   incremental encoder / absolute encoder
  P35   encoder resolution (SSI)
  P36   encoder as counter
  P37   not used
  P38   preferential encoder direction of rotation
  P39   conversion factor (one increment corresponds to ...)

- It is possible to operate one axis with an absolute encoder and the other axis with an incremental encoder.

⚠ **CAUTION**

Danger of device damage!
Do not exchange X3 and X6!

Danger of damage!
Connect the correct encoder type!
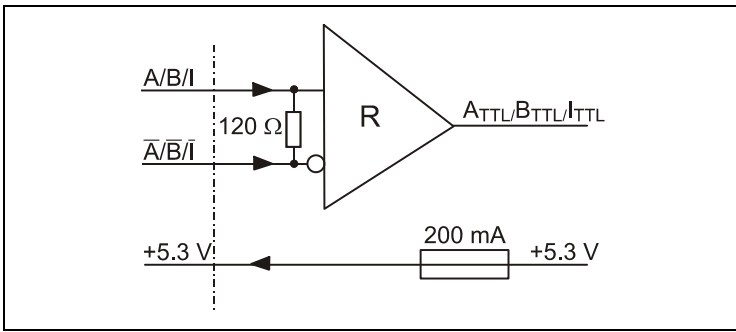Do not parameterize an incremental encoder as SSI.

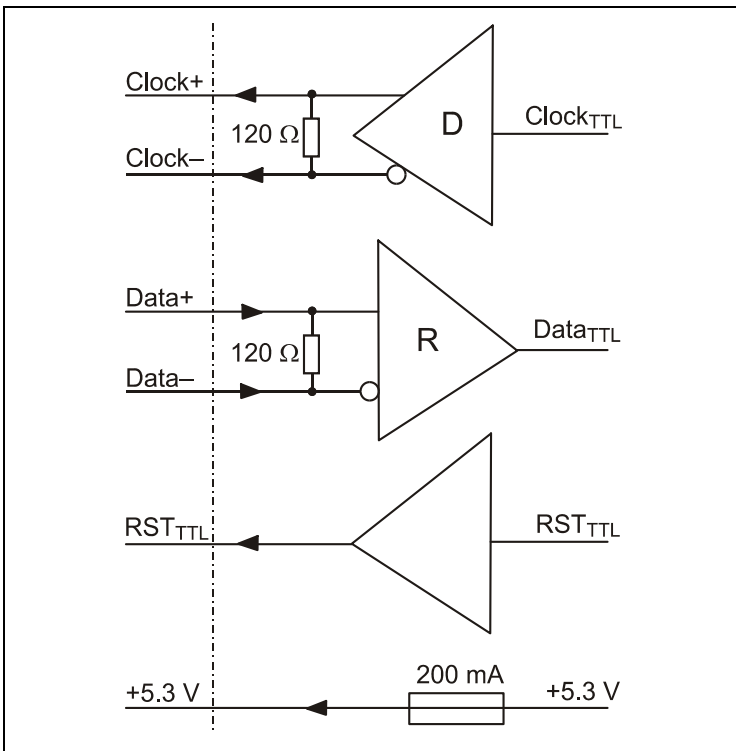Fig. 37: Wiring of incremental encoder

Fig. 38: Wiring of SSI absolute encoder

6.6.5 X10 Enable Connector

- The power stage can be deactivated independent of the logic signals (enable connector X10).

- Two opto-decoupled Enable inputs are used to activate the motor supply.

⚠️ **Both** Enable inputs must be wired for activation!

- The Monitor Enable output is used to check the Enable inputs A and B, i.e. when both inputs are wired, the Monitor Enable output is set to ‚high'.

Fig. 39: X10 Connector Enable
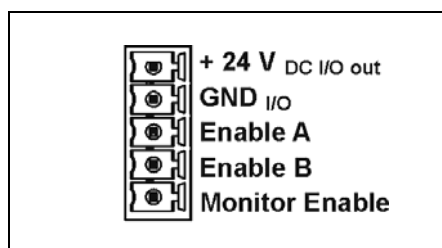
The function Enable doesn´t fulfill 'Protection against unexpected start' according to EN 945-1 for application in the extended safety sections.

