DE
EN

CDF3000

Operation manual

Operation Manual
Manual d'utilisation
Istruzioni di esercizio

Positioning controller

Rated current 8 A
Mains supply 24 ... 48

LTi

LTi

Operating Instructions CDF3000
CDF3000 Operation Manual
Manual d'utilisation CDF3000
Istruzioni di esercizio CDF3000

Note: The German version is the original version of the operation manual.

ID no.: 1040.20B.2-01 • **11/2010**

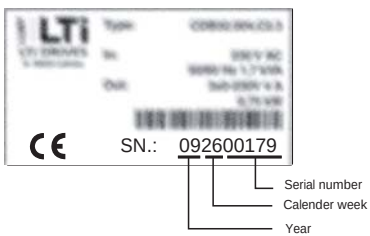
Valid from software version CDF V1.0
Valid from software version CDF V1.0

Documentation overview

Document	Ordering designation	Purpose
Operation manual CDF3000	1040.20B.x-xx	Installation and commissioning
Application Manual CDE/ CDB/CDF3000	1001.22B.x-xx	Project planning and description of function
Communication manual CANopen		Project planning and description of function
Communication manual PROFIBUS-DP		Project planning and description of function

Date of manufacture

On the name plate on the CDF drive units you will find the serial no. from which you can read the date of manufacture using the following key.



Declaration of conformity

Due to the current standardisation situation, there is still no final decision from the responsible institution on whether an EC declaration of conformance is required for drive controllers with integrated safety function.

Pictograms

➔ **Attention!** Operating errors may cause damage to or malfunction of the drive.

➔ **Danger, high voltage!** Improper behaviour may cause fatal accident.

➔ **Danger from rotating parts!** The drive may automatically start.

➔ **Note:** Useful information

Table of contents

1 Safety

1.1 Measures for your safety

In order to avoid physical injury and/or material damage the following information must be read before initial start-up. The safety regulations must be strictly observed at any time.

Read the Operation Manual first!

- Follow the safety instructions!

Electric drives are generally potential danger sources:

- Rotating parts
- Hot surfaces
- Electrical voltages

Protection against magnetic and/or electromagnetic fields during installation and operation.

- For persons with pacemakers, metal containing implants and hearing aids etc. access to the following areas is prohibited:
  - Areas in which drive systems are installed, repaired and operated.
  - Areas in which motors are assembled, repaired and operated. Motors with permanent magnets are sources of special dangers.

Note: If there is a necessity to access such areas a decision from a physician is required.

Your qualification:

- In order to prevent personal injury or damage to property, only personnel with electrical engineering qualifications may work on the device.
- The qualified personnel must familiarise themselves with the Operation Manual (refer to IEC364, DIN VDE0100).
- Knowledge of the national accident prevention regulations (e. g. VBG 4 in Germany)

During installation follow these instructions:

- Always comply with the connection conditions and technical specifications.
- Comply with the standards for electrical installations, such as wire cross-section, earthing lead and ground connections .
- Do not touch electronic components and contacts (electrostatic discharge may destroy components).

Pictograms used

The notes on safety describe the following danger classes.
The danger class describes the risk which may arise when not complying with the note on safety.

Warning symbols	General explanation	Danger class acc. to ANSI Z 535
	**Attention!** Operating errors may cause damage to or malfunction of the drive.	This may result in physical injury or damage to material.
	**Danger, high voltage!** Improper behaviour may cause fatal accident.	Danger to life or severe physical injury.
	**Danger from rotating parts!** The drive may automatically start. In particular, on the usage of the "automatic restart" (Autostart) function it is to be ensured that a hazard is not produced.	Danger to life or severe physical injury.

1.2 Intended use

Drive controllers are components for installation into electric systems or machines.

When installed in machines the commissioning of the drive controller (i. e. start-up of intended operation) is prohibited, unless it has been ascertained that the machine fully complies with the regulations of the EC-directive 2006/42/EC (Machine Directive); compliance with EN 60204 is mandatory.

Commissioning (i. e. starting intended operation) is only permitted when strictly complying with EMC-directive (2004/108/EEC).

CE The series CDF3000 complies with the EMC directive 2004/108/EEC

The harmonized standards EN 61800-3 and EN 61800-5-1 are applied for the drive controllers.

If the drive controller is used in special applications, e. g. in areas subject to explosion hazards, the applicable regulations and standards (e. g. in Ex-environments EN 50014 “General provisions” and EN 50018 “Flame-proof housing”) must be strictly observed.

Repairs must only be carried out by authorized repair workshops. Unauthorised opening and incorrect intervention could lead to physical injury or material damage. The warranty granted by LTi will become void.

1.3 Responsibility

Electronic devices are never fail-safe. The company setting up and/or operating the machine or plant is itself responsible for ensuring that the drive is rendered safe if the device fails.

EN 60204-1/DIN VDE 0113 "Safety of machines", in the section on "Electrical equipment of machines", stipulates safety requirements for electrical controls. They are intended to protect personnel and machinery, and to maintain the function capability of the machine or plant concerned, and must be observed.

An emergency stop system does not necessarily have to cut the power supply to the drive. To protect against danger, it may be more beneficial to keep individual drives running or to initiate specific safety sequences. Execution of the emergency stop measure is assessed by means of a risk analysis of the machine or plant, including the electrical equipment in accordance with EN ISO 14121, and is determined by selecting the circuit category in accordance with EN ISO 13849-1 "Safety of machines - Safety-related parts of controls".

Prior to the use of the Autostart function, the user must ensure that an automatic machine restart does not produce any hazards for the operator or machine.

2 Mechanical installation

2.1 Notes for operation

Please ensure that ...

- no moisture enters into the device,
- no aggressive or conductive substances are in the immediate vicinity,
- no drill chippings, screws or foreign bodies drop into the device,
- the ventilation openings are not covered over.

The unit may otherwise be damaged.

Please note:

- Cooling air must be able to flow through the device without restriction.
- For mounting in switch cabinets with convection (= heat loss is discharged to the outside via the cabinet walls), always fit an internal air circulation fan.
- The backing plate must be well earthed.
- The unit is only intended for vertical installation in cabinets.
- The switch cabinet must as a minimum provide IP4x protection.

Attention: According to EN ISO 13849-2 the switch cabinet must have IP54 protection or higher when using the STO (Safe Torque OFF) safety function.

- To attain the best result for effective EMC installation use a chromated or galvanized backing plate. If backing plates are varnished, remove the coating from the contact area. The devices themselves have an aluminium rear panel.

- Maximum pollution severity 2.

Further information on environmental conditions can be found in the appendix.

2.2 Wall mounting

Step	Action	Comment
1	Mark the position of the tapped holes on the backing plate. Cut a tap for each fixing screw in the backing plate.	Dimensional drawings/hole spacing see Table 2.1 The tapping area will provide you with good, full-area contact.
2	Mount the servo regulator **vertically** on the backing plate.	Do not forget the mounting clearances! The metal of the contact surface must not be insulated.
3	Mount the other components, e.g. mains filter, mains choke etc. on the mounting plate.	The cable between mains filter and servo controller is allowed to be max. 30 cm long.
4	Continue with the electrical installation in section 3.	

Table 2.1 Device mounting

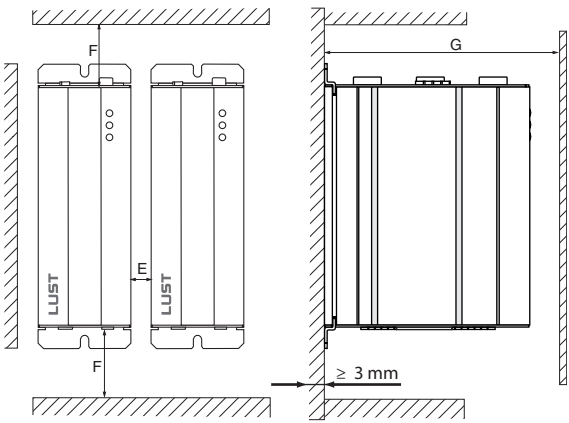
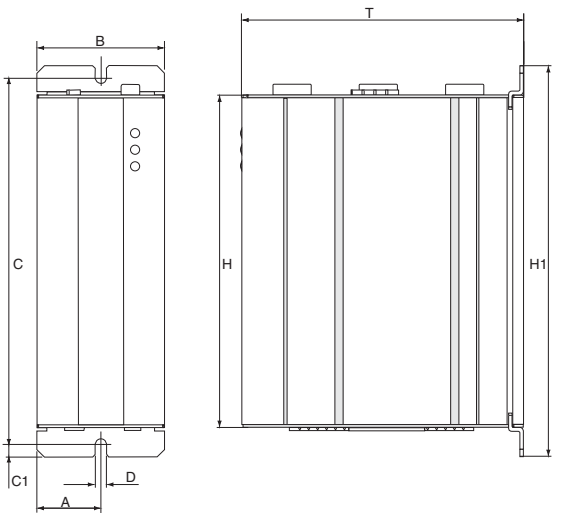


Fig. 2.1 Mounting clearances (see Table 2.2)

	CDF30.008
Weight [kg]	0.8
B (Width)	55
H (Height)	143
T (Depth)	121
A	27.5
C	157
C1	5.2
D	4.8
E	15
F	100
G	≥ 150
H1	167.5



1) for flat mounting

Table 2.2 Dimensional drawings for wall mounting (dimensions in mm)

Please note:

- Air must be able to flow through the device without restriction.
- For mounting in switch cabinets with convection (= heat loss is discharged to the outside via the cabinet walls), always fit an internal air circulation fan.
- The backing plate must be well earthed.

3 Installation

Attention: Installation must only be carried out by qualified electricians who have undergone instruction in the necessary accident prevention measures.

3.1 Connection overview

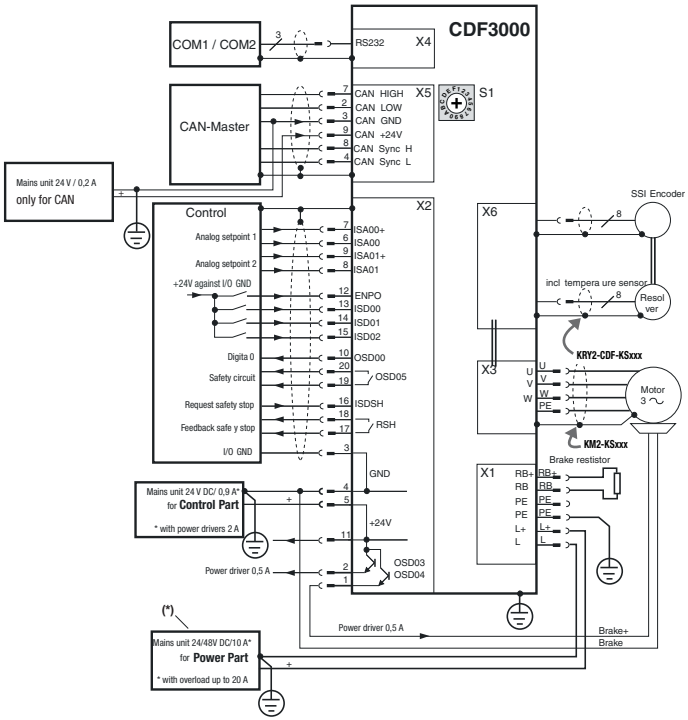


Fig. 3.1 Terminal plan CDF3000 (overview)

*In generator operation the power supply unit must be protected against overvoltage (e.g. by protective diode)

Legend	Explanation	continue
X1	Power terminal (6-pin plug-in terminal)	Page 3-5
X2	Control terminal (2 x 10-pin plug-in terminal)	Page 3-30
X3	Motor terminal (4-pin plug-in terminal)	Page 3-9
X4	RS232-port, for operation with NOTEBOOK/DRIVEMANAGER see chapter 4.5/4.6 (9-pin Sub-D socket)	Page 3-14
X5	CANopen interface with DS402 profile (9-pin Sub-D pins)	Page 3-16
S1	Encoder switch CAN-address	
X6	Resolver / SSI-transducer connection (15-pin Sub-D socket)	Page 3-10

Legend	Explanation	continue
⏚	Connection Protective earth (PE) **Attention:** Please observe chapter 3.3 "Connection of mains units".	Page 3-5

Table 3.1 Legend Terminal plan CDF3000

3.2 Position plan

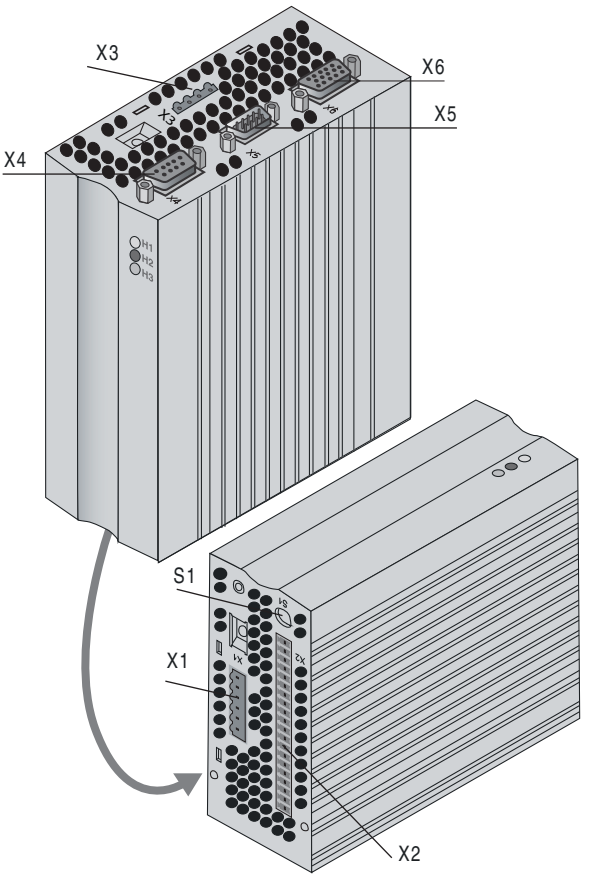


Fig. 3.2 Position plan CDF3000

3.3 Connection of mains units

The positioning drive is only allowed to be connected to power packs (stabilised and smoothed) that satisfy the requirements for a protective extra-low voltage (PELV) with safe isolation in accordance with EN 50178.

