CLD+

phytron

Linear Power Stage For Stepper Motor with Plain Text Display

Manual 2112-A002 GB

customized solutions in motion

CLD+

Linear Power Stage

for Stepper Motor

with Plain Text Display

TRANSLATION OF THE GERMAN ORIGINAL MANUAL

Phytron-Elektronik GmbH

Industriestraße 12

82194 Gröbenzell, Deutschland

Tel.: +49 8142/503-0

Fax: +49 8142/503-190

Every possible care has been taken to ensure the accuracy of this technical manual. All information contained in this manual is correct to the best of our knowledge and belief but cannot be guaranteed. Furthermore we reserve the right to make improvements and enhancements to the manual and / or the devices described herein without prior notification.

We appreciate suggestions and criticisms for further improvement.

Please send your comments to the following e-mail address: doku@phytron.de

You´ll find the updated version of this manual on the webside of www.phytron.de.

Contents

1 CLD+ Linear Power Stage

In this chapter you'll find a brief description of the CLD+ power stage, the extent of supply, the operation modes and the schematic diagram.

1.1 Short Overview

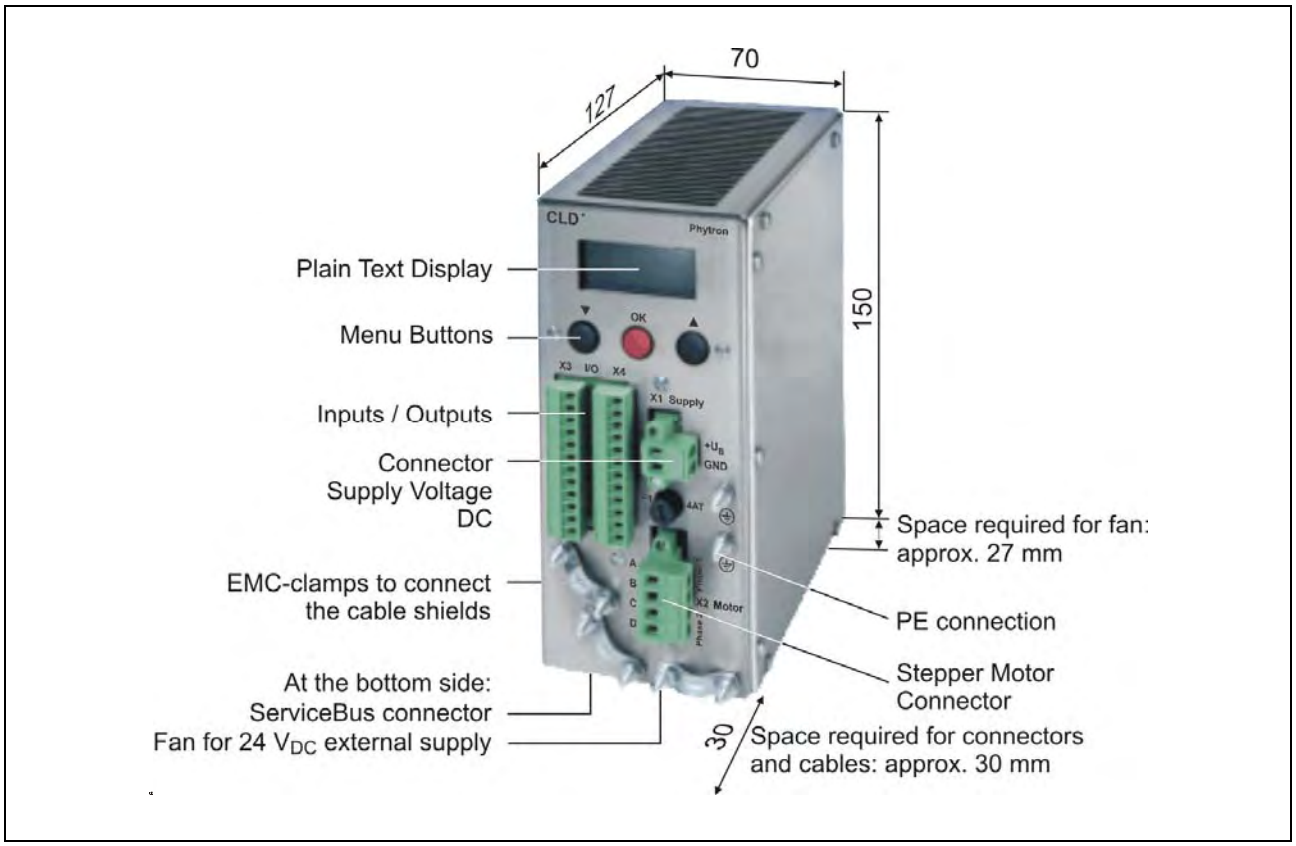


Fig. 1: Operator's control and dimensions (mm)

Ministep power stage for 2 phase stepper motors

The CLD+ is a linear power stage for 2 phase stepper motors for extreme low-noise applications. The source of current is constructed with power operational amplifiers which deliver load independent output currents.

The CLD+ is the preferred solution power stage for extreme applications (e. g. measuring applications), in which sensitive measures could be impaired by noise voltages. Due to the linear design, noise emissions are nearly negligible.

Phytron power stages with the addendum + are particularly service-friendly by the **ServiceBus** which enables configurating, operating and monitoring the power stage via PC. For easy use of all setting options, the free ServiceBus-Comm® for Windows® software is included in delivery.

The step resolution is entered by menu or by ServiceBus: full step to 1/512 step.

Motor currents from 0.14 to 2 A_{Peak}

Run, stop and boost currents can be individually programmed.

Supply voltage DC

A DC voltage with 20 to 50 V_{DC} can be connected to the supply voltage connector.
Rated voltage: 24 V_{DC}. A load capacitor is already included.

Inputs

Controlling via RS 422 push-pull driver ensures high immunity against disturbances.
Open-Collector controlling (OC) is also possible.

Plain text display 2 x 8 characters

Fig. 2: Plain text display with menu control buttons

- Menu-driven set-up of current values, step resolution and other parameters
- Display of actual parameters, test mode
- Display of currents, voltage and temperature
- Diagnostics: Low voltage or over temperature monitors.

ServiceBus

The ServiceBus offers the following possibilities:

- Power stage parameter programming:
  run, stop and boost currents, step resolution, preferential direction,
  current delay time,...
- Software configuration by USB connection,
  opto-decoupled from the motor supply
- Parameter memory for permanent storage of user-defined adjustments in the EPROM of the power stage.

The software ServiceBus-Comm® is able to program the power stage quickly and easily (See manual ServiceBus-Comm®).

Easy to mount and EMC compliant

- Rail mounting or wall mounting in the switching cabinet
- Easy installation by means of screw-type connectors
- Fully EMC compliant metal housing
- Integrated EMC filter for supply cable, motor lead filter
- 24V external fan mounted

1.2 Extent of Supply

The CLD+ is available in the following options (#: Ident number):

CLD+ with mating connector X1 to X4 and fan

- for rail mounting #10010115 (input level 5 V)
  #10010116 (input level 24 V)
- for wall mounting #10010117 (input level 5 V)
  #10010118 (input level 24 V)

Accessories:

- CLD+ manual
- Phytron CD with ServiceBus-Comm® software
- ServiceBus-Comm® manual
- ServiceBus instruction set manual

Supplementary parts are available:

- Fan type Papst 614 / 24 V_{DC} #02005791
- Rail mounting kit #02005659
- USB cable (connection A-B) 200 cm #10006881
- Power supply PS 5-48 (5 A, 48 V) for wall mounting #10006780
- Power supply PS 5-48 (5 A, 48 V) for rail mounting #10006148
- Power supply PS 10-24 (10 A, 24 V) for wall mounting #10006781
- Power supply PS 10-24 (10 A, 24 V) for rail mounting #10006578
- Mating connector set X1 to X4 #02005660:

Connector	Number of poles	Mating connector Phoenix	Ident number
X1	2	MSTB2,5/2-STF-5,08	#02005267
X2	4	IC 2,5/4-STF-5,08	#02005578
X3/X4	12	MC 1,5/12-ST-3,81	#02005576

1.3 Operating Modes

The CLD$^+$ can be used in 3 operating modes:

1.3.1 Operating Mode ‚Menu-Driven‘

All operation parameters are menu-driven with the input keys in the Setup menu. In the process the function **S-BUS=DISABLED** is defined.

1.3.2 Operating Mode ‚ServiceBus‘

The **S-BUS=ENABLED** in the Setup menu activates the ServiceBus mode and all settings are made by ServiceBus. The parameter values are shown in the CLD$^+$ display during the operation. It is not possible to change parameters with the input keys, acknowledged by **!S-BUS ENABLED** (see chap. 9).

1.3.3 Operating Mode ‚Bus Mode Exclusive‘

The ‚bus mode exclusive‘ ensures safe operation in ServiceBus mode. If the power stage is set to ‚Bus mode exclusive’ in the ServiceBus mode by ServiceBus-Comm (instruction code ‚PX’), all settings with the menu buttons are ignored.

Leaving the mode is only possible via ServiceBus by the ‚PX‘ instruction code.

