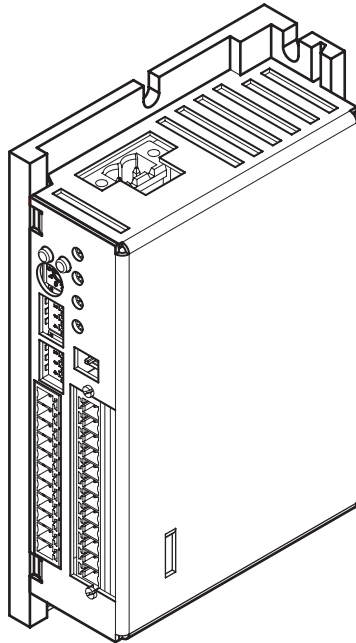


Technical Documentation



Product manual

Drive for stepper motors

SD3150

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Berger Lahr GmbH & Co. KG
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Important information

The drive systems described here are products for general use that conform to the state of the art in technology and are designed to prevent any dangers. However, drives and drive controllers that are not specifically designed for safety functions are not approved for applications where the functioning of the drive could endanger persons. The possibility of unexpected or unbraked movements can never be totally excluded without additional safety equipment. For this reason personnel must never be in the danger zone of the drives unless additional suitable safety equipment prevents any personal danger. This applies to operation of the machine during production and also to all service and maintenance work on drives and the machine. The machine design must ensure personal safety. Suitable measures for prevention of property damage are also required.

See safety section for additional critical instructions.

Not all product variants are available in all countries.

Please consult the current catalogue for information on the availability of product variants.

We reserve the right to make changes during the course of technical developments.

All details provided are technical data and not promised characteristics.

In general, product names must be considered to be trademarks of the respective owners, even if not specifically identified as such.

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Writing conventions and symbols

Work steps If work steps must be carried out in sequence, they are shown as follows:

- Special prerequisites for the following work steps
- Step 1
- ◁ Important response to this work step
- Step 2

If a response to a work step is specified, this will inform you that the step has been carried out correctly.

Unless otherwise stated, the individual instruction steps must be carried in the given sequence.

Lists Lists can be sorted alphanumerically or by priority. Lists are structured as follows:

- Point 1
- Point 2
 - Subpoint to 2
 - Subpoint to 2
- Point 3

Making work easier Information on making work easier can be found at this symbol:



This offers supplementary information on making work easier.

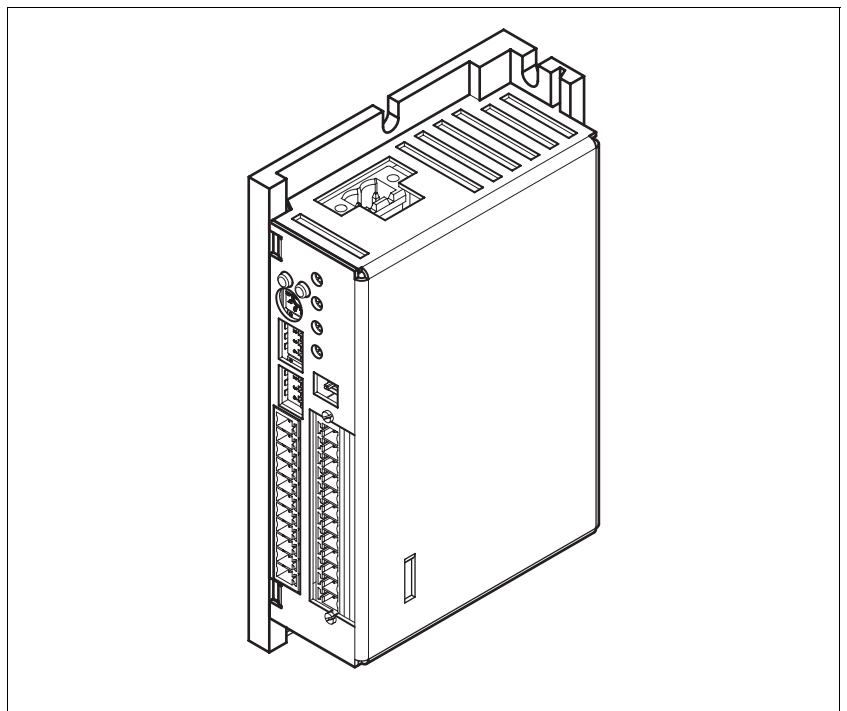
See the chapter on safety for an explanation of the safety instructions.

1 Introduction

1.1 About this manual

This manual is applicable for all SD3150 standard models. This chapter lists the type code for this product. The type code can be used to identify whether your product is a standard model or a customised model.

1.2 Unit overview



Drive system

This drive is used to control a 3-phase stepper motor.

Reference values are typically preset and monitored by a higher level PLC or a Berger Lahr motion controller, e.g. TLM2.

Combined with selected stepper motors from Berger Lahr, the result is a highly compact and powerful drive system.

1.3 Scope of supply

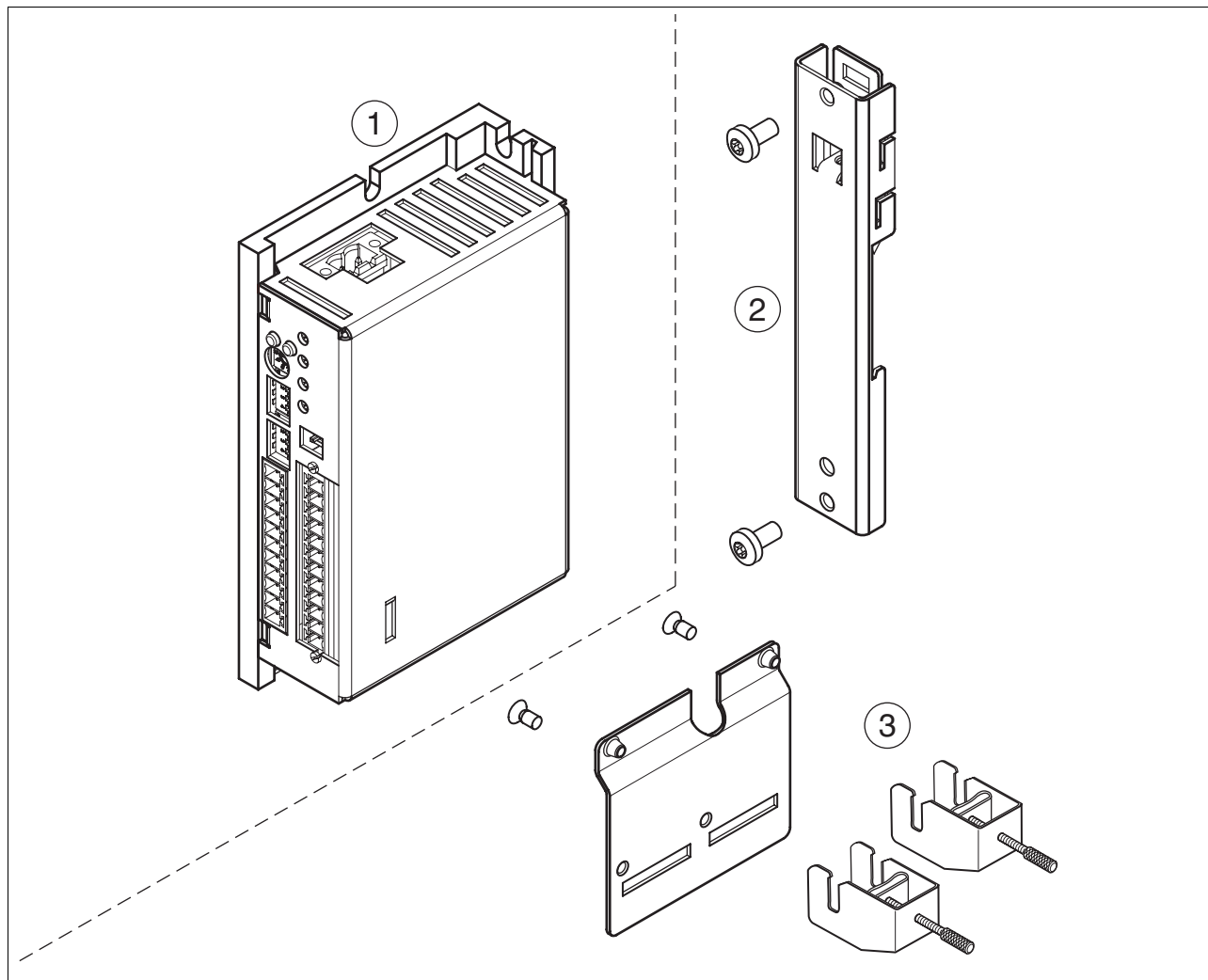


Figure 1.1 Scope of supply

- (1) SD3150
- (2) DIN rail adapter with fixing screws (optional accessory)
- (3) EMC kit (optional accessory)

1.4 Components and interfaces

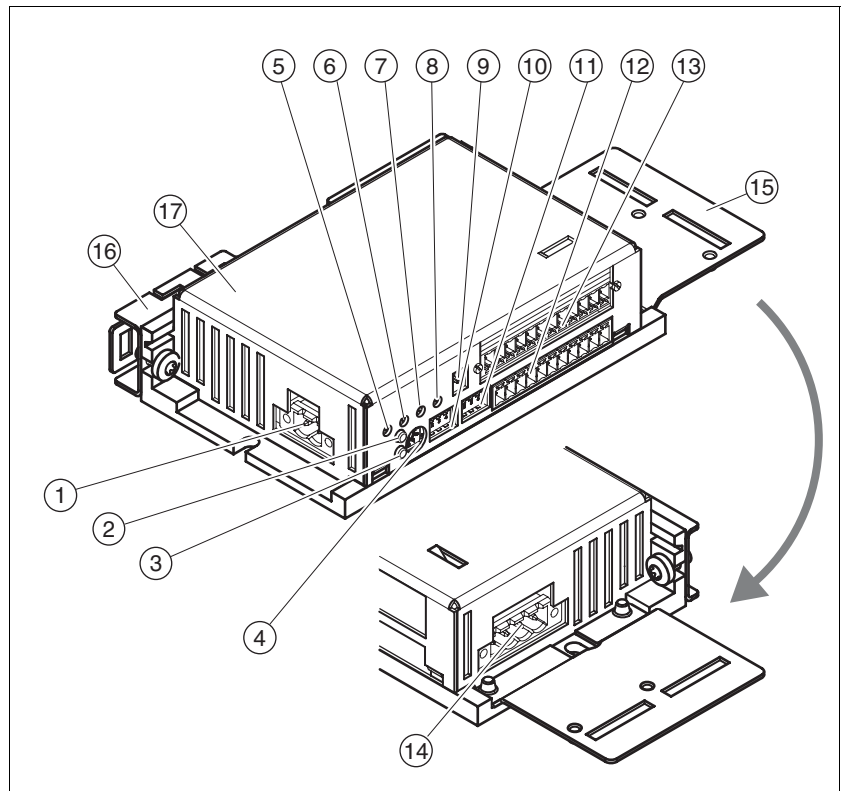


Figure 1.2 Components and interfaces

- (1) Connection of power supply (CN1)
- (2) LED ERR (red)
- (3) LED OK (green)
- (4) Parameter switch S1 for motor phase current
- (5) Potentiometer R1: f_high
- (6) Potentiometer R2: f_low
- (7) Potentiometer R3: ACC
- (8) Potentiometer R4: Dec
- (9) Parameter switch S4 "Source of analogue signal"
- (10) Parameter switch S2 "current reduction" and "softstep"
- (11) Parameter switch S3 Number of steps and type of release
- (12) Connection of signal interface (CN2)
- (13) Connection of signal interface, oscillator (CN4)
- (14) Connection of motor (CN3)
- (15) EMC mounting plate (accessories)
- (16) Top-hat rail adapter (accessories)
- (17) Nameplate with simplified manual

1.5 Type code

	SD3	15	•	N10	B4	••
Product name SD3 = Stepper Drive 3-Phase						
Product design 15 = stepper drive module						
Interface D = pulse-direction O = pulse-direction with oscillator						
Max. motor phase current N10 = 10 A						
Power supply B4 = 24 ... 48 V _{DC}						
Other options 00 = Standard xx = Customer variant ¹⁾						

1) This documentation applies exclusively to the standard variant and not to customer variants.

1.6 Documentation and literature references

The following User's manuals are supplied with this drive system:

- **Product manual**, describes the technical data, installation, commissioning and all operating modes and operating functions.
- **Motor manual**, describes the technical properties of the motors, including correct installation and commissioning.

Source product manuals

The current product manuals are available for download from the Internet.

<http://www.berger-lahr.com/download>.

Additional literature



We recommend the following literature for more in-depth information:

- Vogel, Johannes: Elektrische Antriebstechnik. ISBN: 3-7785-2649-9, Hüthig Verlag Heidelberg
- Riefenstahl, Ulrich: Elektrische Antriebstechnik - Leitfaden der Elektrotechnik. ISBN: 3-519-06429-4, B.G. Teubner Stuttgart, Leipzig

1.7 Directives and standards

<i>CE mark</i>	With the declaration of conformity and the CE mark on the product the manufacturer certifies that the product complies with the requirements of all relevant EC directives.
<i>EC Machine Directive</i>	<p>The drive systems described here are not machines as defined by the EC Machine Directive but components for installation in machines. They do not have moving parts designed for specific purposes. However, they can be components of a machine or system.</p> <p>The manufacturer must certify that the complete system conforms to the machine directive with the CE mark.</p>
<i>EC EMC Directive</i>	<p>The EC Electromagnetic Compatibility Directives applies to products that cause electromagnetic interference or whose operation may be adversely affected by electromagnetic interference.</p> <p>Conformity with the EMC Directive can only be expected of drive systems after correct installation in the machine. The information on ensuring electromagnetic compatibility given in the chapter on "Installation" must be followed to ensure that the drive system in the machine or system is EMC-compatible and that the product can legally be operated.</p>
<i>EC Low-Voltage Directive</i>	The EC Low-Voltage Directive lays down safety requirements for "electrical apparatus" as protection against the risks that can originate in such devices and can be created in response to external influences.
<i>Declaration of conformity</i>	The declaration of conformity certifies that the drive system complies with the specific EC directive.
<i>Standards for safe operation</i>	<p>IEC 60204-1: Electrical equipment of machines, General requirements</p> <p>IEC 60529: IP degrees of protection</p>
<i>Standards for compliance with EMC limit values</i>	IEC 61800-3: Variable-speed electrical drives

1.8 Declaration of conformity

<u>EC Declaration of Conformity</u> <u>Year 2007</u>		
		BERGER LAHR GmbH & Co.KG Breslauer Str. 7 D-77933 Lahr
<input type="checkbox"/> according to EC Directive Low Voltage 73/23/EEC, changed by CE Marking Directive 93/68/EEC <input type="checkbox"/> according to EC Directive on Machinery 98/37/EC <input checked="" type="checkbox"/> according to EC Directive EMC 2004/108/EC		
<p>We declare that the products listed below meet the requirements of the mentioned EC Directives with respect to design, construction and version distributed by us. This declaration becomes invalid with any modification on the products not authorized by us.</p>		
Designation: Drive		
Type: SD315D, SD315O		
Product number: 0062050003001, 0062050003002		
Applied harmonized standards, especially:	EN 61800-3:2004, second environment according to Berger Lahr EMC test conditions	
Applied national standards and technical specifications, especially:	Berger Lahr EMC test conditions 200.47-01 EN Product documentation	
<div style="display: flex; justify-content: space-between;"> <div> Company stamp: Berger Lahr GmbH & Co. KG Postfach 11 80 · D-77901 Lahr Breslauer Str. 7 · D-77933 Lahr </div> <div>  </div> </div>		
Date/ Signature: 25 July 2007		
Name/ Department: Wolfgang Brandstätter/R & D		

2 Safety

2.1 Qualification of personnel

Only technicians who are familiar with and understand the contents of this manual and the other relevant manuals are authorised to work on and with this drive system. The technicians must be able to detect potential dangers that may be caused by setting parameters, changing parameter values and generally by the mechanical, electrical and electronic equipment.

The technicians must have sufficient technical training, knowledge and experience to recognise and avoid dangers.

The technicians must be familiar with the relevant standards, regulations and safety regulations that must be observed when working on the drive system.