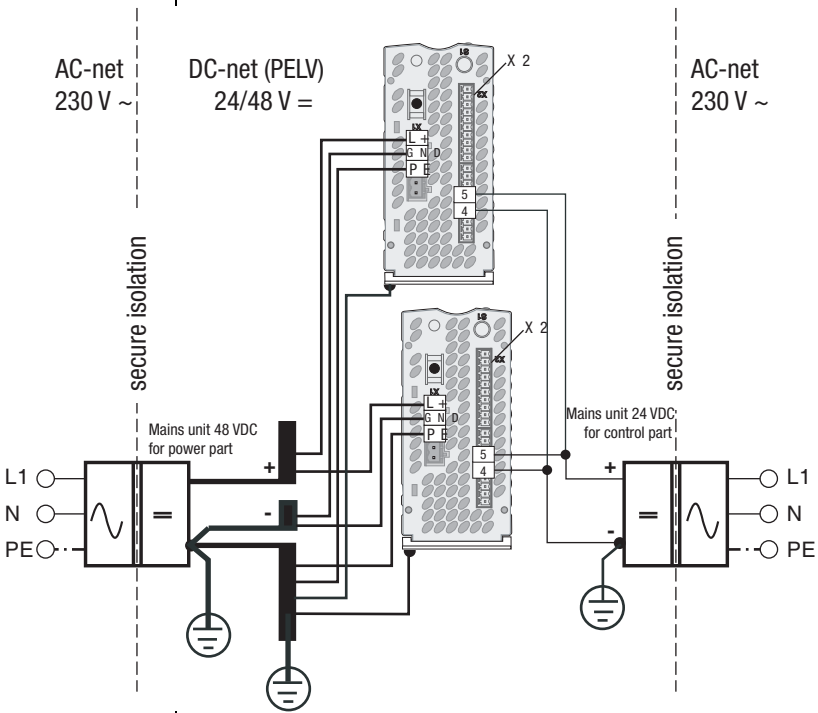


Fig. 3.3 Connection overview DC-mains supply

Note: Power side 24/48 V DC: Each unit is to be protected separately with a fuse of max. rating 16 A utilisation category gG!

Provide power to the control and power sections using a dedicated power supply unit for each!

Please note:

- The power supply units must be suitable for energy recovery (e.g. generator operation). The threshold for the use of the brake chopper can be up to 58 V depending on the setting in the parameter DCVIN (on this topic refer to note on page 3-7).
- Due to the large dynamic range on the DC link, the power supply unit for the power section (supply of X1) is only to be used for the operation of the CDF3000 (no other load allowed).
- Appropriate line protection must be provided in the DC mains supply. The lines must be protected with appropriate fuses.
- The earthing lead must be laid out in star configuration to conform to the EMC standards.
- The motor cable, mains lead and control cable must be laid out separately from each other.
- Avoid loops, and lay cable over short distances.
- At the supply terminal the (-) pole of the power supply units must be earthed as shown in Fig. 3.3.

Attention: +24 V supply voltage (X2)

For the protection of the unit against fire, a fuse with a 7 A rating is integrated in the supply voltage feed internally within the device. The breaking capacity of the fuse is limited to 30 A. If you should use a voltage source with a higher maximum current, a 6 A fuse with an appropriate breaking capacity for the power supply unit is to be provided in series. Protection of the cable is to ensured under any circumstances!

Please note:

The brake chopper enable threshold and the selection of the braking resistor are based on the nominal supply voltage.

In the CDF3000, please first set the parameter DCIN to the nominal value for the supply voltage connected such that U_{nom} = |DCIN| (requirement on supply voltage:
Tolerance max. ± 10 %, voltage stabilised and smoothed).

Please note the setting range for the parameter DCIN (24 to 48 V DC).

The brake chopper enable threshold is then calculated as follows:
U_{Br} = 1.1 * |DCIN| +5.2 V

The overvoltage shutdown threshold is then calculated as follows:
U_{Sp} = 1.1 * |DCIN| +10.2 V

The **minimum** braking resistor allowed is defined by the following table:

DCIN	RB_{min}
24 V	2.2 Ω - 10 %
24 V to 32 V	2.7 Ω - 10 %
32 V to 40 V	3.3 Ω - 10 %
40 V to 48 V	3.9 Ω - 10 %

Table 3.2 Minimum braking resistors allowed

The CDF3000 does not have a pre-charging circuit. It does not therefore limit the charging current when the supply voltage is switched on. To utilise the current limiting in the power supply unit, the power should be switched before the power supply unit (see Fig. 3.4).

Incorrect: Right:

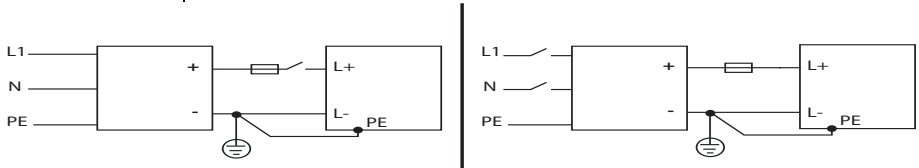


Fig. 3.4 Connection Control supply

3.3.1 Wire cross-section for X1 and X3

Positioning controller	Device connected load [kVA]	Wire cross-section [mm²]
CDF30.008	0.55	1.5 ... 2.5

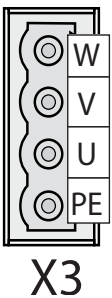
Table 3.3 Cable cross-section X1 and X3 (the local regulations and conditions are to be observed)

Lengths for stripping insulation	
X1	7 mm
X3	10 mm

Table 3.4 Lengths for stripping insulation

3.4 Motor connection

Info: The CDF3000 positioning controllers are at the terminals during operation short-circuit proof. In the event of a short-circuit or earth fault in the motor cable, the output stage is disabled and an error message is submitted.



Synchronous motors from LTi are optimally tuned for the positioning controller CDF3000. Prefabricated motor and encoder cables are also available. For further information on motors of series LSH and accessories please refer to the "Ordering Catalogue for Servo Motors, ID.-No. 0814.05B.x-xx".

Step	Action	Comment
1	Look for the desired synchronous motor.	There are three motors available (LST-037, LSH-050, LSH074).
2	Wire the **motor phases** U, V, W via a shielded cable and earth the motor to X3/ PE.	Use the prefabricated motor cable for **type KM2-KSxxx**
3	The connection of the temperature sensor PTC or KTY is also routed through the encoder cable (see chapter 3.x.	Use the prefabricated encoder cables: **KRY2-CDF-KSxxx** (Resolver)

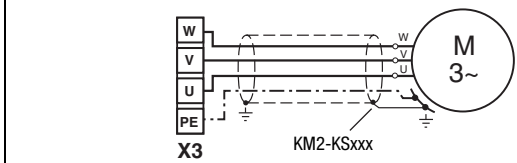


Fig. 3.5 Connection of motor

Attention: Motor phases U,V and W must under no circumstances be mixed up by mistake! With motor phases reversed the positioning controller has no control over the motor. The motor may jerk or accelerate in an uncontrolled manner ("race up").

Attention: At the motor terminals the device is not earth-fault proof !

3.5 Encoder connection on LTi motors

Step	Action	Comment
1	Select the correct encoder type.	
2	Wire the encoder connection with a shielded wire.	Use the prefabricated encoder cables: **KRY2-CDF-KSxxx** (Resolver)

Assignment motor - encoder cable - servo regulator connection

Compare the type plates on the components. Make absolutely sure to use the correct components!
Earth the motor cable screen on the mounting plate as close as possible to the CDF3000.

Do not separate the encoder cable, for example to route the signals via terminals in the switch cabinet. The knurled screws on the D-Sub plug housing are tightly locked!

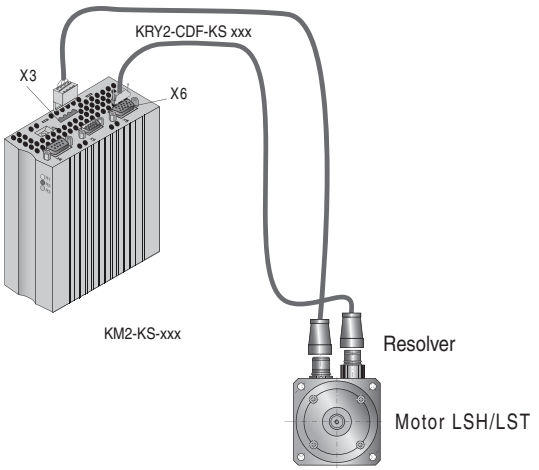


Fig. 3.6 Assignment motor/encoder cable

3.5.1 Specification of interface X6

The electrical specification of the interface is given in the Table 3.5, the terminal assignment in the Table 3.6.

	Resolver	SSI encoder
Connection	Miniature D-SUB 15-pin socket (high-density)	
Interface	-	RS422 (differential)
Wave terminating resistor	-	DATA: 120 Ω (internal) CLK: no connection necessary
Max. signal frequency f_{Grenz}	500 kHz	

Table 3.5 Specification of encoder interface X6

	Resolver	SSI encoder
Voltage supply	-	+ 5.2 V ±5%, max. 150 mA Not electrically isolated from the power potential (+48 V)
Scanning frequency	8 kHz	4 kHz
Interface log	-	SSI (Graycode)
Lines per revolution / resolution	-	13 bit (single turn) 25 bit (multi turn)
Max. cable length	20 m (longer lengths available on request)	

Table 3.5 Specification of encoder interface X6

The cable type for SS-encoders must be chosen acc. to the specification of the encoder manufacturer. Thereby please observe the following boundary conditions:

- Always used shielded cables. The shielding must be placed on both sides of the cable.
- Connect the differential track signals A, B or CLK, DATA to each other via twisted wires.
- Do not separate the encoder cable, for example to route the signals via terminals in the switch cabinet.

Resolver/ SSI

X6-Pin	Function Resolver	Function SSI	Function TTL
1	Sine- (S4)	-	
2	Sine+ (S2)	-	
3	-	+5V (150 mA)	+ 5 V (150 mA)
4	-	DATA+	A+
5	-	DATA-	A-
6	Cosine- (S3)	-	
7	REF- (R2) (Excitation-)	-	
8	-	GND	GND
9	PTC- (KTY / Klixon)	PTC- (KTY / Klixon)	
10	PTC+ (KTY / Klixon)	PTC+ (KTY / Klixon)	
11	Cosine+ (S1)	-	
12	REF+ (R1) (Excitation+ [8 kHz, approx. 7 V AC])	-	
13	n.c.	-	
14	-	CLK+	B+

Table 3.6 Assignment of encoder interface X6

X6-Pin	Function Resolver	Function SSI	Function TTL
15	-	CLK-	B-

Table 3.6 Assignment of encoder interface X6

3.5.2 Connection of 2nd encoder to X6

A SSI encoder can be evaluated on X6, parallel to the resolver connection (see chapter 3.5).

During simultaneous use the Fig. 3.7SSI-encoder must solely be used for the positioning controller, as described in Fig. 3.7.
Motor commutation and lower level speed regulation in this case takes place via the resolver.

