SIEMENS

SINUMERIK, SINAMICS

SINUMERIK 840D sl, SINAMICS S120
Guide for the SINUMERIK 840D sl machine configuring

Manual

Valid for

controller
SINUMERIK 840D sl / 840DE sl

drive
SINAMICS S120

software
NCU system software for 840D sl/840DE sl version 1.3

Safety Guidelines

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

Danger

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

Warning

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

Caution

with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

Caution

without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

Notice

indicates that an unintended result or situation can occur if the corresponding information is not taken into account.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The device/system may only be set up and used in conjunction with this documentation. Commissioning and operation of a device/system may only be performed by **qualified personnel**. Within the context of the safety notes in this documentation qualified persons are defined as persons who are authorized to commission, ground and label devices, systems and circuits in accordance with established safety practices and standards.

Prescribed Usage

Note the following:

Warning

This device may only be used for the applications described in the catalog or the technical description and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens. Correct, reliable operation of the product requires proper transport, storage, positioning and assembly as well as careful operation and maintenance.

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Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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" → "Overview of Publications".

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 device 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.

- Manual SINUMERIK 840D sl
- Commissioning Manual SINUMERIK CNC, Part 1
- SINAMICS S120 Equipment Manual Booksize Power Sections, 06/2005 Edition
- SINAMICS S120 Function Manual, 06/2005 Edition
- SINAMICS S Lists Manual, 06/2005 Edition
- Function Manual Safety Integrated sl

Standard version

The accompanying 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		

Note

Country-specific telephone numbers for technical support are provided under the following Internet address:

http://www.siemens.com/automation/service&support

Questions about the Manual

If you have any queries (suggestions, corrections) in relation to this documentation, please fax or e-mail us:

Fax: +49 (0) 9131 / 98 - 63315

E-mail: mailto:motioncontrol.docu@siemens.com

Fax form: See the reply form at the end of this publication

SINUMERIK Internet address

http://www.siemens.com/sinumerik

SINAMICS Internet address

http://www.siemens.com/sinamics

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System overview

<div style="text-align:right">1</div>

1.1　　Application

Features

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 worldwide in tool and mold making, for high-speed cutting applications, for wood and glass processing, for handling operations, in transfer lines and rotary indexing machines, for mass production and JobShop production.

The SINUMERIK 840DE sl is available as an export version for use in countries where approval is required.

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

With the TCU (Thin Client Unit), the operator panel can be installed as much as 100 meters away. Up to 2 distributed OPs can be operated on an NCU 710 and as many as 4 distributed OPs on an NCU 720/730 or PCU 50.3.
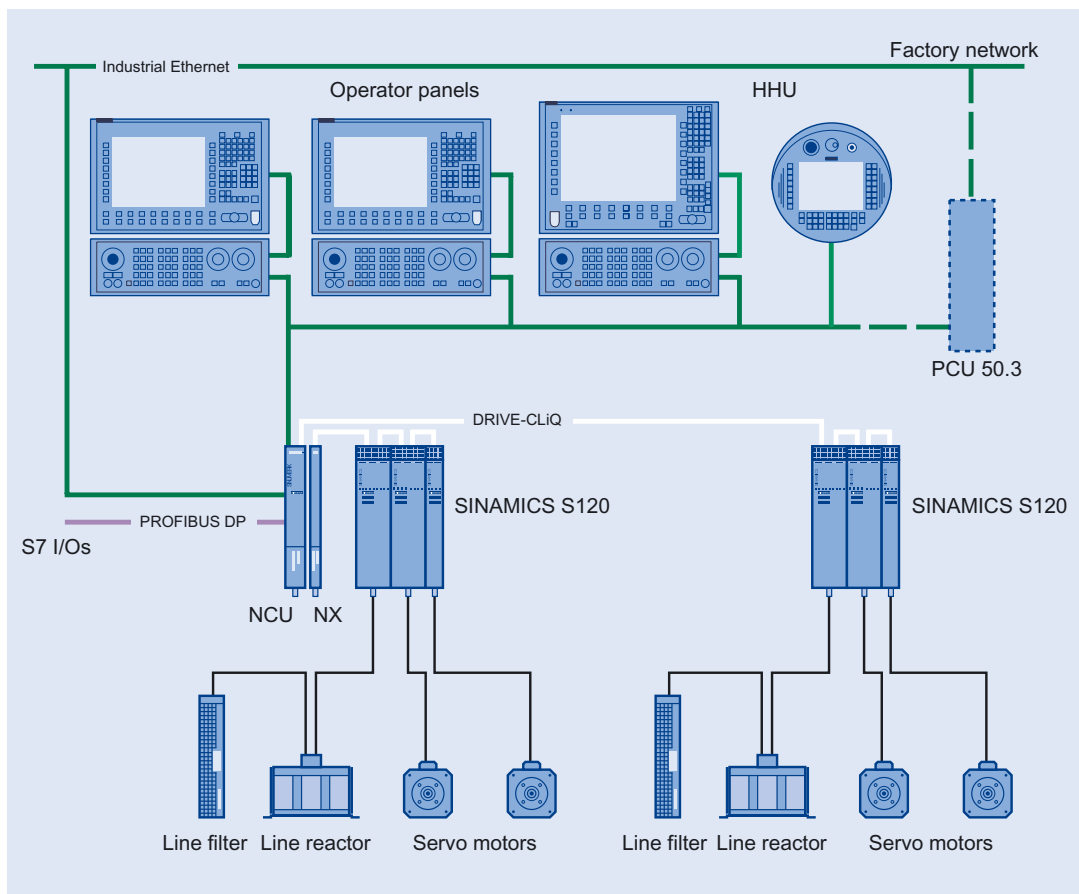
Figure 1-1   Typical topology of the SINUMERIK 840D sl compact system

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/O via PROFIBUS-DP connection

● Programming device

● SINAMICS 120 drive system

● 1FK/1FT/1FN/1FW6/1PH/1FE1/2SP1/1LA motors

1.3 Variants

The scalability of the hardware and software – both in the controller and control area – provides the prerequisites for use of the SINUMERIK 840D sl 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 an NCU 710. On the NCU 720/730, the number of axes and/or the performance of the drive controller can be increased to 31 axes. This is achieved by using the NX10/15 module. The NCU 720/730 can be expanded by up to 6 NX10/15 modules in performance for the drive controller and number of axes.

● If there is a high demand for axes and channels, e.g., when using rotary indexing or multi-spindle machines, the computing performance, configuration facilities and memory areas of the control units can be combined via the CBE 30 option module (available soon), thus becoming significantly extended.

● Use of an NCU 730 is recommended for maximum dynamics and accuracy in mold making or in the high speed cutting sector.

The following table shows the essential features of the various control units:

Table 1-1   Variants

Feature	NCU 710.1	NCU 720.1/730.1
DRIVE CLiQ ports	4	6
Axes	Up to 6	Up to 31
NX10/15	Up to 2	Up to 6

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 realized within a component and are configured in the STARTER commissioning tool with a mouse click.

The SINAMICS S120 control unit solves simple technological tasks by itself. For complex numeric or motion control tasks, it is replaced by powerful modules from the SINUMERIK 840D sl product spectrum.

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 nameplate in all components

All SINAMICS S120 components have an electronic nameplate. This nameplate 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 nameplate 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.

SINAMICS S120 drive system

Line-side components
– Line chokes
– Line filter

Line Modules
– Smart Line Modules
– Active Line Modules

Power supply
– Control Supply Module

DC-link components
– Braking Module
– Braking resistor
– Capacitor Module

Sensor Modules
– SMC10 / SMC20
– SMC30
– SME20 / SME25

Control Unit
– CU320

Control Units
– NCU 710.1
– NCU 720.1
– NCU 730.1
– NX10/NX15

Motor Modules
– Single Motor Modules
– Double Motor Modules

SINUMERIK control system

SINUMERIK 802D sl

SINUMERIK 840Di sl

SINUMERIK 840D sl

Three-phase motors

Synchronous motors
– 1FT6 motors
– 1FK7 motors
– 1FN1 / 1FN3 linear motors
– 1FW6 integrated torque motors
– 1FE1 integrated motors
– 2SP1 ECS motor spindles
– Gearboxes

Asynchronous motors
– 1PH7 motors
– 1PH4 motors
– 1PM4 motors
– 1PM6 motors
– 1PH2 integrated motors
– Gearboxes

Connection methods

MOTION-CONNECT
– Power cables
– Signal cables

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 perform the function of the central energy supply in the DC link

- 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 processes the inter-axis drive and technological functions

- 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, contiguous assembly

- Internal air cooling (other cooling methods on request).

1.6   Power Sections

Line modules

Convert the three-phase supply into a DC voltage for the DC link.

- Smart line modules

  The smart line modules generate a non-stabilized DC link voltage and are capable of regenerative feedback.

- Active line modules

  The active line modules generate a stabilized DC link voltage and are capable of regenerative feedback.

Motor modules

- Convert energy from the DC link for the connected motors with variable voltage and variable frequency.

1.7 HMI User Interface Software

HMI (Human Machine Interface) is a software component used for operating and programming machine tools. The HMI software is available in two variants:

- As the embedded variant (HMI-Embedded, ShopMill HMI, ShopTurn HMI) integrated in the NCU software
- As HMI-Advanced; runs on PCU 50.3

Connection of embedded HMI

For the embedded HMI, the HMI software is used on the NCU 7x0. A thin client (TCU) performs the NCU - operator panel communication.

Industrial Ethernet (factory network)

X202 Ethernet
(plant network)

Operator
Panel
with TCU

X120 Ethernet
X130 Ethernet
X126 PROFIBUS

X136 PROFIBUS

X127 Ethernet
(Service)

NCU 7x0
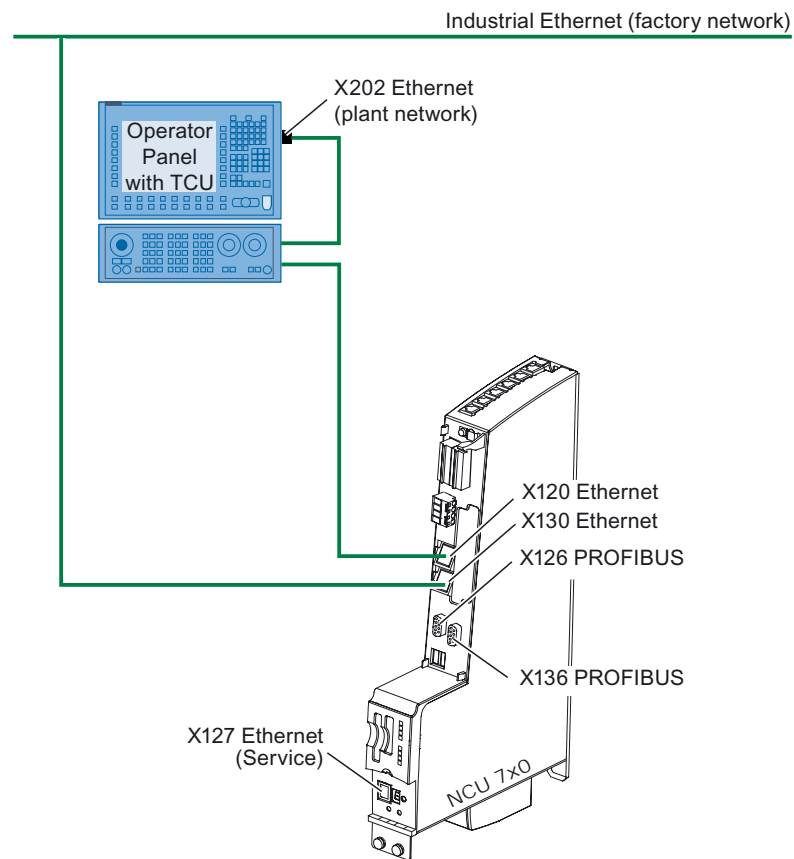
Figure 1-3   Connection of embedded HMI

HMI-Advanced connection

HMI Advanced runs on the PCU 50.3.
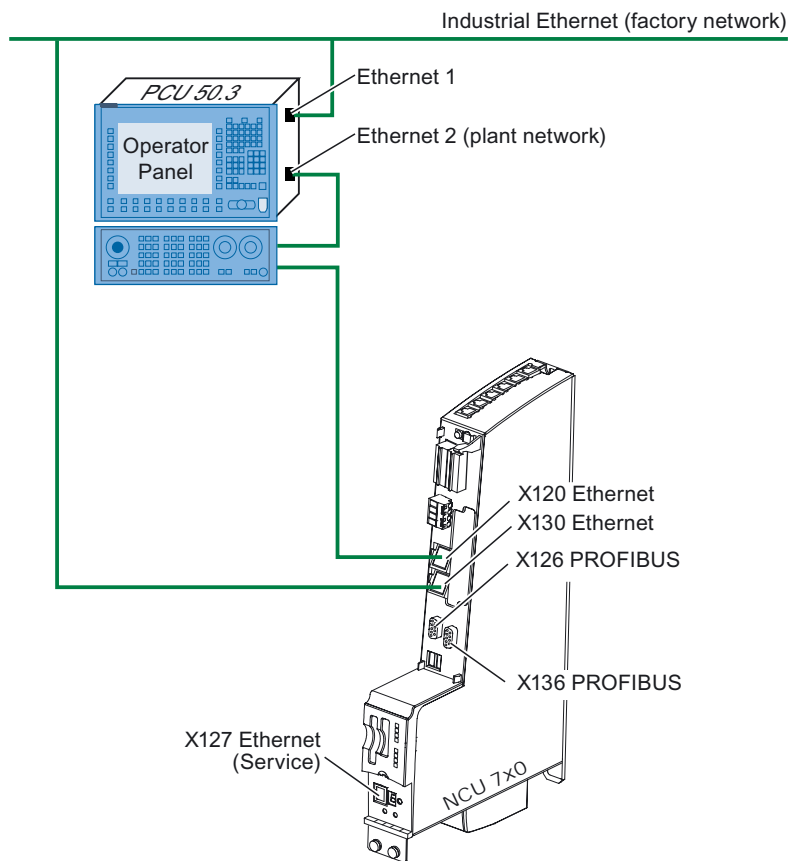
Figure 1-4   HMI-Advanced connection in the example; PCU 50.3 behind the operator panel

Switching between embedded HMI and HMI-Advanced

When an Ethernet switch is used, you can switch between embedded HMI (available on NCU) and HMI-Advanced (available on PCU 50.3).
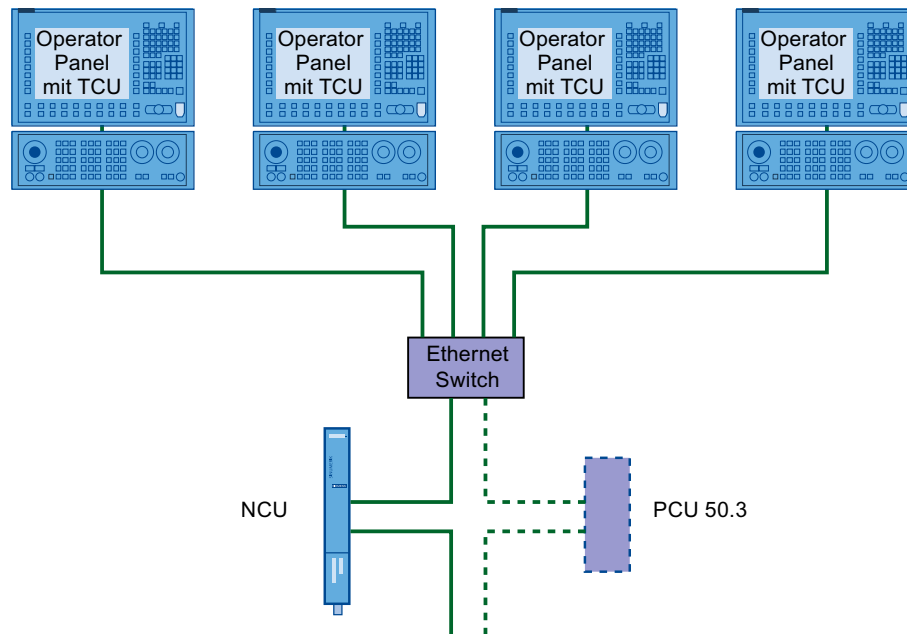
Figure 1-5   HMI-Advanced and embedded HMI on the Ethernet switch

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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)".

Structure of the drive group

<div style="text-align: right; font-size: 3em;">2</div>

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.

Note

For the layout of the components, ensure that the maximum cable lengths are not exceeded. See "Cable Lengths" section.

Note

Higher-power Motor Modules must be placed directly next to the Line Module. The lower-power components then follow. This prevents an overloading of the DC link busbar of the associated component.
Also refer to the "Current Carrying Capacity of the DC Link Busbar" section

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Note

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

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

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

⚠ **Danger**

The insertion of the screws without the DC link bridge is not permitted.
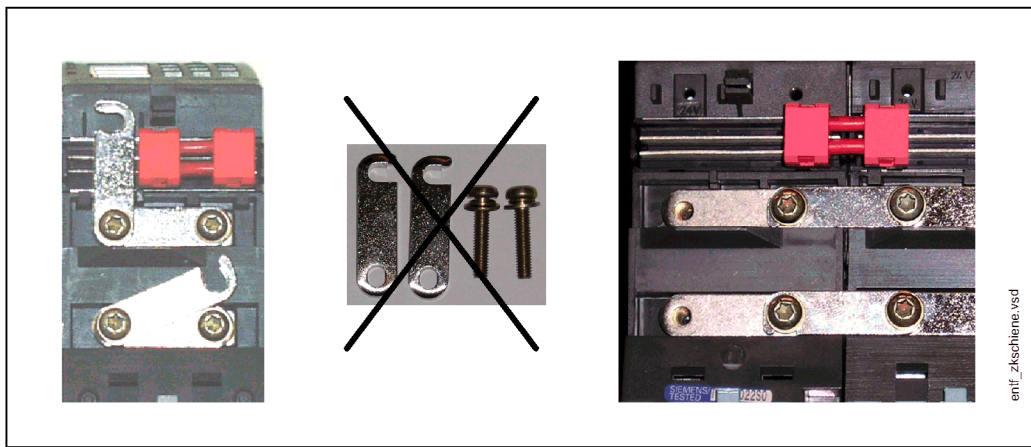
Figure 2-1   Removal of the DC link bridge

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, such as Braking Module, Control Supply Module, Capacitor Module
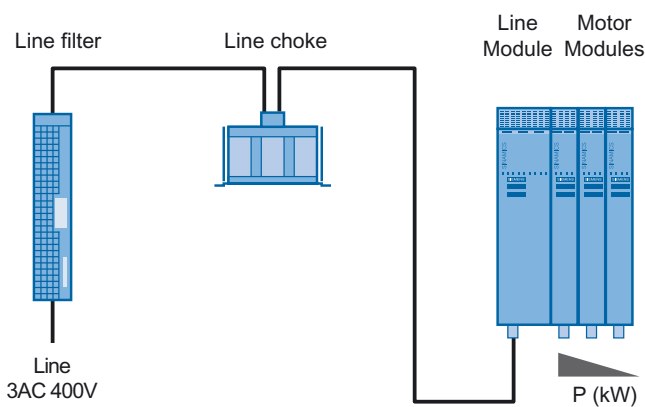
Figure 2-2   Single row layout

Note

For the layout of the NCU 7x0 or NX1x, see "Layout of the Components"

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 ventilation clearances; refer to the "Note for Connection Cable Installation Clearance" section
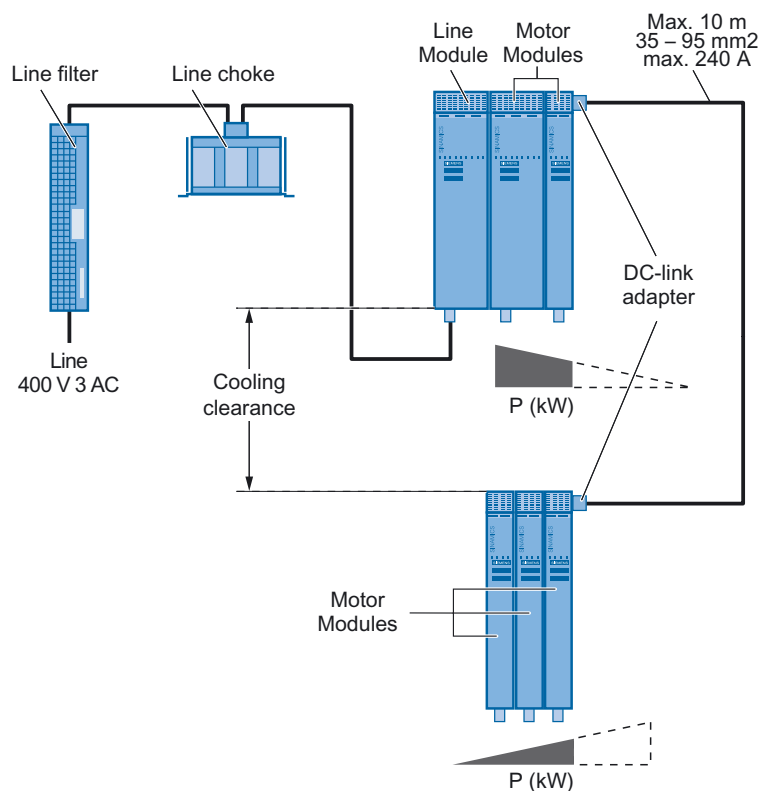
Figure 2-3   Two-row construction

Note

For the layout of the NCU 7x0 or NX1x, see "Layout of the Components"

DC link adapters are used to forward the DC link. Cross-sections of 35 mm² to 95 mm², max. 240 A, can be connected to the connection terminals.

The wiring is performed using single-wire / fine wire and shielded cables and laid short-circuit and ground-fault safe.

Minimum size for the ventilation clearances for the two-/multi-row construction
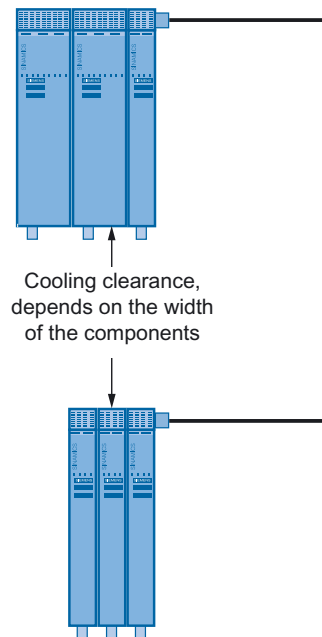
Figure 2-4   Ventilation clearance for the two-row construction

For components with a width of 50 to 100 mm, the separation between the top and bottom row must be at least 300 mm.

For components with a width of 150 to 300 mm, the separation between the top and bottom row must be at least 500 mm.

2.1.4 Center infeed (single row construction) for 55/80/120 kW Line Module

Another variant of the DC link supply is the center infeed. For the 55 / 80 / 120 kW Line Modules, the DC link can be fed from both the left- and right-hand 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.
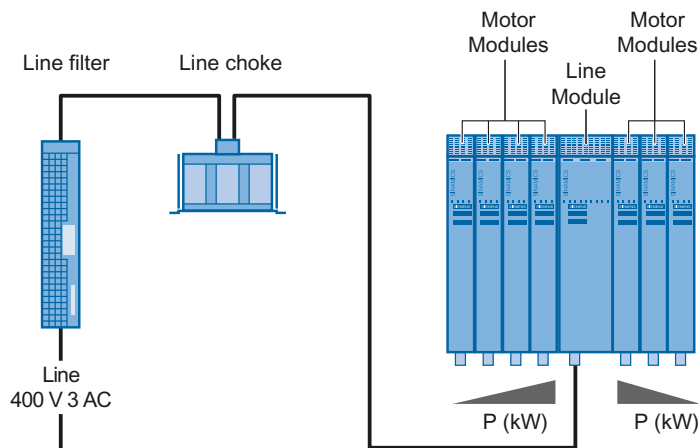
Figure 2-5   Center infeed construction

Note

For the layout of the NCU 7x0 or NX1x, see "Layout of the Components"
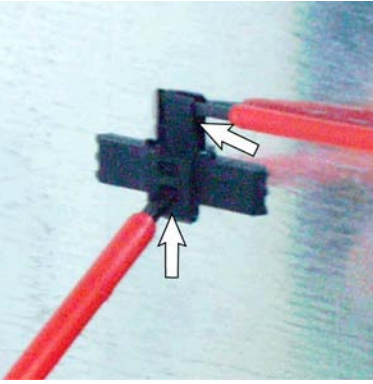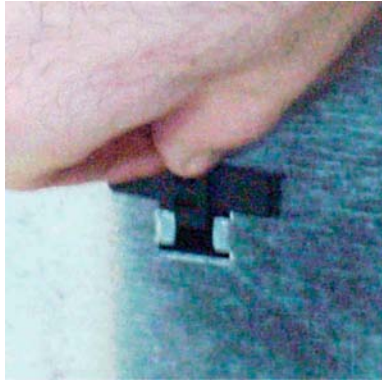
2.1.5   Direct installation of a CU-/NCU-/NX module on the Line Module

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.

Various expansion version make it necessary to remove the plastic retaining element:

- If the component to be mounted comes into contact with the lefthand cabinet panel
- for a center infeed using Line Modules 55 / 80 / 120 kW

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
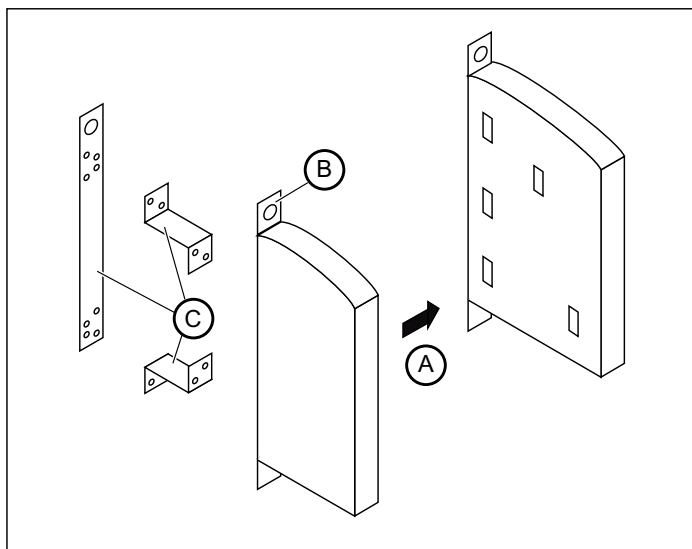
Figure 2-6   NX-NCU fastening types

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

	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. The installation in these cases in made using fastening clips or spacers.
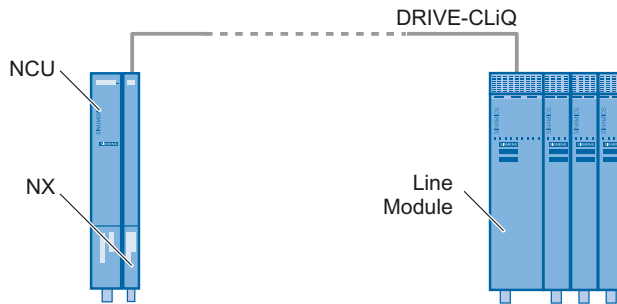
Figure 2-8   NCU/NX as offset solution

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.

The maximum current carrying capacity of the DC link busbar differs depending on the width of the power units.

- For power units from 3 A to 60 A (max. width 150 mm) and DC link components (Braking, Capacitor and Control Supply Module), the DC link busbar can be loaded with **100 A**.

- For power units from 85 A to 200 A (200 / 300 mm width), the DC link busbar can be loaded with **200 A**.

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 Equipment Manual for Booksize Power Units 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.
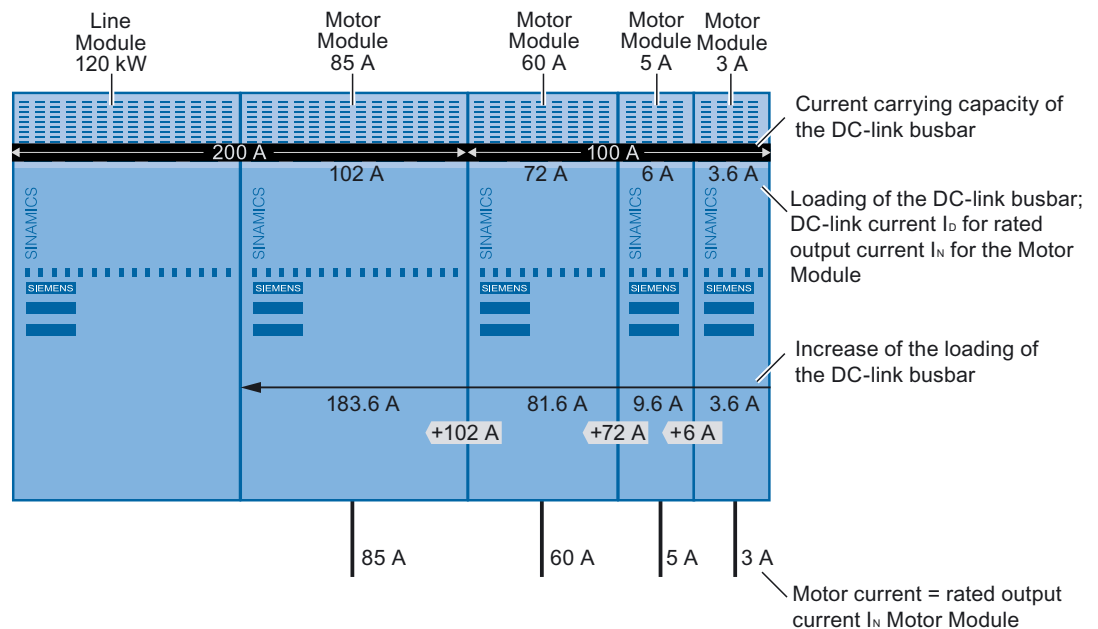
Figure 2-9   Regular construction; DC link busbars not overloaded

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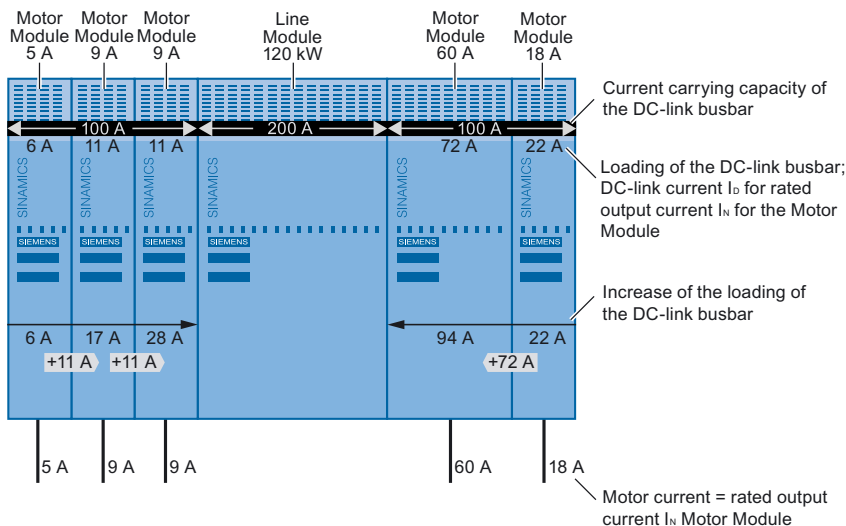
Figure 2-10   Infeed from left and right (center infeed)

Note

Due to the design, center feed is possible only for power units with rated output current of the Line Modules ≥ 55 kW.

The single side infeed would produce an overloading for a 60 A Motor Module. This construction variant is not permitted.
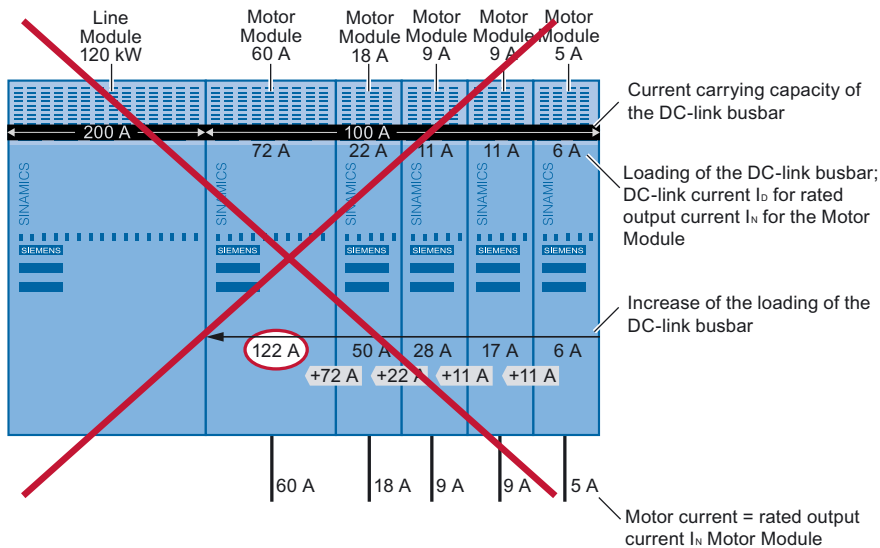
Figure 2-11   Overloading of the DC link busbar for a 60 A Motor Module

2.4 Shield Connection

2.4.1 SINAMICS Components Dimension Drawings (Internal Air Cooling)
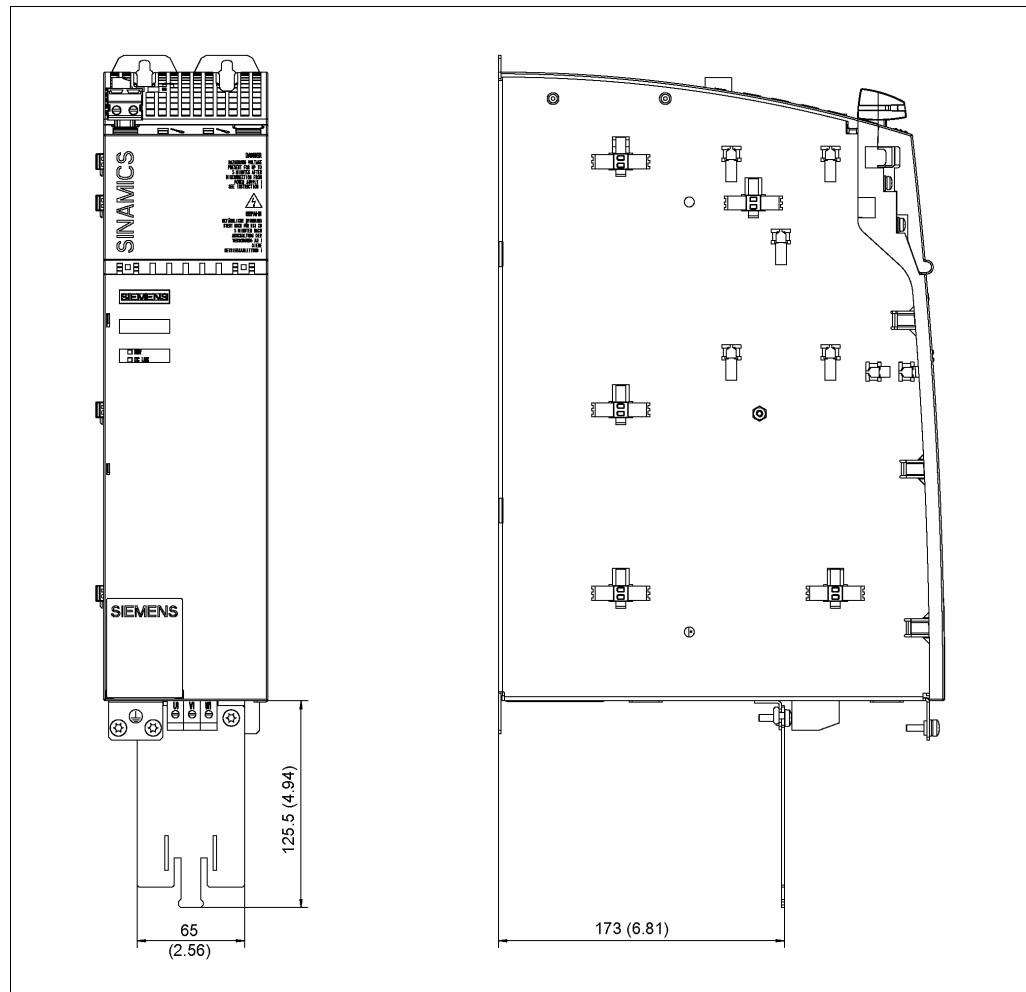
Figure 2-12   Dimension drawing of shield terminal plate on a 100 mm Line Module with internal air cooling

Note

The shield connecting plate is part of the scope of supply of a 100 mm Line Module.

Recommended shield contacts: from Weidmüller, Order No. KLBÜ CO4

Weidmüller: http://www.weidmueller.com

For Motor Modules 50 mm and 100 mm wide, the motor cable shield is connected through the motor connector housing.
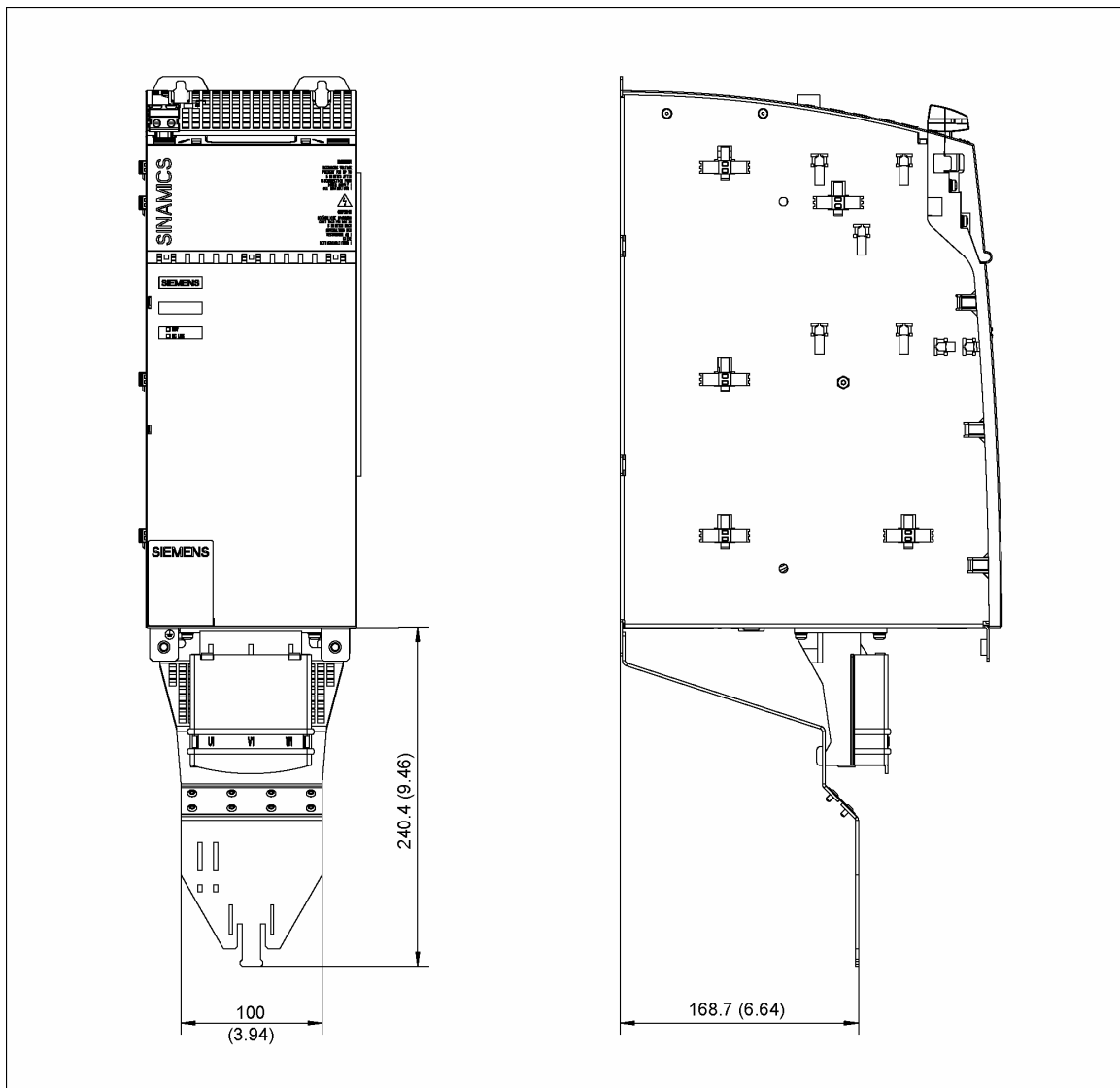
Figure 2-13   Dimension drawing of shield terminal plate on a 150 mm component (Line Module or Motor Module) with internal air cooling

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Note

A shield connecting plate can be ordered as option.

Recommended shield contacts: from Weidmüller, Order No. KLBÜ CO1 and KLBÜ CO4

Weidmüller: http://www.weidmueller.com
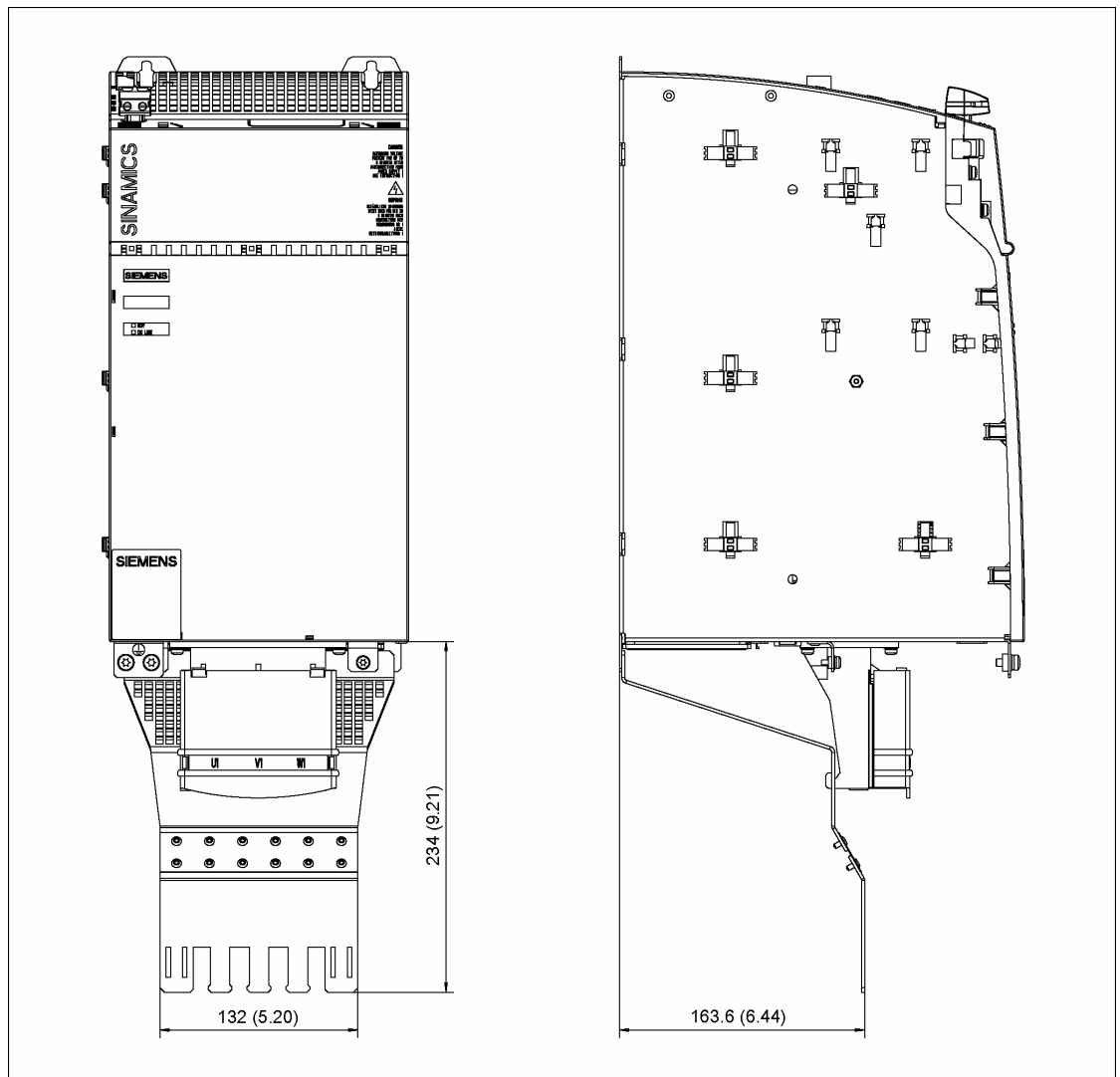
Figure 2-14   Dimension drawing of shield terminal plate on a 200 mm component (Line Module or Motor Module) with internal air cooling

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Note

The shield terminal plate can be ordered as option.

Recommended shield contacts: from Weidmüller, Order No. KLBÜ CO1

Weidmüller: http://www.weidmueller.com
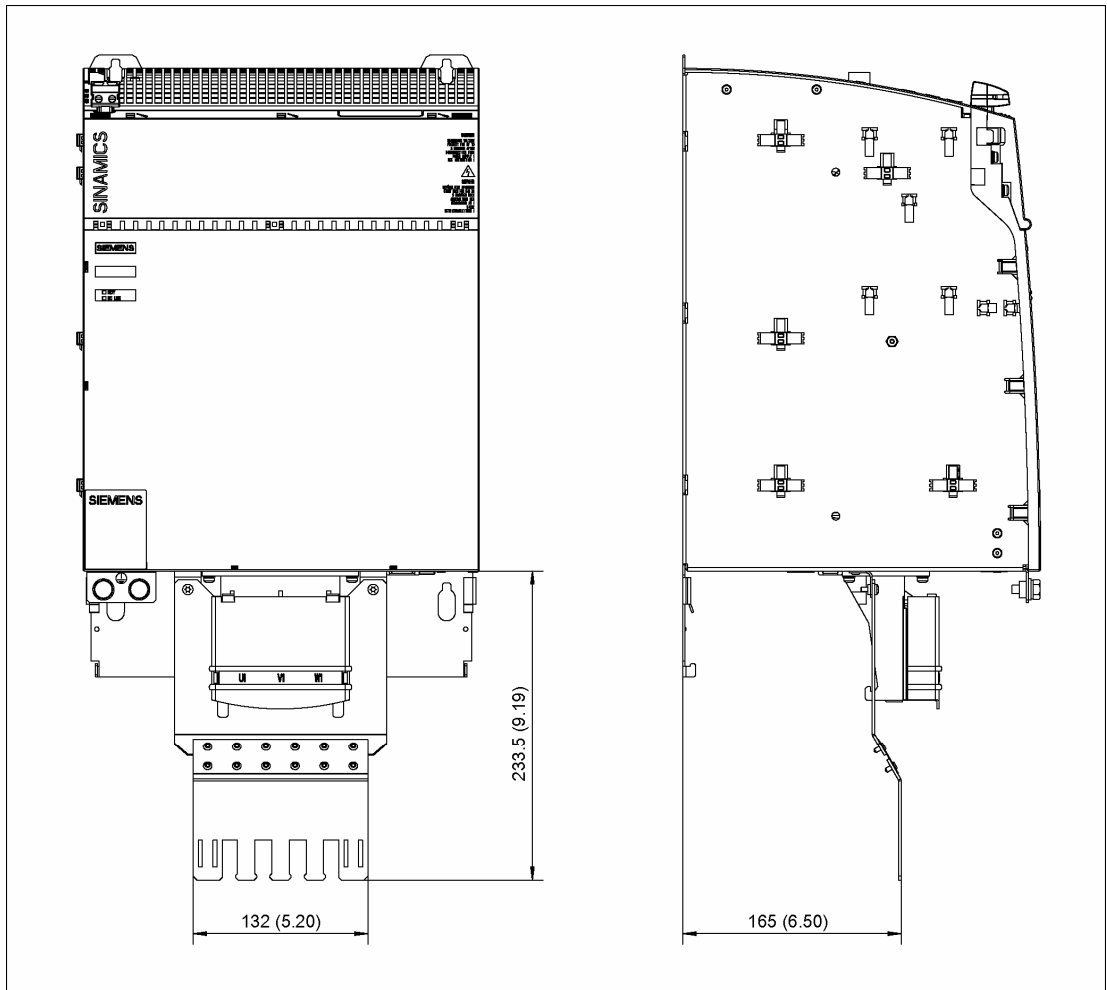
Figure 2-15   Dimension drawing of shield terminal plate on a 300 mm component (Line Module or Motor Module) with internal air cooling

Note

A shield connecting plate can be ordered as option.

Recommended shield contacts: from Weidmüller, Order No. KLBÜ CO1

Weidmüller: http://www.weidmueller.com

2.4.2 SINAMICS Components Dimension Drawings (External Air Cooling)
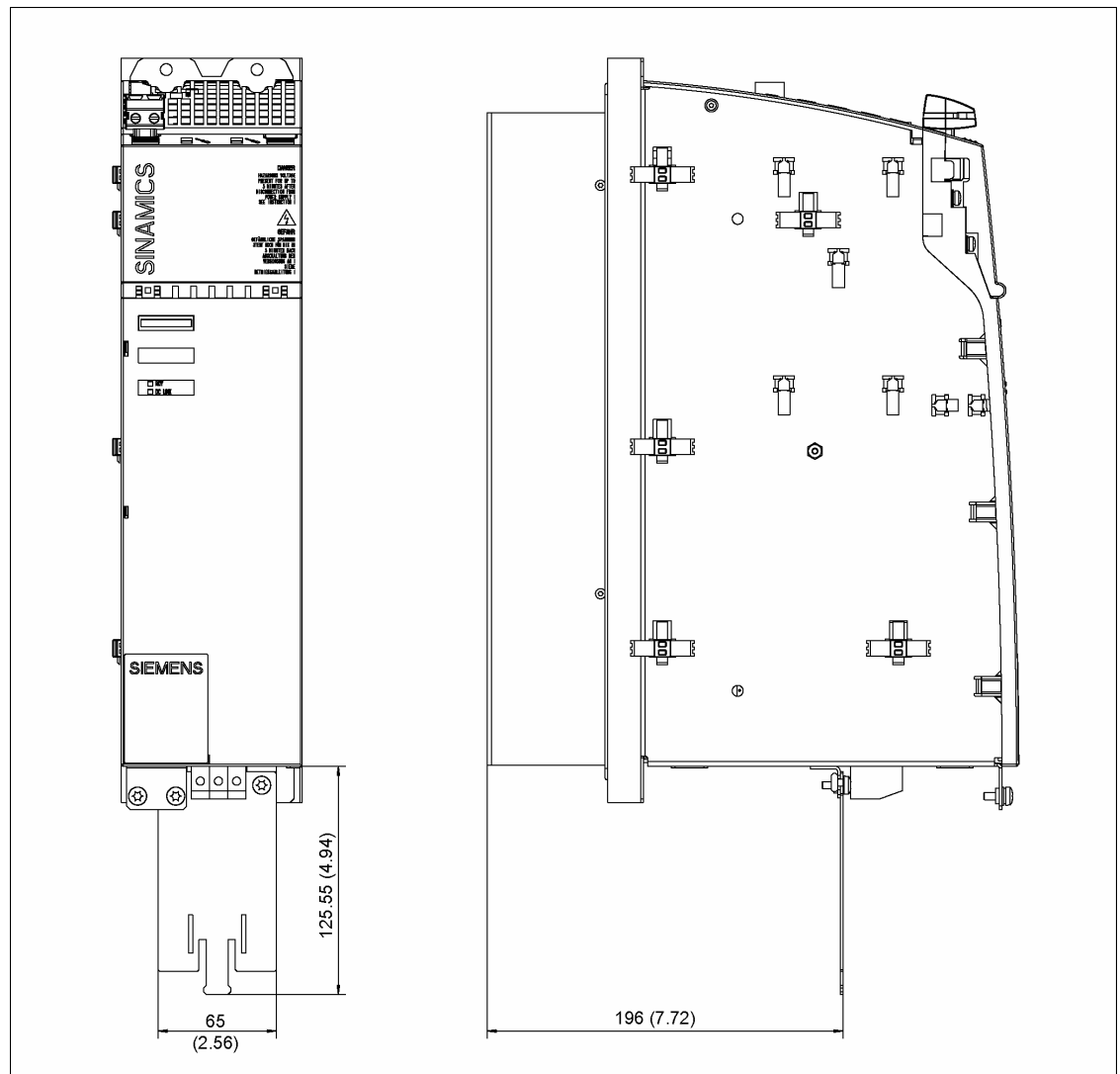
Figure 2-16   Dimension drawing of shield terminal plate on a 100 mm component (Line Module or Motor Module) with external air cooling

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Note

The shield connecting plate is part of the scope of supply of a 100 mm Line Module.

Recommended shield contacts: from Weidmüller, Order No. KLBÜ CO4

Weidmüller: http://www.weidmueller.com
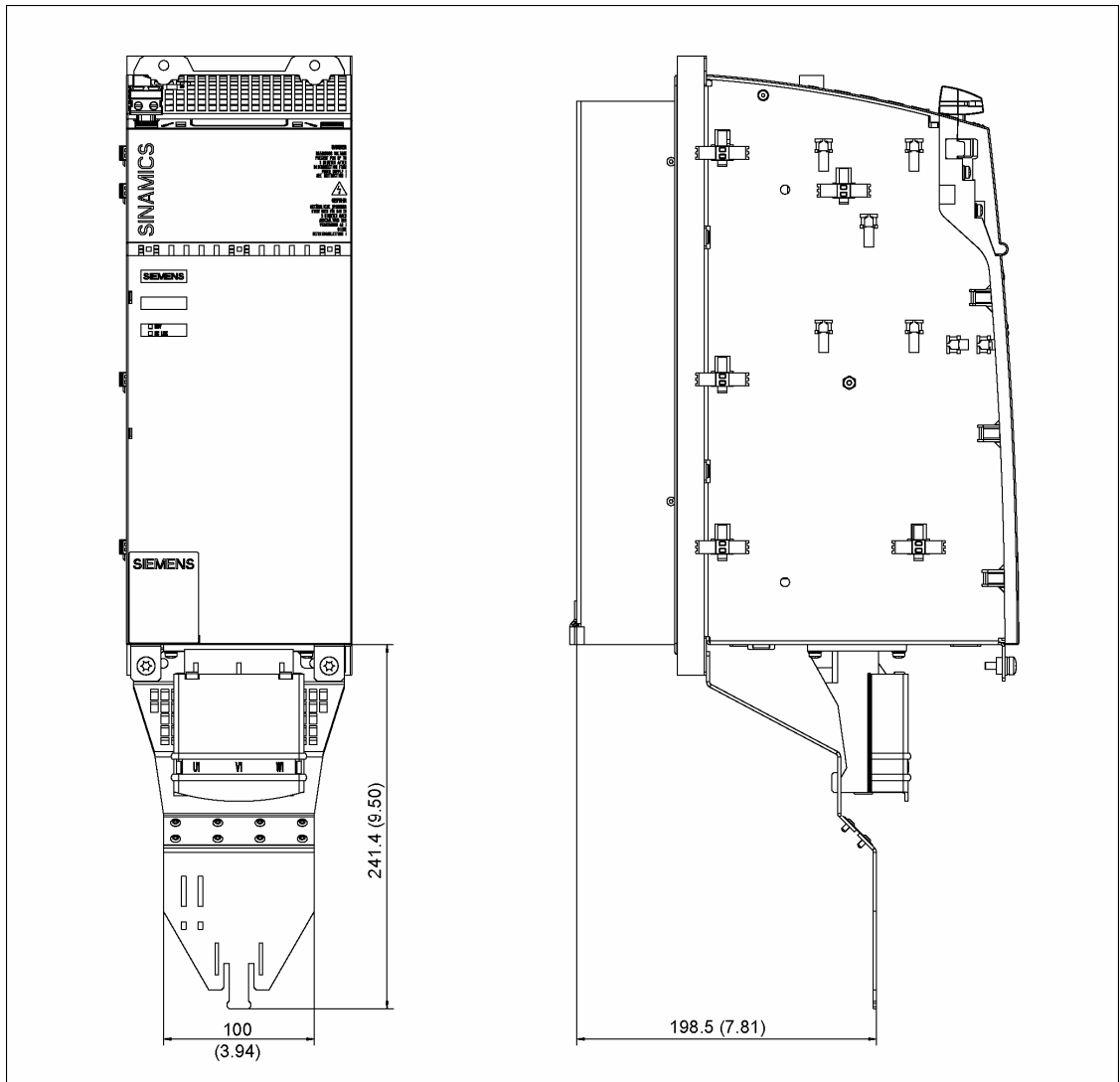
Figure 2-17   Dimension drawing of shield terminal plate on a 150 mm component (Line Module or Motor Module) with external air cooling

Note

A shield connecting plate is available as option.

Recommended shield contacts: from Weidmüller, Order No. KLBÜ CO1 and KLBÜ CO4

Weidmüller: http://www.weidmueller.com
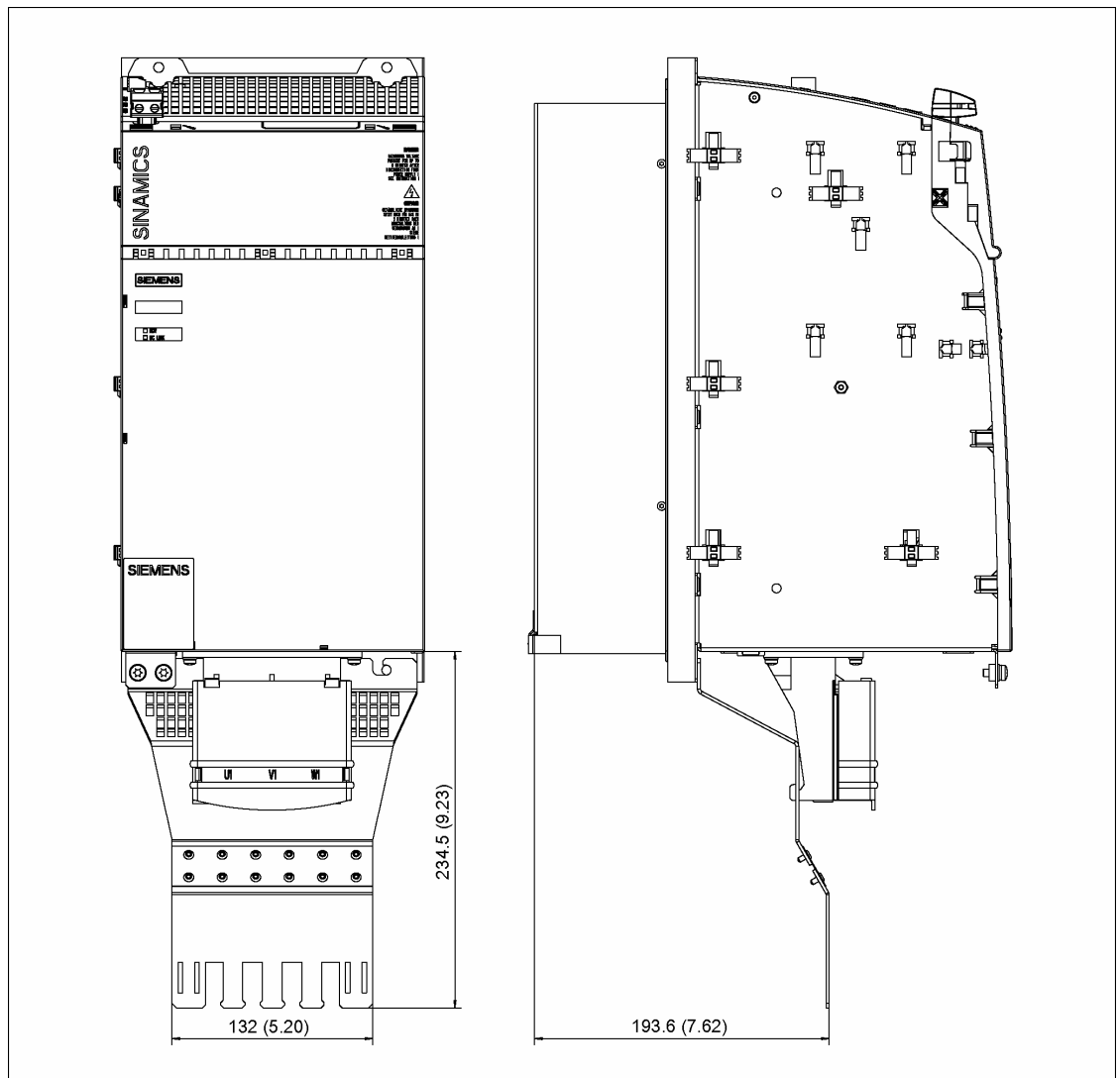
Figure 2-18   Dimension drawing of shield terminal plate on a 200 mm component (Line Module or Motor Module) with external air cooling

Note

A shield connecting plate is available as option.