1.4 Schematic Diagram

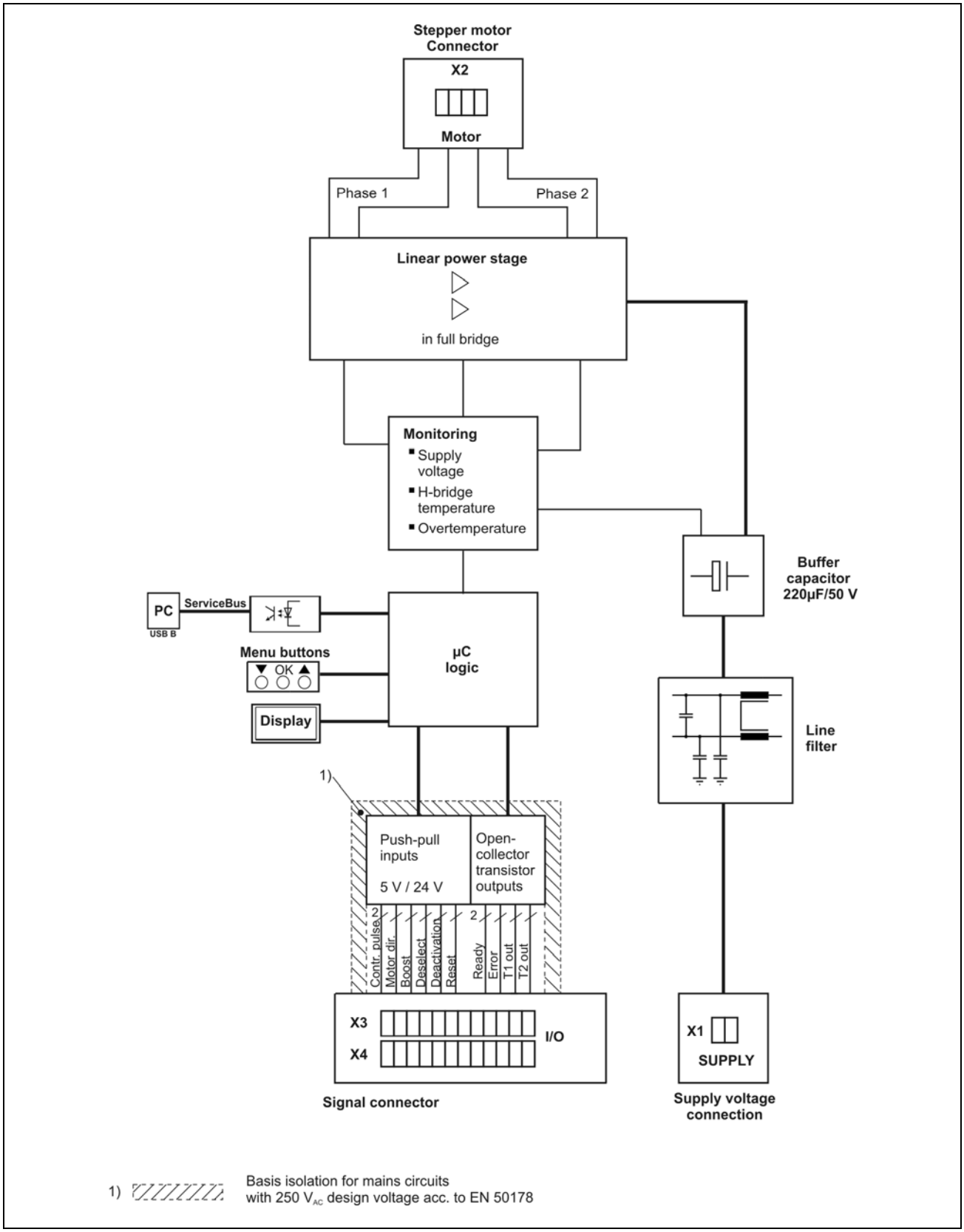


Fig. 3: Schematic diagram CLD+

2 Technical Data Table

Technical Data	
Default values of parameters	The power stages are set to the following values at delivery: Run current I-RUN 1 A Stop current I-STOP 0.5 A Boost current I-BOOST 1 A Preferential direction CCW Current delay time I-DELAY 40 msec Step resolution MINISTEP 1/20 Overdrive N/A Display contrast LCDCTR 30 No Temperature sensor TSENS NONE Temperature limit 1 TLIM1 60 °C Temperature limit 2 TLIM2 80 °C Temperature limit 3 TLIM3 100 °C Degassing D-GAS DISABLED No customer specific displays DISP-1 NONE DISP-2 NONE Password protection off Display: OK S-BUS DISABLED
Stepper motor	2-phase-stepper motors in 4, 6 or 8 lead-design with 0.5 to 2 A_{Peak} phase current Winding resistance < 10 Ohm Winding inductivity of a motor phase 0.5 to 10 mH
Step resolution	Step resolution is adjustable by Setup menu or ServiceBus: Full step, half step, 1/2,5, 1/4, 1/5, 1/8, 1/10, 1/16, 1/20, 1/32, 1/64, 1/128, 1/256 or 1/512-step
Phase currents	Run current, stop current and boost current are set independently in 0.1 A steps in the Setup menu by ServiceBus. Programmable values: 0.1 to 1.4 $A_{r.m.s.}$ Peak current 0.14 to 2 A_{Peak} Set phase currents appropiate to rated current of the motor winding! Settings on device delivery: 1 A run current, 0.5 A stop current and 1 A boost current

Technical Data	
Cable cross-section motor cable	Recommended: at least 0.2 mm². Dependent on the maximum current of the motor and the motor cable length it can also be used a smaller cable cross section.
Supply voltage	20 to 50 V_{DC} Rated voltage: 24 V_{DC} Rated current: 1.4 $A_{r.m.s.}$ (ambient temperature ≤ 40° C) max. phase current at 24 V_{DC}: 1.4 $A_{r.m.s.}$ at 48 V_{DC}: 0.7 $A_{r.m.s.}$
Transformer supply voltage	Base insulation for mains supply circuits with a rating of 250 V_{AC} acc. to EN 50178
Error message Under voltage	Supply voltage < 20 V_{DC}
Short circuit proof	CLD+ is short circuit proofed between the phases. At a supply voltage of about 24 V phase and housing are short circuit proofed. In case of a short circuit no deactivation of the power stage and no error message occurs.
F1 Fuse	4 A slow
Suitability of the device	The device is used for mounting in the switching cabinet. Dependent on the designated power supply and the applied rules other sites of operation are permissible.
Mounting	Rail mounting or wall mounting dependent on the mounting kit.
Minimum technical spaces	Minimum technical spaces with nearby devices: 30 mm Minimal free space over and under the CLD+: 100 mm Required space for connectors and cables: ca. 30 mm on the front side of the CLD+
Permissible ambient temperature	Operation: 5 to 50 °C Storage: –25 to +55 °C Transport: –25 to +50 °C
Ventilation	The CLD+ can be operated up to 50 °C ambient temperature with the fan (Papst 614, 24 V_{DC}), also with rated voltage and up to 1.4 A phase current, see chap. 4.2.
Weight	1.1 kg

Technical Data			
Connector at power supply cable	Phoenix Combicon connector, type MSTB 2,5/2-STF-5,08		
Connector at motor cable	Phoenix Combicon connector, type C 2,5/4-STF-5,08		
Connector at I/O cable	2 x 12 pole Phoenix Mini Combicon connector, type MC 1,5/12-ST-3,81		
Connector at ServiceBus cable	4 pole ServiceBus connector, type (A) DIN IEC 61076-3-107 (to PC) 4 pole ServiceBus connector, type (B) DIN IEC 61076-3-108 (to CLD$^+$)		
Wiring I/Os	Double or reinforced insulation for 160 V_{DC} against supply and motor voltage as well as against temperature sensor wires.		
Inputs	Inputs are opto-decoupled. Triggering by push-pull-drivers or open collector Input level 5 V or 24 V (depends on CLD$^+$ version)		
	Signal level	5 V	24 V
	High	3 – 5.5 V	20 – 30 V
	Low	< 0.4 V	< 3 V
	Necessary driver current	max. 10 mA (at 3 V)	max. 10 mA (at 20 V)
		max. 30 mA (at 5.5V)	max. 20 mA (at 30 V)
Control pulses	Maximum step frequency: 500 kHz Minimum pulse width: 1 µsec The step is done with the falling flank of the control pulse.		
Motor direction	When the optocoupler is energized, the motor rotates in the reverse direction. The direction of rotation signal should not be changed at least 1 µsec before the rising flank and after the falling flank of the control pulse!		
Boost	If the optocoupler is energized, the CLD$^+$ switches the current to the selected value for the Boost current.		

Technical Data	
Deactivation	If the optocoupler is energized, the motor current is deactivated.
Deselect	Pulse inhibit, when current flows through the optocoupler. If the input is **not** connected, the power stage is ready for work.
Reset	A reset causes resetting of all error messages. Waiting time after cut off the Reset signal: about 500 msec
Outputs	Opto-decoupled, type Open-Collector Darlington I_{max} = 20 mA, U_{max} = 30 V, UCE $_{sat}$ at 20 mA < 1 V
Ready	The CLD^{+} is ready to operate, if the output „Ready“ is closed (current is flowing). The input "Deactivation" must not be energized.
Error	The common error output opens in case of the following error signals: under voltage or over temperature. To avoid damages, the drive is deactivated at the same time.

3 To Consider Before Installation

Read this manual very carefully before installing and operating the CLD$^+$.

Observe the safety instructions in the following chapter!

3.1 Qualified Personnel

Design, installation and operation of systems using the CLD$^+$ may only be performed by qualified and trained personnel.

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

WARNING !

By persons without the proper training and qualification damages to devices and persons might result!

3.2 Safety Instructions

1. Please observe the earthing instructions chap. 6.3!
2. In case of supply voltages > 24 V:
   The CLD must only be operated if CLD$^+$ housing and motor housing are connected to protective earth.
3. The connectors SUPPLY and MOTOR should be locked with the fixing screws.

4. **Up to 3 minutes after turning off the supply voltage, dangerous voltages may still exist within the device.**
5. **Be careful handling the connectors „Motor“ at the CLD$^+$ and any motor cable coupling.**
   As long as the CLD$^+$ is connected to supply voltage, a hazardous voltage level is present at motor connector and motor cable, even if the motor is not wired.
6. **Up to 3 minutes after turning off the supply voltage, dangerous voltages may still exist at the CLD$^+$ connectors**.

7. Always switch off the supply voltage if you connect or disconnect any wires or connectors at the CLD+.
   Most important:
   Do not unplug the motor connector while powered.
   Danger of electric arcing.

8. Voltages connected to the signal inputs and outputs (X3, X4 connectors) should be safely separated from mains. The maximum voltage against protective earth must not exceed 60 V_{DC}.

9. Clearing the DEACTIVATION input or deselection with the DESELECT input or RESET is no protective separation in the emergency case.

   The voltage supply has to be interrupted for switching off the drive safely.

10. The surface of the CLD+ may reach temperatures of more than 70 °C.
    Danger of injury if touching the surface!

3.3 Protective Measure Options

The control unit must be operated by the protective measure PELV acc. to VDE 0100. The internal intermediate circuit voltage is connected to the motor housing. The line filter should not be bridged, therefore it **isn`t allowed** to ground the supplied voltage.

The housing of the CLD$^+$ **must** be grounded, the motor **can** be grounded (see Fig. 4).

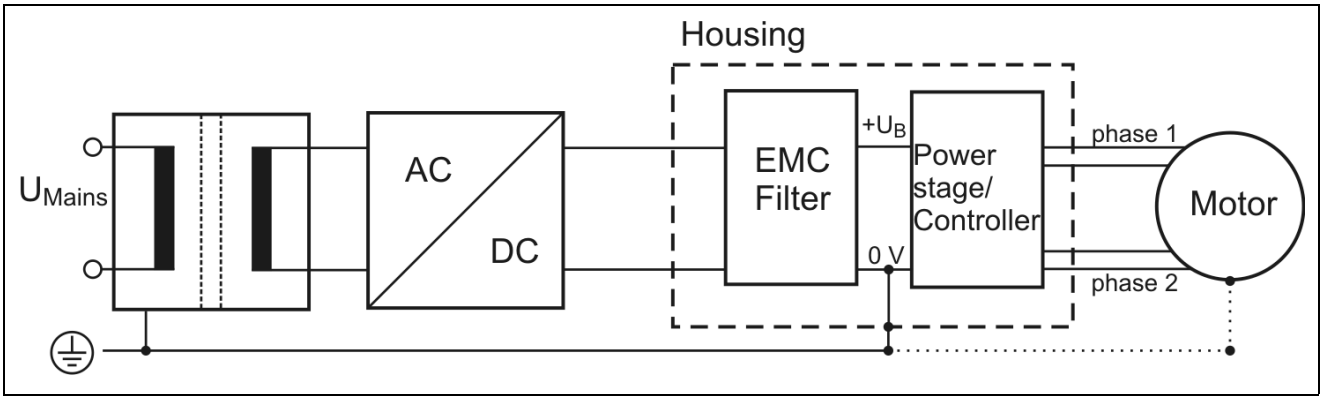


Fig. 4: PELV with SELV-Supply

Protective measure PELV for application of the $+U_B$ should not exceed 50 V_{DC} at dry environment (environmental conditions 3 acc. to IEC 61201).

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}).

4 Mounting

In this chapter you will find all information about mounting the CLD+ inside a switching cabinet, cooling and supply of the fan.

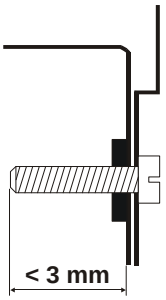
4.1 Mounting Instructions

- The CLD+ has been designed to be mounted inside a switching cabinet. Depending on operating voltage and applicable standards, other environments can also be permissible.
- The CLD+ should be vertically mounted.
- Mount the CLD+ device at a plane surface with appropriate load capacity (device weight is about 1.1 kg).

  Use the mounting kit delivered with the device for rail mounting or wall mounting.

  You may also use the mounting threads in the device's back plate for individual mounting solutions.

- The mounting screws used must intrude not more than 3 mm into the device inner parts!



- Recommended free space below and above the device: 100 mm
  Keep the air slots free to allow a convective air exchange!
- Recommended free space to other devices besides the CLD+: 30 mm.
- Recommended free space for cables and connectors before the front plate of the device: 30 mm.
- The device has to be mounted and operated at a place free of shocks and vibrations.