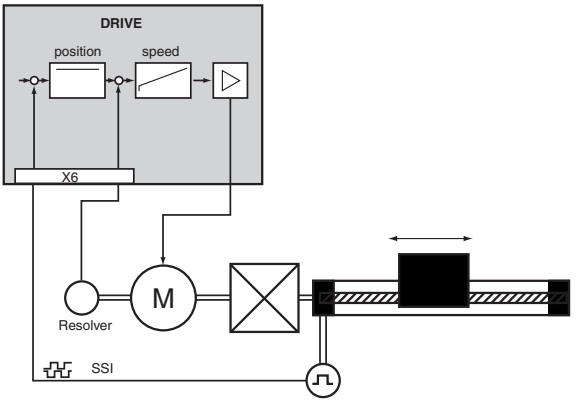


Fig. 3.7 Drive with two measuring systems

3.5.3 Motor temperature monitoring

For thermal monitoring of the motor winding a PTC-thermistor can be connected to X 6/9 and 10 via the encoder line. The type used must be set in parameter 330-MOPTC during commissioning (factory default setting is "off").

Sensor / Technical data	no PTC used	Standard PTC	linear voltage evaluation	TSS, Thermostatic circuit breaker
Usable type	–	PTC to DIN44082	KTY84-130, (tolerance band yellow) *	Klixon
Parameter 330-MOPTC =	OFF	DIN	KTY	TSS

Table 3.7 Motor temperature monitoring specification

Measurement voltage U_{MAX}	–	5 V	–
Error message		E-0TM	
* During the KTX evaluation the shutdown temperature can be selected between limits (**150 °C** ... 250 °C)			

Table 3.7 Motor temperature monitoring specification

Attention: On the usage of motors from other manufacturers, it is to be ensured the motor temperature sensor used is adequately isolated from the motor winding.

3.5.4 Project planning notes on encoder connection

The max. lines per revolution of the encoder can be calculated with the following formula.

$$SZ_{max} = \frac{60 \cdot f_{Grenz}}{n_{max}}$$

SZ_{max} = Maximum number of encoder lines in pulses per rev.

n_{max} = maximum speed of motor in rpm

f_{grenz} = maximum input signal frequency of interface

Example for n_{max} = 6000 rpm, f_{Grenz} = 150 kHz:

calculated: $SZ_{max} = \frac{60 \cdot 150.000}{6000} = 1500$ Pulses/rev.

selected: An encoder with 1024 pulses/rev.

Minimum motor speed

Formula to calculate the minimum displayable motor speed n_{min}, depending on the lines per revolution of the encoder.

$$n_{min} = \frac{3000}{SZ} \cdot \frac{1}{min}$$

SZ = Number of lines of encoder in pulses per rev.

n_{min} = minimum speed of motor in rpm

Note: A speed < n_{min} cannot be measured. In this range the actual speed of 0 min^{-1} is set. In the range 0 < n < n_{min} the amplification of the encoder is reduced.

3.6 Serial interface (SIO)

The serial interface (SIO, X4) is used to connect a KEYPAD with SMART-CARD or a notebook with the PC-Tool DRIVEMANAGER installed. This can be used to parameterize the CDF3000.

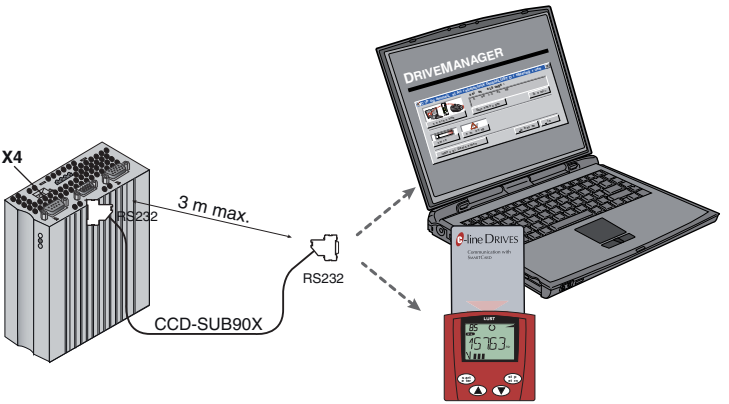
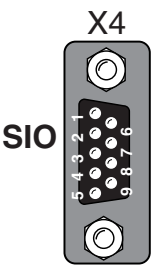


Fig. 3.8 Terminal X4

Attention: The RS232 interface must only be used for service and commissioning. Using the interface for control purposes is not permitted.

Please use only the prefabricated RS232 cable CCD-SUB 90X (max. length 3 m) to connect the positioning controller.

Pin assignment X4



Pin-No.	Function
1	+15 V DC for control unit KP200XL
2	TxD, data transmission
3	RxD, data reception
4	Do not use
5	GND for +15 V DC of the control unit KP200XL
6	Do not use
7	Do not use
8	Do not use
9	Do not use

Table 3.8 Pin assignment of the serial interface X4

Attention: The RS232 interface is connected to the potential of the control electronics (-) pole. Due to possible potential differences between the earthing of the (-) pole and the earthing of the notebook, a PE loop can be setup via the screen and the signal wires in the interface cable, and the screen earthing on the notebook. As a result the RS232, the notebook and the CDF3000 may be irreparably damaged! For this reason an opto-isolator is to be used in the interface cable (suppliers of opto-isolators are established IT accessory suppliers).

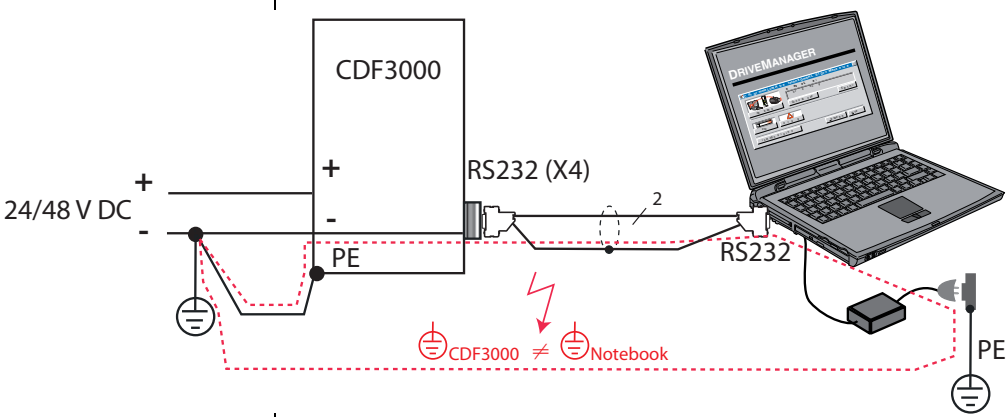


Fig. 3.9 Connection of serial interface with illustration of a PE loop

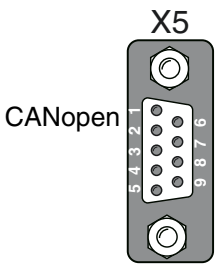
3.7 CAN_{open}-interface X5

The CAN_{open}-interface is integrated in the positioning controller. It is connected via connector X5. The customer is responsible for providing a power supply to the isolated connection.

Connection	Miniature D-Sub 9-pin
Wave terminating resistor - Bus termination -	120 Ω(internal) to be wired by customer via bridge (Pin 1-2)
Max. incoming frequency	1 MHz
Ext. Voltage supply Protective extra-low voltage (PELV) with safe isolation in accordance with EN 50178	+ 24 V ±10% / 100 mA (potential-free to drive controller)

Table 3.9 Connection CAN_{open} - interface

Assignment of terminal X5:



Pin	Function
1	Wave terminating resistor 120 Ω internally for CAN by bridge between PIN 1 and Pin 2
2	CAN_LOW
3	CAN_GND
4	CAN-SYNC_LOW This pin can optionally be switched by the micro controller as input or output.
5	Wave terminating resistor 120 Ω internally for CAN-SYNC by bridge between PIN 4 and Pin 5
6	CAN_GND
7	CAN_HIGH
8	CAN-SYNC_HIGH This pin can optionally be switched by the micro controller as input or output.
9	CAN_+24 V (24 V ±10%)

Table 3.10 Pin assignment X5

The CAN-bus node address is set via coding switch S1.

3.8 Multi-axis operation

The positioning controllers operated in multi-axis interconnection in a regenerative mode (braking operation), feed energy into the network, which is then consumed by the motor operated positioning controllers.

Interconnected operation of several positioning controllers minimises the power consumption from the mains and external braking resistors can be eliminated where appropriate.

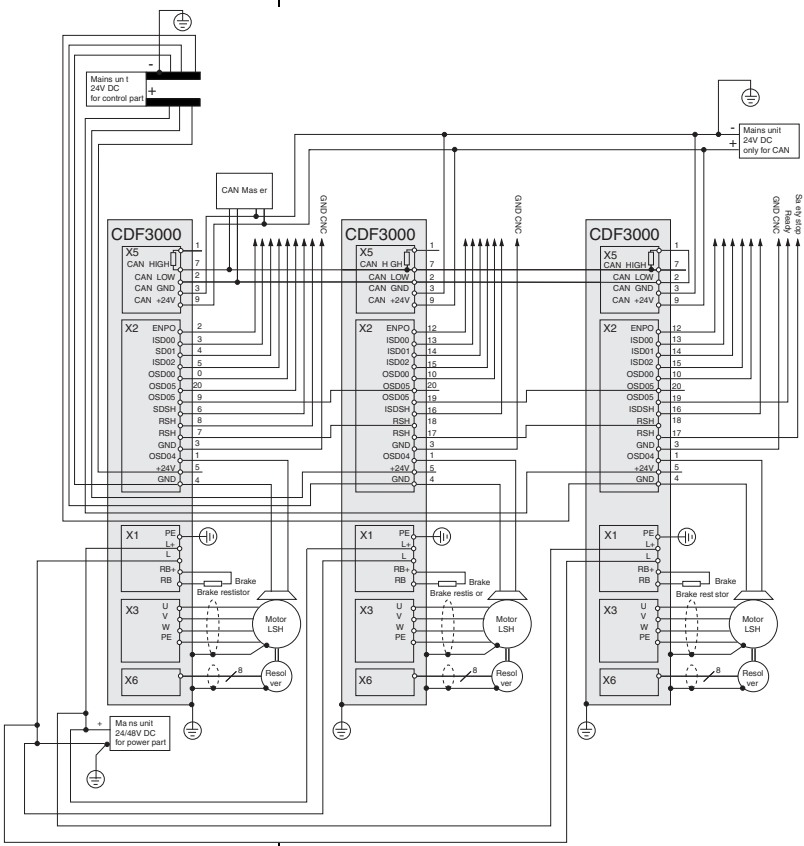


Fig. 3.10 Network plan CDF3000 (example)

Note: The instructions in 3.3 "Connecting the power packs" in particular are also to be observed!
Suitable measures are to be taken to protect the cable.

3.9 Braking resistor (RB)

Attention: Braking of the drive is of importance for the safety of machine or plant!
The safe function of the braking facility must be tested during commissioning! In case of incorrect dimensioning (overloading) the braking resistor or the brake electronics may be destroyed and machine or plant may be damaged. Such overload (failure of the braking facility) may even cause fatal accidents or severe injury, e.g. in case of lifting applications!

In regenerative operation, e. g. when braking the drive, the motor feeds energy back to the positioning controller. This increases the voltage in the DC-link. If the voltage exceeds a threshold value, the internal braking transistor is activated and the regenerated power is converted into heat by means of a braking resistor.

The switching transistor is installed as standard. The design of the external braking resistor depends on various factors of the drive: e. g. the load to be moved, the required dynamics of the drive or the duration of braking and duty cycles.

The RB+ and RB- terminals are not short-circuit proof or overload-proof.

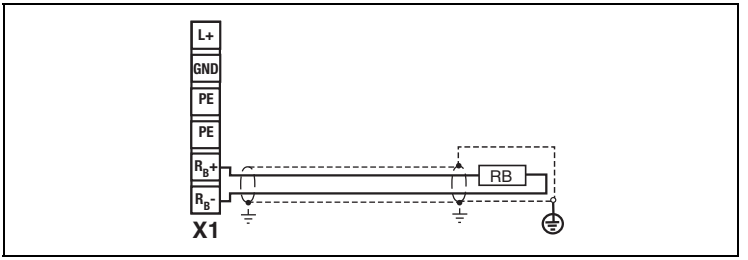


Fig. 3.11 Connection braking resistor

Please note:

- The design of the braking resistor must be clarified at the project planning stage.
- The minimum permissible ohmic resistance of an externally installed braking resistor for the various positioning controllers can be found in appendix A2.

For further information please consult your project engineer.

Attention: The braking resistor is to be mounted such that, in the case of the failure of the chopper transistor (e.g. if there is a "short" in the chopper transistor), the braking resistor will not represent a fire risk and measures are to be taken to electrically isolate the resistor.

3.10 Safe Torque Off (STO)

Applies to all units from hardware index 2.4.

3.10.1 Danger analysis and risk assessment

Users of the safety function (STO) must comply with the EU Machinery Directive 2006/42/EWG, or the latest applicable version as appropriate.

