SIEMENS

SIMODRIVE 611

Planning Guide **05.2001 Edition**

Drive Converter

Manufacturer/Service Documentation

SIEMENS

SIMODRIVE 611

Planning Guide

Drive Converter

Valid for

6SN11- series

05.2001 Edition

SIMODRIVE® documentation

Printing history
Brief details of this edition and previous editions are listed below.

The status of each edition is shown by the code in the ”Remarks” column.

Status code in the ”Remarks” column:

A.... New documentation

B.... Unrevised reprint with new Order No.

C.... Revised edition with new status

If factual changes have been made on the page since the last edition, this is indicated by a new edition coding in the header on that page.

Edition	Order No.	Note
04.93	6SN1060–0AA01–0AA0	**A**
08.93	6SN1197–0AA00–0BP0	**C**
12.94	6SN1197–0AA00–0BP1	**C**
11.95	6SN1197–0AA00–0BP2	**C**
02.98	6SN1197–0AA00–0BP3	**C**
08.98	6SN1197–0AA00–0BP4	**C**
05.01	6SN1197–0AA00–0BP5	**C**

This Manual is included in the documentation on CD–ROM **(DOCONCD)**

Edition	Order No.	Note
08.01	6FC5 298–6CA00–0BG1 (840D)	**C**
07.99	6FC5198–6CA00–0BG1 (840C)	**C**

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Functions may be executable in the control but are not described in this documentation. No claims can be made on these functions if included with a new shipment or when involved with service.

We have checked the contents of this document to ensure that they coincide with the described hardware and software. Nonetheless, differences might exist and therefore we cannot guarantee that they are completely identical. The information contained in this document is, however, reviewed regularly and any necessary changes will be included in the next edition. We are thankful for any recommendations for improvement.

Subject to change without prior notice.

Order No. 6SN1197–0AA00–0BP5
Printed in the Federal Republic of Germany

Siemens–Aktiengesellschaft

Foreword

Structure of the documentation

The SIMODRIVE documentation is sub–divided into the following levels:

- General Documentation/Catalogs
- Manufacturer/Service Documentation
- Electronic Documentation

You can obtain more detailed information on the documents listed in the documentation overview as well as additional SIMODRIVE documentation from your local Siemens office.

This Manual does not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation or maintenance.

The contents of this document are neither part of an earlier or existing contract, agreement or a contract nor do they change this.

The sales contract contains the entire obligation of Siemens. The warranty contained in the contract between the parties is the sole warranty of Siemens.

Any statements contained here do not create new warranties nor modify the existing warranty.

The abbreviations used in this document are explained in Attachment B.

Target group

This documentation addresses machine manufacturers, who wish to configure, assemble and commission a drive group with SIMODRIVE components.

Goals

This Planning Guide provides detailed information about using and handling SIMODRIVE components.

Should further information be desired or should particular problems arise, which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local Siemens sales office.

Definition: Who are qualified personnel?

For the purpose of this documentation and product labels, a "qualified person" is a person who is familiar with the installation, mounting, start–up and operation of the equipment and hazards involved. He or she must have the following qualifications:

- trained and authorized to energize, de–energize, clear, ground and tag circuits and equipment in accordance with established safety procedures.
- trained in the proper care and use of protective equipment in accordance with established safety procedures.
- trained in rendering first aid

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Explanation of the symbols

The following symbols are used in this documentation

Danger

This symbol in the document indicates that death, severe personal injury or substantial property damage **will** result if proper precautions are not taken.

Warning

This symbol in the document indicates that death, severe personal injury or property damage **can** result if proper precautions are not taken.

Caution

This symbol appears in the document indicating that minor personal injury or material damage **can** result if proper precautions are not taken.

Caution

This warning (without warning triangle) indicates that material damage **can** result if proper precautions are not taken.

Notice

This warning indicates than undesirable situation or condition **can** occur if the appropriate instructions/information are not observed.

Note

This symbol indicates important information about the product or part of the document, where the reader should take special note.

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Technical information

Notice

The listed line filters generate a high leakage current through the protective conductor. As a result of the high filter leakage current, the line filter and cabinet must be permanently connected to PE.

The measures in accordance with EN 50178/94, Part 5.3.2.1 must be implemented, e.g.

1. A copper protective conductor with a minimum cross–section of 10 mm^2 must be connected, or
2. A second conductor should be connected in parallel to the protective conductor through separate terminals.

This conductor must fulfill the requirements for protective conductors according to IEC 364–5–543 itself.

Warning

Operational electrical equipment has parts and components which are at hazardous voltage levels.

Incorrect handling of these units, i. e., not observing the warning information can therefore result in severe bodily injury or material damage.

Only appropriately qualified personnel may commission/start–up this equipment.

This personnel must have in–depth knowledge regarding all of the warning information and service instructions according to this Guide.

Perfect and safe operation of this equipment assumes professional transport, storage, mounting and installation as well as careful operator control and service.

Hazardous axis motion can occur when working with the equipment.

Further, all of the valid national, regional and plant/system–specific regulations must be adhered to.

Caution

Clear warning information indicating the danger associated with the DC link discharge voltage must be provided on the modules in the relevant language of the country where the equipment is used

Note

When handling cables observe the following

- they must not be damaged,
- they must not be stressed and
- they must not come into contact with rotating components.

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Note

For IT and TT line supplies, the measuring equipment and programming devices which are connected must be referred to the reference potential of the module group.

Notice

M600 and M500 are not PE potentials. A hazardous voltage of between 300 ... 400 V with respect to PE is present at the terminals. These potentials may not be connected to PE.

Warning

The ”protective electrical separation” can only be guaranteed when components certified for the system are used.

”Protective separation”
can only be guaranteed by ensuring the degree of protection of the system components.

For ”protective separation” the shield of the brake cable must be connected to PE through the largest possible surface area.

”Protective separation” must be provided between the temperature sensor and the motor winding of third–party motors.

Warning

Start–up/commissioning is absolutely prohibited until it has been ensured that the machine, in which the components described here are to be installed, fulfills the regulations/specifications of the Directive 89/392/EEC.

Warning

The information and instructions in all of the documentation supplied and any other instructions must always be observed to eliminate hazardous situations and damage.

- for special versions of the machines and equipment, the information in the associated catalogs and quotation is valid.
- further, all of the relevant national, local and plant/system–specific regulations and specifications must be taken into account.
- all work must be undertaken with the system in a no–voltage condition (powered down)!

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Warning

Residual hazardous voltage are still present even after all of the power supply voltages have been disconnected. The voltages can be present for up to 30 min for the capacitor modules.

The voltage must be measured in order to ensure that there are no hazardous voltages present (generator principle for rotating motors)

Warning

The rated current of the connected motor must match the rated drive converter current, as otherwise motor feeder cable protection is not guaranteed. The cross–section of the motor feeder cable must be dimensioned for the rated drive converter current.

Warning

Before commissioning the 611D, the encoder cable must be checked to ensure that it has no ground faults. If there is a ground fault, uncontrolled movement could occur for pulling loads.

No longer occurs from: 6SN1118–0D□2□–0AA0 Version C.

Note

The following limitations must be observed when the system is subject to a high voltage test:

1. Power down the equipment so that it is in a no–voltage condition.
2. Withdraw the overvoltage module to prevent the voltage limiting responding.
3. Disconnect the line filter to prevent dips in the test voltage.
4. Connect the potential M600–PE through a 100 kΩ resistor (open the grounding bar in the NE modules). The units are subject in the factory to a high–voltage test with voltages of 2.25 kV_{DC}, phase–PE. The NE modules are shipped with the grounding bar open.
5. The maximum permissible test voltage for a high–voltage test in the system is 1.8 kV_{DC} Phase–PE.

Note

The terminal blocks of the SIMODRIVE 611 modules are exclusively used to electrically connect the particular module. If they are used for any other application (e.g. as carrying handle), this can damage the module.

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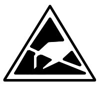
ESDS information

Electrostatic **d**ischarge **s**ensitive devices



Components which can be destroyed by electrostatic discharge are individual components, integrated circuits, or boards, which when handled, tested or transported, could be destroyed by electrostatic fields or electrostatic discharge. **ESDS** (**E**lectro**S**tatic **D**ischarge **S**ensitive Devices).

Handling ESDS boards:

- When handling components which can be destroyed by electrostatic discharge, it should be ensured that personnel, the work station and packaging are well grounded.
- Electronic boards should only be touched when absolutely necessary.
- Components may only be touched, if
  - you are continuously grounded through an ESDS bracelet,
  - you are wearing ESDS shoes or ESDS shoe grounding strips in conjunction with an ESDS floor surface.
- Boards may only be placed on conductive surfaces (desk with ESDS surface, conductive ESDS foam rubber, ESDS packing bag, ESDS transport containers).
- Boards may not be brought close to data terminals, monitors or television sets (a minimum of 10 cm should be kept between the board and the screen).
- Boards may not be brought into contact with materials which can be charged–up and which are highly insulating, e. g. plastic foils, insulating desktops, articles of clothing manufactured from man–made fibers.
- Measuring work may only be carried out on the boards, if
  - the measuring equipment is grounded (e.g. via the protective conductor), or
  - for floating measuring equipment, the probe is briefly discharged before making measurements (e. g. a bare control housing is touched).

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Space for your notes

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1 Overview of the Drive System

1.1 Overview of SIMODRIVE 611

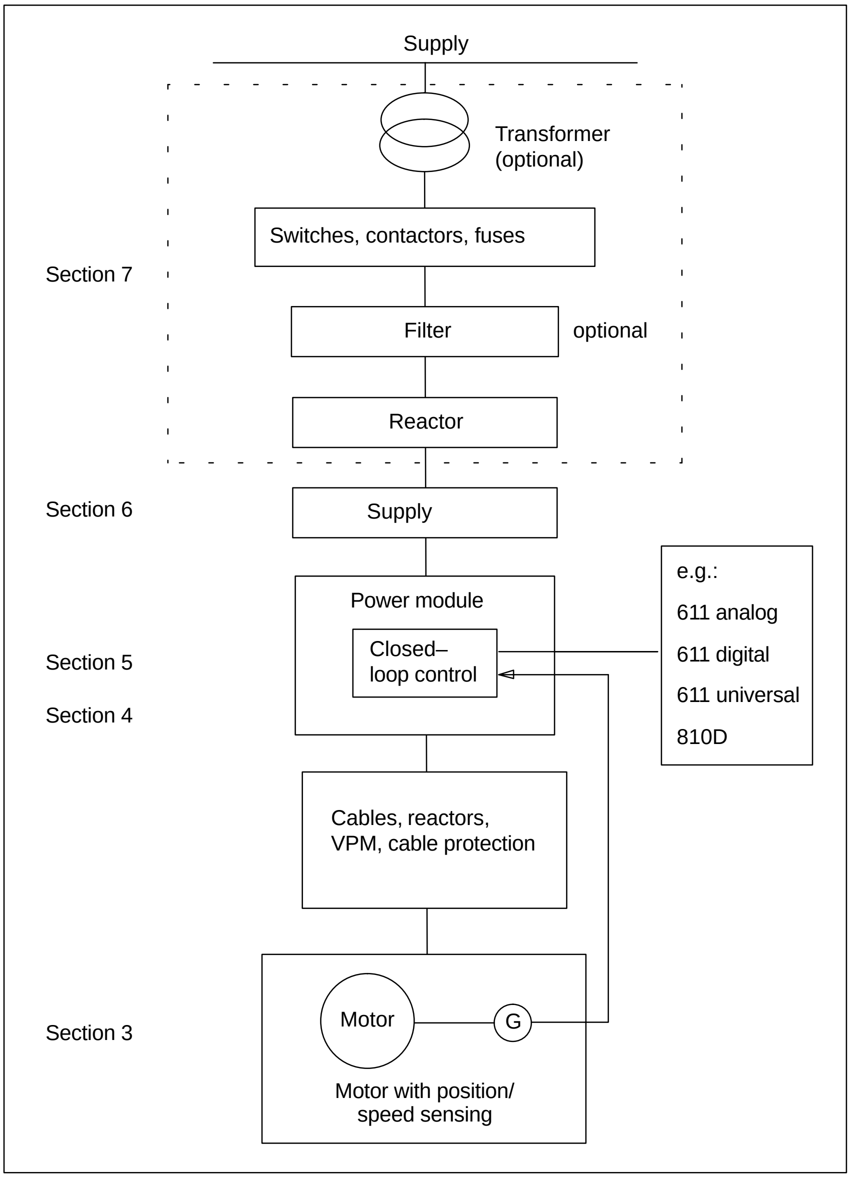

Fig. 1-1 Principle system configuration

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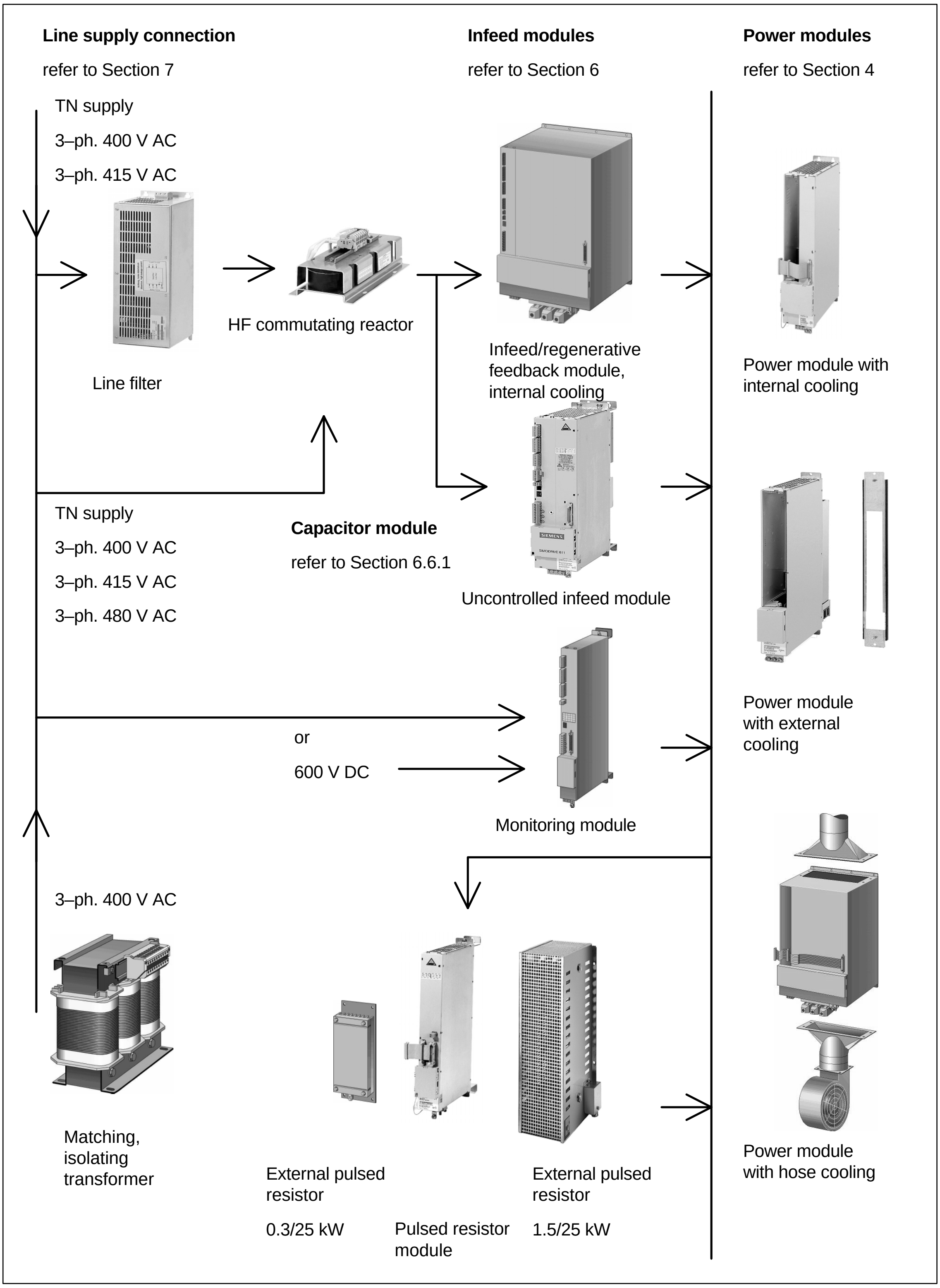

Fig. 1-2 Overview of the SIMODRIVE 611 drive system

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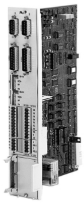
Control modules

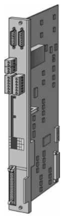
refer to Section 5

Control modules with analog setpoint interface



For 1FK6 motors with resolver

– 1–axis version
– 2–axis version



For 1FT5 motors

– 1–axis version
– 2–axis version

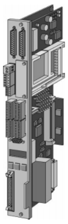
For induction motors

Fixed setpoints/motorized potentiometer including analog speed input

For 1PH motors

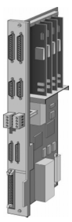
Motor encoder, alternatively/additional direct spindle measuring system or spindle signal output can be selected

Control modules with universal setpoint interface



For 1FT6/1FK6/1FN/1PH/1FE1 motors and induction motors
– 1–axis version (resolver)
– 2–axis version (resolver or encoder with sin/cos 1 V_{pp})
– Standard: Analog setpoint interface
– Option modules: PROFIBUS–DP or TERMINALS

Control modules with digital setpoint interface



For 1PH/1FE1/1LA or 1FT6/1FK6/1FN motors
– 1–axis version (performance 1 control)
– 2–axis version (standard control)

For 1FT6/1FK6 motors
– 2–axis version (performance 1 control)

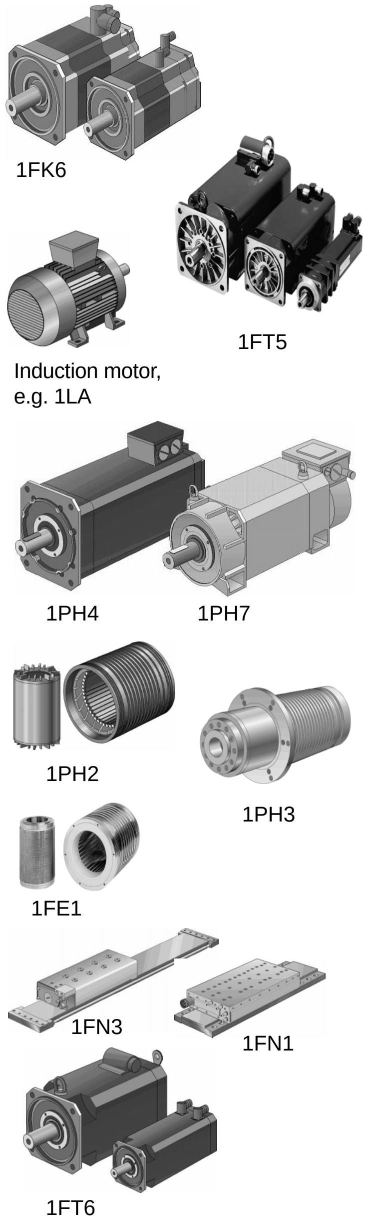
For 1FT6/1FK6 motors
– 1–axis version

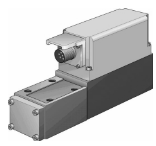
For hydraulic linear axes

2–axis version

Motors

refer to Section 3





Control valve for hydraulic linear axes (not in the scope of supply)

Fig. 1-3 Overview of the drive system

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Note

Siemens guarantees a satisfactory and reliable operation of the drive system as long as only original SIMODRIVE system components are used in conjunction with the original accessories described in this Planning Guide and in Catalog NC 60.

The user must take into consideration the appropriate engineering specifications.

The drive converter system is designed for installation in an electrical cabinet which is designed and implemented in compliance with the relevant Standards for processing machines/machine tools, especially EN 60204.

Description

The drive converter system comprises the following modules (refer to Fig. 1-2 and 1-3):

- Transformer
- Switching and protecting elements
- Line filter
- Commutating reactors
- Infeed modules
- Power modules
- Control modules harmonized with the application technology and motor types
- Special modules and additional accessories

Different cooling types are available for the output–dependent supply infeed and drive modules.

- Internal cooling
- External cooling
- Hose cooling

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1.2 Engineering steps

Note

When engineering/configuring SIMODRIVE 611 drive systems, it is assumed that the motors being used are known.

Reference: /PJM/ Planning Guide, Motors

Procedure

A SIMODRIVE drive group is engineered in 2 phases:

- Phase 1 Selecting the components (refer to Fig. 1-4)
- Phase 2 Connection configuration (refer to Fig. 1-5)

Starting from the required torque, the motor is first selected followed by the drive module and the various encoder evaluation versions.

When required, a second engineering phase can following the first one. Here, the appropriate circuit recommendations and measures are taken into account.

Note

A PC tool is available to configure the 6SN series, e.g.:

- NCSD configurator

Please contact your local Siemens office for further information.

The functions of the control modules are described in this Planning Guide in the form of bullet points and where relevant, with limit values. Please refer to the appropriate documentation for additional details.

Basic engineering information/instructions and detailed ordering information are provided in Catalogs NC 60 and NC Z.

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Phase 1 when engineering

Selecting the components

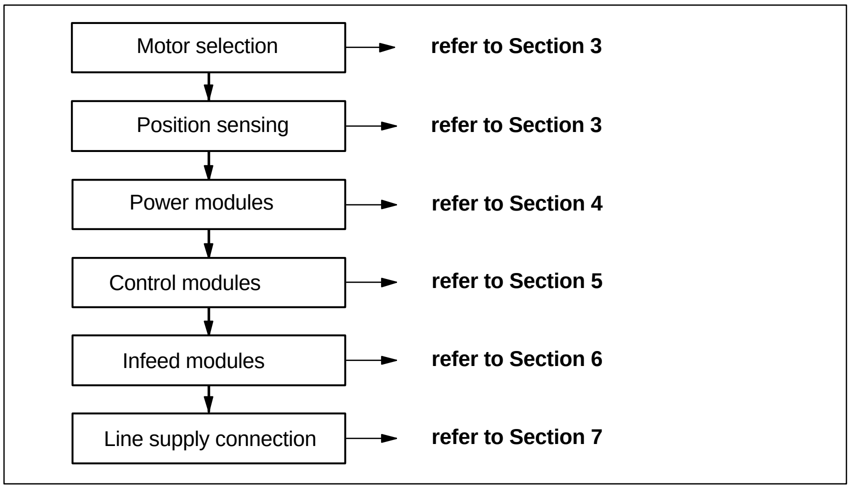

Fig. 1-4 Selecting the components

Phase 2 when engineering

Connection configuration

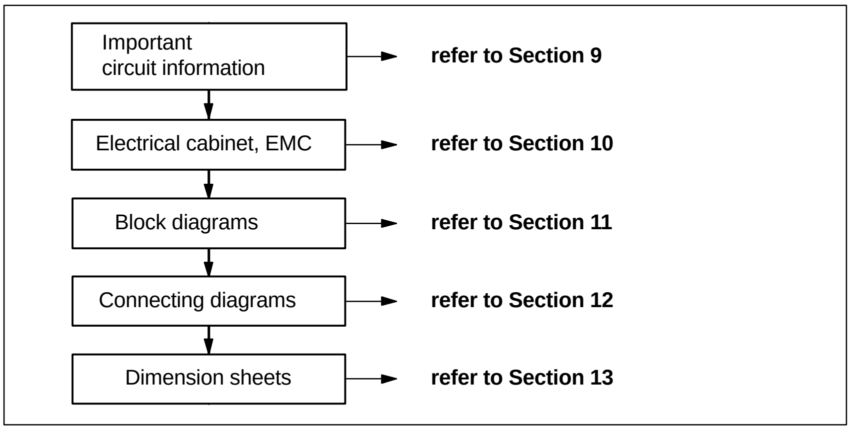

Fig. 1-5 Connection configuration

Selecting cable and conductor protective devices and switching devices

The cable and conductor protective devices and switching devices should be selected taking into account the relevant Standards, regulations and the requirements at the point of installation.

Reference:	/NCZ/	Catalog Connection Technology and System Components
Reference:	/NSK/	Catalog Low–Voltage Switchgear

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2 System Configuration

Drive group

A SIMODRIVE drive group is of a modular design comprising line filter, commutating reactor, line supply infeed module, drive modules as well as when required: Monitoring, pulsed resistor, capacitor and HGL module(s).

One SINUMERIK 840D can be integrated into a module group with digital drive module interfaces.

Modules can be located in several tiers one above the other, or next to each other. In this case, a connecting cable is required for the equipment bus, and if relevant, also for the drive bus; Order designations, refer to Catalog NC60.

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2.1 Module arrangement

The modules can be arranged as required! The modules must be arranged according to their function and the cross–section of their DC link buses.

The I/R or the monitoring module is always the first module starting from the left of the module group. The power modules should be arranged to the right next to the I/R and the monitoring modules.

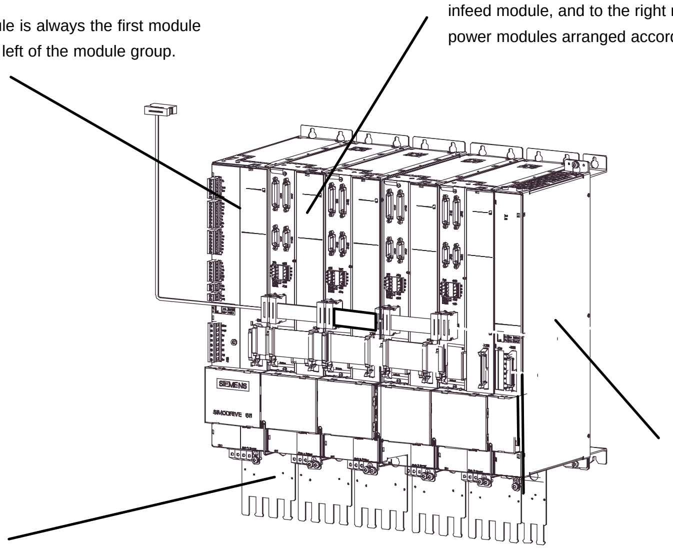

Fig. 2-1 Connection example

Due to the parasitic capacitances with respect to ground, when configuring and engineering the drive group, care should be taken regarding the complete length of the power cables used.

The drive converter system is designed for operation in industrial environments, connected to grounded TN–S and TN–C line supplies (VDE 0100. Part 300). For all other line supply types, a transformer must be used with separate windings, vector group Yyn0 (dimensioning, refer to Section 7).

The modules are designed for cabinet mounting.

The modules of the SIMODRIVE 611 drive converter system have enclosed housings in compliance with the appropriate EMC regulations, conforming to DIN EN 60529 (IEC 60529).

The electrical system is designed in compliance with EN 50 178 (VDE 0160) and EN 60204; Declarations of CE Conformance are available.

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2.2 Ambient conditions

Note

The components are insulated according to DIN EN 50178.

Overvoltage Class III
Degree of pollution II
Installation altitude up to max. 2000 m above sea level
Installation altitude, 2000 m – 5000 m possible when an isolating transformer is used
The unit must be de–rated when installed above 1000 m.
Refer to Section 6.3.1 and Section 4.1.1.
Neutral point of the line supply is directly grounded; the module housing is also grounded.

Warning

The I/R modules (Order No. 6SN114□–1□□0□–0□□1) are set for sinusoidal current operation when they are shipped from the factory:
Please observe the commutating reactor or line filter data in Section 7.

Table 2-1 Ambient conditions

Designation		Description
Vibration and shock stressing in operation	• Vibration stressing in operation	
	Frequency range 10 ... 58 Hz	With constant deflection = 0.075 mm
	Frequency range between 58 ... 500 Hz	With constant acceleration = 9.81 m/s^2 (1 g)
	Applicable standards	IEC 65A (Co) 22–l, DIN IEC 68–2–6, Severity grade, Class 12 acc. to EN 60721 Part 3–0 and Part 3–3
	• Shock stressing in operation	
	Acceleration	49 m/s^2 (5 g)
	Shock duration	Modules/devices without drive (hard disk, floppy disk): 11 ms Modules/devices with drive (hard disk, floppy disk): 30 ms
	Applicable standards	IEC 65A (Co) 22–l Shock immunity, acc. to IEC 60068 2–27
Vibration stressing during transport	Frequency range 5 ... 9 Hz	With constant deflection = 3.5 mm
	Frequency range between 9 ... 500 Hz	With constant acceleration = 9.81 m/s^2 (1 g)
	Applicable standards	DIN IEC 68–2–6, IEC 65A (Co) 22–l Severity grade according to EN 60721 Part 3–0 and Part 3–2
		Note: The data are valid for originally packaged components
Protection against the ingress of foreign bodies and water	• Modules with internal cooling IP20 • Modules with external cooling/hose cooling – Heatsink in the cooling area IP 54 – Electronics area IP20	

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Table 2-1 Ambient conditions

Designation		Description	
Transport and storage	Temperature range	–40 °C – +70 °C	
	Moisture condensation temperature t_d and relative air humidity U	Annual average	U = 75 % td = 17 °C
		30 days (24h) annually	U = 95 % td = 24 °C
		These days should be naturally distributed over the year.	
		On all other days (<24 h) but still maintaining the annual ave-rage	U = 85 % td = 24 °C
	Applicable standards	DIN IEC 68–2–1 DIN IEC 68–2–2 DIN IEC 68–2–3 DIN VDE 0160, Section 5.2.1.3 EN 50178	
Climatic am-bient conditions in operation	Temperature range: for power module/NE modules (100% load): Current/power de–rating above +40 °C:	0 °C – +55 °C +55 °C 2.5 % / °C	
	Moisture condensa-tion temperature t_d and relative air humi-dity U	Annual average	U = 75 % td = 17 °C
		on 30 days (24h) over the year	U = 95 % td = 24 °C
		These days should be naturally distributed over the year.	
		On all other days (<24 h) but still maintaining the annual ave-rage	U = 85 % td = 24 °C
	Temperature change	within one hour: within 3 minutes:	max. 10 K max. 1 K
	Moisture condensa-tion	Not permissible	
	Air pressure	min. 860 mbar (86 kPa) max. 1080 mbar (108 kPa)	
	Gases which can have a negative effect on the function	acc. to DIN 40046, Part 36 and Part 37	
	Applicable standards	DIN IEC 68–2–1 DIN IEC 68–2–2 DIN IEC 68–2–3 DIN VDE 0160, Section 5.2.1.3 EN 50178	

2.3 Motor selection

Selection

The Planning Guide, Motors is used to select the drive motors

The selected motor and the (short–time) overload capability defines the size of the power module (refer to Section 4).

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2.4 Position sensing/speed actual value sensing

Description

The encoder system is used to precisely position and determine the speed actual value of the drive motors for the particular application. The resolution of the measuring system and the selection of the control module is of decisive importANT for the positioning accuracy.

2.4.1 Direct position sensing

Measuring systems which can be evaluated

- Rotating encoders with TTL signals (only for analog MSD modules)
- Rotating encoders with sine–cosine voltage signals.
- Linear scales with sine–cosine voltage signals.
- Distance–coded measuring systems (only SIMODRIVE 611 digital with NC)
- Measuring systems with sine–cosine voltage signals and EnDat/SSI interface (linear scales, single and multi–turn encoders)

The analog main spindle drive modules and the digital drive modules for feed and main spindle applications can be optionally supplied with a second measuring system evaluation e.g. for a table measuring system or for spindle position sensing. The direct measuring system is, for example, required if high accuracy is to be achieved at the workpiece using a linear scale or if precise positioning is required when multi–stage gearboxes are used.

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Main spindle drive module analog system

An additional position measuring system with TTL signals can be connected at the main spindle control to directly sense the spindle position, or the spindle signals can be output for further processing. The HGL module is optionally available if it is necessary to transfer high–resolution position actual values to a numerical control, when using 1PH motors with C–axis quality. This allows a resolution of up to 90,000 increments per revolution to be achieved by multiplying the motor encoder pulse signals (e.g. toothed–wheel encoders for 1PH2 motors).

SIMODRIVE 611 digital, universal

The optimum measuring system for position sensing is suitable to evaluate incremental encoders with sine–cosine voltage signals. Linear scales and rotating encoders with sinusoidal voltage signals can be connected to the drive control systems to operate 1FT6 and 1FK6 feed motors. The measuring signals, received from the encoder system, are evaluated with a high resolution.

Example:

Using a linear scale (20 µm grid constant), a position resolution of 0.01 mm (Performance control) can be achieved.

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2.4.2 Indirect position sensing

Measuring systems which can be evaluated

- Incremental, integrated encoders in the feed and main spindle motors
- Absolute integrated encoder with EnDat interface in the feed motors

Analog system

The controls are equipped, as standard with the connection for the measuring system integrated in the feed and main spindle motors.

An HGL module (option) is available to condition position sensing signals from the 1PH motor directly coupled to the spindle (built–in motor). Signals can be derived from the motor signal using pulse multiplication for use in the CNC position measuring circuit. These signals have a resolution of up to:

90,000 increments/revolution, e.g. C–axis quality for feed operation

2048 increments/revolution, e.g. for the ”thread cutting” function

SIMODRIVE 611 digital/universal

For the digital coupling between SINUMERIK 810D/840D/840C and SIMODRIVE 611, the measuring system is connected to the digital control modules. The controls are, as standard, equipped with the connection for the measuring system integrated in the feed and main spindle motors. In conjunction with the high–resolution position sensing of the digital signal control, with the integrated motor measuring system, a resolution of 4,000,000 increments per revolution is achieved (Performance control). This means that it is not necessary to use an additional C–axis encoder even for the main spindle. The high–resolution position actual value is additionally made available to CNC position control loops via the drive bus. This means, that for the appropriate mechanical arrangement, it is not necessary to use a direct table measuring system. The same secondary conditions apply for SIMODRIVE 611 universal and POSMO SI/CD/CA. The drive coupling is different, which is realized via PROFIBUS.

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2.4.3 Drive modules

The drive modules comprise the following components: Power module, control module, equipment bus cable and, where relevant, drive bus cable as well as option module.

The permissible combinations of power module and control module are listed in the configuring tables (NC60, Section 10, Tables 2 and 3). Depending on the cooling type and the power module size, cooling components must either be additionally ordered or must be additionally provided by the user.

The drive modules of the SIMODRIVE 611 drive converter system comprise, depending on the application as feed, main spindle or induction motors, the following components: Power module, control module, drive bus cable and, if required, option modules.

A drive module is created by inserting the control module in the power module, e.g. for feed or main spindle applications.

As a result of the modular drive system, many applications can be configured using only a few individual components.

Note

Special contractual conditions apply for combinations which deviate from the engineering information/instructions in Catalog NC 60; this also applies when third–party products are also used.

We accept the warranty for our scope of supply up to the system interfaces which we define.

2.5 Power modules

There is a broad range of power modules, 1–axis and 2–axis versions, graduated according to currents and sub–divided into three different cooling types. The range of power modules permits an integrated, modular, space–saving drive solution for:

- Small, compact machines (feed torques and main spindle outputs, e.g. 80 Nm at 500 RPM and 11 kW S1 at 1500 RPM) up to
- Complex machining centers and automatic lathes, e.g. 115 Nm or 145 Nm at 2000 RPM and 100 kW S1 at 1500 RPM

The currents refer to the standard default setting. The output currents can be limited by the control module. After the control module has been inserted, the retaining screws at the control front panel must be tightened in order to guarantee a good electrical connection to the module housing.

The appropriate de–rating must be observed for higher clock frequencies, ambient temperatures and installation altitudes above 1000 m above sea level. Matching and pre–assembled cables are available to connect the motors. The ordering data is provided in the motors Section of Catalog NC 60

Shield connecting plates, which can be mounted onto the module, are available so that the shielded power cables can be connected–up in compliance with the appropriate EMC Guidelines.

The equipment bus cable is supplied with the power module. For the digital system, the drive bus cables must be separately ordered.

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2.5.1 Function of the power modules

The power module provides the required power for the control modules and the motor. The power module is selected depending on the motor and control module.

2

2.5.2 Connecting the power modules

The power module is grounded via the PE connecting studs.

The power module must be mounted on a grounded, low–ohmic conductive mounting surface and be connected with this through a good electrical connection.

The power supply is realized from the DC link buses.

Power module, internal cooling

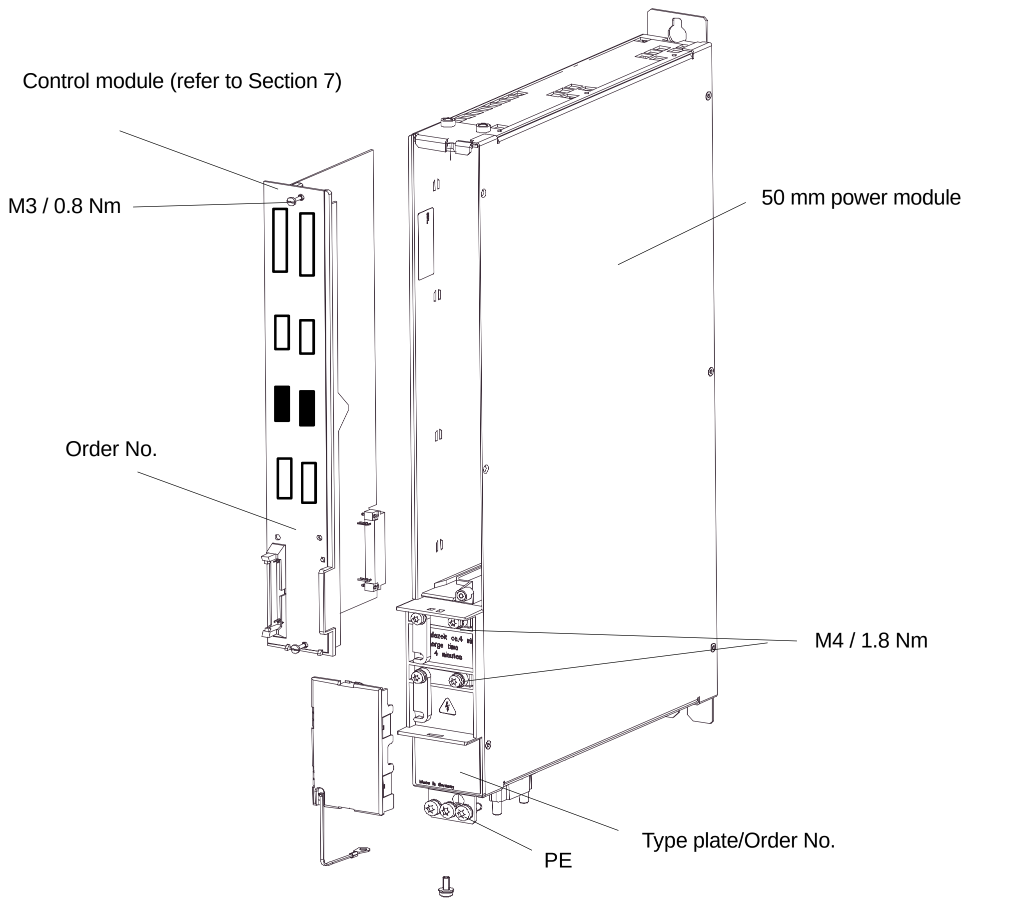

Fig. 2-2 Power module with control module

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2.6 Control modules

Description

The control modules evaluate the encoders which are used with them and control (open–loop) the connected motors through the power modules. The drive system fulfills almost every requirement of state–of–the–art drive technology as a result of the wide range of control modules.

2.6.1 Drive modules with induction motor regulation

Induction motors can be operated with the drive module with induction motor control, which is designed for drive converter operation with a 600 V DC link voltage. The maximum motor stator frequency is 1100 Hz (for SIMODRIVE 611 universal and SIMODRIVE POSMO CD/CA: 1400 Hz). For motor frequencies above 200 Hz or rated motor currents above 85 A, it may be necessary to provide a series inductance or increase the drive converter switching frequency.

The Dimensioning Guidelines under Section 5 must be observed.

2.6.2 Drive module with SIMODRIVE 611 universal

When the control module is inserted in the power module, the user obtains a drive module which can be universally used for the various SIMODRIVE motor systems, such as permanent–magnet synchronous motors 1FT6, 1FK6, 1FN, 1FE1 and induction motors 1PH and 1LA. The motors can also be operated from 2–axis power modules corresponding to the power requirement. Setpoints can either be entered as analog signal or digitally via PROFIBUS–DP. The permissible combinations of power modules and SIMODRIVE 611 universal are listed in the configuring tables (NC60, Section 10, Tables 2 and 3).

SIMODRIVE 611 universal is a control module with analog speed setpoint interface and optional PROFIBUS–DP interface as well as with/without positioning functionality with motor frequencies up to 1400 Hz.

1–axis and 2–axis control modules are available with option; 2–axis versions can also be used in 1–axis power modules.

The following encoder evaluation circuits are available on various control modules

- Resolvers: Pole pair numbers 1 to 6, max. operating frequency, 375 Hz, internal pulse multiplication, 4096 x pole pair number
- Incremental encoders with sin/cos 1–Vpp signals 1–65535 pulses, max. up to 350 kHz, internal pulse multiplication 128 x pulses.
- Absolute value encoder with EnDat interface the same as for sin/cos 1 Vpp encoder, plus absolute position using the EnDat protocol.

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2.6.3 Control modules with analog setpoint interface and Motion Control with PROFIBUS–DP SIMODRIVE 611 universal E

SIMODRIVE 611 universal E is a control module with the “Motion Control with PROFIBUS–DP” function for use with SINUMERIK 802D and SINUMERIK 840Di. They are suitable for motor frequencies up to 1400 Hz, speed/torque controlled for 1FT6, 1FK6, 1FE1, synchronous motors, 1FN linear motors, 1PH, 1LA induction motors with/without encoder and third–party motors if these are suitable for drive converter operation.

SIMODRIVE 611 universal E can be used in 1–axis and 2–axis power modules.

The following encoder evaluation circuits are available for the following encoders:

- Incremental encoders with sin/cos 1–Vpp signals 1 – 65535 pulses, max. up to 350 kHz, internal pulse multiplication, 128 x pulses.
- Absolute value encoders with EnDat interface and sin/cos 1 Vpp.

The drive is either commissioned using a 7–segment display and keypad at the front of the module or using the SimoCom U start–up tool for PCs under Windows 95/98/NT.

2.6.4 Control modules for 1FT5 motors with analog setpoint interface for feed drives

To use 1FT5 AC servomotors, two control versions are available with the same control quality, but with different interfaces to the higher–level open–loop machine control and operator control level.

For the version with user–friendly interface, a parameter module is additionally required on which machine–specific parameters can be saved so that they cannot be lost. The parameter module is inserted into the control module from the front.

The control modules with user–friendly interface can be expanded, using an option module, by special main spindle functions for basic main spindle drives using 1FT5 motors.

For the version with standard interface, either a 1–axis or 2–axis version can be selected.

Table 2-2 Comparison table

Control module with	Standard interface	User–friendly interface
Speed setpoint inputs for each axis:	1	2
Fixed setpoints for each axis:	–	2
Start inhibit:	Module–specific	Axis–specific
Speed and current controlled operation:	yes	yes
Controller and pulse inhibit:	yes	yes
Alarm display with:	2 LEDs	7–segment display

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Table 2-2 Comparison table

Control module with	Standard interface	User–friendly interface
Central group signal (ready/fault)	yes	–
Axis–specific relay signal	–	yes
Master/slave operation:	Module–specific	yes
Current setpoint limiting:	–	yes
Traverse to fixed endstop:	–	yes
Integrator inhibit for speed controller:	–	yes
Current actual value output:	–	yes
I^2t monitoring	yes	yes

2.6.5 Control modules for 1FK6 and 1FT6 motors with resolver and analog setpoint interface for feed drives

This control module is intended for feed drives in transfer lines, handling equipment, basic machine tools for machines with general positioning tasks which do not require high requirements regarding the control quality and positioning accuracy. The data for speed actual value, motor rotor position and position actual value are derived from the encoder (resolver) integrated in the motor. This reduces the number of cables and conductors fed to the motor. The control module is available in either a 1–axis or 2–axis version.

2.6.6 Control modules for 1PH induction motors with analog setpoint interface for main spindle drives

The main spindle control modules of the SIMODRIVE 611A are used in conjunction with the 1PH AC main spindle motors. The control module has an input for a motor encoder, incremental sin/cos 1 Vpp or SIZAG2 and alternatively, an input for a direct spindle measuring system or encoder signal output for external processing. A display and operator unit is integrated for commissioning. Furthermore, commissioning software is available, which runs under MS DOS and Windows Me.

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2.6.7 Control modules with analog setpoint interface for induction motors

The induction motor control modules are designed for the open–loop speed control of standard induction motors or special induction motors for high speeds up to 32000 RPM. The maximum electrical base frequency for the motor is 1100 Hz.

In the frequency range greater than 10 Hz, a field–oriented control algorithm is used due to the actual value being emulated from the terminal quantities. This results in high dynamic response characteristics and high immunity against stalling.

A display and operator unit is integrated in the control modules for commissioning. Furthermore, commissioning software which can run under MS–DOS, is also available.

2.6.8 Control modules with digital setpoint interface for FD and MSD

The digital control modules of SIMODRIVE 611, in conjunction with SIMODRIVE 1FT6/1FK6 AC servomotors and 1FN linear motors, can be used for feed drives, and in conjunction with 1PH/1FE1 motors, for main spindle drives.

The control modules evaluate the incremental sin/cos 1Vpp encoders integrated in the 1FT6/1FK6 or 1PH motor.

This means, that up to 4.2 million increments/motor revolutions can be achieved as measuring circuit resolution. For 1FN motors, an incremental or an absolute–coded measuring system with EnDat interface is required to sense the position, velocity actual value and pole position.

The generated signals for velocity and position actual value are processed via the digital drive bus in the servo area of the SINUMERIK. For control modules with the ”direct position sensing” function, a direct measuring system (DMS) can also be connected. This means that incremental encoders with sine/cosine voltage signals can be evaluated.

The control modules with digital setpoint interface can be used, from the hardware perspective, as feed or main spindle drive in the 1–axis version Performance control universal. The software with the control algorithms is saved in the SINUMERIK 810D/840D/840C. Each time that the drive control (open–loop) is powered–up, the software is downloaded into the digital control modules. When commissioning the system, the drive configuration is used to define whether it involves a feed or main spindle drive.

For control modules with digital setpoint interface, either the standard control or the Performance control can be selected. Both of these versions utilize the same drive interfaces and a firmware with the same control algorithms.

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Table 2-3 Comparison table

Control module with	Standard interface	Performance regulation
Max. electrical base frequency for the motor:	600 Hz	1333 Hz
Encoder limiting frequency:	200 kHz	350 kHz
Pulse multiplication:	128	2048
Maximum cable length for encoders with voltage signal	50 m	50 m
Motor encoder system and direct measuring systems		
Incremental encoder sin/ cos 1 Vpp:	yes	yes
Absolute value encoder En-Dat:	yes	yes
Prerequisites for “SINUMERIK Safety Integrated”:	yes with DMS	yes with DMS
Operation of 1FN linear motors:	–	yes
Applications:	Standard production machines	Precision machines

2.6.9 Control modules with digital setpoint interface for hydraulic/ analog linear drives HLA/ANA

Hydraulic linear drive (HLA)

The digital SIMODRIVE 611 HLA control module is designed to control and regulate electro–hydraulic control values for hydraulic linear axes in conjunction with SINUMERIK 840D. Up to two hydraulic axes can be controlled with the module. An HLA module
is obtained by inserting the control module in the 50 mm wide universal empty housing.

This module can be integrated directly next to the SIMODRIVE 611 drive group both with the mechanical as well as the electrical interfaces, such as equipment bus, drive bus and DC link busbars.

The HLA control module contains the control structures for an electronic control loop with high dynamic response characteristics. The HLA control module generates the power supply for the control valves and shut–off valves from an external DC power supply (e.g. SITOP power, refer to NC 60 Catalog) with a rated voltage of 26.5V.

An analog axis with speed setpoint interface ± 10 V can also be controlled using the HLA control module. In this case, an appropriate axis must be selected. As far as the coarse structure is concerned, the control operates as D/A converter for the setpoint and communicates the position information from the encoder to the position controller in the SINUMERIK 840D via the drive bus.

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An analog axis can essentially be used the same as a digital axis. It can be programmed just like a digital interpolating path axis or spindle. Or course, it is not possible to use the pure functions of the digital drive unit with a coupling via the analog speed setpoint interface. It involves a functionality which accesses the internal axis feedback loops and communications via the drive bus, e.g. SINUMERIK Safety Integrated. Separate EMC measures should also be provided, where necessary, for the external drive devices.

Analog axis (ANA)

Using SINUMERIK 840D, it is possible to operate a maximum of two analog axes on the digital drive bus via the ANA configuration. It is also possible to use an HLA and an ANA axis together.

2.6.10 NCU box for SINUMERIK 840D

If digital drive modules are used in conjunction with the SINUMERIK 840D CNC control, then the NCU box can be located directly to the right of the infeed module.

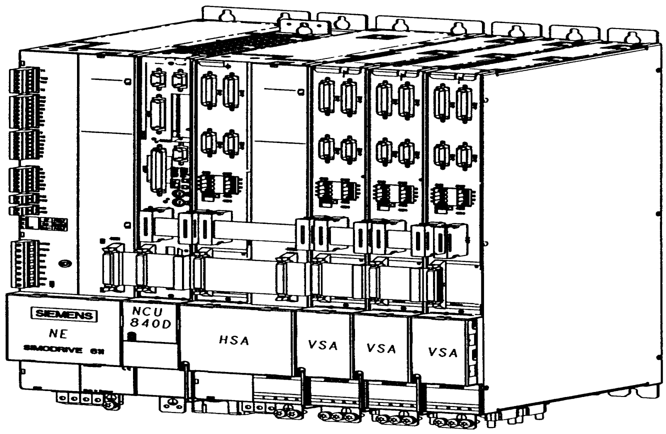

Fig. 2-3 Digital closed–loop control with SINUMERIK 840D

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2.7 Infeed modules

The drive group is connected to the power supply via the infeed modules. The infeed modules generate the DC voltage for the DC link from the line supply voltage 3–ph. 400 V AC ±10%
50 Hz / 60 Hz, 3–ph. 415 V AC ±10 % 50 Hz / 60 Hz, 3–ph. 480 V AC + 6% –10%
50 Hz / 60 Hz. In addition, the electronic voltages (±24 V, ±15 V +5 V etc.) are provided centrally to the drive modules, or the SINUMERIK 840D or SINUMERIK 810D, in the drive group, via the equipment bus. A transformer with separate windings in vector group Yyn0, according to the selection table, is required if the infeed modules are connected to a line supply other than TN line supply or to a line supply which is not equipped with DC sensitive residual–current–operated protective devices. An HF commutating reactor is also required for series transformers for the controlled infeed/regenerative feedback module.

In addition, an appropriate transformer must be selected to adapt the voltage for line supply voltages 3–ph. 200 V / 220 V / 240 V / 440 V / 500 V / 575 V AC 10%
50 Hz / 60 Hz.

The necessary cooling components, such as separately–driven fan and/or air guides to guide the air at the module heatsinks are, for modules up to 200 mm wide, included in the scope of supply, both for the internally as well as externally cooled versions.

The appropriate instructions must be observed for the 300 mm modules.

The infeed module must always be located as the first module to the left. This is then followed, if used, by the NCU box. This is then followed by the main spindle drive modules (induction motor drive modules) and the feed drive modules which should then be located, with decreasing rated currents from left to right at the infeed module.

A minimum clearance of 50 mm to the side must be maintained between module groups mounted at the same height.

SIMODRIVE 611 modules can be supplied with an internal heatsink for heat dissipation (cooling) within the cabinet; 300 mm–wide modules also have the possibility of connecting a hose for hose cooling. All of the module widths are in a 50 mm grid and all of the modules are 480 mm high. However, it should be noted that the dimensions for the air guide and shield connection plate, mounted fans and hose cooling must be additionally taken into account. Alternatively, modules are also available with a heatsink which extends outside the module so that heat is dissipated externally. In this case, the modules are mounted on the rear side of the cabinet through which the heatsink extends; cooling is realized on the customers side. With this configuration, a mounting frame is required for every module (refer to Fig. 2-7). For internal cooling or hose cooling, all of the modules are 288 mm deep (without connector and mounted options) referred to the mounting plane; all externally cooled modules are 231 mm deep. The protrusion depth of the heatsink must be taken into account for the cooling duct.

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2.7.1 Cooling components

Depending on the cooling type, matching supplementary fan units and fan components must be selected.

A differentiation is made between three different cooling types.

1. For internal cooling, the complete heat loss remains in the electrical cabinet which is manifested as temperature rise.
2. For external cooling, the power module power losses are dissipated externally and the control section power loss is dissipated internally.
3. For hose cooling, the complete power loss is dissipated externally through a hose connected to the module.

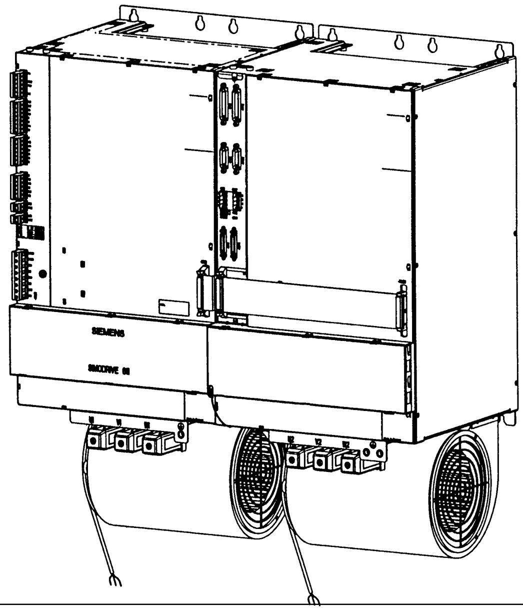

Fig. 2-4 System configuration with 400 V fan (only for 300 mm modules)

Warning

The fan may only be commissioned, if it is electrically connected with the module housing (the PE of the fan is connected via the module housing).

Caution

Cooling is not guaranteed if the fan rotates with the wrong direction of rotation (refer to the arrow)!

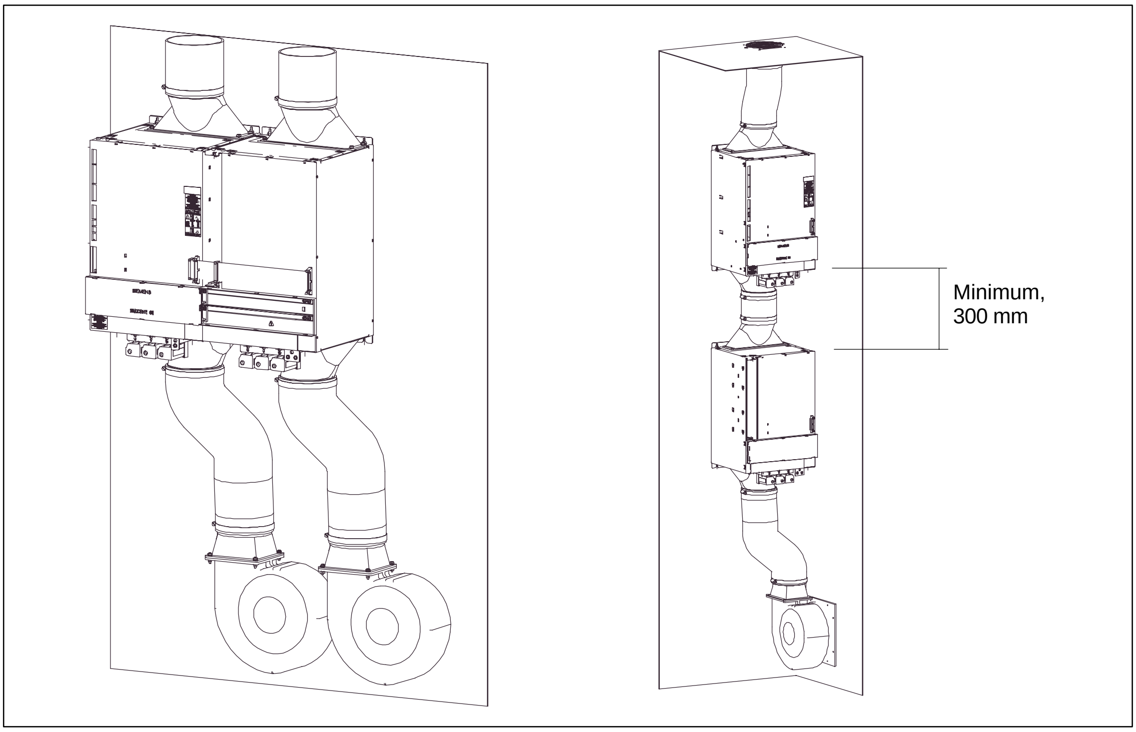

Fig. 2-5 System configuration with hose cooling (only for 300 mm modules)

Note

DC link connection, refer to Section 10.1.3

Connection details for the DC link adapter set, refer to the dimension drawings

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2.7.2 Internal cooling

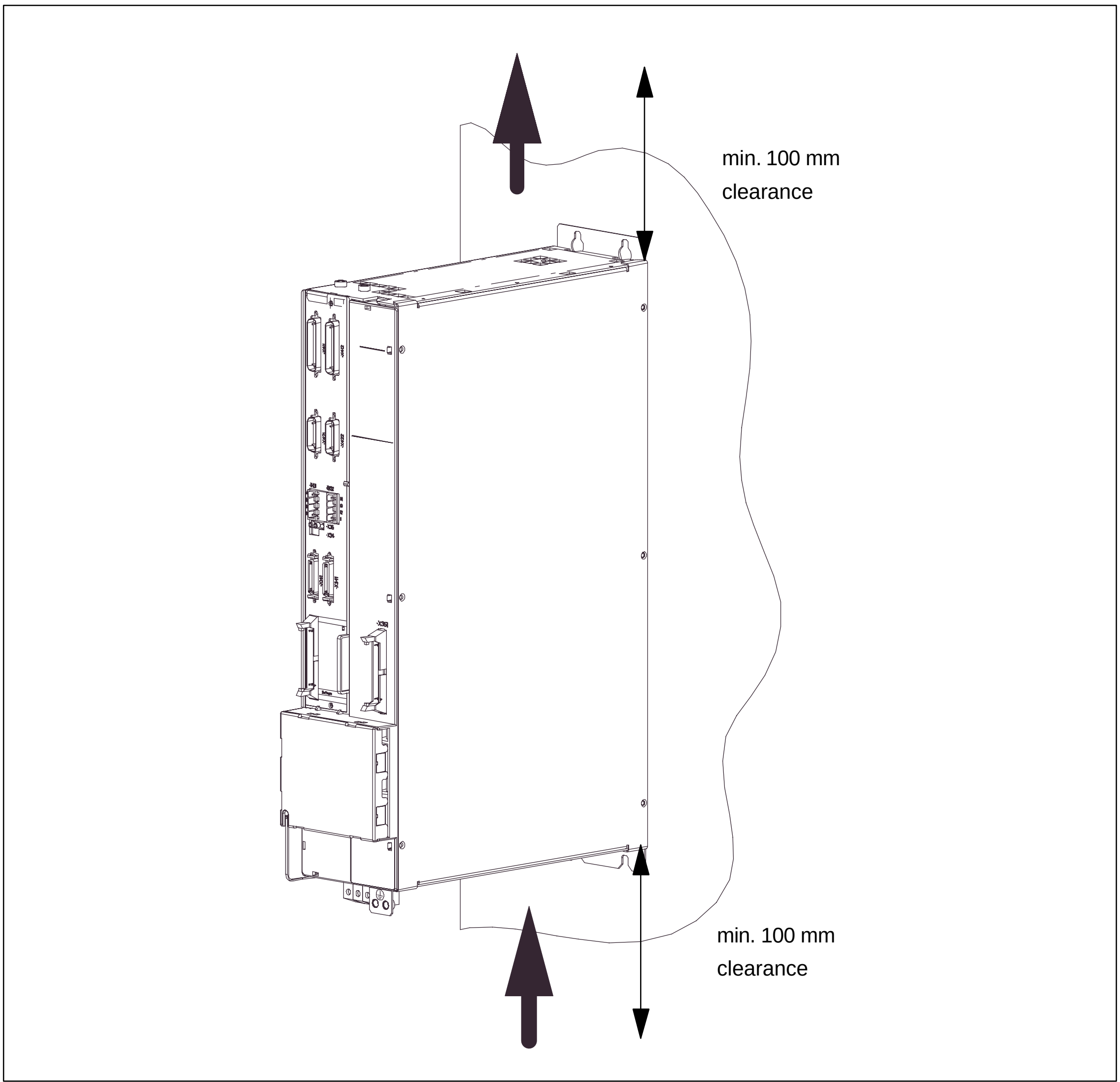

Fig. 2-6 Power module with inserted control module, internal cooling

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Note

The power loss is dissipated inside the cabinet which means that this has to be taken into account when designing the cabinet cooling system.

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2.7.3 External cooling

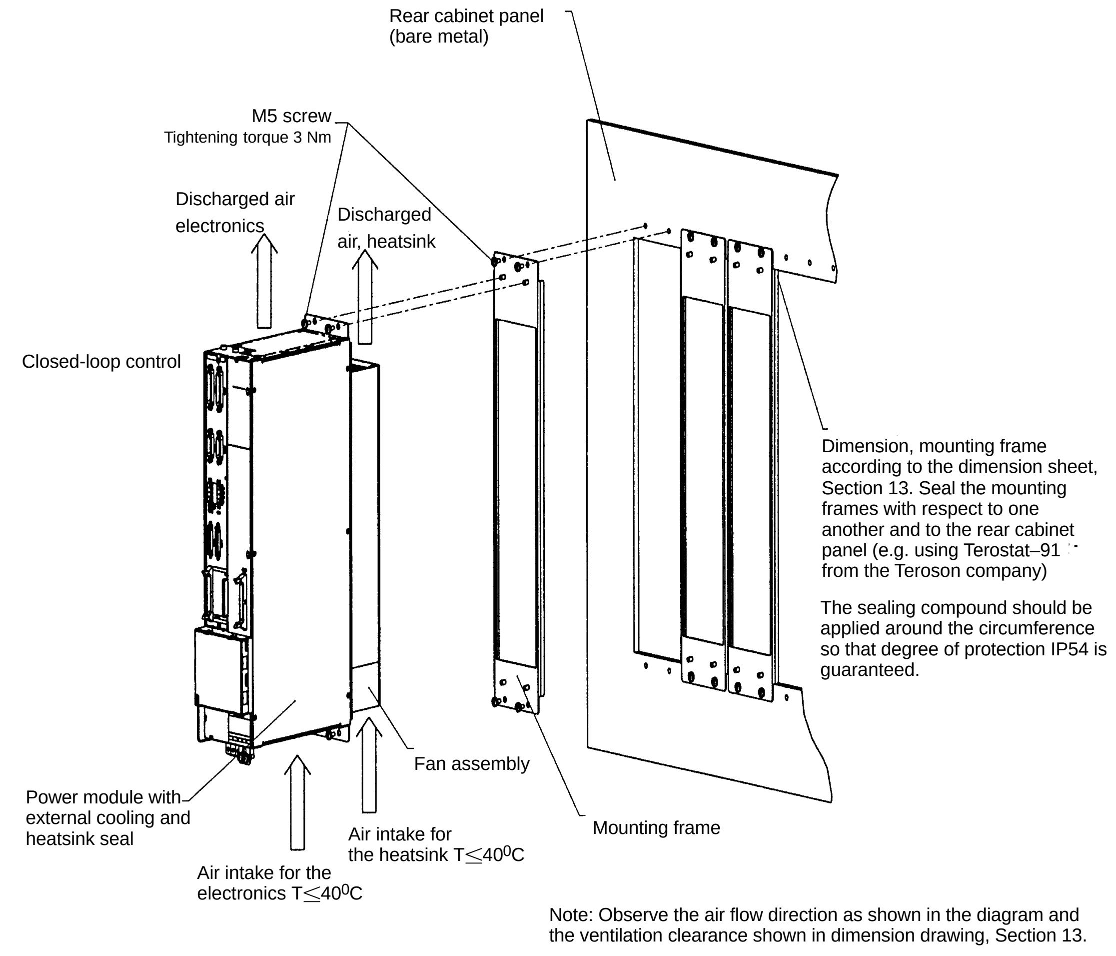

Fig. 2-7 Power module with inserted control module, external cooling

Note

Observe the direction of the airflow according to the diagram and clearance for the cooling air in accordance with the dimension drawing, Section 13. Dimensions, mounting frame according to the dimension drawing, Section 13.

Notice

For external heatsinks and fans, large amounts of accumulated dirt can have a negative impact on the module cooling. The temperature monitoring function in the power module can respond. The heatsink and fan must be checked for dirt accumulation at regular intervals.
Clean as required!

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Engineering information

For external cooling, the module heatsinks protrude through the mounting plane in the cabinet which allows the power loss to be dissipated to an external cooling circuit.

An opening can be provided in the mounting plate for each module or for the complete module group. If an opening is used for the complete module group, then the specific module mounting frames must be used. The appropriate mounting frames (Order No.: 6SN1162–0BA04–0EA0) must always be used for the 300 mm modules. The dimension drawings for the openings are described in Section 13.

The mounting frames should be mounted from either inside the cabinet or the rear side. This then guarantees the required EMC mounting surface

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Note

The dimensions of the openings for the reinforcing lugs have different lengths. Be sure that all of the modules are mounted/installed in the same way.

Sealing

The reinforcing lugs of the mounting frames, which are rounded–off towards the rear are provided with a seal at both sides. A sealing material must be used where the edges of the mounting frame come into contact with the mounting plate (e.g. Terostat–96 from Teroson). Degree of protection IP 54 is achieved when the sealing material is correctly applied.

Mounted fan for 300 mm modules

The fan cable must enter the cabinet through a PG gland so that the degree of protection is maintained.

The mounting plate should be sealed with respect to the rear cabinet panel so that an enclosed space or duct is obtained. Depending on how the cabinet is mounted (free–standing or installed in the machine), this must be cooled through the roof/floor assembly or rear panel.

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2.7.4 Overvoltage limiting module

Application

The overvoltage limiting module limits the overvoltage, e.g. caused by switching operations at inductive loads and at line supply matching transformers, to acceptable values.

For line supply infeed modules above 10 kW (100 mm wide), the overvoltage limiting module can be inserted at interface X181.

The overvoltage limiting module is used if upstream transformers are used, or for line supplies which are not in conformance with IEC (unstable line supplies).

For the 5 kW monitoring module, an appropriate protective circuit is already integrated as standard.

Application conditions

The following application conditions apply:

- Voltage limiting must be provided when using transformers in front of the NE module.
- As voltage limiting due to switching overvoltages, for frequent power failures, for arcing etc.
- Systems, which should fulfill UL/CSA requirements, must be equipped with overvoltage limiting modules.

Mounting

1. Power–down the equipment and bring it into a no–voltage condition.
2. Withdraw connector X181 from the NE module.
3. Insert the overvoltage limiting module up to its endstop in plug connector X181.
4. Insert connector X181 on the overvoltage limiting module.

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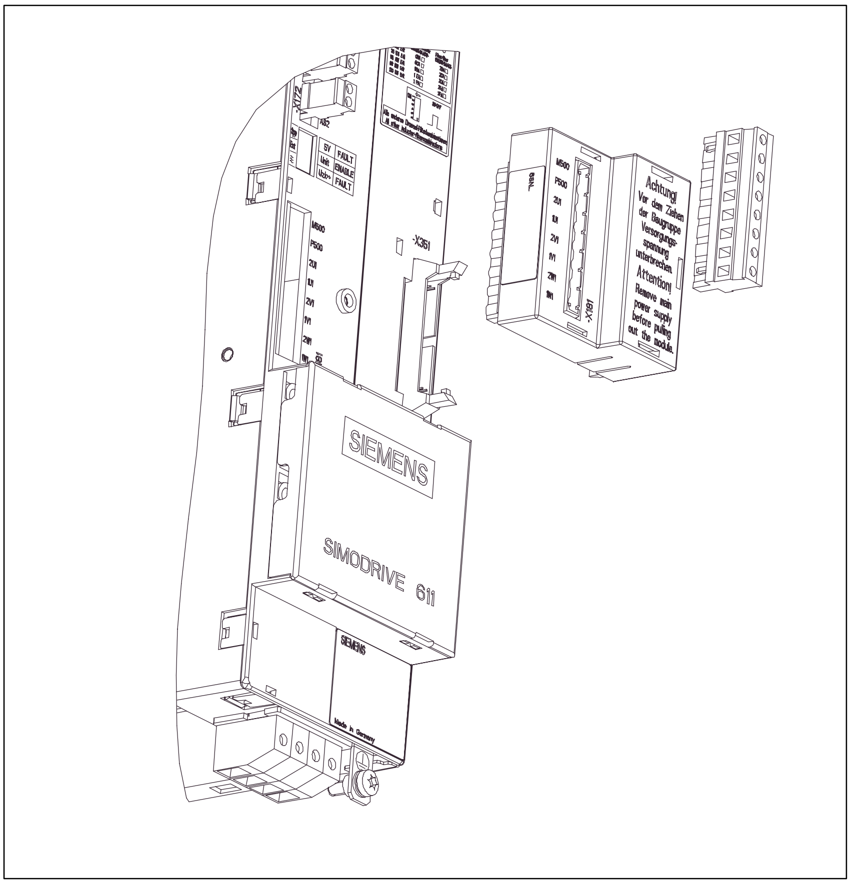

Fig. 2-8 Overvoltage limiting module

If a line supply fault is displayed at the NE module or if the yellow LED is dark, after the line supply and the line fuse have been checked, the overvoltage limiting module should be checked and if required, replaced.

Procedure

1. Power down the equipment and bring it into a no–voltage condition.
2. Withdraw the overvoltage limiting module and insert connector X181 on the NE module. If the NE module is not functioning correctly, then the overvoltage limiting module is defective and must be replaced. Otherwise, check the module group.

Note

A defective overvoltage limiting module indicates high overvoltage spikes in the line supply. The line supply should be investigated as to the reason for these voltage spikes.

Notice

If a system high voltage test is made, the overvoltage limiting module must be removed in order to prevent the voltage limiting responding.

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2.8 Line supply connection

2.8.1 HF commutating reactor

The matching HF commutating reactor is required, in accordance with the selection table (refer to NC60, Section 9) when connecting the uncontrolled 28 kW infeed modules and the controlled infeed regenerative/feedback modules to the line supply.

The HF commutating reactor should be mounted as close as possible to the line supply infeed module.

Commutating reactors have the following tasks:

- Limit the harmonics fed back into the line supply.
- Store the energy for DC link controlled operation in conjunction with the infeed and regenerative feedback module.

HF commutating reactors for line supplies 3–ph. 400 V AC –10% up to 480 V +6%;
50 Hz / 60 Hz ±10%

2.8.2 Line filter

The line filters are assigned to the line supply infeed modules and limit the cable–borne noise emitted by the drive system. The line filter should also be mounted, together with the HF commutating reactor, close to the line supply infeed module, whereby the filter must always be located on the line side. These cables must be shielded as they have high noise levels. We always recommend that the line filter products listed in Section 7 are used.

2.8.3 Line filter packages

The line filter and the HF commutating reactors are combined as logical unit in the form of line filter packages. In order to adapt the line filter packages to the mounting surface and to the mounting points of earlier filter modules, adapter sets are available. The filter package protrudes between 20 mm and 30 mm beyond the front plane of the drive group.

2.8.4 Line supply connection for voltage adaptation

The SIMODRIVE 611 drive converter system is dimensioned for direct operation from TN line supplies with 3–ph. 400 V AC, 3–ph. 415 V AC and 3–ph. 480 V AC. Matching transformers, tailored to the system, are available to adapt the system to other line supply types, e.g. operation from IT or TT line supplies. This wide range covers the line supply voltages normally found in industrial regions worldwide.

TN line supplies distinguish themselves by a low–ohmic electrical path between the reference ground potential of the current source and the protective conductor potential of the electrical equipment. If this arrangement is not available, then the connection conditions must be simulated using a transformer with separate windings whose secondary neutral point is grounded at the protective conductor potential and is connected with the drive converter protective conductor.

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2.8.5 Line supply types

The SIMODRIVE 611 drive converter system is designed for a rated voltage of 300 V phase–grounded neutral point.

It is not permissible that this voltage is exceeded, as otherwise the drive converter insulation system could be damaged resulting in inadmissibly high touch voltages.

Caution

The drive converter may only be connected directly to TN line supplies or through an autotransformer.

For all other line supply types, an isolating transformer with grounded neutral point on the secondary side must be used.

Note

UL requirements, maximum line short–circuit currents at 480 V AC:

- Connected power, 1.1 to 37.3 kW, max. short–circuit current = 5 kA
- Connected power, 39–149 kW, max. short–circuit current = 10 kA

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Connection types

The drive converter can be directly connected to TN line supplies at 3–ph. 400 V AC, 3–ph. 415 V AC, 3–ph. 480 V AC[1)]
An autotransformer can be used to connect the drive converter to other voltage levels.

Example:
TN–C line supplies

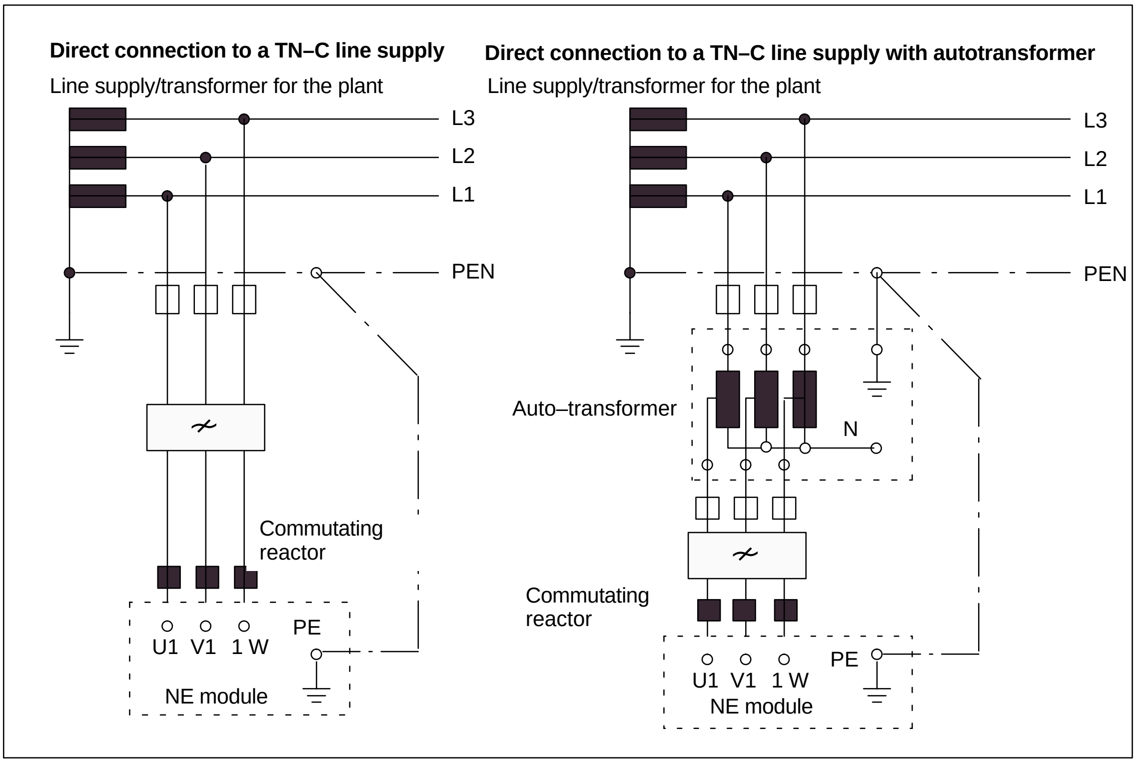

Fig. 2-9 Connection diagram, TN–C line supplies

Note

When using an autotransformer or an isolating transformer upstream from NE modules (module width ≥ 100 mm), an overvoltage limiting module should be used, Order No.: 6SN1111–0AB00–0AA0, refer to Section 7.

TN–C line supply
TN–S line supply
TN–C–S line supply

Symmetrical 4–conductor or 5–conductor three–phase line supply with grounded neutral point which can be loaded with a protective and neutral connector connected at the neutral point – depending on the line supply, realized using one or several conductors.

1) Direct connection to 480 V is only possible in conjunction with the following PM (Order No.: 6SN112□–1□□0□–0□□1) and I/R modules, Order No.: 6SN114□–1□□0□–0□□1 refer to Section 6.1
For motors with shaft height < 100: Utilization up to max. 60 K temperature values according to Catalog NC 60
Please observe the information in the Planning Guide, Motors.

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For all other line supply types [1] the NE module must be connected via an isolating transformer.

TT line supply

Symmetrical 3–conductor or 4–conductor 3–phase line supply with a directly grounded point, the loads are, e.g. connected to grounding electrodes, which are not electrically connected to the directly grounded point of the line supply.

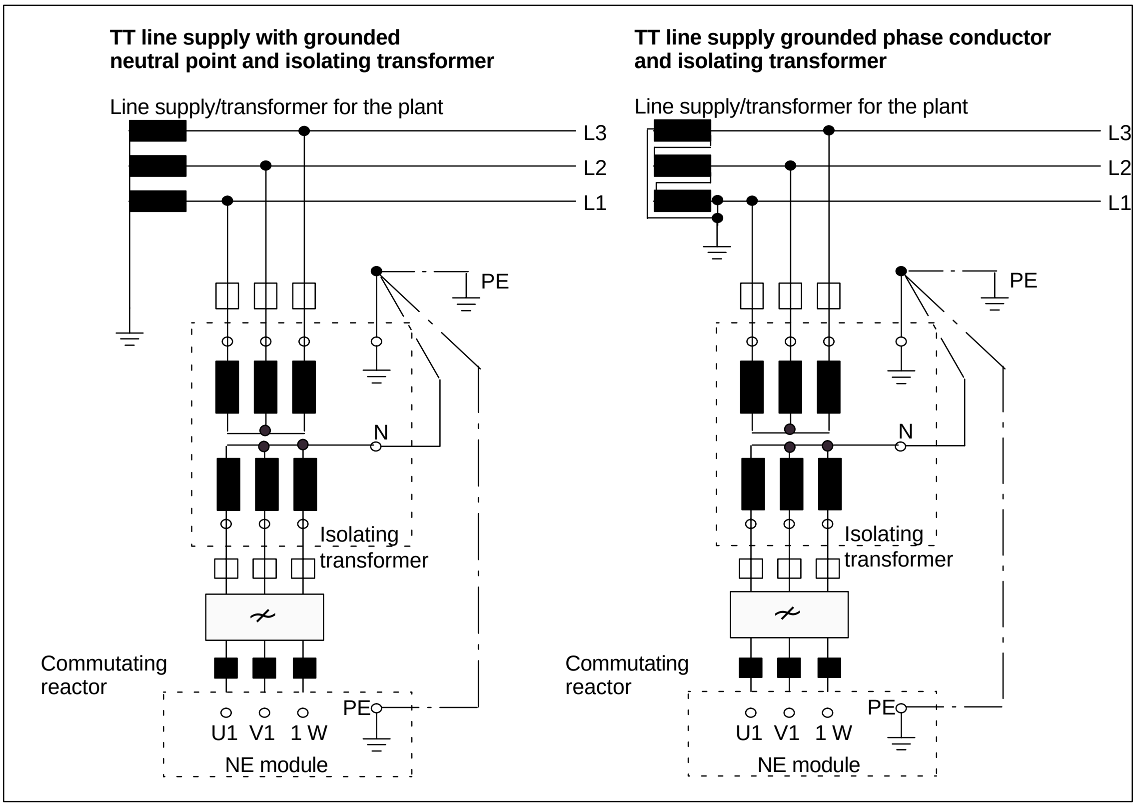

Fig. 2-10 Connection diagram, TT line supplies

[1] Matching transformer types are described in Catalog NC 60, Part 8.

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For all other line supply types [1] the NE module must be connected through an isolating transformer.

IT line supply

Symmetrical 3–conductor or 4–conductor three–phase line supply without a directly grounded point, the loads are, e.g. connected to grounding electrodes.

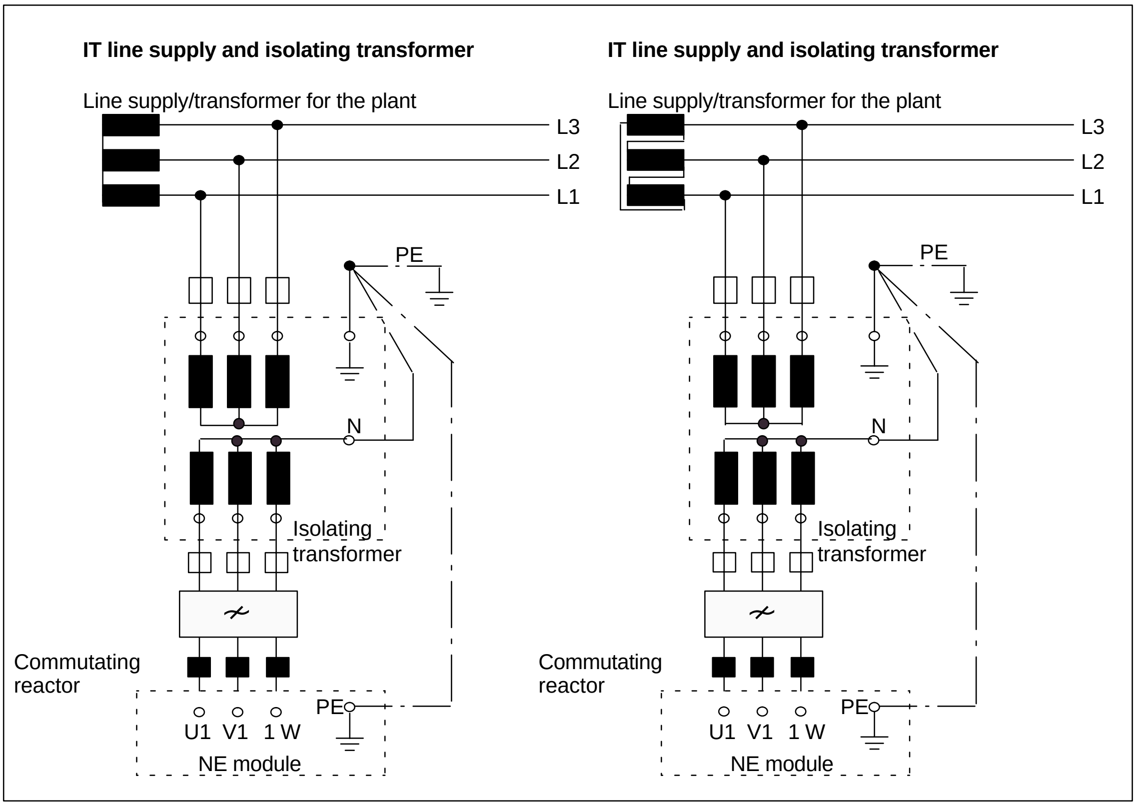

Fig. 2-11 Connection diagram, IT line supplies

Note

When using isolating transformers upstream from I/R and UI modules (module width ≥ 100 mm), an overvoltage limiting module should be used, Order No.: 6SN1111–0AB0□–0AA0; refer to Section 7

UI modules 5 kW Order No.: 6SN1146–2AB00–0BA1, a voltage limiting circuit is included.

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[1] Matching transformer types are described in Catalog NC 60.

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This means, that within the clocked transistor drive converter, the voltage stressing of the insulation distances between the power circuits referred to the line supply potential and the open–loop and closed–loop control circuits, referred to the neutral conductor is maintained according to a rated voltage of 300 V in compliance with DIN EN 50178.

Upstream protective devices to protect against hazardous currents flowing through the human body or for fire protection (e.g. fault current protective devices) must be universal devices in compliance with DIN EN 50178. If other fault current protective devices are used, a transformer with separate windings must be connected upstream from the drive converter to de–couple it from the line supply.

DC current components may be present in fault currents which occur due to the 6–pulse three–phase bridge circuit in the line supply infeed module. This should be taken into account when selecting/dimensioning a fault current protective device.

Direct connection to line supplies with residual–current protective device

The SIMODRIVE unit may be directly connected to TN line supplies with a universal current–sensitive residual–current protective device with selective cut–out characteristics as protective measure.

Note

Only I/R modules, 16 kW and 36 kW, may be directly connected to a line supply with residual–current protective devices.

Delayed universal current–sensitive residual–current protective device with selective cut–out characteristics can be used without any restrictions to provide protection against hazardous currents flowing through the human body.

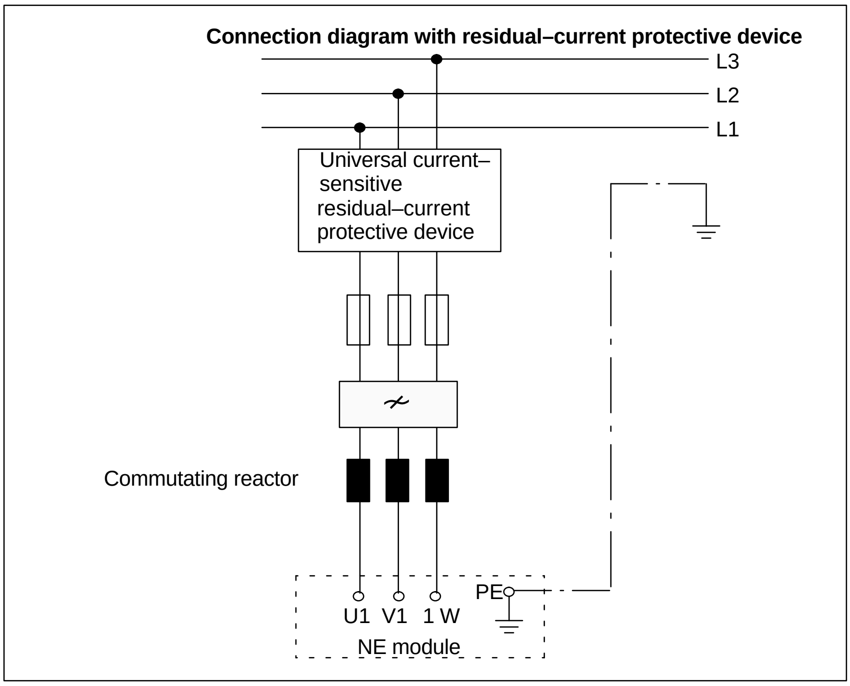

Fig. 2-12 Connection diagram, residual–current protective device

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The following should be observed

- It is only permissible to use a delayed (selective) universal current–sensitive residual–current protective device (connected–up corresponding to the diagram
- It is not possible to connect residual–current protective devices in series for selective tripping
- The max. permissible ground resistance of the ”selective protective device” is maintained (83 Ω max. for residual–current protective device with a rated differential current of 0.3 A)
- The total length of the shielded power cables used in the drive group (motor feeder cable including line supply feeder cables from the line filters up to the NE connecting terminals) must be less than 350 m.
- Operation is only permissible with line filters when using the line filters described in Section 7

Notice

The AC current or pulsed–current–sensitive residual–current protective devices, which today are well–established, are not suitable!

Recommendation

SIEMENS universal current–sensitive residual–current protective devices (selective) corresponding to DIN VDE 0100 T480 and EN 50178, series 5SZ□–□□□–□□□□□.
(e.g. 5SZ6 468–0KG00 or 5SZ6468–0KG30 with auxiliary isolating contact (1NC/1NO) for a rated current of 63 A, nominal fault current, 0.3 A)

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2.8.6 Transformers

Matching transformers (auto/isolating transformers) with supply voltages of 3–ph. 220 V AC to 3–ph. 575 V AC, refer to Section 7.

2

Dimensioning the matching transformer for only an NE module

Only **one** NE module is connected to the matching transformer.

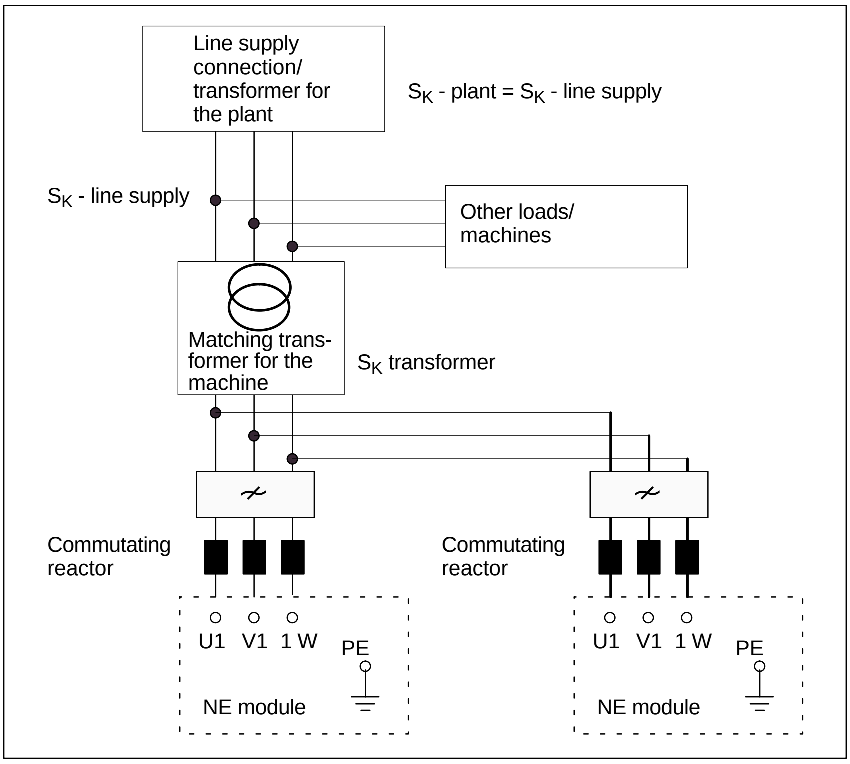

Fig. 2-13 Connection diagram, matching transformer

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Table 2-4 Engineering information/instructions if you dimension the transformer yourself

I/R module used	Required rating Sn of the isolating/autotransformer	Short–circuit voltage required uk
16/21 kW	Sn $\geq$ 21 kVA	uk $\leq$ 3%
36/47 kW	Sn $\geq$ 46.5 kVA	uk $\leq$ 3%
55/71 kW	Sn $\geq$ 70.3 kVA	uk $\leq$ 3%
80/104 kW	Sn $\geq$ 104 kVA	uk $\leq$ 3%
120/156 kW	Sn $\geq$ 155 kVA	uk $\leq$ 3%

UI module used	Rating Sn required for the isolating/autotransformer	Short–circuit voltage required uk
5/10 kW	Sn $\geq$ 7.8 kVA	uk $\leq$ 10%
10/25 kW	Sn $\geq$ 14.5 kVA	uk $\leq$ 10%
28/50 kW	Sn $\geq$ 40.5 kVA	uk $\leq$ 10%

Note

Switching elements (main switch, contactors) to switch–in and switch–out the line filter may have a max. 35 ms delay time between the closing/opening of the individual main contacts.

Connection through an isolating transformer

It is possible to use an isolating transformer in conjunction with a protective measure against hazardous currents going through the human body.

Notice

When using an isolating transformer upstream from I/R and UI modules (module width $\geq$ 100 mm), an overvoltage limiting module should be used, Order No.: 6SN1111–0AB0□–0AA0; refer to Section 7.
A voltage limiting circuit is included for UE 5 kW, Order No.: 6SN1146–2AB00–0BA1.

If line filters are required and if the rated line supply voltage deviates from the permissible supply voltage of the line filters (3–ph. 400 V AC or 3–ph. 415 V AC), then one of the matching transformers, specified in the following, must be used.

The SIMODRIVE 611 drive converter system is designed for a rated voltage of 300 V phase–grounded neutral point.
This voltage may not be exceeded, as otherwise the drive converter insulation system could be damaged resulting in inadmissibly high touch voltages.

■

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Motor Selection, Position/Speed Sensing 3

3.1 Motor selection

The motor should be selected according to the mechanical and dynamic response characteristics which it must fulfill. The motor overload capability required depends on the magnitude and number of load peaks during the operating time.

3.1.1 Motor protection

Motor protection circuit–breakers should be used to protect the motors which only switch a signal contact when the motor is overloaded.

If the motor is isolated from the power module during operation with the drive pulses enabled, there is a danger that the power module and control module could be destroyed.

3.1.2 Motors with holding brake

Description

The holding brakes mounted onto the motors are used to brake the motor at standstill. It can also shorten the braking travel under emergency conditions. However, the holding brake is not an operating brake.

Note

The motor holding brakes may only be actuated when the motor is at a standstill.

If the holding brake is actuated during operation or while the motor is rotating, this results in increased wear and shortens the lifetime of the holding brake. This means that holding brake failure must be taken into account when engineering the drive system and a hazard analysis must be carried out.

Hanging loads

If holding brakes are used for hanging loads, this must be carefully analyzed as there is a high potential danger.

Monitoring

By traversing to a defined endstop, a reference quantity is obtained to monitor the braking travel. The measured braking travel is an indication of the brake wear.

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3.2 Motor encoder

The motors are equipped with various encoder systems for rotor position and speed sensing.

Reference: /PJM/ Planning Guide, Motors

1FT5 motors can be optionally ordered with a mounted or integrated encoder system for position sensing.

Table 3-1 shows the assignment of SIMODRIVE units to the servo/main spindle motor types.

3.3 Indirect position and motor speed sensing

The various possibilities for indirect position and speed sensing and for positioning the motor shaft as a function of the drive configuration (SINUMERIK, SIMODRIVE and motor) are listed in Tables 3-2 and 3-3 (Section 3.5).

3.4 Direct position sensing

3.4.1 Encoder systems which can be evaluated

The various possibilities for direct position sensing to position as a function of the drive configuration (SINUMERIK, SIMODRIVE and motor) and the encoder system used are listed in Tables 3-4 and 3-5 (Section 3.5).

We recommend that measuring systems with sinusoidal voltage signals are used due to the higher data transmission reliability and integrity.

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Incremental systems with two sinusoidal current signals A, B, displaced through 90 degrees and a (for distance–coded systems, several) reference mark(s) R.

Signal transfer:	Differential signals A, *A; B, *B and R, *R
Amplitude A – *A	7–16 µAss (for R_{load} = 1 kΩ)
Amplitude B – *B	7–16 µAss
Amplitude R – *R	2–8 µAss (net component)
Supply:	5 V $\pm$ 5 % (also refer to Section Encoder power supply)
Max. supply current:	300 mA
Max. encoder signal frequency which can be evaluated:	200 kHz

Note

For the above mentioned max. encoder signal frequency, the signal amplitude must be $\geq$ 60 % of the rated amplitude and the deviation of the phase shift from the ideal 90° between tracks A and B $\leqq \times \pm$ 30°.

Observe the frequency characteristics of the encoder signals.

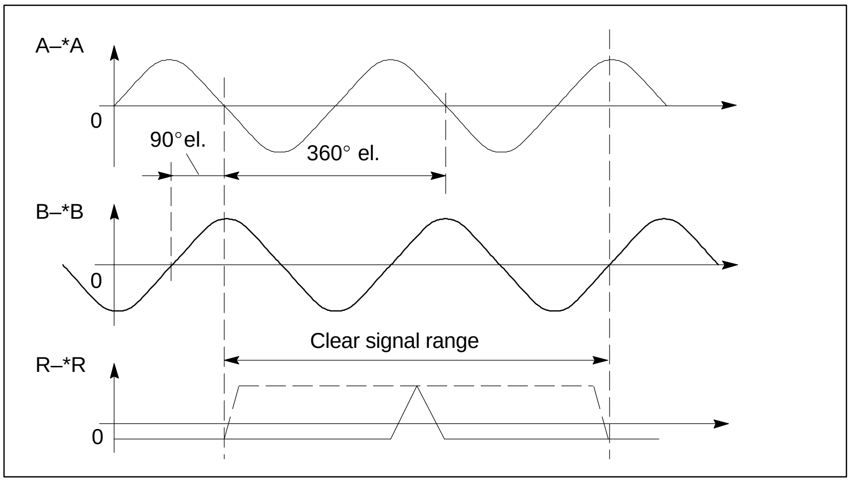

Fig. 3-1 Signal characteristics for a clockwise direction of rotation

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Incremental systems with two sinusoidal voltage signals A, B displaced by 90 degrees and one (for distance–coded systems, several) reference mark(s) R.

Signal transfer:	Differential signals A, *A; B, *B and R, R*
Amplitude A – *A	1 Vpp ± 30 %
Amplitude B – *B	1 Vpp ± 30 %
Amplitude R – *R	0.5 Vpp...1 Vpp
Supply:	5 V ± 5 % (also refer to Section Encoder power supply)
Max. supply current:	300 mA
Max. encoder signal frequency which can be evaluated:	200 kHz standard module 350 kHz without suppressing the amplitude monitoring 650 kHz with suppression of the amplitude monitoring

Note

For the above specified max. encoder signal frequency, the signal amplitude must be $\geq$ 60 % of the rated amplitude and the deviation of the phase shift from the ideal 90° between tracks A and B $\leq \pm$ 30°.

Observe the frequency characteristics of the encoder signals.

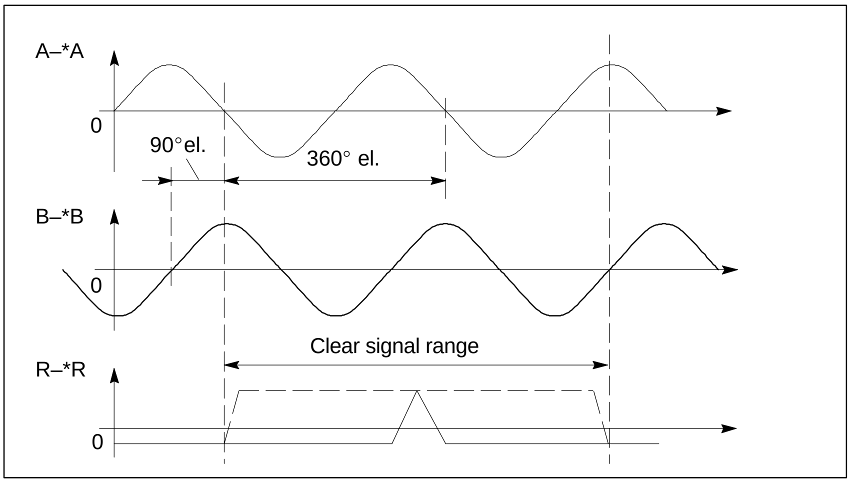

Fig. 3-2 Signal characteristics for a clockwise direction of rotation

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Single–turn, multi–turn and linear absolute systems with two sinusoidal voltage signals A, B displaced through 90 degrees and EnDat interface

Incremental signal transfer:	Differential signals A, *A and B, *B
Amplitude A – *A	1 Vpp ± 30 %
Amplitude B – *B	1 Vpp ± 30 %
Transfer, serial signals:	Differential signals data, *data and clock, *clock
Signal level:	according to EIA 485
Supply:	5 V ± 5 % (also refer to Section Encoder power supply)
Max. supply current:	300 mA
Max. encoder signal frequency which can be evaluated:	200 kHz standard module 350 kHz without suppressing the amplitude monitoring 650 kHz with suppression of the amplitude monitoring

---

Note

For the above specified max. encoder signal frequency, the signal amplitude must be $\geq$ 60 % of the rated amplitude and the deviation of the phase shift from the ideal 90° between tracks A and B $\leq \pm$ 30°.

Observe the frequency characteristics of the encoder signals.

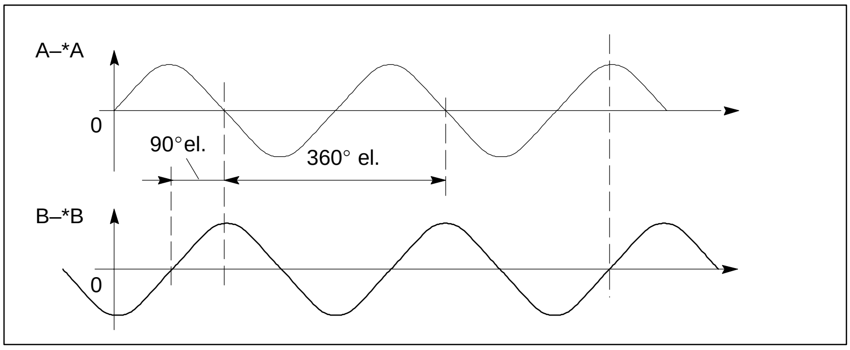

Fig. 3-3 Signal characteristics for incremental tracks for a clockwise direction of rotation

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Incremental systems with two squarewave signals A, B, displaced through 90 degrees and a reference mark(s) R SIMODRIVE 611A

Signal transfer:	Differential signals A, *A; B, *B and R, *R
Signal level:	acc. to RS422
Supply:	5 V ± 5 % (also refer to Section Encoder power supply)
Max. supply current:	300 mA
Max. encoder signal frequency which can be evaluated:	500 kHz

Note

For the above specified max. encoder signal frequency, the distance between the signal edges, tracks A and B must be ≥ 200 ns.

Observe the frequency characteristic of the encoder signals!

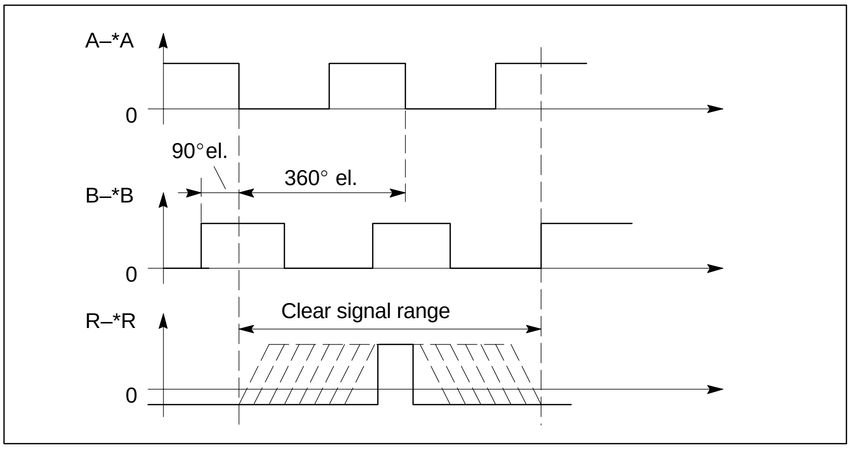

Fig. 3-4 Signal characteristics for a clockwise direction of rotation

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3.4.2 Encoder power supply

Remote/sense operation is possible with the encoder power supply for the motor measuring systems and the encoder power supplies for the measuring systems for direct position sensing, with the exception of the standard 1 Digital drive controls (the voltage is directly regulated at the encoder to ± 5 %).

Remote/sense operation means:

The power supply voltage of the measuring system is sensed via the sense lines P sense and M sense (this is essentially a no–current measurement).

A controller compares the measuring system–supply voltage, sensed via the remote/sense lines with the reference power supply voltage of the measuring system. It then adjusts the power supply voltage for the measuring system at the output of the drive module until the required power supply voltage is obtained directly at the measuring system

This means, that the voltage drops along the power supply lines P encoder and M encoder are compensated and corrected by the encoder power supply.

The power supply voltage is generated from a reference voltage source and is 5 V.

This means that it is possible to use cables up to 50 m long without operating the measuring systems with an undervoltage.

Note

All of the data are only valid for SIEMENS pre–assembled cables as these are dimensioned with the required conductor cross–section.

For the SIMODRIVE connection technology and also for the measuring system suppliers, remote/sense operation is only provided for encoder systems with voltage signals.

For encoder systems with current signals (7 µA ... 16 µA) the maximum possible cable length of 18 m is defined by the signal outputs of the encoder systems, as these can only drive a specific cable capacitance.

For motor measuring systems and mounted SIMODRIVE Sensor encoders, the sense lines are connected in the encoder or in the connector at the encoder side. For third–party encoder systems, customers must make this connection themselves.

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Main spindle control with analog setpoint interface

Remote/sense operation

Drive control, Performance Digital and standard 2 FD and MSD

Remote/sense operation

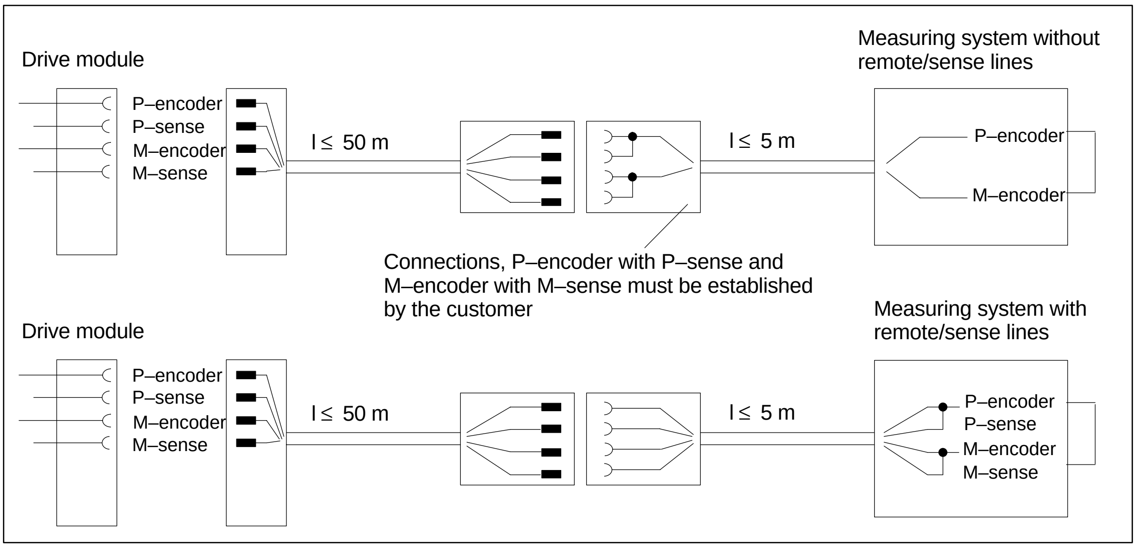

Fig. 3-5 Signal overview of the connections

Connection system for measuring systems with current signals

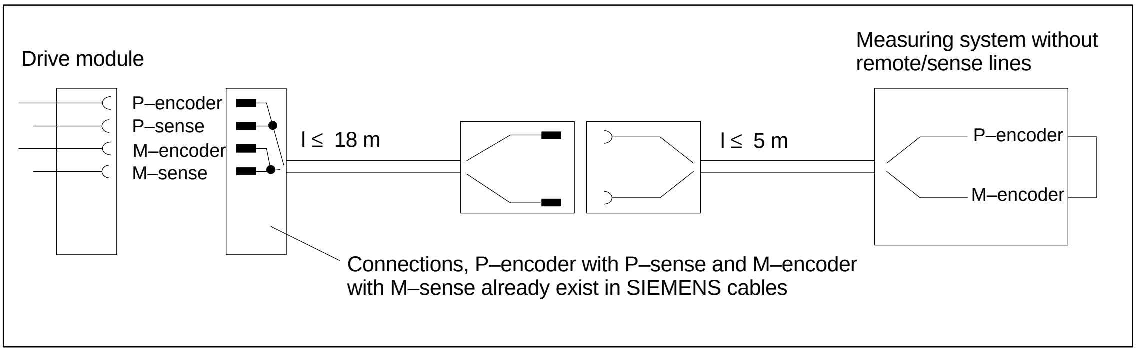

Fig. 3-6 Signal overview of the connections

Drive control, standard Digital

No remote/sense operation, max. cable length for 300 mA encoder current drain, 15 m (for low encoder current drain, appropriately longer cable lengths are possible, however max. 50 m!).

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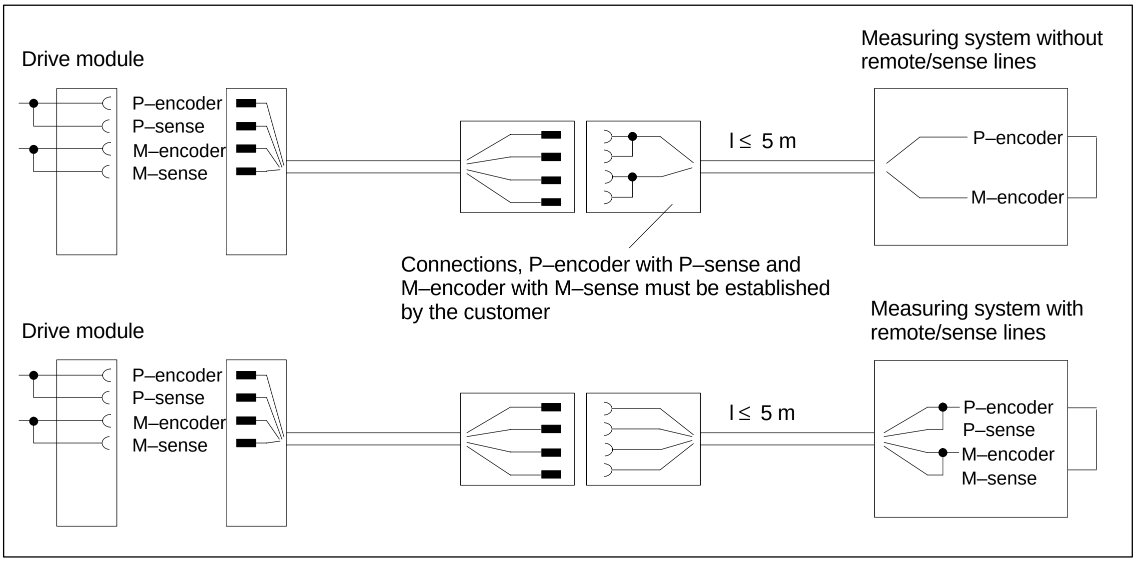

Fig. 3-7 Signal overview of the connections

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3.4.3 Encoder power supply for SSI encoders

General information

For SIMODRIVE, an internal 5 V is provided to supply encoders. When using SSI encoders, the power supply voltage must be externally fed–into the encoder cable.

What has to be observed?

The following must be observed (refer to Fig. 3-8):

- The encoders should be supplied with a separate regulated 24 V voltage (e.g. SITOP power), in order to prevent disturbances caused by contactors etc.
- The external 24 V power supply must have protective separation (PELV).
- Filter data:
  - The special filter is required to filter out noise
  - Max. continuous operating current = 0.8 A (use a fuse!)
  - Max. voltage = 30 V
  - 1 filter is designed for 2 encoders with max. current = 0.4 A
- The 24 V supply (reference potential) should be connected to the electronics ground of the system (e.g. terminal X131 at the NE module) if this connection is not already provided in the encoder.
- Max. cable length between the 24 V supply and filter = 9.9 m
- Max. encoder cable length = 50 m
- The technical data of the encoder manufacturer must be observed.

