SIEMENS

SIMODRIVE 611 digital

Configuration Manual

Drive Converters

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Equipment series 6SN11–

11.05 Edition

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SIMODRIVE® documentation

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The controller may support functions that are not described in this documentation. However, no claim can be made regarding the availability of these functions when the equipment is first supplied or in the event of servicing.

We have checked that the contents of this document correspond to the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee complete conformance. The information in this document is regularly checked and necessary corrections are included in reprints. Suggestions for improvement are also welcome.

Subject to change without prior notice.

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Foreword

Structure of thedocumentation

The SIMODRIVE documentation is subdivided into the following levels:

- General Documentation/Catalogs
- User Documentation
- Manufacturer/Service 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 document 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 not part of an earlier or existing contract or agreement nor do they change this.

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

Any statements contained herein neither create new warranties nor modify the existing warranty.

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

Target group

This documentation addresses machinery construction OEMs that which to engineer, configure and commission (start–up) a drive group with SIMODRIVE components.

Technical Support

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Internet address

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Current documentation

An overview of publications that is updated monthly is provided in a number of languages in the Internet under the following address:

http://www.siemens.com/motioncontrol

Select the menu items –> ”Support” –> ”Technical Documentation” –> ”Publications Overview”.

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

Certificates

Certificates for the products described in this Configuration Manual can be found under:

http://intra1.erlf.siemens.de/qm/home/index.html

Objectives

This Configuration Manual provides all of the detailed information required to use and handle SIMODRIVE components.

Should you wish for additional information or should exceptional problems arise that are not addressed in sufficient detail in this manual, you can request the required information from your local Siemens office.

Information for using this Manual

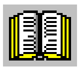
The following should be observed when using this manual:

1. Help: The following help is available for the reader:

- Complete table of contents
- Header line (as orientation):
  the main chapter is in the upper header line
  the sub–chapter is in the lower header line
- Appendix with
  - Abbreviations and List of References
  - Index

    If you require information regarding a specific term, then look for this in the Appendix under the Chapter ”Index”.
    The Chapter number as well as the page number is specified where information on this term can be found.

2. Edition of the documentation:



Reader’s note

Only the digital components for a SIMODRIVE group with High Performance/ High Standard modules are described in Edition 10.04. Please refer to the overview in Chapter 5.1 regarding from which software releases, use is possible.

The Configuration Manual, 02.03 Edition, still remains valid for the analog components that have been discontinued!

Definition: Who are qualified personnel?

Startup and operation of the device/equipment/system in question must only be performed using this documentation. Commissioning and operation of a device/ system may only be performed by **qualified personnel**. Qualified personnel as referred to in the safety instructions in this documentation are persons authorized to start up, ground, and label devices, systems, and circuits in accordance with the relevant safety standards.

Safety information/ instructions

This documentation contains information that must be observed to ensure your personal safety and to prevent material damage. The instructions for your personal safety are marked by a warning triangle. Instructions relating solely to material damage are not marked by a warning triangle. The warnings appear in decreasing order of risk as given below.

Danger

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

Warning

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

Caution

With a warning triangle indicates that minor personal injury **can** result if proper precautions are not taken.

Caution

Without warning triangle indicates that material damage **can** result if proper precautions are not taken.

Notice

indicates that an undesirable result or state **may** arise if the relevant note is not observed.

Proper use

Note the following:

Warning

This device may only be used as described in the catalog and in the technical description and only in connection with third–party devices and components recommended or approved by Siemens. To ensure trouble–free and safe operation of the product, it must be transported, stored and installed as intended and maintained and operated with care.

Other information

Note

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

Reader's note

This symbol is shown, if it relates to important information which the reader must observe.

Technical information

Notice

As a result of the high switching frequencies, capacitances (parasitic and integrated) with respect to ground conduct discharge currents. This is the reason that a permanent PE connection is required at the cabinet and at the line filter!

Measures according to EN 50178/94 Part 5.3.2.1 must be implemented, e.g.

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

This conductor must also fully meet the requirements for PE conductors according to IEC 364–5–543.

Warning

When electrical equipment is operated, certain parts of this equipment are inevitably under dangerous voltage.

Incorrect handling of these units, i.e. not observing the warning information, can therefore lead to death, severe bodily injury or significant material damage.

Only appropriately qualified personnel may commission this equipment.

These personnel must be thoroughly familiar with all warning and maintenance procedures described in these operating instructions.

Perfect, safe and reliable operation of the equipment assumes that it has been professionally transported, stored, mounted and installed as well as careful operator control and service.

Hazardous axis motion can occur when working with the equipment.

Further, all of the relevant national, local land plant/system–specific regulations and specifications must be taken into account.

Caution

The DC link discharge voltage hazard warning in the local language must be clearly attached to the appropriate modules.

Note

When handling cables, please observe the following:

- They may not be damaged,
- they may not be stressed,
- they may not come into contact with rotating components**.**

For IT and TT line supply systems, connected measuring/test equipment and programming devices must be referred to the reference potential of the module group.

Notice

M600 and M500 are not PE potentials (voltages). Hazardous voltages of between 300 ... 400 V with respect to PE are present at the terminals. These potentials (voltages) may not be connected to PE.

Warning

The ”protective separation” can only be guaranteed when using the components permitted/certified for the system.

”Protective separation” can only be guaranteed when it is absolutely certain that the system components have the appropriate degree of protection.

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

For unlisted motors/third–party motors, ”protective separation” is required between the temperature sensor and motor winding.

If these limitations and constraints are not carefully observed then this can result in injury due to electric shock.

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. If this is not observed, this can result in injury.

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 quotations applies.
- Further, all of the relevant national, local land plant/system–specific regulations and specifications must be taken into account.
- All work should be undertaken with the system in a no–voltage condition!

If this is not observed, this can result in injury.

Warning

A hazardous residual voltage is still present after all of the voltages have been shut down/disconnected. For capacitor modules, this hazardous voltage can be present for up to 30 min.

In order to ensure that no hazardous voltages are present, the voltage must be first carefully measured (generator principle when motors are rotating). If this is not observed, then this can result in injury due to electric shock.

Warning

The rated current of the connected motor must match the rated converter current. If this is not the case, then the protection of the motor cables is no longer guaranteed. The cross–section of the motor feeder cable must be dimensioned for the rated drive converter current. If this is not carefully observed, cables can overheat and can even cause an equipment fire.

Caution

When using mobile radios (e.g. cellular phones, mobile phones, 2–way radios) with a transmission power of > 1 W close to the equipment (< 1.5 m) the function of the equipment can be disturbed.

Note

This device/unit is an open–type device corresponding to UK 50 and therefore may only be operated in the appropriate enclosures/cabinets that provide the appropriate protection against mechanical damage and in order to secure protection against mechanical damage, should only be operated in housings/cabinets with degree of protection IP54 according to EN 60529.

Note

The terminals blocks of the SIMODRIVE 611 modules are only used to electrically connect–up the particular module. If the terminal blocks are used for another purpose (e.g. to carry the module), this can damage the module. If the terminal block insulation is damaged, then this can cause injury due to electric shock.

Note

The following secondary conditions/limitations must be carefully observed when the system is subject to a high–voltage test:

1. Power–down the unit.
2. Withdraw the overvoltage module in order to prevent the voltage limiting responding.
3. Disconnect the line filter so that the test voltage doesn't dip.
4. Connect M600 to PE through resistor 100 kΩ (the grounding bar in the NE modules is open). In the factory, the units are subject to a high–voltage test at 2.25 kV_{DC} phase–PE. The NE modules are shipped with the grounding bar open.
5. The maximum permissible voltage for a high–voltage system test is 1.8 kV_{DC} phase–PE.

ESDS information and instructions

Electro**S**tatic **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. These components are referred to as **ESDS** (**E**lectro**S**tatic **D**ischarge **S**ensitive Devices).

Handling ESDS boards:

- When handling devices which can be destroyed by electrostatic discharge, personnel, workstations and packaging must be well grounded!
- Generally, electronic modules may not be touched unless work has to be carried out on them.
- Personnel may only tough components if
  - they are continuously grounded through ESDS wristlets,
  - they wear ESDS shoes, ESDS shoe grounding strips in conjunction with an ESDS floor surface.
- Boards may only be placed on conductive surfaces (table with ESDS surface, conductive ESDS foam rubber, ESDS packing bag, ESDS transport containers).
- Boards/modules may not be brought close to data terminals, monitors or television sets (minimum clearance to the screen > 10 cm).
- Do not bring ESD–sensitive modules into contact with chargeable and highly–insulating materials, such as plastic, insulating table tops or clothing made of synthetic materials.
- Measuring work may only be carried out on the boards, if
  - the measuring unit is grounded (e.g. via a protective conductor) or
  - when floating measuring equipment is used, the probe is briefly discharged before making measurements (e.g. a bare–metal control housing is touched).

Warning

When the system runs–up, this represents a critical operating state with increased risk. In this phase, especially when activating drives, it is not permissible that personnel are close to the hazardous area.

Warning

After hardware and/or software components have been modified or replaced, it is only permissible that the system runs–up and the drives are activated with the protective devices closed (could possibly result in death). Personnel may not be in the hazardous area.

It may be necessary to carry–out a new, partial or complete acceptance test after every change or replacement.

Before entering the hazardous area, it should be carefully checked that all of the drives exhibit stable behavior by briefly moving/traversing the drives in both directions (+/–).

Warning

If the ”safe standstill” function or a stop function, Category 0 acc. to EN 60204–1 is activated, the motor can no longer provide any torque. As a result of this, potentially hazardous motion can occur, e.g. for:

- When the drive axes are subject to an external force.
- Vertical and inclined axes without weight equalization.
- Axes that are moving (coasting down).
- Direct drives with low friction and self–clocking behavior.

Possible hazards must be clearly identified using a risk analysis that must be carried–out by the manufacturer. Using the assessment based on this risk analysis, it must be defined as to which additional measures are required (e.g. external brakes).

Warning

If the ”safe standstill” function is activated, when a fault condition occurs, the mechanical axis system can make a jerky movement (possibility of injury, crushing) as a result of the principle of operation. The magnitude of this movement depends on the following parameters:

- Design/configuration and mechanical ratios between the motor/mechanical system.
- Velocity and acceleration capacity of the motor.
- Magnitude of the selected monitoring clock cycle.
- Size of the selected standstill tolerance window.

The above mentioned information/instructions regarding danger and warning must always be unconditionally observed in order to avoid damage to man and machine.

Residual risks

Using fault analysis, the machinery construction OEM is in the position to determine the residual risk at his machine regarding the control.
The following residual risks are known:

- If the spindle speed increases of the axis moves, this can be caused by:
  - Faults in the absolute measuring systems (CD track).
  - Cyclically interchanged phases of the motor connections (V–W–U instead of U–V–W).
  - Interchanged control sense.
  - Electric faults (defective components, etc.).
- If two power transitions in the inverter are simultaneously destroyed, depending on the motor pole number, this can cause brief axis movement.
  - Example: Synchronous motor:

    For a 6–pole synchronous motor, the axis can move by a maximum of 30 degrees.
    With a ballscrew that is directly driven (e.g. 20 mm per revolution) this corresponds to a maximum linear motion of approximately 1.6 mm.
  - Example, synchronous linear motor:

    For a synchronous linear motor, the movement can be a maximum of one pole width. For a linear motor, this corresponds to the following distances:

—> 1FN107□–...	27 mm
— > 1FN112□–.../1FN118□–.../1FN124□–...	36 mm
—> 1FN3□□□–...	20 mm
- For a 1–encoder system, encoder faults are detected by various HW and SW monitoring functions. It is not permissible that these monitoring functions are de–activated and they must be parameterized carefully.
- Stop function Category 0 according to EN 60204–1 means that the spindle/axes are not braked. Depending on the kinetic energy involved, they coast–down for a long time.

  This must be integrated in the logic of the protective door interlocking (e.g. with a logic operation with the signal n < nx).
- When a limit value is violated, higher speeds than have been set can briefly occur or the specified position position can be exceeded to some degree from between the error being detected and the system responding. This depends on the dynamic response of the drive and the parameter settings (MD).
- Parameterization and programming errors made by the machinery construction OEM cannot be identified. The required level of safety can only be assured by thorough and careful acceptance testing.
- When replacing power modules or motors, the same type must always be used as otherwise the selected parameters may result in different responses.
  When an encoder is replaced, the axis involved must be re–calibrated.

■

Space for your notes

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Space for your notes

1 Overview of the Drive System

1.1 Overview of SIMODRIVE 611

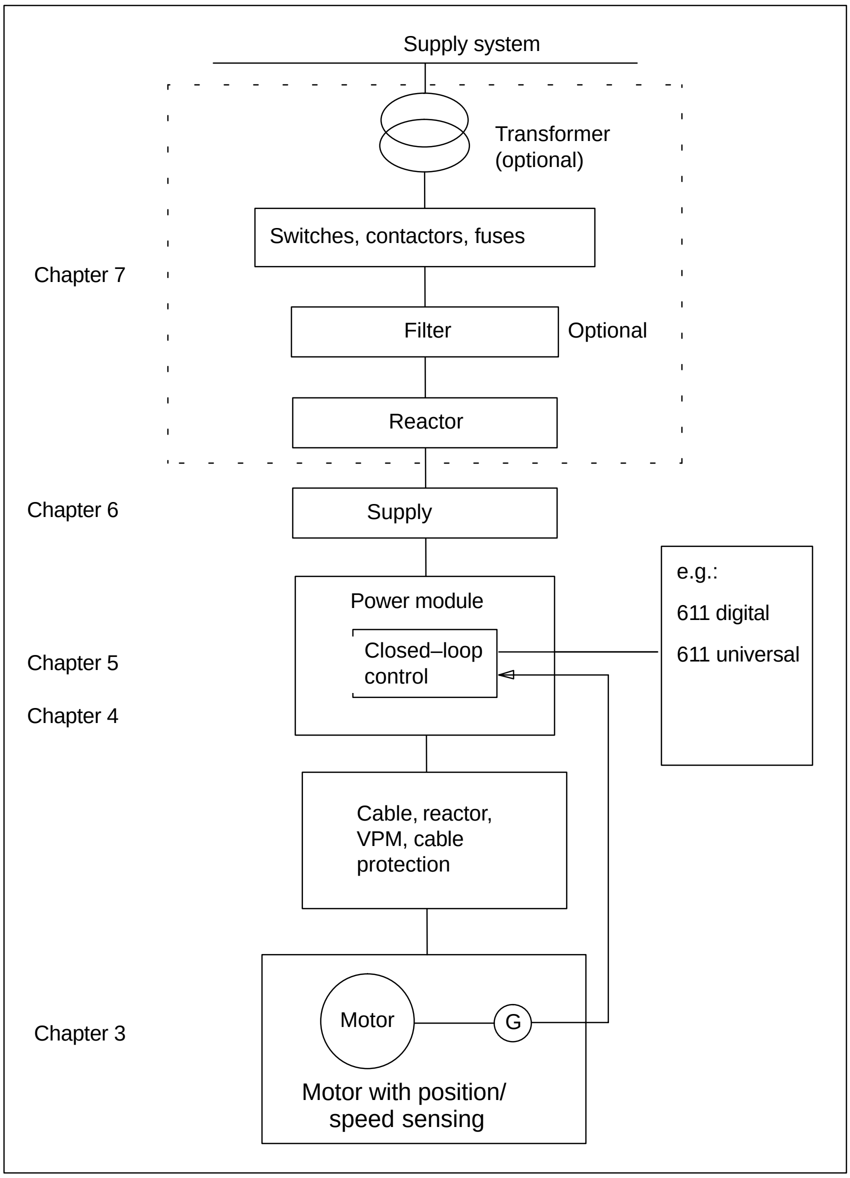


Fig. 1-1 Basic system structure

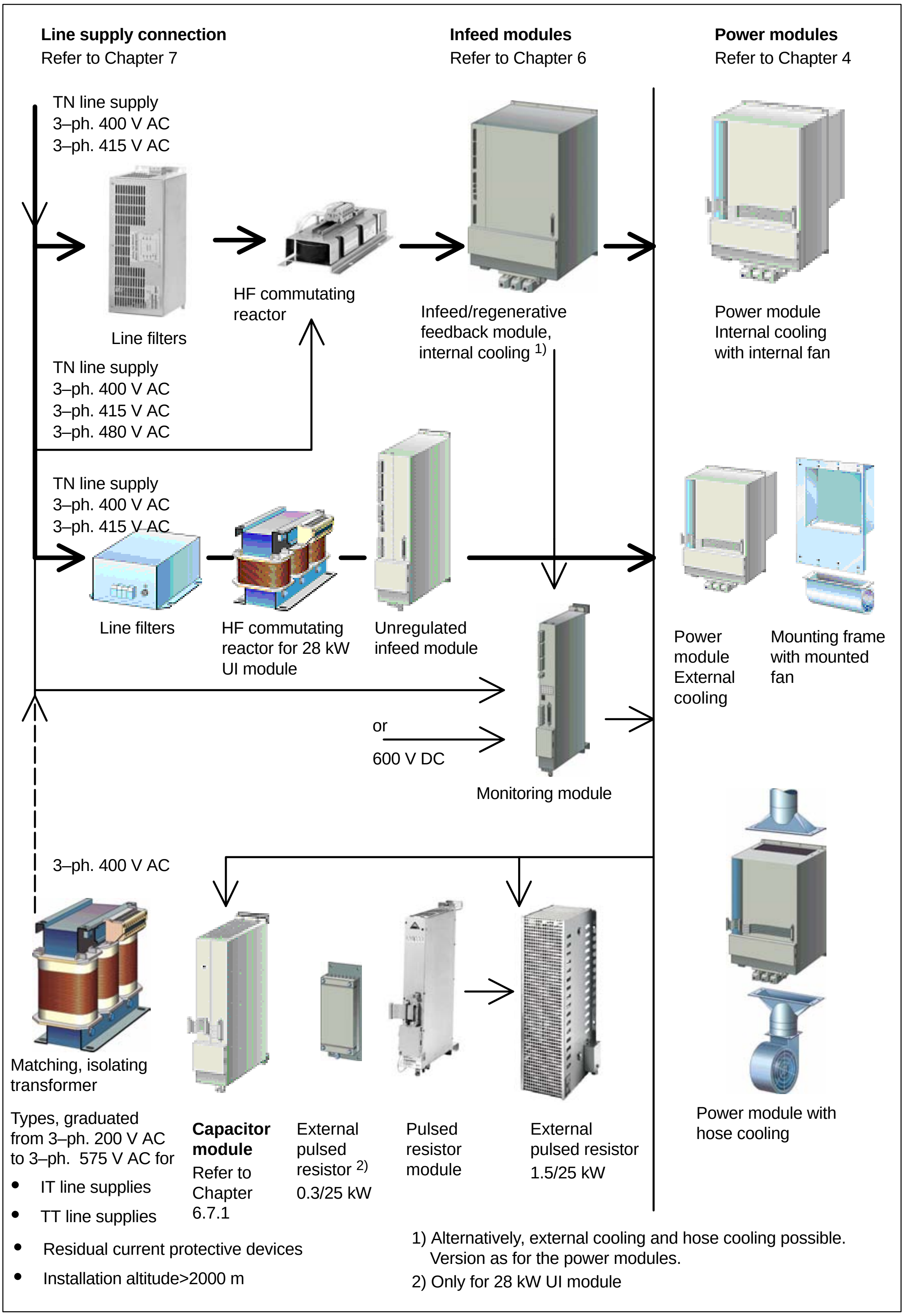


Fig. 1-2 Overview of the SIMODRIVE 611 drive system

1

Control units
Refer to Chapter 5

Control units with analog setpoint interface/PROFIBUS

For 1FT6/1FK/1FN/1FW6–1PH/1FE1 motors and induction motors

- 1–axis version (only with resolver)
- 2–axis version (resolver and motor encoder)
- Standard: analog setpoint interface
- Option modules: PROFIBUS–DP or TERMINALS

Control units with digital setpoint interface

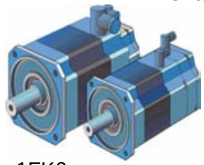
For 1PH/1PM/1LA or 1FT6/1FK/1FE1/2SP1 motors

- 2–axis version (with High Standard control)
  - for motor encoders
  - additional measuring system, voltage signals

For 1FT6/1FK/1FN/1FW/1PH/2SP1/1FE1/1PM motors

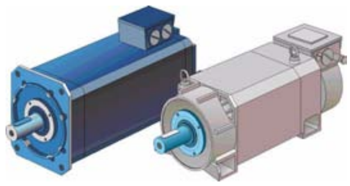
- 1–axis version (with High Performance control)
  - for motor encoders
  - additional measuring system, voltage signals
- 2–axis version (with High Performance control)
  - for motor encoders
  - additional measuring system, voltage signals EnDat and SSI encoders

Motors
Refer to Chapter 3



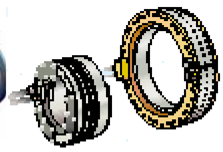
1FK6 1FK7

Induction motor, e.g. 1LA



1PH4 1PH7

1PH2



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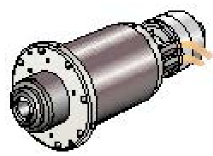
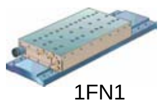
1FE1



2SP1



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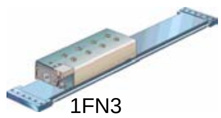
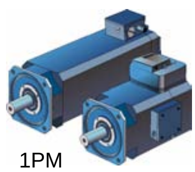
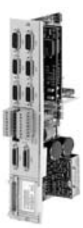


1FN3

1FT6



1PM



For hydraulic linear axes (HLA/ANA)

- 2–axis version

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

Fig. 1-3 Overview of the drive system

Note

Siemens accepts the warranty for satisfactory and reliable operation of the drive system under the clear understanding that only original SIMODRIVE system components are used in conjunction with the original accessories described in this Configuration Manual and in Catalog NC 60.

The user must take the planning and engineering data into consideration.

Combinations that differ from the engineering specifications – where relevant, also in conjunction with third–party products, require a special, contractual agreement.

The converter system is designed for installation in control cabinets which conform with the relevant standards for processing machines, especially EN 60204.

Description

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

- Transformer
- Switching and protective elements
- Line filters
- Commutating reactors
- Infeed modules
- Power modules
- Control units harmonized to the application technology/process and motor types
- Special modules and other accessories

Various cooling methods are available for the power–dependent line supply infeed and drive modules.

- Internal cooling
- External cooling
- Hose cooling

1.2 Engineering steps

Note

When engineering SIMODRIVE 611 systems, it is assumed that the motors to be used are known.

Reference: refer to the appropriate references for motors in the Appendix

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Procedure

A SIMODRIVE drive group is configured in 2 phases:

- Phase 1 Selecting the components (refer to Fig. 1-4)
- Phase 2 Engineering the connection to the line supply (refer to Fig. 1-5)

Starting from the required torque, the motor, the drive module and its various encoder evaluation functions are selected.

After this first engineering phase, when required, this can be followed by a second engineering phase. Here, the appropriate circuit recommendations and measures are taken into account.

Note

When engineering the 6SN series, a selection tool is available, e.g.:

- NCSD Configurator

For additional information, please contact your local Siemens office.

The functions of SIMODRIVE control units are described with keywords in this Configuration Manual. Limit values may be specified in some cases. For additional details, please refer to the appropriate documentation.

Detailed ordering information and instructions are provided in Catalogs NC 60 and NC Z.

Phase 1 when engineering

Selecting components

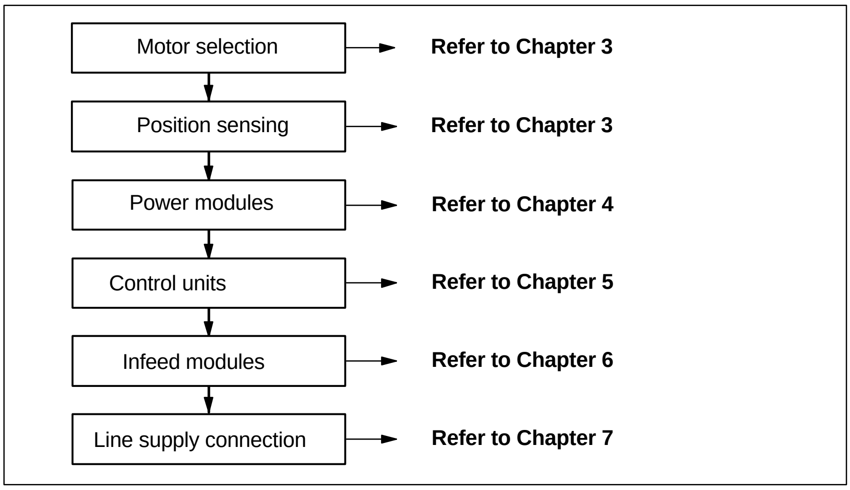


Fig. 1-4 Selecting components

Phase 2 when engineering

Connecting–up

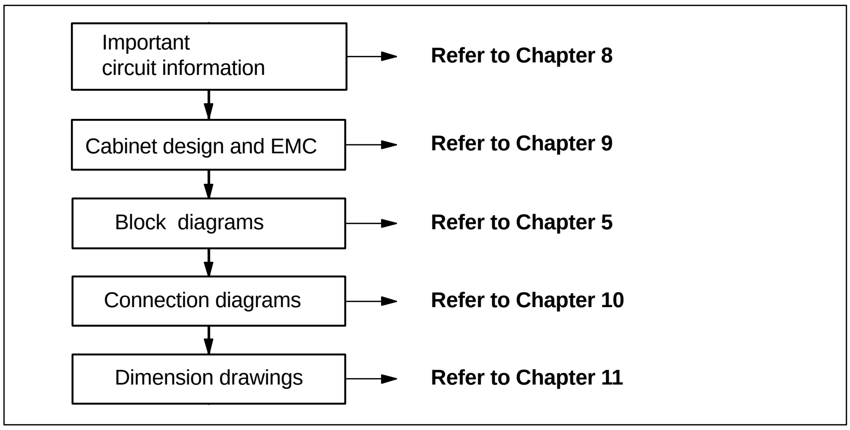


Fig. 1-5 Connecting–up

Selecting cables, cable protection and switching devices

Cables, cable protection and switching devices must be selected carefully taking into account the relevant regulations, Standards and the requirements of the location where the system is installed.

Reference:	/NCZ/	Catalog, Connecting System and System Components
Reference:	/NSK/	Catalog, Low Voltage Switchgear

1.3 Fundamental principles when engineering a drive

Dimensioning

The power modules are selected depending on the motors to be used and the drive requirements (torque, speed ratio).

The infeed module is selected using the DC link power required by the group and the active power requirement of all of the power modules:

- Taking into account the coincidence factor (value determined from the load duty cycle or experience value). Not all of the motors are subject to a full load at the same time.

  —> refer to Fig. 1-6

  and

- The maximum permissible power to charge the DC link capacitors.

  —> refer to Chapter 6.6 and Table 1-7

When calculating the DC link power P_z refer to Fig. 1-6.

Feed axes

In this case it must be noted that the DC link will be over–dimensioned if the motor outputs are simply added together:

- Because, from experience, feed axes are not operated at their rated torque and rated speed
- Because generally, the feed drives are not simultaneously operated

In the engineering sheet (refer to Fig. 1-6) to calculate the DC link power, these factors are taken into account by the speed ratio ñ/nN (ratio between the operating speed and the rated speed) and coincidence factor K.

Power supply rating

Gating and electronic points used to determine the load limits of the power supply. It is not possible to specify the power rating of an individual voltage source as several power supplies are coupled with one another. If the number of gating or electronic points is exceeded, an additional power supply must be used – the ”monitoring module”.

When determining the gating (AP) and electronic points (EP) refer to Chapter 6.6.

When calculating the power supply rating, refer to Chapter 1.3.6.

DC link capacitance

Every infeed module has a maximum value that applies when expanding the DC link capacitors. It must be ensured that the DC link capacitance in the selected drive group is not exceeded (refer to Table 1-1).

Checking the DC link capacitance

The sum (total) of the DC link capacitances (refer to Chapter 1.3.6, Table 1-7) of all modules must be less than or equal to the charge limit corresponding to the following table of the infeed modules.

Table 1-1 Charge limit of the infeed modules

DC link power P_Z [kW]	**Peak power** [kW]	**Infeed module Order No.**	**Charge limit** [µF]
Infeed, unregulated			
≤ 5	10	6SN1146–1AB0□–0BA1	1200
≤ 10	25	6SN1145–1AA0□–0AA1	6000
≤ 28	50	6SN114□–1AA0□–0CA0	20000
Infeed/regenerative feedback module			
≤ 16	35	6SN114□–1BA0□–0BA1	6000
≤ 36	70	6SN114□–1BA0□–0CA1	20000
≤ 55	91	6SN114□–1B□0□–0DA1	20000
≤ 80	131	6SN114□–1BB0□–0EA1	20000
≤ 120	175	6SN114□–1BA0□–0FA1	20000

Pulsed resistor module

Subject to certain conditions, several pulsed resistor modules can be connected in parallel (refer to Chapter 1.3.6, Table 1-7).

Drive bus

The drive bus length may not exceed 11 m.

For more than 6 axes, round cables must be used (refer to Chapter 2.1.2).

Equipment bus

The equipment bus cable that is looped– through a drive group at an infeed or monitoring module may not exceed 2.1 m from the supply connection point. For a two–tier configuration, two equipment bus branches are possible, each with a maximum length of 2.1 m from the branch point at the supply connection point.

Cable length

The total length of all motor cables including the line feeder cable of a drive group must be ≤ 350 m when using shielded cables for I/R modules in sinusoidal current mode, and ≤ 500 m for I/R modules in square–wave current mode as well as for UI modules.

Reader's note

For cable lengths for SIMODRIVE POSMO SI/CD/CA, refer to
Reference: /POS3/ User Manual SIMODRIVE POSMO SI/CD/CA

Operation when the power fails

The energy stored in the power DC link can be briefly used for operation when the power fails, stopping and/or retracting the drive (refer to Chapter 8.13).

1

1.3.1 Standard application

For a standard application, the following applies:

$P_Z = P_{Z\,FD} + P_{Z\,MSD}$

$P_Z \leq P_{continuous\ infeed\ module}$

- Feed axes

  The following formula is used in the engineering sheet to determine the calculated power:

  $P_{calc\,FD} = 0.105 \cdot M_0 \cdot n_N \cdot 10^{-3}$ [kW]

  Where:

$P_{calc\,FD}$	calculated power for feed axes [kW]
0.105	factor $2 \cdot \pi/60$
M_0	stall torque [Nm]
n_N	rated speed [RPM]

- Feed axes with linear motors

  $P_{calc\,FD} = F_N \cdot V_{MAX,\,FN} \cdot 10^{-3}$ [kW]

  Where:

F_N	rated force [N]
$V_{MAX,\,FN}$	maximum velocity at the rated force [m/min]

The DC link power $P_{Z\,FD}$ of the feed axes is calculated using the engineering sheet. The following factors must be taken into account:

- Speed ratio $\tilde{n}/n_N$
- Coincidence factor K for the number of feed axes per area

If the exact values of the speed ratio $\tilde{n}/n_N$ and coincidence factor K are known for the application in question, these should be used.

- Main spindles

  The following formula is used to calculate the power required for main spindle drives:

  – Motors $\leq$ 4 kW

    $P_{Z\,MSD} = 1.45 \cdot P_{motor\ shaft\ MSD}$ [kW]

  – Motors $>$ 4 kW

    $P_{Z\,MSD} = 1.25 \cdot P_{motor\ shaft\ MSD}$ [kW]

  Where:

$P_{Z\,MSD}$	DC link power for the main spindle drive [kW]
1.45 or 1.25	factor to take into account the motor efficiency
$P_{motor\ shaft\ MSD}$	mechanical power [kW] used at the shaft of the main spindle motor

The rated motor current may not exceed the rated output current of the power modules. The maximum motor current must always be less than the maximum converter current.

1.3.2 Dynamic operation

The peak infeed power must also be calculated for applications that are especially critical with regards to power.

- Feed axes

  The peak infeed power expected for feed axes is calculated according to the following formula:

  $P_{S\ FD} = 0.6\ V_{DC\ link} \cdot I_{max} \cdot \tilde{n}/n_N \cdot 10^{-3}$ [kW]

  Where:

$P_{S\ FD}$	peak infeed power (calculated) [kW] for feed axes
0.6	empirical factor: DC link energy and and EMF of the motor are taken into account
$V_{DC\ link}$	DC link voltage [V] (600 V)
I_{max}	peak current [A] set for an axis
$\tilde{n}/n_N$	max. axis speed referred to the motor rated speed

- Feed axes with linear motors

  $P_{S\ FD} = F_{MAX} \cdot V_{MAX,\ FMAX} + (I_{MAX}/I_N)^2 \cdot P_{VN}$ [kW]

  $= 0.5 \ldots 0.9 \cdot U_{ZK} \cdot I_{MAX} \cdot \tilde{v}/V_{MAX,\ FMAX} \cdot 10^{-3}$ [kW]

  Where:

F_{MAX}	maximum force [N]
$V_{MAX,\ FMAX}$	maximum velocity at the maximum force [m/min]
I_{max}	peak current [A] set for an axis
I_N	rated current [A] set for an axis
P_{VN}	rated motor power loss [kW]
$\tilde{v}/V_{MAX,\ FMAX}$	max. axis velocity referred to the maximum velocity at the maximum force

- Main spindles

  The peak infeed power expected for main spindles is calculated according to the following formula:

  – Motors $\leq$ 4 kW

  $P_{S\ MSD} = 1.45 \cdot P_{S\ motor\ shaft\ MSD}$ [kW]

  – Motors > 4 kW

  $P_{S\ MSD} = 1.25 \cdot P_{S\ motor\ shaft\ MSD}$ [kW]

  Where:

$P_{S\ MSD}$	peak power (calculated) for main spindles [kW]
1.45 or 1.25	factor to take into account the motor efficiency
$P_{S\ motor\ shaft\ MSD}$	peak power [kW] used at the shaft of the main spindle motor

1

The sum of $P_{S\ FD}$ and $P_{S\ MSD}$ should be calculated from all of the feed axes and main spindles that are simultaneously operated. This calculated power must be less than the peak power of the regenerative feedback module.

1.3.3 Braking operation

Regarding the braking operation of the motors, check that the energy fed back into the DC link does not exceed the permissible peak load capability of the feedback converter. The peak regenerative feedback power of the drive group is calculated as follows:

$P_{RS} \quad \leq 0.9 \cdot (P_{S\ FD} + P_{S\ MSD})$

Where:

P_{RS} peak regenerative feedback power

1.3.4 Calculating the DC link power (engineering sheet)

Axis name	Order No. of the motor	n_N [RPM]	M_0 [Nm]	I_N [A]	I_0(PM) [A]	P_{calcFD} [kW]	$\tilde{n}/n_N$	P_{calcFD} [kW] n/n_N
Range I for $P_{calc\ FD}$ from 0...1.8 kW								
1								
2								
3								
4								
5								
6								
						Sum, range I		
Range II for $P_{calc\ FD}$ from 1.8...8.8 kW								
1								
2								
3								
4								
5								
6								
						Sum, range II		
Range III for $P_{calc\ FD}$ from 8.8...27 kW								
1								
2								
3								
4								
5								
6								
						Sum, range III		

			K						
Sum, range I		x	K_I	=		+			
Sum, range II		x	K_{II}	=		+		**x 1.1 =**	**DC link power $P_{Z\ FD}$** ______ **kW**
Sum, range III		x	K_{II}	=					
								+	**DC link power $P_{Z\ MSD}$** ______ **kW**
								=	**DC link power P_Z** ______ **kW**

Application	Speed ratio $\tilde{n}/n_N$
Feed drives	0.4 to 0.7
Robot drives	0.9 to 1
Robot drives with 1FT	1

Feed axes per range	Coincidence factor k per range
1	1
2	0.63
3	0.5
4	0.38
5	0.33
6	0.28

Fig. 1-6 Engineering sheet to calculate the DC link power Pz

1.3.5 Engineering the SIMODRIVE 611 line supply infeed for SIMODRIVE POSMO SI/CD

1

When calculating the charge limit of the SIMODRIVE line supply infeed modules, for charging the ”DC link” an equivalent capacitance for POSMO SI/CD should be used for each unit depending on the pre–charging circuit of the line supply infeed module.

The number of POSMO units connected to a line supply infeed module is limited as a result of the charge limits.

Table 1-2 Equivalent capacitance for charge limits

Line infeed modules SIMODRIVE 611	POSMO SI/CD 9 A	POSMO CD 18 A
5 kW, 10 kW, 16 kW	600µF	1100µF
28 kW to 120 kW	1740µF	2200µF

Table 1-3 Line supply power POSMO SI/CD

Designation	Order No.	Power drawn [kW]
POSMO SI	6SN2460–2CF00–☐G☐☐	1.6
	6SN2463–2CF00–☐G☐☐	2.3
	6SN2480–2CF00–☐G☐☐	2.7
	6SN2483–2CF00–☐G☐☐	4.0
	6SN2500–2CF00–☐G☐☐	4.4
POSMO CD 9 A	6SN2703–2A☐0☐–0BA1	5.2
POSMO CD 18 A	6SN2703–2A☐0☐–0CA1	10.3

Table 1-4 Charge limit (net), line supply infeed modules

Designation	Order No.	Charge limit (net) [µF]	Rated power [kW]
UI 5 kW/10 kW	6SN114☐–1AB00–0BA1	1050	5
UI 10 kW/25 kW	6SN114☐–1AA01–0AA1	5560	10
I/R 16 kW/21 kW	6SN114☐–1B☐01–0BA1	5505	16
UI 28 kW/50 kW	6SN114☐–1A☐01–0CA☐	19010	28
I/R 36 kW/47 kW	6SN114☐–1B☐02–0CA1	19010	36
I/R 55 kW/71 kW	6SN114☐–1B☐A☐–0DA1	17855	55
I/R 80 kW/131 kW	6SN114☐–1BB00–0EA1	17855	80
I/R 120 kW/175 kW	6SN114☐–1BB00–0FA1	15710	120

Charge limit (net) = charge limit – DC link capacitance, infeed module

Example, I/R 80 kW: 17855 µF = 20000 µF – 2145 µF

Selection example

The POSMO with grey background listed in Table 1-3 are to be connected with a coincidence factor of 1.

—> equivalent capacitance 600 µF + 600 µF = 1200 µF at 5 kW, 10 kW, 16 kW
—> equivalent capacitance: 1740 µF + 1740 µF = 3480 µF at 28 kW to 120 kW
—> power drain: 1.6 kW + 4.4 kW = 6.0 kW

For this particular example, a 10 kW UI or 16 kW I/R can be used.

1.3.6 Checking the permissible power supply rating

The infeed or monitoring module offers a basic power supply rating for the electronics points (EP) and gating points (AP).

The power supply requirement of a drive group is determined using the following tables.

Enter the total number of all of the modules to be used. Calculate the product of ”Assessment factor single module” and ”Number of modules”.

If one of these values is exceeded, an (additional) monitoring module must be provided. The following tables must then be again applied for the module group that is supplied from the monitoring module.

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

Table 1-5 Engineering table for drive modules with SIMODRIVE 611 universal HRS/universal E HRS

SIMODRIVE 6SN11 power modules, type	**Assessment factors**								
	SIMODRIVE 611 universal HRS				***SIMODRIVE 611 universal E HRS***				DC link capac-itance
	Resolver		Encoder with 1 Vpp		Encoder with 1Vpp				
	6SN1118 –				6SN1118 –				
	– .NJ01 1–axis	– .NK01 2–axis	– .NH01 2–axis		– .NH11 2–axis				µF
1–axis version									
6SN11 2.x – 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 of individual modules for the electronics area (EP) and gating area (AP) as well as permissible combinations of power modules and control units.
Only combinations with entered EP and AP values are permissible.
Data referring to the assessment factors for EP and AP refer to the encoder cable lengths that have been released.
Enter the values into Table 1-7.

SIMODRIVE 611 universal HRS with options
PROFIBUS–DP
When using the option, an additional 0.6 gating points must be added.
Terminal module
In this case, no additional electronic/gating points have to be taken into account.
SIMODRIVE 611 universal HRS/E HRS with options
Absolute value encoder with EnDat
When using EnDat absolute value encoders, an additional 0.4 EP (electronic points) must be added for each encoder.

1) With mounted fan or hose cooling.

Table 1-6 Engineering table for drive modules with digital interface

SIMODRIVE 6SN11 power modules, type	**Assessment factors**						
	Control unit, digital						DC link capac-itance
	1–axis version High Performance control 6SN1118 –		2–axis version High Performance control 6SN1118 –		2–axis version High Standard control 6SN1118 –		
	– 0DJ21 for FD/MSD for motor encoders	– 0DJ23 for FD/MSD 1 additional input for voltage signals	– 0DK21 for FD for motor encoders	– 0DK23 for FD 2 additional inputs for voltage signals	– 0DM31 for FD/MSD for motor encoders	– 0DM33 for FD/MSD 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 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 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 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 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 1.85	EP 1 AP 2.2	495
6SN11 2 . –1AA00 – 0LA1	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 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 1.85	EP 1.75 AP 2.2	2145
6SN11 2 . –1AA00 – 0JA1 1)	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)	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 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 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 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 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 2.8	EP 1 AP 3.4	660

Assessment factors of individual modules for the electronics area (EP) and gating area (AP) as well as permissible combinations of power modules and control units (digital).
Only combinations with entered EP and AP values are permissible.
The data referring to the assessment factors EP and AP refer to the encoder cable lengths that have been released for use.
Enter the values into Table 1-7.

Absolute value encoder with EnDat interface

- An additional 0.5 EP for each absolute value encoder in the electronics area
- SSI encoders require an external power supply – therefore no additional electronic/gating points

1) With mounted fan or hose cooling.

Table 1-7 Engineering sheet to calculate the DC link power Pz

Description	Electronic points (EP)			Gating points (AP)			DC link capacitance		
	Assessment factor, individual module	Number of modules	Product	Assessment factor, individual module	Number of modules	Product	µF	Number of modules	Product
SIMODRIVE 611									
UI module 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		
I/R 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	× =	
Capacitor module (central/distributed)	2.8 mF 4.1 mF	0 0		0 0	× = =		2800 4100	× = =	
HLA module	1.5 [2]	× =		1.5	× =		0		
Power module with control unit for FD/MSD (values from Tables 1-6)		× = = = × = = =			× = = = × = = =			× = = = × = = =	
Power module with SIMODRIVE 611 universal HRS (values from Table 1-5)		× = = =			× = = =			× = = =	
SIMODRIVE POSMO SI/CD 9 A	0			0			Refer to Table 1-2		
SIMODRIVE POSMO CD 18 A	0			0			Refer to Table 1-2		
SINUMERIK 810D powerline [3] including integrated power modules									
CCU box 3LT with CCU 3	2	× =		4.5	× =		660		
CCU box 2LT with CCU 3	2	× =		4.5	× =		220		
SINUMERIK 840D powerline with							0		
NCU 561.4 6FC5 356 – 0BB12 – 0AE0	1	× =		3.8	× =				
NCU 571.4 6FC5 357 – 0BB12 – 0AE0	1	× =		3.8	× =				
NCU 572.4 6FC5 357 – 0BB23 – 0AE0	1	× =		3.8	× =				
NCU 573.4 6FC5 357 – 0BB34 – 0AE1	2.3	× =		5 (5.4) [4]	× =				
NCU 573.5 6FC5 357 – 0BB35 – 0AE0	2.3	× =		5 (5.4) [4]	× =				
	Sum, »Electronics« points maximum value 8		EP	Sum, »Gating« points maximum value 17		AP	Sum, DC link capacitances		
The following applies for the unregulated 5 kW infeed: Maximum 3.5 EP and maximum 7 AP. However, with the control units 6SN1118–0AA11–0AA0 maximum of 3 EP.	Maximum value, 3.5 (3)			Maximum value 7					

1) Only has to be taken into account, if the monitoring modules are not connected to the line supply.
2) 2 electronic points should be taken into consideration when using both axes with absolute value encoders.
3) An additional 0.3 gating points must be taken into consideration for each connected absolute value encoder with EnDat interface.
4) The value of 5.4 only applies to NCU 573.4/573.5 with link module.

■

Space for your notes

2 System Configuration

Drive group

A SIMODRIVE drive group has a modular configuration comprising line filter, commutating reactor, line supply infeed module, drive modules as well as, when required: monitoring, pulsed resistor and capacitor module(s).

A SINUMERIK 840D can be integrated into a module group with digital interface using the digital interfaces of the drive modules.

Modules can also be arranged in several tiers one above the other or next to one another. In this case, it is necessary to have a connecting cable for the equipment bus and, where relevant, also for the drive bus; refer to Catalog NC60 for the Order No.

Note

The screws retaining electrical connections at the modules must be tightened with the following torque:

Screw size	—>	tightening torque
M3	—>	0.5 Nm (for electrical connections)
M3	—>	0.8 Nm (for mechanical connections)
M4	—>	1.8 Nm
M5	—>	3.0 Nm
Tolerance	—>	0/+30 %

After transport, the screws should be tightened!

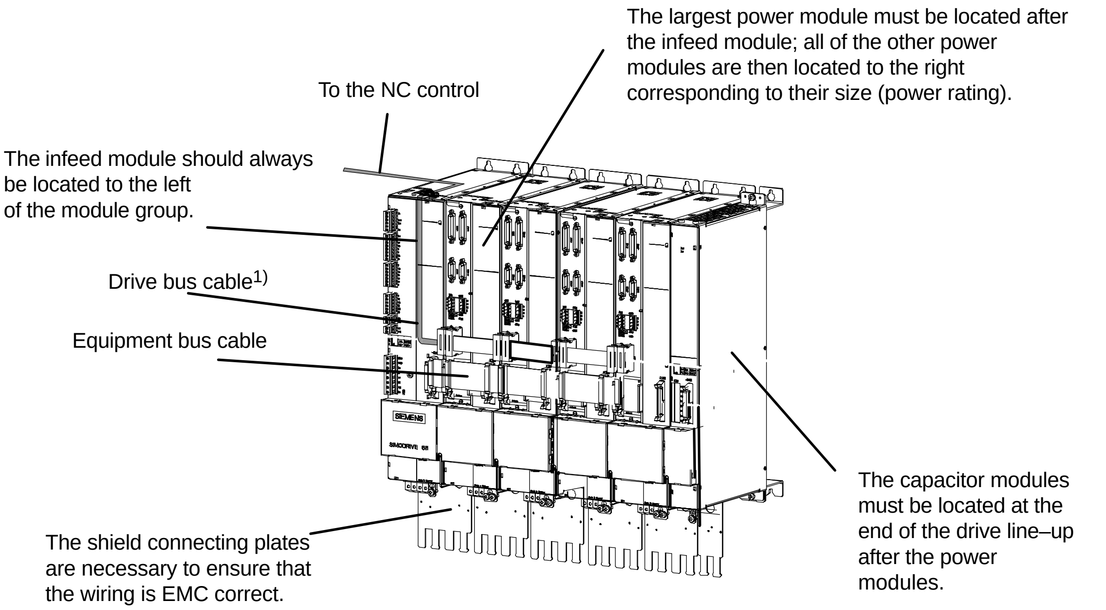
2.1 Arrangement of the modules and their mounting

2.1.1 Arrangement of the modules

The modules must be arranged in a particular fashion. The following criteria must be taken into account:

- Function of the module
- Cross–section of the DC link busbar

The I/R or UI module is always located to the left of the module group at the beginning. The power modules (PM) are located to the right next to the I/R or UI modules (refer to Fig. 2-1).



1) **Note:**
For a round drive bus cable, that is not directly attached to the module group, the shield must be clamped to the module housing at the captive nut provided!

Fig. 2-1 Sample connection

From Order No. [MLFB] 6SN114☐–☐☐☐☐☐–☐☐☐1 onwards, 300 mm wide modules can be connected to modules with a width of $\leq$200 mm. The sum of the DC link power P_Z of these subsequent modules must be $\leq$55 kW due to the limited current rating of the DC link busbars for module width $\leq$150 mm. Larger DC link busbars must be used if this restriction cannot be complied with (refer to Fig. 2-2 and 2-3).

The DC link power P_z of the subsequent modules is calculated according to the engineering rule specified in Chapter 1.3.

The larger DC link busbars can be ordered as set with Order No. [MLFB] 6SN1161–1AA02–6AA0. The set includes larger DC link busbars for module widths 50 mm, 100 mm and 150 mm.

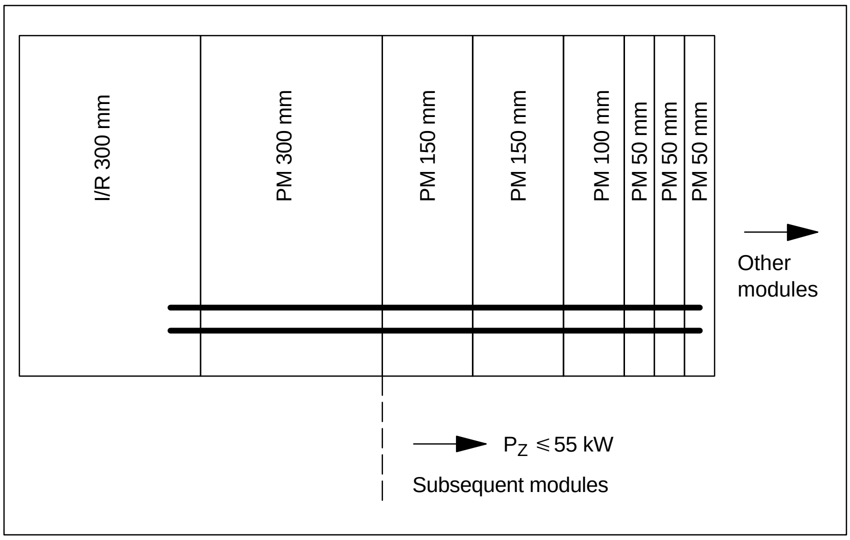


Fig. 2-2 Module group without larger DC link busbars

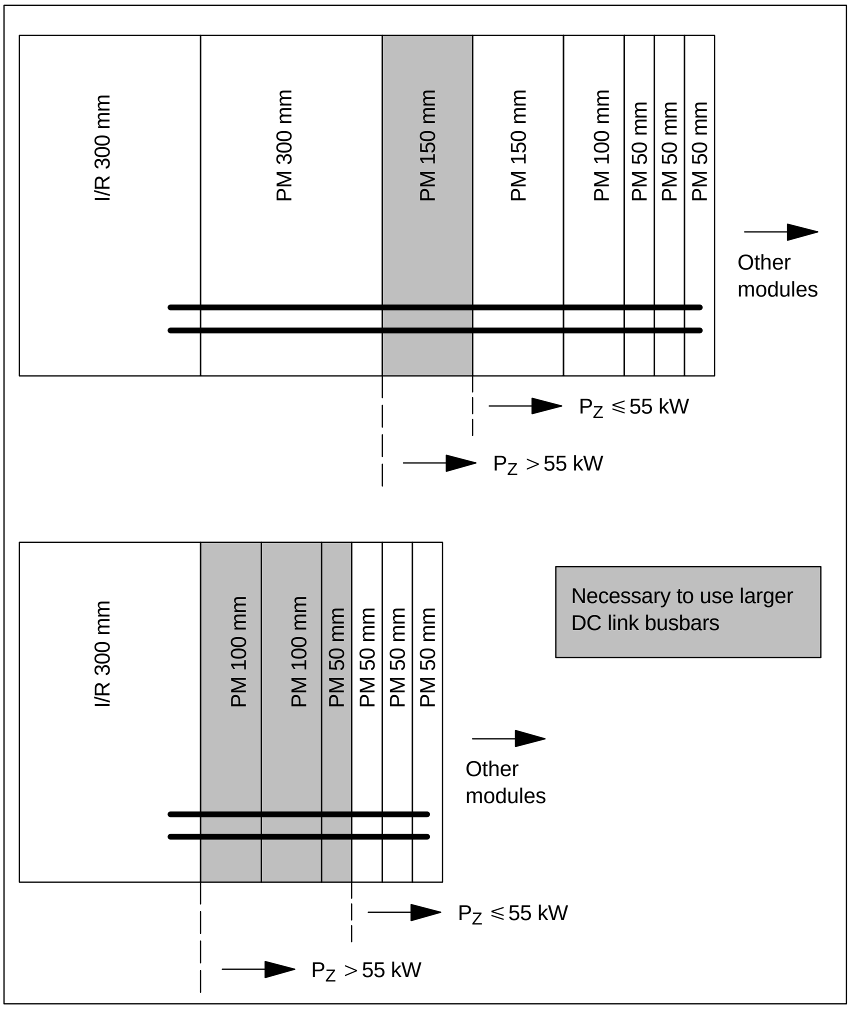


Fig. 2-3 Module group with larger busbars

When engineering the drive group the total length of the power cables used must be carefully observed due to the parasitic capacitances that occur with respect to ground.

The converter system is designed for operation in industrial environments connected to grounded TN–S and TN–C line supplies (VDE 0100. Part 300). For other line supply types, an upstream transformer must be used with isolated windings in a YN vector group on the secondary side (refer to Chapter 7 when dimensioning/selecting this transformer).

The modules have been designed to be installed in an electrical cabinet.

The modules of the SIMODRIVE 611 converter system modules are enclosed and fulfill EMC as specified in DIN EN 60529 (IEC 60529).

The electrical system is designed to conform to EN 50,178 (VDE 0160) and EN 60204. There is a declaration that the system is in conformance with CE.

For digital drive groups with SINUMERIK 840D and more than more than 6 drive axes, in order to increase the noise immunity round cables should be used for the drive bus.

2.1.2 Mounting and installing the modules

When mounting and installing the SIMODRIVE modules on the rear cabinet panel, proceed in the following sequence:

1. Screw–in the retaining screws up to a clearance of approx. 4 mm from the surface of the mounting panel.
2. Locate the modules in the screws and then tighten the screws with 6 Nm.
3. Locate the DC link connecting bar in the adjacent module under the screws provided and tighten these screws with 1.8 Nm –0/+30%.

Drive bus

For drives with a digital setpoint interface, a drive bus cable is required for the control and communications interface SINUMERIK 840D powerline (refer to Fig. 2-1).

Table 2-1 Order number assignment

Description	Order number (MLFB)
for module width	
• 50 mm	6SN11 61–1CA00–0AA☐
• 100 mm	6SN11 61–1CA00–0BA☐
• 150 mm	6SN11 61–1CA00–0CA☐
• 300 mm	6SN11 61–1CA00–0DA0
	☐ —> 0: Ribbon cable
	☐ —> 1: Round cable (this is required from 6 axes onwards)
In order to bypass monitoring/pulsed resistor modules, select the drive bus cable to be 50 mm longer!	
• 350 mm round long cable	6SN11 61–1CA00–0EA1
• 200 mm long ribbon cable	6SN11 61–1CA00–0FA0

Equipment bus

The electronics power supply between the individual modules is established using the equipment bus cable (refer to Fig. 2-1). The equipment bus cable is included in the scope of supply of the power module.

2.2 Ambient conditions

Note

The components are insulated in compliance with DIN EN 50178.

- Overvoltage category III for industrial line supplies
- Degree of pollution II, especially no conductive pollution, moisture condensation is not permissible
- Installation altitude up to max. 2000 m above sea level
- Installation altitudes 2000 m – 6500 m are possible in conjunction with isolating transformer with a grounded neutral point on the secondary side
- As a result of the "thinner air" (poor thermal dissipation), above 1000 m, the drive power must be de–rated (reduced). Refer to Chapter 6.4.1 and 4.4.
- Star point of the line supply is directly grounded, the module housing is grounded.

This means that the following applies for the SIMODRIVE 611 series of drive units.

Line supply type, installation altitude above sea level

- IT <6500 m with isolating transformer, vector group any/Y with grounded star point[1)]
- TT <6500 m with isolating transformer, vector group any/Y with grounded star point[1)]
- TN <2000 m without any additional measures
- TN <6500 m with isolating transformer, vector group any/Y with grounded star point[1)]

Warning

Any conductive dirt/pollution can result in the safe electrical separation being lost and can therefore result in hazards to personnel (electric shock).

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 and/or line filter in Chapter 7.

1) The isolating transformer is used to decouple a line supply circuit (overvoltage category III) from a non–line supply circuit (overvoltage category II). Refer to IEC 60664–1 (this is necessary for the complete system).

Table 2-2 Ambient conditions

<table>
<tr><th>Designation</th><th colspan="3">Description</th></tr>
<tr><td rowspan="9">Vibration and shock stressing in operation</td><td colspan="3">• Vibration stressing in operation</td></tr>
<tr><td>Frequency range
10 ... 58 Hz</td><td colspan="2">With constant deflection = 0.075 mm</td></tr>
<tr><td>Frequency range
above 58 ... 200 Hz</td><td colspan="2">With constant acceleration = 9.81 m/s^2 (1 g)</td></tr>
<tr><td>Relevant Standards</td><td colspan="2">DIN IEC 68–2–6,
severity level Class 3M4 acc. to EN 60721 Part 3–0 and Part 3–3</td></tr>
<tr><td colspan="3">• Shock stressing in operation</td></tr>
<tr><td>Acceleration</td><td colspan="2">49 m/s^2 (5 g)</td></tr>
<tr><td>Shock duration</td><td colspan="2">Modules/equipment without drive: 11 ms
Modules/equipment with drive: 30 ms</td></tr>
<tr><td>Relevant Standards</td><td colspan="2">DIN EN 60721–3–3, Class 3M4
Shock strength according to IEC 60068 2–27</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td rowspan="4">Vibration stressing during transport</td><td>Frequency range
5 ... 9 Hz</td><td colspan="2">With constant deflection = 3.5 mm</td></tr>
<tr><td>Frequency range
above 9 ... 200 Hz</td><td colspan="2">With constant acceleration = 9.81 m/s^2 (1 g)</td></tr>
<tr><td>Relevant Standards</td><td colspan="2">DIN IEC 68–2–6,
Severity level according to EN 60721 Part 3–0 and Part 3–2</td></tr>
<tr><td></td><td colspan="2">Note:
Data applies for components that are in their original packaging.</td></tr>
<tr><td>Protection against ingress of solid foreign bodies and water</td><td colspan="3">• Modules with internal cooling IP20
• Modules with external cooling/pipe cooling
– Heatsink in cooling area IP54
– Electronics area IP20</td></tr>
<tr><td rowspan="6">Transport and storage</td><td>Temperature range</td><td colspan="2">–40 °C – +70 °C</td></tr>
<tr><td rowspan="4">Dew–point temperature t_d and relative air humidity U</td><td>Annual average</td><td>U = 75 %
td = 17 °C</td></tr>
<tr><td>On 30 days (24h) annually</td><td>U = 95 %
td = 24 °C</td></tr>
<tr><td colspan="2">These days should be naturally distributed over the complete year.</td></tr>
<tr><td>On the other days (<24 h)
But maintaining the annual average</td><td>U = 85 %
td = 24 °C</td></tr>
<tr><td>Relevant Standards</td><td colspan="2">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</td></tr>
</table>

2

Table 2-2 Ambient conditions

Designation		Description	
Ambient climatic conditions in operation	Temperature range: for PM/NE modules (100% load): Current/power de–rating from +40 °C onwards:	0 °C – +55 °C +40 °C 2.5 %/°C	
	Dew–point temperature t_d and relative air humidity U	Annual average	U = 75 % td = 17 °C
		On 30 days (24h) annually	U = 95 % td = 24 °C
		These days should be naturally distributed over the complete year.	
		On the other days (<24 h) But maintaining the annual average	U = 85 % td = 24 °C
	Temperature change	Within one hour: Within 3 minutes:	max. 10 K max. 1 K
	Moisture condensation	Not permissible	
	Air pressure	min. 860 mbar (86 kPa) max. 1080 mbar (108 kPa)	
	Gases that can have a negative impact on the function	acc. to DIN 40046, Part 36 and Part 37	
	Relevant 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 Motor Configuration Manuals are used to select the drive motors.

Reader's note

Also refer to the References in the Appendix /PFK6,7/, /PFT5,6/, /PJAL/, /PJFE/, /PJLM/, PJM/, /PJTM/, /PMS/, PPH/ and /PPM/!

The power module size (rating) is determined when the motor is selected and the (brief) overload capability (refer to Chapter 4).

VP module (VPM)

A VP module (VPM, Voltage Protection Module) is required for 1FE1 and 2SP1 motors with an EMF > 800 V.

When a fault condition develops, the VPM limits the DC link voltage at the drive converter.

Technical data and ordering data, refer to 4.3.

Reader's note

Reference: /PJFE/ Configuration Manual, 1FE1 Synchronous Build–in Motors
/BU/ Catalog NC 60
/PMS/ Configuration Manual ECO Motor Spindles for 2SP1 Main Spindle Drives

2.4 Position sensing/speed actual value sensing

Description

The encoder system is used for precise positioning and to determine the speed actual value of the drive motor for the particular application. The resolution of the measuring system and the control board selected are decisive when it comes to positioning accuracy.

2.4.1 Position sensing, direct

Measuring systems that can be evaluated

- Rotary 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 interface (linear scales, single–turn and multi–turn encoders)

The analog main spindle drive modules and the digital feed and main spindle drive modules can be supplied with a second measuring system evaluation, e.g. for a table–top measuring system or for spindle position decoding. A direct measuring system is needed, for example, when a high degree of accuracy has to be achieved on the workpiece with a linear scale or exact positioning is required with a multi–stage gear unit.

SIMODRIVE 611 digital, universal

The optimum measuring system for position detection is suitable for the evaluation of incremental encoders with sine/cosine voltage signals. It is possible to connect linear scales and rotary encoders with sinusoidal voltage signals to drive controls to operate 1FT6 and 1FK6 feed motors. The measuring signals supplied by the encoder system are evaluated with a high degree of resolution.

Example:

With a linear scale (20 µm grid constant) a position resolution of 0.01 mm (Digital High Performance control) is achieved.

2.4.2 Position detection, indirect

Measuring systems that can be evaluated

- Integrated incremental encoder in feed and main spindle motors
- Integrated absolute encoder with EnDat interface in feed motors
- Incremental encoder (SIMAG H) to sense the rotary angle and the rotary angle velocity

  SIMAG H is used for hollow–shaft applications with 1FE1 and 1PH2 direct drives and third–party spindles. It is also used as autonomous spindle encoder.

Reader's note
Reference: /PMH/ Measuring System for Main Spindle Drives

SIMODRIVE 611 digital/universal

When the SINUMERIK 810D/840D and SIMODRIVE 611 are digitally linked, the measuring systems are connected to the digital control units.

The controls are equipped with a connection for the measuring system integrated in the feed and main spindle modules as standard. Together with the high–resolution position detection of the digital controls, the integrated motor measuring system achieves a resolution of 4,000,000 increments per revolution (Performance Control). This makes an additional C–axis encoder unnecessary, even on the main spindle.

The high–resolution actual position value can also be transferred to the NC position control loops via the drive bus so that, given the right mechanical conditions, a direct table–top measuring system is no longer required.

The same secondary conditions/limitations apply for SIMODRIVE 611 universal and POSMO SI/CD/CA. The one difference is the drive link, which is established via PROFIBUS–DP.

2.4.3 Drive module

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

The permissible combinations of power module and control unit are saved in the engineering tables (refer to Chapter 1.3.6). Depending on the cooling method employed or the power module's size, additional cooling components have to be ordered or be provided by the user.

Depending on the application, the drive modules of the SIMODRIVE 611 converter system can function as feed, main spindle or induction motors, and comprise the power module, control unit, and drive bus cable components. Option modules can be added where applicable.

A drive module is created by inserting the control unit into the power module – e.g. for feed or main spindle applications.

The modular design of the drive modules allows a large number of user applications to be implemented using only a small number of individual components.

Note

Combinations that differ from the engineering information and instructions – where relevant, also in conjunction with third–party products, require a special, contractual agreement.

We accept a warranty for our scope of supply up to the system interfaces that we have defined.

2.5 Power modules

A wide range of one–axis or two–axis power modules is available. These modules are graded according to the current ratings and can be supplied with three different cooling techniques. The range of power modules allows a seamless, modular and space–saving drive solution for:

- Small, compact machines (required feed torques and main spindle power ratings – 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 current–related data refers to the series–preset values. The output currents can be limited by the control unit being used. After the control unit has been inserted, the retaining screws of the control unit front panel must be tightened in order to establish a good electrical connection to the module housing.

At higher clock cycle frequencies, ambient temperatures and installation altitudes above 1000 m above sea level, the modules must be de–rated. The appropriate pre–assembled cables are available to connect–up the motors. The ordering data is provided in Catalog NC 60, in the Motors Section.

Shield terminal plates are available to meet EMC requirements when using shielded power cables.

The equipment bus cable is included in the scope of supply of the power module. The drive bus cables must be ordered separately for the digital system.

2

2.5.1 Function of the power modules

The power module provides the required energy for the control boards and the connected motor. The power module is selected depending on the selected motor and the control board.

2.5.2 Connecting–up the power modules

The power module is grounded through the PE connecting screws.

The power module must be mounted on a grounded mounting surface through a good electrical connection. The mounting surface must have good conducting characteristics.

Power is fed–in through the DC link busbars.

Power module
Internal cooling

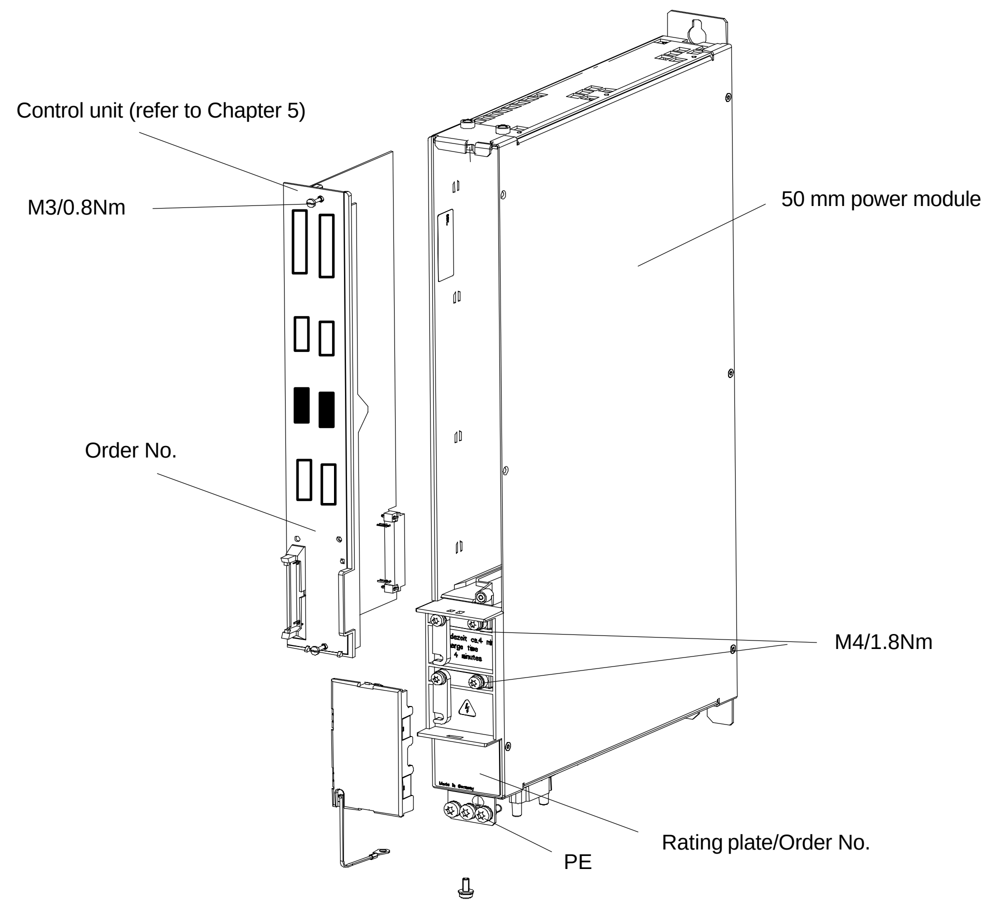


Fig. 2-4 Power module with control unit

2.6 Control units

Description

The control units evaluate the encoders that are used and control the connected motors through the power modules. Almost all of the requirements of state–of–the–art drive technology are fulfilled as a result of the versatile range of control units.

2.6.1 Drive modules with induction motor control

Induction motors, that are designed for converter operation with a 600 V DC link voltage can be operated with the drive module with induction motor control (closed–loop).

The maximum motor stator frequency is 1100 Hz (for SIMODRIVE 611 universal HRS and SIMODRIVE POSMO CD/CA: 1400 Hz).

For motor frequencies above 200 Hz or motor rated currents above 85 A, it may be necessary to provide a series inductor or increase the converter operating frequency.

The dimensioning guidelines, specified in Chapter 5 must be carefully observed.

2.6.2 Drive module with SIMODRIVE 611 universal HRS

By inserting this control unit into the power module, the user obtains a universal drive module for the various SIMODRIVE motor systems – such as permanent–magnet synchronous motors 1FT6, 1FK, 1FN, 1FE1, 1FW6 and induction motors 1PH and 1LA. The motors can also be operated with the 2–axis power modules corresponding to the power requirement. Analog setpoints can be entered and digital communications established via PROFIBUS–DP. The permissible combinations of power module and SIMODRIVE 611 universal HRS are specified in the engineering table (refer to Chapter 1.3.6).

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

Both 1–axis and 2–axis control units are available with options – 2–axis versions can also be used in 1–axis power modules.

The following encoder evaluation functions are available on various control units:

- Resolver: Pole pair numbers 1 to 6, max. operating frequency up to 108/432 Hz (14/12 bits), internal pulse multiplication 4096 x pole pair number
- Incremental encoder with sin/cos 1 Vpp signals 1–65535 pulses, max. up to 350 kHz, internal pulse multiplication 2048 x pulses.
- Absolute value encoder with EnDat interface, same as encoder sin/cos 1 Vpp, plus absolute position via EnDat protocol.

2.6.3 Control unit with analog setpoint interface and motion control with PROFIBUS–DP SIMODRIVE 611 universal E HRS

SIMODRIVE 611 universal E HRS is a control unit with the "motion control with PROFIBUS–DP" function for use with SINUMERIK 802D and SINUMERIK 840Di. It can handle motor frequencies up to 1400 Hz, closed–loop speed/ torque controlled for 1FT6, 1FK, 1FE1 synchronous motors, 1FN linear motors, 1PH induction motors, 1LA with/without encoder and third–party motors – if these are suitable for converter operation.

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

The following encoder evaluation functions are available for the subsequent encoders:

- Incremental encoder with sin/cos 1 Vpp signals 1 – 65535 pulses, max. up to 350 kHz, internal pulse multiplication 2048 x pulses.
- Absolute value encoder with EnDat interface and sin/cos 1 Vpp.

The drive can be commissioned either using a 7–segment display and keyboard on the front of the board or using the SimoCom U for PC commissioning tool under Windows 98/NT/2000/ME/XP.

2.6.4 Control units with digital setpoint interface for FD and MSD

The digital control units of the SIMODRIVE 611 are used in conjunction with

- 1FT6/1FK three–phase servomotors for feed and main spindle drives
- 1FN linear motors for feed drives
- 1PM/1PH three–phase induction motors and 1FE/2SP1 build–in spindle motors for main spindle drives
- 1FW6 build–in torque motors for direct drives with a high torque output

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

This system can achieve a measuring circuit resolution of up to 4.2 million increments per motor revolution. 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 in the servo area of the SINUMERIK via the digital drive bus. In addition, a direct measuring system (DMS) can be connected for control units with the "direct position sensing" function. This system can evaluate incremental encoders with sine–cosine voltage signals.

The control units with digital setpoint interface can – as far as the hardware is concerned – be used in the 1–axis version with High Performance control universal as feed or main spindle drive. The software with the control algorithms is stored in the SINUMERIK 810D/840D. Each time the control and drives are powered–up, the software is downloaded into the digital control units. When commissioning, the drive configuration is used to define whether it involves a feed or main–spindle drive.

For control units with digital setpoint interface, either the High Standard control can be used or the High Performance control. Both of these versions use the same drive interfaces and a firmware with the same controller algorithms.

Features of the High Standard, High Performance controls:

- More computational performance and program memory
- 1 or 2 motor encoder inputs
- 1 or 2 inputs for a direct measuring system voltage
- BERO inputs
- The hardware supports Safety Integrated
- Functional compatibility
  - The front panel design is identical to previous controls (Standard 2/Performance 1 control)
  - Additional 9–pin connector for BERO inputs
- Brake control
- Software compatibility
  - The software release must be upgraded to a new version (SW release ⩾ 6.4.9)
  - With the upgraded software, mixed operation is possible using the previous controls (Standard 2/Performance 1 control) and High–Standard/High–Performance control.

2

Table 2-3 Comparison table

Control unit with	High Standard Closed–loop control	High Performance Closed–loop control
Max. electrical fundamental frequency for motor	600 Hz	1400 Hz
Encoder limit frequency, motor encoder	200 kHz	350 kHz (420 kHz)1)
Encoder limit frequency, motor encoders for Safety Integrated	200 kHz	300 kHz (420 kHz)1)
Encoder limit frequency, direct measuring system	200 kHz	350 kHz (420 kHz)1)
Encoder limit frequency, direct measuring system for Safety Integrated	200 kHz	300 kHz (420 kHz)1)
Pulse multiplication:	128	2048
Maximum cable length, encoder with voltage signal	50 m	50 m (20 m)1)
Smooth running characteristics (measure of the position fluctuation by n_{set} in the range 10 % n_N referred to a 10 mm spindle pitch/motor revolution)		
• 1–axis version	0.2 µm	0.1 µm
• 2–axis version	1.5 µm	0.1 µm
Motor encoder system and direct measuring systems (DMS)		
Incremental encoder sin/cos 1Vpp	Yes	Yes
Absolute value encoder EnDat	Yes	Yes
Prerequisites for ”SINUMERIK Safety Integrated”	Yes, for closed–loop control with DMS	Yes, for closed–loop control with DMS
Safety Integrated with internal pulse suppression via the drive bus	Yes, for closed–loop control with DMS	Yes, for closed–loop control with DMS
Operating 1FT6 and 1FK motors	Yes	Yes
Operating 1FN and 1FW motors	Yes, with restricted closed–loop control performance	Yes
Operating 1PM/1PH7/1FE and 2SP1 motors	Yes	Yes
Preferred applications	Standard production machines	Finishing and precision machines

1) The following limitations/secondary conditions apply for 420 kHz:
- Cable to be used: Siemens cable, Order No. [MLFB]: 6FX2002–2CA31–1CF
- Maximum permissible encoder cable length: 20 m
- Encoder characteristics: ”–3dB cutoff frequency” greater than or equal to 500 kHz
  Examples for permissible encoders: ERA 180 with 9000 pulses/revolution and ERA 180 with 3600 pulses/revolution manufactured by Heidenhain
- Amplitude monitoring up to 420 kHz is active.

2.6.5 Control units with digital setpoint interface for hydraulic/analog linear drives (HLA/ANA)

General information

The 2 axis control units include the selectable HLA and ANA functions. A single control unit can also be used for hybrid operation of one HLA axis and one ANA axis.

When inserted in the 50 mm wide universal empty housing, the HLA/ANA control unit can be integrated into the SIMODRIVE 611 drive group.

Hydraulic linear drive (HLA)

The SIMODRIVE 611 HLA (hydraulic linear drive) control unit has been designed to control (open–loop and closed–loop) electro–hydraulic control valves of hydraulic linear axes in conjunction with the SINUMERIK 840D powerline. Up to two hydraulic axes can be controlled with this control unit.

This unit can be used a multiple number of times in the SIMODRIVE 611 digital drive group – both with the mechanical as well as with the electrical interfaces such as equipment bus, drive bus and DC link busbars.

The HLA control unit contains the control structures for an extremely high–speed electronic control loop. The HL control unit generates the power supply for the control valves and the shutoff valves from an external DC voltage supply (e.g. SITOP power) with a rated voltage up 26.5 V.

The purely hydraulic components, designed for CNC operation, must be supplied by the user.

Analog axis (ANA)

The HLA control unit can also be used for analog axes with a speed setpoint interface ±10 V. The appropriate axis must be selected. The control essentially operates as digital–analog converter and transfers position information from the encoder to the position controller in the SINUMERIK 840D powerline via the drive bus.

An analog axis can be used very much like a digital axis. It can be programmed like a digital interpolating path axis or spindle. Pure functions of the digital drive units are, of course, not possible for external drive units linked via an analog speed setpoint interface. These are functions which are dependent on feedback within the axis and communication along the drive bus, e.g. SINUMERIK Safety Integrated. Separate EMC measures must, if required, be applied for external drive units.

2.6.6 NCU box for SINUMERIK 840D

If the digital drive modules are operated in conjunction with the SINUMERIK 840D CNC control system, then the NCU box must be located immediately to the right of the infeed module.

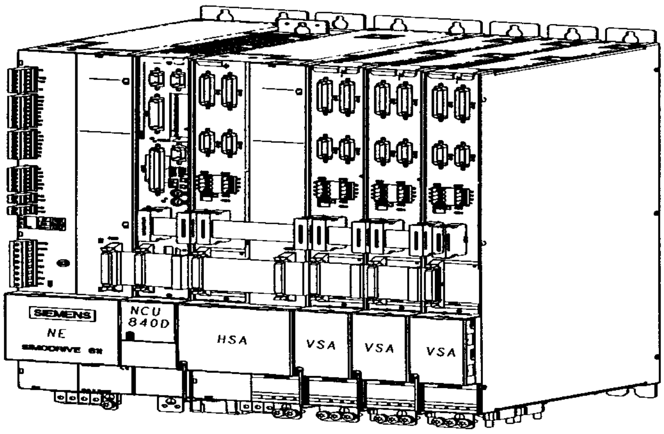


Fig. 2-5 Digital closed–loop control with SINUMERIK 840D

2.7 Infeed modules

Application

The infeed modules are used to connect the drive group to the line supply.

The infeed modules generate the DC voltage for the DC link from the following possible line supply voltages:

- 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 made available centrally to the drive modules and to the SINUMERIK 840D or SINUMERIK 810D – arranged as group – via the equipment bus.

Different line supply

A transformer with separate windings in vector group yn in accordance with the selection table is required if the infeed modules are connected to a line supply that is different from a TN line supply or a line supply not equipped with direct–current–sensitive residual–current devices.

The HF commutating reactor is also required for the regulated infeed/regenerative feedback module when there are upstream transformers.

An appropriate matching transformer is also required for line supply voltages of 3–ph. 200 V/220 V/240 V/440 V/500 V/575 V AC 10% 50 Hz/60 Hz.

Please observe the appropriate information and instructions for the 300 mm modules.

Module arrangement

The infeed module must always be located on the left as the first module. This is then followed, if one is being used, by the NCU box. It is followed by the main spindle drive modules (induction drive modules) and then the feed modules, which must be located next to the infeed module in descending order of rated current from left to right (highest rating on the left, lowest on the right).

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

Cooling

The required cooling components, such as separate fan and/or thermally conductive covers to guide the cooling air to the module heatsinks, are included in the standard packages for modules with a width of up to 200 mm for both the internally and externally cooled versions.

- Internal cooling

  The infeed modules are available with internal heatsinks to cool the inside of the cabinet; in addition, the 300 mm wide modules can also be hose–cooled.

- External cooling

  Alternatively, the infeed modules are available with a heatsink that extends outside the module for external cooling. In this case, the modules are mounted on the rear cabinet panel with the heatsink extending through the panel; the modules are cooled on the customer's side. For this type of configuration, a mounting frame is required for each module (refer to Fig. 2-9).

Dimensions

All of the modules have a width in a 50 mm grid dimension; all of the modules are 480 mm high. However, it must be taken into consideration that additional space is required for the air baffle plates, shield connecting plates, mounted fans and hose cooling.

- Width: 50 mm grid dimension
- Referred to the mounting plane, the depth of all modules (without connectors and optional machine–mounted accessories) are:
  - Internal cooling or hose cooling: 288 mm
  - External cooling: 231 mm, in this case, the heatsink penetration depth must be taken into account for the cooling duct.

2.7.1 Cooling components

Depending on the cooling method used, additional fan units and fan components, specifically designed for the system, must also be ordered.

A differentiation is made between three different cooling types.

1. For internal cooling, the complete power loss remains in the electrical cabinet in the form of heat.
2. With external cooling, the power module power loss (thermal) is externally dissipated in the form of heat and the power loss of the control unit is internally dissipated in the form of heat.
3. With hose cooling, the complete power loss is externally dissipated in the form of heat through a hose connected to the module.

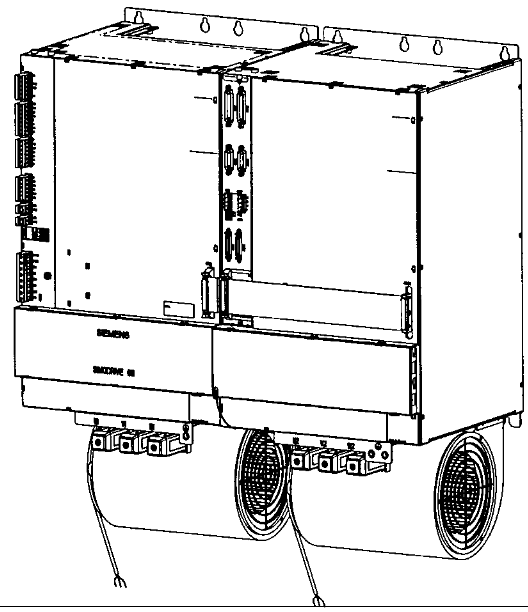


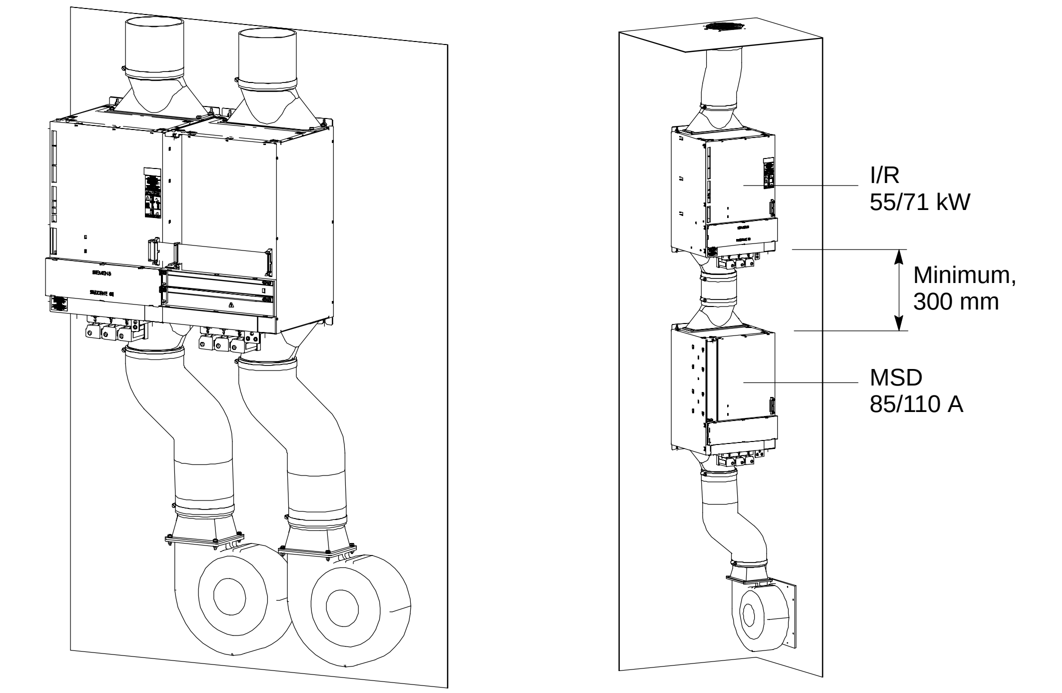
Fig. 2-6 System configuration with 400 V fan (only for 300 mm wide modules)

Warning

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

Caution

If the fan has an incorrect direction of rotation (see arrow) then cooling is not guaranteed!



Hose cooling for a 1–tier configuration

Package 1 for a single module

(Order No. 6SN11 62–0BA03–0AA1)

Hose cooling for a 2–tier configuration

Package 2 for a 2–tier configuration of I/R 55 kW and PM 85 A

(Order No. 6SN11 62–0BA03–0CA1)

Fig. 2-7 System configuration with hose cooling (only for 300 mm wide modules)

Note

DC link connection, refer to Chapter 9.1.3

Connection details for the DC link adapter set, refer to the dimension drawing, Chapter 11.

2.7.2 Internal cooling

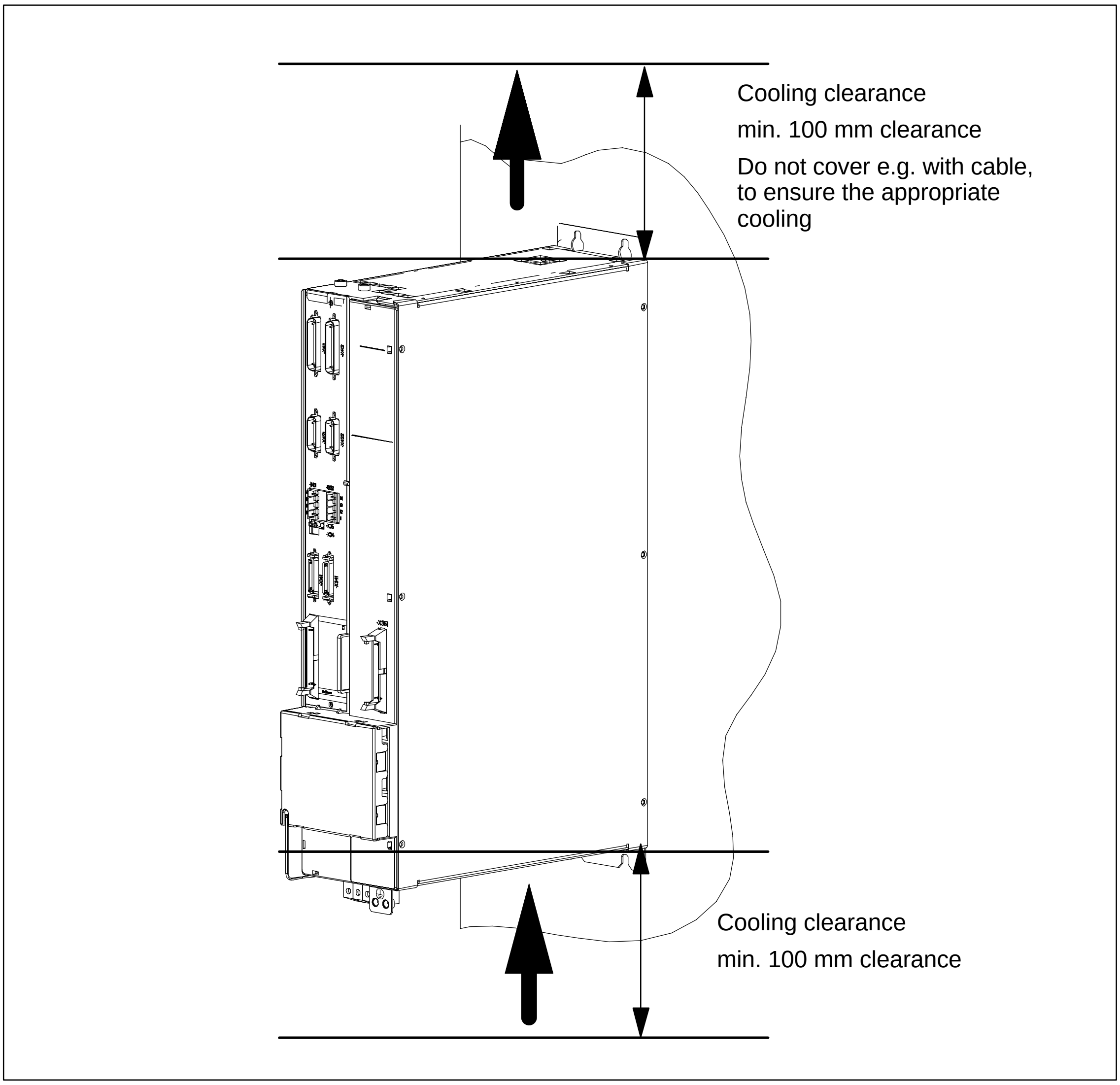


Fig. 2-8 Power module with inserted control unit, internal cooling

Note

The power loss is dissipated in the cabinet and must therefore be taken into account when engineering/dimensioning the cabinet cooling.

2.7.3 External cooling

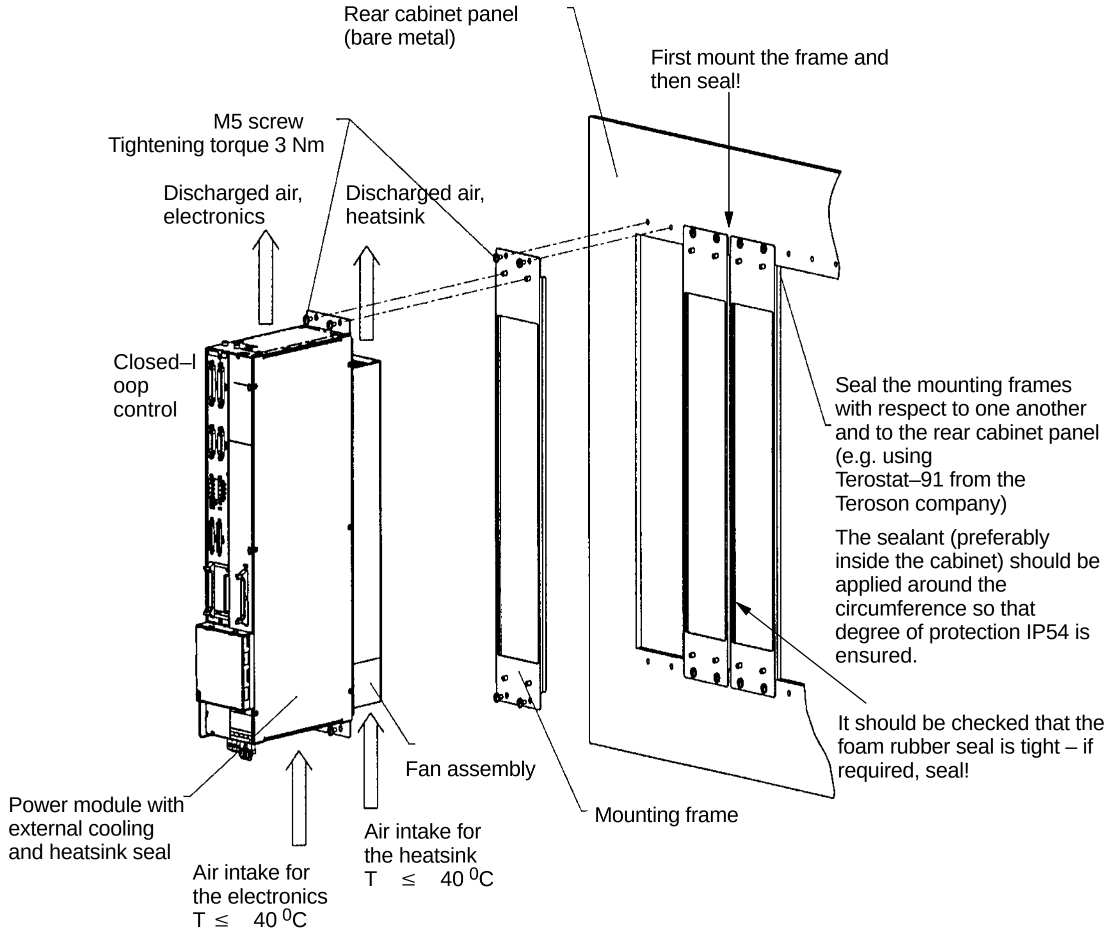


Fig. 2-9 Power module with inserted control unit, external cooling

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Note

Ensure that the airflow direction is according to the diagram and the cooling clearance according to the dimension drawing Chapter 11. For dimensions of the mounting frame, refer to the dimension drawing, Chapter 11.

Notice

For external heatsinks and fans, a high degree of pollution restricts the module cooling. This can cause the temperature monitoring function in the power module to respond. The heatsink and fans must be checked for accumulated dirt at regular intervals.
Clean when required!

Configuration information

For external cooling, the module heatsinks extend through the mounting plane in the electrical cabinet and can therefore dissipate power loss into an external cooling circuit.

The breakout in the mounting panel can be made for each module or also for a complete group of modules. For a breakout for the complete group of modules, the specific mounting frames for the modules should be used. For 300 mm wide modules, the appropriate mounting frame must be used (Order No.: 6SN1162–0BA04–0EA0). The dimension drawings for the breakouts are provided in Chapter 12.

The mounting frames should be installed from the inside of the cabinet or from the rear. This also then guarantees the necessary mounting surface for EMC.

Note

The dimensions of the recesses for the reinforcing ribs have different lengths. Ensure that the modules are mounted/installed in a standard way.

Seal

The reinforcing ribs of the mounting frames, that are rounded–off towards the rear, have seals on both sides. A sealant (e.g. Terostat–96 from Teroson) must be used to seal the edges of the mounting frames in contact with the mounting panel. Degree of protection IP 54 is achieved when the sealant is correctly applied.

Mounted fans for 300 mm wide modules

The fan cable must be fed into the electrical cabinet using a PG gland to ensure that the degree of protection is maintained.

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

2

2.7.4 Overvoltage limiter module

Application

The overvoltage limiter module limits sporadic, transient overvoltages that occur as a result of e.g. switching operations at inductive loads and at line supply matching transformers to acceptable values.

For line supply infeed modules 10 kW and above (100 mm wide), the overvoltage limiter module can be plugged into the X181 interface.

The overvoltage limiter module is used for upstream transformers or for (instable) line supplies that are not in conformance with IEC or line supplies where there are frequent switching operations – e.g. where larger motors are involved (from approx. 30 kW onwards).

An appropriate protective circuit is already integrated in the 5 kW UI module.

Note

It is absolutely necessary to use the overvoltage limiting module:

- For line supplies where also higher power loads are directly connected (depending on the line supply stiffness and extent of the line supply, already necessary from 20 kW and above).
- Line supplies, that do not reliably fulfill the line supply specifications according to IEC–/EN 61000–2–4.

Table 2-4 Technical data

Max. energy absorption	100 joules
Weight	approx. 0.3 kg
Dimensions (H x W x D)	76 mm x 70 mm x 32.5 mm
Max. module depth	325 mm
Order number	6SN11 11–0AB00–0AA0

Operating conditions

The following operating conditions apply:

- A voltage limiter must be used when transformers are used in front of the NE module.
- This limits the voltage for overvoltage condition caused by switching operations, when the line supply frequently fails, for arcing etc.
- Plants and systems that are to fulfill UL/CSA requirements, must be equipped with overvoltage limiter modules.

Mounting

1. Disconnect the equipment from the power source and ensure that it is in a no–voltage condition.
2. Withdraw connector X181 from the NE module.
3. Insert the overvoltage limiter module into connector X181 up to its endstop.
4. Insert connector X181 onto the overvoltage limiter module.

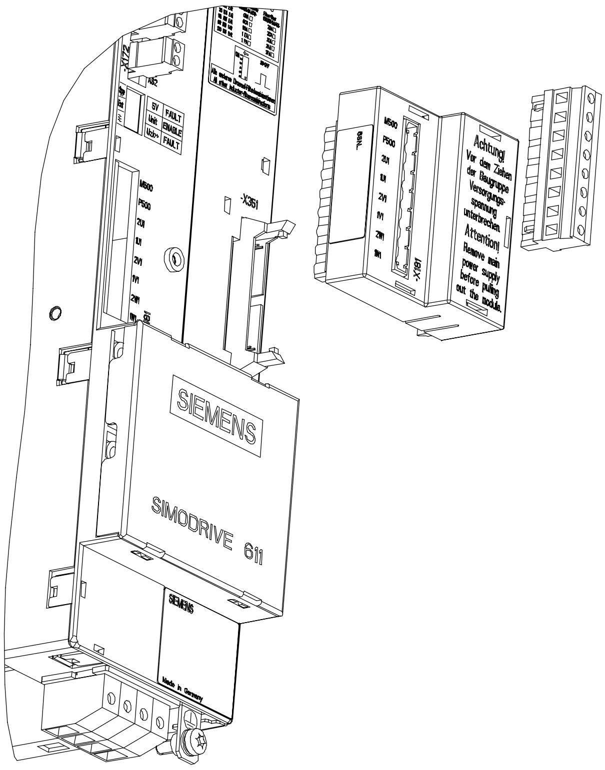

Fig. 2-10 Overvoltage limiter module

If the NE module indicates a line supply fault or if the yellow LED is dark, then after the line supply and the line fuses have been checked, the overvoltage limiter module should be checked and if required, replaced.

Procedure

1. Disconnect the equipment from the power source and ensure that it is in a no–voltage condition.
2. Withdraw the overvoltage limiter module and insert connector X181 on the NE module. If the NE module does not function correctly, then the overvoltage limiter module is defective and must be replaced. Otherwise, check the group of modules.

Note

If an overvoltage limiter module is defective, this results in high overvoltage peaks/spikes in the line supply. The line supply should be checked to check whether this is the case.

Notice

If the system is subject to a high–voltage test, the overvoltage limiter modules must be withdrawn in order to prevent the voltage limiting function responding.

■

Motor Selection, Position/Speed Sensing 3

3.1 Motor selection

The motor should be selected according to the mechanical and dynamic requirements placed on the motor. The requirements relating to the overload capacity of the motor depend on the magnitude and the number of load peaks during operation.

3.1.1 Motor protection

Motor–protection circuit–breakers should be used to protect the motors. When the motor has an overload condition, they only switch a signal contact.

If the motor is separated from the power module with the pulses enabled during operation, then there is the danger that the power module will destroy itself together with the control unit.

3.1.2 Motors with holding brake

Description

The holding brake mounted onto the motors is used to brake the motor when the motor is already at a standstill. In an emergency, it can also additionally reduce the braking travel. The holding brake is not an operational brake.

Notice

The motor holding brakes should only be actuated at standstill.

If the holding brake is operated during operation or while the motor is turning, this results in increased wear and shortens the lifetime of the holding brake. This is the reason that failure of the holding brake must already be taken into consideration when engineering the system. A hazard analysis must be carried–out.

Suspended (hanging) loads

Danger

Special attention and consideration must be given when holding brakes are used for suspended (hanging) loads (injury, crushing, possibility of death, machine damage) as this application represents a high potential hazard.

3.2 Motor encoders

The motors are equipped with various encoder systems to sense the rotor position and speed.

Reference: refer to the Attachment C in the relevant Configuration Manual of the motors

The assignment of the SIMODRIVE units to the servo/main spindle motor types and encoder systems is shown in the Table 3-2.

3.3 Indirect position and motor speed sensing

The various possibilities for indirect position and speed sensing and to position the motor shaft as a function of the drive configuration (SINUMERIK, SIMODRIVE and Motor) are shown in Table 3-3 (Chapter 3.5).

3.4 Direct position sensing

3.4.1 Encoder systems that can be evaluated

The various possibilities for direct position sensing for positioning as a function of the drive configuration (SINUMERIK, SIMODRIVE and Motor) and the encoder system being used are shown in Table 3-4 (Chapter 3.5).

As a result of the higher data transfer reliability, we recommend that sinusoidal voltage signals are used.

Parameterizable encoder limit frequency (SW 5.1.14 and higher)

Machine data MD 1326: $MD_SAFE_ENC_FREQ_LIMIT can be used to parameterize a limit frequency. The maximum value is 420 kHz, the lower limit and default value is 300 kHz.

Note

Changes to this MD may only be made, carefully taking into account the prevailing conditions.

This functionality is **only** supported by SIMODRIVE 611 digital High Performance control units.

Table 3-1 Encoder limit frequency and speed

Encoder pulses/ rev.	Speed at maximum encoder limit frequency		
	200 kHz	**300 kHz**	**420 kHz**
2048	5800 rpm	8700 rpm	12300 rpm
1024	11600 rpm	17400 rpm	24600 rpm
512	22200 rpm	34800 rpm	49200 rpm

The following **secondary conditions/limitations** are specified:

1. Cable to be used:
   Siemens cable, Order No.: 6FX2002–2CA31–1CF0
2. Maximum permissible encoder cable length:

   Encoder limit frequency 420 kHz: 20 m
3. Encoder characteristics: ”–3dB cut–off frequency” greater than or equal to 500 kHz
   Examples of encoders that can be used:
   ERA 180 with 9000 pulses/rev and ERA 180 with 3600 pulses/rev from the Heidenhain Company
4. The amplitude monitoring that is active up to 420 kHz.

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

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
Power supply:	5 V ± 5 % (also refer to Chapter Encoder power supply)
Max. power supply current:	300 mA
Max. encoder signal frequency that can be evaluated:	200 kHz Standard board/ 420 kHz (from SW 5.1.14)[1)] 350 kHz without suppressing the amplitude monitoring function 650 kHz, suppressing the amplitude monitoring function

Note

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

Observe the frequency characteristic of the encoder signals.

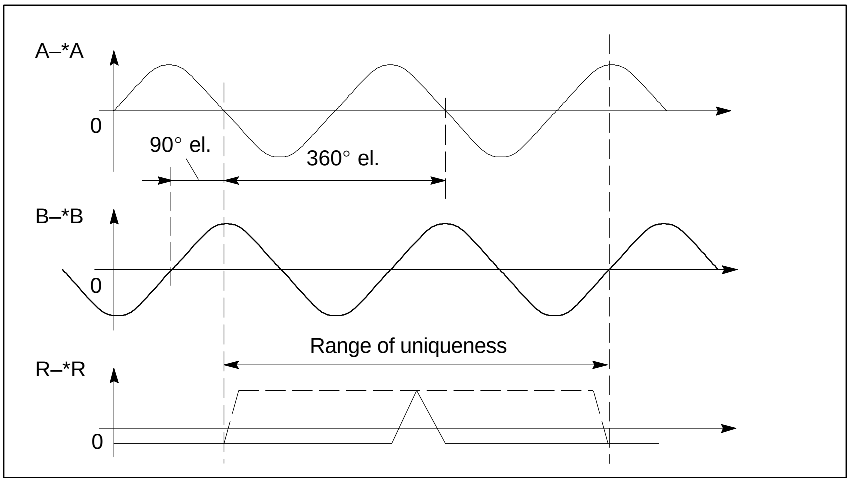

Fig. 3-1 Signal characteristic for a clockwise direction of rotation

1) refer to the parameterizable encoder limit frequency (from SW 5.1.14)

Singleturn, multiturn and linear absolute systems with two sinusoidal voltage signals A, B offset through 90 degrees and EnDat interface

Transfer, incremental signals:	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:	acc. to EIA 485
Power supply:	5 V ± 5 % (also refer to Chapter Encoder power supply)
Max. power supply current:	300 mA
Max. encoder signal frequency that can be evaluated:	200 kHz Standard board/ 420 kHz (from SW 5.1.14)[1)] 350 kHz without suppressing the amplitude monitoring function 650 kHz, suppressing the amplitude monitoring function

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Note

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

Observe the frequency characteristic of the encoder signals.

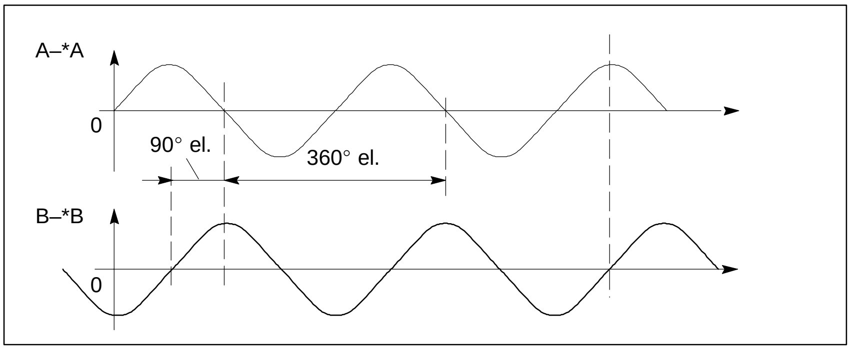


Fig. 3-2 Signal characteristics for incremental tracks for a clockwise direction of rotation

1) refer to the parameterizable encoder limit frequency (from SW 5.1.14)

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

Transfer:	Differential signals A, *A; B, *B and R, *R
Signal level:	according to RS422
Power supply:	5 V $\pm$ 5 % (also refer to Chapter Encoder power supply)
Max. power supply current:	300 mA
Max. encoder signal frequency that can be evaluated:	500 kHz

Note

For the above specified max. encoder signal frequency, the edge clearance between track A and B must be ≥ 200 ns.

Observe the frequency characteristic of the encoder signals!

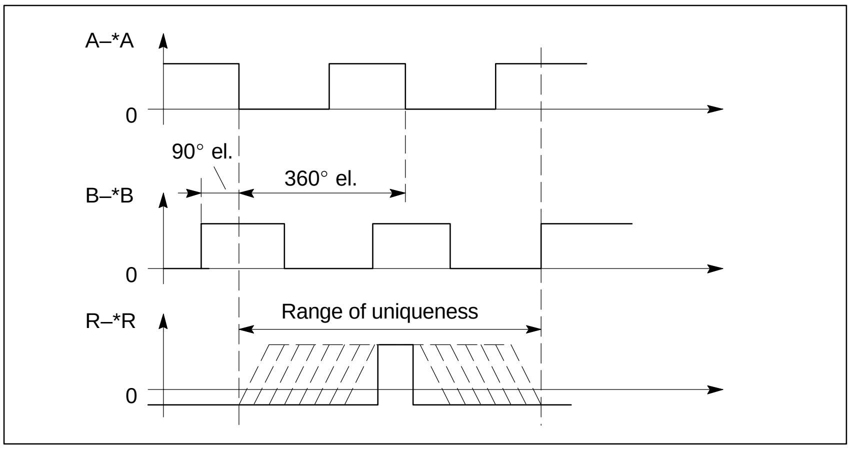


Fig. 3-3 Signal characteristic for a clockwise direction of rotation

SSI encoders

The SSI encoder is used as direct position measuring system (NC) (SSI scale/ encoder is attached to the load). In addition to this direct position measuring system, on the motor side, the speed is sensed using an incremental motor encoder.

The exception is the measuring system sensing for SIMODRIVE 611D HLA, where the linear scale can be used as "motor measuring system".

The SSI encoders used must be in conformance with the following specifications:

Gray or binary coded encoders can be used under the assumption:

- Error bit/alarm bit is the LSB; if, in addition, a parity bit is transferred, then this is the next to last bit. If an alarm bit is not transferred, then the parity bit is the LSB.
- The net (useful) information – also as parity or error bit/alarm bit – are either gray or binary–coded – but never mixed.
- Telegram length (including alarm and/or parity):
  - **SIMODRIVE HLA** 13 <u>and</u> 25 bit,
  - **SIMODRIVE 611D** from 13, <u>to</u> 25 bit
- Data type: **SIMODRIVE HLA** only right justified
- For HLA: The encoder zero from the <u>linear encoder</u> (absolute value 0) may not be located in the traversing range
- Transfer frequency, f: 100 or 500 kHz
- Monoflop time:
  - at 100 kHz t_m min 12 µs,
  - at 500 kHz t_m min 2.4 µs,
  - or $t_m > 1.2 \cdot 1/f$
- Operation is only possible **without** Safety Integrated!

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. (The voltage is directly regulated at the encoder to $\pm$ 5 %).

Remote/sense operation means:

The power supply voltage of the measuring system is sensed using the sense lines P sense and M sense (quasi zero–current measurement).

The controller compares the measuring system power supply voltage, sensed using the remote sense lines, with the reference power supply voltage of the measuring system and adjusts the power supply voltage for the measuring system at the drive module output until the required power supply voltage is set directly at the measuring system.

This means that the voltage drops across the power supply cables – P encoder and M encoder – are compensated and corrected by the encoder power supply.

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

This means that it is possible to use cable lengths up to 50 m without having to operate the measuring systems with an undervoltage condition.

Note

All data only apply for SIEMENS pre–assembled cables as these are correctly dimensioned regarding the cable cross–sections.

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

For motor measuring systems and mounted SIMODRIVE sensor encoders, the sense lines are connected in the encoder or in the connector on the encoder side. For third–party encoder systems, the customers must make the appropriate connections.

High Performance digital FD and MSD drive control

Remote/sense operation

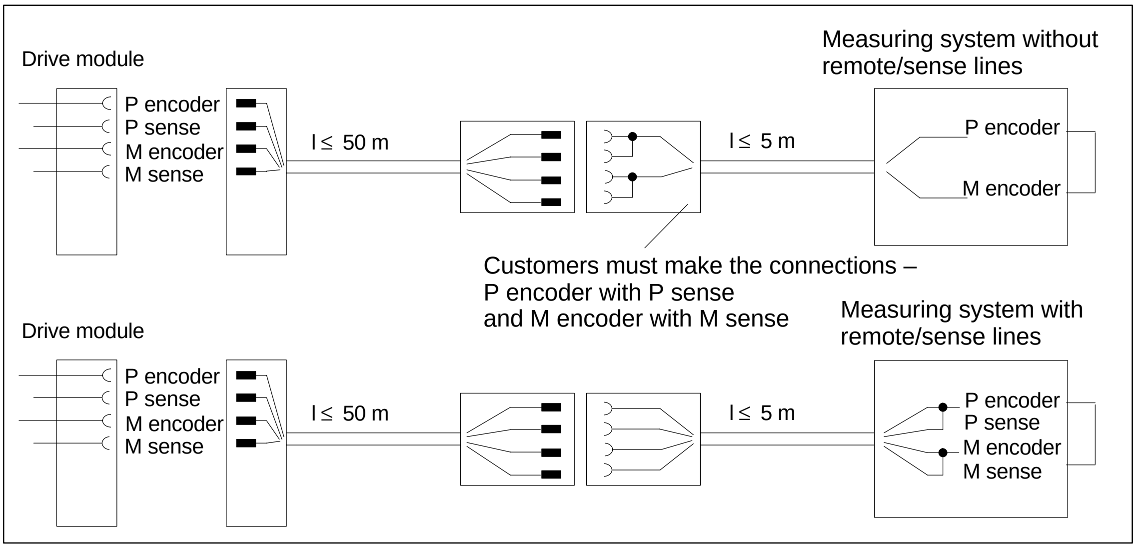


Fig. 3-4 Signal overview of the connections

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 connected to the encoder cable.

What has to be observed?

The following must be observed (refer to Fig. 3-5):

Note

SSI encoders are likely to have lower noise immunity due to the encoder and the 24 V power supply.

- The encoders must be supplied with a separately regulated 24 V voltage (e.g. SITOP power) in order to avoid disturbances/noise due to contactors etc.
- The external 24 V power supply must have ”safe separation” (PELV).
- Filter data:
  - The special filter is required in order to filter–out noise and disturbances
  - Maximum continuous operating current = 0.8 A (use a fuse!)
  - Max. voltage = 30 V
  - 1 filter is designed for 2 encoders with a maximum current = 0.4 A.
- The 24 V supply (reference potential) should be connected to the electronics ground of the system (e.g. terminal X131 on the NE module) if this connection is not already provided in the encoder.
- Maximum cable length between the 24 V supply and the filter = <10 m
- Maximum encoder cable = 50 m
- The technical data of the encoder manufacturer must be carefully observed.
- Third–party encoders must be connected using the adapter cables provided by the particular manufacturer.