The manufacturer or its authorized representative is obliged to conduct a risk analysis (in accordance with the latest applicable Machinery Directive) prior to marketing a machine. An analysis of hazards posed by the machine must be conducted and appropriate measures instigated to reduce/eliminate such hazards.

With the danger analysis all prerequisites for establishing the required safety functions are fulfilled.

The CDF3000 safety function "Safe Torque Off (STO)" has been approved by the accredited certification body "TÜV-Rheinland". Conformance to parts
EN ISO 13849-1, EN 62061, EN 61800-5-1 and EN 61508 is ensured.

Qualification: The operator of the safety related system is trained in accordance with his state of knowledge, as is appropriate for the complexity and safety integrity level of the safety related system. This training includes the study of essential features of the production process and knowledge of the relationship between the safety-related system and the equipment under control (EUC).

3.10.2 Definition of terms

STO = Safe Torque OFF

With the safety function STO the power supply to the drive is reliably interrupted immediately (no electrical isolation). The drive must not be able to generate a torque and so per- form any hazardous movement. The standstill position is not monitored.

The "STO" function complies with stop category 0 in accordance with EN60204-1.

Note: see chapter 3.10.5: Hazard due to dangerous voltage and see chapter 3.10.6: Hazard due to axis movement at the motor.

Restart inhibit

Due to the restart inhibit the evaluation unit (STO) cannot be enabled after a shutdown, after a change to the machine's operation mode or after a change to the form of acknowledgement. The restart inhibit is only lifted by an external command (e.g. on button or, in LTi drive controllers, the ENPO).

Emergency stop

In accordance with the national and European preface to EN 60204-1, electrical equipment may also be used for emergency stop devices provided they comply with relevant standards, such as EN 954-1 and/or IEC 61508. "STO" can thus be used for emergency stop functions.

EN ISO 13849-1: 2008

Safety of machines, safety related parts of controls. The EN ISO 13849 standard emerged from EN 954-1, supplemented by the aspects of quality management and reliability.

EN 62061: 2006

Safety sector standard for machinery, originating from IEC 61508

IEC 61508: 2010

International basic safety standard specifying the status of safety technology in all its aspects.

EN 61800-5-1: 2007, EN61800-5-2: 2007

Electrical drives with variable speed. Part 5-1: Requirements concerning electrical, thermal and function safety.

EUC (equipment-under-control)

EUC - system:
A system that responds to the input signals from the process and/or a user and generates output signals which enable the EUC to work as desired.

EUC equipment:
Equipment, machine, apparatus or plant used for the manufacture, production and processing, transportation, medical or other activities.

EUC risk:
Risk resulting from the EUC or its interaction with the EUC operating equipment.

PFH (Probability of Failure per Hour)

Probability of Failure per Hour, in respect of a hazardous random hardware failure.

Safety function

Function performed by an E/E/PE (electrical/electronic/programmable electronic) safetyrelated system, a safety-related system of other technology or external equipment for risk minimization, with the goal of attaining and maintaining a safe state for the EUC, taking into account a particular undesired event.

Validation

Affirmation that the special requirements for a certain purpose of use are fulfilled by investigation and the submission of objective proof.

Validation describes the activity to prove that the safety-related system under investigation meets the specified safety requirements of the safety-related system in every respect, before or after installation.

Positive opening operation of a contact element

Symbol for positive opening operation according to EN 60947-5-1 annex K 

In a positive opening operation of a contact element, the contact separation is achieved as a direct result of a certain movement of the actuating element caused by non-elastic links (no springs).

Safety circuit

A safety circuit is designed with two channels and has been approved by accredited testing bodies on the basis of the standards. There are a large number of manufacturers offering a vast variety of safety circuits for various applications.

3.10.3 Description of function

The positioning controllers CDE3000 and CDB3000, SH support the "STO" (Safe Torque Off) safety function according to the requirements of EN 61800-5-2, EN ISO 13849-1 "PL e" and EN 61508 / EN 62061 "SIL3".

The "STO" safety function to EN 61800-5-2 describes a safety measure in the form of an interlocking or controlling function. Category 3 means that this safety function will remain in place in case a single fault occurs.

The safety-related parts must be designed in such a way that:

- a single fault in any of the said parts does not result in loss of the safety function and
- whenever feasible in an appropriate manner, the single fault is detected.

For the "STO" function the positioning controllers are equipped with additional logic circuits and a feedback contact. The logic cuts the power supply to the pulse amplifiers to activate the power stage. In combination with the controller enable "ENPO" the system uses two channels to prevent the motor creating a torque.

This variant offers the following advantages over the solution with a motor contactor:

- No need for the external motor contactor
- So less wiring
- Space-saving
- Better EMC performance due to the continuous shielding of the motor cable
- Shorter reaction time

3.10.4 Basic information

Always draw up a validation plan. The plan specifies which tests and analyses were used by you to determine compliance of the solution with the requirements of the application.

Note: Cabinet mounting with ingress protection IP54 is essential.

3.10.5 Hazard due to dangerous voltage:

- If the positioning controller is in the "STO" state all motor and mains cables, braking resistors and DC link voltage cables conduct dangerous voltages against protective conductors.
- With the "STO" function no "shutdown of voltage in case of emergency" is possible without additional measures. There is no electrical isolation between the motor and servocontroller! This means there is a risk of electric shock or other electrical risk.

3.10.6 Hazard due to axis movement at the motor:

- If an external effect of forces can be expected in safety function "STO", e.g. with suspended load, this motion must be reliably prevented by additional measures, e.g. by two brakes, safety bolts or a clamping device with brake.
- Despite correct shutdown, in the case of a short-circuit in two offset branches of the power section an axis movement of max. 180° may be triggered electrically.

Note: The safety circuitry connected to the servocontroller should be designed in such a way that in case of a loss of electrical supply the safe state of the machine can be reached or maintained.

3.10.7 Overview of "STO" connections for CDF

X2	Bez.
20	OSD05
19	OSD05
18	RSH
17	RSH
16	ISDSH
15	ISD02
14	ISD01
13	ISD00
12	ENPO
11	+24 V
10	OSD00
9	ISA01+
8	ISA01-
7	ISA00+
6	ISA00-
5	+24 V
4	GND
3	GND
2	OSD03
1	OSD04

The servocontroller CDF3000 offers a separate input for the "STO" request, a facility to deactivate the restart inhibit and a separate relay contact for feedback.

Des.	Term.	Specification	floating
Digital inputs			
ISDSH (STO)	X2-16	• Request input STO = Low-level • OSSD support* • Switching level low/high: < 4.8 V / > 18 V DC • I_{max} = typically 3 mA (at 24 V) • $U_{In\ max}$ = 24 V +20% • $R_{In\ nom.}$ = 3 kΩ • internal signal delay time ≈ 2ms • Terminal scan cycle = 1 ms	yes
ENPO (STO)	X2-12	• Request input STO = Low-level • OSSD support* • Disable restart inhibit (STO) and enable power stage = High level • Switching level low/high: < 4.8 V / > 18 V DC • I_{max} = typically 7.5 mA (at 24 V) • $U_{In\ max}$ = 24 V +20% • $R_{In\ nom.}$ = 3 kΩ • internal signal delay time ≈ 10 ms • Terminal scan cycle = 1 ms	yes
Note:		In the range > 5 V / < 18 V the performance of the inputs is undefined. *OSSD: (Output Signal Switching Device) tested semiconductor outputs. Test pulses are suppressed for a period of 300 µs.	

Table 3.11 X2 terminal assignment CDF3000,SH

Des.	Term.	Specification		floating
Relay outputs: Feedback signal (normally open contact) "STO"				
OSD02 (RSH)	X2-17 X2-18	• Diagnosis STO, both tripping channels active, one NO contact with automatically resetting circuit-breaker (polyswitch) • 25 V / 200 mA AC, utilization category AC1 • 30 V / 200 mA DC, utilization category DC1 • Operating delay approx. 10 ms • 3 x 10^6 switching cycles		yes
Voltage supply				
Note: In the range > 5 V / < 18 V the performance of the inputs is undefined. *OSSD: (Output Signal Switching Device) tested semiconductor outputs. Test pulses are suppressed for a period of 300 µs.				

Table 3.11 X2 terminal assignment CDF3000,SH

3.10.8 Wiring and commissioning

For the "STO" function the positioning controllers are equipped with additional logic circuits and a feedback contact. The logic cuts the power supply to the pulse amplifiers to activate the power stage. In combination with the controller enable "ENPO" the system uses two channels to prevent the motor creating a torque.

The internal function of the unit and the connection for CDF3000 is shown in Fig. 3.12.

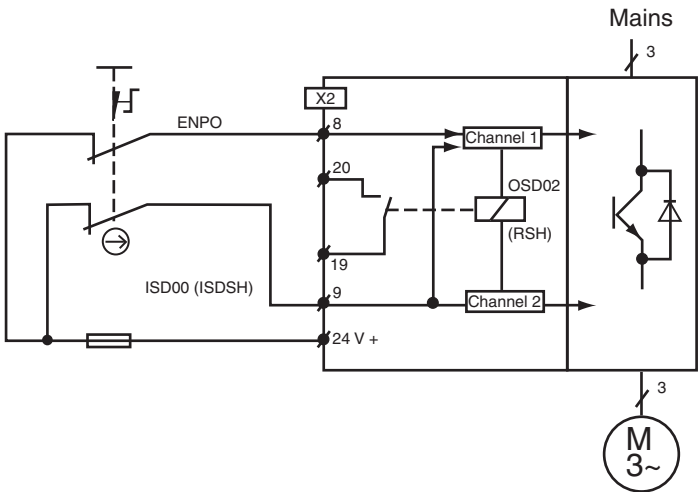


Fig. 3.12 Request "STO" on CDF3000 for shutting down in an emergency (emergency shutdown)

ENPO	ISD00 (CDF,SH)	STO	Restart inhibit	Controller state	Relay[1] OSD02 / (CDF,SH)
L	L	ON	ON	Power stage disabled via twochannels.	high
H[3]	H[3]	OFF	OFF	Power stage ready	low
(L) ➜ H[2]	(L) ➜ H[2]	OFF	OFF	Power stage ready	low
H	(H) ➜ L	ON	ON	Power stage disabled via twochannels.	high
(H) ➜ L	H	OFF	OFF	Power stage disabled via one channel.	low
(L) ➜ H	H	OFF	OFF	Power stage ready.	low

( ) Previous status
1) 3 x 10^6 switching cycles at 200mA (rest position: NO contact)
2) In order to deactivate the restart inhibit the control signals must be simultaneously (ENPO max. 5 ms before ISDSH) set to High (H), or ISDSH must be reliably set to High (H) before ENPO.
3) This only applies when STO has been disabled by the process described in "2)".

Table 3.12 Logic table for operation of the "STO"

3.10.9 Function test STO

The applied control signals "ISDSH" and "ENPO" must always be checked by the operator or a higher-level control for plausibility to the feedback (RSH).

The occurrence of an implausible status is a sign of a system fault (installation or servocontroller). In this case the drive must be switched off and the fault rectified.

Attention: The "STO" (Safe Torque Off) function must generally be checked for correct functionality after:

- initial commissioning
- any modification of the system wiring

replacing one or several appliances in the system.

Note: There is no protection against unexpected restarting after re-establishing the electrical power supply in the illustrated example circuit, unless an external circuit is used. If, on the restoration of the supply of power, ENPO and ISDSH are high (see truth table) and Autostart is programmed, the axis may start, particularly in the case the control electronics are supplied with 24V from an external source in event of power failure. The connected safety circuit on the machine must ensure that the servocontroller (the SRP/CS) can attain and maintain the safe state of the machine.

Note: Where the switch and drive controller are installed in different locations, it must be ensured that the cables from NC contact 1 to ENPO (STO) and from NC contact 2 to ISDSH (STO) are wired separately, or that possible faults are ruled out by using a protective tube for example.

In order to cancel the STO safety function and deactivate the restart inhibit, the ISDSH signal must be set to High before the ENPO signal, or simultaneously with it.