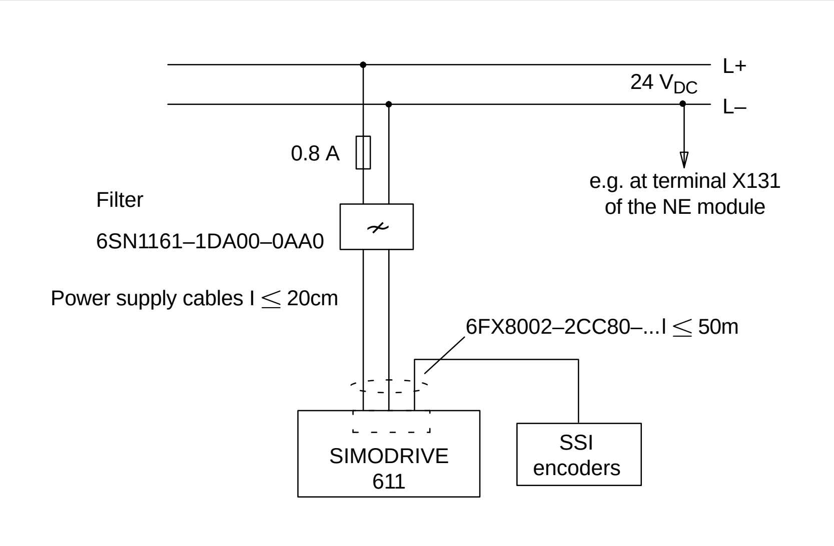

Fig. 3-8 Connecting SSI encoders to SIMODRIVE 611

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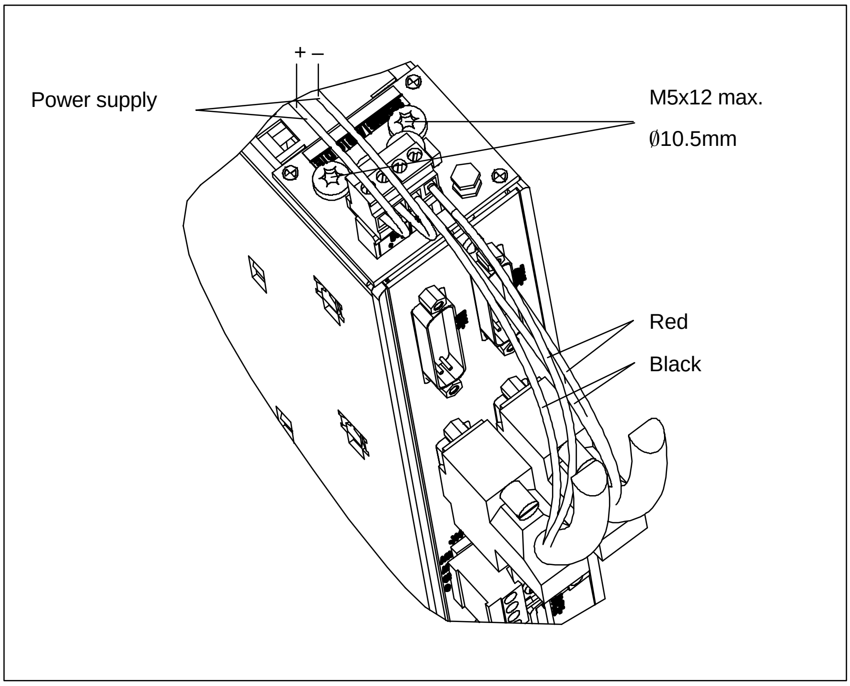

Fig. 3-9 Example of a connection at 6SN1118–0DG23–0AA1/–0DH23–0AA1

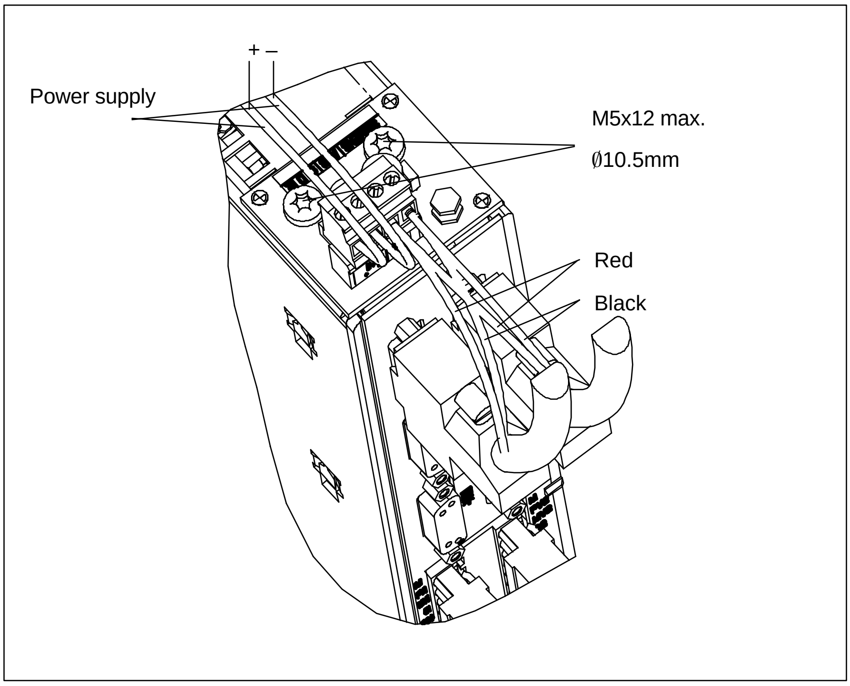

Fig. 3-10 Example of a connection at 6SN1115–0BA11–0AA1

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3.5 Overview, position sensing

Table 3-1 Assignment, motor measuring systems to the plug–in control module

Resolver control plug–in module	Feed control module with standard and user–friendly interface	Main spindle control module with analog setpoint interface	Drive control module Digital Performance (FD mode)	Drive control module Digital Performance (MSD mode)	Drive control module standard Digital	Drive control module 611 Universal Resolver	Drive control module 611 Universal Vpp voltage signals	Motor type	Encoder system
	yes							1FT5 Servomotor	3–ph. tachometer and rotor position encoder
	yes							1FT5 Servomotor	AC tachometer and RLG with optionally mounted/integrated incremental or absolute value encoder
yes						yes		1FK6 Servomotor	Resolver
			yes		yes		yes	1FT6 / 1FK6 Servomotor	Incremental encoder 1 Vpp
			yes		yes		yes	1FT6 / 1FK6 Servomotor	Multi–turn absolute value encoder
		yes		yes			yes	1PH4 / 6 / 7 Main spindle motor	Incremental encoder 1 Vpp
		yes		yes			yes	1FE1 / 1PH2 Main spindle motor	Incremental encoder (hollow–shaft encoder)
		yes	yes	yes	yes	yes	yes	Standard motor	Encoderless

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Table 3-2 Indirect position (motor rotor position) and motor speed sensing, analog controls

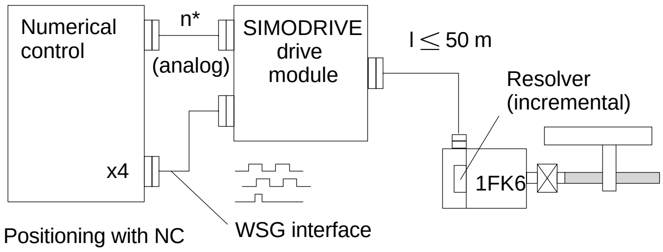
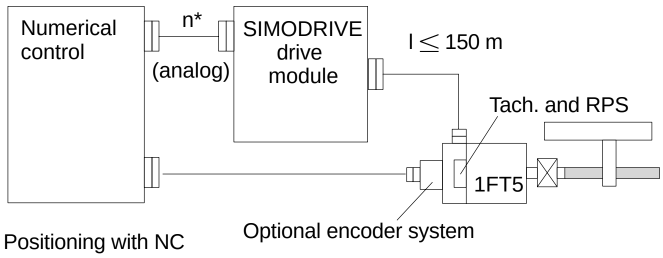
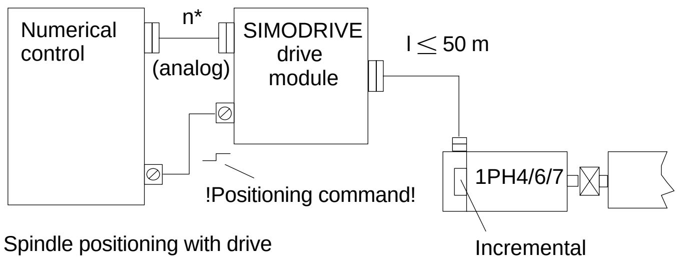
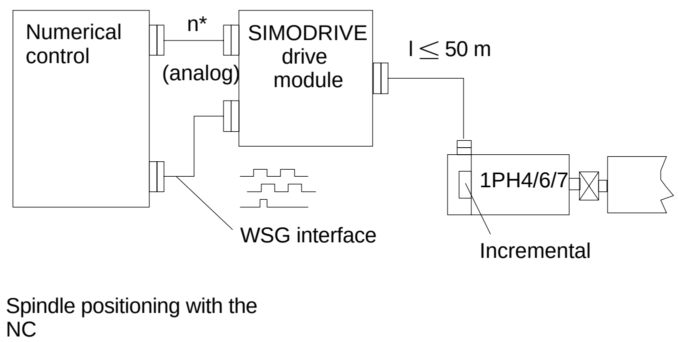
Control board	**Indirect position (motor rotor position) and motor speed sensing, analog controls**	**M: Max. possible measuring steps** **G: Encoder system accuracy** **Z: Pulse number**
Resolver control		M = 1024 · 4 per 360 degrees mech. G = ± 0.12 degrees
Feed control with standard and user–friendly interface		M and G are dependent on the accuracy of the optional encoder system and the evaluation technique in the NC
Main spindle control with analog setpoint interface		M = 2048 · Z per 360 degrees mech. Z = 2048 G = ± 0.006 degrees
Main spindle control with analog setpoint interface WSG (angular incremental e output for NC		M = k · Z · 4 per 360 degrees mech. Z = 2048 k...0.5, 1, 2, 4 (multiplication factor which can be set in the drive) G = ± 0.006 degrees

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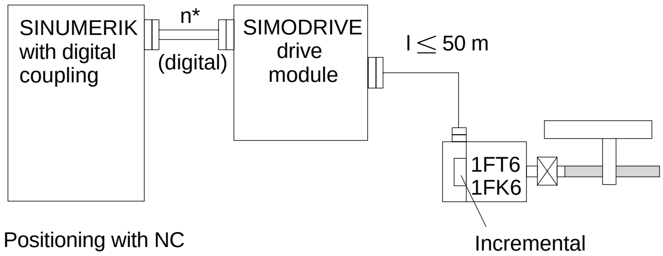
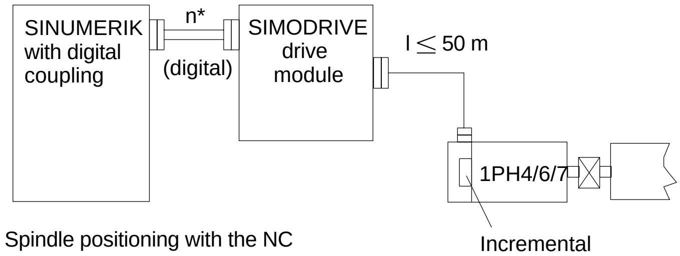
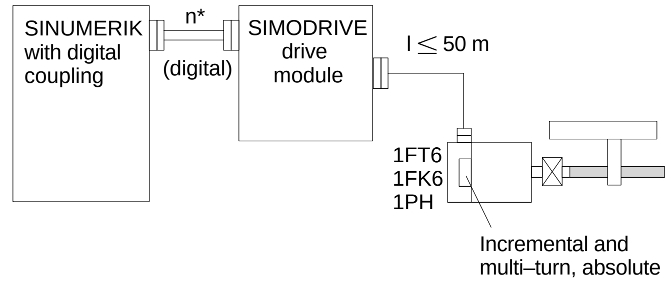
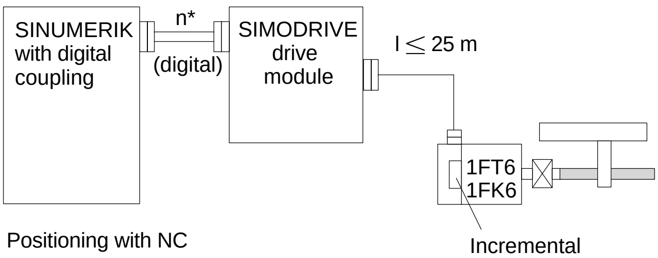
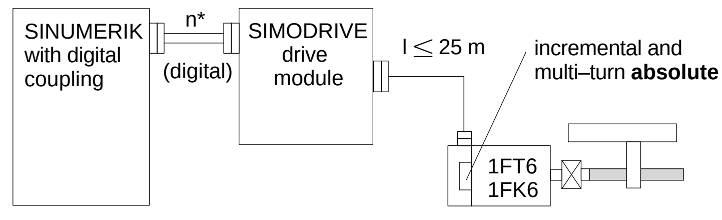
Table 3-3 Indirect position (motor rotor position) and motor speed sensing, digital controls

<table>
<tr><th>Control board version</th><th>Indirect position (motor rotor position) and motor speed sensing, digital controls</th><th>M: Max. possible measuring steps
G: Encoder system accuracy
Z: Pulse number</th></tr>
<tr><td rowspan="3">Drive control Perfor–mance Digital FD and MSD basic version</td><td>

Positioning with NC</td><td>M = 2048 · Z per 360 degrees mech.
Z = 2048
G = ± 0.006 degrees</td></tr>
<tr><td>

Spindle positioning with the NC</td><td>M = 2048 · Z per 360 degrees mech.
Z = 2048
G = ± 0.006 degrees</td></tr>
<tr><td>

Positioning with NC</td><td>M = 2048 · Z per 360 degrees mech.
Z = 2048
G = ± 0.006 degrees multi–turn absolute 4096 revolutions</td></tr>
<tr><td rowspan="2">Drive control standard Digital FD basic version</td><td>

Positioning with NC</td><td>M = 128 · Z per 360 degrees mech.
Z = 2048
G = ± 0.006 degrees</td></tr>
<tr><td>

Positioning with NC</td><td>M = 128 · Z per 360 degrees mech.
Z = 2048
G = ± 0.006 degrees multi–turn absolute 4096 revolutions</td></tr>
</table>

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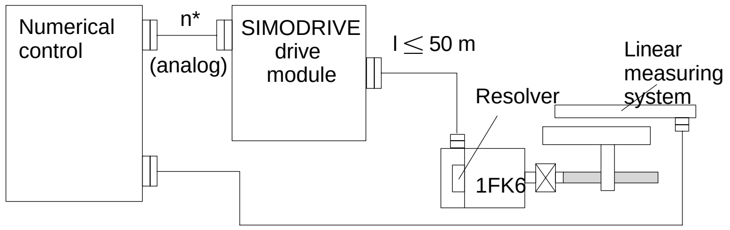
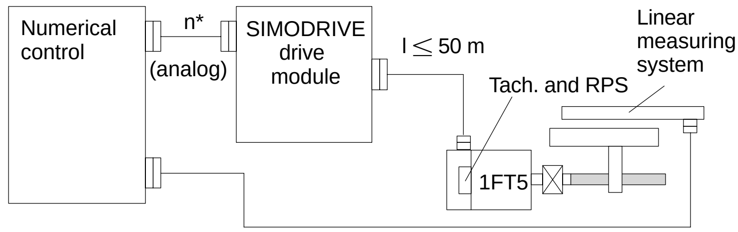
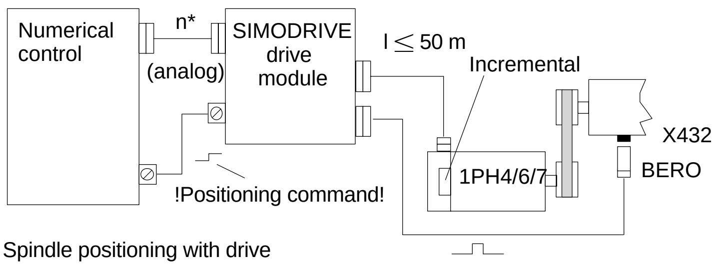
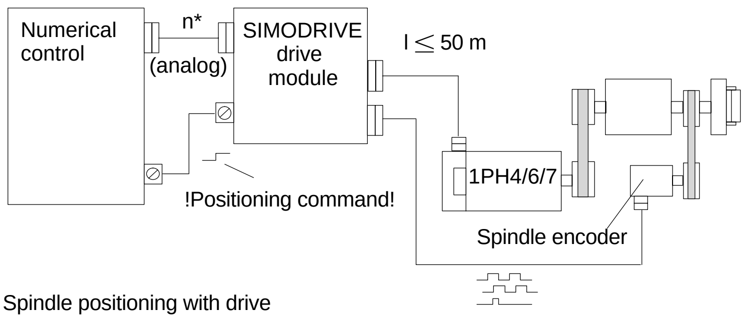
Table 3-4 Direct position sensing, analog controls

Control board version	Direct position sensing, analog controls	**M: Max. possible measuring steps** **G: Encoder system accuracy** **Z: Pulse number**
Resolver control with standard interface	 Positioning with NC	M and G are dependent on the accuracy of the optional encoder system and the evaluation technique in the NC
Feed control with standard and user–friendly interface	 Positioning with NC	M and G are dependent on the accuracy of the optional encoder system and the evaluation technique in the NC
Main spindle control with analog setpoint inter–face	 Spindle positioning with drive	M = 2048 · Z per 360 degrees mech. Z = 2048 $G_{Motor\ encoder}$ = ± 0.006 degrees G_{BERO} = 1)
Main spindle control with analog setpoint inter–face and input spindle–encoder	 Spindle positioning with drive	M = Z · 4 per 360 degrees mech. G is dependent on the accuracy of the optional encoder system.

1) The absolute accuracy when synchronizing with a BERO is a function of:
   - the BERO switching time
   - BERO hysteresis
   - signal edge gradient of the BERO signal (dependent on the direction of rotation!) and the switching thresholds in the drive; high >13 V, low < 5 V
   - the search speed or the signal run times in the evaluation electronics

2) Distance–coded reference marks can be evaluated

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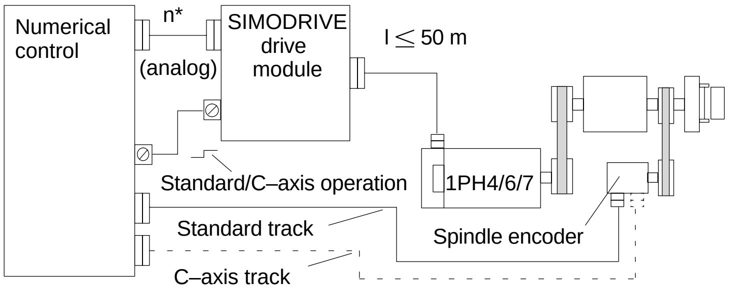
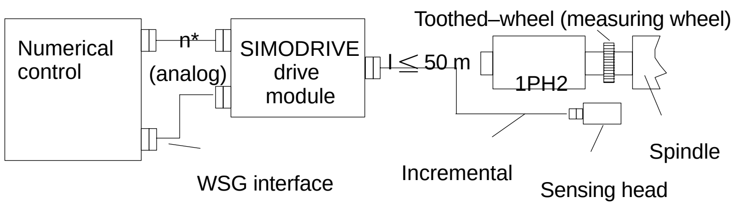
Table 3-4 Direct position sensing, analog controls

Control board version	Direct position sensing, analog controls	**M: Max. possible measuring steps** **G: Encoder system accuracy** **Z: Pulse number**
Main spindle control with analog setpoint inter–face	 C–axis operation with NC	M and G are dependent on the accuracy of the optional encoder system and the evaluation technique in the NC
Main spindle control with analog setpoint inter–face WSG output for NC	 Spindle positioning with the NC	M = 2048 · Z per 360 degrees mech. G depends on the precision of the toothed/measuring wheel encoder system Condition: $Z = 2^n$

---

1) The absolute accuracy when synchronizing with a BERO is a function of:
   – the BERO switching time
   – BERO hysteresis
   – signal edge gradient of the BERO signal (dependent on the direction of rotation!) and the switching thresholds in the drive; high >13 V, low < 5 V
   – the search speed or the signal run times in the evaluation electronics
2) Distance–coded reference marks can be evaluated

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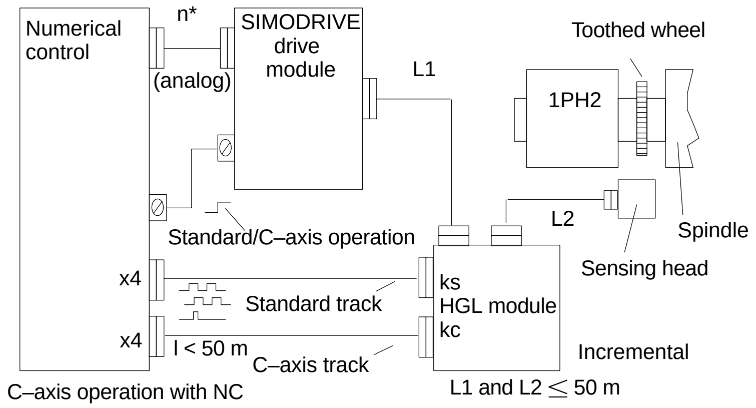
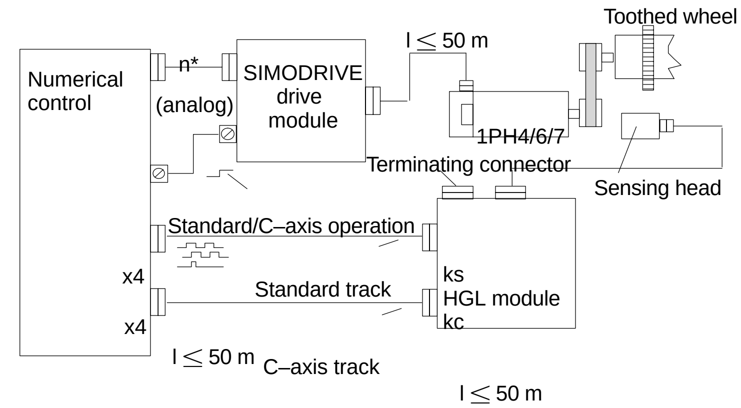
Table 3-4 Direct position sensing, analog controls

Control board version	Direct position sensing, analog controls	M: Max. possible measuring steps G: Encoder system accuracy Z: Pulse number
Main spindle control with analog setpoint inter–face	 C–axis operation with NC HGL module: refer to Section 3.6	Standard track Ms = ks · Z · 4 per 360 degrees mech. C–axis track Mc = kc · Z · 4 per 360 degrees mech. ks...1, 2, 4, 8 kc...175.78, 351.56 ks, kc... factors which can be set in the HGL module G depends on the precision of the toothed/measuring wheel encoder system
Main spindle control with analog setpoint inter–face	 Spindle positioning with the NC HGL module: refer to Section 3.6	Standard track Ms = ks · Z · 4 per 360 degrees mech. C–axis track Mc = kc · Z · 4 per 360 degrees mech. ks...1, 2, 4, 8 kc...175.78, 351.56 ks, kc... factors which can be set in the HGL module G depends on the precision of the toothed/ measuring wheel encoder system

1) The absolute accuracy when synchronizing with a BERO is a function of:
   – the BERO switching time
   – BERO hysteresis
   – signal edge gradient of the BERO signal (dependent on the direction of rotation!) and the switching thresholds in the drive; high >13 V, low < 5 V
   – the search speed or the signal run times in the evaluation electronics
2) Distance–coded reference marks can be evaluated

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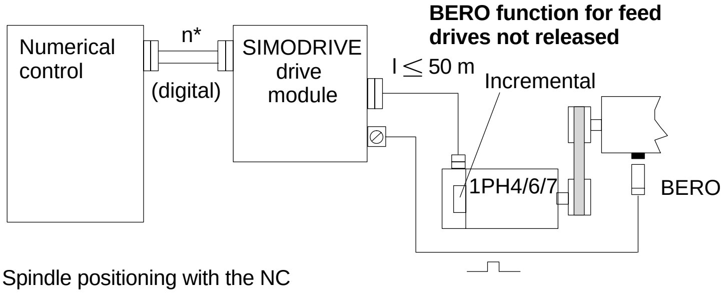
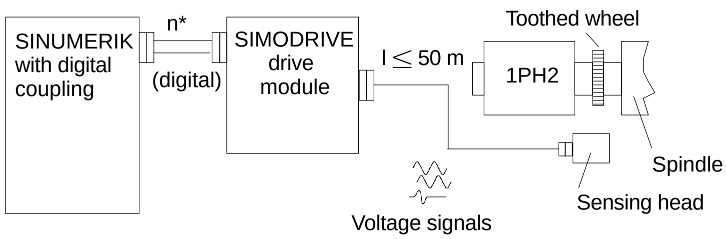
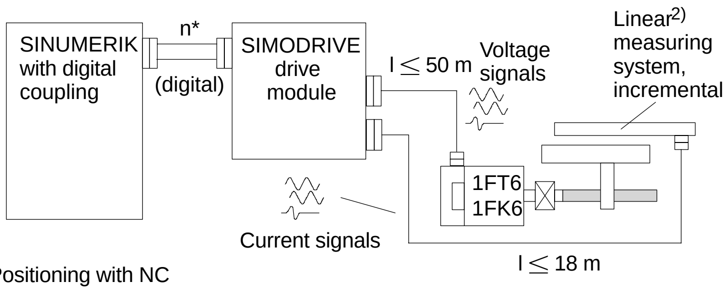
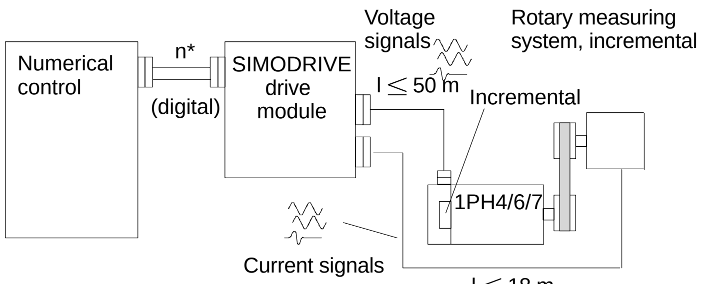
Table 3-5 Direct position sensing, digital controls

Control board version	**Direct position sensing, digital controls**	**M: max. possible measuring steps** **G: Encoder system accuracy** **V: Multiplication** **Z: Pulse number**
Drive control Perfor–mance digital FD and MSD Basic version	 Spindle positioning with the NC	M = V*Z per 360 degrees mech. V = 2048 $G_{Motor\ encoder}$ = ± 0.006 degrees G_{BERO} = 1)
	 Spindle positioning with the NC	M = V*Z per 360 degrees mech. G depends on the precision of the toothed/measuring wheel encoder system
Drive control Perfor–mance Digital FD and MSD with addi–tional input, current signa	 Positioning with NC	M = 2048 per encoder signal period and grid division G is dependent on the accuracy of the optional encoder system.
	 Spindle positioning with the NC	M = V*Z per 360 degrees mech. V = 2048 G is dependent on the accuracy of the optional encoder system.

1) The absolute accuracy when synchronizing with a BERO is a function of:
   – the BERO switching time
   – BERO hysteresis
   – signal edge gradient of the BERO signal (dependent on the direction of rotation!) and the switching thresholds in the drive; high >13 V, low < 5 V
   – the search speed or the signal run times in the evaluation electronics
2) Distance–coded reference marks can be evaluated

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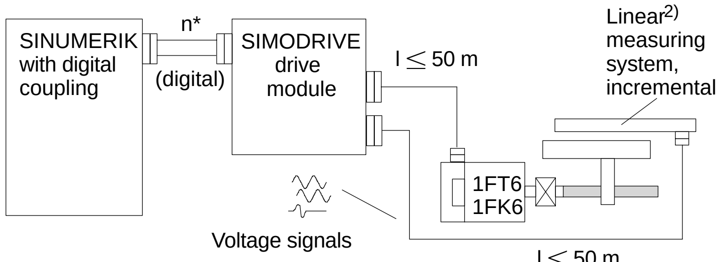
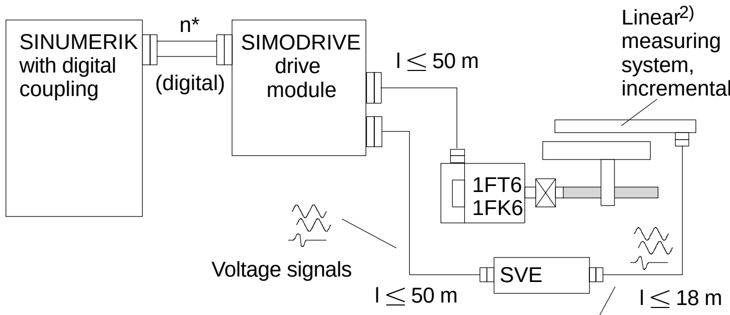
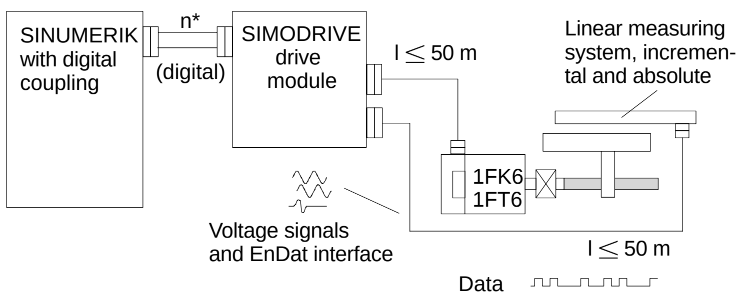
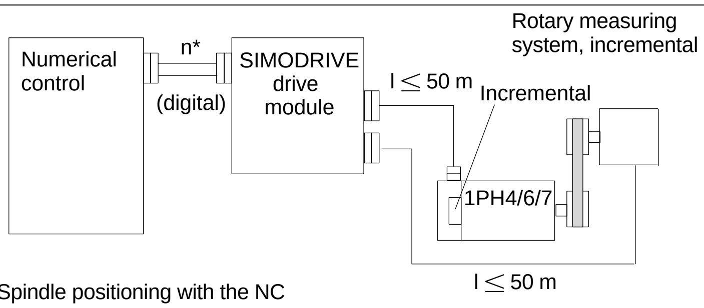
Table 3-5 Direct position sensing, digital controls

Control board version	**Direct position sensing, digital controls**	**M: max. possible measuring steps** **G: Encoder system accuracy** **V: Multiplication** **Z: Pulse number**
Drive control Perfor–mance Digital FD and MSD with addi–tional input voltage signal	 Positioning with NC	M = 2048 per encoder signal period and grid division G is dependent on the accuracy of the optional encoder system.
	 Positioning with NC	M = 2048 per encoder signal period and grid division G is dependent on the accuracy of the optional encoder system.
	 Positioning with NC	M = 2048 per encoder signal period and grid division G is dependent on the accuracy of the optional encoder system.
	 Spindle positioning with the NC	M = 2048 · Z per 360 degrees mech. Z...Pulse number V = 2048 G is dependent on the accuracy of the optional encoder system.

1) The absolute accuracy when synchronizing with a BERO is a function of:
   – the BERO switching time
   – BERO hysteresis
   – signal edge gradient of the BERO signal (dependent on the direction of rotation!) and the switching thresholds in the drive; high >13 V, low < 5 V
   – the search speed or the signal run times in the evaluation electronics
2) Distance–coded reference marks can be evaluated

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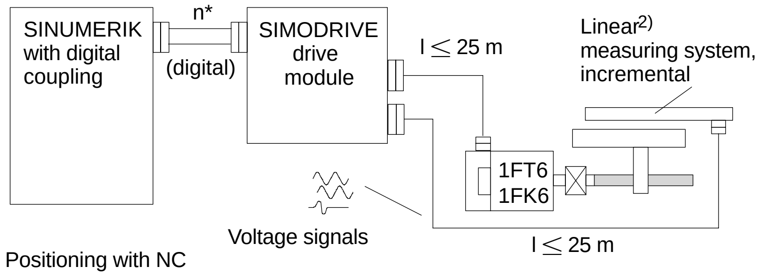
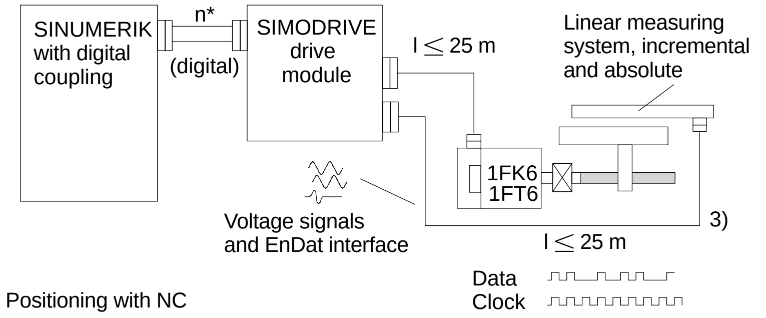
Table 3-5 Direct position sensing, digital controls

Control board version	Direct position sensing, digital controls	M: Max. possible measuring steps G: Encoder system accuracy
Drive control Standard Digital FD with addi–tional input voltage signal		M = 2048 per encoder signal period and grid division G is dependent on the accuracy of the optional encoder system.
		M, G=function of the optional encoder system accuracy, the evaluation technique in the NC and the mechanical design. The resolution per encoder period and grid division in the drive is 128.
	Note: It is not possible to convert current signals into voltage signals via an SVE (signal amplification electronics) due to the encoder power supply design!	

1) The absolute accuracy when synchronizing with a BERO is a function of:
   – the BERO switching time
   – BERO hysteresis
   – signal edge gradient of the BERO signal (dependent on the direction of rotation!) and the switching thresholds in the drive; high >13 V, low < 5 V
   – the search speed or the signal run times in the evaluation electronics
2) Distance–coded reference marks can be evaluated when used as direct measuring system.
3) 25m cable: 6FX2002–2EQ10–1□□□
   18m cable: 6FX2002–2EQ00–1□□□

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3.6 High–resolution position (HGL)

3.6.1 Features and technical data

Applications

HGL is an optional hardware expansion for SIMODRIVE 611 for C axis operation.

HGL allows the toothed–wheel encoder to be independently used as spindle encoder for conventional spindle drives.

Mode of operation

The analog sinusoidal signals of the toothed–wheel encoder are fed to the converter motor encoder connector for the closed–loop speed control.

The encoder signals are multiplied and converted into square–wave signals for the higher–level closed–loop position control. These are fed to the numerical control, once for spindle operation and once for C–axis operation.

Various multiplication factors can be selected using a rotary switch. In addition, the phase sequence of the square–wave signals can be defined using the rotary switch. This allows the direction of rotation of the encoder to be adapted to the motor direction of rotation.

Note

When configuring SIMODRIVE 611 analog:
Assessment factor for the electronics: EP = 2
Assessment factor for control: AP = 0

Order designation

SIMODRIVE 611 analog: 6SN1115–0AA11–0AA0 (module).
The Instruction Manual is included with the equipment.

Technical data

Output signals resolution

Set via rotary switch S1:

Table 3-6 Resolution

Number of teeth	C–axis track	Standard track	Standard encoder phase position	Inverted encoder phase sequence
512	90 000	512	0	8
512	90 000	1 024	1	9
512	90 000	2 048	2	A
512	90 000	4 096	3	B
512	180 000	512	4	C
512	180 000	1 024	5	D
512	180 000	2 048	6	E
512	180 000	4 096	7	F
256	45 000	256	0	8
256	45 000	512	1	9
256	45 000	1 024	2	A
256	45 000	2 048	3	B
256	90 000	256	4	C
256	90 000	512	5	D
256	90 000	1 024	6	E
256	90 000	2 048	7	F

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3.6.2 Connector assignment

X 511 Connection, toothed–wheel encoder

X 512 Output to SIMODRIVE or terminating connector

(Sub–miniature D 15–pin; socket)

Table 3-7 Connector assignment, X511 and X512

PIN No.	Signal name	Explanation
1	P encoder	Encoder power supply
2	M encoder	Encoder power supply (ground)
3	A	Signal A (voltage)
4	A inverse	Signal A, inverted (voltage)
5	inside shield	Inner shield
6	B	Signal B (voltage)
7	B inverse	Signal B, inverted (voltage)
8	nc	Not assigned
9	5 V sense	Sensor cable
10	R	Signal R (voltage)
11	0 V sense	Sensor cable (ground)
12	R inverse	Signal R, inverted (voltage)
13	nc	Not assigned
14	+ Temp.	Temperature sensor
15	– Temp.	Temperature sensor

X 521 Output, standard track

X 522 Output, C axis track

(subminiature D 15–pin; plug connector)

Table 3-8 Connector assignment X521 and X522

PIN No.	Signal name	Explanation
1	nc	Not assigned
2	M	Ground
3	A	Signal A (voltage)
4	A inverse	Signal A, inverted (voltage)
5	nc	Not assigned
6	B	Signal B
7	B inverse	Signal B, inverted (voltage)
8	nc	Not assigned
9	nc	Not assigned
10	nc	Not assigned
11	nc	Not assigned
12	R	Signal R (voltage)
13	R inverse	Signal R, inverted (voltage)
14	nc	Not assigned
15	nc	Not assigned

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3.6.3 System configurations and cable connections

1PH2 motor without C–axis operation

HGL is not required in this configuration.

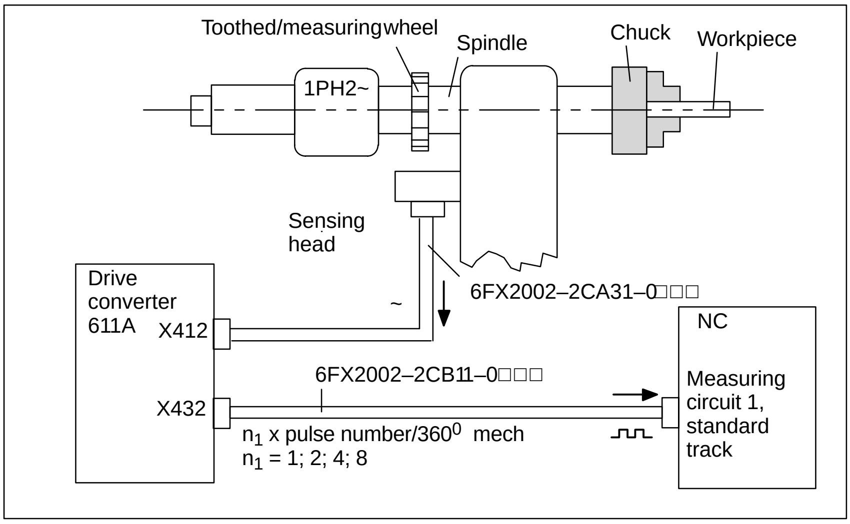

Fig. 3-11 System configuration, 1PH2 motor without C–axis operation

1PH2 motors with C–axis operation

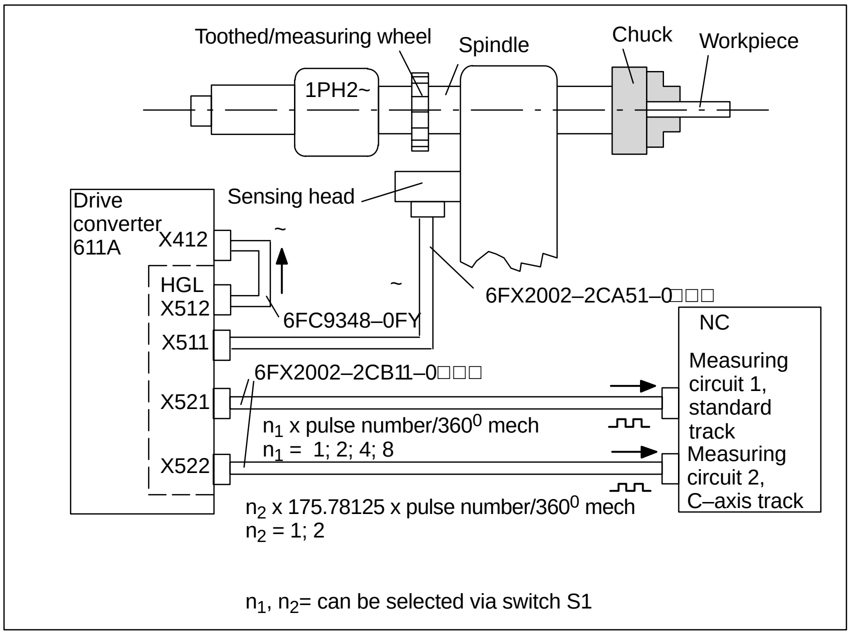

Fig. 3-12 System configuration, 1PH2 motor with C–axis operation

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1PH4/6/7 motor with toothed–wheel encoder as spindle encoder

For this configuration, HGL is required, both for standard spindle operation as well as for C–axis operation.

Note

In order to ensure perfect operation with this configuration, the terminating connector must be inserted at X512. The terminating connector is included with the HGL.

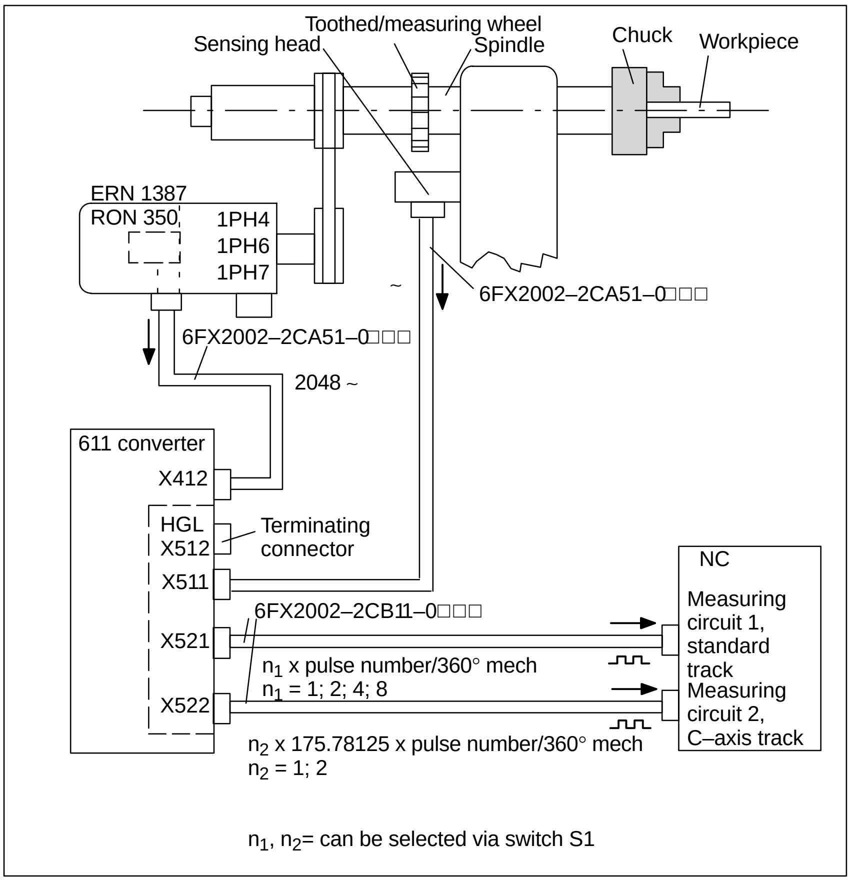

Fig. 3-13 System configuration 1PH4/6/7 motor with C toothed–wheel encoder as spindle encoder

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3.7 Ordering information

Order Nos. for the specified components, refer to the relevant Catalog

• Pre–assembled encoder cables with appropriate maximum permissible cable lengths	refer to Catalog NC Z
• SVE signal amplification	refer to Catalog NC 60
• HGL module	refer to Catalog NC 60
• Toothed wheel encoder and the required diagnostics box for adjustment	refer to Catalog NC Z or NC 60

- For drives with an analog speed setpoint interface, the encoder systems are evaluated in the numerical control to sense the direct and indirect position.

  When using Siemens controls, the encoder systems which can be evaluated can be taken from the appropriate catalogs.

  The same is true for the associated Order Nos. for the controls and measuring circuit boards.

■

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Space for your notes

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4 Power Modules

Description

Together with the control module, the power module forms the drive module, e.g. for feed or main spindle applications.

The power modules are suitable for operation with the following motors:

- 1FT5, 1FT6 and 1FK6 servomotors
- 1FN linear motors
- 1PH2, 1PH3, 1PH4, 1PH7 and 1FE1 main spindle motors
- Standard induction motors

There is a wide range of power modules, in 1–axis and 2–axis versions graduated according to currents and sub–divided into three different cooling types.

The current data refers to the series default setting. Currents must be reduced as listed in the following, for higher basic fundamental frequencies, or for higher clock frequencies, ambient temperature and installation altitudes above 1000 m above sea level. Matching pre–assembled power cables are available to connect the motors. The ordering data is provided in Catalog NC 60, in the "Motors" section.

Shield connecting plates for mounting on the module are available so that shielded power cables can be connected in compliance with EMC guidelines.

The equipment bus cable is part of the scope of supply of the power module. For the digital system, the drive bus cables must be separately ordered.

The current specified on the power modules are normalized values, which refer to all of the control modules. The output currents can be limited by the control module. After the control module has been inserted, the retaining screws at the front panel of the control module must be tightened in order to ensure a good electrical connection to the module housing.

⚠ **Caution**

After the control module has been inserted, the retaining screws at the front panel of the control module must be tightened in order to ensure a good electrical connection to the module housing.

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Power module, internal cooling

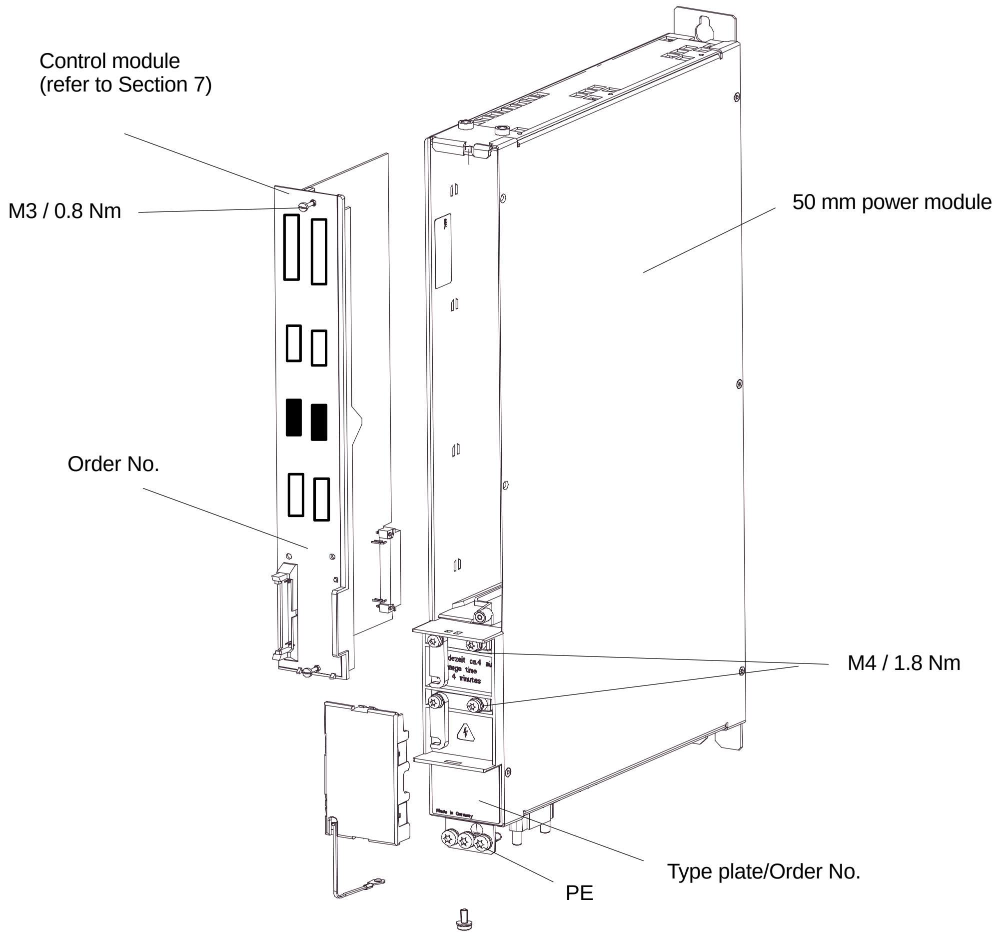

Fig. 4-1 Power module with control module

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4.1 Technical data

4.1.1 Technical data, power modules

Table 4-1 Technical data/power module, 1–axis version

Internal cooling External cooling Hose cooling Cooling type	6SN 1123–1AA0.– 6SN 1124–1AA0.– 6SN 1123–1AA0.–	0HA1 0HA1 – Non–ventila-ted	0AA1 0AA1 – Non–ventila-ted	0BA1 0BA1 – Force ventila-ted	0CA1 0CA1 – Force ventila-ted	0DA1 0DA1 – Force ventila-ted	0EA1 0EA1 – Force ventila-ted	0FA1 0FA1 0FA1 Force ventila-ted
To use 1FT5 motors with control module 6SN11 18–0Ax11–xxxx								
Rated current Peak current	A A	4 8	7.5 15	12.5 25	25 50	40 80	80 160	100 200
Power loss, total/ internal/external [3]	W	35 / 14 / 21	45 / 18 / 27	90 / 35 / 55	180 / 62 / 118	300 / 30 / 270	655 / 30 / 625	740 / 90 / 650
f_o [1] X1 [1]	kHz %	3.3 55	3.3 55	3.3 55	3.3 40	3.3 50	3.3 55	3.3 55
To use 1FT6 motors/1FK6 motors with control module 6SN11 18–0Bx11–xxxx								
Rated current Peak current	A A	3 6	5 10	9 18	18 36	28 56	56 112	70 140
Power loss, total/ internal/external [3]	W	35 / 14 / 21	50 / 19 / 31	90 / 35 / 55	190 / 65 / 125	300 / 30 / 270	645 / 25 / 620	730 / 90 / 640
f_o [1] X1 [1]	kHz %	3.3 55	3.3 55	3.3 55	3.3 40	3.3 50	3.3 55	3.3 55
To use 1FT6 motors/1FK6 motors/1FN motors with control module 6SN11 18–0Dx11–xxxx, 6SN11 18–xNxxx–xxxx								
Rated current Peak current	A A	3 6	5 10	9 18	18 36	28 56	56 112	70 140
Power loss, total/ internal/external [3]	W	35 / 14 / 21	50 / 19 / 31	90 / 35 / 55	190 / 65 / 125	300 / 30 / 270	645 / 25 / 620	730 / 90 / 640
f_o [1] X1 [1]	kHz %	4 55	4 55	4 55	4 50	4 50	4 55	4 55
To use 1PH and 1FE1 motors and induction motors with control module 6SN11 21–0BA11–xxxx, 6SN11 22–0BA11–xxxx To use 1PH and 1FE1 motors with control module 6SN11 18–0Dxxx–xxxx								
Rated current Current for S6–40% Peak current	A A A	3 3 3	5 5 8	8 10 16	24 32 32	30 40 51	60 80 102	85 110 127
Power loss, total/ internal/external [3]	W	30 / 12 / 18	40 / 16 / 24	74 / 29 / 45	260 / 89 / 171	320 / 32 / 288	685 / 30 / 655	850 / 100 / 750
f_o [1] X1 [1]	kHz %	3.2 50	3.2 50	3.2 50	3.2 50	3.2 55	3.2 50	3.2 50

fo = inverter clock frequency
1) X1 = reduction factor of the current, current de–rating from the inverter clock frequency f_0 of the power transistors (Fig. 4-2)
2) The 1st number is valid for cable lugs, the 2nd number is valid for finely–stranded conductors without conn. sleeves.
3) If internal cooling or hose cooling is used, then only Pv_{tot} should be considered.
4) For UL certification: only use copper cables designed for an operating temperature of $\geq$ 60˚C.

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Table 4-1 Technical data/power module, 1–axis version

Internal cooling **External cooling** **Hose cooling** **Cooling type**	**6SN 1123–1AA0.–** **6SN 1124–1AA0.–** **6SN 1123–1AA0.–**	**0HA1** **0HA1** **–** **Non–ventila-ted**	**0AA1** **0AA1** **–** **Non–ventila-ted**	**0BA1** **0BA1** **–** **Force ventila-ted**	**0CA1** **0CA1** **–** **Force ventila-ted**	**0DA1** **0DA1** **–** **Force ventila-ted**	**0EA1** **0EA1** **–** **Force ventila-ted**	**0FA1** **0FA1** **0FA1** **Force ventila-ted**
To use induction motors with control module 6SN11 18–0Dxxx–xxxx, 6SN11 18–xNxxx–xxxx								
Rated current Current for S6–40% Peak current	A A A	2.8 2.8 2.8	4.6 4.6 7.3	7.4 9.3 14.8	22 39 29	28 37 47	55 73 94	79 102 117
Power loss, total/ internal/external 3)	W	30 / 12 / 18	40 / 16 / 24	74 / 29 / 45	260 / 89 / 171	460 / 19 / 441	685 / 30 / 655	850 / 100 / 750
f_o 1) X1 1)	kHz %	4 55	4 55	4 55	4 50	4 50	4 55	4 55
General data for controlled infeed modules								
Input voltage Output voltage Efficiency η	V V	600/625/680 DC 3–ph. 0 to 430 V 0.98						
Module width Max. cross–section 2)4) Weight, approx.: Internal cooling External cooling	mm mm^2 kg kg	50 6/4 6.5 6.5	50 6/4 6.5 6.5	50 6/4 6.5 6.5	50 6/4 6.5 6.5	100 16/10 9.5 9.5	150 50 13 13	300 95 or 2x35 26 26

fo = inverter clock frequency
1) X1 = reduction factor of the current, current de–rating from inverter clock frequency f_0 of the power transistors (Fig. 4-2)
2) The 1st number is valid for cable lugs, the 2nd number is valid for finely–stranded conductors without conn. sleeves.
3) If internal cooling or hose cooling is used, then only Pv_{tot} should be considered.
4) For UL certification: only use copper cables designed for an operating temperature of ≥ 60˚C.

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Table 4-2 Technical data/power module, 1–axis version (additional power modules)

Internal cooling **External cooling** **Hose cooling** **Cooling type**	**6SN 1123–1AA0.–** **6SN 1124–1AA0.–** **6SN 1123–1AA0.–**	**0LA1** **0LA1** **–** **Force ventilated**	**0JA1** **0JA1** **0JA1** **Force ventilated**	**0KA1** **0KA1** **0KA1** **Force ventilated**				
To use 1FT6 motors/1FK6 motors/1FN motors with control module 6SN11 18–0Bx11–xxxx								
Rated current Peak current	A A	42 64	100 100	140 210				
Power loss, total/ internal/external 3)	W	460 / 25 / 435	1300 / 170 / 1130	1910 / 250 / 1660				
f_o 1) X1 1)	kHz %	3.3 55	3.3 55	3.3 55				
To use 1FT6 motors/1FK6 motors/1FN motors with control module 6SN11 18–0Dxxx–xxxx, 6SN11 18–xNxxx–xxxx								
Rated current Peak current	A A	42 64	100 100	140 210				
Power loss, total/ internal/external 3)	W	460 / 25 / 435	1300 / 170 / 1130	1910 / 250 / 1660				
f_o 1) X1 1)	kHz %	4 55	4 55	4 55				
General data for controlled infeed modules								
Input voltage Output voltage Efficiency η	V V	600/625/680 DC 3–ph. 0 to 430 V 0.98						
Module width Max. cross–section 2)4) Weight, approx.: Internal cooling External cooling	mm mm^2 kg kg	150 50 13 13	300 95 or 2 x 35 26 26	300 150 or 2 x 50 28 28				

fo = inverter clock frequency
1) X1 = reduction factor of the current, current de–rating from inverter clock frequency f_0 of the power transistors (Fig. 4-2)
2) The 1st number is valid for cable lugs, the 2nd number is valid for finely–stranded conductors without conn. sleeves.
3) If internal cooling or hose cooling is used, then only Pv_{tot} should be considered.
4) For UL certification: only use copper cables designed for an operating temperature of ≥ 60˚C.

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Table 4-3 Technical data/power module, 2–axis version

Internal cooling External cooling Cooling type	6SN 1123–1AB0.– 6SN 1124–1AB0.–	0HA1 0HA1 Non–ventilated	0AA1 0AA1 Force–ventilated	0BA1 0BA1 Force ventilated	0CA1 0CA1 Force ventilated			
To use 1FT5 motors with control module 6SN11 18–0Ax11–xxxx								
Rated current Peak current	A A	4 8	7.5 15	12.5 25	25 50			
Power loss, total/ internal/external [3]	W	70 / 27 / 43	105 / 40 / 64	174 / 67 / 107	364 / 124 / 240			
f_o [1] X1 [1]	kHz %	3.3 55	3.3 55	3.3 55	3.3 55			
To use 1FT6 motors/1FK6 motors with control module 6SN11 18–0Bx11–xxxx								
Rated current Peak current	A A	3 6	5 10	9 18	18 36			
Power loss, total/ internal/external [3]	W	70 / 27 / 43	100 / 38 / 62	180 / 69 / 111	380 / 130 / 250			
f_o [1] X1 [1]	kHz %	3.3 55	3.3 55	3.3 55	3.3 55			
To use 1FT6 motors/1FK6 motors/1FN motors with control module 6SN11 18–0Dxxx–xxxx, 6SN11 18–xNxxx–xxxx								
Rated current Peak current	A A	3 6	5 10	9 18	18 36			
Power loss, total/ internal/external [3]	W	70 / 27 / 43	100 / 38 / 62	180 / 69 / 111	380 / 130 / 250			
f_o [1] X1 [1]	kHz %	4 55	4 55	4 55	4 55			
To use 1PH and 1FE1 motors and induction motors with control module 6SN11 18–xNxxx–xxxx								
Rated current Current for S6–40% Peak current	A A A	3 3 3	5 5 8	8 10 16	24 32 32			
Power loss, total/ internal/external [3]	W	76 / 28 / 48	118 / 42 / 76	226 / 74 / 152	538 / 184 / 354			
f_o [1] X1 [1]	kHz %	3.2 55	3.2 55	3.2 55	3.2 55			
General data for controlled infeed modules								
Input voltage Output voltage Efficiency η	V V	600/625/680 DC 3–ph. 0 to 430 V 0.98						
Module width Max. cross–section [2)4)] Weight, approx.: Internal cooling External cooling	mm mm^2 kg kg	50 6/4 7 7	50 6/4 7 7	50 6/4 7 7	100 6/4 13.5 13.5			

fo = inverter clock frequency
1) X1 = reduction factor of the current, current de–rating from inverter clock frequency f_0 of the power transistors (Fig. 4-2)
2) The 1st number is valid for cable lugs, the 2nd number is valid for finely–stranded conductors without conn. sleeves.
3) If internal cooling or hose cooling is used, then only Pv_{tot} should be considered.
4) For UL certification only use copper cables designed for an operating temperature of ≥ 60˚C.

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Table 4-4 Order No. assignment

PM type	Power modules	
	Internal cooling	**External cooling**
PM 8 A	6SN11 23 – 1AA00 – 0HA1	6SN11 24 – 1AA00 – 0HA1
PM 15 A	6SN11 23 – 1AA00 – 0AA1	6SN11 24 – 1AA00 – 0AA1
PM 25 A	6SN11 23 – 1AA00 – 0BA1	6SN11 24 – 1AA00 – 0BA1
PM 50 A	6SN11 23 – 1AA00 – 0CA1	6SN11 24 – 1AA00 – 0CA1
PM 80 A	6SN11 23 – 1AA00 – 0DA1	6SN11 24 – 1AA00 – 0DA1
PM 160 A	6SN11 23 – 1AA00 – 0EA1	6SN11 24 – 1AA00 – 0EA1
PM 200 A	6SN11 23 – 1AA00 – 0FA1	6SN11 24 – 1AA00 – 0FA1
PM 2x8 A	6SN11 23 – 1AB00 – 0HA1	6SN11 24 – 1AB00 – 0HA1
PM 2x15 A	6SN11 23 – 1AB00 – 0AA1	6SN11 24 – 1AB00 – 0AA1
PM 2x25 A	6SN11 23 – 1AB00 – 0BA1	6SN11 24 – 1AB00 – 0BA1
PM 2x50 A	6SN11 23 – 1AB00 – 0CA1	6SN11 24 – 1AB00 – 0CA1

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4.2 Current de–rating

Definition of the currents

For MSD/IMM digital and MSD/IMM analog: Sinusoidal current, current data are RMS values.

1. I_n continuous current
2. I_{s6} current for max. 4 min for S6 duty cycle
3. I_{max} Peak current (load duty cycle, refer to Section 4.3)

For FD analog: Square–wave current,
the current values are the amplitude of the square–wave current.

For FD digital: The sinusoidal currents are RMS values.

1. I_n continuous current
2. I_{max} Peak current (load duty cycle, refer to Section 4.3)

Definition of the outputs

Pv_{tot} total module power loss
Pv_{hose} power loss which can be dissipated through hose cooling
Pv_{ext} power loss which can be dissipated through external cooling
Pv_{int} power loss which is not dissipated via hose or external cooling

This power loss remains in the cabinet

Current de–rating depends on the inverter clock frequency

X1 = reduction factor of the current, current de–rating from inverter clock frequency f_0 of the power transistors (refer to technical data).

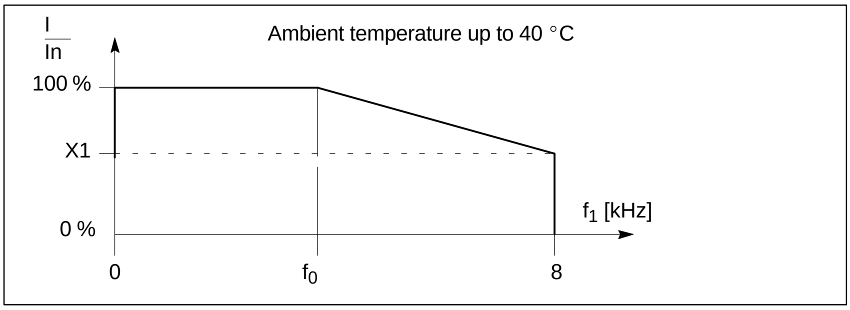

Fig. 4-2 Current de–rating depends on the inverter clock frequency

Formula:

$$X = 100\% - \frac{(100\,\% - X1) \bullet (f_T - f_0)}{8kHz - f_0}$$

x = the reduction factor obtained [in %] for I_n, I_{s6}, I_{max}
f_T = selected inverter clock frequency

$\Rightarrow In_{fT} = x \bullet In_{f0}/100\ \%$
$\Rightarrow Is6_{fT} = x \bullet Is6_{f0}/100\ \%$
$\Rightarrow Imax_{fT} = x \bullet Imax_{f0}/100\ \%$

Caution: The currents I_n, I_{s6} and I_{max} must be reduced in the same way.

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4.2.1 Information on the motor–drive converter selection, MSD analog

Various inverter clock frequencies can be parameterized; observe the current de–rating.
Inverter clock frequency for MSD analog f_0=3.2 kHz: The currents are a function of the inverter clock frequency f_T.

Table 4-5 Currents as a function of the inverter clock frequency

		In/Is6/Imax in A	**In/Is6/Imax in A**	**In/Is6/Imax in A**	**In/Is6/Imax in A**	**In/Is6/Imax in A**	**In/Is6/Imax in A**	**In/Is6/Imax in A**	**In/Is6/Imax in A**
PM type	**Code No.**	**f_T 3.20 kHz**	**f_T 4.70 kHz**	**f_T 6.30 kHz**	**f_T 7.80 kHz**	**f_T 2.80 kHz**	**f_T 3.90 kHz**	**f_T 5.00 kHz**	**f_T 5.90 kHz**
LT 50A	6	24/32/32	20/26/26	15/20/20	10/14/14	24/32/32	22/29/29	19/25/25	16/21/21
LT 80A	7	30/40/51	26/34/44	21/28/36	17/23/29	30/40/51	28/37/48	25/33/42	22/30/38
LT 108A	13	45/60/76	39/52/65	32/43/54	26/34/43	45/60/76	42/56/71	37/50/63	34/45/57
LT 120A	8	45/60/76	39/52/65	32/43/54	26/34/43	45/60/76	42/56/71	37/50/63	34/45/57
LT 160A	9	60/80/102	51/68/86	41/54/69	31/42/53	60/80/102	56/74/95	49/65/83	43/58/73
LT 200A	10	85/110/127	73/95/109	60/78/90	48/63/72	85/110/127	79/103/119	71/91/106	63/82/95
LT 300A	11	120/150/193	101/127/163	81/102/131	62/78/101	120/150/193	111/139/179	98/122/157	86/108/139
LT 400A	12	200/250/257	169/211/217	135/169/174	104/130/134	200/250/257	185/232/238	163/203/209	144/180/185
up to including FW 2.xx									
from FW 3.0									

For special motors with a lower leakage induction, it may be necessary to provide a series reactor and/or increase the inverter clock frequency of the drive converter. From experience, motors with low leakage induction are those which can achieve high stator frequencies (maximum motor stator frequency> 300 Hz) or motors with a higher rated current (rated current > 85 A).

I_N Rated module current at the converter pulse frequency (standard value: f_0 3.2 kHz)
I_{min} Minimum motor current
I_{S6} Max. motor current for an S6 load duty cycle
I_{Short} Short–time limiting current of the module used in A_{rms}
I_{0Mot} No–load motor current in A_{rms}
n_{FS} Speed at the start of field weakening
n_{max} Max. motor speed

Dimensioning the series reactor, refer to Section 6

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4.2.2 Information on the motor–drive converter selection, IM analog

The converter must be selected according to the required duty cycle. Further, the following restrictive conditions must be observed:

- The motor no–load current must be less than the rated current of the drive converter module (IM according to Table 4-6).
- As result of the current actual value resolution, the lowest no–load motor current must fulfill the following condition:

$$\frac{n_{FS}}{n_{max}} \times I_{0Mot} \geq I_{min} \qquad (I_{min} \text{ according to Table 4-6})$$

Various inverter clock frequencies can be parameterized; observe the current de–rating.

Table 4-6 Inverter clock frequency IM analog f_0=3.2 kHz: Currents as a function of the inverter clock frequency f_T

		In/Is6/Imax in A	**In/Is6/Imax in A**	**In/Is6/Imax in A**	**In/Is6/Imax in A**	**In/Is6/Imax in A**	**In/Is6/Imax in A**	**In/Is6/Imax in A**	**In/Is6/Imax in A**	**Imin in A**
PM type	**Code No.**	**f_T 3.20 kHz**	**f_T 4.70 kHz**	**f_T 6.30 kHz**	**f_T 7.80 kHz**	**f_T 2.80 kHz**	**f_T 3.90 kHz**	**f_T 5.00 kHz**	**f_T 5.90 kHz**	
LT 8A	1	3/3/3	2.5/2.5/2.5	2.0/2.0/2.0	1.6/1.6/1.6	3/3/3	2.8/2.8/2.8	2.4/2.4/2.4	2.2/2.2/2.2	0.6
LT 15A	2	5/5/8	4.2/4.2/6.8	3.4/3.4/5.4	2.6/2.6/4.2	5/5/8	4.6/4.6/7.4	4.1/4.1/6.5	3.6/3.6/5.8	1.1
LT 25A	3	8/10/16	6.9/8.6/13.8	5.7/7.1/11.4	4.6/5.7/9.1	8/10/16	7.4/9.3/15.0	6.7/8.3/13.3	6.0/7.5/12.0	1.8
LT 50A	6	24/32/32	20/26/26	15/20/20	10/14/14	24/32/32	22/29/29	19/25/25	16/21/21	3.6
LT 80A	7	30/40/51	26/34/44	21/28/36	17/23/29	30/40/51	28/37/48	25/33/42	22/30/38	5.7
LT 108A	13	45/60/76	39/52/65	32/43/54	26/34/43	45/60/76	42/56/71	37/50/63	34/45/57	8.5
LT 120A	8	45/60/76	39/52/65	32/43/54	26/34/43	45/60/76	42/56/71	37/50/63	34/45/57	11.3
LT 160A	9	60/80/102	51/68/86	41/54/69	31/42/53	60/80/102	56/74/95	49/65/83	43/58/73	11.3
LT 200A	10	85/110/127	73/95/109	60/78/90	48/63/72	85/110/127	79/103/119	71/91/106	63/82/95	14.1
LT 300A	11	120/150/193	101/127/163	81/102/131	62/78/101	120/150/193	111/139/179	98/122/157	86/108/139	21.2
LT 400A	12	200/250/257	169/211/217	135/169/174	104/130/134	200/250/257	185/232/238	163/203/209	144/180/185	28.3
up to including FW 2.xx										
from FW 3.0										

I_N	Rated module current at the converter pulse frequency (standard value: f_0 3.2 kHz)
I_{min}	Minimum motor current
I_{S6}	Max. motor current for an S6 load duty cycle
I_{Short}	Short–time limiting current of the module used in A_{rms}
I_{0Mot}	No–load motor current in A_{rms}
n_{FS}	Speed at the start of field weakening
n_{max}	Maximum motor speed

- For motors with a low leakage induction, it may be necessary to provide a series reactor and/or increase the inverter clock frequency of the drive converter. From experience, motors with low leakage induction are those which can achieve high stator frequencies (maximum motor stator frequency > 300 Hz) or motors with a higher rated current (rated current > 85 A).

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4.2.3 Information on motor–converter selection, FD control, digital

Various inverter clock frequencies can be parameterized; observe the current de–rating.

An inverter clock frequency is pre–set for FD digital f_T=4.0 kHz: The currents are a function of the inverter clock frequency f_T.

Table 4-7 Currents as a function of the inverter clock frequency

		In/Imax [A]	**In/Imax [A]**	**In/Imax [A]**	**In/Imax [A]**	**In/Imax [A]**	**In/Imax [A]**	**In/Imax [A]**
PM type	**Code No.**	**f_T 4.57 kHz**	**f_T 4.92 kHz**	**f_T 5.33 kHz**	**f_T 5.82 kHz**	**f_T 6.40 kHz**	**f_T 7.11 kHz**	**f_T 8.00 kHz**
8 A	17	2.8/5.6	2.7/5.4	2.6/5.2	2.4/4.8	2.2/4.4	2.0/3.9	1.7/3.3
15 A	18	4.7/9.4	4.5/9.0	4.3/8.6	4.0/8.0	3.7/7.3	3.3/6.5	2.8/5.5
25 A	20	8.4/16.8	8.1/16.1	7.8/15.5	7.2/14.3	6.6/13.3	5.9/11.7	5.0/9.9
50 A	22	16/33	16/31	14/29	13/26	12/23	10/19	7/14
2x8 A	17	2x2.8/5.6	2x2.7/5.4	2x2.6/5.2	2x2.4/4.8	2x2.2/4.4	2x2.0/3.9	2x1.7/3.3
2x15 A	18	2x4.7/9.4	2x4.5/9.0	2x4.3/8.6	2x4.0/8.0	2x3.7/7.3	2x3.3/6.5	2x2.8/5.5
2x25 A	20	2x8.4/16.8	2x8.1/16.1	2x7.8/15.5	2x7.2/14.3	2x6.6/13.1	2x5.9/11.7	2x5.0/9.9
2x50 A	22	2x16/33	2x16/31	2x14/29	2x13/26	2x12/23	2x10/19	2x7/14
80 A	23	26/52	25/50	23/47	22/43	20/39	17/34	14/28
160 A	25	52/105	50/100	48/97	45/89	41/82	36/73	31/62
A200	26	66/131	63/126	60/121	56/111	51/102	46/91	39/77
400 A	28	130/195	124/186	117/175	108/162	98/147	85/128	70/105

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4.2.4 Information on motor–converter selection MSD control, digital

Various inverter clock frequencies can be parameterized; observe the current de–rating.

An inverter clock frequency is pre–set for MSD digital f_T=3.2 kHz: The currents are a function of the inverter clock frequency f_T.

Table 4-8 Currents as a function of the inverter clock frequency

		In/Is6/Imax in A	In/Is6/Imax in A	In/Is6/Imax in A	In/Is6/Imax in A	In/Is6/Imax in A	In/Is6/Imax in A
Code No.	**Power module type**	**f_T 3.20 kHz**	f_T 3.37 kHz	f_T 3.56 kHz	f_T 3.76 kHz	f_T 4.00 kHz	f_T 4.27 kHz
6	LT 50A	24/32/32	23/31/31	23/31/31	23/30/30	22/29/29	21/28/28
7	LT 80A	30/40/51	30/39/50	29/39/49	28/38/48	28/37/47	27/36/46
13	LT 108A	45/60/76	44/59/75	43/58/73	43/57/72	42/56/70	40/54/68
8	LT 120A	45/60/75	44/59/75	43/58/73	43/57/72	42/56/70	40/54/68
9	LT 160A	60/80/102	59/79/100	58/77/98	57/75/96	55/73/94	53/71/91
10	LT 200A	85/110/127	84/108/125	82/106/123	81/104/120	79/102/117	76/99/114
11	LT 300A	120/150/193	118/147/190	116/144/186	113/141/182	110/138/177	107/133/171
12	LT 400A	200/250/257	196/246/252	193/241/247	188/235/242	183/229/236	178/222/228

		In/Is6/Imax in A	In/Is6/Imax in A	In/Is6/Imax in A	In/Is6/Imax in A	In/Is6/Imax in A	In/Is6/Imax in A	In/Is6/Imax in A
Code No.	**Power module type**	f_T 4.57 kHz	f_T 4.92 kHz	f_T 5.33 kHz	f_T 5.82 kHz	f_T 6.40 kHz	f_T 7.11 kHz	f_T 8.00 kHz
6	LT 50A	20/27/27	19/25/25	18/23/23	16/22/22	14/19/19	12/16/16	10/13/13
7	LT 80A	26/35/44	25/34/43	24/32/41	23/30/38	21/28/36	19/25/32	17/22/28
13	LT 108A	39/52/66	38/50/64	36/48/61	34/45/57	32/42/53	29/38/48	25/33/42
8	LT 120A	39/52/66	38/50/64	36/48/61	34/45/57	32/42/53	29/38/48	25/33/42
9	LT 160A	51/69/87	49/66/84	47/62/79	44/58/74	40/53/68	36/47/60	30/40/51
10	LT 200A	74/96/111	71/92/107	68/88/102	64/83/96	60/77/89	54/70/80	47/61/70
11	LT 300A	103/129/165	98/123/158	93/117/150	87/109/140	80/100/129	71/89/114	60/75/97
12	LT 400A	171/214/220	164/205/211	156/195/200	145/182/187	133/167/171	119/148/152	100/125/129

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4.2.5 Information on the motor–converter selection IM control digital

Two inverter clock frequencies can be parameterized: 4 kHz and 8 kHz.
Please observe the current de–rating at 8 kHz.

Table 4-9 Current load as a function of the inverter clock frequency

		In/I_{S6}/Imax in A	In/I_{S6}/Imax in A	Imin in A
Code No.	**Power module type**	**f_T 4.00 kHz**	**f_T 8.00 kHz**	
1	LT 8A	2.8/2.8/2.8	1.5/1.5/1.5	0.6
2	LT 15A	4.6/4.6/7.3	2.5/2.5/4.0	1.1
4	LT 25A	7.4/9.3/14.8	4.4/5.5/8.8	1.8
6	LT 50A	22/29/29	10/13/13	3.6
7	LT 80A	28/37/47	17/22/28	5.7
13	LT 108A	42/56/70	25/33/42	8.5
8	LT 120A	42/56/70	25/33/42	11.3
9	LT 160A	55/73/94	30/40/51	11.3
10	LT 200A	79/102/117	47/61/70	14.1
11	LT 300A	110/138/177	60/75/97	21.2
12	LT 400A	183/229/236	100/125/129	28.3

Dimensioning the series reactor, refer to Section 4.2.2

Heatsink temperature monitoring

The individual power modules have different heatsink response temperatures. Range, approx. 80 °C to 100 °C at the measuring point.

Current de–rating is dependent on the installation altitude

All of the specified load currents are valid up to an installation altitude of 1000 m. For installation altitude > 1000 m, the load currents must be de–rated according to the diagram below.

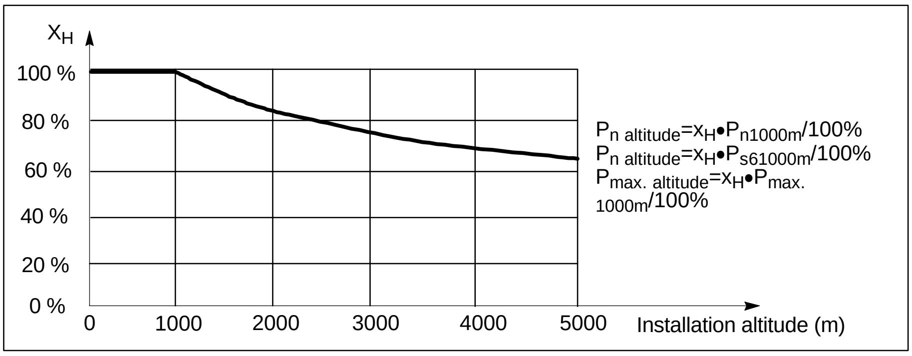

Fig. 4-3 Current de–rating is dependent on the installation altitude

Caution: The currents I_n, I_{s6} and I_{max} must be reduced in the same way.

⇒ $I_{n\ altitude} = x_H \bullet I_{n1000\ m}/100\%$
⇒ $I_{s6\ altitude} = x_H \bullet I_{s61000\ m}/100\%$
⇒ $I_{max\ altitude} = x_H \bullet I_{max1000\ m}/100\%$

Example: PM 50 A: with MSD analog control: selected inverter clock frequencies 6.3 kHz; installation altitude 2000 m

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$$X=100\% - \frac{(100\% - 40\%) \bullet (6.3\ kHz - 3.2\ kHz)}{8kHz - 3.2\ kHz} = 61.25\%;\ X_H = 83\%$$

$\Rightarrow I_{n6.3\ kHz,\ 2000\ m} = (x \bullet I_{nf0}/100\%) \bullet x_H/100\% = 12\ A$
$\Rightarrow I_{s6.3\ kHz,\ 2000\ m} = (x \bullet I_{s6f0}/100\%) \bullet x_H/100\% = 16\ A$
$\Rightarrow I_{max6.3\ kHz,\ 2000\ m} = (x \bullet I_{maxf0}/100\%) \bullet x_H/100\% = 16\ A$

Permissible currents of the SIMODRIVE power modules for induction motors and main spindle drive applications (various S6 load duty cycles, defined, e.g. S6 load duty cycles listed, e.g. S6-25% ⇒ 2.5 min/7.5 min):

Table 4-10 Currents for an inverter clock frequency f_0=3.2 kHz

PM module	8 A *	15 A *	25 A *	50 A **	80 A **	108 A **	160 A **	200 A **	300 A **	400 A **
I_{rated}	3.0 A	5.0 A	8.0 A	24.0 A	30.0 A	45.0 A	60.0 A	85 A	120 A	200 A
$0.7 \bullet I_{rated}$	2.1 A	3.5 A	5.6 A	16.8 A	21.0 A	31.5 A	42.0 A	59.5 A	84 A	140 A
I S6-60%	3.0 A	5.0 A	8.0 A	26.0 A	34.0 A	50.0 A	70.0 A	100 A	135 A	225 A
I S6-40%	3.0 A	5.0 A	10.0 A	32.0 A	40.0 A	60.0 A	80.0 A	110 A	150 A	250 A
I S6-30%	3.0 A	5.2 A	10.8 A	32.0 A	42.1 A	62.7 A	86.5 A	113 A	153 A	252 A
I S6-25%	3.0 A	5.4 A	11.5 A	32.0 A	44.2 A	65.0 A	89.2 A	116 A	155 A	253 A
I S6-20%	3.0 A	5.7 A	12.3 A	32.0 A	45.7 A	67.7 A	91.9 A	119 A	159 A	254 A
I S6-10%	3.0 A	6.6 A	14.9 A	32.0 A	48.6 A	72.3 A	97.4 A	123 A	173 A	255 A
I_{max}	3.0 A	8.0 A	16.0 A	32.0 A	51.0 A	76.0 A	102.0 A	127 A	193 A	257 A

The $0.7 \bullet I_{rated}$ current has been kept constant.

* Currents are only valid for induction motor applications, analog internal and external cooling.
** Currents are valid for main spindle drive/induction motor applications, analog and for main spindle drive digital, int. and external cooling.

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Table 4-11 Currents for an inverter clock frequency f_0=4.0 kHz (derating)

PM module	8 A *	15 A *	25 A *	50 A *	80 A *	108 A *	160 A *	200 A *	300 A *	400 A *
I_{rated}	2.8 A	4.6 A	7.4 A	22.0 A	28.0 A	42.0 A	55.0 A	79.0 A	110 A	183 A
0.7• I_{rated}	2.0 A	3.2 A	5.2 A	15.4 A	19.6 A	29.4 A	38.5 A	55.3 A	77 A	128 A
I S6-60%	2.8 A	4.6 A	7.4 A	23.8 A	31.7 A	46.7 A	64.2 A	92.9 A	124 A	206 A
I S6-40%	2.8 A	4.6 A	9.3 A	29.0 A	37.0 A	56.0 A	73.0 A	102 A	138 A	229 A
I S6-30%	2.8 A	4.7 A	10.0 A	29.0 A	38.8 A	57.8 A	79.7 A	104 A	140 A	231 A
I S6-25%	2.8 A	4.9 A	10.6 A	29.0 A	40.7 A	59.9 A	82.2 A	107 A	142 A	232 A
I S6-20%	2.8 A	5.2 A	11.4 A	29.0 A	42.1 A	62.4 A	84.7 A	110 A	146 A	233 A
I S6-10%	2.8 A	6.0 A	13.8 A	29.0 A	44.8 A	66.6 A	89.8 A	113 A	159 A	234 A
I_{max}	2.8 A	7.3 A	14.8 A	29.0 A	47.0 A	70.0 A	94.0 A	117 A	177 A	236 A

The 0.7•I_{rated} current has been kept constant.

* Currents are exclusively applied for induction motor applications, digital, internal and external cooling.

Observe de–ratings for additional possible clock frequencies and installation altitude.

4.2.6 Technical data of the supplementary components

Supplementary components required, refer to Section 8

4

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4.3 Load duty cycle definitions, drive modules

Nominal load duty cycles, FD

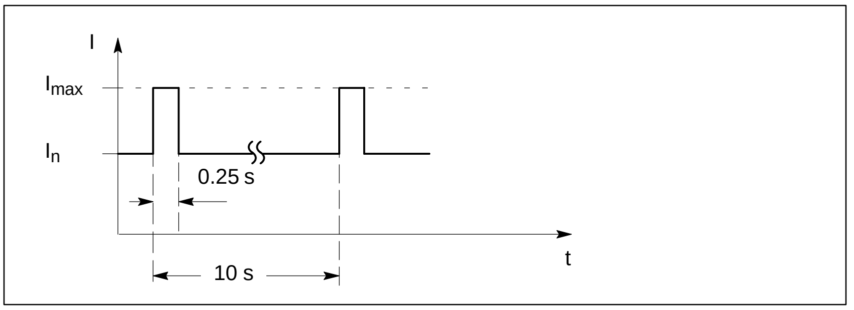

Fig. 4-4 Peak current – load duty cycle with pre–loading condition

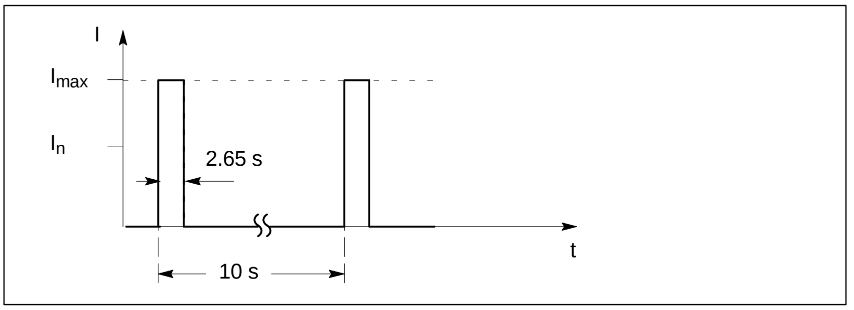

Fig. 4-5 Peak current – load duty cycle without pre–loading condition

Nominal load duty cycles, MSD/IM

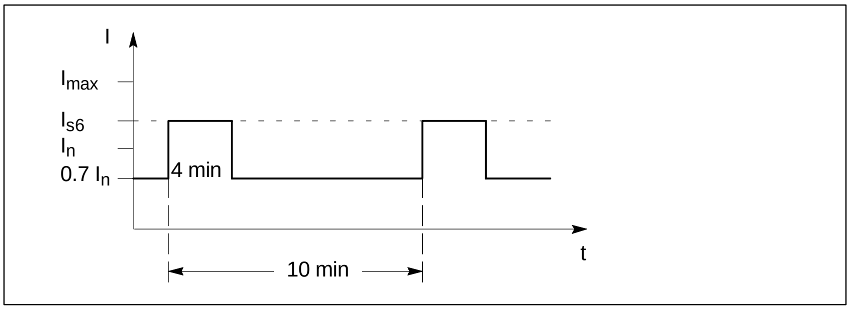

Fig. 4-6 S6 load duty cycle with pre–loading condition

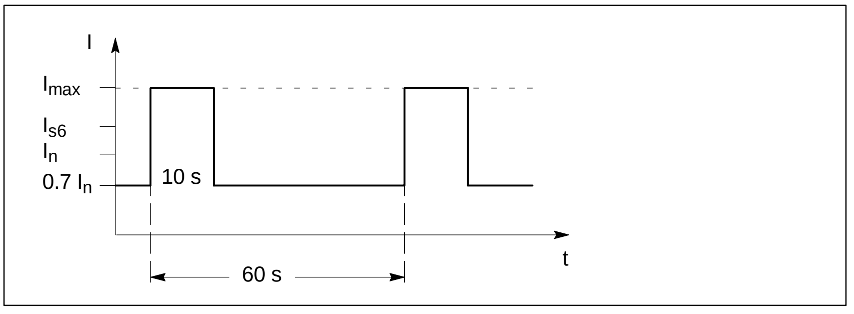

Fig. 4-7 S6 peak current – load duty cycle with pre–loading condition

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4.4 Interface overview

Table 4-12 1-axis module

Term. No.	Desig.	Function	Type 1)	Typ. voltage/ limit values	Max. cross–sect.
U2 V2 W2	1 A	Motor connection	O	3–ph. 430 V AC	refer to Section 4.1
PE	⏚	Protective conductor Protective conductor	I I	0 V 0 V	2 screws
P600 M600		DC link DC link	I/O I/O	+300 V –300 V	Busbar Busbar

Table 4-13 2-axis power modules

Term. No.	Desig.	Function	Type 1)	Typ. voltage/ limit values	Max. cross–sect.
U2 V2 W2	1 A	Motor connection for axis 1	O	3–ph. 430 V AC	refer to Section 4.1
U2 V2 W2	2 A	Motor connection for axis 2	O	3–ph. 430 V AC	refer to Section 4.1
PE		Protective conductor Protective conductor	I I	0 V 0 V	3 screws
P600 M600		DC link DC link	I/O I/O	+300 V –300 V	Busbar Busbar

1) O = Output; I = Input

■

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Control Modules

5

Overview of the control modules

The control modules, listed in the following table can be used in the SIMO-DRIVE power modules.

5

Table 5-1 Overview of control modules

Control board	Version	Axes	Motor encoder	Motors[1)]	Optional interfaces
SIMODRIVE 611 universal	1–axis n–set	1	Resolver	1FT6, 1FK6,1FE1 1FN 1PH, 1LA Third–party: if suitable	PROFIBUS DP; Terminals; RS 232/ 485
SIMODRIVE 611 universal	1–axis pos.	1	Resolver	SRM: 1FT6,1FK6,1FE1 ARM: 1PH,1LA SLM: 1FM	PROFIBUS–DP; Terminals; RS 232/ 485
SIMODRIVE 611 universal	2–axis n–set	2	Resolver	SRM: 1FT6,1FK6,1FE1 ARM: 1PH,1LA SLM: 1FM Third–party: if suitable	PROFIBUS–DP; Terminals; RS 232/ 485
SIMODRIVE 611 universal	2–axis pos	2	Resolver	SRM: 1FT6,1FK6,1FE1 ARM: 1PH,1LA SLM: 1FM	PROFIBUS–DP; Terminals; RS 232/ 485
SIMODRIVE 611 universal	2–axis n–set	2	Incremental encoder sin/cos 1 V_{pp} absolute value encoder	SRM: 1FT6,1FK6,1FE1 ARM: 1PH,1LA SLM: 1FM Third–party: if suitable	PROFIBUS–DP; Terminals; RS 232/ 485
SIMODRIVE 611 universal	2–axis pos	2	Incremental encoder sin/cos 1 V_{pp} absolute value encoder	SRM: 1FT6,1FK6,1FE1 ARM: 1PH,1LA SLM: 1FM Third–party: if suitable	PROFIBUS–DP; Terminals; RS 232/ 485
SIMODRIVE 611 universal E		2	Incremental encoder sin/cos 1 V_{pp} absolute value encoder	SRM: 1FT6,1FK6,1FE1 ARM: 1PH,1LA SLM: 1FM Third–party: if suitable	PROFIBUS–DP; Terminals; RS 232
SIMODRIVE 611 with analog setpoint interface for feed drives	Standard interface	2		SRM: 1FT5	
SIMODRIVE 611 with analog setpoint interface for feed drives	User–friendly interface	1		SRM: 1FT5	
SIMODRIVE 611 with analog setpoint interface for feed drives	User–friendly interface	2		SRM: 1FT5	

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Table 5-1 Overview of control modules

Control board	Version	Axes	Motor encoder	Motors1)	Optional interfaces
SIMODRIVE 611 with analog setpoint interface for feed drives		1	Resolver	SRM: 1FK6, 1FT6	
SIMODRIVE 611 with analog setpoint interface for feed drives		2	Resolver	SRM: 1FK6, 1FT6	
SIMODRIVE 611 with analog setpoint interface for main spindle drives			Incremental encoder sin/cos 1 V_{pp} SIZAG 2	ARM: 1PH	
SIMODRIVE 611 with analog setpoint interface for induction motors				ARM	RS 232 C
SIMODRIVE 611 with digital setpoint interface for FD and MSD	Performance control	1	Incremental encoder sin/cos 1 V_{pp}, EnDat, SSI (from SW 5.1.9)	SRM: 1FT6,1FK6,1FE1 ARM: 1PH SLM: 1FN1, 1FN3 Third–party: if suitable	
SIMODRIVE 611 with digital setpoint interface for FD	Performance control	2	Incremental encoder sin/cos 1 V_{pp}, EnDat, SSI (from SW 5.1.9)	SRM: 1FT6,1FK6,1FE1 ARM: 1PH SLM: 1FN1, 1FN3 Third–party: if suitable	
SIMODRIVE 611 with digital setpoint interface for FD and MSD	Standard 2 control	2	Incremental encoder sin/cos 1 V_{pp}, EnDat	SRM: 1FT6,1FK6,1FE1 ARM: 1PH2/–4/–6/–7 SLM: 1FN1, 1FN3 Third–party: if suitable	
SIMODRIVE 611 with digital setpoint interface for hydraulic/analog linear drives HLA/ANA		2	Incremental encoder sin/cos 1 V_{pp}, EnDat, SSI (from SW 1.2.4)	Hydraulic linear axes	

1) SRM: Rotating synchronous motor
ARM: Rotating induction motor
SLM: Synchronous linear motor
Third–party: Third–party motor

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5.1 Feed control with user–friendly and analog setpoint interface 6SN1118–0AA11–0AA1

A control module with user–friendly interface is available when using1FT5... motors. It is only available as 1–axis version. An additional **parameter board** is required, which can be used to set all of the axis–specific settings. It can be inserted from the front.

This control board can be optionally expanded with the **main spindle function option board** to be able to handle the requirements of main spindle operation.

Feed control with user–friendly interface

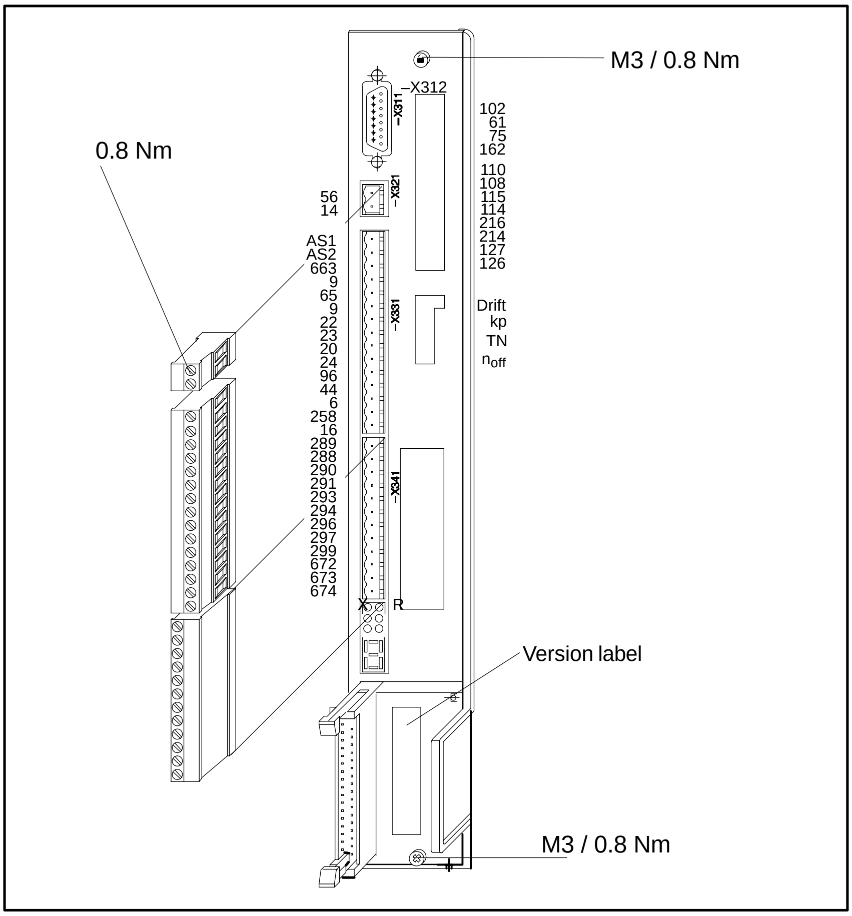

Fig. 5-1 Feed control with user–friendly interface

Note

When using non–PELV circuits at terminals AS1, AS2, connector coding must be used so that the connectors cannot be interchanged (refer to EN60204–1, Section 6.4).
Order No. of the coding, refer to Catalog NC 60.

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5.1.1 Function overview and settings using the parameter board 6SN1114–0AA01–0AA1

Table 5-2 Function overview and settings using the 6SN1114–0AA01–0AA1 parameter module

Parameter	Value range	Setting elements
Speed controller Integral action time Proportional gain Adaptation: • Integral action time • Proportional gain • Adaptation range	 T_N = 7...43 ms Kp = 2...150 T_{Nadap}/T_N = 0.04...1 Kp_{adap}/Kp = 4...35 $n_{x2} - n_{x1}$ = 0 – 0...(65 – 330) mV	 Front panel potentiometer T_N, additionally C2 Front panel potentiometer Kp, additionally R50 R34 and front panel potentiom. ADAP R38 R40
Drift compensation (offset)	–30...+30 mV (referred to n_{set})	Front potentiometer, drift
Direction of rotation reversal	Clockwise/counter–clockwise rotation for pos. n_{set}	S2.1
Tachometer adaptation	$V_{tach.}$ = 40...15 V/n_{rated}	Switch S1; additionally R6, R7, R8
Tachometer adjustment	n_{actN} = 2.2...0.7 · n_{act} (n_{act} = 10 V/n_{rated})	Front panel potentiometer tachometer; additionally R3 and R10
Speed setpoint adaptation (speed reduction)	$\lvert 100\ \% \cdot 11...5\ V \rvert = n_{actN}$ or $10\ V = \frac{n_{actN}}{1...100}$ (only term.56/14)	R5
Inhibit I component	Speed controller without I component	Terminal 6
Limit I component, speed controller	I component fully effective ... ineffective	R52
Current controller Adaptation motor/power module Current actual value normalization Current controller gain	 I_{max} = 23...100 % · I_{limit} Kp(I) = 0.5...11.5;	 S2.2....S2.5 S2.6...S2.9; additionally R15, if K_p (I) > 11.5
Current setpoint adaptation	$\lvert I_{max} \rvert$= 10...0 V	R42
Inhibit I component in current–controlled operation	Current controller without I component	R1
Select current–controlled operation	offline online via terminal 22	S2.10 R14
Master/slave operation	Up to 5 slave modules	Terminals 258, S2.10, R42, R44
Response threshold, I^2t limiting, reduction	6...55 % · I_{limit}	R9
Monitoring time, speed controller at its endstop	26...1200 ms	R54
Monitoring, speed controller at its endstop	ON ↔ OFF	R32
External current setpoint limiting (e. g. travel to endstop)	1...100 % · I_{max} speed controller monitoring OFF	Terminal 96 (variable); R12 (fixed)
Current limiting after the monitoring time, speed controller at its endstop	1...100 % · I_{max}	R2, R32
Current limiting after the I^2t timer has expired	Refer to I^2t limiting in the Start–up Guide	R2/R32
Torque limiting for setting–up operation via terminal 112 (NE module)	1...100 % · I_{max} speed controller monitoring OFF	R12
Electrical weight equalization	$\lvert I_{set,\ suppl.} \rvert$= 0...50 % · I_{max}	R46/R48

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Table 5-2 (Fortsetzung)Function overview and settings using the 6SN1114–0AA01–0AA1 parameter module

Parameter	Value range	Setting elements
Instantaneous controller/pulse inhibit via terminal 65	Delayed after the speed controller monitoring time has expired ↔ instantaneous	R13
Selection: int. supplementary setpoint 1 through terminal 22 Selection: int. supplementary setpoint 2 through terminal 23	10 V...+10 V 10 V...+10 V	R16, R17, R18=setpoint R19, R21, R22=setpoint
Ready/fault signal at terminals 672/673/674		R33
Smoothing: Speed setpoint Speed actual value Speed controller Current setpoint	 T = C4 · 10 kΩ T = C5 · 5 kΩ T = C3 · 68 kΩ T = C6 · 1 kΩ	 C4 C5 C3 C6

5

5.1.2 Interface overview, feed control, user–friendly interface

Table 5-3 Interface overview, feed control, user–friendly interface

Term. No.	Desig.	Function	Type 1)	Typ. voltage/limit values	Max. cross–sect.
56 14	X321 X321	Speed setpoint 1 Differential input 2)	I I	0 V... ± 10 V	1.5 mm^2 1.5 mm^2
AS1 AS2	X331 X331	Checkback signal contact Relay, start inhibit	NC	max. 250 V_{AC}/1 A, 30 V_{DC}/2 A	1.5 mm^2 1.5 mm^2
663 9 65 9 22 23	X331 X331 X331 X331 X331 X331	Pulse enable 3) Enable voltage 3)6) Controller enable 3) Enable voltage 3)6) Select int. fixed setpoint 1 3)/ current–controlled operation Select int. fixed setpoint 2 3)	I O I O I I	+21...30 V +24 V +13...30 V +24 V +13...30 V +13...30 V	1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2
20 24	X331 X331	Speed setpoint 2)/ current setpoint (differential input)	I I	0 V...±10 V (340 µs smoothing)	1.5 mm^2 1.5 mm^2
96 5) 44 5) 6 5) 258 5) 16 5)	X331 X331 X331 X331 X331	Current setpoint limiting Electronics voltage Integrator inhibit, speed controller Current setpoint (master/slave) Norm. current actual value	I O I I/O O	0...±30 V –15 V/10 mA +13...30 V 0 V...±10 V 0 V...±10 V	1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2

1) I=input; O=output; NC=NC contact; NO=NO contact (for signal NO=high/NC=low)
2) Differential input reference point
The common mode range of the differential input is ±24 V with respect to PE potential and may not be exceeded.
3) Reference ground, terminal 19 NE/monitoring module (this may not be connected with the general reference ground, terminal 15)
4) Voltages referred to PE potential
5) Terminal 15 on the NE module is the reference ground
6) Refer to Section 6.3

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Table 5-3 Interface overview, feed control, user–friendly interface

Term. No.	Desig.	Function	Type 1)	Typ. voltage/limit values	Max. cross–sect.
289	X341	Relay signals, center contact	I	4)	1.5 mm^2
288	X341	Speed controller at its endstop	NO	Max. 30 V/1 A	1.5 mm^2
290	X341		NC	Max. 30 V/1 A	1.5 mm^2
291	X341	I^2t monitoring	NO	Max. 30 V/1 A	1.5 mm^2
293	X341		NC	Max. 30 V/1 A	1.5 mm^2
294	X341	Motor overtemperature	NO	Max. 30 V/1 A	1.5 mm^2
296	X341		NC	Max. 30 V/1 A	1.5 mm^2
297	X341	Tachometer/rotor position encoder fault	NO	Max. 30 V/1 A	1.5 mm^2
299	X341		NC	Max. 30 V/1 A	1.5 mm^2
672	X341	Ready/fault signal	NO	30 V/1 A 4)	1.5 mm^2
673	X341		I	30 V/1 A	1.5 mm^2
674	X341		NC	30 V/1 A	1.5 mm^2
	X311	Motor encoder			
	X151	Equipment bus			

1) I=input; O=output; NC=NC contact; NO=NO contact (for signal NO=high/NC=low)
2) Differential input reference point
The common mode range of the differential input is ±24 V with respect to PE potential and may not be exceeded.
3) Reference ground, terminal 19 NE/monitoring module (this may not be connected with the general reference ground, terminal 15)
4) Voltages referred to PE potential
5) Terminal 15 on the NE module is the reference ground
6) Refer to Section 6.3

Note

The drive shuts down and the pulses inhibited after approx. 4 s when the "heat-sink overtemperature" switch responds.

Evaluation of the motor PTC thermistor for temperature monitoring

The SIMODRIVE 611 feed modules with closed–loop control for the 1FT5 servomotors have an evaluation circuit, for the PTC thermistor integrated in the motor winding.

The motors should be protected from inadmissibly high winding temperatures using the monitoring combination (release temperature 150°C).

When the response temperature is reached, it is only signaled at the SIMODRIVE 611 via an individual fault signal, terminals 289/294/296 and centrally via terminals 5.1, 5.2 and 5.3 of the feed module as the drive should not intervene directly in the machining process and disturb operation.

There is no internal system shutdown function to protect the motor. **The user must ensure that the motor can thermally recover immediately after the temperature signal is output, by appropriately designing the adaptation control.** It may be necessary to shut down the motor immediately.

A delay time is not permissible.

If the motor is not thermally monitored, then the complete drive could be destroyed if an overload condition occurs, or if the drive converter was over–dimensioned.

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5.1.3 Option module, main spindle functions 6SN1114–0AA02–0AA0

Main spindle functions can also be realized using an option board (main spindle drive option). In this case, the option board should be mounted on the control board (this is only possible in conjunction with the user–friendly interface).

Installing the MSD option

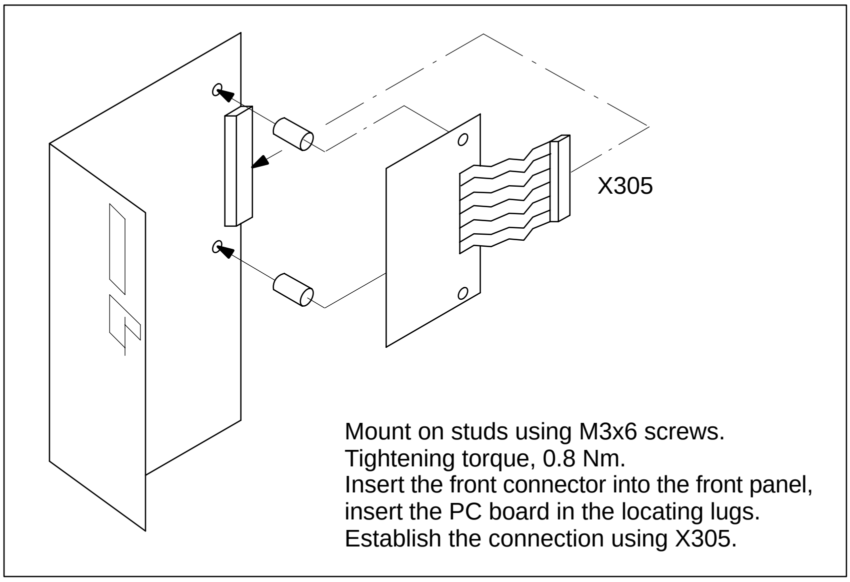

Fig. 5-2 Option board

Function overview and settings on the MSD option

Table 5-4 Function overview and settings on the MSD option

Parameter	Value range	Setting elements
Limit value stages NC/NO	The relay outputs of the limit value stages can be defined as NC or NO contacts	0 Ω resistors
$\|I_{act}\| > I_X$ term. 110/108	4.5 %...100 %	Pot. R211
$\| n_{act}\| < n_{min}$ term. 115/114	0.3 %...1.7 % of n_{max}	Pot. R10
$\| n_{act}\| < n_X$ term.216/214	3 %...100 % of n_{max}	Pot. R43
$n_{set} = n_{set*}$ term. 127/126	n_{set} difference< 20 mV	Resistor R179
$n < n_{off}$	0.3 %...1.7 % of n_{max}	Pot. R1
Ramp–function generator via terminals 56/14	10 ms...1.1 s 0.1 s...11 s (changeover 1:10)	Potentiometer R20 terminal 102
Tracking	Active/inactive	R270
Drift (main spindle drive operation)	–30 mV...+30 mV (referred to n_{set})	Pot. R96
Proportional gain	Reduce Kp to 0 %...95 %	Pot. R45 + parameter board R25
Integral action time	Extend T_N to 100 %...1500 %	Pot. R44 + parameter board R35

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Table 5-4 Function overview and settings on the MSD option

Parameter	Value range	Setting elements
Torque limiting	Start of constant power 23 %...70 % n_{max} Deviation –20 %...+20 % n_{max} Constant limiting 10 %...100 % I_{max} Speed–dependent limiting 1 %...85 % I_{max}	Pot. R214 Pot. R213 Resistor R76 Pot. R225
Changeover speed MSD C–axis operation	0 %...100 % n_{max}	Resistor R77, R78
Select C axis operation, terminal 61	10 V setpoint at term. 24/20 ≙ 1/10 n_{max} from MSD operation	
Speed actual value image	Normalized n_{rated} corresponds to +10 V	Terminal 75
Current actual value image	Normalized $\lvert I_{actN} \rvert$ = 10 V	Terminal 162 if R160 = 1 k, R207 = open
Power image	Factor 1...3	Resistor R903 Terminal 162 if R160 = open, R207 = 1 k

5.1.4 Interface overview, MSD option

Main spindle drive option (only for user–friendly interface)

Table 5-5 Interface overview, MSD option

Term. No.	Desig.	Function	Type 1)	Typ. voltage/limit values	Max. cross–sect.
102	X312	TH = 1:10	I	+13 V...30 V/R_E=1.5 kΩ	1.5 mm^2
61	X312	C–axis operation	I	+13 V...30 V/R_E=1.5 kΩ	1.5 mm^2
75	X312	n_{act}	O	0 V...±10 V	1.5 mm^2
162	X312	P_{act}/I_{act} 2)	O	0 V...±10 V	1.5 mm^2
110	X322	$\lvert I_{act}\rvert > I_X$	NO/	30 V/1.0 A max.	1.5 mm^2
108	X322		NC	30 V/1.0 A max.	1.5 mm^2
115	X322	$n < n_{min}$	I	30 V/1.0 A max.	1.5 mm^2
114	X322		NO/	30 V/1.0 A max.	1.5 mm^2
216	X322	$n < n_X$	NC	30 V/1.0 A max.	1.5 mm^2
214	X322		I	30 V/1.0 A max.	1.5 mm^2
127	X322	$n_{set} = n_{set*}$	NO/	30 V/1.0 A max.	1.5 mm^2
126	X322		NC	30 V/1.0 A max.	1.5 mm^2
			I		
			NO/		
			NC		
			I		

1) I=input; O=output; NC=NC contact; NO=NO contact (for signal NO=high/NC=low)
2) Depending on the equipping version, power image (series) or current actual value image

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5.2 Feed control with standard interface and analog setpoint interface 6SN1118–0A_11–0AA1

Feed control with standard interface

For operating motors 1FT5... a control module with standard interface is also available. It is available as 1 and 2–axis version. All of the axis–specific settings are made on the plug–in control module.

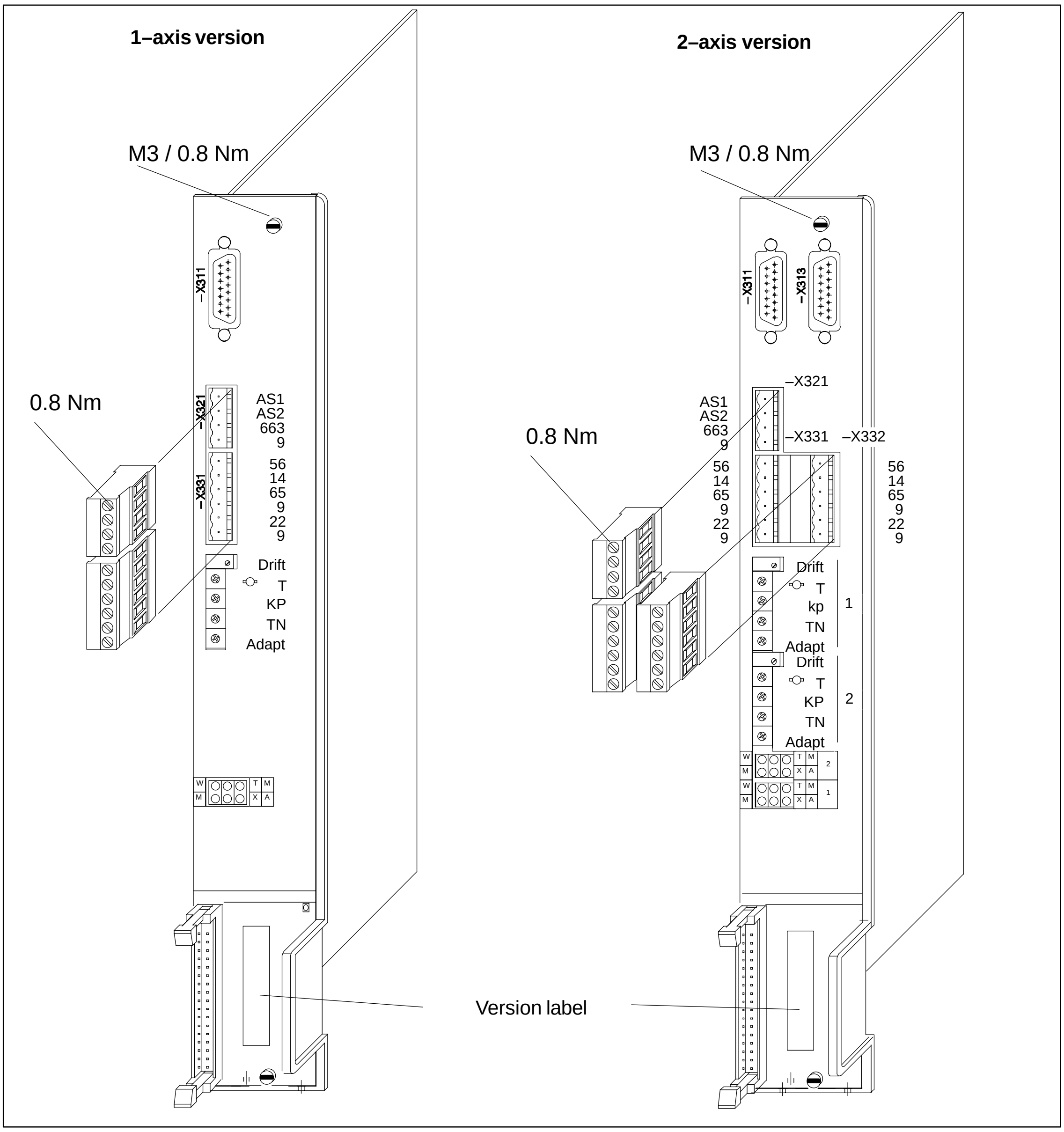

Fig. 5-3 Feed control with standard interface

Note

When using non–PELV circuits at terminals AS1, AS2, connector coding must be used so that the connectors cannot be interchanged (refer to EN60204–1, Section 6.4).
Order No. of the coding connector, refer to Catalog NC 60.

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5.2.1 Function overview and settings on the control module

Table 5-6 Function overview and settings on the control module

Parameter	Value range	Setting elements		
Speed controller Integral action time Proportional gain Adaptation, integral action time	 T_N = 7 ... 43 ms Kp = 2 ... 150 T_{Nadap} / T_N = 0.04 ... 1	 Front potentiometer T_N Front potentiometer Kp S3.5 (axis 2:S6.5), Front potentiometer ADAP		
Drift compensation (offset)	–30 ... +30 mV (referred to n_{set})	Front potentiometer, drift		
Direction of rotation reversal	Clockwise/counter–clockwise rotation	S2.1 (axis 2:S5.1)		
Tachometer adaptation	$V_{tach.}$ = 40 ... 15 V/n_{rated}	Switch S1 (axis 2:S4)		
Tachometer adjustment	n_{actN} = 2.2 ... 0.7•n_{act} (n_{act} = 10 V/n_{rated})	Front potentiometer, tachometer		
Current controller Current actual value normalization Current controller gain	 I_{max} = 23 ... 100 %•I_{limit} LT Kp(I) = 0.5 ... 11.5;	 S2.2 ... S2.5 (axis 2:S5.2 ... 5.5) S2.6 ... S2.9 (axis 2:S5.6 ... 5.9)		
Inhibit I component in current–controlled operation	Current controller without I component	S3.8 (axis 2:S6.8)		
Select current–controlled operation	Offline online via terminal 22	S2.10 (axis 2:S5.10)		
Supplementary functions				
Master/slave mode (only 2–axis version)	Master and slave in one module	S3.7 and S6.7		
Central ready/ fault signal at terminals 72/73/74 NE/monitoring module	Relay signal for ready/ no fault	S3.6 (axis 2:S6.6)		
Smoothing:	Can be permanently switched–in	Can be permanently switched–in	Variable BKZ axis 1	 BKZ axis 2
Speed setpoint	T = 2.2 ms	S3.1 (axis 2:S6.1)	C232	C236
Speed actual value	T = 280 µs	S3.2 (axis 2:S6.2)	C233	C237
Speed controller	T = 370 µs	S3.3 (axis 2:S6.3)	C231	C235
Current setpoint	T = 110 µs	S3.4 (axis 2:S6.4)	C234	C238
Valid from Order No.: 6SN1118–0A□11–0AA1	Timer stage "speed controller at endstop" Tachometer adaptation Adaptation range Speed setpoint adaptation Limiting, I component, speed controller Electronic weight equalization, pos./neg. Response threshold I^2t monitoring	C239 R539, R540, R541 R543 R545 R547 R548/R549 R553	C240 R536, R537, R538 R544 R546 R550 R551/R552 R554	

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5.2.2 Interface overview, feed control, standard interface

Table 5-7 Interface overview, feed control, standard interface

Term. No.	Desig.	Function	Type 1)	Typ. voltage/limit values	Max. cross–sect.
AS1	X321	Checkback signal contact	NC	max. 250V_{AC}/1A, 30V_{DC}/2A	1.5 mm^2
AS2	X321	Relay, start inhibit			1.5 mm^2
663	X321	Pulse enable 2)	I	+21 ... 3o V	1.5 mm^2
9	X321	Enable voltage 2)4)	O	+24 V	1.5 mm^2
56.1	X331	Speed setpoint	I	0 V ... ± 10 V	1.5 mm^2
14.1	X331	Differential input 3)	I		1.5 mm^2
65.1	X331	Controller enable 2)	I	+13 ... 30 V	1.5 mm^2
9	X331	Enable voltage 2)4)	O	+24 V	1.5 mm^2
22.1	X331	Current–controlled operation 2)	I	+13 ... 30 V	1.5 mm^2
9	X331	Enable voltage 2)4)	O	+24 V	1.5 mm^2
56.2	X332	Speed setpoint	I	0 V ... ± 10 V	1.5 mm^2
14.2	X332	Differential input 3)	I		1.5 mm^2
65.2	X332	Controller enable 2)	I	+13 ... 30 V	1.5 mm^2
9	X332	Enable voltage 2)4)	O	+24 V	1.5 mm^2
22.2	X332	Current–controlled operation 2)	I	+13 ... 30 V	1.5 mm^2
9	X332	Enable voltage 2)4)	O	+24 V	1.5 mm^2
	X311	Motor encoder, axis 1			
	X313	Motor encoder, axis 2			
	X151/351	Equipment bus			

1) I=input; O=output; NC=NC contact; NO=NO contact (for signal: Closed=high, open=low)
2) Reference ground, term. 19 NE/monitoring module (this may not be connected to the general reference ground, term. 15)
3) Reference point of the differential input.
The common mode range of the differential input is ±24 V with respect to PE potential and may not be exceeded.
4) Refer to Section 6.4

Note

The drive shuts down and the pulses inhibited after approx. 4 s when the ”heatsink overtemperature” switch responds.