Recommended shield contacts: from Weidmüller, Order No. KLBÜ CO1

Weidmüller: http://www.weidmueller.com
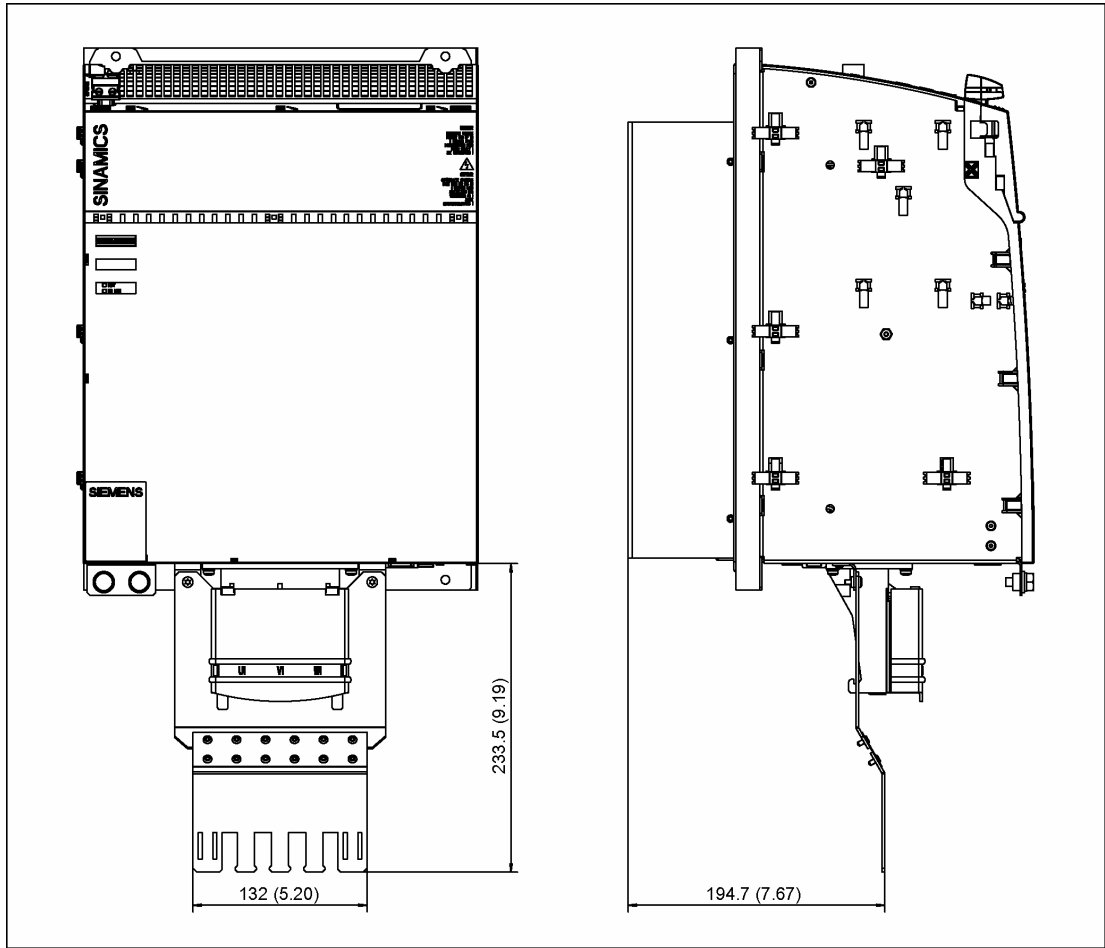
Figure 2-19   Dimension drawing of shield terminal plate on a 300 mm component (Line Module or
Motor Module) with external air cooling

Note

A shield connecting plate is available as option.

Recommended shield contacts: from Weidmüller, Order No. KLBÜ CO1

Weidmüller: http://www.weidmueller.com

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
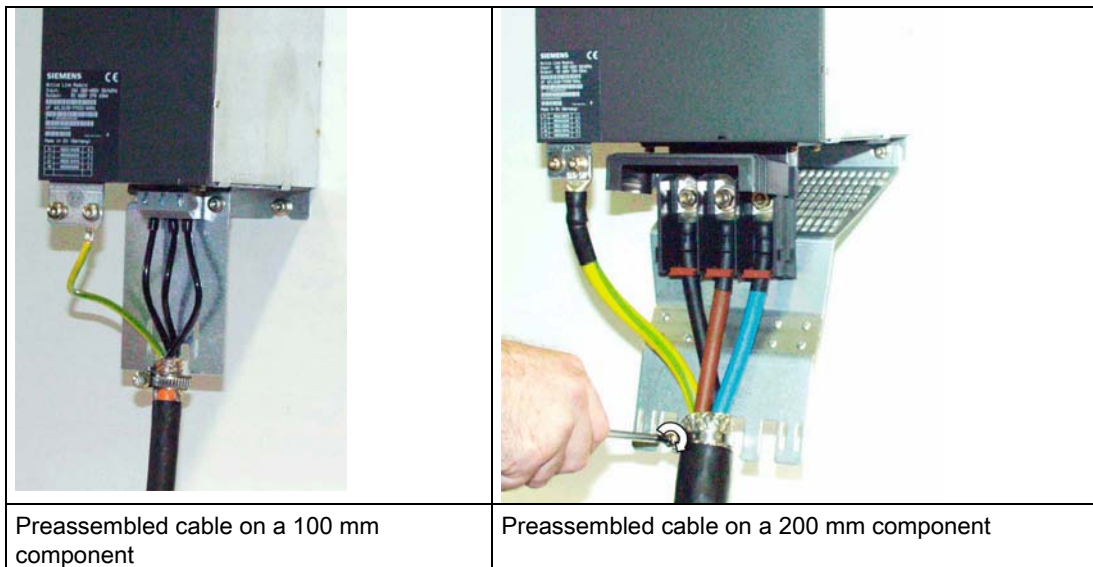
2.5 Note for the installation clearance for the connection cables

2.5.1 General

The arrangement of the components and equipment takes account of

- Space requirements
- Cable routing
- Bending radiuses of the connection cables
  MOTION-CONNECT lines, see D21.1 catalog
- Cooling
- 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
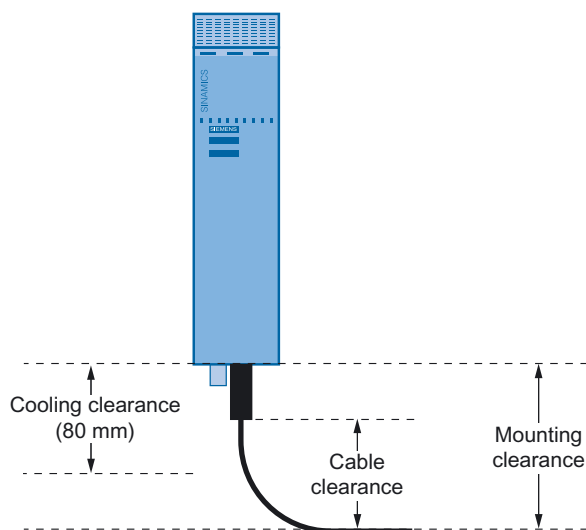
Figure 2-20   Clearance in the vicinity of the power components

2.6　Heat Dissipation of the Control Cabinet

2.6.1　Ventilation Clearances of the SINUMERIK Components

Table 2-1　Ventilation clearances above and below the components

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

2.6.2　General

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

- filtered fans
- heat exchangers or
- cooling units.

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.

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

- Ventilation clearance
- Cable routing
- Air guidance, air-conditioner

Table 2-2   Ventilation clearances above and below the components

Component	Order No.	Clearance [mm]
CU320	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 5 kW - 120 kW	6SL3000-0BExx-xAAx	100
Line reactor for Active Line Module 16 kW – 120 kW	6SN1111-0AA00-xxAx	100
Line reactor for Smart Line Module 5 kW – 36 kW	6SL3000-0CExx-0AAx	100
Active Line Module 16 kW – 55 kW 80 kW – 120 kW	6SL3130-7TExx-xAAx 6SL3130-7TExx-xAAx	80 80 (additional 50 in front of fan)
Smart Line Module 5 kW – 36 kW	6SL3130-6AExx-0AAx	80
Motor Module < 132 A	6SL312x-1TExx-xAAx	80
Motor Module 132 A and 200 A	6SL312x-1TE3x-xAAx	80 (additional 50 in front of fan)
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.
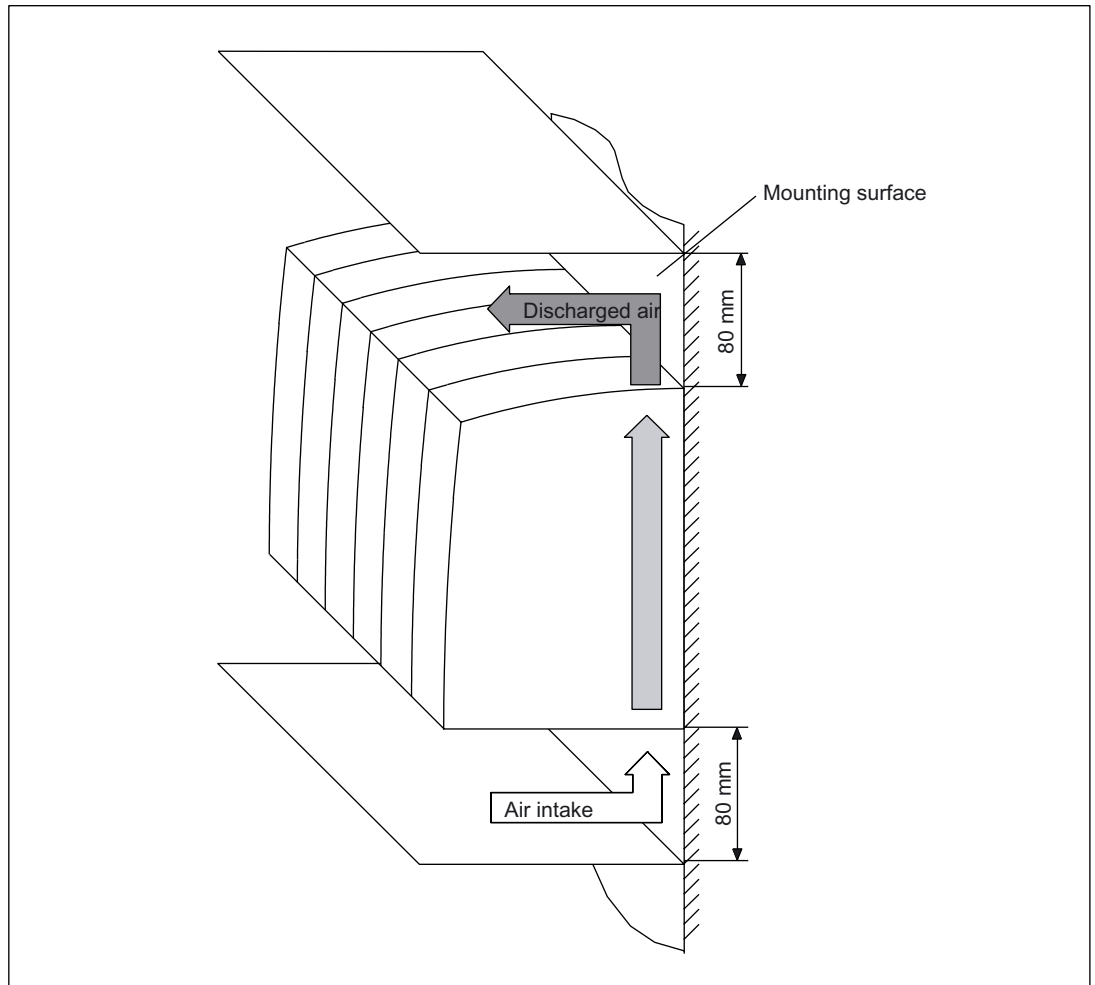
Figure 2-21   Clearances for booksize drive line-up with internal air cooling
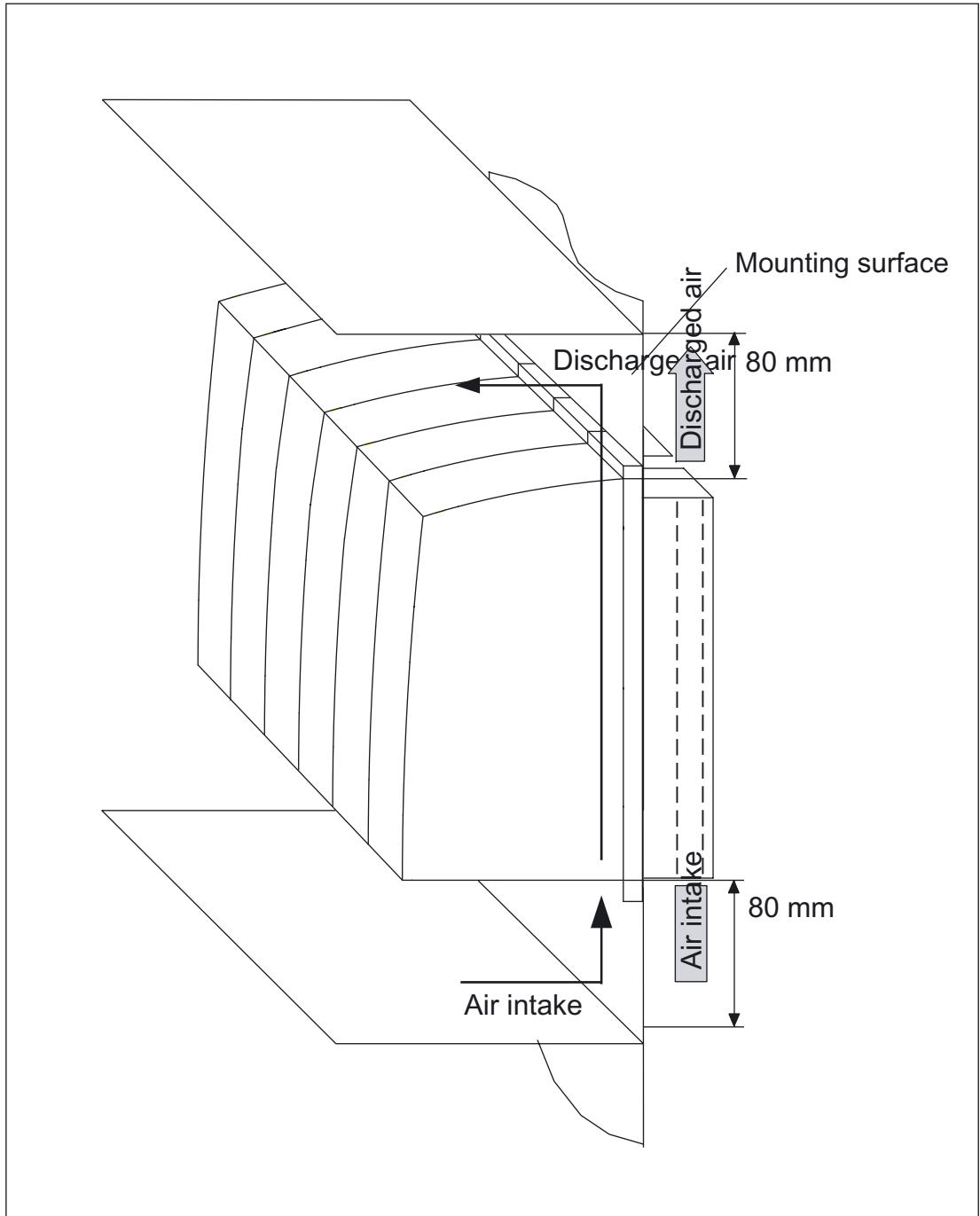
Figure 2-22   Clearances for booksize drive line-up with external air cooling
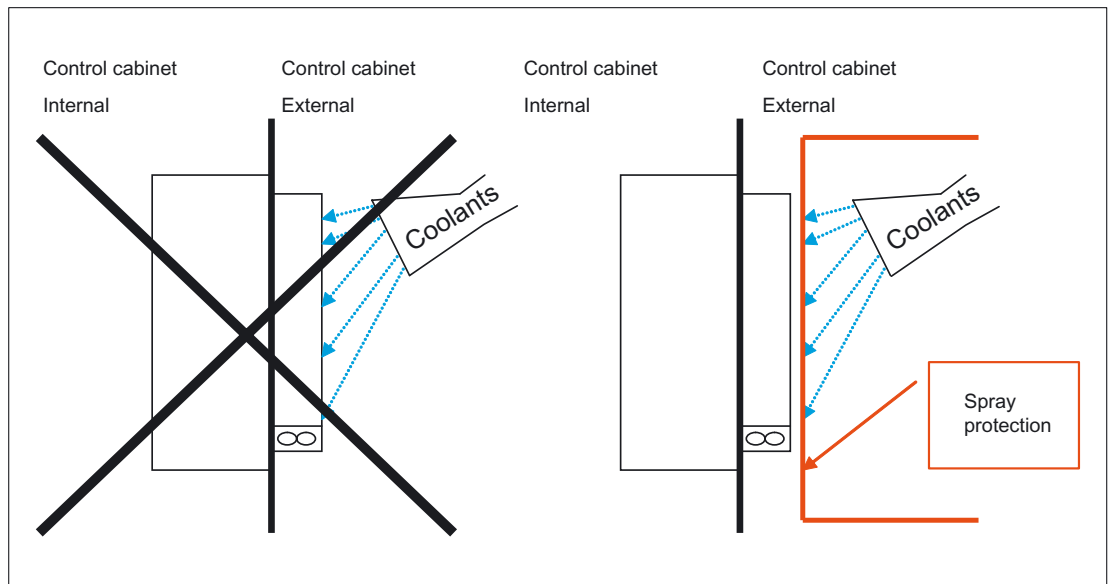
Figure 2-23   Spray protection for external cooling
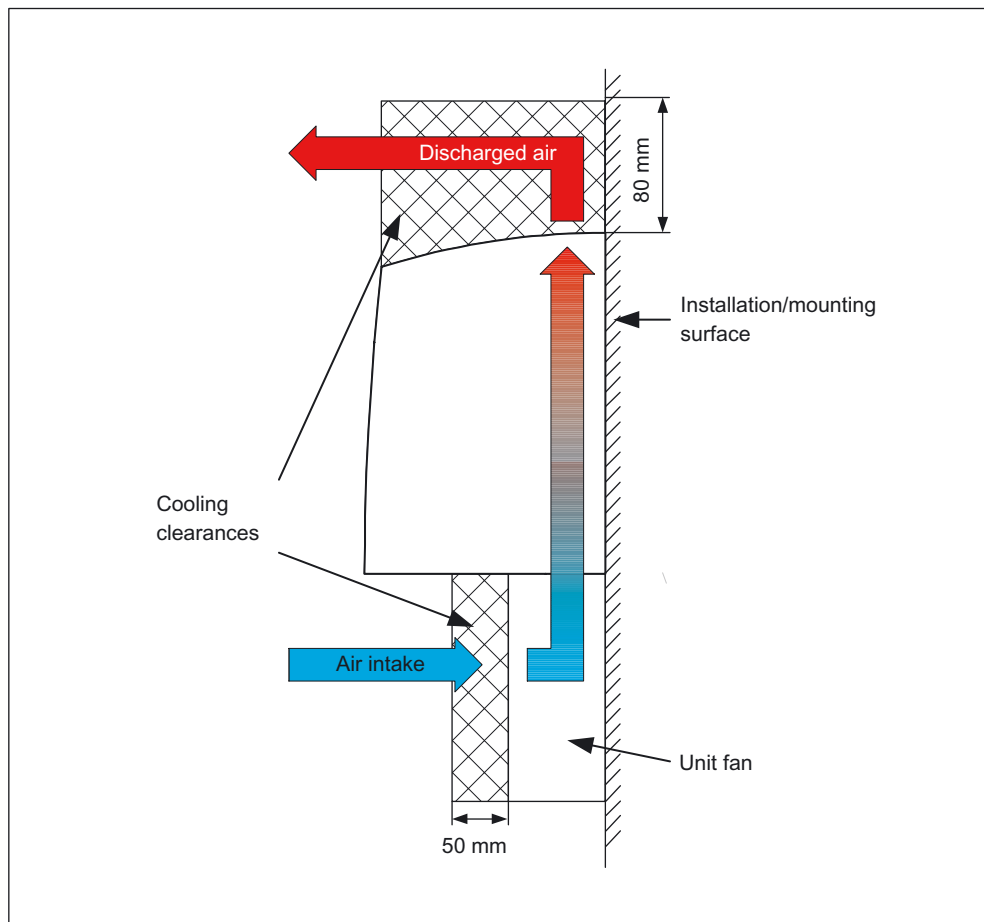
Figure 2-24   Cooling clearances for 300 mm components with mounted equipment fan
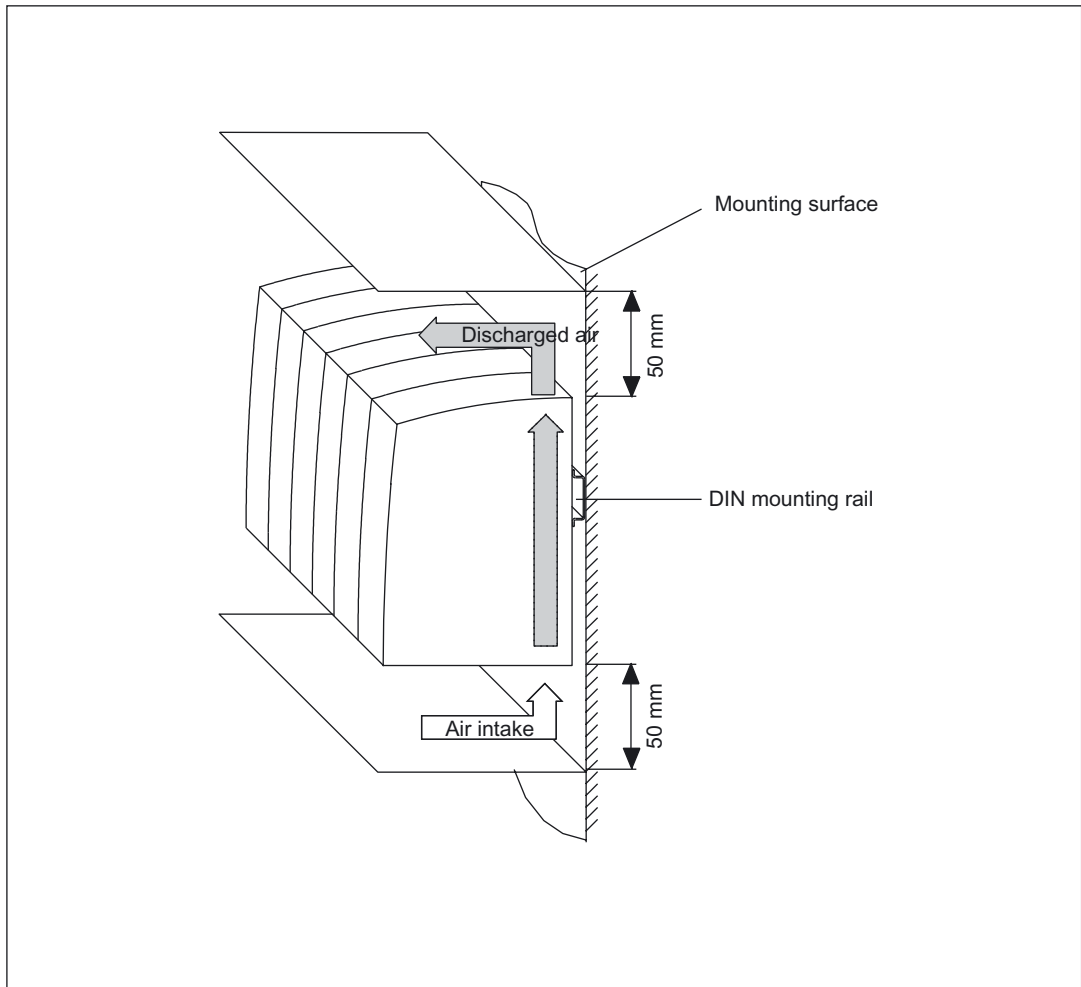
Figure 2-25   Cooling clearances, rail-mounted modules (e.g. VSM, SMC, TM, DMC)

2.6.3   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.

Note

Cables must not be routed on the components; ventilation screens must not be covered.

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).
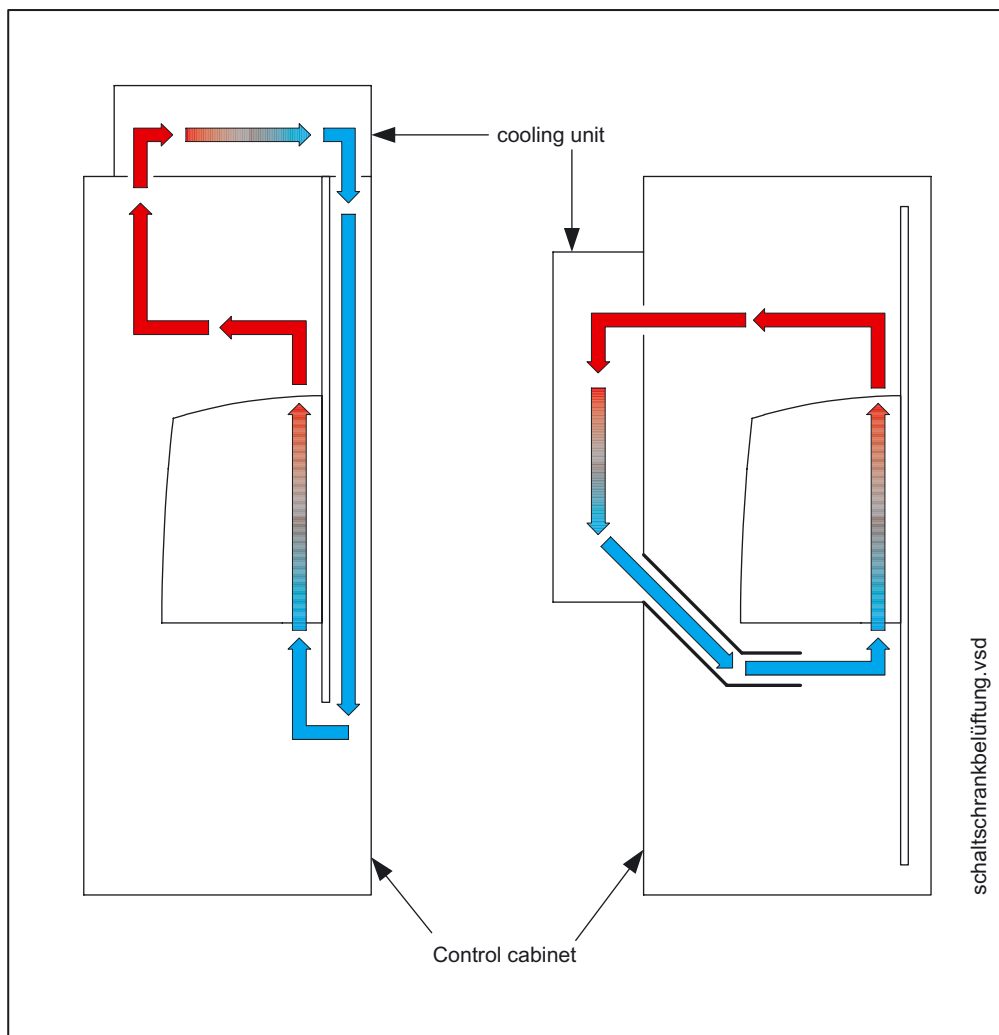
Figure 2-26   Examples of cabinet ventilation

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 (see 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 govern the operation with rated power:

Component	Power loss
NCU 7x0	55 W
NX1x	20 W

2.6.5 Power Loss of the SINAMICS Components

The following table shows the power loss for components with internal air cooling. 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

Table 2-3   Overview of power losses

	Unit	Power loss
Control Units and Option Boards		
CU320	W	20
TB30	W	< 3
CBC10	W	< 3
CBE20	W	2,8
Basic Line Filter for Active Line Modules		
16 kW	W	16
36 kW	W	28
55 kW	W	41
80 kW	W	48
120 kW	W	95
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
Wideband Line Filter for Smart Line Modules		
5 kW	W	5
10 kW	W	9
16 kW	W	16
36 kW	W	28

	Unit	Power loss
Line reactors for Active Line Modules		
16 kW	W	170
36 kW	W	250
55 kW	W	350
80 kW	W	450
120 kW	W	590
Line reactors for Smart Line Modules		
5 kW	W	62
10 kW	W	116
16 kW	W	110
36 kW	W	170
Sensor Modules		
SMC10	W	< 10
SMC20	W	< 10
SMC30	W	< 10
Additional system components		
TM15	W	< 3
TM31	W	< 10
TM41	W	10
DC link components		
Braking Module	W	20
Capacitor Module	W	25
Control Supply Module	W	< 105
Voltage Clamping Module	W	50

The sum of the losses of the various power components (Active Line Module, Smart Line Module, Motor Module) is calculated from the power losses (following table) and electronic losses (next table but one).

Overview, power loss, internal air cooling

Table 2-4   Overview of the power loss for components with internal air cooling

	Unit	Power loss
Active Line Modules		
16 kW	W	260
36 kW	W	630
55 kW	W	900
80 kW	W	1350
120 kW	W	2200
Smart Line Modules		
5 kW	W	89
10 kW	W	170
16 kW	W	165
36 kW	W	370
Single Motor Modules		
3 A	W	30
5 A	W	55
9 A	W	80
18 A	W	165
30 A	W	290
45 A	W	430
60 A	W	590
85 A	W	750
132 A	W	1250
200 A	W	2050
Double Motor Modules		
3 A	W	70
5 A	W	105
9 A	W	160
18 A	W	320

Overview, power loss, external air cooling

Table 2-5   Overview of the power loss for components with external air cooling

	Unit	Internal Power loss	External power loss	Total power loss
Active Line Modules				
16 kW	W	60	200	260
36 kW	W	135	495	630
55 kW	W	200	700	900
80 kW	W	305	1045	1350
120 kW	W	490	1710	2200
Smart Line Modules				
5 kW	W	39	50	89
10 kW	W	65	105	170
Single Motor Modules				
3 A	W	15	15	30
5 A	W	23	30	53
9 A	W	35	45	80
18 A	W	75	90	165
30 A	W	80	210	290
45 A	W	110	320	430
60 A	W	135	455	590
85 A	W	160	590	750
132 A	W	250	1000	1250
200 A	W	435	1615	2050
Double Motor Modules				
3 A	W	35	35	70
5 A	W	45	60	105
9 A	W	65	95	160
18 A	W	80	240	320

Electronic losses of Motor Modules/Line Modules

Table 2-6   Electronic losses of Motor Modules/Line Modules

Component		Internal/external air cooling
		Power loss [W]
Single Motor Modules	3A	20,4
	5A	20,4
	9A	20,4
	18A	20,4
	30A	21,6
	45A	28,8
	60A	28,8
	85A	36,0
	132A	36,0
	200 A	36,0
Double Motor Modules	3 A	24,0
	5 A	24,0
	9 A	24,0
	18 A	24,0
Active Line Modules	16 kW	26,4
	36 kW	36,0
	55kW	45,6
	80kW	36,0
	120kW	60,0
Smart Line Module	5kW	24,0
	10kW	31,2
	16 kW	26,4
	36 kW	36,0

2.6.6 Dimensioning Climate Control Equipment

Cabinet manufacturers provide calculation programs for selecting climate control equipment. It is always necessary to know the power loss of the components and equipment installed in the cabinet.

The physical relationship is shown in the following example.

$$q = \frac{Q}{\Delta T} - k * A$$

Figure 2-27   Formula to calculate the power loss

q = thermal power that has to be dissipated through a cooling unit [W / K]

Q = power loss [W]

ΔT = temperature difference between the room and cabinet interior [K]

k = thermal resistance value, e.g. sheet-steel, painted 5.5 [W / (m² * K)]

A = free-standing cabinet surface area [m²]

Table 2-7   Example, calculating the power loss of a drive configuration

Component	Number	Total power loss [W] (including electronic losses)	Total power loss [W]
CU320	1	20	20
Line filters	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:			2446,6

Assumption:

Free-standing cabinet surface area A = 5 m²

Temperature difference between the room and cabinet interior ΔT = 10 K

q = (2415 [W] / 10 [K]) - 5.5 [W / (m² * K)] * 5 [m²] = 214 [W/K]

NCU/NX Terminal Assignment

3

3.1 Commissioning Macros Overview

Introduction

For the sake of simplifying the drive commissioning, macros are included in the SW. The starting and processing of these ACX macros in the commissioning phase allows the drive group attached to the NCU to be largely preconfigured.

Advantage

Advantage of using macros:

- Default terminal assignment on the NCU
- The DOs of all drive objects are connected (topology)
- Automatic commissioning of motors with DRIVE-CLiQ interfaces

3.2 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.

3.3 Macros for commissioning

Introduction

To commission the drives, the following macro types are available:

- Update macro 150399

  This macro executes an update of all drive components.

- 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

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 3-1   Macros for commissioning

Number	File name	Description
1	pm000001.acx	Line Module **with** DRIVE-CLiQ : • Interconnection p0840 (infeed) • Interconnection 2. OFF 3 (rapid stop) • Reserving input and output terminals for two SH/SBC groups • Bero 1 – zero mark substitute • 1. Probe • 4 x Digital NC – Input ($A_IN[1] …[4]) • Feedback Line Module • 2 x digital NC – output ($A_OUT[1] …[2]) ALM: • Shutdown of network identification (p3410=0) SLM with DRIVE-CLiQ: • Network identification of the SLM is performed automatically on the next pulse enable (p3410=5).
5	pm000005.acx	Line Module **without** DRIVE-CLiQ : • Interconnection p0864 to all drives • Interconnection 2. OFF 3 (rapid stop) • Reserving input and output terminals for two SH/SBC groups • Bero 1 – zero mark substitute • 1. Probe • 4 x Digital NCK – Input ($A_IN[1] …[4]) • 4 x digital NCK – output ($A_OUT[1] …[4])
100116	pm100116.acx	The following parameters are set on all 6 drives: • Set up two encoder data sets p140=2 • Eight drive data sets p180=8 • Profibus protocol p922 = 116
150399	pm150399.acx	Update of all drive components

3.4 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 configuration macro call (on the right in the picture)

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.
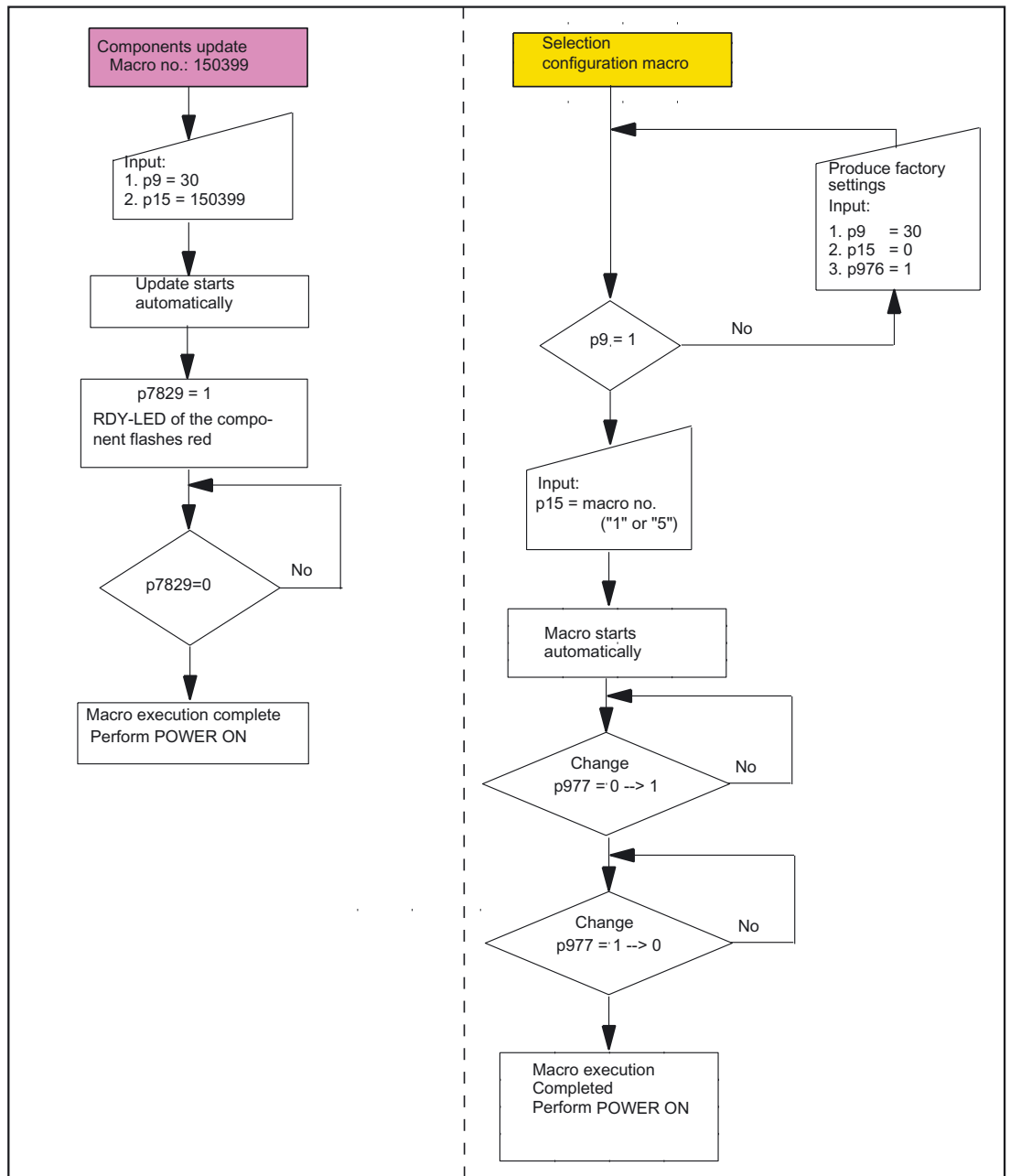
Figure 3-1   Process macro call for update (left) and for configuration (right)

Occurring operator errors

Operator errors that frequently occur when starting macros include:

- incorrect status of p9
- active release to the modules

Note

If you have doubts, load the factory settings prior to executing a macro.

3.5 X122 and X132 Interface Overview

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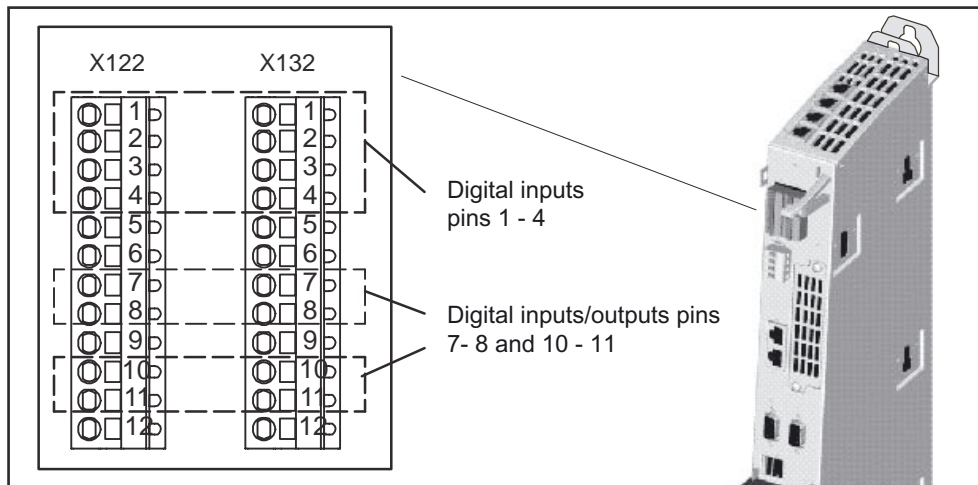
Figure 3-2   X122 and X132 interfaces for NCU 7x0

Note

The NX1x component has only the X122 interface.

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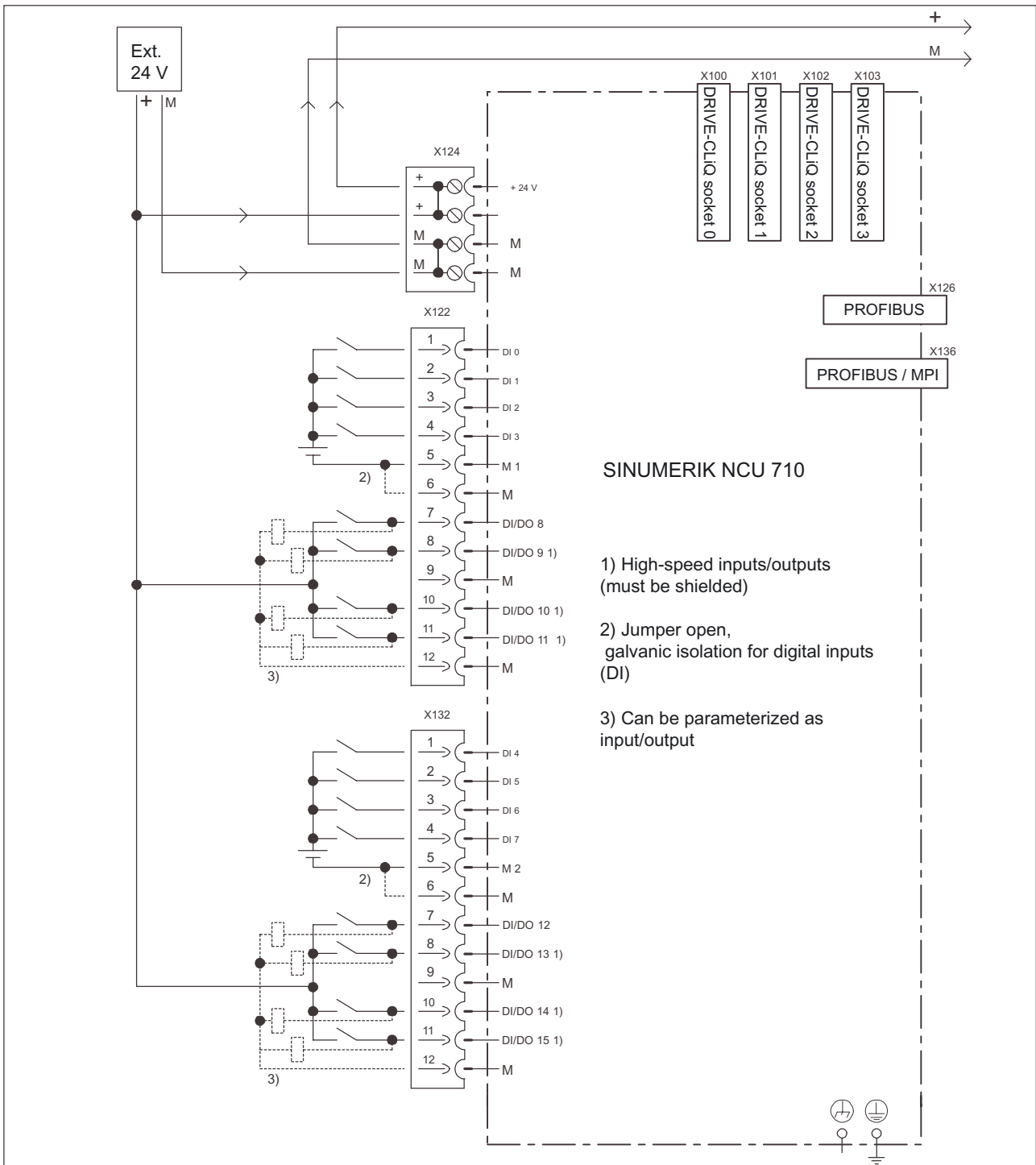
Figure 3-3   X122 and X132 block diagram for NCU 7x0

X122 block diagram for NX1x
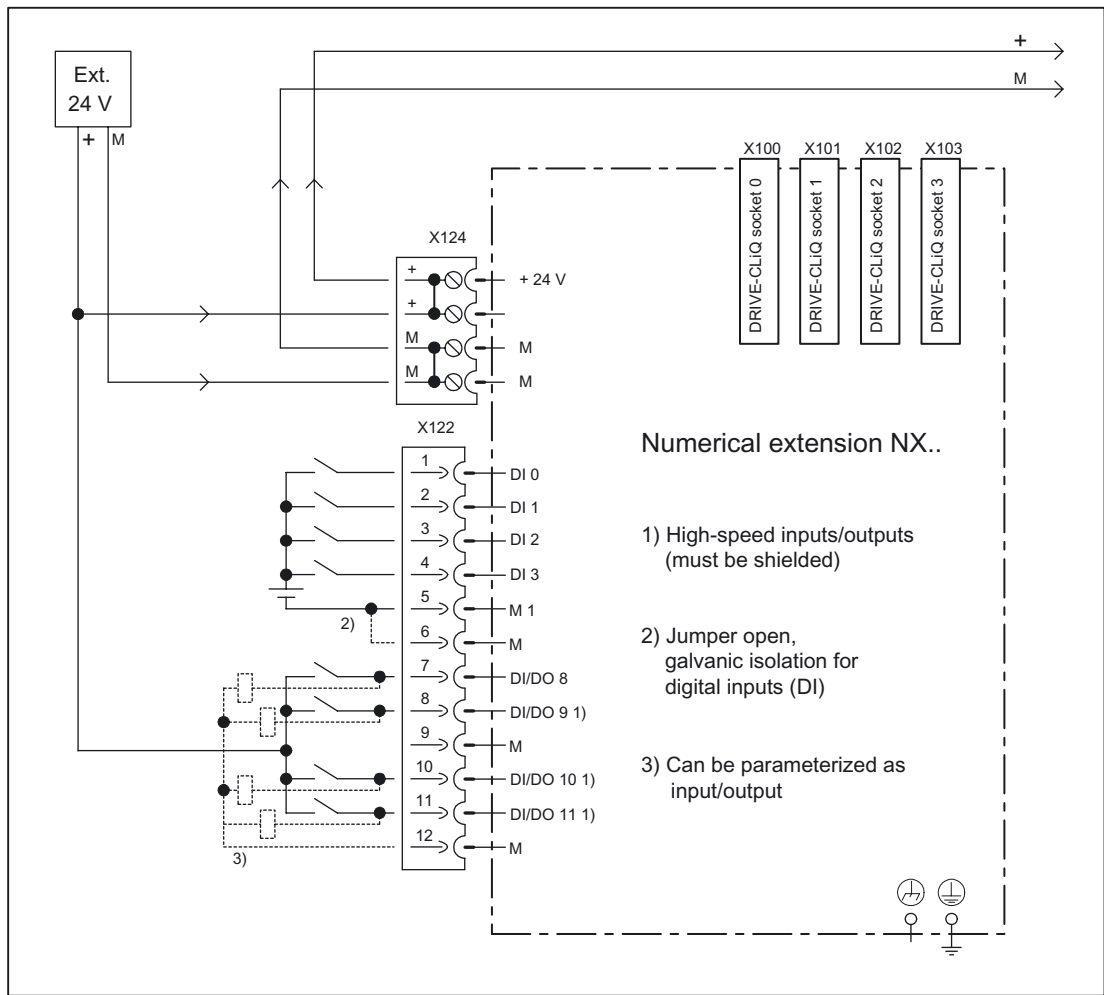
Figure 3-4   NX1x block diagram

3.6   NCU 7x0 and NX1x Terminal Assignment

Introduction

The following terminals are preassigned with the configuration macros for the commissioning:

- NCU 7x0
  - X122
  - X132
- NX1x
  - X122

Terminal assignment X122 (NCU 7x0)

Pin no.	Function	Assignment recommendation	BICO source/sink		Macro number
1	Input[1]	ON / OFF 1 Line Module infeed with DRIVE-CLiQ connection	CU: r0722.0	Infeed p840	1
		"Infeed ready signal" from Line Module without DRIVE-CLiQ connection	SLM X21.1	Drive p864	5
2	Input	"OFF3 – rapid stop" Function: Braking with a configurable OFF3 ramp (p1135,1136,1137); thereafter, pulse suppression and starting lockout. The drive stops controlled. The braking response can be set separately for each servo.	CU: r0722.1	Each drive 2. OFF3, p849	1 5
3	Input	SH/SBC - group 1 SINAMICS Safety Integrated (SH = p9601 release)	CU: r0722.2	p9620 (all drives in the group)	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
4	Input	SH/SBC - group 2 SINAMICS Safety Integrated (SH = p9601 release)	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 - Group 1 SINAMICS Safety Integrated	CU: p0738	r9774 bit 1 BICO from CU after the first drive in the group	The macro does not perform any BICO interconnection; the use of the

Pin no.	Function	Assignment recommendation	BICO source/sink		Macro number
8	Output	SH/SBC - Group 2 SINAMICS Safety Integrated	CU: p0739	p9774 bit 1 BICO from CU after the first drive in the group	function requires parameterization by the user. The pin will be parameterized as output by the macro 1/5.
9		Ground for pins 7, 8, 10, 11			
10	Input	Bero 1 – zero mark substitute"	CU: r 0722.10	p495 = 2	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
11	Input	Probe 1 Central Measuring (check that MD13210 = 0!)	CU: p0680[0] = 3	Each drive p488 [1,2,3]=0	1/5
		Probe 1 - distributed measurement (control MD13210 = 1)	CU: p0680[0] = 0	Each drive p488 [1,2,3]=3	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
12		Ground for pins 7, 8, 10, 11			

[1] Low – high edge required!

Terminal assigment X132 (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
2	Input	Digital input $A_IN[2]	CU: r0722.5	CU: p2082[1]	5
3	Input	Digital input $A_IN[3]	CU: r0722.6	CU: p2082[2]	

Pin no.	Function	Assignment recommendation	BICO source/sink		Macro number
4	Input	Digital input $A_IN[4]	CU: r0722.7	CU: p2082[3]	
		Line contactor, feedback signal		LM : p0860	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
5	Ground for pins 1 ... 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
		Digital output $A_OUT[4]	CU: p2091.3		5
8	Output	Infeed ready to start (Line Module with DRIVE-CLiQ connection)	LM : r0899.0	CU: p0743	1
		Digital output $A_OUT[3]	CU: p2091.2		5
9	Ground for pins 7, 8, 10, 11				
10	Output	Digital output $A_OUT[2]	CU: p2091.1	CU: p0744	1/5
		Line contactor control	LM : r0863.1		The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
	Input	Bero 2 – zero mark substitute	CU: r 0722.14	Drive: p0495 = 5	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
		2. OFF 2		Drive: p0845	
11	Output	Digital output $A_OUT[4]	CU: p2091.0	CU: p0745	1/5
	Input	Probe 2 Central Measuring (check that MD13210 = 0!)	CU: p0680[1] = 6	Each drive p489 [1,2,3]=0	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
		Probe 2 - distributed measurement (control MD13210 = 1)	CU: p0680[1] = 0	Each drive p489 [1,2,3]=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]	ON / OFF 1 Line Module infeed with DRIVE-CLiQ connection	NX: r0722.0	Infeed p840	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
		"Infeed ready signal" from Line Module without DRIVE-CLiQ connection	SLM X21.1	Drive p864	
2	Input	"OFF3 – rapid stop" Function: Braking with a configurable OFF3 ramp (p1135,1136,1137); thereafter, pulse suppression and starting lockout. The drive stops controlled. The braking response can be set separately for each servo.	NX: r0722.1	Each drive 2. OFF3, p849	
3	Input	SH/SBC 1 - Group 2 SINAMICS Safety Integrated (SH enable = p9601)	NX: r0722.2	p9620 (all drives in the group)	
4	Input	SH/SBC 1 - Group 1 SINAMICS Safety Integrated (SH enable = p9601)	NX: 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 - Group 1 SINAMICS Safety Integrated	NX: p0738	r9774 bit 1 BICO from CU after the first drive in the group	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
8	Output	SH/SBC - Group 2 SINAMICS Safety Integrated	NX: p0739	p9774 bit 1 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: p495 = 2	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
11	Input	Bero 2 – zero mark substitute	NX: r0722.11	Drive: p495 = 3	
		2. OFF 2	NX: r0722.11	Drive: p0845	
12	Ground for pins 7, 8, 10, 11				

[1] Low – high edge required!