3.10.10Safety-related approvals

Approval STO shutdown CDF

Safety-related parameters in accordance with EN 62061/ EN 61508:		Safety-related parameters in accordance with EN ISO 13849:	
SIL:	3	PL:	e
HFT:	1	Category:	3
SIL:	5.5 E-10 1/h	PL:	2.907 a

Approval restart inhibit CDF

Safety-related parameters in accordance with EN 62061/ EN 61508:		Safety-related parameters in accordance with EN ISO 13849:	
SIL:	3	PL:	e
HFT:	1	Category:	3
SIL:	7.5 E-11 1/h	PL:	>10,000 a

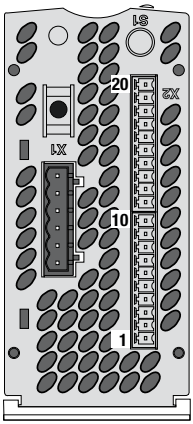
3.11 Control connections

Step	Action	Comment
1	Please check whether you already have a **SmartCard** or a **DriveManager dataset** with a complete device setup available, i.e. the drive has already been planned as required.	
2	If this is the case, a special control terminal assignment applies. Please contact your project engineer to obtain the terminal assignment.	**Bulk customers** For details of how to load the data set into the positioning controller refer to chapter 4.2.
3	Choose a terminal assignment.	**Initial commissioning** There are various pre-set solutions available to make it easier to commission the device.
4	Wire the control terminals with shielded cables. Only the signals ENPO, ISDSH and a start signal (control via terminal) are strictly required.	Earth the cable shields over a wide area at both ends. Wire cross-section maximum 1.5 mm² or two strands with 0.5 mm² per terminal Length for stripping insulation 7 mm.
5	Keep all contacts open (inputs inactive).	
6	Check all connections once again!	Continue with commissioning in section 4.

Please note:

- Always wire the control terminals with shielded cables.
- Lay the control cables separately from the mains lead and motor cable.
- The CDF3000 Application Manual presents more preset drive solutions.
- A cable type with double copper braiding with 60 - 70% coverage must be used for all screened connections.

3.11.1 Specification of control connections



X2	Des.
20	OSD05
19	OSD05
18	RSH
17	RSH
16	ISDSH
15	ISD02
14	ISD01
13	ISD00
12	ENPO
11	+24 V
10	OSD00
9	ISA01+
8	ISA01-
7	ISA00+
6	ISA00-
5	+24 V
4	GND
3	GND
2	OSD03
1	OSD04

Control terminal X2 is located on the bottom side of the device.

Des.	Terminal X2	Specification	floating
Analog inputs, differentially			
ISA00+ ISA00-	7 6	U_{IN} = ± 10 V DC R_{IN} = 101 kΩ Resolution 10 Bit Terminal scan cycle = 1ms Tolerance: U = ±1% of end value	no
ISA01+ ISA01-	9 8		no
Digital inputs Note: In the range > 4.8 V / < 18 V the performance of the inputs is undefined.			
ISD00 ISD01 ISD02	13 14 15	• Limit frequency 500 Hz • Switching level low/high: <4.8 V / >18 V DC • I_{max} at 24 V = typically 3 mA • internal signal delay time ≈ 100µs • Terminal scan cycle = 1 ms	yes
ENPO	12	• Power stage enable = High-Level • Switching level low/high: <4.8 V / >18 V DC • I_{max} at 24 V = typically 7.5 mA • R_{IN} = 3 kΩ • internal signal delay time ≈ 10 ms • Terminal scan cycle = 1 ms	yes
Digital outputs			
OSD00	10	• short-circuit proof • I_{max} = 50 mA • internal signal delay time ≈ 250µs • Terminal scan cycle = 1 ms • Protection against inductive load • High-side driver	yes

Table 3.13 Specification of control connections

Des.	Terminal X2	Specification		floating
OSD03 OSD04	2 1	• short-circuit proof • I_{max} = 500 mA • internal signal delay time ≈ 250µs • Terminal scan cycle = 1 ms • High-side driver • to control up to two motor holding brakes		yes
Safe stop Note: For further information please refer also to the chapter **3.10**"Safe Torque Off (STO)"				
ISDSH	16	**"Safe Standstill" request** • Limit frequency 500 Hz • PLC-compatible • Switching level low/high: <4.8 V / >18 V DC • I_{max} at 24 V = typically 3 mA • R_{IN} = 3 kΩ • internal signal delay time ≈ 100µs • Terminal scan cycle = 1 ms		yes
RSH	18 17	**"Safe Standstill" feedback signal** • Relay, 1 make contact • 24 V / 0,2 A AC, utilization category AC1, cos φ = 1 (resistive load) • 30 V / 0,2 A DC, utilization category DC1, cos φ = 1 (resistive load) • Operating delay approx. 10 ms		yes
Relay outputs				
OSD05	20 19	• 24 V / 1 A AC, utilization category AC1, cos φ = 1 • 30 V / 1 A DC, utilization category DC1, cos φ = 1 • Operating delay approx. 10 ms		yes

Table 3.13 Specification of control connections

Des.	Termina l X2	Specification	floating
Voltage supply			
+24 V	5 11	• ext. +24 V ± 2 V Feed for control electronics • strictly required for operation of the CDF3000 • I_{max_in} = 0.9 A + currents on the outputs OSD00, OSD03 and OSD04	–
GND	3 4	• Reference point for control electronics	

Table 3.13 Specification of control connections

4 Commissioning

Attention: Commissioning must only be carried out by qualified electricians who have undergone instruction in the necessary accident prevention measures.

4.1 Choosing the commissioning

Mode of commissioning	Commissioning steps	Continued on
• Project planning and commissioning have already been completed. • Loading an existing data set.	Serial commissioning	Page 4-3
• Initial project planning and commissioning of the drive system.	Initial commissioning	Page 4-6
• Project planning and basic setting of the drive system have already been carried out.	Test run	Page 4-16

4.2 Serial commissioning

Apply this mode of commissioning when you want to commission several identical drives (i.e. serial commissioning). The same positioning controller and motor must be set for each drive in an identical application.

If you already have a complete dataset available, please skip the paragraph "Saving dataset to SmartCard" (with KP200XL) or *"Save dataset from unit to file"* (with DRIVEMANAGER).

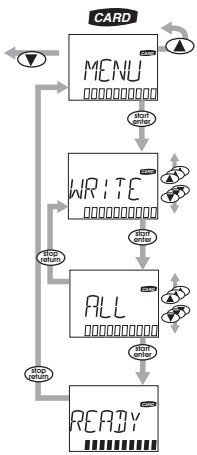
4.2.1 Serial commissioning with KEYPAD

Prerequisite:

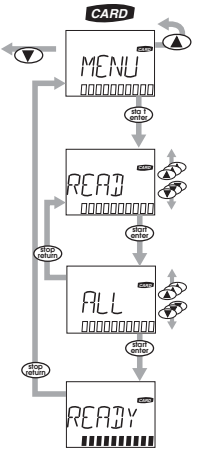
- All positioning controllers are completely connected.
- The **first** drive has already been fully taken into operation.
- The KEYPAD is directly plugged onto the positioning control (X4) via a RS232 interface.

Attention: The CARD-menu can only be selected as long as the **drive is not active**!

Saving dataset to SMARTCARD

Step	Action	Comment	Representation
1	Connect the KEYPAD to the positioning controller of the **first** drive, insert a SMARTCARD and switch on the mains supply.		
2	Select the CARD menu.	= load/save with the SMARTCARD	
3	Choose WRITE.	= save dataset	
4	Choose ALL and start the save operation with the *Start/Enter key.*	= complete dataset will be saved	
5	READY is displayed.	= saving completed without errors	
	With this process you have written your dataset to a SMARTCARD.		

Loading dataset from SMARTCARD into next positioning controller

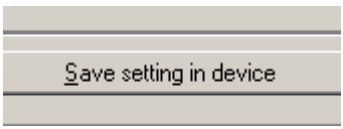
Step	Action	Comment	Representation
1	Connect the KEYPAD to the positioning controller of the **next** drive, insert a SMARTCARD with the required dataset and switch on the mains supply.		
2	Select the CARD menu.	= load/save with the SMARTCARD	
3	Choose READ.	= load dataset	
4	Choose ALL and start the load operation with the *Start/Enter key.*	= complete dataset will be loaded	
5	READY is displayed.	= loading completed without errors	
	Repeat this loading process on all other drives.		

Note: The dataset is automatically saved in the positioning controller.

4.2.2 Serial commissioning with DRIVEMANAGER

Prerequisite:

- All positioning controllers are completely connected.
- The **first** drive has already been fully taken into operation.
- A notebook with the user software DRIVEMANAGER installed is connected.

Step	Action	Comment
1	Connect your notebook with the positioning controller of the **first** drive and switch on the mains supply for the positioning controller (X4).	Use a standard serial cable (9-pin D-SUB, socket/plug) and an opto-isolator.
2	Start DRIVEMANAGER.	Automatically links the connected positioning controller.
	If the connection setup fails you should check the settings in the menu **Extras** > **Options** and retry it via the icon. 	
3	Save the current dataset by clicking on the icon  , either to the parameter database (directory: c:/../userdata) of the DRIVEMANAGER or to a floppy disk (a:/).	The icon always saves the most current dataset of the connected unit. Name the file as desired.
4a	Use this icon to disconnect from all devices 	
4b	Connect your notebook with the positioning controller of the **next** drive and switch on the mains supply for the positioning controller.	
5	Click on icon  to establish a link between the DRIVEMANAGER and the newly connected device.	
6	Click on icon  to load the dataset saved in step 4 into the device.	
7	Use the icon  to select the main window. Save the settings with the button ->	
	Repeat steps 4 ... 7 for all further drives.	

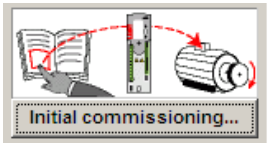
Save dataset from unit to file

Load dataset from file into unit

Please remember to save the setting.

For further information concerning the DRIVEMANAGER please refer to the DRIVEMANAGER manual.

4.3 Initial commissioning



Prerequisites:

- The positioning controller is completely connected, see Chapter 3
- Installed DRIVEMANAGER from version V3.4
- The database for motors is installed on the notebook
- The unit is connected to the notebook via the RS232 interface (X4)

Attention: Never wire or disconnect electrical connections while they are live.

Input ENPO = apply Low-Level to terminal X2/12 to avoid unintended starting of the motor (output stage locked, mains voltage for positioning controller switched on).

Preparations:

- Switching on the positioning controller CDF3000.
  A self-test is performed.
- Start the DRIVEMANAGER.

DRIVEMANAGER Connect
or:
Communication > Connect...

Set up a connection to the device.

DRIVEMANAGER *or:*
Active device >
Change settings

Opening the main window "Setting CDF3000":

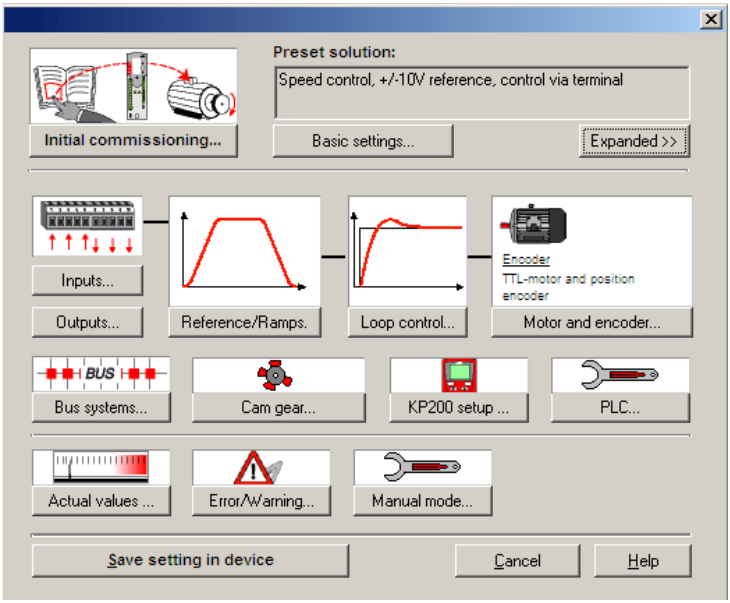
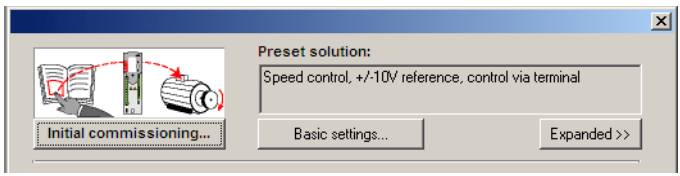


Fig. 4.1 Main window for the different settings in the DRIVEMANAGER.

Continue with:



4.3.1 Pre-set solutions

Pre-set solutions are complete parameter data sets which are provided to handle a wide variety of typical application movement tasks.

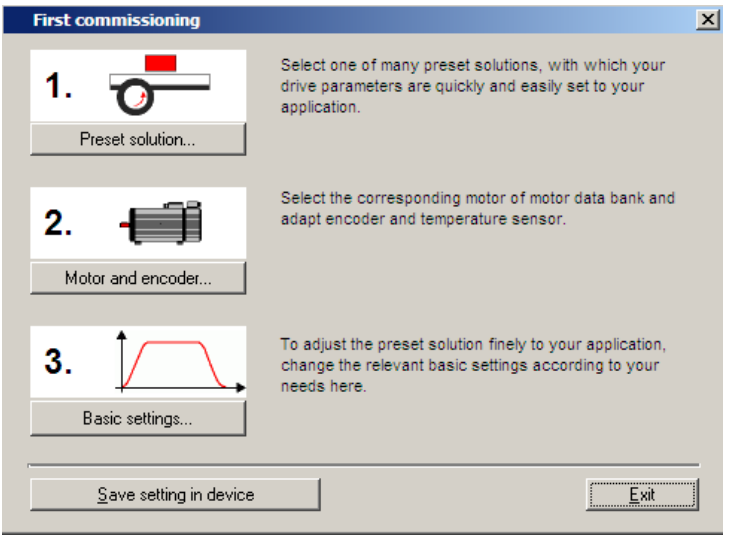


Fig. 4.2 Initial commissioning

The position controller is automatically configured by loading a pre-set solution into the random access memory (RAM). The parameters for

the control location of the drive controller,

- the reference source,
- the assignment of signal processing input and outputs and
- the type of control

are the focal points of the setting.