- The Enable inputs A and B can be permanently activated by bypassing the inputs with the+24 V_{DC} output. This will work only, if +24 V_{DC} is supplied to the connector X4.
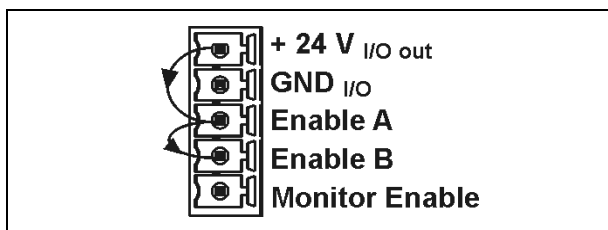

Fig. 40: Activation of A and B Enable inputs

⚠️ A deactivation of the Enable signals during increasing stop and run current values can cause an error and the axes will be stopped by an emergency stop. If the Enable functionality should be checked e. g. after power-on, we recommend either to reduce the current parameters or to detect the extern deactivation in the Minilog program by commands and to reset the axes (see manual MiniLog).

Minilog command for reading the system status:
ST, Bit 5 is set (32_{Dec}) = input Enable is OK
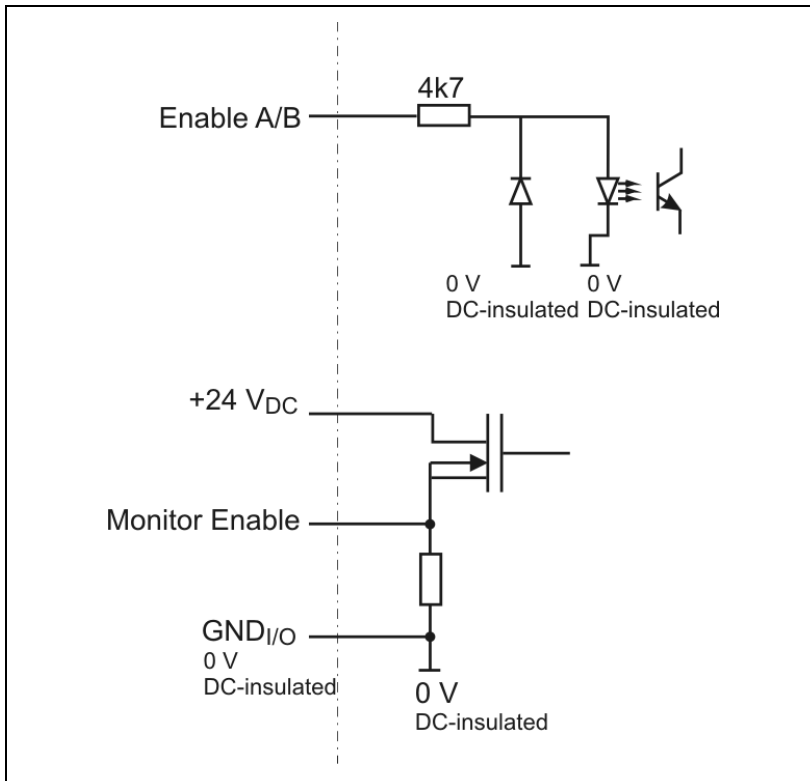
See also MiniLog for MCC programming manual.

Fig. 41: Enable connector wiring

phytron

7 Putting into Service and Test

7.1 Test the Communication between Controller and PC

1. Connect the serial interface of the PC to the controller (X5), see Chap. 1.2.
2. Connect the supply voltage PWR to the controller (X9). The LED should light green.
3. Set the Remote/Local switch to REMOTE.
4. Switch on the PC.
5. Install MiniLog-Comm program package delivered with the controller.
6. Select the required settings in MiniLog-Comm, menu item *Options/Interface parameters*, and save them: Active COM, transmission protocol and baud rate.

The baud rate in the controller can be changed by clicking on `Advanced >>` and can be saved by `Set!` .