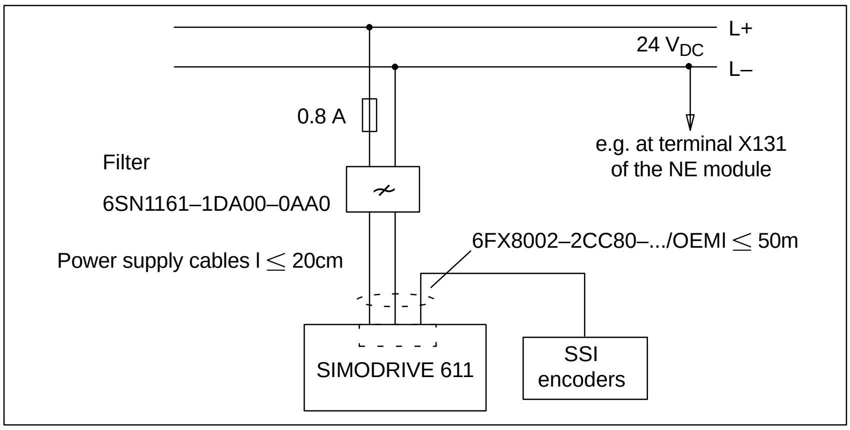


Fig. 3-5 Connecting SSI encoders to SIMODRIVE 611

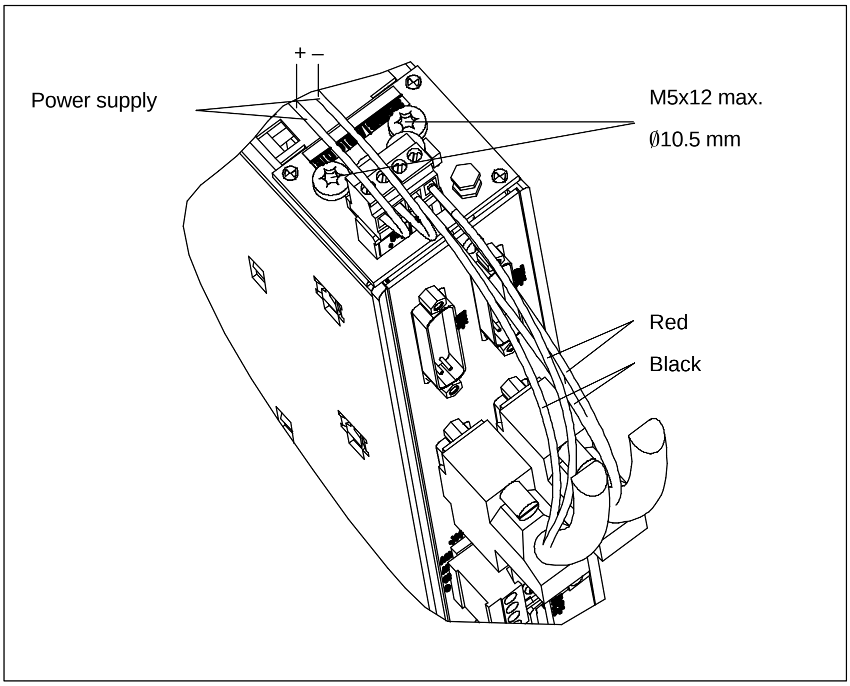


Fig. 3-6 Connection example for the High Performance digital control

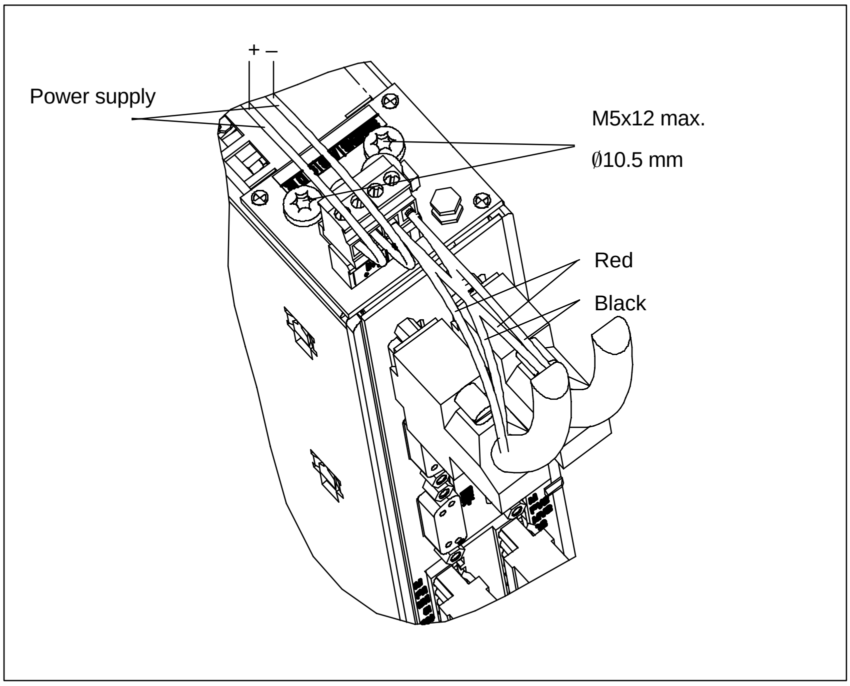


Fig. 3-7 Connection example for the ”HLA module” control board

3.5 Overview, position sensing

Table 3-2 Assignment, motor measuring systems to control unit

Drive control unit, High Performance (FD mode)	Drive control unit, High Performance (MSD mode)	Drive control unit, High Standard (FD mode)	Drive control unit, High Standard (MSD mode)	Drive control unit 611 universal HRS resolver	Drive control unit 611 universal HRS– 1 Vpp voltage signals	Motor type	Encoder system
				yes		1FK Servomotor	Resolver
yes		yes			yes	1FT/1FK Servomotor	1 Vpp incremental encoders
yes		yes			yes	1FT/1FK Servomotor	Multiturn absolute value encoders
yes		yes			yes	1FN Linear motors	Incremental encoder (Hall sensor box) 1 Vpp Absolute encoder
	yes		yes		yes	1PH4/6/7 main spindle motors	1 Vpp incremental encoders
	yes		yes		yes	1FE1/1PH2/1PM/2SP1 main spindle motors	Incremental encoder (hollow–shaft encoder) 1V pp (toothed wheel or magnetic)
yes		yes			yes	1FW build–in torque motors	1 Vpp incremental encoders Absolute encoder
	yes		yes	yes	yes	1LA standard motor	Encoderless (sensorless)

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

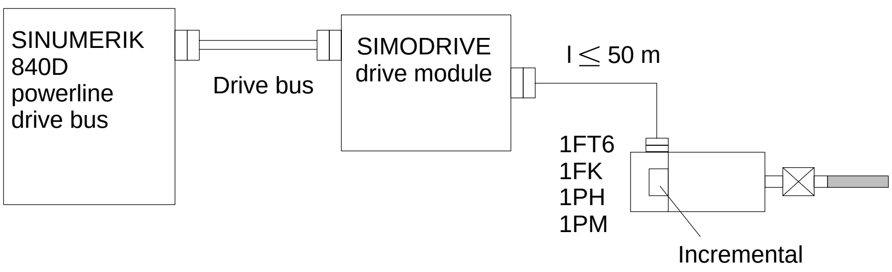
Version of the control board	**Indirect position (motor rotor position) and motor speed sensing digital controls**
Drive control High–Performance/ High Standard	

Table 3-4 Direct position sensing, digital controls

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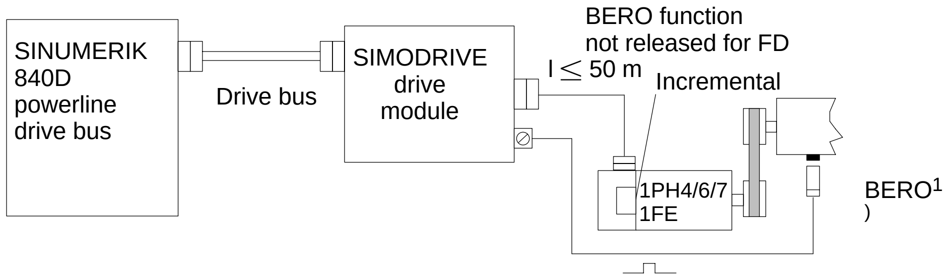
<tr><td rowspan="3">Drive control High–Performance/ High Standard</td><td>
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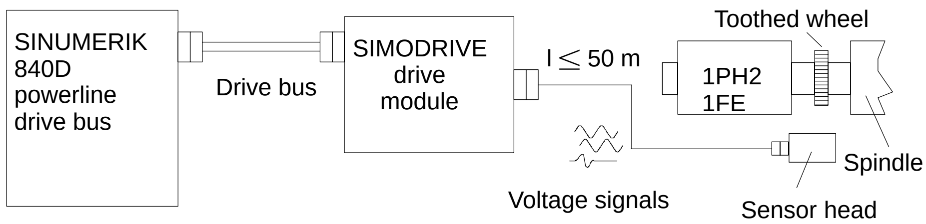
<tr><td>
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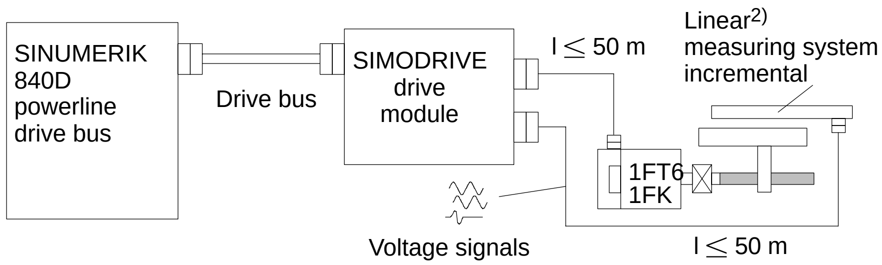
<tr><td>
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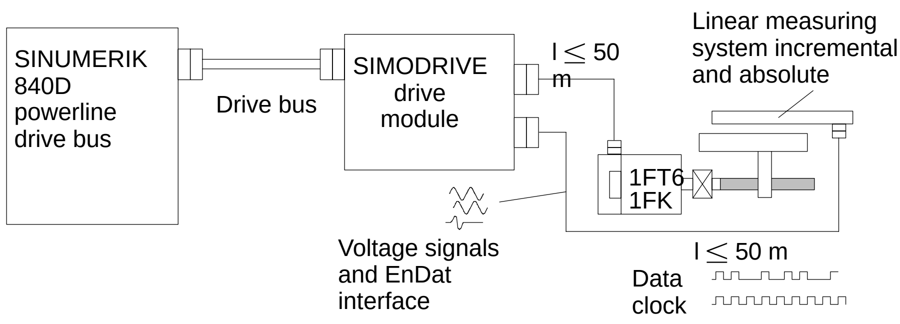
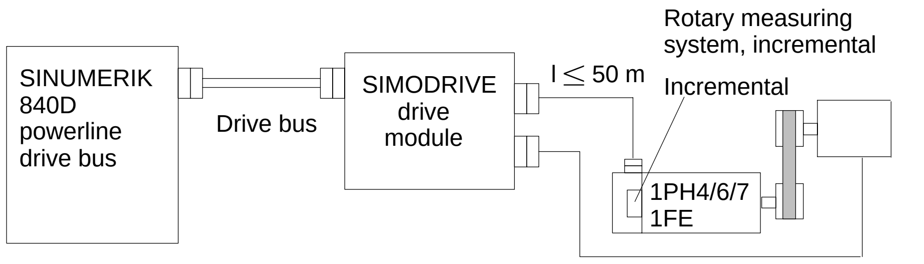
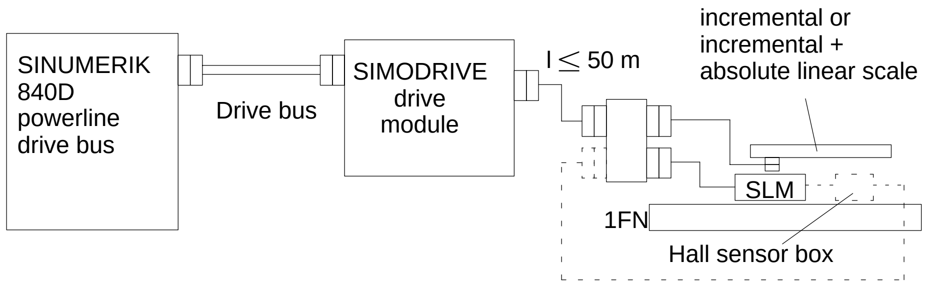
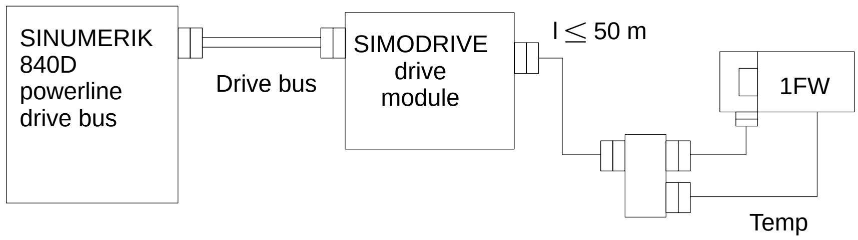
<tr><td>Drive control High–Perfor–mance/ High Standard</td><td>
</td></tr>
</table>

1) The absolute accuracy for so–called synchronization with a BERO depends on the following:
- the switching time of the BERO
- the hysteresis of the BERO
- the signal edge gradient (rate–of–rise) of the BERO signal (depending on the direction of rotation) and the switching thresholds in the drive; high > 13 V, low < 5 V
- the search speed and the signal runtimes in the evaluation electronics

Table 3-4 Direct position sensing, digital controls, continued

<table>
<tr><th>Version of the control board</th><th>Direct position sensing, digital controls</th></tr>
<tr><td>Drive control High–Performance/ High Standard</td><td>
</td></tr>
<tr><td rowspan="2">Drive control High–Performance</td><td>
</td></tr>
<tr><td>
</td></tr>
</table>

3.6 Ordering information

Refer to the relevant catalog for the Order Nos. of the specified components

- Pre–assembled encoder cables with the appropriate maximum permissible cable lengths — refer to Catalog NC Z
- Toothed–wheel encoder and the diagnostics box required to make adjustments — refer to Catalog NC Z or NC 60

■

Power Modules

4

4.1 Description

General information

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

Motors that can be connected

The power modules can be used to operate the following motors:

- 1FT6, 1FK6 and 1FK7 servomotors
- 1FW6 build–in torque motors (direct drives)
- 1FN linear motors
- 1PH main spindle motors
- Standard induction motors; if IM operation is selected, only pulse frequencies of 4 kHz and 8 kHz are permissible.
- 1PM hollow–shaft motors for main spindle drives (direct drives)
- 1FE1 main spindle motors
- 2SP1 motor spindles

For special motors with a low leakage inductance (where the controller settings are not adequate) it may be necessary to provide a series reactor as 3–arm iron reactor (not a Corovac reactor) and/or increase the inverter clock cycle frequency of the converter. From experience, motors with low leakage inductance, are motors that can achieve high stator frequencies (maximum motor stator frequency > 300 Hz) or motors with a high rated current (rated current > 85 A).

Available power modules

A wide range of one–axis or two–axis power modules is available. These modules are graded according to the current ratings and can be supplied with three different cooling techniques.

The current–related data refers to the series–preset values. At higher frequencies of the basic fundamental or for higher clock cycle frequencies, ambient temperatures and installation altitudes above 1000 m above sea level, power de–ratings apply as subsequently listed.

Connecting–up

Matched, pre–assembled cables are available to connect the motors. Ordering information is provided in Catalog NC 60, in the ”Motors” Section.

Shield terminal plates are available to meet EMC requirements when using shielded power cables.

The equipment bus cable is included in the scope of supply of the power module. The drive bus cables must be ordered separately for the digital system.

The current data of the power modules (PM modules) are normalized values to which all of the control units are referred. The output currents can be limited by the control unit being used. After the control unit has been inserted, the retaining screws of the control unit front panel must be tightened in order to establish a good electrical connection to the module housing.

Caution

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

Power module, internal cooling

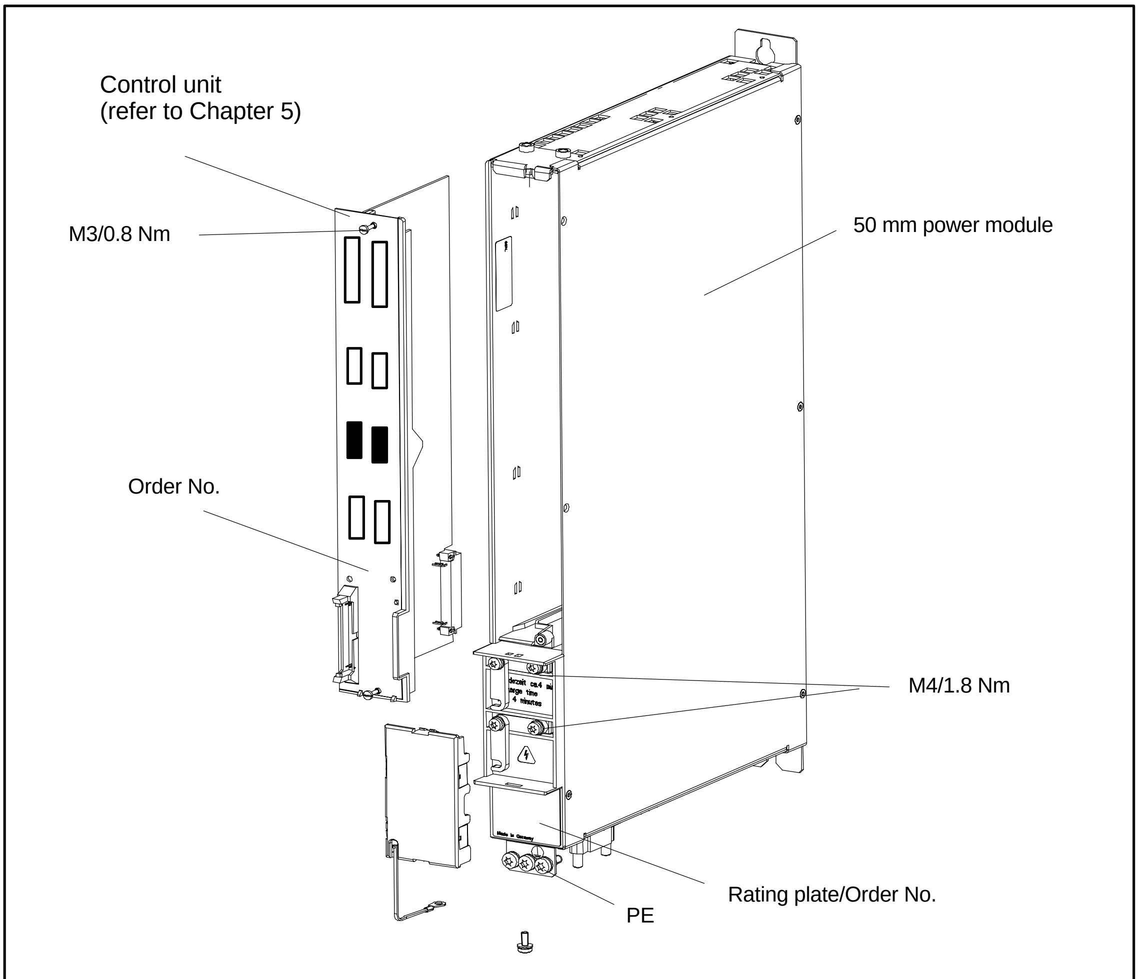


Fig. 4-1 Power module with control unit

4.2 Operating modes

Feed drives

- with synchronous motors (FD)
  - 1FT6, 1FK6 and 1FK7 servomotors
  - 1FW6 build–in torque motors (direct drives)
  - 1FN linear motors

Main spindle drives

- with induction motors (MSD–IM)
  - 1PH main spindle motors
  - 1PM hollow–shaft motors for main spindle drives (direct drives)
  - induction standard motors (sensorless)

    If IM operation is selected, only pulse frequencies of 4 kHz and 8 kHz are permissible.
- with synchronous motors (MSD–SRM)
  - 1FE1 main spindle motors
  - 2SP1 motor spindles

Note

For the MSD–SRM operating mode (high–speed MSD synchronous applications), inverter clock cycle frequencies are set that differ from the rated frequencies. This therefore ensures an optimum ratio between the inverter clock cycle frequency and the output frequency.

The derating resulting from this should be taken into account when selecting the power module.

The frequencies relevant when engineering the system should be appropriately taken from the following documentation.

Reader's note

Technical data and ordering data, refer to

Reference: /PJFE/ Configuration Manual, 1FE1 Synchronous Build–in Motors

/BU/ Catalog NC 60 2004

/PMS/ Configuration Manual ECO Motor Spindles for 2SP1 Main Spindle Drives

WEISS GmbH/Operating Instructions ECO Spindle Units Type 2SP1...

4.3 Technical data

General information

The technical data of the power modules is specified in Table 4-1 for the 1–axis version and in Table 4-2 for the 2–axis version.

The specified values are valid for:

- The specified rated frequency (inverter clock cycle frequency)
- Ambient temperature of 40 °C
- Installation altitude<1000m

De–rating must be applied for conditions that deviate from those specified above

Definition of the currents

Also refer to a definition of the load duty cycles (Figs.)

- FD mode
  - i_N Continuous current
  - I_{max} Peak current
- Operating modes, MSD–IM and MSD–SRM
  - i_N Continuous current
  - IS6–40% Current for max. 4 min. for an S6 load duty cycle
  - I_{max} Peak current

Definition of the power ratings

Appropriate values are specified in Table 4-1 and 4-2 to dimension the cabinet cooling. These are defined as follows:

- P_{Vtot} Total power loss dissipated by the module
- P_{Vext} Power loss that can be dissipated externally or using hose cooling
- P_{Vint} Power loss that cannot be dissipated using hose cooling or external cooling (this power loss remains in the cabinet)

For components with internal cooling, the complete dissipated power loss remains in the electrical cabinet.

Table 4-1 Power modules in the 1–axis version

6SN112□–1AA0□– 3 internal cooling 4 external cooling2)		**0HA1**	**0AA1**	**0BA1**	**0CA1**	**0DA1**	**0LA1**	**0EA1**	**0FA1**	**0JA1**	**0KA1**
Mounting frame external cooling **6SN1162–0BA04–**			**0AA1**		**0FA1**	**0BA1**	**0CA1**			**0EA0**	
Type of cooling		**Non–venti-lated**		**Fans**							
Operating mode, MSD–IM/SRM											
Rated current I_N	A	3	5	8	24	30	45	60	85	120	200
Current for S6–40 % $I_{S6–40\ \%}$	A	3	5	10	32	40	60	80	110	150	250
Peak current I_{max}	A	3	8	16	32	51	76	102	127	193	257
Pulse frequency f_0	kHz					3.2					
Derating factor X_L	%		50			55		50		55	
Power loss, total P_{vtot}	W	30	40	74	260	320	460	685	850	1290	2170
Power loss, internal P_{vint}	W	12	16	29	89	32	19	30	100	190	325
Power loss, external P_{vext}	W	18	24	45	171	288	441	655	750	1100	1845
Operating mode FD/SLM											
Rated current I_N	A	3	5	9	18	28	42	56	70	100	140
Peak current I_{max}	A	6	10	18	36	56	64	112	140	100	210
Pulse frequency f_0	kHz					4					
Derating factor X_L	%		55		50				55		
Power loss, total P_{vtot}	W	35	50	90	190	300	460	645	730	1300	1910
Power loss, internal P_{vint}	W	14	19	35	65	30	25	25	90	170	250
Power loss, external P_{vext}	W	21	31	55	125	270	435	620	640	1130	1660
General technical data for the regulated infeed											
Input voltage	V					DC 600/625/680					
Output voltage	V					3–ph. 0 to 430 V AC					
Efficiency						0.98					
Module width	mm		50			100	150			300 1)	
Weight, approx.	kg		6.5			9.5	13		26		28

1) For 6SN1123–1AA00–0JA1/–0KA1 and 6SN1124–1AA0□–0FA1/–0JA1/–0KA1 the built–on fan 6SN1162–0BA02–0AA2 is required

2) For a module width of 300 mm with external cooling, mounting frames are required that must be separately ordered. The fan assembly required here to mount the built–on fan is included in the scope of supply of the mounting frame. The built–on fan must be separately ordered! Mounting frames are also available for smaller module widths. However, these are not required if openings are cut–out in the rear cabinet panel for the module heatsinks as shown in this Configuration Manual.

Table 4-2 Power modules in the 2–axis version

6SN112□–1AB0□– 3 internal cooling 4 external cooling		**0HA1**	**0AA1**	**0BA1**	**0CA1**
Mounting frame external cooling **6SN1162–0BA04–**		**0AA1**			**0GA1**
Type of cooling		**Non–ventilated**		**Fans**	
Operating mode, MSD–IM/SRM[1)]					
Rated current I_N	A	3	5	8	24
Current for S6–40 % $I_{S6–40\ \%}$	A	3	5	10	32
Peak current I_{max}	A	3	8	16	32
Pulse frequency f_0	kHz	3.2			
Derating factor X_L	%	55			
Power loss, total P_{vtot}	W	76	118	226	538
Power loss, internal P_{vint}	W	28	42	74	184
Power loss, external P_{vext}	W	48	76	152	354
FD mode					
Rated current I_N	A	3	5	9	18
Peak current I_{max}	A	6	10	18	36
Pulse frequency f_0	kHz	4			
Derating factor X_L	%	55			
Power loss, total P_{vtot}	W	70	100	180	380
Power loss, internal P_{vint}	W	27	38	69	130
Power loss, external P_{vext}	W	43	62	111	250
General technical data for the regulated infeed					
Input voltage	V	DC 600/625/680			
Output voltage	V	3–ph. 0 to 430 V AC			
Efficiency		0.98			
Module width	mm	50			100
Weight, approx.	kg	7			13.5

1) For IM operation, corresponding to the selected pulse frequency 4/8 kHz, an appropriate de–rating must be observed.

Load duty cycles

- Rated load duty cycles for FD operation

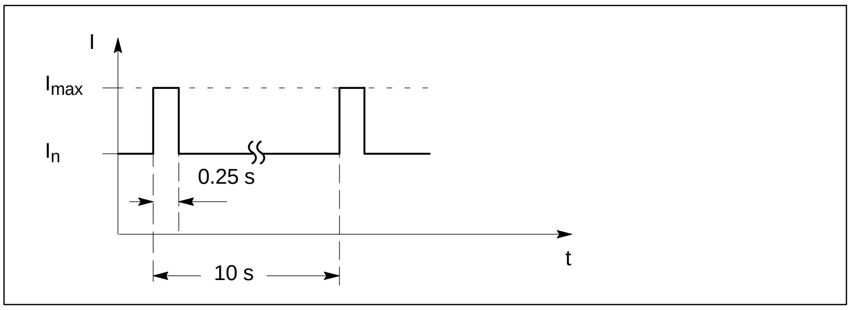


Fig. 4-2 Peak current–load duty cycle with pre–load condition

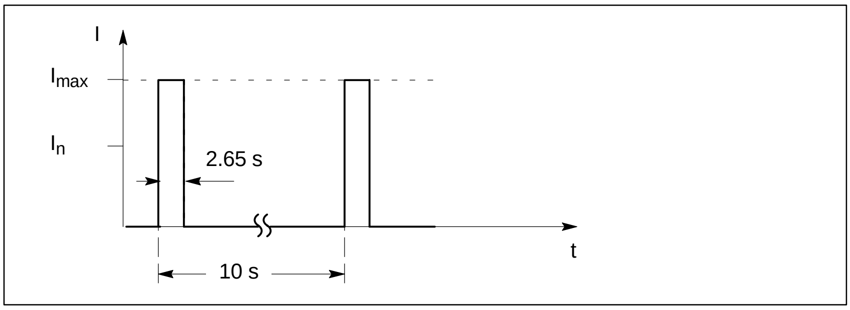


Fig. 4-3 Peak current–load duty cycle without pre–load condition

- Rated load duty cycles for MSD–IM and MSD–SRM

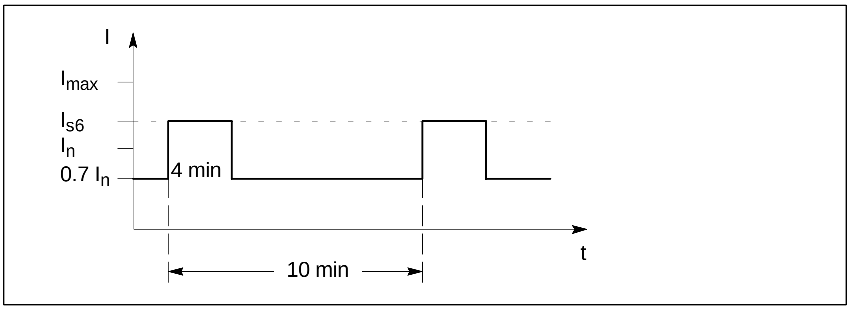


Fig. 4-4 S6 load cycle with pre–load

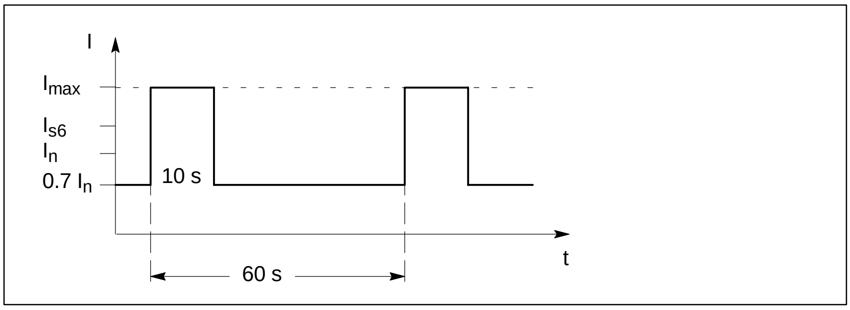


Fig. 4-5 S6 peak current–load duty cycle with pre–load condition

4.4 Current reduction (de–rating)

The current has to be reduced if one or several of the following limitations/secondary conditions apply:

- Selected inverter clock cycle frequency f_T > reference frequency f_0
- Installation altitude>1000 m
- Ambient temperature T_U > 40 °C

Definitions

- f_0 rated frequency
- f set inverter clock cycle frequency
- T_U ambient temperature
- X_L power module–specific de–rating factor for the inverter clock cycle frequency
- X_T de–rating factor for the inverter clock cycle frequency
- X_H de–rating factor for the ambient temperature
- X_{TU} de–rating factor for the installation altitude as a %

Notice

The currents must be reduced for I_n, I_{s6} and I_{max} in the same fashion.

All of the relevant limitations/secondary conditions must be taken into account with an appropriate reduction factor (refer to the calculation example, Chapter 4.4.4).

4.4.1 Inverter clock cycle frequency

The current should be reduced from the reference frequency f_0 onwards according to the following rule:

$$X_T = 100\ \% - \frac{(100\ \% - X_L) \bullet (f - f_0)}{8\ \text{kHz} - f_0}$$

Calculation example

Power module: 6SN1123–1AA0□–0EA1

Operating mode:	FD
Inverter clock cycle frequency:	6.3 kHz
Installation altitude	<1000 m
Ambient temperature	<40 °C
	X_L = 55 %
	f_0 = 4.0 kHz
	I_N = 56 A
	I_{max} = 112 A

$$X_T = 100\ \% - \frac{(100\% - 55\%) \bullet (6.3\ \text{kHz} - 4.0\ \text{kHz})}{8.0\ \text{kHz} - 4.0\ \text{kHz}} = 74.125\ \%$$

$\Rightarrow I_{N6.3} = I_N \bullet X_T = 56\ \text{A} \bullet 0.74125 = 41.5\ \text{A}$
$\Rightarrow I_{max\ 6.3} = I_{max} \bullet X_T = 112\ \text{A} \bullet 0.74125 = 83.0\ \text{A}$

De–rating frequency

- for MSD–IM and MSD–SRM or IM operation (sensorless)

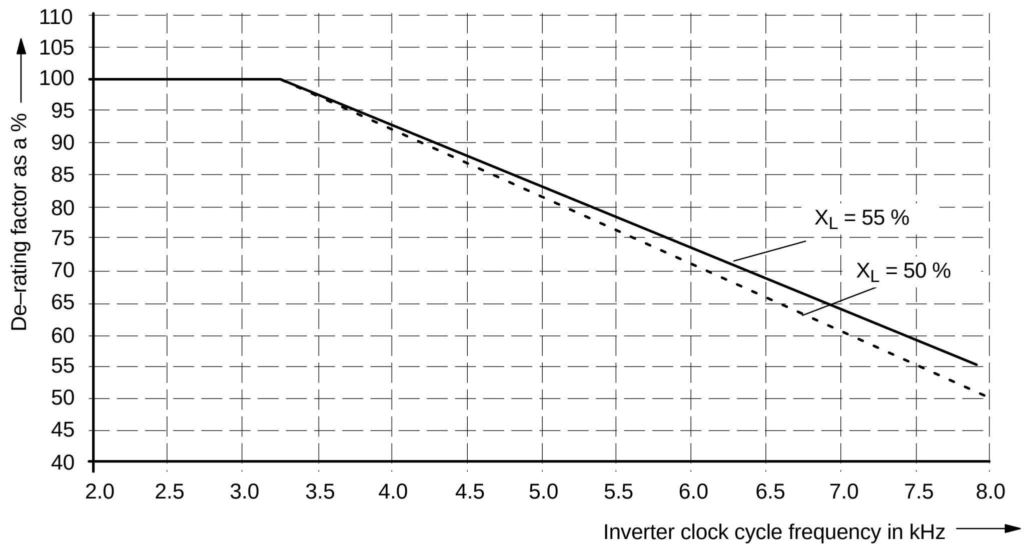


Fig. 4-6 De–rating characteristic, frequency for MSD–IM and MSD–RSM

- for FD

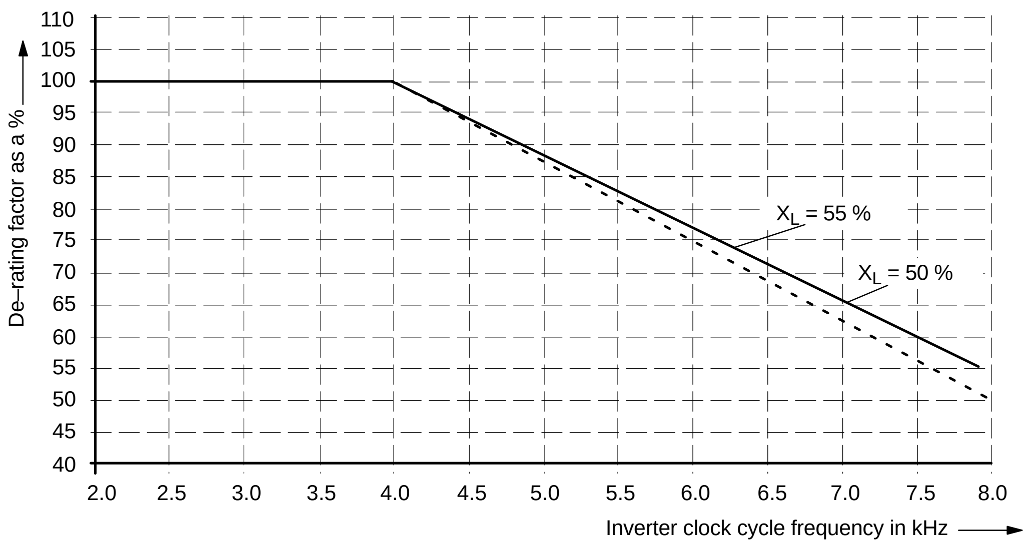


Fig. 4-7 De–rating characteristic, frequency for FD

4.4.2 Temperature

For an ambient temperature T > 40 °C, de–rating is required according to the following rule:

X_{TU}=100 % – 2.5 % (T_U – 40 °C)

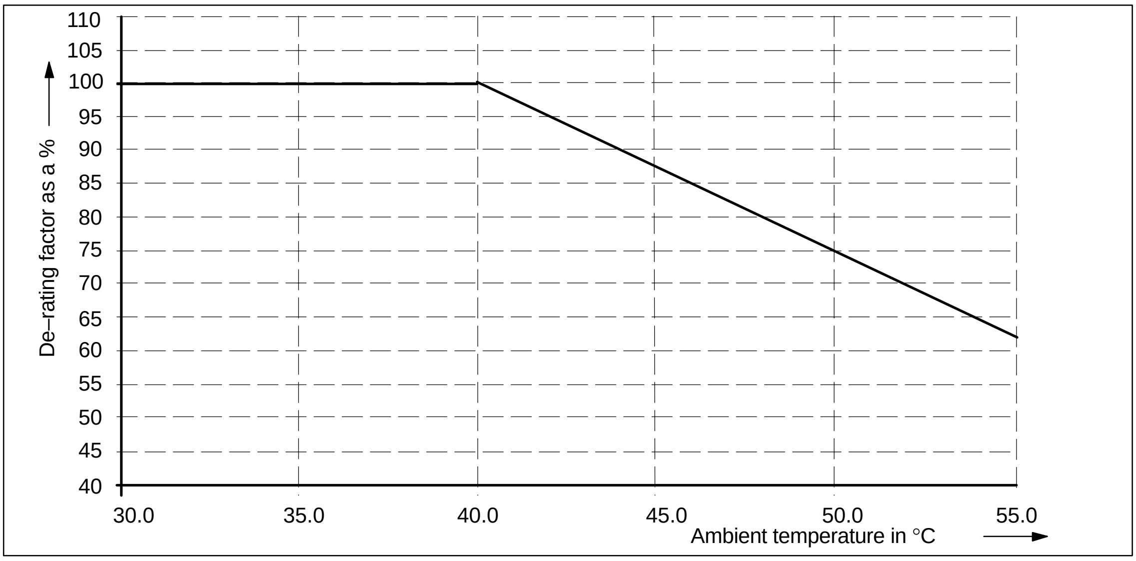


Fig. 4-8 De–rating characteristic for temperature

Notice

The maximum ambient temperature for operation of T_U = 55 °C may not be exceeded.

4.4.3 Installation altitude

For an installation altitude h > 2000 m above sea level, de–rating is required according to the following de–rating characteristic:

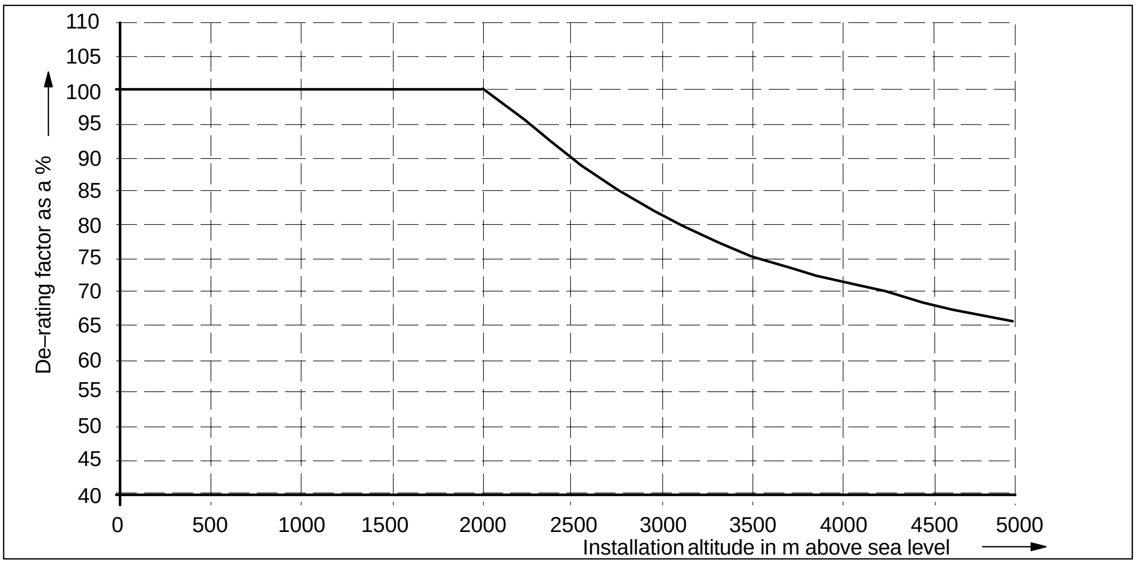


Fig. 4-9 De–rating characteristic for the installation altitude

4.4.4 Calculation example

4

- Limitations/secondary conditions

Power module:	6SN1123–1AA0□–0EA1
Operating mode:	FD
Inverter clock cycle frequency:	6.3 kHz
Installation altitude	2000 m
Ambient temperature	45 °C
	X_L = 55 %
	f_0 = 4.0 kHz
	I_N = 56 A
	I_{max} = 112 A

- Determining the de–rating factors

$$X_T = 100\,\% - \frac{(100\% - 55\%) \bullet (6.3\text{ kHz} - 4.0\text{ kHz})}{8.0\text{ kHz} - 4.0\text{ kHz}} = 74.125\,\%$$

$X_{TU} = 100\,\% - 2.5\,\% \bullet (45\,°C - 40\,°C) = 87.5\,\%$

$X_H \approx 85\,\%$

- Calculating the permissible current values

$I_{Nred} = I_N \bullet X_T \bullet X_{TU} \bullet X_H = 56\text{ A} \bullet 0.74125 \bullet 0.875 \bullet 0.85 = 30.8\text{ A}$

$I_{maxred} = I_{max} \bullet X_T \bullet X_{TU} \bullet X_H = 112\text{ A} \bullet 0.74125 \bullet 0.875 \bullet 0.85 = 61.7\text{ A}$

Table 4-3 Power modules in a 1–axis version, de–rating for MSD–SRM or IM operation (sensorless)

6SN112□–1AA0□–		**0HA1**	**0AA1**	**0BA1**	**0CA1**	**0DA1**	**0LA1**	**0EA1**	**0FA1**	**0JA1**	**0KA1**
Type of cooling		**Non–venti-lated**		**Force–ventilated**							
Inverter clock cycle frequency fT = 4.0 kHz											
Rated current I_N	A	2.8	4.6	7.3	22.0	27.8	41.6	55.0	77.9	111.0	185.0
Current for S6–40 % $I_{S6-40\,\%}$	A	2.8	4.6	9.2	29.3	37.0	55.5	73.3	100.8	138.8	231.3
Peak current I_{max}	A	2.8	7.3	14.7	29.3	47.2	70.3	93.5	116.4	178.5	237.7
Inverter clock cycle frequency fT = 5.33 kHz											
Rated current I_N	A	2.3	3.9	6.2	18.7	24.0	36.0	46.7	66.1	96.0	160.1
Current for S6–40 % $I_{S6-40\,\%}$	A	2.3	3.9	7.8	24.9	32.0	48.0	62.3	85.6	120.0	200.1
Peak current I_{max}	A	2.3	6.2	12.5	24.9	40.8	60.8	79.4	98.8	154.5	205.7
Inverter clock cycle frequency fT = 6.4 kHz											
Rated current I_N	A	2.0	3.3	5.3	16.0	21.0	31.5	40.0	56.7	84.0	140.0
Current for S6–40 % $I_{S6-40\,\%}$	A	2.0	3.3	6.7	21.3	28.0	42.0	53.3	73.3	105.0	175.0
Peak current I_{max}	A	2.0	5.3	10.7	21.3	35.7	53.2	68.0	84.7	135.1	179.9
Inverter clock cycle frequency fT = 8.0 kHz											
Rated current I_N	A	1.5	2.5	4.0	12.0	16.5	24.8	30.0	42.5	66.0	110.0
Current for S6–40 % $I_{S6-40\,\%}$	A	1.5	2.5	5.0	16.0	22.0	33.0	40.0	55.0	82.5	137.5
Peak current I_{max}	A	1.5	4.0	8.0	16.0	28.1	41.8	51.0	63.5	106.2	141.4

Table 4-4 Power modules in a 2–axis version, de–rating for MSD–SRM

6SN112□–1AB0□–		**0HA1**	**0AA1**	**0BA1**	**0CA1**
Type of cooling		**Non–ventilated**		**Force–ventilated**	
Inverter clock cycle frequency fT = 4.0 kHz					
Rated current I_N	A	2.8	4.6	7.4	22.2
Current for S6–40 % $I_{S6-40\,\%}$	A	2.8	4.6	9.3	29.6
Peak current I_{max}	A	2.8	7.4	14.8	29.6
Inverter clock cycle frequency fT = 5.33 kHz					
Rated current I_N	A	2.4	4.0	6.4	19.2
Current for S6–40 % $I_{S6-40\,\%}$	A	2.4	4.0	8.0	25.6
Peak current I_{max}	A	2.4	6.4	12.8	25.6
Inverter clock cycle frequency fT = 6.4 kHz					
Rated current I_N	A	2.1	3.5	5.6	16.8
Current for S6–40 % $I_{S6-40\,\%}$	A	2.1	3.5	7.0	22.4
Peak current I_{max}	A	2.1	5.6	11.2	22.4
Inverter clock cycle frequency fT = 8.0 kHz					
Rated current I_N	A	1.65	2.75	4.4	13.2
Current for S6–40 % $I_{S6-40\,\%}$	A	1.65	2.75	5.5	17.6
Peak current I_{max}	A	1.65	4.4	8.8	17.6

4.5 Interfaces and terminals

4.5.1 Interface overview

Table 4-5 1–axis modules

Term. No.	Designa-tion	Function	Type 1)	Typ. voltage/limit values	Max. cross–section
U2 V2 W2	A1	Motor connection	O	3–ph. 430 V AC	Refer to Chapter 4.5.2
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 4-6 2–axis modules

Term. No.	Designa-tion	Function	Type 1)	Typ. voltage/limit values	Max. cross–section
U2 V2 W2	A1	Motor connection for axis 1	O	3–ph. 430 V AC	Refer to Chapter 4.5.2
U2 V2 W2	A2	Motor connection for axis 2	O	3–ph. 430 V AC	Refer to Chapter 4.5.2
PE	⏚	Protective conductor	I	0 V	2 screws
P600 M600		DC link DC link	I/O I/O	+300 V –300 V	Busbar Busbar

1) O = Output; I = Input

Note

For 2–axis module, Order No.: 6SN1123–1AB00–0CA1. Observe the terminal arrangement, A1, A2!

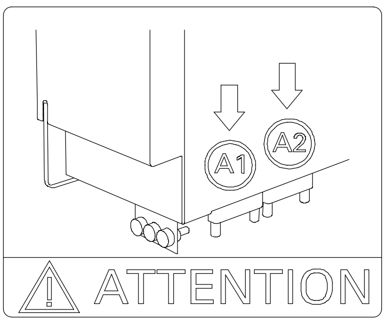


Fig. 4-10 Terminal arrangement A1, A2 for 6SN1123–1AB00–0CA1

4.5.2 Cable cross–sections that can be connected

The cable cross–sections that can be connected can be determined according to Table 4-7.

Table 4-7 Cable cross–sections that can be connected to the power module

	Connection cross–section [mm²]												
	1.5	**2.5**	**4**	**6**	**10**	**16**	**25**	**35**	**50**	**70**	**95**	**120**	**150**
6SN112□–1AA00–0KA1													**X**
6SN112□–1AA00–0JA1											**X**		
6SN112□–1AA00–0FA1											**X**		
6SN112□–1AA00–0EA1									**X**				
6SN112□–1AA00–0LA1									**X**				
6SN112□–1AA00–0DA1	**X**	**X**	**X**	**X**	**X**								
6SN112□–1AA00–0CA1	**X**	**X**	**X**	**X**									
6SN112□–1AA00–0BA1	**X**	**X**	**X**	**X**									
6SN112□–1AA00–0AA1	**X**	**X**	**X**	**X**									
6SN112□–1AA00–0HA1	**X**	**X**	**X**	**X**									
6SN112□–1AB00–0CA1	**X**	**X**	**X**	**X**									
6SN112□–1AB00–0BA1	**X**	**X**	**X**	**X**									
6SN112□–1AB00–0AA1	**X**	**X**	**X**	**X**									
6SN112□–1AB00–0HA1	**X**	**X**	**X**	**X**									

Legend		Terminal area for flexible cable with end sleeves (with or without plastic collars)
		Terminal area for flexible cables with terminal pin
	X	IP20 guaranteed The user does not have to apply any additional measures.

Warning

The internal overload monitoring function of the power modules only protects the cable if this is dimensioned/selected corresponding to the power module currents. If smaller cross–sections are selected, then the user must ensure the appropriate level of cable protection – e.g. by suitably setting the control parameters.

Note

For UL certification, only use copper cables that have been appropriately dimensioned/selected for the corresponding operating temperature ≥60 °C.

Note

In order to clearly indicate potential hazards due to voltages at the terminals, the warning plate WS–2K
(Order No. 1004513) can be ordered under the following address.

Phoenix Contact GmbH & Co. KG
Flachsmarktstr. 8
32825 Blomberg
Germany
Tel. +49 5235 3 00
Fax +49 5235 3 1200
http://www.phoenixcontact.com

Table 4-8 Terminals types and connecting cable, power modules

Terminal type	Designation	Connecting cable [mm^2]	
		Minimum	Maximum
1	PC 4/3–STF–752 GY	0.2	4
2	HDFK 10	0.5	16
3	HDFK 50	16	50
4	UHV 95	35	95
5	UHV 150	50	150

Table 4-9 Using the terminal types in the power module

Type	6SN112□–1AA0□–	0H A1	0A A1	0B A1	0C A1	0D A1	0L A1	0E A1	0F A1	0J A1	0K A1				
	6SN112□–1AB0□–											0H A1	0A A1	0B A1	0C A1
1		X	X	X	X							X	X	X	X
2						X									
3							X	X							
4									X	X					
5											X				

Space for your notes

Control Units

5

Overview of the control units

The control units/boards, listed in the following table, can be used in the SIMODRIVE power modules.

5

Table 5-1 Overview of the control units/boards

Control board	Version	Axes	Motor encoders	Motors1)	Optional interfaces
SIMODRIVE 611 universal HRS	1–axis n–set	1	Resolver	SRM: 1FT6, 1FK, 1FE1, 1FW6, 2SP1 IM: 1PH, 1PM6, SLM: 1FN Third–party: If suitable	PROFIBUS–DP; terminals; RS 232/ 485
SIMODRIVE 611 universal HRS	1–axis pos.	1	Resolver	SRM: 1FT6, 1FK, 1FE1, 1FW6, 2SP1 IM: 1PH, 1PM6, SLM: 1FN	PROFIBUS–DP; terminals; RS 232/ 485
SIMODRIVE 611 universal HRS	2–axis n–set	2	Resolver	SRM: 1FT6, 1FK, 1FE1, 1FW6, 2SP1 IM: 1PH, 1PM6, SLM: 1FN Third–party: If suitable	PROFIBUS–DP; terminals; RS 232/ 485
SIMODRIVE 611 universal HRS	2–axis pos	2	Resolver	SRM: 1FT6, 1FK, 1FE1 1FW6, 2SP1 IM: 1PH, 1PM6, SLM: 1FN	PROFIBUS–DP; terminals; RS 232/ 485
SIMODRIVE 611 universal HRS	2–axis n–set	2	Incremental encoder sin/ cos 1 V_{PP} Absolute encoder	SRM: 1FT6, 1FK, 1FE1 1FW6, 2SP1 IM: 1PH, 1PM6, SLM: 1FN Third–party: If suitable	PROFIBUS–DP; terminals; RS 232/ 485
SIMODRIVE 611 universal HRS	2–axis pos	2	Incremental encoder sin/ cos 1 V_{PP} Absolute encoder	SRM: 1FT6, 1FK, 1FE1 1FW6, 2SP1 IM: 1PH, 1PM6, SLM: 1FN Third–party: If suitable	PROFIBUS–DP; terminals; RS 232/ 485
SIMODRIVE 611 universal E HRS		2	Incremental encoder sin/ cos 1 V_{PP} Absolute encoder	SRM: 1FT6, 1FK, 1FE1, 1FW6, 2SP1 IM: 1PH, 1PM6, SLM: 1FN Third–party: If suitable	PROFIBUS–DP; terminals; RS 232
SIMODRIVE 611 with digital setpoint interface for FD and MSD	High Performance control	2	Incremental encoders sin/ cos 1 $V_{PP,}$ EnDat	SRM: 1FT6, 1FK, 1FE1, 1FW6, 2SP1 IM 1PH, 1PM SLM: 1FN Standard: 1LA Third–party: If suitable	

Table 5-1 Overview of the control units/boards, continued

Control board	Version	Axes	Motor encoders	Motors[1)]	Optional interfaces
SIMODRIVE 611 with digital setpoint interface for FD and MSD	High Performance control	1	Incremental encoders sin/ cos 1 $V_{PP,}$ EnDat	SRM: 1FT6, 1FK, 1FE1, 1FW6, 2SP1 IM: 1PH7, 1PM SLM: 1FN Standard: 1LA Third–party: If suitable	
SIMODRIVE 611 with digital setpoint interface for FD and MSD	High Standard control	2	Incremental encoders sin/ cos 1 $V_{PP,}$ EnDat	SRM: 1FT6, 1FK, 1FE1, 2SP1 IM: 1PH7, 1PM6 Standard: 1LA Third–party: If suitable	
SIMODRIVE 611 with digital setpoint interface for hydraulic/analog Linear drives HLA/ANA		2	Incremental encoders sin/ cos 1 V_{PP}, EnDat, SSI (from SW 1.2.4)	Hydraulic linear axes/ analog axis	

1) SRM: Synchronous rotating motor
IM: Induction rotating motor
IM: Synchronous linear motor
Standard: Standard motor
Third–party: Unlisted motor

5.1 Closed–loop control with digital setpoint interface

General information

Digital control units in 1–axis and 2–axis versions (for 1PH, 2–axis control is only possible with High Performance) are available to operate motors 1FT6/1FK/1FN1/1FN3/1FE1/1PH/1PM/1FM6/2SP1.

The drive software is downloaded from the SINUMERIK 840D via the drive bus into the control board in the initialization phase (power on or reset).

1–axis drive control

High Performance: Order No.: 6SN1118–0DJ2□–0AA1

The digital 1–axis High Performance control can be loaded with the drive software for either FD control or MSD control. MSD and FD have the same operator interface. The board is available in the following versions:

- Basic version with sinusoidal **voltage signals** and the possibility of connecting absolute value encoders with EnDat interface
- In addition, the possibility of evaluating a direct position measuring system with sinusoidal **voltage signals** and the possibility of connecting absolute value encoders with EnDat interface and SSI interface (from SW 5.1.9 onwards)

2–axis drive control

The FD control software can be downloaded into the digital 2–axis control. MSD software can **only** be downloaded for a configuration as single–axis control board or for High Performance, also as 2–axis control. The module is available in three basic versions that differ in the controller performance and in the evaluation of the direct position measuring systems:

High Performance: Order No.: 6SN1118–0DK2□–0AA1

- Basic version with sinusoidal **voltage signals** and the possibility of connecting absolute value encoders with EnDat interface
- In addition 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 onwards)

High Standard: Order No.: 6SN1118–0DM3□–0AA1

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

Note

A 2–axis drive control can also be operated in a single–axis power module for single–axis applications. It is engineered as a 1–axis board.

For motor encoders without any adjustment to the EMF of the synchronous motor (1FE1/1FN1/1FN3) a configurable, automatic identification technique can be used to determine the electrical rotor position. In so doing, motion of typically < ± 5 Degrees mechanical is not exceeded. The identification routine is carried–out after each power–up operation.

Software versions

The digital drive controls can be used with the following software releases of the SIEMENS drive components:

Table 5-2 Software functions

	High Performance	**High Standard**
Order No. [MLFB]	6SN1118–0DJ2□–0AA1 6SN1118–0DK2□–0AA1	6SN1118–0DM3□–0AA1
NCU version	≥ 6.3.19	≥ 6.4.9
drive version	≥ 6.3.11	≥ 6.5.4
PCU50/PCU20	≥ 6.2.18	≥ 6.2.18
Commissioning tool for the PC	≥ 6.2.18	≥ 6.2.18
NCU hardware	≥ 573.3; ≥ 572.3; 571.3	≥ 573.3; ≥ 572.3; 571.3
Mixed operation, FD/MSD	≥ 6.2.12	≥ 6.2.12

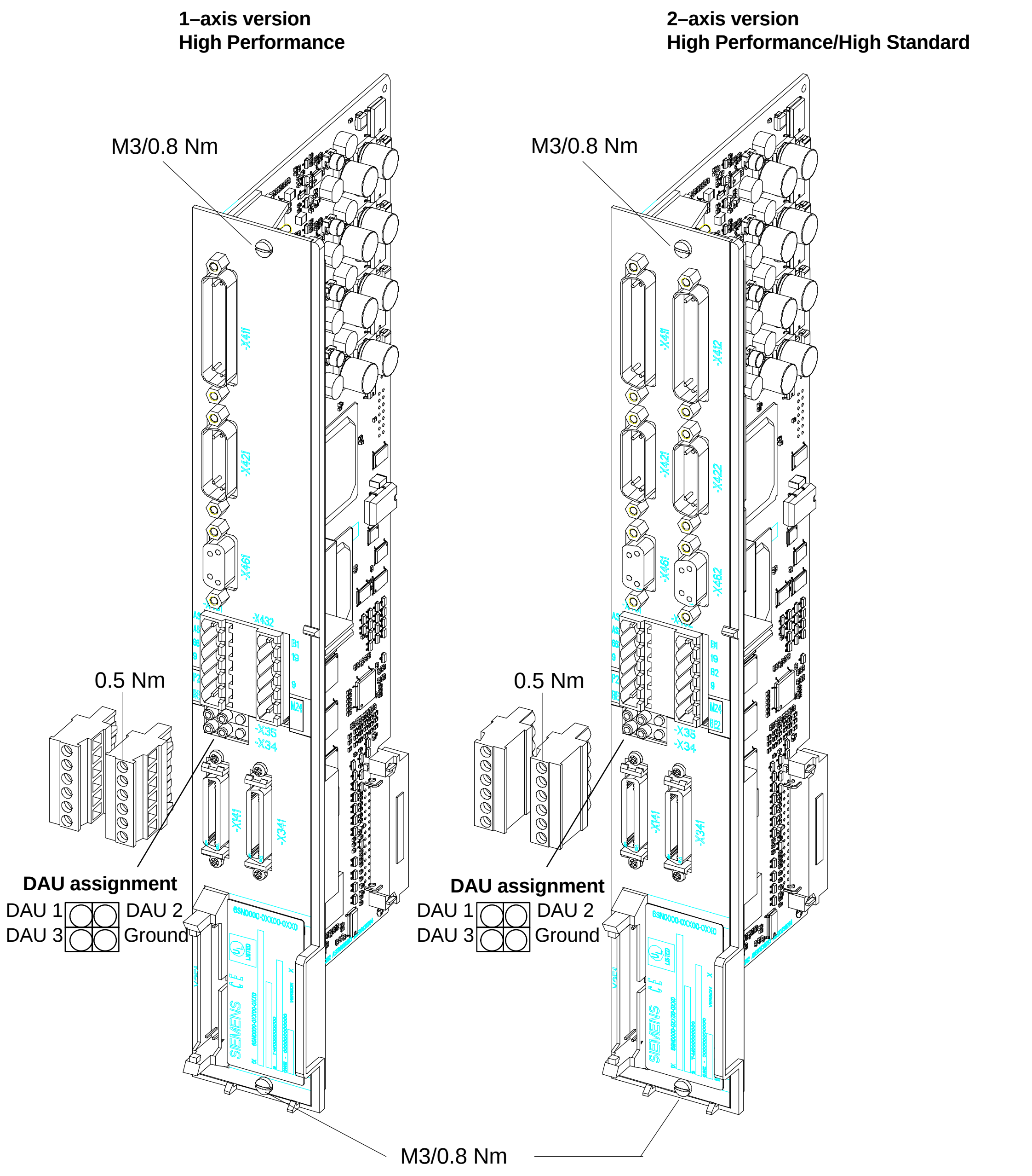


Fig. 5-1 Digital control High Performance and High Standard with direct measuring system

Notice

When using non–PELV circuits at terminals AS1, AS2, connectors must be coded to prevent the connectors being incorrectly inserted (refer to EN60204–1, Chapter 6.4).
For Order No. for coded connectors, refer to Catalog NC 60.

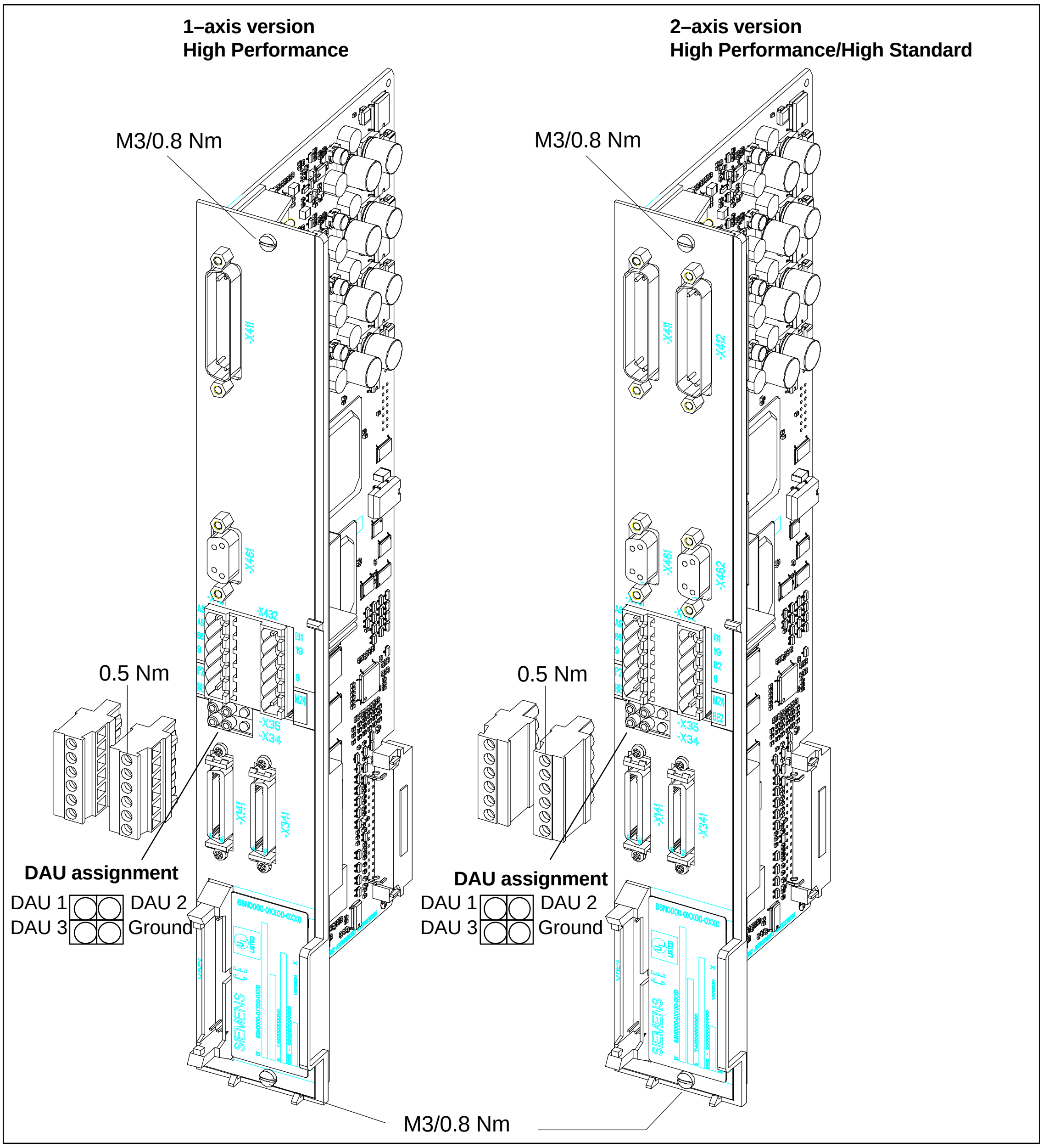


Fig. 5-2 Digital control High Performance and High Standard without direct measuring system

Notice

When using non–PELV circuits at terminals AS1, AS2, connectors must be coded to prevent the connectors being incorrectly inserted (refer to EN60204–1, Chapter 6.4).
For Order No. for coded connectors, refer to Catalog NC 60.

Warning

At terminals 19, P24 and M24, only PELV circuits may be connected. If this is not carefully observed, then this can result in personal injury in the form of electric shock.

5.1.1 Interface overview, closed–loop drive control

High Standard and High Performance

Table 5-3 Interface overview, High Standard and High Performance closed–loop drive control

T. No.	Designa-tion	Function	Type 1)	Typ. voltage/ limit values	Max. cross–section
AS1 3) AS2 3) 663 9 P24 BE1	X431 X431 X431 X431 X431 X431	Relay start inhibit (feedback signal, terminal 663) Relay start inhibit (feedback signal, terminal 663) Pulse enable: The "start inhibit" relay is switched using terminal 663, when opened, the gating pulses are inhibited and the motor is switched into a torque–free condition. Enable voltage 2) +24 V supply for the brake control 4) Output, brake control, axis 1	NC I O I O	max. 250VAC/1A, 30 VDC/2 A +21 V ... 30 V +24 V +18 ... 30 V max. 500 mA	1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2
B1 19 B2 9 M24 BE2	X432 X432 X432 X432 X432 X432	Input, external zero mark (BERO) axis 1 Negative enable voltage Input, external zero mark (BERO) axis 2 Positive enable voltage 2) 0 V supply for the brake control Output, brake control, axis 2	I O I O I O	+13 ... 30 V 0 V +13 ... 30 V +24 V max. 500 mA	1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2
	X34/X35	Test socket, DAU			
	X411	Motor encoder, axis 1 5)			
	X412	Motor encoder, axis 2 5)			
	X421	Direct position encoder, axis 1 5)			
	X422	Direct position encoder, axis 2 5)			
	X461	BERO input, axis 1			
	X462	BERO input, axis 2			
	X351	Equipment bus			
	X141/341	Drive bus			

1) I=Input; O=Output; NC=NC contact; NO=NO contact (for a signal, NO=High/NC=Low)

2) The terminal may only be used to enable the associated drive group.

3) When connecting contacts AS1/AS2 in series, a contact voltage drop up to max. 0.2 V must be taken into account for the lifetime of the contacts (100000 switching operations). For a 24 V switching voltage, due to the non–linear contact characteristics, from experience, 5 contacts can be simply connected in series without encountering any problems.

4) A UL–certified miniature fuse (max. 3.15 A) must be provided at the supply for the brake control:
Value: e.g. 3.15 AT/250 V; 5x20 mm UL
Company: Wickmann–Werke GmbH
Annenstraße 113
58453 Witte
Order No.: 181

5) In order to increase the strength with respect to surge disturbances, for encoder cables > 30 m long, the screen connection 6SN1162–0FA00–0AA2 can be used. In order to ensure noise immunity in compliance with the standard, the encoder cable shields should be connected where the cable enters the control cabinet.
The permissible voltage range for the common mode component of the individual encoder signals (A+. A–. B+, B–, C+. C–, D+, D–, R+, R–) is 1.5...3.5 V.

Holding brake connection

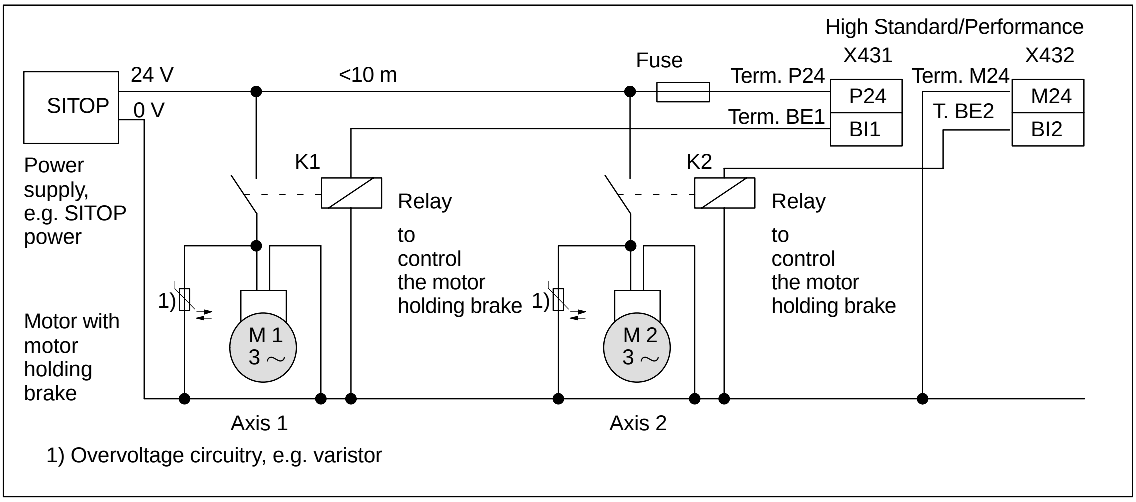


Fig. 5-3 Circuit example: Connecting a motor holding brake to a High Standard/High Performance control board

BERO input X461/X462

Table 5-4 BERO input (X461/X462)

Pin			Function	Type 1)	Technical data
No.	Designation				
	X461	**X462**	Connector type: 9–pin D–sub socket connector		
1	FRP	FRP	Internal enable voltage (jumpered with terminal 9)	O	+24 V
2	BERO1	BERO2	BERO input	I	+13 ... 30 V
3	Reserved, do not use	Reserved, do not use		–	
4				–	
5				–	
6	FRM	FRM	Internal enable voltage (jumpered with terminal 19)	O	0 V
7	Reserved, do not use	Reserved, do not use		–	
8				–	
9				–	

1) I: Input; O: Output

5.2 ”SIMODRIVE 611 universal HRS” control board

Description

The ”SIMODRIVE 611 universal HRS” control board is used in the SIMODRIVE 611 system (SW ⩾ 8.3) and includes two drive controls that are independent of one another. However, the board can also be used for 1–axis applications and in 1–axis power modules.

Note

The control board is described in detail in:

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

The functionality specified in this Description of Functions under ”SIMODRIVE 611 universal” also applies to ”SIMODRIVE 611 universal HR”.

5

Features

The control board has the following features:

- Versions

Table 5-5 Control board, option modules, data medium

Cons. No.	Description		Order No. (MLFB)
	Hardware	Firmware	
Control board			
1	2–axis1) for encoders with sin/cos 1 Vpp	n–set	6SN1118–0NH01–0AA1
2		Positioning	6SN1118–1NH01–0AA1
4	2–axis1) for resolvers	n–set	6SN1118–0NK01–0AA1
6		Positioning	6SN1118–1NK01–0AA1
8	1–axis for resolvers	n–set	6SN1118–0NJ01–0AA1
10			6SN1118–1NJ01–0AA1
Option module (can be alternatively used in the control board)			
1	TERMINALS	–	6SN1114–0NA00–0AA0
3	PROFIBUS–DP2 3)	–	6SN1114–0NB00–0AA2
4	PROFIBUS–DP3 3)	–	6SN1114–0NB01–0AA1
Data medium			
1	CD	SimoCom U, drive firmware, Toolbox, GSD file, readme file, etc.	6SN1153–□NX20–□AG0 2) □ = 0 —> CD with the most current SW version The CD also contains previous SW versions

1) For 2–axis control boards, 1–axis operation is also possible
2) □: Space retainer for software version
3) Prerequisite: Control board from SW 3.1

- Settings
  - All drive–related settings of the control board can be made as follows:
  - using the parameterizing and start–up tool SimoCom U on an external PG/PC
  - Using the display and operator control unit on the front panel
  - Using PROFIBUS–DP (parameter area, PKW area)
- Software and data

  The firmware and the user data are saved on a memory module which can be replaced.

  The software designation on the memory module refers to the system software including the initial program loader.
- Terminals and operator control elements
  - 2 analog inputs, 2 analog outputs per drive
  - 4 digital inputs, 4 digital outputs per drive
  - 2 test sockets
  - POWER–ON RESET pushbutton with LED
  - Display and operator unit
- Safe start inhibit

  The start inhibit is addressed via terminal 663 and is signaled back using a relay with positively–driven signaling contacts (AS1/AS2). Using the start inhibit, the energy feed from the drive to the motor is interrupted.
  When the ”safe start inhibit” function is correctly used, the signaling contacts AS1/AS2 must be included in the line contactor circuit or the EMERGENCY OFF circuit.

Caution

When using the ”safe start inhibit” function, it must be ensured that the velocity goes to zero.

The ”SIMODRIVE 611 universal HRS” control board supports the ”Safe standstill” function.

Detailed information about the ”safe standstill” function is provided in Chapter 8.5.

- Serial interface (RS232/RS485)
- Optional modules
  - Optional TERMINAL module,
    8 digital inputs and 8 digital outputs for drive A
  - Optional PROFIBUS–DP module
- Expanded functions from SW 5.1

  The following expanded functionality is provided with a new control board for sin/cos 1Vpp encoders:
  - Higher internal resolution, interpolation factor 2048 (previously 128)
  - Pulse multiplication is possible (doubling) at the angular incremental encoder interface for absolute value encoders
  - Pulse multiplication (doubling) and division (1:2, 1:4, 1:8) are possible at the angular incremental encoder interface, also for incremental encoders

5.2.1 Control board for 1 or 2 axes

Control boards for 2 axes

The following 2–axis control boards are available:

2–axis for encoders with sin/cos 1Vpp or
2–axis for resolvers
(refer to Table 5-5)

1
Mounting slot for

- Optional TERMINAL module
  or
- Optional PROFIBUS–DP module

2

- Interfaces
- Terminals
- Switch

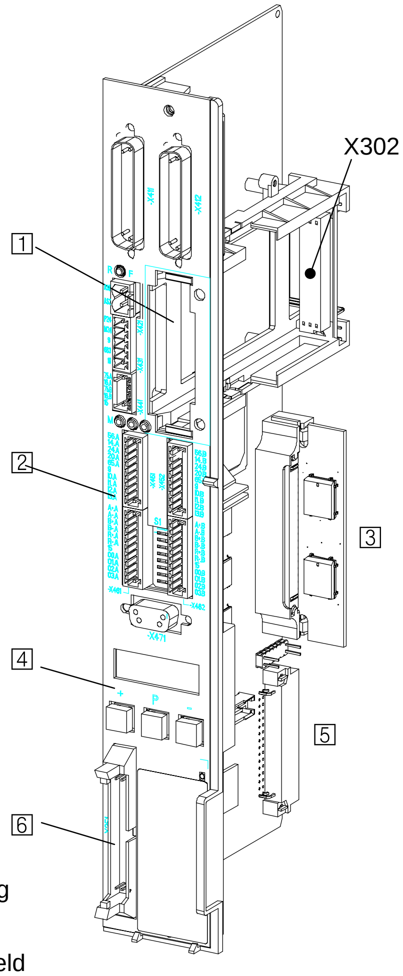
3
Memory module

- Firmware
- User data

4
Display and operator unit

5
Pulse interface

6
Equipment bus



The following applies to retaining screws:

Tighten (to establish a good shield contact) max. torque = 0.8 Nm

For plug connections:

Plug connectors with the same number of pins must be appropriately coded so that they cannot be interchanged (refer under the index entry ”Coding the mini connectors”).

Fig. 5-4 Control boards for 2 axes (SIMODRIVE 611 universal HRS)

Control board for 1 axis

The following 1–axis control boards are available:

1–axis for resolvers

These interfaces have no function for the 1–axis version

1
Mounting slot for

- Optional TERMINAL module
  or
- Optional PROFIBUS–DP module

2

- Interfaces
- Terminals
- Switch

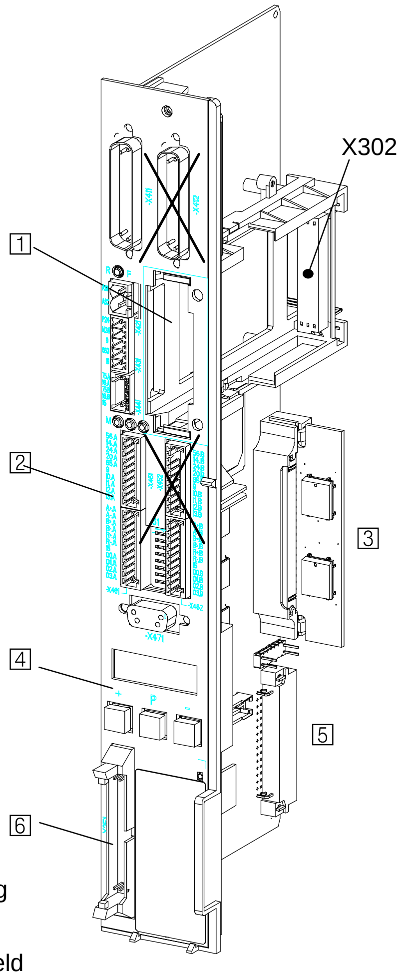
3
Memory module

- Firmware
- User data

4
Display and operator unit

5
Pulse interface

6
Equipment bus



The following applies to retaining screws:

Tighten (to establish a good shield contact) max. torque = 0.8 Nm

For plug connections:

Plug connectors with the same number of pins must be appropriately coded so that they cannot be interchanged (refer under the index entry ”Coding the mini connectors”).

Fig. 5-5 Control board for 1 axis (SIMODRIVE 611 universal HRS)

Optional terminal module

An additional 8 digital inputs and outputs can be realized using this optional module.

The functionality of these inputs/outputs can be freely parameterized.

Note

- The input/output terminals of the optional TERMINAL module are
  – **Before SW 4.1: permanently** assigned to **drive A** or **axis A**
  – **From SW 4.1: can be freely** assigned **axes**
- The optional TERMINAL module can be used as follows, dependent on the software release:
  – The following applies before SW 2.4:
  The module can only be used in the ”positioning” mode.
  – The following applies before SW 2.4:
  The module can be used independently of the operating mode.

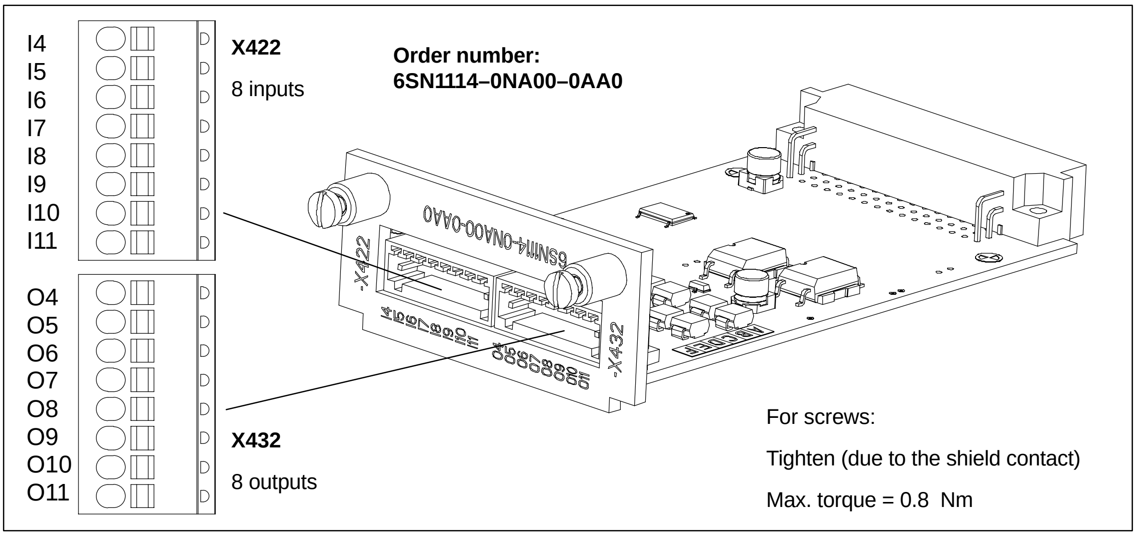


Fig. 5-6 Optional TERMINAL module

Optional PROFIBUS–DP module

The ”SIMODRIVE 611 universal” control board can be connected and operated as DP slave on the PROFIBUS–DP fieldbus when this optional module is used.

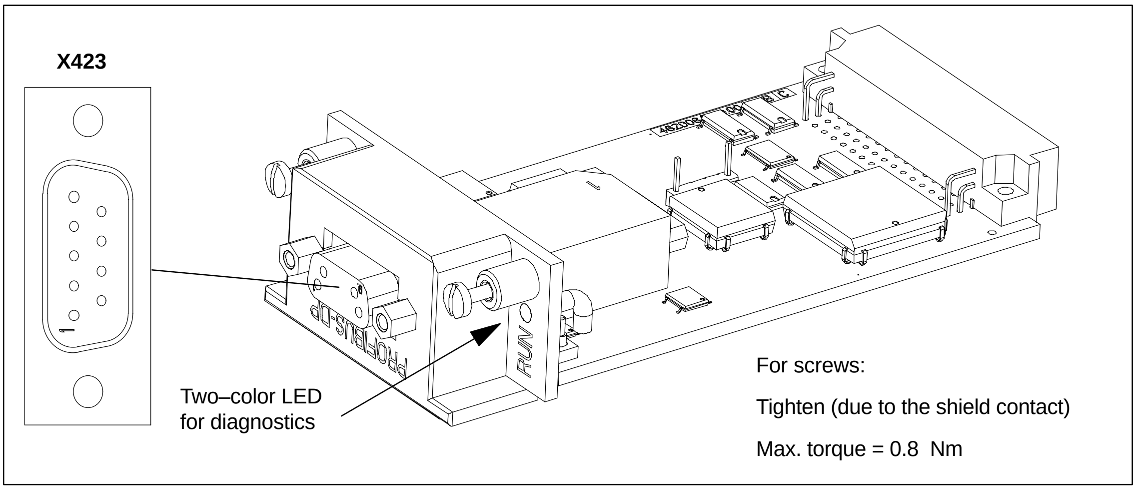


Fig. 5-7 Optional PROFIBUS–DP module

Table 5-6 Which optional modules are available?

Designation	Order No. (MLFB)	Features
PROFIBUS–DP2	6SN1114–0NB00–0AA2	• PROFIBUS–ASIC DPC31 without PLL • For control boards SW 3.1, this module can replace the optional PROFIBUS–DP1 module
Features that PROFIBUS–DP2 and DP3 have in common		• Prerequisites: Control board from SW 3.1 is required • Cyclic data transfer (PKW and PZD section) possible • FW module can be updated using SimoCom U • Non–cyclic data transfer (DP/V1) • ”SimoCom U via PROFIBUS” possible
PROFIBUS–DP3	6SN1114–0NB01–0AA1	• PROFIBUS–ASIC DPC31 with PLL • ”Motion Control with PROFIBUS–DP” function (clock–synchronous PROFIBUS operation) is possible

Table 5-7 Which optional modules can be used for the various software releases?

Case	Firmware release	Optional module	
		DP2	DP3
1. Master configured software, generated with GSD file siem808f.gsd, can be operated with	from SW 3.1	yes	yes
2. Master configured software, generated with a GSD file siem8055f.gsd and P0875 = 2, can be operated with	before SW 4.1	yes	yes
3. Master configured software, generated with a GSD file siem8055f.gsd and P0875 = 2, can be operated with	from SW 4.1	yes	yes
4. Master configured application, generated with a GSD file si02808f.gsd and P0875 = 2 can be operated with	from SW 6.1	yes	yes

Note

Case 1 is for ”new” applications with the DP2, DP3 module.

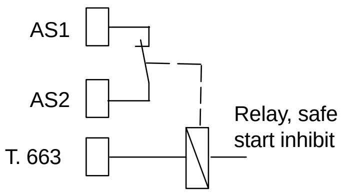
Cases 2 and 3 are for series commissioning of drives using DP1 modules and for replacing a defective DP1 module by a DP2 module.

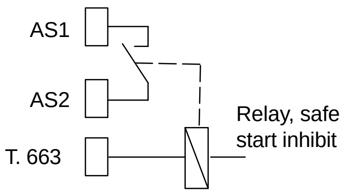
5.2.2 Description of the terminals and interfaces

Board–specific terminals and interfaces

The board–specific terminals and interfaces are available, common for both drive A and B.

Table 5-8 Overview of the board–specific terminals and interfaces

<table>
<tr><th colspan="2">Terminal</th><th rowspan="2">Function</th><th rowspan="2">Type 1)</th><th rowspan="2">Technical data</th></tr>
<tr><th>No.</th><th>Designa-tion</th></tr>
<tr><td colspan="5">Signaling terminal, start inhibit (X421)</td></tr>
<tr><td>AS1 3)</td><td rowspan="2">X421</td><td rowspan="2">Signaling contact Start inhibit
Feedback signal from terminal 663</td><td rowspan="2">NC</td><td rowspan="2">Connector type: 2–pin conn. strip
Max. cond. cross–sect.: 2.5 mm²
Contact: Floating NC contact
Contact load capability: at 250 V_{AC} max. 1 A
at 30 V_{DC} max. 2 A</td></tr>
<tr><td>AS2 3)</td></tr>
<tr><td></td><td colspan="4">

Pulses not enabled (T. 663)
The gating pulses of the power transistors are inhibited.


Pulses enabled (T. 663)
The gating pulses of the power transistors are enabled.</td></tr>
<tr><td colspan="5">Terminals for supply and pulse enable (X431)</td></tr>
<tr><td></td><td>X431</td><td></td><td></td><td>Connector type: 5–pin conn. strip
Max. cond. cross–sect.: 1.5 mm²</td></tr>
<tr><td>P24</td><td>X431.1</td><td>External supply for digital outputs (+24 V)</td><td>S</td><td rowspan="2">Voltage tolerance (including ripple): 10 V to 30 V</td></tr>
<tr><td>M24</td><td>X431.2</td><td>Reference for the external supply</td><td>S</td></tr>
<tr><td></td><td colspan="4">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 power supply, the total current of all of the digital outputs must be taken into account.
Maximum total current:
• for the control board (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 module | 8 + 8 | max. (1.5 A + 280 mA) —> 24 V/1.8 A</td></tr>
</table>

Table 5-8 Overview of the board–specific terminals and interfaces, continued

Terminal No.	Terminal Designation	Function	Type 1)	Technical data
9	X431.3	Enable voltage (+24 V)	S	Reference: Terminal 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. pulse enable) as 24 V auxiliary voltage.
663	X431.4	Pulse enable (+24 V)	I	Voltage tolerance(including ripple): 21 V to 30 V Typ. current consumption: 50 mA at 24 V **Note:** The pulse enable acts simultaneously on drive A and drive B. When this pulse enable is withdrawn, the drives ”coast down” unbraked.
19	X431.5	Reference (Reference for all digital inputs)	S	**Note:** If the enable signals are to be controlled from an external voltage source, 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: 9–pin D–sub socket connector Cable diagram 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–pin Voltages: various Signals: various
Test sockets (X34)				
DAU1	X34	Test sockets 1 2)	M	Test socket: ∅ 2 mm Resolution: 8 bit Voltage range: 0 V to 5 V Maximum current: 3 mA
DAU2	X34	Test sockets 2 2)	M	
M	X34	Reference	M	

1) I: Input; IO: Input/output; M: Measuring signal; NC: NC contact; S: Supply
2) Can be freely parameterized
3) When connecting contacts AS1/AS2 in series, a contact voltage drop up to max. 0.2 V must be taken into account for the lifetime of the contacts (100000 switching operations). For a 24 V switching voltage, due to the non–linear contact characteristics, from experience, 5 contacts can be simply connected in series without encountering any problems.

Drive–specific terminals

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

Table 5-9 Overview of the drive–specific terminals

Terminal				Function	Type [1)]	Technical data
Drive A		Drive B				
No.	Designation	No.	Designation			
Encoder connection (X411, X412)[5)]						
–	X411	–	–	Motor encoder connection Drive A	I	Refer to Chapter 3 **Note:** Encoder limit frequencies: • Encoder with sin/cos 1 V_{pp}: 350 kHz • Resolver: 12 bit 432 Hz 14 bit 108 Hz • Enc. with TTL signal420 kHz
–	–	–	X412	Motor encoder connection Drive B or connection, direct measuring system (from SW 3.3)	I	
Analog outputs (X441)						
75.A	X441.1	–	–	Analog output 1[2)]	AO	Connector type: 5–pin conn. strip Wiring: Connect the cable with the braided shield 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 bit Update: In the speed–contr. 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	–	
Terminals for analog inputs and digital inputs/outputs (X451, X452)						
	X451		X452	Connector type: 10–pin conn. 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 + 13 bits) Wiring: Connect the cable with the 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	Typ. current consumption: 6 mA at 24 V Signal level (incl. ripple) High signal level: 15 V to 30 V Low signal level: –3 V to 5 V Electrical isolation: Ref. is T. 19/T. M24
9	X451.6	9	X452.6	Enable voltage (+24 V)	S	Reference: Terminal 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).

Table 5-9 Overview of the drive–specific terminals, continued

Terminal				Function	Type 1)	Technical data
Drive A		Drive B				
No.	Designa-tion	No.	Designa-tion			
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: 24 V Typ. current consumption: 6 mA at 24 V Signal level (incl. 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: Ref. is T. 19/T. M24 **Note:** An open–circuit input is interpreted as ”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 conn. strip Max. conductor cross–section for finely–stranded or solid conductors: 0.5 mm²		
A+.A	X461.1	A+.B	X462.1	Signal A+	IO	Angular incremental encoder interface (Angular incremental encoder interface) Wiring: • Cable with braided shield, connected at both ends. • The reference ground of the connected node should be connected to terminal X441.5 or X461.7. • Condition to maintain the surge strength: Cable length < 30 m
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	
15	X461.7	15	X462.7	Ground reference	–	
	Note: Devices (stations) can be connected which conform to the RS485/RS422 standard. The angular incremental 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	X461.8	O0.B	X461.8	Digital output 0 4)	DO	Rated current per output: 500 mA Max. current per output: 600 mA Total current, max.: 2.4 A (valid for these 8 outputs) Voltage drop, typical: 250 mV at 500 mA Short–circuit proof **Example:** If all 8 outputs are simultaneously controlled, then the following is valid: Σ Current = 240 mA —> OK Σ Current = 2.8 A —> not OK, as the summed current (total current) is greater than 2.4 A.
O1.A	X461.9	O1.B	X461.9	Digital output 1 4)	DO	
O2.A	X461.10	O2.B	X461.10	Digital output 2 4)	DO	
O3.A	X461.11	O3.B	X461.11	Digital output 3 4)	DO	
Note: • The power switched via these outputs is supplied via terminals P24/M24 (X431). This must be taken into account when dimensioning the external supply. • The digital outputs only ”function” if there is an external supply (+24 V/0 V at terminals P24/M24).						

1) I: Input; DO: Digital output, DI: Digital input, AO: Analog output; AI: Analog input; S: Supply
2) Can be freely parameterized. All of the digital inputs are de–bounced per software. When detecting the signal a delay time of between 1 and 2 interpolation clock cycles (P1010) is therefore incurred.
3) I0.x is internally hard–wired to the position sensing and acts there with almost no delay.
4) 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.
5) The permissible voltage range for the common mode component of the individual encoder signals (A+. A–. B+, B–, C+. C–, D+, D–, R+, R–) is 1.5...3.5 V.

5

5.3 ”SIMODRIVE 611 universal E HRS” control board

Description

The ”SIMODRIVE 611 universal E HRS” control board is used for SINUMERIK 802D with the ”Motion Control via PROFIBUS–DP” function.

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

Note

The control board is described in detail in:

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

The functionality, specified under ”SIMODRIVE 611 universal E” also applies for ”SIMODRIVE 611 universal E HRS”.

Features

The control board has the following features:

- Control board (refer to Chapter 5.3.1)
  - Order No. (MLFB):
    from SW 8.3: 6SN1118–0NH11–0AA1
    (”SIMODRIVE 611 universal E HRS” control board)
  - 2–axis for encoders with sin/cos 1Vpp
  - with memory module for n–set
- Optional PROFIBUS–DP3 module (refer to Chapter 5.3.1)
  - Order No. (MLFB): 6SN1114–0NB01–0AA1
- The parameters can be set as follows:
  - Using the parameterizing and start–up tool ”SimoCom U”
  - Using the display and operator control unit on the front panel
  - Using 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 unit
- Safe start inhibit (refer to Chapter 9.5)
- Serial interface (RS232)
- A TTL encoder can be connected as additional measuring system

5.3.1 Control board with optional module

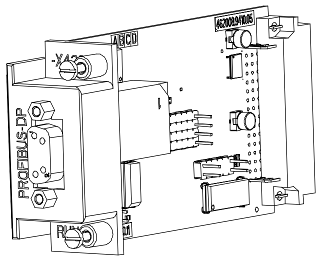
Control board with optional PROFIBUS–DP module

”SIMODRIVE 611 universal E HRS” control board

2 axis for encoders with sin/cos 1Vpp

Optional PROFIBUS–DP3 module

with PROFIBUS–ASIC DPC31 with PLL



1
Mounting slot for the optional PROFIBUS–DP3 module

2
- Interfaces
- Terminals
- Test sockets

3
Serial interface (RS232)

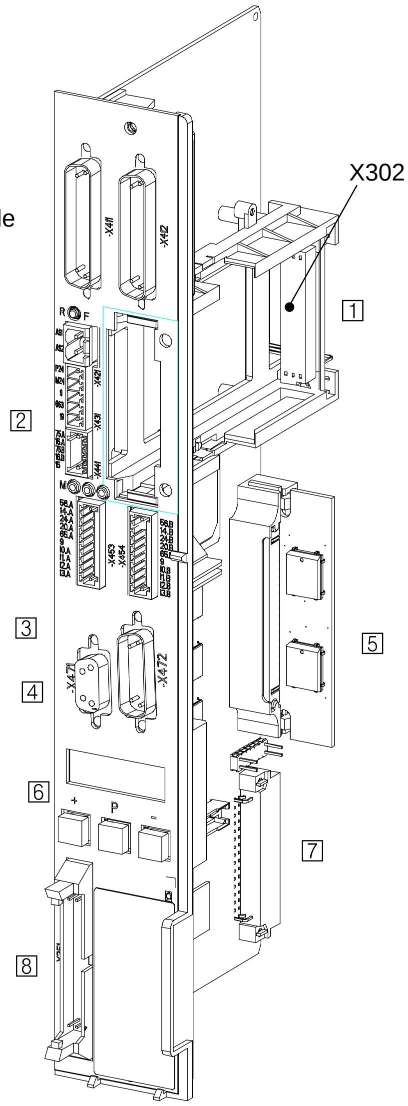
4
Encoder interface for TTL encoders

5
Memory module
- Firmware
- User data

6
Display and operator unit

7
Pulse interface

8
Equipment bus



The following applies to retaining screws:

Tighten (due to the shield contact)

Max. torque = 0.8 Nm

For plug connections:

Plug connectors with the same number of pins must be appropriately coded so that they cannot be interchanged (refer under the index entry ”Coding the mini connectors”).

Fig. 5-8 ”SIMODRIVE 611 universal E HRS” control board with optional PROFIBUS–DP3 module

5.3.2 Description of the terminals and interfaces

Board–specific terminals and interfaces

The board–specific terminals and interfaces are available, common for both drive A and B.

Table 5-10 Overview of the board–specific terminals and interfaces

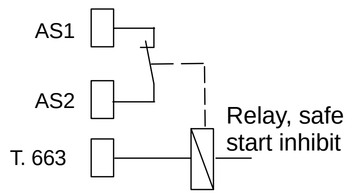
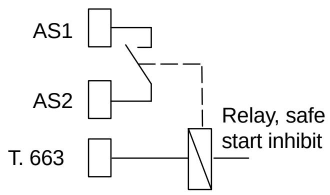
Terminal No.	Terminal Designation	Function	Type 1)	Technical data
Signaling terminal, start inhibit (X421)				
AS1 3) AS2 3)	X421	Signaling contact Start inhibit Feedback signal from terminal 663	NC	Connector type: 2–pin conn. strip Max. cond. cross–sect.: 2.5 mm^2 Contact: Floating NC contact Contact load capability: at 250 V_{AC} max. 1 A at 30 V_{DC} max. 2 A
	 Pulses not enabled (T. 663) The gating pulses of the power transistors are inhibited.			 Pulses enabled (T. 663) The gating pulses of the power transistors are enabled.
Terminals for supply and pulse enable (X431)				
	X431			Connector type: 5–pin conn. strip Max. conductor cross–section: 1.5 mm^2
P24	X431.1	External supply for digital outputs (+24 V)	S	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 power supply, the total current of all of the digital outputs must be taken into account.
M24	X431.2	Reference for the external supply	S	
9	X431.3	Enable voltage (+24 V)	S	Reference: Terminal 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. pulse enable) as 24 V auxiliary voltage.

Table 5-10 Overview of the board–specific terminals and interfaces, continued

Terminal No.	Terminal Designation	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: 50 mA at 24 V **Note:** The pulse enable acts simultaneously on drive A and drive B. When this pulse enable is withdrawn, the drives ”coast down” unbraked.
19	X431.5	Reference (Reference for all digital inputs)	S	**Note:** If the enable signals are to be controlled from an external voltage and not from terminal 9, 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: 9–pin D–sub socket connector **Note:** • The interface can only be used as RS232 interface • For a cable diagram 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: 9–pin D–sub socket connector **Note:** • For the pin assignment, connection diagram and connection of the interface, refer to: **Reference:** /FB611U/, Description of Functions SIMODRIVE 611 universal
Equipment bus (X351)				
–	X351	Equipment bus	IO	Ribbon cable: 34–pole Voltages: various Signals: various
Test sockets (X34)				
DAU1	X34	Test sockets 1 2)	MA	Test socket: ∅ 2 mm Resolution: 8 bit Voltage range: 0 V to 5 V Maximum current: 3 mA
DAU2		Test sockets 2 2)	MA	
M		Reference	MA	

1) I: Input; S: Supply; IO: Input/output; MA: Measuring signal, analog; NC: NC contact; S: Supply
2) Can be freely parameterized
3) When connecting contacts AS1/AS2 in series, a contact voltage drop up to max. 0.20 Ohm must be taken into account for the lifetime of the contacts (100000 switching operations). For a 24 V switching voltage, due to the non–linear contact characteristics, from experience, 5 contacts can be simply connected in series without encountering any problems.

Drive–specific terminals

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

Table 5-11 Overview of the drive–specific terminals

Terminal				Function	Type [1]	Technical data
Drive A		Drive B				
No.	Designation	No.	Designation			
Encoder connection (X411, X412)[7]						
–	X411	–	–	Motor encoder connection, drive A	I	Refer to Chapter 3 **Note:** Encoder limiting frequency: Encoder with sin/cos 1Vpp: 350 kHz
–	–	–	X412	Motor encoder connection, drive B or connection, direct measuring system (from SW 3.3)	I	
Analog outputs (X441)						
75.A	X441.1	–	–	Analog output 1[2]	AO	Connector type: 5–pin conn. strip Wiring: refer to[3] Max. conductor cross–section for finely–stranded or solid cond.: 0.5 mm² Voltage range: –10 V to +10 V Max. current: 3 mA Resolution: 8 bit Update: In the speed–contr. 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	–	
Terminals for the analog inputs and digital inputs/outputs (X453, X454)						
	X453		X454	Connector type: 10–pin conn. strip Max. conductor cross–section for finely–stranded or solid cond.: 0.5 mm²		
56.A	X453.1	56.B	X454.1	none	–	–
14.A	X453.2	14.B	X454.2	none	–	–
24.A	X453.3	24.B	X454.3	none	–	–
20.A	X453.4	20.B	X454.4	none	–	–
65.A	X453.5	65.B	X454.5	Controller enable Drive–specific	I	Typ. current consumption: 6 mA at 24 V Signal level (incl. ripple) High signal level: 15 V to 30 V Low signal level: –3 V to 5 V Electrical isolation: Ref. is T. 19/T. M24
9	X453.6	9	X454.6	Enable voltage (+24 V)	S	Reference: Terminal 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).

Table 5-11 Overview of the drive–specific terminals, continued

Terminal				Function	Type [1]	Technical data
Drive A		Drive B				
No.	Designation	No.	Designation			
I0.A	X453.7	I0.B	X454.7	Digital input 0[4] Fast input [5]	DI	Voltage: 24 V Typ. current consumption: 6 mA at 24 V Signal level (incl. ripple) High signal level: 15 V to 30 V Low signal level: –3 V to 5 V Electrical isolation: Ref. is T. 19/T. M24 **Note:** An open–circuit input is interpreted as 0 signal.
I1.A	X453.8	I1.B	X454.8	Digital input 1[4]	DI	
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 Voltage drop, typical: 250 mV at 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). This must be taken into account when dimensioning the external supply. • The digital outputs only ”function” if an external power supply is available (+24 V, T. P24/M24).					

1) AO: Analog output; I: Input; DI: Digital input; DO: Digital output; S: Supply
2) Can be freely parameterized
3) The analog outputs (X441) should be connected through a terminal strip.
A shielded cable should be used together for all of the analog outputs together between X441 and the terminal strip. For this cable, the shield must be connected at both cable ends.
The 4 analog cables can be routed away from the terminal strip. The shield of the cables must be connected and the ground cables must be connected to a common ground terminal.
4) Can be freely parameterized
All of the digital inputs are de–bounced per software. When detecting the signal a delay time of between 1 and 2 interpolation clock cycles (P1010) is therefore incurred.
5) I0.x is internally hard–wired to the position sensing and acts there with almost no delay.
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. is added
7) The permissible voltage range for the common mode component of the individual encoder signals (A+. A–. B+, B–, C+. C–, D+, D–, R+, R–) is 1.5...3.5 V.

Encoder interface for TTL encoders (X472)

Table 5-12 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>Designation</th></tr>
<tr><td colspan="2">X472</td><td colspan="3">Connector type: 15–pin D–sub socket connector</td></tr>
<tr><td>1</td><td>P_Encoder</td><td rowspan="15">Possibility of connecting a power supply for an additional measuring system (TTL encoders, encoder 3)

The information is transferred to a higher-level control via PROFIBUS.</td><td>S</td><td rowspan="15">• Recommended for TTL encoders:
Order No. (MLFB): 6FX2001–2□B02
Encoder pulse number = 1024
□ = Space retainer for conn. types A, C, E or G
• Cabling
– Max. cable length: 15 m
– Recommended encoder cable:
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: 3.5 A
• Encoder limit frequency
– TTL encoder: 1 MHz</td></tr>
<tr><td>2</td><td>M_Encoder</td><td>S</td></tr>
<tr><td>3</td><td>O</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>5V sense</td><td>S</td></tr>
<tr><td>10</td><td>R</td><td>I</td></tr>
<tr><td>11</td><td>0V sense</td><td>S</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; S: Supply

5.4 ”HLA module” control board

Description

The hydraulics (HLA) module provides a means of controlling hydraulic axes directly from the SINUMERIK 840D system via the digital drive bus.

The HLA module is a control unit belonging to the modular SIMODRIVE 611 converter system mounted in a 50 mm carrier module (universal empty housing). The open and and closed–loop control electronics for operating hydraulic drives are integrated on the HLA module.

The control unit can also be used as ANA control unit for analog axes. It is permissible to use this double–axis board in mixed operation (HLA/ANA).

Hydraulic drives have the same significance as electric drives also when combined within an interpolating group.

Note

The HLA module is described in detail in:

References: /FBHLA/, SINUMERIK 840D SIMODRIVE 611 digital
HLA module, Description of Functions

Features

The HLA module has the following features:

- Software and data

  The communications interface is compatible with SIMODRIVE 611 SRM(FD/ARM(MSD) for supported services. Code and data management is analogous to SIMODRIVE 611 SRM(FD)/ARM(MSD). The hydraulics software is stored as a separate program code in the control system.

- Hardware

  The integration into the SIMODRIVE 611 system is compatible to the SIMODRIVE 611 digital SRM(FD)/ARM(MSD). This basically involves the following interfaces:

  – Drive bus
  – Equipment bus
  – power supply concept

- HLA control unit (2–axis)
  – Velocity pre–control, controller
  – Force control
  – Voltage output for actuators
  – Connection for 2 pressure sensors per axis
  – Control of hydraulic control valves

- Terminals and diagnostics
  – Control of a hydraulic shut–off valve
  – BERO input per axis
  – Module–specific enable signal
  – Test sockets (diagnostics)

5.4.1 System overview

A complete SINUMERIK 840D with HLA module comprises of various individual components. These are listed below.

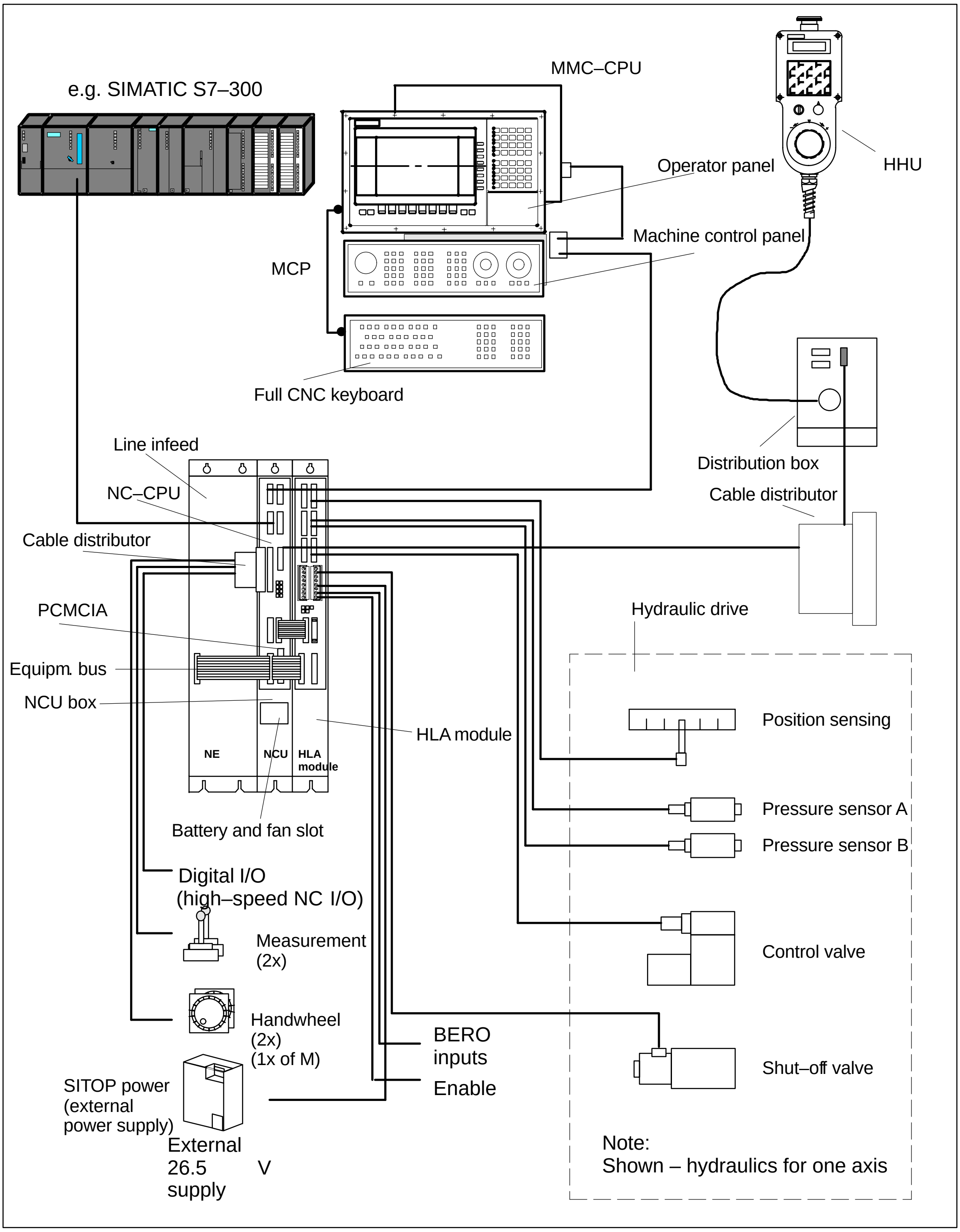


Fig. 5-9 System components

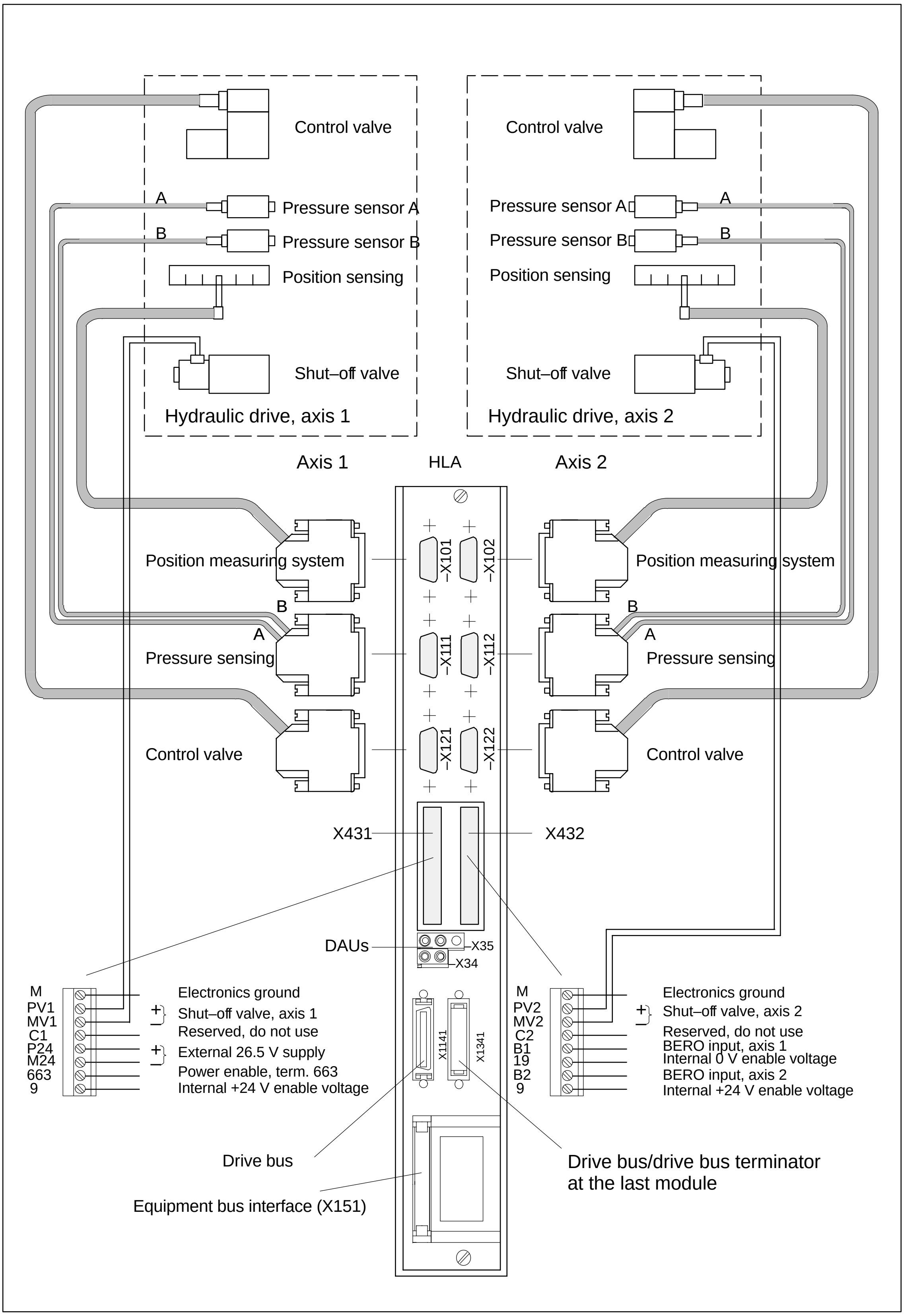


Fig. 5-10 Connection configuration for HLA module

5.4.2 Connecting–up

Line supply connection

The SINUMERIK 840D and the HLA 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 HLA module is used. No provision has been made for any other type of voltage supply and failure to use the supply provided could damage the unit.

Note

It is not permissible to operate an HLA module on its own with a SIMODRIVE monitoring module!

Power is supplied to downstream electrical axes via the DC link busbars (40 mm^2) of the carrier module.

Measuring systems

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

- X101: Axis 1
- X102: Axis 2

The measuring system must always be plugged into the connector of the associated axis.

Table 5-13 Connectors X101, X102; 15–pin sub D plug connector (two–tier)

Pin	X101 1)	X102 1)	Function
1	PENC0	PENC2	Encoder power supply
2	M	M	Encoder power supply ground
3	AP0	AP2	Incremental signal A
4	AN0	AN2	Inverse incremental signal A
5	BMIDAT0	BMIDAT2	Data signal EnDat or SSI interface
6	BP0	BP2	Incremental signal B
7	BN0	BN2	Inverse incremental signal B
8	XBMIDAT0	XBMIDAT2	Inverse data signal EnDat or SSI 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 internal shields)
14	BMICLK0	BMICLK2	Clock signal EnDat or SSI interface
15	XBMICLK0	XBMICLK2	Inverse clock signal, EnDat interface
Note: The SSI encoder requires an external 24 V power supply			
1) The permissible voltage range for the common mode component of the individual encoder signals (AP. AN. BP, BP, RP, RP) is 1.5...3.5 V.			

Pressure sensing system

Connection for 2 pressure sensors per axis

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

Table 5-14 Connectors X111, X112; 15–pin sub D socket connector

Pin	X111	X112	Type 1)	Function
1	P24DS	P24DS	O	External +24 V supply for the pressure sensor
2	P24DS	P24DS	O	External +24 V supply for the pressure sensor
3	–	–	–	Not assigned
4	–	–	–	Not assigned
5	M24EXT	M24EXT	O	External 0 V supply for the pressure sensor
6	–	–	–	Not assigned
7	–	–	–	Not assigned
8	–	–	–	Not assigned
9	M24EXT	M24EXT	O	External 0 V supply for the pressure sensor
10	M24EXT	M24EXT	O	Extra pin for jumper between pins 10–11 with 3–wire 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	Extra pin for jumper between pins 13–14 with 3–wire 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 with 40 kΩ input resistance.

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

The supply output has an electronic short–circuit protection function.

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

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

Notice

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

5

Control valve

- X121: Axis 1
- X122: Axis 2

Table 5-15 Connectors X121, X122; both are 15–pin sub D socket connectors

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	USOLL1N	USOLL2N	O	Analog setpoint output, reference ground
7	USOLL1P	USOLL2P	O	Analog setpoint output +/–10 V
8	M	M		Electronics ground
9	M24EXT	M24EXT	O	24 V external ground
10	M24EXT	M24EXT	O	24 V external ground
11	M24EXT	M24EXT	O	24 V external ground
12	–	–		Not assigned
13	M	M		Electronics ground
14	UIST1N	UIST2N	I	Analog valve actual–value input, reference ground
15	UIST1P	UIST2P	I	Analog valve actual–value input, +/–10 V
1) I = Input, O = Output				

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

The current ratings of the 24 V outputs of the control valves are

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

for the mean current value with a load cycle of 10 s duration.

The temperature corner points may be interpolated linearly.

The short–term current rating of the control valve outputs is 3.0 A (200 ms).

In the event of an overload, fuse F1900 or F1901 on the HLA control unit will rupture.

Fuse

The switched 24 V outputs for axes 1 and 2 are protected by miniature fuses F1900 (axis 1) or F1901 (axis 2).