2.2 Intended use

The drive systems described here are products for general use that conform to the state of the art in technology and are designed to prevent any dangers. However, drives and drive controllers that are not specifically designed for safety functions are not approved for applications where the functioning of the drive could endanger persons. The possibility of unexpected or unbraked movements can never be totally excluded without additional safety equipment. For this reason personnel must never be in the danger zone of the drives unless additional suitable safety equipment prevents any personal danger. This applies to operation of the machine during production and also to all service and maintenance work on drives and the machine. The machine design must ensure personal safety. Suitable measures for prevention of property damage are also required.

In the system configuration described the drive systems must be used in industrial applications only and must have a fixed connection only.

In all cases the applicable safety regulations and the specified operating conditions, such as environmental conditions and specified technical data, must be observed.

The drive system must not be commissioned and operated until completion of installation in accordance with the EMC regulations and the specifications in this manual.

To prevent personal injury and damage to property damaged drive systems must not be installed or operated.

Changes and modifications of the drive systems are not permitted and if made all no warranty and liability will be accepted.

The drive system must be operated only with the specified wiring and approved accessories. In general, use only original accessories and spare parts.

The drive systems must not be operated in an environment subject to explosion hazard (ex area).

2.3 Hazard categories

Safety notes and general information are indicated by hazard messages in the manual. In addition there are symbols and instructions affixed to the product that warn of possible hazards and help to operate the product safely.

Depending on the seriousness of the hazard, the messages are divided into three hazard categories.

DANGER

DANGER indicates an imminently hazardous situation, which, if not avoided, **will result** in death, serious injury, or equipment damage.

WARNING

WARNING indicates a potentially hazardous situation, which, if not avoided, **can result** in death, serious injury, or equipment damage.

CAUTION

CAUTION indicates a potentially hazardous situation, which, if not avoided, **can result** in injury or equipment damage.

2.4 General safety instructions

DANGER

Motor out of view

When the system is started the drives are generally out of the operator's view and cannot be visually monitored.

- Only start the system if there are no persons in the operating zone of the moving components and the system can be operated safely.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING**Loss of control**

- Observe the accident prevention regulations. (For USA see also NEMA ICS1.1 and NEMA ICS7.1)
- The system manufacturer must take the potential error possibilities of the signals and the critical functions into account to ensure a safe status during and after errors. Some examples are: emergency stop, final position limitation, power failure and restart.
- The assessment of error possibilities must also include unexpected delays and the failure of signals or functions.
- Suitable redundant control paths must be in place for dangerous functions.
- Check that measures taken are effective.

Failure to follow these instructions can result in death or serious injury.

⚠ WARNING**Unexpected movement**

Drives may execute unexpected movements because of incorrect wiring, incorrect settings, incorrect data or other errors.

Malfunctions (EMC) may cause unpredictable responses in the system.

- Install the wiring carefully in accordance with the EMC requirements.
- Do not operate a drive system with unknown settings or data.
- Carry out a comprehensive commissioning test.

Failure to follow these instructions can result in death or serious injury.

⚠ WARNING**Interference with signals and devices**

Distorted signals can cause unpredictable device responses.

- Install the wiring in accordance with the EMC requirements.
- Check compliance with the EMC requirements, particularly in an environment subject to strong interference.

Failure to follow these instructions can result in death, serious injury or equipment damage.

2.5 Monitoring functions

The monitoring functions in the product protect the system and reduce the risks involved in a system malfunction. These monitoring functions are not sufficient for personal protection.

The following errors and limit values can be monitored:

Monitoring	Task	Protective function
Overvoltage and undervoltage	Monitoring for overvoltage and undervoltage of the power supply	Functional safety and device protection
Overtemperature	Monitoring device for overtemperature	Device protection
Short circuit	Monitoring for short circuits between the motor phases	Device protection

3 Technical Data

This chapter contains information on the required environmental conditions and on the mechanical and electrical properties of the unit family and the accessories.

3.1 Environmental conditions

When considering the ambient temperature a distinction is made between the permissible temperatures during operation and the permissible storage and transport temperature.

Ambient operating temperature

The maximum permissible ambient air temperature during operation depends on the gap between the installed devices and the performance required. The relevant requirements in the chapter on installation are also very important.

Operating temperature ¹⁾	[°C]	0 ... +50
-------------------------------------	------	-----------

1) no icing

Ambient temperature for transport and storage

The environmental conditions must be dry and free of dust during transport and storage. The maximum oscillation and shock stress must be within the specified limits. The bearing and transport temperature must remain within the specified range.

Temperature	[°C]	-25 ... +70
-------------	------	-------------

Pollution degree

Pollution degree	2
------------------	---

Relative humidity

The following relative humidity is permissible during operation:

rel. humidity	corresponding to IEC60721-3-3, class 3K3, 5% - 85%, no condensation permissible
---------------	---

Installation height

Installation height above mean sea level	<1000 m (with no reduction in output) 1000 m ... 2000 m (with a reduction in output of 1% of the motor phase current per 100m)
--	---

Oscillations and shocks

Oscillations, sinusoidal	in accordance with IEC/EN 60068-2-6 1.5 mm (from 3Hz ... 13Hz) 10 m/s ² (from 13Hz ... 150Hz)
Shocks, semisinusoidal	in accordance with IEC/EN 60068-2-27 150 m/s ² (for 11 ms)

EMC

Emitted interference ¹⁾	IEC/EN 61800-3: class C2 EN 61000-6-4 EN 55022: class A
Noise immunity	IEC/EN 61800-3: Second environment

1) up to 5m motor cable length

3.1.1 Degree of protection*IP degree of protection*

Degree of protection as per DIN EN 60529	IP20
---	------

3.1.2 Service life

The service life of this product is determined largely by the electrolytic capacitors used. It depends on the alternating current (ripple current) in the capacitors.

Service life at 100% Duty Cycle and 50°C ambient temperature	[h]	5000
---	-----	------

3.2 Mechanical data

3.2.1 Dimensions

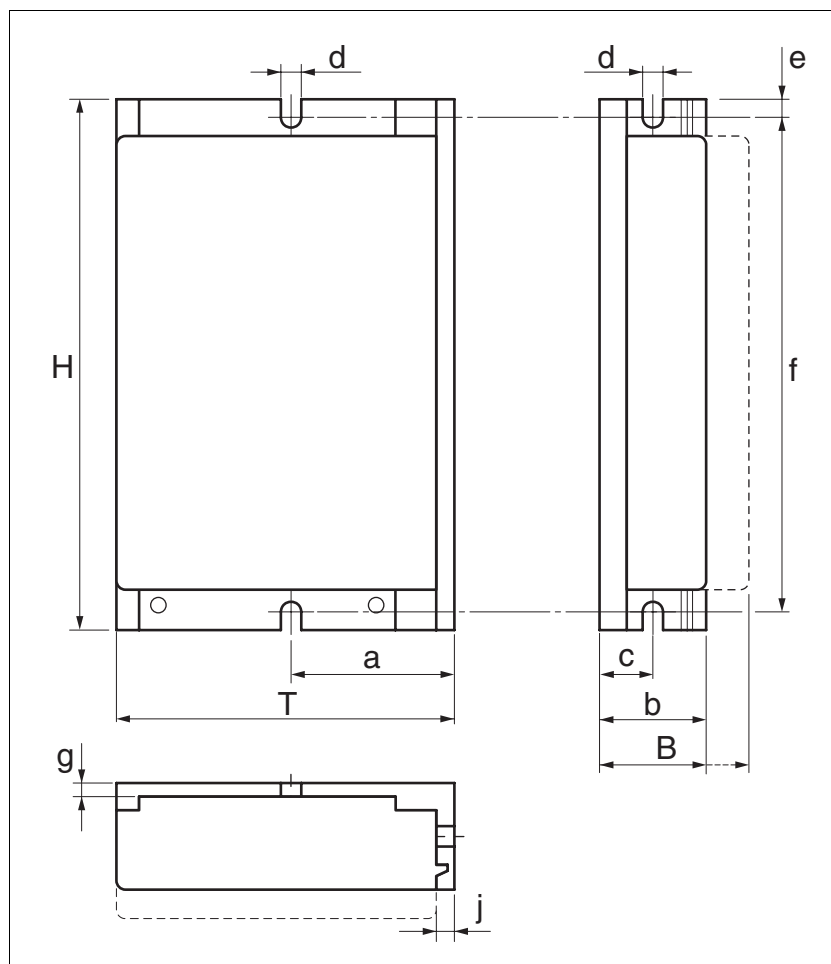


Figure 3.1 Dimensions

H	[mm]	117
B	[mm]	33
T	[mm]	74.5
a	[mm]	36
b	[mm]	23.5
c	[mm]	11.75
d	[mm]	4.5
e	[mm]	4.25
f	[mm]	108.5
g	[mm]	3
j	[mm]	4
Type of cooling		Free convection
Weight	[kg]	0.30

3.3 Electrical Data

3.3.1 Overview of all connections

The following diagram displays an overview of all connections:

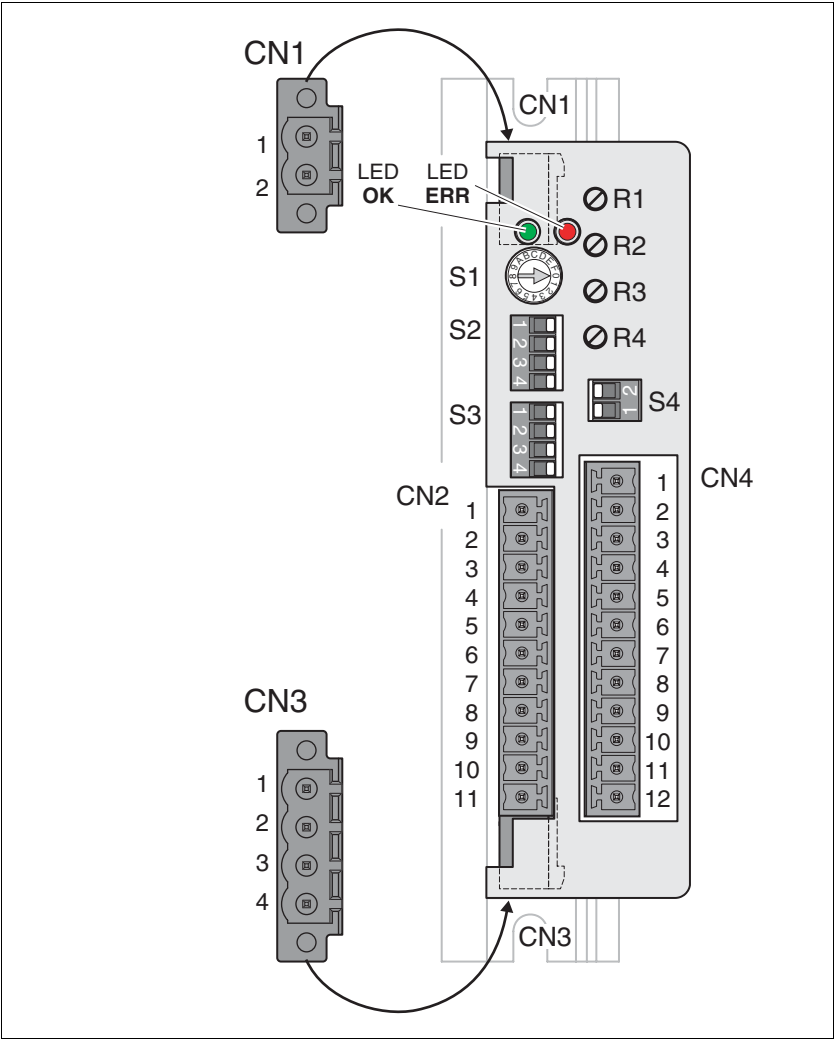


Figure 3.2 Overview of signal connections

Connection	Assignments
CN1	Power supply
CN2	Signal interface
CN3	Motor
CN4	Signal interface for oscillator

3.3.2 Supply voltage V_{DC} to CN1

CAUTION

Destruction of contacts

The connection for the controller supply voltage at the drive system does not have a make current limit. If the voltage is switched on by switching contacts, the contacts may be destroyed or welded shut.

- Use a power supply unit that limits the peak value of the output current to a value permissible for the contact.
- Switch the line input of the power supply unit instead of the output voltage.

Failure to follow these instructions can result in equipment damage.

The V_{DC} power supply is simultaneously the controller supply voltage.

Power data

Nominal voltage V_{DC}	[V _{DC}]	24 ... 48
Limit values V_{DC}	[V _{DC}]	19.2 ... 60
Residual ripple	[%]	< 5
max. current consumption	[A]	7.5
power loss	[W]	≤ 7
Internal capacitors	[μF]	1100
Fuse, external	[A]	≤ 10

Fuses

The current consumption may increase greatly for a short period with dynamic processes such as fast acceleration or brief load torque peaks. The high charging current may also trip a fuse.

Circuit breakers with thermal tripping are therefore recommended. For example, type 2-5700 from E-T-A (www.e-t-a.com).

Circuit breakers with electronic tripping can also be used. For example, type ESS20 from E-T-A (www.e-t-a.com).

Select the nominal current of this circuit breaker depending on the wiring and the current consumption.

3.3.3 Signal interfaces at CN2 and CN4

5V inputs The inputs are optocoupler inputs.

Logical 1 (V_{high})	V	+2.5 ...+5.25
Logical 0 (V_{low})	V	≤0.4
Input current	[mA]	≤25
max. input frequency	[kHz]	≤200

24V inputs The inputs are optocoupler inputs.

Logical 1 (V_{high})	V	+15 ...+30
Logical 0 (V_{low})	V	≤5
Input current	[mA]	≤7
max. input frequency	[kHz]	≤200

Output *ACTIVE_OUT* The output is an electronic relay (bidirectional Mosfet). The output is non-polarised. The output is not short-circuit protected.

max. switching voltage	[V]	≤30
max. switching current	[mA]	≤200
voltage drop at 50 mA load	[V]	≤1

Outputs *PULS_OUT* and *DIR_OUT* The outputs are polarised. The external reference potential is connected to 0V_EXT. The outputs are not short-circuit protected.

max. switching voltage	[V]	≤30
max. switching current	[mA]	≤50
voltage drop at 50 mA load	[V]	≤0.5

Analogue input *ANA1* It is possible to predetermine an external analogue signal for the oscillator via input ANA1, e.g. via a potentiometer.

Measuring range	[V _{DC}]	0 ... 10
Zero voltage window	[mV]	50
Max. input voltage	[V _{DC}]	30
Input resistance	[kΩ]	≥10
Resolution	[Bit]	10

Output for potentiometer *10V_OUT* Voltage is available for an external potentiometer via the output 10V_OUT. The reference potential is 0V_EXT.

Voltage	[V _{DC}]	10
Max. allowable current	[mA]	≤20
Potentiometer resistance	[kΩ]	10

3.3.4 Motor connection at CN3

max. motor phase current	$[A_{pk}]$	14
	$[A_{rms}]$	10
max. motor phase current without the "current reduction" function	$[A_{rms}]$	7.5
Number of phases		3

Approved motors You can use all motors from the motor series VRDM 36x and VRDM 39x.

3.4 Technical Data accessories

3.4.1 Cable

Overview of cables required

	max. length [m]	Stripped length [mm]	Rigid or flexible cross section [mm ²]	Flexible cross section with wire end ferrule [mm ²]
Power supply	-	10	0.2 ... 2.5	0.25 ... 2.5
Signal interface	-	9	0.14 ... 1.5	0.14 ... 0.5 ¹⁾ 0.25 ... 1.5 ²⁾
Oscillator interface	-	9	0.14 ... 1.5	0.14 ... 0.5 ¹⁾ 0.25 ... 1.5 ²⁾
Motor cables	50	10	0.2 ... 2.5	0.25 ... 2.5

1) with plastic cable cover

2) without plastic cable cover

3.4.2 Connector

Overview of required connectors

The connectors are available as a connector set. See chapter 9 "Accessories and spare parts".

	Designation	Type (Phoenix Combicon)
Power supply	Spring force of connector section, 2-pin	FKC 2.5/ 2-STF-5.08
Signal connector	Spring force of connector section, 11-pin	FK-MCP 1.5/11-ST-3.81
Oscillator connector	Spring force of connector section, 12-pin	FK-MCP 1.5/12-ST-3.81
Motor plug	Spring force of connector section, 4-pin	FKC 2.5/ 4-STF-5.08

3.4.3 Other accessories

Top-hat rail adapter

The 35 mm top-hat rail adapter is for a standard TH35 rack as per EN 60715. Two retaining screws are included with this accessory.