Baud rates MCC-2	
can be selected in menu item *Options/Interface parameters* or by programming instruction	
9 600	38 400
14 400	57 600
19 200	115 200
28 800	
Factory settings	

Baud rate programming instruction:
ICp**S**nnn
IC   Code: programming a baud rate
p   Port number 1 or 2
S   Write (Schreiben)
nnn   Enter baud rate

Data format for transmission:
No Parity
1 Stop bit
8 Bit ASCII Code
57 600 Baud

All **instruction strings** must have the following format: **STX Data ETX**
Control characters: see ASCII table

The programming instructions are listed in the MiniLog programming manual.

7.2 Test Stepper Motor(s), I/Os and Limit Switches

If not done before, now inputs, outputs, limit switches and stepper motor(s) should be wired. Supply voltages should be wired after that!

Do not connect or disconnect screw terminals
as long as the matching supply voltage is on!

1. Switch on the PWR supply voltage. The LED will light green.

2. Switch on the supply voltage for I/O.

3. Start MiniLog-Comm.

4. Select menu item *File/New/Parameter* for motor current setting.

   Run current, stop current and boost current[1] can be set in the range 0.1 bis 2.5 $A_{r.m.s.}$ independent from each another. Stage 1 = 0.1 $A_{r.m.s.}$ to stage 25 = 2.5 $A_{r.m.s.}$

   In menu item *Transmission/Send/Parameter* the parameter list is saved in the MCC-2.

   On delivery the following settings are valid:
   Run current: 0.6 A, stop current: 0.2 A, boost current: deactivated

   Set motor currents corresponding to the motor winding parameters!
   See chap. 6.4

5. In the menu item *Parameter* the step resolution can also be set between full step and 1/256 step. It is better to choose a high step resolution in most application situations, because the motor will run more smoothly.

6. After the motor currents have been set to suitable values you can test the motor's run by selecting the menu items *Transmission/Direct Mode* or *Transmission /Operation.*

7. Menu item *Transmission/Direct Mode*
   Many customers are already familiar with MINILOG program instructions. They can enter all types of MINILOG instructions into a dialog box. The instruction is executed at once.

   Example: Enter *X+200*
   The motor axis 1 drives 200 steps in direction +.

---

[1] **Run current** is the motor's rated current for normal operation without acceleration or deceleration phases.

Stop current is a reduced current for motor standstill (about 50% of the run current).

Boost current is the motor current for acceleration and deceleration. During these phases the motor needs more energy as during constant speed.
The boost current should be set to 120 to 130% of the run current. On delivery, boost is deactivated, that means the motor will always run with the selected run current.

The corresponding instruction for the other motor would be: *Y+200.*

8. An icon in the menu bar *Transmission/Operation* opens the following dialog box which enables you to drive the motor per mouse click.