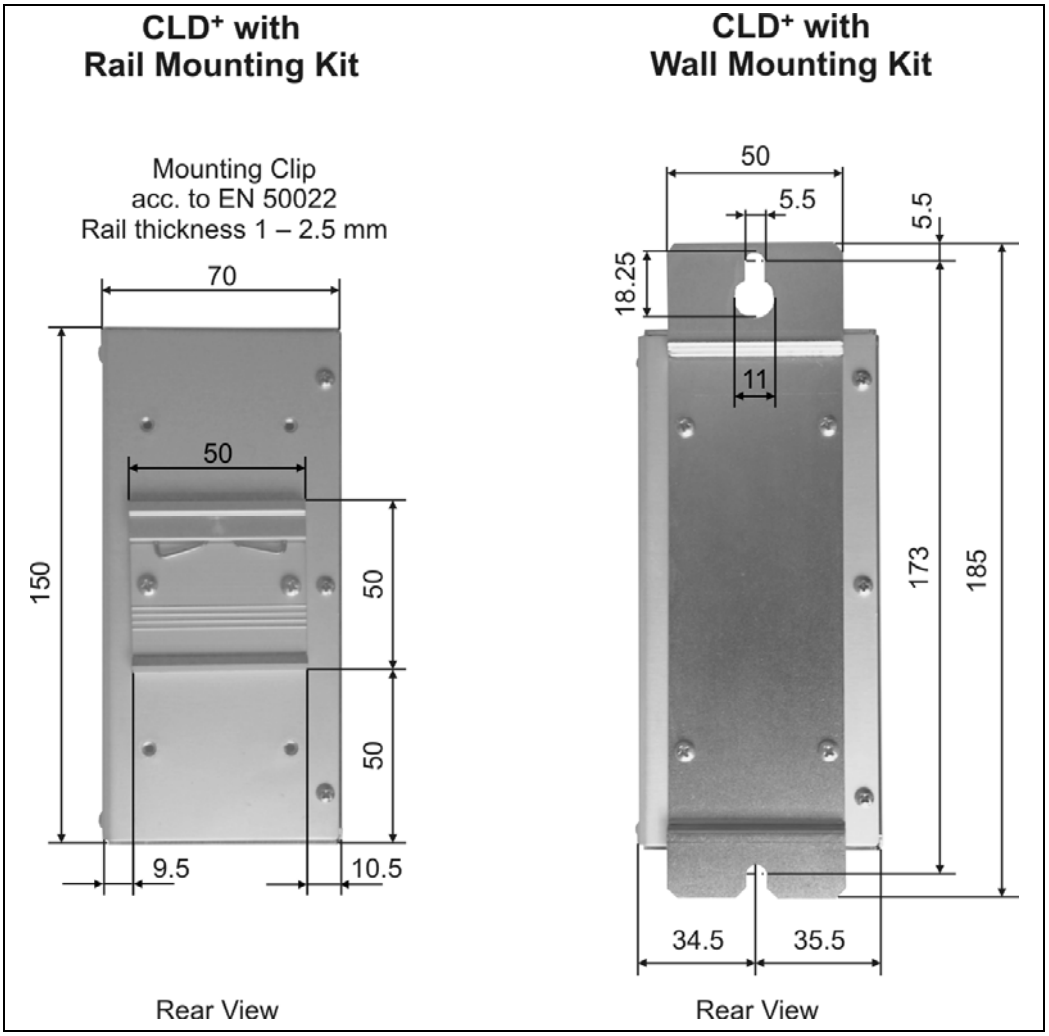


Fig. 5: Mountaing kits

4.2 Temperature and Cooling Air Flow

If mounting several CLD+ devices one upon another be sure that the requirements for cooling air are met also at the topmost air inlet:

- The heat production in the CLD+ devices proportionally depends on the motor current used. It can be maximum 85 W at a rated voltage of 24 V.

- The maximum permissible ambient temperature depends on the phase current and cooling air flow follows from the de-rating diagram (see below).

- The CLD+ can be operated without an external fan with motor currents up to about 0.4 Amps, even at an ambient temperature of 40 °C.

- Using an external fan (Papst type 614 operated at 24 V_{DC}) the CLD+ can be operated with 1.4 Amps phase current at a rated voltage of 24 V and an ambient temperature up to 50 °C.

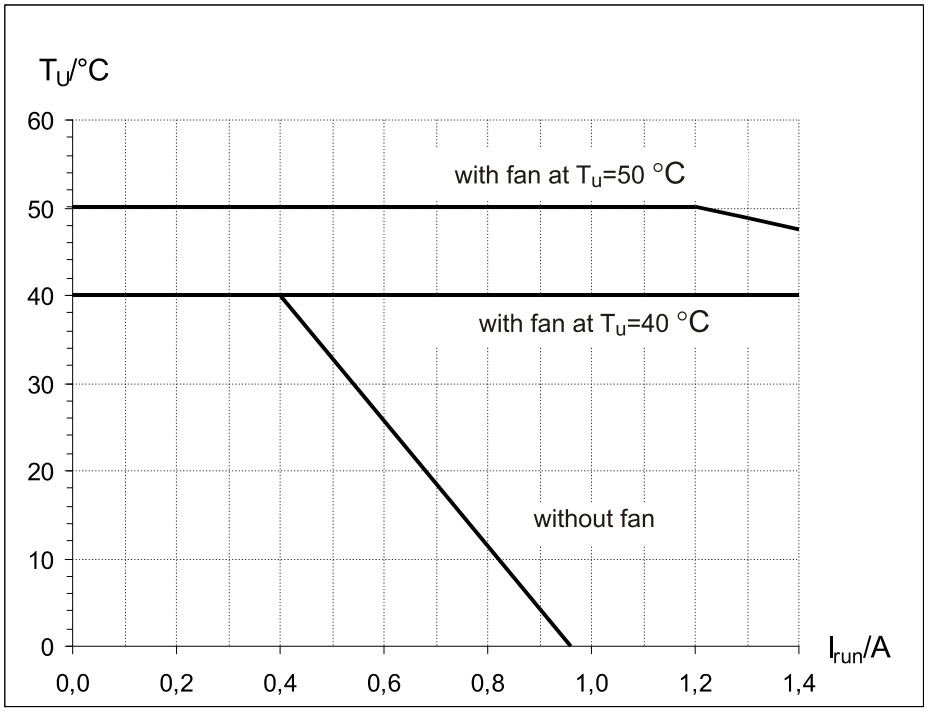


Fig. 6: Derating

Technical Data of the fan:

The mounted fan must have a 24 V_{DC} power supply.

Type Papst 614

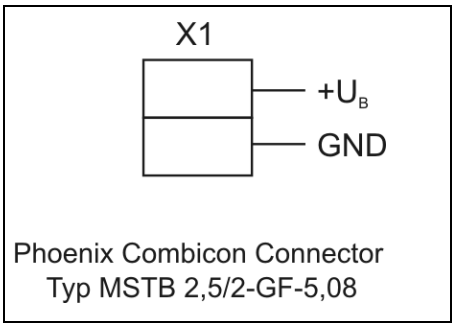
Air flow 40 m^3/h

External power supply 24 V_{DC}

5 Power Supply

The following chapters give information about the power supply of the CLD+ with DC and about current set up. The supply voltage has to be connected to the X1 connector „Supply“.

5.1 Connector „Supply“



Permissible power supply range: 20 to 50 V_{DC}

Rated voltage: 24 V_{DC}

Warning:
Don´t ground the supply voltage!

Fig. 7: Connecting the power supply voltage

We recommend fixing the supply cable with the strain relief clamps.

5.2 Accessories: PS 10-24 Power Supply Unit

The power supply unit PS 10-24 provide 10 A / 24 V_{DC} for the supply of the CLD+. Depended on the load, the power supply unit is able to provide several devices.

PS 10-24 are connected straight to the power supply voltage 230 or 115 V_{AC}.

The power input is protected internally, the output is save against continuous short circuit. Save working is possible because of protective over temperature and over voltage and power failure bridging.

The power supply unit can be mounted by rail mounting in the switching cabinets.

See PS 10-24 manual.

5.3 DC Power Suppy

Acceptable supply voltage range U_B : 20 V_{DC} to 50 V_{DC}

Rated voltage: 24 V_{DC}

Maximum phase current at 24 V_{DC}: 1.4 $A_{r.m.s.}$
at 48 V_{DC}: 0.7 $A_{r.m.s.}$

U_B should be a SELV voltage acc. to VDE0160 or EN50178.
U_B must not be grounded and must be safely separated from mains supply.

The power consumption at 24 V rated voltage can be between 7 and 85 W.

The supply voltage must **not** drop under 20 Volt not even for a very short period (≥ 10 ms). The CLD+ would recognize this as a low voltage error condition and switch off.

There is no reverse battery protection.

Trouble signals on the supply lines are suppressed by an input filter. Behind the input filter, there is a 2200µF / 50V capacitor for a sufficient buffer action of the supply voltage.

The DC supply voltage U_B must not be grounded because the compensating choke in the CLD+ would be bypassed. In this case, the mains reaction limited values couldn't be observed.

The mounted fan must have a 24 V_{DC} power supply.

5.4 Current Setting

Run current, stop current and boost current can be set individually in steps of 0.1 A.

Set up currents correctly fitting to the motor winding's design current!

Current range: 0.1 to 1.4 $A_{r.m.s.}$
Peak current resulting: 0.14 to 2 A_{Peak}

Select a high step resolution at currents > 1.0 $A_{r.m.s.}$ (at least 1/5 step).

Factory default settings of the CLD+:
Run current: 1 A
Stop current: 0.5 A
Boost current: 1 A

The **maximum current consumption** depends on the phase current selected. At supply voltage 24 V nominal the drawing of current is between 0.3 and 3.5 A.

6 Motor Connection

The following chapter gives a description of how to wire different types of 2-phase stepper motors.

CLD$^+$ stepper motor controllers may be connected to stepper motors with 0.5 to 2 A_{Peak} phase current.

The stepper motor winding resistance should be less than 10 Ohm for full power.

The winding inductivity of one phase should be less than 10 mH.

When using motors without basic isolation between motor winding and housing, the maximum admissible supply voltage $U_B \leq 37\ V_{DC}$.

When operated with U_B= 37...50 V_{DC} the motors should have 40 $V_{r.m.s.}$ (or û = 57 V) basic isolation design voltage (acc. to VDE0160 or EN50178).

Stepper motors with 8 leads can be connected with the windings wired in parallel (1) or serial (2).

The wiring scheme (3) with serial windings is recommended for the 6-lead stepper motors.

If wiring scheme (3) cannot be used because of the motor construction, the motor may be operated with only two of the four windings energized according to wiring scheme (4). Stepper motors with 4, 6 or 8 leads can be connected to the controller.

5-lead stepper motors must **not** be connected to the CLD$^+$.
Connecting a 5 lead stepper motor **might damage the CLD$^+$**.

Please compare the motor data of the stepper motor with the adjusted current.