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

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

Order No.: 194

terminals

Shut–off valves (axis–specific), external 26.5 V supply, enable contact, BERO inputs

- X431: Axis 1
- X432: Axis 2

Table 5-16 Connector X431; 8–pin Phoenix Combicon connector

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

Table 5-17 Connector 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 for shut–off valve for axis 2	
4	C2	–	Reserved, do not use	
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 +24 V enable voltage, term. 9	
1)	I = Input, O = Output			

Max. terminal cross–section 2.5 mm^2.

Caution

The +24 V outputs for shut–off valves for axes 1 and 2 are short–circuit–proof. The energy absorbed when inductive loads are disconnected must be limited to 1.7 J by the user. When the supply polarity is reversed, the outputs are not protected against overload.

Warning

If the polarity of the 26.5 V supply is reversed, then the shut–off valves will open immediately, even if the NC or closed–loop control is not in operation!

Notice

Each of the shut–off valves must be connected directly using 2 conductors connected to pins 2/3 of X431 or X432!

A current–compensated interference suppression coil is inserted at the input for the external incoming supply terminal P24, terminal M24 (pins 5 and 6 of X431).

Terminal M24 and terminal MV1/MV2 may therefore not be reversed or short–circuited.

The internal enable voltage (FRP/9) is provided in order to supply the BEROs and
terminals 663 may **not** be used to supply the hydraulics components. The hydraulic components must be supplied via incoming supply P24. The voltages may not be connected in parallel.

Enable inputs

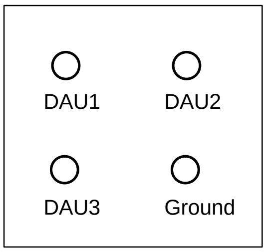
Module–specific enabling commands are issued by terminal 663. As no power section is installed, no relay is available. The input is therefore evaluated via optocouplers in the HLA module and also acts on the shut–off valves.
The enable voltage can be taken from terminal 9.

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

5.4.3 Test sockets (diagnostics)

Test sockets

The start–up tool or an MMC102/103 can be used to assign internal signals to the test sockets on the 611D drive (in conjunction with SINUMERIK 840D), where the signals are then available as analog values.



Functionality

Three 8–bit digital/analog converter (DAC) channels are available on the 611D hydraulics module. An analog image of various drive signals can be connected through to a test socket via these converters.

Only a window of the 24–bit wide drive signals can be displayed with the 8 bits (=1 byte) of the DAC. For this reason, the shift factor must be set to determine how fine the quantization of the selected signal must be. The normalization factor is determined when parameterizing and displayed to the user.

5.5 ”ANA module” control board

Description

Up to two analog axes can be controlled by using the ANA control unit. The ANA module is formed when the ANA control unit is inserted in the 50 mm wide universal empty housing.

The control unit can also be used as HLA control unit for analog axes. It is permissible to use this double–axis board in mixed operation (ANA/HLA).

An analog axis can be used very much like a digital axis. It can be programmed like a digital interpolating path axis or spindle. Pure functions of the SIMODRIVE 611 drive control system are, of course, not possible for external drive units linked via an analog speed setpoint interface. (These are functions which are dependent on feedback within the axis and communication by means of the drive bus, e.g. SINUMERIK Safety Integrated). Separate EMC measures must, if required, be applied for external drive units.

Note

The ANA module is described in detail in:

References: /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 is compatible with SIMODRIVE 611 SRM(FD/ ARM(MSD) for supported services. Code and data management is analogous to SIMODRIVE 611 SRM(FD)/ARM(MSD).

- Hardware

  The integration into the SIMODRIVE 611 system is compatible to the SIMODRIVE 611 digital SRM(FD)/ARM(MSD). This basically involves the following interfaces:

  – Drive bus
  – Equipment bus
  – Power supply concept

- ANA control unit (2 axes)

  – n_{set} output ± 10 V
  – Connection for 2 sensors per axis
  – Control of an analog drive amplifier

- Terminals and diagnostics

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

5.5.1 System overview

A complete 840D control with ANA module comprises various individual components. These are listed below.

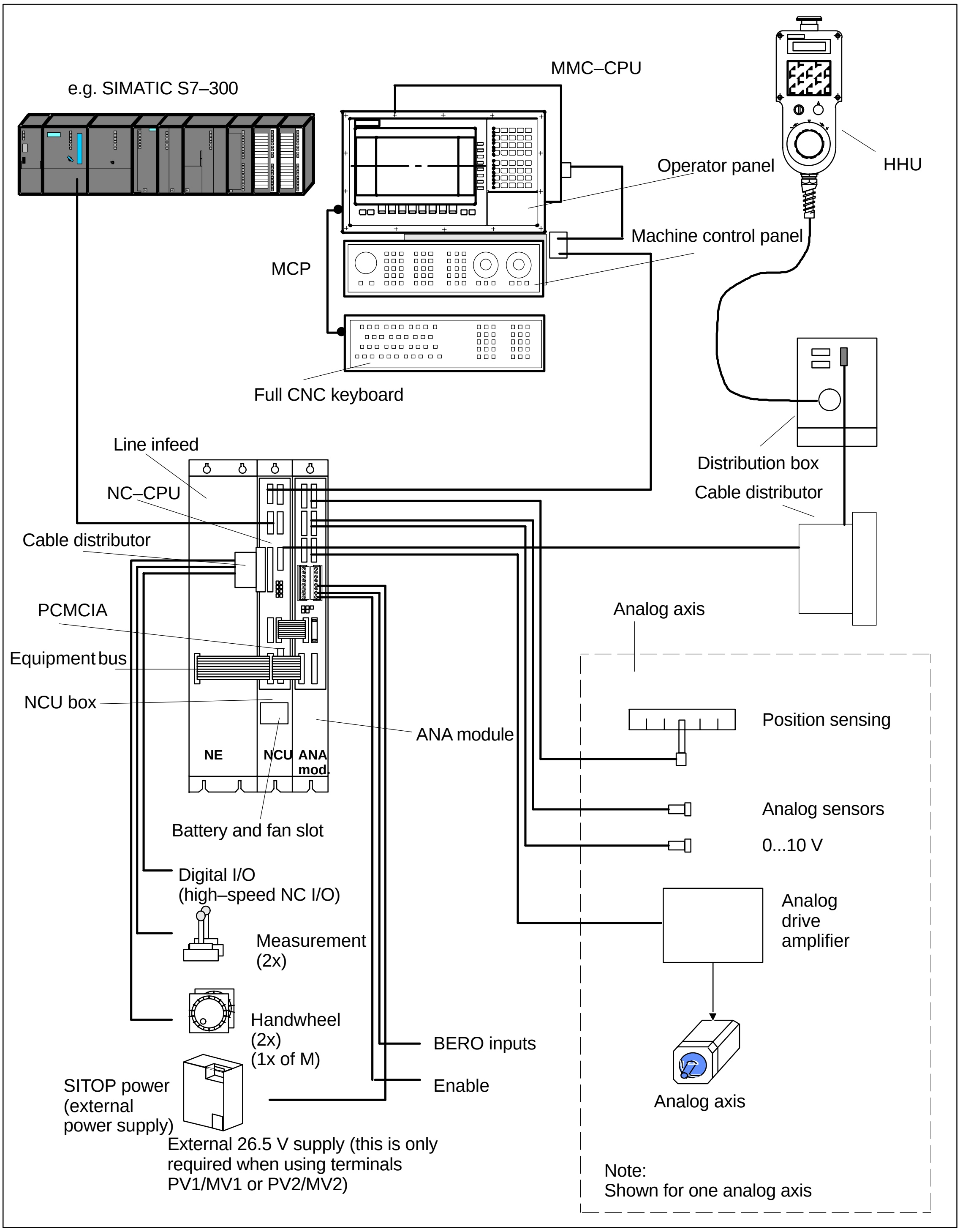

Fig. 5-11 System components

5

ANA control unit

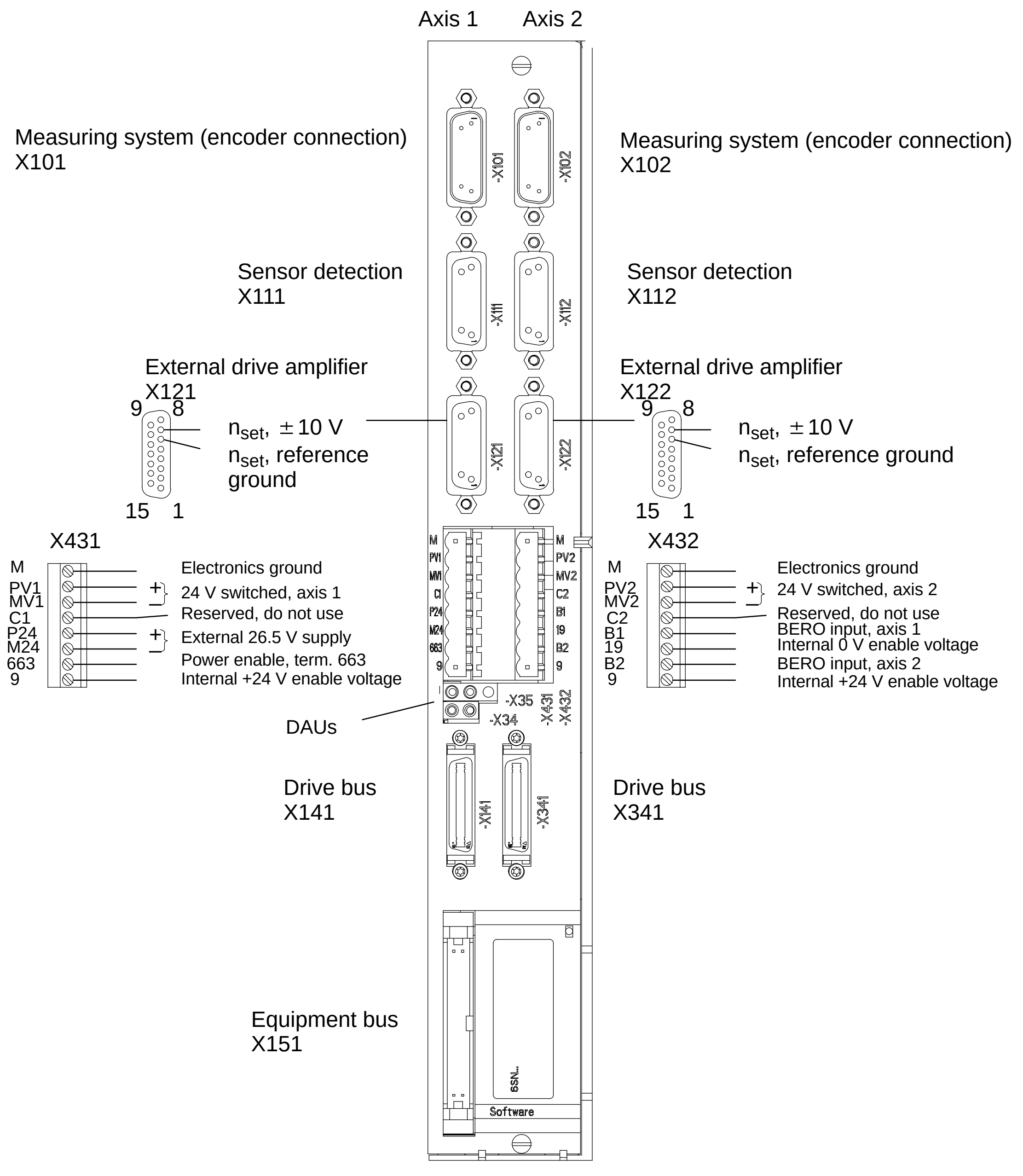

Fig. 5-12 ANA control unit (2 axes)

5.5.2 Connecting–up

Line supply connection

SINUMERIK 840D and the ANA module are supplied from the SIMODRIVE line supply voltage or from the SIMODRIVE monitoring module via the equipment bus. If an ANA module is used, then there must be at least one NE module in the equipment group. No provision has been made for any other type of voltage supply and failure to use the supply provided could damage the unit.

Notice

It is not permissible to operate an ANA module on its own on a SIMODRIVE monitoring module!

Power is supplied to downstream electrical axes via the DC link busbars (40 mm^2) of the carrier module.

Measuring systems

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

- X101: Axis 1
- X102: Axis 2

The measuring system must always be plugged into the connector of the associated axis.

Table 5-18 Connectors X101, X102; 15–pin sub D plug connector (two–tier)

Pin	X101[1)]	X102[1)]	Function
1	PENC0	PENC2	Encoder power supply
2	M	M	Encoder power supply ground
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	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 internal shields)
14	BMICLK0	BMICLK2	Data signal EnDat interface
15	XBMICLK0	XBMICLK2	Inverse clock signal, EnDat interface
1)	The permissible voltage range for the common mode component of the individual encoder signals (AP. AN. BP, BP, RP, RP) is 1.5...3.5 V.		

Analog sensors

Connection for 2 sensors per axis

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

Table 5-19 Connectors X111, X112; 15–pin sub D socket connector

Pin	X111	X112	Type 1)	Function
1	P24DS	P24DS	O	External +24 V supply for the sensor
2	P24DS	P24DS	O	External +24 V supply for the sensor
3	–	–		Not assigned
4	–	–		Not assigned
5	M24EXT	M24EXT	O	External 0 V supply for the sensor
6	–	–		Not assigned
7	–	–		Not assigned
8	–	–		Not assigned
9	M24EXT	M24EXT	O	External 0 V supply for the sensor
10	M24EXT	M24EXT	O	Extra pin for jumper between pins 10–11 with 3–wire 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	Extra pin for jumper between pins 13–14 with 3–wire 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 with 40 kΩ input resistance.
The input voltage range of the actual value inputs is 0...+10 V.

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

Analog setpoints and actual values

- X121: Axis 1
- X122: Axis 2

Table 5-20 Connectors X121, X122; both are 15–pin sub D 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	USOLL1N	USOLL2N	O	Analog setpoint output, reference ground
7	USOLL1P	USOLL2P	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	UIST1N	UIST2N	I	Analog actual value input, reference ground
15	UIST1P	UIST2P	I	Analog valve actual–value input, +/–10 V
1) I = Input, O = Output				

The analog valve actual value inputs are differential 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 mean current value with a load cycle of 10 s duration.

The temperature corner points may be interpolated linearly.

The short–term current rating of the 24 V outputs is 3.0 A (200 ms).

In the event of an overload, fuse F1900 or F1901 on the ANA control unit will rupture.

Fuse

The switched 24 V outputs for axes 1 and 2 are protected by miniature fuses F1900 (axis 1) or F1901 (axis 2).

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

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

Order No.: 19194

terminals

External 26.5 V supply, enable, BERO inputs

- X431: Axis 1
- X432: Axis 2

Table 5-21 Connector X431; 8–pin Phoenix Combicon connector

Pin	X431	Type 1)	Function	Typ. voltage/ Limits
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 use	
5	P24	I	Input for external +24 V	26.5 V ± 2 %
6	M24	I	Input for external 0 V	
7	663	I	Module–specific enable signal	21 V...30 V
8	9	O	Enable voltage, internal, +24 V	
1)	I = Input, O = Output			

Table 5-22 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 use	
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	Enable voltage, internal, +24 V	
1)	I = Input, O = Output			

Notice

A connection (jumper) between X431.6 and X432.3 is **not permissible**!

Max. terminal cross–section 2.5 mm^2.

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

Caution

The +24 V outputs for shut–off valves for axes 1 and 2 are short–circuit–proof. The energy absorbed when inductive loads are disconnected must be limited to 1.7 J by the user. When the supply polarity is reversed, the outputs are not protected against overload.

Enable inputs

The module–specific enable is realized using 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 referenced to the internal enable voltage (ground, terminal 19).

5.5.3 Bus interfaces

Drive bus

(refer to SIMODRIVE 611 digital)

- X141: Input
- X341: Output

A bus terminator must be plugged into the last module.

Equipment bus

(refer to SIMODRIVE 611 digital)

- X151: Equipment bus

■

6 Infeed Modules

6.1 Description

6

General information

The infeed modules are used to connect the drive group to the line supply. The infeed/regenerative feedback module (I/R module) and the module for the unregulated infeed (UI module) are used to input power into the DC link. Further, the I/R, UI, and the monitoring module also provide the electronics power supply for the connected modules.

UI module

For the UI module, when the motor brakes, the drive energy, injected into the DC link is converted into heat in the braking resistors and dissipated to the environment. These braking resistors are either integrated or mounted. When required, one or more additional pulsed resistor modules (PR modules) can be used within the limits specified when engineering the system. This module is used for the following applications:

- Machines with few or short braking cycles, low braking energy
- Drive groups with limited dynamic demands, in particular for the main spindle drive

I/R module

For the I/R module, when the motor brakes, the drive energy injected into the DC link is fed back into the line supply. This module is used for the following applications:

- Machines with high dynamic requirements placed on the drives
- Frequent braking cycles and high braking energy
- Control cabinet designs optimized for low operating costs

Monitoring module

The monitoring module contains a complete electronics power supply for the equipment bus and the central monitoring functions for a separate drive group. The power supply can be taken from either the 400 V to 480 V 3–phase AC supply or from the DC link voltage. If required, the supply can be taken from the DC link via P500/M500. In this particular case, a charge current requirement of 1000 µF should be used as basis.

The monitoring module is required if a higher number of drive modules in a group exceed the electronics power supply of the infeed module (I/R or UI module). The monitoring module also allows groups of drive modules to be created in multiple cabinet compartments or tiers.

Arrangement

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

The mounting surface for the line supply infeed and drive modules as well as the commutating reactors and line filter must be mounted to the mounting panels through a low–resistance connection (e.g. galvanized plates and panels).

Line filters, line filter modules and shielded cables are available in order to comply with the CE requirements regarding the radio interference voltage limit values.

Shield terminal plates are available to meet EMC requirements when using shielded power cables.

The overvoltage limiter module is required so that the line supply and infeed modules are implemented in conformance with UL.

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

Fig. 6-1 DC link pre–charging frequency

In the ”standby mode” of the line supply infeed, pulse inhibit for the power modules, then terminal 63 should be used to also inhibit the pulses in the infeed. The DC link remains at the non–regulated level; this means that when the pulses are enabled, it is immediately regulated and is ready to operate.

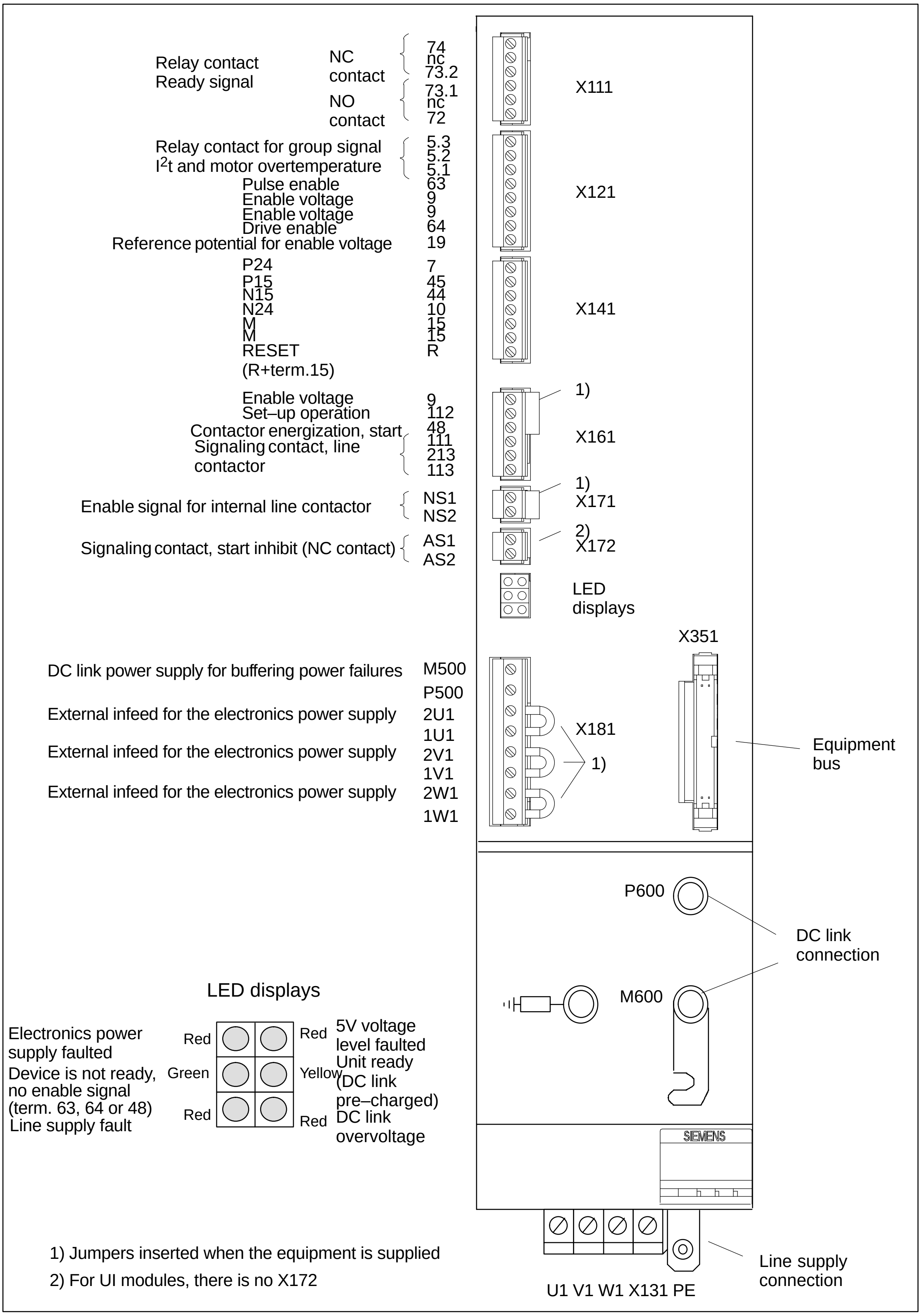

Fig. 6-2 Interfaces, infeed module (UI module) or infeed/regenerative feedback module (I/R module)

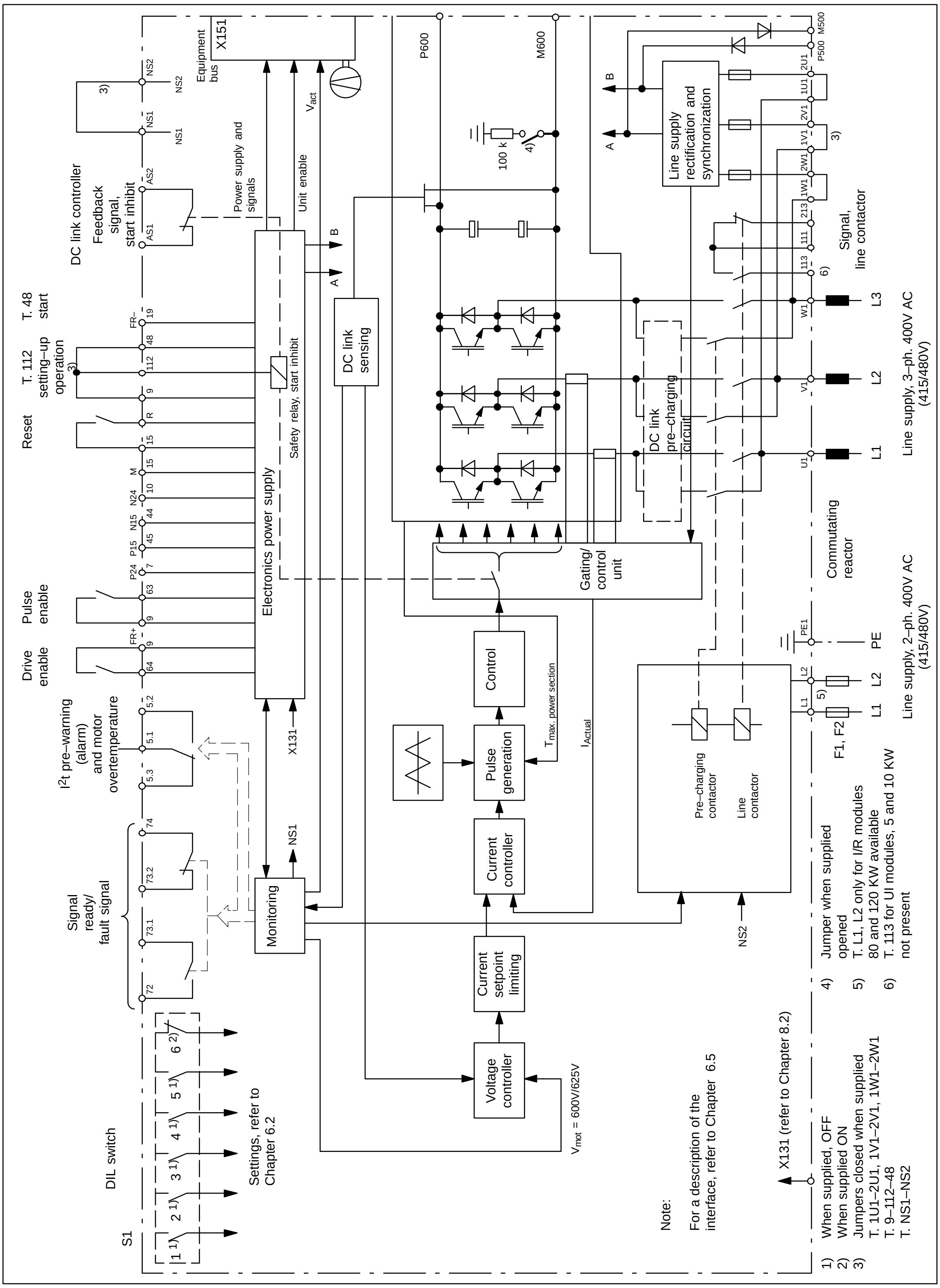

Fig. 6-3 Block diagram, line supply infeed module (I/R)

6.2 Function overview and settings

General information

A switch S1 is provided on the upper side of the NE and monitoring module that is used to set the following functions (for UI 5 kW on the front side):

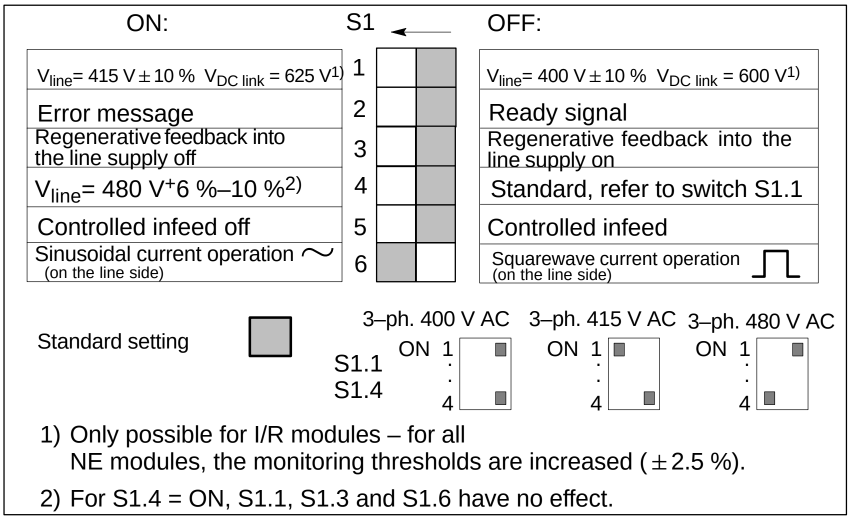

Fig. 6-4 DIL switch S1

Note

For a configuration 480 V S1.4= ON, only controlled regenerative feedback is realized, independent of the position of S1.5.

Notice

For I/R modules Order No.: 6SN114☐–1☐☐0☐–0☐☐**1** the basic setting is for sinusoidal operation.

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

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

Switch S1.1

OFF: I/R module V_{line} = 400 V ±10 %; $V_{DC\ link}$ = 600 V ± 2.5 %
UI module V_{line} = 400 V ±10 %; $V_{DC\ link}$ = V_{line} • 1.35
monitoring thresholds: (I/R, UI, monitoring modules)
PW on = 644 V; PW off = 618 V
$V_{DC\ link}$>> = 695 V ± 2.5 %

ON: I/R module V_{line} = 415 V ±10 %; $V_{DC\ link}$ = 625 V ± 2.5 %
UI module V_{line} = 415 V ±10 %; $V_{DC\ link}$ = V_{line} • 1.35
monitoring thresholds: (I/R, UI, monitoring modules)
PW on = 670 V; PW off = 640 V
$V_{DC\ link}$>> = 710 V ± 2.5 %

PW = pulsed resistor

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)
– Terminals 63, 64 = ON
– No fault present (also not at the FD 611 A Standard, 611 U, resolver and 611 D drives and HLA modules).
– FD with High Standard or resolver for the setting ”ready” is enabled (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 are fulfilled:

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

Switch S1.3

OFF: Standard setting, regenerative feedback into the line supply 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 and active.

ON: Regenerative feedback into the line supply switched–out

I/R modules:	16 KW to 120 KW: Regenerative feedback into the line supply is inhibited
UI module:	5 KW, 10 KW: The pulsed resistor in the module is not active

Valid for
UI 5 KW, Order No.: 6SN1146–1AB00–0BA1 and
UI 10 KW, Order No.: 6SN1145–1AA01–0AA1

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_{line} = 480 V +6% / –10 %; $V_{DC\ link} = V_{line} \bullet 1.35$ in regenerative feedback operation
$V_{DC\ link}$ = 700 ... 750 V $\pm$2.5 % in regenerative feedback operation
monitoring thresholds: (I/R, UI, monitoring modules)
PR on = 744 V; PR off = 718 V
$V_{DC\ link}$>> = 795 V $\pm$ 2.5 %
S1.4 overwrites the setting of S1.1

Note: Unregulated operation in the infeed direction.

Warning

For operation with 480 V line supply applications it must be absolutely ensured that before the line supply is connected, the switch setting S1.4 = ON. If this is not the case, the infeed circuit in the NE module will be overloaded and destroyed.

Note

Only in conjunction with modules, Order No.: 6SN114□–1□□0□–0□**1**.
For motors with shaft height < 100: Utilization, max. up to the 60K values.
Please observe the Configuration Manual, Motors.
S1.4 ON overwrites the functions of S1.5 and S1.1.

Switch S1.5

This function is only applicable in conjunction with I/R modules
Order No.: 6SN114□–1B□0□–0□A**1**

OFF: standard setting controlled/regulated infeed active

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

Caution:
For unregulated operation of the I/R units on V_{line} = 400 V/415 V the power must be reduced (de–rated) to 75 %.

Switch S1.6

OFF: Squarewave current operation (current with a squarewave waveform is drawn from the line supply)

ON: This function is only applicable in conjunction with I/R modules
Order No.: 6SN114□–1B□0□–0□A**1**
sinusoidal current operation (sinusoidal current is taken from the line supply)

Note

The total length of the power cables (motor supply cables and DC link cables) may not exceed 350 m for sinusoidal current operation and 500 m for squarewave current operation.

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

Table 6-1 Combinations 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:**
6SN11 45–1BA01–0BA**1**	6SN11 45–1BA02–0CA**1**	6SN11 45–1BA01–0DA**1**	6SN11 45–1BB00–0EA**1**	6SN11 45–1BB00–0FA**1**
For external cooling:	**For external cooling:**	**For external cooling:**	**For external cooling:**	**For external cooling:**
6SN11 46–1BB01–0BA1	6SN11 46–1BB02–0CA1	6SN11 46–1BB00–0DA1	6SN11 46–1BB00–0EA1	6SN11 46–1BB00–0FA1
HF reactor 16 kW	**HF reactor 36 kW**	**HF reactor 55 kW**	**HF reactor 80 kW**	**HF reactor 120 kW**
6SN11 11–0AA00–0BA1	6SN11 11–0AA00–0CA1	6SN11 11–0AA00–0DA1	6SN11 11–0AA00–1EA0	6SL3 000–0DE31–2BA0
–[3)]	**HFD reactor [2)] 36 kW**	**HFD reactor [2)] 55 kW**	**HFD reactor [2)] 80 kW**	**HFD reactor [2)] 120 kW**
–[3)]	6SL3 000–0DE23–6AA0	6SL3 000–0DE25–5AA0	6SL3 000–0DE28–0AA0	6SL3 000–0DE31–2AA0
Line filter for sine. current[1)] 16 kW	**Line filter for sine. current[1)] 36 kW**	**Line filter for sine. current[1)] 55 kW**	**Line filter for sine. current[1)] 80 kW**	**Line filter for sine. current[1)] 120 kW**
6SL3 000–0BE21–6AA0	6SL3 000–0BE23–6AA0	6SL3 000–0BE25–5AA0	6SL3 000–0BE28–0AA0	6SL3 000–0BE31–2AA0

1) The HF commutating reactor must be externally mounted. (refer to Chapter 7.4.1). The line filter is required in order to achieve the CE conformance for the radio interference voltage.
2) For linear, torque and third–party motors
3) Being prepared

Caution

For all of the combinations not listed here (discontinued filter modules 6SN11 11–0AA01–0□A□) only the squarewave current operation setting is permissible.

For other operating modes, it is possible that the system will be thermally overloaded.

Table 6-2 Power factor

Module	Operation on the line side	Factor cos φ	Factor λ
I/R	Sinusoidal current operation	$\cos \varphi \approx 0.98$	$\lambda = 0.97$
I/R	Squarewave current operation	$\cos \varphi \approx 0.98$	$\lambda = 0.89$
UI	–	$\cos \varphi \approx 0.87$	$\lambda = 0.67$

$\cos \varphi$: The power factor only contains the basic fundamental
λ: The power factor contains the basic fundamental and harmonic components

6.3 Operating power modules from an unregulated infeed

The drive modules can be operated from both unregulated and regulated supply modules belonging to the SIMODRIVE 611 drive converter system. The engineering and power data of this Configuration Manual refer to operation with the regulated infeed/regenerative feedback modules. This data should be corrected, if required, when operated from unregulated infeed modules.

Operating drive modules with 1PH and 1FE1 motors and induction motors from an unregulated infeed

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

As a result of the lower DC link voltage of 490 V (for a line supply infeed with 400 V 3–ph. – 10%) for the UI module, the available continuous output is given by:

If

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

then, only the following continuous power is available

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

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

$V_{N\ motor}$ should, for the particular motor, be taken from the appropriate documentation (refer to Appendix, References).

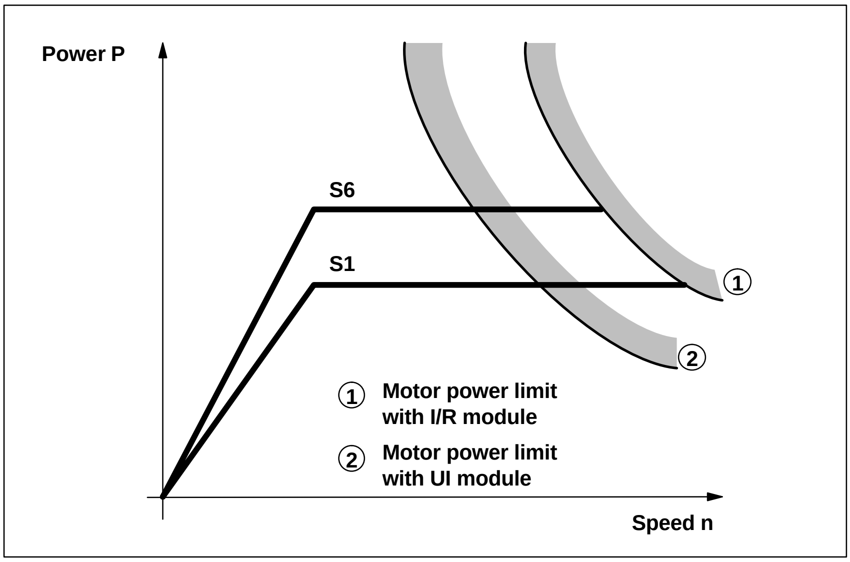

Fig. 6-5 Speed – power diagram

For the UI module, it must also be observed that the braking energy, which is fed–in, does not exceed the power rating of the pulsed resistor:

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

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

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

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

Operating drive modules with 1FT6, 1FK and 1FN motors with an unregulated infeed

Owing to the lower DC link voltage of 490 V [1)] with UI modules (600 V for I/R modules), the following restrictions may apply:

- Reduction of dynamic drive characteristics in the upper speed/velocity range
- Lower utilization of the rated motor speed/velocity if operation under overload conditions is still required.

1) For a line supply infeed with 3–ph. 400 V AC –10%.

6.4 Technical data

Table 6-3 Technical data, I/R modules

Internal cooling **External cooling** **Hose cooling**	**6SN11 45–** **6SN11 46–** **6SN11 45–**	**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 1)						
Rated power (S1)	KW	16	36	55	80	120
Infeed power (S6–40%)	KW	21	47	71	104	156
Peak infeed power	KW	35	70	91	131	175
Regenerative feedback into the line supply 1)						
Continuous feedback power	KW	16	36	55	80	120
Peak feedback power	KW	35	70	91	131	175
Supply data						
Voltage (power)	V	refer to Chapter 6.4.1, Table 6-5				
Voltage (electronics)	V	3–ph. 400 –10 % ... 3–ph. 480 V AC +6 %				
Power supply	V	At the DC link with 600/625/680 V DC or supplied in parallel, AC and DC connection				
Frequency	Hz	50 to 60 $\pm$10 %				
Supply current at 360 V_{AC}	A	30	67.3	103	149	224.5
Supply current at (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	0...600/625/680				
Rated output current	A	27.0	60.5	92.5	134	202
Output current (480V; S6–40%)	A	35.0	78	118	173	260
Peak current	A	59.0	117.5	153	220	294
Module width	mm	100	200	300	300	300
Type of cooling						
Internal cooling		Fans	Fans	Fans	Built–on fan 2)	Built–on fan 2)
External cooling 3)		Fans	Fans	Mounting frame with fan assembly and built–on fan 2)		
Hose cooling		–	–	Kit for hose cooling with fan 2)		
Losses						
Internal cooling	W	320	585	745	1280	1950
External cooling	W (int./ext.)	50/270	50/535	115/630	190/1090	290/1660
Hose cooling	W (int./ext.)	–	–	115/630	190/1090	290/1660
Efficiency η		0.97	0.975	0.977	0.977	0.978
Weights						
Internal cooling	kg	10.5	15.5	26	26	29
External cooling	kg	10.5	15.5	26	26	29
Hose cooling	kg	–	–	26	26	29

1) Power values are referred to 600 V DC
2) Order No. 6SN62–0BA02–0AA2 (must be ordered separately)
3) For a module width of 300 mm with external cooling, mounting frames are required that must be ordered separately. The fan assembly required here to mount the built–on fan is included in the scope of supply of the mounting frame. The built–on fan must be separately ordered! Mounting frames are also available for smaller module widths. However, these are not required if openings are cut–out in the rear cabinet panel for the module heatsinks as shown in this Configuration Manual.

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Table 6-4 Technical data, UI modules

Internal cooling External cooling Hose cooling	6SN11 45– 6SN11 46– 6SN11 45–	1AB00–0AB1 1AB00–0AB1 –	1AA01–0AA1 1AA01–0AA1 –	1AA00–0CA0 1AB00–0CA0 –
Infeed[1)] Rated power (S1) Infeed power (S6–40%) Peak infeed power	 KW KW KW	 5 6.5 10	 10 13 25	 28 36 50
Continuous/peak power rating of the integrated pulsed resistor	KW	0.2/10	0.3/25	–
Supply data Voltage (power)	 V	refer to Chapter 6.4.1, Table 6-5		
Voltage (electronics)	V	3–ph. 400 –10 % ... 3–ph. 480 V AC +6 %		
Power supply	V	At the DC link with 600/625/680 V DC or supplied in parallel, AC and DC connection		
Frequency	Hz	50 to 60 ±10 %		
Rated current Supply current at 360 V_{AC} (minimum voltage value) Peak current Connection cross–section, max.	A A A mm^2	9.4 14 25 6	18.2 26.7 60 16	48.8 72.3 116 50
Output voltage	V	0...490...680 depending on the line supply voltage		
Output frequency	Hz	0...1400 depending on the control unit		
Rated output current Output power (S6–40%) Peak current	A A A	7.8 10 25	15.4 20 60	43.3 55.8 116
Module width	mm	50	100	200
Type of cooling Internal cooling External cooling Hose cooling		 Non–ventilated Non–ventilated –	 Universal cooling internal/external –	 Internal separately–driven fan Integrated separately–driven fan
Losses Internal cooling External cooling Hose cooling	 W W (int./ext.) W (int./ext.)	 270 270/– –	 450 119/331 –	 250 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 –

1) Power values referred to 600 V DC

6.4.1 Technical data, line supply infeed modules

Supply voltage and frequency

The line supply infeed modules are adapted to the actual line supply conditions using switches S1.1 and S1.4 (refer to Chapter 6.2).

Table 6-5 Supply voltage and frequency

	S1.1, S1.4 = OFF Vn = 3–ph. 400 V AC	**S1.1 = ON Vn = 3–ph. 415 V AC**	**S1.4 = ON Vn = 3–ph. 480 V AC**
NE modules Power connection: U1 V1 W1	3–ph. 360...440 V AC 100 % P_n/P_{max} 3–ph. 323...360 V AC 70 % P_n/P_{max} 45...65 Hz	3–ph. 373..457 V AC 45...65 Hz	3–ph. 432..509 V AC 55...65 Hz
Main contactor for 80 kW and 120 kW, external power supply required;	Engineering information on how to connect the contactor, refer to Chapter 8.2.2 terminals L1, L2		

Table 6-6 Line supply conditions

Designation	**Description**		
Line supply conditions for NE modules	The NE modules are designed for symmetrical 3–phase line supplies with grounded neutral point that can be loaded: TN line supplies. The line supply specifications according to EN 50178 are complied with as a result of the series (upstream) commutating reactor (for UI 5 kW and UI 10 kW, these are integrated in the module).		
UI modules	Operation on line supplies from $S_{Kline}/Pn_{UI} \geqq 30$		
I/R modules	In order to guarantee undisturbed operation in the system environment, the fault level of the line supply (S_K line) at the point of connection of the I/R module must have the values listed in the table below. If this requirement is not maintained, this can have a negative impact on the drive; it can also interfere with other equipment and devices that are connected at this connection point.		
	Valid for I/R modules with Order No.: 6SN114□–1□□0□–0□□**1**		
	I/R module used	**Sinusoidal current operation (S1.6 = ON) Chapter 6.1, required S_K line**	**Squarewave current operation (S1.6 = OFF) Chapter 6.1, required S_K line**
	16 KW	S_K line $\geq$ 1.1 MVA (70 x $Pn_{I/R\ module\ in\ kW}$)	S_K line $\geq$ 1.6 MVA (100 x $Pn_{I/R\ module\ in\ kW}$)
	36 KW	S_K line $\geq$ 2.5 MVA (70 x $Pn_{I/R\ module\ in\ kW}$)	S_K line $\geq$ 3.6 MVA (100 x $Pn_{I/R\ module\ in\ kW}$)
	55 KW	S_K line $\geq$ 3.9 MVA (70 x $Pn_{I/R\ module\ in\ kW}$)	S_K line $\geq$ 5.5 MVA (100 x $Pn_{I/R\ module\ in\ kW}$)
	80 KW	S_K line $\geq$ 4.8 MVA (60 x $Pn_{I/R\ module\ in\ kW}$)	S_K line $\geq$ 6.4 MVA (80 x $Pn_{I/R\ module\ in\ kW}$)
	120 KW	S_K line $\geq$ 7.2 MVA (60 x $Pn_{I/R\ module\ in\ kW}$)	S_K line $\geq$ 9.6 MVA (80 x $Pn_{I/R\ module\ in\ kW}$)

No ground faults

Before powering–up the system for the first time, the cabinet wiring, the motor/encoder feeder cables and DC link connections must be carefully checked to ensure that there are no ground faults.

Nominal load duty cycles for NE modules

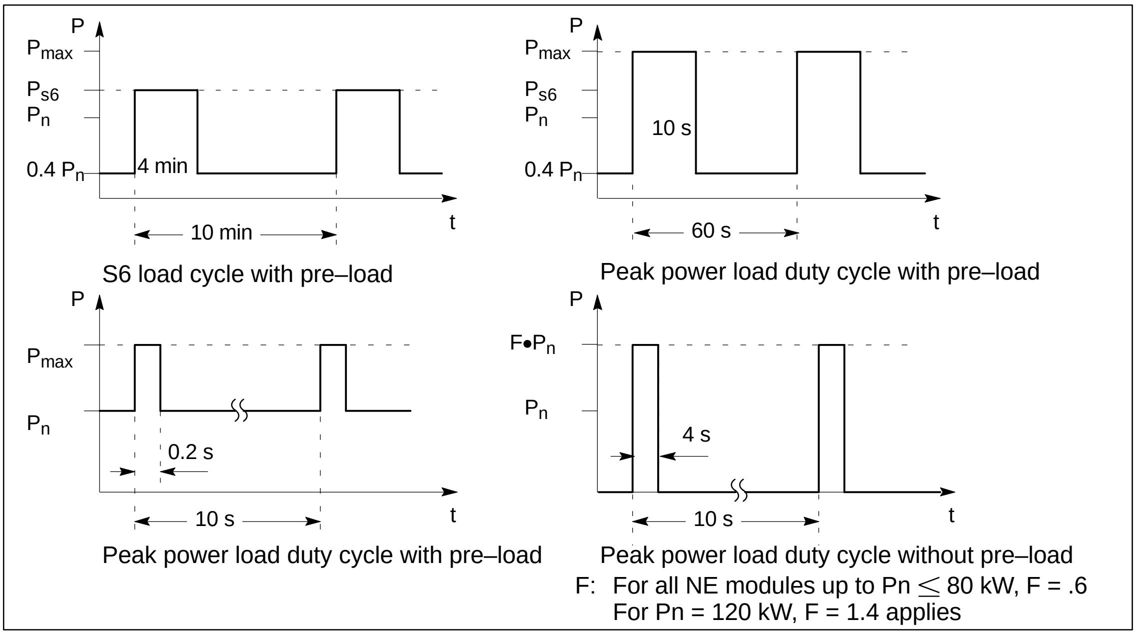


Fig. 6-6 Nominal load duty cycles for NE modules

The following rule of thumb applies:

- General information:

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

P(t) instantaneous power drawn

- For block–type load duty cycles:

$$B < \frac{1}{\sqrt{T}} \bullet \sqrt{\sum_{i=1}^{k} \left(\frac{P_i}{P_n}\right)^2 \bullet\ t_i} = \frac{1}{\sqrt{T}} \bullet \sqrt{\left(\frac{P_1}{P_n}\right)^2 t_1 + \left(\frac{P_2}{P_n}\right)^2 t_2 + ... + \left(\frac{P_k}{P_n}\right)^2 t_k}$$

T	Total duration of the load duty cycle
P_n	Rated power of the I/R module
$P_1...P_k$	Magnitude of the power fed in
$t_1...t_k$	Duration of the corresponding power
B	Evaluation factor for the load duty cycle according to Table 6-7

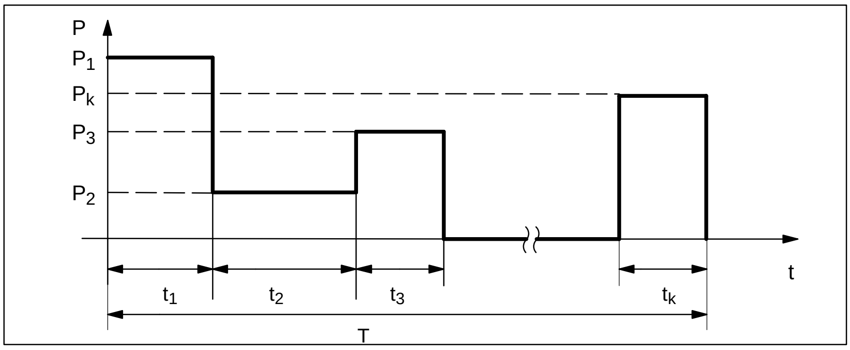


Fig. 6-7 Explanation of the rule of thumb for block–type load duty cycles

The following applies for both rules of thumb:

- The evaluation factor B, calculated for the load duty cycle, must be less than the maximum values B_{max} specified in Table 6-7.
- The maximum infeed power P_{max} of the infeed module may not be exceeded.
- The power de–rating as a function of the installation altitude must be taken into account.

Table 6-7 Evaluation factor for the load duty cycle

	Total duration		
	T >= 10 s	**10 s < T <= 60 s**	**60 s < T <= 600 s**
B_{max}	1.03	0.90	0.89

Calculation example for a block–type load duty cycle:

Evaluation/assessment factor B should be determined for the following load duty cycle:

Infeed module used: I/R 36kW (P_n=36 kW; P_{max}=70 kW)

i	1	2	3	4	5
P [kW]	50	20	36	0	40
t [s]	1.5	1	2	1.2	1.2

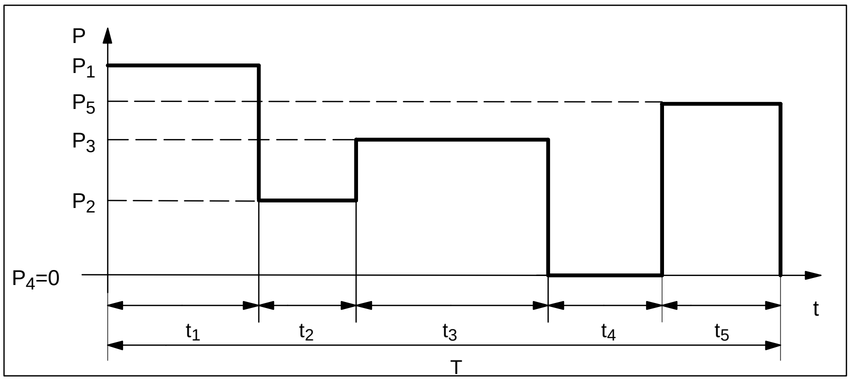


Fig. 6-8 Example, calculating a load duty cycle

1. Is the maximum infeed exceeded? —> No —> OK
2. Calculating the total duration T
   $T = \Sigma\, t_i = t_1 + t_2 + ... + t_k = 1.5\ s + 1\ s + 2\ s + 1.2\ s + 1.2\ s = 6.9\ s$
3. Calculating the evaluation/assessment factor B

$$B = \frac{1}{\sqrt{T}} \bullet \sqrt{\left(\frac{P_1}{P_n}\right)^2 \bullet t_1 + \left(\frac{P_2}{P_n}\right)^2 \bullet t_2 + ... + \left(\frac{P_k}{P_n}\right)^2 \bullet t_k}$$

$$B = \frac{1}{\sqrt{6.9}} \bullet \sqrt{\left(\frac{50}{36}\right)^2 \bullet 1.5 + \left(\frac{20}{36}\right)^2 \bullet 1 + \left(\frac{36}{36}\right)^2 \bullet 2 + \left(\frac{0}{36}\right)^2 \bullet 1.2 + \left(\frac{40}{36}\right)^2 \bullet 1.2}$$

$$B = 0.38 \bullet \sqrt{2.89 + 0.31 + 2 + 0 + 1.48} = 0.98$$

4. Check, whether B is < B_{max} for the calculated load duty cycle T
   B = 0.98
   B_{max} for a load duty cycle less than 10 s = 1.03
   —> the load duty cycle is permissible

Power de–rating as a function of the installation altitude

All of the power ratings specified apply up to an installation altitude of 2000 m. For installation altitudes > 2000 m, the specified power ratings must be reduced according to the de–rating characteristic as shown in Chapter 4.4.3. For installation altitudes > 2000 m, an isolating transformer must be used.

The isolating transformer is used to decouple a line supply circuit (overvoltage category III) from a non–line supply circuit (overvoltage category II). Refer to IEC 60664–1 (this is necessary for the complete system).

Notice

The power ratings for P_n, P_{s6} and P_{max} must be reduced (de–rated) in the same fashion.

Note

For UI modules it must be carefully observed that the braking energy fed in does not exceed the power rating of the pulsed resistor.
A defect does not occur; when an overload condition occurs, the resistor is shutdown. The drive unit then goes into a fault condition, with the fault ”DC link overvoltage” and the motors coast down in an uncontrolled fashion.

6.4.2 Technical data of the supplementary components

Cooling components

<table>
<tr><th>Components</th><th>Order No.</th><th>Supply voltage</th><th>Supply current</th><th>Observe the rotating field!</th><th>Degree of protec-tion</th><th>Weight [kg]</th></tr>
<tr><td>Built–on fan for internal and external cooling</td><td>6SN11 62–0BA02–0AA□</td><td>3–ph.
360..510 V AC
45...65 Hz</td><td>0.2 A to 0.3 A</td><td>For the direction of rotation, refer to the direction of the arrow on the fan</td><td>IP 44</td><td>4</td></tr>
<tr><td><u>Hose cooling package 1</u> for an individual module comprising:
• 2x module connection flange, 2000 mm hose
• 1x cabinet connection flange
• 1x radial fan with cabinet connection flange[1)] (refer to Fig. 2-7)</td><td>6SN11 62–0BA03–0AA1</td><td>3–ph.
360..457 V AC
47.5...62.5 Hz</td><td>1.0...1.2 A</td><td>Counter–clockwise direction of rotation when viewing the rotor</td><td>IP 54</td><td>8</td></tr>
<tr><td><u>Hose cooling package 2</u> for a 2–tier configuration of I/R 55 kW and LT 85 A:
• 4x module connection flange, 2000 mm hose
• 1x cabinet connection flange
• 1x radial fan with cabinet connection flange[1)] (refer to Fig. 2-7)</td><td>6SN11 62–0BA03–0CA1</td><td>3–ph.
360..457 V AC
47.5...62.5 Hz</td><td>1.0...1.2 A</td><td>Counter–clockwise direction of rotation when viewing the rotor</td><td>IP 54</td><td>8</td></tr>
<tr><td>Motor protection circuit–breaker</td><td colspan="6">Size S00:
Setting value, 0.3 A 3RV1011–0DA10 0.22–0.32 A
Setting value, 1 A 3RV1011–0KA10 0.9–1.25 A

Size S0
Setting value, 0.3 A 3RV1021–0DA10 0.22–0.32 A
Setting value, 1 A 3RV1011–0KA10 0.9–1.25 A</td></tr>
<tr><td>Air baffle plate
width 100 mm</td><td>6SN1162–0BA01–0AA0</td><td colspan="5">If heat sensitive parts are located above the UI and/or PR module with a clearance < 500 mm – e.g. cable ducts – then an air baffle plate must be used
(refer to Chapter 11, Dimension drawings).</td></tr>
</table>

1) Replacement filter element: Order No. AFF0
Can be ordered from Pfannenberg GmbH
Postfach 80747
21007 Hamburg

Warning

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

Caution

If the fan has the incorrect direction of rotation (refer to the arrow on the fan) then cooling is not guaranteed!

Connection for 3–phase fans

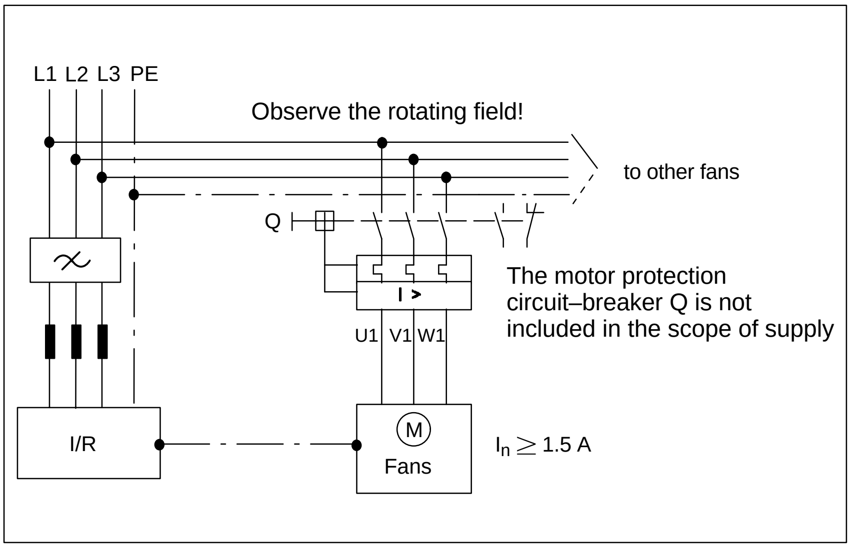


Fig. 6-9 Connection for 3–phase fans

6.5 Interface overview

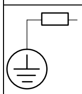
Note

Only PELV or SELV voltages may be connected at terminals with either PELV or SELV voltages (refer to EN 60204–1, Chapter 6.4).
Order Nos. for coding connectors, refer to Catalog NC60.
Refer to the information in the following tables.

6.5.1 Interface overview, NE modules

The interface description applies to all NE modules with the exception of the 5 kW UI module; this interface has its own description (refer to Chapter 6.5.2).

Table 6-8 Interface description for NE modules

T. No.	Designa-tion	Function	Type 1)	Typ. voltage/limit values for V_n 400 V	Max. cross–section 10)	Terminals provided on 3)
U1 V1 W1		Line supply connec-tion	I	3–ph. 400 V AC	refer to Chapter 4.2	I/R, UI
L1 L2		Line supply connec-tion for contactor	I I	refer to Chapter 6.4.1, Table 6-5 refer to Chapter 8.2.2, L1, L2	16 mm²/10 mm² 4) 16 mm²/10 mm² 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	Screw Busbar Busbar	I/R, UI, monitor-ing module
		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 mm²/10 mm² 4) 16 mm²/10 mm² 4)	Monitoring module 11)

1) I = input; O = output; NC = NC contact; NO = NO contact; (for signal, NO = high; NC = low)
P = only for PELV voltage; S = only for SELV voltage
2) Terminal 19 is the reference ground (connected through 10 kΩ to the general ref. ground X131/T.15 inside the module)
Terminal 15 may not be connected to PE or to terminal 19, further, external voltage sources may not be connected to terminal 15. Terminal 19 can be connected to X131.
The terminal may only be exclusively used to enable the associated drive group.
3) I/R = infeed/regenerative feedback module; UI = unregulated infeed; monitoring module;
PR = pulsed resistor module
4) The 1st data apply with pin–type cable lug. The 2nd data apply for finely–stranded conductors without end sleeve.
5) The grounding bar is used to ground the DC link M busbar through 100 kΩ (must be inserted for non–TN line supplies and may not be used if RCCB protective devices are used;
the grounding bar must be removed if the system is subject to a high–voltage test).
6) RESET = resets the fault memory, edge–triggered for the complete drive group (terminal ”R” → Terminal 15 = RESET)
7) Terminals 111–213, positively–driven opening contacts (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
For I/R 16 kW (from version E) and UI 10 kW (from version F) the following apply:
Terminals 111–213, positively–driven opening contacts (series circuit of NC contact, main contactor and NC contact, pre–charging contactor)
Terminals 111–113, positively–driven NO contacts
8) Max. current load of terminal 9 with respect to terminal 19: 0.5 A.
9) Only for UI 28 kW
10) For UL certification only use copper cables dimensioned for an operating temperature ≥ 60° C
11) Max. permissible connected power: Pmax ≤ 43 kW; max. permissible current load:: Imax ≤ 72 A
12) When the AS1/AS2 contacts are connected in series a contact resistance of approx. 0.20 Ohm must be taken into consideration over the lifetime of the contacts. For a 24 V switching voltage, from experience, a series circuit of up to 5 contacts can be used without any problems due to the non–linear contact characteristics.

Table 6-8 Interface description for NE modules, continued

T. No.	Designa-tion	Function	Type 1)	Typ. voltage/limit values for V_n 400 V	Max. cross–section 10)	Terminals provided on 3)
1R, 2R, 3R	TR1, TR2 9)	Connection, external resistor	I/O	300 V	6 mm^2/4 mm^2 4)	UI 28 kW
	X131	Electronics M	I/O	0 V	16 mm^2/10 mm^2 4)	I/R, UI, monitor-ing module
	X151	Equipment bus	I/O	Various	Ribbon cable	I/R, UI, monitor-ing module
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	DC –300 V DC +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	I/R, UI, monitor-ing module
7 45 44 10 15 2) R 6)	X141 X141 X141 X141 X141 X141	P24 P15 N15 N24 M RESET	O O O O O I	+20.4...28.8 V/50 mA +15 V/10 mA –15 V/10 mA –20.4...28.8 V/50 mA 0 V T.15/R_I = 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	I/R, UI, monitor-ing module
5.3 5.2 5.1 63 2) 9 2)8) 9 2)8) 64 2) 19	X121 X121 X121 X121 X121 X121 X121	Relay contact Group signal I^2t/motor temp. Pulse enable Enable voltage Enable voltage Drive enable Enable voltage reference potential	NC NO I I O O I	DC 50 V/0.5 A/12 VA max DC 5 V/3 mA min +13 V...30 V/R_E = 1.5 kΩ +24 V +24 V +13 V...30 V/R_E = 1.5 kΩ 0 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 1.5 mm^2 1.5 mm^2	I/R, UI, monitor-ing module

1) I = input; O = output; NC = NC contact; NO = NO contact; (for signal, NO = high; NC = low)
P = only for PELV voltage; S = only for SELV voltage
2) Terminal 19 is the reference ground (connected through 10 kΩ to the general ref. ground X131/T.15 inside the module)
Terminal 15 may not be connected to PE or to terminal 19, further, external voltage sources may not be connected to terminal 15. Terminal 19 can be connected to X131.
The terminal may only be exclusively used to enable the associated drive group.
3) I/R = infeed/regenerative feedback module; UI = unregulated infeed; monitoring module;
PR = pulsed resistor module
4) The 1st data apply with pin–type cable lug. The 2nd data apply for finely–stranded conductors without end sleeve.
5) The grounding bar is used to ground the DC link M busbar through 100 kΩ (must be inserted for non–TN line supplies and may not be used if RCCB protective devices are used;
the grounding bar must be removed if the system is subject to a high–voltage test).
6) RESET = resets the fault memory, edge–triggered for the complete drive group (terminal ”R” → Terminal 15 = RESET)
7) Terminals 111–213, positively–driven opening contacts (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
For I/R 16 kW (from version E) and UI 10 kW (from version F) the following apply:
Terminals 111–213, positively–driven opening contacts (series circuit of NC contact, main contactor and NC contact, pre–charging contactor)
Terminals 111–113, positively–driven NO contacts
8) Max. current load of terminal 9 with respect to terminal 19: 0.5 A.
9) Only for UI 28 kW
10) For UL certification only use copper cables dimensioned for an operating temperature ≥ 60°C
11) Max. permissible connected power: Pmax ≤ 43 kW; max. permissible current load:: Imax ≤ 72 A
12) When the AS1/AS2 contacts are connected in series a contact resistance of approx. 0.20 Ohm must be taken into consideration over the lifetime of the contacts. For a 24 V switching voltage, from experience, a series circuit of up to 5 contacts can be used without any problems due to the non–linear contact characteristics.

Table 6-8 Interface description for NE modules, continued

T. No.	Designa-tion	Function	Type 1)	Typ. voltage/limit values for V_n 400 V	Max. cross–section 10)	Terminals provided on 3)
74 nc 73.2 73.1 nc 72	X111 X111 X111 X111 X111 X111	Relay contact Signal Ready	NC I I NO	max. 1–ph. 250 V AC/ 30 V DC/2 A	1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2 1.5 mm^2	I/R, UI, monitor-ing module
9[2)8)] 112[2)]	X161 X161	Enable voltage Setting–up operation/ normal operation	O I	+24 V +21 V...30 V/R_E = 1.5 kΩ	1.5 mm^2 1.5 mm^2	I/R, UI, monitor-ing module
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 max. cable length, 30 m	I/R, UI
AS1[12)] AS2[12)]	X172 X172	Signaling contact Start inhibit (T.112)	I NC	max. 250 V AC/1 A/ 30V DC/2 A	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

1) I = input; O = output; NC = NC contact; NO = NO contact; (for signal, NO = high; NC = low)
P = only for PELV voltage; S = only for SELV voltage
2) Terminal 19 is the reference ground (connected through 10 kΩ to the general ref. ground X131/T.15 inside the module)
Terminal 15 may not be connected to PE or to terminal 19, further, external voltage sources may not be connected to terminal 15. Terminal 19 can be connected to X131.
The terminal may only be exclusively used to enable the associated drive group.
3) I/R = infeed/regenerative feedback module; UI = unregulated infeed; monitoring module;
PR = pulsed resistor module
4) The 1st data apply with pin–type cable lug. The 2nd data apply for finely–stranded conductors without end sleeve.
5) The grounding bar is used to ground the DC link M busbar through 100 kΩ (must be inserted for non–TN line supplies and may not be used if RCCB protective devices are used;
the grounding bar must be removed if the system is subject to a high–voltage test).
6) RESET = resets the fault memory, edge–triggered for the complete drive group (terminal "R" → Terminal 15 = RESET)
7) Terminals 111–213, positively–driven opening contacts (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
For I/R 16 kW (from version E) and UI 10 kW (from version F) the following apply:
Terminals 111–213, positively–driven opening contacts (series circuit of NC contact, main contactor and NC contact, pre–charging contactor)
Terminals 111–113, positively–driven NO contacts
8) Max. current load of terminal 9 with respect to terminal 19: 0.5 A.
9) Only for UI 28 kW
10) For UL certification only use copper cables dimensioned for an operating temperature ≥ 60° C
11) Max. permissible connected power: Pmax ≤ 43 kW; max. permissible current load:: Imax ≤ 72 A
12) When the AS1/AS2 contacts are connected in series a contact resistance of approx. 0.20 Ohm must be taken into consideration over the lifetime of the contacts. For a 24 V switching voltage, from experience, a series circuit of up to 5 contacts can be used without any problems due to the non–linear contact characteristics.

Warning

In order to avoid damage to the infeed circuit of the NE modules, when controlling/energizing terminal 50 at X221 (PW module, DC link fast discharge) it should be ensured that terminal 48 of the NE module is de–energized (the module is then electrically isolated from the line supply). The feedback signal contacts from the main contactor of the NE module (X161 term.111, term.113, term.213) must be evaluated.

6.5.2 Interface overview, 5 kW UI modules

Table 6-9 Interface overview, 5 kW UI modules

T. No.	Desig-nation	Function	Type 1)	Typ. voltage/limit values	Max. cross–section 6)
U1 V1 W1	X1	Line supply connection	I	3–ph. 400 V AC	4 mm^2 finely–stranded without conductor end sleeves 6 mm^2 with pin–type 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	Thread M5 Thread M4 34 pin 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 temperature	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	1–ph.250 V AC/50 V DC/2 A max 5 V DC/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 terminal 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 ground (connected through 10 kΩ to the general refer. ground X131 inside the module) Terminal 15 may not be connected to PE or with terminal 19, further, external voltage sources may not be connected to terminal 15. Terminal 19 can be connected to X131. The terminal may only be exclusively used to enable the associated drive group.
3) The grounding bar is used to ground the DC link M busbar through 100 kΩ (must be inserted; the grounding bar must be removed if the system is subject to a high–voltage test).
4) max. current load of terminal 9 – terminal 19 $\leq$ 1 A
Notice: For UI 5 kW, there are no terminals 7, 45, 44 and 10.
5) RESET = resets the fault memory, edge–triggered for the complete drive group (terminal ”R” → Term. 19 = RESET)
6) For UL certification: only use copper cables dimensioned for an operating temperature $\geq$ 60°C

Table 6-9 Interface overview, 5 kW UI modules, continued

T. No.	Desig- nation	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 ground (connected through 10 kΩ to the general refer. ground X131 inside the module) Terminal 15 may not be connected to PE or with terminal 19, further, external voltage sources may not be connected to terminal 15. Terminal 19 can be connected to X131. The terminal may only be exclusively used to enable the associated drive group.
3) The grounding bar is used to ground the DC link M busbar through 100 kΩ (must be inserted; the grounding bar must be removed if the system is subject to a high–voltage test).
4) max. current load of terminal 9 – terminal 19 $\leq$ 1 A
Notice: For UI 5 kW, there are no terminals 7, 45, 44 and 10.
5) RESET = resets the fault memory, edge–triggered for the complete drive group (terminal ”R” → Term. 19 = RESET)
6) For UL certification: only use copper cables dimensioned for an operating temperature ≥ 60°C

Notice: For UI kW, there are no terminals 7, 45, 44 and 10.

Note

For 5 kW UI, the DC link is pre–charged through <u>two</u> phases.
If no DC link voltage can be established although enable signals are present (the ready signal is missing), it must be checked to ensure that all three phases are connected to terminals U1, V1, W1.

6

6.6 Monitoring module

6.6.1 Integration into the overall system

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

A monitoring module is required if the power supply rating of the NE module is not sufficient for the drive group.[1)]

6.6.2 Technical data (supplement to the general technical data)

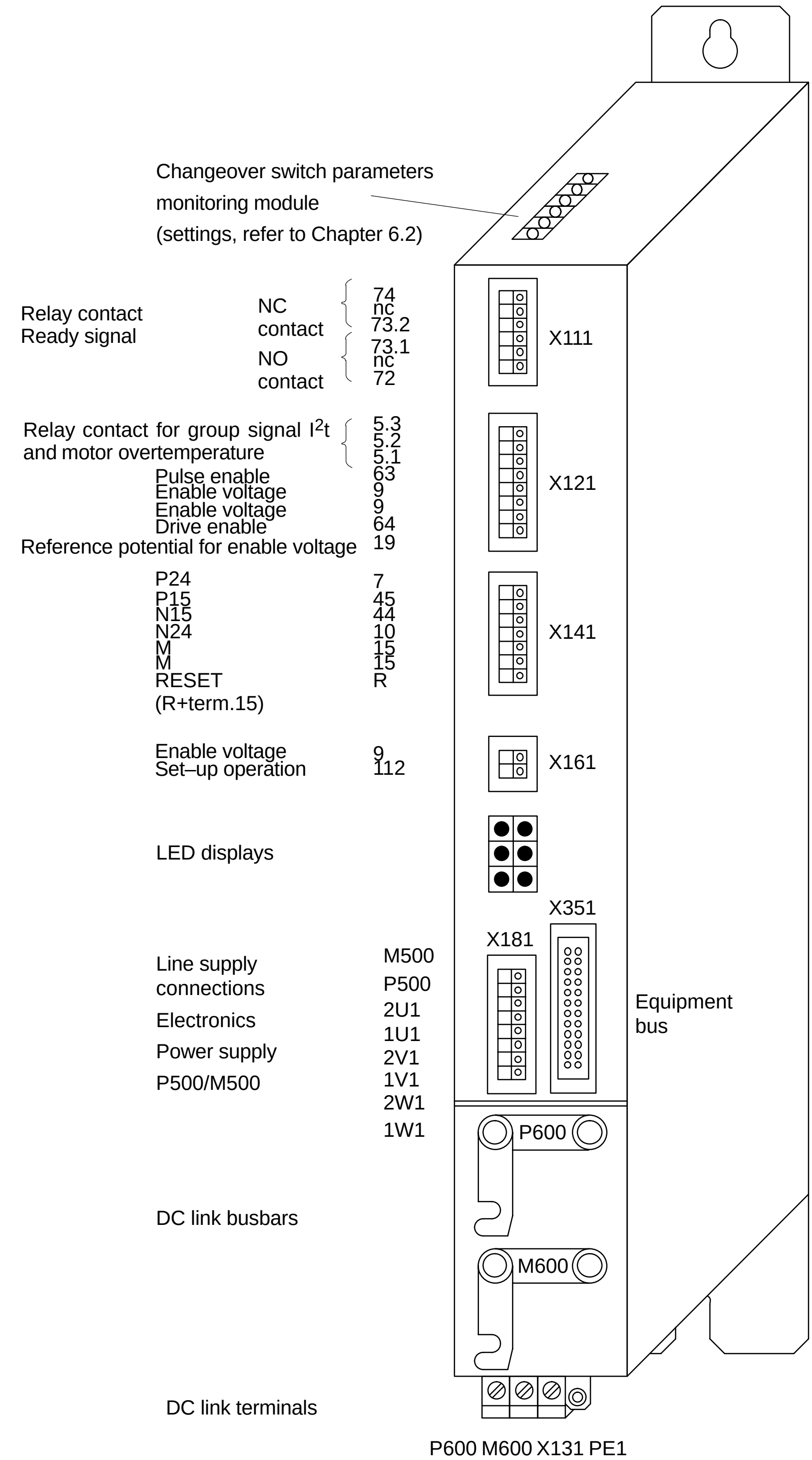
Table 6-10 Technical data, monitoring module

Power loss	70 W
Rated supply voltage	3–ph. 400 V – 10 % up to 480 V AC +6 %
Alternatively, rated supply voltage DC link	600/625/690 V DC
Current consumption	for 3–ph. 400 V AC: approx. 600 mA
Type of cooling	Natural cooling
Weight	approx. 5 kg
Assessment factor for the electronic points (EP)	max. 8
Assessment factor for the gating points (AP)	max. 17

Reader's note

For an overview of the interfaces, refer to Chapter 6.5.1, Table 6-8 in the column "Terminals used" under monitoring module.

1) Up to version "B", we recommend that at least two control units are connected to a monitoring module.



Note:
For a description of the interfaces, refer to Chapter 6.5.1; Table 6-8.

Fig. 6-10 Monitoring module 6SN1112–1AC01–0AA1

6

6.6.3 Mode of operation

Parameters critical for operation are monitored in the monitoring module – these include:

- 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 for the ”Unit ready” signal are available. The module group connected to the monitoring module is enabled as soon as the external enable signals have been issued via terminals 63 (pulse enable) and 64 (drive enable). The group signal controls the ”Ready” relay and can be taken, floating (with electrical isolation) via terminals 74/73.2 and 73.1/72. The load capability of the contacts is 250 V AC/1 A or 30 V DC/1 A.

LEDs on the front panel of the monitoring module indicate the signal states of the monitoring circuits.

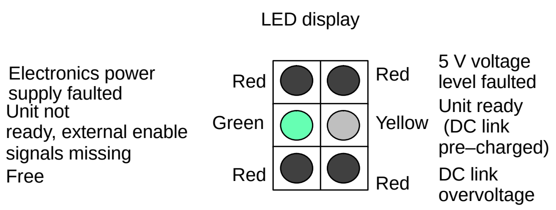


Fig. 6-11 LED display of the monitoring module

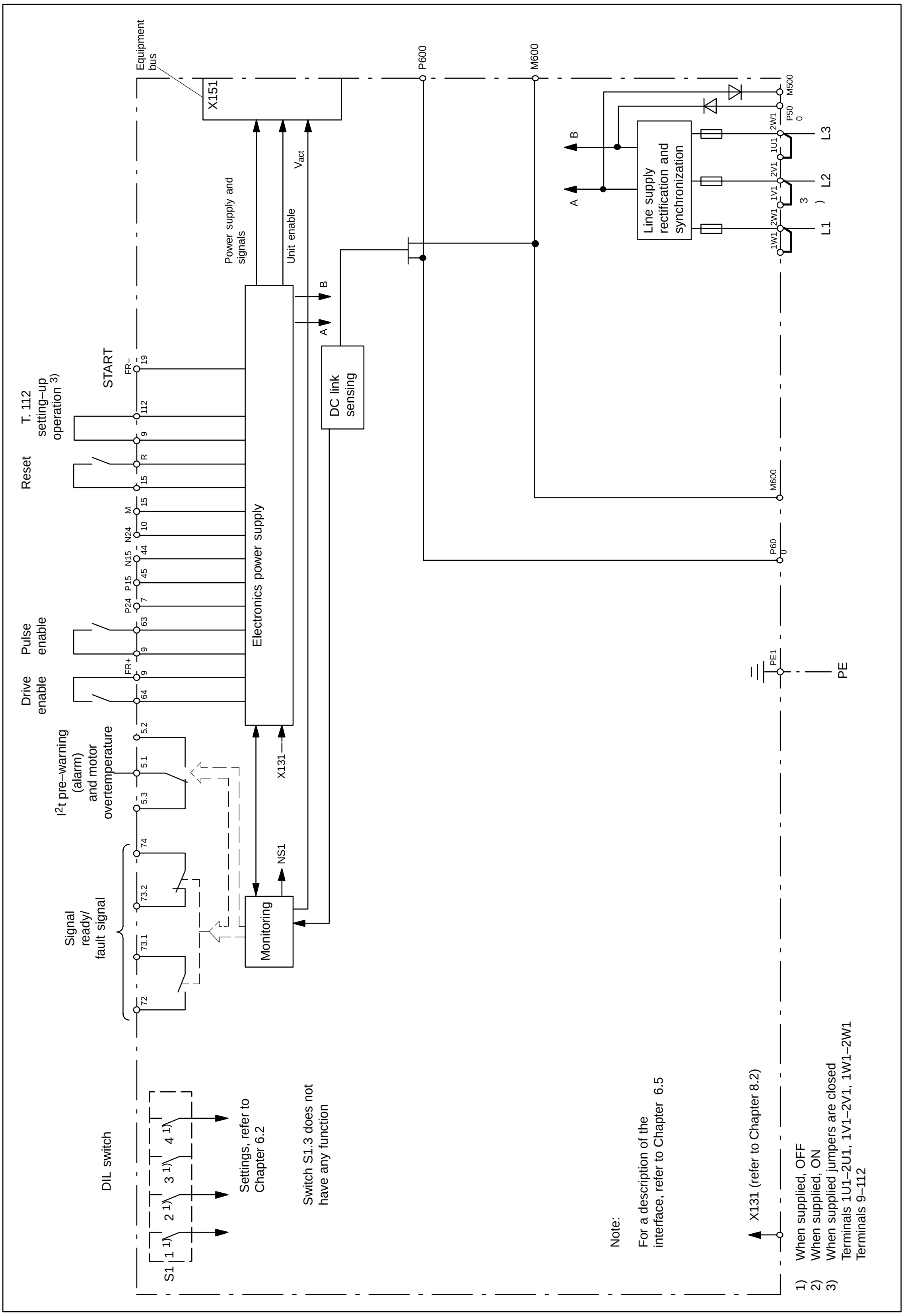


Fig. 6-12 Block diagram, monitoring module

6.7 DC link options

6.7.1 Capacitor module with 2.8 mF, 4.1 mF or 20 mF

Description

The capacitor modules are used to increase the DC link capacitance. This means that on one hand, a brief power failure can be buffered and on the other hand, it is also possible to store the braking energy.

A differentiation is made between the modules as follows:

- Modules with 2.8 mF and 4.1 mF —> are used as dynamic energy storage devices
- Module with 20 mF —> is used to buffer line supply dips

The modules are available in the following versions:

- Central modules: 4.1 mF and 20 mF
  - SIMODRIVE housing type – integrated into the system group.
- Distributed modules: 2.8 mF and 4.1 mF
  - New housing types are mounted decentrally in the control cabinet and are connected to the SIMODRIVE DC link via an adapter terminal and cable.

The capacitor modules have a ready display; this is lit from a DC link voltage of approximately 300 V and above. This also means that if an internal fuse ruptures, it can be identified. This does not guarantee safe and reliable monitoring of the charge state.

The module with 2.8 mF or 4.1 mF is implemented without pre–charging circuit and can – because it is directly connected to the DC link – absorb dynamic energy and therefore operate as dynamic energy storage device. For these modules, the charge limits of the line supply modules must be carefully taken into consideration.

For the 20 mF module, the pre–charging is realized through an internal pre–charging resistor; this is designed to limit the charge current and to de–couple the module from the central pre–charging function. This module cannot dynamically absorb any energy as the pre–charging resistor limits the charge current. When the power fails (line supply failure), a diode couples this capacitor battery to the system DC link so that it can be buffered by the capacitors.

Note

The capacitor modules may only be used in conjunction with the SIMODRIVE 611 line supply infeed units.

The central modules are suitable for internal and external cooling.

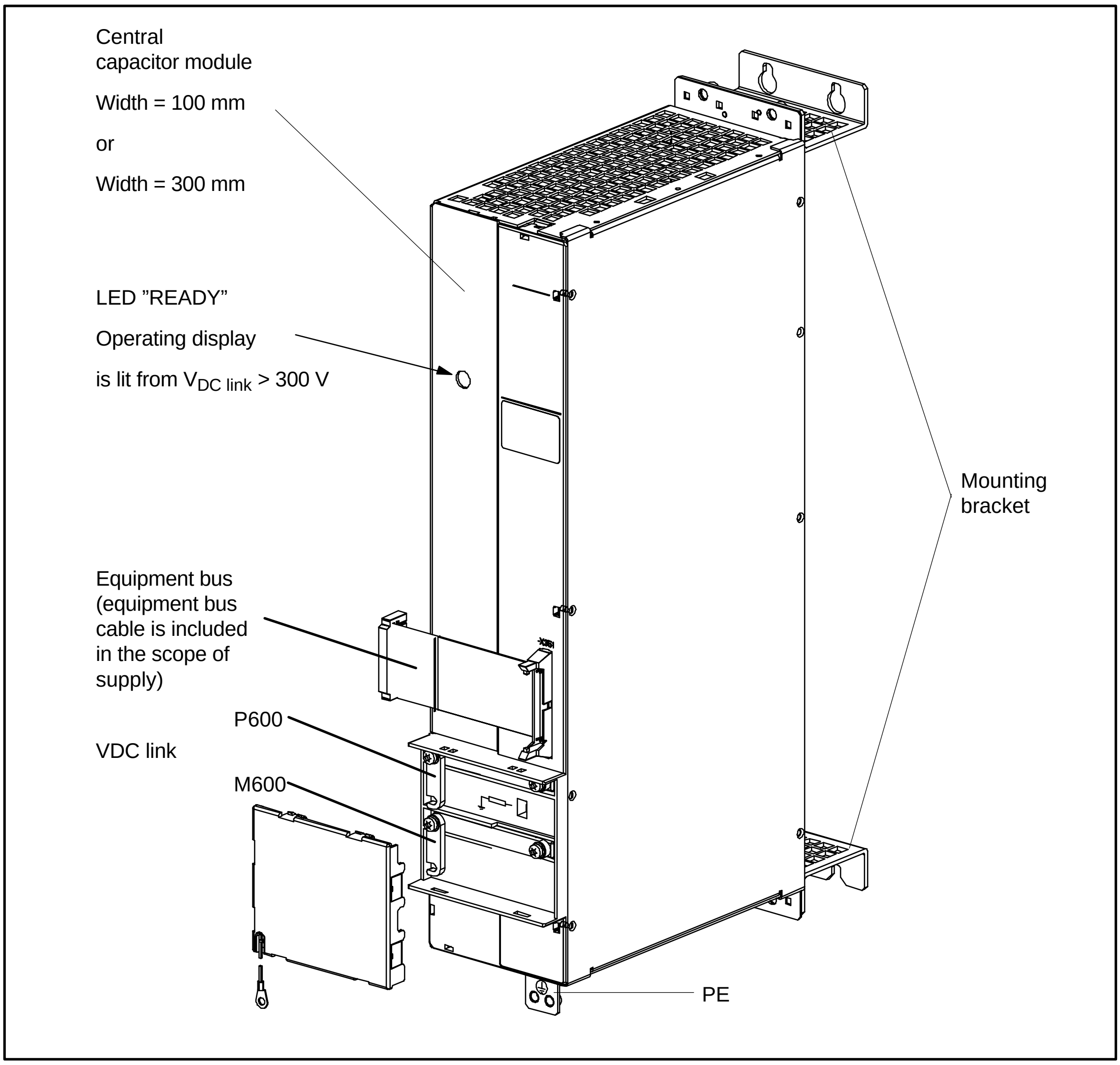


Fig. 6-13 Central capacitor module 4.1 mF

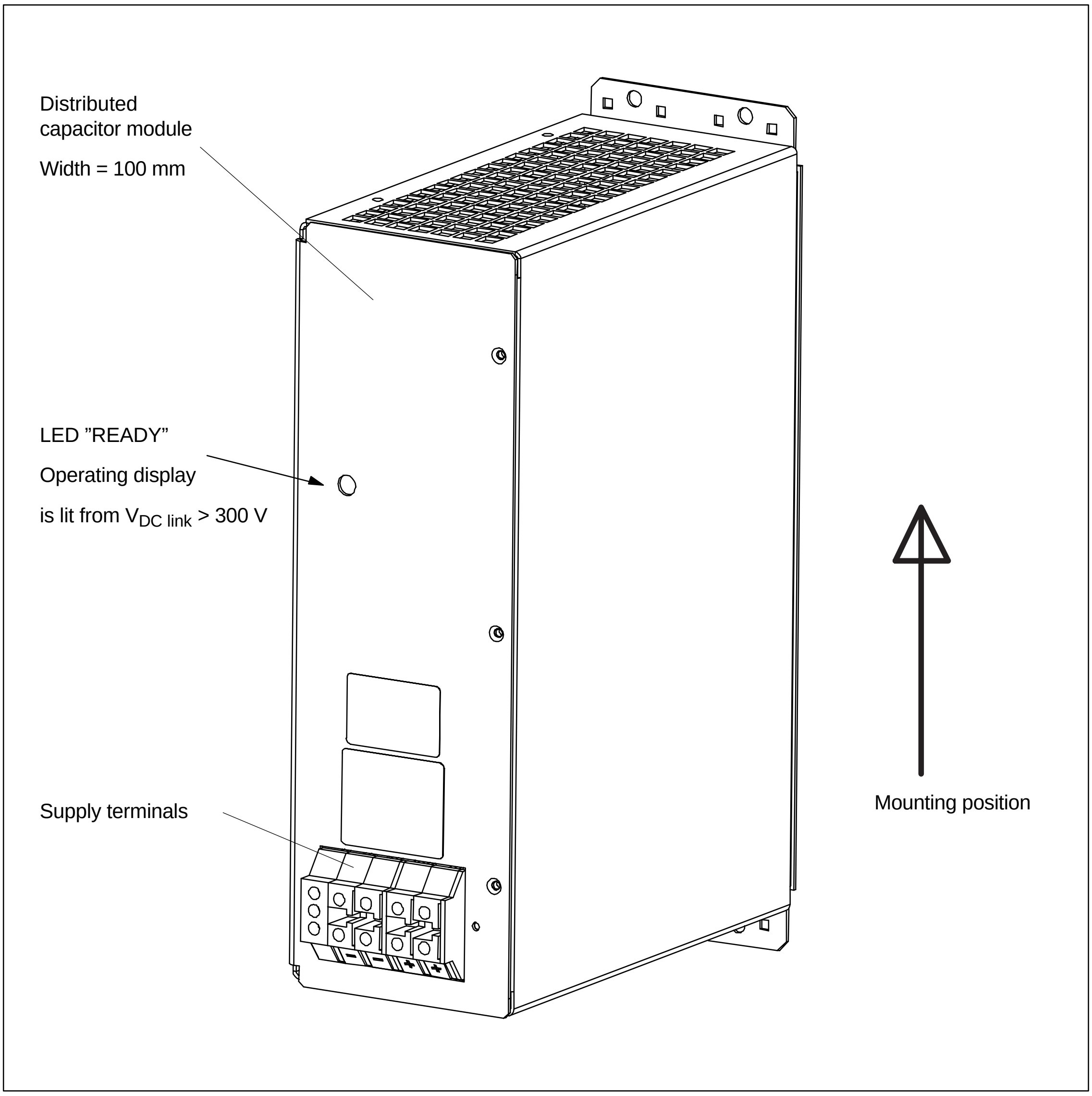


Fig. 6-14 Distributed capacitor module, 2.8 mF/4.1 mF

Technical data

The following technical data apply:

Table 6-11 Technical data of the central capacitor modules

Designation	Central modules	
	4.1 mF	**20 mF**
Order number	6SN11 12–1AB00–0BA0	6SN11 12–1AB00–0BA0
Voltage range	V_{DC} 350 ... 750 V	
Storage capacity w = 1/2 x C x V^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: As a result of the internal pre–charging resistor, the voltage at the capacitors is only approx. 0.94 x V_{DC}.
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]

Table 6-12 Technical data of the distributed capacitor modules

Designation	Distributed modules	
	2.8 mF	**4.1 mF**
Order number	6SN11 12–1AB00–1AA0	6SN11 12–1AB00–1BA0
Voltage range	V_{DC} 350 ... 750 V	
Storage capacity w = 1/2 x C x V^2	$V_{DC\ steady–state}$ (examples) 600 V —> 504 Ws 680 V —> 647 Ws	$V_{DC\ steady–state}$ (examples) 600 V —> 738 Ws 680 V —> 948 Ws
Temperature range	0 °C to +55 °C	
Weight	5.3 kg	5.8 kg
Dimensions	W x H x D 100 x 334 x 231 [mm]	W x H x D 100 x 334 x 231 [mm]
Connection	AWG12 ... AWG 6 (4 ... 16 mm^2) finely stranded	
Degree of protection	IP 20	

Examples for the calculation

The storage capacity in dynamic operation and for regenerative braking is calculated as follows:

Formula: $w = ½ \times C \times (V^2_{DC\ link\ max} – V^2_{DClinkn})$

Assumptions for the example:

Capacitance of the capacitor battery C = 4.1 mF

Rated DC link voltage $V_{DClinkn}$ = 600 V

Maximum DC link voltage $V_{DClinkmax}$ = 695 V

—> $w = ½ \times 4.1 \times 10^{–3}\ F \times ((695\ V)^2 – (600\ V)^2) = 252\ Ws$

The following applies for the storage capacity of the capacitor battery when the power fails:

Formula: $w = ½ \times C \times (V^2_{DClinkn} – V^2_{DClinkmin})$

Assumptions for the example:

Capacitance of the capacitor battery	C = 20 mF
Rated DC link voltage	$V_{DClinkn}$ = 600 V
Minimum DC link voltage	$V_{DClinkmin}$ = 350 V

—> $w = ½ \times 20 \times 10^{–3}\ F \times ((600\ V)^2 – (350\ V)^2) = 2375\ Ws$

For a DC link voltage of 680 V, the storage capacity increases up to 3399 Ws.

Notice

$V_{DClinkmin}$ must be ≧ 350 V.

For voltages below 350 V, the switched–mode power supply for the electronics shuts down.

The 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 should be considered as battery. The capacitance and the storage capacity are increased as a result of the capacitor module.

In order to evaluate the required capacitance for a specific requirement in a certain application, the energy flow must be determined.

The energy flow depends on the following:

- All moved masses and moments of inertia
- Velocity, speed (and their change, acceleration, deceleration)
- Efficiencies: Mechanical system, gear units, motors, inverters (driving/braking)
- Back–up duration, buffering
- DC link voltage and the permissible change, output value, upper/lower limit value.

In practice, often there is no precise data about the mechanical system. If the mechanical system data is determined using rough calculations or estimated values, then the capacitance of the DC link capacitors required can only be determined during tests carried–out during the commissioning phase.

The energy for dynamic operations is obtained as follows:

The following applies for braking or accelerating operations within time t_V of a drive from one speed/velocity to another:

$$w = ½ \times P \times t_V$$

For rotary 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	$\eta_G = \eta_M \times \eta_{INV}$
Accelerating	$\eta_G = 1/(\eta_M \times \eta_{INV})$

w [Ws]	Energy
P [kW]	Motor power
t_V [s]	Time of the operation
M_{mot} [Nm]	Max. motor torque when braking or accelerating
F_{mot} [N]	Max. motor force when braking or accelerating
$n_{mot\,max}$ [RPM]	Max. speed at the start or the end of the operation
$n_{mot\,min}$ [RPM]	Min. 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	Total efficiency
η_M	Motor efficiency
η_{INV}	Inverter efficiency

Torque M and force F depend on the moved masses, the load, and the acceleration in the system.

If precise data is not available for the previously specified factors, then generally rated/nominal data is used instead.

Engineering information

The central capacitor module should preferably be located at the end of the system group. The connection is made using the DC link busbar.

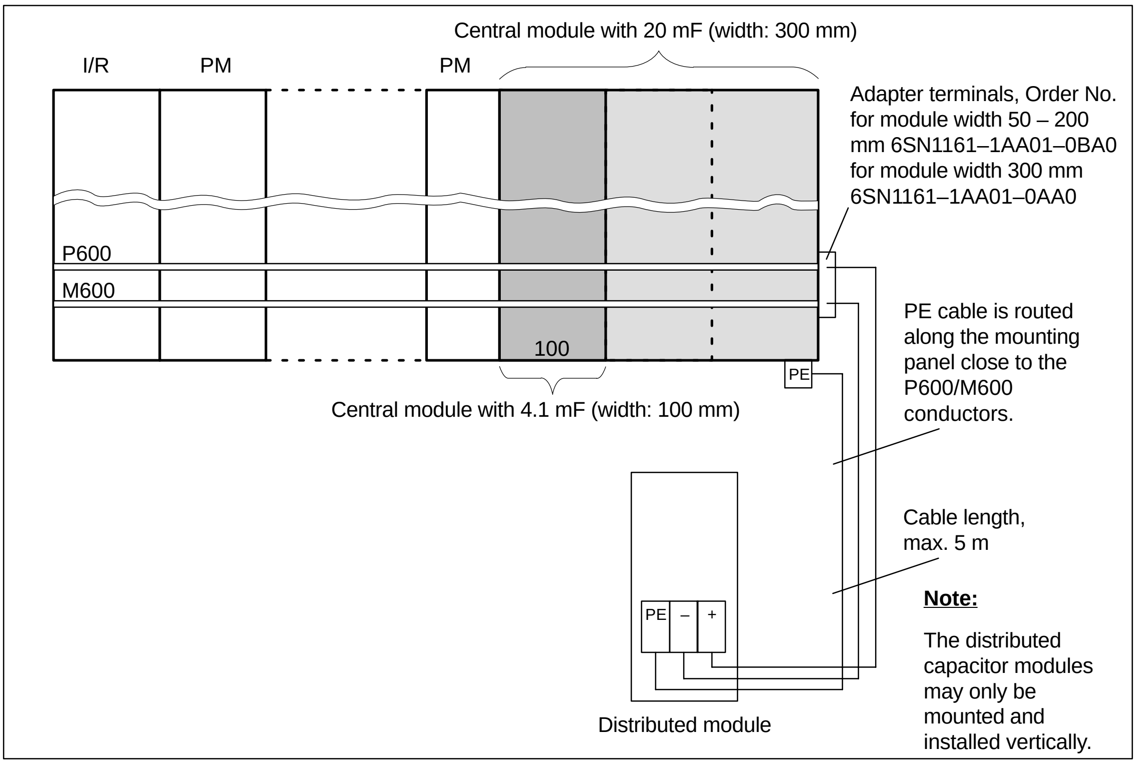


Fig. 6-15 Mounting location for the capacitor modules

Depending on the line infeed used, several capacitor modules can be connected in parallel.

For the capacitor modules with 2.8 mF and 4.1 mF, the charge limit of the line infeed may not be exceeded as total (refer to Chapter 1.3).

Capacitor modules that can be connected

The capacitor modules 2.8 mF and 4.1 mF (central/distributed) must be dimensioned/selected corresponding to the engineering table 1-7 in Chapter 1.3.6 taking into account the charge limits of the infeed.

The 20 mF capacitor modules do not have to be taken into account in the 1-7 engineering table. They must be selected as required taking into account the maximum number from Table 6-13.

Table 6-13 Maximum number of 20 mF capacitor modules

Infeed unit	Maximum that can be connected1)
UI 5 kW	1
UI 10 kW I/R 16 kW	3
UI 28 kW I/R 36 kW...120 kW	5

1) Valid if all of the monitoring modules used are connected to the line supply.

Charge times
Discharge times
Discharge voltage

Before carrying–out any commissioning or service work it is absolutely necessary to ensure that the DC link is in a no–voltage condition.

Table 6-14 Charge/discharge times, discharge voltage

Capacitor module	Charging time depends on the total DC link capacitance	Discharge time depending on the total DC link capacitance to 60 V of the DC link voltage at 750 V DC
2.8 mF/4.1 mF	As for the power modules	approx. 30 min
20 mF	approx. 2 min	approx. 40 min

If there is a pulsed resistor in the system, in order to reduce the discharge time after opening terminal 48, the DC link can be quickly discharged via terminals X221:19 and 50 (jumpers). In this case, the electronics power supply must be implemented using a 3–phase line supply connection; this is not disconnected while discharging.

6

Note

Discharge through a pulsed resistor is not possible for UI 5kW!

Warning

The pulsed resistor modules can only convert a certain amount of energy into heat (refer to Table 6-15). The energy available to be converted depends on the voltage.

A monitoring function protects the resistance against overload. If this responds, then no additional energy is converted into heat in the resistor.

Caution

In order to avoid damage to the infeed circuit of the NE modules, when controlling/energizing terminal X221 T.19/50, it should be ensured that terminal 48 of the NE module is de–energized (the module is electrically isolated from the line supply).

The feedback signal contacts of the main contactor of the NE module must be evaluated to check whether the contactor has actually dropped–out (X161 terminal 111, terminal 113 and terminal 213).

6.7.2 Overvoltage limiter module

The overvoltage limiter module limits overvoltages at the line supply input to acceptable values. These overvoltages can occur, e.g. due to switching operations at inductive loads and line supply matching transformers.

The overvoltage limiter module is used for upstream transformers or for line supplies that do not meet ICE requirements (instable line supplies).

Reader's note

Also refer to additional information in Chapter 2.7.4.

6.7.3 Braking power

Using external braking resistors, heat loss can be dissipated outside the cabinet.

The UI and pulsed–resistor modules are equipped with a switch–on time monitoring; this protects the pulsed resistor from overheating.

Table 6-15 Braking power of the UI and pulsed resistor modules (PR)

Technical data				
	External PR 0.3/25 kW	External PR Plus 1.5/25 kW	Internal PR 0.3/25 kW	Internal PW 0.2/10 kW
Order No.	6SN1113–1AA00–0DA0	6SL3100–1BE22–5AA0	–	–
integrated in	–	–	UI 10 kW, PR module	UI 5 kW
Can be used for	UI module 28 kW	PR module 6SN1113–1AB0□–0BA□ • Attenuation: 0...230 kHz $\leq$ 3 dB • Should be used together with HFD commutating reactor for attenuation (damping)	–	–
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	IP 20	Refer to the module	Refer to the module
Existing, shielded connecting cable	3 m	5 m	–	–
Dimension drawings, refer to Chapter 11				

6.7.4 Pulsed resistor module

The pulsed resistor module (PW module) is used to dissipate excess energy in the DC link. Energy, for example, that is generated for UI modules when braking or for I/R modules when the power fails when stopping. The possible braking power of the total system can be increased by using one or several pulsed resistor modules connected in series.

If the monitoring module is supplied using a 3–phase line supply, then the DC link can be quickly discharged through the pulsed resistor module. The energy is converted into heat in a controlled fashion in the resistor.

Fast discharge is not possible if the electronics power supply is exclusively implemented through the DC link (P500/N500).

If heat–sensitive components are located above the PR module with a clearance < 500 mm – e.g. cable ducts – then an air baffle plate must be provided (Order No. 6SN1162–0BA01–0AA0).

As a result of the universal housing design of the pulsed resistor module, this can be used both for internally as well as externally cooled module groups.

Notice

Fast discharge is only possible when there is a 3–phase AC line supply that is also used to feed the power supply!

If the power supply is realized via the DC link (P500 /M500), then the DC link voltage is only discharged down to approx. 380 V DC. The control is then removed along with the power supply!

Table 6-16 Technical data

Rated supply voltage	600/625/680 V DC
Continuous power/peak power/energy for a single braking operation	• with internal pulsed resistor P = 0.3/25 kW; E = 7.5 kWs • with an external pulsed module P = 1.5/25 kW; E = 13.5 kWs
Weight	approx. 5 kg
Module width	50 mm
Order number	6SN11 13–1AB01–0AA1

Engineering information is applicable for UI 5 kW, 10 kW, 28 kW and PR module

Dimensioning the load duty cycles with pulsed resistors

Des.	Units	Description
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 power rating of the pulsed resistor
P_{max}	W	Peak power of the pulsed resistor
E_{max}	Ws	Energy of the pulsed resistor for a single braking operation

Load duty cycles for braking operations

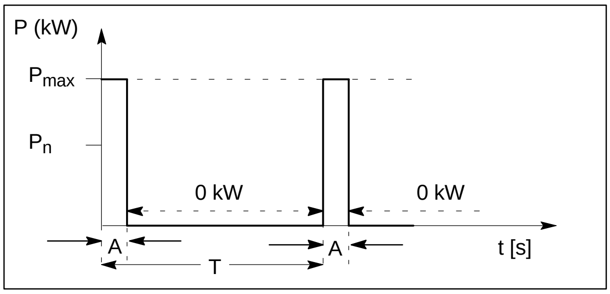


Fig. 6-16 Load duty cycle for internal and external pulsed resistors

Table 6-17 Examples

	Values	PR 0.2/10 kW	PR 0.3/25 kW	PR 1.5/25 kW
	E_{max} Pn P_{max}	13500 Ws [1)] 200 W 10000 W	7500 Ws 300 W 25000 W	180000Ws 1500 W 25000 W
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

1) As a result of the mechanical dimensions, the resistor can absorb a relatively high level of energy.

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. $P_n \geq E/T$

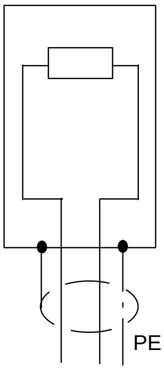
Note

An external resistor cannot be connected to UI 5 kW and UE 10 kW.

Mounting positions

The resistor can be mounted either horizontally or vertically.

Connection for an external PR 0.3/25 kW
Order No.: 6SN1113-1AA00-0DA0

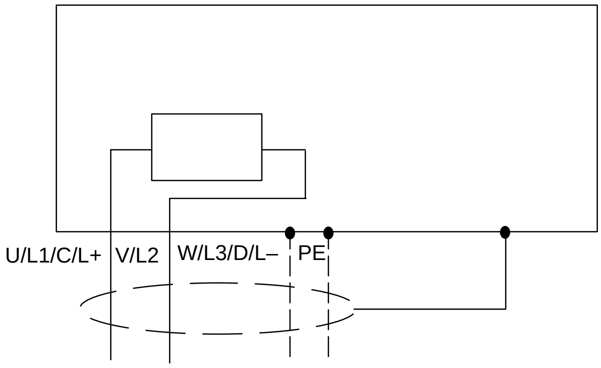


red, blue, PE (green yellow), each 1.5 mm²

Shielded 3 m connecting cable, can be extended up to max. 10 m

Fig. 6-17 Connection for external pulsed resistor 0.3/25 kW

Connection for external PR for braking power ratings up to 1.5/25 kW
Order No.: 6SL3 100-1BE22-5CA0



The shield is connected through a PG gland
Shielded connecting cable (braided shield), cross–section 2.5 – 4 mm² Max. length, 10 m

Fig. 6-18 Connection for external PR for braking power ratings up to 1.5/25 kW

Note

Conductors that are not used in multi–conductor cables must always be connected to PE at both ends.

Connection types, pulsed resistor modules

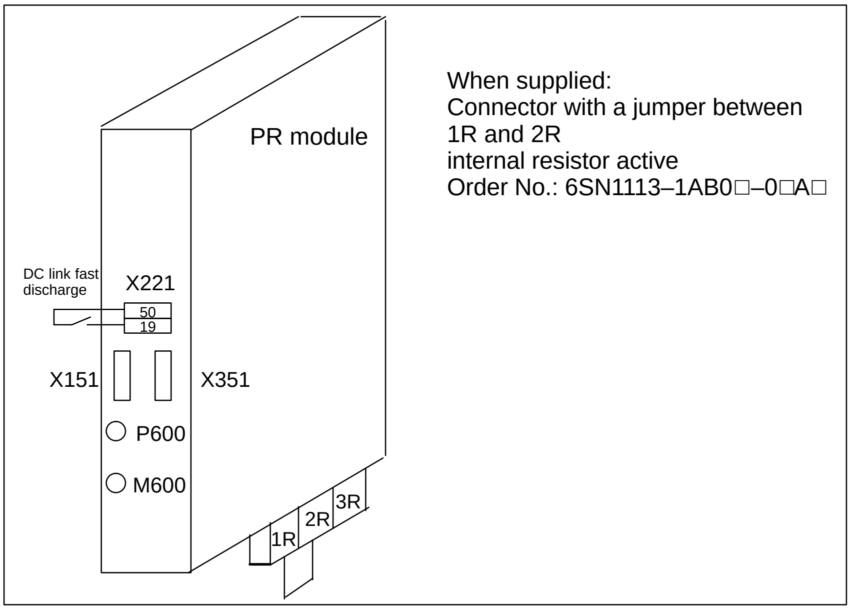


Fig. 6-19 Status when the pulsed resistor module is shipped

Note

For the pulsed resistor module, only the external PR 6SL3 100–1BE22–5AA0 can be connected.

Table 6-18 Interface description for PW modules

Term. No.	Designation	Function	Type 1)	Typ. voltage/ limit values for V_n 400 V	Max. cross–section
PE P600 M600		Protective conductor DC link DC link	I I/O I/O	0 V +300 V –300 V	Screw Busbar Busbar
	X151/X351	Equipment bus	I/O	Various	Ribbon cable
1R, 2R, 3R	TR1, TR2	Connection, external resistor	I/O	300 V	6 mm^2/4 mm^2 2)
19 50	X221 X221	Enable voltage Reference potential Control contact for fast discharge	O,P I	0 V 0 V	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)
P = only for PELV voltage; S = only for SELV voltage

2) The 1st data apply with pin–type cable lug.
The 2nd data apply for finely–stranded conductors without end sleeve.

The following connection combinations are possible:

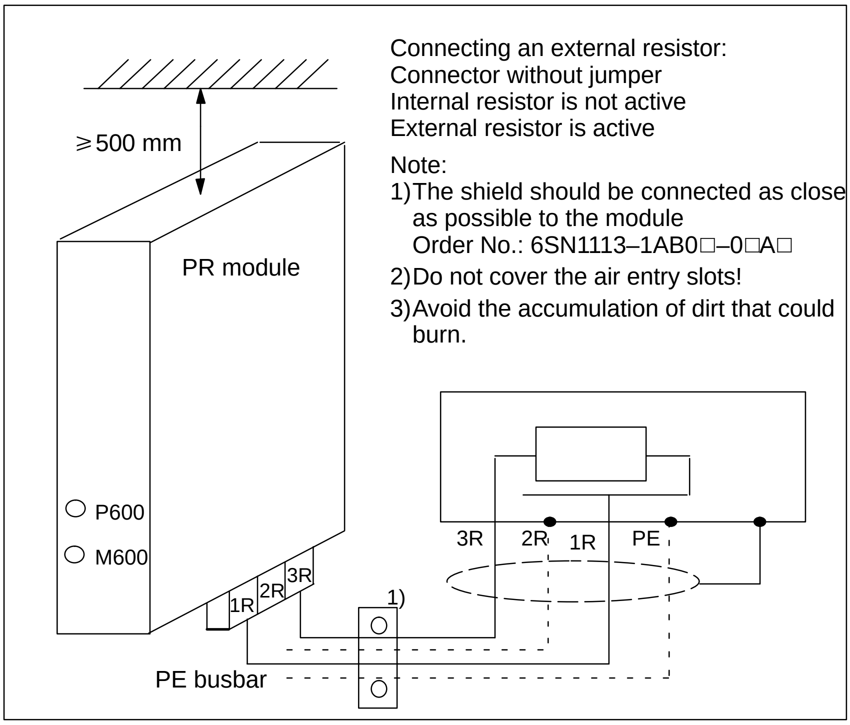


Fig. 6-20 Connecting an external pulsed resistor

Number of PW modules connected to the same DC link, refer to Catalog NC60

$N \leq C / 500\ \mu F$

N = max. number of pulsed resistor modules

C = DC link capacitance of the drive group in µF

Note

For a module group with one UI module, one pulsed resistor module and one monitoring module, the pulsed resistor module should be connected to the equipment (device) bus of the UI module. Only then is it guaranteed that the pulsed resistor in the UI module and the pulsed resistor in the pulsed resistor module are simultaneously controlled.

UI 28 kW module

The UI 28 kW module requires external pulsed resistors. Up two identical resistors – with the same power rating – may be connected.

Connecting external pulsed resistors to the 28 kW module

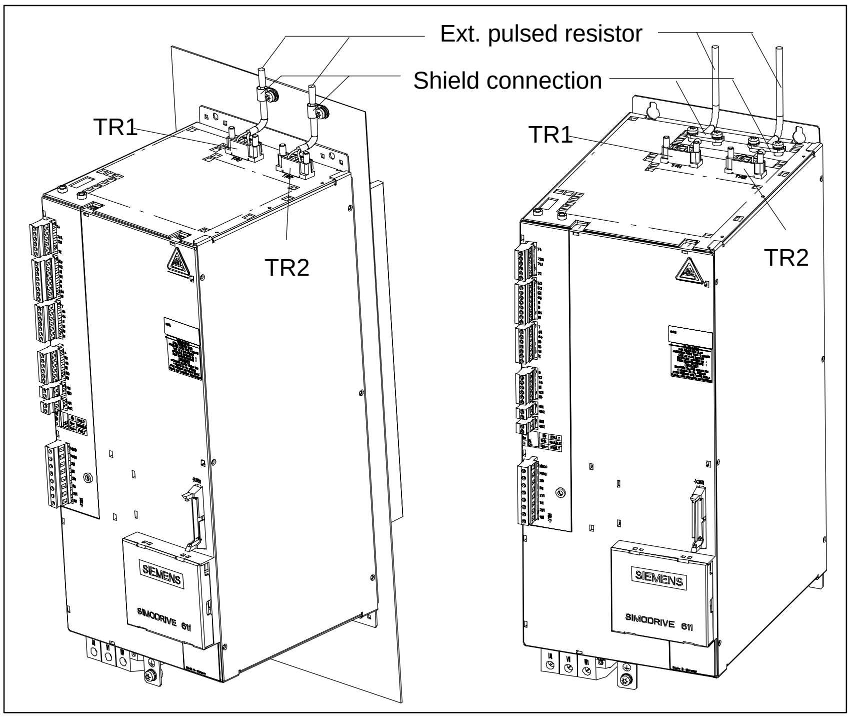


Fig. 6-21 Connecting the external pulsed resistor with shield connection

Table 6-19 Permissible ways of connecting external pulsed resistors to UI 28 kW

PR	Terminal block TR1	Terminal block TR2
0.3/25 kW	1R 2R 3R 1) PR 0.3 kW	1R 2R 3R
2 x 0.3/25 kW=0.6/50 kW	1R 2R 3R 1) PR 0.3 kW	1R 2R 3R 1) PR 0.3 kW
1.5/25 kW	1R 2R 3R PR 1.5 kW/25	1R 2R 3R
2 x 1.5/25 kW=3/50 kW	1R 2R 3R PR 1.5 kW	1R 2R 3R PR 1.5 kW

1) Jumper for coding the thermal limit characteristic.

6.7.5 Pulsed resistor, external

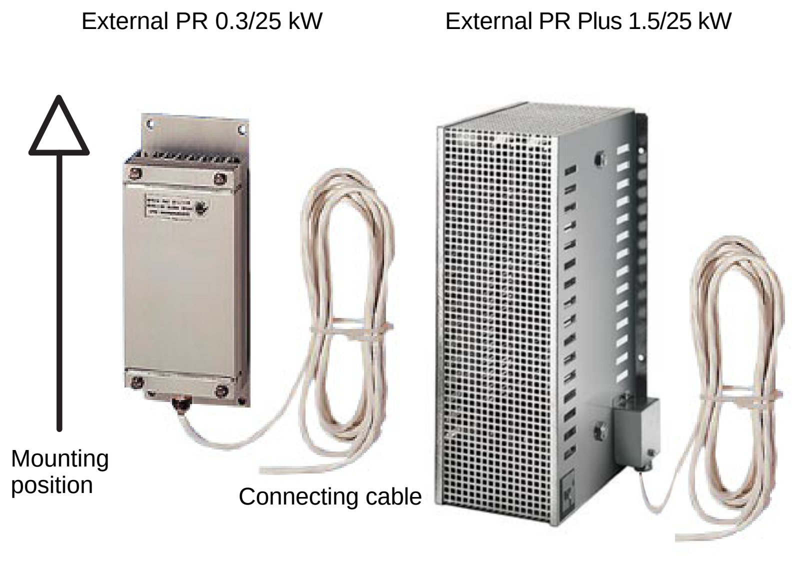
The external pulsed resistors are used to conduct the generated heat out of the control cabinet.

The external pulsed resistors are generally required for the 28kW UI module.

Depending on the power requirement, up to two equal pulsed resistors can be connected in the case of the 28kW UI module. The protection function is parameterized via the connecting terminals.

Table 6-20 Technical data

Data	External pulsed resistor	
	0.3/25 kW (15 Ω)	**Plus 1.5/25 kW (15 Ω)**
Order number	6SN1113–1AA00–0DA0 (only for 28 kW UI module)	6SL3100–1BE22–5AA0
Degree of protection acc. to DIN EN 60529 (IEC 60529)	IP 54	IP20
Weight [kg]	3.4	5.6
Type of cooling	Natural cooling	Natural cooling
Dimensions (W x H x D) [mm]	80 x 210 x 53	193 x 410 x 240
including the connecting cable [m]	3	5



Note:
Carefully note the mounting position, base mounting is possible.
When mounting the pulsed resistor it must be carefully ensured that it is not located in the cooling airflow of the drive group and there is sufficient clearance to the cable ducts.

Fig. 6-22 Pulsed resistor, external

■

Space for your notes

Line Supply Connection 7

7.1 Line supply conditions for line supply infeed modules

Supply voltage and frequency

Technical data, refer to Chapter 6.4.

