SIEMENS

# SINUMERIK, SINAMICS

# SINUMERIK 840D sl, SINAMICS S120 Guidelines for machine configuration

System Manual



Valid for
NCU SW 2.6 SP1


(MA1), 10/2009
6FC5397-6CP10-0BA1

## Legal information

### Warning notice system

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|---|
| indicates that death or severe personal injury **will** result if proper precautions are not taken. |

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|---|
| indicates that death or severe personal injury **may** result if proper precautions are not taken. |

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|---|
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| CAUTION |
|---|
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|---|
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# Preface

## SINUMERIK Documentation

The SINUMERIK documentation is organized in 3 parts:

- General documentation
- User documentation
- Manufacturer/service documentation

You can obtain further information for publications about SINUMERIK 840D sl and for publications that concern all SINUMERIK controllers from your SIEMENS regional office.

An overview of publications, which is updated monthly and also provides information about the language versions available, can be found on the Internet at:
http://www.siemens.com/motioncontrol
Select "Support" → "Technical Documentation".

The Internet version of DOConCD (DOConWEB) is available at:
http://www.automation.siemens.com/doconweb

## Target readership of this documentation

This guide has as audience the experienced drive and CNC configuration engineers who have already worked with the current Siemens SIMODRIVE and SINUMERIK systems . This document should provide you with a compact guide for integrating the SINAMICS S120 and SINUMERIK 840D sl components.

This document supplements the product-related manuals for SINAMICS S120 and SINUMERIK 840D sl. The document contains examples for the mechanical layout of the components, for their functional integration and for the logical connection to the signal interfaces of a machine tool.

Where necessary for the understanding and for important general conditions, this guide contains extracts from the product manuals listed below. You can find there detailed descriptions for the product-internal functions and properties, and for the mechanical and electrical user interfaces.

- SINUMERIK 840D sl manual, 07/2007 edition
- Commissioning Manual SINUMERIK 840D sl, SINAMICS S120 IBN CNC: NCK, PLC, Drive, 03/2009 edition
- SINAMICS S120 Booksize Power Units Equipment Manual, 11/2009 edition
- SINAMICS S120 Function Manual, 11/2009 edition
- SINAMICS S120/S150 List Manual, 11/2009 edition
- Safety Integrated sl Function Manual, 03/2009 edition

## Standard version

This documentation also mentions components that have not been released for use with SINUMERIK 840D sl. The NC61 catalog is binding for the permitted combinations.

## Technical Support

If you have any questions, please contact our hotline:

| | Europe / Africa | Asia / Australia | America |
|---|---|---|---|
| Phone | +49 180 5050 222 | +86 1064 719 990 | +1 423 262 2522 |
| Fax | +49 180 5050 223 | +86 1064 747 474 | +1 423 262 2289 |
| Internet | http://www.siemens.de/automation/support-request | | |
| E-mail | mailto:adsupport@siemens.com | | |

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| | |
|---|---|
| Fax: | +49 (0) 9131 / 98 - 63315 |
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## SINUMERIK Internet address

http://www.siemens.com/sinumerik

## SINAMICS Internet address

http://www.siemens.com/sinamics

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# System overview 1

## 1.1 Application

### General system characteristics and areas of application

SINUMERIK 840D sl is a digital complete system integrated in the SINAMICS S120 drive system and supplemented by the SIMATIC S7-300 automation system that is suitable for the mid-sized and large power range.

- Maximum performance and flexibility, above all for complex multi-axis systems.
- Uniform openness from operation up to the NC core.
- Optimum integration into networks.
- Uniform structure in respect of operation, programming and visualization.
- Integrated safety functions for man and machine: SINUMERIK Safety Integrated
- Operating and programming software such as ShopMill or ShopTurn, as well as Motion Control Information System Products (MCIS-Products) can be used for the production sector.

### Fields of application

The SINUMERIK 840D sl can be used anywhere in the world for the following applications: machine tools, packaging and textile machines, rotary indexing machines, transfer machines and handling systems, glass and wood processing machines, press equipment, plastic processing and printing machines. It can be used in production and preparatory areas and is also suitable for both series and one-off production environments.
Thanks to this level of versatility, it offers all the main forms of technology associated with metal working (e.g. milling, turning, grinding, hobbing, laser cutting, punching, nibbling, and erosion).

The optional version is ideal for high-technology tool and mold making applications. It can also be used for high-speed cutting applications in 3 or even as many as all 5 axes, as well as for special applications.

The SINUMERIK 840DE sl is available as an export version for use in countries requiring an export authorization.

## 1.2 System configuration

The heart of the SINUMERIK 840D sl is the Numerical Control Unit (NCU). It combines NCK, HMI, PLC, closed-loop control and communication tasks.

### Components

For operating, programming, and visualization, the corresponding HMI software is integrated in the NCU software. For increased operating performance, the SINUMERIK PCU 50.3 industrial PC can be used.

With the TCU (Thin Client Unit), the operator panel can be installed as much as 100 meters away. Up to 4 distributed operator panel fronts can be operated on an NCU or PCU 50.3.

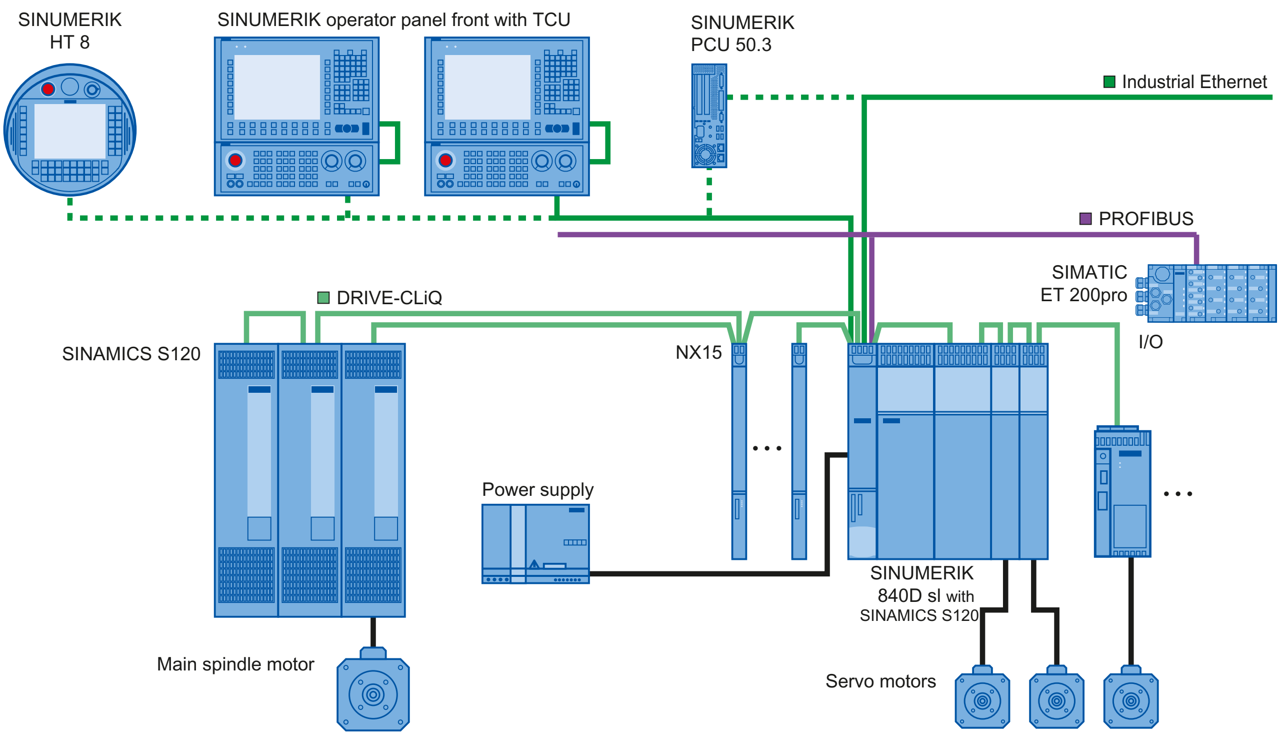


Figure 1-1 Typical topology of the SINUMERIK 840D sl complete system

The following components can be attached to the Control Unit:

- SINUMERIK operator panel front with TCU/PCU 50.3 and machine control panel/pushbutton panel
- SIMATIC CE panel
- Handheld units
- SIMATIC S7-300 I/O
- Distributed PLC I/Os using a PROFIBUS DP connection or PROFINET I/O (only applies to NCU 720.2 PN and NCU 730.2 PN)

- Programming device
- SINAMICS S120 drive system with feed and main spindle motors, such as
  - 1FT/1FK/1FN/1FW6/1FE1/2SP1 synchronous motors
  - 1PH/1PM asynchronous motors

With the NCU 720.2 PN and NCU 730.2 PN components, the SINUMERIK 840D sl offers integrated PROFINET functionality.

Supported:

- PROFINET CBA functionality

  The CBA functionality integrated in the NCU allows users to modularize machinery and systems: Rapid real-time communication (up to 10 ms) between the controllers means that systems lend themselves better to standardization and can be reused or expanded more easily. Response to customer demands is faster and more flexible and startup is simplified and speeded up by pretesting at component level.
- PROFINET IO

  As part of PROFINET, PROFINET IO is a communication concept that is used to implement modular, distributed applications. PROFINET IO is based on Industrial Ethernet and allows distributed field and I/O equipment to be connected to the central processing unit.

  256 PROFINET IO devices can be operated on the NCU as an IO controller.

  The typical topology with Industrial Ethernet, illustrated above, can be integrated in exactly the same way using PROFINET IO (or PROFINET components). Using PROFINET machine control panels or operator panels means, of course, that diagnostics is available as a PN device.

## 1.3 Variants

Thanks to the scalability of the hardware and software, both in the controller and operating areas, the SINUMERIK 840D sl can be used in many sectors. The possibilities range from simple positioning tasks up to complex multi-axis systems.

### Application areas and performance

- As many as 6 axes can be implemented on one NCU 710.x in SERVO control mode, with a sampling time of 125 µs for both the speed and current controllers. The NCU 710.x can be expanded by up to 2 NX modules in order, for example, to improve drive control performance.
- On the NCU 720.x/730.x, the number of axes can be increased to as many as 31 and/or drive control performance can be improved in SERVO control mode, with a sampling time of 125 µs for both the speed and current controllers. This is achieved by using the NX10.x/15.x module. The NCU 720.x/730.x can be expanded by up to 5 NX10.x/15.x modules for the purpose of increasing drive control performance or the number of axes.

- The NCU 730.x is recommended for maximum dynamics and accuracy in mold making applications or the high-speed cutting sector.
- Since it has the highest PLC capacity, the NCU 730.2 PN represents the most advanced configuration within the SINUMERIK 840D sl range.

The following table shows the essential features of the various Control Units:

Table 1- 1 Versions, increased numbers of axes

| Property | NCU 710 .2 | NCU 720.2/.2 PN | NCU 730.2/.2 PN |
|---|---|---|---|
| DRIVE CLiQ ports | 4 | 6 | 6 |
| Axes in SERVO control mode with speed and current controller sampling times of 125 μs | Up to 6 | Up to 31 | Up to 31 |
| NX10/15 expansions | Up to 2 | Up to 3/Up to 5 | Up to 3/Up to 5 |
| TCU | Up to 2 | Up to 4 | Up to 4 |

### Further information

Please refer to the following for detailed information on the number of axes and controller axis performance:
/FH1/SINAMICS S120 Function Manual Drive Functions, 11/2009 edition, Section 12.13.

## 1.4 SINAMICS S120 components

### Modular system toolbox for complex drive tasks

SINAMICS S120 can be used to solve complex drive tasks for a very wide spectrum of industrial applications and consequently designed as a modular system toolbox. From a wide range of matched components and functions, the user uses just the combination that best meets the user's requirements. The powerful SIZER configuration tool simplifies the selection and the determination of the optimum drive configuration.

SINAMICS S120 is supplemented with a large range of motors. Irrespective whether synchronous or asynchronous motors, SINAMICS S120 optimally supports them all.

### Drive for multi-axis applications

The trend to desynchronization in machine construction continues uninterrupted. Unless it has already been done, central drives will be replaced by electronically-coordinated servo drives. These require drives with coupled DC link to provide a cost-effective energy compensation between braking and driving axes.

SINAMICS S120 has a wide power range using power feeds and inverter modules designed for a smooth installation in its type and which permit space-saving multi-axis drive configurations.

## New system architecture with central control unit

Electronically-coordinated single drives solve your drive task together. Overlaid controllers control the drives so that the required coordinated motion results. This requires a cyclical data exchange between the controller and all drives. Previously, this exchange had to be realized using a fieldbus with the associated installation and configuration cost. SINAMICS S120 follows new paths here: a central control unit performs as master the drive control for all attached axes and also realizes the technological links between the axes. Because all required information is present in the central control unit, it does not need to be transferred with difficulty. Inter-axis couplings can be created within a component and are configured in the STARTER commissioning tool or the drive wizard in the HMI of the SINUMERIK 840D sl simply by clicking the mouse.

The SINAMICS S120 control unit solves simple technological tasks by itself. For complex numeric or motion control tasks, powerful modules from the SINUMERIK 840D sl product range are used in conjunction with the integrated SINAMICS S120 drive control instead.

## DRIVE-CLiQ – the digital interface between SINAMICS components

The SINAMICS S120 components, including the motors and encoders, are connected with each other using the shared DRIVE-CLiQ serial interface. The standardized form of the cable and plug engineering reduces the range of parts and the storage costs.

Converter modules for the conversion of traditional encoder signals to DRIVE-CLiQ are available for non-Siemens motors or retrofit applications.

## Electronic rating plate in all components

All SINAMICS S120 components have an electronic rating plate. This rating plate contains all relevant technical data for the corresponding component. In the motors, these are, for example, the parameters of the electrical equivalent circuit diagram and characteristic values of the installed motor encoder. This data is recorded automatically by the control unit via DRIVE-CLiQ and does not have to be entered during the commissioning or after replacement.

The electronic rating plate contains not only the technical data, but also logistical data, such as the manufacturer identification, the order number and the worldwide unique identification number. Because these values can be fetched electronically both on-site and by remote diagnosis, a unique identification of all components used in a machine is always possible with the consequent simplification of the servicing.

# 1.5 SINAMICS S120 / SINUMERIK 840D sl Component Overview

The following overview contains the SINAMICS S120 and SINUMERIK components that should be used in preference for multi-axis drive tasks.

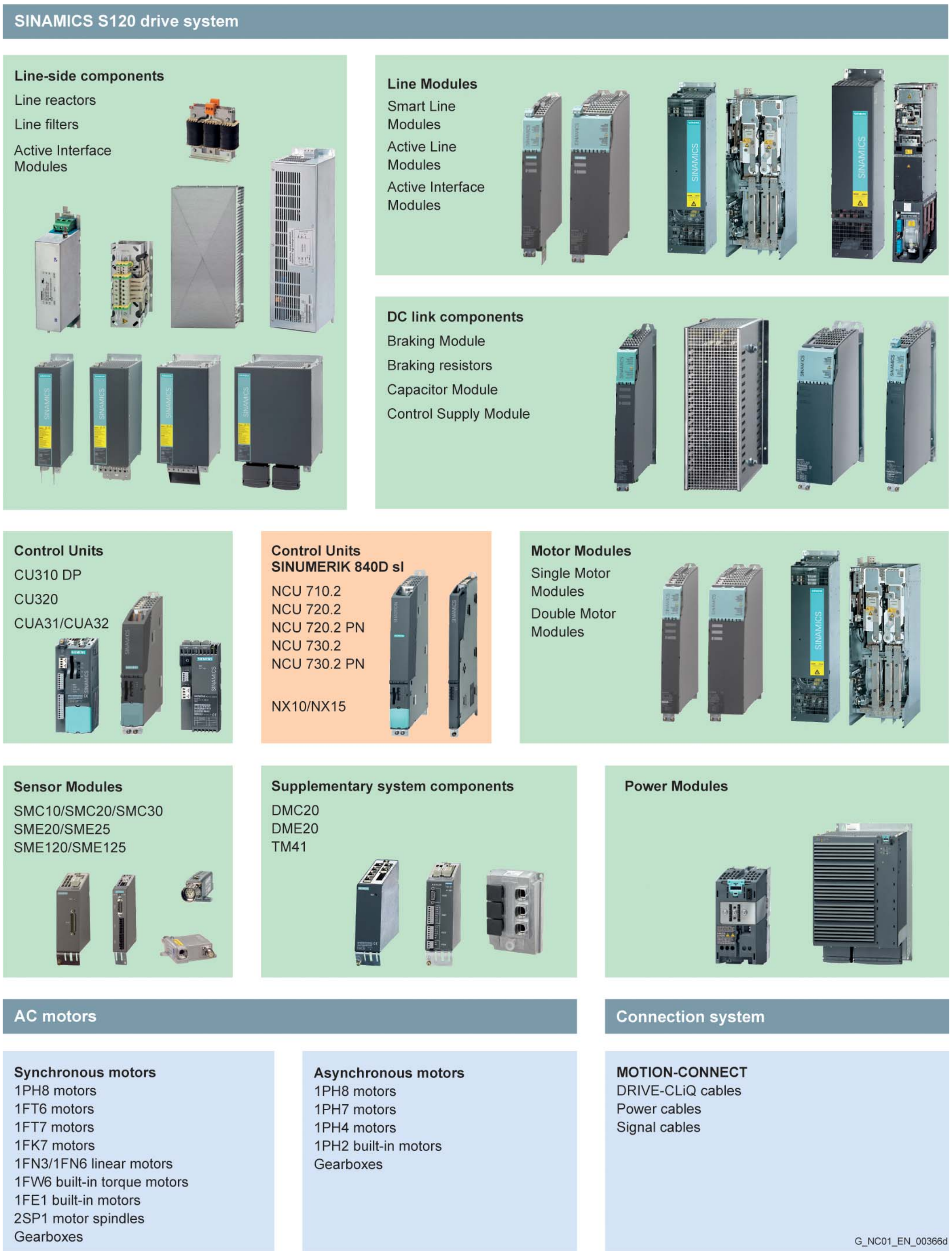


Figure 1-2 SINAMICS, SINUMERIK components

The following power components are offered:

- Line-side power components, such as fuses, contactors, chokes and filters for switching the energy supply and for observing the EMC regulations
- Line Modules that are responsible for the central energy supply in the DC link and, where necessary, for feeding energy back into the supply system
- DC link components used optionally for stabilizing the DC link voltage
- Motor modules that operate as inverter obtain their energy from the DC link and supply the attached motors.

To handle the required functions, SINAMICS S120 has

- A Control Unit that carries out all drive and technological functions across all axes.
- Additional system components to expand the functionality and to handle various interfaces for encoders and process signals.

The SINAMICS S120 components have been developed for installation in control cabinets. They are characterized by the following properties:

- Simple handling, simple installation and wiring
- Practice-oriented connection engineering and EMC-conform cable placement
- Consistent design, seamless installation,
  multi-tier configuration and configuration involving gaps also available where required
- Alternative cooling solutions tailored to the application
- Modules for internal air cooling, external air cooling, and other innovative cooling methods (e.g. cold plate) are also available.

## Power units

## Line Modules

The three-phase supply voltage is converted into the DC voltage for the DC link.

- Smart Line Modules

  The Smart Line Modules generate a non-regulated DC link voltage and are capable of regenerative feedback.
- Active Line Modules

  The Active Line Modules generate a regulated DC link voltage and are capable of regenerative feedback.

### Motor Modules

They make the energy from the DC link available at an adjusted voltage and with variable frequency. This is used to operate the connected motors.

## 1.6 User interface software (HMI software)

The HMI software is used to operate and program machine tools. There are several versions:

- The user interface software (SINUMERIK Operate, HMI-Embedded, ShopMill HMI, ShopTurn HMI) integrated in the CNC software
- The HMI software (SINUMERIK Operate, HMI-Advanced) running on the PCU 50.3

### Linking of HMI software

Use HMI software on the NCU 7x0. A thin client (TCU) is responsible for NCU - operator panel communication.

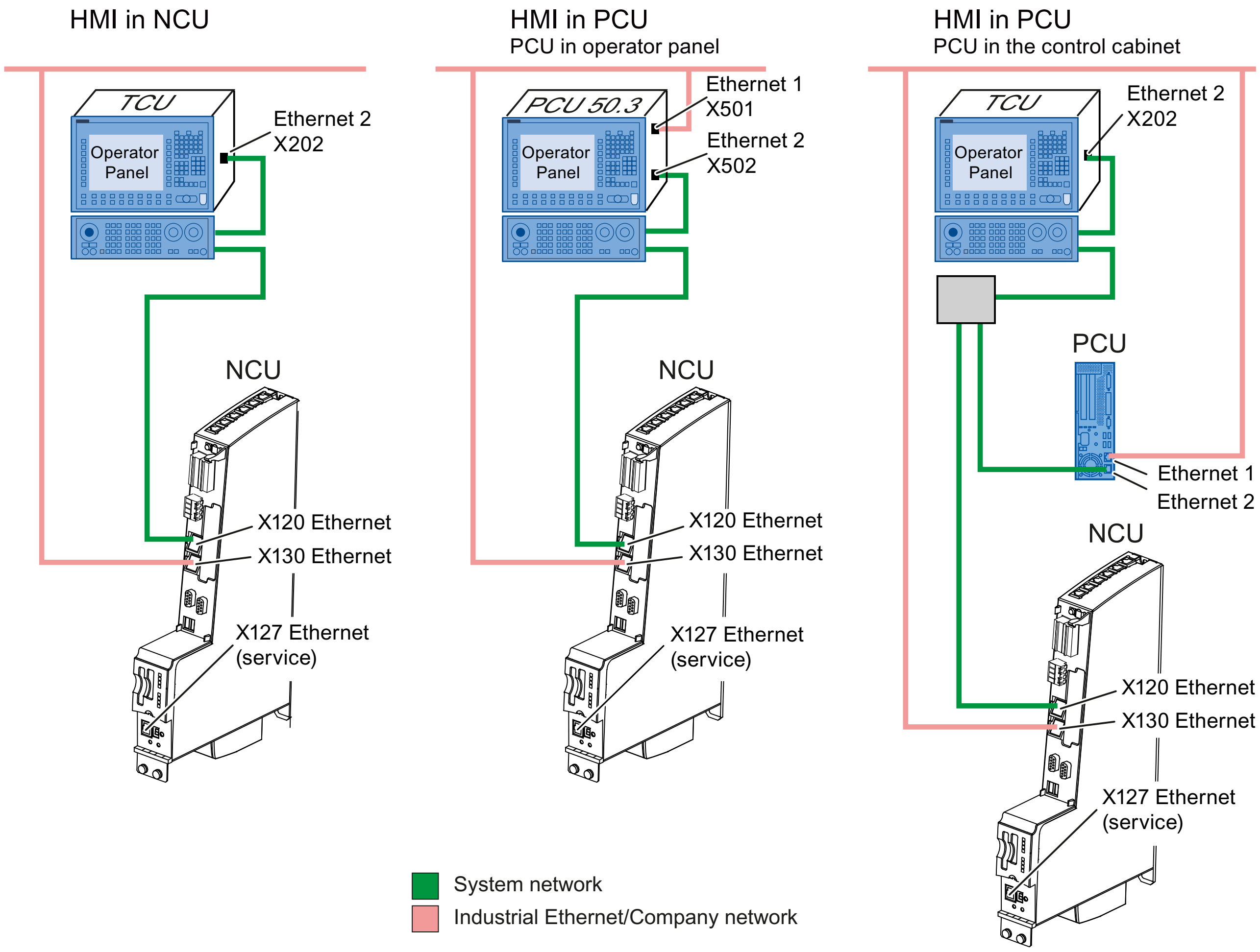


Figure 1-3 HMI SW connection options

## Switching between operator panels

When an Ethernet switch is used, you can switch between embedded HMI (available on NCU) and HMI-Advanced (available on PCU 50.3).

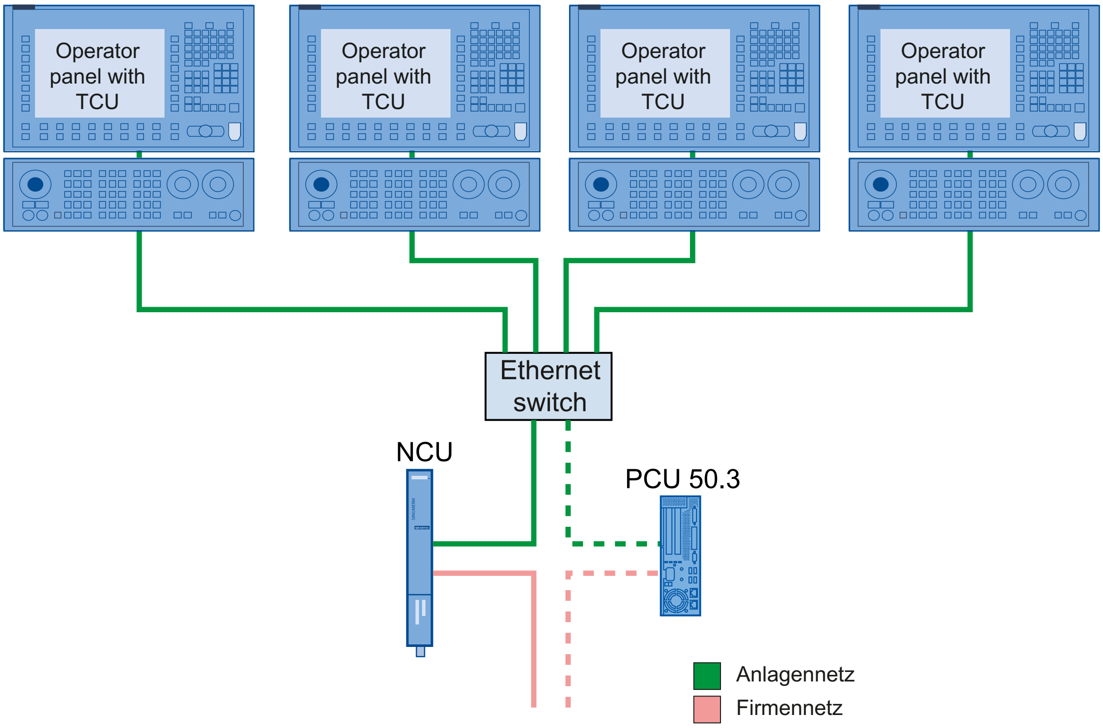


Figure 1-4 HMI connection with switch

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**Note**

Detailed information about the operator panels, TCU and PCU 50.3 is contained in the "sl Operator Components Device Manual" and in "CNC Commissioning, Part 2 (HMI)".

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# Structure of the drive group 2

## 2.1 Structure

### 2.1.1 Drive group structure

The individual components, such as Control Unit and power units, can be attached directly to each other without any separation. The specified safety clearance and ventilation space above, below and in front of the associated components must be observed. The maximum configuration of the drive group depends on the rated power of the Line Module or on the current load of the DC link busbar of the individual components.

The components can be assembled in a single line or as several lines. The stacked installation is possible for the multi-line layout; the installation next to each other in various cabinet sections is also possible for the cabinet string.

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**Note**

For the layout of the components, ensure that the maximum cable lengths are not exceeded. See Section Cable Lengths (Page 190).

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**Note**

Higher-power Motor Modules must be placed directly next to the Line Module. The lower-power components then follow. This prevents overloading of the DC link busbar of the associated component.
See also Section Current Carrying Capacity of the DC Link Busbar (Page 30).

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**Note**

The appropriate measures must be adopted to satisfy the EMC requirement (see below).

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#### Note concerning the use of components with a width of 50 mm

If a 50 mm wide Motor Module or a DC link component with a similar width (e.g. Braking Module or Control Supply Module) is located at the left-hand end of the drive group, then the DC link bridge, including all of the screws, must be removed.

| ⚠ DANGER |
| --- |
| The insertion of the screws without the DC link bridge is not permitted. |

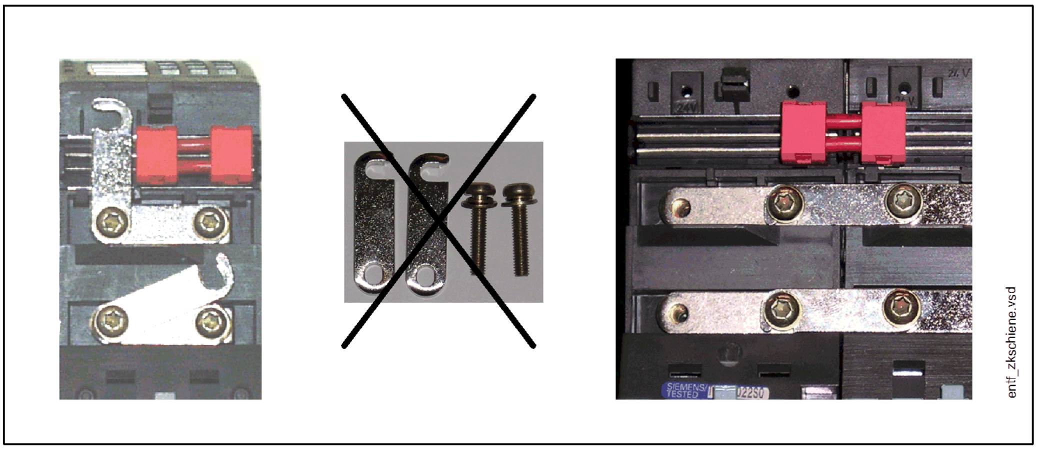

Figure 2-1 Removal of the DC link bridge

The DC link bridges must be removed by loosening the M4 screws.

| ⚠ DANGER |
| --- |
| The DC link bridge must not be removed for power units and DC link components (e.g. Capacitor Module) that are wider than 50 mm. |

## 2.1.2 Single row layout

All required components, such as Control Unit and power units are arranged in a row. The drive group is constructed depending on the available installation location in the control cabinet and the corresponding general conditions (see above).

The following rule is used as installation rule of the power units from left to right:

- Line Module
- Motor Modules depending on their power, starting with the highest power and ending with the lowest power
- DC link components (e.g. Braking Module, Control Supply Module, Capacitor Module)

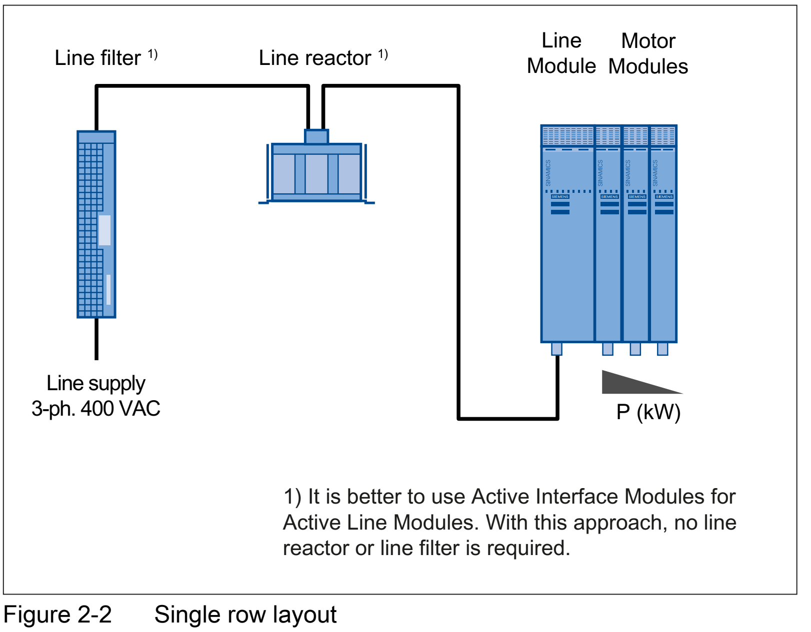


Figure 2-2 Single row layout

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**Note**

For information on the NCU 7x0 or NX1x layout, see Section Layout of the Components (Page 27).

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### 2.1.3 Two-row / multi-row construction

The components of the SINAMICS system can also be constructed as two or more rows. As previously described above, the limit is the maximum DC link length and the current carrying capacity of the DC link busbar. For the stacked construction, the appropriate ventilation clearances must be observed in accordance with the Equipment Manual for Booksize Power Units.

**Note**

Observe the installation and cooling clearances; see Section Note for the installation clearance for the connection cables (Page 41).

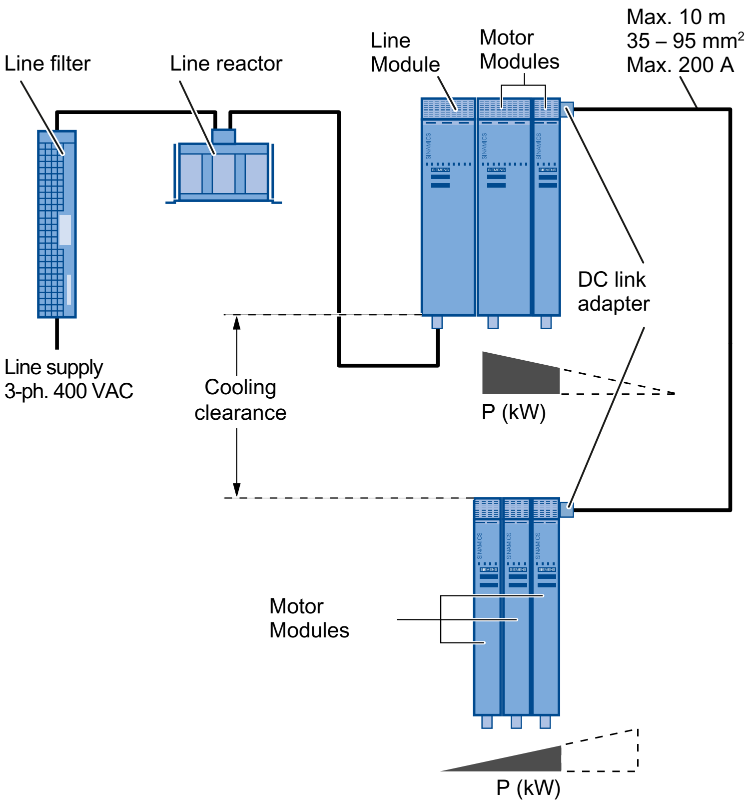


Figure 2-3 Two-row construction

**Note**

For information on the NCU 7x0 or NX1x layout, see Layout of the Components (Page 27).

DC link adapters are used to forward the DC link. Cross-sections of 35 mm² to 95 mm², max. 200 A, can be connected to the connection terminals.

The wiring outside the components is based on single-core, finely stranded, shielded cables. These should be laid in such a way that they are inherently short-circuit and earth fault proof.

The individual wires must be shielded, and the shield must be attached at both ends.

### Minimum size for the ventilation clearances for the two-/multi-row construction

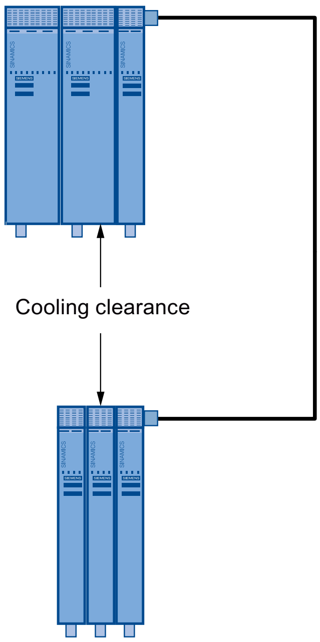


Figure 2-4 Ventilation clearance for the two-row construction

- The distance between the rows of components largely depends on the wiring, the cable cross-section, and the bending radius of the power cables to be connected.
- The inlet temperature of the air sucked in for cooling the components must not exceed 40 °C (with derating, it must not exceed 55 °C). This must be ensured by means of suitable air guidance, e.g. involving the distance between the component rows or air baffle plates.

### 2.1.4 Center infeed (single row construction) for 16 to 120 kW Line Modules

Another variant of the DC link supply is the center infeed. For the 16 to 120 kW Line Modules, the DC link can be fed from both the left and right side of the device. This allows the drive group to be mounted on both sides. The installation guidelines are the same as the previous guidelines.

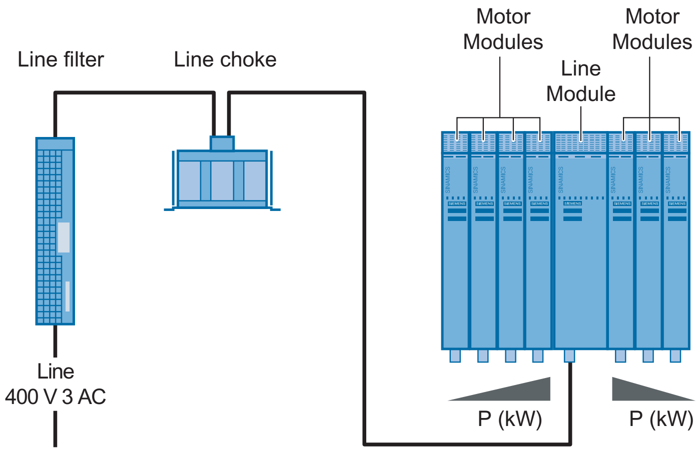


Figure 2-5 Center infeed construction

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**Note**

For information on the NCU 7x0 or NX1x layout, see Section Layout of the Components (Page 27).

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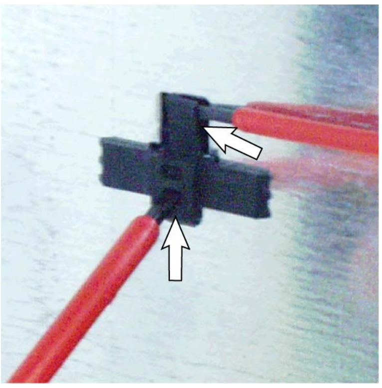
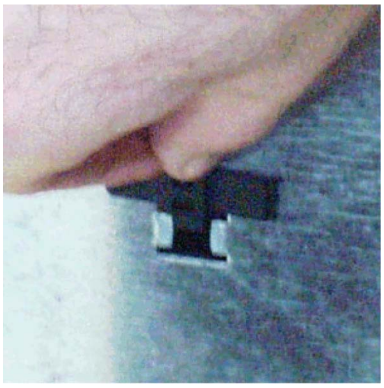
### 2.1.5 Direct installation of a CU-/NCU-/NX module on the Line Module

The Line Modules permit the docking of a CU320-/ NCU-/ NX component using the attachment elements present as standard on the left-hand side of the housing.

**Remove the holder for securing the Control Unit.**

If an additional component is to be flush-mounted to the left of the component, the holders for securing the Control Unit must be removed.

|  |  |  |
|---|---|---|
| Use suitable tools to lift the latching device and push up the holder | Remove the holder | After the removing the holder |

## 2.2 Layout of the Components

### 2.2.1 Layout and Fastening of the NCU/ NX Modules

#### Fastening of the NCU 7x0/ NX Modules

For the fastening of the NCU / NX modules, a differentiation is made between fastening using direct installation, using fastening clip or using spacers.

The fastening of the NX component to the NCU differs depending on whether an NCU 710 or an NCU 720/730 is used (cooling fins on the rear side of the NCU 720/730).

## Fastening Possibilities

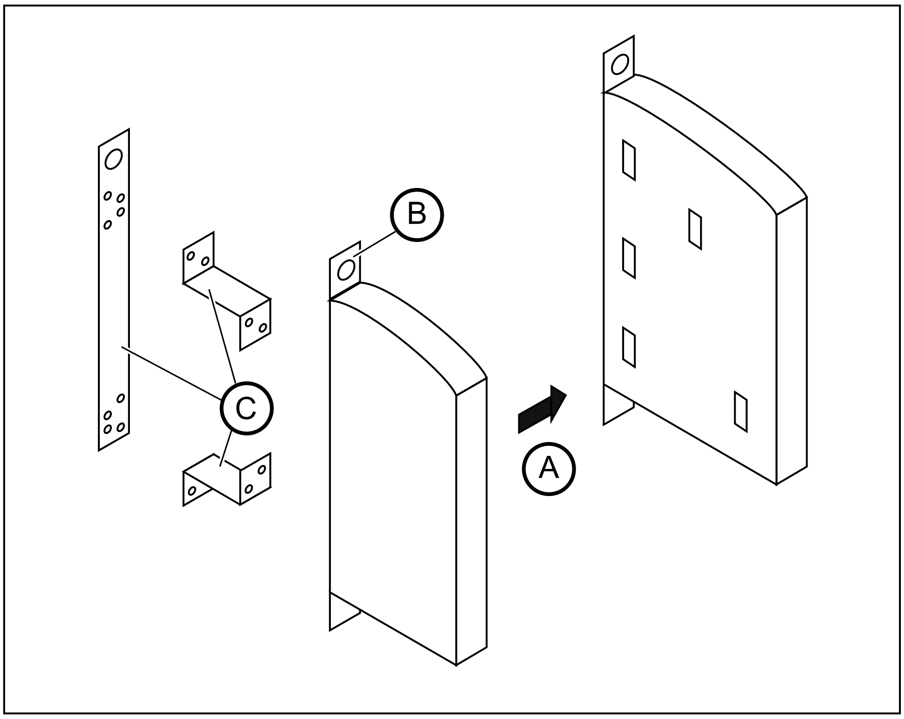



Figure 2-6 Main NCU-NX fastening types

Table 2- 1 Fastening possibilities for NCU 710 and NX

| | NCU 710 | NX | NCU 710+NXs |
|---|---|---|---|
| A (direct to the Line Module) | possible | possible | – |
| B (with fastening clip) | | possible | |
| C (with spacer) | possible | possible | possible |

Table 2- 2 Fastening possibilities for NCU 720/730 and NX

| | NCU 720/730 | NX | NCU 720/730 +NXs |
|---|---|---|---|
| A (direct to the Line Module) | possible | possible | – |
| B (with fastening clip) | – | possible | – |
| C (with spacer) | possible | possible | possible |

### Note

To ensure the optimum reachability and the access to the connection plugs for digital signals / bus connections, the following placement notes should be observed.

### 2.2.2 Layout of the NX for single row construction integrated in the power unit group

If NX components are present, they should be added between the power unit and the NCU. This ensures the best-possible reachability and access to the connection plugs for digital signals / bus connections.

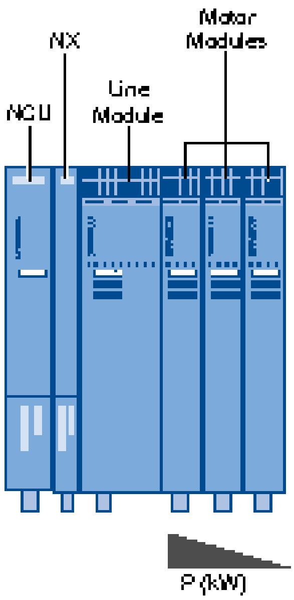



Figure 2-7 NX between NCU and Line Module

### 2.2.3 NCU/NX Layout as Offset Solution

The DRIVE-CLiQ connection of the SINAMICS components permits any layout of the NCU / NX modules. The layout of the NCU / NX directly in the drive group is thus not mandatory. This type of installation involves fastening clips or spacers. To stabilize a group containing several NX components, specially prepared connection brackets can be fastened to the front of the NX between the components.

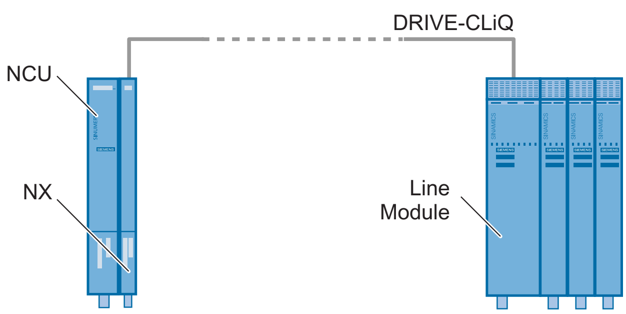



Figure 2-8 NCU/NX as offset solution

## 2.3 Current Carrying Capacity of the DC Link Busbar

The current carrying capacity of the DC link busbar must be observed for the configuring and the construction of the drive group.

Depending on the width of the power units, the maximum current carrying capacity of the DC link busbar is represented by the following values:

- With power units between 3 A and 30 A (max. width 100 mm) and DC link components (Braking, Capacitor, and Control Supply Modules), the DC link busbar can be loaded with **100 A**
- With power units between 45 A and 200 A (150/300 mm width), the DC link busbar can be loaded with **200 A**

### DC link busbar gain

Gain is possible as an option. It may be required if the drive group is fed via a Line Module > 55 kW or a DC link adapter.
Using reinforced DC link busbars raises the current carrying capacity from 100 A to 150 A for all booksize components with widths of 50 mm or 100 mm.

Table 2- 3 "Reinforced DC link busbar" option

| Area | Order No. |
|---|---|
| Suitable for 50 mm components | 6SL3162-2DB00-0AAx |
| Suitable for 100 mm components | 6SL3162-2DD00-0AAx |

#### Optimizing current load

The current in the DC link busbar is directly dependent on the current active power of the motor. To calculate the current generated, the entire process operation associated with the drive group connected to the DC link needs to be considered. The current load for the DC link busbar can be optimized if influencing variables such as partial load, duty cycles, and the simultaneity factors of the individual drive motors are taken into account.

If the current carrying capacity of the DC link busbar is exceeded, two solutions are possible: either the building of the drive group with infeed from left and right (center infeed; see below) or the use of another Line Module.

**Note**

The following examples are based on the concurrent use and loading of the Motor Modules with the rated output current of the Motor Modules. The current values are taken from the Booksize Power Units Equipment Manual or the NC61 catalog.

## Example 1:

Connection of several Motor Modules with different current carrying capacity of the DC link busbar to a Line Module.

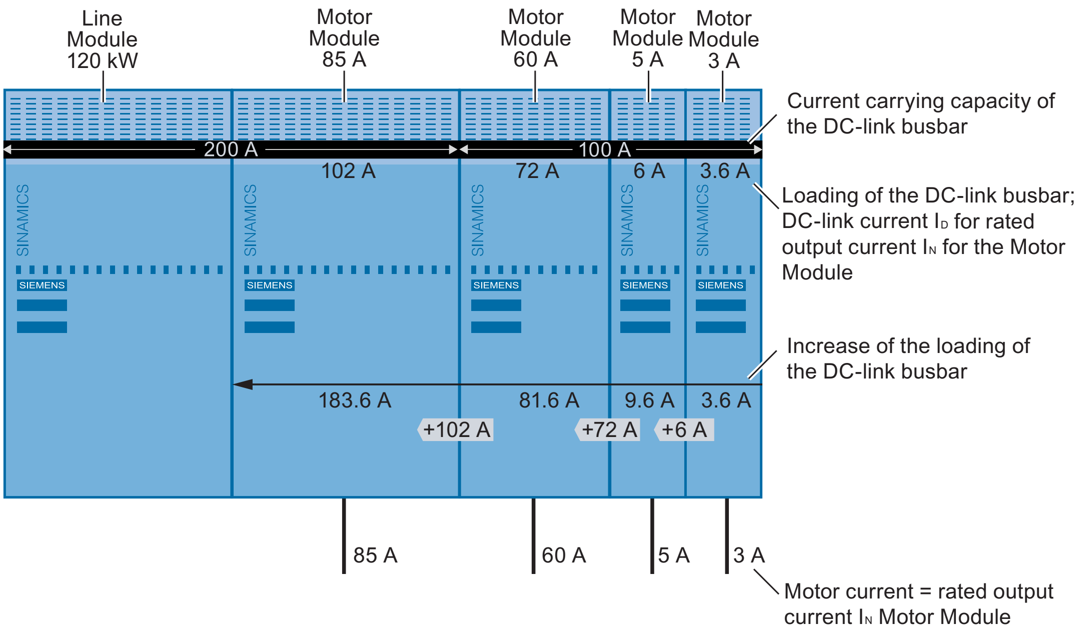



Figure 2-9 Regular construction; DC link busbars not overloaded

## Example 2:

Connection of several Motor Modules with the same current carrying capacity of the DC link busbar to a Line Module with center infeed.

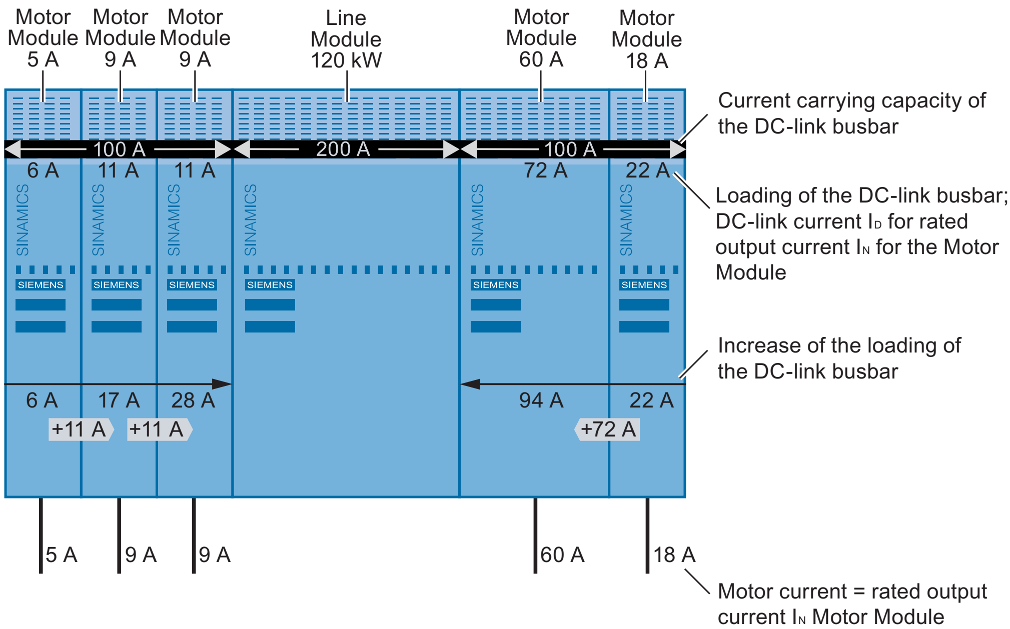



Figure 2-10 Infeed from left and right (center infeed)

---

**Note**

A center infeed with Motor Modules to the right and left of the Line Module can be configured for all Line Modules.
Exception: Smart Line Modules 5 kW and 10 kW

---

A single-sided infeed would overload the DC link busbar for a 60 A Motor Module. This type of configuration is therefore not permitted.

## 2.4 Shield Connection

For information on the shield connection, please see the dimension drawings of the SINAMICS components.

For details of the shield connections of Active Interface Modules, please refer to the relevant figures in the Overview (Page 107) section. The shield connections are located near the line supply connections.

### 2.4.1 SINAMICS Components Dimension Drawings (Internal Air Cooling)

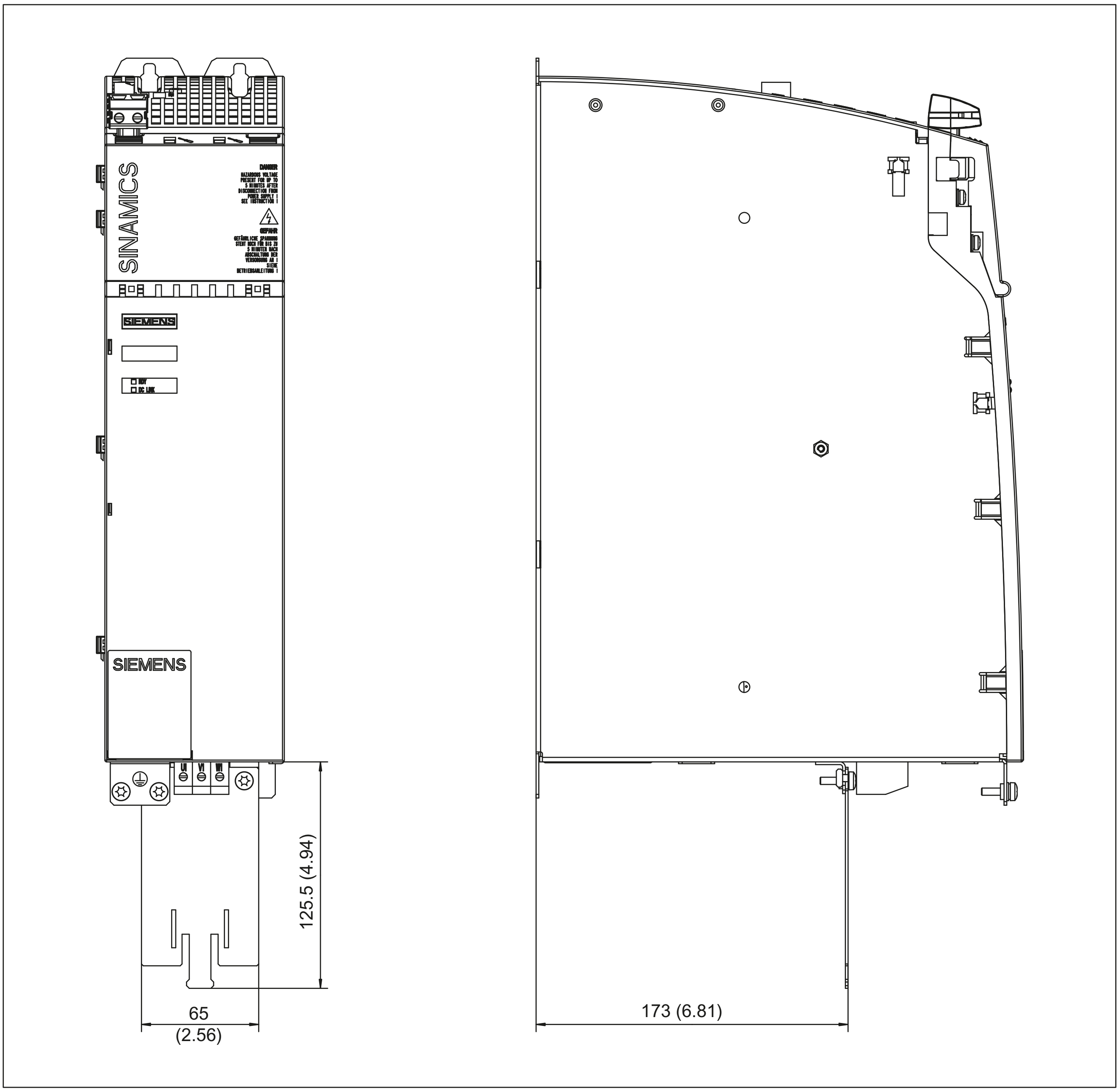



Figure 2-11 Dimension drawing of shield connecting plate on a 100 mm component with internal air cooling, all dimensions in mm and (inches)

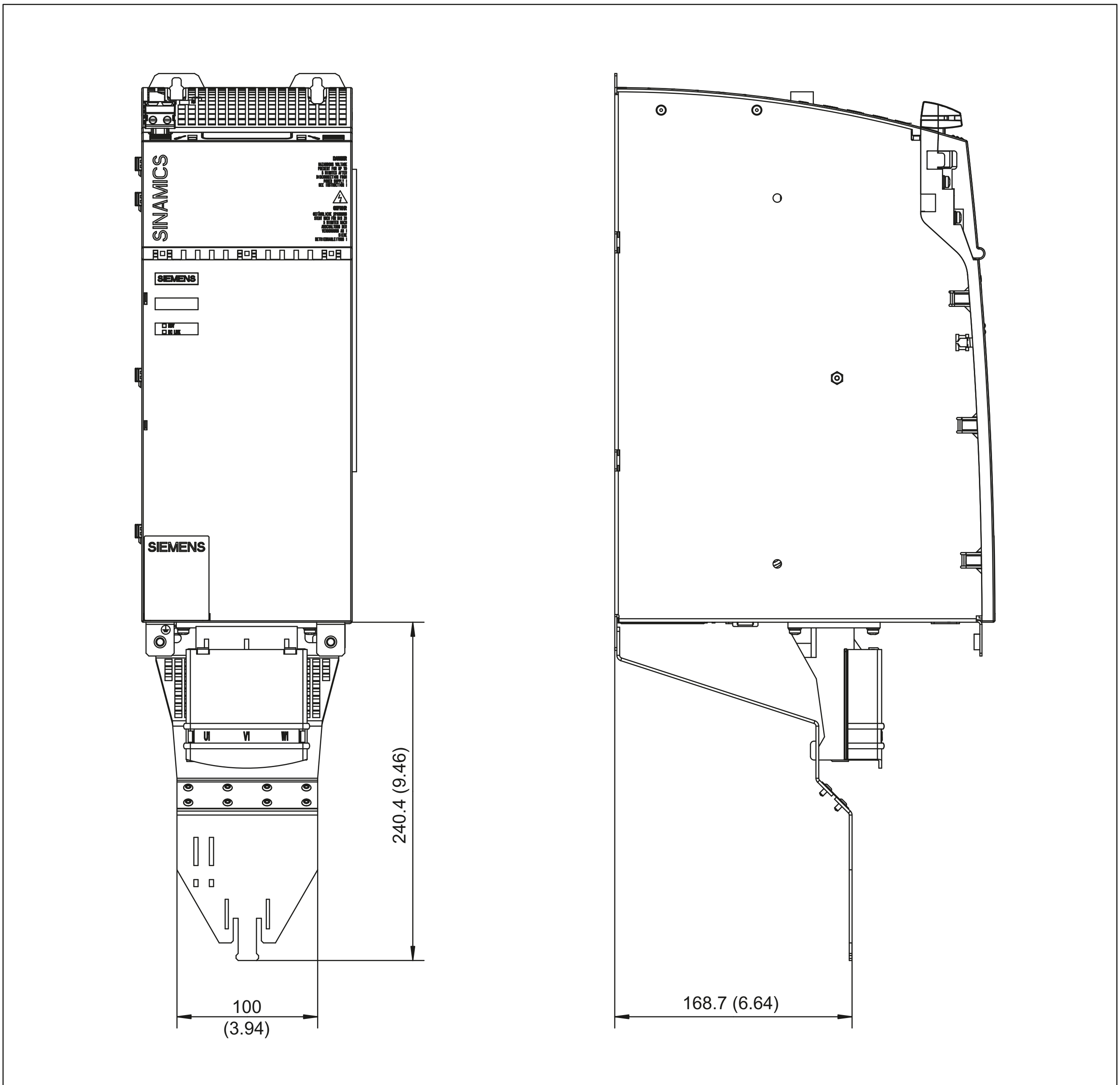



Figure 2-12 Dimension drawing of shield connecting plate on a 150 mm component with internal air cooling, all dimensions in mm and (inches)

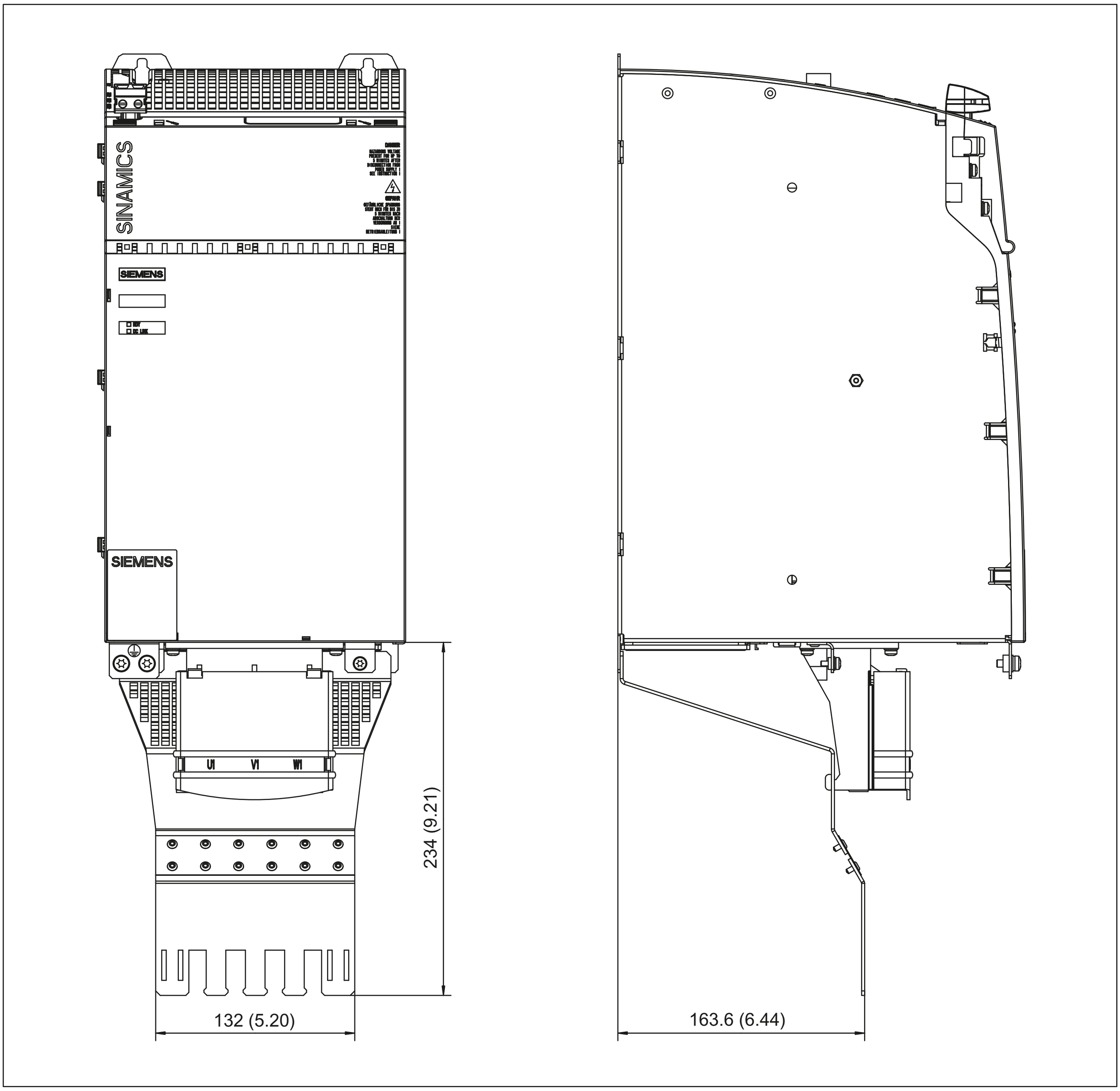



Figure 2-13 Dimension drawing of shield connecting plate on a 200 mm component with internal air cooling, all dimensions in mm and (inches)

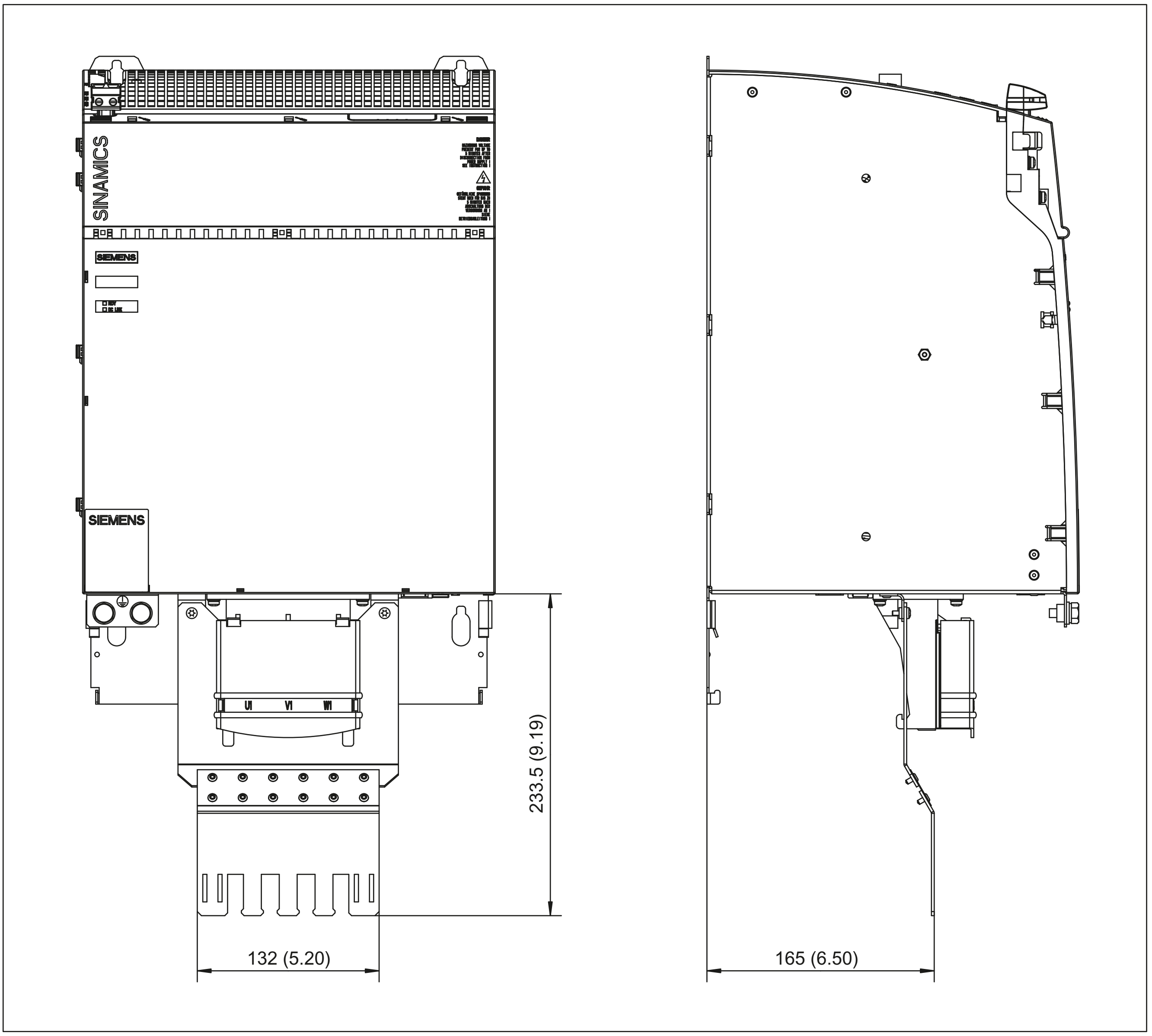



Figure 2-14 Dimension drawing of shield connecting plate on a 300 mm component with internal air cooling, all dimensions in mm and (inches)

### 2.4.2 SINAMICS Components Dimension Drawings (External Air Cooling)

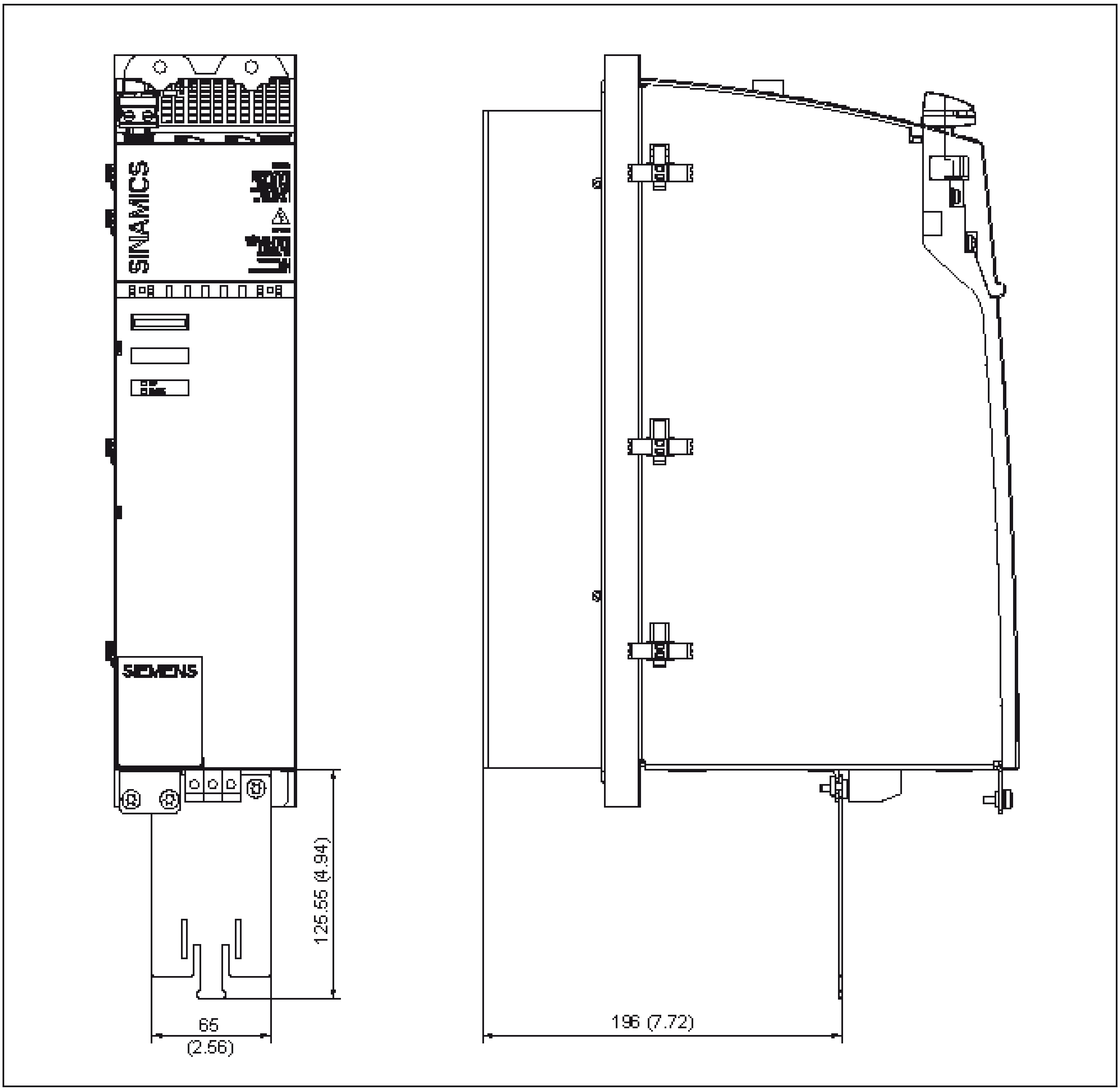



Figure 2-15 Dimension drawing of shield connecting plate on a 100 mm component with external air cooling, all dimensions in mm and (inches)

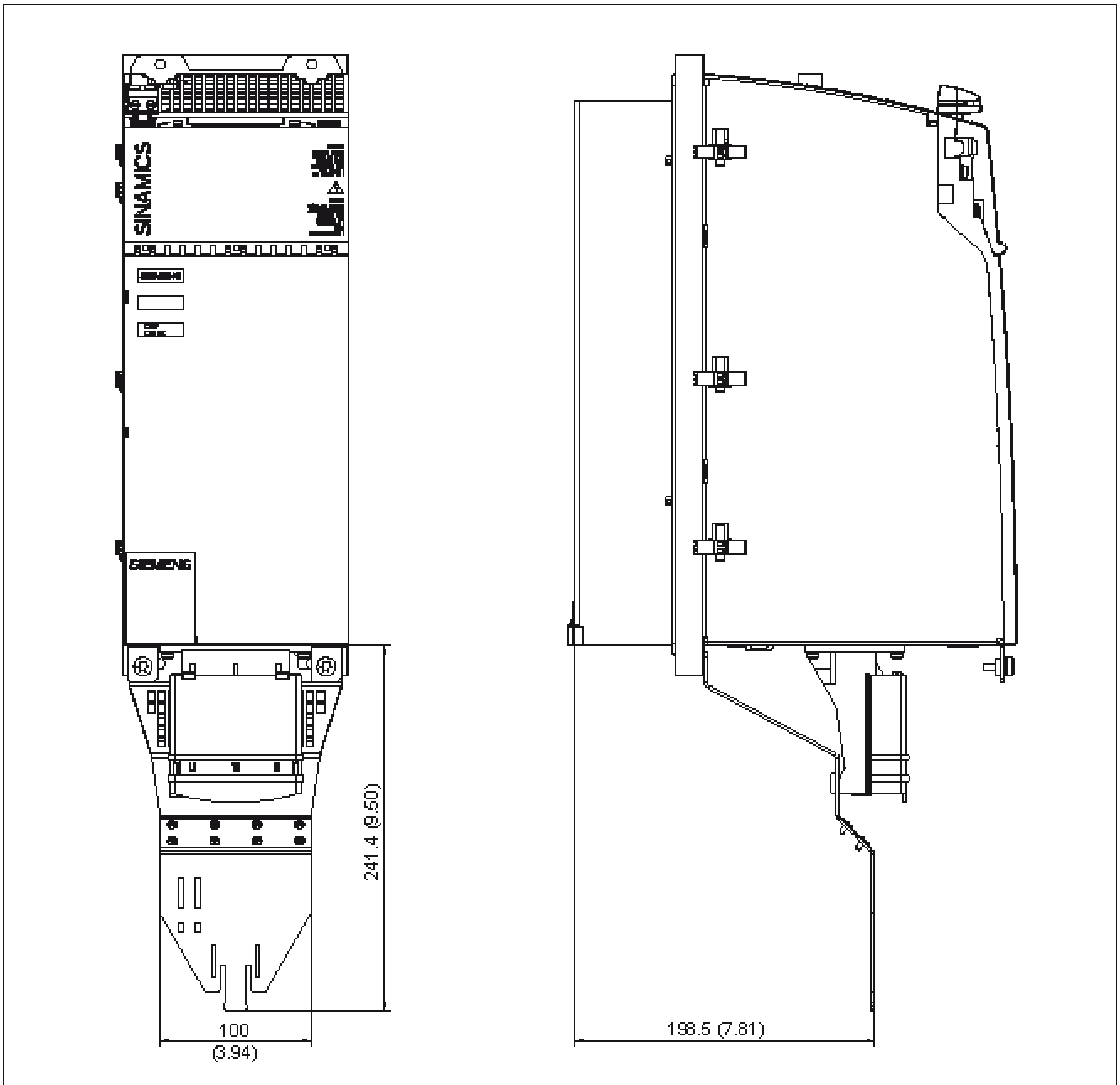



Figure 2-16 Dimension drawing of shield connecting plate on a 150 mm component with external air cooling, all dimensions in mm and (inches)

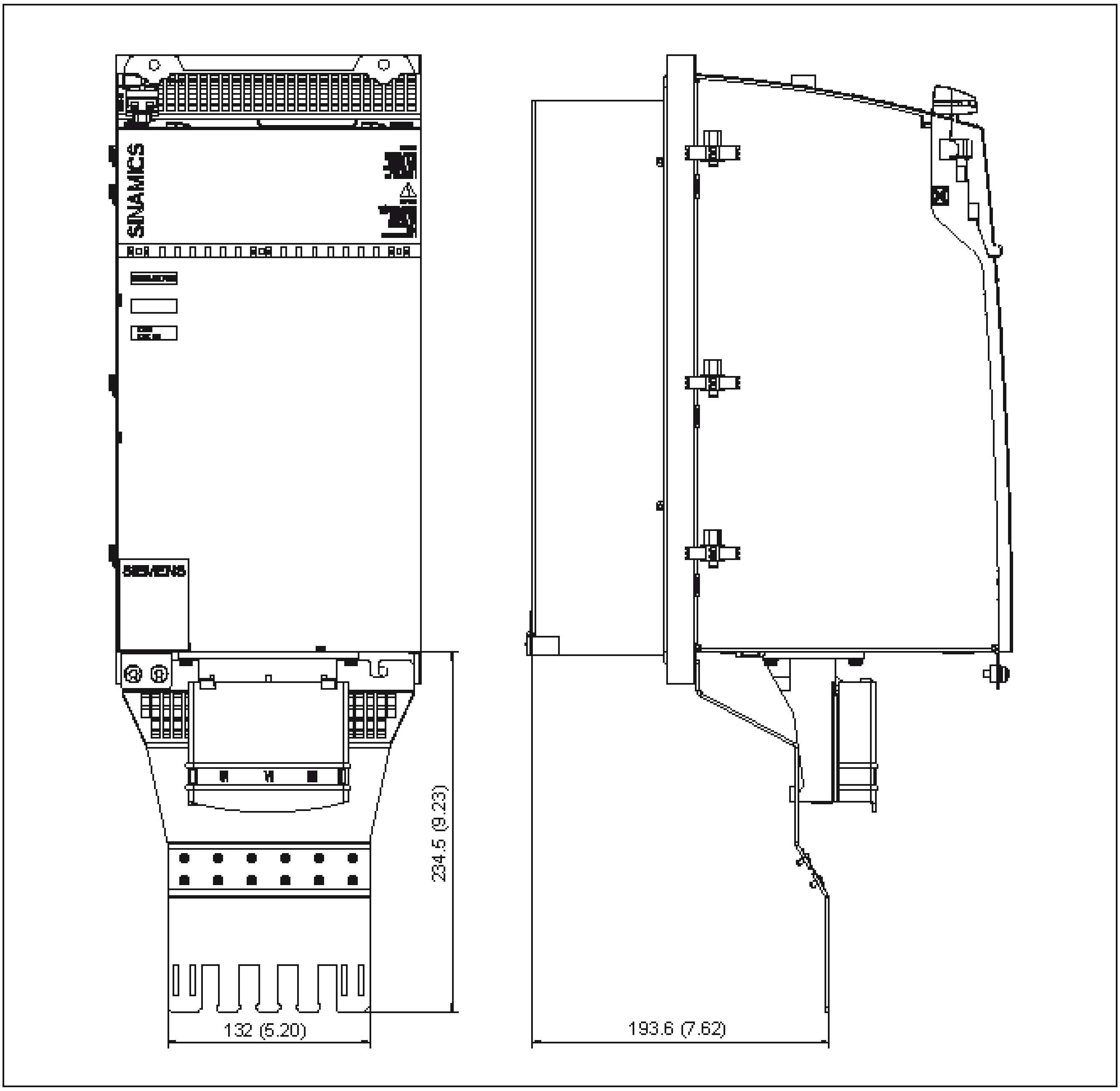



Figure 2-17 Dimension drawing of shield connecting plate on a 200 mm component with external air cooling, all dimensions in mm and (inches)

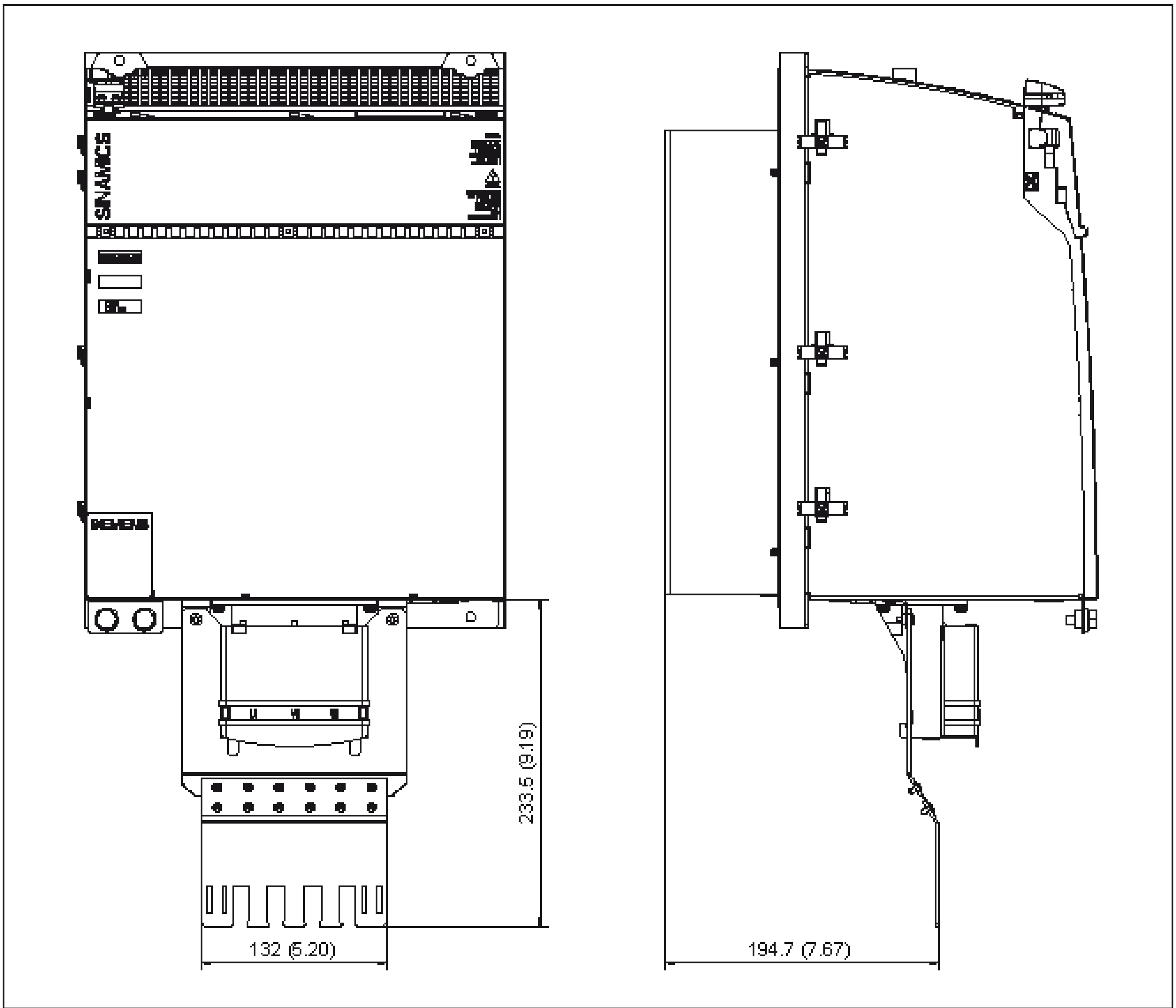
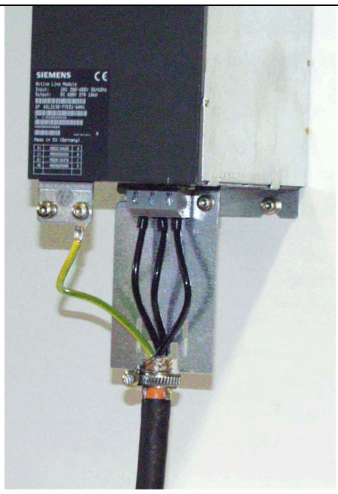
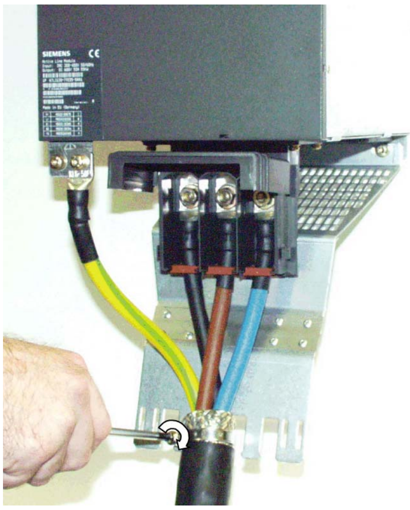



Figure 2-18 Dimension drawing of shield connecting plate on a 300 mm component with external air cooling, all dimensions in mm and (inches)

### 2.4.3 Shield Connection for Internal Heat Dissipation

The two examples for preassembled cables on power components of different width follow:

| | |
|---|---|
|  |  |
| Preassembled cable on a 100 mm component | Preassembled cable on a 200 mm component |

## 2.5 Note for the installation clearance for the connection cables

### 2.5.1 General information

The arrangement of the components and equipment takes account of

- Space requirements
- Cable routing
- Bending radii of the connection cables
  MOTION-CONNECT cables, refer to catalog PM21 or NC61
- Heat dissipation
- EMC

Components are usually located centrally in a cabinet.

The necessary mounting and installation clearances above an below the components can, under certain circumstances, exceed the minimum clearances specified in the product documentation.

## 2.5.2 Clearance of the Power Components

The installation clearance is defined by

- Ventilation clearance
- Cable clearance

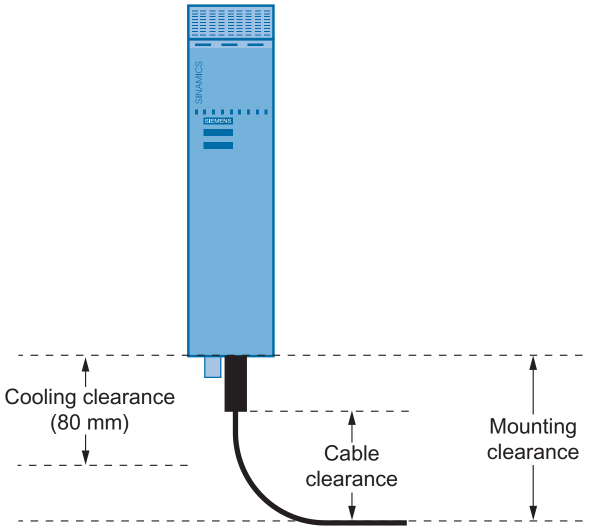



Figure 2-19 Clearance in the vicinity of the power components

# 2.6 Heat Dissipation of the Control Cabinet

## 2.6.1 Ventilation Clearances of the SINUMERIK Components

Table 2- 4 Ventilation clearances above and below the components

| Component | Clearance [mm] |
|---|---|
| NCU 7x0 | 80 mm |
| NX1x | 80 mm |

## 2.6.2 General information

The cabinet can be cooled, among others, by using:

- Filter fans
- Heat exchangers
- Refrigerators
- Liquid cooling
- external air cooling
- external liquid cooling

The decision in favor of one of these methods will depend on the prevailing ambient conditions and the cooling power required.

The air routing inside the control cabinet and the cooling clearances specified here, must be carefully observed. No other components or cables must be located in these areas.

| CAUTION |
|---|
| If you do not observe the guidelines for installing SINAMICS equipment in the cabinet, this can reduce the service life of the equipment and result in premature component failure. |

**Note**

When the line reactor is being installed, it is best not to install it in the same cabinet (max. distance approx. 0.5 m). If necessary, it can be installed on the heat sink.

You must take into account the following specifications when installing a SINAMICS drive line-up:

- Ventilation clearance
- Wiring and cabling
- Air guidance, air-conditioner

Table 2- 5 Ventilation clearances above and below the components

| Component | Order number | Clearance [mm] |
|---|---|---|
| CU320/CU320-2 DP | 6SL3040-0MA00-0AAx | 80 |
| SMCxx | 6SL3055-0AA00-5xAx | 50 |
| TM15 | 6SL3055-0AA00-3FAx | 50 |
| TM31 | 6SL3055-0AA00-3AAx | 50 |
| TM41 | 6SL3055-0AA00-3PAx | 50 |
| Line filter for Line Module<br>5 kW - 120 kW | <br>6SL3000-0BExx-xAAx | <br>100 |
| Active Interface Module<br>16 kW<br>36 kW<br>50 kW<br>80 kW<br>120 kW | <br>6SL3100-0BE21-6ABx<br>6SL3100-0BE23-6ABx<br>6SL3100-0BE25-5ABx<br>6SL3100-0BE28-0ABx<br>6SL3100-0BE31-2ABx | <br>80 |
| Line reactor for Active Line Module<br>16 kW – 120 kW | <br>6SN1111-0AA00-xxAx | <br>100 |
| Line reactor for Basic Line Module<br>20 kW – 100 kW | <br>6SL3000-0CExx-0AAx | <br>100 |
| Line reactor for Smart Line Module<br>5 kW – 36 kW | <br>6SL3000-0CExx-0AAx | <br>100 |
| Active Line Module<br>16 kW – 55 kW<br>80 kW – 120 kW | <br>6SL3130-7TExx-xAAx<br>6SL3130-7TExx-xAAx | <br>80<br>80 (additional 50 in front of fan) |
| Smart Line Module Booksize format<br>5 kW – 36 kW | <br>6SL3130-6AExx-0AAx | <br>80 |
| Smart Line Module Booksize Compact format<br>16 kW | <br>6SL3430-6TE21-6AAx | <br>80 |
| Basic Line Module<br>20 kW – 100 kW | 6SL3130-1TExx-xAAx | 80 |
| Motor Module Booksize format < 132 A | 6SL312x-1TExx-xAAx | 80 |
| Motor Module Booksize format<br>132 A a. 200 A | <br>6SL312x-1TE3x-xAAx | <br>80 (additional 50 in front of fan) |
| Motor Module Booksize Compact format<br>1.7 A - 18 A | <br>6SL3420-xTExx-xAAx | <br>80 |
| Braking Module | 6SL3100-1AE31-0AAx | 80 |
| Control Supply Module | 6SL3100-1DE22-0AAx | 80 |
| Capacitor Module | 6SL3100-1CE14-0AAx | 80 |

The specifications regarding ventilation clearances for two-tier configurations are provided in Drive Line-Up.