1.
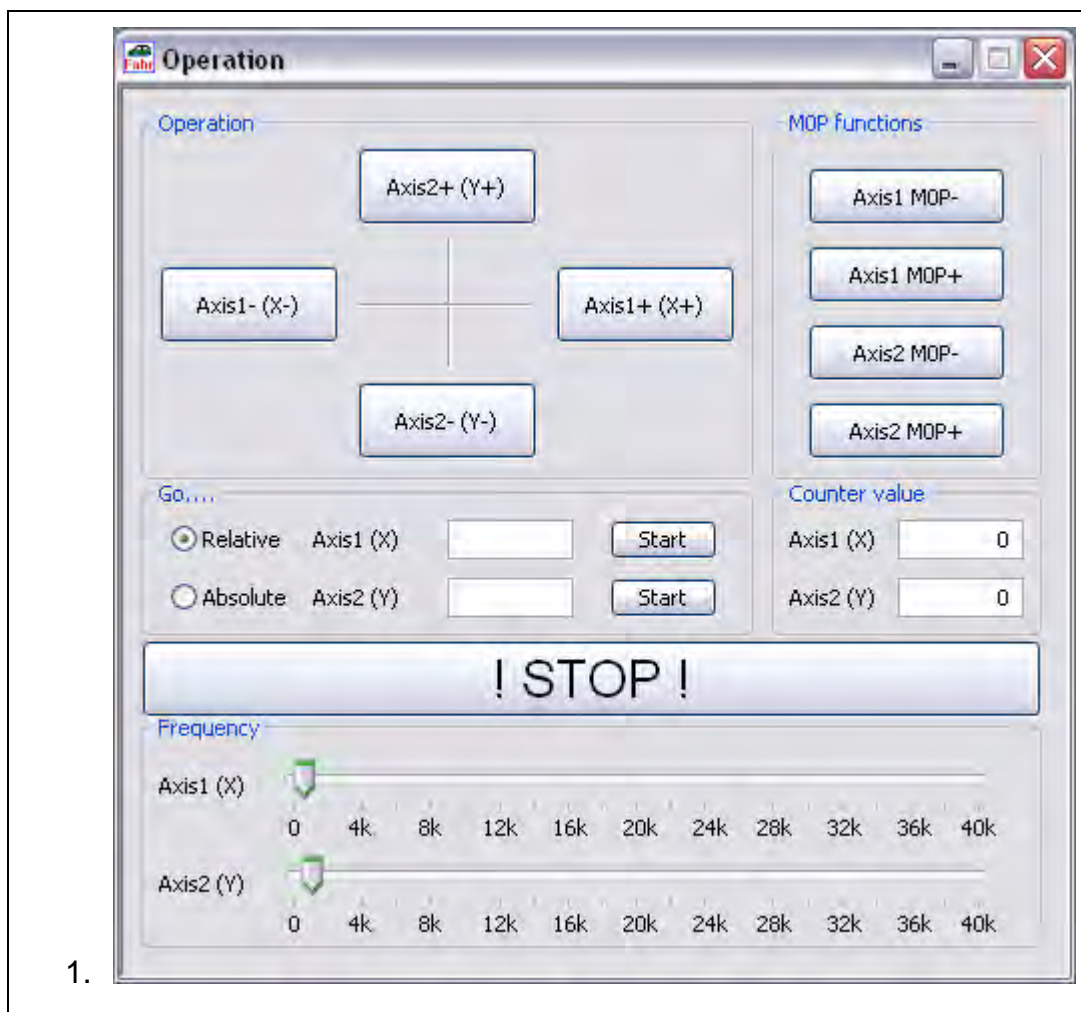
9. Click on simply one of the buttons `Axis1– (X–)` to `Axis2+ (Y+)`. Direction + means clockwise, seen onto the motor axis from outside.

    2. If the motor should move in the wrong direction, exchange the connecting leads of one motor phase, e.g. A and B.

10. You can enter drive instructions for both axes into the window "Drive relative ... " The symbol + or – before the entered number of steps defines the direction.

    When you click on the button `Start` the instruction will be executed. Now the button has the marking `! STOP !` in order to cancel the movement if required.

11. You can change the drive frequencies of both motors with two slider controls at the bottom of the window 'Frequency'.

12. You can initialize each axis with click on one of the buttons `Axis1 M0P–` or `Axis2 M0P+`. The initializing can be cancelled by `! STOP !`.

13. Another MiniLog-Comm window allows to test inputs and outputs.

8 Programming

8.1 LabVIEW®

LabVIEW is a graphical programming environment with symbols.

Graphic icons (in the programming language G), which are representing a particular function, are linked. These programs are called virtual instruments (VIs).

Phytron has created special VIs for MCC-controllers. The user therefore needs LabVIEW qualification. Basic programming knowledge like data types, loops etc. are required.

The MCC-VIs are developed for LabVIEW 8.0 and higher.

A detailed description can be found in the LabVIEW-VIs MCC manual.

8.2 MiniLog

The "Phytron Programming Language" MiniLog is welltried for editing sequential programs for machine controllers.

Complete sequential programs can be realized with MiniLog: drive instructions, initializing axes, sub programs, jump instructions, reading and setting registers and many other special instructions (see MiniLog programming manual).

MCC-2 controller can store MiniLog programs up to 128 kB program memory.

For editing and managing MiniLog programs, the MiniLog-Comm communication software for PC is delivered together with the controller. Actual MiniLog-Comm program versions can be downloaded from the Phytron homepage: http://www.phytron.de/

In the MiniLog-Comm menu item *File/New* you can enter and edit parameters, sequential programs and registers.

Please refer to the MiniLog programming manual for all programming instructions.