EMC kit

The optional EMC kit improves the EMC characteristics. Shielded cable must be used with this plate. Two retaining screws and two SK terminals are included with this accessory.

4 Installation

⚠ WARNING

Loss of control

- Observe the accident prevention regulations. (For USA see also NEMA ICS1.1 and NEMA ICS7.1)
- The system manufacturer must take the potential error possibilities of the signals and the critical functions into account to ensure a safe status during and after errors. Some examples are: emergency stop, final position limitation, power failure and restart.
- The assessment of error possibilities must also include unexpected delays and the failure of signals or functions.
- Suitable redundant control paths must be in place for dangerous functions.
- Check that measures taken are effective.

Failure to follow these instructions can result in death or serious injury.

4.1 Electromagnetic compatibility, EMC

⚠ WARNING

Interference with signals and devices

Distorted signals can cause unpredictable device responses.

- Install the wiring in accordance with the EMC requirements.
- Check compliance with the EMC requirements, particularly in an environment subject to strong interference.

Failure to follow these instructions can result in death, serious injury or equipment damage.

Limit values

This drive system complies with the EMC requirements for the second environment in accordance with IEC 61800-3 when used with the original accessories and if the measures described for installation have been implemented. When operating outside this application area note the following:

⚠ WARNING

High-frequency interference

In a domestic environment this product may cause high-frequency interference that may require action to suppress interference.

An EMC-compliant design is required to maintain the specified limit values. Depending in the case better results can be achieved with the following measures:

- Particularly EMC-compliant design, e.g. in an enclosed control cabinet with 15 dB damping of radiated interference

Control cabinet setup

EMC measures	Effect
Use EMC plate or galvanised or chrome-plated mounting plates, make large contact surface connections for metal parts, remove paint from contact surfaces	Good conductivity due to two-dimensional contacts
Earth the control cabinet, door and EMC plate with metal tapes or cables with a cross section area greater than 10 mm ² .	Reduction of emissions.
Fit switching devices such as contactors, relays or solenoids with interference suppressors or spark suppressors (e.g. diodes, varistors, RC elements)	Reduction of mutual interference
Install power and control components separately.	Reduction of mutual interference

Cabling

EMC measures	Effect
Keep wiring as short as possible. Do not install "safety loops", short cables from the star point in the switch cabinet to outlying earth connection.	Avoidance of capacitive and inductive interference injection
Use cable clamps to connect a large surface area of the shield of all shielded cables to the mounting plate at the control cabinet entry.	Reduction of emissions.
Fieldbus lines and signal lines must not be laid in the same conduit with lines for DC and AC voltage over 60 V. (Fieldbus lines can be laid in the same conduit with signal and analogue lines)	Prevention of mutual interference
Recommendation: lay in separate conduits at least 20 cm apart.	
Connect large surface areas of cable shields, use cable clamps and tapes	Reduction of emissions.
Earth shields on digital signal lines over a wide area at both ends or via conductive plug housing.	Preventing interference on control cables, reduction of emissions
Earth shield on analogue signal lines directly at the device (signal input), and insulate the shield at the other end of the cable or earth via a capacitor if interference occurs, e.g. 10 nF.	Preventing ripple loops due to low-frequency interference
Use only shielded motor cables with copper braiding and at least 85% covering, ground a large surface area of the shield at each end.	Controlled discharge of interference currents, reduction of emissions
If motor and machine are not conductively connected, e.g. by an insulated flange or a non-flat connection, earth the motor with an earth wire >10 mm ² (>6 AWG) or ground strap.	Reduction of emissions, increase in resistance to interference
Lay connections of the supply voltage as "twisted pair".	Preventing interference on control cables, reduction of emissions

Power supply

EMC measures	Effect
Connect the negative output of the PELV power supply unit to PE.	Reduction of EMC emissions, safety
Circuit breaker if there is danger of overvoltage or lightning strike	Protection against damage by overvoltage

EMC requirement for motor cables

Use the cables recommended by your local representative. These have been tested for EMC safety and are suitable for drag chains.

The motor cable must be fitted to the device and the motor with a low impedance path that provides a large surface contact area.

- Lay the motor cable from the motor to the device without any breaks (do not include any switching elements). If you do have to break a line, you must use shielded connections and metal casings, as otherwise unwanted emissions may occur.

Equipotential bonding conductors

The shields are connected at both ends for fault protection. Potential differences can result in excessive currents on the shield and must be prevented by equipotential bonding conductor cables.

If lines over 100 m are approved, the following applies: up to 200 m length a cable cross section of 16 mm² is sufficient, for greater lengths a cable cross section of 20 mm² is required.

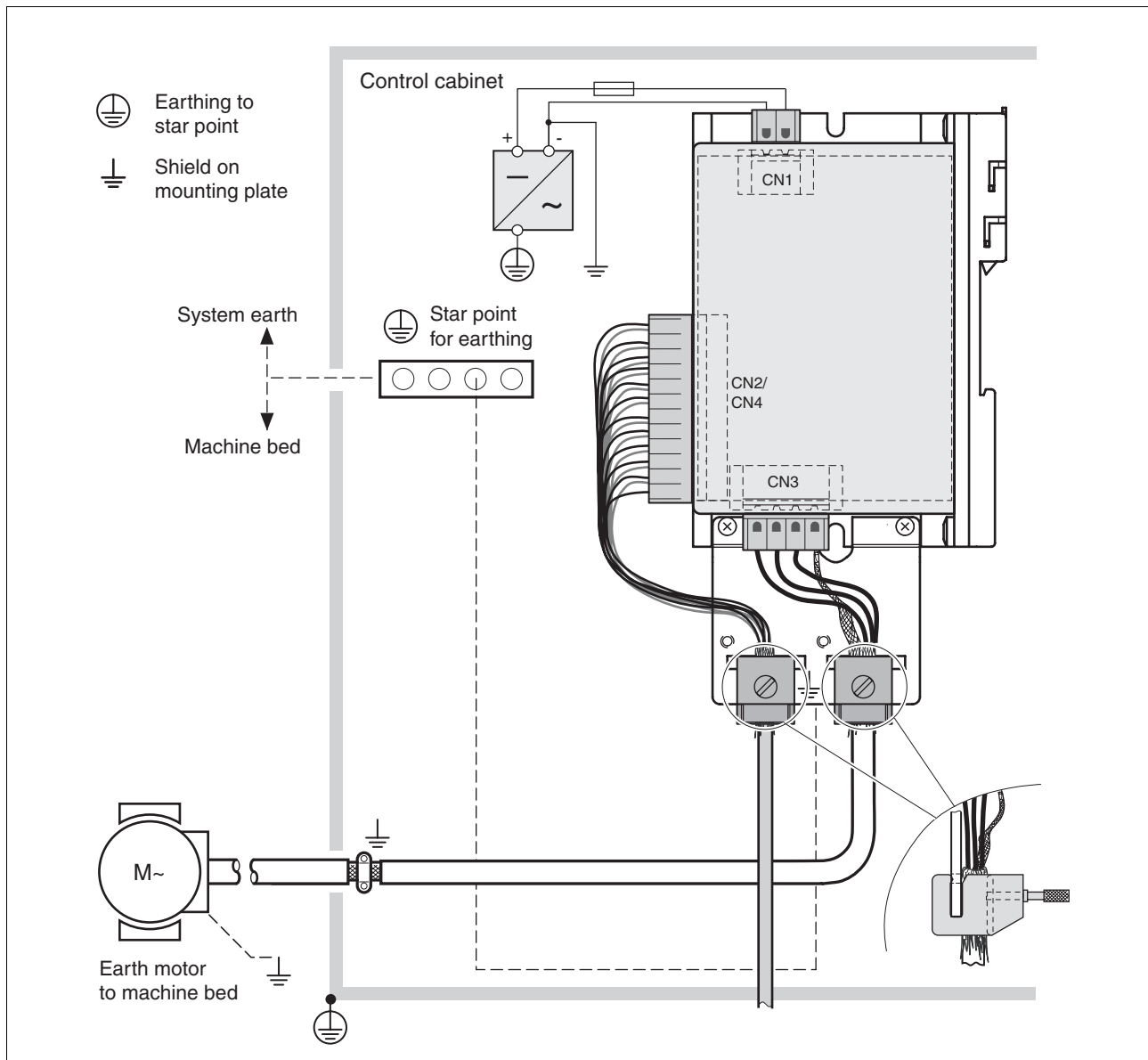


Figure 4.1 EMC measures

4.2 Mechanical installation

⚠ CAUTION

Hot Surfaces

The heat sink on the product may heat up to over 100 °C (212 °F) depending on the operating mode.

- Prevent contact with the hot heat sink.
- Do not install flammable or heat-sensitive components in the immediate vicinity.
- Follow the actions described for heat dissipation.

Failure to follow these instructions can result in injury or equipment damage.

4.2.1 Installing the device

Control cabinet

The control cabinet must be dimensioned so all devices and accessories can be fixed in place and wired to meet EMC standards.

The control cabinet ventilation must be capable of extracting the heat generated by all devices and components installed in the control cabinet.

Installation spacing; ventilation

When selecting the position of the device in the switching cabinet, note the following instructions:

- Adequate cooling of the device must be ensured by complying with the minimum installation distances. Prevent heat accumulation.
- The device must not be installed close to heat sources or mounted on flammable materials.
- The warm airflow from other devices and components must not heat the air used for cooling the device.
- The drive will switch off as a result of overtemperature when operated above the thermal limits.

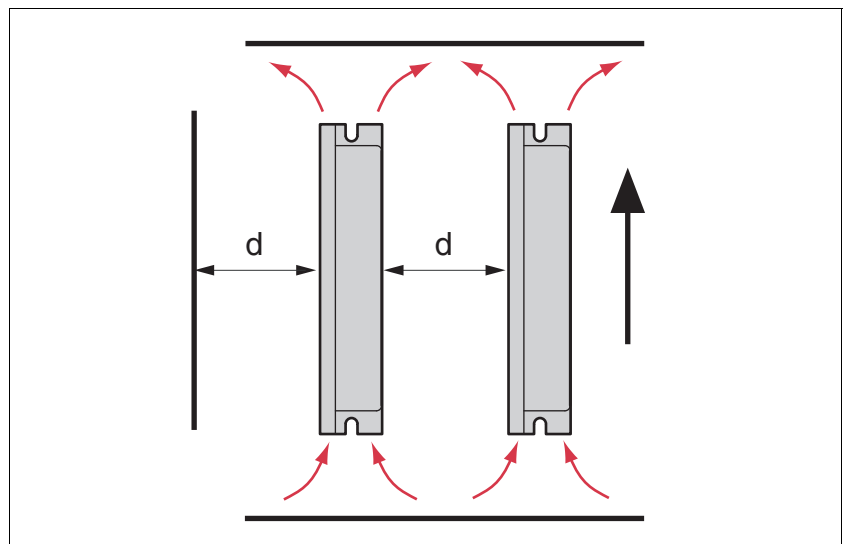


Figure 4.2 Installation spacing and air circulation

The specified continuous current is applicable if the following distances are maintained and the device is installed upright.

- At least 10mm of free space is required in front of the device.
- At least 50 mm of free space is required above the device.
- For "d" ist mindestens 30mm Freiraum einzuhalten.
- At least 200mm free space under the device is required to ensure that wiring can be installed without excessive bending.

If other components are installed in these areas, the possible continuous current is reduced.

Installing the device

The product can be mounted directly on the narrow or wide mounting surface with two M4 screws. The product can optionally be snapped on to a standard TH35 rack (EN 60715) with a DIN rail adapter (optional accessory) (DIN rail 35 mm). For the dimensions of the fastening holes, see chapter 3.2.1 "Dimensions".

- ▶ Install the device in a vertical position ($\pm 10^\circ$). This is particularly important for cooling the device.
- ▶ Use attaching elements (comb bars, shield clamps, busbars) for the cable layout and connecting the shielding.



Painted surfaces have an insulating effect. Remove the paint from the attachment points over a wide area (bright metal) before attaching the unit to a painted mounting plate.

4.3 Electrical installation

⚠ WARNING

Unexpected behaviour due to external objects

External objects, deposits or humidity can cause unexpected behaviour.

- Do not use damaged products.
- Prevent external objects such as chips, screws or wire clippings from entering the product.
- Do not use products that contain external objects.

Failure to follow these instructions can result in death, serious injury or equipment damage.

Suitability of wiring

Cables must not be twisted, stretched, crushed or kinked. Use only cables that comply with the cable specification. For example, make sure that it is suitable for:

- Use as a trailing cable
- Temperature range
- Chemical resistance
- Layout outdoors
- Layout underground

4.3.1 Overview of procedure

- ▶ Connect the housing to the earthed neutral point of the system.
- ▶ Follow the EMC requirements, see page 27.
- ▶ At the end check the installation.

Chapter	from page
4.3.3 "Connection of power supply (CN1)"	35
4.3.4 "Connection for signal interface (CN2)"	37
4.3.5 "Connection for signal interface (CN4)"	40
4.3.6 "Connection of motor phases (CN3)"	42

4.3.2 Overview of all connections

The following diagram displays an overview of all connections:

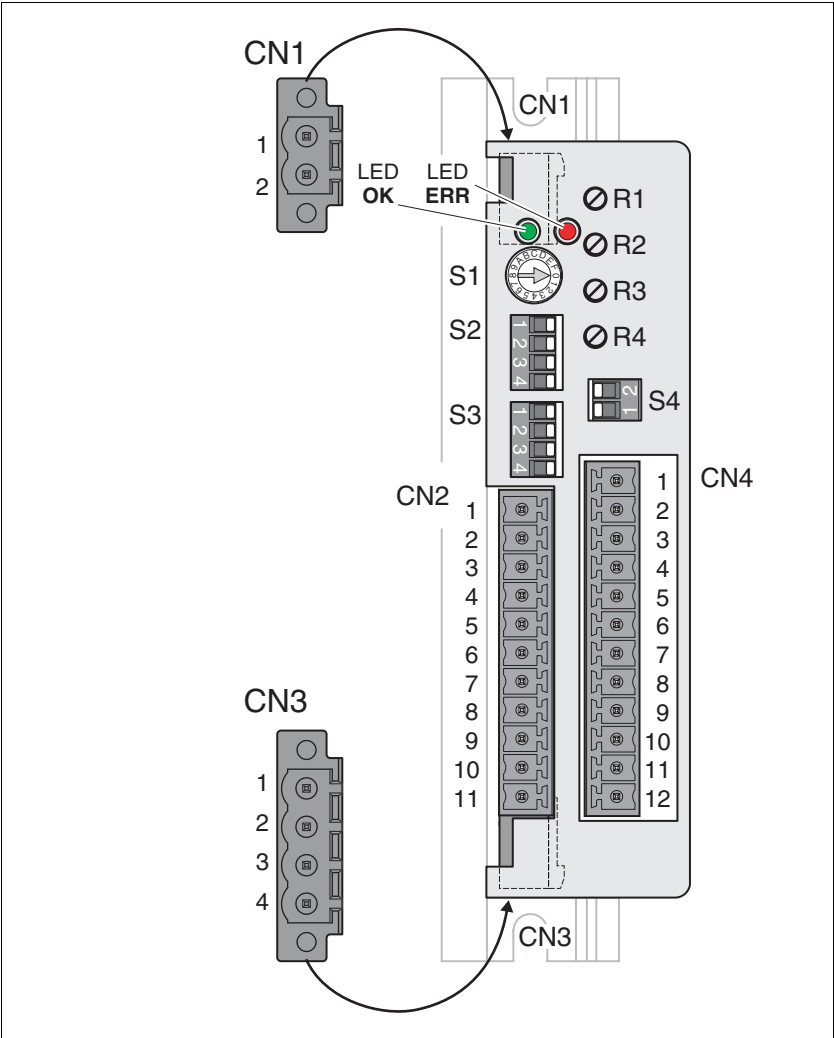


Figure 4.3 Overview of signal connections

Connection	Assignments
CN1	Power supply
CN2	Signal interface
CN3	Motor
CN4	Signal interface for oscillator

4.3.3 Connection of power supply (CN1)

⚠ DANGER

Electric shock from incorrect power supply unit

The supply voltage V_{DC} is connected with many accessible signals in the drive system.