Safety Integrated

4

⚠️ **Warning**

The following chapter describes the uses of the "Safety Integrated" functionality. The detailed knowledge of the "Safety Integrated sl Function Module" (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.
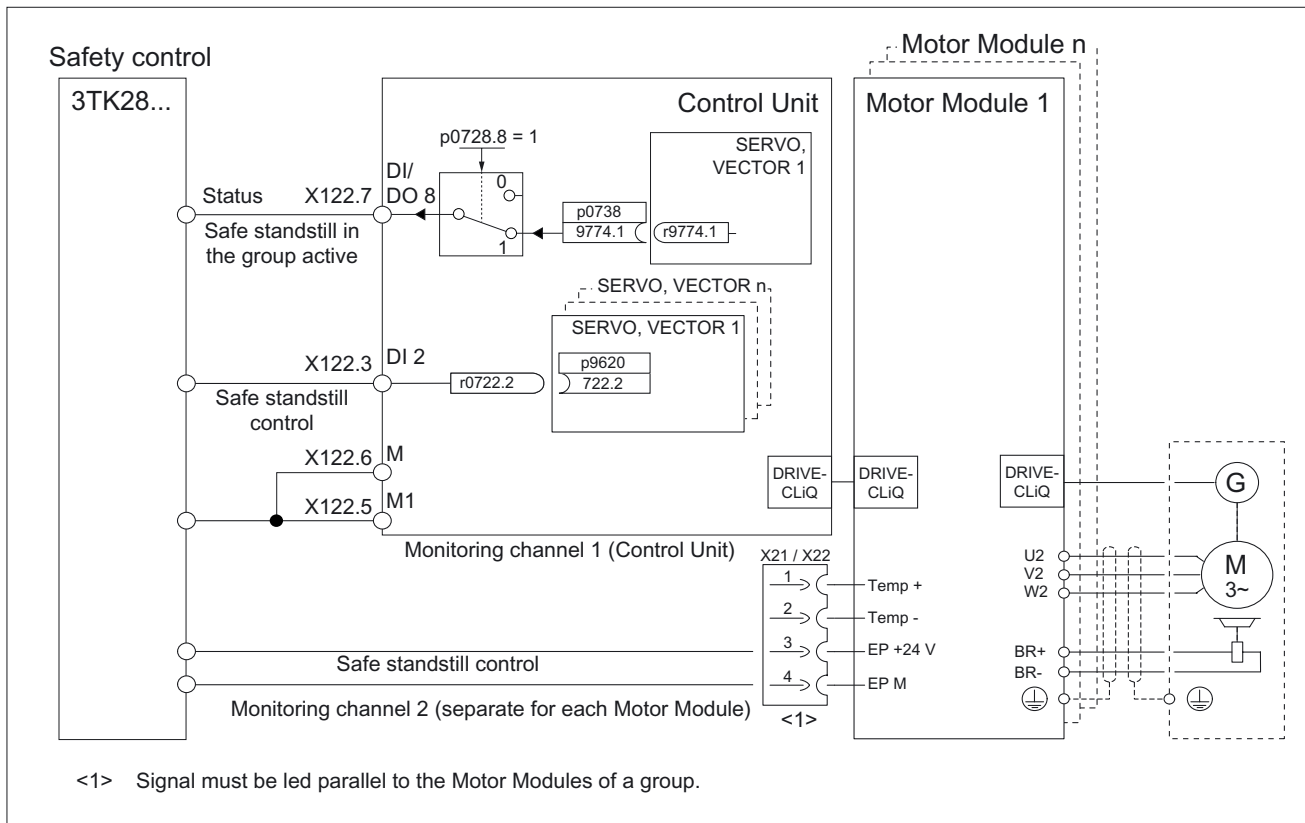
Figure 4-1   Terminals for "safe standstill"
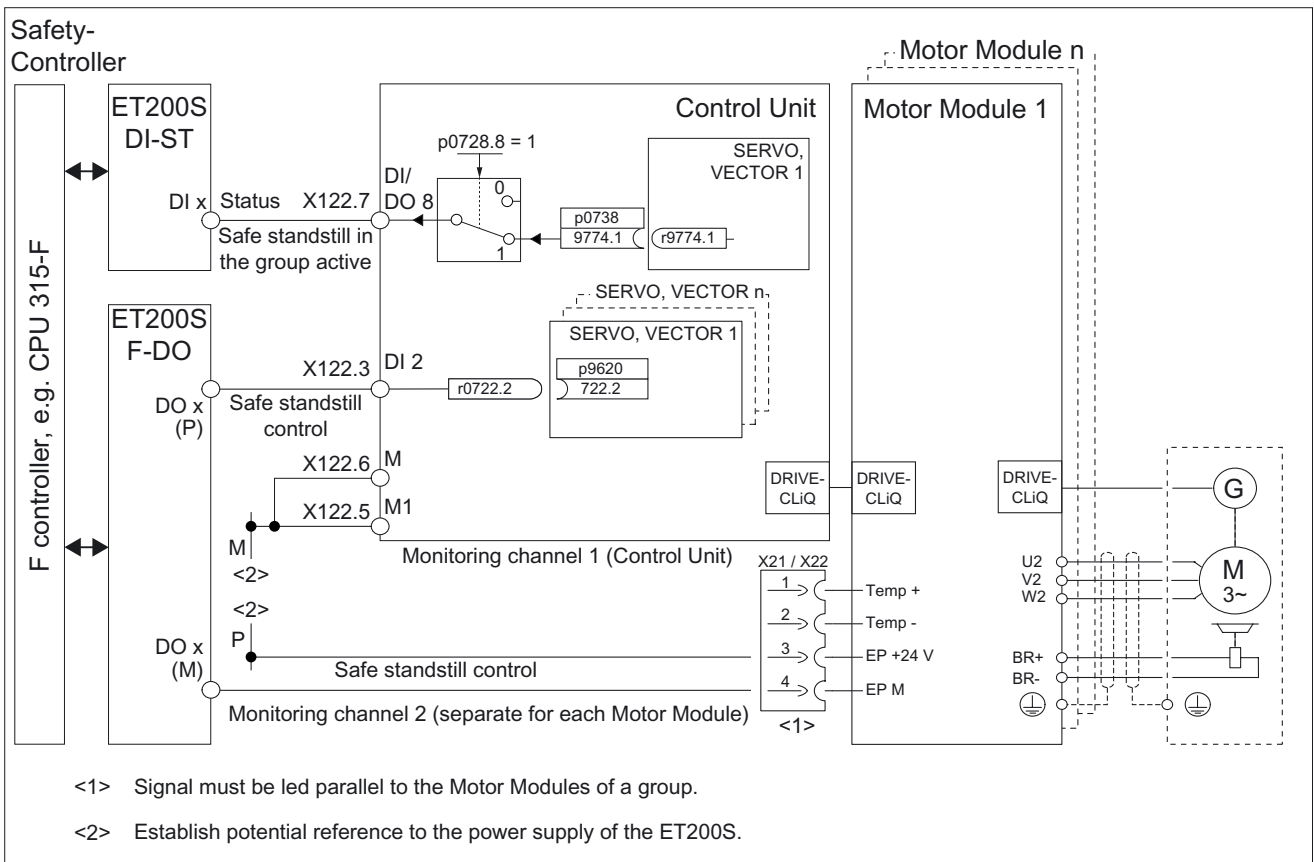
Figure 4-2   Safe standstill terminals; control, e.g. with the fail safe output of the ET200S

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.
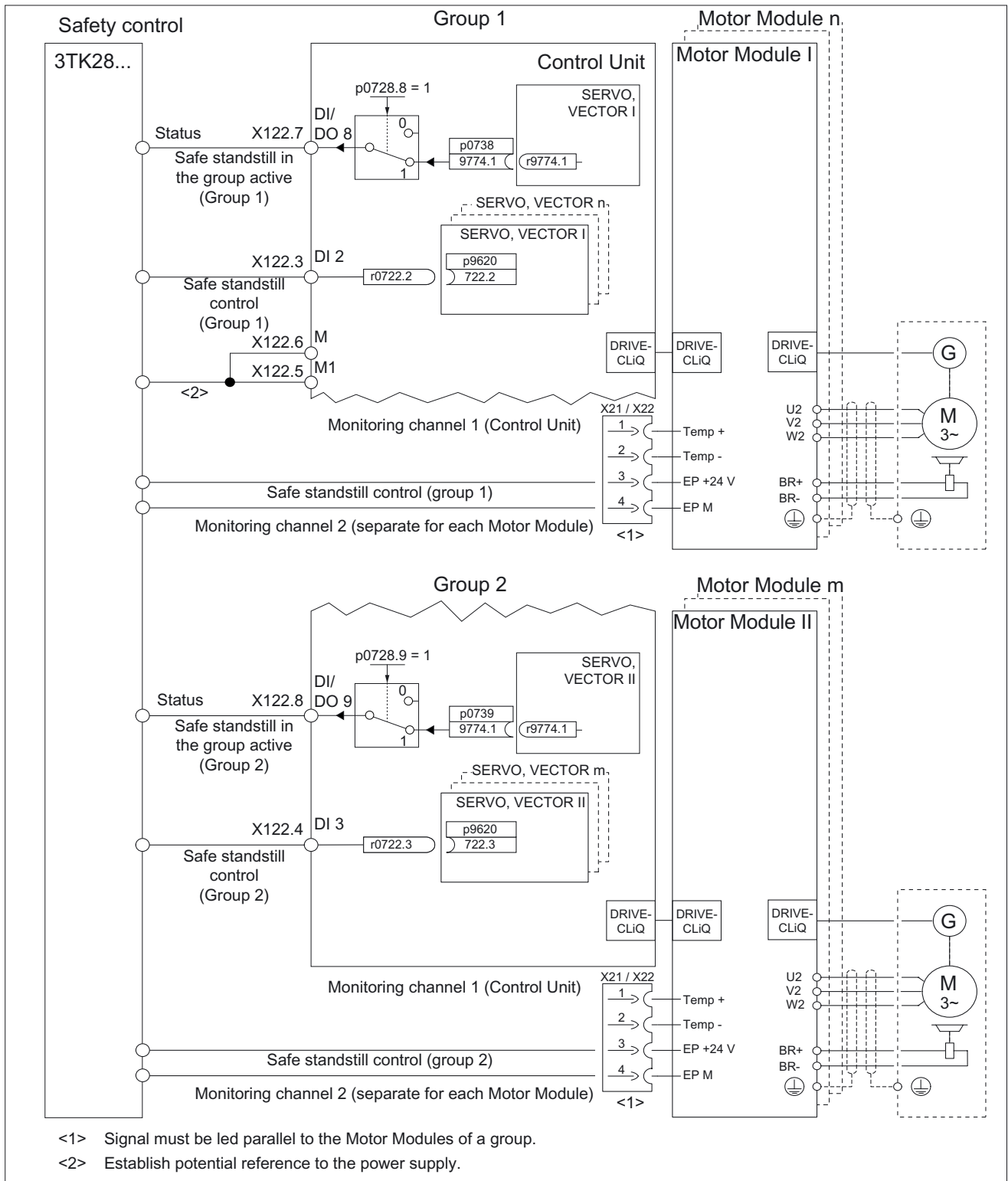
Figure 4-3   Terminal grouping for "safe standstill"
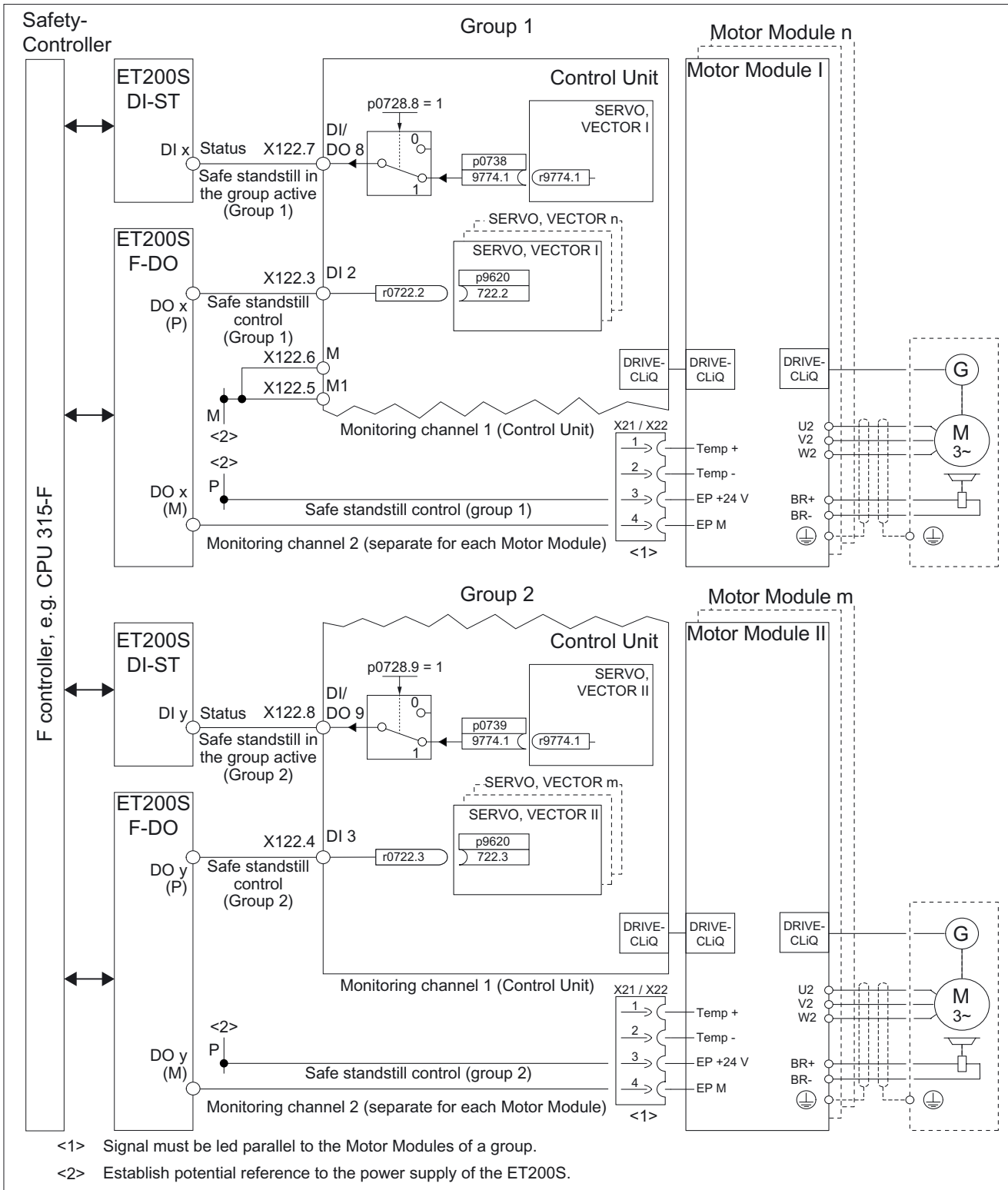
Figure 4-4   Safe standstill terminals grouping; control, e.g. with the fail safe output of the ET200S

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

<2>   Establish potential reference to the power supply 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
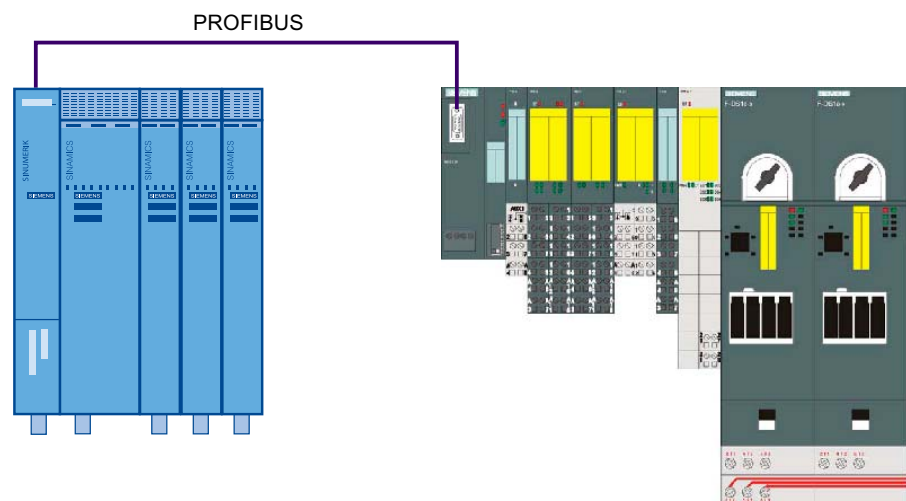
Figure 4-5   Overview of the ET200S peripheral connection to the NCU

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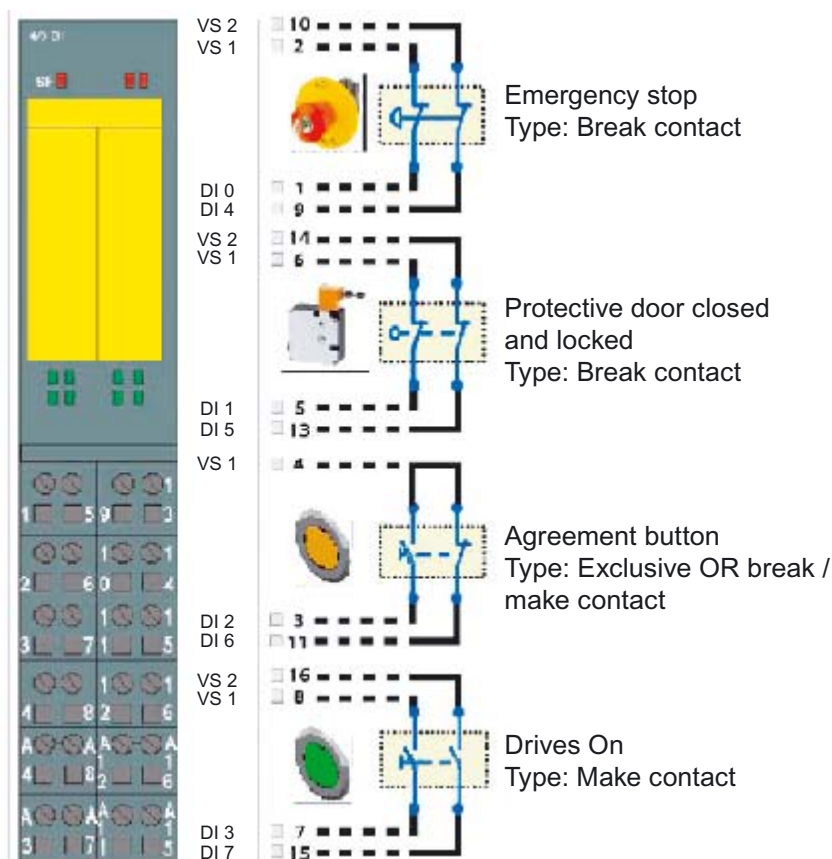
Figure 4-6   Signal assignment, electronics module, 4/8F-DI, 24 VDC, PROFIsafe

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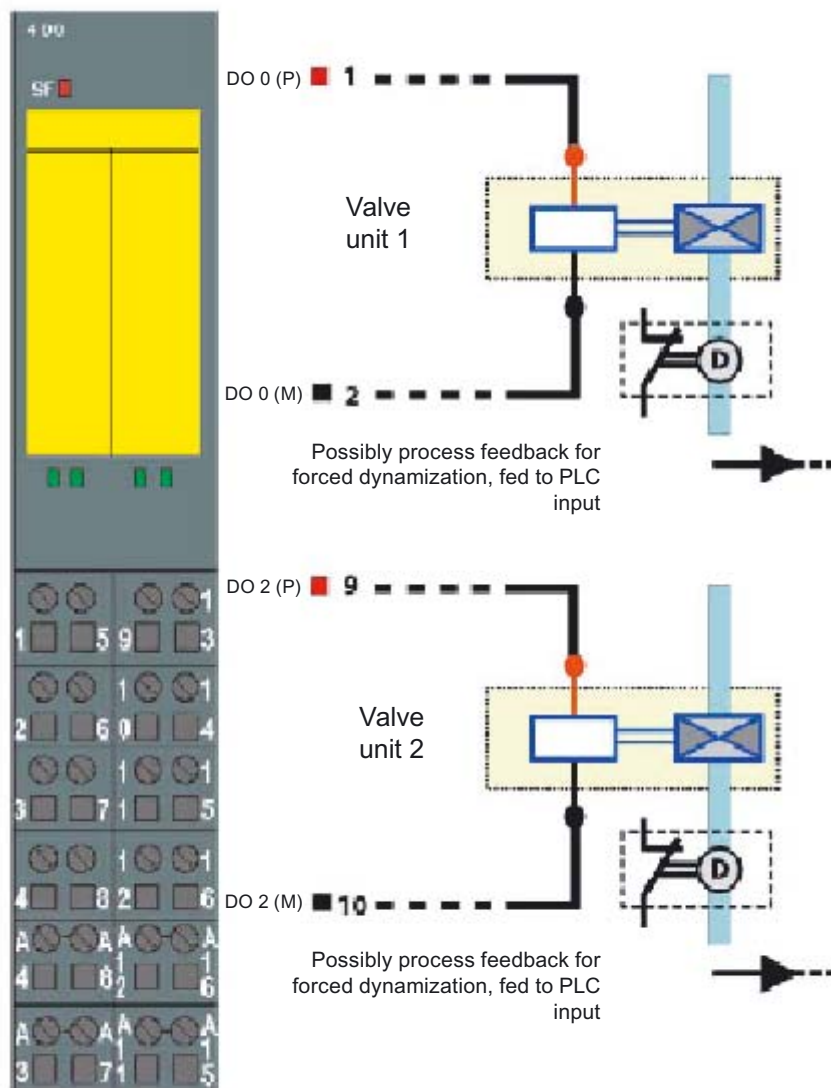
Figure 4-7   Signal assignment electronics module, 4F-DO, 24 VDC_2 A, PROFIsafe

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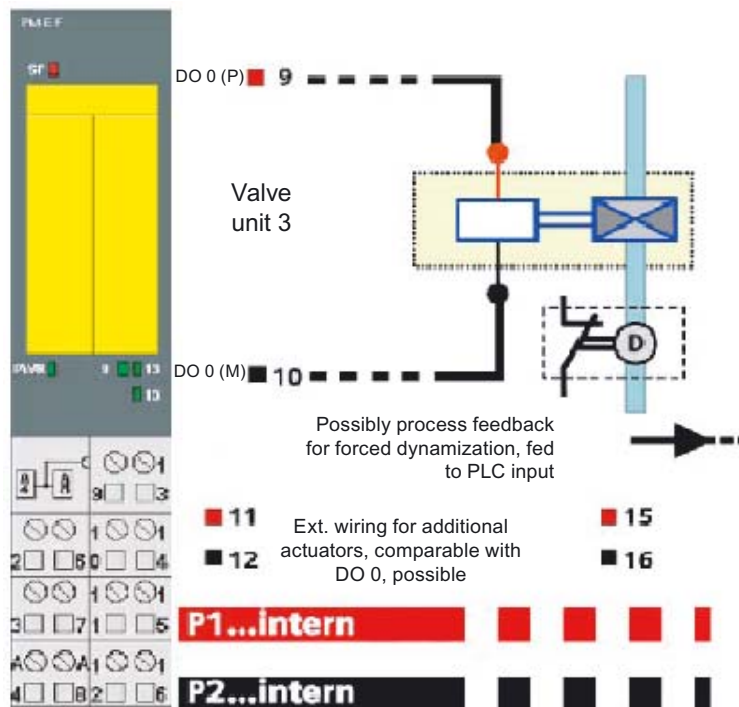
Figure 4-8   Signal assignment, power module PM-E F PROFIsafe 24 V DC

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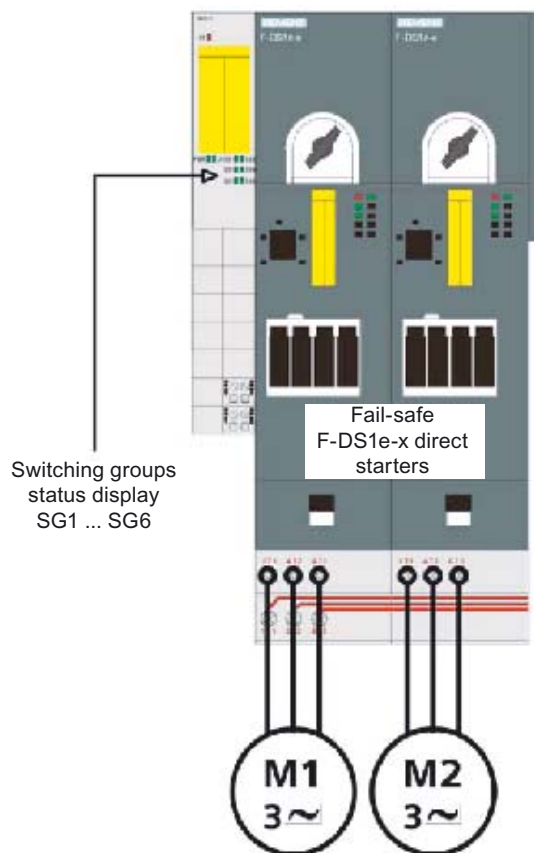
Figure 4-9   Signal assignment, power module PM-D F 24 V DC PROFIsafe, fail-safe motor starter

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.

5

Connection of the Components

5.1 Power Supply Interface Variants

5.1.1 Ways of connecting the line supply

A distinction is made between:

- Direct operation of the line connection components on the supply
- Operating line connection components via an autotransformer
- Operating line connection components via an isolating transformer
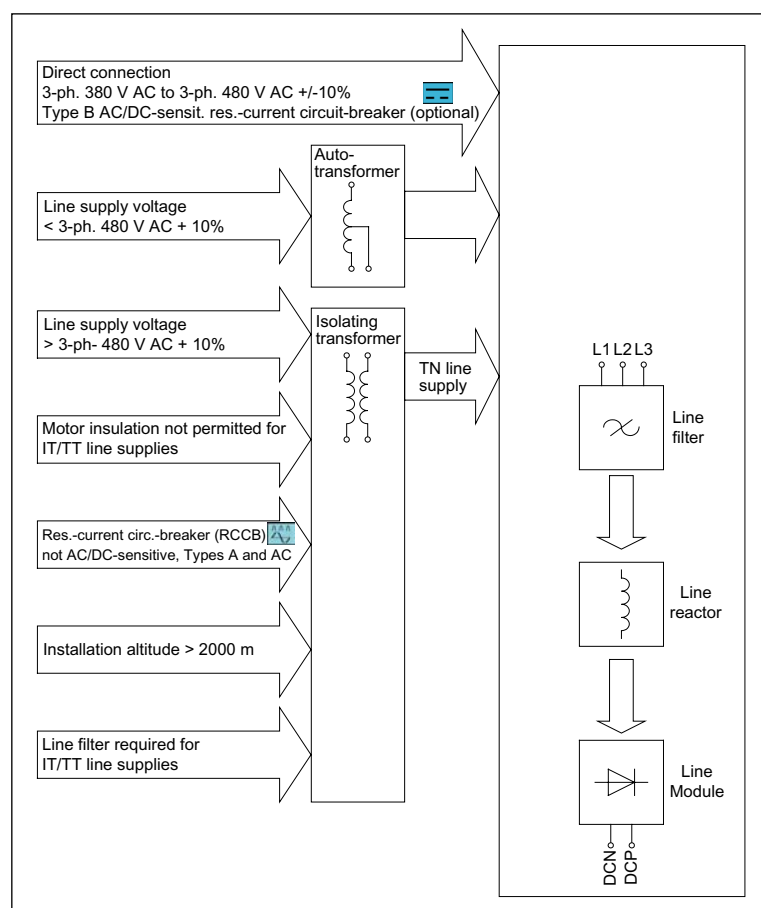
Figure 5-1   Overview of line connection versions

5.1.2 Operation of the line connection components on the supply network

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

Note

Operation with a line filter is only permitted for a TN line supply.
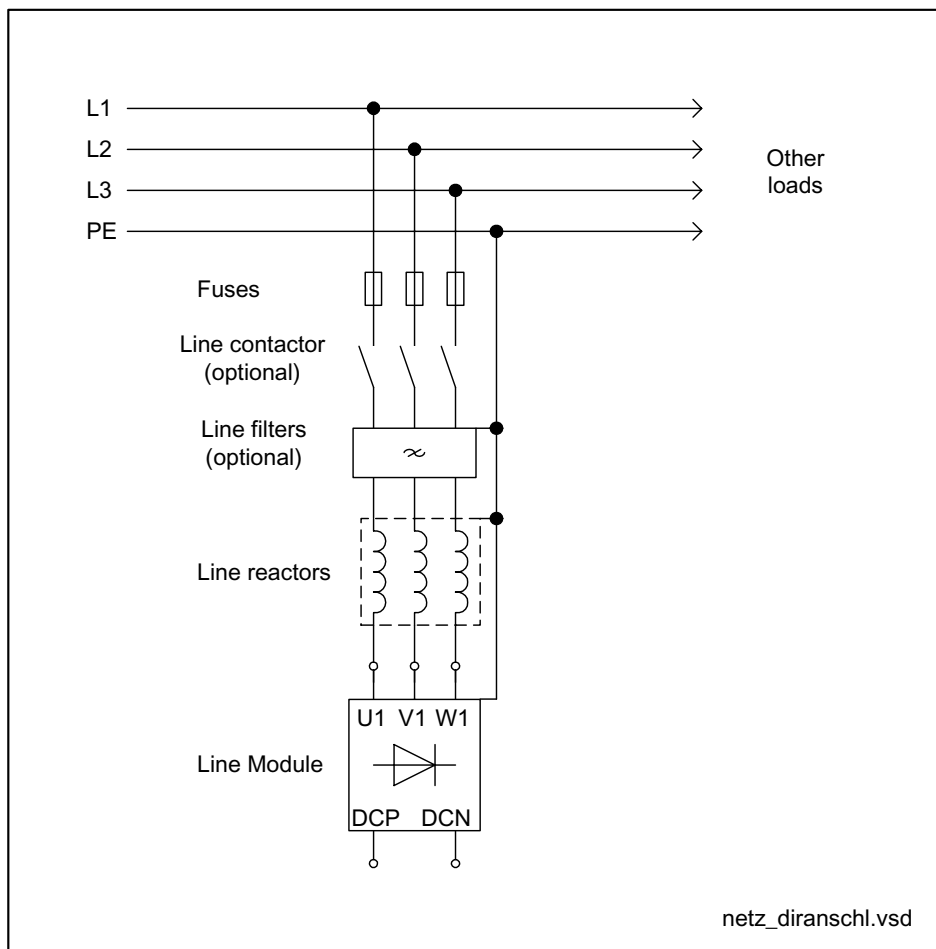
Figure 5-2   Direct operation on the line supply

5.1.3 Operating 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 %.

⚠️ **Caution**

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. It can be in the range 380 V to 415 V.
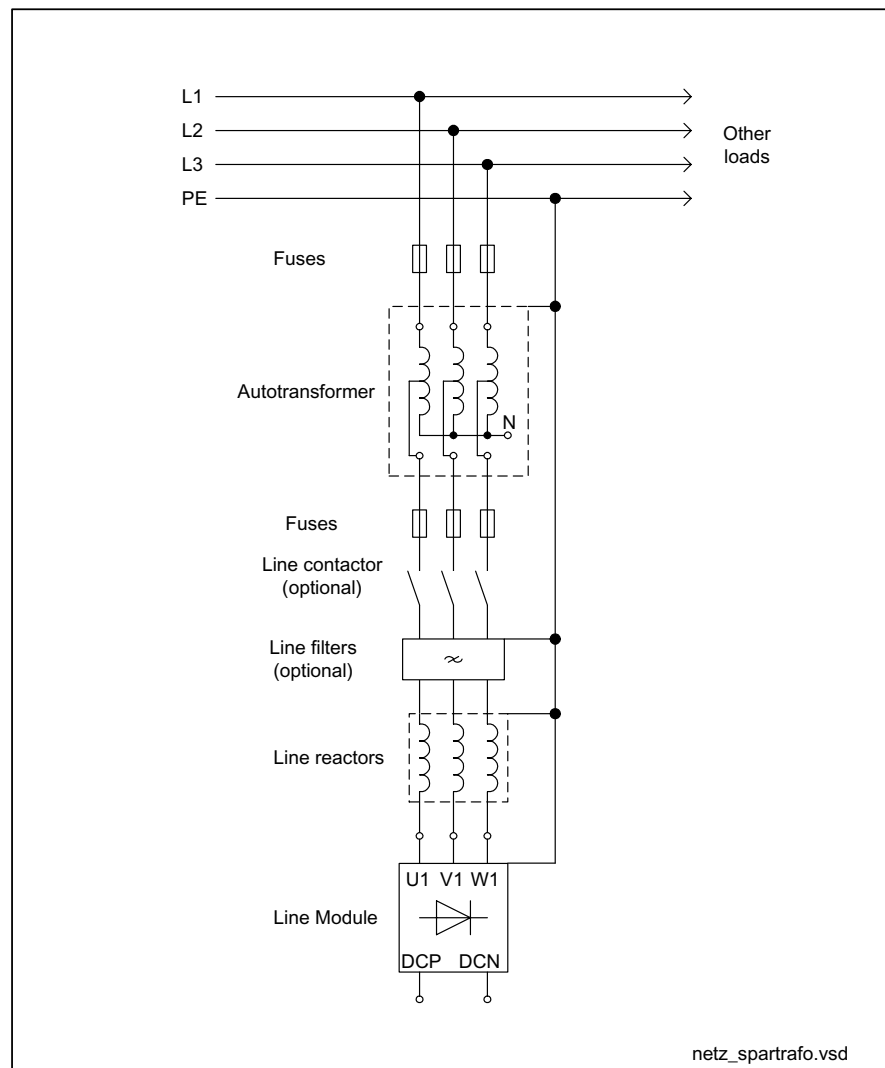
Figure 5-3   Autotransformer

5.1.4 Operating 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.
An isolating transformer must be used to ensure protective separation.
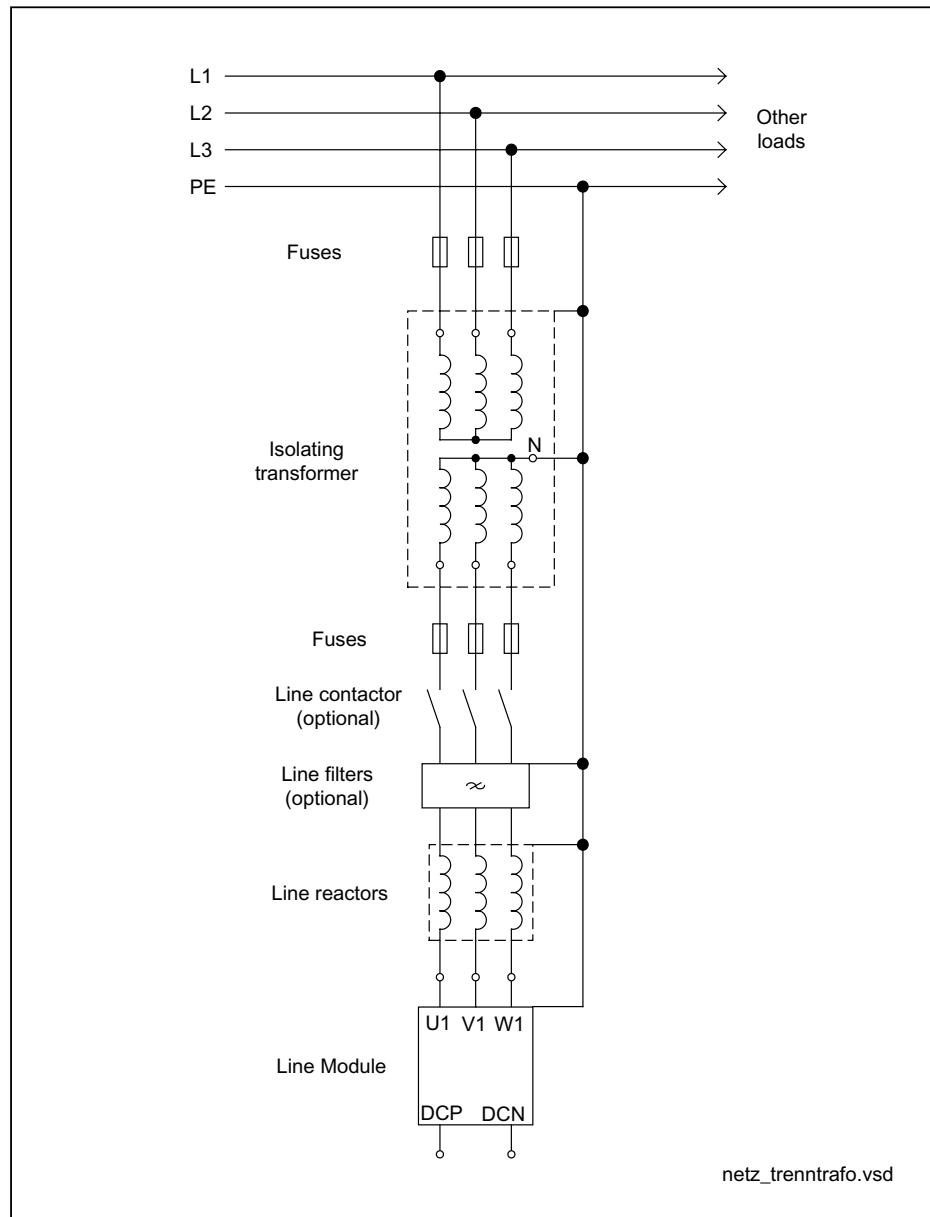
Figure 5-4   Isolating transformer

5.1.5   Line connection via a ground-fault circuit interrupter

In addition to protective measures against direct and indirect contact, selectively tripping AC/DC-sensitive residual-current circuit-breakers (Type B) can be used.

Danger

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

Note

A direct connection to a power system with selectively tripping AC/DC-sensitive residual-current circuit-breakers is only possible with the 5 kW, 10 kW, 16 kW and 36 kW Line Modules because suitable residual-current devices with higher ratings are not available as qualified products.
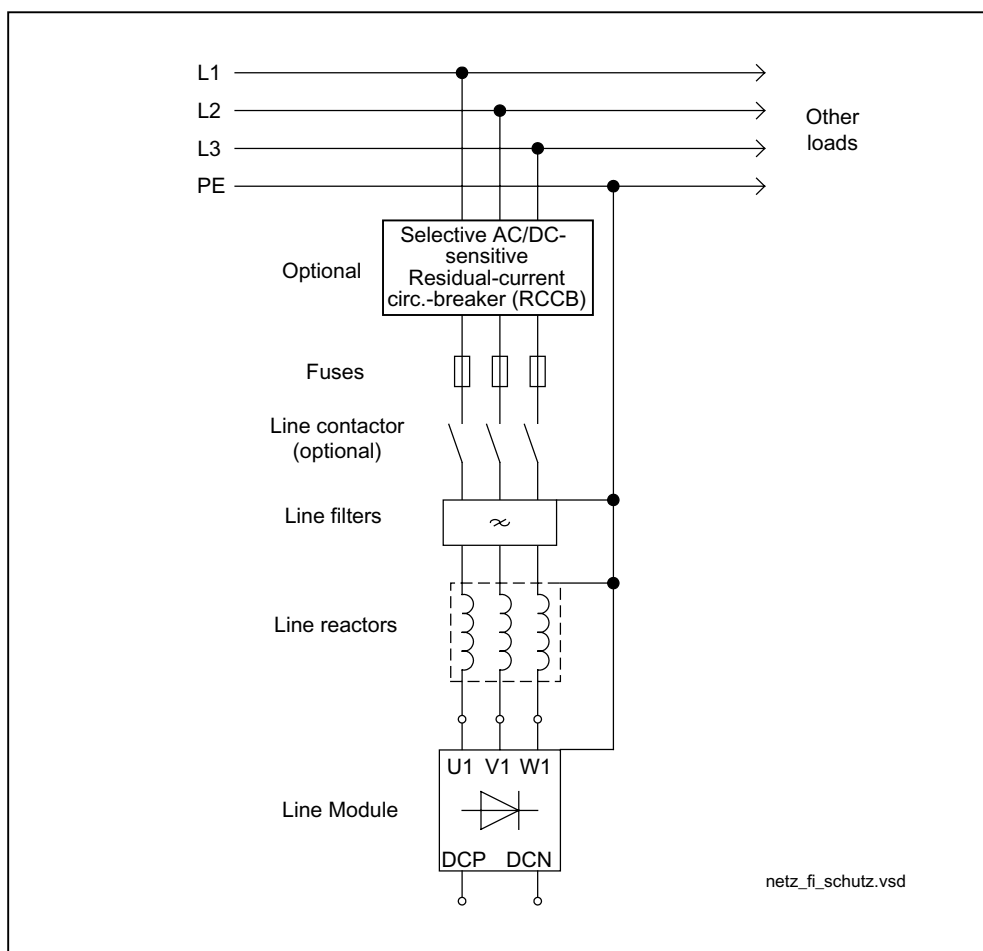
Figure 5-5   Residual-current circuit-breaker (RCCB)

Please note the following:

- It is only permissible to use a delayed tripping, selective AC/DC-sensitive residual-current circuit-breakers, Type B.

- The max. permitted grounding resistance of the "selective protective equipment" is included (83 Ω max. for residual-current circuit-breakers with 0.3 A rated differential current).

- Parts of the electrical equipment and machine that can be touched are integrated in a protective grounding system.

- The total length of the shielded power cables in the drive line-up (motor cables incl. line supply cables 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 (main power switch, contactor) for connecting and disconnecting the drive group have max. 35 ms delay time time between the closing/opening of the individual main contacts.

Recommendation

SIEMENS selectively switching AC/DC-sensitive residual-current circuit-breaker in accordance with EN 61800-5-1 of the 5SM series, e.g. 5SM36465 or 5SM36465+5SW3300 with auxiliary separation switch (1 break contact / 1 make contact) for 63 A rated current, 0.3 A rated residual current (see "BETA Installation Built-in Devices - ET B1" catalog).

Notice

AC or pulse-sensitive RCCBs are not suitable.

5.2 Line Contactor Control

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

5.2.1 Line Contactor Control for Line Modules without DRIVE-CLiQ Interface

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, if required, the line contactor may only be deactivated after a delay time (t ≥ 10 ms). The current is removed during the delay time.
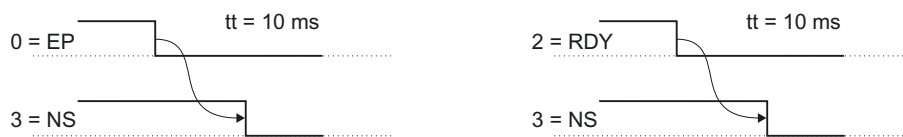
Figure 5-6   Line contactor control signal chart
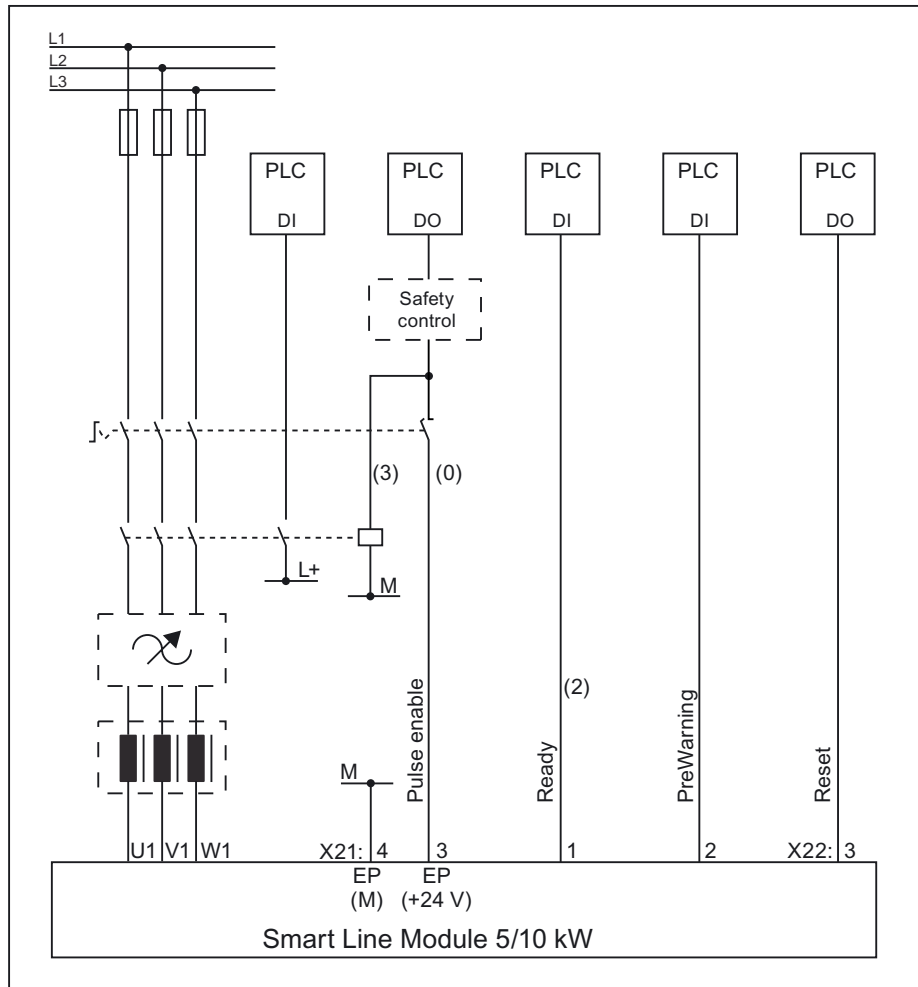
Figure 5-7   Line Contactor Control for Smart Line Module without DRIVE-CLiQ

Note

If the line contactor should also be safely disconnected (safety), the control must be integrated in an existing safety control. This is required so that the line contactor is switched in accordance with the required safety categories; also refer to the "Safety Integrated" section.

5.2.2 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. Also refer to the "Safety Integrated" section.

5.2.3 Line Contactor Control Commissioning using an Example

Assumption:

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

Note

Based on the macro preassignment, the parameterization of the pins 4 and 10 on the X132 interface must be changed.
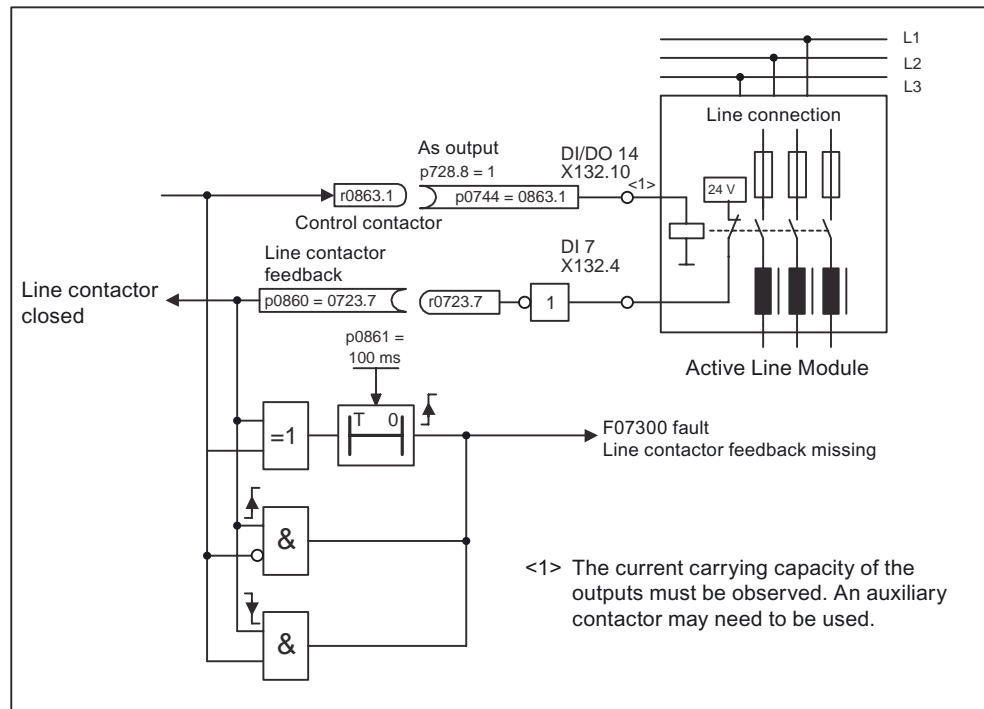
Figure 5-8   Line Contactor Control

Commissioning steps:

> **Note**
>
> If the current carrying capacity of the digital output could be exceeded, an auxiliary contactor may possibly be used (refer to the Equipment Manual for Booksize Power Units)!

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 (see SINAMICS S Parameter Manual)

- 8934 missing enables, line contactor control

Parameter overview (see SINAMICS S Parameter Manual)

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

5.3 Line Modules Interfaces Description

5.3.1 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 destroyed using an additional Braking Module with braking resistor provided in the drive group.

The Line Module is suitable for direct operation on both TN and TT networks.

Smart Line Module

The Smart Line Module is an uncontrolled infeed/regenerative 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 results directly from the supply voltage $U_{DC\ link} = U_{Supply} * 1.35$.

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

Supply voltage	380 V	400 V	415 V	440 V	460 V	480 V
$U_{DC\ link} = U_{Supply}$ x 1.35	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 motors configuring guide)!

⚠ **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. An enable, etc., is not required.

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. The data exchange is performed using DRIVE-CLiQ.

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 results from the rectified supply voltage $U_{DC\,link} = U_{Supply} * 1.35$.

  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:

Supply system voltage p0210	380 V	400 V	415 V	440 V	460 V	480 V
Active Mode (default values) V_{DC} set p3510 [V] (with boost converter p3400.0=1)	600 V	600 V	600 V	-	-	-
Smart Mode (p0210 x 1.35) (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 the parameter p3400.0=0.

2. Smart Mode sets itself automatically during the parameterization of 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 motors configuring guide)!

⚠

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} x 1.35). An enable, etc., is not required.

Once the "Enable Pulses" enable signal is also present on 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.

5.3.2 Active Line Modules with Internal Air Cooling

5.3.2.1 Overview
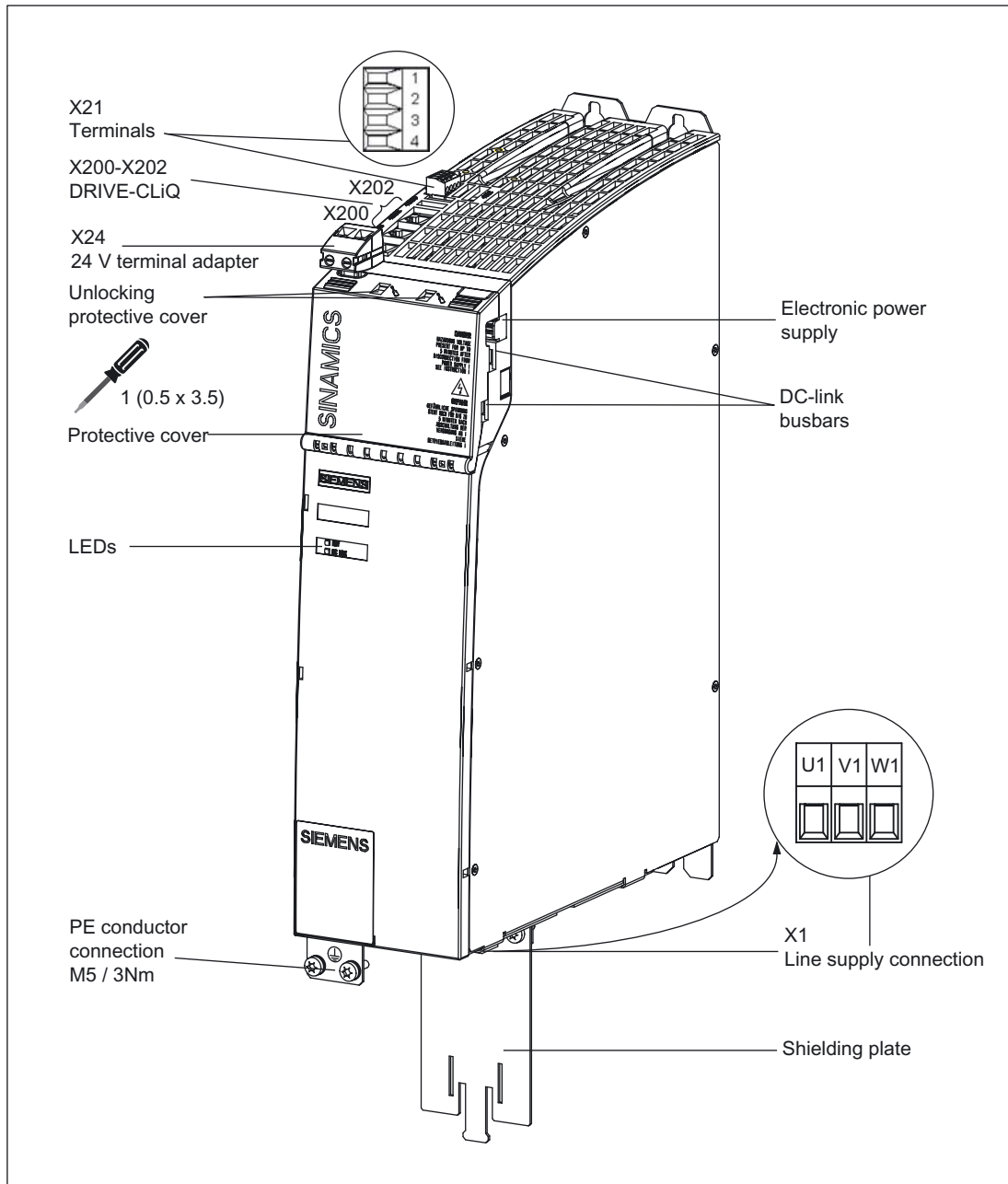
Figure 5-9   Active Line Module with internal air cooling (example: 16 kW)

5.3.2.2   Connection example

1) Leading breaking contact t >10 ms; for operation, 24 VDC and ground must be attached.
2) DI/DO, controlled from the Control Unit.
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.
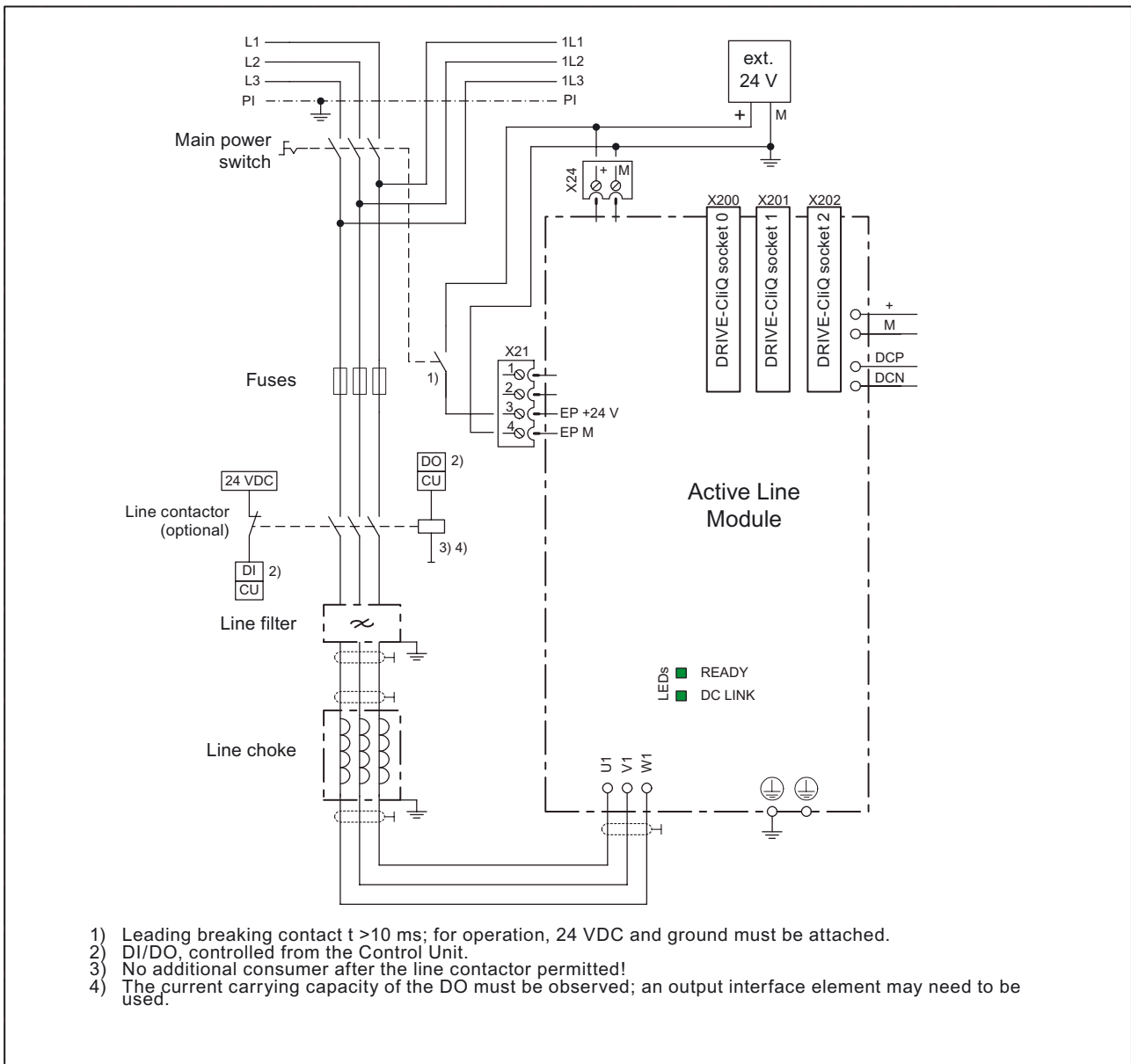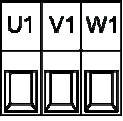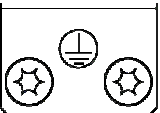
Figure 5-10   Example connection of Active Line Module
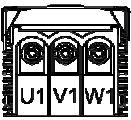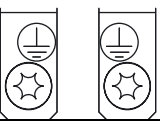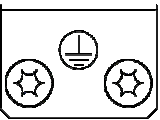
5.3.2.3 X1 line connection

Table 5-1   Terminal block X1 Active Line Module 16 kW

	Terminal	Technical specifications
U1 V1 W1	U1	Max. connectable cross-section: 10 mm^2
	V1	Type: Screw terminal 6 (see Connection Methods)
	W1	Tightening torque: 1.5 - 1.8 Nm
	PE connection	Threaded hole M5/3 Nm [1]

[1] for ring cable lugs to DIN 46234
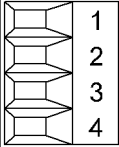
Table 5-2   Terminal block for the Active Line Module (36 kW to 120 kW)

	Terminals	Technical specifications
U1 V1 W1	U1	Max. connection voltage:
	V1	3-ph. 480 V AC +10 % at 47 Hz to 63 Hz
	W1	**36 kW:** Threaded bolt M6/6 Nm [1] **55 kW:** Threaded bolt M8/13 Nm [1] **80 kW to 120 kW:** Threaded bolt M8/13 Nm [1]
	PE connection	**36 kW:** Threaded hole M6/6 Nm [1]
		55 kW: Threaded hole M6/6 Nm [1] **80 kW to 120 kW:** Threaded hole M8/13 Nm [1]

[1] for ring cable lugs to DIN 46234

5.3.2.4 Active Line Module X21 EP Terminals

Table 5-3   X21 terminal block

	Terminal	Designation	Technical data
	1	Reserved, do not use!	
	2	Reserved, do not use!	
 1 2 3 4	3	EP +24 V (Enable Pulses)	**Enable EP control input:** The activation, and thus the enable of the boost converter and the regenerative operation, is achieved by placing a voltage 24 VDC (High level) at the -X21:3 (EP +24 V) terminal. 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. **Disable EP control input:** 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 $U_{DC\ link} = U_N*1.35$. The regenerative function is also disabled. **Signal propagation delays**: Enable: switch from Low to High level in 100 μs Disable: switch from High to Low level in 1000 μs **Notice**: For the case that the EP control input is disabled and the boost converter is non-operational, the CD link remains connected with 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. **Warning**: 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, for example, using a leading (≤ 10 ms) disabling auxiliary switch on the main power switch. **Note** : Without enable of the EP control input, no enable of the line contactor On/Off control function will be performed.
	4	EP M (Enable Pulses)	Reference potential for the -X21:3 terminal
Max. connectable cross-section: 1.5 mm²			
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, for example, with a leading (≥10 ms) disconnecting auxiliary contact.
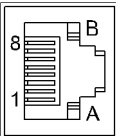
5.3.2.5 Active Line Module X24 24 V Terminal Adapter

Table 5-4   X24 terminal block

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

5.3.2.6 X200-X202 DRIVE-CLiQ interfaces

Table 5-5   DRIVE-CLiQ interface X200-X202

	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
Blanking plate for DRIVE-CLiQ interface: Molex, order number: 85999-3255			

5.3.2.7 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	

5.3.2.8 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 using the -X21 terminal block, terminal 3 and 4 (EP), and using 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 S Parameter Manual.

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.

5.3.2.9 Meaning of the LEDs on the Active Line Module

Table 5-6 Meaning of the LEDs on the Line 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 Red	Flashing 2 Hz	Firmware is being downloaded.
	Green/ Orange or Red/ Orange	Flashing 2 Hz	Component recognition via LED is activated (p0124). Note: 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 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.

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

5.3.3.1 Overview
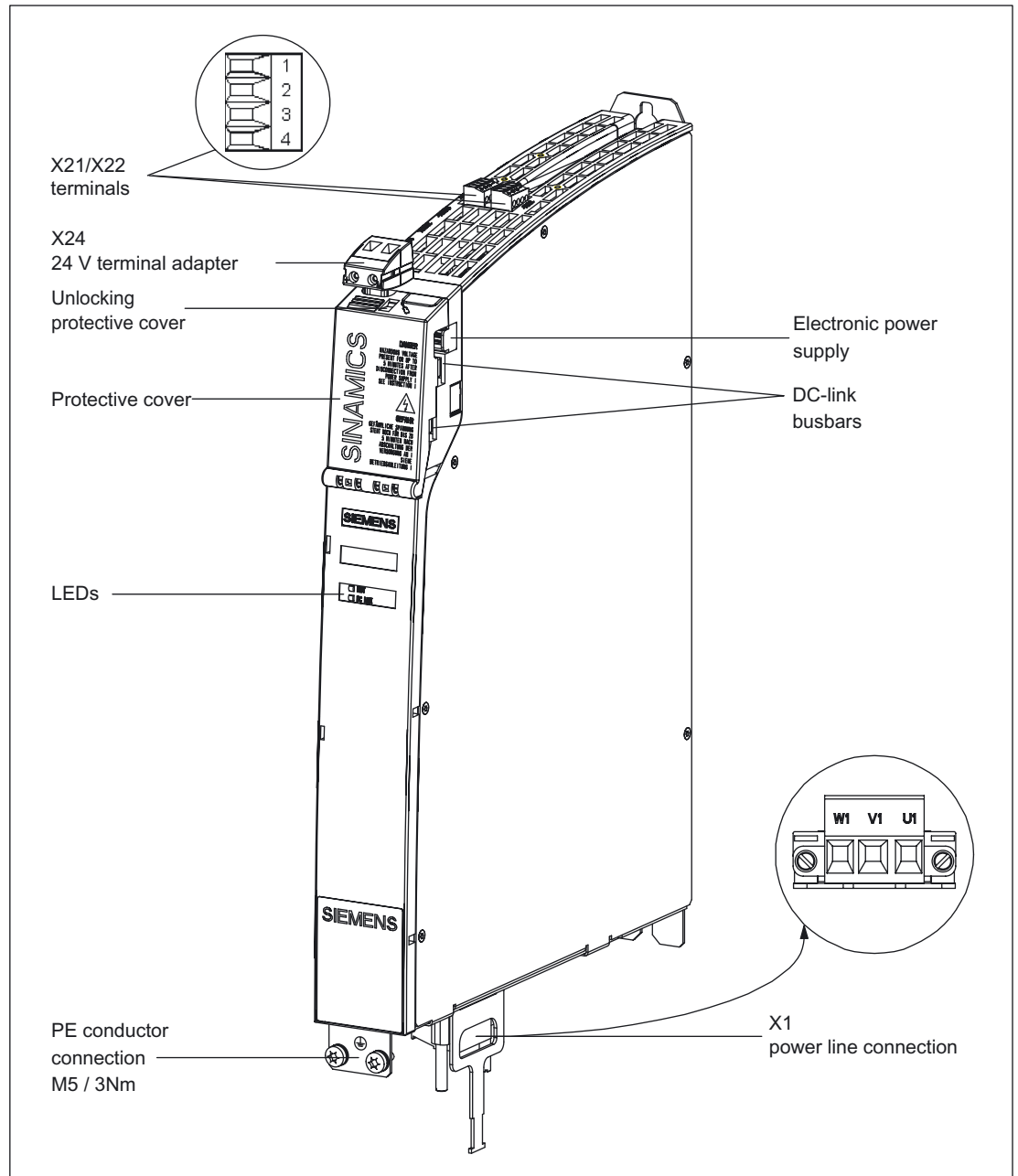
Figure 5-11   Smart line module with internal air cooling (example 5 kW)

5.3.3.2 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 5-12   Smart Line Module connection example

5.3.3.3 X1 line connection

Table 5-7 Terminal block X1 of Smart Line Module (5 kW and 10 kW)

	Terminal	Technical data
	U1	Max. connection voltage:
	V1	3 AC 480 V +10% at 47 Hz to 63 Hz
	W1	Max. connectable cross-section: 6 mm^2
		Type: Screw terminal 5 (see Connection Engineering section)
		Tightening torque: 1,2 - 1,5 Nm
	PE connection	Threaded hole M5/3 Nm [1]

[1] for ring terminal end in accordance with DIN 46234

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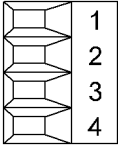
The Smart Line Module (5/10 kW) is controlled using the -X21, -X22 terminal block. A connection to the Control Unit using DRIVE-CLiQ is not present. A detailed function description for the individual signals and control/status words is contained in the SINAMICS S Parameter Manual.