The use of a pre-set solution considerably simplifies and shortens the commissioning of the positioning controller. By changing individual parameters, the preset solutions can be adapted to the needs of the specific task. Pre-set solutions modified this way are stored in the unit as user datasets. In this way, you can arrive more rapidly at your desired movement solution.

A total of 20 preset solutions covers the typical areas of application for speed control with the CDF3000 controller.

Abbreviation	Reference source	Start of controller via/ Bus control profile
TCT_1	+/-10V-analog - torque	I/O-terminals
SCT_1	+/-10V-analog	I/O-terminals
SCT_2	Fixed speed table	I/O-terminals
SCC_2	Fixed speed table	CANopen field bus interface - EasyDrive-Profile "Basic"
SCB_2	Fixed speed table	Field bus options module (Profibus) - EasyDrive-Profile "Basic"
SCC_3	CANopen field bus interface	CANopen field bus interface - EasyDrive-Profile "Basic"
SCB_3	Field bus options module (Profibus)	Field bus options module (Profibus) - EasyDrive-Profile "Basic"
SCP_3	PLC	PLC
SCT_4	PLC	I/O-terminals
SCC_4	PLC	CANopen field bus interface - EasyDrive-Profile "Basic"
SCB_4	PLC	Field bus options module (Profibus) - EasyDrive-Profile "Basic"
PCT_2	Drive set tables	I/O-terminals
PCC_2	Drive set tables	CANopen field bus interface - EasyDrive-Profile "TabPos"
PCB_2	Drive set tables	Field bus options module (Profibus) - EasyDrive-Profile "TabPos"
PCC_1	CANopen field bus interface	CANopen field bus interface - DSP402-Profiles position mode - DSP402-Profiles velocity mode
PCB_1	Field bus options module (Profibus)	Field bus options module (Profibus) - EasyDrive-Profile "DirectPos"
PCP_1	PLC	PLC
PCT_3	PLC	I/O-terminals
PCC_3	PLC	CANopen field bus interface - EasyDrive-Profile "PlcPos"
PCB_3	PLC	Field bus options module (Profibus) - EasyDrive-Profile "PlcPos"

Table 4.1 Preset solutions for speed control with CDF3000

All pre-set solutions have an individual window for basic settings in DRIVEMANAGER.

Select the pre-set solution matching your application.

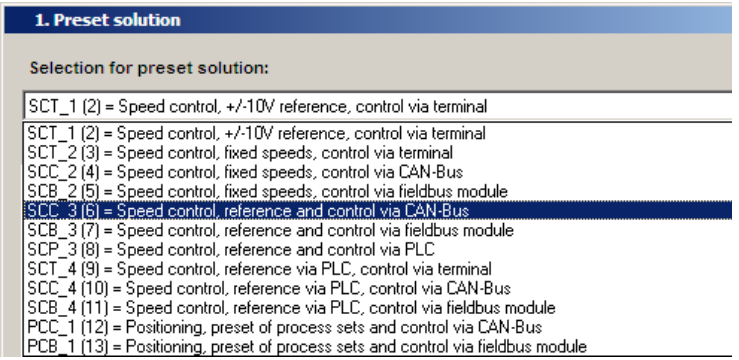
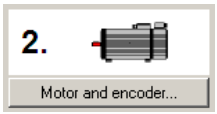


Fig. 4.3 Selecting the pre-set solution

Note: For more detailed information on pre-set solutions and terminal assignment please refer to the application manual CDF3000.

4.3.2 Setting the motor and encoder



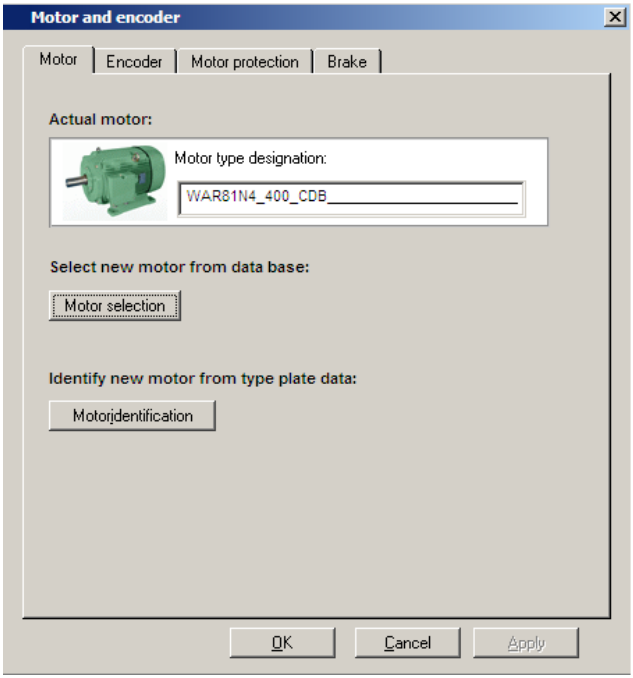


Fig. 4.4 Setting up the motor and encoder

Setting up the motor data via the motor database

This setting must be made if a suitable motor dataset or a complete motor database is available. Using the correct motor dataset ensures:

- that the electrical data of the motor are correctly parameterized,
- that the motor protection (tab "Motor protection") is correctly set and
- the control circuits for the drive are preset.

Note: The torque control is optimally adjusted, so that no further adaptations are required.
The setting of the speed control is based on the assumption that the moment of inertia of the machine reduced to the motor shaft is identical with the moment of inertia of the motor.
The speed and positioning controllers have a high level of attenuation and therefore also suitable for the control of elastic mechanical components.

For special settings in optimizing the speed and position circuitry you should use the application manual for the CDF3000.

Setting up the encoder

The encoder connected to the motor is set in the tab "Encoder". There is also the possibility to work with two encoders. In such cases, the first rotary encoder is used for commutation and speed control of the motor (motor encoder), the second one for position control (position controller). It is also possible to perform both functions with a single encoder.

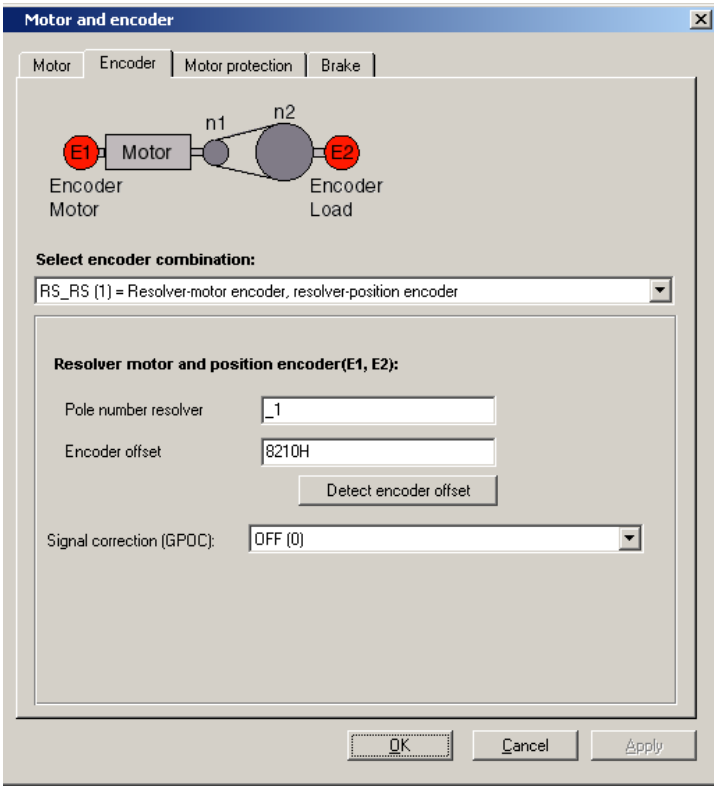


Fig. 4.5 Encoder configuration

Every rotary encoder combination has a special setup screen.

For more information on setting up the rotary encoders, refer to the CDF3000 Application Manual.

Checking the encoder

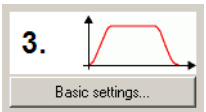
To check the encoder, rotate the motor shaft by hand.

Attention: Before the shaft is touched with the hands, the CDF3000 must be placed in the "Safe Standstill" state.

The viewing is from the front onto the end of the shaft (flange). The "CDF3000 reference and actual values" status display, under "n_{ist}, Actual speed", must indicate a positive speed in clockwise rotation and a negative speed in anti-clockwise rotation. If the speed is incorrect, check the following points:

- Is the encoder cable correctly connected to the motor and the positioning controller?
- Is the encoder cable in use the correct one for the type of encoder?

4.3.3 Making basic settings



Custom setup screens are provided for fine adjustment of each preset solution. You can use them to adapt the drive to your application. For a detailed description of the individual functions, refer to the CDF3000 Application Manual.

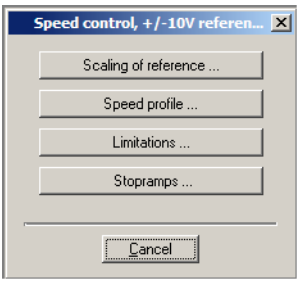


Fig. 4.6 Speed control

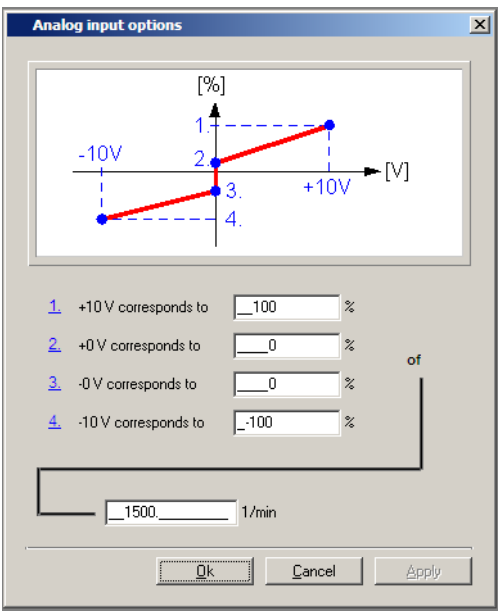


Fig. 4.7 Analogue input options

4.3.4 Saving the settings

DRIVEMANAGER
CDF3000 Settings

or:
Active device > Change settings

DRIVEMANAGER
CDF3000 Settings

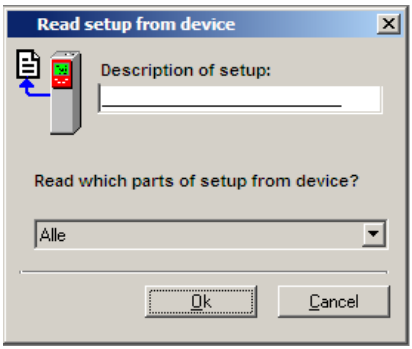
or:
Active device > Save device settings in a > file

Saving the settings in the device

All changes that are to be permanently stored in the device, must be saved via the mask *CDF3000 Settings*.

These changes can also be saved in a file.

Saving the settings in a file



Choose the file name (e.g. mydata). All parameters are saved under the chosen file names (e.g. mydata) with the appropriate extension (*.00D). It is possible to assign a description to the device data prior to saving it.

Continue with "Test run", see chapter 4.4.

4.4 Test run

Attention: Test run with motor installed:
In this case it must be assured that the test will not cause any damage to the system! Pay particular attention to the limitations of the positioning range.
Please note that you yourself are responsible for safe operation. LTi DRiVES Antriebstechnik GmbH will not assume liability for any occurring damage.

Danger to life from uncontrolled rotation!
Before starting motors with feather keys in the shaft end these must be reliably secured against being ejected, as far as this is not already prevented by drive elements such as belt pulleys, couplings or similar.

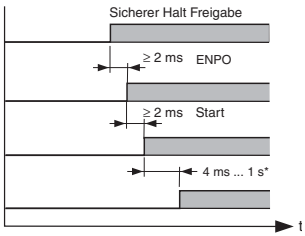
Pre-set solution for torque control:
In this pre-set solution the drive must not be operated without load torque, because otherwise the motor shaft would accelerate uncontrolled up to the adjusted speed limit.