Motor PTC thermistor evaluation for temperature monitoring

The SIMODRIVE 611 feed modules with the control for 1FT5 servomotors are equipped with an evaluation circuit for the PTC thermistor integrated in the motor windings.

The motors should be protected from inadmissibly high winding temperatures using the monitoring combination (trigger temperature, 150°C).

As the drive shouldn't unpredictably intervene in the cutting process, when the response temperature is reached, this is only signaled to the SIMODRIVE 611, centrally via terminals 5.1, 5.2, and 5.3 of the rectifier module.

There is no internal system shutdown function to protect the motor.**The user must ensure that the motor can thermally recover immediately after the signal output, by appropriately designing the adaptation control. It may be necessary to shutdown the motor immediately.**

A delay time is not permissible.

If the motor is not thermally monitored, then the complete drive could be destroyed if an overload condition occurs, or if the drive converter was over–dimensioned.

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5.3 Resolver control with standard and analog interface 6SN1118–0B_11–0AA0

Resolver control with standard interface

For 1FK6 and 1FT6 motors with resolvers, a control module is available which includes incremental shaft encoder interface with TTL signal output for external processing. This is available as 1–axis and 2–axis versions. All of the axis–specific settings are made on the control board.

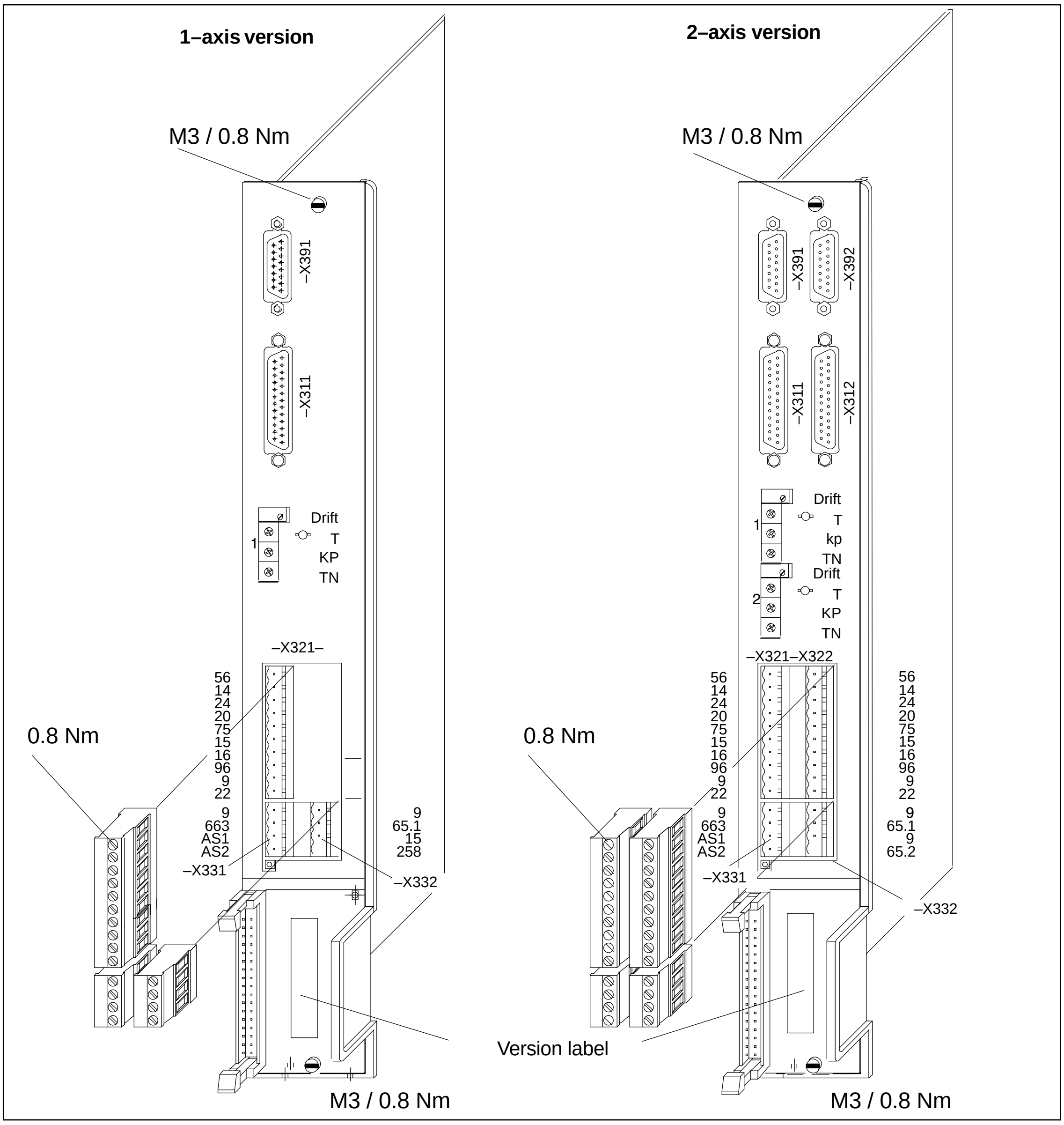

Fig. 5-4 Resolver control with standard interface and analog interface

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Note

When using non–PELV circuits at terminals AS1, AS2, connector coding must be used so that the connectors cannot be interchanged (refer to EN60204–1, Section 6.4).
Order No. of the coding, refer to Catalog NC 60.

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5.3.1 Function overview and settings

Table 5-8 Function overview and settings

Parameter	Value range	Setting elements
Position processing Pole pair number, motor Pole pair number, resolver Phase sequence of tracks A, B of the WSG interface Pulse number of the WSG interface Zero mark offset	 p = 1, 2, 3, 4 p = 1, 2, 3, 4 A before B, B before A for the same direction of rotation 512 pulses/revolution or 1024 pulses/revolution Shifted through 180° mechanical Shifted through 90° mechanical Shifted through 45° mechanical Shifted through 22.5° mechanical Shifted through 11.25° mechanical Shifted through 5.625° mechanical	 DIL switch S1/S2 1) DIL switch S1/S2 1) DIL switch S1/S2 1) DIL switch S1/S2 1) DIL switch S11 DIL switch S11 DIL switch S11 DIL switch S11 DIL switch S11 DIL switch S1/S2 1)
Current controller I_{act} normalization Current controller gain	 70 % or 100 % of I_{limit} LT Setting according to Table in the Start–up Guide, depending on the motor/power module combination	 DIL switch S3/S6 1) DIL switch S3/S6 1)
Current setpoint limiting Proportion of the limit. current	Can be adjusted in steps 100 %, 75 %, 55 %, 45 %, 25 %, 20 %, 5 %	DIL switch S12
Speed normalization Speed actual value normalization Speed actual value calibration	2000 RPM, 3000 RPM, 6000 RPM Setting acc. to the Table in the Installation Guide Value ranges, refer to SIMODRIVE 611, Installation Guide	 DIL switch S4 Pot. R105/R106 1)
Speed controller Drift adjustment Proportional gain Integral action time	 –45 mV ... +45 mV 2.5 ... 95 3 ms ... 40 ms	 Pot. R129/R130 1) Pot. R64/R65 1) Pot. R107/R108 1)
Other functions Integrator inhibit, speed controller Integrator inhibit, current controller2) in closed–loop current–controlled operation Fault signal Master/slave operation timer, terminal 65	 Enable/inhibit Enable/inhibit Changeover, ready/fault signal 2nd axis as slave 300 ms, 1 s	 DIL switch S5 DIL switch S5 DIL switch S5 DIL switch S5 DIL switch S5
LED	Display, ready or fault	DIL switch S5
Adaptation using components Smoothing: speed setpoint speed actual value speed controller T_N limit. in the speed controller Weight equalization, pos.,neg.	For difficult operating conditions, adaptation is realized by soldering components on the board (SMD components). Value range/characteristics, refer to SIMODRIVE 611, Installation Guide	Position of the components, refer to SIMODRIVE 611, Installation Guide C135/C148 1) C143/C149 1) C134/C147 1) R448/R454 1) R349/R348, R356/R355 1)

1) 1st axis / 2nd axis
2) Only effective for closed–loop current controlled operation; the integrator of the current controller is always disabled in closed–loop speed controlled operation.

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5.3.2 Interface overview, resolver control

Table 5-9 Interface overview, resolver control

Term. No.	Desig.2)	Function	Type 1)	Typ. voltage/limit values	Max. cross–sect.
56	X321/322	Speed setpoint	I	0 V ... ±10 V	1.5 mm^2
14	X321/322	Differential input	I		1.5 mm^2
24	X321/322	Speed/current setpoint	I	0 V ... ±10 V	1.5 mm^2
20	X321/322	Differential input	I		1.5 mm^2
75	X321/322	Speed actual value	O	0 V ... ±10 V	1.5 mm^2
15	X321/322	Reference potential	O	0 V	1.5 mm^2
16	X321/322	Active current actual value	O	0 V ... ±10 V	1.5 mm^2
96	X321/322	Current setpoint limiting on	I	+13 V ... 30 V	1.5 mm^2
9	X321/322	Enable potential4)	O	+24 V	1.5 mm^2
22	X321/322	Changeover, closed–loop speed/current control	I	+13 V ... 30 V	1.5 mm^2
9	X331	Enable potential	O	+24 V	1.5 mm^2
663	X331	Pulse enable	I	+21 V ... 33 V	1.5 mm^2
AS1	X331	Relay, start inhibit	NC	max. $250V_{AC}$/1A	1.5 mm^2
AS2	X331	Relay, start inhibit		max. $30V_{DC}$/2A	1.5 mm^2
9	X332	Enable potential4)	O	+24 V	1.5 mm^2
65.1	X332	Controller enable, axis 1	I	+13 V ... 30 V	1.5 mm^2
9	X332	Enable potential3)4)	O	+24 V	1.5 mm^2
65.2	X332	Controller enable, axis 2 3)	I	+13 V ... 30 V	1.5 mm^2
	X391	WSG interface, axis 1			
	X392	WSG interface, axis 2			
	X311	Motor encoder, axis 1			
	X312	Motor encoder, axis 2			
	X151/351	Equipment bus			
For the 1–axis version, X332 is assigned as follows:					
9	X332	Enable potential	O	+24 V	1.5 mm^2
65.1	X332	Controller enable	I	+13 V ... 30 V	1.5 mm^2
15	X332	Reference potential	O	0 V	1.5 mm^2
258	X332	Current setpoint	O	0 V ... ±10 V	1.5 mm^2

1) I=input; O=output; NC=NC contact; NO=NO contact (for signal: Closed=high, open=low)
2) X321=1. axis, X322=2nd axis
3) Only for the 2–axis version
4) Refer to Section 6.4

Note

The drive shuts down and the pulses inhibited after approx. 4 s when the ”heat-sink overtemperature” switch responds.

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Evaluation, motor PTC thermistor for temperature monitoring

The SIMODRIVE 611 feed modules with control for 1FT6 and 1FK6 servomotors with resolver, have an evaluation circuit for the PTC resistor integrated in the motor winding.

The motors should be protected from inadmissibly high winding temperatures using the monitoring combination (trigger temperature 150°C).

As the drive shouldn't unpredictably intervene in the cutting process, when the response temperature is reached, this is only signaled to the SIMODRIVE 611, centrally via terminals 5.1, 5.2, and 5.3 of the rectifier module.

There is no internal system shutdown function to protect the motor. **The user must ensure that the motor can thermally recover immediately after the temperature signal is output, by appropriately designing the adaptation control.** It may be necessary to shut down the motor immediately.

A delay time is not permissible.

If the motor is not thermally monitored, then the complete drive could be destroyed if an overload condition occurs, or if the drive converter was over–dimensioned.

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5.4 Main spindle control with analog setpoint interface 6SN1121–0BA1_–0AA_

The control components are available for 1PH induction motors with optical rotary encoders or inductive toothed–wheel encoders (Order No.: 6SN1121–0BA11–0AA**1**).

The following interface X432 can be used either as spindle encoder input for positioning, or as WSG interface (rotary position output to the NC).

Main spindle control with analog setpoint interface

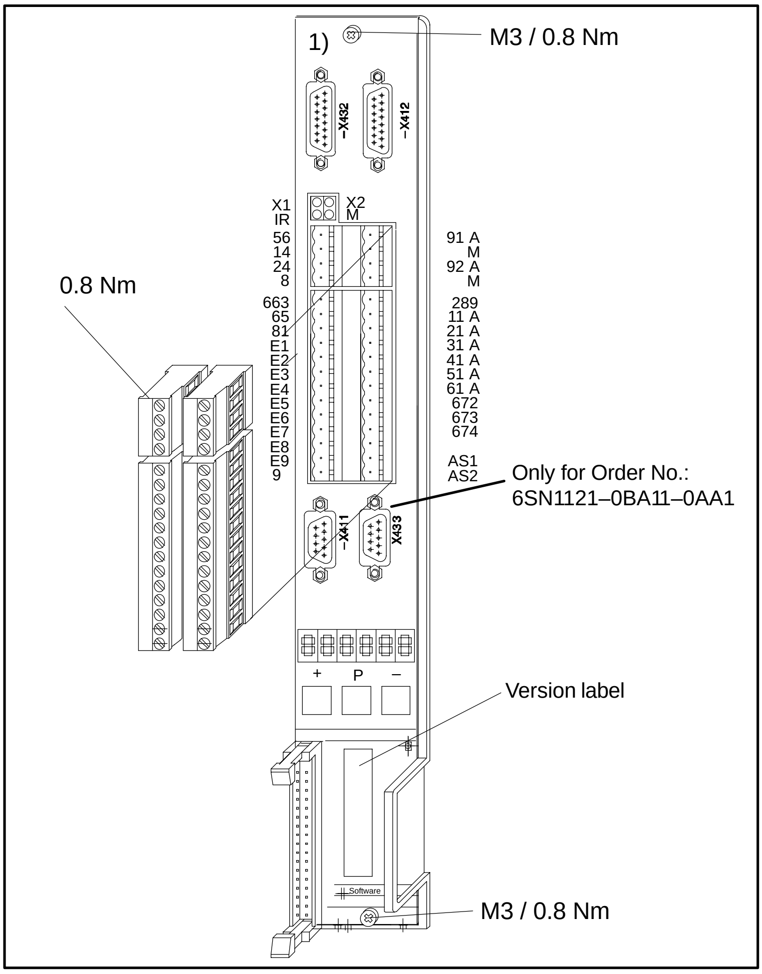

Fig. 5-5 Main spindle control with analog setpoint interface

Note

When using non–PELV circuits at terminals AS1, AS2, connector coding must be used so that the connectors cannot be interchanged (refer to EN60204–1, Section 6.4).
Order No. of the coding, refer to Catalog NC 60.

Only PELV circuits may be connected at connector X432 pin 15 or X433 pin 3 (FR–).

---

1) Interface X432 can either be used as spindle encoder input for positioning or as WSG interface (rotor position output to the NC).

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5.4.1 Select terminal functions

The select input terminals E1 to E9 (max. 9) are freely–programmable. A control parameter is assigned to each select terminal, in which the code number of the selected function is entered.

Table 5-10 Select terminal functions

Select terminal	Function
2nd torque limit value	When selected, if a speed, which can be parameterized, is exceeded, the 2nd torque limit is activated when a speed, which is parameterized, is exceeded.
Oscillation	2 internal speed setpoints, where the frequency and speed can be adjusted, are generated.
Reset fault memory (reset) 1)	Acknowledges a fault/error message after the cause has been removed. *Note: Terminal 65 (controller enable) must be open.*
Open–loop torque controlled operation 1)	The analog setpoint is interpreted as torque setpoint in this mode. (This function is required for master–slave drives)
Open–loop torque controlled operation with slip monitoring	Open–loop torque controlled operation with slip monitoring
Star–delta operation	When the signal changes, the motor data sets are also changed and a change-over made from the star to the delta winding configuration using control commands. *Note: This function can only be used for motors with star/delta windings.*
M19 operation	NC auxiliary function for oriented spindle stop. When selected, and if a speed, which can be parameterized, is fallen below, a finer speed setpoint normalization is selected.
Ramp–time = 0	If the enable voltage is connected to this terminal, the ramp–function generator is bypassed.
Integrator inhibit, speed controller 1)	The integral component of the PI speed controller is inhibited using this terminal.
Gearbox stage (max. 3 terminals)	A total of 8 parameter sets for setpoint normalization, speed monitoring, controller setting, torque limiting and torque monitoring can be entered using these terminals.
Setpoint enable	Terminal open–circuit: Digital zero setpoint Terminal selected: The setpoint is enabled (analog setpoint or oscillation setpoint)
Positioning on	When selected, the internal closed–loop position control is selected and the spindle is moved into the required position.
Position reference value 1–4 (max. 2 terminals)	Using these terminals, a total of 4 parameterizable position reference values can be entered.
Incremental positioning	When selected, the spindle moves from the actual position–controlled position through a specified position difference.
Spindle re–synchronization	The spindle is re–referenced: This is necessary after every mechanical gearbox stage changeover.
C axis	Changeover to a finer C–axis setpoint normalization. *Note: Only setpoint input 2 (terminal 24–8) is evaluated.*
HPC axis 1)	Changeover to **H**igh **P**recision **C** axis mode; i.e. finer setpoint normalization and higher speed control loop dynamic performance with a lower functional scope (only E1 to E6 are evaluated). *Note: Only setpoint input 2 (terminal 24–8) is evaluated.*
Speed setpoint smoothing 1)	The speed setpoint smoothing is activated with a time constant, which can be parameterized.
Suppress fault 11 1)	Fault message 11 is suppressed (speed controller at its limit) for the function ”travel to endstop”.
Inverter clock frequency changeover 1)	It is possible to select different inverter clock frequencies using the select terminals.

1) Only these terminal functions are available in the HPC axis mode.

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5.4.2 Select relay functions/signals

The select relay terminals A11 to A61 (max. 6) can be freely programmed.
A control parameter is assigned to every select relay, in which the code number of the selected function is entered.

Table 5-11 Select relay functions/signals

Select relay	Function
n_{act}=n_{set} (ramp–up completed)	The relay pulls–in, if the ramp–up sequence has been completed after a setpoint step. The signal is **not** withdrawn as a result of speed fluctuations due to load surges.
n_{act}=n_{set} (actual)	The relay pulls–in, if the actual value lies within a tolerance bandwidth of the setpoint. Speed fluctuations due to load surges **can** cause the signal to be withdrawn.
$\|M_d\| < M_{dx}$	The relay pulls–in, if the actual torque of the threshold, which can be parameterized, is fallen below (this is suppressed during acceleration" after a time which can be parameterized).
$\|n_{act}\| < n_{min}$ 1)	The relay pulls–in, if the speed actual value falls below the threshold which can be parameterized.
$\|n_{act}\| < n_x$	The relay pulls–in, if the speed actual value falls below the threshold which can be parameterized.
Motor overtemperature pre–alarm 1)	The relay drops out for an overtemperature condition. If the temperature continues to increase, an additional fault signal is output and the pulses cancelled after a parameterizable time.
Heatsink overtemperature alarm 1)	The relay drops out, if the main heatsink temperature switch of the power module responds. **After 20 s the drive shuts down and a fault signal is output.**
Variable relay function (max. 2 terminals) 1)	Any of the control program variables can be monitored using this function.
In position 1	The relay pulls–in, if the spindle is within tolerance bandwidth 1 after positioning has been completed.
In position 2	The relay pulls–in, if the spindle is within tolerance bandwidth 2 after positioning has been completed.
Relay, star operation	An external auxiliary contactor can be controlled via this relay to changeover the winding into the star configuration.
Relay, delta operation	An external auxiliary contactor can be controlled via this relay to changeover the winding into the delta configuration.

1) The signals/messages are only available in the HPC–axis mode.

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5.4.3 Interface overview, main spindle control

Table 5-12 Interface overview, main spindle control

Term. No.	Desig.	Function	Type 1)	Typ. voltage/ limit values	Max. cross–sect.
56 14 24 8	X421 X421 X421 X421	Speed setpoint 1 5) Differential input 5) Speed setpoint 2 5) Differential input 5) (C axis or supplementary setpoint)	I I I I	0 V ... ±10 V max. 0.5 A 0 V ... ±10 V max. 0.5 A	1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2
A91 M A92 M	X451 X451 X451 X451	Analog input DA1 (n_{act}) Reference voltage for DA1 Analog input DA2 (utilization) Reference voltage for DA2	I I I I	–10 V ... +10 V max. 3 mA –10 V ... +10 V max. 3 mA	1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2
9 663 65	X431 X431 X431	Enable potential 6) Pulse enable Controller enable: To power–up the drives, in addition to terminal 65, terminals 663 and 81 must also be energized. If terminal 65 is opened, the motor brakes with the selected deceleration time (ramp–down time). The pulses are canceled when n_{min} is fallen below.	O I I	+24 V +21 V ... 30 V +13 V ... 30 V	1.5 mm^2 1.5 mm^2 1.5 mm^2
81	X431	Ramp–function generator fast stop: The motor brakes along the torque limit after terminal 81 has been opened. When n_{min} is fallen below, either the pulses are canceled, or the motor remains magnetized.	I	+13 V ... 30 V	1.5 mm^2
E1 to E9	X431	Freely–programmable select terminals	I	+13 V ... 30 V	1.5 mm^2
AS1 AS2	X441 X441	Relay, start inhibit (checkback signal, terminal 663) Relay, start inhibit (checkback signal, terminal 663)	NC	max.250V_{AC}/1A 30 V_{DC}/2 A	1.5 mm^2 1.5 mm^2
A11 to A61 289	X441 X441	Freely–programmable relay signals Relay contact supply	NO I	30 V_{DC}/1 A 30 V_{DC}/6 A	1.5 mm^2 1.5 mm^2
672 673 674	X441 X441 X441	Axis–specific signal Ready or no fault	NO I NC	30 V_{DC}/1 A 30 V_{DC}/1 A 30 V_{DC}/1 A	1.5 mm^2 1.5 mm^2 1.5 mm^2
RS 232C	X411	Serial interface for computer–supported start–up (start–up program)			D–Sub 9–pin
	X432	Spindle encoder input, BERO or motor encoder output2)3)			D–Sub 15–pin
	X433	BERO connection2)3)4)			D–Sub, 9 pin.
	X412	Motor encoder			D–Sub, 15 pin
	X151	Equipment bus			

1) I=input; O=output; NC=NC contact; NO=NO contact (for signal: Closed=high, open=low)
2) The BERO can either be connected to X433 or to X432.
3) X433 is only available for Order No.: 6SN1121–0BA11–0AA1.
4) BERO type: 3–conductor PNP NO contact, e.g. BERO M30 Order No.: 3RG4014–0AG01 or
BERO M12 Order No.: 3RG4012–3AG01
The BERO cable must be shielded.
5) The cable shields of setpoint cables must be connected at both ends.
6) The terminal may only be used to enable the associated drive group.

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5.5 Induction motor control with analog setpoint interface 6SN1122–0BA1_–0AA_

The following appropriate control components are available for standard induction motors without rotary encoder (Order No. 6SN1122–0BA11–0AA**1**).

Induction motor control

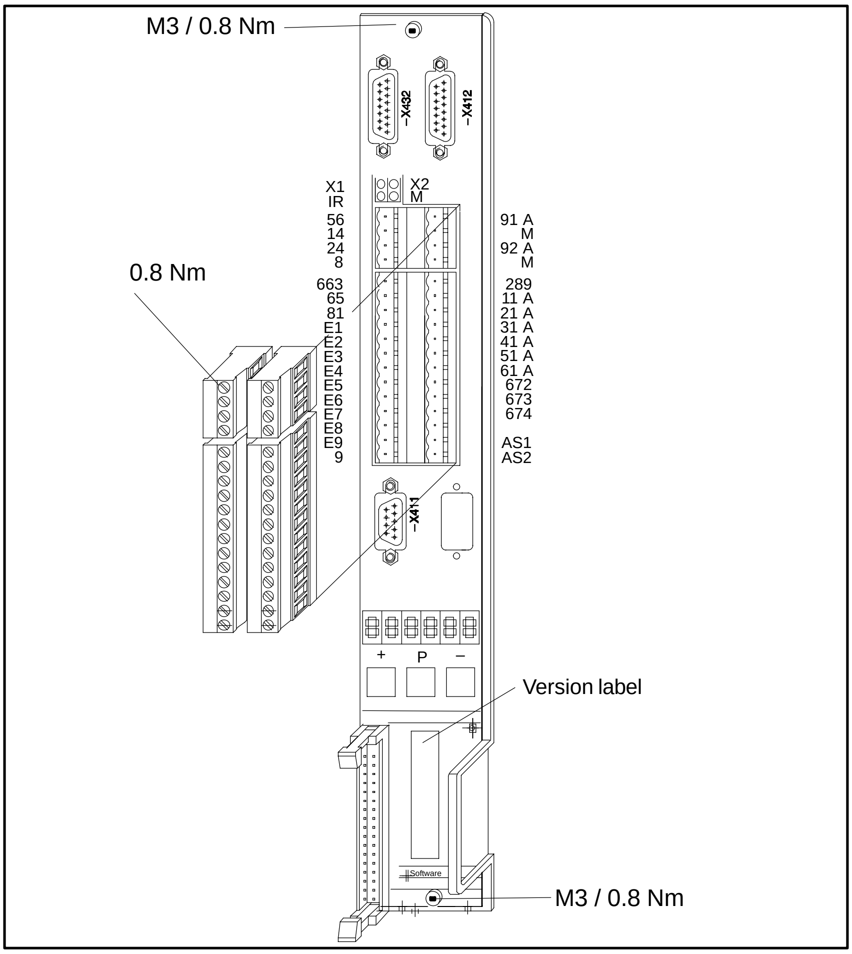

Fig. 5-6 Induction motor control

Note

When using non–PELV circuits at terminals AS1, AS2, connector coding must be used so that the connectors cannot be interchanged (refer to EN60204–1, Section 6.4).
Order No. of the coding, refer to Catalog NC 60.

Notice

Only PELV circuits may be connected at connector X432 pin15 (FR–).

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5.5.1 Select terminal functions

The select input terminals E1 to E9 (max. 9) are freely–programmable. A control parameter is assigned to each select terminal, in which the code number of the selected function is entered.

Table 5-13 Select terminal functions

Select terminal	Function
2nd torque limit value	When selected, if a speed, which can be parameterized, is exceeded, the 2nd torque limit is activated.
Oscillation	Generates an internal frequency setpoint with adjustable frequency and speed.
Reset fault memory (reset)	Acknowledges a fault/error message after the cause has been removed. *Note: Terminal 65 (controller enable) must be open.*
Ramp–function generator 1/2	When selected, a changeover is made from ramp–up/ramp–down time 1 to ramp–up/ramp–down time 2. The ramp–up/ramp–down times 1 and 2 can be separately entered for each of the maximum of four motor data sets.
Clockwise/counter–clockwise	Specifies the motor direction of rotation Terminal open: Clockwise phase sequence Terminal energized: Counter–clockwise rotating field *Note: Positive analog setpoint, 0 ... 10 V*
Increase setpoint Decrease setpoint	Motorized potentiometer function. Starting from an initial value which can be parameterized, the speed setpoint can be continuously adjusted using these two select terminals.
Ramp–time = 0	If the enable voltage is connected to this terminal, the ramp–function generator is bypassed.
Integrator inhibit, speed controller	Via this terminal, the integral component of the PI speed controller can be inhibited (I component=0ms).
Motor selection (max. 2 terminals)	A total of four different motor data sets can be selected using these terminals. Each data set is assigned the following parameters: Motor data, setpoint normalization, ramp–function generator, controller parameters, current and power limiting and frequency bandstop filter.
Gearbox stage (max. 3 terminals)	A total of 8 parameter sets for speed monitoring, torque limiting and torque monitoring can be entered using these terminals.
Setpoint enable	Terminal open–circuit: Digital zero setpoint Terminal selected: Setpoint enabled (analog setpoint or speed setpoint)
Fixed setpoint selection (max. 4 terminals)	A maximum of 16 speed setpoints can be selected. Setpoint 1 corresponds to the standard setpoint (analog setpoint and the internal setpoint); setpoints 2 to 16 are fixed setpoints which can be parameterized.

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5.5.2 Select relay functions/signals

The select relay terminals A11 to A61 (max. 6) can be freely programmed. A control parameter is assigned to every select relay, in which the code number of the selected function is entered.

Table 5-14 Select relay functions/signals

Select relay	Function
$n_{act}=n_{set}$ (ramp–up completed)	The relay pulls–in, if the ramp–up sequence has been completed after a setpoint step. The signal is **not** withdrawn as a result of speed fluctuations due to load surges.
$n_{act}=n_{set}$ (actual)	The relay pulls–in, if the actual value lies within a tolerance bandwidth of the setpoint. Speed fluctuations due to load surges **can** cause the signal to withdrawn.
$\|M_d\| < M_{dx}$	The relay pulls–in, if the actual torque falls–below the threshold which has been parameterized (this becomes active for "ramp–up completed" after a time which can be parameterized).
$\|n_{act}\| < n_{min}$	The relay pulls–in, if the speed actual value falls below the threshold which can be parameterized.
$\|n_{act}\| < n_x$	The relay pulls–in, if the speed actual value falls below the threshold which can be parameterized.
I^2t alarm	The relay drops out when the parameterized I^2t limit of the motor is exceeded.
Motor overtemperature alarm	The relay drops out for an overtemperature condition. If the temperature continues to increase, an additional fault message is output and the drive pulses are canceled after a parameterizable time.
Heatsink overtemperature, alarm	The relay drops out, if the main heatsink temperature switch of the power module responds. **After 20 s the drive shuts down and a fault signal is output.**
Variable relay function (max. 2 terminals)	Any control program variable can be monitored using this function.
Motor 1/2/3/4 active	The relay pulls–in, if motor 1/2/3/4 is active.

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5.5.3 Interface overview, induction motor control

Table 5-15 Interface overview, induction motor control

Term. No.	Desig.	Function	Type 1)	Typ. voltage/limit values	Max. cross–sect.
56 14	X421 X421	} Speed setpoint 1 Differential input	I I	0 V ... ±10 V	1.5 mm^2 1.5 mm^2
24 8	X421 X421	} Speed setpoint 2 Differential input (supplementary setpoint)[2]	I I	0 V ... ±10 V	1.5 mm^2 1.5 mm^2
A91 M A92 M	X451 X451 X451 X451	Analog output DA1 Reference voltage for DA1 Analog output DA2 Reference voltage for DA2 *Note: The analog output is only available with the appropriate control version.*	O I O I	–10 V ... +10 V max. 3 mA –10 V ... +10 V max. 3 mA	1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2
9	X431	Enable potential 5)	O	+24 V	1.5 mm^2
663	X431	Pulse enable: The relay ”start inhibit” is energized using terminal 663, and when it opens, the firing pulses are inhibited and the motor is switched to a torque–free condition.	I	+21 V ... 30 V	1.5 mm^2
65	X431	Controller enable: To power–up the drives, in addition to terminal 65, terminals 663 and 81 must also be energized. If terminal 65 is opened, the motor brakes with the selected deceleration time (ramp–down time). The pulses are canceled when n_{min} is reached.	I	+13 V ... 30 V	1.5 mm^2
81	X431	Ramp–function generator fast stop: The motor brakes along the torque limit after terminal 81 has been opened. The pulses are canceled, or the motor remains magnetized, when n_{min} is reached.	I	+13 V ... 30 V	1.5 mm^2
E1 to E9	X431	Freely–programmable select terminals	I	+13 V ... 30 V	1.5 mm^2
	X432	Connecting a BERO to monitor the maximum speed[3)4)]			D–Sub 15–pin
AS1 AS2	X441 X441	Relay, start inhibit (checkback signal, term. 663) Relay, start inhibit (checkback signal, term. 663)	NC	max. 250V_{AC}/1A 30 V_{DC}/2 A	1.5 mm^2 1.5 mm^2
A11 to A61	X441	Freely–programmable relay signals	NO	30 V/1 A	1.5 mm^2
289	X441	Relay contact supply	I	30 V/6 A	1.5 mm^2
672 673 674	X441 X441 X441	Axis–specific signal Ready or fault	NO I NC	30 V/1 A 30 V/1 A 30 V/1 A	1.5 mm^2 1.5 mm^2 1.5 mm^2
RS 232C	X411	Serial interface for computer–supported start–up (start–up program)			D–Sub 9–pin
	X412	Possibility of connecting a motor temperature sensor KTY84 acc. to IEC 134[3)] or PTC			D–Sub 15–pin
	X151/351	Equipment bus			

1) I=input; O=output; NC=NC contact; NO=NO contact (for signal, NO=high, closed / NC=low, open)
2) Only available for the appropriate control version; the shields of the setpoint cable should be connected at both ends
3) X412, X432 is only available for Order No. 6SN1122–0BA11–0AA1.
4) BERO type: 3–conductor PNP NO contact, e.g. BERO M30 Order No.: 3RG4014–0AG01 or BERO M12 Order No.: 3RG4012–3AG01
The BERO cable/motor temperature sensing cable must be shielded.
5) The terminal may only be used to enable the associated drive group

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- The voltage rate–of–rise (gradient) of the drive converter manifests typical values of between
  5 – 7 kV / µs.
  For third–party motors, where the insulation has not been designed to handle these voltage gradients, a series reactor must be used, independent of the selected pulse frequency.
- For the IM operating type, motors with a maximum rated torque of

$$Mn = \frac{Pn}{2\pi \frac{n_N}{60\ s/min}} \leq 650\ Nm$$

  may be used.

If the motor data are known, a series reactor or the drive converter pulse frequency can be defined using the following formula, whereby it must be observed, that when increasing the inverter clock frequency, the module current must be reduced; or, a module with a higher current rating must be selected:

$$L_{\sigma 1} + L_{\sigma 2} + L_{vor} \geq \frac{U_{ZK}}{10 \times \sqrt{2} \times fT} \times \frac{n_{max}}{n_{FS} \times I_0}$$

$L_{\sigma 1}$	Stator leakage inductance of the motor in H
$L_{\sigma 2}$	Rotor leakage inductance of the motor in H
L_{vor}	Inductance of the series reactor in H (=0, if a series reactor is not used)
$V_{DC\ link}$	DC link voltage (=600 V or 625 V for a controlled infeed, = rectified line supply voltage for an uncontrolled infeed e.g. 570 V at 400 V_{RMS} line supply voltage)
f_T	Inverter clock frequency of the drive converter in Hz, refer to Section 4.2.2
n_{max}	Max. motor speed
n_{FS}	Speed at the start of field weakening An approximate value can be calculated with $n_{FS} \approx \frac{V_{DC\ link} \times n_N}{1.6 \times V_{Nmot}}$
I_0	No–load motor current in A_{rms}
V_{Nmot}	Rated motor voltage in V_{rms}
n_N	Rated motor speed

If the motor data is not known, the converter current should be dimensioned for 4950 Hz pulse frequency for higher current motors, (rated current > 85 A). This results in a converter current reduction factor of approx. 83 %.

Please note that this formula is less accurate than the one specified above. If possible, please use the more accurate formula. This could possibly mean that the series reactor costs could be reduced.

- for motors, which have a higher motor frequency than 500 Hz, the converter pulse frequency must be increased. The following formula is valid:

$$f_T \geq \times 6 \times f_{max\ mot}$$

f_T	Inverter clock frequency of the drive converter in Hz, refer to Section 4.2.2
$f_{max\ mot}$	Max. motor stator frequency

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It should be observed, that for an inverter clock frequency above 3200 Hz, the module current rating must be reduced, or if required a higher–rating module should be used.

- The max. field weakening range for induction motor operation is limited. The following relationships are valid:

$$\frac{n_{max}}{n_{FS}} \leq \begin{cases} 2 & \text{for high–speed motors (max. output frequency > 300 Hz), standard motors} \\ 5 & \text{for wide–range motors} \end{cases}$$

n_{max} Max. motor speed
n_{FS} Speed at the start of field weakening (motor)

Approximate value can be calculated with $n_{FS} \approx \frac{V_{DC\ link} \times n_N}{1.6 \times V_{Nmot}}$ (refer above)

5

One auxiliary and one main contactor are required if a motor changeover is made. The motor contactors must be mutually interlocked. Changeover is only realized when the pulses are inhibited. At the changeover command, the new motor data set is loaded and the auxiliary contactors are controlled via the select relays.

Parallel operation of several induction motors connected to an induction module, refer to Section 9.11.1.

- The voltage drive across a series reactor depends on the motor current and the motor frequency. If an uncontrolled infeed is used, the maximum rated motor voltage is a a function of the line supply voltage. The following approximate values are recommended when dimensioning the motor so that there is an adequately high motor voltage available:

$f_{max, motor}$	400 Hz	600 Hz	800 Hz	1000 Hz	1200 Hz
I/R module $V_{DC\ link}$=625V					
$V_{N, motor}$	400 V_{RMS}	380 V_{RMS}	360 V_{RMS}	340 V_{RMS}	320 V_{RMS}
VE module V_{supply}=400V supply waveform: Sinusoidal					
$V_{N1\ motor}$	320 V_{RMS}			300 V_{RMS}	

If these approximate values are not observed, then power reductions can be expected in the upper speed range.

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5.6 Drive control with digital setpoint interface

General information

To operate motors 1FT6/1FK6/1FN1/1FE1 and 1PH (2–axis, not for 1PH), digital 1–axis and 2–axis control modules are available. The drive software is downloaded, in the initialization phase (power supply on or reset) from the SINUMERIK 840C or 840D via the drive bus into the control module.

1–axis drive control

Order No.: 6SN1118–0DG2_–0AA1

The digital 1–axis performance control can be loaded with the drive software for feed drive– or main spindle drive control. The operator interface is the same as for MSD and FD. The board is available in three different versions:

- Basic version with **sinusoidal voltage signals** and the possibility of connecting absolute value encoders with EnDat interface
- Additionally with evaluation for a direct position measuring system with sinusoidal **current signals**
- Additionally with evaluation for a direct position measuring signal with sinusoidal **voltage signals** and the possibility of connecting absolute value encoders with EnDat interface and SSI interface (from SW 5.1.9)

2–axis drive control

FD control software can be downloaded into the digital 2 axis closed–loop control. The MSD software can **only** be downloaded when configured as signal–axis control module. The board is available in two basic versions, which differ both in the controller performance and in the evaluation of the direct position measuring systems:

Performance 6SN1118–0DH2_–0AA1

- Basic version with **sinusoidal voltage signals** and the possibility of connecting absolute value encoders with EnDat interface
- Additionally with evaluation for 2 direct measuring systems with sinusoidal **current signals**
- Additionally with evaluation for 2 direct measuring systems with sinusoidal **voltage signals** and the possibility of connecting absolute value encoders with EnDat interface and SSI interface (from SW 5.1.9)

Standard 2 6SN1118–0DM__–0AA0

- Basic version with **sinusoidal voltage signals** and the possibility of connecting absolute value encoders with EnDat interface
- Additionally with evaluation for 2 direct measuring systems with sinusoidal **voltage signals** and the possibility of connecting absolute value encoders with EnDat interface

---

Note

We recommend that measuring systems with current signals are not used for new applications. Voltage signals offer a higher noise immunity, and will replace current signals.

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Note

A 2–axis drive control can be used for single–axis applications, also in a single–axis power module. The configuring is realized as a single–axis module.

For motor encoders, the electrical rotor position can be determined using a configurable, automatic identification run without having to adjust the EMF of the synchronous motor (1FE1). In this case, traversing motion, typically < ± 5 degrees mech. is not exceeded. The identification run must be executed each time the equipment is powered–up.

Additional planning/configuring instructions, refer to Catalog NC 60.

Drive control

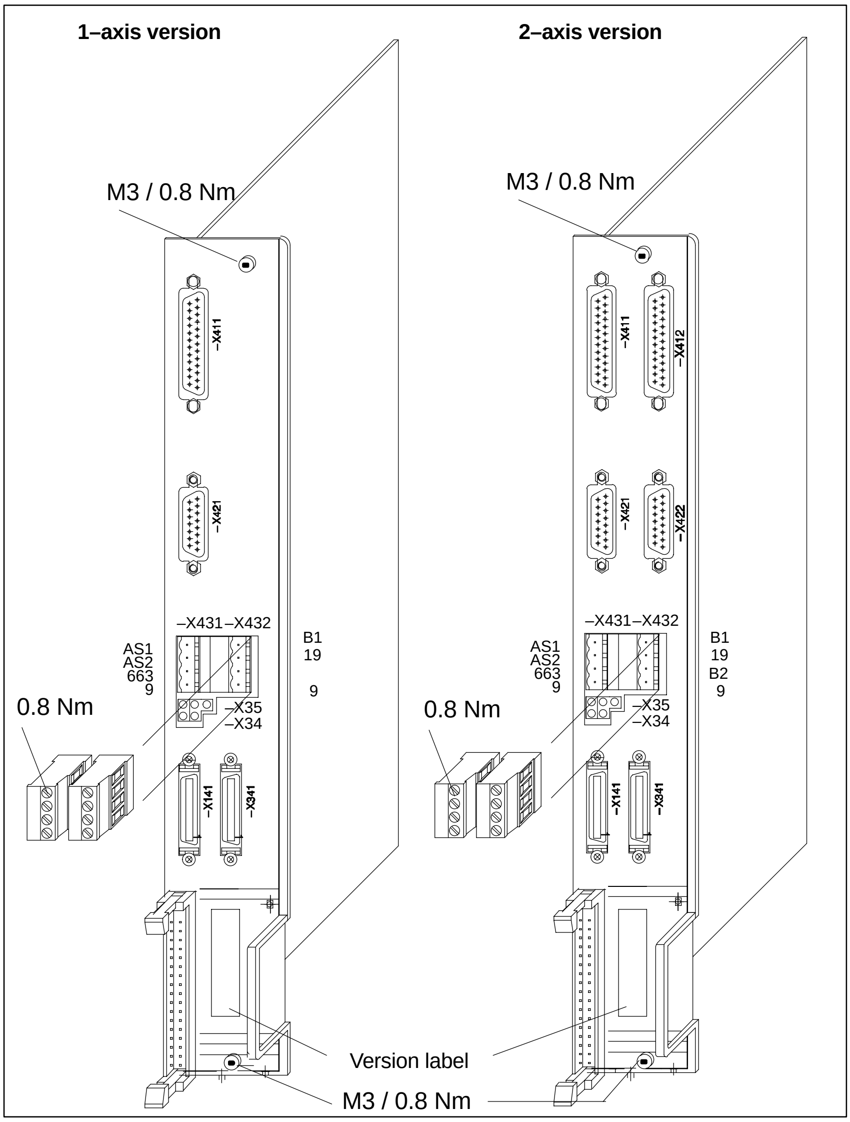

Fig. 5-7 Digital control with direct measuring system

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Notice

When using non–PELV circuits connected to terminals AS1, AS2, the connector must be prevented from being incorrectly inserted using plug coding (refer to EN60204–1, Section 6.4).
Order No. of the coding, refer to Catalog NC 60.

Warning

Only PELV circuits may be connected to terminal 19.

5.6.1 Interface overview, drive control

Table 5-16 Interface overview, drive control

Term. No.	Desig.	Function	Type 1)	Typ. voltage/ limit values	Max. cross–sect.
9	X431	Enable potential 2)	O	+24 V	1.5 mm^2
663	X431	Pulse enable: The ”start inhibit” relay is switched using terminal 663; when it opens, the gating pulses are inhibited and the motor is switched into a no–torque condition.	I	+21 V ... 30 V	1.5 mm^2
AS1	X431	Relay, start inhibit (feedback signal. term. 663)	NC	max. 250VAC/1A	1.5 mm^2
AS2	X431	Relay, start inhibit (feedback signal, term. 663)		30 VDC/2 A	1.5 mm^2
B1	X432	Input, external zero mark (BERO) axis 1	I	+13 ... 30 V	1.5 mm^2
19	X432	negative enable potential	O	0 V	1.5 mm^2
B2	X432	Input, external zero mark (BERO) axis 2	I	+13 ... 30 V	1.5 mm^2
9	X432	positive enable potential 2)	O	+24 V	1.5 mm^2
	X411	Motor encoder, axis 1			
	X412	Motor encoder, axis 2			
	X421	Direct position encoder axis 1			
	X422	Direct position encoder axis 2			
	X151	Equipment bus (not labeled on the front panel)			
	X141/341	Drive bus			

1) I=Input; O=Output; NC=NC contact; NO=NO contact (for signal NO=High/NC=Low)
2) The terminal may only be used to enable the associated drive group.

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5.7 Control module ”SIMODRIVE 611 universal”

Description

The control module ”SIMODRIVE 611 universal” is used in the SIMODRIVE 611 system and includes two independent drive controls. However, the board can also be operated in the one–axis mode or in one–axis power modules.

All of the drive–specific settings on the control board can be made as follows:

- using the “SimoCom U“ parameterizing and start–up tool
- using the display and operator unit on the front of the module
- via PROFIBUS–DP (parameter area, PKW area)

Note

The control module is described in detail in:

Reference: /FBU/, Description of Functions SIMODRIVE 611 universal

---

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Features

The control module has the following features:

- Control module versions
  - 1–axis, resolver, n/M–set
  - 1–axis, resolver, n/M–set, positioning
  - 2–axis, resolver, n/M–set
  - 2–axis, resolver, n/M–set, positioning
  - 2–axis, sin/cos 1 Vpp / absolute value encoder, n/M–set
  - 2–axis, sin/cos 1 Vpp / absolute value encoder, n/M–set, positioning
- Software and data

  The software and the user data are saved on an interchangeable memory module.
- Terminals and operator control elements
  - 2 analog inputs and 2 analog outputs per drive
  - 4 digital inputs and 4 digital outputs per drive
  - 2 test sockets
  - POWER–ON RESET button with integrated LED
  - Display and operator control unit
- Safe start inhibit (refer to Section 9.5)
- Serial interface (RS232, RS485)
- Optional modules
  - Optional terminal module, 8 digital inputs and 8 digital outputs
  - Option module, PROFIBUS–DP1
  - Option module, PROFIBUS–DP2 (from SW 3.1)
  - Option module, PROFIBUS–DP3 (from SW 3.1)

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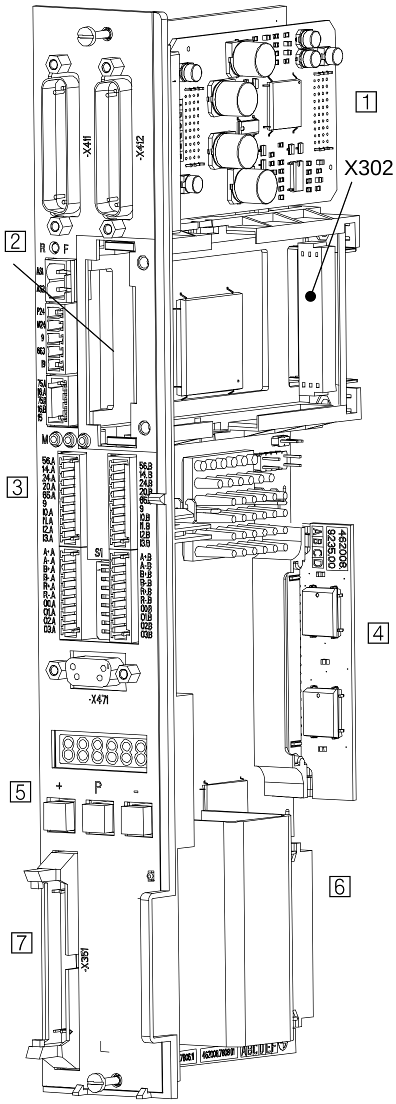
5.7.1 Control module for 1 or 2 axes

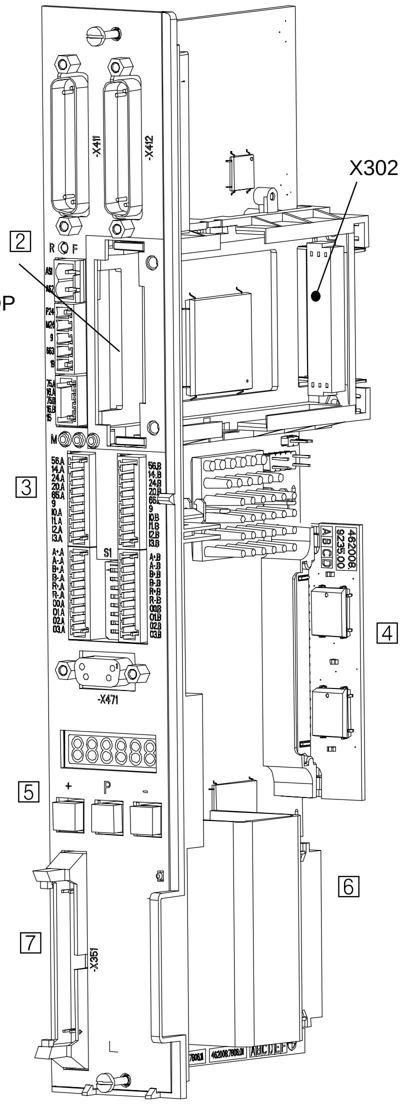
Control modules for 2 axes

The following 2 axis control modules are available:

2–axis for encoders with sin/cos 1Vpp



2–axis for resolvers



1
Module for encoder evaluation

2
Slot for

- optional TERMINAL modules
  or
- optional PROFIBUS–DP module

3

- Interfaces
- Terminals,
- Switch

4
Memory module

- Firmware
- User data

5
Display and operator unit

6
Pulse interface

7
Equipment bus

The following is valid for screws:

Tighten (for the shield contact)

Max. torque = 0.8 Nm

The following applies for plug connections:

In order that the plug connections with the same number of pins cannot be incorrectly inserted, they must be appropriately coded.

Fig. 5-8 Control modules for 2 axes

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Control module for 1 axis

The following 1 axis control module is available:

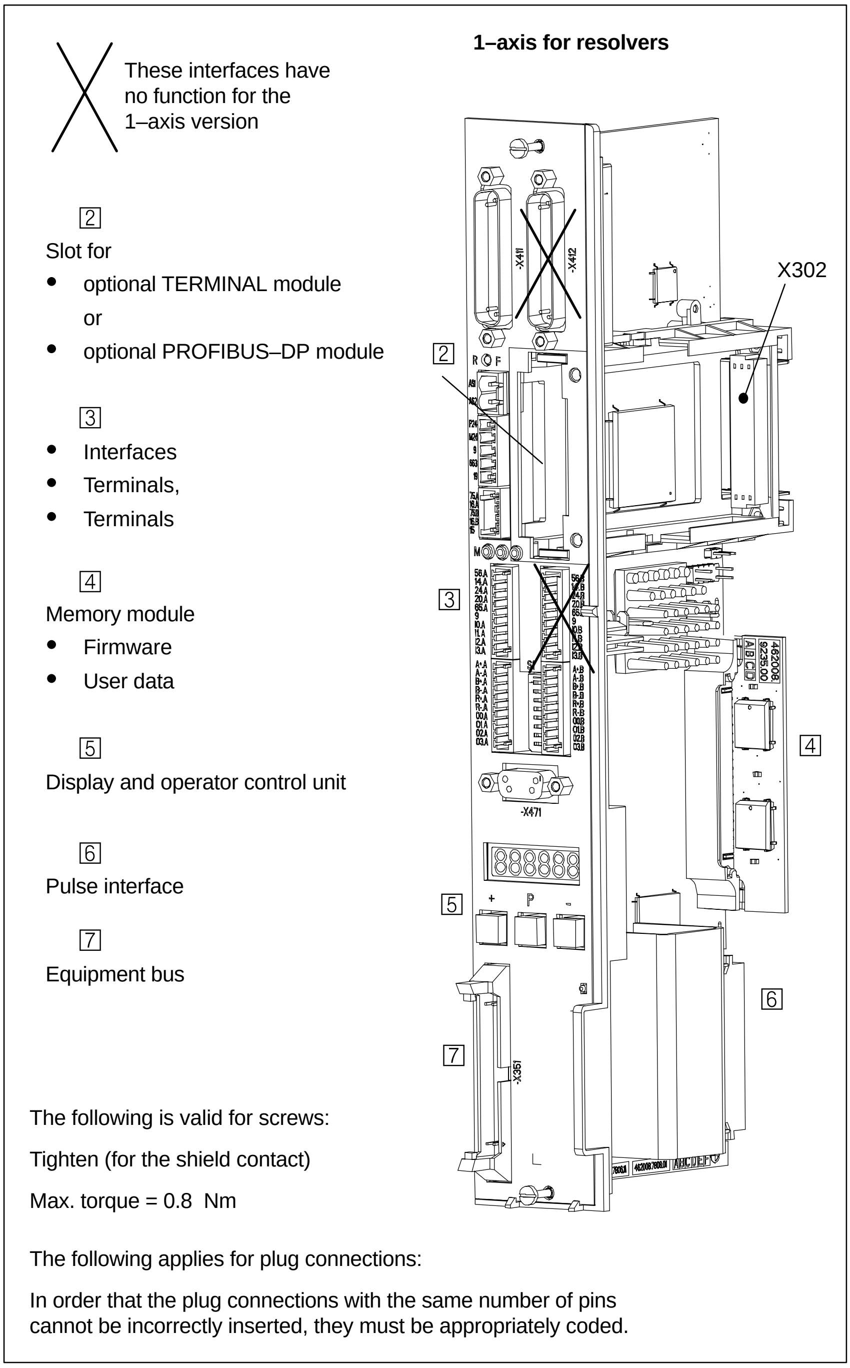

Fig. 5-9 Control module for 1 axis

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Optional terminal module

Using this option module, an additional 8 digital inputs and outputs can be implemented for drive A.

The functionality of these inputs/outputs can be freely parameterized

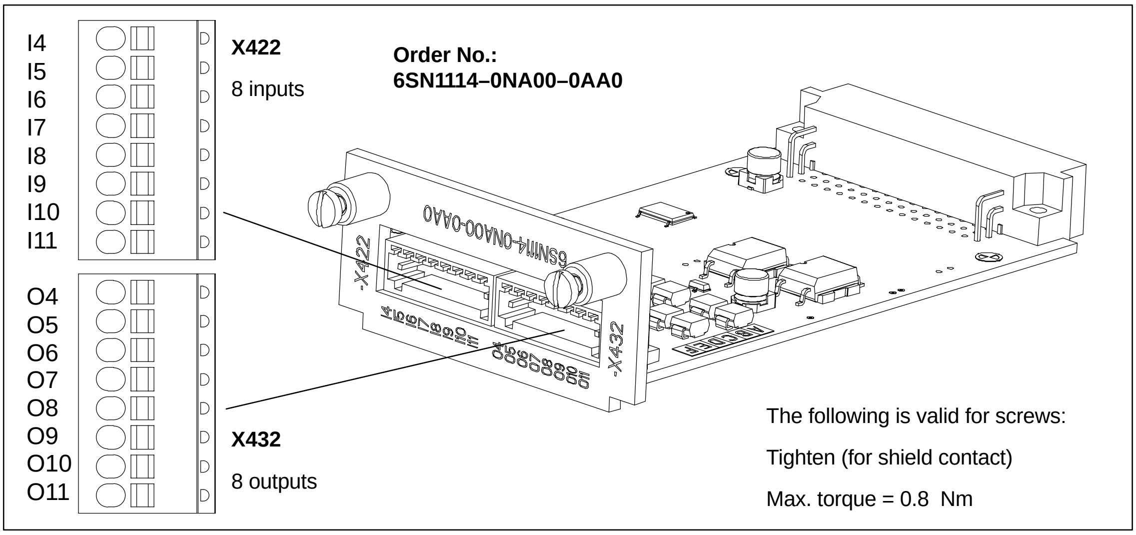

Fig. 5-10 Optional TERMINAL module

Optional PROFIBUS–DP module

The ”SIMODRIVE 611 universal” control module can be connected and operated as DP slave on the PROFIBUS DP fieldbus using this option module.

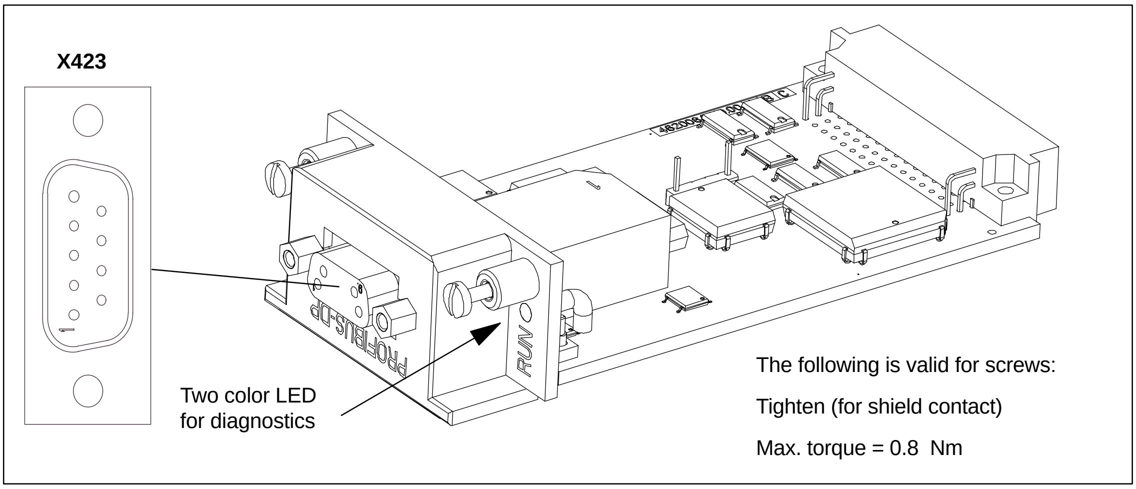

Fig. 5-11 Optional PROFIBUS–DP module

Which PROFIBUS–DP option modules are there?

- PROFIBUS–DP1 6SN1 114–0NB00–0AA0
- PROFIBUS–DP2 6SN1 114–0NB00–0AA1
- PROFIBUS–DP3 6SN1 114–0NB01–0AA0

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5.7.2 Description of the terminals and interfaces

Module–specific terminals and interfaces

The module–specific terminals and interfaces are available together for drive A and drive B.

Table 5-17 Overview of the module–specific terminals and interfaces

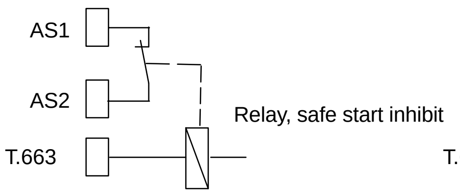
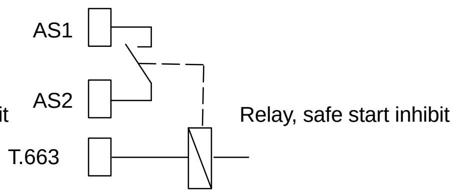
Terminal No.	Terminal Desig.	Function	Type 1)	Technical data
Signal terminal, start inhibit (X421)				
AS1 AS2	X421	Signal contact, start inhibit Checkback signal from terminal 663	NC	Connector type: 2–pin plug connector Max. conductor cross–section: 2.5 mm² Contact: Floating NC contact Contact load capability: at 250 V_{AC} max. 1 A at 30 V_{DC} max. 2 A
	 No pulse enable (terminal 663) The gating pulses of the power transistors are inhibited.			 Pulse enable (terminal 663) available The gating pulses of the power transistors are enabled.
Terminals für supply and pulse enable (X431)				
	X431			Connector type: 5–pin plug connector Max. conductor cross–section: 1.5 mm²
P24	X431.1	External supply for digital outputs (+24 V)	V	Voltage tolerance (including ripple): 10 V to 30 V
M24	X431.2	Reference for external supply	V	
	The external supply is required for the following digital outputs: • 8 outputs of the drive–specific terminals (X461, O0.A – O3.A / X462, O0.B – O3.B) • 8 outputs of the optional TERMINAL module (X432, O4 – O11) When dimensioning the external supply, the total current of all of the digital outputs must be taken into account. Max. total current: • for control modules (all 8 outputs): 2.4 A • for the optional TERMINAL module (all 8 outputs): 480 mA **Example:** Board/module — Outputs — Dimensioning the external supply Control board — 8 — max. 1.5 A —> 24 V / 1.5 A Control module + Optional TERMINAL mod. — 8 + 8 — max. (1.5 A + 280 mA) —> 24 V / 1.8 A			
9	X431.3	Enable voltage (+24 V)	V	Reference: T.19 Max. current (for the complete group): 500 mA **Note:** The enable voltage (terminal 9) can be used to supply the enable signals (e.g. pulse enable) as 24 V auxiliary voltage.

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Table 5-17 Overview of the module–specific terminals and interfaces, continued

Terminal No.	Terminal Desig.	Function	Type 1)	Technical data
663	X431.4	Pulse enable (+24 V)	I	Voltage tolerance (including ripple): 21 V to 30 V Current drain, typical: 25 mA at 24 V **Note:** The pulses are enabled for both drive A and B simultaneously. The drives coast down, unbraked when the pulse enable is withdrawn.
19	X431.5	Reference (reference for all digital inputs)	V	**Note:** If the enable signals are to be controlled from an external voltage source, then the reference potential (ground) of the external source must be connected to this terminal.
Serial interface (X471)				
–	X471	Serial interface for “SimoCom U”	IO	Connector type: D–Sub socket, 9–pin Cable plan and pin assignment for RS232 or RS485, refer to: **Reference:** /FB611U/, Description of Functions SIMODRIVE 611 universal
Equipment bus (X34)				
–	X351	Equipment bus	IO	Ribbon cable: 34–core Voltages: Various Signals: Various
Test socket (X34)				
DAU1	X34	Test socket 1 2)	M	Test socket: ∅ 2 mm Resolution: 8 bits Voltage range: 0 V to 5 V Max. current: 3 mA
DAU2		Test socket 2 2)	M	
M		Reference	M	

1) I: Input; IO: Input/output; M: Measuring signal; NC: NC contact; V: supply
2) Can be freely parameterized

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Drive–specific terminals

The drive–specific terminals are available for drive A and for drive B.

Table 5-18 Overview of the drive–specific terminals

Terminal				Function	Type 1)	Technical data
Drive A		Drive B				
No.	Desig.	No.	Desig.			
Encoder connection (X411, X412)						
–	X411	–	–	Motor encoder connection Drive A	I	Refer to Section 3 **Note:** Encoder limiting frequencies: • Encoders with sin/cos 1 V_{pp}: 350 kHz • Resolver: 375 Hz
–	–	–	X412	Motor encoder connection Drive B	I	
Analog outputs (X441)						
75.A	X441.1	–	–	Analog output 1[2)]	AO	Connector type: 5–pin plug connector Connection: Cable with braided shield, connect at both ends Max. conductor cross–section for finely–stranded or solid conductors: 0.5 mm^2 Voltage range: –10 V to +10 V Max. current: 3 mA Resolution: 8 bits Updated: in the speed controller clock cycle Short–circuit proof
16.A	X441.2	–	–	Analog output 2[2)]	AO	
–	–	75.B	X441.3	Analog output 1[2)]	AO	
–	–	16.B	X441.4	Analog output 2[2)]	AO	
15	X441.5	15	X441.5	Reference	–	
Drive–specific terminals (X451, X452)						
	X451		X452	Connector type: 10–pin, plug connector strip Max. conductor cross–section for finely–stranded or solid conductors: 0.5 mm^2		
56.A	X451.1	56.B	X452.1	Analog input 1	AI	Differential input Voltage range: –12.5 V to +12.5 V Input resistance: 100 kΩ Resolution: 14 bits (sign + bits) Connection: Connect a cable with braided shield at both ends
14.A	X451.2	14.B	X452.2	Reference		
24.A	X451.3	24.B	X452.3	Analog input 2		
20.A	X451.4	20.B	X452.4	Reference		
65.A	X451.5	65.B	X452.5	Controller enable Drive–specific	I	Current drain, typical: 6 mA at 24 V Signal level (including ripple) High signal level: 15 V to 30 V Low signal level: –3 V to 5 V Electrical isolation: Reference is terminal 19 / terminal M24
9	X451.6	9	X452.6	Enable voltage (+24 V)	V	Reference: T.19 Maximum current (for the total group): 500 mA **Note:** The enable voltage (terminal 9) can be used to supply the enable signals (e.g. controller enable).

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Table 5-18 Overview of the drive–specific terminals, continued

Terminal				Function	Type 1)	Technical data
Drive A		Drive B				
No.	Desig.	No.	Desig.			
I0.A	X451.7	I0.B	X452.7	Digital input 0 2) Fast input 3) e.g. for equivalent zero mark, external block change	DI	Voltage: 24V Current drain, typical: 6 mA at 24 V Signal level (including ripple) High signal level: 15 V to 30 V Low signal level: –3 V to 5 V Sampling time, fast input: 62.5 µs Electrical isolation: Reference is terminal 19/terminal M24 **Note:** An open input is interpreted just like a "0" signal.
I1.A	X451.8	I1.B	X452.8	Digital input 1 2) Fast input	DI	
I2.A	X451.9	I2.B	X452.9	Digital input 2 2)	DI	
I3.A	X451.10	I3.B	X452.10	Digital input 3 2)	DI	
Drive–specific terminals (X461, X462)						
	X461		X462	Connector type: 10–pin, plug connector strip Max. conductor cross–section for finely–stranded or solid conductors: 0.5 mm^2		
A+.A	X461.1	A+.B	X462.1	Signal A+	IO	Incremental shaft encoder interface (WSG–SS) Connection: • Cable with braided shield, connected at both ends. • The reference ground of the connected node must be connected to terminal X441.5.
A–.A	X461.2	A–.B	X462.2	Signal A–	IO	
B+.A	X461.3	B+.B	X462.3	Signal B+	IO	
B–.A	X461.4	B–.B	X462.4	Signal B–	IO	
R+.A	X461.5	R+.B	X462.5	Signal R+	IO	
R–.A	X461.6	R–.B	X462.6	Signal R–	IO	
	Note: Nodes can be connected which are in compliance with standard RS485/RS422. The incremental shaft encoder interface can either be parameterized as input or output. • Input To enter incremental position reference values • Output To output incremental position actual values					
O0.A	X461.7	O0.B	X462.7	Digital output 0 4)	DO	Rated current per output: 500 mA Maximum current per output: 600 mA Maximum total current: 2.4 A (valid for these 8 outputs) Typical voltage drop: 250 mV for 500 mA Short–circuit proof **Example:** The following is valid if all outputs are simultaneously energized: Σ current = 240 mA —> O.K. Σ current = 2.8 A —> not O.K., as the total current is greater than 2.4 A.
O1.A	X461.8	O1.B	X462.8	Digital output 1 4)	DO	
O2.A	X461.9	O2.B	X462.9	Digital output 2 4)	DO	
O3.A	X461.10	O3.B	X462.10	Digital output 3 4)	DO	
	Note: • The power switched via these outputs is supplied via terminals P24 / M24 (X431). When dimensioning the external supply, this must be taken into account. • The digital outputs only "function" if the external supply (+24 V / 0 V is available at terminals P24/M24).					

1) I: Input; DO: Digital output, DI: Digital input, AO: Analog output; AI: Analog input, V: supply
2) Can be freely parameterized. All of the digital inputs are de–bounced per software. A delay time of between 1 and 2 interpolation clock cycles (P1010) is obtained due to the signal detection process.
3) I0.x is hard–wired internally for position sensing and therefore acts almost instantaneously.
4) Freely parameterizable. The digital outputs are updated in the interpolation clock cycle (P1010). A hardware–related delay time of approx. 200 µs is involved.

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5.8 Control module “SIMODRIVE 611 universal E”

Description

For SINUMERIK 802D, the “SIMODRIVE 611 universal E” control module is used with the function “Motion Control with PROFIBUS–DP”.

Using this function, a clock cycle–synchronous drive coupling can be implemented between a DP master (e.g. SINUMERIK 802D) and the “SIMODRIVE 611 universal E” DP slave.

Note

The control module is described in detail in:

Reference: /FBU/, Description of Functions SIMODRIVE 611 universal

---

Features

The control module has the following features:

- Control module (refer to Section 5.8.1)
  - Order No. (MLFB): 6SN1118–0NH10–0AAx
  - 2–axis for encoders with sin/cos 1 Vpp
  - With memory module for n–set
- Optional PROFIBUS–DP3 (refer to Section 5.8.1)
  - Order No. (MLFB): 6SN1114–0NB01–0AA0
- The parameters can be set as follows:
  - using the “SimoCom U” parameterizing and start–up tool
  - using the display and operator control unit on the front panel
  - using the PROFIBUS–DP (parameter area, PKW area)
- Software and data

  The software and the user data are saved on an interchangeable memory module.
- Terminals and operator control elements
  - 2 analog inputs and 2 analog outputs per drive
  - 2 digital inputs and 2 digital outputs per drive
  - 2 test sockets
  - POWER–ON RESET button with integrated LED
  - Display and operator control unit
- Safe start inhibit (refer to Section 9.5)
- Serial interface (RS232)
- TTL encoder can be connected as an additional measuring system

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5.8.1 Control module with option module

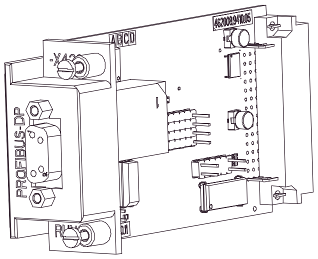
Control module with optional PROFIBUS–DP module

“SIMODRIVE 611 universal E” control module

2–axis for encoders with sin/cos 1Vpp

Option module PROFIBUS–DP3

with PROFIBUS–ASIC DPC31 with PLL



1
Module for encoder evaluation

2
Slot for option module PROFIBUS–DP3

3
- Interfaces
- Terminals
- Test sockets

4
Serial interface (RS232)

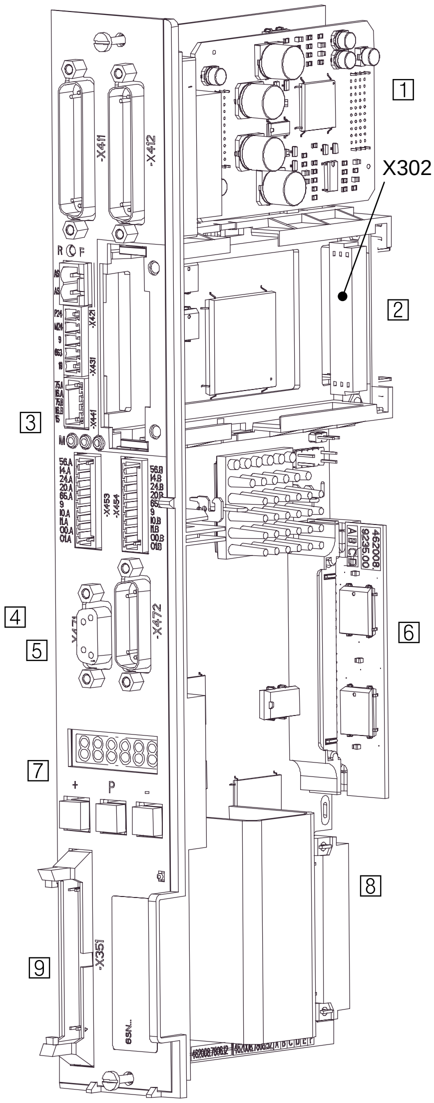
5
Encoder interface for TTL encoders

6
Memory module
- Firmware
- User data

7
Display and operator control unit

8
Pulse interface

9
Equipment bus



The following applies for plug connections:

In order that the plug connections with the same number of pins cannot be incorrectly inserted, they must be appropriately coded (refer under the index entry “Coding the mini connectors”).

The following is valid for screws:

Tighten (for shield contact)

Max. torque = 0.8 Nm

Fig. 5-12 “SIMODRIVE 611 universal E” control module with optional PROFIBUS–DP3 module

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5.8.2 Description of the terminals and interfaces

Module-specific terminals and interfaces

The module–specific terminals and interfaces are available for both drive A and drive B together.

Table 5-19 Overview of the module–specific terminals and interfaces

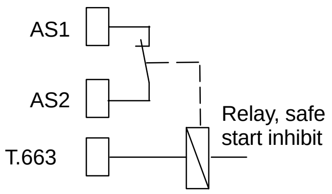
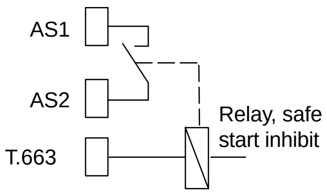
Terminal No.	Terminal Desig.	Function	Type 1)	Technical data
Signal terminal, start inhibit (X421)				
AS1 AS2	X421	Signal contact start inhibit Checkback signal of terminal 663	NC	Connector type: 2–pin plug connector Max. conductor cross–section: 2.5 mm^2 Contact: Floating NC contact Contact load capability: at 250 V_{AC} max. 1 A at 30 V_{DC} max. 2 A
	 No pulse enable (terminal 663) The gating pulses of the power transistors are inhibited.			 Pulse enable (terminal 663) available The gating pulses of the power transistors are enabled.
Terminals for supply and pulse enable (X431)				
	X431			Connector type: 5–pin plug connector Max. conductor cross–section: 1.5 mm^2
P24	X431.1	External supply for digital outputs (+24 V)	V	Voltage tolerance (including ripple): 10 V to 30 V Max. total current: 2.4 A **Note:** • The external supply is required for the 4 digital outputs (O0.A, O1.A and O0.B, O1.B). • When dimensioning the external supply, the actual total current of all digital outputs must be taken into account.
M24	X431.2	Reference for external supply	V	
9	X431.3	Enable voltage (+24 V)	V	Reference: T.19 Max. current (for the complete group): 500 mA **Note:** The enable voltage (terminal 9) can be used to supply the enable signals (e.g. pulse enable) as 24 V auxiliary voltage.
663	X431.4	Pulse enable (+24 V)	I	Voltage tolerance (including ripple): 21 V to 30 V Current drain, typical: 25 mA at 24 V **Note:** The pulses are simultaneously enabled for drives A and B. When the pulse enable is withdrawn, the drives coast down unbraked.
19	X431.5	Reference (Reference for all digital inputs)	V	**Note:** If the enable signals are to be controlled from an external voltage source and not from terminal 9, then the reference potential (ground) of the external source must be connected to this terminal.

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Table 5-19 Overview of the module–specific terminals and interfaces, continued

Terminal		Function	Type 1)	Technical data
No.	**Desig.**			
Serial interface (X471)				
–	X471	Serial interface for “SimoCom U”	IO	Connector type: D–Sub socket, 9–pin **Note:** • The interface can only be used as RS232 interface • For the cable assignment and pin assignment of the interface, refer to: **Reference:** /FB611U/, Description of Functions SIMODRIVE 611 universal
PROFIBUS–DP interface (X423) for the optional PROFIBUS–DP3 module				
–	X423	Communications interface for PROFIBUS	IO	Connector type: D–Sub socket, 9–pin **Note:** • Pin assignment, connection diagram and wiring of the interface: **Reference:** /FB611U/, Drive ”SIMODRIVE 611 universal”
Equipment bus (X351)				
–	X351	Equipment bus	IO	Ribbon cable: 34–core Voltages: Various Signals: Various
Test sockets (X34)				
DAU1	X34	Test socket 1 2)	MA	Test socket: ∅ 2 mm Resolution: 8 bits Voltage range: 0 V to 5 V Max. current: 3 mA
DAU2		Test socket 2 2)	MA	
M		Reference	MA	

1) I: Input; V: Supply; IO: Input/output; TA: Measuring signal, analog; NC: NC contact; V: supply
2) can be freely parameterized

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Drive–specific terminals

The drive–specific terminals are available both for drive A and for drive B.

Table 5-20 Overview of the drive–specific terminals

<table>
<tr><th colspan="4">Terminal</th><th rowspan="3">Function</th><th rowspan="3">Type 1)</th><th rowspan="3">Technical data</th></tr>
<tr><th colspan="2">Drive A</th><th colspan="2">Drive B</th></tr>
<tr><th>No.</th><th>Desig.</th><th>No.</th><th>Desig.</th></tr>
<tr><td colspan="7">Encoder connection (X411, X412)</td></tr>
<tr><td>–</td><td>X411</td><td>–</td><td>–</td><td>Motor encoder connection, drive A</td><td>I</td><td rowspan="2">Refer to Section 3
Note:
Encoder limiting frequency:
Encoder with sin/cos 1Vpp: 350 kHz</td></tr>
<tr><td>–</td><td>–</td><td>–</td><td>X412</td><td>Motor encoder connection, drive B</td><td>I</td></tr>
<tr><td colspan="7">Analog outputs (X441)</td></tr>
<tr><td>75.A</td><td>X441.1</td><td>–</td><td>–</td><td>Analog output 1[2)]</td><td>AO</td><td rowspan="5">Connector type: 5–pin plug connector
Connection: refer to[3)]
Max. conductor cross–section for finely–stranded or solid conductors: 0.5 mm^2
Voltage range: –10 V to +10 V
Max. current: 3 mA
Resolution: 8 bits
Updated: in the speed controller clock cycle
Short–circuit proof</td></tr>
<tr><td>16.A</td><td>X441.2</td><td>–</td><td>–</td><td>Analog output 2[2)]</td><td>AO</td></tr>
<tr><td>–</td><td>–</td><td>75.B</td><td>X441.3</td><td>Analog output 1[2)]</td><td>AO</td></tr>
<tr><td>–</td><td>–</td><td>16.B</td><td>X441.4</td><td>Analog output 2[2)]</td><td>AO</td></tr>
<tr><td>15</td><td>X441.5</td><td>15</td><td>X441.5</td><td>Reference</td><td>–</td></tr>
<tr><td colspan="7">Terminals for analog inputs and digital inputs/outputs (X453, X454)</td></tr>
<tr><td></td><td>X453</td><td></td><td>X454</td><td colspan="3">Connector type: 10–pin, plug connector strip
Max. conductor cross–section for finely–stranded or solid conductors: 0.5 mm^2</td></tr>
<tr><td>56.A</td><td>X453.1</td><td>56.B</td><td>X454.1</td><td>none</td><td>–</td><td>–</td></tr>
<tr><td>14.A</td><td>X453.2</td><td>14.B</td><td>X454.2</td><td>none</td><td>–</td><td>–</td></tr>
<tr><td>24.A</td><td>X453.3</td><td>24.B</td><td>X454.3</td><td>none</td><td>–</td><td>–</td></tr>
<tr><td>20.A</td><td>X453.4</td><td>20.B</td><td>X454.4</td><td>none</td><td>–</td><td>–</td></tr>
<tr><td>65.A</td><td>X453.5</td><td>65.B</td><td>X454.5</td><td>Controller enable Drive–specific</td><td>I</td><td>Current drain, typical: 6 mA at 24 V
Signal level (including ripple)
High signal level: 15 V to 30 V
Low signal level: –3 V to 5 V
Electrical isolation: Reference is terminal 19/ terminal M24</td></tr>
<tr><td>9</td><td>X453.6</td><td>9</td><td>X454.6</td><td>Enable voltage (+24 V)</td><td>V</td><td>Reference: T.19
Maximum current (for the total group): 500 mA
Note:
The enable voltage (terminal 9) can be used to supply the enable signals (e.g. controller enable).</td></tr>
<tr><td>I0.A</td><td>X453.7</td><td>I0.B</td><td>X454.7</td><td>Digital input 0[4)]

Faster Input[5)]</td><td>DI</td><td rowspan="2">Voltage: 24V
Current drain, typical: 6 mA at 24 V
Signal level (including ripple)
High signal level: 15 V to 30 V
Low signal level: –3 V to 5 V
Electrical isolation: Reference is terminal 19/ terminal M24
Note:
An open–circuit input is interpreted just the same as a 0 signal.</td></tr>
<tr><td>I1.A</td><td>X453.8</td><td>I1.B</td><td>X454.8</td><td>Digital input 1[4)]</td><td>DI</td></tr>
</table>

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Table 5-20 Overview of the drive–specific terminals, continued

Terminal				Function	Type 1)	Technical data
Drive A		Drive B				
No.	Desig.	No.	Desig.			
O0.A	X453.9	O0.B	X454.9	Digital output 0[6)]	DO	Rated current per output: 500 mA Maximum current per output: 600 mA Typical voltage drop: 250 mV for 500 mA Short–circuit proof
O1.A	X453.10	O1.B	X454.10	Digital output 1[6)]	DO	
	Note: • The power, switched via these outputs, is supplied via terminals P24 / M24 (X431). When dimensioning the external supply, this must be taken into account. • The digital outputs only ”function” if the external supply (+24 V, terminals P24/M24) is available.					

1) AO: Analog output; I: Input; DI: Digital input; DO: Digital output; V: supply
2) Can be freely parameterized
3) The analog outputs (X441) should be connected via a terminal strip.
A shielded cable should be used for all of the analog outputs between X441 and the terminal strip. For this piece of cable, the shield should be connected at both ends of the cable.
4 analog cables can then be fed from the terminal strip. The cable shields should be connected and the M cables should be fed from a common M terminal.
4) Can be freely parameterized
All of the digital inputs are de–bounded per software. A delay time of between 1 and 2 interpolation clock cycles is obtained due to the signal detection process (P1010).
5) I0.x is internally hardwired for position sensing where it acts almost instantaneously.
6) Can be freely parameterized
The digital outputs are updated in the interpolation clock cycle (P1010). A hardware–related delay time of approx. 200 µs must be added.

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Encoder interface for TTL encoders (X472)

Table 5-21 Encoder interface for TTL encoders (X472)

<table>
<tr><th colspan="2">Pin</th><th rowspan="2">Function</th><th rowspan="2">Type 1)</th><th rowspan="2">Technical data</th></tr>
<tr><th>No.</th><th>Desig.</th></tr>
<tr><td colspan="2">X472</td><td colspan="3">Connector type: D–Sub socket, 15–pin</td></tr>
<tr><td>1</td><td>P_Encoder</td><td rowspan="15">Possibility of connecting to a power supply for an additional measuring system (TTL encoder, encoder 3).

The data is transferred to a higher–level control system via PROFIBUS.</td><td>V</td><td rowspan="15">• Recommendation for TTL encoders:
Order No. (MLFB): 6FX2001–2□B02
Encoder pulse number = 1024
□ = Spare retainer for connection types A, C, E or G
• Cabling
– Max. cable length: 15 m
– Recommendation for encoder cables:
Order No. (MLFB): 6FX2002–2CA11–1□□0
□ = Space retainer for cable type (length, ...)
Reference:
/NCZ/ Catalog, Accessories and Equipment
• Encoder power supply
– Voltage: 5.1 V ± 2 %
– Short–circuit proof
– Max. current: 300 mA
– Max. short–circuit current: A3.5
• Encoder limiting frequency
– TTL encoder: 1 MHz</td></tr>
<tr><td>2</td><td>M_Encoder</td><td>V</td></tr>
<tr><td>3</td><td>A</td><td>I</td></tr>
<tr><td>4</td><td>*A</td><td>I</td></tr>
<tr><td>5</td><td>Reserved</td><td>–</td></tr>
<tr><td>6</td><td>B</td><td>I</td></tr>
<tr><td>7</td><td>*B</td><td>I</td></tr>
<tr><td>8</td><td>Reserved</td><td>–</td></tr>
<tr><td>9</td><td>P_Encoder</td><td>V</td></tr>
<tr><td>10</td><td>R</td><td>I</td></tr>
<tr><td>11</td><td>M_Encoder</td><td>V</td></tr>
<tr><td>12</td><td>*R</td><td>I</td></tr>
<tr><td>13</td><td rowspan="3">Reserved</td><td>–</td></tr>
<tr><td>14</td><td>–</td></tr>
<tr><td>15</td><td>–</td></tr>
</table>

1) I: Input; V: supply

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5.9 Control module ”HLA module”

Description

The hydraulic module (HLA–module) allows SINUMERIK 840D to directly control hydraulic axes via the digital drive bus.

The HLA module is a control module belonging to the modular SIMODRIVE 611 drive converter system which is inserted in a 50 mm carrier module (universal housing). The control and closed–loop control electronics to operate hydraulic drives is integrated on the HLA module.

The control module can also be used as ANA control module for analog axes. Mixed operation (HLA/ANA) is permissible for this double–axis module.

Hydraulic drives are available, the same as electric drives, and can also be combined within an interpolating group.

Note

The HLA module is described in detail in:

Reference: /FBHLA/, SINUMERIK 840D SIMODRIVE 611 digital HLA Module, Description of Functions

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Features

The HLA module has the following features:

- Software and data

  The communications interface, for supported utilities (services), is compatible to SIMODRIVE 611 SRM(FD)/ARM(MSD). The code and data management is implemented essentially the same as SIMODRIVE 611 SRM(FD)/ARM(MSD). The software for the hydraulics is saved in the control as dedicated program code.

- Hardware

  The integration into the SIMODRIVE 611 system has been implemented so that it is compatible to SIMODRIVE 611 digital SRM(FD)/ARM(MSD). This essentially includes the interfaces:

  – Drive bus
  – Equipment bus
  – Power supply concept

- HLA control module (2 axes)

  – Velocity pre–control, controller
  – Closed–loop force control
  – Control voltage output
  – 2 pressure sensors can be connected per axis
  – A hydraulic control valve can be controlled

- Terminals and diagnostics

  – A hydraulic shut–off valvecan be controlled
  – BERO input per axis
  – Module–specific enable
  – Test sockets (DAU)

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5

5.9.1 System overview

A complete 840D control with HLA module comprises various individual components. These are now listed.

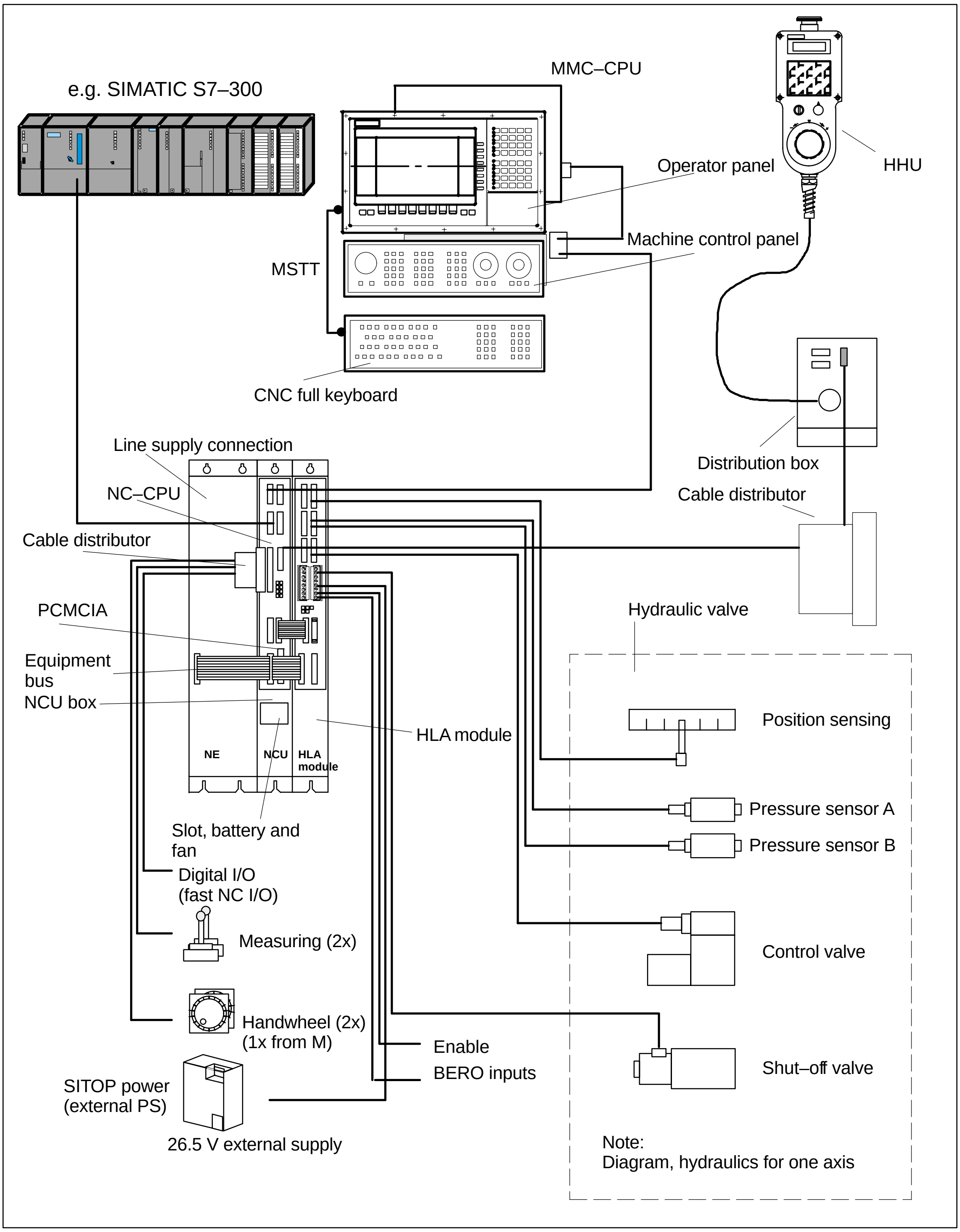

Fig. 5-13 System components

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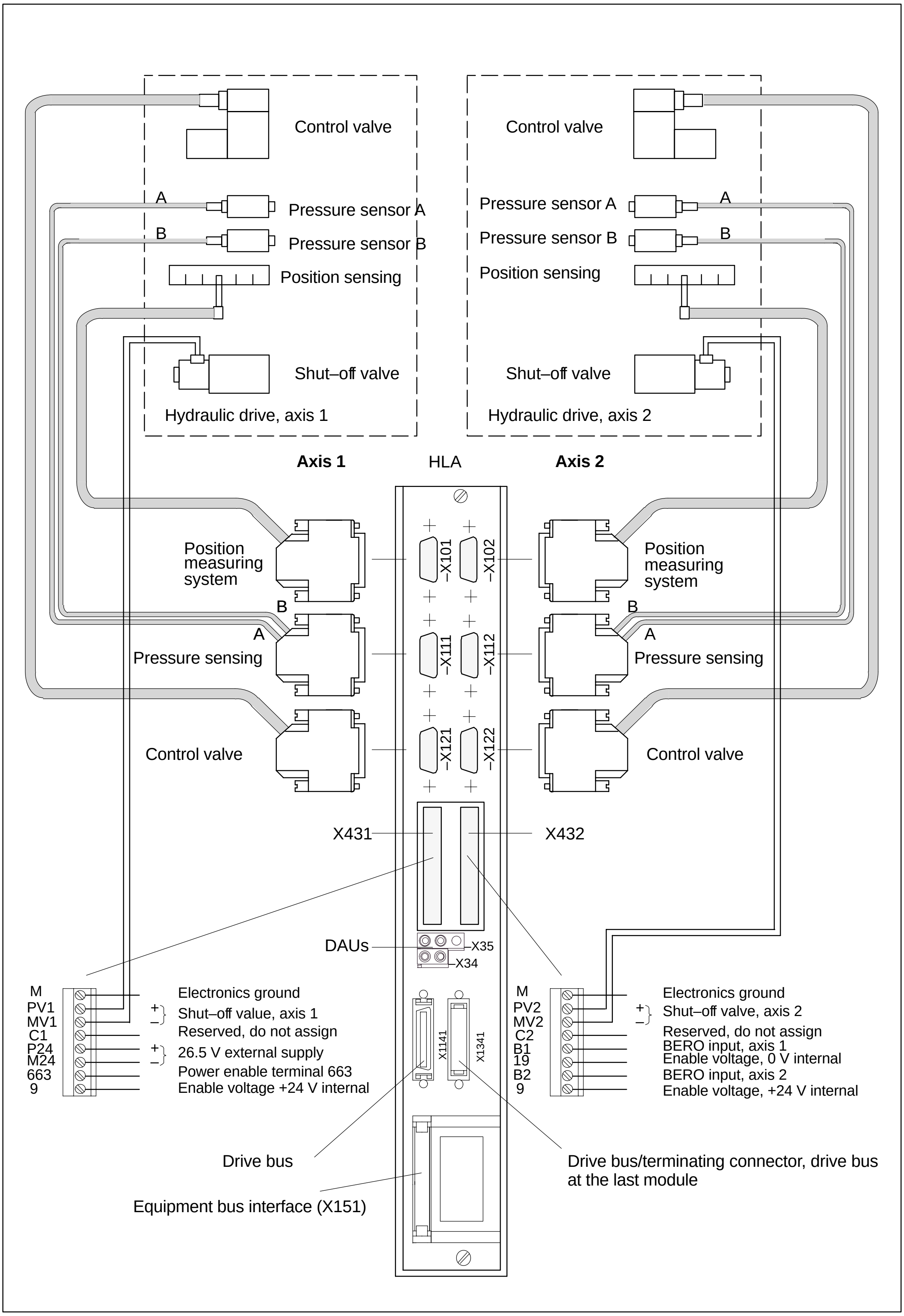

Fig. 5-14 Connection configuration, HLA module

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5.9.2 Wiring

Supply connection

SINUMERIK 840D and HLA modules are supplied from the SIMODRIVE line supply infeed or the SIMODRIVE monitoring module via the equipment bus. If an HLA module is used, at least one NE module must be used in the equipment group. It is not possible to input a voltage in any other way and this could damage the equipment.

Note

It is not permissible to use an HLA module alone connected to the SIMODRIVE monitoring module!

5

The power supply for the following electric axes is realized via the DC link busbars (40 mm^2) of the carrier module.

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Measuring systems

One position encoder can be evaluated for each axis on the HLA module.

- X101: Axis 1
- X102: Axis 2

The measuring system must always be inserted at the connector of the associated axis.

Table 5-22 Connectors X101, X102; × 15–pin D–sub plug connectors (double tier)

Pin	X101	X102	Function	I[1)]	E[1)]	S[1)]
1	PENC0	PENC2	Encoder power supply	X	X	
2	M	M	Ground, encoder power supply	X	X	
3	AP0	AP2	Incremental signal A	X	X	
4	AN0	AN2	Inverse incremental signal A	X	X	
5	BMIDAT0	BMIDAT2	Data signal		X	X
6	BP0	BP2	Incremental signal B	X	X	
7	BN0	BN2	Inverse incremental signal B	X	X	
8	XBMIDAT0	XBMIDAT2	Inverse data signal		X	X
9	PSENSE0	PSENSE2	Remote sense, encoder power supply (P)	X	X	
10	RP0	RP2	Incremental signal R	X		
11	MSENSE0	MSENSE2	Remote sense, encoder power supply (M)	X	X	
12	RN0	RN2	Inverse incremental signal R	X		
13	M	M	Ground (or inner shields)		X	
14	BMICLK0	BMICLK2	Clock signal	X	X	X
15	XBMICLK0	XBMICLK2	Inverse clock signal	X	X	X
1) I = Incremental, E = EnDat, S = SSI **Note:** The SSI encoder requires an external 24 V power supply						

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Pressure sensor system

2 pressure sensors can be connected per axis

- X111: Axis 1 (sensor 1A, 1B)
- X112: Axis 2 (sensor 2A, 2B)

Table 5-23 Connectors X111, X112; 15–pin D–Sub socket connectors

Pin	X111	X112	Type 1)	Function
1	P24DS	P24DS	O	Supply, pressure sensor with external +24 V
2	P24DS	P24DS	O	Supply, pressure sensor with external +24 V
3	–	–	–	not assigned
4	–	–	–	not assigned
5	M24EXT	M24EXT	O	Supply, pressure sensor with external 0 V
6	–	–	–	not assigned
7	–	–	–	not assigned
8	–	–	–	not assigned
9	M24EXT	M24EXT	O	Supply, pressure sensor with external 0 V
10	M24EXT	M24EXT	O	Supplementary pin for jumper, pins 10–11 for 3–conductor connection
11	PIST1BN	PIST2BN	I	Analog actual value signal, reference ground
12	PIST1BP	PIST2BP	I	Analog actual value signal, max. range 0...10 V
13	M24EXT	M24EXT	O	Supplementary pin for jumper, pins 13–14 for three–conductor connection
14	PIST1AN	PIST2AN	I	Analog actual value signal, reference ground
15	PIST1AP	PIST2AP	I	Analog actual value signal, max. range 0...10 V
I = Input, O = Output				

The inputs are differential inputs with 40 kΩ input resistance.

The input voltage range is 0...+10 V.

The power supply output is provided with electronic short–circuit protection.

The power supply output is designed for a total current (4 sensors) of 200 mA.

Supply, pressure sensors with 26.5 V ± 2 % according to the external supply at X431.

Notice

The external 26.5 V power supply voltage cannot be replaced by a 24 V voltage.

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Control valve

- X121: Axis 1
- X122: Axis 2

Table 5-24 ConnectorsX121, X122;15–pin D–Sub socket connector

Pin	X121	X122	Type 1)	Function
1	P24RV1	P24RV2	O	+24 V switched
2	P24RV1	P24RV2	O	+24 V switched
3	P24RV1	P24RV2	O	+24 V switched
4	P24RV1	P24RV2	O	+24 V switched
5	M	M		Electronics ground
6	VSET1N	VSET2N	O	Analog setpoint output, reference ground
7	VSET1P	VSET2P	O	Analog setpoint output +/–10 V
8	M	M		Electronics ground
9	M24EXT	M24EXT	O	Ground, 24 V external
10	M24EXT	M24EXT	O	Ground, 24 V external
11	M24EXT	M24EXT	O	Ground, 24 V external
12	–	–		Not assigned
13	M	M		Electronics ground
14	VACT1N	VACT2N	I	Analog valve actual value input, reference ground
15	VACT1P	VACT2P	I	Analog valve actual value input, +/–10 V
1) I = Input, O = Output				

The analog valve actual value inputs are differential inputs with 100 kΩ input resistance.

The load capability of the 24 V outputs, control value are

- for an ambient temperature 40 °C A2.0
- for an ambient temperature 55 °C 1.5 A

for the average current value for a load duty cycle 10 s duration

It is permissible to linearly interpolate between the temperature transition points.

The short–time load capability of the control valve outputs is 3.0 A (200 ms).

When overloaded, the fuse F1900 or F1901 on the HLA control module is destroyed.

Fuse

The outputs 24 V switched for axes 1 and 2 are protected using a fine fuse F1900 (axis 1) and F1901 (axis 2).

Value: 2.5 AF/250 V; 5x20 mm UL

Company: Wickmann–Werke GmbH
Annenstraße 113
58453 Witten
or
Postfach 2520
58415 Witten

Order No.: 19194

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Terminals

Shut–off valve (axial) supply, 26.5 V external, enable, BERO inputs

- X431: Axis 1
- X432: Axis 2

Table 5-25 Connector X431; 8–pin Phoenix Combicon connector

Pin	X431	Type 1)	Function	Typ. voltage/ limit values
1	M	I	Electronics ground	
2	PV1	O	+24V shut–off valve, axis 1	max. 2.0 A
3	MV1	O	Ground, shut–off valve, axis 1	
4	C1	–	Reserved, do not connect	
5	P24	I	Input +26.5 V external	26.5 V ± 2 %
6	M24	I	Input 0 V external	
7	663	I	Module–specific enable	21 V...30 V
8	9	O	Enable voltage internal +24 V term. 9	
1)	I = Input, O = Output			

Table 5-26 Connectors X432; 8–pin Phoenix Combicon connector

Pin	X432	Type 1)	Function	Typ. voltage/ limit values
1	M	I	Electronics ground	
2	PV2	O	+24V shut–off valve, axis 2	max. 2.0 A
3	MV2	O	Ground, shut–off valve, axis 2	
4	C2	–	Reserved, do not connect	
5	B1	I	BERO input, axis 1	13 V...30 V
6	19	O	Enable voltage internal, ground terminal 19	
7	B2	I	BERO input axis 2	13 V...30 V
8	9	O	Enable voltage internal +24 V terminal 9	
1)	I = Input, O = Output			

Max. terminal cross–section 2.5 mm^2.

Caution

The +24 V outputs, shut–off valve axes 1 and 2 are short–circuit proof. The energy, absorbed when switching–off inductive loads must be limited by the user to 1.7 J. When interchanged (incorrect polarity), the outputs are not protected against overload.

Warning

If the 26.5 V supply is connected with the incorrect polarity then the shut–off valves open immediately, even if the NC or closed–loop control is not operational!

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Notice

There is a current–compensated radio interference suppression reactor at the input of the external supply, terminal P24, terminal M24 (Pins 5, 6 of X431).

This is the reason that it is neither permissible to interchange nor short–circuit terminal M24 and terminal MV1/MV2.

The internal enable voltage (FRP/9) is provided to supply the BEROs and terminal 663, and may **not** be used to supply the hydraulic components. The hydraulic components should be supplied via the supply, P24. The voltages may not be switched in parallel.

Enable inputs

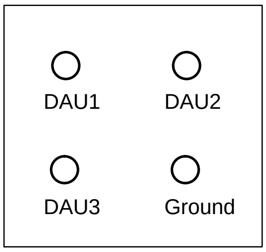
The module–specific enable is realized via terminal 663. There is no relay as there is no power module; the input is evaluated via opto–coupler and additionally acts on the shut–off valve.

Terminal 663 is referred to the internal enable voltage (ground, terminal 19).

5.9.3 Test sockets (diagnostics)

Test sockets

Internal signals can be assigned to test sockets of the 611D drive (in conjunction with SINUMERIK 840D) using the start–up tool or the MMC102/103. These signals are then available at the test sockets as analog values.



Functionality

8–bit D/A converters (DAU) channels are available at the 611D hydraulic module. An analog image of various drive signals can be switched to a test socket via these channels.

Using the 8 bits (=1 byte) of the DAU, only a specific window of the 24 bit drive signals can be displayed. For this reason, the quantization of the selected signal must be defined using a shift factor. The normalization factor is determined when parameterizing the system and is displayed to the user.

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5.10 Control module ”ANA module”

Description

Up to two analog axes can be handled using the ANA control module. An ANA module is obtained when it is inserted in the 50 mm wide universal empty housing.

The control module can also be used as HLA control module for hydraulic axes. It is permissible to mix axes (ANA/HLA) using this double–axis module.

An analog axis can be essentially used just like a digital axis. It can be programmed just like a digital interpolating path axis or spindle. Naturally, pure functions of the digital SIMODRIVE 611 drive control are not possible for the external drive units when coupled via an analog speed setpoint interface. (In this case, it involves a functional scope, which accesses the internal axis feedback and communications via the drive bus, e.g. Safety Integrated). If required, separate EMC measures should be provided for the external drive equipment.

Note

The ANA module is described in detail in:

Reference: /FBANA/, SINUMERIK 840D SIMODRIVE 611 digital ANA module, description of functions

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Features

The ANA module has the following features:

- Software and data

  The communications interface for supported utilities (services) is compatible to SIMODRIVE 611 SRM(FD)/ARM(MSD). The code and data administration is analog to SIMODRIVE 611 SRM(FD)/ARM(MSD).

- Hardware

  The ANA module is integrated into the SIMODRIVE 611 system, compatible to
  SIMODRIVE 611 digital SRM(FD)/ARM(MSD). This essentially involves the following interfaces:

  – Drive bus
  – Equipment bus
  – Power supply concept

- ANA control module (2 axes)

  – n_{set} output $\pm$10 V
  – 2 sensors can be connected per axis
  – An analog drive amplifier can be controlled

- Terminals and diagnostics

  – BERO input per axis
  – Module–specific enable
  – Test sockets (DAU)

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5.10.1 System overview

A complete 840D control with ANA module comprises various individual components. These will now be listed.

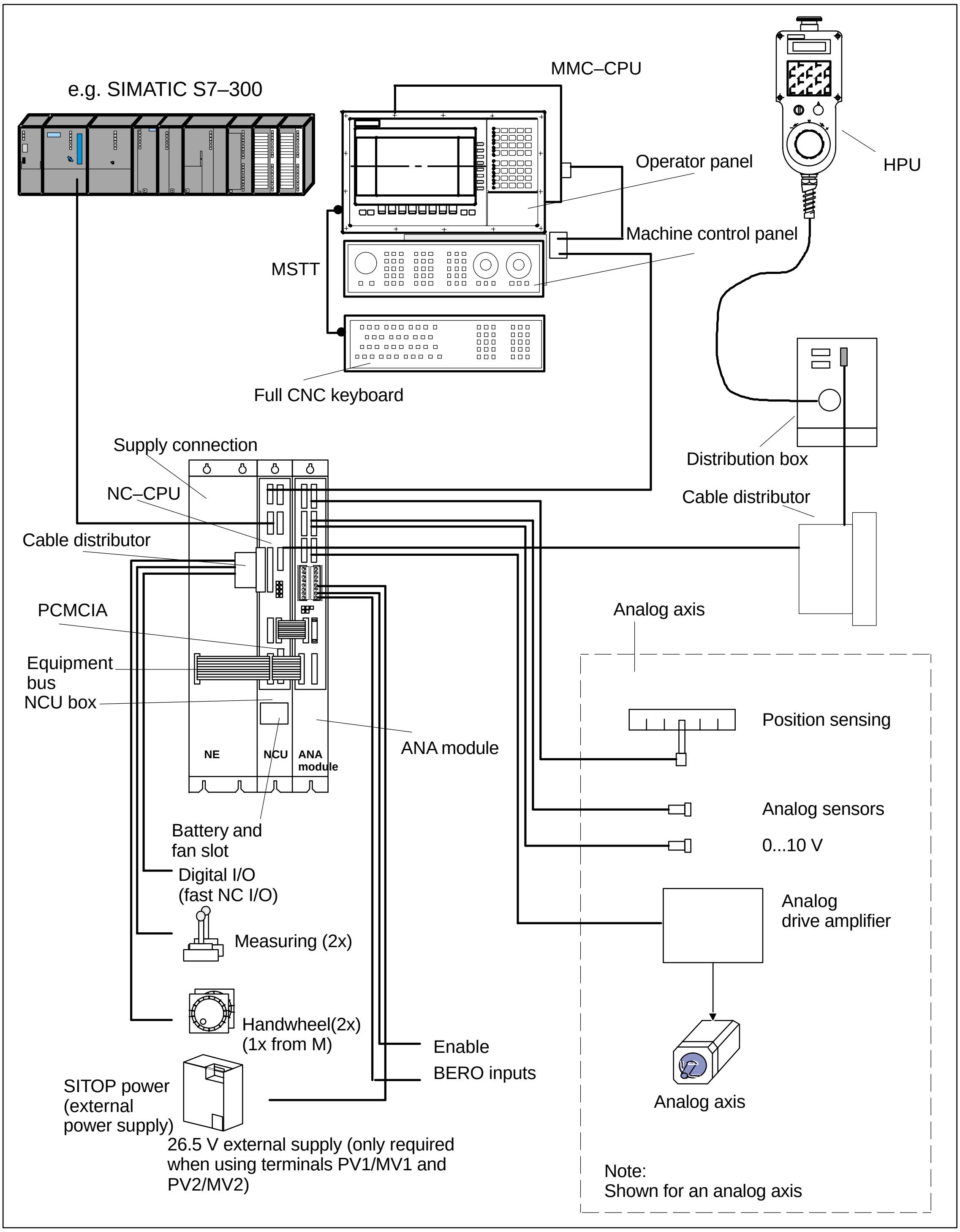

Fig. 5-15 System components

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ANA control module

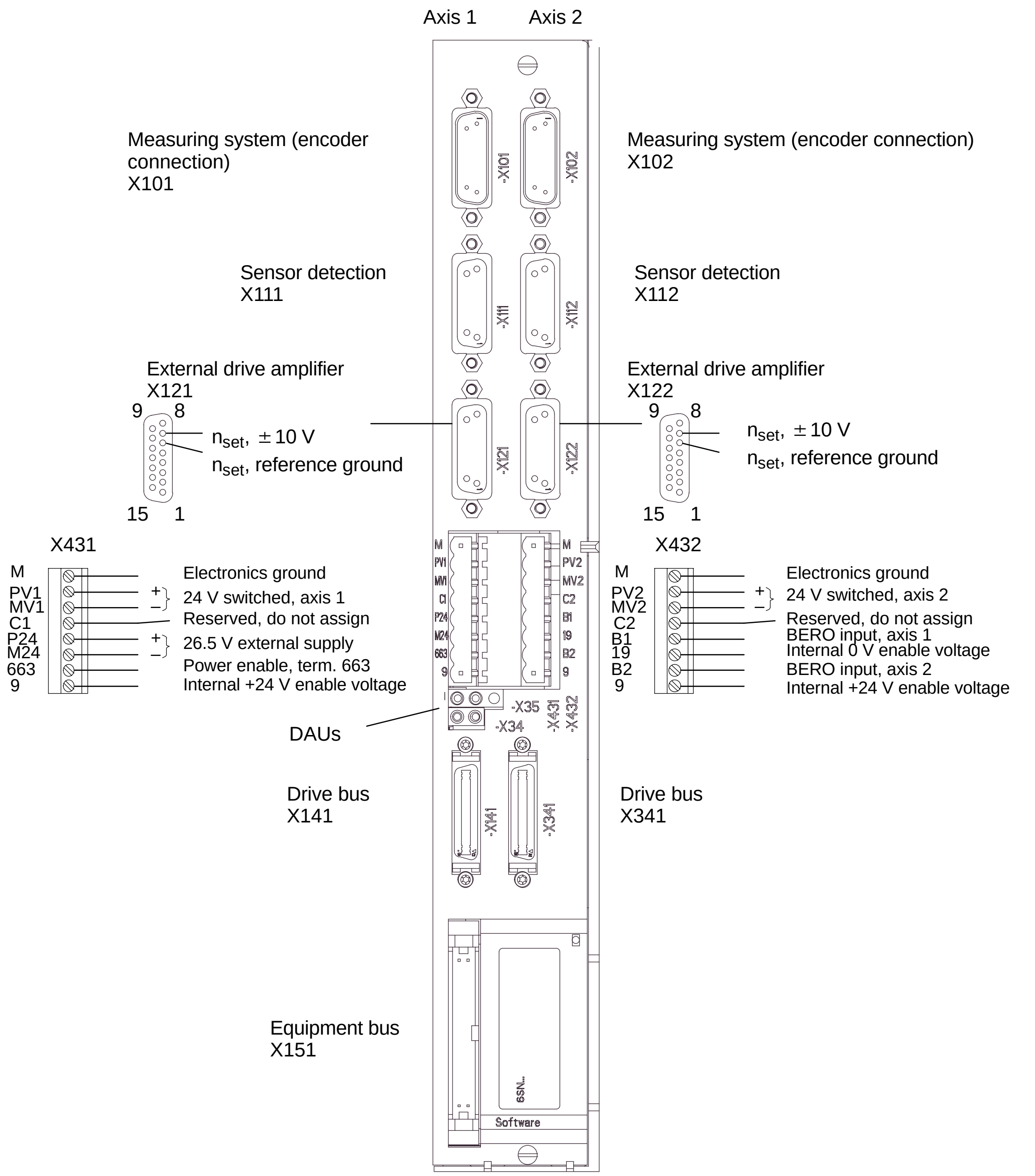

Fig. 5-16 ANA control module (2 axes)

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5.10.2 Wiring

Supply connection

SINUMERIK 840D and the ANA module are supplied from the SIMODRIVE line supply infeed or from the SIMODRIVE monitoring module via the equipment bus. There must be at least one NE module in the equipment group if an ANA module is used. It is not possible to connect a voltage in any other way and this could damage the equipment.

Notice

It is not permissible to operate an ANA module alone on the SIMODRIVE monitoring module!