Compatibility/ noise immunity

SIMODRIVE infeed units are designed to be connected to line supplies with compatibility level, Class 3 of electromagnetic environments in industrial plants and systems according to IEC/DIN EN61000–2–4:2002.

When the EMC mounting/installation guidelines are complied with, noise immunity values according to IEC/DIN EN61000–6–2 Electromagnetic Compatibility (EMC) – Generic Standard, Noise Immunity/emission – Part 2: Industrial environments (1999) are complied with.

Compatibility with fault current protective devices

SIMODRIVE units with I/R module 16 kW and I/R module 36 kW may be directly connected to TN line supplies with delayed tripping, selective universal current sensitive RCCBs under the following limitations.

1. It is only permissible to use a delayed–tripping (selective) AC/DC–sensitive RCCB.
2. It is not possible to connect RCCBs in series in order to implement selective tripping.
3. The maximum permissible ground resistance of the RCCB must be maintained (83 Ohm maximum for RCCBs with a nominal differential current of 0.3 A).
4. The total length of all of the shielded power cables used in the drive group (motor feeder cables including line supply feeder cables from line filters to NE connection terminals) must be less than 350 m.
5. Only the line filters intended for the purpose may be used for operation of the equipment.
6. Notice: AC or pulse–current sensitive RCCBs – that are today widely established – are definitely not suitable!

Harmonics fed back into the line supply/noise emission

When the requirements regarding system fault level are observed and when using the appropriate line supply filters, the harmonics fed back into the line supply lie below the compatibility level of Class 3 of the electromagnetic environment of industrial plants and systems according to EN61000–2–4:2002.

When the recommended SIEMENS line filter is used and the EMC mounting/installation regulations are complied with, the noise emission limits according to EN50081–2 Electromagnetic Compatibility (EMC) – Generic Standard, Noise Immunity/emission – Part 2: Industrial environments (1993) are complied with.

Notice

If line filters are used that SIEMENS has not certified for use with SIMODRIVE 6SN11xx, this can result in harmonics being fed back into the line supply. These harmonics can damage/disturb other equipment connected to this line supply.

It is not permissible to connect other loads after the line filter.

System fault level

Table 7-1 System fault level

<table>
<tr><th colspan="2">Designation</th><th colspan="2">Description</th></tr>
<tr><td>UI modules and I/R modules in non–regulated operation</td><td colspan="3">Operation on line supplies from $S_{Kline}/Pn_{UI} \geqq 30$
UL requirement regarding the maximum line short–circuit current when connected to 480 V AC:
• Infeed power, 1.1 up to 37.3 kW, max. short–circuit current = 5 kA
• Infeed power, 39 up to 149 kW, max. short–circuit current = 10 kA</td></tr>
<tr><td rowspan="4">I/R modules</td><td colspan="3">Valid for I/R modules with Order No.: 6SN114□–1□□0□–0□□1 in regulated operation</td></tr>
<tr><td>P_n I/R module</td><td>Sinusoidal current operation (S1.6 = ON)</td><td>Squarewave current operation (S1.6 = OFF)</td></tr>
<tr><td>16 KW, 36 kW, 55 kW</td><td>$S_{Kline}/P_n \geq 70$</td><td>$S_{Kline}/P_n \geq 100$</td></tr>
<tr><td>80 KW, 120 kW</td><td>$S_{Kline}/P_n \geq 60$</td><td>$S_{Kline}/P_n \geq 80$</td></tr>
<tr><td colspan="4">S_{Kline}: System fault level at the location where the SIMODRIVE infeed module is connected
Pn: Rated power of the SIMODRIVE line supply infeed module</td></tr>
</table>

Notice

If the system fault level is too low, this can result in faults/disturbances at the SIMODRIVE drive converter. It can also result in faults and damage to other equipment and devices that are connected at the same point of the line supply as the drive converter.

7.2 Voltage matching

7.2.1 General information

A distinction is made between:

- Line connection components are directly connected to the line supply
- Line connection components are directly connected to an autotransformer
- Line connection components to be directly connected to an isolating transformer

The SIMODRIVE 611 converter system is designed to be directly connected to TN line supplies with rated voltages of 400 V 3–phase AC, 415 V 3–phase AC, and 480 V 3–phase AC. Matching, isolating transformers, tailor–made for the system are available to adapt
the system for use with other line supply types, such as for operation on IT or TT line supplies.

7

Note

If isolating transformers are used upstream (in front of) I/R and UI modules, an overvoltage limiter module, Order No.: 6SN1111–0AB00–0AA0 must be used, refer to Chapter 6.7.2.

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

7.2.2 Line supply types

The air and creepage distances in the SIMODRIVE 611 drive converter system have been dimensioned for rated voltages up to 520 V AC, 300 V phase —grounded neutral point.

This voltage may never be exceeded as otherwise the converter insulation system would be damaged and would result in inadmissibly high touch voltages.

Caution

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

The SIMODRIVE 611 drive converter system is insulated in compliance with DIN EN 50178. This means that the insulation system is designed for direct connection to a TN line supply with grounded neutral point. For all other line supply types, an isolating transformer with neutral point on the secondary side must be used upstream (in front of) the units. This transformer is used to de–couple the line supply circuit (overvoltage Category III) from a non line–supply circuit (overvoltage Category II), refer to IEC 60644–1.

Note

UL requirement regarding a maximum line short–circuit current at 480 V AC:

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

Connection types

The infeed can be directly connected to a TN line supply for 3–ph. 400 V AC, 3–ph. 415 V AC, 3–ph. 480 V AC[1)]
For other voltage levels, the infeed can be connected through an autotransformer.

Example:
TN–C line supply

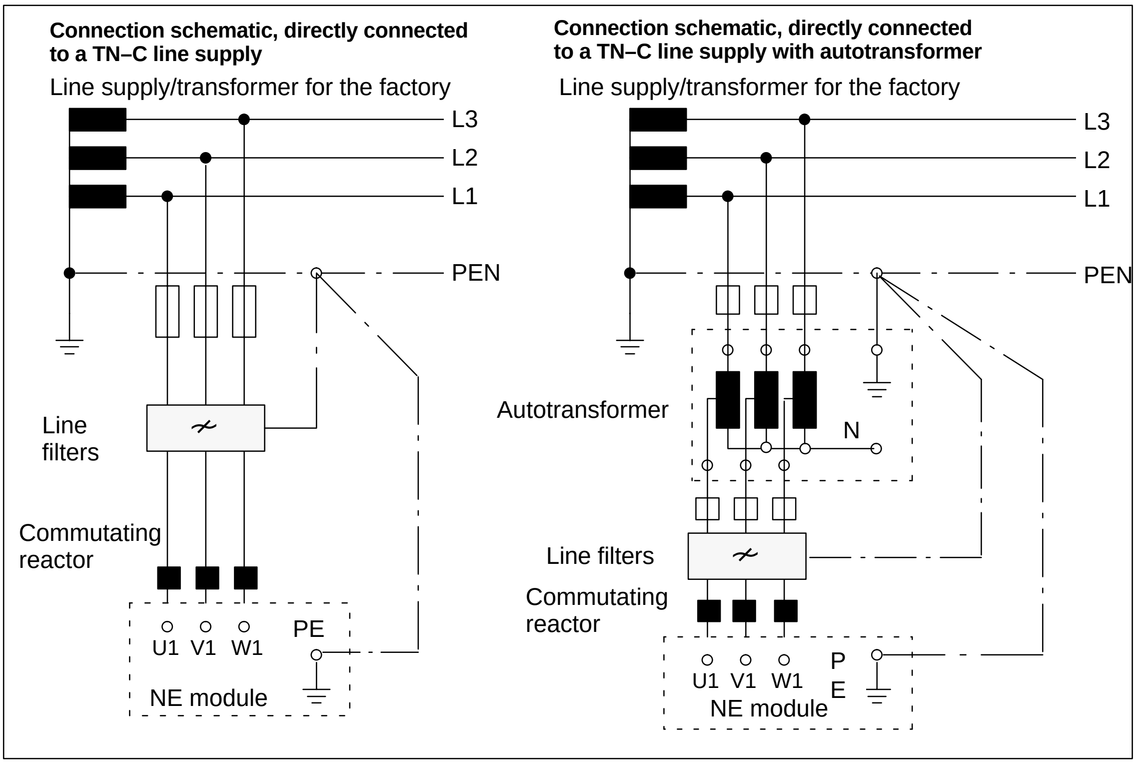


Fig. 7-1 Connection schematic, TN–C line supplies

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 conductor connector connected at the neutral point which, depending on the line supply type, uses one or several conductors.

For other line supply types [2)] the NE module must be connected through an isolating transformer.

1) 480 V direct connection 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 Chapter 6.2
For motors with shaft height < 100: Utilization, max. up to the 60 K temperature values according to Catalog NC 60
Please observe the information and data in the Configuration Manual, Motors.

2) Harmonized transformer types are described in Catalog NC 60.

TT line supply

Symmetrical 3–conductor or 4–conductor three–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 points of the line supply.

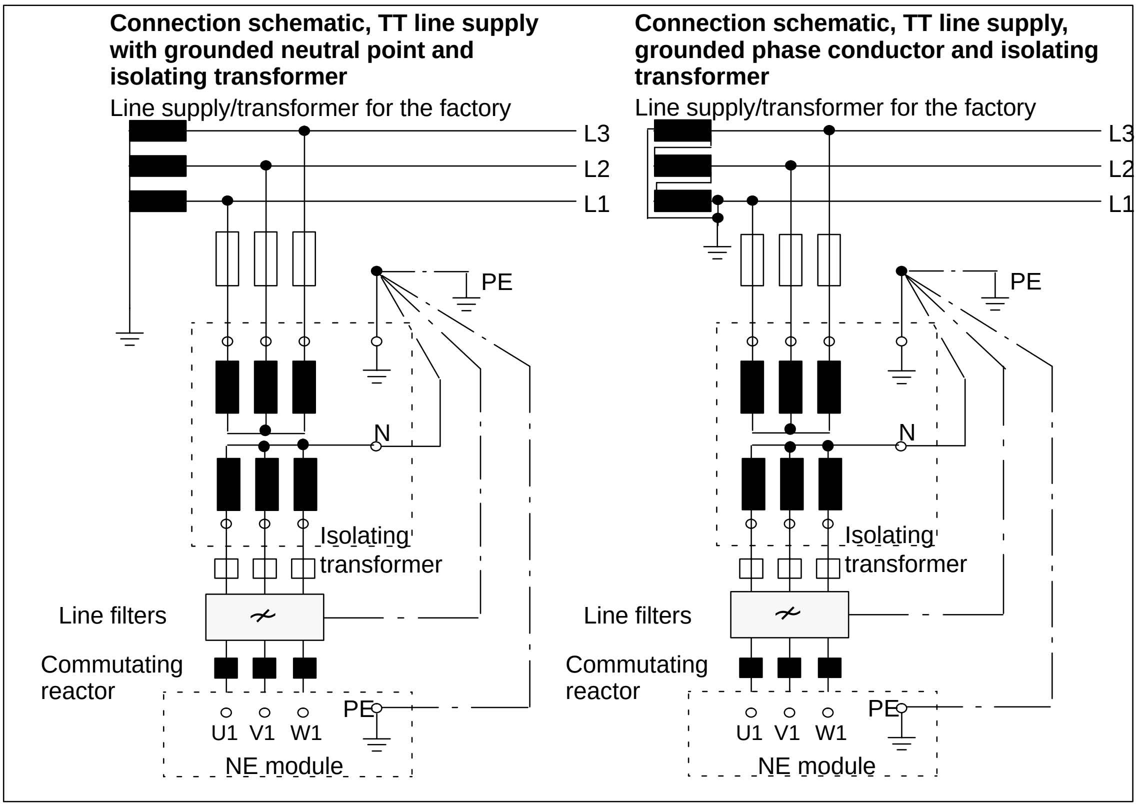


Fig. 7-2 Connection schematic, TT line supplies

IT line supply

Symmetrical 3–conductor or 4–conductor three–phase line supply with no directly grounded point – for instance, the loads are connected with grounders.

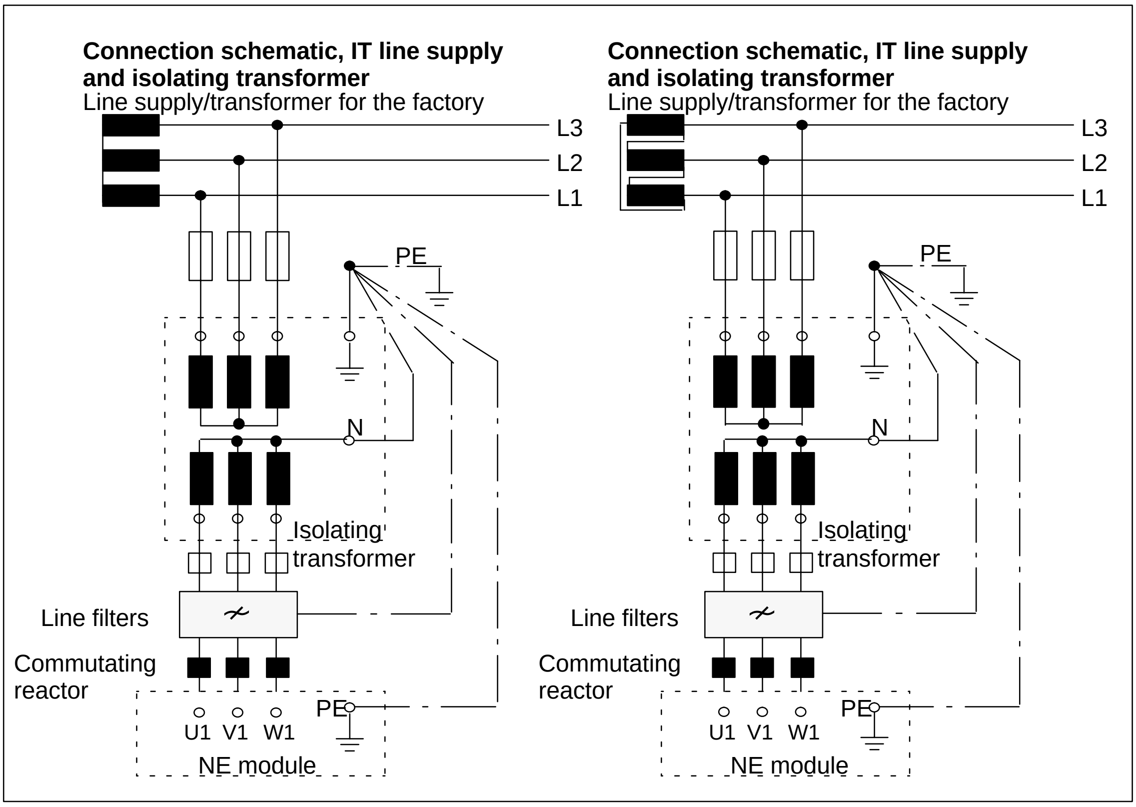


Fig. 7-3 Connection schematic, IT line supplies

Thus, within the pulsed transistor converter, the voltage stressing on the insulating clearances between the power circuits at the line supply potential and the open and closed–loop control circuits referred to the protective conductor potential, according to a rated voltage of 300 V complies with IEC/DIN EN 50178.

If fault currents occur, these can contain DC components. The reason for this would be the 6–pulse three–phase bridge circuit in the line supply infeed module. This must be taken into consideration when selecting/dimensioning a fault current protective device – e.g. an RCCB..

Direct connection to line supplies with RCCBs

The SIMODRIVE unit may be directly connected to TN line supplies with selectively tripping, AC/DC current sensitive RCCBs as protective measure.

Upstream devices providing protection against hazardous leakage currents or for fire protection (such as residual–current protective devices) must be universal current–sensitive in accordance with the requirements of DIN EN 50178. In the case of other residual–current protective devices, a transformer with separate windings must be connected upstream of the converter for purposes of decoupling.

Note

A direct connection to a line supply with RCCB is only possible with the following power ratings:

- UI modules 5 kW, 10 kW and 28 kW.
- I/R modules 16 kW and 36 kW.

Selectively tripping AC/DC–sensitive residual–current protective devices (RCCBs) that trip with delay can be used without restriction as a protective measure against hazardous shock currents.

7

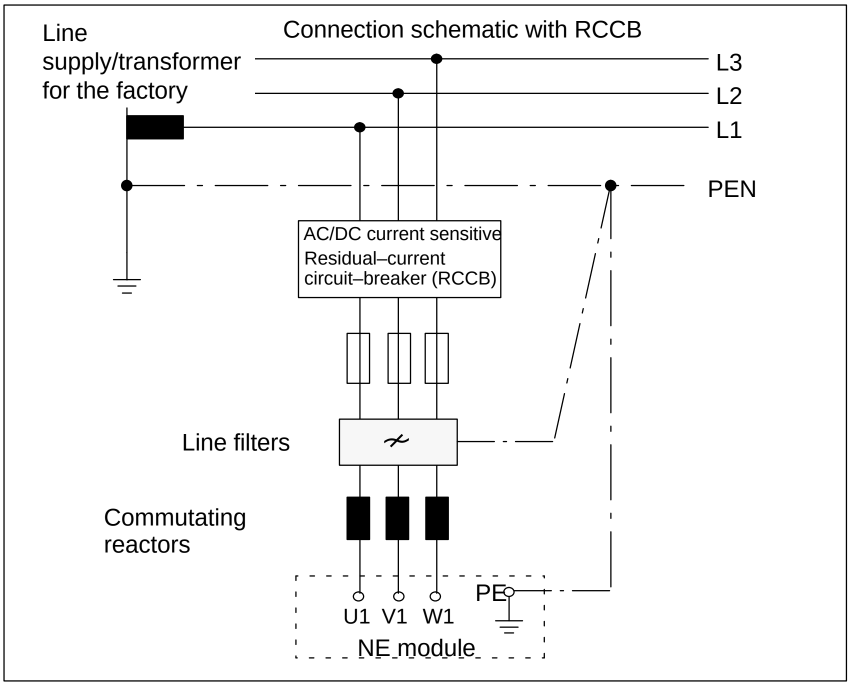


Fig. 7-4 Connection schematic, residual–current protective device (RCCB)

Note

Points to bear in mind:

- It is only permissible to use a delayed–tripping, (selective) AC/DC current–sensitive residual–current protective device (RCCB) (connection corresponding to the diagram 7-4).
- It is not possible to connect RCCBs in series in order to implement selective tripping.
- The max. permissible ground resistance of the ”selective protection device” must be observed (83 Ω max. for RCCBs with a rated differential current of 0.3 A).
- The total length of the shielded power cables used in the drive group (motor cable, incl. supply cables from supply system filters to the NE connection terminals) is less than 350/500 m for sinusoidal/squarewave current.
- Operation is only permissible with line filters and only the line filters described in Chapter 7 may be used.

Notice

AC or pulse–current sensitive RCCBs – that are today widely established – are definitely not suitable!

Recommendation

SIEMENS selective AC/DC–sensitive residual–current protective devices (RCCBs) are in compliance with DIN VDE 0100 T480 and EN 50178 – Series 5SZ□–□□□–□□□□□.
(e. g. 5SZ6 468–0KG00 or 5SZ6468–0KG30 with auxiliary contact block (1NC/1NO) for a rated current of 63 A and a rated fault current of 0.3 A).

7.2.3 Transformers

Matching, coordinated transformers (auto/isolating transformers) with supply voltages of 3–ph. 220 V to 3–ph. 575 V AC, refer to Chapter 7.3.2 and 7.3.3.

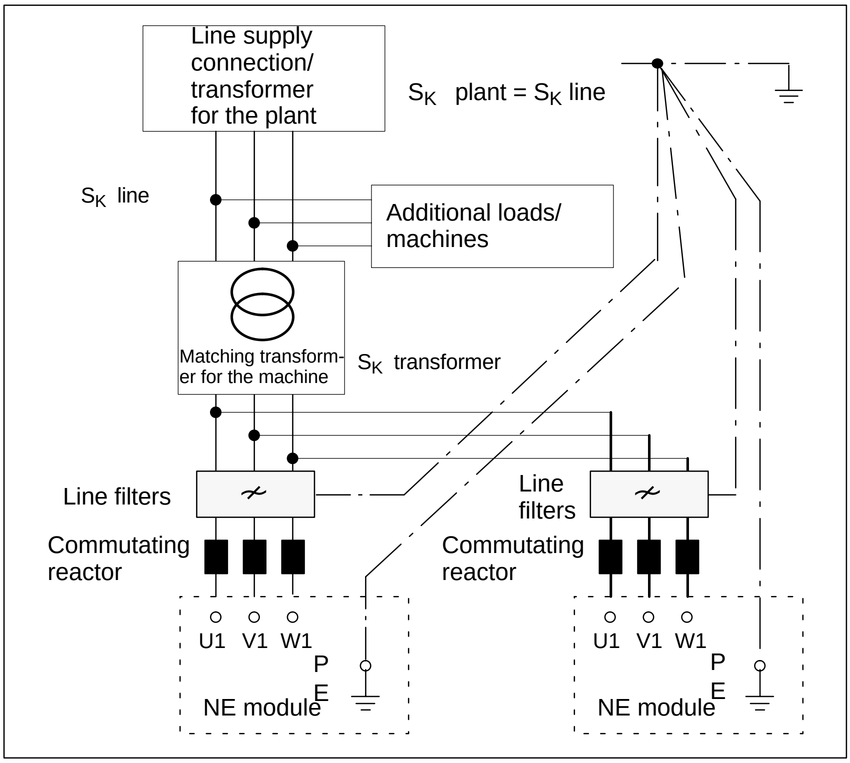


Fig. 7-5 Connection schematic, matching transformer

Table 7-2 Engineering information if you dimension and select the transformer yourself

I/R module used	Required rating Sn of the isolating/autotransformer	Required short–circuit voltage 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	Required rating Sn of the isolating/autotransformer	Required short–circuit voltage 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%

Vector group of the transformer
Recommendation: Dyn0 or Yyn0; this means either a delta or star circuit on the primary side and star circuit on the secondary side where the neutral point is brought–out. Connection, refer to Chapter 7.2.2.

Note

Switching elements (main circuit–breakers, contactors) for connecting and disconnecting the line filter must feature a max. 35ms delay time between closing and opening individual main contacts.

Connection through an isolating transformer

A configuration with isolating transformer can be configured in conjunction with a protective measure against hazardous currents flowing through the human body.

Dimensioning and selecting the matching transformer for several loads

A SIMODRIVE NE module and other loads/machines are connected at the matching transformer (refer to Fig. 7-6).

I/R module with Order No. [MLFB]: 6SN114☐–1☐☐0☐–0☐☐1 and for all UI modules.

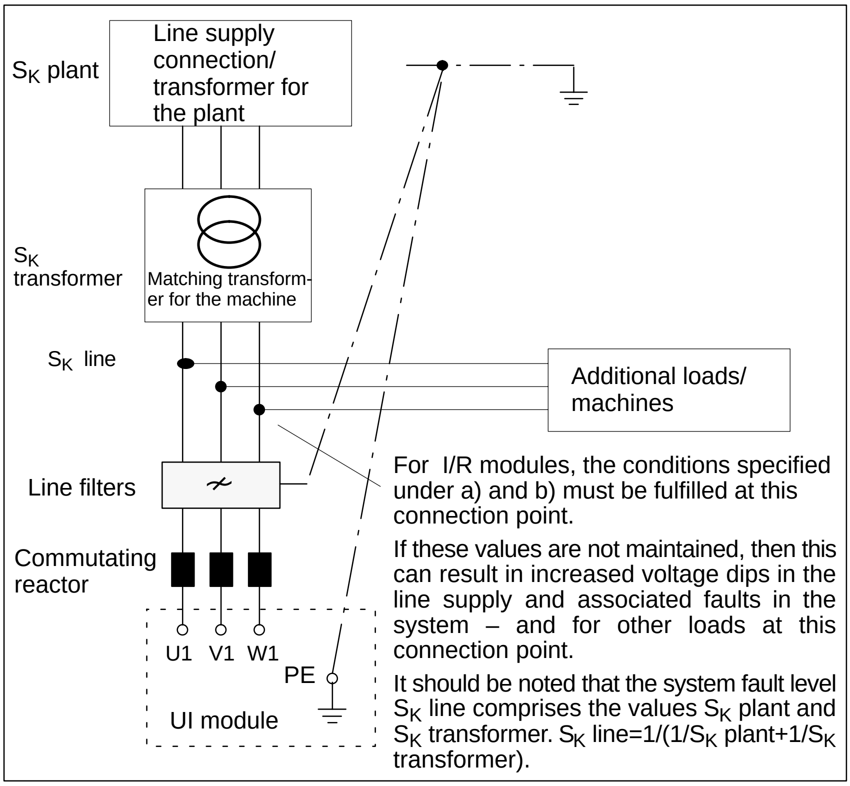


Fig. 7-6 Connection schematic, matching transformer for additional loads

If the conditions are not maintained, then this can result in a significant level of harmonics being fed back into the line supply and also EMC faults and disturbances (Chapter 9.2 EMC measures).

If other loads are connected to the secondary side of the matching transformer (refer to Fig. 2.11) when selecting the matching transformer, the limitations/secondary conditions under a) and b) must be carefully observed.

Sn1, Sn2 = calculated nominal rating of the transformer from a) and b)
uk=short–circuit voltage of the matching transformer as a %
(for I/R modules this must lie in the range 1...6%)
S_K=system fault level (short–circuit power)

Warning

A sufficiently high system fault level (short–circuit power) is required to ensure that when a ground fault does occur, the fuses rupture in the specified time. An insufficient system fault level (short–circuit power) increases the time to trip beyond permissible levels (e.g. a fire is possible).

Limitation a)

The nominal power rating (Sn) of the matching transformer must always be $\geq$ 1.27 x Pn I/R module
Sn1(kVA) $\geqq$ 1.27 x Pn I/R module in kW.
E.g. – the minimum nominal rating of a matching transformer for the I/R module 16/21 is 21kVA.

Limitations b)

In order to avoid faults and disturbances at the other loads, that are connected to the secondary side of the matching transformer, the sum of the system fault level (short–circuit power) of the plant connection and that of the matching transformer at the connection point (S_K line) must reach the values as listed in the Table 7-1 Chapter 7.1.

S_K line $\geqq$ 1 / (1/S_K plant + 1/S_K transformer). (in kVA)
e.g. S_K line for I/R 16/21 sinusoidal current:
S_K line = 1.1 MVA = 1100kVA
In order to be able to correctly dimension the matching transformer, S_K transformer must be determined.
S_K transformer $\geqq$ 1 / (1/S_K line – 1/S_K plant). (in kVA)
From S_K transformer, the required nominal rating of the matching transformer can be calculated.
Sn2 (kVA) = S_K transformer (kVA) x uk (%) / 100%.

Note:

The system fault level at the plant connection S_K plant plays a decisive role in dimensioning/selecting the matching transformer.

From the nominal power rating (Sn1 or Sn2) calculated under a) and b), the higher must be used for the matching transformer.

Examples

Matching transformer for I/R module 16/21kW sinusoidal current:
uk matching transformer = 3%; S_K plant = 50000kVA ; S_K line for I/R 16/21kW sinusoidal current according to the Table 1-1: S_K line = 1100kVA
according to a) Sn = 1.27 x 16kW = 21kVA
according to b) Calculating Sn2

Case 1:
S_K transformer = 1 / (1/1100–1/50000) = 1125kVA
Sn2 = 1125kVA x 3% / 100% = 34kVA.
Sn2>Sn1 >>Sn2 is decisive:

The matching transformer requires a nominal power rating Sn of 34kVA for a uk of 3%

Case 2:
If the uk of the matching transformer is less than, e.g. uk=1% for otherwise unchanged conditions to Case 1:
Sn2 = 1125kVA x 1% / 100% =11.25kVA
Sn1 > Sn2==>Sn1 is decisive:

The matching transformer requires a nominal power rating Sn of 21kVA for a uk of 1%

Case 3:
If S_K plant is less, then a transformer with a higher rating must be selected, e.g. S_K plant = 3000kVA – otherwise as for Case 1:
S_K transformer = 1/(1/1100–1/3000) = 1737kVA
Sn2 = 1737kVA x 3% / 100% = 52kVA.
Sn2>Sn1 >>Sn2 is decisive:

The matching transformer requires a nominal power rating Sn of 52kVA for a uk of 3%.

Case 4:
When compared to Case 3, the uk of the matching transformer is reduced to e.g. uk = 1%:
Sn2 = 1737kVA x 1% / 100% = 17.37kVA.
Sn1 > Sn2==>Sn1 is decisive

The matching transformer requires a nominal power rating Sn of 21kVA for a uk of 1 %.

Comment: Sn2 for the matching transformer can be reduced by reducing uk. In the examples above, the power drawn from other loads has not been taken into account.

7.3 Line supply fuses, transformers and main switch

7.3.1 Assignment of the line fuses to the NE modules

Fuses should be used that are dimensioned to protect the line supply feeder cables. Alternatively, the circuit–breakers listed on the following page (Table 7-3).

The following can be used: LV HRC, D, DO with gL characteristics. We recommend the SIEMENS fuse types, listed below – these do not restrict/limit the main power data of the NE modules.

Table 7-3 Assignment of the line 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	160A	250A
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./Order No. 5SE2116	25 A D02 Neoz./Order No. 5SE2125	–	35 A D02 Neoz./Order No. 5SE2135	–	–	–	–
Rated voltage 500 V∼	16 A DII Diazed/ Order No. 5SB261	25 A DII Diazed/ Order No. 5SB281	80 A DIV Diazed/ Order No. 5SC211	35 A DIII Diazed/ Order No. 5SB411	80 A DIV Diazed/ Order No. 5SC211	–	–	–
Rated voltage 500 V∼	16 A Size 00 LV HRC/Order No. 3NA3805	25 A Size 00 LV HRC/Order No. 3NA3810	80 A Size 00 LV HRC/Order No. 3NA3824	35 A Size 00 LV HRC/Order No. 3NA3814	80 A Size 00 LV HRC/Order No. 3NA3824	125 A Size 00 LV HRC/Order No. 3NA3832	160 A Size 1 LV HRC/ Order No. 3NA3136	250 A Size 1 LV HRC/ Order No. 3NA3144
Fuses for North America								
Designation	AJT 17.5	AJT 25	AJT 80	AJT 35	AJT 80	AJT 125	AJT 175	AJT 250
SIEMENS circuit–breakers								
Designation	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

Warning

When connected to line supplies with a lower system fault level, e.g. in trial operation, the fuses should be dimensioned/selected so that when a fault occurs the line fuses rupture after approx. 10 ms. If this is not the case, there is, for example, the danger of fire.

It is not permissible to overdimension fuses as this can result in significant levels of danger and also faults!

When carrying–out work in the control cabinet, the devices must always be protected against conductive dirt in order to avoid possible injury to personnel, e.g. as a result of electric shock or damage to the devices!

7.3.2 Assigning autotransformers to the I/R modules

Note

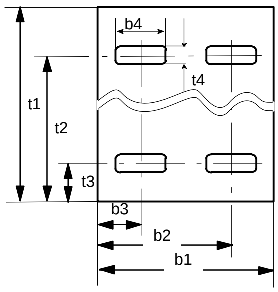
If, for I/R modules, a transformer is used, this does **not** replace the external commutating reactor.

When using a transformer, from NE module ≥ 10kW onwards,
Order No.: 6SN114□–1□□0□–0□□**1** a overvoltage limiter module must be used. Order number: 6SN1111–0AB00–0AA0

Table 7-4 Autotransformers 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**
Nominal power rating [kVA] • Autotransf. IP00/IP20 • Autotransformer IP23	 21 18.9	 46.5 42	 70.3 63.3	 104 93.5	 155 140
Input voltage [V]	3–ph. 480/440 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %				
Output voltage [V]	3–ph. 400 V AC				
Vector group	Yna0				
Permissible ambient temperature • Operation °C • Storage/transport °C	–25 to +40, for power de–rating up to +55 °C –25 to +80				
Humidity classification in accordance with DIN EN 60721–3–3	Class 3K5, moisture condensation and formation of ice not permissible Low air temperature 0 °C				
Degree of protection acc. to DIN EN 60529 (IEC 60529) IP00/IP20/IP23	• Degree of protection IP 00: □ —> Order No. A • Degree of protection IP 23: □ —> Order No. C [2)]				
Order No. according to Catalog PD10	4AP2796–0EL40–2X□0	4AU3696–0ER20–2X□0	4AU3696–2NA00–2X□0	4AU3996–0EQ80–2X□0	IP00: 4BU4395–0CB5**0**–8B IP20: 4BU4395–0CB5**8**–8B IP23: 4BU4395–0CB5**2**–8B
Power loss [W] • Autotransf. IP00/IP20 • Autotransformer IP23	 160[1)] 135	 430 370	 550 460	 700 590	 700 600
Conn. cross–section, max. primary/secondary sides	16 mm^2	35 mm^2	70 mm^2	Flat termination [3)]	
Fuse, primary side	35 A gL	80 A gL	125 A gL	160 A gL	224 A gL
Weight [kg], approx. for • Degree of prot. IP 00 • Degr. of prot. IP 20/23	 29 40	 52 70	 66 85	 95 115	 135 155
Terminal arrangement	1U1/1U3/1V1/1V3/1W1/1W3/2U1/2V1/2W1/N			Flat termination connections	
	1U1 to 1W1 = 480 V input, 1U3 to 1W3 = 440 V input, 2U1 to 2W1 = 400 V output, N = neutral point				

Table 7-4 Autotransformers for 480/440V input voltage, continued

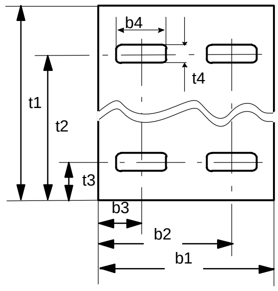
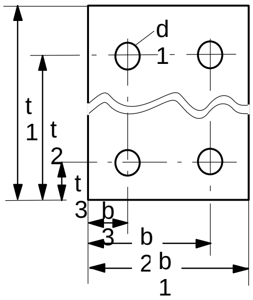
	I/R module 16/21 kW	I/R module 36/47 kW	I/R module 55/71 kW	I/R module 80/104 kW	I/R module 120/156 kW
Dimensions (L x W x H) approx. [mm]					
• Autotransf. IP00/IP20	270x192x250	370x220x330	370x240x340	420x260x370	480x220x420
• Autotransformer IP23	351x330x395	460x465x555	460x465x555	460x465x555	565x460x520
Drilling template Dimensions in mm Footprint, view from the top					
	t1 = 270/351 t2 = 235 t3 = 35 t4 = 10 b1 = 192/330 b2 = 140.5 b3 = 39.5 b4 = 18 Height 250/395	t1 = 370/460 t2 = 317 t3 = 53 t4 = 10 b1 = 220/465 b2 = 179 b3 = 41 b4 = 18 Height 330/555	t1 = 370/460 t2 = 317 t3 = 53 t4 = 10 b1 = 240/465 b2 = 189 b3 = 51 b4 = 18 Height 340/555	t1 = 420/460 t2 = 368 t3 = 52 t4 = 10 b1 = 260/465 b2 = 200.5 b3 = 59.5 b4 = 18 Height 370/555	t1 = 480/565 t2 = 418 t3 = 62 t4 = 15 b1 = 220/460 b2 = 217.5 b3 = 62.5 b4 = 22 Height 420/520

1) Not IP20
2) 10 % power de–rating required
3) FL = flat termination, hole ∅ 9 mm

Table 7-5 Autotransformer for a 220V 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
Nominal power rating [kVA] • Autotransf. IP00/IP20 • Autotransformer IP23	 21 18.9	 46.5 42	 70.3 63.3	 104 93.5	 155 140
Input voltage [V]	3–ph. 220 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %				
Output voltage [V]	3–ph. 400 V AC				
Vector group	Yna0				
Permissible ambient temperature • Operation °C • Storage/transport °C	–25 to +40, for power de–rating up to +55 °C –25 to +80				
Humidity classification in accordance with DIN EN 60721–3–3	Class 3K5, moisture condensation and formation of ice not permissible Low air temperature 0 °C				
Degree of protection acc. to DIN EN 60529 (IEC 60529) IP00/IP20/IP23	• Degree of protection IP 00: □ —> Order No. 0 • Degree of protection IP 20: □ —> Order No. 8 • Degree of protection IP 23: □ —> Order No. 2 [2)]				
Order No. according to Catalog PD10	IP00: 4AU3696–0ER30–2X**A**0 IP23: 4AU3696–0ER30–2X**C**0	4BU4395–0CB6□–8B	4BU4595–0BD0□–8B	4BU5295–0AE4□–8B	4BU5495–1AA1□–8B
Power loss [W] • Autotransf. IP00/IP20 • Autotransformer IP23	 550[1)] 460	 900[1)] 760	 980[1)] 830	 1350[1)] 1150	 1650 1400
Conn. cross–section, max. primary/secondary sides	16/16 mm^2	70/50 mm^2	95/70 mm^2	Flat termination [3)]	
Fuse, primary side	63 A gL	160 A gL	224 A gL	300 A gL	500 A gL
Weight [kg], approx. for • Degree of prot. IP 00 • Degr. of prot. IP 20/23	 57 75	 110 130	 155 175	 215 275	 310 370
Terminal arrangement	1U1 to 1W1 = 220 V input, 2U1 to 2W1 = 400 V output, N = neutral point				
Dimensions (L x W x H) approx. [mm] • Autotransf. IP00/IP20 • Autotransformer IP23	 370x220x330 460x465x555	 480x230x430 565x290x520	 480x300x430 565x460x520	 530x290x520 900x600x720	 590x320x585 900x600x720

Table 7-5 Autotransformer for a 220V input voltage, continued

	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**
Max. dimensions Drilling template in mm Footprint, view from the top					
	t1 = 370/460 t2 = 317 t3 = 53 t4 = 10 b1 = 220/465 b2 = 179 b3 = 41 b4 = 18 Height 330/555	t1 = 480/565 t2 = 418 t3 = 62 t4 = 15 b1 = 230/460 b2 = 205 b3 = 50 b4 = 22 Height 430/520	t1 = 480/565 t2 = 418 t3 = 62 t4 = 15 b1 = 300/460 b2 = 241 b3 = 59 b4 = 22 Height 430/520	t1 = 530/900 t2 = 470 t3 = 60 b1 = 290/600 b2 = 254 b3 = 71 d1 = 12.5 Height 520/720	t1 = 590/900 t2 = 530 t3 = 60 b1 = 320/600 b2 = 279 b3 = 81 d1 = 15 Height 585/720

1) Not IP20
2) 10 % power de–rating required
3) FL = flat termination, hole ∅ 9 mm

7

Operating conditions all transformers

The permissible current of the transformers, reactors etc. depends on the ambient temperature and the installation altitude. The permissible current/power rating of transformers and reactors is as follows:

I_n (PD) reduced = c × I_n (PD)

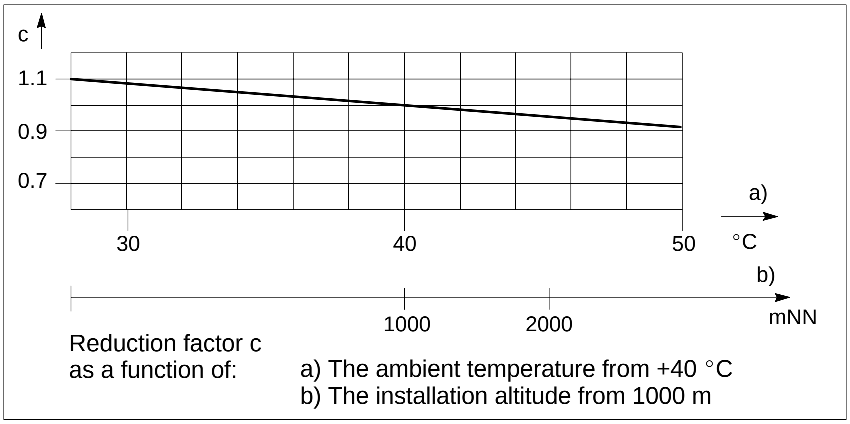


Fig. 7-7 Reduction factor c

7.3.3 Assigning the transformers to the I/R modules

Table 7-6 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
Nominal rated power [kVA]	21	47	70	104	155
Power loss, max. [W]	650	1200	2020	2650	3050
Degree of protection acc. to DIN EN 60529 (IEC 60529)	• Degree of protection IP 00: □ —> Order No. 0 • Degree of protection IP 20: □ —> Order No. 2 • Degree of protection IP 23: □ —> Order No. 8 1)				
Humidity classification in accordance with DIN EN 60721–3–3	Class 3K5, moisture condensation and formation of ice not permissible Low air temperature 0 °C				
Permissible ambient temperature • Operation °C • Storage/transport °C	–25 to +40, for power de–rating up to +55 –25 to +80				
Approx. weight for • Degree of prot. IP 00 [kg] • Degr of prot. IP 20/23[kg]	120 131	200 216	300 364	425 536	600 688
Dimensions (L x W x H) approx. [mm]	480 x 209 x 420	480 x 267 x 420	630 x 328 x 585	780 x 345 x 665	780 x 391 x 665
Max. conn., secondary [mm²]	16	35	70	Cable lug according to DIN 46235	
Input voltage, 3–ph. 575 V – 500 V – 480 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %					
Rated input current [A]	26	58	87	127	189
Max. conn., primary [mm²]	16	35	50	70	Cable lug according to DIN 46235
Order No. acc. to Catalog PD10	4BU43 95–0SA7□–0C	4BU47 95–0SC3□–0C	4BU55 95–0SA4□–0C	4BU58 95–0SA6□–0C	4BU60 95–0SA6□–0C
Input voltage, 3–ph. 440 V – 415 V – 400 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %					
Rated input current [A]	31	69.5	104	154	228
Max. conn., primary [mm²]	16	35	70	70	Cable lug according to DIN 46235
Order No. acc. to Catalog PD10	4BU43 95–0SA8□–0C	4BU47 95–0SC4□–0C	4BU55 95–0SA5□–0C	4BU58 95–0SA7□–0C	4BU60 95–0SA7□–0C
Input voltage, 3–ph. 240 V –220 V –200 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %					
Rated input current [A]	62	138.5	210	309	450
Max. conn., primary [mm²]	35	70	Cable lug according to DIN 46235		
Order No. according to Catalog PD10	4BU43 95–0SB0□–0C	4BU47 95–0SC5□–0C	4BU55 95–0SA6□–0C	4BU58 95–0SA8□–0C	4BU60 95–0SA8□–0C

1) For degree of protection IP 23, a 10 % power de–rating must be taken into account
In conformance with the Standards with regulation: EN61558/VDE0532
Insulation Class: T40/b–H

7.3.4 Assigning the transformers to the UI modules

Table 7-7 Matching transformers with separate windings for 50 Hz / 60 Hz line supplies

	UI module 5 kW 2)	UI module 10 kW 2)	UI module 28 kW
Nominal rated power [kVA]	8.2	15.7	47
Power loss, max. [W]	520	650	1200
Degree of protection acc. to DIN EN 60529 (IEC 60529)	• Degree of protection IP 00: □ —> Order No. 0 • Degree of protection IP 20: □ —> Order No. 8 • Degree of protection IP 23: □ —> Order No. 2 1)		
Humidity classification in accordance with DIN EN 60721–3–3	Class 3K5, moisture condensation and formation of ice not permissible Low air temperature 0 °C		
Permissible ambient temperature • Operation °C • Storage/transport °C	 –25 to +40, for power de–rating up to +55 –25 to +80		
Approx. weight for • Degree of prot. IP 00 [kg] • Degree of prot. IP 20/23 [kg]	 55 65	 70 95	 200 216
Dim. (L x W x H) approx. [mm]	360 x 268 x 320	420 x 262 x 370	480 x 267 x 420
Max. conn., secondary [mm²]	6	6	35
Input voltage, 3–ph. 575 V – 500 V – 480 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %			
Rated input current [A]	10.5	20	58
Max. connection, primary [mm²]	6	6	35
Order No. according to Catalog PD10	4AU36 95–0SB0□–0CN2	4AU39 95–0SA3□–0CN2	4BU43 95–0SA7□–0C
Input voltage, 3–ph. 440 V – 415 V – 400 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %			
Rated input current [A]	12.5	23.5	69.5
Max. connection, primary [mm²]	6	16	35
Order No. according to Catalog PD10	4AU36 95–0SB1□–0CN2	4AU39 95–0SA4□–0CN2	4BU43 95–0SA8□–0C
Input voltage, 3–ph. 240 V –220 V –200 V AC ± 10 %; 50 Hz – 5 % to 60 Hz + 5 %			
Rated input current [A]	25.5	47	138.5
Max. connection, primary [mm²]	6	16	70
Order No. according to Catalog PD10	4AU36 95–0SB2□–0CN2	4AU39 95–0SA5□–0CN2	4BU43 95–0SB0□–0C

1) For degree of protection IP 23, a 10 % power de–rating must be taken into account
2) Not degree of protection IP 20

7.3.5 Assigning the main switches

Note

When shutting down, terminal 48 of the NE modules must be de–energized 10 ms before the line contacts separate.

Main switches (breakers) with leading auxiliary contact can be used to ensure that terminal 48 of the NE modules is de–energized using a leading contact.

Leading shutdown is not required for certain drive configurations. For information refer to Chapter 7.3.6.

Recommendation:
Siemens 3LD.../3KA... switches (as listed in the Catalog SIEMENS "Low–Voltage Switchgear")

Table 7-8 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	3KA5330–1EE01 + 3KX3552–3EA01	3KA5530–1EE01 + 3KX3552–3EA01	3KA5730–1EE01 + 3KX3552–3EA01

7.3.6 Using a leading contact

For various plant and system configurations the use and the correct connection of a leading contact (integrating terminal 48) for the switching element is either absolutely necessary or not required. In conjunction with this, the following considered as switching element:

- Line supply disconnecting elements (main switches)
- Line contactors (external)

Note

When connecting several NE modules to a main switch, the restrictions as listed in Chapter 8.2.3 apply.

Note

If the objective is that an application is not to have a leading contact over the complete power range of the infeed modules, then this can be implemented using the following measures:

- Changing–over from possibly existing I/R modules to unregulated infeed (this is generally the case for 480 V applications).
- De–activating the regenerative feedback if I/R modules are being used.

The I/R modules then operate as UI modules and can be operated with additional loads connected to a switching element without leading contact.

Leading contact is absolutely necessary

For the configurations that are now described, a leading contact for the switching element is absolutely necessary:

- If one or several I/R modules are connected, together with other loads, through a switching element.
- If NE modules having different power classes are connected together to one switching element. In this case, the restrictions, described on the following page, must be carefully fulfilled.

The following diagram shows two examples where a leading contact is absolutely necessary.

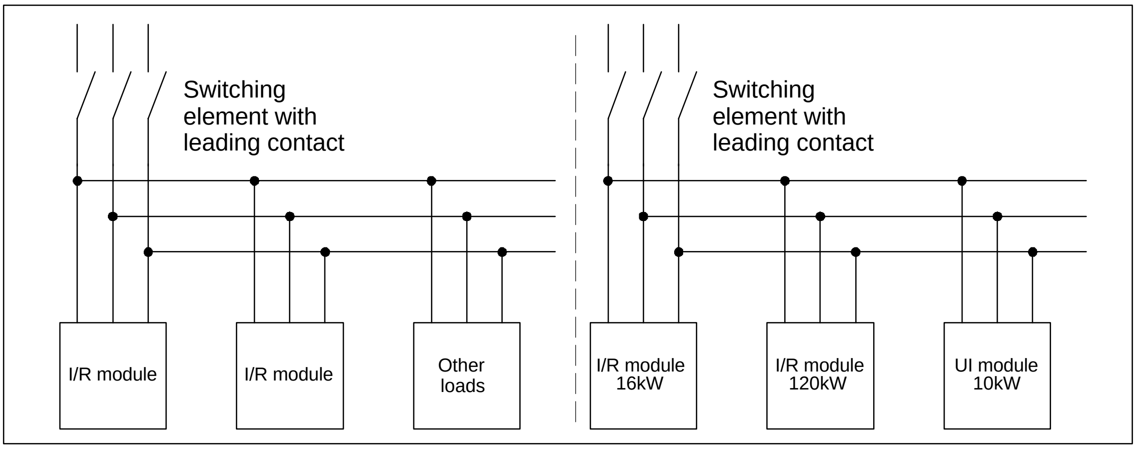


Fig. 7-8 Examples of a configuration where a leading contact is required

Leading contact is not absolutely required

Caution

If switching elements are used without leading contact, then it must be absolutely ensured that after powering–down and powering–up the NE module again, terminal 48 (start/contactor control) is de–energized in order to activate the pre–charging circuit. If this is not the case, then high re–charging currents (similar to short–circuit currents) can occur when powering–up again. These re–charging currents are not limited by the pre–charging circuit. This can result in damage/destruction of the NE module.

For the subsequently described configurations, it is not absolutely necessary that a leading contact is used for the switching element:

- Only one NE module is connected to the switching element.

Caution

When using I/R modules, no additional loads may be connected to the switching element.

- Connecting NE modules with the same power class to one switching element. In this case, the restrictions for connecting several NE modules to a switching element must be carefully observed (refer to the following page).

Caution

If I/R modules are connected together with UI modules to one switching element, then it is absolutely necessary that overvoltage limiter modules are used.

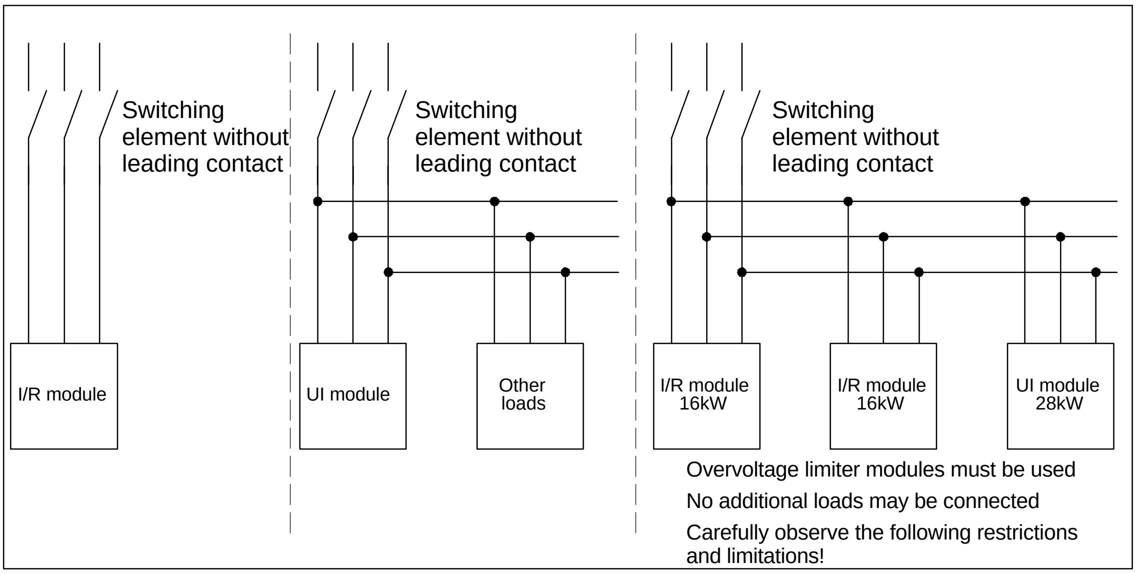


Fig. 7-9 Examples of 3 configurations that do not require a leading contact

Restrictions

If several NE modules are to be connected to a switching element without leading contact, then the following restrictions regarding the power rating of the individual modules must be carefully observed.

Caution

If these restrictions are not carefully observed, then smaller rating modules can be destroyed by the modules that are presently regenerating when the switching element is opened.

Note

The worst case should always be used when making the following calculations.

Example:

Two 16kW I/R modules are connected to an infeed together with one 28kW UI module. In this case, the worst case would be if the switching element would open precisely when both I/R modules are regenerating back into the line supply.

7

- **I/R and UI modules connected together to one switching element**

  The following restriction must be carefully observed for the power ratings when connecting I/R and UI modules to one switching element:

$$P_{tot/IR} \leqslant 2 \cdot P_{min} \Rightarrow \frac{P_{tot/IR}}{P_{min}} \leqslant 2$$

$P_{tot/IR}$ Sum of the rated powers of all of the connected I/R modules

P_{min} Rated power of the smallest connected NE module (observe the worst case, refer to example 1)

- **Connecting I/R modules to one switching element**

$$P_{tot} - P_{min} \leqslant 2 \cdot P_{min} \Rightarrow \frac{P_{tot}}{P_{min}} - 1 \leqslant 2$$

P_{tot} Sum of the rated powers of all of the connected I/R modules

P_{min} Rated power of the smallest connected I/R module

- **Examples**

1. Connecting two 16 kW I/R modules and one 28 kW UI module:

$P_{tot/IR}$ = 2 x 16 kW = 32 kW

P_{min} = 28 kW

$$\frac{P_{tot/IR}}{P_{min}} = \frac{32\ \text{kW}}{28\ \text{kW}} = 1.14$$

—> A leading contact is not required

2. Connecting two 80 kW I/R modules to one 120 kW I/R module:

P_{tot} = 2 x 80 kW + 1 x 120 kW= 280 kW

P_{min} = 80 kW

$$\frac{P_{tot}}{P_{min}} - 1 = \frac{280\ \text{kW}}{80\ \text{kW}} - 1 = 2.5$$

—> a leading contact is required (as an alternative: An I/R module 80kW is connected through a separate switching element)

Summary

Table 7-9 Using a leading contact for SIMODRIVE units

<table>
<tr><th>Unit connected to the switching element</th><th>Leading contact required</th><th>No leading contact</th><th>Remarks</th><th>Risks</th></tr>
<tr><td>Only UI modules</td><td>–</td><td>X</td><td>–</td><td>–</td></tr>
<tr><td>Only UI modules with additional loads</td><td>–</td><td>X</td><td>–</td><td>–</td></tr>
<tr><td>Only I/R modules (without additional loads)</td><td>–</td><td>X</td><td>The appropriate restrictions must be carefully observed.</td><td>If these restrictions are not carefully observed, then smaller rating modules can be destroyed by the modules that are presently regenerating when the switching element is opened.</td></tr>
<tr><td>Only modules that can regenerate into the line supply with additional loads</td><td>X</td><td>–</td><td>–</td><td>If a leading contact is not used, then the additional connected loads could be destroyed by overvoltages</td></tr>
<tr><td rowspan="2">I/R modules together with UI modules</td><td rowspan="2">–</td><td rowspan="2">X</td><td>It is necessary to use overvoltage limiter modules.</td><td>If an overvoltage limiter module is not used, when the contact is opened the module could be destroyed by other modules that are regenerating at that time.</td></tr>
<tr><td>The appropriate restrictions must be carefully observed.</td><td>If these restrictions are not carefully observed, then smaller rating modules can be destroyed by the modules that are presently regenerating when the switching element is opened.</td></tr>
<tr><td>I/R modules together with UI modules and additional loads</td><td>X</td><td>–</td><td>–</td><td>If a leading contact is not used, then the additional connected loads could be destroyed by overvoltages.</td></tr>
</table>

7.3.7 Minimum cross–sections for PE (protective conductor)

Table 7-10 Minimum cross–sections for PE (protective conductor)

P_{rated} [kW]	I_{rated} [A]	PE [mm^2]	PE [AWG/kcmil]
5	7	1.5	16
10	14	4	14
28	40	10	8
16	23	4	10
36	52	16	6
55	79	16	4
80	115	25	3
120	173	50	1/0

7.4 HF/HFD commutating reactors

General information

The matching HF/HFD commutating reactor – as listed in the selection table 7-12 – is required when connecting the unregulated 28 kW infeed and the regulated infeed/regenerative feedback modules to the line supply.

For the unregulated 5 kW and 10 kW infeed modules, the HF commutating reactor is integrated.

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

When using direct drives (e.g. torque motors and linear motors), especially for third–party/unlisted motors with unknown winding characteristics, that are fed from regulated infeeds, HFD commutating reactors and an appropriate resistance must be used so that electrical system oscillations are dampened.

Tasks

Commutating reactors have the following tasks:

- To limit the harmonics fed back into the line supply
- Store energy for DC link controller operation in conjunction with the infeed and regenerative feedback modules
- Designed for the voltage range
  Line supplies 3–ph. 400 V –10 % to 480 V AC +6 %; 50/60 Hz ±10 %

Note

If commutating reactors are used, that have not been released by SIEMENS for SIMODRIVE 6SN11, harmonics can occur that can damage/disturb other equipment connected to the particular line supply.

Safety information/ instructions

Notice

It is not permissible to use HF/HFD commutating reactors in the motor cable.

Caution

The 100 mm clearance above and below the components to ensure air circulation and cooling must be carefully maintained. If this is not observed, then the components could prematurely age.

Note

The connecting cables to the NE module must be kept as short as possible (max. 5 m). If at all possible, shielded connecting cables should be used.

Caution

The surface temperature of the line reactors may exceed 80 °C.

HFD resistor, external

Together with the HFD commutating reactor, an external resistor must be used for damping purposes (refer to Fig. 7-10).

Table 7-11 Technical data

	Pulsed resistor 0.3/25 kW[1)]	**Pulsed resistor plus 1.5/25 KW**	**HFD damping resistor**
Order No.	6SN1113–1AA00–0DA0	6SL3100–1BE22–5AA0	6SL3100–1BE21–3AA0
Rated power (kW)	0.3	1.5	0.8
Damping	0...230 kHz ⩽ 3 dB		
including the connecting cable [m]	3	5	5
Connection	3 x 1.5 mm^2	4 x 2.5 mm^2	4 x 1.5 mm^2
Weight [kg]	1.45	5.6	5.5
Degree of protection acc. to DIN EN 60529 (IEC 60529)	IP20	IP20	IP51
Temperature range [°C]	0...40 °C; >40 °C with de–rating		
Dimensions (W x H x D) [mm]	80 x 210 x 53	193 x 410 x 240	277 x 552 x 75

1) This resistor (0.3 kW) can be used for HFD applications after a check measurement has been made.
A heat run must be carried–out in the particular system with all of the axes in the controlled condition. During an operating time of 2 hours the temperature measured at the surface of the resistance may not exceed 155 °C. This heat run test must be repeated if the hardware configuration is changed!

Note

The HFD damping resistor (6SL3100–1BE21–3AA0) may not be connected as external pulsed resistor to the pulsed resistor module!

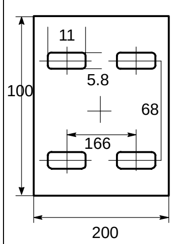
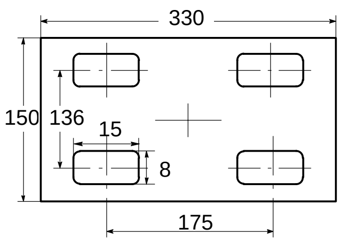
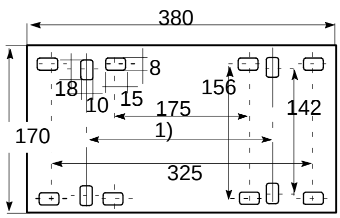
Reader's note

Mounting information and instructions for external HFD resistors, refer to Chapter 6.7.5.

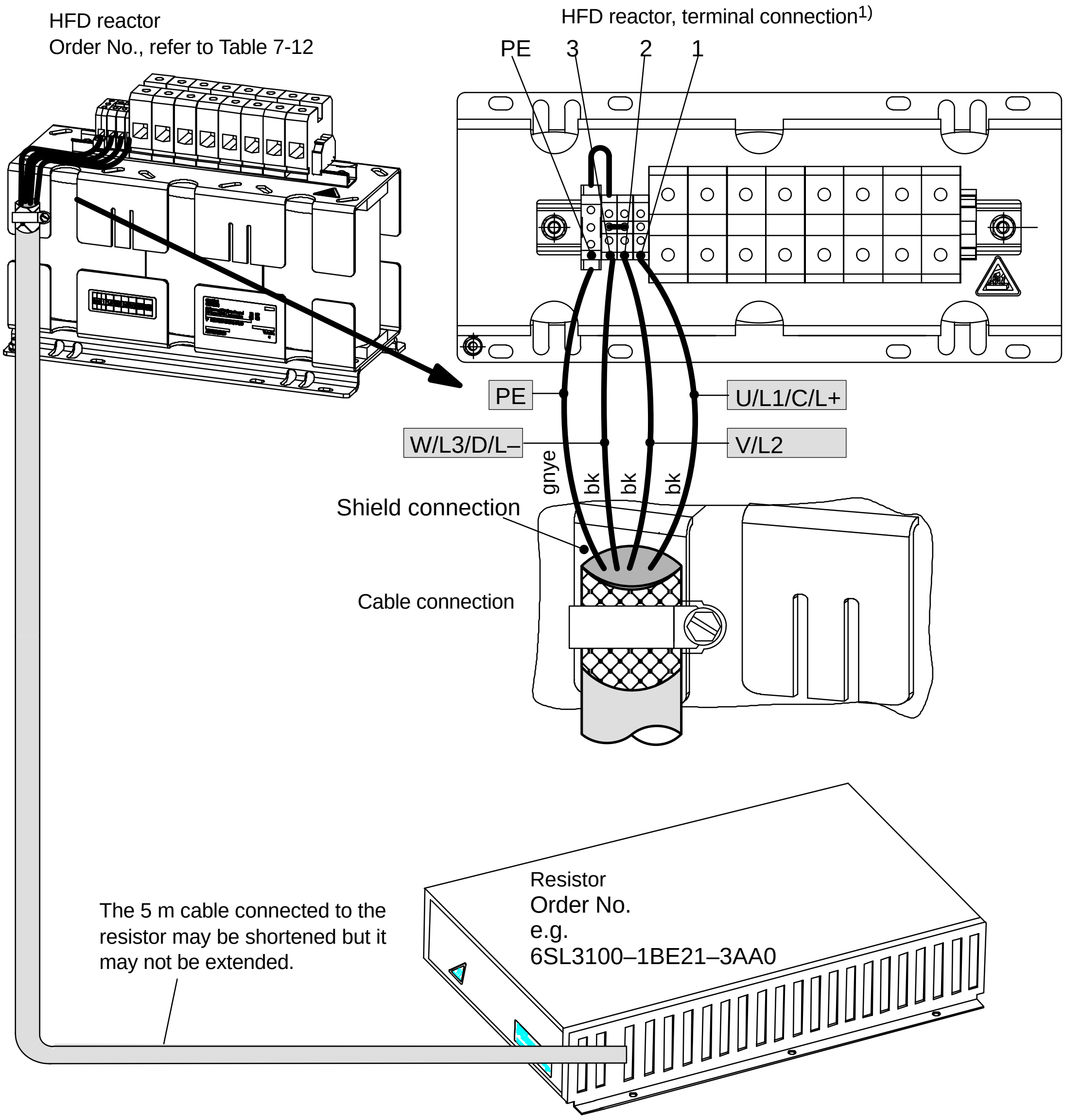
7.4.1 Assigning the line/commutating reactors to the NE modules

Operating voltage: 3–ph. 300 to 520 V/45 to 65 Hz

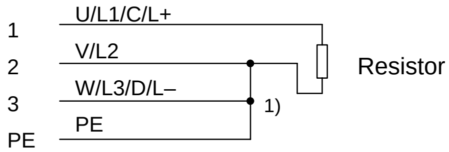
Table 7-12 Assigning commutating reactors of the NE modules

	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 HF reactor	28 kW	16 kW	36 kW	55 kW	80 kW	120 kW
Order No. 6SN1111–	1AA00–0CA0 **1)**	0AA00–0BA1 **1)**	0AA00–0CA1 **1)**	0AA00–0DA1 **1)**	0AA00–1EA0 **1)**	0AA00–1FA0 **1)**
Type HFD reactor	–	–	36 kW	55 kW	80 kW	120 kW
Order No. 6SL3000–	–	0DE21–6AA0 **1)** 2)	0DE23–6AA0 **1)** 2)	0DE25–5AA0 **1)** 2)	0DE28–0AA0 **1)** 2)	0DE31–2AA0 **1)** 2)
Pv	70W	170 W	250 W	350 W	450 W	590 W
Connection	max. 35 mm^2	max. 16 mm^2	max. 35 mm^2	max. 70 mm^2	Flat termination 3)	
Approx. weight	6 kg	8.5 kg	13 kg	18 kg	40 kg	50 kg
Mounting position	any	any	any	any	any	any
Terminal arrangement	Input: 1U1, 1V1, 1W1					
	Output : 1U2, 1V2, 1W2					
Drilling template Dimensions in mm Top view, foot–print	 Height 190	 Height (HF/HFD) for 16 kW: 145 Height (HF/HFD) for 36 kW: 230 Height (HF) for 55 kW: 280			 1):(HF) 80 kW: 224, height 200 (HF) 120 kW: 264, height 300	

1) Suitable for sinusoidal current operation and squarewave current operation.
2) Suitable for direct drives.
3) FL = flat termination, hole ∅ 9 mm



Resistor connection circuit to an HFD reactor



1) Jumper, 2–3–PE for potential connection (EMC) is provided as standard

Note:
It is not permissible to route cables in or close to the warm airflow of the damping resistor!

Schematic diagram

Fig. 7-10 Wiring, HFD reactor and damping resistor

7.5 Line filters for I/R and UI modules

7.5.1 General information

Description

The line filters limit the cable–borne noise and disturbances, originating from the converter units, to permissible EMC values for industrial environments. If the system is consequentially executed in–line with the Configuration Manual and the EMC Guidelines for SIMODRIVE, SINUMERIK, SIROTEC, then the prerequisites are created so that the limit values at the installation location will be in compliance with the EU Directives for EMC.

The line filters can be used both for sinusoidal current as well as squarewave current operation.

The mounting/installation and connection regulations as listed in Chapter 9.1 must be carefully observed.

For more detailed information regarding an EMC–correct design, please also refer to the EMC Guidelines for SINUMERIK, Order No.: 6FC5297–0AD30–0BP1.

Other suitable measures can be used to ensure that the EMC limit values are maintained; in some cases it may be necessary to investigate the EMC situation.

Note

The line supply connection conditions as specified in Chapter 7.1 must always be observed. If the line supply does not comply with the requirements according to EN–/IEC 61000–2–4
Class 3, then the filters could be overloaded.

Even if a matching transformer is used this does not mean that the HF / HFD reactor or line filter can be eliminated.

Optional line filter rows that are coordinated with the power range are also available with the SIMODRIVE 611 digital converter system. These line filters differ with regard to the frequency range in which they reduce the conducted emissions.

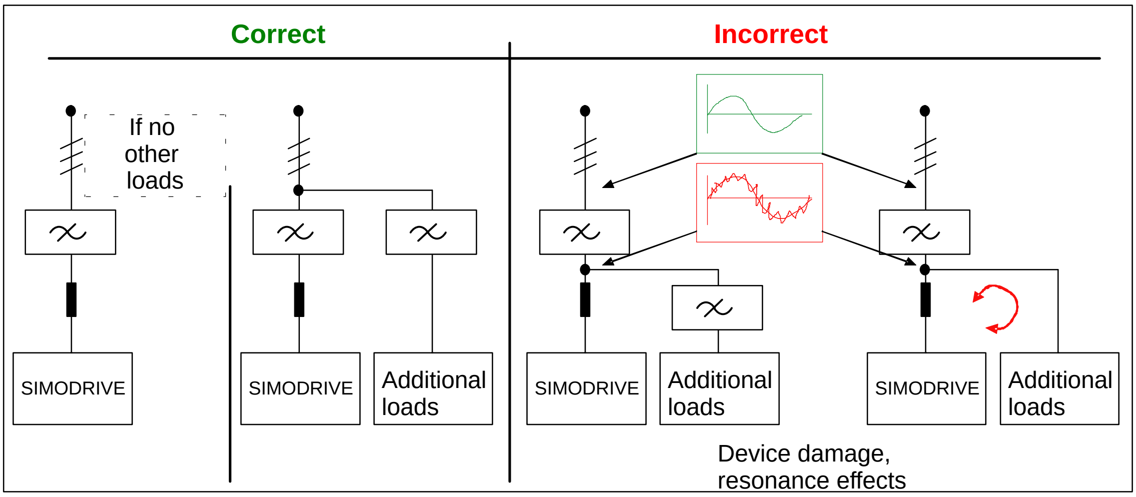


Fig. 7-11 Wiring information and instructions

Wideband line filter

Wideband line filters function in the frequency range from 2 kHz to 30 MHz.

They also help to effectively limit low–frequency harmonics fed back into the line supply. This therefore reduces negative effects or damage to other loads, e.g. electronic equipment, connected to the same line supply.

Basic line filter

Basic line filters function in the frequency range from 150 kHz to 30 MHz. This especially suppresses disturbances for radio–based services.

Safety information/ instructions

Caution

Line filters are only suitable for direct connection to TN line supplies.

The line filters listed conduct a high leakage current via the PE conductor. Because of the high leakage current of the line filters, a permanent PE connection of the line filter or switching cabinet is required.

Measures according to DIN EN 61800–5–1 must be taken, e.g. a PE conductor $\geq$10 mm^2 CU or fit an additional connection terminal for a PE conductor with the same cross–section as the original PE conductor.

Danger

The 100 mm clearances for circulating air above and below the components must be maintained. The mounting position must ensure that cool air flows vertically through the filter. This measure prevents thermal overloading of the filter.

Warning

A hazardous voltage will be present at the terminals for up to 20 minutes after the system has been shutdown depending on the DC link capacitance.

Note

If the system is subject to a high–voltage test using AC voltage, a line filter must be disconnected in order to obtain a correct measurement result.

Caution

Only the line filters described in the Configuration Manual must be used. Other line filters can lead to line harmonics that can interfere with or damage other loads powered from the network.

It is not permissible to connect other loads after the line filter.

7.5.2 Wideband line filter

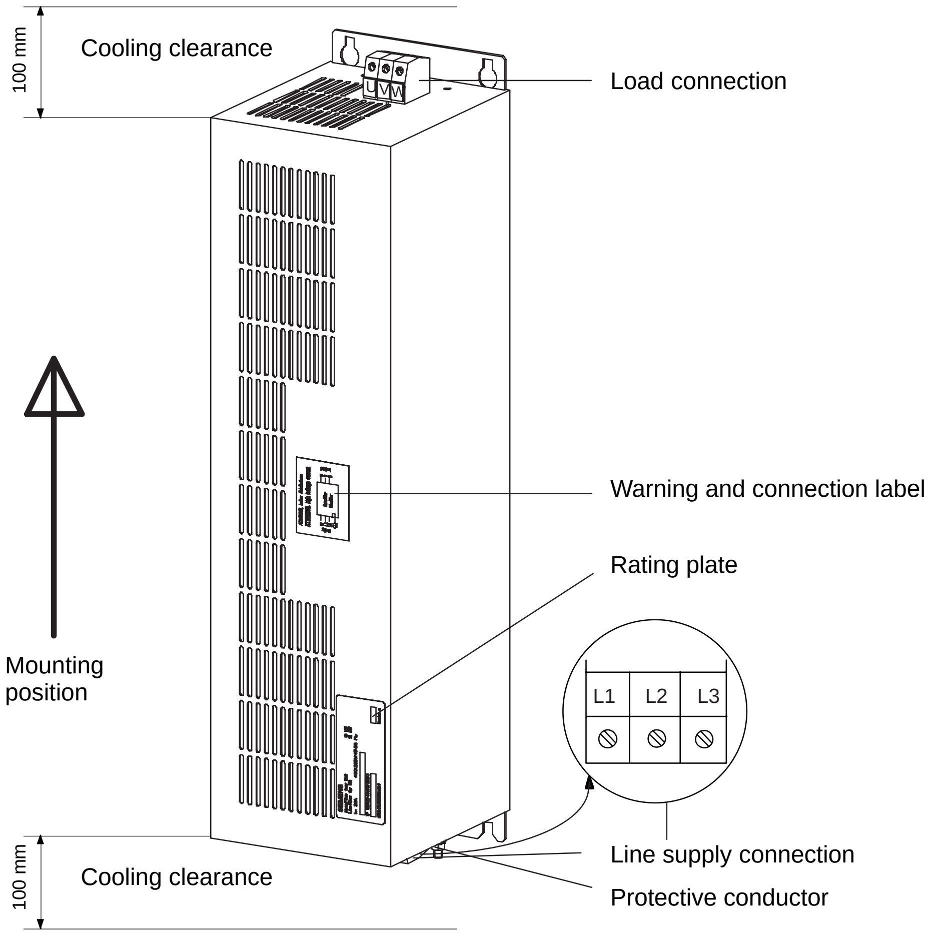
Description

The damping characteristics of wideband line filters not only conform with the requirements of EMC standards for the frequency range of 150 kHz to 30 MHz but also include low frequencies as of 2 kHz. As a result, these line filters have an extended function area, which means that they can, to a certain extent, be used regardless of the machine installation location and any unknown line properties (e.g. line impedance).

These line filters fulfill limit value Class A1 according to EN55011 and should be preferably used.

The total cable length must be less than 350 m (motor cables, power supply cable between the line filter and the module).

Interfaces



Note:

- If the line supply and load connections are interchanged, this will immediately damage the components!
- Carefully note the mounting position, base mounting is possible. However, the appropriate cooling must be guaranteed.

Fig. 7-12 Wideband line filter (example 16 kW)

Caution

The connections/terminals may not be interchanged:

- Incoming line supply cable to LINE/NETZ L1, L2, L3
- Outgoing cable to the line reactor to LOAD/LAST U, V, W

If this is not observed, the line filter could be damaged.

Table 7-13 Assigning the wideband 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
Rated AC current	30 A	67 A	103 A	150 A	225 A
Supply voltage	3–ph. 380 V –10 % ... 3–ph. 480 V AC +10 % (TN line supply)1); 47 ... 63 Hz				
Order number	6SL3000–0BE21–6AA□	6SL3000–0BE23–6AA□	6SL3000–0BE25–5AA□	6SL3000–0BE28–0AA□	6SL3000–0BE31–2AA□
Mounting position	Wall or base/floor mounting, refer to Fig. 7-12				
Dimensions (W x H x D), approx.	130x480x150	130x 480x245	130x480x260	200x480x260	300x480x260
Module width	Refer to dimension drawings, Chapter 11				
Weight, filter	9 kg	16 kg	19 kg	22 kg	32 kg
Power loss	70 W	90 W	110 W	150 W	200 W
Connection	16/10 mm^2 3) /1.5 Nm PE, M5 studs /3 Nm2)	50 mm^2 /6 Nm PE, M8 studs /13 Nm2)	50 mm^2 /6 Nm PE, M8 studs /13 Nm2)	95 mm^2 /15 Nm PE, M8 studs /13 Nm2)	Connection strap: d = 11 mm (M10/25 Nm)5) PE, M8 studs /13 Nm2)
Terminals Line supply connection (line)	L1, L2, L3, PE	L1, L2, L3, PE	L1, L2, L3, PE	L1, L2, L3, PE	L1, L2, L3, PE
terminals Load connection (load)	U, V, W	U, V, W	U, V, W	U, V, W	U, V, W
I_{rated} fuse4)	35 A	80 A	125 A	160 A	250 A
Permissible ambient temperature • Operation • Storage/transport	0 ... +40 °C; max. +55 °C for 0.6 x P_N of the I/R module –25 ... +70 °C				
Cooling	Natural cooling				
Degree of protection acc. to DIN EN 60529 (IEC 60529)	IP20				
Installation altitude	1000 m, for power de–rating, up to 2000 m above sea level				
Radio interference suppression EN 55011	Limit value Class A for cable–borne interference if systems are engineered according to the Configuration Manual Limit value Class B for cable–borne faults and disturbances on request				

1) The permissible supply voltage of the system depends on the infeed module used.
2) For ring cable lugs to DIN 46234.
3) The 1st data apply for pin–type cable lugs, the 2nd data apply to finely–stranded conductors without end sleeves
4) The fuse used must have this rated current. Recommendations for the fuses, refer to Table 7-3.
5) Note: No shock–hazard protection (IP00)

Table 7-14 Assigning wideband line filters 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, 36 kW
Rated AC current	16 A	25 A	65 A
Order number	6SN1111–0AA01–1BA□[3)]	6SN1111–0AA01–1AA□[3)]	6SN1111–0AA01–1CA□[3)]
Supply voltage	3–ph. 380 V –10 % ... 3–ph. 480 V AC +10 % (TN line supply)[1)]; 47 ... 63 Hz		
Mounting position	any		
Dimensions (W x H x D), approx.	156 x 193 x 81	156 x 281 x 91	171 x 261 x 141
Module width	Refer to dimension drawings, Chapter 11		
Weight, filter	3.8 kg	5.7 kg	12.5 kg
Power loss	20 W	20 W	25 W
Connection	4 mm^2 /1.5 Nm PE, M6 studs /3 Nm	10 mm^2 /1.5 Nm PE, M6 studs /3 Nm	50 mm^2 /6 Nm PE, M10 studs
Terminals Line supply connection (line)	L1, L2, L3, PE	L1, L2, L3, PE	L1, L2, L3, PE
terminals Load connection (load)	U, V, W	U, V, W	U, V, W
I_{rated} fuse[2)]	16 A	25 A	80 A
Permissible ambient temperature • Operation • Storage/transport	0 ... +40 °C; max. +55 °C for 0.6 x P_N of the UI module –25 ... +70 °C		
Cooling	Natural cooling		
Degree of protection acc. to DIN EN 60529 (IEC 60529)	IP20		
Installation altitude	1000 m, for power de–rating, up to 2000 m above sea level		
Radio interference suppression EN 55011	Limit value Class A for cable–borne interference if systems are engineered according to the Configuration Manual Limit value Class B for cable–borne faults and disturbances on request		

1) The permissible supply voltage of the system depends on the infeed module used.
2) The fuse used must have this rated current. Recommendations for the fuses, refer to Table 7-3.
3) Last position of the Order No. ≥ 1

7

7.5.3 Basic line filter for I/R modules

Description

The basic line filter for I/R modules are designed for use in machines in which the conducted interference in the frequency range is to be reduced in accordance with EMC regulations.

The machine manufacturer must carry out EMC–compliant CE certification for the product before it is implemented.

Note

The company that puts the machine on the market takes full responsibility for ensuring CE EMC conformity and that the basic line filter is used correctly. The machine manufacturer (OEM) must have the machine conformity confirmed (e.g. by the EPCOS Company; mailto:emv.labor@epcos.com).

The basic line filters can be used in accordance with the following general conditions for ensuring CE conformity with regard to conducted interference:

- The machine/system must only be used in industrial networks.
- No. of axes <12.
- Total cable lengths <150 m (motor cables, power supply cable between the line filter and I/R module).

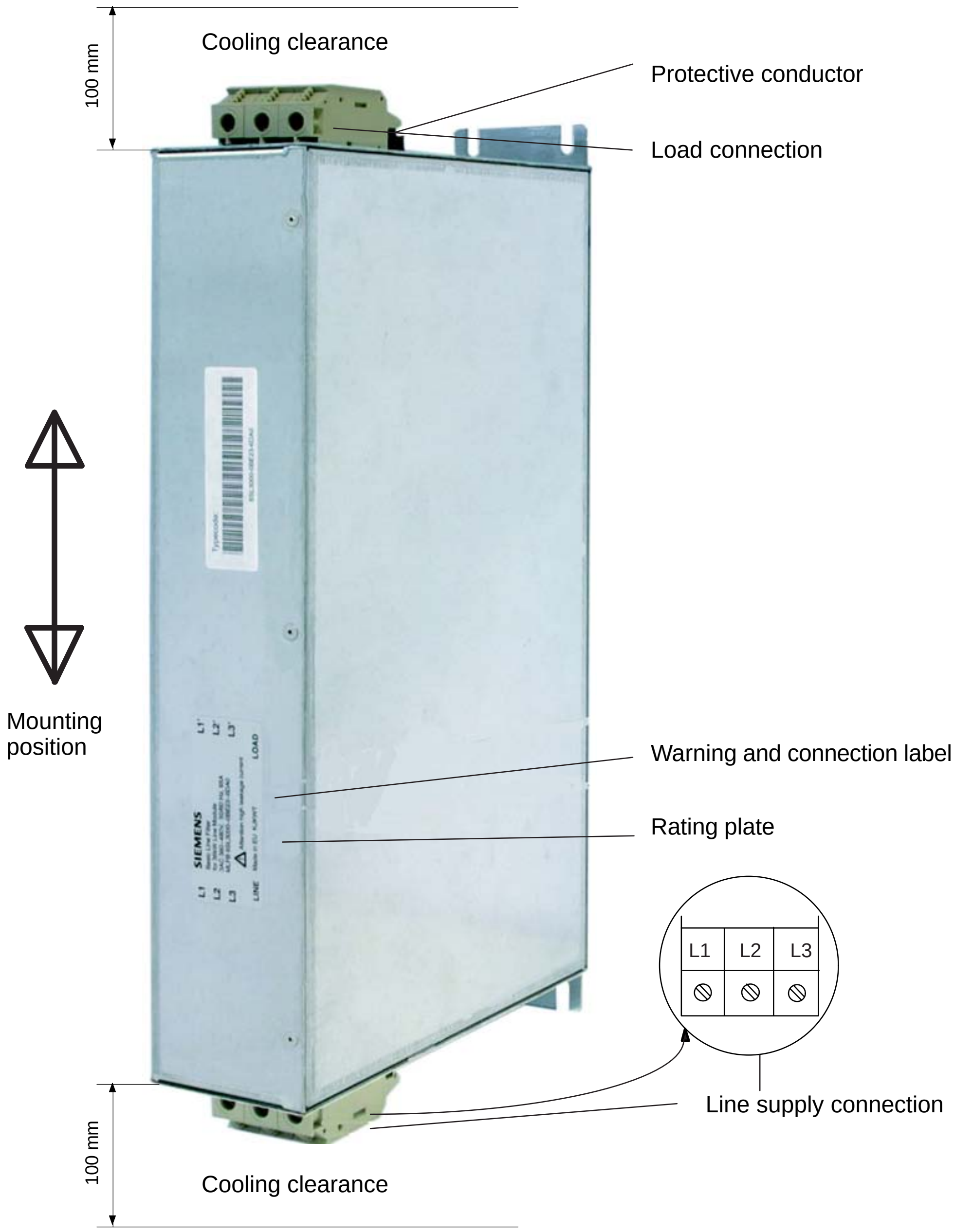
Caution

The connections/terminals may not be interchanged:

- Incoming line supply cable to LINE/NETZ L1, L2, L3
- Outgoing cable to the line reactor to LOAD/LAST L1’, L2’, L3’

If this is not observed, the line filter could be damaged.

Interfaces



Note:

- If the line supply and load connections are interchanged, this will immediately damage the components!
- Carefully note the mounting position, base mounting is possible. However, cooling must be guaranteed and it is not permissible to interchange the line supply and load connection!

Fig. 7-13 Basic line filter for I/R module (example 36 kW)

Table 7-15 Assigning the basic 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 kW3)	I/R module 120/156 kW3)
Filter components	Line filter 16 kW	Line filter 36 kW	Line filter 55 kW	Line filter 80 kW	Line filter 120 kW
Rated AC current	36 A	65 A	105 A		
Supply voltage	3–ph. 380 V AC – 10 % ... 3 –ph. 480 V + 10 % /–15 % < 1 min) (TN line supply)1); 47 ... 63 Hz				
Order number	6SL3000–0BE21–6DA□	6SL3000–0BE23–6DA□	6SL3000–0BE25–5DA□		
Mounting position	Wall or base/floor mounting, refer to Fig. 7-13				
Dimensions (W x H x D), approx.	50x429x226	75x 433x226	100x466x226		
Module width	Refer to dimension drawings, Chapter 11				
Weight, filter	5 kg	6.5 kg	11.5 kg		
Power loss	16 W	28 W	41 W		
Connection	10 mm^2 /1.5 Nm PE, M6 studs /3 Nm2)	35 mm^2 PE, M6 studs /3 Nm2)	50 mm^2 PE, M6 studs /3 Nm2)		
Terminals Line supply connection (line)	L1, L2, L3, PE	L1, L2, L3, PE	L1, L2, L3, PE		
terminals Load connection (load)	L1', L2', L3', PE	L1', L2', L3', PE	L1', L2', L3', PE		
I_{rated} fuse4)	35 A	80 A	125 A		
Compatibility, residual current protective devices	The discharge current is limited to approx. 110 mA in conjunction with a universally current sensitive residual current protective device and Siemens cables and the 150 m cable.				
Permissible ambient temperature • Operation • Storage/transport	0 ... +40 °C; max. +55 °C for 0.6 x P_N of the I/R module –25 ... +70 °C				
Cooling	Natural cooling				
Degree of protection acc. to DIN EN 60529 (IEC 60529)	IP20				
Installation altitude	1000 m, for power de–rating, up to 2000 m above sea level				
Radio interference suppression EN 55011	Limit value Class A for cable–borne interference if systems are engineered according to the Configuration Manual Limit value Class B for cable–borne faults and disturbances on request				

1) The permissible supply voltage of the system depends on the infeed module used.
2) For ring cable lugs to DIN 46234
3) Being prepared
4) The fuse used must have this rated current. Recommendations for the fuses, refer to Table 7-3.

7.5.4 Line filter package and adapter set

Filter packages must be combined for shipment under a sales parts list comprising HF/HFD reactor and wideband line filter in order to simplify order administration. The order numbers, MLFB of HF–/HFD reactor and line filter remain unchanged in the original!

Adapter sets are available to facilitate an extremely compact installation of the 16 kW or 36 kW and the wideband filter. The mounting depth extends beyond the front plane of the drive group by 20 mm to 30 mm (dimension drawings, refer to Chapter 11).

Fig. 7-14 Line filter package with an adapter set (example 6SL3060–1FE21–6AA0)

Table 7-16 Line filter packages and adapter set

	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**
HF filter package Order No. 6SL3000–	0FE21–6AA□	0FE23–6AA□	0FE25–5AA□	0FE28–0AA□	0FE31–2AA□
	Content				
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□
6SL3000–	Line filter 16 kW 0BE21–6AA□	Line filter 36 kW 0BE23–6AA□	Line filter 55 kW 0BE25–5AA□	Line filter 80 kW 0BE28–0AA□	Line filter 120 kW 0BE31–2AA□
HFD filter package Order No. 6SL3000	0FE21–6BA□	0FE23–0BA□	0FE25–5BA□	0FE28–0BA□	0FE31–2BA□
	Content				
6SL3000–	HFD commutating reactor 16 kW 0DE21–6AA□	HFD commutating reactor 36 kW 0DE23–6AA□	HFD commutating reactor 55 kW 0DE25–5AA□	HFD commutating reactor 80 kW 0DE28–0AA□	HFD commutating reactor 120 kW 0DE31–2AA□
6SL3000–	Line filter 16 kW 0BE21–6AA□	Line filter 36 kW 0BE23–6AA□	Line filter 55 kW 0BE25–5AA□	Line filter 80 kW 0BE28–0AA□	Line filter 120 kW 0BE31–2AA□
Adapter set Order No.	6SL3060–1FE21–6AA□	6SN1162–0GA00–0AA□	–	–	–

■

Space for your notes

Important Circuit Information

8

8.1 General information

Note

The following circuit examples, information and descriptions are of a general nature and are not binding from a legal perspective. Every system must be adapted to ensure that it is complete and is correct for the particular application.

These circuit examples are intended to support the machinery construction OEM/user when integrating the SIMODRIVE 611 drive system – from the control perspective – into the overall control concept of his machine/system.

The user is responsible in ensuring that the overall control is in compliance with the Guidelines/Standards applicable for his particular application and the safety measures, derived from the hazard analysis/risk assessment to avoid injury to personnel and damage to machine, have been appropriately engineered and implemented.

Warning

After the line isolating devices (main switch/breaker) or the line contactor have been opened, residual energy and hazardous touch voltages up to 60 V DC are still available at the power DC link of the drive group while the DC link capacitors discharge – max. 30 min. This means that these hazardous touch voltages are also available at components that are electrically connected to the DC link (terminals, cables, switching devices, motors etc.). This must be carefully taken into consideration as part of the hazard analysis/risk assessment.

Service personnel must ensure that the complete plant or system is actually in a no–voltage condition before they carry–out any service, maintenance and cleaning work!

Warning

Before the drive group is powered–up or powered–down using the line supply isolating device (main switch/breaker) or a line contactor, 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.

For specific drive configurations it may not be necessary to use a leading contact when powering–down the NE modules. For information refer to Chapter 7.3.6.

Warning

If the electronics power supply of the NE or monitoring module is connected in front of the commutating reactor directly at the line supply at the 2U1–2V1–2W1 terminals, with a six–conductor connection, then a connection between X181: P500/M500 and the DC link P600/M600 is not permissible in order to avoid damage to the equipment, refer to Chapter 9.13.

Warning

In order to shutdown the system when the power fails using the DC link energy then it is possible to have a connection between terminal P500/M500 and the DC link P600/M600.

This connection must be safely and reliably disconnected at each power–off operation using the line contactor or in the setting–up mode using, for example, a contactor with ”safe separation”, refer to Chapter 8.13.

Warning

When the NE module is connected–up using a six–conductor connection, and the electronics power supply is connected directly to the line supply, the jumpers in connector X181 at the NE module, inserted when the equipment is supplied, must be removed, refer to Chapter 8.14.

Warning

The input and output side connections at the line filter may not be interchanged in order to avoid damage to the equipment.

Warning

In the setting–up mode, the ”reduced” DC link voltage should first be ramped–up and then after this has been completed the enable signals may be issued.

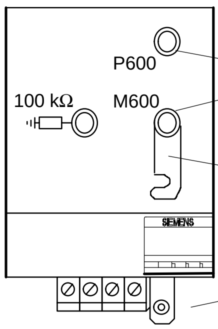


Fig. 8-1 NE module

Warning

The grounding bar is used to ground the DC link M rail through 100 kΩ. It must be inserted when connected to non TN line supplies and it is not permissible to insert it when using residual current protective devices.

If the system is subject to a high–voltage test, then the grounding bar must be opened.

8

Note

Electrically disconnecting the line supply from the power circuit of the drive group using the internal line contactor.

The coil circuit can be disconnected in order to reliably open (de–energize) the line contactor using external electrically isolated contacts via terminals NS1, NS2 at the NE. The DC link is not pre–charged if the connection is missing when the unit is powered–up. The state of the contactor (whether it is open/de–energized) can be interrogated using terminals 111, 113, 213.

The NS1, NS2 connection may only be opened if terminal 48 and/or terminal 63 are de–energized using a leading contact, or is simultaneously opened when these terminals are de–energized, refer to Chapter 8.7.

8.2 Infeed modules

8.2.1 Three–conductor connection (standard circuit)

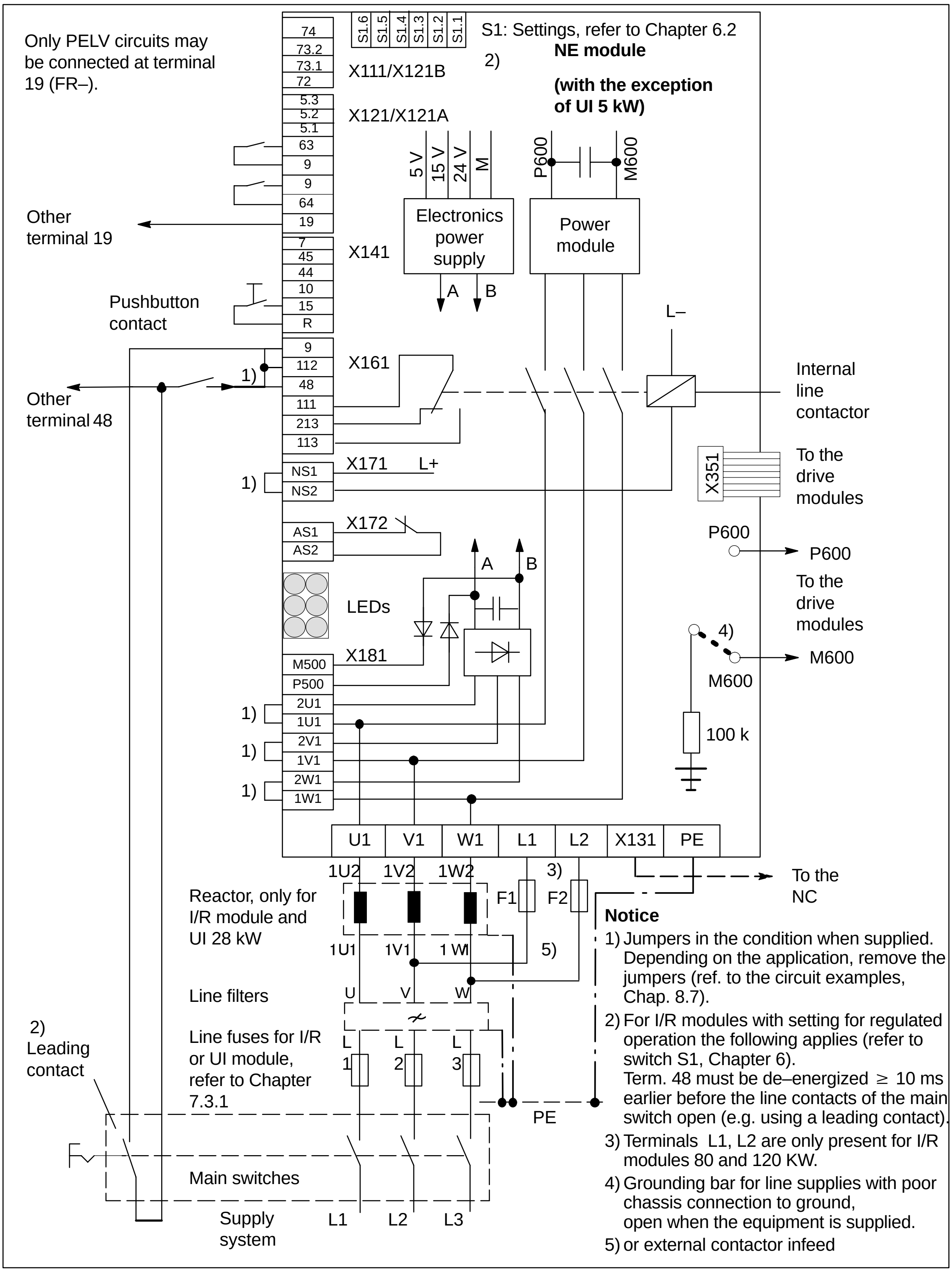


Fig. 8-2 Three–conductor connection (standard circuit)

8.2.2 Description of the interfaces and functions

Table 8-1 Overview, infeed modules, internal cooling, commutating reactors, line filters, fuses

Power [KW] S1/S6/S_{max}	Order number	HF commutating reactor	HFD commutating reactor	Line filter [1]	HF line filter package	HFD line filter package	Fuse [3] [A]
UI 5/6.5/10	6SN1146–1AB0□–0BA1	2) –	–	6SN1111–0AA01–1BA□	–	–	16
UI 10/13/25	6SN1145–1AA0□–0AA1	2) –	–	6SN1111–0AA01–1AA□	–	–	25
UI 28/36/50	6SN1145–1AA0□–0CA0	6SN1111–1AA00–0CA□	–	6SN1111–0AA01–1CA□	–	–	80
I/R 16/21/35	6SN1145–1BA0□–0BA1	6SN1111–0AA00–0BA□	6SL3000–0DE21–6AA□ [4]	6SL3000–0BE21–6AA□	6SL3000–0FE21–6AA□	6SL3000–0FE21–6BA□ [4]	35
I/R 36/47/70	6SN1145–1BA0□–0CA1	6SN1111–0AA00–0CA□	6SL3000–0DE23–6AA□	6SL3000–0BE23–6AA□	6SL3000–0FE23–6AA□	6SL3000–0FE23–6BA□	80
I/R 55/71/91	6SN1145–1BA0□–0DA1	6SN1111–0AA00–0DA□	6SL3000–0DE25–5AA□	6SL3000–0BE25–5AA□	6SL3000–0FE25–5AA□	6SL3000–0FE25–5BA□	125
I/R 80/104/131	6SN1145–1BB0□–0EA1	6SN1111–0AA00–1EA□	6SL3000–0DE28–0AA□	6SL3000–0BE28–0AA□	6SL3000–0FE28–0AA□	6SL3000–0FE28–0BA□	160
I/R 120/156/175	6SN1145–1BB0□–0FA1	6SN1111–0AA00–1FA□	6SL3000–0DE31–2AA□	6SL3000–0BE31–2AA□	6SL3000–0FE31–2AA□	6SL3000–0FE31–2BA□	250

Notes:
1) The line filter does <u>not</u> include the commutating reactor! This must be additionally installed between the line filter and I/R !
   The line filter package comprises a commutating reactor and a line filter; they are separately combined to form a package.
2) The commutating reactor is included in the NE module.
3) Version NH, D, DO, gL
4) Being prepared

Note

The maximum cable length at the terminals of connector X161 is 30 m.

Switch S1

Switch S1 to set various functions is provided on the upper side of the NE and monitoring modules or on the front side/panel for the UI module 5 kW, refer to Chapter 6.2.

Terminal 19

FR–

Reference potential for the enable voltage terminal 9, non–floating (with electrical isolation) (connected to the general reference ground terminal 15 through 10 kΩ). It is not permissible that terminal 19 is connected to terminal 15! (connect to the PE bus or X131).

When controlling the enable signals using electronic outputs that switch to P (PLC), terminal 19 must be connected to the 0 V reference potential (ground) of the external power supply.

The circuit/current source must comply with the requirements specified by PELV (Protection Extra Low Voltage), extra low functional voltage with protective separation according to EN 60204–1; 6.4.

8

Terminal 9

FR+

Only use the +24 V enable voltage for the internal enable signals of the NE and drive modules.

Maximum power supply load: 500 mA
(corresponds to 8 EP; 1 optocoupler input requires 12 mA, for UI 5 kW —> 1 A)

Terminal 48

Start

This terminal has the highest priority. A defined power–on and power–off sequence of the NE module is initiated using terminal 48.

If terminal 48 is energized, then internally the pre–charging operation is initiated (interrogation $V_{DC\ link} \geq 300$ V and $V_{DC\ link} \geq \sqrt{2} \bullet V_{line\ supply} - 50$ V). After the DC link has been charged, then, simultaneously

- after 500 ms —> the pre–charging contactor is opened and the main contactor is closed.
- after 1s —> the internal enable signals are then issued.

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 delayed by the drop–out time of the internal line contactor.

If terminal 48 is de–energized during a charge operation, then this is first completed and terminal 48 is only inhibited after the charge operation has been completed under the assumption that terminals NS1–NS2 are jumpered.

Terminals NS1, NS2

Coil circuit of the internal line and pre–charging contactor

If the line contactor is opened (de–energized) by interrupting the coil circuit using electrically isolated (floating) contacts, then the DC link is safely and electrically disconnected from the line supply (signal contact, terminals 111–213 must be interrogated).

The terminals have a safety–relevant function. The shutdown using terminals NS1–NS2 can be realized at the same time or delayed to terminal 48 Start (refer to Chapter 8.7 Circuit examples = 2 and = 4).

Max. cable length 50 m (2–conductor cable) for 1.5 mm^2 cross–section

Terminal 63

Pulse enable

For the pulse enable and inhibit functionality, this terminal has the highest priority. The enable and inhibit functions are effective after approx. 1 ms simultaneously for all of the modules including the NE module. When the signal is withdrawn, the drives ”coast down” unbraked.

Standby operation of the infeed:

If an infeed module is to be kept in the ready state for a longer period of time (DC link charged), then in order to avoid unnecessary switching losses and reactor losses, a pulse inhibit should be enabled! The DC link voltage then remains at the non–regulated value and is again ready in the regulated mode immediately after the pulses have been enabled.

Terminal 64

Drive enable

The drive modules are enabled using terminal 64. The modules are simultaneously enabled or inhibited after approx. 1 ms.

If terminal 64 is inhibited, then $n_{set} = 0$ is set for all drives and the axes brake as follows:

- For 611D/611 universal/ANA/HLA drives, after a selectable speed has been fallen below or after a selectable timer stage has expired, the impulses are cancelled. The axes brake along the selected limits (MD 1230, 1235, 1238).

  For spindles, a ramp can only be achieved using regenerative limiting (MD 1237).

Terminals L1, L2

External switching voltage for the coil circuit of the line contactor

Is used to supply the coil circuit of the internal line contactor only at the 80 kW and 120 kW I/R modules
(do not connect between the I/R module and reactor).

Fuse: I_N ≥4 A, version gL
2AC 360 ... 457 V / 45 ... 53 Hz; 400 ... 510 V / 57 ... 65 Hz

Table 8-2 Technical data of the internal line and pre–charging contactor

I/R module	Type	Pull–in power [VA]		Holding power [VA]	
		50 Hz	60 Hz	50 Hz	60 Hz
6SN114□–1BB0□–0EA1	3TK48	330	378	36	44.2
6SN114□–1BB0□–0FA1	3TK50	550	627	32	39

Matching transformer for the coil connections L1, L2 at the line supply voltage 230 V and 380 V; for two contactors 5TK5022–0AR0.

Table 8-3 Matching transformer SIDAC 1–phase autotransformer

	For 50 Hz line supplies	For 60 Hz line supplies
Type	4AM4096–0EM50–0AA0	4AM4696–0EM70–0FA0
Throughput rating [VA]	80	80
Input voltage [V]	380/230	380/230
Output voltage [V]	415 (min. 360/max. 458)	460/415
Output current [A]	0.193	0.19...0.17
Insulating material class	T40/B	T40/B
Regulations	EN 61558–13	VDE 0532
Frequency [Hz]	50/60	50/60
Vector group	IA0	Ii0
Degree of protection	IP00	IP00
Dimension sketch	PD10 T8/2	LV 10
for voltage fluctuations	+10% –13.2 %	+10% –13.2 %

Note

If, for the 80/104 kW or 120/156 kW I/R module, the line supply voltage at terminals L1, L2 fails or fuses F1, F2 rupture, then only the pulses in the I/R module are cancelled and the internal line contactor drops–out.

This is displayed using the line fault LED, the ready relay and also the contactor signaling contacts. In this case, in order to re–close the internal line contactor, terminal 48 must be inhibited (de–energized) and re–energized after ≥1 s or the unit must be powered–down/powered–up.

Terminal R

Reset

The fault signal is reset using a pushbutton (pulse edge) between terminal R and terminal 15.

For the SIMODRIVE 611 universal HRS control unit, the reset is effective if, in addition, terminal 65 ”controller enable” is also inhibited.

Terminal 112

Set–up operation

Terminal 112 is jumpered, as standard with terminal 9 (+24 V enable voltage).

In the setting–up mode (terminal 112 open), the drive machine data apply:

- MD 1239 torque limit (ROT) or force limit (LIN) setting–up operation [%]
- MD 1420 maximum motor speed (ROT) or velocity (LIN), setting–up operation [RPM or m/min]

Setting–up operation is displayed in the ”Service Overview” and ”Service Drive”.

Terminals AS1, AS2

Signaling contact, start inhibit DC link controller

Terminals AS1 – AS2 closed means that ”start inhibit is effective”
(i.e. terminal 48 = open, setting–up operation)

(not available for UI modules 5 kW, 10 kW, 28 kW)

Terminal X131

Reference potential, electronics

X131 must be connected to the NC reference potential when establishing a coupling to a numerical control with analog setpoint interface. This cable must be routed in parallel to the speed setpoint cable.

Cross–section = 10 mm^2!

For a digital drive group with SINUMERIK 840D/810D or
SIMODRIVE 611 universal HRS/ E HRS, terminal X131 does not have to be connected as the connection is already established to PE within the unit.

Terminals 7, 45, 44, 10, 15 (X141)

Electronics power supply

- Terminal 7: P24 +20.4...28.8 V/50 mA
- Terminal 45: P15 +15 V/10 mA
- Terminal 44: N15 –15 V/10 mA
- Terminal 10: N24 –20.4 ÷ 28.8 V/50 mA
- Terminal 15: M 0 V (only for circuits of terminals, term. 7, term. 45, term. 44 and term. 10; max. load, 120 mA)
  - Terminal 15 may not be connected to PE (ground loop)
  - Terminal 15 may not be connected to terminal 19 (otherwise there will be a short–circuit through the reactor; terminal 15 is internally connected to X131).

Terminals 2U1, 2V1, 2W1

Connecting terminals to separately supply the internal electronics power supply, e.g. through fused terminals (refer to the circuit example in Chapter 8.3.1).

In this case, jumpers 1U1–2U1, 1V1–2V1, 1W1–2W1 must be removed.

Notice

Observe additional information and instructions under Chapter 8.3 Monitoring module, and Chapter 8.14 Six–conductor connection!

Terminal P500, M500

Connection, P500 and M500 to internally couple the power supply to the DC link, 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. The jumpers at connector X181 must under all circumstances be kept!

For a six–conductor connection (refer to Chapter 8.14) a connection between P500/M500 and the DC link P600/M600 is not permissible; otherwise, the power supply will be destroyed!

Terminals 111, 113, 213

Signaling contacts, internal line contactor

111–113	NO contact
111–213	NC contact

Terminals 72, 73.1, 73.2, 74 (X111)

Ready relay

Terminals 72 – 73.1: NO contact	– closed for ”Ready”
Terminals 73.2 – 74: NC contact	– open for ”Ready”

In addition to the interface signals provided for the 611D, the terminal signal 72/73 also includes the line supply infeed monitoring as well as signals from the watchdog and the reset controller of the closed–loop control. These signals are available to the control unit independently of the processor.

The function of terminals 72/73 is not a safety function in the sense of the Machinery Directive 89/392/EEC.

For the switch position S1.2 = OFF ”Ready” the relay pulls–in if the following conditions are fulfilled:

- Internal main contactor CLOSED (terminals NS1 – NS2 connected, terminal 48 enabled)
- Terminals 63, 64 = On
- It is not permissible that a fault is present (also not at the 611D/611 universal drives)
- FD with High Standard/High Performance or resolver must be enabled for the ready setting (terminals 663, 65)
- The NCU/CCU must have booted (SINUMERIK 840D, 810D)

For the switch position S1.2 = ON ”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 a fault is present (also not at the 611D/611 U drives)
- The NCU/CCU must have booted (SINUMERIK 840D, 810D)

If there is a fault, the relay drops–out.

With the exception of the line monitoring function, all of the internal monitoring functions on all of the drive modules are effective at the relevant equipment bus and also the ready signal. For line supply faults, only the I/R module pulses are inhibited.

Notice

The ready signal should be evaluated in the external NC control in order to derive enable signals, inhibit signals, fault responses etc.

Terminals 5.1, 5.2, 5.3 (X121)

I^2t pre–warning and motor temperature monitoring

Terminals 5.1 – 5.2: NO contact   open for ”no fault”

Terminals 5.1 –5.3: NC contact   closed for ”no fault”

The relay pulls–in, if:

- At the NE module
  - heatsink–temperature monitoring responds
- At FD 611D
  - motor–temperature monitoring responds
  - heatsink–temperature monitoring responds
- At 611universal HRS
  - motor–temperature monitoring responds
  - heatsink–temperature monitoring responds

Input current, enable circuits:

Terminals 48, 63, 64 and 65: Input current, optocoupler approx. 12 mA at +24V

Terminal 663: Input current, optocoupler and start inhibit relay approx. 30 mA at +24 V

When selecting the switching devices and the auxiliary contact on the main switch, the contact reliability when switching low currents must be carefully taken into consideration.

Switching capacity of the signaling contacts:

The max. switching power of the signaling contacts is specified in the interface overviews of the modules in Chapter 5 and 6 must be absolutely complied with!

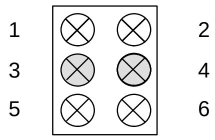
Note

All of the connected actuators, contactor coils, solenoid valves, holding brakes etc. must be provided with overvoltage limiting elements, diodes, varistors, etc.

This is also applicable for switching devices/inductances that are controlled from a PLC output.

Display elements (LEDs)

The NE and monitoring modules have the following display elements (LEDs):



1	LED red	– electronics power supply ±15 V faulted
2	LED red	– 5 V voltage level faulted
3	LED green	– external enable signals not present (term. 63 and/or term. 64 missing)
4	LED yellow	– DC link charged (normal operation)
5	LED red	– line supply fault (single or multi–phase power failure at terminals U1, V1, W1) 1) – commutating reactor not available, incorrectly installed or incorrectly selected – system fault level of the line supply or transformer too low
6	LED red	– DC link overvoltage possible causes: Regenerative feedback off, setting–up operation, line fault, for UI, PW either not operational or too small, line supply voltage too high, dynamic overload, line filter inserted between I/R and the commutating reactor

Note:

1) Line supply fault detection time, approx. 30 ms
Line faults are detected from a 3–phase voltage < 280 V and above.
For a 1–phase power failure, after approx. 1 min, the pulses for the drive axes are cancelled (this signal is saved/latched), valid for
Order No. [MLFB] 6SN1114□–1□□0□–0□□**1**

Fig. 8-3 Display element, NE and monitoring module

Effects of the display states:

1	LED red bright:	Pulses are cancelled for the complete drive group
2	LED red bright:	Pulses are cancelled for the complete drive group
4	LED yellow dark:	Pulses are cancelled for the complete drive group
5	LED red bright:	Pulses are only cancelled for the I/R module (regenerative feedback into the line supply no longer possible. Axes initially continue to run. Ready relay drops out)
6	LED red bright:	Pulses are cancelled for the complete drive group

8

Display, line fault

If a line fault is displayed or if the yellow LED is not lit, then the overvoltage limiter module must be checked.

Procedure:

1. Switch the unit into a no–voltage condition
2. Withdraw the overvoltage limiter module and insert connector X181 on the NE module.

   Does the NE module function correctly?

   Yes —> The overvoltage limiter module is defective and must be replaced.

   No—> Check the line supply and possibly the NE module/group

---

Note

Operation can continue, but **without overvoltage protection** when the overvoltage limiter module is withdrawn and connector X181 has been removed from the NE module!

Operation without overvoltage limiter module is not in conformance with UL!

---

3. Insert a new overvoltage limiter module up to its endstop and reinsert connector X181 on the overvoltage limiter module.

8.2.3 Connecting several NE modules to a main switch

A maximum of 6 terminals 48 can be connected in parallel with one another in order to be able to shutdown a maximum of 6 NE modules with one leading contact of the main switch.

Maximum cable length with a 1.5 mm^2 cross–section: 150 m (2–conductor cable)

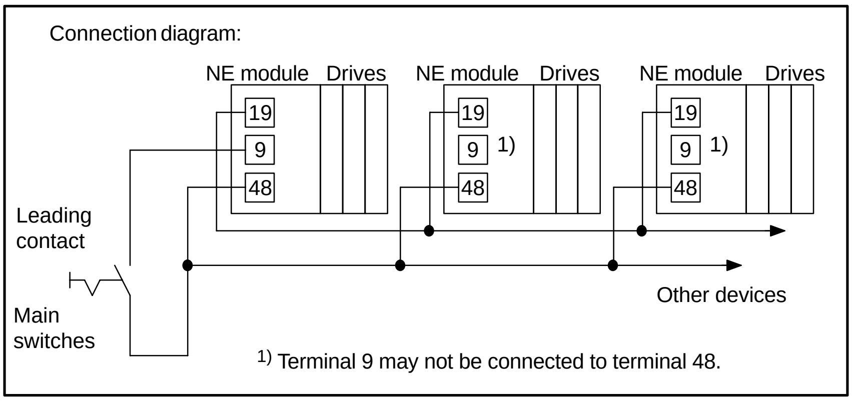


Fig. 8-4 Connection diagram, several NE modules connected to terminal 48

If enable signal terminals are connected in parallel to terminal 48 – e.g. terminal 663 etc. – then due to the higher current load connected to terminal 9, the number of NE modules must be appropriately reduced.

8

Note

If the internal power supply at NE module 1 fails, then the remaining NE modules and drives that are connected are also inhibited. The drives ”coast down” unbraked.

As an alternative to the limited current capability of the internal power supply via terminal 9, the enable voltage can be taken from an external 24 V PELV power supply.

In this case, the terminals 19 of the NE modules must be connected to the 0 V reference potential (ground) of the external power supply.

8.2.4 Application, mode of operation and connection of the line contactor

The infeed modules include an integrated line contactor that is listed in the Catalog.

The line contactor is electronically controlled (energized) via terminal 48.

In order to safely and reliably disconnect the DC link from the line supply, e.g. for stopping in an emergency situation, the coil circuit of the line contactor must additionally be interrupted via terminal NS1–NS2 using electrically isolated (floating) mechanical switching elements. This means that the electronic control has no influence when shutting down with electrical isolation. The cable routing to the connecting terminals must be safely and electrically de–coupled from the electronics.

Before or at the same time that connection NS1–NS2 is interrupted, the line contactor must always be opened using terminal 48.

The NC contact 111–213 of the line contactor, positively–driven with the power contacts, must be included in the feedback circuit of the external, safety–relevant EMERGENCY STOP switchgear combination (safety relay). This means that the function of the line contactor is cyclically monitored.

Notice

In order that the power circuit is safely and reliably isolated from the line supply, it must be carefully ensured that all of the parallel connections to the power infeeds are also electrically isolated through switching contacts. In this case, a possible user–specific external connection between the electronics power supply and the power DC link must be taken into consideration.

In order to shutdown in a controlled fashion when the power fails using the DC link energy, it is possible, for example, to still keep a connection between terminals 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 power DC link could be charged–up via the auxiliary DC link of the electronics power supply.

In the setting–up mode, the connection between the electronics power supply and the power DC link must also be disconnected.