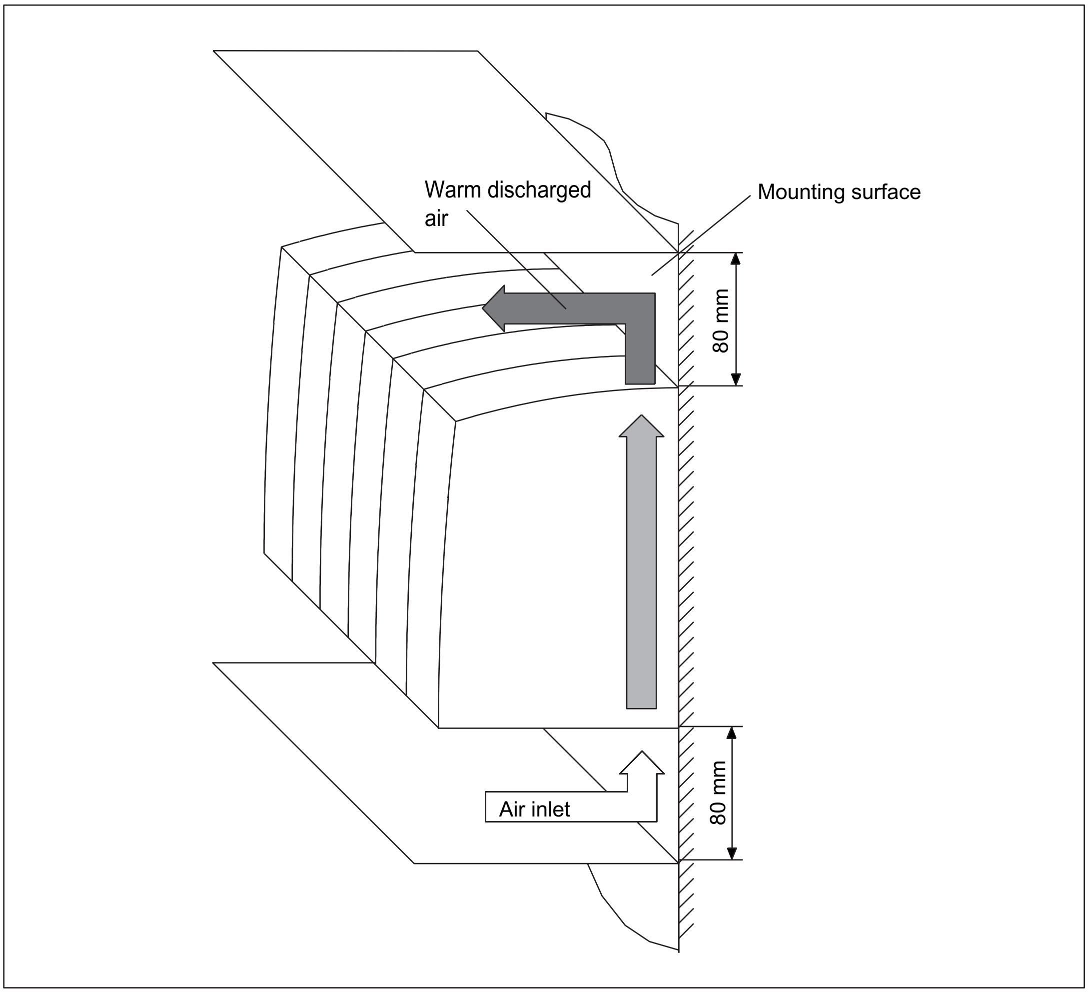



Figure 2-20 Clearances for booksize drive line-up with internal air cooling

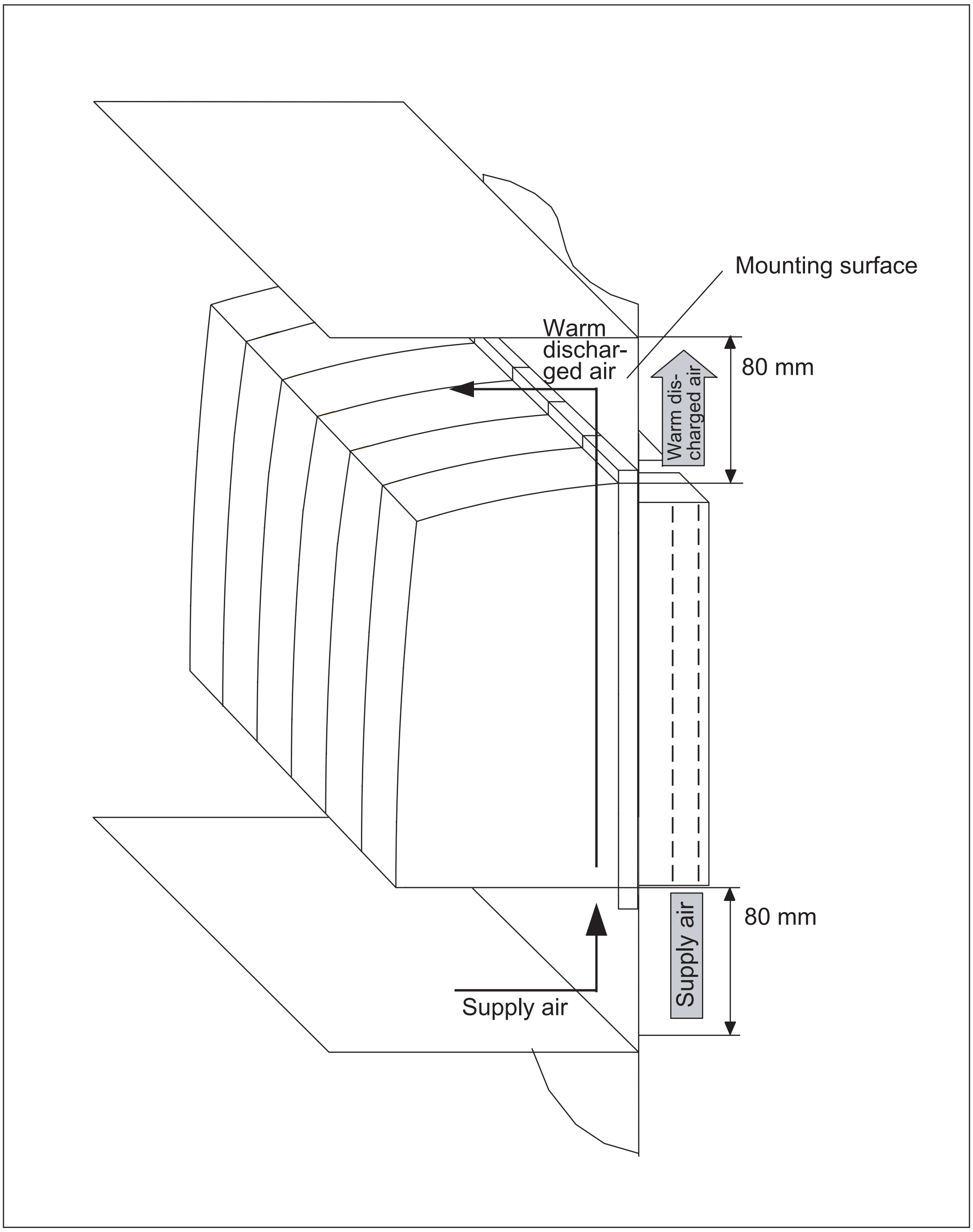



Figure 2-21 Clearances for booksize drive line-up with external air cooling

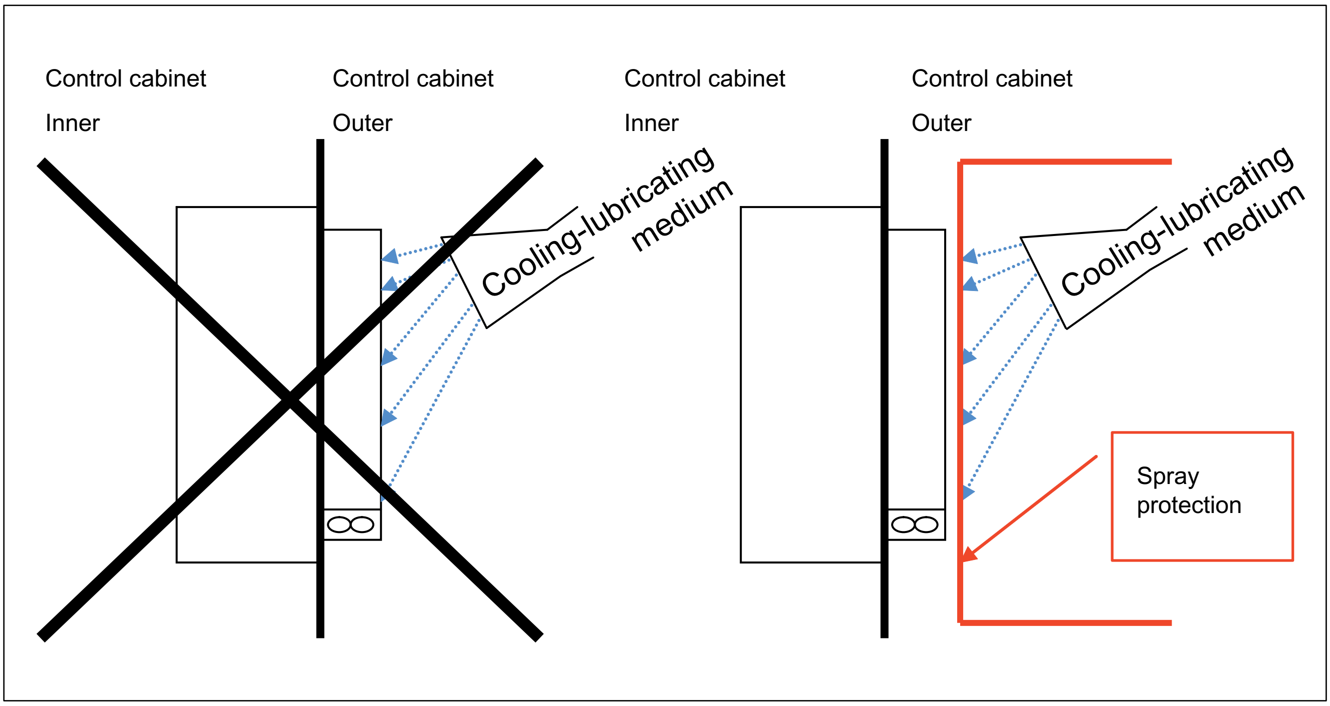



Figure 2-22 Spray protection for external cooling

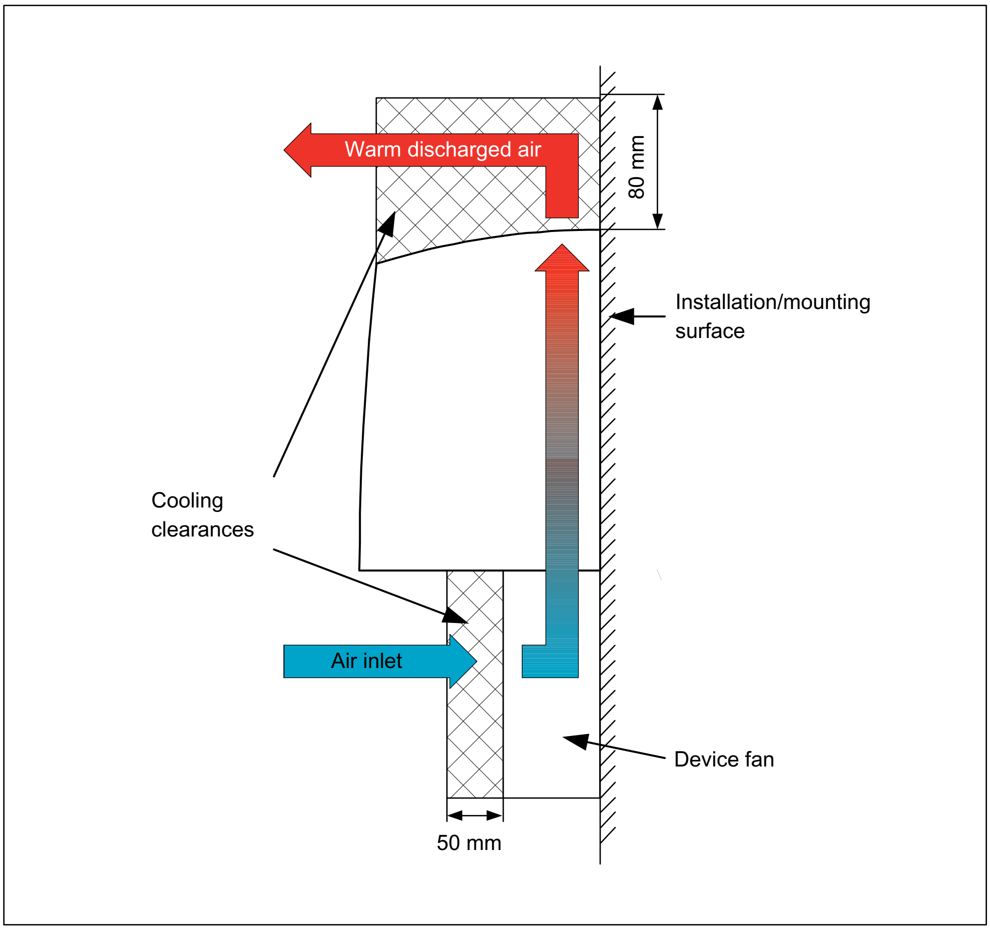



Figure 2-23 Cooling clearances for 300 mm components with mounted equipment fan

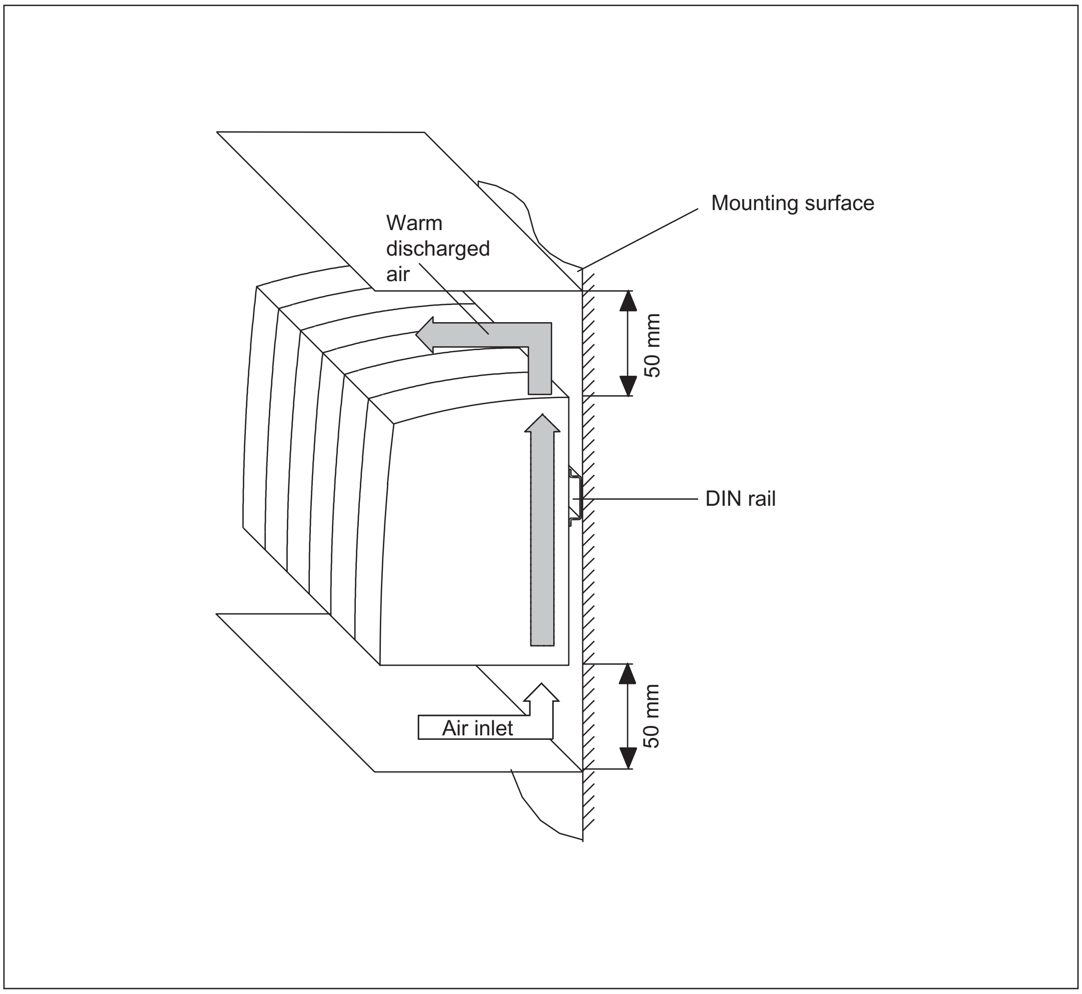



Figure 2-24 Cooling clearances, rail-mounted modules (e.g. VSM, SMC, TM, DMC)

### 2.6.3 General information on ventilation

The SINAMICS equipment is ventilated separately by means of integrated fans and is in some cases cooled by means of natural convection.

The cooling air must flow through the components vertically from bottom (cooler region) to top (region heated by operation).

If filtered fans, heat exchangers, or air conditioners are used, you must ensure that the air is flowing in the right direction. You must also ensure that the warm air can escape at the top. A ventilation clearance of at least 80 mm above and below must be observed.

| NOTICE |
| --- |
| The connected signal and power cables must be routed to the components in such a way that they do not cover the ventilation slots.<br>Cold air must not be allowed to blow directly onto electronic equipment. |

**Note**

The distance between the blow-out aperture of the air conditioner and the electronic equipment must be at least 200 mm.

**Note**

If the components are installed in a sealed cabinet, an internal air cooling system must be installed to circulate the air and prevent hot spots. It is best to install the fan above the components to optimize the air flow (suction).

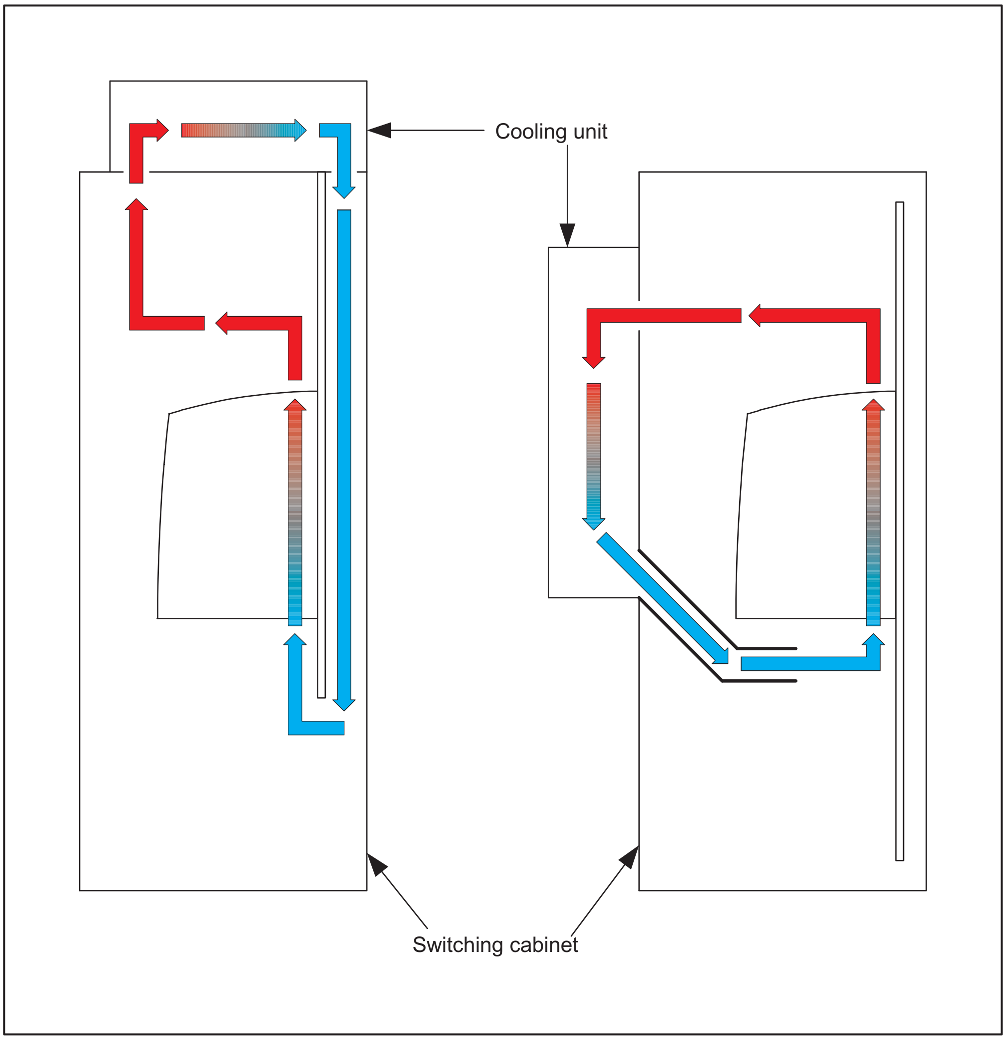



Figure 2-25 Examples of cabinet ventilation

| CAUTION |
| --- |
| The air guidance and arrangement of the cooling equipment must be chosen in such a way as to prevent condensation from forming. If necessary, cabinet enclosure heating may have to be installed. |

If air conditioners are used, the relative air humidity of the expelled air increases as the air in the air conditioner cools and may exceed the dew point. If the relative humidity of the air entering the SINAMICS equipment is over 80% for an extended period of time, the insulation in the equipment may fail to function properly due to electrochemical reactions (refer to System Overview). Using air baffle plates, for example, you must ensure that the cold air expelled from the air conditioner mixes with warm air in the cabinet before it enters the equipment. This reduces the relative air humidity to uncritical values.

### 2.6.4 Power Loss of the SINUMERIK Components

The following power losses apply to operation with rated power:

Table 2- 6 List of power losses

| Component | Power loss |
|---|---|
| NCU 710.2 | 170 W |
| NCU 720.2 | 174 W |
| NCU 720.2 PN | 216 W |
| NCU 730.2 | 216 W |
| NCU 730.2 PN | 225 W |
| NX1x.x | 20 W |

### 2.6.5 Power Loss of the SINAMICS Components

The tables below provide an overview of the power loss of all components during rated operation. The characteristic values apply for the following conditions:

- Line voltage for Line Modules 400 V
- Pulse frequency of the Motor Modules 4 kHz
- Rated pulse frequency of the Active Line Modules 8 kHz
- Operating components at their rated power

The total losses of the relevant power unit (Line Module, Motor Module) are calculated from the power loss and the corresponding electronics loss of the power unit.

### 2.6.6 Power loss for Control Units, Sensor Modules, and other system components

Table 2- 7 Overview of power loss during rated operation for Control Units, Sensor Modules, and other system components

| | Unit | Power loss |
|---|---|---|
| Control Units and Option Boards | | |
| CU320 | W | 20 |
| CU320-2 DP | W | 24 |
| TB30 | W | < 3 |
| CBC10 | W | < 3 |
| CBE20 | W | 2,8 |
| Sensor Modules | | |
| SMC10 | W | < 10 |
| SMC20 | W | < 10 |
| SMC30 | W | < 10 |
| SME20 | W | ≤ 4 |
| SME25 | W | ≤ 4 |
| SME120 | W | ≤ 4,5 |
| SME125 | W | ≤ 4,5 |
| Terminal Modules | | |
| TM15 | W | < 3 |
| TM31 | W | < 10 |
| TM41 | W | 10 |
| TM54F | W | 4,5 |
| Additional system components | | |
| VSM10 | W | < 10 |
| DC-link components | | |
| Braking Module | W | 20 |
| Capacitor Module | W | 25 |
| Control Supply Module<br>Line<br>DC link | W | <br>70<br>65 |
| Voltage Clamping Module | W | 50 |

### 2.6.7 Power loss for line filters and line reactors

Table 2- 8 Overview of power loss during rated operation for line filters and line reactors

| | Unit | Power loss |
|---|---|---|
| Basic Line Filter for Active Line Modules | | |
| 16 kW | W | 16 |
| 36 kW | W | 26 |
| 55 kW | W | 43 |
| 80 kW | W | 56 |
| 120 kW | W | 73 |
| Basic Line Filter for Active Line Modules with Active Interface Module | | |
| 16 kW | W | 16 |
| 36 kW | W | 26 |
| 55 kW | W | 43 |
| 80 kW | W | 56 |
| 120 kW | W | 73 |
| Wideband Line Filter for Active Line Modules | | |
| 16 kW | W | 70 |
| 36 kW | W | 90 |
| 55 kW | W | 110 |
| 80 kW | W | 150 |
| 120 kW | W | 200 |
| Basic Line Filter for Smart Line Modules | | |
| 5 kW | W | 5 |
| 10 kW | W | 9 |
| 16 kW | W | 16 |
| 36 kW | W | 26 |
| Basic Line Filter for Basic Line Modules | | |
| 20 kW | W | 16 |
| 40 kW | W | 26 |
| 100 kW | W | 73 |
| Active Interface Modules | | |
| 16 kW | W | 270 [1)] |
| 36 kW | W | 340 [1)] |
| 55 kW | W | 380 [1)] |
| 80 kW | W | 490 [1)] |
| 120 kW | W | 585 [1)] |
| Line reactors for Active Line Modules (HF/HFD line reactors) | | |
| 16 kW | W | 170 |
| 36 kW | W | 250 |
| 55 kW | W | 350 |
| 80 kW | W | 450 |
| 120 kW | W | 590 |

| | Unit | Power loss |
|---|---|---|
| Line reactors for Smart Line Modules | | |
| 5 kW | W | 62 |
| 10 kW | W | 116 |
| 16 kW | W | 110 |
| 36 kW | W | 170 |
| Line reactors for Basic Line Modules | | |
| 20 kW | W | 130 |
| 40 kW | W | 270 |
| 100 kW | W | 480 |

1) Referred to $V_{DC\ link}$ 600 V

## 2.6.8 Power loss for power units with internal air cooling

Table 2- 9 Overview of power loss at rated operation for power units with internal air cooling (including electronics losses)

| | Unit | Power loss |
|---|---|---|
| Active Line Modules | | |
| 16 kW | W | 282,8 |
| 36 kW | W | 666 |
| 55 kW | W | 945,6 |
| 80 kW | W | 1383,6 |
| 120 kW | W | 2243,2 |
| Smart Line Modules Booksize | | |
| 5 kW | W | 79,2 |
| 10 kW | W | 141,6 |
| 16 kW | W | 187,8 |
| 36 kW | W | 406 |
| Smart Line Modules Booksize Compact | | |
| 16 kW | W | 187,8 |
| Basic Line Modules | | |
| 20 kW | W | 144 |
| 40 kW | W | 283,6 |
| 100 kW | W | 628 |
| Single Motor Modules Booksize | | |
| 3 A | W | 50,4 |
| 5 A | W | 75,4 |
| 9 A | W | 100,4 |
| 18 A | W | 185,4 |
| 30 A | W | 309,2 |
| 45 A | W | 455,2 |

| | Unit | Power loss |
|---|---|---|
| 60 A | W | 615,2 |
| 85 A | W | 786 |
| 132 A | W | 1270,4 |
| 200 A | W | 2070,4 |
| Single Motor Modules Booksize Compact | | |
| 3 A | W | 68 1) |
| 5 A | W | 98 1) |
| 9 A | W | 100,4 |
| 18 A | W | 185,4 |
| Double Motor Modules Booksize | | |
| 3 A | W | 97,6 |
| 5 A | W | 132,6 |
| 9 A | W | 187,6 |
| 18 A | W | 351,2 |
| Double Motor Modules Booksize Compact | | |
| 1.7 A | W | 114 1) |
| 3 A | W | 134 1) |
| 5 A | W | 194 1) |

1) Power loss at 8 kHz

### 2.6.9 Power loss for power units with external air cooling

Table 2- 10 Overview of power loss at rated operation for power units with external air cooling (including electronics losses)

| | Unit | Internal Power loss 1) | External power loss | Total power loss |
|---|---|---|---|---|
| Active Line Modules | | | | |
| 16 kW | W | 82,8 (60 + 22,8) | 200 | 282,8 |
| 36 kW | W | 171 (135 + 36,0) | 495 | 666 |
| 55 kW | W | 245,6 (200 + 45,6) | 700 | 945,6 |
| 80 kW | W | 338,6 (305 + 33,6) | 1045 | 1383,6 |
| 120 kW | W | 533,2 (490 + 43,2) | 1710 | 2243,2 |
| Smart Line Modules | | | | |
| 5 kW | W | 41,2 (22 + 19,2) | 38 | 108,2 |
| 10 kW | W | 66,6 (45 + 21,6) | 75 | 141,6 |
| Single Motor Modules | | | | |
| 3 A | W | 35,4 (15 + 20,4) | 15 | 50,4 |
| 5 A | W | 43,4 (23 + 20,4) | 30 | 73,4 |
| 9 A | W | 55,4 (35 + 20,4) | 45 | 100,4 |
| 18 A | W | 95,4 (75 + 20,4) | 90 | 185,4 |
| 30 A | W | 99,2 (80 + 19,2) | 210 | 309,2 |
| 45 A | W | 135,2 (110 + 25,2) | 320 | 455,2 |
| 60 A | W | 160,2 (135 + 25,2) | 455 | 615,2 |
| 85 A | W | 196 (160 + 36,0) | 590 | 786 |
| 132 A | W | 270,4 (250 + 20,4) | 1000 | 1270,4 |
| 200 A | W | 455,4 (435 + 20,4) | 1615 | 2070,4 |
| Double Motor Modules | | | | |
| 3 A | W | 62,6 (35 + 27,6) | 35 | 97,6 |
| 5 A | W | 72,6 (45 + 27,6) | 60 | 132,6 |
| 9 A | W | 92,6 (65 + 27,6) | 95 | 187,6 |
| 18 A | W | 111,2 (80 + 31,2) | 240 | 351,2 |

1) Power loss of the power electronics + power loss of the 24 V electronics

## 2.6.10 Power loss for power units with cold plate

With cold-plate cooling, only part of the power loss remains in the cabinet.
The table below shows the internal and external power loss of the components.

Table 2- 11 Overview of power loss at rated operation for power units with cold plate (including electronics losses)

| | Unit | Internal power loss 1) | External power loss | Total power loss |
|---|---|---|---|---|
| Active Line Modules | | | | |
| 16 kW | W | 70,4 (50 + 20,4) | 210 | 280,4 |
| 36 kW | W | 135,2 (110 + 25,2) | 520 | 655,2 |
| 55 kW | W | 187,6 (160 + 27,6) | 740 | 927,6 |
| 80 kW | W | 283,6 (250 + 33,6) | 1100 | 1383,6 |
| 120 kW | W | 443,2 (400 + 43,2) | 1800 | 2243,2 |
| Smart Line Modules Booksize | | | | |
| 5 kW | W | 34,4 (20 + 14,4) | 40 | 74,4 |
| 10 kW | W | 56,8 (40 + 16,8) | 80 | 136,8 |
| Smart Line Modules Booksize Compact | | | | |
| 16 kW | W | 56,6 (36,2 + 20,4) | 130 | 186,6 |
| Basic Line Modules | | | | |
| 20 kW | W | 46,6 (25 + 21,6) | 95 | 141,6 |
| 40 kW | W | 71,4 (45 + 26,4) | 205 | 276,4 |
| 100 kW | W | 168,4 (130 + 38,4) | 450 | 618,4 |
| Single Motor Modules Booksize | | | | |
| 3 A | W | 27,6 (12 + 15,6) | 18 | 45,6 |
| 5 A | W | 35,6 (20 + 15,6) | 35 | 70,6 |
| 9 A | W | 45,6 (30 + 15,6) | 50 | 95,6 |
| 18 A | W | 80,6 (65 + 15,6) | 100 | 180,6 |
| 30 A | W | 85,6 (70 + 15,6) | 220 | 305,6 |
| 45 A | W | 108 (90 + 18,0) | 340 | 448 |
| 60 A | W | 128 (110 + 18,0) | 480 | 608 |
| 85 A | W | 149,2 (130 + 19,2) | 620 | 769,2 |
| 132 A | W | 220,4 (200 + 20,4) | 1050 | 1270,4 |
| 200 A | W | 370,4 (350 + 20,4) | 1700 | 2070,4 |
| Single Motor Modules Booksize Compact | | | | |
| 3 A | W | 25,6 (10 + 15,6) | 40 | 65,6 |
| 5 A | W | 30,6 (15 + 15,6) | 65 | 95,6 |
| 9 A | W | 45,6 (30 + 15,6) | 50 | 95,6 |
| 18 A | W | 80,6 (65 + 15,6) | 100 | 180,6 |
| Double Motor Modules Booksize | | | | |
| 2x3 A | W | 55,6 (34 + 21,6) | 36 | 91,6 |
| 2x5 A | W | 61,6 (40 + 21,6) | 65 | 126,6 |
| 2x9 A | W | 81,6 (60 + 21,6) | 100 | 181,6 |
| 2x18 A | W | 95,2 (70 + 25,2) | 250 | 345,2 |

| | Unit | Internal power loss 1) | External power loss | Total power loss |
|---|---|---|---|---|
| Double Motor Modules Booksize Compact | | | | |
| 2x1.7 A | W | 42 (20,4 + 21,6) | 72 | 114 |
| 2x3 A | W | 44 (22,4 + 21,6) | 90 | 134 |
| 2x5 A | W | 59 (37,4 + 21,6) | 135 | 194 |

1) Power loss of the power electronics + power loss of the 24 V electronics

**Note**

Lower average power losses are obtained for intermittent duty.

## 2.6.11 Power loss for liquid-cooled power units

Table 2- 12 Overview of power loss during rated operation for liquid-cooled power units (including electronics losses)

| | Unit | Internal power loss 1) | External power loss | Total power loss |
|---|---|---|---|---|
| Active Line Modules | | | | |
| 120 kW | W | 443,2 (400 + 43,2) | 1800 | 2243,2 |
| Single Motor Modules | | | | |
| 200 A | W | 370,4 (350 + 20,4) | 1700 | 2070,4 |

1) Power loss of the power electronics + power loss of the 24 V electronics

## 2.6.12 Electronics losses of power units

Table 2- 13 Electronics losses for power units with internal/external air cooling

| Component | | Internal/external air cooling<br>Power loss [W] |
|---|---|---|
| Single Motor Modules | 3 A | 20,4 |
| | 5 A | 20,4 |
| | 9 A | 20,4 |
| | 18 A | 20,4 |
| | 30 A | 19,2 |
| | 45 A | 25,2 |
| | 60 A | 25,2 |
| | 85 A | 36,0 |
| | 132 A | 20,4 |
| | 200 A | 20,4 |
| Single Motor Modules Booksize Compact | 3 A | 20,4 |
| | 5 A | 20,4 |
| | 9 A | 20,4 |
| | 18 A | 20,4 |
| Double Motor Modules | 3 A | 27,6 |
| | 5 A | 27,6 |
| | 9 A | 27,6 |
| | 18 A | 31,2 |
| Double Motor Modules Booksize Compact | 1.7 A | 27,6 |
| | 3 A | 27,6 |
| | 5 A | 27,6 |
| Active Line Modules | 16 kW | 22,8 |
| | 36 kW | 36,0 |
| | 55 kW | 45,6 |
| | 80 kW | 33,6 |
| | 120 kW | 43,2 |
| Basic Line Modules | 20 kW | 24 |
| | 40 kW | 33,6 |
| | 100 kW | 48 |
| Smart Line Module | 5 kW | 19,2 |
| | 10 kW | 21,6 |
| | 16 kW | 22,8 |
| | 36 kW | 36,0 |
| Smart Line Module Booksize Compact | 16 kW | 22,8 |

Table 2- 14 Electronics losses for power units with cold plate

| Component | | Cold plate<br>Power loss [W] |
|---|---|---|
| Motor Modules Booksize | 3 A | 15,6 |
| | 5 A | 15,6 |
| | 9 A | 15,6 |
| | 18 A | 15,6 |
| | 30 A | 15,6 |
| | 45 A | 18,0 |
| | 60 A | 18,0 |
| | 85 A | 19,2 |
| | 132 A | 20,4 |
| | 200 A | 20,4 |
| | 2x3 A | 21,6 |
| | 2x5 A | 21,6 |
| | 2x9 A | 21,6 |
| | 2x18 A | 25,2 |
| Motor Modules Booksize Compact | 3 A | 15,6 |
| | 5 A | 15,6 |
| | 9 A | 15,6 |
| | 18 A | 15,6 |
| | 2x1.7 A | 21,6 |
| | 2x3 A | 21,6 |
| | 2x5 A | 21,6 |
| Active Line Modules | 16 kW | 20,4 |
| | 36 kW | 25,2 |
| | 55 kW | 27,6 |
| | 80 kW | 33,6 |
| | 120 kW | 43,2 |
| Smart Line Module Booksize | 5 kW | 14,4 |
| | 10 kW | 16,8 |
| Smart Line Module Booksize Compact | 16 kW | 20,4 |
| Basic Line Modules | 20 kW | 21,6 |
| | 40 kW | 26,4 |
| | 100 kW | 38,4 |

Table 2- 15 Electronics losses for liquid-cooled power units

| Component | | Liquid cooled<br>Power loss [W] |
|---|---|---|
| Motor Module | 200 A | 20,4 |
| Active Line Module | 120 kW | 43,2 |

## 2.6.13 Dimensioning Climate Control Equipment

Cabinet manufacturers provide calculation programs for selecting climate control equipment. It is important to know the power losses for the components and devices in the control cabinet.

### Formula to calculate the power loss

$q = Q - k \cdot A \cdot \Delta T$

q = thermal power that has to be dissipated through a refrigerator [W]
Q = power loss [W]
$\Delta T$ = temperature difference between the room and cabinet interior [K]
k = thermal resistance value, e.g. sheet-steel, painted 5.5 [W/(m² * K)]
A = freestanding cabinet surface area [m²]

### Example

Table 2- 16 Power loss calculation for a drive configuration

| Component | Number | Total power loss [W] (including electronic losses) | Total power loss [W] |
|---|---|---|---|
| CU320 )[1] | 1 | 20 | 20 |
| Line filter | 1 | 90 | 90 |
| Line reactor | 1 | 250 | 250 |
| Active Line Module 36 kW | 1 | 666 | 666 |
| Motor Module 18 A | 2 | 185.4 | 370.8 |
| Motor Module 30 A | 3 | 311.6 | 934.8 |
| SMC | 5 | 10 | 50 |
| SITOP 20 | 1 | 53 | 53 |
| Line contactor | 1 | 12 | 12 |
| Total: | | | **2,446.6** |
| [1)] For information on NCU and NX, see Power Loss of the SINUMERIK Components (Page 52). | | | |

- Assumption:
  - freestanding cabinet surface area $A = 5\ m^2$
  - temperature difference between the room and cabinet interior $\Delta T = 10\ K$

$q = 2{,}446.6\ W - 5.5\ W/(m^2\ K) \cdot 5\ m^2 \cdot 10\ K = 2{,}171.6\ W.$

# Communication within the system

3

## 3.1 Communication overview

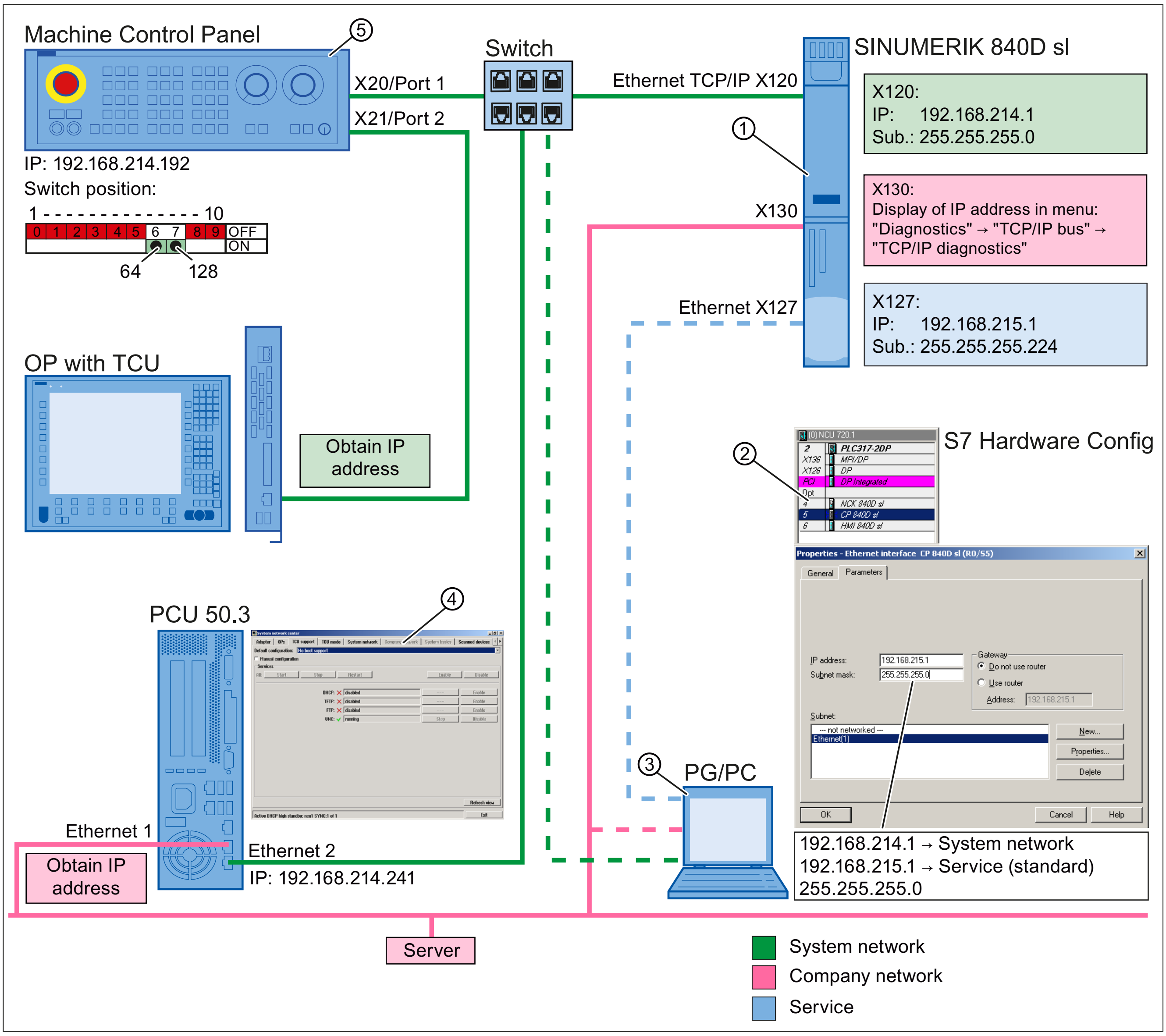



Figure 3-1 Example based on the SINUMERIK 840D sl network configuration

### Note

The significance of items ① to ⑤ is explained on the pages that follow.

### ① (NCU)

- IP assignment of the server
- The ports need to be activated if VNC and HMI/Step7 are to be used (SW2.4.xxx and higher):

```
/user/system/etc/basesys.ini
[LinuxBase]
FirewallOpenPorts="TCP/102 TCP/5900"
```

### ② (S7 Hardware Config)

- If the DHCP of the NCU (X120) is active:
  Set the "Settings system network" program on the "TCU support" tab.
- Set "No boot support".

Access parameters need to be set in the S7 hardware configuration.

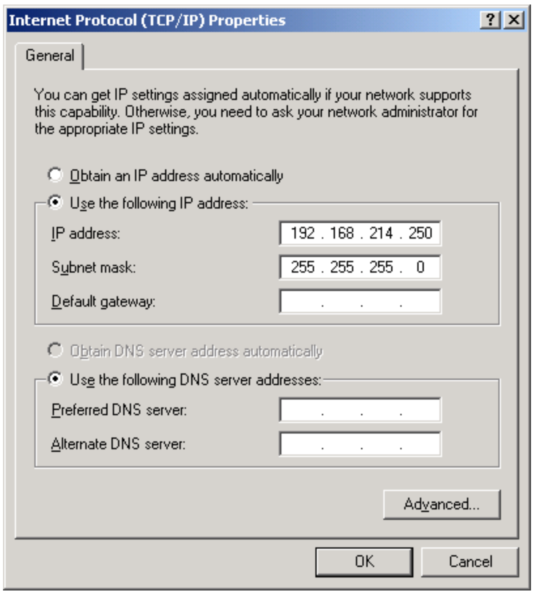
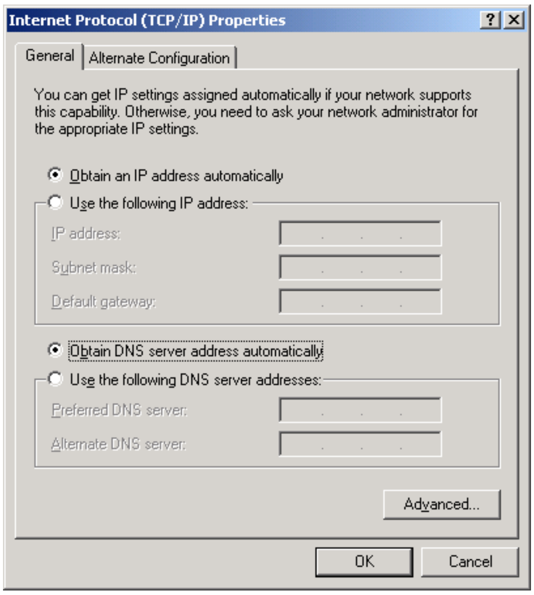
1. Check the network connection (ping on selected access path X120/X130/X127).
2. Select the PG/PC interface in SIMATIC Manager.

> **Note**
>
> Do not select "TCP/IP (AUTO)…" or "ISO Ind. Ethernet ..." under any circumstances!

3. Set parameters for HW Config → Machine control panel using the selected access IP address (X120/X130/X127).
4. Load the parameter assignment to the station.

| NOTICE |
| --- |
| **SW 2.4 and higher:**<br>The ports must be activated first where connections via the company network are involved (X130). |

### ③ (PG/PC)

| On the system network (X120): | On the service network (X127): |
|---|---|
|  |  |
| • TCP/IP Internet protocol<br>– properties<br>– general<br>– Set fixed IP addresses<br>• Example:<br>– IP: 192.168.214.250<br>– Sub.: 255.255.255.0 | • TCP/IP Internet protocol<br>– properties<br>– general<br>– IP address obtained automatically |

### ④ (System Network Center > TCU support)

When TCU – PCU50.3 (HMI Advanced) is powered up, the IP address of the PCU must be entered in the
/user/common/<TCU-Name>/common/tcu/config.ini
file:

```
[Station]
mcpIndex=…
tcuIndex=…
dckEnable=…
MaxHostIndex=1
[host_1]
Address=192.168.214.241
```

### ⑤ (machine control panel – Industrial Ethernet)

**Note**

The Service menu (Backup/Restore) is only available for an analog monitor, TCU OP, or PCU OP.

- mcp_client.ini file:
  - copy mcp_client.ini from
    /siemens/sinumerik/mcp_client/mcp_client.ini
    to
    /user/sinumerik/mcp_client/mcp_client.ini
  - "addrMode" change: 1=DNS (default) 0=HWS
    This may be required after a change of software if the machine control panel no longer uses PROFIBUS for communication
- Organization block 100 (OB100):

```
CALL "RUN_UP" , "gp_par
"MCPNum :=1
MCP1BusAdr :=192 // bus address in accordance with MCP switch
MCPMPI :=FALSE
MCPSDB210 :=FALSE
MCPCopyDB77 :=FALSE
MCPBusType :=B#16#55 (PROFIBUS = 3)
```

**Note**

In B#16#55, the initial "5" refers to the first machine control panel and the last "5" refers to the second.

# 3.2 X122 and X132 Interface Overview

## X122 and X132 interfaces for NCU 7x0

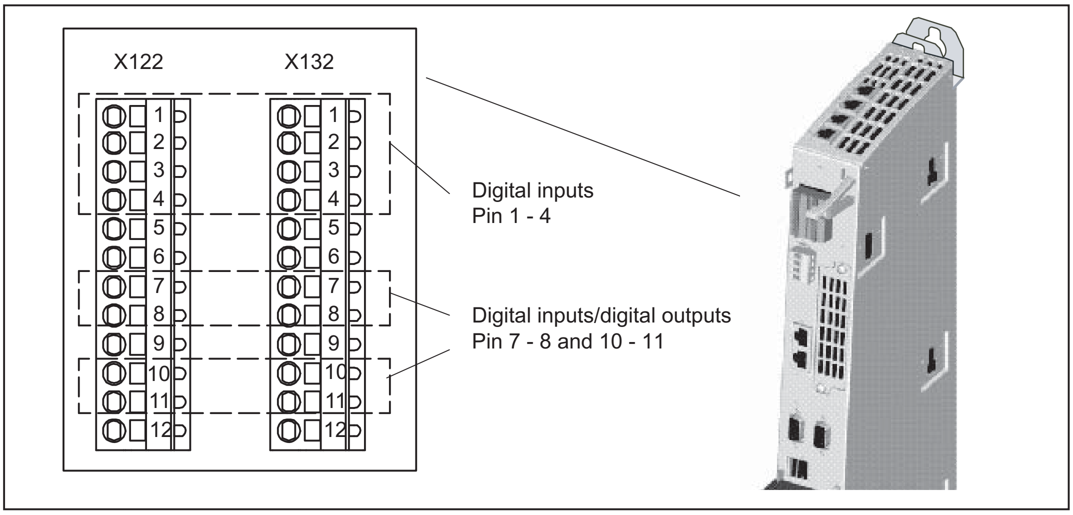



Figure 3-2 X122 and X132 interfaces for NCU 7x0

---

**Note**

The NX1x component has only the X122 interface.

---

## X122 and X132 block diagram for NCU 7x0

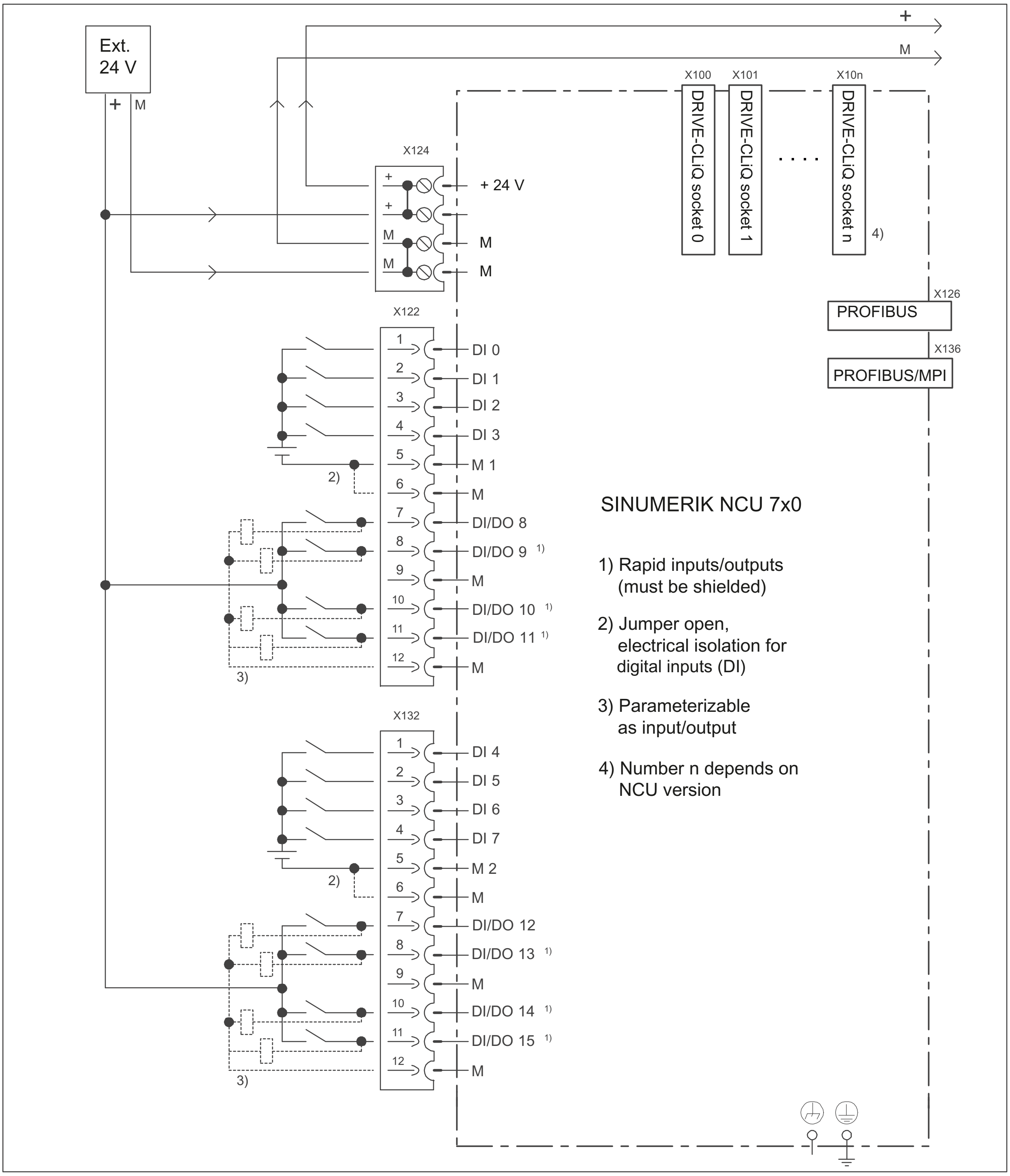



Figure 3-3 X122 and X132 block diagram for NCU 7x0

### X122 block diagram for NX1x

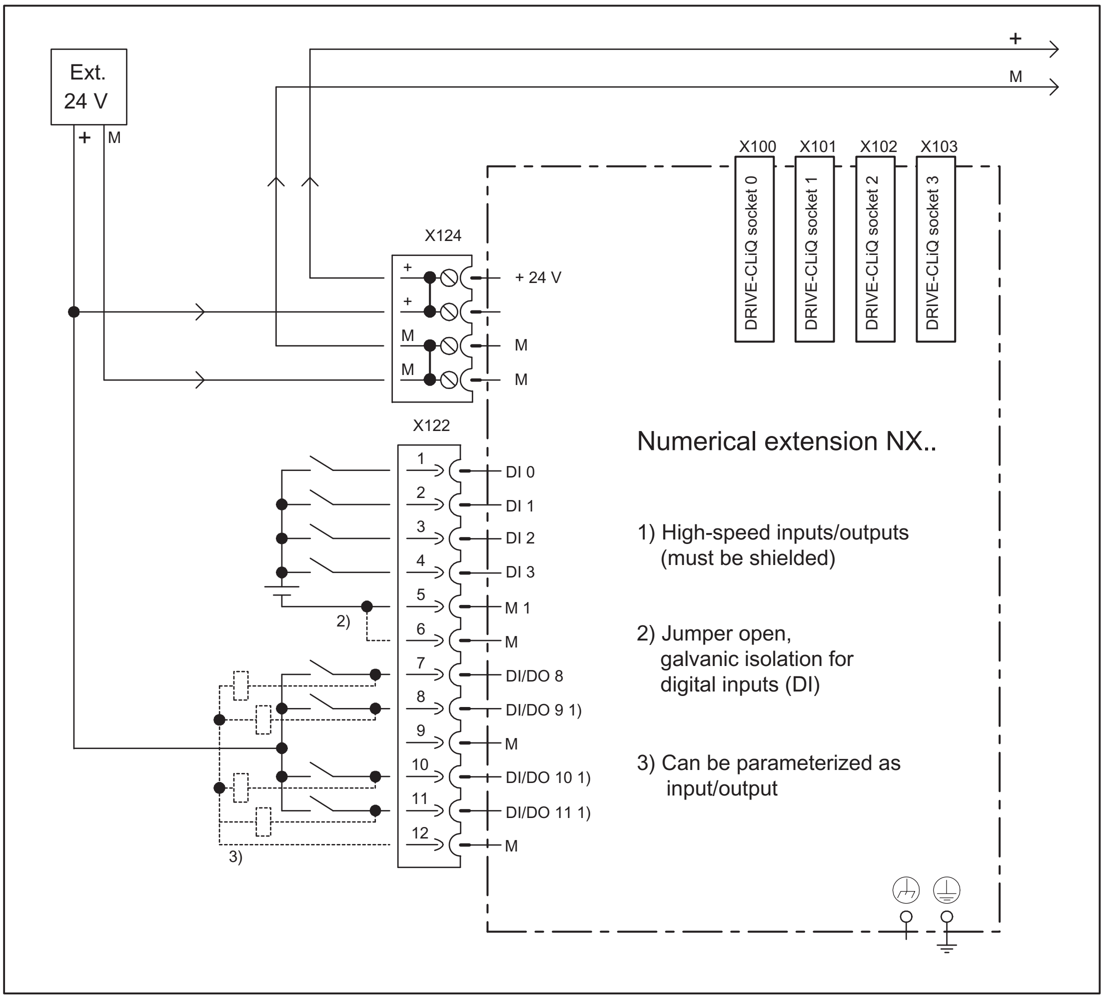



Figure 3-4 NX1x block diagram

## 3.3 NCU 7x0 and NX1x Terminal Assignment

### Introduction

When the drive wizard is used, various terminals are pre-assigned for commissioning:

- For the NCU 7x0:
  - X122
  - X132
- For the NX1x:
  - X122

## Terminal assignment X122 (NCU 7x0)

| Pin no. | Function | Assignment recommendation | BICO source/sink | | Macro number (up to SW 2.5) |
|---|---|---|---|---|---|
| 1 | Input[1)] | ON/OFF 1 infeed for:<br>Line Module **with** DRIVE-CLiQ connection | CU: r0722.0 | Line Module: p0840 | 1 |
| | | Alternative assignment:<br>"Infeed ready signal" for:<br>Line Module **without** DRIVE-CLiQ connection | SLM X21.1 | Drive p0864 | 5 |
| 2 | Input | "OFF3 – rapid stop" | CU: r0722.1 | Each drive<br>2. OFF3, p0849 | 1<br>5 |
| 3 | Input | SH/SBC 1 - Group 1<br>SINAMICS Safety Integrated<br>(SH enable = p9601) | CU: r0722.2 | p9620 (all drives in the group) | No pre-assignment |
| 4 | Input | SH/SBC 2 - Group 2<br>SINAMICS Safety Integrated<br>(SH enable = p9601) | CU: r0722.3 | p9620 (all drives in the group) | |
| 5 | Ground for pins 1 ... 4 | | | | |
| 6 | - Ground for pins 7, 8, 10, 11 | | | | |
| 7 | Output | SH/SBC 1 - Group 1<br>SINAMICS Safety Integrated | CU: p0738 | p9774 Bit 1<br>BICO from CU after the first drive in the group | No pre-assignment |
| 8 | Output | SH/SBC 2 - Group 2<br>SINAMICS Safety Integrated | CU: p0739 | p9774 Bit 1<br>BICO from CU after the first drive in the group | |
| 9 | Ground for pins 7, 8, 10, 11 | | | | |
| 10 | Input | BERO 1 - zero mark substitute | CU: r0722.10 | Drive: p0495 = 2 | No pre-assignment |
| 11 | Input | Probe 1 - central measurement (MD13210 = 0) | CU: p0680[0] = 3 | Each drive p0488[n] = 0 | 1 and 5 |
| | | Alternative assignment:<br>Probe 1 - distributed measurement (MD13210 = 1) | CU: p0680[0] = 0 | Each drive p0488[n] = 3 | No pre-assignment |
| 12 | Ground for pins 7, 8, 10, 11 | | | | |

[1)] Positive edge required!

## Terminal assignment X132 (for NCU 7x0)

| Pin no. | Function | Assignment recommendation | BICO source/sink | | Macro number |
|---|---|---|---|---|---|
| 1 | Input | Digital input $A_IN[1] | CU: r0722.4 | CU: p2082[0] | 1 and 5 |
| 2 | Input | Digital input $A_IN[2] | CU: r0722.5 | CU: p2082[1] | |
| 3 | Input | Digital input $A_IN[3] | CU: r0722.6 | CU: p2082[2] | |
| 4 | Input | Digital input $A_IN[4] | CU: r0722.7 | CU: p2082[3] | |
| | | Alternative assignment:<br>Line contactor, feedback signal | CU: r0722.7 | Line Module: p0860 | No pre-assignment |
| 5 | Ground for pins 1, 2, 3, 4 | | | | |
| 6 | Ground for pins 7, 8, 10, 11 | | | | |
| 7 | Output | Infeed operation (Line Module with DRIVE-CLiQ connection) | LM :r0863.0 | CU: p0742 | 1 |
| | | Alternative assignment:<br>Digital output $A_OUT[4] | CU: p2091.3 | CU: p0742 | 5 |
| 8 | Output | Infeed ready to start (Line Module with DRIVE-CLiQ connection) | LM : r0899.0 | CU: p0743 | 1 |
| | | Alternative assignment:<br>Digital output $A_OUT[3] | CU: p2091.2 | CU: p0743 | 5 |
| 9 | Ground for pins 7, 8, 10, 11 | | | | |
| 10 | Output | Digital output $A_OUT[2] | CU: p2091.1 | CU: p0744 | 1/5 |
| | | Alternative assignment:<br>Line contactor control | LM : r0863.1 | CU: p0744 | No pre-assignment |
| | Alternative: Input | BERO 2 - zero mark substitute | CU: r0722.14 | Drive: p0495 = 5 | No pre-assignment |
| | | 2. OFF 2 | CU: r0722.14 | Drive: p0845 | |
| 11 | Output | Digital output $A_OUT[1] | CU: p2091.0 | CU: p0745 | 1 and 5 |
| | Alternative: Input | Probe 2 - central measurement (MD13210 = 0) | CU: p0680[1] = 6<br>CU: p0728<br>Bit 15=0 | Each drive<br>p0489[n] = 0 | No pre-assignment |
| | | Probe 2 - distributed measurement (control MD13210 = 1) | CU: p0680[1] = 0<br>CU: p0728<br>Bit 15=0 | Each drive<br>p0489[n] = 6 | |
| 12 | Ground for pins 7, 8, 10, 11 | | | | |

## Terminal assignment X122 (NX 10/15)

| Pin no. | Function | Assignment recommendation | BICO source/sink | | Macro number |
|---|---|---|---|---|---|
| 1 | Input[1)] | "Infeed ready signal" | NX: r8510.0 [2)]<br>(NX: r0722.0 [3)] ) | Drive: p0864 | |
| 2 | Input | "OFF3 - rapid stop" | NX: r8511.1 [2)]<br>(NX: r0722.1[3)] ) | Each drive<br>2. OFF3, p0849 | No pre-assignment |
| 3 | Input | SH/SBC 1 - Group 1<br>SINAMICS Safety Integrated (SH enable = p9601) | NX: r0722.2 | p9620 (all drives in the group) | |
| 4 | Input | SH/SBC 2 - Group 2<br>SINAMICS Safety Integrated (SH enable = p9601) | NX: r0722.3 | p9620 (all drives in the group) | No pre-assignment |
| 5 | Ground for pins 1, 2, 3, 4 | | | | |
| 6 | Ground for pins 7, 8, 10, 11 | | | | |
| 7 | Output | SH/SBC 1 - Group 1<br>SINAMICS Safety Integrated | NX: p0738 | r9774 bit 1<br>BICO from CU after the first drive in the group | No pre-assignment |
| 8 | Output | SH/SBC 2 - Group 2<br>SINAMICS Safety Integrated | NX: p0739 | p9774 bit 1<br>BICO from CU after the first drive in the group | |
| 9 | Ground for pins 7, 8, 10, 11 | | | | |
| 10 | Input | BERO 1 - zero mark substitute | NX: r0722.10 | Drive: p0495 = 2 | |
| 11 | Input | BERO 2 - zero mark substitute | NX: r0722.11 | Drive: p0495 = 3 | No pre-assignment |
| | | Alternative assignment:<br>2. OFF 2 | NX: r0722.11 | Drive: p0845 | |
| 12 | Ground for pins 7, 8, 10, 11 | | | | |

[1)] Positive edge required!

[2)] Pre-assignment as part of "device configuration" commissioning

[3)] With external wiring

[n] Encoder index

# 3.4 Power Supply Interface Variants

## 3.4.1 Ways of connecting the line supply

A distinction is made between:

- Direct operation of the line connection components on the supply system
- Operating line connection components via an autotransformer
- Operating line connection components via an isolating transformer

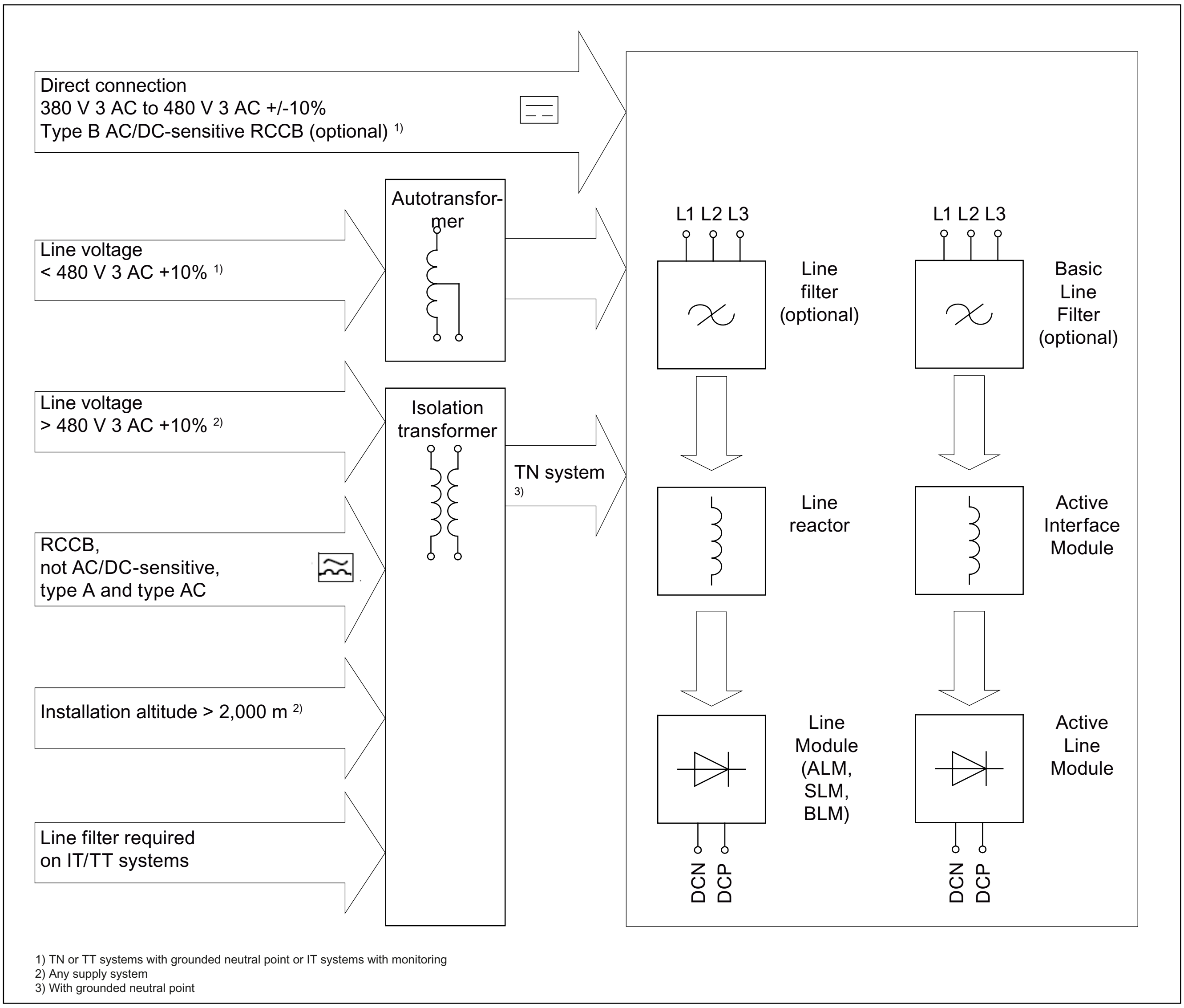



Figure 3-5 Overview of line connection versions

**Note**

**Line connection of motors**

In combination with the drive system, the motors are generally approved for operation on TN and TT systems with grounded neutral point and on IT systems.

In operation on IT systems, the occurrence of a first fault between an active part and ground must be signaled by a monitoring device. In accordance with IEC 60364-4-41, it is recommended that the first fault be eliminated as quickly as is practically possible in order to minimize the temporary overload of the motor insulation.

In all other systems, except TN and TT systems with grounded neutral point and IT systems, such as systems with a grounded line conductor, an isolation transformer with grounded neutral point (secondary side) must be connected between the supply and the drive system in order to protect the motor insulation from excessive stress.

### 3.4.2 Operation of the line connection components on the supply network

The SINAMICS S Booksize converter system is rated for direct operation on TN, TT, and IT line supply systems with a rated voltage of 380 V 3 AC to 480 V 3 AC.

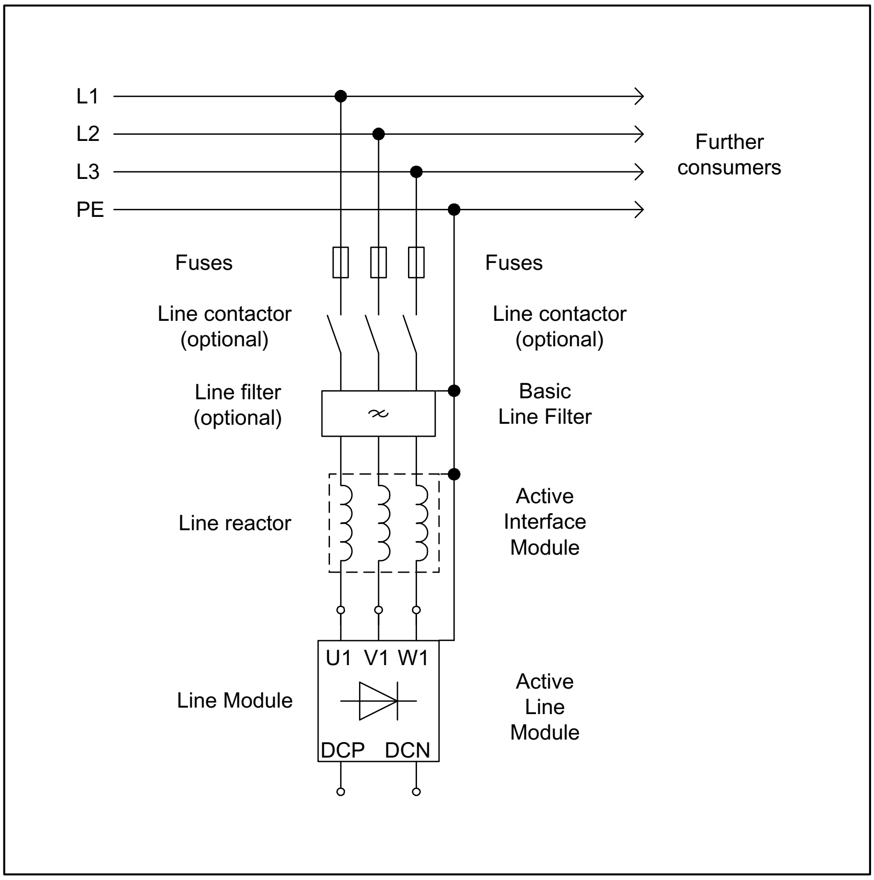



Figure 3-6 Direct operation on the line supply

### 3.4.3 Operation of the line connection components via an autotransformer

An autotransformer can be used to adapt the voltage in the range up to 3-ph. 480 V AC +10 %.

| ⚠ DANGER |
|---|
| To ensure protective separation an isolating transformer must be used for voltages greater than 3-ph. AC 480 V AC +10 %. |

Applications:

- The motor insulation must be protected from excessive voltages.
- The active line module must provide a stabilized DC link voltage. This is possible with a rated voltage of 380 V to 415 V.
  A combination with motors that may be operated with a DC link voltage of up to 660 V, and a line voltage > 415 V requires a controlled DC link voltage.

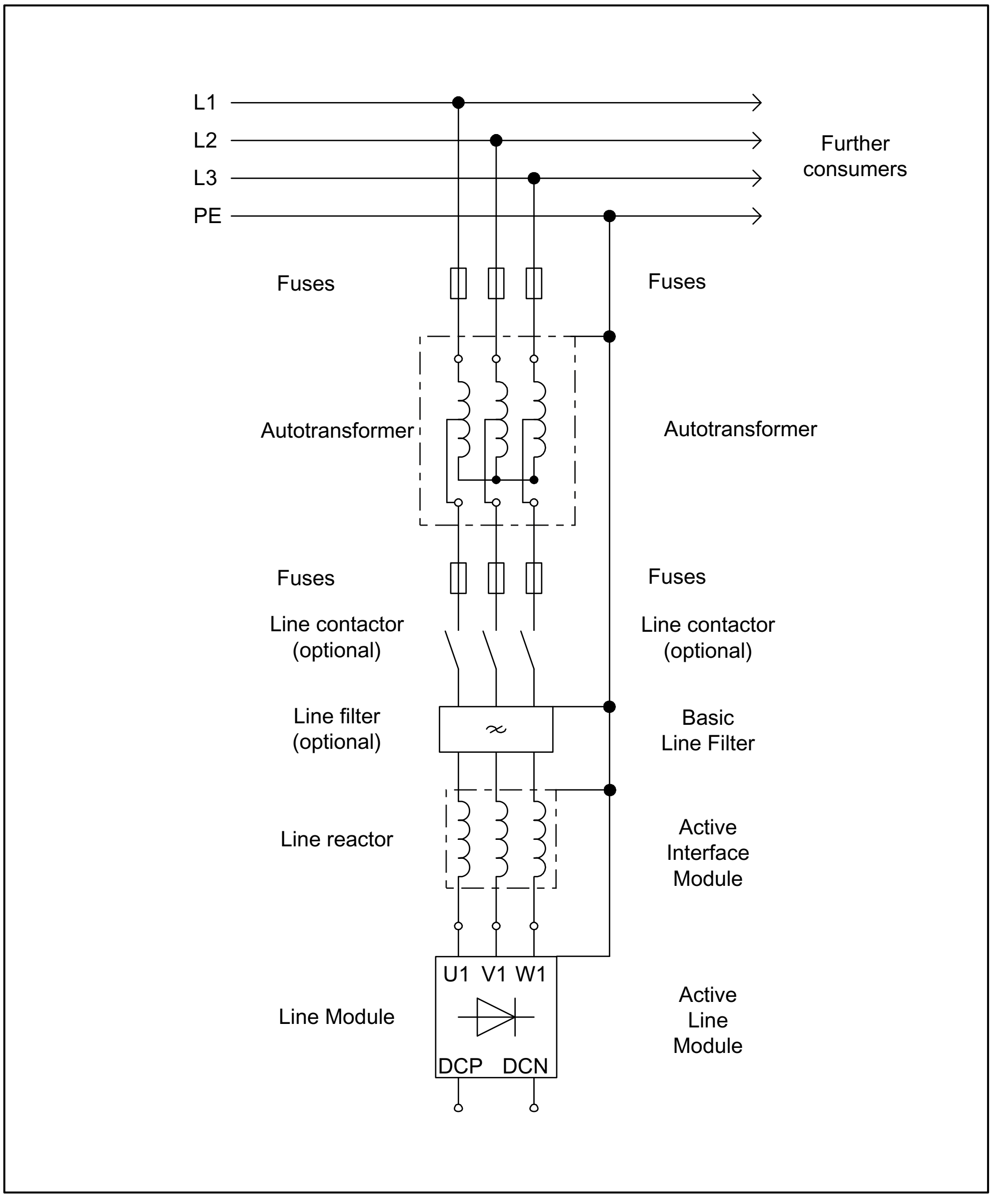



Figure 3-7 Autotransformer

### 3.4.4 Operation of the line connection components via an isolating transformer

The isolating transformer converts the network configuration of the system (e.g. IT/TT system) to a TN system. Additional voltage adaptation to the permissible voltage tolerance range is possible.

An isolating transformer must be used in the following cases:

- The insulation of the Motor Module and/or the motor is not suitable for the voltages that occur.
- There is no compatibility with an existing residual-current protective device.

- The installation altitude is higher than 2000 m above sea level.
- A line filter should be used in a line supply system that is not a TN line supply system with grounded neutral conductor.

| CAUTION |
| --- |
| If the supply voltage is greater than 480 V +10 %, it is not permissible to use an autotransformer.<br>An isolating transformer must be used to ensure protective separation. |

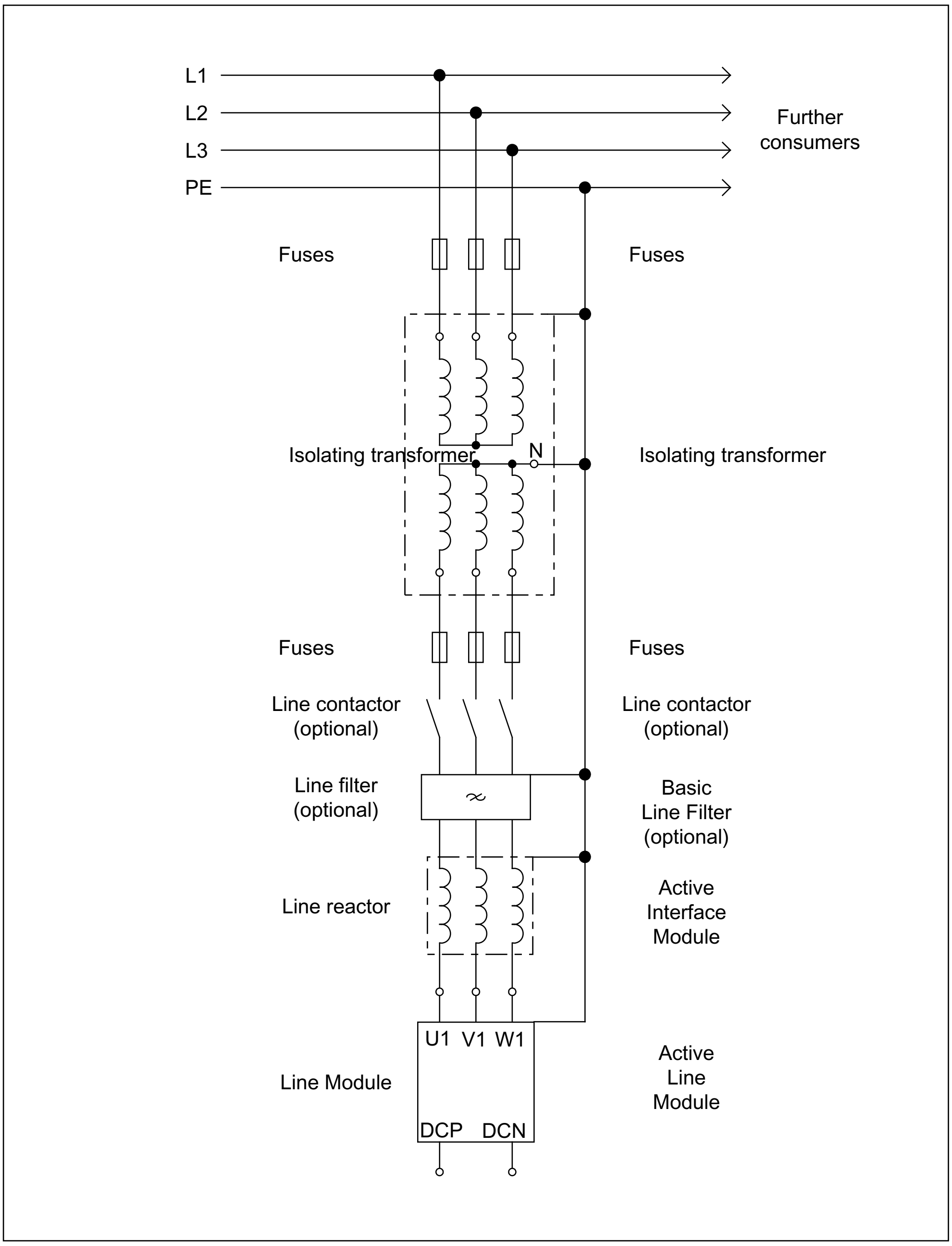



Figure 3-8 Isolating transformer

### 3.4.5 Residual-current operated circuit breakers (RCD)

Residual-current operated circuit breakers (RCD) can be used in addition to the overcurrent protection devices provided.

| ⚠ DANGER |
|---|
| Residual-current circuit-breakers alone are not permissible to provide protection against direct and indirect contact. |

| ⚠ DANGER |
|---|
| As a general rule, the higher loop impedance of TT systems means they are not suitable for tripping the installed overcurrent protection devices within the prescribed period should an insulation fault occur. If TT systems are used, residual-current operated circuit breakers should ideally be used in addition to the overcurrent protection devices. |

---

**Note**

Operation on residual-current operated circuit breakers is currently only possible with Line Modules up to and including 36 kW.

---

#### Please note the following:

- It is only permissible to use a delayed tripping, selective AC/DC-sensitive residual-current operated circuit breaker, type B.
- The max. permitted grounding resistance of the "selective protective device" is observed (83 Ω max. for residual-current devices with 0.3 A rated differential current).
- Accessible parts of the Power Drive System and the machine are connected to the system's protective ground conductor.
- The total length of the shielded power cables in the drive line-up (motor cables incl. line supply conductors from line filters to the connecting terminals of the Line Module) must be less than 350 m.
- Only recommended line filters must be used during operation.
- Only one residual-current circuit-breaker may be connected in series (cascading is not possible).
- Switching elements (disconnector unit, contactors) for connecting and disconnecting the drive line-up have max. 35 ms delay time time between the closing/opening of the individual main contacts.

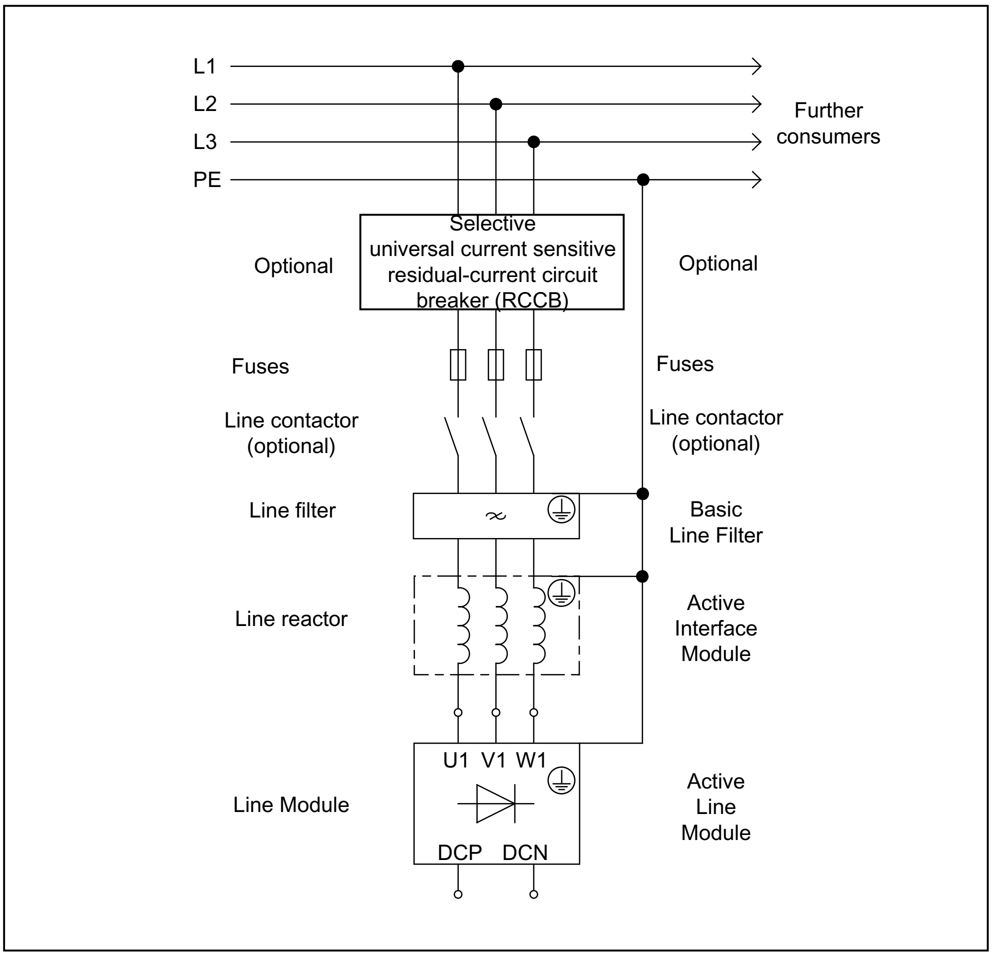



Figure 3-9 Connecting a residual-current operated circuit breaker

## Recommendation

SIEMENS selectively switching AC/DC-sensitive residual-current circuit-breakers in accordance with EN 61009-1 of the 5SM series (e.g. 5SM3646-4 or 5SM3646-4+5SW3300 with an auxiliary disconnector (1 NC contact / 1 NO contact) for a rated current of 63 A and rated fault current of 0.3 A (see catalog "BETA Modular Installation Devices - ET B1")).

| NOTICE |
| --- |
| AC or pulse-sensitive RCCBs are not suitable. |

### 3.4.6 Residual-current monitors (RCM)

Used in conjunction with appropriate circuit breakers, residual-current monitors (RCMs) provide fire and system protection even at high levels of grounding resistance (in TT systems, for example).

| ⚠DANGER |
| --- |
| Residual-current monitors must always be used in conjunction with appropriate circuit breakers. |

| ⚠DANGER |
| --- |
| As a general rule, the higher loop impedance of TT systems means they are not suitable for tripping the installed overcurrent protection devices within the prescribed period should an insulation fault occur. When operating on TT systems at infeed powers above 55 kW and with systems that extend across a large area, residual-current monitors must be installed in addition to appropriate circuit breakers. |

#### Please note the following:

- It is only permissible to use a delayed tripping, AC/DC-sensitive RCM type B, in order to ensure reliable tripping even with smooth residual currents.
- Accessible parts of the power drive system and the machine are connected to the system's protective conductor.
- The protective conductor must not be routed through the measuring current transformer, as this would negate its protection function.

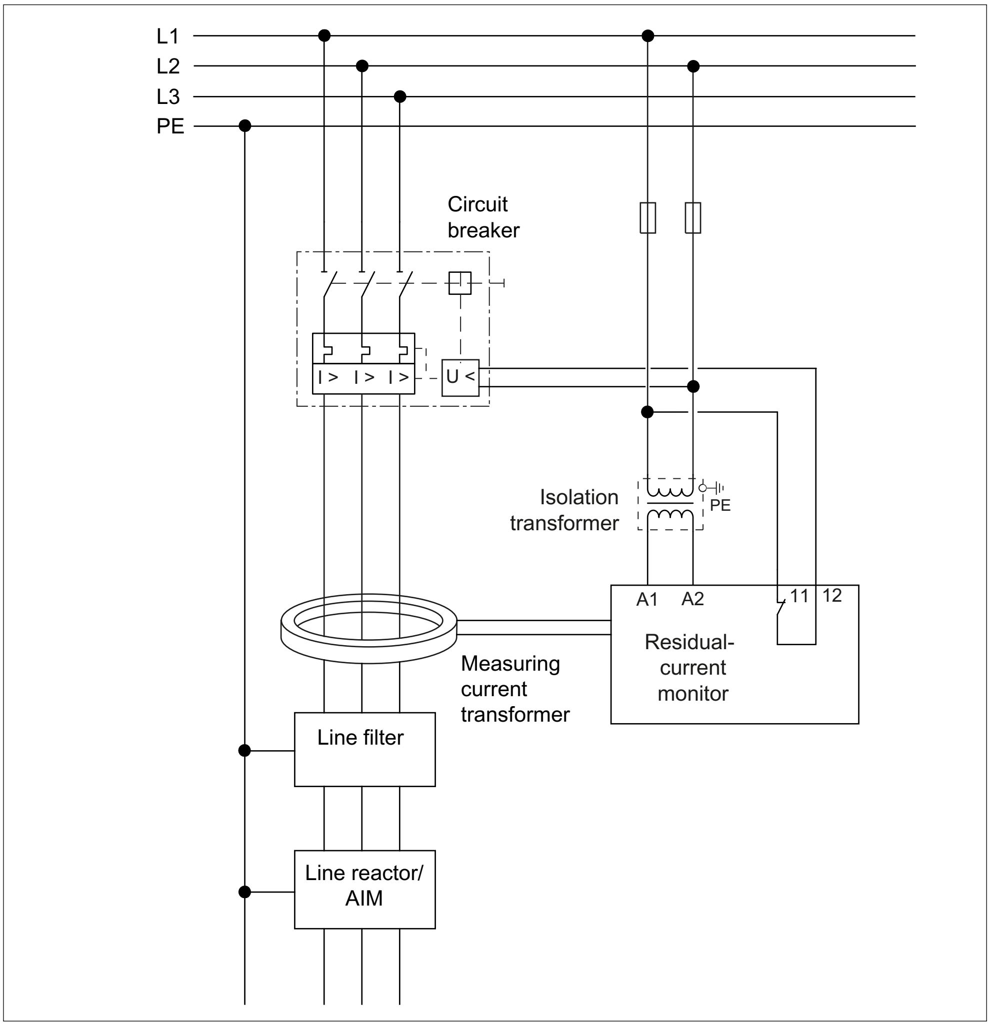



Figure 3-10 Connecting a residual-current monitor

## Recommendation

- Bender AC/DC-sensitive residual-current monitor RCMA471LY, with measuring current transformer W120B (120 mm) or W210B (210 mm)
- Circuit breaker with thermal overload release, short-circuit release, and undervoltage release

To protect the units against line-side surge voltages, you are advised to install an overvoltage protection device directly at the infeed point (upstream of the main switch). To fulfill the requirements of CSA C22.2 no. 14-05, surge protection is essential. For examples of suitable voltage surge arresters, see www.raycap.com (for example)

# 4 Safety Integrated

> ⚠ WARNING
>
> The following chapter describes the uses of the "Safety Integrated" functionality. The detailed knowledge of the "Safety Integrated sl Function Manual" (FBSI sl) is assumed as prerequisite.

## 4.1 SINAMICS Safety Integrated

SINAMICS Safety Integrated provides the following safety functions:

- Safe standstill (SH)
- Safe Brake Control

1. The functions must be released using parameters.
2. The control terminals for the Safe Standstill (SH) function can be grouped.
3. The functions are drive-integrated, i.e. they are present for each drive and must be individually brought into operation for each drive.

### 4.1.1 Control of the "Safe Standstill" Safety Function

#### Terminals for safe standstill

The safe standstill function is selected/deselected separately for each drive using a specific terminal on the Control Unit and Motor Module.

- Control Unit

  The required input terminal for safe standstill (SH) is selected via the BICO interconnection (BI: p9620).

  Digital input DI 0 ... DI 7 on the Control Unit can be used as a signal source (NCU). The NX modules have DI 0 to DI 3 digital input.

- Motor Module

  The input terminal for "safe standstill (SH)" is terminal "EP" ("enable pulses").

Both terminals must be simultaneously energized, otherwise a fault will be issued.

---

**Note**

For the secure control of the safety functions using terminals, an external safety control, e.g. safety relay (3TK28...) or SIMATIC S7 F control (e.g. ET200S F-DO- P/M-switching) in accordance with EN954-1 or prEN 13849-1 must be provided.

---

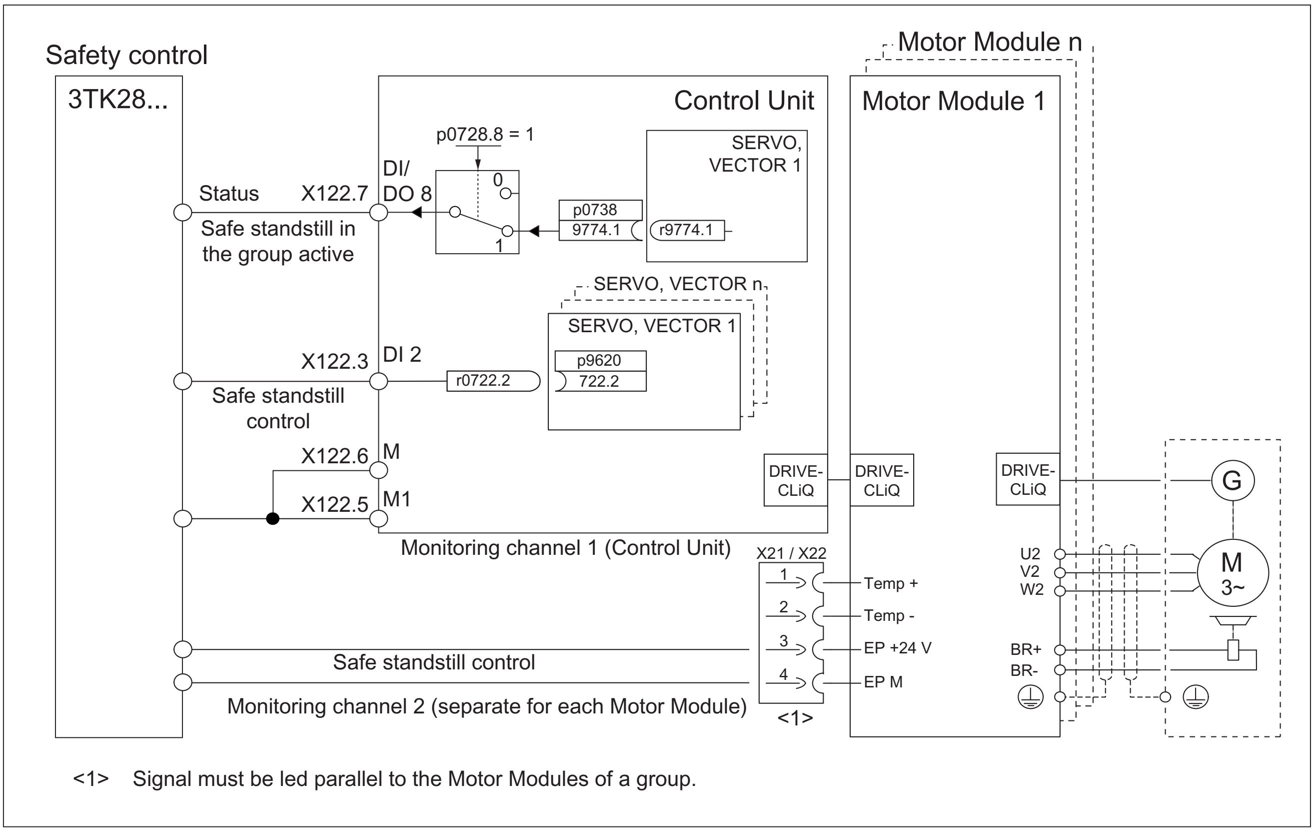



Figure 4-1 Terminals for "safe standstill"

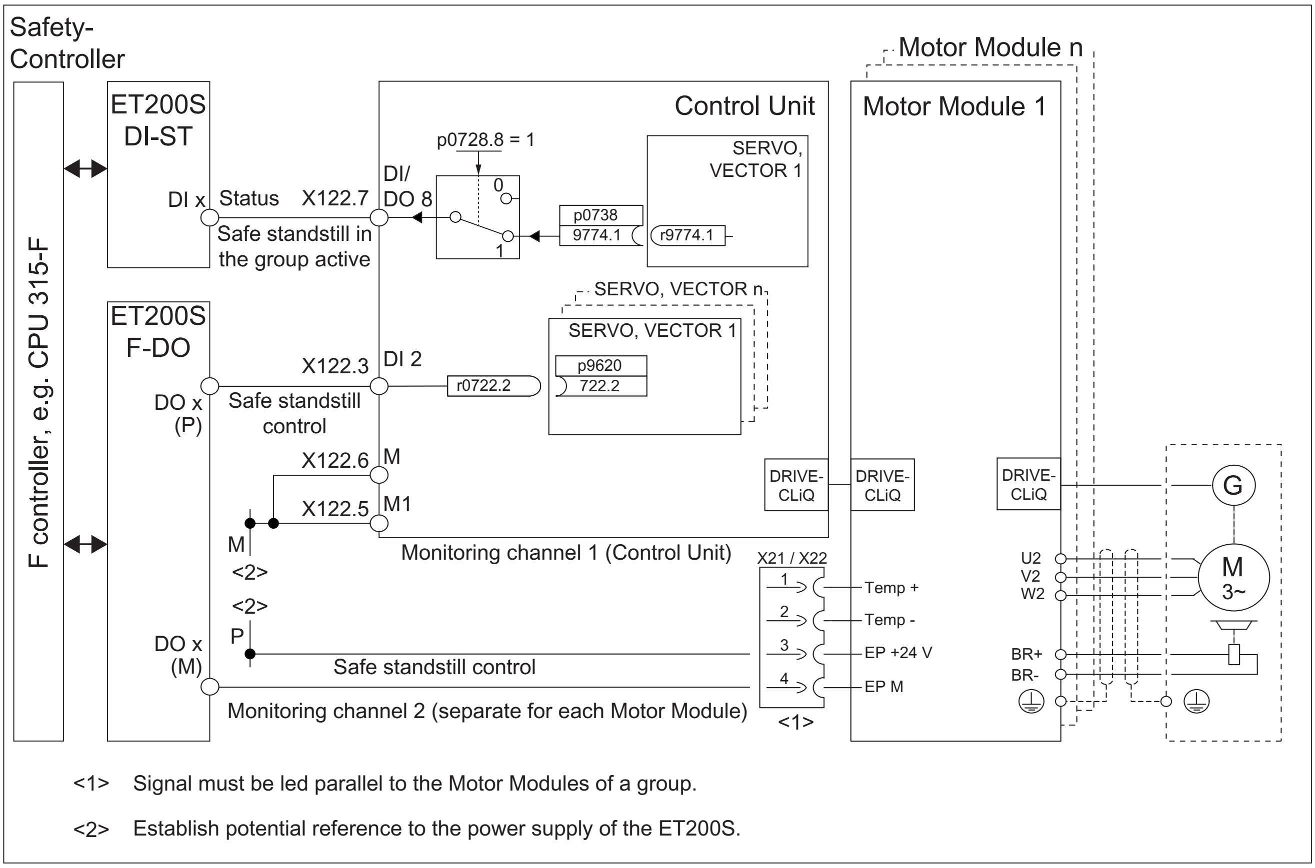



Figure 4-2 Safe standstill terminals; control, e.g. with the fail safe output of the ET200S

## Grouping drives

If the function is to be simultaneously initiated for several drives, the terminals for the corresponding drives must be grouped together:

- Control Unit

  By appropriately interconnecting the binector input to a joint input terminal for the drives to be combined to form a group.

- Motor Module

  By appropriately connecting terminal "EP" for the individual Motor Modules belonging to a group.

---

**Note**

The same grouping must be set in both monitoring channels.

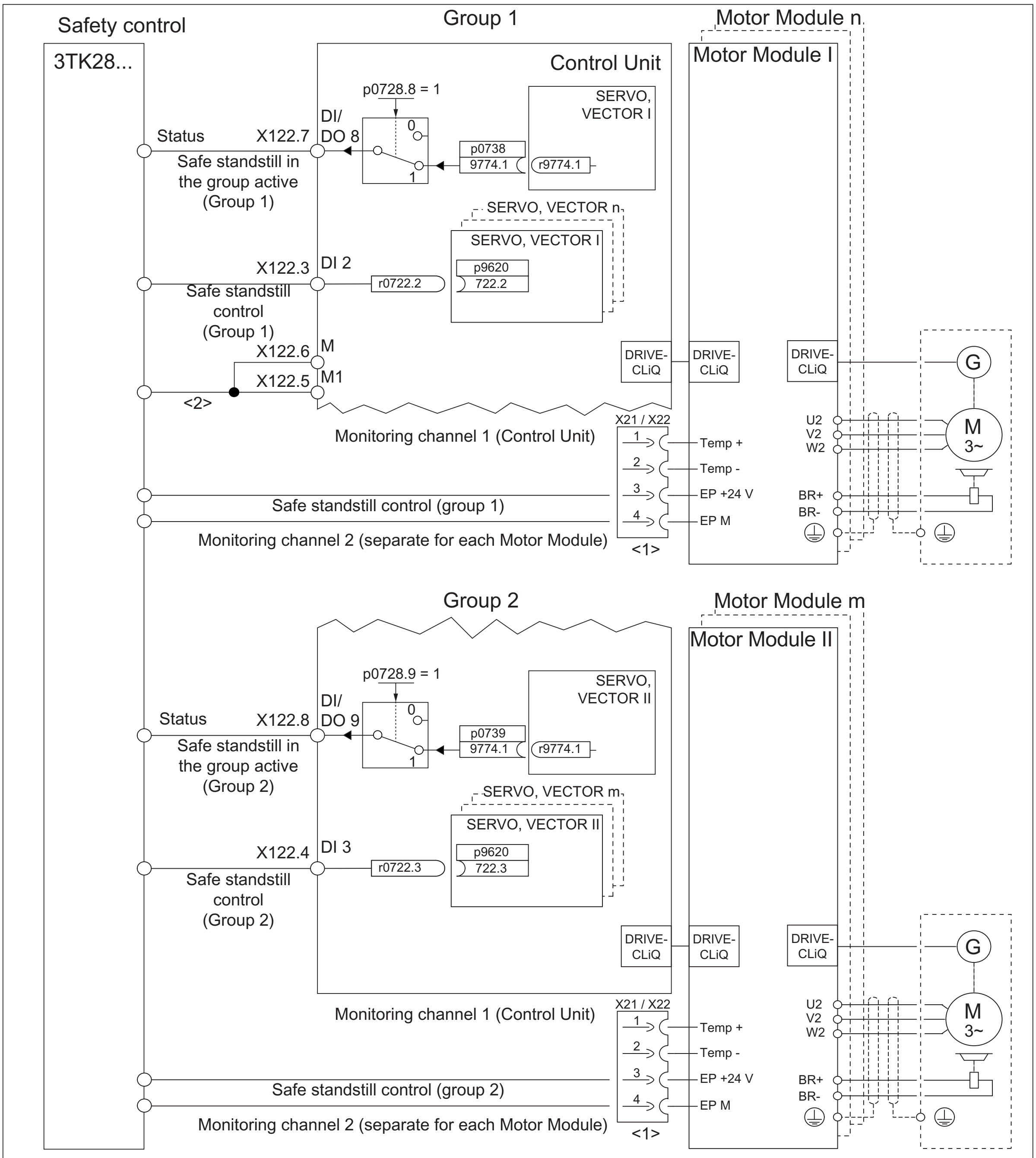
If a fault in a drive causes the safe standstill (SH), the other drives of the same group will not automatically be placed in the safe standstill (SH).

---

## Example: Terminal grouping for safe standstill (SH)

The "Safe standstill" function should be able to be selected/deselected separately for group 1 (drive 1 and 2) and group 2 (drive 3 and 4).