The power supply for subsequently connected electrical axes is realized via the DC link busbars (40 mm^2) of the support module.

Measuring systems

One position encoder can be evaluated per axis on the ANA module.

- X101: Axis 1
- X102: Axis 2

The measuring system must always be inserted at the connector of the associated axis.

Table 5-27 Connectors X101, X102; × 15–pin D–Sub plug connectors (double tier)

Pin	X101	X102	Function
1	PENC0	PENC2	Encoder power supply
2	M	M	Ground, encoder power supply
3	AP0	AP2	Incremental signal A
4	AN0	AN2	Inverse incremental signal A
5	BMIDAT0	BMIDAT2	Data signal EnDat interface
6	BP0	BP2	Incremental signal B
7	BN0	BN2	Inverse incremental signal B
8	XBMIDAT0	XBMIDAT2	Inverse data signal EnDat interface
9	PSENSE0	PSENSE2	Remote sense, encoder power supply (P)
10	RP0	RP2	Incremental signal R
11	MSENSE0	MSENSE2	Remote sense, encoder power supply (M)
12	RN0	RN2	Inverse incremental signal R
13	M	M	Ground (for inner shields)
14	BMICLK0	BMICLK2	Clock signal, EnDat interface
15	XBMICLK0	XBMICLK2	Inverse clock signal EnDat interface

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Analog sensors

2 sensors can be connected per axis

- X111: Axis 1 (sensors 1A, 1B)
- X112: Axis 2 (sensors 2A, 2B)

Table 5-28 Connectors X111, X112; respective 15–pin D–Sub socket connector

Pin	X111	X112	Type 1)	Function
1	P24DS	P24DS	O	Sensor supply with external +24 V
2	P24DS	P24DS	O	Sensor supply with external +24 V
3	–	–		not assigned
4	–	–		not assigned
5	M24EXT	M24EXT	O	Sensor supply with external 0 V
6	–	–		not assigned
7	–	–		not assigned
8	–	–		not assigned
9	M24EXT	M24EXT	O	Sensor supply with external 0 V
10	M24EXT	M24EXT	O	Supplementary pin for jumper, pins 10–11 for 3–conductor connection
11	**PIST1BN**	**PIST2BN**	I	**Analog actual value signal, reference ground**
12	**PIST1BP**	**PIST2BP**	I	**Analog actual value signal, max. range 0...10 V**
13	M24EXT	M24EXT	O	Supplementary pin for jumper pins 13–14 for 3–conductor connection
14	**PIST1AN**	**PIST2AN**	I	**Analog actual value signal, reference ground**
15	**PIST1AP**	**PIST2AP**	I	**Analog actual value signal, max. range 0...10 V**

1) I: Input, O: Output

The inputs are differential inputs with 40 kΩ input resistance.
The input voltage range of the actual value inputs is 0...+10 V.

The power supply output has electronic short–circuit protection.
The supply output is dimensioned for a total current (4 sensors) of 200 mA.

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Analog setpoints and actual values

- X121: Axis 1
- X122: Axis 2

Table 5-29 Connectors X121, X122; 15–pin D–Sub socket connectors

Pin	X121	X122	Type 1)	Function
1	P24RV1	P24RV2	O	P24EXT switched, from X431.5
2	P24RV1	P24RV2	O	P24EXT switched, from X431.5
3	P24RV1	P24RV2	O	P24EXT switched, from X431.5
4	P24RV1	P24RV2	O	P24EXT switched, from X431.5
5	M	M		Electronics ground
6	**VSET1N**	**VSET2N**	**O**	**Analog setpoint output, reference ground**
7	**VSET1P**	**VSET2P**	**O**	**Analog setpoint output +/–10 V**
8	M	M		Electronics ground
9	M24EXT	M24EXT	O	M24EXT, from X431.6
10	M24EXT	M24EXT	O	M24EXT, from X431.6
11	M24EXT	M24EXT	O	M24EXT, from X431.6
12	–	–		Not assigned
13	M	M		Electronics ground
14	**VACT1N**	**VACT2N**	I	**Analog actual value input, reference ground**
15	**VACT1P**	**VACT2P**	I	**Analog actual value input, +/–10 V**

1) I: Input, O: Output

The analog actual value inputs are differential inputs with 100 kΩ input resistance.

The load capability of the 24 V outputs (P24RV1/2) is

- for an ambient temperature of 40 °C 2.0 A
- for an ambient temperature of 55 °C 1.5 A

For the average current value and a load duty cycle with 10 s duration.

It is permissible to linearly interpolate between the temperature transition points.

The short–time load capability of the 24 V output is 3.0 A (200 ms).

When overloaded, fuse F1900 or F1901 on the ANA control module is destroyed.

Fuse

The 24 V switched outputs for axes 1 and 2 are protected with a fine fuse F1900 (axis 1) or F1901 (axis 2).

Value: 2.5 AF/250 V; 5x20 mm UL

Company: Wickmann–Werke GmbH
Annenstraße 113
58453 Witten
or
Postfach 2520
58415 Witten

Order No.: 19194

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Terminals

26.5 V external supply, enable, BERO inputs

- X431: Axis 1
- X432: Axis 2

Table 5-30 Connector X431; 8–pin Phoenix Combicon connector

Pin	X431	Type 1)	Function	Typ. voltage/ limit values
1	M	I	Electronics ground	
2	PV1	O	P24EXT switched, axis 1	max. 2.0 A
3	MV1	O	M24EXT switched, axis 1	
4	C1	–	Reserved, do not connect	
5	P24	I	Input +24 V external	26.5 V ± 2 %
6	M24	I	Input 0 V external	
7	663	I	Module–specific enable	21 V...30 V
8	9	O	Internal +24 V enable voltage	
1)	I = Input, O = Output			

Table 5-31 Connector X432; 8–pin Phoenix Combicon connector

Pin	X432	Type 1)	Function	Typ. voltage/ limit values
1	M	I	Electronics ground	
2	PV2	O	P24EXT switched, axis 2	max. 2.0 A
3	MV2	O	M24EXT switched, axis 2	
4	C2	–	Reserved, do not connect	
5	B1	I	BERO input, axis 1	13 V...30 V
6	19	O	Internal enable voltage, ground term. 19	
7	B2	I	BERO input, axis 2	13 V...30 V
8	9	O	Internal enable voltage, +24 V	
1)	I = Input, O = Output			

Notice

It is **not permissible** to establish a connection (jumper) between X431.6 and X432.3!

Max. terminal cross–section 2.5 mm^2.

It is only necessary to supply terminal X431, pins 5 and 6, with 24 V, if the 24 V outputs of connector X111/112, X121/122 or X431/432 are to be used.

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Caution

The +24 V outputs of shut–off valves, axes 1 and 2 are short–circuit proof. The energy absorbed when switching–off inductive loads must be limited by the user to 1.7 J. When incorrectly connected (polarity interchanged), the outputs are not protected against overload.

Enable inputs

The module–specific enable is realized via terminal 663. The input is evaluated via the optocoupler in the ANA module. The enable voltage can be taken from terminal 9.

Terminal 663 is referred to the internal enable voltage (ground, terminal 19).

5.10.3 Bus interfaces

Drive bus

(refer to SIMODRIVE 611A/D)

- X141: Input
- X341: Output

A bus terminating connector must be inserted at the last module.

Equipment bus

(refer to SIMODRIVE 611A/D)

- X151: Equipment bus

■

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6 Infeed Modules

Description

The drive group is connected to the power supply through the infeed modules. The infeed/regenerative feedback module (I/R module) and the module for uncontrolled infeed (UI module) is used to feed the power to the DC voltage link. Furthermore, the I/R, UI, and the monitoring module also provides the electronics power supply for the connected modules.

UI module

For the UI module, the energy of the drives fed into the DC link when braking is converted into heat in the integrated brake resistors or brake resistors which should be mounted externally and then dissipated to the ambient air. When required, in addition, one or several pulsed resistor modules can be used within the configuring limits. This module is used for:

- Machines with only a few and short braking cycles with low energy when braking
- Operation on line supplies from $SK_{\text{line supply}}/P_{nUI} \geqq 30$
- Drive groups with low dynamic requirements, especially for main spindle drives

I/R module

For the I/R module, the energy of the drives, fed into the DC link when braking, is fed back into the line supply. This module is used for:

- Machines with high dynamic requirements placed on the drives
- Frequent braking cycles and high levels of braking energy
- Cabinet concepts optimized for low operating costs

Monitoring module

The monitoring module includes a complete electronics power supply for the equipment bus and the central monitoring functions for a separate drive group. The power supply can be derived from both the 3–ph. 400V to 480V AC line supply as well as from the DC link. The monitoring module is required if a larger number of drive modules in a group exceeds the electronics power supply of the infeed module (I/R or UI module). Using the monitoring module, groups of drive modules can be formed in several cabinet panels or mounting tiers.

Arrangement

The I/R, UI and monitoring module are located as the first module to the left in the drive group.

The line supply infeed and drive modules as well as the commutating reactors and line filters must be mounted on mounting panels with a good conductive surface (e.g. galvanized mounting panel).

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Line filter and line filter modules and shielded cables are available to fulfill CE conformance for the radio interference suppression voltage limit values.

Shield connecting plates should be used for wiring in compliance with EMC guidelines using shielded power cables.

The overvoltage limiting module is required for line supply infeed modules in conformance with UL.

$$\text{Number of pre–charging operations within 8 min.} = \frac{\text{Charge limit, infeed module } [\mu F]}{\Sigma \text{ DC link capacitance of the drive group } [\mu F]}$$

Fig. 6-1 Pre–charging frequency of the DC link

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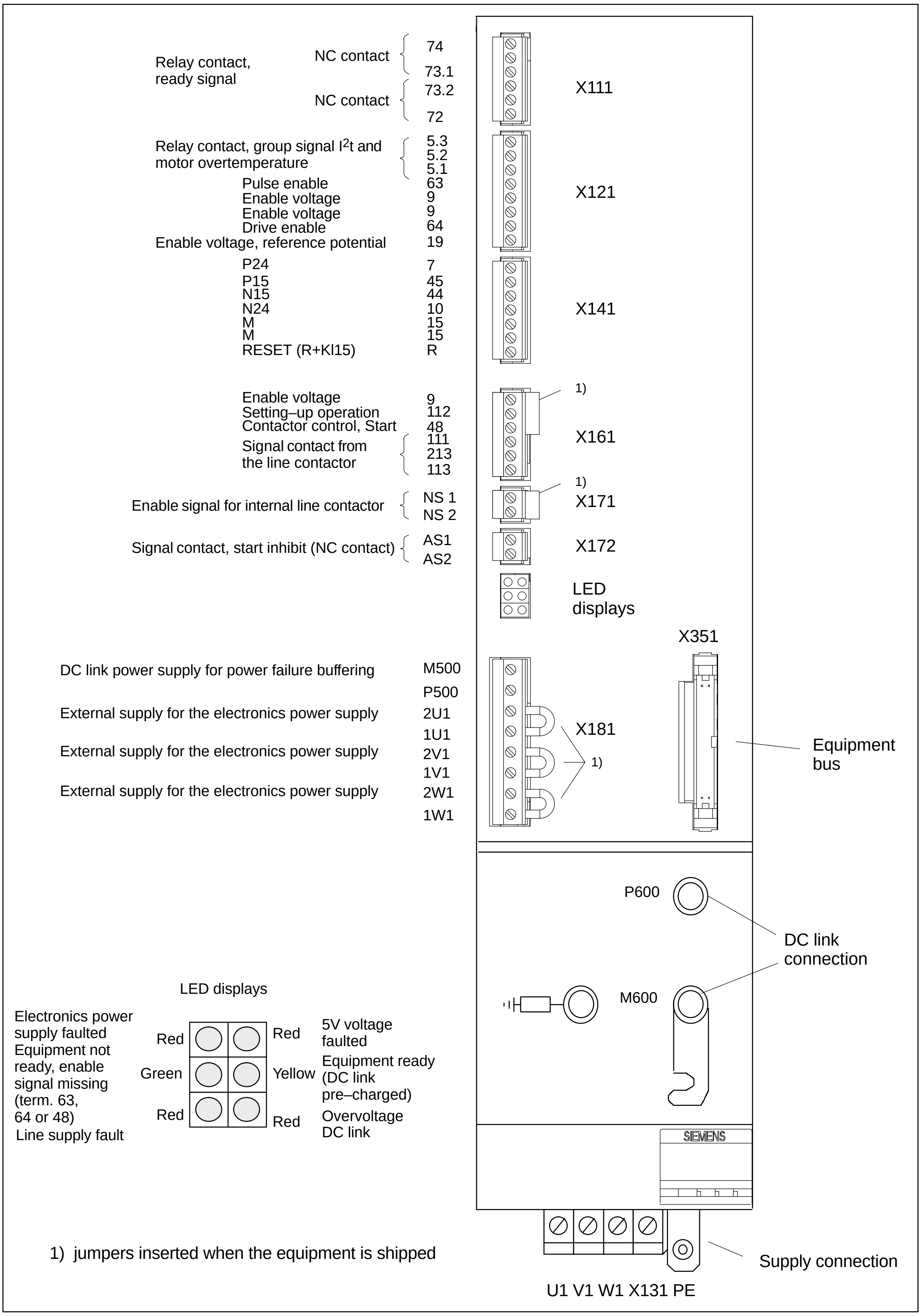

Fig. 6-2 Infeed/regenerative feedback module

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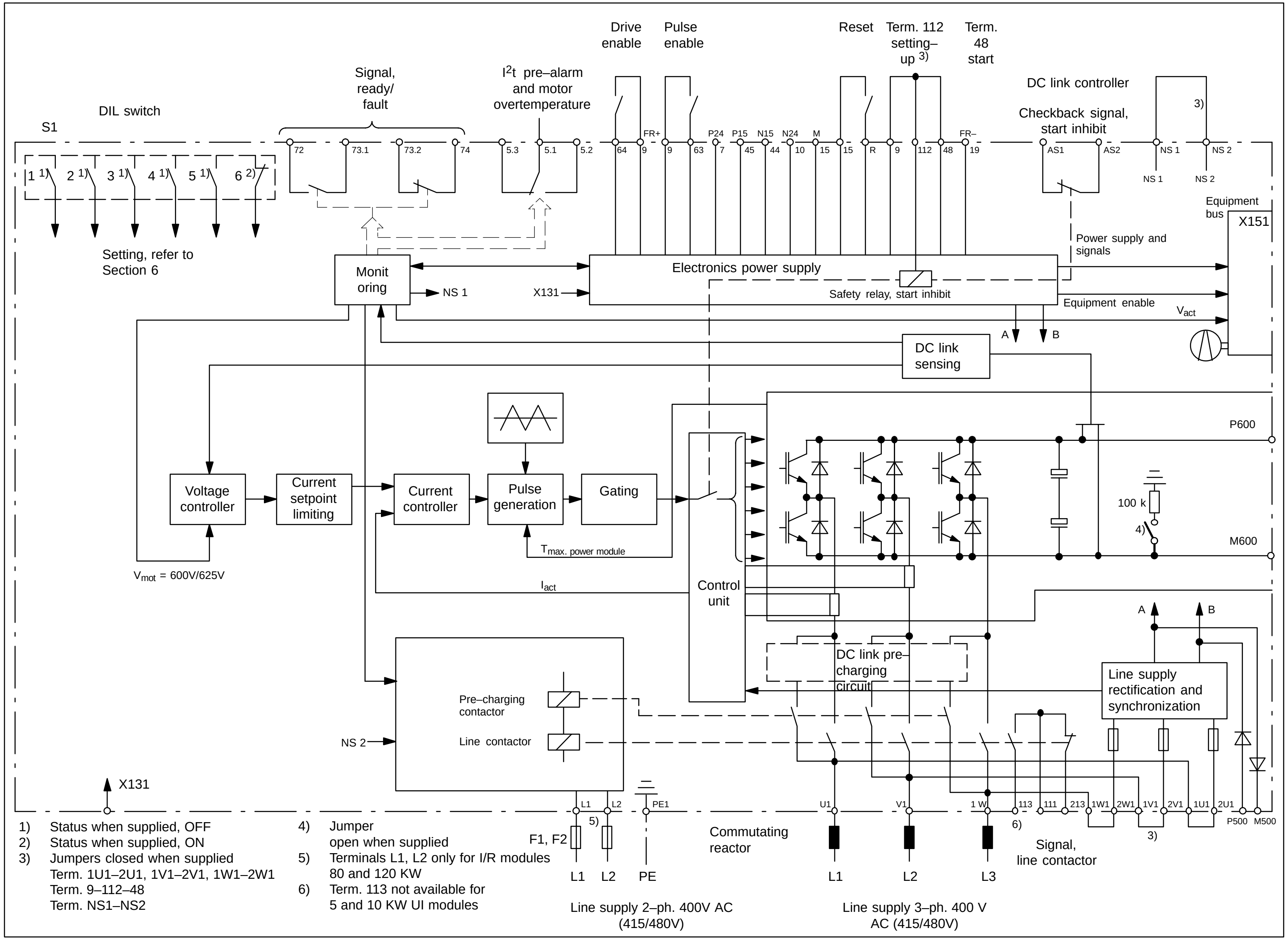

Fig. 6-3 Block diagram, line supply infeed module (I/R)

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6.1 Function overview and settings

General information

Switch S1 is provided on the upper side of the NE and monitoring module to set the following functions (for 5 kW UI at the front panel):

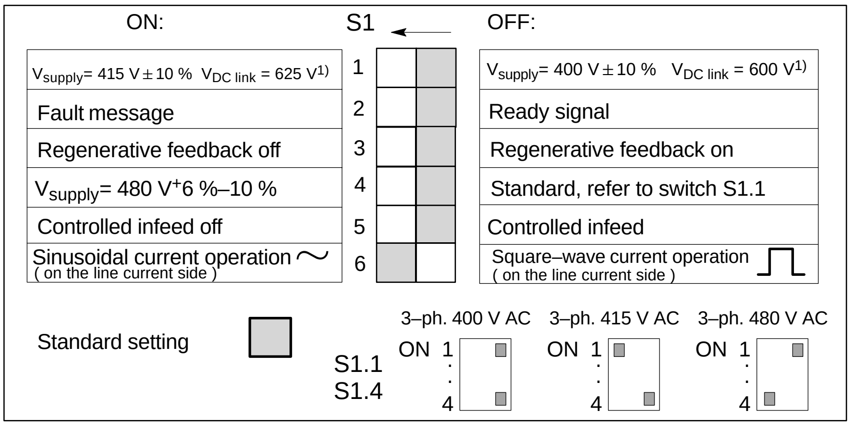

Fig. 6-4 DIL switch S1

Note

For a configuration for 480 V (S1.4= ON), the regenerative feedback is closed–loop controlled. The setting of S1.5 is of no importance.

Notice

For I/R modules, Order number: 6SN114□–1□□0□–0□□**1** Sinusoidal operation is the basic setting.

For operation with filters, which are not listed in Table 6-1 the system must be changed–over to squarewave current operation, in order that the filter is not thermally overloaded.

Terminal 63 (pulse enable) and/or terminal 48 (start terminal, contactor control) must be de–energized before the system is powered–up or powered–down using the main switch or a line contactor!

Switch S1.1

OFF: I/R module, V_{supply} = 400 V ± 10 %; $V_{DC\ link}$ = 600 V
UI module V_{supply} = 400 V ± 10 %; $V_{DC\ link}$ = V_{supply}•1.35
Monitoring thresholds: (I/R, UI, monitoring modules)
PW on = 644 V; PW off = 618 V
$U_{DC\ link}$ >> = 695 V

ON: I/R module V_{supply} = 415 V ± 10 %; $V_{DC\ link}$ = 625 V
UI module V_{supply} = 415 V ± 10 %; $V_{DC\ link}$ = U_{supply}•1.35
Monitoring thresholds: (I/R, UI, monitoring modules)
PW on = 670 V; PW off = 640 V
$V_{DC\ link}$>> = 710 V

PR = Pulsed resistor

1) only possible for the I/R module, monitoring thresholds are increased for all NE modules.

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Switch S1.2

OFF: Ready signal (X111 ready relay)
For S1.2 = OFF, the relay pulls–in if the following conditions are fulfilled:

- Internal main contactor CLOSED (terminals NS1 - NS2 connected, terminal 48 enabled)
- Terminal 63, 64=ON (energized)
- No fault present (also not on FD 611 A standard, 611 U, resolver and 611 D drives or HLA modules).
- FD with Standard interface or resolver is enabled in the "ready" setting (terminals 663, 65)
- For 840D/810D, the NCU must have run–up

ON: Fault signal (X111 ready relay)
For S1.2 = ON, the relay pulls–in if the following conditions have been fulfilled:

- Internal main contactor CLOSED (terminals NS1 - NS2 connected, terminal 48 enabled)
- No fault present (also not on FD 611 A standard, 611U, resolver and 611 D drives and HLA modules).
- FD with Standard interface or resolver is enabled in the "ready" setting (terminals 663, 65)
- For 840D and 810D, the NCU must have run–up

Switch S1.3

OFF: Standard setting, regenerative feedback active
I/R modules: 16 KW to 120 KW are capable of regenerative feedback.
UI module: 5 KW, 10 KW, 28 KW: The pulsed resistor in the module is effective.

ON: Regenerative feedback disabled
I/R modules: 16 KW to 120 KW: Regenerative feedback operation is inhibited
UI module: 5 KW, 10 KW: The pulsed resistor in the module is inactive

Valid for all 5 KW and 10 KW UI from
Order number: 6SN1146–1AC00–0AA1.

Not valid for UI 28 KW. In this case, the external pulsed resistor must be disconnected.

Switch S1.4

OFF: Standard setting for all NE modules, refer to S 1.1

ON: V_{supply} = 480 V +6% / –10 %; $V_{DC\ link} = V_{supply} \bullet 1.35$ for infeed operation
$V_{DC\ link}$ = 700 ... 750 V in regenerative feedback operation
Monitoring thresholds: (I/R, UI, monitoring modules)
Pulsed resistor on = 744 V; Pulsed resistor off = 718 V
$V_{DC\ link}$>> = 795 V
S1.4 overwrites the setting of S1.1

Comment: Uncontrolled operation in the infeed direction.

Warning

For operation with 480 V line supplies, it is extremely important that before powering up (switching in the line supply), switch S1.4 = ON is set to ON, as otherwise the infeed circuit in the NE module will be overloaded.

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Note

Only in conjunction with module Order No.: 6SN114_–1__0_–0__**1**.
For motors with shaft heights < 100: Utilized up to max. 60 k values.
Please observe the Planning Guide, Motors.
S1.4 ON overwrites the functions of S1.5 and S1.1.

Switch S1.5

This function is only available in conjunction with I/R modules
Order number: 6SN114_–1B_0_–0_A**1**
OFF: Standard setting, controlled infeed active

ON: Uncontrolled operation in the infeed direction $V_{DC\ link} = V_{supply} \bullet 1.35$

Notice:
When the I/R units are operated uncontrolled, they must be de–rated by approx. 75 %.

Switch S1.6

OFF: Square–wave current operation (the line supply is loaded with a square–wave current)

ON: This function is only available in conjunction with I/R modules
Order number: 6SN114_–1B_0_–0_A**1**
Sinusoidal current operation (the line supply is loaded with sinusoidal current)

Note

For sinusoidal supply, the total length of the power cables (motor feeder cable, DC link cable) may not exceed 350m, and for squarewave, they may not exceed 500m.

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Sinusoidal current operation is only permissible, if the following components are used:

Table 6-1 Combination for sinusoidal current operation (regenerative feedback into the line supply)

I/R 16 kW	I/R 36 kW	I/R 55 kW	I/R 80 kW	I/R 120 kW
For internal cooling:	**For internal cooling:**	**For internal cooling:**	**For internal cooling:**	**For internal cooling:**
6SN1145–1BA01–0BA1	6SN1145–1BA02–0CA1	6SN1145–1BA01–0DA1	6SN1145–1BB00–0EA1	6SN1145–1BB00–0FA1
For external cooling:	**For external cooling:**	**For external cooling:**	**For external cooling:**	**For external cooling:**
6SN1146–1BB01–0BA1	6SN1146–1BB02–0CA1	6SN1146–1BB00–0DA1	6SN1146–1BB00–0EA1	6SN1146–1BB00–0FA1
HF reactor 16 kW	**HF reactor 36 kW**	**HF reactor 55 kW**	**HF reactor 80 kW**	**HF reactor 120 kW**
6SN1111–0AA00–0BA1	6SN1111–0AA00–0CA1	6SN1111–0AA00–0DA1	6SN1111–0AA00–1EA0	6SN1111–0AA00–1FA0
Line filter for sinusoidal current [1)]16 kW	**Line filter for sinusoidal current [1)]36 kW**	**Line filter for sinusoidal filter[1)]55 kW**	**Line filter for sinusoidal current[1)]80 kW**	**Line filter for sinusoidal current[1)]120 kW**
6SN1111–0AA01–2BA0	6SN1111–0AA01–2CA0	6SN1111–0AA01–2DA0	6SN1111–0AA01–2EA0	6SN1111–0AA01–2FA0

Line supply filter packages are available for the I/R modules. These line filter packages comprise a line supply filter and an HF commutating reactor. If non–certified/authorized components are used, then it is possible that the certificate, issued for this equipment, no longer applies and that these components represent a potential hazard. Adapter sets are available to adapt the line supply filter packages to the mounting surface and to the retaining points of the previous filter modules (Order No., refer to Catalog NC 60)

Caution

It is only permissible to set squarewave current operation for all of the combinations which are not listed here (discontinued filter module 6SN11 11–0AA01–0_A_).

For all other operating modes, there is a danger of thermal overload.

Table 6-2 Power factor

I/R	Line–side sinusoidal current operation	cos φ ≈ 0.98	cos λ = 0.97
I/R	Line–side squarewave current operation	cos φ ≈ 0.98	cos λ = 0.89
UI		cos φ ≈ 0.87	cos λ = 0.67

cos φ: The power factor only includes the basic fundamental
cos λ: Power factor includes the basic fundamental and harmonic components

[1)] The HF commutating reactor must be externally mounted. (refer to Section 7.1.3).
The line filter is required in order to achieve the CE Conformance for the radio interference voltage.

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6.2 Power modules operated from an uncontrolled infeed

The drive modules can always be operated from the uncontrolled and controlled infeed modules of the SIMODRIVE 611 drive converter system. The configuring/ engineering and power data of this Planning Guide refers to operation with the controlled infeed/regenerative feedback modules. This data, if required, should be corrected when operated from uncontrolled infeed modules.

– Operation of drive modules with PH and 1FE1 motors and induction motors on the uncontrolled infeed

When operating main spindle and induction drive modules from uncontrolled infeeds (UI modules), a lower maximum motor output is available in the upper speed range than when using the infeed/regenerative feedback module.

For the UI module, the following inter–relationship is obtained for the available continuous output as a result of the lower DC link voltage of 490 V (for line supply infeed with 3–ph. 400 V AC – 10%):

If

$$\frac{V_{DC\ link}}{1.5 \times V_{N\ motor}} < 1$$

then, the max. continuous output is given by:

$$P_{cont.} = P_N \times \frac{V_{DC\ link}}{1.5 \times V_{N\ motor}}$$

$V_{DC\ link}$ = 490 for UI modules
$V_{DC\ link}$ = 600 for I/R modules

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Furthermore, for UI modules, it must be observed that the braking energy does not exceed the pulsed resistor rating:

- 5 kW infeed module
  - 200 W continuous output
  - 10 kW short–time output
    for 120 ms once per 10 s switching cycle without pre–load condition
- Infeed module 10 kW
  - 300 W continuous output
  - 25 kW short–time output
    for 120 ms once per 10 s switching cycle without pre–load condition
- Infeed module 28 kW
  - max. 2 x 300 W continuous output
  - max. 2 x 25 kW short–time output
    for 120 ms once per 10 s switching cycle without pre–load condition

    or

  - max. 2 x 1.5 kW continuous output
  - max. 2 x 25 kW short–time output
    for 120 ms once per 10 s switching cycle without pre–load condition

For 28 kW UI, the pulsed resistors must be separately ordered and must be externally mounted.

For higher regenerative feedback powers, a separate pulsed resistor module must be used or the regenerative feedback power must be reduced by using longer braking times.

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6.3 Technical data

Table 6-3 Technical data, I/R modules

Internal cooling **External cooling** **Hose cooling**	**6SN 1145–** **6SN 1146–** **6SN 1145–**	**1BA0.–0BA1** **1BB0.–0BA1** **–**	**1BA0.–0CA1** **1BB0.–0CA1** **–**	**1BA0.–0DA1** **1BB0.–0DA1** **1BB0.–0DA1**	**1BB0.–0EA1** **1BB0.–0EA1** **1BB0.–0EA1**	**1BB0.–0FA1** **1BB0.–0FA1** **1BB0.–0FA1**
Infeed: Rated power (S1) Infeed power (S6–40%) Infeed peak power	 KW KW KW	 16 21 35	 36 47 70	 55 71 91	 80 104 131	 120 156 175
Regenerative feed-back: Continuous regenera-tive feedback power Regenerative feedback peak power	KW KW	16 35	36 70	55 91	80 131	120 175
Connection data Voltage Frequency	 V Hz	 3–ph. 400 V AC –10 % to 3–ph. 480 V AC +6 % 50 to 60 ± 10 %				
Rated current (400V/480V)	A	27/22.5	60.5/50.4	92.5/77.1	134/111.7	202/168.3
Input current at 360 V_{AC}	A	30	67.3	103	149	224.5
Input current for (480V; S6–40%)	A	29.6	65.8	99.2	145.8	218.3
Peak current (400V/480V)	A	59/49.2	117.5/97.9	153/127.5	220/183.3	294/245
Connection cross–section, max.	mm^2	16	50	95	95	150
Output voltage	V	600 / 625 / 680				
Output current at 600 V_{DC} Rated current Output current (480V; S6–40%) Peak current	 A A A	 22.1 29.2 48.3	 50 65 96.7	 75.8 98.3 125.8	 110.8 144.2 181.7	 166.7 216.7 242.5
Module width	mm	100	200	300	300	300
Cooling type Internal cooling		Internal separately–driven fan	Internal separately–driven fan	Internal sepa-rately–driven fan	Mounted fan	Mounted fan
External cooling		Integrated separately–driven fan	Integrated separately–driven fan	Fan assembly and mounted fan required		
Hose cooling		–	–	Kit for hosing cooling with fan		
Cooling type Internal cooling External cooling Hose cooling	 W W (int./ext.) W (int./ext.)	 320 50/270 –	 585 50/535 –	 745 115/630 115/630	 1280 190/1090 190/1090	 1950 290/1660 290/1660
Efficiency η		0.97	0.975	0.977	0.977	0.978
Weights Internal cooling External cooling Hose cooling	 kg kg kg	 10.5 10.5 –	 15.5 15.5 –	 26 26 26	 26 26 26	 29 29 29

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Table 6-4 Technical data, UI modules

Internal cooling **External cooling** **Hose cooling**	**6SN 1145–** **6SN 1146–** **6SN 1145–**	**–** **1AA0.–0AA1** **–**	**1AA0.–0CA0** **1AB0.–0CA0** **–**	**1AA0.–0CA0** **1AB0.–0CA0** **–**
Infeed: Rated power (S1) Infeed power (S6–40%) Infeed peak power	 KW KW KW	 5 6.5 10	 10 13 25	 28 36 50
Continuous/peak power of the integrated pulsed resistor	KW	0.2/10	0.3/25	–
Connection data: Voltage Frequency	 V Hz	 3–ph. 400 V AC –10 % up to 3–ph. 480 V AC +6 % 50 to 60 ± 10 %		
Rated current Input current for 360 V_{AC} Peak current Connection cross–section, max.	A A A mm^2	9.4 12.3 18.8 6	18.2 23.8 38.8 16	48.8 62.5 87.1 50
Output voltage	V	490 to 680 +6 %		
Output current for 650 V_{DC} Rated current Output current (S6–40%) Peak current	 A A A	 7.8 10 15.5	 15.4 20 38.8	 43.3 55.8 77.5
Module width	mm	50	100	200
Cooling type Internal cooling External cooling Hose cooling		 Non–ventilated Non–ventilated –	 Universal cooling internal/external –	 Internal separately–driven fan Integrated separately–driven fan
Cooling type Internal cooling External cooling Hose cooling	 W W (int./ext.) W (int./ext.)	 270 270/– –	 450 119/331 –	 745 90/160 –
Efficiency η		0.985	0.985	0.985
Weights Internal cooling External cooling Hose cooling	 kg kg kg	 6.5 6.5 –	 9.5 9.5 –	 15.5 15.5 –

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6.3.1 Technical data, line supply infeed modules

Supply voltage and frequency

Table 6-5 Supply voltage and frequency

	S1, S4 = OFF Vn = 3–ph. 400 V AC	**S1 = ON Vn = 3–ph. 415 V AC**	**S4 = ON Vn = 3–ph. 480 V AC**
NE modules up to P_n ≤ ×55 kW I/R modules Pn = 80/120 kW Power connection: U1, V1, W1	3–ph. 360...440 V AC 3–ph. 300...360 V AC [1)] 45...65 Hz	3–ph. 373...457 V AC 3–ph. 312...373 V AC [1)] 45...65 Hz	3–ph. 432...509 V AC 3–ph. 408...432 V AC [1)] 55...65 Hz
Coil connection: L1, L2 only for 80 kW and 120 kW	2–ph. 360...457 V AC / 45...53 Hz 2–ph. 400...510 V AC / 57...65 Hz		

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No ground fault

The cabinet wiring, the motor/encoder feeder cables and the DC link connections should be checked to ensure that there are no ground faults before the equipment is powered–up for the first time.

Nominal load duty cycles for NE modules

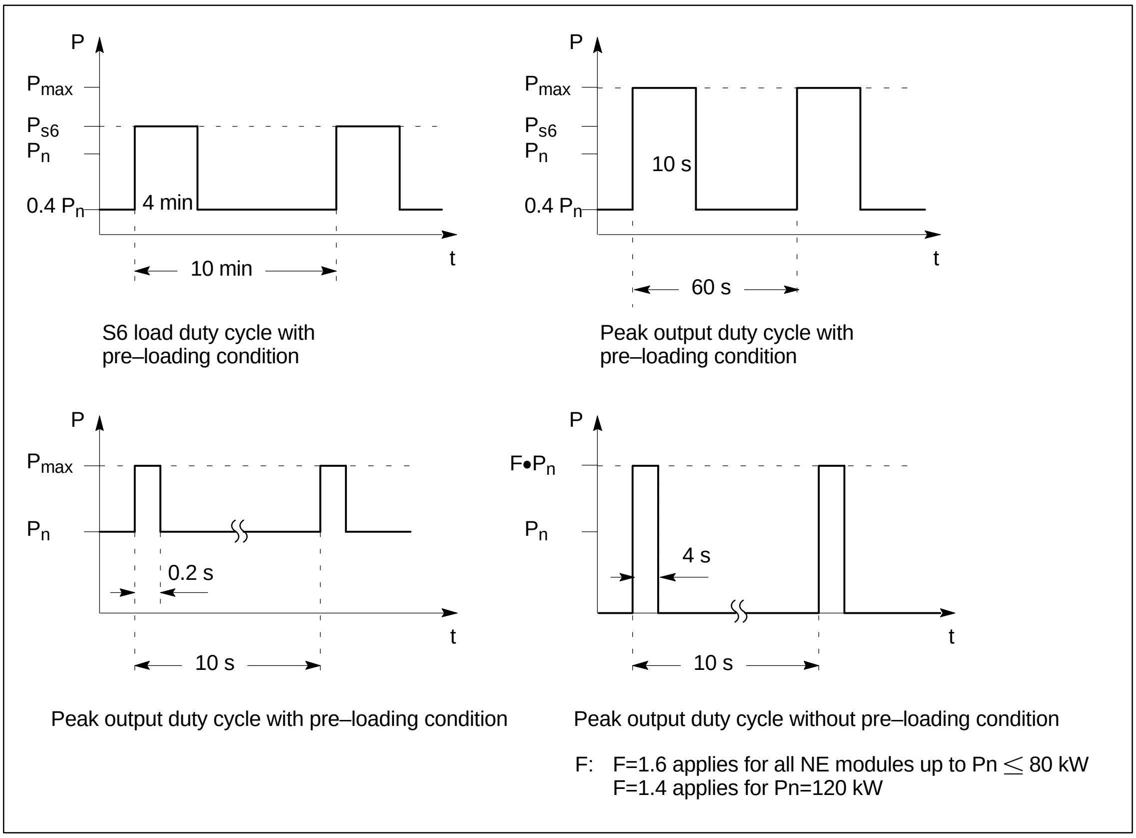

Fig. 6-5 Nominal load duty cycles for NE modules

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The following rule of thumb is valid:

The following applies for load duty cycles with a period duration $T \leq 10$ s:

$$\sqrt{\frac{1}{T}\int_0^T \left(\frac{P_{(t)}}{P_n}\right)^2 dt} < 1.03; \quad P_n < P_{(\tau)} \leq P_{max}; \quad \tau \in [0, T]$$

The following applies for load duty cycles with a period duration $10\ \text{s} < T \leq 1$ min:

$$\sqrt{\frac{1}{T}\int_0^T \left(\frac{P_{(t)}}{P_n}\right)^2 dt} < 0.90; \quad P_n < P_{(\tau)} \leq P_{max}; \quad \tau \in [0, T]$$

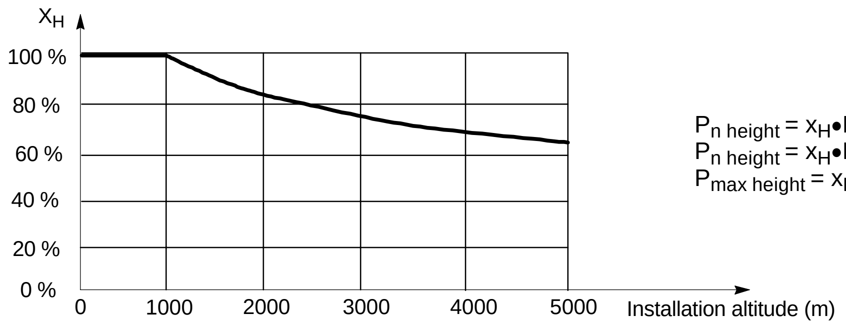
The following applies for load duty cycles with a period duration $1\ \text{min} < T \leq 10$ min:

$$\sqrt{\frac{1}{T}\int_0^T \left(\frac{P_{(t)}}{P_n}\right)^2 dt} < 0.89; \quad P_n < P_{(\tau)} \leq P_{max}; \quad \tau \in [0, T]$$

$P_{(t)}$ = the power presently drawn

De–rating dependent on the installation altitude

All of the specified outputs are valid up to 1000 m above sea level. For an installation altitude > 1000 m, the specified outputs should be reduced according to the diagrams below. For installation altitudes > 2000 m[1)] an isolating transformer must be used.



$P_{n\ height} = x_H \bullet P_{n1000\ m}/100\ \%$
$P_{n\ height} = x_H \bullet P_{s61000\ m}/100\ \%$
$P_{max\ height} = x_H \bullet P_{max1000\ m}/100\ \%$

Fig. 6-6 De–rating depends on the installation altitude

Caution: P_n, P_{s6} and P_{max} must be de–rated in the same way.

Note

For the UI module, it must be observed that the braking energy applied to the braking resistor does not exceed the rating of the pulsed resistor.
A defect does not occur, the resistor is switched–out when an overload condition develops.
The unit goes into a fault condition with the ”DC link overvoltage” fault.

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6.3.2 Technical data of the supplementary components

Cooling components

Components	Component Order No.	Supply voltage	Supply current	Observe phase sequence!	Degr. of protection	Weight [kg]
Mounted fan for internal and external cooling	6SN1162–0BA02–0AA□	3–ph. 360 to 510 VAC 45 to 65 Hz	0.2 A to 0.3 A	Direction of rotation refer to the arrow on the fan	IP 44	4
Hose cooling package for an individual module comprising: 2x module connecting flange, hose 2000 mm 1x cabinet connecting flange 1x radial fan with cabinet connecting flange[1)] (refer to Fig. 2-4)	6SN1162–0BA03–0AA□	3–ph. 360 to 457 VAC 47.5 to 62.5 Hz	1.0 A +20%	Ccw direction of rot. when viewing the rotor	IP 54	8
Hose cooling package for 2–tier configuration of I/R 55 kW and PM 85 A comprising: 4x module connecting flange, hose 2000 mm 1x cabinet connecting flange 1x radial fan with cabinet connecting flange[1)] (refer to Fig. 2-4)	6SN1162–0BA03–0CA□	3–ph. 360 to 457 VAC 47.5 to 62.5 Hz	1.0 A +20%	Ccw direction of rot. when viewing the rotor	IP 54	8
Motor protection circuit–breaker	Size S00: Setting value 0.3 A Setting value 1 A Quantity S0 Setting value 0.3 A Setting value 1 A		 3RV1011–0DA10 0.22–0.32 A 3RV1011–0KA10 0.9–1.25 A 3RV1021–0DA10 0.22–0.32 A 3RV1011–0KA10 0.9–1.25 A			
Hot air deflection plate	6SN1162–0BA01–0AA0	Required for UI and pulsed–resistor modules when the pulsed resistor is utilized to its maximum (> 200 W) (refer to Section 13, dimension drawings)				

1) Replacement filter element: Order No. 8MR 1191–0A0
Ordering location: Pfannenberg GmbH
Postfach 80747
21007 Hamburg

Warning

The fan may only be commissioned, if it is electrically connected with the module housing (the PE of the fan is connected via the module housing).

Caution

Cooling is not guaranteed when the fan rotates in the incorrect direction (refer to arrow)!

Connection for three–phase fan

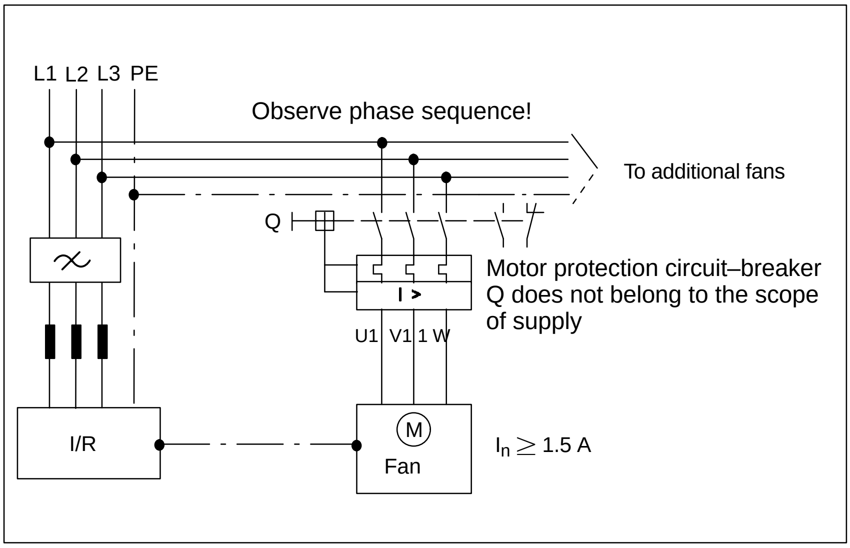

Fig. 6-7 Connection for three–phase fan

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6.4 Interface overview

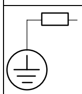
Note

Only PELF or SELF voltages may be connected (refer to EN 60204–1 Section 6.4).
Order Nos. for the coding connector, refer to Catalog NC60.
Only PELV circuits may be connected to terminal 19.

6.4.1 Interface overview, NE modules

The interface description is valid for all NE modules with the exception of the 5 kW UI module; this interface has its own description (refer to Section 6.4.2).

Table 6-6 Interface description for NE modules

Term. No.	Desig.	Function	Type 1)	Typ. voltage/ limit values	Max. cross–section 10)	Terminals available in 3)
U1 V1 W1		Supply connection	I	3–ph. 400 V AC	Refer to Section 4.2	I/R, UI
L1 L2		Contactor supply	I I	2–ph. 400 V AC, directly from the supply L1, L2, L3, refer to Sect. 9.2	16 mm^2/10 mm^2 4) 16 mm^2/10 mm^2 4)	I/R 80 kW, 120 kW
PE P600 M600		Protective conductor DC link DC link	I I/O I/O	0 V +300 V –300 V	Bolt Busbar Busbar	I/R, UI, monitoring module, pulsed resistor
		Grounding bar 5)	I/O	–300 V	Busbar	I/R, UI
P600 M600		DC link DC link	I/O I/O	+300 V –300 V	16 mm^2/10 mm^2 4) 16 mm^2/10 mm^2 4)	Monitoring module 11)
1R, 2R, 3R	TR1, TR2 9)	External resistance connection	I/O	V300	6 mm^2/4 mm^2 4)	Pulsed resistor; UI 28 kW
	X131	Electronics M	I/O	0 V	16 mm^2/10 mm^2 4)	I/R, UI, monitoring module

1) I = input; O = output; NC = NC contact; NO = NO contact; (for signal, NO = high; NC = low)
2) Terminal 19 is the reference ground (connected in the module with 10 kΩ to a general reference ground, X131/terminal 15)
Terminal 15 may neither be connected to PE nor to terminal 19, furthermore, it is not permissible that external voltage sources are connected to terminal 15. Terminal 19 may be connected to terminal X131.
The terminal may only be used to enable the associated drive group.
3) I/R = Infeed/regenerative feedback module; UI = Uncontrolled infeed; MM = Monitoring module;
PW = Pulse resistor module
4) The 1st number is valid for cable lugs. The 2nd number is valid for finely–stranded conductors without conn. sleeves.
5) The grounding bar is used to ground the DC link M rail through 100 kΩ (this should be preferably inserted; if the system is subject to a high voltage test, the grounding bar should be opened).
6) RESET = reset the fault memory, edge–triggered for the complete drive group (terminal ”R” → terminal 15 = RESET)
7) Terminal 111–213 positively–driven NC contact (for I/R 16 kW and UI 10 kW, only from Order No. [MLFB]: 6SN114□–1□□0**1**–0□□□)
Terminals 111–113 NO contact, not positively driven
8) Maximum current load of terminal 9 with respect to 19: 0.5 A.
9) Only for UI 28 kW
10) For UL certification, only use copper cables designed for an operating temperature of ≥ 60˚C
11) Max. permissible connection power Pmax ≤ 43 kW
Max. permissible current load Imax ≤ 72 A

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Table 6-6 Interface description for NE modules

Term. No.	Desig.	Function	Type 1)	Typ. voltage/ limit values	Max. cross–section 10)	Terminals available in 3)
	X151	Equipment bus	I/O	Various	Ribbon cable	I/R, UI, monitoring module, pulsed resistor
M500	X181	DC link power supply	I	DC –300 V	1.5 mm^2	I/R, UI, monitoring module
P500	X181	DC link power supply	I	DC +300 V	1.5 mm^2	
1U1	X181	Output L1	O	3–ph. 400 V AC	1.5 mm^2	
2U1	X181	Input L1	I	3–ph. 400 V AC	1.5 mm^2	
1V1	X181	Output L2	O	3–ph. 400 V AC	1.5 mm^2	
2V1	X181	Input L2	I	3–ph. 400 V AC	1.5 mm^2	
1W1	X181	Output L3	O	3–ph. 400 V AC	1.5 mm^2	
2W1	X181	Input L3	I	3–ph. 400 V AC	1.5 mm^2	
7	X141	P24	O	+20.4...28.8 V/50 mA	1.5 mm^2	I/R, UI, monitoring module
45	X141	P15	O	+15 V/10 mA	1.5 mm^2	
44	X141	N15	O	–15 V/10 mA	1.5 mm^2	
10	X141	N24	O	–20.4...28.8 V/50 mA	1.5 mm^2	
15 2)	X141	M	O	0 V	1.5 mm^2	
R 6)	X141	RESET	I	Term.15/R_E = 10 kΩ	1.5 mm^2	
5.3	X121	Relay contact Group signal I^2t/motor temp.	NC	50 V DC/0.5 A/12 VA max	1.5 mm^2	I/R, UI, monitoring module
5.2	X121		NO	5 V DC/3 mA min	1.5 mm^2	
5.1	X121		I		1.5 mm^2	
63 2)	X121	Pulse enable	I	+13 V...30 V/R_E = 1.5 kΩ	1.5 mm^2	
9 2)8)	X121	Enable voltage	O	+24 V	1.5 mm^2	
9 2)8)	X121	Enable voltage	O	+24 V	1.5 mm^2	
64 2)	X121	Drive enable	I	+13 V...30 V/R_E = 1.5 kΩ	1.5 mm^2	
19		Enable voltage, reference potential		0 V	1.5 mm^2	
74	X111	Relay contact Ready signal	NC	1–ph. 250 V AC/50 V DC/2 Amax. 5 V DC/3 mA min	1.5 mm^2	I/R, UI, monitoring module
nc	X111				1.5 mm^2	
73.2	X111		I		1.5 mm^2	
73.1	X111		I		1.5 mm^2	
nc	X111				1.5 mm^2	
72	X111		NO		1.5 mm^2	
9 2)8)	X161	Enable voltage	O	+24 V	1.5 mm^2	I/R, UI, monitoring module
112 2)	X161	Setting–up mode/ Standard mode	I	+21 V...30 V/R_E = 1.5 kΩ	1.5 mm^2	

1) I = input; O = output; NC = NC contact; NO = NO contact; (for signal, NO = high; NC = low)
2) Terminal 19 is the reference ground (connected in the module with 10 kΩ to a general reference ground, X131/terminal 15)
Terminal 15 may neither be connected to PE nor to terminal 19, furthermore, it is not permissible that external voltage sources are connected to terminal 15. Terminal 19 may be connected to terminal X131.
The terminal may only be used to enable the associated drive group.
3) I/R = Infeed/regenerative feedback module; UI = Uncontrolled infeed; MM = Monitoring module; PW = Pulse resistor module
4) The 1st number is valid for cable lugs. The 2nd number is valid for finely–stranded conductors without conn. sleeves.
5) The grounding bar is used to ground the DC link M rail through 100 kΩ (this should be preferably inserted; if the system is subject to a high voltage test, the grounding bar should be opened).
6) RESET = reset the fault memory, edge–triggered for the complete drive group (terminal "R" → terminal 15 = RESET)
7) Terminal 111–213 positively–driven NC contact (for I/R 16 kW and UI 10 kW, only from Order No. [MLFB]: 6SN114□–1□□01–0□□□)
Terminals 111–113 NO contact, not positively driven
8) Maximum current load of terminal 9 with respect to 19: 0.5 A.
9) Only for UI 28 kW
10) For UL certification, only use copper cables designed for an operating temperature of ≥ 60˚C
11) Max. permissible connection power Pmax ≤ 43 kW
Max. permissible current load Imax ≤ 72 A

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Table 6-6 Interface description for NE modules

Term. No.	Desig.	Function	Type [1]	Typ. voltage/ limit values	Max. cross–section [10]	Terminals available in [3]
48[2] 111[7] 213[7] 113[7]	X161 X161 X161 X161	Contactor control Signaling contacts Line contactor	I I NC NO	+13 V...30 V/R_E = 1.5 kΩ +30 V/1 A (111–113) 1–ph. 250 V AC/50 V DC/ 2 A max 17 V DC/3 mA min	1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2	I/R, UI
AS1 AS2	X172 X172	Signaling contact Start inhibit (terminal 112)	I NC	250 V AC / 1 A / 50 V DC/ 2A max 5 V DC/10 mA min	1.5 mm^2 1.5 mm^2	I/R
NS1 NS2	X171 X171	Coil contact for line, pre–charging contactor	O I	+24 V	1.5 mm^2 1.5 mm^2	I/R, UI
19 50	X221 X221	Enable voltage, reference potential Control contact for fast discharge	O I	0 V 0 V	1.5 mm^2 1.5 mm^2	Pulsed resistor

6

1) I = input; O = output; NC = NC contact; NO = NO contact; (for signal, NO = high; NC = low)
2) Terminal 19 is the reference ground (connected in the module with 10 kΩ to a general reference ground, X131/terminal 15)
Terminal 15 may neither be connected to PE nor to terminal 19, furthermore, it is not permissible that external voltage sources are connected to terminal 15. Terminal 19 may be connected to terminal X131.
The terminal may only be used to enable the associated drive group.
3) I/R = Infeed/regenerative feedback module; UI = Uncontrolled infeed; MM = Monitoring module; PW = Pulse resistor module
4) The 1st number is valid for cable lugs. The 2nd number is valid for finely–stranded conductors without conn. sleeves.
5) The grounding bar is used to ground the DC link M rail through 100 kΩ (this should be preferably inserted; if the system is subject to a high voltage test, the grounding bar should be opened).
6) RESET = reset the fault memory, edge–triggered for the complete drive group (terminal "R" → terminal 15 = RESET)
7) Terminal 111–213 positively–driven NC contact (for I/R 16 kW and UI 10 kW, only from Order No. [MLFB]: 6SN114□–1□□0**1**–0□□□)
Terminals 111–113 NO contact, not positively driven
8) Maximum current load of terminal 9 with respect to 19: 0.5 A.
9) Only for UI 28 kW
10) For UL certification, only use copper cables designed for an operating temperature of ≥ 60˚C
11) Max. permissible connection power Pmax ≤ 43 kW
Max. permissible current load Imax ≤ 72 A

Warning

In order to prevent damage to the infeed circuit of the NE modules, when energizing terminal 50 at X221 (DC link fast discharge), ensure that terminal 48 of the NE module is de–energized (electrically isolated from the line supply). The checkback signal contacts of the main contactor of the NE module must be evaluated (X161 terminal 111, terminal 113, terminal 213).

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6.4.2 Interface overview, 5 kW UI module

Table 6-7 Interface overview, 5 kW UI module

Term. No.	Desig.	Function	Type [1]	Typ. voltage/limit values	Max. cross–section [6]
U1 V1 W1	X1	Supply connection	I	3–ph. 400 V AC	4 mm^2 finely stranded without end sleeves 6 mm^2 with cable lug
PE	– X131 X351	Protective conductor Electronics M Equipment bus Grounding bar [3]	I I I/O I/O	0 V 0 V Various –300 V	M5 thread M4 thread 34–core ribbon cable Busbar
P600 M600		DC link	I/O	+300 V –300 V	Busbar
M500 P500 1U1 2U1 1V1 2V1 1W1 2W1	X181 X181 X181 X181 X181 X181 X181 X181	DC link power supply DC link power supply Output L1 Input L1 Output L2 Input L2 Output L3 Input L3	I I O I O I O I	–300 V +300 V 3–ph. 400 V AC 3–ph. 400 V AC 3–ph. 400 V AC 3–ph. 400 V AC 3–ph. 400 V AC 3–ph. 400 V AC	1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2
5.3 5.2 5.1 nc	X121A X121A X121A X121A	Relay contact group signal I^2t/motor temp.	NC NO I	50 V DC/0.5 A/12 VA max 5 V DC/3 mA min	1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2
74 73.2 73.1 72	X121B X121B X121B X121B	Relay signal Ready/fault	NC I I NO	1AC 250 V/DC 50 V/2 A max 1DC 5 V/3 mA min	1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2
63 [2] 9 [2,4] 9 [2,4] 64 [2] R [5] 19	X141AX 141A X141A X141A X141A X141A	Pulse enable FR+ FR+ Drive enable RESET FR, reference ground enable voltage	I O O I I O	+13 V...30 V/R_E = 1.5 kΩ +24 V +24 V +13 V...30 V/R_E = 1.5 kΩ term.19/R_E = 10 kΩ	1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2

1) I = input; O = output; NC = NC contact; NO = NO contact
2) Terminal 19 is the reference terminal (connected in the module to 10 kΩ to general reference ground X131) Terminal 15 may neither be connected to PE nor to terminal 19, furthermore, it is not permissible that external voltage sources are connected to terminal 15. Terminal 19 may be connected to terminal X131.
The terminal may only be used to enable the associated drive group.
3) The grounding bar is used to ground the DC link M rail through 100 kΩ (this should be preferably inserted; if the system is subject to a high–voltage test, the grounding bar should be opened).
4) Max. current load of terminal 9 - terminal 19 $\leq$ 1 A
Notice: UI 5 kW does not have terminals 7, 45, 44 and 10.
5) RESET = Reset the fault memory, edge triggered for the complete drive group (term. ”R” → term. 19 = RESET)
6) For UL certification, only use copper cables designed for an operating temperature of $\geq$ 60˚C

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Table 6-7 Interface overview, 5 kW UI module

Term. No.	Desig.	Function	Type 1)	Typ. voltage/limit values	Max. cross–section 6)
111	X161	} Signaling contact	I	1–ph. 250 V AC/50 V DC/2 A	1.5 mm^2
213	X161	} Line contactor	NC	17 V DC/3 mA min	1.5 mm^2
9 2)4)	X141B	FR+	O	+24 V	1.5 mm^2
112	X141B	Setting–up/normal operation	I	+13 V...30 V/R_E = 1.5 kΩ	1.5 mm^2
48	X141B	contactor control	I	+13 V...30 V/R_E = 1.5 kΩ	1.5 mm^2
NS1	X141B	} Coil contact for line,	O	+24 V	1.5 mm^2
NS2	X141B	} pre–charging contactor	I	0/+24 V	1.5 mm^2
15	X141B	M	O	0 V	1.5 mm^2

1) I = input; O = output; NC = NC contact; NO = NO contact
2) Terminal 19 is the reference terminal (connected in the module to 10 kΩ to general reference ground X131)
Terminal 15 may neither be connected to PE nor to terminal 19, furthermore, it is not permissible that external voltage sources are connected to terminal 15. Terminal 19 may be connected to terminal X131.
The terminal may only be used to enable the associated drive group.
3) The grounding bar is used to ground the DC link M rail through 100 kΩ (this should be preferably inserted; if the system is subject to a high–voltage test, the grounding bar should be opened).
4) Max. current load of terminal 9 - terminal 19 $\leq$ 1 A
Notice: UI 5 kW does not have terminals 7, 45, 44 and 10.
5) RESET = Reset the fault memory, edge triggered for the complete drive group
(term. ”R” → term. 19 = RESET)
6) For UL certification, only use copper cables designed for an operating temperature of ≥ 60˚C

Notice: UI kW does not have terminals 7, 45, 44 and 10.

Note

For UI 5 kW, the DC link is pre–charged via two phases.
If a DC link voltage is not established (there is no ready signal) even if all of the enable signals are present, then a check must be made as to whether all of the three phases are present at terminals U1, V1, W1.

6

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6.5 Monitoring module

6.5.1 System integration

The monitoring module includes the electronics power supply and the central monitoring functions which are required to operate the drive modules.

A monitoring module is required if the power supply rating of the NE module is not sufficient for the equipment group.

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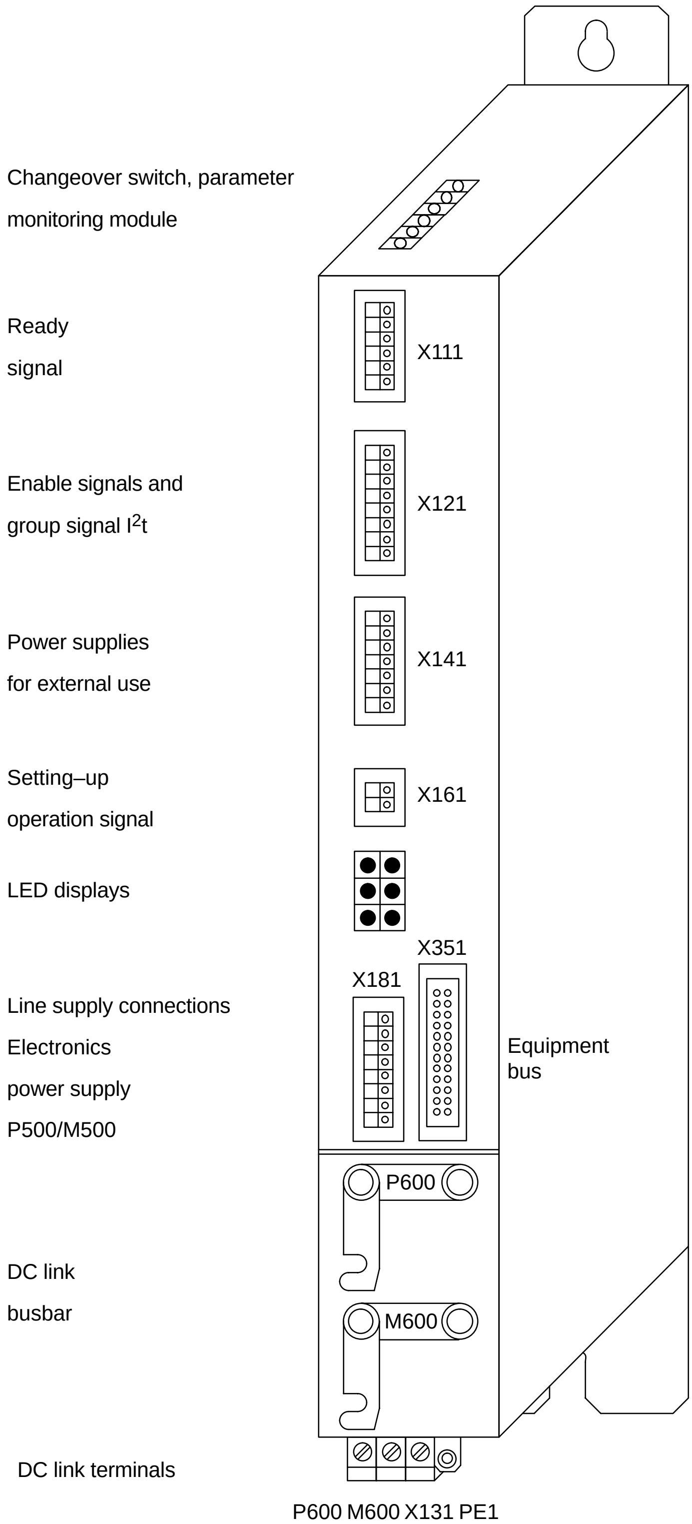

Fig. 6-8 Monitoring module 6SN1112–1AC01–0AA1

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6.5.2 Mode of operation

Parameters critical for operation are monitored in the monitoring module, for example:

- DC link voltage
- Controller power supply (±15 V)
- 5 V voltage level

If these parameters are in the permissible operating range, then the internal prerequisites are provided for the "equipment ready" signal. The group of modules is enabled at the monitoring module as soon as the external enable signals have been made available via terminals 63 (pulse enable) and 64 (drive enable). The sum signal controls the "ready" relay and can be taken, floating, via terminals 72/73.2 and 73.1/74. The load capability of the contacts is 250 V AC/1 A or 30 V DC/1 A.

The signal statuses of the monitoring circuits are displayed using LEDs on the front panel of the monitoring module

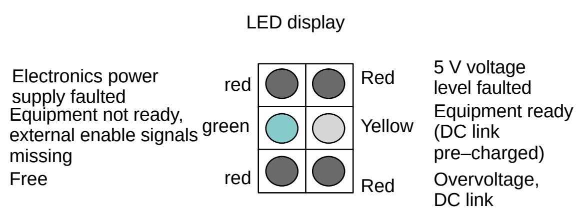

Fig. 6-9 LED display of the monitoring module

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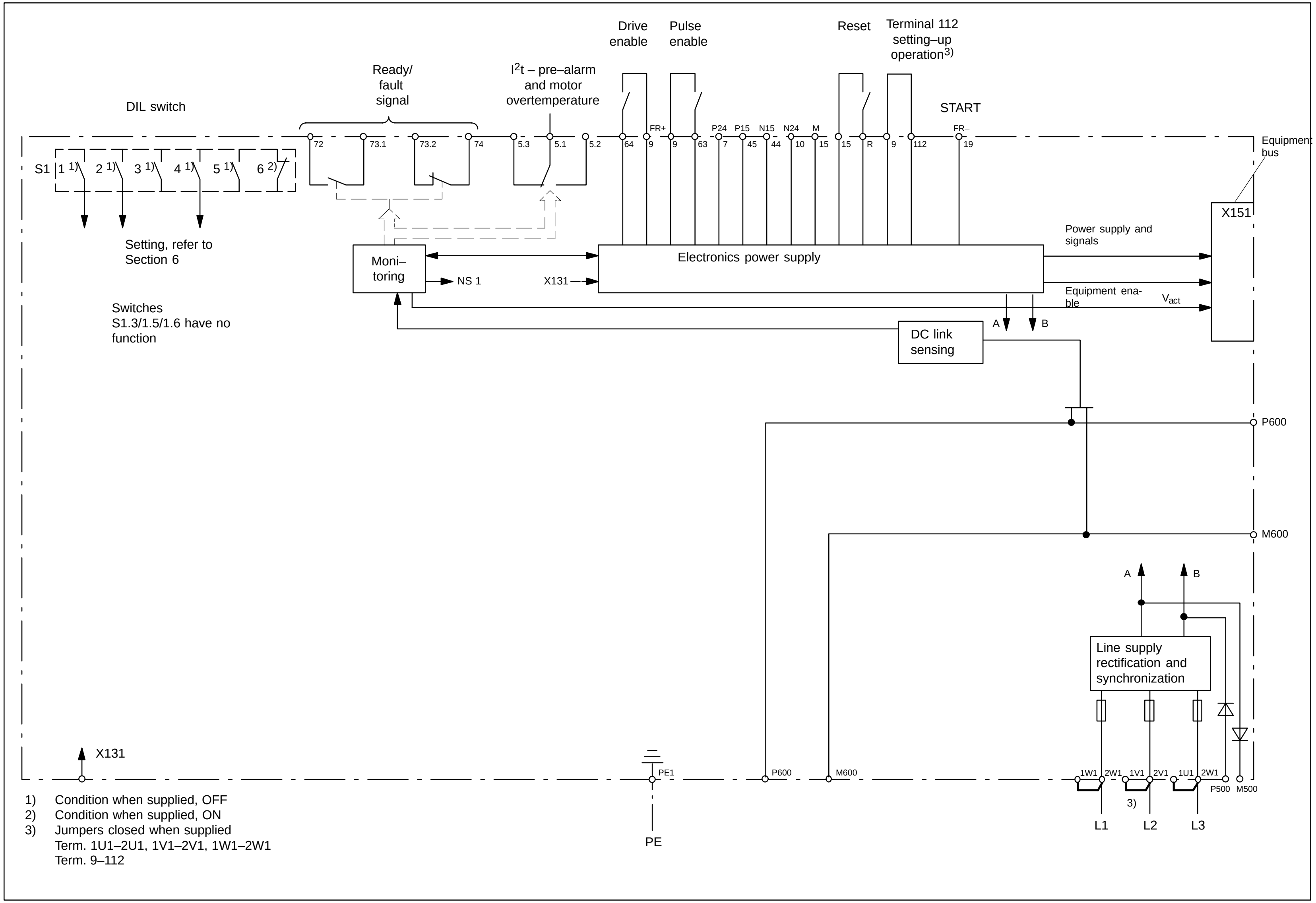

Fig. 6-10 Block diagram, monitoring module

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6.5.3 Technical data (supplements the general technical data)

Table 6-8 Technical data, monitoring module

Power loss	70 W
Alternative, rated supply voltage DC link	600/625/690 V DC
Cooling type	Non–ventilated
Weight	4 kg

6.5.4 Checking the permissible power supply rating

The infeed or monitoring module used offers a basic equipping of the electronics (EP values) and gating power supply (AP values).

The power supply requirement of a drive group is determined using Table 6-12.

The number of all of the modules used should be entered. It is the product of »assessment factor, individual module« and »number of modules«.

If one of these values is exceeded, then an (additional) monitoring module must be provided. In this case, Table 6-12 must be re–applied for the module group, which is supplied from the monitoring module.

The monitoring module must be located to the left in front of the modules to be monitored.

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Table 6-9 Planning table for drive modules with analog setpoint interface

SIMODRIVE 6SN11 power modules, type	Assessment factors: FD closed–loop control, analog: 1-axis user–friendly interface 6SN1118 - - 0AA11 without MSD option	- 0AA11 with MSD option	1-axis standard-interface 6SN1118 - - 0AD11	- 0BJ11 Resolver control	2-axis standard-interface 6SN1118 - - 0AE11	- 0BK11 Resolver control	MSD closed–loop control, analog 6SN1121 - - 0BA11	IM closed–loop control, analog 6SN1122 - - 0BA11	DC link capacitance µF
1-axis version									
6SN11 2 . - 1AA00 - 0HA1	EP 1 AP 0.5	EP 1.5 AP 0.5	EP 1 AP 0.5	EP 1.2 AP 0.5				EP 1 AP 1.5	75
6SN11 2 . - 1AA00 - 0AA1	EP 1 AP 0.5	EP 1.5 AP 0.5	EP 1 AP 0.5	EP 1.2 AP 0.5				EP 1 AP 1.5	75
6SN11 2 . - 1AA00 - 0BA1	EP 1 AP 0.5	EP 1.5 AP 0.5	EP 1 AP 0.5	EP 1.2 AP 0.5				EP 1 AP 1.5	110
6SN11 2 . - 1AA00 - 0CA1	EP 1 AP 0.5	EP 1.5 AP 0.5	EP 1 AP 0.5	EP 1.2 AP 0.5			EP 1 AP 1.5	EP 1 AP 1.5	330
6SN11 2 . - 1AA00 - 0DA1	EP 1 AP 0.5	EP 1.5 AP 0.5	EP 1 AP 0.5	EP 1.2 AP 0.5			EP 1 AP 1.5	EP 1 AP 1.5	495
6SN11 2 . - 1AA00 - 0LA1 2)							EP 1 AP 1.5	EP 1 AP 1.5	990
6SN11 2 . - 1AA00 - 0EA1	EP 1 AP 0.5	EP 1.5 AP 0.5	EP 1 AP 0.5				EP 1 AP 1.5	EP 1 AP 1.5	990
6SN11 2 . - 1AA01 - 0FA1	EP 1.75 AP 0.5	EP 2.25 AP 0.5	EP 1.75 AP 0.5				EP 1.75 AP 1.5	EP 1.75 AP 1.5	2145
6SN11 2 . - 1AA00 - 0JA1 1) 2)							EP 1.5 AP 1.75	EP 1.5 AP 1.75	2145
6SN11 2 . - 1AA00 - 0KA1 1) 2)							EP 1.5 AP 1.75	EP 1.5 AP 1.75	4290
6SN11 23 - 1AA02 - 0FA1 1)	EP 1.5 AP 0.5	EP 2 AP 0.5	EP 1.5 AP 0.5				EP 1.25 AP 1.5	EP 1.25 AP 1.5	2145
2-axis version									
6SN11 2 . - 1AB00 - 0HA1					EP 1.5 AP 1	EP 2 AP 1			150
6SN11 2 . - 1AB00 - 0AA1					EP 1.5 AP 1	EP 2 AP 1			150
6SN11 2 . - 1AB00 - 0BA1					EP 1.5 AP 1	EP 2 AP 1			220
6SN11 2 . - 1AB00 - 0CA1					EP 1.5 AP 1	EP 2 AP 1			660

Assessment factors for individual modules for the electronics area (EP) and gating area (AP) as well as permissible combinations of power modules and control modules (analog).
Only combinations are permissible with entered EP and AP values.

The data regarding the assessment factors EP and AP refer to the encoder cable lengths which have been released.
Enter the values into Table 6-12.

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Table 6-10 Configuring table for drive modules with SIMODRIVE 611 universal

SIMODRIVE 6SN11 power modules, type	Assessment factors								
	SIMODRIVE 611 universal				***SIMODRIVE 611 universal E***				DC link capaci-tance
	6SN1118 -				6SN1118 -				
	- .NJ00	- .NK00	- .NH00		- .NH10				µF
1-axis version									
6SN11 2 . - 1AA00 - 0HA1	EP 1.1 AP 1.7	EP 1.4 AP 2.0	EP 1.5 AP 2.0		EP 1.5 AP 2.6				75
6SN11 2 . - 1AA00 - 0AA1	EP 1.1 AP 1.7	EP 1.4 AP 2.0	EP 1.5 AP 2.0		EP 1.5 AP 2.6				75
6SN11 2 . - 1AA00 - 0BA1	EP 1.1 AP 1.7	EP 1.4 AP 2.0	EP 1.6 AP 2.0		EP 1.6 AP 2.6				110
6SN11 2 . - 1AA00 - 0CA1	EP 1.1 AP 1.7	EP 1.4 AP 2.0	EP 1.6 AP 2.0		EP 1.6 AP 2.6				330
6SN11 2 . - 1AA00 - 0DA1	EP 1.2 AP 1.7	EP 1.4 AP 2.0	EP 1.7 AP 2.0		EP 1.7 AP 2.6				495
6SN11 2 . - 1AA00 - 0LA1	EP 1.7 AP 1.8	EP 1.7 AP 2.1	EP 1.7 AP 2.1		EP 1.7 AP 2.7				990
6SN11 2 . - 1AA00 - 0EA1	EP 2.7 AP 1.8	EP 2.7 AP 2.1	EP 2.7 AP 2.1		EP 2.7 AP 2.7				990
6SN11 2 . - 1AA01 - 0FA1	EP 2.7 AP 1.9	EP 2.7 AP 2.1	EP 2.7 AP 2.1		EP 2.7 AP 2.7				2145
6SN11 2 . - 1AA00 - 0JA1 [1]	EP 1.3 AP 1.9	EP 1.5 AP 2.1	EP 1.7 AP 2.1		EP 1.7 AP 2.7				2145
6SN11 2 . - 1AA00 - 0KA1 [1]	EP 1.4 AP 1.9	EP 1.6 AP 2.1	EP 1.8 AP 2.1		EP 1.8 AP 2.7				4290
6SN11 23 - 1AA02 - 0FA1 [1]	EP 1.3 AP 1.9	EP 1.5 AP 2.1	EP 1.7 AP 2.1		EP 1.7 AP 2.7				2145
2–axis version									
6SN11 2 . - 1AB00 - 0HA1	EP 1.3 AP 2.1	EP 1.5 AP 2.4	EP 1.6 AP 2.4		EP 1.6 AP 3.0				150
6SN11 2 . - 1AB00 - 0AA1	EP 1.4 AP 2.1	EP 1.7 AP 2.4	EP 1.7 AP 2.4		EP 1.7 AP 3.0				150
6SN11 2 . - 1AB00 - 0BA1	EP 1.6 AP 2.1	EP 1.8 AP 2.4	EP 1.8 AP 2.4		EP 1.8 AP 3.0				220
6SN11 2 . - 1AB00 - 0CA1	EP 1.7 AP 2.1	EP 1.8 AP 2.4	EP 1.8 AP 2.4		EP 1.8 AP 3.0				660

Assessment factors for individual modules in the electronics area (EP) and gating area (AP) as well as a permissible combination of power modules and control modules (analog).
Only the combinations are permissible with entered EP and AP values.
The data on the assessment factors EP and AP refer to encoder cable lengths which have been released.
Enter the values into Table 6-12.

SIMODRIVE 611 universal with options
PROFIBUS-DP
When using the option, in addition, 0.6 gating points must be added.
Terminal module
In this case, no additional electronics/gating points have to be taken into account.
SIMODRIVE 611 universal/universal E with options
Absolute value encoder with EnDat
When using EnDat absolute value encoders, for each encoder, and additional 0.4 EP (electronic points) must be added.

1) With mounted fan or hose cooling.

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Table 6-11 Configuring table for drive modules with digital interface

SIMODRIVE 6SN11 power modules, type	**Assessment factors** *Control module, digital*								DC link capacitance
	1–axis version Performance control 6SN1118 -			2–axis version Performance control 6SN1118 -			2–axis version Standard 2 control 6SN1118 -		
	- 0DG21 for FD/ MSD for motor encoder	- 0DG22 for FD/MSD 1 additional input for current signals	- 0DG23 for FD/MSD 1 additional input for voltage signal	- 0DH21 for FD for motor encoder	- 0DH22 for FD 2 additional inputs for current signals	- 0DH23 for FD 2 additional inputs for voltage signals	- 0DM21 for FD/ MSD 3) for motor encoders	- 0DM23 for FD/ MSD 3) 2 additional inputs for voltage signals	µF
1–axis version									
6SN11 2 . - 1AA00 - 0HA1	EP 1 AP 1.85	EP 1 AP 2.2	EP 1 AP 2.2				EP 1 AP 1.85	EP 1 AP 2.2	75
6SN11 2 . - 1AA00 - 0AA1	EP 1 AP 1.85	EP 1 AP 2.2	EP 1 AP 2.2				EP 1 AP 1.85	EP 1 AP 2.2	75
6SN11 2 . - 1AA00 - 0BA1	EP 1 AP 1.85	EP 1 AP 2.2	EP 1 AP 2.2				EP 1 AP 1.85	EP 1 AP 2.2	110
6SN11 2 . - 1AA00 - 0CA1	EP 1 AP 1.85	EP 1 AP 2.2	EP 1 AP 2.2				EP 1 AP 1.85	EP 1 AP 2.2	330
6SN11 2 . - 1AA00 - 0DA1	EP 1 AP 1.85	EP 1 AP 2.2	EP 1 AP 2.2				EP 1 AP 1.85	EP 1 AP 2.2	495
6SN11 2 . - 1AA00 - 0LA1 2)	EP 1 AP 1.85		EP 1 AP 2.2				EP 1 AP 1.85	EP 1 AP 2.2	990
6SN11 2 . - 1AA00 - 0EA1	EP 1 AP 1.85	EP 1 AP 2.2	EP 1 AP 2.2				EP 1 AP 1.85	EP 1 AP 2.2	990
6SN11 2 . - 1AA01 - 0FA1	EP 1.75 AP 1.85	EP 1.75 AP 2.2	EP 1.75 AP 2.2				EP 1.75 AP 1.85	EP 1.75 AP 2.2	2145
6SN11 2 . - 1AA00 - 0JA1 1) 2)	EP 1.5 AP 2.1		EP 1.5 AP 2.45				EP 1.5 AP 1.85	EP 1 AP 2.2	2145
6SN11 2 . - 1AA00 - 0KA1 1) 2)	EP 1.5 AP 2.1		EP 1.5 AP 2.45				EP 1.5 AP 1.85	EP 1 AP 2.2	4290
6SN11 23 - 1AA02 - 0FA1 1)	EP 1 AP 1.85	EP 1 AP 2.2	EP 1 AP 2.2				EP 1 AP 1.85	EP 1 AP 2.2	2145
2–axis version									
6SN11 2 . - 1AB00 - 0HA1				EP 1 AP 2.8	EP 1 AP 3.4	EP 1 AP 3.4	EP 1 AP 2.8	EP 1 AP 3.4	150
6SN11 2 . - 1AB00 - 0AA1				EP 1 AP 2.8	EP 1 AP 3.4	EP 1 AP 3.4	EP 1 AP 2.8	EP 1 AP 3.4	150
6SN11 2 . - 1AB00 - 0BA1				EP 1 AP 2.8	EP 1 AP 3.4	EP 1 AP 3.4	EP 1 AP 2.8	EP 1 AP 3.4	220
6SN11 2 . - 1AB00 - 0CA1				EP 1 AP 2.8	EP 1 AP 3.4	EP 1 AP 3.4	EP 1 AP 2.8	EP 1 AP 3.4	660

Assessment factors for individual modules in the electronics area (EP) and gating area (AP) as well as a permissible combinations of power modules and control modules (digital).
Only the combinations are permissible with entered EP and AP values.
The data on the assessment factors EP and AP refer to encoder cable lengths which have been released. Enter the values into Table 6-12.

Absolute value encoder with EnDat interface Performance control
When using absolute value encoders with EnDat interface, in conjunction with Performance control modules, for each coder, an additional 0.5 EP (electronic points) must be taken into account in the electronics area.
Standard 2 control
When using absolute value encoders with EnDat interface in conjunction with the standard 2 control modules, for each encoder, an additional 0.5 EP (electronic points) should be taken into account in the electronics area.

1) With mounted fan or hose cooling.
2) Only for drive modules with main spindle control.
3) MSD is only permissible for 1–axis operation.

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Table 6-12 Configuring sheet to calculate the DC link power Pz

Designation	Electronics area (EP) Assessment factor, individual module	Num-ber of modu-les	Pro-duct	Gating area (AP) Assessment factor, individual module	Num-ber of modu-les	Pro-duct	DC link capacitance µF	Num-ber of modu-les	Pro-duct
SIMODRIVE 611									
Infeed uncontrolled 5 kW/10 kW	0.3			-			150		
10 kW/25 kW	0.5			0.5			440		
28 kW/50 kW	0.5			0.5			990		
infeed/regenerative feedback module 16 kW/21 kW	0.5	× 1 =		0.5	× 1 =		495	× 1 =	
36 kW/47 kW	0.5			0.5			990		
55 kW/71 kW	0.5			0.5			2145		
80 kW/131 kW	1			0.75			2145		
120 kW/175 kW	1			0.75			4290		
Monitoring module	0			0			1000 1)	× =	
Pulsed resistor module	0.2	× =		0.1	× =		75	× =	
HGL module	2	× =		0			0		
HLA module	1.5 2)	× =		1.5	× =		0		
Power module with control module <u>for FD</u> (values from the tables 6-9 or)		× = × = × = × = × = × =			× = × = × = × = × = × =			× = × = × = × = × = × =	
Power module with control module <u>for MSD/IM</u> (Values from Tables 6-9 or)		× = × = × =			× = × = × =			× = × = × =	
Power module with SIMODRIVE 611 universal (values from Table 2.2)		× = × = × = × = × = × =			× = × = × = × = × = × =			× = × = × = × = × = × =	
SINUMERIK 810D 3) including integrated power modules									
CCU box 3LT with CCU 1 or CCU 2	2	× =		4.5	× =		660		
CCU box 2LT with CCU 1 or CCU 2	2	× =		4.5	× =		220		
SINUMERIK 840D with							0		
NCU 561.2 6FC5 356 - 0BB11 - 0AE0	1	× =		3.8	× =				
NCU 571.2 6FC5 357 - 0BB11 - 0AE0	1	× =		3.8	× =				
NCU 572.3 6FC5 357 - 0BB22 - 0AE0	1	× =		3.8	× =				
NCU 573.3 6FC5 357 - 0BB33 - 0AE2	2.3	× =		5 (5.4) 5)	× =				
NCU 573.2 4) 6FC5 357 - 0BB31 - 0AE0	2.3	× =		5	× =				
Digitizing unit	1	× =		1.5	× =		0		
	Sum, area »electronics« max. value 8		EP	Sum, area, »gating« max. value 17		AP	Sum of the DC link capacitances		
The following applies for the uncontrolled 5 kW infeed: Max. 3.5 electronic points and max. 7 gating points. However, with control modules 6SN1118-0AA11-0AA0 max. 3 electronics points.	Max. value 3.5 (3)			Max. value 7					

1) For regenerative feedback, only 75 µF is effective. This must be taken into account when dimensioning the pulsed-resistor modules, if the monitoring module is connected to the DC link.
2) When using both axes with absolute value encoder, 2 electronic points should be taken into account.
3) An additional 0.3 gating points must be taken into account for each connected absolute value encoder with EnDat interface.
4) NCU for »digitizing«.
5) Value of 5.4 is valid for NCU 573.3 with link module

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6.6 DC link options

6.6.1 Capacitor module with 4.1 mF or 20 mF

Description

The capacitor modules are used to increase the DC capacitance. In this case, a brief power failure can be buffered and it is also possible to buffer the braking energy.

The modules differ as follows:

- Module with 4.1 mF —> used as dynamic energy storage device
- Module with 20 mF —> used to buffer power failures

The capacitor modules have a ready display which is lit above a DC link voltage of approx. 300 V. This also means that an internal fuse failure can be detected. However, this does not reliably monitor the charge condition.

The 4.1 mF module does not have a pre–charging circuit, which means that it can directly absorb the energy during dynamic braking operations as it is directly connected to the DC link which also means that it can operate as dynamic energy storage device. For these modules, the charge limits of the line supply modules must be taken into account.

For 20 mF modules, pre–charging is realized through an internal series resistor in order to limit the charge current and to de–couple the module from the central pre–charging. This module cannot absorb any energy generated from dynamic switching operation, as the series resistor limits the charging current. During power failures, a diode couples this capacitor battery to the system DC link which it then supports.

Note

The capacitor modules may only be used in conjunction with SIMODRIVE 611 line supply infeed modules.

The modules are suitable for internal and external cooling.

6

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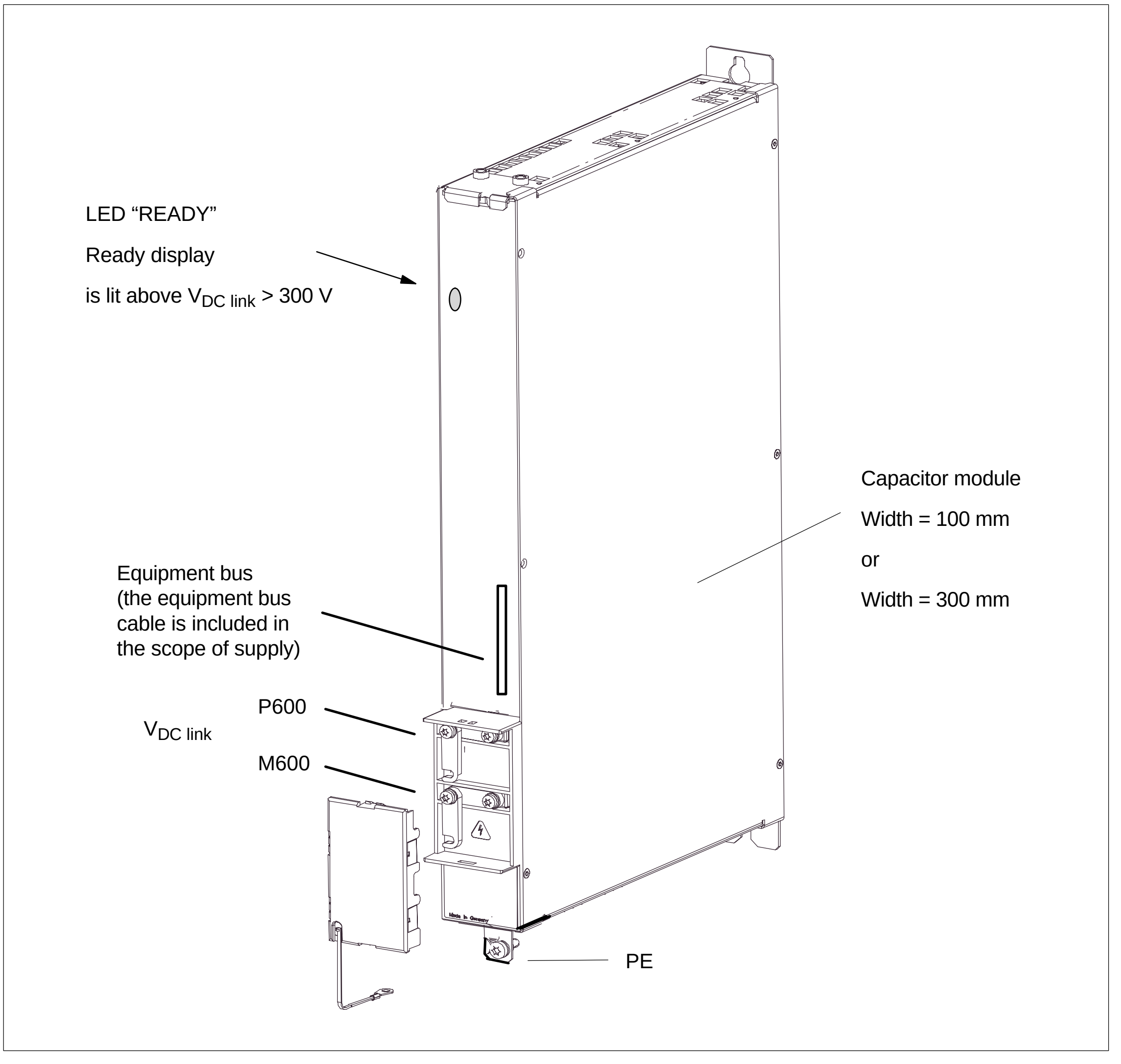

Fig. 6-11 Capacitor modules

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Technical data

The following technical data apply:

Table 6-13 Technical data of the capacitor modules

Desig.	Module	
	4.1 mF	20 mF
Order number	6SN1 112–1AB00–0BA0	6SN1 112–1AB00–0CA0
Voltage range	V 350 to 750 V DC	
Storage capacity $w = 1/2 \times C \times U^2$	$V_{DC\ steady–state}$ (examples) 600 V —> 738 Ws 680 V —> 948 Ws	$V_{DC\ steady–state}$ (examples) 600 V —> 3 215 Ws 680 V —> 4 129 Ws Note: The voltage at the capacitors is only approx. 0.94 x V_{DC} as a result of the internal pre–charging resistor.
Temperature range	0 °C to +55 °C	
Weight	approx. 7.5 kg	approx. 21.5 kg
Dimensions	W x H x D 100 x 480 x 211 [mm]	W x H x D 300 x 480 x 211 [mm]

Calculation examples

The energy storage capacity in dynamic operation and for regenerative braking is calculated as follows:

Formula: $w = ½ \times C \times (V^2_{DC\ link\ max} – V^2_{DC\ link\ n})$

Assumptions for the example:

Capacitance of the capacitor battery $C = 4.1$ mF

DC link voltage, nominal value $V_{DC\ link\ n} = 600$ V

Max. DC link voltage $V_{DC\ link\ max} = 695$ V

—> $w = ½ \times 4.1 \times 10^{–3}$ F x $((695\ V)^2 – (600\ V)^2) = 252$ Ws

The following applies for the energy storage capacity of the capacitor batteries and power failure:

Formula: $w = ½ \times C \times (V^2_{DC\ link\ n} – V^2_{DC\ link\ min})$

Assumptions for the example:

Capacitance of capacitor battery $C = 20$ mF

DC link voltage, nominal value $V_{DC\ link\ n} = 600$ V

DC link voltage, min. $V_{DC\ link\ min} = 350$ V

—> $w = ½ \times 20 \times 10^{–3}$ F x $((567\ V)^2 – (350\ V)^2) = 1990$ Ws

For a DC link voltage of 680 V, the energy storage capacity increases to 2904 Ws.

Notice

$V_{DC\ link\ min}$ must ≧ be 350 V.

For voltages below 350 V, the switched–mode power supply for the electronics shuts–off.

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Possible buffer time $t_Ü$ is calculated as follows with the output DC link power $P_{DC\ link}$:

$t_Ü = w / P_{DC\ link}$

Dynamic energy

The DC link capacitors can be seen as battery. The capacitor module increases the capacitance and the energy storage capability.

The energy flow must be determined in order to evaluate the capacitance required for a special requirement.

The energy flow depends on the following:

- All moved masses and moments of inertia
- Velocity, speed (or its change, acceleration, deceleration)
- Efficiencies: Mechanical system, gearboxes, motor, inverter (motoring/ braking)
- Buffer time, buffering
- DC link voltage and the permissible change, output value, upper/lower value.

Often, in practice, there is no precise data regarding the mechanical system. If the mechanical system data was determined by making approximate calculations or estimated values, the adequate capacitance of the DC link capacitors can only be determined by making the appropriate tests when the system is commissioned.

The energy required for dynamic operations is obtained as follows:

The following applies when a drive brakes or accelerates from one speed/ velocity to another within time t_V:

$$w = ½ \times P \times t_V$$

For rotating drives with

$$P = \frac{M_{Mot} \times (n_{Mot\ max} - n_{Mot\ min})}{9\,550} \times \eta_G$$

For linear drives with

$$P = F_{Mot} \times (V_{Mot\ max} - V_{Mot\ min}) \times 10^{-3} \times \eta_G$$

with η_G:

Braking	$\eta_G = \eta_M \times \eta_{WR}$
Acceleration	$\eta_G = 1/(\eta_M \times \eta_{WR})$

w [Ws]	Energy
P [kW]	Motor output
t_V [s]	Duration of the operation
M_{Mot} [Nm]	Max. motor torque when either accelerating or braking
F_{Mot} [N]	Max. motor force when either braking or accelerating
$n_{Mot\ max}$ [RPM]	Max. speed at the start or end of the operation

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$n_{Mot\ min}$ [RPM]	Max. speed at the start or end of the operation
$v_{Mot\ max}$ [m/s]	Max. velocity at the start or end of the operation
$v_{Mot\ min}$ [m/s]	Min. velocity at the start or end of the operation
η_G	Efficiency, total
η_M	Efficiency, motor
η_{WR}	Efficiency, inverter

The torque M and force F, depend on the moved masses, the load and the acceleration in the system.

If there is no precise data for the mentioned factors, then generally, nominal data are used.

Configuring information

The capacitor module should be preferably located at the righthand end of the system group. It is connected via the DC link busbar.

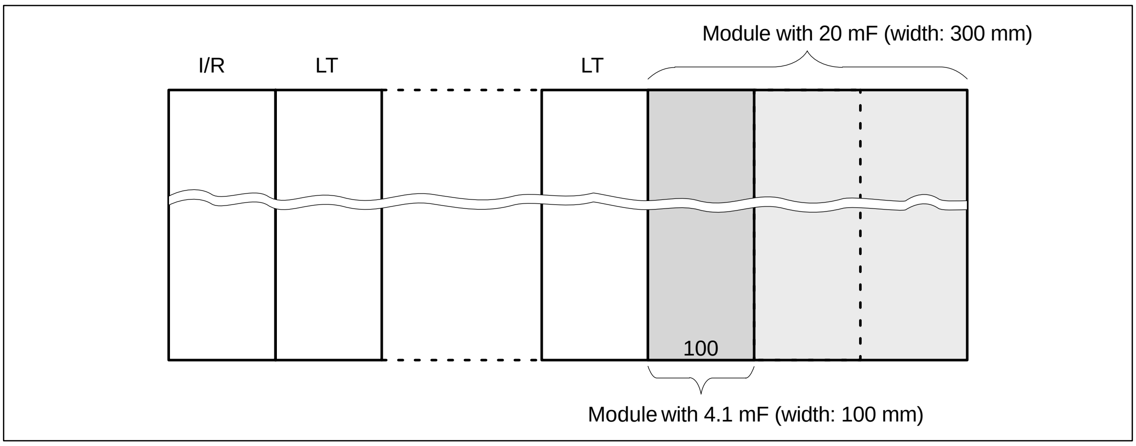

Fig. 6-12 Mounting location of the capacitor module

Several capacitor modules can be connected in parallel depending on the line supply infeed used.

For 4.1 mF capacitor modules, the total charging limits of the line supply infeed may not be exceeded (refer to Catalog NC 60, Section 10).

Table 6-14 Max. number of capacitor modules

Infeed unit	**Capacitor modules which can be connected**			
UI 5 kW	None			
		Monitoring module		
		without	1	≥ 2
UI 10 kW I/R 16 kW	Module 4.1 mF	1	1	1
	Module 20 mF	3	1	0
UI 28 kW I/R 36–120 kW	Module 4.1 mF	4	4	4
	Module 20 mF	3	1	0

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Charging times, discharging times, discharge voltage

It should be checked that the DC link is in a no–voltage condition before carrying out any commissioning or service work.

Table 6-15 Charging/discharging times, discharge voltage

Capacitor module	Charging time for each module	Discharging time for each module to 60 V of the DC link voltage at 750 V DC
4.1 mF	As for the power modules	Approx. 30 min
20 mF	Approx. 2 min	Approx. 40 min

If the system has a pulsed resistor, the DC link can be quickly discharged via terminals X221:19 and 50 (jumpers) after opening terminal 48 to reduce the discharge time.

Warning

The pulsed resistor modules can only convert a specific amount of energy into heat (refer to Table 6-17). The energy available to be converted depends on the voltage.

Caution

In order to prevent damage to the infeed circuit of the NE modules, when energizing terminal X221, terminal 19/50, it should be absolutely guaranteed that terminal 48 of the NE module is de–energized (electrically isolated from the line supply).

The checkback signal contacts of the NE module main contactor must be evaluated to ensure that this has dropped–out (X161 terminal 111, terminal 113, terminal 213).

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6.6.2 Overvoltage limiting module

The overvoltage limiting module limits overvoltages at the line supply input to acceptable values. These are caused, e.g. as a result of switching operations at inductive loads and at line supply matching transformers. For line supply infeed modules above 10 kW (100 mm wide), the overvoltage limiting module can be inserted at interface X181.

The overvoltage limiting module is used if there are upstream transformers or for line supplies which are not in conformance with CE (unstable line supplies).

The overvoltage limiting module is required if the line supply infeed module is to be implemented in conformance with UL.

For the 5 kW UI module, an appropriate protective circuit is already integrated as standard.

Table 6-16 Technical data

Max. energy absorption	100 Joule
Weight	approx. 0.3 kg
Dimensions (H x W x D)	76 mm x 70 mm x 32.5 mm
Module depth max., for the stretched–out status	325 mm
Order number	6SN1111–0AB00–0AA0

6.6.3 Pulsed resistor module

The pulsed resistor module can be used to quickly discharge the DC link. The DC link energy is converted into heat. Additional applications are, for example, increasing the pulsed resistor rating when using an uncontrolled infeed module or reducing the DC link voltage for controlled braking operations when the power supply fails. Several modules can also be connected in parallel.

When using the internal pulsed resistor > 200 W to its maximum, we recommend that the hot air deflection plate is used as this keeps the heat from the modules located above.

The universal housing design of the pulsed resistor module can be used in externally cooled module groups.

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6.6.4 External pulsed resistors

Using the external pulsed resistors, the heat loss can be dissipated outside the cabinet. External pulsed resistors are always required for the 28 kW UI module.

Shielded cables must be used to connect the pulsed resistors.

Notice

The pulsed resistor is equipped with a temperature monitoring function, which protects it against overheating.

Table 6-17 UI modules with pulsed resistors

Pulsed resistors, technical data				
	External pulsed resistor 0.3/25 kW	External pulsed resistor 1.5/25 kW	Internal pulsed resistor 0.3/25 kW	Internal pulsed resistor 0.2/10 kW
Order No.	6SN1113–1AA00–0DA0	6SN1113–1AA00–0CA0	–	–
Integrated in	–	–	UI 10 kW, pulsed resistor module	UI 5 kW
Can be used for	UI module 28 kW	UI module 28 kW	–	–
Can be used for	–	Pulsed resistor module 6SN1113–1AB0□–0BA□	–	–
Pn	0.3 kW	1.5 kW	0.3 kW	0.2 kW
P_{max}	25 kW	25 kW	25 kW	10 kW
E_{max}	7.5 kWs	180 kWs	7.5 kWs	13.5 kWs
Degree of protection	IP 54	IP20	refer to module	refer to module
Dimension drawings, refer to Section 13				

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Engineering information applies for UI 5 kW, 10 kW, 28 kW and pulsed resistor module

Dimensioning the load duty cycles for pulsed resistors

Desig.		Units
Explanation		
E	Ws	Regenerative feedback energy when braking a motor from n_2 to n_1
T	s	Period of the braking load duty cycle
A	s	Load duration
J	kgm^2	Total moment of inertia (including J motor)
M	Nm	Braking torque
n	RPM	Speed
Pn	W	Continuous rating of the pulsed resistor
P_{max}	W	Peak rating of the pulsed resistor
E_{max}	Ws	Energy of the pulsed resistor for a single braking operation

Load duty cycles for braking operations

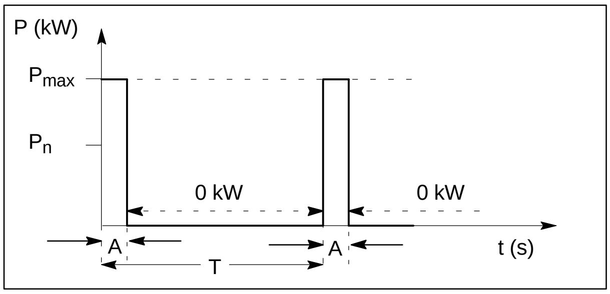

Fig. 6-13 Load duty cycle for internal and external pulsed resistors

Table 6-18 Examples

	Values	Pulsed resistor 0.2/10 kW	Pulsed resistor 0.3/25 kW	Pulsed resistor 1.5/25 kW
	E_{max} Pn P_{max}	13500 Ws [1)] 200 W 10000 W	7500 Ws 300 W 25000W	180000 Ws 1500 W 25000W
Example	A= T=	0.2 s 10 s	0.12 s 10 s	0.6 s 10 s
	A= T=	1.35 s 67.5 s	0.3 s 25 s	7.2 s 120 s

All of the following conditions must be fulfilled:

1. $P_{max} \geq M \bullet 2 \bullet \pi \bullet n/60$
2. $E_{max} \geq E$; $E = J \bullet [(2 \bullet \pi \bullet n_2/60)^2 - (2 \bullet \pi \bullet n_1/60)^2]/2$
3. $P_n \geq E/T$

Note

For UI 5 kW and UI 10 kW, it is not possible to connect an external resistor.

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1) As a result of the mechanical dimensions, the resistor can accept a relatively high level of energy.

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Mounting positions

Horizontal and vertical mounting positions are possible.

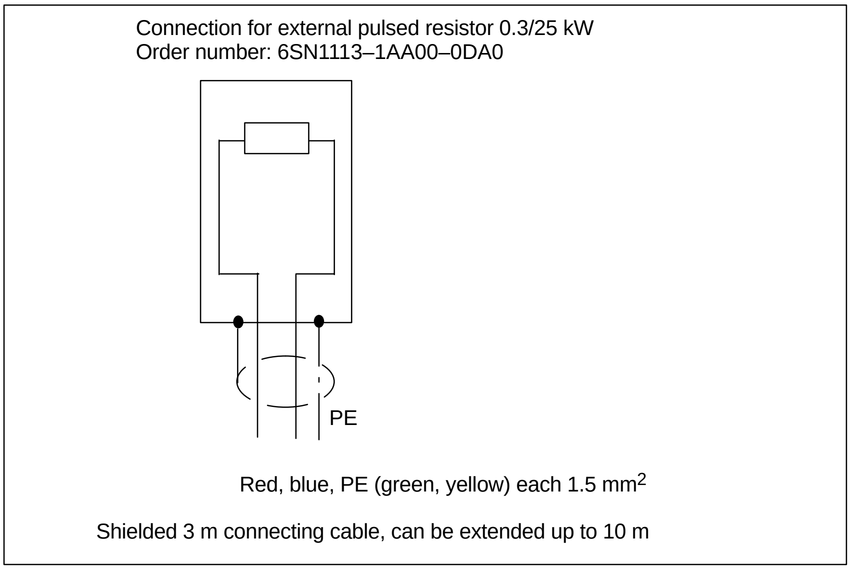

Fig. 6-14 Connection for external pulsed resistor 0.3/25 kW

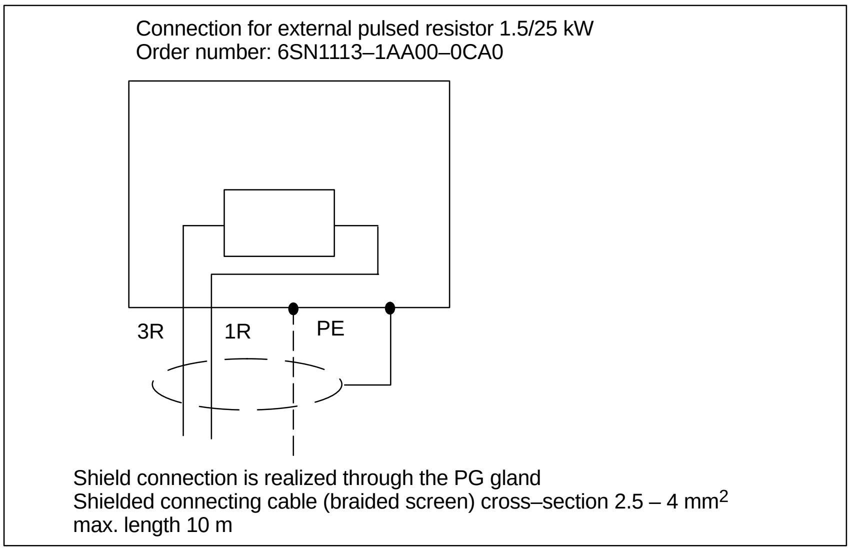

Fig. 6-15 Connection for external pulsed resistor 1.5/25 kW

Note

Conductors which are not used in multi–conductor cables must always be connected to PE at both ends.

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Pulsed resistor module

Connection types, pulsed resistor module

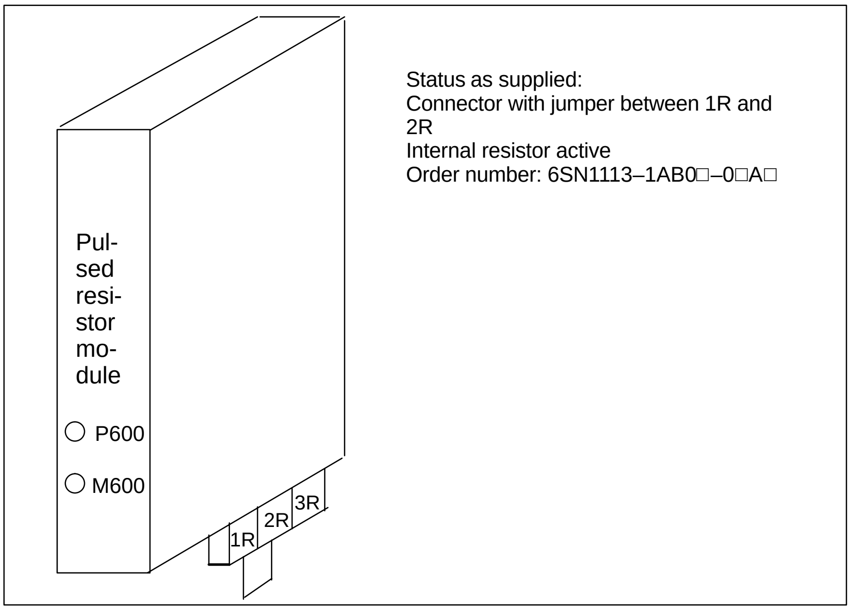

Fig. 6-16 Status of the pulsed resistor module when supplied

Note

For pulsed resistor modules, only the external pulsed resistor 1.5/25 kW can be connected.

The following connection combinations are possible:

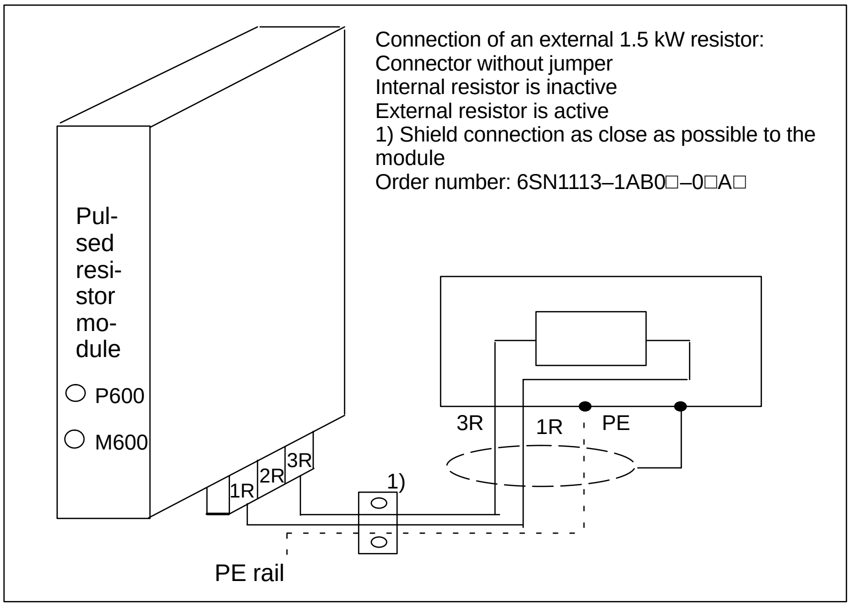

Fig. 6-17 Connecting an external 1.5 kW pulsed resistor

Number of pulsed resistor modules connected to the same DC link, refer to Catalog NC60

$N \leq C / 500\ \mu F$

N = max. number of pulsed resistor modules (must always be rounded–off)

C = DC link capacitance of the drive group in μF

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UI 28 kW module

The UI 28 kW module does not include a pulsed resistor.

Possibilities of connecting external pulsed resistors to the 28 kW module

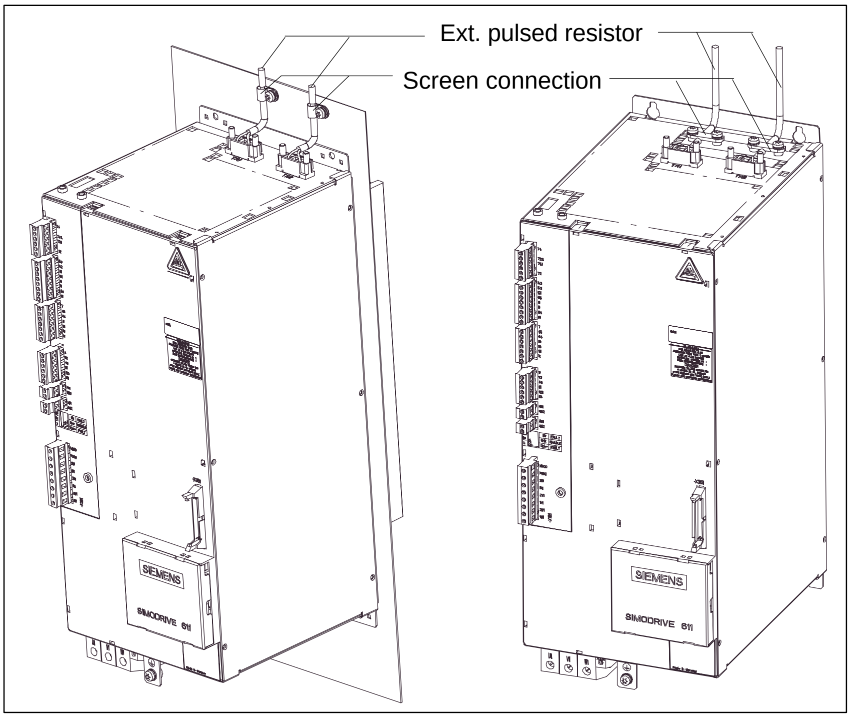

Fig. 6-18 Connecting an external pulsed resistor with screen connection

Table 6-19 Permissible methods of connecting an external pulsed resistor to UI 28 kW

Pulsed resistor	Terminal block TR1	Terminal block TR2
0.3/25 kW	1R 2R * 3R Pulsed resistor 0.3 kW	1R 2R 3R
2 x 0.3/25 kW=0.6/50 kW	1R 2R * 3R Pulsed resistor 0.3 kW	1R 2R * 3R PW 0.3 kW
1.5/25 kW	1R 2R 3R Pulsed resistor 1.5/25 kW	1R 2R 3R
2 x 1.5/25 kW=3/50 kW	1R 2R 3R Pulsed resistor 1.5 kW	1R 2R 3R Pulsed resistor 1.5 kW

* Jumper to code the thermal limiting characteristic

■

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Line Supply Connection 7

7.1 Line supply fuses, commutating reactors, transformers and main switches

7.1.1 Assignment of the line supply fuses to the NE modules

Fuses must be used which are designed to protect the line supply feeder cables.

The following can be used: NH, D, DO with gL characteristics. Without restricting the performance data of the NE modules, we recommend the SIEMENS fuse types listed below.

Table 7-1 Assignment of line supply fuses and circuit–breakers to the NE modules

	UI module 5/10 kW	UI module 10/25 kW	UI module 28/50 kW	I/R module 16/21 kW	I/R module 36/47 kW	I/R module 55/71 kW	I/R module 80/104 kW	I/R module 120/156 KW
I_{rated} fuse	16 A	25 A	80 A	35 A	80 A	125 A	160 A	250 A
I_{fuse} 0.2 s	>70 A	>100 A	>360 A	>180 A	>360 A	>450 A	>650 A	>865 A
I_{fuse} 4 s	>50 A	>80 A	>260 A	>130 A	>260 A	>350 A	>505 A	>675 A
I_{fuse}10 s	>42 A	>65 A	>200 A	>100 A	>200 A	>250 A	>360 A	>480 A
I_{fuse}240 s	>30 A	>40 A	>135 A	>60 A	>135 A	>200 A	>280 A	>380 A
Recommended SIEMENS fuse types								
Rated voltage 415 V ~	16 A D01 Neoz./ B.No. 5SE2116	25 A D02 Neoz./ B.No. 5SE2125		35 A D02 Neoz./ B.No. 5SE2135				
Rated voltage 500 V ~	16 A DII Diazed/ B.No. 5SB261	25 A DII Diazed/ B.No. 5SB281	80 A DIV Diazed/ B.No. 5SC211	35 A DIII Diazed/ B.No. 5SB411	80 A DIV Diazed/ B.No. 5SC211			
Rated voltage 500 V ~	16 A size 00 NH/ B.No. 3NA3805	25 A size 00 NH/ B.No. 3NA3810	80 A size 00 NH/ B.No. 3NA3824	35 A size 00 NH/ B.No. 3NA3814	80 A size 00 NH/ B.No. 3NA3824	125 A size 00 NH/ B.No. 3NA3832	160 A size 1 NH/ B.No. 3NA3136	250 A size 1 NH/B.No. 3NA3144
SIEMENS circuit–breakers								
Desig.	3RV1031–4BA10	3RV1031–4EA10	3RV1041–4LA10 3VF3111–3FQ41–0AA0	3RV1031–4FA10	3RV1041–4LA10 3VF3111–3FQ41–0AA0	3VF3211–3FU41–0AA0	3VF3211–3FW41–0AA0	3VF4211–3DM41–0AA0

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7.1.2 HF commutating reactors

General information

The matching HF commutating reactor, according to the selection table, is required to connect the uncontrolled 28 kW infeed and the controlled infeed/regenerative feedback modules to the line supply (refer to Section 6).