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 with hardware control. Also consult the "Safety Integrated" and "Line Contactor Control" sections.

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 5-8   X21 terminal block

	Terminal	Designation	Technical data
	1	DO: Ready	Checkback: Smart Line Module ready
			The signal switches to high level when the following conditions have been met:
			• Electronics power supply (X24) OK
			• DC link is pre-charged
			• Enable pulse (X21:3/.4) present
			• No overtemperature
			• No overcurrent switch-off
			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.
			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 High = no prewarning Low = prewarning
	3	DI: Enable pulses	**EP +24 V EnablePulses** Enable EP control input: The activation is achieved by placing a 24 VDC voltage (High level) at the -X21:3 (EP +24 V) terminal.
			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.
			Disable EP control input: The disable signal from the Smart Line Module cannot be set if the EP control input is not enabled (Low level).
			Notice: 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.
			If this is to be avoided, a line contactor, for example, can be used.
			Warning: 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, for example, using a leading (≤ 10 ms) disabling auxiliary switch on the main power switch.
	4	DI: Enable pulses ground	**EP M Enable Pulses** Reference potential for the –X21:3 terminal.

Max. connectable cross-section: 1.5 mm^2
Type: Screw terminal 1

Note
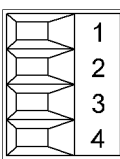
For operation, ground must be attached to the -X21:3 24 VDC terminals and the -X21:4 terminals. When removed, pulse inhibit is activated, feedback is deactivated and the bypass relay drops out. If the Line Module is not disconnected from the network when the EP terminal is deactivated (e.g. a main contactor 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, for example, with a leading (≥10 ms) disconnecting auxiliary contact.

5.3.3.5   X22 terminals: smart line module

Table 5-9   Terminal block X22
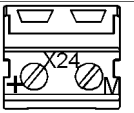
	Terminal	Designation	Technical data
1 2 3 4	1	24 V power supply	**24 VDC electronic power supply** (24 VDC, 100 mA) for the control of the X22.2 and 3 digital inputs.
	2	DI: Disable Regeneration	**DigitalinputDisable** Enable Disable control input: Enable and thus activate the regenerative capability of the Smart Line Module when the Disable control input is open (Low level). **Disable Disable control input**: If the Disable control input is not enabled (High level), the regenerative capability of the Smart Line Module is deactivated. No energy from the DC link can be fed into the supply system. The energy may need to be removed using braking resistors. **Note**: The Disable control input may not be operated during running operation. The preselection should be made using a fixed wire jumper. **Notice**: In the case that the Disable control input has the High level and thus the regenerative capability is deactivated, the DC link remains connected with the energy supply system using the diode bridge / precharging resistors. No electrical isolation exists.
	3	DI: Reset	**DigitalinputReset** If this input is jumpered with the electronic 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).

	Terminal	Designation	Technical data
	4	Chassis ground	**Electronic ground** Reference potential to the -X22.2;3 terminal, for example, for an external control from the PLC.
Max. connectable cross-section: 1.5 mm² Type: Screw terminal 1			

5.3.3.6   X24 24 V terminal adapter

Table 5-10   Terminal block X24

	Terminal	Name	Technical specifications
	+	24 V supply	24 V DC supply voltage
	M	Ground	Electronic ground
The 24 V terminal adapter is supplied as standard Max. connectable cross-section: 6 mm² Type: Screw terminal 5 (see Connection Methods)			

5.3.3.7   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	

5.3.3.8 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	

5.3.3.9 Meaning of the LEDs on the Smart Line Module

Table 5-11   Meaning of the LEDs on the Smart Line Module

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

5.4 Motor Modules Interface Description

5.4.1 Overview
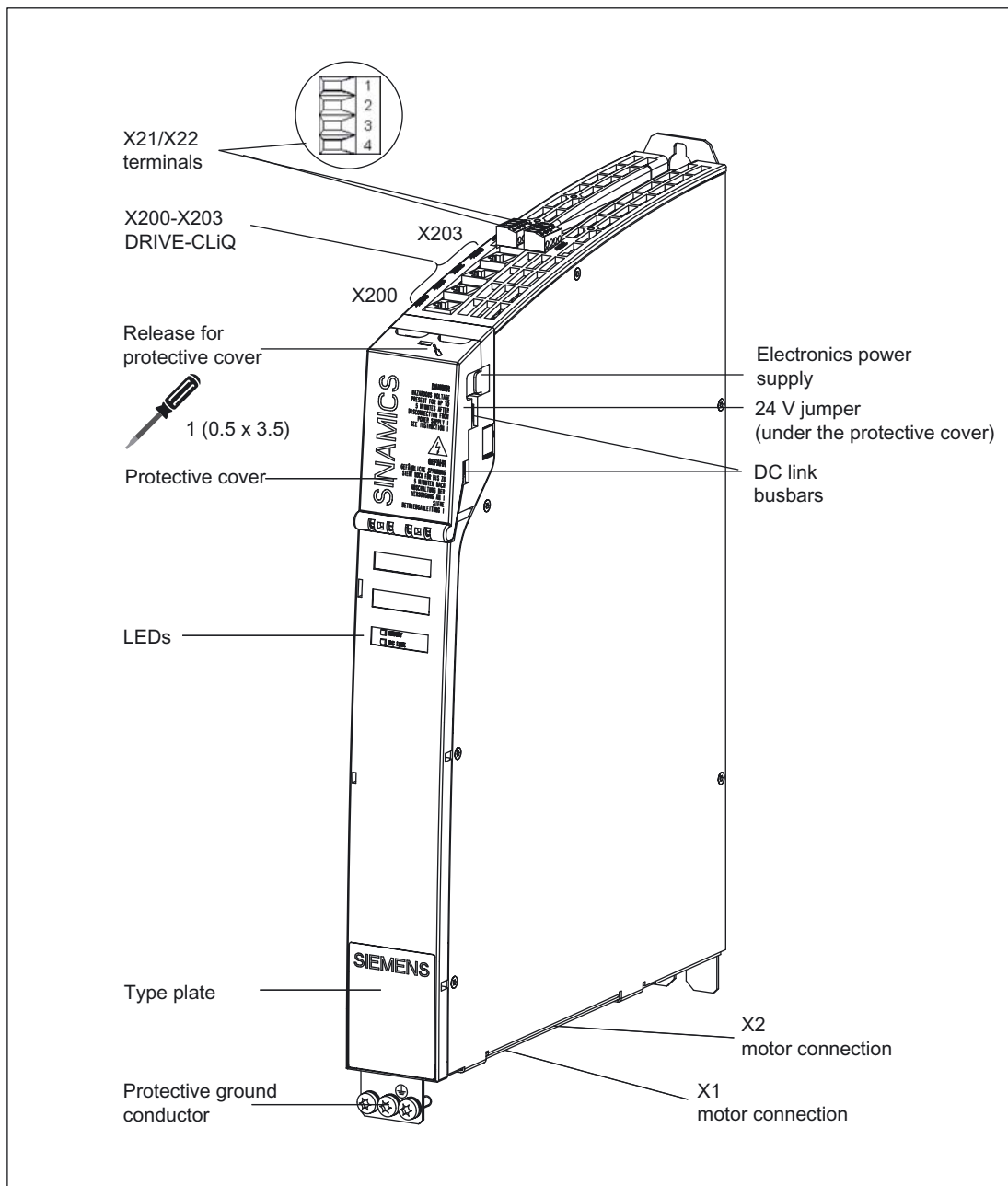
Figure 5-13   Example: Double motor module with internal air cooling (2 x 3 A)

5.4.2 Connection Examples
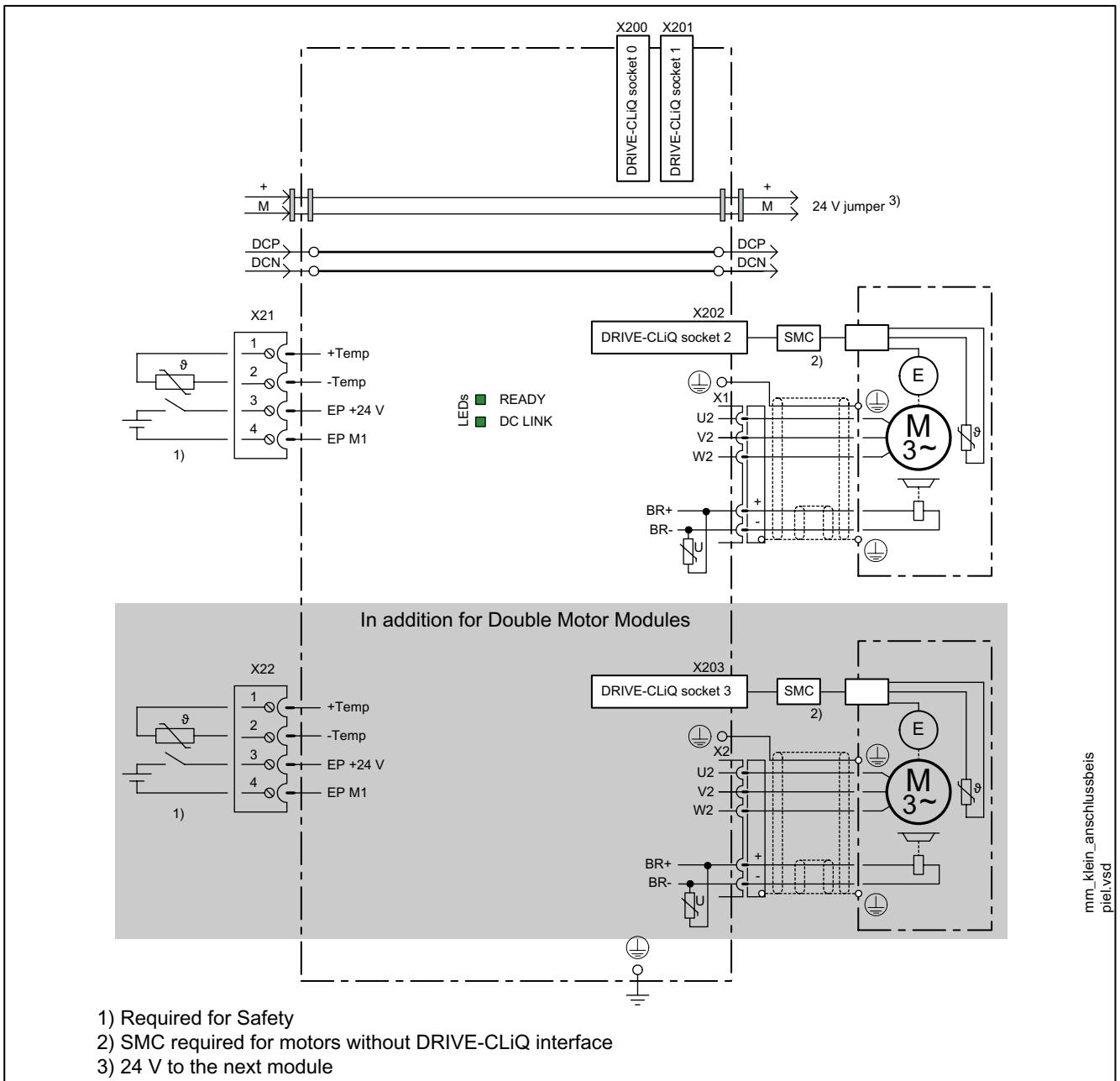
Figure 5-14   Connection example of Motor Modules 3 A to 30 A and Double Motor Modules 3 A to 18 A
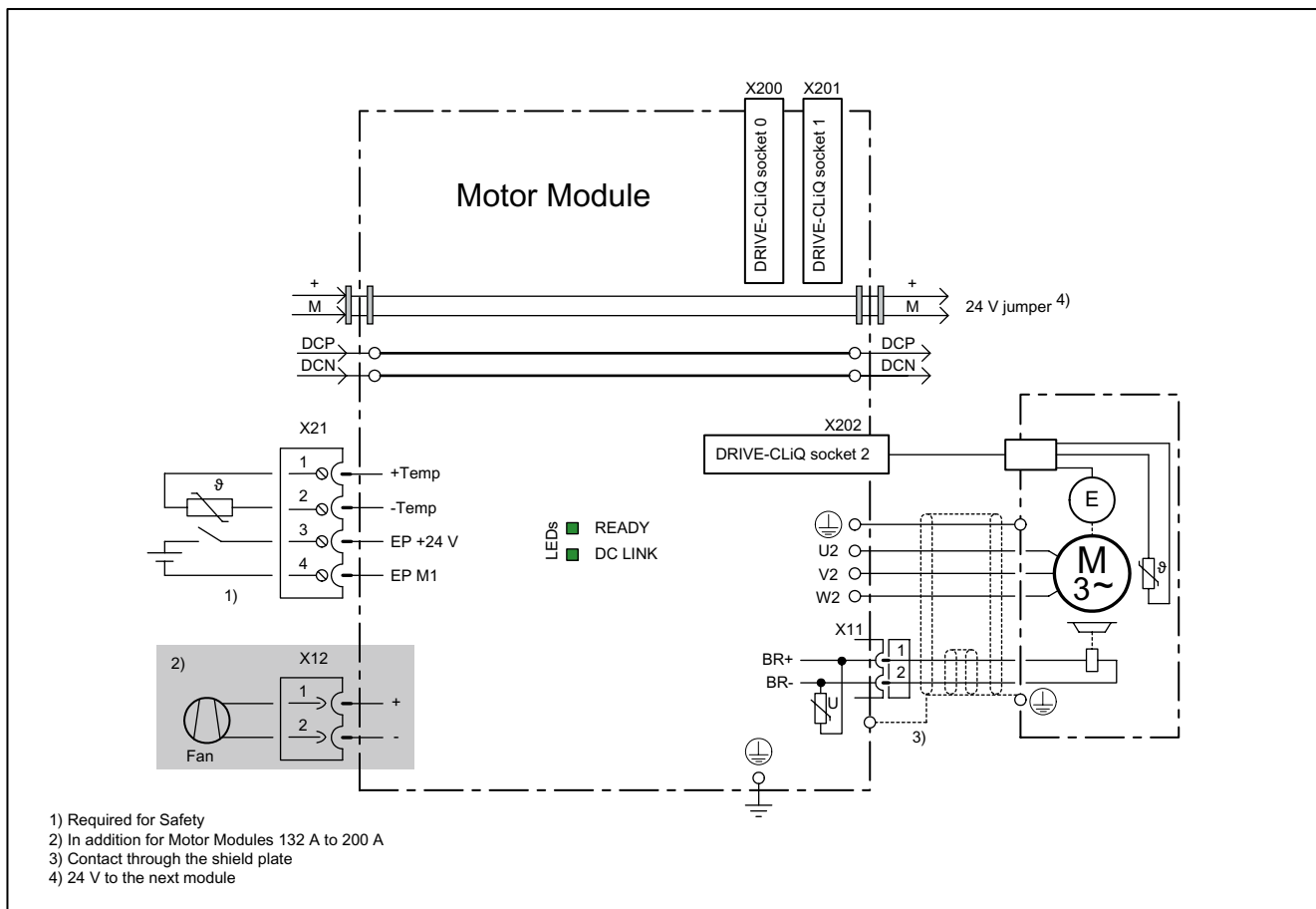
Figure 5-15   Example connection of Single Motor Modules 45 A to 200 A
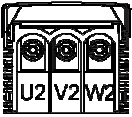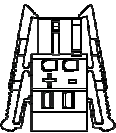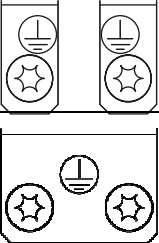
5.4.3   Motor/brake connection

Table 5-12   Terminal block 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-)	
	PE connection	Threaded hole M5/3 Nm [1]

[1] for ring cable lugs to DIN 46234

Table 5-13   Terminal block Single Motor Module 45 A to 200 A

	Terminals	Technical specifications
	U2	**45 A to 60 A:**
	V2	Threaded bolt M6/6 Nm [1]
	W2	**85 A:**
		Threaded bolt M8/13 Nm [1]
		132 A to 200 A:
		Threaded bolt M8/13 Nm [1]
	+ (BR+)	X11 brake connector [2]:
	- (BR-)	Voltage 24 V DC Max. load current 2 A Min. load current 0.1 A Max. connectable cross-section 2.5 mm^2 Type: Spring-loaded terminal 2 (see Connection Methods) Manufacturer: Wago; Order No.: 721-102/026-000/56-000 The brake connector is part of the prefabricated cable.
	PE connection	**Single Motor Module with a rated output current of 45 A to 60:** 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 Threaded bolt for motor cables: M8/13 Nm [1] Threaded hole for PE: M6/6 Nm[1] **Single Motor Module with a rated output current of 132 A to 200 A** Threaded bolt for motor cables: M8/13 Nm [1] Threaded hole for PE: M8/6 Nm [1]

[1] For ring cable lugs to DIN 46234

[2] The circuit for protecting the brakes against overvoltage is 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 total length of the shielded power cables (motor supply cables and DC link cables) must not exceed 350 m.

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 (PELVs) that comply with EN60204-1 must be connected to all connections and terminals between 0 and 48 V DC.

The voltage tolerances of the motor holding brakes must be taken into account.

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

Table 5-14   Terminal block X21/X22

	Terminal	Function	Technical data
	1	+Temp	Temperature sensor connection KTY84–1C130/PTC
	2	-Temp	
	3	EP +24 V (Enable Pulses)	Supply voltage: 24 V DC (20.4 V - 28.8 V)
1 2 3 4	4	EP M1 (Enable Pulses)	Current consumption: 10 mA Optically isolated input Signal propagation times: L → H: 100 µs H → L: 1000 µs
Max. connectable cross-section 1.5 mm²			
Type: Screw terminal 1 (see Connection Engineering section)			

> **Notice**
>
> The KTY temperature sensor/the PTC must be connected with the correct polarity.

> **Note**
>
> The temperature sensor connection is required for motors for which the temperature value is not transferred using DRIVE-CLiQ.
> If the "Safe standstill" function is selected, for operation, ground must be placed at the -X21:3 24 VDC and the -X21:4 terminal. For cancelation, a pulse suppression will be activated.

Terminal	Function	Remarks
1	+Temp	Temperature sensor connection (KTY)
2	-Temp	
3	EP +24 V (Enable Pulses)	EP +24 V Enable Pulses
4	EP M1 (Enable Pulses)	EP M1 Enable Pulses
Max. connectable cross-section 1.5 mm^2 Type: Screw terminal 1		

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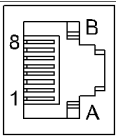
The protective circuit of the Enable Pulses (EP) input is required only when the "Safe standstill" function on the Motor Module and on the Control Unit was activated by parameterizing.

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").

5.4.5 X200-X203 DRIVE-CLiQ interface

Table 5-15   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	GND (0 V)	Electronic ground
Blanking plate for DRIVE-CLiQ interface: Molex, order number: 85999-3255			

5.4.6 Meaning of the LEDs on the Motor Module

Table 5-16   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 Red	Flashing 2 Hz	Firmware is being downloaded.
	Green/ Orange or Red/Orange	Flashing 2 Hz	Component recognition via LED is activated (p0124). Note: 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.

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 DRIVE-CLiQ Topologies

5.5.1 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:

- 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.

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 lines between each of 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 5-16   DRIVE-CLiQ wiring

Miscellaneous

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

5.5.2   NX10/15 Wiring

NX10/15 DRIVE-CLiQ topology

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. 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 5-17   NX10/15 PROFIBUS addresses

DRIVE-CLiQ port	Drive PROFIBUS addresses
X105	15
X104	14
X103	13
X102	12
X101	11
X100	10

The following figure shows a sample topology:
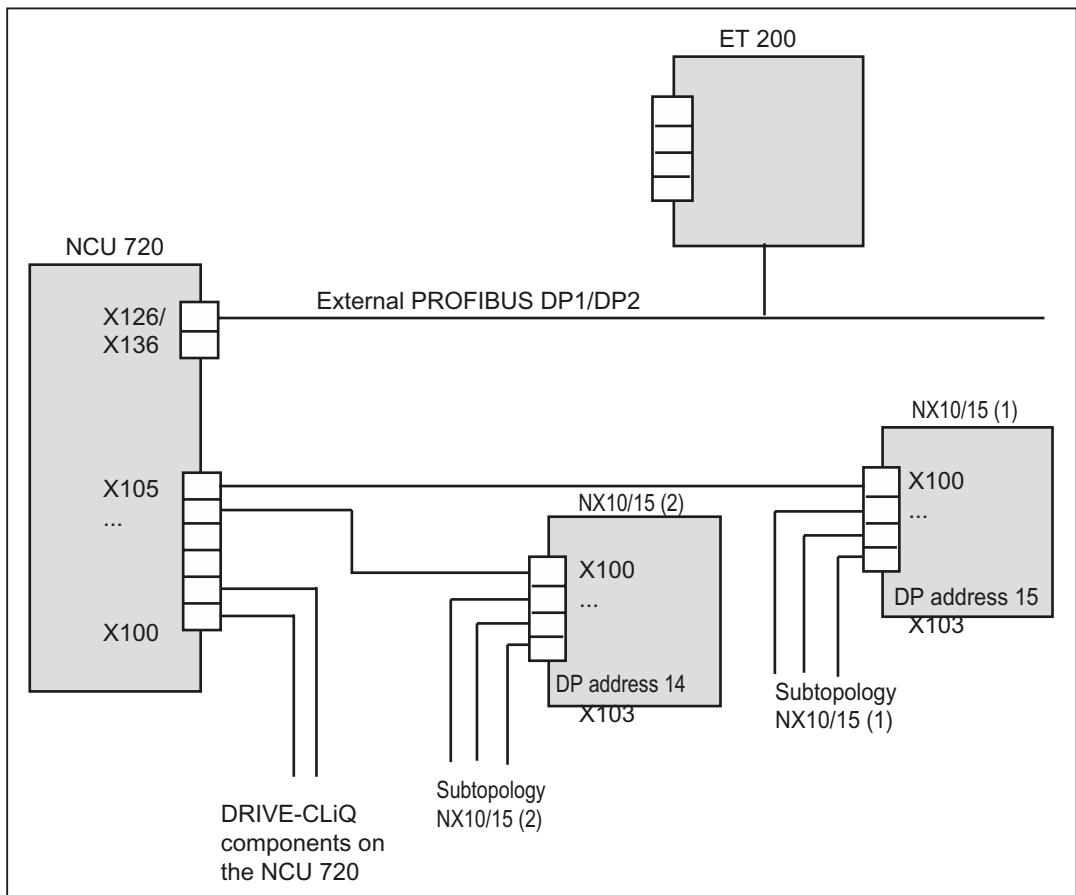
Figure 5-17   NX10/15 topology

5.5.3 Connectable DRIVE-CLiQ components

Components

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

Table 5-18   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.
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.
NX10/15	Drive expansion module for up to 6 axes

Further reading

- You will find information about Line Modules and Motor Modules in the SINAMICS S120 Booksize Power Units Equipment Manual.
- You will find information about Sensor Modules in the SINAMICS S120 Control Units Equipment Manual.

5.6 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)

5.6.1 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

5.6.2 Selection of the Power Supply Devices

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

Table 5-19   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	6EP1336-3BA00
40	3AC 320 – 550	46	6EP1337-3BA00

Table 5-20   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 NC61 catalog.

⚠ **Warning**

When external power supplies are used, e.g. SITOP, the ground potential must be connected to the protective conductor terminal (PELV).

5.6.3   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 1-3, 24 VDC power consumption overview

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 each digital output PROFIBUS Teleservice	0,8 0,1
CBC 10	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

Component	Typical current consumption [A_{DC}]
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
Sensor Modules External	
SME 20	0,19
SME 25	0,19
SME 120	0,24
SME 125	0,24
Supplementary system components	
Braking Module	0,5

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

5.6.4 Calculation of the 24 VDC Power Requirement Example

Table 5-21   Example of 24 V DC current requirements

Component	Number	Current consumption [A]	Total current consumption [A]
NCU7x0 8 digital outputs	1 8	2,00 0,01	2,00 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.).

5.6.5 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.

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.

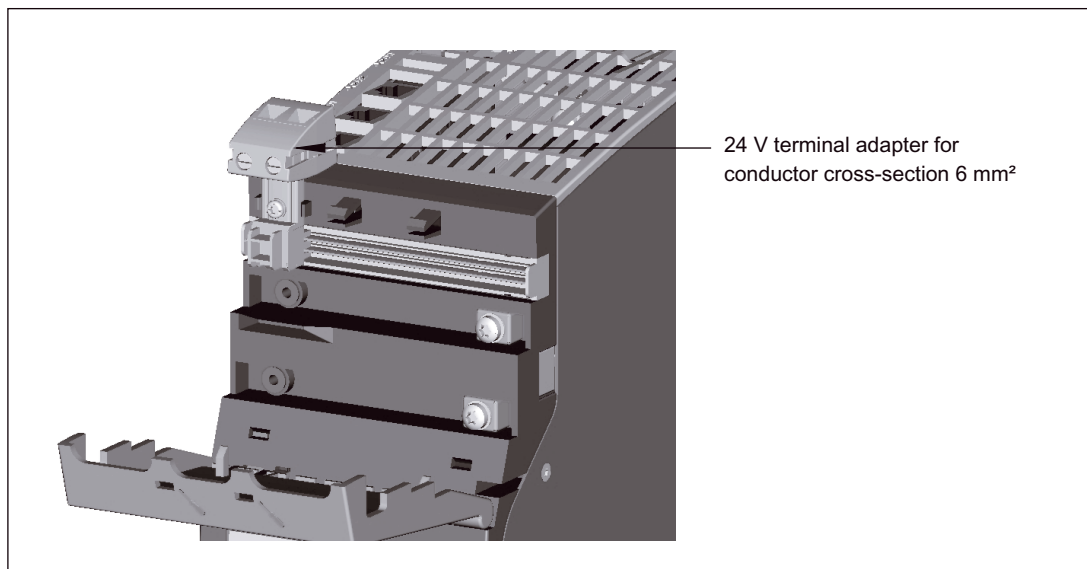24 V terminal adapter for conductor cross-section 6 mm²

Figure 5-18   24 V terminal adapter

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 of the 24 V busbar of 20 A is exceeded, an additional infeed of the electronic current must be provided. This must be performed, for example, at a Motor Module using an additional 24 V terminal adapter that must be ordered separately (order no. 6SL3162-2AA00-0AA0). The 24 V busbar must not be jumpered in front of the new infeed, because a new potential begins after the additional infeed.

<1> 24 VDC terminal adapter
<2> Jumper plug
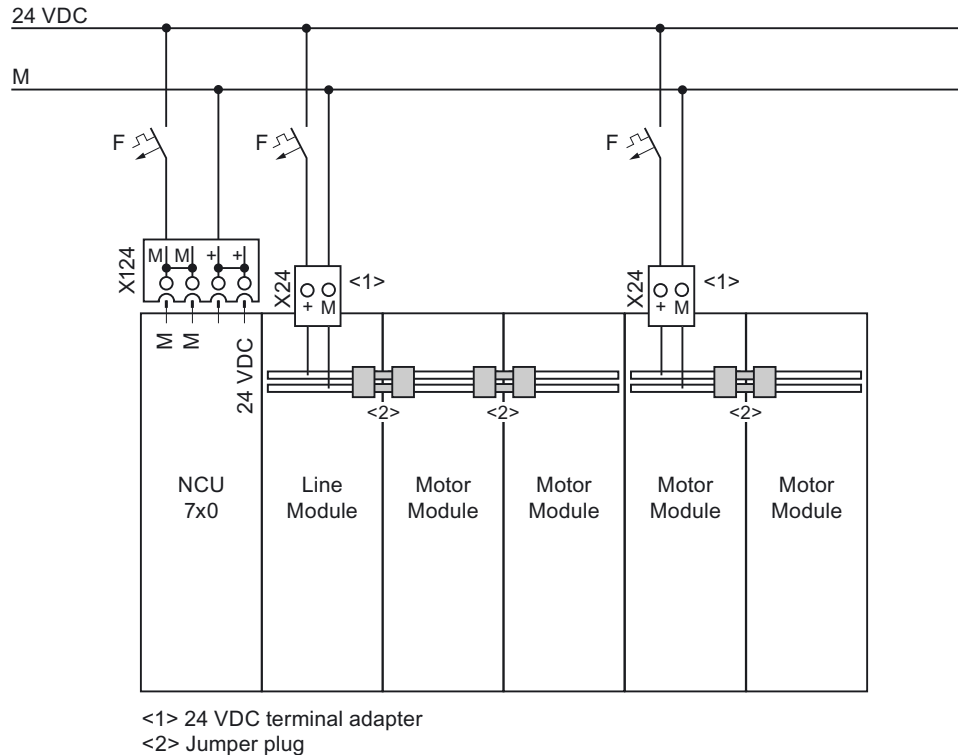
Figure 5-19   Electronic power supply infed more than once

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 mm² 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.

The supply voltage, for example, the digital inputs/outputs at Control Unit and Sensor Module, is made separately using appropriate terminals (max. 0.5 mm²).

5.6.6　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 performed by the device protection of the SITOP power supply and also the 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

● Cable bundling (e.g. laying 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.: 6EP1961-2BA00).

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 protection 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 with an integrated electronic short-circuit protection in accordance with EN 60204-1 which in the case of overload/short-circuit, independently protects the SITOP power and the supplied 24 VDC circuits against overload.

Circuit-breakers

The following conditions apply to the cables when the MCBs are selected from the following table:

- 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 routed separately from other cables and conductors carrying operating current.
- Cable type: PVC conductor cable

Table 5-22   MCBs by conductor cross-section and temperature

Conductor cross-section	Max. value up to 40 °C	Max. value up to 55°C
1.5 mm²	10 A	10 A
2.5 mm²	20 A	10 A
4 mm²	25 A	16 A
6 mm²	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".

5.6.7   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 mm² for the 24 V power supply terminal adapter of the power busbar
- 2.5 mm² for the 24 V power supply infeed terminal of the CU and SMC components
- 0.5 mm² 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:

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.

5.6.8   Power Supply Connection Example

<1> Power supply protection in accordance with manufacturer details, KT 10.1 catalog, Chapter 7

<2> max. connection cross-section 2.5 mm^2, max. fuse 20 A

<3> max. connection cross-section 6 mm^2, 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, on the required current and the type of laying.
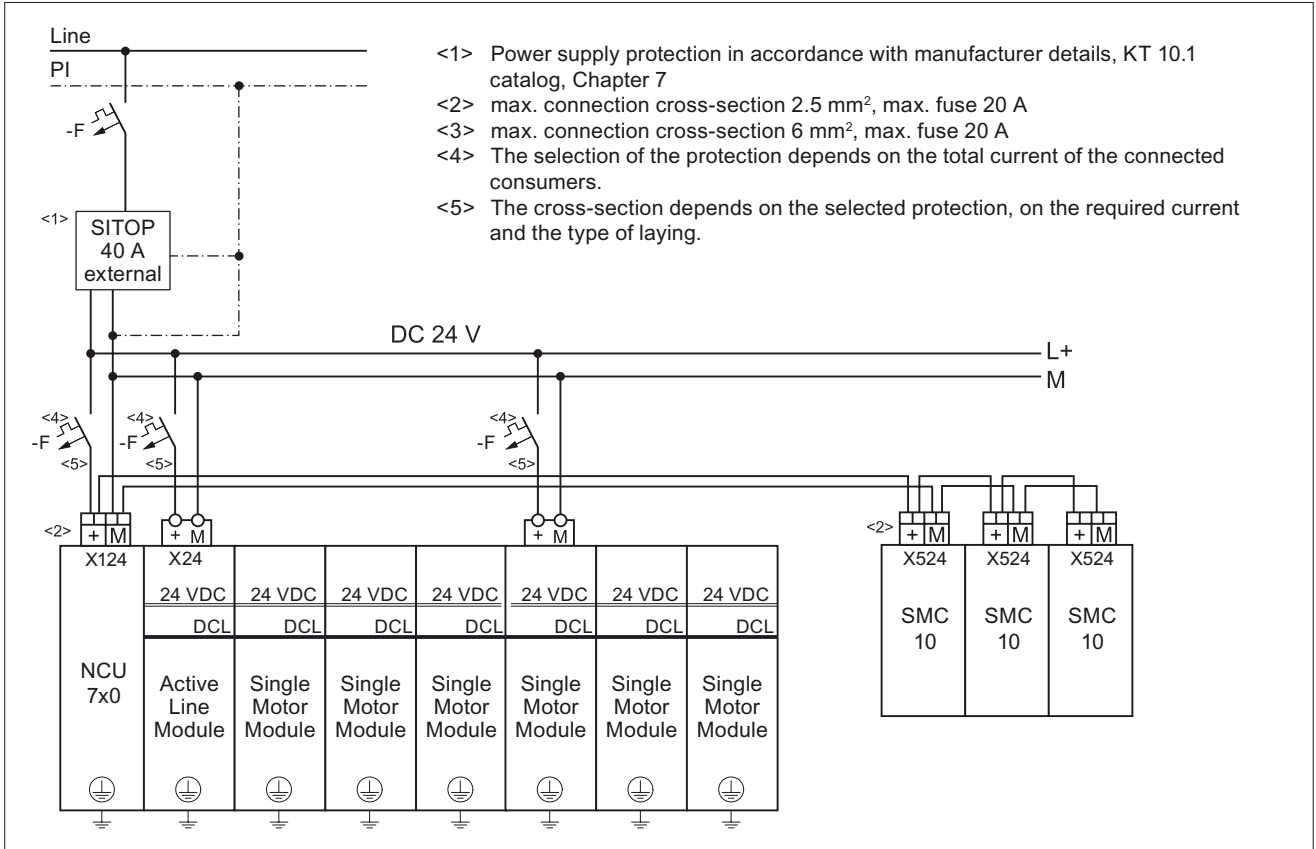
Figure 5-20   Power Supply Connection Example

5.7 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. The CSM provides the 24 VDC power supply optionally using the line voltage or, in a fault situation, 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/undershot, the corresponding error messages will be generated by the system and an internal pulse suppression performed. 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.

5.7.1 Connection example

<1> Permitted types:
   a) circuit-breaker type SIRIUS, 3RV 1021 1DA10, setting 3A
   b) branch circuit fuse type KTS-R-6 (class RK1)

<2> The power line connection must always be present

<3> DI/DO, controlled from the Control Unit.

<4> No additional consumer after the line contactor permitted!

<5> The current carrying capacity of the DO must be observed; an output interface element may need to be used.
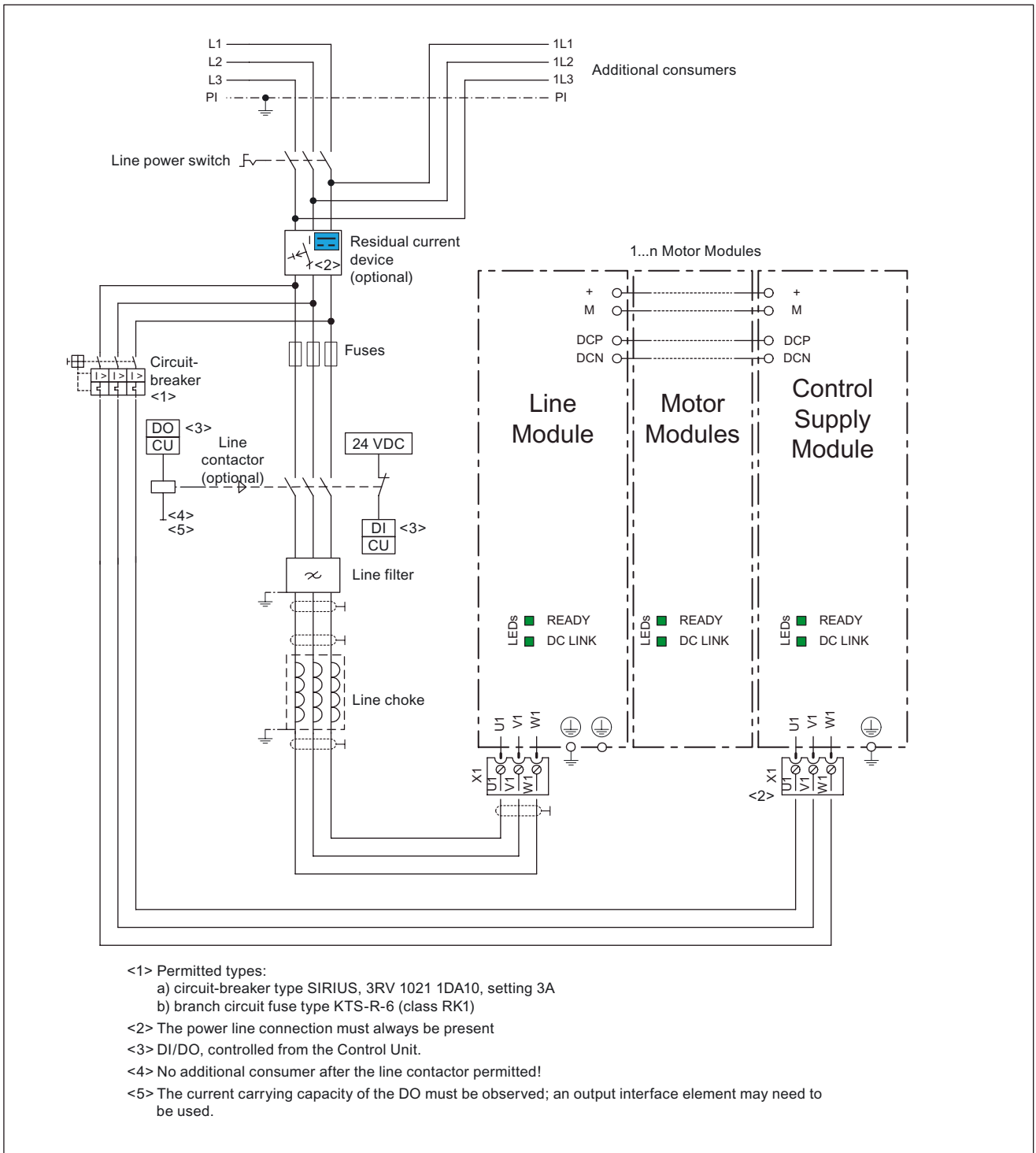
Figure 5-21   Example connection of Control Supply Module

The Control Supply Module (CSM) is connected to the line supply (3-ph. 380 V 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 is protected corresponding to the data provided in the Equipment Manual for Booksize power units. 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.

Note

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.

Notice

If a selectively tripping AC/DC-sensitive residual-current circuit-breaker is used, the Control Supply Module must be connected downstream of this.

5.7.2 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 consideration, for example, applies to the direct power supply of the drive group from the 24 V busbar.

The corresponding load feeders must be selectively protected for the supply to external components. Circuit-breakers (for example, order no.: 5S…, ETB1 catalog) or the SITOP Select diagnostic module (order no.: 6EP1961-2BA00) can be used. The rated size of the protective devices depends on the required current. The protection 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

- The bunching of the cables, e.g. laying in a single duct

- the cable types

The EN60204-1 and VDE 660 Part 500 can be used to determine the over-current 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.

5.7.3 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. The Control Supply Module so supplies only the drive group consisting, for example, of Line, Motor, Capacitor and Braking Module.

  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 also supply power for external consumers. 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.
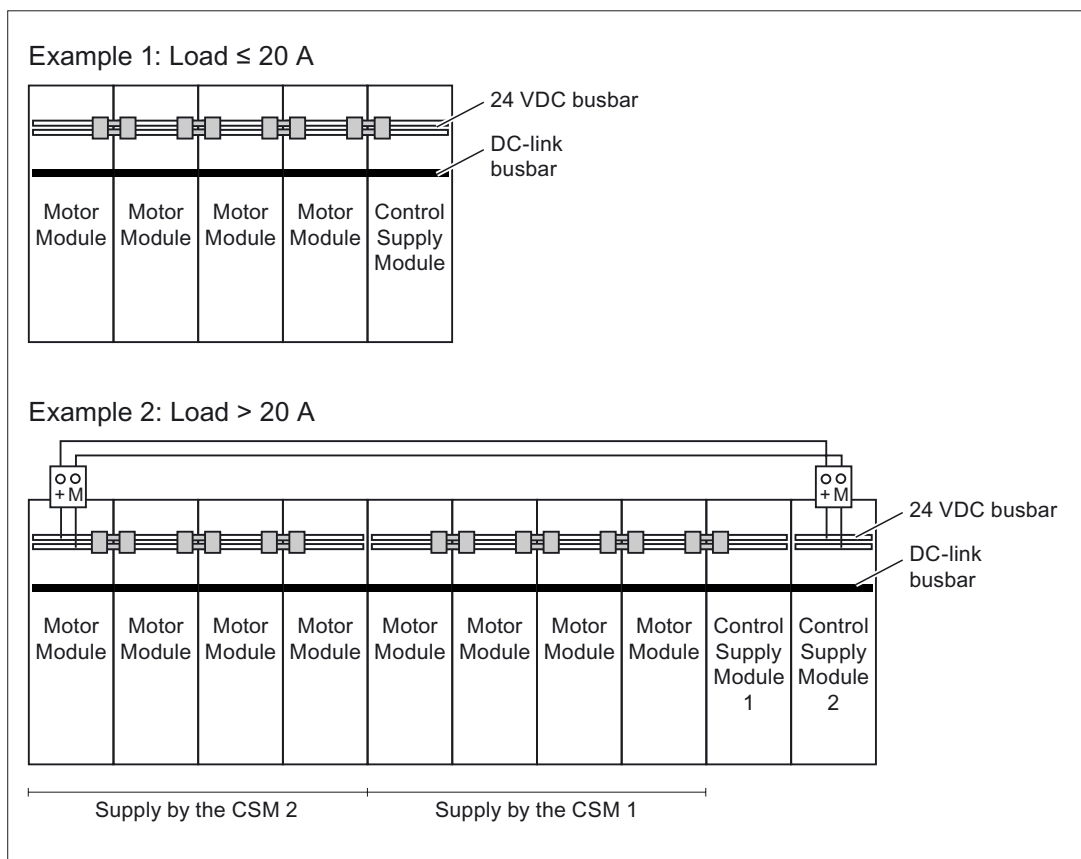
Figure 5-22   24 VDC division

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 the protection (e.g. automatic devices) for the consumer lines

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

Danger

The Control Supply Module has two supply circuits!
Risk of electrical shock. Dangerous voltage present for as long as five minutes after the supply has been switched off.
The protective cover may be opened only after this time has expired.

When the protective cover of the DC link is opened, ensure that the unlatching is activated. An appropriate tool, such as a screwdriver, must be used.

The components may be operated only when the protective covers of the DC link are closed. Damaged components (for example, with defective locking of the protective cover) must not be continued to be used.

The non-observance can cause death or severe injury.

Caution

The danger note for the DC link discharge time must be placed on the component in the national language.

A set of labels in 16 languages is provided with the component.

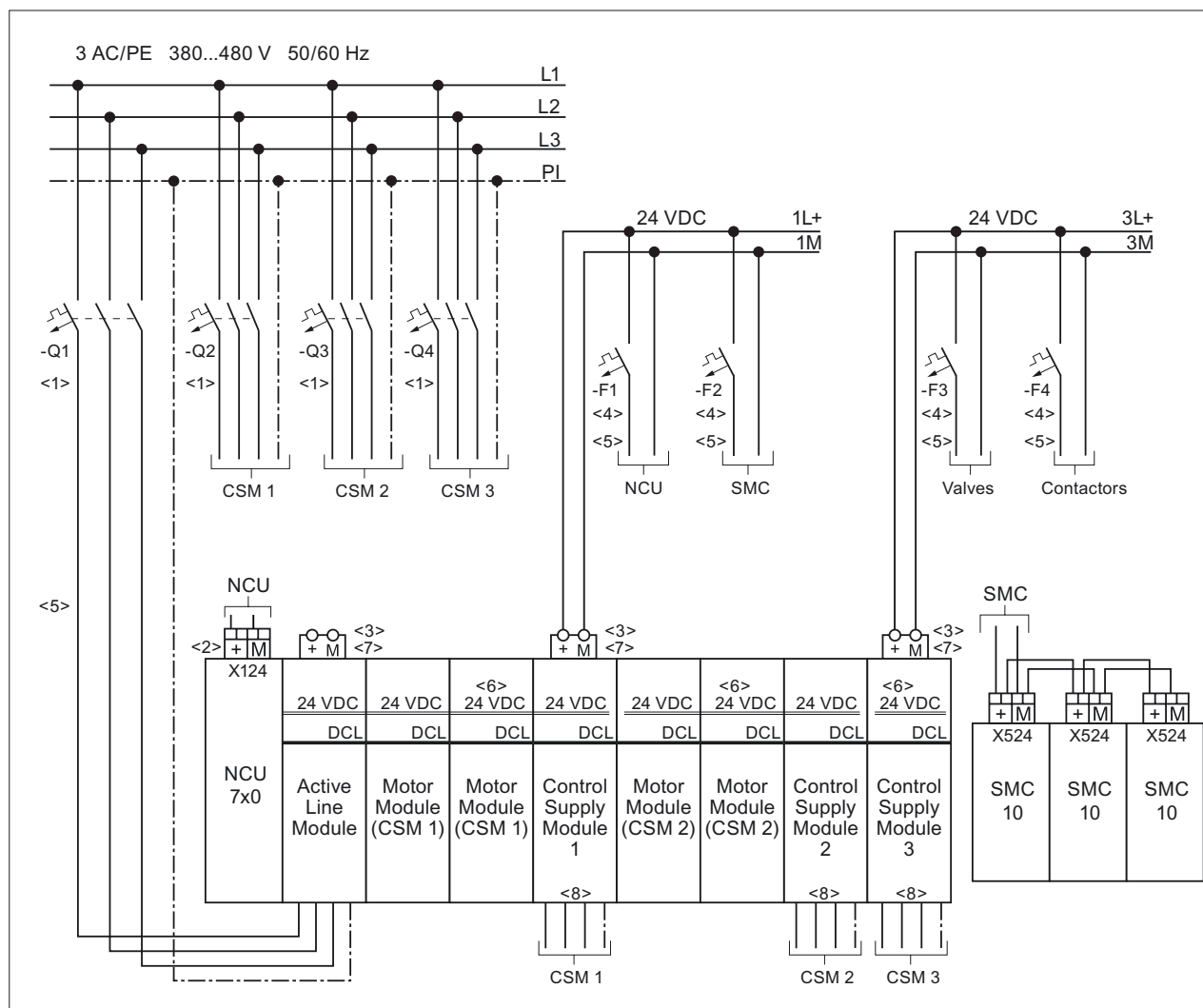## 5.7.4 Control Supply Module Power Supply - Connection Example

Figure 5-23   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 formed; also refer to the "Current Carrying Capacity of the DC Link Busbar" section.

5.8 Cable Lengths

5.8.1 General information

⚠️ **Danger**

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

5.8.2 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:

- Power supply cables 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

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 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 contact.

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 supply of the components, or they are integrated in the connector.

All cables inside the cabinet must be connected as closely as possible to parts connected with cabinet ground, such as a mounting plate or cabinet wall. Ducts made of sheet steel or routing cables between 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 lines (shielded and unshielded) connected to the drive line-up, must be routed as far as possible away from strong external magnetic fields (e.g. transformers, line reactors). In both cases, a distance of ≥ 300 mm is usually sufficient.

⚠️ **Caution**

The Voltage Clamping Module conducts a high leakage current via the functional ground. This means that a permanent PE connection must be provided for the cabinet (PE) rail.

Measures according to EN 61800-5-1 must be taken e.g. PE conductor ≥10 mm^2 Cu or fit an additional connection terminal for a PE conductor with the same cross-section as the original PE conductor.

Signal and DC power supply cables

Operating unshielded signal and direct current supply cables (e.g. 24 V infeed with external supply):

* Direct current supply cables: Max. permissible length: 10 m

* Unshielded signal cables: Max. permissible length: 30 m (without additional wiring)

For greater lengths, suitable wiring must be connected by the user to provide overvoltage protection. For example:

Table 5-23   Recommendations for overvoltage protection

DC supply	24 V signal cables
Weidmüller Type No.: PU DS 24V 16A	Weidmüller Type No.: MCZ OVP TAZ
Weidmüller GmbH & Co. KG An der Talle 89 33102 Paderborn Tel. 05252/960-0 Fax 05252/960-116 http://www.weidmueller.com	

Caution

The connected signal and power cables must not cover the ventilation slots.

Caution

Unshielded signal cables must not be routed parallel to power cables.

Table 5-24   Maximum cable lengths

Type	Maximum length [m]
24 V DC power cables [2]	10
24 V signal cables [2]	30
DC link, including extensions	10
Total length of power cables in the drive line-up comprising the following: Motor power cables, DC link cable(s) and line feeder cable from the line filter output	350 (shielded) 560 (unshielded)
Total length: Motor cables, line feeder cable from the Basic Line Filter to the Active Line Module	**< 150 (shielded)**
Total cable length with Voltage Clamping Module (limitations/constraints, refer to the Chapter, Voltage Clamping Module)	630 (shielded) 850 (unshielded)
Power cable between line filter and line reactor	10 (shielded/unshielded) [1]
Power cable between line reactor and Line Module	10 (shielded/unshielded) [1]
Power cable between Motor Module and motor ≤ 18 A	70 (shielded) 100 (unshielded)
Power cable between Motor Module and motor ≤ 30 A	50 (shielded) 75 (unshielded)
Power cable between Motor Module and motor ≤ 45 A	100 (shielded) 150 (unshielded)
DRIVE-CLiQ signal cables MC500	100
DRIVE-CLiQ signal cables MC800	50
DRIVE-CLiQ signal cables FIX	70
Cable between the Braking Module and braking resistor	10

[1] To comply with EMC limit values, shielded cables (preferably Motion Connect cables) must be used.

[2] For greater lengths, suitable circuitry must be connected by the user to provide overvoltage protection.

5.8.3 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 mm² 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 mm² 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.
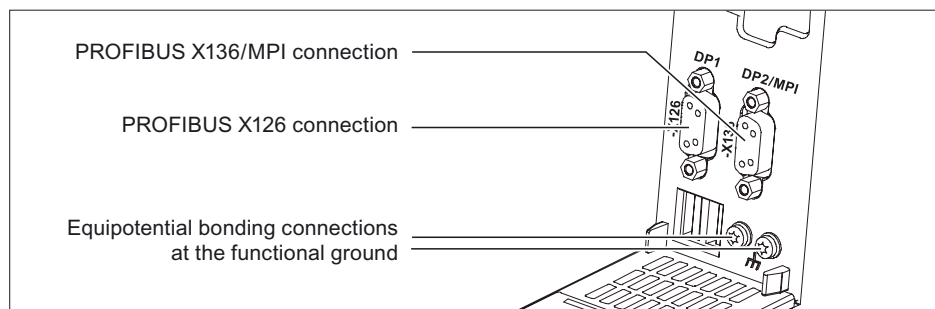
Figure 5-24   PROFIBUS and function ground connections

5.8.4 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.