When using a monitoring module, that is connected to the power DC link via P500/M500 and is also, in addition, connected to the line supply, when the line contactor opens, either the connection between the line supply and monitoring module or the connection between P500/M500 and the power DC link must also be reliably and safely disconnected through contacts.

8.2.5 Timing diagram for the ready signal in the I/R module

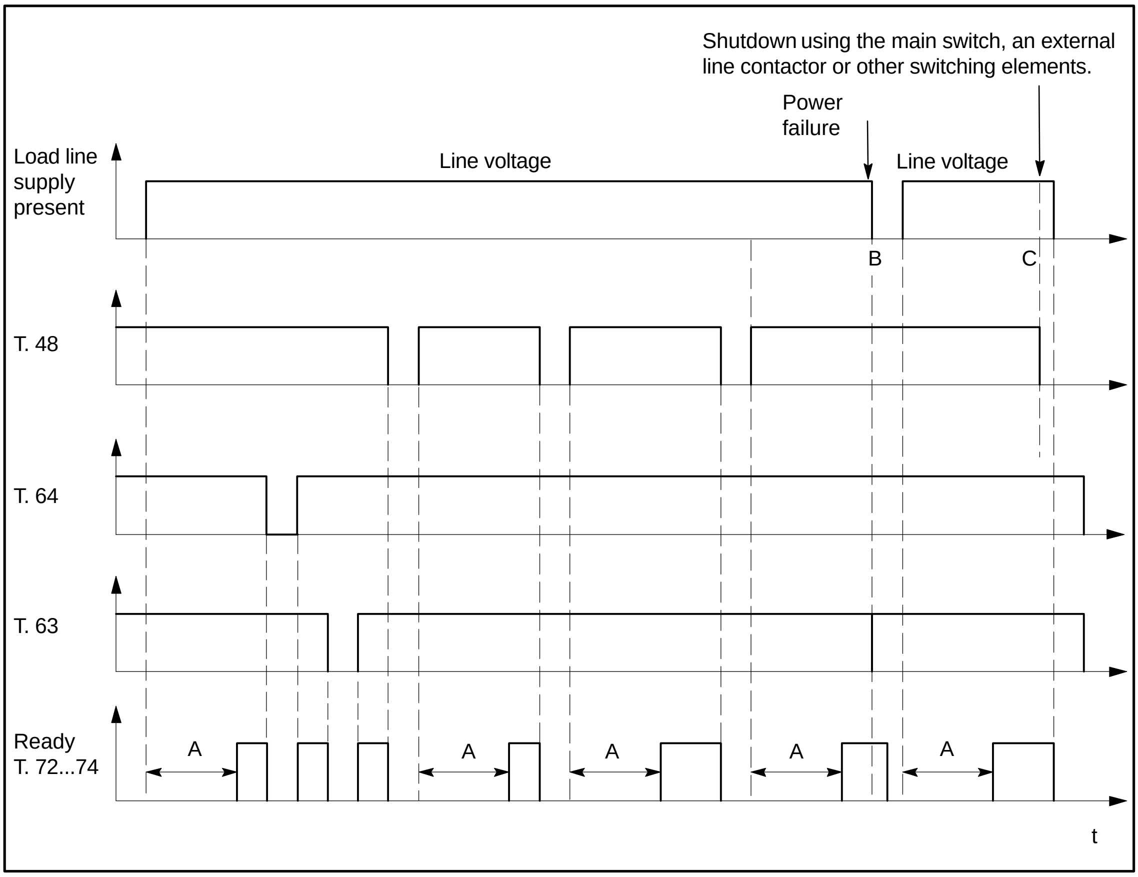


Fig. 8-5 Timing diagram for the ready signal in the I/R module

Switch S1.2 = OFF standard setting in the I/R module "Ready signal"

A

The ready relay can only pull–in if pre–charging has been completed and the internal line contactor has pulled–in.

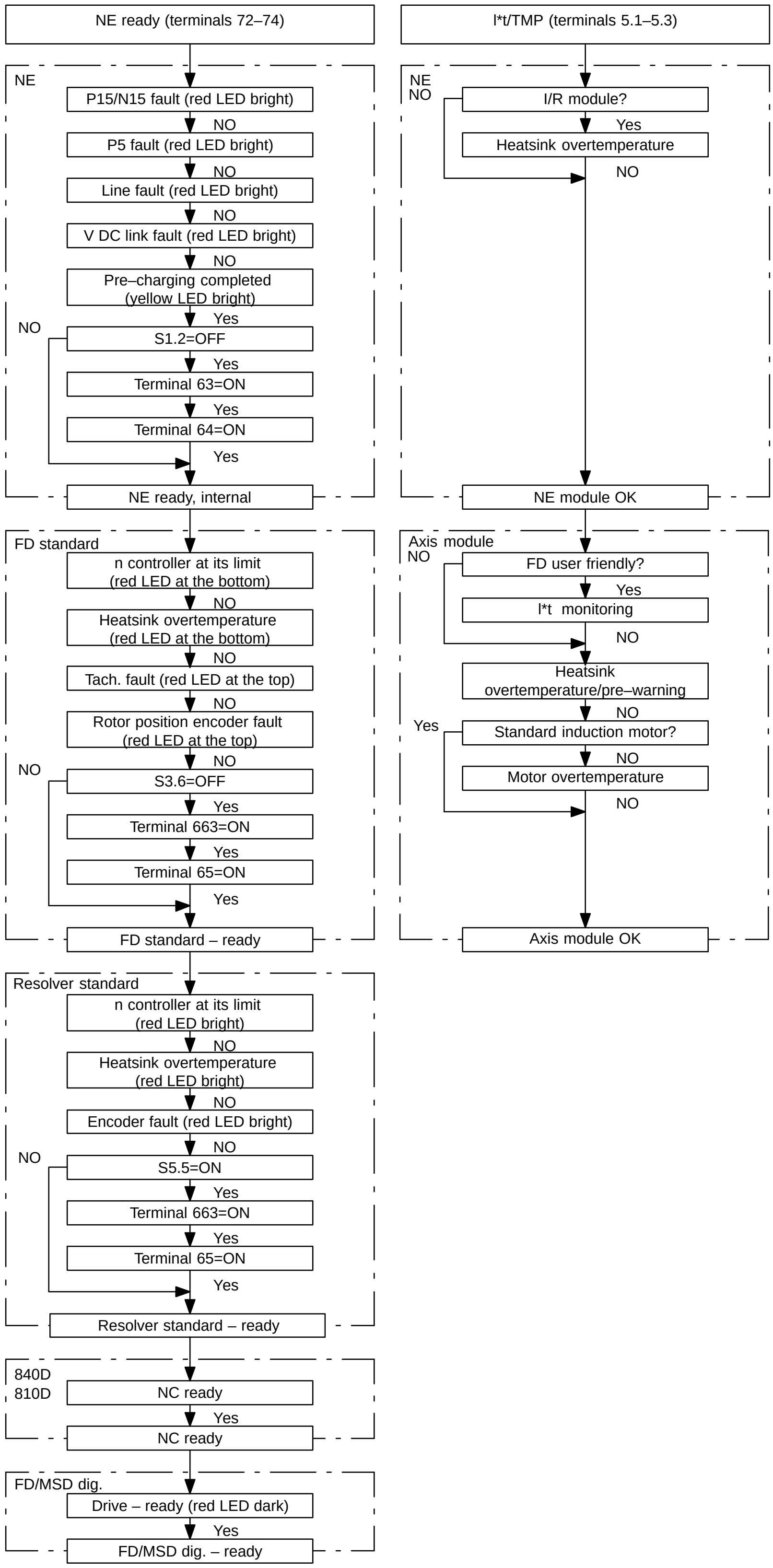
B

When the power fails (line supply failure), the I/R module is internally inhibited. This means that the I/R module can no longer regulate the DC link voltage which means that no braking energy can be fed back into the line supply (no regenerative feedback). The drives are not inhibited, but the ready relay drops–out after the power failure detection time with a delay that depends on the line supply impedances.

C

When the load line supply is disconnected using the main switch or an external line contactor, e.g. for a six–conductor connection (refer to Chapter8.14) or using other switching elements it must be carefully ensured that at least 10 ms beforehand terminal 48 is de–energized at the I/R module. This can be achieved, e.g., by using a main switch with leading contact or interlocking circuits for the external line contactor or other switching elements. The leading shutdown is not required for certain drive configurations. For information refer to Chapter 7.3.6.

8.2.6 Timing diagram, central signals at the NE module



8.3 Axis expansion using a monitoring module

8.3.1 Connection example, power supply (standard)

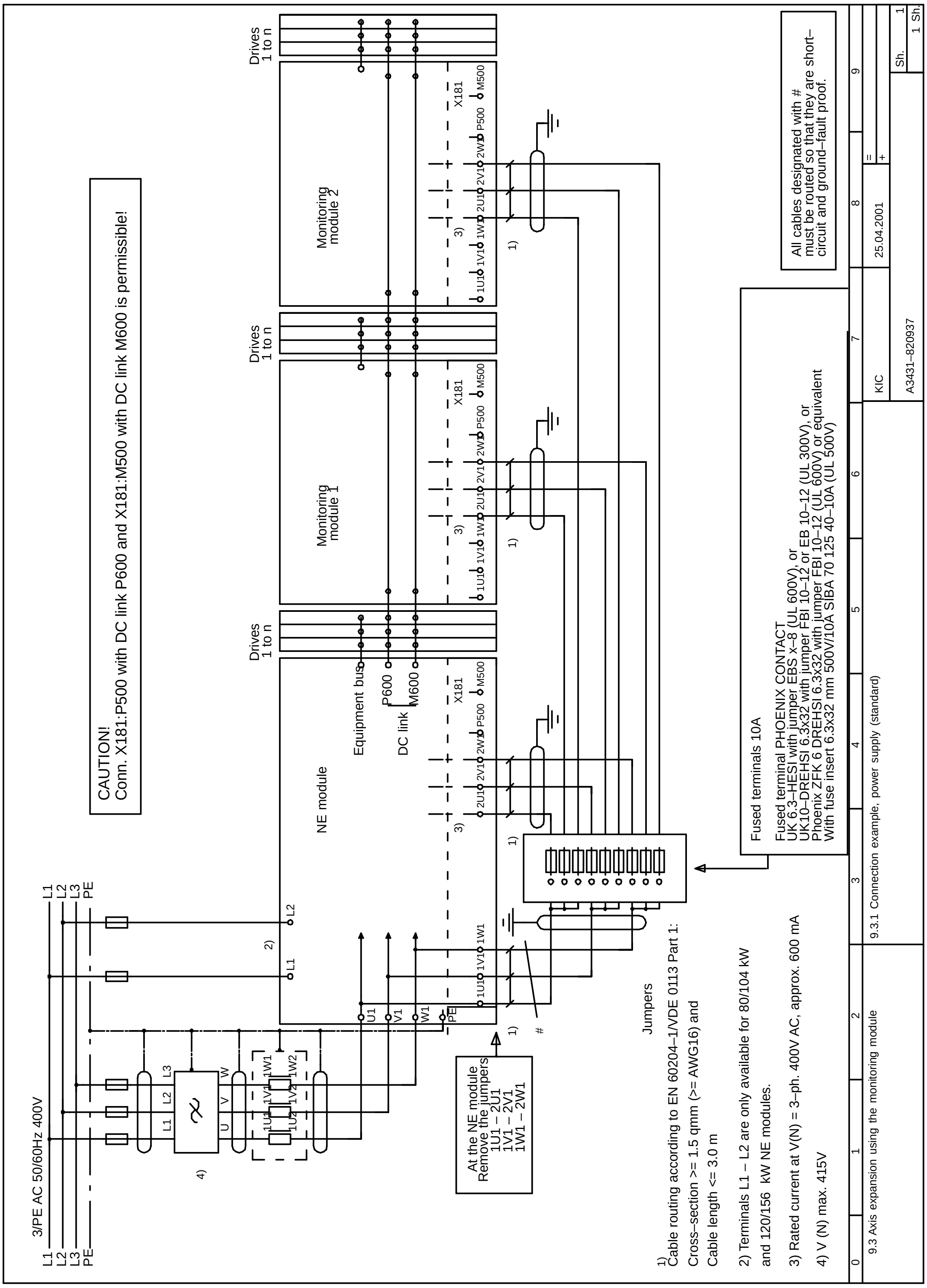


Fig. 8-6 Connection example, power supply (standard)

8.3.2 Connection example, pulse enable

Instantaneous shutdown

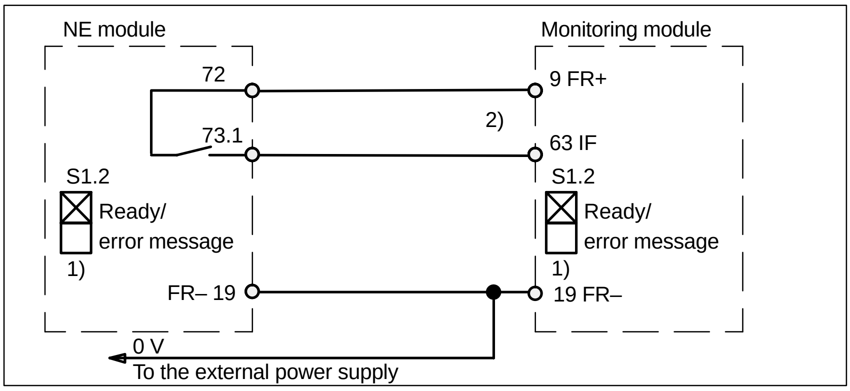


Fig. 8-7 Instantaneous shutdown, pulse enable

Delayed shutdown

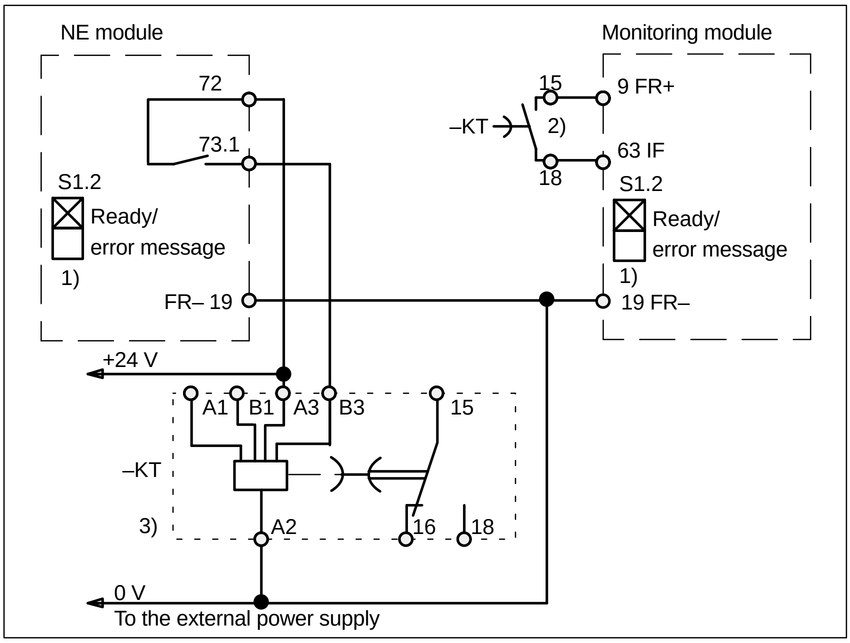


Fig. 8-8 Delayed shutdown, pulse enable

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1) Settings, S1.2 Ready/fault signal, refer to Chapter 6.2.

2) The shutdown function is shown in a simplified fashion without the contacts of the drive–related control.

3) Time relay with delayed drop–out with auxiliary voltage e.g. 3RP1505–1AP30, $t_{(v)} \geq$ max. braking time of the drives after the monitoring module.

8.3.3 Description of the interfaces and functions

General information

The electronics power supply integrated in the NE module supplies the connected drive modules via the equipment bus; and, for the digital drive groups 611 digital, also the SINUMERIK controls 840D or 810D integrated in the group.

The number of modules that can be connected is limited. The connection power of the modules that can be connected is determined by adding the assessment factors regarding the electronics points (EP) and gating points (AP). If the power requirement exceeds the power rating of the NE module power supply, then the drive group must be expanded by one or several monitoring modules. The overall system then includes two or several electronic systems that are independent of one another.

Further, the charge limit of the DC link must be carefully observed (refer to Chapter 1.3).

Enable signals/commands or fault signals only effect the axes connected to a 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. 8-6.

  The connection example shows the three–phase connection of the monitoring modules using fused terminals after the power connection of the NE module.

  As an alternative, the power supply of the monitoring module can also be taken from the P600/M600 power DC link through terminals P500/M500. In this case it must be taken into account that as a result of the limit imposed by the DC link pre–charging circuit in the NE module, a maximum of 2 monitoring modules with the associated axes may be connected. In this case it must be carefully observed that after the line contactor is opened, the DC link voltage decreases and therefore the power supply/communications to the drive modules is interrupted.

  As an alternative to fused terminals, the following circuit–breaker can be used:

  e.g. SIRIUS circuit–breaker, Order No. 3RV1011–1EA1□, (2.8–4 A)
  This should be set to between 3.5 and 4 A. Although the active current drain of the monitoring module is approx. 1 A, the rated current of the circuit–breaker should be selected somewhat higher due to the high–frequency harmonic components. When a connection cross–section of 1.5 mm^2 is used, this therefore guarantees adequate cable protection.

- Connection example, pulse enable —> refer to Chapter 8.3.2

  The axes connected after the monitoring module may only be enabled if the NE module signaled ready/fault signal. This means that the power DC link has been charged–up and the internal line contactor has been closed. Any fault signals present at the NE module must act either instantaneously or delayed, interlocked with the pulse enable terminal 63 on the monitoring modules and the subsequent axes.

- Instantaneous shutdown, pulse enable —> refer to Fig. 8-7

  The ready/fault signal at terminals 72–73.1 of the NE module act directly on the pulse enable, terminal 63 at the monitoring module. If there is a line fault or a fault signal, then the ready signal is withdrawn at the NE module; this means that after the drop–out time of the ready relay, the pulses of the drives after the monitoring module are inhibited and these drives " coast down".

  This interlock cannot be used e.g. for a power failure concept – and also it can disadvantages with respect to other applications when compared to a delayed shutdown.

- Delayed shutdown pulse enable —> refer to Fig. 8-8

  Terminal 63 at the monitoring module is also only enabled via the ready/fault signal at the NE module. If the signal is withdrawn at the NE module, terminal 63 is however only inhibited via time relay–KT with drop–out delay.

  This means, for example, for a line fault or a fault signal at the NE module, under certain secondary conditions, the drives can be even more quickly braked:

  – When braking, the DC link voltage must remain within the minimum and maximum monitoring limits (refer to Chapter 6.2).

  – The external +24V power supply must maintain the enable signals of terminals 65, 663.

  – For 611 digital drive modules, the internal enable signals must be maintained via the digital drive bus of the SINUMERIK 840D, 810D or for SIMODRIVE 611 universal, communications must be kept via PROFIBUS–DP.

Addresses

Contact addresses for the fused terminals used in connection examples in Chapter 8.3.1 and 8.14.

PHOENIX KONTACT GmbH & Co.
Flachsmarktstraße 8
32825 Blomberg
Tel. +49 (0)5235/30 0
Fax +49 (0)5235/341200

SIBA Sicherungen–Bau GmbH
Borker Straße 22
44532 Lünen
Tel. +49 (0)2306/7001–0
Fax +49 (0)2306/7001–10

8.4 Drive modules

8.4.1 611 feed module with High Performance/High Standard

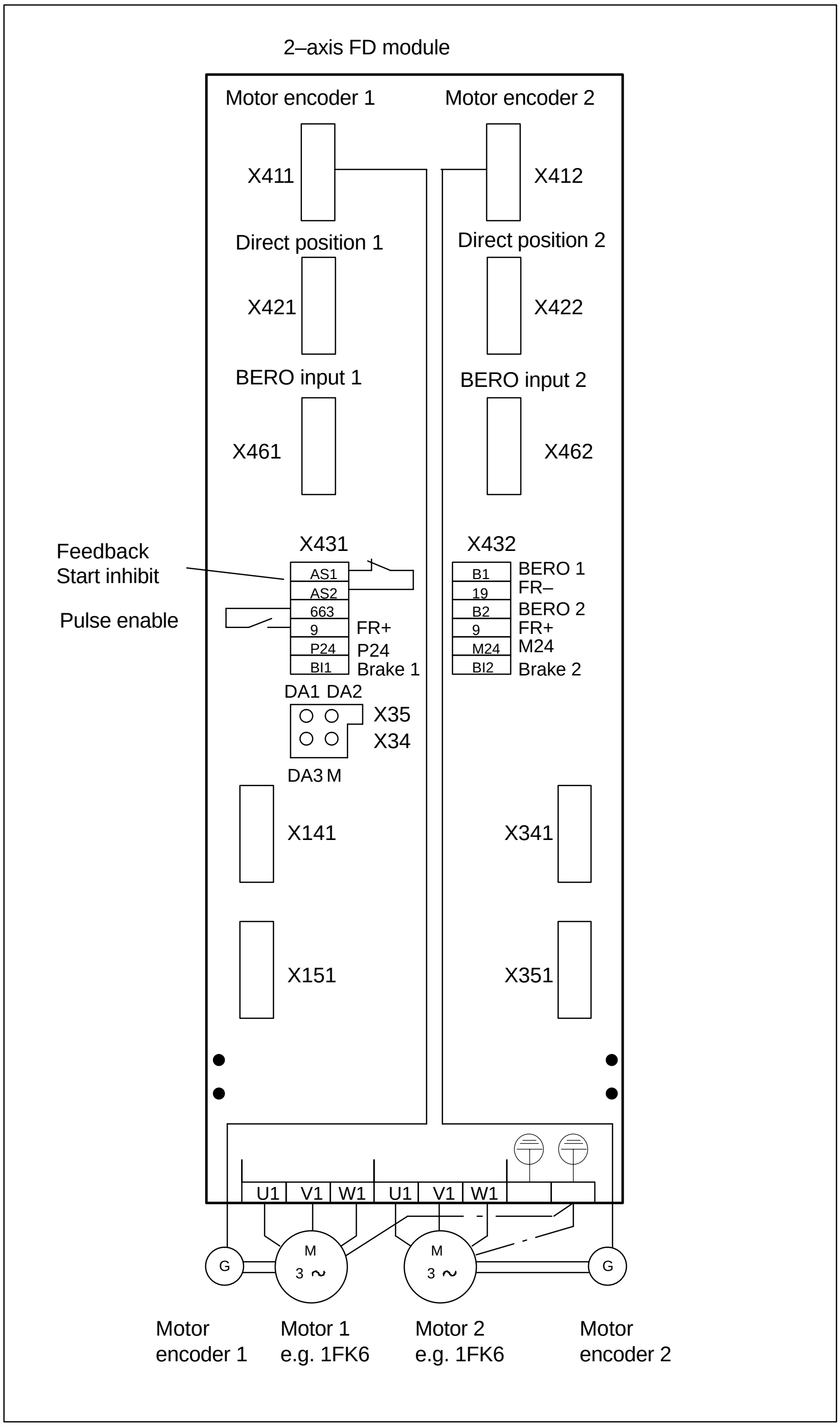

Fig. 8-9 Diagram showing the terminals of the FD module with High Performance/High Standard

8.4.2 Description of the interfaces and functions

The diagram of the terminals in Fig. 8-9 shows, in a simplified form, a 2–axis 611 feed module – comprising power module, control unit with High Performance/High Standard.

Reader's note

Control unit with digital and PROFIBUS–DP interface
—> refer to Chapter 5.

Terminals AS1, AS2

Signaling contact, relay, start inhibit

When connecting contacts AS1/AS2 in series, a contact voltage drop up to max. 0.2 V must be taken into account for the lifetime of the contacts (100000 switching operations). For a 24 V switching voltage, due to the non–linear contact characteristics, from experience, 5 contacts can be simply connected in series without encountering any problems.

Terminal 663

Pulse enable/start inhibit

When terminal 663 is energized, this initiates two functions:

- The pulse enable and inhibit are effective via an optocoupler input after 1 ms for a specific axis or for 2–axis modules, for a specific module.
- The start inhibit, terminal 663 open–circuit, acts with a delay of approx. 40 ms after terminal 663 is inhibited due to the drop–out delay of the start inhibit relay.

The start inhibit supports safety–relevant functions, refer to Chapter 8.5.

For pulse inhibit/start inhibit, the drives "coast down" without being braked.

Further, the 611D 1–axis and 2–axis modules and 611 universal HRS with PROFIBUS interface also have a pulse enable signal that acts on specific axes. The control is realized through NC/PLC interface signals via the digital drive bus or via the PROFIBUS–DP interface. The signals are effective, delayed corresponding to the appropriate cycle times.

Terminal 9

FR+

+ 24 V enable voltage for the internal enable signals.

The terminal may only be used to enable the associated drive group.

Terminal 19

FR–

0 V enable voltage for the internal enable signals.

P24 terminals

+24 V supply for the brake control, tolerance range +18...30 V

M24 terminals

0 V supply for the brake control

Terminals BE1, BE2

Output, brake control axis 1 and axis 2,
max. current is 500 mA

A UL–certified miniature fuse (max. 3.15 A) must be provided at the supply for the brake control:

Value:	e.g. 3.15 AT/250 V; 5x20 mm UL
Company:	Wickmann–Werke GmbH Annenstraße 113 58453 Witte
Order No.:	181

Reader's note

Connection example for a holding brake, refer to Chapter 5.1.1.

Terminals B1, B2

Input, external zero mark (BERO), axis 1 and axis 2.

Voltage range: +13...30 V

If the encoder zero pulse cannot be evaluated when referencing, then a signal supplied from a mounted sensor (BERO) can be fed via this input as ”equivalent zero mark”.

DAU assignment

Three 8–bit digital/analog converter (DAC) channels are available. An analog image of various drive signals can be connected through to a test socket via these converters.

The three DAU channels are assigned, as standard, with the following drive signals:

DA1:	Current setpoint	Default shift factor: 4
DA2:	Speed setpoint	Default shift factor: 6
DA3:	Actual speed	Default shift factor: 6
M:	Reference point (ground)	

Resolution: 8 bits

Voltage range: 0...5 V

Maximum current: 3 mA

8.5 Start inhibit in the drive modules/safe standstill

8.5.1 Start inhibit applications

The SIMODRIVE 611 drive control units support the ”safe standstill” function – this provides protection against unexpected starting according to the requirements of Appendix I No. 1.2.7 of the Machinery Directive 98/37/EC, DIN EN 954–1 Category 3 and DIN EN 1037. It is important that the information and the instructions in this documentation are precisely adhered to.

For this purpose, the drive control units have, as standard, an internal safety relay with positively–driven contacts – designated as ”start inhibit” or ”start inhibit relay” in the Configuration Manuals and Operating Instructions.

This safety relay electrically isolates the optocoupler power supply used to transfer the pulses to the IGBT. This means that the connected motor can no longer develop a torque.

The ”safe standstill” function prevents unexpected starting of the motor (from standstill) that is connected to the drive control unit. The motor shaft is in a no–torque condition when the ”safe standstill” function is active. This is the reason that this safety function should only be activated after the drive actually comes to a standstill. Otherwise, it will not be able to brake. The external machine control must have first brought the machine to a standstill and ensured that this has actually taken place (that the machine has come to a standstill).

Caution

When the ”safe standstill” function is used it must be ensured that the velocity goes to zero.

Notice

When the start inhibit function is correctly used, the positively–driven signaling contacts AS1/AS2 must always be included in the line contactor circuit or the EMERGENCY STOP circuit. If the function of the start inhibit relay is not plausible regarding the operating mode of the machine, then the drive involved must be electrically isolated from the line supply, e.g. using the line contactor in the infeed module. The start inhibit and the associated operating mode may only be re–used again after the fault has been removed.

Note

Depending on the result of a hazard analysis/risk assessment to be carried–out according to the Machinery Directive 98/37/EC and EN 292–1; EN 954–1; and EN 1050, the machinery construction company must configure, for all of his machine types and versions, the safety–relevant control sections for the complete machine, incorporating all of the integrated components. These also include the electric drives.

8.5.2 Mode of operation of the start inhibit

The current through the individual motor windings is controlled using the inverter power module. The motors are fed with sinusoidal current.

A pulse generation logic clocks the 6 power transistors in a rotating field–orientated pattern. An optocoupler for potential isolation is connected in each transistor arm between the control logic and the control (gating) amplifier of the power module.

The start inhibit acts on each specific module. In each of the drive modules, a positively–driven relay in the inverter control acts in the input circuits of the optocouplers.

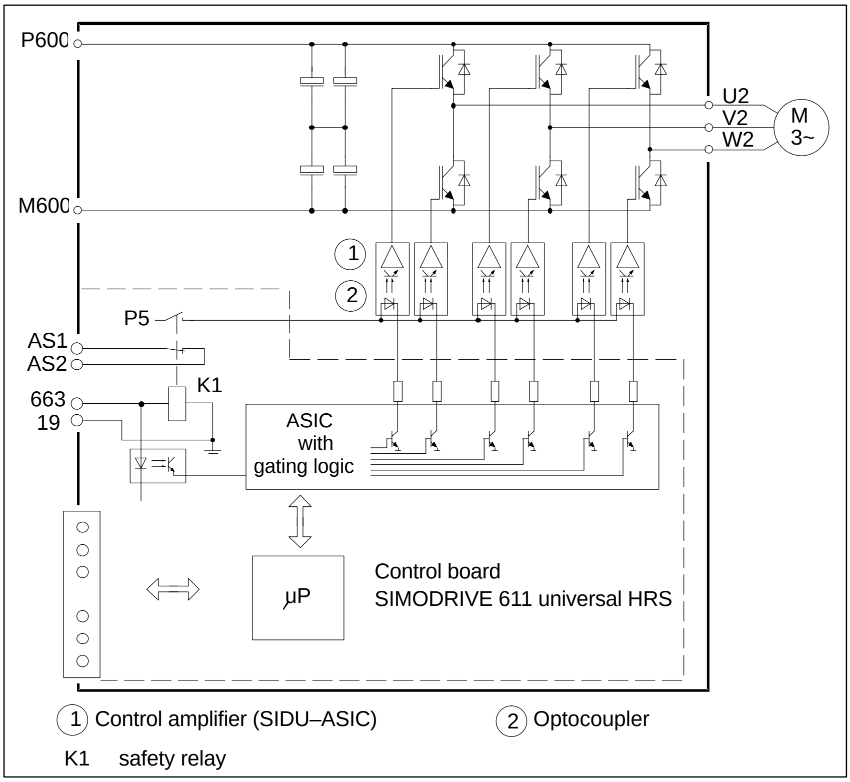

Fig. 8-10 Mode of operation using as an example the SIMODRIVE 611 universal HRS

A relay contact interrupts the power supply for the optocoupler inputs. This means that the optocoupler blocks and cannot transfer any signal. The pulse generation logic is inhibited using an additional branch that is electrically isolated.

For the drive modules, these two circuits are controlled from the machine control through terminal 663 (motor start inhibit). The state of the relay contact in the pulse power supply circuit is signaled to the external adaptation circuit through a positively opening contact.

The signaling contact is accessible at the module terminals AS1 and AS2 and the user can interlock this with his safety–relevant control. When the start inhibit fails, these start inhibit signaling contacts must disconnect the drive from the line supply via the power contactor in the line supply infeed (line contactor in the infeed module).

When the start inhibit circuit is activated, it is no longer possible to gate several power transistors orientated to the rotating field.

Warning

In the case that two faults simultaneously occur in the power module, a residual risk remains where the drive suddenly rotates through a small angle:

—> FT motors: 4 pole 90°, 6 pole 60°, 8 pole 45°;

—> Induction motors: In the area of remanence, max. 1 slot division, that corresponds to approx. 5° to 15°

1FN linear motors can, when a fault occurs, continue to move through 180° (approx. 56 or 72 mm including overshoot).

Warning

When the start inhibit is active, the motor can no longer generate any torque. If external forces act on the drive axes, additional holding devices and equipment are required – e.g. brakes. Here, it is especially important to note the effect of gravity on hanging/suspended axes.

The start inhibit does not result in electrical isolation. This means that under no circumstances does it provide protection against "electric shock".

The complete machine must be electrically isolated from the line supply through suitable line disconnecting equipment (e.g. main switch) when the equipment is down for operational reasons, or when carrying–out service, repair and cleaning work on the machine or plant (refer to EN 60204–1; 5.3).

8.5.3 Connecting–up the start inhibit

The start inhibit is addressed in the drive modules via terminal 663. The start inhibit relay is controlled using the internal enable voltage FR+ (terminal 9, +24V) /or an external +24 V voltage. When using an external voltage source, its reference potential (ground) must be connected to FR– (terminal 19).

When the relay is open, terminal 663 open, the start inhibit is activated.
When the AS1/AS2 signaling contact is closed, this signals the "start inhibit is effective" state with electrical isolation. The circuit must be protected against overload and short–circuit using a fuse with a max. 2 A rating!

When terminal 663 is externally controlled (drive), a fail–safe signal must be used.

Notice

The start inhibit relay has pull–in and drop–out delay times of max. 40 ms. The external wiring must be connected to terminals AS1/AS2 so that it is short–circuit proof.

One side of the excitation coil of the safety relay is connected to the grounded electronics chassis (PELV circuit according to DIN VDE 0160). When supplying the excitation coil (relay coil) from an external 24 V power supply, its negative pole must be connected to ground potential. The external 24 V power supply must fulfill the requirements for a PELV circuit in compliance with DIN VDE 0160.

Table 8-4 Technical data of the safety relay

Terminal	Designation	Description	Type 1)	Range
AS1 2)	Contact 1	Feedback signal contact, relay	NC	30 V DC/max. 2 A
AS2 2)	Contact 2	Start inhibit		250 V AC/max. 1 A
663	Control input ”start inhibit”	Nominal resistance of the excitation coil 600 Ω ... 1000 Ω	I	21 V– 30 V DC Max. switching frequency: 6/min Electrical lifetime: min. 100.000 operating cycles Mechanical lifetime: 10 million operating cycles
9	Enable voltage FR+ (internal)		O	+ 24 V
19	Reference FR– (external)		O	Ground

1) I = input; O = output; NC = NC contact

2) When the AS1/AS2 contacts are connected in series a contact resistance of approx. 0.20 Ohm must be taken into consideration over the lifetime of the contacts. For a 24 V switching voltage, due to the non–linear contact characteristics, from experience, 5 contacts can be simply connected in series without encountering any problems.

Warning

Only qualified personnel may install and commission the ”safe standstill” function.

All of the external safety–relevant cables (e.g. control cable for the safety relay, feedback signal contacts) must be routed so that they are protected, e.g. using cable ducts. Short and cross–circuit faults must be absolutely excluded.

8.5.4 Sequence and timing when using the start inhibit

The drives must have been stopped before terminal 663 is inhibited and the start inhibit is activated.

The drives can be stopped, e.g. by ramping–down the drives in a controlled fashion using the NC program, inhibiting the drive enable terminal 64 or the axis–specific controller enable, terminal 65.

Under fault conditions, the equipment must be safely disconnected and isolated from the line supply using the line contactor.

If a fault occurs when actuating the start inhibit, then this fault must be removed before the isolating mechanical protective devices (e.g. guards) to the working space of the machine or plant are opened. After the fault has been removed, the handling sequence for the start inhibit must be repeated. Under fault conditions, all of the drives, machine and the plant must be shutdown.

If one of the following faults occurs with terminal 663 de–energized and the protective devices withdrawn, then under all circumstances, EMERGENCY STOP must be immediately initiated.

- The feedback signaling contacts AS1/AS2 remain open; the start inhibit is not activated.
- There is a fault in the external control circuit itself.
- There is a fault in the signal cables of the feedback signal contact.

All of the drives of the machine/plant must be disconnected and isolated from the line supply via the line contactor.

If the control of the start inhibit has been correctly integrated in the external safety–relevant drive control – and has been carefully checked – the drives in the isolated working zone of the machine are secure against undesirable starting and personnel can enter or access the hazardous zone that has been restricted.

Notice

The relevant regulations for setting–up operation must be carefully observed.

8.5.5 Checking the start inhibit

The safety relay is an important component associated with the safety and availability of the machine. This is the reason that if the system functions incorrectly, the control unit together with the safety relay must be replaced. Function checks are required at regular intervals in order to detect an incorrect function.

The intervals specified in the appropriate regulation BGV A1 §39, Paragraph 3 are decisive for the intervals in which the system must be checked. This is the reason that the function check/test must be carried–out – depending on the application conditions; however, it must be carried–out at least once a year and in addition, after the system has been commissioned for the first time as well as when modifications and repairs have been made.

- The drive pulses must be inhibited when the voltage at terminal 663 is removed. Further, the feedback signal contacts AS1/AS2 of the start inhibit must close. The drive "coasts down".
- Withdrawing the protective devices, e.g. opening the protective door/guard while the drive is running. The drive must be braked as quickly as possible and then shut down. In so doing, no inadmissible hazard may occur.
- All of the possible fault/error cases that can occur must be individually simulated in the signal lines/cables between the feedback signal contacts and the external control as well as the signal evaluation functions of this control – for example, by interrupting the start inhibit monitoring circuit at terminals AS1–AS2.
- The monitoring circuit AS1 – AS2 should be disconnected for this purpose.

  In all of the simulated fault situations, the line contactor must isolate all of the drives of the machine or system from the line supply.

  If there is a connection between the NE or monitoring module power supply, terminal 500/M500 to the power DC link P600/M500, then this must be safely and reliably disconnected at the same time as the line contactor is opened, e.g. using contactors.

Warning

Only qualified personnel may carry–out these checks carefully observing the necessary safety measures.

After the start inhibit check has been completed, all of the changes made to the control as part of this check must be reversed.

8.5.6 Example ”safe standstill” with contactor safety combination

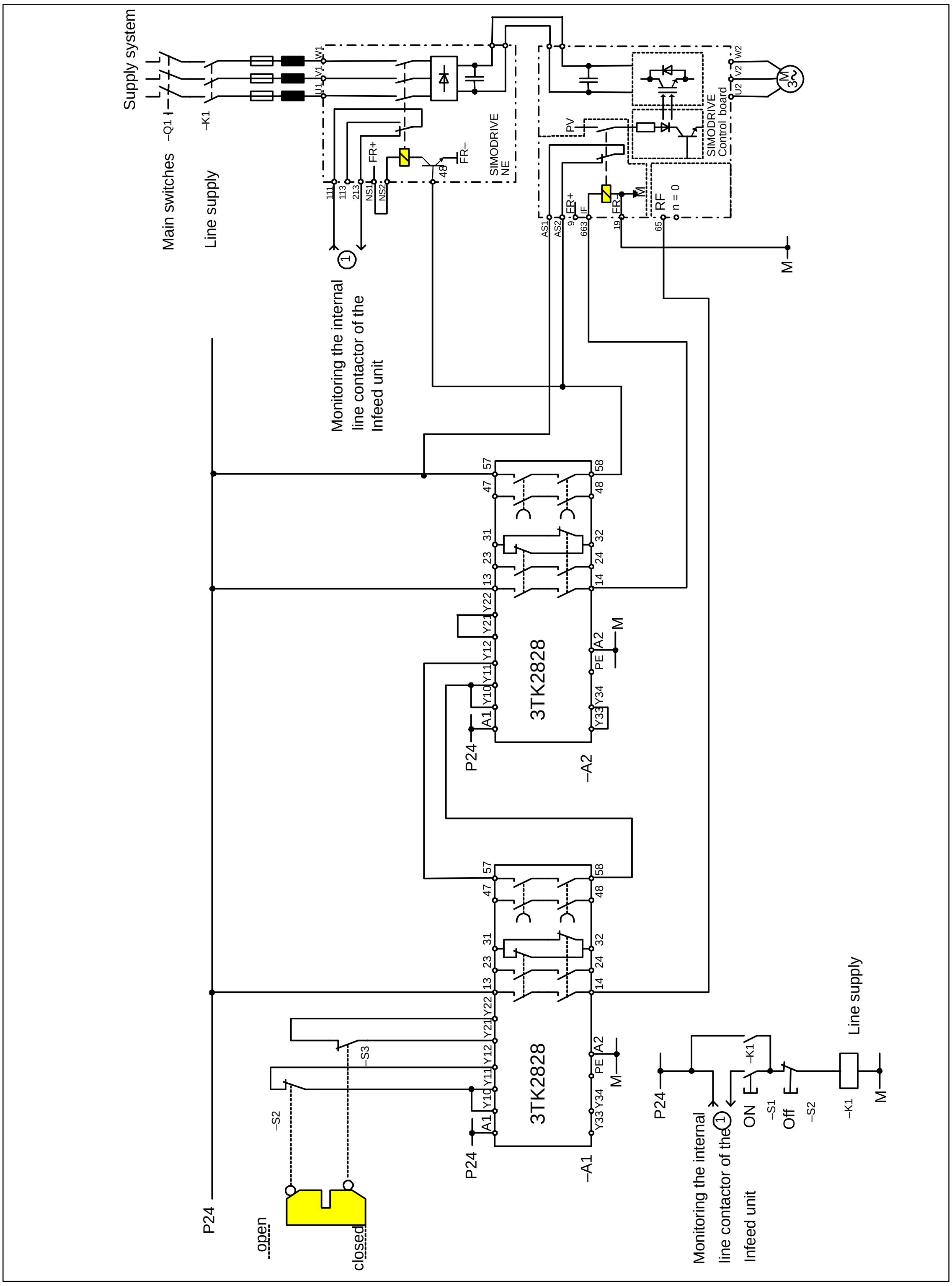

Fig. 8-11 Example, minimum circuitry for the ”safe standstill” function with SIMODRIVE 611

Function

Using two SIGUARD contactor safety combinations (A1. A2) for Emergency Stop and protective interlocking, it is possible to implement a configuration according to EN954–1 control Category 3 and EN1037. Using the circuitry as shown in Fig. 8-11, a stop function, Category 1 according to EN 60204 is implemented.

Switches S2 and S3 are positively–opening position switches corresponding to EN 1088.

Behavior when the protective doors are open

When the protective doors are opened, the contactor safety combinations trip, staggered in time and initiate that the drive is stopped in accordance with EN 60204–1 stop Category 1.

- A 0 signal is applied to the input, controller enable (RF) of the drive via the enable contacts of the contactor safety combination A1; the drive is immediately braked down to 0 speed and the pulses cancelled.
- The delay time of the contactor safety combination A1 is set so that the drive has come to a standstill when the delayed contacts open therefore initiating the second contactor safety combination A2.
- The contactor safety combination A2 instantaneously de–energizes the safety relay in the drive via terminal 663. The feedback signal contacts of the safety relay must be closed after the selected delay time has expired, otherwise the drive is isolated from the line supply via terminal 48.
- For a protective door with tumbler mechanism, the drive is stopped with subsequent pulse cancellation – e.g. by pressing an appropriate button on the machine. The ”zero speed” signal releases the tumbler mechanism and when the protective doors open, the safety relay in the drive is immediately de–energized. In this particular case, the first timer stage (contactor safety combination A1) is not required.
- When the line supply is switched–in through K1 with button S1 ”power on” the correct functioning of the internal line contactor of the infeed unit is checked using the feedback signal in the power–on circuit.

8.5.7 Example, ”safe standstill” for several drive groups

Function

The concept of the ”safe standstill” function with higher–level main contactor as shown in Fig. 8-12 is implemented on an electrical injection moulding machine.

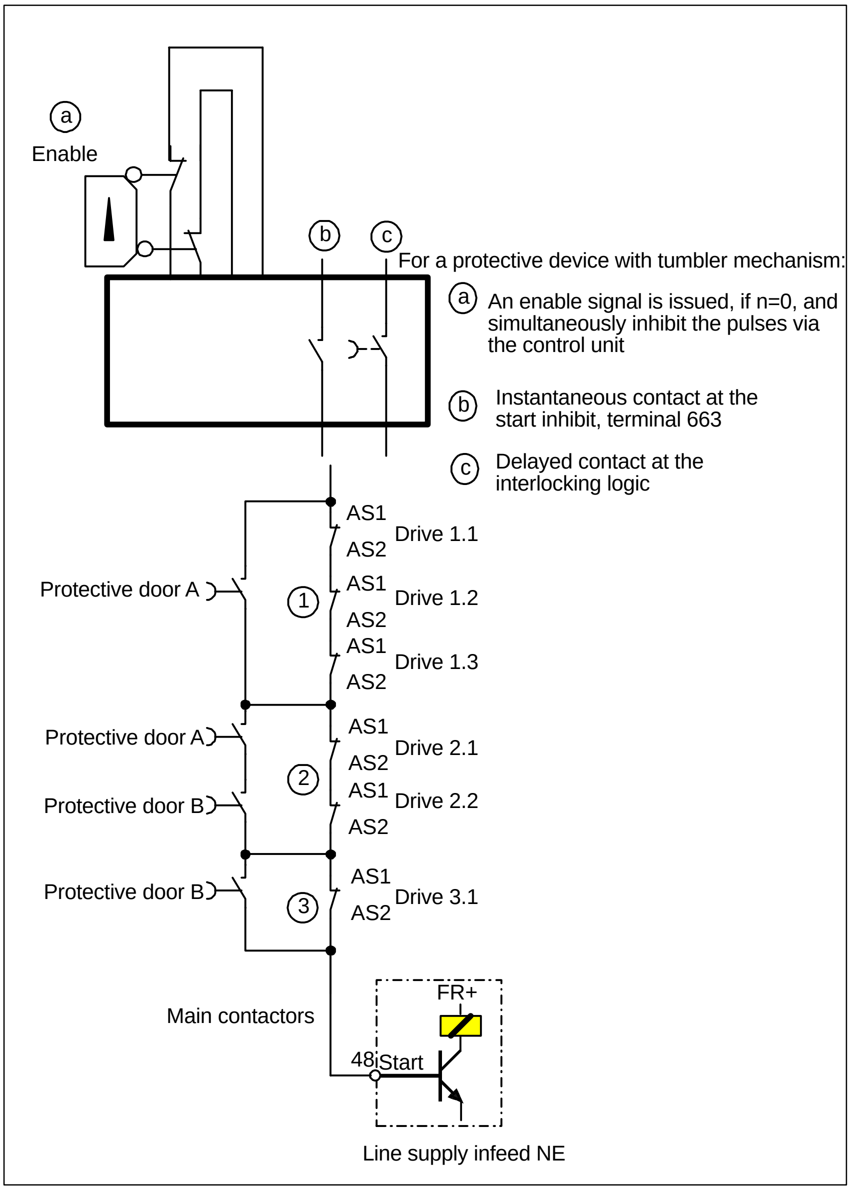

Fig. 8-12 Example, ”safe standstill” function with several drive groups

The machine comprises three functional drive groups. The feedback signal contacts of each control unit AS1/AS2 within a drive group are connected in series. Every drive group is secured using a moving protective device. Interdependencies according to Table 8-5 apply between the drive groups and moving protective devices.

Table 8-5 Effect of the moving protective devices on the drive groups

Moving protective device	Drive 1.1/1.2/1.3 1	Drive 2.1/2.2 2	Drive 3.1 3
Protective door A	X	X	–
Protective door B	–	X	X
X = the drives are shutdown when the protective device is actuated			

Behavior when the protective doors are open

As long as the assigned protective device prevents any intervention in the hazardous zone, the feedback signal contacts of these power modules are jumpered. After the protective device has been opened, the drives must be shutdown in the defined time and the feedback signal contacts of the safety relay must be closed – otherwise, the higher–level main contactor will open.

8.6 Application examples with SIMODRIVE 611

8.6.1 Block diagram of the application example

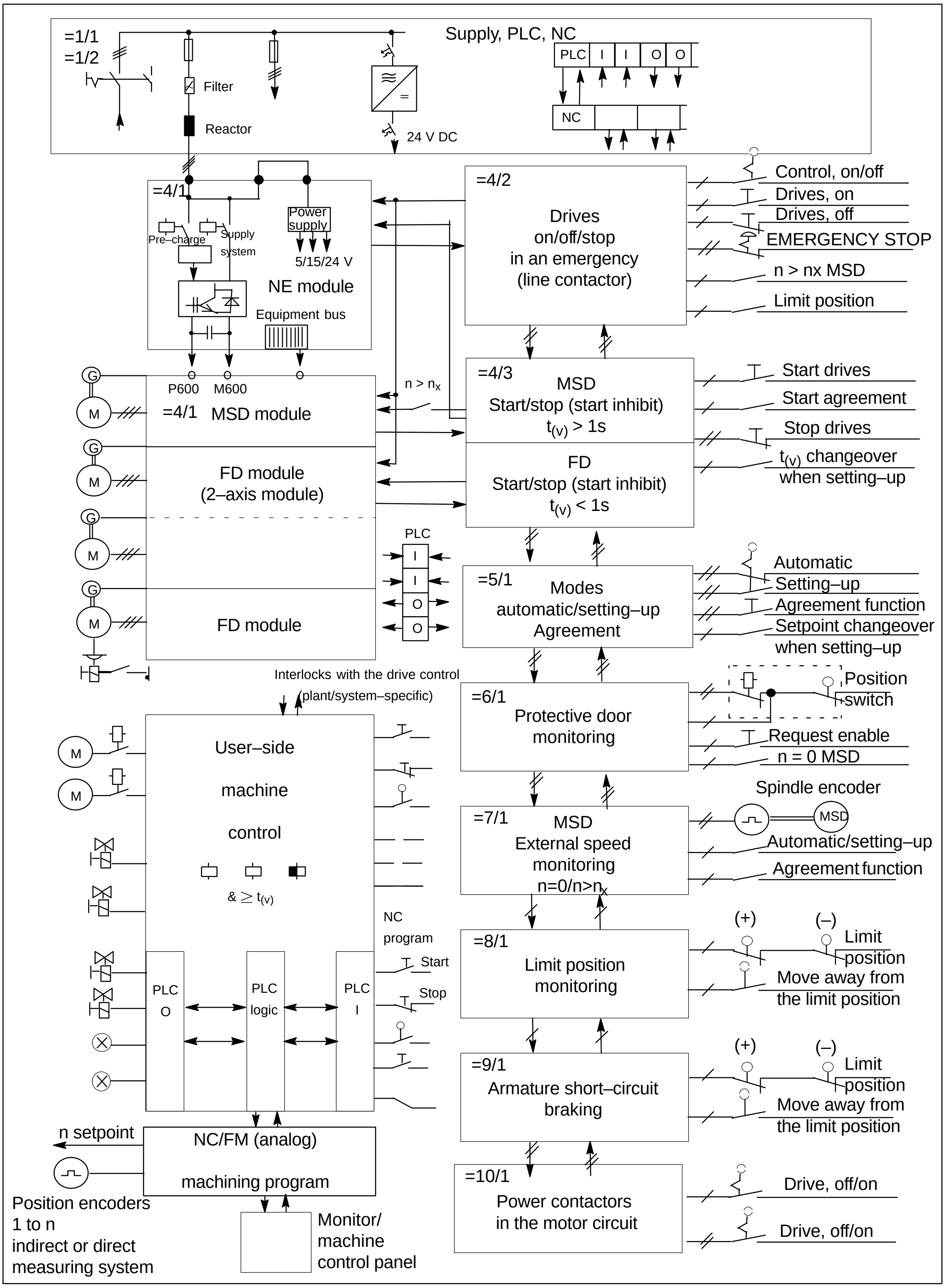

Fig. 8-13 Block diagram of the application example

8.6.2 Function description of the application example

Application

The block diagram, Chapter 8.6.1 shows an overview of an application example for a complete drive–related control of a machine with SIMODRIVE 611 drive components with analog setpoint interface.

For information on versions with SIMODRIVE 611 digital and 611 universal, refer to Chapter 8.8.

The individual applications and functions of the drive control are described in detail in the following Chapter 8.7 using circuit examples =1 to =10.

The circuit examples =1 to =3 are provided for basic machine applications. Circuit examples =1 and =4 to =10 describe all of the essential functions that are used for a processing machine/machine tool.

The circuit concept has been designed so that the individual control groups, from the basic function in circuit example =4

- Drives on/off/stopping in an emergency situation; start/stop/safe standstill through additional functions
- Operating mode selection, automatic / setting–up operation with agreement =5
- Protective door monitoring with tumbler mechanism =6
- External speed monitoring =7
- Limit switch, limit position monitoring =8
- Armature short–circuit braking =9, and
- Power contactors in motor circuit =10

can be used for the particular applications, graduated from basic up to complex functions. When expanding the control system, step–by–step, up to the fully expanded configuration, the terminal jumpers, in the circuit examples, should be removed (interrupted), and the required interlocking and monitoring circuits inserted.

In the application example, Fig. 8-13 the SIMODRIVE 611 drive group comprises a 1PH7 main spindle drive and three 1FT5 feed drives as an example for a machine tool.

The drive–related control essentially includes the safety–relevant, 2–channel hardware control with the associated PLC functions. The PLC control handles the coordinated sequence of the drive control through logic operations; however it does not handle any safety–relevant functions.

The NC/FM (positioning control) with the setpoint and actual value interface as well as the machine control of the user side, is not discussed in the subsequent text. This is the reason that they are only depicted from the essential principle.

- Control Category in accordance with EN 954–1

  The 2–channel system structure of controls =4 to =6 corresponds, when the individual components are correctly used, to control Category 3 according to EN 954–1. This means that if a single fault occurs in the system, then the safety function must still be kept.

The user should evaluate the control Categories of the additional circuits =7 to =10. This depends on how he uses the third–party components/monitoring devices that he selected etc. and how they are integrated into the basic control in a safety–relevant fashion.

Note

For machines that are, after the hazard analysis/risk evaluation or type C Standard, are to be classified in a lower Category – e.g. 1 or 2 according to EN 954–1 – then the control can be principally derived from these circuit examples and implemented in a more simple, single–channel, system structure!

This also applies to the sub–areas/sub–functions of a machine that, for example, according to type C Standards, must be implemented with either a lower or higher control category, deviating from the basic machine. For example, after the hazard analysis/risk evaluation, it may also be necessary that a hydraulic/ pneumatic clamping device in the working zone must be controlled using a 2–hand control device in compliance with Category 4.

Functions

- Circuit examples =4 to =10

  The 2–channel system structure is achieved in this application example:

  First shutdown path: The power feed to the drive motors is disconnected via the start inhibit functions in the drive modules.

  The shutdown is realized using terminal 663. The positively–driven feedback signal contact of the start inhibit relay via terminals AS1–AS2 intervenes cyclically monitored in the EMERGENCY STOP circuit of the safety relay.
  For a detailed description of the start inhibit function, refer to Chapter 8.5.

  Second shutdown path: The line contactor in the NE module electrically disconnects the line supply from the DC link of the drive modules.

  The shutdown is realized using terminal 48 at the same time (simultaneously) with the de–energization of the contactor coil in a safety–relevant, electrically isolated fashion using terminals NS1– NS2.

  The shutdown is realized, for example, when stopping in an emergency, from fault signals received from the drive system or via the start inhibit monitoring when a fault condition occurs.

  After each power–off cycle, the positively–driven opening contacts 111 – 213 of the line contactor are monitored in the feedback circuit of the EMERGENCY STOP safety relay. For a detailed description of the line contactor, refer to Chapter 8.2.4.

  For an EMERGENCY STOP, the drives are stopped in stop Category 1 according to EN 60204–1; 9.2.2: ”Controlled stopping” – the power feed is only interrupted when the motor has come to a standstill.

  Circuit examples =2 and =3, shown in Chapter 8.7, can be used for basic and average applications.

- Circuit example =2:

  When the drives are powered–up and powered–down, the complete drive group, including the line contactor and start inhibit terminals are switched in a safety–related fashion through two channels. The power–on frequency per unit time of the NE module is limited. This is due to the pre–charging circuit to ramp–up the DC link voltage at the capacitors.

  This circuit is, for example, not suitable for machines where the protective door is frequently opened or for the ”setting–up” mode where the agreement function is frequently applied.

- Circuit example =3:

  Using this circuit, one or several drives can be selectively shut–down in a safety–related fashion from an operational drive group – e.g. using a key–operated switch, limit switch, light barriers etc. – and brought into the ”safe standstill” condition.
  Beforehand, the NC control must have safely stopped the drives. This circuit can also be used in conjunction with the basic control =4.

  Circuit examples =2 and =3 are also used to obtain a basic understanding of the complex and extensive control functions from circuit =4 onwards.

Note

All of the following circuit examples neither include safety–related or other mechanical interlocks that may be necessary with the machine control on the user side.

8

8.6.3 Safety systems and Standards

Objectives

The objective of safety systems is to keep potential hazards for both people and the environment as low as possible by using suitable technical equipment, without restricting, more than absolutely necessary, industrial production, the use of machines and the production of chemical products. The protection of man and environment has to be put on an equal footing in all countries by applying rules and regulations that have been internationally harmonized. At the same time, this is also intended to avoid that safety requirements in different countries have an impact on the competitive situation – i.e. the intention is to facilitate international trade.

Basic principle of the legal requirements in Europe

Legislation demands, ”the quality of the environment and the health of people are to be protected using preventive measures” (Directive 96/82/EC of the Council ”Seveso II”). Legislation also promotes ”health and safety at work” (Machinery Directive, health and safety legislation). The objective to achieve these and similar goals are specified in the appropriate EU Directives by legislative bodies for various areas (”regulated area”). In order to achieve these objectives, the legislative bodies place demands on companies operating plants and systems and the manufacturers of equipment and machines. These legislative bodies have at the same time allocated responsibility for possible damage.

EU Directives

A new concept (”new approach”, ”global approach”) used as basis for the EU Directives:

- EU Directives only specify generally valid safety objectives and define basic safety requirements
- EU Directives specify that the Member States must mutually recognize domestic regulations.

The EU Directives are of equal importance, i.e. if several Directives are applicable for a specific piece of equipment or machine, then the requirements of all of the relevant Directives apply.

For a machine with electrical equipment, among others, the following apply

- Machinery Directive 98/392 EEC
- Low–Voltage Directive 73/23/EEC
- EMC Directive 89/336 EEC

Machinery Directive

The European Machinery Directive is essential valid for all machines. The minimum requirements are defined in Appendix I of the Directive. More detailed information is then provided in the harmonized European Standards – types A, B and C.

However, Standards have not been drawn–up for all types of machines. For machine tools for metal working, robots, and automatic manufacturing systems, some Draft Standards and final Standards do exist, e.g. type C Standards. In many cases, Category 3 acc. to EN 954–1 is defined in these Standards for the safety–related controls. The basic requirement of this Category is:" Single–fault fail–safety with partial fault recognition". Generally, this requirement can be fulfilled using a 2–channel system structure (redundancy). Sub areas of a machine control can also be classified with other Categories – B, 1, 2, or 4 according to EN 954–1.

Hazard analysis and risk assessment

According to the Machinery Directive 89/392/EEC, the manufacturer of a machine or a safety component or the person or persons responsible for placing such equipment on the market is legally obliged to carry–out a risk analysis in order to determine all of the risks that may arise in connection with the machine or safety component concerned. He must design and construct the machine or safety component on the basis of this analysis.

A risk assessment must identify all residual risks that need to be documented. For the technique to evaluate and assess these risks, among others, the following Standards should be carefully observed EN 292 "General Design Guidelines for the Safety of Machinery"; EN 1050 "Safety of Machinery, Guidelines for Risk Assessment" and EN 954 "Safety–relevant Parts of Controls".

CE conformance

The machinery manufacturer or the company based in the European Economic Community or persons that they have nominated must make a legal declaration regarding the CE Conformance for the complete machine.

Note

The listed Directives and legislation represent just a selection to communicate the essential goals and principles. This list does not claim to be complete.

8.7 Circuit examples =1 to =10 with SIMODRIVE 611

Fig. 8–14=1	Cabinet supply, PLC, NC; Sheet 1/2	8–257
Fig. 8–15=1	Cabinet supply, PLC, NC; Sheet 2/2	8–258
Fig. 8–16 =2	On/off/stopping in an emergency situation, Sheet 1/2	8–259
Fig. 8–17 =2	On/off/stopping in an emergency situation, Sheet 2/2	8–260
Fig. 8–18 =3	Start/stop/safe standstill; Sheet 1/1	8–261
Fig. 8–19 =4	On/off/stopping in an emergency; start/stop/safe standstill; Sheet 1/3	8–262
Fig. 8–20 =4	On/off/stopping in an emergency; start/stop/safe standstill; Sheet 2/3	8–263
Fig. 8–21 =4	On/off/stopping in an emergency; start/stop/safe standstill; Sheet 3/3	8–264
Fig. 8–22 =5	Operating modes, automatic/setting–up operation with agreement; Sheet 1/1	8–265
Fig. 8–23 =6	Automatic operating mode with protective door monitoring; Sheet 1/1	8–266
Fig. 8–24 =7	External speed monitoring MSD; Sheet 1/1	8–267
Fig. 8–25 =8	Limit switch, limit position monitoring; Sheet 1/1	8–268
Fig. 8–26 =9	Armature short–circuit braking FD; Sheet 1/1	8–269
Fig. 8–27 =10	Power contactors in the motor circuit; Sheet 1/1	8–270

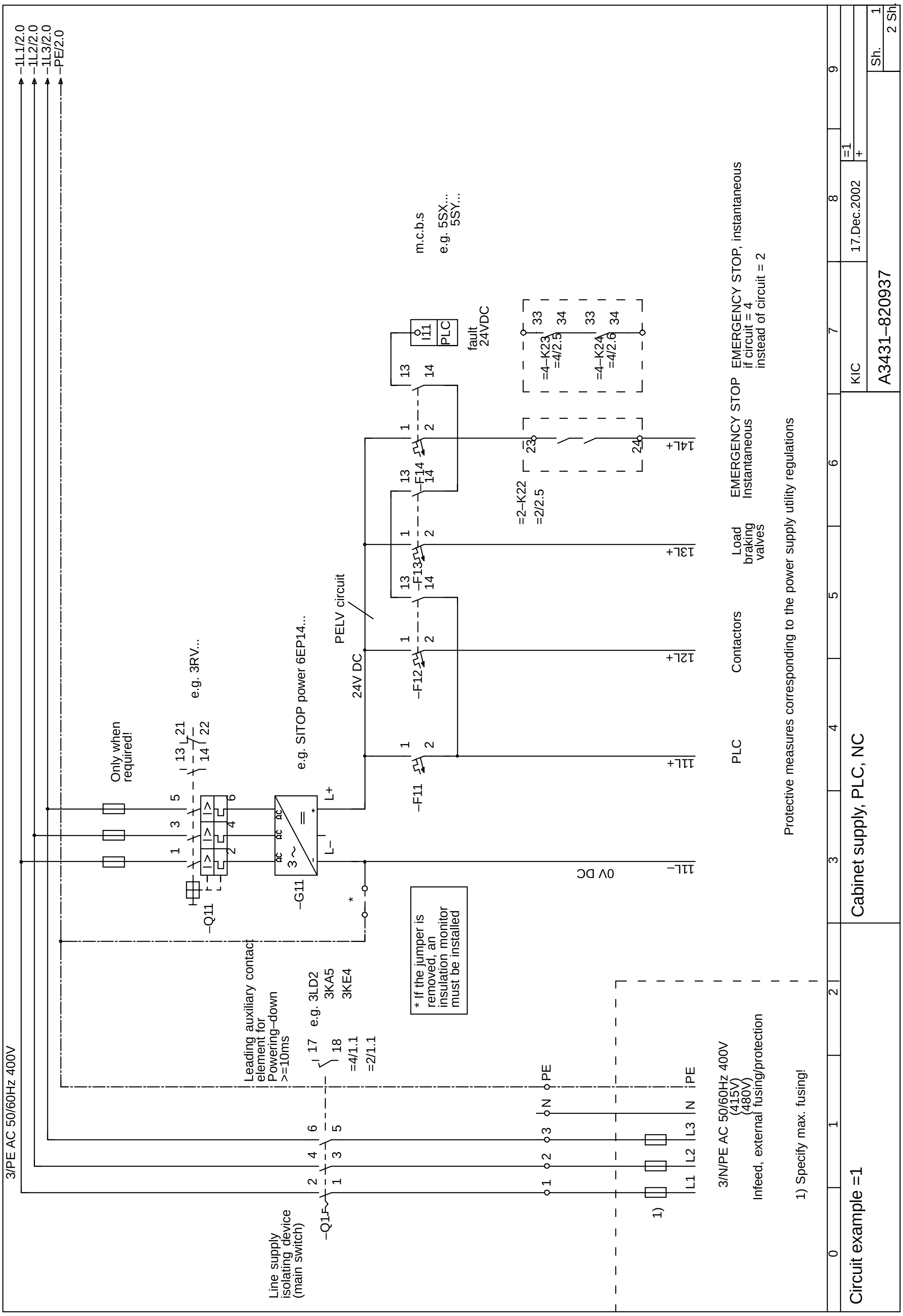

Fig. 8-14 =1 cabinet supply, PLC, NC; Sheet 1/2

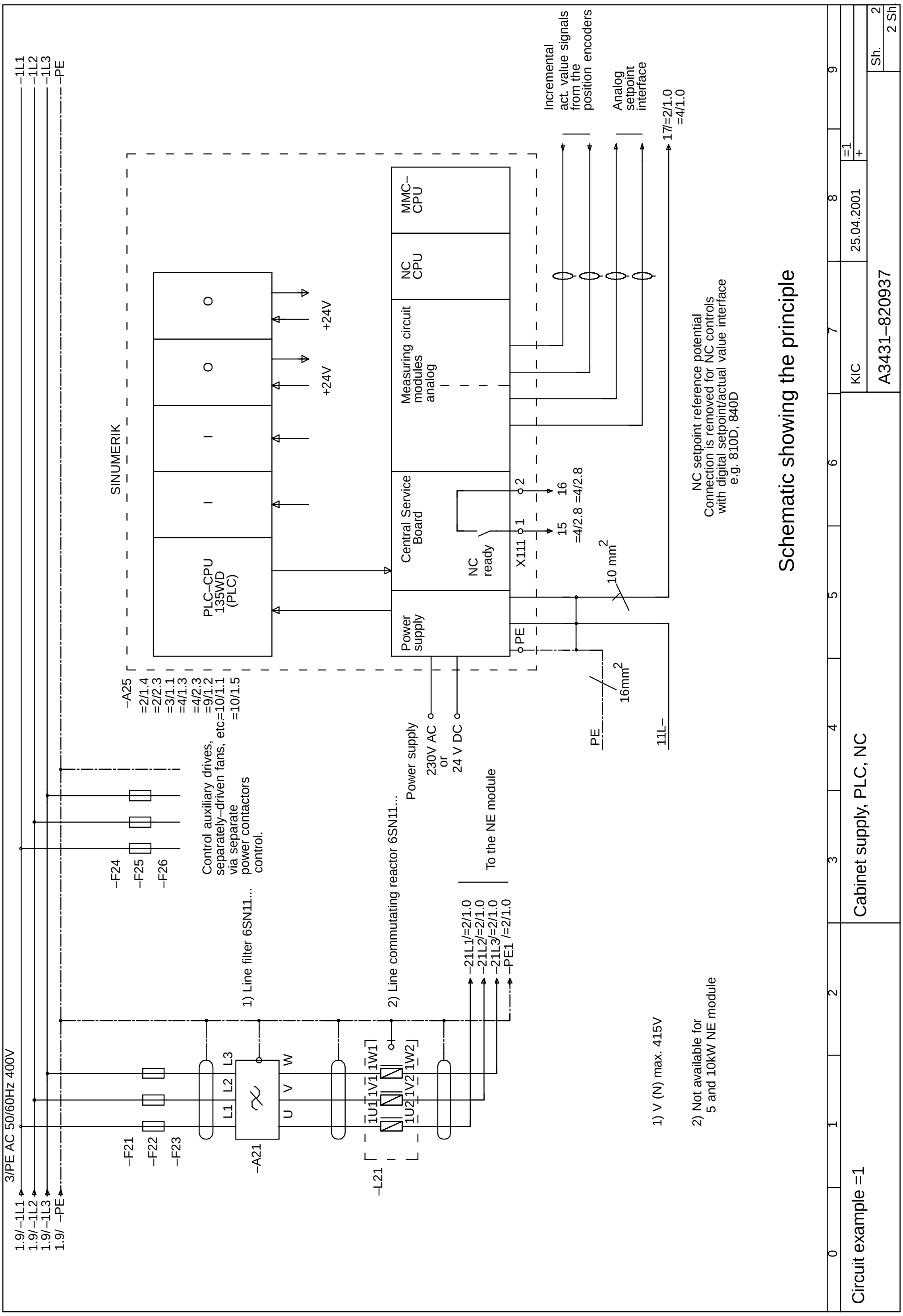

Fig. 8-15 =1 cabinet supply, PLC, NC; Sheet 2/2

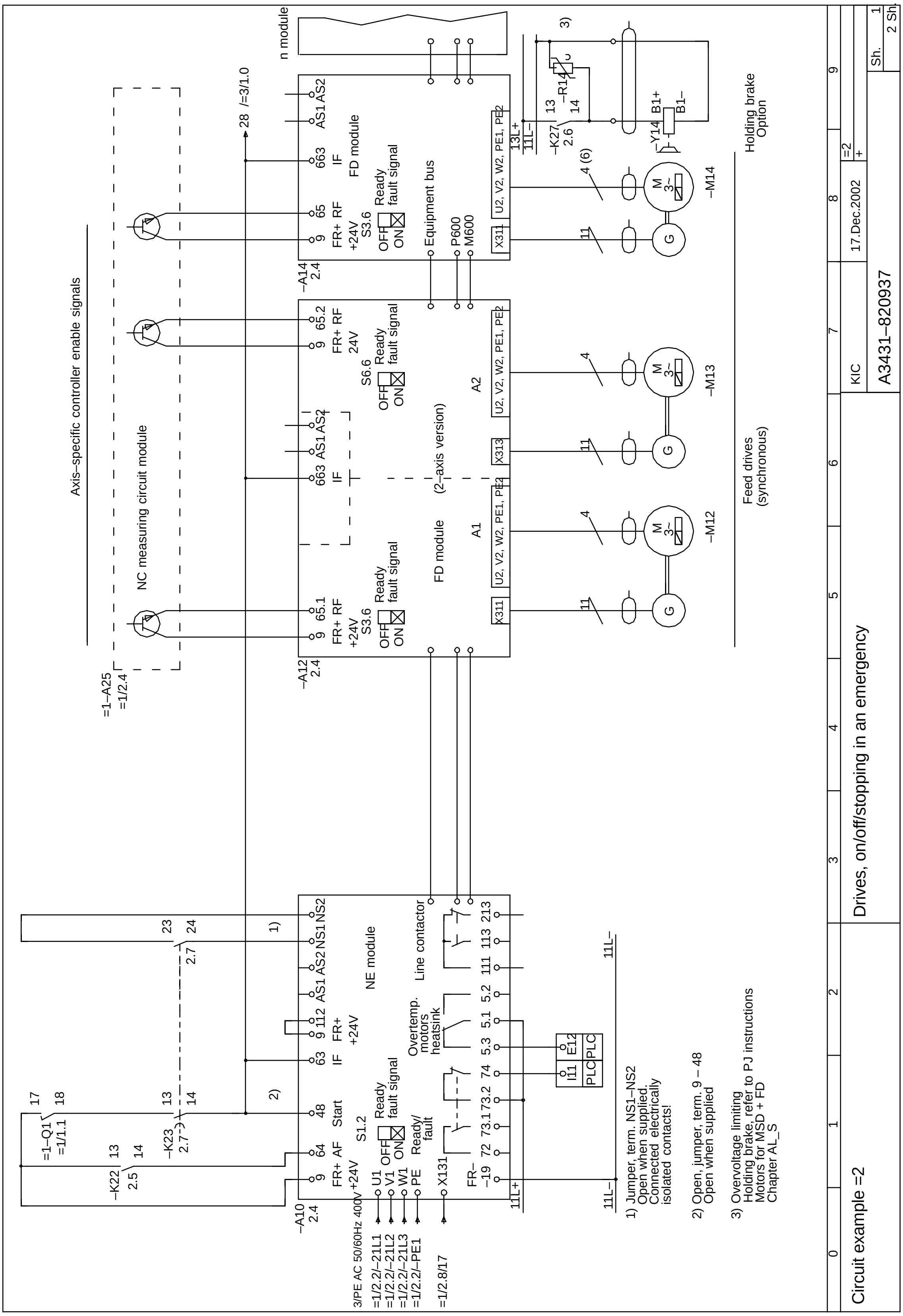

Fig. 8-16 =2 On/off/stopping in an emergency; Sheet 1/2

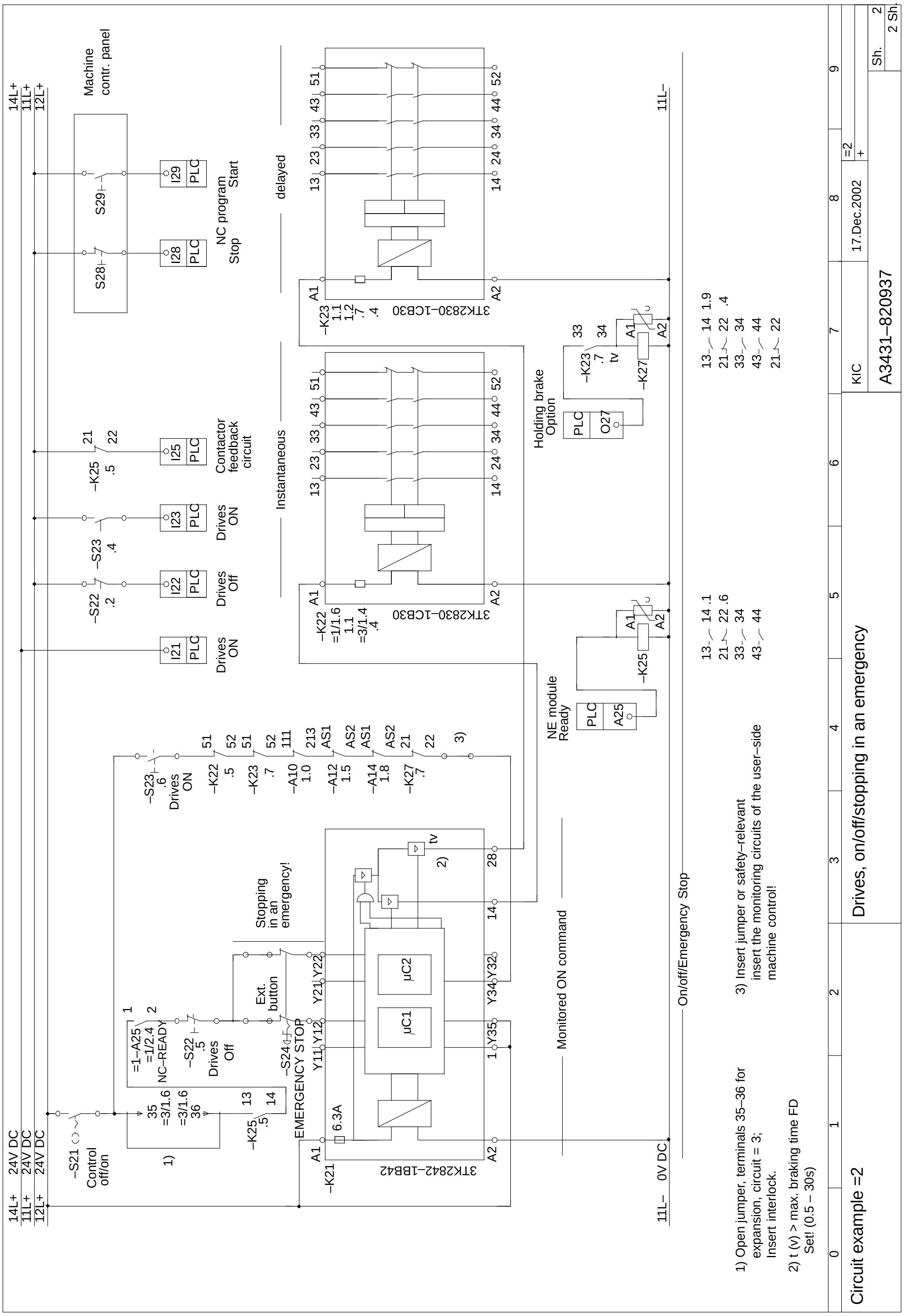

Fig. 8-17 =2 On/off/stopping in an emergency; Sheet 2/2

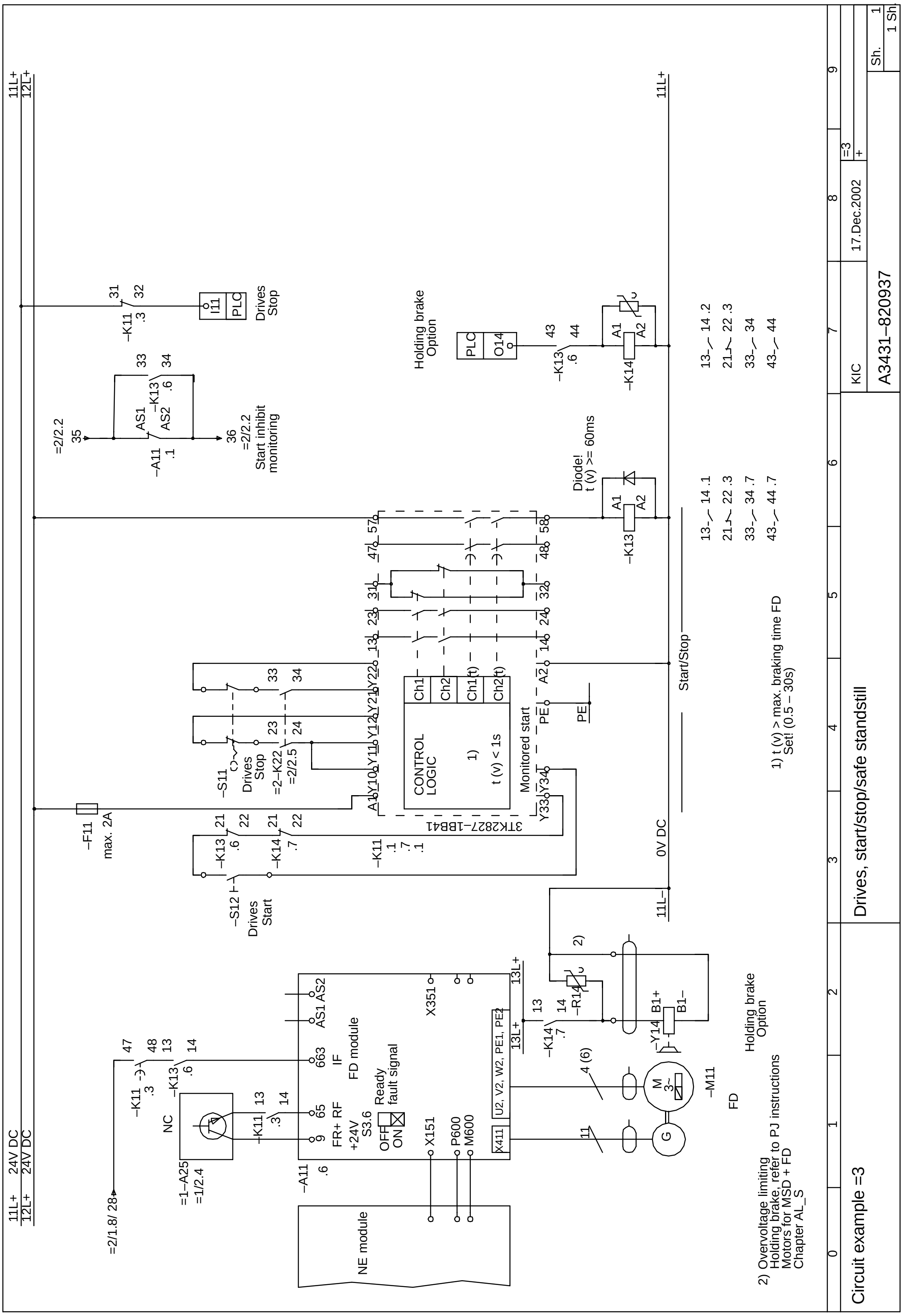

Fig. 8-18 =3 Start/stop/safe standstill; Sheet 1/1

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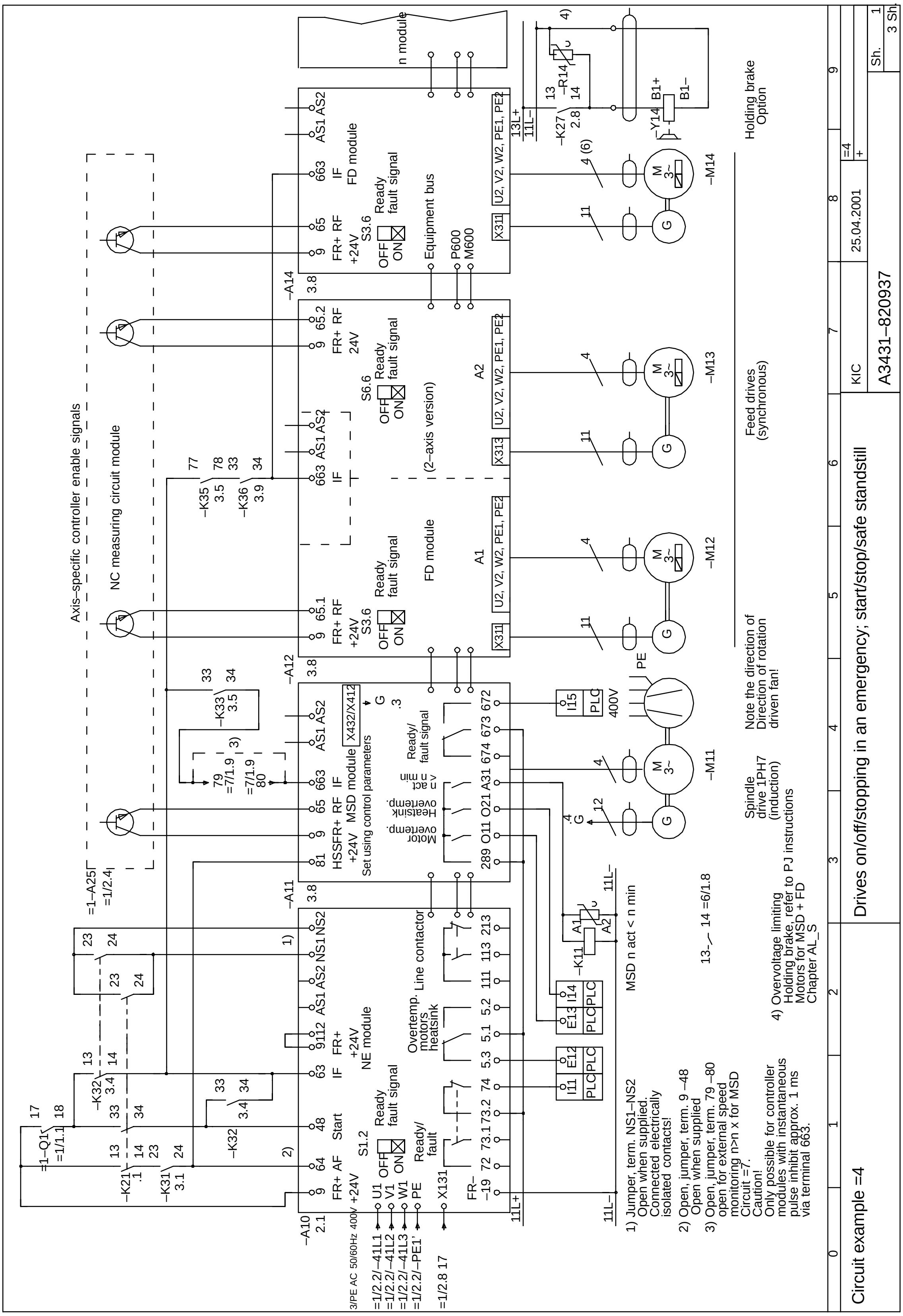

Fig. 8-19 =4 On/off//stopping in an emergency; start/stop/safe standstill; Sheet 1/3

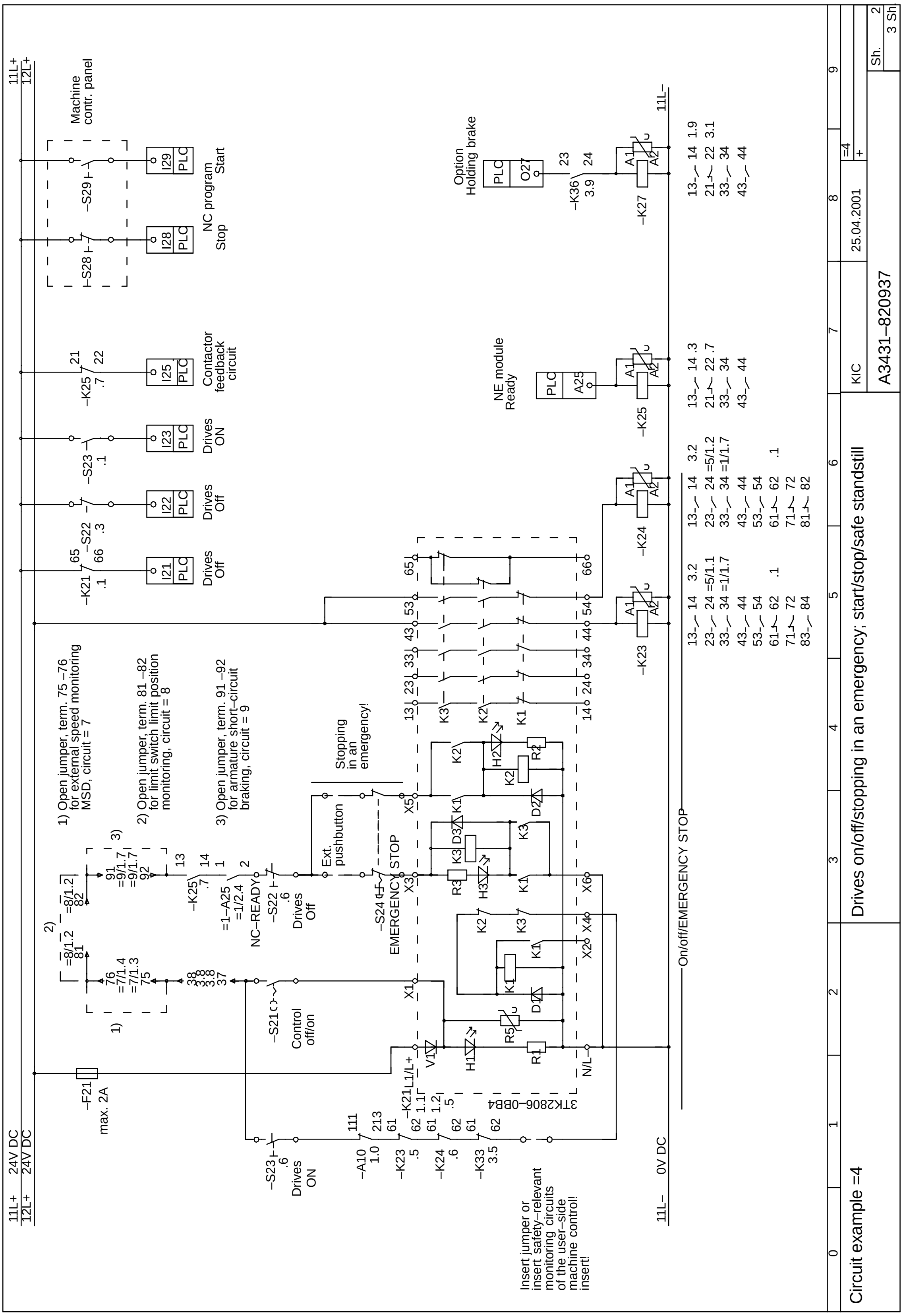

Fig. 8-20 =4 On/off//stopping in an emergency; start/stop/safe standstill; Sheet 2/3

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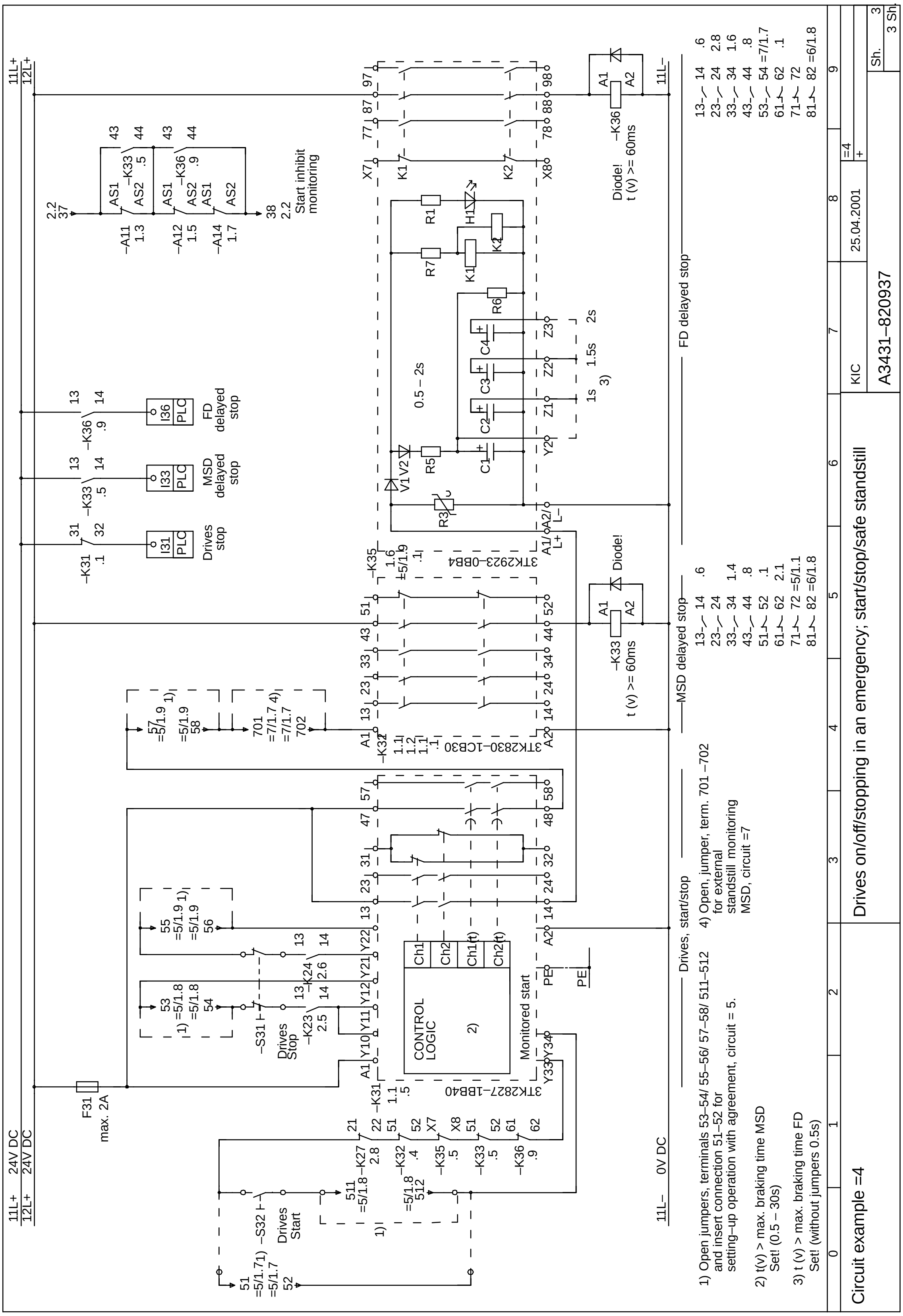

Fig. 8-21 =4 On/off//stopping in an emergency; start/stop/safe standstill; Sheet 3/3

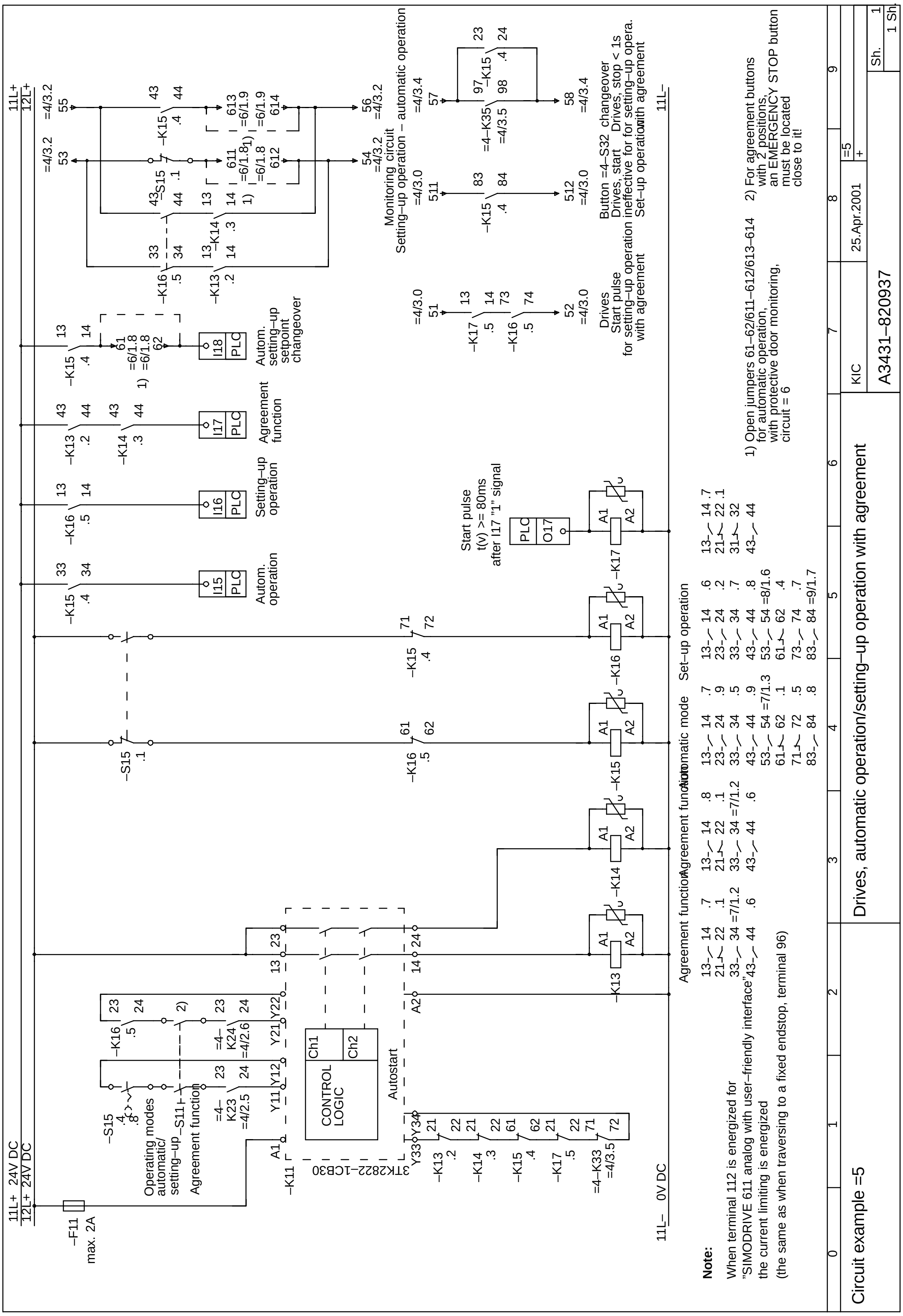

Fig. 8-22 =5 Operating modes, automatic/setting–up operation with agreement; Sheet 1/1

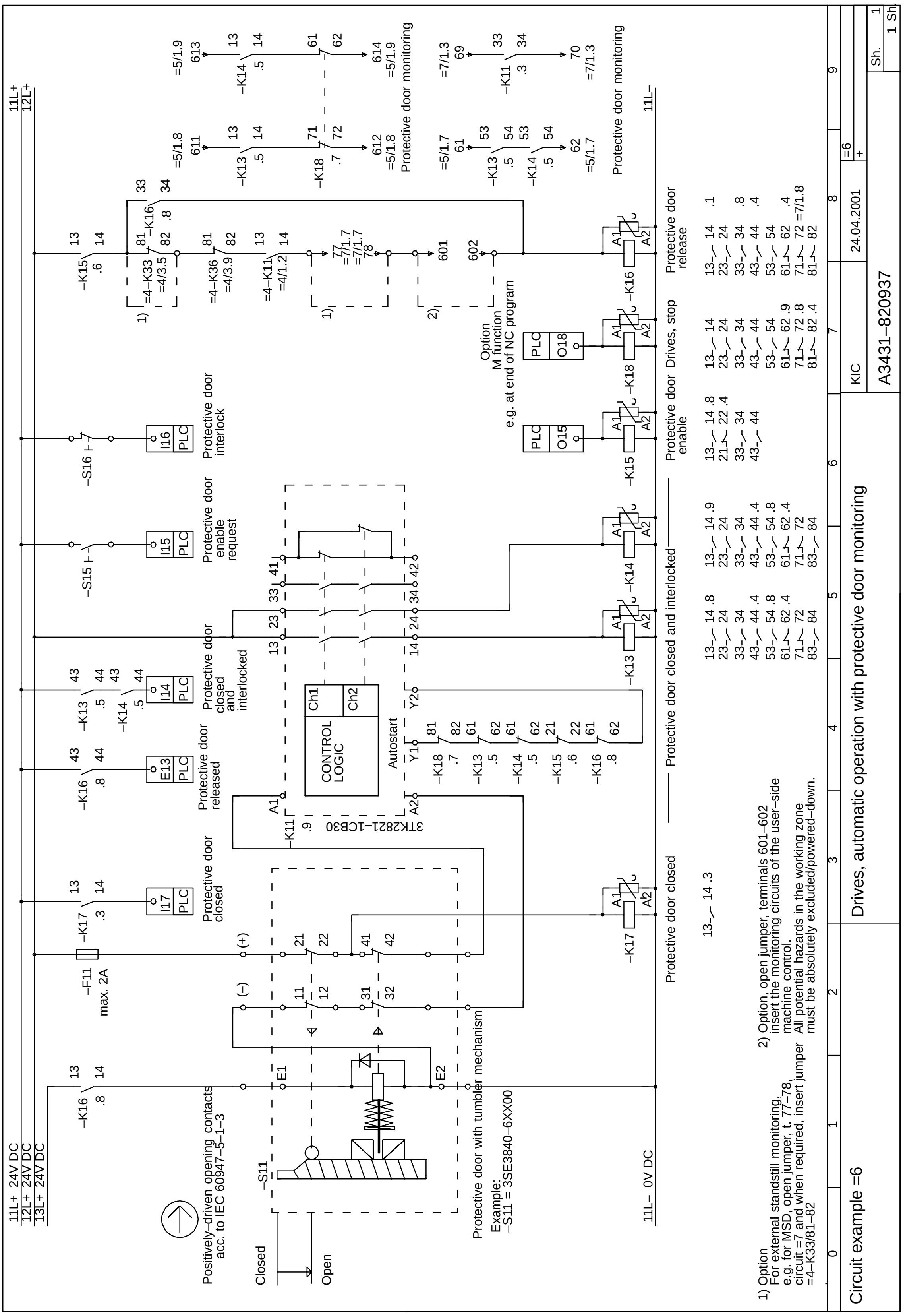

Fig. 8-23 =6 Automatic operation with protective door monitoring; Sheet 1/1

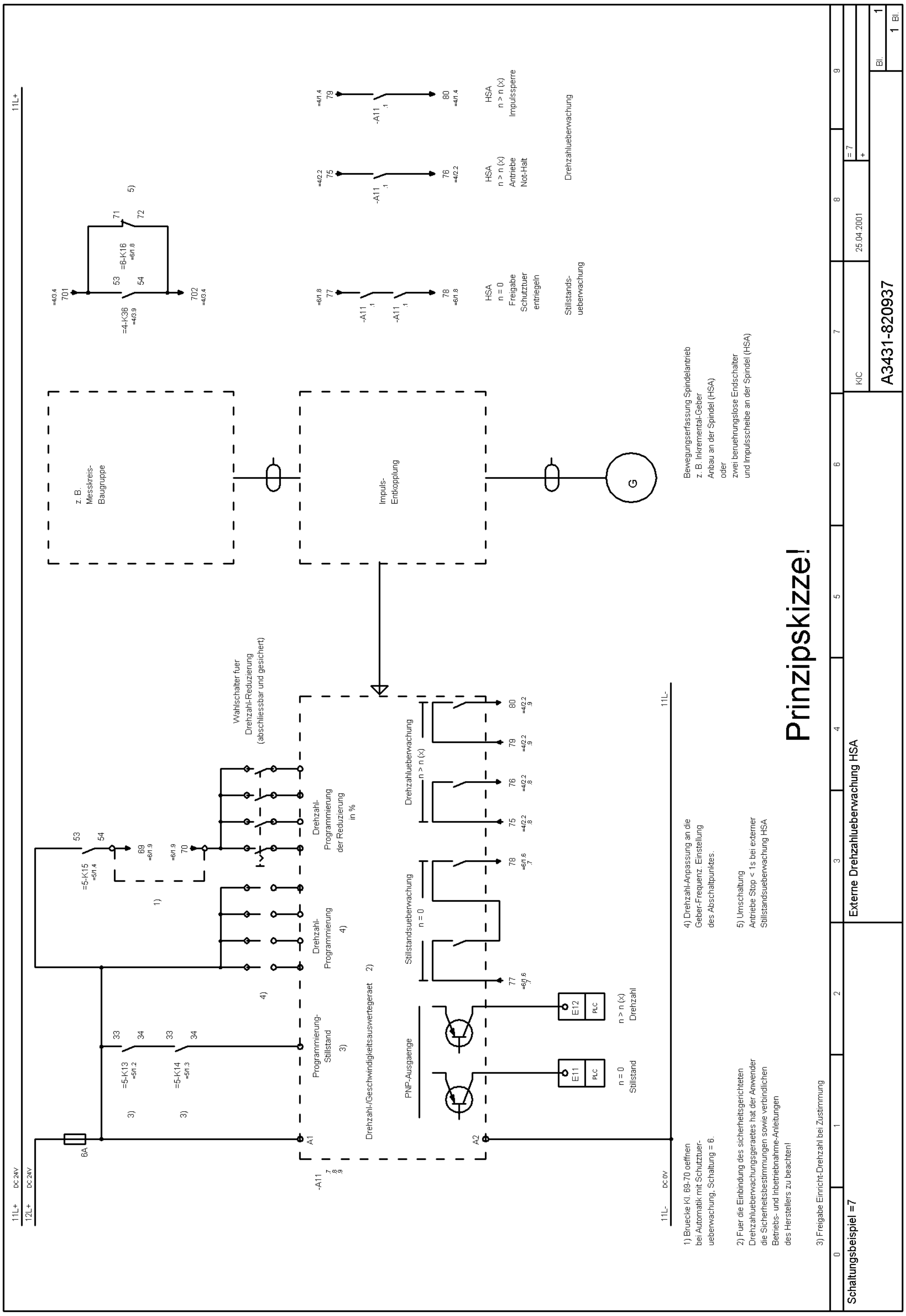

Fig. 8-24 =7 External speed monitoring, MSD; Sheet 1/1

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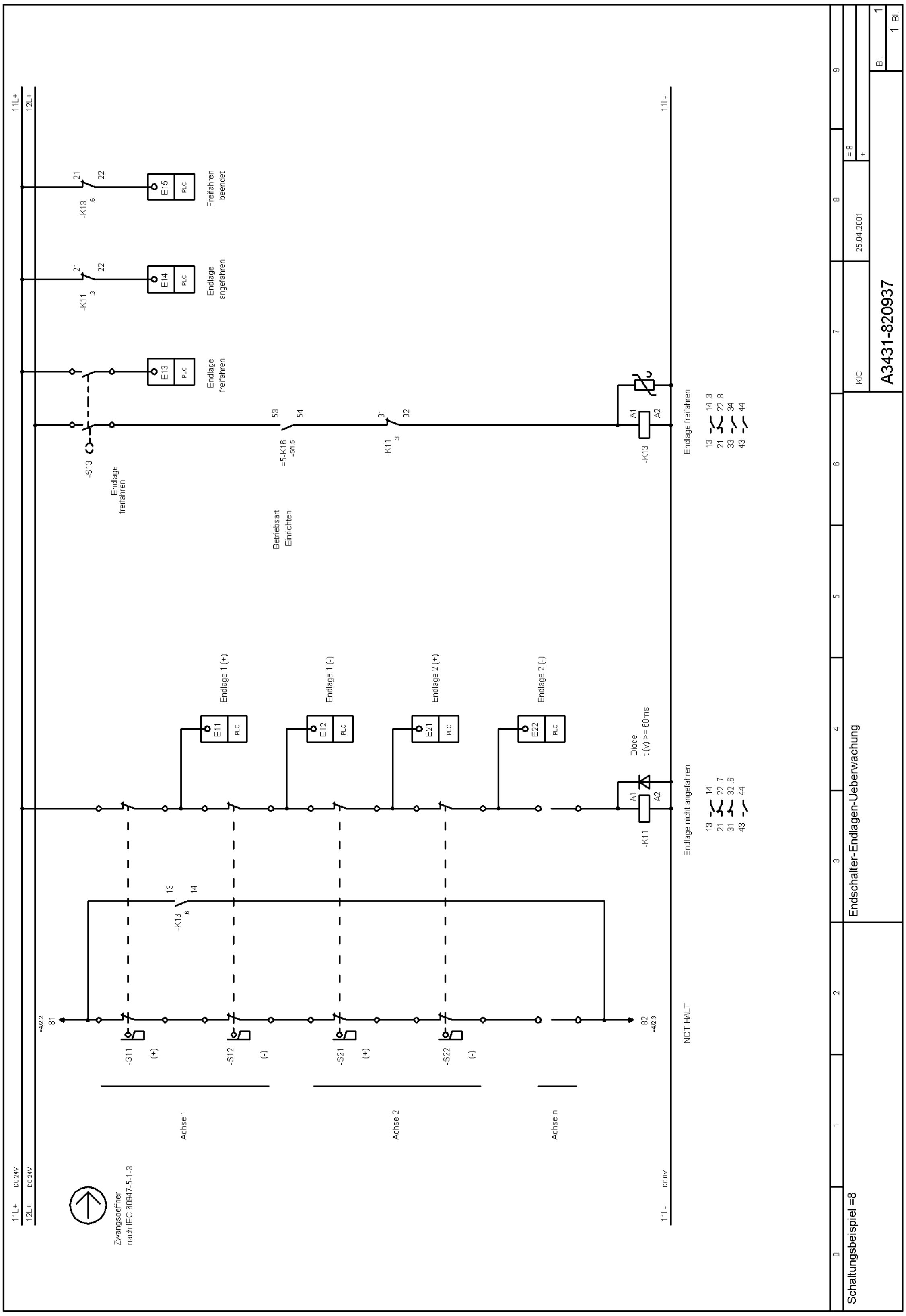

Fig. 8-25 =8 Limit switch, limit position monitoring; Sheet 1/1

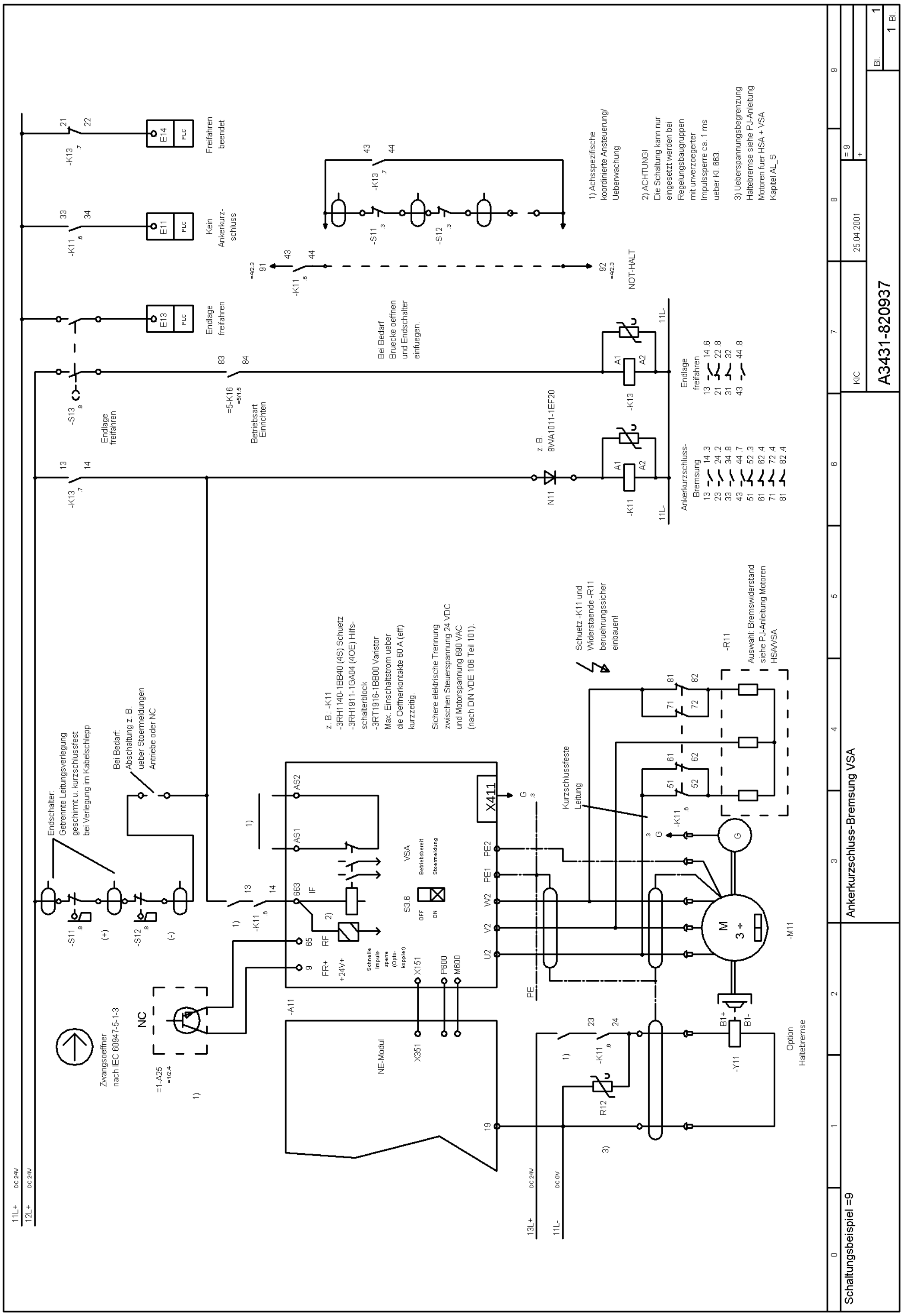

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Fig. 8-26 =9 Armature short–circuit braking, FD; Sheet 1/1

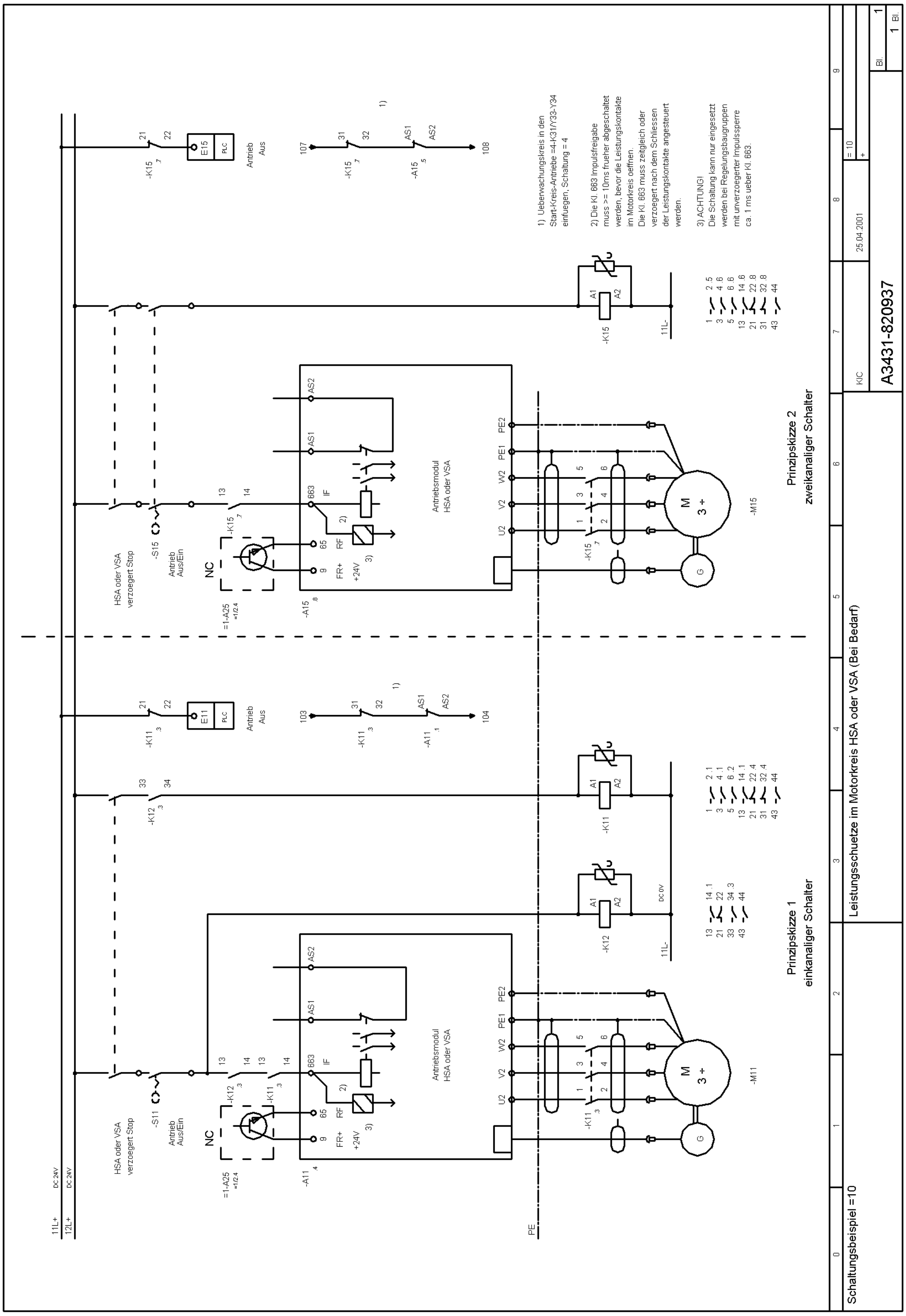

Fig. 8-27 =10 Power contactors in the motor circuit; Sheet 1/1

8.7.1 Function description, circuit examples =1 to =10

Higher–level information, instructions and functions

Connection information, technical data, selecting equipment and devices

When engineering the drive components, safety switching devices, contactors, shown in the circuit examples, it is absolutely necessary to carefully observe the associated connection information/instructions, technical data of the current Operating Instructions and Configuration Manuals as well as the appropriate Catalogs and Application Manuals.