6.1 Motor Connector

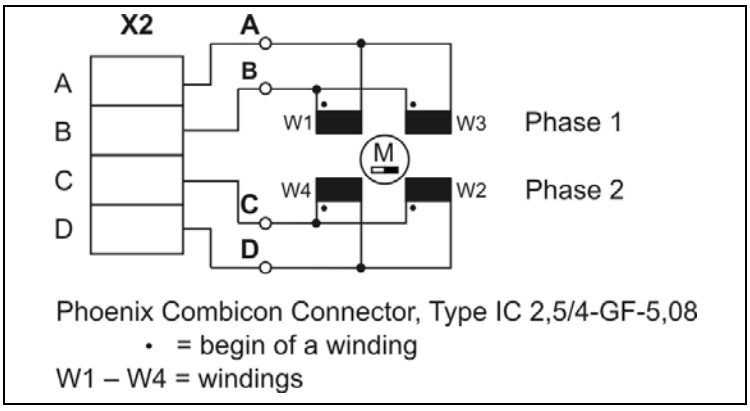


Fig. 8: X2 Motor connector

6.2 Wiring Schemes

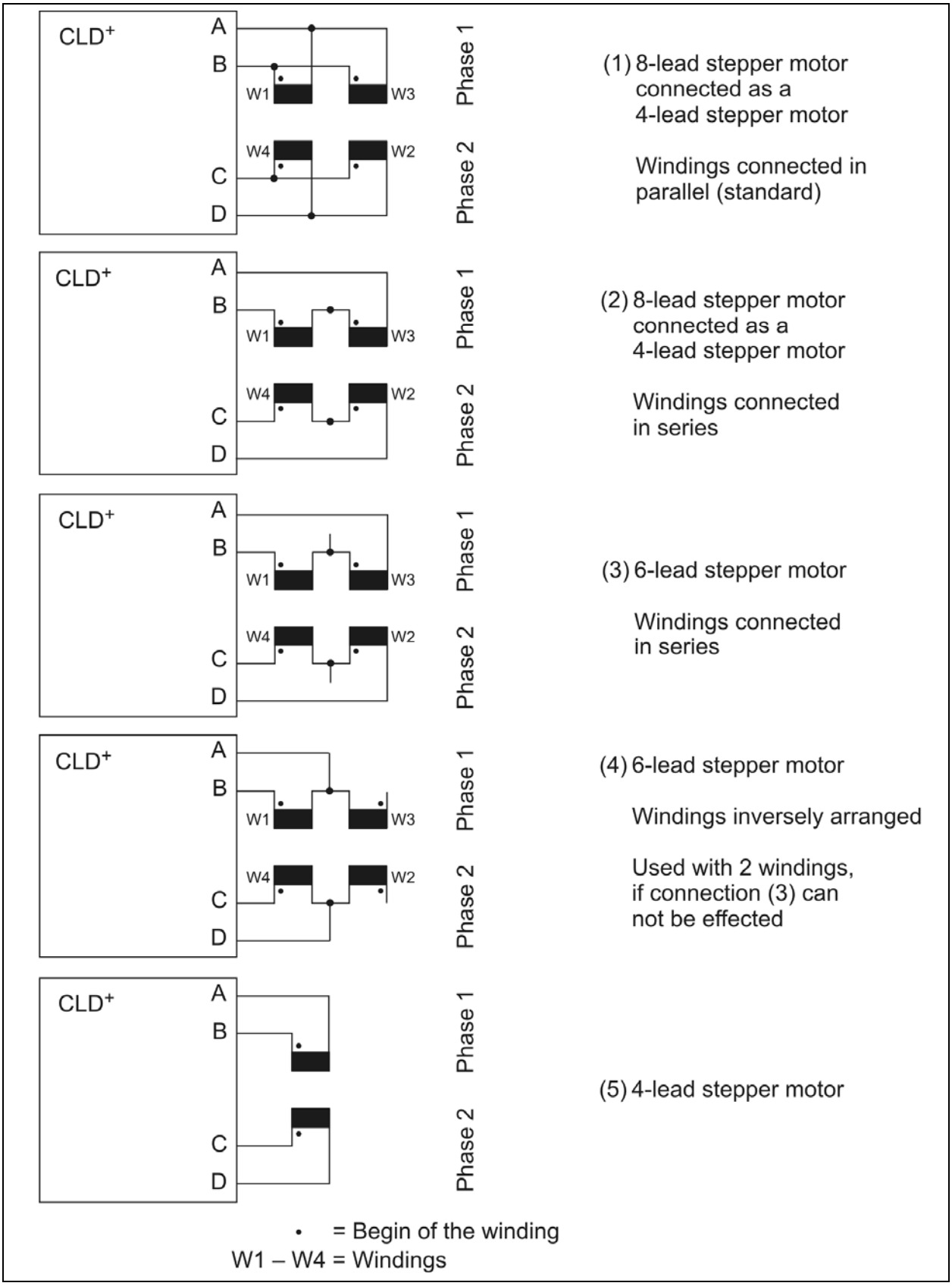


Fig. 9: Connection diagrams for 4, 6 and 8 wire stepper motors

6.3 Motor Cables

We recommend to wire the stepper motor with a 5-lead cable with shielding mesh. For optimum electromagnetic compatibility (EMC), the cable should not be interrupted by additional connectors or screw terminals.

Recommended minimum cable cross section: 0.2 mm²
(0.1 mm² per Ampere motor current)

The protective earth wire (green/yellow) of the motor cable should be connected to the earthing screw near the CLD$^+$ motor connector. At the other motor cable end, the green/yellow wire should be connected to the motor's earthing screw.

The phase currents are leaded outside through a motor lead filter to damp the logic's high frequency noise signals. So the noise emission on the motor cables is nearly neglectable.

For best electromagnetic compatibility (EMC) , you must connect the shielding mesh to the CLD$^+$ housing. Use the cable clamps at the front side. Free cable ends must be as free as possible.

The shielding mesh must also be connected on a large surface to the motor housing. Use EMC-type conduit fittings. All parts of the motor must be conductively connected with each other.

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.

Important:
Motor leads not used should be insulated separately
(important if using wiring scheme 3 or 4)!

If the motor is connected in the required way, the fault-free operation is assured according to EN 61000-6-1/2.

The manufacturer of the equipment/machine is responsible for the adherence to limit values, required by the EMC legislation.

7 Input and Output Connectors

The X3 and X4 I/O connectors are used to connect the CLD+ with digital process control signals.

Warning:
Please check the input level of the CLD+ – 5 V or 24 V – corresponding to the controller!

7.1 Signal Connector

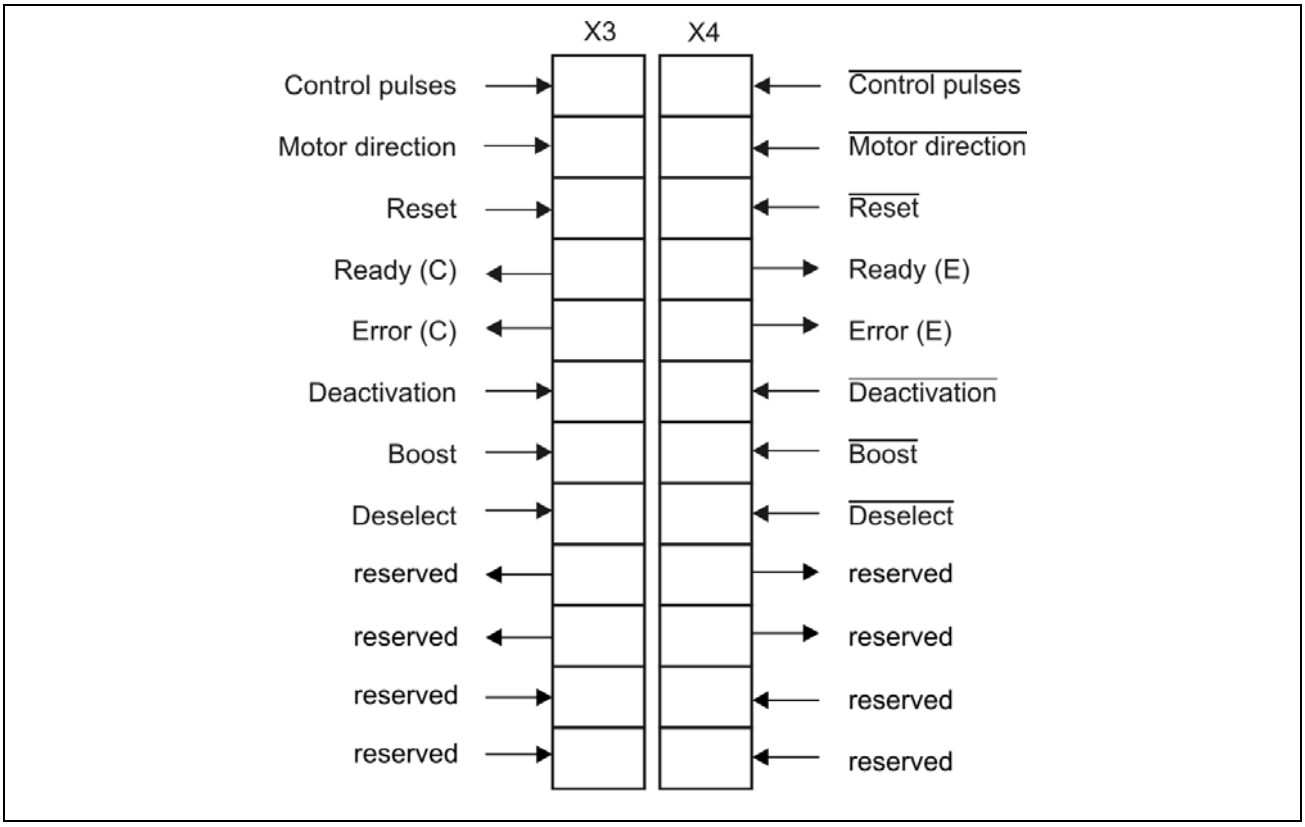


Fig. 10: I/O signal connectors

7.2 Inputs

The inputs Control Pulses, Motor Direction, Reset, Boost, Deactivation and Deselect are optically insulated from the motor supply voltage by optocoupler. This assures best noise suppression between control and power circuit.

The signals are active, when current flows through the optocoupler. The controlling via push-pull driver confers optimum suppression of disturbances, because always the current flows. Especially in case of long leads this kind of controlling should be preferred.

The input level is 5 V or 24 V depending on the CLD$^+$ version.

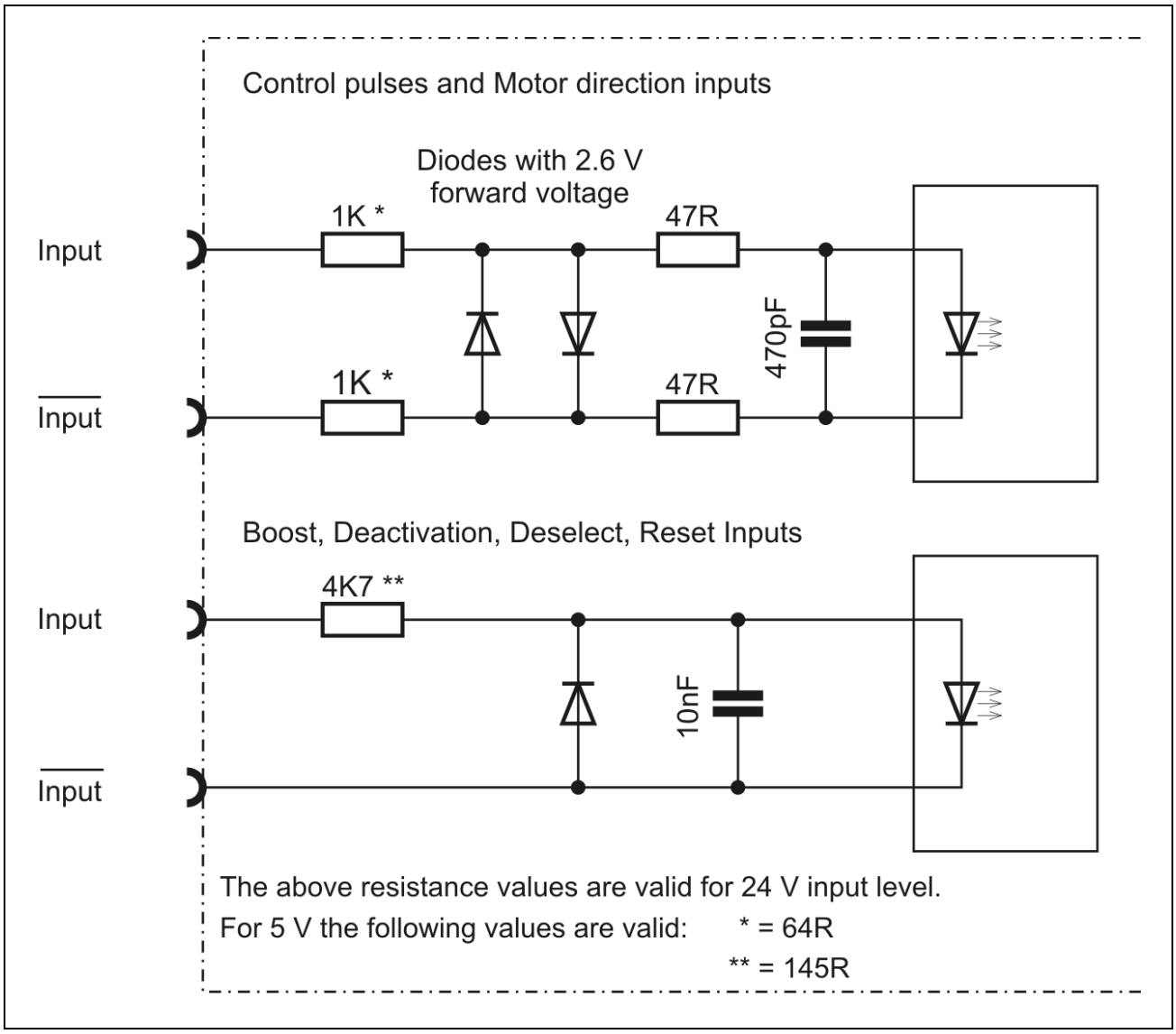


Fig. 11: Input wiring diagram

7.2.1 Push-Pull- or Open Collector-Controlling

We recommend to control the CLD+ inputs by push-pull drivers. This confers optimum suppression of disturbances.

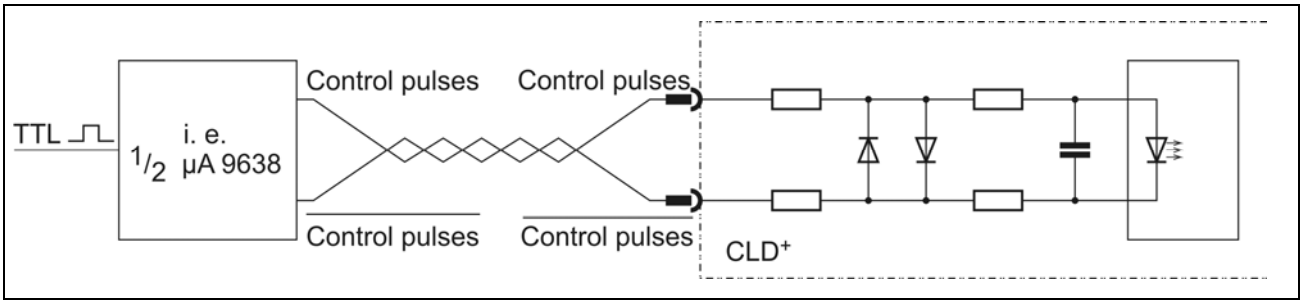


Fig. 12: Push-pull controlling

Alternatively a controlling via open-collector is possible.