5.9 Motor Connection

5.9.1 Motor Connection Power Cables

Power plugs on the motor with crimp connection for Motor Modules ≤ 30 A

Preassembled Motion Connect power cables should be used in preference to connect motors to Motor Modules ≤ 30 A. The appropriate module and motor power plugs are preinstalled on the power cables (cross-section ≤ 10 mm^2). The connection plugs use the crimp technology. These cables are primarily used for connection to Motor Modules ≤ 30 A.
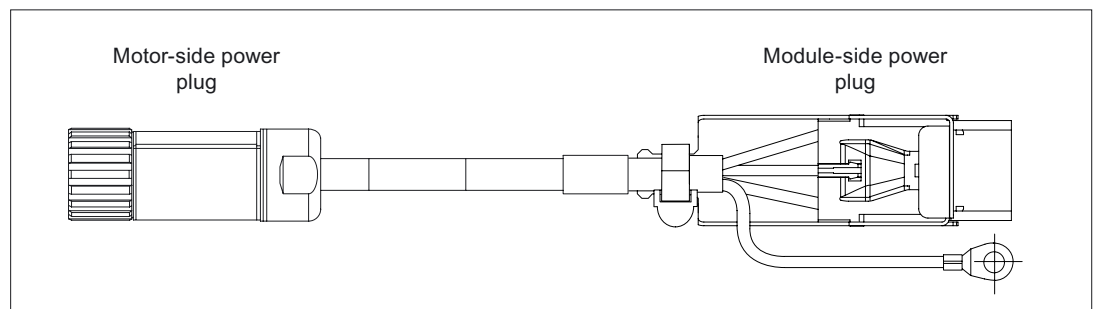

Motor-side power plug

Module-side power plug

Figure 5-25   Motor Module - motor connection for Motor Modules ≤ 30 A

If the power cable is required, for example, without module-side power connector (e.g. for simplified installation in trailed cable), this must be specified with the order. The crimp power connectors to be ordered separately for Motor Modules 3...30 A consist of power connector (without pin contacts) and additional required pin contacts. The pin contacts are available for cross-sections 1.5 mm^2, 2.5 mm^2, 4 mm^2, 6 mm^2 and 10 mm^2.
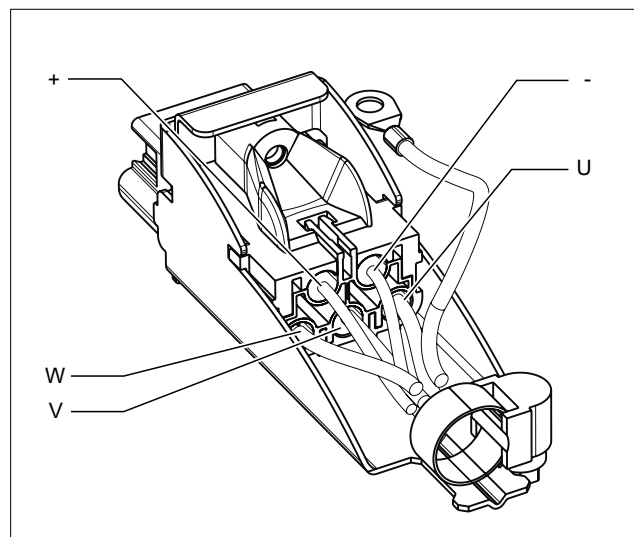
Figure 5-26   Motor-side power connector

Power plugs on the motor with screw connection for Motor Modules ≤ 30 A

Only the connector itself must be ordered for power connectors on the motor in the "screw connection" variant.
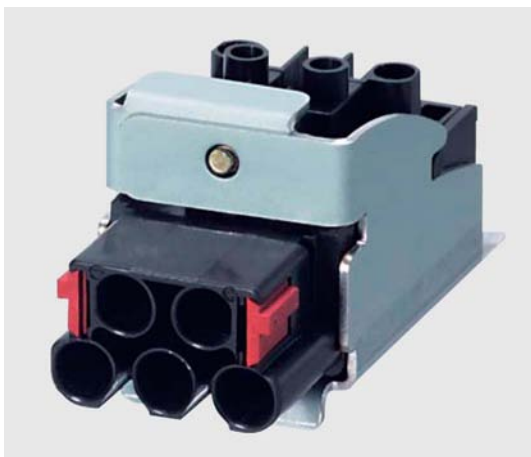
Figure 5-27   Power connector with screw connection

Direct connection for Motor Modules > 30 A

For Motor Modules > 30 A, the power cable is not connected using a power connector, but with a ring terminal end. Only the motor brake is connected using a brake connection plug supplied for preassembled cables.
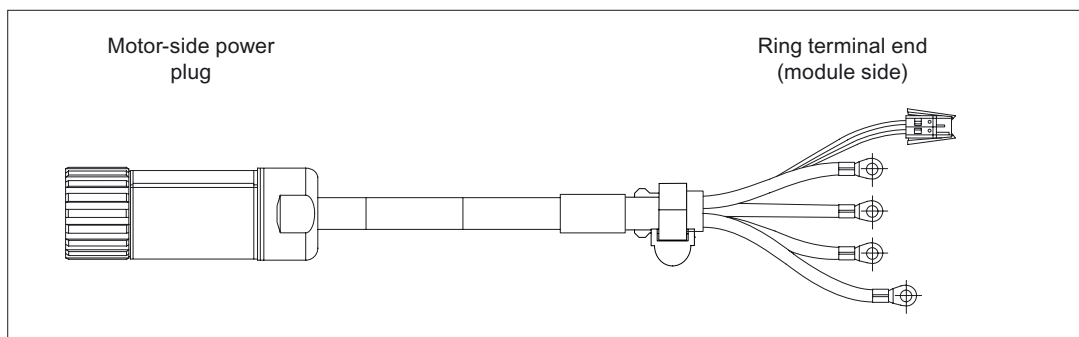
Motor-side power plug

Ring terminal end (module side)

Figure 5-28   Motor Module - motor connection for Motor Modules > 30 A

5.9.2 Connection Examples
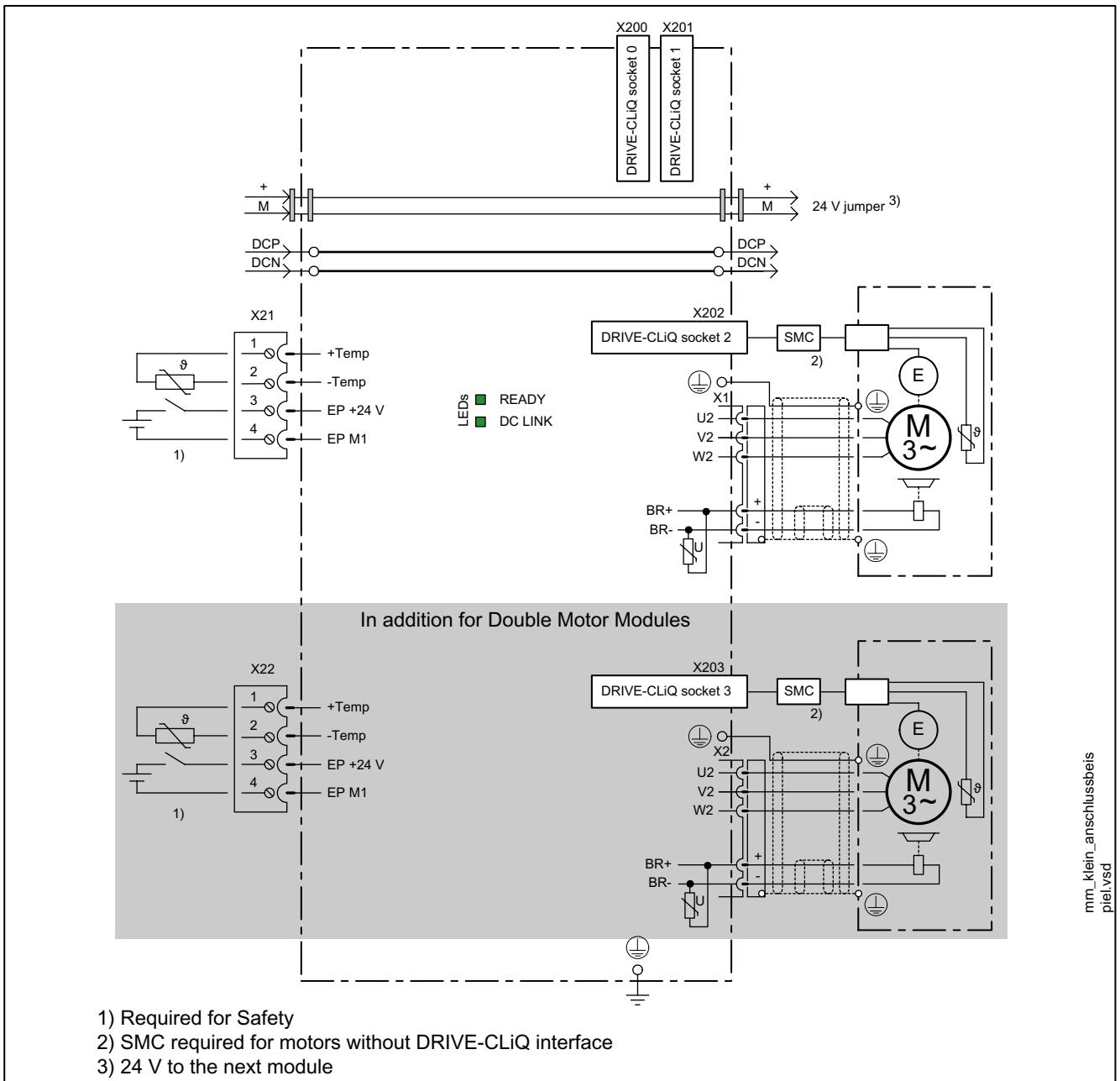
Figure 5-29   Connection example of Motor Modules 3 A to 30 A and Double Motor Modules 3 A to 18 A
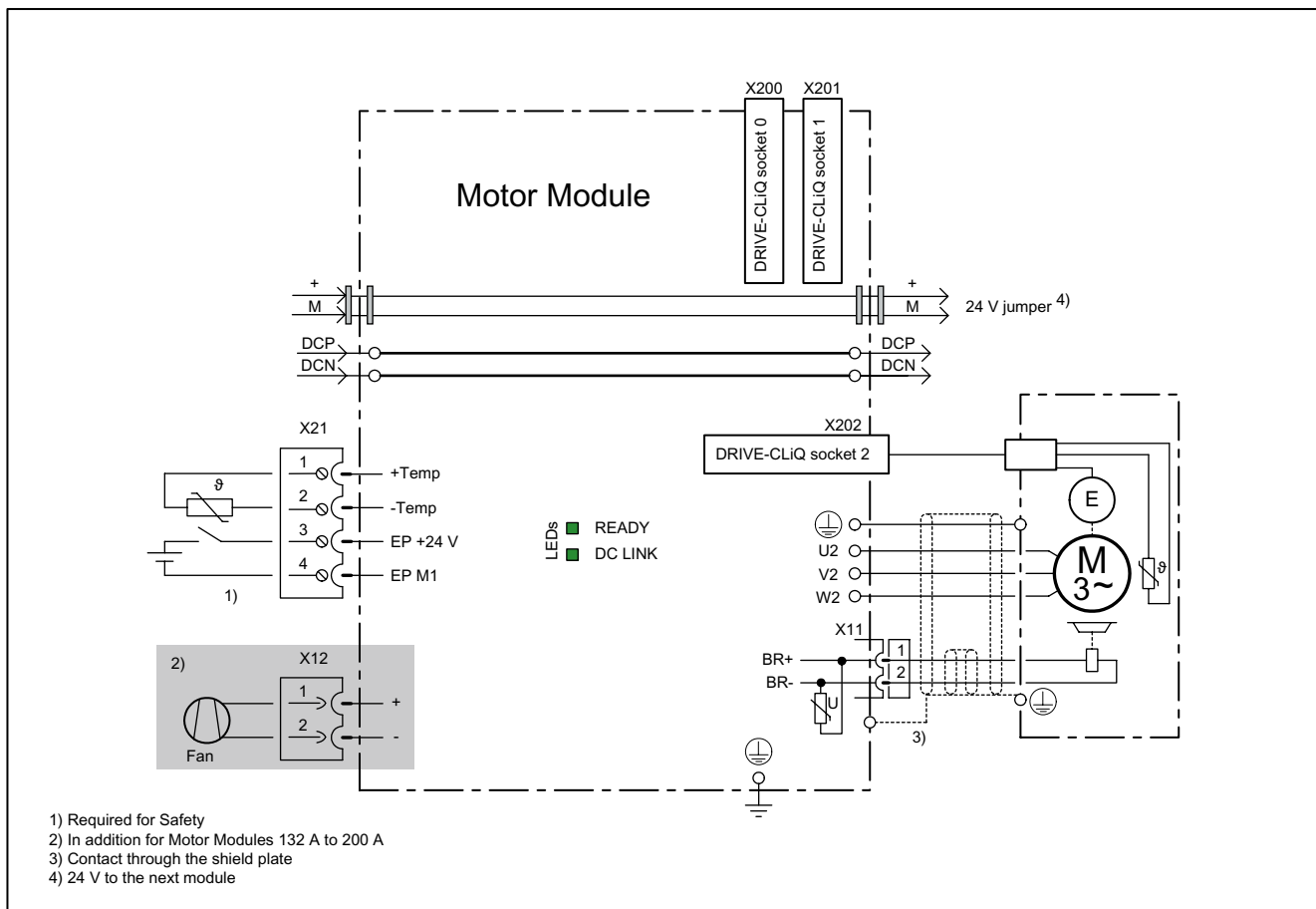
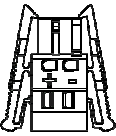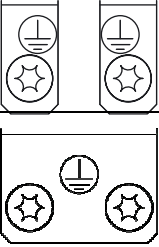Figure 5-30   Example connection of Single Motor Modules 45 A to 200 A
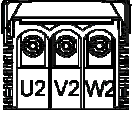
5.9.3   Motor/brake connection

Table 5-25   Terminal block 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-)	
	PE connection	Threaded hole M5/3 Nm [1]

[1] for ring cable lugs to DIN 46234

Table 5-26   Terminal block Single Motor Module 45 A to 200 A

	Terminals	Technical specifications
	U2	**45 A to 60 A:**
	V2	Threaded bolt M6/6 Nm [1]
	W2	**85 A:**
		Threaded bolt M8/13 Nm [1]
		132 A to 200 A:
		Threaded bolt M8/13 Nm [1]
	+ (BR+)	X11 brake connector [2]:
	- (BR-)	Voltage 24 V DC Max. load current 2 A Min. load current 0.1 A Max. connectable cross-section 2.5 mm^2 Type: Spring-loaded terminal 2 (see Connection Methods) Manufacturer: Wago; Order No.: 721-102/026-000/56-000 The brake connector is part of the prefabricated cable.
	PE connection	**Single Motor Module with a rated output current of 45 A to 60:**
		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
		Threaded bolt for motor cables: M8/13 Nm [1] Threaded hole for PE: M6/6 Nm[1]
		Single Motor Module with a rated output current of 132 A to 200 A
		Threaded bolt for motor cables: M8/13 Nm [1] Threaded hole for PE: M8/6 Nm [1]

[1] For ring cable lugs to DIN 46234

[2] The circuit for protecting the brakes against overvoltage is 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 total length of the shielded power cables (motor supply cables and DC link cables) must not exceed 350 m.

Note

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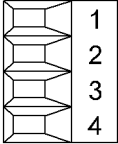

⚠ **Warning**

Only protective extra-low voltages (PELVs) that comply with EN60204-1 must be connected to all connections and terminals between 0 and 48 V DC.

The voltage tolerances of the motor holding brakes must be taken into account.

5.9.4 X21/X22 EP terminals / temperature sensor connection motor module

Table 5-27   Terminal block X21/X22

	Terminal	Function	Technical data
	1	+Temp	Temperature sensor connection KTY84–1C130/PTC
	2	-Temp	
	3	EP +24 V (Enable Pulses)	Supply voltage: 24 V DC (20.4 V - 28.8 V)
1 2 3 4	4	EP M1 (Enable Pulses)	Current consumption: 10 mA Optically isolated input Signal propagation times: L → H: 100 µs H → L: 1000 µs
Max. connectable cross-section 1.5 mm^2			
Type: Screw terminal 1 (see Connection Engineering section)			

Notice

The KTY temperature sensor/the PTC must be connected with the correct polarity.

Note

The temperature sensor connection is required for motors for which the temperature value is not transferred using DRIVE-CLiQ.
If the "Safe standstill" function is selected, for operation, ground must be placed at the -X21:3 24 VDC and the -X21:4 terminal. For cancelation, a pulse suppression will be activated.

5.10 Sensor Systems Connection

5.10.1 Introduction

The sensor 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 with DRIVE-CLiQ interfaces can be connected to the associated Motor Module via the available MOTION-CONNECT DRIVE-CLiQ cables. In this way, the motor sensor and temperature signals as well as the electronic type plate data, such as the unique identification number, rated data (voltage, current and torque) are transferred directly to the Control Unit. These motors simplify commissioning and diagnosis because the motor and sensor type are identified automatically.

Motors without DRIVE-CLiQ interfaces

The sensor and temperature signals from motors without DRIVE-CLiQ interfaces, as well as external sensors must be connected via Sensor Modules. Sensor Modules Cabinet-Mounted (IP20) for the direct installation in control cabinets and Sensor Modules External (IP67) for the installation outside control cabinets are currently available, .

Only one encoder system can be connected to each Sensor Module.

Motors with DRIVE-CLiQ interfaces

The encoder systems can be connected to SINAMICS S120 via DRIVE-CLiQ. Motors with DRIVE-CLiQ interface are available for this purposes, e.g. 1FK7 synchronous motor.

Motors with DRIVE-CLiQ interfaces can be directly connected to the associated Motor Module via the available MOTION-CONNECT DRIVE-CLiQ cables. 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 V DC 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) directly to the Control Unit. This means that for the various encoder types - e.g. resolver or absolute value encoder - different encoder cables are no longer required; just one MOTION-CONNECT DRIVE-CLiQ cable can be used for all types.

Further information

Motor sensors and temperature signals should preferably be connected to the associated Motor Module, while external sensors should be connected to the Control Unit.

5.10.2 Description

Sensor Modules Cabinet-Mounted (SMC)

Cabinet-mounted Sensor Modules (SMC) can be ordered and configured separately. They are used when a motor with a DRIVE-CLiQ interface is not available and when external sensors in addition to the motor sensor are required. Only one sensor system can be connected to each cabinet-mounted Sensor Module (SMC). Only sensor systems in which the power supply for the sensor system is not grounded may be connected.

Note

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

SMC10   SMC20   SMC30
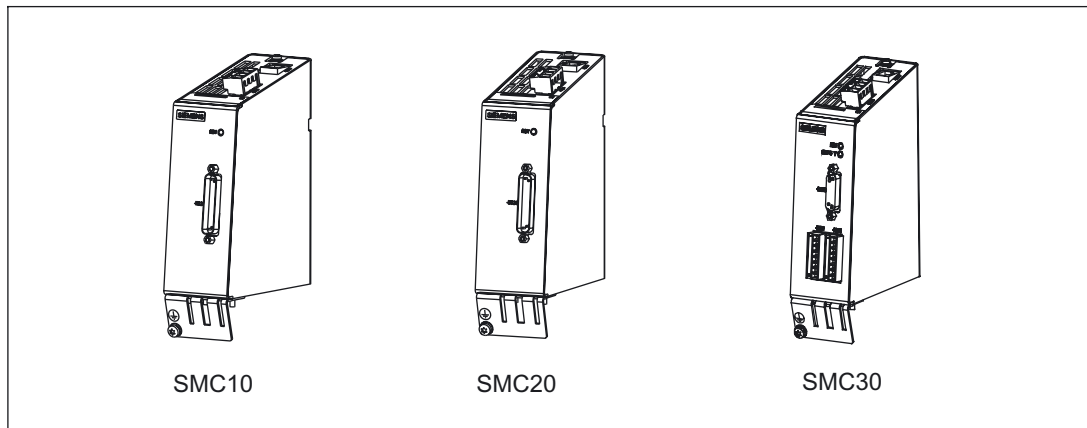
Figure 5-31   Sensor Modules Cabinet-Mounted (SMC)

Sensor Modules External (SME)

Measuring systems outside the cabinet can be connected directly to the Sensor Module External (SME). The SME evaluates these measuring systems and converts the calculated values to DRIVE-CLiQ. No motor or sensor data is stored in the SME.

Note

The SME supplies the power to the sensor; the SME, however, must be provided separately with 24 VDC power. The power is supplied to the SME from the connected DRIVE-CLiQ cable. This must be taken into consideration when the DRIVE-CLiQ cable is selected.

| SME20/25 | SME120 | SME125 |
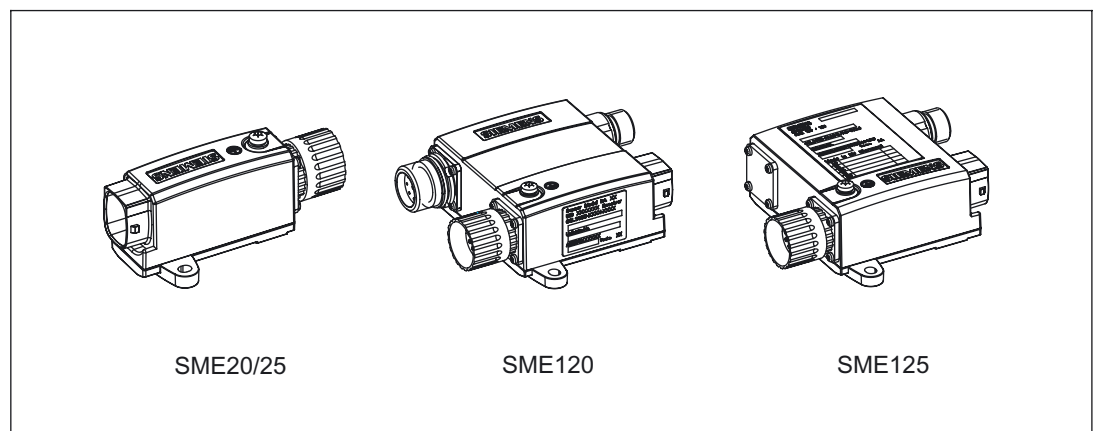
Figure 5-32   Sensor Modules External (SME)

Connectable sensor systems
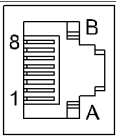
Table 5-28   Connectable sensor systems

Measuring systems	SMC			SME			
	SMC10	SMC20	SMC30	SME20	SME25	SME120	SME125
Resolver	Yes	-	-	-	-	-	-
sin/cos incremental encoder (1 Vss) with / without reference signal	-	Yes	-	Yes	-	Yes	-
Absolute encoder EnDat	-	Yes	-	-	Yes	-	Yes
Incremental encoder TTL/HTL	-	-	Yes	-	-	-	-
SSI absolute encoder [1]	-	Yes	Yes	-	-	-	-
Temperature evaluation	Yes	Yes	Yes	-	-	Yes (electrically isolated)	Yes (electrically isolated)

[1]As of Order No. 6SL3055-0AA00-5CA1 and Firmware 2.4

5.10.3 X200-X203 DRIVE-CLiQ interface

Table 5-29   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	GND (0 V)	Electronic ground
Blanking plate for DRIVE-CLiQ interface: Molex, order number: 85999-3255			

5.10.4 Sensor Connections
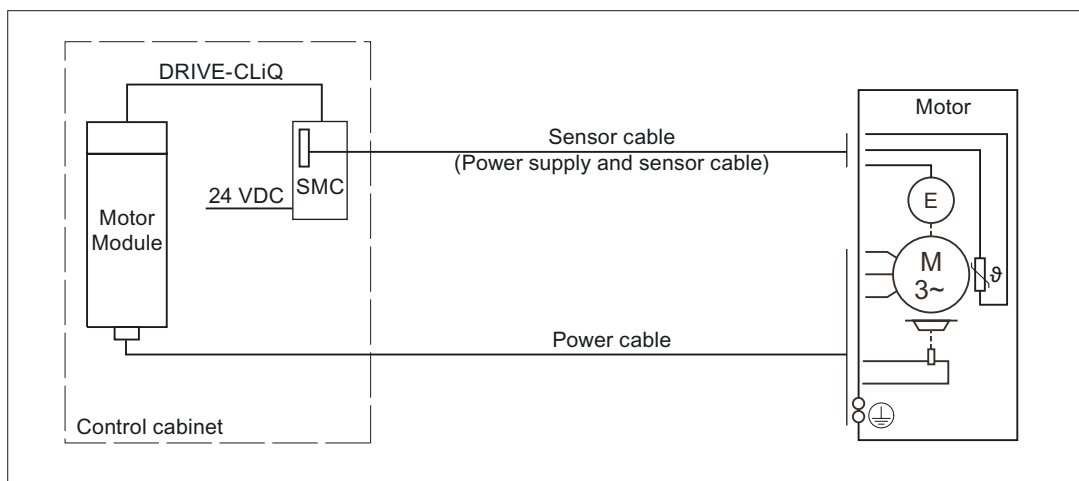
Figure 5-33   Sensor connection using Sensor Module Cabinet (SMC)
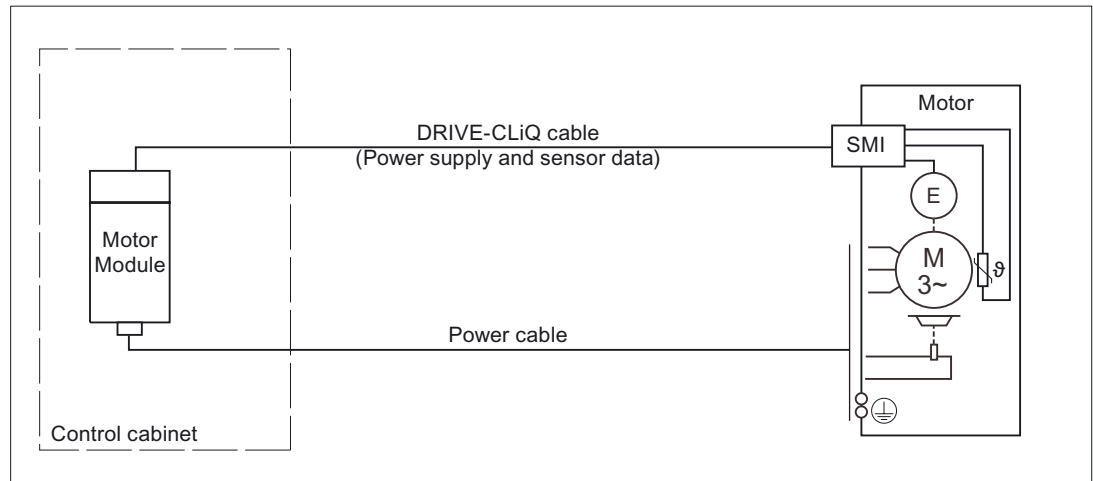
Figure 5-34   Sensor connection via a motor with a DRIVE-CLiQ interface
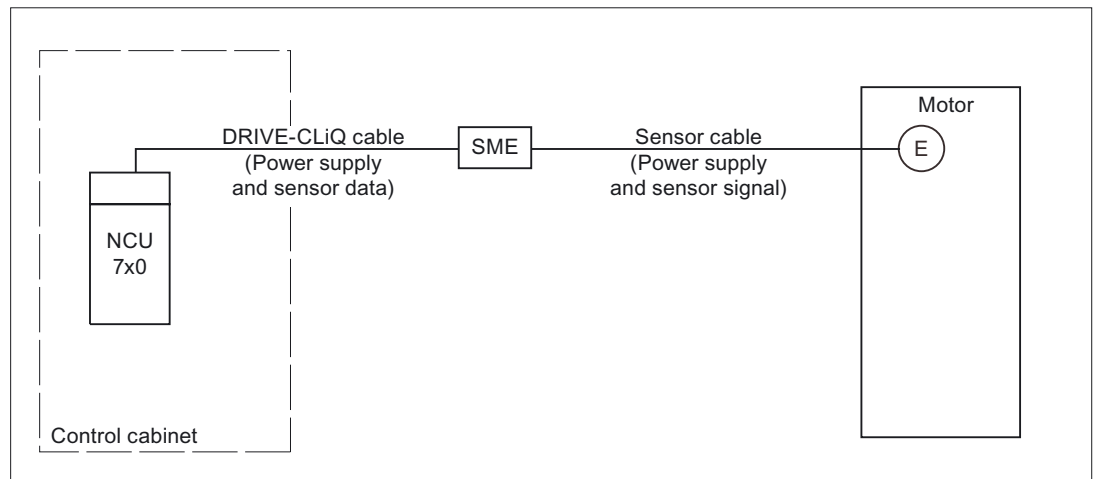
Figure 5-35   Sensor connection using Sensor Module External (SME)

5.11 Brake Connection

5.11.1 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.

In addition, the residual risks must be evaluated, for example, the effects of hanging axes.

5.11.2 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 for the BR+/BR- connection terminals is supplied 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.

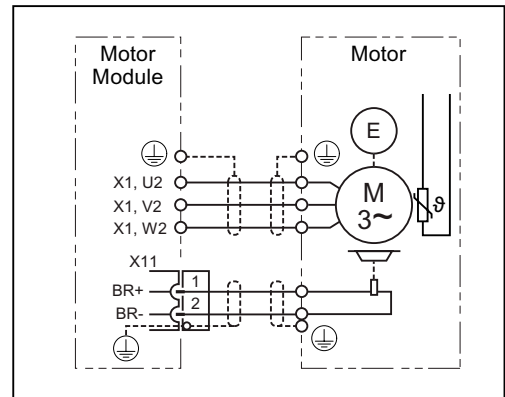- Connection for the device size 3 A to 30 A or 2 x 3 A to 2 x 18 A

  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
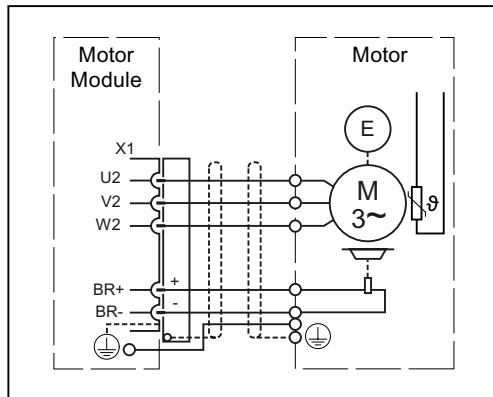
Motor Module 3 A to 30 A;   Motor Module 45 A to 200 A
2 x 3 A to 2 x 18 A

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.

5.11.3 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.
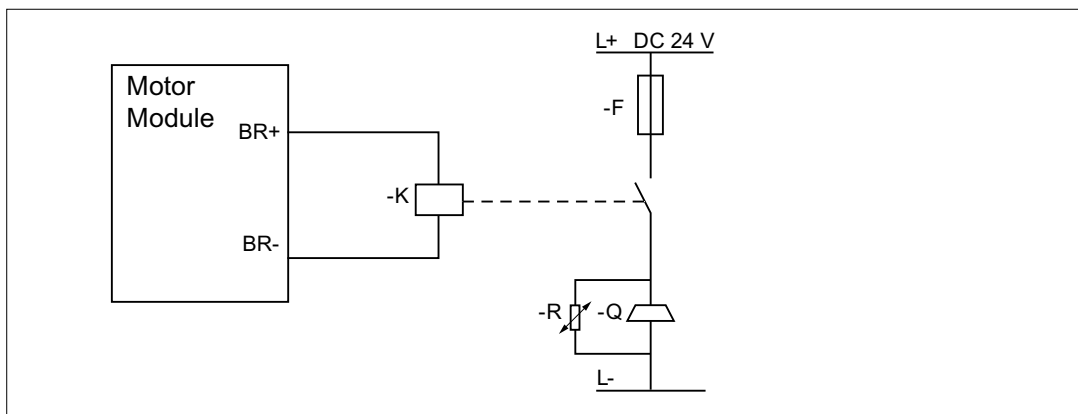
Brake current IBR > 2 A DC

Figure 5-36   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.
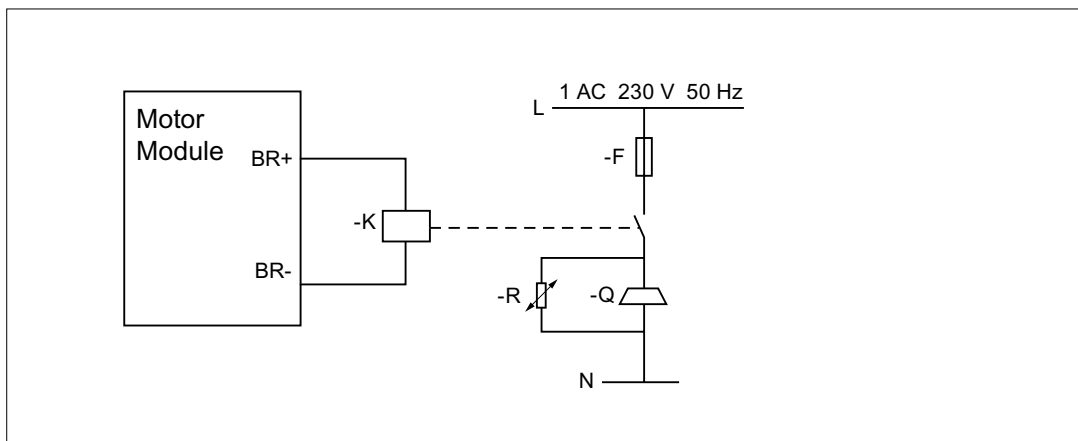
Figure 5-37   Supply voltage not 24 VDC.

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).

5.12 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] Parameter 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:

- Open 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. The unconditional opening of the holding brake, for example, can lead to dangerous motions for hanging axes. Additional safety measures may need to be adopted.
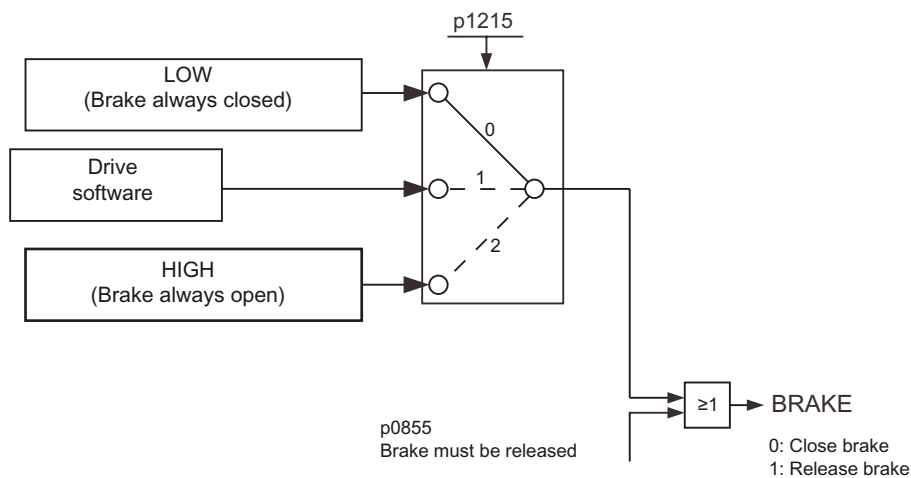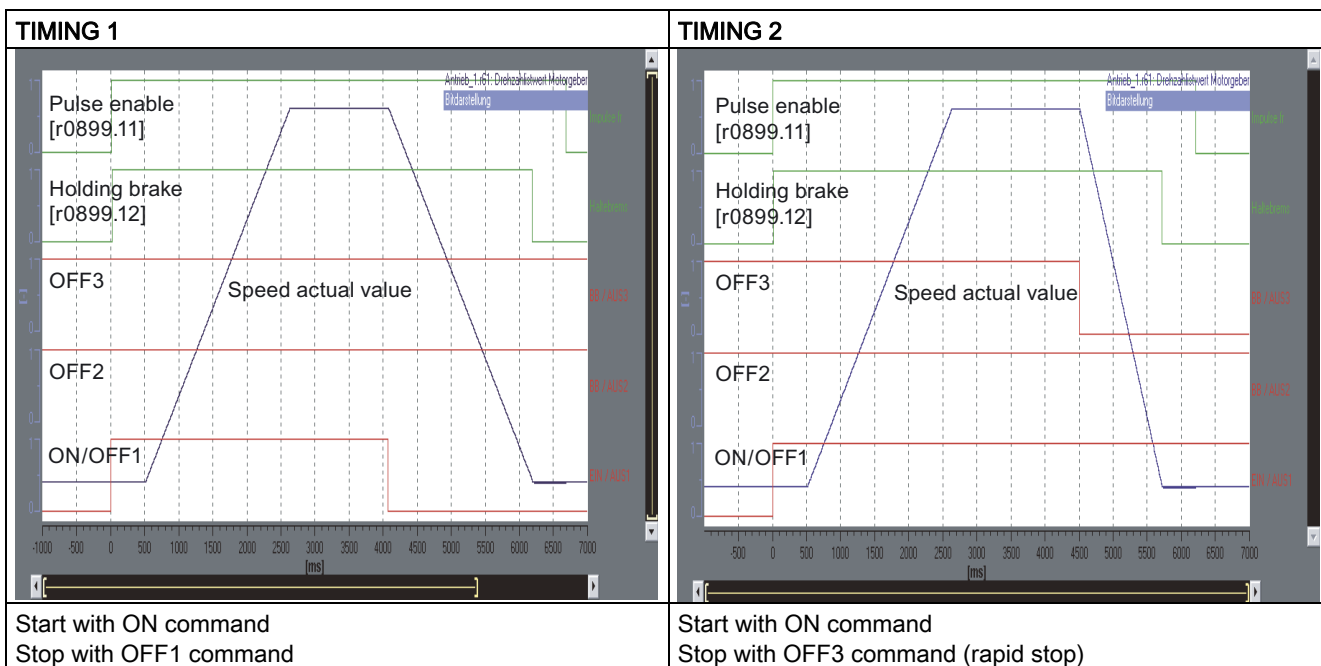

Figure 5-38   Operating modes of the conventional brake control

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.

TIMING 1	TIMING 2
Start with ON command Stop with OFF1 command	Start with ON command Stop with OFF3 command (rapid stop)

TIMING 3	TIMING 4
Start with ON command Stop with OFF2 command (coast to standstill)	Start with ON command Stop with OFF1 command and during the braking Stop with OFF3 command
TIMING 5	
Start with ON command Stop with OFF1 command, then Stop with OFF3 command (rapid stop), then Stop with OFF2 command (coast to standstill)	

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.

The "Safe brake control" does not detect any fault in the holding brake itself, such as a short-circuit of the brake winding, brake worn out, 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 dynamization" cycle must be controlled appropriately externally and mechanically, for example, using a brief interruption of 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.
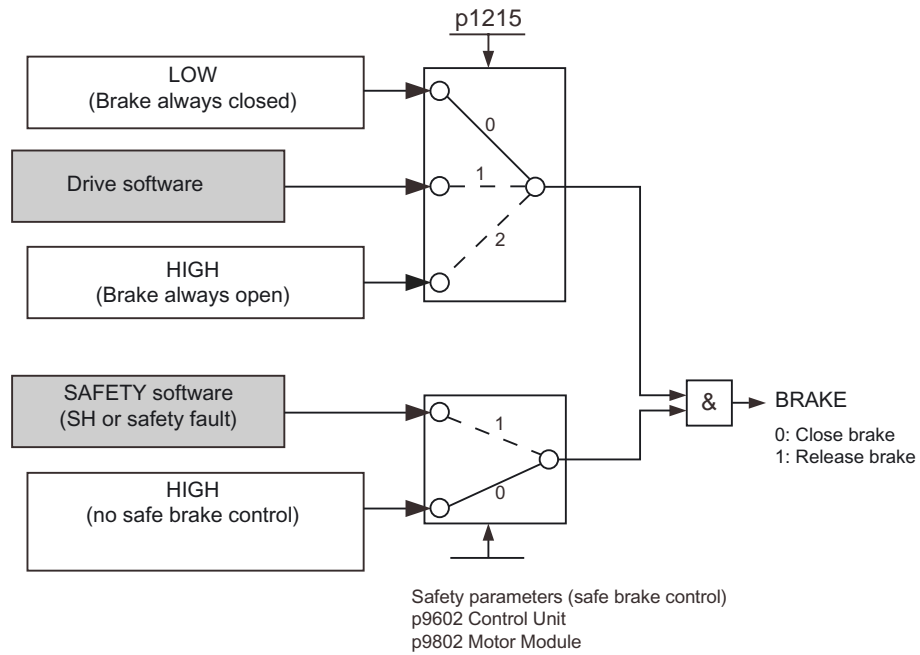
Figure 5-39   Operating modes of the safe brake control

5.13 Voltage Protection Module (VPM)

5.13.1 Voltage Protection Module (VPM)

Introduction

The VPM (Voltage Protection Module) is used for the 1FE1 and 2SP1 motors and for motors with an electromagnetic force (EMF) of 800 V to 2000 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 (VPM) detects an excessive DC link voltage (> 800 V) and short-circuits the three motor supply cables. The energy remaining 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**
>
> For non-observance and if the limit values specified for the technical data are exceeded (see VPM user's guide), there is the danger of device overloading, damage to the device and the impairment of the electrical safety.

> **Notice**
>
> The device must be equipped with a safety switching unit and may be used only for its proper purpose. Other uses, for example, operational armature short-circuit, etc., are not permitted.
>
> The warning notices attached to the device must be observed.

An operation with VPM is possible only in conjunction with SINAMICS, SIMODRIVE 611digital, SIMODRIVE 611 universal HR/HRS and 1FE1/2SP1 motors. Shielded 6FX8 motor supply cables must be used with the VPM.

⚠ **Warning**

In a fault situation, voltages as high as 2 kV can occur at chafed or damaged cables.

Depending on the speed of the motors, the motor terminal voltage of the 1FE1 motors can attain values as high as 2 kV.
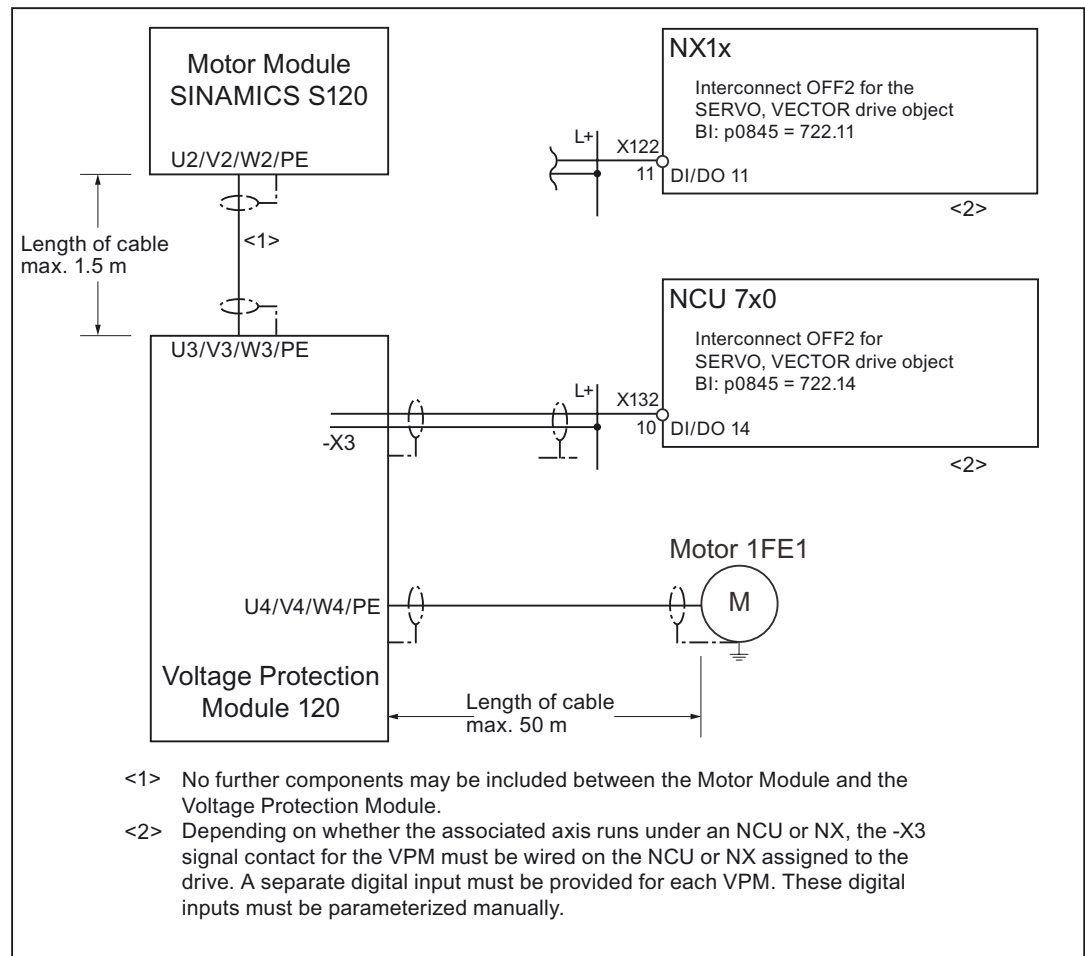
Connection example for VPM 120

<1> No further components may be included between the Motor Module and the Voltage Protection Module.

<2> Depending on whether the associated axis runs under an NCU or NX, the -X3 signal contact for the VPM must be wired on the NCU or NX assigned to the drive. A separate digital input must be provided for each VPM. These digital inputs must be parameterized manually.

Figure 5-40   Voltage Protection Module 120 connection

Signal contact X3

The X3 signal contact closes after t > 2 min or after resetting the temperature switch.

$\vartheta_{off} \geq 77,5$ °C
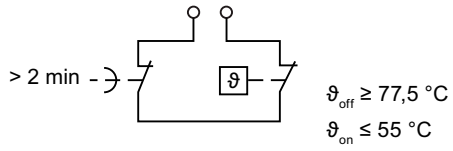
$\vartheta_{on} \leq 55$ °C

Figure 5-41   Signal contact X3 of the Voltage Protection Module

Warning

Measures must be adopted to prevent the drive from starting by itself!

Signal Interconnection

<div style="text-align: right; font-size: 3em;">6</div>

Introduction

The ACX macros assign functions to the NCU and NX terminals (see the "NCU/NX Terminal Assignment" section).

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. For safety functions, the NCU and NX or the Motor Modules must be controlled in accordance with the required safety categories (see the "Safety Integrated" section).

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

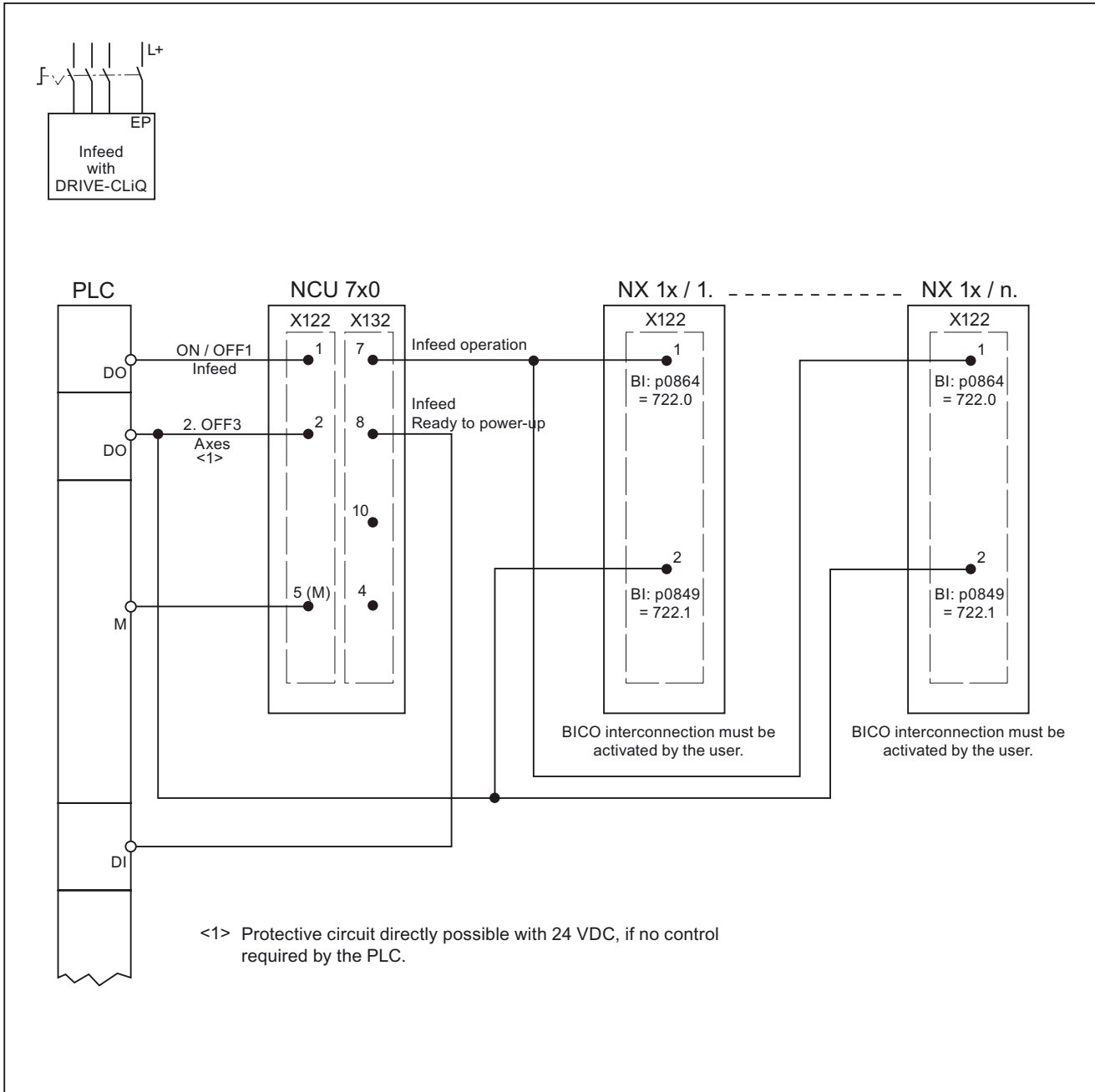[4]   Line contactor provided, with safe control

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 when the "1" signal is on.

Interconnection of the PLC output signals

- "ON/OFF1" of the infeed (NCU terminal X122.1)

  The 0/1 edge activates the infeed. A lock 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 made from 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).
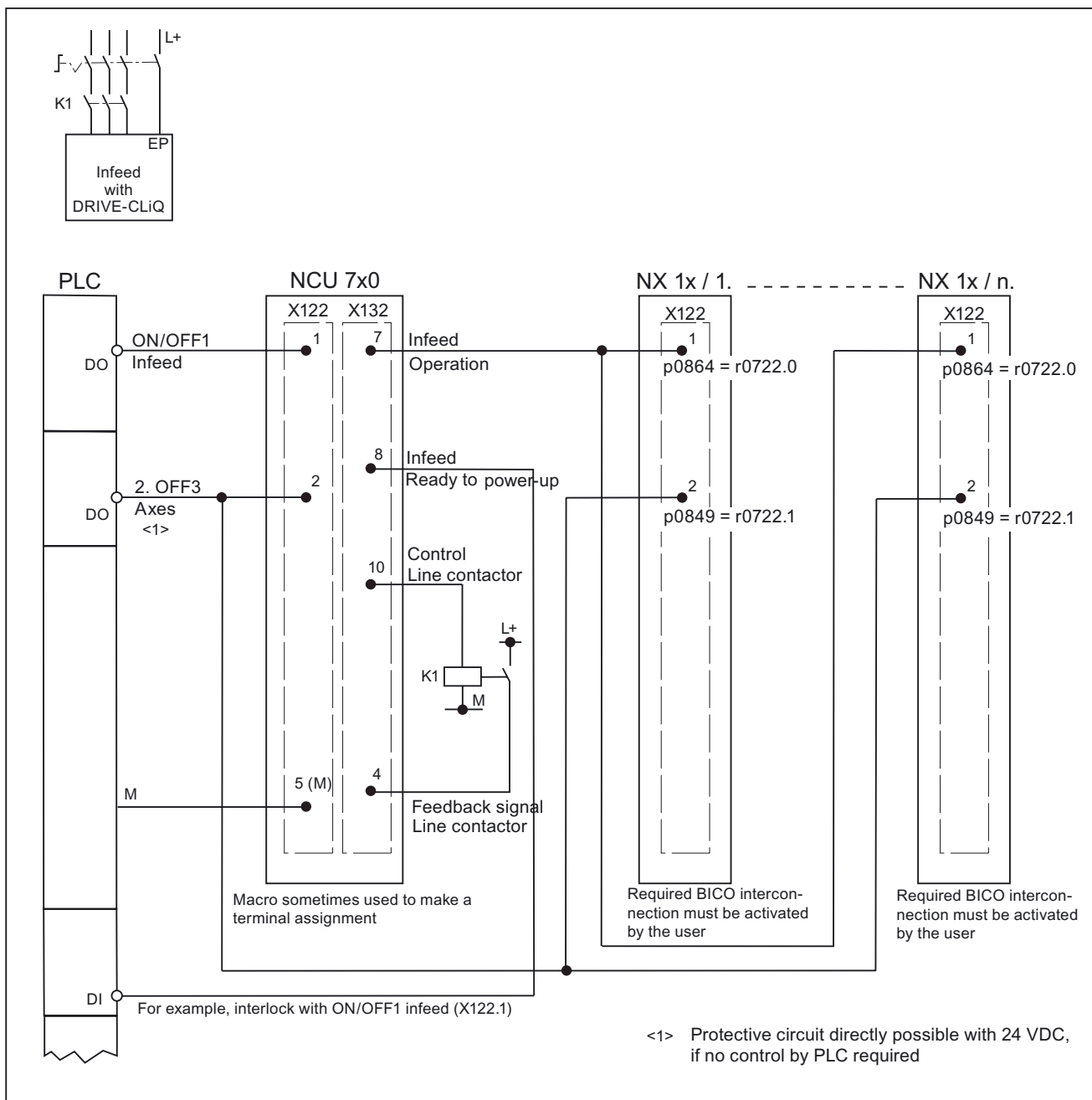
6.2 Application 2

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 when the "1" signal is on.

Interconnection of the PLC output signals

- "ON/OFF1" of the infeed (NCU terminal X122.1)

  The 0/1 edge activates the infeed. A lock 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 made from 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).

Line contactor control

- The line contactor is controlled from the "Line contactor control" function (NCU terminal X132.10). The signal state for the line contactor (make 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 made with standard signals with regard to the safety engineering. If the appropriate safety categories must be satisfied, the control must be made in accordance with the required safety categories using a safety controller.
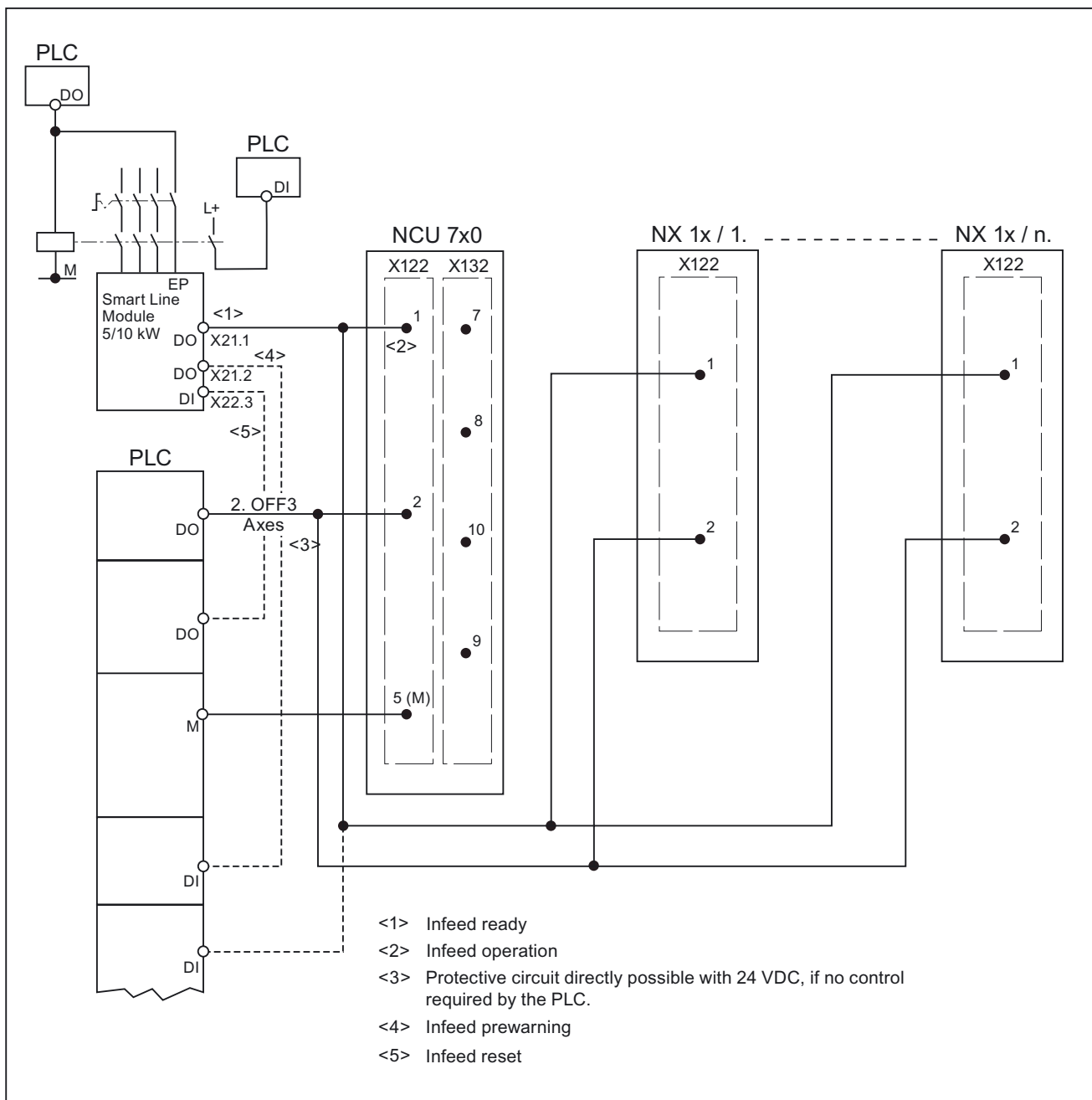

6.3 Application 3

Figure 6-3   Infeed without DRIVE-CLiQ (SLM 5/10 kW); line contactor without safe control

<1>   Infeed ready
<2>   Infeed operation
<3>   Protective circuit directly possible with 24 VDC, if no control required by the PLC.
<4>   Infeed prewarning
<5>   Infeed reset

Interconnection of the PLC input signals

- "Infeed Ready" (SLM terminal X21.1)

  The infeed is operating when the "1" signal is on.

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 made from a PLC. A fixed protective circuit with 24 VDC 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 using 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. An 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 using the input/output condition

⚠️ **Caution**

If the named conditions are not observed, the line contactor and the infeed can be damaged.

Notice

The described control is made with standard signals with regard to the safety engineering. If the appropriate safety categories must be satisfied, the control must be made 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 using 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 prewarning

Interconnection of the PLC output signals

- "Infeed Reset" (SLM terminal X22.3)

  Reset of a pending fault

6.4 Application 4
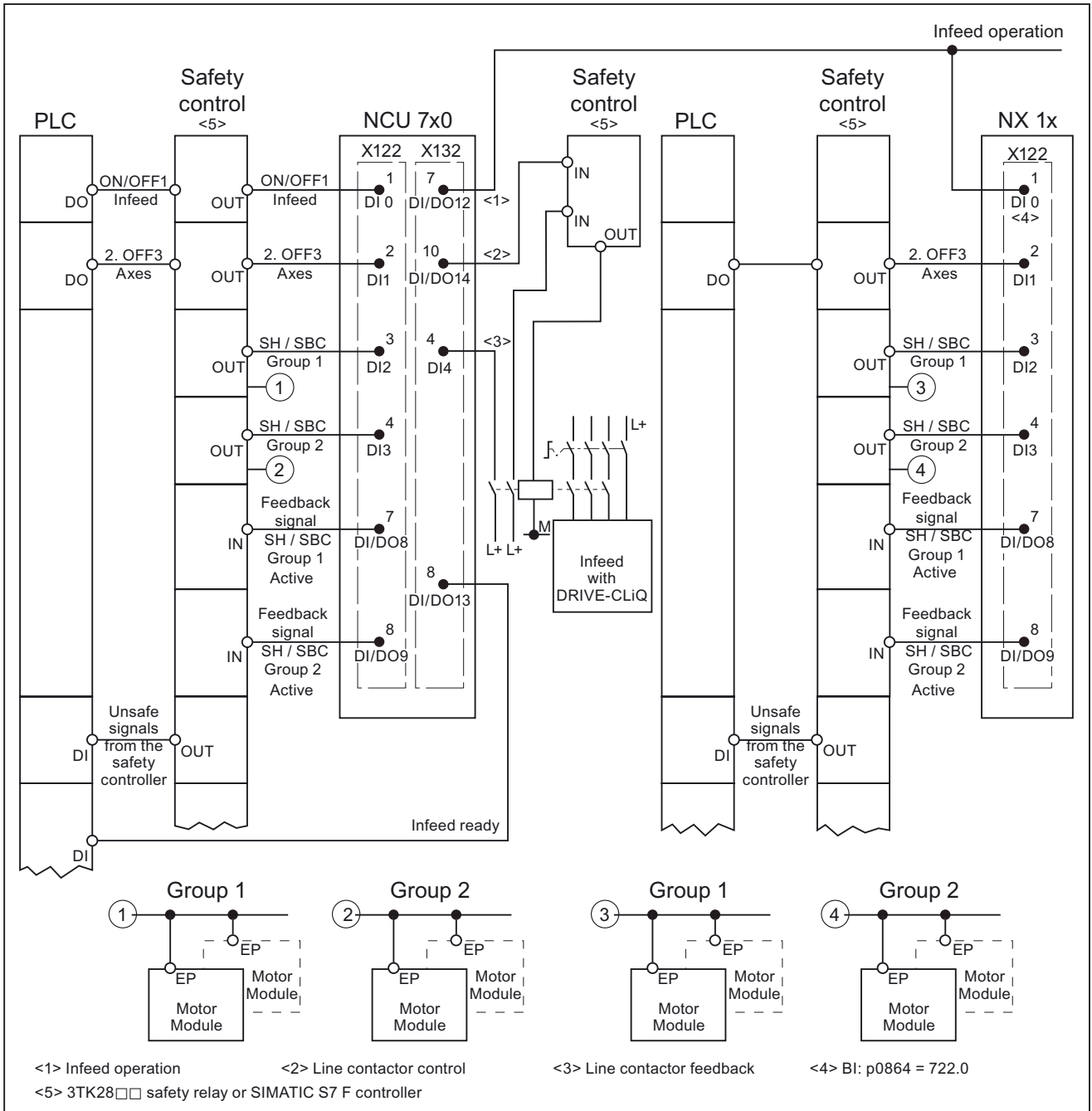
Figure 6-4   Infeed with DRIVE-CLiQ (SLM/ALM 16 kW to 120 kW), use of a drive-integrated SH/SBC safety function by SINAMICS and line contactor with safe control

Interconnection of the PLC input signals

- "Infeed ready" (NCU terminal X132.8)

  The infeed is ready when the "1" signal is on.

Interconnection of the PLC output signals

Notice

To achieve a 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 required so that a deactivation 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. A lock 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 provided NX components (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 starting from standstill of the motor connected to the drive device.

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 from the "Line contactor control" function (NCU terminal X132.10). The signal state for the line contactor (make 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.
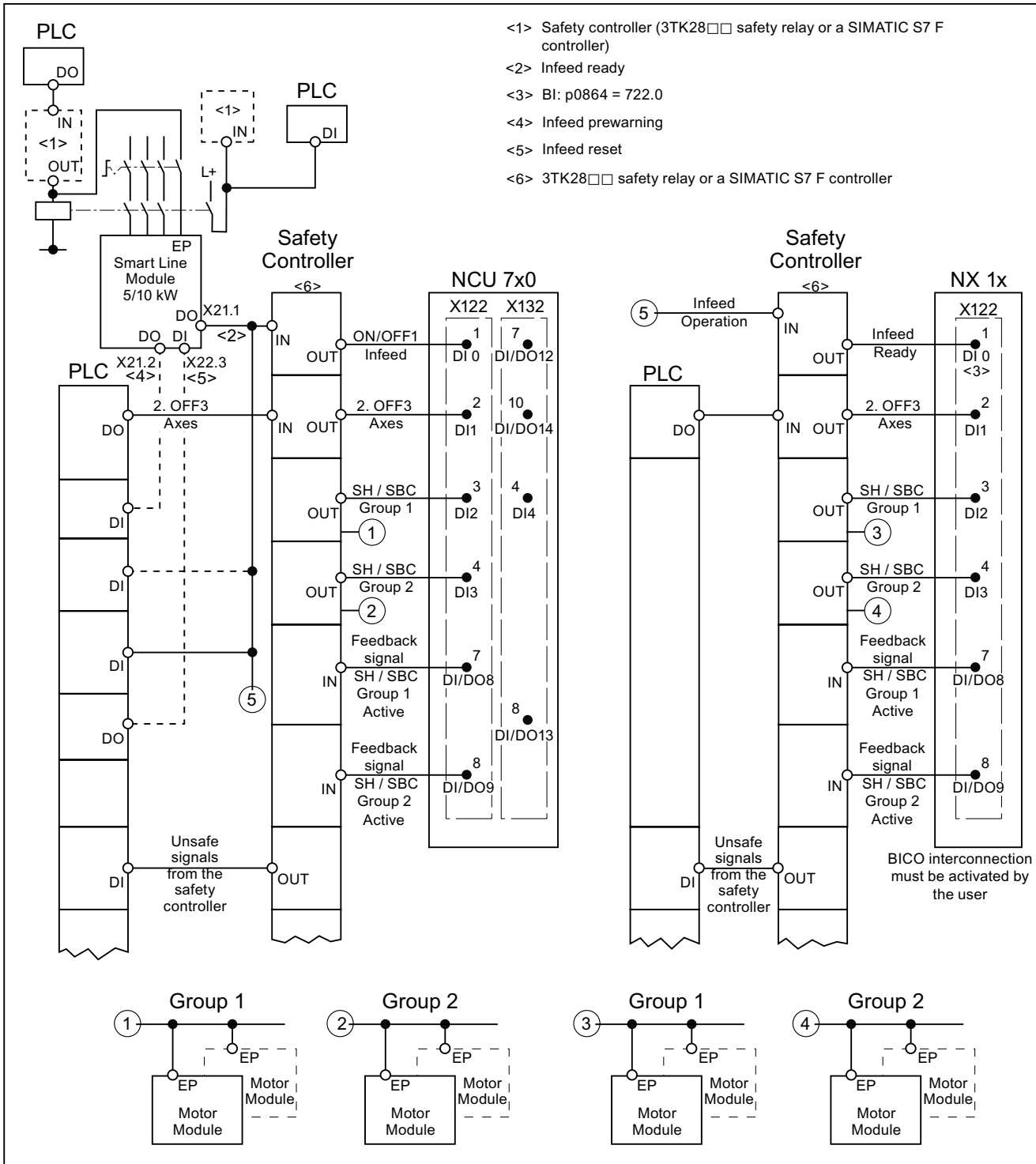
6.5 Application 5

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 when the "1" signal is on.