9   Heating Curve of MCC-2

ℹ️ The adjusting housing temperature depends on the motor type, the motor cable length, phase current, supply voltage, arrangement of the housing and the tolerance of the components.

In practice it can differ from the diagrams below.

The housing temperature should not exceed 75 °C (measured on the right side of the housing and MCC-2 vertically arranged). In order to prevent destruction of the hardware, the internal emergency cutout shuts down actively at higher temperature.

On the basis of the heating curve (fig. 41) the τ_ϑ thermal time constant can be computed (point of intersection between $0.63\Delta\vartheta$ and the heating curve).

The expected housing temperature at different ambient conditions can be estimated by τ_ϑ time constant, start tangent and the combination of heating- and cooling curve.

Measuring conditions or operation:

- Device vertical arranged (LED on the top)
- 48 V_{DC} supply voltage
- Motor type: ZSS42.200.2.5
- Temperatures are normalized, i.e. relatively without bench mark

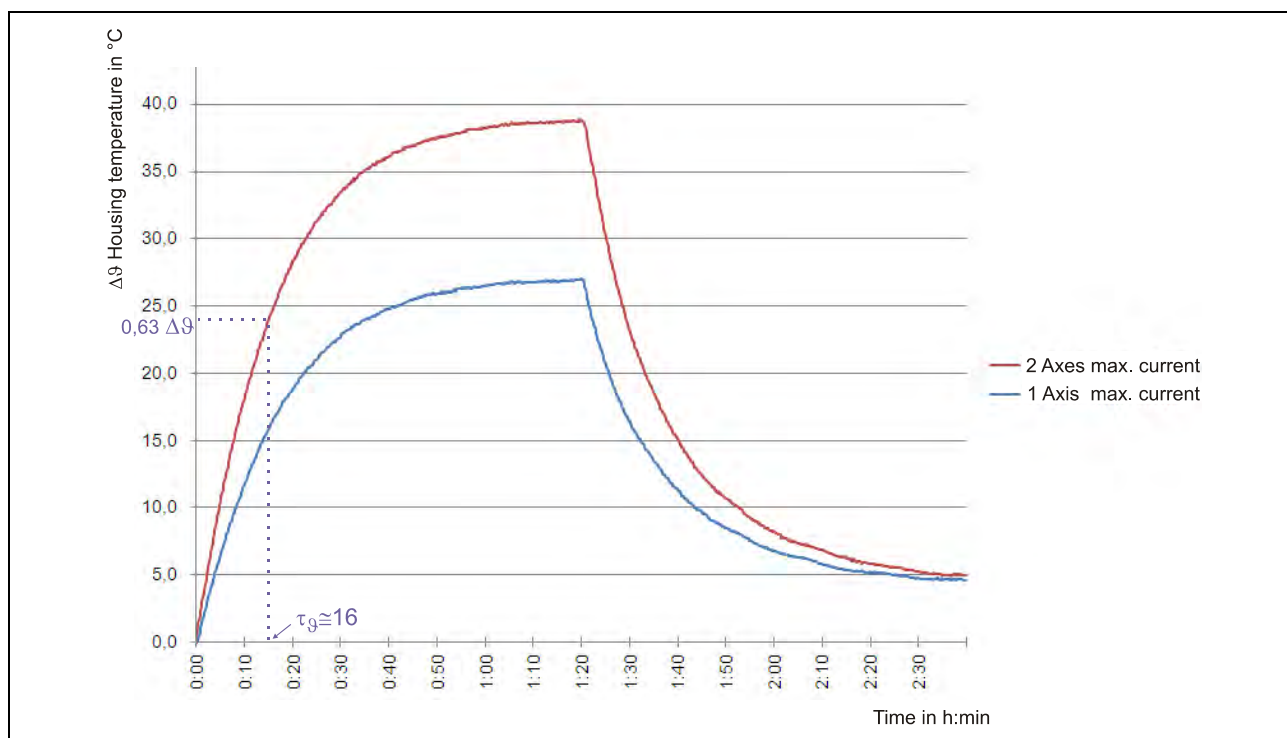**Normalized housing temperature, maximum current, 100% duty cycle**