Selecting switching devices

- SIGUARD safety combinations 3TK28 / 3TK29; circuit examples as well as the functions ”automatic start” and ”monitored start” are described in the Application Manual ”Safety Integrated”, Order No. E20001–A110–M103.
- SIRIUS power and auxiliary contactors 3 RT1 and 3 RH11 should be selected with positively–driven auxiliary contacts according to ZH1/457, IEC 60947–5–1.
- Contact reliability

  The auxiliary contacts, switching contacts of the switching devices and the line isolation equipment must be able to reliably switch low switching currents $\leq$17 V, 5 mA.
- Overvoltage limiting

All of the switching devices, coils, inductances, brakes etc. must be equipped, for EMC reasons and for reasons associated with the functional safety, with RC elements, varistors, diodes or diode combinations. These are intended to dampen overvoltages at switch–off if these damping elements are not already integrated in the devices.

This also applies to switching devices that are controlled from PLC outputs.

Note

The selection of the overvoltage limiting function also influences the off delay of the devices. This effect must be carefully taken into account when engineering the system.

Refer to Catalog NSK Low–Voltage Switchgear for selection and technical data

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8

Functions/safety aspects

Definition of the terminology
”Powering–down in an emergency” EMERGENCY SWITCHING–OFF and
”Stopping in an emergency” EMERGENCY STOP

- Actions taken when an emergency arises according to EN 60204–1 (VDE 0113, Part 1): 1998–11, Chapter 9.2.5.4 should be interpreted as follows:
- Powering–down in an emergency: In stop Category 0 according to EN 60204–1;9.2.2 stopping is achieved by immediately disconnecting the power feed to the machine drive elements (i.e. uncontrolled stop). Generally, this type of power–down operation is interpreted as EMERGENCY SWITCHING–OFF.
- Stopping in an emergency: In stop Category 1 according to EN60204–1; 9.2.2 a system is stopped in a controlled fashion; in this case, the power feed to the machine drive elements is maintained in order to stop in a controlled fashion. The power feed is only interrupted when standstill has been reached. Generally, this type of stopping is defined as EMERGENCY STOP.
- In the circuit examples, when stopping in an emergency, the term EMERGENCY STOP function is used.

  The EMERGENCY STOP buttons cause a shutdown according to control Category 3 in compliance with EN 954–1 through two channels using the 3TK2806–0BB4/3TK2842–1BB42 safety relays. When required, the switching devices also allow an EMERGENCY STOP button to be connected in a configuration that is cross–fault circuit proof, Category 4 according to EN954–1.
- Braking using terminal 64 – drive inhibit – at the current limit

  By inhibiting terminal 64 – drive enable at the NE module or the monitoring module – the drives are stopped as quickly as possible at the selected current limit (torque limit)/ramp of the drive module.
- Regenerative feedback power, NE module

  The power rating of the NE module is selected according to the rated power of the connected motors – reduced by a coincidence factor (demand factor). When braking at the current limit it should be ensured that the braking power does not exceed the peak – regenerative feedback power of the I/R modules (refer to Table 6.3) and/or the braking power of the pulsed resistor in the UI modules. In borderline cases, the NE modules should be dimensioned somewhat larger or additional pulsed resistor modules with external pulsed resistors should be used.
- Setpoint and position actual value interfaces

  A complete drive module with power and control section with standard interface and analog setpoint interface for 1FT5 motors is shown in a block diagram in Chapter 8.4.1. The setpoint is controlled through terminals 56/14. In the circuit example =1, the setpoint and position actual value interface of the NC – e.g. 840C – is only shown once as a general schematic. These are not discussed any further in the additional circuits.

  A detailed description of the control units is provided in Chapter 5.
- Motor holding brake

  The holding brake must be controlled in a coordinated fashion with respect to time. For instance, using the PLC logic as a function of the pulse cancellation, controller enable and speed setpoint input. In this case, the times required for the holding brake to open and close must be taken into account. If the brake control is not optimally harmonized and coordinated, then this results in increased wear and premature loss of the braking performance.

  In the circuit examples, for a drive stop, the holding brake is disconnected with drop–out delay using the appropriate hardware in addition to the PLC control. This means that a PLC fault cannot result in the brake being incorrectly controlled when the drive is stationary. It must be decided, on an application–for–application basis, whether when stopping in emergency, the brake is to be shutdown instantaneously or with a delay. Using an internal sequence control, 611U controls allow a holding brake to be controlled in a coordinated fashion (refer to the Function Description for SIMODRIVE 611 universal).

Holding brakes must be provided with external circuitry to dampen overvoltages.

A detailed description is provided in Reference /PJM/ for SIMODRIVE motors MSD and FD.

- Safe stop

After the drives have stopped, by safely disconnecting the power feed to the motors, the drives are in the safe standstill condition. When the start inhibit is activated, then the pulses are safely cancelled in the drive modules.

Features

- The motor cannot be started accidentally.
- The power feed to the motor is safely disconnected
- The motor is not electrically isolated from the drive module or the converter DC link.

The machinery construction OEM must take the appropriate measures to ensure that the drives do not undesirably move after the power feed has been disconnected.

Secondary conditions, e.g. for vertical/suspended axes:

Safe standstill is only guaranteed if the kinetic energy stored in the machine cannot result in an unpredictable motion of the drives/axes. For example, for vertical or inclined axes without weight equalization, motion can occur as a result of non–symmetrical rotating bodies or workpieces.

The motor holding brake supports the safe standstill operating condition.

When manually intervening in the automatic mode, when traversing in the setting–up mode as well as during service/maintenance and repair work, depending on the hazard analysis, it may be necessary to apply additional measures for personnel and machinery protection.

Axes can be secured from dropping/falling or axes can be locked in a specific position using redundant devices in addition to the holding brake – e.g. using electromechanical or pneumatic locking devices with cyclic monitoring.

Circuit example =1 ”Cabinet supply, NC, PLC”

- Cabinet design and regulations relating to the implementation and design:

When designing, constructing and implementing the electrical/control cabinets to accommodate the drive components, among others, the following important regulations must be carefully observed:

DIN EN 60439–1 (VDE 0660 Part 500) 2000–08 Low–Voltage Switchgear Combination

DIN EN 60204–1 (VDE 0113 Part 1) 1998–11 Electrical Equipment of Machines, Safety

DIN VDE 0106 Part 100 1983–03 Protection against Electric Shock.

EMC and Low–Voltage Directive

Enclosure/housing degree of protection IP 54 or corresponding to the requirements of the ambient conditions.

Selecting equipment and devices:

- Q1 line isolating device (main switch) with leading auxiliary contact when opening

  Selection, refer to Chapter 7.3.5 and Catalog NSK

  The line isolating 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=function extra low voltage with protective separation. We recommend that regulated power supply units that limit the current are used – e.g. SITOP–power.
- F11–F14 m.c.b.s 5SX or 5SY, refer to Catalog I2.1. The potential assignment of the circuits has been randomly selected. The max. permissible values of the protective elements must, under all circumstances, be carefully observed when protecting the safety relays and circuits.
- F21–F23 line fuses for the NE modules, assignment refer to Chapter 7.3.1 and 8.2.2.
- A21 line filter, refer to Chapter7.5 and Catalog NC 60
- L21 line commutating reactor, refer to Chapter 7.4.1 and Catalog NC 60
- A25 NC control SINUMERIK 840C with analog setpoint interface and PLC–CPU 135WD, refer to Catalog NC 60.

Circuit example =2 ”Drives on/off/stopping in an emergency”

Application

Drive group, comprising an NE module, three FD modules 611 with control boards High Standard. This circuit concept can be used, for example, for basic 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 via the line contactor and start inhibit functions.

Functions

Drives, on

- Key–operated switch –S21, control on.

The power–off circuit before the EMERGENCY STOP safety relay –K21 – with the expansion devices –K22, –K23 – must be switched–in taking into account the following conditions:

- Contactor –K25 closes, ready signal from the NE module. (ready conditions, NE module, refer to Chapter 8.2.2!) When the control is powered–up, the ready signal is still not present. This means that the PLC output O25 must be set to ”1” using the PLC logic so that the power–off circuit is closed through contactor –K25. After the drive group has been powered–up through the switching devices –K21, –K22, –K23, if a fault is not present, then the ready signal is received via PLC input I11. The ready signal monitoring in the power–off circuit is now active via the PLC logic.

  The feedback circuit from contactor –K25 is monitored using PLC I25.
- Contact =A1–A25/1–2 NC ready (ready signal) must be switched through to the NC control.
- Interlock circuit terminals 35–36 is closed.
- The expansion devices –K22, –K23, the line contactor, the start inhibit functions/terminals and contactor –K27 for the brake control are now monitored, at each power–on cycle for the safety–related off switching condition. When required, safety–relevant functions of the machine control on the user side can also be incorporated in the feedback circuit.
- Pushbutton –S23, drives on

Contactors –K21, –K22, –K23 are closed and power–up the drive group. After the DC link pre–charging has been completed, the line contactor in the NE module is closed. The ready signal is issued as long as there is no fault signal present.

NC program, start/stop

- Pushbutton –S29/–S28

  The axis–specific controller enable signals are activated and the NC machining program started using pushbutton –S29 – NC program start. At the end of the program or using pushbutton –S28 – stop – the drives are brought to a controlled standstill.

Drives, off

Using pushbutton –S24 – EMERGENCY STOP – or –S22 – off –, the drives are, assuming that they have still not been stopped via the NC program, are braked and stopped as quickly as possible at the selected current limit of the drive modules. Terminal 64, drive enable, is inhibited and braking is initiated using the instantaneous contact of contactor –K22. After braking has been completed, the line contactor is opened using a safely overlapping shutdown time via the off delay contact of –K23 in a safety–relevant fashion through two channels via terminal 48 and NS1–NS2 of the line contactor; the drive inhibit functions are activated by inhibiting terminals 663. Fault signals of the drive system, interlocked using the PLC logic can be used, depending on the application, to brake along the current limit or for controlled braking along a setpoint ramp. The Off button also acts on PLC I22. This means that the PLC logic can be used to evaluate which power–off command caused the drive group to be powered–down. The drive group can also be powered–down via the PLC, logically interlocked, independent of the ready signal of the NE module using contactor –K25.

Holding brake

The holding brake is controlled, coordinated as far as the timing is concerned by the PLC logic through PLC O27. When the drives are stopped, the brake is additionally safely shutdown per hardware using an off delay contact of contactor –K23. This means that a PLC fault, when the drive is stationary, cannot cause the brake to be incorrectly controlled.

Temperature monitoring

If the temperature monitoring responds as a result of an overtemperature condition of a drive module and/or a motor, input PLC I12 is energized at the NE module via relay contacts 5.1–5.3. Using the logical interlocking in the PLC, the drives must, depending on the application, be shutdown either instantaneously or delayed e.g. via PLC O25 and contactor –K25.

Circuit example =3 ”Drives start/stop/safe standstill”

Application

This control is used where one or several drives must be selectively shutdown from an operational drive group using safety–relevant technology. The drive can be shutdown in a safety–relevant fashion from the drive group using a two–channel key–operated switch or, e.g. using light barriers or limit switches.
Beforehand, the drive must have been safely stopped by the NC control.
The ”safe standstill” condition is achieved using the start inhibit function.

Functions

Drives, start

The 2–channel stop circuit in front of safety relay –K11 must be closed using the key–operated switch –S11 and the EMERGENCY STOP circuit contactor =2–K22. Contactor –K11 is closed with ”monitored start” and latches using button –S12 – start – and the closed feedback circuit. Terminal 65, controller enable, and terminal 663, pulse enable, are energized.

The drive is moved and stopped in a controlled fashion using the NC program.

Drives, stop

Safety relay –K11 is de–energized using key–operated switch –S11 or when EMERGENCY STOP is pressed. The instantaneous contact withdraws terminal 65 ”controller enable” and the drive is braked at the current limit. Terminal 663 is de–energized via the off delay contact –K11 and therefore the start inhibit activated.

Monitoring the start inhibit functions

The start inhibit monitoring function terminals 35–36 is effective in the EMERGENCY STOP circuit of contactor =K2–K21.

Normally, when a drive is stopped, the NC contact AS1–AS2 of the start inhibit relay should always be closed before the NO contact of contactor –K13 opens. To ensure this, the contactor coil –K13 must be equipped with a diode to extend the contactor off delay. If the start inhibit function is incorrect, the monitoring circuit opens and disconnects the complete drive group through the line contactor.

The start inhibit is cyclically monitored after every stop operation.

Holding brake

The function is similar to that in circuit =2

Circuit example =4 ”Drives, on/off/stopping in an emergency; start/stop/safe standstill”

Application

Drive group, comprising an NE module, MSD module for 1PH7 motor and three FD modules 611 with High Standard control boards. Circuit =4 is the basic circuit for the drive–related control, e.g. of a machine tool. Using the subsequent circuit components =5 to =10 with the associated and necessary interlock and monitoring circuits and the application–specific supplements, the control can be expanded and therefore individually adapted to the particular application.

Functions

Drives, on (NE module)

- Key–operated switch –S21, control on.

  The power–off circuit in front of the EMERGENCY STOP safety switching device –K21 must be closed under the following conditions:

- The interlocking circuits of the following expansions to circuits =7 to =9 are jumpered.
- Contactor –K25 closes and contact =A1–A25/1–2 NC ready is closed. The power–on conditions are almost comparable to circuit =2. The additional function is that the ready signal of the MSD module – PLC I15 must be interlocked in the PLC in addition to the ready signal of the NE module – PLC I11.
- Pushbutton –S23, drives on

  Contactor –K21 closes and latches. Initially, only the NE module is powered–up. After the DC link pre–charging has been completed, the line contactor is closed. The ready signal is issued as long as there is no fault signal at the NE module and at the FD modules (switch, ready/fault signal is set to fault signal).

Drives, start (drive modules)

- The NE module must be powered–up. The stop circuit in front of safety relay –K31 must be closed. The interlocking circuits of the following expansions of circuits =5 and =7 are jumpered.
- Using pushbutton –S32 – drives, start (monitored start) – with the feedback circuit closed, safety relay –K31 with expansion device –K32 and contactors –K35, –K33, –K36 are closed and latch.
- Simultaneously, terminal 63 central pulse enable, terminal 64 ”drive enable” at the NE module and terminal 663 ”pulse enables ” for the drive modules are energized and therefore the start inhibit functions are withdrawn.

NC program, start/stop

- Pushbutton –S29/–S28

  The axis–specific controller enable signals are activated and the machining program started using pushbutton –S29 – NC program start. At the end of the program or using pushbutton –S28 – stop – the drives are brought to a controlled standstill.

Drives, stop

- Using the two–channel pushbutton –S31, drives stop – the drives are braked and stopped as quickly as possible at the selected current limit of the drive modules if these have already not been stopped by the NC program.
- Terminal 64 – drive enable – is de–energized by the instantaneous contact of contactor –K31. After the drives have come to a standstill, terminal 663 is inhibited and the start inhibit functions become active via the off delay contacts of the safety relays –K32 and –K35.
- The shutdown times are adapted to the various braking times of the MSD and FD drives and must safely overlap these from a time perspective, e.g. MSD, 5 s; FD, 0.5 s.

Monitoring the start inhibit functions

The start inhibit monitoring function terminals 37–38 are effective in the EMERGENCY STOP circuit in front of contactor –K21. Normally, when the drives stop, the NC contacts AS1–AS2 of the start inhibit relays in the drive modules must always be closed before the NO contact of contactors –K33 and –K36 open. In order to realize this, the coils of these contactors must be equipped with a diode to extend the contactor drop–out delay. If the start inhibit function is incorrect, the monitoring circuit opens, EMERGENCY STOP contactor –K21 drops–out and shuts down the complete drive group through the line contactor. The start inhibit functions are actively monitored cyclically after every stop operation.

Drives, off

- Using the EMERGENCY STOP pushbutton – –S24 – or off – –S22 – the drives are braked and stopped as quickly as possible at the current limit. The function is similar to circuit =2. After the braking time of the spindle drive, the drive group is shutdown through 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 is similar to circuit =2

In addition, the temperature monitoring function of the spindle drive must be evaluated via PLC I13 and –I14.

Circuit example =5 ”Drives, operating modes automatic operation/setting–up operation with agreement”

Application

The operating mode changeover is used, for most machines/plants in order, e.g. in the setting–up mode to traverse/operate sub–functions of the machine at a controlled, reduced velocity. In this particular operating mode, other sub–areas must be shutdown in a safety–related fashion to avoid potential hazards. The drives can only be operated with an agreement issued by the operator in the setting–up mode with reduced velocity/speed. This agreement can, for example, depending on the risk assessment, be issued from a secure location outside the hazardous zone of the machine or using a mobile handheld unit with additional EMERGENCY STOP pushbutton in the operating zone of the machine.

Notice

In this case, the user is responsible for observing and complying with the specific technological and machine–specific regulations and Standards to maintain the protection and safety of personnel and machinery. Further, residual risks must be evaluated – those risks that are due for example to vertical/suspended axes.

The phase when the machine starts after power–on is especially critical. An agreement for a specific traversing motion should only be issued if the machine had previously moved in a controlled fashion.

Functions

Operating modes

The operating mode selector switch –S15 must be able to be locked as key–operated switch or must be implemented in another way so that it can be locked–out.

Notice

The operating mode may only be changed when the drives are stationary and they may – under no circumstances – result in a hazardous situation at the machine.

Automatic mode

The interlocking circuits terminals 51–52/53–54/55–56/57–58/511–512 should be inserted into circuit =4. The interlocking circuit terminals 611–612/613–614 is closed.

Key–operated switch –S15 is set to automatic, contactor –K15 pulls–in. 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, drives, Start =4–S32.

Set–up operation

Key–operated switch –S15 is set to setting–up, contactor –K15 drops–out, contactor –K16 closes. The monitoring circuits terminals 53–54/55–56 are open. This means that the drives cannot be started. When the monitoring circuit, terminals 511–512 is opened, pushbutton =4–S32 – Start drives is ineffective in the setting–up mode.

Using the interlocking circuit terminals 57–58, the drop–out delay for contactor =4–K32, used for the shutdown time of the spindle drive is changed–over from e.g. 5 s to the shorter time of the FD drives, e.g. 0.5 s. If a fault condition is present this means that the complete drive group is already shutdown after this shorter time. Further, with the changeover to setting–up, the speed setpoint for the drives is reduced via PLC I18. The speeds and feed velocities are therefore to be reduced to permissible values according to the type C Standard or the hazard analysis.

Notice

Setpoint limiting is not a safety–relevant function.

Agreement function

The safety relay –K11 and contactors –K13/–K14 are switched–in – if the feedback circuit is closed – using pushbutton –S11 – agreement (pushbutton with two positions).

The interlocking circuit is then closed through terminals 53–54/55–56. A start pulse must be generated via PLC I17 with a time delay >= 80 ms; this pulse is output at PLC O17. Contactor –K17 briefly pulls–in and issues the start commands for contactors =4–K31, –K32, –K33, –K35 and –K36 through terminals 51–52.

The start inhibit functions are withdrawn and therefore the drives are enabled in a safety–relevant fashion – as long as the agreement button is pressed.

Using the non safety–relevant PLC function keys – in conjunction with the hardware agreement function – the selected drives can now be individually traversed with reduced parameters.

Notice

No motion may be started by just pressing the agreement button alone. Note: When terminal 81 – ramp–function generator fast stop – is withdrawn, after every agreement command, the spindle induction motor must be re–magnetized and therefore starts with some delay $\geq$ 0.5 s.

If hazardous operating states exist, if the PLC function keys fail, or for any other unpredictable situation, the drives can be stopped in a safety–related fashion by releasing the agreement button.

Notice

For high–speed drives with inadmissible speed increases, under fault conditions, potential hazards can occur due to the response times of personnel and the delay when the agreement device switches. These hazards must be reduced by applying additional measures – e.g. a safety–related speed monitoring function. Various type C Standards – e.g. for machine tools – specify a safely monitored speed in the setting–up mode for spindle drives.

Circuit example =6 ”Drives, automatic operation with protective door monitoring”

Application

In the automatic mode, the working zone of a machine is isolated using a moving, closed protective door (e.g. guard). In the circuit example, the protective door is interlocked and cannot be opened while the drives are running or if other hazardous operating states exist. This is realized using a position switch with tumbler mechanism with an interlock using spring force with sealed auxiliary release. Automatic operation for the drives is only enabled if the protective door is closed and interlocked via the position switch.

Depending on the hazard analysis, the user must decide whether, e.g. a second limit switch is additionally required for the door monitoring function.

The protective door is prevented from being opened as long as a hazardous state exists – e.g. as a result of the drives running–down. The enable signal is only issued with a time delay after the drive with the longest braking time has been reliably and safely stopped or optionally using the standstill signal of an external speed monitoring function in circuit =7.

For several applications, e.g. if personnel can enter the working area of a machine, the tumbler mechanism of the protective door is implemented using a position switch interlocked with magnetic force. This is for safety–related reasons. When the line supply or control voltage fails, the position switch can be used to release the protective door and allow it to be opened.

Functions

Request that the protective door is enabled.

The drives must initially be shutdown using pushbutton =4–S31 – stop drives – or optionally, e.g. at the end of the NC program by the output of an NC auxiliary function, PLC O18 closes contactor –K18.

The protective door enable is requested using pushbutton –S15. Contactor –K15 pulls–in, interlocked through the PLC logic when the drives are stopped and shutdown. This means that contactors =4–K33 and =4–K36 have dropped–out. PLC logic: PLC O15 = ”1”, if =4–I33 and =4–I36 = ”0” signal. When expanded with an external MSD speed monitoring function, circuit =7, the PLC logic must be appropriately adapted: PLC O15 = ”1”, if =4 I36 = ”0” and =7 I11 = ”1” signal.

When requesting that the protective door is enabled, in the secured working zone of the machine/plant, all hazardous motion and other potential hazards of the user–side machine control must be shutdown. The shutdown must then realized in a safety–relevant fashion using the released or opened protective door.

Releasing the protective door

The protective door is released using contactor –K16 if the following conditions are fulfilled:

- Contactor –K15 is closed (energized)
- Drives, delayed stop, contactors =4–K33 and =4–K36 open (de–energized).
- MSD standstill signal n act < n min via relay =4–K11.
- User–side interlocking circuit is closed via terminals 601–602.

Optional:

- External standstill monitoring closed through terminals 77–78.

The interlocking solenoid of the door position switch –S11 is energized and the safety relay –K11 and contactors –K13/–K14 are de–energized via the position monitoring function of the solenoid. The drives are shutdown in a safety–relevant fashion through two channels via the interlocking circuit, terminals 611–612/613–614. The protective door is initially just released, but is still closed, relay –K17 energized. Using the PLC, e.g., sub–functions of the user–side machine control, that are still not hazardous, can be executed.

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 – redundantly to the position monitoring function of the solenoids.

Closing the protective door

The protective door must be closed. Using pushbutton –S16 – interlock protective door – contactors –K15/–K16 are de–energized (they drop–out) and the protective door is again interlocked. The interlock circuit is again closed through terminals 611–612/613–614 which means in the selected automatic mode, the drives can again be released using pushbutton =4–S32 – start.

For protective doors that are infrequently opened, we recommend that the control is adapted so that each time before the drives are powered–up, the position switch function is checked by opening and again closing the door.

Circuit example =7 ”External speed monitoring function, spindle drive”

Application

Several type C Standards specify a safety–relevant speed monitoring for the following functions:

- Standstill monitoring function for a spindle drive in order to release a protective door
- Speed monitoring functions for max. speeds or velocities in the setting–up mode – e.g. 50 RPM – or in the automatic mode, depending on the chuck size or the clamped tool as a result of the max. permissible clamping and centrifugal forces. The setting for the max. limit is realized, e.g., using a selector switch that is secured against manipulation and tampering.

When the automatic mode is de–selected, or when the protective door is opened, the speed is automatically monitored for standstill (zero speed monitoring). The setting–up speed (crawl speed) is released with the agreement function. After the agreement is withdrawn, the speed is again monitored for standstill after a delay (zero speed monitoring). The speed sensing for the monitoring device can be realized, e.g. using an incremental encoder or two proximity switches located at the spindle. The device to secure the speed monitoring function can be purchased from various manufacturers and is therefore only shown in its principle form but without any precise connection designations. The user is responsible for using the device in his particular application, carefully taking into account all of the safety–related issues and carefully complying with the manufacturer’s data.

8

Note

The device monitoring function should be proven and logged using an acceptance test!

Functions

Standstill (zero–speed) monitoring

The speed monitoring device is activated using the control voltage. The door release in circuit =6 is released using the safety–relevant standstill (zero speed) signal of the spindle drive, contact –A11/terminals 77–78 at the monitoring device. This means that the time until the protective door is released can be significantly reduced with respect to the delayed release using contact =4–K33, MSD stop. The contact =4–K33/81–82 must be jumpered in circuit =6. For NC machining programs with low spindle speeds, the time that it takes for the drive to brake down to standstill (zero speed) is appropriately short, so that it is no longer necessary to wait for the time, selected at contactor =4–K33 (for the maximum braking time) before opening the door. Further, the interlocking circuit terminals 701–702, changeover drive stop < 1 s for external standstill monitoring functions MSD, must be inserted in front of the contactor =4–K32/A1. This means that after the safety–relevant standstill (zero speed) signal of the spindle drive has been issued, the drives are already shutdown after < 1 s and brought into the safe standstill condition.

Speed monitoring

Set–up operation

The speed is monitored for standstill (zero speed) when de–selecting the automatic mode, contactor =5–K15 is de–energized or the protective door released or opened, contact =6–K11 de–energized, terminals 69–70 open. With the agreement issued using pushbutton =5–S11, contactors =5–K13/=5–K14 are energized (closed) and this means that the speed, set at the monitoring device is monitored in the setting–up mode.

When the permissible speed is exceeded, contacts –A11/79–80 and –A11/75–76 open. The pulse enable for the spindle drive is inhibited and simultaneously, using contactor =4–K21, the EMERGENCY STOP function is initiated and therefore the drives stopped.

Automatic mode

If the max. permissible speed, set at the selector switch (the reduction is programmed as a %) is exceeded, then immediate shutdown is realized as described above. The device must be adapted to the speed and pulse frequency of the speed encoder using the speed programming inputs.

After the appropriate hazard analysis has been carried–out, it may be necessary to use a speed monitoring function – e.g. also for feed drives and/or also for the machine functions on the user side. The control must be appropriately adapted on the user side.

Circuit example =8 ”Limit switch, limit position monitoring”

Application/functions

Normally, the end position (end stop) of the traversing range of the axes in the machine are monitored using software limit switches; these become active after the reference point approach (homing). If, in a fault situation, a software limit switch is passed, and therefore a hardware limit switch actuated, then contactor =4–K21 is de–energized (opened) via the interlocking circuit, terminals 81–82 in the EMERGENCY STOP circuit. The drives are braked at the current limit and are then stopped.

However, electrical braking of an axis is only effective if there is an appropriate distance for the braking travel between the hardware limit switch and the mechanical end stop of the axis.

The actuated end position limit switches can be evaluated/detected using PLC inputs. In the setting–up mode, the axis can be moved away in the opposite direction using key–operated switch –S13 and button =5–S11 – ”agreement”.

Circuit example =9 ”Armature short–circuit braking”

Application

Armature short–circuit braking is only possible when using permanent–magnet motors and is used, for example, when passing end position limit switches, when the power fails, for fault signals or EMERGENCY STOP with some delay.

When a software limit switch is passed, often, the fault/error is in the NC, PLC or in the drive module itself. Electrical braking beyond the limit position limit switches according to circuit =8 is therefore no longer possible. For critical drives – e.g. vertical axes, – in cases such as these, emergency braking is possible using armature short–circuit braking or optionally using a fast shutdown with a holding brake implemented with the appropriate hardware.

The braking torque for armature short–circuit braking is optimized using the additional braking resistor in the motor circuit.

Caution

Short–circuit braking without braking resistor can result in partial de–magnetization of the motor.

Functions

Armature short–circuit

The pulse enable is withdrawn via terminal 663 when the limit position limit switch is actuated/passed or when the power fails. The armature short–circuit contactor –K11 is simultaneously de–energized (opened). The drive is braked after the contactor drop–out time. The interlocking circuit, terminals 91–92, is simultaneously opened therefore initiating an EMERGENCY STOP function for all of the drives. A varistor must be connected to the contactor coil in order to achieve a short contactor drop–out time. The selected auxiliary contactor from the SIRIUS series of industrial controls with mounted, four–pole auxiliary contact element fulfills ”protective separation” between the control voltage and the 690 V AC motor circuit. For operation with power failure and when the +24 V control voltage is buffered, or for other shutdown functions, the circuit must be appropriately adapted to the particular application.

Holding brake

The fast application of the holding brake, independent of the PLC cycle time using the armature short–circuit contactor, supports braking. When compared to armature short–circuit braking, there is a delay before the holding brake actually closes and starts to brake.
In the setting–up mode, the axis can be moved away using the key–operated switch –S13 – move away from end position – and pushbutton =5–S11 – agreement.

Circuit example =10 ”Power contactors in the motor circuit FD”

Application

For special applications, the circuits allow the motor to be electrically disconnected from the drive module via contactors. The contactors may only be de–energized with a leading pulse inhibit >=10 ms via terminal 663 with respect to the power contacts. When powering–up, the pulses must be simultaneously enabled when the power contacts are closed.

Notice

The contactors are generally not suitable for interrupting clocked inverter currents or interrupting DC currents of a stationary drive that is in closed–loop position control. If this is not carefully observed, this can result in high voltage peaks/spikes when powering–down and in turn can destroy the drive module, the motor winding and/or cause the contactor contacts to weld.

Functions

The drives are powered–down in a safety–relevant fashion using key–operated switch –S11 through one channel or –S15 through two channels – a) Via the start inhibit function and b) In addition, using a contactor to electrically isolate from the drive module.

The pulse enable is withdrawnn before the power contacts of the power contactor open as a result of the drop–out delay. The interlocking circuit, terminals 103–104 or terminals 107–108, should be inserted in the start circuit of the safety combination =4–K31/Y33–Y34, drives stop.

8.8 Information and instructions regarding applications with 611 digital/611 universal

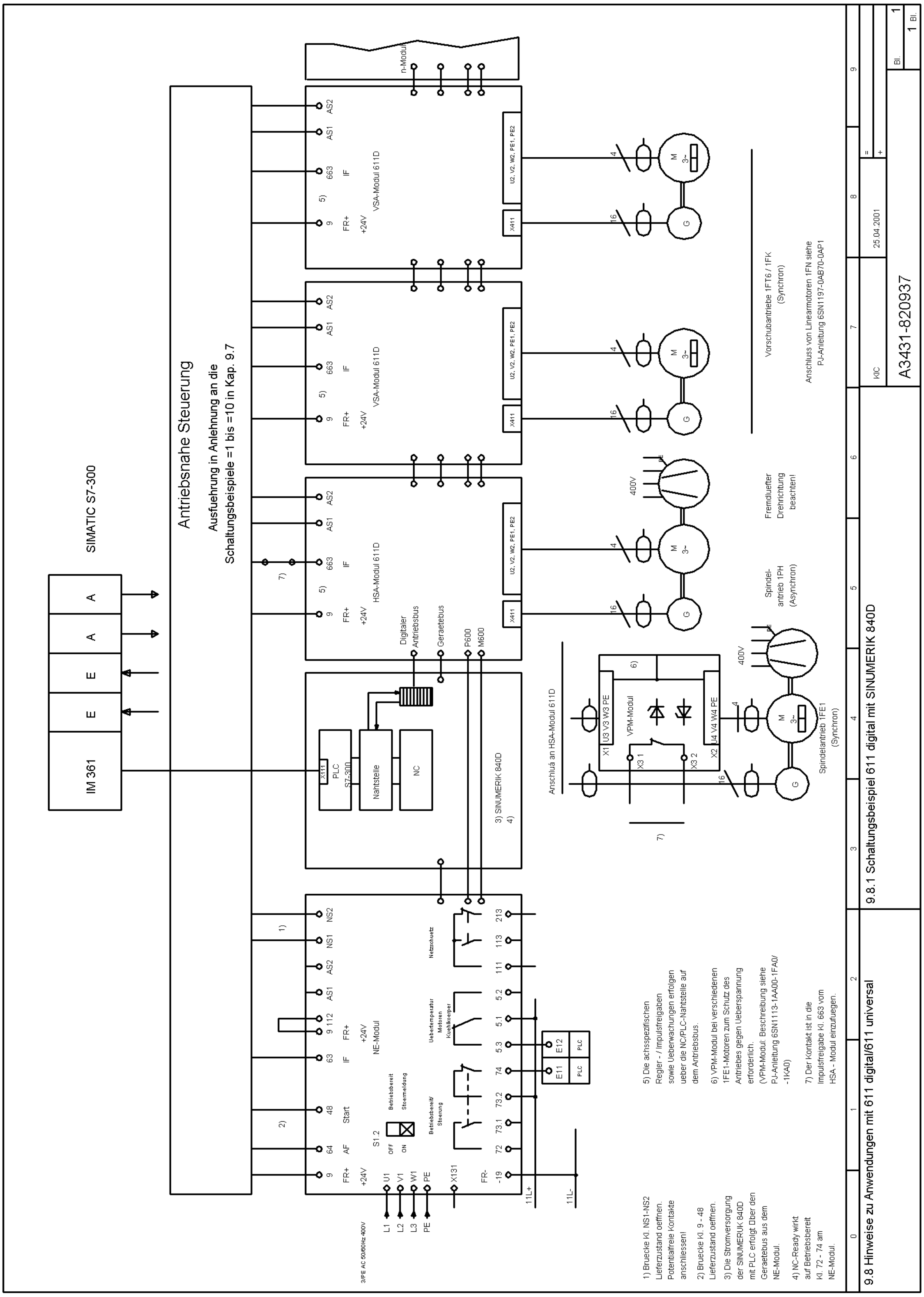


Fig. 8-28 Circuit example, 611 digital with SINUMERIK 840D

8.8.1 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 Chapter 8-28 with 611 in its principle form, is shown in Fig. 8.7.

8.8.2 Circuits with 611 digital

The digital control units 611 digital have a digital setpoint and position actual value interface to the 840D or 810D NC control systems. The boards are available as either 1–axis or 2–axis modules with High Performance or High Standard control.

Further, the units differ in the connection version:

- Incremental encoder as motor encoder (indirect measuring system), or
- Incremental encoder as motor encoder (indirect measuring system) and connection for a direct measuring system encoder

For a description of the interfaces of the 611 digital control units
—> refer to Chapter 5.

All of the NC control communications to the 611D drive modules are realized via the digital drive bus. The axis–specific controller and pulse enable signals as well as the operating (run) and monitoring signals are placed on the digital drive bus via NC/PLC interface signals.

The terminal 663 pulse enable/start inhibit for the 611D modules is provided on a module–for–module basis. The axis–specific pulse enable signals received via the drive bus are logically AND'ed with the signal state 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 that is compatible to the SIMODRIVE drive modules.

The control is integrated in the SIMODRIVE 611D drive group and can be expanded 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.

Control with SINUMERIK 810D

SINUMERIK 810D is a highly integrated compact control accommodated in a 150 mm wide housing – compatible to the SIMODRIVE modules – with integrated PLC–CPU SIMATICS7–300 and 611D power and control sections onboard. The control is available in two versions:

- CCU box with three integrated power modules
  - 2 x 6 A/12 A for FD
  - 1 x 18 A/36 A for FD or 1 x 24 A/32 A for MSD
- CCU box with two power modules
  - 2 x 9 A/18 A for FD

Using an axis expansion function, the control can be expanded up to 5 (4) axes + 1 spindle with separately–mounted power modules. The controls are already integrated on the CCU modules. Just like the SINUMERIK 840D, the control power supply is taken 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. For all of the axes, the control has a common hardware–related terminal 663 pulse inhibit/start inhibit function. The controllers and pulses are enabled on an axis–for–axis basis and are controlled on the digital internal drive bus via NC/PLC interface signals. The safety–relevant drive–related control for a machine/system with SINUMERIK 810D can be engineered on the user–side based on the circuit examples in Chapter 8.7.

8.8.3 Circuits with 611 universal HRS

The SIMODRIVE 611 universal HRS control board is available as either 1–axis or 2–axis module.

The setpoint can either be entered as analog signal or via PROFIBUS.

The interfaces are described in Chapter 5.

Implementation of the safety–relevant, drive–related control for a machine.

The SIMODRIVE 611 universal control board with analog setpoint interface can be used in a comparable fashion to the circuit examples =1 to =10 in Chapter 8.7.

8.9 Master/slave operation, SIMODRIVE 611

Application example, master/slave

Two SIMODRIVE main spindle drives can be operated, rigidly and mechanically coupled together if the master drive is closed–loop speed controlled and the slave drive is closed–loop torque controlled.

The application of a master/slave function with ”SIMODRIVE 611 universal HRS” is shown in the following example

The master specifies the torque setpoint for the slave via an analog output (terminals 75.x/15 or terminals 16.x/15).

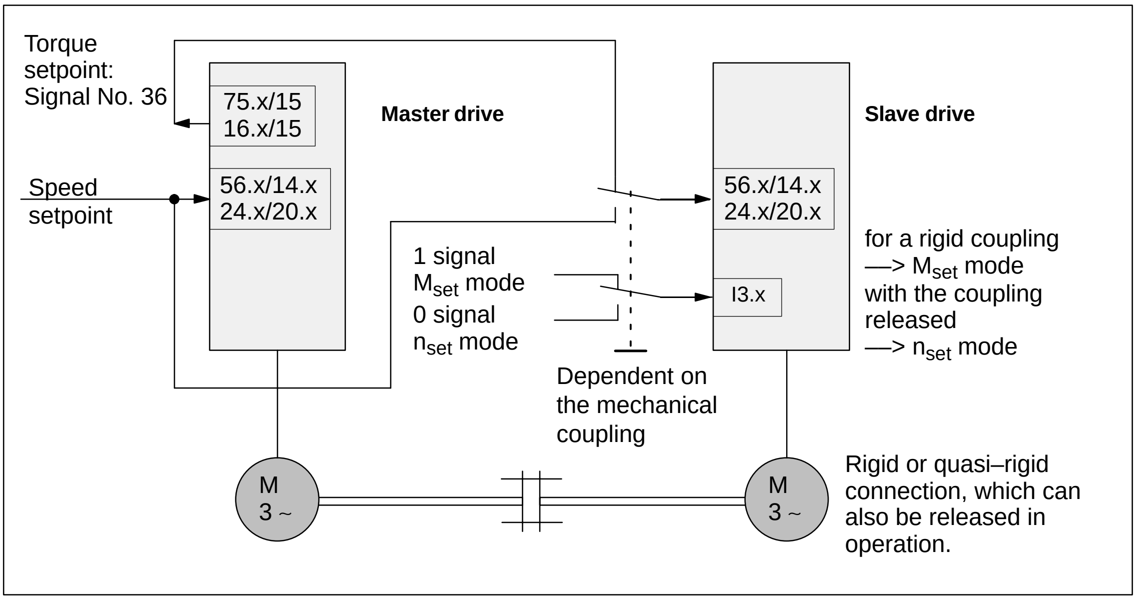


Fig. 8-29 Master/slave operation with SIMODRIVE 611 universal HRS

Warning

If the rigid mechanical coupling is released (opened), then the slave drive must be simultaneously changed–over to ”closed–loop speed control” as otherwise inadmissibly high speeds could occur which could result in injury to personnel.

For information and data on the settings and parameterization associated with this master/slave mode as well as additional possibilities regarding axis couplings, refer to:

Reader's note

For information and data on the settings and parameterization associated with this master/slave mode as well as additional possibilities regarding axis couplings, refer to:

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

References: /FB3/ Description of Functions SINUMERIK 840D/840Di/810D
TE3: Speed/torque coupling, master–slave
M3: Axis coupling and ESR

8.10 Star–delta operation

The SIMODRIVE 611 main spindle function supports the use of motors that can changeover between star**/**delta configurations.

At lower 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 speed when changing–over from a star into a delta configuration (star to delta operation) must lie within the stall power range for star operation (refer to the speed–torque diagram for Y**/**Δ operation).

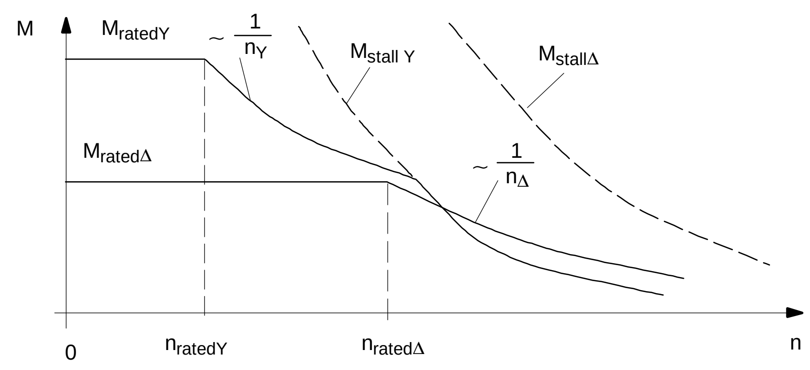


Fig. 8-30 Speed–torque diagram for Y**/**Δ operation

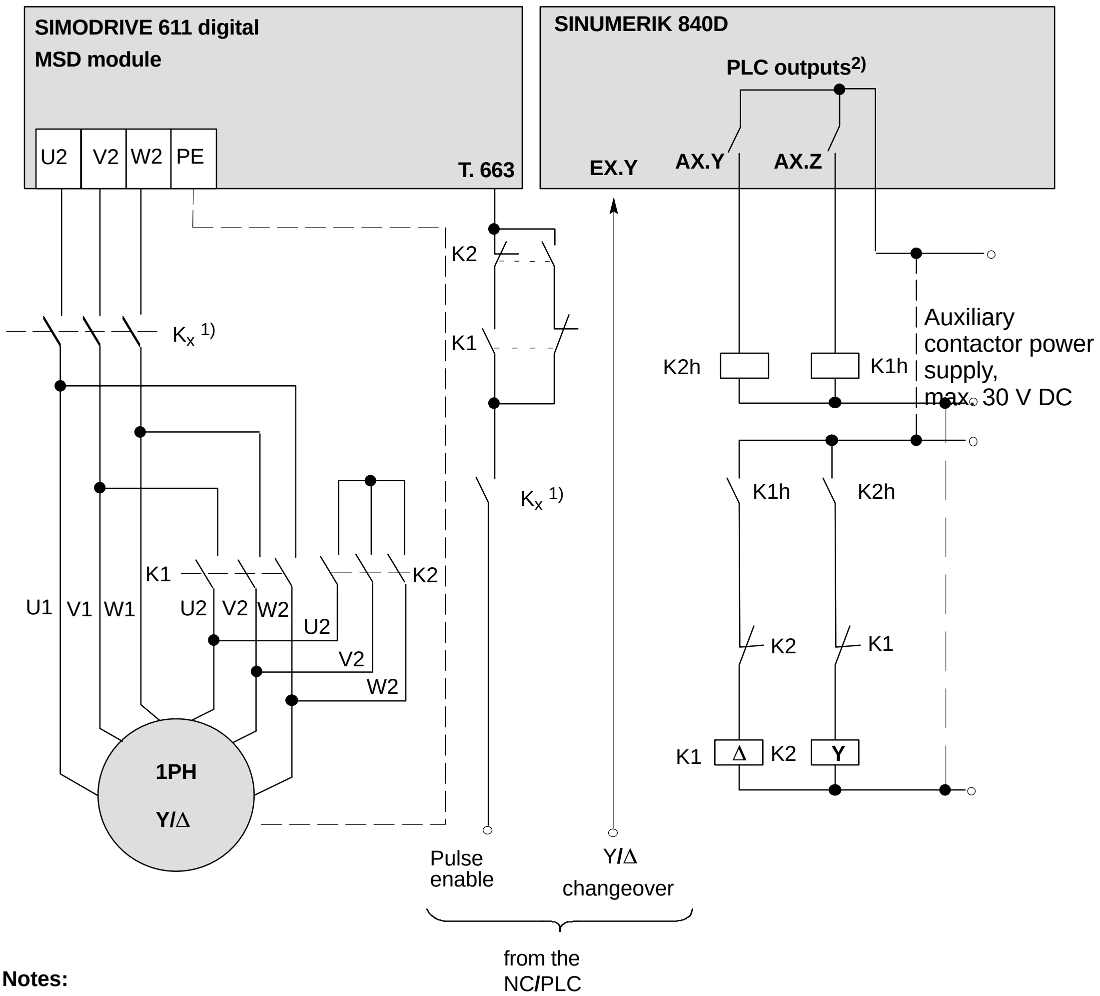
Note

If, in the delta mode, a torque lower than Mrated is required, an appropriately smaller power module can be selected (as a maximum up to root 3)!

Warning

During the phase when changing–over from Y to Δ operation, no torque may be demanded from the 1PH motor. In this case, a minimum deadtime of 0.5 s must be taken into account for contactor changeover times, safety margins, de–magnetizing and magnetizing operations.

Connection diagram for Y/Δ changeover, 611 digital system



Notes:

1) A safe standstill is not guaranteed by just opening K1 and K2. This is the reason that for safety–related reasons, contactor K_x should be used to provide electrical isolation. This contactor may only be opened/closed in the no–current condition, i.e. the pulse enable must be withdrawn 40 ms before the contactor is opened (de–energized). Refer to Chapter 9.4.2 and 9.7. Circuit example =10.
2) Two relay outputs, selectable from terminals AX.Y to AX.Z.

Fig. 8-31 Connection diagram for Y/Δ changeover with SIMODRIVE 611 digital

The connection diagram for Y/Δ changeover 611 universal HRS can be engineered, based on the previous examples. For a description of the function, refer to the separate Configuration Manuals and documentation SIMODRIVE 611 universal.

Dimensioning and selecting the contactors

The main contactors must be dimensioned/selected, harmonized and coordinated with the rated motor current and the overload factor.

The following table showing the assignment between 1PM4/6 motor/main contactors and auxiliary contactors can be used to provide engineering support:

Table 8-6 Dimensioning and selecting the main contactors for 1PM motors

Three–phase motor	Power [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

8

8.11 Series reactor

General information

For special motors with a low leakage inductance (where the controller settings are not adequate) it may be necessary to provide a series reactor as 3–arm iron reactor (not a Corovac reactor) and/or increase the inverter clock cycle frequency of the converter. Motors with a low leakage inductance are, from experience, motors that can achieve high stator frequencies (maximum motor stator frequency > 300 Hz) or motors with a high rated current (rated current > 85 A)

Selection/ calculations

- The voltage rate–of–rise (gradient) of the drive converter has typical values such as:

  5 – 7 kV / µs

  For third–party motors where the insulation is not designed for this voltage rate–of–rise, a series reactor should be used, independent of the selected pulse frequency.

- In the IM mode, motors can be used with a maximum rated torque of

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

  The inductance value of a series reactor or the necessary drive converter pulse frequency can be estimated using the following formula. However, it must be taken into account that when the inverter clock cycle frequency is increased, the module current must be reduced; or, a module with a higher current rating must be selected:

$$L_{series} \sim \frac{V_{DC\ link}}{30 \times f_T} \times \frac{n_{max}}{n_{FS} \times I_0} - L_{\sigma 1} - L_{\sigma 2}$$

$L_{\sigma 1}$	Stator leakage inductance of the motor in H
$L_{\sigma 2}$	Rotor leakage inductance of the motor in H
L_{series}	Inductance of the series reactor in H (=0, if a series reactor is not used)1)
$V_{DC\ link}$	Voltage (=600 V or 625 V for a regulated infeed, = rectified line supply voltage for a non–regulated infeed e.g. 570 V at 400 V_{rms} line supply voltage)
f_T	Inverter clock cycle frequency of the converter in Hz, refer to Chapter 4.4.1
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	Motor no–load current in A_{rms}
V_{Nmot}	Rated motor voltage in V_{rms}
n_N	Rated motor speed

1) For calculated/theoretical inductance values less than 0.2 mH, a series reactor is not required.

If the motor data are not known, then for motors with a high current (rated current > 85 A), the converter current should be dimensioned for a pulse frequency of 4950 Hz. This means that a drive converter reduction factor of approx. 83% is obtained.

- For motors that require a higher motor frequency than 500 Hz, the drive converter pulse frequency must be increased.
The following formula applies:

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

f_T Inverter clock cycle frequency of the drive converter in Hz, refer to Chapter 4.4.1

$f_{max\ mot}$ Max. motor stator frequency

It should be noted that for inverter clock cycle frequencies above 3200 Hz, the module current rating must be reduced or, if required, a module with a higher–current rating must be selected.

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

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

n_{max} Max. motor speed

n_{FS} Speed at the start of field weakening for the motor

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

If a motor is changed–over from delta to star operation and vice versa, and auxiliary and main contactors are required for each motor. The motor contactors must be mutually interlocked. The changeover is only made when the pulses are inhibited using select terminal signals. When the changeover command is issued, the motor data set is re–loaded and the auxiliary contactors are controlled via the selector relay.

Parallel operation of several induction motors, refer to Chapter 8.12.1.

- The voltage drop across a series reactor depends on the motor current and the motor frequency. If an unregulated infeed is used, the maximum rated motor voltage depends on the line supply voltage available. In order to be able to provide a sufficiently high motor voltage, we recommend the following guide values when dimensioning/selecting a motor:

Table 8-7 Guide values when dimensioning/selecting a motor

$f_{max,\ motor}$	400 Hz	600 Hz	800 Hz	1000 Hz	1200 Hz
I/R module $V_{DC\ link}$=625V, S1 must be switched to V_N=415 V.					
$V_{N,\ motor}$	400 V_{rms}	380 V_{rms}	360 V_{rms}	340 V_{rms}	320 V_{rms}
UI module V_{line}=400V line supply type: Sinusoidal					
$V_{N1motor}$	320 V_{rms}			300 V_{rms}	

If these guide values are not observed, then this can have a negative impact on the power (lower power) in the upper speed range.

8.12 Induction motor operation

8.12.1 Operating several induction motors in parallel

Several motors can also be operated in parallel on a main spindle drive with induction motor functionality. When selecting the motor and drive module, several engineering guidelines must be observed.

When expanded to the maximum, a drive configuration for parallel operation can comprise up to eight motors. Motors connected to a drive module in parallel must have the same V/f characteristics. Further, we recommend that the motors have the same number of poles. If more than two motors are connected to a drive module, then these should essentially have the same power ratings.

For a 2–motor configuration, the difference between the power ratings of the motors should not exceed a ratio of 1:10.

The following engineering guidelines must be carefully observed:

- Selecting the size of the drive module
  - Steady–state operation of the motors connected in parallel – namely 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 drive module
  - Operation of motors connected in parallel with dynamic load (where the load condition changes quickly) and in the open–loop controlled range require an additional dimensioning:

    1.2 (Σ rated motor currents) $\leq$ rated current of the drive module
  - The current limit of the drive module must be increased to 150% of the rated current when commissioning the system.
- The motors should not be subject to torques that exceed their rated torque.
- For special high–speed induction motors (e.g. for woodworking), a series reactor must always be located between the drive module and the motor group:

  Rated reactor current: rms current of the motor group[2)]

When the above information and instructions are taken into consideration, the individual motors are able to correct even for dynamic load and speed steps. ”Stable” operation without stalling – also for individual motors – is achieved when following the dimensioning guidelines specified above. The speeds of the individual motors depend on the load. The currently set speeds can drift apart by several percent due to the closed–loop group slip control.

---

1) Standard motor: 2 pole → > 600 RPM
4 pole → > 300 RPM
6 pole → > 200 RPM
8 pole → > 150 RPM

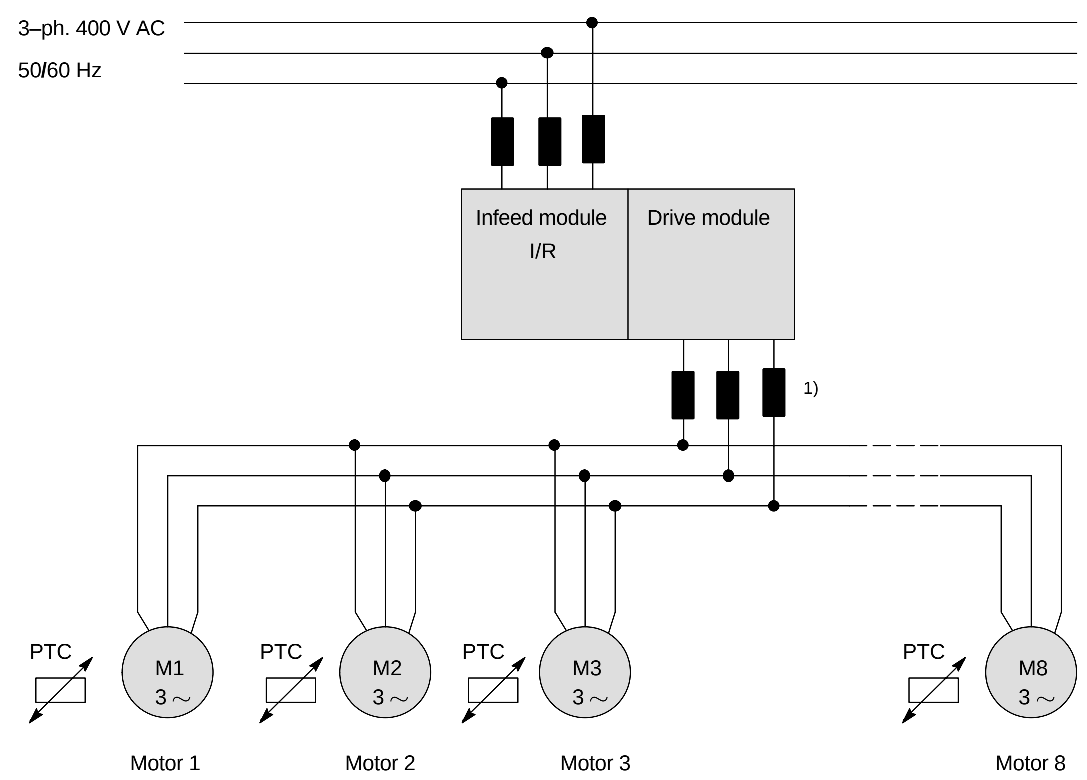
Special motors: $$n_{min} > \frac{40\text{ V} \cdot n_{rated}}{V_{rated\ motor}} > \frac{600\text{ RPM}}{\text{No. of pole pairs}}$$

2) Σ Rated motor currents, or when taking into account the load duty cycles, the total rms current of the motor group.

Load surges and overload conditions in the field–weakening range can result in oscillation and should be avoided.

The drive module cannot detect if an individual motor is overloaded.

Individual thermal monitoring functions must be provided to ensure that each individual motor has overload protection. We recommend that the motor is monitored using a PTC thermistor evaluation circuit.



Notes:

1) Σ Rated motor currents, or when taking into account the load duty cycles, the total rms current of the motor group

Fig. 8-32 Motors connected in parallel to SIMODRIVE 611

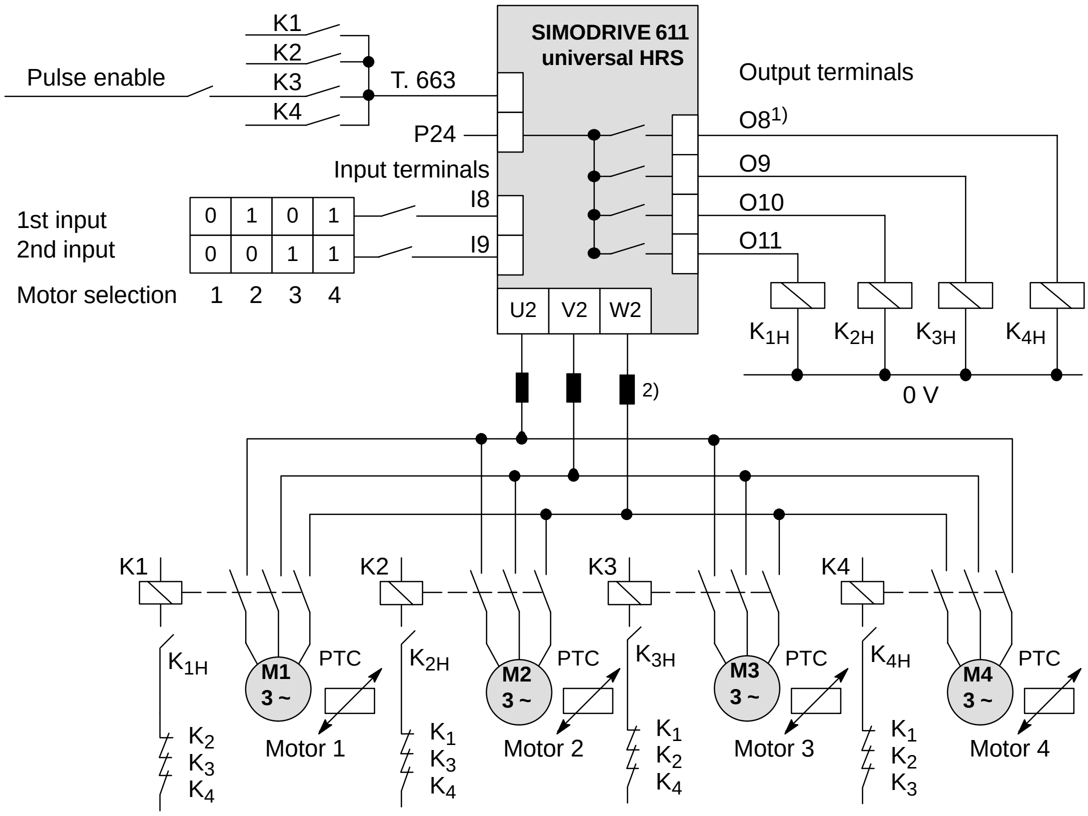
Notice

For parallel operation, all of the motors must always be operated simultaneously. The motor data set must be adapted (e.g. by using a motor changeover function) when a motor is shutdown (e.g. when a fault condition develops).

When motors are connected in parallel, motor cable protection must be implemented outside the drive converter.

8.12.2 Selecting individual induction motors 611

The ”SIMODRIVE 611 universal HRS” drive allows up to four different motors to be selected. Every motor has its own motor parameter set.



Notes:

1) Several motors cannot be simultaneously selected as this is interlocked per software. The recommended contactor interlocking additionally guarantees that only one motor can be operated at any one time.
2) This is only required for special high speed motors.

Fig. 8-33 Motor changeover at SIMODRIVE 611 universal HRS

For the motor selection circuit, one 3RH11 auxiliary contactor and one 3RT10 main contactor are required for each motor.

Reader’s note

For additional information and possibilities for selecting and changing–over induction motors, refer to:

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

Overload protection

Individual thermal monitoring functions must be provided for overload protection of the individual induction motors. We recommend that the motor is monitored using a PTC thermistor temperature sensor (embedded in the motor) and a 3RN1 thermistor motor protection evaluation unit.

If motor feeder cables have to be protected where the rated drive converter current is significantly greater than the rated motor current then this must be implemented outside the drive converter.

Notice

Motors may only be changed–over/selected using the power contactors in the motor circuit when terminal 663 – pulse enable/start inhibit – is inhibited (de–energized). This means that the power contactor may only be switched when the motor circuit is in a no–current condition.

For additional information also refer to circuit examples =10 in Chapter 9.7

8

8.13 Operation when the power fails

8.13.1 Application and mode of operation

The function ”operation with the power fails” (power failure buffering) is used, for example, for machines where personnel could be in danger or significant machine damage could occur due to a danger of collision when machining due to power failure or for internal control fault signals. Further, the function is used for machines with complex machining operations. For example, when machining gear wheels (hobbing, roller grinding) where expensive tools and workpieces are used and which should be protected from possible damage if power failures were to occur.

For operation when the power fails, stopping and/or retracting drive motion, the energy stored in the capacitors of the power DC link and the kinetic energy of the moved masses stored when the drives regenerate into the line supply can be briefly used. To do this, a connection must be established from the power DC link P600/M600 to the auxiliary power supply via the terminals P500/M500 in the NE module or in the monitoring module, refer to Fig.8-34.

Further, additional circuit measures are required. For example, the control voltages must be buffered and a power failure and/or DC link monitoring function to initiate the appropriate control functions.

After a hazard analysis, the machinery construction OEM must evaluate these risks and requirements and apply appropriate measures to avoid such hazards or damage.

The requirements placed on the power failure concepts differ significantly depending on the user and machine and must therefore be individually engineered.

8.13.2 Functions

An essential criterion when implementing power failure concepts is to be able to quickly detect a line supply fault (power failure, line supply undervoltage or phase failure).

When a line supply fault occurs, the DC link voltage quickly dips/fails due to the power drawn by the drives and the connected power supplies for the drive and control components. The characteristics of the discharge operation with respect to time depends on the ratio between the stored DC link capacitance in the power circuit and the power drawn (load duty cycle) of the drives at the instance that the line supply fault occurs.

Operation when the power fails with initiation of the regenerative feedback of one or several drives into the DC link must become effective before the DC link voltage decreases below the rated voltage, e.g. 600 V DC to 350 V DC. At approx. 350 V, the pulses are internally inhibited in the drive group, and the drives coast down.

The DC link voltage of 600 V DC is proportionally emulated at the control level and can be evaluated in the 611 digital and 611 universal control units via the equipment bus. The DC link voltage can be monitored to provide a fast response using parameterizable limit value stages. This therefore allows indirectly, an immediate response to be made to a line supply fault (e.g. power failure).

The ready signal via terminals 72–74 in the NE module also responds when a line supply fault occurs and inhibits the pulses in the NE module. The response time is, among other things, dependant on the line supply impedances and other quantities and can therefore not be precisely calculated in advance. Generally, the power failure detection time is >30 ms and is alone not sufficient to initiate functions for operation when the power fails (line supply failure).

Operation when the power fails with the SIMODRIVE 611 universal HRS

Example:

The DC link voltage is monitored using the limit value stage of a 611 universal HRS control board in the SIMODRIVE 611 universal HRS. When a selectable limit value is fallen below, e.g. a DC link voltage of 550 V, 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 at the current limit.

In addition, for example, via a second digital output of the 611 universal module, the setpoint polarity of a drive can be changed–over and retraction motion initiated for a drive before the other remaining drives are braked, delayed via terminal 64.

The safety–relevant circuit examples in Chapter 8.7 for the drive control must be appropriately adapted by the user for operation when the power fails (line supply fault).

Additional possibilities for braking when the power fails:

Braking using armature short–circuit braking for permanent–magnet servomotors, refer to circuit example =9 in Chapter 8.7.

Note

The power failure monitoring device must directly interrupt the coil circuit of the armature short–circuit contactor as a buffered +24 V power supply will either respond too late or not even respond at all.

Braking by quickly applying the holding brake, bypassing the PLC cycle time, refer to circuit example =9 in Chapter 8.7.

Note

The holding brake is not an operating brake and can only be conditionally used for such braking operations.

Operation when the power fails with SIMODRIVE 611 digital in conjunction with SINUMERIK 840D

Extended stopping and retraction: ESR

These more complex functions can be used in conjunction with the optional software NC functions that can be used in SINUMERIK 840D and the digital drives 611D with High Performance controls.

For certain machining technologies where several drives, for example, interpolate with one another using electronic gear functions, when the power fails, these drives must be stopped or retracted in a coordinated fashion using special NC functions.

The user must engineer these functions for the special requirements of the particular machining process or technology.

Also here, the DC link voltage is monitored for a lower threshold value that can be parameterized. When a limit value, selected using a machine data is fallen below, within just a few interpolation clock cycles, the NC quickly responds via the digital drive bus and stops the drives in a controlled fashion and/or raises, retracts the tool from the machining contour.

Further, for example, when a connection between the NC and the drives is interrupted, for a sign–of–life failure of the NC or other selected fault signals in the drive system, the drives can be stopped/retracted using a drive–based function (i.e. a function that runs autonomously in the drives)

When the power fails, the energy required to stop/retract the drives is supplied from the energy stored in the capacitors of the power DC link.

If the energy is not sufficient, the DC link capacitance can be increased by adding additional capacitor modules, refer to Chapter 6. However, it is not permissible that the charge limit of the I/R module is exceeded.

However, for cases where the energy stored in the DC link is still not sufficient to stop/retract the drives, an additional energy storage device can be activated through regenerative operation. As autonomous drive mode when line supply faults occur, it provides the necessary energy for the drive DC link.

A detailed description of ”Extended stopping and retraction” –ESR– is contained in the following reference:

References: /FB3/ SINUMERIK 840D/840Di/810D
Special functions Part 3 ”Axis couplings and ESR”.

The following control and secondary conditions/limitations must be carefully taken into consideration when engineering and configuring power failure concepts:

- The braking energy must be converted into heat using one or several pulsed resistor module(s) – or for unregulated infeed units, using the internal pulsed resistor (it may be necessary to use, in addition, an external resistor). When the drives brake, the DC link voltage may not fall below or exceed the max. set monitoring thresholds.
- The safety–relevant hardware control must, when the power fails, e.g. briefly maintain the enable signals via terminals 48, 63, 64, NS1, NS2 and 663. Further, the internal axis–specific enable signals of the NC/PLC interface via the digital drive bus must also be maintained until the drives come to a standstill.
- For controlled retraction motion, holding brakes must remain energized, if required, until the operation has been completed and clamping operations must be 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. This keeps the drive enable signals, the PLC functions and the control and machine functions on the user side.
- During the braking and retraction phase, it is not permissible that the NC and PLC controls generate fault signals that inhibit the drives.
- The power supply of the SINUMERIK 840 D with the integrated PLC–CPU is supplied through the DC link of the NE module when the power fails.

8

Information regarding the following circuit example, Fig. 8-34

The 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, twisted and shielded in compliance with EMC measures. The cable shields must be connected, at both ends to the mounting panel 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 opens or when changing–over to the setting–up operating mode, the connection P600,M600 to terminals P500,M500 must be safely and reliably interrupted; this can be realized, e.g. using the power contacts of contactor –K1. Also refer to Chapter 8.2.4.

This also applies for the connection to the terminals P500, M500 when using monitoring modules.

Contactor –K1 must be safely de–energized (opened) using the functions drives – EMERGENCY STOP, SWITCHING–OFF – together with the off function of the internal line contactor in the NE module and when changing the operating mode to setting–up.

The auxiliary contacts (NC contacts) positively–driven with the main contacts of contactor –K1 must be incorporated in the drive control in a safety–relevant fashion as follows:

An NC contact must be inserted in the feedback circuit of the safety combination to control the line contactor, a second NC contact must be inserted in the feedback circuit of the safety combination for the agreement function in the setting–up mode or as an alternative in the enable circuit for the setting–up mode. The NO contact can be processed in the PLC for the contactor closed (contactor energized) signal.

Notice

If the power supply is supplied through P500/M500 at connector X181, then a six–conductor connection, electronics power supply connection through terminals 2U1, 2V1, 2W1 before the HF commutating reactor of the NE module is not permissible, refer to Chapter 8.14.

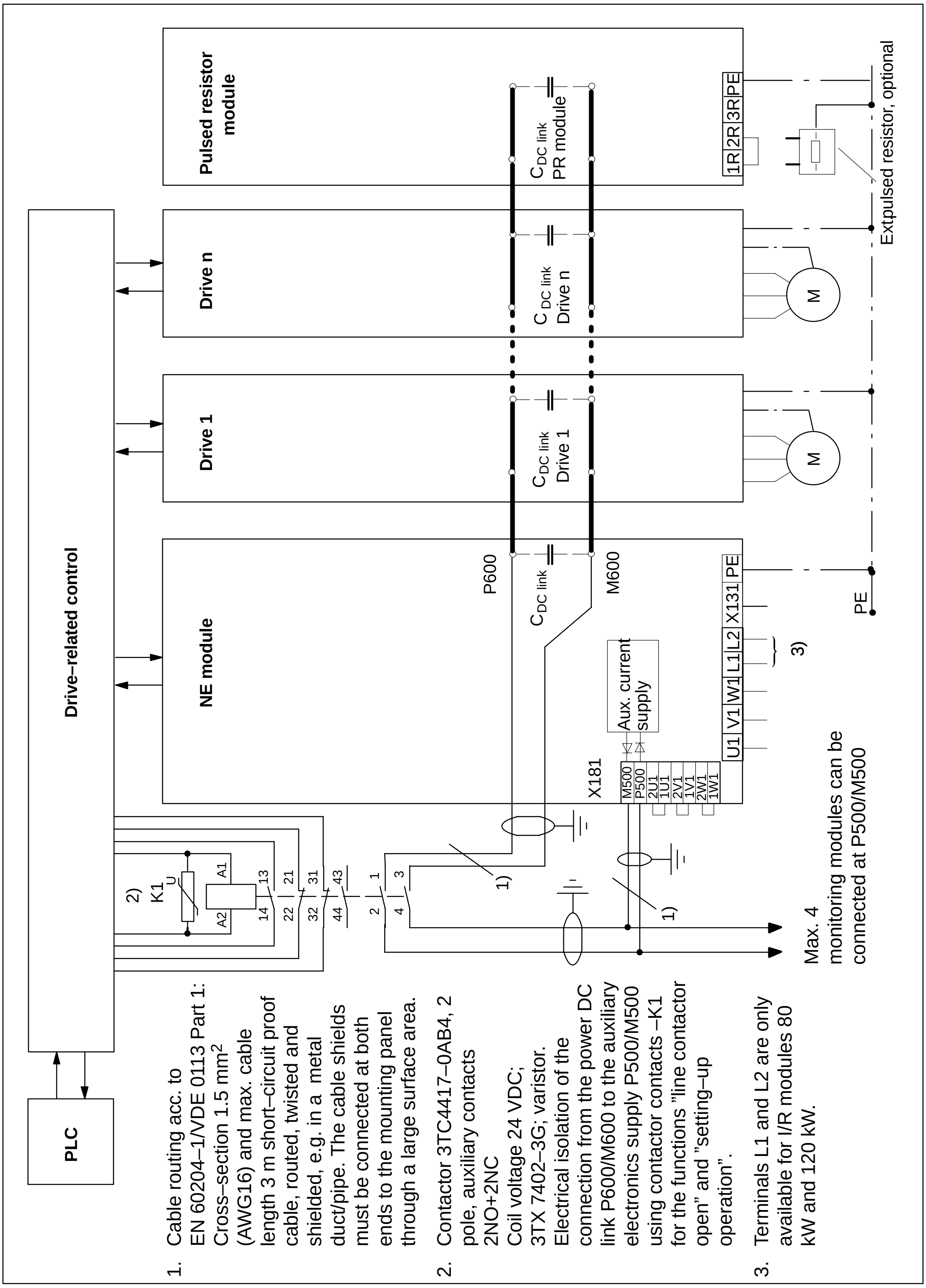


Fig. 8-34 Circuit example: Operation when the power fails

8.13.3 DC link buffering

The energy stored in the DC link of the drive units can be used when the power fails. Capacitor modules are used to increase the DC link capacitance. This means that on one hand, a brief power failure can be buffered and on the other hand, it is also possible to store the braking energy.

Note

Examples to calculate and select a capacitor module, refer to Chapter 6.7.1.

Energy balance

When configuring the emergency retraction, it is always necessary to consider the energy flow (balance) to find out whether you can do without an additional capacitor module or a generator axis/spindle (with correspondingly dimensioned flywheel effect).

8.14 Special applications

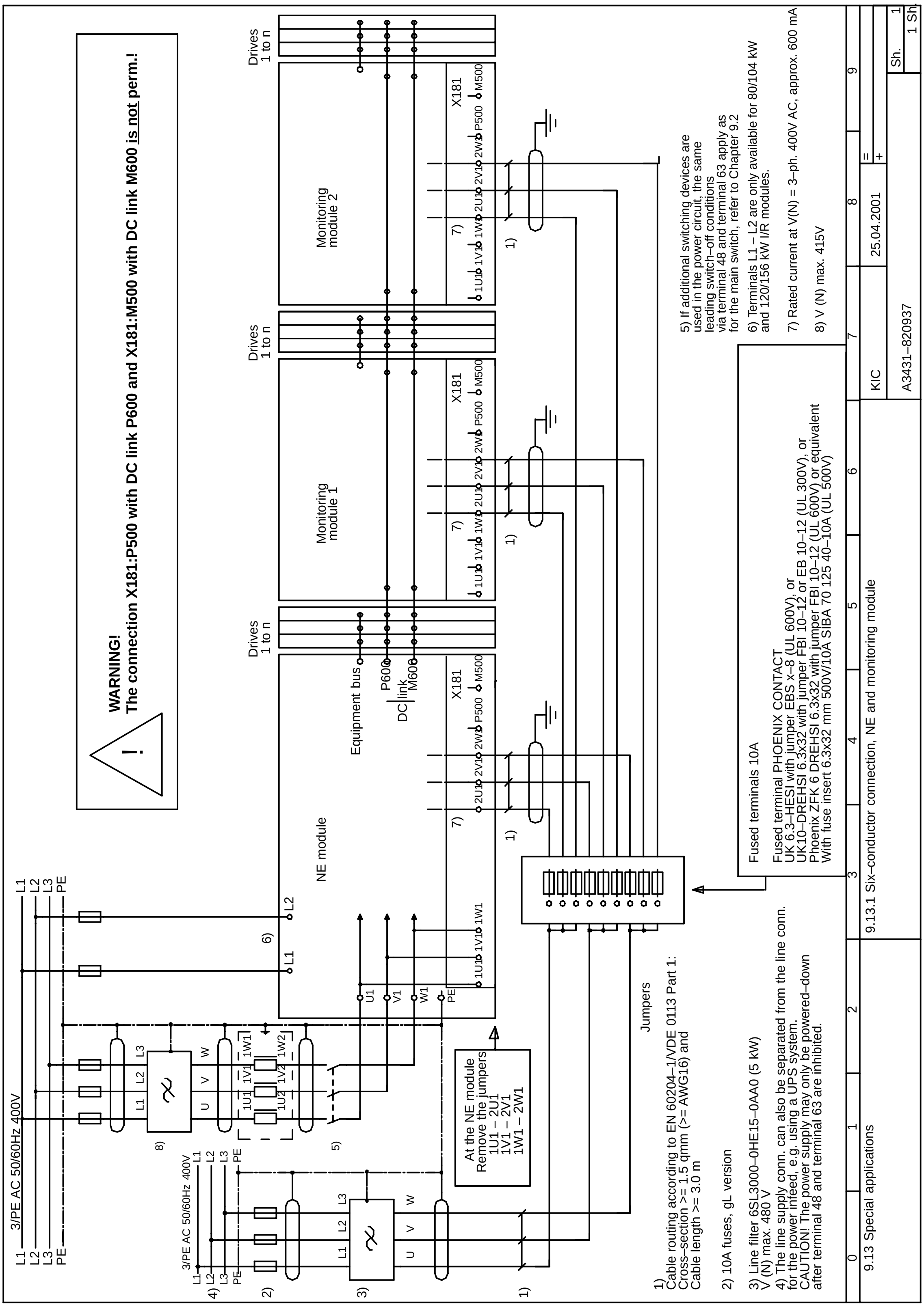


Fig. 8-35 Six–conductor connection, NE and monitoring module

8.15 SINUMERIK Safety Integrated

General information

”SINUMERIK Safety Integrated**”** offers type–tested safety functions which allow highly effective personnel and machine protection to be implemented in–line with that required in practice.

All 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 units are required; this means lower installation time and costs at the machine and a ”low profile” electrical cabinet.

The function scope includes, e.g.:

- Safety–relevant monitoring of velocity and standstill (zero speed)
- Safety–relevant traversing range demarcation and range identification/ detection

Direct connection of two–channel I/O signals

Using the additional, integrated functions in the safety package ”Safety Integrated” for SINUMERIK 840D/611D, for the first time, it is also possible to directly connect two–channel I/O signals – for example, an Emergency Stop button or light barriers. Logic operations and responses are performed internally using safety–related technology.

Mastering extreme conditions professionally

All safety–relevant faults/errors in the system always cause potentially hazardous movement to be brought to a standstill or the motor to be contactlessly disconnected from the line supply. The drives are brought to a standstill in the optimum way, adapted to the operating conditions of the machine. This means, for example, in the setting–up mode with the protective door opened it is possible to stop axes as quickly as possible path–related – and also in the automatic mode with closed protective door.

This means: High degree of protection for personnel in the setting–up mode and additional protection for the machine, tool and workpiece in the automatic mode.

Highly effective safety concept

The safety functions provide a previously unknown, intelligent and direct link right through the system to the electric drives and measuring system. Reliable operation, fast response and wide acceptance mean that this certified safety concept is extremely effective.

Safety functions incorporated redundantly

A two–channel, diverse system structure has been formed on the basis of the existing multi–processor structure. The safety functions have been configured redundantly in the NC, drive and internal PLC. A special feature of this safety concept is that with just one measuring system, the standard motor measuring system, safety Category 3 according to EN 954–1 (SIL2 according to IEC 61508) can be implemented. A second sensor is not necessary but can be added as an additional, direct measuring system (e.g. linear scale).

Innovative safety technology setting new standards

It has been clearly seen that new practical machine operation concepts can be implemented with this innovative safety technology. The result is a new standard for machines which makes them safer and more flexible to use and which increases the availability of the entire plant.

References

Please refer to the following documentation for a detailed description of SINUMERIK Safety Integrated:

Reader’s note

References: /FBSY/ Description of Functions, SINUMERIK Safety Integrated

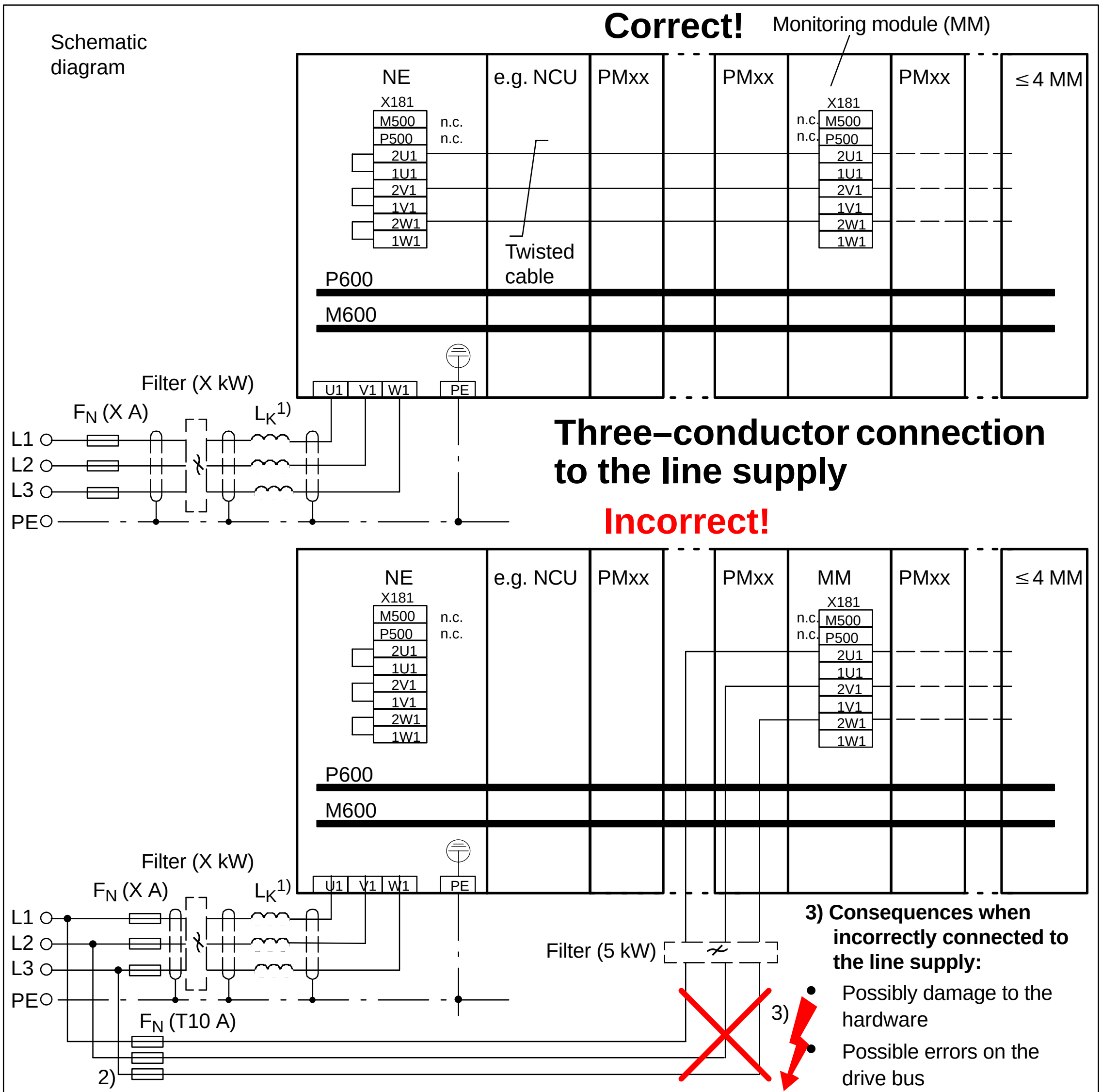
/HBSI/ Application Manual, Safety Integrated

8.16 Examples of correctly and incorrectly connecting NE to the line supply

8.16.1 Three–conductor connection to the line supply

Note

- All X181 connections of a drive group must be electrically switched in parallel!
- A maximum of 4 monitoring modules may be connected at X181 of an NE module.
- If a DC link is buffered (DC link connection), the voltage must always be taken from between the reactor (L_K) and the line supply infeed (NE).
- For all of the following examples, cables must be routed so that they are short–circuit and ground–fault proof (fuse)!



1) **Note:** L_K for 5 kW and 10 kW integrated, therefore in this case not necessary here!
2) Cable protection fuses

Fig. 8-36 Examples of correctly/incorrectly connecting up the unit using a three–conductor connection with a maximum of 4 monitoring modules connected to a line infeed module (NE module)

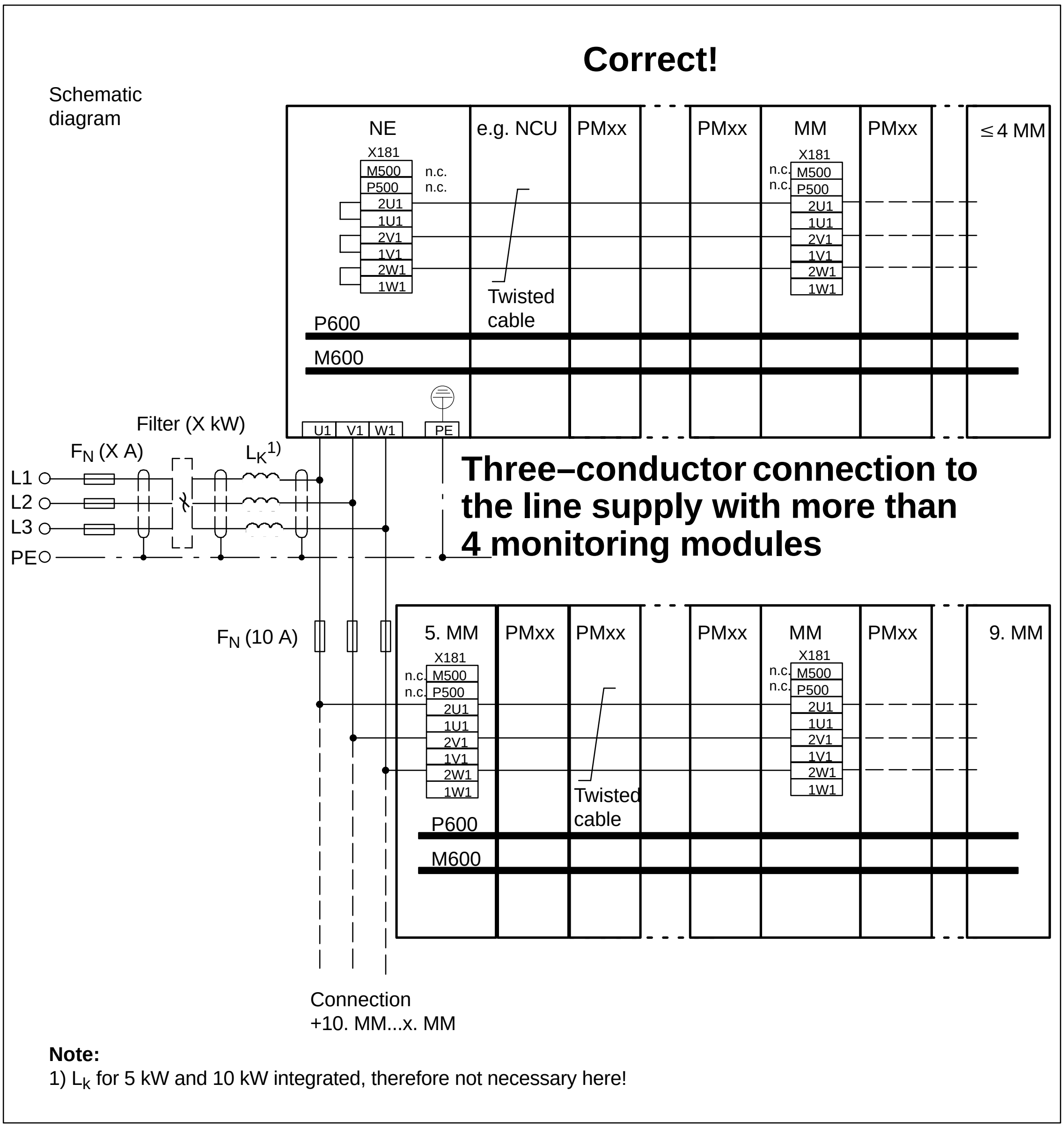
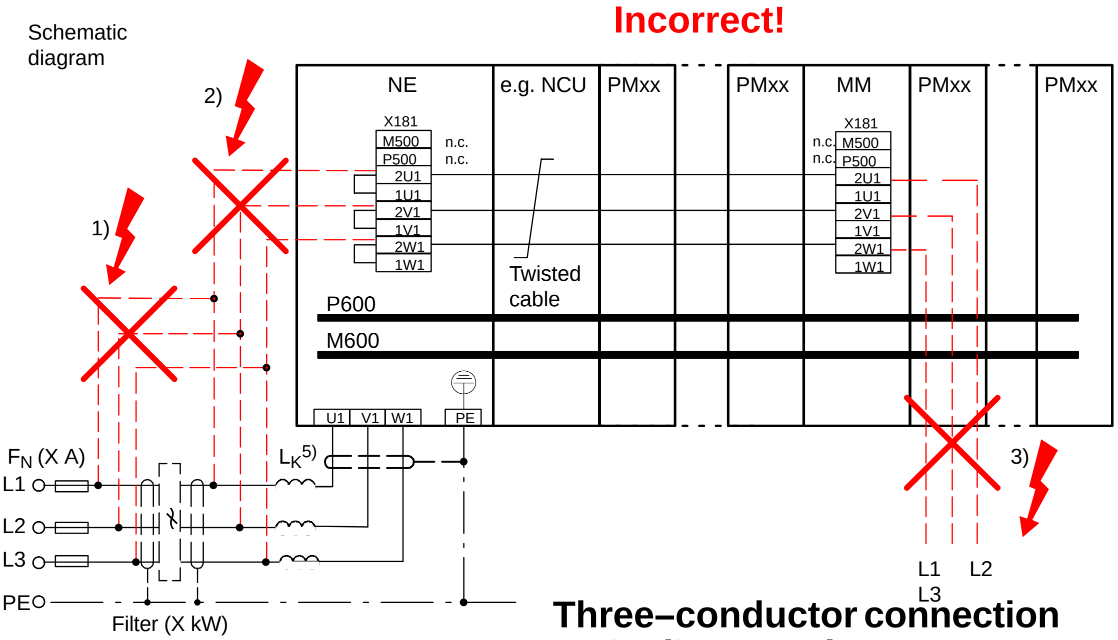
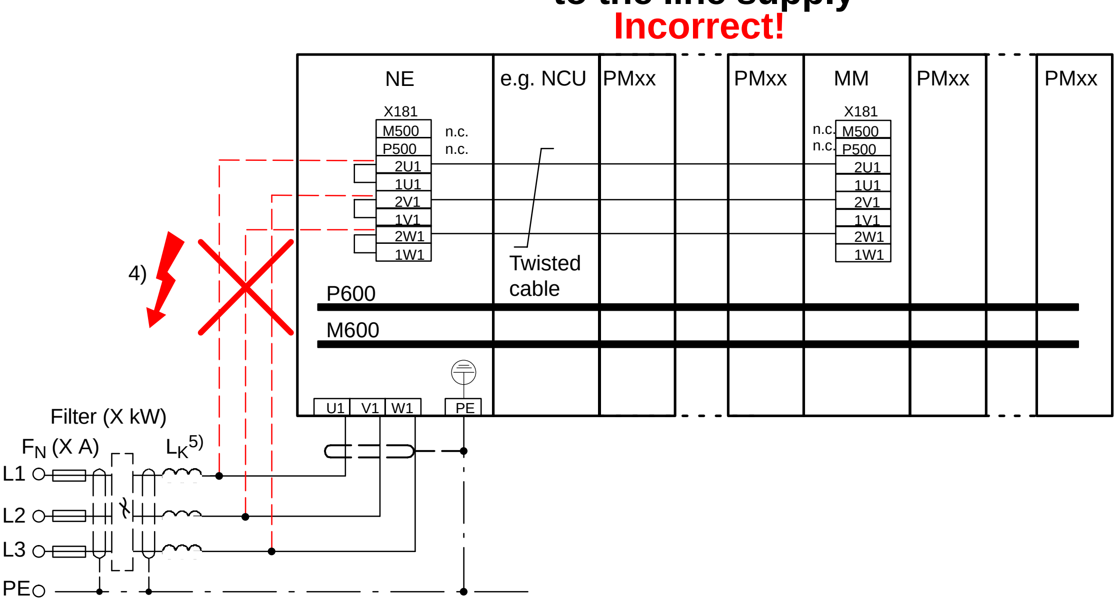


Fig. 8-37 Examples of correctly connecting up the unit using a three–conductor connection for more than 4 monitoring modules connected to a line infeed module (NE module)



Three–conductor connection to the line supply



Consequences when incorrectly connected to the line supply:

1)/2) Connected in front of the reactor (choke):

- Burnt PC board tracks/connectors

3) Another connection to the line supply in front of the reactor (choke):

- Defective DC link Elko capacitors
- The following burn:
  – Connector in the power supply
  – Rectifier diodes
  – Pre–charging de–coupling, diodes

4) Short–circuit due to phase interchange with jumper X181 —> the following will burn:

- PC board tracks of the internal power supply
- Varistor module at X181
- Connector in the power supply

5) **Note:**
L_k for 5 kW and 10 kW integrated, therefore not necessary here!
Possibility of faults, essentially the same as 1) to 4)

Fig. 8-38 Examples of three–conductor connection to the line supply that are absolutely prohibited

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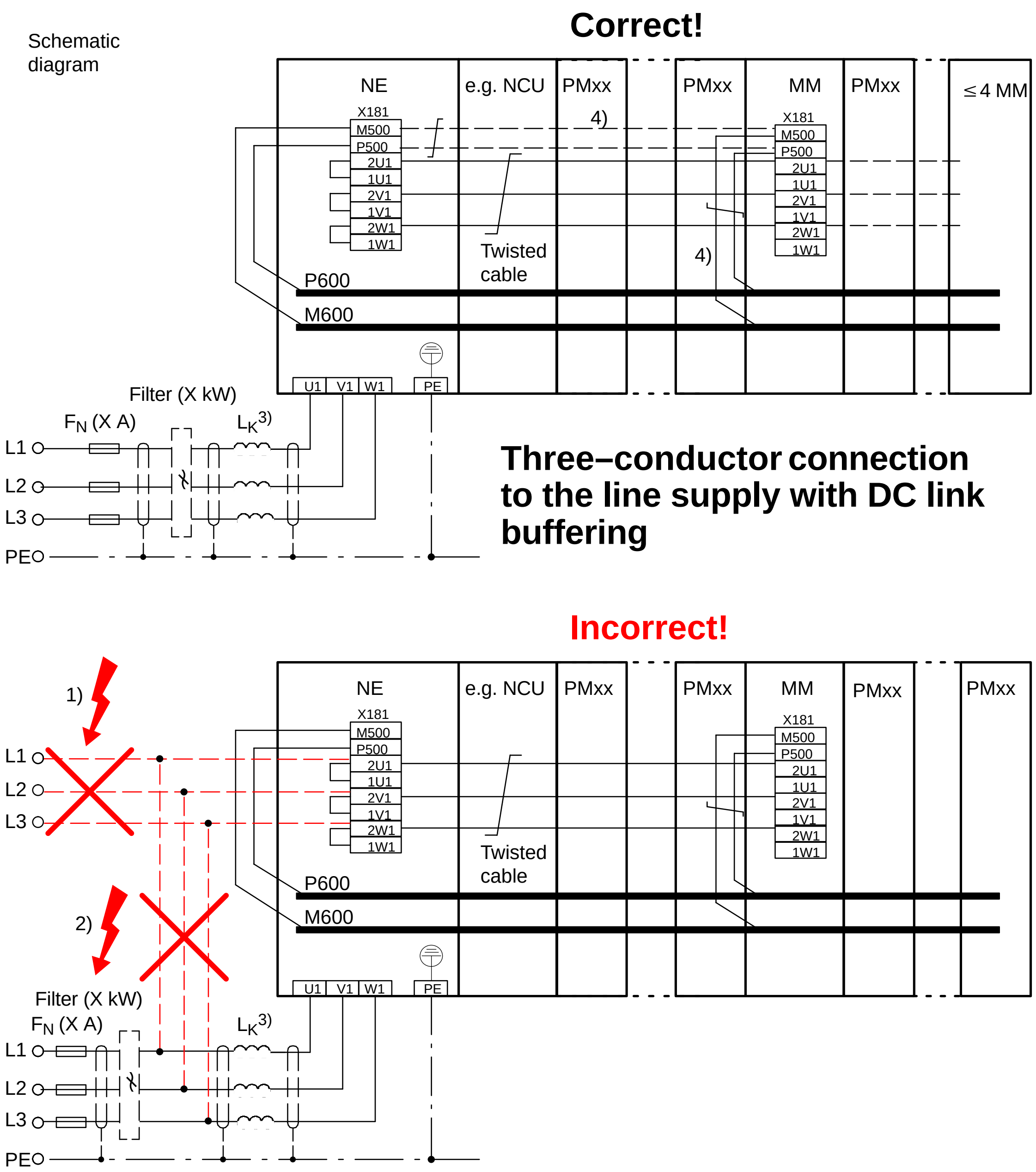


Consequences when incorrectly connected to the line supply:

1) Another supply (e.g. UPS):

- Defective DC link Elko capacitors at the power supply
- The following burn:
  - DC link de–coupling diodes
  - PC board tracks of the power supply

2) Another connection to the line supply in front of the reactor (choke):

- Defective DC link Elko capacitors at the power supply
- The following will burn in the power supply
  - Connector
  - De–coupling diodes
  - PC board tracks
  - Pre–charging circuit, printed circuit board

Note:

3) L_K for 5 kW and 10 kW integrated, therefore not necessary here!

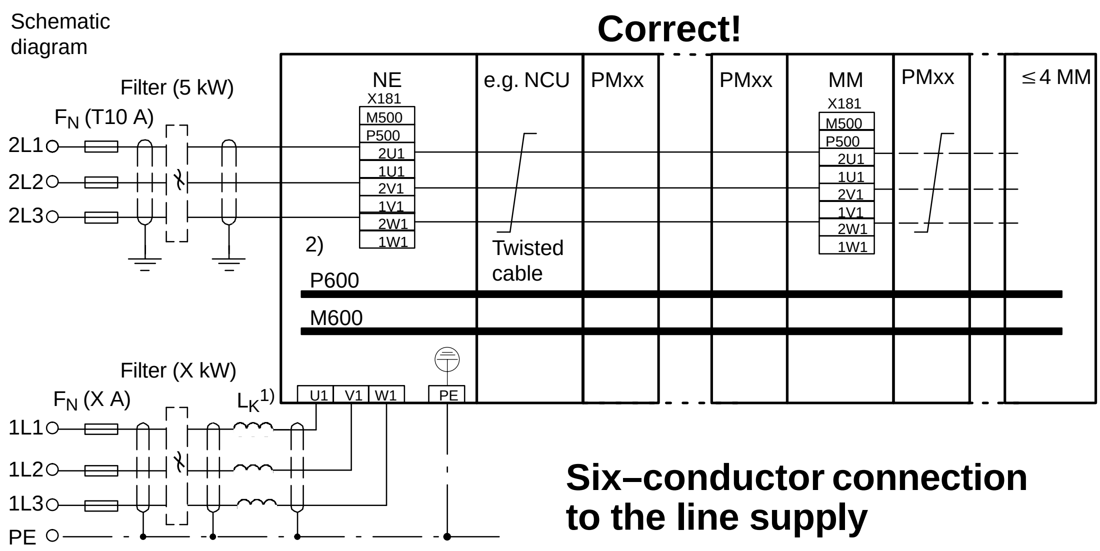
4) P500/M500 connection at X181 either loop–through at X181 or connect directly to the DC link.

Fig. 8-39 Examples for correct and prohibited three–conductor connection to the line supply + DC link connection

8.16.2 Six–conductor connection to the line supply

Note

- All X181 connections of a drive group must be electrically switched in parallel!
- All of the jumpers at X181 must be removed!
- A maximum of 4 monitoring modules may be connected at X181 of an NE module.
- If a DC link is buffered (DC link connection), the voltage must always be taken from between the reactor (L_K) and the line supply infeed (NE).
- Different line supplies may be used (e.g. using UPS).
- For all of the following examples, cables must be routed so that they are short–circuit and ground–fault proof (fuse)!



Note:
1) L_k for 5 kW and 10 kW integrated, therefore not necessary here!
2) DC link connection not permissible for six–conductor connection to the line supply!

Fig. 8-40 Examples for correct six–conductor connection to the line supply with a maximum of 4 monitoring modules connected to a line infeed module (NE module)

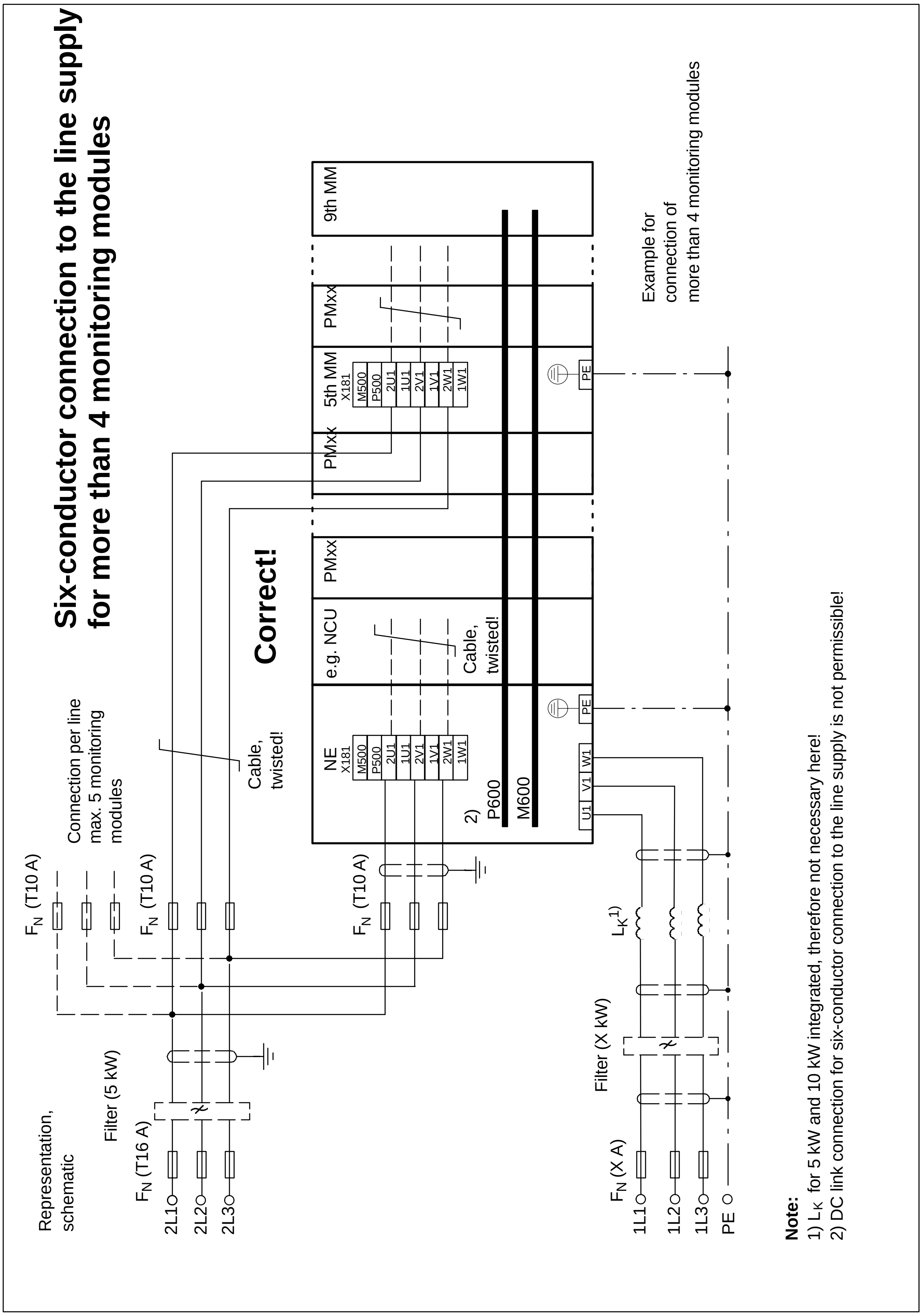


Fig. 8-41 Examples for correct six–conductor connection to the line supply with more than 4 monitoring modules connected to a line infeed module (NE module)

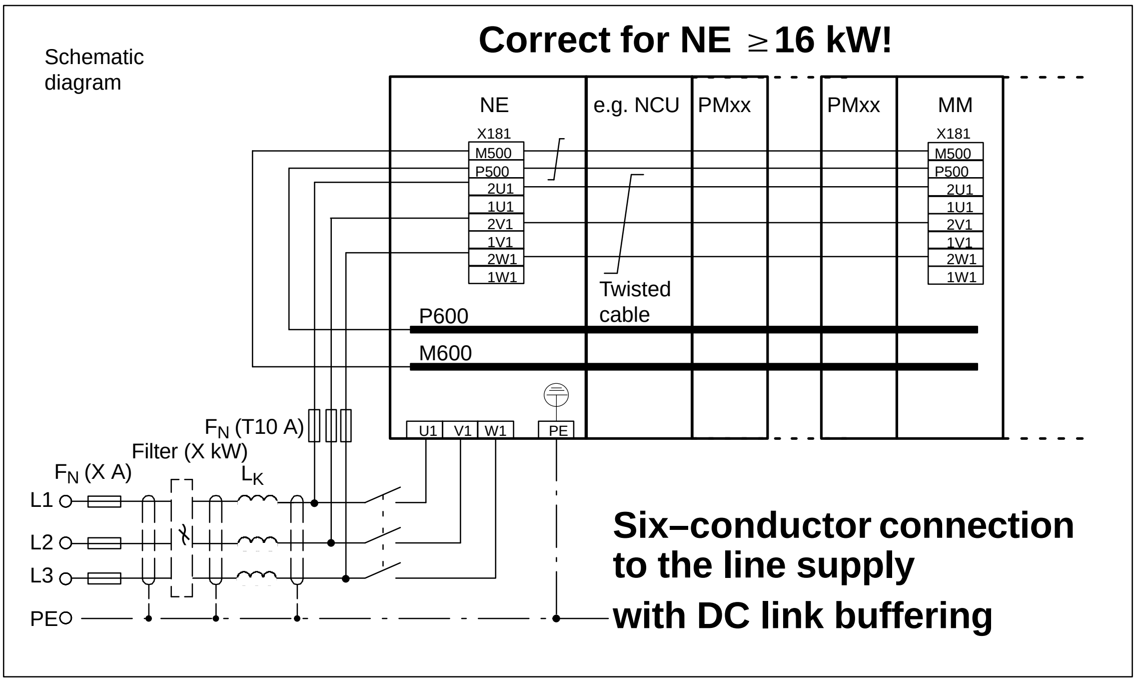
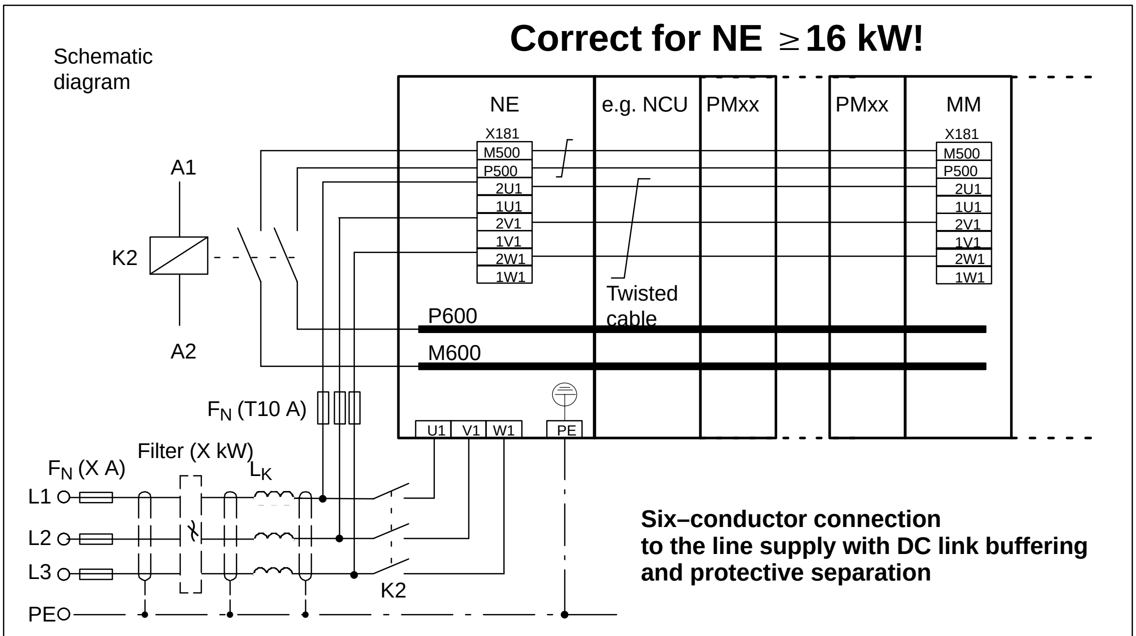


Fig. 8-42 Example for correct six–conductor connection to the line supply + DC link connection



The following conditions must be fulfilled for K2;

- Auxiliary switches for 600 V DC (current capacity of the auxiliary switches = 1 A + 1 A · number of monitoring modules)
- Open in the non–energized state (NO contacts)
- Positively–driven auxiliary switches
- K2 must be either a contactor or switch

Fig. 8-43 Example for correct six–conductor connection to the line supply with protective separation of the power circuit

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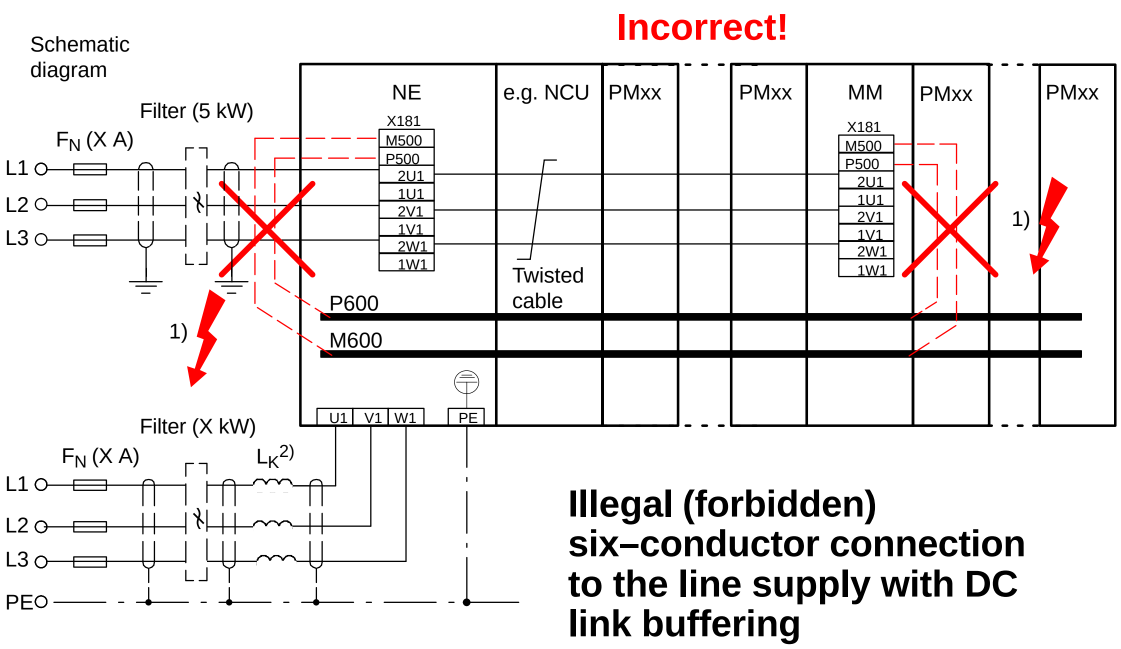


Consequences when incorrectly connected to the line supply:

1) For a six–conductor connection to the line supply with DC link connection, the following can occur immediately or over the medium term:

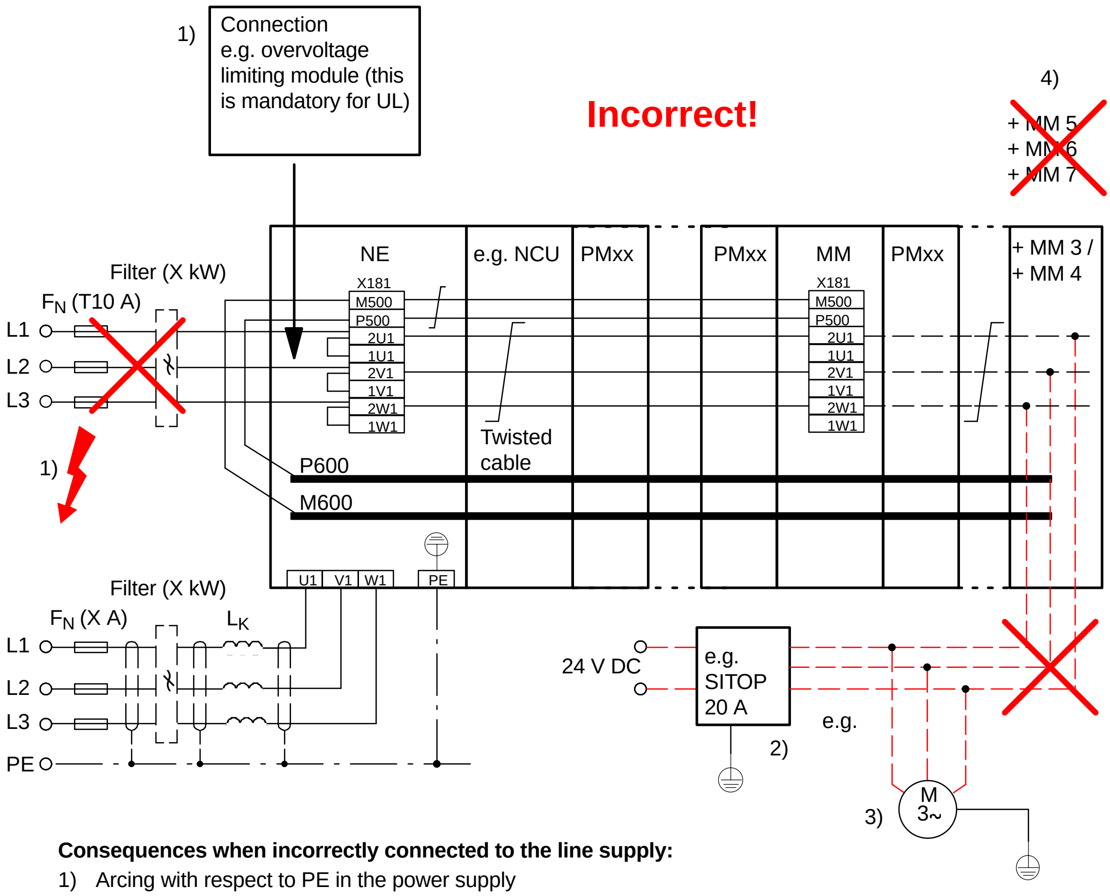
- DC link Elko capacitors on the power supply will be destroyed
- Arcing occurs
- The following burn:
  – DC link de–coupling diodes
  – PC board tracks

Note:

2) L_K for 5 kW and 10 kW integrated, therefore not necessary here!