Interconnection of the PLC output signals

Notice

To achieve a 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 required so that a deactivation 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 provided NX components (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 using 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 starting from standstill of the motor connected to the drive device.

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. An 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 using the input/output 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 using 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 prewarning

Interconnection of the PLC output signals

- "Infeed Reset" (SLM terminal X22.3)

  Reset of a pending fault

6.6 Application 6
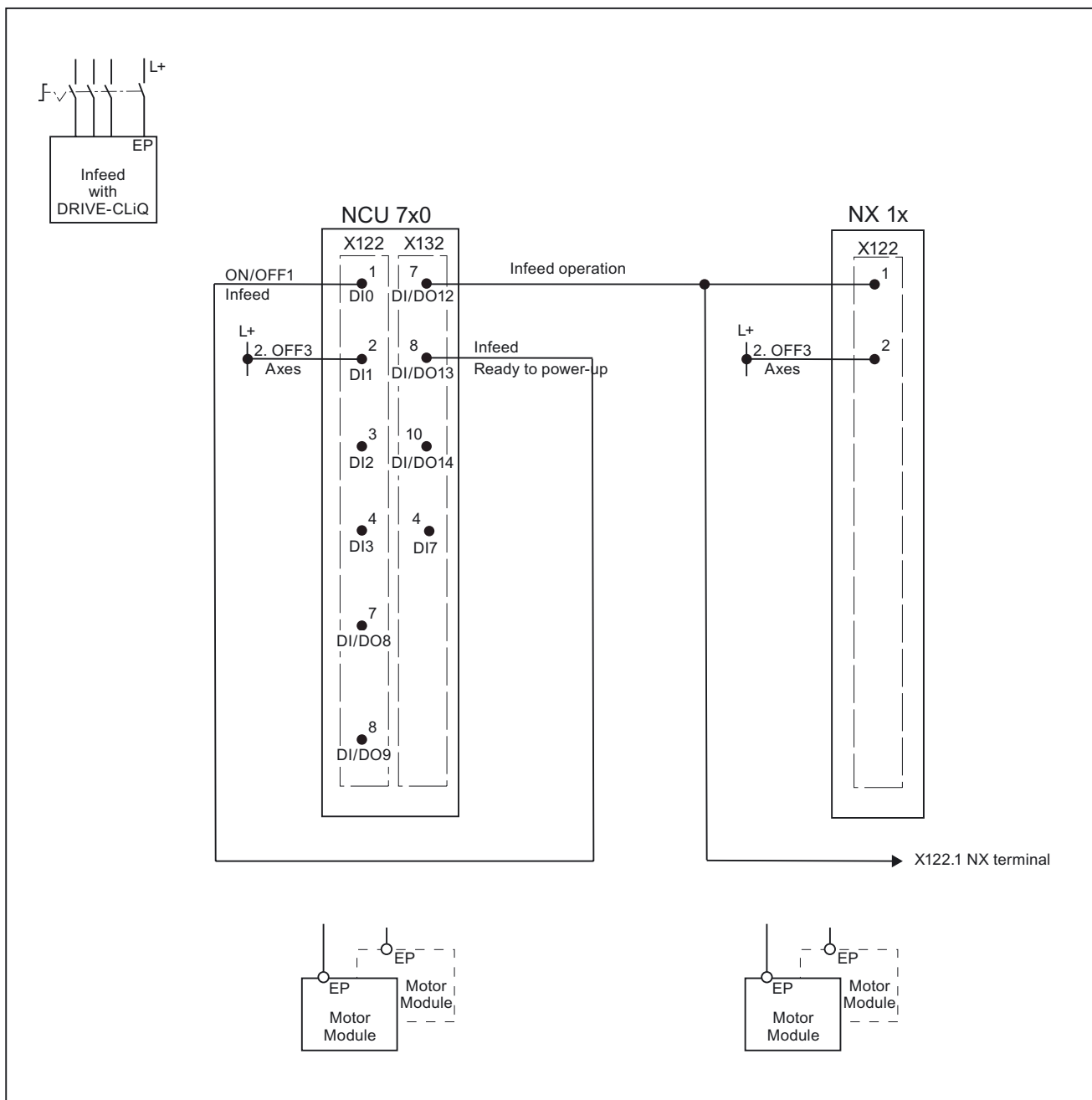
Figure 6-6   Infeed with DRIVE-CLiQ (SLM/ALM 16 kW to 120 kW); use of the system/drive-integrated safety function of the SINUMERIK

Interconnection to the NCU component

- "Infeed ready" (NCU terminal X132.8)

    The infeed is ready when the "1" signal is on.

- "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 VDC.

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 startup, 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 using NCU/NX functions 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 starting from standstill of the motor connected to the drive device.

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 possibly the main power switch turned off.
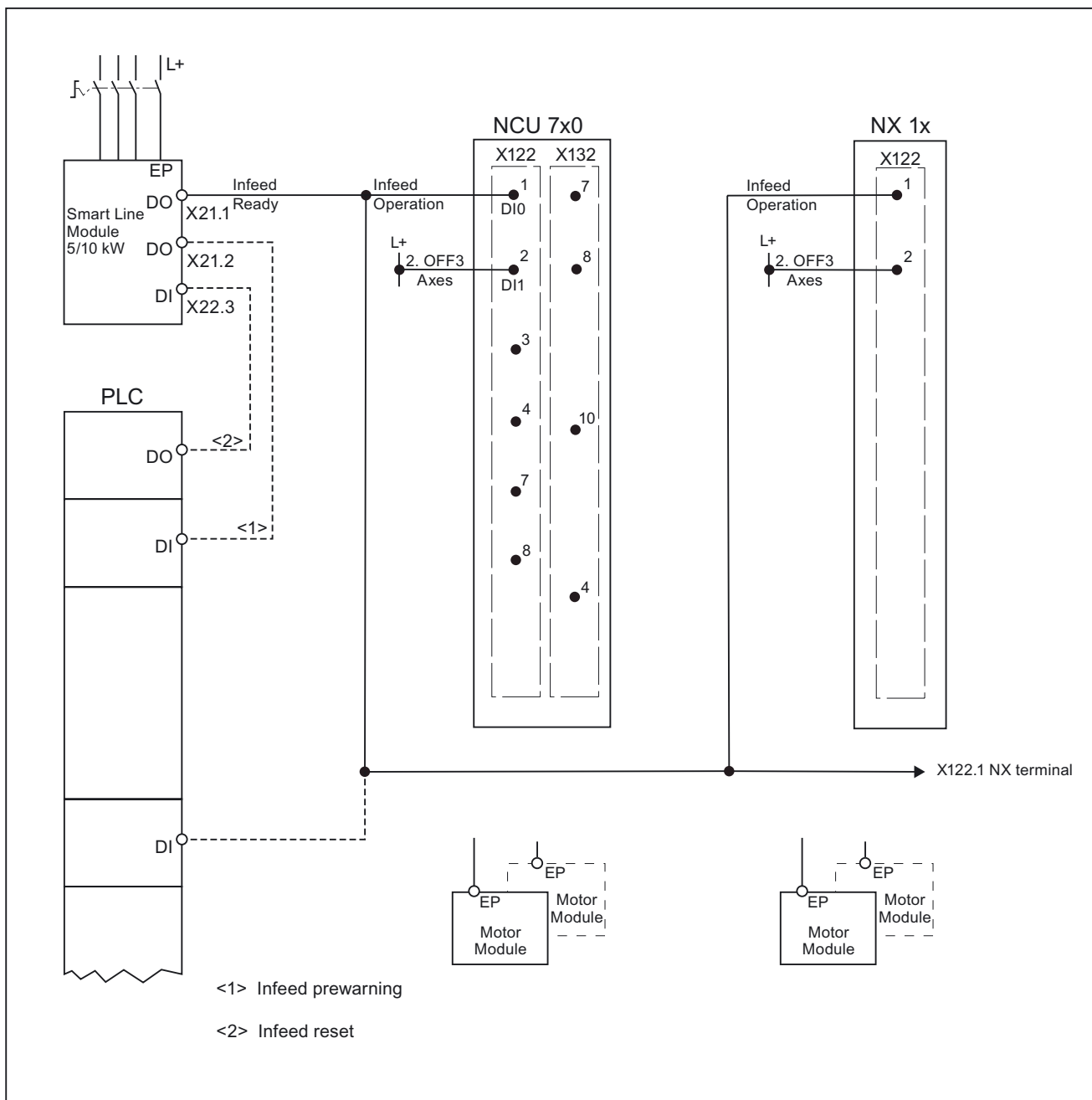

6.7 Application 7

Figure 6-7   Infeed without DRIVE-CLiQ (SLM 5/10 kW); use of the system/drive-integrated safety function of the SINUMERIK

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 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 VDC.

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 using 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 prewarning

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 using NCU/NX functions 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 starting from standstill of the motor connected to the drive device.

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 possibly the main power switch 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.

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.

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 requirements placed on the environmental conditions (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.

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

Device selection:

=1.-Q11	**Main power switch with leading auxiliary switch for switching off**
	The main switch disconnects the electrical equipment from the energy supply. The main power switch should not be operated while the machine is running.
	Selection, see the device manual and the LV10/NC61 catalog. The leading auxiliary switch is required for enabling the Line Module.
=1.-F23	**Protection against over-current for the Line Module**
=1.-Q24	Depending on the requirement, either a fuse or a circuit-breaker can be used. The associated specifications of the safety characteristics must be observed.
=1.-Q26	
=1.-Q27	
	For assignment, see the Equipment Manual for Booksize Power Units; for selection, see NC61 catalog
=2.-Q15	**Line contactor**
	Optionally, a line contactor can be used; also see "Line Contactor Control" and "Safety Integrated" sections; selection, see NC61 catalog
=1.-V23	**Line filter**
=1.-V24	See the Equipment Manual for Booksize Power Units; for selection, see NC61 catalog
=1.-V27	
=1.-R23	**Line reactor**
=1.-R24	See the Equipment Manual for Booksize Power Units; for selection, see NC61 catalog
=1.-R26	
=1.-R27	

=1.-T31 =1.-T33 =1.-T36	**SITOP power 24 VDC power supply for SINAMICS components**
	Separate power supply (DC 24 V, 20 A) for the power supply busbar for the drive group and 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.
	See the Equipment Manual for Booksize Power Units See KT10.1 catalog

=1.-T41	**SITOP power 24 VDC power supply for auxiliary components**
	Separate power supply (24 VDC) for the controller and auxiliary components, such as valves, contactors, etc.
	See the Equipment Manual for Booksize Power Units See KT10.1 catalog

=1.-Q31 =1.-Q33 =1.-Q36 =1.-Q41	**Protection of the power supply devices**
	See the Equipment Manual for Booksize Power Units See KT10.1 catalog

=1.-F42...-F48 =1.-F52…-F58 =1.-F62…-F64	**Protection of the individual circuits**
	The potential assignment of the circuits is chosen arbitrarily. 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.
	See the Equipment Manual for Booksize Power Units See KT10.1 catalog

Line infeed and power supply of the automation system is made as shown in the following typical circuit diagrams.

Circuit manual group =1 examples
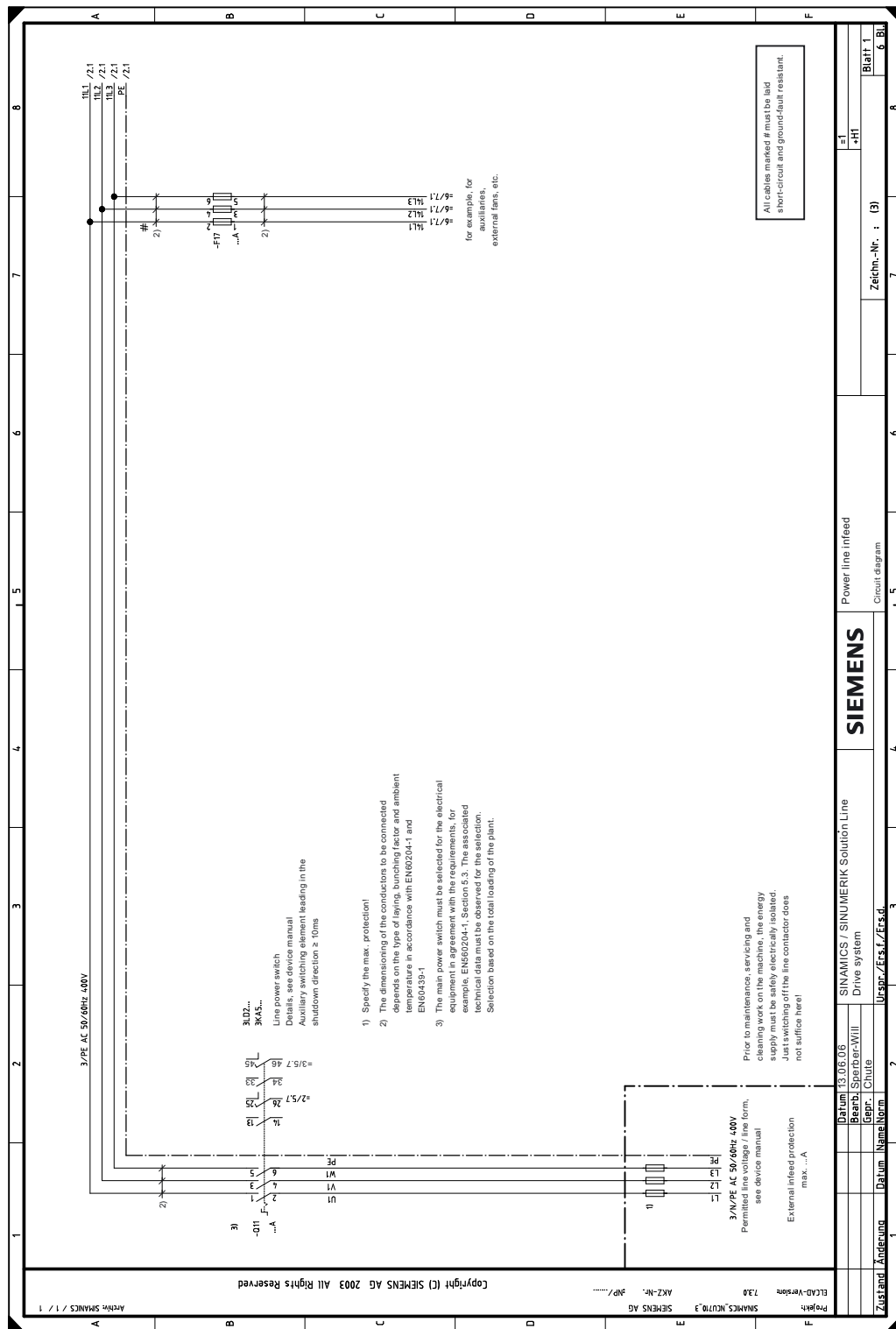
Figure 7-1   Circuit manual group =1, page 1

Figure 7-2   Circuit manual group =1, page 2

Figure 7-3   Circuit manual group =1, page 3
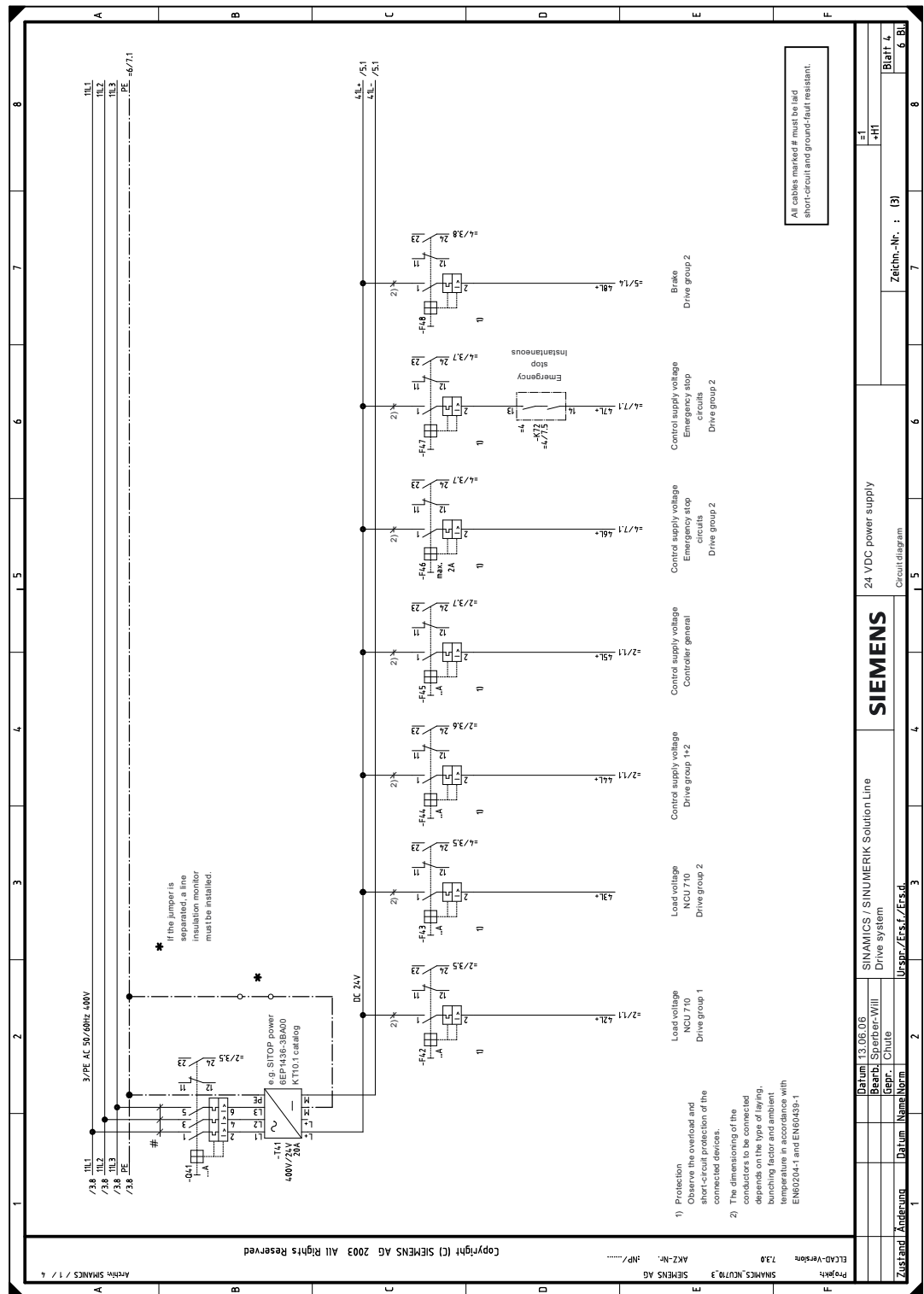
Figure 7-4   Circuit manual group =1, page 4
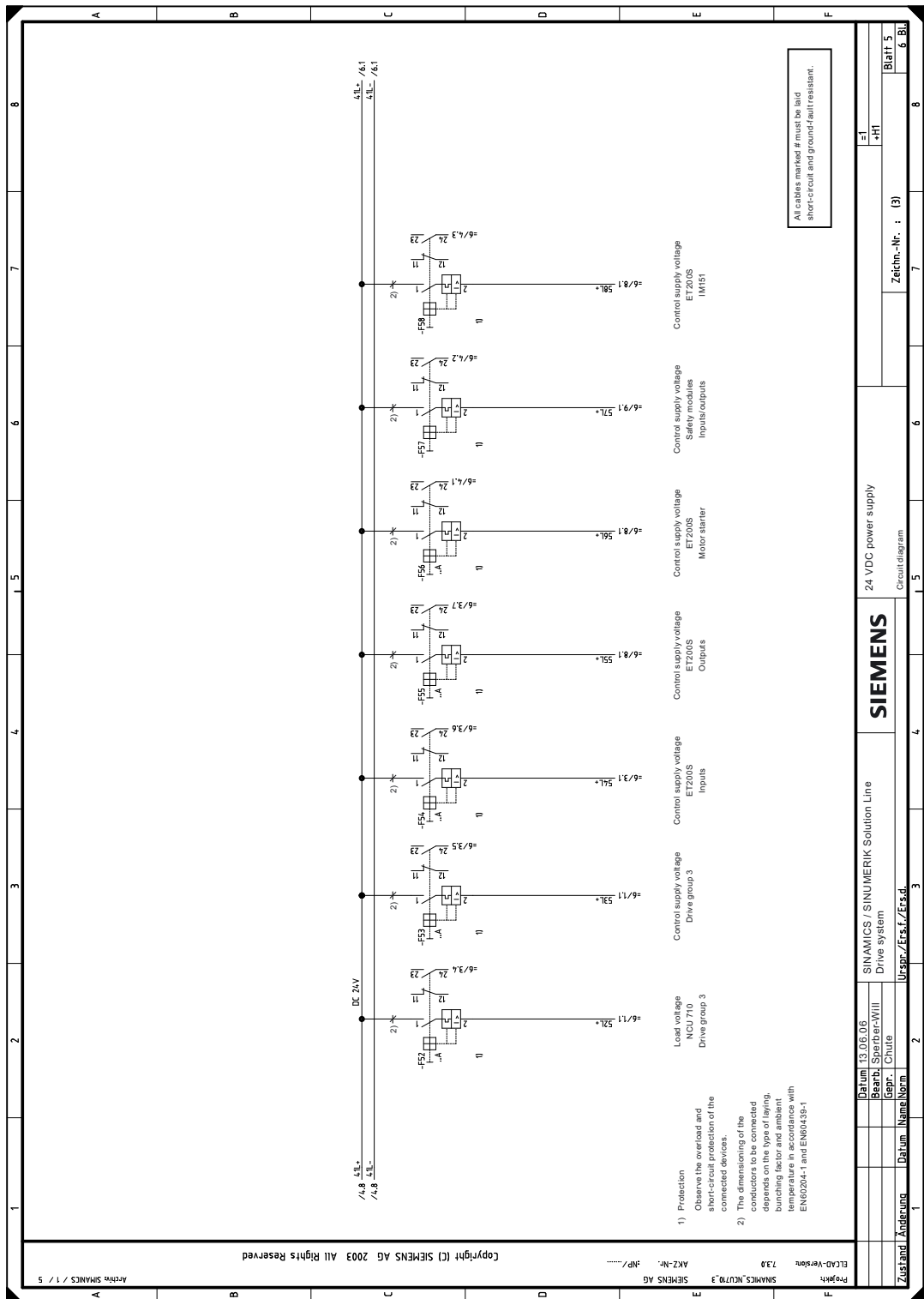
Figure 7-5   Circuit manual group =1, page 5
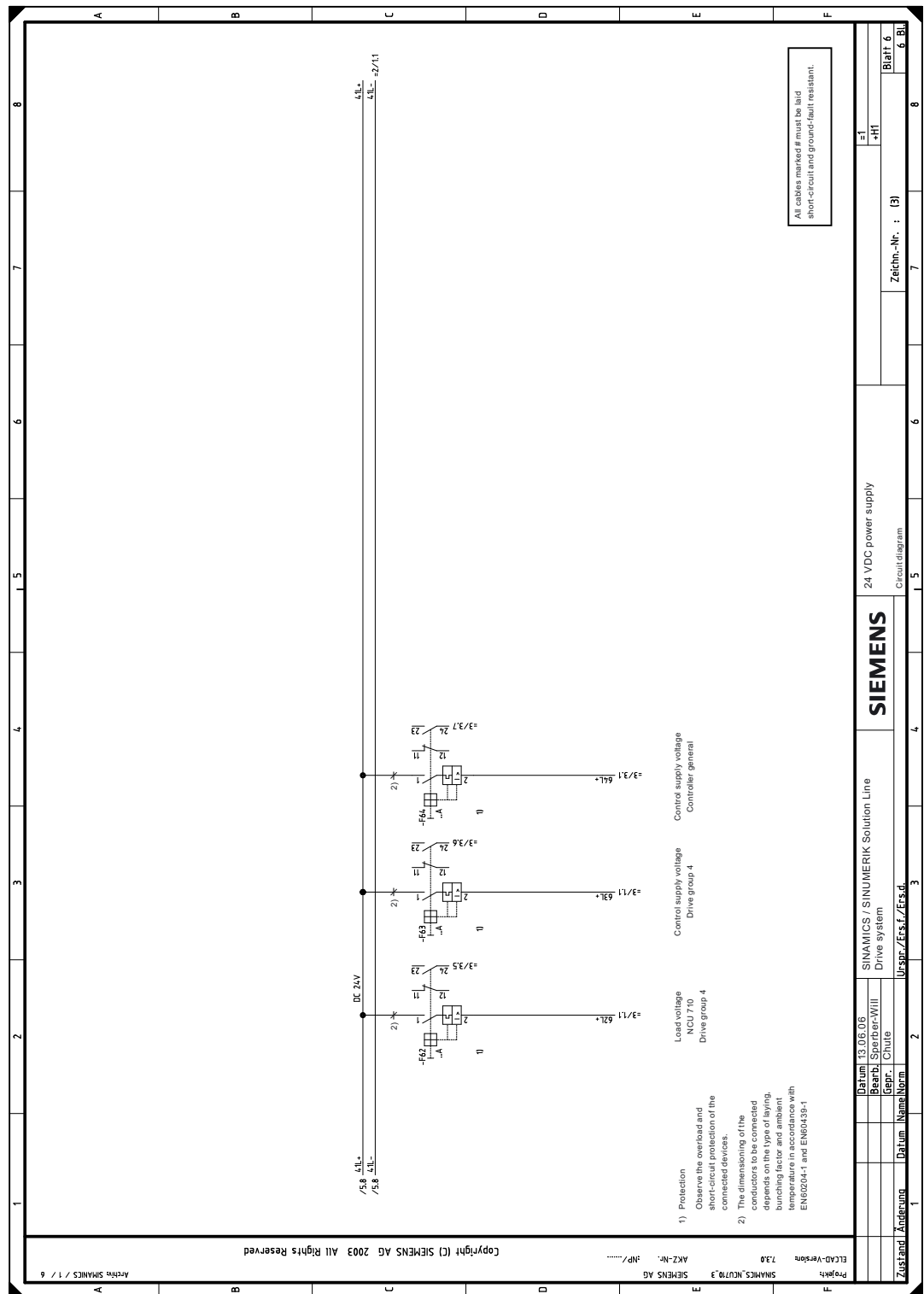
Figure 7-6   Circuit manual group =1, page 6

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 communications, open- and 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, where the Control Unit is always designed for a multi-axis operation. 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 signals

  External fault signals, such as the monitoring of the safety cut-outs (=1.-F42, F44, F45), circuit-breakers (=1.-Q31, Q41), etc., may also need to be interlocked with the On/Off command. Signals can be visualized appropriately on the Operator Panel.

- Interlocking of component states and system signals

  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 enable signals of the Active Line Module.

- Enable signal from the Active Line Module

  The protective circuit of the Enable Pulses digital input (-X21: 3/ 4) is required 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, for example, using a leading (<=10 ms) 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 to enable the Motor Modules. The interconnection is made within the drive objects in the Control Unit.
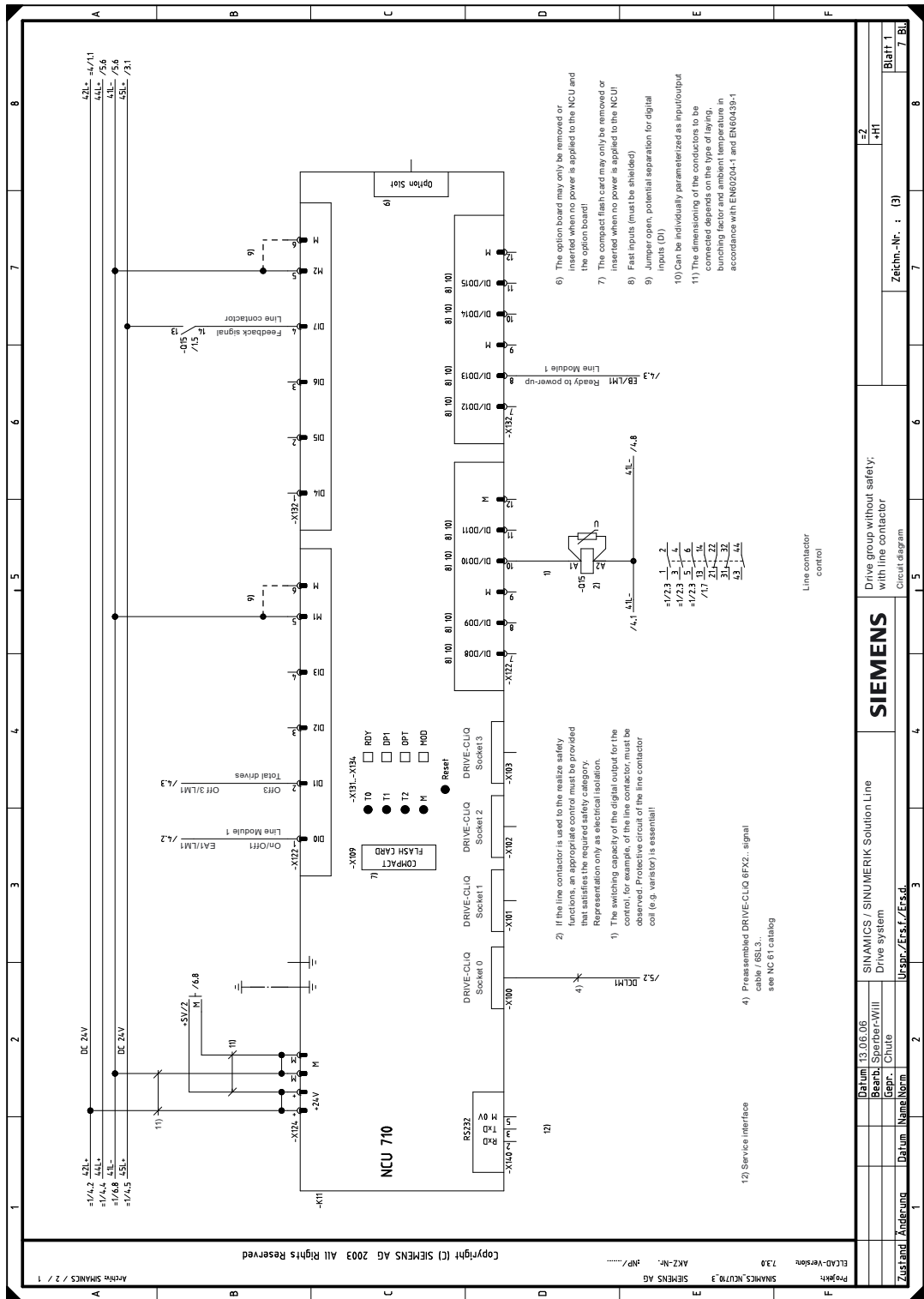
Circuit manual group =2 examples

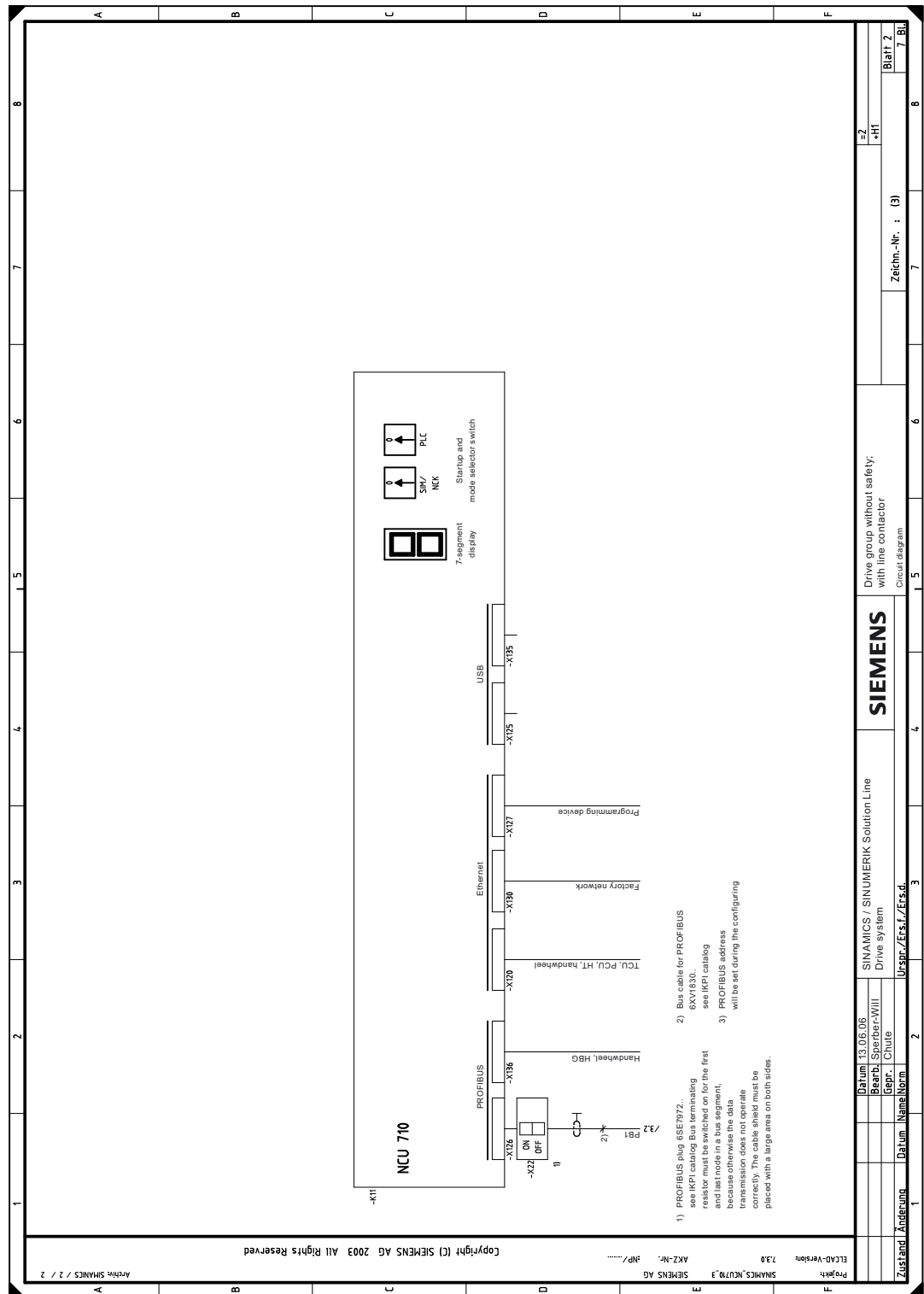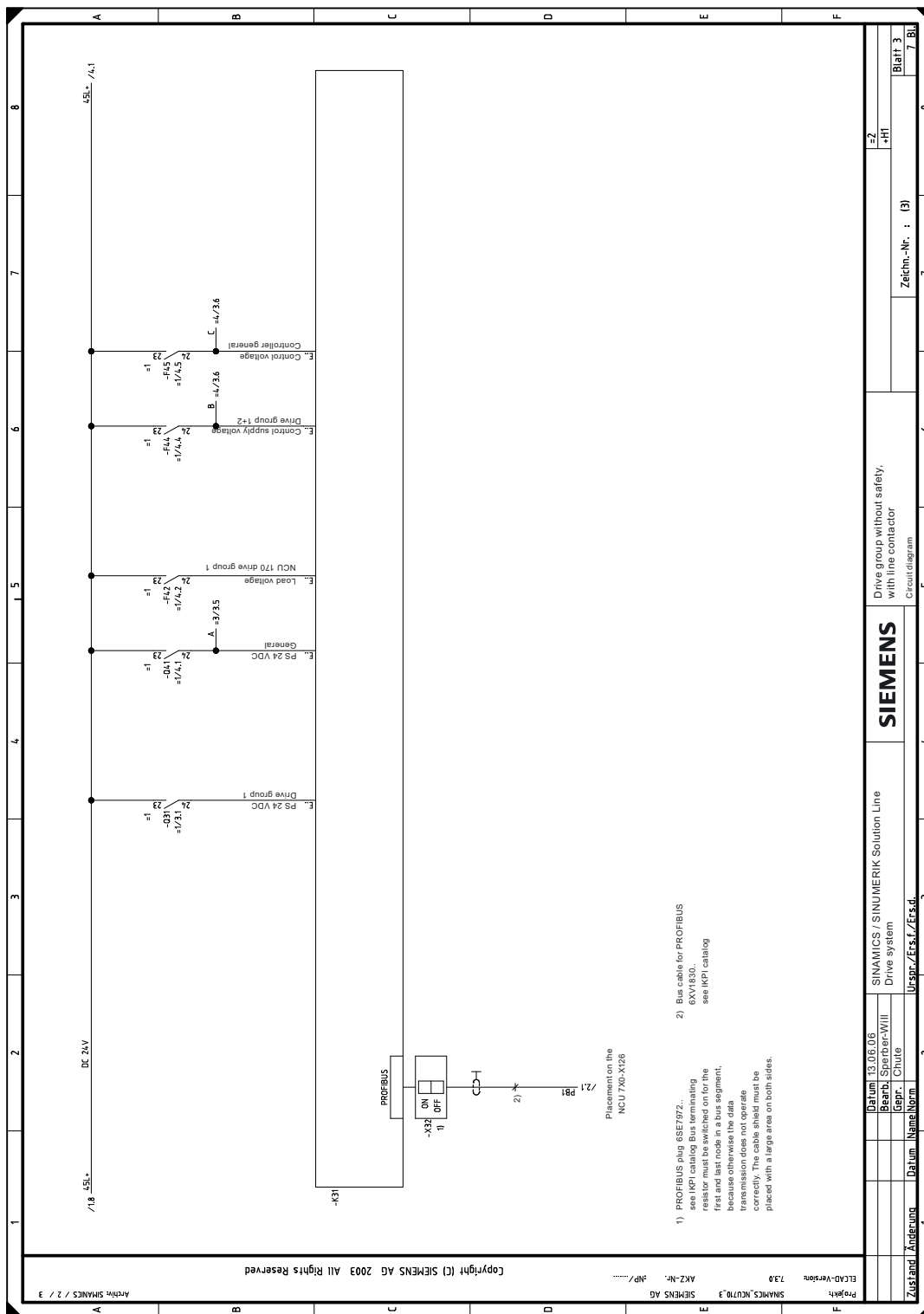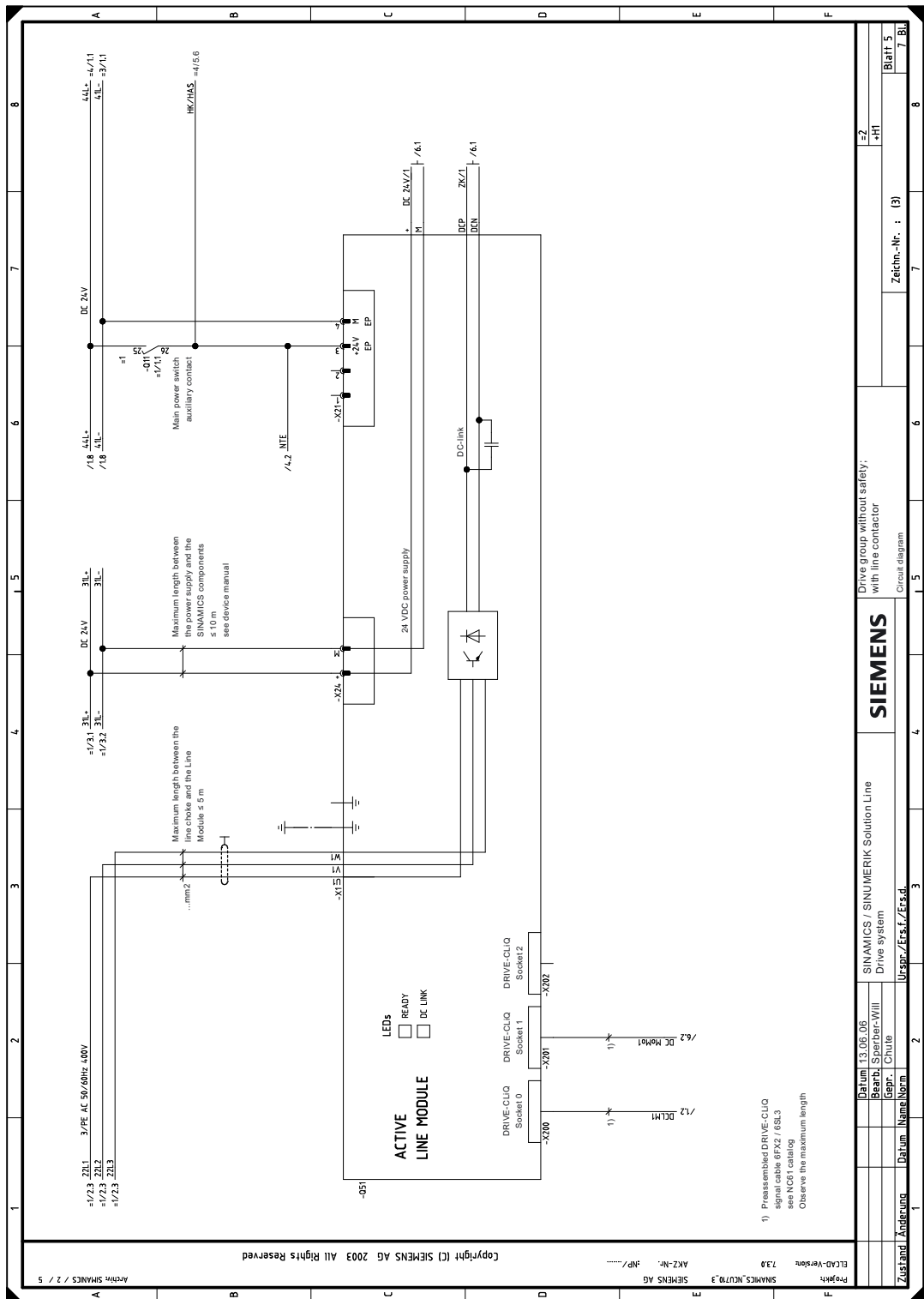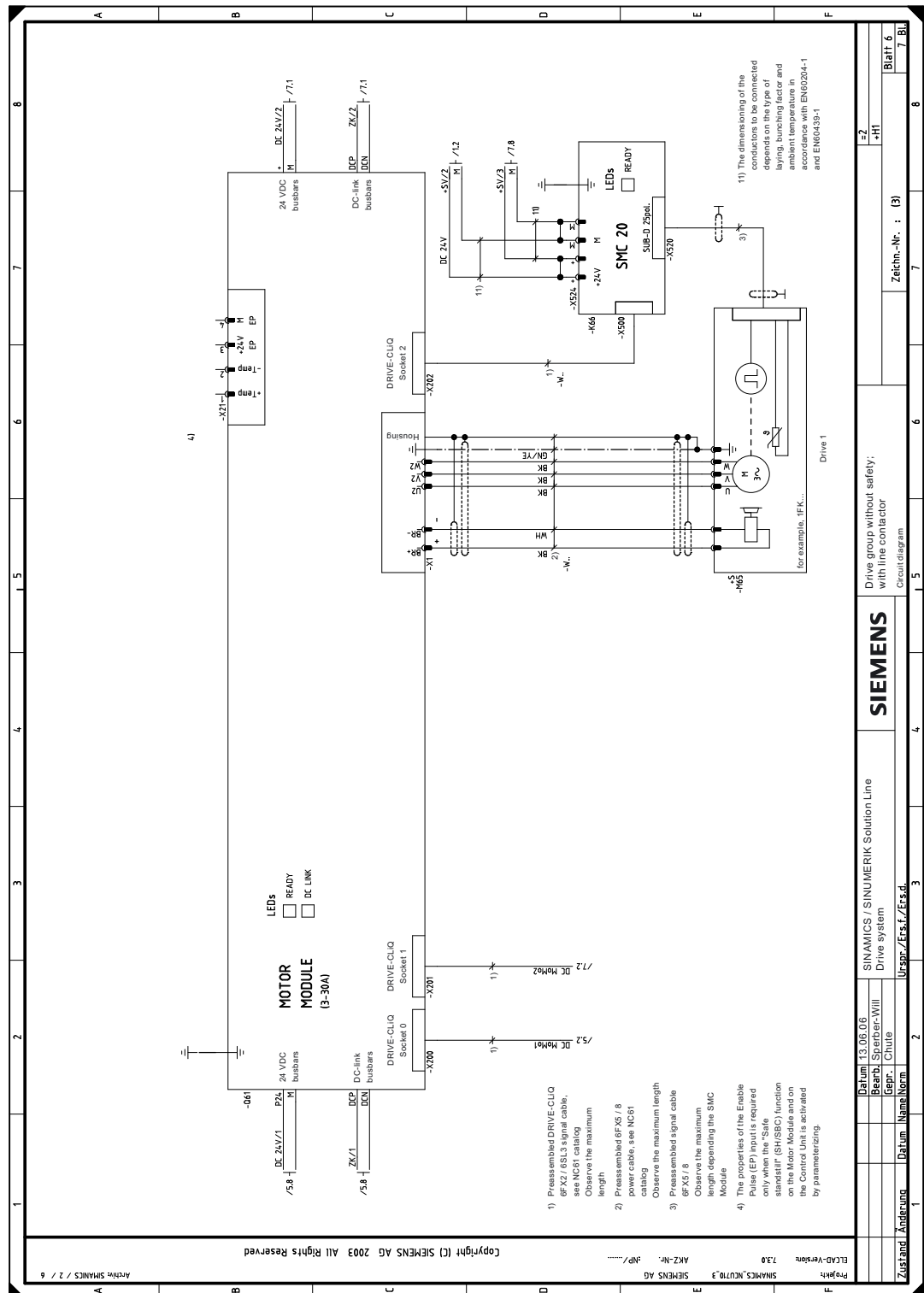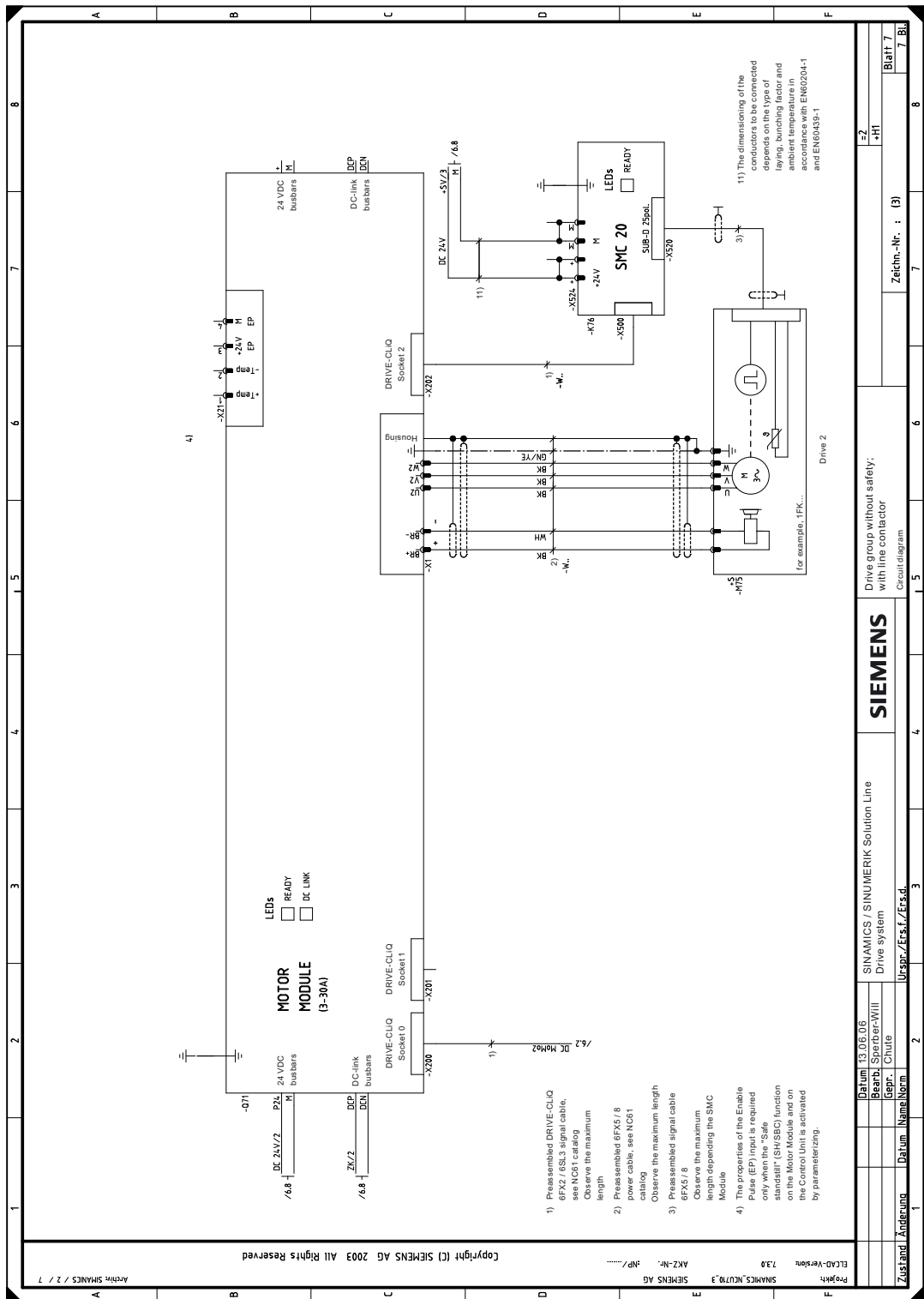
Figure 7-7   Circuit manual group =2, page 1

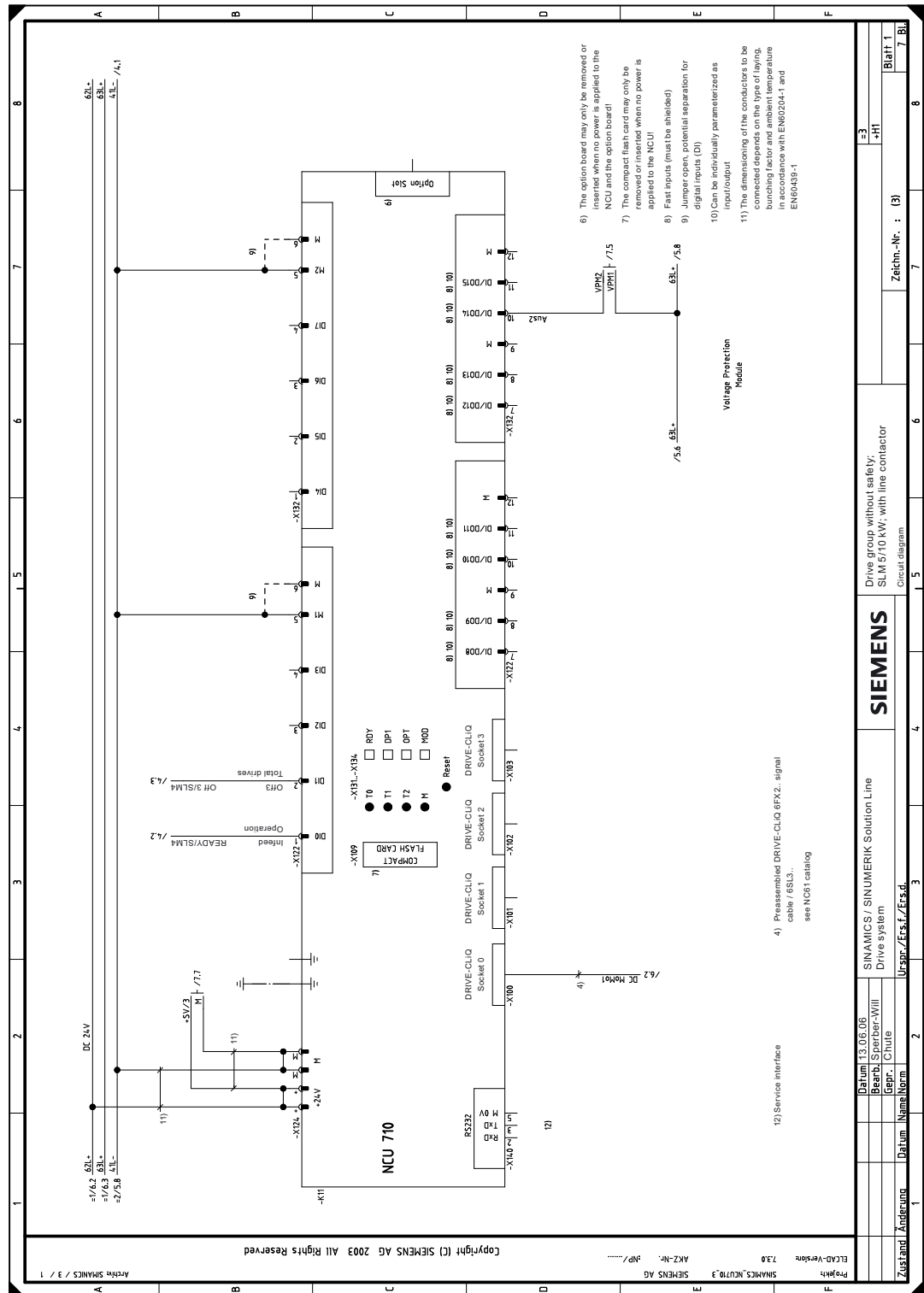Figure 7-8   Circuit manual group =2, page 2

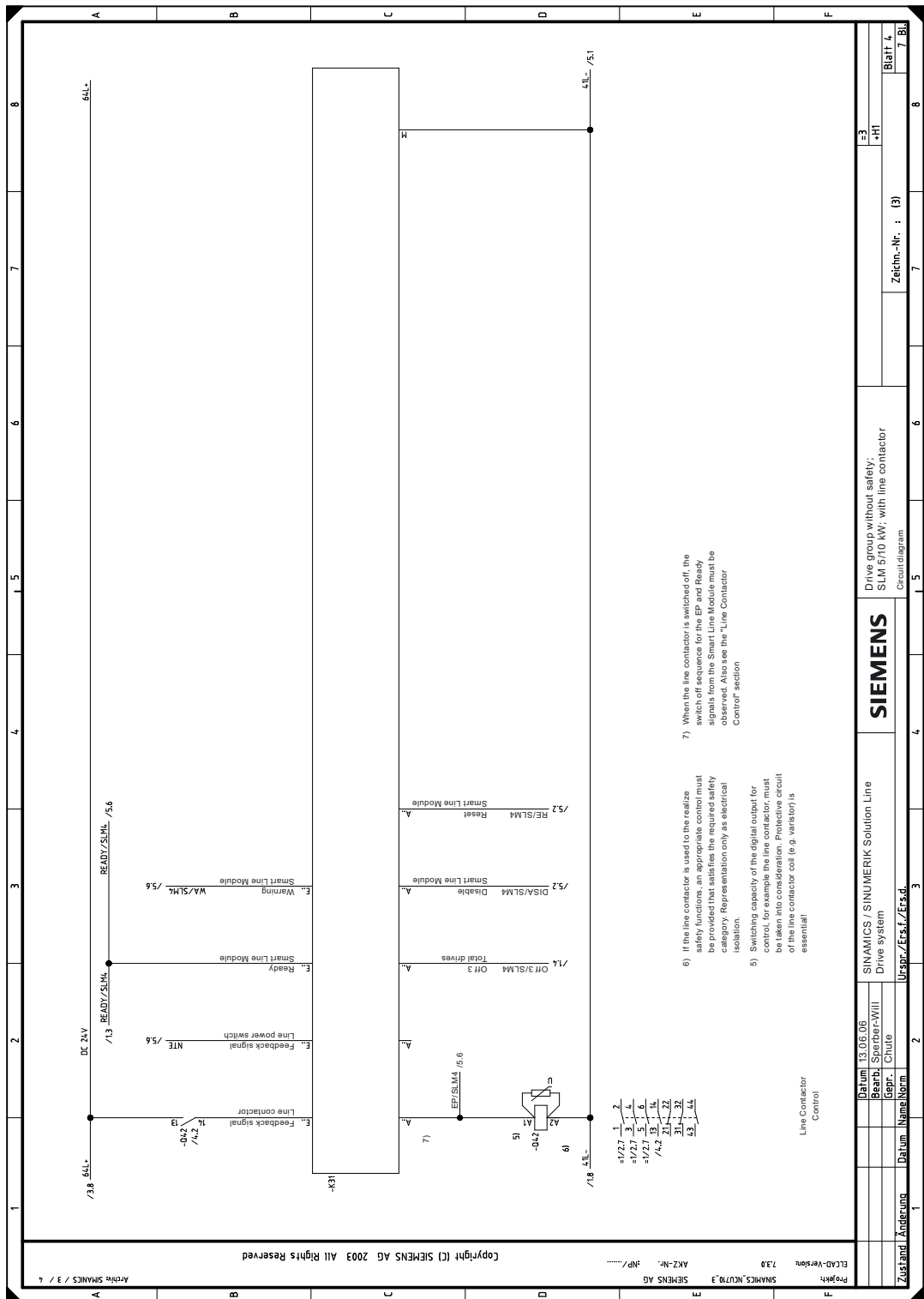Figure 7-9   Circuit manual group =2, page 3

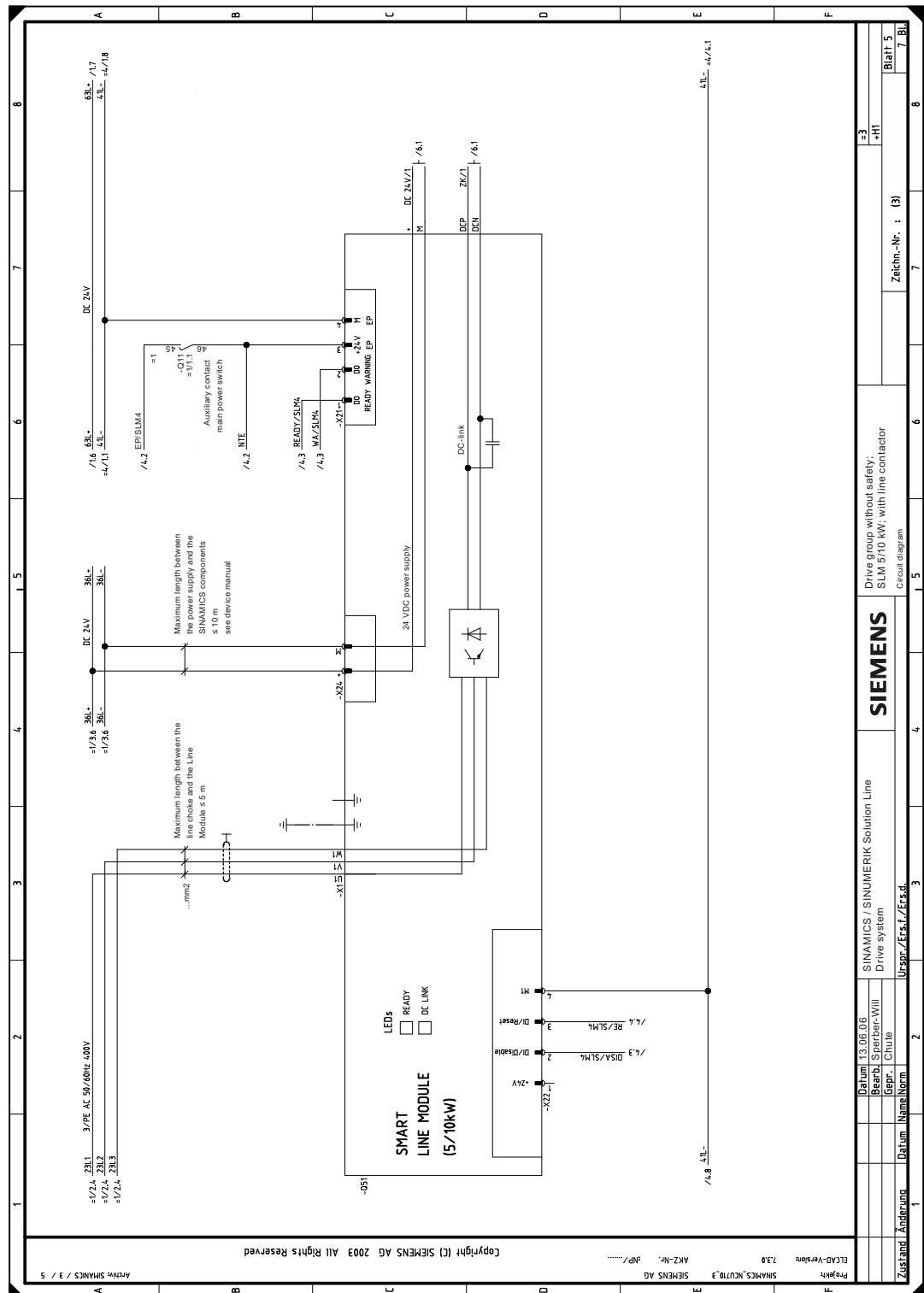Figure 7-10   Circuit manual group =2, page 4

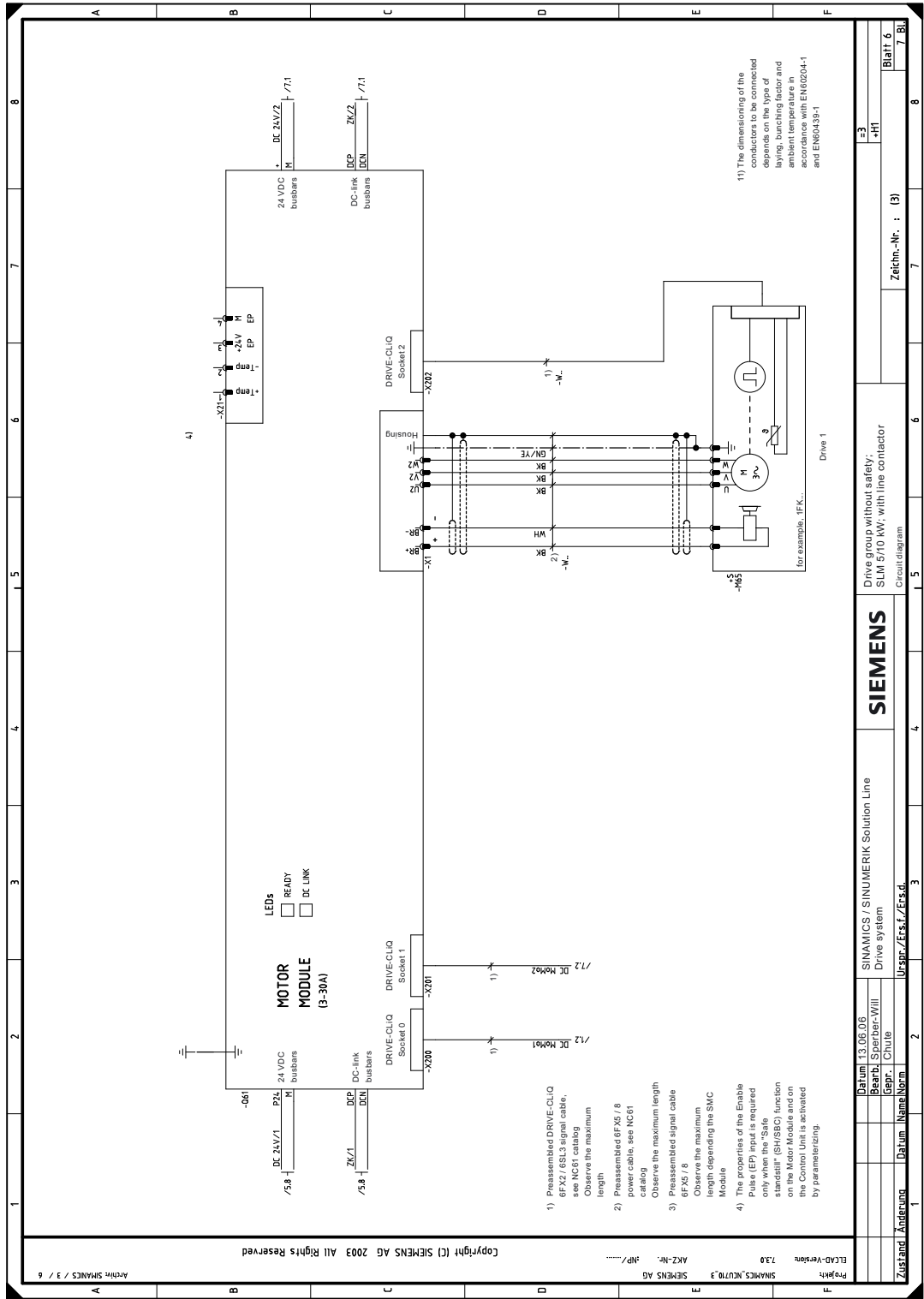Figure 7-11   Circuit manual group =2, page 5

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 the 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 signals

  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. Signals can be visualized appropriately on the Operator Panel.