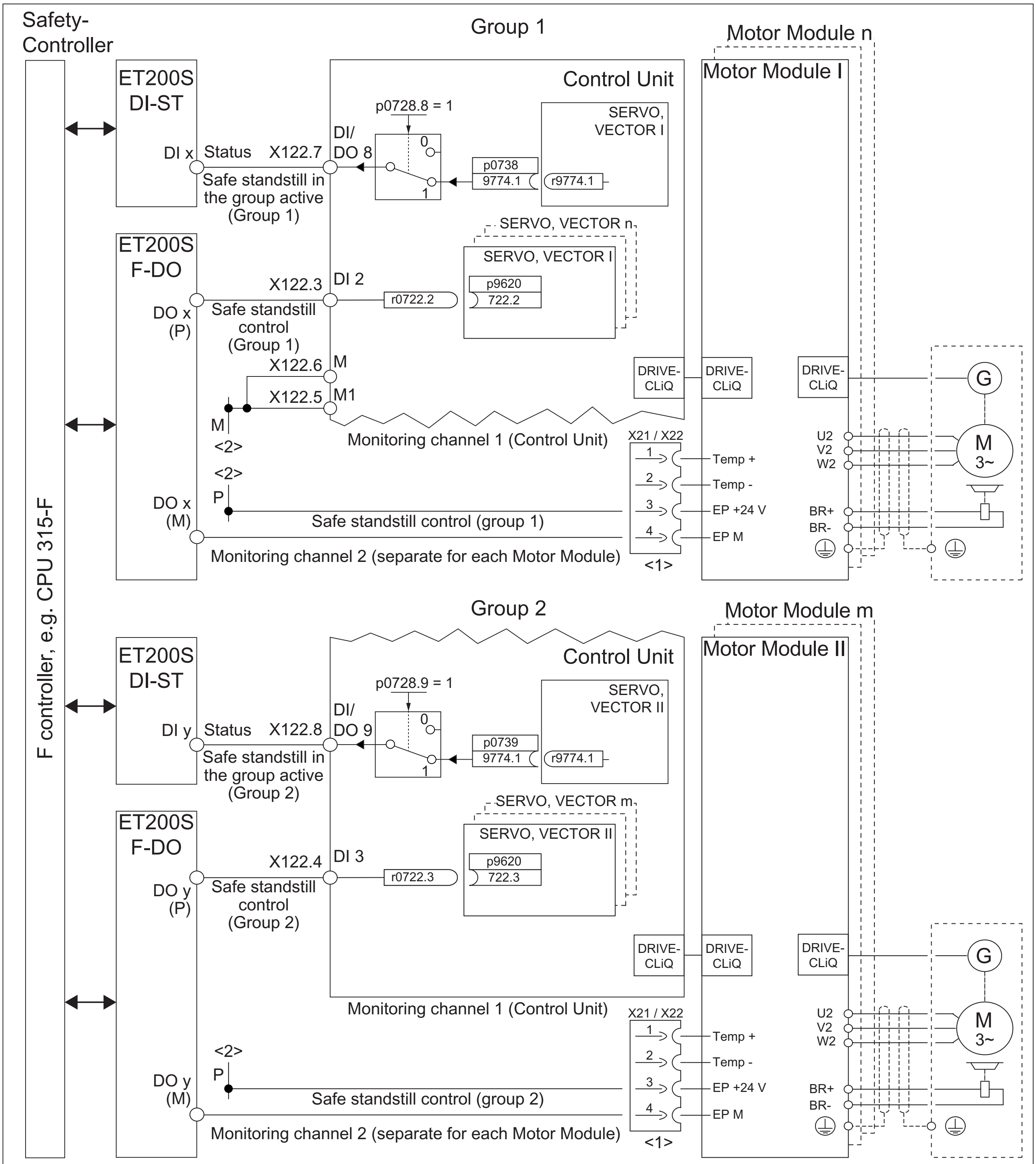
The same grouping for the safe standstill must be performed for both the Control Unit and for the Motor Modules.




<1> Signal must be led parallel to the Motor Modules of a group.

<2> Establish potential reference to the power supply.

Figure 4-3 Terminal grouping for "safe standstill"




<1> Signal must be led parallel to the Motor Modules of a group.

<2> Establish potential reference to the power supply of the ET200S.

Figure 4-4 Safe standstill terminals grouping; control, e.g. with the fail safe output of the ET200S

## Enabling the safe standstill (SH) function

The safe standstill (SH) function is enabled using the following parameters:

| | |
|---|---|
| p9601.0 | SH using terminals on the Control Unit |
| p9801.0 | SH using terminals on the Motor Module |

The "Safe standstill" function does not need to be enabled for applications that do not require any Safety Integrated. All input terminals on the Control Unit can be used.

The SH terminal on the Motor Module does not need to be used.

## Selecting/deselecting safe standstill

The "Safe standstill" function does not need to be selected/deselected concurrently in both monitoring channels using input terminals and acts only on the affected drive.

1 signal: Deselection of the function

0 signal: Selection of the function

## Restart once the safe standstill function has been selected

1. Deselect the function in each monitoring channel via the input terminals.
2. Issue drive enable signals.
3. Cancel the power-on inhibit and power-up again.
   - 1/0 edge at input signal "ON/OFF1" (cancel power-on inhibit)
   - 0/1 edge at input signal "ON/OFF1" (power-up drive)
4. Move/traverse the drives again.

## Status with safe standstill

The status of the safe standstill (SH) function is indicated using the following parameters:

| | |
|---|---|
| r9772 | CO/BO: Safety Integrated Status (Control Unit) |
| r9872 | CO/BO: Safety Integrated Status (Motor Module) |
| r9773 | CO/BO: Safety Integrated Status (Control Unit + Motor Module) |
| r9774 | CO/BO: Safety Integrated Status (Safe Standstill Group) |

### 4.1.2 Safe Brake Control (SBC)

#### Description

The Safe Brake Control (SBC) is used to control the holding brakes that operate using the quiescent current principle.

#### Safe pulse cancellation for safe brake control (SBC)

When safe standstill is selected or when safety monitor functions respond with safe pulse cancellation, SBC is initiated.

---

**Note**

The monitoring and the forced checking procedure of the brake outlet is possible only when the brake is connected directly and not using a coupling relay to the connection terminals!

---

# 4.2 SINUMERIK Safety Integrated

## 4.2.1 Fundamentals

### Functions

SINUMERIK Safety Integrated can use not only "Safe standstill (SH)" and "Safe brake control (SBC)", but also additional safety functions. The function and system description is contained in the Safety Integrated sl function manual.

External safety-related process signals are read by an appropriate provided peripheral and further processed by the system. An external safety relay (3TK28...) and a safety controller (SIMATIC S7) are no longer essential.

## 4.2.2 Connection to Monitoring Channels

The following example illustrates the wiring possibilities of the ET200S PROFIsafe component.

No complete plant with all required hardware and software settings is shown. Only the data always required for the application is described for each of the used ET200S components. A detailed description is contained in the associated product/function manuals.

The sensor/actuator connection for SINUMERIK Safety Integrated is performed using PROFIBUS with PROFIsafe profile and PROFIsafe-conform peripheral modules (e.g. ET200S, ET200eco or ET200pro).

**Overview of the ET200S peripheral connection to the NCU**

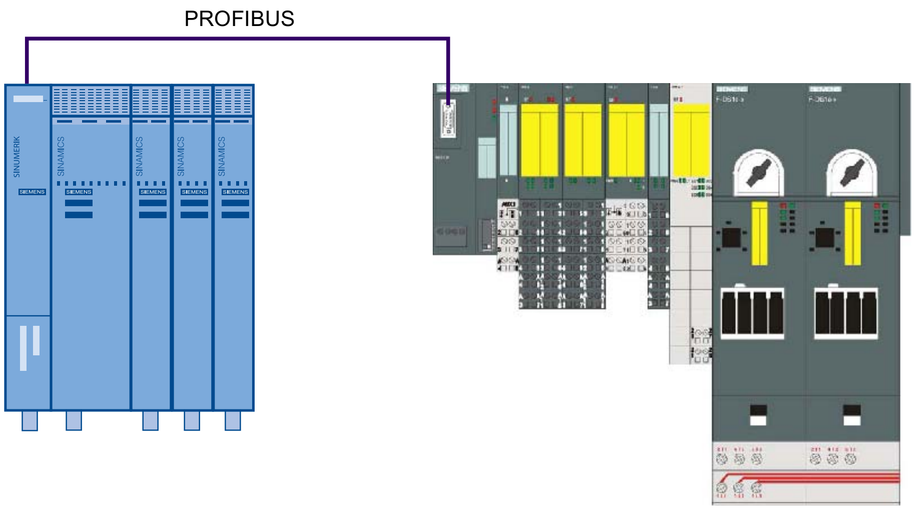



Figure 4-5 Overview of the ET200S peripheral connection to the NCU

## Signal assignment and significance

Part of the signal assignment and significance for the PROFIsafe modules is explained in the following section:

### 4/8 F-DI 24 VDC PROFIsafe electronic module

The safety-related I/O input signals are connected to this module. These sensors in the example are optionally exclusive OR with two break contacts (emergency stop activator and protective door interlocked state), i.e. provided with a break contact and a make contact (agreement button) or with two make contacts (<drive on> button).

All of the sensor signals are connected through two channels.

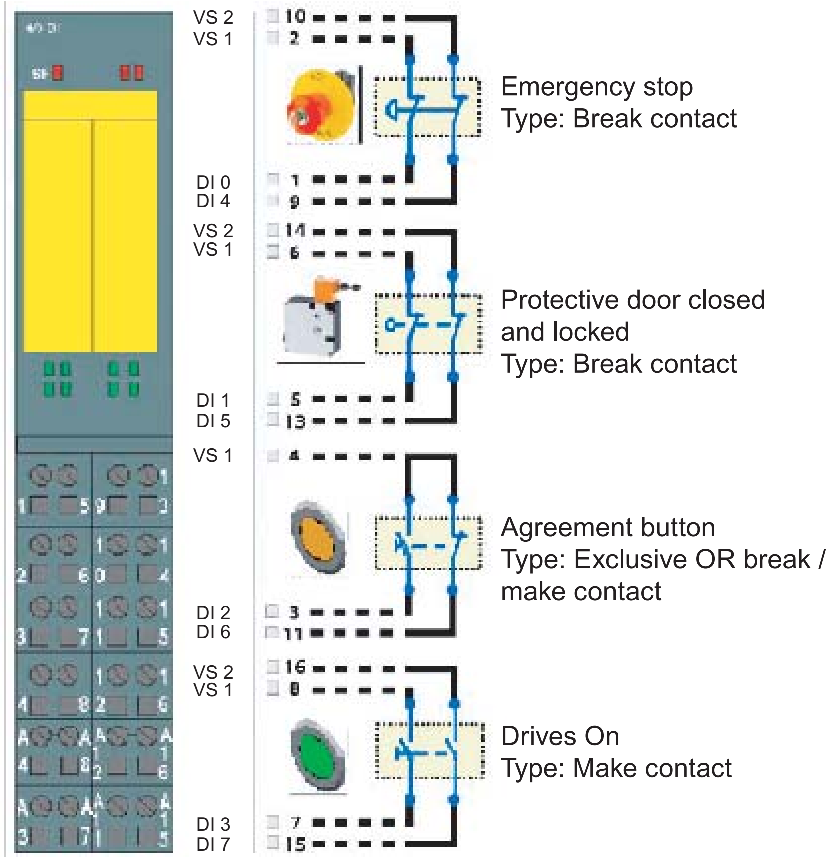



Figure 4-6 Signal assignment, electronics module, 4/8F-DI, 24 VDC, PROFIsafe

### Meaning and use of the individual signals

### Emergency stop activator [F-DI terminal 1 (channel 0), terminal 9 (channel 4)]

Signal state channel 0 = "1" and channel 4 = "1":
Emergency stop activator not pressed.

Signal state channel 0 = "0" and channel 4 = "0":
Emergency stop activator pressed.

### Protective door interlocked state [F-DI terminal 5 (channel 1), terminal 13 (channel 5)]

The door switch only interlocks if the actuator is inserted. The contacts of the monitoring circuit then signal the status "closed and interlocked"

Signal state channel 1 = "1" and channel 5 = "1":
Protective door closed and interlocked.

Signal state channel 1 = "0" and channel 5 = "0":
Protective door not closed or not interlocked.

Agreement button [F-DI terminal 3 (channel 2), terminal 11 (channel 6)]

Signal state channel 2 = "1" and channel 6 = "0":
Agreement button pressed.

Signal state channel 2 = "0" and channel 6 = "1":
Agreement button not pressed.

Drives On button [F-DI terminal 7 (channel 3), terminal 15 (channel 7)]

Signal state channel 3 = "0" and channel 7 = "0":
Drives On button not pressed.

Signal state channel 3 = "1" and channel 7 = "1":
Drives On button pressed.

VS1: internal sensor supply for channel 0 to 3

VS2: internal sensor supply for channel 4 to 7

These two sensor supplies must be used when the short-circuit test is activated. The exclusive OR sensor agreement button is an exception. For this sensor variant, in conjunction with the short-circuit test, the VS1 sensor supply must be used for both contacts.

Electronics module 4 F-DO 24 VDC/2 A PROFIsafe

The actuators that must be shut-down in a safety-related fashion are connected through two channels. Each output channel can be separately shutdown.

Two valve units are connected in the configuration example. These are used to control the motion of the supplementary pneumatic axis.

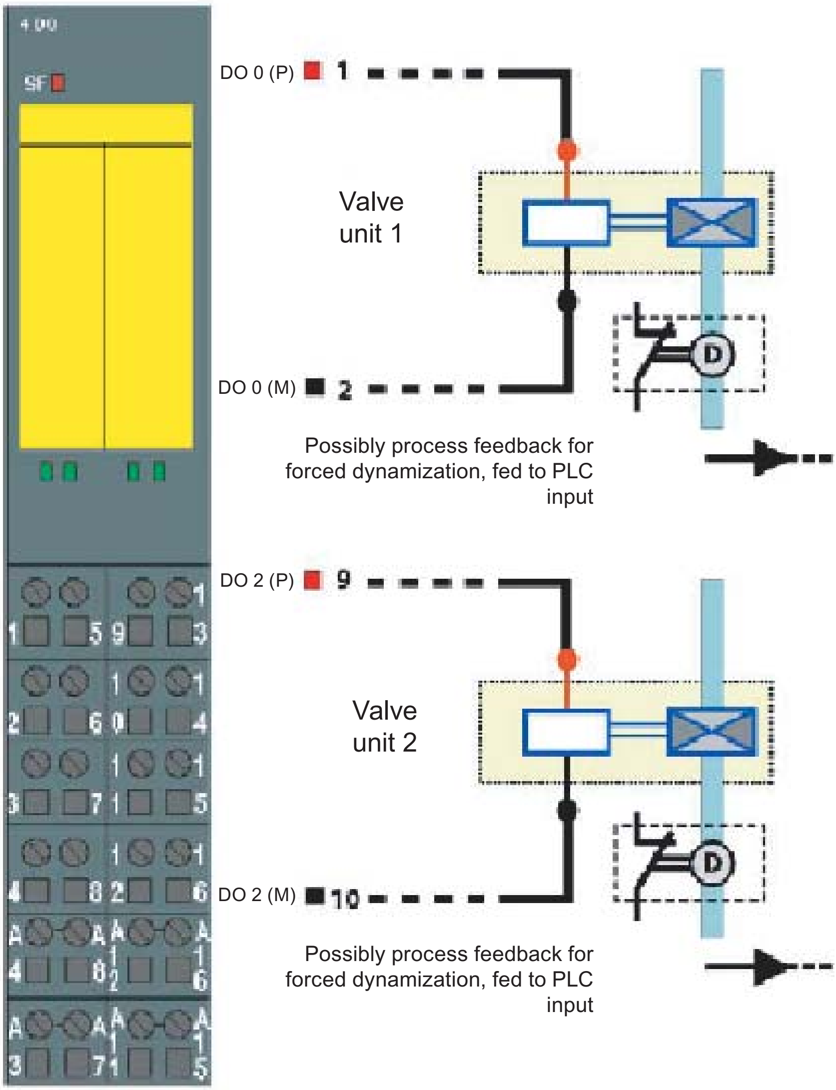



Figure 4-7 Signal assignment electronics module, 4F-DO, 24 VDC_2 A, PROFIsafe

## Meaning and use of the individual signals

### Valve unit 1 F-DO terminal 1,2 (channel 0 P/M)

Signal state channel 0 = "0"
Valve in the locked neutral position

Signal state channel 0 = "1"
Valve in the flow position

Not assigned [F-DO terminal 5,6 (channel 1 P/M)]

### Valve unit 2 [F-DO terminal 9,10 (channel 2 P/M)]

Signal state channel 2 = "0"
Valve in the locked neutral position

Signal state channel 2 = "1"
Valve in the flow position

Not assigned [F-DO terminal 13.14 (channel 3 P/M)]

Power module PM-E F

This module combines two functions. Not only can individual actuators (comparable with the functionality of an F-DO module) be connected to all three two-channel output channels, but the third DO2 output channel also has a further function.

The DO2 output channel is used to internally (no external wiring required) disconnect safety-oriented (i.e. with two potentials) to supply power for the subsequent standard DO or also standard DI modules. Namely, the outputs on the DO modules can not only be controlled using a single channel in the PLC for the "normal" function, but also a safety-oriented shutdown of the power supply for all DO modules following the PM-E F module is possible.

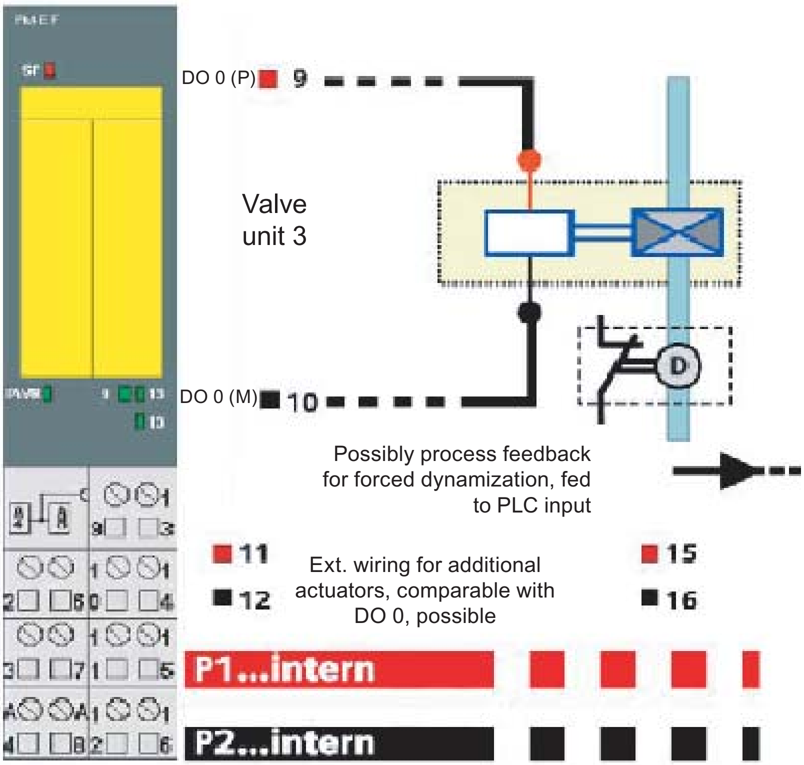



Figure 4-8 Signal assignment, power module PM-E F PROFIsafe 24 V DC

Meaning and use of the individual signals

Valve unit 3 [PM-E F terminal 9,10 (channel 0 P/M)]

Signal state channel 0 = "0"
Valve in the locked neutral position

Signal state channel 0 = "1"
Valve in the flow position

Not assigned [PM-E F terminal 13.14 (channel 1 P/M)]

**Not assigned [PM-E F terminal 11,12 or channel 15,16 (channel 2 P/M)]**

Shutdown of the power supply for the following external standard DO module (terminal 11,12 or terminal 15,16)

Signal state, channel 2 = "0"
The supply power at the two P1/P2 voltage buses for the following standard DO module is switched off.

Signal state, channel 2 = "1"
The supply power at the two P1/P2 voltage buses for the following standard DO module is switched on.

**Power module PM-D F 24 V DC PROFIsafe**

The power module can switch off fail-safe the SG 1 to SG 6 voltage buses using six digital outputs. The outputs are implemented using two P switches. There is a main power switch for all six shutdown groups and six subsequent (downstream) individual switches for each shutdown group.

The voltage bus U 1 (electronics power supply for the motor starter) is supplied with 24 V DC. If an overvoltage or undervoltage condition exists, U 1 is shutdown through two P switches and the subsequent (downstream) motor starters are brought into the passive state. If the motor starter is safely shutdown, U 1 is not shutdown.

Through the six available shutdown groups (SG1...SG6), the power module is, among other things, suitable for supplying fail-safe motor starters such as F-DS1e-x and F-RS1e-x.

**Fail-safe direct starters F-DS1e-x**

The fail-safe direct starter with electronic overload protection can either power-up or power-down the connected motor (implemented in the application through the PLC I/O interface). Further, when the SG signal is missing at the upstream PM-D F, the PM module can shutdown the motor in a safety-related fashion.

Depending on the type, three-phase motors up to 7.5 kW can be connected and operated with integrated protection against overload and short-circuit.

On the one hand, the SG 1...SG 6 safe shutdown group will be assigned to the fail-safe motor starter using the STEP 7 hardware configuration. On the other hand, the assignment is realized using the coding connector on the terminal module of the motor starter. Both assignments must match one another.

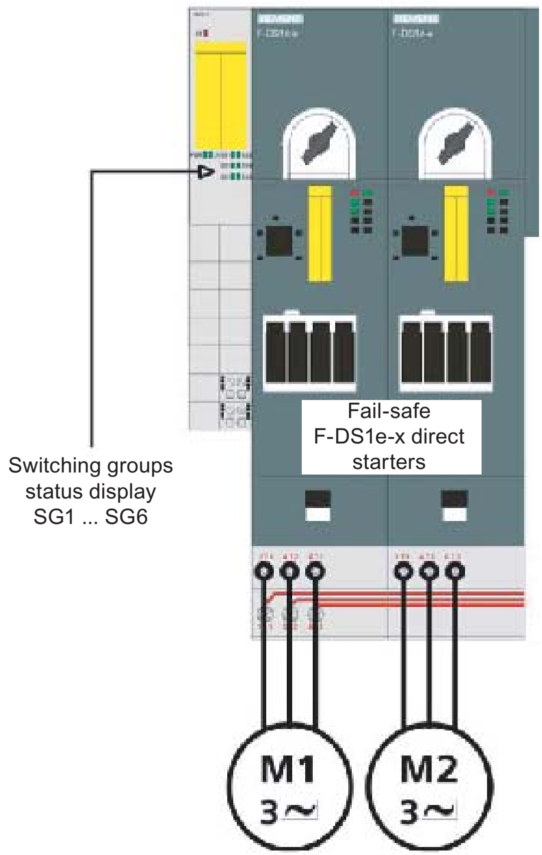



Figure 4-9 Signal assignment, power module PM-D F 24 V DC PROFIsafe, fail-safe motor starter

### Significance and use of the individual signals:

No (external) wiring is require (except for the 24 VDC power supply). The safety-oriented shutdown is performed internally using the SG 1...SG 6 shutdown groups. In addition to the safety-oriented shutdown using the upstream PM-D F PROFIsafe module, if the shutdown group has been enabled, the motor starter can be enabled and disabled using its PLC output interface.

# Connection of the Components 5

## 5.1 Line Contactor Control

The line contactor is used for the electrical isolation of the drive group and the DC link from the energy supply system.

When selecting a line contactor, the characteristic values in the technical data apply. The cable routing, the bundling factor, and the factor for the ambient temperature according to EN 60204-1 must be taken into account when dimensioning the various cables.

| ⚠ CAUTION |
|---|
| Line contactors must not be switched under load. |

---

**Note**

To limit the switching overvoltage, the contactor coil must be connected to a surge suppression device (e.g. freewheeling diode or varistor).

When the digital output is used to control the line contactor, its switching capacity must be taken into account.

---

### 5.1.1 Line contactor control for Line Modules without DRIVE-CLiQ interface (5 kW and 10 kW versions)

If a line contactor is required for Line Modules without DRIVE-CLiQ interface, it must be controlled and monitored using an external controller. An appropriate activation and deactivation sequence must be observed here otherwise the line contactor or the Line Module can be damaged.

A largely load-free switching of the line contactor must be provided for the control of the line contactor.

#### Activation:

Once the line contactor has been activated and a feedback is present, the enable pulse of the -X21:3/4 terminal can be made.

#### Deactivation:

The deactivation of the line contactor may only be made in a specific timing for the enable pulse (-X21:3/4) and/or ready (-X21:1) signals.

- Enable pulse (EP):

  A deactivation of the line contactor may only be made when the enable pulse (EP) signal has been removed previously (t ≥ 10 ms). The current is removed during the delay time.
- Ready:

  When the ready message leaves the SLM, the line contactor may only, if required, be deactivated after a delay time (t ≥ 10 ms). The current is removed during the delay time.

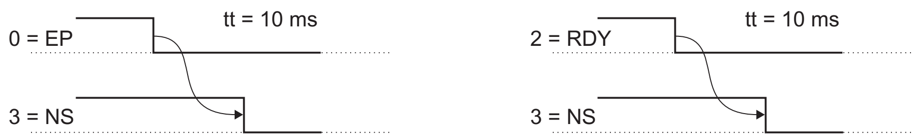



Figure 5-1 Line contactor control signal chart

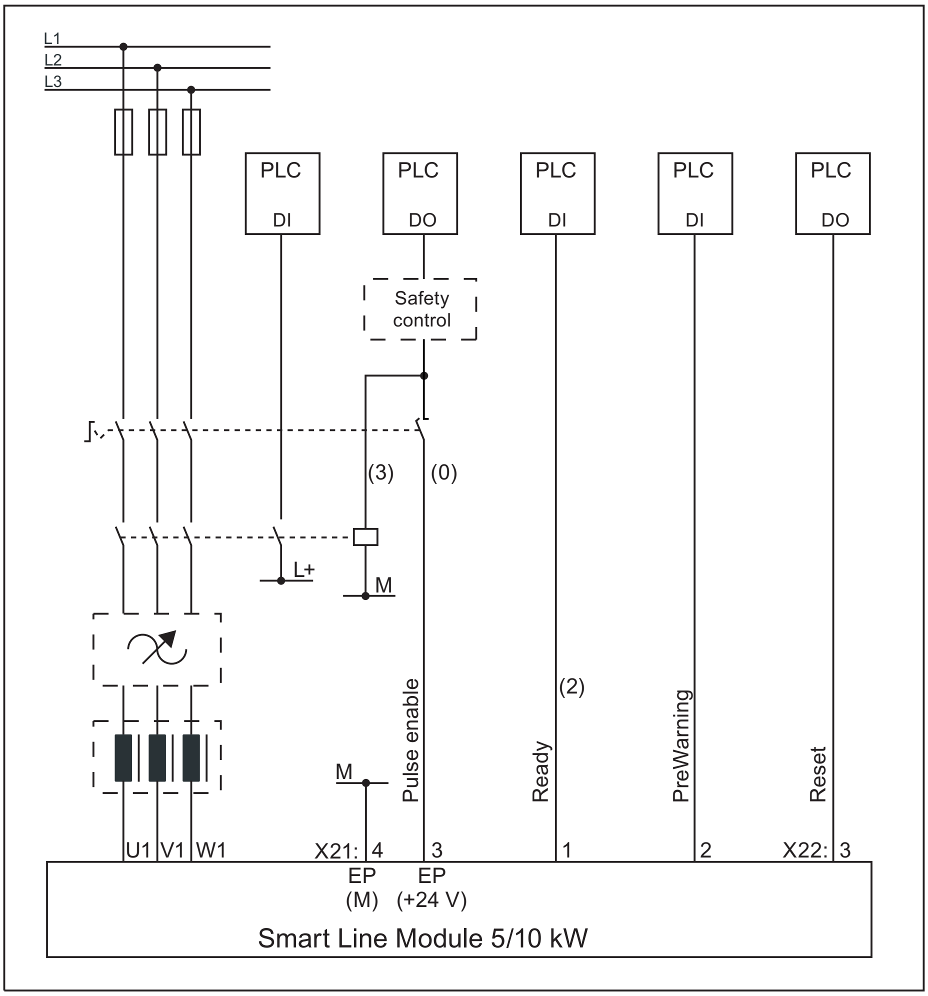



Figure 5-2 Line Contactor Control for Smart Line Module without DRIVE-CLiQ

**Note**

If the line contactor should also be safely disconnected (safety), the control must be integrated in an existing safety control. This is the only way to ensure the line contactor is switched in accordance with the required safety categories; see also Section Safety Integrated (Page 83).

### 5.1.2 Line Contactor Control for Line Modules with DRIVE-CLiQ Interface

Line Modules with DRIVE-CLiQ interface can control an external line contactor. The closing and opening of the line contactor can be monitored by evaluating the feedback contact of the line contactor. This control ensures that the line contactor always switches in a defined manner and so prevents overloading or damaging the line contactor and/or the infeed.

The line contactor can be controlled using the r0863.1 bit of the INFEED drive object (for 840D sl and 16 kW to 120 kW Line Module).

**Note**

For further information about the line contactor, refer to the device manuals.

**Note**

If the line contactor should also be safely disconnected (safety), the control must be integrated in an existing safety control. This is required so that the line contactor is switched in accordance with the required safety categories. See also Section Safety Integrated (Page 83).

### 5.1.3 Line Contactor Control Commissioning using an Example

Assumption:

- Line contactor control uses a digital output of the Control Unit (DI/DO 14)
- Line contactor feedback uses a digital input of the Control Unit (DI/DO 7)
- Line contactor switching time is less than 100 ms

---

**Note**

The parameter assignment for interface X132 at pins 4 and 10 must be changed using the "SINUMERIK Operate" drive commissioning wizard.

---

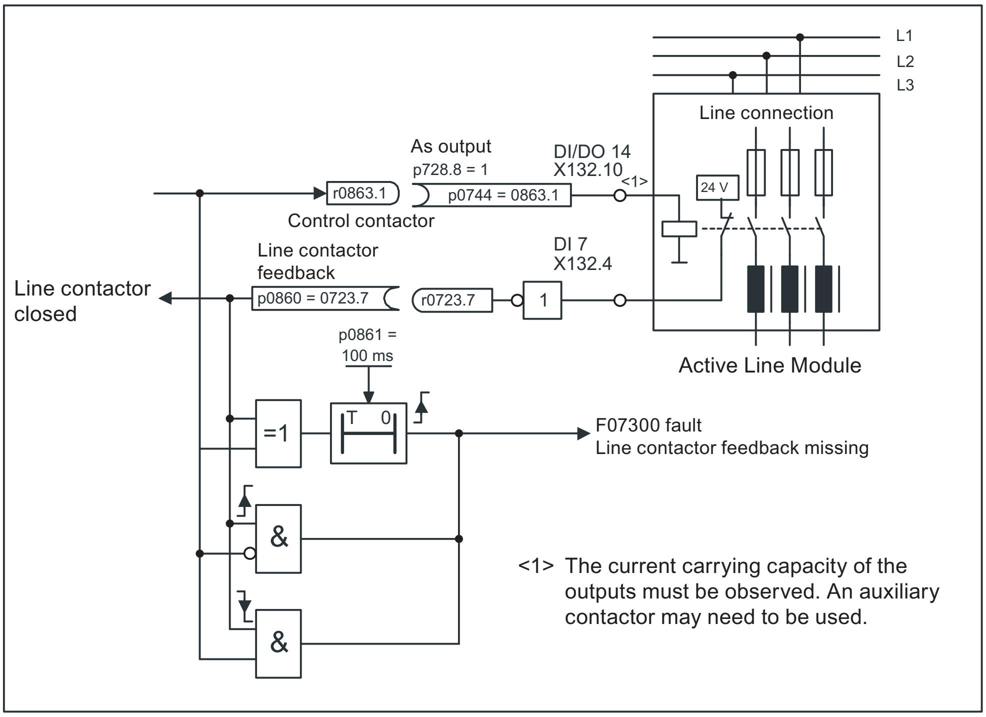



Figure 5-3 Line Contactor Control

**Commissioning steps:**

---

**Note**

If the current carrying capacity of the digital output may be exceeded, an auxiliary contactor must be used (refer to the Booksize Power Units Equipment Manual).

---

1. Connect control contact of the line contactor to DI/DO 14.
2. Parameterize DI/DO 14 as output (p0728.14 = 1).
3. Interconnect (BI: p0744 = r0863.1) DI/DO 14 with "control contactor" signal (r0863.1).
4. Connect the feedback contact of the line contactor to DI 7.
5. Interconnect (BI: p0860 = r0723.7) p0860 with the inverted input signal (p0723.7).
6. Enter the monitoring time of the line contactor (p0861 = 100 ms).

### Function diagram overview

- 8934 missing enables, line contactor control

### Parameter overview

- r0863.1 CO/BO: Drive coupling status word/control word
- p0860 BI: Line contactor feedback

### References

/LH1/SINAMICS S120/S150 List Manual

## 5.2 Active Interface Module (AIM)

### 5.2.1 Safety information

| NOTICE |
| --- |
| Active Interface Modules must only be operated if the option "Line filter available" has been set for the Active Line Module in the commissioning wizard, and if "AIM 400 V xxkW (6SL3100-0BE**-*AB*)" has been selected as the line filter. When used in conjunction with SINAMICS V2.6 and SINUMERIK 840D sl CNC SW ≥ 2.6, the appropriate AIM is already set by default when the Starter wizard or the HMI drive wizard is run.<br>With software release SINAMICS V2.5, the default is "Wideband Line Filter"; this must be changed manually to "AIM (P220 = 4*)".<br>Operation with SINAMICS SW < V2.5 or SINUMERIK 840D sl CNC SW <2.5 is not permitted.<br><br>Before putting the Active Interface Module into operation, it is essential to connect 24 VDC at connector X124 to supply the fans. Current required ≤ 1.2 A.<br><br>The temperature signaling contact of the Active Interface Module must be connected to the temperature input of the associated Active Line Module.<br><br>If this is not the case, the Active Interface Module may be destroyed. |

| ⚠ DANGER |
| --- |
| The drive components generate high leakage currents in the protective conductor. The components must only be operated in cabinets or in closed electrical operating areas and must be connected with the protective conductor. To protect against electric shock, the protective conductor connection at the control cabinet or machine must be implemented in accordance with one of the following measures:<br>• Fixed connection and protective conductor connection by means of ≥ 10 mm² Cu or ≥ 16 mm² Al<br>• Fixed connection and automatic disconnection of the supply system if the protective conductor is interrupted<br><br>(See connection example: Active Interface Module) |

| ⚠ CAUTION |
| --- |
| The surface temperatures of the component may be high. |

| ⚠ DANGER |
| --- |
| The cooling clearances of 80 mm above and below the components must be observed. |

---

**Note**

The Active Interface Modules must only be operated in a vertical position ("hanging").

---

### 5.2.2 Description

Active Interface Modules are line-side interfaces for the Active Line Modules.

They contain the following functional units:

- Line reactor
- Low-frequency/switching frequency filters
- Line filter to EN61800-3, category C3, max. total motor cable length 350 m (shielded)
- Reduction of the stress on the motor insulation from system-dependent resonance factors

In conjunction with an Active Line Module and an EMC-compliant configuration the following radio interference voltage categories are achieved:

- EN 61800-3 category C3 without an additional line filter up to a total cable length of 350 m (shielded) for 16 kW, 36 kW, 55 kW, 80 kW and 120 kW components
- EN 61800-3 category C2 with an additional Basic Line Filter up to a total cable length of 350 m (shielded) for 16 kW, 36 kW, 55 kW, 80 kW and 120 kW components
- EN 61800-3, category C3, with an additional Basic Line Filter up to a total cable length of
  - 630 m (shielded) for 16 kW and 36 kW components
  - 1000 m (shielded) for 55 kW, 80 kW, and 120 kW components

The Active Interface Module is fitted with a fan. The 24 V supply is essential for operating the component. Connection of the temperature signaling contact to the Active Line Module is also required.

### 5.2.3 Operating an Active Interface Module on an isolated-neutral network (IT system)

#### Operating an Active Interface Module on an isolated-neutral network (IT system)

**Note**

When an Active Interface Module is operated in an isolated-neutral system (IT system), the connection bracket for the interference-suppression capacitor in the AIM must be removed. The connection bracket for the interference-suppression capacitor is located on the lower side of the component.

If the connection bracket for the interference-suppression capacitor is not removed, an insulated supply will be grounded and may cause tripping of the isolation monitor in the case of failure.

There are no limits of interference for isolated-neutral systems. Removing the connection bracket to the interference-suppression capacitor eliminates the effect of the filter against ground. It nevertheless makes sense to install an Active Interface Module because the clock frequency filter is still effective and also protects other loads on the same network from clock frequency disturbances.

**⚠ DANGER**

The connecting bracket may only be removed in the de-energized state.
Risk of electric shock. A hazardous voltage is present for up to 5 minutes after the power supply has been switched off.

| | | |
|---|---|---|
|  |  |  |
| Remove the connection bracket for the interference-suppression capacitor with a Tx25 screwdriver. | Remove the connection bracket. | Connection bracket for the interference-suppression capacitor |

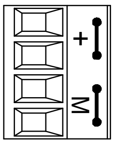
### 5.2.4 IT systems

In IT systems, all live parts are isolated from ground, or one point is connected to ground through an impedance. The exposed conductive parts of the electrical installation are either grounded separately or grounded together, or jointly connected to the system ground.

Only Line Modules without a line filter are to be operated on this system type. The emitted interference can exceed the limit values of category C3. The Active Interface Module must be set for operation on an IT system.

### 5.2.5 Electronics power supply X124

Table 5- 1 Terminal block X124

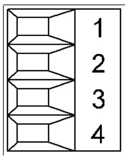
| | Terminal | Function | Technical specifications |
|---|---|---|---|
|  | + | Electronics power supply | Voltage: 24 VDC (20.4 V - 28.8 V)<br>Current consumption: max. 1.6 A<br>Max. current via jumper in connector:<br>20 A at 55 °C |
| | + | Electronics power supply | |
| | M | Electronics ground | |
| | M | Electronics ground | |
| Max. connectable cross-section: 2.5 mm² | | | |

**Note**

The two "+" or "M" terminals are jumpered in the connector. This ensures the supply voltage is looped through.

### 5.2.6 X121 temperature sensor and fan control

Table 5- 2 Plug-in screw terminal X121

| | Terminal | Designation | Technical specifications |
|---|---|---|---|
|  | 1 | +Temp | Output temperature switch<br>Must be connected to X21 of the Active Line Module |
| | 2 | -Temp | Temperature switch output |
| | 3 | +24 V power supply for digital inputs | Current carrying capacity: 500 mA |
| | 4 | Disable Fan | The fan can be disabled. The fan may only be switched off while the Active Line Module is disabled. |
| Max. connectable cross-section: 1.5 mm² | | | |

**Note**

If the terminals are not connected (or connected with low level), the fan will run in continuous mode.

## 5.2.7 Line/power connection

Table 5- 3 Type of connection

| Terminals | Designations |
|---|---|
| Line supply connection (line supply) | L1, L2, L3 |
| Load connection (load) | U2, V2, W2 |
| **Active Interface Module** | |
| 16 kW | Connector, cross-section 16 mm²<br>Tightening torque 1.7 Nm |
| 36 kW | Screw terminal, cross-section 50 mm², ferrule<br>Tightening torque 6 Nm |
| 55 kW | Screw terminal, cross-section 50 mm², ferrule (see section on screw terminals)<br>Tightening torque 6 Nm |
| 80 / 120 kW | Threaded bolt M8, cross-section 120 / 2 x 50 mm²,<br>tightening torque 13 Nm 1) |
| 1) for ring cable lugs to DIN 46234 | |

**Note**

The connection terminals of the 36 kW and 55 kW Active Interface Modules are only certain to be finger-safe if cables with a minimum cross-section of 25 mm² and insulated ferrules are used.

## 5.2.8 Overview

When establishing a shield connection, please use an appropriate plate at the base of the component (36 kW and above).

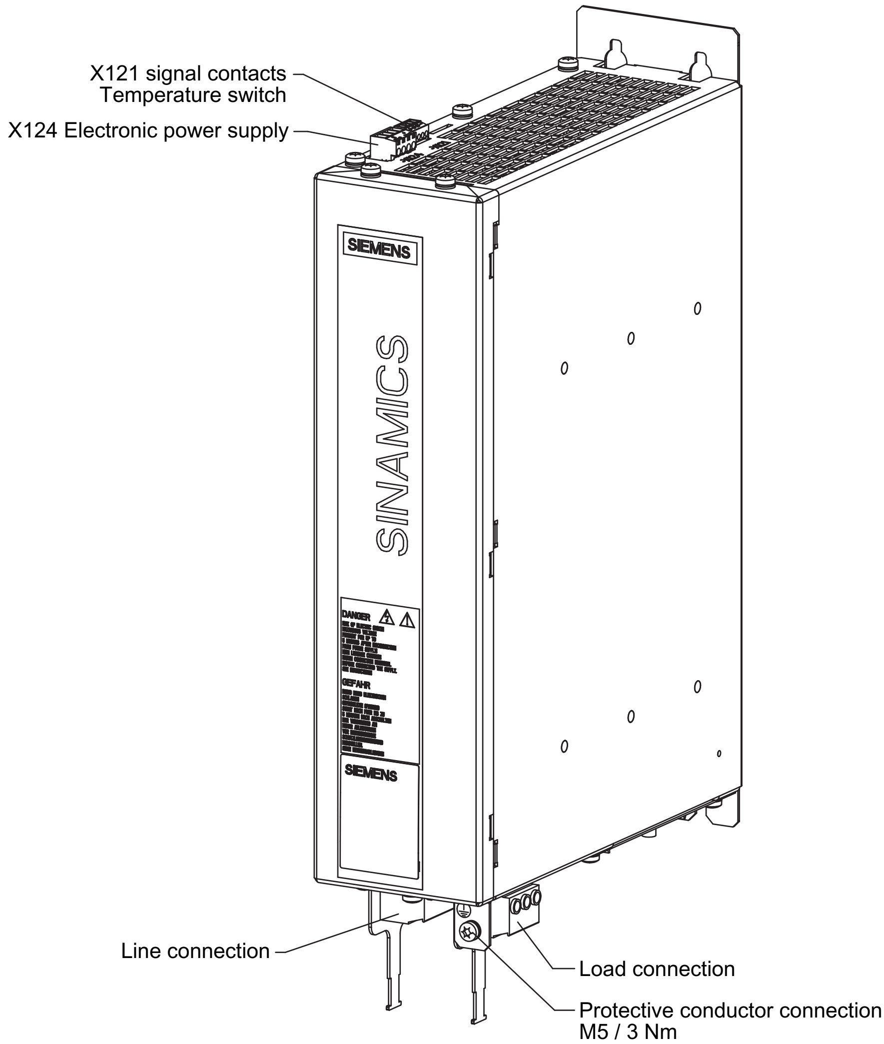



Figure 5-4 Interface description: Active Interface Module 16 kW

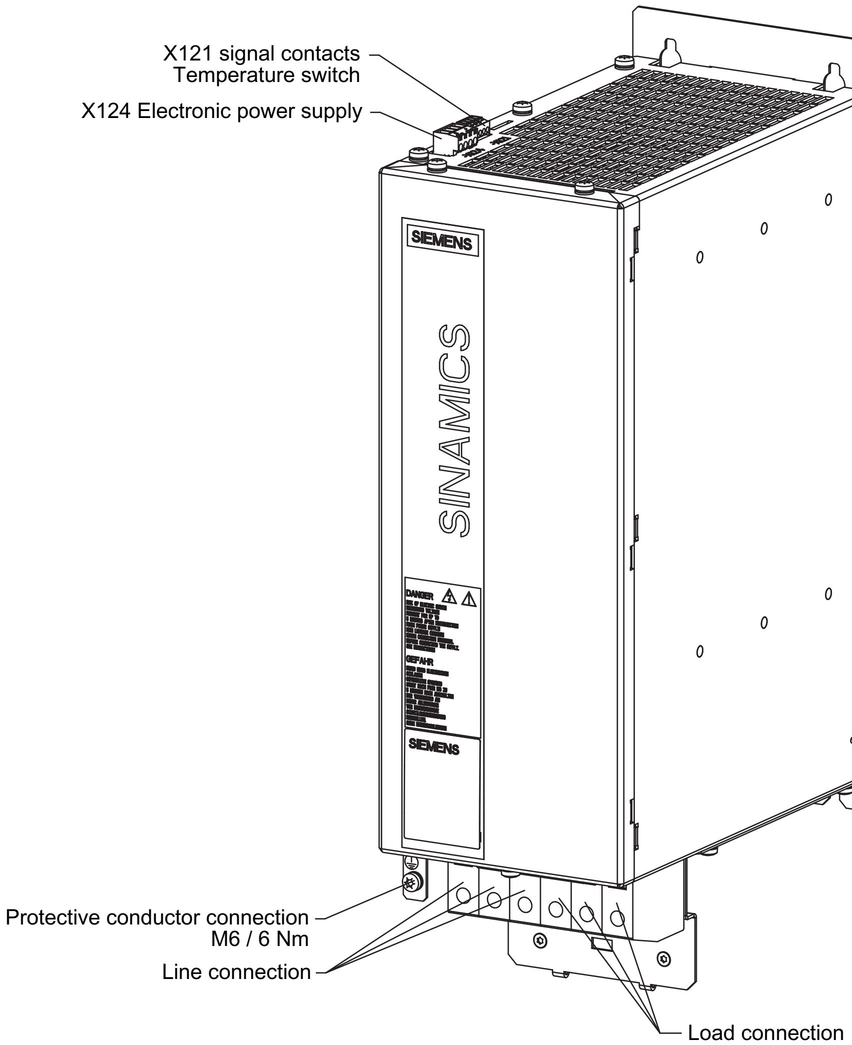



Figure 5-5 Interface description: Active Interface Module 36 kW

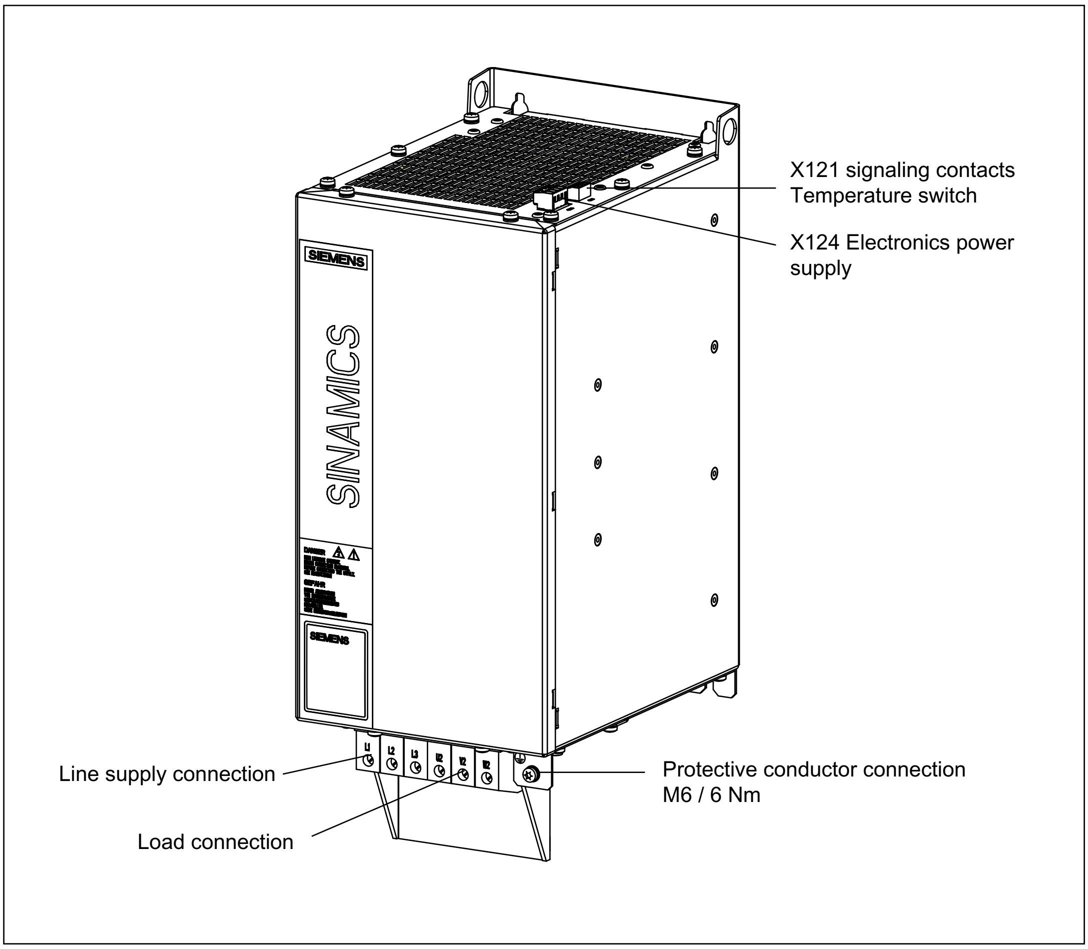



Figure 5-6 Interface description: Active Interface Module 55 kW

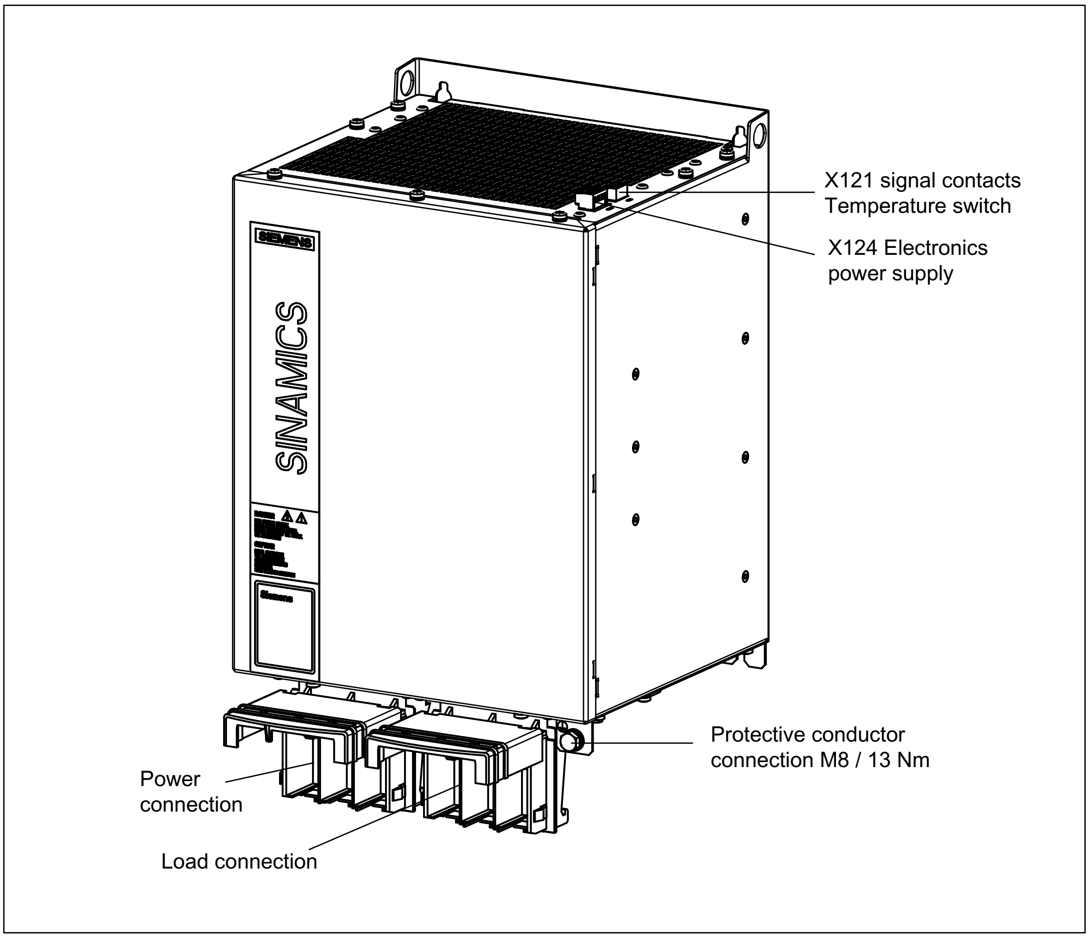



Figure 5-7 Interface description: Active Interface Module 80 kW and 120 kW

### 5.2.9 Connection example

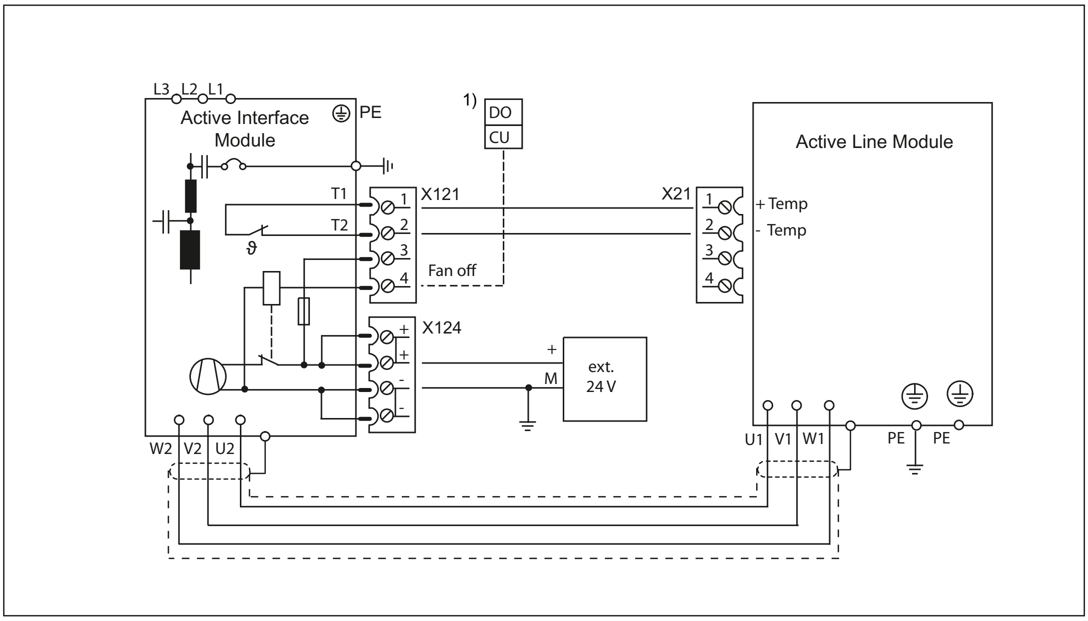



Figure 5-8 Connection example: Active Interface Module

1) Digital input (DI) or digital output (DO) controlled by the Control Unit

## 5.3 HFD reactors for Active Line Modules

### 5.3.1 Safety information

| CAUTION |
|---|
| Only the line reactors or Active Interface Modules described in the Booksize Power Units Equipment Manual (GH2) are to be used.<br>If line reactors are used that have not been approved by Siemens for SINAMICS S120:<br>• The Line Modules may become damaged/faulty<br>• Line reactions may occur and damage or interfere with other consumers powered from the same network |

| ⚠ CAUTION |
|---|
| If system oscillations do occur and no damping resistor is connected, impermissibly high voltages may arise at the additional winding of the HFD line reactor. For this reason, it is essential that a damping resistor be connected. |

**⚠ CAUTION**

The surfaces of the line reactors can become extremely hot. To prevent adjacent components from suffering damage due to these high temperatures, a clearance of 100 mm must be left on all sides of the reactors. If this clearance cannot be observed, additional measures such as shielding plates or a cooling function must be put in place.

**CAUTION**

Reactors generate magnetic fields. Components and cables which could be subject to interference or be affected by these fields must, therefore, be located a sufficient distance (at least 100 mm) away or be shielded accordingly.

---

Note

**Connection cables**

The connection cables between line reactor and Line Module, as well as between line reactor and line filter, must be kept as short as possible (max. 10 m).

You must use shielded connection cables, whose cable shields are attached at both ends.

Shielding for connection cables in the mains supply interface may only be omitted if the following conditions are met:

- The cables do not exceed 1 m in length.
- The cables are laid flush with the rear metal wall of the control cabinet.
- The cables are laid in a way that keeps them physically separate from signal lines.

Do not route any cables near the line reactor. If this cannot be avoided, observe a minimum distance of 150 mm.

---

## 5.3.2 Combining line reactors and line filters

| Selected combinations | | | | | | | | Properties that can be reached | | | | | Available for | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Active Line Module | Smart Line Module | Basic Line Module | Basic Line Filter | Wideband Line Filter | HFD line reactor | FE line reactor | Active Interface Module | DC link step-up factor or rectified value B6 | Radio interference suppression according to EN 61800-3-C2 summing cable Shielded | Radio interference suppression according to EN 61800-3-C3 summing cable Shielded | Integrated Clock frequency filter 8 kHz | Operated on IT line supplies | 5 kW | 10 kW | 16 kW | 20 kW | 36 kW | 40 kW | 55 kW | 80 kW | 100 kW | 120 kW |
| X | | | | | X | | | 1,4 - 1,6 | no [3] | no [3] | No | Yes | | | X | | X | | X | X | | X |
| X | | | X | | X | | | 1,4 - 1,6 | 150 m | 150 m | No | No | | | X | | X | | X | | | |
| X | | | | X | X | | | 1,4 - 1,6 | 350 m | 350 m | Yes | No | | | X | | X | | X | X | | X |
| X | | | | | | | X | 1,4 - 2 [2] | no [3] | 350 m | Yes | yes [1] | | | X | | X | | X | X | | X |
| X | | | X | | | | X | 1,4 - 2 [2] | 350 m | 630 m | Yes | No | | | X | | X | | | | | |
| X | | | X | | | | X | 1,4 - 2 [2] | 350 m | 1000 m | Yes | No | | | | | | | X | X | | X |
| | X | | | | | X | | 1,35 | no [3] | no [3] | Not relevant | Yes | X | X | X | | X | | | | | |
| | X | | X | | | X | | 1,35 | 350 m | 350 m | Not relevant | No | X | X | X | | X | | | | | |
| | | X | | | | X | | 1,35 | no [3] | 350 m | Not relevant | yes [1] | | | | | | | | | X | |
| | | X | X | | | X | | 1,35 | 350 m | 630 m | Not relevant | No | | | | X | | X | | | X | |

1) Remove the connection bridge
2) The insulation strength of the motors has to be taken into account
3) Only permissible with vector control and sine-wave filter

Figure 5-9 Options for combining line reactors and line filters

**Note**

Ideally, new systems using Active Line Modules should be designed with Active Interface Modules as line connection components.

### 5.3.3 Description

The HFD reactor must be used to connect regulated infeed/regenerative feedback components (Line Modules) to the network.

The HFD reactors perform the following functions:

- Limiting of low-frequency line reactions
- Energy store for the step-up operation of the infeed units
- Current limiting for line supply oscillations
- Together with a damping resistor, the HFD reactors dampen the system oscillations of the converter system. HFD reactors with damping resistors are supplanting HF reactors because they provide increased operational reliability and a longer lifetime.

The HFD reactor should be mounted as close as possible to the line supply infeed component.

### 5.3.4 Line/power connection

Table 5- 4 Connection of HFD line reactors

| Order number | 6SL3000-0DE21-6AAx | 6SL3000-0DE23-6AAx | 6SL3000-0DE25-5AAx | 6SL3000-0DE28-0AAx | 6SL3000-0DE31-2AAx |
|---|---|---|---|---|---|
| Power [kW] | 16 | 36 | 55 | 80 | 120 |
| Line supply connection 1U1, 1V1, 1W1 | Screw terminal 16 $mm^2$/1.2 Nm | Screw terminal 35 $mm^2$/2.5 Nm | Screw terminal 70 $mm^2$/7 Nm | POWER CAGE CLAMPS 95 $mm^2$/self-locking [1] | |
| Load connection 1U2, 1V2, 1W2 | | | | POWER CAGE CLAMPS 95 $mm^2$/self-locking [1] | |
| PE connection | Screw terminal 16 $mm^2$/1.2 Nm | Screw terminal 35 $mm^2$/2.5 Nm | Screw terminal 70 $mm^2$/3.5 Nm | PE connecting lug M10/25 Nm for ring cable lugs in accordance with DIN 46234 | |
| | | | | **Note: No touch protection (IP00B acc. to EN 60529)** | |
| Damping-resistor connection 1, 2, 3 PE | Screw terminal max. 1.5 $mm^2$/1.2 Nm | | | | |

1) Refer to the chapter titled "Spring-loaded terminals"

---

**Note**

Data relating to the permissible tightening torques can also be found on the label showing the terminal layout of the screw terminal for the corresponding HFD line reactor.

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## 5.3.5 Overview

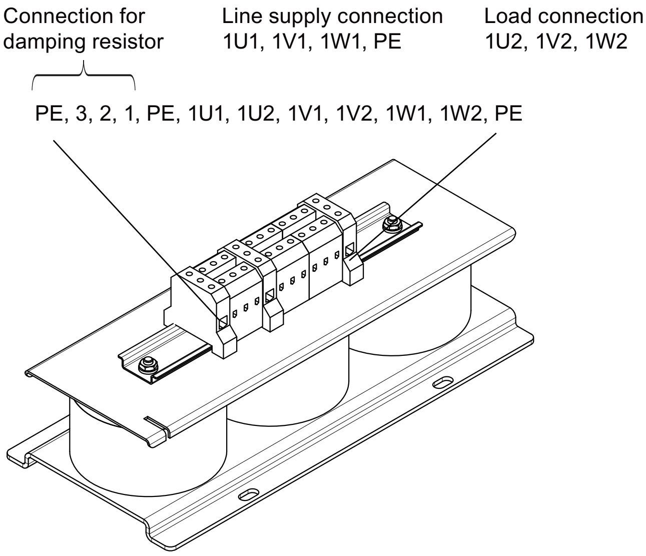



Figure 5-10 HFD line reactor 16 kW

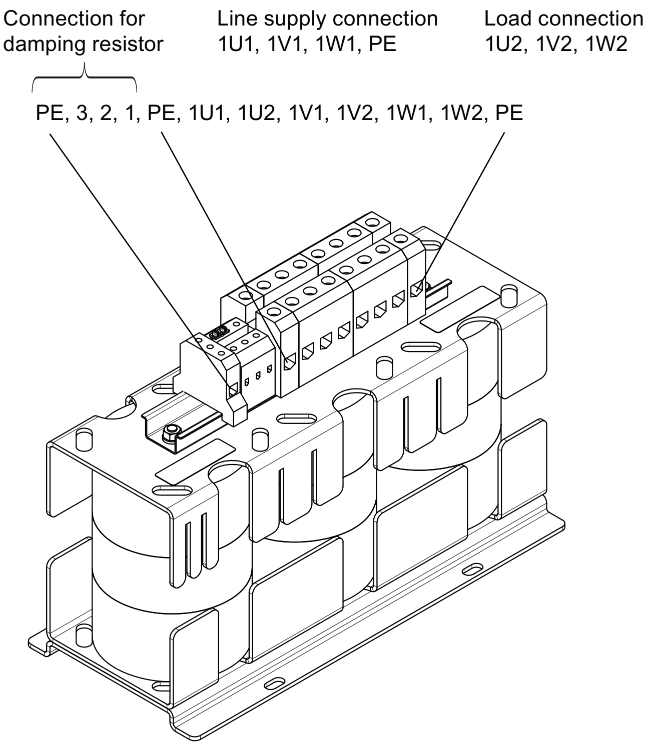



Figure 5-11 HFD line reactor 36 kW

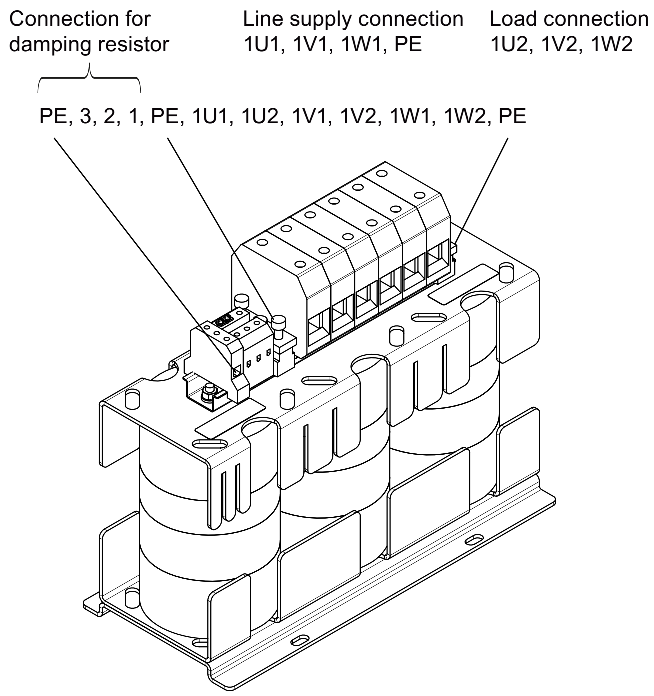



Figure 5-12 HFD line reactor 55 kW

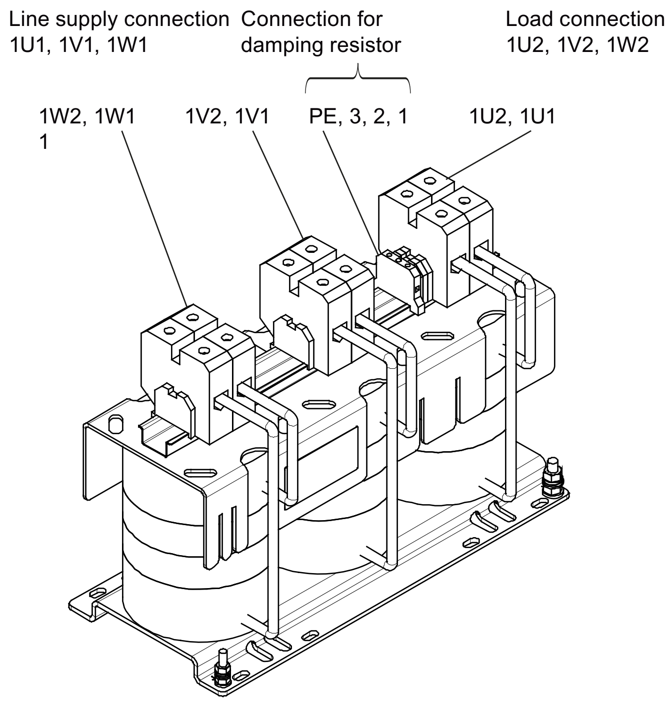



Figure 5-13 HFD line reactor 80 kW

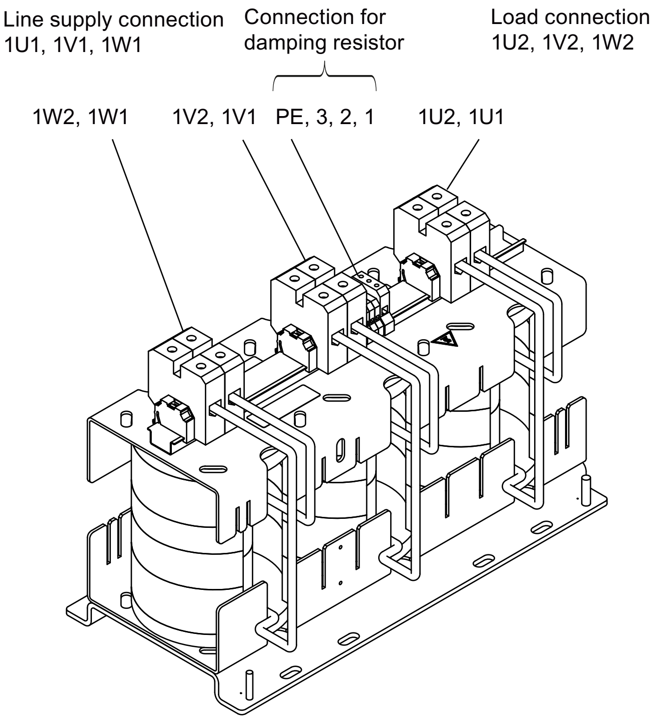



Figure 5-14 HFD line reactor 120 kW

## 5.3.6 Technical data

Table 5- 5 Technical data for HFD line reactors

| | Unit | 6SL3000–0DE21-6AAx | 6SL3000–0DE23-6AAx | 6SL3000–0DE25-5AAx | 6SL3000–0DE28-0AAx | 6SL3000-0DE31-2AAx |
|---|---|---|---|---|---|---|
| Power | kW | 16 | 36 | 55 | 80 | 120 |
| Rated current | $A_{rms}$ | 30 | 67 | 103 | 150 | 225 |
| Power loss[1)] | W | 170 | 250 | 350 | 450 | 590 |
| Weight | kg | 13 | 21 | 27 | 37 | 67 |
| Mounting position | | Any | | | | |

1) For the data for rated operation/an overview, see the power loss tables in the chapter titled "Control cabinet installation".

### 5.3.7 Dimension drawings

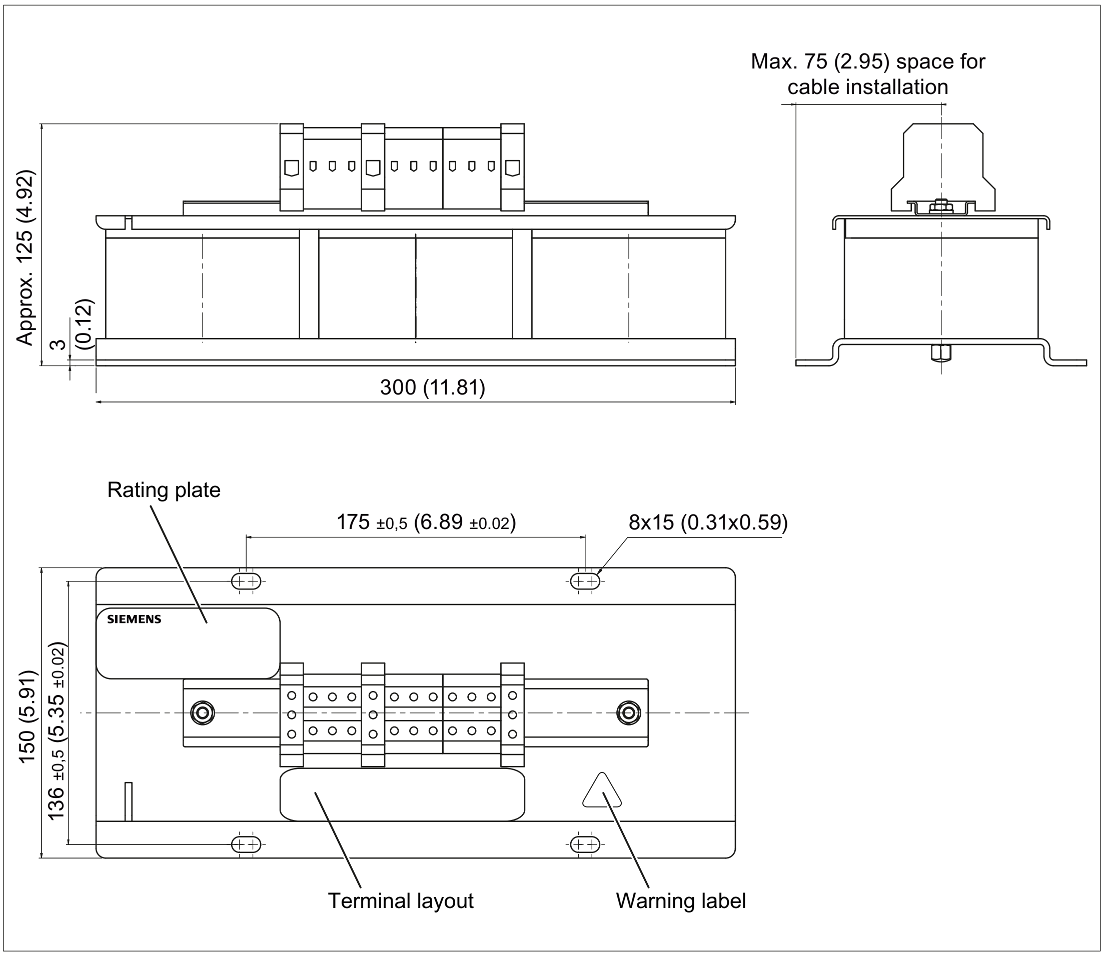



Figure 5-15 Dimension drawing of HFD line reactor 16 kW, all dimensions in mm and (inches)

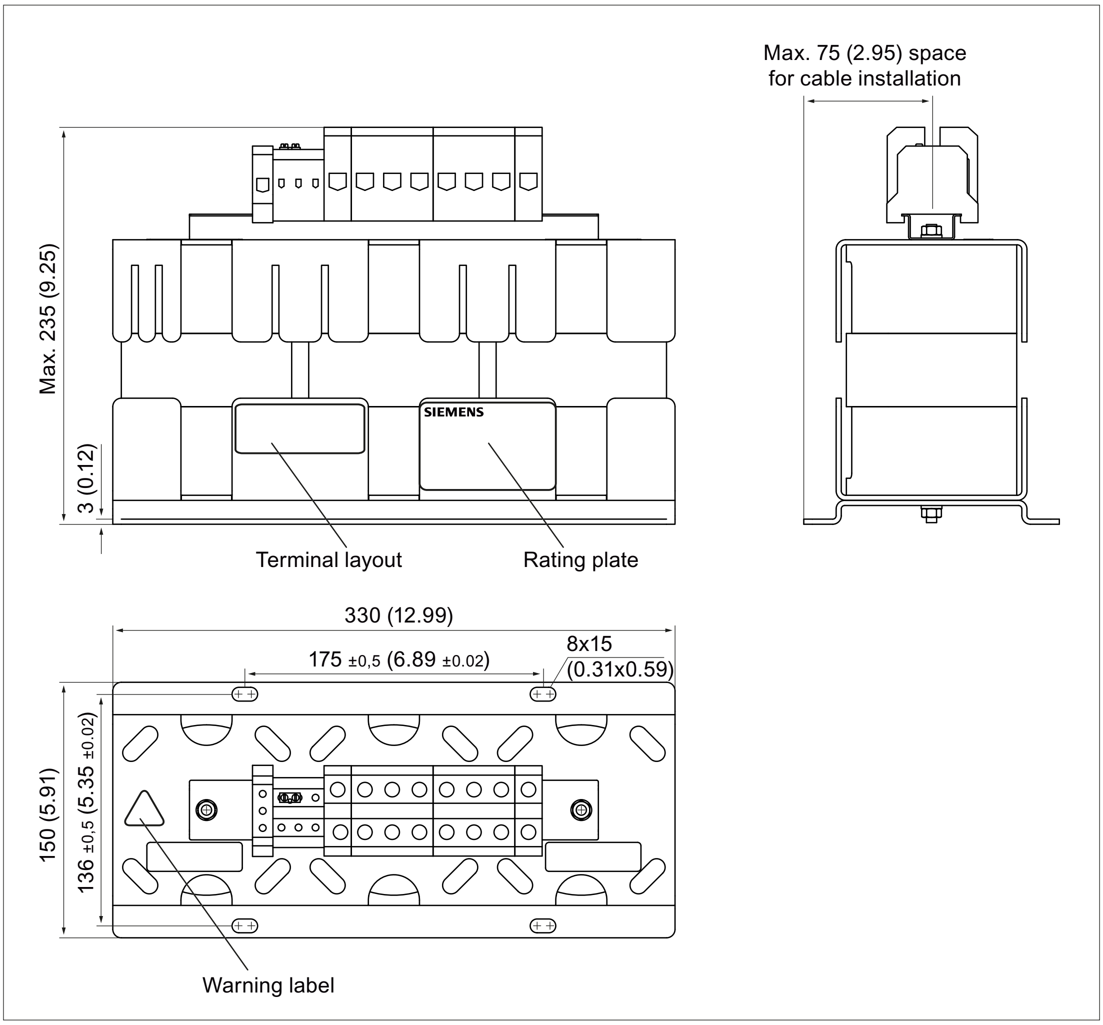



Figure 5-16 Dimension drawing of HFD line reactor 36 kW, all dimensions in mm and (inches)

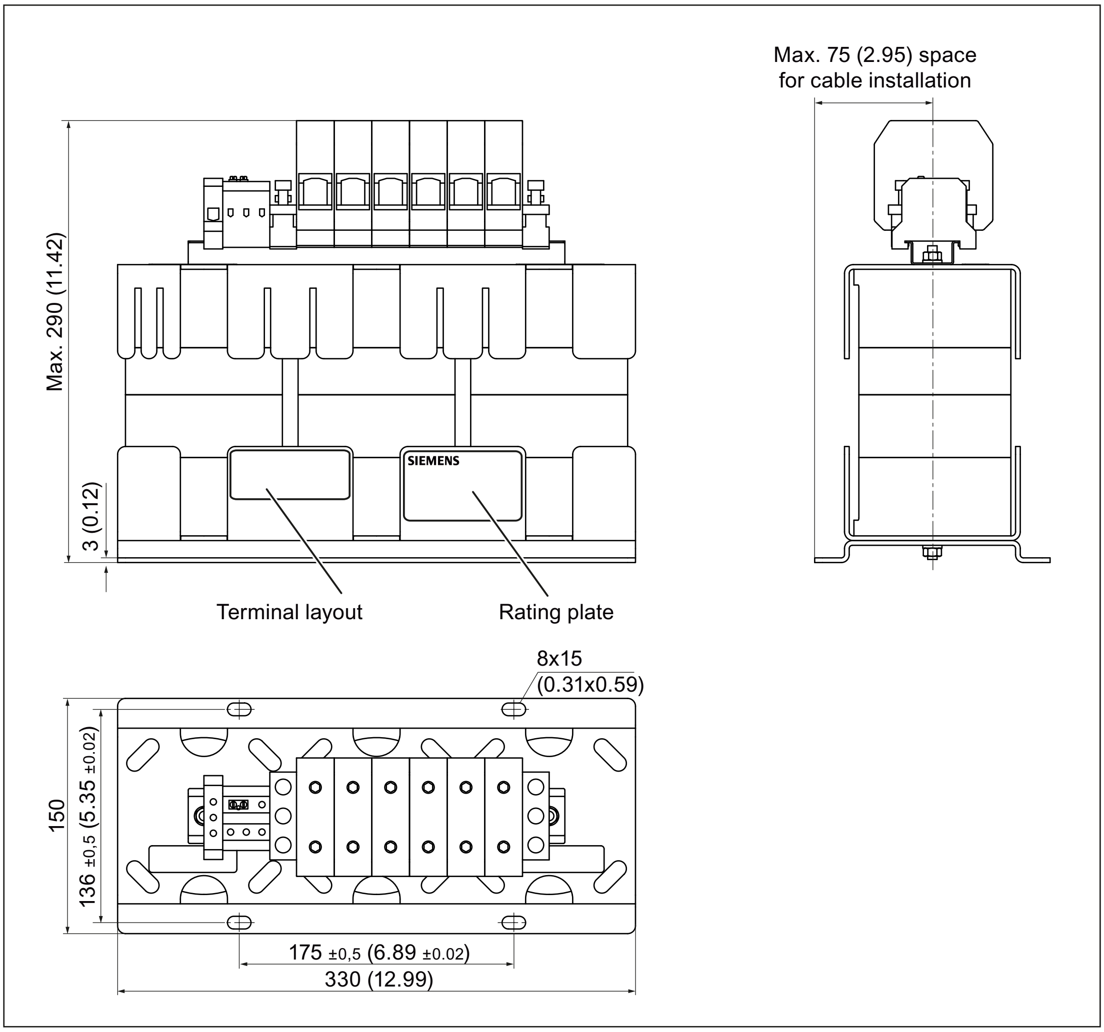



Figure 5-17 Dimension drawing of HFD line reactor 55 kW, all dimensions in mm and (inches)

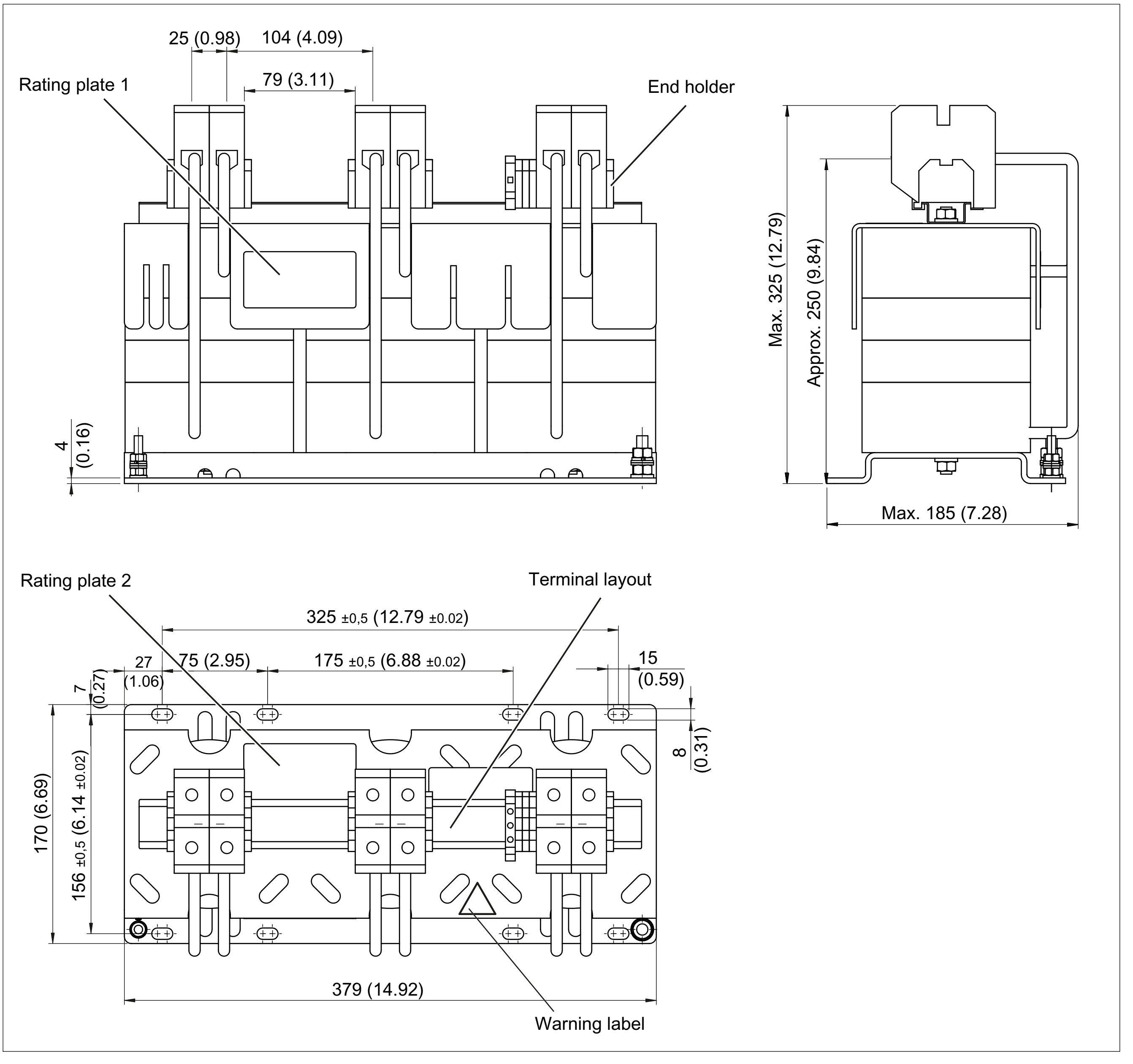



Figure 5-18 Dimension drawing of HFD line reactor 80 kW, all dimensions in mm and (inches)

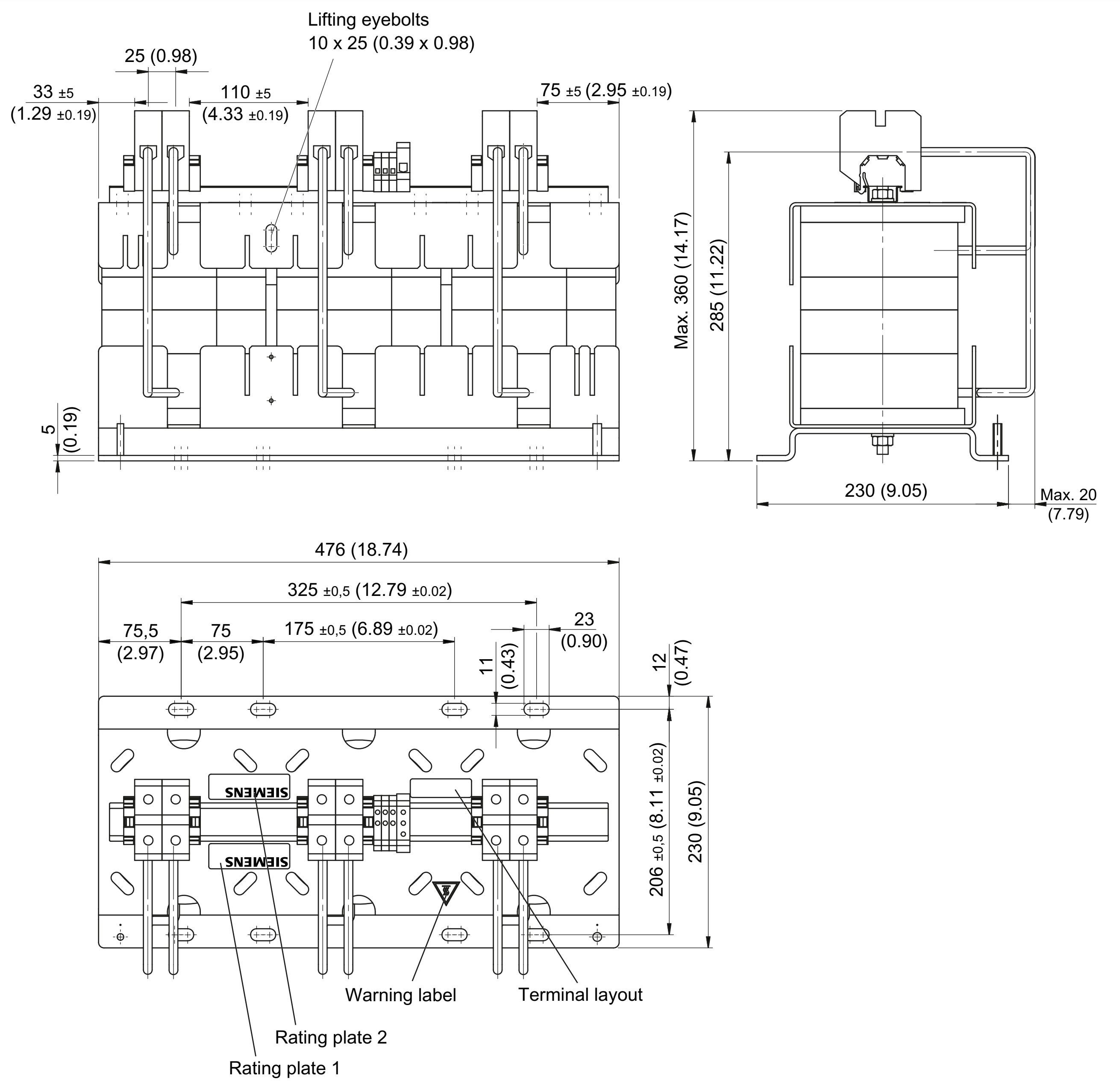



Figure 5-19 Dimension drawing of HFD line reactor 120 kW, all dimensions in mm and (inches)

# 5.4 Line Modules Interfaces Description

## 5.4.1 Line Modules Overview

The Line Module is used to connect the drive group to the energy supply system.

The Line Module is used for the power infeed into the DC link.

In generator operation, the energy of the drives fed into the DC link will be returned to the energy supply system. For an energy supply system that cannot accept any regenerative energy (e.g. diesel generator), the regenerative capability of the Line Module must be deactivated. The braking energy must then be converted into heat via a Braking Module with braking resistor that also needs to be included in the drive group.

Line Modules can be directly connected to TN and TT systems, both with grounded neutral point and grounded line conductor; they can also be connected to IT systems. Line Modules have an integrated overvoltage protection function.

### Additional references

/GH2/ SINAMICS S120, Booksize Power Units, 11/2009 edition, Section 3.2

### Smart Line Module

The Smart Line Module is a non-regulated infeed/regenerative feedback unit. The regenerative capability can be deactivated using a digital input.

The DC link is supplied using an uncontrolled diode bridge. The size of the DC link voltage is based on the supply voltage according to the following formula: $U_{DC\ link} = U_{supply} * 1.35$.

The following DC link values are achieved for the Smart Line Module:

Table 5- 6 Smart Line Module DC link voltages

| Supply voltage | 380 V | 400 V | 415 V | 440 V | 460 V | 480 V |
|---|---|---|---|---|---|---|
| $U_{DC\ link}$ | 513 V | 540 V | 561 V | 594 V | 621 V | 648 V |

**The insulation voltage of the motors must be observed. (See the NC61 catalog or the configuring guide for the motors.)**

| ⚠ CAUTION |
|---|
| As soon as the energy supply is present at the infeed terminals (-X1:U1/V1/W1) of the Smart Line Module, the DC link will be precharged. |

Digital inputs/outputs are used exclusively to control and monitor the 5/10 kW types of the Smart Line Module. No connection to the Control Unit using DRIVE-CLiQ exists.

## Active Line Module

The self-managed infeed/regenerative unit with booth converter creates an increased controlled DC link voltage. This makes the connected Motor Modules independent of tolerances in the energy supply system.

The Control Unit is used to control, trigger and monitor the Active Line Module. Data exchange is performed via the DRIVE-CLiQ interface.

**Control types:**

The Active Line Module operates in two different control types depending on the parameterized supply voltage (p0210).

- Active Mode

  The Active Line Module can control the DC link voltage in a rated voltage range of 3 AC 380 V to 3 AC 415 V; boost converter with controlled DC link voltage and sinusoidal supply voltage.

- Smart Mode

  In the rated voltage range of 3 AC 416 V to 3 AC 480 V, the Smart Mode is automatically activated and the supply system transistors will be switched to be synchronous with the supply system. The DC link voltage is not regulated, but is based on the rectified supply voltage according to the following formula: $U_{DC\ link} = U_{supply} * 1.35$.

  The setpoint for the DC link voltage (p3510) will be preassigned automatically.

The following DC link values will be attained for the Active Line Module in Active / Smart Mode:

Table 5- 7 Active Line Module DC link voltages

| Supply system voltage p0210 | 380 V | 400 V | 415 V | 440 V | 460 V | 480 V |
|---|---|---|---|---|---|---|
| Active Mode (default values)<br>$V_{DC}$ set p3510 [V]<br>(with boost converter p3400.0=1) | 600 V | 600 V | 600 V | - | - | - |
| Smart Mode (p0210 x 1.35)<br>(without boost converter p3400.0=1) | 513 V 1) | 540 V 1) | 561 V 1) | 594 V 2) | 621 V 2) | 648 V 2) |

1) Smart Mode can be selected using parameter p3400.0=0.

2) Smart Mode sets itself automatically during the parameter assignment for the supply voltage p0210 > 416 V.

| NOTICE |
|---|
| The setpoint for the DC link voltage (p3510) can be changed. The insulation voltage of the motors must be observed. (See the NC61 catalog or the configuring guide for the motors.) |

**CAUTION**

As soon as the energy supply is present at the infeed terminals (-X1:U1/V1/W1) of the Active Line Module, the DC link will be precharged ($U_{DC\ link} = U_{Supply} \times 1.35$).

Once the "Enable Pulses" enabling signal is also present at the Active Line Module, the boost converter increases the DC link to the specified setpoint p3510 (e.g. $U_{DC\ link}$ = 600 V for $U_{supply}$ = 400 V).

**Note**

The Active Line Module (16 kW, 36 kW) and the Smart Line Module (16 kW, 36 kW) interfaces are identical.

## 5.4.2 Active Line Modules with Internal Air Cooling

### 5.4.2.1 Overview

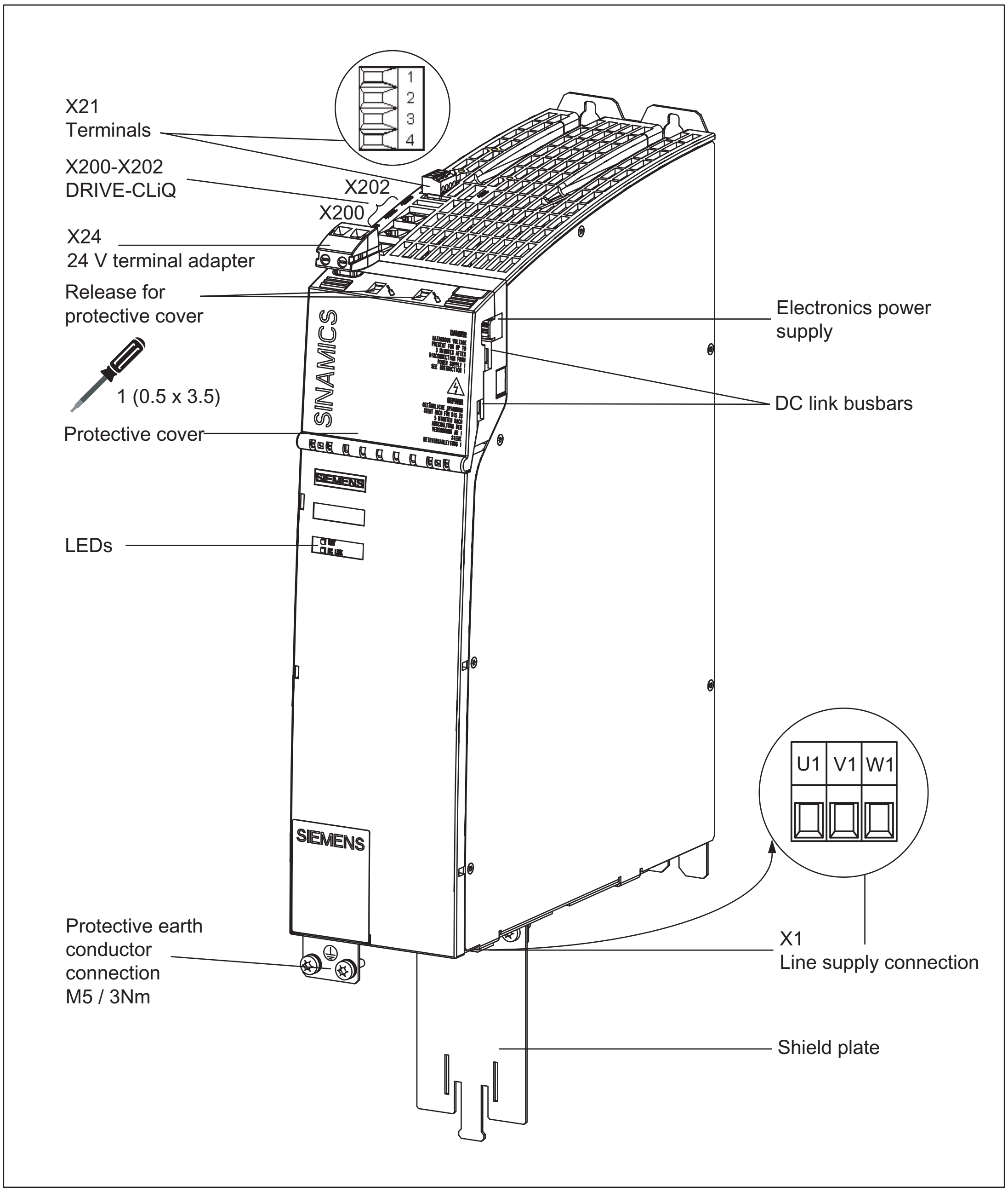
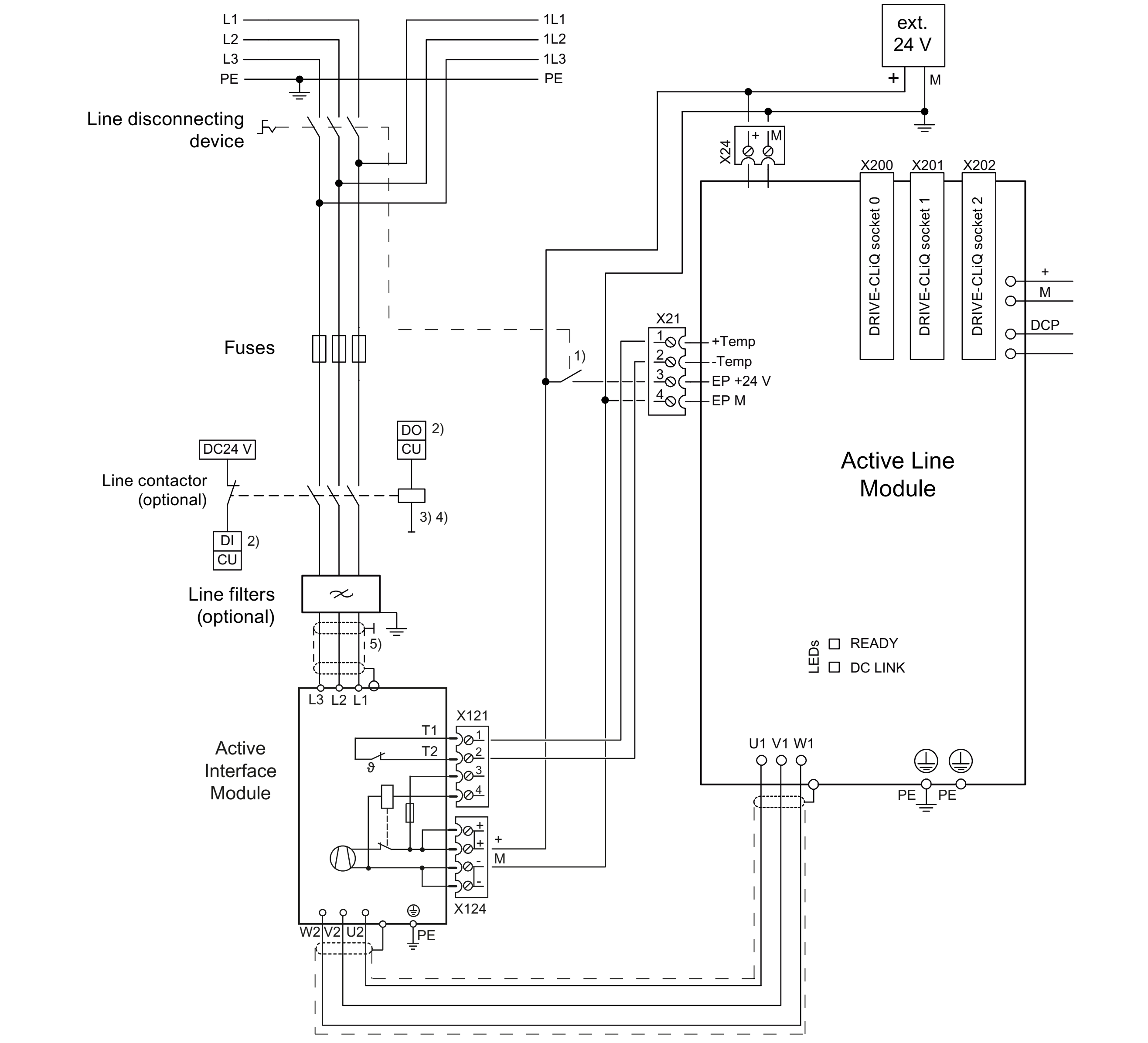



Figure 5-20 Active Line Module with internal air cooling (example: 16 kW)

### 5.4.2.2 Connection example



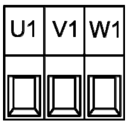
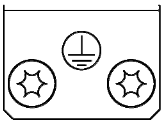

1) Leading opening contact t > 10 ms
2) DI/DO, controlled by the Control Unit.
3) No additional load permitted downstream of line contactor!
4) The current carrying capacity of the DO must be observed; an output coupling device must be used if required.
5) Contact through installation backplane or shield buses in accordance with EMC directive.