Attention: Destruction of motor:
The motors are intended for operation on the positioning controller. Direct connection to the mains can destroy the motor.
The surface temperatures on the motors may increase to a very high level. No temperature sensitive parts may touch or be mounted to these areas, appropriate measures to prevent contact must be applied wherever necessary.
A temperature sensor that may possibly be installed in the winding, must be connected to the positioning controller, so that overheating of the motor can be prevented by the temperature monitoring system.
Before starting the motor the motor brake (if present) must be checked for correct function.
The optionally installed holding brake is only designed for a limited number of emergency brake operations. Use as working brake is strictly prohibited.

The drive is tested without the coupled mechanics. The test run is conducted in the speed controlled mode, independently from the selected pre-set solution.

A test run is still possible, even if the motor has already been coupled to the system:

1. **Enable Safe Standstill**
   High level on terminal X2/16
2. **Set power stage enable ENPO**
   High-level at terminal X2/12



Observe the temporal behaviour of the inputs.
* After controller initialisation as a consequence of parameter change

3. **Control with DRIVEMANAGER:**
   Select "speed control" and start the drive, e.g. with nominal value 100 min^{-1}.

DRIVEMANAGER
Open-loop control
or:
Active device > Open-loop control> Basic operating modes

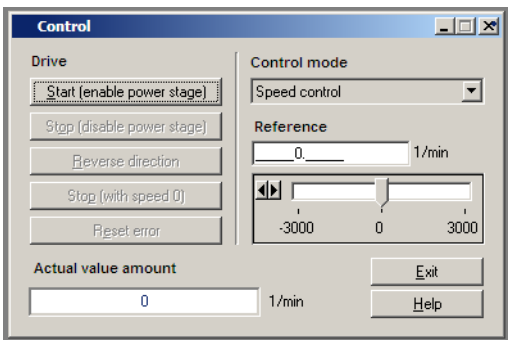


Fig. 4.8 Control

DRIVEMANAGER
Digital Scope
or:
Active device > Monitor > Quickly changing digital scope values

Check the drive response

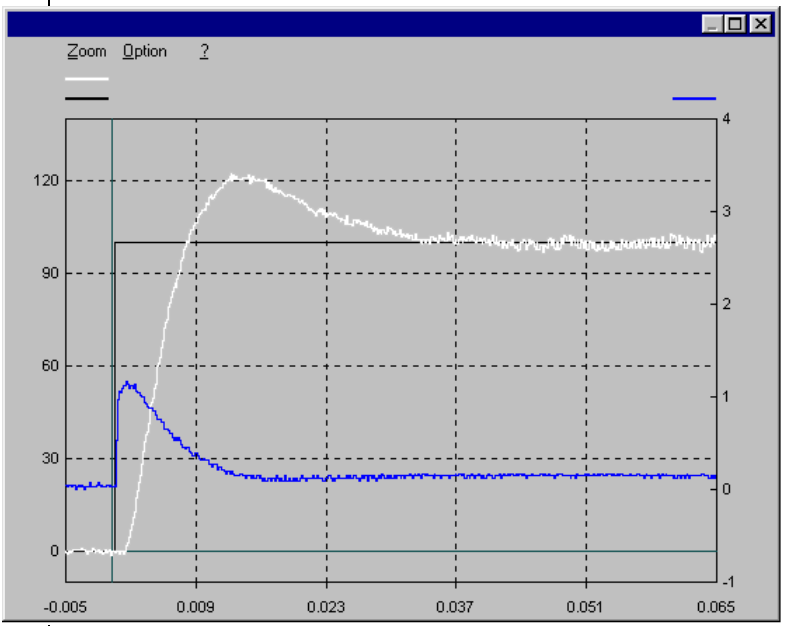
Now you can assess the drive performance with the aid of step responses, which can be recorded using the digital scope function of the DRIVEMANAGER.

Select the following four recording variables:

- 0: Speed:Reference
- 1: Speed:Actual value
- 2: Torque:Reference
- 3: Torque:Actual value

Triggering condition:

Channel 0; rising flank, pre-trigger 10%; level: 30 min^{-1}



Start the drive with a reference value of e.g. 100 min^{-1}.
Compare the step response of your drive with the illustration. With resolvers the overshoot of the actual speed value should be around 20 %; with sin/cos incremental encoders approx. 30% (with reference to the nominal value). Make sure that the drive system shows small-signal response (the nominal value of the torque must be less than the maximum value).

If the torque reference reaches its maximum, reduce the speed step.

The time response (rise time, correction time) of the speed control loop is independent of the speed step.

Result:

If the step response of your drive does approximately correspond with the illustration, it is assured that the motor phases are correctly wired, the encoder is correctly connected and the CDF3000 is parameterized to the correct motor.

If the step response deviates considerably from the illustration, it is to be assumed that

- the motor dataset was incorrectly selected or
- that the wiring is incorrect.

Check the individual steps from Chapter 3 "Installation" and Chapter 4.3 "Initial commissioning" and repeat the test run.

The step response may also deviate if the ratio of the machine moment of inertia reduced onto the motor shaft relative to the motor moment of inertia is very high. Here the loop control settings must be optimized. For special settings to optimize the speed and position control loops, please use the CDF3000 Application Manual.

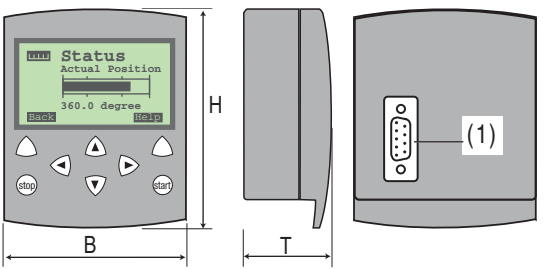
4.5 Operation with KEYPAD KP300

The KP 300 can be connected directly to the positioning drive (X4). You will find exact details on the individual functions and their use in the KP300 operation manual.

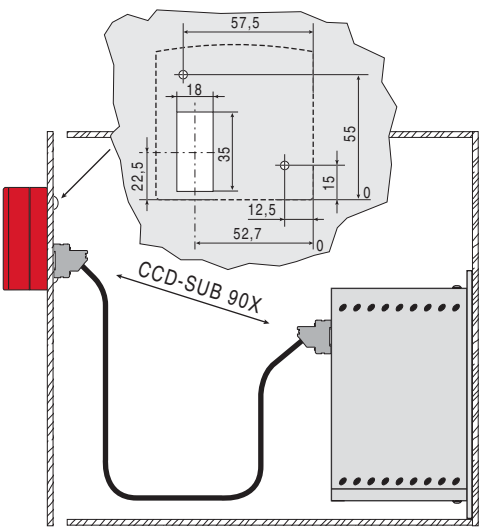
Overview KEYPAD

Designator	Summary explanation
KP300	KEYPAD with graphic display (128 x 64 pixels) for setting parameters, actual value indication and serial commissioning of the positioning drive. Display of graphics such as unit status and text for parameters. Language German or English (can be configured). The KEYPAD KP300 supports the SMARTCARD "SC-XL".

Mechanical KP300	
Dimensions (see fig.)	70 x 84 x 37 mm (W x H x D)
Weight	120 g
Connection (RS232)	
Standard (1)	Can be connected directly to the drive unit



Cable connection	**Mounting in the cabinet door**
Connection between KP300 and the positioning drive CDF3000 using the cable CCD-SUB90X	For mounting in the cabinet door, two holes for fastening screws and a cut-out for the connector are required. Please only use self-tapping screws for thermoplastics (e.g. EJOT PT screw, type K30 x 8 WN1412). Max. cable length is 3 m.



4.6 Operation with DRIVEMANAGER

Prerequisite:

- DRIVEMANAGER version V3.2 or higher is installed on the notebook.
- The CDF3000 has been installed as instructed in chapter 3.

Attention: Make sure that both the CDF3000 housing as well as the GND-connection (control voltage 0V) are connected to the protective conductor potential. Otherwise the serial interface of the CDF3000 may be destroyed by potential displacement (see chapter 3.3).

Attention: The RS232 interface must only be used for service and commissioning. Using the interface for control purposes is not permitted.

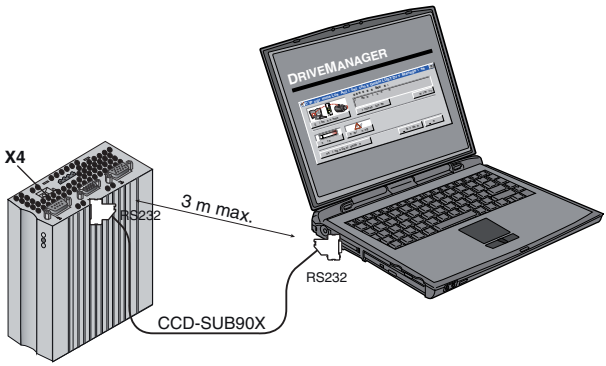


Fig. 4.9 Connection of positioning controller to notebook/DRIVEMANAGER

Attention: The RS232 interface is connected to the potential of the control electronics (-) pole. Due to possible potential differences between the earthing of the (-) pole and the earthing of the notebook, a PE loop can be setup via the screen and the signal wires in the interface cable, and the screen earthing on the notebook. As a result the RS232, the notebook and the CDF3000 may be irreparably damaged! For this reason an opto-isolator is to be used in the interface cable (suppliers of opto-isolators are established IT accessory suppliers).

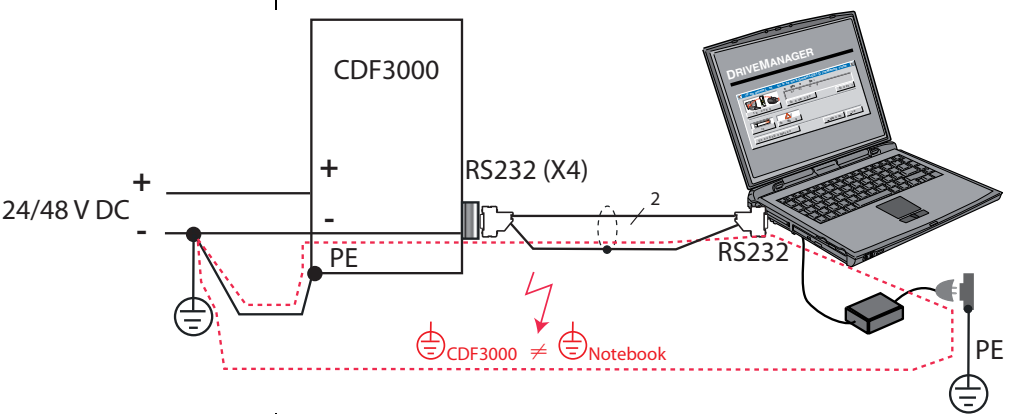


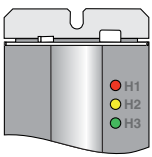
Fig. 4.10 Connection of serial interface with illustration of a PE loop

The most important functions

Icon	Function	Menu
	Changing the setting of the active device	Active device > Change settings
	Print parameter dataset	Active device > Print settings
	Digital Scope	Active device > Monitor > Quickly changing digital scope values
	Control drive	Active device > Open-loop control > Basic operation modes
	Connect to device	Communication > Connect > Single device
	Bus-initialization, Change settings	Communication> Bus-configuration
	Disconnect all devices	Communication > Disconnect
	Save dataset of active device in file	Active device > Save settings of device to
	Dataset transfer from file to active device	Active device > Load settings into device from

5 Troubleshooting

5.1 LEDs



The positioning controller is fitted with three status LED's in red (H1), yellow (H2) and green (H3) at the top right.

Device status	red LED (H1)	yellow LED (H2)	green LED (H3)
Power* on	-	-	●
Ready [1)]	❍	●	●
In service/auto-tuning active	❍	✳	●
Warning	●	● / ✳	●
Error	✳ (flash code)	❍	●

❍LED off, ● LED on, ✳ LED flashing

+ 24 V on control terminal X2

[1)] Prerequisite: "Safe Standstill" and ENPO placed beside each other.

5.2 Error messages

If an error occurs during operation it is indicated by a flash code from LED H1 (red) on the positioning controller. The code indicates the type of error. If a KP200XL is connected via an adapter, the KP200XL indicates the error type as a code.