Tasks

Commutating reactors have the following tasks:

- Limit the amount of harmonics fed back into the line supply
- Store energy for step–up controller operation in conjunction with infeed and regenerative feedback modules

HF commutating reactor for line supplies 3–ph. 400 V AC –10 % to 480 V +6 %; 50/60 Hz ± 10 %

Note

When using commutating reactors, which SIEMENS has not released for SIMODRIVE 6SN11, harmonics can occur which can damage/disturb other equipment connected to the line supply.

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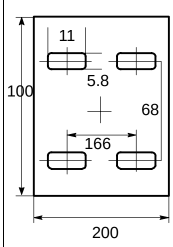
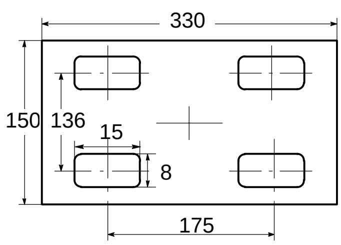
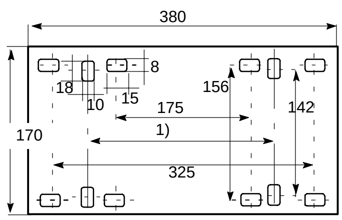
7.1.3 Assigning commutating reactors to the NE modules

Note

When using SIMODRIVE filter modules for I/R modules in squarewave current operation (refer to Section 7.2), a separate commutating reactor is not required.

For UI 5/10 kW and UI 10/25 kW, commutating reactors are not required.
Operating voltage: 3–ph. 300 to 520 V AC/45 to 65 Hz

Table 7-2 Assigning commutating reactors to the NE modules

	UI module 28/50 kW	**I/R module 16/21 kW**	**I/R module 36/47 kW**	**I/R module 55/71 kW**	**I/R module 80/104 kW**	**I/R module 120/156 kW**
Type	28 kW commutating HF reactor	16 kW commutating HF reactor	36 kW commutating HF reactor	55 kW commutating HF reactor	80 kW commutating HF reactor	120 kW commutating HF reactor
Order No. 6SN1111– 0AA00–	6SN1111– 1AA00– 0CA0 1)	–0BA1 1)	–0CA1 1)	–0DA1 1)	–1EA0 1)	–1FA0 1)
L_{phase}	0.15 mH	0.7 mH	0.4 mH	0.27 mH	0.23 mH	0.2 mH
I_n	65 A	30 A	67 A	103 A	150 A	225 A
Voltage drop/ phase	V3.1	8.6 V	12.3 V	12.3 V	11.1 V	15.2 V
Pv	70 W	170 W	250 W	350 W	450 W	590 W
Connec- tion	max. 35 mm^2	max. 16 mm^2	max. 35 mm^2	max. 70 mm^2	Cable lug acc. to DIN 46235	
Weight (max)	6 kg	9 kg	20 kg	26 kg	40 kg	50 kg
Mounting position	Any	Any	Any	Any	Any	Any
Terminal assign- ment	Input:					
	1U1, 1V1, 1W1					
	Output:					
	1U2, 1V2, 1W2					
Drilling template Dimen- sions in mm Top view, foorprint	 Height 190	 Height for 16 kW: 145 Height for 36 kW: 230 Height for 55 kW: 280			 1): 80kW: 224, Height 200 120kW: 264, Height 300	

1) Suitable for sinusoidal current and squarewave current operation.

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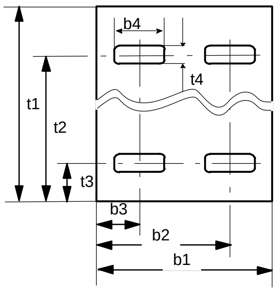
7.1.4 Assigning autotransformers to the I/R modules[2)]

Note

If a transformer is used for I/R modules, this does **not** replace the external commutating reactor.

When using a transformer, from NE module ≥ 10kW onwards
Order number: 6SN114□–1□□0□–0□□**1** an overvoltage limiting module must be used. Order number: 6SN1111–0AB00–0AA0

Table 7-3 Auto–transformers for 480/440V input voltage

	I/R module 16/21 kW	**I/R module 36/47 kW**	**I/R module 55/71 kW**	**I/R module 80/104 kW**	**I/R module 120/156 kW**
PD type 3–ph. 480/ 440/400 V AC [1)]	21 kVA auto–transformer	46.5 kVA auto–transformer	70.3 kVA auto–transformer	104 kVA auto–transformer	155 kVA auto–transformer
Order No. 6SN1111–0AA00–	–0BB□	–0CB0	–0DB0	–0EB0	–0FB□
Pv	170 W	376 W	445 W	550 W	700 W
Connection	16 mm^2	50 mm^2	70 mm^2	Cable lug acc. to DIN 46235	
Fuse, primary	35 A gL	80 A gL	125 A gL	160 A gL	224 A gL
Weight	26 kg	60 kg	60 kg	80 kg	125 kg
Terminal assignment	1U1 / 1U3 / 1V1 / 1V3 / 1W1 / 1W3 / 2U1 / 2V1 / 2W1 / N			Flat connectors	
	1U1 to 1W1=480 V input, 1U3 to 1W3=440 V input, 2U1 to 2W1=400 V output, N=neutral point				
Drilling template Dimensions in mm Top view, footprint					
	t1 = 270 t2 = 235 t3 = 35 t4 = 10 b1 = 180 b2 = 140.5 b3 = 39.5 b4 = 18 Height 250	t1 = 370 t2 = 317 t3 = 53 t4 = 10 b1 = 220 b2 = 179 b3 = 41 b4 = 18 Height 330	t1 = 370 t2 = 317 t3 = 53 t4 = 10 b1 = 240 b2 = 189 b3 = 51 b4 = 18 Height 340	t1 = 420 t2 = 368 t3 = 52 t4 = 10 b1 = 260 b2 = 200.5 b3 = 59.5 b4 = 18 Height 370	t1 = 480 t2 = 418 t3 = 62 t4 = 15 b1 = 280 b2 = 217.5 b3 = 62.5 b4 = 22 Height 440

1) The transformers for 3–ph. 480/440/400 V AC can be used at the 480 V tap up to 550 V for a line supply frequency of 57 – 63 Hz.
2) Assigning isolating transformers to I/R modules, refer to Catalog NC 60.

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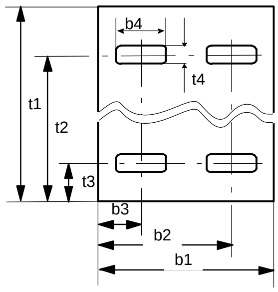
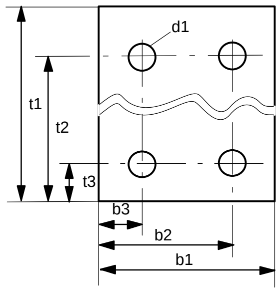
Table 7-4 Auto–transformer for 220V input voltage[2)]

	I/R module 16/21 kW	**I/R module 36/47 kW**	**I/R module 55/71 kW**	**I/R module 80/104 kW**	**I/R module 120/156 kW**
PD type[1)] 3–ph. 220/400 V AC	21 kVA auto–transformer	46.5 kVA auto–transformer	70.3 kVA auto–transformer	104 kVA auto–transformer	155 kVA auto–transformer
Order No., 6SN1111–0AA00–	–0BC0	–0CC0	–0DC0	–0EC0	–0FC0
Pv	412 W	644 W	790 W	1100 W	1340 W
Connection	Prim. 16 mm^2 Sec. 16 mm^2	Prim. 70 mm^2 Sec. 50 mm^2	Prim. 95 mm^2 Sec. 70 mm^2	Cable lug acc. to DIN 46235	
Fuse, primary	63 A gL	160 A gL	224 A gL	300 A gL	500 A gL
Weight	60 kg	120 kg	135 kg	220 kg	300 kg
Terminal assignment	1U1 to 1W1=220 V input, 2U1 to 2W1=400 V output, N=neutral point				
Max. dimensions Drilling template in mm Top view, footprint					
	t1 = 370 t2 = 317 t3 = 53 t4 = 10 b1 = 220 b2 = 179 b3 = 41 b4 = 18 Height 330	t1 = 480 t2 = 418 t3 = 62 t4 = 15 b1 = 255 b2 = 205 b3 = 50 b4 = 22 Height 430	t1 = 480 t2 = 418 t3 = 62 t4 = 15 b1 = 300 b2 = 241 b3 = 59 b4 = 22 Height 430	t1 = 530 t2 = 470 t3 = 60 b1 = 325 b2 = 254 b3 = 71 d1 = 12.5 Height 520	t1 = 590 t2 = 530 t3 = 60 b1 = 360 b2 = 279 b3 = 81 d1 = 15 Height 600

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7.1.5 Assigning transformers to the I/R modules

Table 7-5 Matching transformers with separate windings for 50 Hz / 60 Hz line supplies

	I/R module 16 kW	I/R module 36 kW	I/R module 55 kW	I/R module 80 kW	I/R module 120 kW
Rated power [kVA]	21	47	70	104	155
Pv [W]	750	1380	2100	2800	3700
Weight [kg]	120	160	310	440	540
Secondary connection [mm^2]	16	50	70	Cable lug acc. to DIN 46235	
Input voltage 3–ph. 500 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %					
Rated input current [A]	25.2	55.9	84.1	124	183
Primary connection [mm^2]	10	35	50	70	Cable lug acc. to DIN 46235
Order No., 6SN1111–0AA02–	–0BE0	–0CE0	–0DE0	–0EE0	–0FE0
Input voltage 3–ph. 440 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %					
Rated input current [A]	28.7	63.5	95.5	141	207
Primary connection [mm^2]	10	50	50	70	Cable lug, acc. to DIN 46235
Order No., 6SN1111–0AA02–	–0BF0	–0CF0	–0DF0	–0EF0	–0FF0
Input voltage 3–ph. 415 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %					
Rated input current [A]	30.4	67.3	101	149	220
Primary connection [mm^2]	10	35	50	70	Cable lug, acc. to DIN 46235
Order No., 6SN1111–0AA02–	–0BG0	–0CG0	–0DG0	–0EG0	–0FG0
Input voltage 3–ph. 400 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %					
Rated input current [A]	31.5	69.9	105	155	228
Primary connection [mm^2]	16	50	70	Cable lug, acc. to DIN 46235	
Order No., 6SN1111–0AA02–	–0BH0	–0CH0	–0DH0	–0EH0	–0FH0
Input voltage 3 AC 220 V ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %					
Rated input current [A]	57.3	127	191	281	415
Primary connection [mm^2]	16	50	Cable lug, acc. to DIN 46235		
Order No., 6SN1111–0AA02–	–0BC0	–0CC0	–0DC0	–0EC0	–0FC0
Input voltage 3–ph. 200 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %					
Rated input current [A]	63	140	210	309	456
Primary connection [mm^2]	35	70	Cable lug, acc. to DIN 46235		
Order No., 6SN1111–0AA02–	–0BJ0	–0CJ0	–0DJ0	–0EJ0	–0FJ0

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Operating conditions, all transformers and reactors

The following operating conditions are permitted:

- Supply voltage 3–ph. 480/440/400 V AC or 3–ph. 220/400 V AC/45...60 Hz[1)]
- Temperature range –25°C...40°C (to 55°C with de–rating)
- Degree of protection IP00
- Humidity rating F according to DIN 40040 for transformers and reactors

The maximum current of transformers/reactors is dependent on the ambient temperature and the installation altitude. The permissible current/power rating of the transformers and reactors is:

I_n (PD) reduced = $c \times I_n$ (PD)

1) 3–ph. 240 V AC at 60 Hz ±5% can be used as input voltage.
Note: The secondary voltage increases and the NE modules should be set to S1.1=ON, refer to Section 6.1.
2) Assigning isolating transformers to I/R modules, refer to Catalog NC 60.

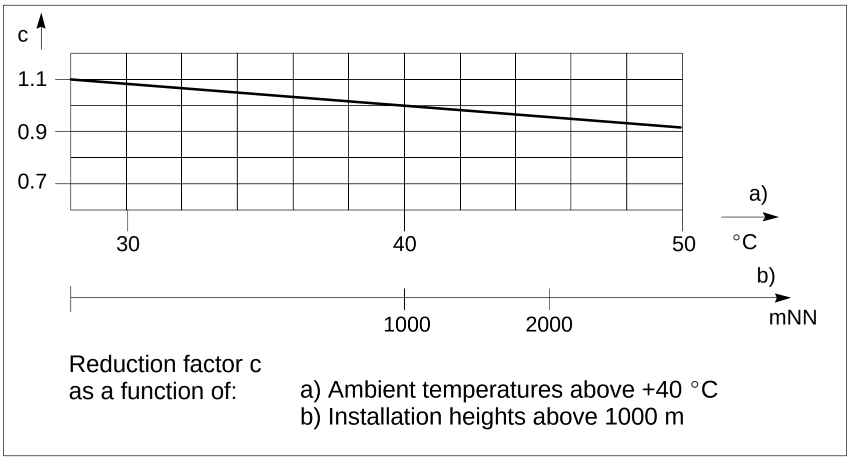

Fig. 7-1 Reduction factor c

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7.1.6 Assigning transformers to the UI modules

Table 7-6 Matching transformers with separate windings for 50 Hz / 60 Hz line supplies

	UI module 5 kW	**UI module 10 kW**	**UI module 28 kW**
Rated power [kVA]	8.2	15.7	42.6
Pv [W]	600	730	1300
Weight [kg]	60	100	170
Secondary connection [mm^2]	4	10	35
Input voltage 3–ph. 500 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %			
Rated input current [A]	9.95	19	50.7
Primary connection [mm^2]	4	6	25
Order No., 6SN1111–0AA02–	–1BE0	–1AE0	–1CE0
Input voltage 3–ph. 440 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %			
Rated input current [A]	11.3	21.6	57.6
Primary connection [mm^2]	4	6	35
Order No., 6SN1111–0AA02–	–1BF0	–1AF0	–1CF0
Input voltage 3–ph. 415 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %			
Rated input current [A]	12	22.9	61
Primary connection [mm^2]	4	6	35
Order No., 6SN1111–0AA02–	–1BG0	–1AG0	–1CG0
Input voltage 3–ph. 400 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %			
Rated input current [A]	12.4	23.8	63.3
Primary connection [mm^2]	4	10	35
Order No., 6SN1111–0AA02–	–1BH0	–1AH0	–1CH0
Input voltage 3–ph. 220 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %			
Rated input current [A]	22.6	43.3	115
Primary connection [mm^2]	6	25	50
Order No., 6SN1111–0AA02–	–1BC0	–1AC0	–1CC0
Input voltage 3–ph. 200 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %			
Rated input current [A]	24.9	47.6	127
Primary connection [mm^2]	10	25	70
Order No., 6SN1111–0AA02–	–1BJ0	–1AJ0	–1CJ0

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7.1.7 Assigning main switches

Note

Before powering–down, terminal 48 of the NE module must be de–energized 10 ms before the contacts of the switch open.

Main switches with leading auxiliary contacts can be used to ensure that terminal 48 of the NE module is first de–energized.

Recommendation:
Siemens switches, types 3LC.../3KA5... (from the Catalog SIEMENS ”Low–voltage switchgear”)

Table 7-7 Assigning the main and auxiliary switches

For UI modules					
	5 kW	10 kW	28 kW		
Switch-type	3LD2103–0TK... + 3LD9220–3B	3LD2504–0TK... + 3LD9250–3B	3LD2704–0TK... + 3LD9280–3B		
For I/R modules					
	16 kW	36 kW	55 kW	80 kW	120 kW
Switch type	3LD2504–0TK... + 3LD9250–3B	3LD2704–0TK... + 3LD9280–3B	3LD5330–1EE00 + 3LD1400–0A	3LD5330–1EE00 + 3LD1400–0A	3LD5730–1EE00 + 3LD1400–0A

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7.2 Line filter and HF commutating reactors for I/R and UI modules

General information

Line filters and HF commutating reactors are available in the SIMODRIVE 611 system in order to comply with EMC Guidelines. In addition to using a line filter and HF commutating reactors, in order to maintain the limit values, it is important that the cabinet is designed in compliance with EMC Guidelines. The installation and connection specifications according to Section 10.1 must be observed.

Please refer to the EMC Guidelines for SINUMERIK, Order No.: 6FC5297–0AD30–0AP1 for additional information regarding EMC correct design.

These EMC limit values can also be fulfilled using other suitable measures; an EMC investigation should be made on a case–for–case basis.

If the system is to be in compliance with the EMC Guidelines, then we recommend using the line filter packages Catalog NC 60

Table 7-8 Line supply conditions

Desig.	Description		
Line supply conditions of the NE modules	The NE modules are designed for symmetrical 3–phase line supplies with grounded neutral point which can be loaded: TN line supplies. The line supply requirements according to EN 50178 are maintained using the upstream commutating reactor (for UI 5 kW and UI 10 kW, these are integrated in the module).		
UI modules	The line supply connection must be designed for Pn/Ps6/Pmax of the connected UI module.		
I/R modules	In order to guarantee that the system environment is not polluted, the fault rating of the line supply (S_K line supply) at the connection point of the I/R module must have the values as shown in Table 6-13. If these requirements are not maintained, this can have a negative impact on the drive system, and also result in faults and disturbances in other devices which are connected at this particular point.		
	Valid for I/R modules with Order No.: 6SN114□–1□□0□–0□□**1**		
	I/R module used	**Sinusoidal current operation (S1.6 = ON) Section 6.1, required S_K line supply**	**Squarewave current operation (S1.6 = OFF) Section 6.1 required S_K line supply**
	16 KW	S_K – line supply ≥ 1.1 MVA (70 x $Pn_{I/R\ module\ in\ kW}$)	S_K – line supply ≥ 1.6 MVA (100 x $Pn_{I/R\ module\ in\ kW}$)
	36 KW	S_K – line supply ≥ 2.5 MVA (70 x $Pn_{I/R\ module\ in\ kW}$)	S_K – line supply ≥ 3.6 MVA (100 x $Pn_{I/R\ module\ in\ kW}$)
	55 KW	S_K – line supply ≥ 3.9 MVA (70 x $Pn_{I/R\ module\ in\ kW}$)	S_K – line supply ≥ 5.5 MVA (100 x $Pn_{I/R\ module\ in\ kW}$)
	80 KW	S_K – line supply ≥ 4.8 MVA (60 x $Pn_{I/R\ module\ in\ kW}$)	S_K – line supply ≥ 6.4 MVA (80 x $Pn_{I/R\ module\ in\ kW}$)
	120 KW	S_K – line supply ≥ 7.2 MVA (60 x $Pn_{I/R\ module\ in\ kW}$)	S_K – line supply ≥ 9.6 MVA (80 x $Pn_{I/R\ module\ in\ kW}$)

Note

If a matching transformer is used, it is still necessary to use a line filter and HF commutating reactor.

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Notice

When using filters which SIEMENS have not released for SIMODRIVE 6SN11, harmonics can be fed back into the line supply which can damage/disturb devices connected to that line supply.

It is not permissible to connect other loads to the line filter output.

Function description of the HF commutating reactors

The HF commutating reactors have the task of limiting harmonics fed back into the line supply and saving the energy for step–up control operation in conjunction with infeed and regenerative feedback modules. The matching HF commutating reactor, according to the selection table is required when connecting the uncontrolled 28 kW infeed and the controlled infeed/regenerative feedback modules to the line supply.

Function description of the line filters

The line filters limit the cable–borne faults emitted from the drive converter units to permissible EMC values for industry. In conjunction with consequentially implementing the plant/system in accordance with the Planning Guide and the EMC Guidelines for SIMODRIVE, SINUMERIK, SIROTEC, the limit values at the installation location are maintained in accordance with EC Guidelines EMC. The line filter and line filter packages can be used both in sinusoidal as well as squarewave current operation.

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7.2.1 Assigning the line filters to the I/R modules

Table 7-9 Assigning the line filters to the I/R modules

	I/R module 16/21 kW	**I/R module 36/47 kW**	**I/R module 55/71 kW**	**I/R module 80/104 kW**	**I/R module 120/156 kW**
Filter components	Line filter 16 kW	Line filter 36 kW	Line filter 55 kW	Line filter 80 kW	Line filter 120 kW
Order No. Line filter	6SN1111–0AA01–2BA☐	6SN1111–0AA01–2CA☐	6SN1111–0AA01–2DA☐	6SN1111–0AA01–2EA☐	6SN1111–0AA01–2FA☐
Mounting position	Wall or floor mounting, refer to dimension drawings, Section 12.				
Module width	Refer to the dimension drawings, Section 12.				
Filter Filter	9 kg	16 kg	19 kg	22 kg	32 kg
I_{rated} filter	30 A	67 A	103 A	150 A	225 A
P_V filter	70 W	90 W	110 W	150 W	190 W
Connection	16/10 mm^2 [1)] PE, (M5)	50 mm^2 PE, (M8)	50 mm^2 PE, (M8)	95 mm^2 PE, (M8)	Cable lug acc. to DIN 46235
Terminals, Line supply input	LINE L1, L2, L3, PE	LINE L1, L2, L3, PE	LINE L1, L2, L3, PE	LINE L1, L2, L3, PE	LINE L1, L2, L3, PE
Terminals, output	LOAD L1, L2, L3	LOAD L1, L2, L3	LOAD L1, L2, L3	LOAD L1, L2, L3	LOAD L1, L2, L3
I_{rated} fuse[2)]	35 A	80 A	125 A	160 A	250 A
Cooling	Non–ventilated	Non–ventilated	Non–ventilated	Non–ventilated	Non–ventilated
Radio interference suppression EN 55011	Cable–borne, limit value Class A	Cable–borne, limit value Class A	Cable–borne, limit value Class A	Cable–borne, limit value Class A	Cable–borne, limit value Class A

Table 7-10 Filter packages

Filter packages	16 kW package 6SN1111–0AA01–2BB0	36 kW package 6SN1111–0AA01–2CB0	55 kW package 6SN1111–0AA01–2DB0	80 kW package 6SN1111–0AA01–2EB0	120 kW package 6SN1111–0AA01–2FB0
Contents:					
6SN1111–0AA00–	HF commutating reactor 16 kW –0BA☐	HF commutating reactor 36 kW –0CA☐	HF commutating reactor 55 kW –0DA☐	HF commutating reactor 80 kW –1EA☐	HF commutating reactor 120 kW –1FA☐
6SN1111–0AA01–	Line filter 16 kW –2BA☐	Line filter 36 kW –2CA☐	Line filter 55 kW –2DA☐	Line filter 80 kW –2EA☐	Line filter 120 kW –2FA☐

Mounting position of the filter modules

The filter modules can be mounted horizontally and vertically (line at the bottom, load at the top).

1) The 1st number is valid for cable lugs, the 2nd number is for finely–stranded conductors without connector sleeves.
2) The fuse used must have this rated current. Refer to Table 7-1 for recommended fuses.

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7.2.2 Assignment of the line filters to the UI modules

Table 7-11 Assignment of the line filter to the UI modules

	UI module 5/10 kW	**UI module 10/25 kW**	**UI module 28/50 kW**
Filter components	Line filter, 5 kW	Line filter, 10 kW	Line filter, 28 kW
Order No.,	6SN1111–0AA01–1BA0	6SN1111–0AA01–1AA0	6SN1111–0AA01–1CA0
Mounting position	Any		
Module width	Refer to Dimension Drawings, Section 12		
Filter Filter	3.8 kg	5.7 kg	12.5 kg
I_{rated} filter	16 A	25 A	65 A
P_v filter	20 W	20 W	25 W
Connection	4 mm^2 PE, M6 studs	10 mm^2 PE, M6 studs	50 mm^2 PE, M10 studs
Terminals, Line supply input	LINE L1, L2, L3, PE	LINE L1, L2, L3, PE	LINE L1, L2, L3, PE
Terminals, output	LOAD L1, L2, L3, PE	LOAD L1, L2, L3, PE	LOAD L1, L2, L3, PE
I_{rated} fuse[1)]	16 A	25 A	80 A
Cooling	Non–ventilated	Non–ventilated	Non–ventilated
Radio interference suppression EN 55011	Cable–borne, limit value Class A	Cable–borne, limit value Class A	Cable–borne, limit value Class A

1) The fuse used must have this rated current. Refer to Table 7-1 for recommended fuses.

7.2.3 Adapter set and line filter package

Line filter packages are available for the I/R modules (refer to Catalog NC60). These line filter packages comprise a line filter and an HF commutating reactor (refer to Table 7-10).

We recommend that these line filter packages are ordered.

Adapter sets are available to adapt the line filter packages to the mounting surface and to the retaining points of the earlier filter modules. The mounting depth protrudes beyond the front of the drive group by 20 – 30 mm.

Note

It is not permissible that the filter inputs and outputs are interchanged.

■

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Space for your notes

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Supplementary System Components 8

8.1 Signal amplifier electronics

The signal amplifier electronics is used to amplify the current signals for distances > 18 m between the encoder and the digital drive module for 1FT6 motors whereby the current signals are converted into voltage signals.

Notice

Current signals should no longer be used for new applications, as voltage signals offer higher noise immunity.

The signal amplification electronics can only be used in conjunction with the Performance control of SIMODRIVE 611 digital.

8

Table 8-1 Technical data of the signal amplifier electronics

Technical data	
Signal waveform	Sine–cosine
Input signal	7 μA_{pp} to 16 μA_{pp}
Output signal	$1V_{pp}$
Signal frequency, max.	300 kHz
Operating voltage, max. at remote sense	8 V DC
Operating current, max.	200 mA
Encoder power supply	5 V DC ± 5 %
Encoder power supply current, max.	120 mA
Dimensions (H x W x D)	54 mm x 121 mm x 57 mm
Order number	6SN11 15–0AA12–0AA0
Degree of protection of the enclosure	IP 65

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8.2 Connecting cable for 2–tier arrangement

If space is restricted, the SIMODRIVE 611 drive converter system modules can also be arranged in two tiers one above the other or in adjacent cabinet panels (refer to Section 10.1.3)

For 2–tier arrangements, a connecting cable must be ordered to connect the equipment bus and if required, the drive bus.

Parallel cables must be used to connect the DC link (M600/P600) in a 2–tier arrangement. For adjacent 300 mm wide modules, a CU conductor cross–section of 70 mm^2 and for smaller modules, CU 50 mm^2 should be used.
The cables must be routed so that they are short–circuit proof and ground–fault proof. A potential bonding conductor having the same cross–section must be connected in parallel and connected to the housings of the modules which are connected with one another. This cable is not included with the equipment. Adapter terminals are available to connect the DC link.

Ordering data, refer to Catalog NC 60.

8.3 Adapter terminals for DC link connection

The DC link voltage can be connected using the adapter terminals, e.g. to connect the DC link for two–tier arrangements.

The following adapter terminals are available:

1. Package with 2 double terminals 50 mm^2 for module widths 50 to 200 mm

   Order No. (MLFB): 6SN1161–1AA01–0BA0

2. Package with 2 double terminals 95 mm^2 for module width 300 mm

   Order No. (MLFB): 6SN1161–1AA01–0AA0

8.4 Shield connecting rail

The shield connecting rail is used to connect the electronics cable to the ground potential of the module housing so that the connection is in–line with EMC guidelines. The rail can be mounted above the control modules on the power and infeed modules using threaded sockets.

Ordering data, refer to Catalog NC60

■

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Important Circuit Information

9

9.1 General information

Note

The following circuit examples, information and descriptions are of a general nature and do not claim to be complete and correct for a particular application. They must be adapted for every plant or system.

The circuit examples are intended to support the machine manufacturer/user when integrating the control–related part of a SIMODRIVE 611 drive system into the complete control concept of his machine/plant.

The user is responsible in configuring and engineering the complete control system, taking into account all of the guidelines/standards valid for his particular application, and the safety measures, derived from a hazard analysis/risk evaluation, to avoid injury to personnel and damage to machinery.

Warning

After opening the line supply disconnection device (main switch) or the line contactor, a residual energy and hazardous touch voltages up to 60 V DC are available at the power DC link of the drive group and therefore at electrically connected components (terminals, cables, switching devices, motors etc.). This residual energy and hazardous touch voltages are present while the DC link capacitors discharge, max. 30 min., and must be taken into consideration in a hazard analysis/risk evaluation.

The service personnel must be absolutely certain that the plant or system is actually in a no–voltage condition before carrying out any service, maintenance or cleaning work on the machine!

Warning

Before the line disconnection device (main switch) or a line contactor is used to power up or power down the drive group, terminal 48, start and/or terminal 63, pulse enable, must be de–energized at the NE module. This can be realized, for example, using a leading auxiliary contact at the main switch.

The terminals do not have to be first de–energized for uncontrolled UI modules, 5, 10 and 28 kW as well as for I/R modules, if these are operated uncontrolled in the line supply infeed and regenerative operating modes and an overvoltage limiting module is used.

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Warning

If the electronics power supply of the NE or monitoring module is connected directly in front of the commutating reactor at the line supply, 6–conductor connection, via terminals 2U1–2V1–2W1, then it is not permissible to connect X181: P500/M500 to the DC link P600/M600, refer to Section 9.13.

Warning

To shut down in a controlled fashion using the DC link energy at power failure, e.g. terminal P500/M500 can for example, remain connected to the DC link P600/M600.

When powering down using the line contactor, or in the setting–up mode, this connection must be reliably and safely disconnected, e.g. using a contactor with ”protective separation” refer to Section 9.12.

Warning

For a six conductor connection of the NE module, and where the electronic supply is connected directly to the line supply, the jumpers, inserted in connector X181 at the NE module when the equipment is supplied, must be removed, refer to Section 9.13.

Warning

The connections at the input and output side at the line filter may not be interchanged.

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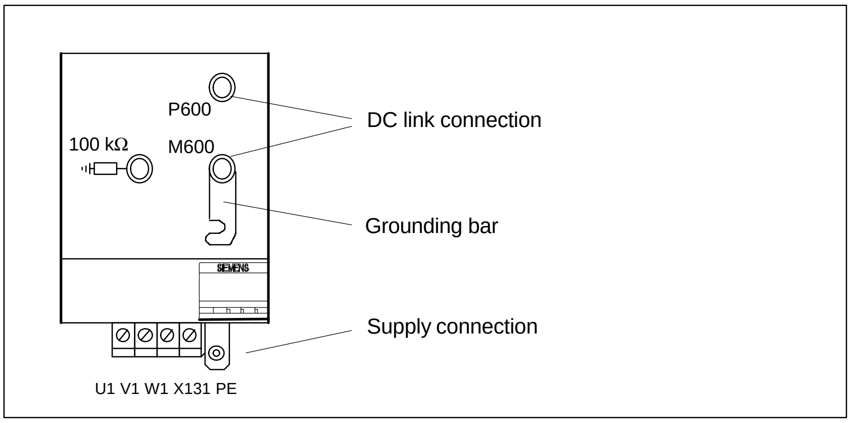

Fig. 9-1 NE–module,

Warning

The grounding bar is used to ground the M600 DC link bus through resistor 100 kΩ and this should be preferably inserted. When the equipment is supplied, the grounding bar is open.

If the system is subject to a high voltage test, then the grounding bar must be opened

Note

The line supply is electrically isolated from the power circuit of the drive group via the internal line contactor.

The coil circuit can be disconnected to reliably de–energize the line contactor via the floating contacts, using terminals NS1, NS2 at the NE module. The DC link will not be pre–charged if the connection is missing when the unit is powered up.

The connection NS1, NS2 may only be switched when terminal 48 and/or terminal 63 are first de–energized or simultaneously with these terminals, refer to Section 9.7.

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9.2 Infeed modules

9.2.1 Three–conductor connection (standard circuit)

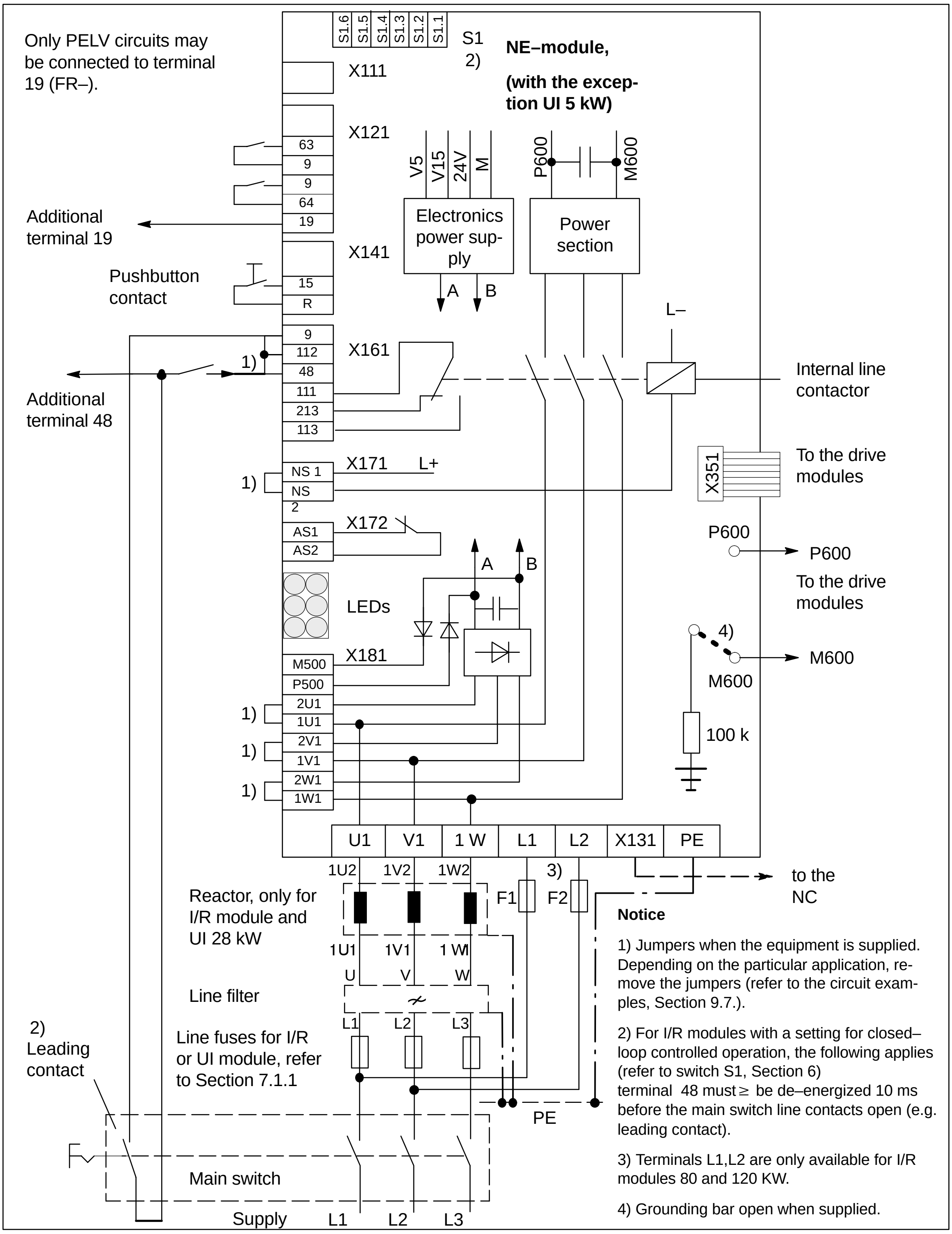

Fig. 9-2 Three–conductor connection (standard circuit)

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9.2.2 Description of the interfaces and functions

Table 9-1 Overview, infeed modules, internal cooling, commutating reactors, line filter, fuse

Power [KW] S1/S6/S_{max}	**Order number**	**Commutating reactor**	**Line filter** 1) **only 415 V !**	**Line filter package only 415 V !**	**Fuse** 3) **[A]**
5/6.5/10 UI	6SN1146–1AB0☐–0BA1	2) –	6SN1111–0AA01–1BA0	–	16
10/13/25 UI	6SN1145–1AA0☐–0AA1	2) –	6SN1111–0AA01–1AA0	–	25
28/36/50 UI	6SN1145–1AA0☐–0CA0	6SN1111–1AA00–0CA0	6SN1111–0AA01–1CA0	–	80
16/21/35 I/R	6SN1145–1BA0☐–0BA1	6SN1111–0AA00–0BA☐	6SN1111–0AA01–2BA☐	6SN1111–0AA01–2BB0	35
36/47/70 I/R	6SN1145–1BA0☐–0CA1	6SN1111–0AA00–0CA☐	6SN1111–0AA01–2CA☐	6SN1111–0AA01–2CB0	80
55/71/91 I/R	6SN1145–1BA0☐–0DA1	6SN1111–0AA00–0DA☐	6SN1111–0AA01–2DA☐	6SN1111–0AA01–2DB0	125
80/104/131 I/R	6SN1145–1BB0☐–0EA1	6SN1111–0AA00–1EA☐	6SN1111–0AA01–2EA☐	6SN1111–0AA01–2EB0	160
120/156/175 I/R	6SN1145–1BB0☐–0FA1	6SN1111–0AA00–1FA☐	6SN1111–0AA01–2FA☐	6SN1111–0AA01–2FB0	250

Note:
1) The line filter does not include the commutating reactor! This must be additionally mounted between the line filter and I/R !
The line filter package comprises a commutating reactor and a line filter, which are separately combined to form a package.
2) Commutating reactor included in the NE module.
3) Versions NH, D, DO, gL

Switch S1

Switch S1 is provided on the upper side of the NE and monitoring module and at the front of the UI module 5 kW. It is used to select various functions, refer to Section 6.1.

Terminal 19

FR–

Reference potential for the enable voltage, terminal 9,
floating (connected to the general reference ground terminal 15 via 10 kΩ).
It is not permissible that terminal 19 is connected to terminal 15! (Connect to the PE rail or X131).

When controlling the enable signals via P–switching electronic outputs (PLC), terminal 19 should be connected to the 0 V reference potential (ground) of the external power supply.

The circuit/source must correspond to the requirements of PELV (Protection Extra Low Voltage) function extra low voltage with protective separation in compliance with EN 60204–1; 6.4.

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Terminal 9

FR+

+24 V enable voltage for the internal enable signals of the NE and drive modules

Max. load: 500 mA

Terminal 48

Start

This terminal has the highest priority. Terminal 48 is used to initiate a defined power–on and power–off sequence of the NE module.

If terminal 48 is energized, then the pre–charging sequence is internally initiated. After the DC link has been charged up, the pre–charging contactor is opened and the main contactor pulls in. The internal enable signals are then available.

If terminal 48 is de–energized, then initially, after approx. 1 ms the internal pulse enable signals are inhibited and then the DC link is electrically isolated from the line supply, with a delay caused by the drop–out time of the internal line contactor.

if terminal 48 is de–energized during charging, then charging is first completed and terminal 48 is only inhibited after charging has been completed, if terminals NS1–NS2 are jumpered.

Terminals NS1, NS2

Coil circuit of the internal line and pre–charging contactor

When the line contactor is opened by interrupting the coil circuit using floating contacts, the DC link is safely isolated from the line supply.

The terminals have a safety–relevant function. Disconnection using terminals NS1–NS2 must be realized either at the same time or delayed to terminal 48 Start (refer to Section 9.7 circuit examples = 2 and = 4).

Max. cable length 50 m (2–conductor cable) for 1.5 mm^2 cross–section

Terminal 63

Pulse enable

This terminal has the highest priority for the pulse enable and inhibit. The enable and the inhibit act, after approx. 1 ms, simultaneously on all of the modules including the NE module. When the signal is withdrawn, the drives “coast down” unbraked.

Terminal 64

Drive enable

The drives modules are enabled using terminal 64. The enable and inhibit act simultaneously on all modules after approx. 1 ms.

If terminal 64 is inhibited, n_{set} is set to 0 for all drives and the drives are braked as follows:

- For MSD/IMM 611A, the drives are braked along the selected ramp, and the pulses are cancelled after a selectable speed has been fallen below.

  If terminal 81 is simultaneously inhibited, the drives brake along the current limit.

- For FD 611A, after the ar set timers have expired (as supplied: 240 ms) all of the controllers and pulses are inhibited. The drives brake along the current limit.

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- For 611D/611U/ANA/HLA drives, the pulses are cancelled after a selectable speed has been fallen below or after a selectable timer has expired. The drives are braked along the set limit (MD 1230, 1235, 1238).

For spindles, a ramp can only be achieved using regenerative limiting (MD 1237).

Terminals L1, L2

Line supply connection 2–ph. 360 ... 457 V AC / 45 ... 53 Hz; 400 ... 510 V / 57 ... 65 Hz.

Coil voltage of the internal line connector is connected directly to the line supply (do not connect between the I/R module and reactor).

The terminals are only provided at the 80/104 kW and 120/156 kW I/R modules.

Fuse: $I_N \geq 4$ A, version gL

Note

If, for the 80/104 kW or 120/156 kW I/R module, the line supply voltage fails at terminals L1, L2, or fuses F1, F2 blow, then only the pulses in the I/R module are inhibited and the internal line contactor drops out.

This is displayed via the line supply fault LED and the ready relay as well as the contactor signal contacts. In this case, after the internal line contactor has been re–closed, terminal 48 must be inhibited, and after ≥ 1 sec, re–enabled or the unit powered down/powered up.

9

Terminal R

Reset

The fault signal is reset using a button (pulse edge) between terminal R and 15.

For the SIMODRIVE 611 universal control module, the reset is effective, if in addition, terminal 65 ”controller enable” is inhibited

For 611A MSD and AMM modules, the reset is effective if additionally terminal 63, 64, 65 or 48 are inhibited.

Terminal 112

Setting–up operation

Terminal 112 is jumpered, as standard with terminal 9.

For a special application,
“setting–up operation with reduced DC link voltage”,
the DC link controller is inhibited when terminal 112 is opened. The power in-feed is supplied through a three–phase isolating transformer with a reduced secondary voltage. This function is only available for 611 analog with user–friendly interface for 1FT5 feed motors. Regenerative feedback is no longer possible, i.e. when braking, $V_{DC\ link}$ > 600 V DC.

Notice

For induction motors or for vertical 1FT5 feed axes, high speeds can even be achieved at lower $V_{DC\ link}$.

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Terminals AS1, AS2

Signaling contact, start inhibit DC link controller

(not available for NE modules 5, 10, 28 kW)

Terminal X131

Reference potential

When coupled to a numerical control, X131 must be connected to the NC reference potential. This cable must be routed in parallel with the speed setpoint cable.

Cross–section = 10 mm^2!

For a digital drive group with 840D/810D/840C, keep terminal X131 open circuit.

Terminal X141

Electronics voltage

- Term. 7: P24; +20.4 ÷ 28.8 V / 50 mA
- Term. 45: P15; +15 V /10 mA
- Term. 44: N15; –15 V / 10 mA
- Term. 10: N24; –20.4 ÷ 28.8 V / 50 mA
- Term. 15: M; 0 V

It is not permissible that terminal 15 is connected to PE (ground loop)

It is not permissible that terminal 15 is connected to terminal 19 (otherwise a short–circuit will be established through the reactor, terminal 15 is internally connected with X131).

Terminals 2U1, 2V1, 2W1

Terminals to allow the internal electronics power supply to be separately connected, e.g. through fused terminals (refer to the circuit example in Section 9.3.1).

In this case, jumpers 1U1–2U1, 1V1–2V1, 1W1–2W1 must be removed (opened).

Notice

Additional information is provided under Section 9.3 Monitoring module and Section 9.13 Observe the six–conductor connection!

Terminals P500, M500

The internal power supply connection at DC link P600/M600.

e.g. for power failure concepts.

Notice

With this operating mode, terminals 2U1, 2V1, 2W1 of the power supply must be supplied with the line supply voltage between the I/R module and line reactor.

For a six conductor connection (refer to Section 9.13) it is not permissible to establish a connection between P500/M500 and the DC link P600/M600. Otherwise, the power supply will be destroyed!

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Terminals 111, 113, 213

Signaling contacts of the internal line contactor

111–113	NO contact
111–213	NC contact

Terminal X111

Ready relay

Term. 72 – 73.1: NO contact – closed for ”ready”

Term. 73.2 – 74: NC contact – open for ”ready”

When switch S1.2 is in the OFF position “ready”, the relay pulls in if the following conditions are fulfilled:

- The internal main contactor is CLOSED (terminals NS1–NS2 connected, terminal 48 enabled)
- Terminal 63, 64 = on
- It is not permissible that there is a fault condition (also not on FD 611A Standard, or 611D/611U drives)
- FD 611A with standard interface or resolver with the ready setting must be enabled (terminals 663, 65)
- The NCU must have run up (840D, 810D)

If switch S1.2 is in the ON position, “fault signal”, the relay pulls in if the following conditions are fulfilled:

- Internal main contactor CLOSED (terminals NS1–NS2 connected, terminal 48 enabled)
- It is not permissible that there is a fault condition (also not on FD 611A Standard or 611D/611U drives)
- FD 611A with standard interface or resolver with the ready setting must be enabled (terminals 663, 65)
- The NCU must have run up (840D, 810D)

For a fault condition, the relay drops out.

With the exception of the line supply monitoring, all of the internal monitoring functions act on all drive modules connected to the drive converter bus and on the ready signal. The pulses in the I/R module are inhibited when line supply faults develop.

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Terminal X121

I^2t pre–alarm and motor temperature monitoring

Terminals 5.1 – 5.2: NO contact

Terminals 5.1 – 5.3: NC contact

The relay drops out, if:

- at the NE module
  - heatsink temperature monitoring responds
- at the FD 611A standard/resolver
  - motor temperature monitoring responds
  - heatsink temperature monitoring responds
- at the FD 611A user–friendly
  - motor temperature monitoring responds
  - heatsink temperature monitoring
  - I^2t pre–alarm responds
- at FD 611D
  - motor temperature monitoring responds
  - heatsink temperature monitoring responds
- at 611U
  - motor temperature monitoring responds
  - heatsink temperature monitoring responds

Input current, enable circuit:

Terminals 48, 63, 64 and 65: Input current, optocoupler approx. 12 mA at +24V

Terminals 663: Input current, optocoupler and start inhibit relay approx. 30 mA at +24 V

When selecting the switching devices, auxiliary contacts at the main switch, the contact reliability when switching low currents should be taken into account.

Switching capability of the signal contacts:

The max. switching capability of the signal contacts is specified in the interface overviews of the modules in Section 5 and 6 and must be carefully observed!

Note

All connected actuators, contactor coils, solenoid valves, holding brakes etc. must be provided with overvoltage limiters, diodes, varistors etc.

This is also true for switching devices/inductances which can be controlled from a PLC output.

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9.2.3 Connecting several NE modules to a main switch

A maximum of 6 terminal 48 can be connected in parallel, in order to power down a maximum of 6NE modules with the leading contact of the main switch.

Max. cable length for 1.5 mm^2 cross section: 150 m (2–conductor cable)

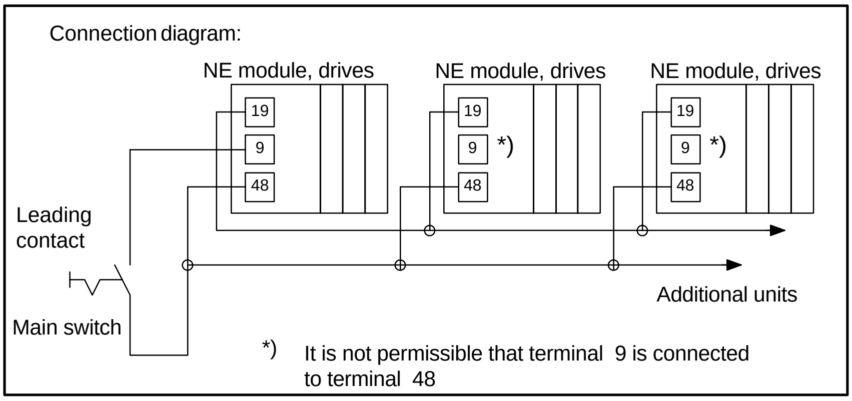

Fig. 9-3 Connection diagram of several NE modules at terminal 48

When enable terminals are connected in parallel to terminal 48, e.g. terminal 63 etc., the number of NE modules must be appropriately reduced as a result of the higher current load at terminal 9.

Note

When the internal power supply fails at NE module 1, all of the other connected NE modules and drives are inhibited. The drives “coast down” unbraked.

As an alternative to the limited current load capability of the internal power supply, the enable voltage can be taken via terminal 9 from an external 24 V PELV power supply.

Terminals 19 of the NE modules must, in this case, be connected to the 0 V reference potential (ground) of the external power supply.

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9.2.4 Use, mode of operation and connection of the line contactor

The infeed modules have a standard line contactor, integrated in the module itself.

The line contactor is electronically controlled via terminal 48.

The coil circuit of the line contactor must be interrupted using floating mechanical switching elements via terminals NS1–NS2 in order to ensure that the DC link is safely and electrically disconnected from the line supply, e.g. for the emergency stopping function. Thus, the influence of the electronic control has no effect when the unit is disconnected with electrical isolation. The cable routing to the connection terminals must be safely and electrically de–coupled from the electronics.

When the NS1–NS2 connection is interrupted, beforehand, or at the same time, the line contactor must be opened using terminal 48.

The NC contact 111–213 of the line contactor is positively driven with the power contacts, and must be inserted in the feedback circuit of the external safety–related EMERGENCY STOP switchgear combinations. This means that the line contactor function is cyclically monitored.

Notice

In order that the power DC link is reliably isolated from the supply, it should be ensured that all connections in parallel to the power infeed are electrically isolated through switching contacts. Here, it is important that any user–specific external connection between the electronics power supply and power DC link is taken into consideration.

In order to shutdown the drive at power failure and to use the DC link energy, there can be e.g. a connection between terminal P500/M500 and P600/M600.

This connection between the electronics power supply and the power DC link must be safely and reliably disconnected and remain disconnected, as otherwise, the electronics power supply of the power DC link could be charged through the auxiliary DC link.

In the setting–up mode, the connection between the electronics power supply and power DC link must also be disconnected.

When using a monitoring module, which is connected to the power DC link through P500/M500, and is also connected to the line supply, when the line contactor is opened, either the connection between the line supply and the monitoring module or the connection between the P500/M500 and power DC link must be reliably and safely interrupted using contacts.

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9.2.5 Timing diagram for the ready signal in the I/R module

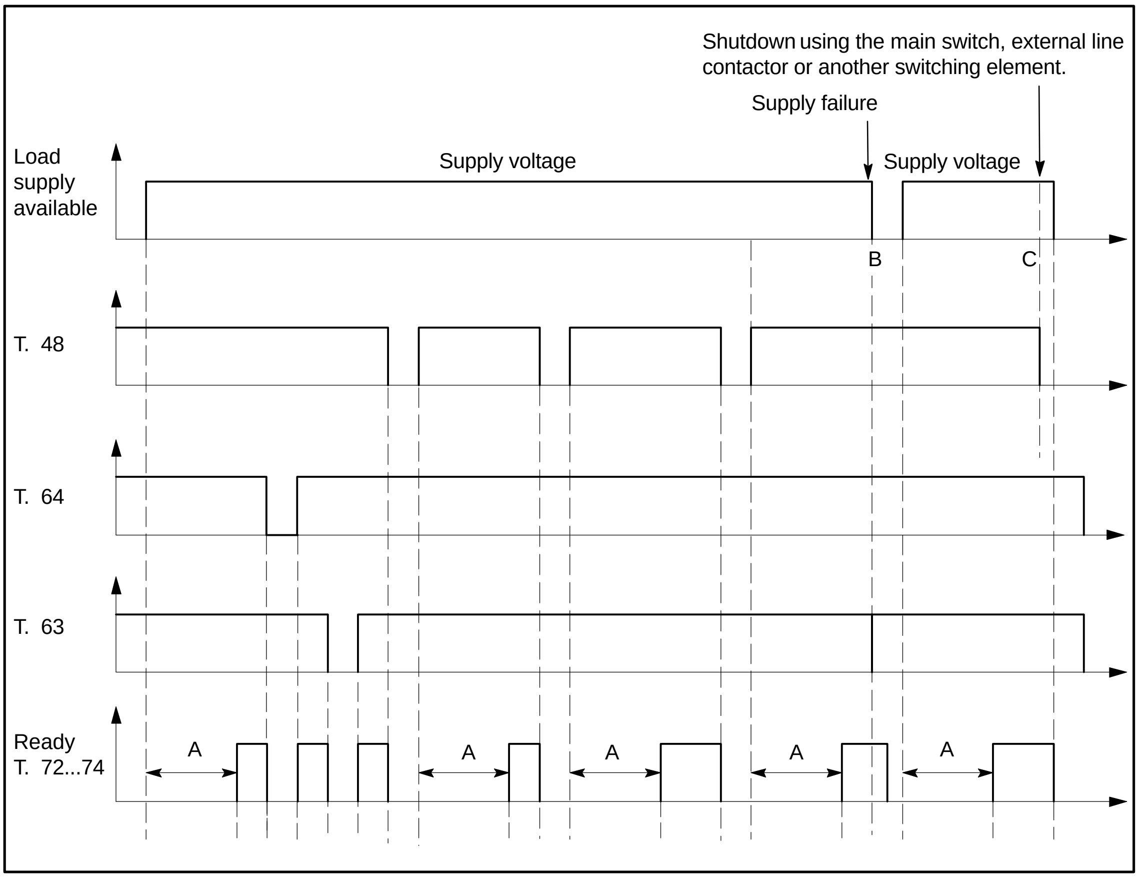

Fig. 9-4 Timing diagram for the ready signal in the I/R module

Switch S1.2 = OFF, standard setting at the I/R module "Ready signal"

A

The ready relay can only pull in if the pre–charging sequence has been completed and the internal line contactor has pulled in.

B

The I/R module is internally inhibited during power failures, i.e. the I/R module can no longer control (closed–loop) the DC link voltage which means that braking energy can no longer be fed back into the line supply. The drives are not inhibited, but the ready relay drops out with a delay, after the line failure detection time, dependent on the line impedances.

C

When the load supply is disconnected using the main switch or an external line contactor, e.g. for a six–conductor connection (refer to Section 9.13) as well as other switching elements, it must be ensured, that at least 10 ms beforehand, terminal 48 at the I/R module is de–energized. This can be achieved, e.g. using a main switch with leading contact or interlocking circuits for the external line contactor or other switching elements.

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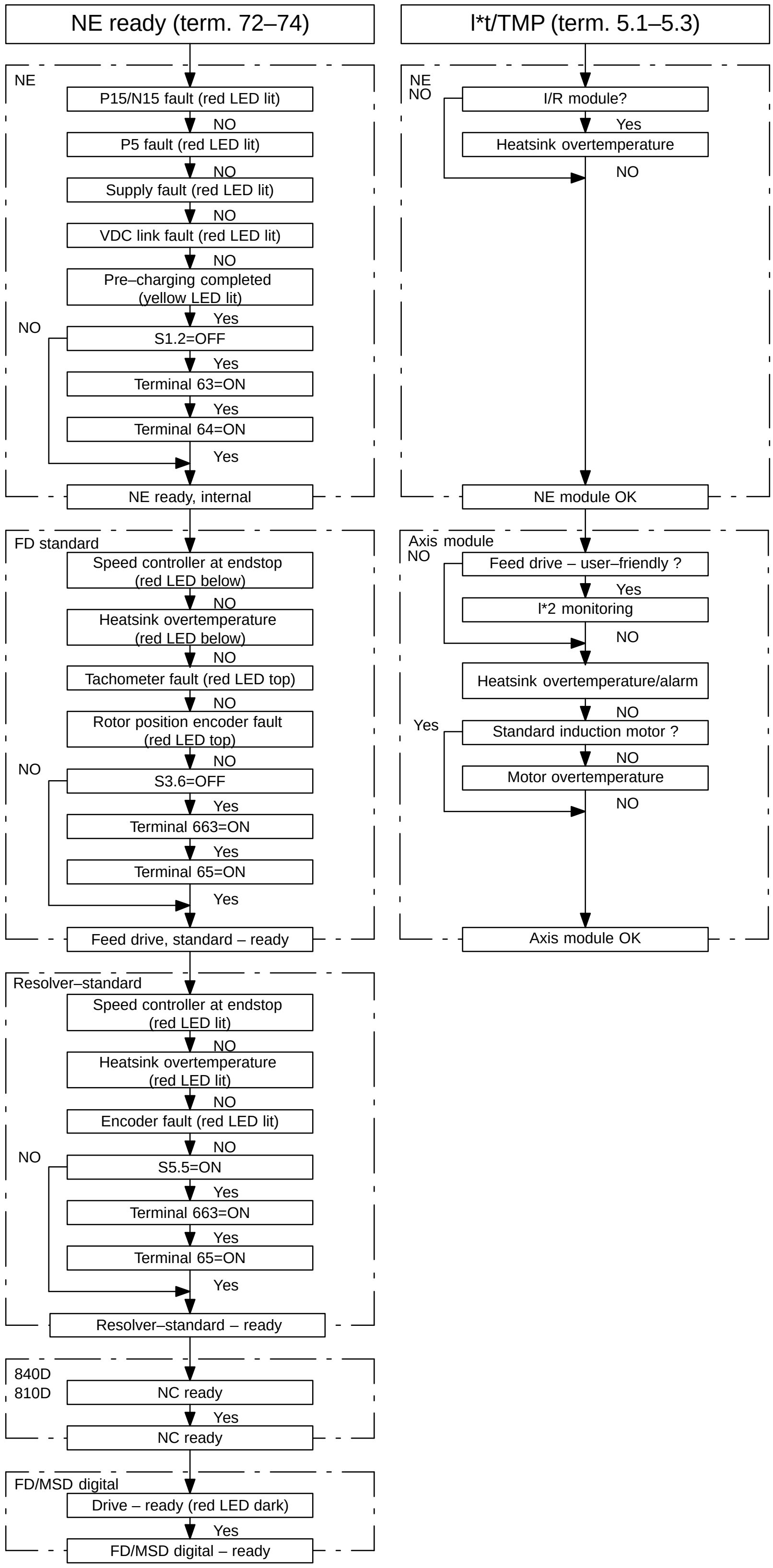
9.2.6 Sequence diagram, central signals at the NE module



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9.3 Axis expansion using the monitoring module

9.3.1 Connection example, power supply (standard)

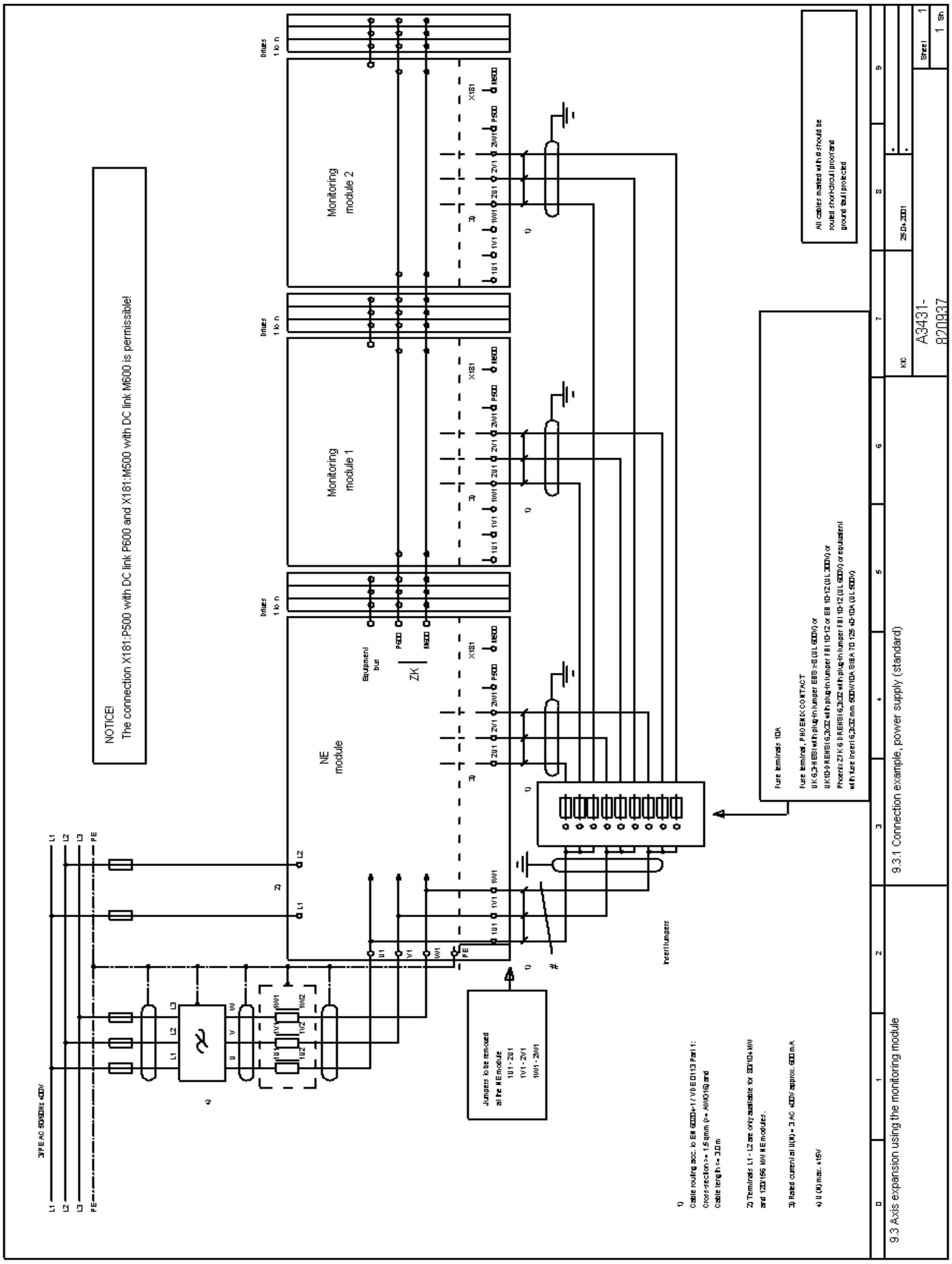

Fig. 9-5 Connection example, power supply (standard)

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9.3.2 Connection example, pulse enable

Instantaneous shutdown

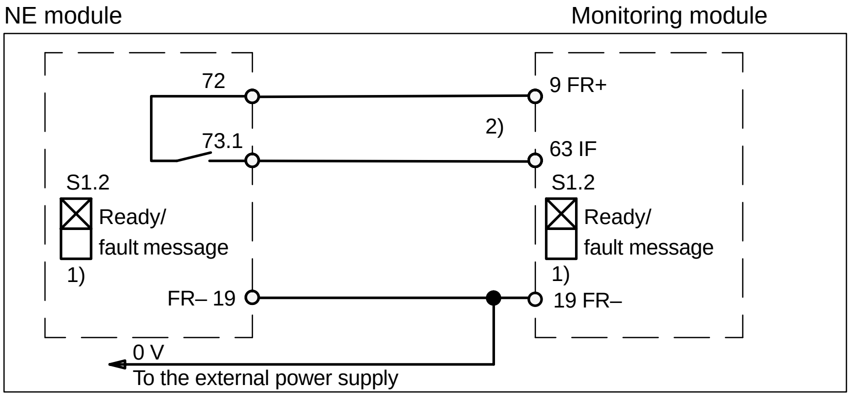

Fig. 9-6 Instantaneous shutdown, pulse enable

Delayed shutdown

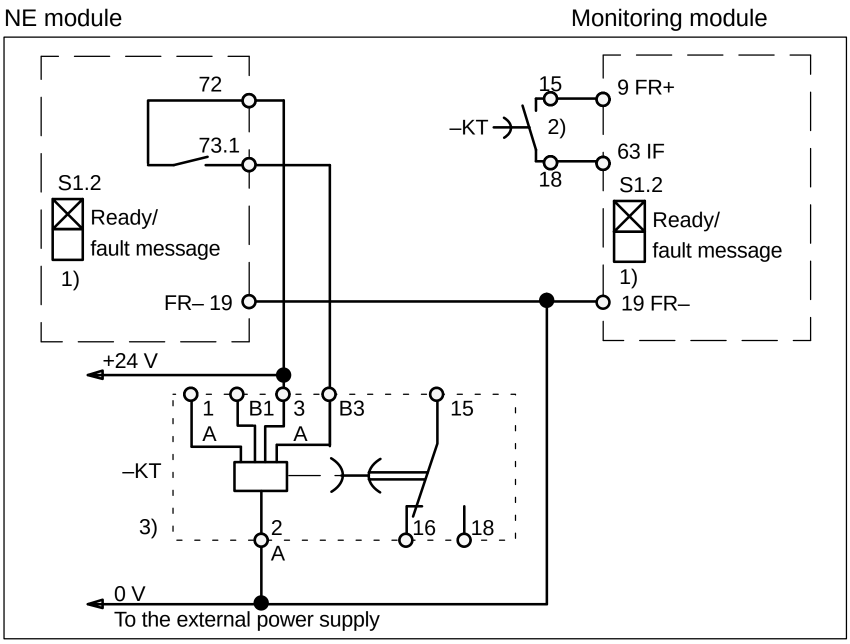

Fig. 9-7 Delayed shutdown, pulse enable

1) Settings, S1.2 ready/fault signal, refer to Section 6.1.

2) The shutdown is shown in a simplified fashion without any contacts of the drive–related control

3) Time relay with delayed drop–out with auxiliary function, e.g. 3RP1505–1AP30, $t_{(v)} \geq$ max. braking time of the drive after the monitoring module.

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9.3.3 Description of the interfaces and functions

General information

The electronics power supply, included in the NE module, supplies the drive modules, connected through the equipment bus, as well as for the digital 611 digital drive groups, also the SINUMERIK 840D and 810D controls integrated in the group.

The number of modules which can be connected is limited. The power of the modules which can be connected is determined by adding assessment factors in the electronics area (EP) and gating area (AP). If the power requirement exceeds the NE module power supply rating, then the drive group must be expanded by one or several monitoring modules. This means that the complete system has two or several independent electronic systems.

The charge limit of the DC link should also be observed.

Reference: /NC60/ SIMODRIVE 611, Catalog NC 60

Enable signals or fault signals only act on the axes connected together on the common equipment bus. The equipment bus is interrupted between the last axis after the NE module and the monitoring module.

Examples

- Connection example, power supply (standard) —> refer to Fig. 9-5.

  The connection example indicates the three–phase connection of the monitoring modules after the power connection of the NE module via fused terminals.

  Alternatively, the monitoring module power supply can also be provided through terminals P500/M500 at the power DC link P600/M600. In this case, it should be taken into account that a max. 2 monitoring modules, limited by the DC link pre–charging circuit in the NE module, may be connected to the associated axes. It should be observed, that after the line contactor has opened, the DC link voltage decreases which means that the power supply/ communications to the drive modules is interrupted.

- Connection example, pulse enable —> refer to Section 9.3.2

  The axes, connected after the monitoring module, may only be enabled if the NE module signals ready/fault signal, i.e. the power DC link is charged and the internal line contactor is closed. Any fault signals at the NE module must act, either instantaneously or delayed, interlocked with the pulse enable terminal 63 of the monitoring module and the associated axes.

- Instantaneous pulse enable withdrawal —> refer to Fig. 9-6

  The ready/fault signal at terminal 72–73.1 of the NE module acts directly on pulse enable terminal 63 at the monitoring module. If there is a line supply fault or a fault signal, the ready signal is withdrawn at the NE module which means that the pulses of the drives after the monitoring module are cancelled after the drop–out delay time of the ready relay, and the drives coast down.

  This interlocking cannot, e.g., be used for the line supply failure concept and also for other applications where it has a disadvantage with respect to a delayed shutdown.

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- Delayed pulse enable withdrawal —> refer to Fig. 9-7

  Terminal 63 at the monitoring module is also only enabled via the ready/fault signal at the NE module. If the NE module signal is withdrawn, terminal 63 is only inhibited via time relay KT.

  This means, that the drives, e.g. for a line supply fault or a fault signal at the NE module can still only be briefly braked under specific secondary conditions:

  – The DC link voltage must remain, when braking, within the minimum and maximum monitoring limits (refer to Section 6.1).

  – The external +24V power supply must maintain the enable signals of terminal 65, terminal 663.

  – For the 611 digital drive modules, the internal enable signals must be maintained via the digital drive bus of SINUMERIK 840D, 810D or 840C, or for SIMODRIVE 611 universal, communications via the PROFIBUS–DP must be maintained.

Addresses

Contact addresses for fused terminals in the connection examples in Sections9.3.1 and 9.13.

PHOENIX KONTACT GmbH & Co.
Flachsmarktstraße 8
32825 Blomberg
Tel. 05235/30 0
Fax. 05235/341200

SIBA Sicherungen–Bau GmbH
Borker Straße 22
44532 Lünen
Tel. 02306/7001–0
Fax. 02306/7001–10

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9.4 Drive modules

9.4.1 Block diagram, 611 analog feed module with standard interface

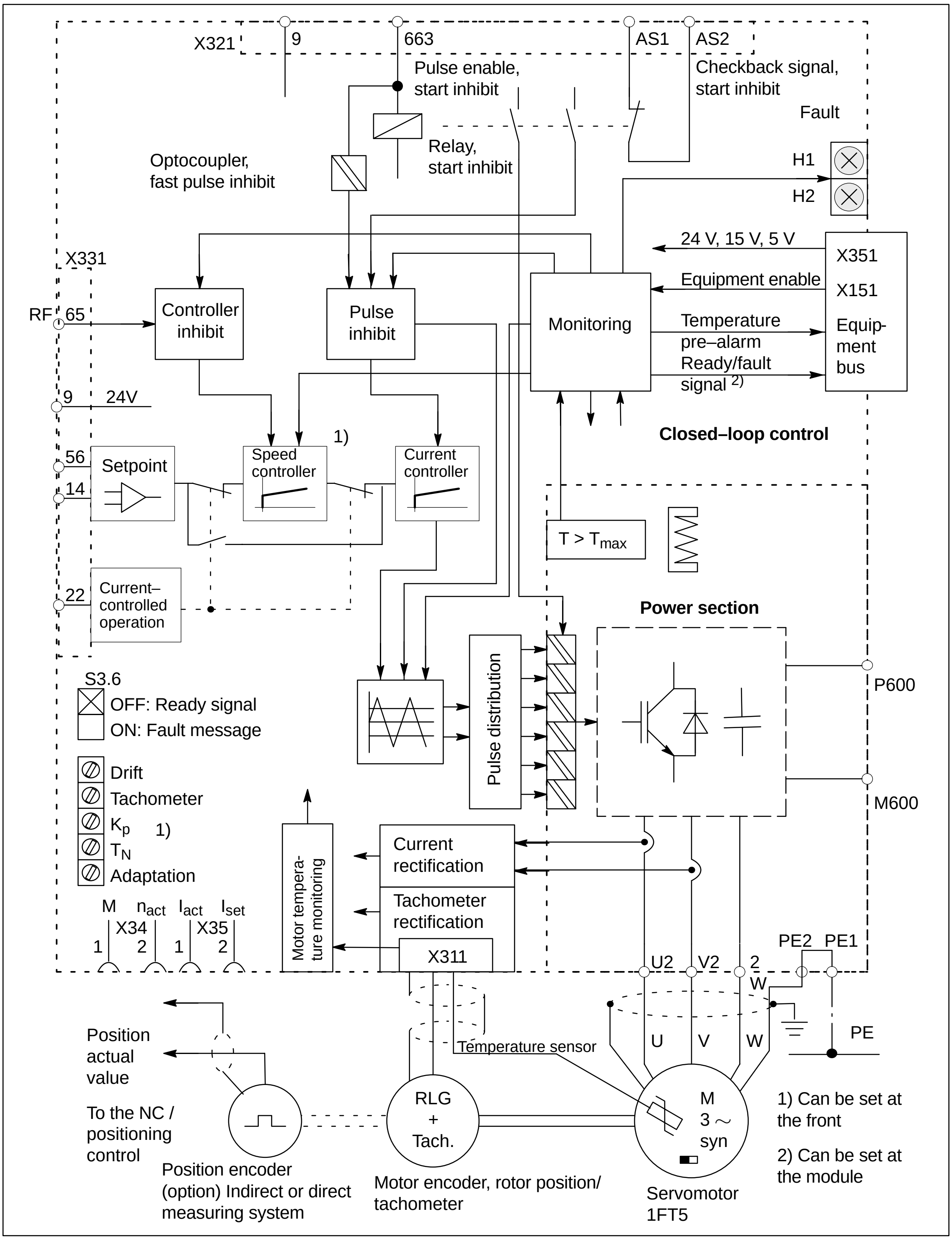

Fig. 9-8 Block diagram, FD module with standard interface

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9.4.2 Description of the interfaces and functions

A simplified 1–axis 611A feed module is shown in block diagram 9-8. This comprises power module, control module with standard interface and analog setpoint interface for 1FT5 servomotors.

Additional control modules with analog, digital and PROFIBUS–DP interface —> refer to Section 5.

Terminal 9

FR+

+ 24V enable voltage for the internal enable signals

Terminal 663

Pulse enable / start inhibit

When terminal 663 is energized, this has a double function:

- The pulse enable and inhibit act on a specific axis after 1 ms or on a module for two–axis modules via an optocoupler input.
- The start inhibit, terminal 663 open–circuit, acts with an approx. 40 ms delay after terminal 663 is inhibited, as a result of the drop–out delay of the start inhibit relay.

The start inhibit supports all of the safety–relevant functions, refer to Section 9.5.

For pulse inhibit/start inhibit, the drives coast down unbraked.

The 1–axis and 2–axis 611D modules with digital and 611U with PROFIBUS interface have, beyond this, also an axis–specific pulse enable. It is controlled through NC/PLC interface signals via the digital drive bus or via the PROFIBUS–DP interface. The signals act with delay, corresponding to the particular cycle time.

Notice

The pulse inhibit using terminal 663 for control modules with Order Nos. 6SN1118–0AA11–0AA0, 6SN1118–0AD11–0AA0 and 6SN1118–0AE11–0AA0 (old FD types) only become active approx. 40 ms after actuation after the relay drops out.
For type 6SN1118–0....–0..1, 6SN1118–0DM2.–0AA0, 6SN1121–....–...1 and 6SN1122–....–...1, (new types), the pulse inhibit becomes effective approx. 1 ms.

The different times must be observed. The older modules, with the delayed pulse inhibit after approx. 40 ms may <u>not</u> be used for the circuit examples, Section 9.7 , external speed monitoring = 7 ; armature short–circuit braking = 9 and power contactors in the motor circuit =10.

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Terminal 65

Controller enable

The axis is enabled with terminal 65. The controller and inhibit become effective after 1 ms at the specific axes. If terminal 65 is inhibited, n_{set}=0 is set for the drive and it is braked as follows:

- For MSD/IMM 611A, the pulses are canceled after an adjustable speed has been fallen below. The drive is braked along the selected ramp, or if terminal 81 is simultaneously inhibited, the drive is braked along the current limit.
- For FD 611A, all of the controllers and pulses are inhibited after the set timers have expired (setting when supplied:240 ms). The drives brake along the current limit.
- For 611D/611U drives, the pulses are cancelled after a speed, which can be set, is fallen below or after a selected timer has expired. The drive is braked along the selected limits (MD 1230, 1235, 1238). For spindles, a ramp can only be achieved using regenerative limiting (MD1237).
  The 611D modules do not have a hard–wired terminal 65. The controller enable is controlled using the NC/PLC interface signals via the digital drive bus.

Terminals AS1, AS2

Signal contact, start inhibit

The NC contact closes, max. 40 ms after terminal 663 has been inhibited

Terminal 56

Speed setpoint

Analog speed setpoint input: 0 to +/–10V

Terminal 14

Differential input

Reference potential from terminal 56

Terminal 22

Closed–loop current controlled operation

Switch S3.6

Switch setting = OFF “Ready signal”, switch position = ON “fault signal”

The ready signal from the 611A standard and resolver control acts centrally at terminal 72–74, ready at the NE module, if:

S3.6= OFF “ready signal”,
a) There is no fault present in the drive module and
b) Terminal 65 and terminal 663 are enabled,

or for

S3.6 = ON “fault signal”
there is no fault present in the drive module.
Switch S6.6 for 2–axis versions has the same function as for S3.6.

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9.5 Start inhibit in the drive modules

Notice

The start inhibit function is not a safety function in the sense of the Machinery Guidelines 89/392/EC. It only supports the measures which the user has to make.

9.5.1 Reason for using the start inhibit (IEC 204 No. 44/184/CDV)

The ”start inhibit” function is included in the SIMODRIVE 611 drive modules.

The power feed from the converter to the motor is interrupted with the start inhibit (motor rotation). This is based on Standard IEC 204 No. 44/184/CDV.

The start inhibit prevents feed, main spindle or induction motor drives unexpectedly starting from standstill. This circuit macro can be used in the “Safe standstill” machine function. However, beforehand, the must have been brought to a complete standstill and ensured using the external machine control.

This is especially valid for vertical axes without any self–locking mechanical system or without weight equalization!

The remaining risk is in this case, if two errors/faults occur simultaneously in the power section; the motor briefly rotates (jolts) through a small angle (1FT motors: 4–pole 90°, 6–pole 60°, 8–pole 45°; induction motors: in the vicinity of the remanence, max. 1 slot pitch, which corresponds to approximately 5° and 15°).1FN linear motors can, under fault conditions, continue to move through 180° electrical (approx. 56 or 72 mm incl. overshoot).

The start inhibit function does not provide electrical isolation. It does not provide protection against ”electric shock”.

The complete machine or system must always be electrically isolated from the line supply through the main disconnection device (main switch) before any work is carried out on the machine or system, e.g. maintenance, service or cleaning work (refer to EN 60204–1; 5.3).

When correctly used, the start inhibit function must be looped in in the line contactor circuit or EMERGENCY STOP circuit with the positively–driven signal contact AS1/AS2. The associated drive must be electrically isolated from the supply if the start inhibit relay function is not plausible, referred to the machine operating mode; e.g. via the line contactor in the infeed module. The start inhibit and the associated operating mode may only be used again after the fault has been removed.

As a result of a hazard analysis/risk analysis which must be carried out according to the Machinery Directive 89/392/EC and EN 292; EN 954; and EN 1050, the machinery manufacturer must configure the safety circuit for the complete machine taking into account all of the integrated components for his machine types and versions of them. This also includes the electric drives.

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9.5.2 Mode of operation of the start inhibit

The inverter power module controls the current through the individual motor windings. 1FT5 motors are fed with square–wave current.

A pulse generating logic clocks the 6 power transistors in a three–phase oriented pulse pattern An optocoupler is provided in every transistor arm between the gating logic and the power section gating amplifier. These optocouplers provide the electrical isolation.

The start inhibit acts on each module. A positively–driven relay (permitted according to ZH1/457, TÜV) acts on the inverter gating on the particular drive module at the input circuits of the optocouplers.

A relay contact interrupts the power supply for the optocoupler inputs. Thus, no signals can be transferred through the optocoupler. The pulse generating logic is inhibited through an additional electrically isolated arm.

These two active circuits are controlled in parallel from the machine control via terminal 663 (motor start inhibit) for the drive modules or via terminal 112 (DC link controller start inhibit) for the line supply infeed modules.The status of the relay contact, located in the pulse power supply circuit, is signaled to the external adaptation circuit via a positively–driven NC contact.

The signaling contact is accessible at module terminals AS1 and AS2, and the user can interlock it with the safety control. When the start inhibit fails, these start–inhibit signaling contacts must isolate the supply infeed from the supply via the power contactor (line contactor in the supply module).

If the start inhibit circuit is activated, it is no longer possible to control the power transistors in a rotating field. When two power transistors are destroyed (double fault) in the most unfavorable constellation, then this results in the residual risk as described in Section 9.5.1.

9

Warning

When the start inhibit is activated, the motor can no longer generate a torque. Drives which are not automatically clamped when powered down (e.g. vertical/ inclined axes), must be clamped using a mechanical brake.

9.5.3 Connecting the start inhibit

The start inhibit function is controlled in the drive modules using terminal 663 or in the infeed modules using terminal 112. The start inhibit relay is controlled using the internal/external +24 V enable voltage (FR+ terminal 9; FR– terminal 19).

When the relay is de–energized, terminal 663 is open–circuit, the start inhibit is activated.
The AS1/AS2 signal contact closed indicates the condition ”start inhibit” is effective. The circuit must be protected against overload and short–circuit using a fuse of max. 2 A!

Terminal 663 (drive) and terminal 112 (NE–module) must be externally controlled using a fail–safe signal.

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Notice

The start inhibit relay has maximum pull–in and drop–out delay times of 40 ms. Any external wiring connected at terminals AS1/AS2 must be short–circuit proof.

9.5.4 Sequence and procedure when using the start inhibit

The drives must be shut down before terminal 663 is inhibited and the drive inhibit is activated.

The drives can be shutdown, e.g. by decelerating them in a controlled fashion using the NC program, by inhibiting the drive enable terminal 64 or the axis–specific controller enable terminal 65.

If a fault occurs when actuating the start inhibit, then this fault must be removed before the mechanically isolating protective devices to the working zone of the machine or plant are opened. After the fault has been removed, this procedure must be repeated for the start inhibit. Under fault conditions, all of the drives, machine and plant must be shut down.

If one of the following faults should occur with terminal 663 de–energized and the protective devices withdrawn, then the EMERGENCY STOP must be immediately initiated:

- The acknowledgement contact AS1/AS2 remains open, the start inhibit is not activated.
- There is a fault in the external control circuit itself.
- There is a fault in the signal lines of the acknowledge contact.

All of the drives associated with the machine/plant must be disconnected and isolated from the line supply through the line contactor.

If the start inhibit control has been correctly integrated into the external safety–related drive control and has been checked to ensure correct functioning, then the drives in the separate working zone of the machine are protected against undesirable starting, and personnel can enter or intervene in the hazardous zone which has been defined.

Notice

The relevant regulations for setting–operation must be taken into account.

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9.5.5 Checking the start inhibit

The following checks must always be made at the first start–up and when possible must be repeated at certain intervals during the operating lifetime.

A check should also be made after longer production standstills. Each individual drive as well as the NE module must be checked.

The check must be made by qualified personnel taking into account the necessary safety measures:

- The drive pulses must be inhibited by withdrawing the voltage at terminal 663. Furthermore, the acknowledge contact AS1/AS2 of the start inhibit must close. The drive then coasts down.
- Disabling the protective devices, e.g. opening the protective doors while the drive is running. The drive must be braked as quickly as possible and then powered down. This must not result in a hazardous condition.
- All possible fault situations, which could occur, must be individually simulated in the signal lines between the acknowledge contacts and the external control as well as the signal evaluation functions of this control e.g. by disconnecting the start inhibit monitoring circuit at terminals AS1–AS2.
- The monitoring circuit AS1 – AS2 must be disconnected.

  For all of the simulated fault situations, the line contactor must disconnected all of the machine or plant drives from the line supply.

  If there is a connection between the power supply NE or monitoring module, terminal 500/M500 to the power DC link P600/M500, this must be safely and reliably disconnected at the same time with the line contactor, e.g. using contactors.

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9.6 Application examples with SIMODRIVE 611

9.6.1 Block diagram, application example

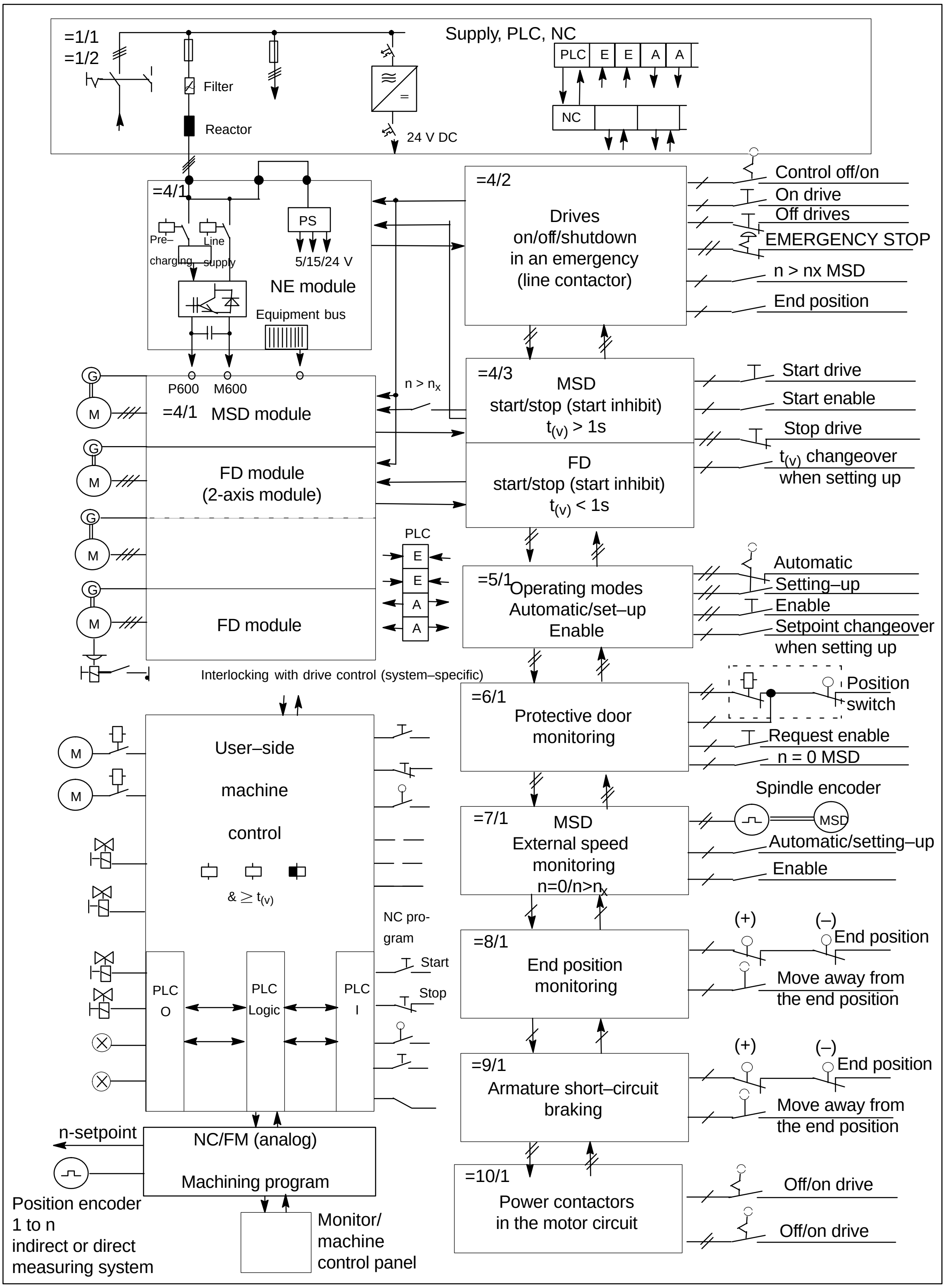

Fig. 9-9 Block diagram, application example

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9.6.2 Function description, application example

Application

An overview of an application example for a complete, drive–related control of a machine with SIMODRIVE 611A drive components with analog setpoint interface is shown in the block diagram, Section 9.6.1.

Refer to Section 9.8 for versions with SIMODRIVE 611 digital and 611 universal.

In the following Section 9.7 the individual applications and functions of the drive control will be described in detail using circuit examples =1 to =10.

Circuit examples =1 to =3 are intended for simple machine applications. The circuit examples =1 and =4 to =10 describe all of the essential functions which are used for a machine tool.

The circuit concept is designed so that the individual control groups of the basic function in circuit example =4 can be used for basic up to more complex applications – graduated to the task in hand.

- Power up/powering down/shutting down drives in an emergency; start/stop/ safe standstill
  using the additional functions
- Operating modes select automatic/setting–up operation with enable =5
- Protective door monitoring with tumbler mechanism =6
- External speed monitoring =7
- Limit switch end position monitoring =8
- Armature short–circuit braking =9 and
- Power contactors in the motor circuit =10

When the control is expanded, step–by–step, up to its fully expanded stage, the bridged terminal connections in the circuit examples must be removed, and the necessary interlocking and monitoring circuits inserted.

In the application example, Fig. 9-9, the 611A drive group comprises a 1PH7 main spindle drive and three 1FT5 feed drives using as an example, a machine tool.

The drive–related control essentially comprises the safety–related, two–channel hardware control and the associated PLC functions. The PLC control handles the coordinated drive control using logical interlocking functions, but does not have a safety–related function.

The NC/FM (positioning control) with the setpoint and actual value interface as well as the user–side machine control is not discussed in the following. This is the reason that they are only shown in principle.

- Control category according to EN 954–1

  The two–channel system structure of controls =4 to =6 complies with control category 3 according to EN 954–1 when the individual components are correctly used. This means that if a single fault/error occurs in the system, the safety function must be maintained.

9

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The control categories of the other circuits =7 to =10 must be evaluated by the user. This depends on how the third–party components/monitoring devices, which he selected, are used integrated in the basic controls in a safety–related fashion.

Note

For machines, which are to be classified in a lower Category, e.g. 1 or 2 acc. to EN 954–1, after a hazard analysis/risk assessment or type C standard, the control can essentially be derived from these circuit examples and implemented in a somewhat simpler, single–channel system structure!

This also applies to sub–areas/sub–functions of a machine, which can be implemented, e.g. according to type C standards also with a lower or also higher control category, deviating from the basic machine. For instance, after hazard analysis/risk assessment, it may also be necessary that a hydraulic/pneumatic clamping device in the working zone must be controlled using a two–hand control device in compliance with Category 4.

Functions

- Circuit examples =4 to =10

  The two channel system structure in the application example is achieved:

  First shutdown path: The energy to the drive motors is disconnected via the start inhibit functions in the drive modules.

  Shutdown is realized via terminal 663. The positively–driven checkback signal contact of the start inhibit relay via terminals AS1–AS2 intervenes in the EMERGENCY STOP circuit of the safety device. This is cyclically monitored. Refer to Section 9.5 for a detailed description of the start inhibit.

  Second shutdown path: The line contactor in the NE module electrically disconnects the DC link of the drive modules from the supply.

  Shutdown is realized via terminal 48 and at the same time, the contactor coil is opened, in a safety–related fashion using terminals NS1– NS2.

  The drive is shutdown, e.g. when stopping in an emergency, as a result of fault messages/signals from the drive system or the start inhibit monitoring when a fault condition develops.

  The positively–driven NC contacts 111 – 213 of the line contactor is monitored after each switch–off cycle in the feedback circuit of the EMERGENCY STOP safety device. Refer to Section 9.2.4 for a detailed description of the line contactor.

  For an EMERGENCY STOP, the drives are stopped in Stop Category 1 according to EN 60204–1; 9.2.2: “Controlled stopping”, the energy feed is only interrupted when the drive has come to a standstill.

  The circuit examples =2 and =3, included in Section 9.7 can be used for basic and medium complexity applications.

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- Circuit example =2:

  When the drives are powered up and powered down, the complete drive group, including line contactor and start inhibits are switched through two channels in a safety–related fashion. The frequency with which the NE module can be powered up per unit time is limited as a result of the pre–charging circuit to ramp up the DC line voltage at the capacitors

  This circuit is not suitable, e.g. for machines where the protective door is frequently opened or for the ”setting–up” mode where the enable function is frequently used.

- Circuit example = 3:

  Using this circuit, one or several drives can be selectively stopped in the drive group, e.g. using a key–actuated switch, limit switch, light barriers etc., in a safety–related fashion and brought into the ”safe standstill” operating condition.
  Beforehand, the drives must be safely stopped via the NC control. This circuit can also be used in conjunction with the basic control = 4.

  The circuit examples =2 and =3 are used to essentially understand the more complex control functions from circuit =4 onwards.

Note

All of the following circuit examples do not include any safety–related or other machine specific functions which may be required, with the machine control on the user side.

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9.6.3 Safety technology and standards

Objectives

The objective of safety technology is to keep the potential hazards for man and the environment as low as possible by applying the relevant technology. However, this should be achieved without imposing unnecessary restrictions on industrial prooduction, the use of machines and the production of chemical products. By applying internationally harmonized regulations, man and the environment should be protected to the same degree in every country. At the same time, differences in competitive environments, due to different safety requirements, should be eliminated.

Basic principles of European legislation

Legislation states that we must focus our efforts ”...at preserving and protecting the quality of the environment, and protecting human health through preventive actions” (Council Directive 96/82/EG on the control of major accident hazards involving dangerous substances “Seveso II”). Legislation demands that this and similar goals are achieved for various areas (areas which are legislated”) in the EC Directives. In order to achieve these goals, legislation places demands on the operators and users of plants, and the manufacturers of equipment and machines. It also assigns the responsibility for possible injury or damage.

EC Directives

The EC Directives provide a new global concept (“new approach”, “global approach”):

- EC Directives only contain general safety goals, and define fundamental safety requirements.
- EC Directives specify that Member Stages recognize each other’s national regulations and laws.

The EC Directives have the same degree of importance, i.e. if several Directives apply for a specific piece of equipment or device, then the requirements of all of the relevant Directives have to be met.

For a machine with electrical equipment, the following apply.

- Machinery Directive 98/392 EC
- Low–Voltage Directive73/23/ECG
- EMC Directive 89/336 EC

Machinery Directive

The European Machinery Directive applies for all machinery. The minimum requirements are defined in the Appendix I of the Directive. More detailed information is provided through the European, harmonized standards, types A, B and C.

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However, Standards have not been drawn up for all types of machinery. There are several Draft Standards and ratified Standards, e.g. type C Standards, for machine tools in metal processing/finishing, robots and automated production systems. In many cases, these standards specify Category 3 in compliance with EN 954–1 for the safety–related controls. The basic requirement of this category is as follows: ”Tolerance to single–faults with partial fault detection”. Generally, the requirement can be fulfilled using a two–channel system structure (redundant system). Sub–areas of a machine control can also be classified in other Categories B, 1, 2, or 4 in compliance with EN 954–1.

Hazard analysis and risk assessment

According to the Machinery Directive 89/392/EC, the manufacturer or the party marketing a machine or a safety component is responsible in carrying out a hazard analysis in order to determine all of the hazards associated with his/her particular machine or safety component. He or she must design and build the machine or safety component, taking into consideration this analysis.

A risk evaluation must indicate remaining risks, which must then be documented. Among others, the following Standards EN 292 “General Design Principles for Safety of Machinery”; EN 1050 “Safety of machinery, design guidelines to assess risk” and EN 954 “Safety–related parts of controls” should be considered when applying techniques and methods to evaluate these risks.

CE conformance

The machinery manufacturer or the party marketing the machinery, domiciled in the EC or its nominated party must declare CE conformance for the complete machine.

Note

This list of Directives and legislation are just a selection to determine essential goals and principles. This list does not claim to be complete.

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9.7 Circuit examples =1 to =10 with SIMODRIVE 611 analog

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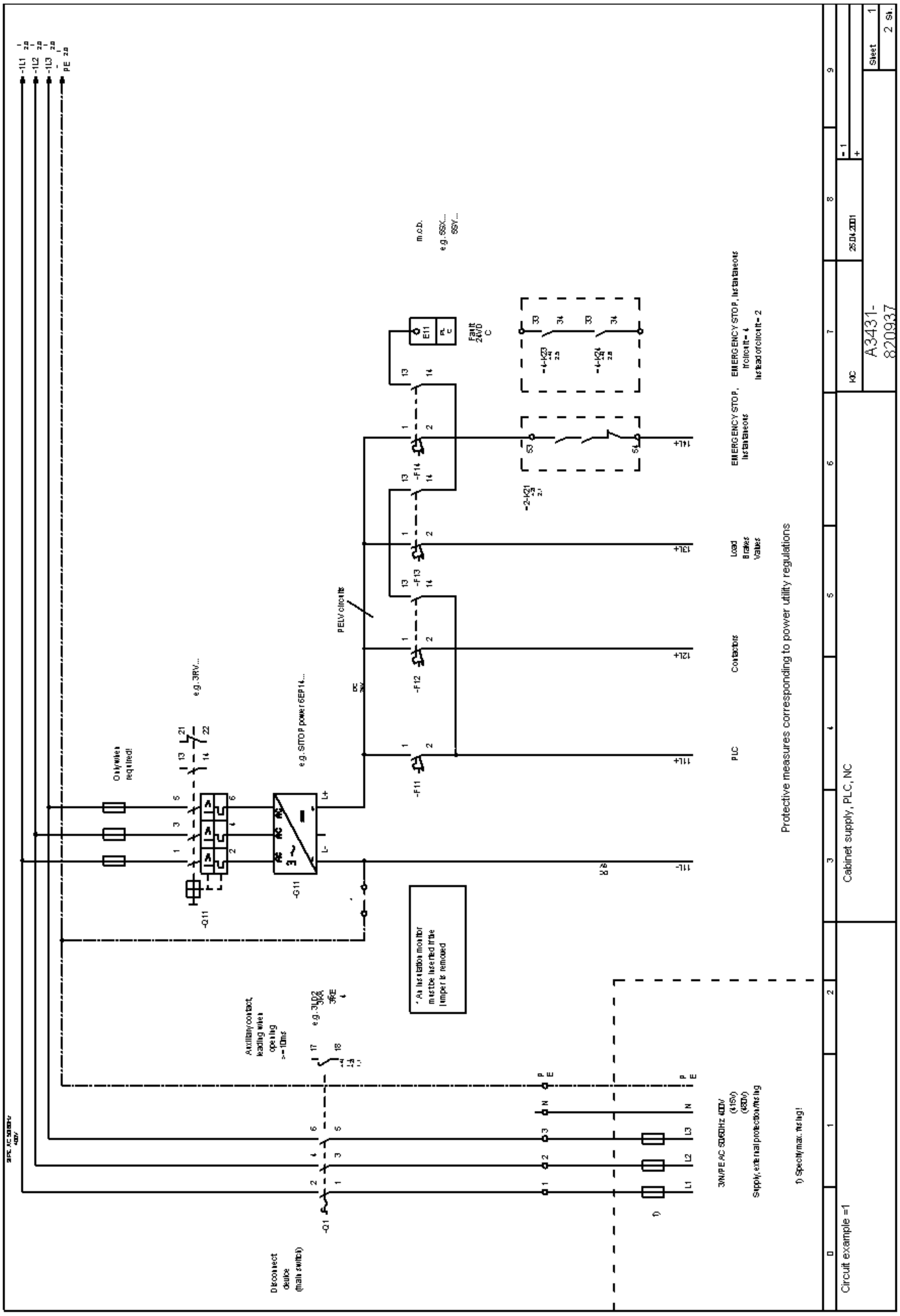

Fig. 9-10 =1 Cabinet supply, PLC,NC; Sheet 1/2

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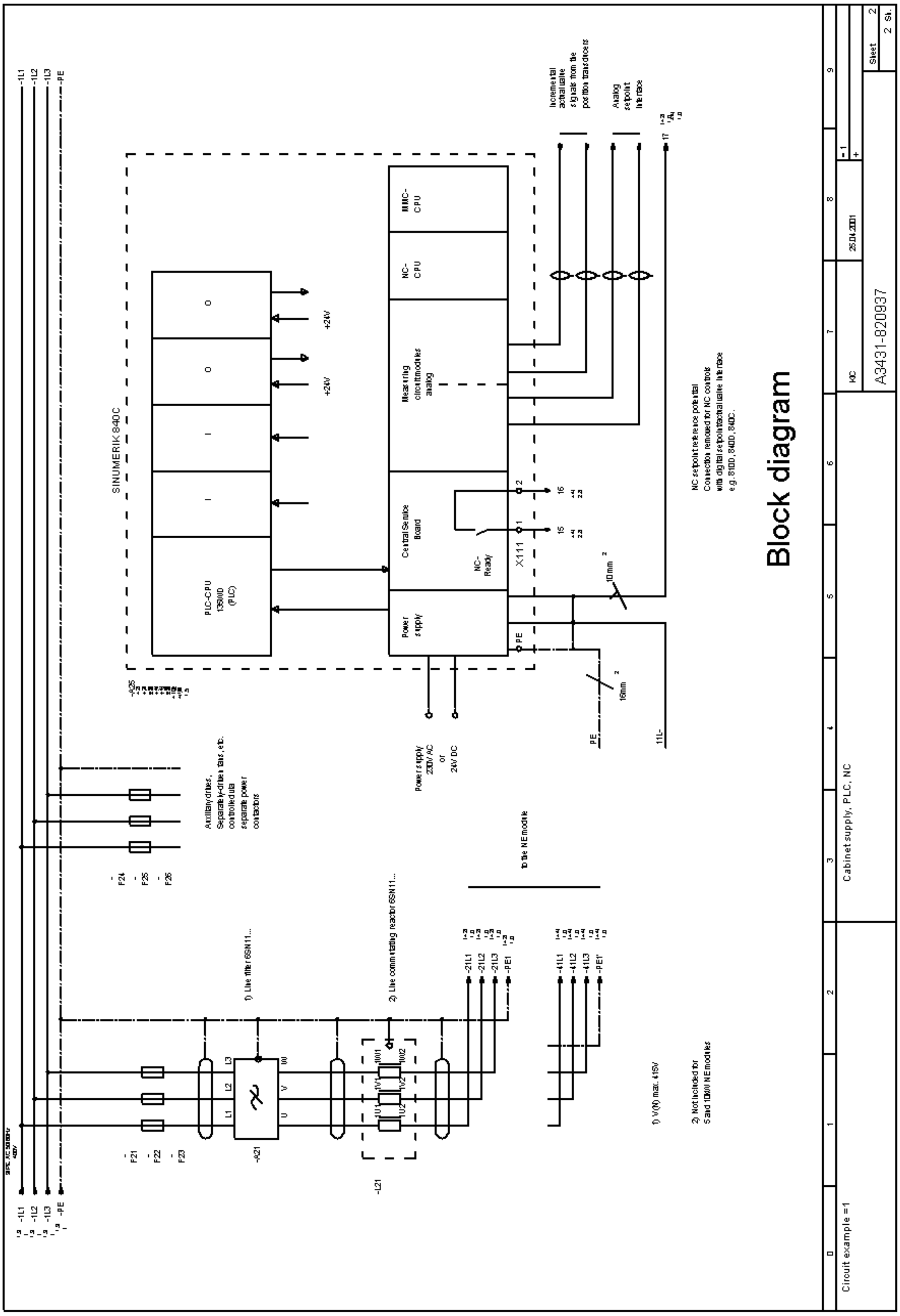

Fig. 9-11 =1 Cabinet supply, PLC,NC; Sheet 2/2

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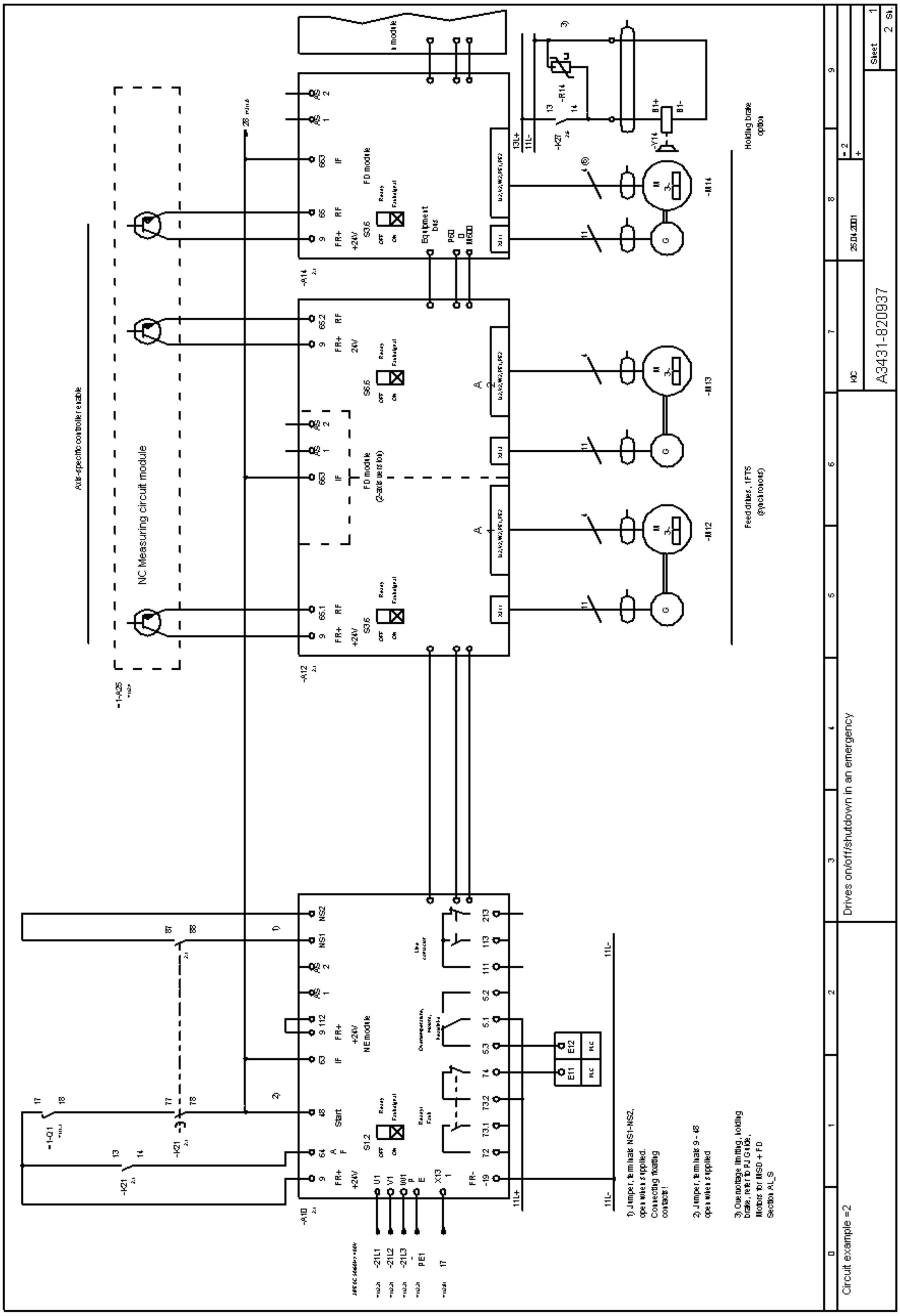

Fig. 9-12 =2 Powering up/powering down/stopping in an emergency; Sheet 1/2

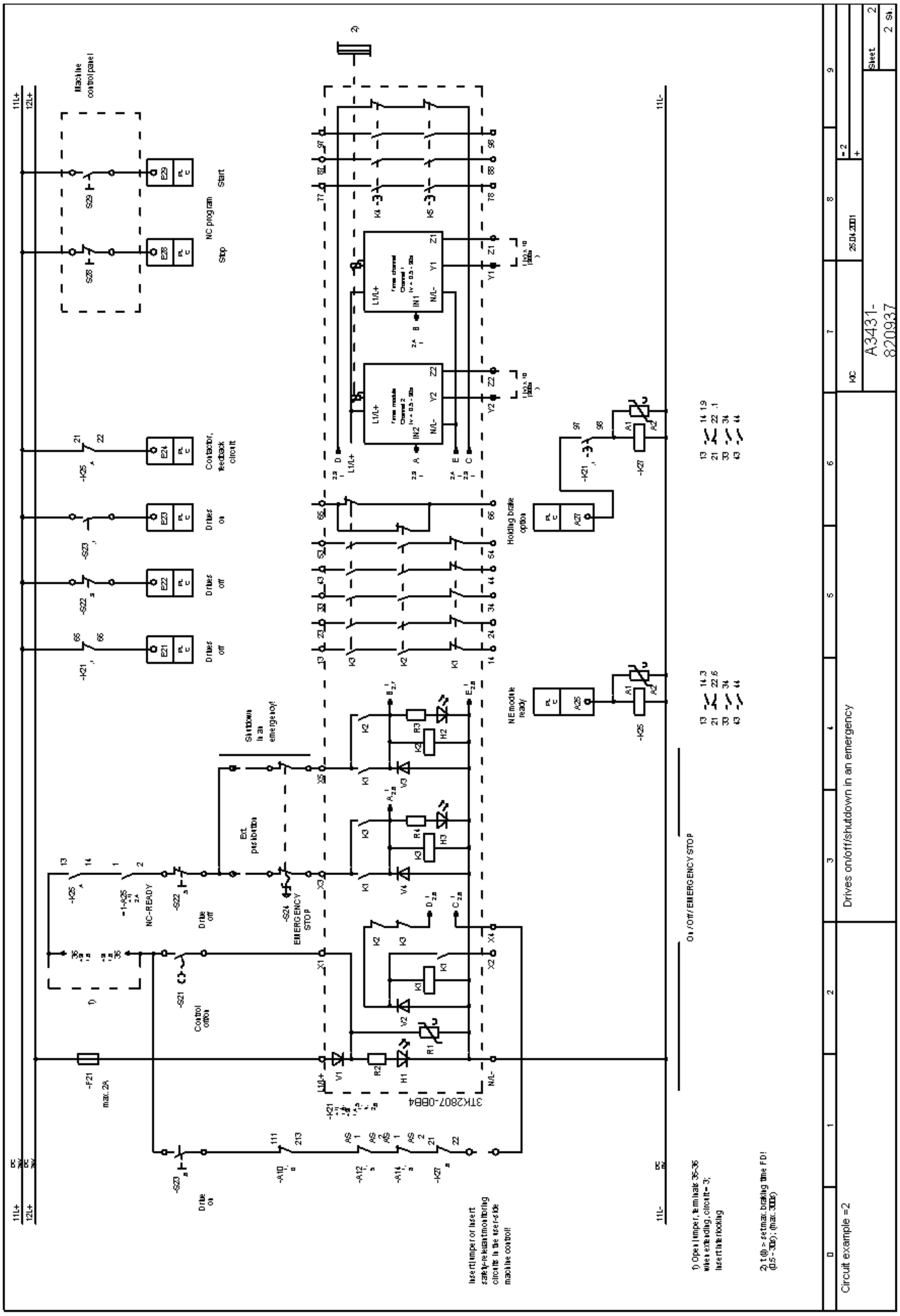

Fig. 9-13 =2 Powering up/powering down/stopping in an emergency; Sheet 2/2

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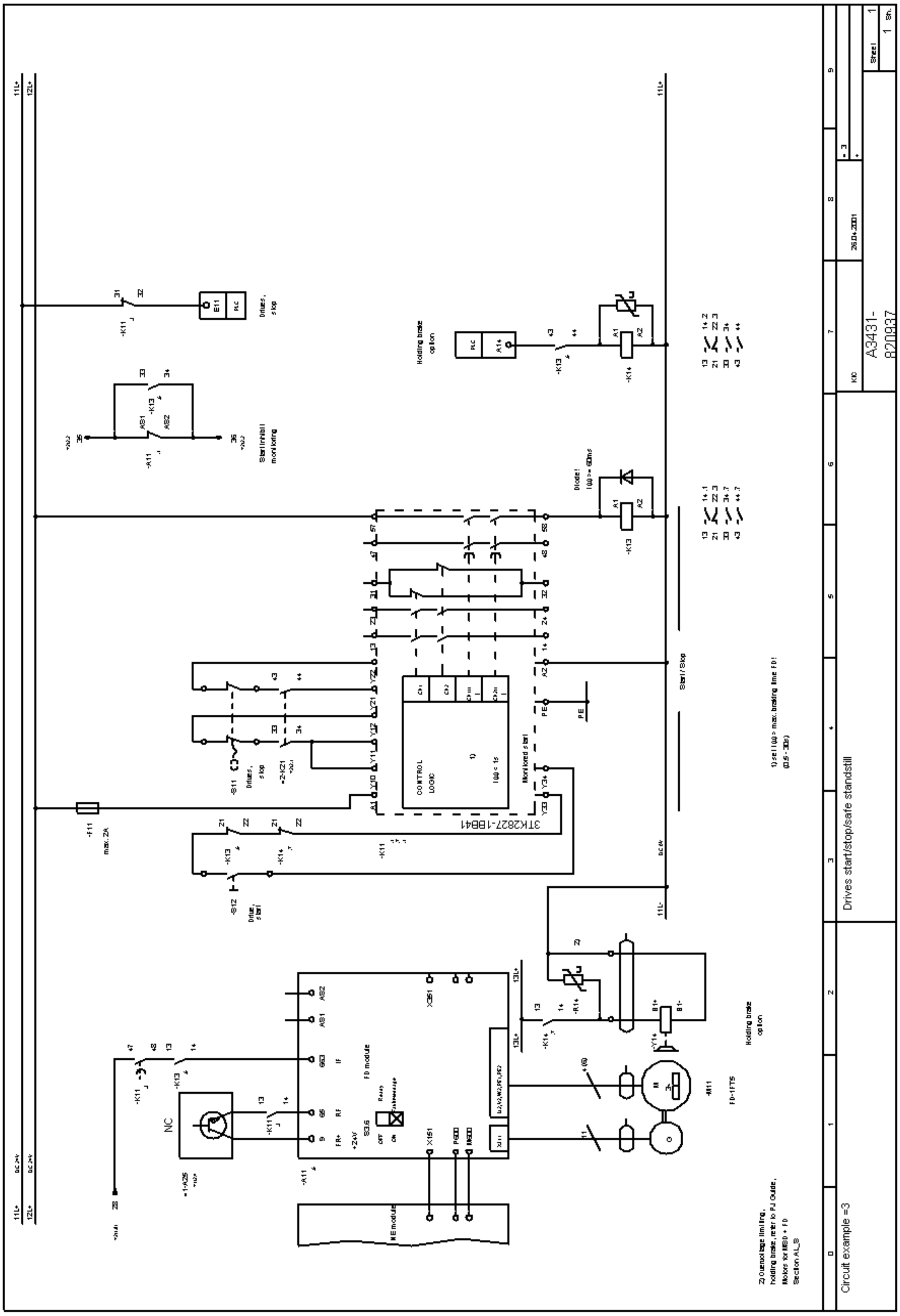