- Interlocking of component states and system signals

  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. Also see the "Line Contactor Control" section

- 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 any internal sensor, an SMC20 module must be used to connect a separate external sensor (e.g. SIMAG H2) to the Motor Module.

Circuit manual group =3 examples

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
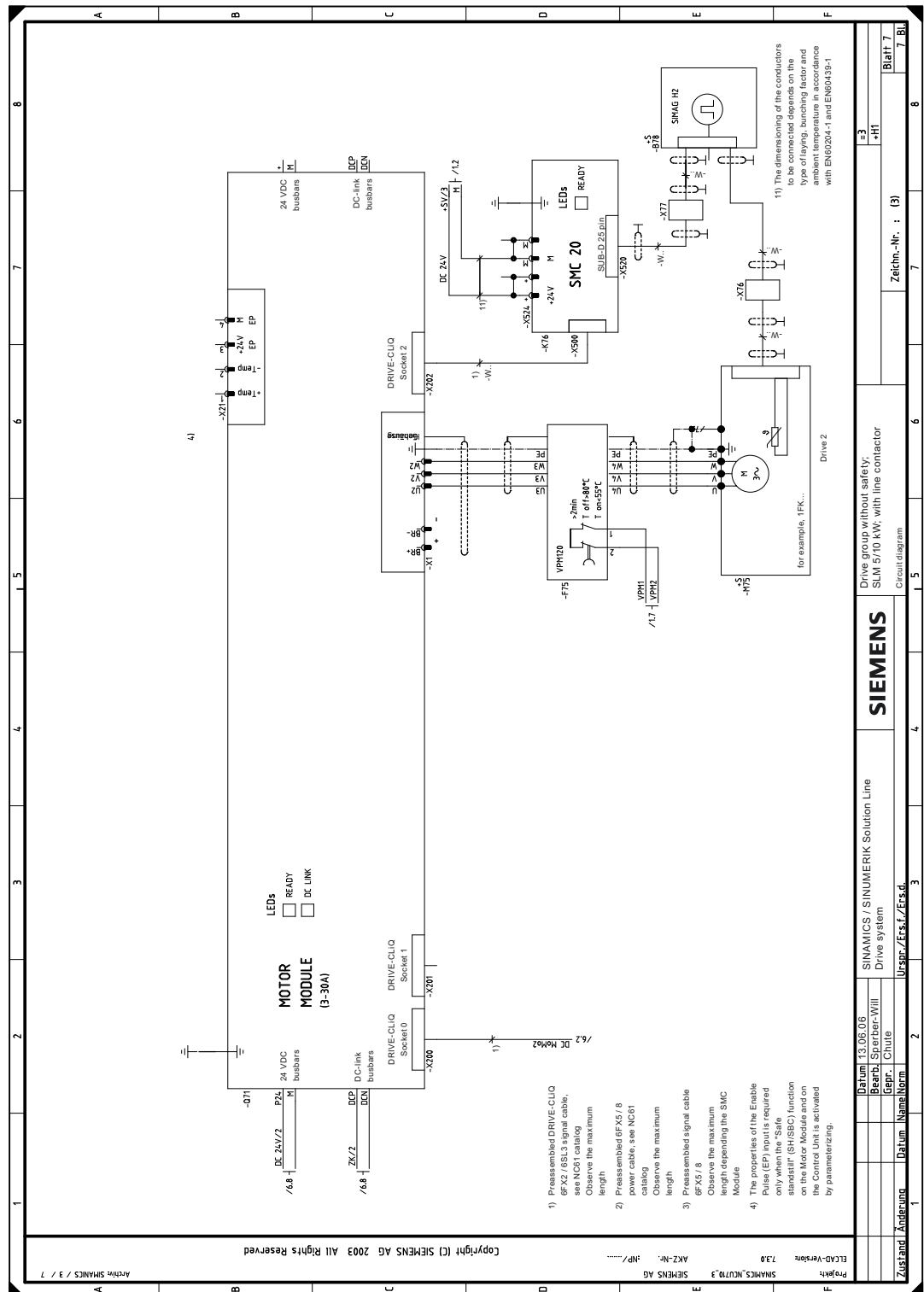
Figure 7-19   Circuit manual group =3, page 6

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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.
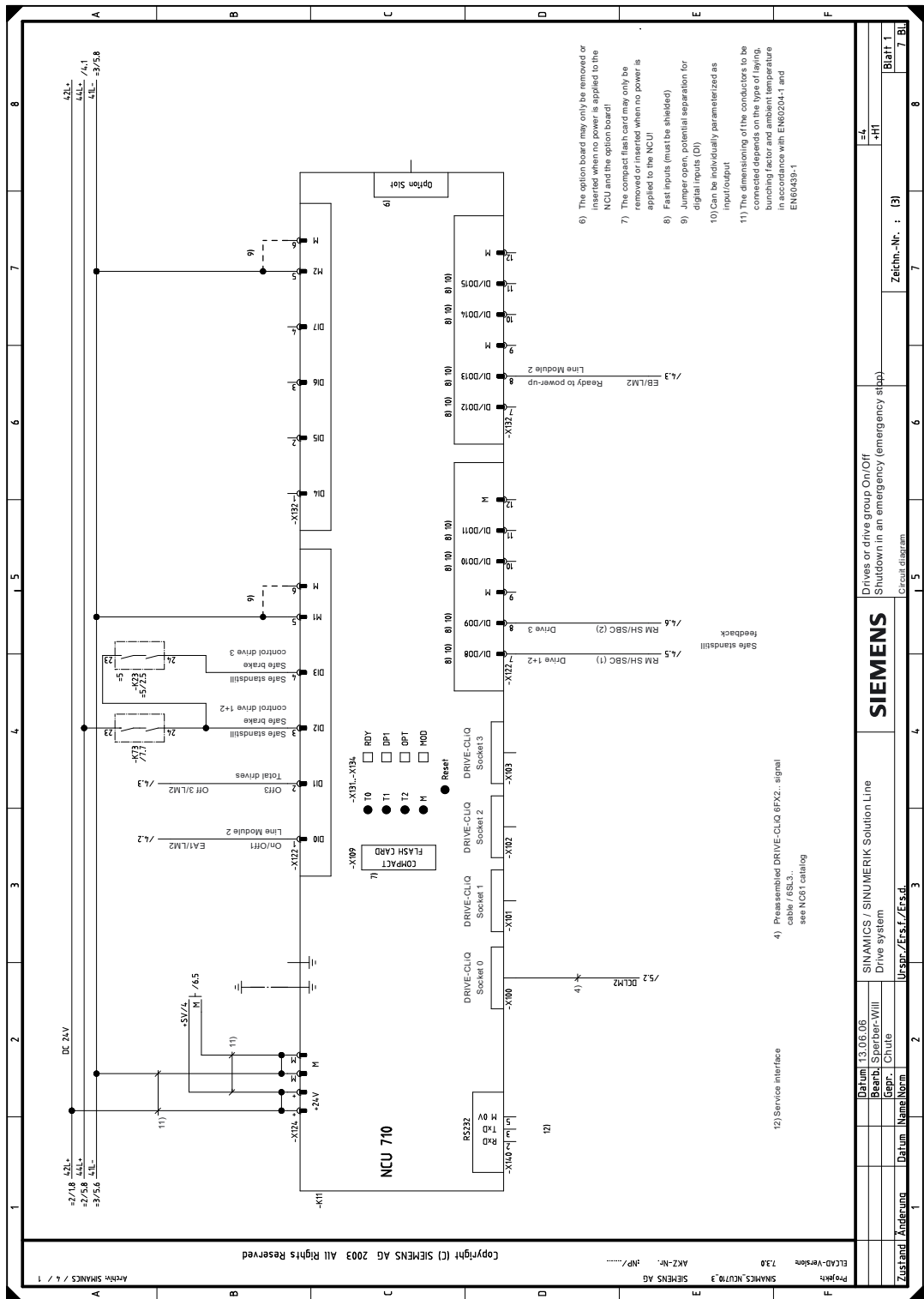
Circuit manual group =4 examples

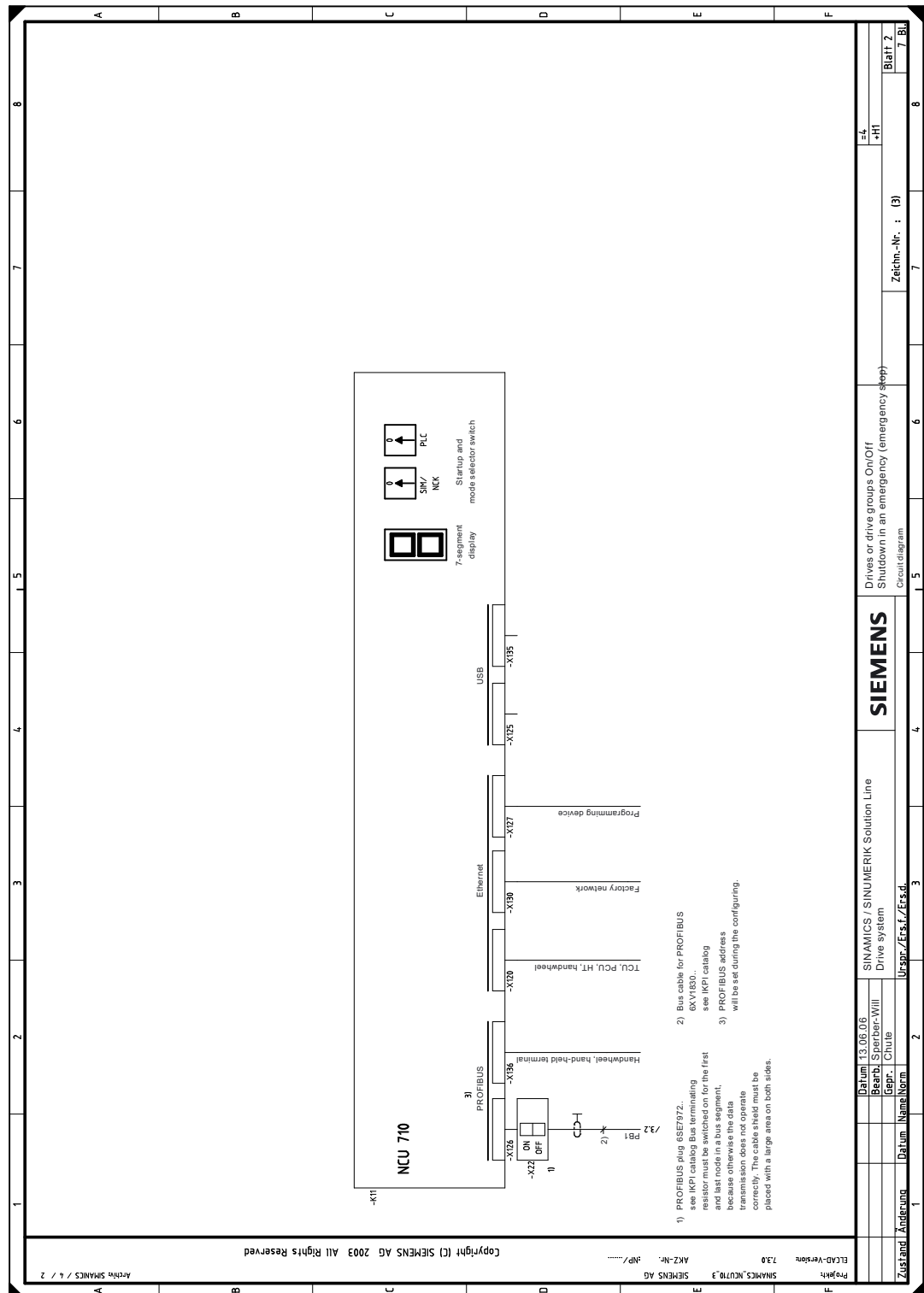Figure 7-21   Circuit manual group =4, page 1
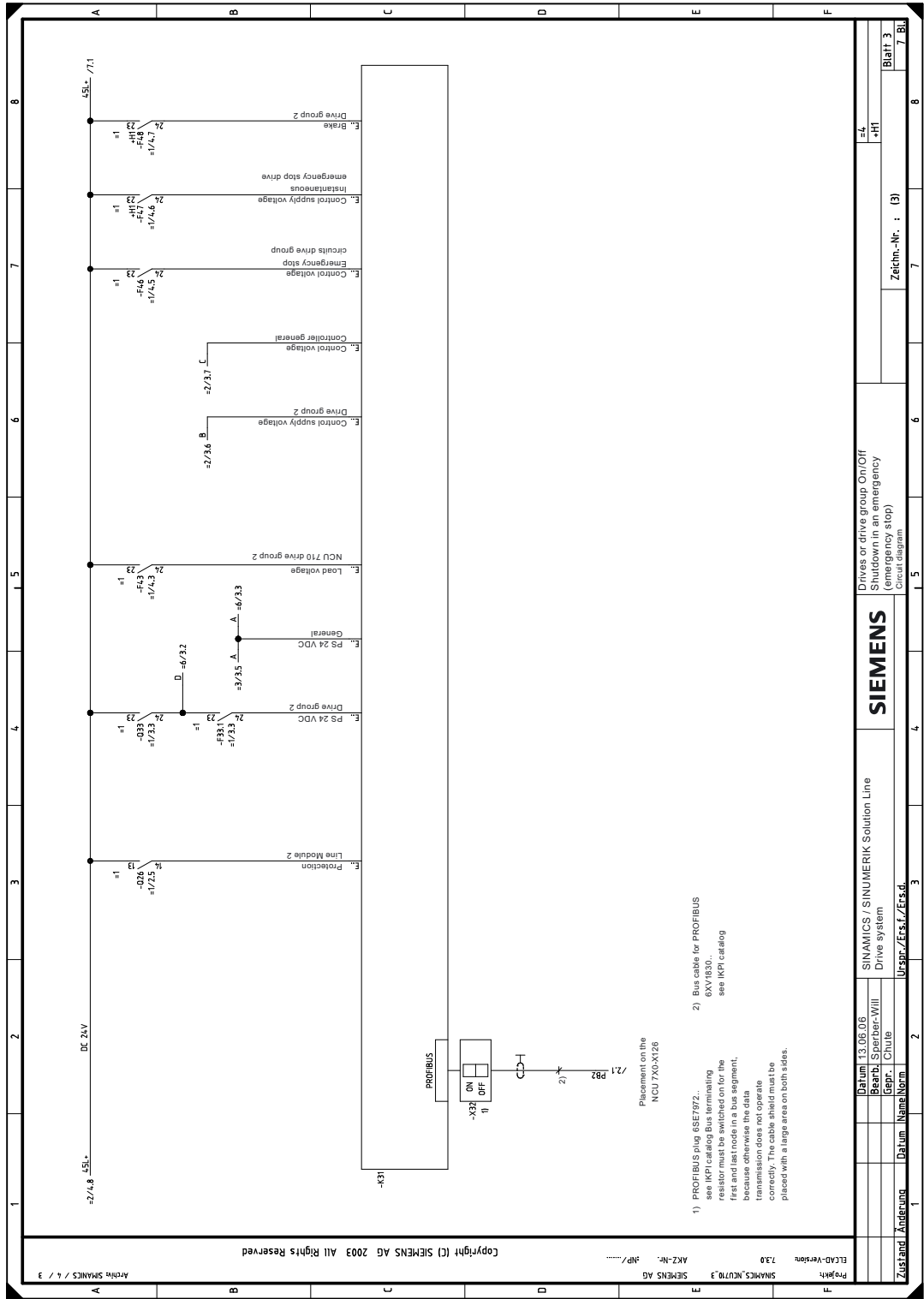
Figure 7-22   Circuit manual group =4, page 2

Figure 7-23   Circuit manual group =4, page 3

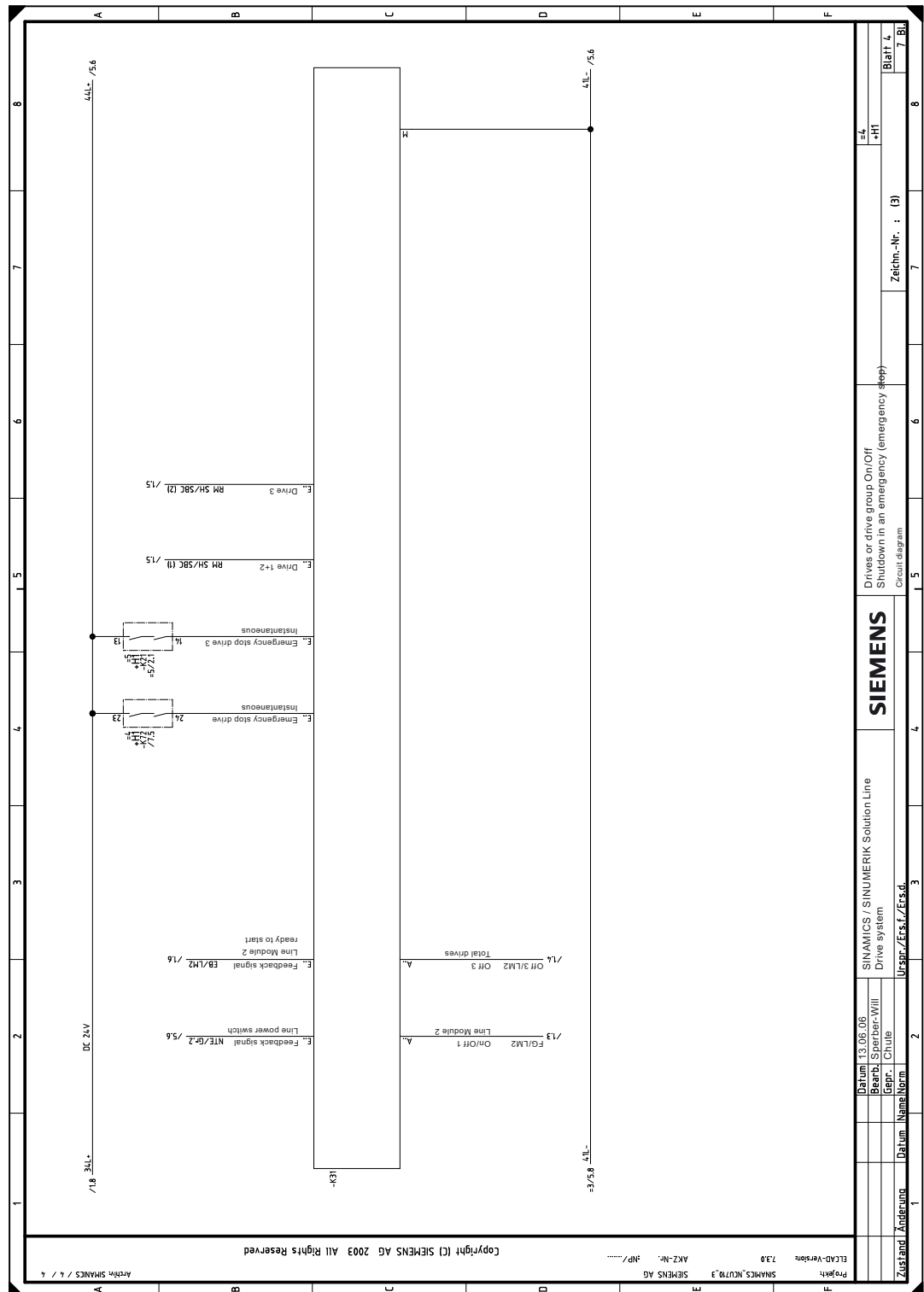Figure 7-24   Circuit manual group =4, page 4
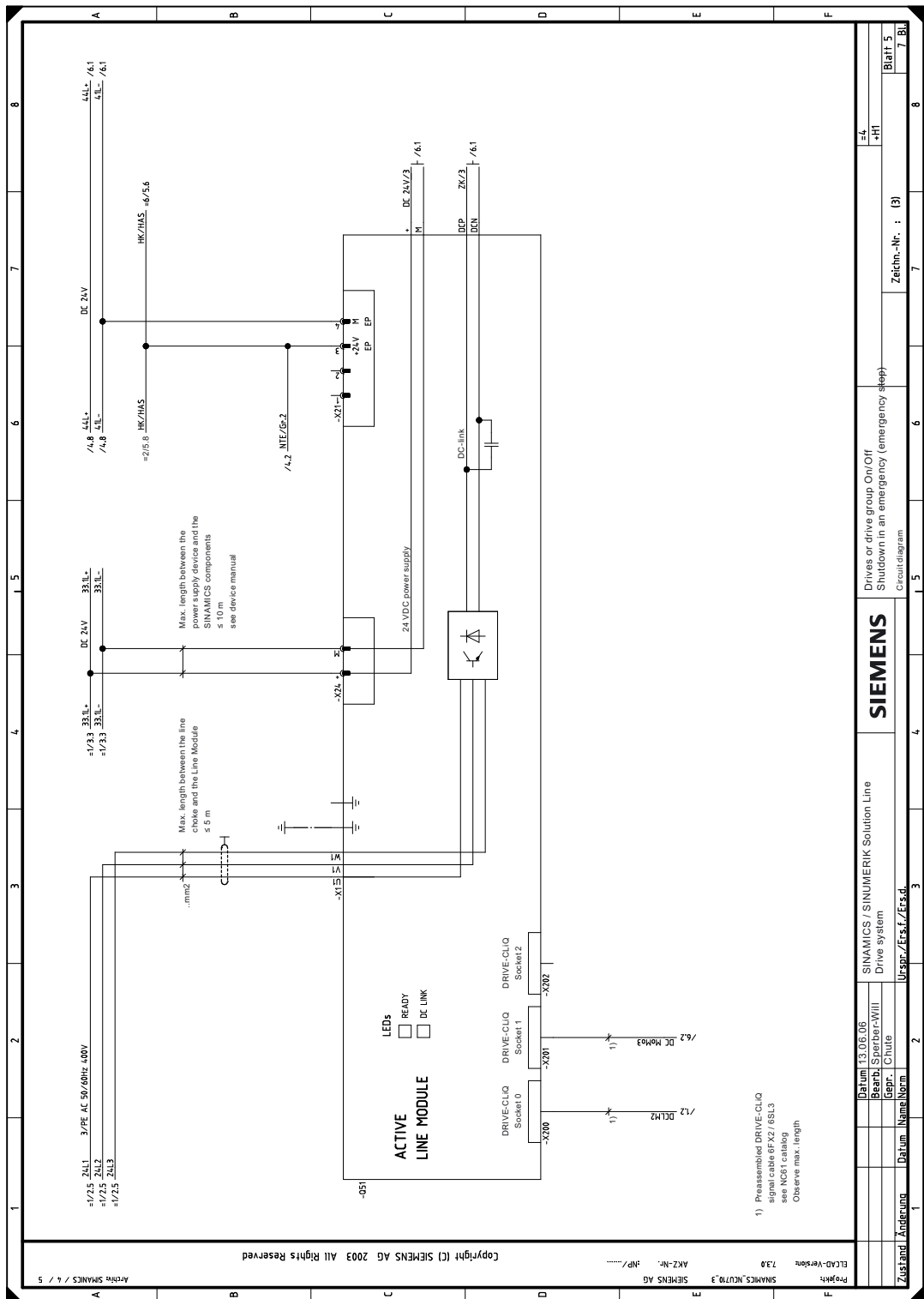
Figure 7-25   Circuit manual group =4, page 5

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Manual, 07/2006 Edition, 6FC5397-6CP10-0BA0
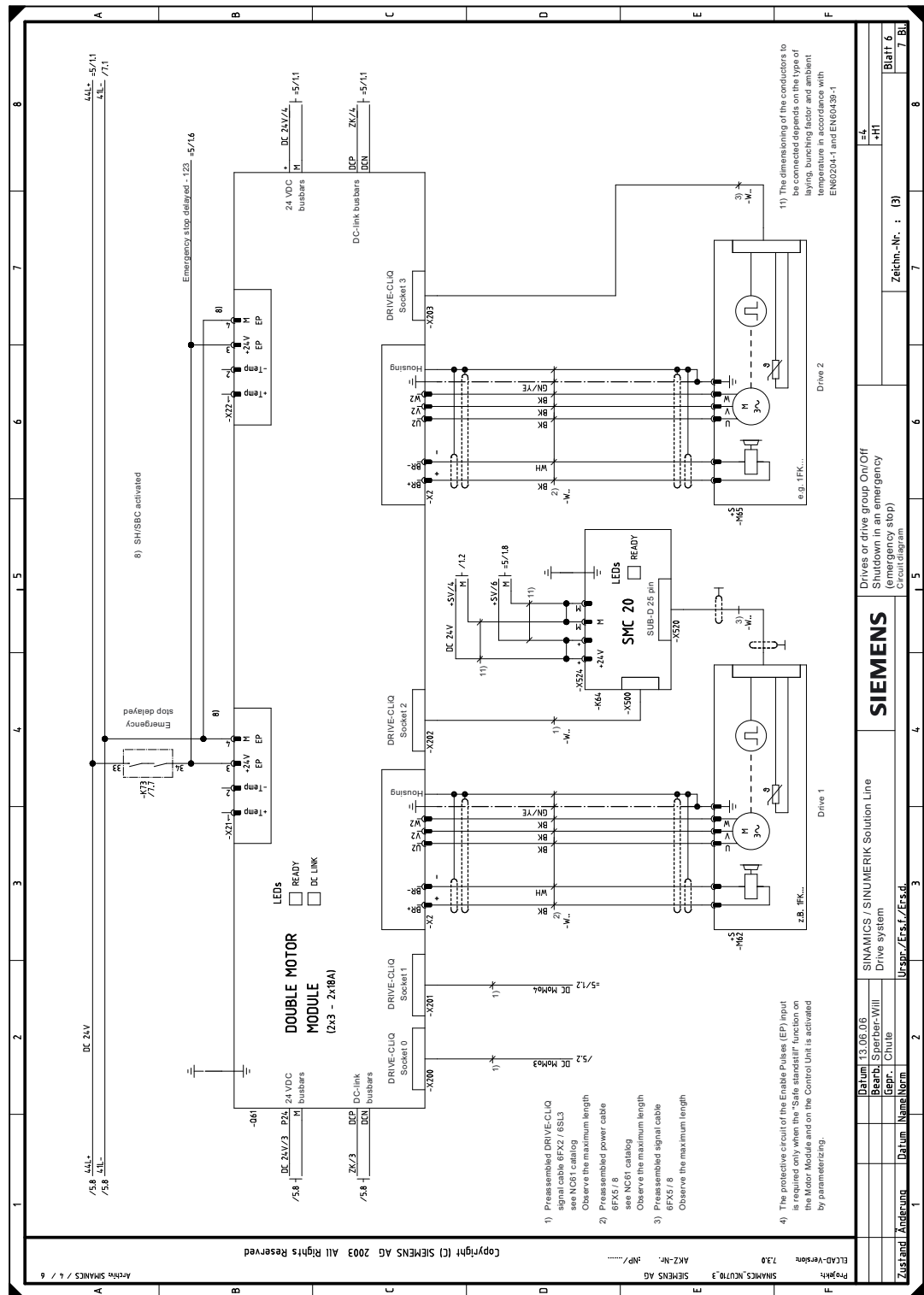
Figure 7-26   Circuit manual group =4, page 6
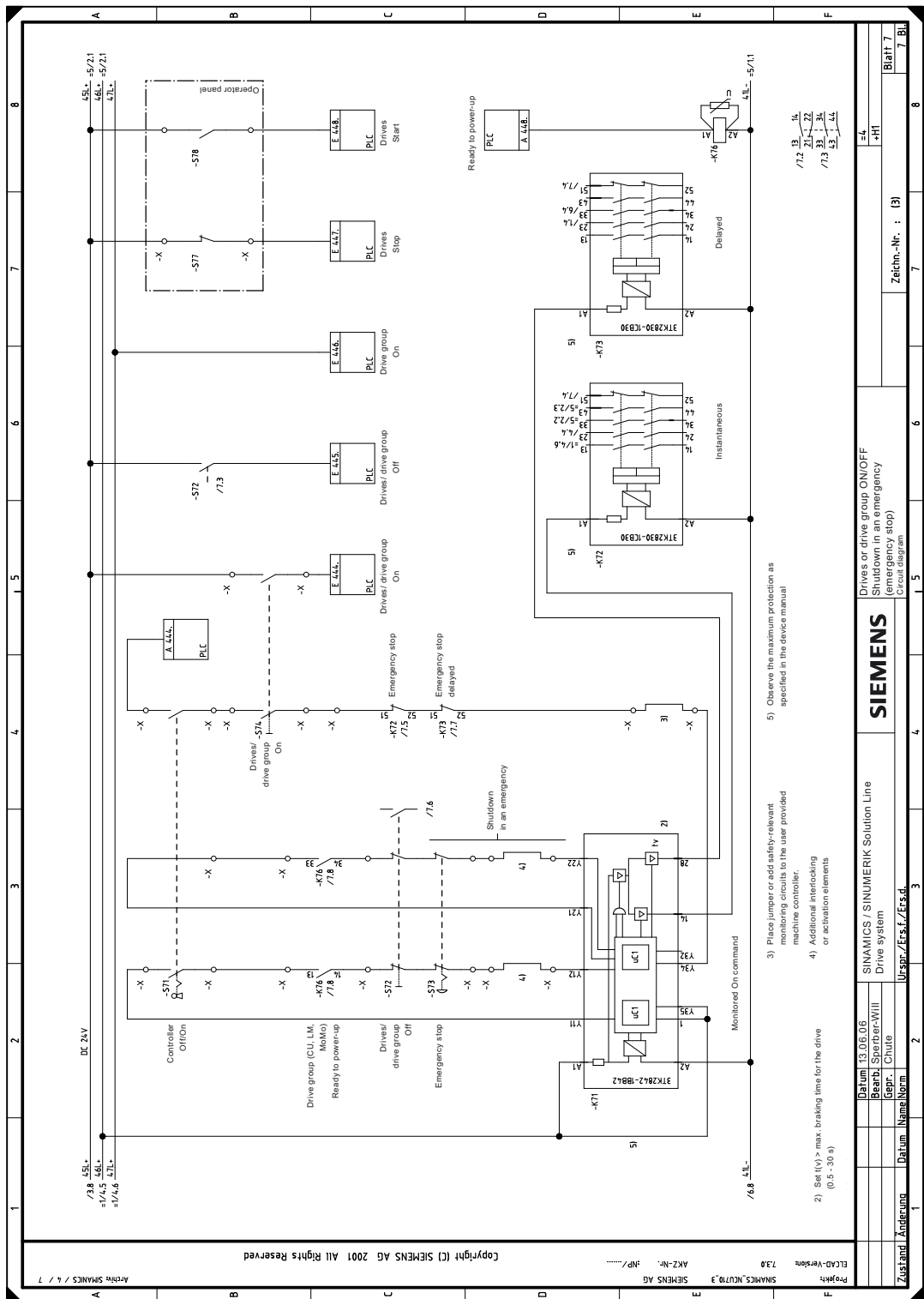
Figure 7-27   Circuit manual group =4, page 7

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. A two-channel keyswitch or, for example, light barriers or limit switches, can be used to safely remove the drive from the drive group. 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 keyswitch (=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 latches.

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 for 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 interface 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 monitored actively 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 =5 examples
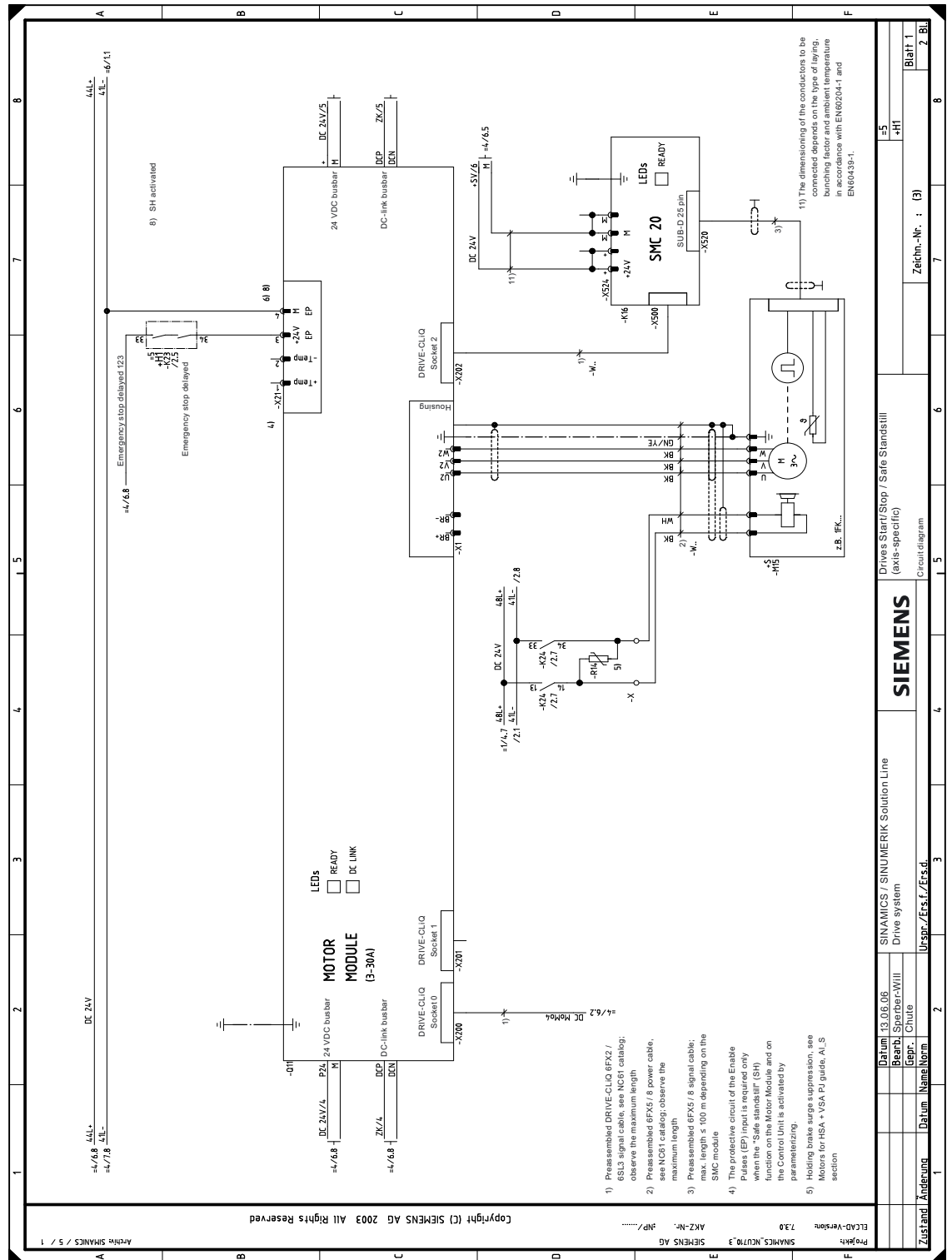
Figure 7-28   Circuit manual group =5, page 1
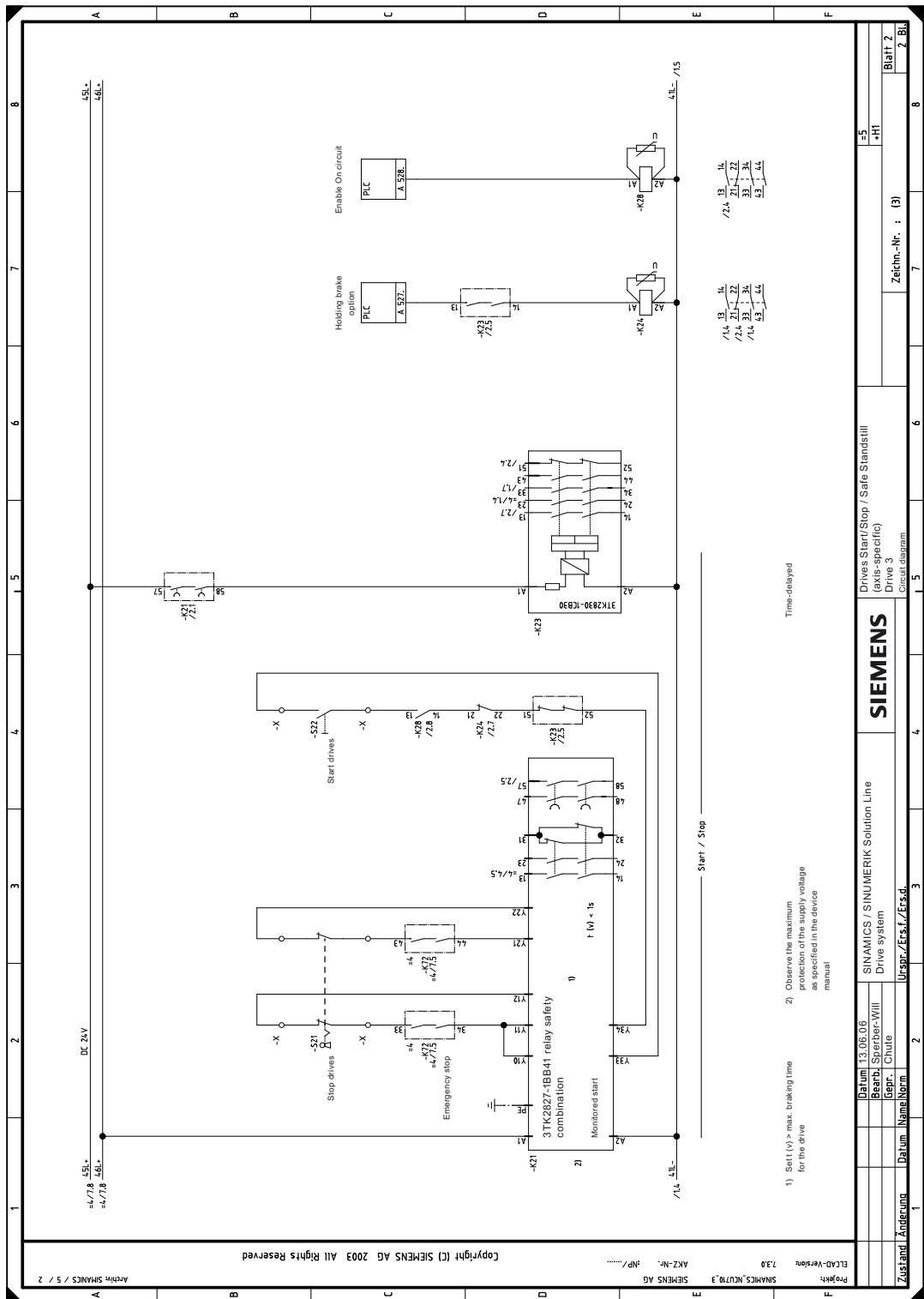
Figure 7-29   Circuit manual group =5, page 2

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.
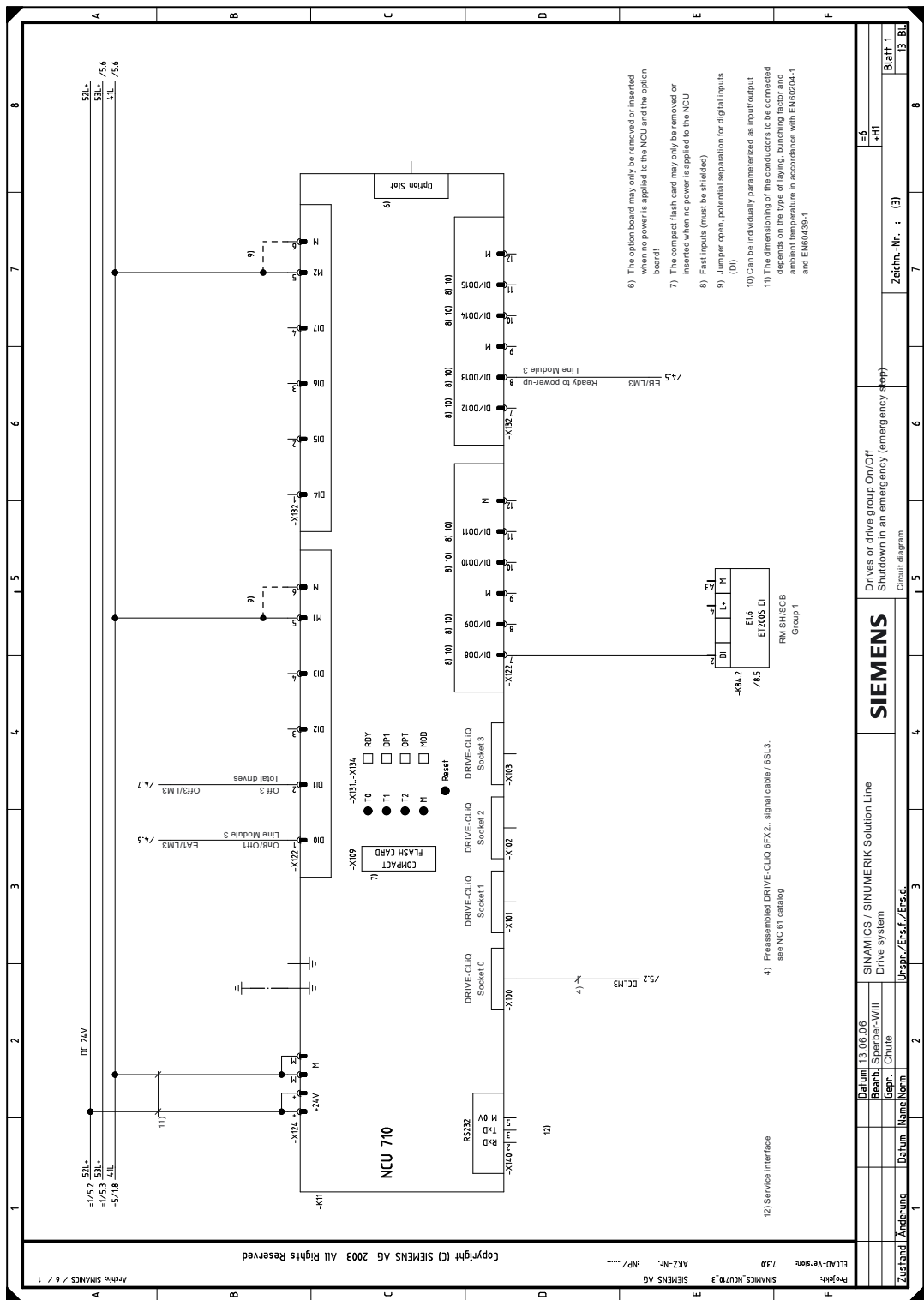
Circuit manual group =6 examples

Figure 7-30   Circuit manual group =, page 1

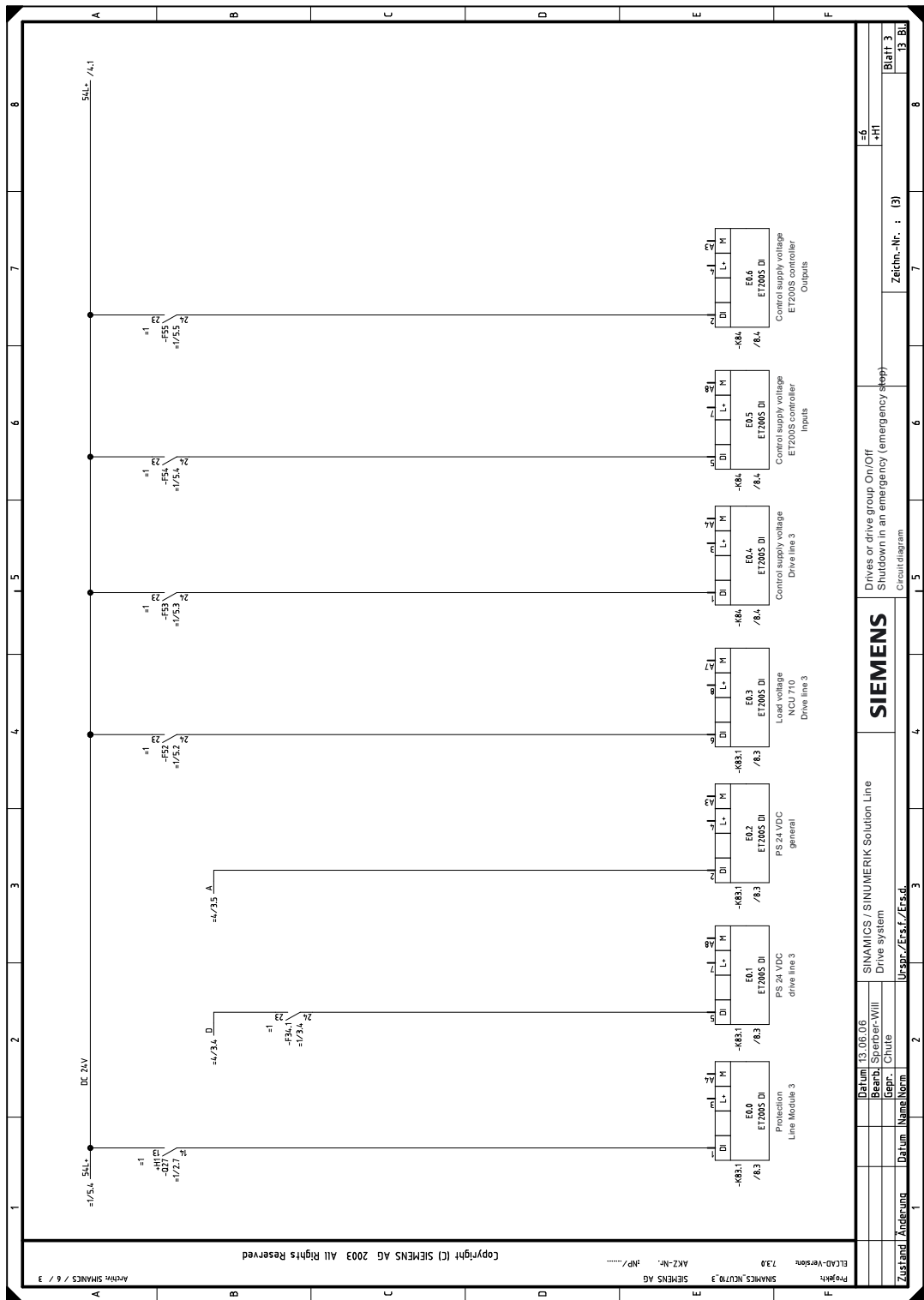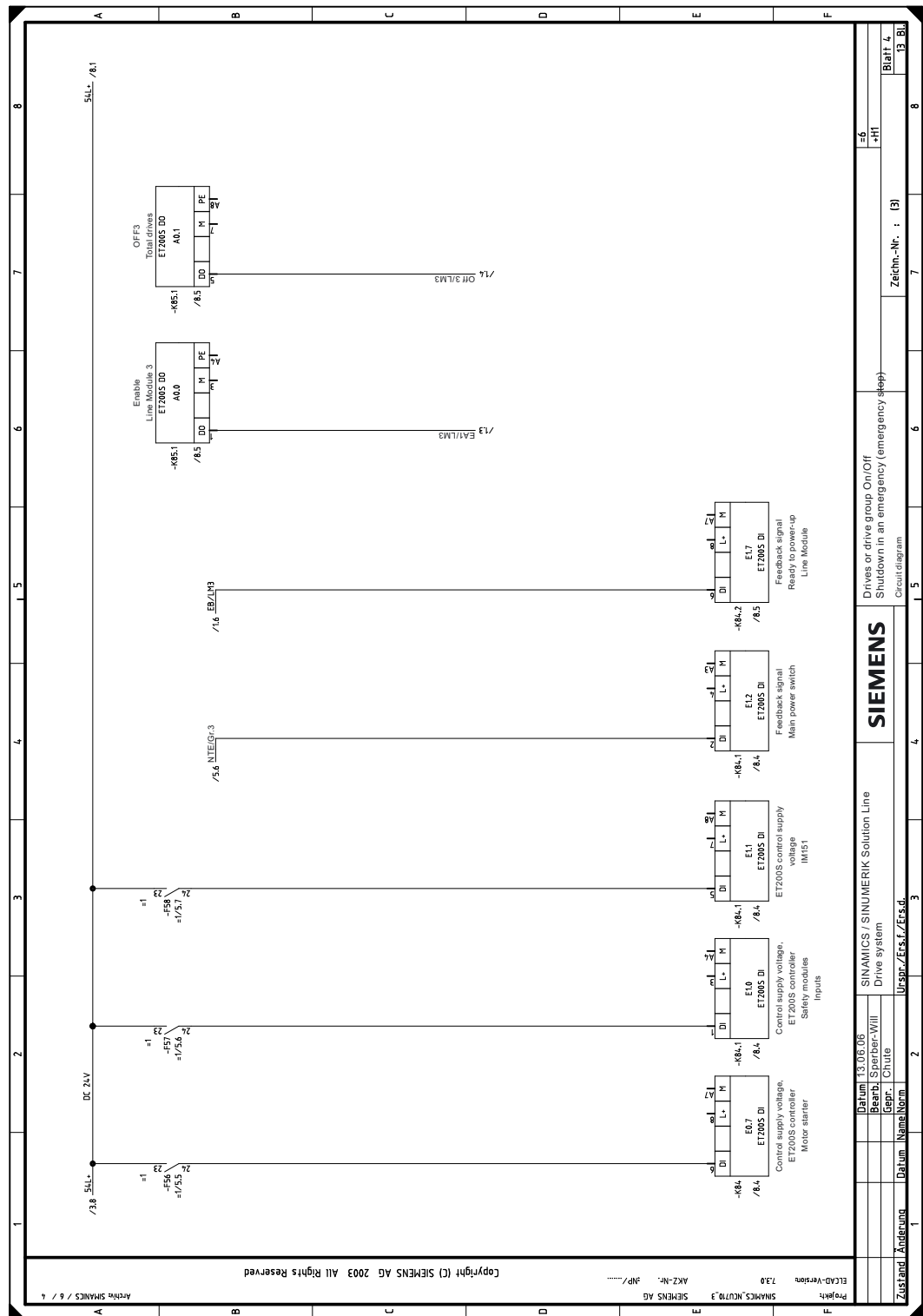Figure 7-31   Circuit manual group =6, page 2

Figure 7-32   Circuit manual group =6, page 3
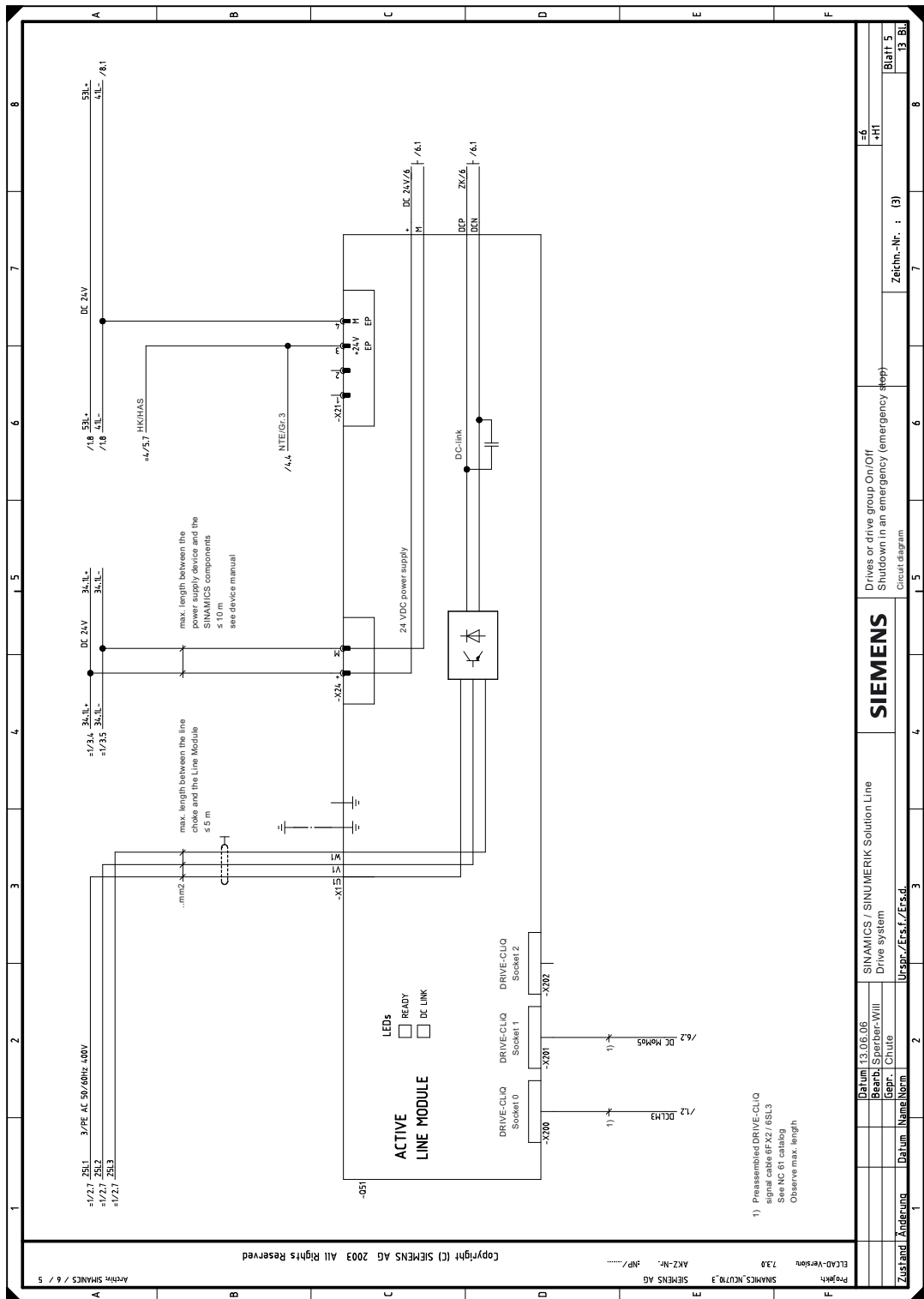
Figure 7-33   Circuit manual group =6, page 4