- Use a power supply unit that meets the requirements for PELV (Protective Extra Low Voltage)
- Connect the negative output of the power supply unit to PE.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

Loss of control by regeneration condition

A regeneration condition during braking or external drive may increase the V_{DC} supply voltage by an unexpected degree. Parts that are not designed for this voltage may be destroyed or malfunction.

- Check that all consumers on V_{DC} are designed for the voltage occurring during a regeneration condition (for example limit switches).
- Use only power supply units that will not be damaged by a regeneration condition.
- Use a braking resistor actuator if necessary.

Failure to follow these instructions can result in injury or equipment damage.

CAUTION

Destruction of contacts

The connection for the controller supply voltage at the drive system does not have a make current limit. If the voltage is switched on by switching contacts, the contacts may be destroyed or welded shut.

- Use a power supply unit that limits the peak value of the output current to a value permissible for the contact.
- Switch the line input of the power supply unit instead of the output voltage.

Failure to follow these instructions can result in equipment damage.

Required connectors

The connector is available as a component of a connector set. See chapter 9 "Accessories and spare parts".

Designation	Type (Phoenix Combicon)
Spring force of connector section, 2-pin	FKC 2.5/ 2-STF-5.08

Wiring diagram CN1

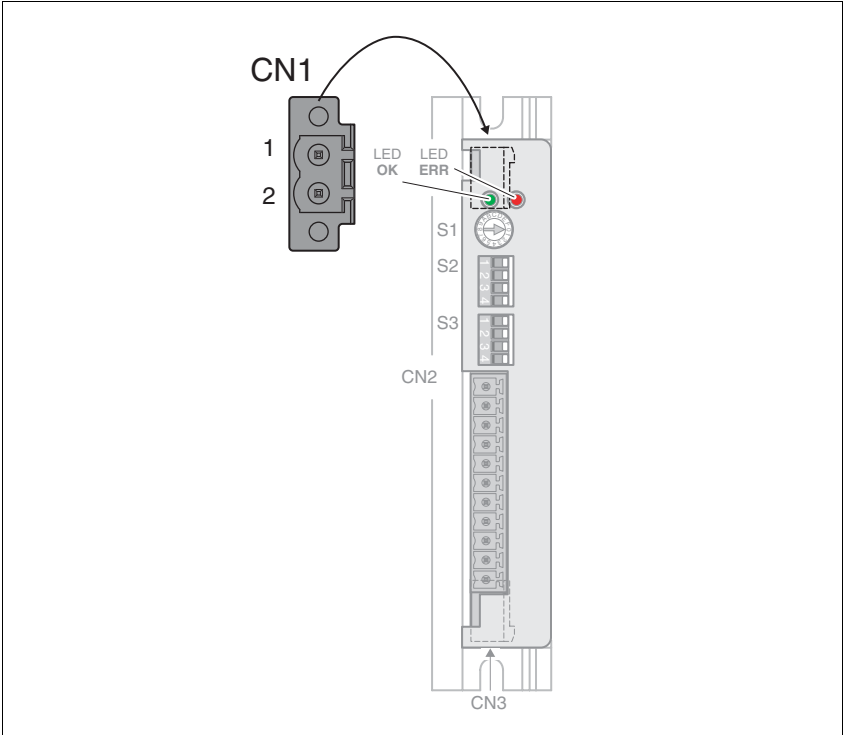


Figure 4.4 Connector CN1

Pin	Signal	Description
1	VDC	Power supply
2	0VDC	Reference potential to VDC

- Reverse polarity


The CN1 connection has no reverse polarity protection.
- Fuses

Notes on fuses are listed at 3.3.2 "Supply voltage VDC to CN1".
- Preparing cables

Note the dimensions specified when fabricating cables.

	max. length [m]	Stripped length [mm]	Rigid or flexible cross section [mm ²]	Flexible cross section with wire end ferrule [mm ²]
Power supply cable	-	10	0.2 ... 2.5	0.25 ... 2.5

4.3.4 Connection for signal interface (CN2)



WARNING

Unexpected movement

Incorrect or faulty signals as reference position can trigger unexpected movements.

- Use shielded cables with twisted-pair.
- Operate the interface with push-pull signals.
- Do not use signals without push-pull in critical applications or in an environment subject to interference.
- Do not use signals without push-pull with cable lengths over 3 m and limit the frequency to 50 kHz

Failure to follow these instructions can result in death, serious injury or equipment damage.

IMPORTANT: The 5V_{DC} signal inputs must not be connected to 24V_{DC}.

Input circuit diagram

The following diagram shows the general design of the opto-isolated inputs based on the PULSE signal input.

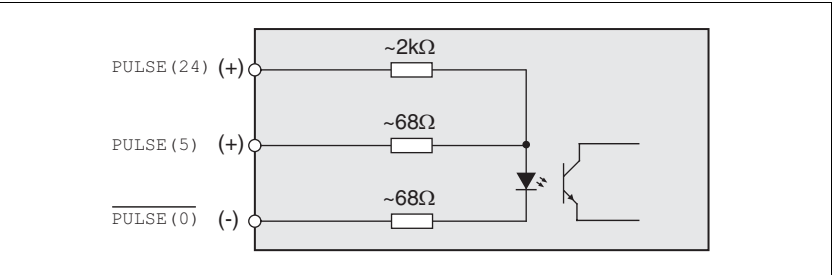


Figure 4.5 Input circuit diagram

Output circuit diagram

The diagram below shows the main layout of the output ACTIVE_OUT.

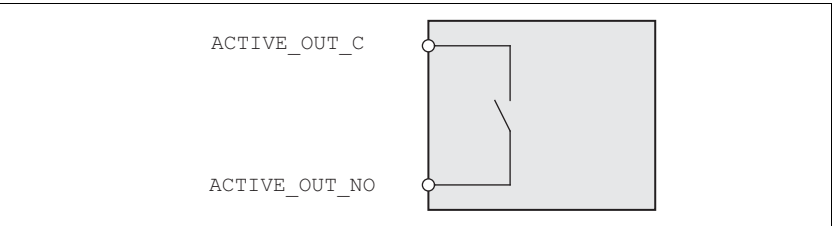


Figure 4.6 Output circuit diagram

Required connectors

The connector is available as a component of a connector set. See chapter 9 "Accessories and spare parts".

	Designation	Type (Phoenix Combicon)
Signal connector	Spring force of connector section, 11-pin	FK-MCP 1.5/11-ST-3.81

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Wiring diagram CN2

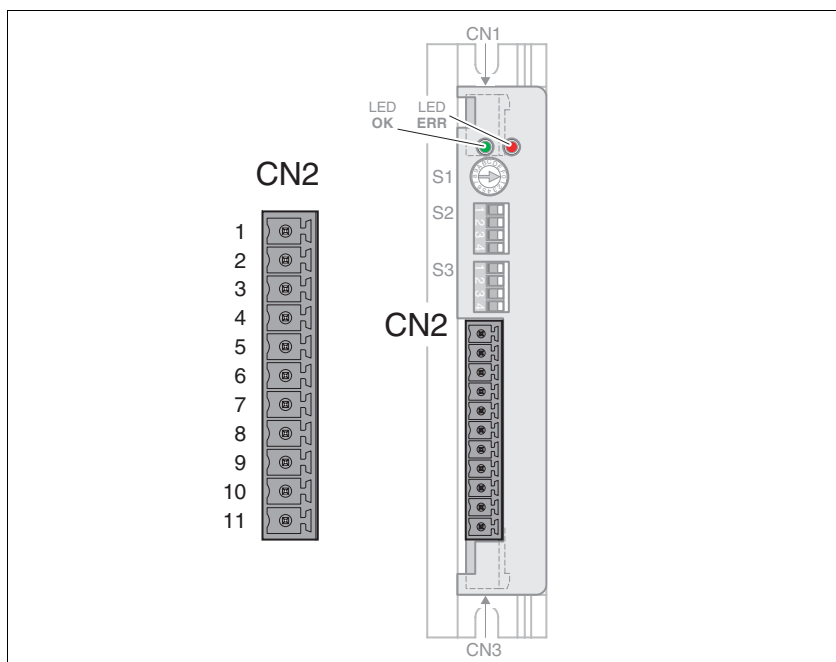


Figure 4.7 Wiring diagram signal interface CN2

Pin	Signal	Description	5V/24V	I/O
1	PULSE (24)	Motor step	24 V	I
2	PULSE (5)	Motor step	5V	I
3	$\overline{\text{PULSE}} (0)$	Reference potential		I
4	DIR (24)	Direction of rotation	24 V	I
5	DIR (5)	Direction of rotation	5V	I
6	$\overline{\text{DIR}} (0)$	Reference potential		I
7	ENABLE (24) or GATE (24)	Activating the power amplifier or locking the reference values	24 V	I
8	ENABLE (5) or GATE (5)	Activating the power amplifier or locking the reference values	5V	I
9	$\overline{\text{ENABLE}} (0)$ or $\overline{\text{GATE}} (0)$	Reference potential		I
10	ACTIVE_OUT_C	Readiness		O
11	ACTIVE_OUT_NO	Readiness		O

The 24V input and 5V input per signal, for example PULSE (24) and PULSE (5), must not be connected simultaneously.

Preparing cables Note the dimensions specified when fabricating cables.

	max. length [m]	Stripped length [mm]	Rigid or flexible cross section [mm ²]	Flexible cross section with wire end ferrule [mm ²]
Signal interface	-	9	0.14 ... 1.5	0.14 ... 0.5 ¹⁾ 0.25 ... 1.5 ²⁾

1) with plastic cable cover

2) without plastic cable cover

- Connecting signal interface*
- ▶ Make sure that the wiring and the cables meet the requirements for PELV.
 - ▶ Attach the connector to CN2.

4.3.5 Connection for signal interface (CN4)

⚠ WARNING

Unexpected movement

Incorrect or faulty signals as reference position can trigger unexpected movements.

- Use shielded cables with twisted-pair.
- Operate the interface with push-pull signals.
- Do not use signals without push-pull in critical applications or in an environment subject to interference.
- Do not use signals without push-pull with cable lengths over 3 m and limit the frequency to 50 kHz

Failure to follow these instructions can result in death, serious injury or equipment damage.

IMPORTANT: The 5V_{DC} signal inputs must not be connected to 24V_{DC}.

Input circuit diagram

The following diagram shows the general design of the opto-isolated inputs based on the START signal input.

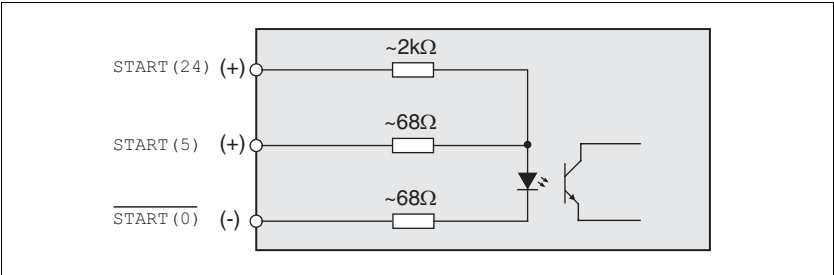


Figure 4.8 Input circuit diagram

Output circuit diagram

The following diagram shows the main layout of the outputs PULS_OUT_NO and DIR_OUT_NO.

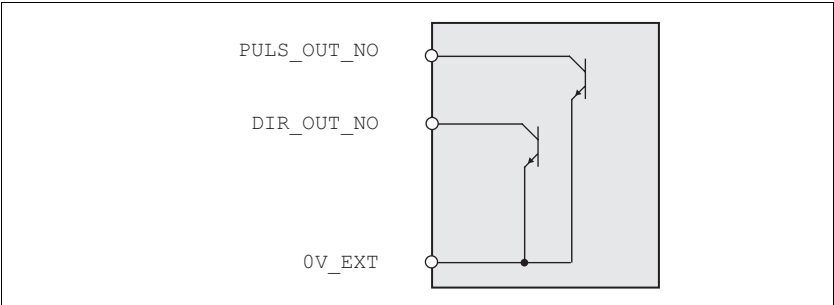


Figure 4.9 Output circuit diagram

Required connectors

The connector is available as a component of a connector set. See chapter 9 "Accessories and spare parts".

Designation	Type (Phoenix Combicon)
Oscillator connector	Spring force of connector section, 12-pin
	FK-MCP 1.5/12-ST-3.81

Wiring diagram CN4

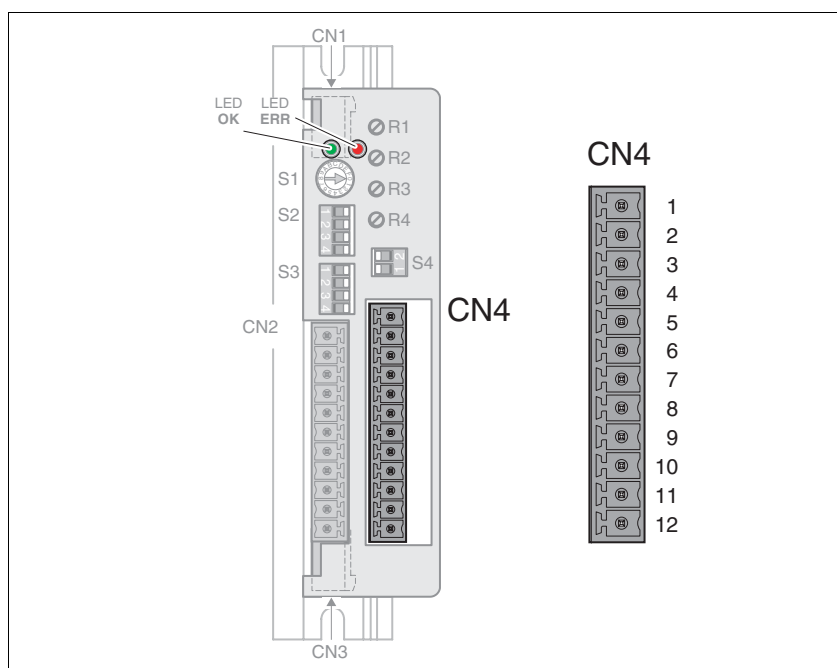


Figure 4.10 Wiring diagram for signal interface (CN4)

Pin	Signal	Description	5V/24V	I/O
1	START (24)	Activates the oscillator	24 V	I
2	START (5)	Activates the oscillator	5V	I
3	$\overline{\text{START}}(0)$	Activates the oscillator	-	-
4	F_HIGH (24)	Fast/slow movement	24 V	I
5	F_HIGH (5)	Fast/slow movement	5V	I
6	$\overline{\text{F_HIGH}}(0)$	Fast/slow movement	-	-
7	PULS_OUT_NO	Pulse output	-	O
8	DIR_OUT_NO	Direction signals output	-	O
9	10V_OUT	10VDC supply for external potentiometer	-	O
10	ANA_0V	Reference potential for potentiometers	-	-
11	ANA1	Analogue input	-	I
12	0V_EXT	Reference potential for the outputs PULS_OUT_NO and DIR_OUT_NO	-	-

The 24V input and 5V input per signal, for example PULSE (24) and PULSE (5) , must not be connected simultaneously.

Preparing cables Note the dimensions specified when fabricating cables.

	max. length [m]	Stripped length [mm]	Rigid or flexible cross section [mm ²]	Flexible cross section with wire end ferrule [mm ²]
Signal interface	-	9	0.14 ... 1.5	0.14 ... 0.5 ¹⁾ 0.25 ... 1.5 ²⁾

1) with plastic cable cover

2) without plastic cable cover

- Connecting signal interface*
- ▶ Make sure that the wiring and the cables meet the requirements for PELV.
 - ▶ Attach the connector to CN4.

4.3.6 Connection of motor phases (CN3)

⚠ DANGER

Electric shock

High voltages at the motor connection may occur unexpectedly.

- The motor generates voltage when the shaft is rotated. Lock the motor shaft to prevent rotation before starting work on the drive system.
- AC voltages may jump over unused wires in the motor cable. Isolate unused wires at both ends of the motor cable.
- It is the system manufacturer's responsibility to ensure compliance with all applicable regulations on earthing the drive system. Extend the earth through the motor cable with an additional earth at the motor housing.

Failure to follow these instructions will result in death or serious injury.

Required connectors The connector is available as a component of a connector set. See chapter 9 "Accessories and spare parts".

	Designation	Type (Phoenix Combicon)
Motor plug	Spring force of connector section, 4-pin	FKC 2.5/ 4-STF-5.08

Monitoring The motor phases are monitored for short-circuiting between the phases.