Fig. 9-14 =3 Start/stop/safe standstill; Sheet 1/1

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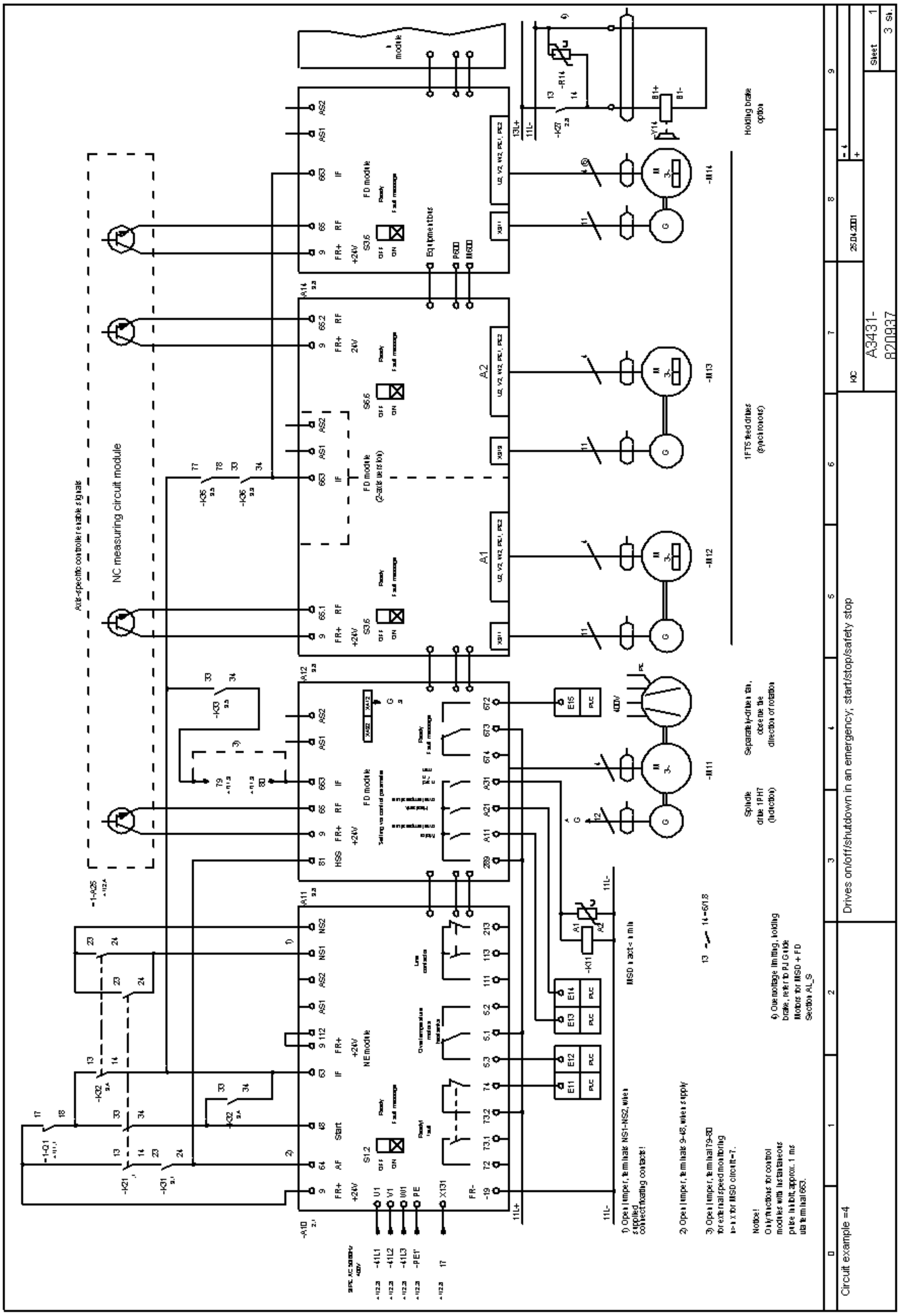

Fig. 9-15 =4 Powering up/powering down/stopping in an emergency; start/stop/safe standstill; Sheet 1/3

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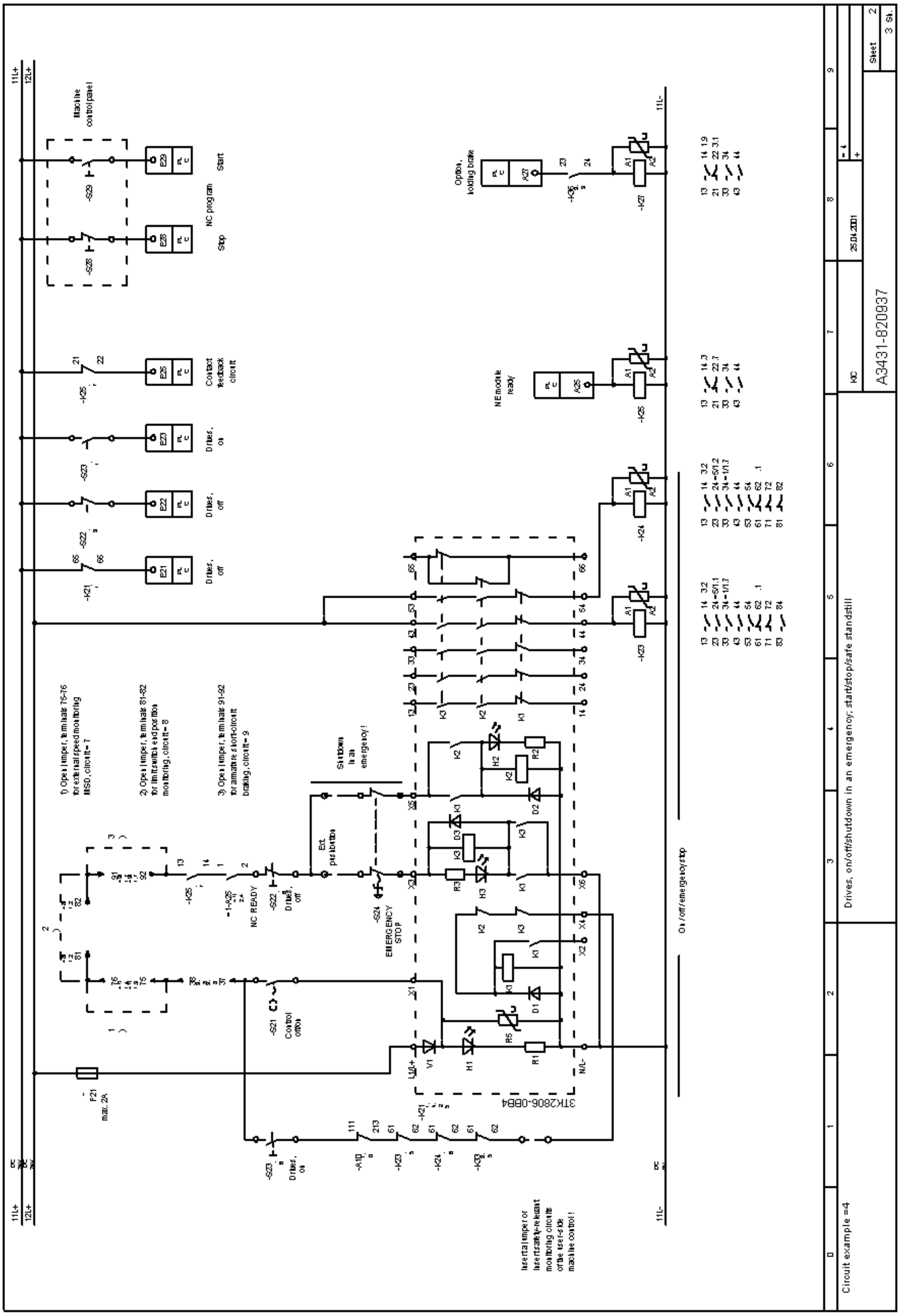

Fig. 9-16 =4 Powering up/powering down/stopping in an emergency; start/stop/safe standstill; Sheet 2/3

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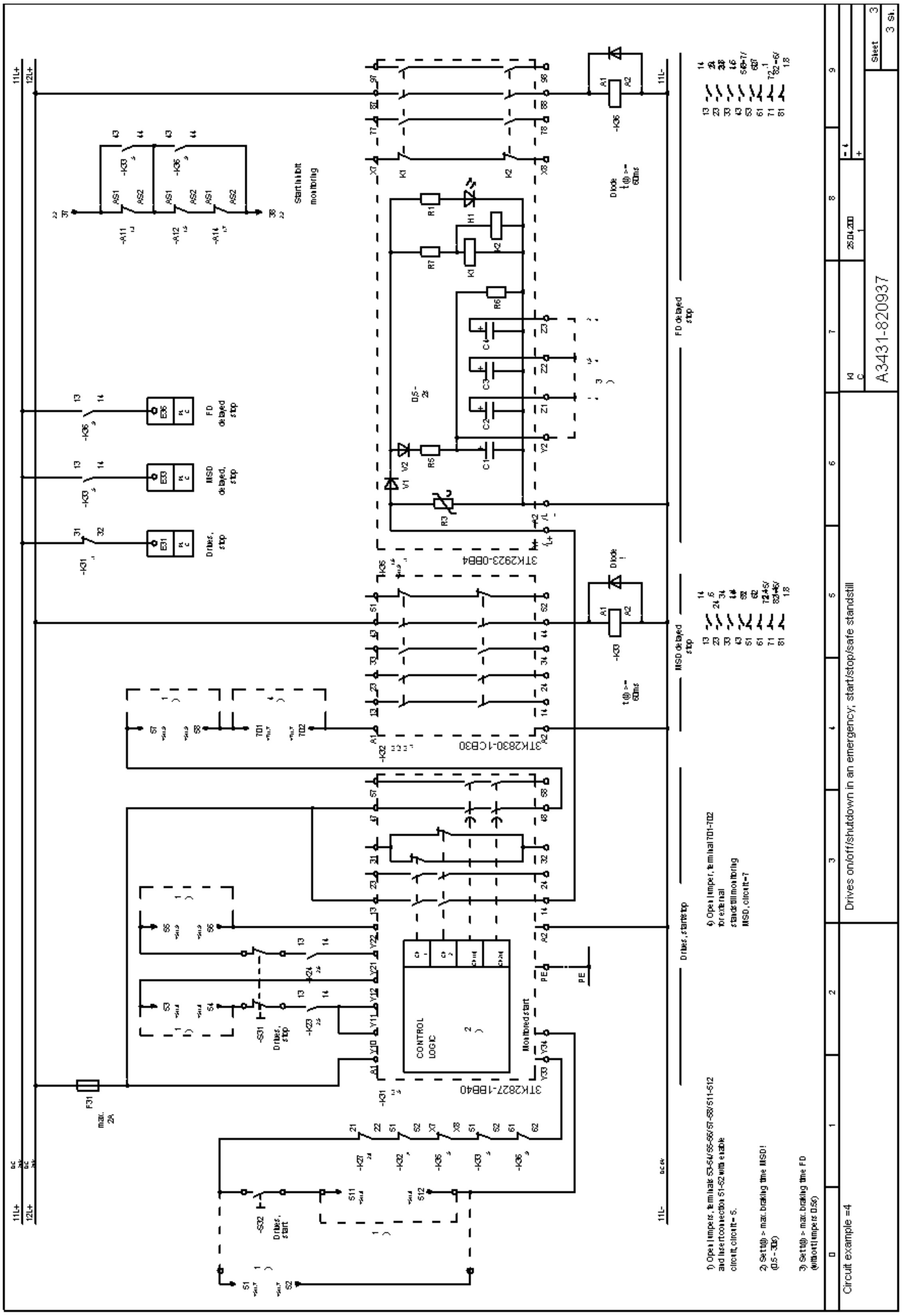

Fig. 9-17 =4 Powering up/powering down/stopping in an emergency; start/stop/safe standstill; Sheet 3/3

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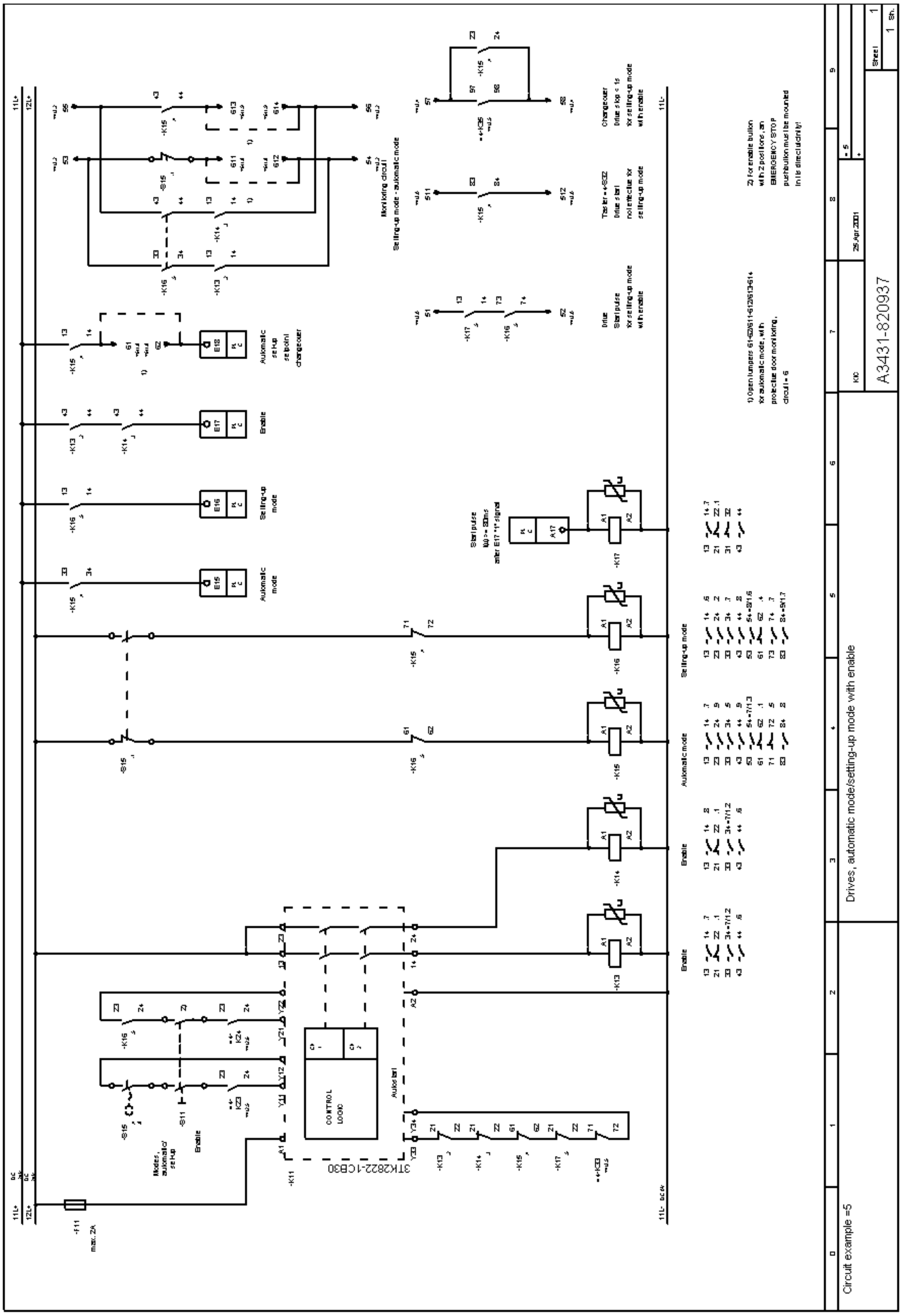

Fig. 9-18 =5 Automatic/setting up mode with enable; Sheet 1/1

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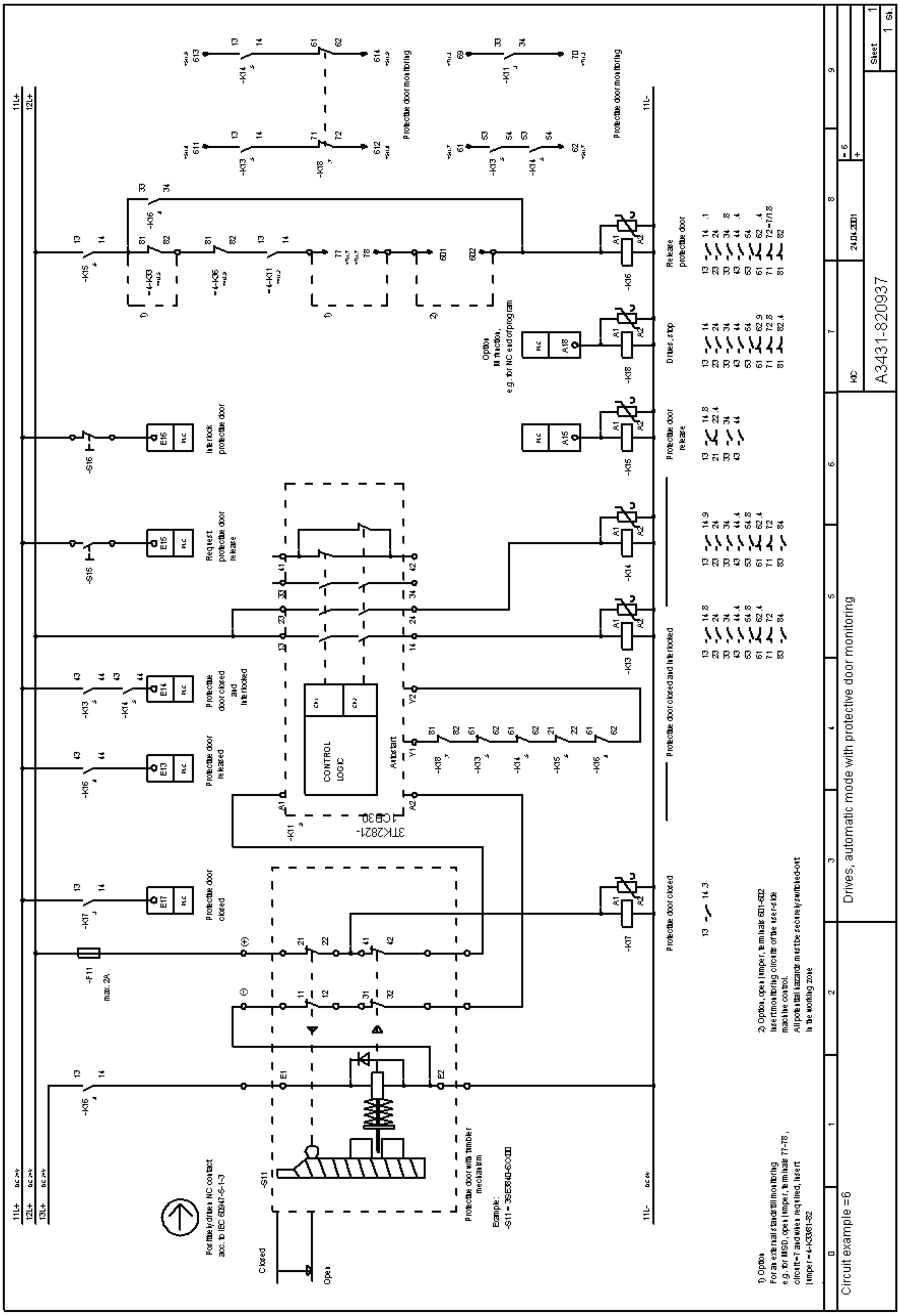

Fig. 9-19 =6 Automatic mode with protective door monitoring; Sheet 1/1

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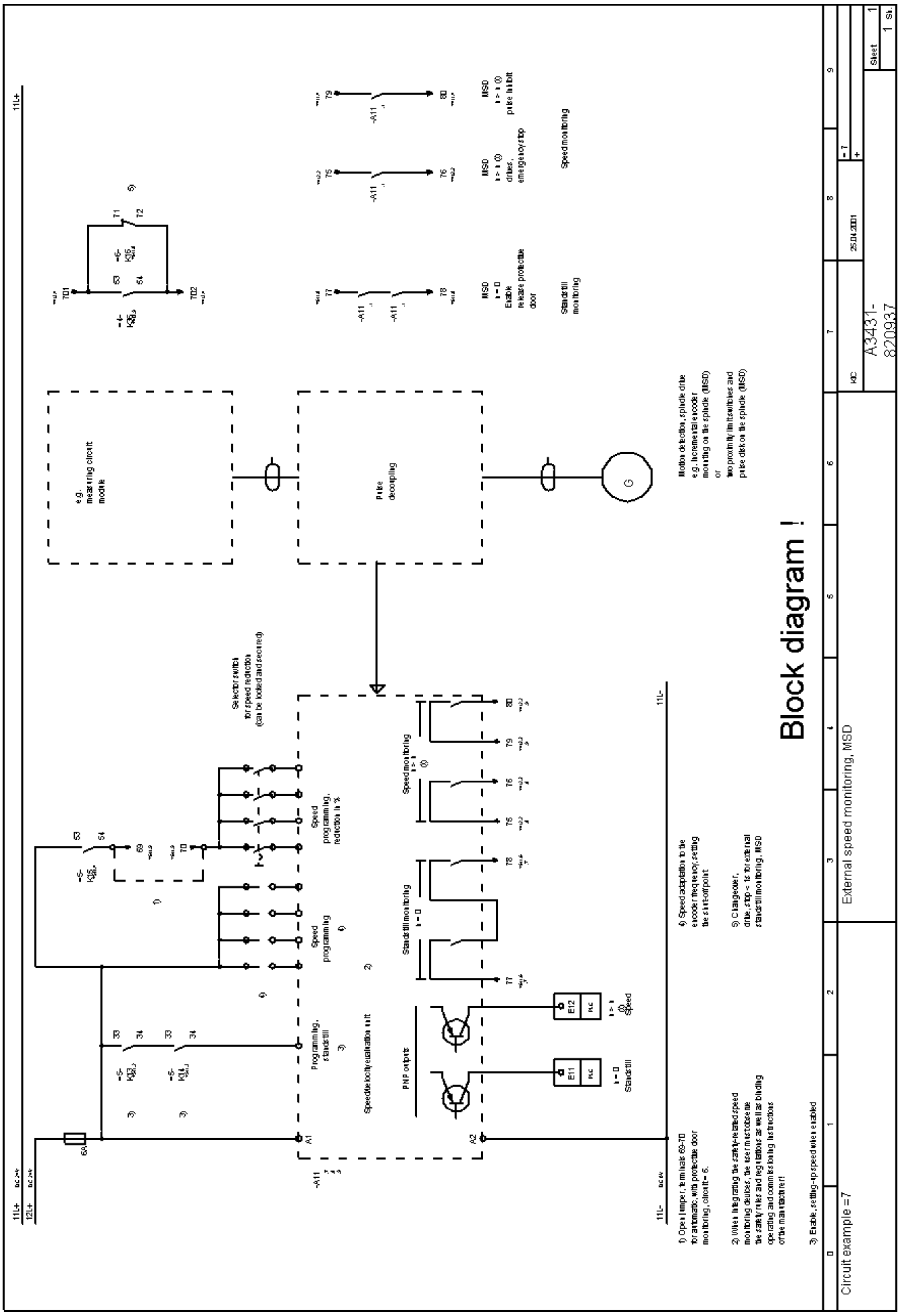

Fig. 9-20 =7 External speed monitoring, MSD; Sheet 1/1

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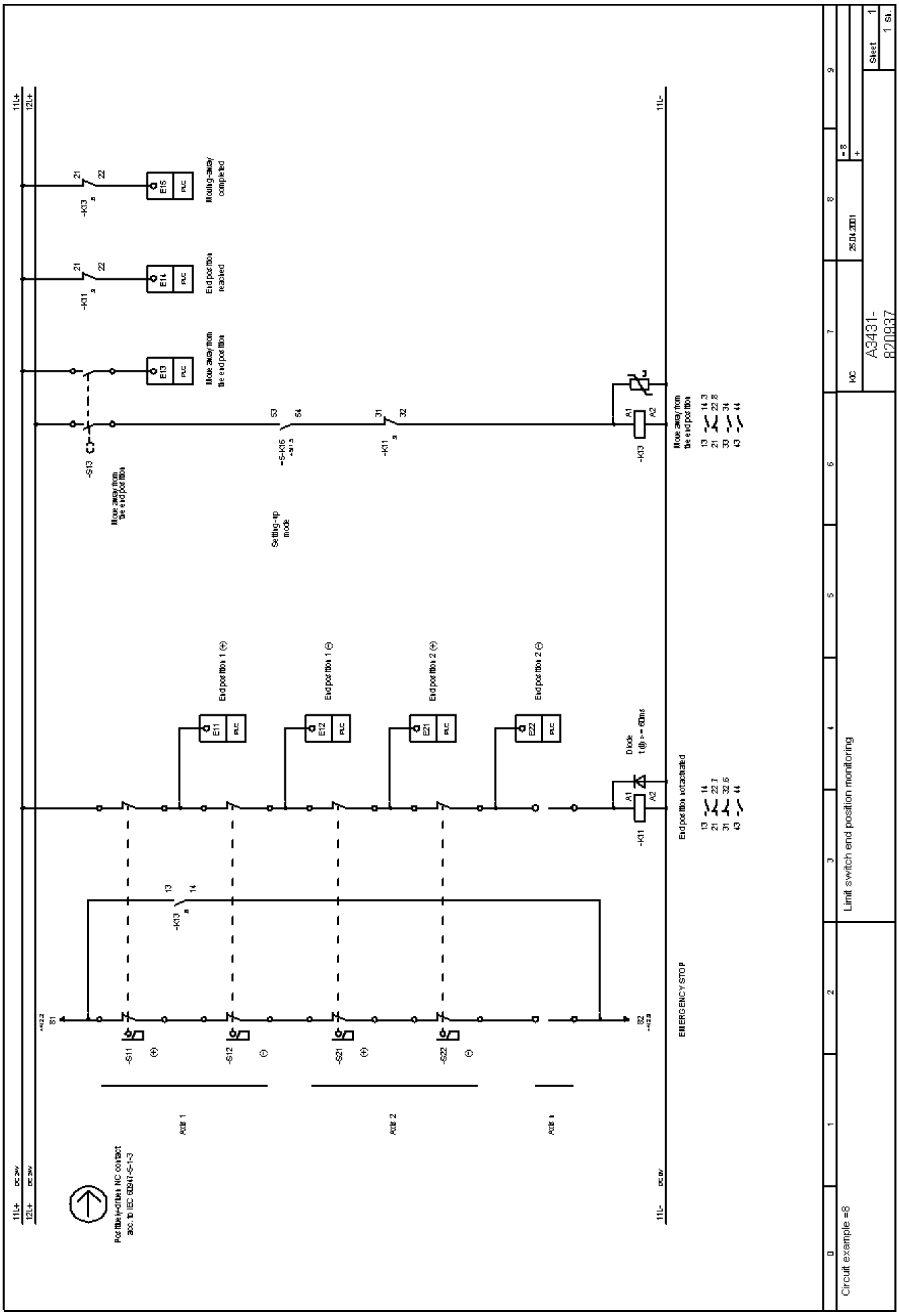

Fig. 9-21 =8 Limit switch end position monitoring; Sheet 1/1

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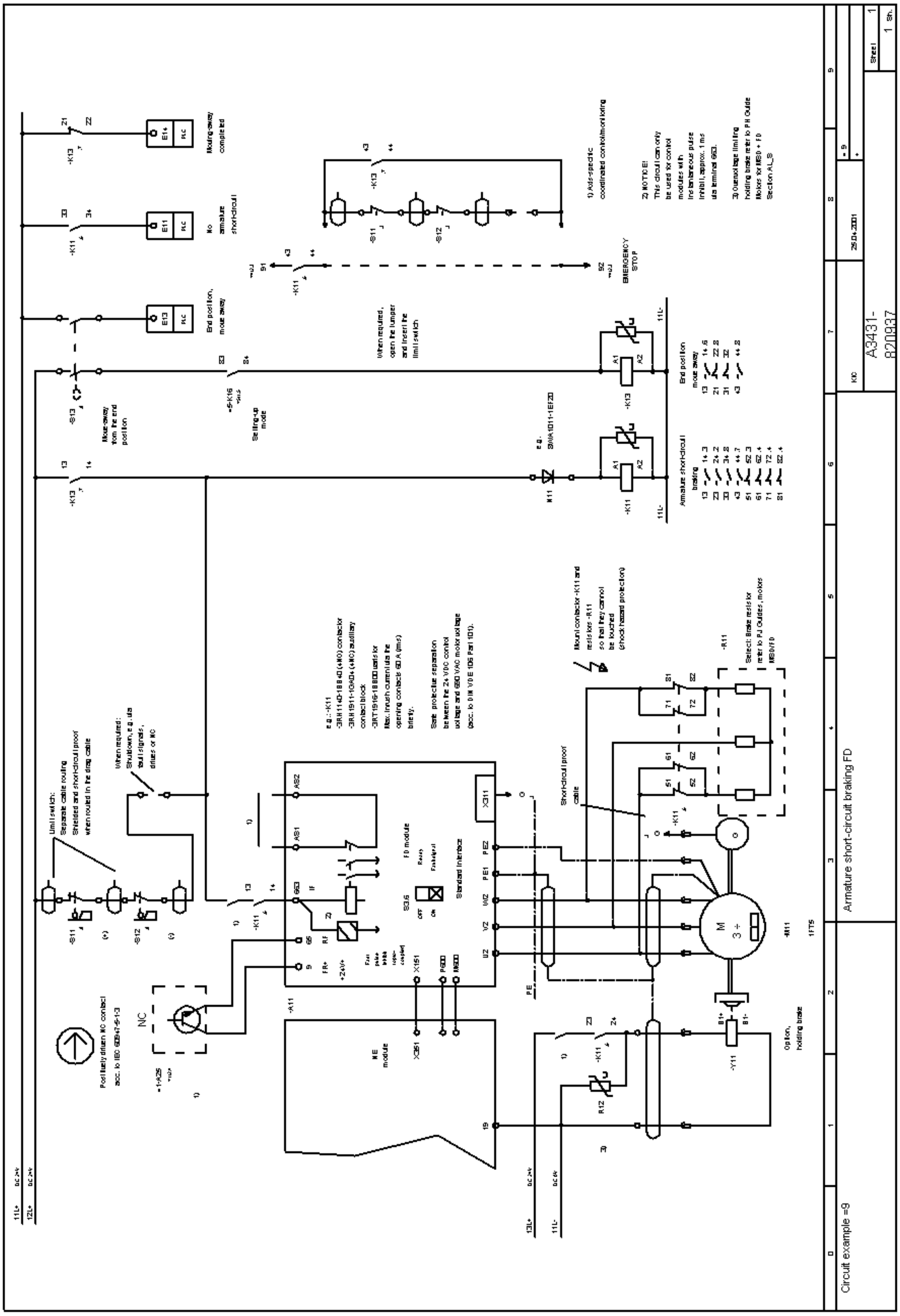

Fig. 9-22 =9 Armature short–circuit braking FD; Sheet 1/1

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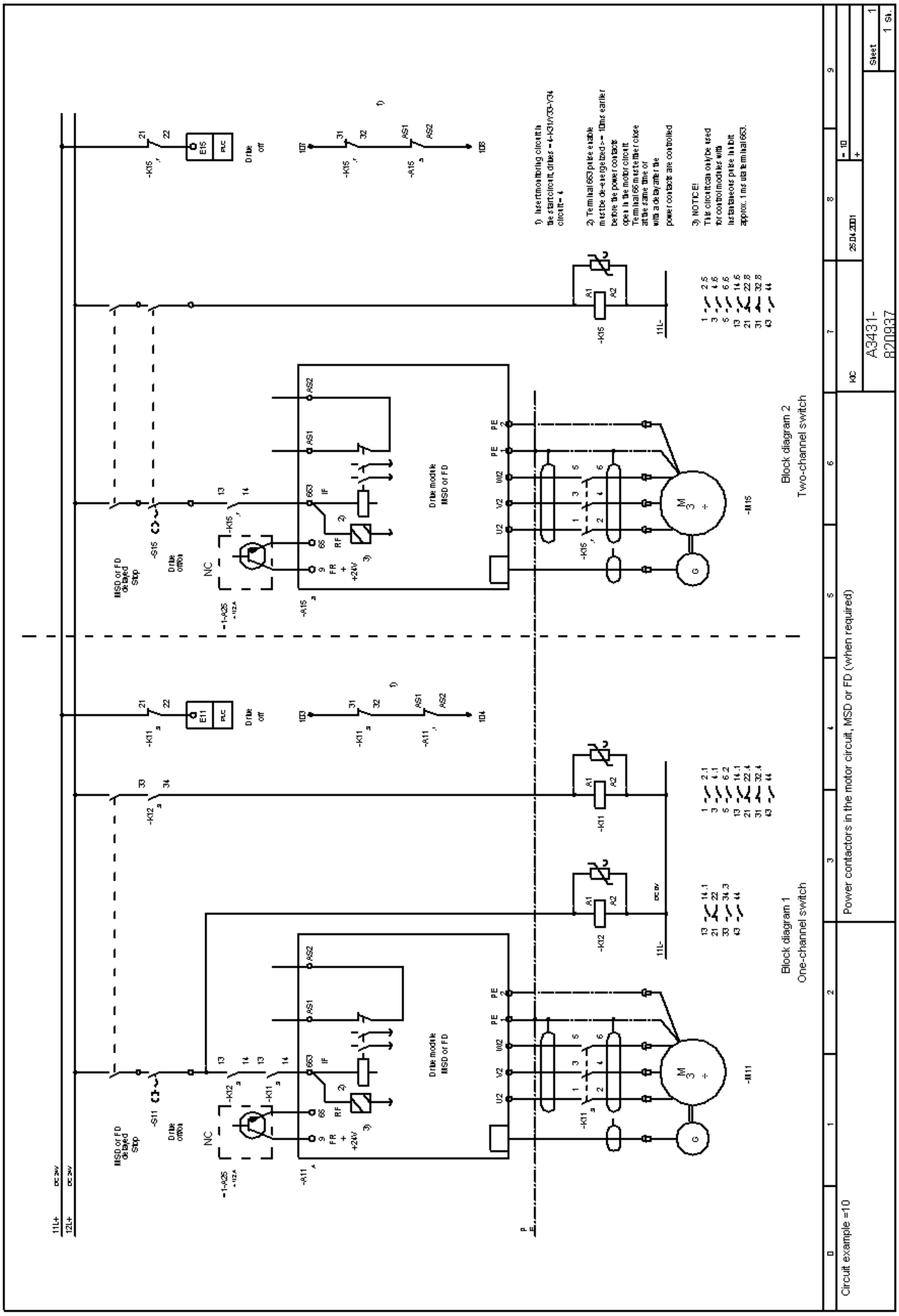

Fig. 9-23 =10 Power contactors in the motor circuit; Sheet 1/1

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9.7.1 Function description, circuit examples =1 to =10

Higher–level information and functions

Connection information, technical data, equipment selection

When configuring/engineering the drive components, safety devices, contactors etc., listed in the circuit examples, it is mandatory to observe associated connection information and instructions, technical data associated with the current Operating and Planning Guides as well as Catalogs and Applications Manuals.

Selecting switching devices

- SIGUARD 3TK28 / 3TK29 safety combinations;circuit examples and the “Autostart” and “Monitored start functions” are described in the Application Manual “Safety Integrated,” Order No. E20001–A110–M103.
- SIRIUS 3 RT1 and 3 RH11 power and auxiliary contactors must be selected with positively–driven auxiliary contacts in compliance with ZH1/457, IEC 60947–5–1.
- Contact reliability

  The auxiliary contacts, switching contacts of the switching devices and the equipment to isolate from the line supply must be capable of reliably switching low switching currents ≤ 17 V, 5 mA.
- Overvoltage limiting

All of the switching devices, coils, inductances, brakes etc. must be provided with RC elements, varistors, diodes or diode combinations, if these are not already integrated in the devices. These are used to dampen overvoltages when switching–off for EMC reasons and the ensure the functional safety.

This also applies to switching devices which are controlled from PLC outputs.

Note

The selected overvoltage limiting influences the switch–off delay of the devices. This influence must be taken into consideration when engineering the drive system.

Refer to Catalog NK Low–Voltage Switchgear when selecting devices and for technical data

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Functions/safety aspects

Definition of the terminology used
“Powering down in an emergency ” EMERGENCY STOP and “stopping in an emergency” EMERGENCY STOP

- Actions made in an emergency situation according to EN 60204–1 (VDE 0113, Part 1): 1998–11, Section 9.2.5.4 should be interpreted as follows:
- Powering down in an emergency: In Stop Category 0 acc. to EN 60204–1;9.2.2, the drive is stopped by immediately disconnecting the energy to the machine drive elements (i.e. uncontrolled stopping). This type of shutdown is generally interpreted as EMERGENCY OFF.
- Shutting down in an emergency: In Stop Category 1 in accordance with EN60204–1; 9.2.2 the drive is shutdown in a controlled fashion, whereby energy is still fe to the machine drive elements is kept in order to stop the motion. The energy is only disconnected when standstill has been reached. This type of shutdown is generally defined as EMERGENCY STOP
- In the circuit examples, the EMERGENCY STOP function is used for shut-down in an emergency.

  The EMERGENCY STOP pushbuttons act through two channels to shut-down in control Category 3 according to EN 954–1 using the 3TK2806–0BB4/3TK2807–0BB4 safety switching devices. When required, the 3TK2806–0BB4 switching device allows an EMERGENCY STOP button to be connected in a cross–circuit proof version, Category 4 acc. to EN954–1.
- Braking using the drive inhibit, terminal 64, along the current limit.

  By inhibiting terminal 64, drive enable at the NE module or monitoring module, the drives are stopped as quickly as possible along the selected current limit (torque limit)/ramp of the drive module.

Notice

For applications, where a spindle drive may not be braked along the current limit for safety reasons, terminal 81 ramp–function generator fast stop must remain energized when shutting down in an emergency. This means that the drive can be stopped in a controlled fashion along an adjustable setpoint ramp.

- Regenerative feedback power NE module

  Generally, the NE module is dimensioned according to the rated output of the connected motor, reduced by a coincidence factor. When braking along the current limit, it should be observed that the braking power should not exceed the peak regenerative feedback power of the I/R modules (refer to Table 6.3) or the braking power of the pulsed resistors in the UI modules. For borderline cases, larger NE modules should be used, or additional pulsed resistor modules with external pulsed resistor.
- Setpoint and position actual value interfaces

  A complete drive module with power module and control section with Standard interface and analog setpoint interface for 1FT5 motors is shown in the block diagram in Section 9.4.1. The setpoint is controlled via terminals 56/14. The setpoint and position actual value interface of the NC control, e.g. 840C analog, is only shown in principle in circuit example =1 These are no longer discussed in other circuits

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The control modules are described in detail in Section 5.

- Motor holding brake

The holding brake must be controlled so that it is coordinated as far as the timing is concerned, e.g. using the PLC logic as a function of the pulse cancellation, controller enable and speed setpoint input. The time taken for the holding brake to mechanically open and close must be taken into account here. If the control has not been optimally set, this results in increased wear and premature reduction in the braking performance.

In the circuit examples, in addition to being controlled from the PLC, the holding brake is disconnected with drop–out delay per hardware for a drive stop. This means that a PLC fault cannot result in the brake being erroneously controlled when the drive is stopped. Depending on the particular application, it must be decided when stopping in an emergency, whether the brake is switched–off with a delay or instantaneously. Using an internal sequence control, 611U closed–loop controls allow a holding brake to be controlled in a coordinated fashion (refer to Description of Functions SIMODRIVE 611 universal).

Damping devices must be externally connected to the holding brakes to dampen overvoltages.

For a detailed description, refer to the reference /PJM/ for SIMODRIVE motors MSD and FD.

- Safe standstill

After the drives have been stopped, these are in the safe standstill operating condition as the energy feed to the motors has been safely disconnected. When the start inhibit is activated, the pulses are safely cancelled in the drive modules.

Features

- Motors cannot undesirably start.
- The energy feed to the motor is safely interrupted.
- The motor is not electrically isolated from the drive module or DC link of the drive converter.

The machinery manufacturer must apply suitable measures to prevent undesirable motion after the energy feed to the motor has been disconnected.

Secondary conditions, e.g. for vertical axes

Safe standstill is only guaranteed if the kinetic energy, stored in the machine cannot result in unpredictable movement of the drives/axes. Movement can occur, e.g. as a result of vertical or inclined axes without weight equalization, as a result of non–symmetrical rotating bodies or workpieces.

The motor holding brake supports the safe standstill operating condition.

Depending on the hazard analysis, additional measures may be required for personnel and machinery protection when manually intervening in the automatic mode, when traversing in the setting–up mode as well during service and repair work.

Equipment which is used in parallel with the holding brake, can be used to prevent axes falling or to safely clamp axes at a specific position. This redundant equipment can be e.g. electromechanical or pneumatic clamping devices with cyclic monitoring.

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Circuit example =1 “Cabinet supply, NC, PLC”

- Cabinet layout and design regulations:

When designing cabinets to accommodate drive components, among others, the following essential regulations and specifications must be observed:

DIN EN 60439–1 (VDE 0660 Part 500) 2000–08 Low–Voltage Switchgear Combinations

DIN EN 60204–1 (VDE 0113 Part 1) 1998–11 Electrical Equipment of Machinery, Safety

DIN VDE 0106 Part 100 1983–03 Protection against Electric Shock.

EMC and Low–Voltage Directive

Enclosure degree of protection IP 54 or corresponding to the ambient conditions.

Selecting equipment:

- Q1 device to disconnect the equipment from the line supply (main switch) with leading auxiliary contactor when disconnecting

  Section, refer to Section 7.1.7 and Catalog NSK

  The line supply disconnecting device electrically disconnects the equipment from the power supply.

- G11 SITOP–power power supply unit for 24 V DC, refer to Catalog KT 10.1. The power supply and the connected circuits must fulfill the requirements of PELV (extra low function voltage with protective separation). We recommend current–limiting regulated power supply units, e.g. SITOP power.

- F11–F14 m.c.b.’s 5SX or 5SY, refer to Catalog I2.1. The potential assignment of the circuit has been randomly selected. The max. permissible values of the protective elements must be carefully observed when fusing/protecting the safety switching devices and circuits.

- F21–F23 line fuses for the NE modules, assignment, refer to Section 7.1.1 and 9.2.2.

- A21 line filter, refer to Section 7.2.1 and 7.2.3 and Catalog NC 60

- L21 line commutating reactor, refer to Section 7.1.3 and Catalog NC 60

- A25 NC SINUMERIK 840C control with analog setpoint interface and PLC–CPU 135WD, refer to Catalog NC 60.

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Circuit example =2 “Powering up/powering down/ stopping drives in an emergency”

Application

Drive group comprising an NE module, three FD modules 611 A, control modules with standard interface and analog–setpoint interface for 1FT5 motors. This circuit concept can, e.g. be used for simple drive controls. When the drives are powered up and powered down, the complete drive group is switched through two channels in a safety–related fashion using line contactors and start inhibits.

Functions

Drives on

- Key–actuated switch–S21, control on.

The power–off circuit in front of the EMERGENCY STOP safety switching device –K21 must be closed by the following conditions:

- Contactor –K25 energized, NE module ready. (ready conditions, NE module, refer to Section 9.2.2!) When the control is switched–on, the ready signal is still not present. This means that the PLC output A25 must be set to “1” via the PLC logic so that the power–off circuit is closed through contactor K25. After the group has been powered up via contactor –K21, if there is no fault message, the ready signal is received via PLC input E11. The ready monitoring is in the power–off circuit now becomes active through the PLC logic.

  The feedback circuit from contactor –K25 is now monitored through PLC–E25.

- Contact =A1–A25/1–2 NC ready at the NC control must have switched.
- Interlocking circuit, terminal 35–36 closed.
- Feedback circuit, contactor –K21 is closed:

  The line contactor, the start inhibits and contactor –K27 for the brake control are monitored to ensure that they are in the safe off condition at power–up cycle. When required, safety–relevant functions associated with the user–side machine control can also be incoroprated in the feedback circuit

- Pushbutton –S23, drives on

Contactor –K21 is energized and latches. The drive group is powered up. After the DC link has been pre–charged, the line contactor in the NE module is energized. The ready signal is received as long as there is no fault message.

NC program, start/stop

- Pushbutton –S29/–S28

  The axis–specific controller enable signals are activated using pushbutton –S29 NC–program start – and the NC machining program is started. The drives are brought to a controlled standstill at the end of the program or using the pushbutton –S28 stop.

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Drives off

The drives, if they have not already been shutdown by the NC program, are braked as quickly as possible and stopped along the selected current limit of the drive modules using pushbutton –S24 EMERGENCY STOP or –S22 off. Terminal 64, drive enable is inhibited and braking initiated using the instantaneous contact from contactor –K21. After braking has been completed, the line contactor is opened in a safety–related fashion through two channels via terminal 48 NS1–NS2 with a reliable overlapping shutdown time using the delayed drop–out contacts of –K21. The start inhibit functions become active by inhibiting terminal 663. -Any fault messages/signals of the drive system, logically combined and interlocked using the PLC logic, can be used, depending on the application, to brake along the current limit, or for controlled braking via a setpoint ramp. The off pushbutton also acts on PLC–E22. The PLC logic can therefore be used to evaluate which power down command caused the drive group to be shut down. The PLC logic can also be used to shut down the drive group, independent of the ready signal of the NE module, using contactor –K25.

Holding brake

The holding brake is controlled, coordinated in time by the PLC logic via PLC–A27. When the drives are stopped, the brake is also additionally de–energized per hardware in a safety–related fashion using a delayed drop–out contact of contactor –K21. This means that a PLC fault cannot result in the brake being incorrectly controlled when the drive is stationary.

Temperature monitoring

Input PLC–E12 is energized when the temperature monitoring responds, either as a result of a drive module overtemperature and/or a motor via relay 5.1–5.3 at the NE module. Depending on the application, the drives must be shut down, either instantaneously or with delay, e.g. using PLC–A25 and contactor –K25 via the logical interlocking in the PLC.

Circuit example =3 “Starting/stopping/safe standstill for drives”

Application

The control is use for applications, where one or several drives must be selectively shutdown in an operational drive group using safety technology. A drive, in a drive group, can be shut down in a safety–related fashion using a two–channel key–actuated switch or, e.g. also using light barriers or limit switches. Beforehand, the drive must have been safely shut down via the NC control. The ”safe standstill” operating condition is achieved using the start inhibit

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Functions

Start drives

The two–channel stop circuit in front of safety switching device –K11 must be closed–via key–actuated switch –S11 and the EMERGENCY STOP circuit, =2–K21. Contactor –K11 is energized (switched in) with ”monitored start” using pushbutton –S12 start and closed feedback circuit. It latches. Terminal 65 controller enable and terminal 663 pulse enable are energized

The drive is traversed and shut down in a controlled fashion using the NC program

Stop drives

The switching device–K11 is opened via key–actuated switch –S11 or an EMERGENCY STOP. The instantaneous contact de–energizes terminal 65 ”controller enable” and the drive is braked along the current limit. Terminal 663 is de–energized, which activates the start inhibit via the delayed drop–out contact –K11.

Start inhibit – monitoring

The start inhibit – monitoring, terminals 35–36 is effective in the EMERGENCY STOP circuit of contactor =K2–K21.

Under normal operating conditions, when the drive is being stopped, the NC contact AS1–AS2 of the start inhibit relay should first be closed before the NO contact of contactor –K13 opens. To realize this, the contactor coil –K13 must be provided with a diode to extend the contactor drop–out delay. For an erroneous start inhibit, the monitoring circuit opens and shuts down the complete drive group via the line contactor.

The start inhibit is cyclically and actively monitored after every stop.

Holding brake

Function, similar to circuit =2

Circuit example =4 “Powering up/powering down/stopping drives in an emergency; start/stop/safe standstill”

Application

Drive group comprising NE module, MSD module for 1PH7 motor and three FD modules 611A control modules with standard interface and analog setpoint interface for 1FT5 motors. The circuit =4 is the basis circuit for the drive–related control, e.g. a machine tool. The control can be expanded in a modular fashion using the following circuit components =5 to =10 with the necessary interlocking and monitoring circuits and the application–specific supplements/options. This means that it can be individually adapted to the particular application.

Functions

Drives on (NE module)

- Key–actuated switch –S21 control on.

  The power–off circuit in front of the EMERGENCY STOP safety switching device –K21 must be closed using the following conditions:

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- The interlocking circuits of the subsequent expansions to circuits =7 to =9 are jumpered.
- Contactor –K25 energized and contact =A1–A25/1–2 NC ready is closed The power–on conditions are almost comparable with those of circuit =2. The ready signal of the MSD module PLC–E15 must be additionally logically combined with the ready signal of the NE module PLC–E11 in the PLC.
- Pushbutton –S23, drives on

  Contactor –K21 is energized and latches. Initially, only the NE module is powered up. After the DC link has been pre–charged, the line contactor is closed. As long as there are no fault messages at the NE module and at the FD modules (switch, ready/fault message is set to fault message), the ready signal is output.

Start drives (drive modules)

- The NE module must be powered up. The stop circuit in front of the safety switching device –K31 must be closed. The interlocking circuits of the subsequent expansions to circuits =5 and =7 are jumpered
- When the feedback circuit is closed, contactors –K31 with expansion device –S32 and contactor –K35, –K33, –K36 close and latch through pushbutton –S32, start drives (monitored start).
- At the same time, terminal 63, central pulse enable, terminal 64 ”drive enable” at the NE module and terminal 663 ”pulse enable” are energized for the drive modules which withdraws the start inhibit signals.

NC program start/stop

- Pushbutton –S29/–S28

  The axis–specific controller enable signals are activated via pushbutton –S29 NC program start and the machining program is started. The drives are brought to a controlled standstill at the end of the program or using the pushbutton –S28 stop.

Stop drives

- The drives, assuming that these still have not been shut down via the NC program are braked down to standstill as fast as possible along the selected current limit via the two–channel pushbutton –S31 stop drives.
- The instantaneous contact of contactor –K31 de–energizes terminal 64 drive enable. After the drives come to a standstill, terminal 663 is de–energized and the start inhibits are active via the delayed drop–out contacts of safety switching devices –K32 and –K35.
- The stopping times are adapted to the different braking times of the MSD and FD drives and must reliably and safely covers these, e.g. MSD 5 s ; FD 0.5 s.

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Start inhibit monitoring

The start inhibit monitoring, terminals 37–38 acts in the EMERGENCY STOP circuit in front of contactor –K21. Under standard operating conditions, when the drives stop, the NC contact AS1–AS2 of the drive inhibit relay in the drive modules must first be closed before the NO contacts of contactors –K33 and –K36 open. To realize this, the coils of these contactors must be provided with a diode to extend the contactor drop–out delay. If the start inhibit is erroneous, the monitoring circuit opens, the EMERGENCY STOP contactor –K21 drops out and powers down the complete drive group via the line contactor. The start inhibits are cyclically and actively monitored after each stopping operation.

Drives off

- The drives are braked to a standstill as fast as possible along the current limit via pushbutton EMERGENCY STOP –S24 or Off –S22. The function is similar to circuit =2. After the spindle drive braking time has expired, the drive group is shut down via contactors –K31/–K32, i.e. the line contactor drops out and the start inhibit functions become active.

Holding brake

The control is similar to circuit =2

Temperature monitoring

The function similar to circuit =2.

The temperature monitoring of the spindle drive must additionally evaluated via PLC–E13 and –E14.

Circuit example =5 “Drives, automatic/setting–up operating mode with enable”

Application

For most machines/plants, the operating mode changeover is used, in order, e.g. to be able to traverse drives with a monitored, reduced speed in the setting up machine mode. In this operating mode, other sub–areas must be shut down in a safety–related fashion due to potential hazards. The operator must enable drive operation in the setting up mode with reduced speed. This enable signal can come, e.g. depending on the risk assessment, from a secure location outside the machine hazardous zone or from a handheld terminal with additional EMERGENCY STOP pushbutton in the machine working zone.

Notice

The user must carefully observe special technological and machine–specific regulations and standards to remain in compliance with personnel and machinery protection legislation. Furthermore, the residual risks must be evaluated, e.g. as a result of vertical axes.

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Functions

Operating modes

The operating mode selector switch –S15 must be able to locked as key–actuated switch or another version must be used which can be disabled.

Notice

The operating mode may only be changed over when the drives are stationary and this changeover may not result in a potentially dangerous machine condition.

Automatic mode

The interlocking circuits, terminals 51–52/53–54/55–56/57–58/511–512 must be inserted in the circuit =4. The interlocking circuit, terminals 611–612/613–614, is closed.

Key–actuated switch –S15 is set to automatic; contactor –K15 energized. The monitoring circuit, drives stop, in front of contactor =4–K31 is closed via terminals 53–54/55–56. This means that the drives can be started under the power–on conditions, specified in circuit example =4, using the pushbutton, start drives =4–S32.

Setting–up operation

Key–actuated switch –S15 is set to setting–up, contactor –K15 de–energized, contactor –K16 pulled in. The monitoring circuit, terminals 53–54/55–56 are open. This means that the drives cannot be started. By opening the monitoring circuit, terminals 511–512, pushbutton =4–S32, start drives is not effective in the setting–up mode.

The drop–out delay for the contactor =4–K32, for the shutdown time of the spindle drive, is changed over from e.g. 5 s to the shorter time for FD drives, e.g. 0.5 s, via interlocking circuit, terminals 57–58. Under fault conditions, the complete drive group is powered down, after this shortened time.When changing over to setting–up, in addition, the speed setpoint for the drives is reduced via PLC E18. The speeds and feed velocity should therefore be reduced to values permitted in accordance with Type C standard or the hazard analysis.

Notice

The setpoint limiting is not a safety–related function.

Enabling function

The safety switching device –K11 and contactors –K13/–K14 are switched in via pushbutton –S11, enable (pushbutton with two positions), under the assumption that the feedback circuit is closed.

The interlocking circuit is, in turn, closed through terminals 53–54/55–56.
A start pulse must be generated via PLC–A17 using PLC–E17 with time delay >= 80 ms. Contactor –K17 briefly pulls in and provides, via terminal 51–52 the start command for contactors =4–K31, –K32, –K33, –K35 and –K36.

The start inhibits are withdrawn and therefore the drives are enabled in a safety–related fashion as long as the enable button is pressed.

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The selected drives can now be individually moved with reduced parameters via the non safety–related PLC function keys in conjunction with the hardware enable

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Notice

It is not permissible that motion can be started when only the enable button is pressed. Note: By de–energizing terminal 81, ramp–function generator fast stop, after each enable command, the induction spindle motor must be again magnetized and therefore runs up with a delay $\geq$ 0.5 s.

The drives can be shut down in a safety–related fashion by releasing the enable button when hazardous operating conditions occur, when the PLC function pushbuttons fail or for other unpredictable situations.

Notice

For drives with high dynamic response with inadmissible speed increases, under fault conditions, potential hazards can occur as a result of human response times and the switching delay of the enable device. These potential hazards must be reduced by using additional measures, e.g. safe speed monitoring.Various type C standards, e.g. for machine tools require that the spindle drive speed is safely monitored in the setting–up mode.

Circuit example =6 “Drives, automatic operation with protective door monitoring”

Application

The working zone of a machine, in the automatic mode, is mechanically isolated using a closed protective door which can be moved. In the circuit example, the protective door is secured against being opened when the drives are operational or for hazardous operating conditions, using a position switch with tumbler mechanism. This tumbler mechanism is interlocked using spring–force with sealed auxiliary release. Automatic drive operation is only enabled if the protective door is closed and interlocked using the position switch.

Depending on the hazard analysis, the user must decide whether, e.g. second limit switch is additionally required for door monitoring.

The protective door cannot be opened as long as there is still a hazardous condition, e.g. if the drives are still moving. The enable is realized with time delay after the drive with the longest braking time is safely shutdown or optionally using the standstill signal from an external speed monitoring in circuit =7.

For several applications, e.g. if personnel can enter the working zone of a machine for safety reasons, the protective door is provided with a tumbler mechanism using a position switch, interlocked with solenoid force. If the line supply or control voltage fails, this position switch can release the protective door and it can be opened.

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Functions

Request protective door release

The drives must first be shut down using pushbutton =4–S31 drive stop or optionally, e.g. at the end of the NC program by the output of an NC auxiliary function, PLC–A18 controls contactor –K18.

The protective door release is requested using pushbutton –S15. Contactor –K15 pulls in, logically combined using the PLC logic, if the drives are shut down and powered down, e.g. contactors =4–K33 and =4–K36 are de–energized. PLC logic: PLC–A15 = "1", if =4–E33 and =4–E36 = "0" signal. When expanded using an external MSD speed monitoring, circuit =7, the PLC logic must be adapted: PLC–A15 = "1", if =4–E36 = "0" and =7–E11 = "1" signal.

With the protective door release request, in the secured working zone of the machine, all of the hazardous motion and other potential hazards associated with the user's machine control must be shutdown. Finally, shutdown must be made in a safety–related fashion via the released or opened protective door.

Protective door release

The protective door is released via contactor –K16 if the following conditions are fulfilled:

- Contactor –K15 is energized
- Drives, delayed stop, contactors =4–K33 and =4–K36 de–energized
- MSD standstill signal n act < n min via relay =4–K11.
- Interlocking circuit on the user side closed via terminals 601–602.

Optional:

- External standstill monitoring via terminals 77–78 closed.

The interlocking solenoid of the door position switch –S11 is energized and the safety switching device –K11 and contactors –K13/–K14 de–energized via the position monitoring of the solenoids. The drives are shut down in a safety–related fashion through two channels via interlocking circuit terminals 611–612/613–614. The protective door is initially released but is still closed, relay –K17 energized. This means that non–hazardous partial–functions of the user–side machine control can still be executed via the PLC.

Opening the protective door

By opening the protective door, the protective door safety circuit is opened via the actuator of the door position switch –S11 in parallel to position monitoring of the solenoids.

Closing the protective door

The protective door must be closed. The contactors –K15/–K16 are de–energized and the protective door is interlocked again via pushbutton –S16 interlock protective door. The interlocking circuit is re–closed via terminals 611–612/613–614 which means that in the selected automatic mode, the drives can be re–released using pushbutton =4–S32 start.

For protective doors, which are only seldomly opened, we recommend that the control is adapted so that before the drives are powered up, the correct functioning of the position switch is checked by opening and closing the door again.

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Circuit example =7 “External speed monitoring, spindle drive”

Application

Several type C standards demand safe speed monitoring for the functions:

- Standstill monitoring for a spindle drive to release a protective door
- Speed monitoring functions for max. speeds or velocities in the setting–up mode, e.g. 50 min^{-1} or in the automatic mode, depending on the chuck size or the clamped workpiece as a result of the maximum permissible clamping and centrifugal forces. The max. limit is set, e.g. using a selector switch which can be locked.

The speed is automatically monitored for zero speed when the automatic mode is cancelled or when the protective door is opened. The setting–up speed (crawl speed) is enabled with the enable signal. After the enable signal has been withdrawn, the speed is again monitored for standstill after a delay. The speed sensing for the monitoring device e.g. be either realized using an incremental encoder or two proximity switches mounted onto the spindle. The device to provide the speed monitoring can be purchased from various manufacturers which is the reason that it is only shown in principle without any precise connection designations. The user must incorporate the device used into his control, taking into account the safety–related requirements and the manufacturers data.

Note

The monitoring function of the device should be proven using an acceptance test and documented !

9

Functions

Standstill monitoring

The speed monitoring device is actively switched in via the control voltage. Contact –A11/terminals 77–78 at the monitoring unit is closed, via the safe standstill signal of the spindle drive and the door release is released in circuit =6. Therefore, the time until the protective door has been released can be significantly shortened with respect to the delayed release using contactor =4–K33 MSD Stop. In this case, contact =4–K33/81–82 must be jumpered in circuit =6. For NC machining programs with low spindle speeds, the time for the drive to brake down to standstill is appropriately short so that it is not necessary to wait for the delay, set at contactor =4–K33, for the max. braking time until the door is opened. The interlocking circuit, terminals 701–702, changeover, stop drives < 1 s for external standstill monitoring functions MSD should be inserted in front of contactor =4–K32/A1. In this case, after the spindle drive has issued a safe standstill signal, the drives are already shut down after < 1 s and go into safe standstill.

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Speed monitoring

Setting–up operation

When the automatic mode is cancelled, contactor =5–K15 de–energized or the protective door released or opened, contactor =6–K11 is de–energized, terminal 69–70 opened, and the speed is monitored for standstill. When enabled via pushbutton =5–S11, contactors =5–K13/=5–K14 are energized and the speed, set at the monitoring device, for setting–up operation, monitored.

When the permissible speed is exceeded, contacts –A11/79–80 and –A11/75–76 open. The pulses for the spindle drive are inhibited, and at the same time the emergency stop function is initiated via contactor =4–K21 and the drives are shut down.

Automatic operation

When the max. permissible speed, set at the selector switch (the reduction is programmed as a %) is exceeded, the drives are also immediately shutdown as described before. The device should be adapted to the speed and pulse frequency of the speed encoder via the speed programming inputs.

Depending on the hazard analysis, it may be necessary to use speed monitoring, e.g. also for the feed drives and/or also for the user–side machine functions. The control must be appropriately adapted on the user side.

Circuit example =8 “Limit switch end position monitoring”

Application/functions

Normally, the end position of the axis traversing range in the machine is monitored using software limit switches which become active after the reference point approach. If, under a fault condition, a software limit switch is passed, and therefore a hardware limit switch actuated, contactor =4–K21 is de–energized via the interlocking circuit terminals 81–82 in the EMERGENCY STOP circuit. The drives are braked along the current limit and are then shutdown.

However, an axis can only be effectively braked if there is an appropriate distance between the hardware limit switch and the mechanical end stop of the axis to take into account brake travel.

The actuated end position limit switches can be disabled via the PLC inputs. In the setting–up mode, the axis can move away from the end position using key–actuated switch –S13 and be moved away in the opposite direction using pushbutton =5–S11, enabling.

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Circuit example =9 “Armature short–circuit braking”

Application

The armature short–circuit braking is only possible using permanent–magnet motors and, for example, is only used when passing end position limit switches, at power failure, for fault messages or EMERGENCY STOP.

Often, there is a fault/error in the NC PLC or in the drive module itself when the software limit switch is passed. This means that electrical braking via the position limit switches according to circuit =8 is no longer possible. For critical drives, e.g. vertical axes, in such cases, emergency braking is still possible using armature short–circuit braking and optionally using a holding brake (fast stopping).

The braking torque for armature short–circuit braking is optimized using the additional braking resistor in the motor circuit.

Caution

Short–circuit braking without using a brake resistor can result in partial motor de–magnetization.

Functions

Armature short–circuit

When passing/actuating the end position limit switches or for power failure, the pulses are inhibited via terminal 663 and, at the same time, armature short–circuit contactor –K11 is de–energized. The drive is braked after the contactor drop–out time. The interlocking circuit, terminals 91–92 is simultaneously opened which initiates the EMERGENCY STOP function for all of the drives. The contactor coil has a varistor in order to achieve an extremely short contactor drop–out time. The selected auxiliary contactor of the SIRIUS series with four pole auxiliary contact block fulfills the “protective separation” between the control voltage and 690 V AC motor circuit. The circuit must be appropriately adapted for operation when the power fails, buffering the +24 V control voltage or for other shut down functions.

Holding brake

The fast shutdown using the holding brake independent of the PLC cycle time via the armature short–circuit contactor supports braking. The mechanical pull–in delay of the holding brake acts somewhat delayed with respect to armature short–circuit braking.
In the setting–up mode, the axis can be moved–away from the end position using key–actuated switch –S13 and moved away again using pushbutton =5–S11 enable.

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Circuit example =10 “Power contactors in the motor circuit FD”

Application

For special applications, the circuits allow the energy feed to the motor from the drive module to be electrically disconnected through contactors. The contactors may only be de–energized if the pulses are inhibited >=10 ms using terminal 663 before the power contacts open. When powering up, the pulses must be enabled at the same time that the power contacts close.

Notice

The contactors are generally not suitable for disconnecting clocked inverter currents or disconnecting DC currents of a drive which is stationary in closed–loop position control. If this is not observed when disconnecting, high voltage peaks can occur which could destroy, the drive module, motor winding and/or the contactor contacts can weld up.

Functions

The drives are powered down, safety–related a) via the start inhibit and b) additionally via contactor by electrically isolating from the drive module using key–actuated switch –S11 through one channel or –S15 through two channels.

The pulse enable is first withdrawn before the power contacts of the power contactor separate with the drop–out delay. The interlocking circuit, terminals 103–104 or terminals 107–108 should be incorporated in the start circuit of the safety combination =4–K31/Y33–Y34 stop drives.

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9.8 Information on applications with 611 digital/611 universal

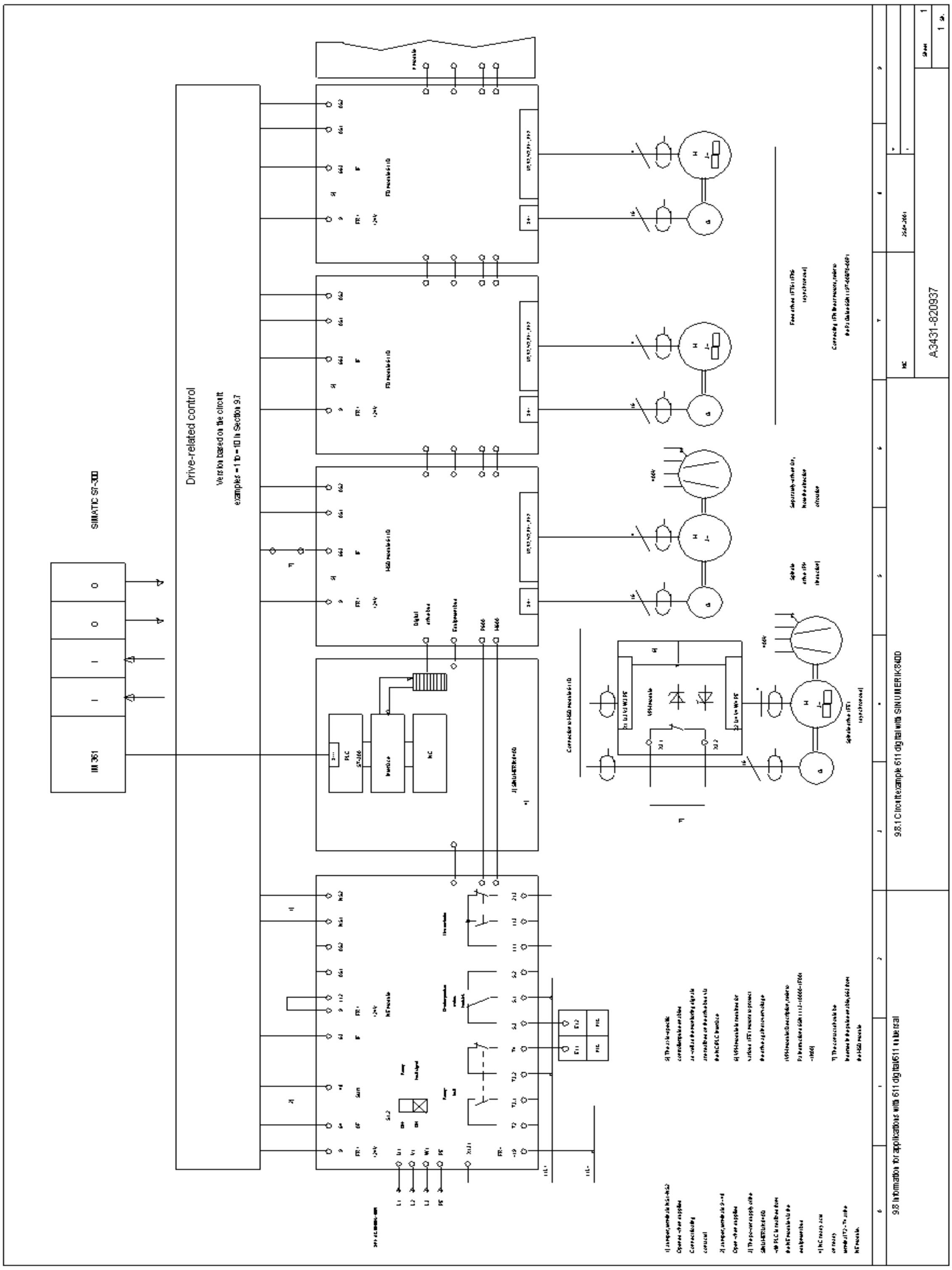

Fig. 9-24 Circuit example 611 digital with SINUMERIK 840D

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9.8.1 Circuit example 611 digital with SINUMERIK 840D

A circuit example SIMODRIVE 611 digital and SINUMERIK 840D with the drive–related control for a machine/plant, based on the circuit examples in Section 9-24 with 611A, is shown as block diagram in Fig. 9.7.

9.8.2 Circuits with 611 digital

The 611 digital control modules have a digital setpoint and position actual value interface to the 840D, 810D or 840C MC controls. The modules are available as 1–axis or 2–axis modules with Performance of Standard control.

Furthermore, the modules differ by the connection type:

- Incremental encoder as motor encoder (indirect measuring system) or
- Incremental encoder as motor encoder (indirect measuring system) and connection for direct measuring system encoders

An essential difference between 611 digital and 611 analog controls is, among other things that the motor encoder (incremental encoder cos/sin 1 Vpp) at the drive motors, in addition to the tachometer and rotor position signals (only for synchronous motors) also transfers position actual value signals to the measuring system input of the 611D. These signals are fed to the position controllers in the NC control via the digital drive bus where they can be processed for indirect position actual value/position sensing of the drive.

Description of the interfaces of the 611 digital control module —> refer to Section 5.

All of the communications of the NC control to the 611D drive modules is realized via digital drive bus. The axis–specific controller and pulse enable signals as well as the operating and monitoring messages are realized via NC/PLC interface signals on the digital drive bus.

The hard–wired terminal 65 axis–specific control enable is not available for the 611D modules. Terminal 663, pulse enable/start inhibit is available on a module–for–module basis for the 611D modules as for the 611 A modules. The axis–specific pulse enable signals via the drive bus are AND'ed with the signal status at terminal 663.

Control with SINUMERIK 840D

The NC control with the integrated PLC–CPU SIMATIC S7–300 is accommodated in a 50 mm–wide housing, compatible to the SIMODRIVE drive modules.

The control is integrated in the SIMODRIVE 611D drive group and can be expanded by up to 31 axes. It is located between the NE module and the first drive module in the drive group. The power supply for the internal control voltage is derived from the NE module power supply via the equipment bus. The NC ready signal acts on the ready signal, terminals 72–74, of the NE module via the equipment bus.

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Control with SINUMERIK 810D

SINUMERIK 810D is a highly integrated compact control, accommodated in a 150mm wide enclosure, compatible to the SIMODRIVE modules with integrated PLC–CPU SIMATICS7–300 and 611D power and control modules onboard. The control is available in two versions:

- CCU1 module with three integrated power modules (1x MSD, 2x FD)
- CCU2 with two power modules (2x FD)

The control can be configured using axis expansion modules up to 5 (4) axes + 1 spindle with separately mounted power modules. The controls are already integrated in the CCu modules. The control power supply is realized, just like the SINUMERIK 840D, from the NE module power supply via the equipment bus.

The NC ready signal acts on the ready signal, terminal 72–74 of the NE module via the equipment bus. The control has, for all axes, a hard–wired terminal 663 pulse enable/start inhibit. The controller and pulse enable signals are available for each specific axis, and are controlled using NC/PLC interface signals on the internal digital drive bus. The safety–related, drive–related control for a machine–system with SINUMERIK 810D can be configured by the user based on the circuit examples in Section 9.7.

Control with SINUMERIK 840C

The SINUMERIK 840C control is located in a separate subrack, utilizing modular packaging technology, with integrated PLC–CPU SIMATIC 135 WD. The control is available in two versions with digital or analog setpoint interface, and can be expanded up to 30 axes.

The 840C has its own power supply with separate feed to connected to 115–230 V AC or 24 V DC. The NC ready signal is available via a relay contact output. The digital drive bus is connected to the first drive module in the 611D group, also refer to the connection diagram, Section 12, Fig. 12-1.

The safety and drive–related control for a machine/system can be based on the circuit examples in Section 9.7.

The 840C control with analog setpoint interface is essentially used for circuit examples =1 to =10 in Section 9.7.

9.8.3 Circuits with 611 universal

The SIMODRIVE 611 universal control module is available as either 1–axis or 2–axis version.

The setpoint can be entered either as analog signal or via PROFIBUS.

The interfaces are described in Section 5.

Safety and drive–related controls for a machine:

The SIMODRIVE 611 universal control module with analog setpoint interface can be used essentially the same as in circuit examples =1 to =10 in Section 9.7 for SIMODRIVE 611 analog.

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9.9 Master/slave operation SIMODRIVE 611 analog

MSD

Two SIMODRIVE main spindle drives can be mechanically rigidly coupled if the master drive is closed–loop speed controlled and the slave drive is close–loop torque controlled.
There are two operating modes available:
1. Open–loop torque control and
2. Open–loop torque control with slip monitoring

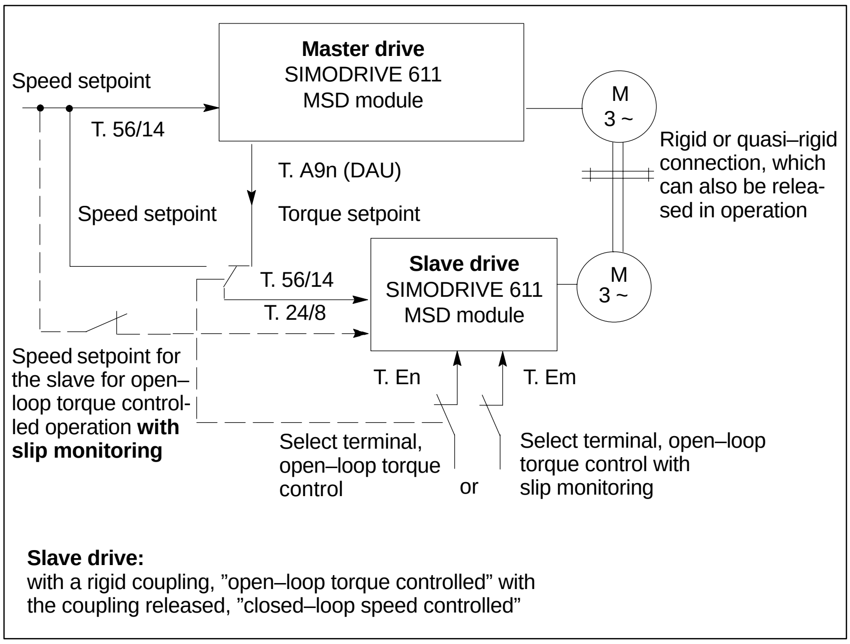

Fig. 9-25 Master/slave operation with an analog SIMODRIVE 611 system

Master drive:	Term. A9n:	Torque setpoint
Slave drive:	Term. En:	Open–loop torque controlled mode (function number 4)

The torque setpoint of the master drive is entered into the slave drive as torque setpoint (terminal 56/14) via a select analog output, terminal A9n.

Warning

If the mechanically rigid coupling is released, the slave drive must be simulta-neously changed over to ”closed–loop speed control”.

FD

Parallel operation (master/slave function, only user–friendly interface and standard interface, 2-axis operation, max. 5 slave axes connected to a master) Frequently, for parallel operation, a closed–loop speed controlled master drive is equipped with one or several subordinate closed–loop current controlled drive axes. The master drive outputs the current setpoint of the speed controller out-put in parallel to the current controllers of the slave axes. The feed modules are equipped with a master/slave function which can be activated.

Terminal 258 is used as the connection points. In the master axis, terminal 258 is used as current setpoint output; in the slave axes, terminal 258 is the current setpoint input.

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Note

For SIMODRIVE 611 digital and SIMODRIVE 611 universal, the master/slave operation is realized via a speed setpoint coupling —> also refer to the literature associated with the particular drives.

9.10 Star–delta operation

SIMODRIVE 611 main spindle modules support the operation of star/delta motors.

At low speeds, the drive is operated in the star circuit configuration (high torque) and at higher speeds in the delta circuit configuration (high stall torque). Changeover is also possible during operation.

The changeover speed from star to delta operation must lie within the stall power range for star operation (refer to the speed–torque diagram for Y/Δ operation).

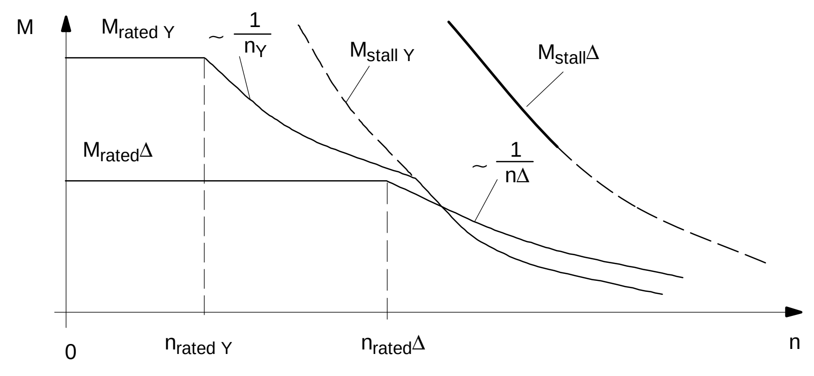

Fig. 9-26 Speed–torque diagram for Y/Δ operation

Warning

While changing over from Y to Δ operation torque may not be demanded from the 1PH motor. In this case, a minimum deadtime of 0.5 s must be taken into consideration for contactor changeover times, safety times, de–magnetization and magnetizing operations.

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Connection diagram for Y/Δ changeover 611 analog system

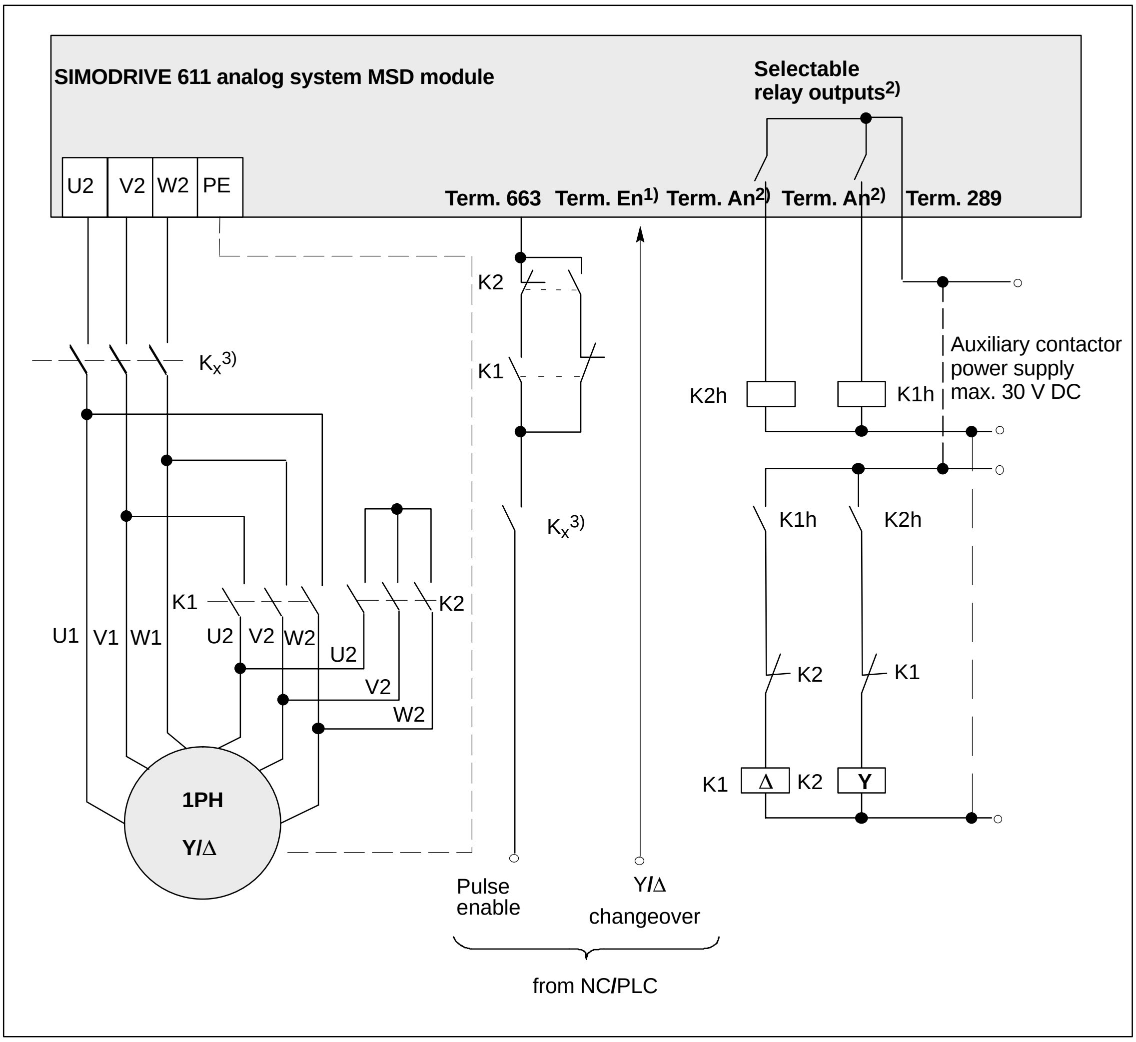

Fig. 9-27 Connection diagram for Y/Δ changeover SIMODRIVE 611 analog

1) One input terminal, which can be selected from terminals E1 to E9.

2) Two relay outputs which can be selected from terminals A11 to A61.

3) Safe standstill is not guaranteed by only opening K1 and K2.Thus, for safety–related reasons, electrical isolation must be provided by contactor K_x. This contactor may only be switched in the no–current condition, i.e. pulse enable must be withdrawn 40 ms before the contactor is opened (de–energized). Refer to Sections 9.4.2 and 9.7. Circuit example =10.

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Connection diagram for Y/Δ changeover 611 digital system

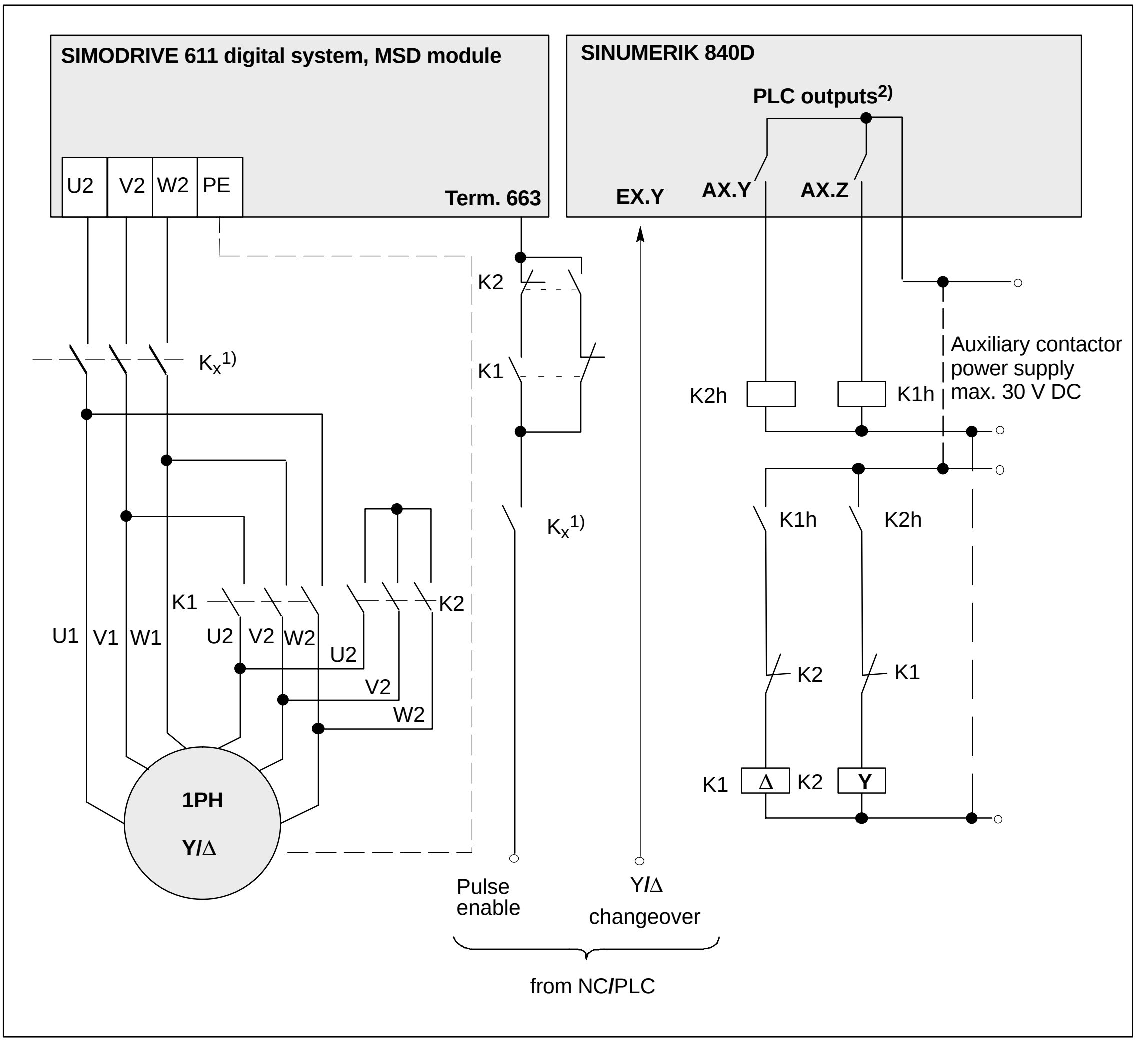

Fig. 9-28 Connection diagram for Y/Δ changeover SIMODRIVE 611 digital

1) Safe standstill is not guaranteed by only opening K1 and K2.Thus, for safety–related reasons, electrical isolation must be provided by contactor K_x. This contactor may only be switched in the no–current condition, i.e. pulse enable must be withdrawn 40 ms before the contactor is opened (de–energized). refer to Sections 9.4.2 and 9.7. Circuit example =10.

2) Two relay outputs can be selected from terminals AX.Y to AX.Z.

The connection diagram for Y/Δ changeover for the 611 universal system can be configured, based on the specified examples. For a description of the function, refer to the separate Planning Guide and documentation SIMODRIVE 611 universal.

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Dimensioning the contactors

The main contactors must be dimensioned according to the rated motor current and overload factor.

The following table showing the assignment of 1PM4/6 motors/main contactors and auxiliary contactors can be used to support configuring:

Table 9-2 Dimensioning the main contactors for 1PM motors

AC motor	Output [kW]	I_{rated} [A]	Recommended contactor type/K1/K2 duty category AC 1	Recommended auxiliary contactor type K1h, K2h
1PM4101–2LF8...	3.7	13.0	3RT1023	3RH11
1PM4105–2LF8...	7.5	23.0	3RT1025	3RH11
1PM4133–2LF8...	11	41.0	3RT1026	3RH11
1PM4137–2LF8...	18.5	56.0	3RT1035	3RH11
1PM6101–2LF8...	3.7	13.0	3RT1023	3RH11
1PM6105–2LF8...	7.5	23.0	3RT1025	3RH11
1PM6133–2LF8...	11	41.0	3RT1026	3RH11
1PM6137–2LF8...	18.5	56.0	3RT1035	3RH11
1PM6138–2LF8...	22	58.0	3RT1035	3RH11

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9.11 Induction motor operation 611A (611D/611U)

9.11.1 Several induction motors 611A operated in parallel

Several motors can be operated in parallel from an induction motor module. Several design guidelines must be observed when selecting the motor and module.

A maximum drive constellation for parallel operation can include up to eight motors. Motors connected in parallel to an induction motor module must have the same V/Hz characteristics. Further, it is recommended that motors should have the same pole number. If more than two motors are operated from a single module, then these motors should have, as far as possible, the same output.

For a two–motor constellation, the power differential between the motors may not exceed a ratio of 1:10.

The following design guidelines should be observed:

- Selecting the induction motor module rating
  - Steady–state operation of the motors connected in parallel essentially in the closed–loop controlled range (> n_{min}[1)]) and preferably in the rated speed range:

    Σ Rated motor currents $\leq$ Rated current of the induction motor module
  - Operation of motors connected in parallel with dynamic loading and in the open–loop controlled range require a higher rating:

    1,2 (Σ Rated motor currents) $\leq$ Rated current of the induction motor module
  - The current limit of the induction motor module is increased to 150% rated current for commissioning.
- The motors should not be loaded above rated torque.
- For high–speed induction motors (e.g. for woodworking), a series reactor must be connected between the induction motor module and the motor group:

  Rated reactor current: RMS current of the motor group[2)]

When taking into account the above information, load and speed steps applied to individual motors, are corrected. By applying the selection guidelines, a ”stable”, stall–proof operation of the individual motors can be achieved. The speeds of individual motors are load–
dependent. The actually selected speeds can drift apart by several percent due to the summed slip control.

1) Standard motor: 2pole → > 600 RPM
4pole → > 300 RPM
6pole → > 200 RPM
8pole → > 150 RPM

Special motors: $n_{min} > \frac{40\ V \cdot n_{rated}}{V_{rated\ motor}} > \frac{600\ RPM}{\text{Pole pair number}}$

2) Σ Rated motor currents or, when taking into account the load duty cycle, the total RMS currents of the motor group.

9

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Load surges and overload conditions in the field–weakening range can result in oscillations and should be avoided.

An induction motor module cannot identify if an individual motor is overloaded.

Individual thermal monitoring devices should be provided for overload protection of the individual motors. We recommend that the motor is monitored using a PTC thermistor evaluation circuit.

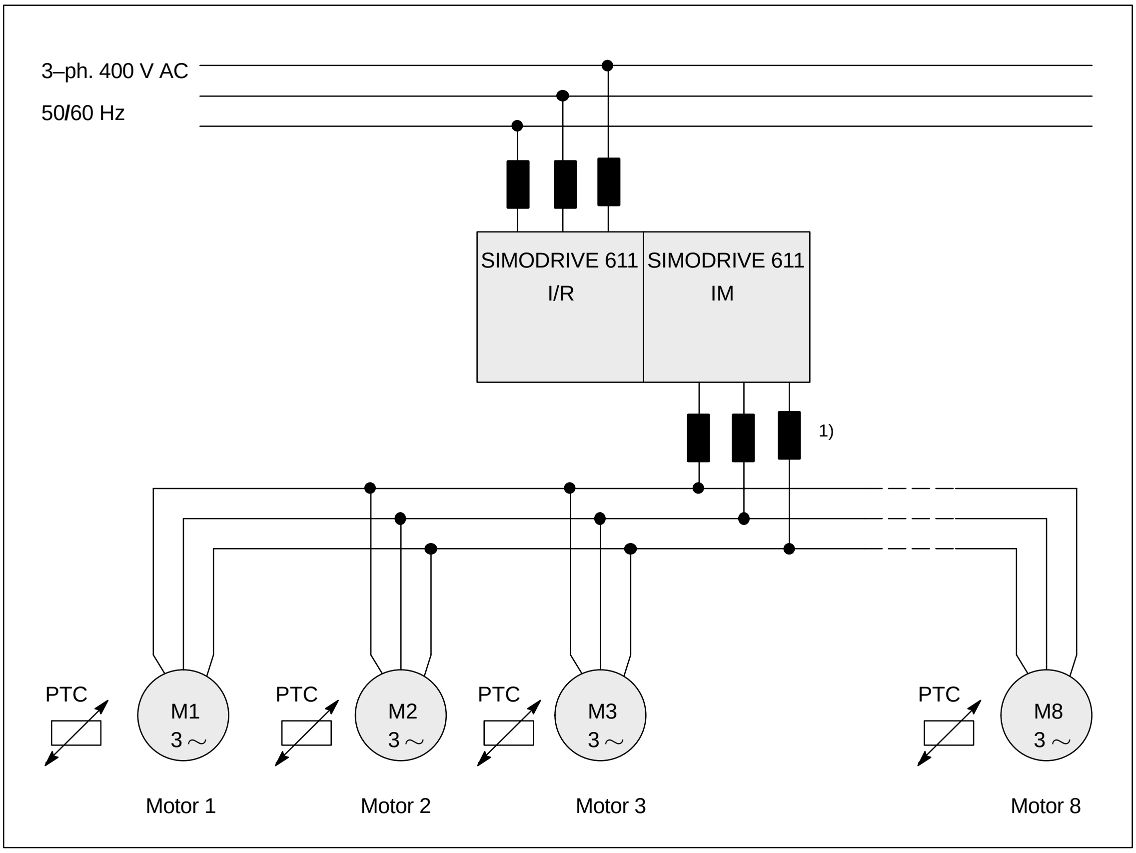

Fig. 9-29 Parallel motor configuration with a SIMODRIVE 611 induction motor module

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Notice

For parallel operation, all of the motors must always be simultaneously operated. When a motor is shutdown (e. g. due to a fault), the motor data set must be adapted (e. g. by using a motor changeover function).

When connecting motors in parallel, the cable protection for the motor cables must be implemented outside the drive converter.

1) Σ Rated motor currents or, when taking into account the load duty cycle, the total RMS currents of the motor group

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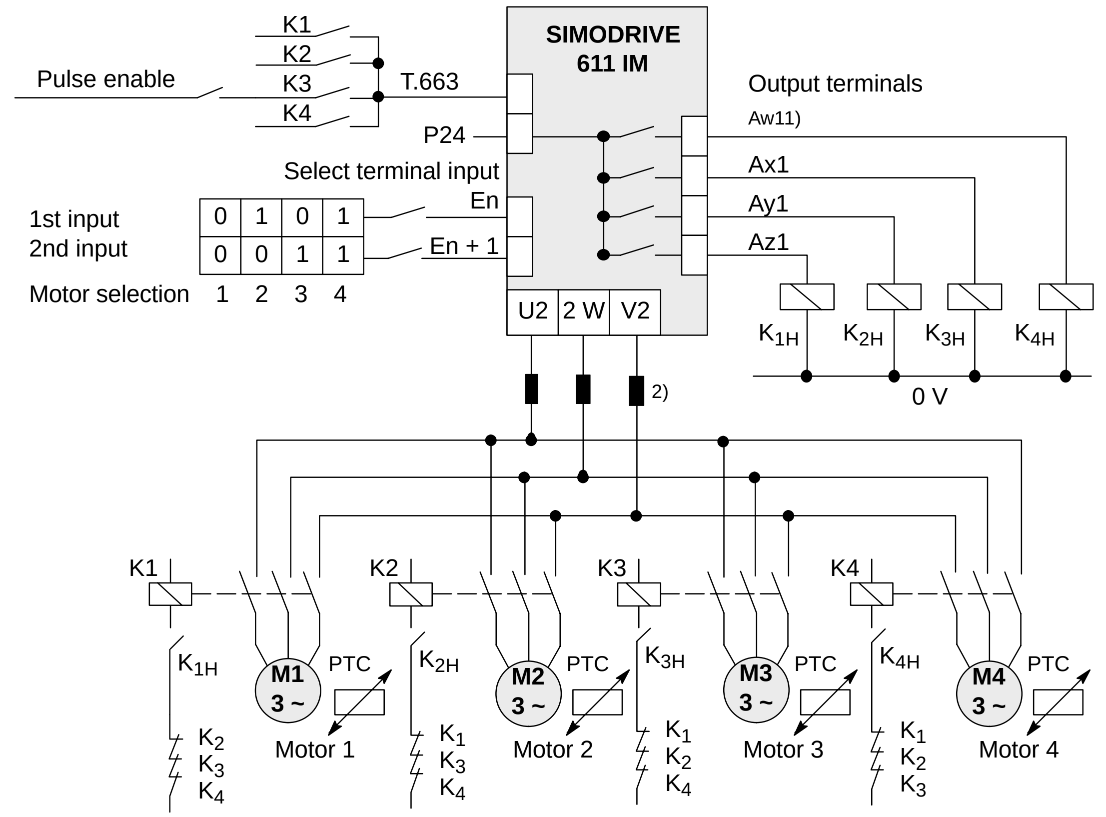
9.11.2 Motor changeover, individual induction motors 611 analog

The SIMODRIVE 611 IM module allows up to four different motors to be changed over. Each motor has a dedicated motor parameter set.



1) Several motors cannot be simultaneously controlled as this interlocked in the software. In addition, the recommended contactor interlocking ensures that only one motor can be operated.

2) Only required for high–speed special motors.

Fig. 9-30 Motor changeover at the SIMODRIVE 611 IM module

For motor changeover, an auxiliary contactor 3RH11 and a main contactor 3RT10 are required for each motor.

A binary–coded switching command is connected to select input terminals En/En + 1 (max. two terminals for four motors) to changeover a motor. The changeover command is only executed when the drive pulses are inhibited. In this case, one of the terminals 663, 65 or 81 (function: Pulse inhibit) must be opened. After the pulses have been inhibited, the active motor parameter set is loaded and the motor auxiliary contactors controlled via select relay.

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Induction motor operation for 611 digital/universal

Parallel operation of several induction motors and changeover of individual induction motors for SIMODRIVE 611 digital/SIMODRIVE 611 universal, refer to the separate configuring and documentation, SIMODRIVE 611 digital/ SIMODRIVE 611 universal.

Note

The 611 digital control module allows two different induction motors to be changed over via the motor parameter sets.

Overload protection

Individual thermal monitoring functions must be provided for overload protection of the individual induction motors. We recommended that PTC temperature sensors are used in the motor and the 3RN1 thermistor motor protection evaluation units.

If cable protection is required for the motor cables, for rated drive converter currents which are significantly higher than the rated motor current, then this must be implemented outside the drive converter.

Notice

Motors may only be changed over using the power contactors in the motor circuit when terminal 663, pulse enable/start inhibit is inhibited. i.e. the motor circuit must be in a no–current condition.

For an additional explanation, also refer to the circuit examples =10 in Section 9.7

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9.12 Operation at power failure

9.12.1 Application and mode of operation

The ”operation at power failure” function (power failure buffering) is used, e.g. for machines where personnel can be in danger or significant material damage could occur at power failure or for internal control fault messages as a result of collision hazard during machining. Furthermore, the function is used for machines performing complex machining operations, e.g. when machining gear wheels (hobbing, roller grinding) with expensive tools and workpieces which should, as far as possible, be protected against damage when line supply faults occur.

For operation at power failure, shutdown and/or retracting drive movements, the energy, saved in the power DC link capacitors and kinetic energy of the moved masses when the drives regenerate can be used. In this case, a connection must be established from the P600/M600 power DC link to the auxiliary power supply via the P500/M500 terminals in the NE module or monitoring module, refer to Fig. 9-31.

Beyond this, additional circuit measures are required, for example, buffering the +24V control voltage and a power failure and/or DC link monitoring to initiate the appropriate control functions.

The machinery manufacturer must evaluate these risks and requirements using a hazard analysis and apply appropriate measures to prevent such hazards or damage from occurring.

The requirements placed on power failure concepts differ widely depending on the particular user and machines and must therefore be individually configured.

9.12.2 Functions

The ability to quickly detect a line supply fault is an essential criterion when implementing power failure concepts (power failure, line supply undervoltage or phase failure).

When a line supply fault occurs, the DC link voltage quickly collapses due to the energy drawn by the drives and the connected power supplies for the drive and control components. The discharge characteristic depends on the ratio between the stored DC link capacitance in the power circuit and the power drawn (load duty cycle) of the drive at the instant that the line supply fault occurs.

For operation at power failure, regenerative feedback of one or several drives into the DC link must become effective before the DC link voltage drops from the rated voltage, e.g. 600 V DC to 350 V DC. At approx. 350 V, the impulses are inhibited in the drive group and the drives coast down.

The 600 V DC link voltage is proportionally simulated at the control level and can be evaluated in the 611 digital and 611 universal control modules via the equipment bus. The DC link voltage can be monitored, with a fast response, using parameterizable limit value stages so that indirectly the system can immediately respond to a line supply voltage.

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The ready signal via terminals 72–74 in the NE module also responds when a line supply fault develops and inhibits the pulses in the NE module. The response time is, among other things, dependent on the line impedances and other quantities and therefore cannot be precisely calculated. Generally, the line supply failure detection time is >30ms and is therefore not sufficient to initiate functions for operation when the power fails.

Operation at power failure with the SIMODRIVE 611 universal drive

Example:

The DC link voltage is monitored in the SIMODRIVE 611 universal group via the limit value stage of a 611 universal control module. When a selectable limit value is fallen below, e.g. 550 V DC link voltage, the limit value stage responds and switches a positive output signal from +24 V to 0 V via a digital output stage. For example, terminal 64, drive enable, can be inhibited in an "and" logic operation with the relay contact of the ready signal of terminals 72–73.1 of the NE module. The drives are braked and stopped as quickly as possible along the current limit.

In addition, e.g. via a second digital output of the 611 universal module, the setpoint polarity of a drive can be changed over and the drive retracted before the other drives are then braked, delayed using terminal 64.

The safety–related circuit examples in Section 9.7 for the open–loop drive control must be appropriately adapted on the user–side for operation at power failure.

Additional possibilities of braking when the power fails:

Braking via the armature short–circuit braking for permanent–magnet servo motors, refer to the circuit example =9 in Section 9.7.

Note

The power failure monitoring device must directly disconnect the coil circuit of the armature short–circuit contactor, as a buffered +24 V power supply either responds too late or not at all.

Braking by quickly applying the holding brake, bypassing the PLC cycle time, refer to circuit example =9 in Section 9.7.

Note

The holding brake is not an operating brake and can therefore only be used for such braking operations to a limit extend.

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Operation at power failure with SIMODRIVE 611 digital in conjunction with SINUMERIK 840D and 840C:

Extended shutdown and retraction: ESR

These more complex functions can be used in conjunction with the optional software NC functions in SINUMERIK 840D and 840 C and the digital drives 611D with performance controls.

For certain machining technologies, where several drives are used, e.g. interpolating through electronic gear functions, when power fails, these must be shut down or retracted in a coordinated fashion using special NC functions.

These functions must be configured by the user for the special requirements of the machining technology.

In this case, the DC link voltage is monitored against a parameterizable lower threshold value. If a limit value, which can be adjusted using a machine data, is fallen below, the NC quickly responds, within a few interpolation cycles via the digital bus to shut down the drives in a controlled fashion and/or raise, retract the tools from the machining contour.

Beyond this, e.g. if communications between the NC and drives is interrupted, for a sign–of–life failure of the NC or other selectable fault messages in the drive system, the drives can be shut down/retracted, independent of the actual drive function.

At power failure, the energy required to shut down/retract the drives must be provided from the energy stored in the power DC link capacitors.

If the energy is not sufficient, the DC link capacitance can be increased using additional capacitor modules, refer to Section 6. In this case, it is not permissible that the charge limit of the I/R module is exceeded.

For situations, where the energy in the DC link is still not sufficient to shut down/attract the drives, additional energy storage can be activated using regenerative operation. This provides the necessary energy for the drive DC link as an autonomous drive operating mode when line supply faults occur.

The detailed description ”extended shutdown and retraction” –ESR– is included in the SINUMERIK 840D and 840C documentation, in the sections:

- 840D: Function description, special functions ”axis couplings and ESR”.
- 840C: Start–up Guide 840C “ESR”

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When configuring/engineering line supply failure concepts, the following control and secondary conditions should be taken into account:

- The braking energy must be converted into heat using one or several pulsed–resistor module(s) or for uncontrolled rectifier units, using the internal pulsed resistor (an external resistor may be additionally required). When the drives brake, it is not permissible that the DC link voltage violates the max. set monitoring thresholds.
- At power failure, the safety–related hardware control must briefly maintain, e.g. the enable signals via terminals 48, 63, 64, NS1, NS2 and 663. Furthermore, the internal, axis–specific enable signals of the NC/PLC interface must also be kept until the drives come to a standstill via the digital drive bus.
- For controlled retraction movements, if required, until the operation has been completed, holding brakes must remain energized and mechanical clamps must released.
- The external +24 V power supply for the control voltage must be buffered, using power supply units, e.g. SITOP power with capacitor or battery back–up in order to maintain the drive enable signals, the PLC functions and the open–loop control and machine functions on the user side.
- During the braking and retraction phases, it is not permissible that the NC and PLC controls generate fault/error signals which inhibit the drives.
- The power supply of the SINUMERIK 840 D with integrated PLC–CPU is supplied through the NE module DC link when the line supply fails. The SINUMERIK 840C power supply with 115–230V AC or 24V DC must be separately buffered.

Information on the subsequent circuit example, Fig. 9-31

Terminals P500,M500 for the auxiliary power supply in the NE module and monitoring module must be connected to the power DC link P600,M600 using short–circuit proof cables, which are twisted and shielded in compliance with EMC Guidelines. The cable shields should be connected to the mounting panel at both ends through the largest possible surface area.

Cross–section: 1.5 mm^2 , max. cable length: 3 m.

Notice

In order to safely and electrically isolate the DC link from the line supply, when the line contactor is opened or when changing over to the setting–up mode, the connection P600,M600 to terminals P500,M500 must be reliably and safely disconnected, e.g. via the power contacts of contactor –K1, also refer to Section 9.2.4.

This is also valid for the connection to terminals P500,M500 when using monitoring modules.

Contactor –K1 must be safely de–energized via the drive EMERGENCY STOP, OFF functions together with the power–off function of the internal line contactor in the NE module or when changing over the operating mode to setting–up.

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In addition to the main contacts, positively–driven auxiliary contacts (NC contacts) of contactor –K1 must be incorporated, in a safety–related fashion, into the drive control as follows:

An NC contact must incorporated in the feedback circuit of the safety combination to control the line contactor; a second NC contact must be incorporated in the feedback circuit of the safety combination for the enable function in the setting–up mode or, alternatively the enable circuit for the setting–up mode.
The NO contact can be processed in the PLC for the contactor energized signal.

Notice

If the power supply is supplied through P500/M500 at connector X181, it is not permissible to use a six conductor connection, electronic power supply connection via terminals 2U1, 2V1, 2W1 in front of the HF commutating reactor, refer to Section 9.13.

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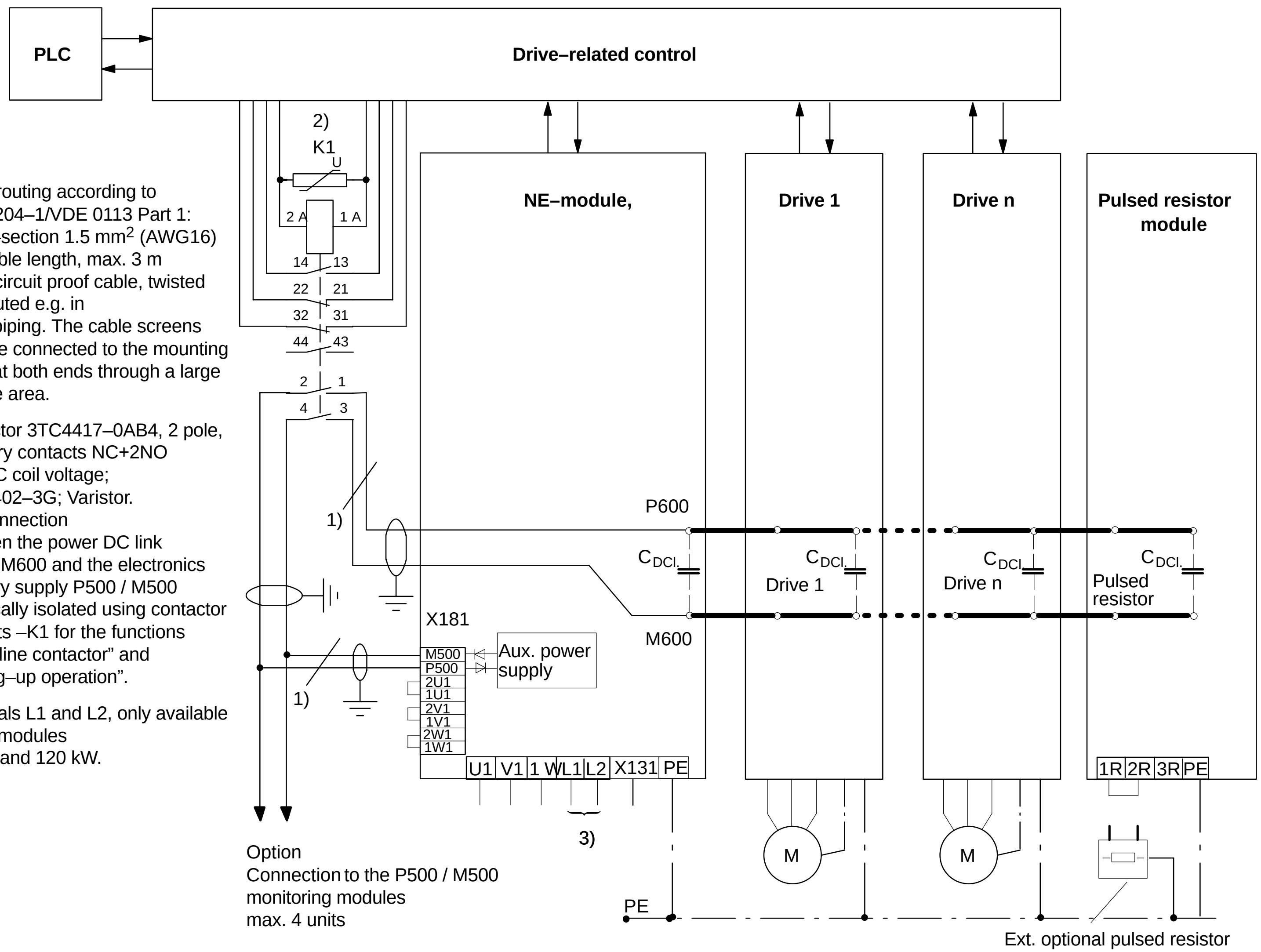

1. Cable routing according to EN 60204–1/VDE 0113 Part 1: Cross–section 1.5 mm^2 (AWG16) and cable length, max. 3 m short–circuit proof cable, twisted and routed e.g. in metal piping. The cable screens must be connected to the mounting panel at both ends through a large surface area.
2. Contactor 3TC4417–0AB4, 2 pole, Auxiliary contacts NC+2NO 24 VDC coil voltage; 3TX 7402–3G; Varistor. The connection between the power DC link P600 / M600 and the electronics auxiliary supply P500 / M500 electrically isolated using contactor contacts –K1 for the functions “Open line contactor” and “Setting–up operation”.
3. Terminals L1 and L2, only available for I/R modules 80 kW and 120 kW.

Fig. 9-31 Circuit example: Operation at power failure

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9.12.3 DC link buffering

The energy, available in the DC link of the drive units is calculated as follows at power failure:

$E = 1/2 * C * (V_{DC\ link}^2 – V_{min}^2)$

In this case,
E= energy in Watt seconds [Ws]
C= total capacitance of the DC link in Farad [F]
$V_{DC\ link}$= DC link voltage (response limit, line supply failure)
V_{min}= lower limit for safe reliable operation
(taking into account the motor–specific EMF, in any case, above the switch–off threshold of e.g.350V)

Example:
For
C= 6000μF (refer to Table 9-3, 1. line) – 20% = 4800 μF
$V_{DC\ link}$= 550V
V_{min}= 350V
is obtained as follows:

$E = 1/2 * 4800\mu F *((550V)^2 – (350V)^2) = 432Ws$

This energy, under load conditions is available for a time of

$t_{min} = E / P_{max} * \eta$

in order to initiate emergency retraction.

In this case,
t_{min} = buffer time in milliseconds [ms]
P_{max} = power in Kilowatt [kW]
η = efficiency of the drive unit

For the example above, with:
E = 432Ws
P_{max} = 16kW (refer to Table 9-3, 1. line)
η = 0.90
is obtained as follows:

$t_{min} = 432Ws / 16kW * 0.9 = 24.3ms$

as minimum achievable buffer duration for emergency retraction.