Fig. 42: Heating curve for one/two axes operation and maximum current

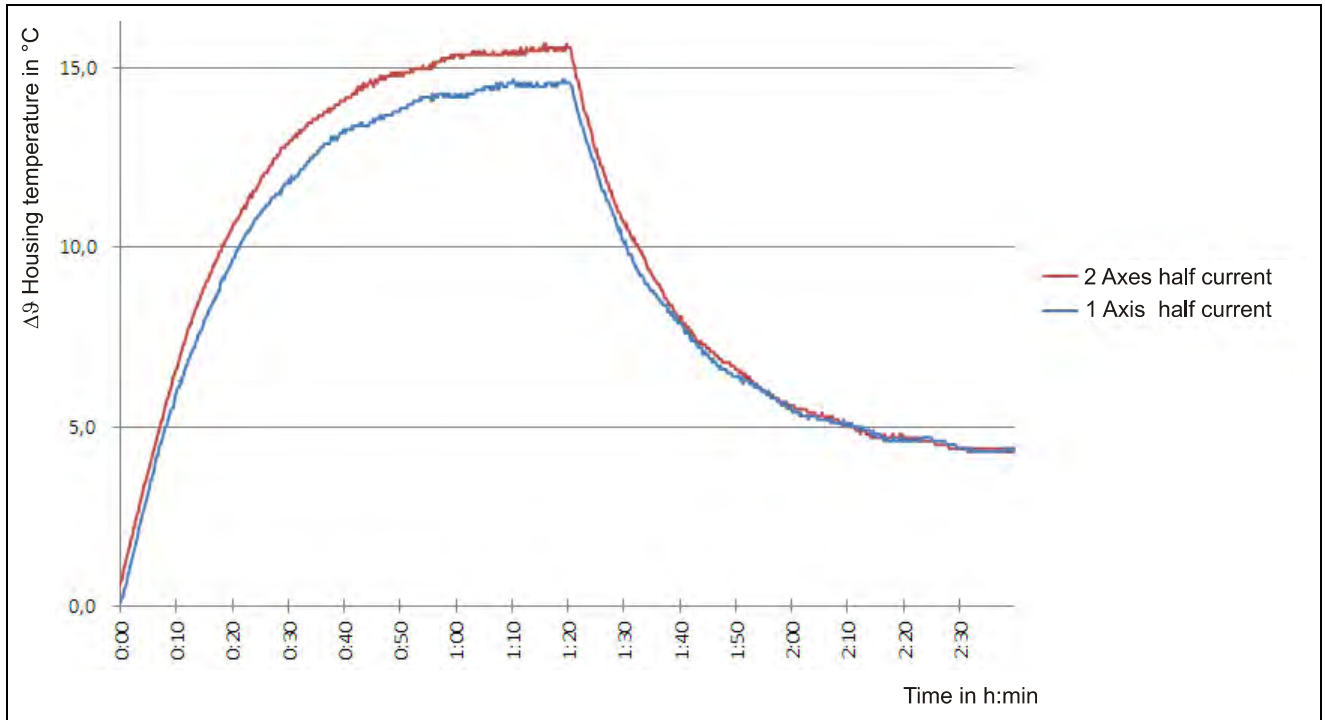## Normalized housing temperature, half current, 100% duty cycle