Figure 5-21 Example connection of Active Line Module

> **Note**
>
> If you are using a VSM10 Voltage Sensing Module, the leading opening contact can be omitted.

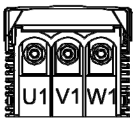
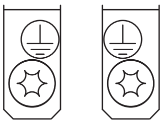
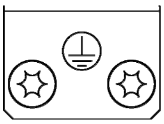
### 5.4.2.3 X1 line connection

Table 5- 8 Terminal block X1 Active Line Module 16 kW

| | Terminal | Technical specifications |
|---|---|---|
|  | U1<br>V1<br>W1 | Max. connectable cross-section: 10 $mm^2$<br>Type: Screw terminal 6<br>Tightening torque: 1.5 - 1.8 Nm |
|  | PE connection | Threaded hole M5/3 Nm 1 |

1) For ring cable lugs in accordance with DIN 46234

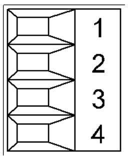
Table 5- 9 Terminal block for the Active Line Module (36 kW to 120 kW)

| | Terminals | Technical specifications |
|---|---|---|
|  | U1<br>V1<br>W1 | Supply voltage:<br>380 V - 480 V 3 AC, 50 / 60 Hz<br>**36 kW:**<br>Threaded bolt M6/6 Nm 1)<br>**55 kW, 80 kW and 120 kW**<br>Threaded bolt M8/13 Nm 1) |
|  | PE connection | **36 kW:**<br>Threaded hole M6/6 Nm 1) |
|  | | **55 kW:**<br>Threaded hole M6/6 Nm 1)<br>**80 kW and 120 kW:**<br>Threaded hole M8/13 Nm 1 |

1) For ring cable lugs in accordance with DIN 46234

### 5.4.2.4 Active Line Module X21 EP Terminals

Table 5- 10 X21 terminal block

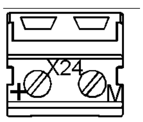
| | Terminal | Designation | Technical specifications |
|---|---|---|---|
|   | 1 | Reserved, do not use | |
| | 2 | Reserved, do not use | |
| | 3 | EP +24 V (Enable Pulses) | **Enable EP control input:**<br>The boost converter and regenerative operation are activated and, therefore, enabled by applying a 24 VDC (High level) voltage to the -X21:3 (EP +24 V) terminal.<br>The supply voltage must be provided from an external power supply. The -X21:4 (EP M) terminal is used as reference ground for the external supply voltage.<br>**Disable EP control input:**<br>If the EP control input is not enabled (Low level), the boost converter for the Active Line Module must be deactivated (Smart Mode). The diode bridge remains active, the DC link operates unregulated, and the DC link voltage reduces to the value $U_{DC\ link} = U_{supply}$*1.35. The regenerative function is also disabled.<br>**Signal propagation delays**:<br>Enable: switch from Low to High level in 100 µs<br>Disable: switch from High to Low level in 1000 µs<br>**Notice**:<br>If the EP control input is disabled and the boost converter is non-operational, the DC link remains connected to the supply voltage via the diode bridge/precharging resistors. Energy continues to be loaded into the DC link. If this is to be avoided, a line contactor, for example, can be used.<br>**Warning**:<br>Before the main power switch is used to switch off the drive group, the EP function (–X21:3 (+ 24 V) and –X21:4 (M) connections) on the Active Line Module must be disabled via, for example, a leading disabling auxiliary switch (≤ 10 ms) on the main power switch.<br>**Note**:<br>If the EP control input is not enabled, the line contactor On/Off control function will not be enabled. |
| | 4 | EP M (Enable Pulses) | Reference potential for the -X21:3 terminal |
| Max. connectable cross-section: 1.5 mm$^2$<br>Type: Screw terminal 1 | | | |

> ⚠ **WARNING**
>
> For operation, ground must be attached to the -X21:3 24 VDC terminals and the -X21:4 terminals. For cancelation, a pulse suppression will be activated. Feedback is deactivated and the bypass relay drops out. If the Line Module is not separated from the supply system when the EP terminal is opened (e.g. no main power switch present), the DC link will remain charged.

> **NOTICE**
>
> If the main power switch is used to switch off a running drive group, the voltage at terminal 3 (EP +24 V) and 4 (EP M) must be interrupted beforehand. This can be achieved with a leading disabling auxiliary contact (≥ 10 ms), for example.

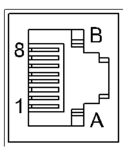
### 5.4.2.5 Active Line Module X24 24 V Terminal Adapter

Table 5- 11 X24 terminal strip

| | Terminal | Designation | Technical data |
|---|---|---|---|
|   | + | 24 V supply | 24 V DC supply voltage |
| | M | Chassis ground | Electronic ground<br>(tolerance limit 20.4 VDC to 28.8 VDC, voltage interruption for 3 ms without function impairment).<br>Used for the central infeed of the 24 VDC power supply of the drive group |
| The 24 V terminal adapter is supplied as standard<br>Max. connectable cross-section: 6 mm²<br>Type: Screw terminal 5 | | | |

### 5.4.2.6 X200-X202 DRIVE-CLiQ interfaces

Table 5- 12 DRIVE-CLiQ interface X200-X202 for 16 kW and 36 kW Smart Line Modules

| | PIN | Signal name | Technical specifications |
|---|---|---|---|
|   | 1 | TXP | Transmit data + |
| | 2 | TXN | Transmit data - |
| | 3 | RXP | Receive data + |
| | 4 | Reserved, do not use | |
| | 5 | Reserved, do not use | |
| | 6 | RXN | Receive data - |
| | 7 | Reserved, do not use | |
| | 8 | Reserved, do not use | |
| | A | + (24 V) | 24 V power supply |
| | B | M (0 V) | Electronics ground |

| | PIN | Signal name | Technical specifications |
|---|---|---|---|
| Blanking plate for DRIVE-CLiQ interfaces included in the scope of delivery;<br>blanking plate (50 pieces) Order number: 6SL3066-4CA00-0AA0 | | | |

### 5.4.2.7 24 V busbar

Table 5- 13 24 V busbar

| Busbar | Designation | Remarks |
|---|---|---|
| + | 24 VDC power supply busbar, plus pole | Two connection straps on the distribution busbar can be used to pass the voltage potential to neighboring components. |
| M | 24 VDC power supply busbar, ground pole | |

### 5.4.2.8 Active Line Module DC Link Busbar

| Busbar | Designation | Remarks |
|---|---|---|
| DCP | DC link plus pole | Two connection straps on the distribution busbar can be used to pass the voltage potential to neighboring components. |
| DCN | DC link minus pole | |

The Active Line Module is controlled via the -X21 terminal block, terminals 3 and 4 (EP), and via DRIVE-CLiQ at the -X200/202/203 terminal block. The detailed function description for the individual signals and control/status words is contained in the SINAMICS S120/S150 List Manual (LH1).

Once the Active Line Module has been switched on, the DC link has been precharged and the boost converter has attained the setpoint of the DC link voltage, the unit uses the r0863.0 parameter to signal the "infeed ready" status. The signal must then be connected by parameter for enabling the Motor Modules. This ensures that the Motor Modules can be started only when the DC link is operating correctly. The Motor Modules will be disabled immediately in case of faults, etc.

### 5.4.2.9 Meaning of the LEDs on the active line module

Table 5- 14 Meaning of the LEDs on the Line Module

| LED | Color | Status | Description |
|---|---|---|---|
| READY | - | Off | Electronics power supply outside permissible tolerance range |
| | Green | Steady light | The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. |
| | Orange | Steady light | DRIVE-CLiQ communication is being established. |
| | Red | Steady light | At least one fault is present in this component. |
| | Green<br>Red | Flashing<br>2 Hz | Firmware is being downloaded. |
| | Green/Orange<br>or<br>Red/Orange | Flashing<br>2 Hz | Component recognition via LED is activated (p0124).<br>**Note:**<br>Both options depend on the LED status when component recognition is activated via p0124 = 1. |
| DC LINK | - | Off | Electronics power supply outside the permissible tolerance range. |
| | Orange | Steady light | DC link voltage within permissible tolerance range (only when ready for operation) |
| | Red | Steady light | DC link voltage outside the permissible tolerance range (only when Active Line Module is ready for operation). |

> **⚠ WARNING**
>
> Hazardous DC link voltages may be present at any time regardless of the status of the "DC link" LED.
>
> The warning information on the components must be carefully observed!

#### Cause and rectification of faults

The following reference contains information about the cause and rectification of faults:

Reference: /IH1/ SINAMICS S120, Commissioning Manual.

### 5.4.3 Smart Line Modules (5 kW und 10 kW) with internal air cooling

#### 5.4.3.1 Overview

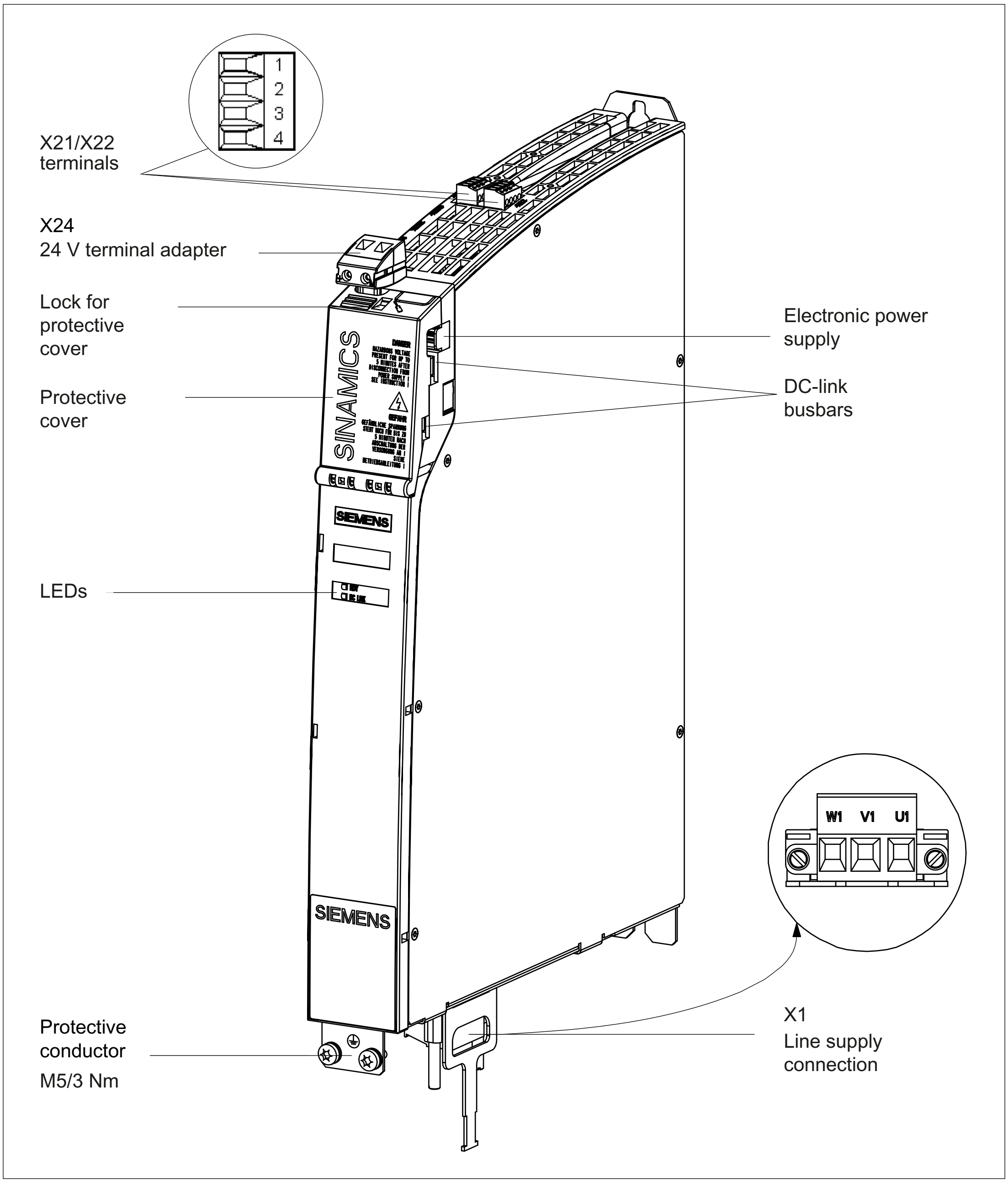



Figure 5-22 Smart Line Modules 5 kW and 10 kW with internal air cooling (example 5 kW)

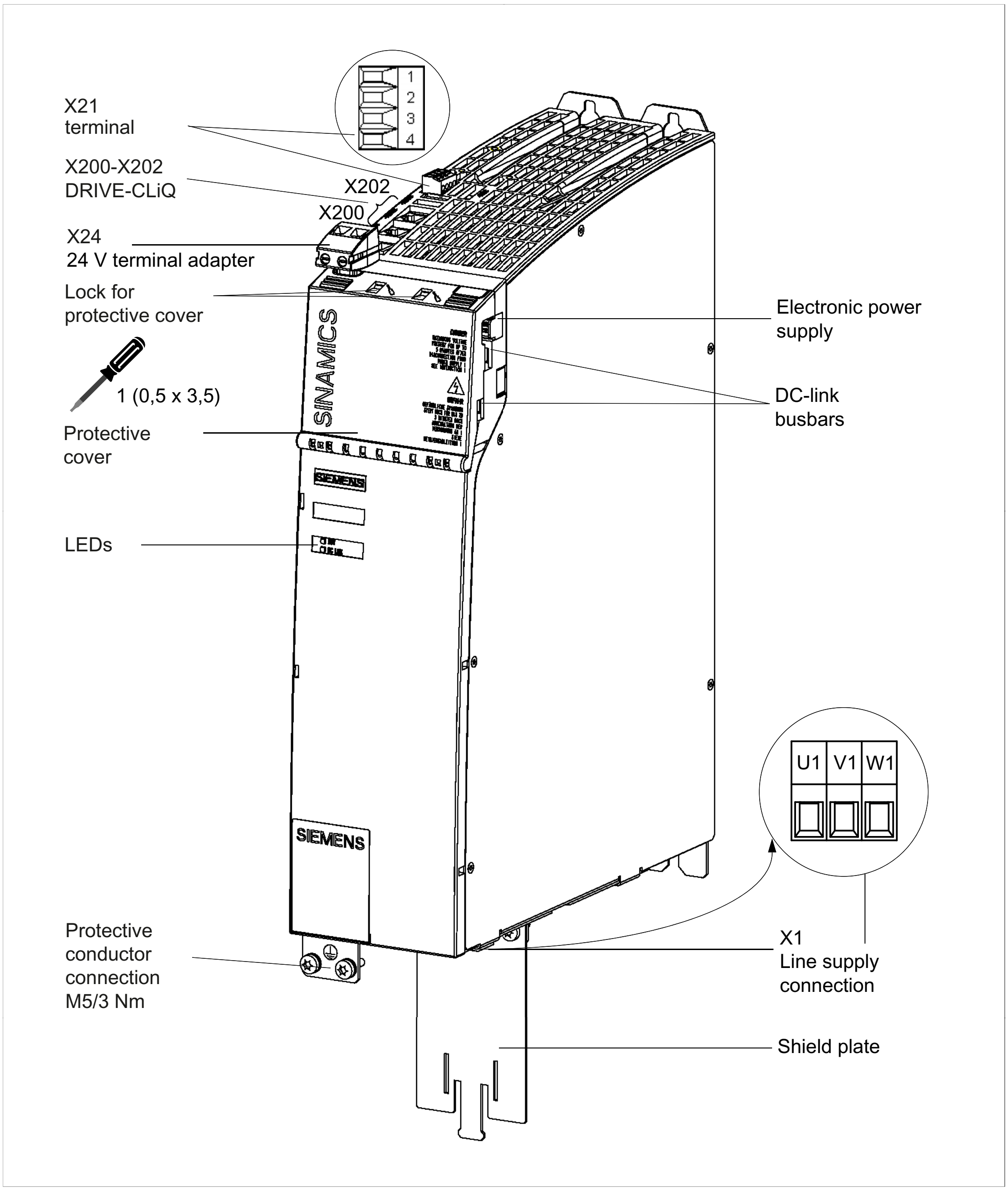



Figure 5-23 Smart Line Module with internal air cooling (16 kW)

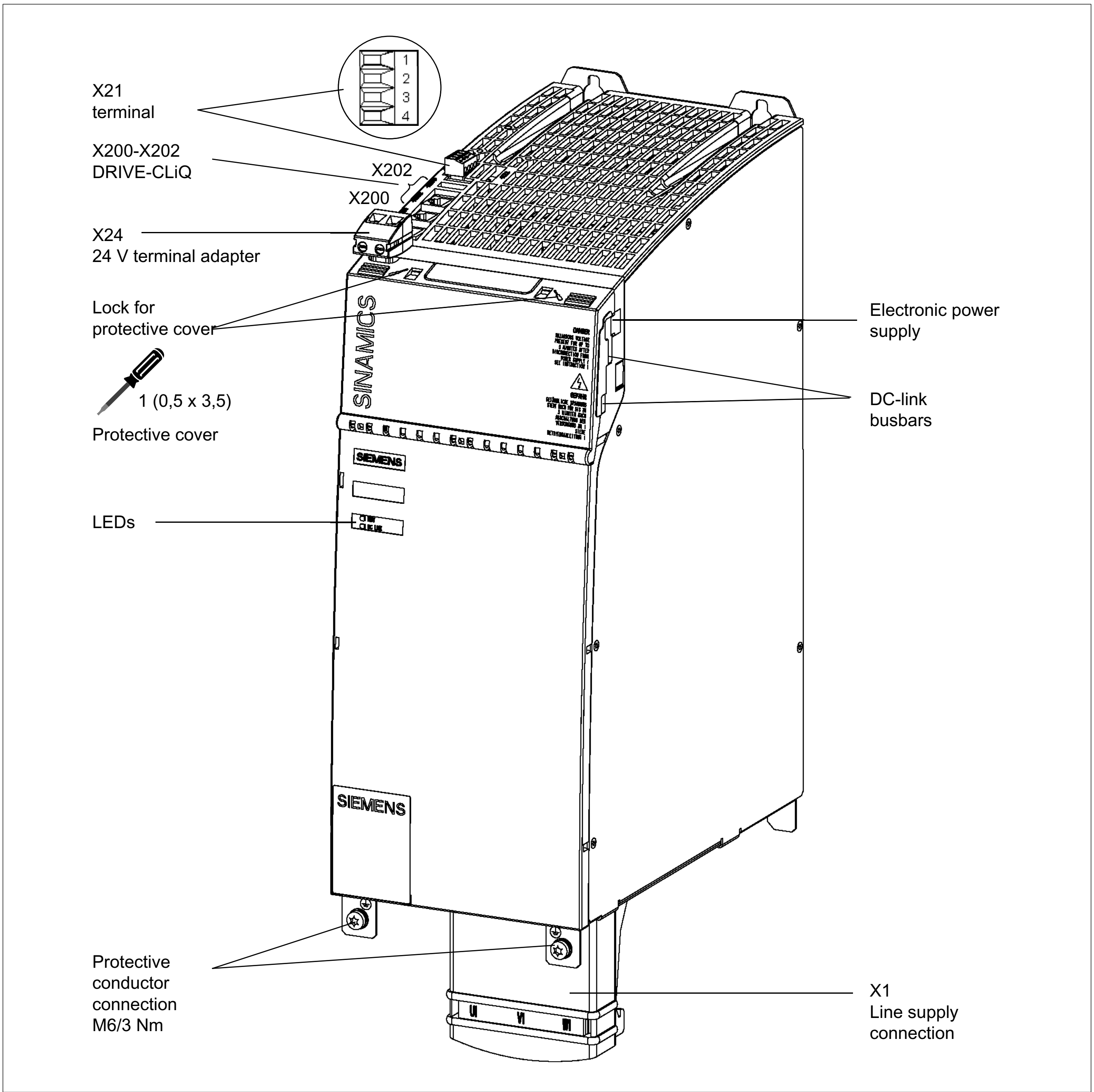
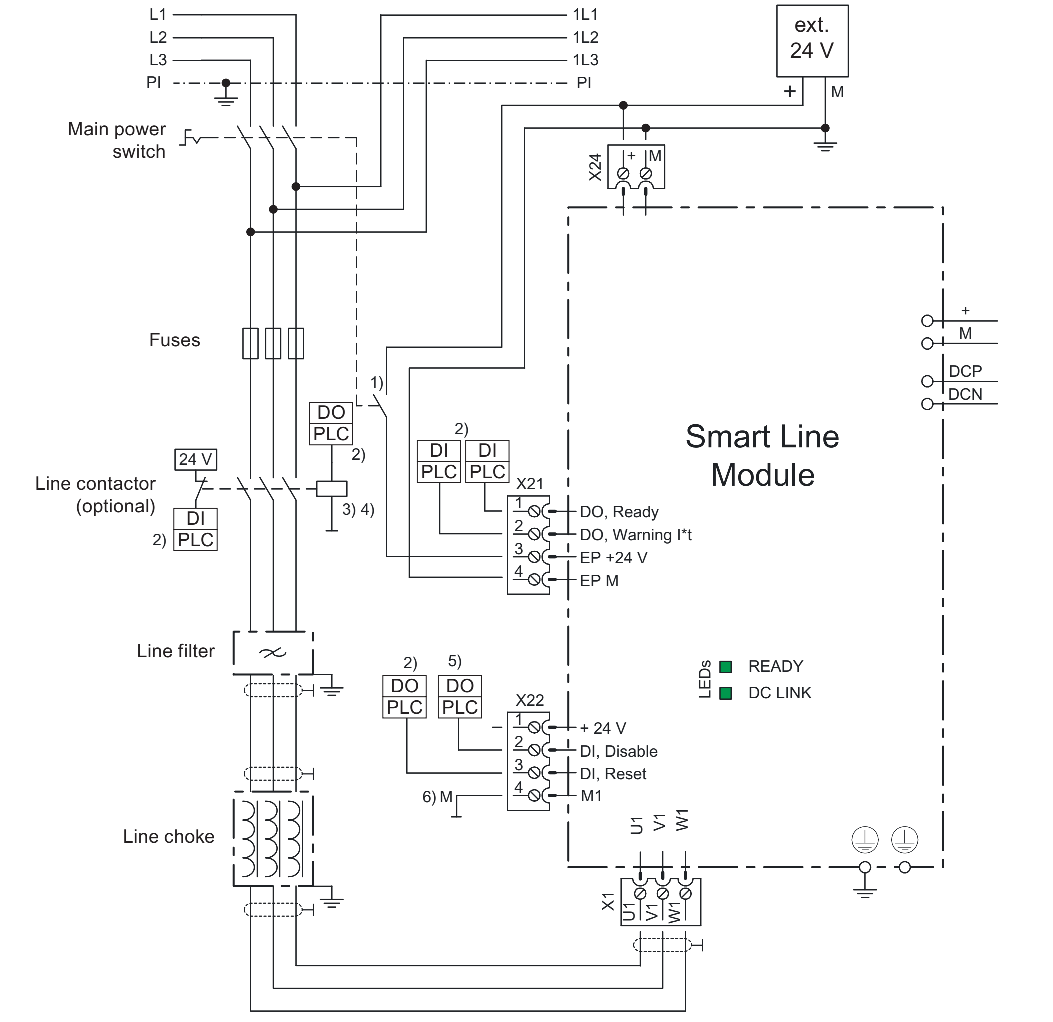



Figure 5-24 Smart Line Module with internal air cooling (36 kW)

### 5.4.3.2 Connection example

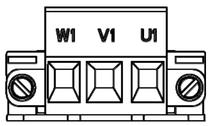
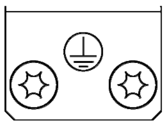



1) Leading breaking contact t >10 ms; for operation, 24 VDC and ground must be attached.
2) DI/DO, controlled from the PLC.
3) No additional consumer after the line contactor permitted.
4) The current carrying capacity of the DO must be observed; an output interface element may need to be used.
5) DO high, regeneration deactivated (for permanent deactivation, a jumper can be installed between X22 pin 1 and 2).
6) X22 pin 4 must be connected with ground (ext 24 V).

Figure 5-25 Smart Line Module connection example

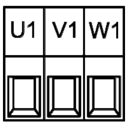
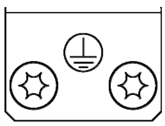
### 5.4.3.3 X1 line connection

Table 5- 15 Terminal strip X1 of Smart Line Modules 5 kW and 10 kW

| | Terminal | Technical specifications |
|---|---|---|
|  | U1 | Supply voltage:<br>380 V - 480 V 3 AC, 50/60 Hz<br>Max. connectable cross-section: 6 $mm^2$<br>Type: Screw terminal 5 (see chapter Connection methods)<br>Tightening torque: 1.2 - 1.5 Nm |
| | V1 | |
| | W1 | |
|  | PE connection | Threaded hole M5/3 Nm [1] |

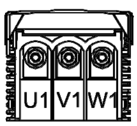
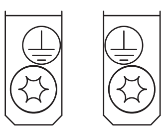
1) For ring cable lugs in accordance with DIN 46234

Table 5- 16 Terminal strip X1 Smart Line Module 16 kW

| | Terminal | Technical specifications |
|---|---|---|
|  | U1 | Supply voltage:<br>380 V - 480 V 3 AC, 50/60 Hz<br>Max. connectable cross-section: 10 $mm^2$<br>Type: Screw terminal 6 (see chapter Connection methods)<br>Tightening torque: 1.5 - 1.8 Nm |
| | V1 | |
| | W1 | |
|  | PE connection | Threaded hole M5/3 Nm [1] |

1) For ring cable lugs in accordance with DIN 46234

Table 5- 17 Terminal strip Smart Line Module 36 kW

| | Terminals | Technical specifications |
|---|---|---|
|  | U1 | Supply voltage:<br>380 V - 480 V 3 AC, 50/60 Hz<br>Threaded bolt M6/6 Nm [1)] (see chapter Connection system) |
| | V1 | |
| | W1 | |
|  | PE connection | Threaded hole M6/6 Nm [1)] |

1) For ring cable lugs in accordance with DIN 46234

### 5.4.3.4 X21 terminals: smart line module

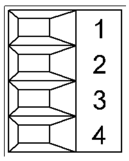
The Smart Line Module (5/10 kW) is controlled using the -X21, -X22 terminal block. A connection to the Control Unit using DRIVE-CLiQ is not present. A detailed function description for the individual signals and control/status words is contained in the SINAMICS S S120/S150 List Manual.

A control of the line contactor by the Smart Line Module or in conjunction with the Control Unit is not provided. If, however, a line contactor is used, it must be switched with a PLC or hardware control, for example. See also Section Safety Integrated (Page 83) and Section Line Contactor Control (Page 97).

If the Smart Line Module has been switched on, the DC link has been precharged and no faults are present, the unit uses the "Ready" digital output to signal the "infeed ready" status.

This signal must then be fed appropriately to the Control Unit using an external interconnection. The Control Unit forwards the "infeed ready" signal to the Motor Modules to enable them (see above). This ensures that the Motor Modules can be started only when the DC link is operating correctly. The Motor Modules will be disabled immediately in case of faults, etc.

Table 5- 18 X21 terminal block

| | Terminal | Name | Technical specifications |
|---|---|---|---|
|   | 1 | DO: Ready | Checkback: Smart Line Module ready<br>The signal switches to high level when the following conditions have been met:<br>• Electronics power supply (X24) OK<br>• DC link is pre-charged<br>• Enable pulse (X21:3/.4) present<br>• No overtemperature<br>• No overcurrent switch-off<br>**Note:** Because the Ready signal is cancelled only for fatal faults, this signal must be processed by the Control Unit or some other controller and used for the drive group enable/disable. This must be performed as fast as possible for the ready cancelation.<br>**Note:** All connected actuators, contactor coils, magnetic valves, holding brakes, etc. must be connected using surge suppression devices (e.g. diodes, varistors, RC elements, etc.). This is also true for switchgear/inductances controlled by a PLC output. |
| | 2 | Pre Warning | DO: Over-temperature prewarning threshold / I x t<br>High = no prewarning<br>Low = prewarning |

| | Terminal | Name | Technical specifications |
|---|---|---|---|
| | 3 | DI: Enable pulses | **EP +24 V EnablePulses** Enable EP control input:<br>The activation is achieved by placing a 24 VDC voltage (High level) at the -X21:3 (EP +24 V) terminal.<br>The supply voltage must be provided from an external power supply. The -X21:4 (EP M) terminal is used as reference ground for the external supply voltage.<br>Disable EP control input:<br>The disable signal from the Smart Line Module cannot be set if the EP control input is not enabled (Low level).<br>**Notice:**<br>If the EP control input is disabled, the DC link remains connected with the supply system voltage using the diode bridge / precharging resistors. No electrical isolation exists.<br>If this is to be avoided, a line contactor, for example, can be used.<br>**Warning**:<br>Before the main power switch is used to switch off the drive group, the EP function (–X21:3 (+ 24 V) and –X21:4 (M) connections) on the Active Line Module must be disabled via, for example, a leading disabling auxiliary switch (≤ 10 ms) on the main power switch. |
| | 4 | DI: Enable pulses ground | **EP M Enable Pulses**<br>Reference potential for the –X21:3 terminal. |
| Max. connectable cross-section: 1.5 mm²<br>Type: Screw terminal 1 | | | |

**Note**

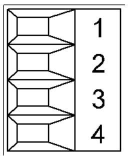
For operation, ground must be attached to the -X21:3 24 VDC terminals and the -X21:4 terminals. When removed, pulse inhibit is activated, feedback is deactivated and the bypass relay drops out. If the Line Module is not disconnected from the supply system when the EP terminal is deactivated (e.g. a line contactor is not installed), the DC link remains charged.

**NOTICE**

If the main power switch is used to switch off a running drive group, the voltage at terminal -X21:3 (EP +24 V) and -X21:4 (EP M) must be interrupted beforehand. This can be achieved with a leading disabling auxiliary contact (≥ 10 ms), for example.

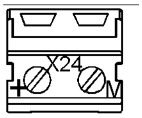
### 5.4.3.5 X22 terminals: smart line module

Table 5- 19 Terminal block X22

| | Terminal | Designation | Technical specifications |
|---|---|---|---|
|  | 1 | 24 V power supply | **24 VDC electronic power supply** (24 VDC, 100 mA)<br>for the control of the X22.2 and 3 digital inputs. |
| | 2 | DI: Disable Regeneration | **Disable digital input** Enable Disable control input:<br>Enable and, therefore, activate the regenerative capability of the Smart Line Module when the Disable control input is open (Low level).<br>**Disable Disable control input**:<br>If the Disable control input is not enabled (High level), the regenerative capability of the Smart Line Module is deactivated.<br>No energy from the DC link can be fed into the supply system. The energy may need to be removed using braking resistors.<br>**Note**:<br>The Disable control input may not be operated during running operation. The preselection should be made using a fixed wire jumper.<br>**Notice**:<br>If the Disable control input has the High level and the regenerative capability is, therefore, deactivated, the DC link remains connected to the energy supply system via the diode bridge/precharging resistors.<br>No electrical isolation exists. |
| | 3 | DI: Reset | **DigitalinputReset**<br>If this input is jumpered with the electronics ground or the input is controlled from an external PLC, the internal fault memory will be reset (a negative edge resets the fault). If the fault is still present, no reset will be performed. The reset is also possible by canceling the external 24 VDC (-X24). |
| | 4 | Chassis ground | **Electronics ground**<br>Reference potential for the -X22.2;3 terminal in order, for example, to support external control from the PLC |
| Max. connectable cross-section: 1.5 mm$^2$<br>Type: Screw terminal 1 | | | |

### 5.4.3.6 X24 24 V terminal adapter

Table 5- 20 Terminal block X24

| | Terminal | Designation | Technical specifications |
|---|---|---|---|
|   | + | 24 V power supply | 24 V DC supply voltage |
| | M | Ground | Electronic ground |
| The 24 V terminal adapter is supplied as standard<br>Max. connectable cross-section: 6 $mm^2$<br>Type: Screw terminal 5 (see Connection Methods) | | | |

### 5.4.3.7 24 V busbar

Table 5- 21 24 V busbar

| Busbar | Designation | Remarks |
|---|---|---|
| + | 24 VDC power supply busbar, plus pole | Two connection straps on the distribution busbar can be used to pass the voltage potential to neighboring components. |
| M | 24 VDC power supply busbar, ground pole | |

### 5.4.3.8 Smart Line Module DC Link Busbar

| Busbar | Designation | Remark |
|---|---|---|
| DCP | DC link plus pole | Two connection straps on the distribution busbar can be used to pass the voltage potential to neighboring components. |
| DCN | DC link minus pole | |

### 5.4.3.9 Meaning of the LEDs on the Smart Line Module

Table 5- 22 Meaning of the LEDs on the Smart Line Module

| LED | Color | State | Description |
|---|---|---|---|
| READY | Green | Steady light | Operation |
| | Orange | Steady light | Pre-charging not yet complete; bypass relay dropped out |
| | Red | Steady light | Overtemperature/overcurrent switch-off, or<br>Electronics power supply outside the permissible tolerance range |
| DC LINK | --- | OFF | Electronics power supply outside the permissible tolerance range |
| | Orange | Steady light | DC link voltage within permissible tolerance range |
| | Red | Steady light | DC link voltage outside permissible tolerance range |

> **WARNING**
>
> Hazardous DC link voltages may be present at any time regardless of the status of the "DC link" LED.
>
> The warning information on the components must be carefully observed!

#### Cause and rectification of faults

The following reference contains information about the cause and rectification of faults:

Reference: /IH1/ SINAMICS S120 Commissioning Manual

# 5.5 Motor Modules Interface Description

## 5.5.1 Overview

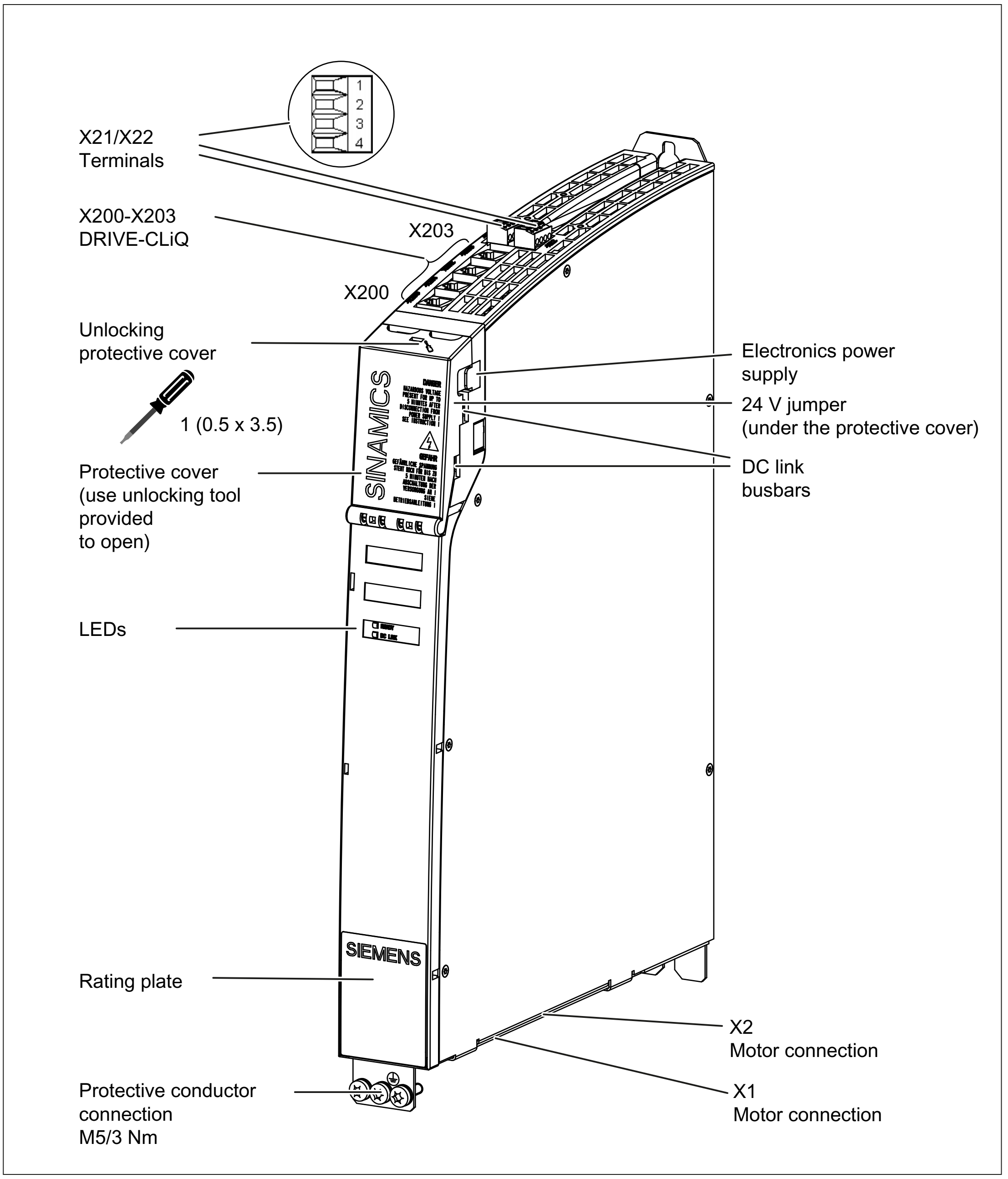



Figure 5-26 Double Motor Module, booksize format, with internal cooling

## 5.5.2 Connection examples

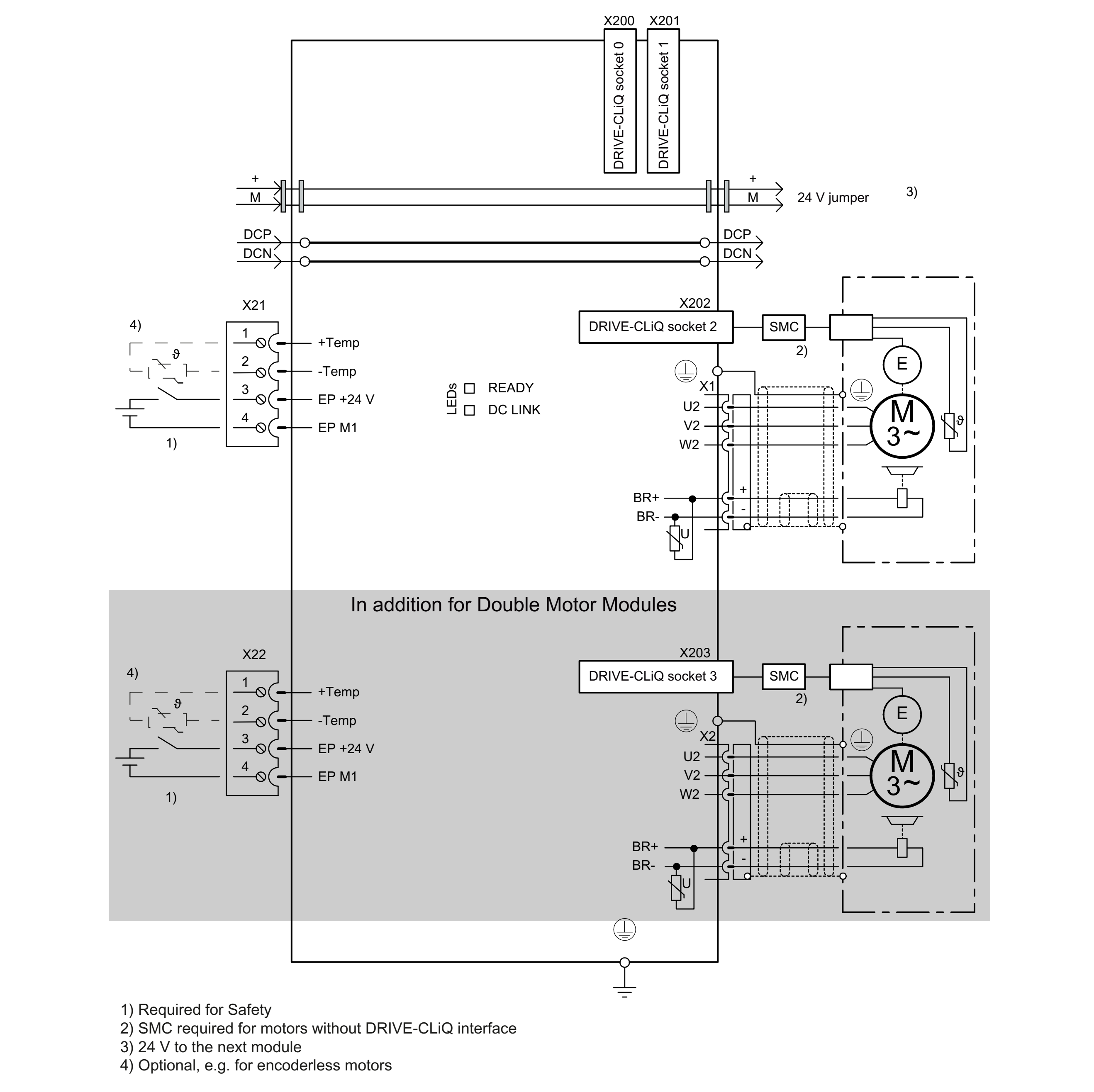
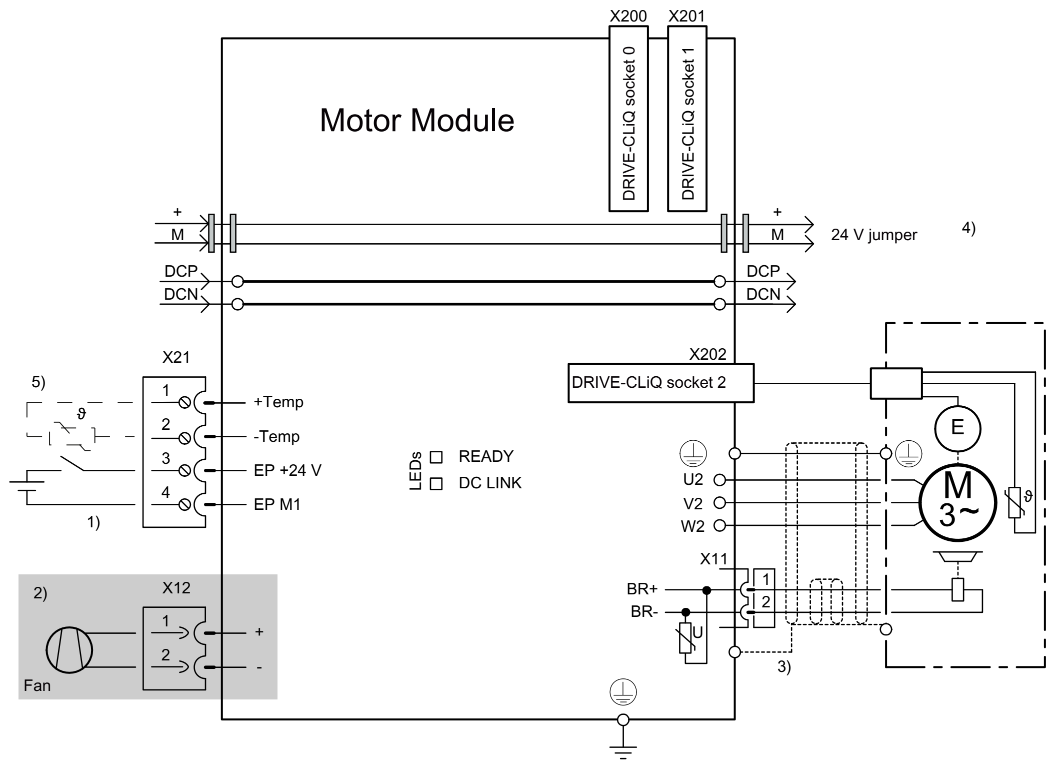



Figure 5-27 Connection example of Motor Modules 3 A to 30 A and Double Motor Modules 3 A to 18 A

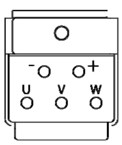
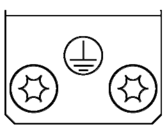



1) Required for Safety
2) In addition for Motor Modules 132 A to 200 A
3) Contact through the shield plate
4) 24 V to the next module
5) Optional, e.g. for encoderless motors

Figure 5-28 Example connection of Single Motor Modules 45 A to 200 A

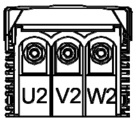
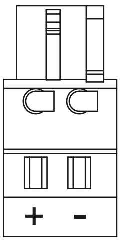
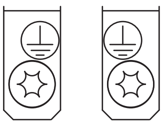
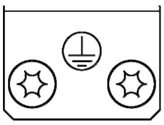
## 5.5.3 Motor/brake connection

Table 5- 23 Terminal strip X1/X2 Motor Modules 3 A to 30 A and Double Motor Modules 3 A to 18 A

| | Terminal | Technical specifications |
|---|---|---|
|  | U (U2) | Motor connection |
| | V (V2) | |
| | W (W2) | |
| | + (BR+) | Brake connection<br>max. load current 2 A<br>min. load current 0.1 A |
| | - (BR-) | |
|  | PE connection | Threaded hole M5/3 Nm [1] |

1) For ring cable lugs in accordance with DIN 46234

Table 5- 24 Terminal strip Single Motor Module 45 A to 200 A

| | Terminals | Technical specifications |
|---|---|---|
|  | U2<br>V2<br>W2 | **45 A to 60 A:**<br>Threaded bolt M6/6 Nm 1)<br>**85 A:**<br>Threaded bolt M8/13 Nm 1)<br>**132 A to 200 A:**<br>Threaded bolt M8/13 Nm 1) |
|  | + (BR+)<br>- (BR-) | X11 brake connector 2):<br>Voltage 24 V DC<br>Max. load current 2 A<br>Min. load current 0.1 A<br>Max. connectable cross-section 2.5 mm²<br>Type: Spring-loaded terminal 2 (see chapter Connection methods)<br>The brake connector is part of the pre-assembled cable |
|  | PE connection | **Single Motor Module with a rated output current of 45 A to 60:**<br>Threaded bolt for motor cables: M6/6 Nm 1) Threaded hole for PE: M6/6 Nm 1) |
|  | | **Single Motor Module with a rated output current of 85 A**<br>Threaded bolt for motor cables: M8/13 Nm 1)<br>Threaded hole for PE: M6/6 Nm 1)<br>**Single Motor Module with a rated output current of 132 A to 200 A**<br>Threaded bolt for motor cables: M8/13 Nm 1)<br>Threaded hole for PE: M8/13 Nm 1) |

1) For ring cable lugs in accordance with DIN 46234

2) The circuit for protecting the brake against overvoltage is integrated in the Motor Module and does not need to be installed externally. The max. load current is 2 A, the min. load current 0.1 A.

**Note**

The overall length of the power cables (motor supply cables and DC-link cables) must not exceed the values given in chapter "Possible line reactor and line filter combinations".

**Note**

The motor brake must be connected via connector X11. The BR- cable must not be connected directly to electronic ground (M).

**⚠ WARNING**

Only protective extra-low voltages (DVC A) that comply with EN 60204-1 must be connected to all connections and terminals between 0 and 48 VDC.

The voltage tolerances of the motor holding brakes (24 V ± 10%) must be taken into account.

## 5.5.4 X21/X22 EP Terminals / Motor Module Temperature Sensor Connection

---

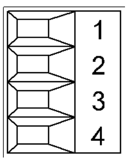
**Note**

The Motor Module is controlled using the -X21, -X22 terminal block and using DRIVE-CLiQ at the -X200/201/202/203 terminal block. The detailed function description for the individual signals and control/status words is contained in the SINAMICS S List Manual.

To enable the Motor Module, the "infeed ready" signal must be connected from the Line Module.

---

Table 5- 25 Terminal strip X21/X22

| | Terminal | Function | Technical specifications |
|---|---|---|---|
|  | 1 | + Temp | Temperature sensors: KTY 84-1C130/PTC/bimetallic switch with NC contact |
| | 2 | - Temp | |
| | 3 | EP +24 V (Enable Pulses) | Supply voltage: 24 V DC (20.4 V - 28.8 V)<br>Current consumption: 10 mA<br>Isolated input<br>Signal propagation times:<br>L → H: 100 μs<br>H → L: 1000 μs<br>The pulse inhibit function is only available when Safety Integrated Basic Functions are enabled. |
| | 4 | EP M1 (Enable Pulses) | |
| Max. connectable cross-section 1.5 mm²<br>Type: Screw terminal 1 (see chapter Connection methods) | | | |

| NOTICE |
|---|
| The KTY temperature sensor must be connected with the correct polarity. |

| NOTICE |
|---|
| The function of the EP terminals is only available when Safety Integrated Basic Functions are enabled. |

---

**Note**

The temperature sensor input is not needed if the motors feature an integrated DRIVE-CLiQ interface or if temperature values are detected by means of a different module (SMC, SME, TM).

---

The "Safe standstill (SH)" function is used in a fault situation or in conjunction with a machine function for the safe disconnection (safe pulse suppression) of the energy supply to the motor. No electrical isolation is made between the Motor Module and the motor!

In addition, if connected, the motor holding brake will be closed.

All hardware and software functions important for Safety Integrated are dual-channel (Control Unit and Motor Module). This means in addition to the EP+/EPM terminal on the Motor Module, a digital input on the Control Unit (e.g. DI3) must be configured with the "Safe standstill" function.

**EP+/EPM Low level (function selection) control input:**

1. If the "Safe standstill" function is not activated using parameters, the signal level on the EP+/EPM input has no significance.
2. The "safe pulse suppression" will be initiated and executed when the "Safe standstill" function and the Low level at the EP+/EPM input are activated. For cancelation, a pulse suppression will be activated.

**EP+/EPM High level (function deselection) control input:**

1. If the "Safe standstill" function is not activated using parameters, the signal level on the EP+/EPM input has no significance.
2. The "safe pulse suppression" is not active when the "Safe standstill" function and the High level at the EP+/EPM input are activated.

---

**Note**

The protective circuit of the Enable Pulses (EP) input is required only when the "Safe standstill" function on the Motor Module and on the Control Unit was activated by parameterizing.

---

**Note**

Protective measures must be adopted (e.g. for hanging axes) to prevent motions after disconnection of the energy supply from the motor ("coast to a standstill").

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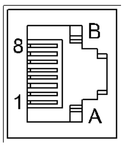
### 5.5.5 X200-X203 DRIVE-CLiQ interface

Table 5- 26 DRIVE-CLiQ interface X200-X202: Single Motor Module
DRIVE-CLiQ interface X200-X203: Double Motor Module

| | Pin | Name | Technical specifications |
|---|---|---|---|
|   | 1 | TXP | Transmit data + |
| | 2 | TXN | Transmit data - |
| | 3 | RXP | Receive data + |
| | 4 | Reserved, do not use | |
| | 5 | Reserved, do not use | |
| | 6 | RXN | Receive data - |
| | 7 | Reserved, do not use | |
| | 8 | Reserved, do not use | |
| | A | + (24 V) | Power supply |
| | B | M (0 V) | Electronics ground |
| Blanking plate for DRIVE-CLiQ interfaces included in the scope of delivery;<br>blanking plate (50 pieces) Order number: 6SL3066-4CA00-0AA0 | | | |

### 5.5.6 Meaning of the LEDs on the Motor Module

Table 5- 27 Meaning of the LEDs on the Motor Module

| LED | Color | State | Description |
|---|---|---|---|
| READY | - | Off | Electronics power supply outside the permissible tolerance range. |
| | Green | Steady light | The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. |
| | Orange | Steady light | DRIVE-CLiQ communication is being established. |
| | Red | Steady light | At least one fault is present in this component. |
| | Green<br>Red | Flashing<br>2 Hz | Firmware is being downloaded. |
| | Green/ Orange<br>or Red/Orange | Flashing<br>2 Hz | Component recognition via LED is activated (p0124).<br>Note:<br>Both options depend on the LED status when module recognition is activated via p0124 = 1. |
| DC LINK | - | Off | Electronics power supply outside the permissible tolerance range. |
| | Orange | Steady light | DC link voltage within permissible tolerance range (only when ready for operation) |
| | Red | Steady light | DC link voltage outside permissible tolerance range (only when ready for operation) |

| ⚠ WARNING |
|---|
| Hazardous DC link voltages may be present at any time regardless of the status of the "DC link" LED.<br>The warning information on the components must be carefully observed! |

### Cause and rectification of faults

The following reference contains information about the cause and rectification of faults:

Reference: /IH1/ SINAMICS S120, Commissioning Manual.

## 5.6 DRIVE-CLiQ topologies

### 5.6.1 DRIVE-CLiQ topology

#### Introduction

The term "topology" is used in SINAMICS to refer to a wiring harness with DRIVE-CLiQ cables. A unique component number is allocated to each component during the start-up phase.

DRIVE-CLiQ (Drive Component Link with IQ) is a communication system for connecting the various SINAMICS components (e.g. Control Unit, Line Module, Motor Modules, motors, and encoders).

DRIVE-CLiQ supports the following functions:

- Automatic detection of components by the Control Unit
- Standard interfaces to all components
- Standardized diagnostics down to component level
- Standardized service down to component level

#### Electronic rating plate

The electronic rating plate contains the following data:

- Component type (e.g. SMC20)
- Order number (e.g. 6SL3055-0AA0-5BA0)
- Manufacturer (e.g. SIEMENS)
- Hardware version (e.g. A)
- Serial number (e.g. "T-PD3005049)
- Technical data (e.g. rated current)

## Actual topology

The actual topology is the actual DRIVE-CLiQ wiring harness.

When the drive system components are started up, the actual topology is detected automatically via DRIVE-CLiQ.

## Target topology

The target topology is stored on the memory card on the Control Unit and is compared with the actual topology when the Control Unit is started up.

The target topology can be specified in two ways and saved on the memory card:

- Via the SINUMERIK 840D sl drive wizard or via the STARTER commissioning tool (by creating the configuration and loading it to the drive unit)
- Via quick commissioning (automatic configuration):
  the actual topology is read and the target topology written to the memory card.

## Comparison of topologies at Power On

Comparing the topologies prevents a component from being controlled/evaluated incorrectly (e.g. drive 1 and 2).

When the drive system boots, the Control Unit compares the detected actual topology and the electronic rating plates with the target topology stored on the memory card.

You can specify how the electronic rating plates are compared for all the components of a Control Unit via p9906. The type of comparison can be changed subsequently for each individual component. You can use p9908 for this or right-click in the topology view in the STARTER tool. All data on the electronic rating plate are compared by default.

The following data in the target and actual topologies is compared depending on the settings made in p9906/9908:

- p9906/p9908 = 0 component type, order number, manufacturer, serial number
- p9906/p9908 = 1 component type, order number

- p9906/p9908 = 2 component type
- p9906/p9908 = 3 component class (e.g. Sensor Module or Motor Module)

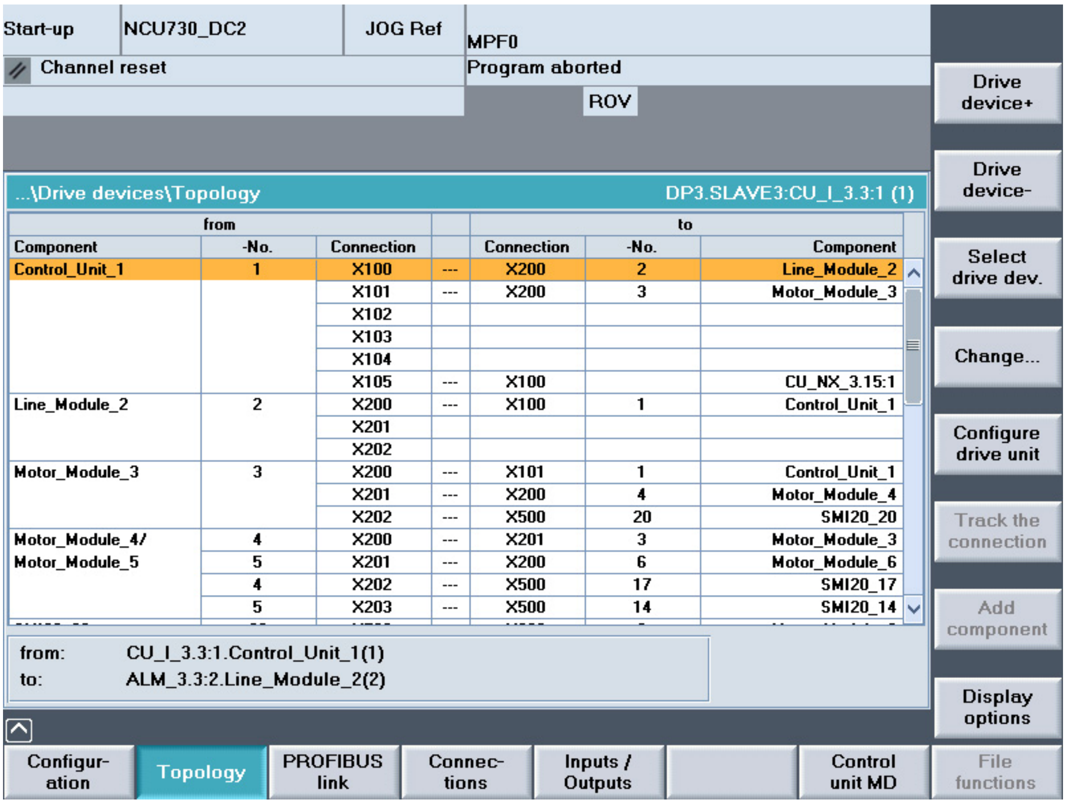



Figure 5-29 Topology of the SINUMERIK drive wizard

| NOTICE |
| --- |
| The Control Unit and the Option Board are not monitored. A replacement of components is accepted automatically and not displayed. |

## 5.6.2 DRIVE-CLiQ wiring

### Introduction

The components of the SINAMICS S120 drive family and the control unit are interconnected using DRIVE-CLiQ. When connecting the components, please note the following rules.

## Rules for wiring DRIVE-CLiQ

The following rules must be observed when wiring DRIVE-CLiQ (the SINAMICS S120 Function Manual contains additional rules and information):

- Ring wiring is not permitted.
- Components must not be double-wired.
- A maximum of 8 nodes can be connected in one row. A row is always regarded as starting at the control unit.
- Up to one Line Module, 6 Motor Modules (a Double Motor Module counts as 2 nodes) and 3 direct measuring systems may be connected to one control unit.
- A maximum of 14 DRIVE-CLiQ nodes can be connected to one DRIVE-CLiQ line at a Control Unit.
- Terminal Modules TM15 and TM41 have faster sample cycles than TM31. For this reason, the two Terminal Module groups must be connected to separate DRIVE-CLiQ lines.
- A maximum of 2 Terminal Modules can be connected to the CU.
- SINUMERIK 840D sl does not support vector operation.
- For Active Line Modules (ALM) in booksize format, only a current controller sampling time of 125.0 µs or 250.0 µs can be set.
- For ALMs in chassis format, only a current controller sampling time of 250.0 µs or 400.0 µs/375.0 µs (375 µs when p0092 = 1) can be set.
- A current controller sampling time between 62.5 µs and 250.0 µs can be set for servo drives (62.5 µs ≤ p0115[0] ≤ 250.0 µs).
- For servo drives with a current controller sampling time of p0115[0] = 62.5 µs, the following applies:

  - only possible in booksize and blocksize format

  - maximum quantity structure:

  – booksize: 2x servo with p0115[0] = 62.5 µs + Line Module (connected to a different DRIVE-CLiQ line)

  – servo drives in booksize format can be combined on one DRIVE-CLiQ line with a servo with p0115[0] = 125.0 µs (but with same quantity structure).

  – a DRIVE-CLiQ-Hub DMC20 cannot be operated with servo drives with p0115[0] = 62.5 µs on one DRIVE-CLiQ line, but must be connected to a separate DRIVE-CLiQ line instead

  – blocksize: 1 servo with p0115[0] = 62.5 µs
- The booksize Active Line Module and booksize Motor Modules, together with the SINUMERIK 840D sl CU, should be connected in servo mode to separate DRIVE-CLiQ lines.
- The Voltage Sensing Module (VSM) should be connected to a free DRIVE-CLiQ port on the associated Active Line Module (due to the automatic assignment of the VSM).
- The Chassis Line Module (Active Line) and Chassis Motor Modules must be connected to separate DRIVE-CLiQ lines.

- When a unit in chassis format is connected to a DRIVE-CLiQ line, the smallest current controller sampling time must be at least 250 µs.
  Example: mixture of chassis and booksize units on a DRIVE-CLiQ line.
- Motor Modules in chassis format with different current controller cycles must be connected to separate DRIVE-CLiQ lines. For this reason, Chassis Motor Modules and Booksize Motor Modules with a current controller sampling time < 250 µs must also be connected to separate DRIVE-CLiQ lines.
- The current controller sampling times of the drive objects (DOs) and the sampling times of the inputs/outputs of the Control Unit, TM, and TB modules must be a multiple integer of 125 µs.
- The sampling times (p0115[0] and p4099) of all components that are connected to a DRIVE-CLiQ line must be integrally divisible by one another. If the current controller sampling time on a DO has to be changed to another pattern that does not match the other DOs on the DRIVE-CLiQ line, the following options are available:
  – reconnect the DO to a separate DRIVE-CLiQ line
  – also change the current controller sampling time and the sampling time of the inputs/outputs of the DOs not involved so that they fit back into the pattern
- A Double Motor Module, a DMC20, and a CUA32 each correspond to two DRIVE-CLiQ nodes. This also applies to Double Motor Modules, where just one drive is configured.

To enable the "Automatic configuration" function to assign the encoders to the drives, the rules recommended below must be observed:

- The DRIVE-CLiQ cable from the Control Unit must be connected to X200 on the first booksize power unit or X400 on the first chassis power unit
- The DRIVE-CLiQ connections between the power units must each be connected from interface X201 to X200/from X401 to X400 on the next component
- A Power Module with the CUA31 should be connected to the end of the DRIVE-CLiQ line If a CUA31 is connected as the first module to the Control Unit, then the maximum number is decreased by one
- The motor encoder must be connected to the associated power unit

Table 5- 28 Connecting the motor encoder via DRIVE-CLiQ

| Component | Connecting the motor encoder via DRIVE-CLiQ |
|---|---|
| Single Motor Module booksize | X202 |
| Double Motor Module booksize | • Motor connection X1: Encoder at X202<br>• Motor connection X2: Encoder at X203 |
| Single Motor Module chassis | X402 |
| Power Module blocksize | • CUA31: Encoder at X202<br>• CU310: Encoder at X100 or via TM31 at X501 |

**Note**

If an additional encoder is connected to a Motor Module, it is assigned to this drive as encoder 2 in the automatic configuration.

Table 5- 29 VSM connection

| Component | VSM connection |
|---|---|
| Active Line Module booksize | X202 |
| Active Line Module chassis | X402 |

The SINAMICS S120 Function Manual 1 contains further information on DRIVE-CLiQ topology.

## Rules for DRIVE-CLiQ sockets

The following rules must be observed when using DRIVE-CLiQ sockets:

- The control unit must be connected to X200 on the first booksize power unit after it.
- The DRIVE-CLiQ cables between the power units should be connected from interface X201 to X200 on the next component
- The power line to the motor and the associated motor encoder must be connected to a Motor Module. The motor encoder is connected via terminal X202 or X203 on Double Motor Modules

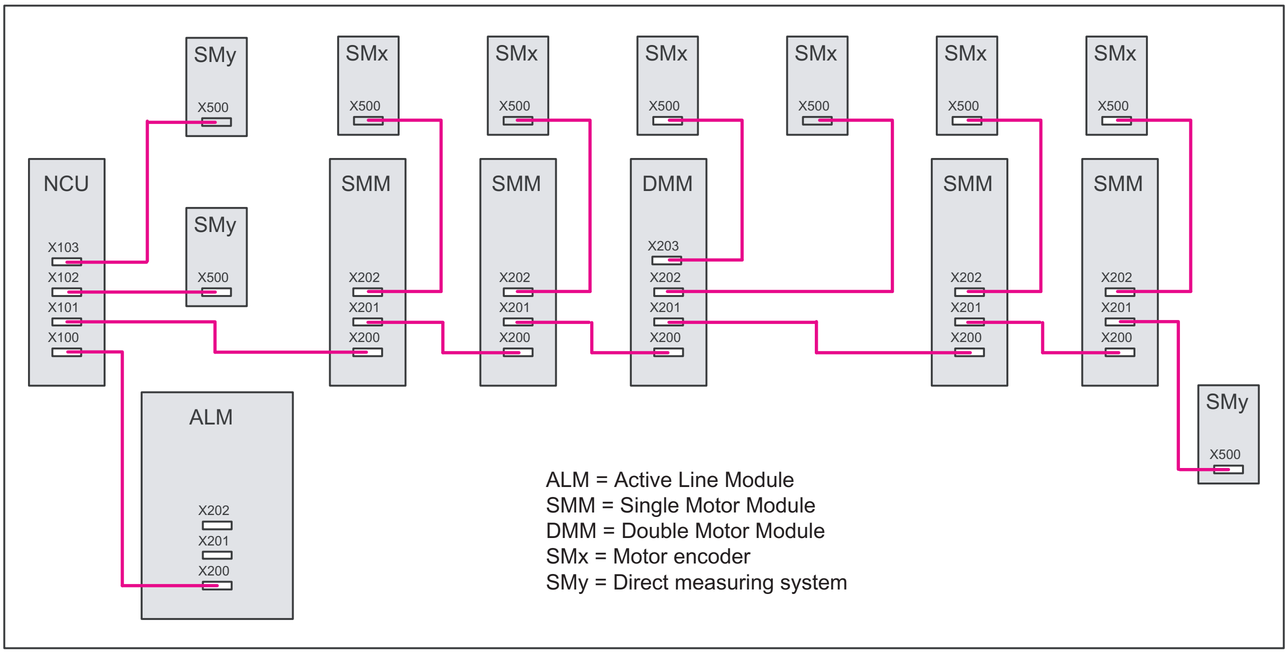



Figure 5-30 DRIVE-CLiQ wiring

## Miscellaneous

If an additional encoder is connected to a Motor Module, it is automatically assigned to this drive as encoder 2.

### 5.6.3 NX10/15 wiring

NX10/15 components can be connected to the control unit via DRIVE-CLiQ. The following rules apply to wiring of the NX10/15:

- Only one star topology is permitted between the NX10/15 and the Control Unit, as the address assignment is fixed (HW configuration). This means that only one NX10/15 can be operated per DRIVE-CLiQ port on a control unit.
- DRIVE-CLiQ ports not assigned to NX10/15 can be wired to other DRIVE-CLiQ components
- Once an NX10/15 has been connected and configured, you cannot simply insert it into a different DRIVE-CLiQ port, as the addresses of the integrated drives are set permanently from the point of view of the PLC. The following table illustrates this relation:

Table 5- 30 NX10/15 PROFIBUS addresses

| DRIVE-CLiQ port on the NCU | Drive PROFIBUS addresses |
|---|---|
| X105 | 15 |
| X104 | 14 |
| X103 | 13 |
| X102 | 12 |
| X101 | 11 |

The following figure shows a sample topology:

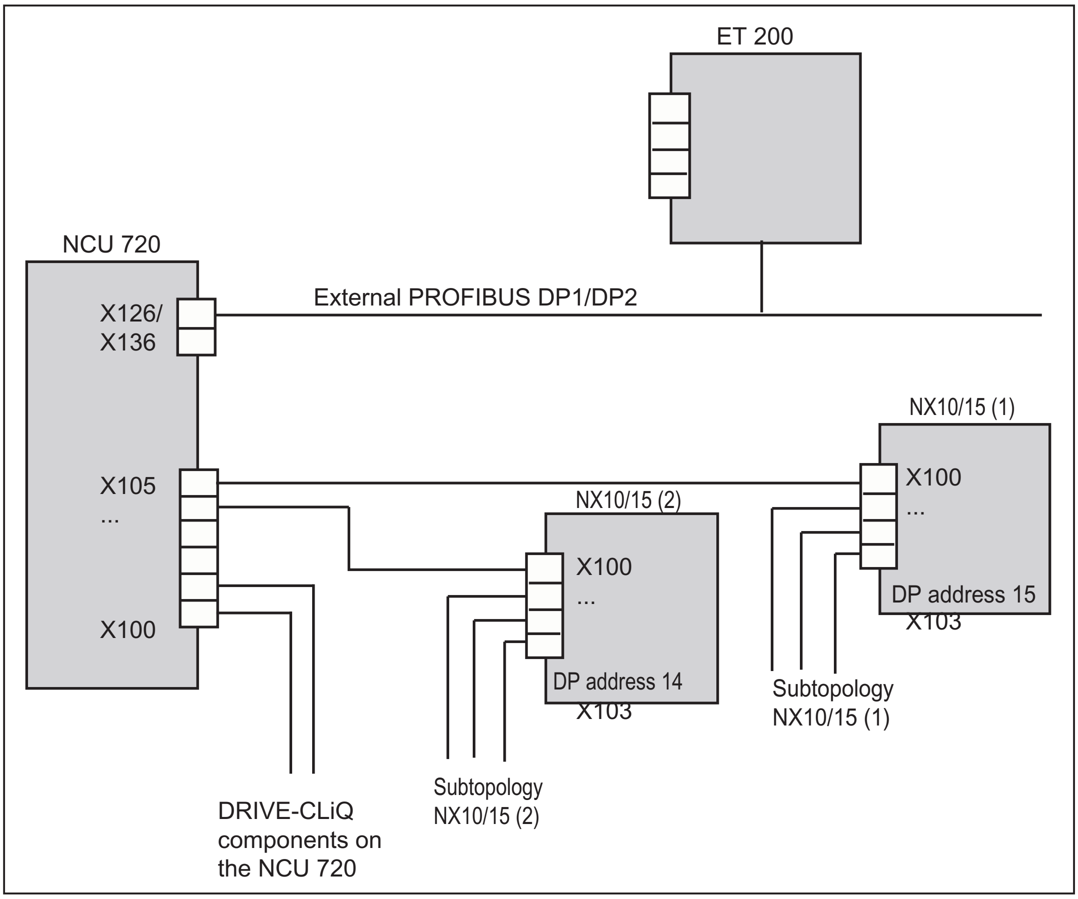



Figure 5-31 NX10/15 topology

## Additional references

For information on commissioning NX components, please refer to the "IBN CNC: NCK, PLC, Drive Commissioning Manual".

### 5.6.4 Connectable DRIVE-CLiQ components

#### Components

As a rule, all SINAMICS components approved for SINUMERIK can be connected using the DRIVE-CLiQ interface.

Table 5- 31 Components with DRIVE-CLiQ

| Component | Description |
|---|---|
| Active/Smart Line Module, Booksize | Line Modules provide the central power supply to the DC link. |
| Single/Double Motor Module, Booksize | Motor Modules draw their power from the DC link to supply the connected motors. |
| NX10/15 | Drive expansion module for up to 6 axes |
| SMC10/20/30 | Cabinet-Mounted Sensor Modules are needed when a motor with a DRIVE-CLiQ interface is not available and when external encoders are required in addition to the motor encoder. |
| SME20/25 | Measuring systems outside the cabinet can be connected directly to the Sensor Module External. |
| DMC20/DME20 | DRIVE-CLiQ Hub Modules are used to implement star-shaped distribution of a DRIVE-CLiQ line. |
| TM15 | The number of available digital inputs and outputs within a drive system can be expanded with the Terminal Module. |
| Motors | 1FT/1FK/1PH/1PM/1FW with DRIVE-CLiQ interface |

#### Additional references

- For information on SINAMICS S120 Line Modules and Motor Modules, please refer to the
  - Booksize Power Units Equipment Manual
  - Chassis Power Units Equipment Manual
- You can find information on all the other components in the SINAMICS S120 "Equipment Manual for Control Units and Additional System Components".

## 5.7 DRIVE-CLiQ Hub Modules (DMC20, DME20)

### 5.7.1 DMC20

#### 5.7.1.1 Description

The DMC20 DRIVE-CLiQ Hub Module is used to implement a star-shaped configuration of a DRIVE-CLiQ line. With the DMC20, an axis grouping can be expanded by up to 5 DRIVE-CLiQ sockets for additional subgroups.

The component is especially suitable for applications which require DRIVE-CLiQ nodes to be removed in groups, without interrupting the DRIVE-CLiQ line and, therefore, the data exchange process.

DMC20 can be used for the SINUMERIK 840D sl with CNC SW 2.6 and higher.

### 5.7.1.2 Overview

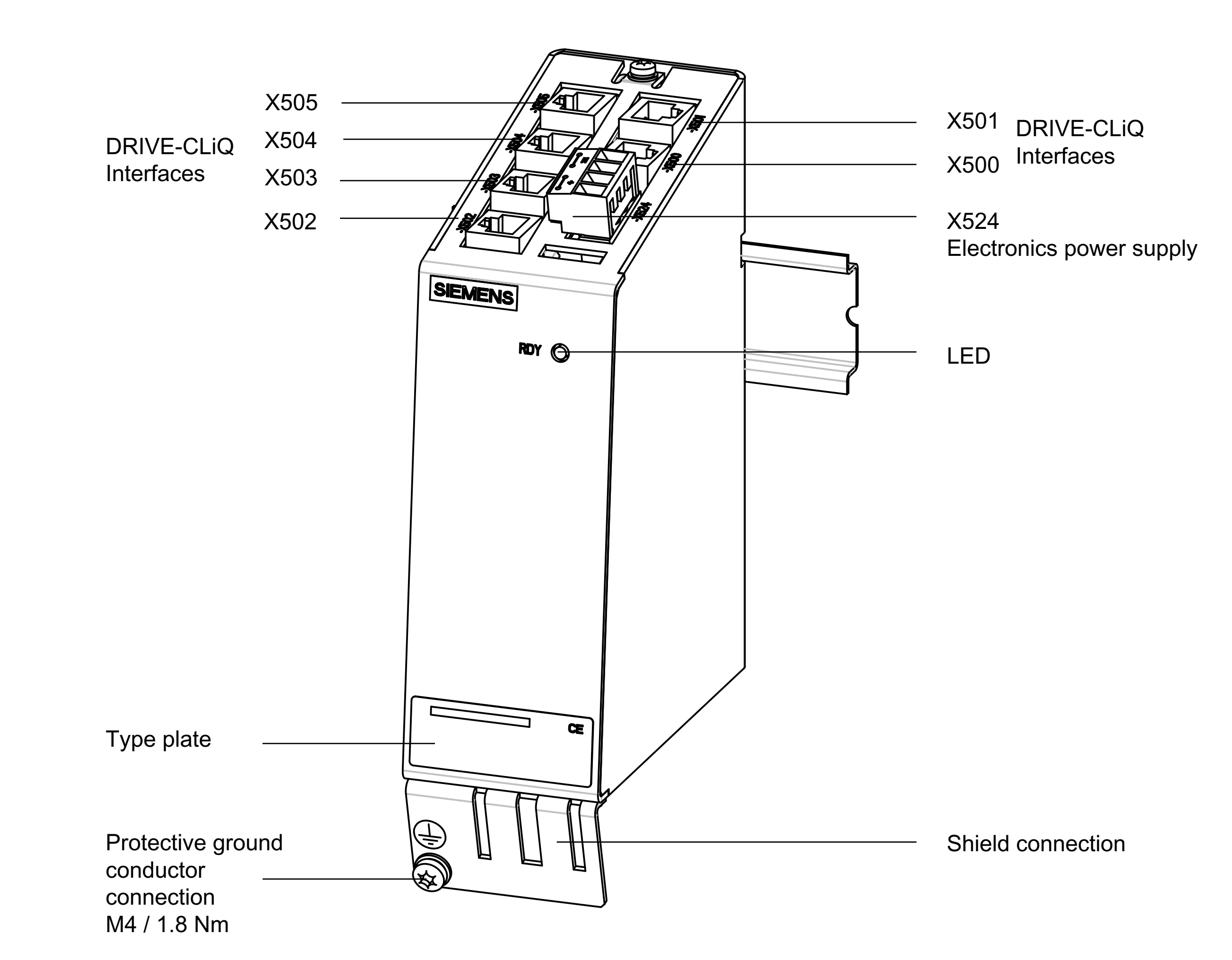
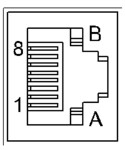



Figure 5-32 Interface description of the DMC20

### 5.7.1.3 DRIVE-CLiQ interface

Table 5- 32 DRIVE-CLiQ interfaces X500 - X505

| | Pin | Signal name | Technical specifications |
|---|---|---|---|
|  | 1 | TXP | Transmit data + |
| | 2 | TXN | Transmit data - |
| | 3 | RXP | Receive data + |
| | 4 | Reserved, do not use | |
| | 5 | Reserved, do not use | |
| | 6 | RXN | Receive data - |
| | 7 | Reserved, do not use | |
| | 8 | Reserved, do not use | |

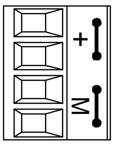
| | Pin | Signal name | Technical specifications |
|---|---|---|---|
| | A | + (24 V) | Power supply |
| | B | M (0 V) | Electronics ground |
| Type: RJ45 plus socket<br>Blanking plate for DRIVE-CLiQ interface: Yamaichi, order number: Y-ConAS-13 | | | |

**Note**

Only MOTION-CONNECT DRIVE-CLiQ cables may be used to establish connections.
The maximum lengths of MOTION-CONNECT 500 and MOTION-CONNECT 800 cables are 100 m and 50 m respectively.

### 5.7.1.4 Electronics power supply X524

Table 5- 33 X524 terminals for the electronics power supply

| | Terminal | Name | Technical specifications |
|---|---|---|---|
|  | + | Electronics power supply | 24 DC (20.4 – 28.8) |
| | + | N. c. | |
| | M | Electronics ground | |
| | M | Electronics ground | |
| Maximum connectable cross-section: 2.5 mm²<br>Type: Screw terminal type 2 | | | |

**Note**

The two "+" or "M" terminals are jumpered in the connector. This ensures the supply voltage is looped through.

The current consumption increases by the value for the DRIVE-CLiQ node and digital outputs.

### 5.7.1.5 Significance of the LED on the DMC20

Table 5- 34 Significance of the LED on the DMC20

| LED | Color | Status | Description |
|---|---|---|---|
| READY | - | Off | Electronics power supply outside the permissible tolerance range. |
| | Green | Steady light | The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. |
| | Orange | Steady light | DRIVE-CLiQ communication is being established. |
| | Red | Steady light | At least one fault is present in this component. |
| | Green<br>Red | Flashing<br>2 Hz | The firmware is being downloaded.<br>Component recognition via LED is activated (p0154). |

### 5.7.1.6 Dimension drawing

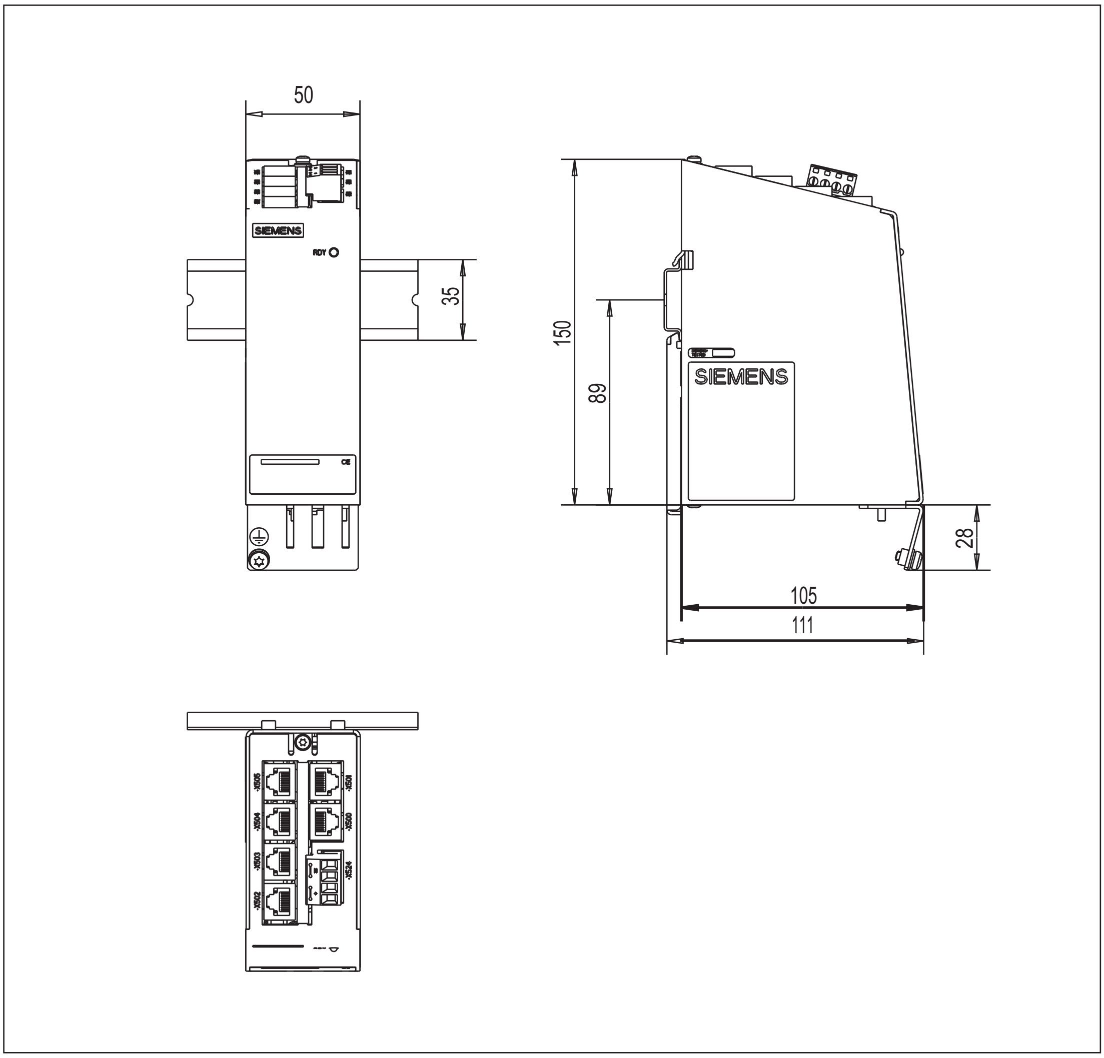



Figure 5-33 Dimension drawing of the DMC20

### 5.7.1.7 Technical data

Table 5- 35 Technical data of the DMC20

| | Unit | Value |
|---|---|---|
| Electronics power supply<br>Voltage<br>Current (without DRIVE-CLiQ consumer) | <br>$V_{DC}$<br>$A_{DC}$ | <br>24 DC (20.4 – 28.8)<br>0.15 |
| PE/ground connection | At the housing with M4/1.8 Nm stud | |
| Weight | kg | 0.8 |

## 5.7.2 DME20

### 5.7.2.1 Description

The DRIVE-CLiQ Hub Module External DME20 is used to implement star-shaped distribution of a DRIVE-CLiQ line. With the DME20, an axis grouping can be expanded by up to 5 DRIVE-CLiQ sockets for additional subgroups.

The component has degree of protection IP67 and is especially suitable for applications which require DRIVE-CLiQ nodes to be removed in groups, without interrupting the DRIVE-CLiQ line and therefore the data exchange.

With firmware 2.6 and higher, the DME20 can be used in conjunction with the SINUMERIK 840D sl CNC SW2.6.

### 5.7.2.2 Safety information

**NOTICE**

In order to guarantee degree of protection IP67, all of the plug connectors must be correctly screwed into place and appropriately locked.

**NOTICE**

The unused DRIVE-CLiQ interfaces must be closed using a protective cap (included in the scope of delivery).

**Note**

All components operated on the DRIVE-CLiQ must be integrated into the equipotential bonding concept.
They should preferably be connected by installing them on bright machine parts and devices, which are all bonded to one another in an equipotential manner.
Alternatively, equipotential bonding can be achieved by means of a conductor (min. 6 mm²), which should be routed parallel to the DRIVE-CLiQ where possible. This applies to all distributed DRIVE-CLiQ nodes, such as DM20, SME2x, SM12x, etc.
For the DME20 this also applies to the 24 V power supply.

### 5.7.2.3 Overview

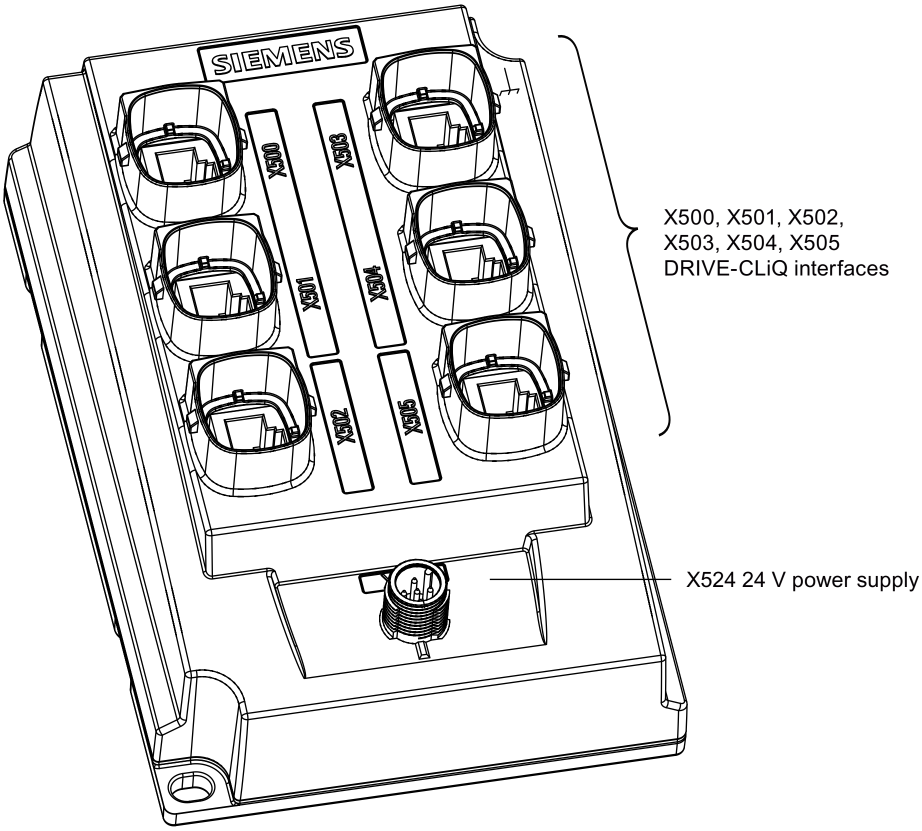
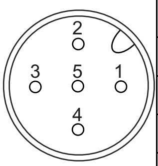



Figure 5-34 Interface overview: DME20

### 5.7.2.4 Electronics power supply X524

Table 5- 36 X524 socket for the electronics power supply

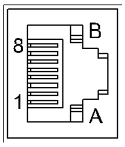
<table>
<tr><th></th><th>Pin</th><th>Designation</th><th>Technical specifications</th></tr>
<tr><td rowspan="5"></td><td>1</td><td>Electronics power supply</td><td rowspan="5">The connection voltage of 20.4 V – 28.8 V refers to the (terminal) voltage at the DME20. This must be taken into account when selecting the cable cross-section and supply cable lengths.<br>Pins 1 and 2: jumpered internally<br>Pins 3 and 4: jumpered internally</td></tr>
<tr><td>2</td><td>Electronics power supply</td></tr>
<tr><td>3</td><td>Electronics ground</td></tr>
<tr><td>4</td><td>Electronics ground</td></tr>
<tr><td>5</td><td>not connected</td></tr>
<tr><td colspan="4">Max. connectable cross-section: 4 x 0.75 mm²<br>e.g. 5-pole shielded connector, user-assembled: Phoenix company, Order No.: 1508365,<br>4-pole non-shielded connector, user-assembled, Speedcon quick-lock: Phoenix company, Order No. 1521601</td></tr>
</table>

**Note**

The maximum cable length for the P24 supply of the DME20 is 100 m.

### 5.7.2.5 DRIVE-CLiQ interface

Table 5- 37 DRIVE-CLiQ interface X500, X501, X502, X503, X504, X505

| | Pin | Signal name | Technical specifications |
|---|---|---|---|
|  | 1 | TXP | Transmit data + |
| | 2 | TXN | Transmit data - |
| | 3 | RXP | Receive data + |
| | 4 | Reserved, do not use | |
| | 5 | Reserved, do not use | |
| | 6 | RXN | Receive data - |
| | 7 | Reserved, do not use | |
| | 8 | Reserved, do not use | |
| | A | + (24 V) | Power supply |
| | B | M (0 V) | Electronics ground |
| Type: RJ45 plus socket<br>Blanking plates for DRIVE-CLiQ interfaces are included in the scope of delivery. | | | |

**Note**

Only MOTION-CONNECT DRIVE-CLiQ cables may be used to establish connections.
The maximum lengths of MOTION-CONNECT 500 and MOTION-CONNECT 800 cables are 100 m and 50 m respectively.

### 5.7.2.6 Cable lengths

Table 5- 38 Cable length of P24 supply cable:

| Connected consumers 1) | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Cross section | | | | | |
| 0.34 mm² | 75 m | 45 m | 30 m | 25 m | 20 m |
| 2 x 0.34 mm² | 100 m | 90 m | 65 m | 50 m | 40 m |
| 0.75 mm² | 100 m | 100 m | 75 m | 60 m | 50 m |
| 2 x 0.75 mm² | 100 m | 100 m | 100 m | 100 m | 100 m |
| 1) Connected motors with DRIVE-CLiQ encoder, DRIVE CLiQ mounted encoder SME | | | | | |
| Ta = 55 °C<br>100 m DRIVE-CLiQ | | | | | |

### 5.7.2.7 Specifications for use with UL approval

#### Pre-assembled cables

Sensor/actuator cable, 5-pin, variable cable,
free cable end at straight socket M12-SPEEDCON,
cable length: 2, 5, 10, 15 m
SAC-5P-xxx-186/FS SCO
Up to 100 m on request

Phoenix Contact, www.phoenixcontact.com

#### Cables to be assembled by the user

Table 5- 39 Assembled by the user

| Cable | Connector |
|---|---|
| Cable coil, black PUR/PVC, 5-pin<br>Conductor colors: brown/white/blue/black/gray<br>Cable length: 100 m<br>SAC-5P-100.0-186/0.75<br>Order number: 1535590 | Sensor/actuator connector, socket, straight, 5-pin, M12, A-coded<br>Screw connection, metal knurl, cable gland Pg9<br>SACC-M12FS-5CON-PG9-M<br>Order number: 1681486 |
| Phoenix Contact, www.phoenixcontact.com | |

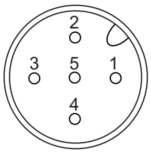
#### Power supply

The DME20 must be connected to a 24 V power supply with voltage limitation.