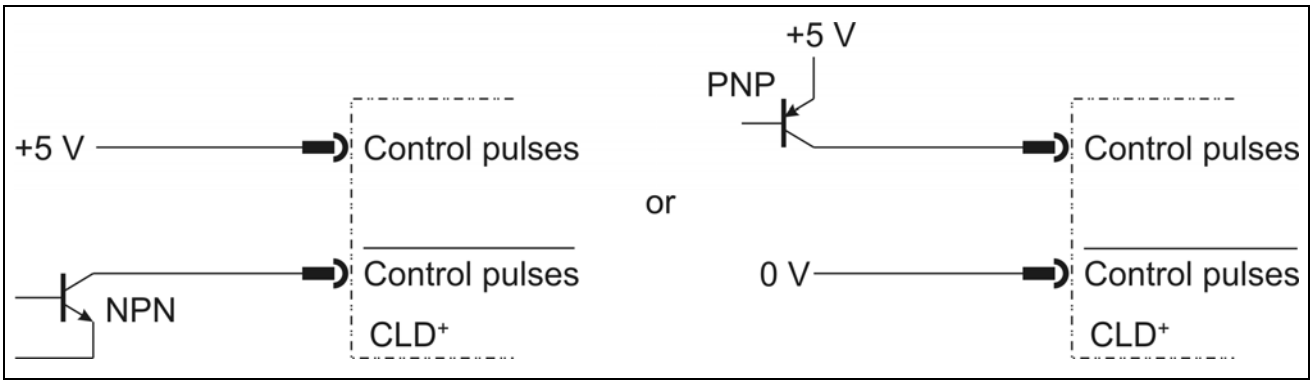


Fig. 13: Open-Collector controlling

7.2.2 Logic-Level 24 V or 5 V

CLD+ power stages are available in two versions with input level 5 V or 24 V.

The input level can also be changed subsequently on demand.

Signal level	**5 V**	**24 V**
High	3 – 5.5 V	20 – 30 V
Low	< 0.4 V	< 3 V
Necessary driver current	max. 10 mA (at 3 V)	max. 10 mA (at 20 V)
	max. 30 mA (at 5.5 V)	max. 20 mA (at 30 V)

7.2.3 Control Pulses

Maximum pulse frequency: 500 kHz

Minimum pulse width 1 µs

The step is done with the falling flank of the control pulses signal.

The control pulse sequency must not suddenly start or stop, if the control pulse frequency is higher than the start/stop frequency[1] of the motor. Mispositioning of the drive would be the result.

If the motor is to be operated above the start/stop frequency range, the indexer has to generate frequency ramps to accelerate and decelerate the motor.

Current delay time

After the last control pulse the stop current is activated after a waiting time. The waiting time after the last control pulse until the changing to the stop current is called current delay time. The current delay time can be set in the Setup menu, the default value is 40 msec.

Warning:
As long as the Boost input is energized, the motor current will **always** be the Boost current.
Although no control pulses arrive, the stop current is **not** activated!

7.2.4 Direction

If the input optocoupler is powered, the selected motor direction of rotation is reversed. Don't change the signal 1 µsec before the rising flank and after the falling flank of the control pulses!

7.2.5 Boost

If the input optocoupler is energized the CLD$^+$ sets the current to the selected value for the Boost current. Therefore it is possible, to set a Boost current, which is higher than the run current.

Thus, a higher torque can be reached during the acceleration and deceleration time of the motor.

As long as the Boost input is energized, the motor current will **always** be the Boost current. **No change to the stop current!**

[1] The start/stop frequency is defined as that frequency, from which a stepper motor can start from standstill without losing a step. Typical values for the start/stop frequency are 200 to 2000 Hz. The exact value depends on the load torque and the load inertia on the motor shaft.

7.2.6 Deactivation

If the input optocoupler is energized, the motor current is switched off.

This input is useful, for instance, during maintenance operations to switch the power stage off, without having to disconnect it physically from the mains. It is possible now to rotate the motor by hand slowly.

WARNING!

The „Deactivation“ input is not on conformance with the professional emergency stop circuit requirements!

7.2.7 Deselect

If the input optocoupler is energized, the pulse inhibit is active.
If the input is not connected, the CLD+ is ready for work.

7.2.8 Reset

If the input opto coupler is energized, all error signals are reset and the monitoring circuits are initialized.

After cut-off the reset signal, the power stage enables the ready signal after approximately 500 msec.

Remark:
Reset can also be activated by the menu item **RESET** in the Setup menu.

7.3 Outputs

Open-Collector-Darlington outputs insulated by means of optocoupler

I_{max} = 20 mA, U_{max} = 30 V, UCE_{sat} at 20 mA < 1 V

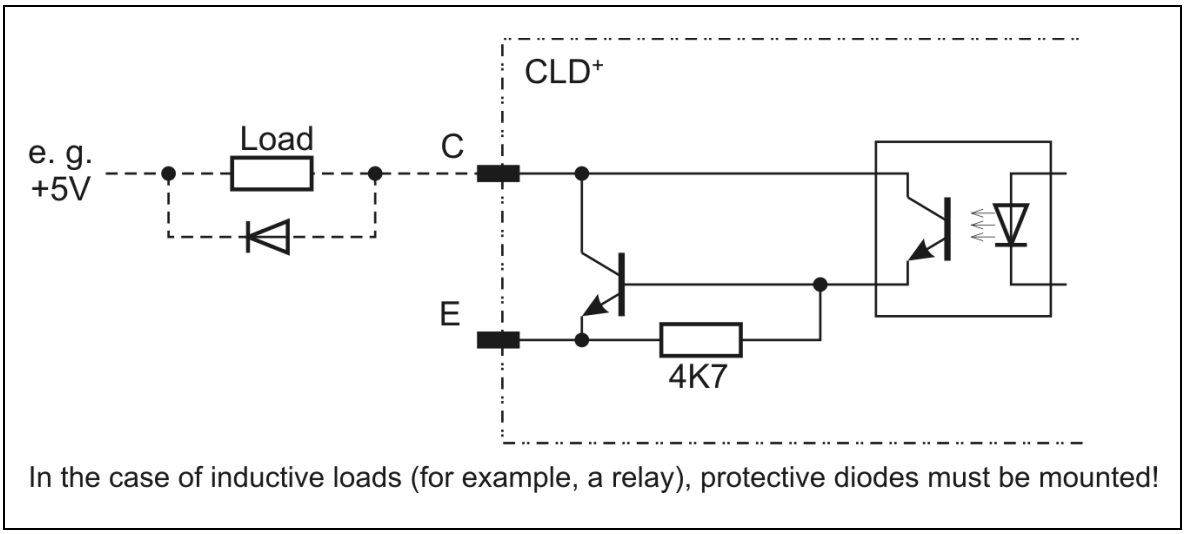


Fig. 14: Output wiring diagram

7.3.1 Ready

The CLD+ is ready, when the output „Ready“ is activated (current is flowing). The power stage should be activated, that means that the input „Deactivation“ should be powered off. See also chap.7.2.6.

7.3.2 Error

This output opens at the error messages: under voltage, over current / short circuit, over temperature. At the same time the drive system is deactivated to avoid damages.

An error message can be reset after error elimination or cooling. For this the menu item RESET should be selected in the test menu and verified with OK. The CLD+ can also be reset by the input Reset.

After cut-off the reset signal, the power stage will enable the ready signal after approximately 500 msec.

Under voltage

The under voltage identification starts as soon as the supply voltage drops under 20 V.

This error message can also occur if an external supply voltage of +24 V breaks down under load for a short time.

Over temperature Power Stage

The temperature at the heat sink of the power transistors reaches the limit value (≥ 85° C). At the same time the power stage is powered off.

8 The Menu

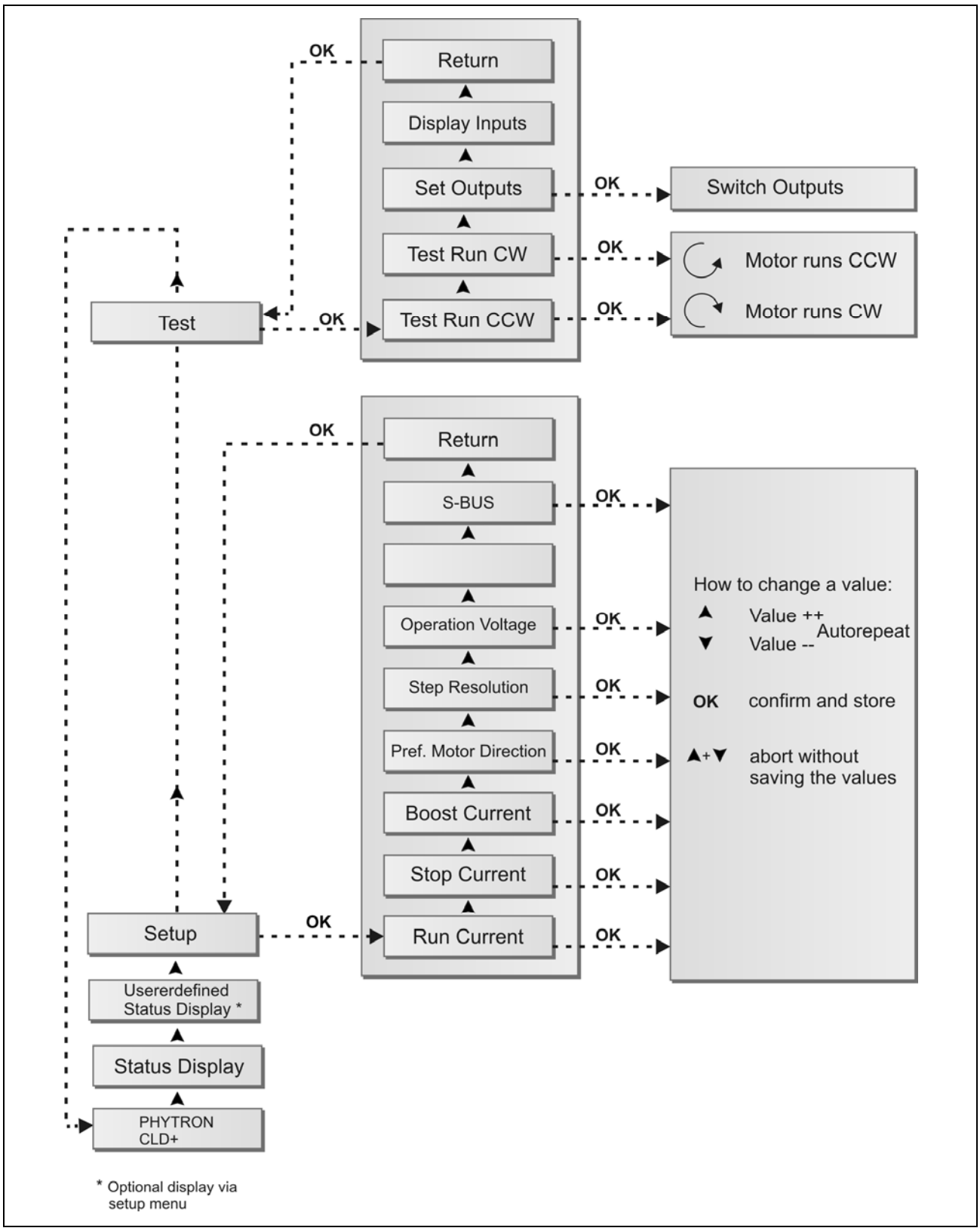


Fig. 15: Structogram of the menu

8.1 Menu Function Test

Read the safety instructions in chapter 3.2 before installing the CLD+.

1. First connect **only the current supply**.
2. Set the motor currents in the Setup menu, see obove. Excessively high motor currents may overheat or damage the motor windings.
3. Power off the device.
4. Connect the stepper motor.
5. Switch on the power supply of the CLD+.
6. Test the menu functions shown in Fig. 15 and the stepper motor should turn. These functions can be done without connecting a superior control.
7. Mount the CLD+ in the switching cabinet for operation (chap. 4)
   Control pulse- and direction signals have to be connected at least (chap. 7).