A short-circuit between a motor phase and V_{DC} and a short circuit between a motor phase and 0V_{DC} is not recognised.

CN3 wiring diagram

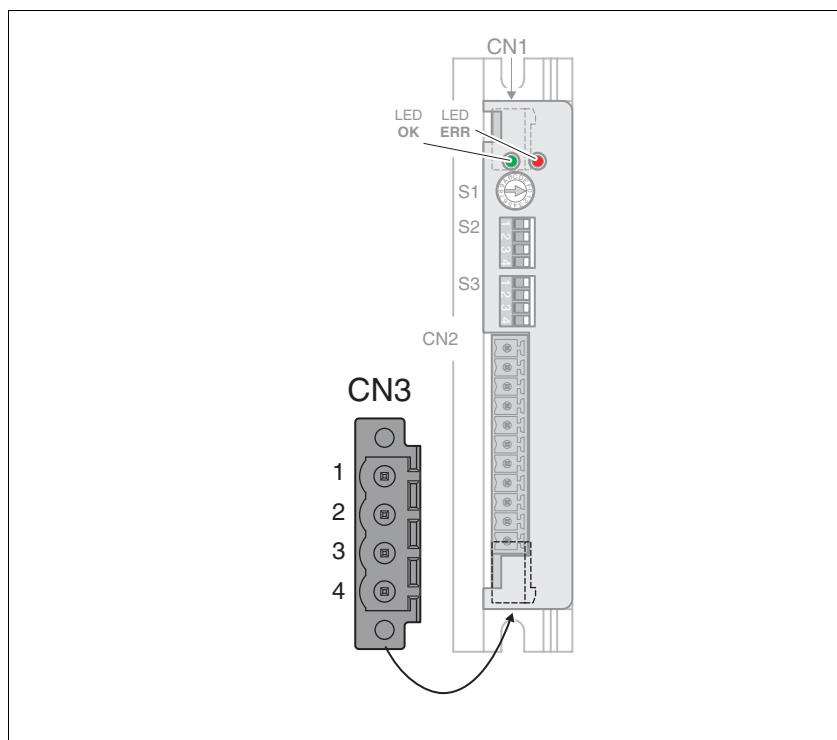


Figure 4.11 Motor wiring diagram

Connection	Description
1	Motor line U
2	Motor line V
3	Motor line W
4	Shield connection

Preparing cables

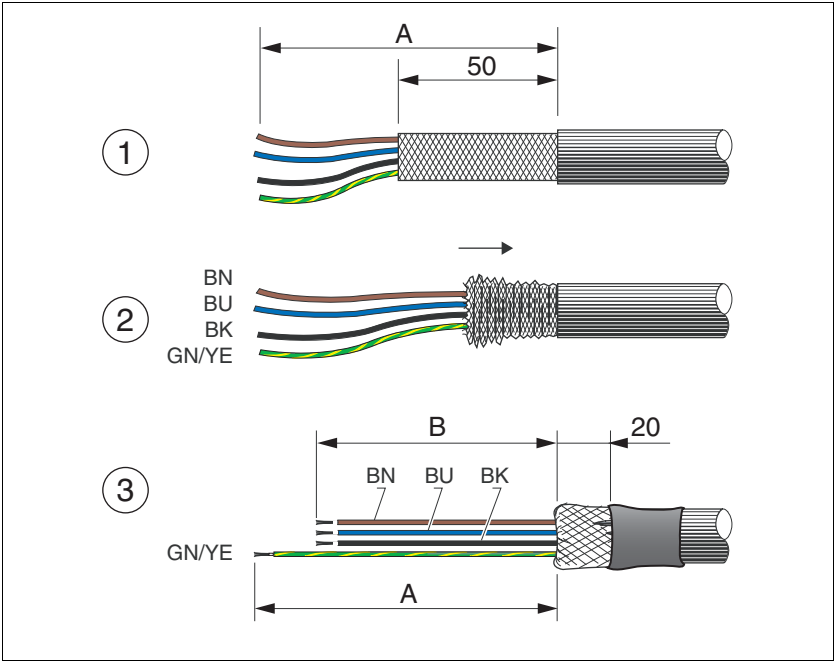


Figure 4.12 Preparing the motor cable

- (A) 70 mm
- (B) 60 mm

Connection	Description	Colour ¹⁾
U	Motor line	brown (BN)
V	Motor line	blue (BU)
W	Motor line	black (BK)
SHLD/Earth	Shield connection / Earth	green/yellow (GN/YE)

1) Colour specifications refer to the cables available as accessories

Note the dimensions specified when fabricating cables.

	max. length [m]	Stripped length [mm]	Rigid or flexible cross section [mm ²]	Flexible cross section with wire end ferrule [mm ²]
Motor cables	50	10	0.2 ... 2.5	0.25 ... 2.5

4.4 Checking installation

Check the following items:

- Are all cables and connectors safely installed and connected?
- Are any live cables exposed?
- Are the control lines connected correctly?
- Are all fuses correct?

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5 Commissioning

5.1 General safety instructions

DANGER

Motor out of view

When the system is started the drives are generally out of the operator's view and cannot be visually monitored.

- Only start the system if there are no persons in the operating zone of the moving components and the system can be operated safely.

Failure to follow these instructions will result in death or serious injury.

WARNING

Unexpected movement

When the drive is operated for the first time there is a high risk of unexpected movements because of possible wiring errors or unsuitable parameters.

- If possible, run the first test movement without coupled loads.
- Make sure that a functioning button for EMERGENCY STOP is within reach.
- Also anticipate a movement in the incorrect direction or oscillation of the drive.
- Make sure that the system is free and ready for the movement before starting the function.

Failure to follow these instructions can result in death, serious injury or equipment damage.

WARNING

Unbraked motor

In the case of power failure and faults which cause the power amplifier to be switched off, the motor is no longer controlled by the brake and increases its speed even more until it comes to a mechanical stop.

- Check the mechanical situation.
- If necessary, use a cushioned mechanical stop or a suitable brake.

Failure to follow these instructions can result in death, serious injury or equipment damage.

⚠ WARNING**Unexpected behaviour**

The behaviour of the drive system is governed by numerous stored data or settings. Unsuitable settings or data may trigger unexpected movements or reactions to signals and disable monitoring functions.

- Do not operate a drive system with unknown settings or data.
- Check the stored data or settings.
- When commissioning carefully run tests for all operating statuses and fault cases.
- Check the functions after replacing the product and also after making changes to the settings or data.
- Only start the system if there are no persons or materials in the danger zone and the system can be operated safely.

Failure to follow these instructions can result in death, serious injury or equipment damage.

⚠ CAUTION**Hot Surfaces**

The heat sink on the product may heat up to over 100 °C (212 °F) depending on the operating mode.

- Prevent contact with the hot heat sink.
- Do not install flammable or heat-sensitive components in the immediate vicinity.
- Follow the actions described for heat dissipation.

Failure to follow these instructions can result in injury or equipment damage.

5.2 Overview



The following commissioning steps are also required if you are using a configured unit under changed operating conditions.

What must be done

Chapter	from page
4.4 "Checking installation"	44
5.3.2 "Setting the nominal current at S1"	48
5.3.3 "Setting the current reduction and softstep at S2"	49
5.3.4 "Setting the number of steps and release at S3"	51
5.3.5 "Setting the source of the analogue signal at S4"	52
5.3.6 "Setting the potentiometers f_high (R1) and f_low (R2)"	52
5.3.7 "Setting potentiometers Acc (R3) and Dec (R4)"	52
5.3.8 "Test operation of the drive"	53

5.3 Commissioning procedure

5.3.1 Overview of parameter switches

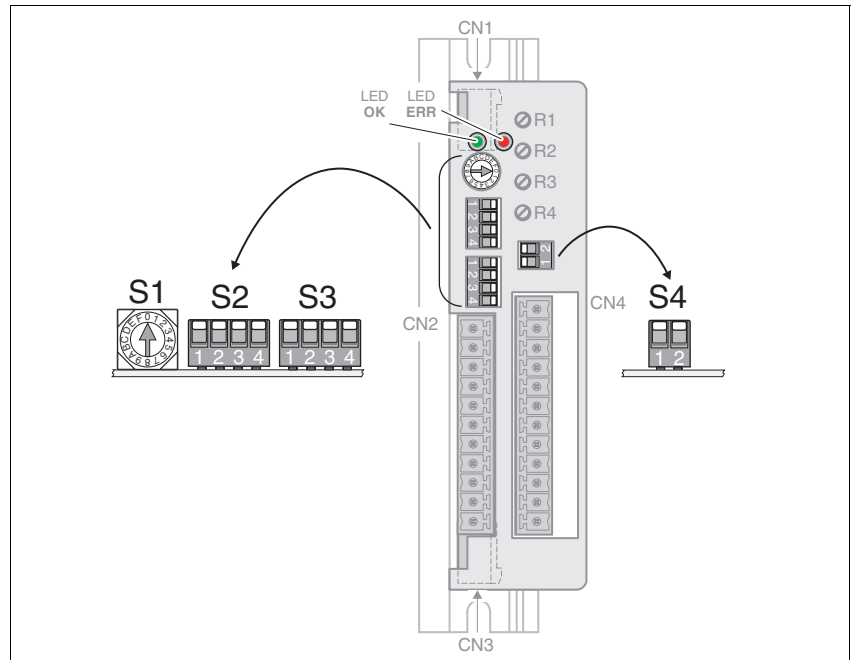


Figure 5.1 Overview of parameter switches

The settings for parameter switches S1, S2 and S3 only come into effect when the power amplifier is activated. Changing the settings when the power amplifier is activated has no direct impact. The settings for parameter switch S4 are also scanned when the power amplifier is activated.

5.3.2 Setting the nominal current at S1

IMPORTANT: The motor may be damaged or destroyed if you set a nominal current that is higher than the nominal current of the motor.

The nominal current of the motor is set using parameter switch S1.

- Using parameter switch S1, set the nominal current of the motor.

IMPORTANT: If the nominal current of the motor >7.5 A, you must set a current reduction of 67%.

Switch setting S1		Nominal current of motor
0 (factory setting)	[A]	3
1	[A]	3.7
2	[A]	4.4
3	[A]	4.8
4	[A]	5.2
5	[A]	5.5
6	[A]	5.8
7	[A]	6.2
8	[A]	6.6
9	[A]	7
A	[A]	7.5
B	[A]	8
C	[A]	8.5
D	[A]	9
E	[A]	9.5
F	[A]	10

5.3.3 Setting the current reduction and softstep at S2

Setting "current reduction" If the full holding torque is not required at standstill, the "current reduction" function can be used to reduce the holding torque.

⚠ WARNING

Dropping load at standstill

When the current reduction is enabled, the motor torque at standstill is reduced and result dropping in the case of axes with external forces (vertical axes).

- Check whether the load conditions allow operation with current reduction.
- If necessary, switch on the current reduction.

Failure to follow these instructions can result in death, serious injury or equipment damage.

Motor and electrics heat up less and the efficiency is improved.

The motor phase current is reduced to the defined value 100 ms after the last pulse edge. The defined value refers to the defined nominal current of the motor.

- Switch off all supply voltages. Make sure that power is no longer connected (safety instructions).
- Using parameter switches S2.1 to S2.3, set the current reduction.

IMPORTANT: If the nominal current of the motor >7.5 A, you must set a current reduction of 67%.

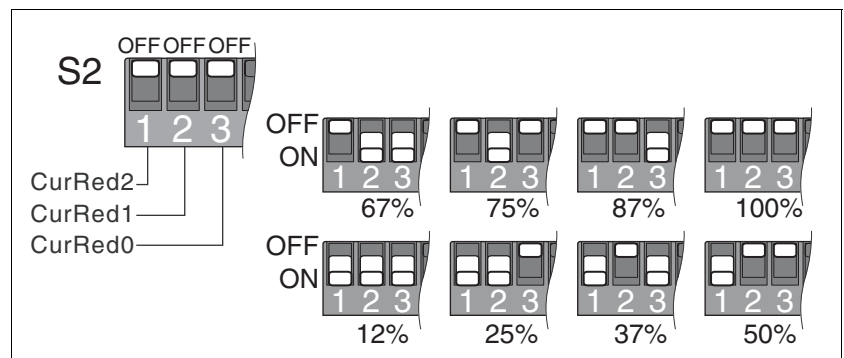


Figure 5.2 Setting "current reduction"

Setting the "softstep" Using the S2.4 parameter switch, you can set the "softstep" function.

When the function is active, the signals at the reference value interface are internally equalised. As a result, the motor operation is significantly smoother, particularly at low speeds or with a rough preset reference value.

A temporary position deviation then occurs temporarily during a motor movement. The size of the position deviation depends on the speed. The position deviation increases in line with the speed and may measure as much as a motor revolution.

You can calculate the position deviation using the following formula:

- Position deviation in degrees = speed in [1/min] / 8
- Position deviation in revolutions = speed in [1/min] / 2880

Once the motor is at a standstill, the position deviation is adjusted.

- Switch off all supply voltages. Make sure that power is no longer connected (safety instructions).
- Using the S2.4 parameter switch, set the "softstep" function to active or inactive.

Switch setting S2.4	Description
OFF (factory setting)	"softstep" function is deactivated
ON	"softstep" function is activated

5.3.4 Setting the number of steps and release at S3

Setting number of steps The resolution of the drive can be adjusted by the number of steps.

Example: at a number of steps of 1000 the drive runs exactly one complete motor revolution at 1000 pulses. At a pulse frequency of 1 kHz, this results in a speed of 60 1/min.

Factory setting The factory setting has a number of steps of 1000.

- Switch off all supply voltages. Make sure that power is no longer connected (safety instructions).
- Use parameter switches S3.1 to S3.3 to set the number of steps.

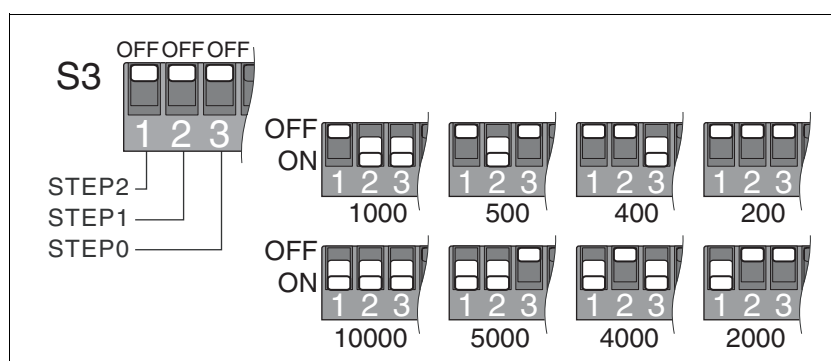


Figure 5.3 Setting number of steps

Setting release type The release type can be set with parameter switch S3.4.

For a description of the function see Chapter 6.2 "Functions".

- Switch off all supply voltages. Make sure that power is no longer connected (safety instructions).
- Use parameter switch S3.4 to set the type of release to "ENABLE" or "GATE".

Switch setting S3.4	Description
OFF (factory setting)	"ENABLE" function Activating and deactivating the power amplifier
ON	"GATE" function Block or release reference values

5.3.5 Setting the source of the analogue signal at S4

Source of the analogue signal Use parameter switch S4.1 to determine the source of the analogue signal for the oscillator. You can either use the integrated potentiometer f_high and f_low or an external potentiometer.

IMPORTANT: If an external potentiometer is used, the integrated potentiometer and the signal input F_HIGH do not have a function.

- ▶ Switch off all supply voltages. Make sure that power is no longer connected (safety instructions).
- ▶ Using parameter switch S4.1, set the source for the analogue signal.

Switch setting S4.1	Description
OFF (factory setting)	Integrated potentiometer f_high and f_low
ON	External potentiometer on ANA1

5.3.6 Setting the potentiometers f_high (R1) and f_low (R2)

The two integrated potentiometers f_high and f_low are used to set the frequency for fast and slow movement. Using appropriate parameter settings, you can set a higher frequency at f_low than at f_high. The scaling for both potentiometers is the same.

IMPORTANT: If an external potentiometer is used, the integrated potentiometer and the signal input F_HIGH do not have a function.

Direction of rotation	Description
clockwise	Higher frequency
counterclockwise	Lower frequency

5.3.7 Setting potentiometers Acc (R3) and Dec (R4)

The acceleration and deceleration ramps are set between two specified speeds using the two integrated potentiometers Acc and Dec.