- SITOP 6EP1x.. or 6ES7307..
- SINAMICS Control Supply Module 6SL3100-1DE22-0Axx

## Pin assignment of the cable

Table 5- 40 Connection to X524 electronics power supply

| | Pin | Designation | Technical specifications |
|---|---|---|---|
|  | 1 (brown) 1) | Electronics power supply | The connection voltage of 20.4 V – 28.8 V refers to the (terminal) voltage at the DME20. This must be taken into account when selecting the cable cross-section and supply cable lengths.<br>Pins 1 and 2: jumpered internally<br>Pins 3 and 4: jumpered internally |
| | 2 (white) 1) | Electronics power supply | |
| | 3 (black) 1) | Electronics ground | |
| | 4 (blue) 1) | Electronics ground | |
| | 5 (gray) 1) | Not connected internally | |

1) The colors stated refer to the cable specified above

### 5.7.2.8 Dimension drawing

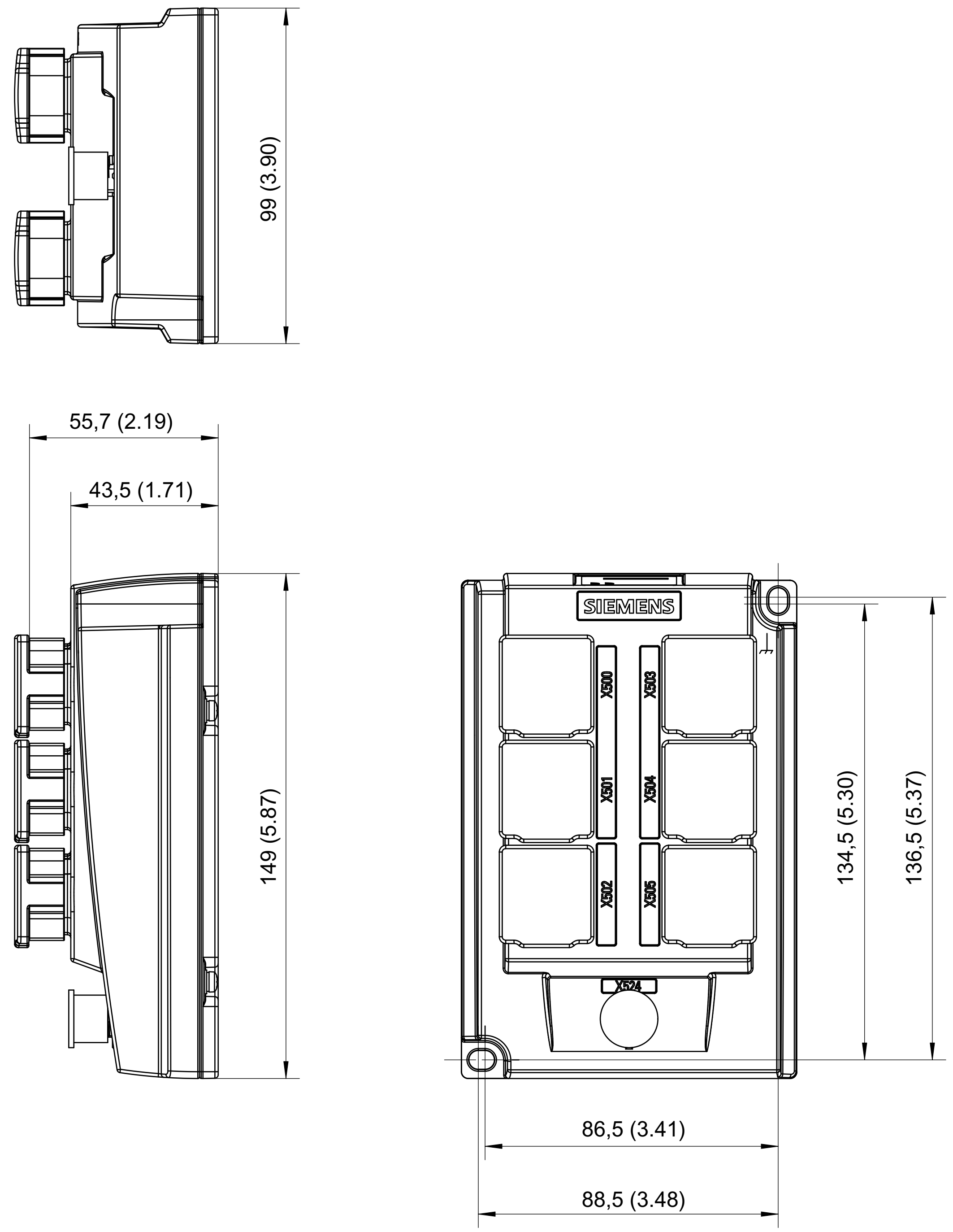



Figure 5-35 Dimension drawing: DME20

### 5.7.2.9 Installation

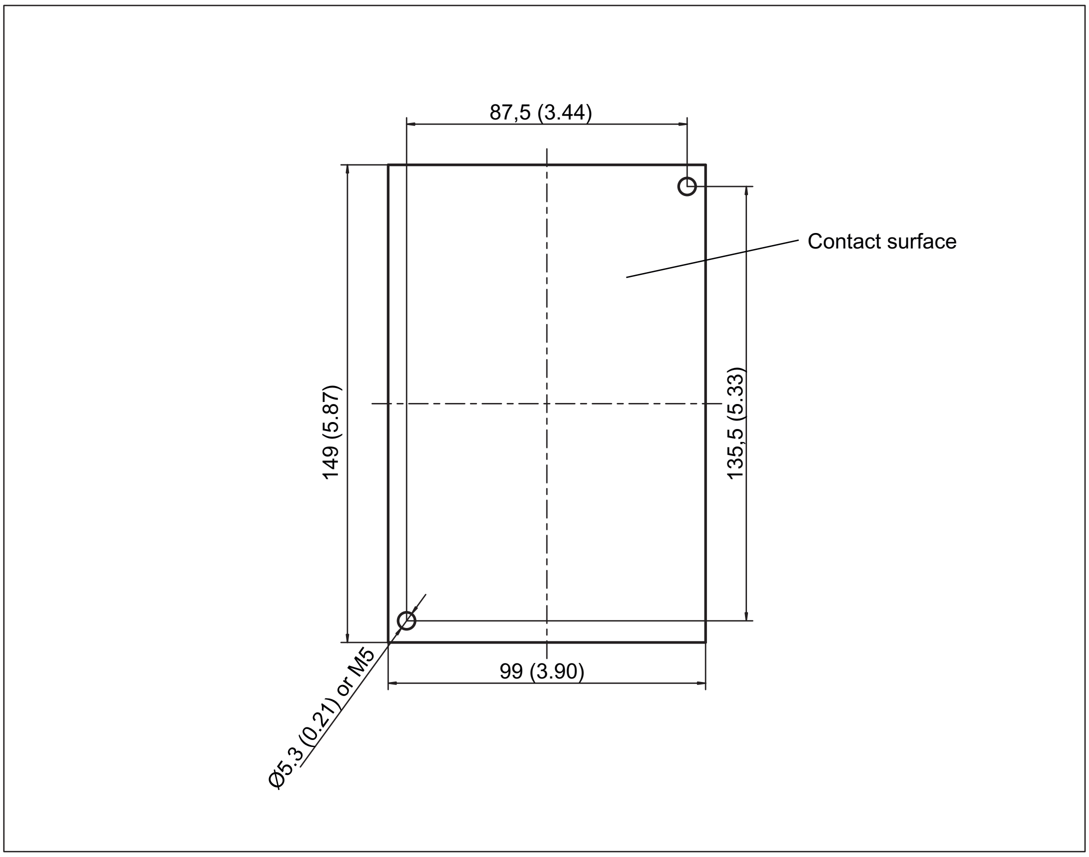



Figure 5-36 DME20 installation

### Installation

1. Place the hole drilling template on the contact surface.
2. The contact surfaces must be unpainted metal.
3. Holes Ø5.3 or threads M5
4. Tighten with a tightening torque of 6.0 Nm.

### 5.7.2.10 Technical data

Table 5- 41 Technical data of the DME20

| | Unit | Value |
|---|---|---|
| Electronics power supply<br>Voltage<br>Current (without DRIVE-CLiQ node) | <br>$V_{DC}$<br>$A_{DC}$ | <br>24 DC (20.4 – 28.8)<br>0,15 |
| PE/ground connection | Fastened to housing M5 / 6 Nm | |
| Degree of protection | IP67 | |
| Weight | kg | 0,8 |

## 5.8 Electronics Power Supply

For the electronics power supply, a differentiation is made between:

- external power supply with SITOP modular
- internal power supply with Control Supply Module (CSM)

### 5.8.1 External power supply (SITOP modular)

An external SITOP modular power supply must be provided for the electronics power supply of the individual SINAMICS components. This ensures the trouble-free operation of all SINAMICS components. The SITOP electronics power supply also has the advantage that the power supply is already equipped with an internal line filter (class B in accordance with EN55022). This ensures an EMC-conform operation.

If a power supply other than SITOP is used, the required rated data (see Equipment Manual for Booksize Power Units) must be observed to ensure a trouble-free operation.

24 VDC power is required to supply

- the electronics of the SINAMICS components using the integrated 24 V busbar
- the electronics for Control Units, Option Boards and Sensor Modules, and the process voltage of their digital inputs
- the load voltage of the digital outputs
- the motor holding brakes

Other consumers may be connected to the power supply devices provided they have separate protection against excess current.

| ⚠ CAUTION |
|---|
| If other consumers are connected to the power supply, switch inductances (contactors, relays) must be provided with suitable over-voltage protective circuits. |

The operation of motors with integrated holding brake requires a regulated DC power supply. The power is supplied from the internal 24 V busbars. The voltage tolerances of the motor holding brakes and the voltage losses of the connection cables must be observed.

The DC power supply should be set to 26 V. The Control Supply Module supplies 26 V. This ensures that the voltage supplied to the brake lies within the permitted range when the following general conditions are satisfied:

- Use of Siemens three-phase motors
- Use of Siemens MOTION-CONNECT power cables
- Motor cable lengths maximum 100 m

### 5.8.2 Selection of the Power Supply Devices

Devices specified in the following table are recommended. These devices satisfy the associated EN 60204-1 requirements.

Table 5- 42 SITOP Power modular recommendation

| Rated output current [A] | Input voltage range [V] | Short-circuit current [A] | Order number |
|---|---|---|---|
| 5 | 2AC 85-132/170 – 550 | 5.5 | 6EP1333-3BA00 |
| 10 | 2AC 85-132/176 – 550 | 30 for 25 ms | 6EP1334-3BA00 |
| 20 | 3AC 320 – 550 | 23 | 6EP1436-3BA.0 |
| 40 | 3AC 320 – 550 | 46 | 6EP1437-3BA.0 |

Table 5- 43 Control Supply Module recommendation

| Rated output current [A] | Input voltage range [V] | Short-circuit current [A] | Order number |
|---|---|---|---|
| 20 | 3AC 380 -10% (-15% < 1 min) to 3AC 480 +10% | DC 300 – 800 < 24 | 6SL3100-1DE22-0AA0 |

See also NC61 catalog.

**WARNING**

When external power supplies, such as SITOP, are used, the ground potential must be connected to the protective conductor connection (PELV).

### 5.8.3 24 V current consumption of the components

A separate 24 V power supply must be used for the SINAMICS S120 drive group.

The following table can be used to calculate the 24 VDC power supply for the components. The values of the typical power consumption serve as configuring basis.

Table 5- 44 Overview of 24 VDC current consumption

| Component | Typical current consumption [$A_{DC}$] |
|---|---|
| NCU 7x0 (without load at the digital outputs) | 2.1 |
| NX1x | 0.8 |
| CSM | 1.1 |
| CU320 without load<br>each digital output<br>PROFIBUS Teleservice | 0.8<br>0.1 |
| CBC10 | 0.1 |
| **Active Line Modules** | |
| 16 kW | 1.1 |
| 36 kW | 1.5 |
| 55 kW | 1.9 |
| 80 kW | 1.7 |
| 120 kW | 2.1 |
| **Smart Line Modules** | |
| 5 kW | 0.9 |
| 10 kW | 1.0 |
| 16 kW | 1.1 |
| 36 kW | 1.5 |
| **DRIVE-CLiQ and brake** | |
| DRIVE-CLiQ (e.g. motors with DRIVE-CLiQ interface) | typ. 0.25, max. 0.45 |
| Brake (e.g. motor holding brake) | typ. 0.4 to 1.1; max. 2 |
| **Single Motor Modules** | |
| 3 A (+ 1 x DRIVE-CLiQ; + 1 x brake) | 0.85 |
| 5 A (+ 1 x DRIVE-CLiQ; + 1 x brake) | 0.85 |
| 9 A (+ 1 x DRIVE-CLiQ; + 1 x brake) | 0.85 |
| 18 A (+ 1 x DRIVE-CLiQ; + 1 x brake) | 0.85 |
| 30 A (+ 1 x DRIVE-CLiQ; + 1 x brake) | 0.9 |
| 45 A (+ 1 x DRIVE-CLiQ; + 1 x brake) | 1.2 |
| 60 A (+ 1 x DRIVE-CLiQ; + 1 x brake) | 1.2 |
| 85 A (+ 1 x DRIVE-CLiQ; + 1 x brake) | 1.5 |
| 132 A (+ 1 x DRIVE-CLiQ; + 1 x brake) | 1.2 |
| 200 A (+ 1 x DRIVE-CLiQ; + 1 x brake) | 1.2 |
| **Double Motor Modules** | |
| 2 x 3 A (+ 2 x DRIVE-CLiQ; + 2 x brake) | 1.15 |
| 2 x 5 A (+ 2 x DRIVE-CLiQ; + 2 x brake) | 1.15 |
| 2 x 9 A (+ 2 x DRIVE-CLiQ; + 2 x brake) | 1.15 |
| 2 x 18 A (+ 2 x DRIVE-CLiQ; + 2 x brake) | 1.3 |
| **Sensor Modules Cabinet** | |
| SMC 10 | 0.25 |
| SMC 20 | 0.25 |
| SMC 30 | 0.33 |

| Component | Typical current consumption [$A_{DC}$] |
|---|---|
| **Sensor Modules External** | |
| SME 20 | 0.19 |
| SME 25 | 0.19 |
| SME 120 | 0.24 |
| SME 125 | 0.24 |
| **Additional system components** | |
| Braking Module | 0.5 |

The details apply to Motor Modules / Line Modules with internal/external heat dissipation.

## 5.8.4 Calculation of the 24 VDC Power Requirement Example

Table 5- 45 Example of 24 V DC current requirements

| Component | Number | Current consumption [A] | Total current consumption [A] |
|---|---|---|---|
| NCU7x0<br>8 digital outputs | 1<br>8 | 2,00<br>0,01 | 2,00<br>0,08 |
| Active Line Module 36 kW | 1 | 1,50 | 1,50 |
| Motor Module 18 A | 2 | 0,85 | 1,70 |
| Motor Module 30 A | 3 | 0,90 | 2,70 |
| SMC | 5 | 0,25 | 1,25 |
| Brake | 5 | 1,10 | 5,50 |
| **Total:** | | | **14,73** |

The following conditions should be considered for the configuring:

- The line infeed of the power supply devices must be tapped in front of the line filter of the Line Module.
- The line connection of the power supply should be made directly and without additional switched feeders.
- The dimensioning of the output rated current of the power supply is determined by the load of the connected consumers.
- A load reserve should be provided; a utilization of 0.7 to 0.8 $I_N$ is recommended.
- The total length (sum of all cables) of the supply cables for the 24 VDC electronic power supply between the power supply and the SINAMICS components must not exceed 10 meters.
- The connection cable does not need to be shielded nor twisted. The maximum value of the ripple voltage, however, must not be exceeded. If this is the case, appropriate measures must be adopted.
- Where possible, the additional supply for consumers exterior to the SINAMICS system, such as contactors, valves, etc., should come from a separate power supply. This reduces any interactions (voltage dips, etc.).

### 5.8.5 Assignment of the power supply to other components

For Smart/Active Line Module, Motor Module and for the NX component, the supply voltage is monitored by the system. The components are connected using DRIVE-CLiQ; the monitoring is performed in the Control Unit.

#### Connection via 24 V terminal adapter

The component's front cover will need to be opened before establishing a 24 V connection to a module in booksize format. This exposes other live components, such as DC link busbars.

> ⚠ **DANGER**
>
> **Risk of electric shock**
>
> A hazardous DC link voltage is present for up to 5 minutes after the power supply has been switched off.
> The protective cover may only be opened after this time has elapsed.
>
> When opening the protective cover for the DC link, you must press the release catch. A suitable tool (e.g. screwdriver or supplied unlocking tool) must be used for this purpose.

An integrated 24 VDC busbar is used for the electronic power supply of the Line/Motor/Braking and Capacitor Modules. The current carrying capacity of this busbar is max. 20 A. The integrated busbar also supplies the motor brake control terminals of the Motor Modules.

The infeed of the electronic power supply is normally made directly on the Line Module using the 24 V terminal adapter (max. connectable cross-section 6 mm², max. fuse 20 A) supplied with the Line Modules.

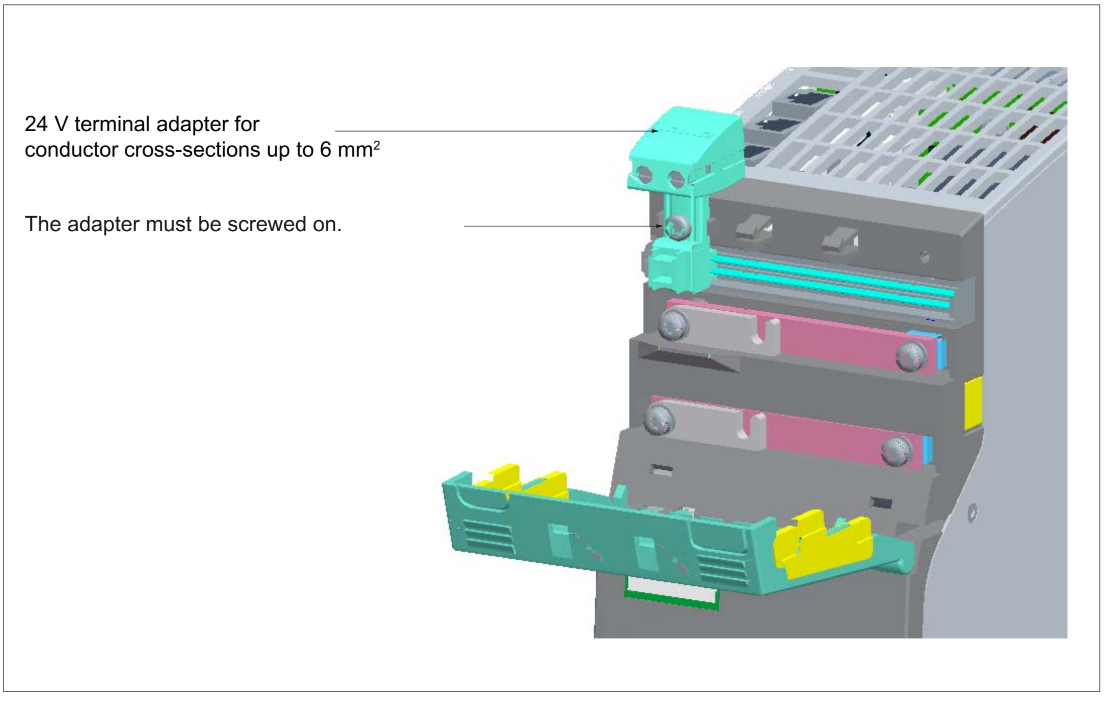



Figure 5-37 24 V terminal adapter on the booksize module, front cover open

The 24 V busbar is used to pass the 24 VDC power between the individual components. 24 V jumper plugs (supplied with the Line Modules) are used to jumper the 24 V busbar at the component transitions.

If the maximum current carrying capacity (20 A ) of the 24 V busbar is exceeded, an additional electronic current infeed must be provided. This must be implemented, for example, on a Motor Module using an additional 24 V terminal adapter, which must be ordered separately (order no. 6SL3162-2AA00-0AA0). The 24 V busbar must not be jumpered upstream of the new infeed, because a new potential begins downstream of the additional infeed.

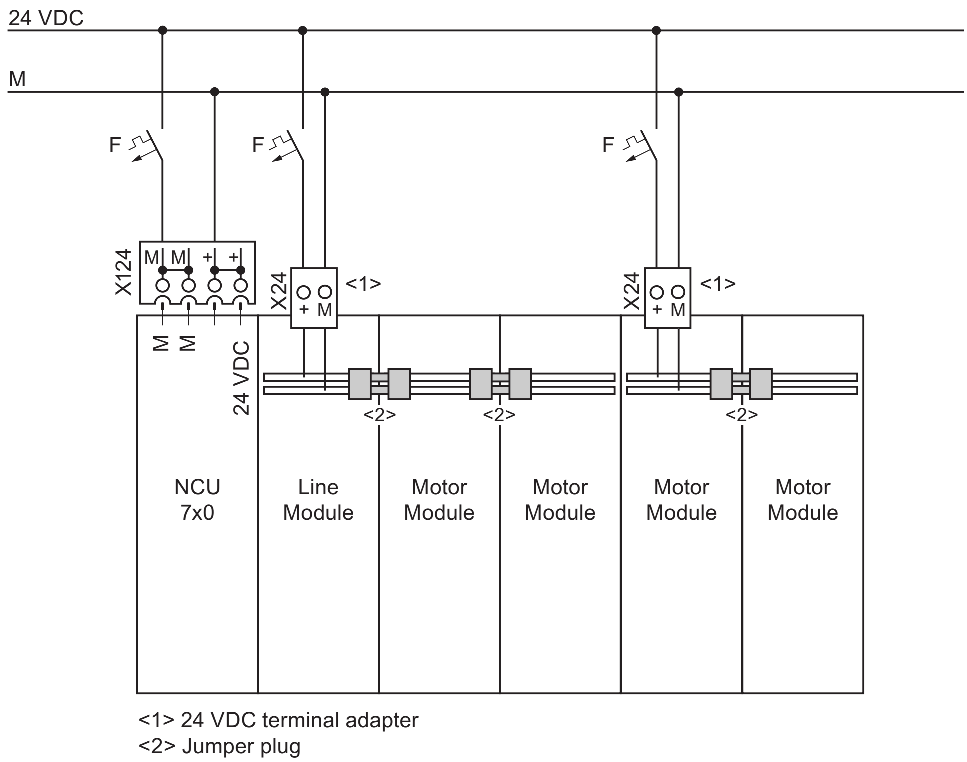



Figure 5-38 Electronic power supply infed more than once

For all other components, such as Control Unit or Sensor Module, the electronic power supply is connected using appropriate infeed plugs at the associated component. The infeed plugs are identical for all components. The maximum connectable cross-section is 2.5 mm$^2$ and the maximum current carrying capacity is 20 A.

To improve the wiring of the individual components with each other, a potential jumpering at the infeed plugs is possible. The total current of all attached components, however, must not exceed 20 A.

Power is supplied to the digital inputs/outputs at the Control Unit and Sensor Module, for example, via appropriate terminals (max. 0.5 mm$^2$).

## 5.8.6 Overcurrent protection

On the primary side and on the secondary side of the power supply device, devices and cables must be protected from over-current using suitable protection devices.

### Primary side

Recommended circuit-breakers (IEC 898) in the suppy cable can be found in the technical data of the SITOP devices in the KT 10.1 catalog. The cable cross-section must be considered.

The primary protection is responsible for providing device protection for the SITOP power supply as well as line protection between the protective device and the power supply.

### Secondary side

For the protection of the secondary side, particular attention must be paid to:

- Loading due to loads, possibly the simultaneity factor in response to machine operation
- The current carrying capacity of the cables in normal operation and in a short-circuit situation
- The ambient temperature
- The effect of bundling together cables, e.g. where these are laid in a common duct
- Cable laying method to EN 60204-1

EN 60204-1, Section 14, can be used to determine the overcurrent protection devices.

### Protection of the load feeders

Load feeders must be protected selectively. Circuit-breakers are suitable (order no.: 5S…, ETB1 catalog) or the SITOP select diagnostic component (order no.: 6EP1961-2BA.0).

Configuration details for the secondary protection of the load feeders are contained in the KT 10.1 catalog (SITOP Power Supplies, "Technical Information and Configuration Notes" section).

The rated size of the protective devices depends on the current need. The protective device also performs the line protection and sometimes also the device protection of the attached consumers. In a fault situation, the used power supply must be able to supply the required power until being controlled.

Regulated power supplies (such as SITOP power) must be provided, in accordance with EN 60204-1, with integrated electronic short-circuit protection capable of independently protecting SITOP power and the supplied 24 VDC circuits against overloading in the event of overloads/short circuits.

### Circuit-breakers

When selecting circuit breakers from the table below, the following cable conditions need to be considered:

- Ambient temperature 40 °C or 55 °C
- Max. 1 conductor pair bunched
- Conductor limit temperature 70 °C for normal operation
- Maximum cable length:
  - 10 m for the supply cables
  - 30 m for signal lines
- To be laid separately from other cables and conductors carrying operating current
- Cable type: PVC conductor cable

Table 5- 46 Types of circuit breaker depending on conductor cross-section and temperature

| Conductor cross-section | Max. value up to 40 °C | Max. value up to 55 °C |
|---|---|---|
| 1.5 mm$^2$ | 10 A | 10 A |
| 2.5 mm$^2$ | 20 A | 10 A |
| 4 mm$^2$ | 25 A | 16 A |
| 6 mm$^2$ | 32 A | 20 A |
| 24 V busbar | 20 A | 20 A |

The tripping characteristic of the circuit-breakers must be chosen appropriately for the consumers to be protected and the maximum current provided by the power supply device in a short-circuit situation.

The MCBs can be selected according to Siemens catalog "BETA Modular Installation Devices - ET B1".

### 5.8.7 Line formation

The corresponding different supply lines should be configured and constructed depending on the size of the drive group and the overall length. This ensures that should one line fail, the power supply to all attached consumers does not fail. The fault-free consumer lines remain operational.

The maximum connectable cross-section of the consumers must also be considered:

- 6.0 mm$^2$ for the 24 V power supply terminal adapter of the power busbar
- 2.5 mm$^2$ for the 24 V power supply infeed terminal of the CU and SMC components
- 0.5 mm$^2$ for the digital inputs/outputs and analog inputs/outputs

Example for the splitting of the consumer lines:

- NCU / NX
- Line / Motor Modules
- Supply of the Sensor Modules
- Consumers such as relays, valves, etc.
- Additional brakes not supplied from the Motor Module

Multiple power supplies are recommended for larger plant concepts.

Example of the separation:

- Power supply for the direct drive system (NCU, NX, LM, MM, SME and SMC)
- Power supply for additional consumers, such as brakes, valves and power contactors

If required, the circuit-breakers can be equipped with additional auxiliary switches. If these signal contacts are fed to a higher-level controller, a detailed fault diagnosis can be performed when the circuit-breakers trip.

## Notes

- SINAMICS components have a reverse polarity protection on the 24 VDC infeed side.
- Line, Motor, Braking, Capacitor and Control Supply Modules are short-circuit resistant on the 24 V busbar for a maximum current of 20 A. The 24 V terminal adapter for the infeed has a maximum connection cross-section of 6 mm$^2$.
- If no higher short-circuit current can occur, a protection can be omitted. This means the components can be connected directly to the power supply.
- If higher short-circuit current occur, a protection against over-current / short-circuit must be provided, max. 20 A, however. In a fault situation, the used power supply must be able to supply the required current until tripping.
- The maximum protection of the power supply infeed for Control Unit and Sensor Module Cabinet depends on the connected cable cross-section (max. 2.5 mm$^2$), maximum 20 A, however.
- The maximum protection of the controller inputs/outputs at the other components depends on the connected cable cross-section:

Table 5- 47 Controller inputs/outputs and their connectable cross-sections

| Component | max. cable cross-section |
|---|---|
| Control Unit | 0.5 mm$^2$ |
| Sensor Module Cabinet (SMC) | 1.5 mm$^2$ |
| Smart Line Module | 1.5 mm$^2$ |
| Active Line Module | 1.5 mm$^2$ |
| Motor Module | 1.5 mm$^2$ |

- Controller outputs at the Line, Motor and Braking Module, Control Unit and Sensor Module Cabinet are short-circuit resistant.

### 5.8.8 Power Supply Connection Example

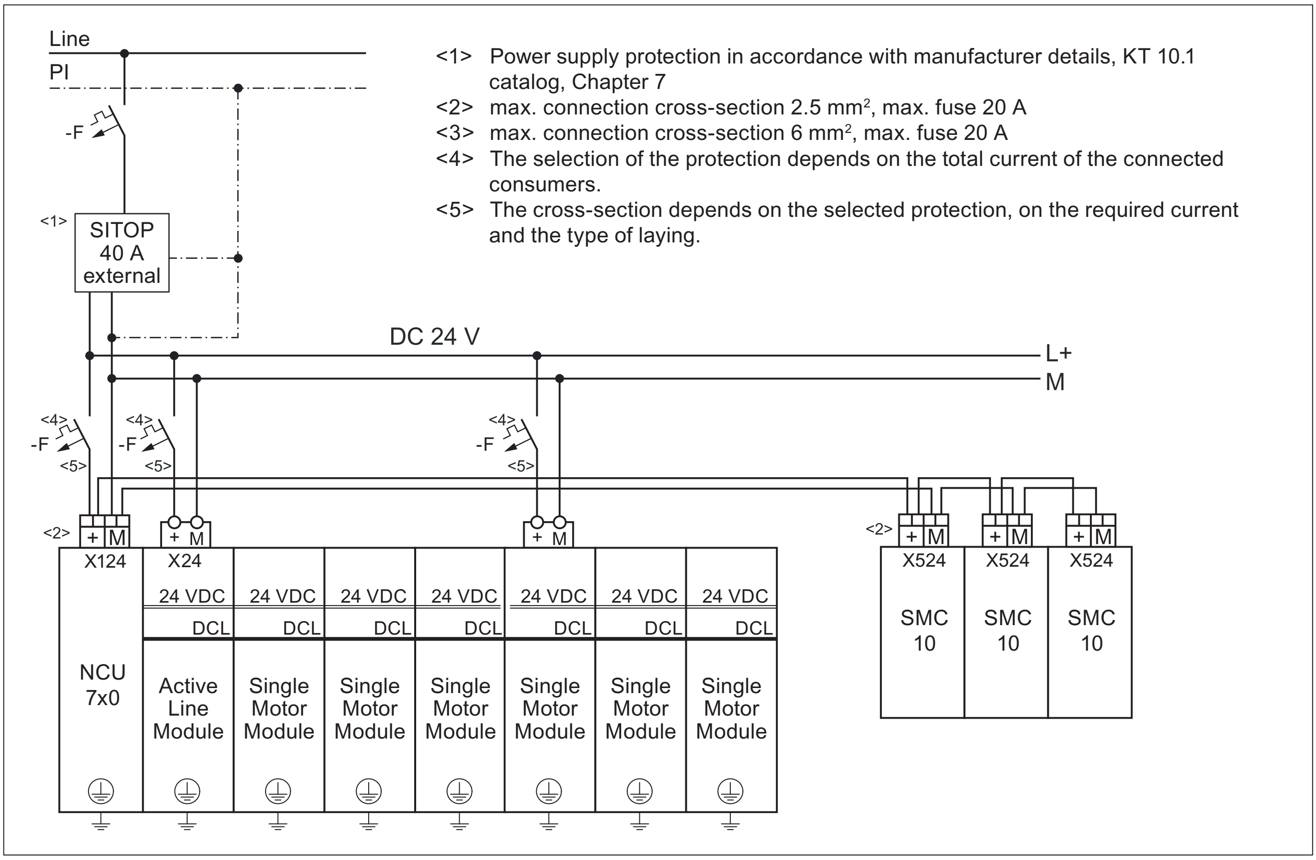



Figure 5-39 Power Supply Connection Example

## 5.9 Control Supply Module (CSM)

The Control Supply Module (CSM) is a 24 VDC power supply unit integrated as a separate SINAMICS component in the drive group.

The CSM supplies all SINAMICS components in the drive group and also components, such as Control Unit or Sensor Module Cabinet with 24 VDC. The maximum output current is 20 ADC. An external power supply is not essential.

Only the power supply network is used for the startup of the CSM. As an option, the CSM provides the 24 VDC power supply via the line voltage or, in a fault situation (e.g. power failure), from the DC link of the drive group. The switching is performed automatically internal in the CSM.

The functionality of the complete drive group can be retained should the line power supply fail. Depending on the energy content in the DC link, the CSM can maintain the supply of the 24 V busbar. This allows transient line fluctuations to be bridged without the drive group failing.

To achieve longer bridging times, additional Capacitor Modules can be used to increase the DC link capacity. The consequent increased storage capacity of the DC link acts positively should the line voltage drop.

Specific emergency return movements, such as those required in the machine tool area, can also be initiated. This is necessary, for example, to stop fast rotating spindles as fast as possible or to protect expensive workpieces by making appropriate return movements of the axis. Further measures, however, must be considered for the realization.

## CSM for line failure

For the planning of the line failure concepts, those components located outside the SINAMICS drive group must also be considered (line contactor, controller, etc.).

If, in the event of a fault, the primary energy supply of the CSM comes from the DC link, this can be performed only in the voltage range $U_{DC\ link}$ = 430 - 882 $V_{DC}$ (300 - 430 $V_{DC}$ for < 1 min). If these limits are overshot or undershot, the corresponding error messages will be generated by the system and internal pulse suppression will be triggered. The drives coast to a standstill and can no longer be controlled!

To limit the maximum/minimum DC link voltage, the use of Capacitor and Braking Modules may be necessary.

---

**Note**

The supply voltage corresponds to PELV (protective extra-low voltage). The required connection of the ground potential to the protective conductor system is realized in the CSM.

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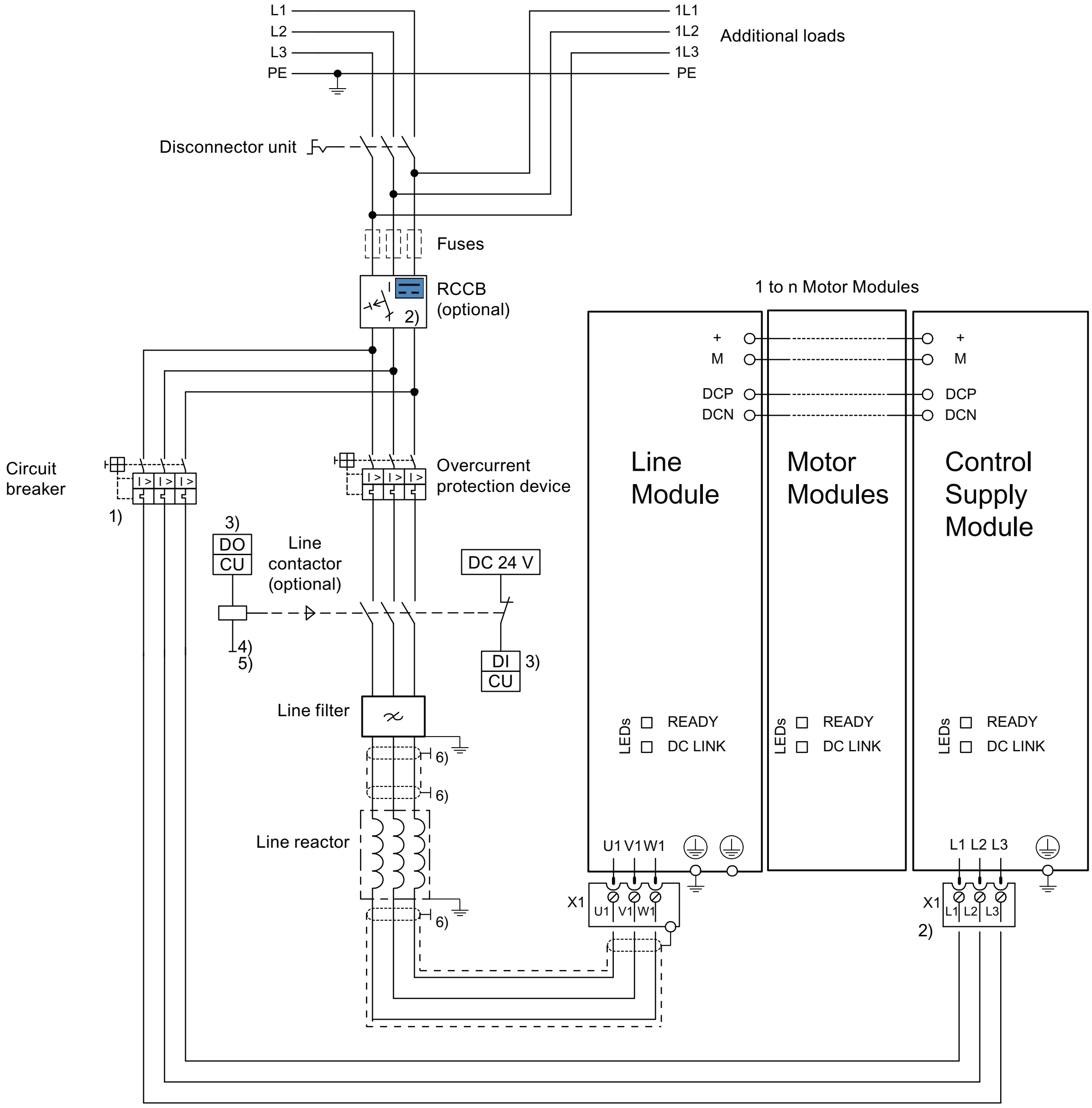
## 5.9.1 Connection example




1) Permissible types:
   a) SIRIUS circuit breaker, 3RV 1021 1DA10, set to 3A
   b) KTS-R-6 branch circuit fuse (class RK1)
2) The line supply connection must be established at all times.
3) DI/DO, controlled by the Control Unit
4) No additional load permitted downstream of line contactor
5) The current carrying capacity of the DO must be observed; an output coupling device must be used if required.
6) Contact through the rear of the mounting surface or shielding buses in accordance with the EMC Directive

Figure 5-40 Example connection of Control Supply Module

The Control Supply Module (CSM) is connected to the line supply (380 V 3 AC –10 % up to 480 V +10 %) via the appropriate screw terminals (0.2 to 4 $mm^2$). This connection should preferably be made without using an isolating device (e.g. contactor).

The CSM has an internal line filter (Class A for TN line supplies), and the pre-charging circuit for the DC link inside the unit is electrically isolated from the 24 V supply.

The CSM also features a current limitation function. If cables with a cross-section of 2.5 $mm^2$ are used and a maximum operating temperature of 40 °C is observed, there is no need for additional fuse protection on the 24 V side, nor do the cables on that side have to be laid in a way that makes them short-circuit proof.
If it is necessary to create multiple branches, we recommend using a SITOP select diagnostics module as a form of overcurrent protection. You can find more information on fuse protection in the chapter titled "Control cabinet installation and EMC".

---

Note

If a selectively tripping, AC/DC-sensitive RCCB is used for the drive line-up, the Control Supply Module must always be connected to the line supply downstream of this circuit breaker.

---

Note

Connecting to the line

When engineering the line supply of the CSM, it should be noted that the CSM may not be connected to the line supply after the Line Module is connected to the line supply. When charging, this prevents the DC link from being immediately loaded by the CSM.

---

Note

Using several Control Supply Modules

It is possible to use several CSMs in one DC link, but they must not be connected in parallel. An individual line, complete with 20 A fuse protection, must be created for each CSM.

---

Note

Installation of the 24 V terminal adapter

If necessary, the 24 V terminal adapter can be installed on the right-hand side of the CSM. The adapter must be screwed tight using the screw supplied.

---

### 5.9.2 Criteria for the protection, line formation and monitoring

Devices and cables must be protected against overload and short-circuit in accordance with the manufacturer's specifications and appropriate standards.

The primary protection is performed by the device protection of the CSM power supply and the line protection between the protective device and the power supply.

Recommended circuit-breakers (IEC 898) in the suppy cable can be found in the technical data in the Equipment Manual for Booksize Power Units. The appropriate cable cross-section must be considered.

The 24 VDC output circuit of the CSM must normally use an appropriate protection to protect the device in an overload/short-circuit situation.

Regulated power supplies, such as the CSM in contrast, are equipped with an integrated electronic short-circuit protection as required by the EN 60204-1 standard for the electronic equipment for machines, that independently protects the CSM and the supplied 24 VDC circuits against over-current in an overload/short-circuit situation. This applies, for example, to the direct power supply for the drive group via the 24 V busbar.

The corresponding load feeders must be selectively protected for the supply to external components. Circuit-breakers are suitable (order no.: 5S…, ETB1 catalog) or the SITOP Select diagnostic module (order no.: 6EP1961-2BA.0). The rated size of the protective devices depends on the required current. The protective device also performs the line protection and sometimes also the device protection of the attached consumers. In a fault situation, the CSM must be able to supply the required current until tripping.

The cable layout of the external consumers must conform to the associated conditions:

- The loading by the attached consumers (also refer to the Equipment Manual for Booksize Power Units); the concurrency factor depending on the operation of the machine may need to be considered.
- Current carrying capacity of the conductors used and cables in normal and short-circuit conditions
- The ambient temperature
- Cable bundling (e.g. laying in a common duct)
- The cable types

EN60204-1 and EN 60439 (VDE 660, Part 500) can be referred to when selecting the overcurrent protective devices.

If required, the circuit-breakers can be equipped with additional auxiliary switches. If these signal contacts are fed to a higher-level controller, a detailed fault diagnosis can be performed when the circuit-breakers trip.

### 5.9.3 Interconnection of the voltage output for the CSM

#### Interconnection of the 24 VDC voltage output for the Control Supply Module

- Exclusive supply of the drive group
  The appropriate jumper plugs are used to connect the secondary 24 VDC voltage output to the 24 V busbar of the drive group. It is not permissible to connect a number of CSM modules in parallel using 24 V jumper plugs. This means the Control Supply Module only supplies the drive group consisting, for example, of Line, Motor, Capacitor and Braking Modules.

  An additional SITOP Modular power supply must be provided to supply power to the other external consumers.
- Supply of external components, such as CU and SMC
  An appropriate connection adapter can be used to supply power for external consumers as well. For example, only a specific Control Supply Module can be used for these consumers. This means an external power supply can be omitted.

| NOTICE |
| --- |
| The maximum current carrying capacity of the DC link busbars is 100 A. This must be considered for the positioning of the CSM in the drive group. The CSM must not be installed between or in front of the 300 mm components! In preference, the CSM should be placed at the end of the drive group. |

**Note**

The maximum length of the supply cables for the 24 VDC electronic power supply between the power supply and the SINAMICS components must not exceed 10 meters. The connection cable does not need to be shielded nor twisted. The maximum value of the ripple voltage, however, must not be exceeded. If this is not the case, shielded or twisted cables should be used.

## Use of several Control Supply Modules, division of the consumer lines

An additional CSM must be provided if the load caused by the supplied consumers causes the maximum output current (20 A) of the CSM to be exceeded. The 24 VDC busbar must not be jumpered in front of the new infeed, because a new potential begins after the additional infeed.

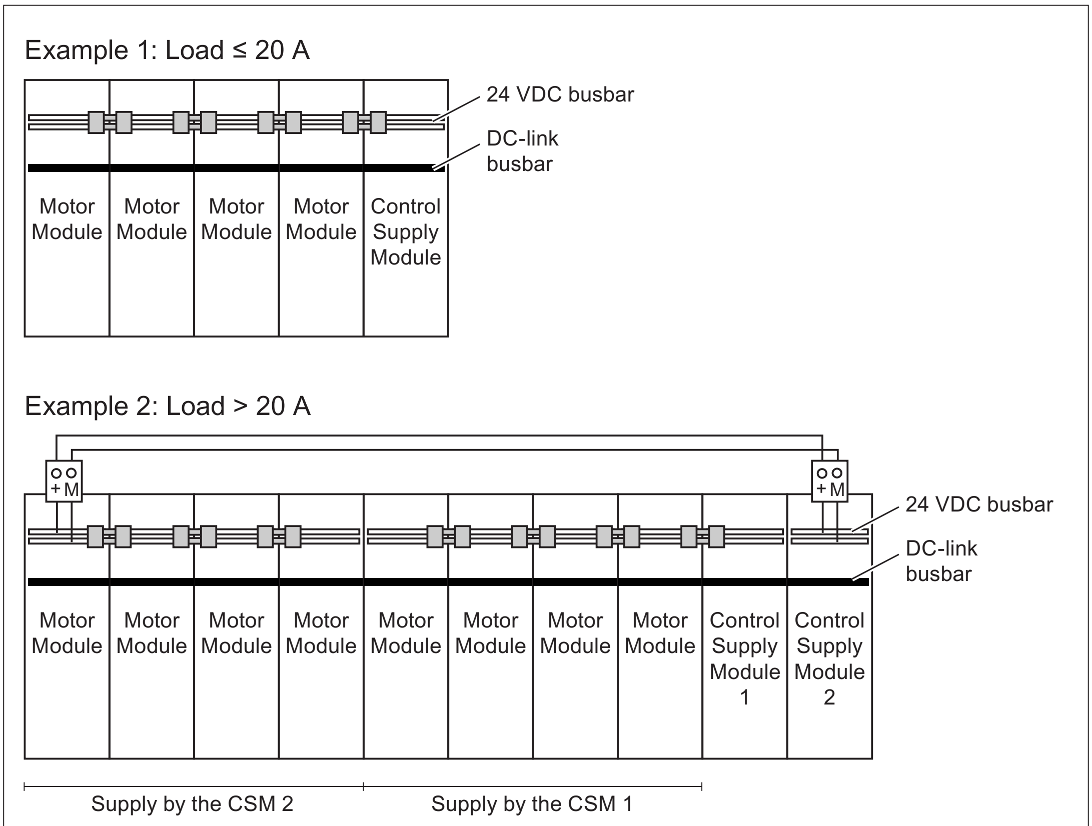



Figure 5-41 24 VDC division

The corresponding different supply lines must be configured and constructed depending on the size of the drive group and the overall length. This ensures that should one line fail, the power supply to all attached consumers does not fail. The fault-free consumer lines remain operational.

Multiple Control Supply Modules are recommended for larger plant concepts. This achieves a decoupling and reduces possible influencing of the supplied components amongst each other.

### Example: Subdivision of the consumer groups:

- CSM for the direct drive system (CU, Line Module, Motor Module and SMC)
- CSM for additional consumers, such as brakes, valves and power contactors

**Example: Division of protection (e.g. automatic devices) for consumer lines**

- NCU
- Supply of the Sensor Modules
- Consumers such as relays, valves, etc.

| ⚠ DANGER |
| --- |
| The Control Supply Module has two supply circuits!<br>Risk of electrical shock. Dangerous voltage present for as long as five minutes after the supply has been switched off.<br>The protective cover may be opened only after this time has expired.<br><br>When opening the protective cover for the DC link, you must press the release catch. A suitable tool (e.g. unlocking tool for opening the DC link protective covers) must be used for this purpose.<br><br>The components may be operated only when the protective covers of the DC link are closed. Damaged components (e.g. with a defective lock on the protective cover) must not be operated any longer. |

| CAUTION |
| --- |
| The danger note for the DC link discharge time must be placed on the component in the national language.<br><br>A set of labels in 16 languages is provided with the component. |

### 5.9.4 Control Supply Module Power Supply - Connection Example

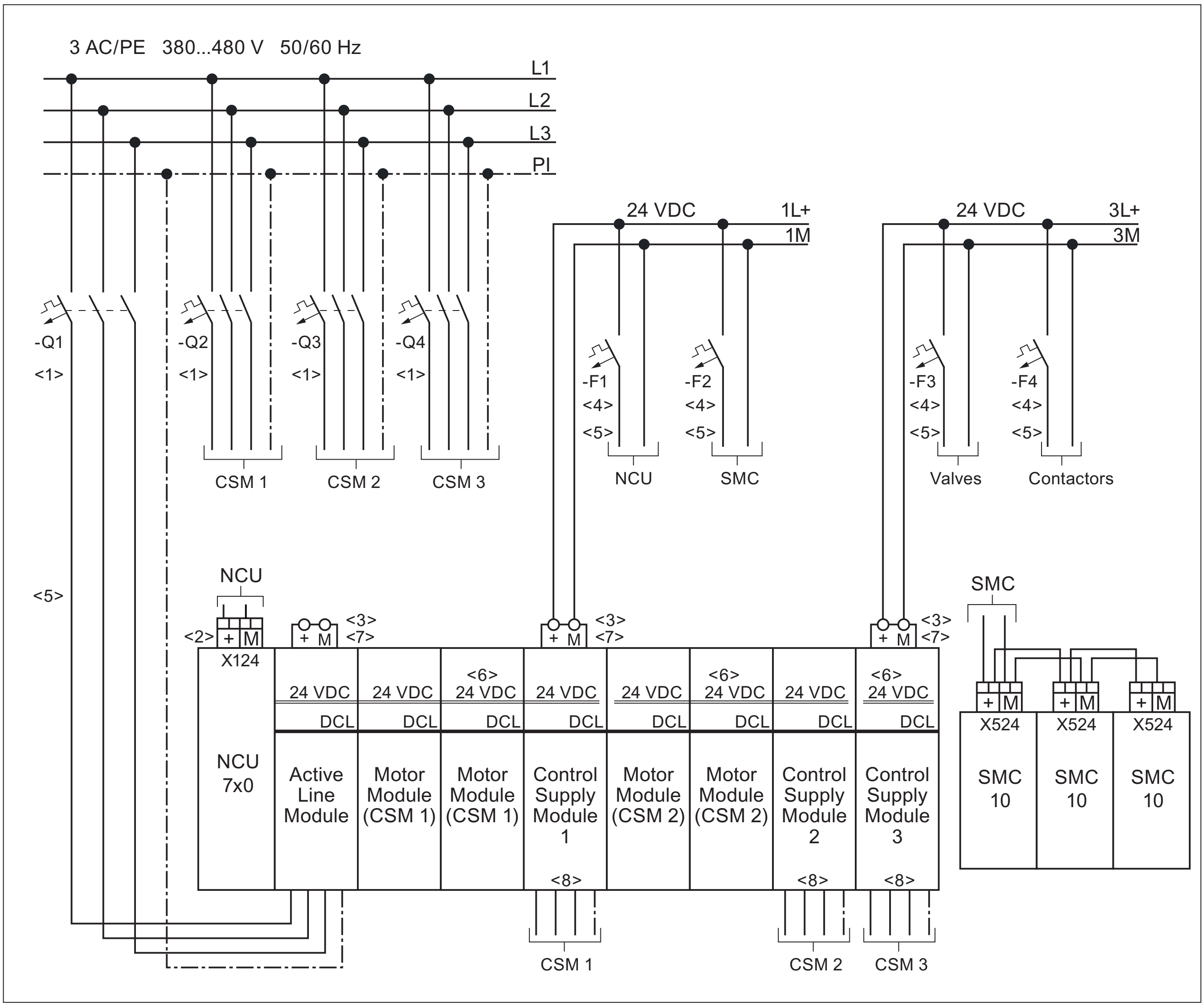



Figure 5-42 CSM power supply connection example

1. Protection using the manufacturer's specifications
2. Max. connection cross-section 2.5 mm², max. fuse 20 A
3. Max. connection cross-section 6 mm², max. fuse 20 A
4. The selection of the protection depends on the total current of the connected consumers.
5. The cross-section depends on the selected protection and on the required current.
6. The current carrying capacity of the 24 VDC busbar is max. 20 A; if this value is exceeded, the 24 V busbar must be interrupted and an additional supply selected.

7. The 24 VDC terminal adapters are included with the supplied Line Module. If additional terminal adapters are required, they must be ordered separately (6SI3162-2AA00-0AA0).
8. Observe the maximum current carrying capacity of the DC link busbar on the Control Supply Module (100 A) when the drive group is put together; see also Section Current Carrying Capacity of the DC Link Busbar (Page 30).

# 5.10 Cable Lengths

## 5.10.1 General information

**⚠ DANGER**

If the shielding procedures described and the specified cable lengths are not observed, the machine may not operate properly.

## 5.10.2 Cable shielding and routing

In order to comply with the EMC requirements, certain cables must be routed apart from other cables and from certain components. To full EMC requirements, the following cables must be used with shields:

- Line supply conductors from line filter via line reactor to Line Module
- All motor cables (if necessary, including cables for motor holding brake)
- Cables for "fast inputs" of the Control Unit
- Cables for analog direct voltage/current signals
- Signal cables for sensors
- Cables for temperature sensors

**⚠ DANGER**

A suitable PE conductor must be connected to all devices in protection class I.

The protective conductor connection of the individual components must be at least 4 mm².

Alternative measures (e.g. routing behind mounting plates, suitable clearances) can also be used provided they have similar results. This excludes measures that relate to the design, installation, and routing of motor power cables and signal cables. If unshielded cables are used between the line supply connection point and line filter, make sure that no interfering cables are routed in parallel.

The cable shields must be connected as close to the conductor terminal connections as possible to ensure a low-impedance connection with cabinet ground. For Siemens power cables in which the shield is connected to the connector shell (see relevant catalog), this is a sufficiently good shield support.

With components that do not have any special shield connection or where the shield connection is not sufficient, the cable shields can be connected to the metal mounting plate using hose clamps and toothed rails. The cable length between the shield contact point and the terminals for cable conductors must be kept as short as possible.

Shield contact plates with pre-prepared clip contacts are available for contacting the shields for power cables of Line Modules and Motor Modules. Up to a module width of 100 mm, these plates are part of the scope of delivery of the components, or they are integrated in the connector.

All cables inside the cabinet must be routed as closely as possible to parts connected with cabinet ground, such as a mounting plate or cabinet wall. Ducts made of sheet steel or cables routed between steel sheets (e.g. between the mounting plate and back wall) should provide adequate shielding.

Avoid, where possible, routing unshielded cables, connected to the drive line-up, in the immediate vicinity of noise sources, e.g. transformers. Signal cables (shielded and unshielded) connected to the drive line-up must be laid at a great distance from strong external magnetic sources (e.g. transformers, line reactors). In both cases, a distance of ≥ 300 mm is usually sufficient.

**DANGER**

The drive components generate high leakage currents in the protective conductor. The components must only be operated in cabinets or in closed electrical operating areas and must be connected with the protective conductor. To protect against electric shock, the protective conductor connection at the control cabinet or machine must be implemented in accordance with one of the following measures:

- Fixed connection and protective conductor connection by means of ≥ 10 $mm^2$ Cu or ≥ 16 $mm^2$ Al
- Fixed connection and automatic disconnection of the supply system if the protective conductor is interrupted

## 5.10.3 Equipotential Bonding

The SINAMICS S120 Booksize drive system is designed for use in control cabinets with protective conductor terminal.

If the drive line-up is arranged on a common unpainted metal-surfaced mounting plate, e.g. with a galvanized surface, no additional equipotential bonding is needed within the drive line-up as

- All parts of the switchgear assembly are connected to the protective conductor system.
- The mounting plate is connected with the external PE conductor by means of a finely-stranded copper conductor with a cross-section of 16 mm², including the outer conductor. From a cross-section of 25 mm² copper, the outer cross-section of the finely-stranded conductor is halved.

For other installation methods, equipotential bonding must be implemented using conductor cross-sections as stated in the second item in the list or at least equal to the conductance.

If components are mounted on DIN rails, the data listed in the second item applies for equipotential bonding. If only smaller connection cross-sections are permitted on the components, use the largest possible, e.g. 6 $mm^2$ for SMC. These requirements also apply to distributed components located outside the cabinet.

For a PROFIBUS connection between two control cabinets, a fine-wire potential equalizing conductor with a cross-section of 4 $mm^2$ should be used. This conductor must be laid together with the PROFIBUS connection cable and connected to the NCU 7x0 using a cable lug.

### Equipotential bonding and shielding for PROFIBUS

The cable shield must be connected over a large contact surface area.

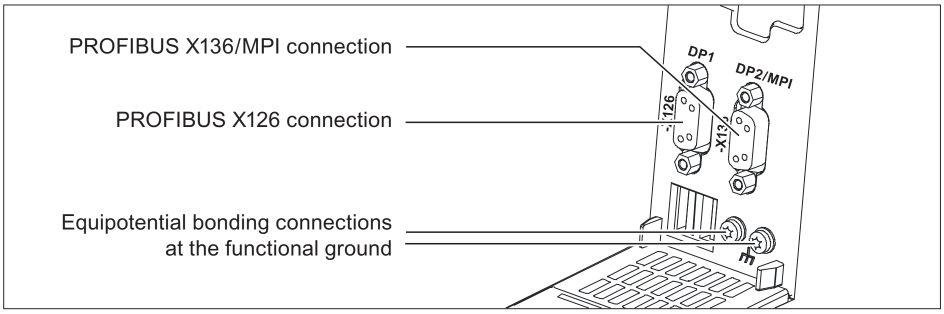



Figure 5-43 PROFIBUS and function ground connections

## 5.10.4 Protective Ground Connection

The bodies of electrical resources which because of their fastening cannot be included in the protective measure must be connected with the protective conductor circuit of the switching device combination (control cabinet) in order to establish the protection connection.

All protective conductors must be selected to conform with EN 60204-1 or EN 60439-1 and connected in accordance with the specifications of the associated device manuals.

# 5.11 Motor Connection

## 5.11.1 Motor connection plug

### 5.11.1.1 Installation of the motor connection plug with locking mechanism

Motor connection plugs with locking mechanism are available in two versions:

- Crimp plug for pre-assembled motor cables
- Screw connector for motor cables that need to be assembled

The way in which the motor connection plug is installed depends on the type of Motor Module used.

---

**Note**

With Double Motor Modules, the rear motor connection plug must be installed first and then locked.

---

#### Installation on Motor Modules without pre-assembled interlock bolt

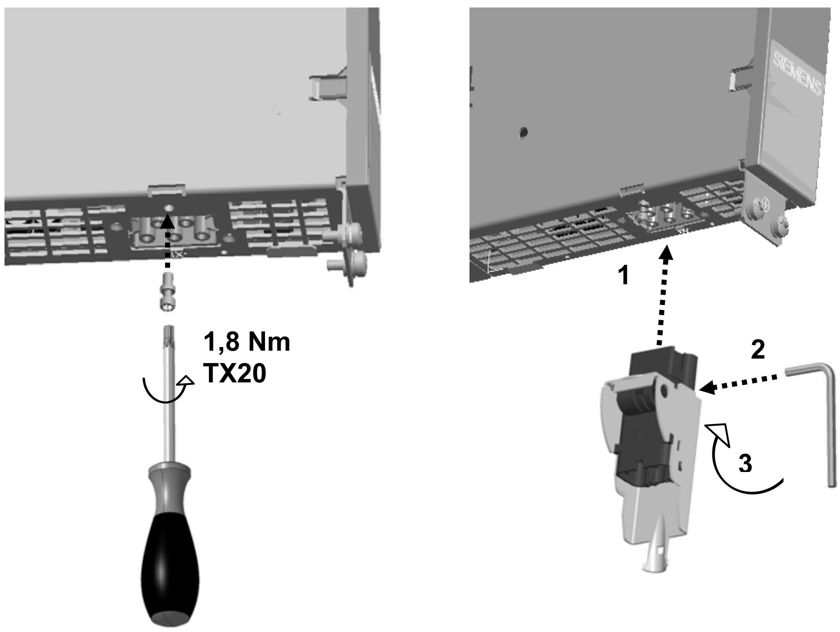



Figure 5-44 Installation example: Crimp plug

1. Screw the interlock bolt into the threaded socket provided in the enclosure.
2. Insert the plug, including the motor cable, and lock it in place by turning a screwdriver or size 4 hexagon socket-head screw clockwise by a ¼ turn (90°).

### Installation on Motor Modules with pre-assembled interlock bolt

If Motor Modules with a pre-assembled interlock bolt are used, step 1 described above can be omitted.

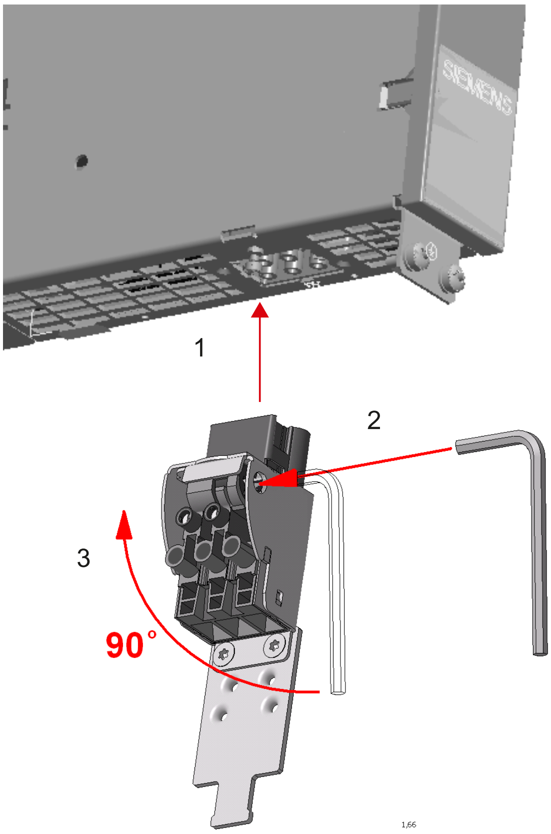



Figure 5-45 Installation example: Screw connector

Simply insert the connector, including the motor cable, and lock it in place by turning a screwdriver or size 4 hexagon socket-head screw clockwise by a ¼ turn (90°).

### 5.11.1.2 Installation of the motor connection plug with screwed joint

The way in which the motor connection plug with screwed joint is installed depends on the type of Motor Module used.

---

**Note**

With Double Motor Modules, the rear motor connection plug must be installed first and then locked.

---

### Installation on Motor Modules with interlock bolt

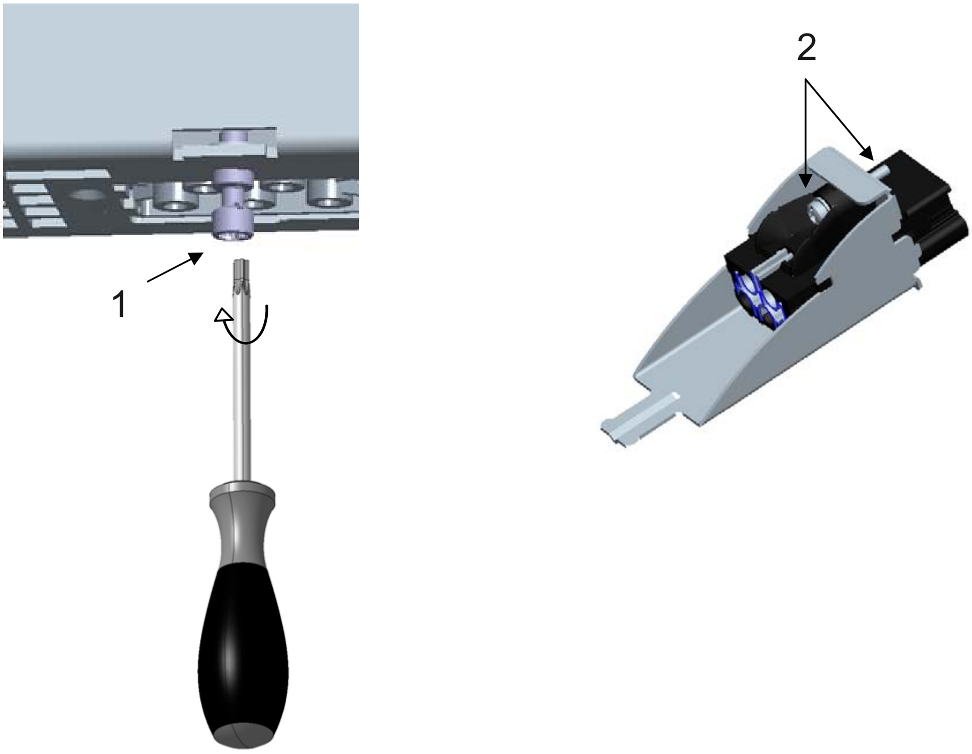



Figure 5-46 Installation of the motor connection plug with screwed joint

1. Use a TX20 screwdriver to remove the interlock bolt from the lower side of the enclosure.
2. Insert the plug, including the motor cable, and screw in with a TX20 screwdriver.

### Installation on Motor Modules without interlock bolt

If the motor connection plug with screwed joint is being installed on a Motor Module without a pre-assembled interlock bolt, step 1 described above can be omitted.

Simply insert the plug, including the motor cable, and screw in with a TX20 screwdriver.

### 5.11.1.3 Removal and coding

## Removing the motor connection plug

The motor connection plug of a pre-assembled motor cable might have to be removed if the cable needs to be routed through narrow cable glands, for example.

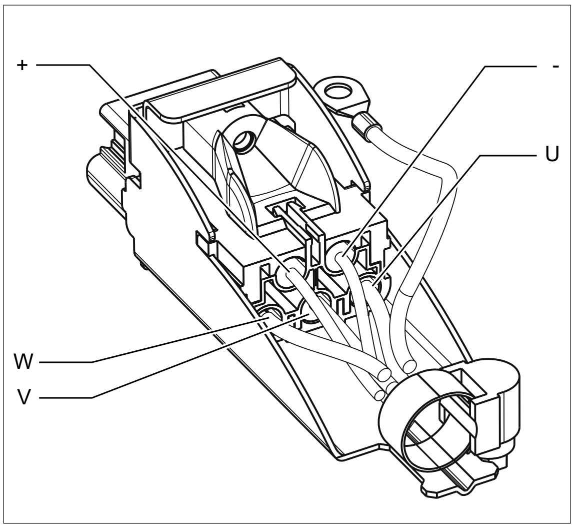



Figure 5-47 Motor connection plug with screwed joint

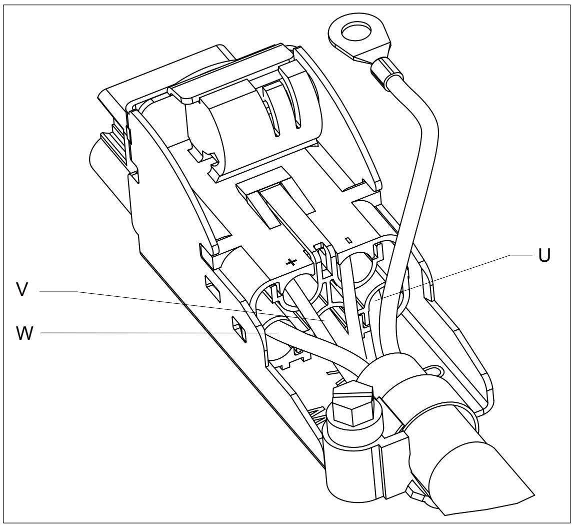



Figure 5-48 Crimp version motor connection plug with locking mechanism

In the case of motor connection plugs with a screwed joint, the pipe clamp first needs to be released. The interlock in the plug can then be raised using a pair of engineer's pliers, for example, and the cable can be removed.

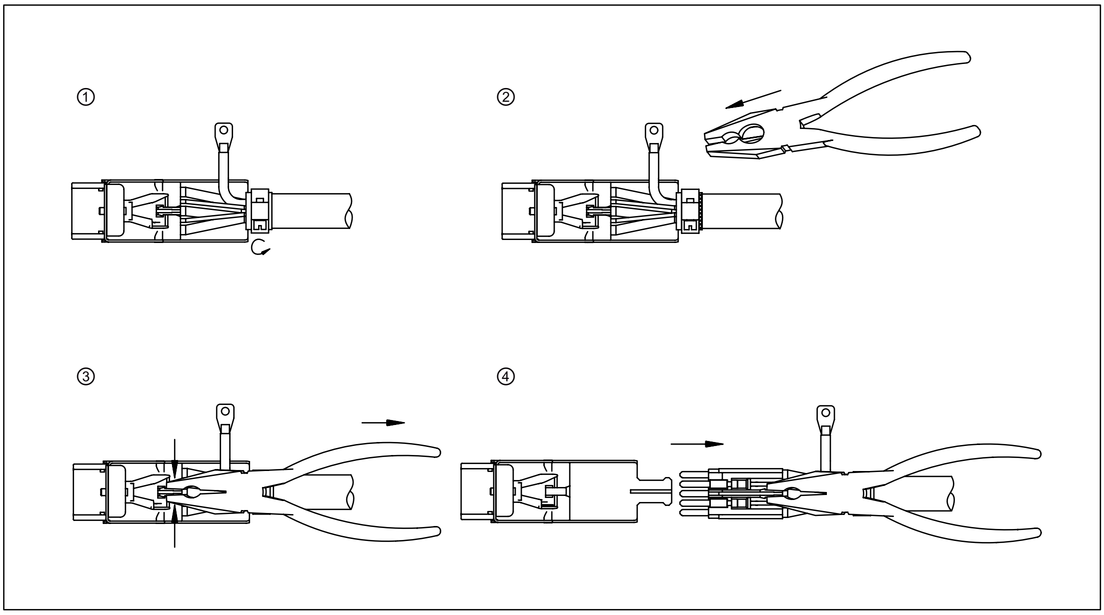



Figure 5-49 Removing the motor connection plug with screwed joint

In the case of motor connection plugs with a locking mechanism, the clamp first needs to be released. The interlock then has to be raised using a screwdriver, for example. After that, the insert can be removed, followed by the motor cable.

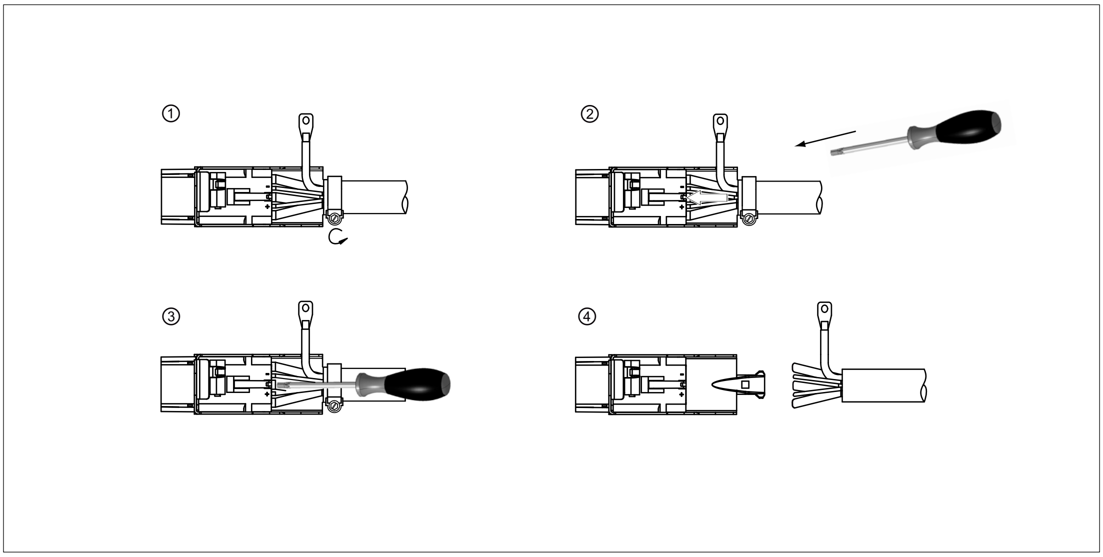



Figure 5-50 Removing the crimp plug with locking mechanism

## Coding the motor connection plug

The coding of a motor connection plug is illustrated below, using the example of a plug with screwed joint. Coding can be used to prevent incorrect connections being made, particularly in the case of Double Motor Modules.

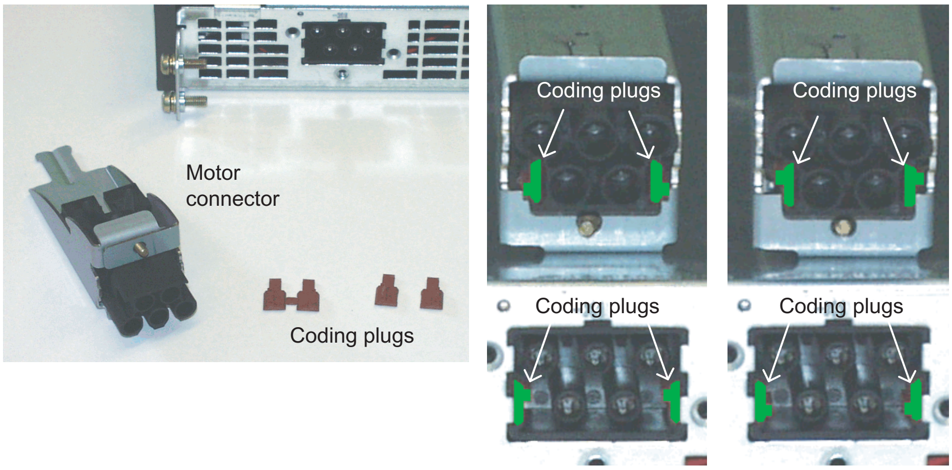
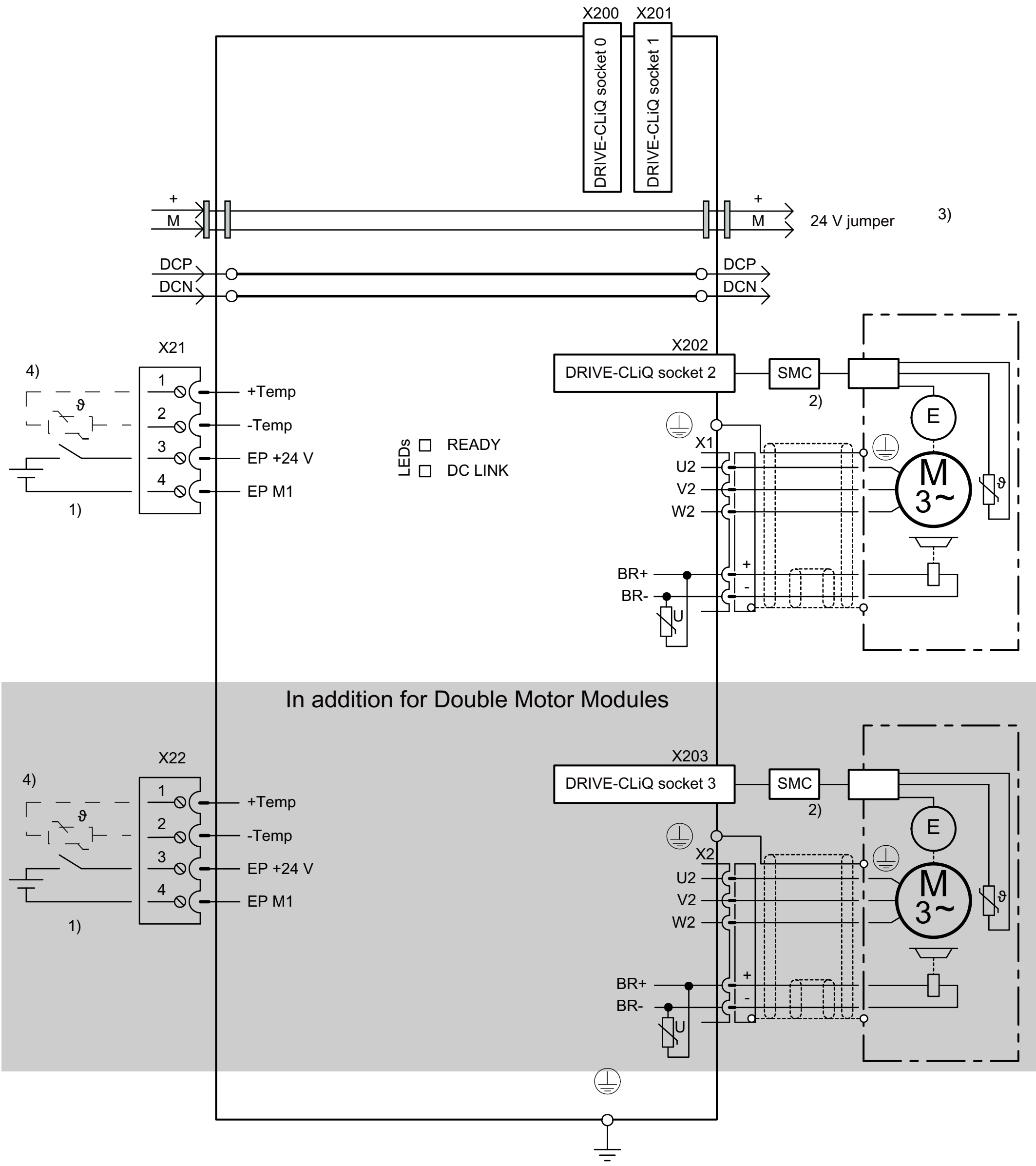



Figure 5-51 Coding the motor connection plug

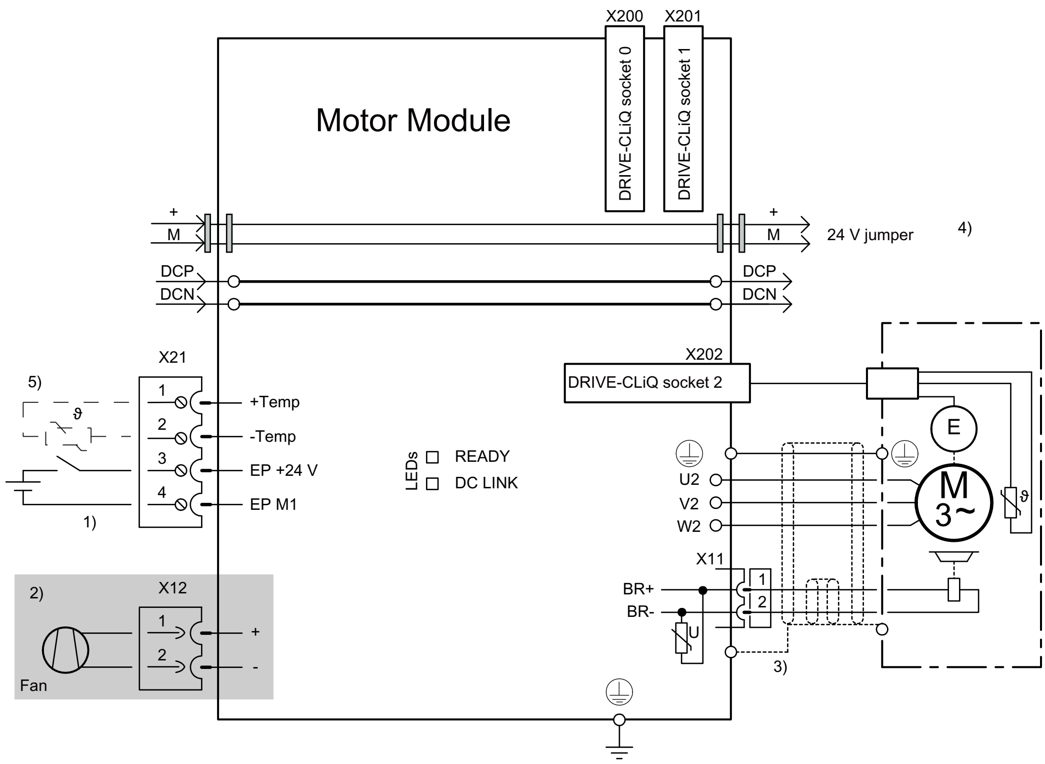
The coding plugs are included in the scope of delivery of the motor cables and screw connectors (motor connection plug with locking mechanism and screwed joint).

## 5.11.2 Connection examples




1) Required for Safety
2) SMC required for motors without DRIVE-CLiQ interface
3) 24 V to the next module
4) Optional, e.g. for encoderless motors

Figure 5-52 Connection example of Motor Modules 3 A to 30 A and Double Motor Modules 3 A to 18 A

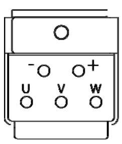
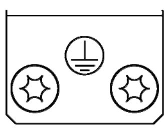



1) Required for Safety
2) In addition for Motor Modules 132 A to 200 A
3) Contact through the shield plate
4) 24 V to the next module
5) Optional, e.g. for encoderless motors

Figure 5-53 Example connection of Single Motor Modules 45 A to 200 A

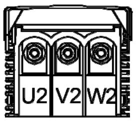
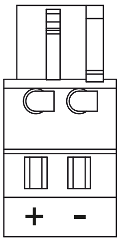
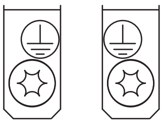
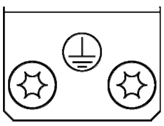
## 5.11.3 Motor/brake connection

Table 5- 48 Terminal strip X1/X2 Motor Modules 3 A to 30 A and Double Motor Modules 3 A to 18 A

| | Terminal | Technical specifications |
|---|---|---|
|  | U (U2) | Motor connection |
| | V (V2) | |
| | W (W2) | |
| | + (BR+) | Brake connection<br>max. load current 2 A<br>min. load current 0.1 A |
| | - (BR-) | |
|  | PE connection | Threaded hole M5/3 Nm 1 |

1) For ring cable lugs in accordance with DIN 46234

Table 5- 49 Terminal strip Single Motor Module 45 A to 200 A

| | Terminals | Technical specifications |
|---|---|---|
|  | U2<br>V2<br>W2 | **45 A to 60 A:**<br>Threaded bolt M6/6 Nm 1)<br>**85 A:**<br>Threaded bolt M8/13 Nm 1)<br>**132 A to 200 A:**<br>Threaded bolt M8/13 Nm 1) |
|  | + (BR+)<br>- (BR-) | X11 brake connector 2):<br>Voltage 24 V DC<br>Max. load current 2 A<br>Min. load current 0.1 A<br>Max. connectable cross-section 2.5 mm$^2$<br>Type: Spring-loaded terminal 2 (see chapter Connection methods)<br>The brake connector is part of the pre-assembled cable |
|  | PE connection | **Single Motor Module with a rated output current of 45 A to 60:**<br>Threaded bolt for motor cables: M6/6 Nm 1) Threaded hole for PE: M6/6 Nm 1) |
|  | | **Single Motor Module with a rated output current of 85 A**<br>Threaded bolt for motor cables: M8/13 Nm 1)<br>Threaded hole for PE: M6/6 Nm 1)<br>**Single Motor Module with a rated output current of 132 A to 200 A**<br>Threaded bolt for motor cables: M8/13 Nm 1)<br>Threaded hole for PE: M8/13 Nm 1) |

1) For ring cable lugs in accordance with DIN 46234

2) The circuit for protecting the brake against overvoltage is integrated in the Motor Module and does not need to be installed externally. The max. load current is 2 A, the min. load current 0.1 A.

**Note**

The overall length of the power cables (motor supply cables and DC-link cables) must not exceed the values given in chapter "Possible line reactor and line filter combinations".

**Note**

The motor brake must be connected via connector X11. The BR- cable must not be connected directly to electronic ground (M).

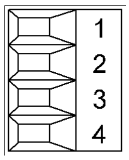
**⚠ WARNING**

Only protective extra-low voltages (DVC A) that comply with EN 60204-1 must be connected to all connections and terminals between 0 and 48 VDC.

The voltage tolerances of the motor holding brakes (24 V ± 10%) must be taken into account.

### 5.11.4 X21/X22 EP terminals / temperature sensor Motor Module

Table 5- 50 Terminal strip X21/X22

| | Terminal | Function | Technical specifications |
|---|---|---|---|
|   | 1 | + Temp | Temperature sensors: KTY 84-1C130/PTC/bimetallic switch with NC contact |
| | 2 | - Temp | |
| | 3 | EP +24 V (Enable Pulses) | Supply voltage: 24 V DC (20.4 V - 28.8 V)<br>Current consumption: 10 mA<br>Isolated input<br>Signal propagation times:<br>L → H: 100 μs<br>H → L: 1000 μs<br>The pulse inhibit function is only available when Safety Integrated Basic Functions are enabled. |
| | 4 | EP M1 (Enable Pulses) | |
| Max. connectable cross-section 1.5 mm²<br>Type: Screw terminal 1 (see chapter Connection methods) | | | |

| NOTICE |
|---|
| The KTY temperature sensor must be connected with the correct polarity. |

| NOTICE |
|---|
| The function of the EP terminals is only available when Safety Integrated Basic Functions are enabled. |

**Note**

The temperature sensor input is not needed if the motors feature an integrated DRIVE-CLiQ interface or if temperature values are detected by means of a different module (SMC, SME, TM).

# 5.12 Sensor Systems Connection

## 5.12.1 Introduction

The encoder system should be connected to SINAMICS S120 via DRIVE-CLiQ.

Motors with DRIVE-CLiQ interfaces (e.g. synchronous motors 1FK7 and 1FT6, and induction motors 1PH7) are designed for this purpose. These motors simplify commissioning and diagnostics because the motor and encoder type are identified automatically.

### Motors and external encoders without DRIVE-CLiQ interface

Motors without DRIVE-CLiQ interfaces, as well as external encoders, must be connected via Sensor Modules to enable the encoder and temperature signals to be evaluated. Sensor Modules Cabinet-Mounted (SMC) are available for installation in control cabinets and Sensor Modules External (SME) for installation outside control cabinets.

If not otherwise specified, only one encoder system can be connected to each Sensor Module.

### Motors and external encoders with DRIVE-CLiQ interface

Motors with DRIVE-CLiQ interfaces can be connected to the associated Motor Module directly via the MOTION-CONNECT DRIVE-CLiQ cables available. The connection of the MOTION-CONNECT DRIVE-CLiQ cable at the motor has degree of protection IP67.

The DRIVE-CLiQ interface supplies the motor encoder via the integrated 24 VDC supply and transfers the motor encoder and temperature signals and the electronic rating plate data, e.g. a unique identification number, rated data (voltage, current, torque, etc.) directly to the Control Unit. Different encoder cable are therefore no longer required for the various encoder types, e.g. resolvers or absolute encoders. Wiring can be effected throughout with a MOTION-CONNECT DRIVE-CLiQ cable.

### DRIVE-CLiQ encoder

The DRIVE-CLiQ encoder is an absolute encoder with integrated DRIVE-CLiQ interface (see the section titled "DRIVE-CLiQ encoder").

## 5.12.2 Overview of Sensor Modules

### Sensor Modules Cabinet-Mounted (SMC)

Sensor Modules Cabinet-Mounted can be ordered and configured separately. They are used when a motor with a DRIVE-CLiQ interface is not available or when external encoders in addition to the motor encoder are required. Only one encoder system can be connected to each Sensor Module Cabinet-Mounted. The SMCs evaluate these measuring systems and convert the calculated values to DRIVE-CLiQ. Neither motor nor encoder data are saved.

---

**Note**

The SMC supplies the power to the encoder; the SMC, however, must be provided separately with 24 VDC power.

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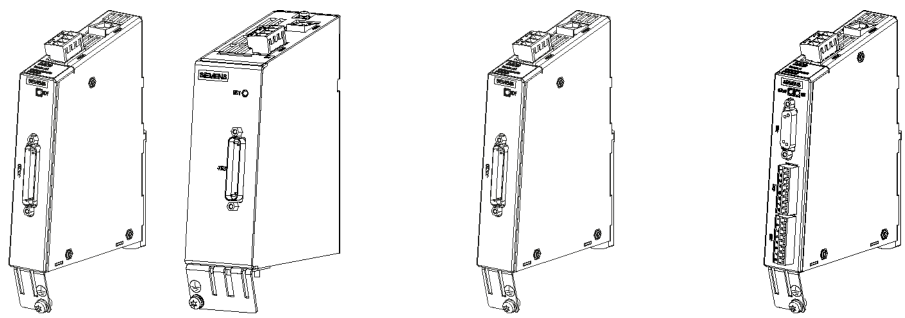


SMC10 — 30 mm, 50 mm
SMC20 — 30 mm
SMC30 — 30 mm

Figure 5-54 Overview of Sensor Modules Cabinet-Mounted (SMC)

### Sensor Modules External (SME)

The Sensor Modules SME20, SME25, SME120, and SME125 are only intended for use on machines (in North America, in accordance with the NFPA 79 "Electrical Standard for Industrial Machinery") and may only be connected to the DRIVE-CLiQ interfaces of proprietary components.

Direct encoder systems outside the cabinet can be connected to the Sensor Modules External. The SMEs evaluate these encoder systems and convert the calculated values to DRIVE-CLiQ. No motor or encoder data is stored in the SMEs.

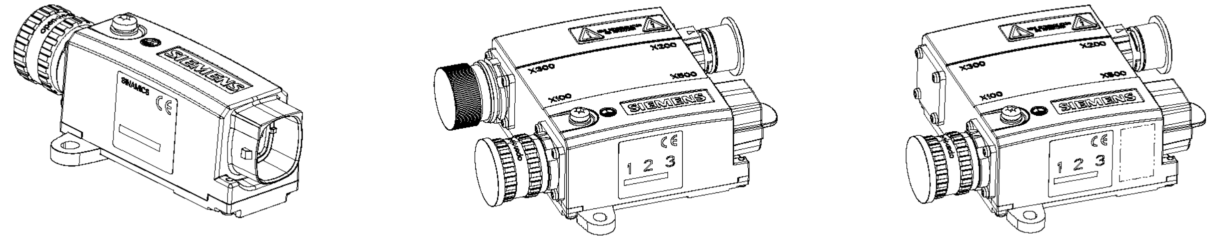
---

**Note**

The SME provides the encoder power supply. The power supply for the SME is provided from the connected DRIVE-CLiQ cable. This must be taken into consideration when the DRIVE-CLiQ cable is selected.

---

The Sensor Modules External have a higher degree of protection (IP67) and are therefore suitable for installation outside the cabinet.



SME20/25 SME120 SME125

Figure 5-55 Overview of Sensor Modules External (SME)

## Connectable encoder systems

Table 5- 51 Connectable encoder systems

| | SMC | | | | SME | | | |
|---|---|---|---|---|---|---|---|---|
| Encoder systems | SMC10 30 mm | SMC10 50 mm | SMC20 30 mm | SMC30 30 mm | SME20 | SME25 | SME120 | SME125 |
| Resolver | Yes | Yes | - | - | - | - | - | - |
| Incremental encoder sin/cos (1 Vpp) with/without reference signal | - | - | Yes | - | Yes | - | Yes | - |
| Absolute encoder EnDat 2.1 | - | - | Yes | - | - | Yes | - | Yes |
| Incremental encoder TTL / HTL | - | - | - | Yes | - | - | - | - |
| Absolute encoder SSI | - | - | Yes 1) | Yes 2) | - | Yes 1) | - | Yes 1) |
| Temperature evaluation | Yes | Yes | Yes | Yes | Yes 3) | - | Yes (electric-ally isolated) | Yes (electric-ally isolated) |

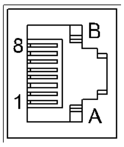
1) Only possible for SSI encoders with 5 V supply

2) Possible for SSI encoders with 5 V or 24 V supply

3) With prescribed adapter cable 6FX8002-2CA88

### 5.12.3 X200-X203 DRIVE-CLiQ interface

Table 5- 52 DRIVE-CLiQ interface X200-X202: Single Motor Module
DRIVE-CLiQ interface X200-X203: Double Motor Module

| | Pin | Name | Technical specifications |
|---|---|---|---|
|   | 1 | TXP | Transmit data + |
| | 2 | TXN | Transmit data - |
| | 3 | RXP | Receive data + |
| | 4 | Reserved, do not use | |
| | 5 | Reserved, do not use | |
| | 6 | RXN | Receive data - |
| | 7 | Reserved, do not use | |
| | 8 | Reserved, do not use | |
| | A | + (24 V) | Power supply |
| | B | M (0 V) | Electronics ground |
| Blanking plate for DRIVE-CLiQ interfaces included in the scope of delivery;<br>blanking plate (50 pieces) Order number: 6SL3066-4CA00-0AA0 | | | |

### 5.12.4 Examples of encoder connections

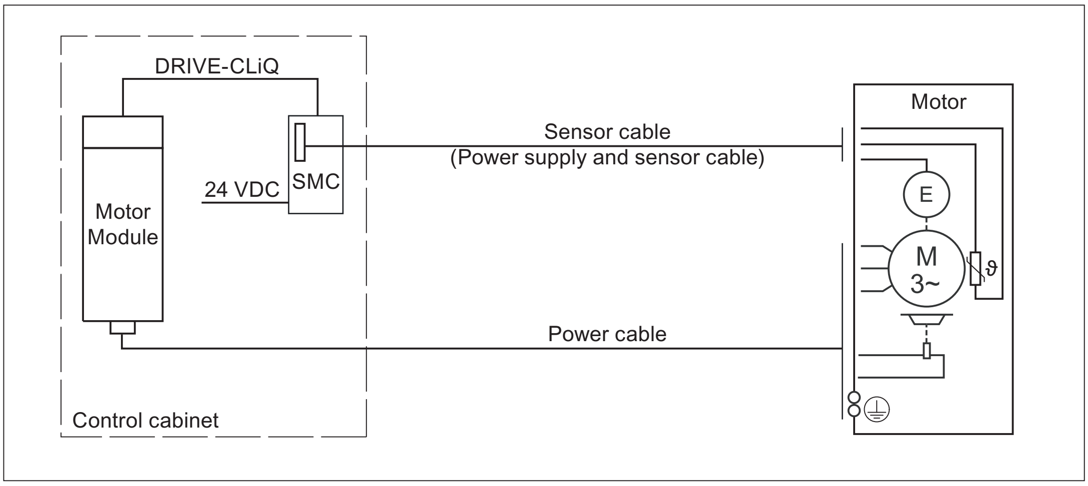



Figure 5-56 Sensor connection using Sensor Module Cabinet (SMC)

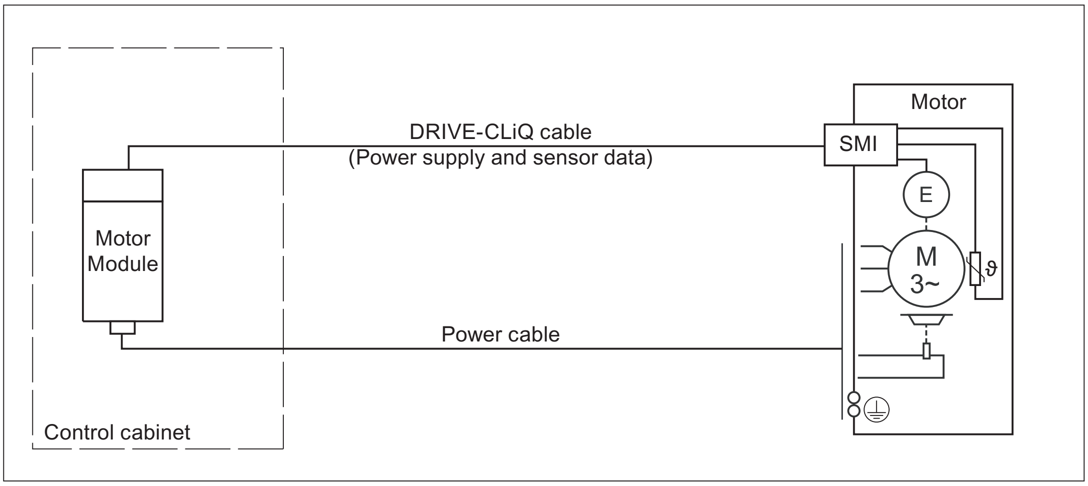



Figure 5-57 Sensor connection via a motor with a DRIVE-CLiQ interface

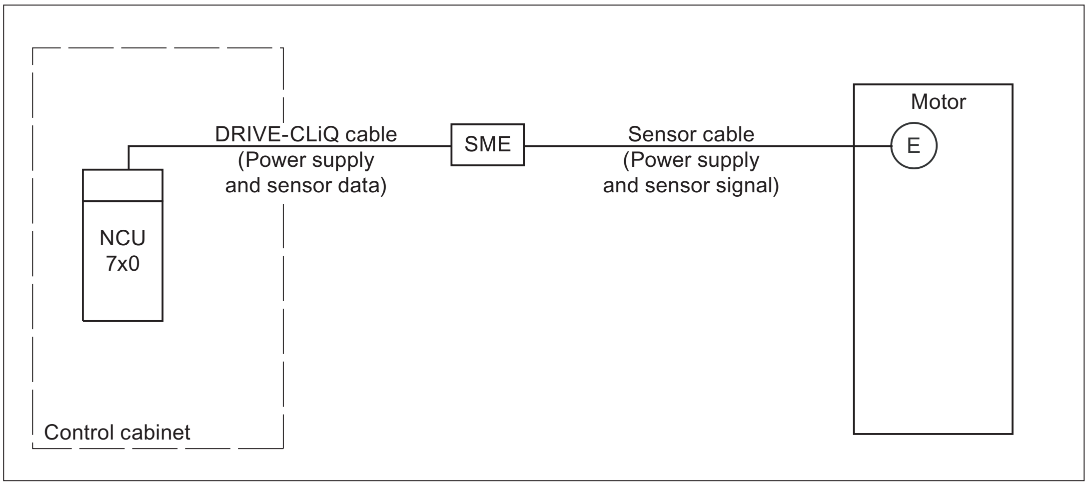



Figure 5-58 Sensor connection using Sensor Module External (SME)

# 5.13 Brake connection

## 5.13.1 General Notes

The motors are optionally available with integrated holding brake. The holding brake prevents the axes from making unwanted movements in the switched off state.

| ⚠ WARNING |
|---|
| The use of the motor holding brake as operational brake is not permitted! |

| ⚠ WARNING |
|---|
| When holding brakes are used, the user must observe the special technological and machine-specific regulations and standards to ensure the person and machine protection.<br>In addition, the residual risks must be evaluated, for example, the effects of hanging axes. |

## 5.13.2 Connection of the Brake Directly on the Motor Module

A brake control is integrated in the Motor Module. The maximum output current is 24 VDC 2 A.

The power supply for the BR+/BR- connection terminals is provided directly from the integrated 24 VDC power supply busbar.

The connection of the brake supply cable is made at the appropriate terminal blocks provided on the Motor Module. The brake cables are normally integrated in the preassembled motor supply cable that is also shielded.