8.2 Main Menu

After turning on the supply voltage, the following text will appear in the LCD display: **PHYTRON CLD+**. With the button ▲ and ▼ of the menu all items of the upper menu level can be selected: Status display, Setup, Test, customer specific status displays.

Changes of parameters during motor operation cause the display message **! MOTOR RUNNING**.

Menu display	**Meaning**
Status display	This stop current flows, when a stepper motor is connected. If the stepper motor runs, the run current or the boost current is displayed. Before connecting the stepper motor the motor currents must set to fitting motor values ! → Setup
Customer specific Status display	Two additional Status displays in the main menu: **DISP 1** and **DISP 2** In the Setup menu you can select the parameters to be displayed. **I + U** = motor current (reference value) + supply voltage **I + M** = motor current (reference value) + motor current (actual value) **I + T** = motor current (reference value) + power stage temperature **TEMP** = power stage temperature + motor temperature

8.3 Setup

Changing the operating parameters:

1. The sub menu for positioning is activated by the button OK.
2. Changing the value with the buttons: ▲ (higher) or ▼ (lower).
3. The value is confirmed and the sub menu quitted by OK.
4. Interrupting the edit mode: press the buttons ▲ and ▼ in one operation.

The display of power stage temperature, motor voltage and software version can be activated in the Setup menu.

N/A= not available

8.3.1 Menu Items in the Setup Menu

With the buttons ▲ and ▼ you can scroll up and down from item to item:

Menu item	**Meaning**
I-RUN = x.x A **I-STOP = x.x A** **IBOOST = x.x A**	Setting of run-, stop- and boost current in $A_{r.m.s.}$
IDELAY	Current delay time in msec It is a proved method to keep to the run current level for a short time after the last step pulse arrived, and after that reduce to stop current level (s. Appendix A3).
DEFDIR	The motor turns in preferred direction of rotation **DEF**inition **DIR**ection, if there is no direction signal to change the direction. **CW** = clockwise **CCW** = counter clockwise
MINIST	Setting of the step resolution **MINIST**ep **FULL** = Full step, **HALF** = Half step, **1/2.5** step, **1/8** step, **1/10** step, **1/16** step,..... **1/256** step, **1/512** step
OVERDR	Overdrive function: **N/A:** not available
PSTEMP	Display of the power stage temperature in °C
VOLT	Display of the motor current in V
LCDCTR	Display contrast from 0 to 100 in steps of 5 (e.g. 5 = miner contrast, 90 = higher contrast)

TSENS[1]	**N/A**
TMOTOR[1]	**N/A**
TLIM1,TLIM2,TLIM3[1]	**N/A**
DEGAS[1]	**N/A**
DISP1,DISP2	Customer specific status display **NONE:** No item is selected. A list of display parameters, from which you can select; a list of display parameters appears, from which you can select: **I + U** = Motor current (reference value) + operating voltage **I + M** = Motor current (reference value) + Motor current (actual value) **I + T** = Motor current (reference value) + power stage temperature **TEMP** = power stage temperature (TE) + motor temperature (TM) Enter OK to confirm the input. The selected parameters, for example motor current and power stage temperature can be displayed permanently on the main menu. **NOSENS:** the display motor temperature is set, although no temperature monitoring module is built-in
PASSWO	Lock the Setup and test menu and prevent unauthorized access If OK is pressed, the letter **A** appears on display. If you want to inhibit the access, confirm with OK. For allowing again the access, select the letter **P** and confirm with OK. **PASSWO FALSE** is on display, if an inaccessible menu item is selected.

[1] provided for further development: connection of a temperature sensor

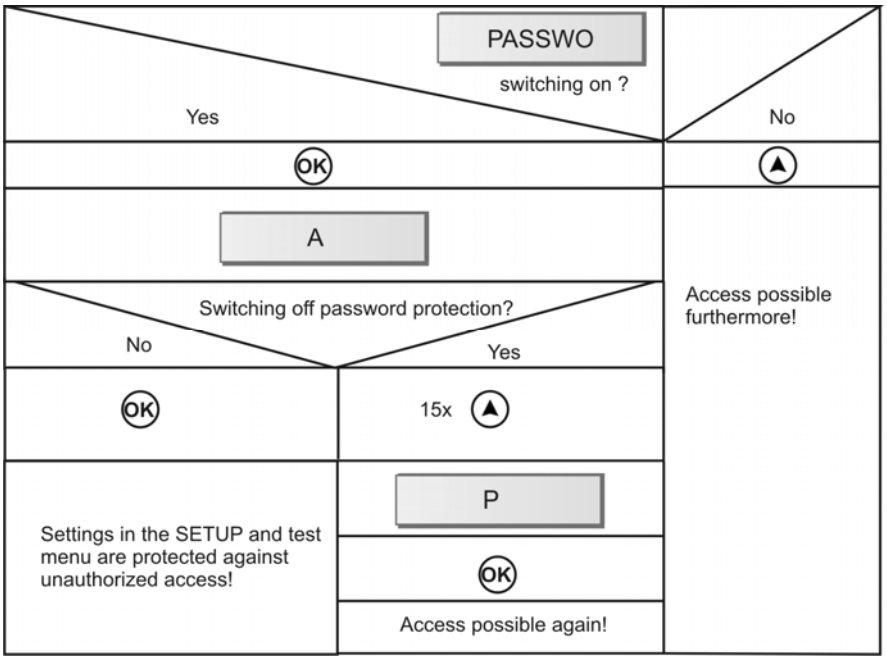
S-BUS	Activation of the operation mode **ServiceBus** **ENABLED:** ServiceBus on. The operating parameters can **only** be regulated by ServiceBus-Comm. The adjusted parameters and status values are shown on the CLD+ display. **Remark:** If the power stage is set to **bus mode exclusive** in the ServiceBus mode, all settings are ignored at the menu buttons. The ServiceBus mode can only be deactivated by the ‚PX' instruction code. **DISABLED:** ServiceBus off. The operating parameters are configured by the menu driven input.
SW-V.	The actual version number is shown.
RETURN	The last menu item in the Setup menu.

= Values **only** shown on the display

Return to menu item run current by ▲. If you confirm with OK, the Setup menu is quitted.

8.3.2 Password Protection

If the password protection is activated, the settings in the Setup menu and the test menu are protected against unauthorized access.
PASSWO FALSE is on display, if an inaccessible menu item is selected.



8.4 Test

The menu item **TEST** contains several sub menu items, which can be selected with the arrow buttons.

Menu item	Meaning
TESTCCW **TESTCW**	Test run: A connected stepper motor turns (slowly) by pressing OK key. The motor turns, as long as OK is pressed. **CCW** counter clockwise **CW** clockwise
TESTOUTputs	Display and edit the **Output status** e.g.: **e R t2 t1** Small letter: output not set Capital letter: output set In our example: **e** = Error not set **R** = Ready set **t2** = Temperature warning 2 not set **t1** = Temperature warning 1 not set The flashing letter can be changed by pressing the button ▼ e ↔ E. By pressing the button ▲ the next letter can be selected. If you confirm with OK, the changes are saved.
TESTINPuts	**Input status** display e.g.: **A b S d r** — Inputs: **A** = power stage activated — Entregen not active **b** = no Boost — Boost not active **S** = power stage selected — Deselect not active **d** = preferred motor direction — Motor direction not active **r** = no reset — Reset not active **Remark:** The CLD+ is set in this example with the input and output status, that the motor should turn, as soon as control pulses arrive (or a test run is started).
RESET	**Power stage reset** The Reset is done, if the OK key is pressed. With the input Reset the power stage can also be reset.
RETURN	The last menu item in the test menu.

With the key ▲ you return to the menu item test run. If you confirm with OK, the test menu is quitted.

8.5 Error Messages

If an error occurs, the error message is shown on the display alternately with the status:

ERROR TEMP-LIM	over temperature
ERROR LOW-VOLT	under voltage < 17 V
MOTOR RUNNING	This error message appears, if you try to change parameters during the motor runs.
PASSWO FALSE	The access on this menu item is inhibited.

If there are several errors **at the same time** the error message with the highest priority is shown.

An error message can be reset after elimination of the error conditions or cooling. Select the menu item **RESET** in the test menu and confirm with OK. The power stage can also be reset by the Reset input.

8.6 Trouble-Shooting

The following sample point collection will help you to eliminate eventual faults:

Problem: Changes in the Setup menu or test menu not possible
Display: **PASSWO FALSE**

The password protection is active. Select the menu item **PASSWORD** in the Setup menu. Press the button OK. Now appears the letter **A**. Select the letter **P** with the arrow key and confirm with OK. The password protection is now deactivated.

Problem: Display badly readable

Change the display contrast in the menu item **LCDCTR**.

Problem: Display dark

Eventually the temperature in the switching cabinet is too high.

Problem: Error message over temperature

Check the ventilation (see chap. 4.2) and current setups (see chap. 5.4). Mount a fan.

Problem: Motor does not run.

1. Check the current setups. Run current and boost current are set to 1 A at delivery.

2. Check the cable and the correct mounting of the connectors.

Problem: Motor becomes very hot

Check the current settings. The set run or boost current might be too high for the motor winding. The stop current should be set to above 50% of the run current.

As long as the input Boost is active, the set boost current **always** flows. Even if there are no Control Pulses, the stop current is **not** activated!

9 ServiceBus Connection

The operation parameters in the CLD+ can be set by the serial bus connection (ServiceBus). The instruction set and other information about ServiceBus can be read in the manual ‚Instruction Set for Stepper Motor Power Stages with ServiceBus‘.

ServiceBus displays:

S-BUS DISABLED	ServiceBus is deactivated. The operation parameters are set by the menu driven input.
S-BUS ENABLED	ServiceBus is activated and can be deactivated by the menu buttons. Parameter settings are only possible by the ServiceBus.
S-BUS LOCKED	The power stage is set to bus mode exclusive by ServiceBus-Comm. All settings with the menu buttons are ignored and only possible by ServiceBus. Leaving this mode is only possible by ServiceBus with the ‚PX‘ instruction code.

9.1 ServiceBus Interface

CLD+ 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 power stage (type B).

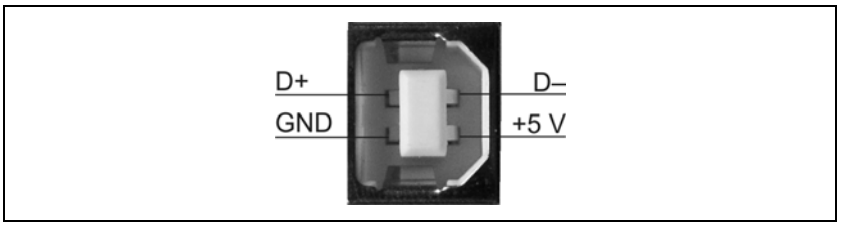


Fig. 16: ServiceBus connector at the bottom of the housing
USB port type B (DIN IEC 61076-3-108)

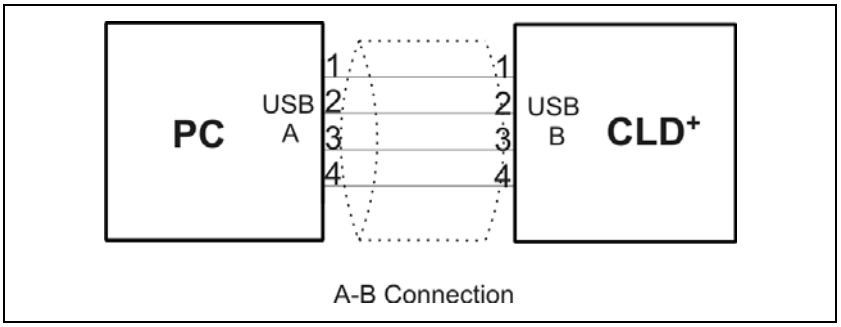


Fig. 17: Wiring scheme PC <-->CLD+ by cable type A-B

Important: The corresponding USB drivers, which are stored on the phytron CD, must be installed on the PC, if the USB interface is used.

9.2 USB Driver Installation

- When the CLD+ is connected to the PC by USB-interface, USB drivers, stored on the phytron CD, 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.

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 CLD+ 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.

Appendix A: Technical Details

A stepper motor can be used with different step resolutions, which are described in the first part of this chapter. You'll find the Boost and Current delay time functions in the second part.

A1 Full Step / Half Step / Ministep

Full Step (FS)

The FULL STEP mode is the operating mode in which a 200 step motor, for example, drives 200 steps per revolution. In the full step mode, both stepper motor phases are permanently energized.