Flash code of red LED H1	Display KeyPad	Explanation	Cause/Remedy
1x	E-CPU	Collective error	The exact error code can be read out via the KeyPad or the DriveManager.
2x	E-OFF	Undervoltage shut-off	Check power supply, also occurs briefly in response to normal power-off.
3x	E-OC	Overcurrent shut-off	**Short-circuit, earthing fault**: Check cabling of connections, check motor coil (see also section 3, Installation). **Device setup not correct**: Check parameters of control circuits, check ramp setting.
4x	E-OV	Overvoltage shut-off	**Voltage overload from mains**: Check mains voltage, restart device. **Voltage overload resulting from feedback from motor** (regenerative operation): Decelerate brake ramps - if not possible use braking resistor.
5x	E-OLM	Motor protection shut-off	**Motor overloaded** (after I x t-monitoring): If possible slow down process cycle, check dimensioning of motor.
6x	E-OLI	Device protection shut-off	**Device overloaded**: Check dimensioning
7x	E-OTM	Motor temperature too high	**Motor-PTC correctly connected**? **Parameter MOPTC correctly set** (type of motor-PTC evaluation)? **Motor overloaded**: Allow motor to cool down, check dimensioning.
8x	E-OTI	Excessive temperature of positioning controller	**Ambient temperature too high**: Improve ventilation in control cabinet. Excessive load during driving/braking: Check dimensioning
1) For further information please refer also to the **CDE/CDB/CDF3000 application manual**			

Table 5.1 Error messages

Helpline

Contact us at the following address:

Mo.-Fr.:	8.00 a.m. to 5.00 p.m. Tel. 06441/966-180
E-Mail:	helpline@lt-i.com
Fax:	06441/966-137

Service repair

If you need further assistance, our specialists at the LTi-Service Center will be happy to help.

Contact us at the following address:

Mo.-Fr.:	8.00 a.m. to 5.00 p.m. Tel. 06441/966-888
E-Mail:	service@lt-i.com
Fax:	06441/966-211

Note: If you need more detailed assistance and advice, you will find all the services we offer in the "Support & Service" order catalogue. You can download the order catalogue from our website, www.lt-i.com, in the section of the same name.

5.3 User errors in KEYPAD operation

Error	Cause	Remedy
ATT1	Parameter cannot be changed at current user level or is not editable	Select user level 1-MODE higher.
ATT2	Motor must not be controlled via the CTRL menu	Cancel start signal from a different control location.
ATT3	Motor must not be controlled via the CTRL menu because of error state	Reset error.
ATT4	New parameter value impermissible	Change value.
ATT5	New parameter value too high	Reduce value.
ATT6	New parameter value too low	Increase value.
ATT7	Card must not be read in current state	Reset start signal.
ERROR	Invalid password	Enter correct password.

*Table 5.2 User errors KEYPAD: Reset with **start/enter***

5.4 User errors in SMARTCARD operation

Error	Meaning	Remedy
ERR91	SMARTCARD write-protected	Use different SMARTCARD
ERR92	Error in plausibility check	
ERR93	SMARTCARD not readable, wrong positioning controller type	
ERR94	SMARTCARD not readable, parameter not compatible	
ERR96	Connection to SMARTCARD interrupted	
ERR97	SMARTCARD data invalid (checksum)	
ERR98	Insufficient memory on SMARTCARD	
ERR99	Selected area not present on SMARTCARD, no parameters transferred from SMARTCARD	

*Table 5.3 SMARTCARD error: Reset with **stop/return***

5.5 Reset

The reset function is divided into two areas with differing effects. Parameter reset restores to the last value stored in the device. Device reset restores the entire dataset to factory setting (delivery defaults).

Parameter reset with KEYPAD

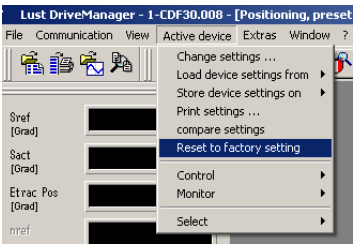
If you are in the setup mode of a parameter and press the two cursor keys simultaneously, the parameter you are currently editing will be reset to the last setting saved (= saved with parameter 150-SAVE).

Factory setting with KEYPAD

Press both cursor keys simultaneously during positioning controller power-up to reset all parameters to their factory defaults and reinitialise the system

Factory setting with DRIVEMANAGER

In the "Active device" menu, the "Reset to factory setting" option can be used to restore the delivery defaults of the device.



Note: Attention! This factory setting also resets the selected default solution. Check the terminal assignment and the functionality of the positioning controller in these operating modes or load your user dataset.

A Appendix

A.1 Technical data

CDF30.008

Technical data	CDF30.008
Output motor side	
Voltage	16.5 V ... 33 V AC
Continuous current effective (I_N)	8.0 A
Peak current 2 x I_N for 5 s	16 A
Rotating field frequency	0 ... 400 Hz
Power stage switching frequency	8, **16** kHz
Input mains supply side (X1)	
Mains voltage	1 x 24 VDC -10 %/ 48 VDC +10 %
Device connected load	480 VA
Power loss	25 W
Brake chopper power electronics	
Minimum ohmic resistance of an externally installed braking resistor	3,9 Ω -10 % at 48 V DC 2,2 Ω -10 % at 24 V DC*
* Attention: Set DCIN parameters!	

Table A.1 Technical data

Please note:

The brake chopper enable threshold and the selection of the braking resistor are based on the nominal supply voltage.

In the CDF3000, please first set the parameter DCIN to the nominal value for the supply voltage connected such that U_{nom} = |DCIN| (requirement on supply voltage:
Tolerance max. ± 10 %, voltage stabilised and smoothed).

Please note the setting range for the parameter DCIN (24 to 48 V DC).

The brake chopper enable threshold is then calculated as follows:
U_{Br} = 1.1 * |DCIN| +5.2 V

The overvoltage shutdown threshold is then calculated as follows:
U_{Sp} = 1.1 * |DCIN| +10.2 V

The **minimum** braking resistor allowed is defined by the following table:

DCIN	RB_{min}
24 V	2.2 Ω - 10 %
24 V to 32 V	2.7 Ω - 10 %
32 V to 40 V	3.3 Ω - 10 %
40 V to 48 V	3.9 Ω - 10 %

Table A.2 Minimum braking resistors allowed

A.2 Ambient conditions

Characteristic		Positioning controller	Accessories (KEYPAD KP300)
Climatic conditions	**in operation** as per EN 61800-2, IEC 60721-3-3 class 3K3	+5 ... 40 °C [2] at relative air humidity 5 ... 85 % without condensation	+5 ... 40 °C [2] at relative air humidity 5 ... 85 % without condensation
	in storage as per EN 61800-2, IEC 60721-3-1 class 1K3 and 1K4	-25 ... +55 °C [3] at air relative humidity 5 ... 95 %	
	in transitas per EN 61800-2, IEC 60721-3-2 class 2K3	-25 ... +70 °C [4] relative air humidity 95 % at max. +40 °C	
Protection	Device	IP20 (terminals IP00)	
	Cooling method	Convection	
Protection against direct contact		BGV A3	
Type of mounting		Built-in unit only for mounting vertically in a cabinet with min. ingress protection IP4x, on the usage of the STO safety function min. IP54	
Mounting height		up to 1000 m above zero level, at altitudes higher than 1000 m above zero level with power reduction, max. 2000 m above zero level	

Vibration limit in transit, as per EN 61800-2, IEC 60721-3-2 class 2M1		
Frequency	**Amplitude**	**Acceleration**
2 < f < 9 Hz	3.5 mm	Not applicable
9 < f < 200 Hz	Not applicable	10 m/s^2
200 < f < 500 Hz	Not applicable	15 m/s^2

Shock limit in transit as per EN 61800-2, IEC 60721-2-2 class 2M1
Drop height of packed device max. 0.25 m

Vibration limit of the system[5], as per EN 61800-2, IEC 60721-3-3 class 3M1		
Frequency	**Amplitude**	**Acceleration**
2 < f < 9 Hz	0.3 mm	Not applicable
9 < f < 200 Hz	Not applicable	1 m/s^2

2) The absolute humidity is limited to max. 25 g/m^3. That means that the maximum values for temperature and relative air humidity stipulated in the table must not occur simultaneously.

3) The absolute humidity is limited to max. 25 g/m^3. So the maximum values for temperature and relative air humidity stipulated in the table must not occur simultaneously.

4) The absolute humidity is limited to max. 60 g/m^3. This means, at 70 °C for example, that the relative humidity may only be max. 40 %.

5) The devices are only designed for stationary use.

A.3 UL-Approbation

Additional measures for compliance with the UL approval:

- The units must be mounted in a cabinet.
- Maximum pollution severity 2
- Each unit is to be protected with a "listed branch circuit breaker" approved by UL as a branch circuit breaker (category code DIVQ). Rated current of the branch circuit breaker: maximum 16 A.
- Tightening torque for the terminals on X1: 0.5 ... 0.6 Nm
  Tightening torque for the terminals on X2: 0.22 ... 0.25 Nm
- Copper cable, UL-approved, AWG14, at least 75 °C
- The short-circuit capacity of the mains (before the power supply unit) is allowed to be max. 5000 A.

Electrical isolation concept CDF3000

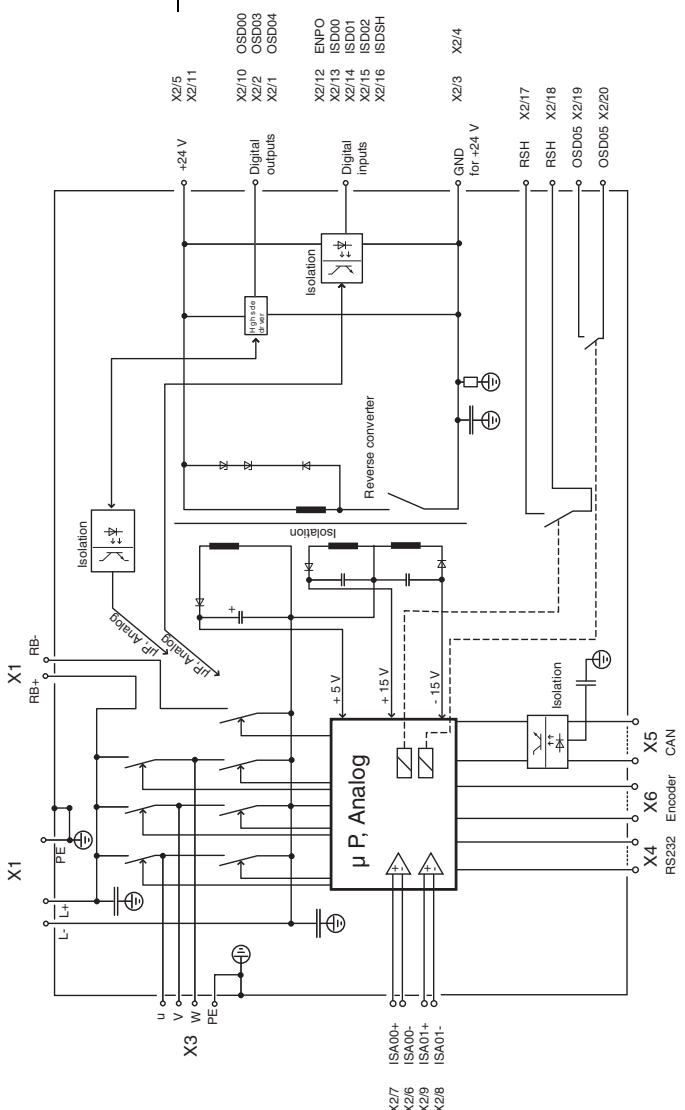


Fig.A.1 *It is only allowed to lay signals and voltages to the CDF that meet the requirements for a protective extra-low voltage (PELV) or safety extra-low voltage (SELV) in the context of EN 61800-5-1. The related specifications and connection conditions for the signals and voltages must comply with the descriptions in the operation manual.*

Appendix B Index

R

S

T

U

V

W

Notes on EN 61000-3-2 DE	Notes on EN 61000-3-2 EN
(load on the mains due to harmonics) Our positioning drives and servo controllers are "professional equipment" in the context of EN61000 such that with a nominal connected load ≤1kW they fall within the scope of the standard. On the direct connection of drive units ≤1kW to the public low voltage grid, either measures to conform with the standard are to be taken or the responsible utility must grant approval for connection. If you should use our drive units as a component in your machine / system, then the scope of the standard is to be checked for the complete machine / system.	(limits for harmonic current emissions) Our frequency inverters and servocontrollers are "professional devices" in the sense of the European Standard EN 61000, and with a rated power of ≤1kW obtained in the scope of this standard. Direct connection of drive units ≤1kW to the public low-voltage grid only either by means of measurements for keeping the standard or via an authorization of connection from the responsible public utility. In case our drive units are used as a component of a machinery/plant, so the appropriate scope of the standard of the machinery/plant must be checked.

LTi DRiVES GmbH
Gewerbestr. 5-9
D-35633 Lahnau
GERMANY
Fon: +49 (0) 64 41 / 96 6-0
Fax: +49 (0) 64 41 / 9 66-1 37

Heinrich-Hertz-Str. 18
D-59423 Unna
GERMANY
Fon: +49 (0) 23 03 / 77 9-0
Fax: +49 (0) 23 03 / 77 9-3 97

www.lt-i.com
info@lt-i.com

Id.-No.: / ID no.: 1040.20B.2-01 • 11/2010