Fig. 43: Heating curve for one/two axes operation and half current

Normalized housing temperature, half current, 60% duty cycle
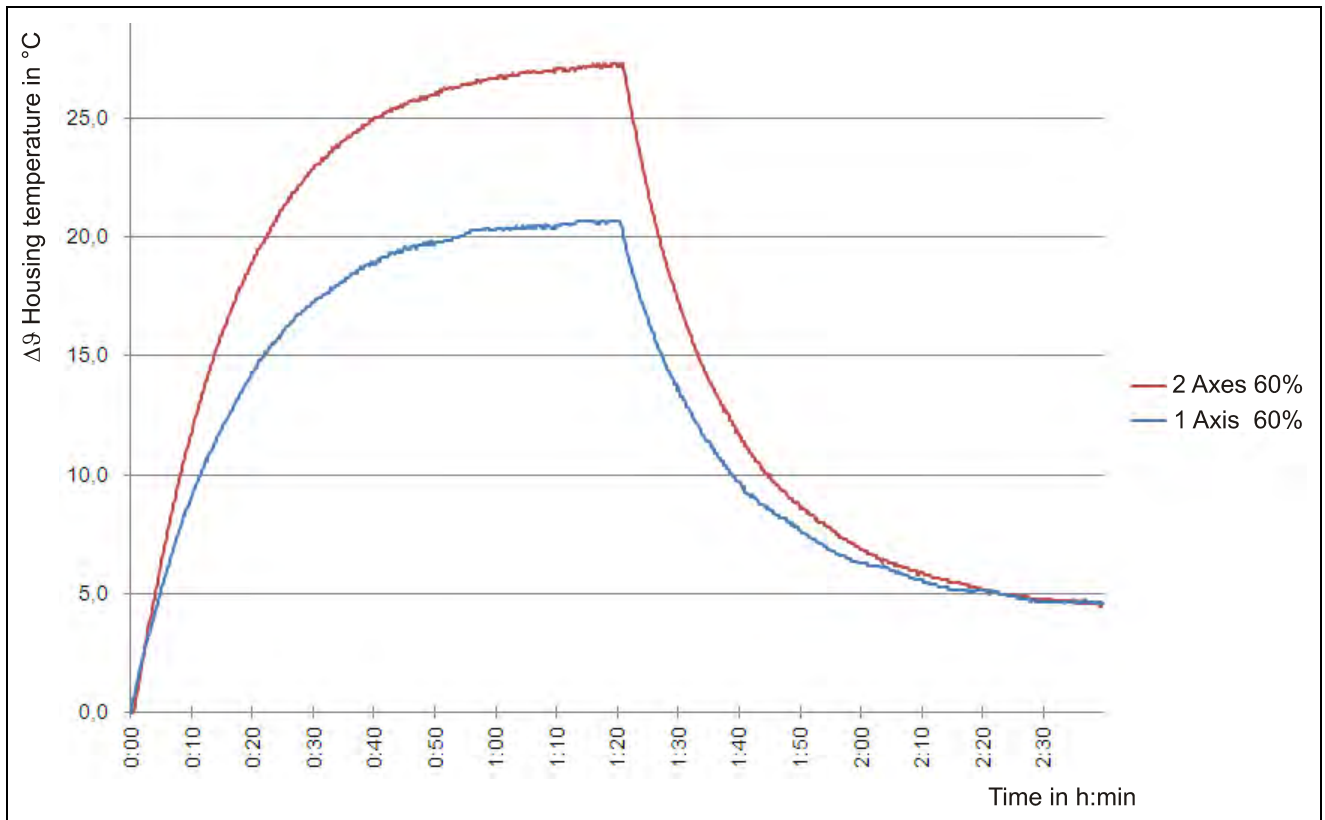

Fig. 44: Heating curve for one/two axes operation and 60 % duty cycle

10 Warranty, Trade Marks and Protective Measures

In this chapter warranty, trade marks and ESD protective measures are described.

10.1 Warranty

The MCC controllers are subject to legal warranty. Phytron will repair or exchange devices which show a failure due to defects in material or caused by the production process. This warranty does not include damages which are caused by the customer, as there are, for example, not intended use, unauthorized modifications, wrong treatment or wrong wiring.

10.2 Trade Marks

In this manual several trade marks are used which are no longer explicitly marked as trade marks within the text. The lack of this signs may not be used to draw the conclusion that these products are free of rights of third parties.

- MiniLog-Comm is a trade mark of the Phytron GmbH.

- Microsoft is a registered trade mark and WINDOWS is a trade mark of the Microsoft Corporation in the USA and other countries.

10.3 ESD Protective Measures

All the products which we deliver have been carefully checked and submitted to a longterm test. To avoid the failure of components sensitive to electrostatic discharge (ESD), we apply a great number of protective measures during manufacturing, from the component input check until the delivery of the finished products.

Warning:

Manipulation of ESD sensitive devices must be effected by respecting special protective measures (EN 61340–5). Only return the modules or boards in adapted packaging.

Phytron's warranty is cancelled in case of damages arising from improper manipulation or transportation of ESD modules and components.

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