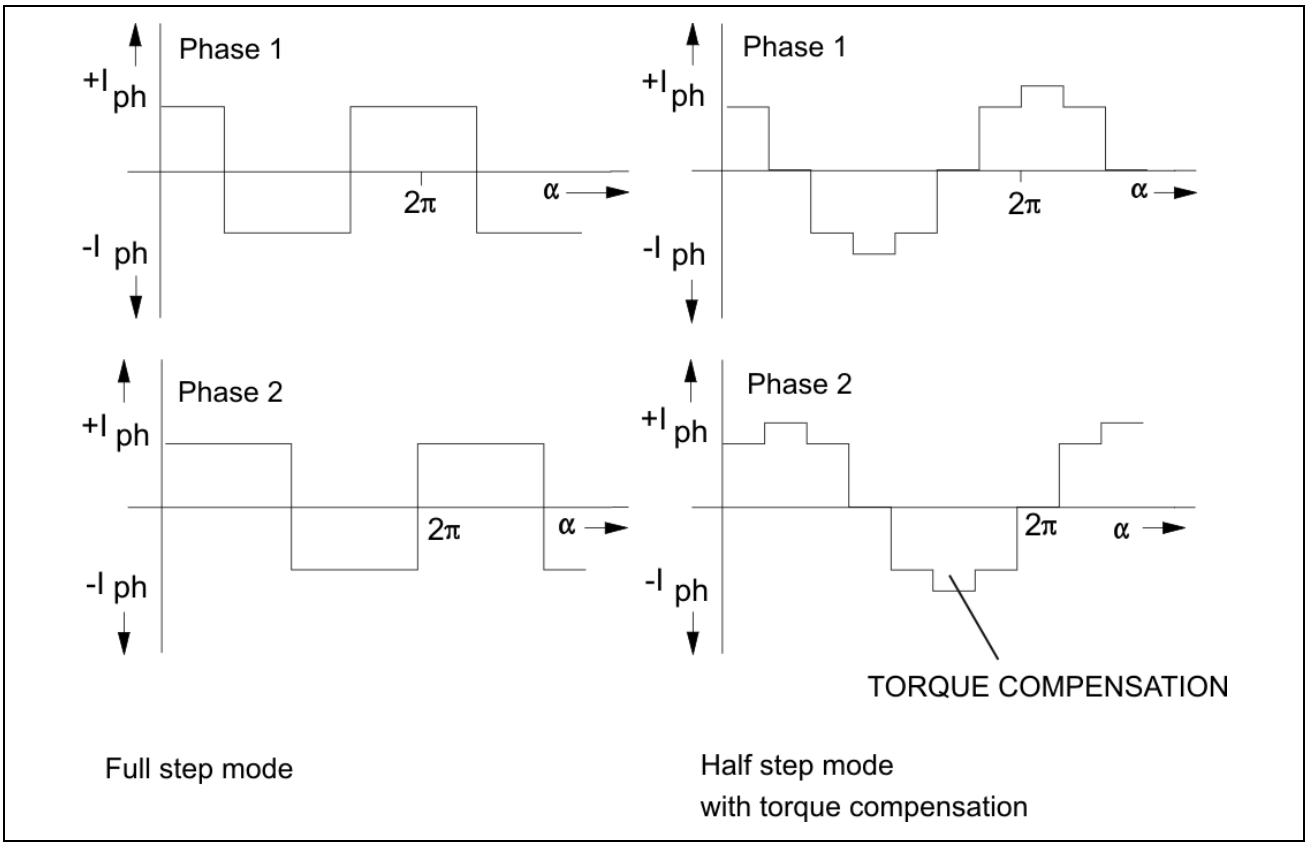


Fig. 18: Phase current curves

Half step (HS)

The motor step resolution can be electronically multiplied by 2 by alternately energizing the stepper motor's phases 1, 1+2, 2 etc. This is the HALF STEP mode. The torque, however, is reduced in the half step mode, compared to the full step mode.

To compensate this lack of torque, the operating mode HALF STEP MODE WITH TORQUE COMPENSATION was developed: the current is increased by $\sqrt{2}$ in the active phase. Compared to the full step mode, the torque delivered is almost the same. Most of the resonance is suppressed.

The following diagram shows extent and direction of the holding torques of a 4 step motor during one revolution without and with torque compensation. In the full step position two phases, in the half step position only one phase is energized. The total moment is the result of superpositioning both phase moments.

The moment in the full step mode, $M_{FS,}$ as compared to the moment in the half-step mode, M_{HS} is: $|M_{FS}| = |M_{HS}| \times \sqrt{2}$

This means, when a single phase is energized, the current must be increased by a $\sqrt{2}$ factor to obtain an identical torque.

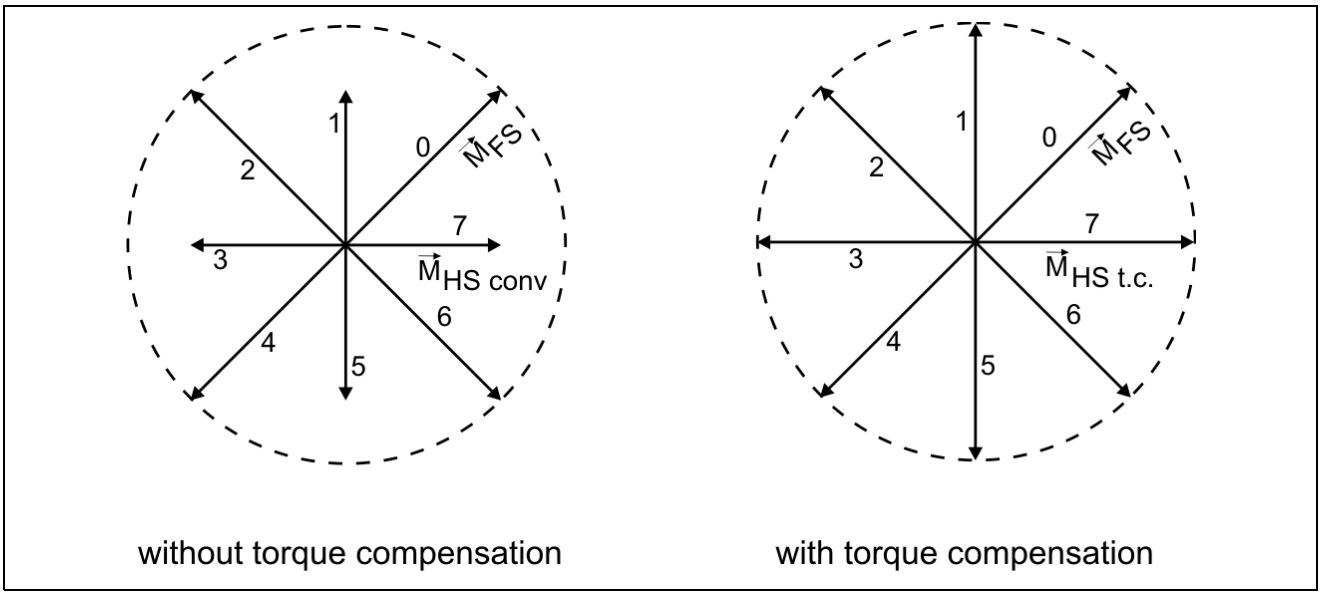


Fig. 19: Holding torques without/with torque compensation

Ministep

When used in the „ministep mode“, the power stage CLD$^+$ increases the step resolution by a factor 2.5, 4, 5, 8, 10, 16, 20, 32, 64, 128, 256 or 512.

Various advantages are obtained by the ministep mode:

- The torque undulation drops when the number of ministeps is increased.
- Resonance and overshoot phenomenae are greatly reduced; the motor operation is almost resonance-free.
- The motor noise also drops when the number of ministeps is increased.

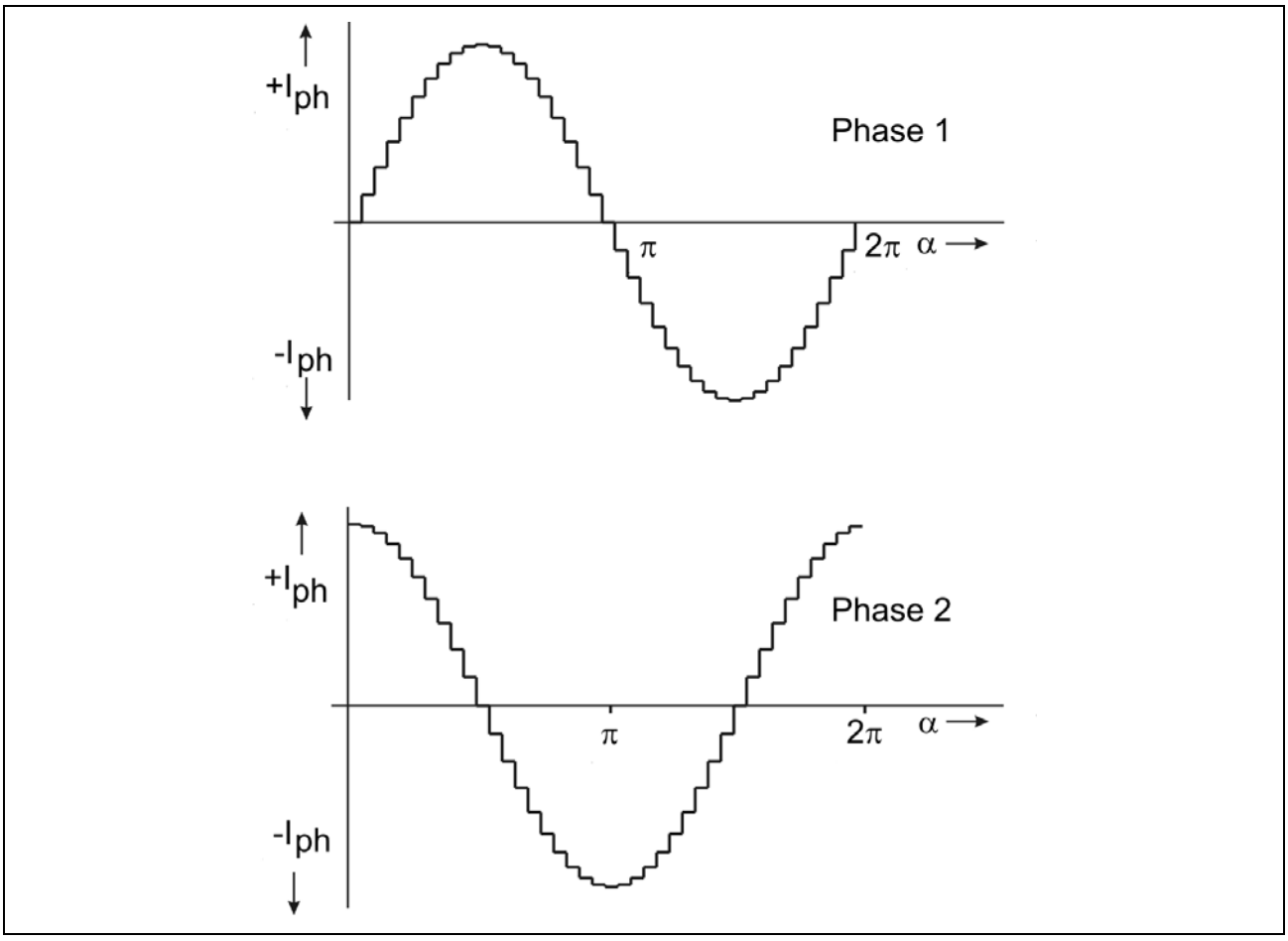


Fig. 20: Ministep 1/10 (of a Full step)

A2 Boost

The motor torque required during acceleration and deceleration is higher than that required during continuous motor operation (f_{max}). For fast acceleration and deceleration settings, (steep ramps), the motor current is too high during continuous operation and results in motor overheating. However, a lower phase current results in too flat acceleration and deceleration ramps.

Therefore, different phase currents should be used:

- Continuous operation: run current
- During acceleration and deceleration: Boost current

  The Boost signal is activated by the superior controller. While „Boost“input is energized, the CLD+ selects the phase current set by the Setup menu item „Boost“.