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The values for various I/R units are summarized in the following table. In this case, nominal and minimum capacitances are taken into account. The maximum possible capacitance (charge limits) comprises the sum of the capacitance of the I/R module and the axis/spindle modules and external supplementary capacitors (to be provided by the user).The minimum capacitance, used in table, takes into account a component tolerance of –20% (worst case)

Table 9-3 Nominal and minimum buffer times as a function of various I/R units

Power P_{max} of the I/R unit [kW]	Max. possible capacitance C_{max} [µF]	Energy contents (C_{max}) [Ws]	Energy contents (C_{min}) [Ws]	Buffer time t_n at P_{max} [ms]	Buffer time t_{min} at P_{max} [ms]
16	6000	540	432	30.38	24.30
36	20000	1800	1440	45.00	36.00
55	20000	1800	1440	29.46	23.56
80	20000	1800	1440	20.25	16.20
120	20000	1800	1440	13.50	10.80

Energy flow

When engineering emergency retraction, the energy must always be investigated in order to evaluate whether additional capacitor modules or a generator axis/spindle is required or not (with approximately dimensioned inertia).

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9.13 Special applications

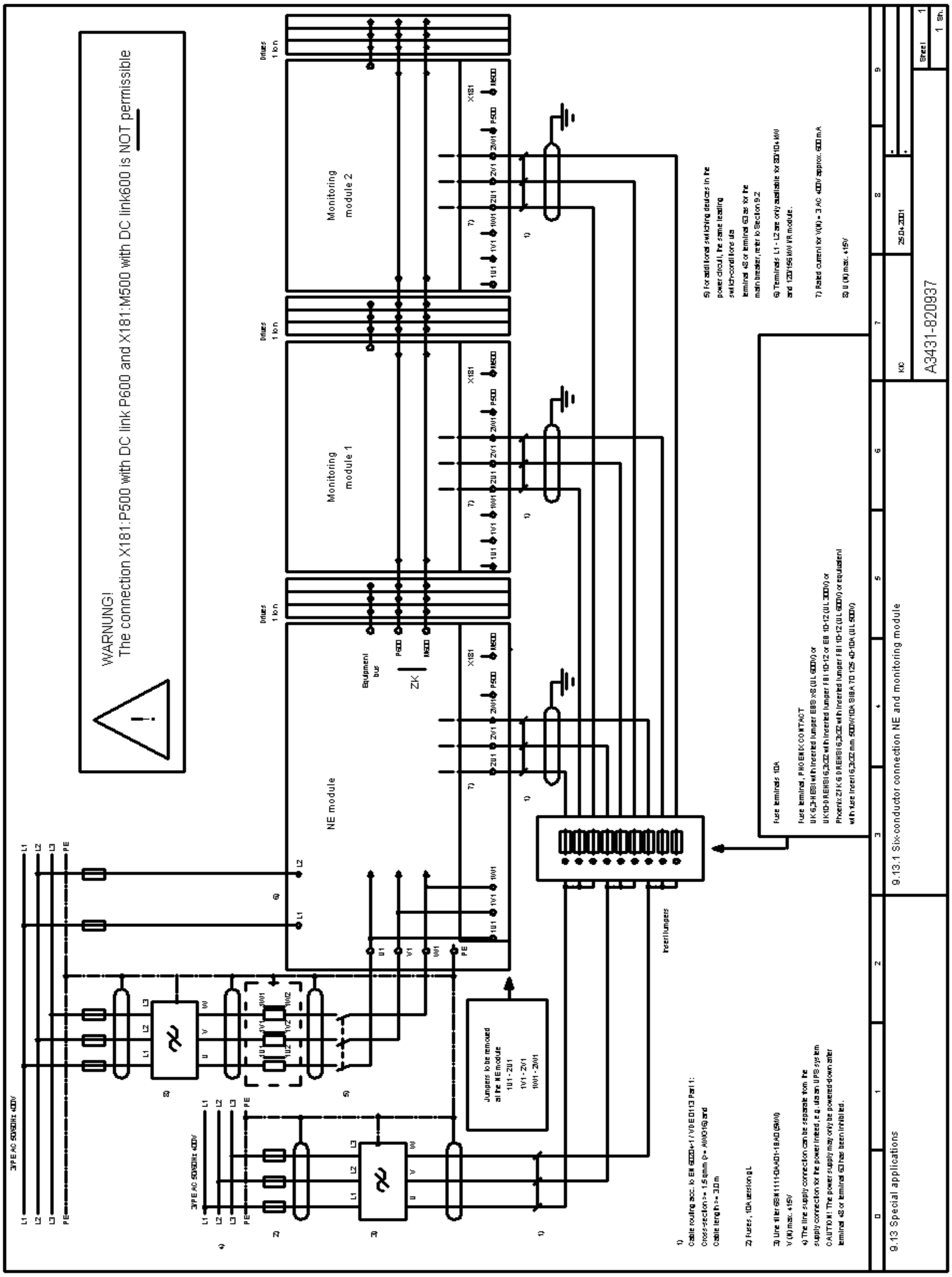

Fig. 9-32 Six–conductor connection NE and monitoring module

9.14 SINUMERIK Safety Integrated

General information

”SINUMERIK Safety Integrated**”** offers type–tested safety functions which can be used to implement highly effective personnel and machinery protection in–line with that required in practice.

All of the safety functions fulfill the requirements of safety Category 3 according to EN 954–1 and are a fixed component of the basic system.

Neither additional sensors nor evaluation devices are required, i.e. less installation costs at the machine and a favorably–priced cabinet

The following are included in the scope of supply, e.g.:

- Safe monitoring of velocity and standstill
- Safe traversing range limiting and range identification

Direct connection of two–channel peripheral signals

With the additional, integrated functions in the safety package ”Safety Integrated” for SINUMERIK 840D/611D, for the first time, it is possible to directly connect two–channel peripheral (I/O signals). For example, an Emergency Stop pushbutton or light barriers. The logical interlocking and response is realized internally using safety–related technology.

Professionally master extreme situations

All safety–relevant faults in the system result in the hazardous motion being safely stopped or the energy being disconnected to the motor contactlessly. The drives are always stopped, optimally adapted to the operating status of the machine. This means, for example, in the setting–up mode, with the protective door open, motion can be stopped as quickly as possible and in the automatic mode with closed protective door, the machine can be shut down path–related.

This means: A high degree of personnel protection in the setting–up mode and additional protection for the machine, tool and workpiece in the automatic mode.

Safety concept with a high degree of effectivity

These safety functions offer intelligent system access directly down to the electric drives and measuring systems, to a level which was previously unknown. Reliable function, fast response, and a wide degree of acceptance make these certified safety concepts extremely effective.

Safety functions redundantly integrated

A two–channel, diverse system structure is formed using the multi–processor structure. The safety functions are redundantly integrated into the NC, drive and internal PLC. A special feature of this safety concept is that already with a measuring system – the standard motor measuring system – safety category 3 according to EN 954–1 (SIL2 in accordance with IEC 61508) can be implemented. A second measuring encoder is not required, however, can be integrated as additional, direct measuring system (e.g. linear scale).

Innovative safety technology – on the way to a new standard

It has been clearly shown, that this innovative safety technology can be used to implement new machine operator concepts in–line with those required in practice. This results in a new standard for machines which enhances their safety and flexibility in use and also increases the plant or system availability.

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Safety Integrated literature

The detailed description of SINUMERIK Safety Integrated can be taken from the following documentation:

- SINUMERIK 840 D Safety Integrated
  Description of functions: 6FC5297–5AB80–0.P1
- SINUMERIK 840 C Safety Integrated
  Description of functions: 6FC5297–0AC50–0.P0
- Safety Integrated: The safety program for the Industrial World
  Application Manual: E20001–A110–M103

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Cabinet Design and EMC

10

10.1 Installation and connection regulations

Warning

The filters become extremely hot in the vicinity of the internal line supply resistors. If other components are mounted above a filter module (clearance < 400 mm) then a heat barrier can be mounted which deflects the heat away from these components. The mounting position must guarantee that the cooling air flows vertically through the filter.

Caution

Ensure that the line filter is correctly connected to the line supply in accordance with the regulations:

LINE L1, L2, L3 for line filters for the UI module and I/R module for sinusoidal current operation.

If this is not observed, the line filter could be damaged. Also refer to the connection diagrams 10-1.

10

Caution

The listed line filters conduct a high leakage current through the protective conductor. A permanent PE connection of the line filter and the cabinet is required as a result of the high leakage current of the filter.

Measures in accordance with EN 50178/94 Part 5.3.2.1 must be applied, e.g. protective conductor ($\geq$ 10 mm^2 Cu) or a second conductor must be routed in parallel to the protective conductor through separate terminals. This conductor must fulfill the requirements for protective conductors according to IEC 364–5–543 itself.

General information

The ”EMC Guidelines for SINUMERIK and SIROTEC controls” (Order No.: 6FC5297–0AD30–0AP1) should be observed, refer to the documentation overview on the first cover page.

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Applications

The line filters described are designed to provide noise suppression for SIMODRIVE 611 drive converters; they are not designed to provide noise suppression for other loads in the cabinet. A dedicated filter must be provided for other loads in the cabinet.

If the electronics power supply is connected to a separate line supply, then the feeder cable must be connected through a second filter. The feeder to the electronics power supply (connector X181) must be screened and the screen must be connected at both ends, at the connector side, as close as possible to connector X181, and at the cabinet mounting panel.

The fan units must also be connected to the line supply through a second filter.

Cabinet mounting

For high frequency noise currents, the housing of the drive converter and line filter must be connected in a low–ohmic fashion to the cabinet rear panel. The cabinet rear panel, must, in turn, be connected through a low–ohmic connection to the motors/machine. The optimum solution is to mount the modules on a common bare metal mounting panel so that there is an electrical connection through the largest possible surface. This mounting panel must then be connected to the motor/machine, also through the largest possible surface area so that a good electrical connection is established. Painted cabinet panels as well as mounting rails or other similar installation equipment with small mounting surfaces do not fulfill this requirement.

The line filters must arranged close to the NE modules (not at the cabinet entry, but directly next to the NE module). The shielded connecting cable between the line filter and the NE module should be as short as possible. The incoming cables to the line filter should be separately routed from one another.

Recommended design, refer to Fig. 10-1.

Cable routing

Power and signal cables must always be routed separately from one another. In this case, the power cables from the converter module should be routed away towards the bottom and the encoder cable towards the top in order to achieve the largest possible separation.

All of the control cables connected to the function terminals, e. g. terminals 663, 63, 48 etc. should be grouped together and routed away towards the top. Individual cores which are associated with the same signal should be twisted. The function cable assembly is best routed away from the encoder cable assembly. Clearance between the cable assemblies $\geq$ 200 mm (separate cable ducts).

All cables and conductors inside the cabinet should be routed as close as possible to the cabinet panels as loose random wiring can result in noise being coupled–in (antenna effect). Fault sources in the vicinity should be avoided (contactors, transformers etc.) and if required, a shield should be located between the cable and noise source.

Cables and conductors should not be extended or lengthened through terminals.

To protect the equipment from noise being coupled–in from external noise sources on the filter cable, screened cables must be used up to where the cable is connected to the cabinet terminals.

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Power cables

Screened cables must be used for all of the motor– and line supply feeder cables. A covered metal cable duct which is connected through the largest possible surface area, can alternatively be used. In both cases, it should be ensured that the shield/cable duct are connected through the largest possible surface area to the appropriate components (converter module, motor).

Note

If the system is subject to a high–voltage test using an AC voltage, a line filter must be disconnected in order to achieve a correct test result.

Connecting the cable shield

All of the cable shields must be connected as close as possible to the particular terminal point through the largest possible surface area; for components which do not have a special shield connection, e.g. using the appropriate clamps or serrated rail on the bare cabinet mounting panel. The length of the cable between the screen connection point and the terminal must be kept as short as possible.

Screen connecting plates are available on the NE– and power modules to connect the screens of screened power cables. These connecting plates have clamp connections and mounting points for brake terminals (Order No., refer to Table 10-1. Also refer to the dimension drawing "EMC measures" Section 13).

Table 10-1 Order numbers for the shield connecting plates

Module width [mm]	Shield connecting plate for modules with	
	internal cooling 6SN1162–0EA00	external cooling 6SN1162–0EB00
50	–0AA0	–0AA0
100	–0BA0	–0BA0
150	–0CA0	–0CA0
200	–0JA0	–0JA0
300	–0DA0	–0DA0
300 for fan/pipe	–0KA0	————

If the motor is equipped with a brake, then the screen of the brake feeder cable must be connected at both ends with the screen of the power cable.

If there is no way of connecting the shield at the motor side, then a gland must be provided in the terminal box which allows the shield to be connected through the largest possible surface area (e. g. UNI IRIS DICHT U71.Pg from the PFLITSCH company).

Warning

Cable shields and unused cores in power cables (e. g. braking conductors) must be connected to PE potential in order to discharge capacitive cross–coupling charge effects.

If this is not observed, lethal contact voltages can occur, i.e. the voltages could cause serious injury or death.

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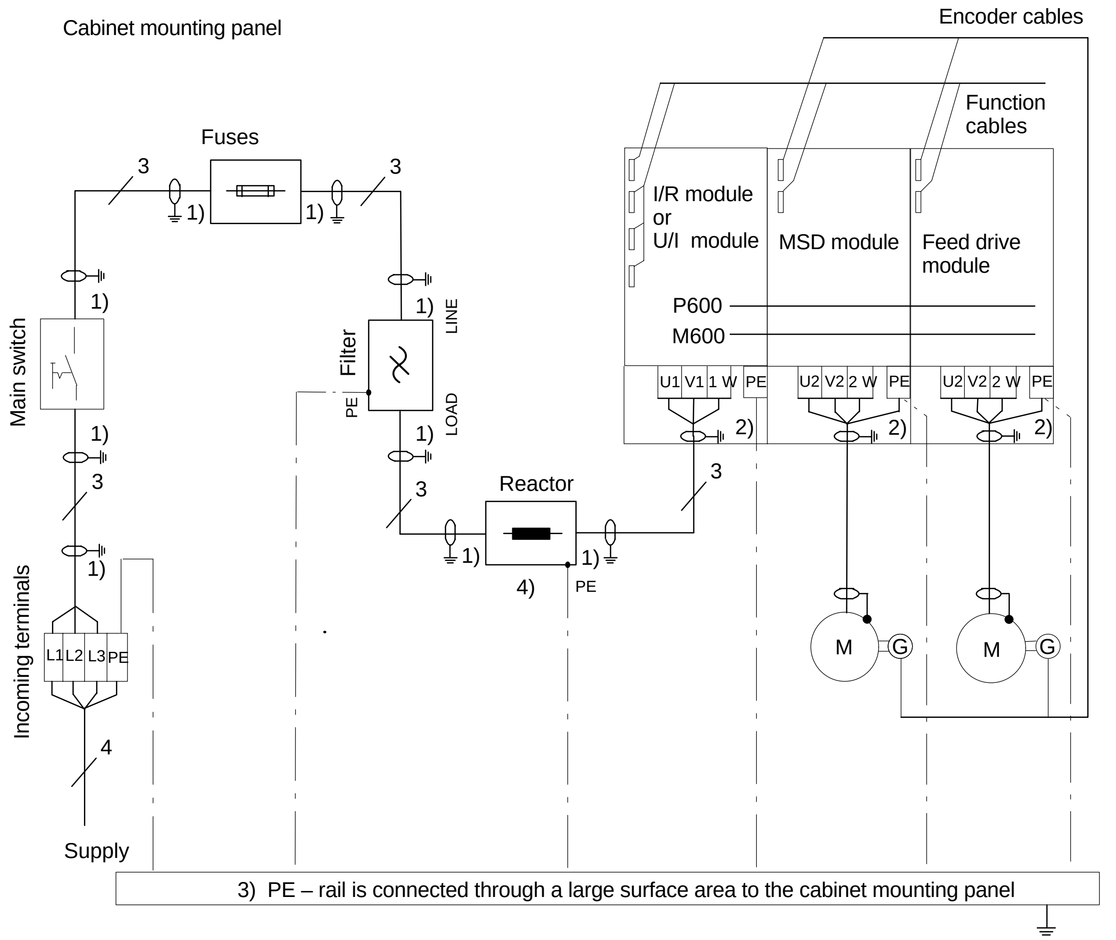

1) Shield connection, connected through the largest possible surface area with the cabinet mounting panel.
2) Shield connection at the module–specific connecting panel
3) The PE cables can be alternatively connected via PE rail, taking into consideration EN50178 (protective connections).
4) Refer to Sections 3.4.2 and 3.1 for permissible commutating reactors for I/R module sinusoidal operation
Refer to Section 3.4.2 for permissible commutating reactors for the 28 kW UI module
A clearance of > 100mm around the HF reactor must be provided at the cable entry into the cabinet.

Fig. 10-1 Connection diagram for line filters for 5 kW and 10 kW UI modules, for I/R modules, 16 kW to 120 kW. The connection diagram is also valid for UE 28 kW, however, as a result of the uncontrolled infeed, 6–pulse squarewave current is present

10.1.1 Shield connecting plates

Shield connecting plates, which can be retrofitted, are available for the infeed modules and power modules. Mounting points are available on these plates to attach terminals to connect a brake.

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10.1.2 Internal cooling

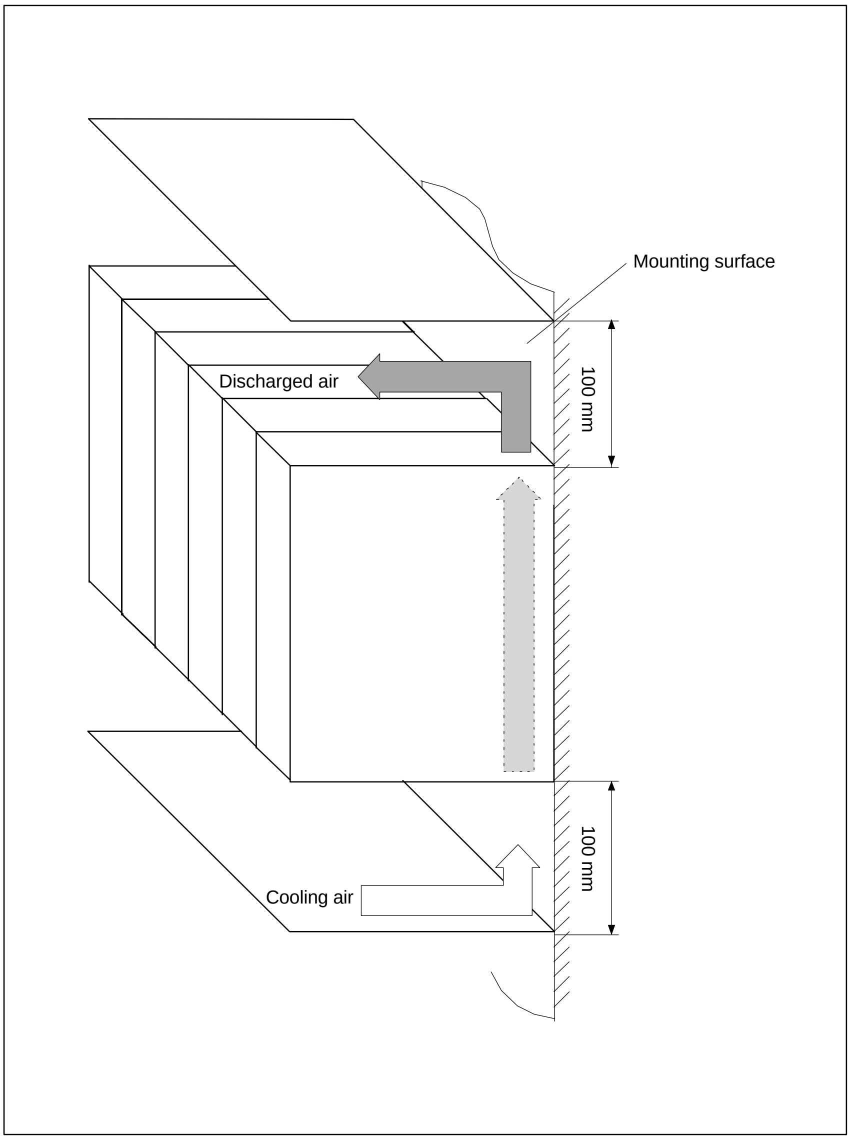

Fig. 10-2 Air flow in the cabinet

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10.1.3 Two–tier unit arrangement

If space is restricted, the SIMODRIVE 611 drive converter system modules can be arranged in two tiers one above the other.

The distance between the tiers may not be less than 200 mm. The maximum clearance is obtained depending on the arrangement as a result of the equipment bus cable.

When arranging the wiring ducts which may be required for the wiring, it should be ensured that the necessary minimum clearance to the SIMODRIVE 611 drive converter system is not fallen below.

Larger modules and the infeed module must be located in the upper tier.

For a two–tier arrangement for the SIMODRIVE 611 drive converter system, a connecting cable is required for the equipment bus. For the digital SIMODRIVE 611 drive group, in addition, a connecting cable is required for the drive bus.

For two–tier arrangements, a parallel cable should be used to connect the DC link (max. length 5 m). For subsequently connected modules, 300 mm wide, the copper conductor cross–section must be 70 mm^2 and for smaller modules, 50 mm^2 . The cable must be routed so that it is short–circuit proof and ground fault proof. A potential bonding conductor having the same cross–section must be used and connected to the housing of the two modules which are connected. The three conductors should be bundled. DC link adapter terminals are available to connect the DC link.

The maximum expansion of a drive group is limited by the rating of the infeed module. Only one equipment bus extension is permissible: Either to the left, e.g. for a second tier or to the right, e.g. to bypass a cabinet panel.

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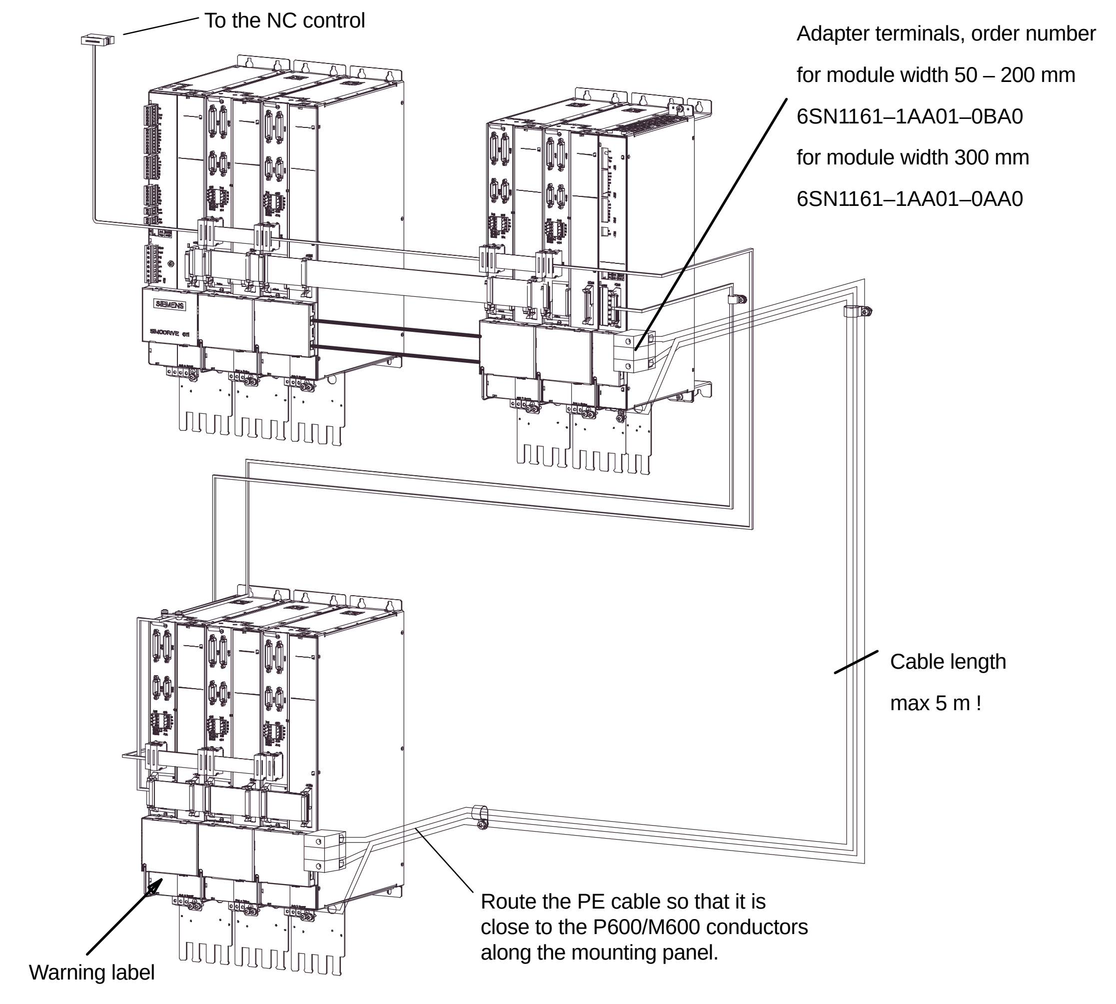

Fig. 10-3 Connection example, for a two–tier arrangement

Data on the system arrangement

1. The continuous bus cable for a drive group at an input module or monitoring module may be a max. of 2.1 m (from the supply point).
   (from the supply point)
   For two–tier arrangements, two equipment bus branches, each max. 2.1 m long can be used from the branch point at the supply point.
2. The drive bus may be a max. of 11 m.
3. Equipment bus extension, 1500 mm.

Note

Refer to the dimension drawing for connection details of the DC link adapter set

For multi–tier arrangements, a warning label must attached to the first module of each tier referring to the DC link voltage. The warning information is supplied on a sheet with the line supply infeed.

10

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10.1.4 Wiring

All of the power cables, such as the line supply feeder cable, must be shielded. The shields must be connected to ground through the largest possible surface area.

The mounting surfaces for the line supply infeed and drive modules as well as the commutating reactors and line filter must be mounted on mounting panels with a good conducting surface (e.g. galvanized mounting panels).

10.2 EMC measures

Screen connection cables

The screens of pre–assembled original manufacturer's cables are automatically connected when the connector is inserted.
Exceptions:

– Setpoint cable from an analog NC
In this case, the shields of the setpoint pairs must be connected to the upper side of the module. The threaded holes can be used for this purpose. (M5x10/3 Nm).

– SINUMERIK 840C drive bus cable
Here, the shield is connected to the above mentioned threaded socket using the clamp provided

– Drive bus– and equipment bus extensions for two–tier designs.
In this case, the screens at each end of the cable must be connected to the above mentioned threaded holes using the clamps provided.

– Motor power cables
The screens of the motor power cables are connected to the screen connecting plates (accessories) of the modules using the clamp connectors provided.

Additional measures, refer to Section 7.2.1

Connecting up the shield to the front panel

In order to ensure a good connection between the front panel and the housing, the front panel screws must be tightened up to 0.8 Nm.

Connection, electronics ground

Terminal X131 (electronics ground) at the NC.

Protection against overvoltages

A varistor module Order No.: 6SN1111–0AB00–0AA0 can be inserted at connector X181 at the NE module to protect against overvoltage conditions (line supplies which are not in compliance with VDE (this measure is not required for UI 5 kW and monitoring module).

Additional measures

Note

All of the measures described here are only valid for supply networks which are not compatible with VDE. In normal industrial supply networks, it is guaranteed, without having to use other measures that the disturbance and noise values remain below the permissible limits, thus ensuring disturbance–free operation

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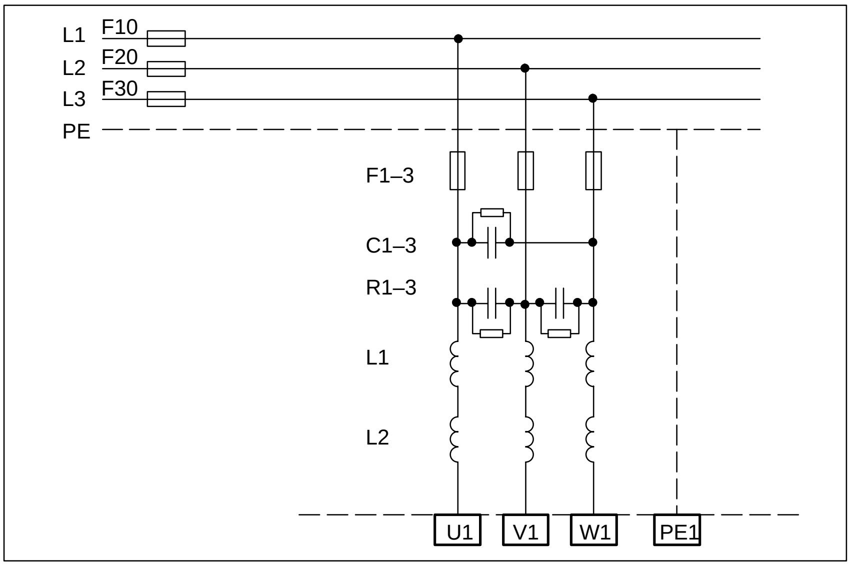

Fig. 10-4 Additional EMC measures

The drive converters are designed for operation on industrial line supplies in accordance with
EN 50178. In this case, it is assumed that the ratio between PN**/**PK is 1**/**100. Under this condition, the series reactor limits the line supply dips, caused by the general converter operating principle, to permissible values, which allows other loads, which are suitable for industrial applications, to be used on the same line supply network.

For unfavorable line supply and grounding characteristics at the location where the unit is installed, under exceptional cases, cable–borne noise and disturbances can occur, which are the result of an excessively high line supply reactance. Line filters should be used in cases such as these (they can be used for line supply voltages up to 415 V).

10

Note

We recommend that the pre–assembled cables are used, as perfect screening is required for an optimum EMC connection.

Further, for optimum signal transfer appropriate cable parameters are required. A guarantee for the correction functioning is only given when the original manufacturers cables are used.

Reference: /EMC/ EMC Design Guideline
SINUMERIK, SIROTEC, SIMODRIVE

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11 Block Diagrams

11

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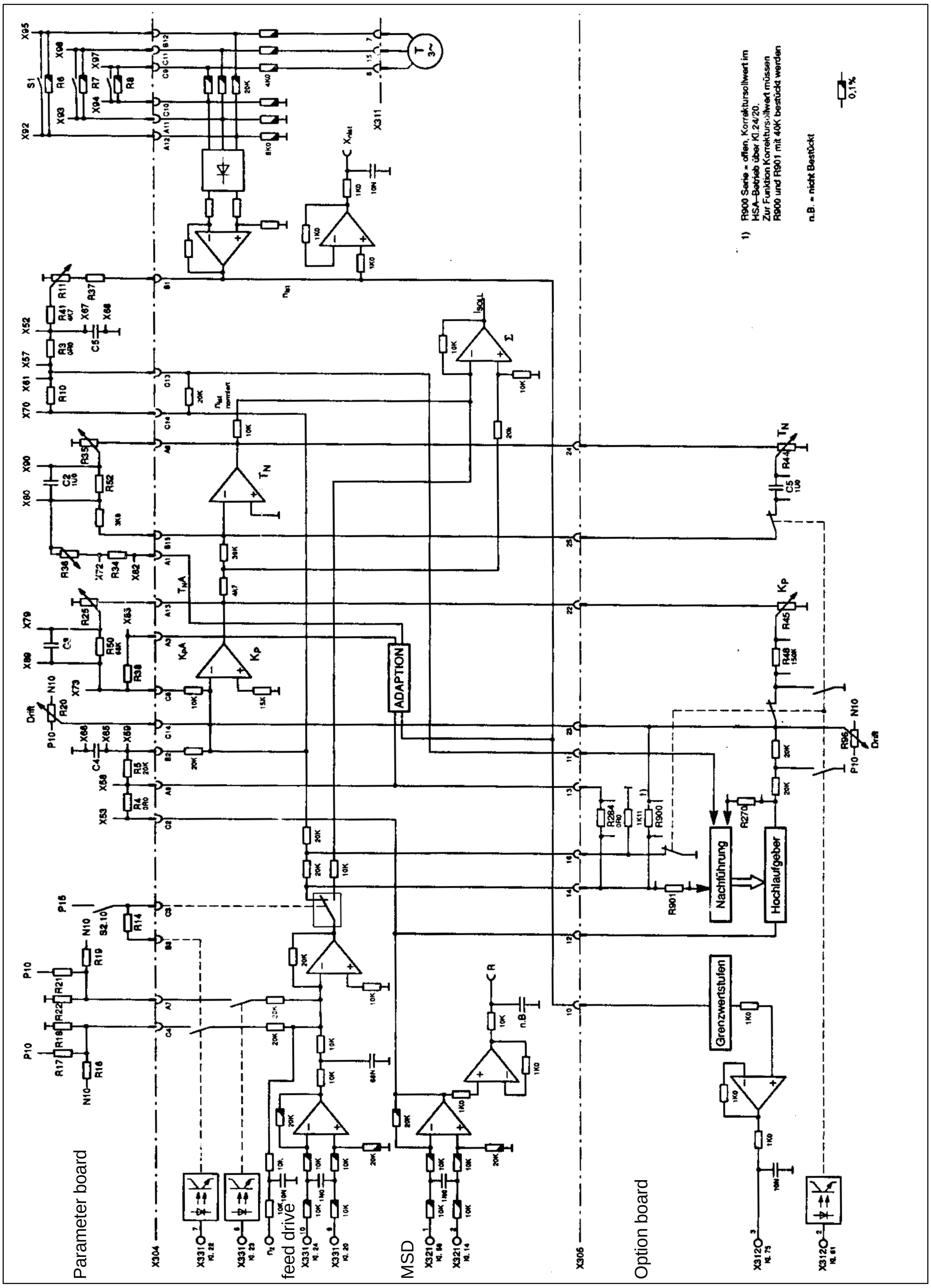

Fig. 11-1 Block diagram, speed control loop FD closed–loop control, analog

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Connection Diagrams 12

Note

The diagram is only intended to show the terminal connections. Furthermore, the external components aren't shown complete. In this case, refer to Section 9.

12

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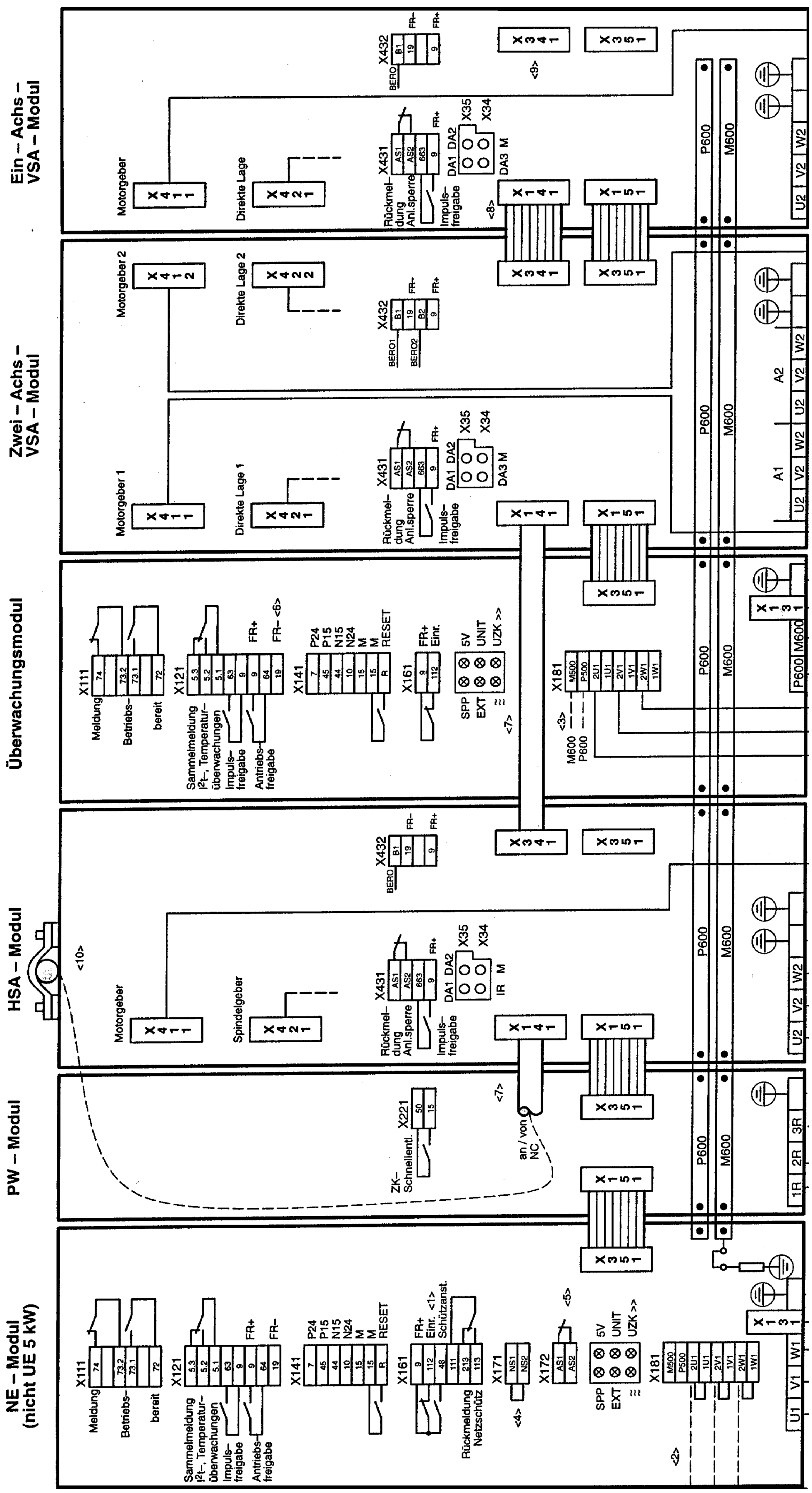

Fig. 12-1 Terminal overview, SIMODRIVE 611 digital

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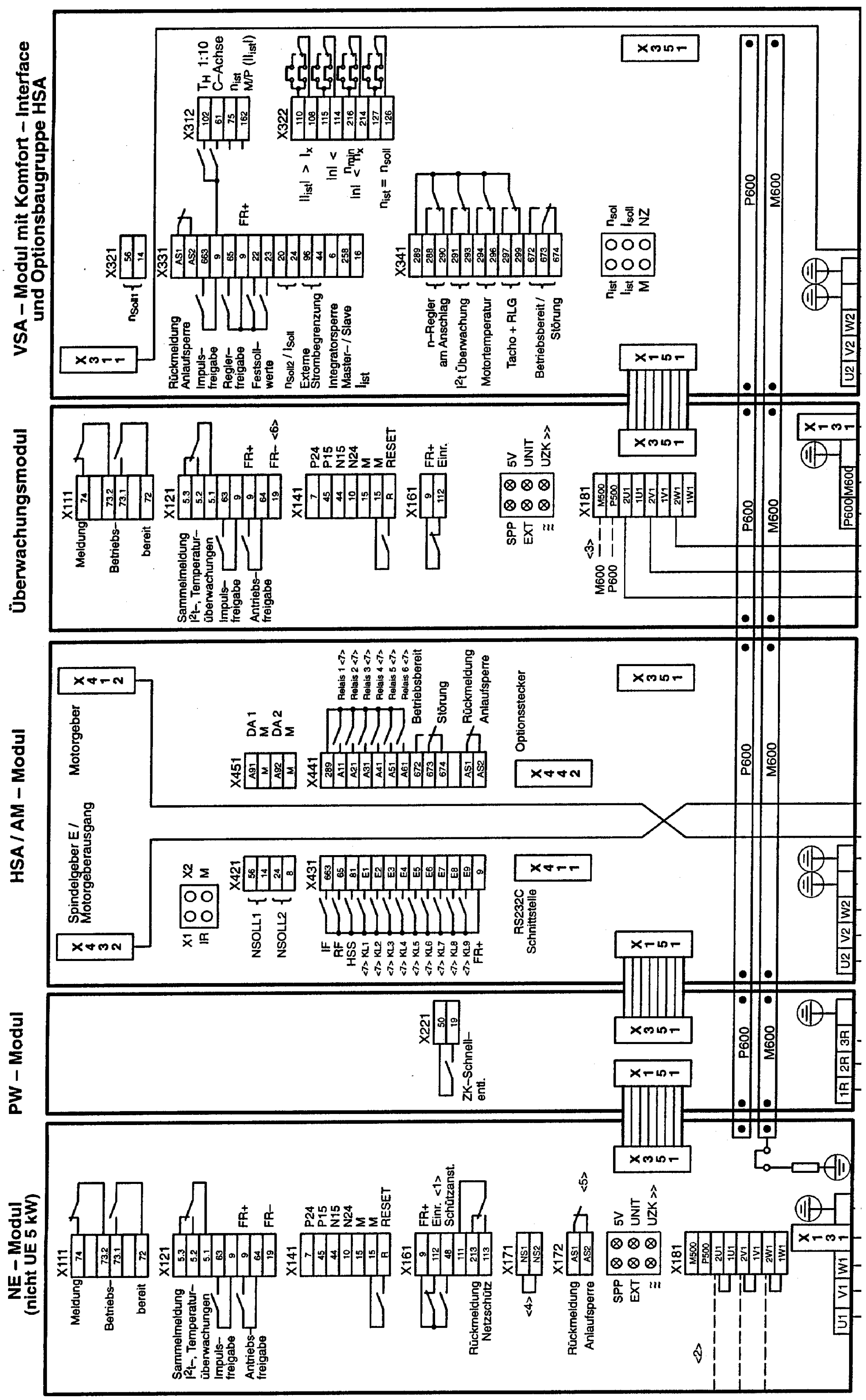

Fig. 12-2 Terminal overview, SIMODRIVE 611 analog

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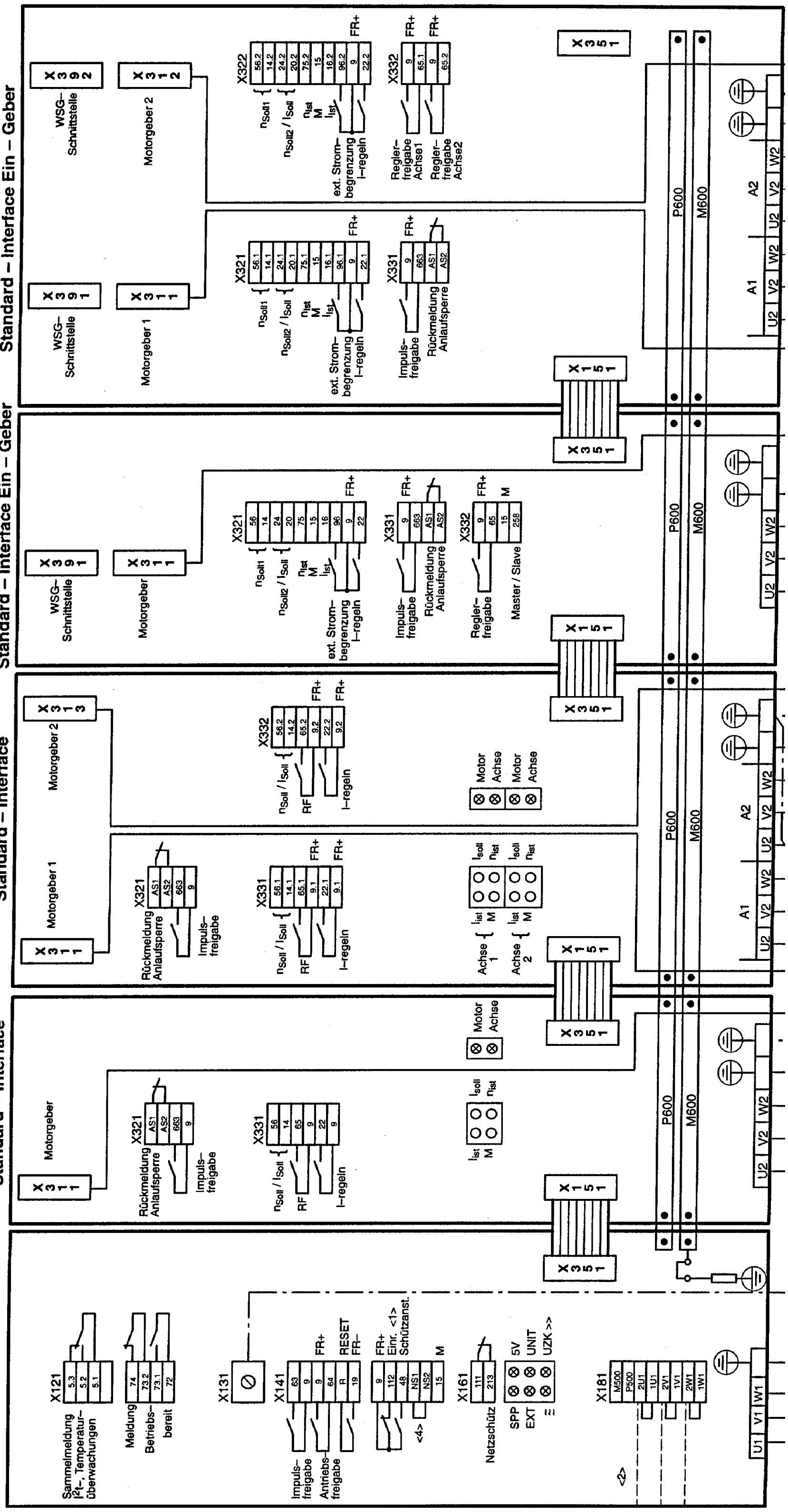

Fig. 12-3 Terminal overview, 611 analog

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Dimension Drawings

13

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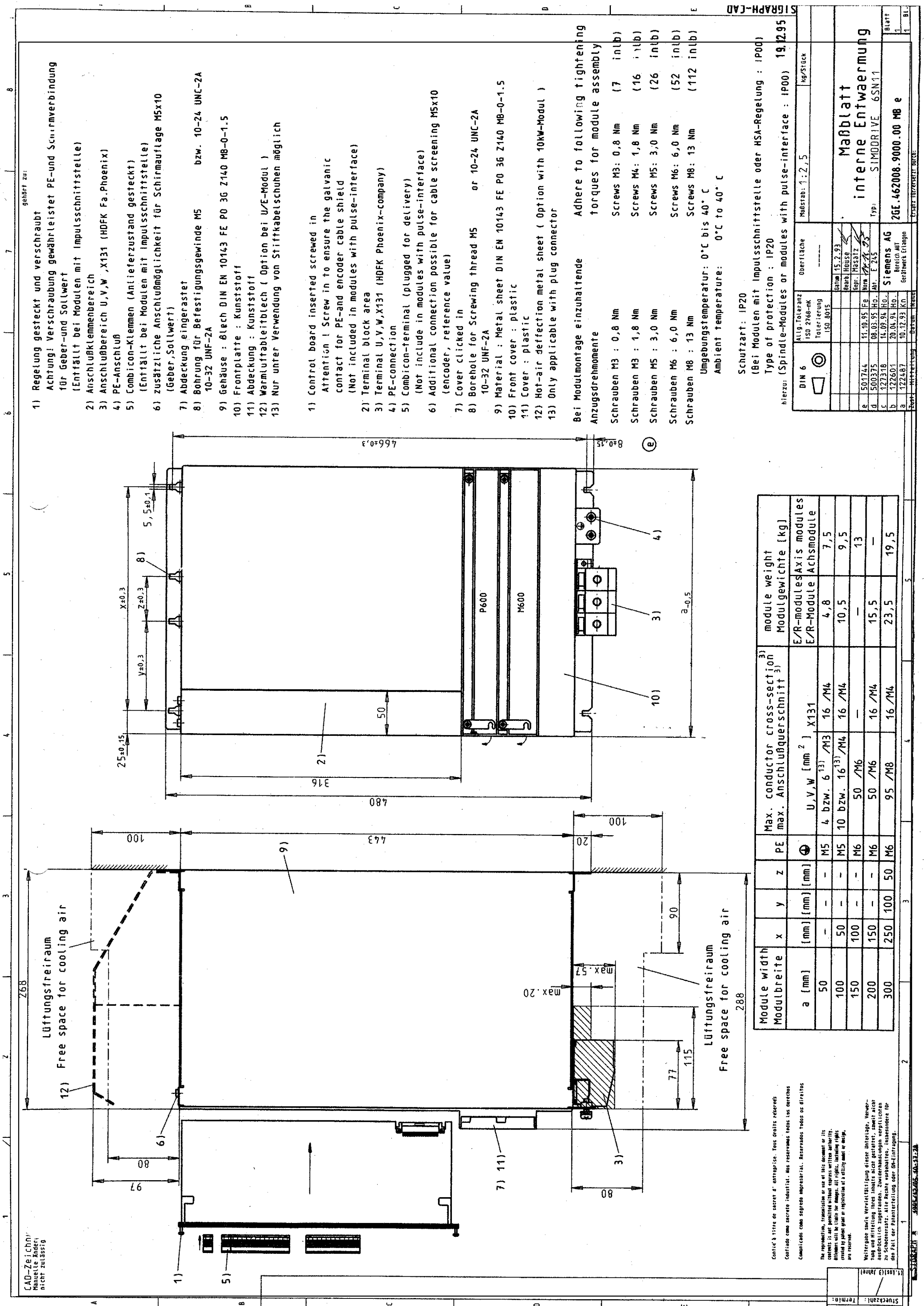

Fig. 13-1 Internal cooling, 2GE.462008.9000.00 MB e, Sheet 1

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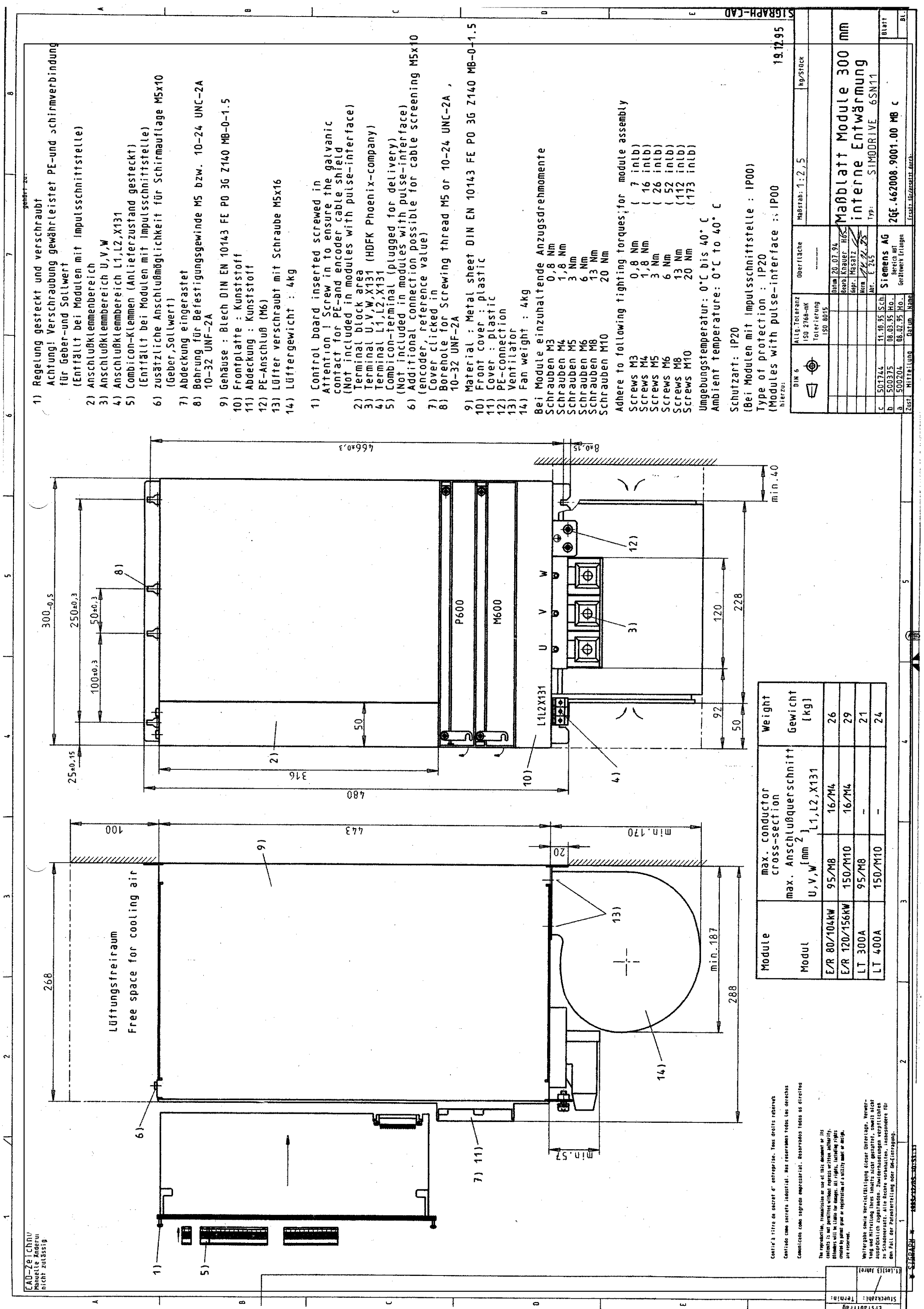

Fig. 13-2 Module 300 mm int. cooling, 2GE.462008.9001.00 MB c, Sheet 1

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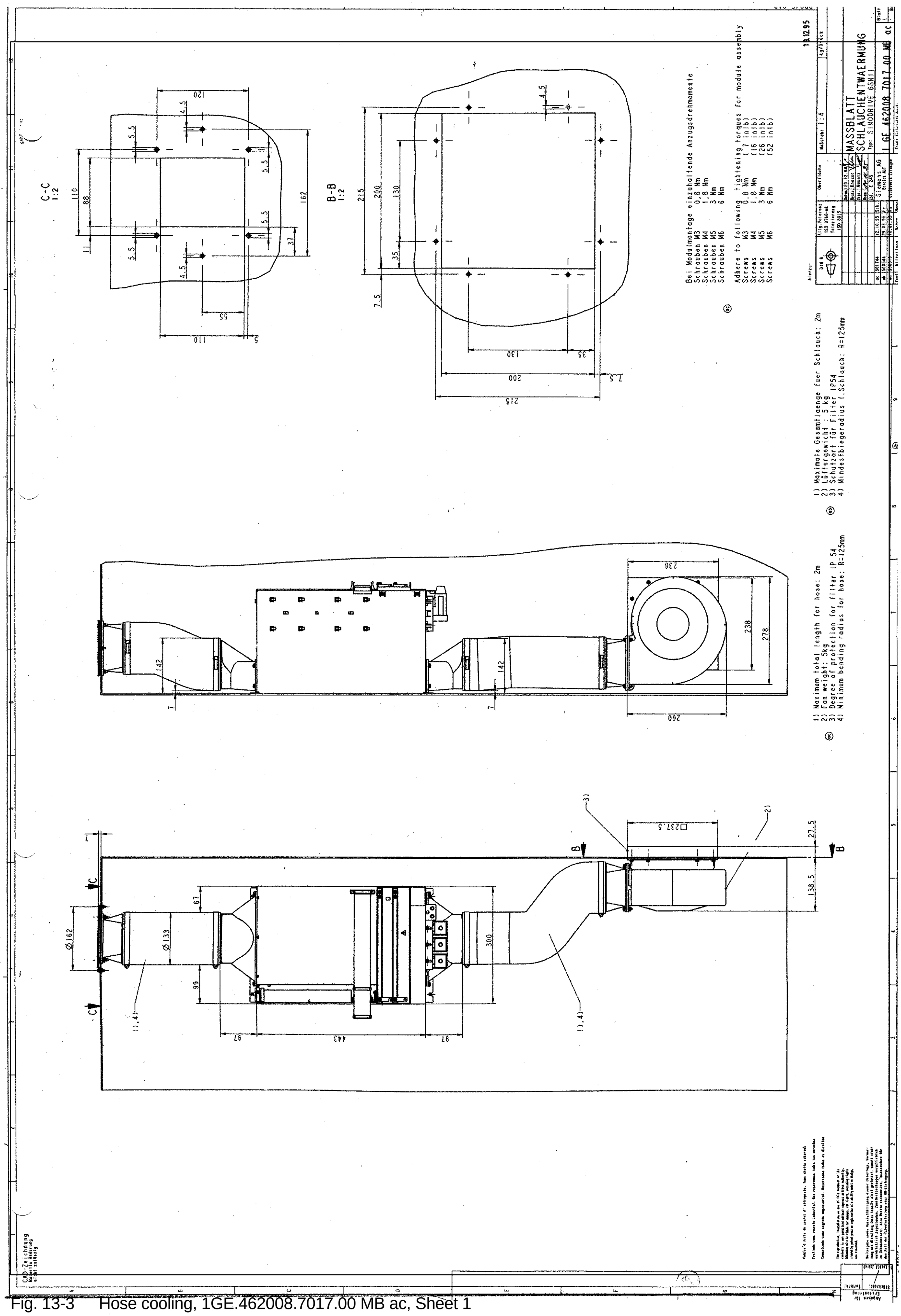

Fig. 13-3 Hose cooling, 1GE.462008.7017.00 MB ac, Sheet 1

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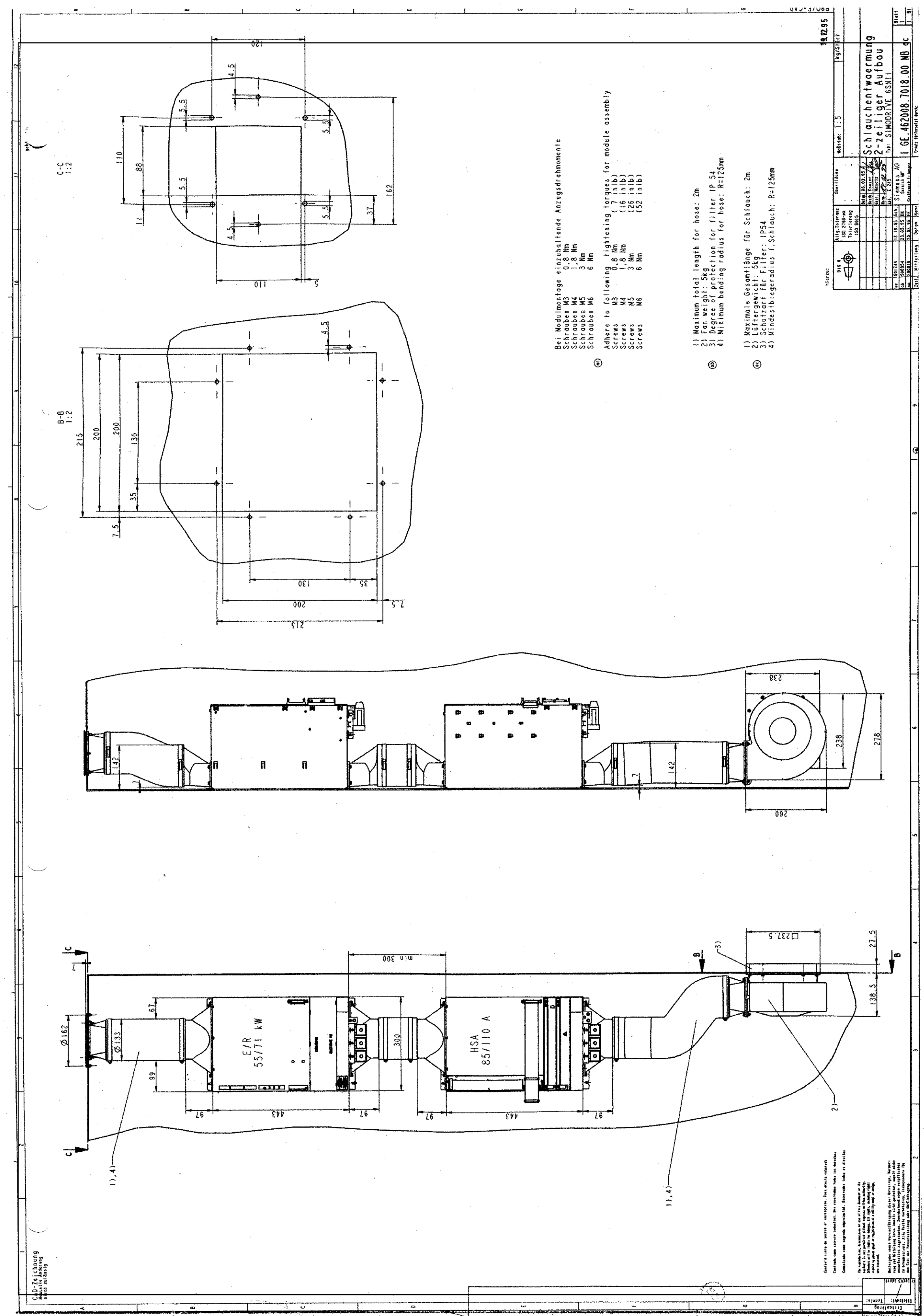

Fig. 13-4 Hose cooling, 2–tier, 1GE.462008.7018.00 MB ac, Sheet 1

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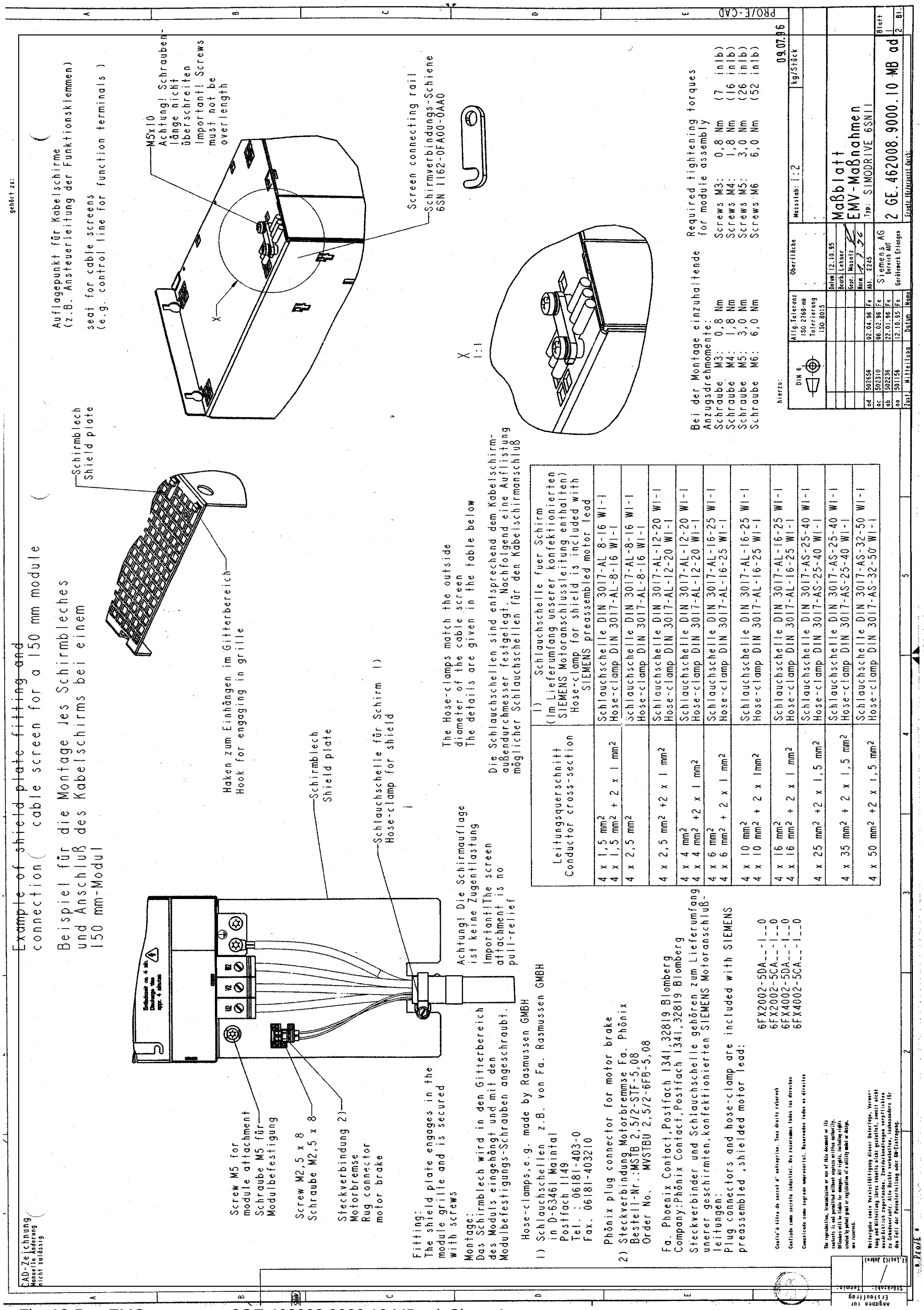

Fig. 13-5 EMC measures, 2GE.462008.9000.10 MB ad, Sheet 1

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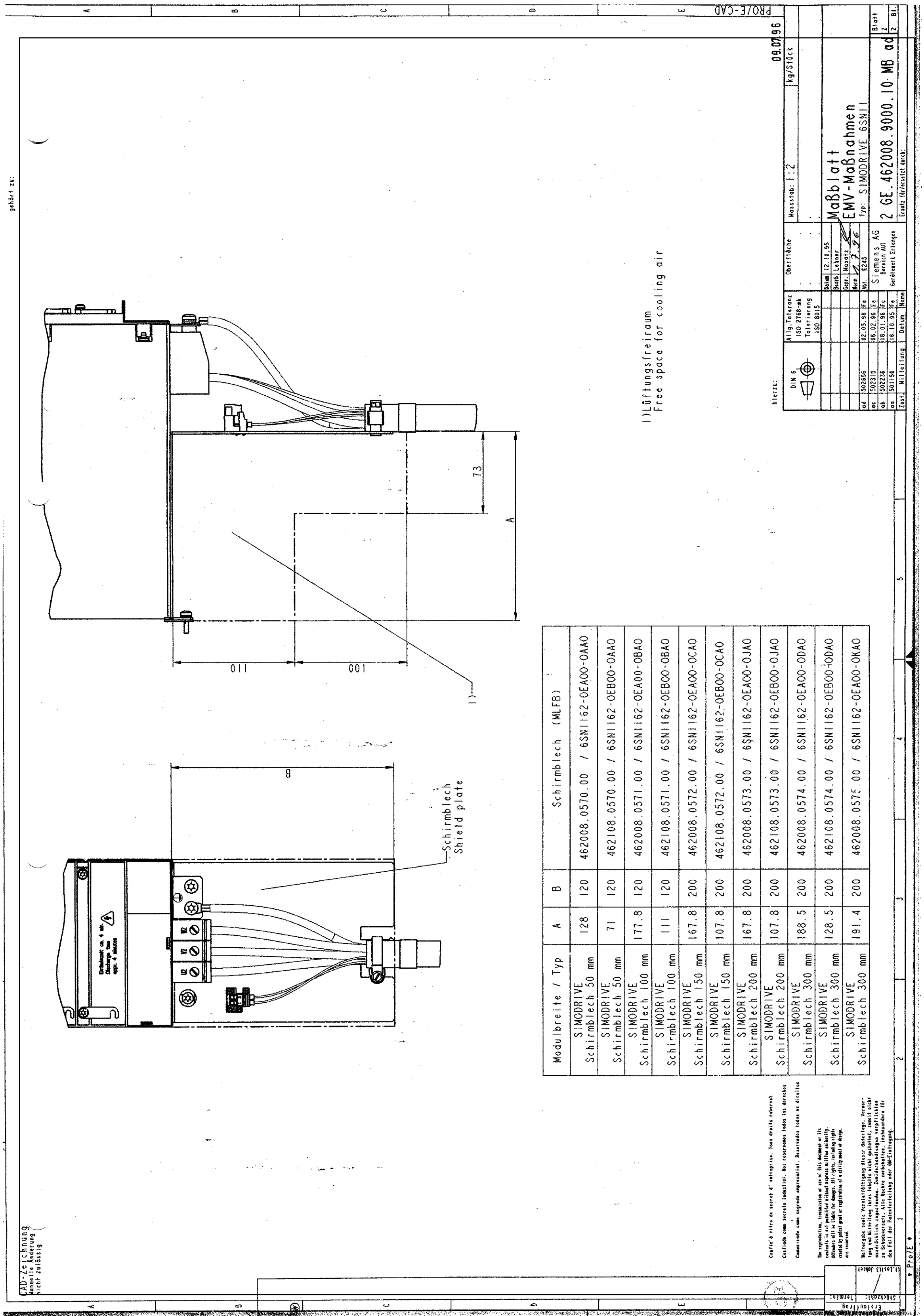

Modulbreite / Typ	A	B	Schirmblech (MLFB)
SIMODRIVE Schirmblech 50 mm	128	120	462008.0570.00 / 6SN1162-0EA00-0AA0
SIMODRIVE Schirmblech 50 mm	71	120	462108.0570.00 / 6SN1162-0EB00-0AA0
SIMODRIVE Schirmblech 100 mm	177.8	120	462008.0571.00 / 6SN1162-0EA00-0BA0
SIMODRIVE Schirmblech 100 mm	111	120	462108.0571.00 / 6SN1162-0EB00-0BA0
SIMODRIVE Schirmblech 150 mm	167.8	200	462008.0572.00 / 6SN1162-0EA00-0CA0
SIMODRIVE Schirmblech 150 mm	107.8	200	462108.0572.00 / 6SN1162-0EB00-0CA0
SIMODRIVE Schirmblech 200 mm	167.8	200	462008.0573.00 / 6SN1162-0EA00-0JA0
SIMODRIVE Schirmblech 200 mm	107.8	200	462108.0573.00 / 6SN1162-0EB00-0JA0
SIMODRIVE Schirmblech 300 mm	188.5	200	462008.0574.00 / 6SN1162-0EA00-0DA0
SIMODRIVE Schirmblech 300 mm	128.5	200	462108.0574.00 / 6SN1162-0EB00-0DA0
SIMODRIVE Schirmblech 300 mm	191.4	200	462008.0575.00 / 6SN1162-0EA00-0KA0

Fig. 13-6 EMC measures, 2GE.462008.9000.10 MB ad, Sheet 2

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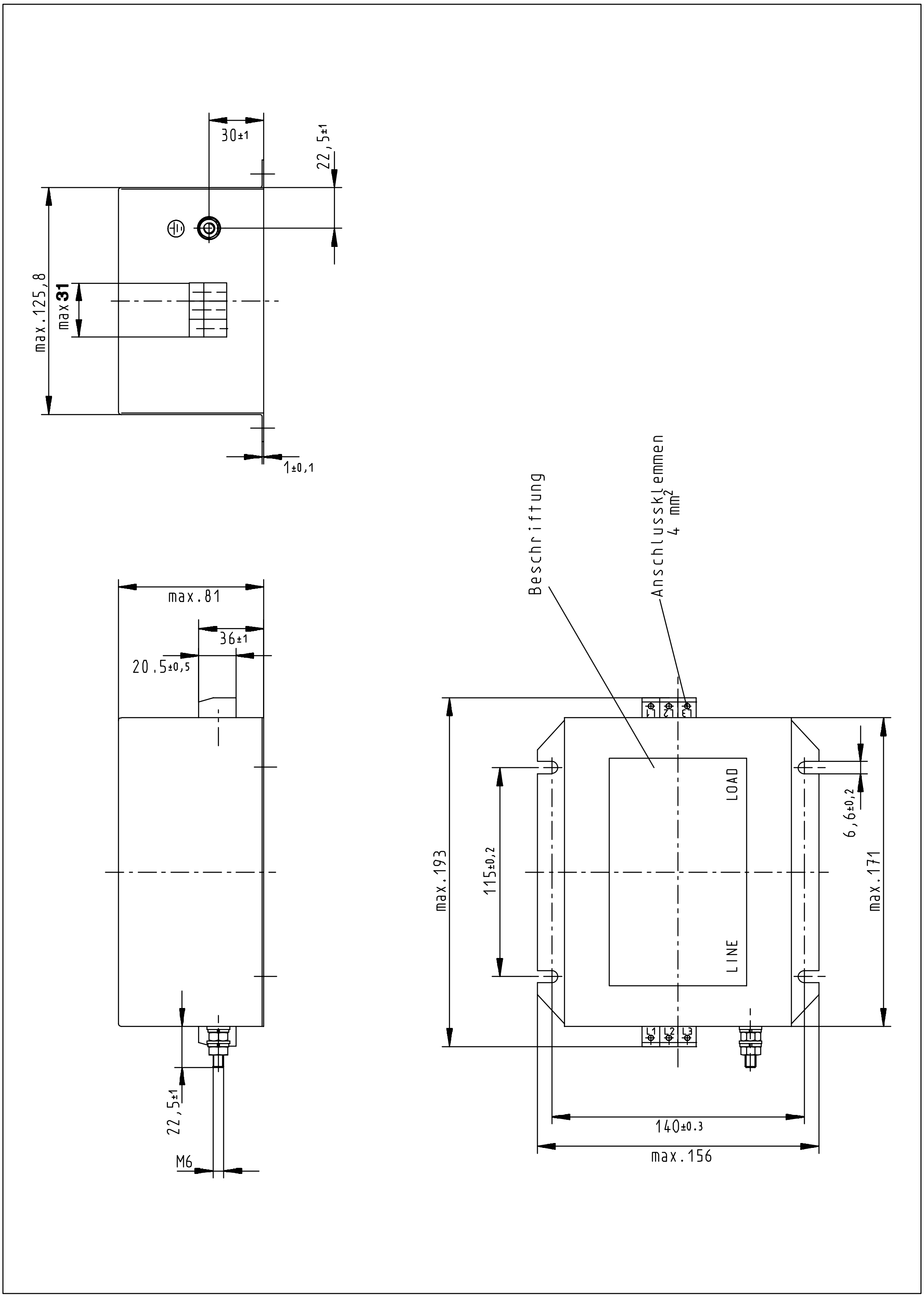

Fig. 13-7 Line filter 5 kW, 4GE.581793 TA ab, Sheet 1

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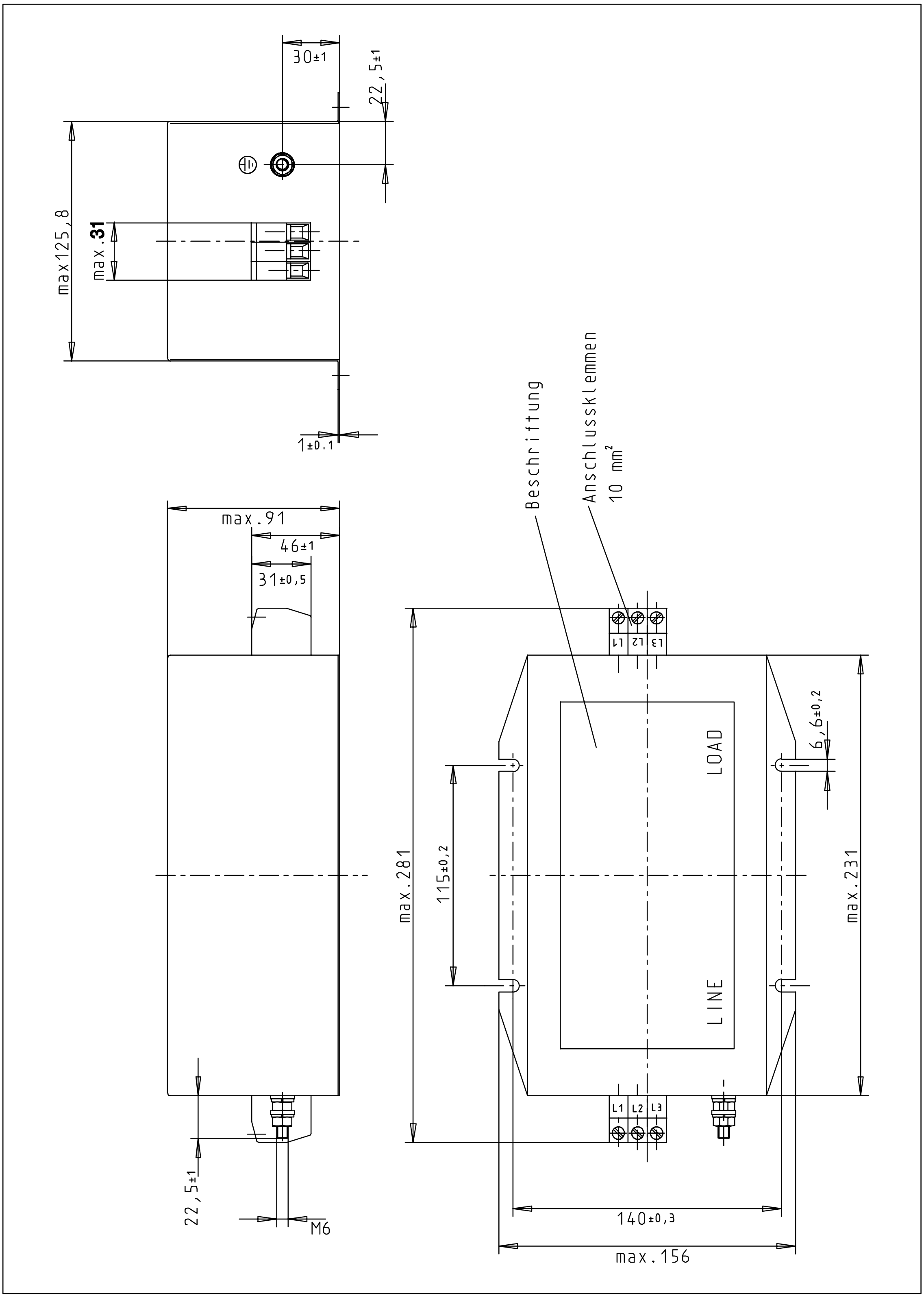

Fig. 13-8 Line filter 10 kW, 4GE.581785 TA ab, Sheet 2

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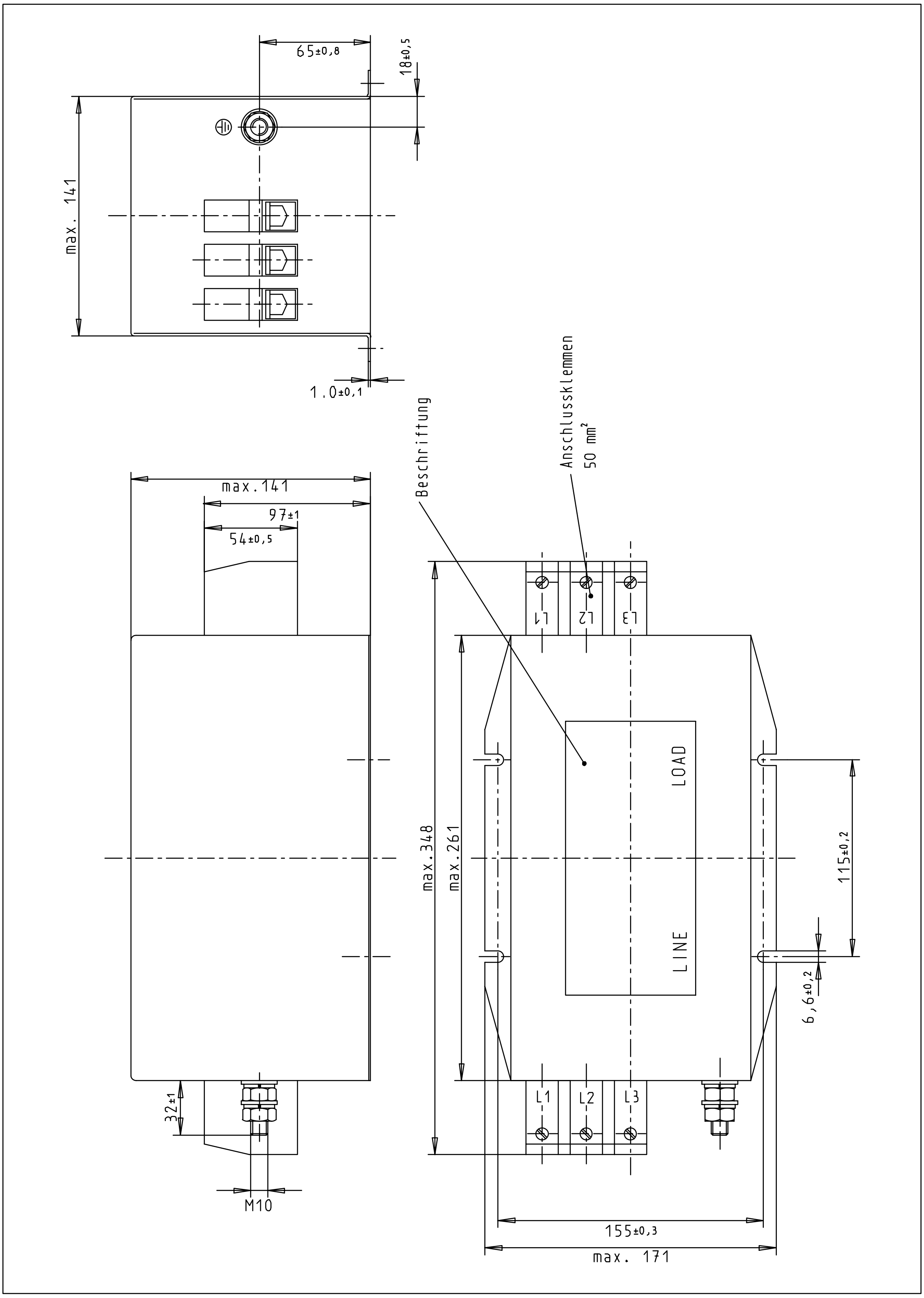

Fig. 13-9 Line filter 28 kW, 3GE.585455 TA aa, Sheet 2

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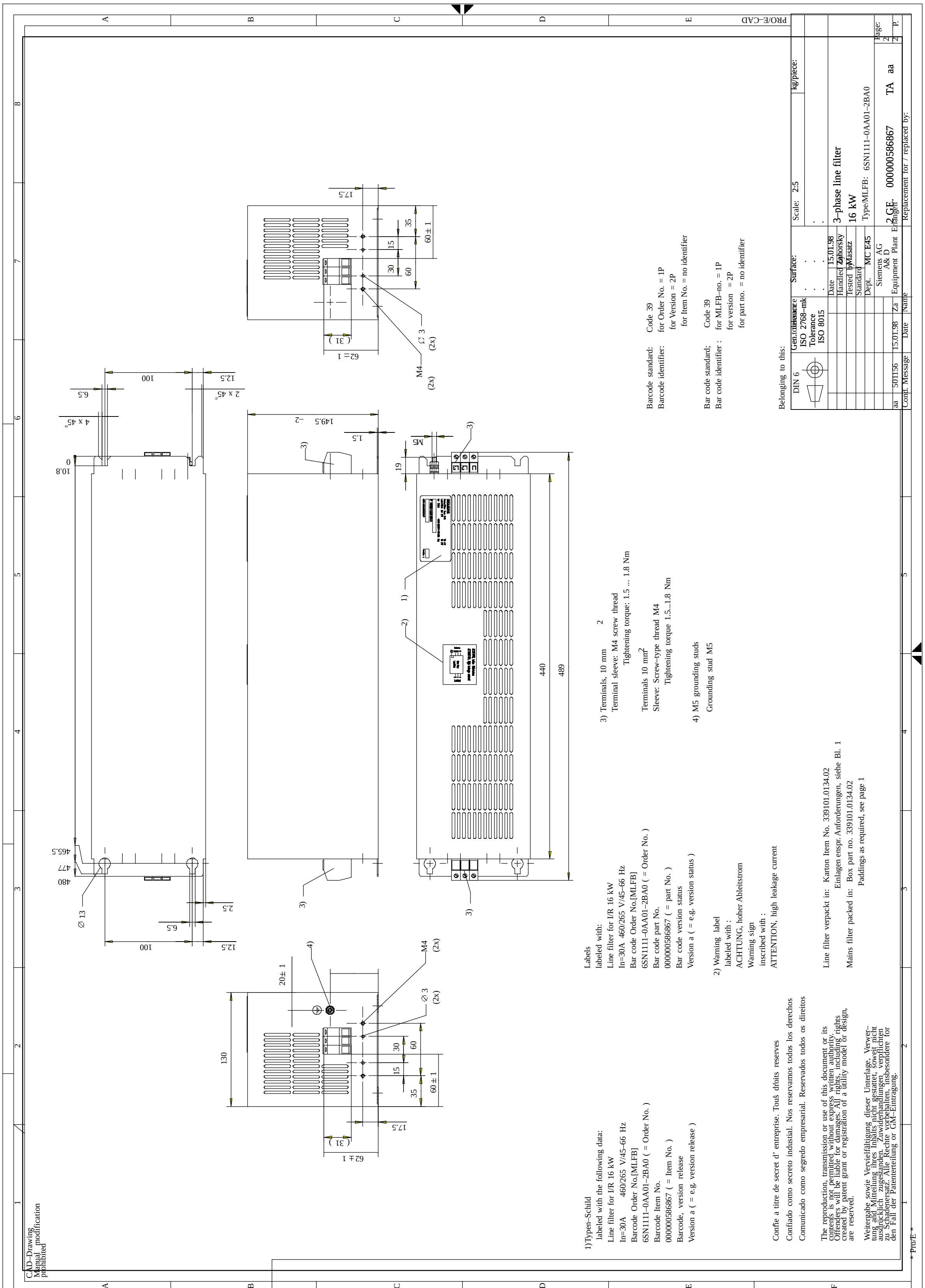

Fig. 13-10 3–phase line filter 16kW, 2GE.586867 TA aa, Sheet 2

13

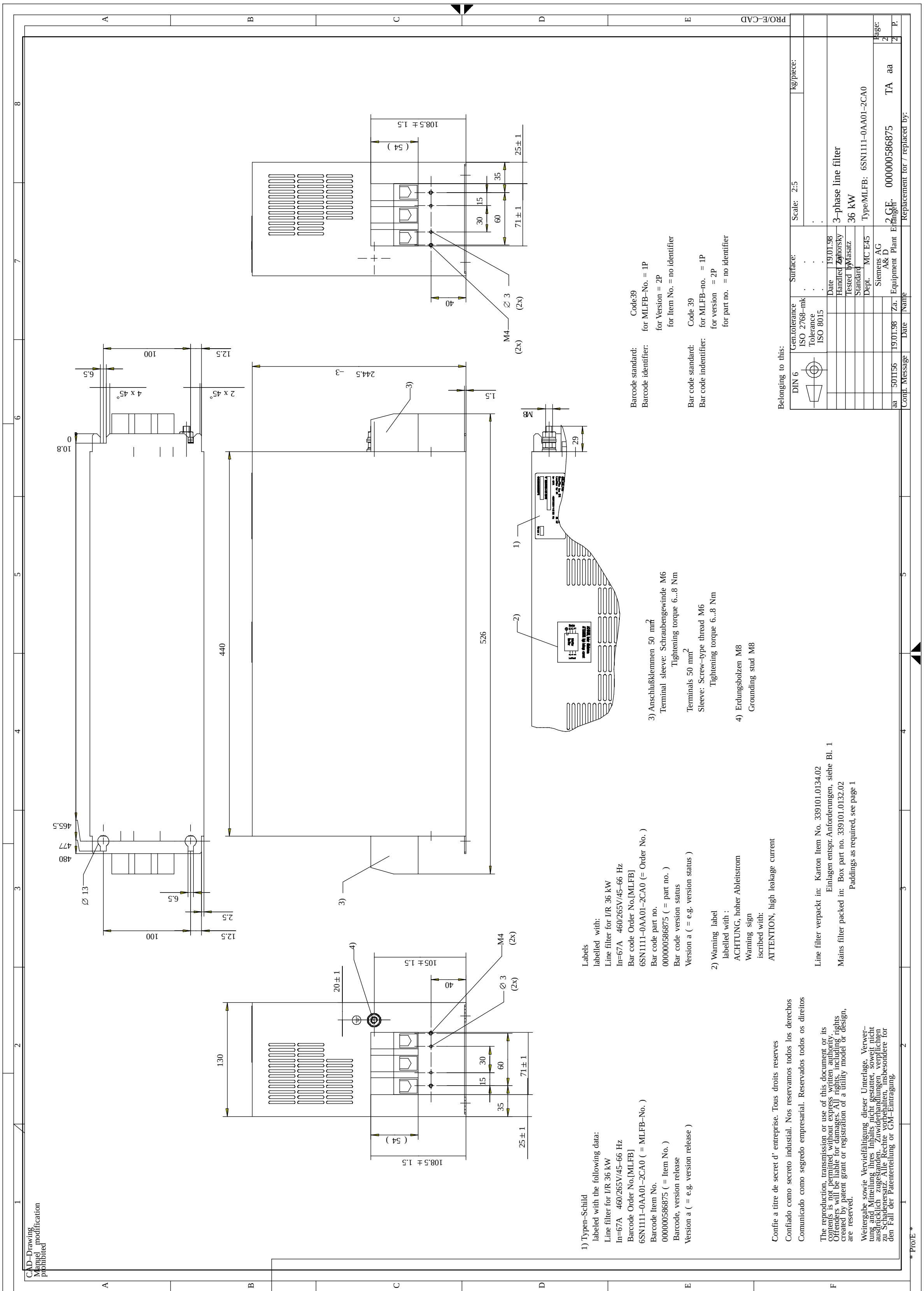

Fig. 13-11 3–phase line filter 36kW, 2GE.586875 TA aa, Sheet 2

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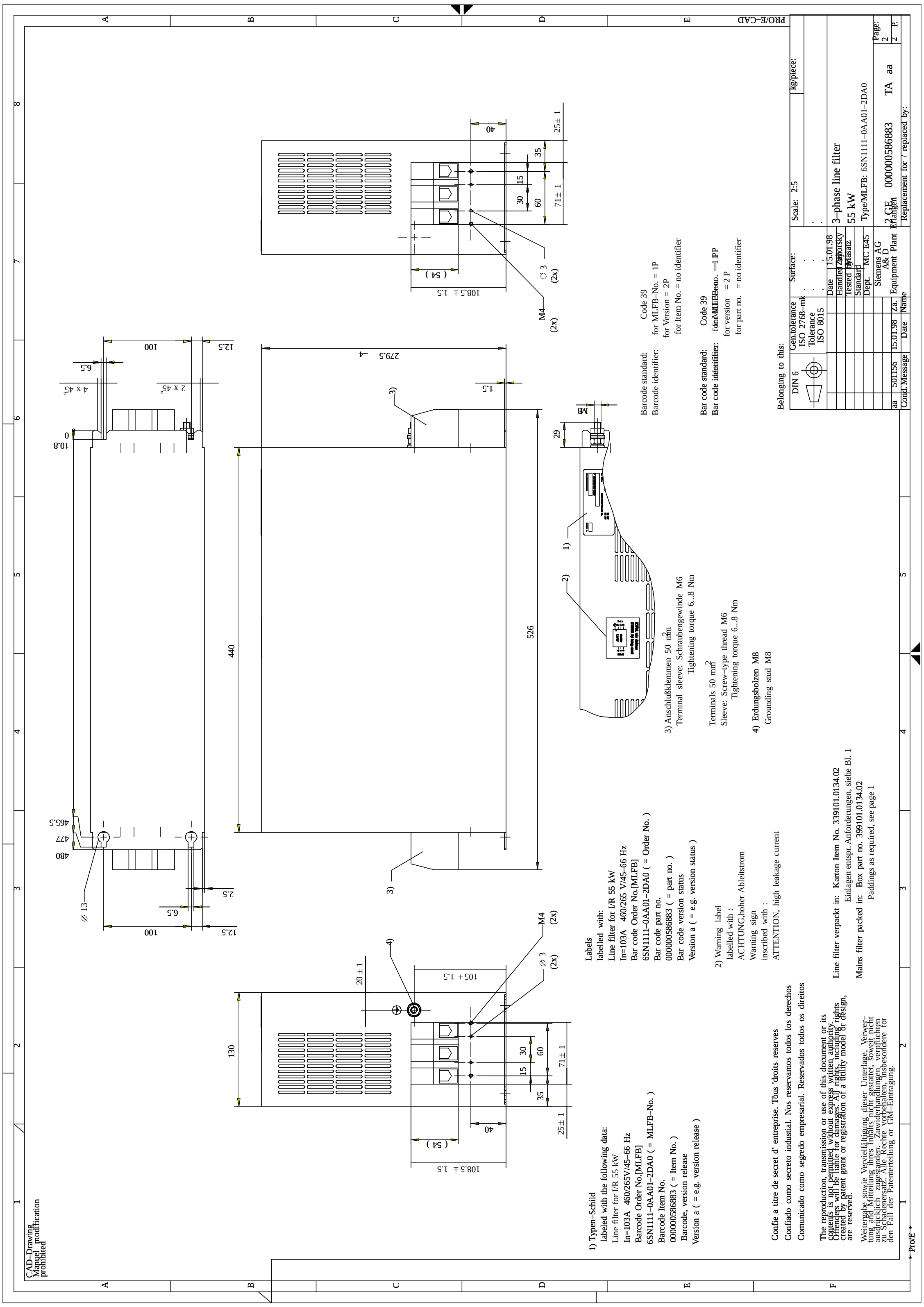

Fig. 13-12 3–phase line filter 55kW, 2GE.586883 TA aa, Sheet 2

13

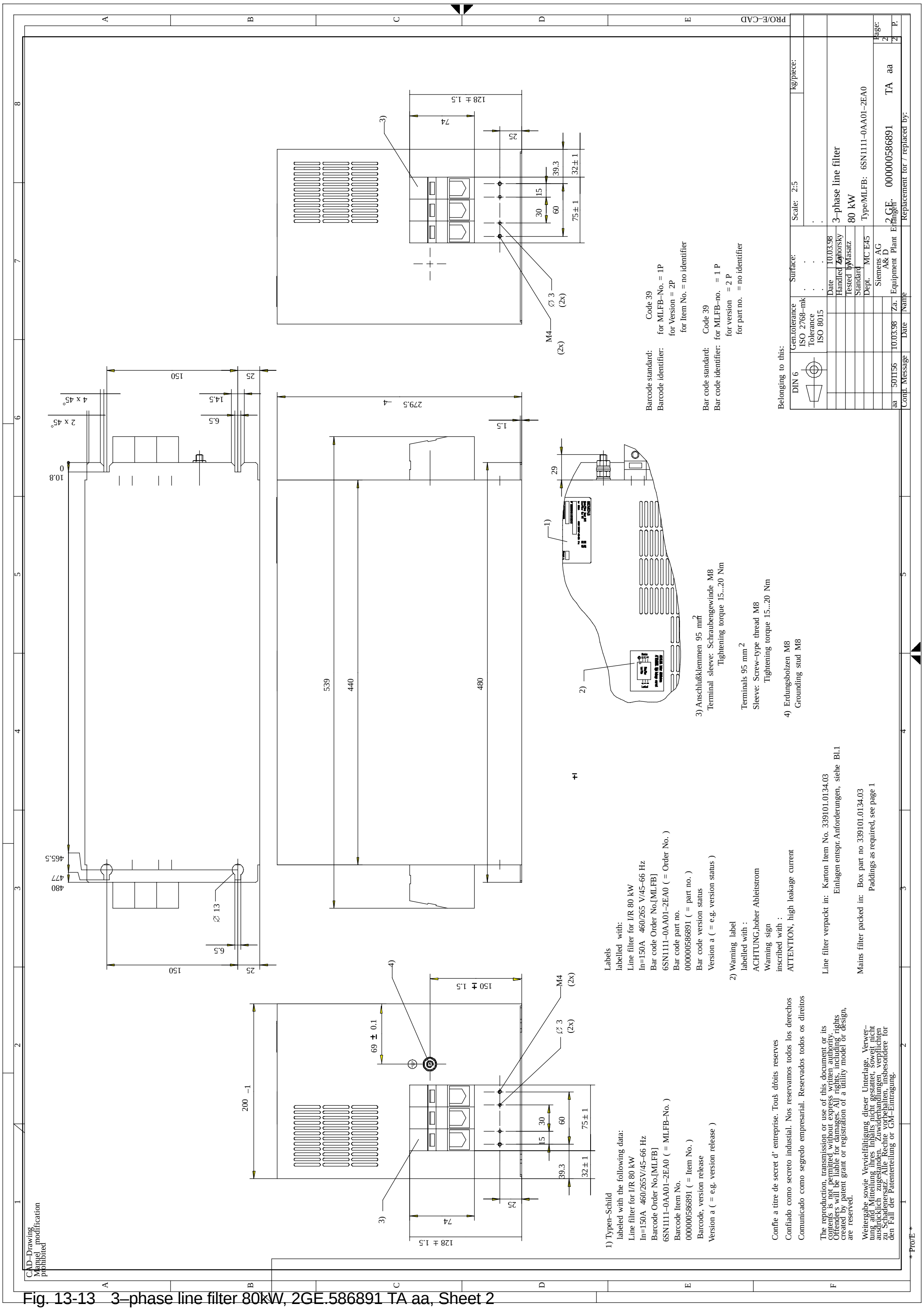

Fig. 13-13 3–phase line filter 80kW, 2GE.586891 TA aa, Sheet 2

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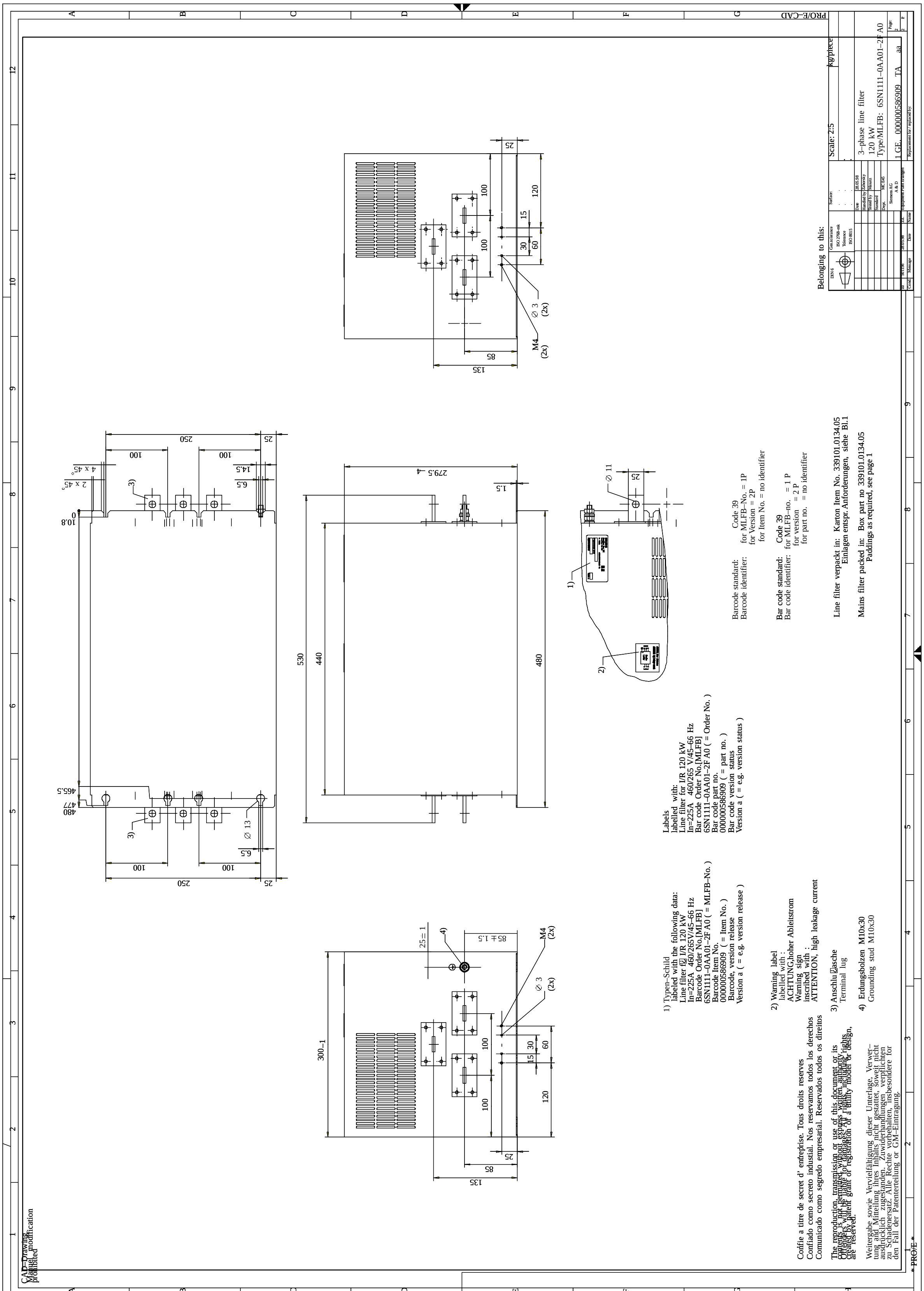

Fig. 13-14 3–phase line filter 120kW, 1GE.586909 TA aa, Sheet 2

13

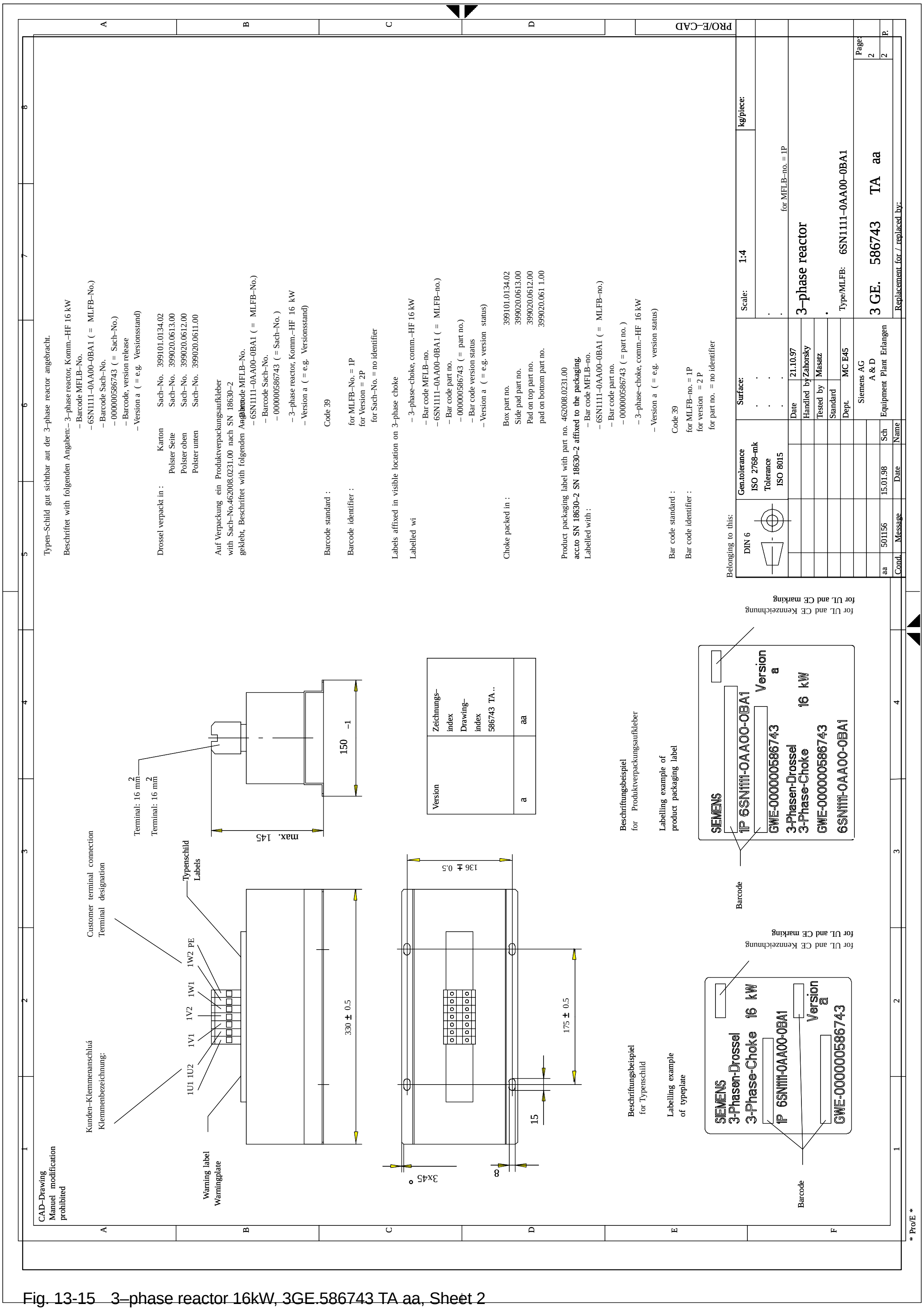

Fig. 13-15 3–phase reactor 16kW, 3GE.586743 TA aa, Sheet 2

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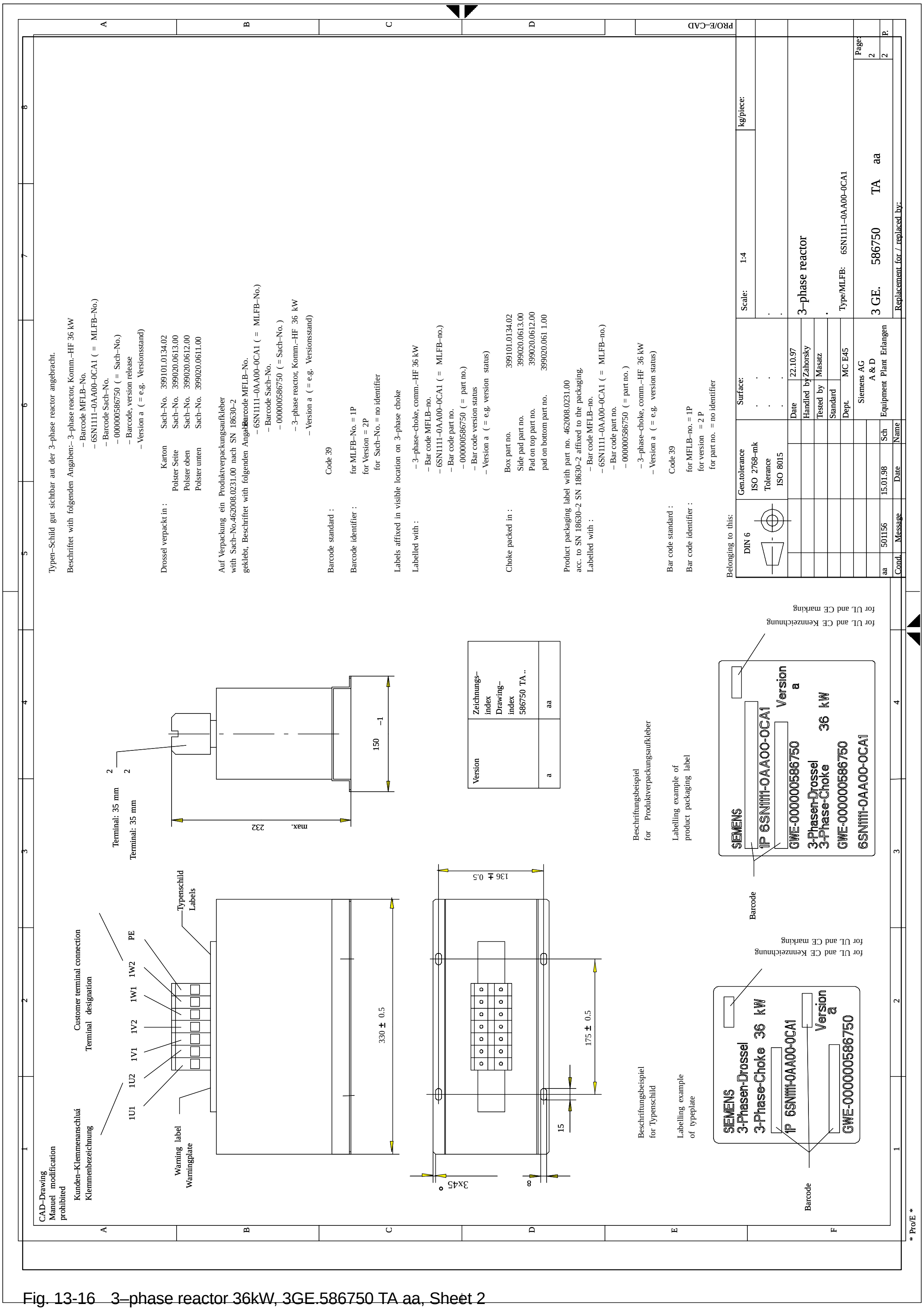

Fig. 13-16 3–phase reactor 36kW, 3GE.586750 TA aa, Sheet 2

13

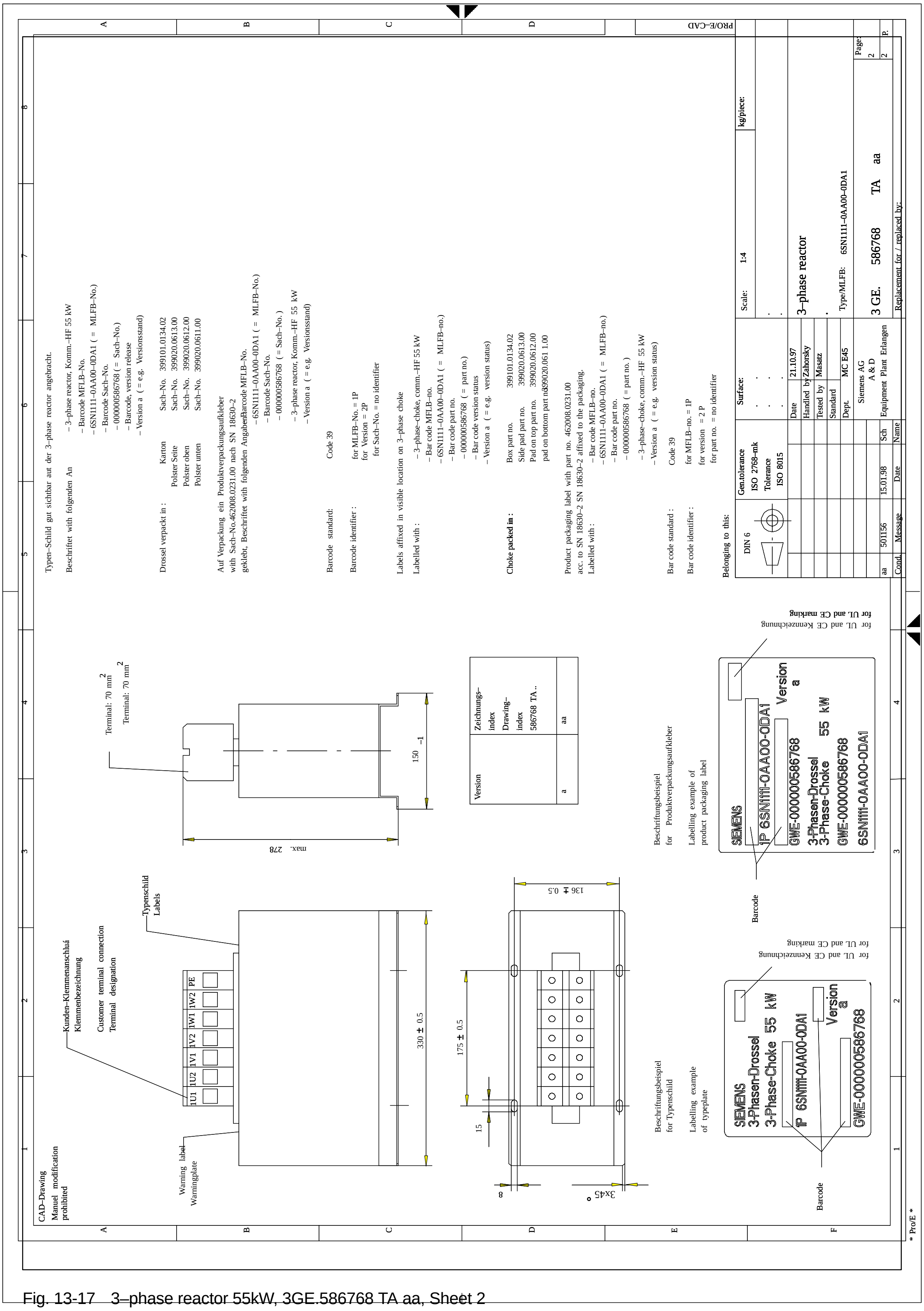

Fig. 13-17 3–phase reactor 55kW, 3GE.586768 TA aa, Sheet 2

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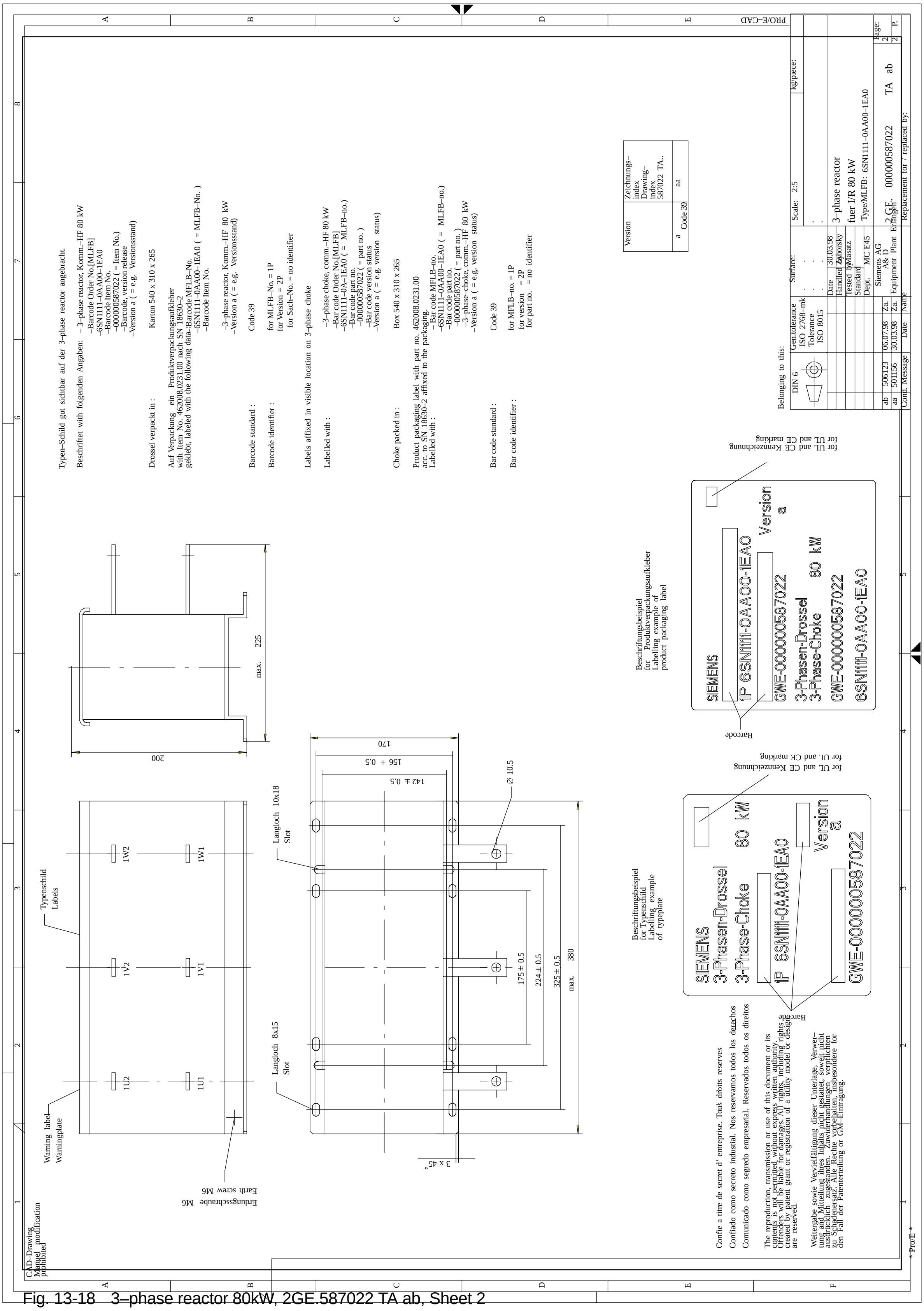