IMPORTANT: If an external potentiometer is used, the integrated potentiometer and the signal input F_HIGH do not have a function.

Direction of rotation	Description
clockwise	steeper ramp
counterclockwise	flatter ramp

5.3.8 Test operation of the drive

Direction of rotation Rotation of the motor shaft in a positive or negative direction of rotation. A positive direction of rotation is defined as the motor shaft rotating clockwise as the observer faces the end of the protruding shaft.

- Function test*
- The type of release must be set to "ENABLE".
No signal should be available yet at the input `ENABLE..`
 - ▶ Switch on the supply voltage.
 - ▶ Check the status display, see Chapter 8.1 "Status display via LEDs".
 - ◁ LED OK (green) flashing: The device has the "Disable" status.
 - ▶ Activate the power amplifier via the `ENABLE` input.
 - ◁ LED OK (green) permanently lit up.
Output `ACTIVE_OUT` is ready for operation.
 - ▶ Start the first test with a low pulse frequency. If the signal `DIR` has 0-level, the motor must rotate clockwise.
 - ▶ Also carry out positioning in the reverse direction. Interchanging the active edge at the signal `PULSE` may displace the position if the direction is reversed.

If the motor follows the reference values, the motor is correctly controlled.

Temperature check The maximum temperature of the motor must not be exceeded. The temperature of the motor is not monitored by the drive.

- ▶ Test the motor under realistic conditions.
- ▶ Check the temperature of the motor.

6 Operation

The chapter "Operation" describes the basic functions of the device.

6.1 Overview

Drive The drive SD3150 moves the stepper motor in line with a preset reference value.

There are several ways of specifying the reference values:

- using a pulse signal from a positioning or NC controller
- using 2 different frequencies set on the integrated potentiometers
- using an external potentiometer

If the two integrated potentiometers are used, you can select the particular frequency via the signal input `F_HIGH`.

The drive accelerates or decelerates the motor to a new specified speed with the acceleration and deceleration values set using the integrated potentiometers `Acc` and `Dec`.

The resolution of the drive can be adjusted by the number of steps.

6.2 Functions

⚠ WARNING

Unexpected movement

The product has static inputs. Depending on the wiring, the product may accidentally be restarted when the supply voltage is applied or after a power outage.

- Plan and check the response of the system when the supply voltage is applied.
- Make sure that no persons can be endangered by a restart of the system after a power failure.

Failure to follow these instructions can result in death or serious injury.

6.2.1 Input `ENABLE`

Function The input `ENABLE` activates or deactivates the power amplifier. In the case of a falling edge, an error message is also reset.

Signal value	Description
rising edge	Activate power amplifier
falling edge	Deactivate power amplifier and reset error message

If there is no malfunction, the output `ACTIVE_OUT` displays the readiness status approximately 500 ms after the power amplifier is activated.

6.2.2 Input GATE

Function The input **GATE** blocks the signals at the signal interface without disabling the operating readiness. In a multi-axis system you can select individual axes with **GATE**.

Signal value	Description
rising edge	blocking signals
falling edge	releasing signals

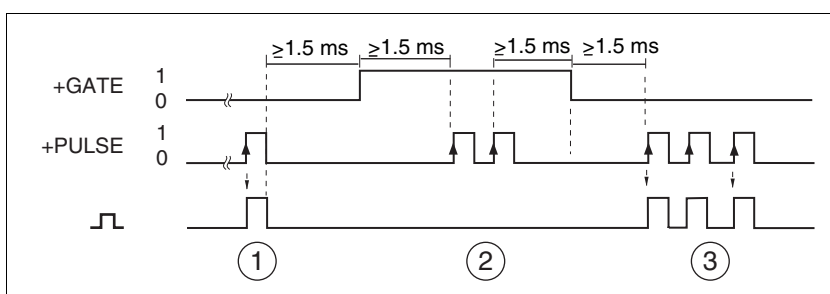


Figure 6.1 Signal sequences during switch-on via **GATE**

- (1) Motor step
- (2) no motor steps
- (3) motor steps

There must be no pulse pending for 1.5 ms before and after switching the signal **GATE** to ensure that the drive can follow the pulse preset step by step.

6.2.3 Input PULSE/DIR

Function The motor executes a motor step with the rising edge of the **PULSE** signal. The direction of rotation is controlled by the **DIR** signal.

IMPORTANT: The signal input **PULS** must not be used in parallel with the oscillator.

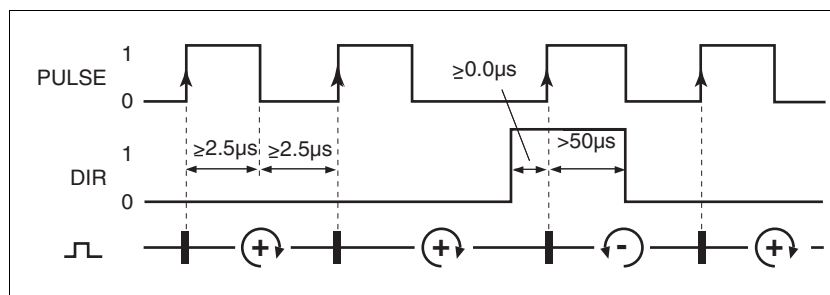


Figure 6.2 "PULSE/DIR" interface mode

Signal	Signal value	Description
PULSE	rising edge	Motor step
DIR	0 level	clockwise rotation
	1 level	counterclockwise rotation

The maximum frequency is 200 Hz.

6.2.4 Input START

Function The START input activates the oscillator and thus the conversion of analogue signals into a rotary movement. For a motor movement to take place, either the power amplifier must be activated via the signal input ENABLE or the signal input GATE must be released.

IMPORTANT: The signal input PULS must not be used in parallel with the oscillator.

Signal value	Description
0 level	Oscillator deactivated
1 level	Oscillator activated

6.2.5 Input F_HIGH

Function The F_HIGH input activates the fast movement. The frequencies for the fast and slow movement are set using the integrated potentiometers f_high and f_low. This function is not available if an external potentiometer is used.

Signal value	Description
0 level	Slow movement; frequency of f_low is analysed
1 level	Fast movement; frequency of f_high is analysed

6.2.6 Input ANA1

Function You can connect an external potentiometer to the ANA1 analogue input. Depending on the switch setting of S4.1, the analogue signal is specified for the oscillator using ANA1. See 5.3.5 "Setting the source of the analogue signal at S4"

IMPORTANT: If an external potentiometer is used, the integrated potentiometer and the signal input F_HIGH do not have a function.

6.2.7 Output PULS_OUT_NO

Function The PULS_OUT_NO output outputs the pulse signal generated by the oscillator. The output is polarised. The corresponding reference potential is connected to 0V_EXT.

6.2.8 Output DIR_OUT_NO

Function The DIR_OUT_NO output switches in accordance with the direction of rotation of the motor. The output is polarised. The corresponding reference potential is connected to 0V_EXT.

Signal value	Description
open	clockwise rotation
closed	counterclockwise rotation

6.2.9 Output ACTIVE_OUT

The ACTIVE_OUT output displays the operating readiness.

Signal value	Description
open	Power amplifier deactivated, motor de-energised
closed	Power amplifier activated, Motor energised

6.3 Monitoring functions

Multiple monitoring systems protect the product from destruction.

<i>Overtemperature</i>	<p>If the maximum allowable temperature ($>90\text{ °C}$) of the power amplifier is exceeded, the product is shut down. The error is signalled by the LED ERR (red).</p> <p>Once the fault is cleared, you can reset the error message using a falling edge at the <code>ENABLE</code> signal input.</p> <p>The temperature of the motor is not monitored.</p>
<i>Overvoltage</i>	<p>The power amplifier is deactivated if an upper voltage threshold ($60V_{DC}$) is exceeded. The error is signalled by the LED ERR (red).</p> <p>Once the fault is cleared, you can reset the error message using a falling edge at the <code>ENABLE</code> signal input.</p>
<i>Undervoltage</i>	<p>The power amplifier is deactivated if a lower voltage threshold ($<18V_{DC}$) is not reached. The error is indicated by the LED ERR (red), if sufficient voltage is available.</p> <p>Once the fault is cleared, you can reset the error message using a falling edge at the <code>ENABLE</code> signal input.</p>
<i>Short circuit</i>	<p>With the power amplifier active the device continuously checks the motor phases for short circuits. In the event of a short circuit, the power amplifier is deactivated and the motor coasts down in an uncontrolled manner. The error is signalled by the LED ERR (red).</p> <p>Once the fault is cleared, you can reset the error message using a falling edge at the <code>ENABLE</code> signal input.</p> <p>An earth fault is not detected.</p>

7 Examples

7.1 Wiring examples

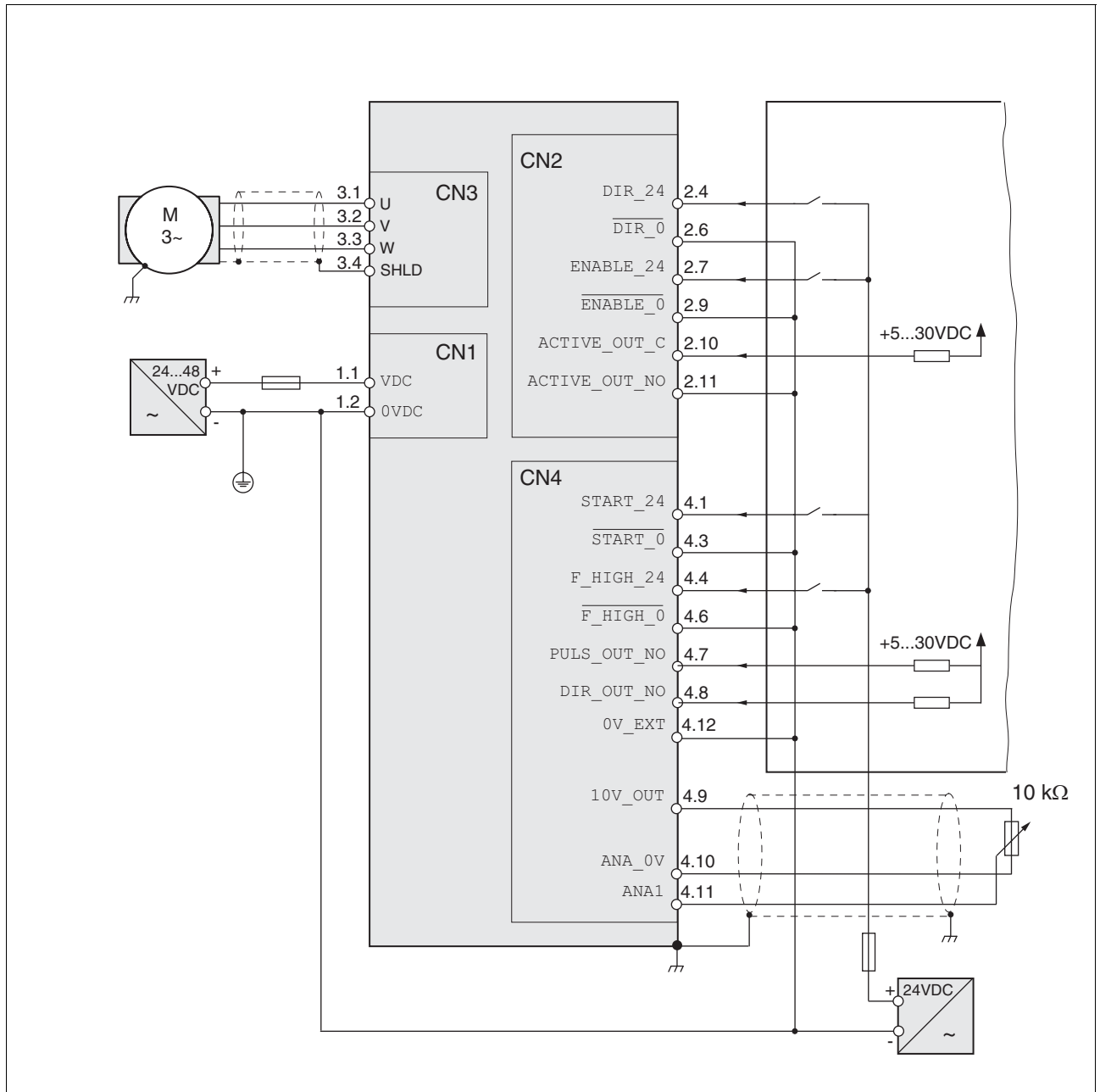


Figure 7.1 Wiring example with 24V

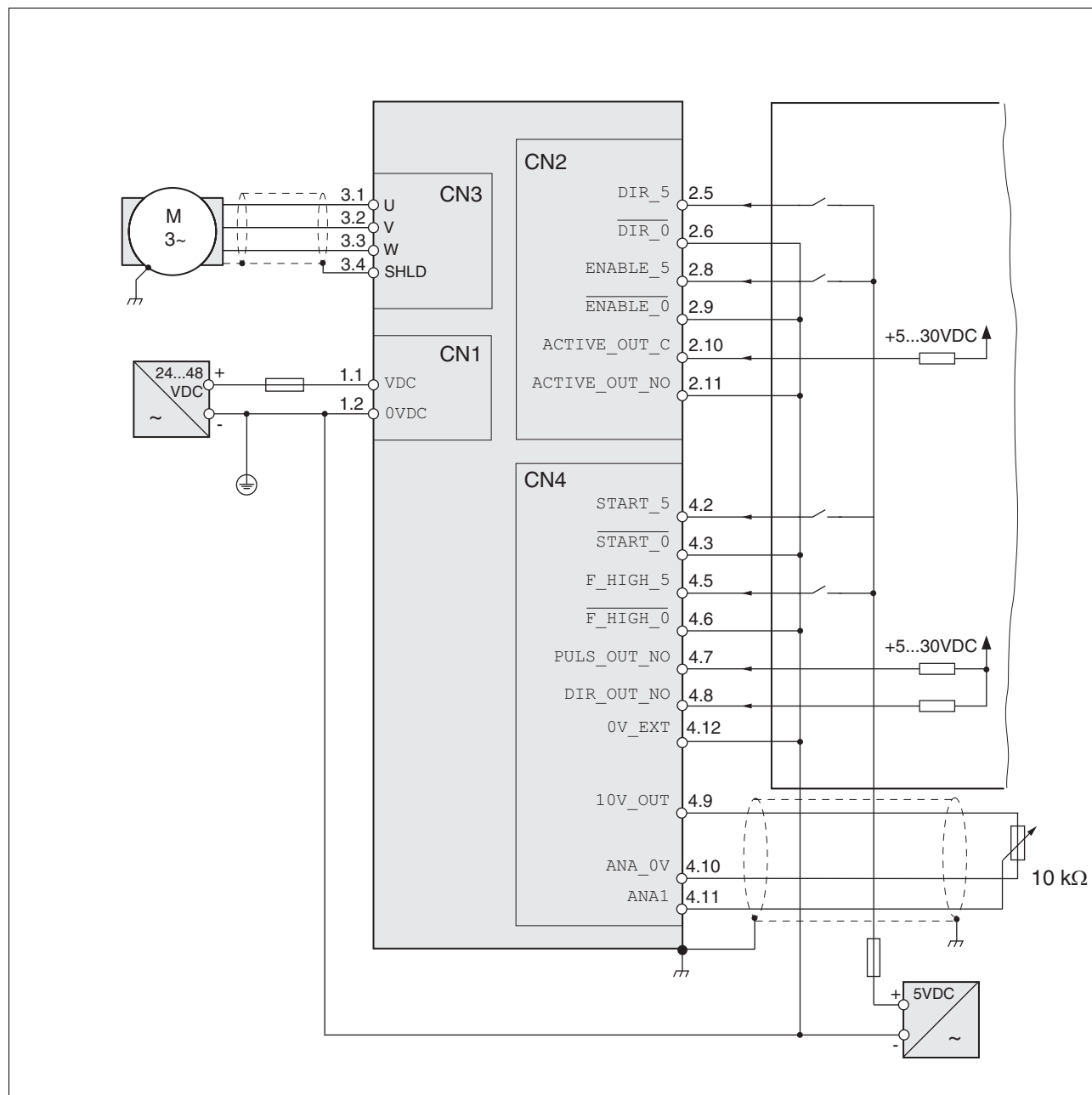


Figure 7.2 Wiring example with 5V

8 Diagnostics and troubleshooting

8.1 Status display via LEDs

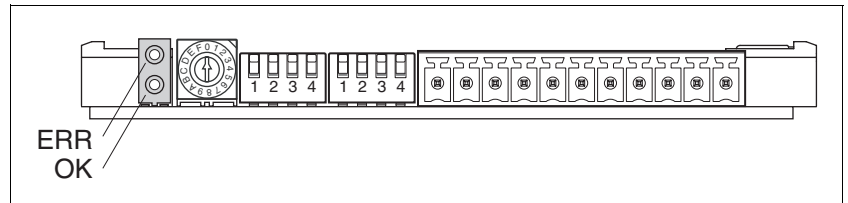


Figure 8.1 Status display via LEDs

The two LEDs display the current operating status.