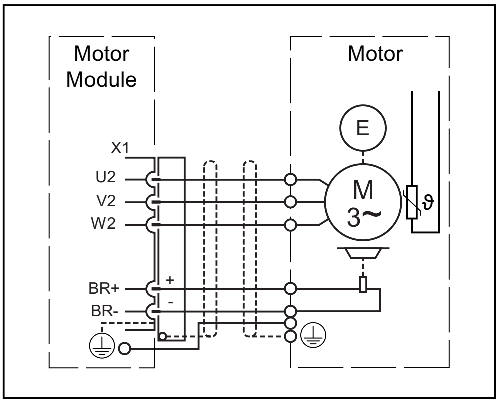
The maximum cable length of the brake supply cable is 50 meters.

- Connection for the device size 3 A to 30 A or 2 x 3 A to 2 x 18 A

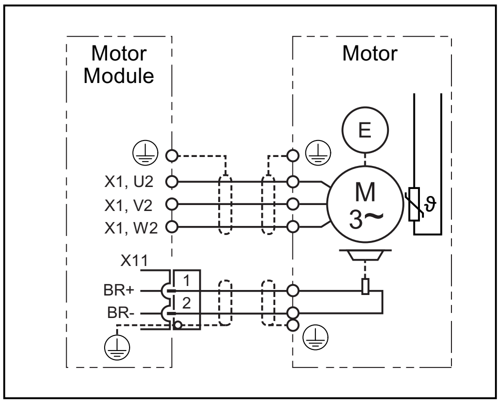
  The connection is made to the shared -X1 motor connection terminal: BR+/BR- terminal, max. connectable cross-section 1.5 $mm^2$

- Connection for device size 45 A to 200 A

  The connection is made to a separate -X11 brake connection terminal: BR+/BR- terminal, max. connectable cross-section 1.5 $mm^2$




Motor Module 3 A to 30 A;
2 x 3 A to 2 x 18 A




Motor Module 45 A to 200 A

The brake outlet is internally equipped with an overvoltage protection circuit. This reduces high voltage peaks that can occur when the brake is switched off and protects the electronic outputs. An additional external protective circuit for the brake output is not required. The brake output is short-circuit resistant. The following monitoring is also performed on the brake outlet:

- Current flow only when the brake is switched on; monitors whether a consumer is attached
- Wire breakage only when the brake is switched on

---

**Note**

The above-mentioned monitoring is possible only when the brake is directly attached to the Motor Module without interface contactor.

---

### 5.13.3 Connection of the Brake using Interface Relay

The motor holding brake can be attached directly to the provided connecting terminal or indirectly using an interface relay switched between. This may be necessary, for example, when the brake rated current $I_{BR}$ > DC 2 A or the connection voltage of the brake is 1AC 230 V. It is important, however, that the rated current of the interface relay is > 100 mA to prevent a fault message from the brake monitoring.

### Brake current IBR > 2 A DC

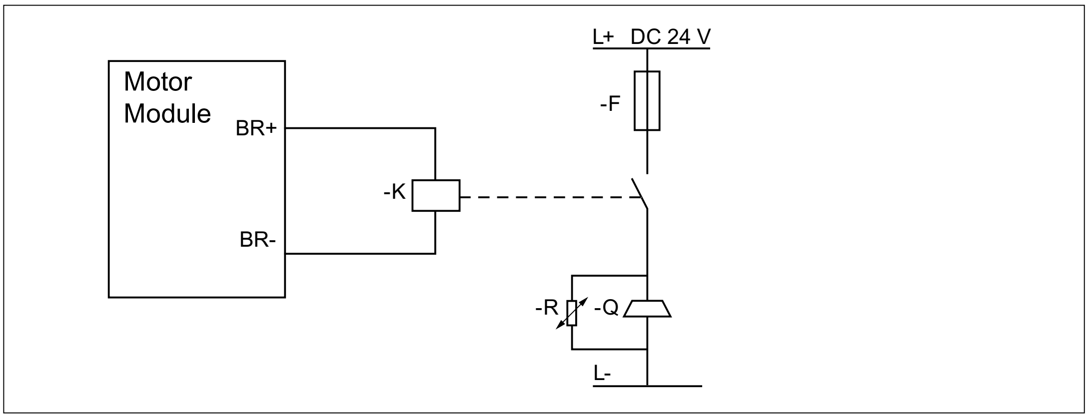



Figure 5-59 Brake current IBR > 2 A DC

Protective circuit for the interface relay is not required because this function exists in the Motor Module. A protective circuit, however, must be provided for the brake.

### Supply voltage not 24 VDC.

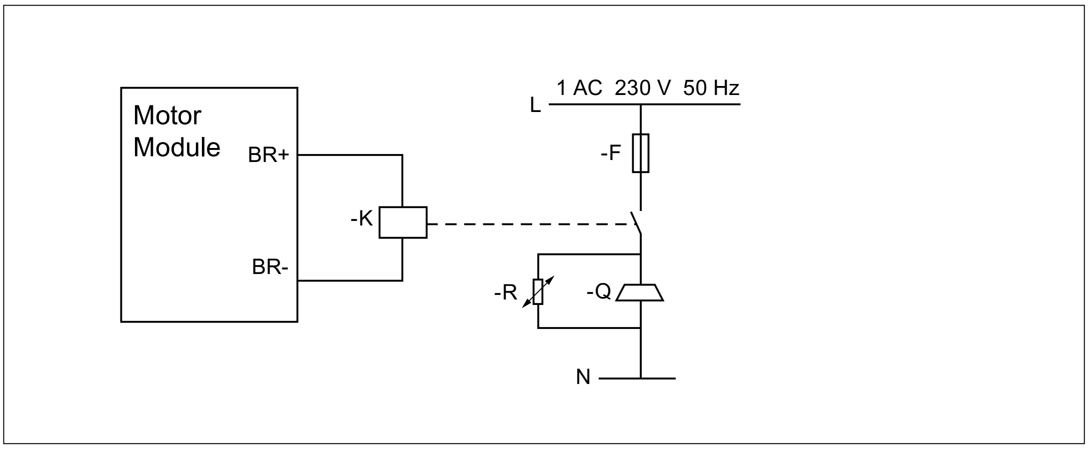



Figure 5-60 Supply voltage not 24 VDC.

Protective circuit of the brake coil required. For the choice of the protective circuit, ensure that the demagnetization of the brake is achieved fast. This is performed, for example, with varistors for an AC supply power (also refer to the motors configuring guide).

## 5.14 Brake Control

For the brake control, a differentiation is made between:

- Conventional brake control and
- Safe brake control

The control command to open or close the holding brake is transferred directly to the Motor Module over the DRIVE-CLiQ from the Control Unit that logically links and monitors the signals with the system-internal execution sequences. The Motor Module then performs the action and controls the output for the holding brake appropriately.

## Conventional brake control

The exact execution control is described in the SINAMICS S [2701…2704] List Manual. For example, the p1215, p1219, p1224 and p0855 parameters can be used to configure the operation of the holding brake.

The control (open/close) of the holding brake is differentiated as follows:

- Opening of the holding brake after pulse enable (e.g. using ON/OFF1)
- Immediate close of the holding brake after a successful pulse suppression (e.g. using ON/OFF2)

  The brake acts immediately after pulse suppression. It is possible that the holding brake operates against any motion that occurs. In the long term, this will damage the holding brake. Consequently, the direct pulse suppression and closing of the holding brake should be avoided.
- Close the holding brake only after braking with pulse suppression (e.g. using ON/OFF1=1->0)

  The holding brake acts when the motor has been brought to a standstill. The pulse suppression results after a deceleration time.
- Unconditional opening of the holding brake using the execution control command and the p0855 parameter.

---

**Note**

For the selection/deselection of the brake, any pending pulse enable will not be further influenced. Unconditional opening of the holding brake can, for example, lead to dangerous motions involving hanging axes. Additional safety measures may need to be adopted.

---

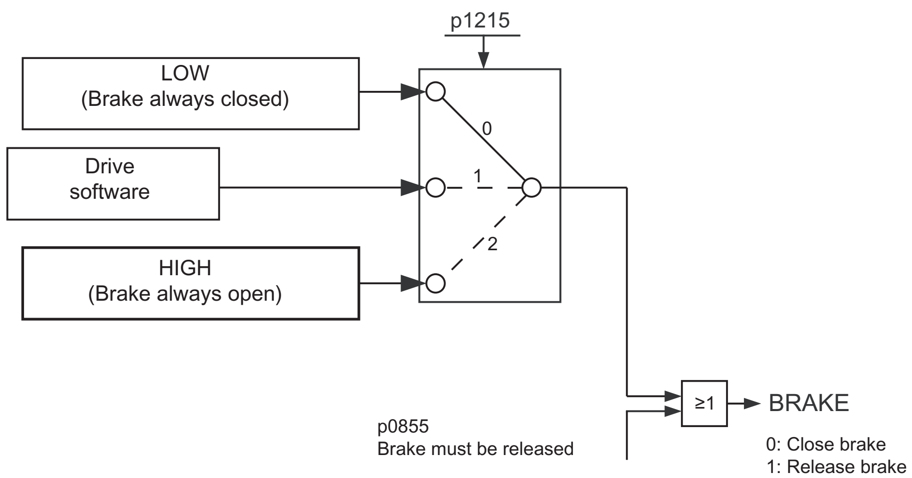
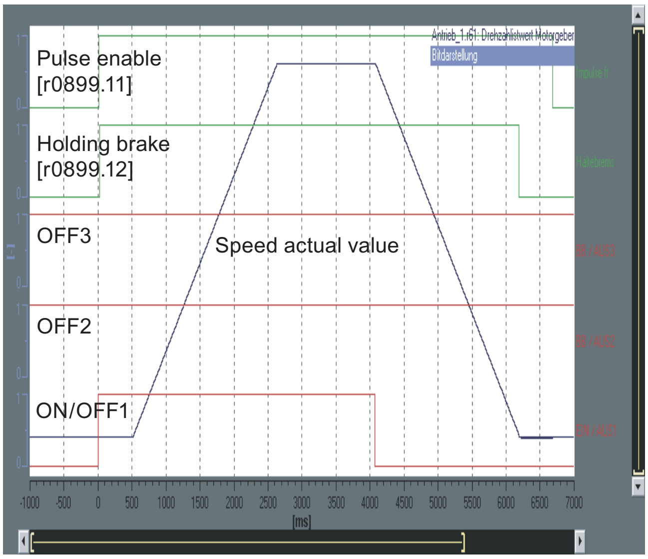


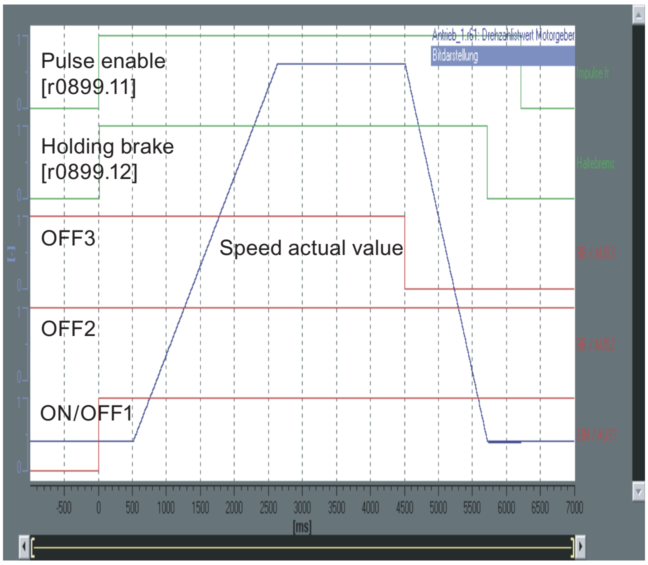

Figure 5-61 Operating modes of the conventional brake control

**Timing examples:**

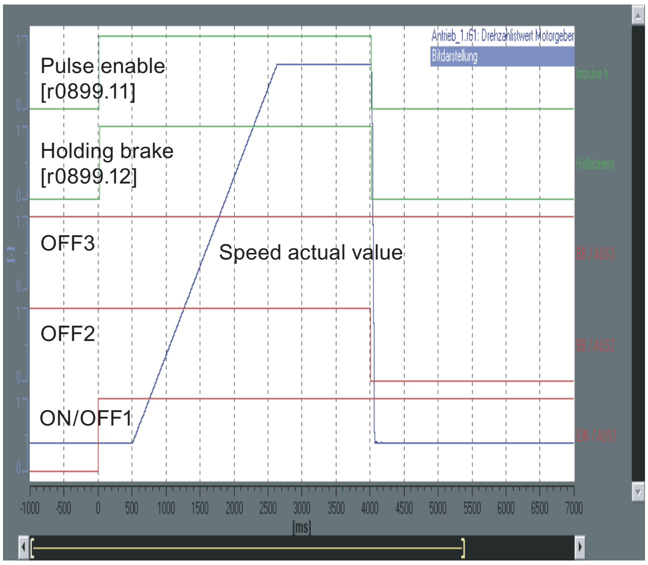
In all cases listed below, the drive starts the motion with an ON command (BB/OFF1). For clarification, the closing and opening times are set to 500 ms. The acceleration and deceleration times are 7 seconds (OFF1) and 4 seconds (OFF3), respectively. The drive will be accelerated to a speed of 2000 RPM. Important control and status bits (OFF1/2/3, holding brake status, pulse enable) are also shown.



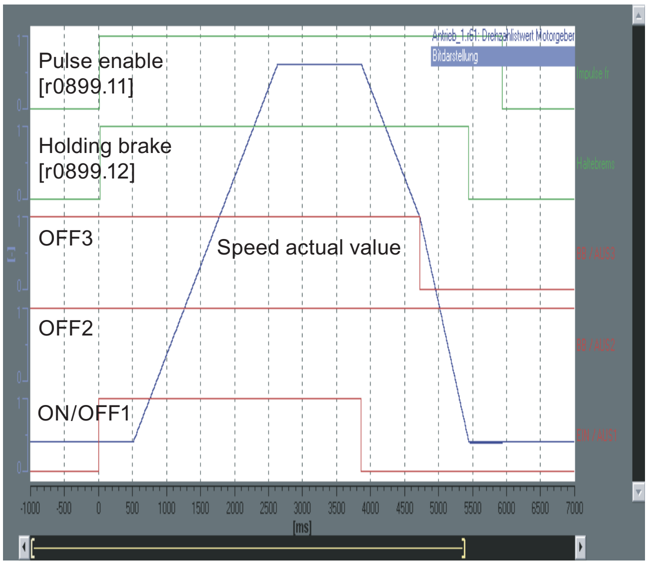

Start with ON command;
stop with OFF1 command



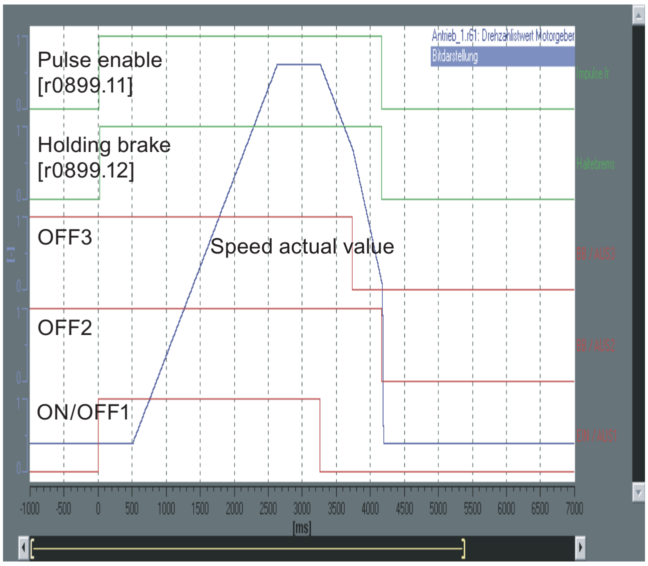

Start with ON command;
stop with OFF3 command (rapid stop)




Start with ON command;
stop with OFF2 command (coast to standstill)




Start with ON command; stop with OFF1 command and during braking; stop with OFF3 Command

| | |
|---|---|
|   Start with ON command;<br>stop with OFF1 command;<br>stop with OFF3;<br>stop with OFF2 | |

The switch-off behavior in a fault situation will be assigned to the associated fault numbers and largely corresponds to a stop behavior OFF1/2/3.

## Safe Brake Control (SBC)

### Note

The "Safe brake control" function is activated only in conjunction with the enable of the "Safe standstill" (SH) function.

"Safe brake control" does not detect any fault in the holding brake itself, such as a short circuit of the brake winding, worn out brake, etc.

Wire breakage will be monitored only for each activation of the brake, not, however, during operation.

The control paths must be provided as two channels for the "Safe brake control". This is performed with a separate control by the Control Unit and the Motor Module. These units switch and monitor the brake control independent of each other.

For safety-related functions, it is necessary for the fault detection to perform in a defined interval a test using forced dynamization. In this case, the switch-off path must be performed and tested in the two monitoring channels at least once within a defined interval. The "forced checking procedure" cycle must be controlled externally and mechanically in the appropriate manner by means, for example, of a brief interruption to the two "Safe standstill" (SH) inputs on the Control Unit and on the Motor Module.

The dynamization is also performed:

- For each brake control with "open holding brake" and "close holding brake"
- For selection of the "Safe standstill" function

**Note**

The monitoring and the forced checking procedure of the brake outlet is possible only when the brake is connected directly and not using a coupling relay to the connection terminals! The p9602 and p9802 parameters can be used to specify the control operation. The "Safe brake control" is performed independent of the setting in p1215. A "Safe brake initiation" always has priority over the conventional brake control.

When the "Safe standstill" function is selected, an internal OFF2 command will be issued and the holding brake closed immediately.

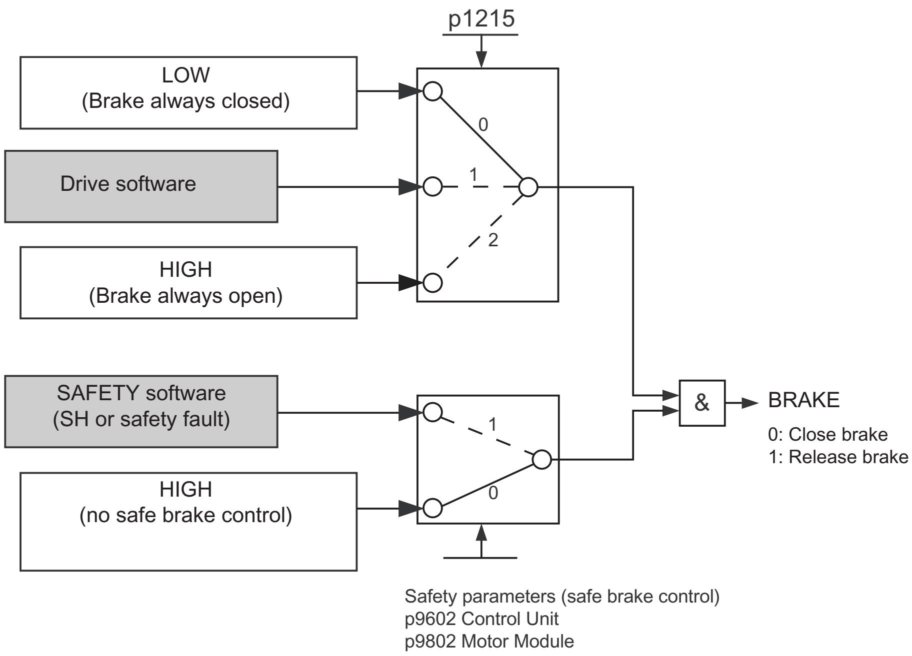



Figure 5-62 Operating modes of the safe brake control

# 5.15 Voltage Protection Module (VPM), external

## General information

The external Voltage Protection Module (VPM) is used for the 1FE1 and 2SP1 motors and for motors with an electromagnetic force (EMF) of 800 V to 2,000 V to limit the DC link voltage at the converter in a fault situation.

If the line voltage fails when the motor is running at maximum speed, or as consequence the pulses at the converter are cleared, the motor returns high-voltage energy to the DC link. The Voltage Protection Module detects an excessive DC link voltage (> 800 V) and short-circuits the three motor supply cables. The energy stored in the motor is converted into heat by the short circuit between the motor supply cables.

## Integration

- The installation must be performed in accordance with the VPM 120 or VPM 200 connection diagram.
- Above and below the device, clearance spaces of approx. 200 mm must be provided for the cable routing.
- Any installation position is possible.
- No switching elements may be added to the U, V, W connection cables between the drive, VPM and motor!
- The air intake temperature measured 10 mm below the device must not exceed 55 °C.

| ⚠ CAUTION |
|---|
| In the event of non-compliance and if the limit values specified in the "technical data" are exceeded (see VPM operating instructions), there is a danger of device overloading, irreparable damage to the device, and impairment of electrical safety. |

| NOTICE |
|---|
| The device must be equipped with a safety switching unit and may be used only for its proper purpose. Other applications, e.g. armature short circuits in operation, are not permissible.<br>The warning notices attached to the device must be observed. |

Operation with VPM is possible only in conjunction with SINAMICS, SIMODRIVE 611 digital, SIMODRIVE 611 universal HR/HRS, and 1FE1/2SP1 motors. When the external VPM is used, shielded 6FX8 motor supply cables are required.

**NOTICE**

Depending on the size of the type used, the conditions associated with the relevant VPM operating instructions must be observed.

VPM 120, order No.: A5E00302281B
VPM 120 PG, order No.: A5E01017613A
VPM 200, order No.: A5E00302261B
VPM 200 PG, order No.: A5E01018358A
VPM 200 DYN, order No.: A5E00777655A

**WARNING**

Under fault conditions, voltages up to 2 kV can occur at cables that are cut or damaged.

Depending on the speed of the motors, the motor terminal voltage of the 1FE1 motors can attain values as high as 2 kV.

## Connection example for VPM 120

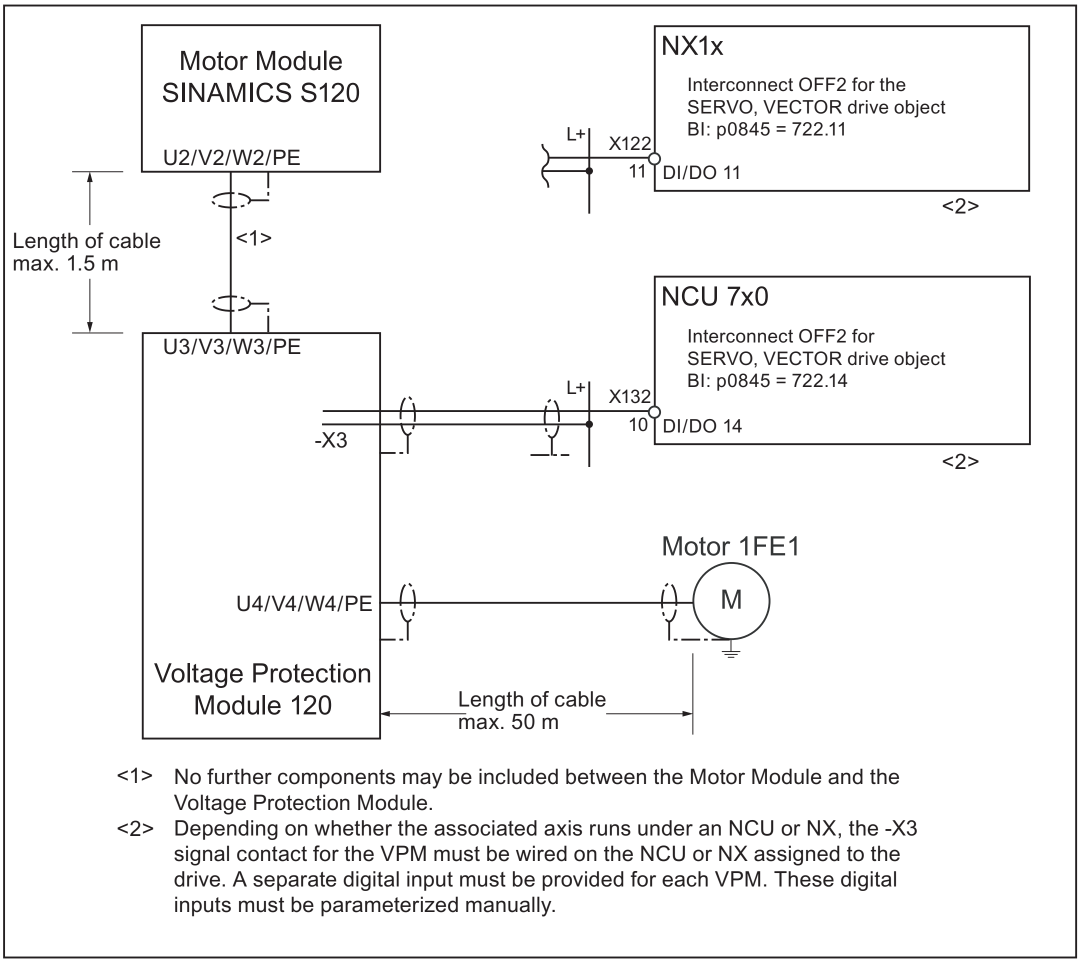



Figure 5-63 Connection of Voltage Protection Module VPM 120

## Signaling contact X3

The X3 signaling contact closes after t > 2 min or after resetting the temperature switch.

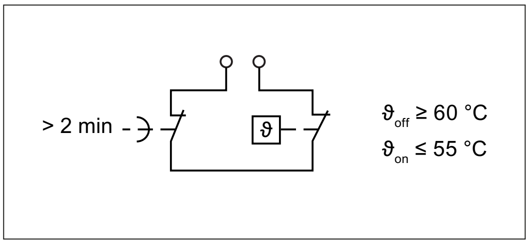



Figure 5-64 Signaling contact X3 of the Voltage Protection Module

| ⚠ WARNING |
| --- |
| Measures must be adopted to prevent the drive from starting automatically. |

If the external VPM is being used, the following parameter needs to be set on the NCU or NX:

p0643[0...n]

- Description:
  Setting overvoltage protection for synchronous motors in field weakening mode
- Value:

  0: No action

  1: Voltage Protection Module (VPM)

## Additional references

For more detailed information on the external Voltage Protection Module, please refer to the following:
/GH2/SINAMICS S120/, Booksize Power Units, Motor Side Power Components, VPM/

# Signal Interconnection 6

## Introduction

The drive wizard assigns functions to NCU and NX terminals (see Section NCU 7x0 and NX1x Terminal Assignment (Page 69)). This section discusses the interconnection of the terminals between the SINUMERIK and SINAMICS S120 components.

The used terminals must be controlled from a higher-level controller or PLC. As far as safety functions are concerned, the NCU and NX or the Motor Modules must be controlled in accordance with the required safety categories (see Section Safety Integrated (Page 83)).

## For the applications

The following pages show the signal interconnection for typical SINUMERIK / SINAMICS S120 applications.

The following table shows the characteristics of the individual applications. The listed applications show only a few possiblities. If necessary, the control must be adapted to the requirements of the associated application.

Table 6- 1 Applications

| Application | Infeed | Safety | | Line contactor | |
|---|---|---|---|---|---|
| | | Drive-integrated 1) | System/drive-integrated 2) | Without safety 3) | With safety 4) |
| 1 | With DRIVE-CLiQ: | No | No | No | No |
| 2 | With DRIVE-CLiQ: | No | No | Yes | No |
| 3 | Without DRIVE-CLiQ: | No | No | Yes | No |
| 4 | With DRIVE-CLiQ: | Yes | No | No | Yes |
| 5 | Without DRIVE-CLiQ: | Yes | No | No | Yes |
| 6 | With DRIVE-CLiQ: | No | Yes | No | No |
| 7 | Without DRIVE-CLiQ: | No | Yes | No | No |

1) Safety realized with external safety controller (e.g. 3TK28 safety relay or SIMATIC S7 F control) using the SINAMICS SH/SBC function

2) Safety realized with the system/drive-integrated safety function of the SINUMERIK 840D sl

3) Line contactor provided, however, without safe control

4) Line contactor provided, with safe control

# 6.1 Application 1

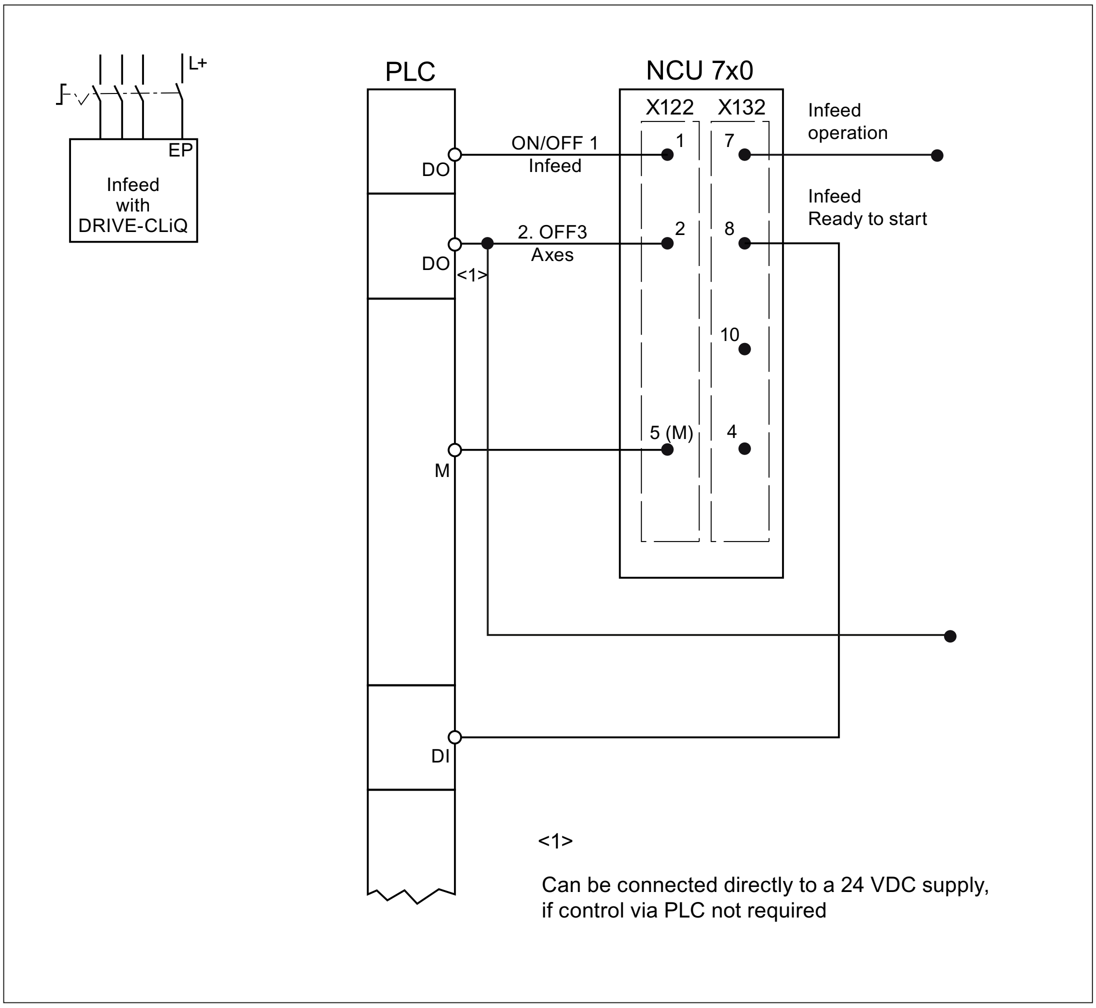



Figure 6-1 Infeed with DRIVE-CLiQ (SLM/ALM 16 kW to 120 kW)

### Interconnection of the PLC input signals

- "Infeed ready" (NCU terminal X132.8)

  The infeed is ready for 1 signal.

### Interconnection of the PLC output signals

- "ON/OFF1" of the infeed (NCU terminal X122.1)

  The 0/1 edge activates the infeed. Interlocking with "infeed ready" (NCU terminal X132.8) is desirable.
- "2. OFF3" for all axes (NCU terminal X122.2)

  The "2. OFF3" will be forwarded to all axes of the NCU. The additional interconnection to the individual NX components (NX terminal X122.2) means these axes also receive the "2. OFF3" signal. The enable does not need to be carried out via a PLC. A fixed protective circuit with 24 VDC is also possible.

### Interconnection between NCU and NX components

- After activating the infeed, given correct operation, the "Infeed operation" state will be attained and all axes (BI: p0864) will be enabled. This status must also be forwarded to the NX components (NCU terminal X132.7 and NX terminal: X122.1).

# 6.2 Application 2

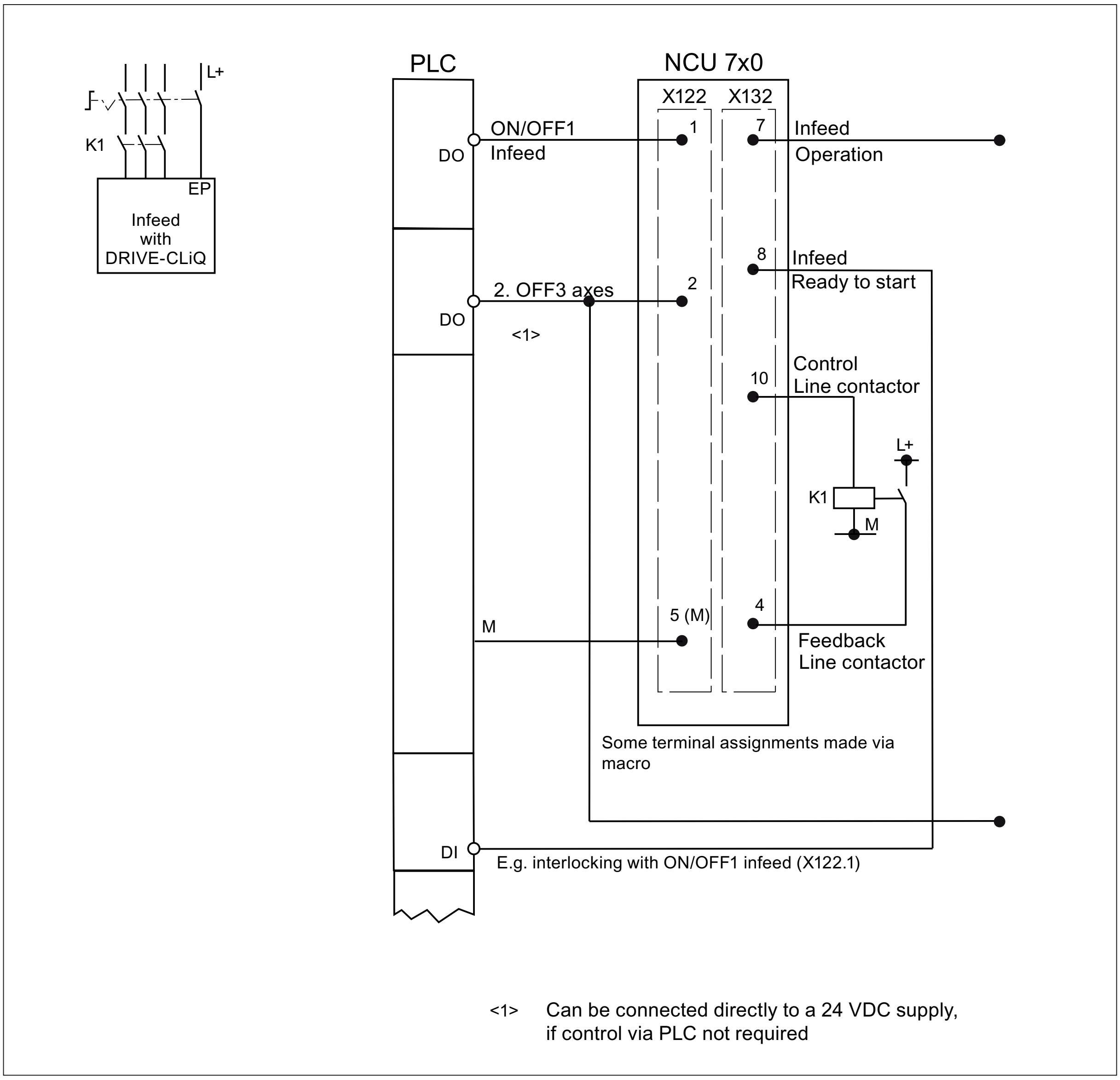



Figure 6-2 Infeed with DRIVE-CLiQ (SLM/ALM 16 kW to 120 kW) and line contactor without safe control

## Interconnection of the PLC input signals

- "Infeed ready" (NCU terminal X132.8)

  The infeed is ready for 1 signal.

### Interconnection of the PLC output signals

- "ON/OFF1" of the infeed (NCU terminal X122.1)

  The 0/1 edge activates the infeed. Interlocking with "infeed ready" (NCU terminal X132.8) is desirable.
- "2. OFF3" for all axes (NCU terminal X122.2)

  The "2. OFF3" will be forwarded to all axes of the NCU. The additional interconnection to the individual NX components (NX terminal X122.2) means these axes also receive the "2. OFF3" signal. The enable does not need to be carried out via a PLC. A fixed protective circuit with 24 V DC is also possible.

### Interconnection between NCU and NX components

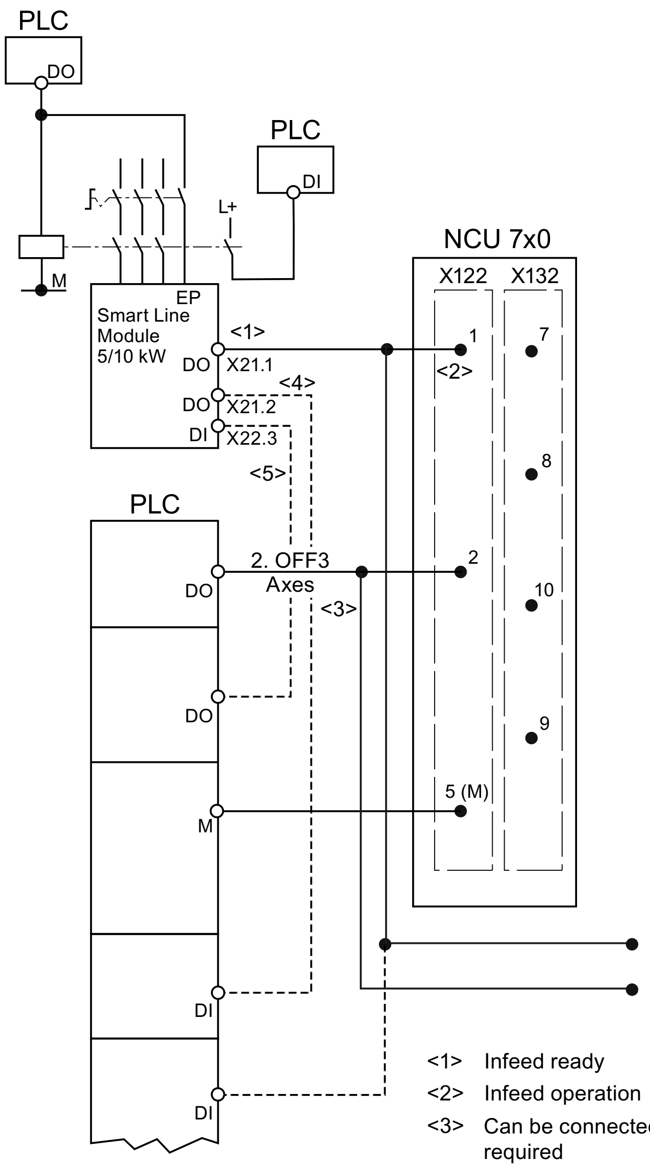
- After activating the infeed, given correct operation, the "Infeed operation" state will be attained and all axes (BI: p0864) will be enabled. This status must also be forwarded to the NX components (NCU terminal X132.7 and NX terminal: X122.1).

### Line contactor control

- The line contactor is controlled via the "Line contactor control" function (NCU terminal X132.10). The signal state for the line contactor (form A contact) can be returned (NCU terminal X132.4). This control ensures that the line contactor always switches in a defined manner and so prevents overloading or damaging the line contactor and/or the infeed.

| NOTICE |
| --- |
| The described control is conducted with standard signals with regard to the safety engineering. If the appropriate safety categories must be satisfied, the control must be conducted in accordance with the required safety categories using a safety controller. |

# 6.3 Application 3




<1> Infeed ready
<2> Infeed operation
<3> Can be connected directly to a 24 VDC supply, if control via PLC not required
<4> Infeed prewarning
<5> Infeed reset

Figure 6-3 Infeed without DRIVE-CLiQ (SLM 5/10 kW); line contactor without safe control

### Interconnection of the PLC input signals

- "Infeed Ready" (SLM terminal X21.1)

  The infeed is operating for 1 signal.

### Interconnection of the PLC output signals

- "2. OFF3" for all axes (NCU terminal X122.2)

  The "2. OFF3" will be forwarded to all axes of the NCU. The additional interconnection to the individual NX components (NX terminal X122.2) means these axes also receive the "2. OFF3" signal. The enable does not need to be carried out via a PLC. A fixed protective circuit with 24 V DC is also possible.

### Interconnection of the NCU 7x0 component

- "Infeed Ready" (connection between SLM terminal X21.1 and NCU terminal X122.1)

  After activating the infeed, given correct operation, the "Infeed operation" state will be attained and all axes (BI: p0864) will be enabled. This status must also be forwarded to the NX components (NX terminal: X122.1).

  The Smart Line Module without DRIVE-CLiQ interface is not switched on/off using a Drive Object of the NCU. The control is performed exclusively via terminals on the Smart Line Module, for example, from a PLC or hardware controller.

### Line contactor control

The line contactor must be controlled from an external PLC or hardware controller. Internal line contactor control using a Drive Object by the NCU is not possible.

The following activation/deactivation conditions must be observed for the control (also see the "Line Contactor Control" chapter):

#### PLC input signal

- "Line contactor feedback"

  Query the switching state of the line contactor

### PLC output signal

- "Line contactor control"

  Control the line contactor taking into consideration the activation/deactivation condition

| ⚠ CAUTION |
| --- |
| If the named conditions are not observed, the line contactor and the infeed can be damaged. |

| NOTICE |
| --- |
| The described control is conducted with standard signals with regard to the safety engineering. If the appropriate safety categories must be satisfied, the control must be conducted in accordance with the required safety categories using a safety controller. |

## Smart Line Module operation

The Smart Line Module without DRIVE-CLiQ interface is not switched on/off using a Drive Object of the NCU. The control is performed exclusively via terminals on the Smart Line Module, for example, from a PLC or hardware controller.

### Interconnection of the PLC input signals

- "Infeed Ready" (SLM terminal X21.1)

  Infeed operational

- "Infeed PreWarning" (SLM terminal X21.2)

  Overtemperature advance warning

### Interconnection of the PLC output signals

- "Infeed Reset" (SLM terminal X22.3)

  Reset of a pending fault

# 6.4 Application 4

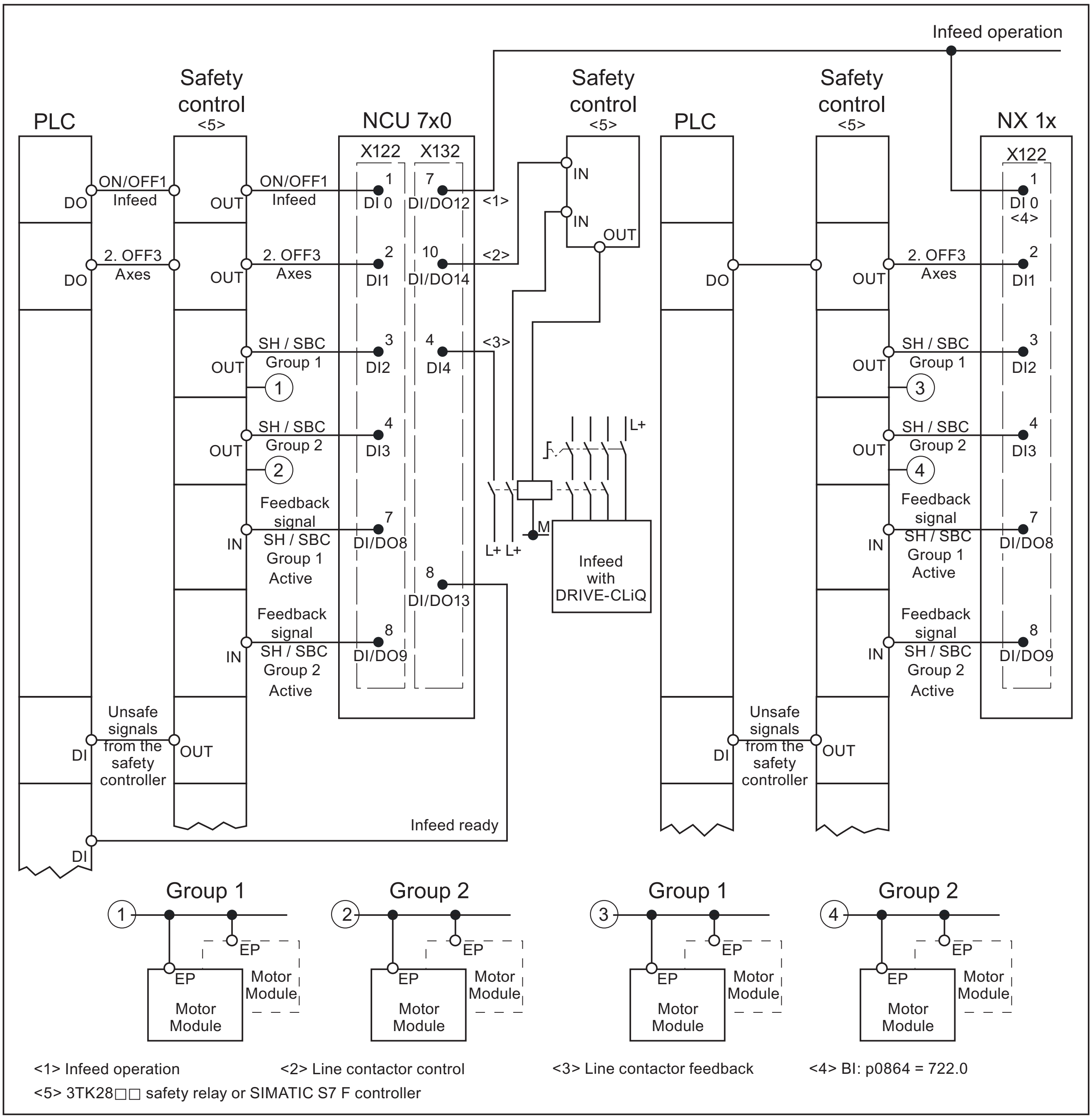



Figure 6-4 Infeed with DRIVE-CLiQ (SLM/ALM 16 kW to 120 kW), use of a drive-integrated SH/SBC safety function by SINAMICS and line contactor with safe control

### Interconnection of the PLC input signals

- "Infeed ready" (NCU terminal X132.8)

  The infeed is ready for 1 signal.

### Interconnection of the PLC output signals

| NOTICE |
| --- |
| To achieve safe control of the line contactor and the drive-integrated SH/SBC safety function by SINAMICS, the control signals must be provided by a safety relay (3TK28) or a SIMATIC F controller. This is the only way to ensure that disconnection is achieved in accordance with the required safety categories. |

- "ON/OFF1" of the infeed (NCU terminal X122.1)

  The 0/1 edge activates the infeed. Interlocking with "infeed ready" (NCU terminal X132.8) is desirable.

  **Note**

  The "ON/OFF1" signal must also be locked by the safety controller.

- "2. OFF3" for all axes (NCU terminal X122.2)

  The "2. OFF3" will be forwarded to all axes of the NCU. The "2. OFF3" must be interconnected to the NX components provided (NX terminal X122.2). This means that the axes downstream from the NX also receive the enable.

  **Note**

  The "2. OFF3" signal must also be locked by the safety controller.

### Interconnection between the safety controller and the NCU and NX components

- The SH/SBC function must be controlled by the safety controller using two channels.

  The first channel goes to the NCU/NX.

  The second channel goes to the Motor Module.

  If required, appropriate groups (1/2) can be formed that must be controlled depending on the switching condition. The feedback of the SH/SBC function must be evaluated in the safety controller.

## Interconnection between NCU and NX components

- After activating the infeed, given correct operation, the "Infeed operation" state will be attained and all axes (BI: p0864) will be enabled. This status must also be forwarded to the NX components (NCU terminal X132.7 and NX terminal X122.1).

## Line contactor control

**Note**

The SINAMICS ("Safe Standstill" and "Safe Brake Control") safety functions satisfy the requirement for safety integrity level 2 (SIL2) in accordance with IEC 61508. This corresponds to the control category 3 in accordance with DIN EN 954-1 and DIN VDE 0801.

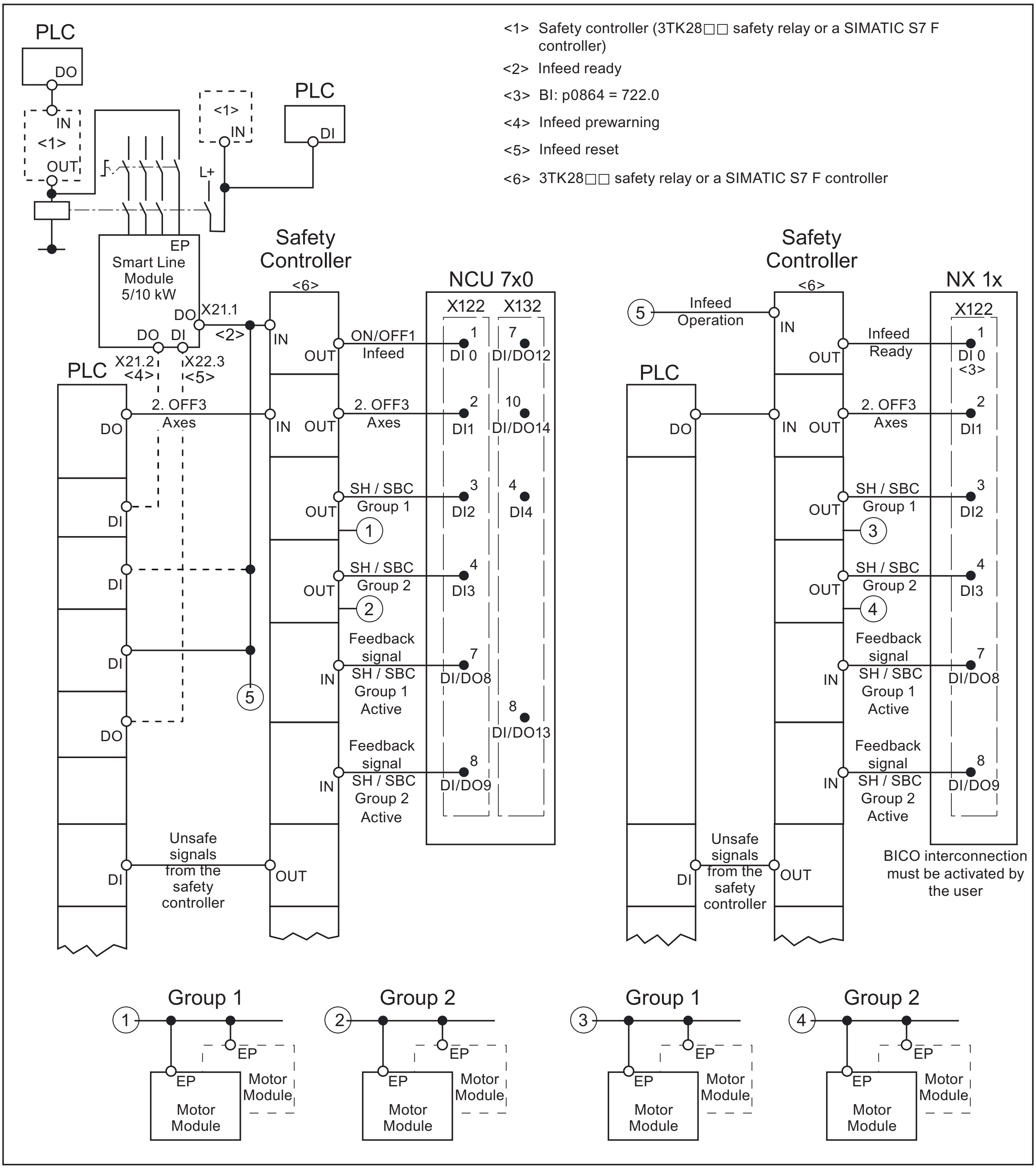
The "Safe Standstill" function prevents an unwanted start-up from standstill of the motor connected to the drive unit.

The need for a line contactor for the safe separation of the energy supply to the motor is no longer assured.

- The line contactor is controlled via the "Line contactor control" function (NCU terminal X132.10). The signal state for the line contactor (form A contact) can be returned (NCU terminal X132 4). This control ensures that the line contactor always switches in a defined manner and so prevents overloading or damaging the line contactor and/or the infeed.

| NOTICE |
| --- |
| The described control must be locked by the safety controller in accordance with the required safety category. |

# 6.5 Application 5




<1> Safety controller (3TK28□□ safety relay or a SIMATIC S7 F controller)

<2> Infeed ready

<3> BI: p0864 = 722.0

<4> Infeed prewarning

<5> Infeed reset

<6> 3TK28□□ safety relay or a SIMATIC S7 F controller

Figure 6-5 Infeed without DRIVE-CLiQ (SLM 5 kW to 10 kW), use of a drive-integrated SH/SBC safety function by SINAMICS and line contactor with safe control

### Interconnection of the PLC input signals

- "Infeed Ready" (SLM terminal X21.1)

  The infeed is operating for 1 signal.

### Interconnection of the PLC output signals

| NOTICE |
| --- |
| To achieve safe control of the line contactor and the drive-integrated SH/SBC safety function by SINAMICS, the control signals must be provided by a safety relay (3TK28) or a SIMATIC F controller. This is the only way to ensure that disconnection is achieved in accordance with the required safety categories. |

- "2. OFF3" for all axes (NCU terminal X122.2)

  The "2. OFF3" will be forwarded to all axes of the NCU. The "2. OFF3" must be interconnected to the NX components provided (NX terminal X122.2). This means that the axes downstream from the NX also receive the enable.

  **Note**

  The "2. OFF3" signal must also be locked by the safety controller.

### Interconnection between the safety controller and the NCU and NX components

- The SH/SBC function must be controlled by the safety controller using two channels.

  The first channel goes to the NCU/NX.

  The second channel goes to the Motor Module.

  If required, appropriate groups (1/2) can be formed that must be controlled depending on the switching condition. The feedback of the SH/SBC function must be evaluated in the safety controller.

## Interconnection of the NCU 7x0 component

- "Infeed Ready" (connection between SLM terminal X21.1 and NCU terminal X122.1)

  After activating the infeed, given correct operation, the "Infeed operation" state will be attained and all axes (BI: p0864) will be enabled. This status must also be forwarded to the NX components (NX terminal: X122.1).

  The Smart Line Module without DRIVE-CLiQ interface is not switched on/off using a Drive Object of the NCU. The control is performed exclusively via terminals on the Smart Line Module, for example, from a PLC or hardware controller.

**Note**

The "Infeed Ready" signal must also be locked by the safety controller.

## Line contactor control

**Note**

The SINAMICS ("Safe Standstill" and "Safe Brake Control") safety functions satisfy the requirement for safety integrity level 2 (SIL2) in accordance with IEC 61508. This corresponds to the control category 3 in accordance with DIN EN 954-1 and DIN VDE 0801.

The "Safe Standstill" function prevents an unwanted start-up from standstill of the motor connected to the drive unit.

The need for a line contactor for the safe separation of the energy supply to the motor is no longer assured.

The line contactor must be controlled from an external PLC or hardware controller. Internal line contactor control using a Drive Object by the NCU is not possible.

The following activation/deactivation conditions must be observed for the control (also see the "Line Contactor Control" chapter):

### PLC input signal

- "Line contactor feedback"

  Query the switching state of the line contactor

**PLC output signal**

- "Line contactor control"

  Control the line contactor taking into consideration the activation/deactivation condition

| CAUTION |
|---|
| If the named conditions are not observed, the line contactor and the infeed can be damaged. |

| NOTICE |
|---|
| The described control must be locked by the safety controller in accordance with the required safety category. |

## Smart Line Module operation

The Smart Line Module without DRIVE-CLiQ interface is not switched on/off using a Drive Object of the NCU. The control is performed exclusively via terminals on the Smart Line Module, for example, from a PLC or hardware controller.

**Interconnection of the PLC input signals**

- "Infeed Ready" (SLM terminal X21.1)

  Infeed operational

- "Infeed PreWarning" (SLM terminal X21.2)

  Overtemperature advance warning

**Interconnection of the PLC output signals**

- "Infeed Reset" (SLM terminal X22.3)

  Reset of a pending fault

# 6.6 Application 6

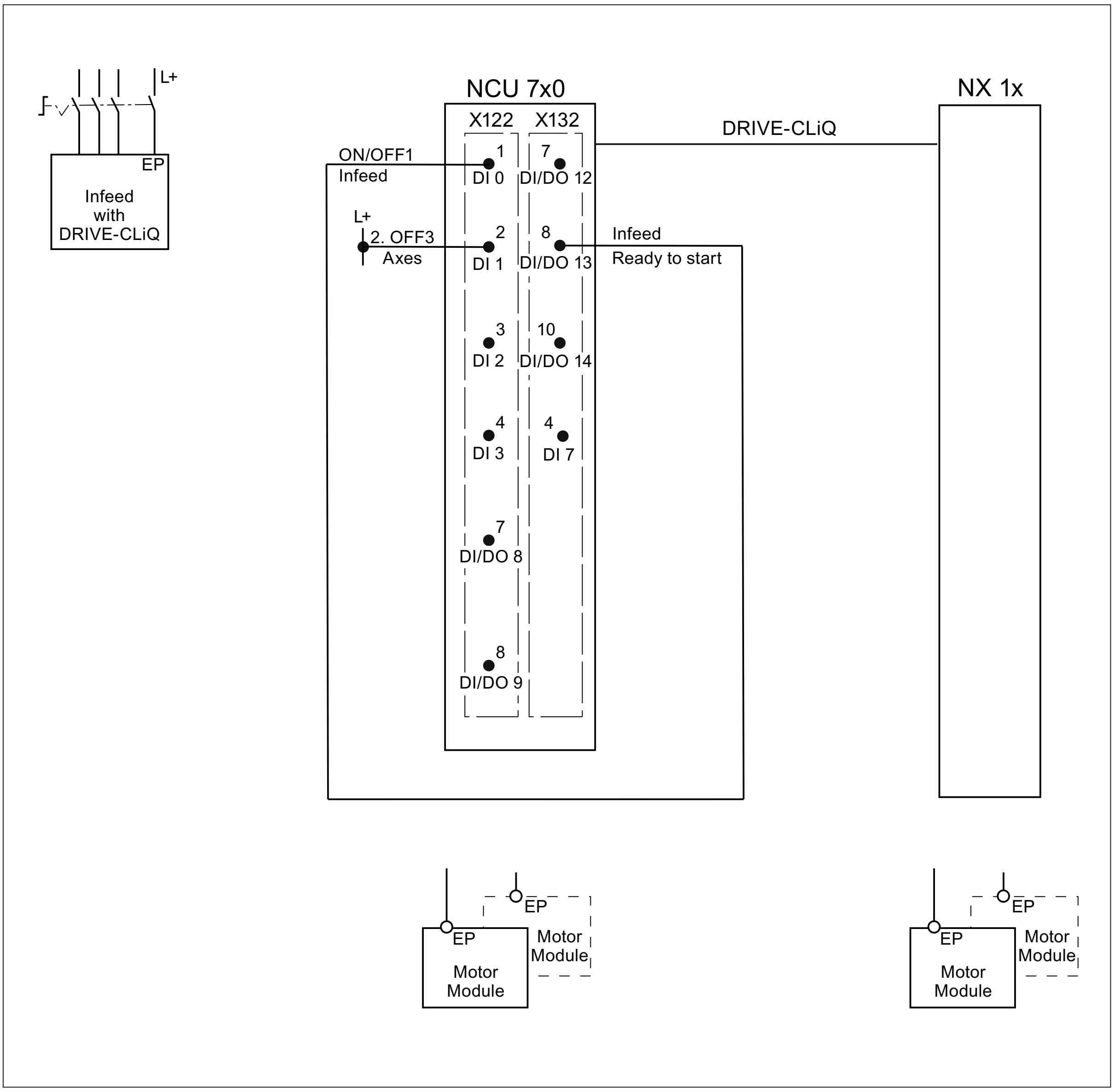



Figure 6-6 Infeed with DRIVE-CLiQ (SLM/ALM 16 kW to 120 kW); use of the SINUMERIK system/drive-integrated safety function

### Interconnection to the NCU component

- "Infeed ready" (NCU terminal X132.8)

  The infeed is ready for 1 signal.
- "ON/OFF1 Line Module" (NCU terminal X122.1)

  The 0/1 edge activates the infeed. The "Infeed Ready" signal (NCU terminal X132.8) is used for the control.
- "2. OFF3" for all axes (NCU terminal X122.2)

  The "2. OFF3" will be forwarded to all axes of the NCU. The input is hard-wired with the 24 VDC.

### Interconnection to the NX component

- "2. OFF3" for all axes (NCU terminal X122.2)

  The "2. OFF3" will be forwarded to all axes of the NX. The input is hard-wired with the 24 V DC.

### Interconnection between NCU and NX components

- After activating the infeed, given correct operation, the "Infeed operation" state will be attained and all axes (BI: p0864) will be enabled. This status must also be forwarded to the NX components (NCU terminal X132.7 and NX terminal: X122.1).

### Operation of the infeed

After the NCU power up, the infeed is activated automatically.

### Realization of the safety control

The system/drive-integrated safety function performs this task. External safety relays or safety controllers are thus no longer required. The terminal control of the SH/SBC function via NCU/NX and Motor Modules is no longer essential because this function is controlled by the system.

The SINAMICS ("Safe Standstill" and "Safe Brake Control") safety functions satisfy the requirement for safety integrity level 2 (SIL2) in accordance with IEC 61508. This corresponds to the control category 3 in accordance with DIN EN 954-1 and DIN VDE 0801. The "Safe Standstill" function prevents an unwanted start-up from standstill of the motor connected to the drive unit.

The need for a line contactor for the safe separation of the energy supply to the motor is no longer assured.

| NOTICE |
| --- |
| When servicing work is performed, power must be removed and, if necessary, the disconnector unit must be turned off. |

## 6.7 Application 7

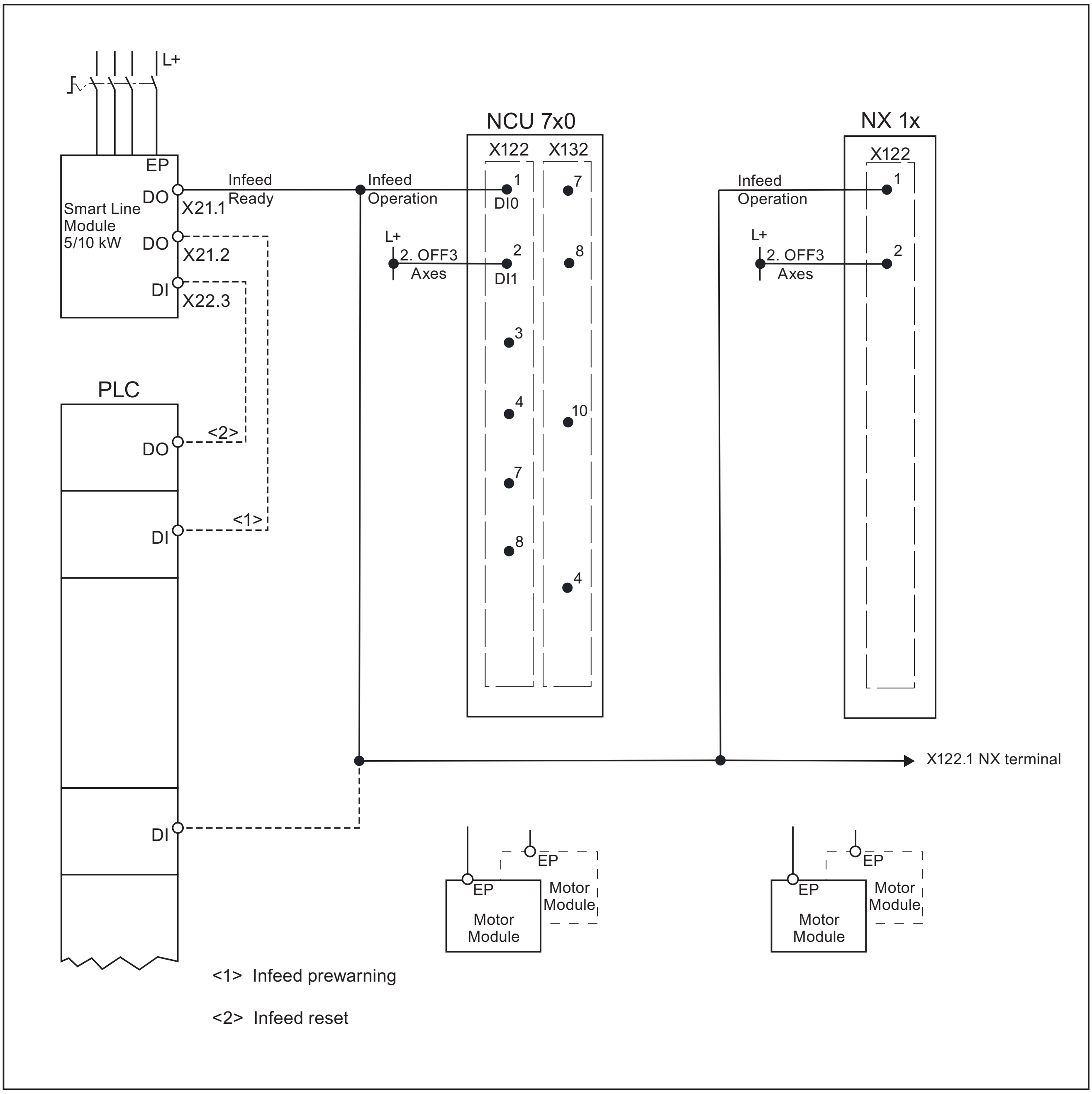



Figure 6-7 Infeed without DRIVE-CLiQ (SLM 5/10 kW); use of the SINUMERIK system/drive-integrated safety function

### Interconnection of the NCU 7x0 component

- "Infeed Ready" (connection between SLM terminal X21.1 and NCU terminal X122.1)

  After activating the infeed, given correct operation, the "Infeed operation" state will be attained and all axes (BI: p0864) will be enabled. This status must also be forwarded to the NX components (NX terminal: X122.1).
- "2. OFF3" for all axes (NCU terminal X122.2)

  The "2. OFF3" will be forwarded to all axes of the NCU. The input is hard-wired with the 24 V DC.

### Interconnection to the NX component

- "2. OFF3" for all axes (NCU terminal X122.2)

  The "2. OFF3" will be forwarded to all axes of the NX. The input is hard-wired with the 24 V DC.

### Smart Line Module operation

The Smart Line Module without DRIVE-CLiQ interface is not switched on/off using a Drive Object of the NCU. The control is performed exclusively via terminals on the Smart Line Module, for example, from a PLC or hardware controller.

#### Interconnection of the PLC input signals

- "Infeed Ready" (SLM terminal X21.1)

  Infeed operational
- "Infeed PreWarning" (SLM terminal X21.2)

  Overtemperature advance warning

#### Interconnection of the PLC output signals

- "Infeed Reset" (SLM terminal X22.3)

  Reset of a pending fault

### Realization of the safety control

The system/drive-integrated safety function that is an integrated part of the system performs this task. External safety relays or safety controllers are thus no longer required. The terminal control of the SH/SBC function via NCU/NX and Motor Modules is no longer essential because this function is controlled by the system.

The SINAMICS ("Safe Standstill" and "Safe Brake Control") safety functions satisfy the requirement for safety integrity level 2 (SIL2) in accordance with IEC 61508. This corresponds to the control category 3 in accordance with DIN EN 954-1 and DIN VDE 0801. The "Safe Standstill" function prevents an unwanted start-up from standstill of the motor connected to the drive unit.

The need for a line contactor for the safe separation of the energy supply to the motor is no longer assured.

When servicing work is performed, power must be removed and, if necessary, the disconnector unit must be turned off.

# Typical circuit diagrams 7

## 7.1 Connection Notes, Technical Data, Device Selection

The associated connection notes and technical data from the current operating and configuring guides, and catalogs and application manuals must be used for the configuring of the drive components, safety switching devices, contactors, etc., listed in the typical circuit diagrams.

### Selection of the switching devices

- 3TK SIGUARD safety combinations

  Typical circuit diagrams as well as the descriptions of functions are included in the "Safety Integrated" Application Examples, order no.: 6ZB5000-0AA01-0BA0.

- Positive-action contacts

  SIRIUS 3RT, 3RH, -0BA1 and 3TH power and auxiliary contactors must be chosen with positive-action auxiliary contacts in accordance with ZH1/457, IEC 60947-5-1.

- Contact reliability

  The auxiliary switches, switching contacts of the switching devices and the main power switch must be suitable for the reliable switching of breaking currents ≤ 17 V, 5 mA.

- Surge suppression

  For EMC and function reliability reasons, all switching devices, coils, inductances, brakes, etc., must be generally connected using RC elements, varistors, diodes or diodes combinations to counter switching overvoltages, provided such units are not already integrated in the devices.
  This is also the case for switching devices controlled by PLC outputs.

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**Note**

The selection of the surge suppression affects the switch-off delay of the devices. This influence must also be taken into account for the configuring.
For the selection and the technical data, see the LV10 (Low-voltage Switchgear) catalog.

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### Installation and execution specifications for control cabinets

For the form of the control cabinets for the installation of drive components, the following important specifications must be observed when selecting:

- DIN EN 60439-1 (VDE 0660 Part 500), low-voltage switchgear combination
- DIN EN 60204-1 (VDE 0113 Part 1), electrical equipment for machines, safety
- DIN VDE 0106 Part 100, protection against electrical shock

- EMC regulations (89/336 EEC) and low-voltage regulations (73/23/EEC)
- The associated environmental requirements (e.g. housing degree of protection IP.., installation altitude, ambient temperature, etc.)

## 7.2 Functional description of the typical circuit diagrams

The following section uses typical circuit diagrams to illustrate and describe in detail the individual applications and functions of the drive control.

First, the connection of the system to the line voltage and the the 24 VDC power supply is discussed. Simple control connections using the PROFIBUS interface or digital interface to a higher-level PLC are also described. Building on the general switching notes, safety-oriented functions are described in additional typical circuit diagrams. The PLC controller handles the coordinated execution of the drive control, but does not have any safety-related function.

### Layout of the typical circuit diagrams

- Circuit manual group =1
  Line infeed and creation of the 24 VDC power supply
- Circuit manual group =2
  Drive group with line contactor, Active Line Module, without safety functions
- Circuit manual group =3
  Drive group without line contactor, Smart Line Module without DRIVE-CLiQ connection, without safety functions, motor protection with Voltage Protection Module (VPM).
- Circuit manual group =4
  Activate/deactivate/stop drives or drive group in an emergency (emergency stop) using drive-integrated safety function
- Circuit manual group =5
  Drives start / stop / safe standstill (axis-specific) using drive-integrated safety function
- Circuit manual group =6
  Drives or drive group on/off; stop in an emergency (emergency stop); safety using drive-integrated safety function of the SINUMERIK 840D sl; ET 200S distributed peripherals.

The following section does not further discuss the setpoint and actual value interface and the user's machine control. This means they are shown only in general form.

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Note

For machines that must be placed in a lower category (e.g. 1 or 2 in accordance with EN 954–1) based on the danger analysis / risk evaluation or type C standard, the control can in general be derived from the provided typical circuit diagrams and constructed as a simpler, single channel system structure!

This is also true for subareas/subfunctions of a machine, which, for example, in accordance with the type C standards, must be constructed with a different lower or higher control category than that of the base machine. For example, after the danger analysis / risk evaluation it can also be necessary that a hydraulic/pneumatic clamping unit must be controlled in the work area using a two-handed control device in accordance with category 4.

---

Note

All subsequent typical circuit diagrams do not contain any safety-relevant or other possible machine-specific essential interlocks with the user-provided machine control.

---

# 7.3 Circuit Manual Group =1

## Line infeed and creation of the 24 VDC power supply

- Line infeed including the main power switch
- Power outlets including fuses for the Line Modules
- 24 VDC power supply for the drive group
- 24 VDC power supply for other consumers

Selection of equipment:

| | |
|---|---|
| =1.-Q11 | **Disconnector unit with leading auxiliary switch for switching off**<br>The disconnector unit disconnects the electrical equipment from the energy supply. The disconnector unit should not be switched off while the machine is running.<br>For selection, see the Manual and the LV10/NC61 catalog. The leading auxiliary switch is required for enabling the Line Module. |
| =1.-F23<br>=1.-Q24<br>=1.-Q26<br>=1.-Q27 | **Protection against overcurrent for the Line Module**<br>Depending on the requirement, either a fuse or a miniature circuit breaker can be used. The associated specifications of the safety characteristics must be observed.<br>For assignment, see the Booksize Power Units Equipment Manual; for selection, see NC61 catalog |
| =2.-Q15 | **Line contactor**<br>Optionally, a line contactor can be used; see also Section Line Contactor Control (Page 97) or Safety Integrated (Page 83); for selection, see NC61 catalog |
| =1.-V23<br>=1.-V24<br>=1.-V27 | **Line filter**<br>See the Booksize Power Units Equipment Manual; for selection, see NC61 catalog |
| =1.-R23<br>=1.-R24<br>=1.-R26<br>=1.-R27 | **Line reactor**<br>See the Booksize Power Units Equipment Manual; for selection, see NC61 catalog |

| | |
|---|---|
| =1.-T31<br>=1.-T33<br>=1.-T36 | **SITOP power 24 VDC power supply for SINAMICS components**<br>Separate power supply (24 VDC, 20 A) for the power supply busbar of the drive group and for external components. The corresponding power consumptions of the individual SINAMICS components must be taken into consideration for the layout. The maximum total current of the power supply busbar is 20 A DC.<br>See Booksize Power Units Equipment Manual<br>See KT10.1 catalog |
| =1.-T41 | **SITOP power 24 VDC power supply for auxiliary components**<br>Separate power supply (24 VDC) for the controller and auxiliary components, such as valves, contactors, etc.<br>See Booksize Power Units Equipment Manual<br>See KT10.1 catalog |
| =1.-Q31<br>=1.-Q33<br>=1.-Q36<br>=1.-Q41 | **Protection of the supply units**<br>See Booksize Power Units Equipment Manual<br>See KT10.1 catalog |
| =1.-F42...-F48<br>=1.-F52…-F58<br>=1.-F62…-F64 | **Protection of the individual circuits**<br>The potential assignment of the circuits is chosen freely. The maximum permitted values in accordance with details supplied by the manufacturer must be observed for the protection of the individual components. The overload and short-circuit protection must also be observed.<br>See Booksize Power Units Equipment Manual<br>See KT10.1 catalog |

Line infeed and power supply of the automation system is provided as shown in the following typical circuit diagrams.

## Circuit manual group examples = 1

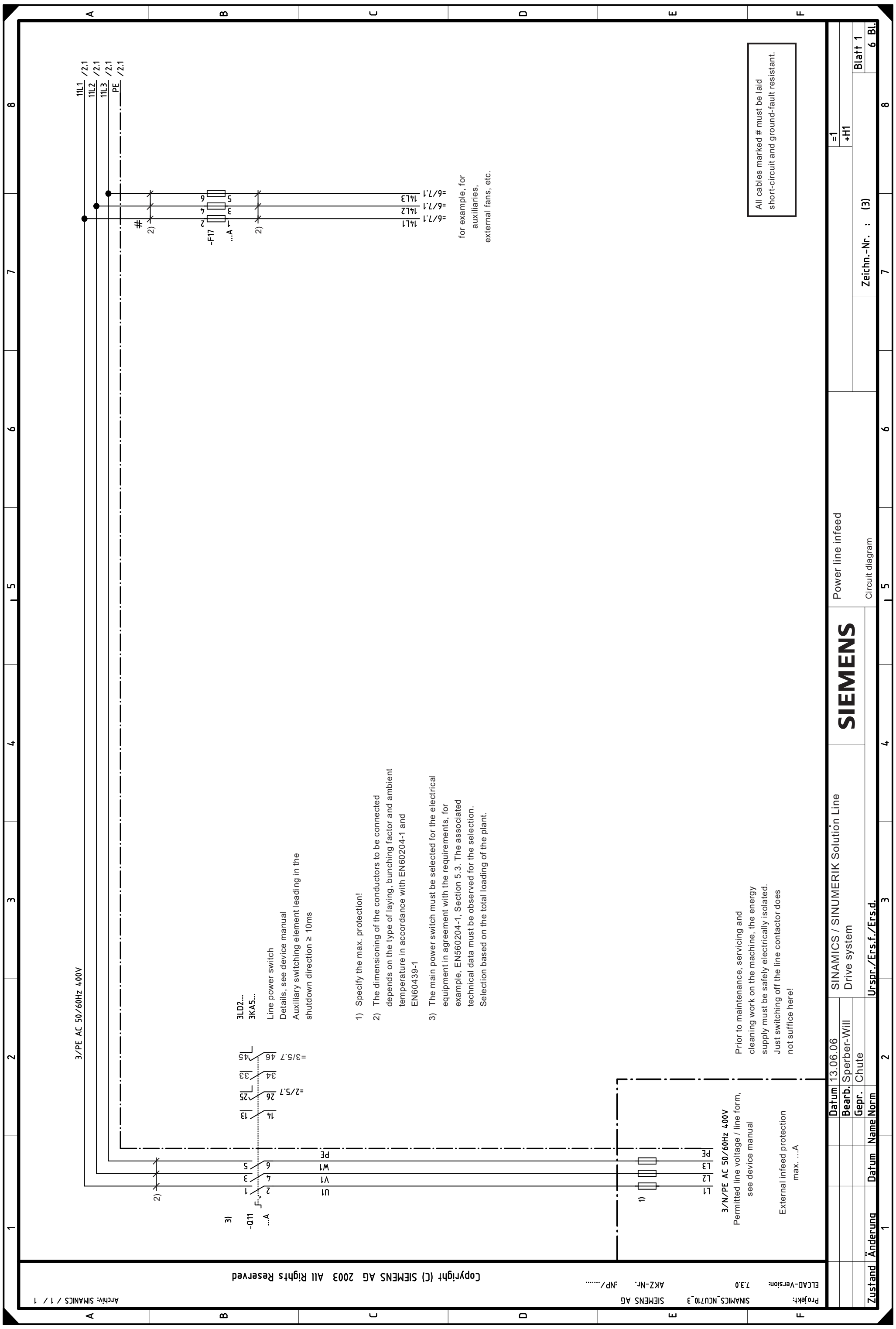


Figure 7-1 Circuit Manual Group =1, Page 1

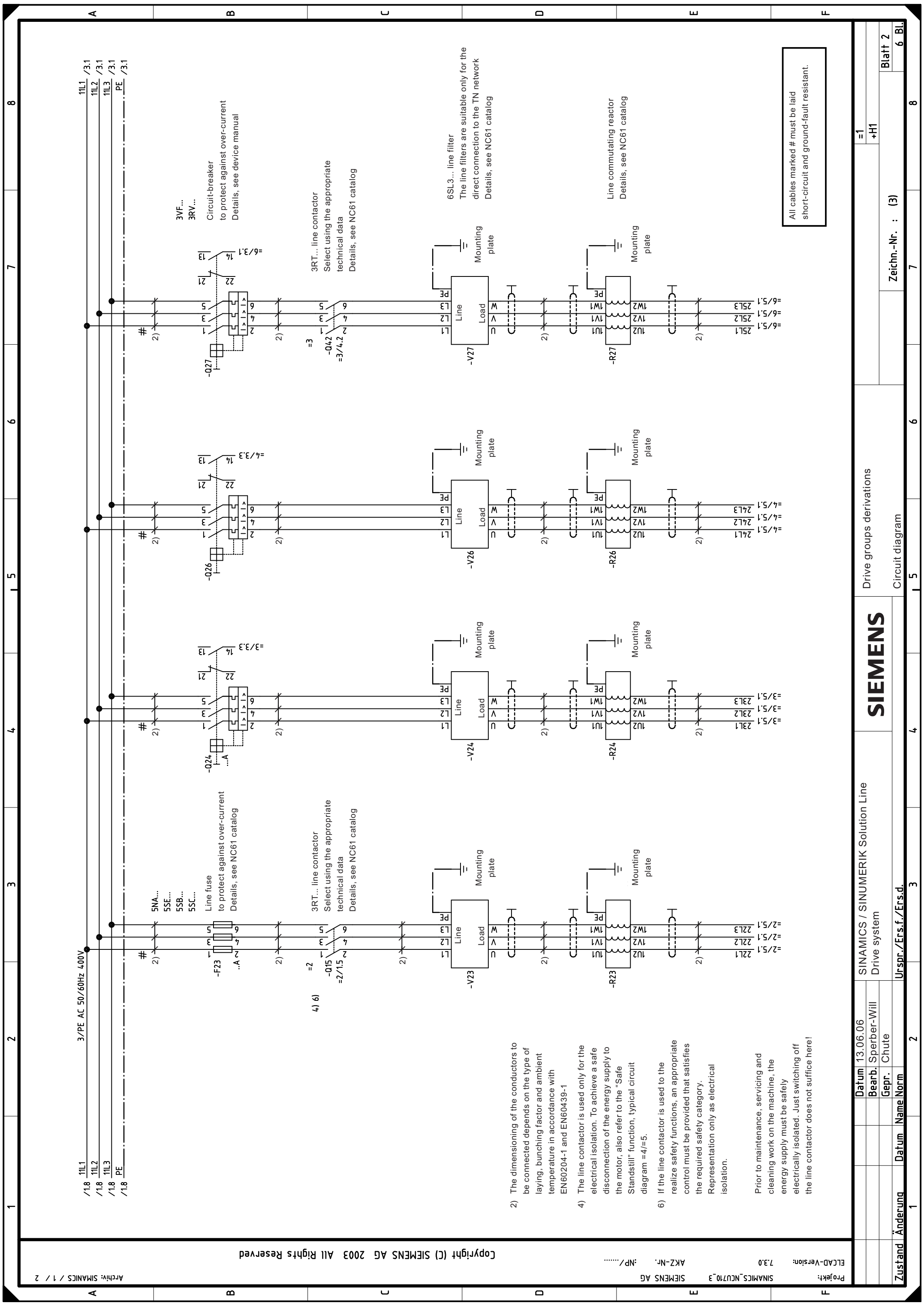


Figure 7-2 Circuit Manual Group =1, Page 2

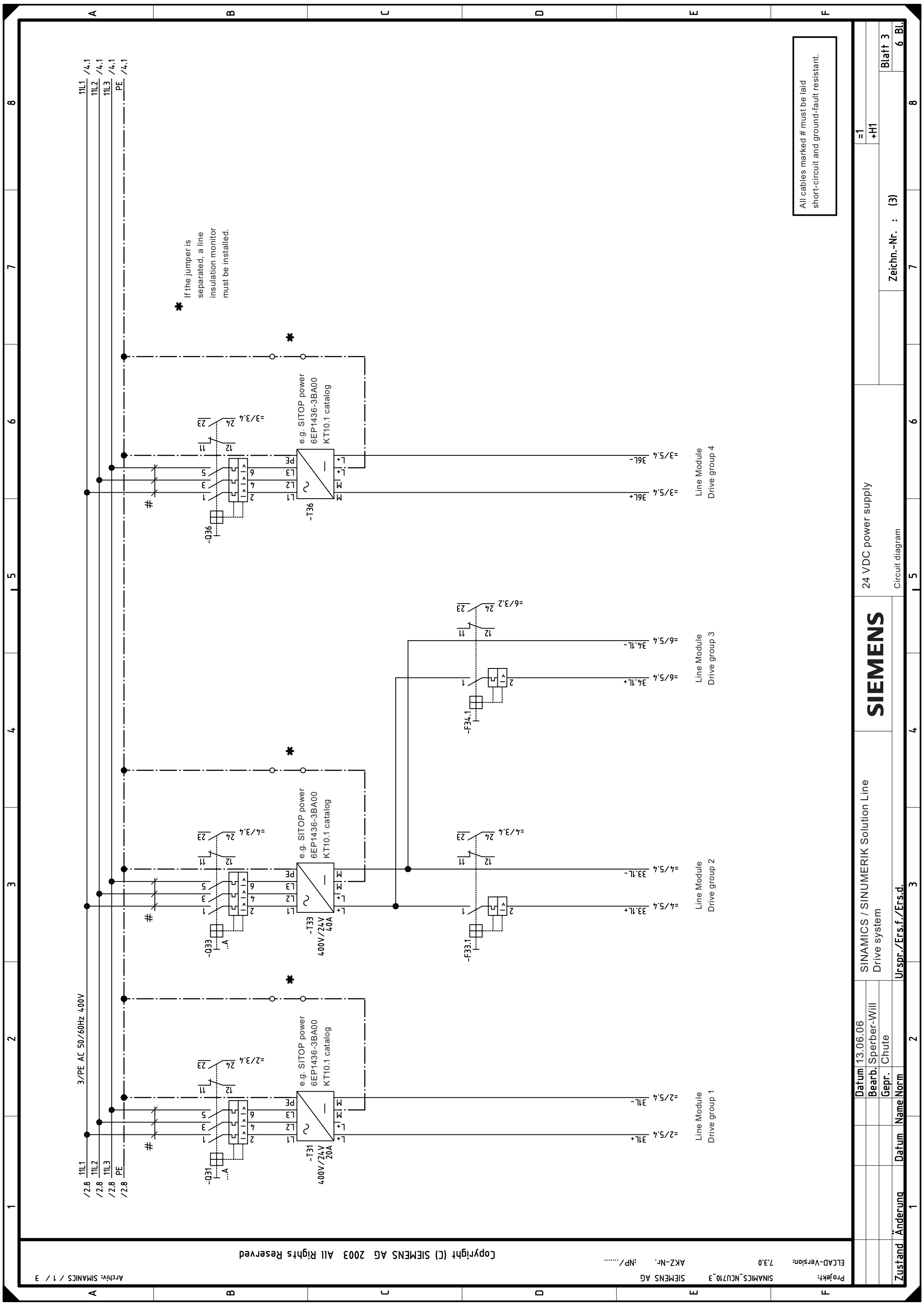


Figure 7-3 Circuit Manual Group =1, Page 3

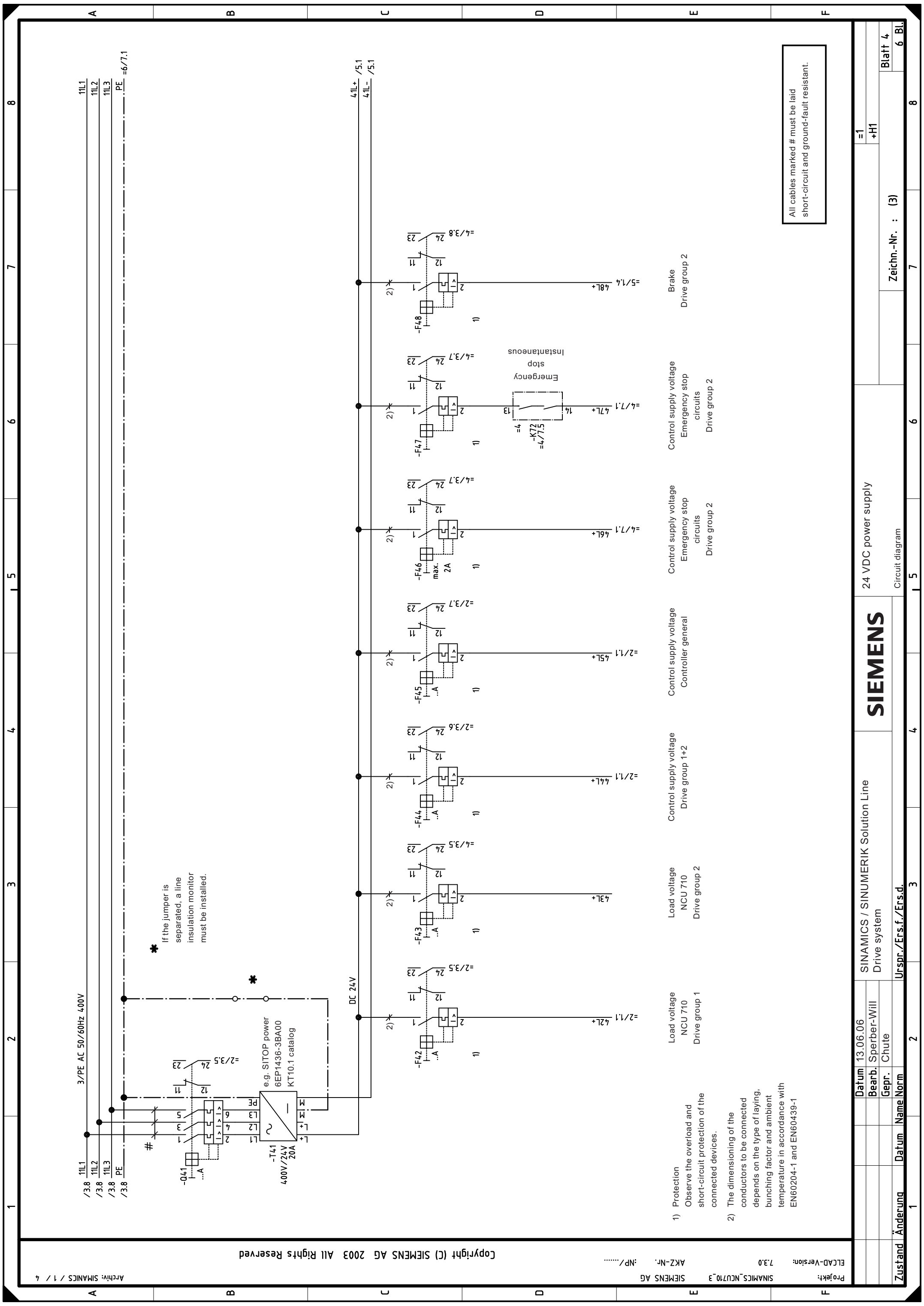


Figure 7-4 Circuit Manual Group =1, Page 4

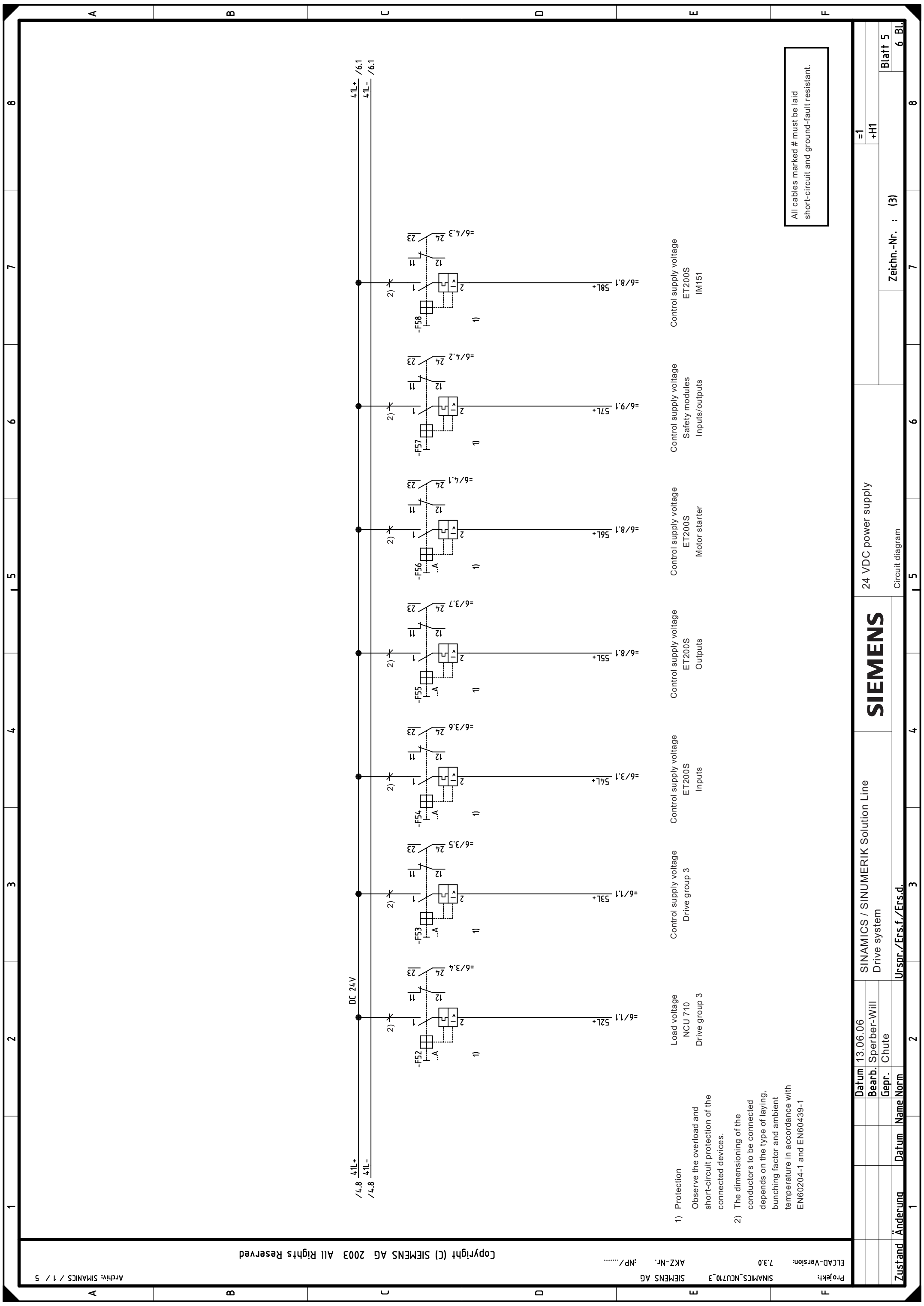


Figure 7-5 Circuit Manual Group =1, Page 5

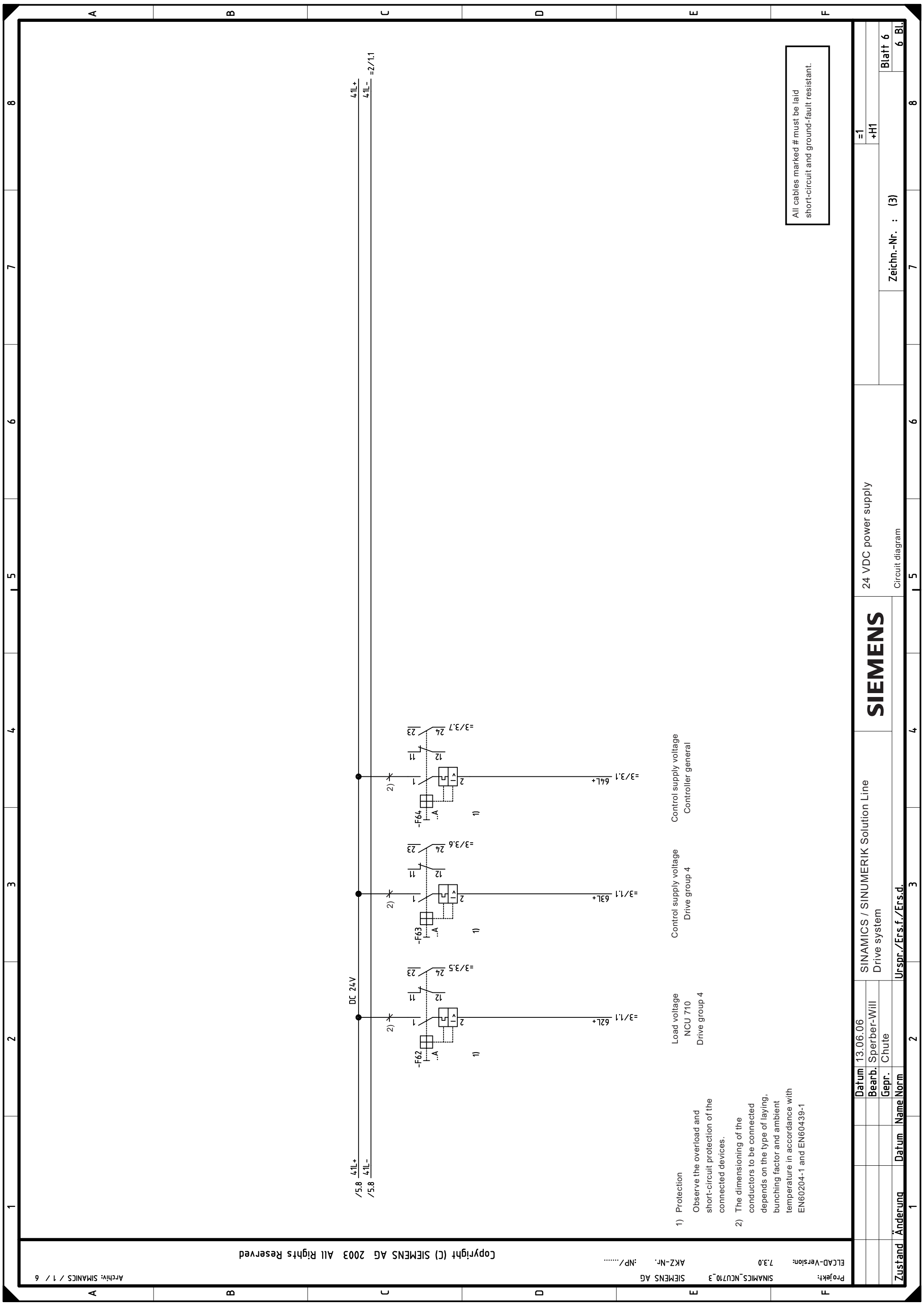


Figure 7-6 Circuit Manual Group =1, Page 6

## 7.4 Circuit Manual Group =2

### Drive group without safety, with line contactor

- Power supply of the NCU 710 (=2.-K11)
- Control signals to the NCU 710 (=2.-K11)
- DRIVE-CLiQ connection to the power units
- PROFIBUS connection to the distributed peripherals (=2.-K31)
- Control signals to the distributed peripherals
- Control of the line contactor (=2.-Q15) by the Control Unit
- Supply and control of the Line Module (=2.-Q51), including the integration of the auxiliary contact of the main power switch
- Supply and control of the Single Motor Modules (=2.-Q61; =2.-Q51)
- Connection of the motor, holding brake, and SMC20 sensor system to the Motor Module (=2.-K66; =2.-K76)

### Application

The drive group consists of the NCU 7x0 Control Unit (=2.-K11), the Line Module (=2.-Q51), and two Motor Modules (=2.-Q61/Q71).