Figure 7-34   Circuit manual group =6, page 5

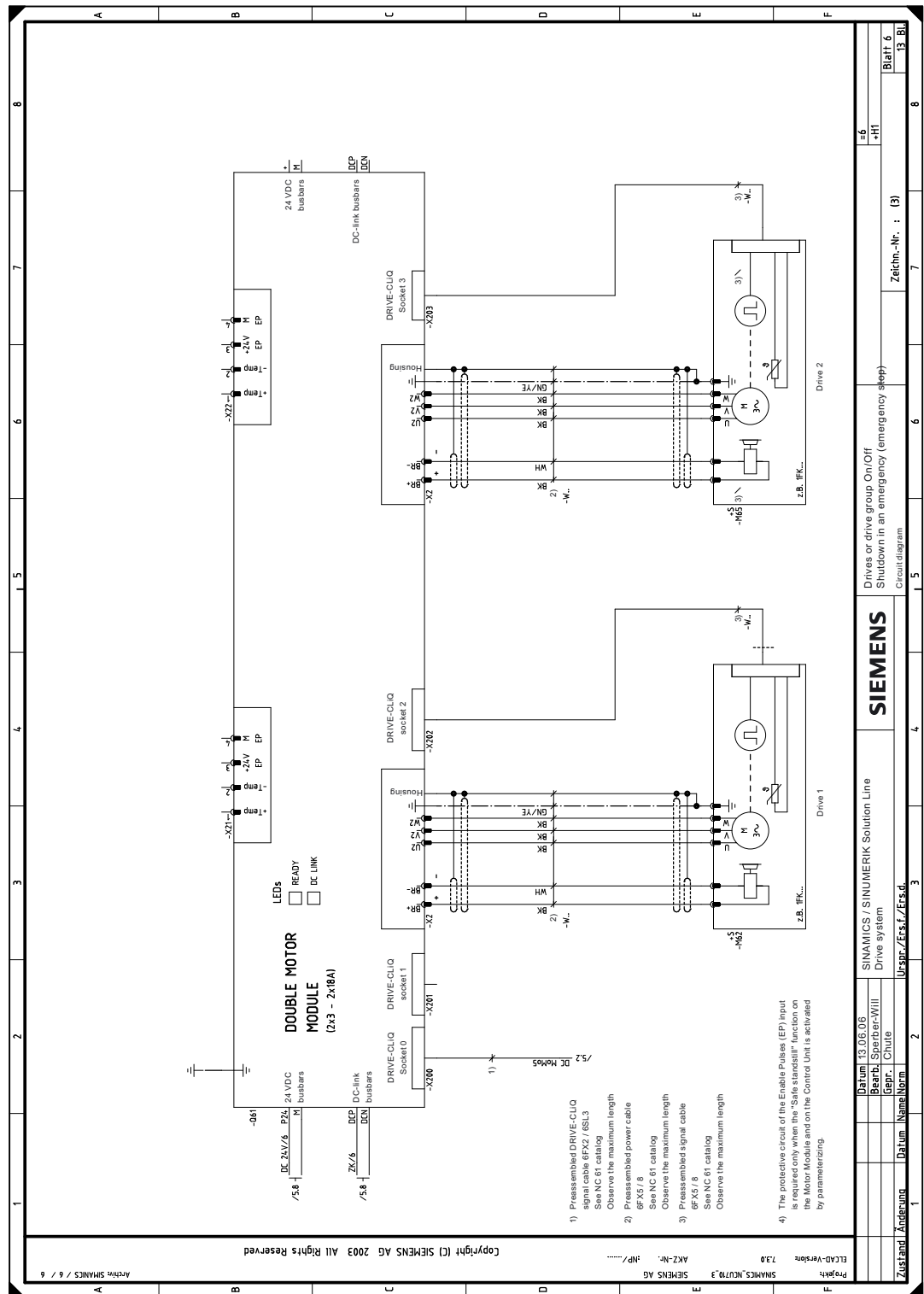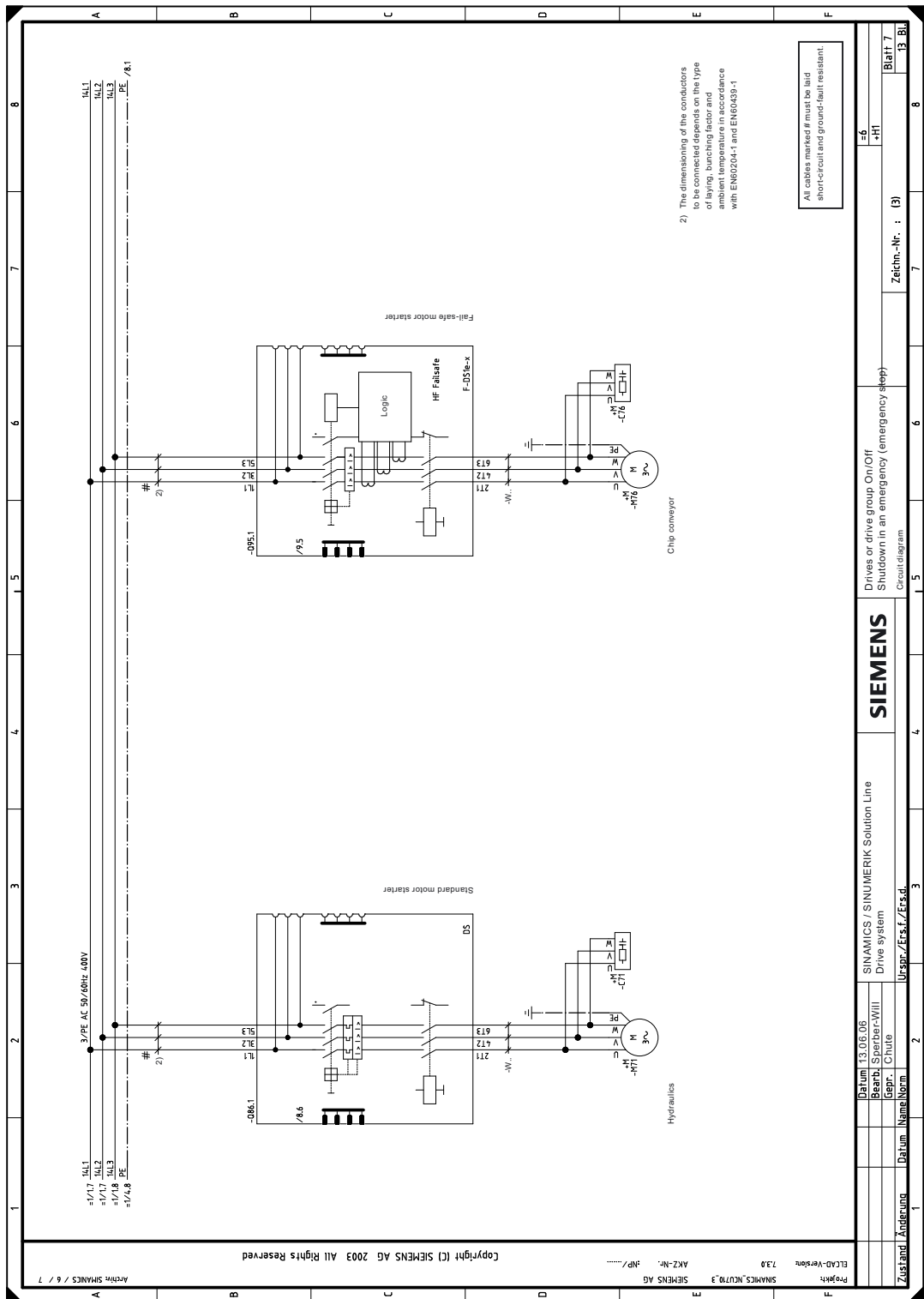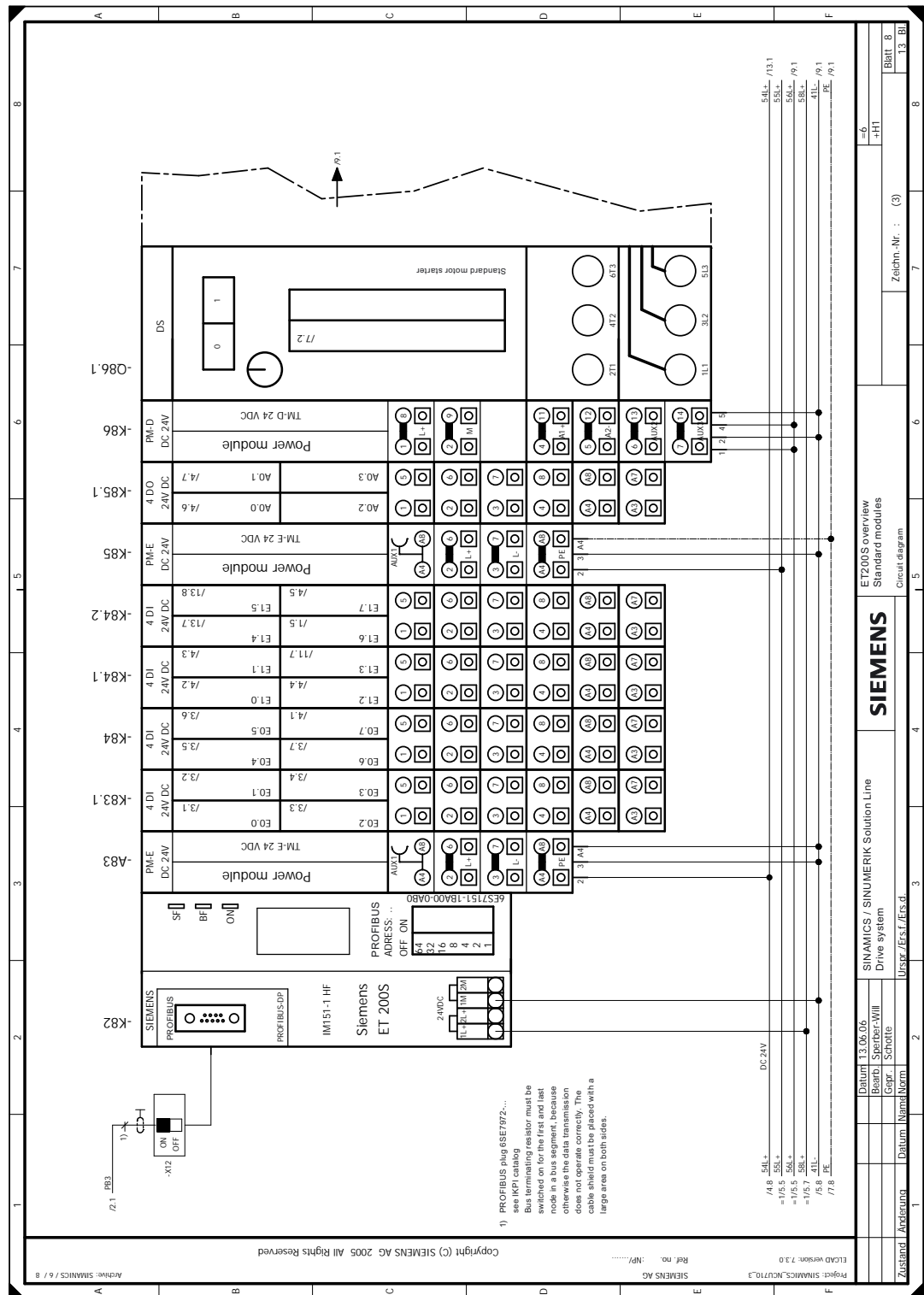Figure 7-35   Circuit manual group =6, page 6

Figure 7-36   Circuit manual group =6, page 7

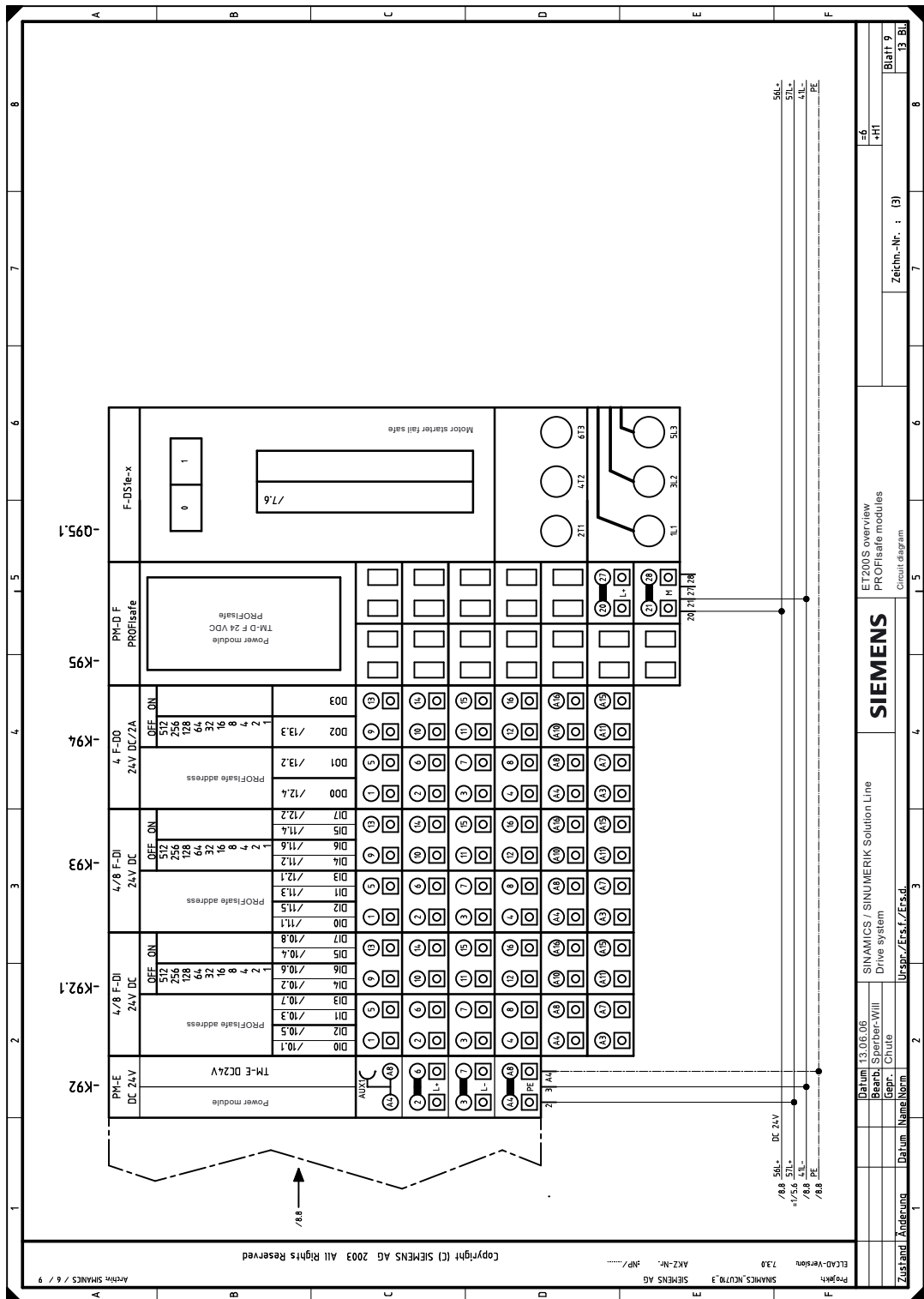Figure 7-37   Circuit manual group =6, page 8
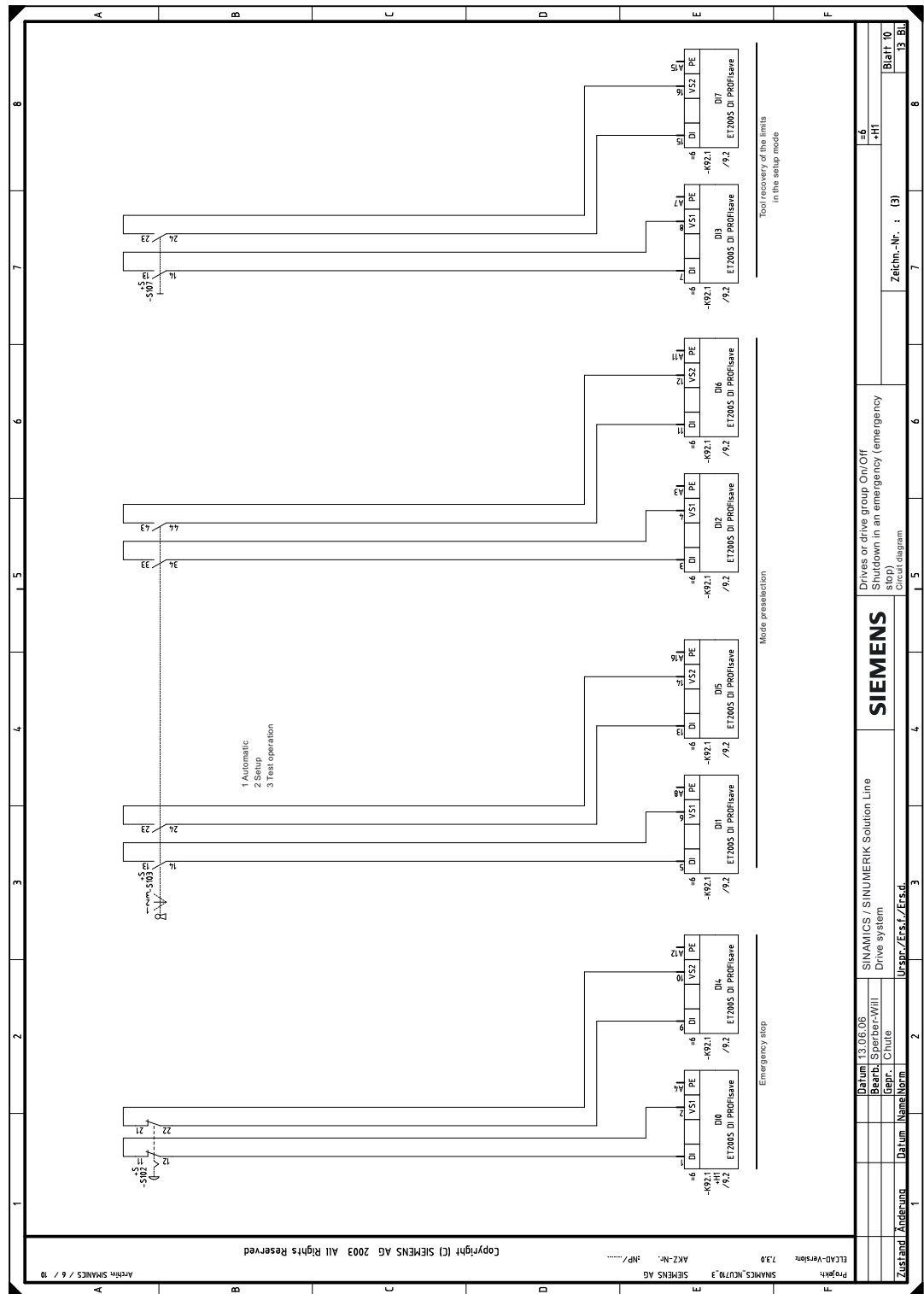
Figure 7-38   Circuit manual group =6, page 9

Figure 7-39   Circuit manual group =6, page 10

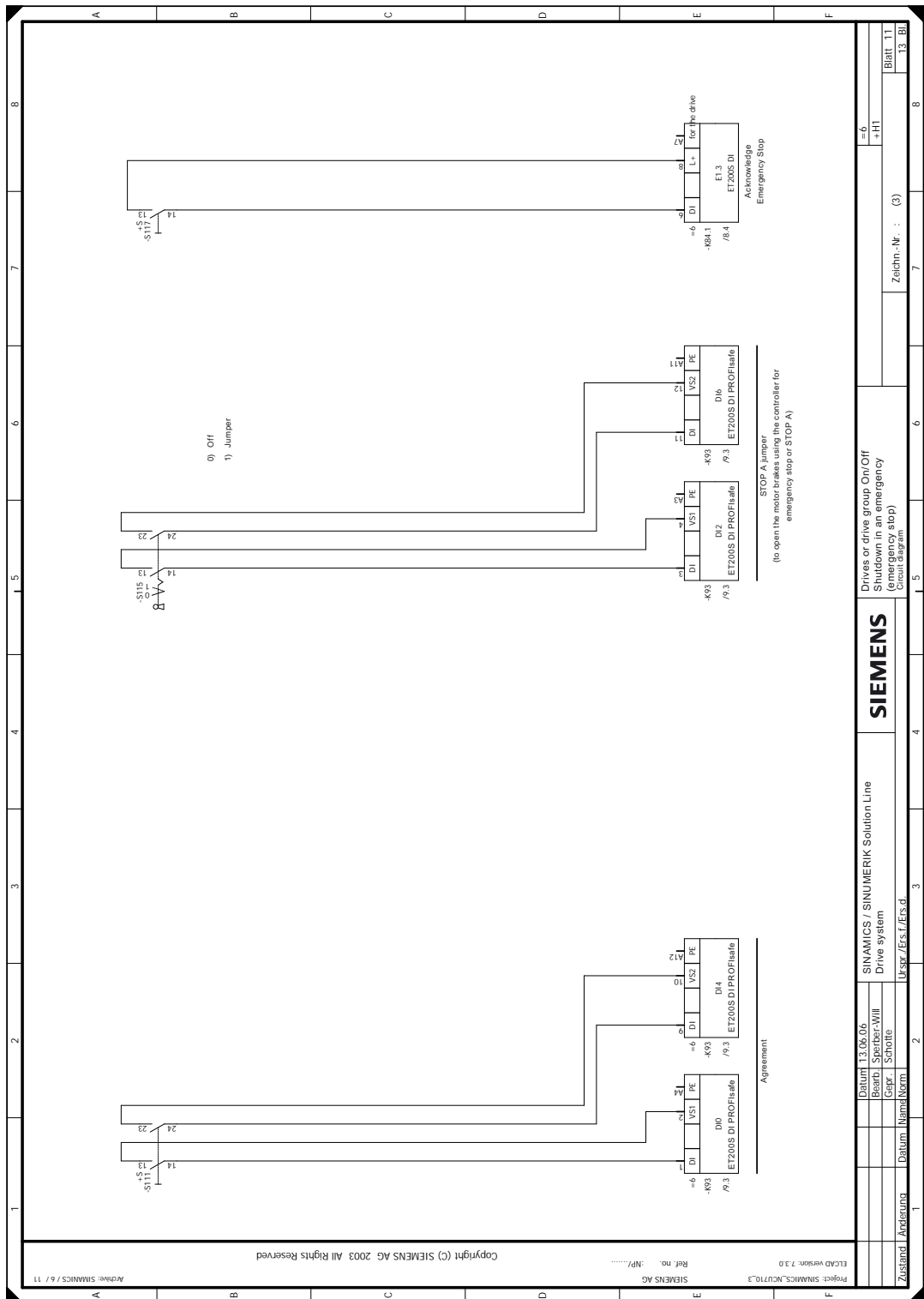Figure 7-40   Circuit manual group =6, page 11
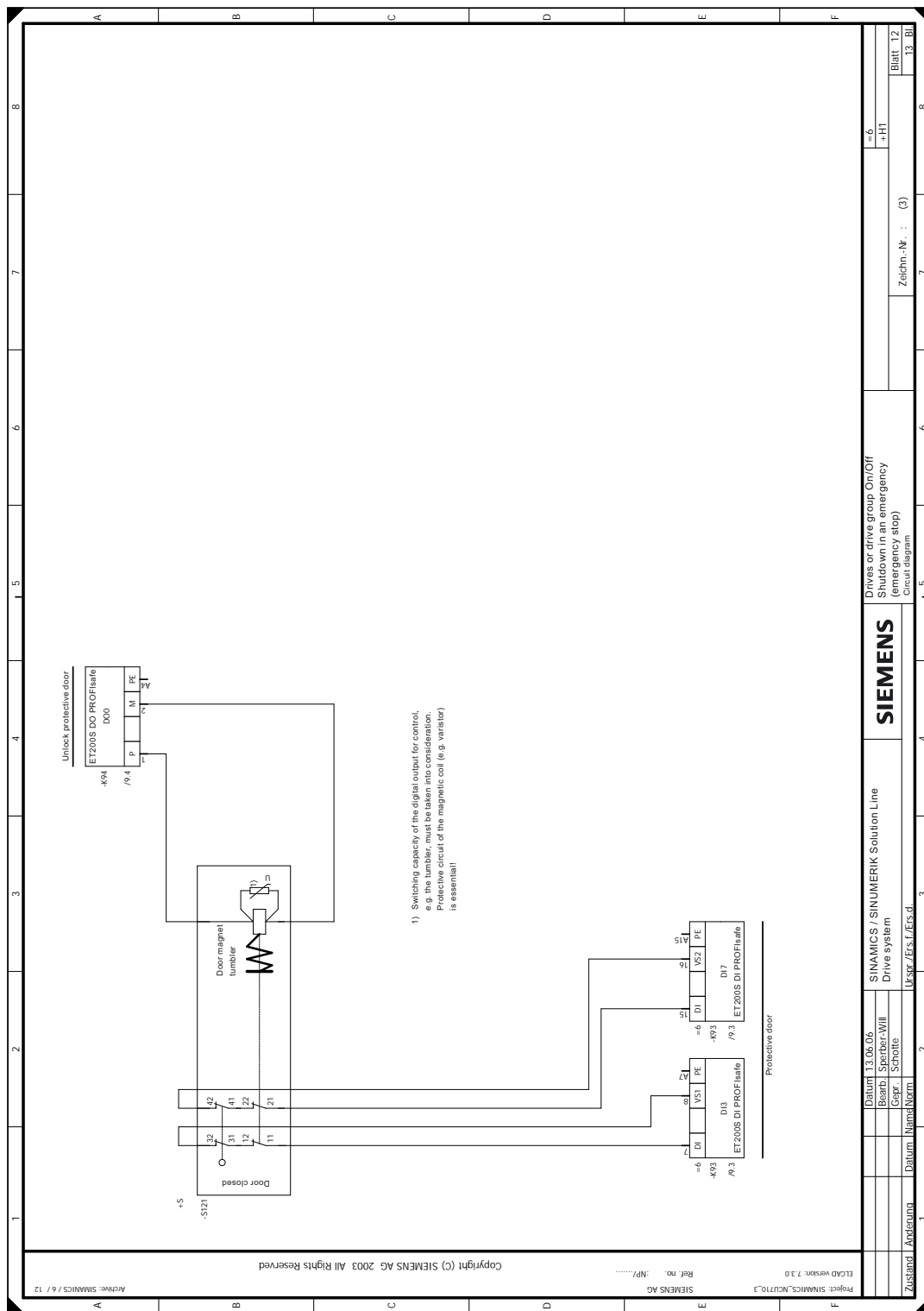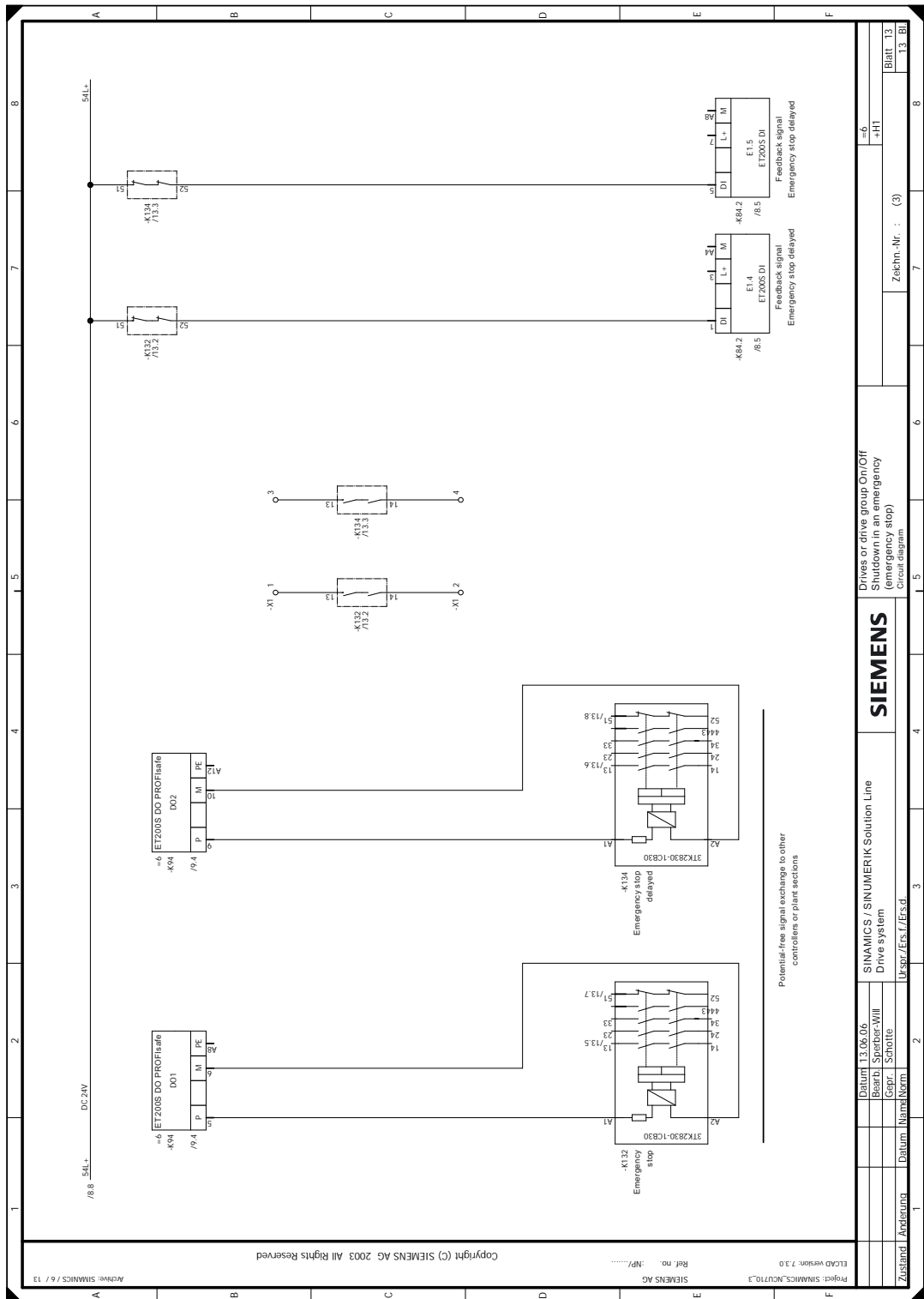
Figure 7-41　Circuit manual group =6, page 12

Figure 7-42   Circuit manual group =6, page 13

Additional Information

8

8.1 Distributed Installation

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..
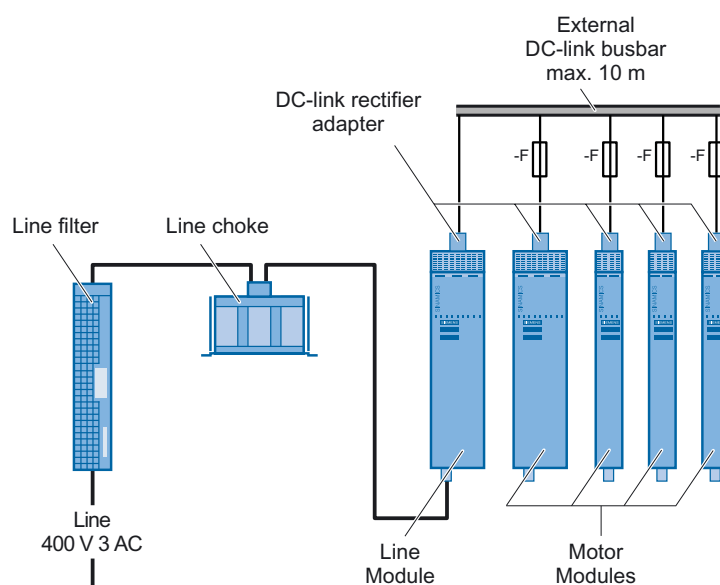

Figure 8-1   Distributed Installation

Depending on the component width, two variants are available:

Component width 50/100 mm

DC link rectifier adapter with connection possibilities from 0.5 mm² to 10 mm², max. 36 A.

Component width 150 ... 300 mm

DC link rectifier adapter with connection possibilities from 35 mm² to 95 mm², max. 240 A.

Protection of the DC link connection

Each of the DC link outlets to the Motor Modules must be provided with a protection. The corresponding protection details are contained in the Cabinet Modules device manual.

Note

The internal DC link busbar may not be used if the DC link rectifier adapter is connected to a power unit. The provided DC link strap must be removed. Each power unit requires a DC link rectifier adapter!

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.
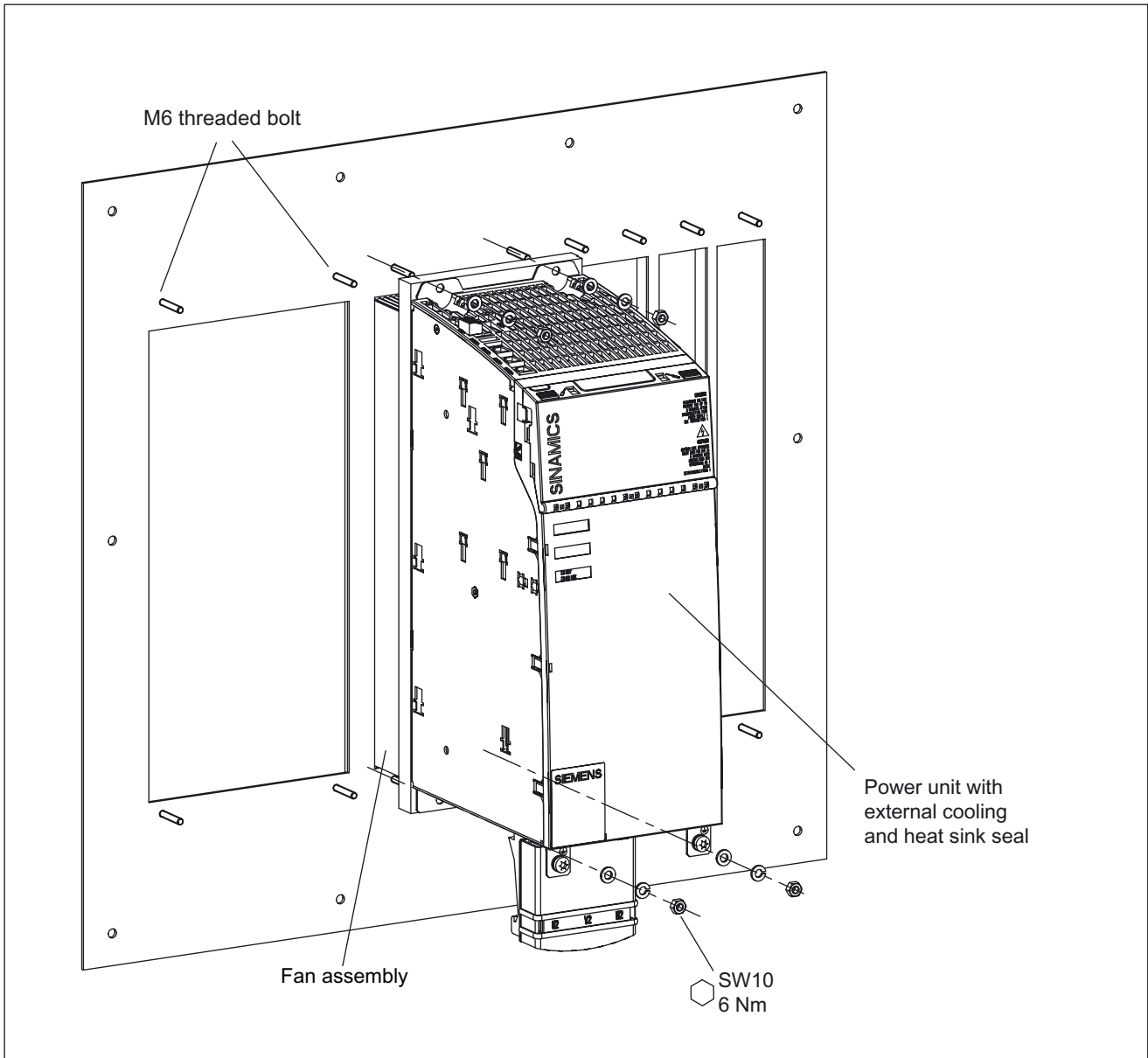
Figure 8-2   Installation of a booksize power unit with external air cooling

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.

- **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.

SINAMICS S120 Booksize power unit with cold plate

Cold plate

Cooling type

with internal liquid cooling
(in preparation)

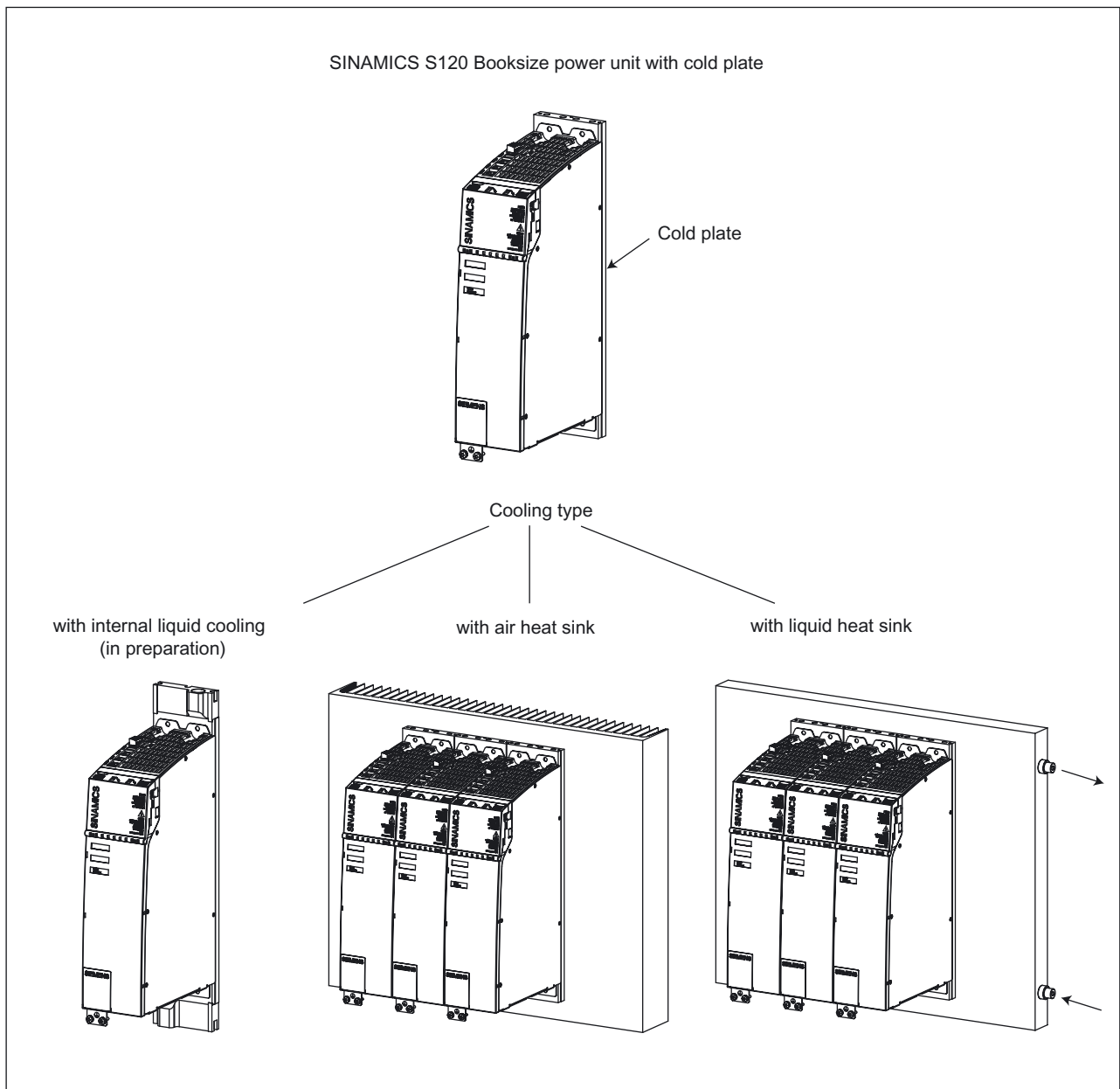with air heat sink

with liquid heat sink

Figure 8-3   Cooling systems for cold plate

Note

The associated notes contained in the device 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
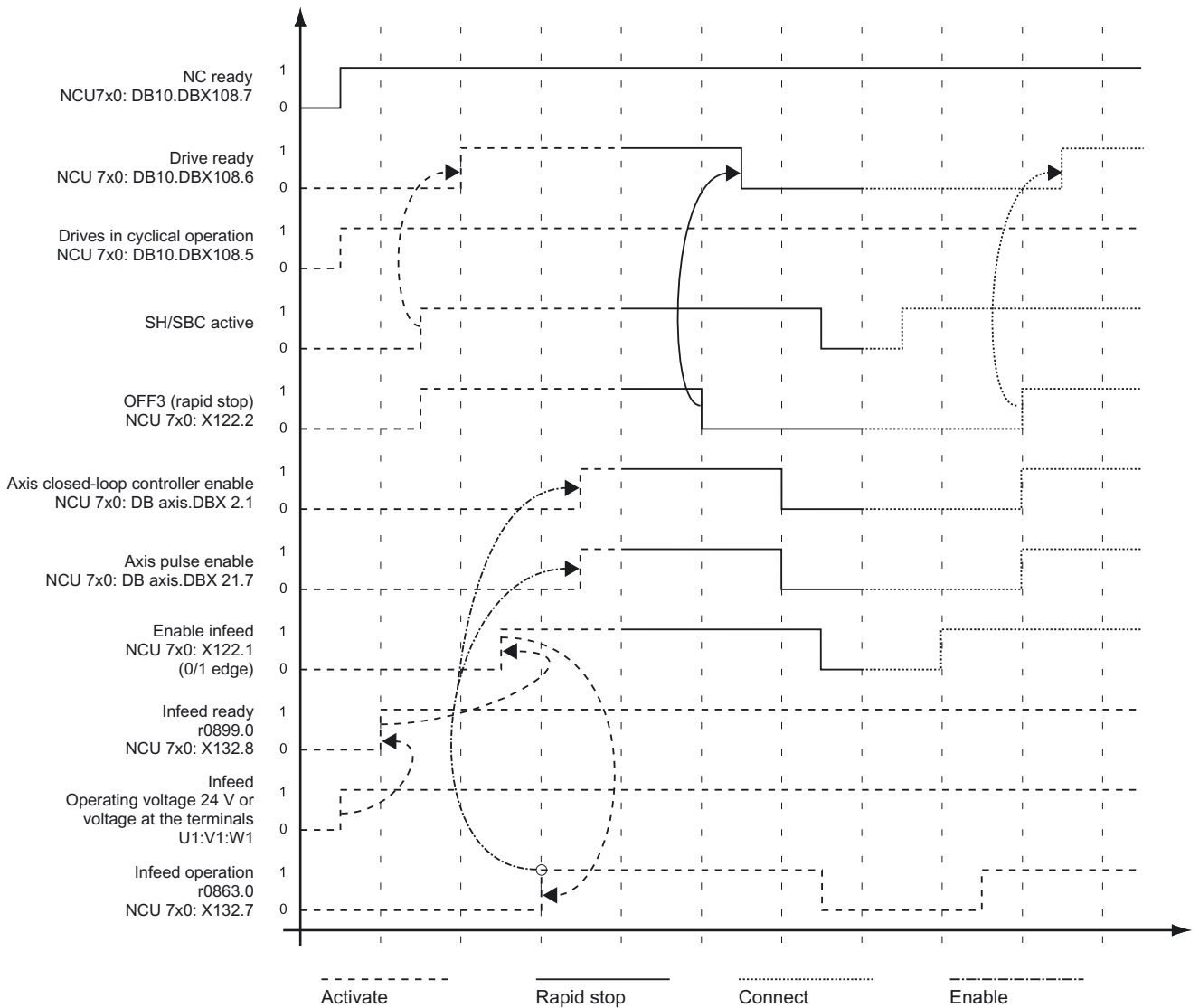
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9.1 Overview of the Status Signals

Figure 9-1   Overview of the Status Signals

9.2 Drive Group with Several Axes

The Motor Module is controlled 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 Parameter 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.
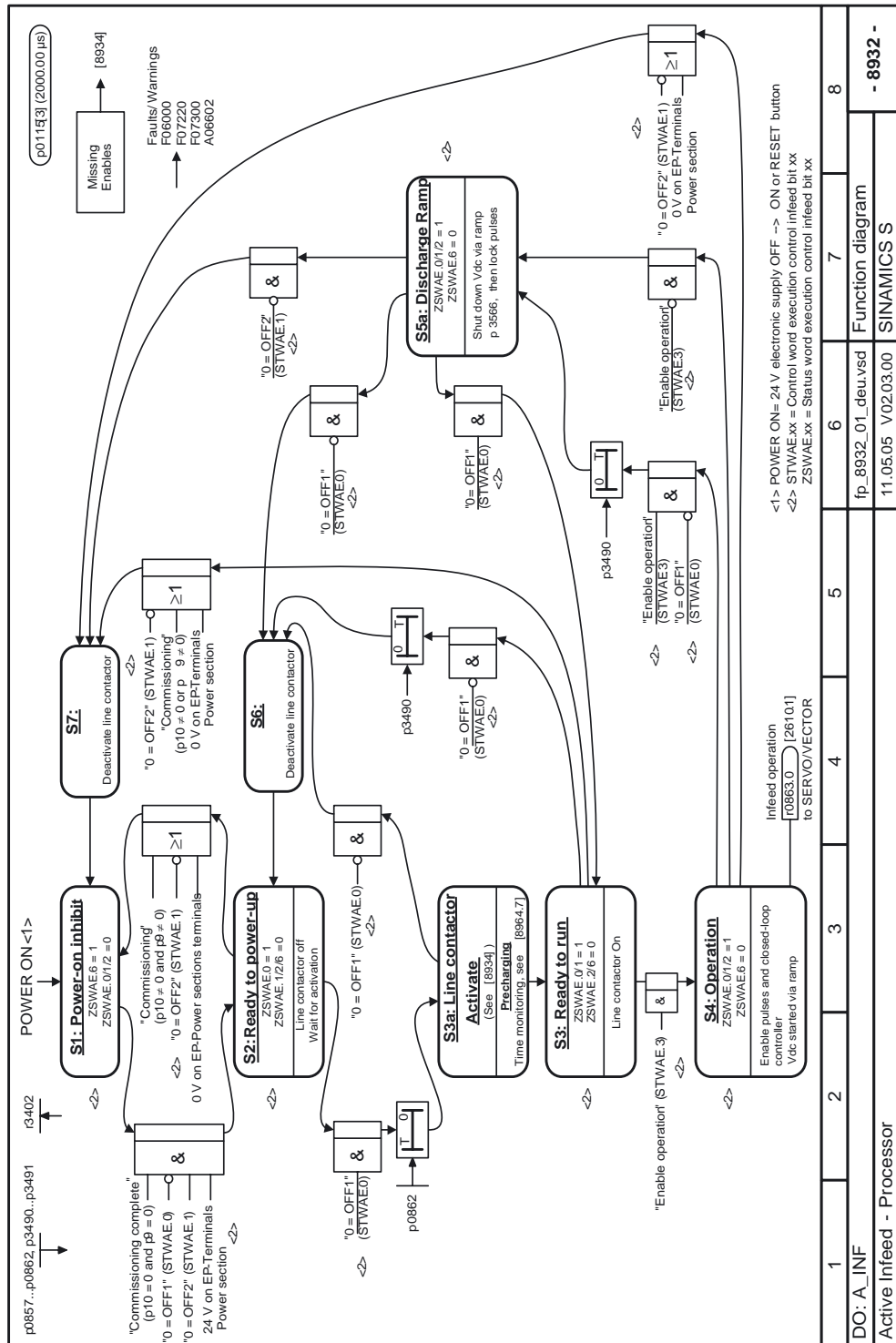
Activating the infeed

Figure 9-2   Activating the infeed
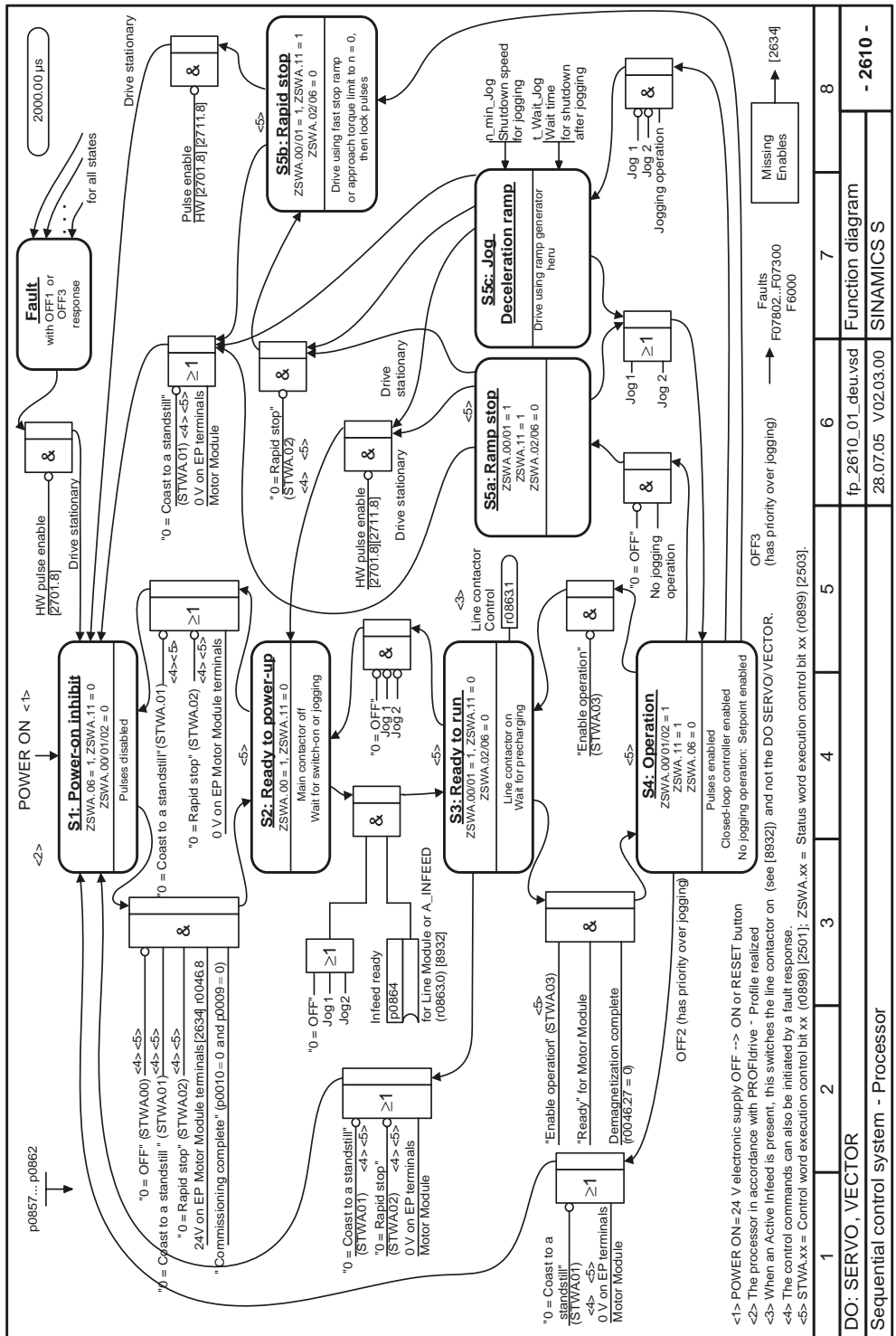
Activating the drive

Figure 9-3   Activating the drive

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 brake application time (p1217) expires. The standstill is detected when the actual speed value of the speed threshold (p1226) is undershot 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.

    – Power-on inhibit 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 application time of the holding brake (p1217) expires. The standstill is detected when the speed actual value of the speed threshold (p1226) is undershot or when the monitoring time (p1227) started when speed setpoint ≤ speed threshold (p1226) has expired.

    – Power-on inhibit is activated.

Control and status signals

Table 9-1   Activate/deactivate controller

Signal name	Internal control word	Binector input	PROFIBUS message frame 2 … 106	VDI interface (PLC)
0 = OFF1	STWA.00 STWAE.00	p0840 ON/OFF1	STW1.0	DB(AX).DBX2.1 (controller enable) DB(AX).DBX1.5/6 (measuring system selected and OK) DB(AX).DBX21.7 (pulse enable)
0 = OFF2	STWA.01 STWAE.01	p0844 1. OFF2 p0845 2. OFF2	STW1.1	1
0 = OFF3	STWA.02	p0848 1. OFF3 P0849 2. OFF3	STW1.2	1
Enable operation	STWA.03 STWAE.03	p0852 operation enabled	STW1.3	DBX21.7

Table 9-2   Activate/deactivate status signals

Signal name	Internal status word	Parameters	PROFIBUS message frame 2 … 106
Ready to power-up	ZSWA.00 ZSWAE.00	r0899.0	ZSW1.0
Ready to run	ZSWA.01 ZSWAE.01	r0899.1	ZSW1.1
Operation enabled	ZSWA.02 ZSWAE.02	r0899.2	ZSW1.2
Power-on inhibit	ZSWA.06 ZSWAE.06	r0899.6	ZSW1.6
Pulses enabled	ZSWA.11	r0899.11	ZSW1.11

Function diagram overview (see SINAMICS S Parameter Manual)

- 2610 execution control - processor
- 2634 missing enables, line contactor control
- 8732 basic infeed - processor
- 8832 smart infeed - processor
- 8932 active infeed - processor

ESD Notes

A

⚠️ **Caution**

Electrostatic sensitive devices (ESD) are single components, integrated circuits or devices that can be damaged by electrostatic fields or electrostatic discharges.

Regulations for the ESD handling:

During the handling of electronic components, pay attention to the grounding of the person, workplace and packaging!

Electronic components may be touched by persons only when

- these persons are grounded using an ESD bracelet, or
- these persons in ESD areas with a conducting floor wear ESD shoes or ESD grounding straps.

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.

Electronic components must not be brought into contact with plastics or clothing made of artificial fibers.

Electronic components may only be placed on conducting surfaces (table with ESD coating, conducting ESD foamed material, ESD packing bag, ESD transport container).

Electronic components may not be placed near display units, monitors or televisions (minimum distance from the screen > 10 cm).

Measurements may be made on electronic components when the measuring unit is grounded (e.g. with a protective conductor) or prior to measuring with a potential-free measuring unit, the measuring head is briefly discharged (e.g. by touching a bare metal housing).

Abbreviations

<div style="text-align: right; font-size: 2em;">B</div>

B.1 Abbreviations

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
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

Abbreviation	German meaning	English meaning
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	Spannungsversorgung	Voltage Supply
VSM	Voltage Sensing Module	Voltage Sensing Module
ZSW	Zustandswort	Status word

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Suggestions

Corrections

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SINUMERIK 840D sl,
SINAMICS S120

Guide for the SINUMERIK 840D sl
machine configuring

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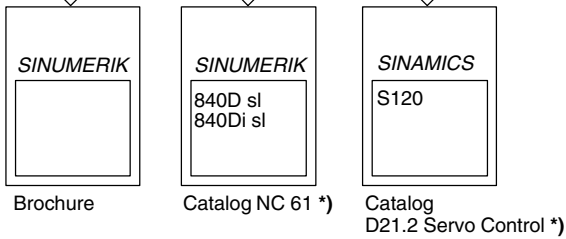
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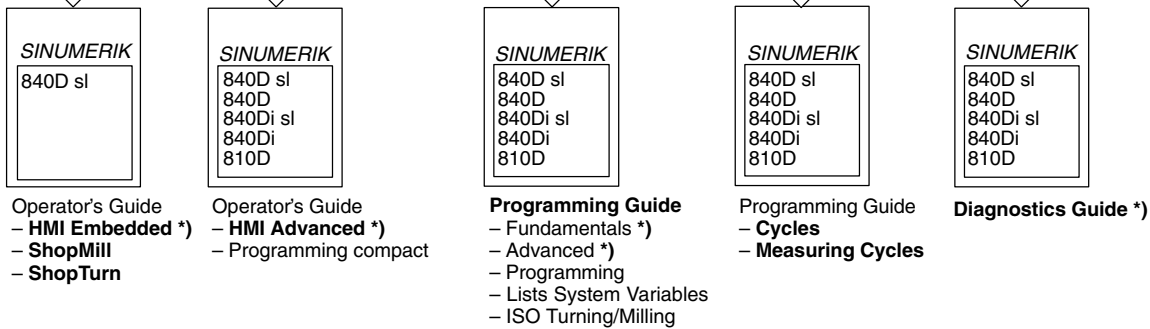Suggestions for improvements are
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Suggestions and/or corrections

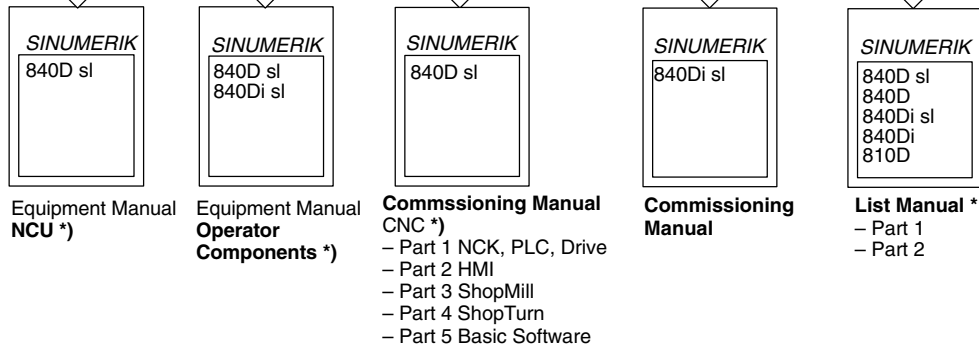# Overview of SINUMERIK 840D sl/840Di sl Documentation (03/2006)
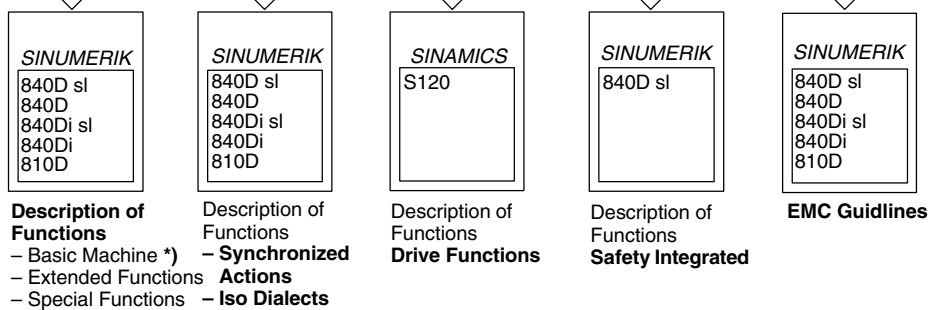
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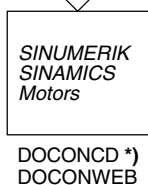Brochure

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