Fig. 8-44 Examples of illegal (forbidden) six–conductor connection to the line supply + DC link connection

Schematic diagram



Consequences when incorrectly connected to the line supply:

1) Arcing with respect to PE in the power supply
Refer to the use of HF/HFD commutating reactor to prevent system oscillations in Chapter 7.4.
Consequences when the system oscillates: Burned overvoltage limiting module

2)/3)/4):

- More than 4 monitoring modules:
- Additional loads:

Consequence: Burnt PC board tracks on the line infeed module (NE module) power supply

Fig. 8-45 Additional examples for frequent faults/mistakes when connecting to the line supply

8

8.17 VPM Voltage Protection Module

General information

The Voltage Protection Module VPM (voltage limiting module) is used with motors 1FE1 and 2SP1 with EMF of >800 V to 2000 V to limit the DC link voltage at the converter in the event of a fault. If the line supply voltage fails or if the drive converter pulses are canceled as a result of the power failure, at maximum motor speed, the synchronous motor regenerates a high voltage back into the DC link.

The VPM detects a DC link voltage that is too high (>800 V) and short–circuits the three motor supply cables. The power remaining in the motor is converted to heat via the short–circuit between the VPM and motor cables.

Table 8-8 Technical data VPM

	VPM 120	**VPM 200**
Order No.:	6SN1113–1AA00–1JA□	6SN1113–1AA00–1K□□
Type of voltage	Pulsed DC voltage	
Lower limit, DC link voltage	490 V DC	
Inverter clock cycle frequency	3.2...8 kHz	
Rated current	Max. 120 A rms	Max. 200 A rms
Permissible short–circuit current		
Time range 0...10 ms 10...500 ms 500...2 min > 2 min	Maximum 1500 A 255 A 90 A 0 A	Maximum 2000 A 600 A 200 A 0 A
Electrical separation	Safe electrical separation between the signaling contact and the motor cables U, V, W according to DIN VDE 0160/pr EN 50178, UL 508	
Degree of protection DIN EN 60529 (IEC 60529)	IP20	
Humidity classification according to DIN EN 60721–3–3	Cl. 3K5 – no condensation or ice–formation. Low air temperature 0 °C	
Permissible ambient temperature • Storage and transport • Operation	 –25...+55 °C 0...+55 °C	
Cooling	Air–cooled, free convection	
Weight	approx. 6 kg	approx. 11 kg
Dimensions (W x H x D) [mm]	300 x 150 x 180	300 x 250 x 190
Connection U, V, W, PE Torque Cable cross–section Cable entry Screwed connection	Screw connection, 4 x M6 10 NM ≤ 50 mm^2 ∅ approx. 40 mm M50	Screw connection, 4 x M8 25 Nm ≤ 2 x 50 mm^2 ∅ approx. 40 mm 2 x M50
Connection X3 (signaling contact) Cable cross–section Cable entry Screwed connection	Terminal, type 226–111 Wago ≤ 1.5 mm^2 ∅ approx. 9 mm M16	

Integration

It must be installed according to the connection schematic VPM 120 (Fig. 8-46) or VPM 200 (Fig. 8-47).

Clearances of approx. 200 mm must be provided above and below the unit for cable entry.

It can be mounted in any position.

It is not permissible that switching elements are inserted in the connecting cables U, V ,W between the drive, VPM and motor!

The air intake temperature, measured 10 mm below the unit, may not exceed 55 °C.

Caution

If the limit values, specified under technical data, are not observed or are exceeded, then there is a danger that the unit will be overloaded; this can result in destruction of the unit or in a reduction in the electrical safety.

Notice

The unit is a safety–relevant piece of equipment and may only be used as specified. Other application, e.g. armature short–circuit in operation and others are not permissible.

The warning information on the unit must be carefully observed!

Operation with VPM is only possible in conjunction with SIMODRIVE 611digital, SIMODRIVE 611 universal HR/HRS and 1FE1/2SP1 motors. When the VPM is used, shielded 6FX8 motor cables must be used.

⚠ **Warning**

Under fault conditions, voltages up to 2 kV can occur at cables/conductors that are cut or damaged.

The motor terminal voltage of 1FE1 motors can, dependent on the speed, have values up to ≤ 2 kV.

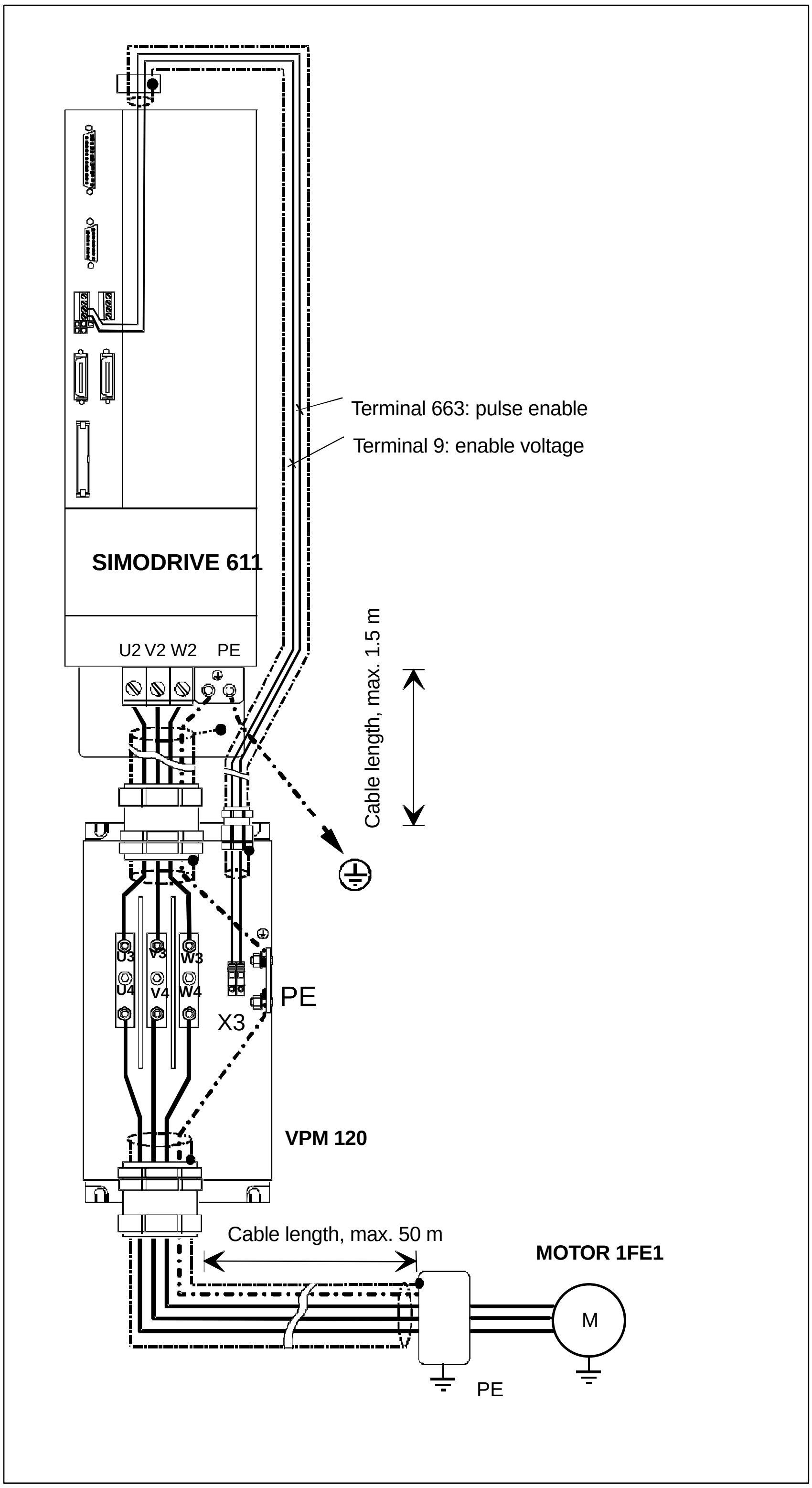


Fig. 8-46 Connection, VPM 120

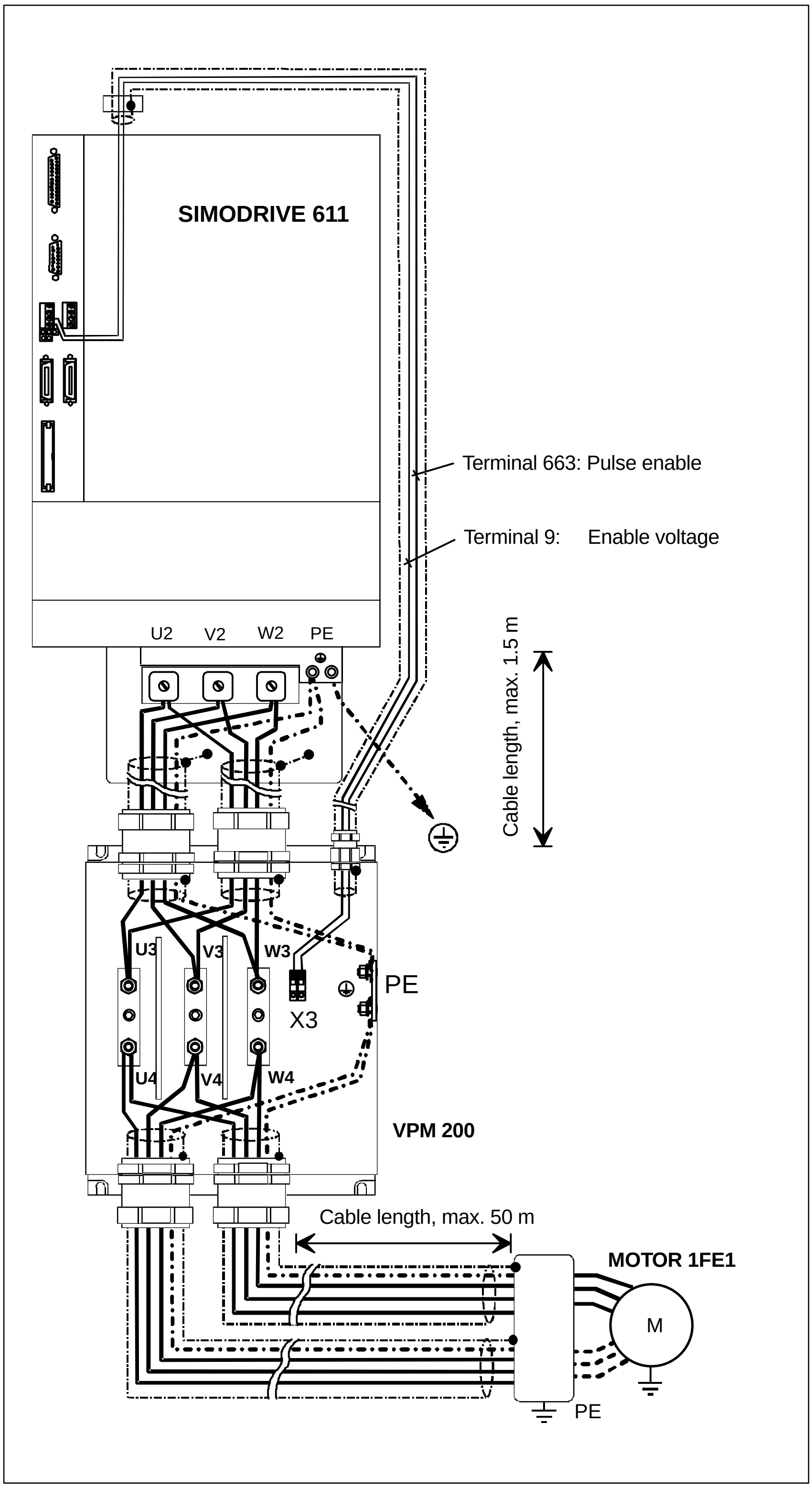


Fig. 8-47 Connection, VPM 200

Signaling contact X3

The signaling contact X3 closes after t > 2 min or after the temperature switch has been reset.

Warning

This is the reason that measures must be applied to prevent the drive from accidentally starting by itself!

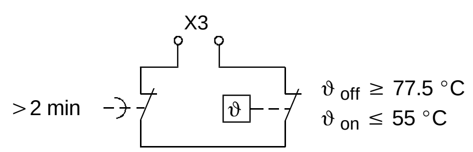
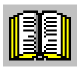


Fig. 8-48 Signaling contact X3 of the VPM

Table 8-9 Technical data, signaling contact X3

Designation	Technical data
Contact	NC contact, floating
Switch rating	60 V DC at 0.5 A
Switching voltage/switching current	min 19 V/10 mA
Interrupts when the housing temperature	≥ 80 ± 2.5 °C
Switches back	≤ 55 °C
Interruption time after the start of short–circuit operation	> 2 min Note: This value is valid 15 s after the drive and pulse enable



Reader's note

Reference: Operating Instructions Order No. A5E00143311B

■

Cabinet Design and EMC

9

9.1 Installation and connecting–up regulations

Caution

Carefully ensure that the line filter is connected to the line supply in–line with the specifications/regulations

LINE L1, L2, L3 for line filters for the UI module and I/R module for sinusoidal operation.

If this is not observed, the line filter could be damaged. Also refer to the connection diagram 9-1.

Caution

The line filters listed conduct a high leakage current via the PE conductor. Because of the high leakage current of the filters, PE must be permanently connected to the line filter and/or the cabinet.

Measures according to EN 50178/94 Part 5.3.2.1 must be taken, e.g. a PE conductor ($\geq$10 mm^2 Cu) or a second conductor must be routed electrically parallel to the PE conductor via separate terminals. This conductor must also fully meet the requirements for PE conductors according to IEC 60364–5–543.

General information

The ”EMC Directive must always be carefully observed for SINUMERIK and SIROTEC controls” (Order No.: 6FC5297–0AD30–0BP1); refer to the overview of documentation on the first cover page.

Applications

The line filters described have been dimensioned to suppress SIMODRIVE 611 drive converters; they have not been designed to suppress (noise/interference suppression) other loads in the electrical cabinet. A dedicated filter must be provided for other loads in the electrical cabinet.

If the electronics power supply is connected to a separate line supply, then the feeder cable must be routed through a second filter. The feeder cable to the electronics power supply (connector X181) must be shielded and the shield must be connected at both ends at the connector side as close as possible to connector X181 – on the cabinet mounting panel.

The line supply connection for fan units must also be routed through a second filter.

Mounting in the electrical cabinet

The housings of the drive converter and line filter must be connected to the cabinet ground through a low–resistance connection for the high–frequency noise/ interference currents; the cabinet ground must, in turn, be connected to the motors or the machine through a low–resistance connection. The ideal situation is that the modules are mounted on a common galvanized mounting panel to which they are connected through the largest possible surface area to establish a good electrical connection; this mounting panel must, in turn, be connected to the motor/machine through the largest possible surface area to establish a good electrical connection. Painted cabinet panels as well mounting rails or similar mounting equipment with a small mounting footprint do not fulfill this requirement.

The line filter must be located in the same cabinet field close to the NE modules; the shielded cable connecting the line filter to the NE module should be kept as short as possible. The incoming and outgoing cables to/from the line filter must be routed separately from one another.

Recommended configuration, refer to Fig. 9-1.

Notice

For modules that generate a significant amount of heat – pulsed resistor module and 10 kW UI module, a heat deflecting plate (100 mm wide) should be used to protect the cable from the source of heat. (for the pulsed resistor module, 50 mm wide, mounted so that they overlap.)

Note

When connecting modules with terminals from 50 mm^2 and onwards and for cable cross–sections smaller than the terminal size, the user must ensure that the appropriate shock hazard protection is provided in accordance with IP20.

Cable routing

Power and signal cables must always be routed separately from one another. In this case, the power cables from the drive converter module must be routed away towards the bottom and the encoder cables towards the top in order to ensure the largest possible spatial clearance.

All of the control cables of the function terminals – e.g. terminals 663, 63, 48 etc. – should be grouped together and routed away towards the top. Individual conductors that are associated with one another from the signal perspective, must be twisted together. Ideally, the function cable assembly should be routed separately from the encoder cable assembly. Clearance between the cable assemblies $\geq$ 200 mm (separate cable ducts).

All cables and lines within the control cabinet should always be routed as close as possible to the mechanical components connected to the cabinet ground (e.g. mounting panel); cables simply routed freely in the cabinet can result in interference (antenna effect). The proximity to sources of interference (contactors, transformers, etc.) must be avoided by placing a shield plate between the cable and the source of interference, if necessary.

Cables and conductors should not be extended using terminals or similar devices.

Shielded cables up to the terminals at the entry point into the electrical cabinet should be used in order to protect noise and interference from being coupled in from external sources to the filtered cables.

Power cables

Shielded cables should always be used for the motor and line supply feeder cables. Alternatively, a metal duct can be used that has a cover that is in contact with the metal duct through a large surface area. In both cases it is important to ensure that the shield/cable duct is connected at both ends to the corresponding components (drive converter module, motor) through the largest possible surface area.

Note

If the system is subject to a high–voltage test using AC voltage, a line filter must be disconnected in order to obtain a correct measurement result.

Connection cable shield

All of the cable shields should be connected as close as possible to the terminal point through the largest possible surface area; for components that do not have a special shield connection, pipe clamps or serrated rails on the galvanized mounting panel can be used. It must always be ensured that the free cable length between the shield connection point and the terminal is as short as possible.

Shield connecting plates with a clamp connection are provided on the NE and PM modules to connect the shields of shielded powered cables; mounting locations are also provided for brake terminals (Order No., refer to Table 9-1. Also refer to the dimension drawing ”EMC measures”, Chapter 11).

Table 9-1 Order Nos. 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/hose	–0KA0	————

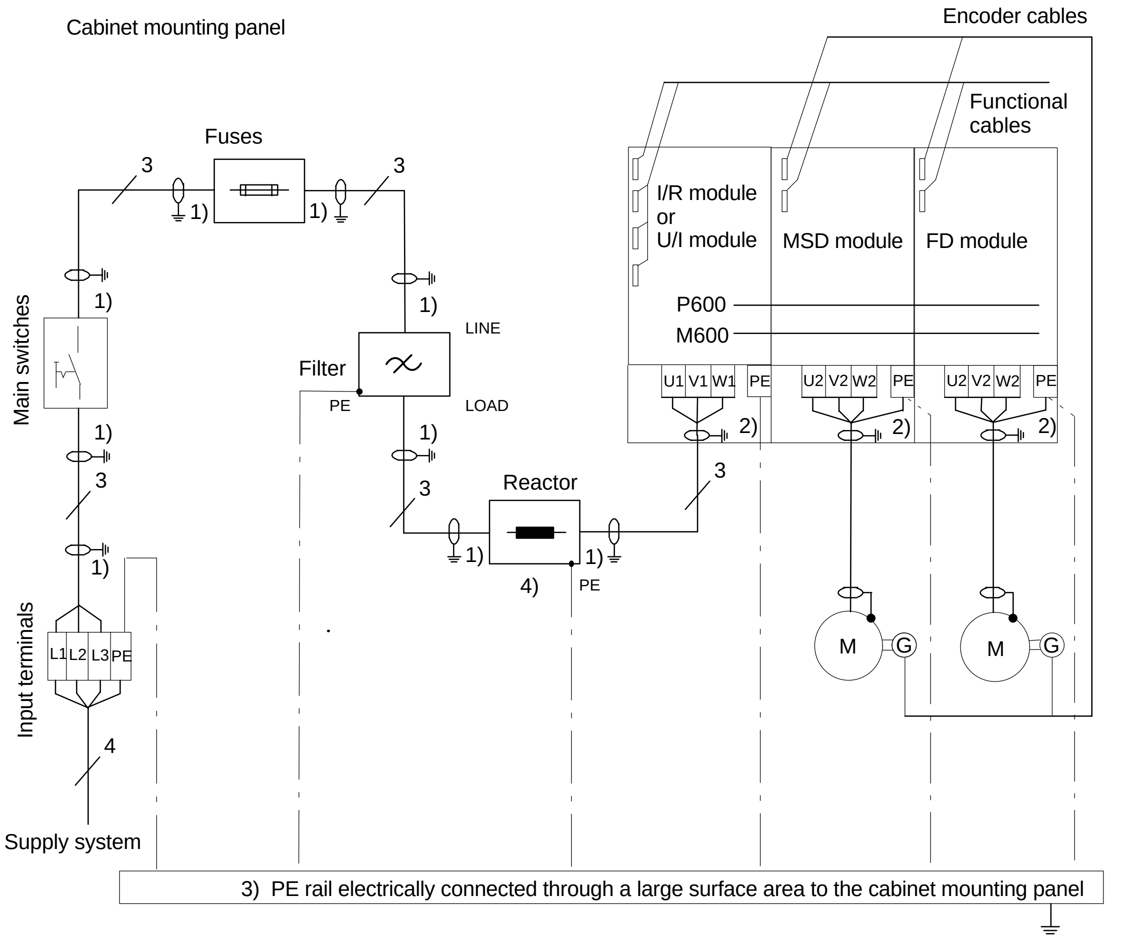
If the motor is equipped with a brake, then the shield of the brake feeder cable must be connected at both ends to the shield of the power cable.

If there is no possibility of connecting a shield on the motor side, a gland must be incorporated in the terminal box with the possibility of establishing a shield–motor connection through the largest possible surface area.

Warning

Cable shields and cores/conductors of power cables which are not used (e.g. brake conductors) must be connected to PE potential in order to discharge charges arising from capacitive coupling.

Hazardous voltages can occur if this is not observed.



1) Shield connected through the largest possible surface area to the cabinet mounting panel.
2) Shield connection at the module–specific connecting plate
3) PE cables can be connected using a PE rail alternatively, also observing EN50178 (protective connections).
4) Permissible commutating reactors for I/R module, sinusoidal operation – refer to Chapter 3.4.2 and Chapter 3.1
Permissible commutating reactor for 28kW UI module, refer to Chapter 3.4.2
A clearance of > 100mm must be provided above the HF reactor when routing the cable in the electrical cabinet.

Note:
The filter may only be mounted with the line supply connection at the bottom (downwards).

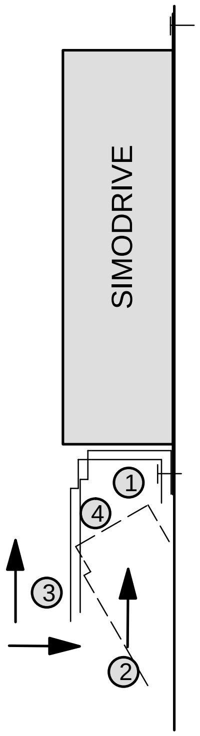
Fig. 9-1 Connecting diagram for line filters for 5 kW and 10 kW U/I modules and for 16 kW to 120 kW I/R modules. The connecting diagram also applies to UI–28 kW, – however as a result of the unregulated infeed, 6–pulse squarewave current is drawn.

Note

1. The EMC measures described above ensure CE compliance with the EMC Directive.
2. Alternative measures can be applied (e.g. routing behind mounting plates, suitable clearances) under the assumption that they have similar results.
3. This excludes measures that relate to the design, installation, and routing of motor power cables and signal cables.

9.1.1 Shielded connecting plates

Shield connecting plates are available that can be retrofitted for the infeed and power modules. These plates also have mounting points for brake connecting terminals.



The shield plates should be mounted after the devices have been mounted/installed in the electrical cabinet.

The screw/s 1 below should be released so that the keyhole can be engaged in the shield plate and then mounting is continued in the sequence 2, 3, 4.

When removing the module, proceed in the inverse sequence.

Fig. 9-2 Mounting the shield plate

9.1.2 Mounting conditions, internal cooling

General information

If the guidelines for installing/mounting SIMODRIVE 611 equipment in the cabinet are not carefully observed, this can significantly reduce the service life of the equipment and result in premature component failure.

The following specifications must be carefully observed when mounting/installing a SIMODRIVE 611 drive group:

- Cooling clearance
- Cable routing
- Air flow, climate–control equipment

Cooling clearance

Minimum 100 mm clearance at the top and bottom for cooling.

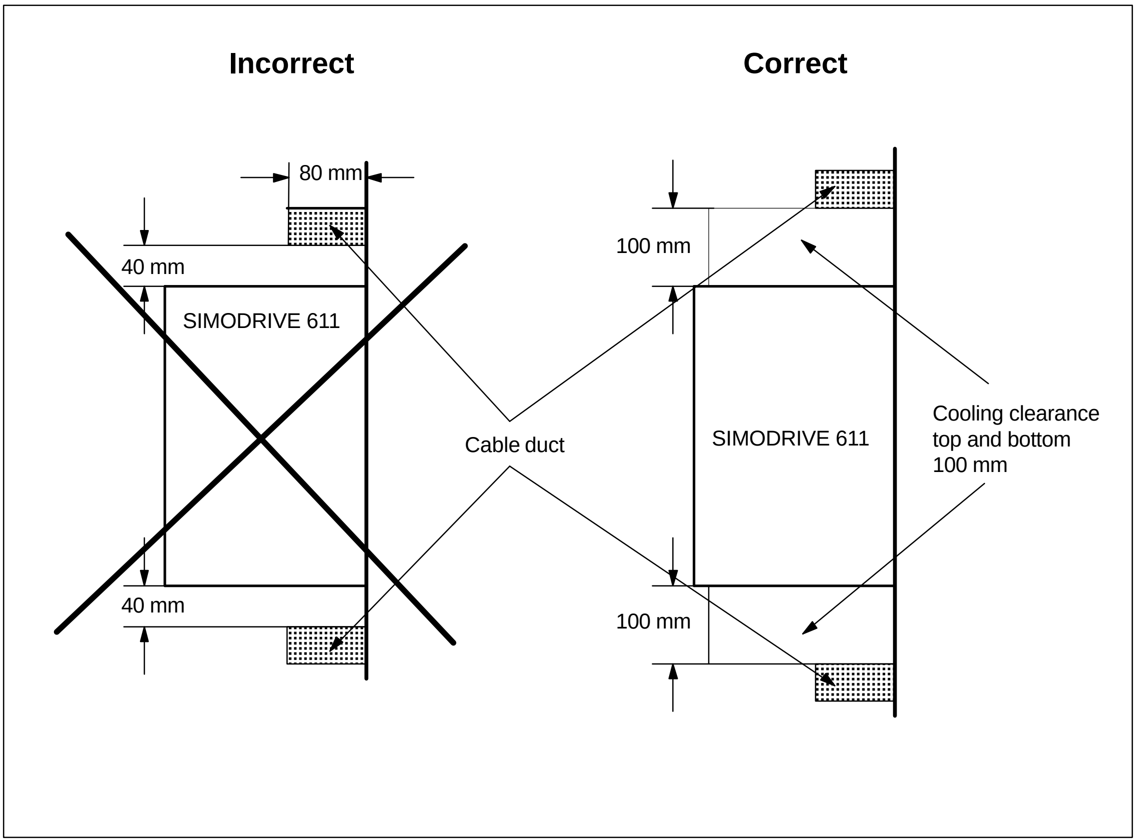


Fig. 9-3 Cooling clearance

Air intake temperature, max 40 °C, at higher temperatures (max 55 °C), the power must be reduced (de–rating).

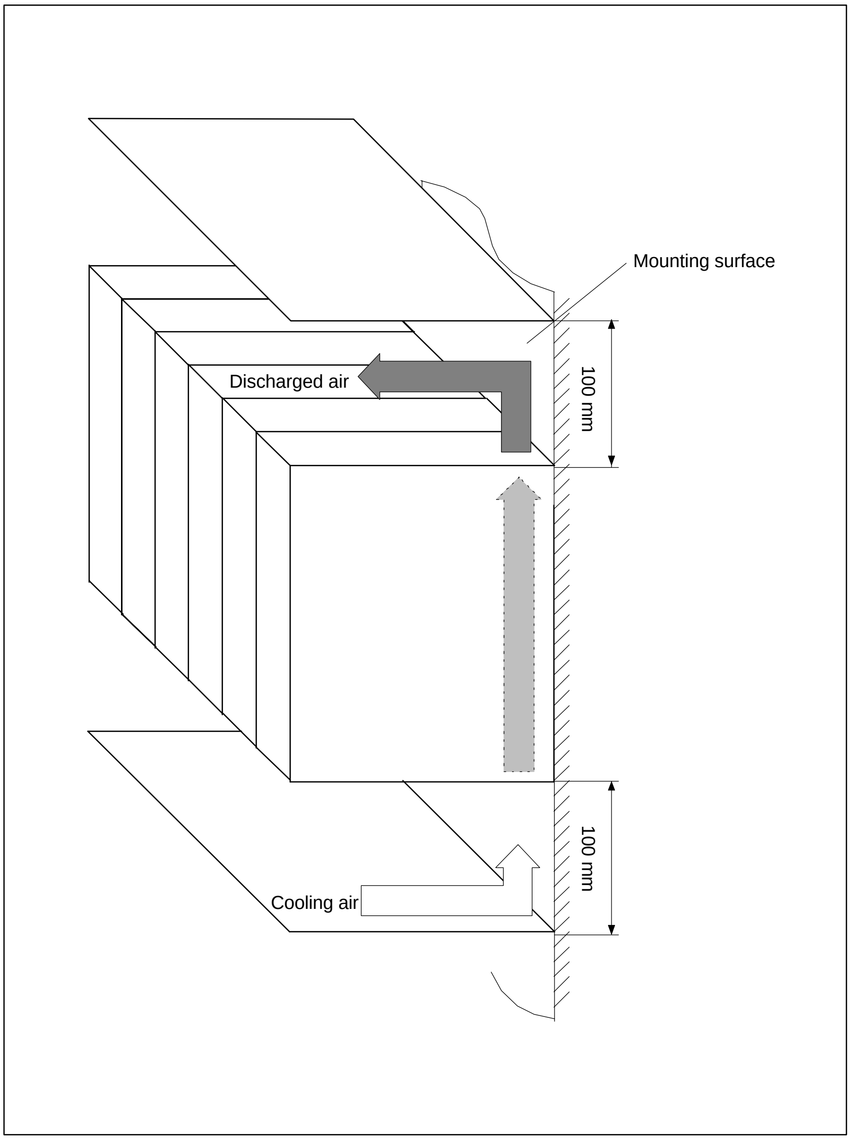


Fig. 9-4 Air flow in the electrical cabinet

Notice

For modules that generate a significant amount of heat – pulsed resistor module and 10 kW UI module, a heat deflecting plate (100 mm wide) should be used to protect the cable from the source of heat. (for the pulsed resistor module, 50 mm wide, mounted so that they overlap.)

Air intake when arranging power modules

Measures are shown in the following diagram if the following conditions/arrangements simultaneously exist in the cabinet:

- Number of power modules (50 mm wide) N >10
- Shield plate
- Cable duct

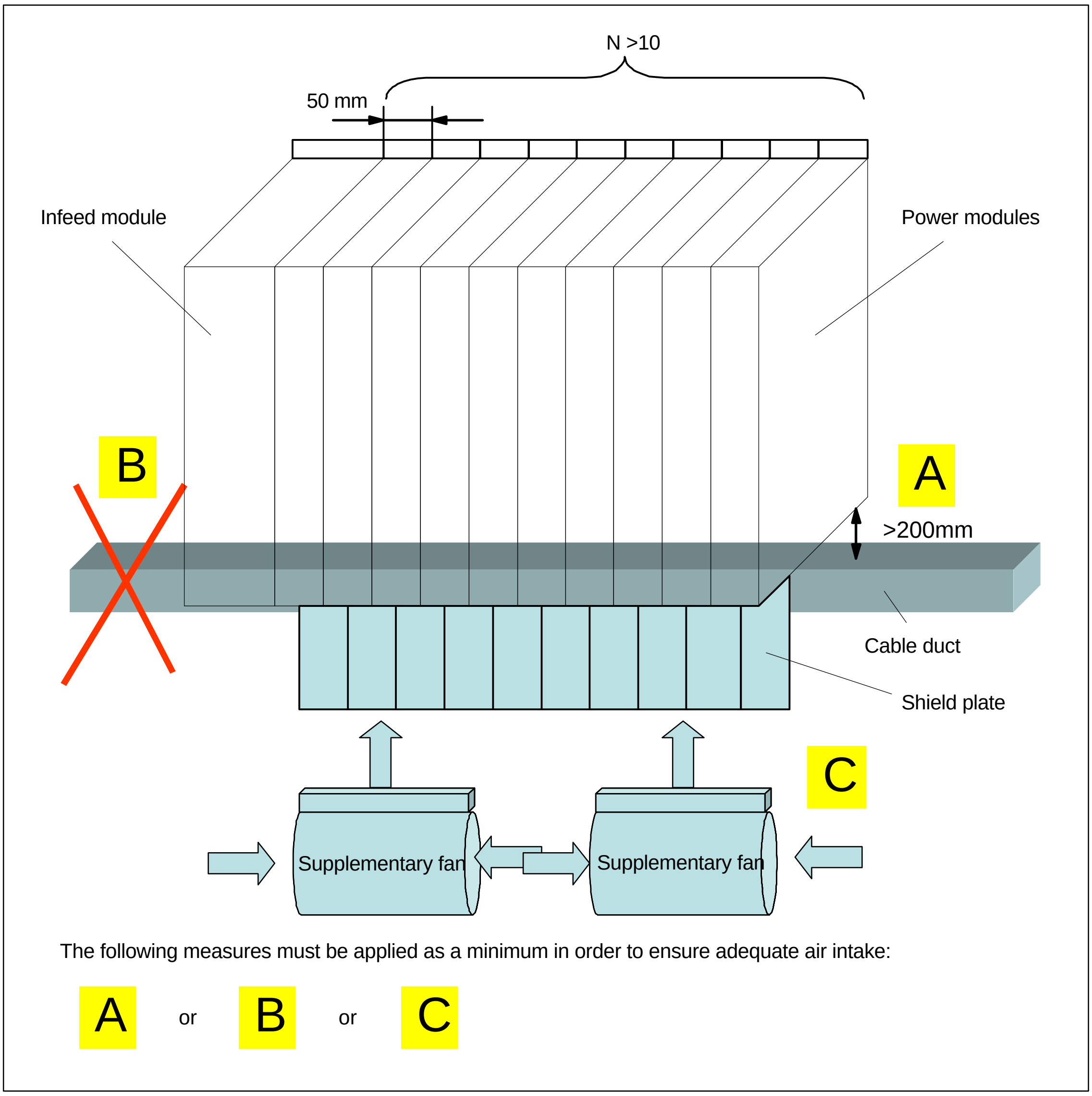


Fig. 9-5 Measures when building the cabinet

Cable routing

Cables may not be routed over modules; the ventilation grilles may not be covered. The 50 mm wide devices are especially critical.

Air flow, climate–control equipment

Some SIMODRIVE 611 devices are force–ventilated using integrated fans and some are non–ventilated using self–convection. Self (natural) convection responds very sensitively to external effects. It must be absolutely ensured that the cold air is drawn–in from below and the hot air is free to discharge upwards. When using filter fans, heat exchangers or climate–control equipment it must be ensured that the air flows in the correct direction. Refer to Figs. 9-6 and 9-7.

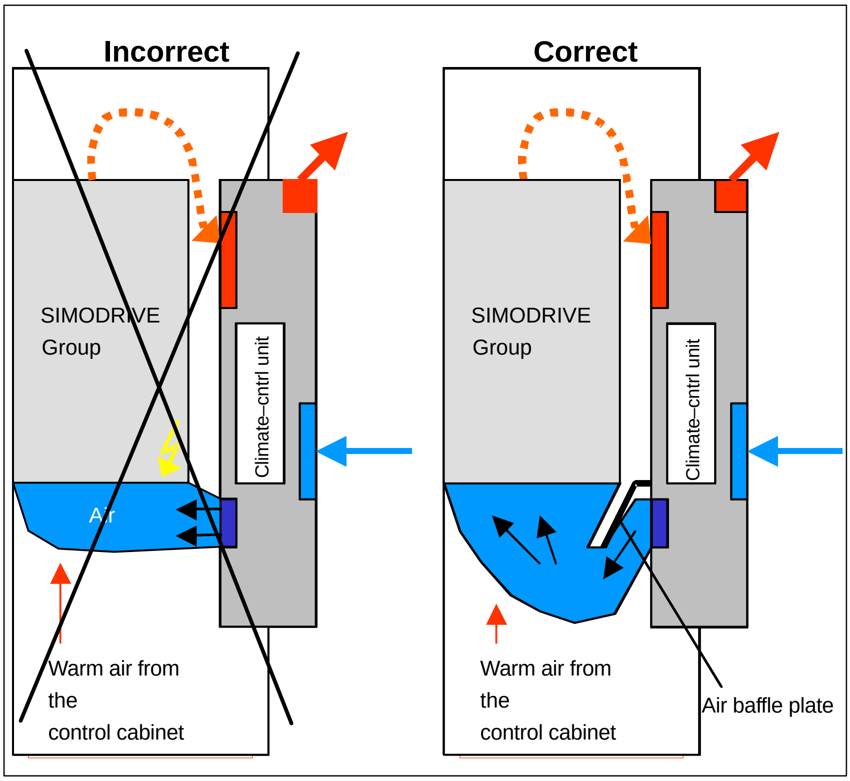


Fig. 9-6 Air flow and climate–control equipment

If climate–control equipment is used, the relative air humidity of the expelled air increases as the air in the air conditioner cools and may exceed the dew point. If the relative humidity of the air entering the SIMODRIVE 611 equipment is between 80% and 100% for an extended period of time, the insulation in the equipment may fail to function properly due to electrochemical reactions. Using air baffle plates, for example, you must ensure that the cold air expelled from the air conditioner mixes with warm air in the cabinet before it enters the equipment. This reduces the relative air humidity to uncritical values.

Example:

A room temperature with 25°C with 60 % relative air humidly is considered pleasant. If this air is kept enclosed in a cabinet, when cooling–down to 20 °C, the critical limit of 80 % relative air humidity is already reached in the discharged air; when cooling–down further to 16 °C, the dew point is already reached.

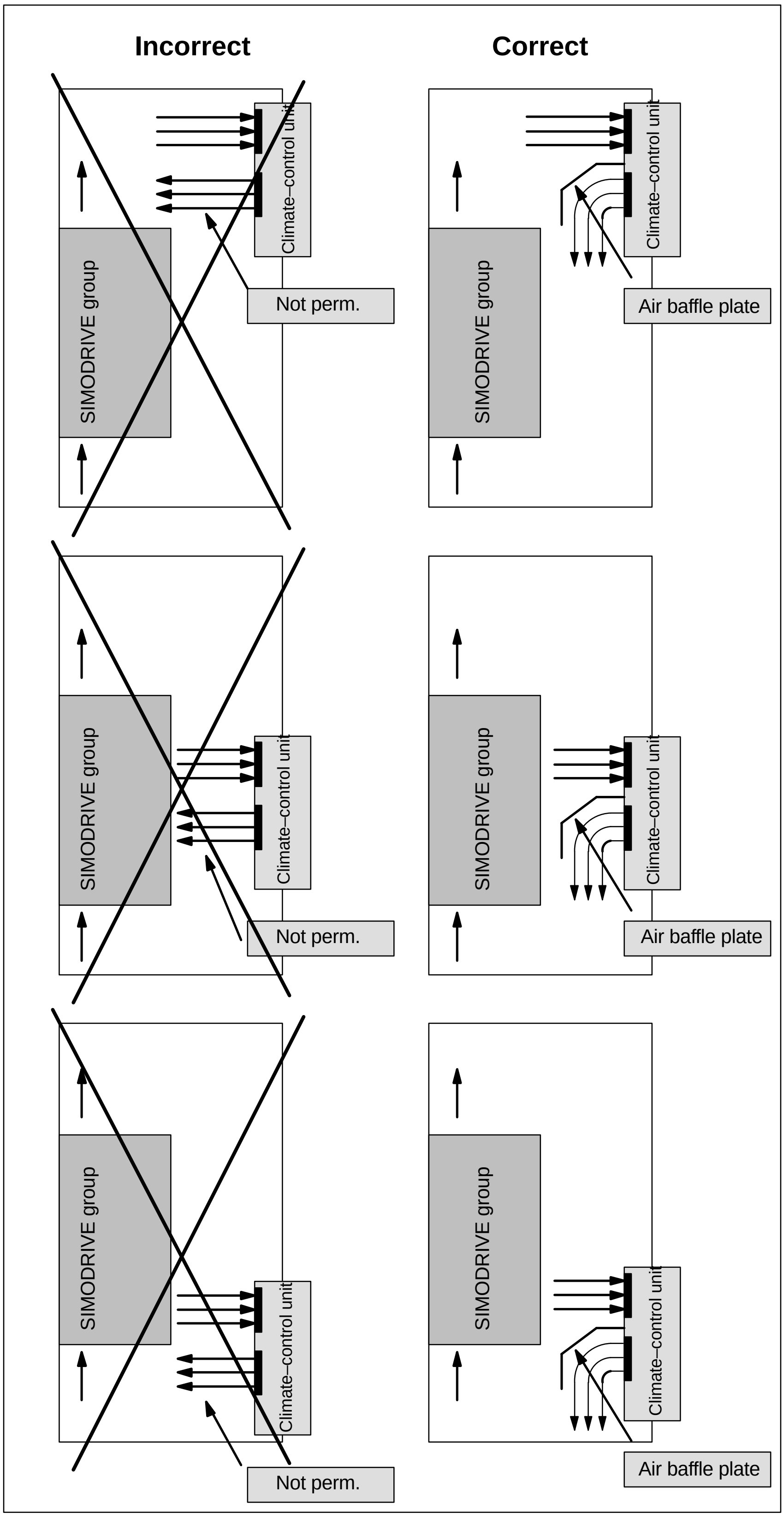


Fig. 9-7 Air flow in the electrical cabinet

Note

When using climate–control equipment special care must be taken to avoid moisture condensation:

- Power–down the climate–control equipment if the cabinet doors are open.
- We recommend that the cooling air temperature is set to 35 °C in order to avoid moisture condensation forming on the components.

For multi–section electrical cabinets, the cooling air should be provided at that location where the highest power loss occurs (thermal loss).

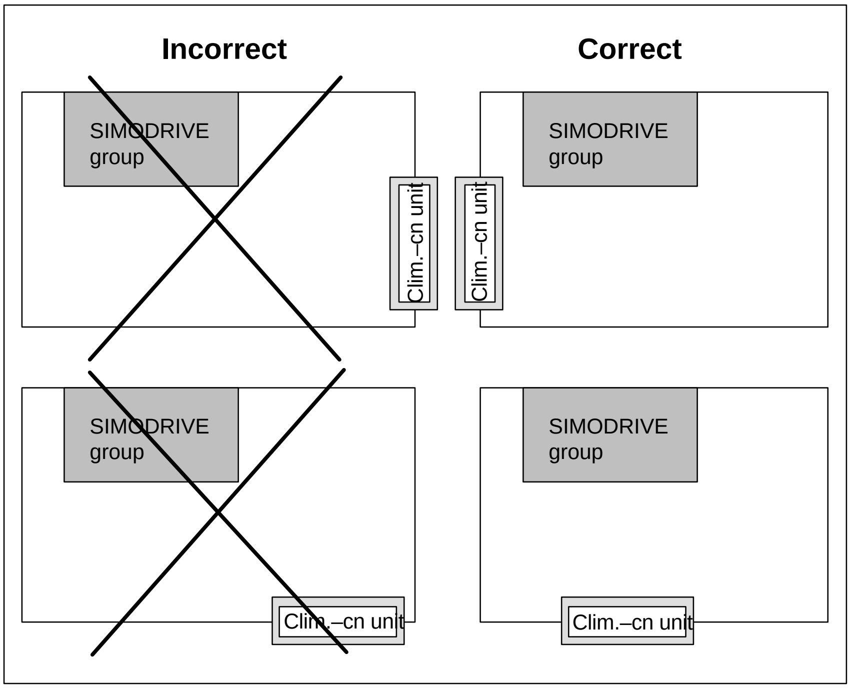


Fig. 9-8 Arrangement of the climate–control equipment for multi–section electrical cabinets

9

9.1.3 Two–tier equipment configuration

Arrangement

The modules of the SIMODRIVE 611 drive converter system can also be arranged in two tiers one above the other or next to each other.

The distance between the rows of modules may not be less than 200 mm to ensure unrestricted cooling. The maximum clearance is specified, depending on the configuration, by the equipment bus cable.

When arranging the cable ducts that may be required for the wiring it must be ensured that the required minimum clearance to SIMODRIVE 611 converter system is not fallen below.

The modules with the higher power ratings – as well as the infeed module – must be located in the upper row of modules.

The maximum expansion phase of a drive group is limited by the power 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 cubicle panel.

Connecting cable

For the SIMODRIVE 611 drive converter system, for a two–tier equipment configuration, a connecting cable is required for the equipment and drive bus.

In the two–tier equipment configuration, the DC link is connected using parallel cables (max. length, 5 m; in conjunction with SIMODRIVE POSMO SI/CD/CA, the guidelines correspond to the User Manual SIMODRIVE POSMO SI/CD/CA).

In the case of series–connected modules 300 mm wide, the conductor cross–section must be Cu 70 mm^2 and for smaller modules it must be Cu 50 mm^2. The cable must be routed so that it is short–circuit and ground fault proof. An potential bonding conductor having the same cross–section must also be routed in parallel and connected at the housings/enclosures of the two modules that are connected to one another. The three cables should be tied together. These cables are not included with the equipment.

The dimensions, specified in the diagram 9-9 apply for the DC link connection of components that are separately located next to each other, e.g. extending over several electrical cabinets.

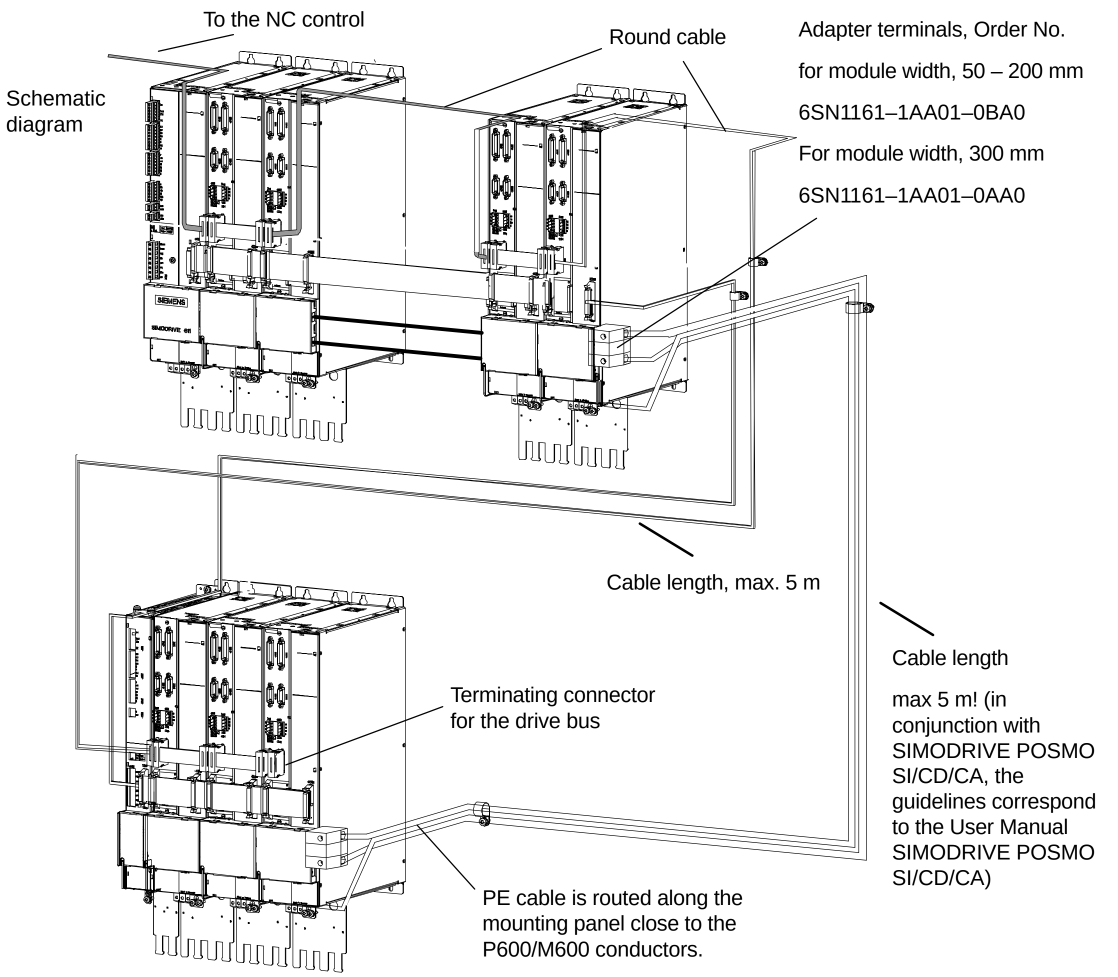
Adapter terminals to connect the DC link

Adapter terminals are available to connect the DC link.

The DC link voltage can be connected further using these adapter terminals – e.g. to connect the DC link for two–tier configurations.

The following adapter terminals are available (refer to Fig. 9-9):

- Package with 2 double terminals 50 mm^2 for a module width 50...200 mm (Order No.: 6SN1161–1AA01–0BA0)
- Package with 2 double terminals 95 mm^2 for a module width of 300 mm (Order No.: 6SN1161–1AA01–0AA0)



1) The drive group has more than 6 drive axes. This is the reason that round drive bus cables are used in the complete group. Further, the shields of those round drive bus cables that are used to jumper/bridge ”Gaps in the module group” must be clamped/connected to the associated module housing!

Fig. 9-9 Connection example, two–tier configuration

Data on the system design

1. The continuous equipment bus cable of a drive group at one input module or monitoring module may be a maximum of 2.1 m long (from the supply point). For a two–tier configuration, two equipment bus branches, each with max. 2.1 m length from the branching point (supply point) can be used at the in-feed.
2. 1500 mm equipment bus extension for a 2–tier configuration with a branch at the supply/infeed point (Order No.: 6SN1161–1AA00–0AA1).
3. The drive bus length may not exceed 11 m.

Note

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

9

9.2 EMC measures

Shield connection cables

The shield connection is used to ensure that cables for electronics (e.g. incremental shaft–angle encoders for SIMODRIVE 611 universal HRS) are connected to the ground potential of the module housing in compliance with EMC (for Siemens encoder cables, the shield is connected in the encoder connector). The shield connection is mounted above the control units using the screws supplied above the threaded sockets at the power modules.

Order No. (MLFB): 6SN1162–0FA00–0AA1.

Note

For SIMODRIVE 611 digital, for encoder cables > 30 m long, the shield connection 6SN1162–0FA00–0AA2 can be used.

Limitations and constraints, refer to Chapter 5.1.1.

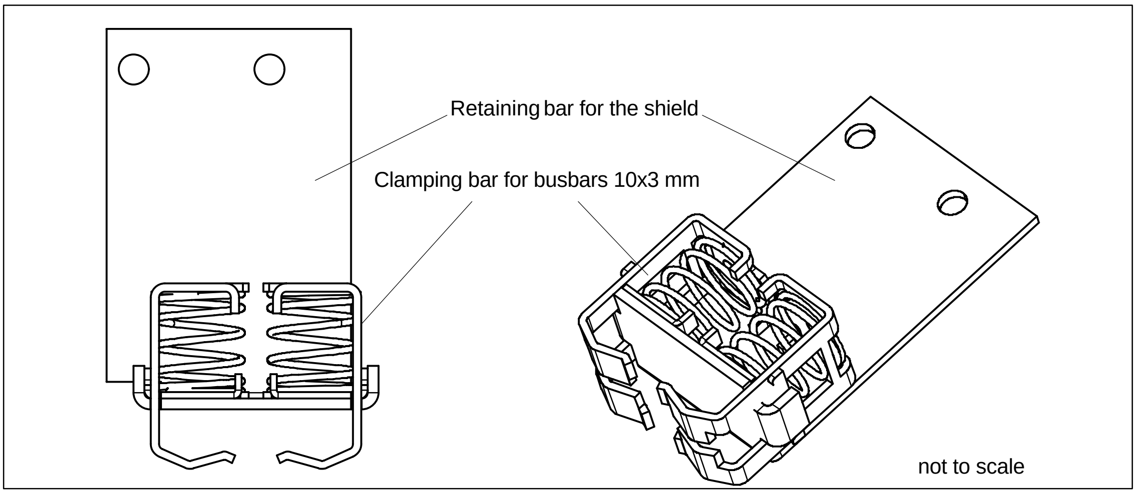


Fig. 9-10 Shield connection 6SN1162–0FA00–0AA1

The shields of original pre–assembled cables are automatically connected when the cable is plugged–in.
Exceptions:

– Setpoint cable from the analog NC
Here, the shields of the setpoint pairs must be connected to the upper side of the module. The threaded sockets provided can be used for this purpose. (M5x10/3 Nm).

– Drive bus cable from SINUMERIK 840C
Here, the shield is connected to the threaded socket mentioned above using the clamp provided.

– Drive bus and equipment bus extension cables for 2–tier configurations.
Here, shields are connected at both ends of the cables to the above mentioned threaded sockets using the clamps provided.

– Motor power cables
The shields of the motor feeder cables are connected, using the hose connectors provided, to the shield connecting plates (accessories) of the modules.

Shield connection front panel

In order to ensure a good connection between the front panel and the housing, the screws at the front panel must be tightened with a torque of 0.8 Nm.

Connection, electronics ground

Terminal X131 (electronics ground) at the NC.

Protection against overvoltages

In order to provide protection against overvoltage (for line supplies that are not in compliance with VDE), an overvoltage limiter module (Order No.: 6SN1111–0AB00–0AA0) can be inserted at connector X181 on the NE module (this is not necessary for UI 5 kW and monitoring module).

Maximum cable lengths

Using non–shielded signal and direct current supply cables (e.g. 24 V infeed with external supply):

- DC power supply cables: Length $\leqslant$ 9.90 m permissible.
- Non–shielded signal cables: Length, max. 30 m permissible without any additional circuitry

For longer lengths, the user **must** connect suitable circuitry to provide overvoltage protection, e.g. the following type:

TERMITRAB–UK5/ 24DC
Product No. 27 94 69 9 from
Phoenix Contact GmbH & Co
32823 Blomberg
Tel. +49 (0)5235/300
Fax +49 (0)5235/341200
http://www.phoenixcontact.com

Note

We recommend that pre–fabricated cables are used, as correct shielding is necessary to ensure an EMC–safe connection.

Further, the appropriate cable parameters are required in order to ensure optimum signal transfer characteristics. The function will only be guaranteed when using the original cables.

Reference: /EMC/ EMC Configuring Guidelines
SINUMERIK, SIROTEC, SIMODRIVE

9

9.3 High–voltage test in the system

It is permissible to carry–out a high–voltage test on SIMODRIVE 611 drive converters.

The components are designed/dimensioned in compliance with DIN EN 50178.

The following secondary conditions/limitations must be carefully observed when the system is subject to a high–voltage test:

1. Power–down the unit.
2. Withdraw the overvoltage module in order to prevent the voltage limiting responding.
3. Disconnect the line filter so that the test voltage doesn't dip.
4. Connect M600 to PE through resistor 100 kΩ (the grounding bar in the NE modules is open). In the factory, the units are subject to a high–voltage test at 2.25 kV_{DC} phase–PE. The NE modules are shipped with the grounding bar open.
5. The maximum permissible voltage for a high–voltage system test is 1.8 kV_{DC} phase–PE.

If these points aren't carefully observed, then the modules can be damaged (preliminary damage).

■

Connection Diagrams 10

Note

The following connection diagrams only show the terminal connections. Further, external components are not completely shown. Refer to Chapter 8.

The following comments should be observed in the connection diagrams:

1 Terminals 9/48/112 are always jumpered in normal operation. Otherwise, the pre–charging circuit is not active.
2 For 6–conductor connection, remove jumpers 2U1/1U1, 2V1/1V1, 2W1/1W1.
3 The monitoring module can **either be** connected to the line supply **or** directly to the DC link.
4 The jumper may only be removed in conjunction with the start inhibit.
5 For unregulated infeed not available.
6 Connect with terminal 19 of the NE module.
7 Drive bus – round cable
8 Drive bus – ribbon cable
9 Drive bus – terminating connector
10 For an external pulsed resistor, remove jumper 1R/2R.

Spare parts

Spare parts are available for the following terminals:

Table 10-1 Terminals for SIMODRIVE 611

Designation	Terminal	available in	Order No. [MLFB]
X421	2–pole	SIMODRIVE 611 universal HRS	6SY9907
X431	5–pole		6SY9908
X451, X452, X461, X462	10–pole		6SY9910
X461, X462 X453, X454	11–pole		6SY9913
X441	5–pole		6SY9911
X422, X432	8–pole	611 universal HRS option module terminals	6SY9912
Power connector, motor connection	3–pole		6SY9904
Power connector, pulsed resistor	3–pole		6SY9905
X161, X171, X172	2–pole	Module I/R, UI, monitoring module	6SY9433
X121	4–pole	UI module	6SY9432
X111, X161, X431, X432	6–pole	Module I/R, High Performance/High Standard module	6SY9896
X141	7–pole	I/R module	6SY9898
X121, X431, X432	8–pole	Module I/R, HLA/ANS module	6SY9897
X181 electronics power supply	8–pole	I/R module	6SY9900

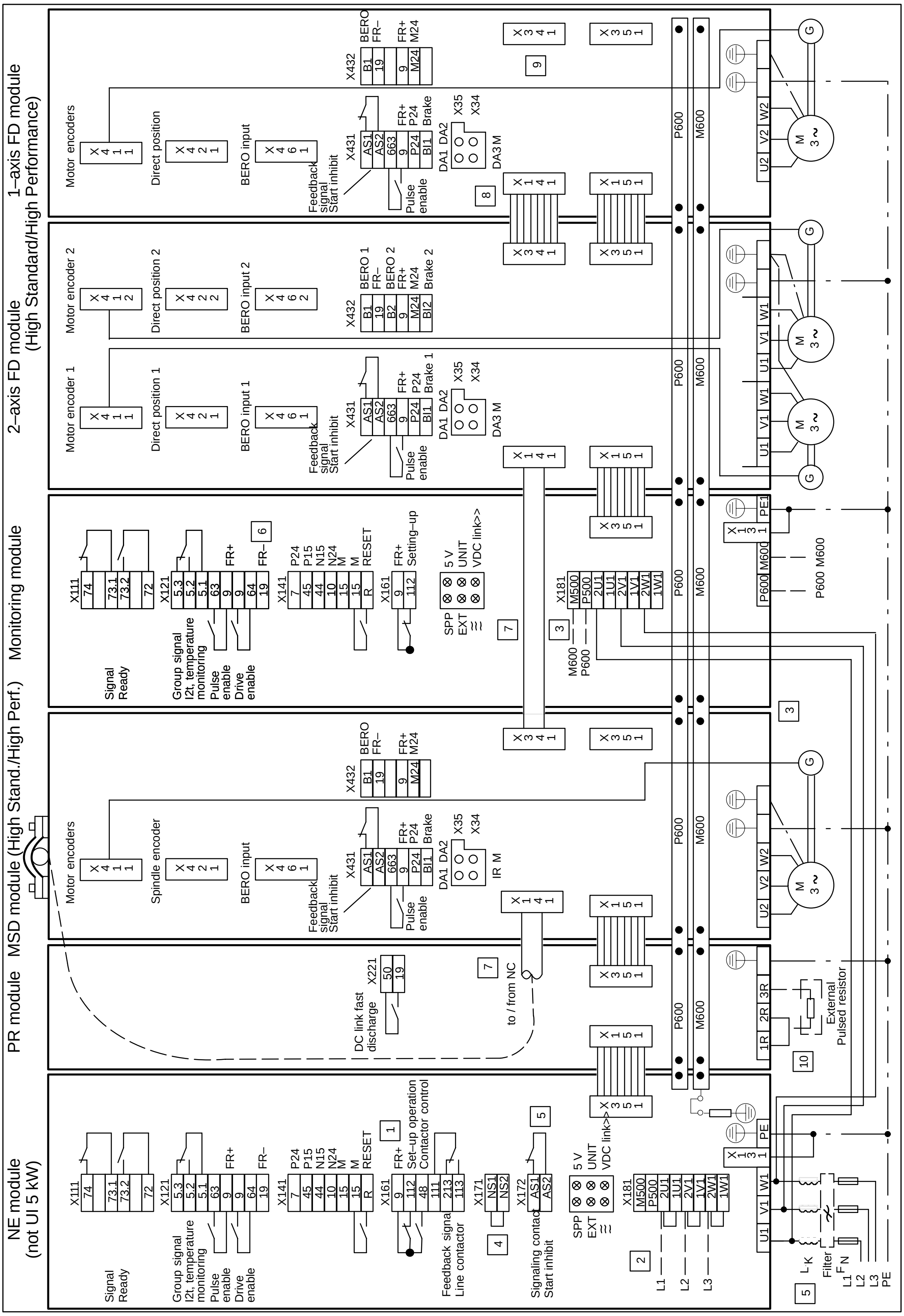


Fig. 10-1 Terminal overview SIMODRIVE 611 digital (High Standard and High Performance)

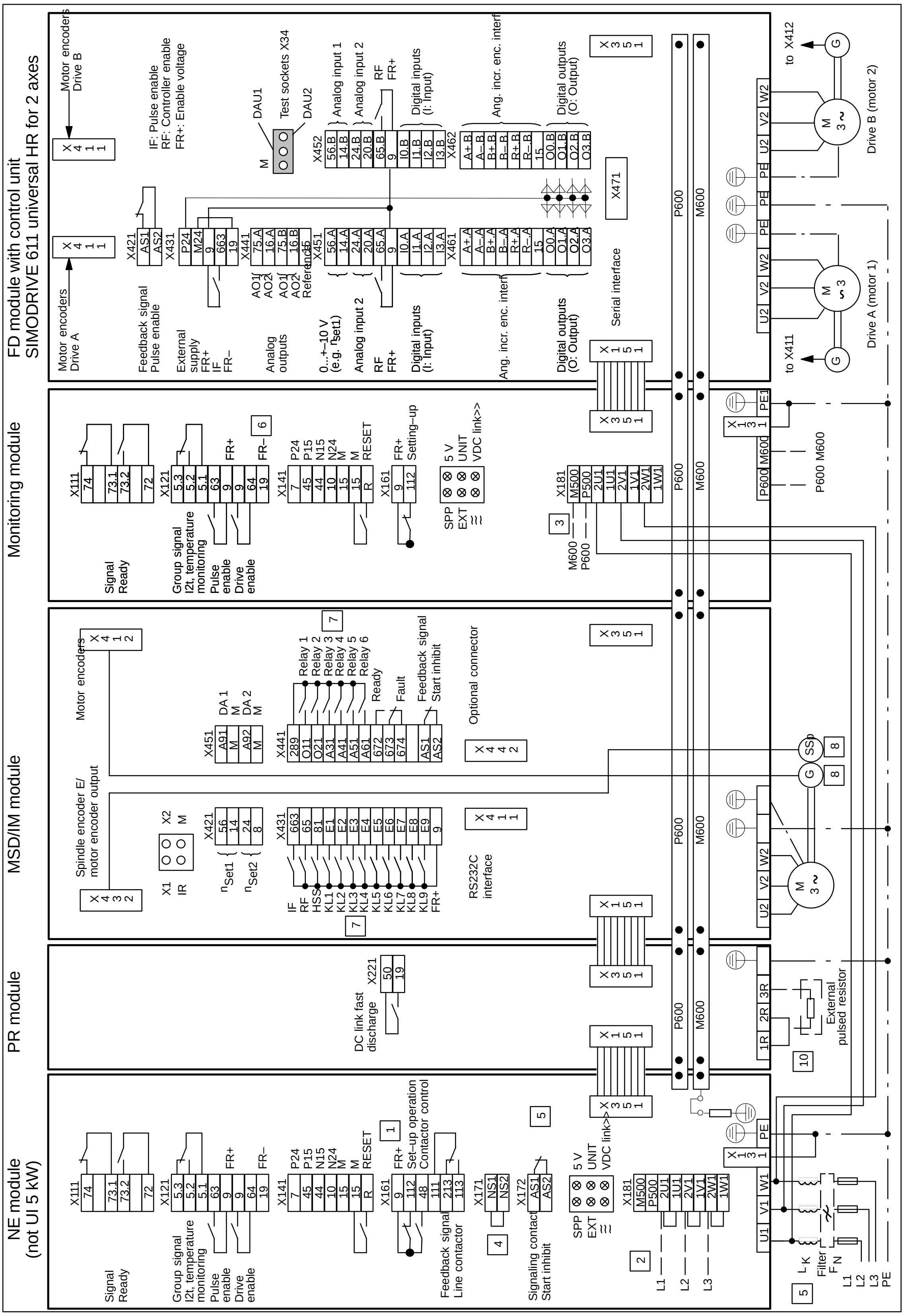


Fig. 10-2 Terminal overview, SIMODRIVE 611 universal HRS

10

Space for your notes

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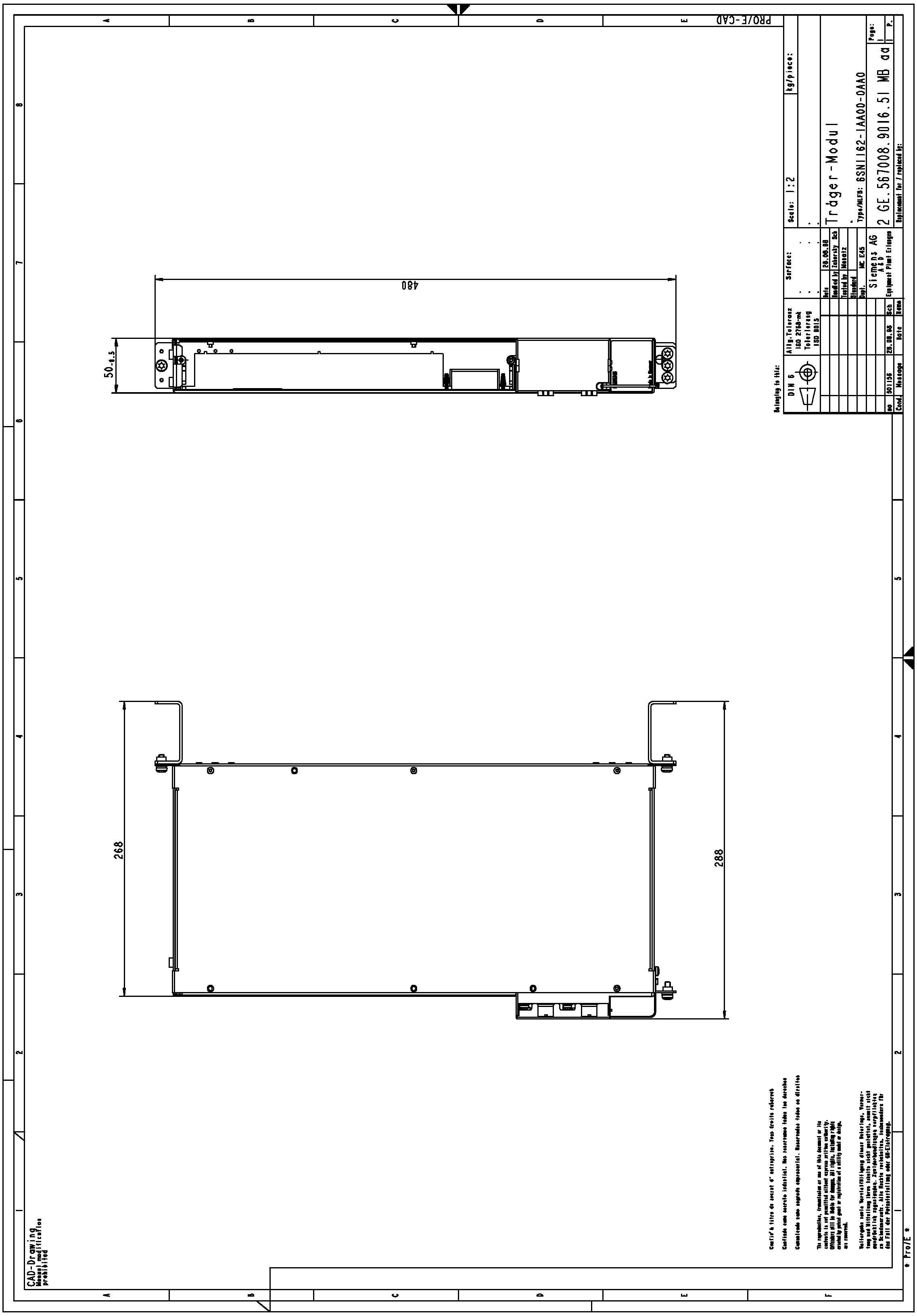


Fig. 11-1 Empty housing, Order No.: 6SN1162–1AA00–0AA0

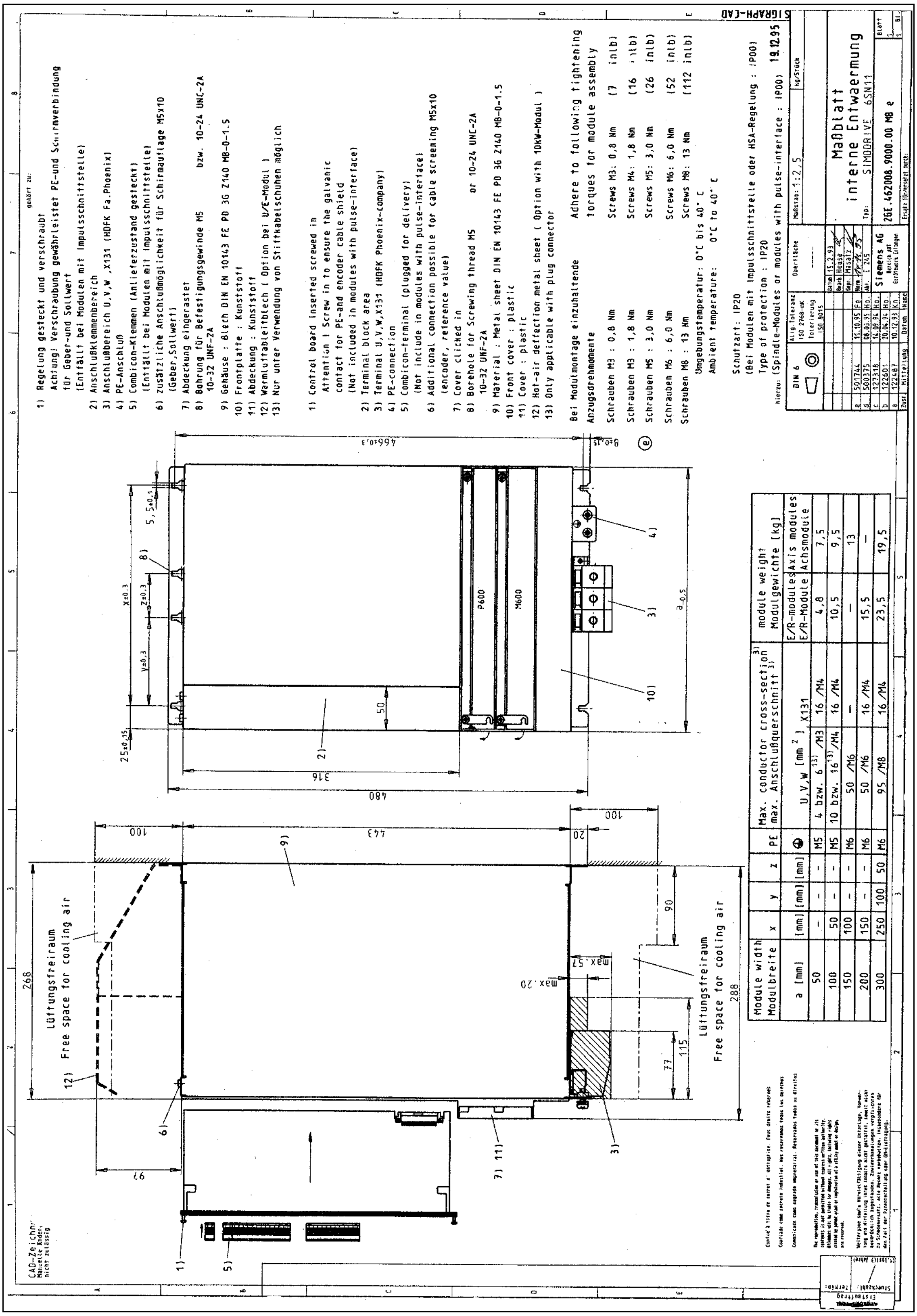
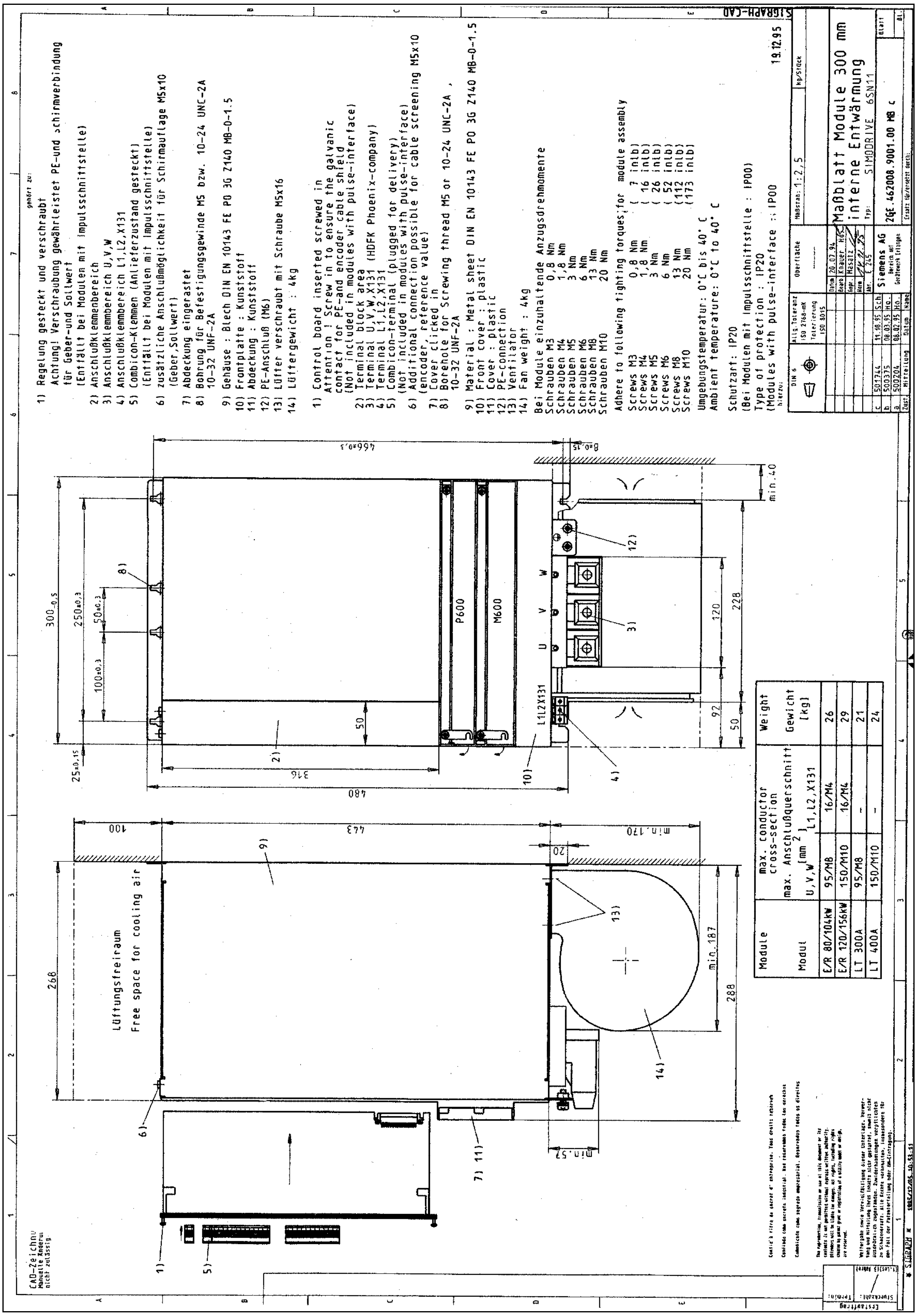


Fig. 11-2 Internal cooling, module width 50/100/150/200/300 mm



Module / Modul	max. conductor cross-section / max. Anschlußquerschnitt [mm²] U,V,W	L1,L2,X131	Weight / Gewicht [kg]
E/R 80/104kW	95/M8	16/M4	26
E/R 120/156kW	150/M10	16/M4	29
LT 300A	95/M8	–	21
LT 400A	150/M10	–	24

Fig. 11-3 Internal cooling I/R modules 80 kW/120 kW and PM modules 300 A/400 A

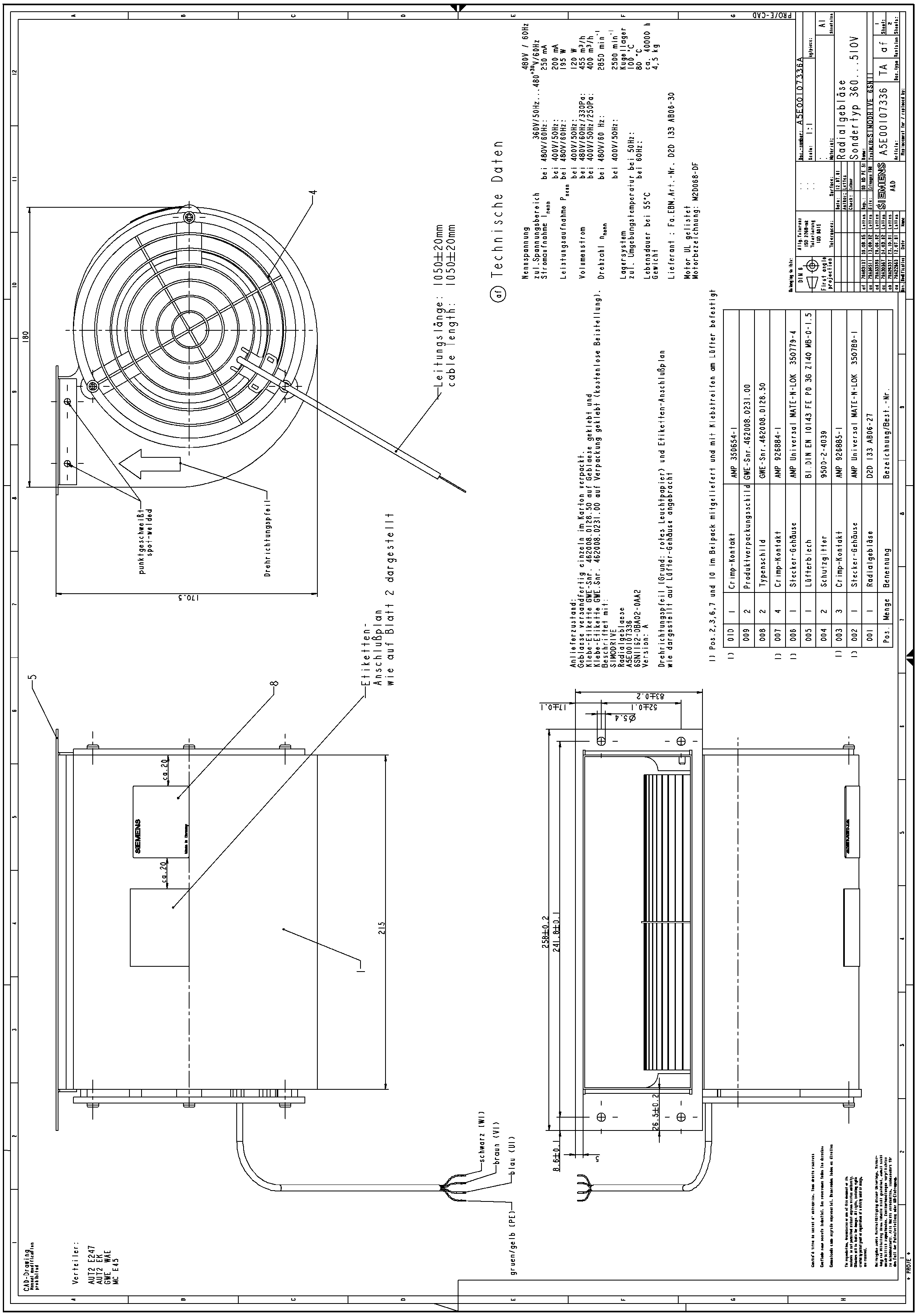


Fig. 11-4 Built-on fan, 6SN1162-0BA02-0AA2; dimension drawing

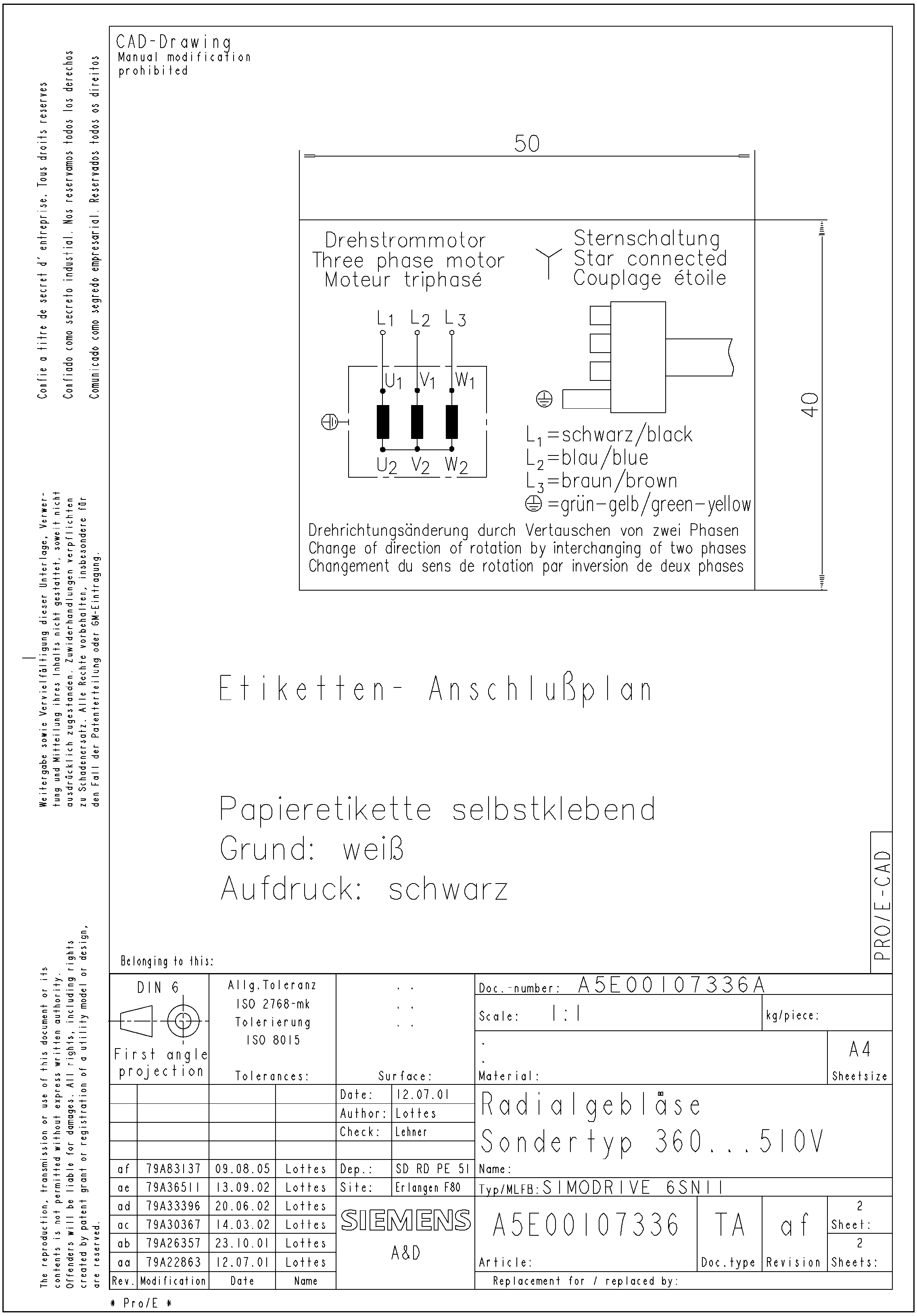


Fig. 11-5 Built-on fan, 6SN1162-0BA02-0AA2; connection diagram

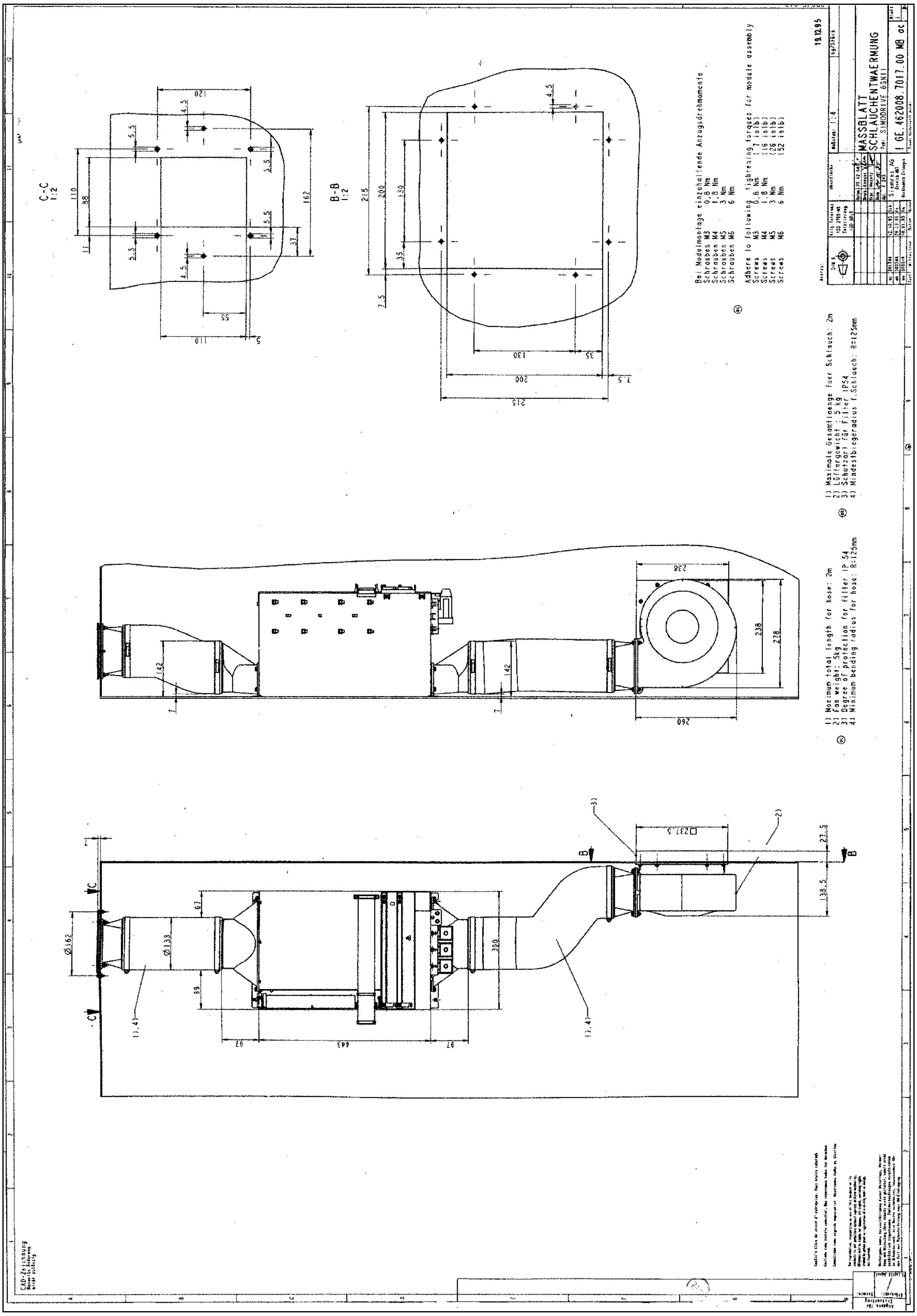


Fig. 11-6 Hose cooling for individual modules

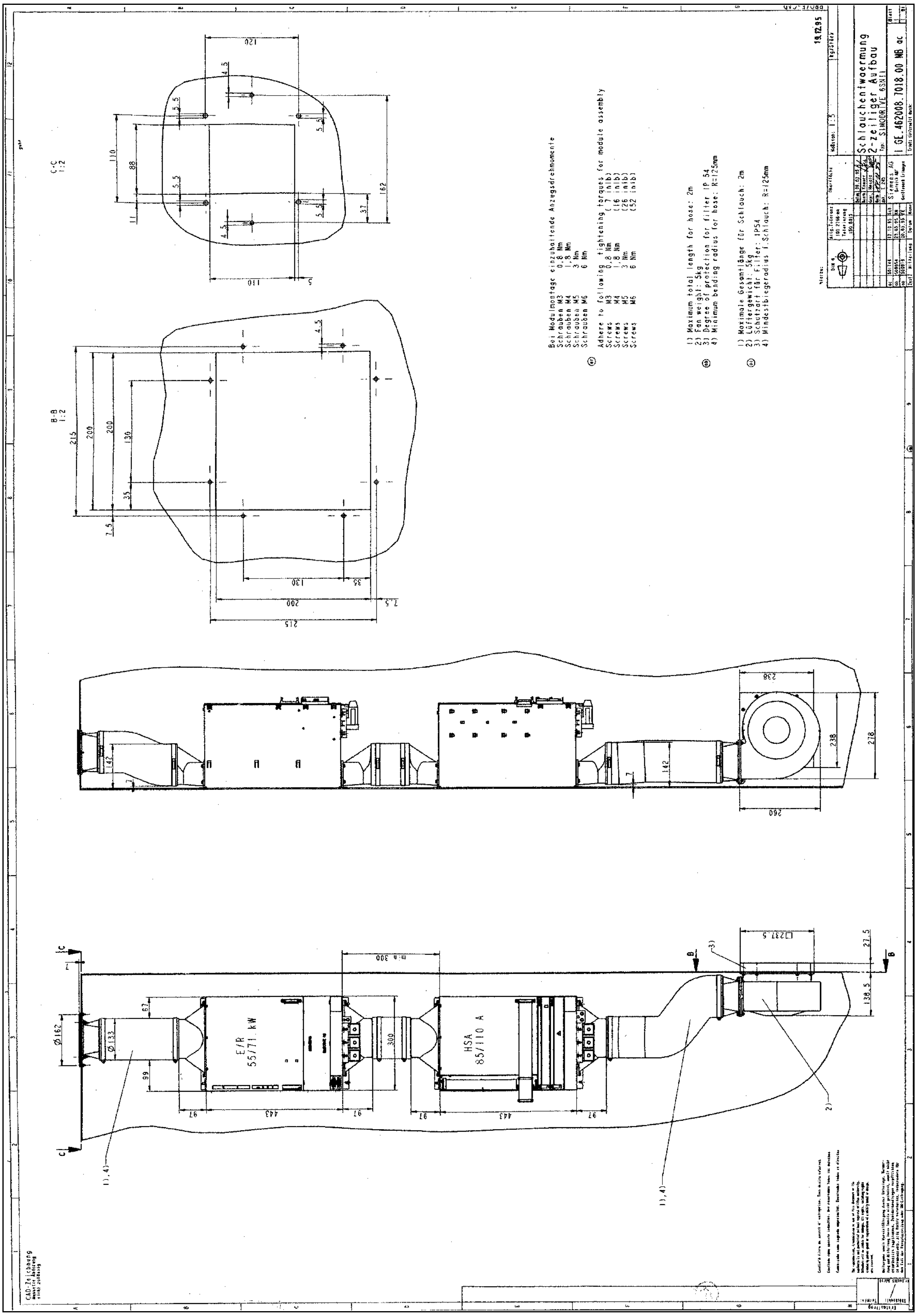


Fig. 11-7 Hose cooling for 2–tier configurations

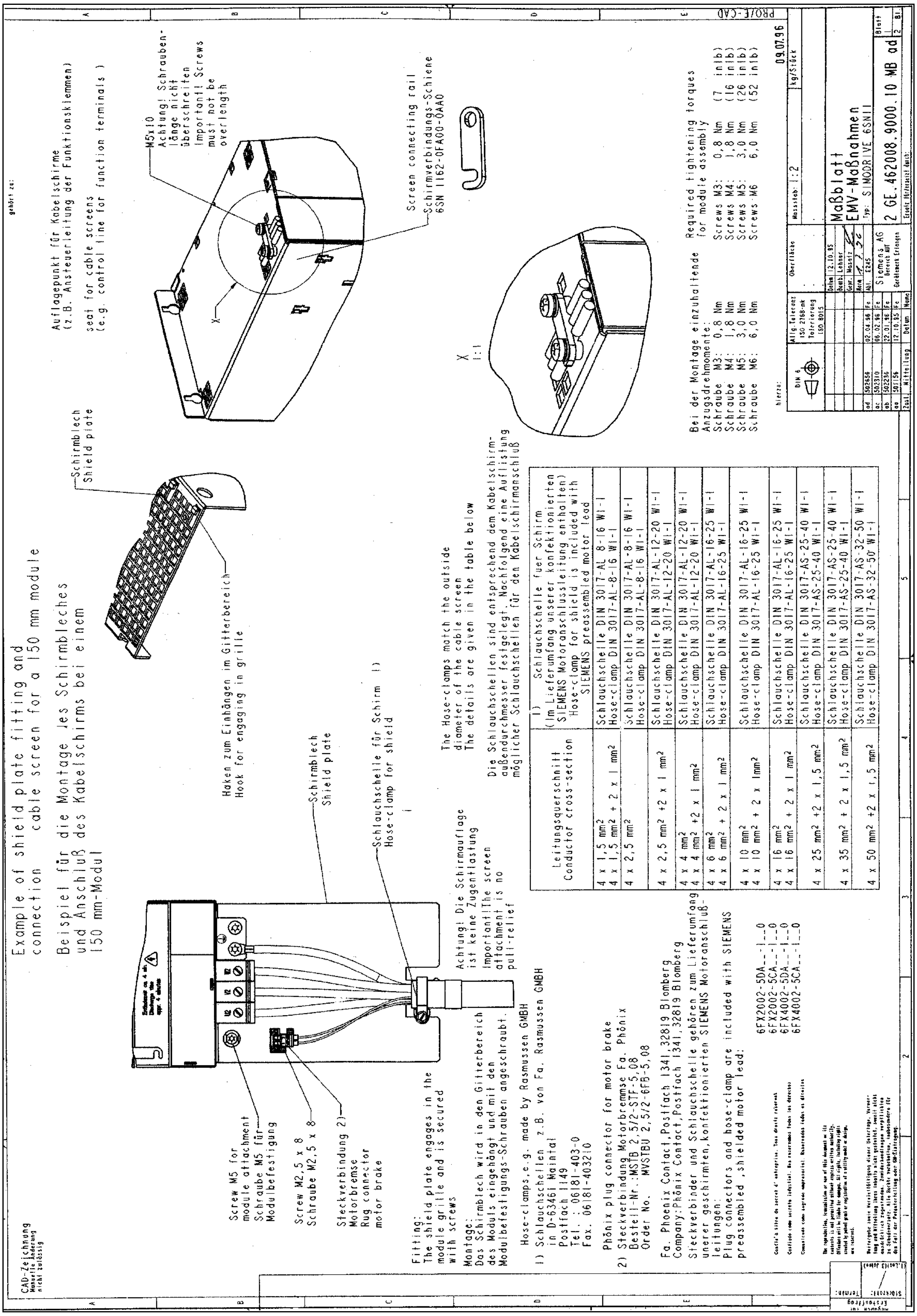
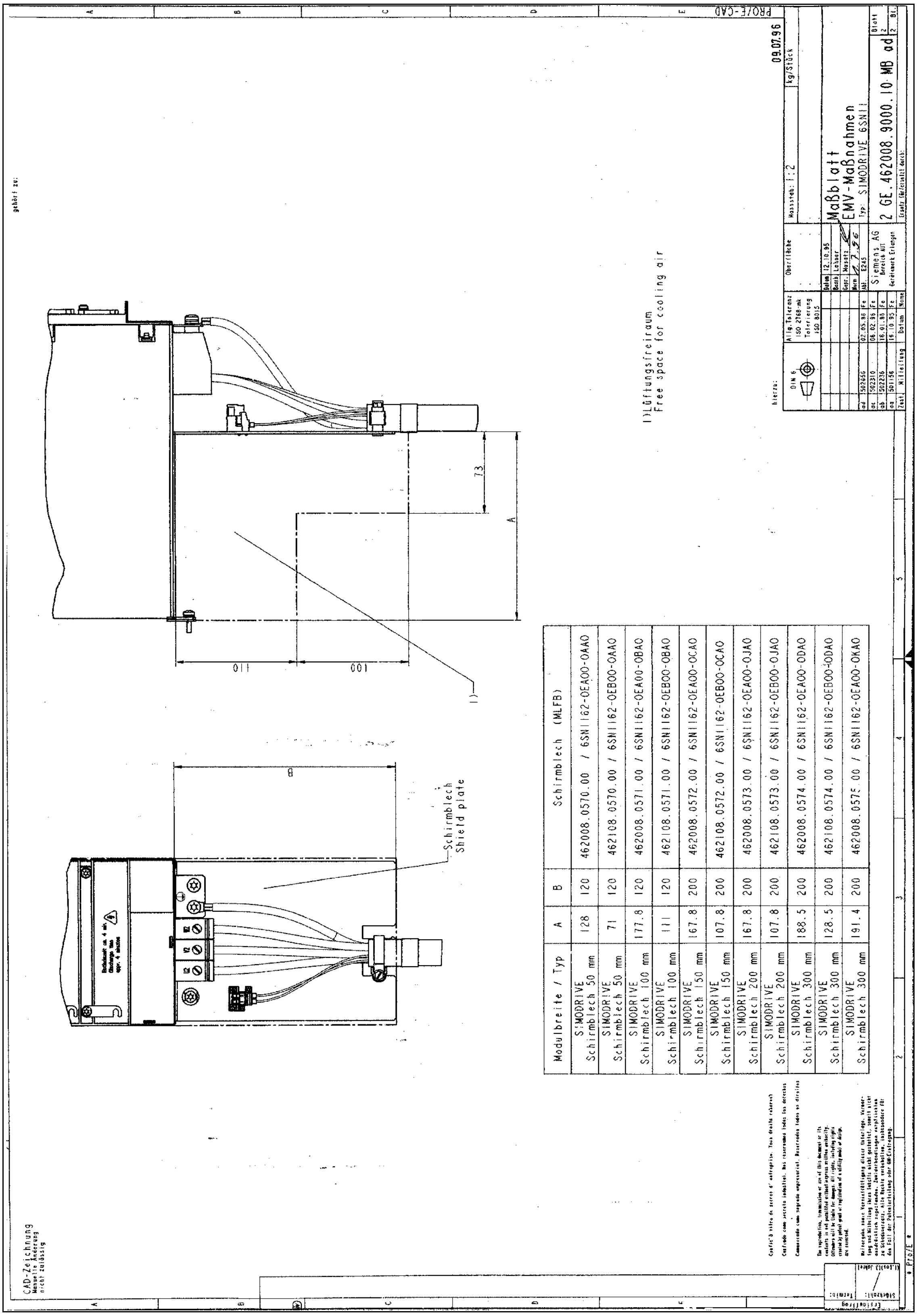
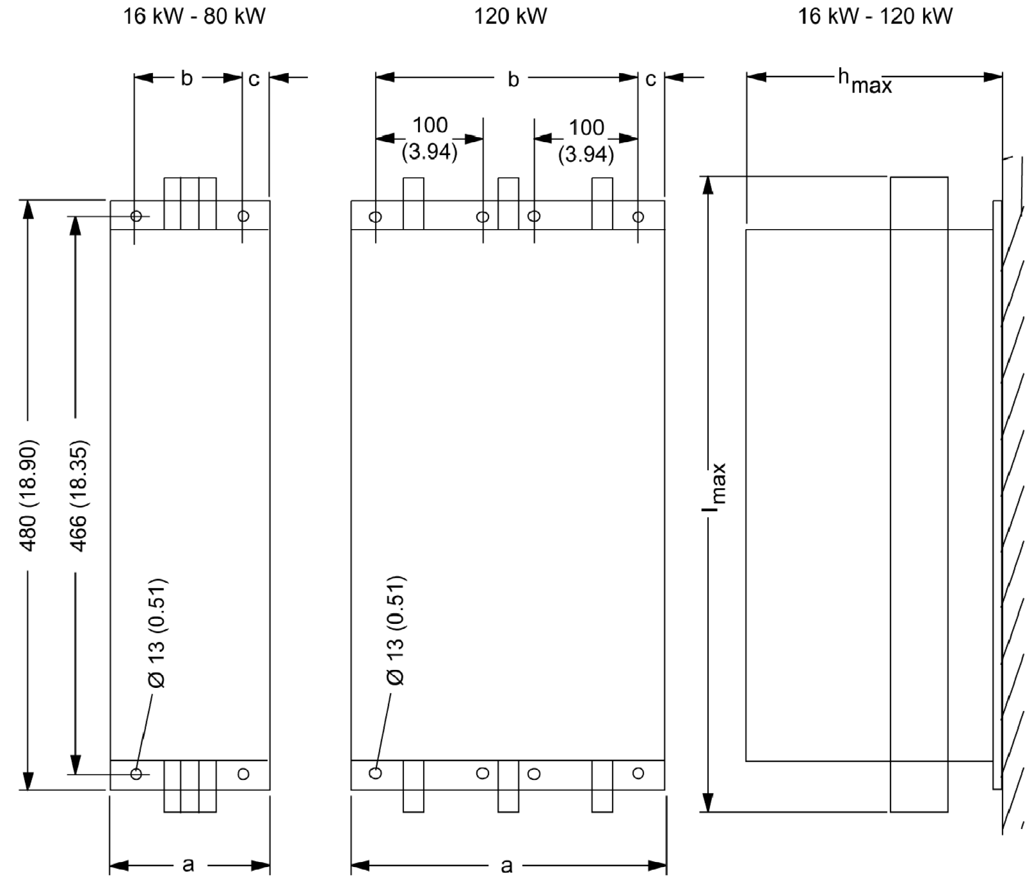


Fig. 11-8 EMC measures, Sheet 1 (shield connecting plate)



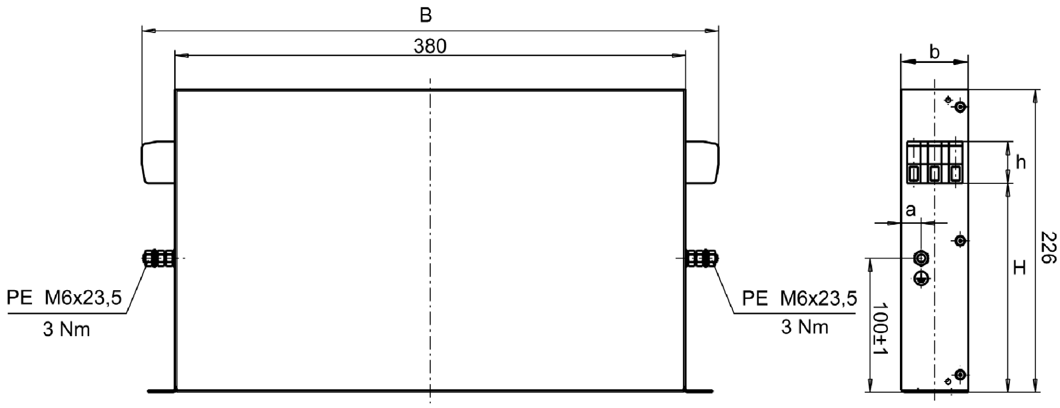
Modulbreite / Typ	A	B	Schirmblech (MLFB)
SIMODRIVE Schirmblech 50 mm	128	120	462008.0570.00 / 6SN1162-0EA00-0AA0
SIMODRIVE Schirmblech 50 mm	71	120	462108.0570.00 / 6SN1162-0EB00-0AA0
SIMODRIVE Schirmblech 100 mm	177.8	120	462008.0571.00 / 6SN1162-0EA00-0BA0
SIMODRIVE Schirmblech 100 mm	111	120	462108.0571.00 / 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. 11-9 EMC measures, Sheet 2 (shield connecting plate)



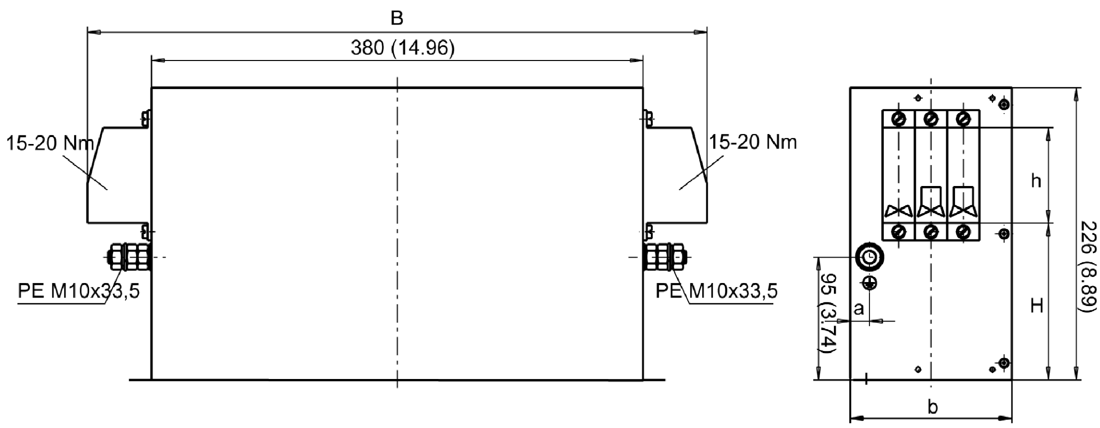
for I/R module	Order No. 6SL3000–	a [mm] (inches)	b [mm] (inches)	c [mm] (inches)	h_{max} [mm] (inches)	l_{max} [mm] (inches)
16 kW	0BE21–6AA□	130 (5.12)	100 (3.94)	15 (0.59)	150 (5.91)	489 (19.25)
36 kW	0BE23–6AA□	130 (5.12)	100 (3.94)	15 (0.59)	245 (9.65)	526 (20.71)
55 kW	0BE25–5AA□	130 (5.12)	100 (3.94)	15 (0.59)	260 (10.24)	526 (20.71)
80 kW	0BE28–0AA□	200 (7.87)	150 (5.91)	25 (0.98)	260 (10.24)	539 (21.22)
120 kW	0BE31–2AA□	300 (11.81)	250 (9.84)	25 (0.98)	260 (10.24)	530 (20.87)

Fig. 11-10 Line filter "Wideband line filter" for I/R modules, 80 kW to 120 kW



for I/R module	Order No. 6SL3000–	B [mm] (inches)	b [mm] (inches)	a [mm] (inches)	H [mm] (inches)	h [mm] (inches)
16 kW	0BE21–6DA□	429 (16.88)	50 (1.96)	15 (0.59)	156 (6.14)	31 (1.22)
36 kW	0BE23–6DA□	433 (17.07)	75 (2.95)	15 (0.59)	135 (5.31)	68 (2.67)
55 kW	0BE25–5DA□	466 (18.34)	100 (3.93)	15 (0.59)	148 (5.82)	54 (2.12)

Fig. 11-11 Line filter ”Basic line filter” for I/R modules, 16 kW to 55 kW



for I/R module	Order No. 6SL3000–	B [mm] (inches)	b [mm] (inches)	a [mm] (inches)	H [mm] (inches)	h [mm] (inches)
80 kW	0BE28–0DA□□	479 (18.85)	125 (4.92)	15 (0.59)	121.3 (4.77)	74 (2.91)
120 kW	0BE31–2DA□	479 (18.85)	125 (4.92)	15 (0.59)	121.3 (4.77)	74 (2.91)

Fig. 11-12 Line filter ”Basic line filter” for I/R modules, 80 kW to 120 kW (being prepared)