Fig. 13-18 3–phase reactor 80kW, 2GE.587022 TA ab, Sheet 2

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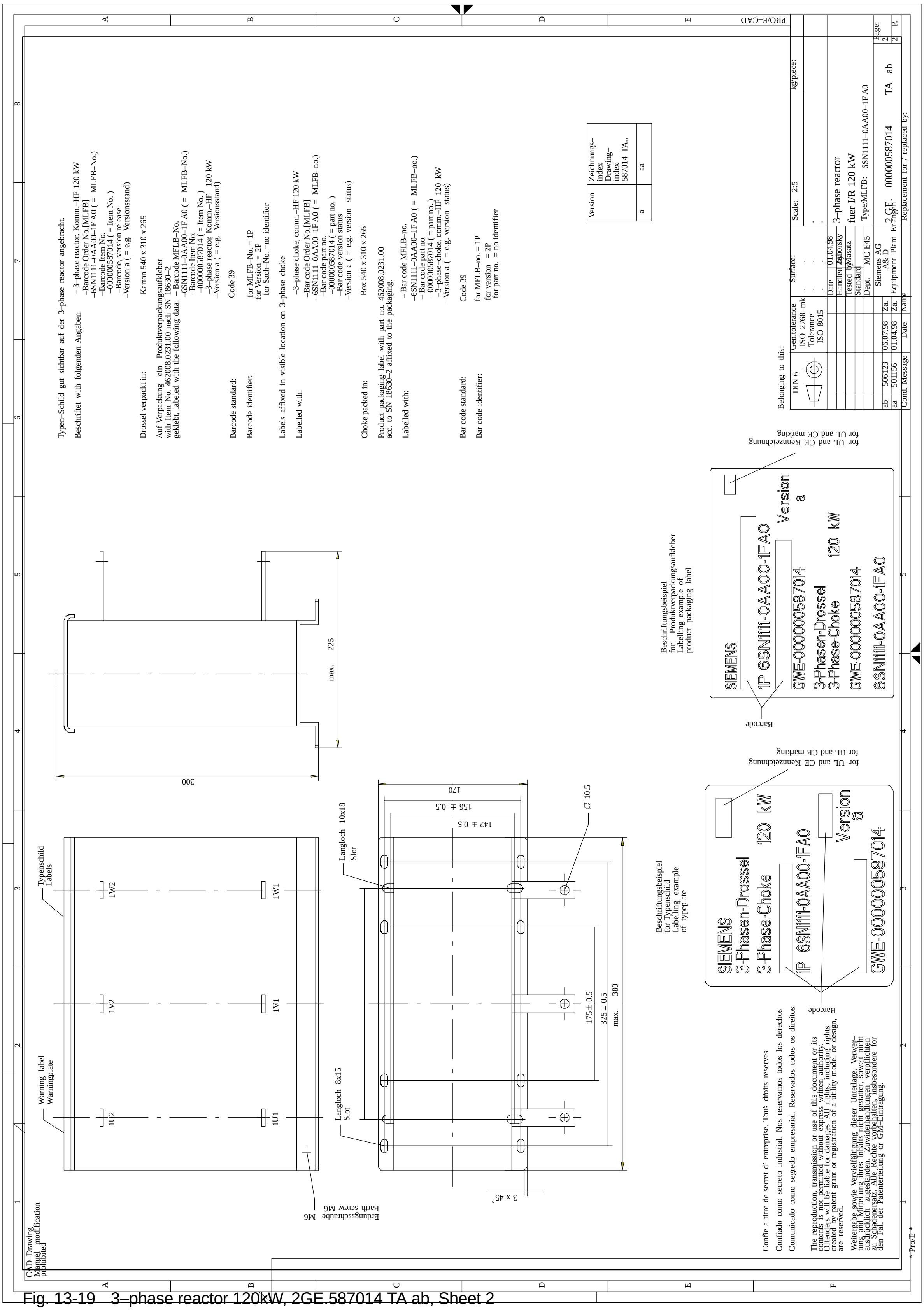

Fig. 13-19 3–phase reactor 120kW, 2GE.587014 TA ab, Sheet 2

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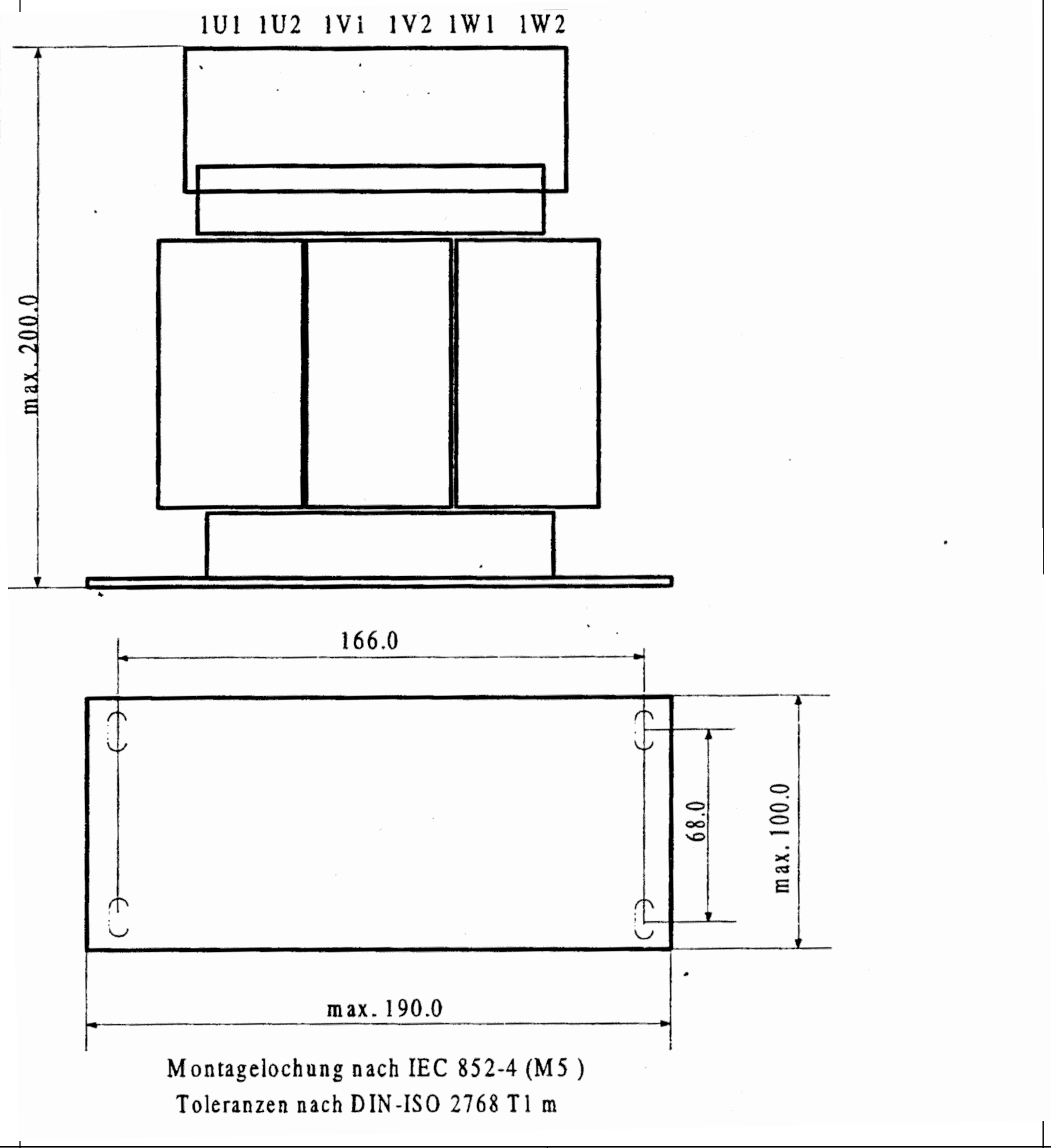

3–Phasendrossel 28 kW
Typ HF, Commutating reactor
Ln=0.15 mH, In=65 A
Order No.: 6SN1111–1AA00–0CA0

Fig. 13-20 3–phase reactor Typ HF, TA 585034, Sheet 2

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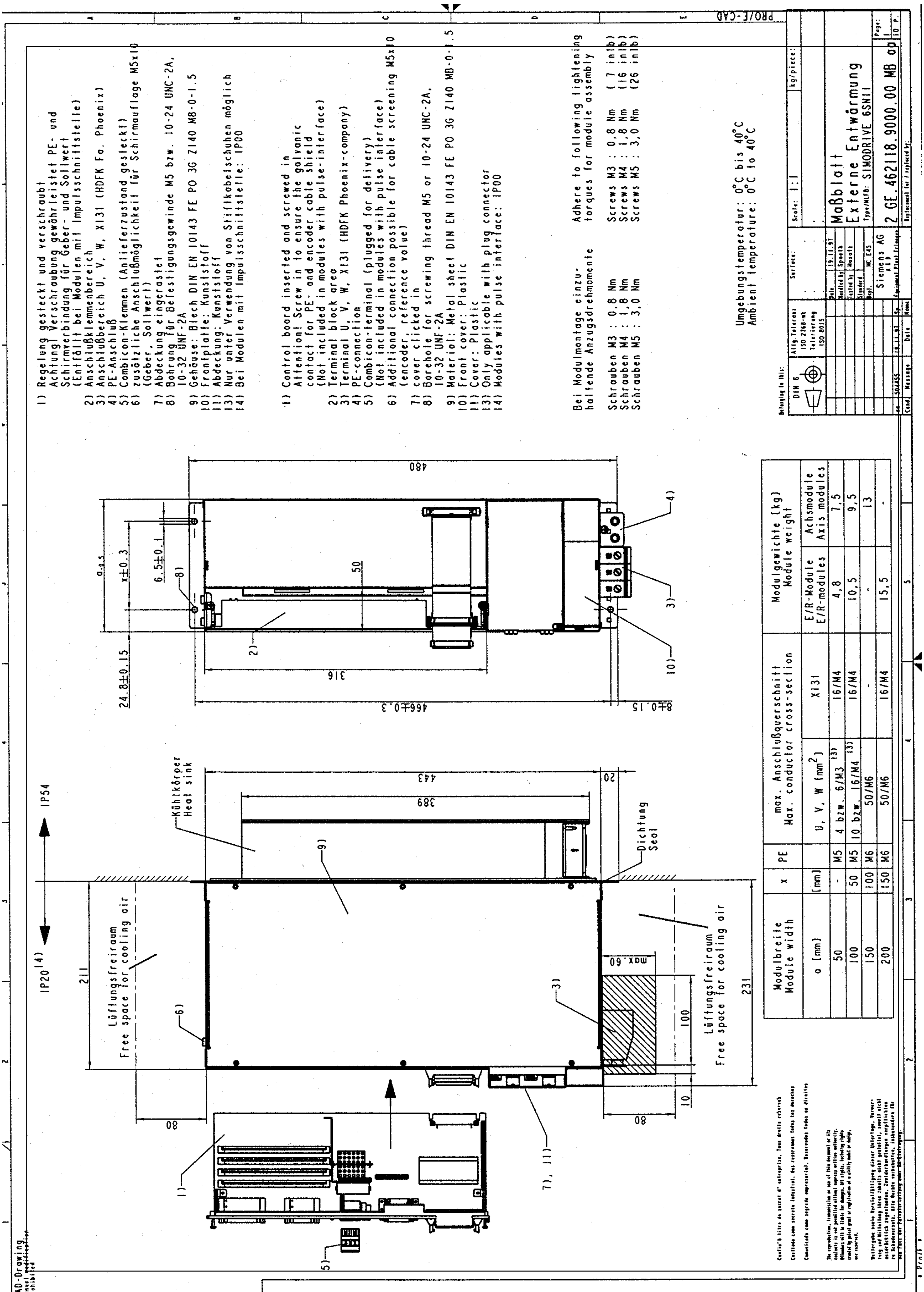

Fig. 13-21 External cooling, 2GE.462118.9000.00 MB aa, Sheet 1

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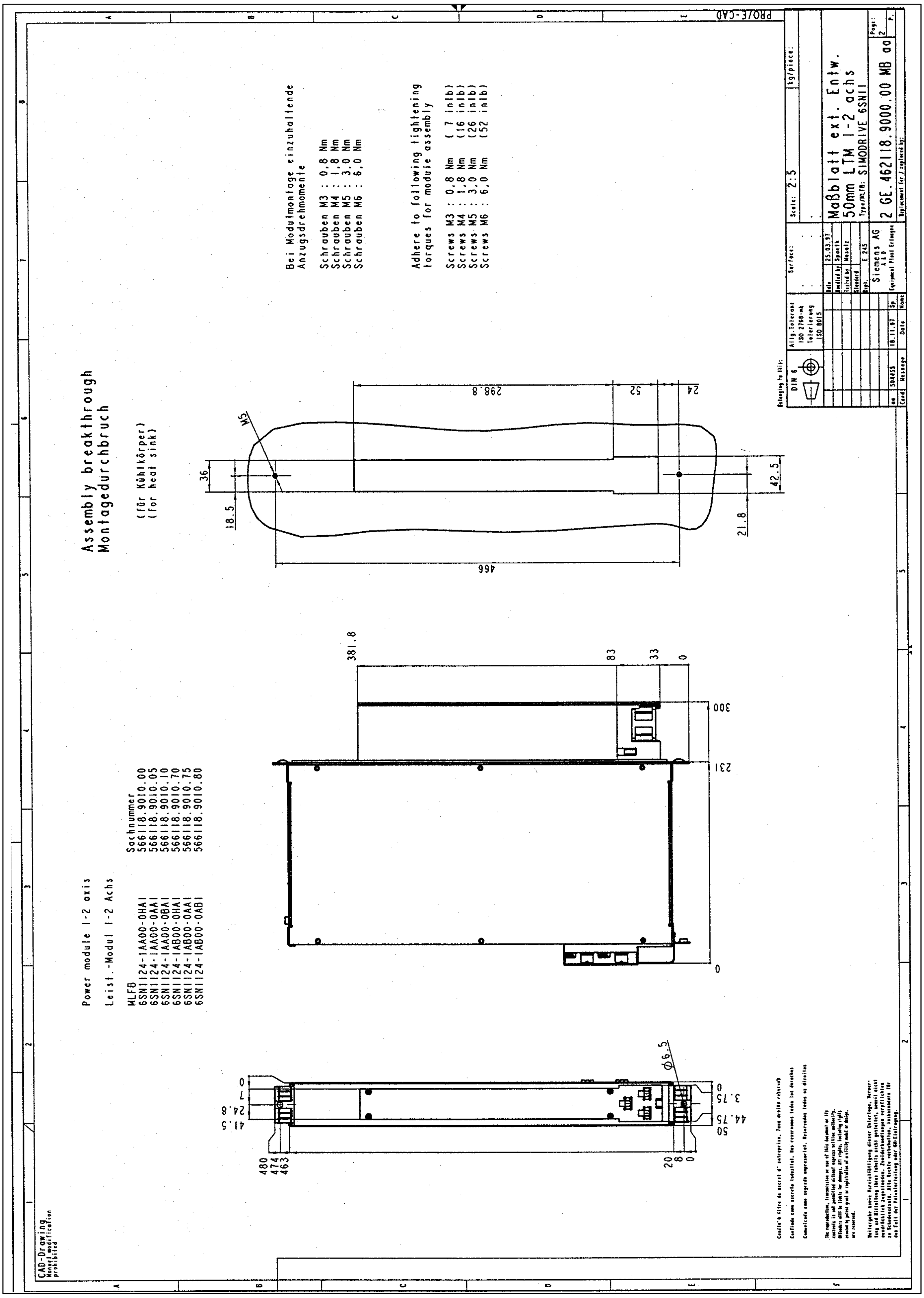

Fig. 13-22 External cooling, 2GE.462118.9000.00 MB aa, Sheet 2

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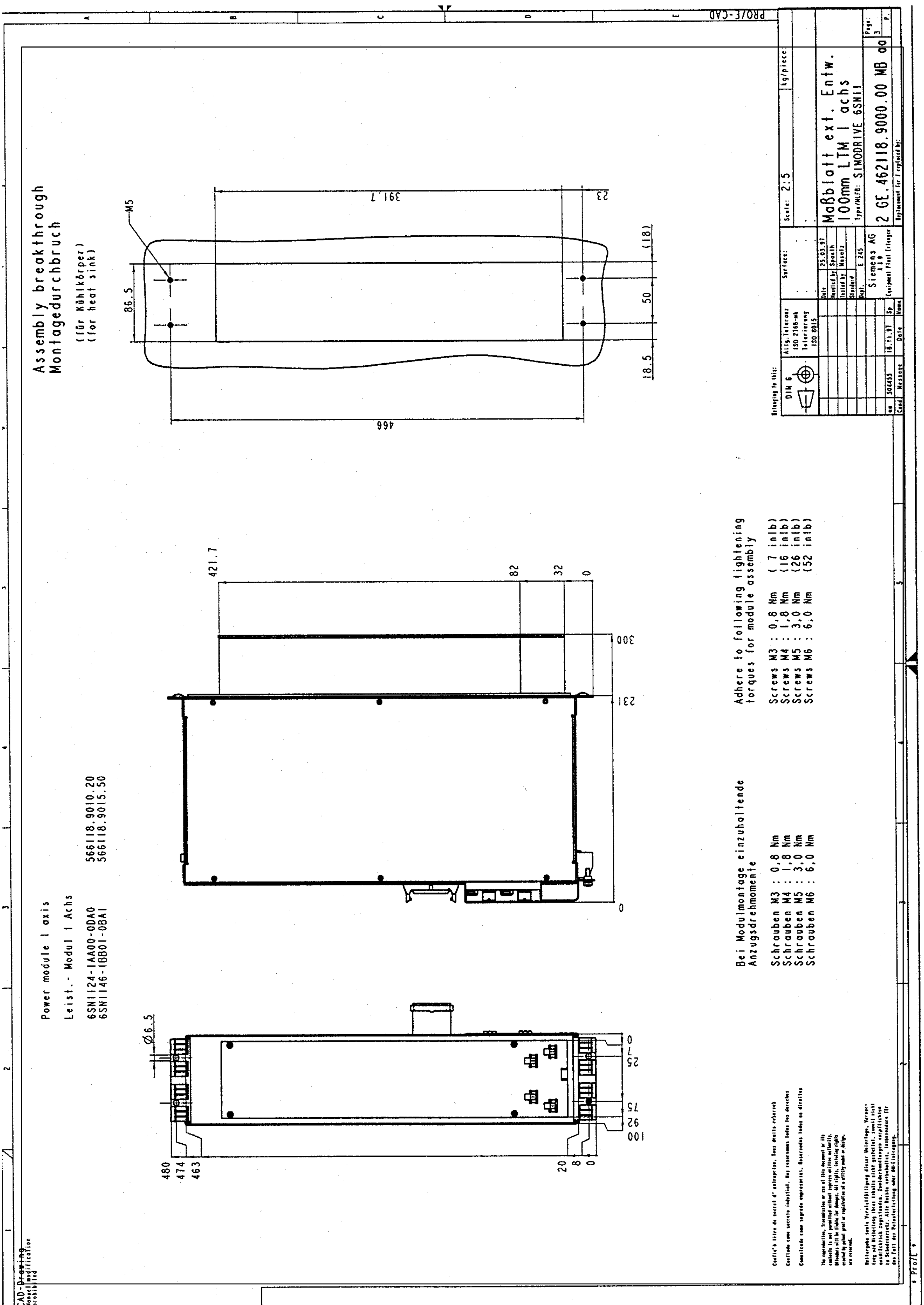

Fig. 13-23 External cooling, 2GE.462118.9000.00 MB aa, Sheet 3

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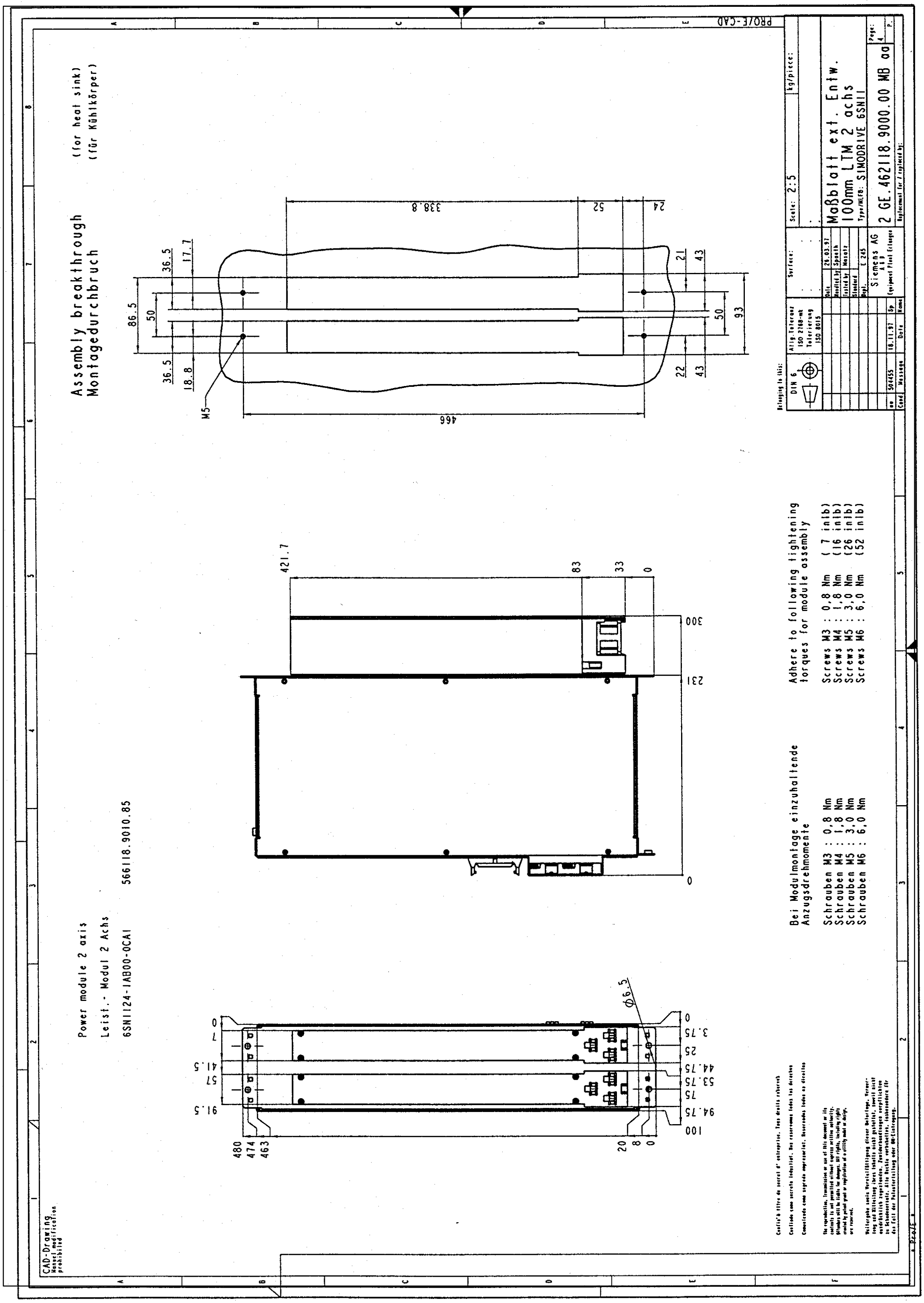

Fig. 13-24 External cooling, 2GE.462118.9000.00 MB aa, Sheet 4

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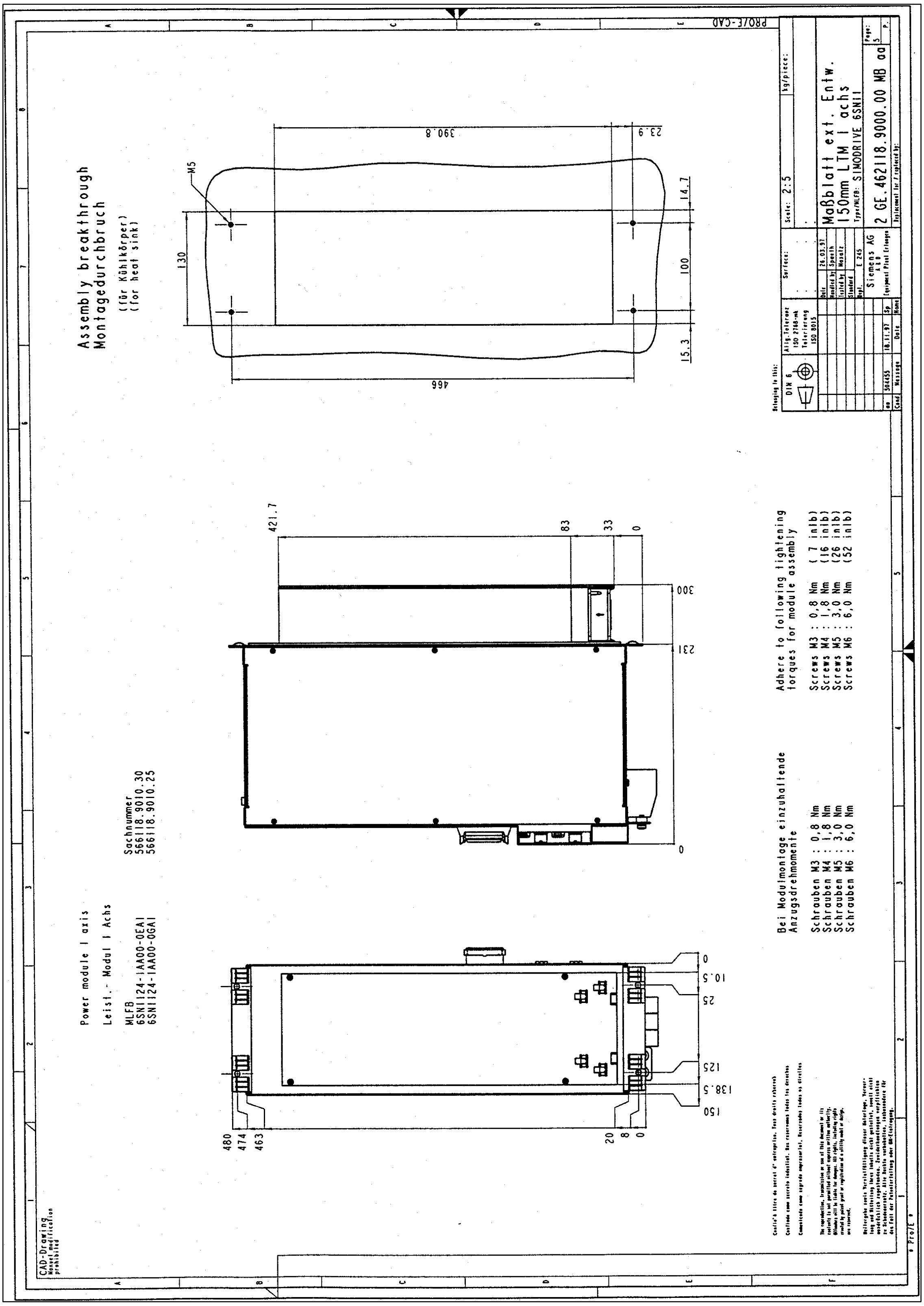

Fig. 13-25 External cooling, 2GE.462118.9000.00 MB aa, Sheet 5

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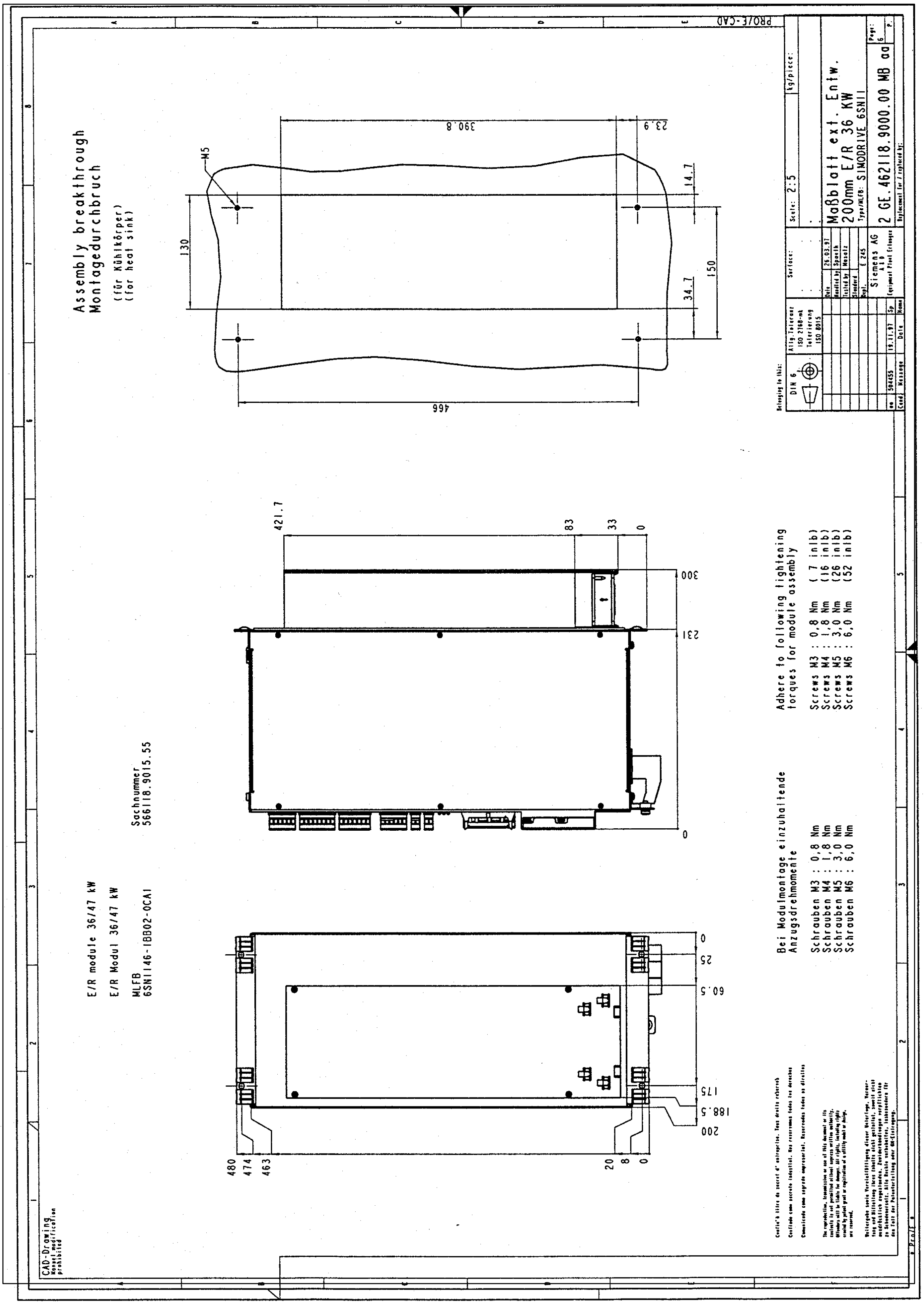

Fig. 13-26 External cooling, 2GE.462118.9000.00 MB aa, Sheet 6

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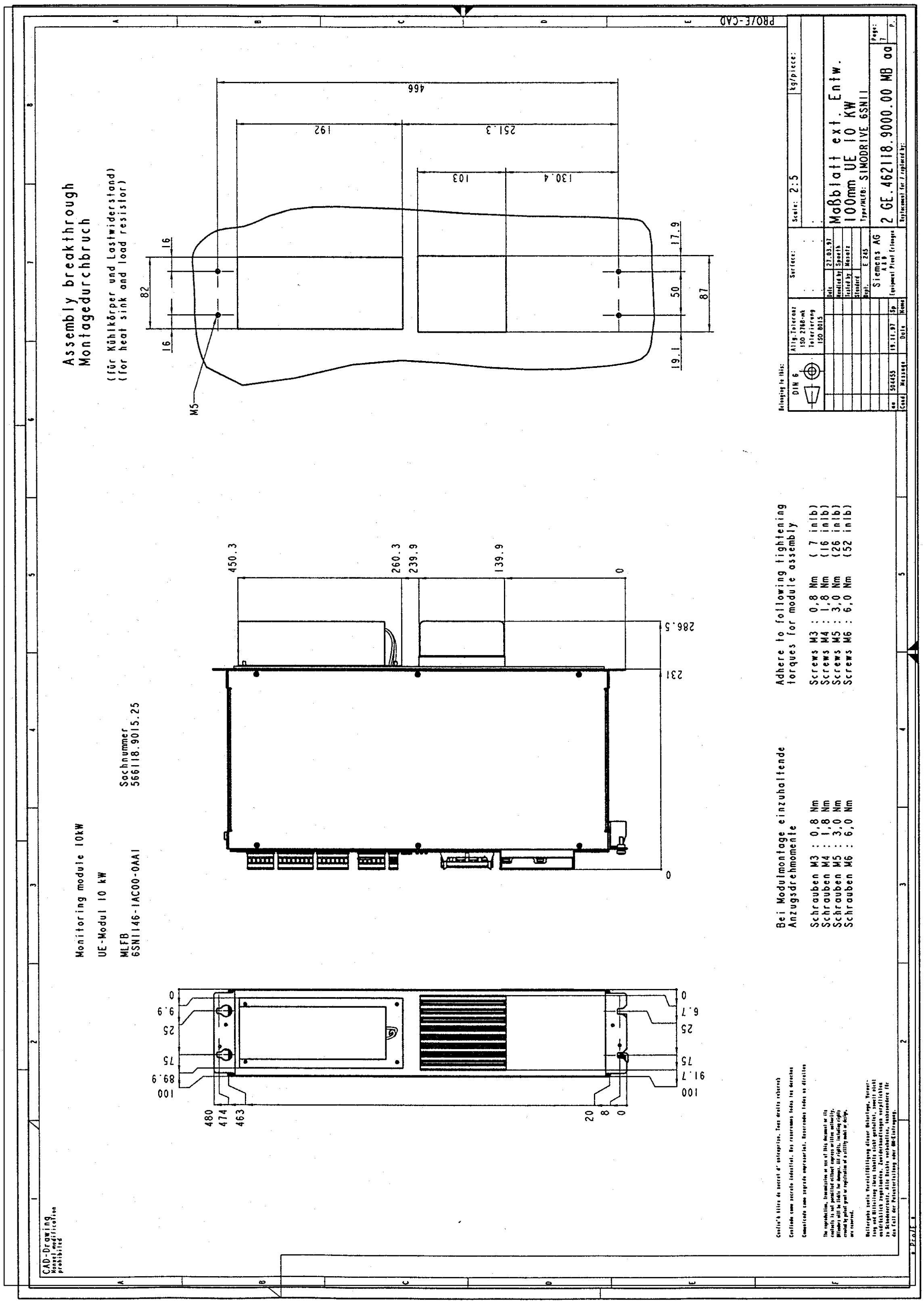

Fig. 13-27 External cooling, 2GE.462118.9000.00 MB aa, Sheet 7

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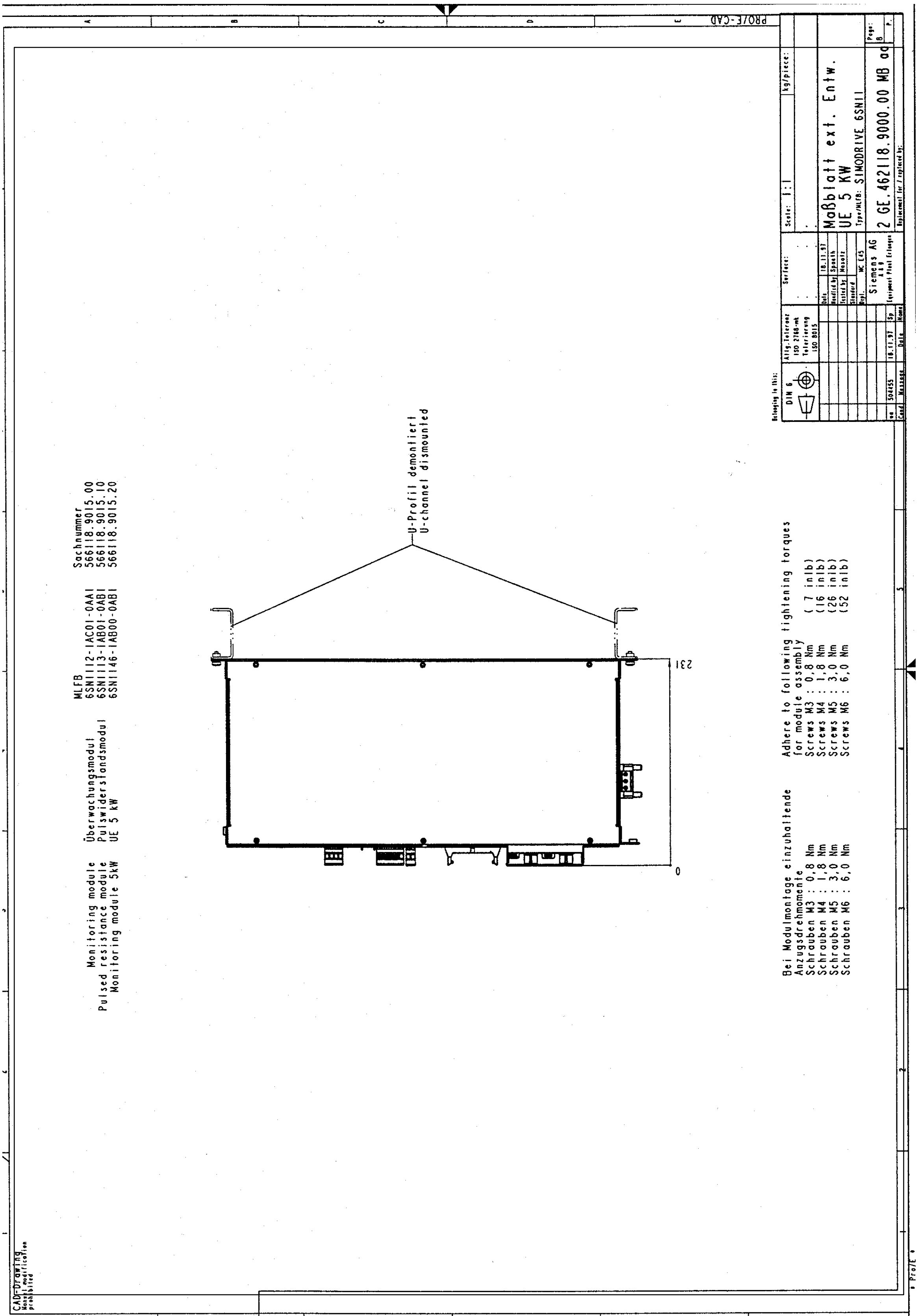

Fig. 13-28 External cooling, 2GE.462118.9000.00 MB aa, Sheet 8

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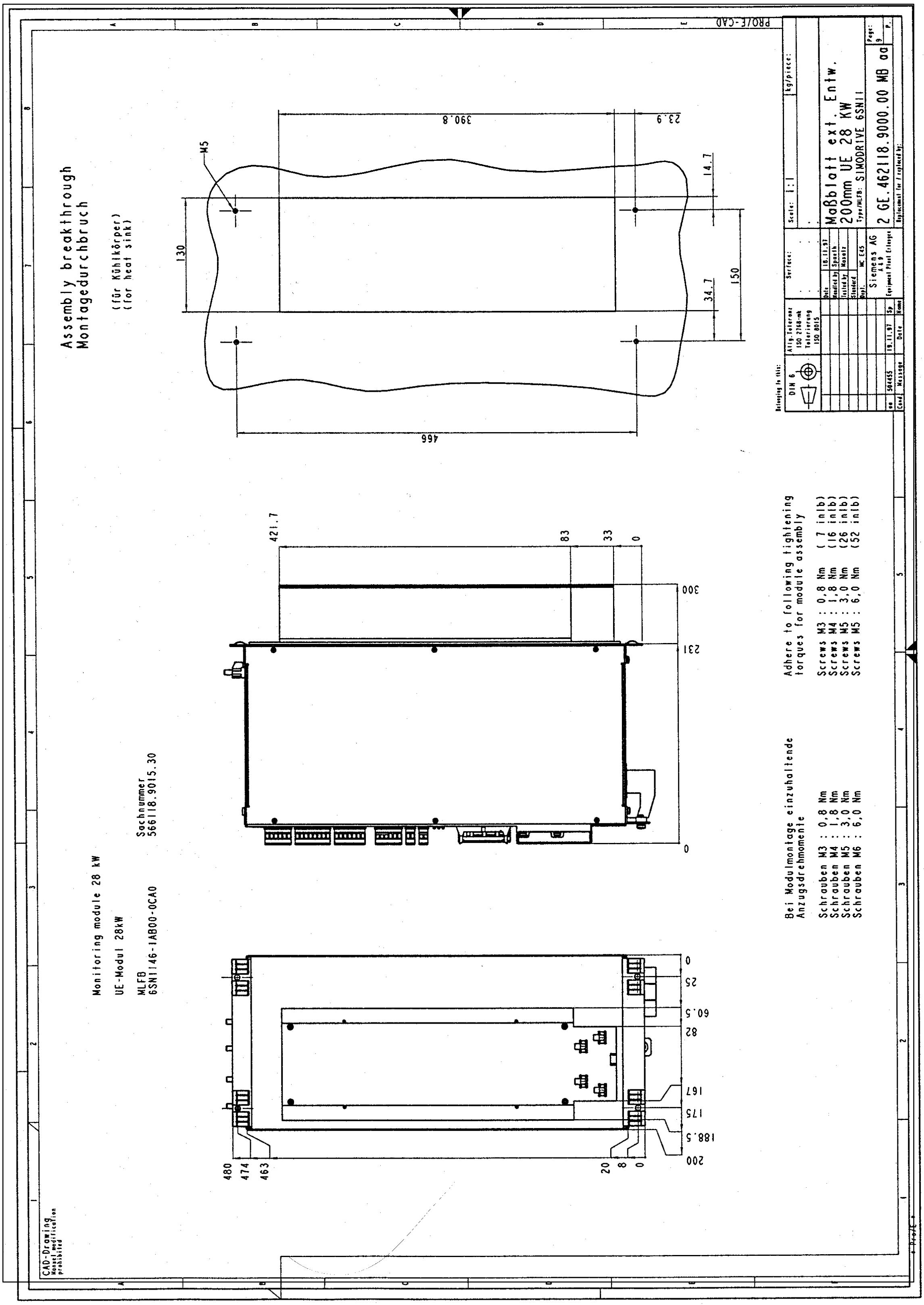

Fig. 13-29 External cooling, 2GE.462118.9000.00 MB aa, Sheet 9

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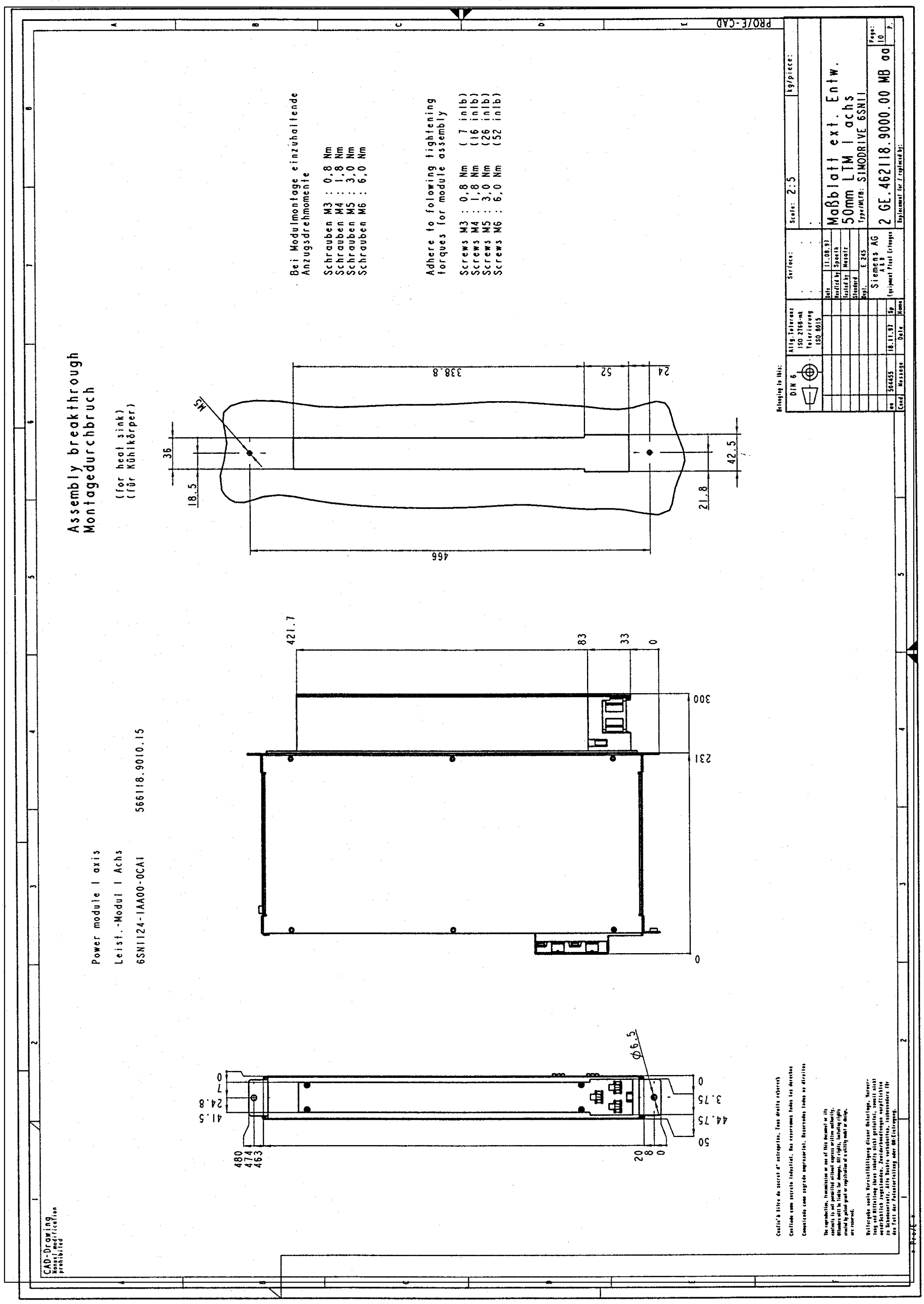

Fig. 13-30 External cooling, 2GE.462118.9000.00 MB aa, Sheet 10

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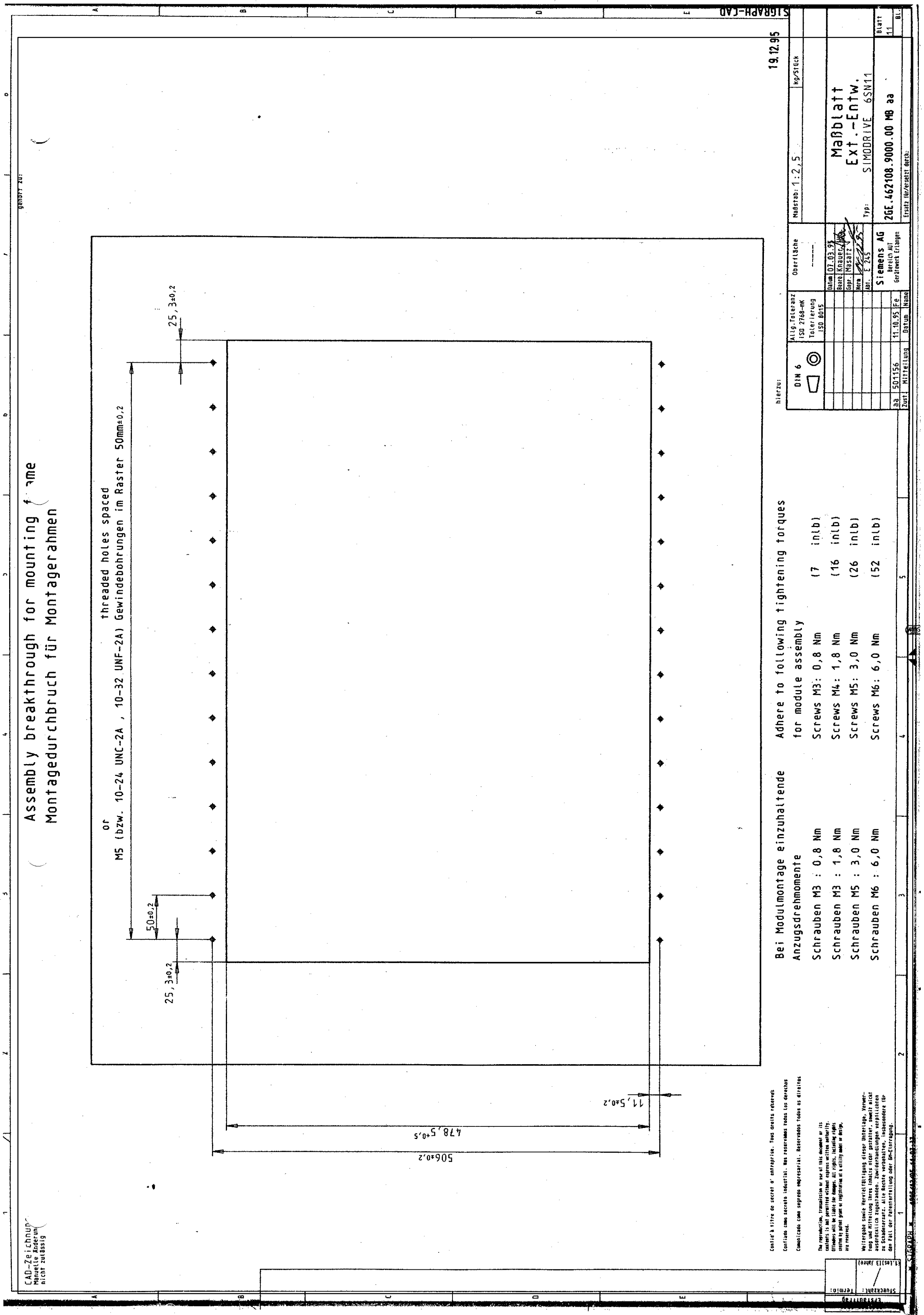

Fig. 13-31 External cooling, 2GE.462118.9000.00 MB aa, Sheet 11

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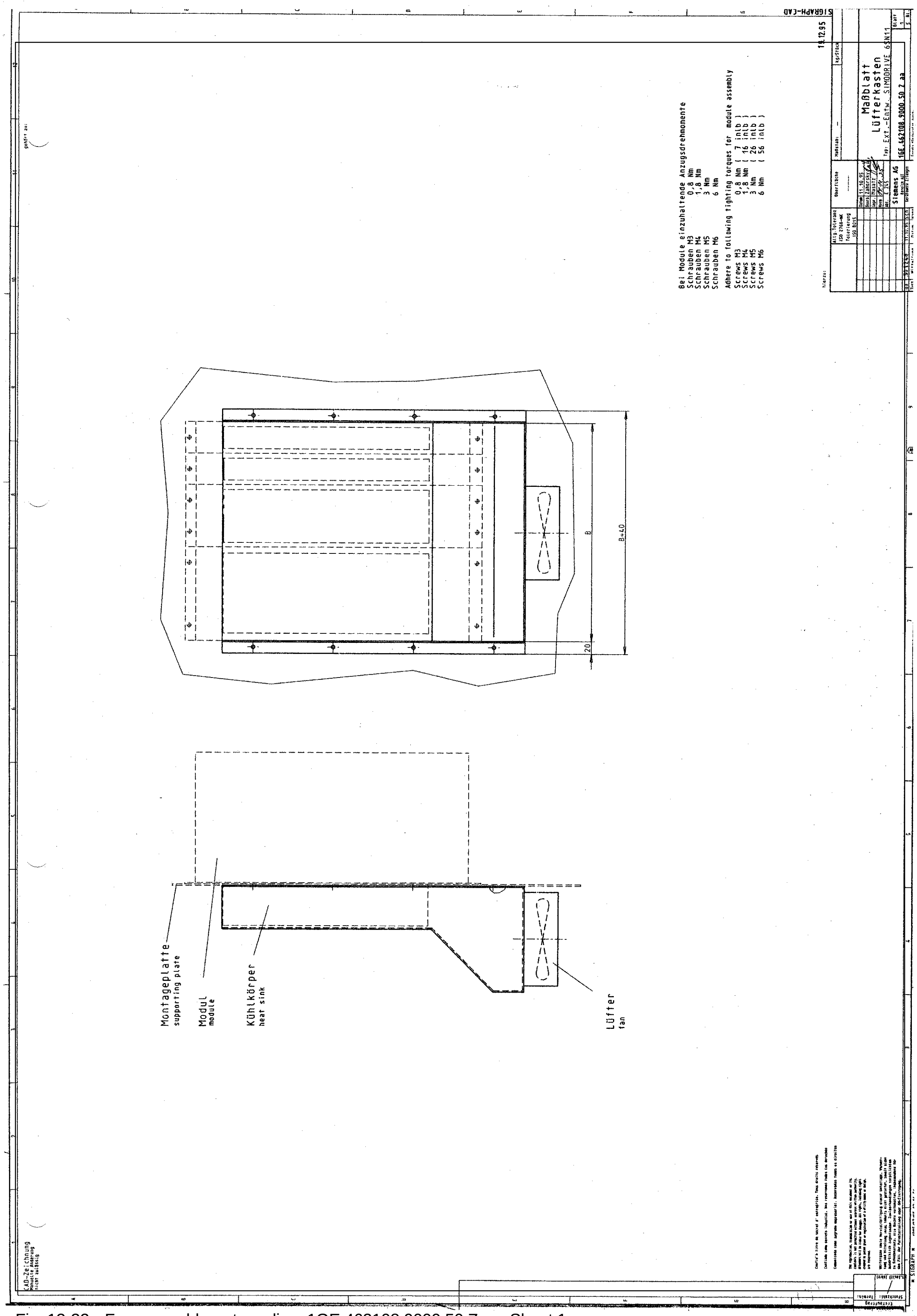

Fig. 13-32 Fan assembly, ext. cooling, 1GE.462108.9000.50 Z aa, Sheet 1

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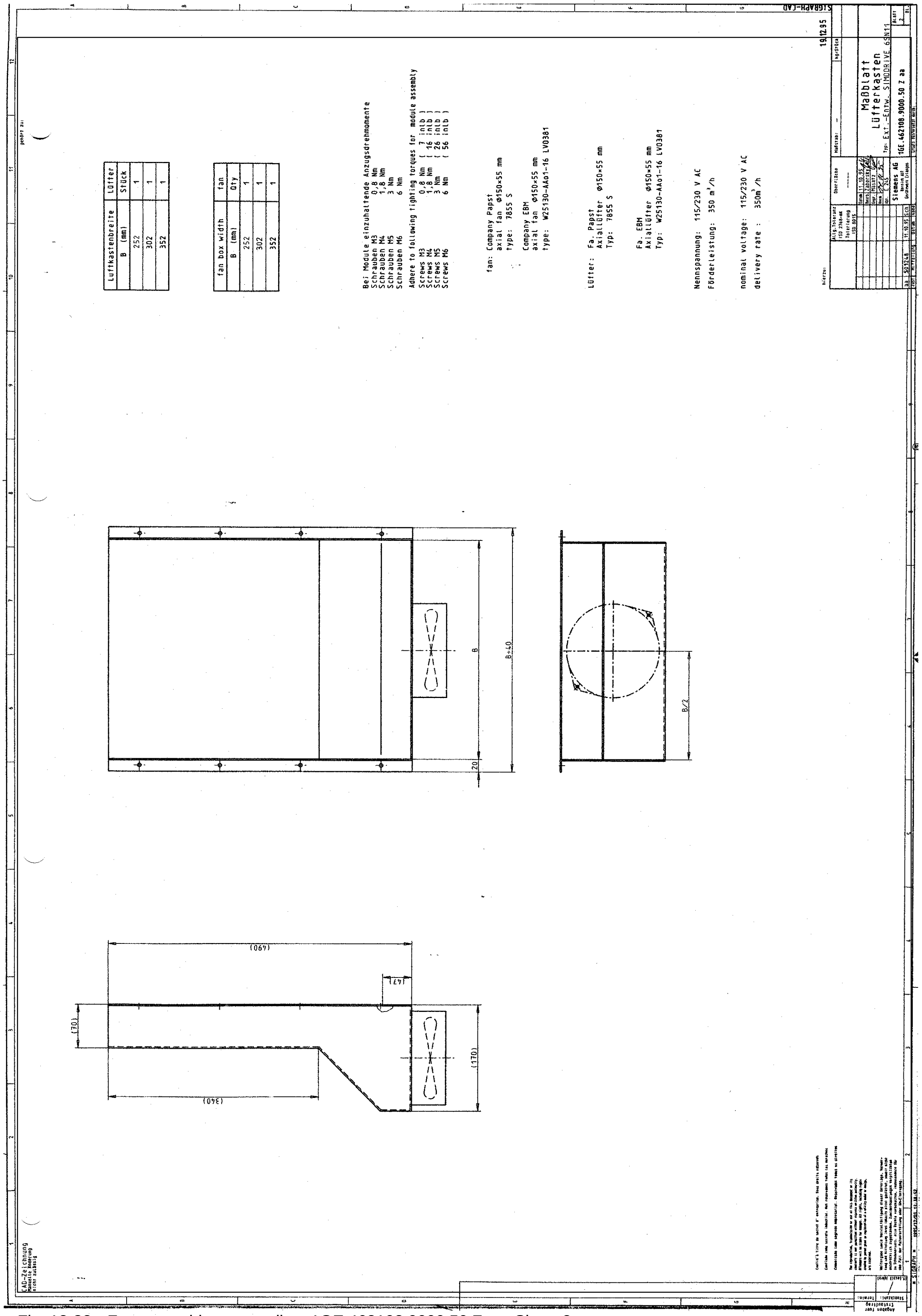

Fig. 13-33 Fan assembly, ext. cooling, 1GE.462108.9000.50 Z aa, Sheet 2

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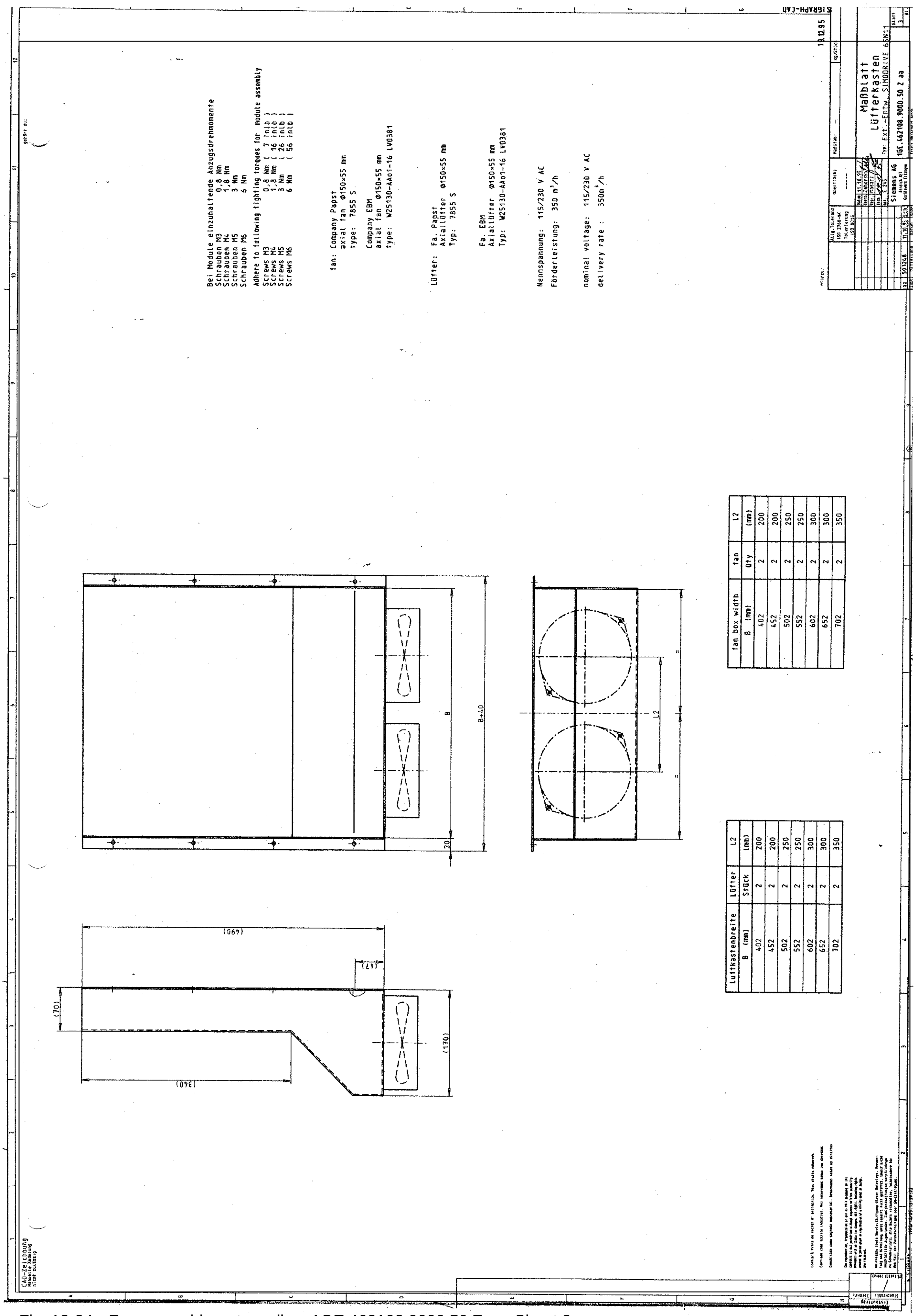

Fig. 13-34 Fan assembly, ext. cooling, 1GE.462108.9000.50 Z aa, Sheet 3

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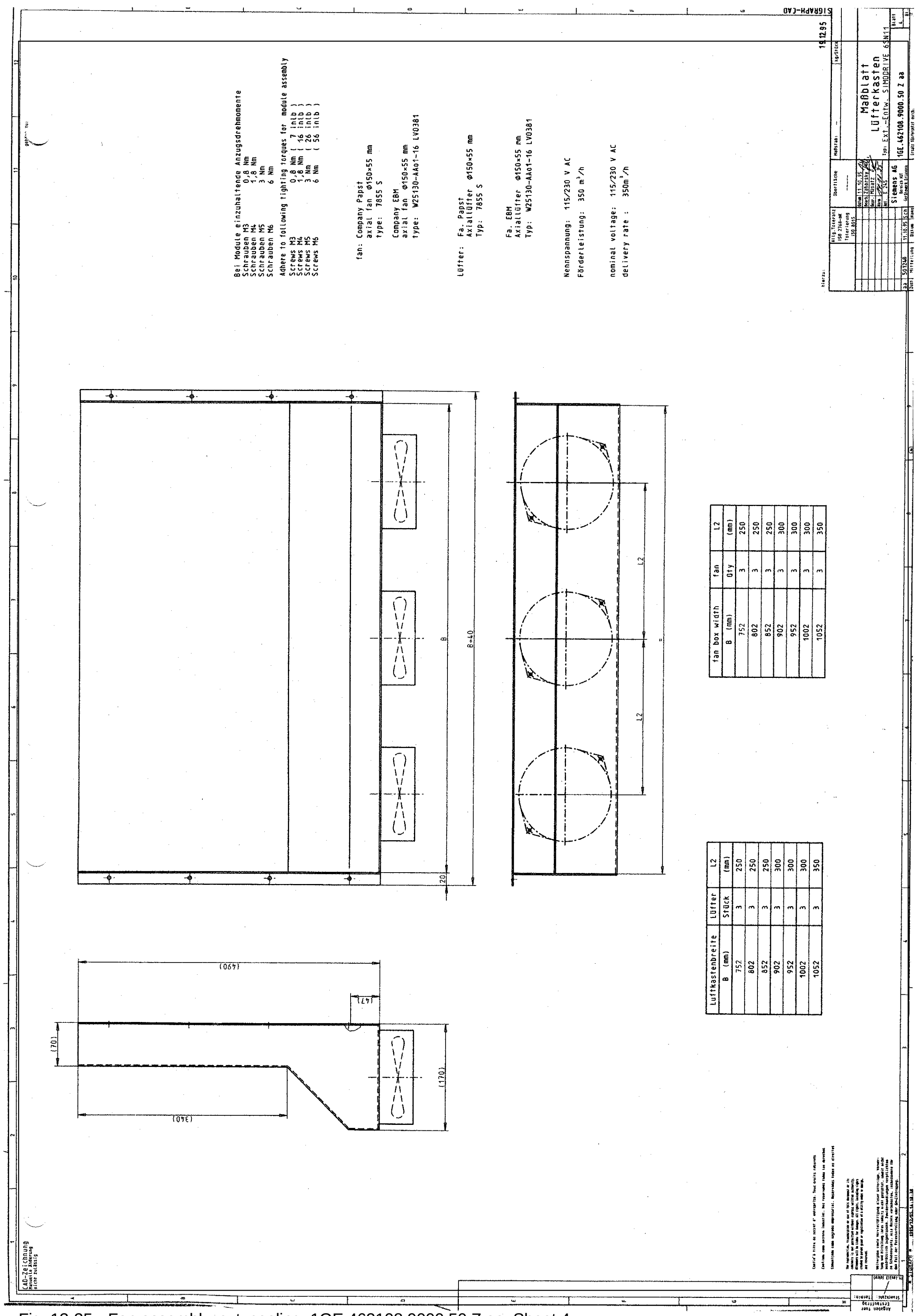

Fig. 13-35 Fan assembly, ext. cooling, 1GE.462108.9000.50 Z aa, Sheet 4

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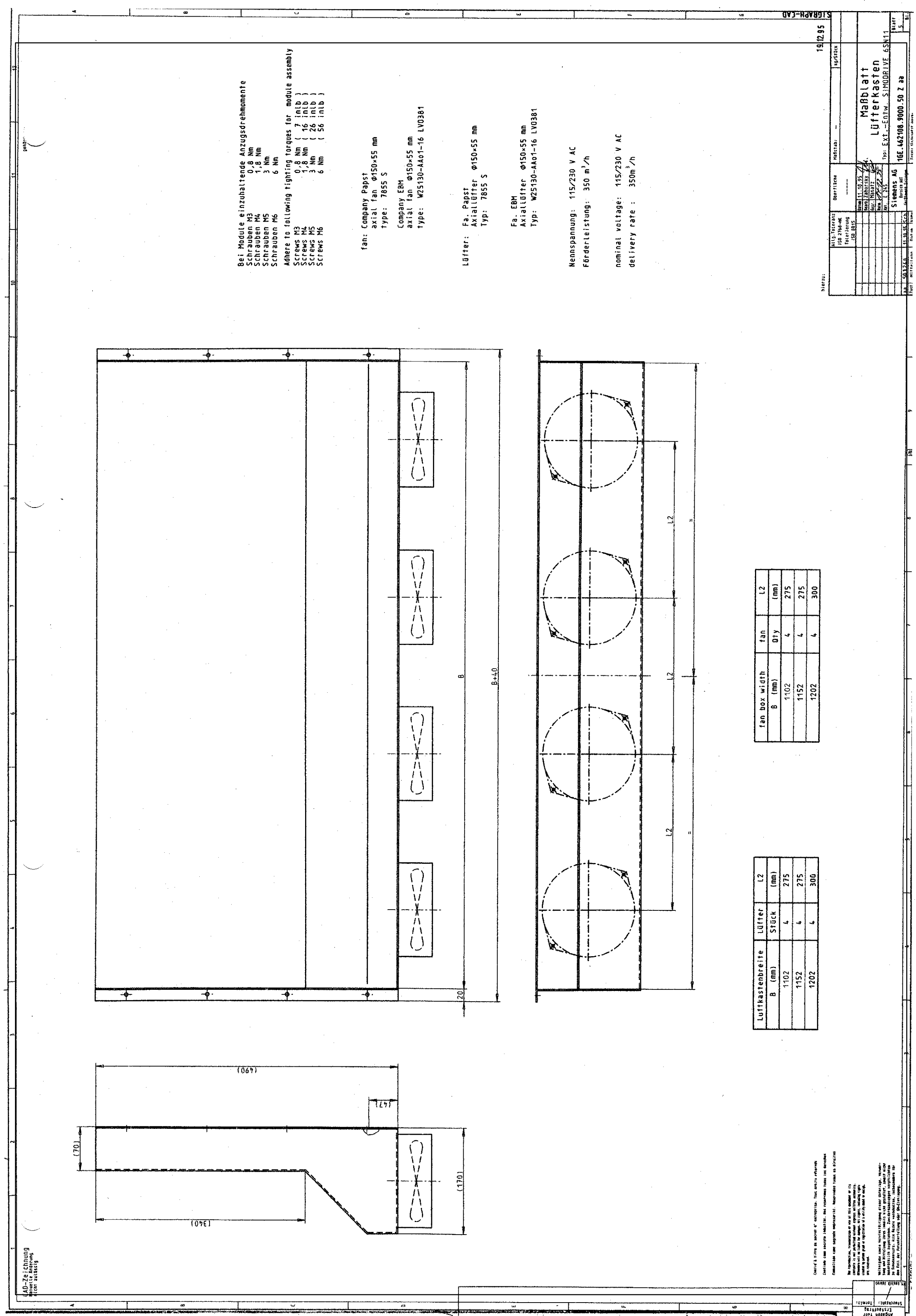

Fig. 13-36 Fan assembly, ext. cooling, 1GE.462108.9000.50 Z aa, Sheet 5

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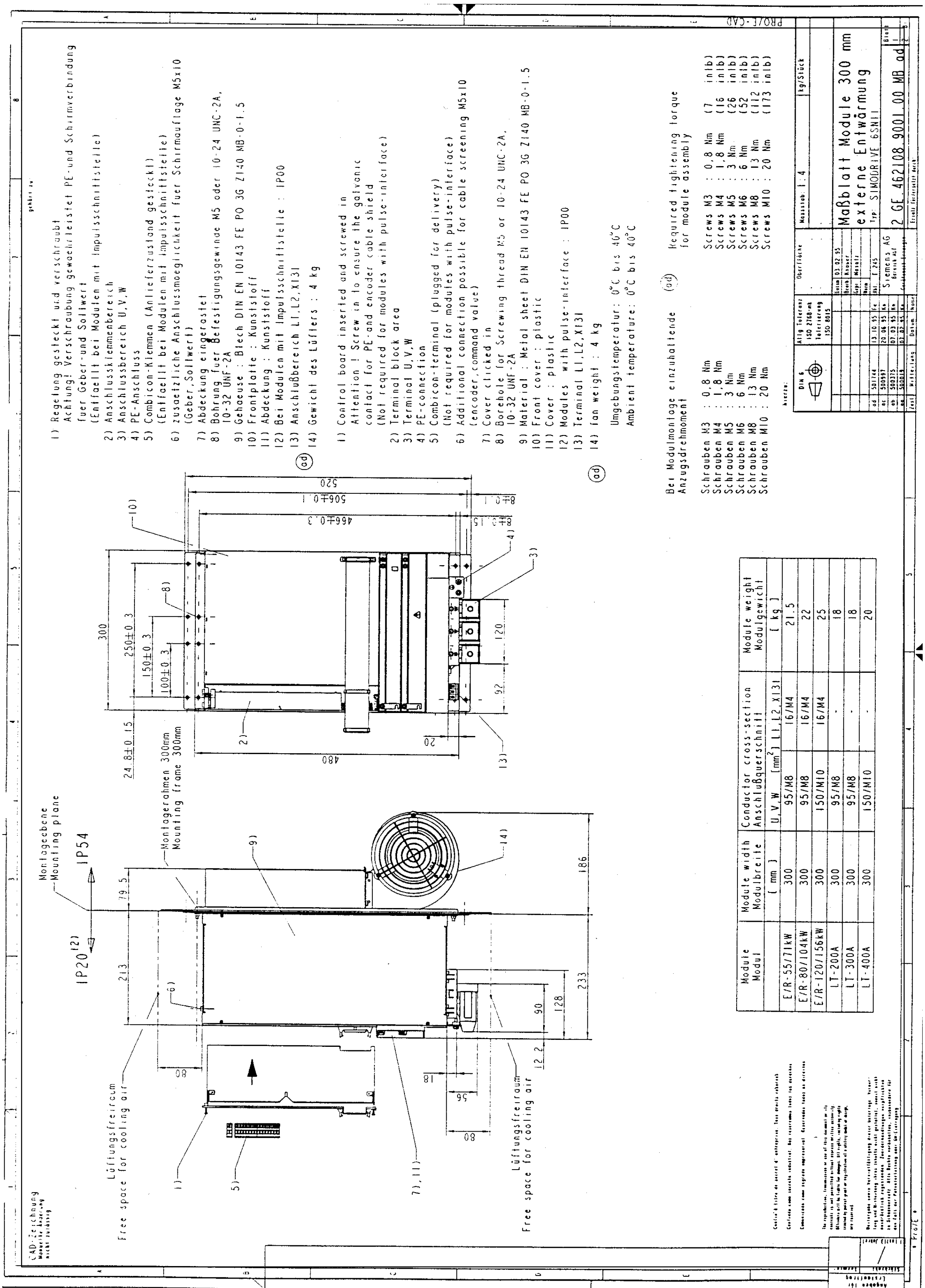

Fig. 13-37 Module 300 mm, ext. cooling, 2GE.462108.9001.00 MB ad, Sheet 1

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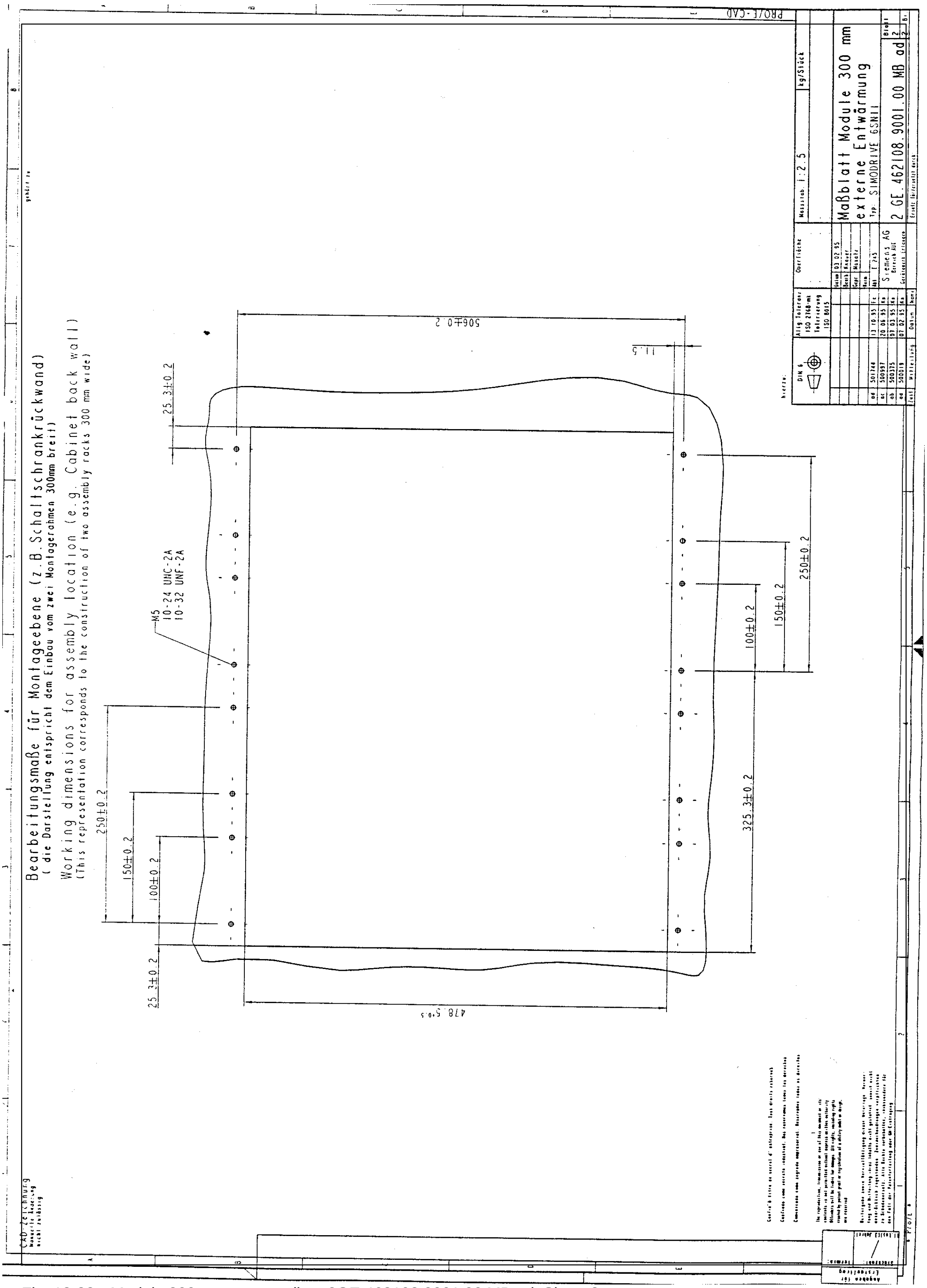

Fig. 13-38 Module 300 mm, ext. cooling, 2GE.462108.9001.00 MB ad, Sheet 2

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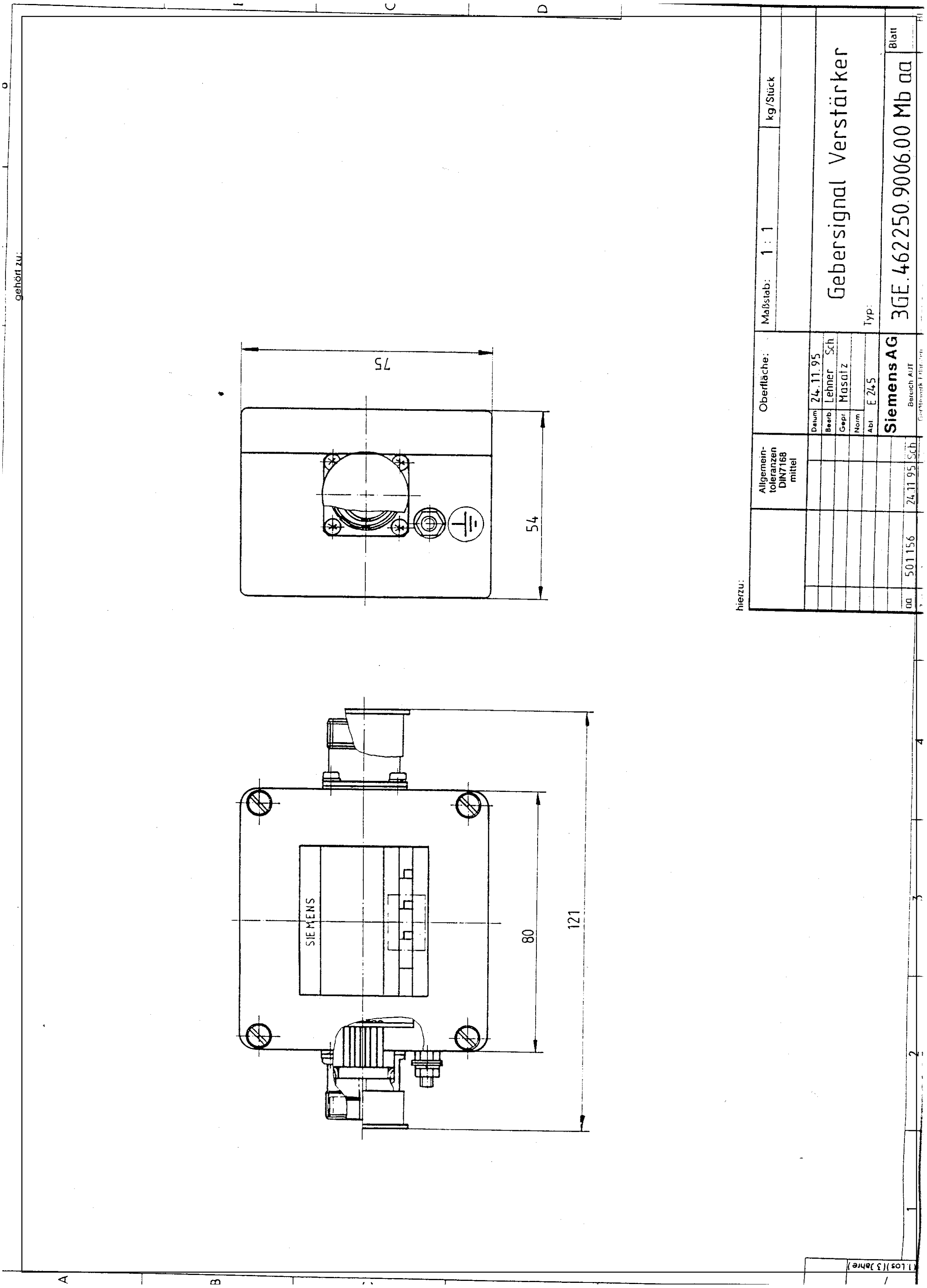

Fig. 13-39 Encoder signal amplifier, 3GE.462250.9006.00 MB aa

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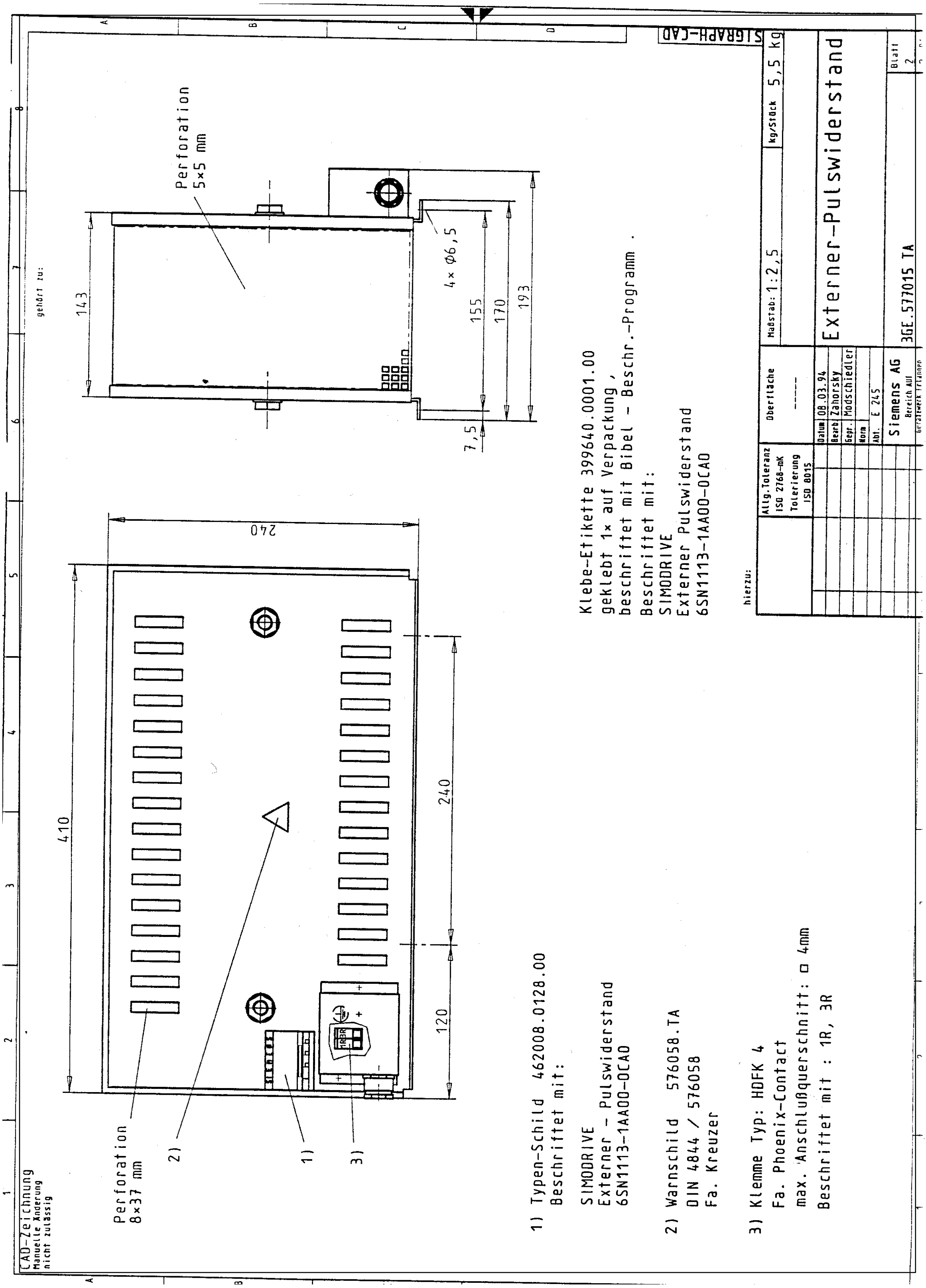

Fig. 13-40 External pulsed resistor, 3GE.577015 TA ab, Sheet2

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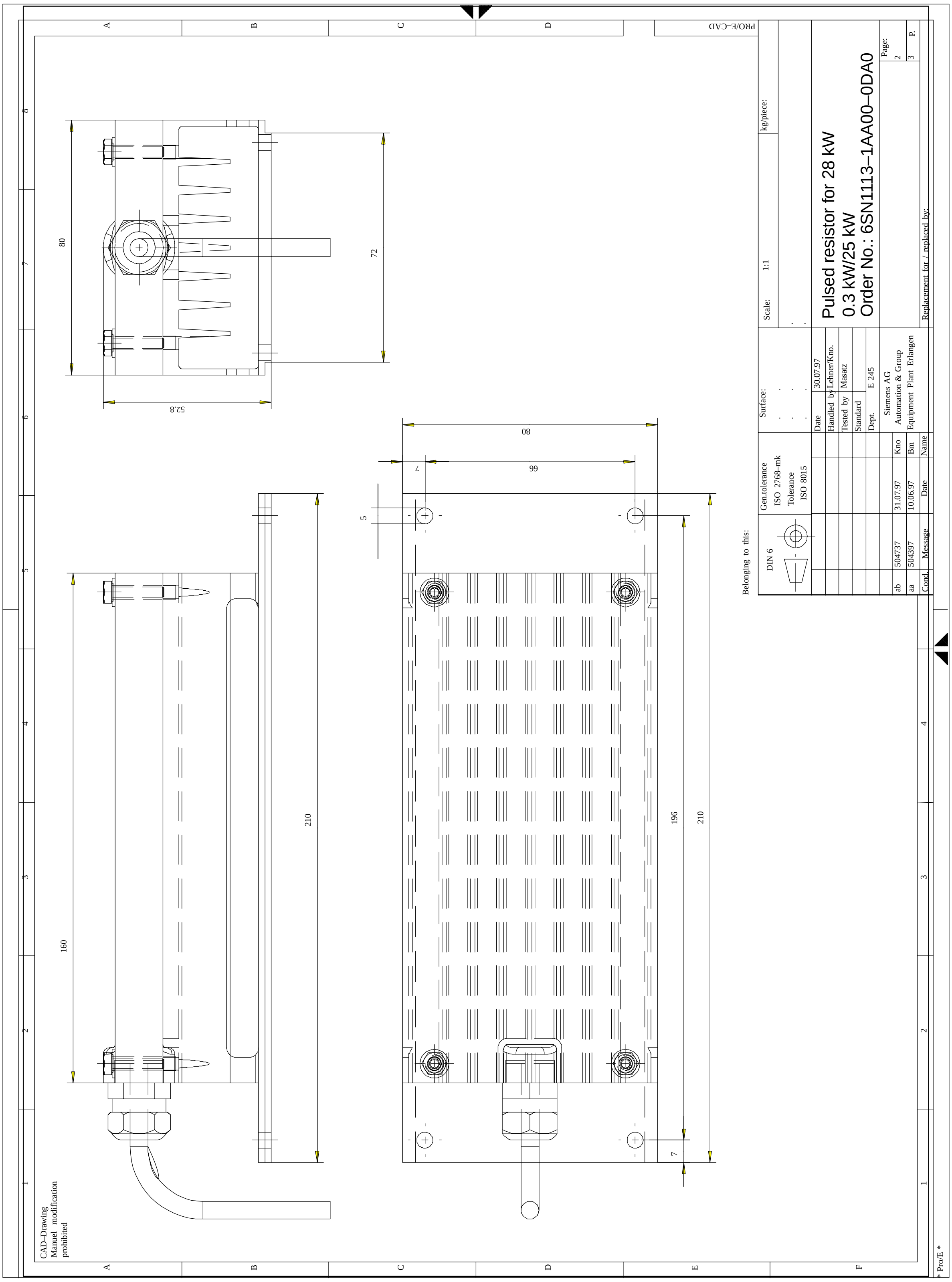

Fig. 13-41 Pulsed resistor for 28kW, 3GE.585679 TA ab, Sheet2

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EC Declaration of Conformance

A

Note

An excerpt from the EC Declaration of Conformation No. 002 V 18/10/95 is provided in the following. The complete EC Declaration of Conformance is provided in the brochure ”EMC Guidelines for SINUMERIK and SIROTEC controls”.

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SIEMENS

EG-Konformitätserklärung

Nr. 002 V 18/10/95

Hersteller: SIEMENS AG

Anschrift: SIEMENS AG AUT 2
Frauenauracherstraße 80
91056 Erlangen

Produktbezeichnung: SINUMERIK 805, 805SM-P, 805SM-TW, 810, 820,
840C, 840D, FM NC
SIROTEC RCM1D, RCM1P
SIMODRIVE 610, 611A, 611D

Die bezeichneten Produkte stimmen mit den Vorschriften folgender Europäischer Richtlinie überein:

89/336/EWG-Richtlinie des Rates zur Angleichung der Rechtsvorschriften der Mitgliedsstaaten über die elektromagnetische Verträglichkeit (geändert durch 91/263/EWG, 92/31/EWG und 93/68/EWG)

Die Einhaltung dieser Richtlinie setzt einen EMV-gerechten Einbau der Produkte in die Gesamtanlage voraus.
Anlagenkonfigurationen, bei der die Einhaltung dieser Richtlinie nachgewiesen wurde, sowie angewandte Normen, siehe:

- **Anhang A1 - A10 (Anlagenkonfigurationen)**
- **Anhang B1 - B7 (Komponenten)**
- **Anhang C (Normen)**

SIEMENS

Erlangen, den 18.10.1995

Name, Funktion	Unterschrift	Name, Funktion	Unterschrift
R. Müller Entwicklungsleitung		P. Müller Qualitätsmanagement	

Der Anhang ist Bestandteil dieser Erklärung.
Diese Erklärung bescheinigt die Übereinstimmung mit der genannten Richtlinie, ist jedoch keine Zusicherung von Eigenschaften im Sinne des Produkthaftungsgesetzes.
Die Sicherheitshinweise der mitgelieferten Produktdokumentation sind zu beachten.

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Attachment A
to the EC Declaration of Conformance No. 002 V 18/10/95

It has been proven that the products are in compliance with the Directive of the Council Committee 89/336/EC.

Relevant Standards:

Product Standard EN 61800–3 status 07/96

Components are offered (e.g. filter etc.), which allow the basic standard to be met when correctly mounted/installed .

Basic Standard: EN 50081–2 status 8/93

Basic Standards:	EN 55011	status 1991	1)

Specialist standard prEN 50082–2 status 8/94

Basic Standards:	ENV 50140	status 8/1993	2)
	ENV 50141	status 8/1993	3)
	EN 61000–4–8	status 5/1994	4)
	EN 61000–4–2	status 10/1994	5)
	IEC 801–4	status 1988	6)

Other standards which are complied with

to 1)	VDE 0875, Part 11	status 7/1992
to 2)	VDE 0847, Part 3	status 8/1993
to 3)	IEC 801–6	status 2/1992
to 4)	VDE 0847, Part 4–8	status 5/1994
	IEC 1000–4–8	status 1993
to 5)	VDE 0847, Part 4–2	status 10/1994
	EN 60801, Part 2	status 3/1994
	IEC 801–2	status 4/1991
	VDE 0843, Part 2	status 3/1994
to 6)	VDE 0843, Part 4	status 9/1987

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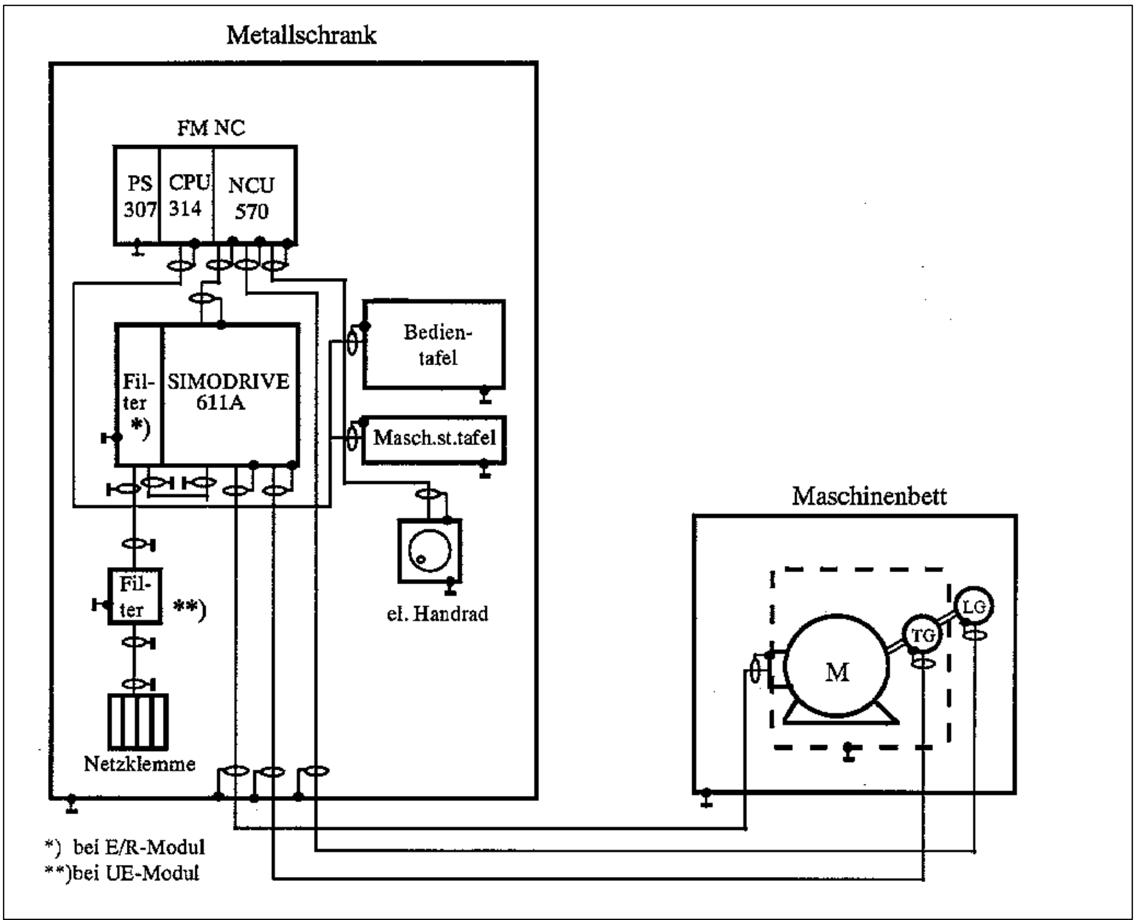
Attachment A
to the EC Declaration of Conformance No. 002 V 18/10/95 (excerpt)

A8: Typical system configuration SINUMERIK FM NC/SIMODRIVE 611A



- All of the components, which are permitted in accordance with the ordering documentation for the SINUMERIK FM NC and SIMODRIVE 611A drive group fulfill, as a group, Directive 89/336/EWG
- Conformance with the Standards, refer to Attachment C

Note

Only the basic measures requried for compliance with the Directive 89/336/EC of a typical system configuration are shown in the sketch of the system configuration. The installation information/instructions for EMC correct system design in the product documentation and the Siemens EMC Directive (Order No.: 6ZB5410–0HX01–0AA0) should be additionally observed, especially when deviating from system configuration.

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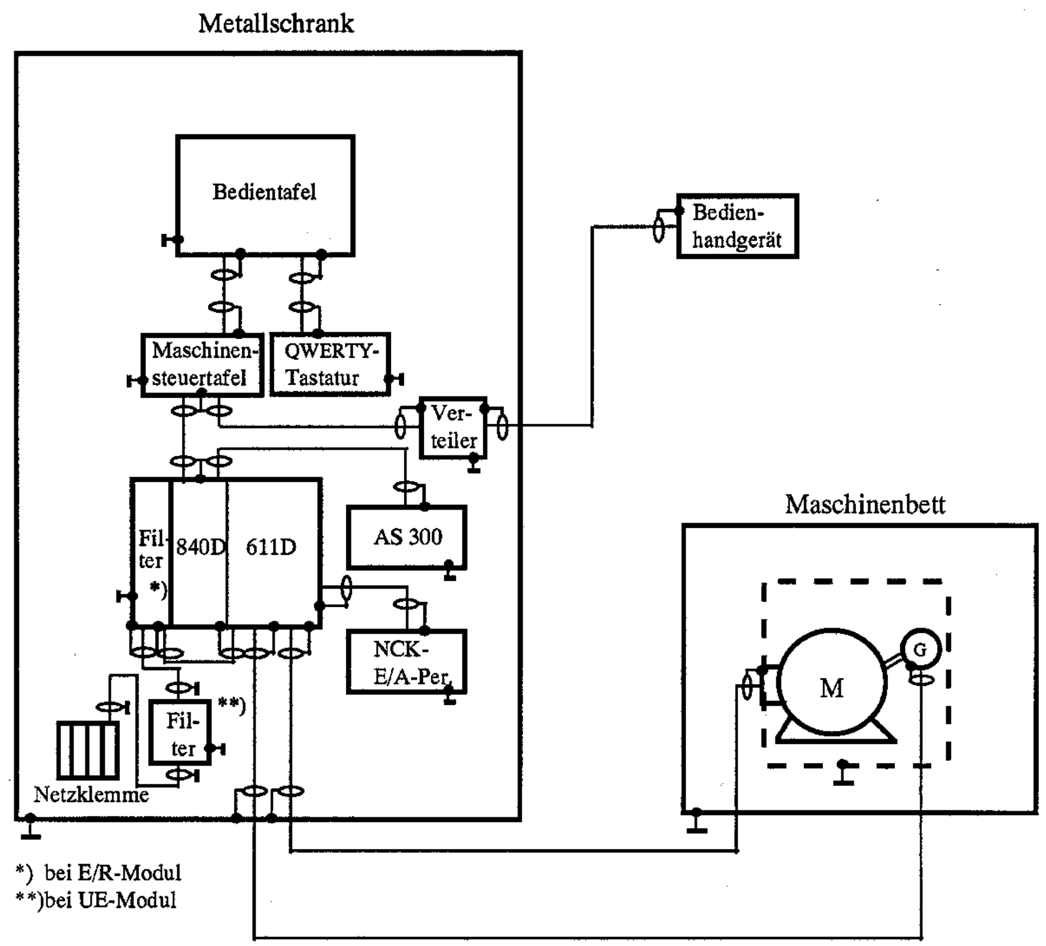
Attachment A
to EC Declaration of conformance No. 002 V 18/10/95 (excerpt)

A9: Typical system configuration SINUMERIK 840D / SIMODRIVE 611D



- All of the components which are permitted, in accordance with the ordering documentation for the SINUMERIK 840D and SIMODRIVE 611D drive group fulfill, as a group, Directive 89/336/EWG
- Conformance with the Standards, refer to Attachment C

Note

Only the basic measures required for compliance with the Directive 89/336/EC of a typical system configuration are shown in the sketch of the system configuration. The installation information/instructions for EMC correct system design in the product documentation and the Siemens EMC Directive (Order No.: 6ZB5410–0HX01–0AA0) should be additionally observed.

A

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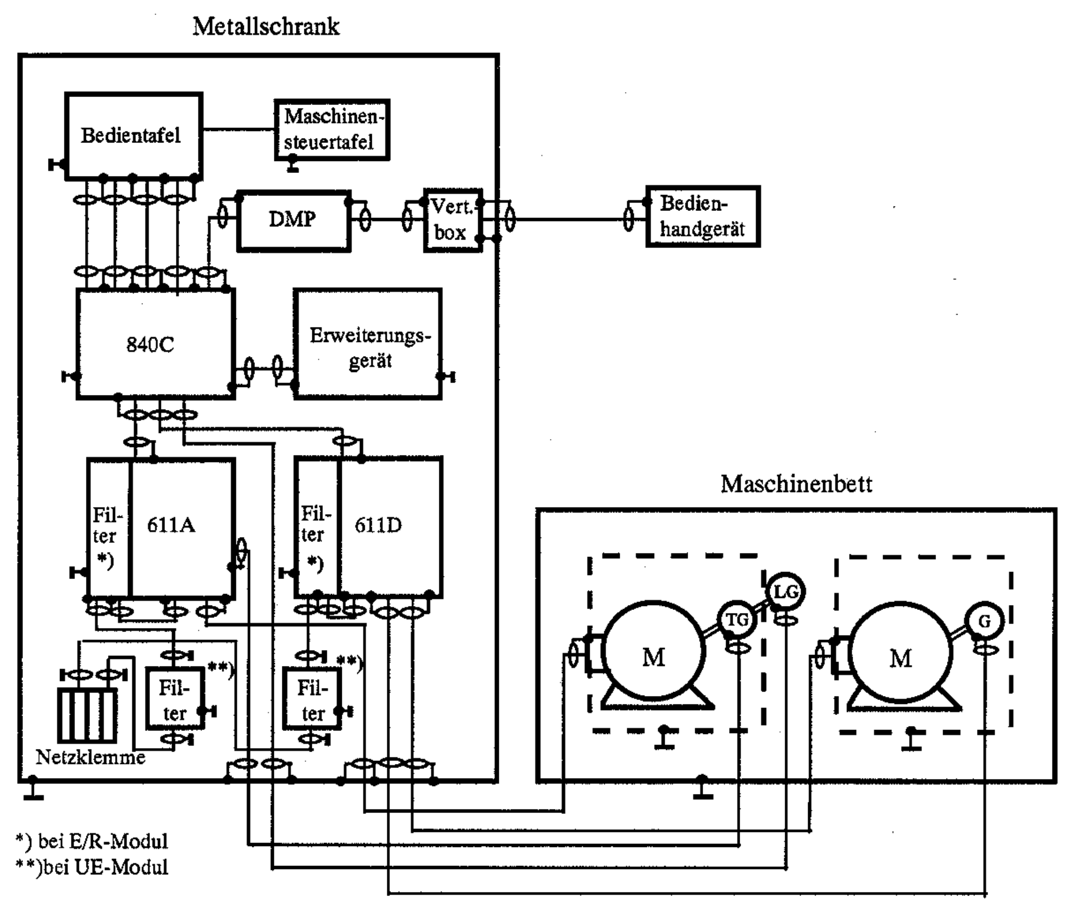
Attachment A
to EC Declaration of Conformance No. 002 V 18/10/95 (excerpt)

A10: Typical system configuration SINUMERIK 840C / SIMODRIVE 611A/D



- All of the components, which are permitted in accordance with the ordering documentation for the SINUMERIK 840C and SIMODRIVE 611A/D drive group fulfill, as a group, Directive 89/336/EWG
- Conformance with the Standards, refer to Attachment C

Note

Only the basic measures required for compliance with the Directive 89/336/EC of a typical system configuration are shown in the sketch of the system configuration. The installation information/instructions for EMC correct system design in the product documentation and the Siemens EMC Directive (Order No.: 6ZB5410–0HX01–0AA0) should be additionally observed.

■

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Abbreviations and Terminology

B

611 A	A for Analog
611 D	D for Digital
611 U	U for Universal
611 UE	UE for Universal Eco
Analog closed–loop control	Control board with analog interface
Digital closed–loop control	Control board with digital interface
Drive module	General term for main spindle and feed modules
EP	Electronics weighting factor
EnDat	Encoder–Data–Interface (bi–directional synchronous–serial interface)
External cooling	Module with heatsink for insertion, cooling on the customer's side
FD module	Feed drive module
HGL	High–resolution position actual value
I/R module	Infeed regenerative feedback module with controlled DC link voltage
IM	Induction Motor
IRM	Induction Rotating Motor
Internal cooling	Module with integrated heatsink, in some cases with pipe connection
L2DP	L2 distributed periphery
MCU	Motion–Control–Unit (single–axis positioning board)
Monitoring module	Monitoring module
MPI	Multi Point Interface
MRPD	Machine Readable Product Designation
MSD module	Main spindle module
MSD option	Option board, main spindle options for FD module

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NCU Numeric control unit

NE module Supply infeed module (general term for UI and I/R module)

Operator panel interface Operator panel interface

PELV Protective Extra Low Voltage

Power module Power module

PPU Protected Power Unit

Pulsed resistor module Pulsed resistor module

SLM Synchronous linear motor

SRM Synchronous rotating motor

SSI Synchronous Serial Interface

SVE Current amplification electronics

UI module Infeed module with uncontrolled DC link voltage and pulsed resistor

VDClink DC link voltage

VE Packing unit

WSG Angular encoder interface

■

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References

C

General documentation

/NC60/ SIMODRIVE 611
Catalog NC 60
Order number: E86060–K4460–A101–A8
Order number: E86060–K4460–A101–A8 –7600 (English)

/NCZ/ SINUMERIK, SIROTEC, SIMODRIVE
Accessories and Equipment for Special–Purpose Machines
Catalog NC Z
Order number: E86060–K4490–A001–A7
Order number: E86060–K4490–A001–A7 –7600 (English)

/NSK/ Low–Voltage Switchgear
Automation and Drives
Catalog NS K
Order number: E86060–K1002–A101–A1

Electronic documentation

/CD6/ The SINUMERIK System (10.00 Edition)
DOC ON CD
(includes all SINUMERIK 840D/840Di/810D/FM–NC and SIMODRIVE publications)
Order number: 6FC5 298–6CA00–0BG0

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User documentation

/PI /

PCIN 4.4
Software for Data Transfer to/from MMC module
Order number: 6FX2 060 4AA00–4XB0 (German, English, French)
Ordering location: WK Fürth

Manufacturer/Service Documentation

a) Lists

/LIS/

SINUMERIK 840D/840Di/810D/FM–NC
SIMODRIVE 611D
Lists (10.00 Edition)
Order number: 6FC5 297–6AB70–0BP0

/ASA/

Safety Integrated
Application Manual
Order number: E20001–A110–M103

b) Hardware

/BHA/

SIMODRIVE **Sensor**
Absolute value encoder with Profibus–DP
User Manual (HW) (02.99 Edition)
Order number: 6SN1197–0AB10–0YP1

/EMV/

SINUMERIK, SIROTEC, SIMODRIVE
EMC Design Guideline
Planning Guide (HW) (06.99 Edition)
Order number: 6FC5 297–0AD30–0BP1

/PHF/

SINUMERIK FM–NC
Configuring Manual NCU 570 (HW) (04.96 Edition)
Order number: 6FC5 297–3AC00–0BP0

/PMH/

SIMODRIVE **Sensor**
Measuring System for Main Spindle Drives
Configuring/Installation Guide SIMAG–H (HW) (05.99 Edition)
Order number: 6SN1197–0AB30–0BP0

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c) Software

/FBAN/
SINUMERIK 840D/SIMODRIVE 611 digital
Description of Functions
ANA module (02.00 Edition)
Order number: 6SN1 197–0AB80–0BP0

/FBHLA/
SINUMERIK 840D/SIMODRIVE 611 digital
Description of Functions
HLA module (04.00 Edition)
Order number: 6SN1 197–0AB60–0BP2

/FBSI/
SINUMERIK 840D / SIMODRIVE 611 digital
Description of Functions **SINUMERIK Safety Integrated** (03.01 Edition)
Order number: 6FC5 297–6AB80–0BP0

/FBU/
SIMODRIVE 611 universal
Description of Functions (05.00 Edition)
Closed–Loop Control Component for Speed Control and Positioning
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/KBU/
SIMODRIVE 611 universal
Short Description (05.00 Edition)
Closed–Loop Control Component for Speed Control
Order number: 6SN1 197–0AB40–0BP3

/PJLM/
SIMODRIVE
Planning Guide **Linear Motors** (10.00 Edition)
(on request)
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1FN1 1FN1 Three–Phase AC Linear Motor
1FN3 1FN3 Three–Phase AC Linear Motor
CON Connections
Order number: 6SN1 197–0AB70–0BP1

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SIMODRIVE
Planning Guide **Motors**
Three–Phase AC Motors for Feed and
Main Spindle Drives (09.00 Edition)
Order number: 6SN1 197–0AA20–0BP4

/PJFE/
SIMODRIVE
Planning Guide **Synchronous Motors 1FE1**
Three–Phase AC Motors for Main Spindle Drives (03.00 Edition)
Order number: (on request)

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/SP/ **SIMODRIVE 611–A/611–D,**
SimoPro 3.1
Program for Configuring Machine–Tool Drives
Order number: 6SC6 111–6PC00–0AA□
Ordering location: WK Fürth

d) Installation and start–up

/IAA/ **SIMODRIVE 611A**
Installation and Start–up Guide (09.00 Edition)
Order number: 6SN 1197–0AA60–0BP5

/IAD/ SINUMERIK 840D/SIMODRIVE 611D
Installation and Start–up Guide (10.00 Edition)
(incl. description of SIMODRIVE 611D start–up software)
Order number: 6FC5 297–6AB10–0BP0

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Edition: 05.01

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General Documentation / Catalogs

- *SINUMERIK SIMODRIVE*
  Catalog NC 60 • 2000/2001
  Automation Systems for Machine Tools

- *SINUMERIK SIROTEC SIMODRIVE* — Accessories
  Catalog NC Z
  Connection Systems & System Components

- *SINUMERIK SIMODRIVE*
  Catalog CA 01
  Components for Automation & Drives

Manufacturer/Service Documentation

- *SIMODRIVE* — 611
  Planning Guide
  Inverters
  Drive converters

- *SIMODRIVE*
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  Motors
  Three–phase AC motors for feed and main spindle drives

- *SIMODRIVE*
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  1FE1 built–in synchronous motors

- *SIMODRIVE*
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- *SINUMERIK SIROTEC SIMODRIVE*
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  SINUMERIK SIROTEC SIMODRIVE

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- *SINUMERIK SIMODRIVE* — 840C
  DOC ON CD