The communication and open-loop/closed-loop control functions for the complete drive group, consisting, for example, of the Active Line Module and Motor Modules, can run in the Control Unit, whereby the Control Unit is designed for multi-axis operation at all times. DRIVE-CLiQ is used for the communication between the Control Unit and the connected SINAMICS components.

#### Functions

- Signal exchange between the NCU 710 Control Unit and the PLC
- Interlocking of external status and fault messages:

  External fault messages relating, for example, to the monitoring of miniature circuit breakers (=1.-F42, F44, F45), circuit-breakers (=1.-Q31, Q41), etc., may also need to be interlocked with the On/Off command. Messages can be visualized appropriately on the Operator Panel.
- Interlocking of component states and system alarms:

  Depending on their information and importance, some internal status signals can or must be linked with the On/Off command, controller enable, etc.
- Line contactor control:

  An internal control logic handles the control and monitoring of the optional line contactor (=2.-Q15). The line contactor is switched depending on the On/Off and enabling signals of the Active Line Module.

- Enabling signal from the Active Line Module:

  The protective circuit of the Enable Pulses digital input (-X21: 3/ 4) is essential for the Active Line Module (=2.-Q51). Before the main power switch is used to switch off the drive group, the Enable Pulses input on the Active Line Module must be disabled via, for example, a leading (≤ 10 ms) disabling auxiliary switch on the main power switch.

  The "Infeed Ready" signal is activated only when the Line Module is operating correctly and the DC link has started properly.

- Enables for Motor Modules:

  The "Infeed Ready" signal from the Line Module must be switched parallel on all connected Motor Modules in order to attain an enable for the Motor Modules. The interconnection is made within the drive objects in the Control Unit.

## Circuit manual group examples = 2

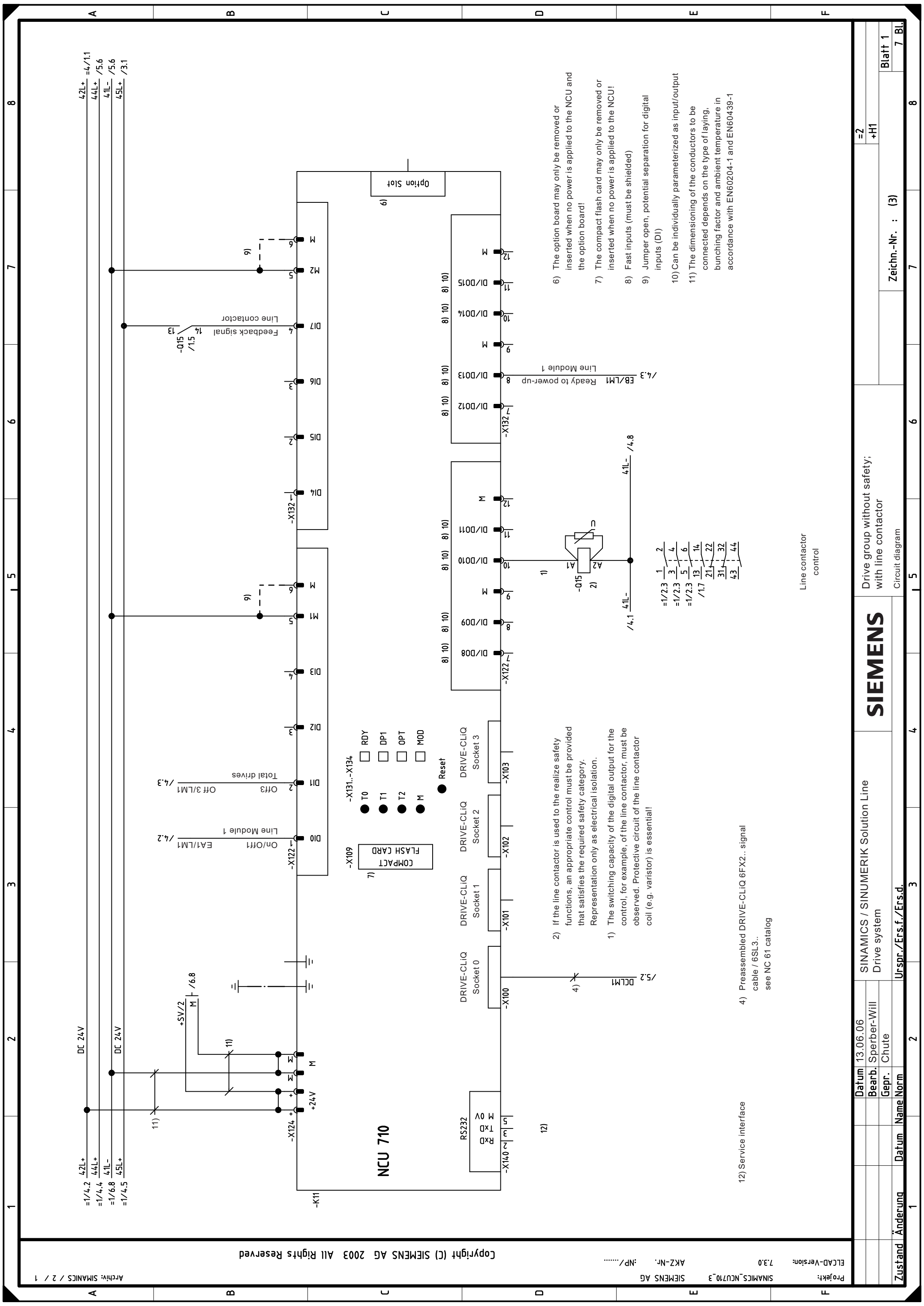

Figure 7-7 Circuit Manual Group =2, Page 1

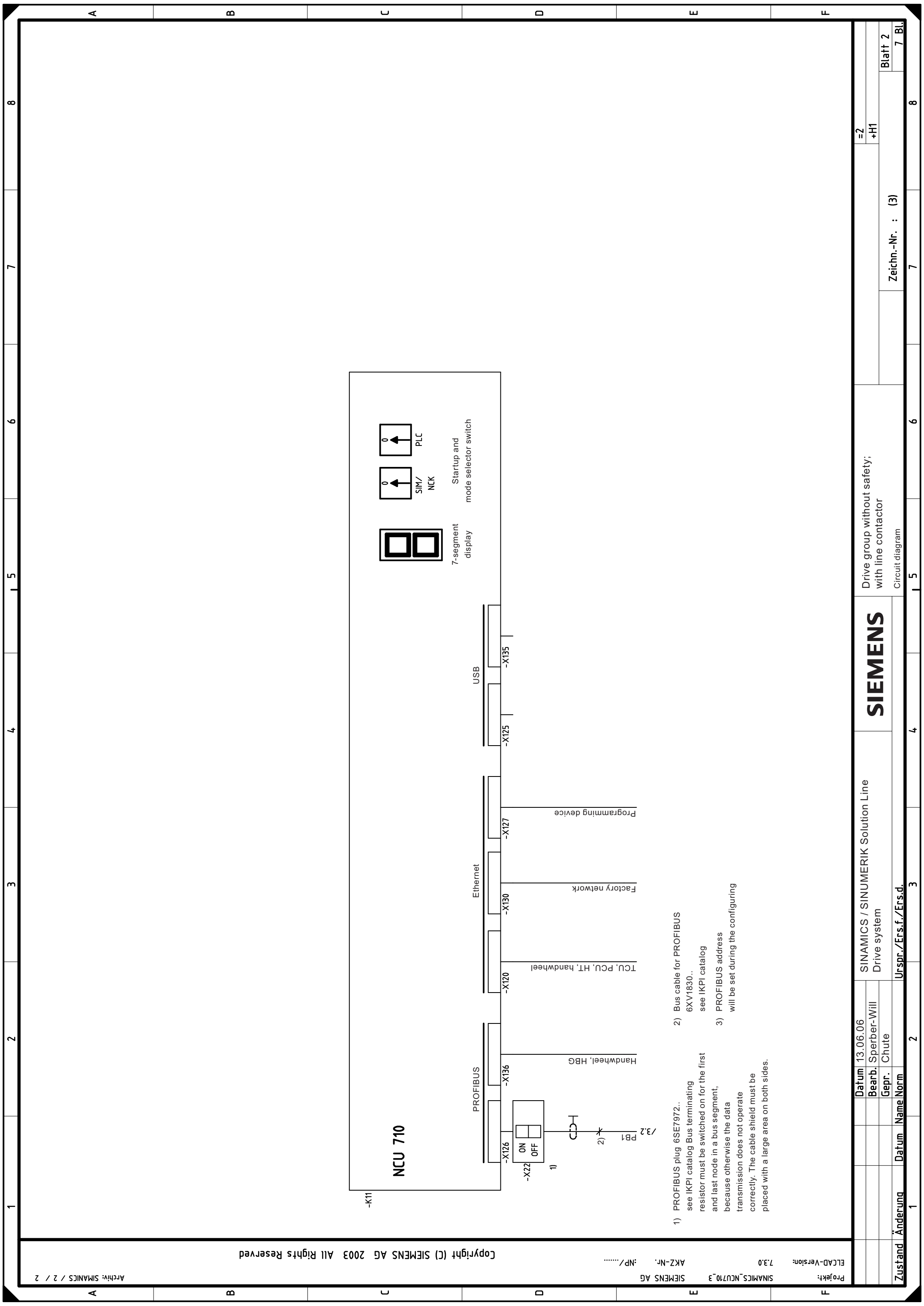


Figure 7-8 Circuit Manual Group =2, Page 2

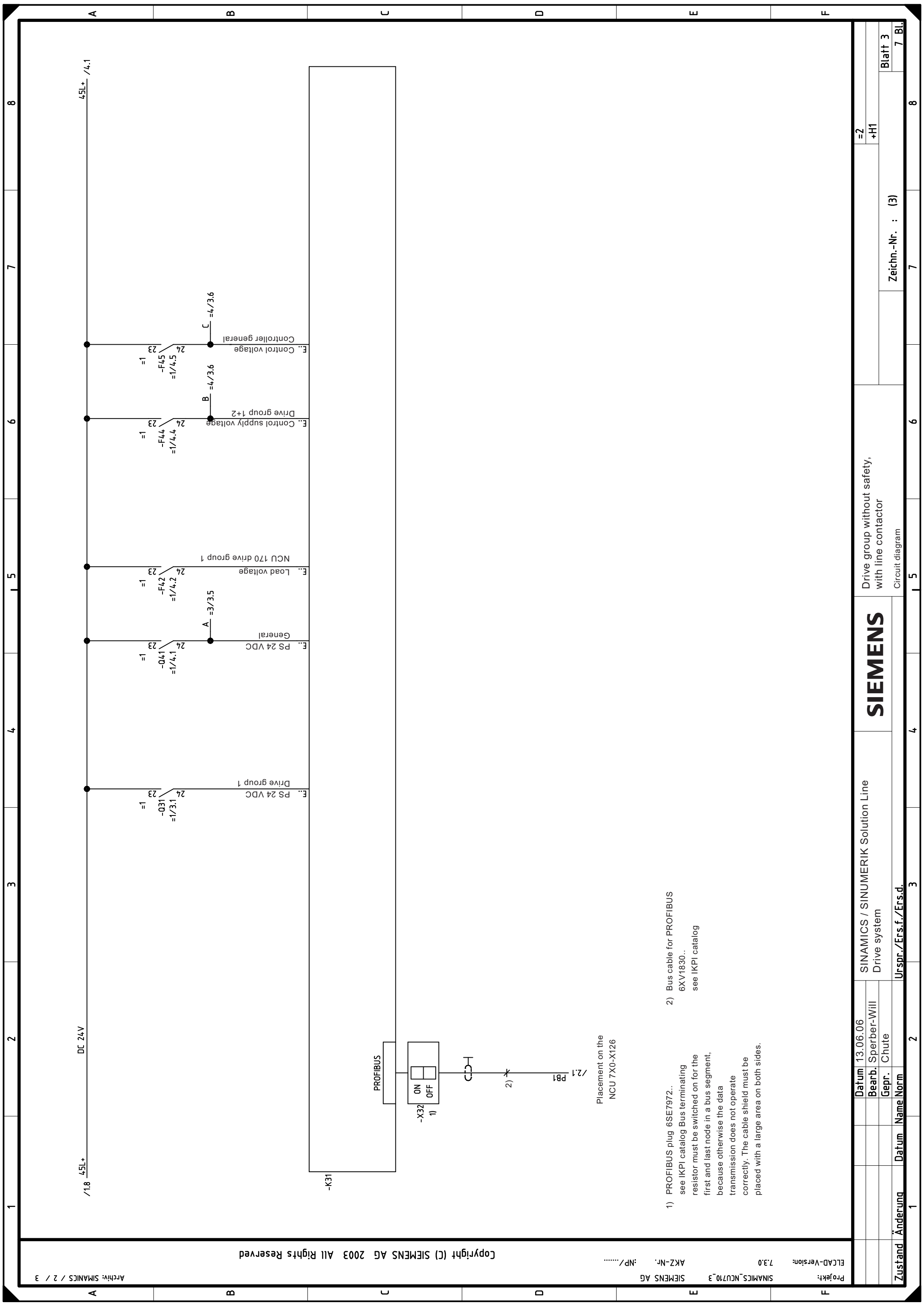


Figure 7-9 Circuit Manual Group =2, Page 3

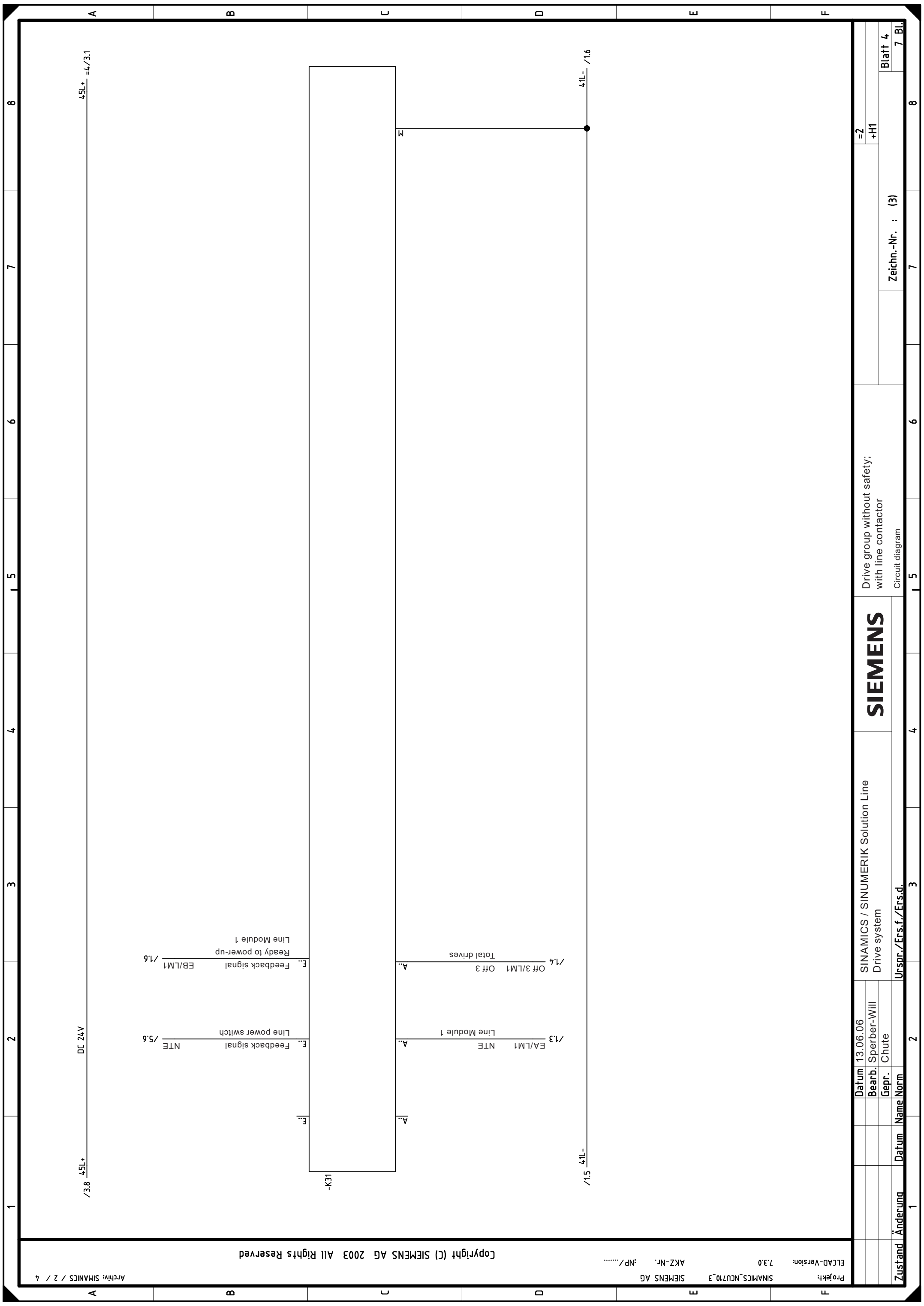

Figure 7-10 Circuit Manual Group =2, Page 4

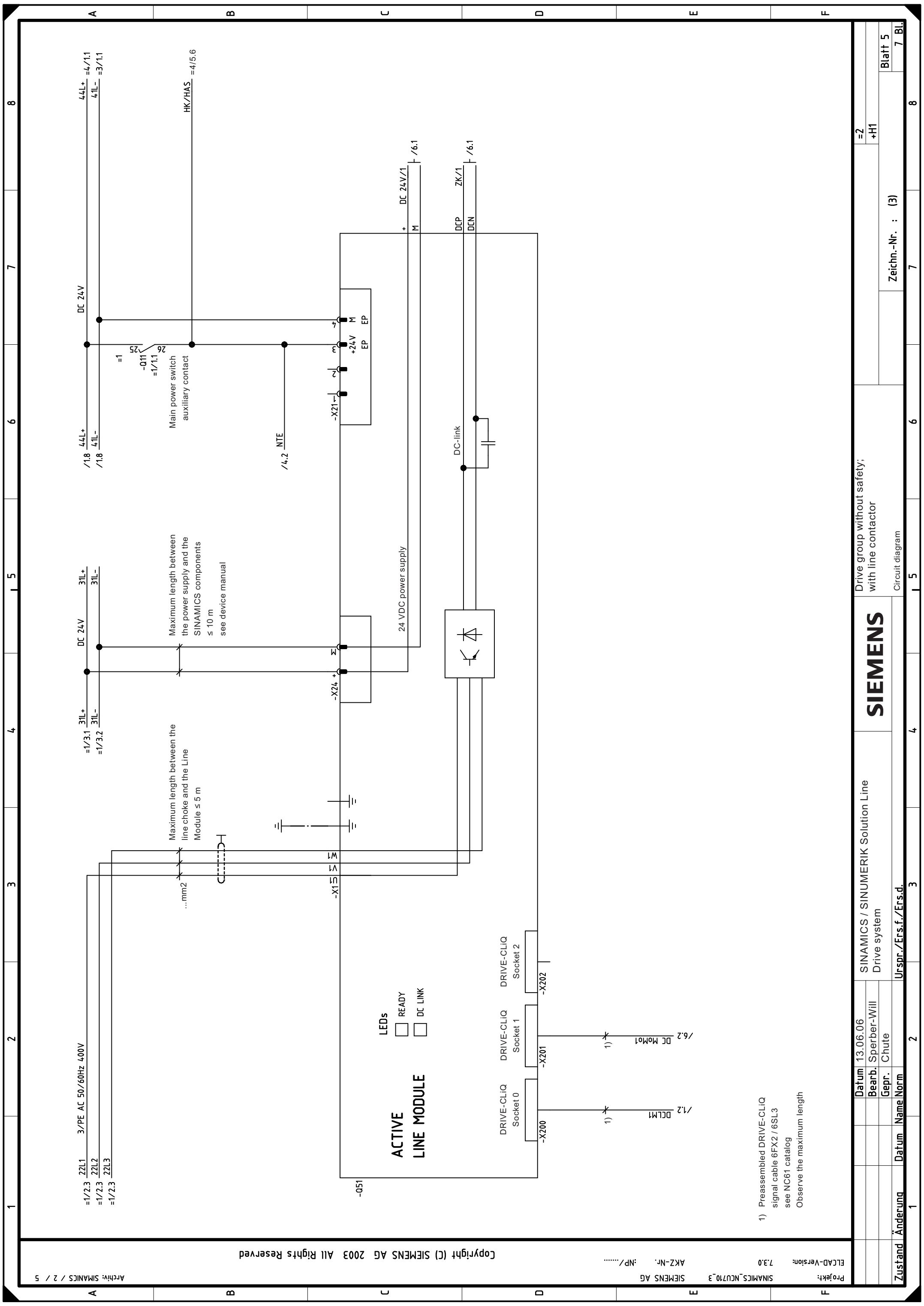


Figure 7-11 Circuit Manual Group =2, Page 5

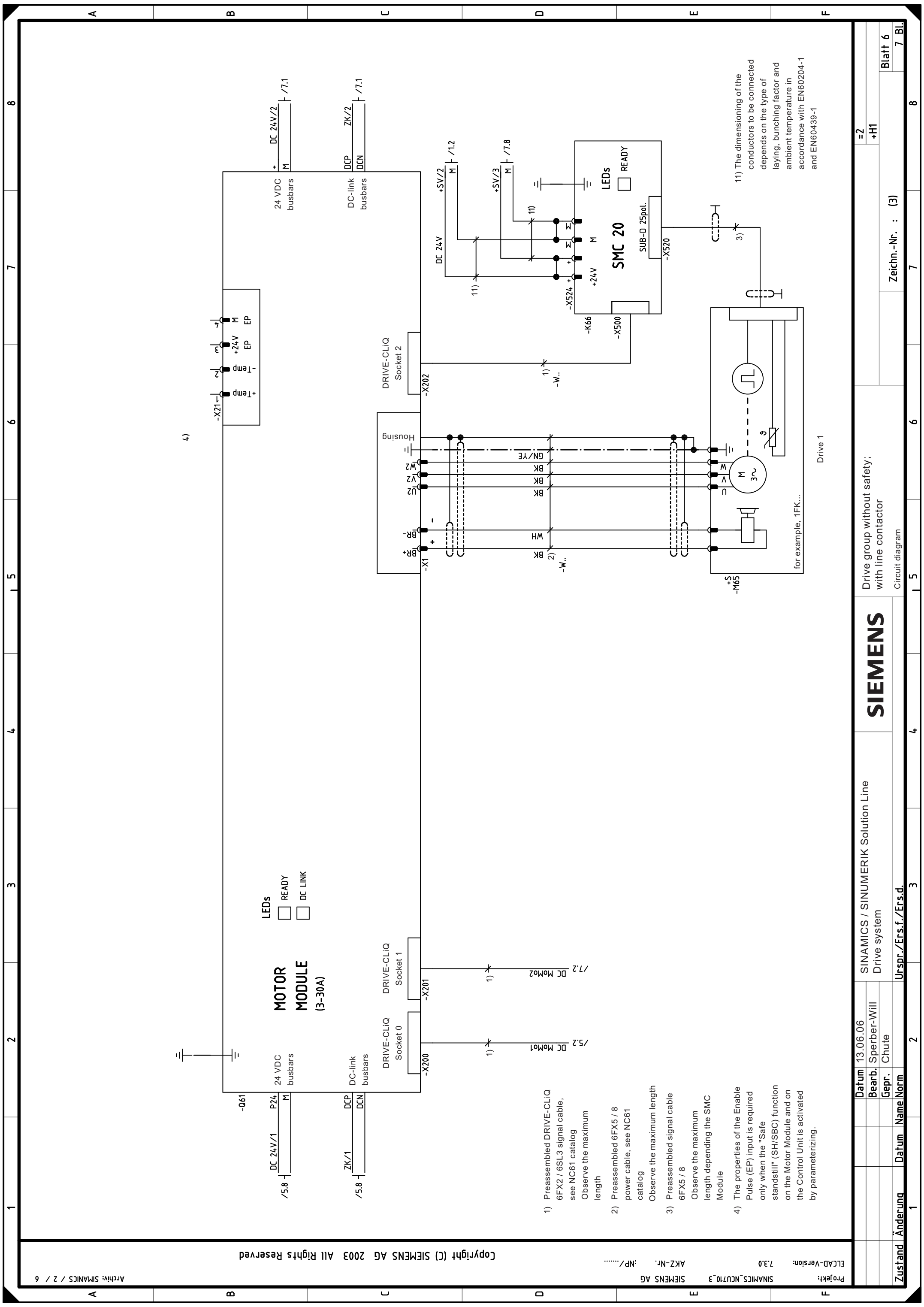


Figure 7-12 Circuit Manual Group =2, Page 6

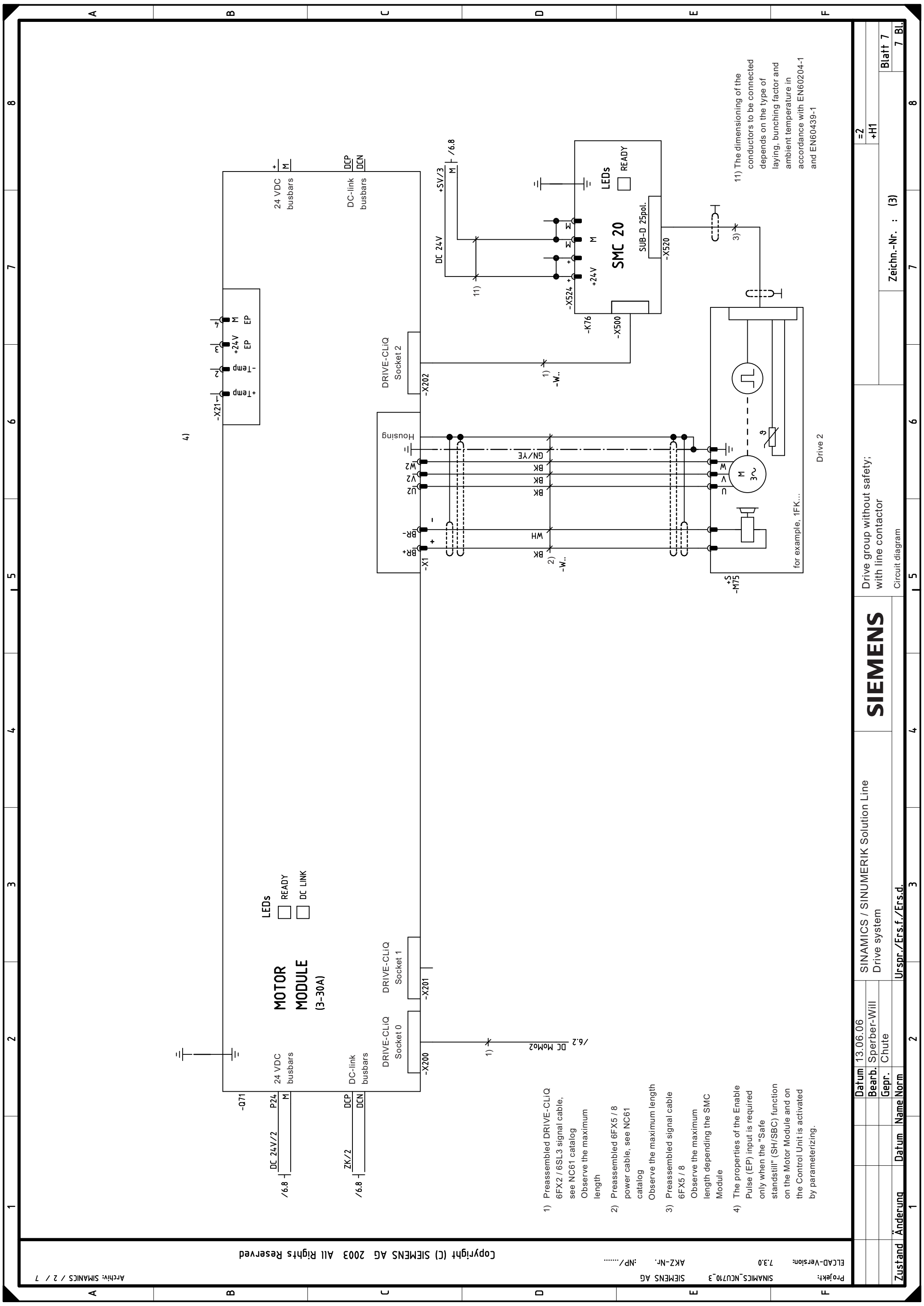


Figure 7-13 Circuit Manual Group =2, Page 7

## 7.5 Circuit Manual Group =3

### Drive group with line contactor, Smart Line Module without DRIVE-CLiQ connection, without safety functions, motor protection without Voltage Protection Module (VPM).

- Power supply of the NCU 710 (=3.-K11)
- Control signals to the NCU; digital inputs and digital outputs in accordance with standard macro specifications
- DRIVE-CLiQ connection to the Motor Module
- PROFIBUS connection to the distributed peripherals
- Supply and control of the Smart Line Module (=3.-Q51), including the integration of the auxiliary contact of the main power switch
- Supply and control of the Single Motor Module
- Connection of the motor, holding brake and sensor system to the Motor Module (=3.-Q61)
- Connection of the motor and separate sensor system (=3.-B78) to the Motor Module (=3.-Q71)
- Motor protection (=3.-F75) by the Voltage Protection Module (VPM)

The drive group consists of the Control Unit (=3.-K11), the Smart Line Module (=3.-Q51), two Motor Modules (=3.-Q61, =3.-Q71), the Voltage Protection Module (=3.-F75) and the SIMAG H2 (=3.B78) actual value sensor. The DRIVE-CLiQ connection is used for communication between the Control Unit and the Motor Modules.

### Functions

- Signal exchange

  The signal exchange between the NCU 710 Control Unit and the PLC
- Interlocking of external status and fault messages

  External fault signals, such as the monitoring of the safety cut-outs (=1.-F62, =1.-F63, =1.-F64), circuit-breakers (=1.-Q36, =1.-Q41), etc., may also need to be interlocked with the On/Off command. Messages can be visualized appropriately on the Operator Panel.
- Interlocking of component states and system alarms

  Depending on their information and importance, some internal status signals can or must be linked with the On/Off command, controller enable, etc.
- Enable signal from the Smart Line Module (5/10 kW)

  The protective circuit of the Enable Pulses digital input (X21: 3/ 4) is required for the Smart Line Module (=3.-Q51). Before the main power switch is used to switch off the drive group, the Enable Pulses input on the Smart Line Module must be disabled, for example, using a leading (<=10 ms) auxiliary switch on the main power switch. The "Infeed Ready" signal is activated only when the Smart Line Module is operating correctly and the DC link has started properly.

- Line contactor control

  The PLC is used to control the line contactor, because the Line Module 5/10 kW (without DRIVE-CLiQ) does not have any internal control logic for control and monitoring. An appropriate activation and deactivation must be observed. See also Section Line Contactor Control (Page 97).

- Signal exchange between the PLC and the Smart Line Module (5/10 kW)

  Because the Smart Line Module (5/10 kW) does not have any DRIVE-CLiQ connection, digital signals are used for the signal exchange between the Smart Line Module and the PLC.

- Enables for Motor Modules

  The "Infeed Ready" signal from the Line Module must be switched parallel on all connected Motor Modules to enable the Motor Modules here. The signal interconnection is made within the Drive Module in the Control Unit.

- Motor protection for the 1FE motor

  A Voltage Protection Module (VPM) is provided to protect the 1FE motor against over-voltages. The signal contact from the VPM must be interconnected with the Control Unit. When the VPM is triggered, an OFF2 (=3.-K11, X132: 10, DI/DO 14) of the corresponding axis will be initiated.

- Sensor connection for the 1FE motor

  Because the 1FE motor does not have an internal encoder, an SMC20 module must be used to connect a separate external encoder (e.g. SIMAG H2) to the Motor Module.

## Circuit manual group examples = 3

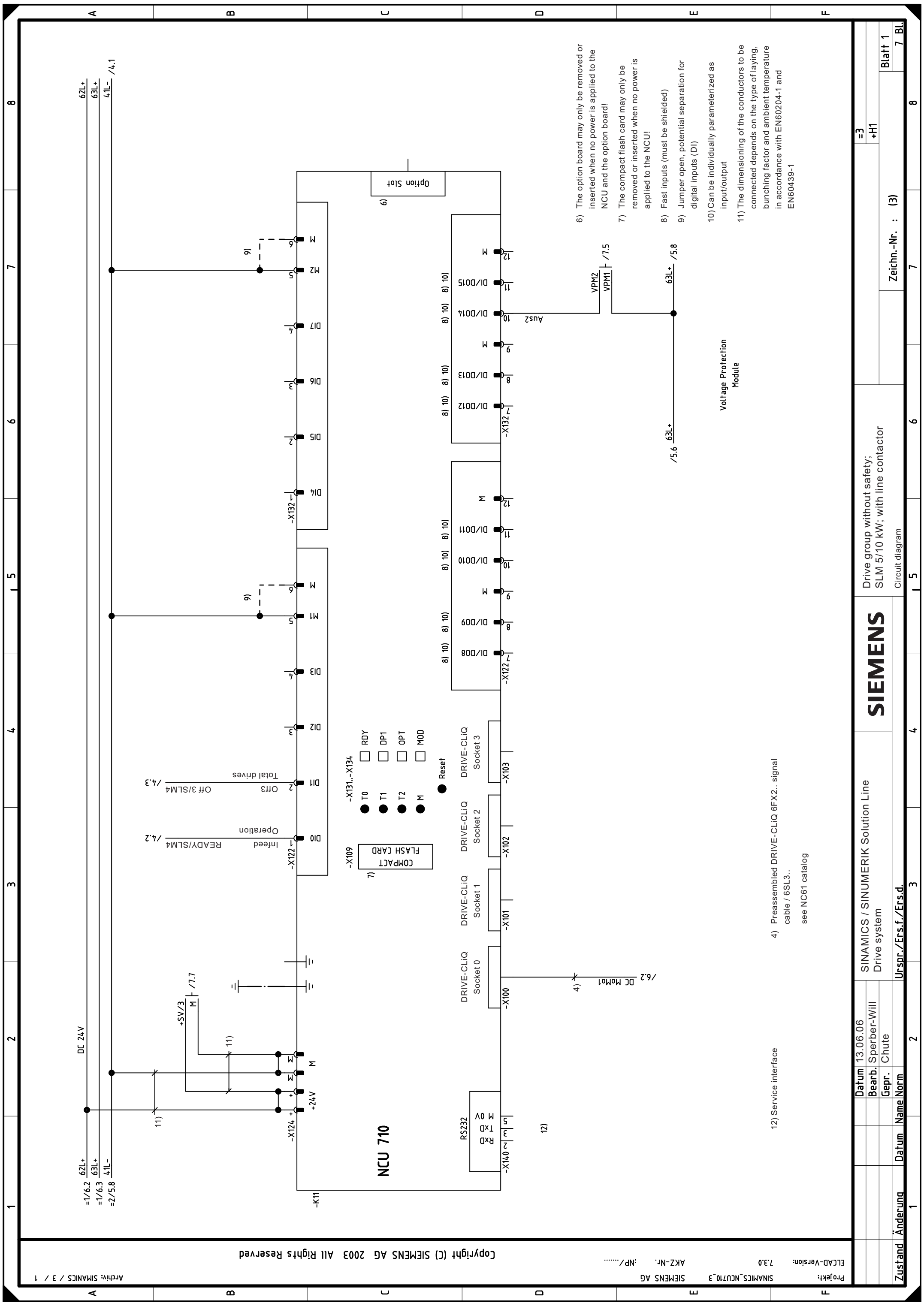

Figure 7-14 Circuit Manual Group =3, Page 1

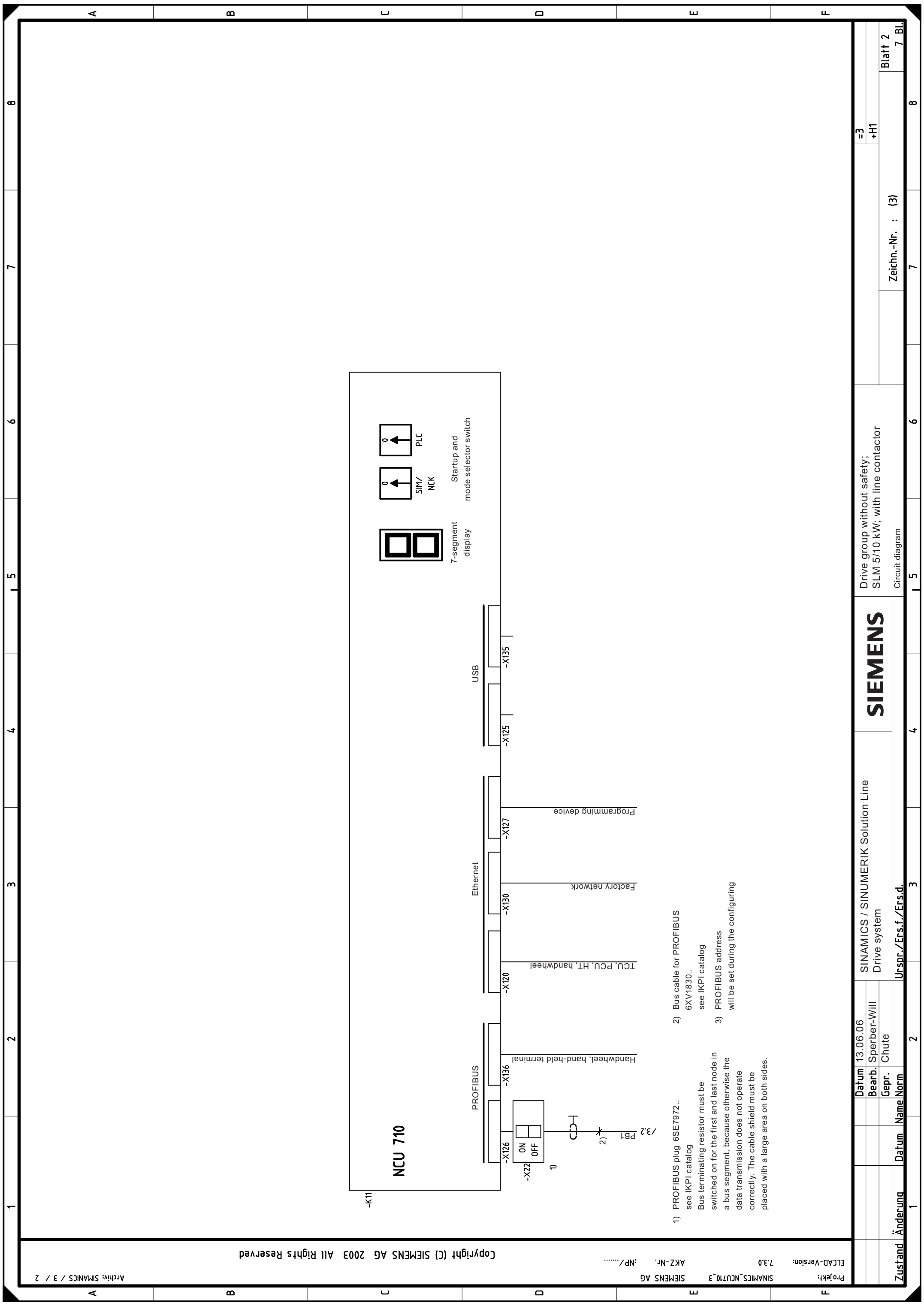


Figure 7-15 Circuit Manual Group =3, Page 2

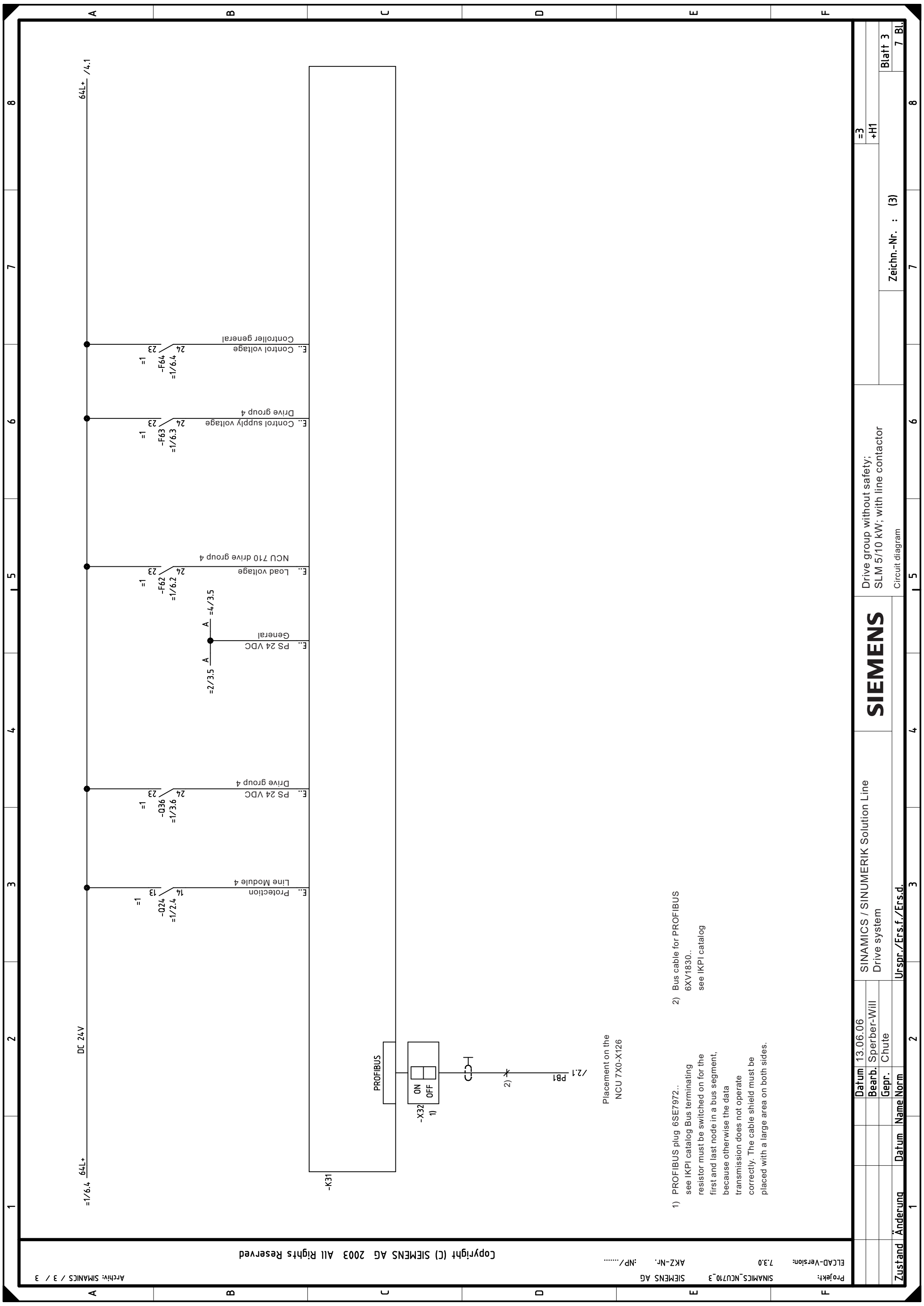


Figure 7-16 Circuit Manual Group =3, Page 3

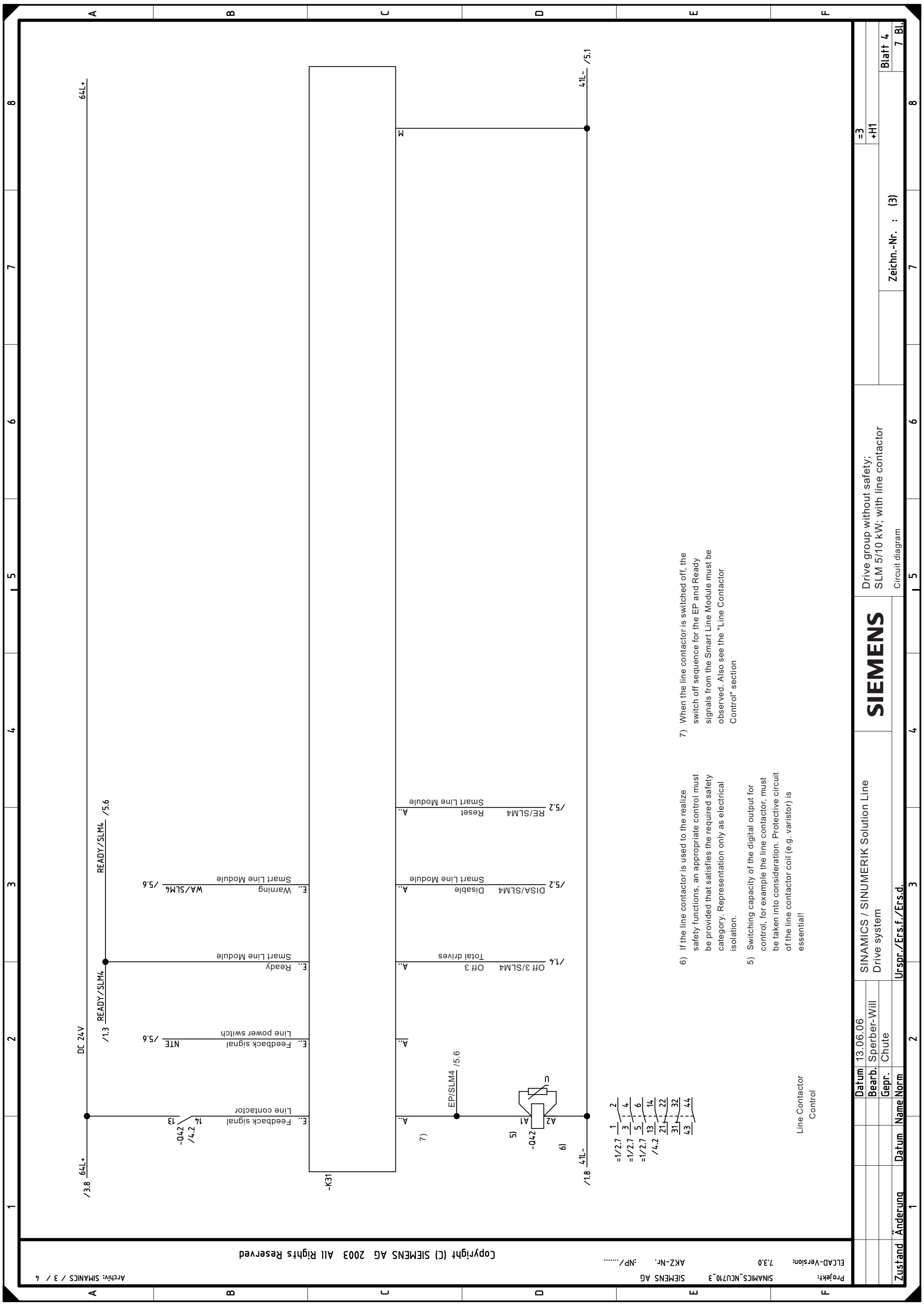

Figure 7-17 Circuit Manual Group =3, Page 4

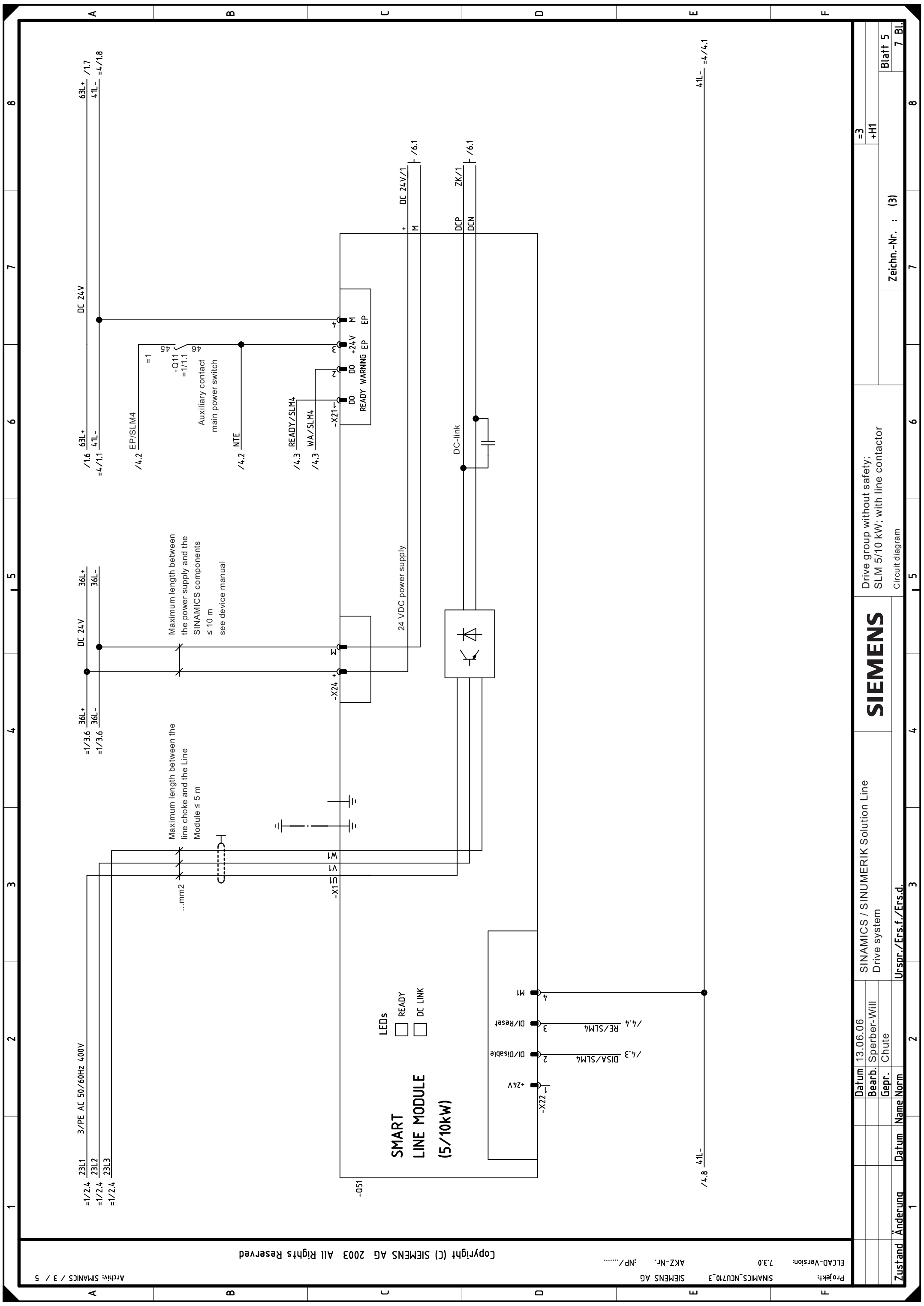


Figure 7-18 Circuit Manual Group =3, Page 5

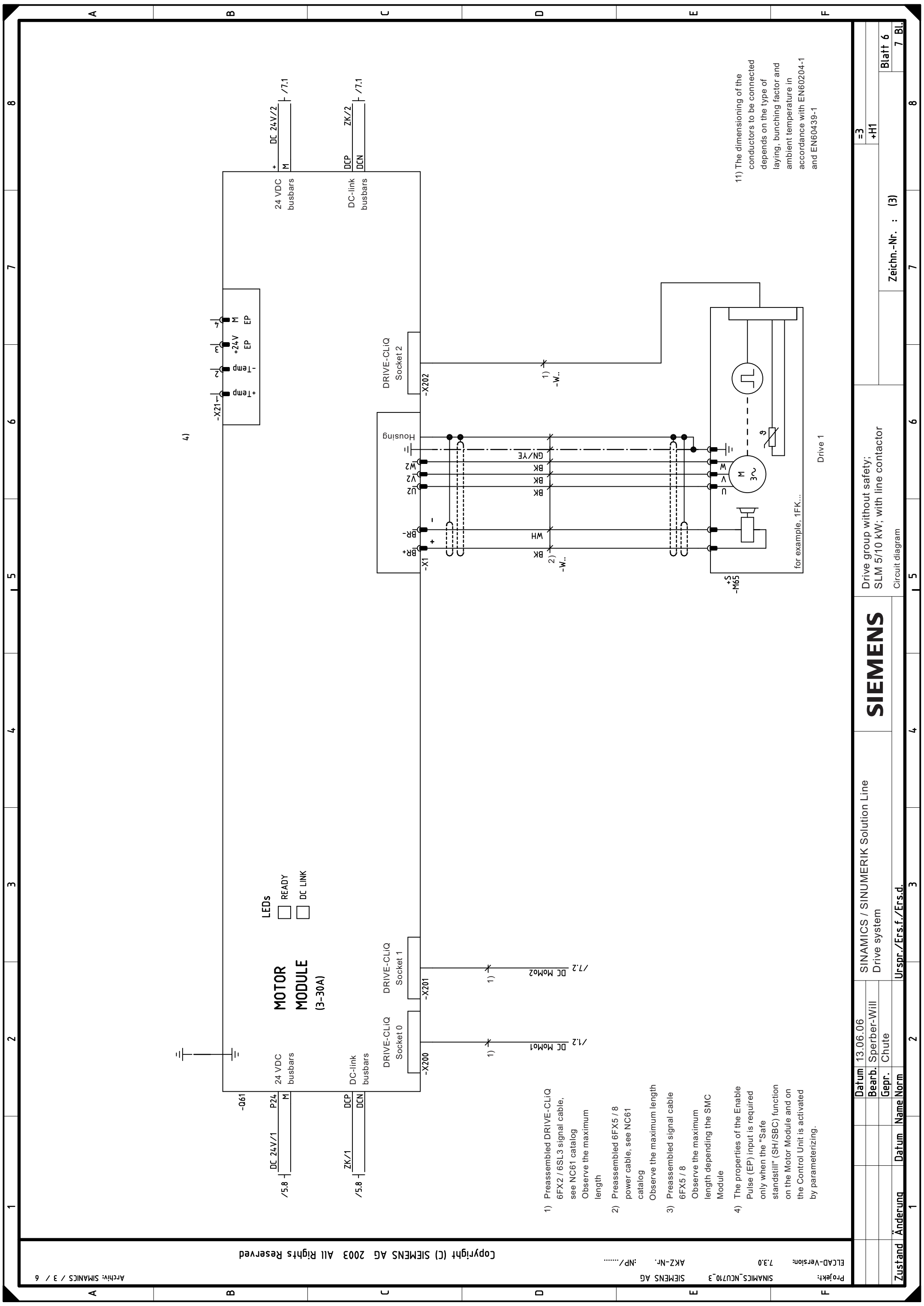


Figure 7-19 Circuit Manual Group =3, Page 6

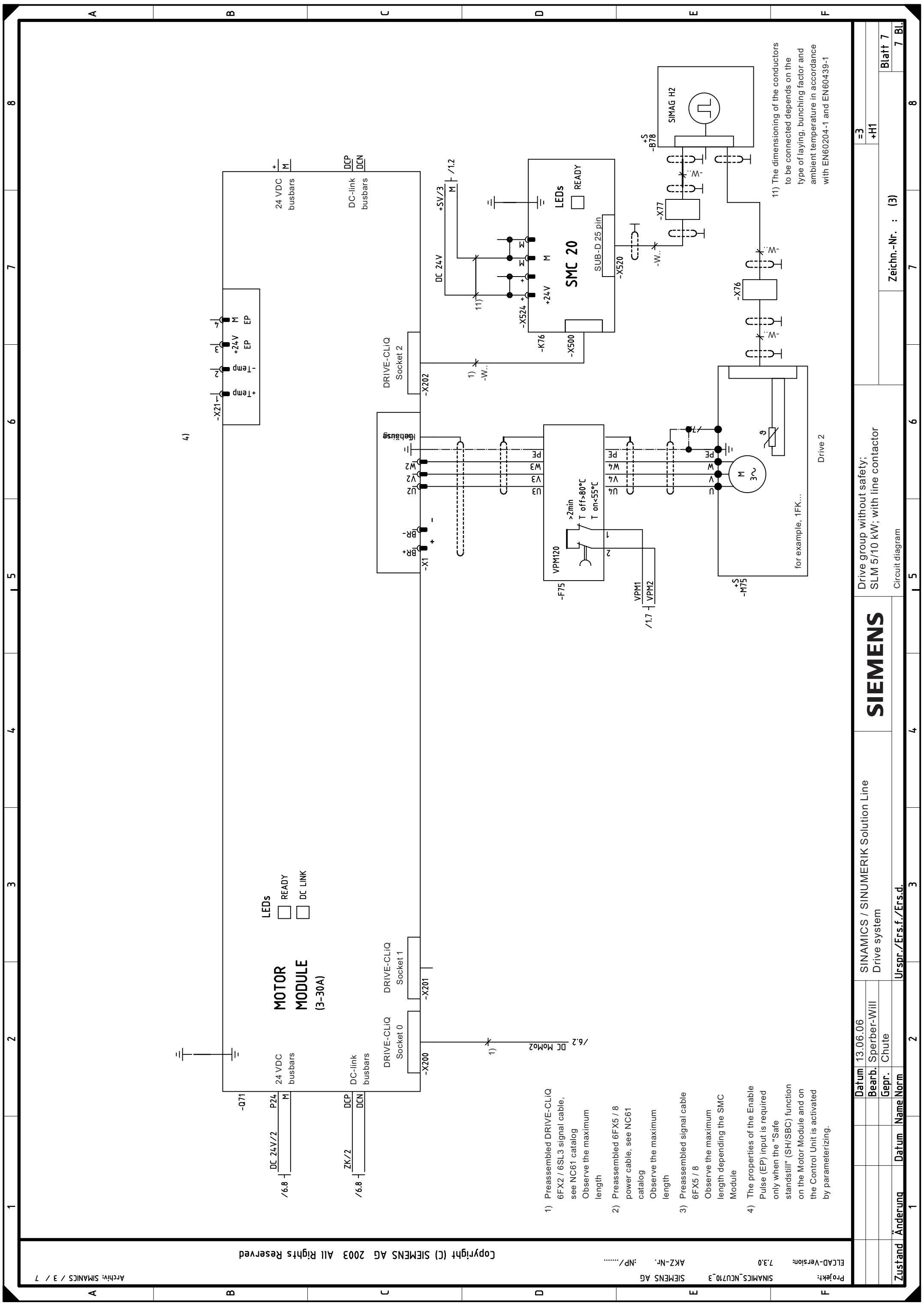

Figure 7-20 Circuit Manual Group =3, Page 7

## 7.6 Circuit Manual Group =4

Drive group without line contactor, however, with safety functions using a safety relay (3TK28..). Disconnection of all drives, also of the group =5 for an emergency stop; assignment of the digital inputs and outputs using the data of the standard macro.

- Power supply of the NCU 710 (=4.-K11)
- Control signals on the NCU 710, incl. channel formation for the Safe Standstill (SH) function; digital inputs and outputs using the data of the standard macros
- DRIVE-CLiQ connection to the power units
- PROFIBUS connection to the distributed peripherals (=4-K31)
- Control signals to the distributed peripherals
- Supply and control of the Line Module, including the integration of the auxiliary contact of the main power switch
- Supply and control of the Double Motor Module (=4.-Q61), incl. channel formation for the Safe Standstill (SH) function
- Motor connection (=4.-M62), incl. holding brake and sensor system using the Sensor Module Cabinet (=4.-K64), to the Motor Module (=4.-Q61)
- Motor connection (=4.-M65), incl. holding brake and sensor system with integrated DRIVE-CLiQ interface
- Safety control for emergency stop with safety relay (=4.-K71, -K72, -K73)

### Application

The higher-level PLC (=4.-K31) allows the complete drive group to be activated and deactivated in a defined manner. The "Safe Standstill" function is activated time-delayed safety-related over two channels (the drives should already have stopped).

### Functions - drive group On

The deactivation circuit in front of the emergency stop safety switching device (=4.-K71) must be closed using the following conditions:

- Keyswitch (=4.-S71), controller On.
- Contactor (=4.-K76) On, Control Unit, Line Module and Motor Modules components ready. These operational states must be queried and linked by the higher-level PLC.
- The emergency off pushbutton (=4.-S73) must not be operated.
- The drive group Off pushbutton (=4.-S72) must not be operated.

- The feedback loop for the safety switching device (=4.-K71) is closed.

  The "Safe Standstill" feedback of the individual drive axes on the Control Unit (=4.-K11-X122: 7/8; DI/DO 8/9) is monitored for the safe switching state Off for each activation cycle. This is also the case for the relay contact multiplication (=4.–K72/-K73). If required, the safety-related functions of the user-provided machine control can also be added to the feedback loop.
- Drive group (=4.-S74) On pushbutton, the safety switching device (=4.-K71) is activated and latches. The drive group is activated. Once the DC link has been charged, and the Line Modules and the Motor Modules report ready, the drive axes can be operated with the corresponding controller enables via PROFIBUS.

## Drives Start/Stop

The (=4.–K78) Drives Start pushbutton activates the axis-specific controller enables. The (=4.-S77) Drives Stop pushbutton brings the drives to a standstill. The type of the standstill action must be defined in the Drive Object of the Control Unit.

## Drive group / drives Off

The Emergency Stop (=4.-S73) pushbutton or the Drives / Drive Group Off (=4.-S72) pushbutton brakes the drives as fast as possible at a set current level (OFF3) of the drive components to a standstill, provided they have not yet been stopped by the PLC program.

The instantaneous contact of the safety switching device (=4.-K72) on the Control Unit is used to control the OFF3 switch off command (=4.-K11-X122:2, DI1).

Once the braking action has completed, a time delay (=4.-K71) and a replication block (=4.-K73) is used to select safety-relevant the "Safe Standstill" function. This is done with the Control Unit (=4.-K11-X122:3, DI2) and parallel with the associated Motor Module (=4.-Q61, =5.-Q11, -X21/22:3, EP).

The "Safe Standstill" function must be controlled using safe engineering. Depending on the requirement in the corresponding categories in accordance with EN 954-1.

The Drives Off (=4.-S72) pushbutton also acts on the PLC -E445. This means PLC logic can be used to determine which switch-off command caused the drive group to be shutdown. ??The PLC can be used for logical linking, which, independent of the operational state of the components, drive group can also be switched off by the contactor (=4.–K76)??.

The drives are stopped with emergency stop in the stop category 1 in accordance with EN 60204–1, "Controlled Stopping", the energy supply is interrupted only when the standstill is achieved.

## Holding brake

The holding brake is controlled coordinated using the Motor Module. When the "Safe Standstill" is selected, the brake is closed immediately. Consequently, the "Safe Standstill" function should be selected only when the drives have been brought to a standstill. Otherwise the holding brake can be damaged.

## Circuit manual group examples = 4

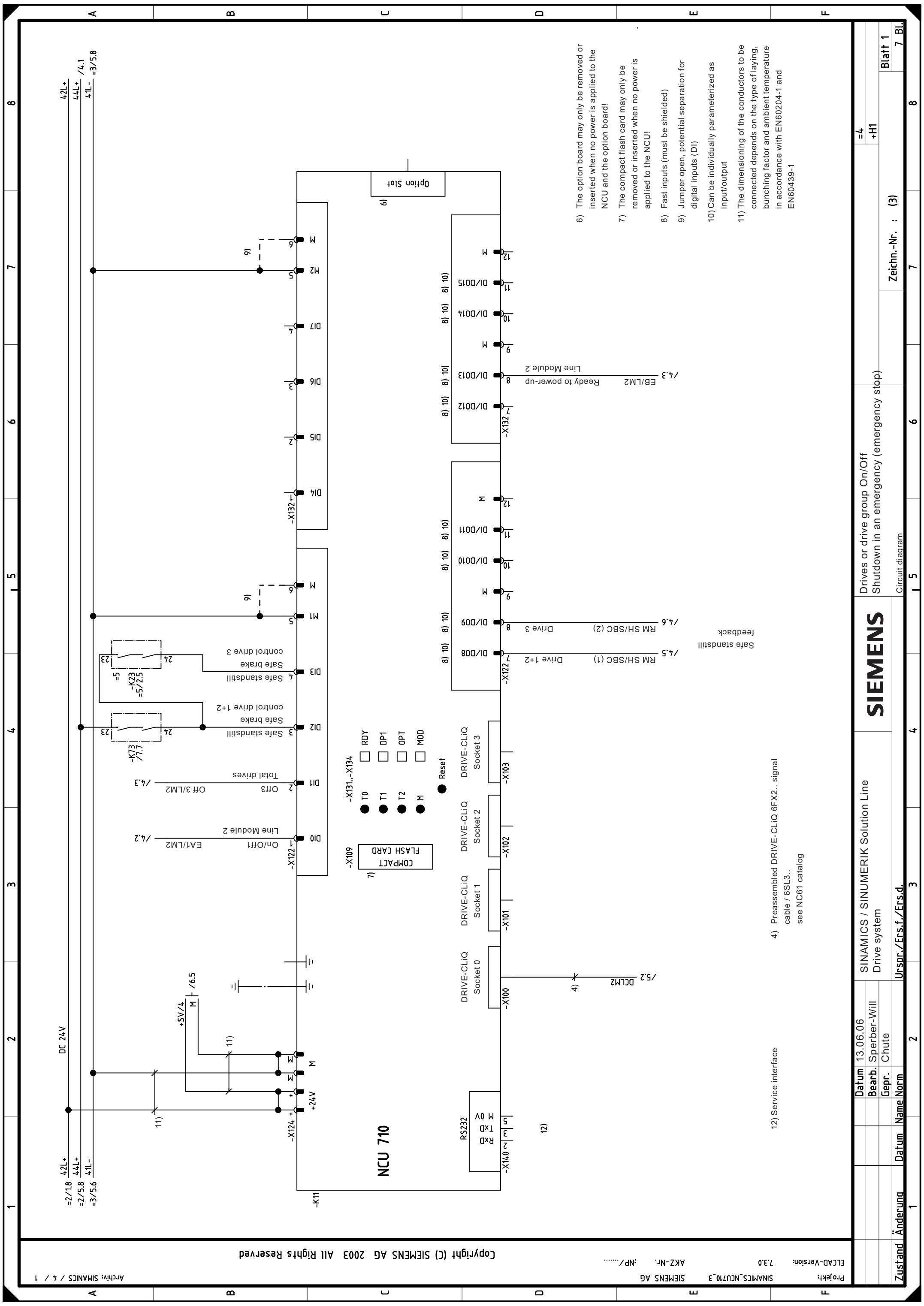

Figure 7-21 Circuit Manual Group =4, Page 1

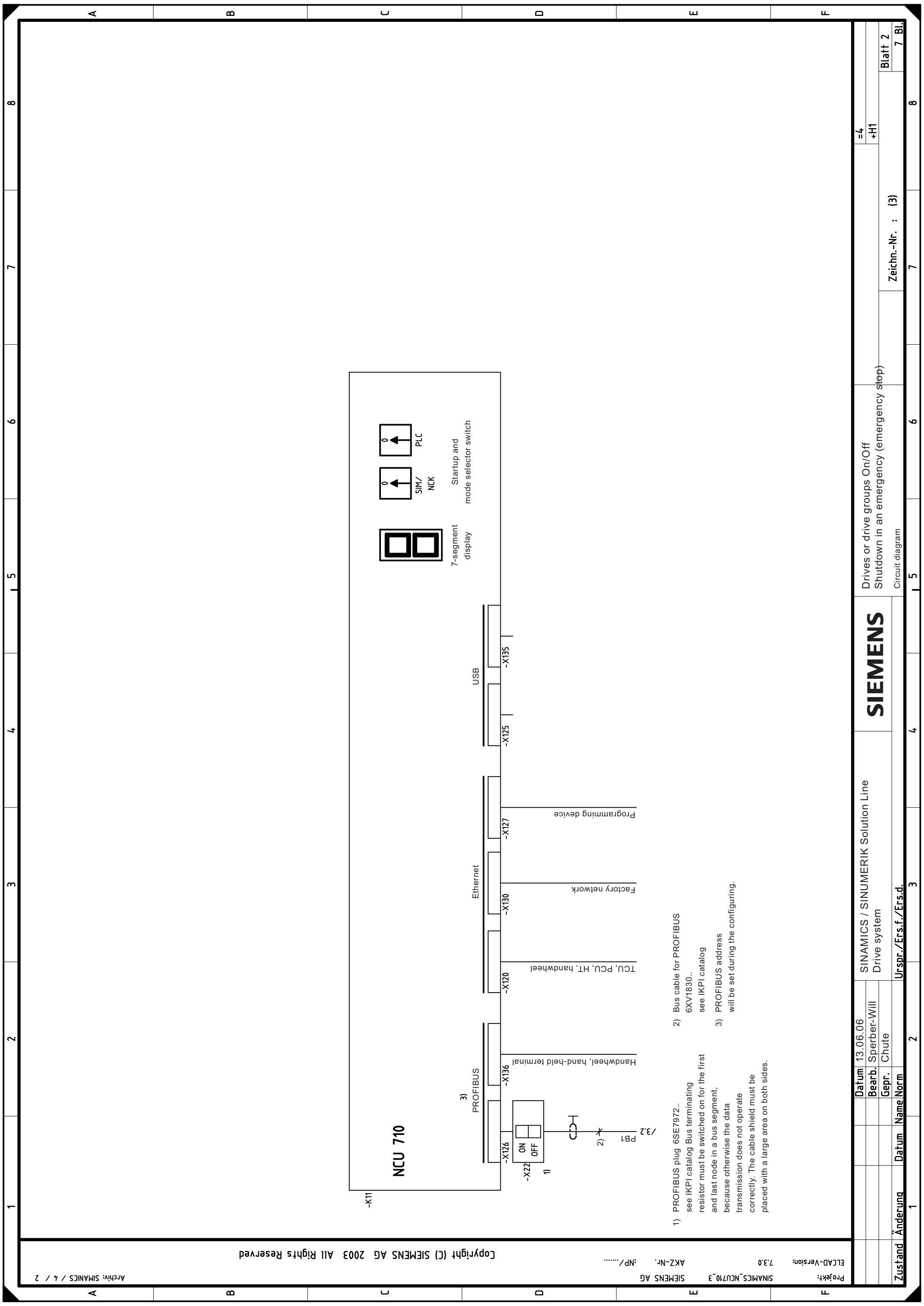


Figure 7-22 Circuit Manual Group =4, Page 2

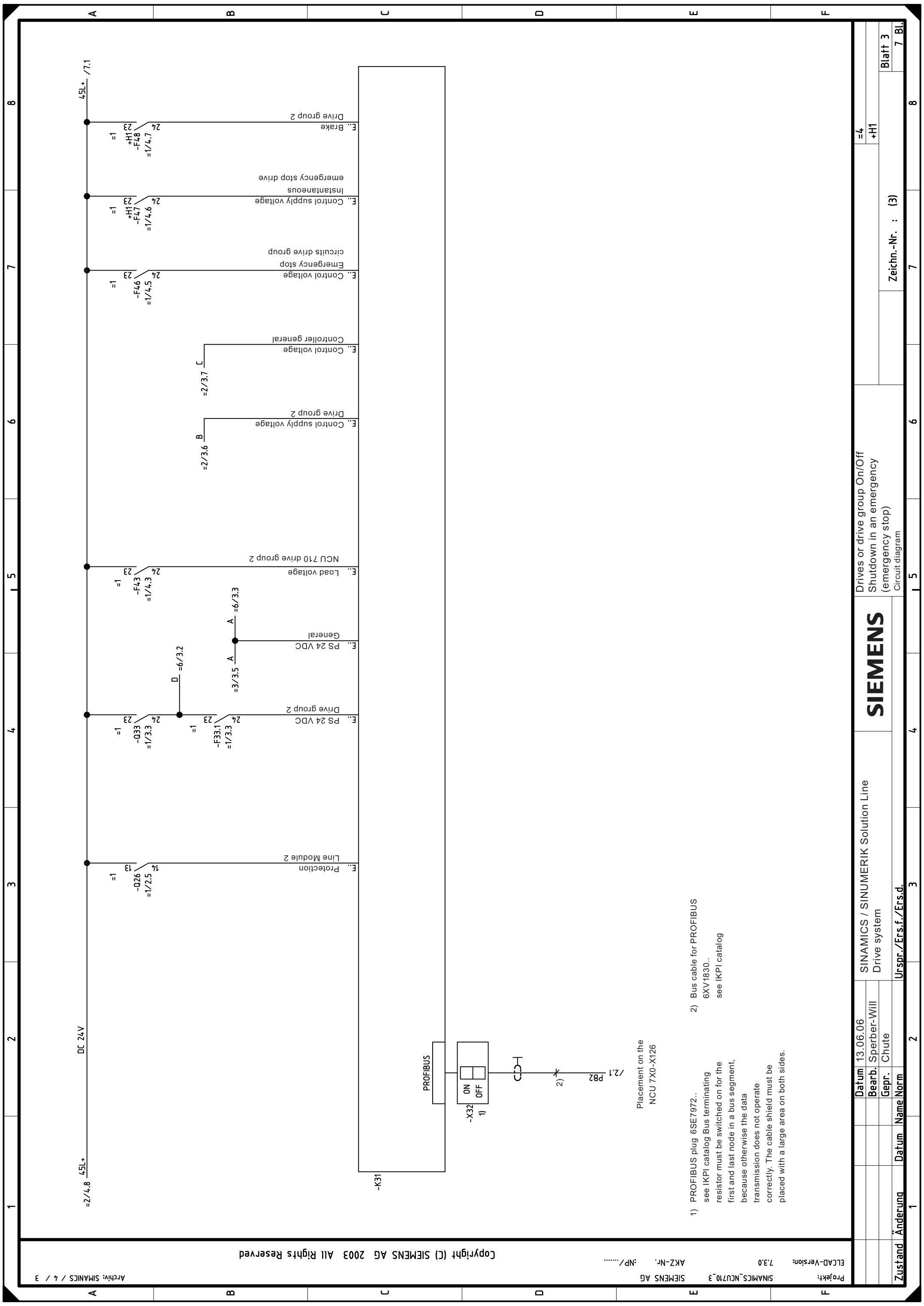

Figure 7-23 Circuit Manual Group =4, Page 3

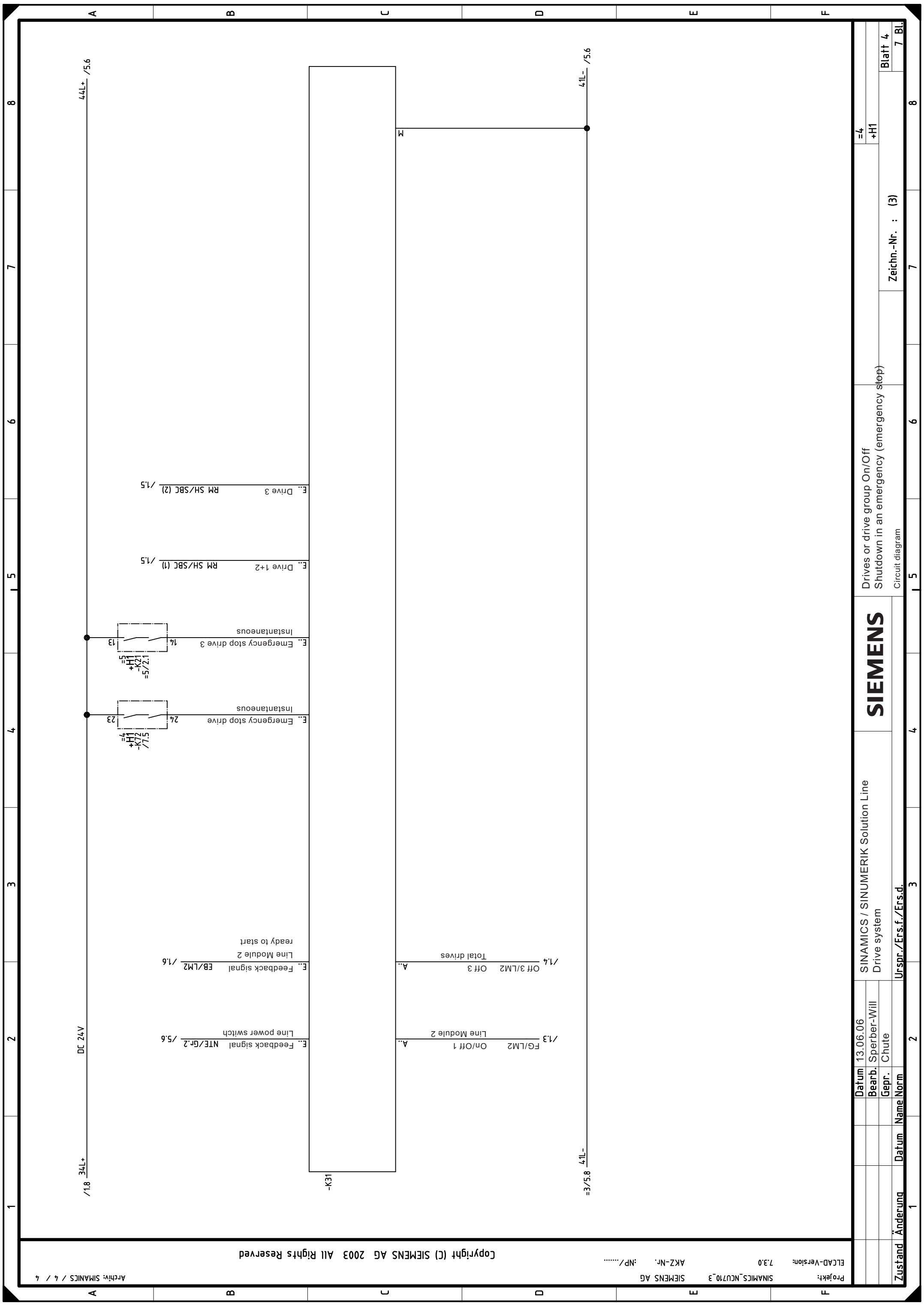


Figure 7-24 Circuit Manual Group =4, Page 4

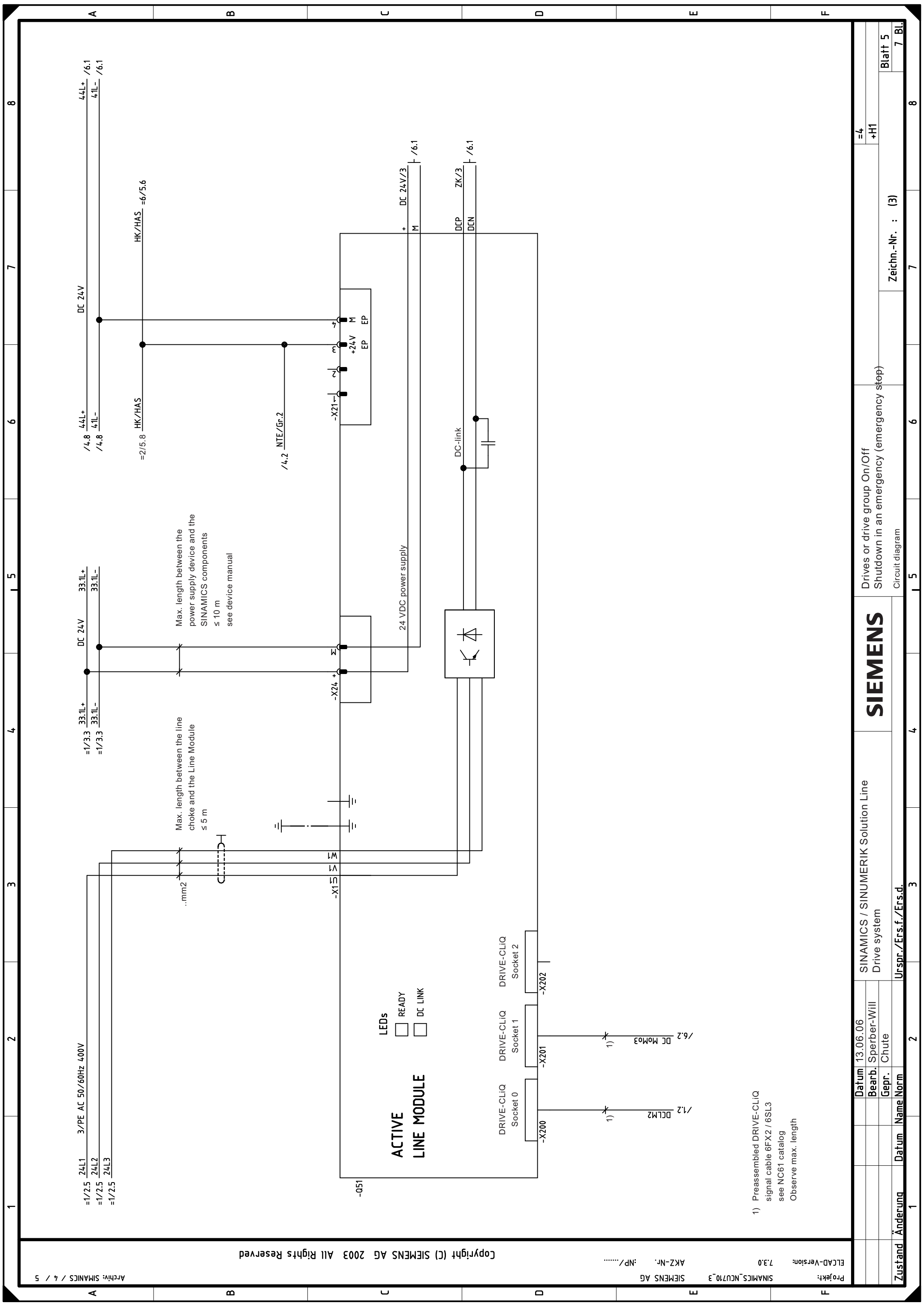


Figure 7-25 Circuit Manual Group =4, Page 5

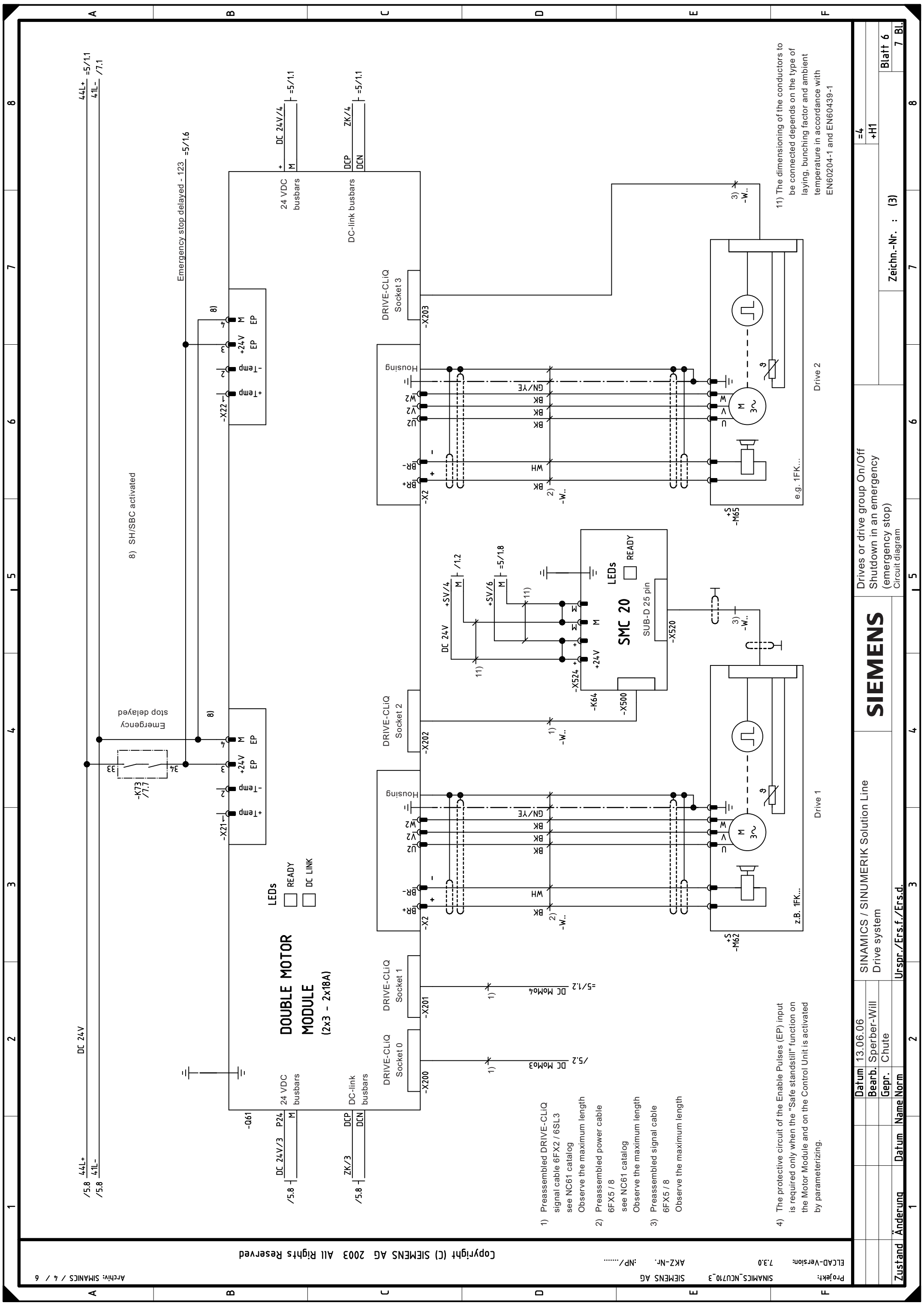


Figure 7-26 Circuit Manual Group =4, Page 6

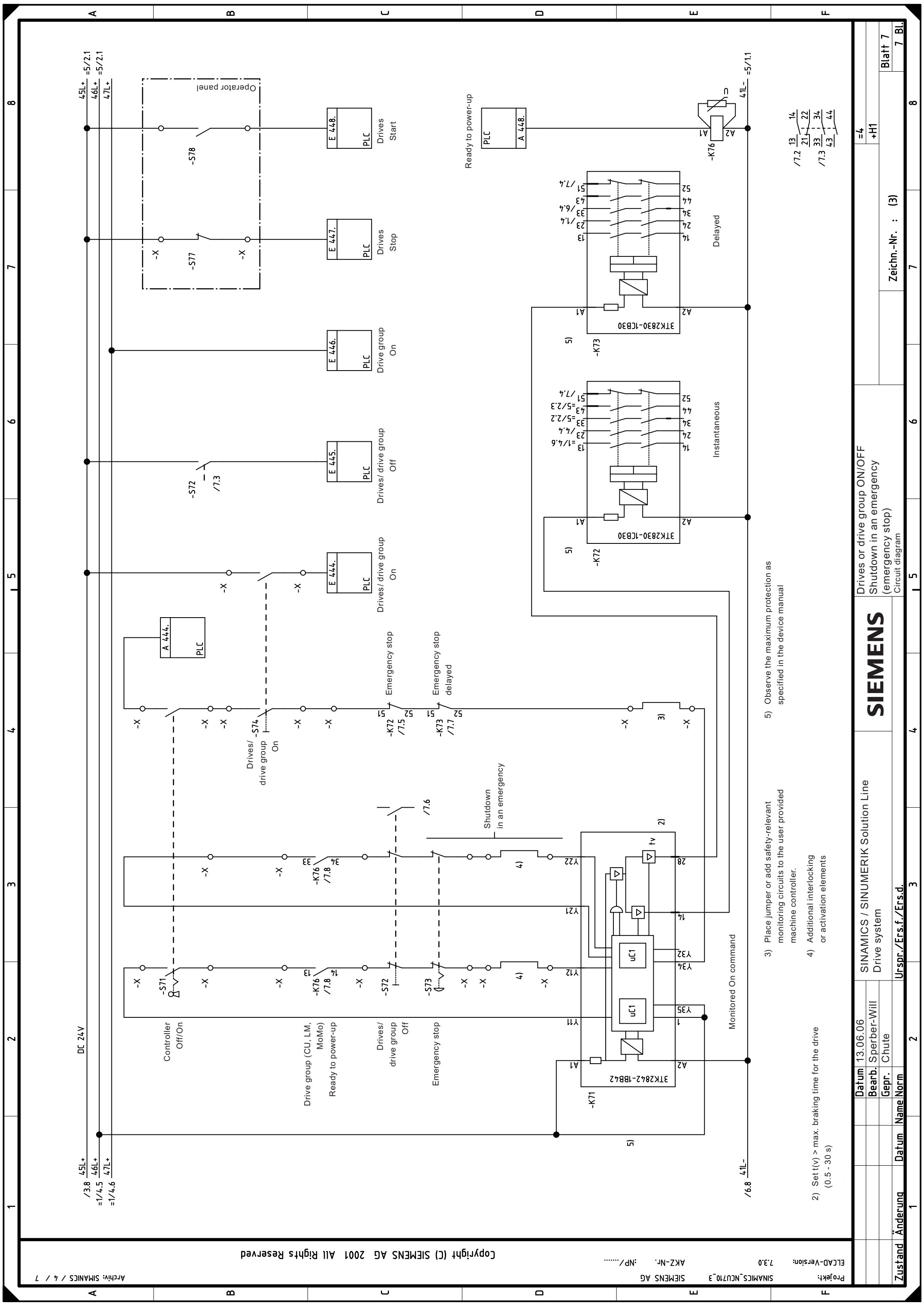


Figure 7-27 Circuit Manual Group =4, Page 7

## 7.7 Circuit Manual Group =5

Axis-specific drive with safety functions; shutdown with emergency stop (circuit manual group =4) or with the separate Axis Drive Stop pushbutton. Assignment of the digital inputs and outputs using the data of the standard macros.

- Supply and control of the Single Motor Module, incl. axis-specific channel formation for the Safe Standstill (SH) function
- Connection of the motor and the SMC20 sensor system to the Motor Module
- Control of the motor holding brake using the contactor (=5.-K24), internal brake control of the Motor Module is not activated
- Safety control for the axis-specific emergency stop with safety relay (=5.-K21, -K23)

### Application

The control is used where one or more drives must be selectively shutdown from a running axis group in safe engineering. The drive can be shut down safely from the drive group via a two-channel key-operated switch or, for example, via light barriers or limit switches. The drive must have been previously shutdown safely using the PLC logic. The "Safe Standstill" function is used to prevent an unwanted restart.

### Functions

#### Start drives

The two-channel stop circuit in front of the safety switching device (=5.-K21) must be closed using the following conditions:

- Drive Stop key-operated switch (=5. –S21) closed.
- Emergency Stop Circuit Protection (=4. -K42) closed.
- The Start (=5. -S22) pushbutton and the closed feedback loop is used to activate the contactor (=5.-K21) with "monitored start" which then self-locks.

The state of the safety switching device (=5.-K21) is queried using PLC -E526 (=4./Bl. 4.5). The drive can now be traversed using the PLC.

#### Stop drives

The Drives Stop (=5.-S21) keyswitch, or emergency stop (=4.-K72), is used to shutdown the safety switching device (=5. -K21). The instantaneous contact uses the PLC input (=4./Bl. 4.5) and the internal PROFIBUS connection to remove the OFF3 command from the drives, the drive (=5.-M15) is braked at the torque limit.

The off-delayed contact (=5.-K21) is used to select and activate the "Safe Standstill" function on the Control Unit (=4. -K11-X122:4, DI3) and the Motor Module (=5.-Q11-X21:3, EP) on two channels.

## "Safe Standstill" function feedback

The "Safe Standstill" function is monitored in the Control Unit and in the Motor Module.

A corresponding feedback from the Control Unit (=4.-K11-X122:8, DI/DO 9) and the coupling relay (=5.-K28) is linked with the safety relay (=5.-K21) in the On circuit. The On circuit is enabled only when the feedback from the safe standstill functions properly.

The "Safe Standstill" function is actively monitored after each stop action.

## Holding brake

A braking current > 2 A DC means that the power cannot come directly from the Motor Module, but will be supplied from a separate infeed.

The holding brake is controlled time-coordinated by the PLC logic using PLCA527. When the drive is stopped, an off-delayed contact is used for the contactor (=5.-K24) to also safely shutdown the brake using hardware. This means a fault in the PLC cannot cause an incorrect control of the brake when the drive is stationary.