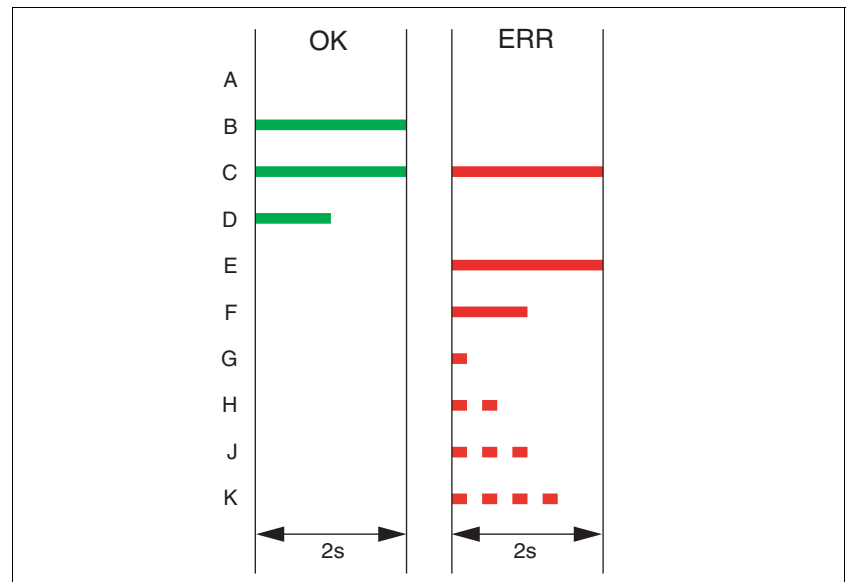


Figure 8.2 Flashing code of LED OK (green) and LED ERR (red)

- (A) No power supply.
- (B) Power amplifier is activated.
- (C) Reserved
- (D) Power amplifier is deactivated.
- (E) Reserved
- (F) Power amplifier overtemperature
- (G) Overvoltage, also in case of regeneration conditions.
- (H) Undervoltage
- (J) Reference signal frequency too high
- (K) Short circuit between two motor phases.

8.2 Troubleshooting

8.2.1 Resolution of malfunctions

Malfunction	Cause	Correction
Motor does not rotate and has no holding torque.	Break in the motor cable.	Check motor cable and connection. One or more motor phases are not connected.
	Signal input <code>ENABLE</code> is inactive.	Enable power amplifier.
Motor does not rotate and has no holding torque.	Motor mechanically blocked.	Check ancillary devices.
	Holding brake set.	Check the holding brake controller.
Motor rotates irregularly.	Overload.	Reduce load.
	Motor faulty.	Replace motor.
Motor rotates in the wrong direction.	Motor phases reversed.	Check motor phases.
	Signal input <code>DIR</code> has incorrect level.	Checking signal input.
LED flash code A	No power supply.	Check the power supply.
LED flash code E	reserved	reserved
LED flash code F	Overtemperature of power amplifier (>90 °C).	Check the temperature in the control cabinet. Check the motor phase current.
LED flash code G	Overvoltage (>60V _{DC}), also with regeneration	Also use a brake resistor actuator if applicable (e.g. UBC60).
		Error message must be reset.
LED flash code H	Undervoltage (<18V _{DC}).	Check power supply.
		Error message must be reset.
LED flash code J	Reference signal frequency too high	Check the frequency.
LED flash code K	Short circuit between two motor phases.	Check connections.
		Error message must be reset.

Reset error message Once the fault is cleared, you can reset the error message using a falling edge at the `ENABLE` signal input.

9 Accessories and spare parts

9.1 Optional accessories

Description	Order number
Adapter plate for mounting on DIN rail	MNA3MFDINR1
EMC kit	MNA3CS013
Braking Resistor Controller UBC60	ACC3EA001
Connector set 2, 4, 11, 12-pin, spring clamp terminals	MNA3CS009
Motor cable for stepper motor 4x1.5, shielded, 6-pin circular plug at the motor end; other cable end = open; length= 3m	VW3S4101R30
Motor cable for stepper motor 4x1.5, shielded, 6-pin circular plug at the motor end; other cable end = open; length= 5m	VW3S5101R50
Motor cable for stepper motor 4x1.5, shielded, 6-pin circular plug at the motor end; other cable end = open; length= 10m	VW3S5101R100
Motor cable for stepper motor 4x1.5, shielded, 6-pin circular plug at the motor end; other cable end = open; length= 15m	VW3S5101R150
Motor cable for stepper motor 4x1.5, shielded, 6-pin circular plug at the motor end; other cable end = open; length= 20m	VW3S5101R200
Motor cable for stepper motor 4x1.5, shielded, both cable ends = open; length= 3m	VW3S5102R30
Motor cable for stepper motor 4x1.5, shielded, both cable ends = open; length= 5m	VW3S5102R50
Motor cable for stepper motor 4x1.5, shielded, both cable ends = open; length= 10m	VW3S5102R100
Motor cable for stepper motor 4x1.5, shielded, both cable ends = open; length= 15m	VW3S5102R150
Motor cable for stepper motor 4x1.5, shielded, both cable ends = open; length= 20m	VW3S5102R200
HBC Holding brake controller	VW3M3103

Connector set 2, 4, 11, 12-pin The listed connectors can be procured as a connector set.

	Designation	Type (Phoenix Combicon)
Power supply	Spring force of connector section, 2-pin	FKC 2.5/ 2-STF-5.08
Signal connector	Spring force of connector section, 11-pin	FK-MCP 1.5/11-ST-3.81
Motor plug	Spring force of connector section, 4-pin	FKC 2.5/ 4-STF-5.08
Oscillator connector	Spring force of connector section, 12-pin	FK-MCP 1.5/12-ST-3.81

10 Service, maintenance and disposal



You cannot carry out repairs yourself. The repair should only be carried out by a certified customer service organisation. No warranty or liability is accepted for repairs made by the customer.

10.1 Service address

If you cannot resolve the fault yourself please contact your appointed sales partner. Have the following details available:

- Type plate (Type, identification number, serial number, DOM, ...)
- Type of fault (possibly with flash code or fault number)
- Previous and concurrent conditions
- Your own ideas regarding the cause of the fault

Include this information if you return the product for inspection or repair.



If you have any questions please contact your local dealer. Your dealer will be happy to give you the name of a customer service outlet in your area.

<http://www.berger-lahr.com>

10.2 Maintenance

The product is maintenance free.

10.3 Replacing units

⚠ WARNING

Unexpected behaviour

The behaviour of the drive system is governed by numerous stored data or settings. Unsuitable settings or data may trigger unexpected movements or reactions to signals and disable monitoring functions.

- Do not operate a drive system with unknown settings or data.
- Check the stored data or settings.
- When commissioning carefully run tests for all operating statuses and fault cases.
- Check the functions after replacing the product and also after making changes to the settings or data.
- Only start the system if there are no persons or materials in the danger zone and the system can be operated safely.

Failure to follow these instructions can result in death, serious injury or equipment damage.

10.4 Changing the motor

- ▶ Switch off all supply voltages. Make sure that power is no longer connected (safety instructions).
- ▶ Label all connections and remove the product.
- ▶ Note the identification number and the serial number from the product nameplate for later identification.
- ▶ Install the new product as specified in 4 "Installation"
- ▶ Carry out commissioning as described in chapter 5 "Commissioning".

10.5 Shipping, storage, disposal

Note the ambient conditions in the chapter 3.1 "Environmental conditions"!

<i>Shipping</i>	The product must be protected against shocks during transport. Use the original packaging for this purpose.
<i>Storage</i>	Store the product only under the specified, approved environmental conditions for room temperature and humidity. Protect the product against dust and dirt.
<i>Disposal</i>	The product consists of various materials that can be recycled and must be disposed of separately. Dispose of the product in accordance with local regulations.

11 Extract

This extract does not replace the manual. It simply provides a brief overview of the device, but it is definitely not sufficient for correct commissioning. The manual must always be read carefully before commissioning to prevent errors in connection or installation.

DANGER

Unexpected risks

Unexpected risks may arise during installation, commissioning and maintenance.

- You should only perform the installation, commissioning or maintenance work if you are a qualified technician.
- Read the manual carefully, paying particular attention to the safety instructions in the chapter on Safety, Installation and Commissioning.

Failure to follow these instructions will result in death or serious injury.

11.1 Electromagnetic compatibility, EMC

Note the EMC specifications and instructions in the chapter on “Installation”. Make sure that all national regulations are observed.

11.2 Compact installation

Connection CN1

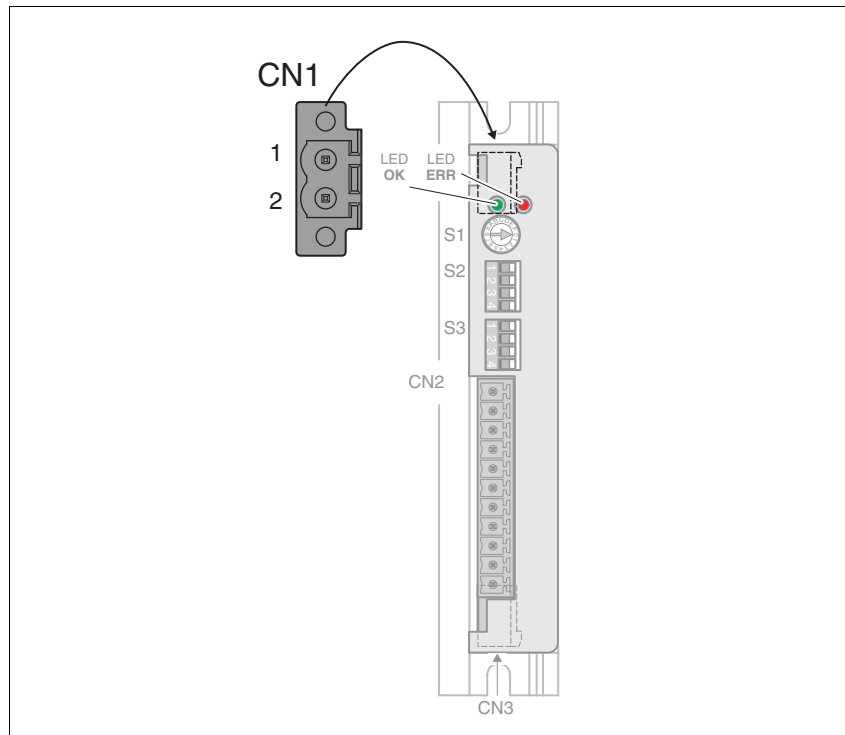


Figure 11.1 Connector CN1

Pin	Signal	Description
1	VDC	Power supply
2	0VDC	Reference potential to VDC

Connection CN2

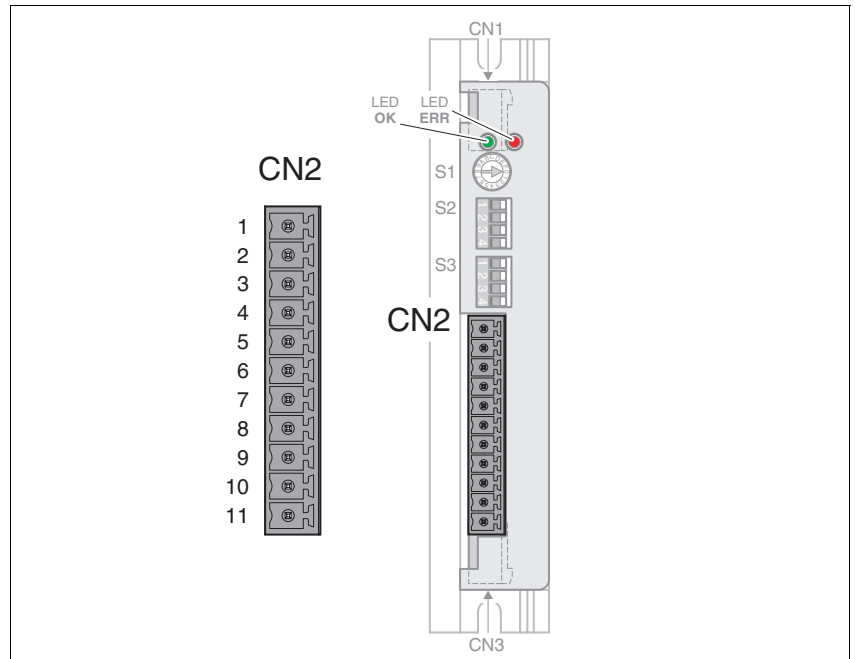


Figure 11.2 Wiring diagram signal interface CN2

Pin	Signal	Description	5V/24V	I/O
1	PULSE (24)	Motor step	24 V	I
2	PULSE (5)	Motor step	5V	I
3	$\overline{\text{PULSE}} (0)$	Reference potential		I
4	DIR (24)	Direction of rotation	24 V	I
5	DIR (5)	Direction of rotation	5V	I
6	$\overline{\text{DIR}} (0)$	Reference potential		I
7	ENABLE (24) or GATE (24)	Activating the power amplifier or locking the reference values	24 V	I
8	ENABLE (5) or GATE (5)	Activating the power amplifier or locking the reference values	5V	I
9	$\overline{\text{ENABLE}} (0)$ or $\overline{\text{GATE}} (0)$	Reference potential		I
10	ACTIVE_OUT_C	Readiness		O
11	ACTIVE_OUT_NO	Readiness		O

Connection CN3

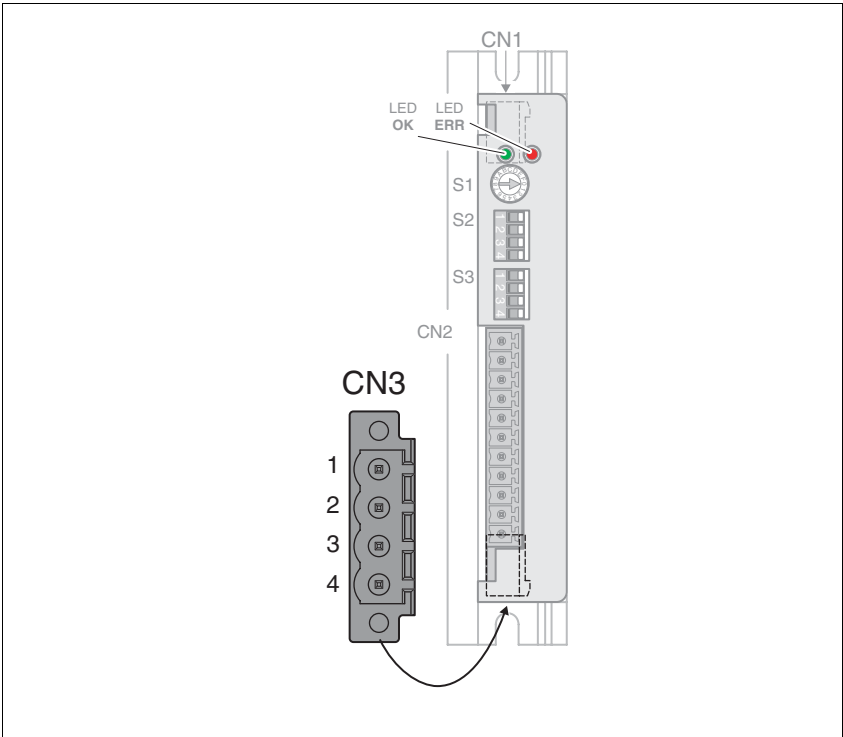


Figure 11.3 Motor wiring diagram

Preparing cables

PIN	Connection	Description	Colour ¹⁾
1	U	Motor line	brown (BN)
2	V	Motor line	blue (BU)
3	W	Motor line	black (BK)
4	SHLD/Earth	Shield / Earth	green/yellow (GN/YE)