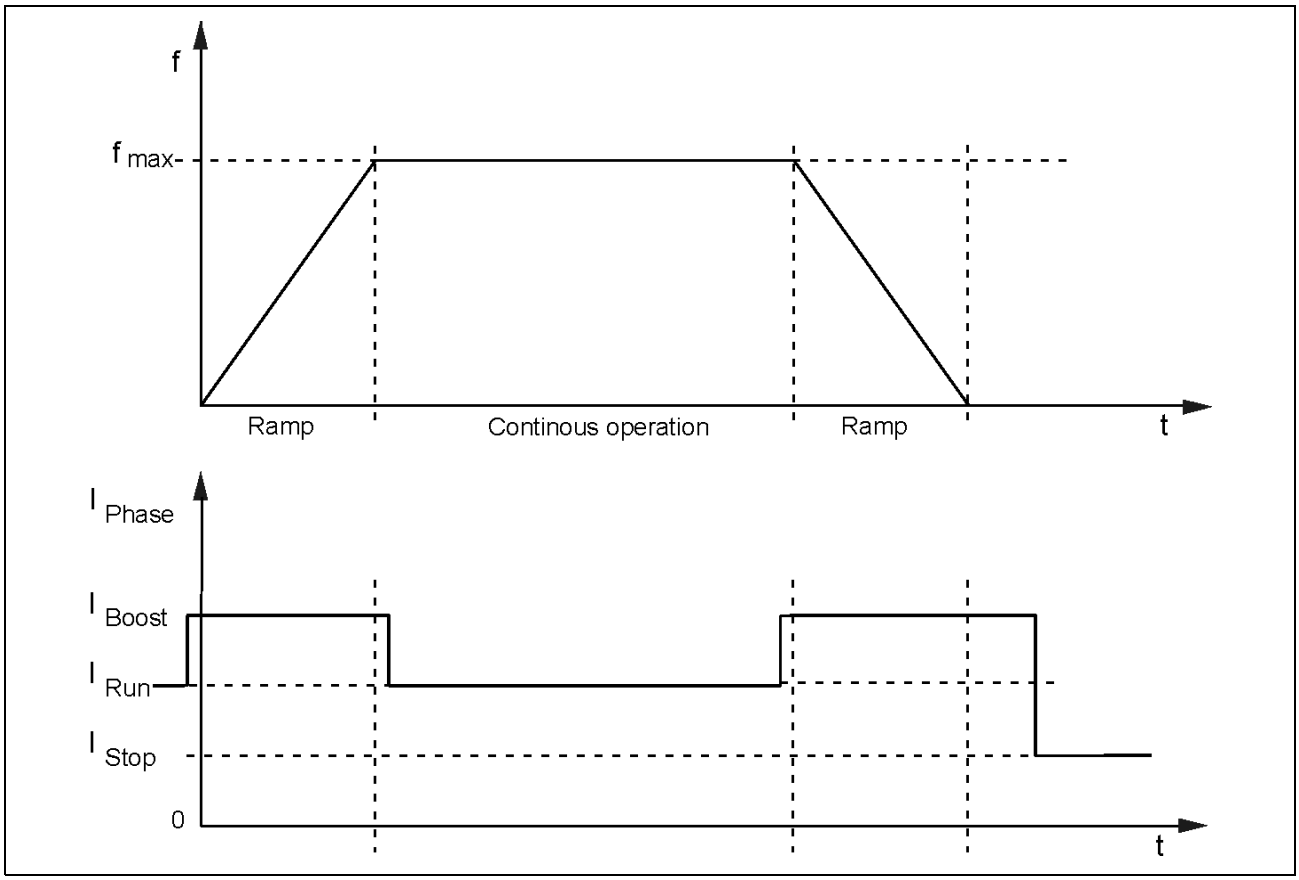


Fig. 21: Boost

A3 Current Delay Time

After the last control pulse the stop current is activated after a waiting time. The waiting time after the last control pulse until the changing to the stop current is called current delay time.

We recommend to specify t_{Delay} so that the motor's oscillations are dying out after the last motor step and mispositioning is avoided.

In Rotary switch mode the current delay time is set to 40 msec.
In ServiceBus mode the delay time can be programmed from 1 to 1000 msec in 15 steps.

Automatic change from run to stop current:

The ratio between both phase currents remains equal in the respective current feed pattern. Changing from run to stop current is synchronously.
In the following figure the next motor step follows after every **rising** control pulse edge:

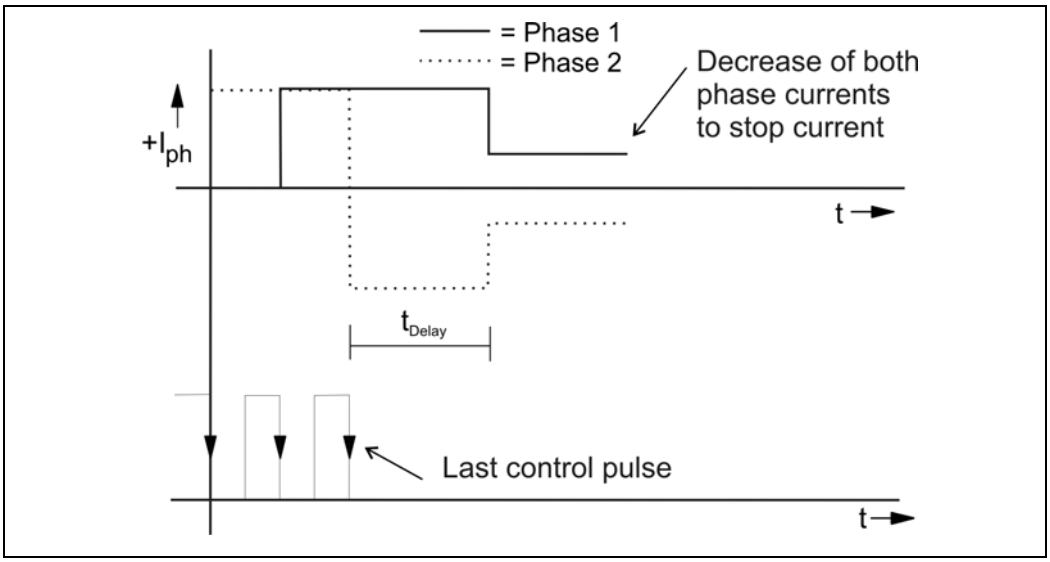


Fig. 22: Decrease to stop current after the last control pulse (full step)

Decreasing to stop current takes the following advantages:

- Motor and power stage heating is reduced.
- EMC is improved because of smaller current values.

Appendix B

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

B1 Warranty

The CLD+ power stages 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.

B2 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. Some product names used herein are for instance:

- ServiceBus-Comm is a trade mark of the Phytron-Elektronik GmbH.
- Microsoft is a registered trade mark and Windows is a trade mark of the Microsoft Corporation in the USA and other countries.

B3 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.

Appendix C: Declarations of Conformity

Phytron-Elektronik GmbH

EG-Konformitätserklärung
Declaration of Conformity

Hiermit erklären wir, dass die Bauart der nachfolgend bezeichneten Produkte in der von uns in Verkehr gebrachten Ausführung den unten genannten einschlägigen EG-Richtlinien entspricht.

We, the manufacturer, declare hereby on our own responsibility, that the following products meet all the provisions of the EU directive cited below:

Produktbezeichnung ***Part name***	**Identnummer** ***ID-No.***	**Ab Seriennr.** **From *Serial No***
CLD+	10010115, 10010116, 10010117, 10010118	Alle/all

Angewendete EG-Richtlinie / *EU Directive Applied*:
89/336/EWG vom 3. Mai 1989 (EMV-Richtlinie) *89/336/EEC of May 3rd, 1989 (EMC Directive)*

Angewendete harmonisierte Normen / *Harmonized Standards Applied*:		
EN 61000-3-2	2006-10	Elektromagnetische Verträglichkeit (EMV) Grenzwerte für Oberschwingungsströme *Limits for harmonic current emissions*
EN 61000-6-3	2005-11	Elektromagnetische Verträglichkeit (EMV) Fachgrundnorm Störaussendung - Wohnbereich, Geschäfts- und Gewerbebereiche sowie Kleinbetriebe *Electromagnetic compatibility (EMC) - Emission standard for residential, commercial and light-industrial environments*
EN 61000-6-4	2002-08	Elektromagnetische Verträglichkeit (EMV) - Fachgrundnorm Störaussendung für Industriebereich *Electromagnetic compatibility (EMC) - Emission standard for industrial environments*
EN 61000-6-1	2002-08	Elektromagnetische Verträglichkeit (EMV) - Störfestigkeit für Wohnbereich, Geschäfts- und Gewerbebereiche sowie Kleinbetriebe *Electromagnetic Compatibility (EMC) - Immunity for residential, commercial and light-industrial environmental*
EN 61000-6-2	2002-08	Elektromagnetische Verträglichkeit (EMV) - Störfestigkeit für Industriebereiche *Electromagnetic compatibility (EMC) - Immunity for industrial environments*

Anmerkung/*Comment:*

Gröbenzell, den 15. Mai 2008 / Gröbenzell, May 15th, 2008

Heribert Schmid
Technischer Geschäftsführer/ Managing Director

Sitz Gröbenzell · Germany
Kaufm. Geschäftsführer B. Hartmann
Techn. Geschäftsführer H. Schmid
Reg.-Gericht München HRB 44 426
Ust.-IdNr. DE 128242222

Telefon +49 8142 503-0
Fax: +49 8142 503-190
info@phytron.de · www.phytron.de
Industriestraße 12 · 82194 Gröbenzell
Postfach 12 55 · 82180 Gröbenzell

customized solutions in motion

Phytron-Elektronik GmbH

EG-Herstellererklärung

gemäß EG-Richtlinie Maschinen 98/37/EG, Anhang II B

Declaration of Conformity
According to EC Directive on Machinery 98/37/EC, Annex II B

Hiermit erklären wir, dass es sich bei dieser Lieferung um die nachfolgend bezeichnete unvollständige Maschine handelt. Die Inbetriebnahme dieser Maschine/des Maschinenteils ist so lange untersagt, bis festgestellt wurde, dass die Maschine, in die sie eingebaut werden soll, den Bestimmungen der EG-Richtlinien Maschinen 98/37/EG entspricht.

We, the manufacturer, declare that this delivery is for an incomplete machinery as defined below. The start-up of this machine/machine part is prohibited until it has been determined that the machine in which it is to be incorporated complies with the requirements of EC machine guidelines 98/37/EC machine guidelines 98/37/EC.

Produktbezeichnung *Part name*	**Identnummer** *ID-No.*	**Ab Seriennr.** **From *Serial No***
CLD+	10010115, 10010116, 10010117, 10010118	Alle/all

Angewendete harmonisierte Normen / *Harmonized Standards Applied*:	
EN 12100-1: 2004-04	Sicherheit von Maschinen - Grundbegriffe, allgemeine Gestaltungsleitsätze - Teil 1: Grundsätzliche Terminologie, Methodologie
EN 12100-2: 2004-04	Sicherheit von Maschinen - Grundbegriffe, allgemeine Gestaltungsleitsätze - Teil 2: Technische Leitsätze
EN 60204-1: 1998-11	Sicherheit von Maschinen - Elektrische Ausrüstung von Maschinen - Teil 1: Allgemeine Anforderungen

Anmerkung/*Comment:*
Diese Erklärung verliert ihre Gültigkeit bei baulicher Veränderung und bei nicht bestimmungsgemäßer Verwendung, sofern nicht ausdrücklich die schriftliche Zustimmung des Herstellers vorliegt.

This declaration loses its validity as a result of structural alterations and/or use other than defined, unless the express written approval of the manufacturer is present.

Gröbenzell, den 15. Mai 2008 / Gröbenzell, May 15th, 2008

Heribert Schmid
Technischer Geschäftsführer/ Managing Director

Sitz Gröbenzell · Germany
Kaufm. Geschäftsführer B. Hartmann
Techn. Geschäftsführer H. Schmid
Reg.-Gericht München HRB 44 426
Ust.-IdNr. DE 128242222

Telefon +49 8142 503-0
Fax: +49 8142 503-190
info@phytron.de · www.phytron.de
Industriestraße 12 · 82194 Gröbenzell
Postfach 12 55 · 82180 Gröbenzell

customized solutions in motion

Index

Phytron-Elektronik GmbH • Industriestraße 12 • 82194 Gröbenzell, Germany
Tel. +49(0)8142/503-0 • Fax +49(0)8142/503-190 • E-Mail info@phytron.de • www.phytron.de

Phytron, Inc. • 600 Blair Park Road Suite 220 • Williston, VT 05495 USA
Tel. +1-802-872-1600 • Fax +1-802-872-0311 • Email info@phytron.com • www.phytron.com