## Circuit manual group examples = 5

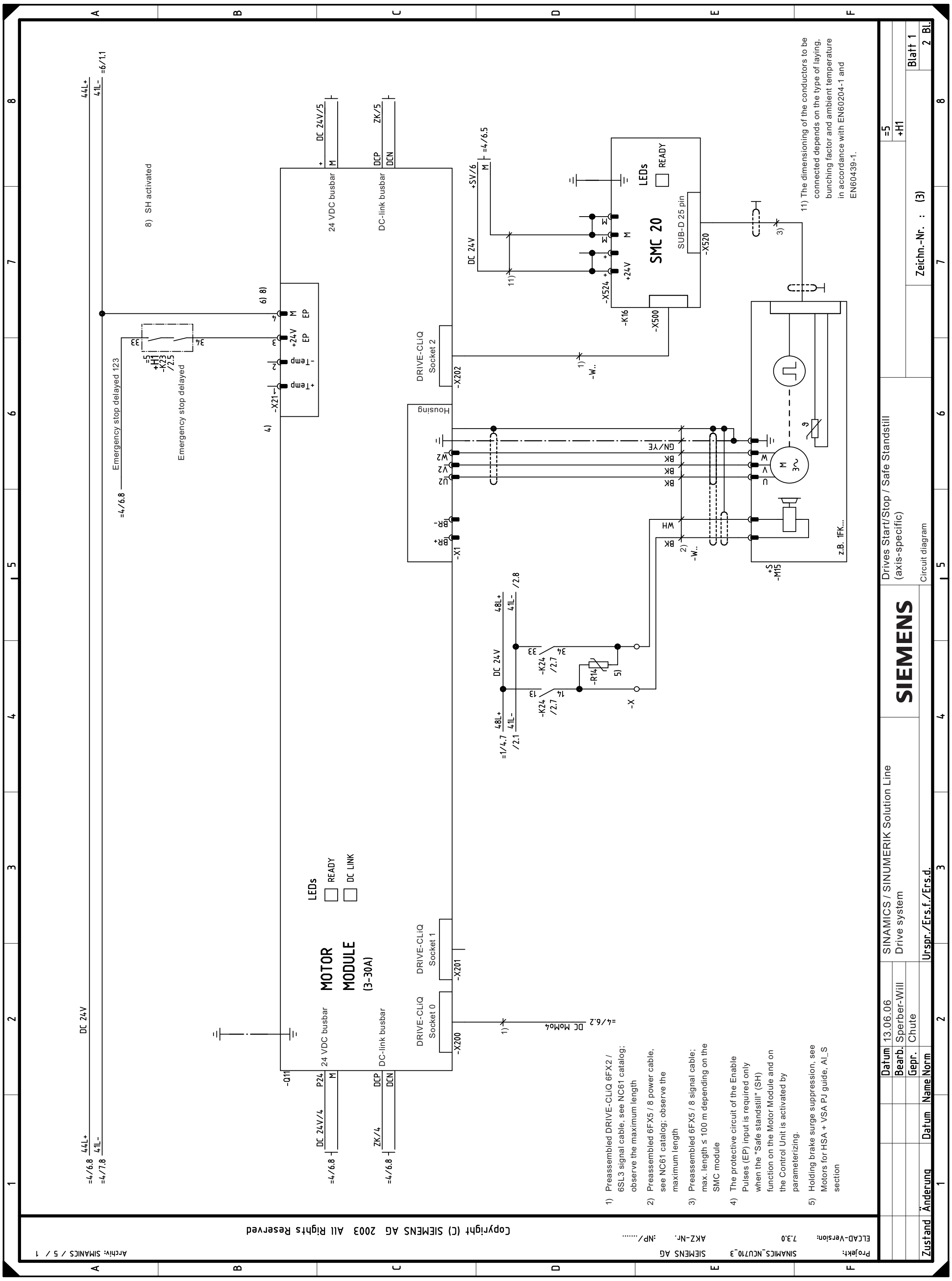


Figure 7-28 Circuit Manual Group =5, Page 1

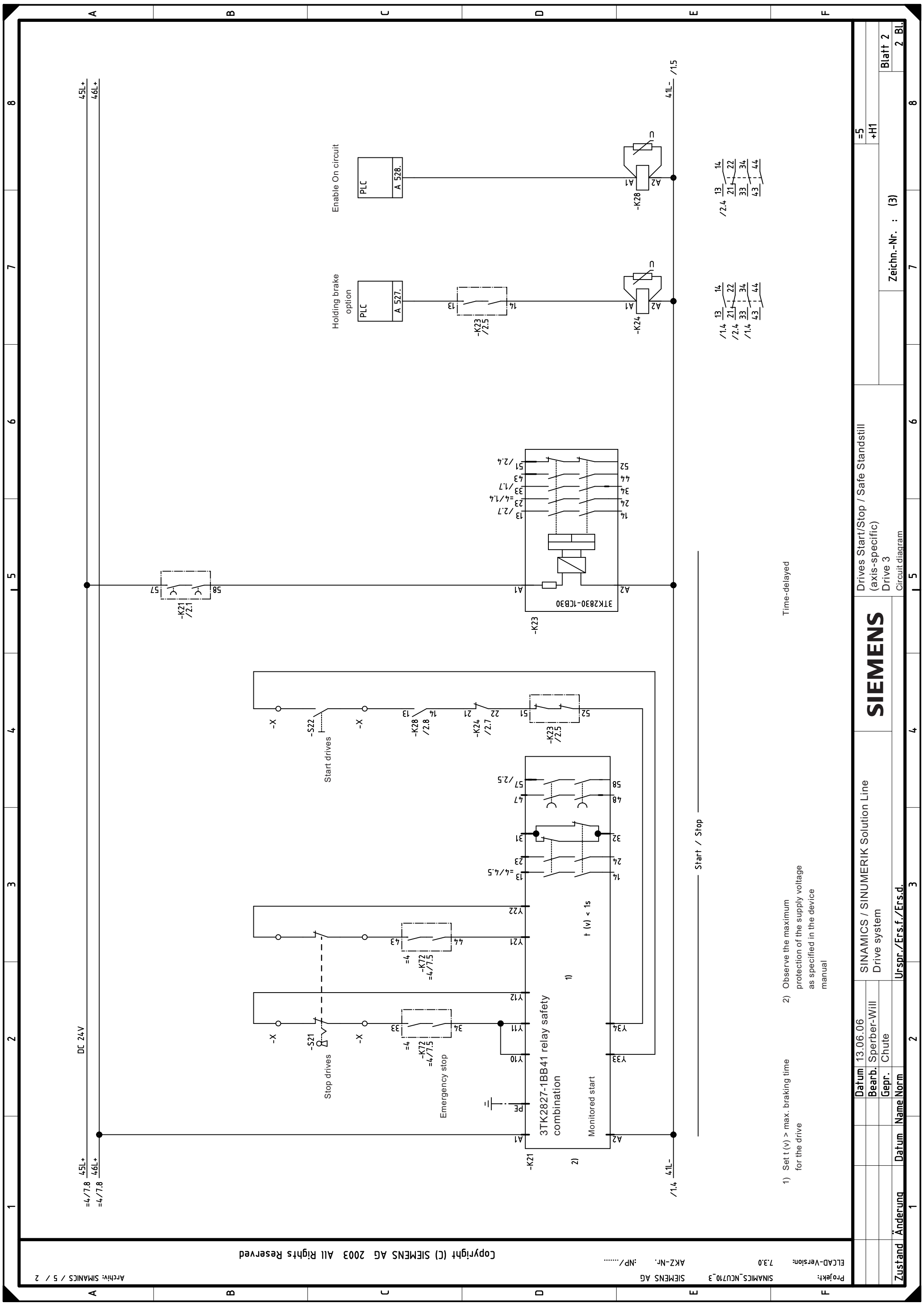


Figure 7-29 Circuit Manual Group =5, Page 2

## 7.8 Circuit Manual Group =6

A drive group without main contactor, however, with the system/drive-integrated safety function of the SINUMERIK 840D sl; connection of the safety sensor technology / actuators using ET200S.

- Power supply of the NCU 710 (=6.-K11)
- Control signals to the NCU 710; digital inputs and digital outputs using the data of the standard macros
- DRIVE-CLiQ connection to the power units
- PROFIBUS connection to the ET200S distributed peripherals (=6.-K82)
- Control signals to the ET200S distributed peripherals
- Supply and control of the Line Module, including the integration of the auxiliary contact of the main power switch
- Supply and control of the Double Motor Module (=6.-Q61)
- Motor, holding brake and sensor system (motor-integrated sensor component) connection to the Motor Module
- Constant motor outgoing feeder using ET200S "Standard" motor starter (=6.-Q86.1)
- Constant motor outgoing feeder using ET200S "Fail-safe" motor starter (=6.-Q95.1)
- Safety control with ET200S safe digital input modules (=6.-K92.1, -K93) and output modules (=6.-K94)
- Safe interface level for external signals (=6.-K132, -K134)

All sensor/actuator signals required for the safety function are connected to the fail-safe modules of the ET200S peripherals (=6.-K92.1, -K93, -K94, -K95). All fail-safe signals are linked using the system/drive-integrated safety function of the SINUMERIK 840D sl. External safety relays or safety controllers are no longer required. An external control of the SH/SBC function using the terminals on the NCU or on the Motor Modules is also not required but is performed internally by the system.

## Circuit manual group examples = 6

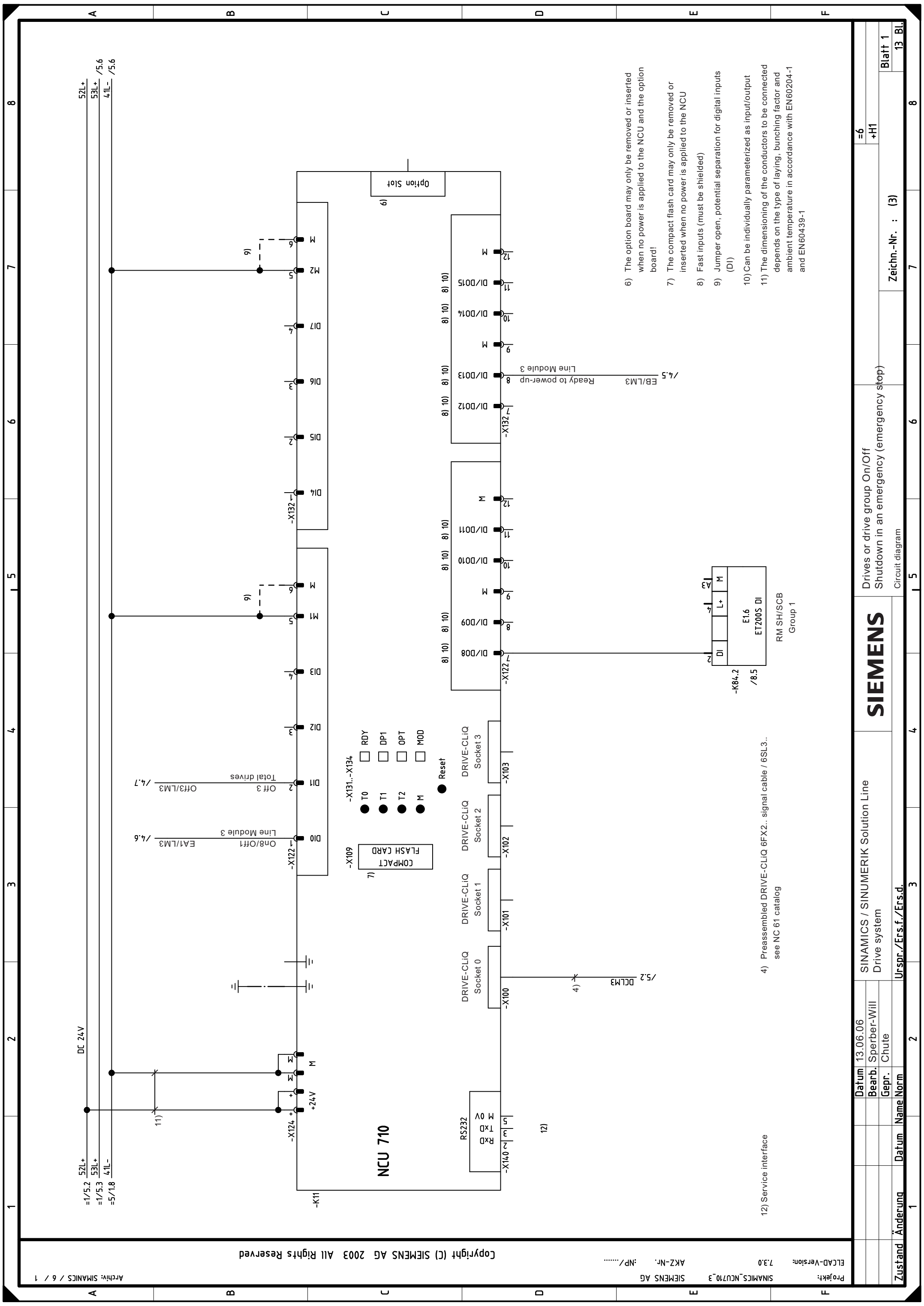


Figure 7-30 Circuit manual group =, page 1

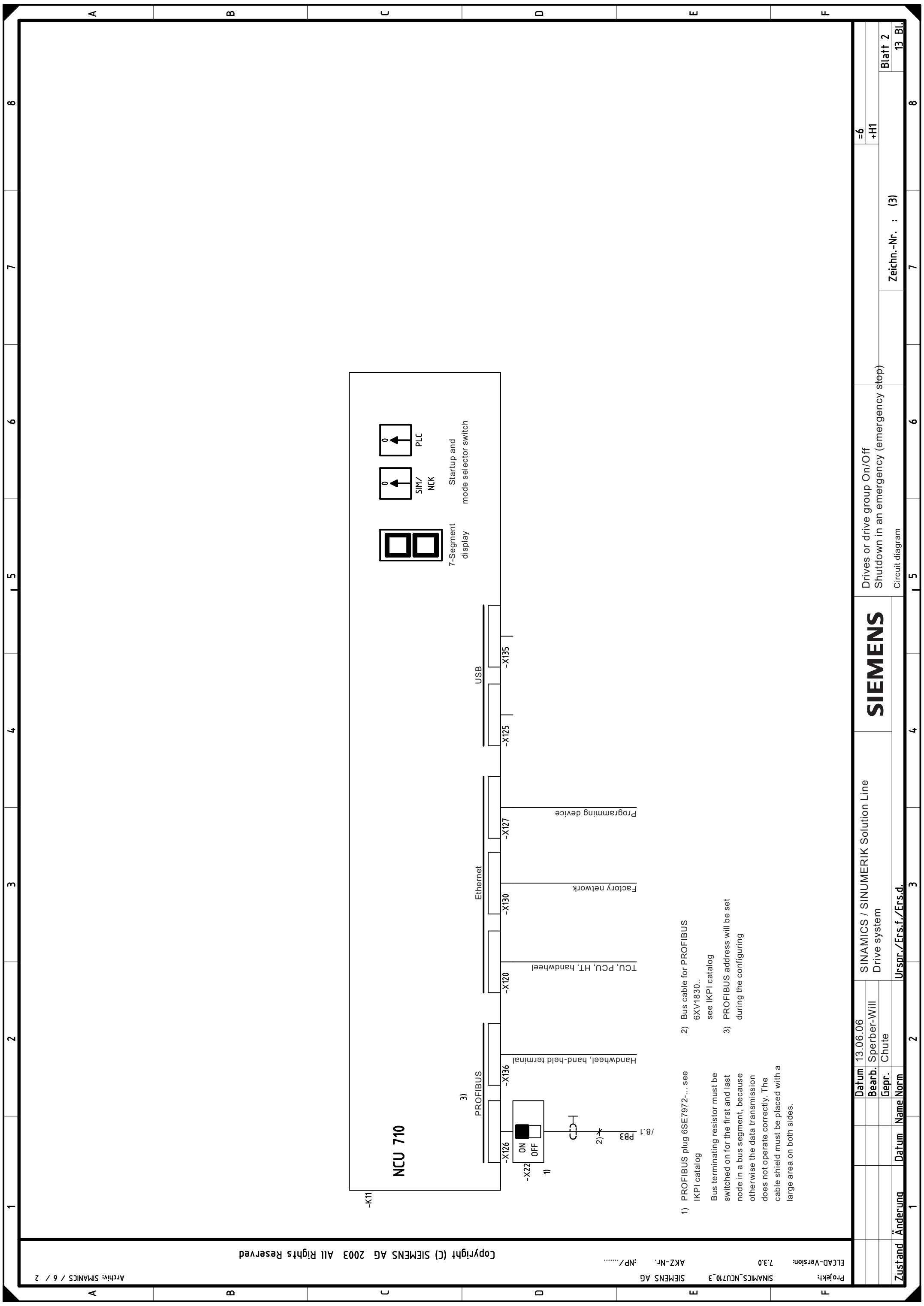


Figure 7-31 Circuit Manual Group =6, Page 2

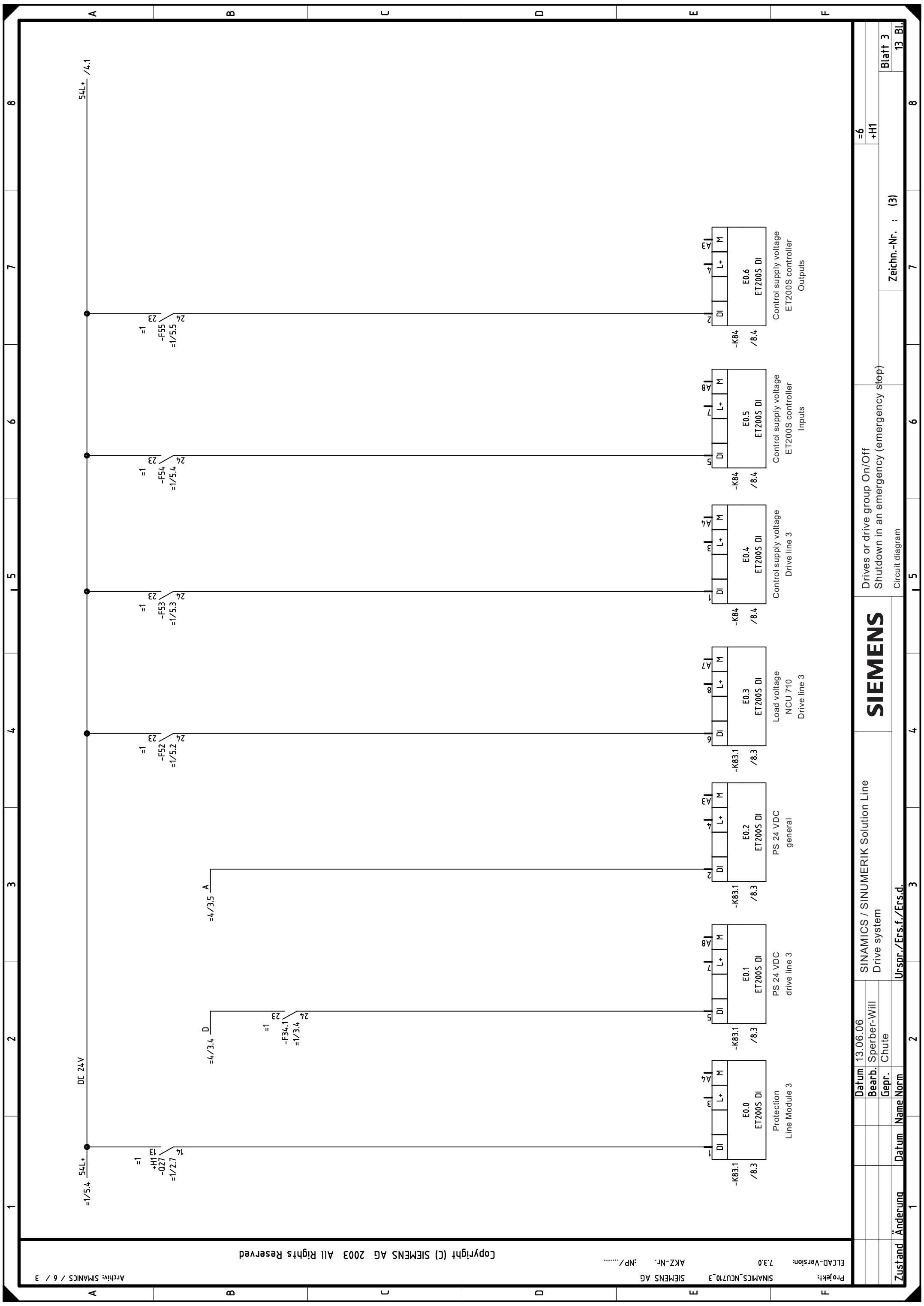


Figure 7-32 Circuit Manual Group =6, Page 3

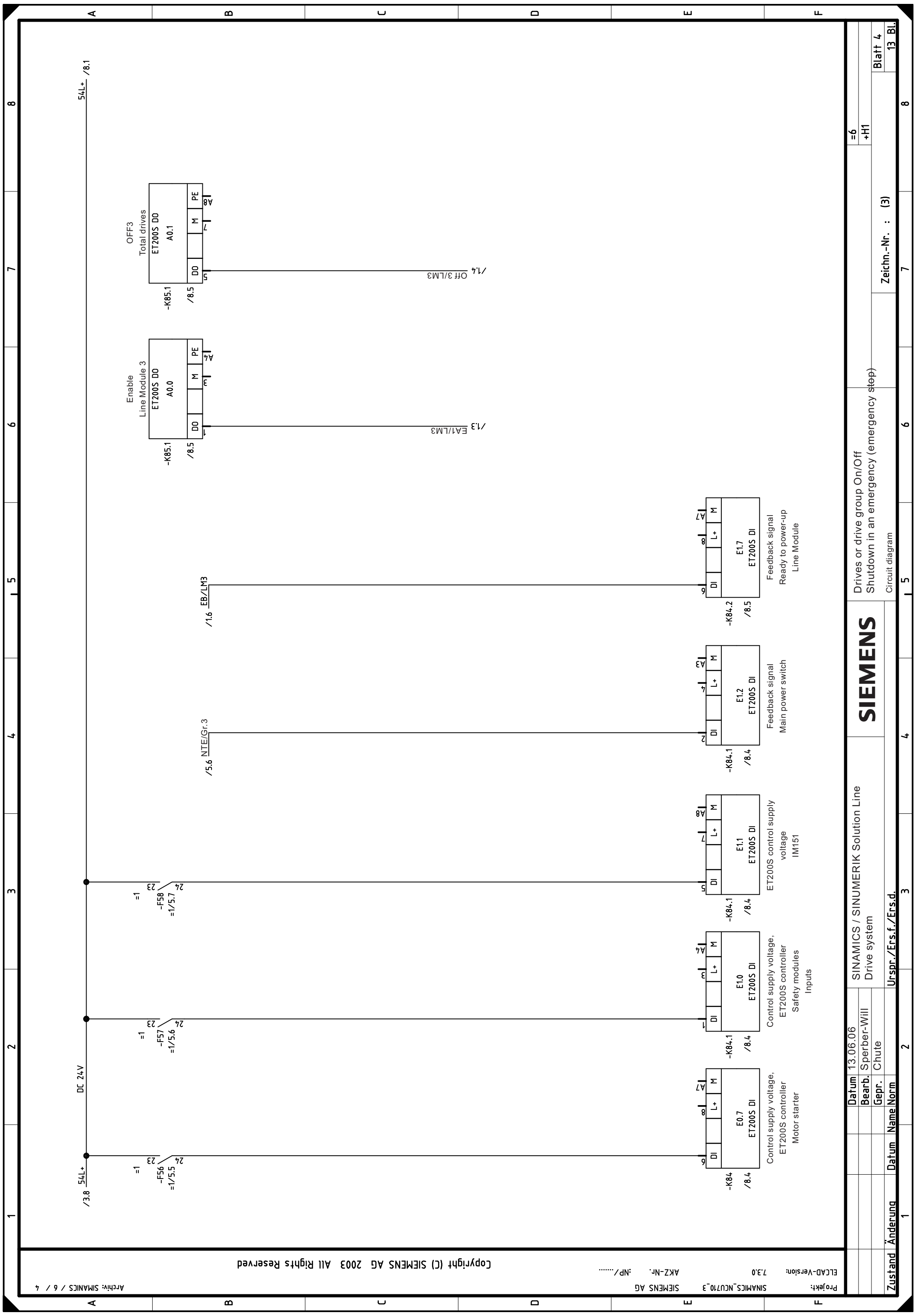


Figure 7-33 Circuit Manual Group =6, Page 4

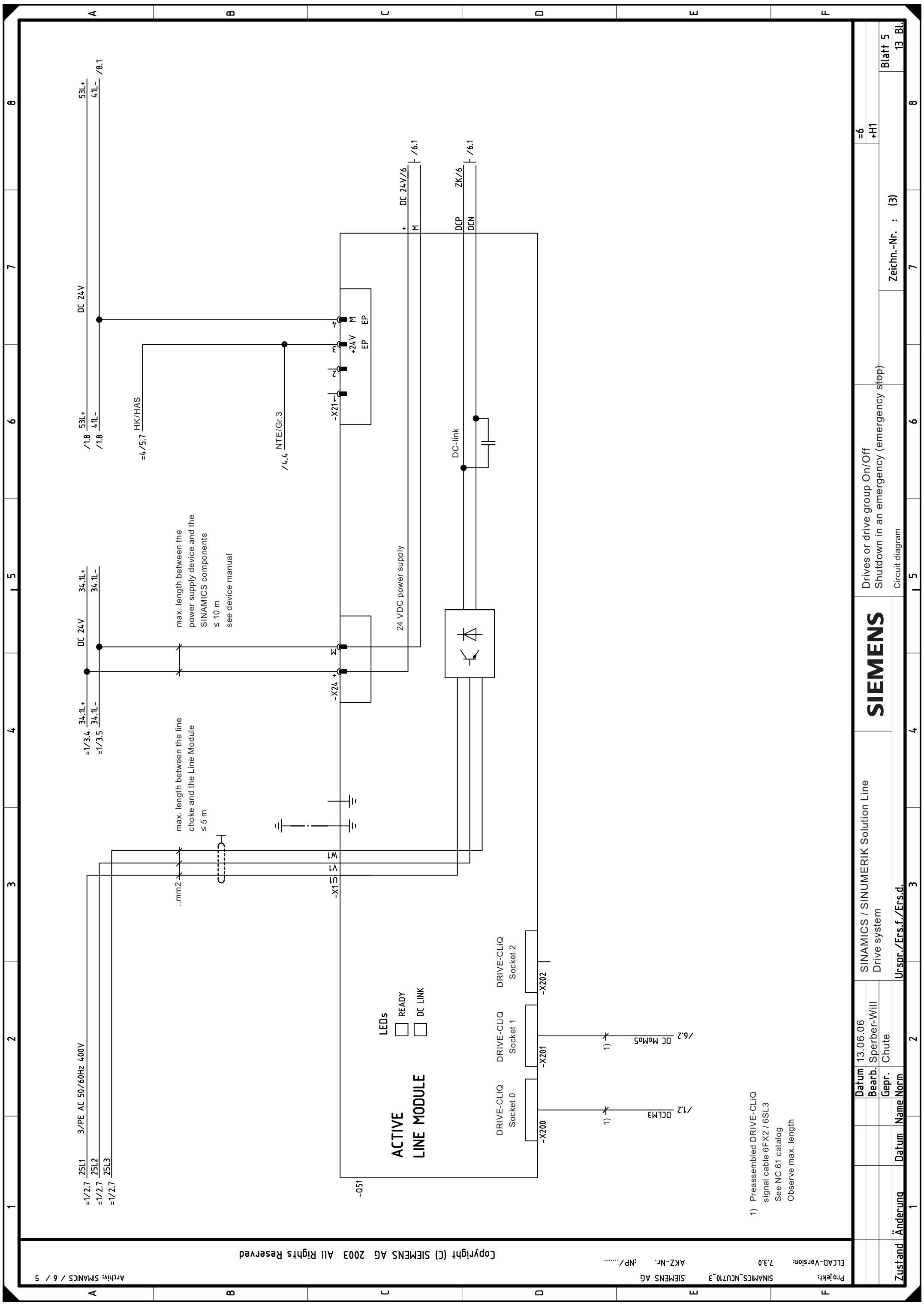


Figure 7-34 Circuit Manual Group =6, Page 5

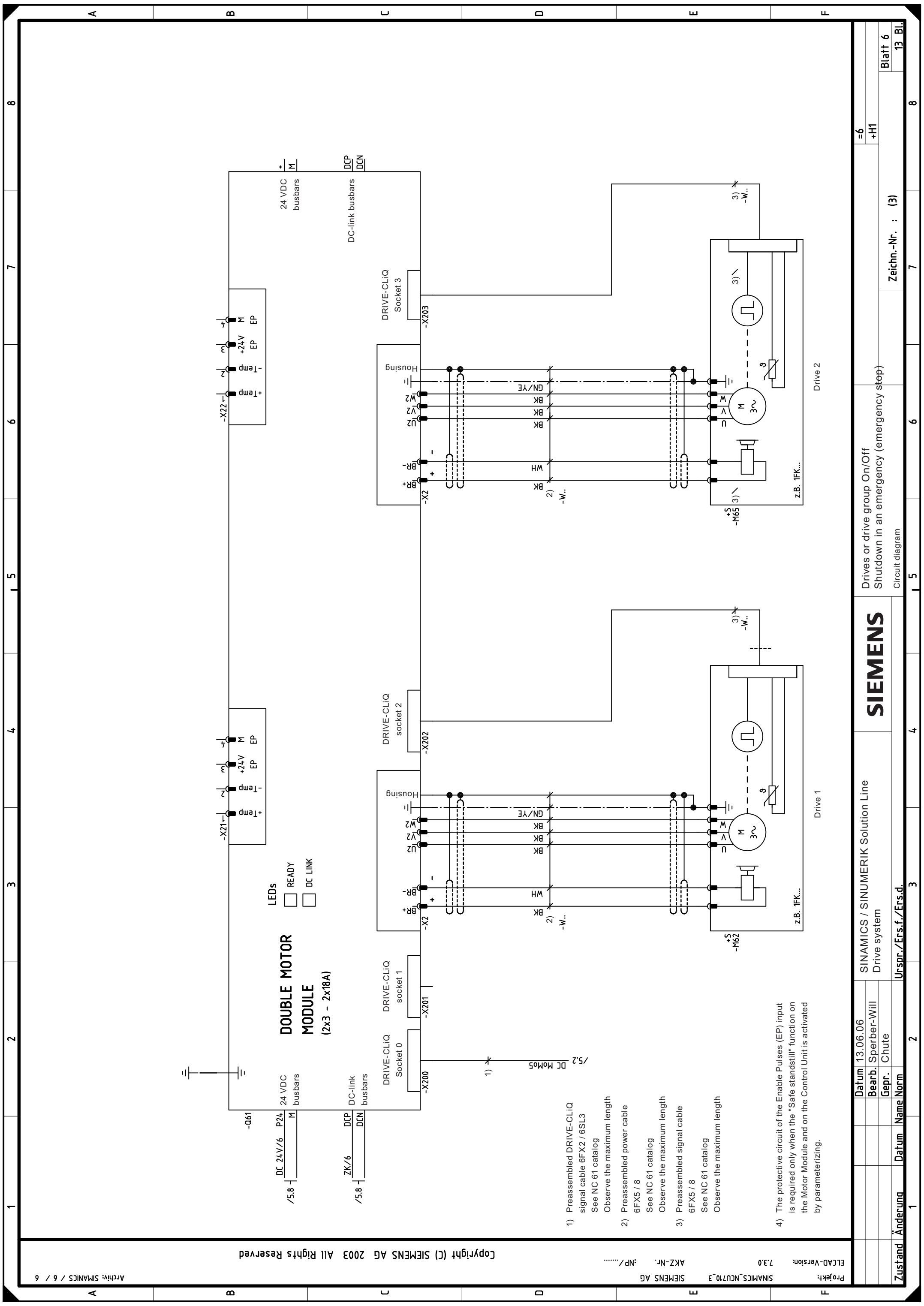


Figure 7-35 Circuit Manual Group =6, Page 6

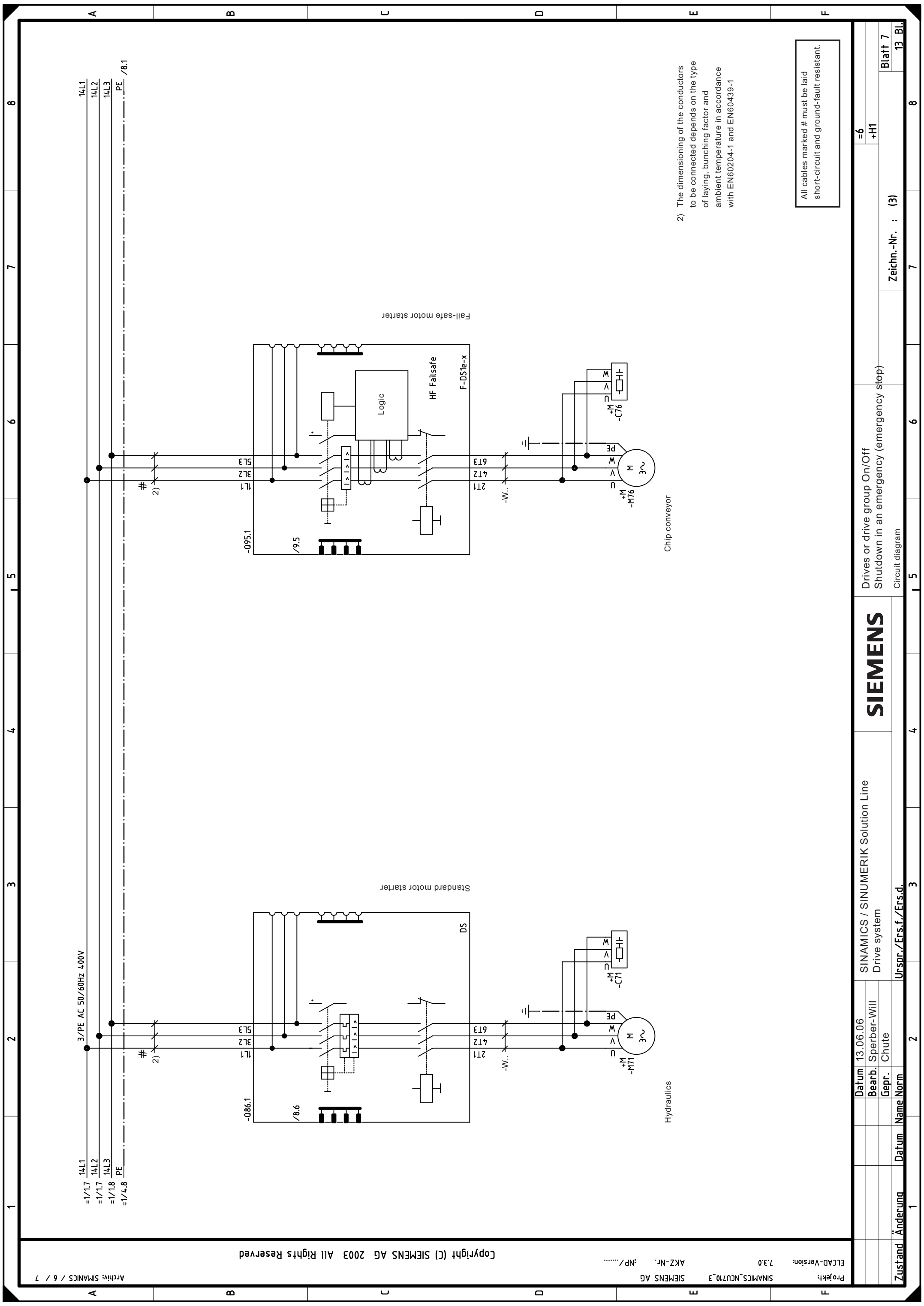


Figure 7-36 Circuit Manual Group =6, Page 7

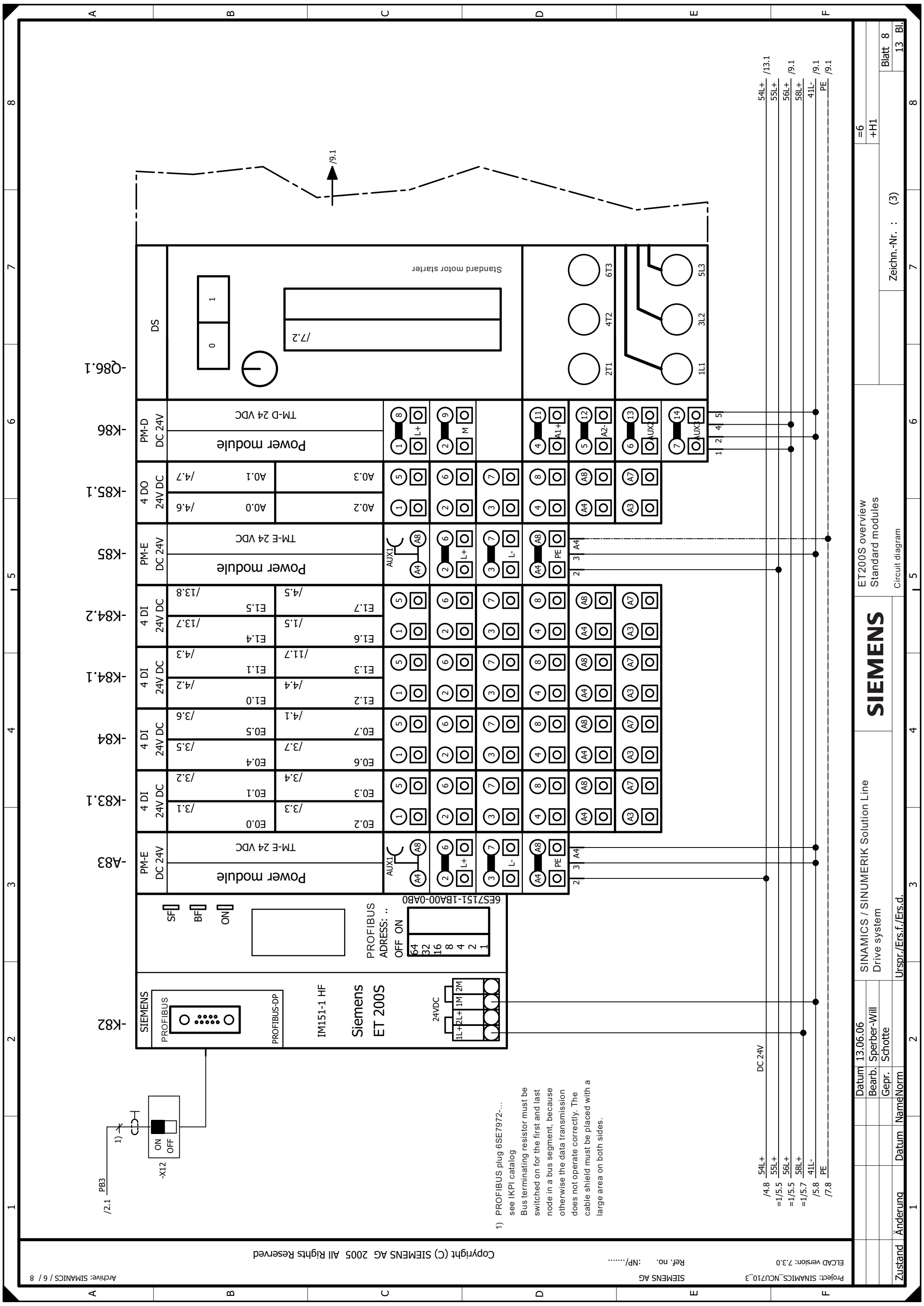

Figure 7-37 Circuit Manual Group =6, Page 8

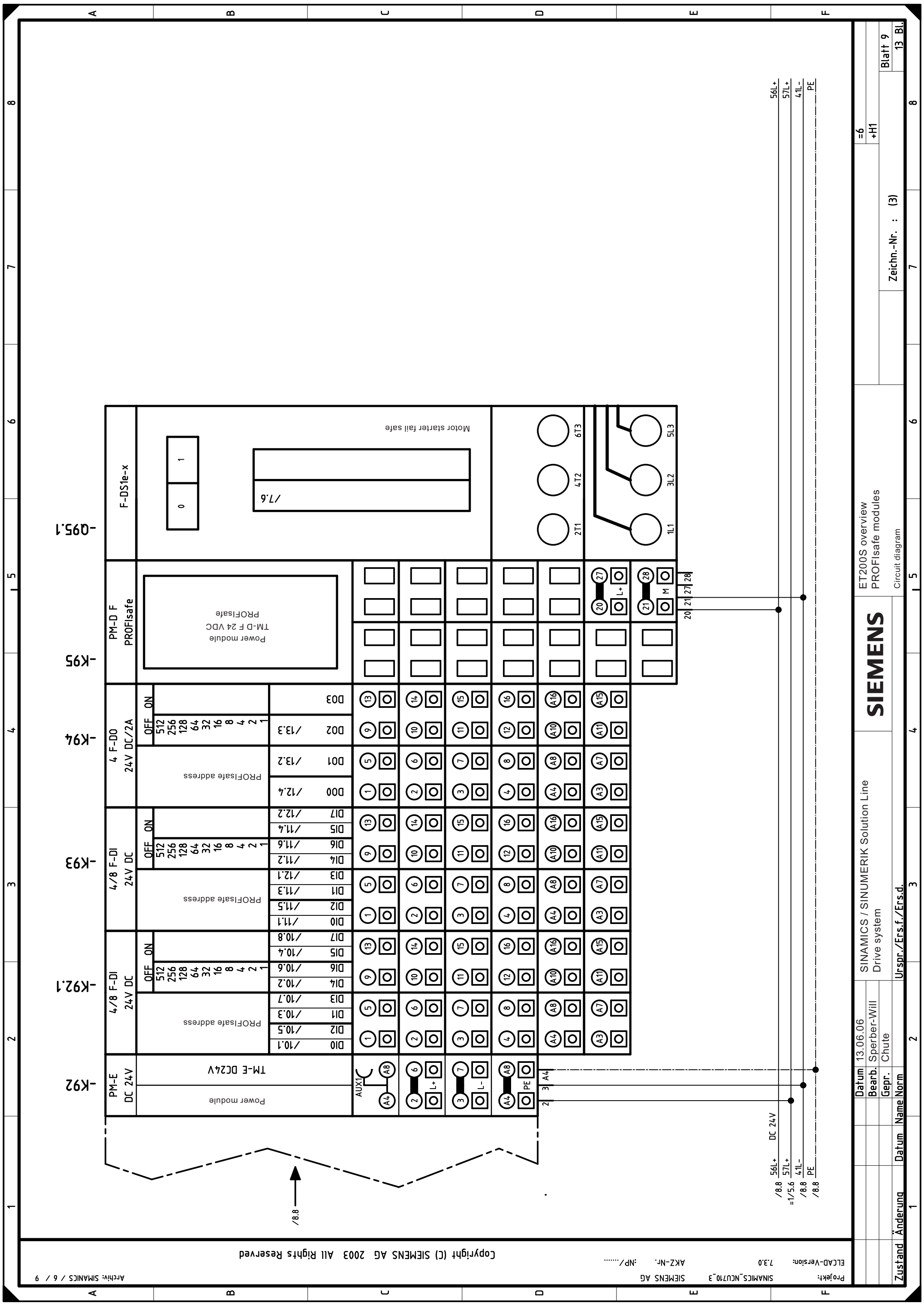


Figure 7-38 Circuit Manual Group =6, Page 9

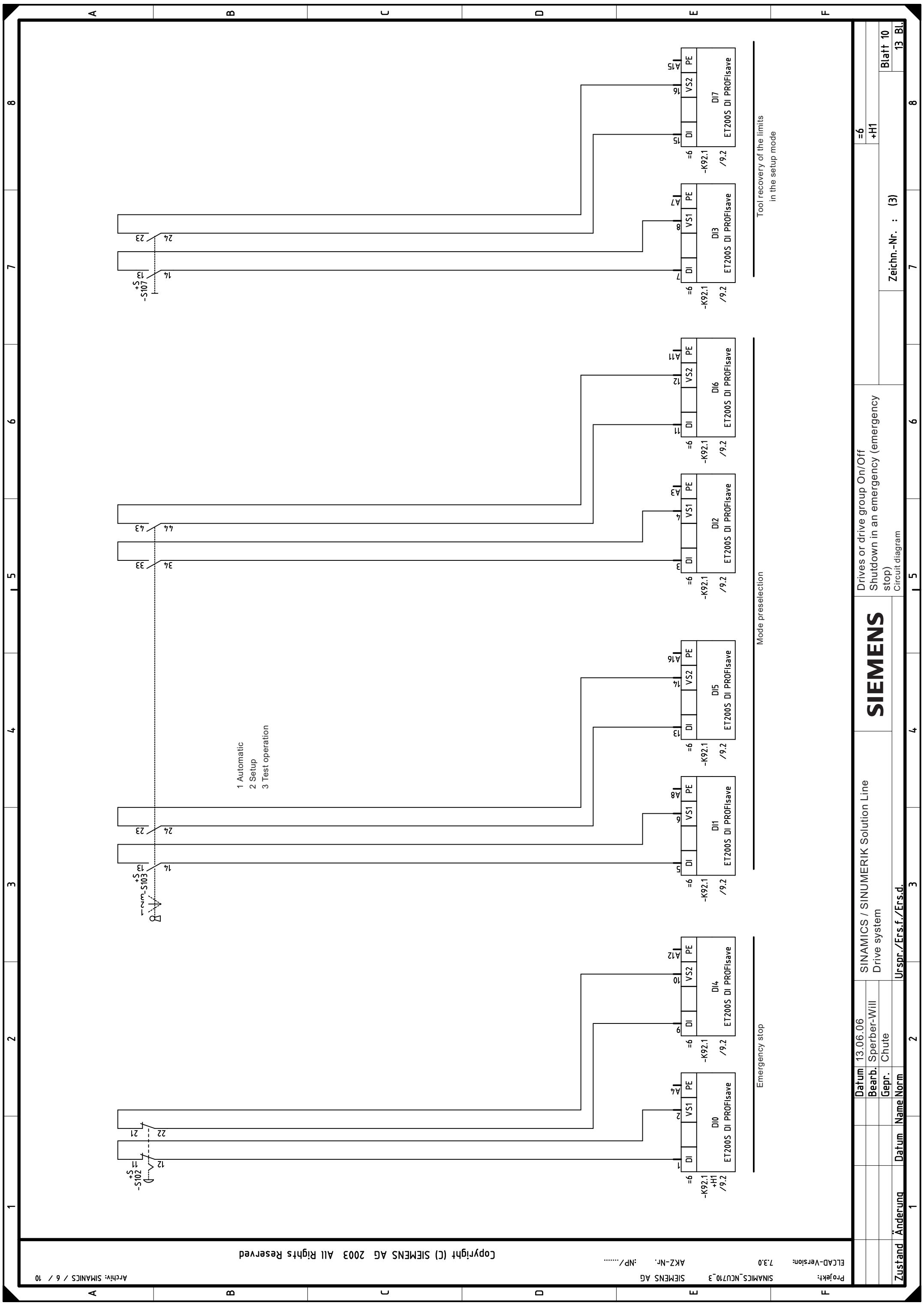


Figure 7-39 Circuit Manual Group =6, Page 10

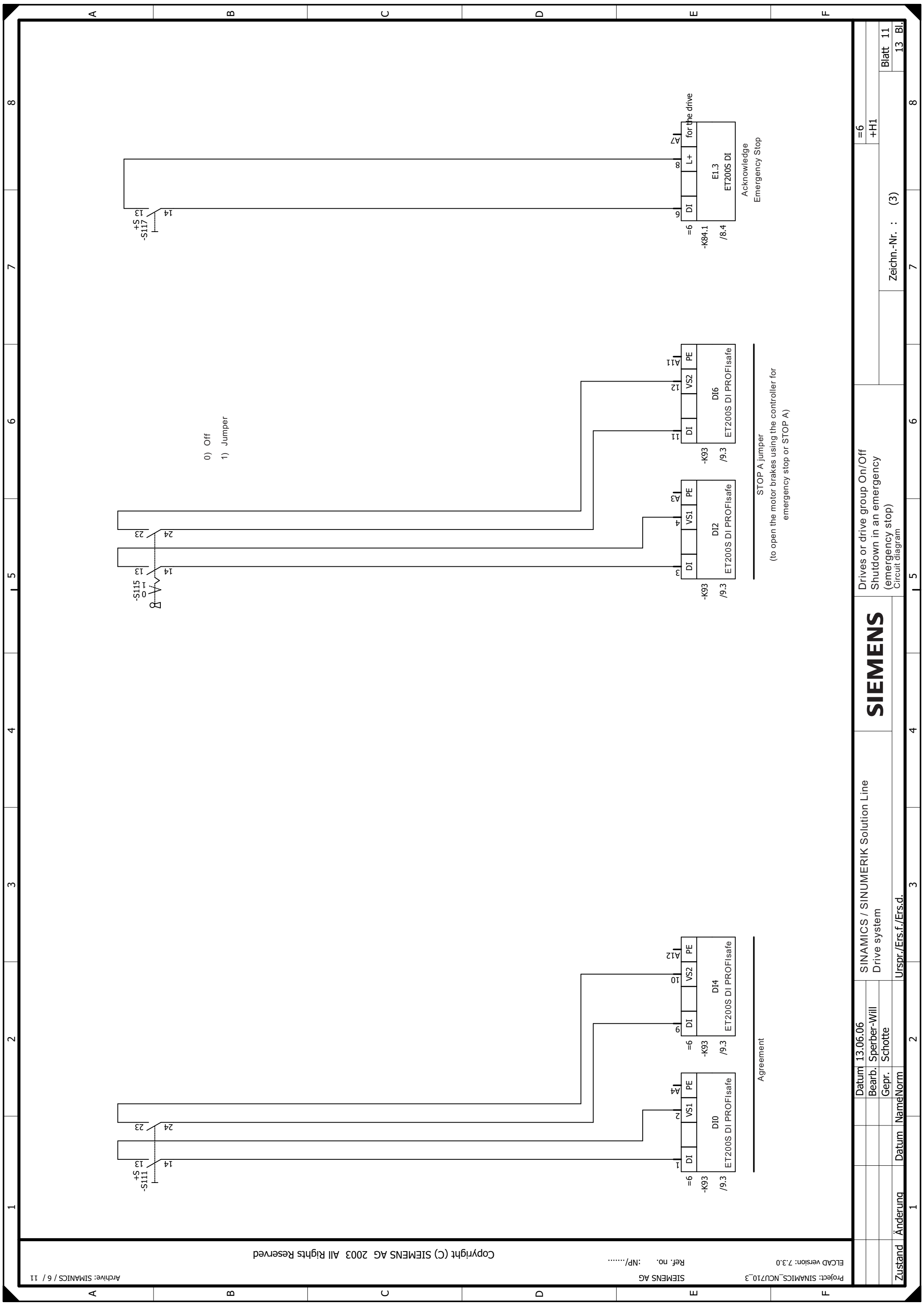


Figure 7-40 Circuit Manual Group =6, Page 11

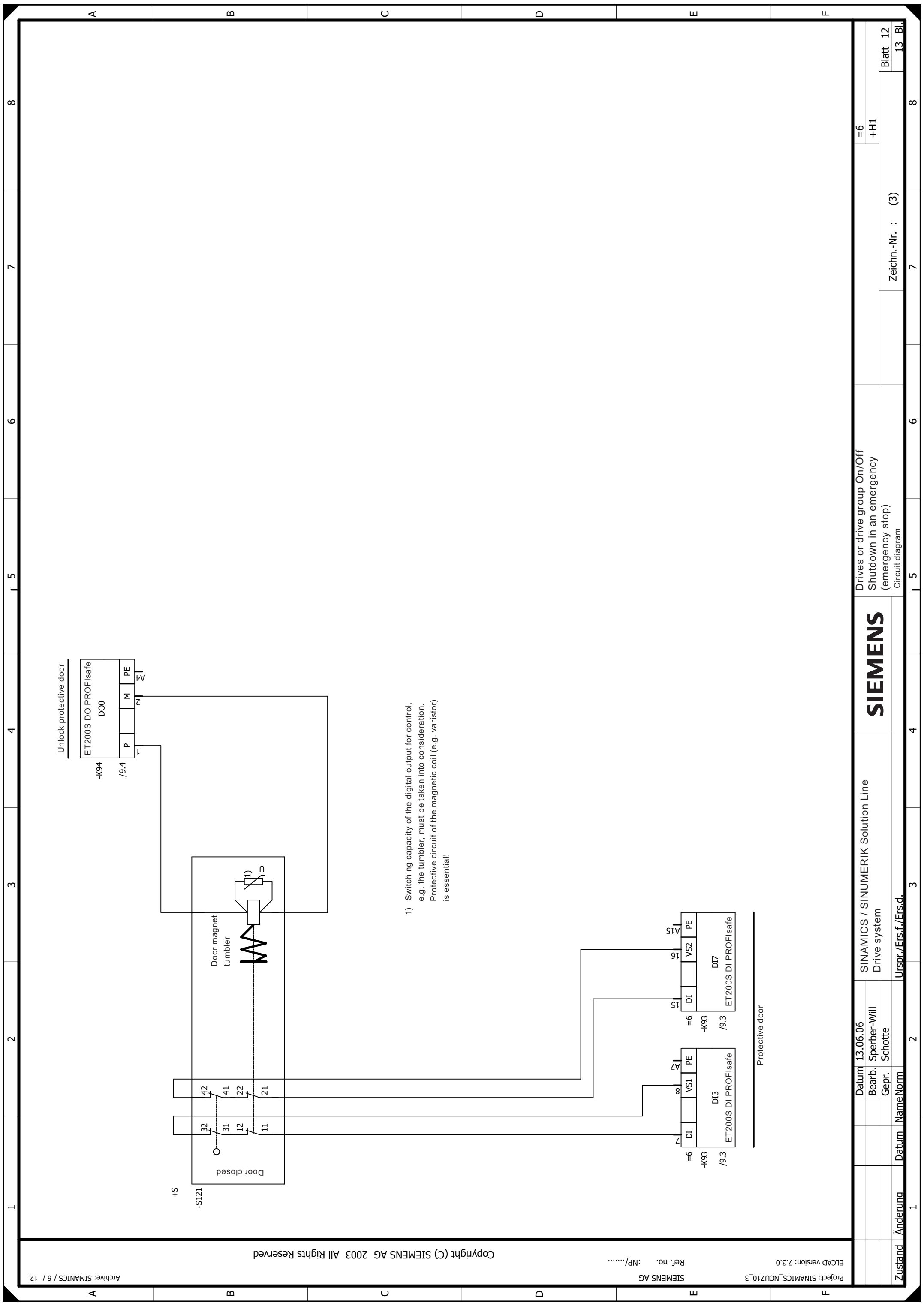


Figure 7-41 Circuit Manual Group =6, Page 12

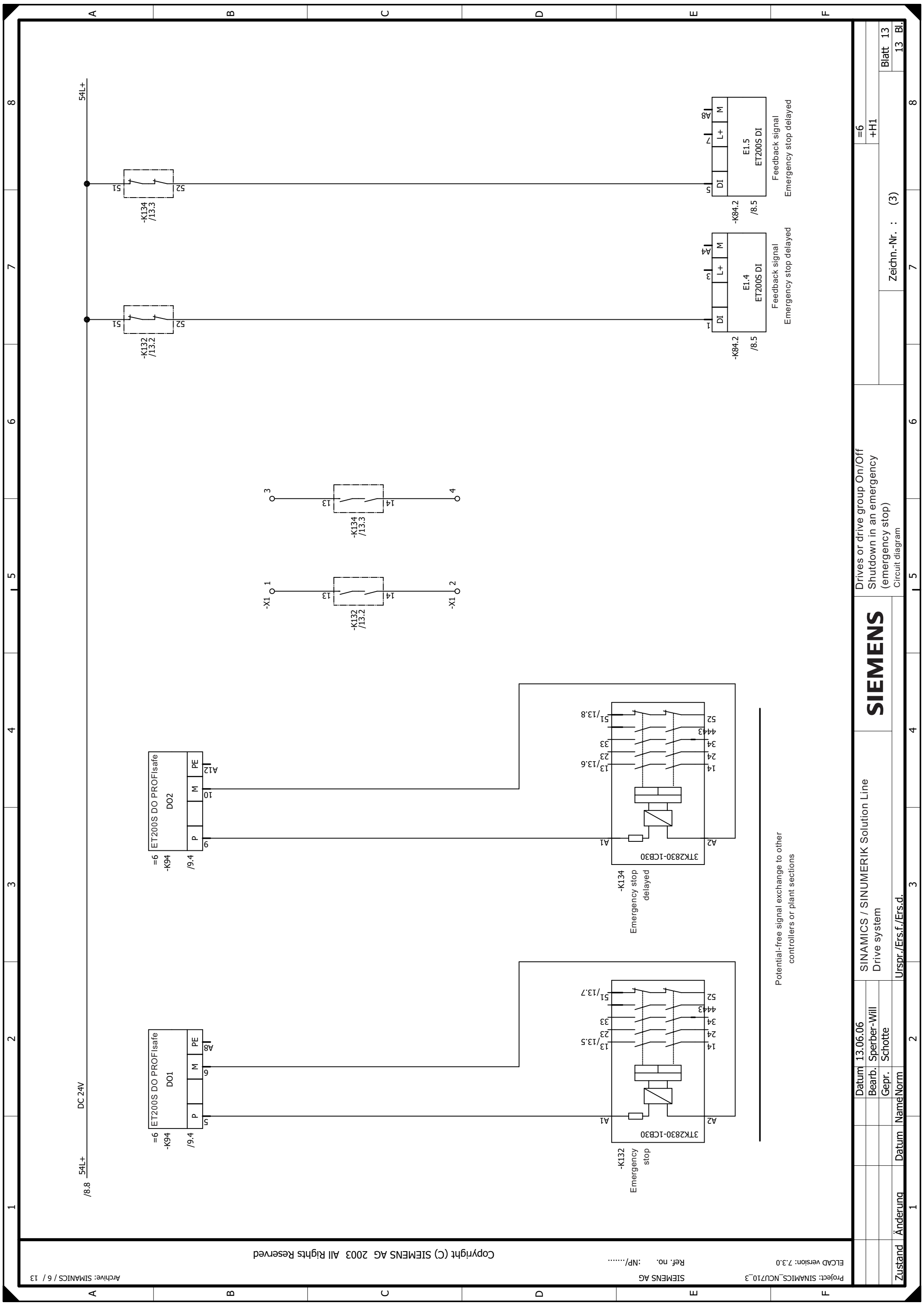


Figure 7-42 Circuit Manual Group =6, Page 13

# Additional Information 8

## 8.1 Distributed configuration

For the distributed installation, an external busbar is used for the DC link connection. From there, the cables are led to the power units. DC link rectifier adapters are used for the connection to the power units..

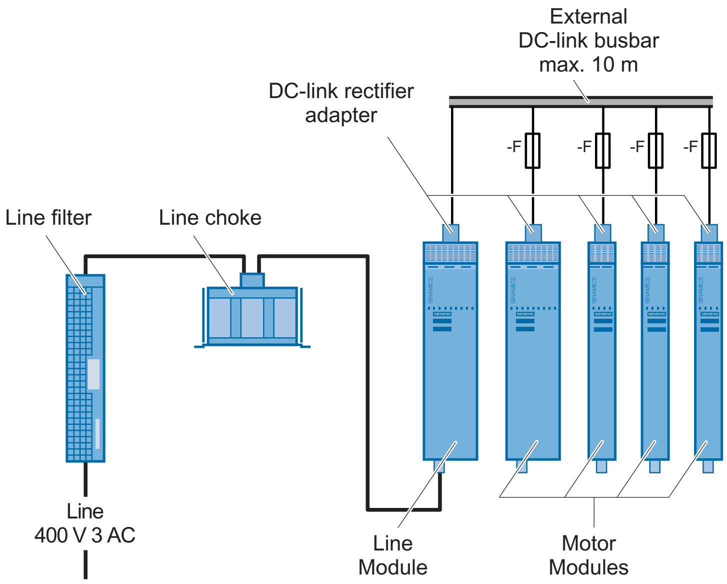


Figure 8-1 Distributed configuration

Depending on the component width, two variants are available:

### Component width 50/100 mm

DC link rectifier adapter with connection option from 0.5 mm² to 10 mm², max. 36 A

### Component width 150 ... 300 mm

DC link rectifier adapter with connection option from 35 mm² to 95 mm², max. 240 A

### Additional references

For details of DC link rectifier adapters in booksize format and information on cable installation, please refer to
/GH2/ SINAMICS S120/Booksize Power Units Equipment Manual/.

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**Note**

The internal DC link busbar must not be used if the DC link rectifier adapter is connected to a power section. The DC link bridge provided must be removed. Each power section requires a DC link rectifier adapter.

---

| ⚠ WARNING |
| --- |
| The DC link connection cables must be laid in such a way that they are ground-fault and short-circuit proof in accordance with DIN/VDE 0100 or suitable fuse protection must be provided. |

## 8.2 Cooling Systems

### 8.2.1 Introduction

For the SINAMICS System S120, three cooling systems are differentiated:

- Internal air cooling
- External air cooling
- Cold plate cooling

### 8.2.2 Internal Air Cooling

All SINAMICS S120 booksize components are installed within a control cabinet. The total heat loss of all components is dissipated in the control cabinet. There are three ways to remove the heat from the control cabinet:

- Filter fan
- Heat exchanger
- Cooling unit

The device to be used depends on the associated environmental conditions and the required cooling capacity. The configuring must also maintain the specified clearances for the ventilation. No other components may be placed in these areas.

### 8.2.3 External Air Cooling

The external air cooling is a cooling system for SINAMICS booksize power units. The through-hole technology is used for this construction form. The booksize power unit with its heat sink can be placed in the rectangular cutout of the control cabinet rear wall and installed with a seal. The heat sink with its cooling fins and fan (contained in scope of delivery) extends at the back out of the control cabinet and the heat dissipation is made externally from the control cabinet or in a separate air duct.

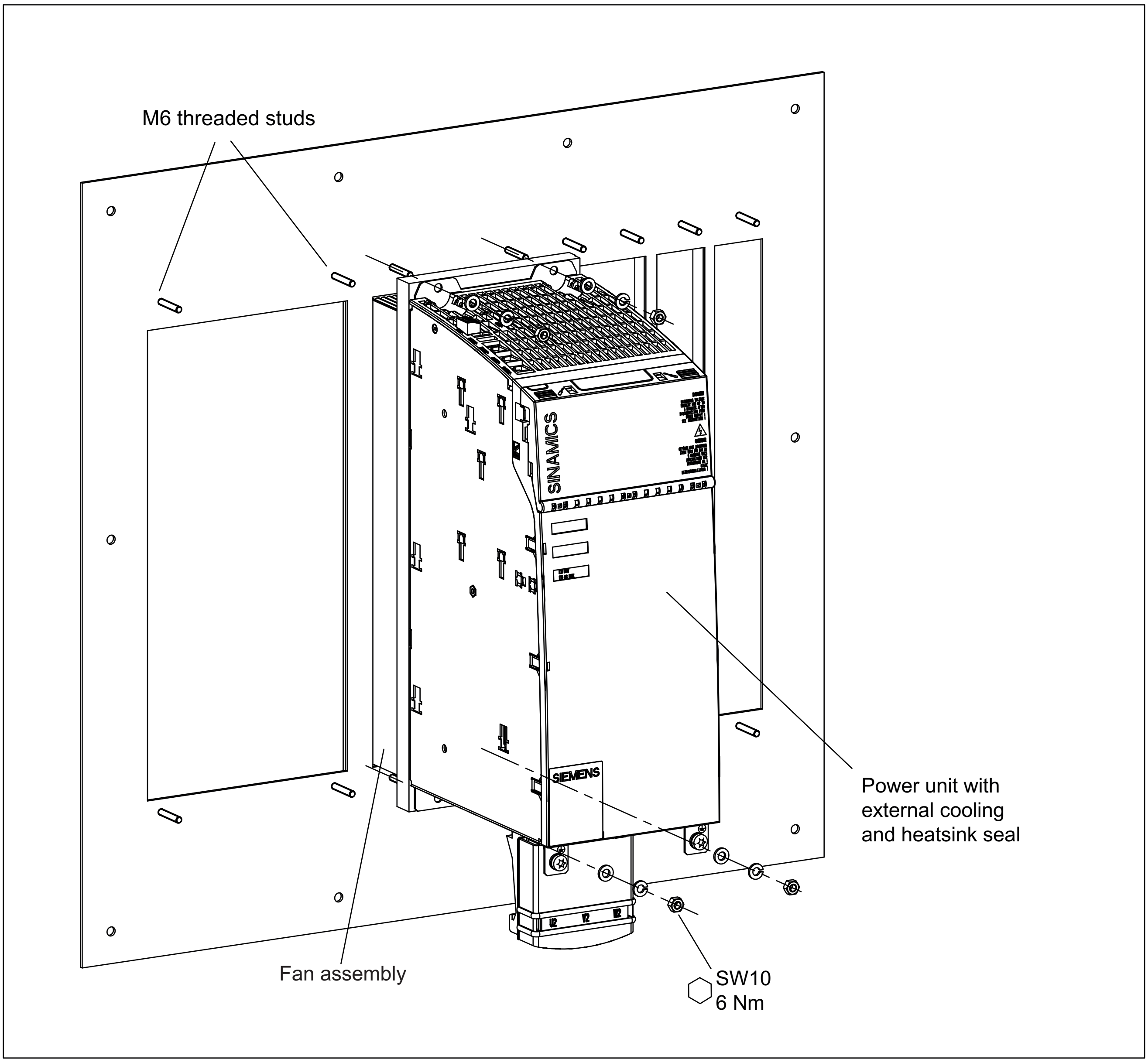


Figure 8-2 Installation of a booksize power section with external air cooling

## 8.2.4 Cold Plate

Cold plate cooling is a cooling system for SINAMICS S120 booksize power units. The flat aluminum cooling plate located at the rear side of the devices serves as thermal interface.

### Special advantages of the cold plate technology

1. It is particularly suitable for machine concepts in which a high level of dirt accumulates in the machine vicinity. The reduction of the cabinet-internal heat loss simplifies the heat dissipation of a sealed control cabinet (IP54).
2. Advantageous for machine concepts for which liquid is already present in the process. This heat dissipation method is thus suitable for both internal and external cold plate cooling of the power components.

### A distinction is made between:

- Cold plate with an external air heat sink
  The components of the drive group are typically all attached with screws to the cooling fins of an air heat sink located outside the control cabinet.
- Cold plate with an external liquid heat sink
  The components of the drive group are typically all attached with screws to the liquid heat sink located outside the control cabinet.
  Derating must be applied with 300 mm wide modules, given the heat transferred to the external heat sink. If the temperature at the interface to the power unit is 40 °C, derating is 80% for 6SL3136-7TE28-0AAx/6SL3126-1TE31-3AAx and 70% for 6SL3136- 7TE31-2AAx/6SL3126-1TE32-0AAx.
  When the Active Line Modules and Motor Modules feature direct liquid cooling (6SL3135-7TE31-2AA3/6SL3125-1TE32-0AA3), the derating referred does not apply to the above cold plate modules.
- Cold plate with internal liquid heat sink
  This is considered to be a liquid cooling using a connection adapter. The liquid passes through the integrated channels in the cold plate.

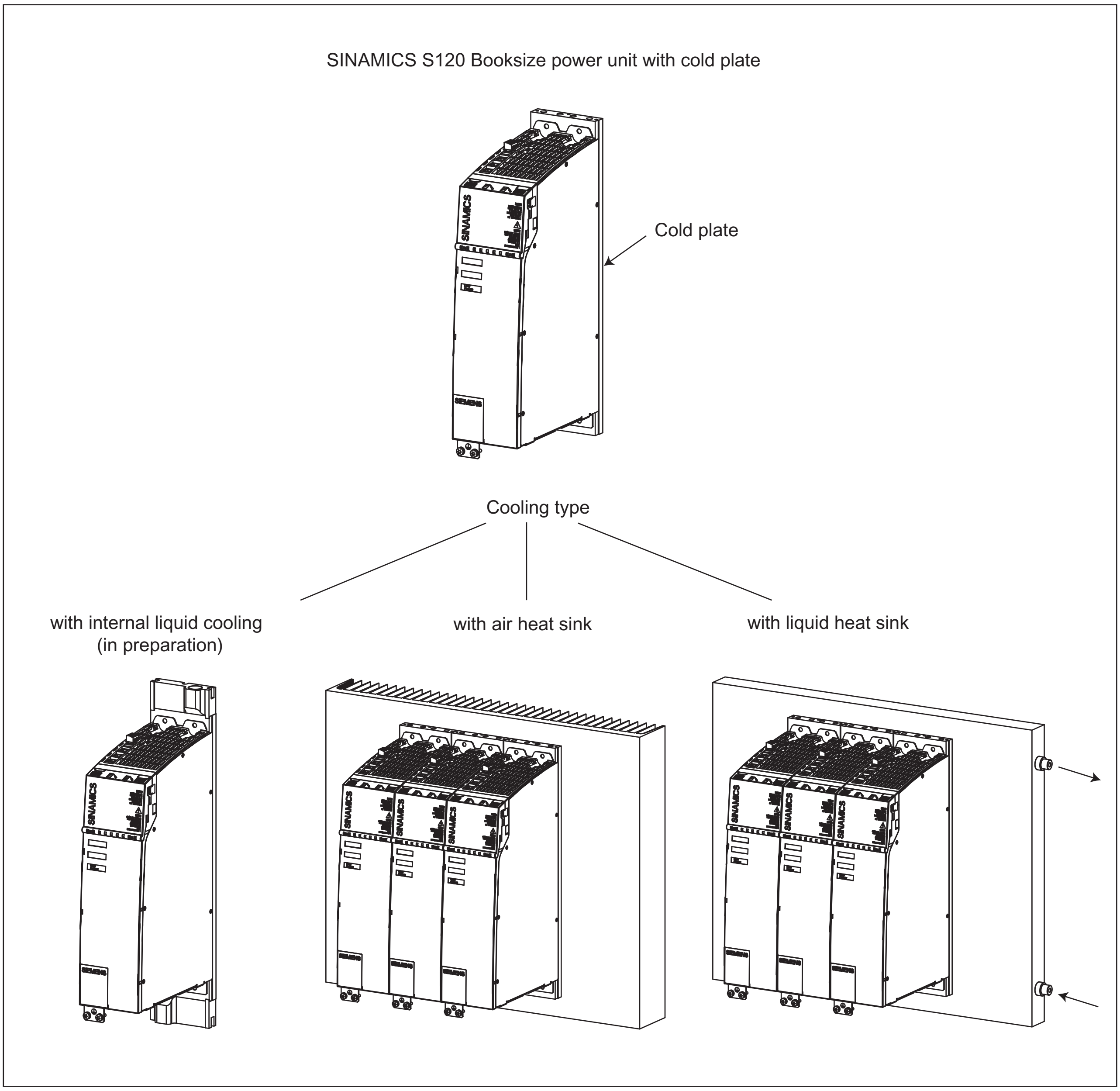


Figure 8-3 Cooling systems for cold plate

**Note**

The associated notes contained in the manuals must be observed for the configuring and the layout of the corresponding component. This ensures that devices in the control cabinet are not damaged as a result of leaks, etc.

# Activate/Deactivate Drive System 9

## 9.1 Overview of the Status Signals

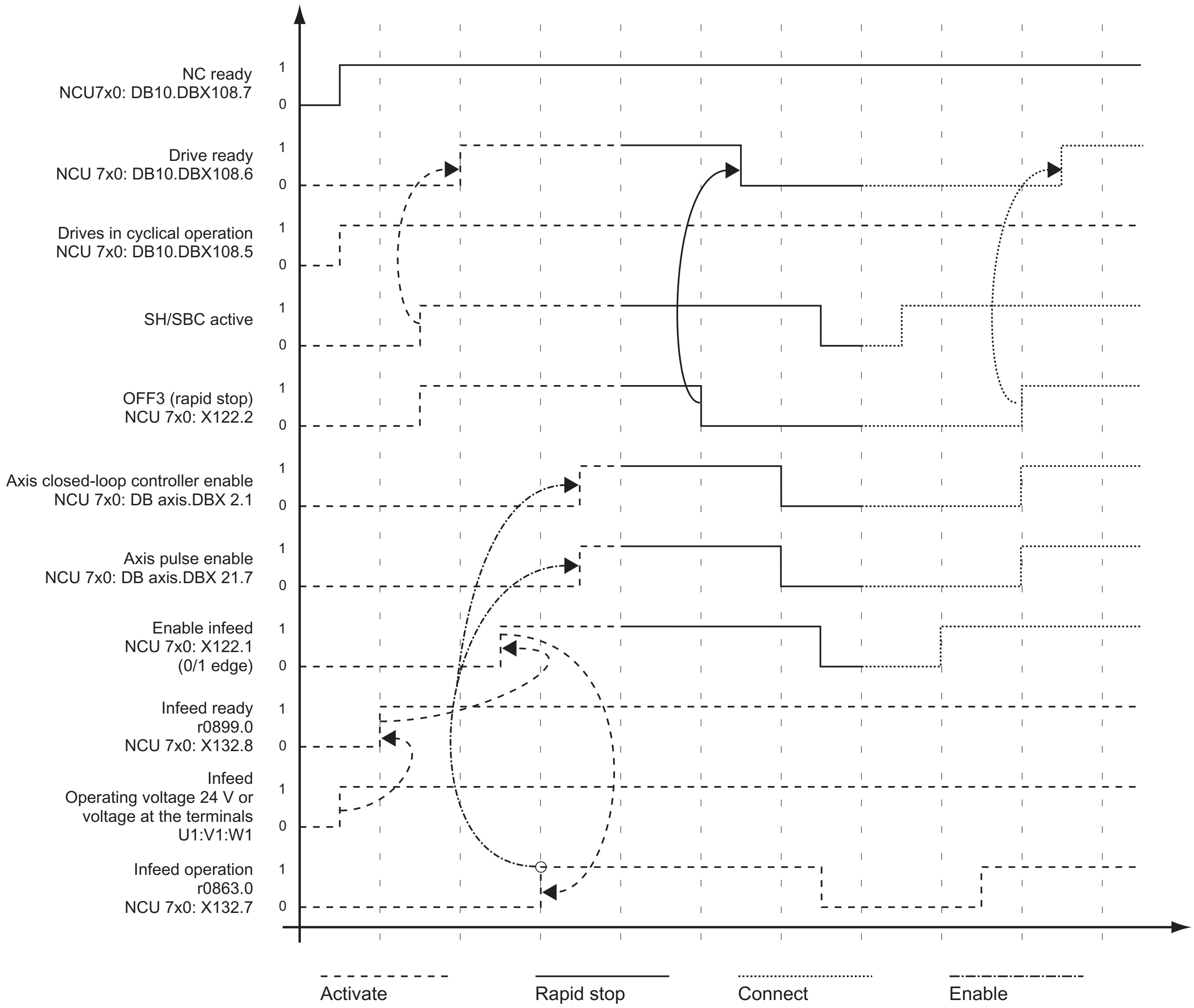


Figure 9-1 Overview of the Status Signals

## 9.2 Drive Group with Several Axes

The Motor Module is controlled via the -X21, -X22 terminal block and DRIVE-CLiQ at the -X200/201/202/203 terminal block. The detailed function description for the individual signals and control/status words is contained in the following document:

\LH1\SINAMICS S120/S150 List Manual

To enable the Motor Module, the "infeed ready" signal must be connected from the Line Module.

The following function diagrams show how the individual signals interact.

## Activating the infeed

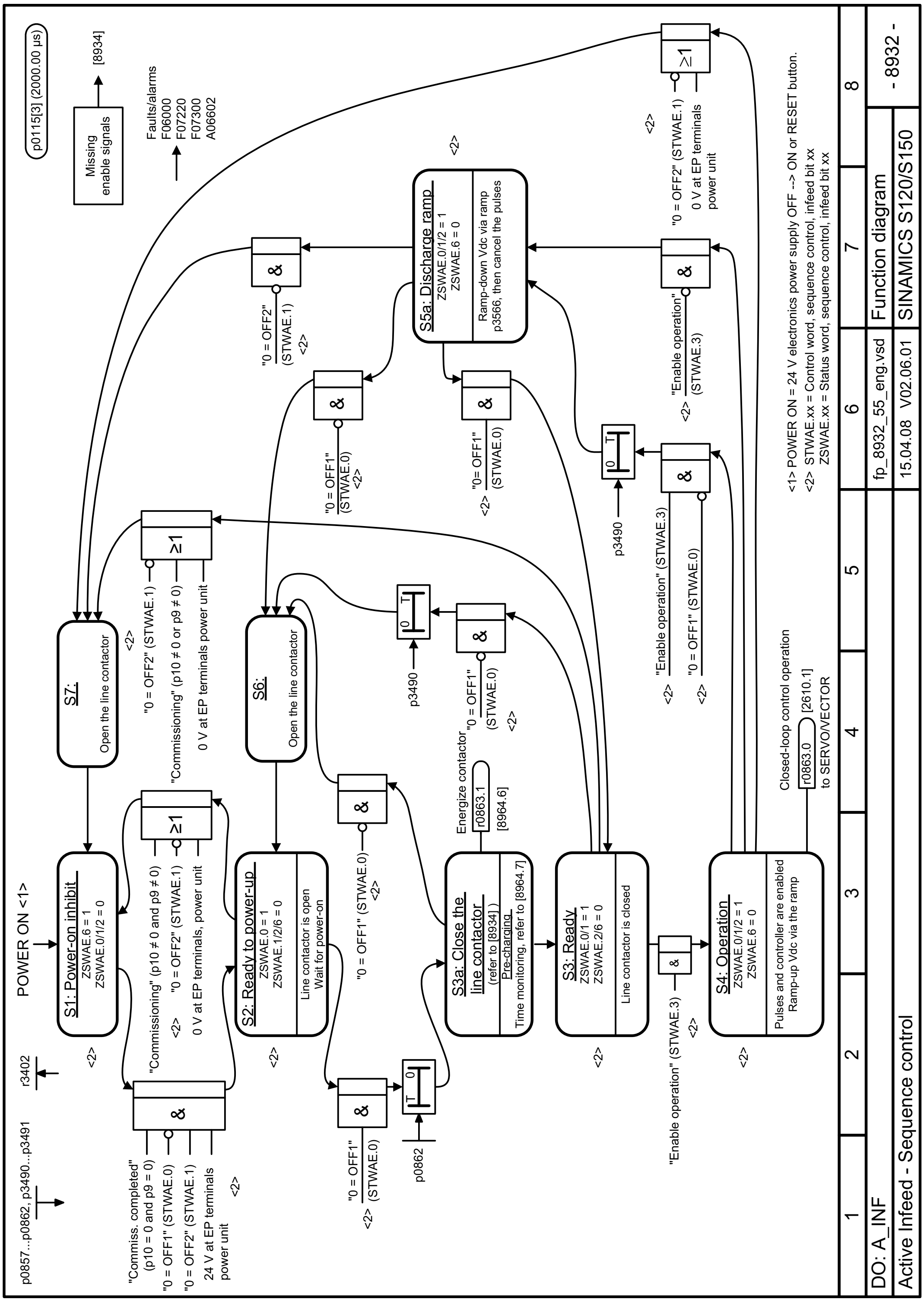


Figure 9-2 "Infeed activation" function diagram

## Activating the drive

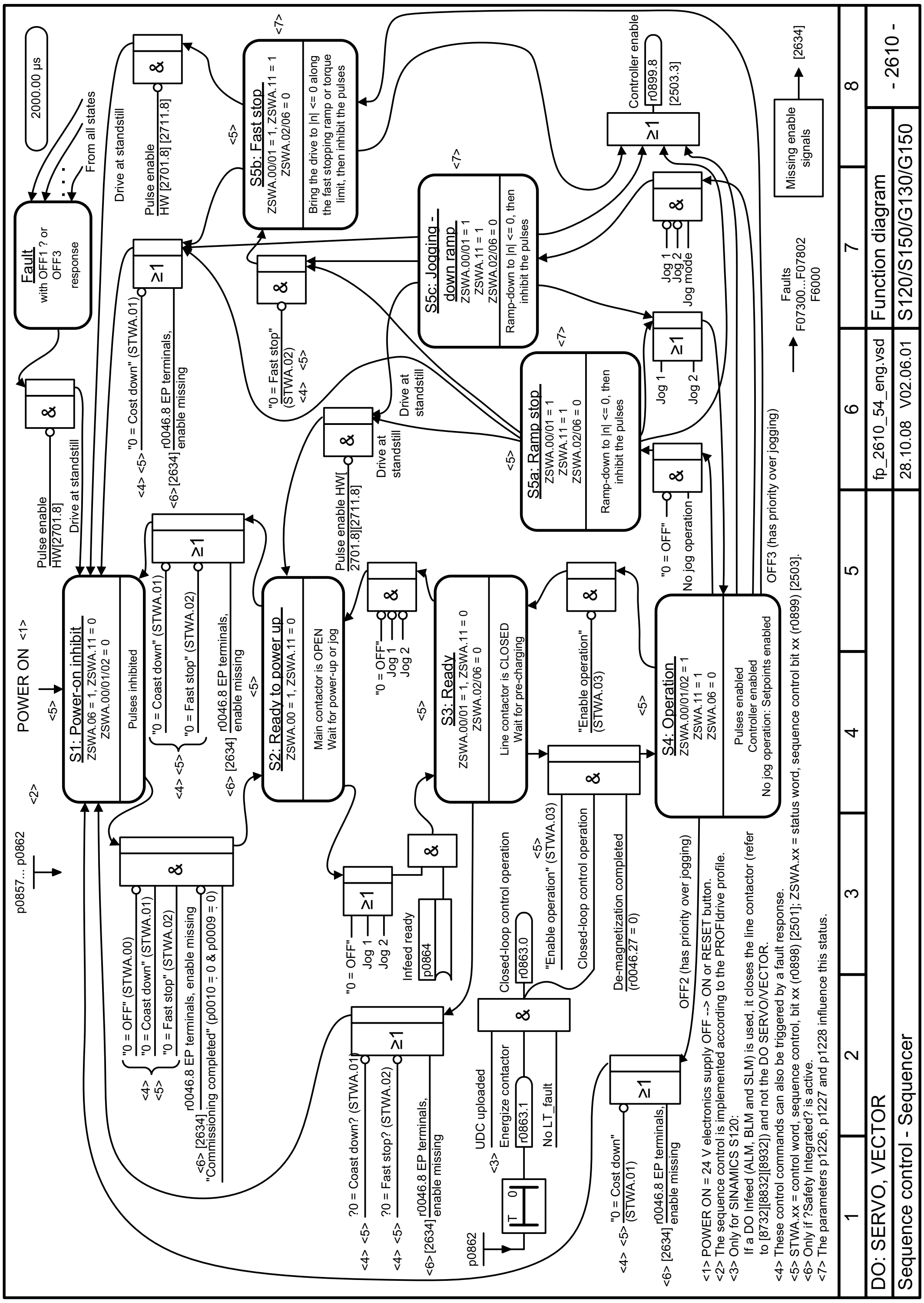

Figure 9-3 "Drive activation" function diagram

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**Note**

Applies to CU320; with integrated drive solutions (e.g. NCU, NX, etc.), some signals are already processed by means of internal communication

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## Off responses

- OFF1
  - The immediate specification of n_set = 0 at the ramp generator return ramp (p1121) causes the drive to be braked.
  - When zero speed is detected, the motor holding brake (if parameterized) is closed (p1215). The pulses are suppressed when the closing time (p1217) expires. The zero speed is detected when the speed actual value is lower than the speed threshold (p1226) or when the monitoring time (p1227) started when speed setpoint ≤ speed threshold (p1226) has expired.
- OFF2
  - Immediate pulse suppression, the drive coasts to standstill.
  - The motor holding brake (if parameterized) is closed immediately.
  - Closing lockout is activated.
- OFF3
  - The immediate specification of n_set = 0 at the OFF3 return ramp (p1135) causes the drive to be braked.
  - When zero speed is detected, the motor holding brake (if parameterized) is closed. The pulses are suppressed when the closing time of the holding brake (p1217) expires. The zero speed is detected when the speed actual value is lower than the speed threshold (p1226) or when the monitoring time (p1227) started when speed setpoint ≤ speed threshold (p1226) has expired.
  - Closing lockout is activated.

## Control and status signals

Table 9- 1 Switching on/switching off the control system

| Signal name | Internal control word | Binector input | PROFIBUS message frame 2 … 106 | VDI interface (PLC) |
|---|---|---|---|---|
| 0 = OFF1 | STWA.00<br>STWAE.00 | p0840 ON/OFF1 | STW1.0 | DB(AX).DBX2.1 (controller enable)<br>DB(AX).DBX1.5/6 (measuring system selected and OK)<br>DB(AX).DBX21.7 (pulse enable) |
| 0 = OFF2 | STWA.01<br>STWAE.01 | p0844 1. OFF2<br>p0845 2. OFF2 | STW1.1 | 1 |
| 0 = OFF3 | STWA.02 | p0848 1. OFF3<br>P0849 2. OFF3 | STW1.2 | 1 |
| Enable operation | STWA.03<br>STWAE.03 | p0852 operation enabled | STW1.3 | DBX21.7 |

Table 9- 2 Activate/deactivate status signals

| Signal name | Internal status word | Parameter | PROFIBUS message frame 2 … 106 |
|---|---|---|---|
| Ready to start | ZSWA.00<br>ZSWAE.00 | r0899.0 | ZSW1.0 |
| Ready | ZSWA.01<br>ZSWAE.01 | r0899.1 | ZSW1.1 |
| Operation enabled | ZSWA.02<br>ZSWAE.02 | r0899.2 | ZSW1.2 |
| Closing lockout | ZSWA.06<br>ZSWAE.06 | r0899.6 | ZSW1.6 |
| Pulses enabled | ZSWA.11 | r0899.11 | ZSW1.11 |

### Function block diagram overview (see SINAMICS S List Manual)

- 2610 sequence control - sequencer
- 2634 missing enables, line contactor control
- 8732 basic infeed - sequencer
- 8832 smart infeed - sequencer
- 8932 active infeed - sequencer

# Appendix A

| ⚠ CAUTION |
| --- |
| Electrostatic sensitive devices (ESD) are single components, integrated circuits or devices that can be damaged by electrostatic fields or electrostatic discharges.<br>Regulations for the ESD handling:<br>During the handling of electronic components, pay attention to the grounding of the person, workplace and packaging!<br>Electronic components may be touched by persons only when<br>• these persons are grounded using an ESD bracelet, or<br>• these persons in ESD areas with a conducting floor wear ESD shoes or ESD grounding straps.<br>Electronic components should be touched only when this is unavoidable. The touching is permitted only on the front panel or on the circuit board edge.<br>Electronic components must not be brought into contact with plastics or clothing made of artificial fibers.<br>Electronic components may only be placed on conducting surfaces (table with ESD coating, conducting ESD foamed material, ESD packing bag, ESD transport container).<br>Electronic components may not be placed near display units, monitors or televisions (minimum distance from the screen > 10 cm).<br>Measurements must only be taken on boards when the measuring instrument is grounded (via protective conductors, for example) or the measuring probe is briefly discharged before measurements are taken with an isolated measuring device (for example, touching a bare metal housing). |

## A.1 Abbreviations

Table A- 1 Abbreviations and meanings, German/English

| Abbreviation | German meaning | English meaning |
| --- | --- | --- |
| AC | Wechselstrom | Alternating current |
| ALM | Active Line Module | Active Line Module |
| CBC | Communication Board CAN | Communication Board CAN |
| CBE | Communication Board Ethernet | Communication Board Ethernet |
| CPU | Zentrale Recheneinheit | Central Processing Unit |
| CSM | Control Supply Module | Control Supply Module |
| CU | Control Unit | Control Unit |
| DC | Gleichstrom | Direct Current |

| Abbreviation | German meaning | English meaning |
|---|---|---|
| DO | Antriebsobjekt | Drive Object |
| DP | Dezentrale Peripherie | Decentralized Peripherals |
| DRIVE-CLiQ | Drive Component Link with IQ | Drive Component Link with IQ |
| EP | Impulsfreigabe | Enable Pulses |
| EMC | Elektromagnetische Verträglichkeit | Electromagnetic Compatibility (EMC) |
| EN | Europäische Norm | European Standard |
| FI | Fehlerstrom-Schutzschalter | Earth Leakage Circuit Breaker (ELCB) |
| HMI | Mensch-Maschine-Schnittstelle | Human Machine Interface |
| IEC | Internationale Norm in der Elektrotechnik | International Electrotechnical Commission |
| IT | Drehstromversorgungsnetz ungeerdet | Insulated three-phase supply network |
| LED | Leuchtdiode | Light Emitting Diode |
| LM : | Line Module | Line Module |
| NC | Numerische Steuerung | Numerical Control |
| NCK | Numerik-Kern mit Satzaufbereitung, Verfahrbereich usw. | Numerical Control Kernel |
| NCU | Numerical Control Unit | Numerical Control Unit |
| NX | Numerical Extension | Numerical Extension |
| OP | Bedientafelfront | Operator Panel |
| PE | Schutzerde | Protective Earth |
| PLC | Speicherprogrammierbare Steuerung (SPS) | Programmable Logic Controller |
| SBC | Safe Brake Control | Safe Brake Control |
| SH | Sicherer Halt | Safe standstill |
| SIL | Sicherheitsintegritätsgrad | Safety Integrity Level |
| SLM | Smart Line Module | Smart Line Module |
| SMC | Sensor Module Cabinet | Sensor Module Cabinet |
| SME | Sensor Module External | Sensor Module External |
| SPL | Sichere Programmierbare Logik | Safe Programmable Logic |
| STW | Steuerwort | Control word |
| TCU | Thin Client Unit | Thin Client Unit |
| TM | Terminal Module | Terminal Module |
| TN | Drehstromversorgungsnetz geerdet | Grounded three-phase supply network |
| TT | Drehstromversorgungsnetz geerdet | Grounded three-phase supply network |
| VPM | Voltage Protection Module | Voltage Protection Module |
| VS | Power supply | Voltage Supply |
| VSM | Voltage Sensing Module | Voltage Sensing Module |
| ZSW | Zustandswort | Status word |

# A.2 Description of drive wizard (up to SINUMERIK V2.5)

## A.2.1 Commissioning Macros Overview

### Introduction

For the sake of simplifying drive commissioning, "macros" are included in the software. The drive group connected to the NCU can be extensively preconfigured by starting and running a drive wizard in the commissioning phase.

### Advantage

The drive wizard performs the following tasks:

- Default terminal assignment on the NCU
- Connection of all drive objects (topology)
- Automatic commissioning of motors with DRIVE-CLiQ interfaces

## A.2.2 Functions in the macro

### Functions in the configuration macro

- The "1" and "5" configuration macros parameterize the central measuring of the first probe of the SINUMERIK 840D sl. The second probe must be parameterized by the user.
- For the default settings of BEROs, only the corresponding input or output on the NCU is configured via the macro. You must make the link to the corresponding axis (BERO) via separate links.
- The safety (SH/SBC) interconnection is to be made according to the "SINAMICS S120" Commissioning Manual, Chapter "SINAMICS Safety Integrated (Booksize)".
- A final test must be carried out for the SH/SBC functions.

## A.2.3 Drive wizard for commissioning

### Introduction

The following macros are available for drive commissioning:

- Macro for infeed (Line Module) **with** DRIVE-CLiQ -> "1"
- Macro for infeed (Line Module) **without** DRIVE-CLiQ -> "5"

- Macros 100116 for preassigning the data sets and message-frame types
- Update macro 150399

  This macro executes an update of all drive components.

## Overview

The table below lists macros for commissioning. Using the macros "1" or "5" allows a standard terminal circuit to be achieved. This terminal circuit can be modified according to the terminal plan.

Table A- 2 Macros for commissioning

| Number | File name | Description |
|---|---|---|
| 1 | pm000001.acx<br>pm150001.acx 1) | Line Module **with** DRIVE-CLiQ :<br>• Interconnection p0840 (infeed)<br>• Interconnection 2. OFF 3 (rapid stop)<br>• Reserving input and output terminals for two SH/SBC groups<br>• Bero 1 – zero mark substitute<br>• 1. Probe<br>• 4 x Digital NC – Input ($A_IN[1] …[4] )<br>• Feedback Line Module<br>• 2 x digital NC – output ($A_OUT[1] …[2] )<br>ALM:<br>• Shutdown of network identification (p3410=0)<br>SLM with DRIVE-CLiQ:<br>• Network identification of the SLM is performed automatically on the next pulse enable (p3410=5). |
| 5 | pm000005.acx<br>pm150005.acx 1) | Line Module **without** DRIVE-CLiQ :<br>• Interconnection p0864 to all drives<br>• Interconnection 2. OFF 3 (rapid stop)<br>• Reserving input and output terminals for two SH/SBC groups<br>• Bero 1 – zero mark substitute<br>• 1. Probe<br>• 4 x Digital NCK – Input ($A_IN[1] …[4] )<br>• 4 x digital NCK – output ($A_OUT[1] …[4] ) |
| 100116 | pm100116.acx | The following parameters are set on all 6 drives:<br>• Set up two encoder data sets p140=2<br>• Eight drive data sets p180=8<br>• Profibus protocol p922 = 116 |
| 150399 | pm150399.acx | Update of all drive components |

1) Not for 850D sl (NCU7x0)

## A.2.4 Procedure for calling ACX macros

### Introduction

**WARNING**

Prior to starting the macro for the drive configuration, all drive releases (ON/OFF1, OFF2, OFF3, etc.) must be switched off.

### Process when calling a macro

The principle processes for calling an individual macro are laid out below.

These steps include:

- Process for update macro call 150399 (left in the picture)
- Process for calling configuration macro 1 or 5 (on the right in the figure)

**Note**

For an initial commissioning or component replacement, an update of the drive components to the current software version can be required. The 150399 macro can be used to update all components.

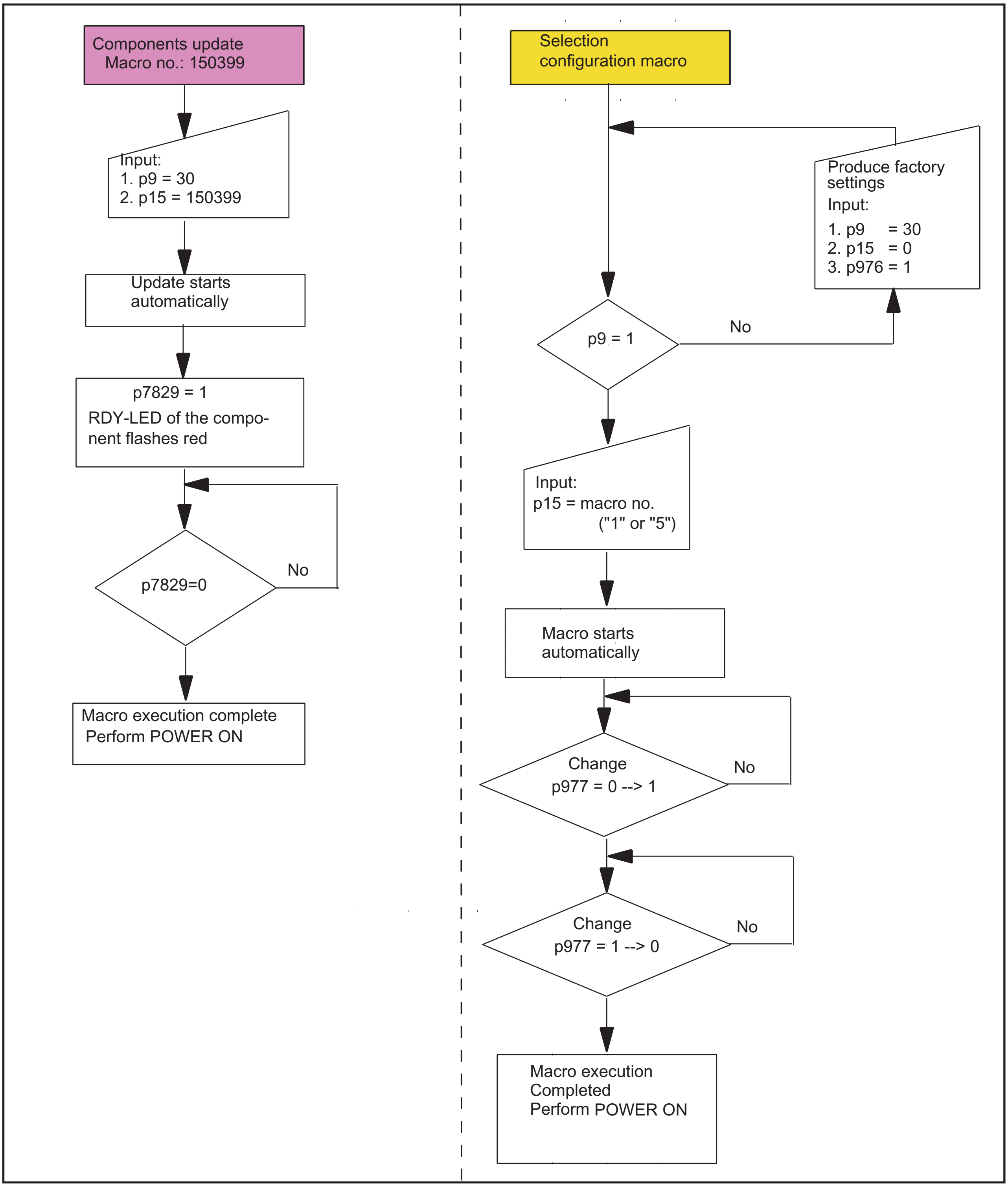


Figure A-1 Process macro call for update (left) and for configuration (right)

## Occurring operator errors

Operator errors that frequently occur when starting macros include:

- Incorrect status of p0009
- Active enables on the modules

**Note**

If you have doubts, load the factory settings prior to executing a macro.

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