1) Colour specifications refer to the cables available as accessories

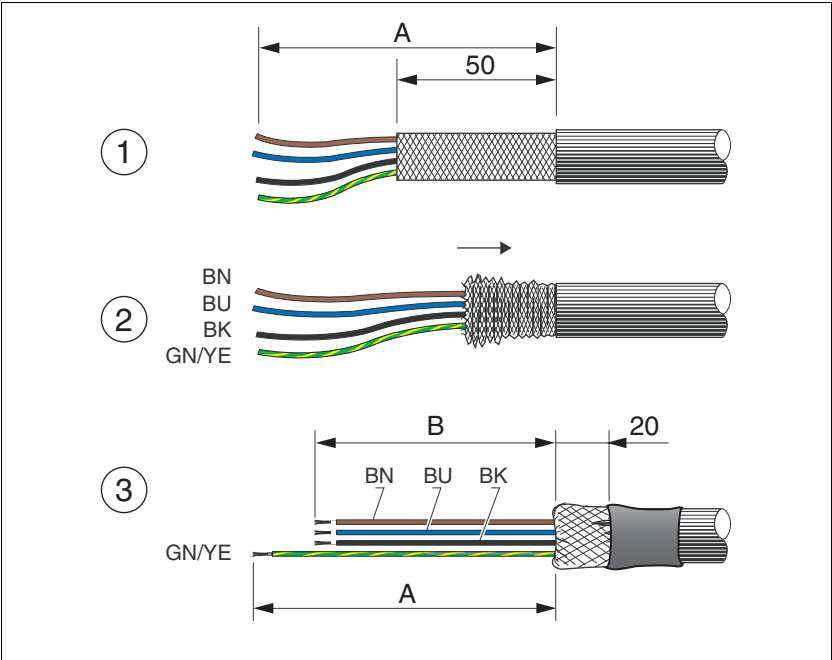


Figure 11.4 Preparing the motor cable

- (A) 70 mm
- (B) 60 mm

	max. length [m]	Stripped length [mm]	Rigid or flexible cross section [mm ²]	Flexible cross section with wire end ferrule [mm ²]
Motor cables	50	10	0.2 ... 2.5	0.25 ... 2.5

Connection CN4

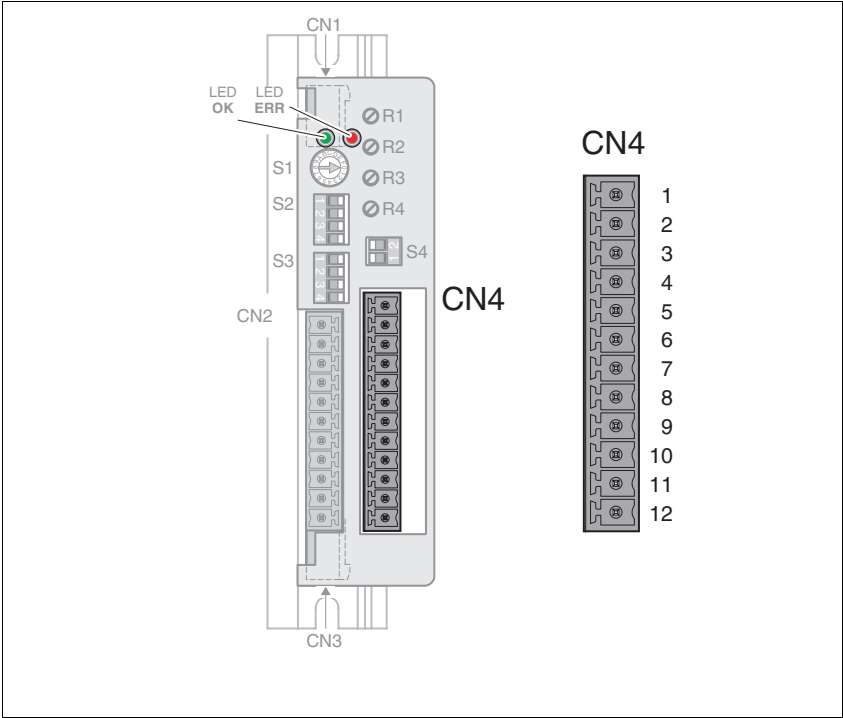


Figure 11.5 Wiring diagram for signal interface (CN4)

Pin	Signal	Description	5V/24V	I/O
1	START (24)	Start of motor movement	24 V	I
2	START (5)	Start of motor movement	5V	I
3	$\overline{\text{START}} (0)$	Start of motor movement	-	-
4	F_HIGH (24)	Fast/slow movement	24 V	I
5	F_HIGH (5)	Fast/slow movement	5V	I
6	$\overline{\text{F_HIGH}} (0)$	Fast/slow movement	-	-
7	PULS_OUT_NO	Pulse output	-	O
8	DIR_OUT_NO	Direction signals output	-	O
9	10V_OUT	10VDC supply for external potentiometer	-	O
10	ANA_0V	Reference potential for potentiometers	-	-
11	ANA1	Analogue input	-	I
12	0V_EXT	Reference potential for the outputs PULS_OUT_NO and DIR_OUT_NO	-	-

The 24V input and 5V input per signal, for example PULSE (24) and PULSE (5), must not be connected simultaneously.

11.3 Compact commissioning

11.3.1 Setting the nominal current at S1

The nominal current of the motor is set using parameter switch S1.

- Using parameter switch S1, set the nominal current of the motor.

IMPORTANT: If the nominal current of the motor >7.5 A, you must set a current reduction of 67%.

Switch setting S1		Nominal current of motor
0 (factory setting)	[A]	3
1	[A]	3.7
2	[A]	4.4
3	[A]	4.8
4	[A]	5.2
5	[A]	5.5
6	[A]	5.8
7	[A]	6.2
8	[A]	6.6
9	[A]	7
A	[A]	7.5
B	[A]	8
C	[A]	8.5
D	[A]	9
E	[A]	9.5
F	[A]	10

11.3.2 Setting the current reduction and softstep at S2

Setting "current reduction" If the full holding torque is not required at standstill, the "current reduction" function can be used to reduce the holding torque.
Motor and electrics heat up less and the efficiency is improved.



Figure 11.6 Setting "current reduction"

Setting the "softstep" Using the S2.4 parameter switch, you can set the "softstep" function.
When the function is active, the signals at the reference value interface are internally equalised. As a result, the motor operation is significantly smoother, particularly at low speeds or with a rough preset reference value.

Switch setting S2.4	Description
OFF (factory setting)	"softstep" function is deactivated
ON	"softstep" function is activated

11.3.3 Setting the number of steps and release at S3

Setting number of steps The resolution of the drive can be adjusted by the number of steps.

Example: at a number of steps of 1000 the drive runs exactly one complete motor revolution at 1000 pulses.

At a pulse frequency of 1 kHz, this results in a speed of 60 1/min.

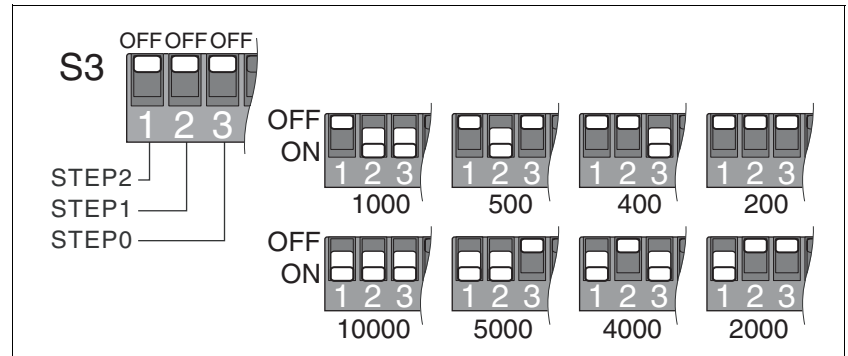


Figure 11.7 Setting number of steps

Setting release type The release type can be set with parameter switch S3.4.

Switch setting S3.4	Description
OFF (factory setting)	"ENABLE" function Activating and deactivating the power amplifier
ON	"GATE" function Block or release reference values

11.3.4 Setting the source of the analogue signal at S4.1

Source of the analogue signal Use parameter switch S4.1 to determine the source of the analogue signal for oscillator mode. You can either use the integrated potentiometer f_high and f_low or an external potentiometer.

IMPORTANT: If an external potentiometer is used, the integrated potentiometer and the signal input F_HIGH do not have a function.

- ▶ Switch off all supply voltages. Make sure that power is no longer connected (safety instructions).
- ▶ Using parameter switches S4.1, set the source for the analogue signal.

Switch setting S4.1	Description
OFF (factory setting)	Integrated potentiometer f_high and f_low
ON	External potentiometer on ANA1

11.3.5 Setting the f_high and f_low potentiometers

The two integrated potentiometers f_high and f_low are used to set the frequency for fast and slow movement.

IMPORTANT: If an external potentiometer is used, the integrated potentiometer and the signal input F_HIGH do not have a function.

Direction of rotation	Description
clockwise	Higher frequency
counterclockwise	Lower frequency

11.3.6 Setting the potentiometers Acc (R3) and Dec (R4)

The acceleration and deceleration ramps are set between two changes in speed using the two integrated potentiometers Acc and Dec.

IMPORTANT: If an external potentiometer is used, the integrated potentiometer and the signal input F_HIGH do not have a function.

Direction of rotation	Description
clockwise	steeper ramp
counterclockwise	flatter ramp

12 Glossary

12.1 Units and conversion tables

The value in the specified unit (left column) is calculated for the desired unit (top row) with the formula (in the field).

Example: conversion of 5 metres [m] to yards [yd]

5 m / 0.9144 = 5.468 yd

12.1.1 Length

	in	ft	yd	m	cm	mm
in	-	/ 12	/ 36	* 0.0254	* 2.54	* 25.4
ft	* 12	-	/ 3	* 0.30479	* 30.479	* 304.79
yd	* 36	* 3	-	* 0.9144	* 91.44	* 914.4
m	/ 0.0254	/ 0.30479	/ 0.9144	-	* 100	* 1000
cm	/ 2.54	/ 30.479	/ 91.44	/ 100	-	* 10
mm	/ 25.4	/ 304.79	/ 914.4	/ 1000	/ 10	-

12.1.2 Mass

	lb	oz	slug	kg	g
lb	-	* 16	* 0.03108095	* 0.4535924	* 453.5924
oz	/ 16	-	* 1.942559*10 ⁻³	* 0.02834952	* 28.34952
slug	/ 0.03108095	/ 1.942559*10 ⁻³	-	* 14.5939	* 14593.9
kg	/ 0.453592370	/ 0.02834952	/ 14.5939	-	* 1000
g	/ 453.592370	/ 28.34952	/ 14593.9	/ 1000	-

12.1.3 Force

	lb	oz	p	dyne	N
lb	-	* 16	* 453.55358	* 444822.2	* 4.448222
oz	/ 16	-	* 28.349524	* 27801	* 0.27801
p	/ 453.55358	/ 28.349524	-	* 980.7	* 9.807*10 ⁻³
dyne	/ 444822.2	/ 27801	/ 980.7	-	/ 100*10 ³
N	/ 4.448222	/ 0.27801	/ 9.807*10 ⁻³	* 100*10 ³	-

12.1.4 Power

	HP	W
HP	-	* 745.72218
W	/ 745.72218	-

12.1.5 Rotation

	1/min (RPM)	rad/s	deg./s
1/min (RPM) -		$\ast \pi / 30$	$\ast 6$
rad/s	$\ast 30 / \pi$	-	$\ast 57.295$
deg./s	/ 6	/ 57.295	-

12.1.6 Torque

	lb-in	lb-ft	oz-in	Nm	kp-m	kp-cm	dyne-cm
lb-in	-	/ 12	$\ast 16$	$\ast 0.112985$	$\ast 0.011521$	$\ast 1.1521$	$\ast 1.129 \ast 10^6$
lb-ft	$\ast 12$	-	$\ast 192$	$\ast 1.355822$	$\ast 0.138255$	$\ast 13.8255$	$\ast 13.558 \ast 10^6$
oz-in	/ 16	/ 192	-	$\ast 7.0616 \ast 10^{-3}$	$\ast 720.07 \ast 10^{-6}$	$\ast 72.007 \ast 10^{-3}$	$\ast 70615.5$
Nm	/ 0.112985	/ 1.355822	/ 7.0616 $\ast 10^{-3}$	-	$\ast 0.101972$	$\ast 10.1972$	$\ast 10 \ast 10^6$
kp-m	/ 0.011521	/ 0.138255	/ 720.07 $\ast 10^{-6}$	/ 0.101972	-	$\ast 100$	$\ast 98.066 \ast 10^6$
kp-cm	/ 1.1521	/ 13.8255	/ 72.007 $\ast 10^{-3}$	/ 10.1972	/ 100	-	$\ast 0.9806 \ast 10^6$
dyne-cm	/ 1.129 $\ast 10^6$	/ 13.558 $\ast 10^6$	/ 70615.5	/ 10 $\ast 10^6$	/ 98.066 $\ast 10^6$	/ 0.9806 $\ast 10^6$	-

12.1.7 Moment of inertia

	lb-in ²	lb-ft ²	kg-m ²	kg-cm ²	kp-cm-s ²	oz-in ²
lb-in ²	-	/ 144	/ 3417.16	/ 0.341716	/ 335.109	$\ast 16$
lb-ft ²	$\ast 144$	-	$\ast 0.04214$	$\ast 421.4$	$\ast 0.429711$	$\ast 2304$
kg-m ²	$\ast 3417.16$	/ 0.04214	-	$\ast 10 \ast 10^3$	$\ast 10.1972$	$\ast 54674$
kg-cm ²	$\ast 0.341716$	/ 421.4	/ 10 $\ast 10^3$	-	/ 980.665	$\ast 5.46$
kp-cm-s ²	$\ast 335.109$	/ 0.429711	/ 10.1972	$\ast 980.665$	-	$\ast 5361.74$
oz-in ²	/ 16	/ 2304	/ 54674	/ 5.46	/ 5361.74	-

12.1.8 Temperature

	°F	°C	K
°F	-	$(^{\circ}\text{F} - 32) \ast 5/9$	$(^{\circ}\text{F} - 32) \ast 5/9 + 273.15$
°C	$^{\circ}\text{C} \ast 9/5 + 32$	-	$^{\circ}\text{C} + 273,15$
K	$(\text{K} - 273.15) \ast 9/5 + 32$	$\text{K} - 273.15$	-

12.1.9 Conductor cross section

AWG	1	2	3	4	5	6	7	8	9	10	11	12	13
mm ²	42.4	33.6	26.7	21.2	16.8	13.3	10.5	8.4	6.6	5.3	4.2	3.3	2.6

AWG	14	15	16	17	18	19	20	21	22	23	24	25	26
mm ²	2.1	1.7	1.3	1.0	0.82	0.65	0.52	0.41	0.33	0.26	0.20	0.16	0.13

12.2 Terms and Abbreviations

<i>AC</i>	Alternating Current
<i>DC</i>	Direct current
<i>Direction of rotation</i>	Rotation of the motor shaft in a positive or negative direction of rotation. A positive direction of rotation is defined as the motor shaft rotating clockwise as the observer faces the end of the protruding shaft.
<i>DOM</i>	(Date of manufacturing), the nameplate of the device shows the date of manufacture in the format DD.MM.YY, e.g. 31.12.06 (31. December 2006).
<i>Drive system</i>	The drive system consists of the controller, power amplifier and motor.
<i>EMC</i>	Electromagnetic compatibility.
<i>ESD</i>	(electrostatic discharge) is the electrostatic discharge and describes the processes and effects during compensation of electrical charges.
<i>LED</i>	Light-Emitting Diode
<i>Parameter switches</i>	Small, side-by-side switches. Must be set during installation.
<i>PELV</i>	Protective Extra Low Voltage, functional low voltage with safe isolation.
<i>PK</i>	Peak value of a voltage (V_{pk}) or a current (A_{pk}); abbreviation for "Peak".
<i>PLC</i>	Programmable Logic Controller
<i>Power amplifier</i>	A device that generates current for controlling the motor in accordance with the positioning signals from the controller.
<i>Protection class</i>	The protection class is a standardised specification for electrical equipment that describes the protection against the ingress of foreign bodies and water (for example, IP20).
<i>rms</i>	RMS value of a voltage (V_{rms}) or a current (A_{rms}); abbreviation of "Root Mean Square".

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