11

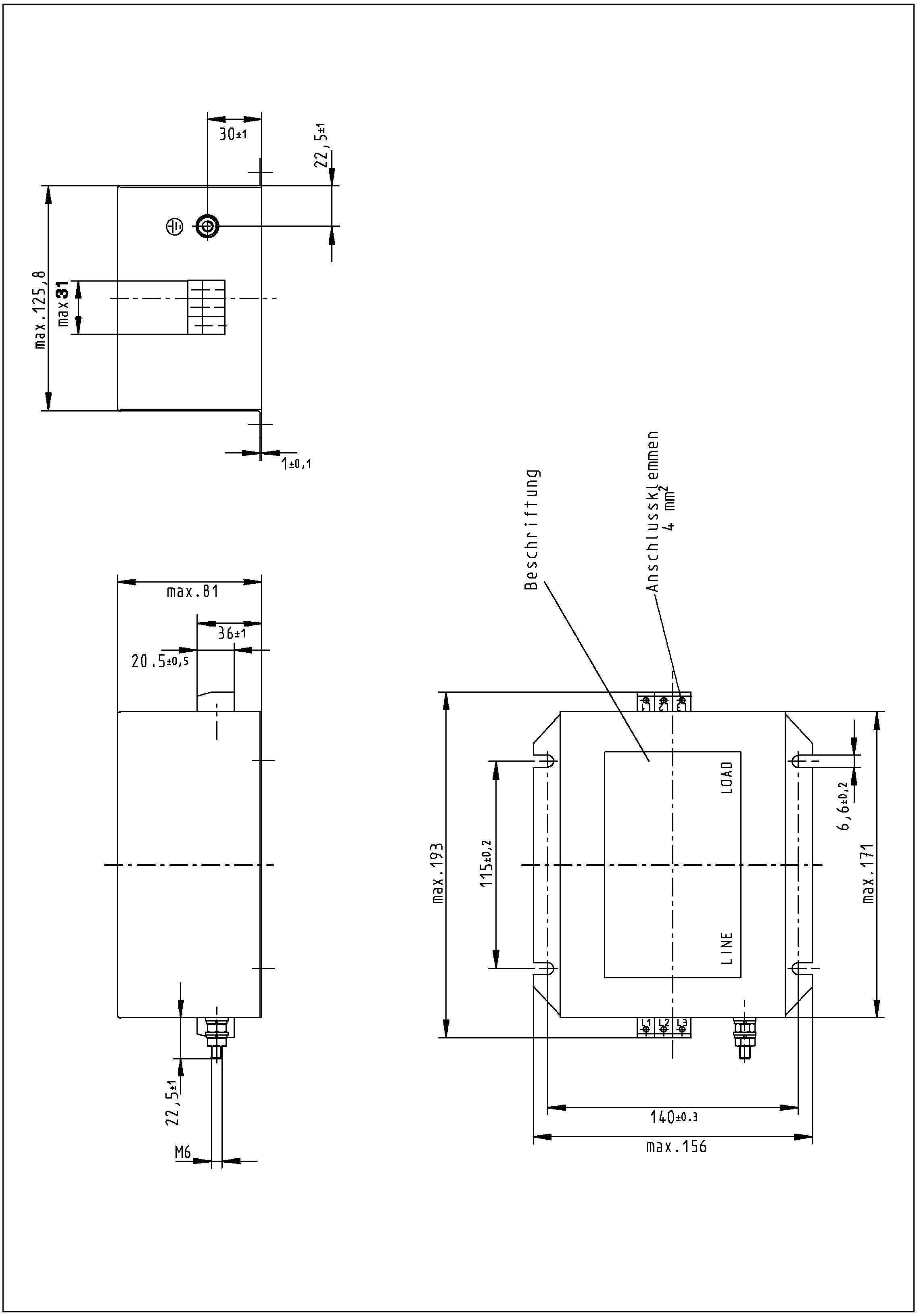


Fig. 11-13 Line filter for UI modules, 5 kW, 6SN1111–0AA01–1BA0

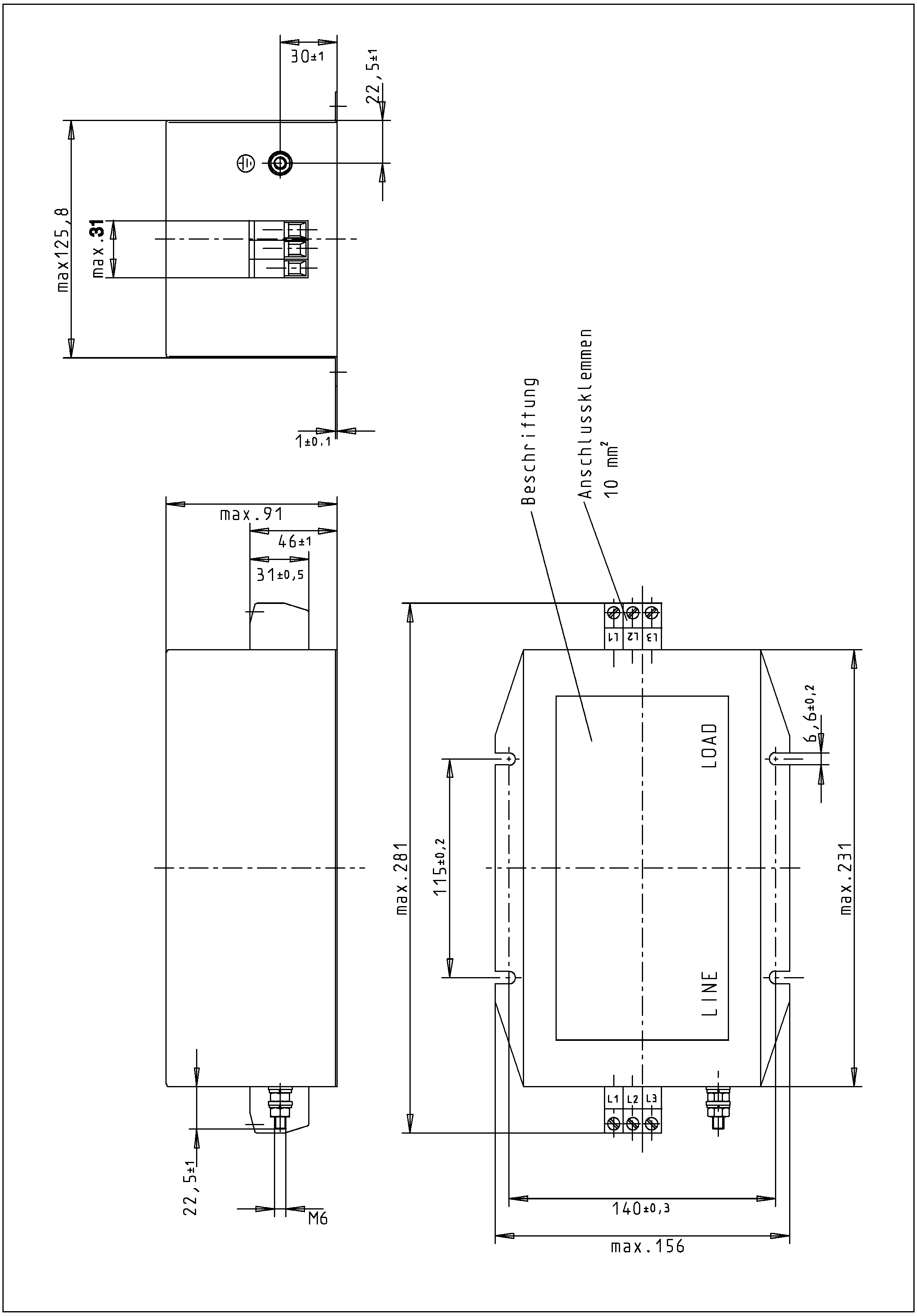


Fig. 11-14 Line filter for UI modules, 10 kW, 6SN1111–0AA01–1AA0

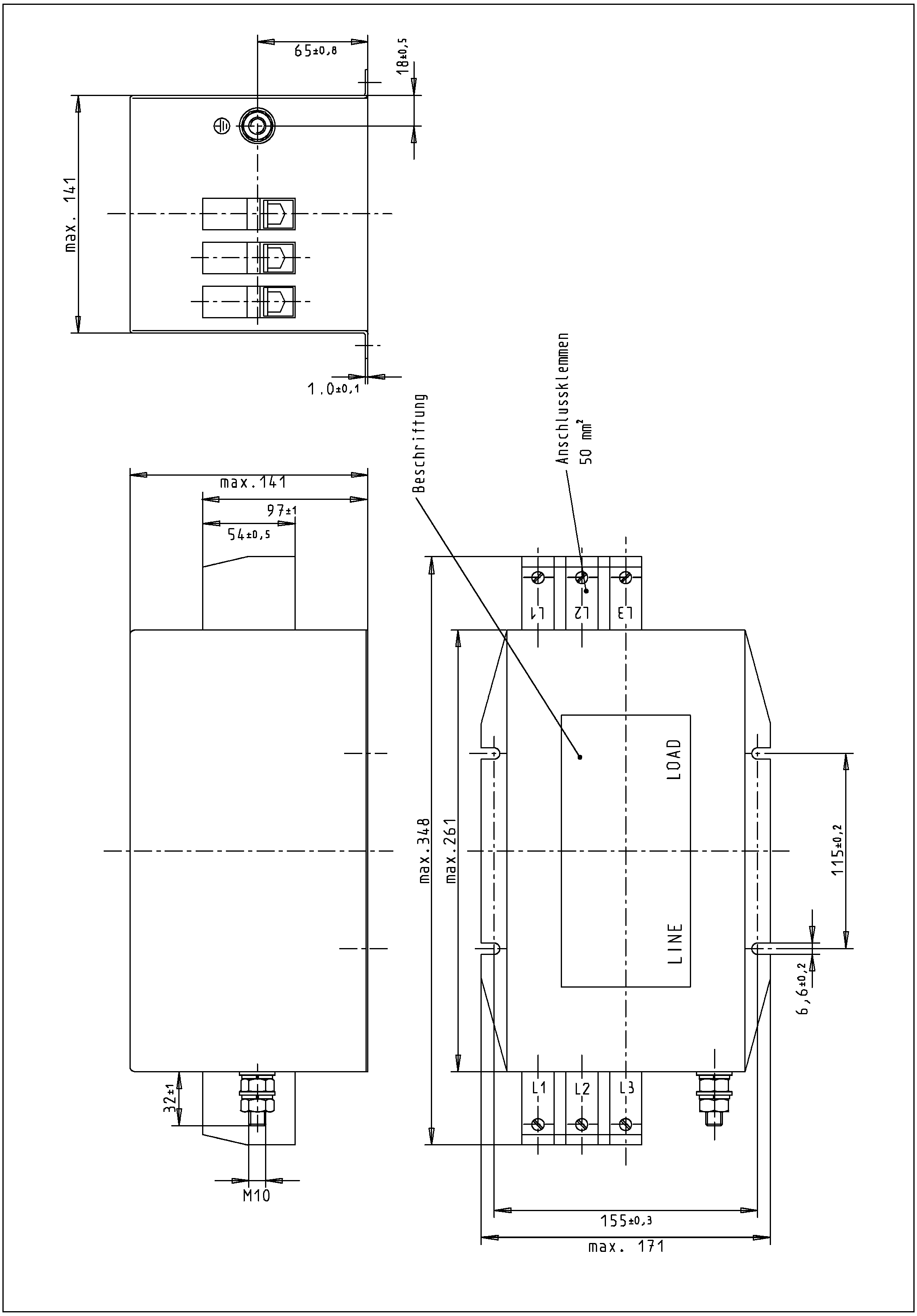


Fig. 11-15 Line filter for UI modules, 28 kW, 6SN1111–0AA01–1CA0

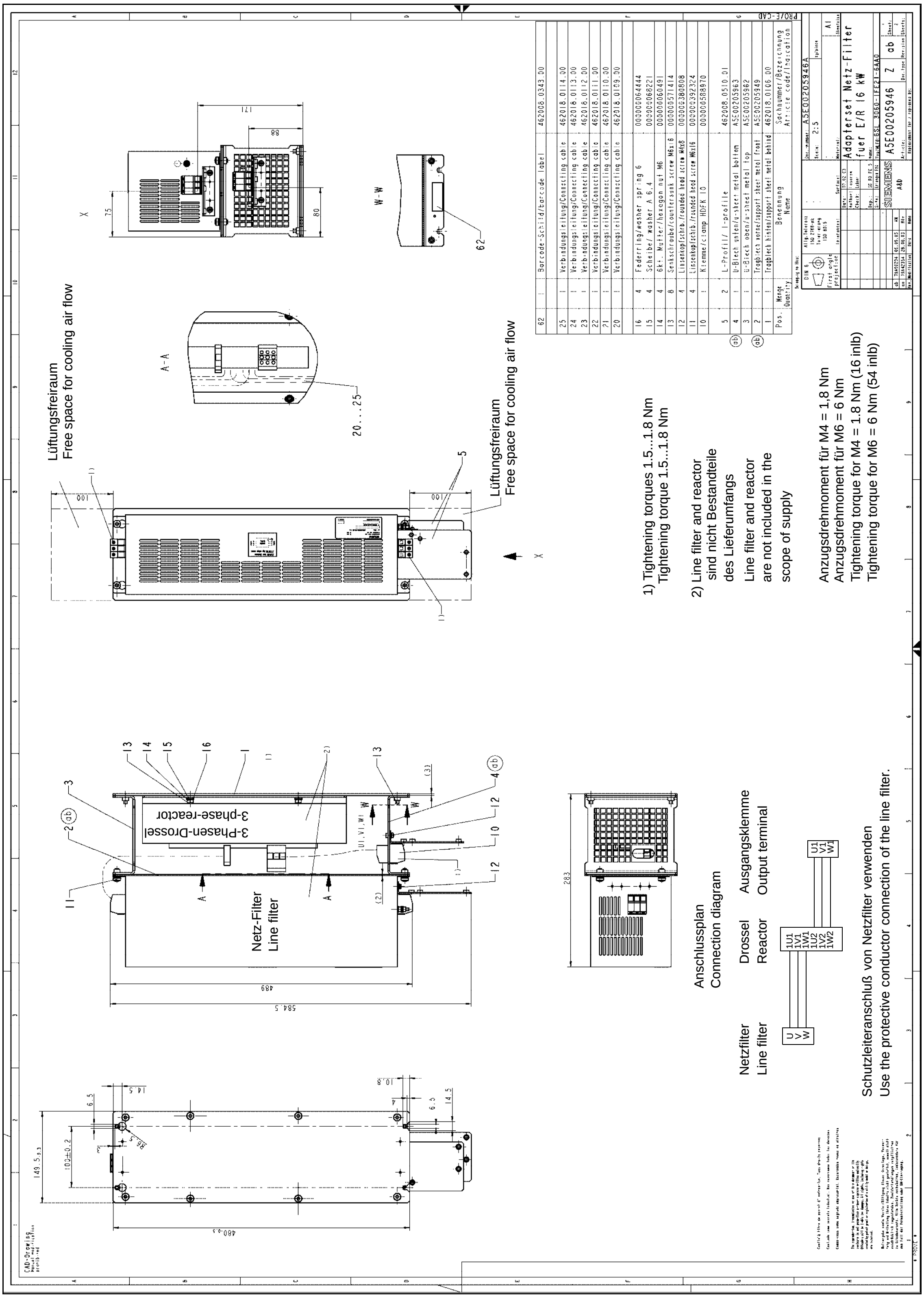


Fig. 11-16 Adapter set, line filter for I/R module 16 kW, 6SL3060–1FE21–6AAx; dimension drawing

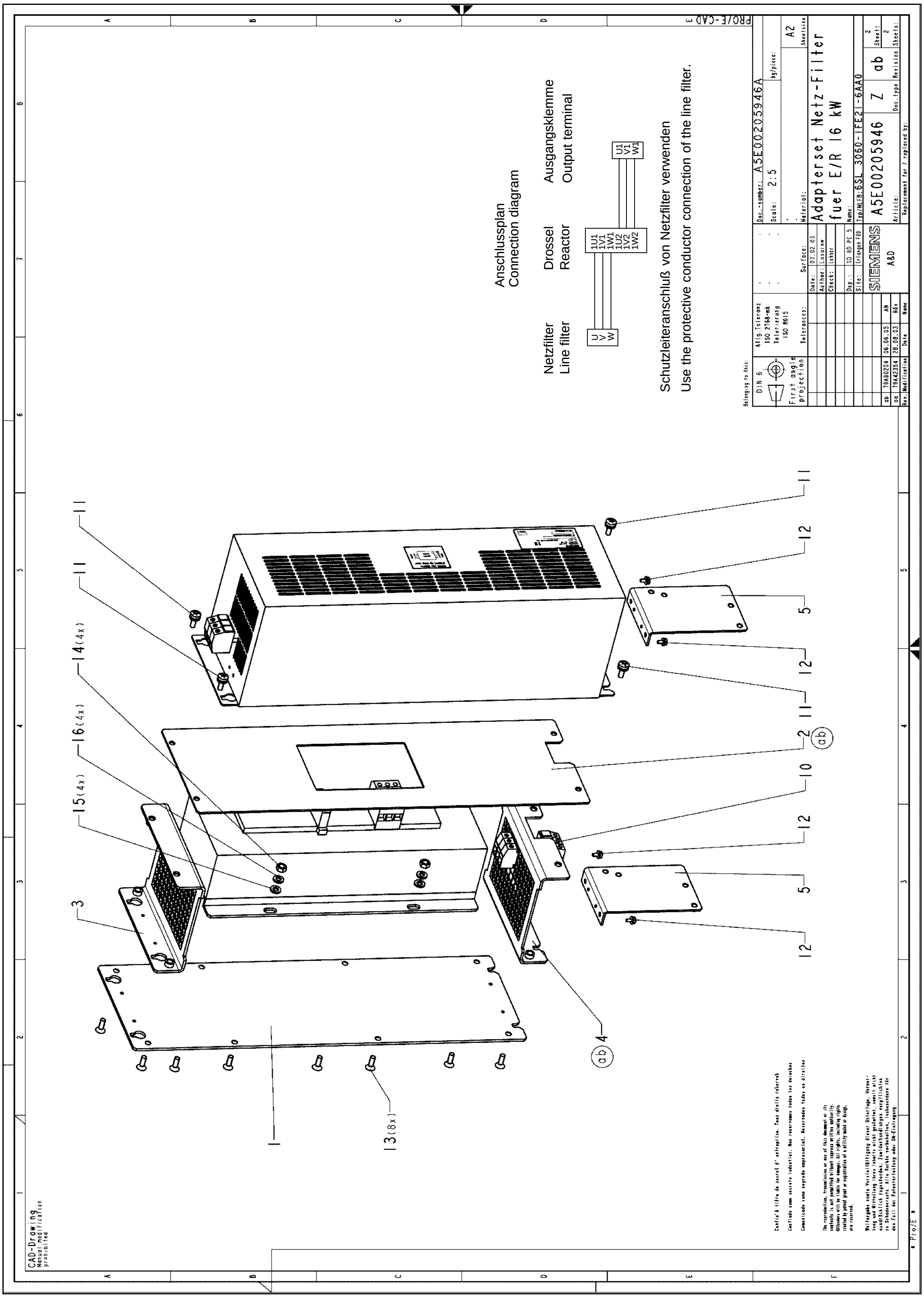


Fig. 11-17 Adapter set, line filter for I/R module 16 kW, 6SL3060–1FE21–6AAx; mounting

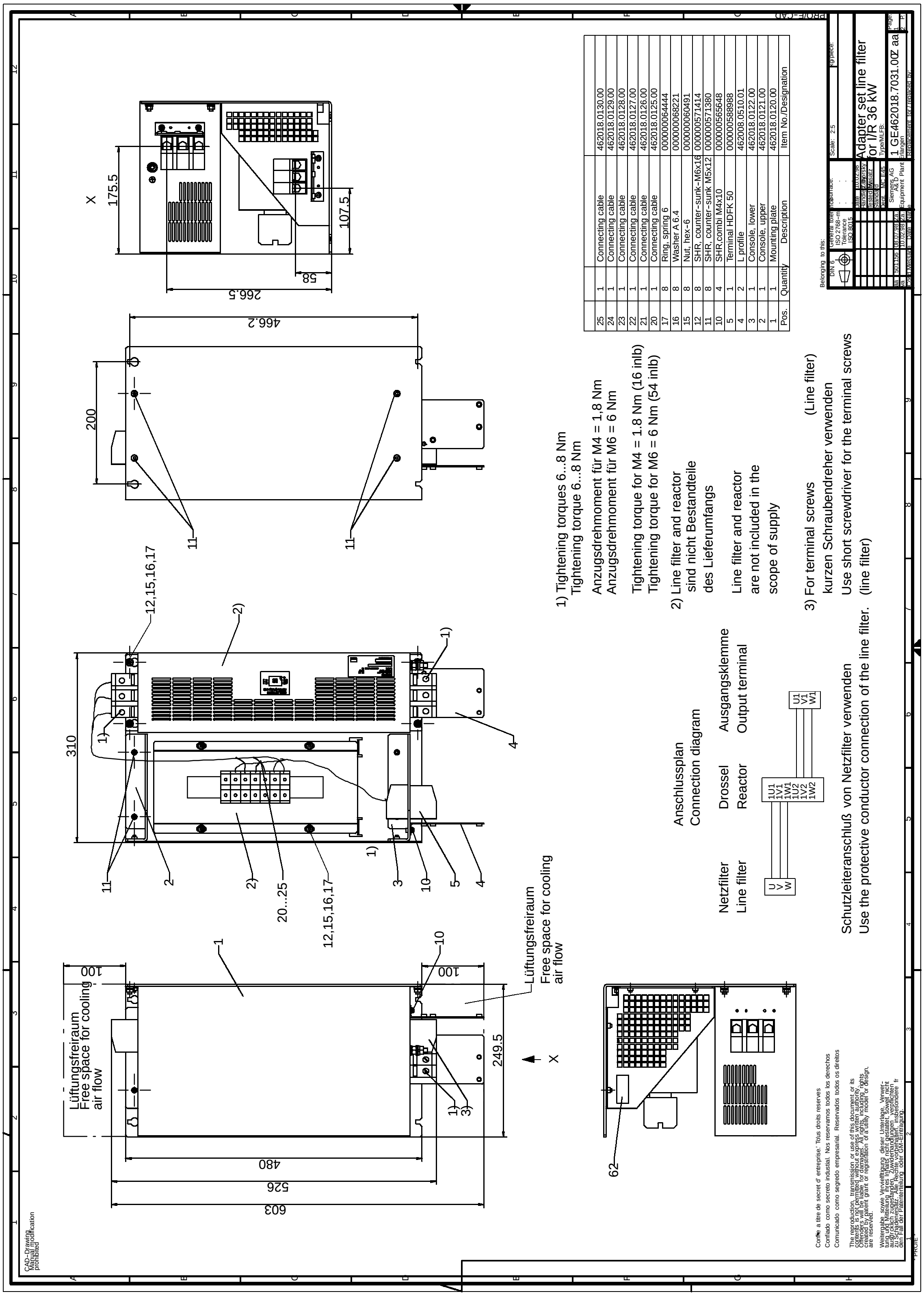


Fig. 11-18 Adapter set, line filter for I/R module 36 kW, 6SN1162–0GA00–0CAx; dimension drawing

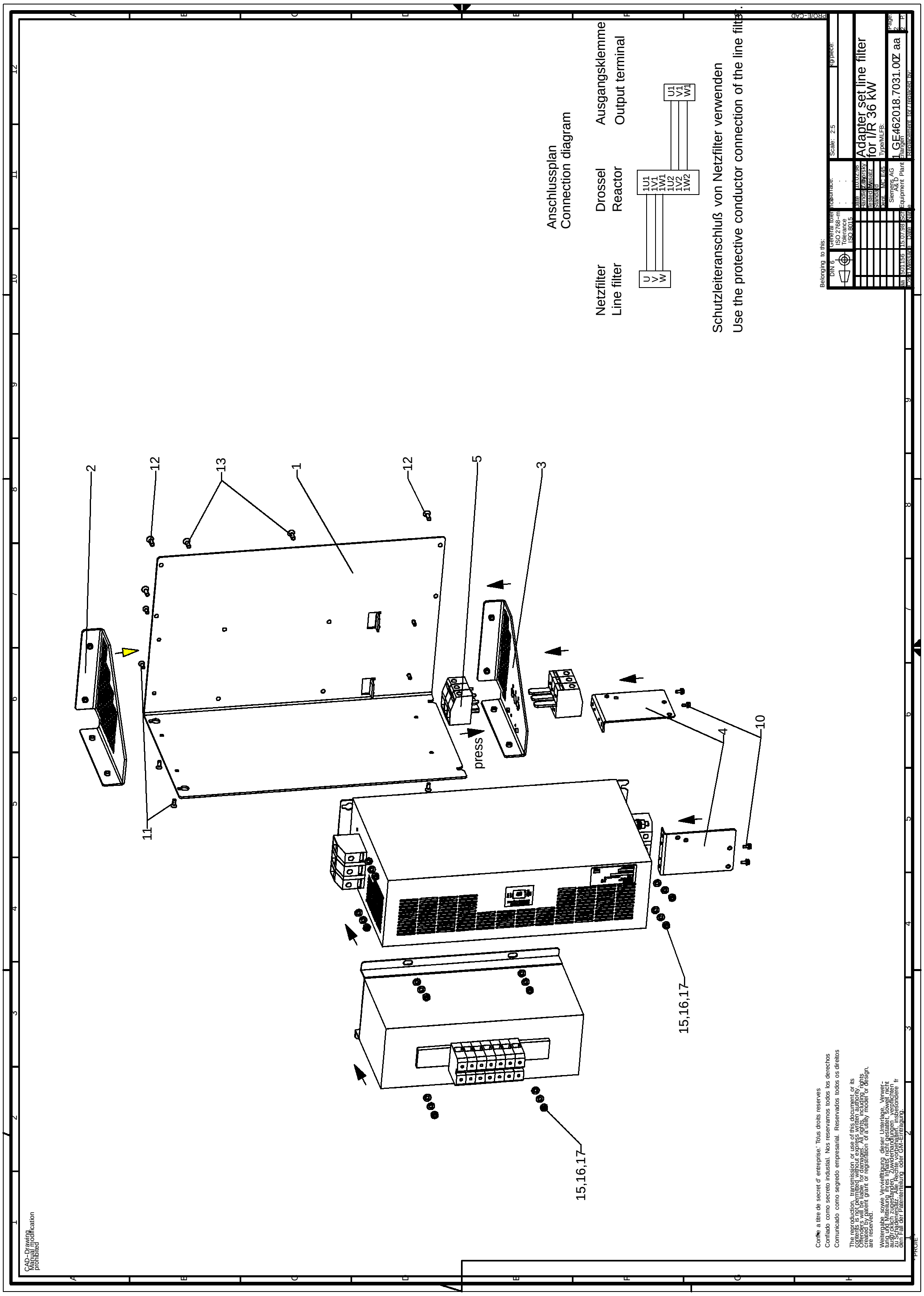


Fig. 11-19 Adapter set, line filter for I/R module 36 kW, 6SN1162–0GA00–0CAx; mounting

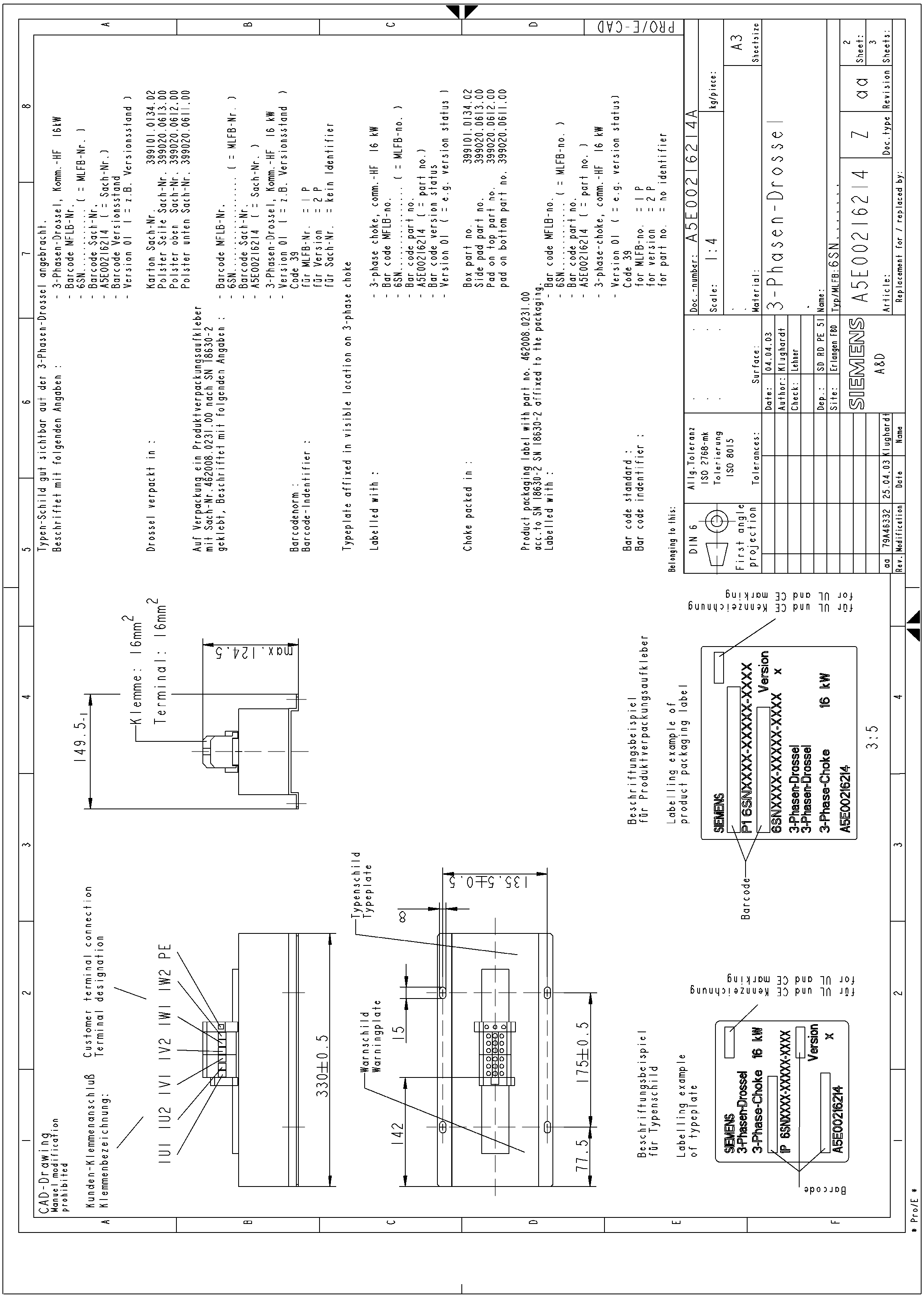


Fig. 11-20 3–phase HF reactor 16 kW, 6SN1111–0AA00–0BAx

11

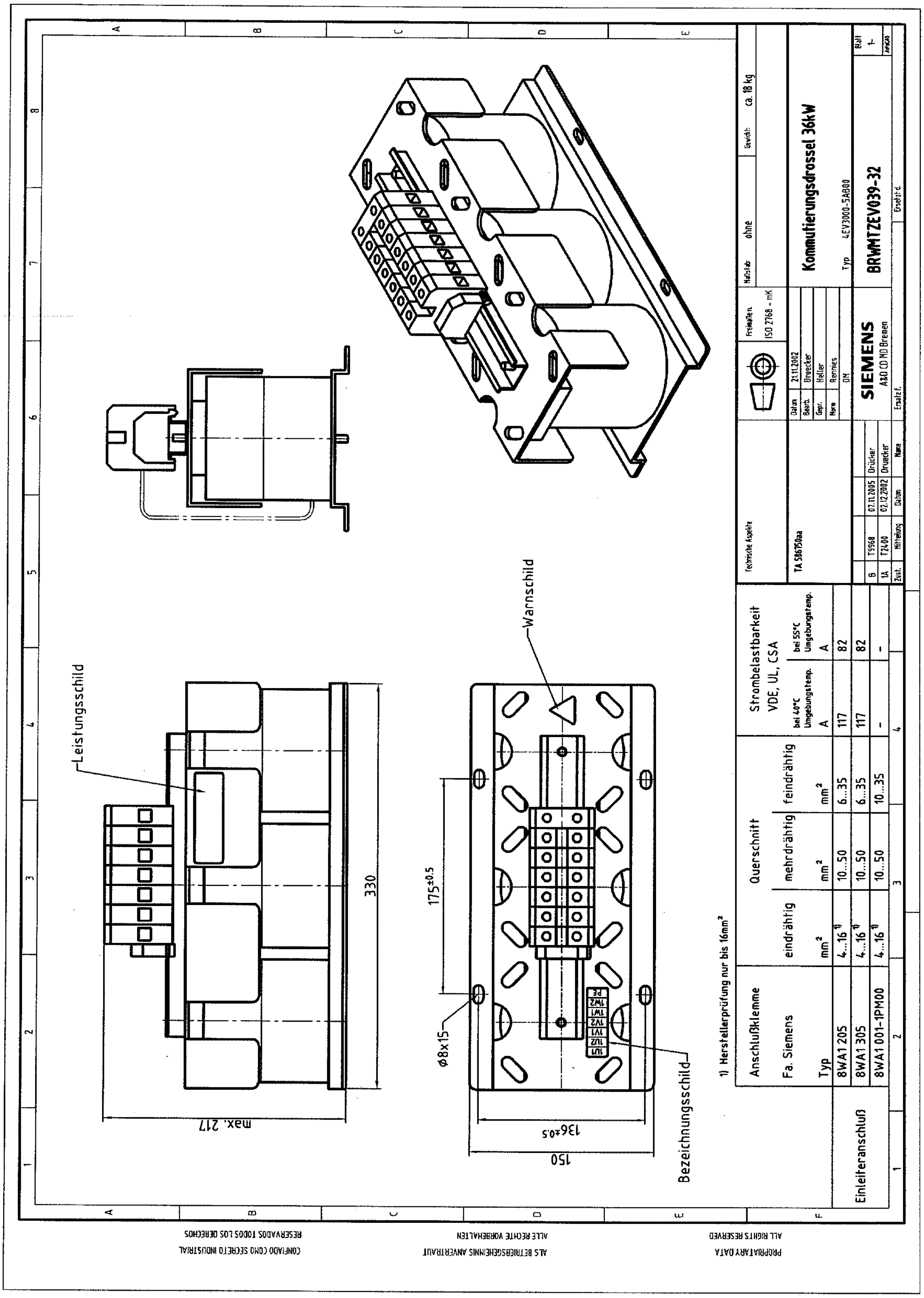


Fig. 11-21 3-phase HF reactor 36 kW, 6SN1111-0AA00-0CAx

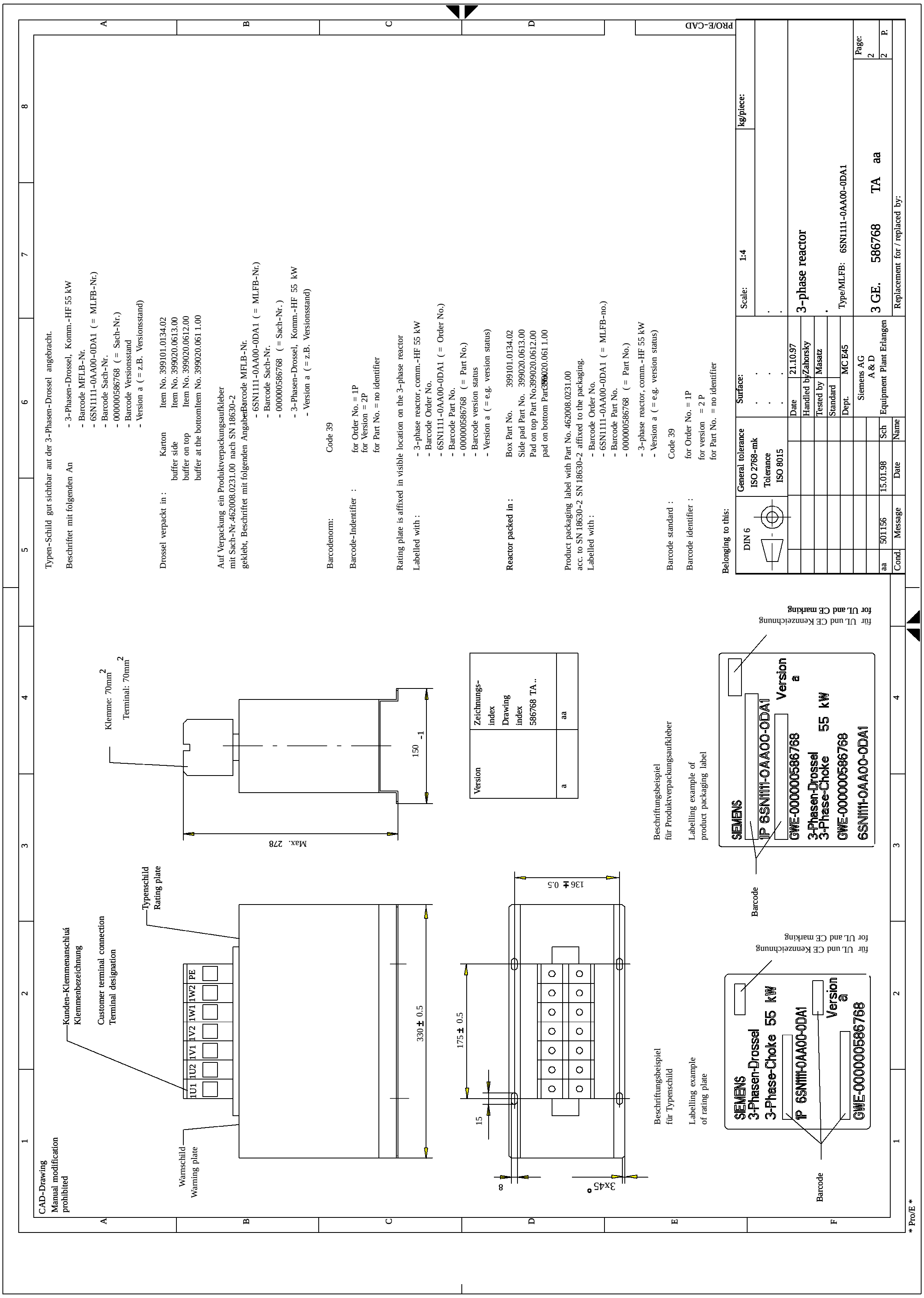


Fig. 11-22 3-phase HF reactor 55 kW, 6SN1111-0AA00-0DAx

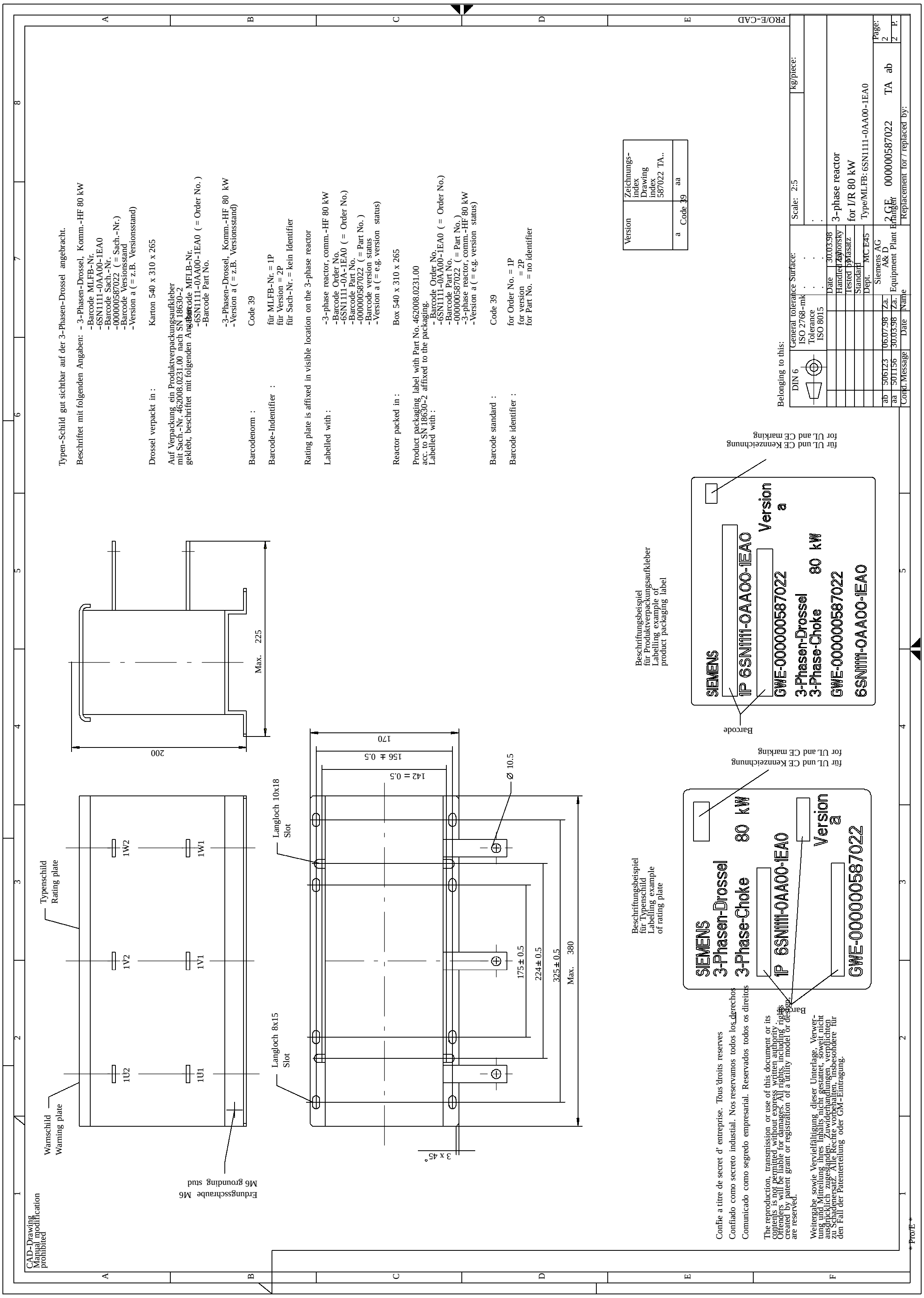


Fig. 11-23 3–phase HF reactor 80 kW, 6SN1111–0AA00–1EAx

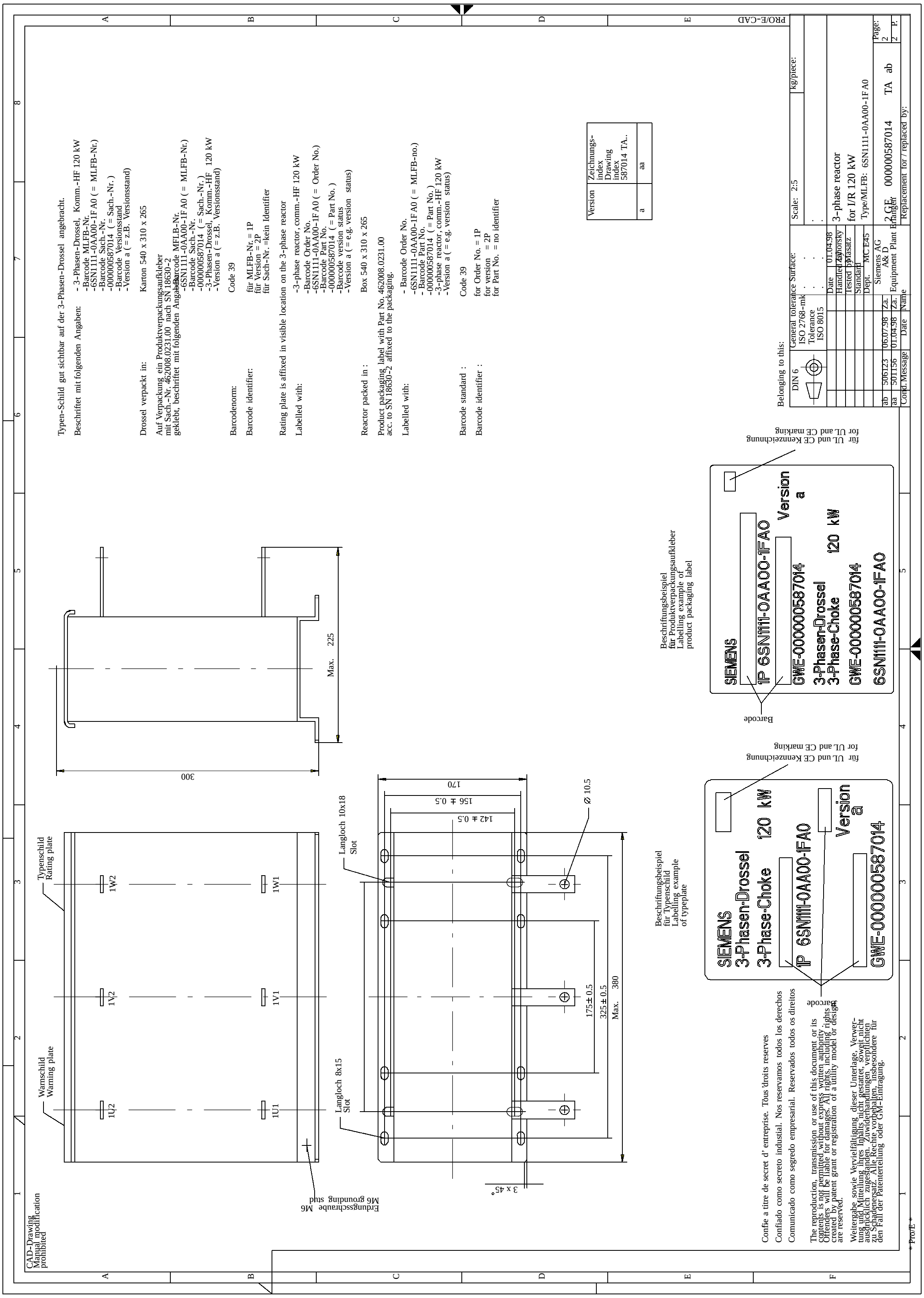


Fig. 11-24 3–phase HF reactor 120 kW, 6SN1111–0AA00–1FAx

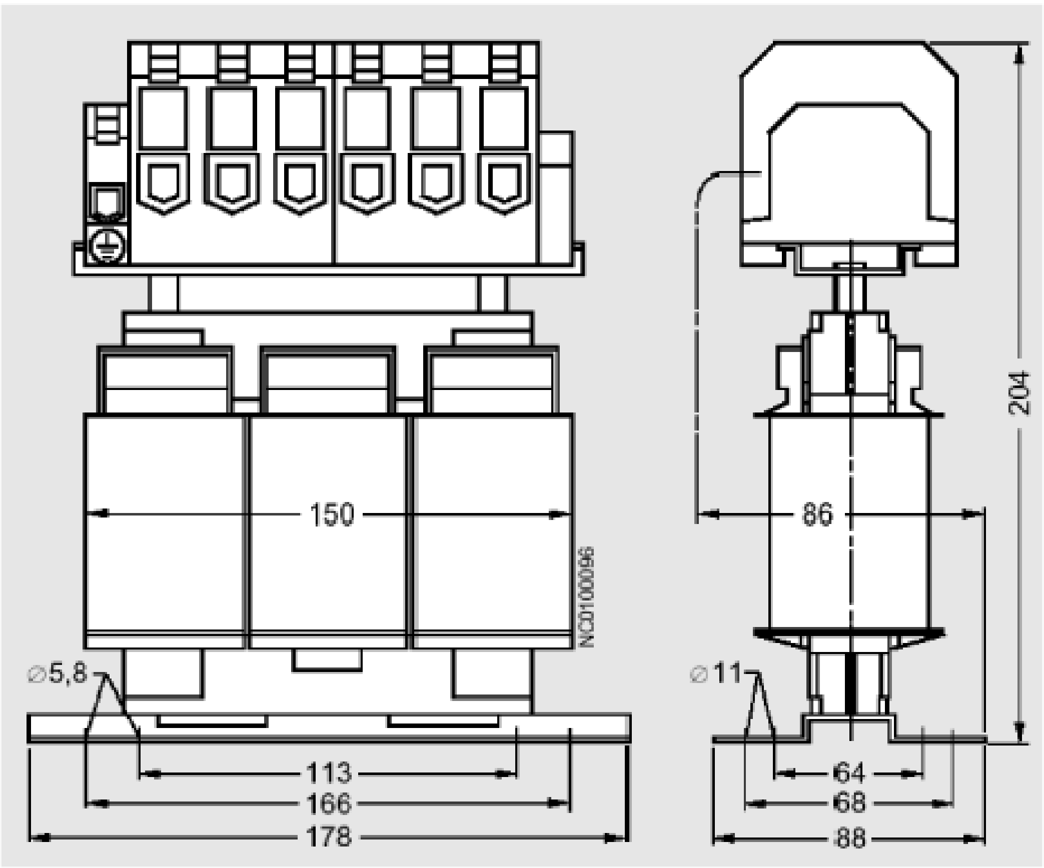


Fig. 11-25 3-phase HF reactor 28 kW, 6SN1111-1AA00-0CAx

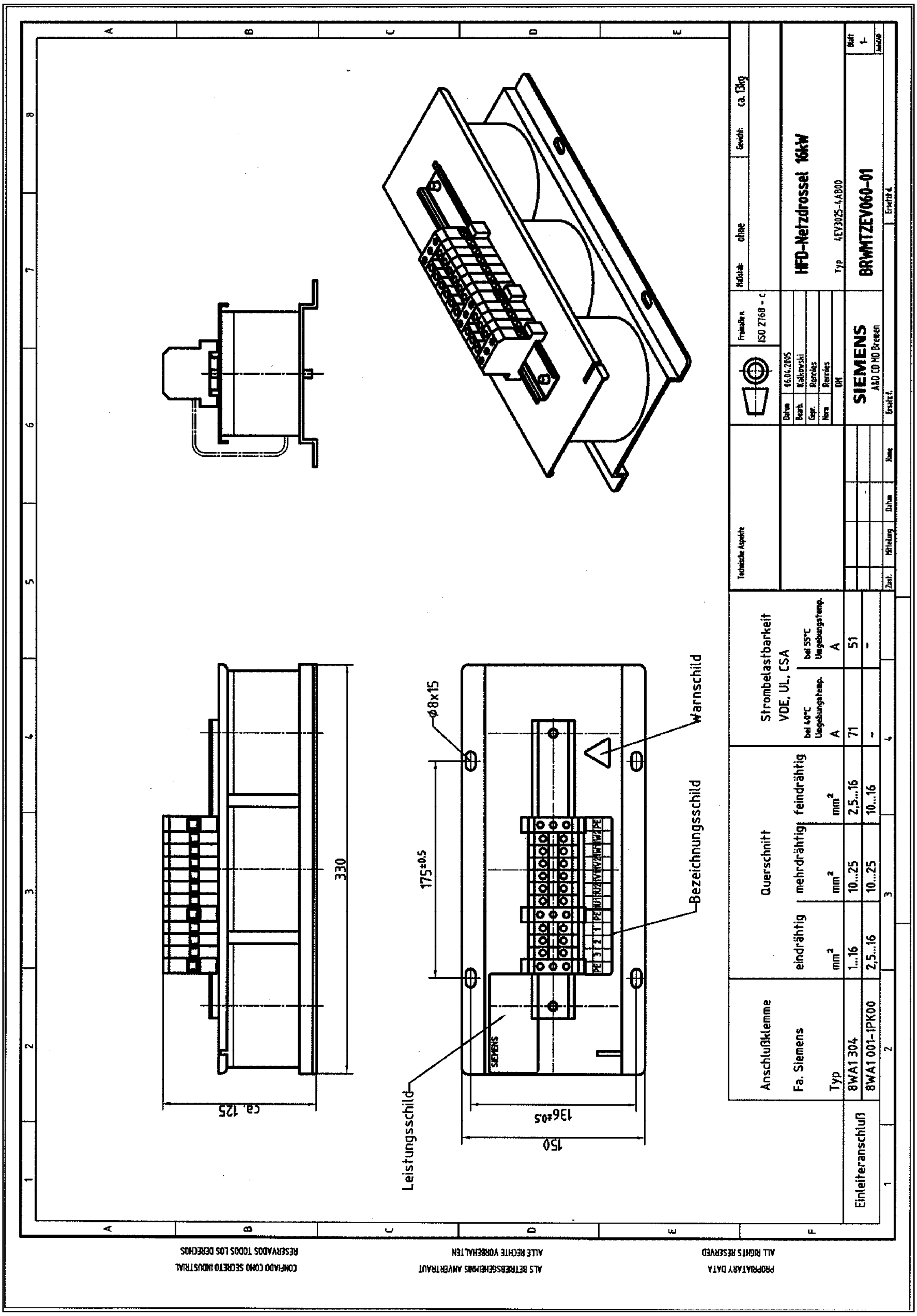


Fig. 11-26 3-phase HFD line/commutating reactor 16 kW, 6SL3000-0DE21-6AAx

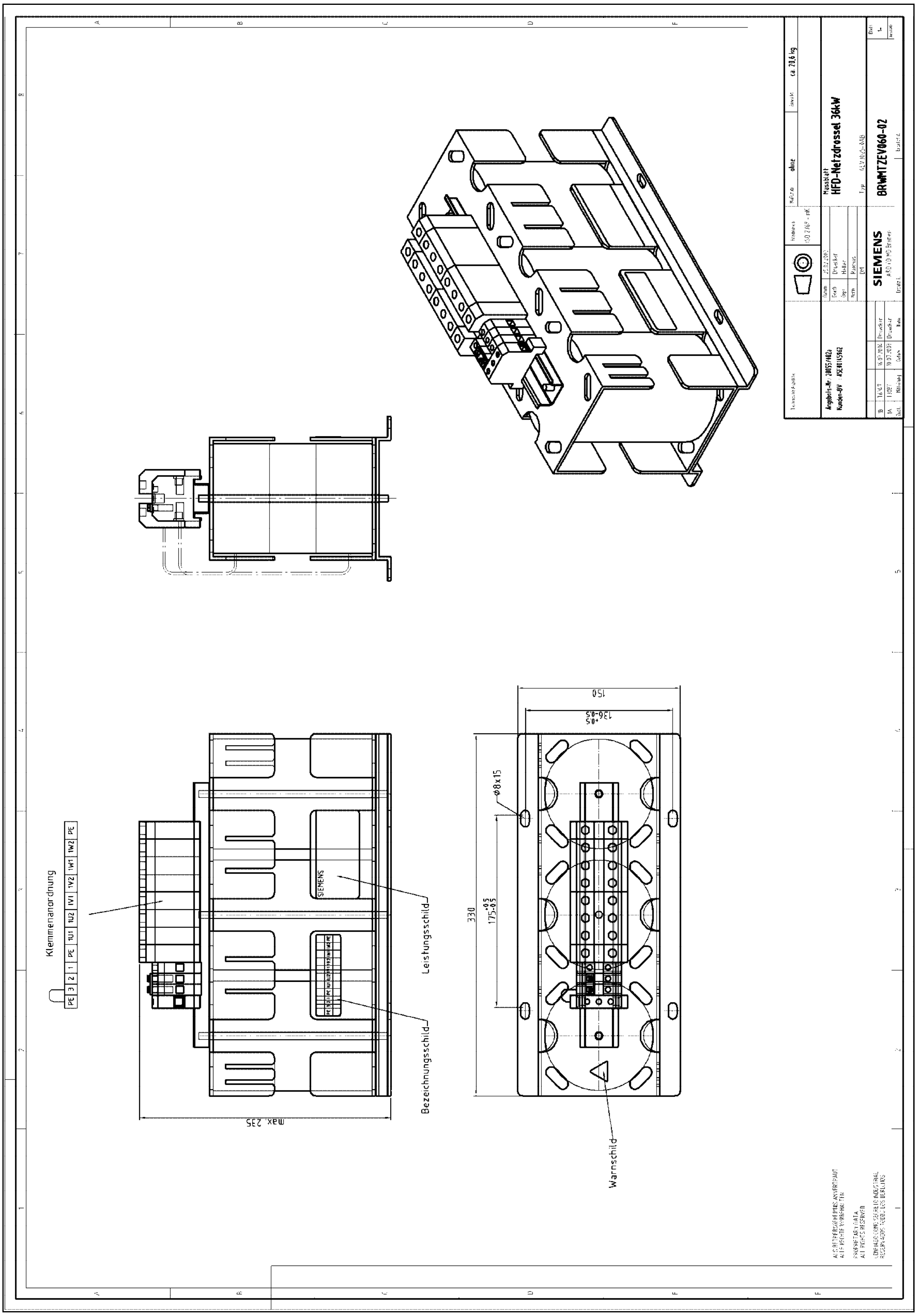


Fig. 11-27 3-phase HFD line/commutating reactor 36 kW, 6SL3000-0DE23-6AAx

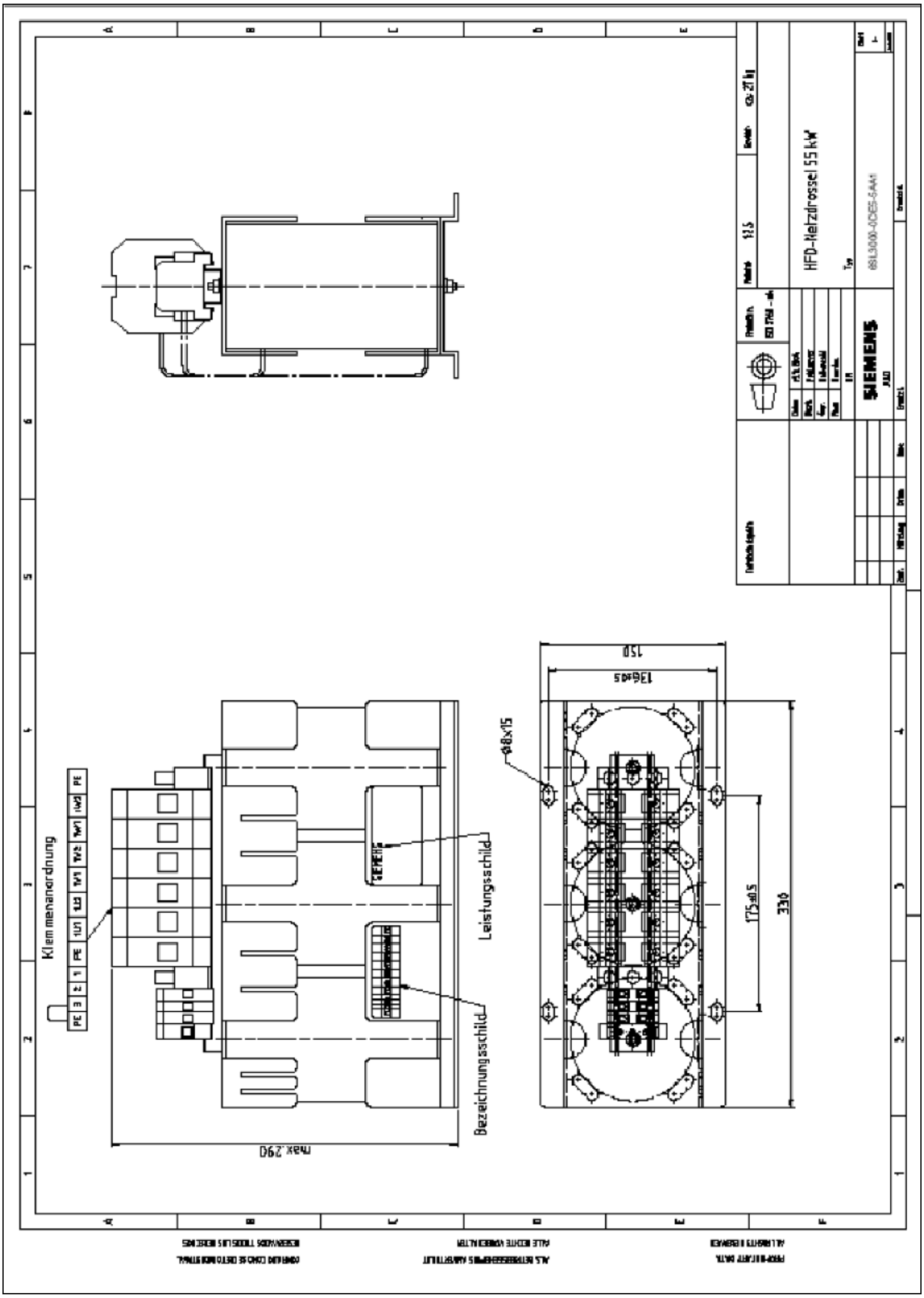


Fig. 11-28 3–phase HFD line/commutating reactor 55 kW, 6SL3000–0DE25–5AAx

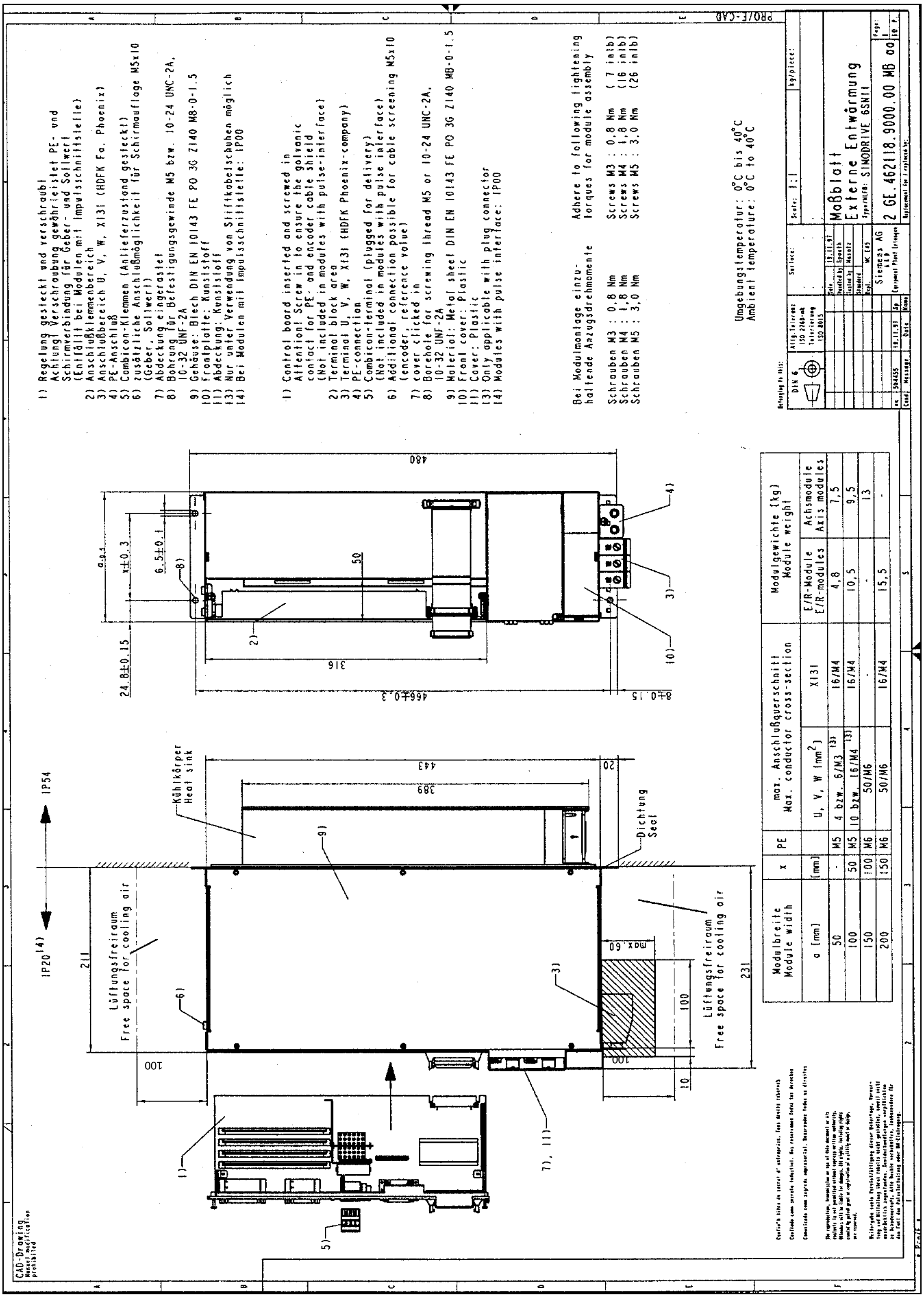


Fig. 11-29 External cooling, module width 50...200 mm

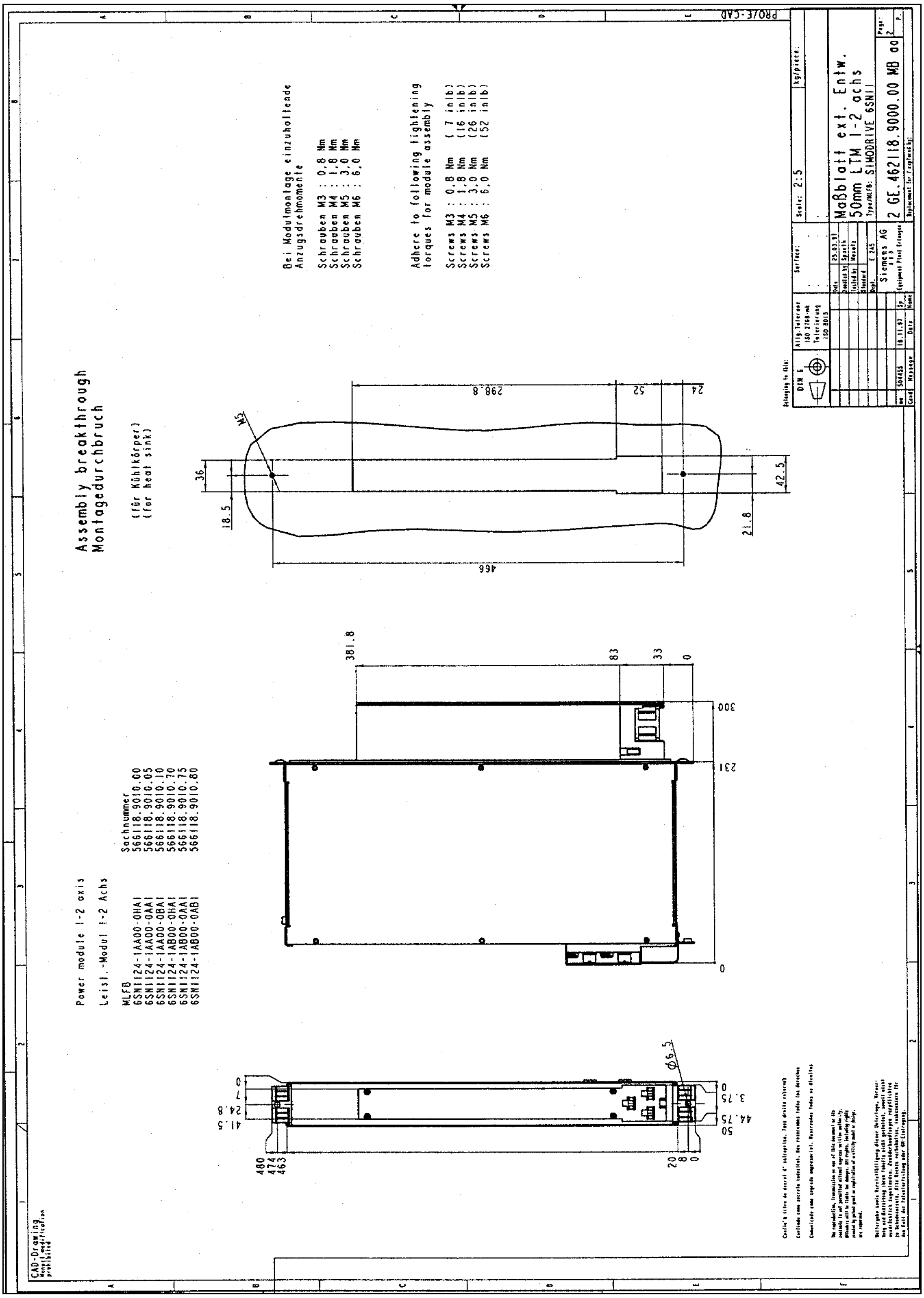


Fig. 11-30 External cooling, power module 50 mm 1–2 axes

11

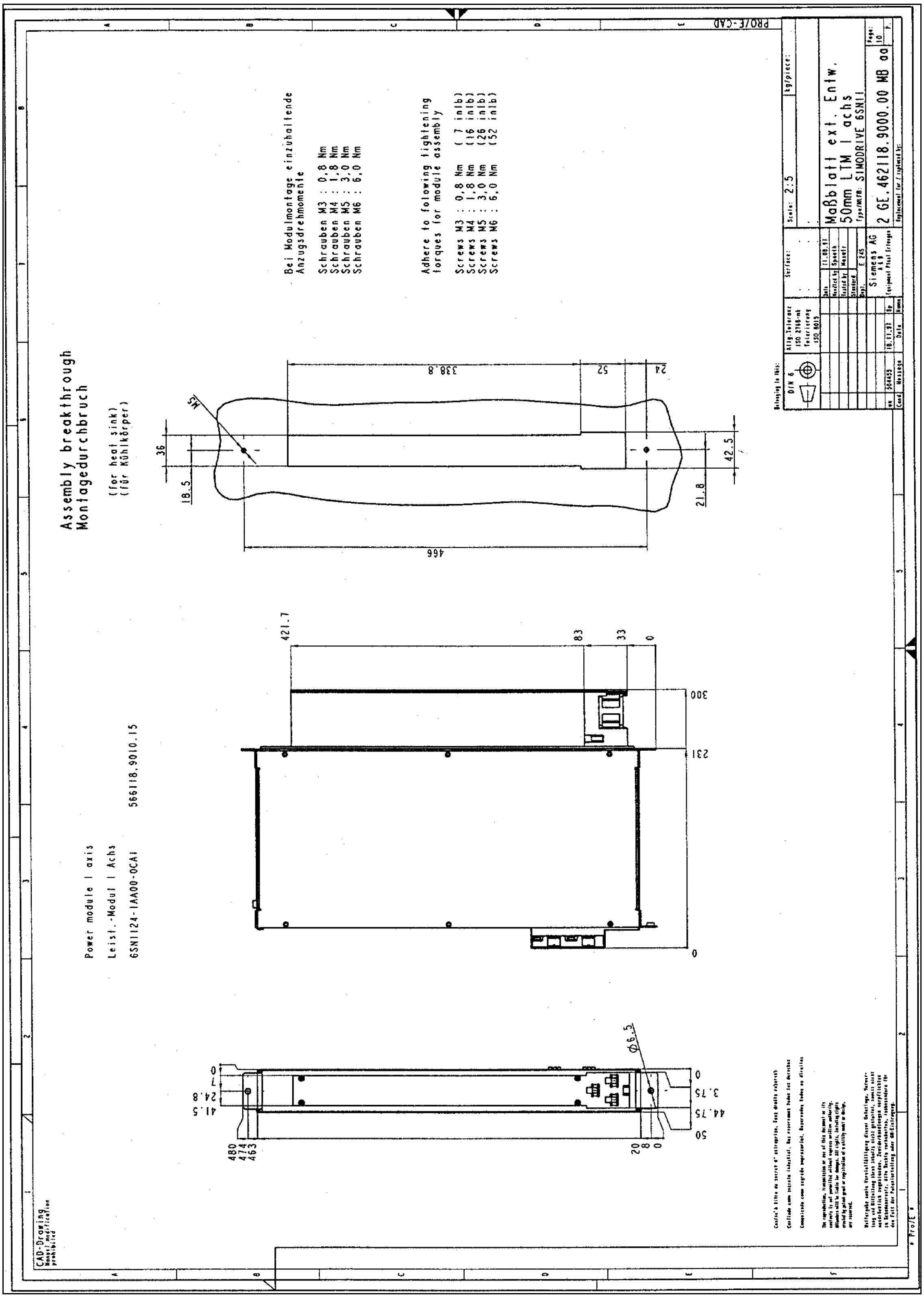


Fig. 11-31 External cooling, power module 50 mm 1 axis

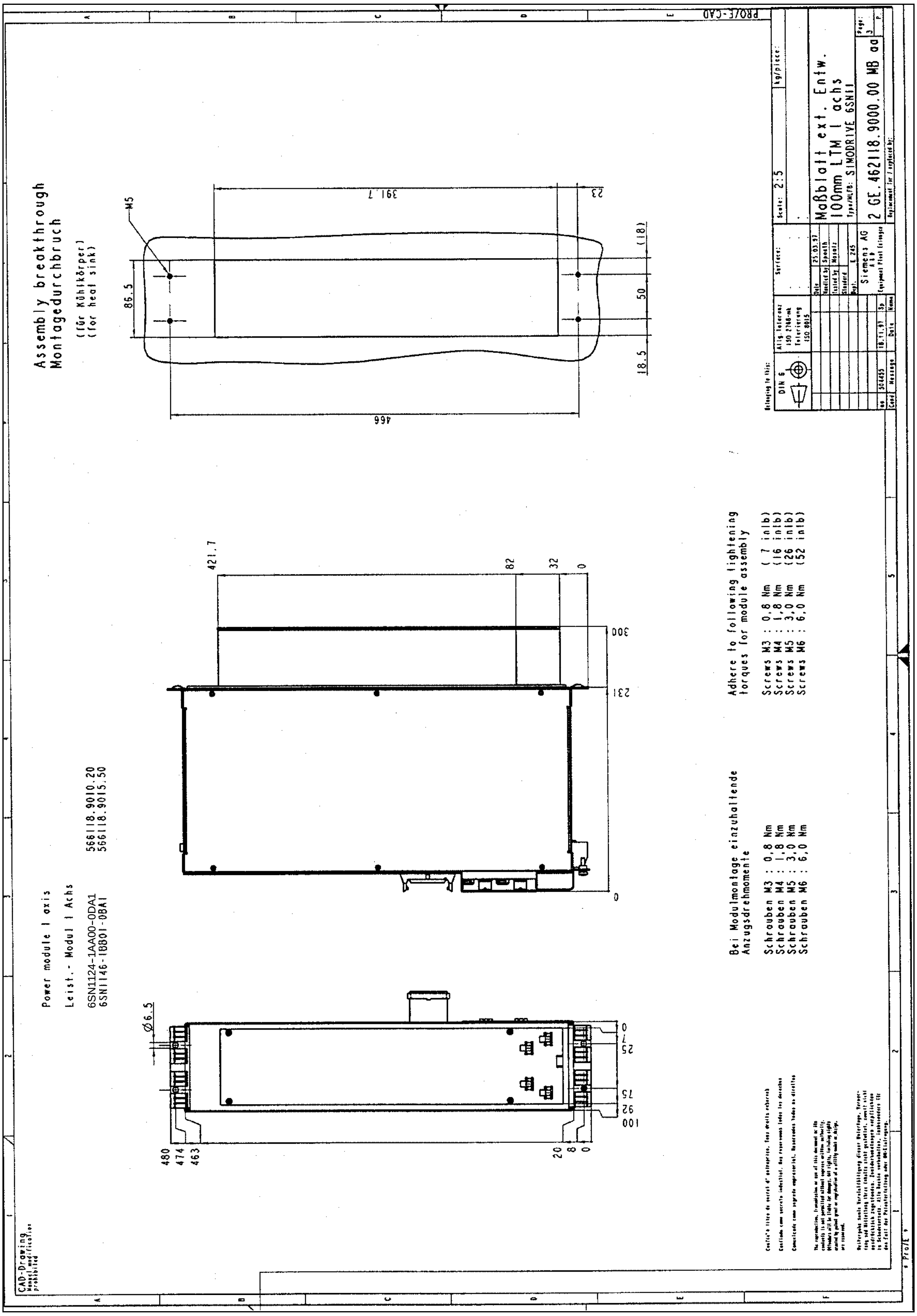


Fig. 11-32 External cooling, power module 100 mm 1 axis and I/R module

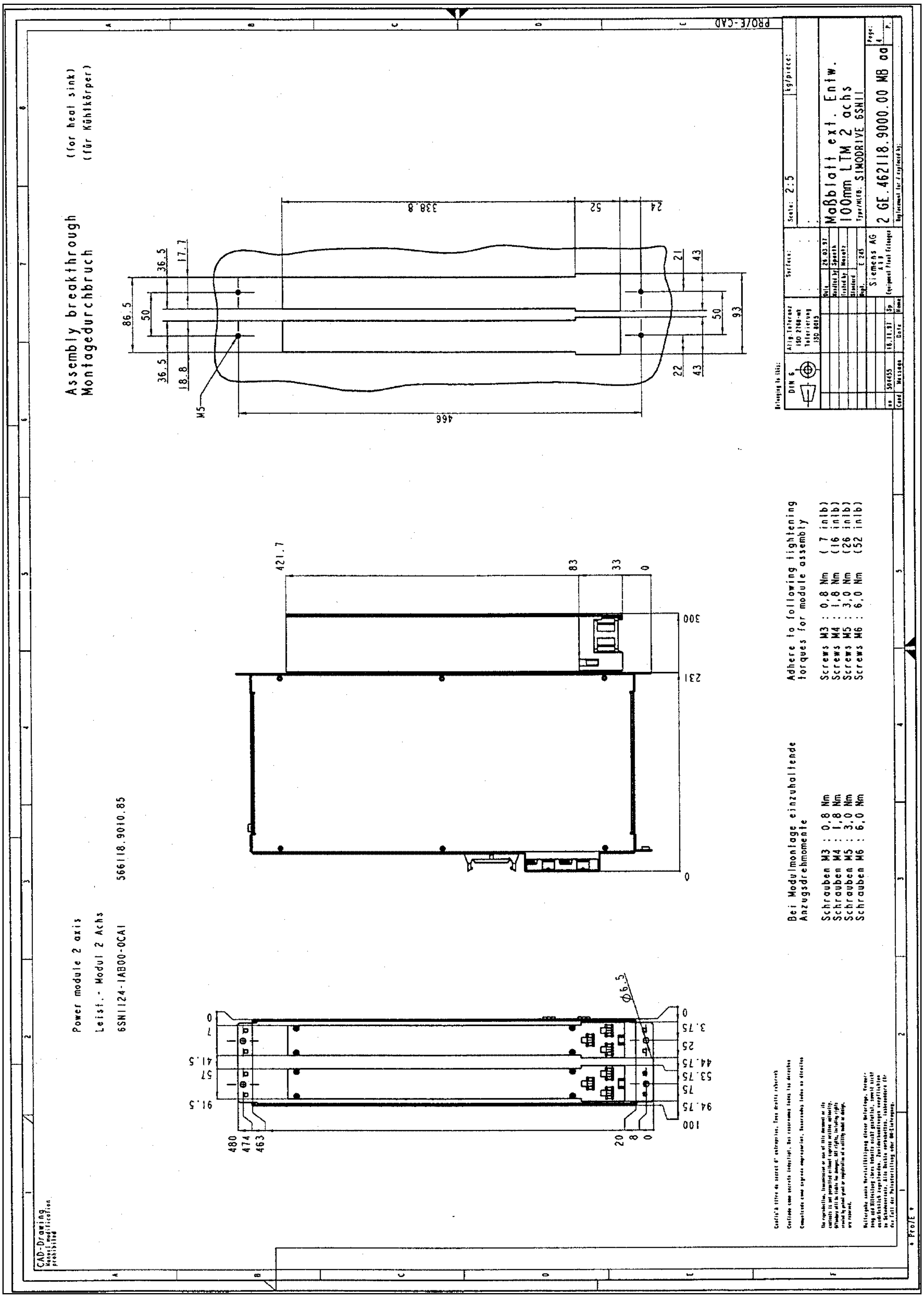


Fig. 11-33 External cooling, power module 100 mm 2 axes

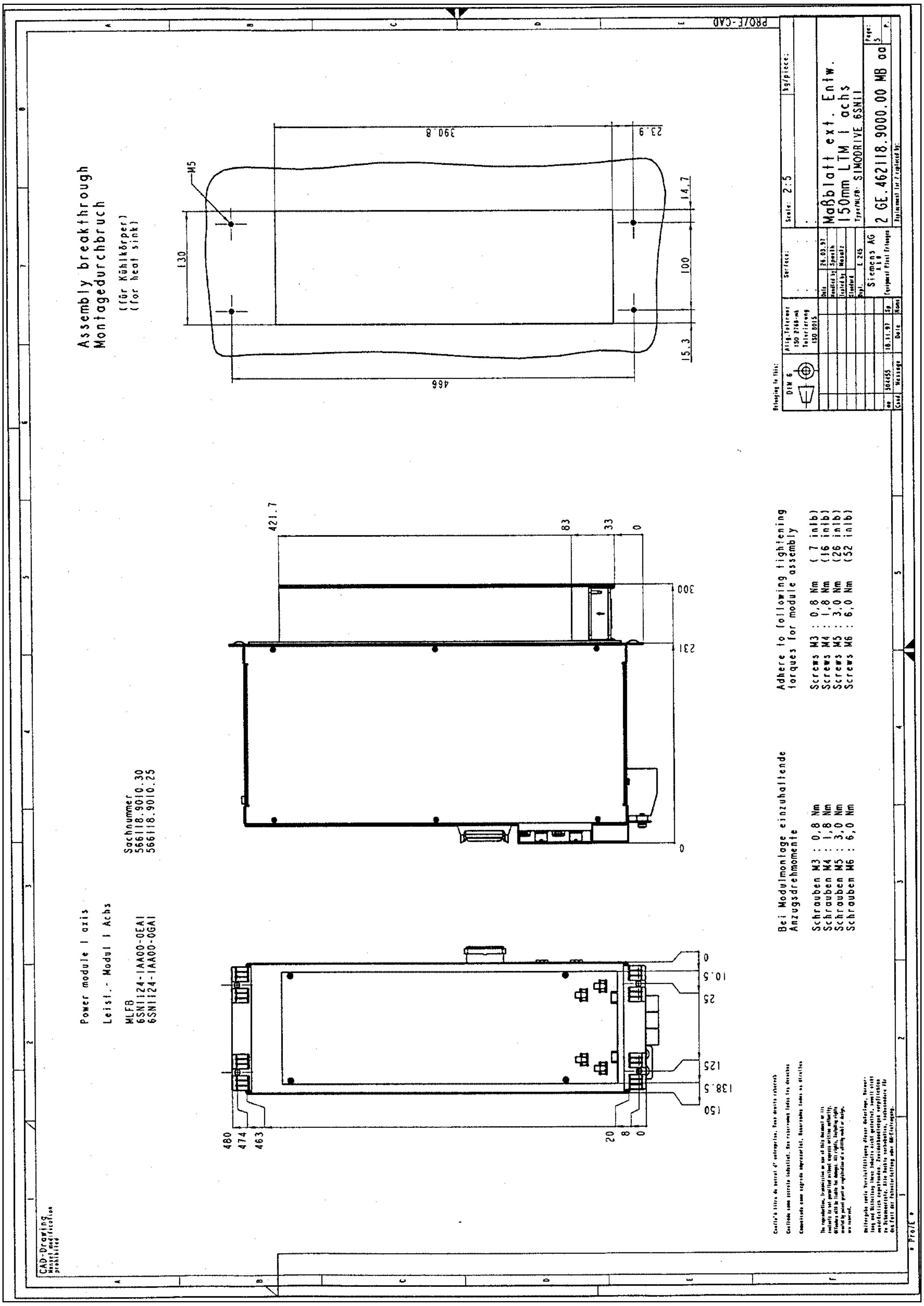


Fig. 11-34 External cooling, power module 150 mm 1 axis

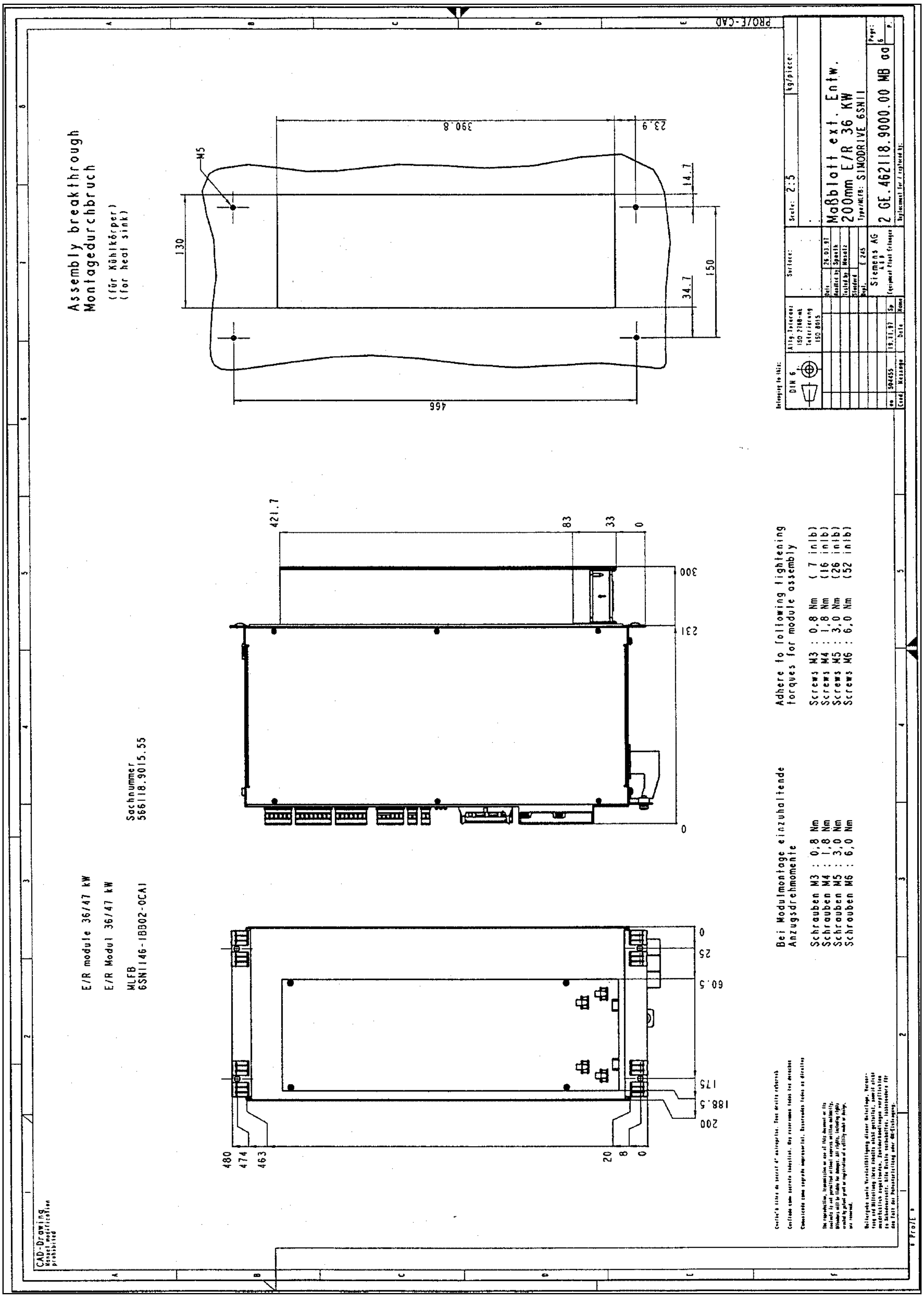


Fig. 11-35 External cooling, I/R module 200 mm

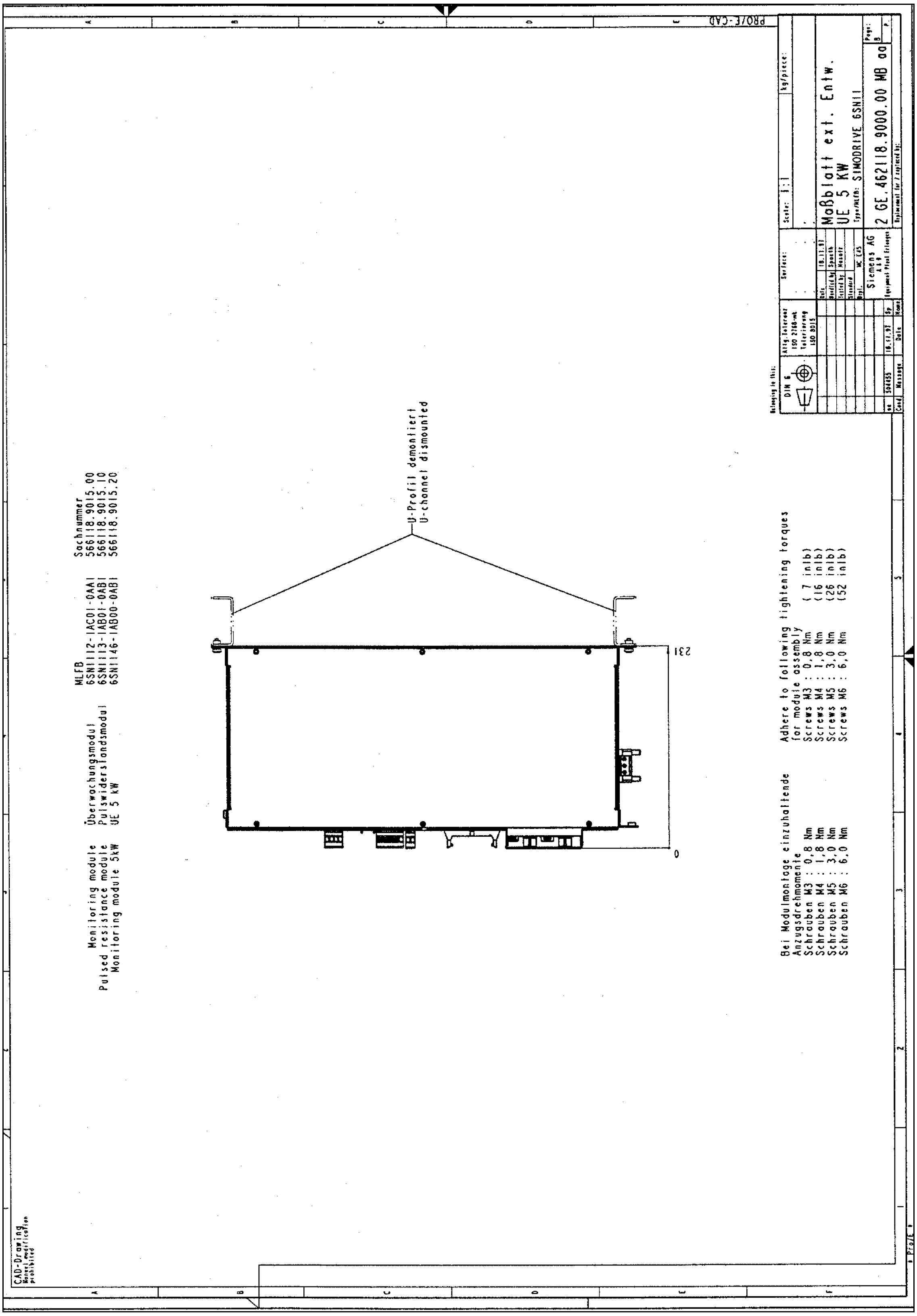


Fig. 11-36 External cooling, UI module 5 kW

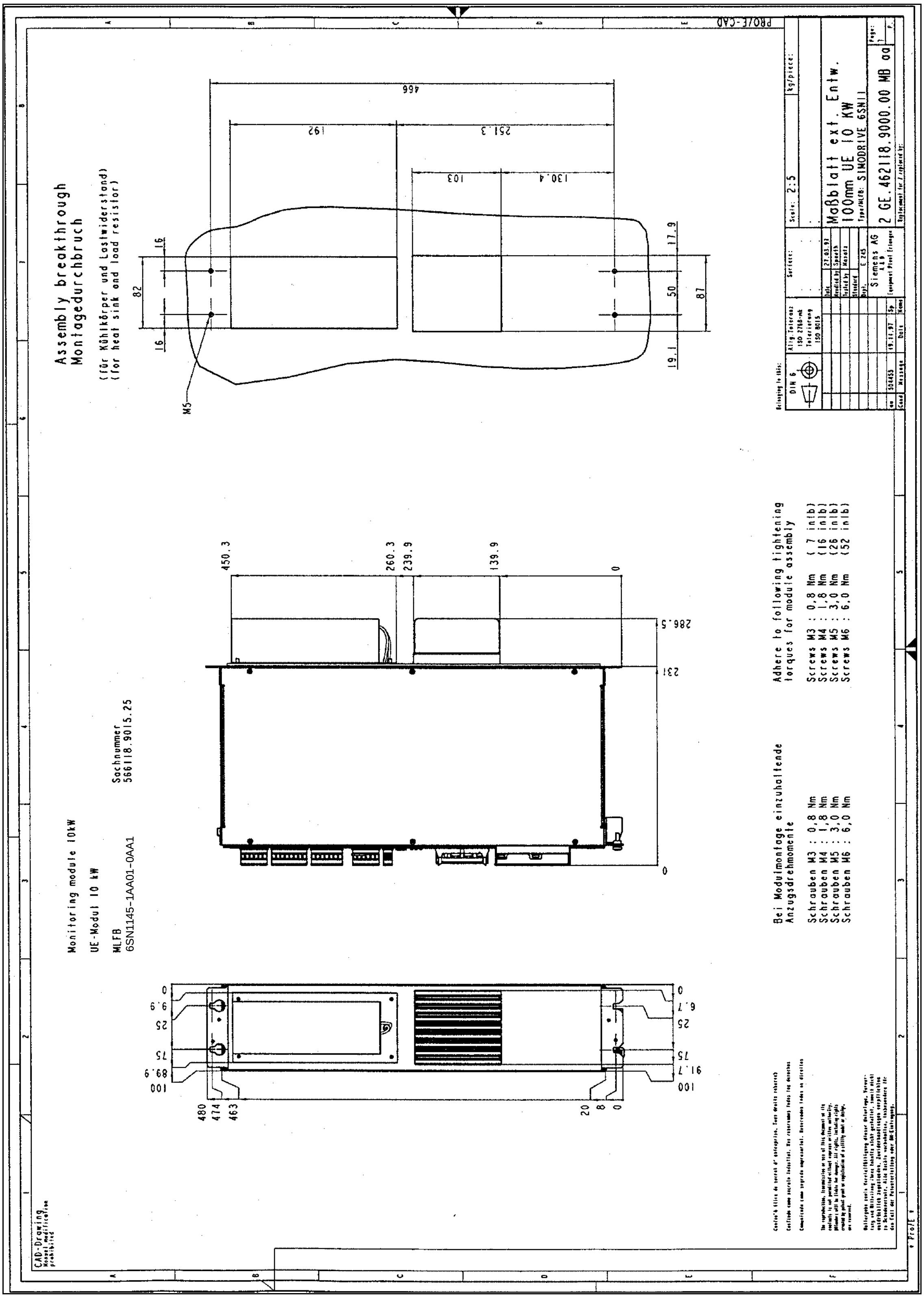


Fig. 11-37 External cooling, UI module 10 kW

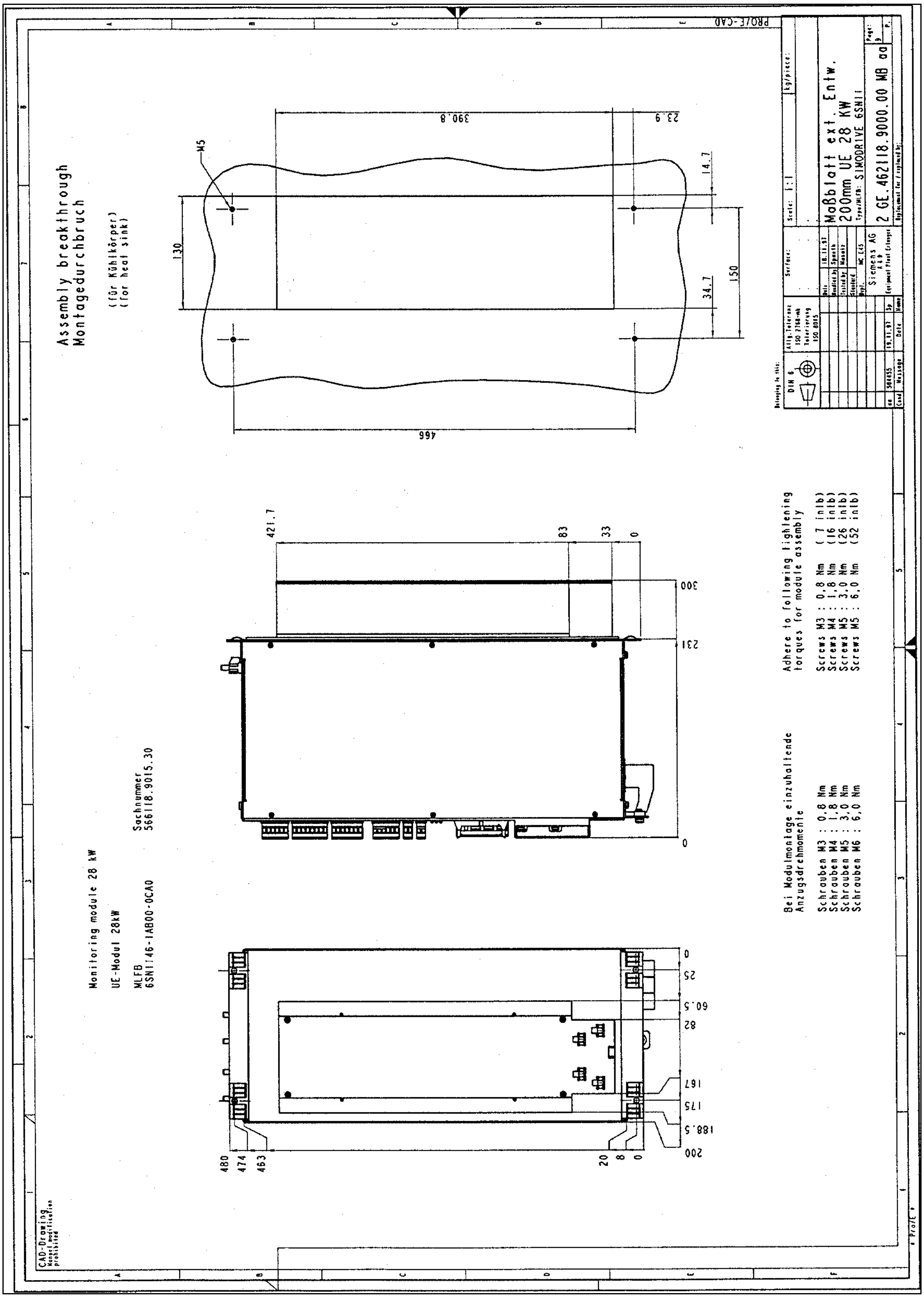


Fig. 11-38 External cooling, UI module 28 kW

11

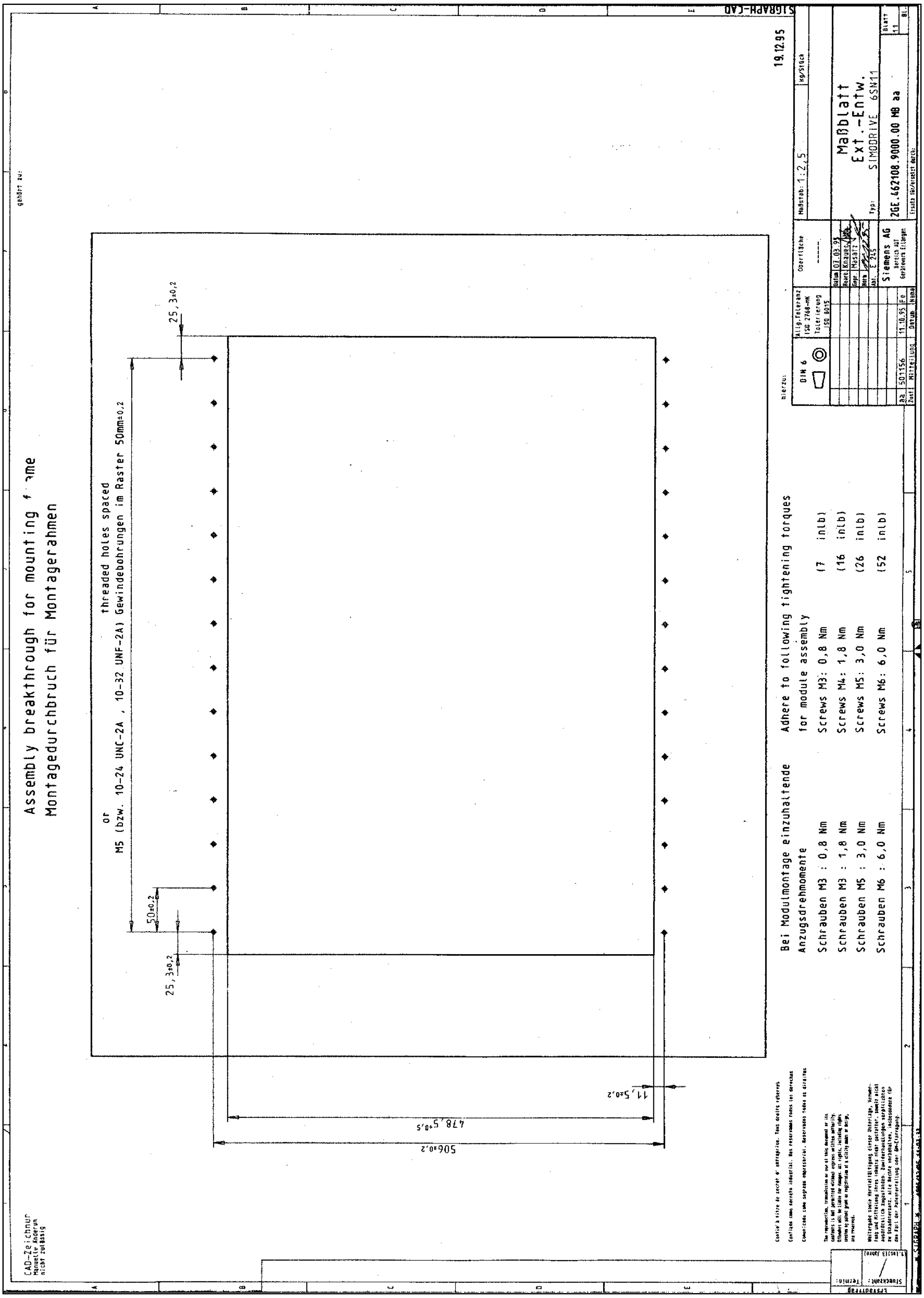


Fig. 11-39 External cooling, mounting break-through for the mounting frame

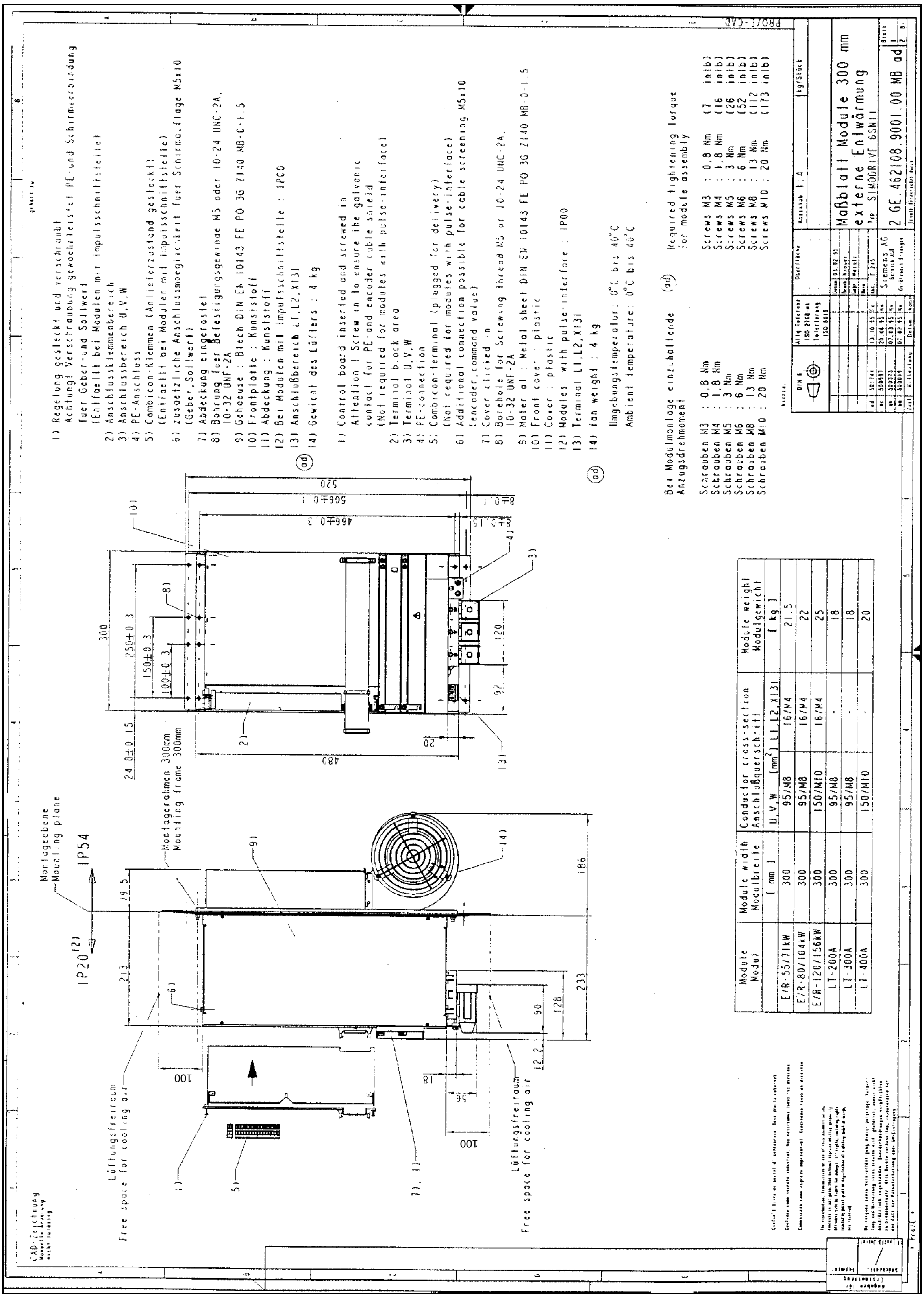


Fig. 11-40 External cooling, module 300 mm

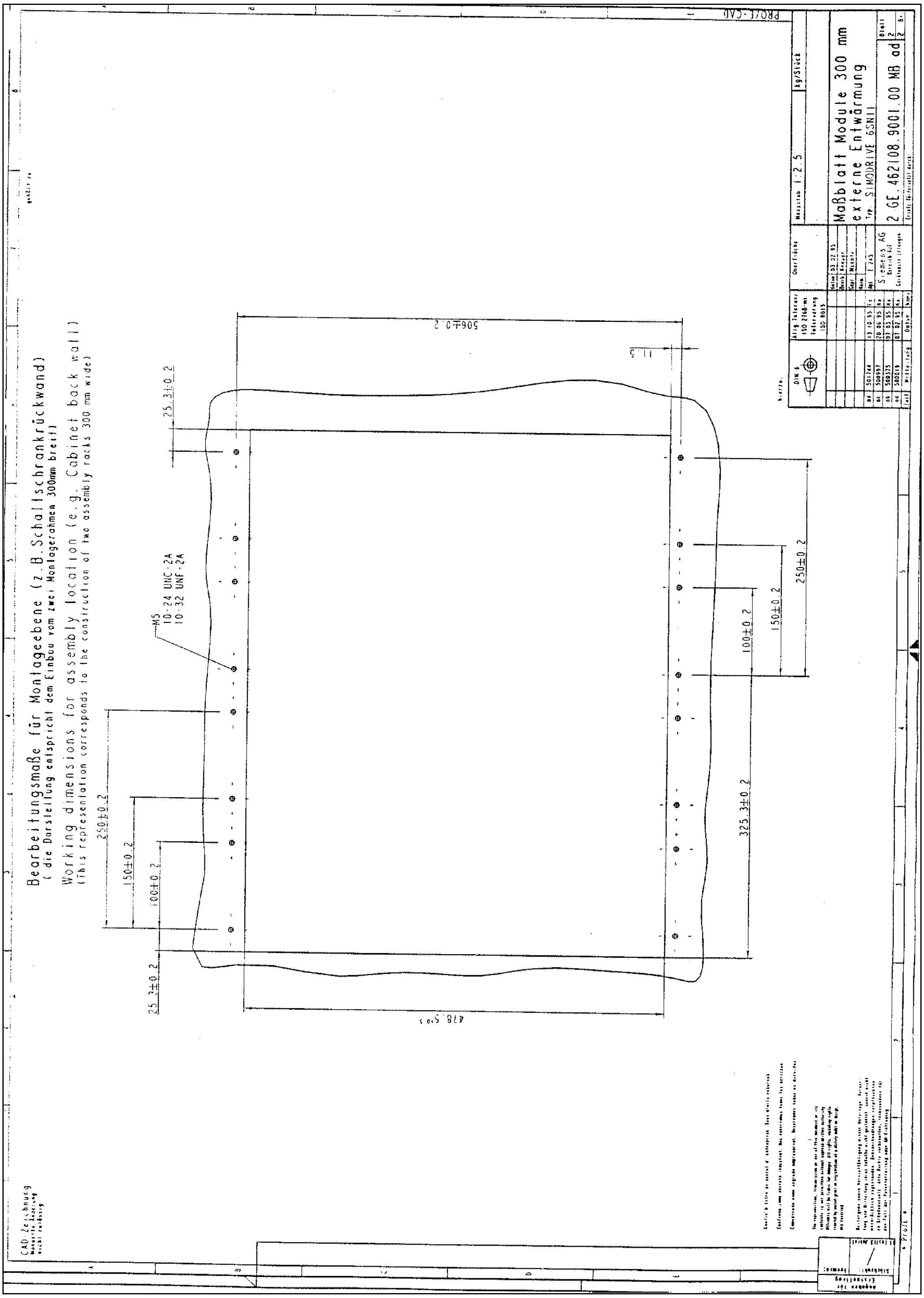


Fig. 11-41 External cooling, module 300 mm mounting plane

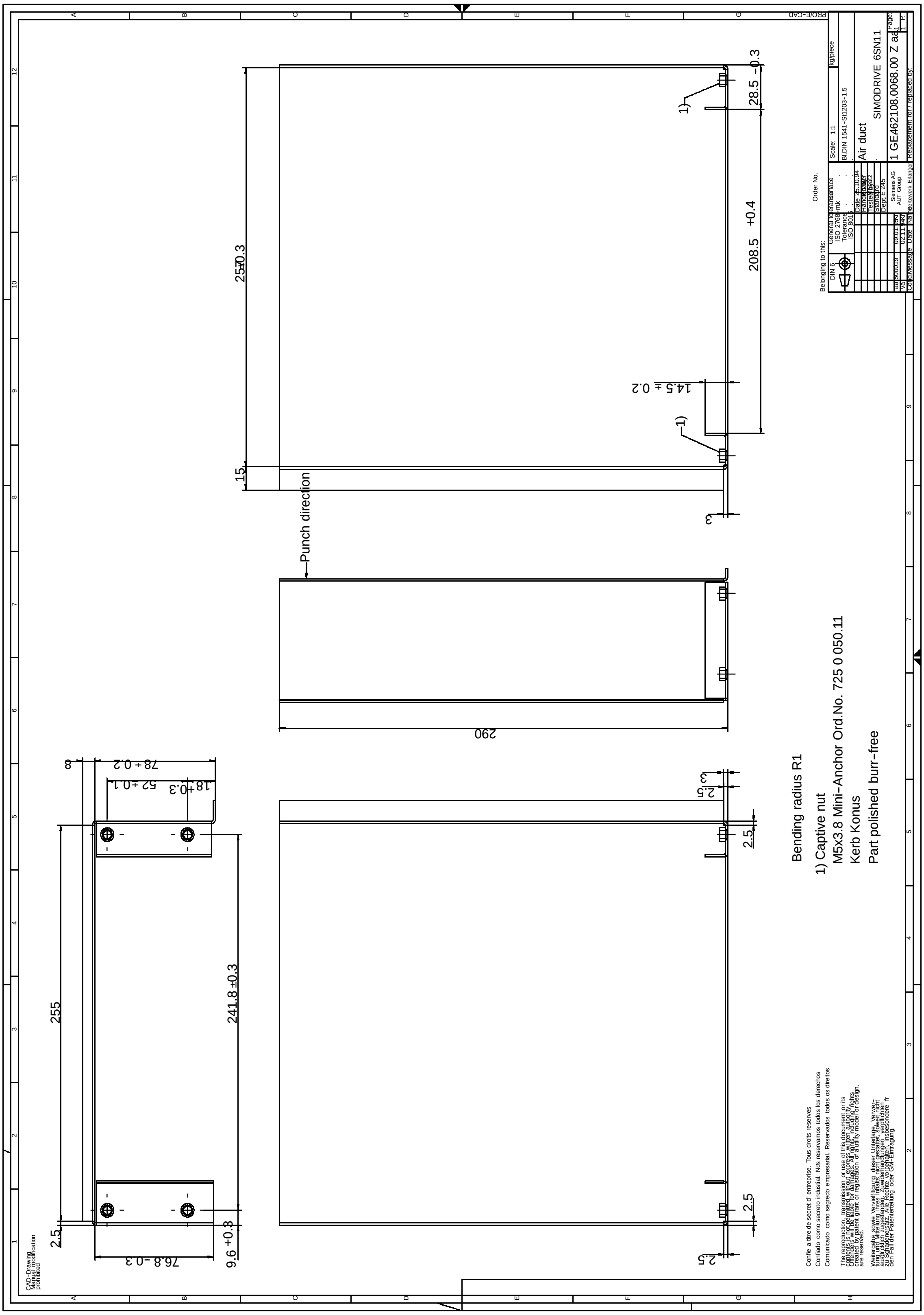


Fig. 11-42 External cooling, air duct

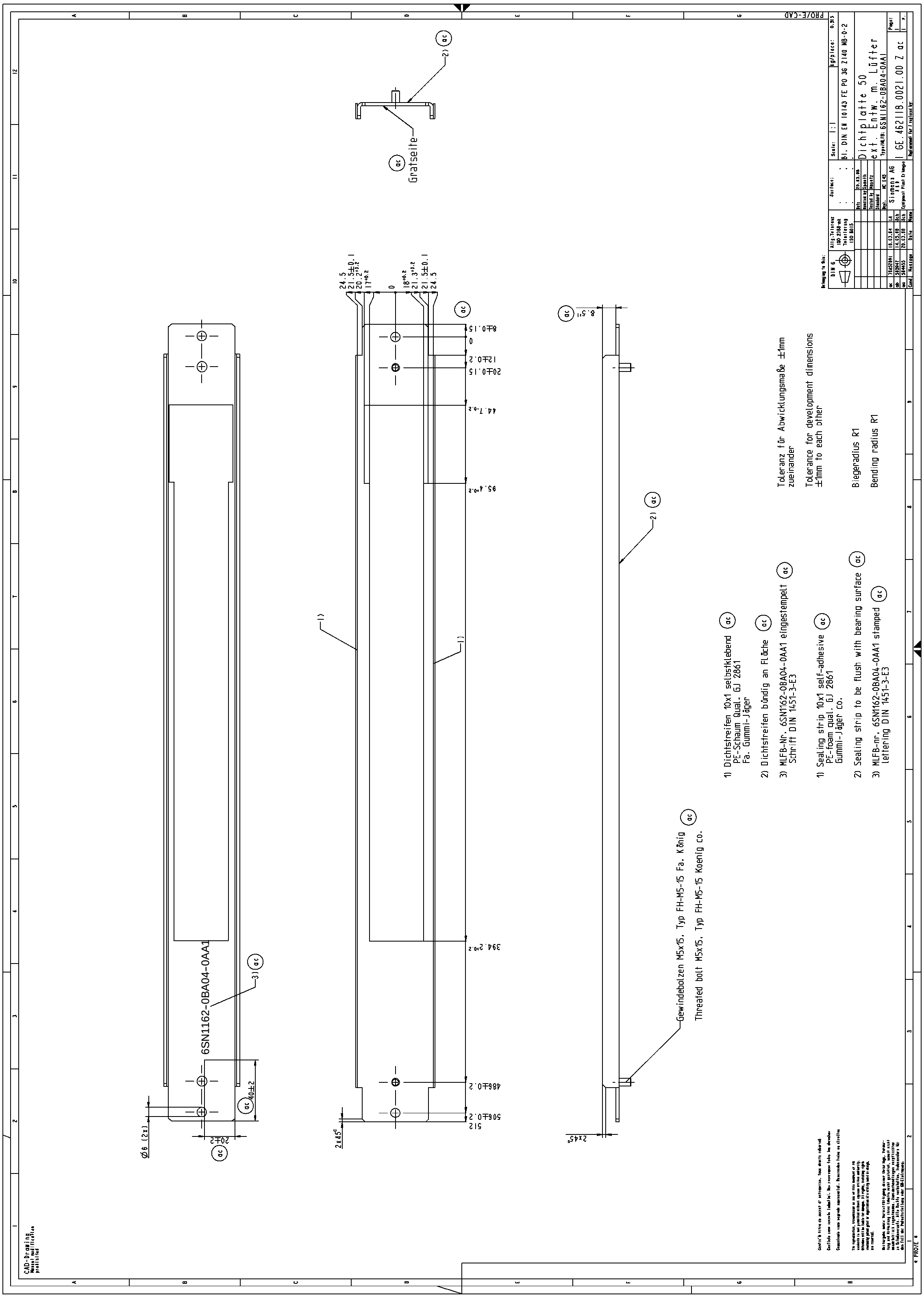


Fig. 11-43 External cooling, mounting frame for cabinet installation module width 50 mm, 6SN1162–0BA04–0AA1

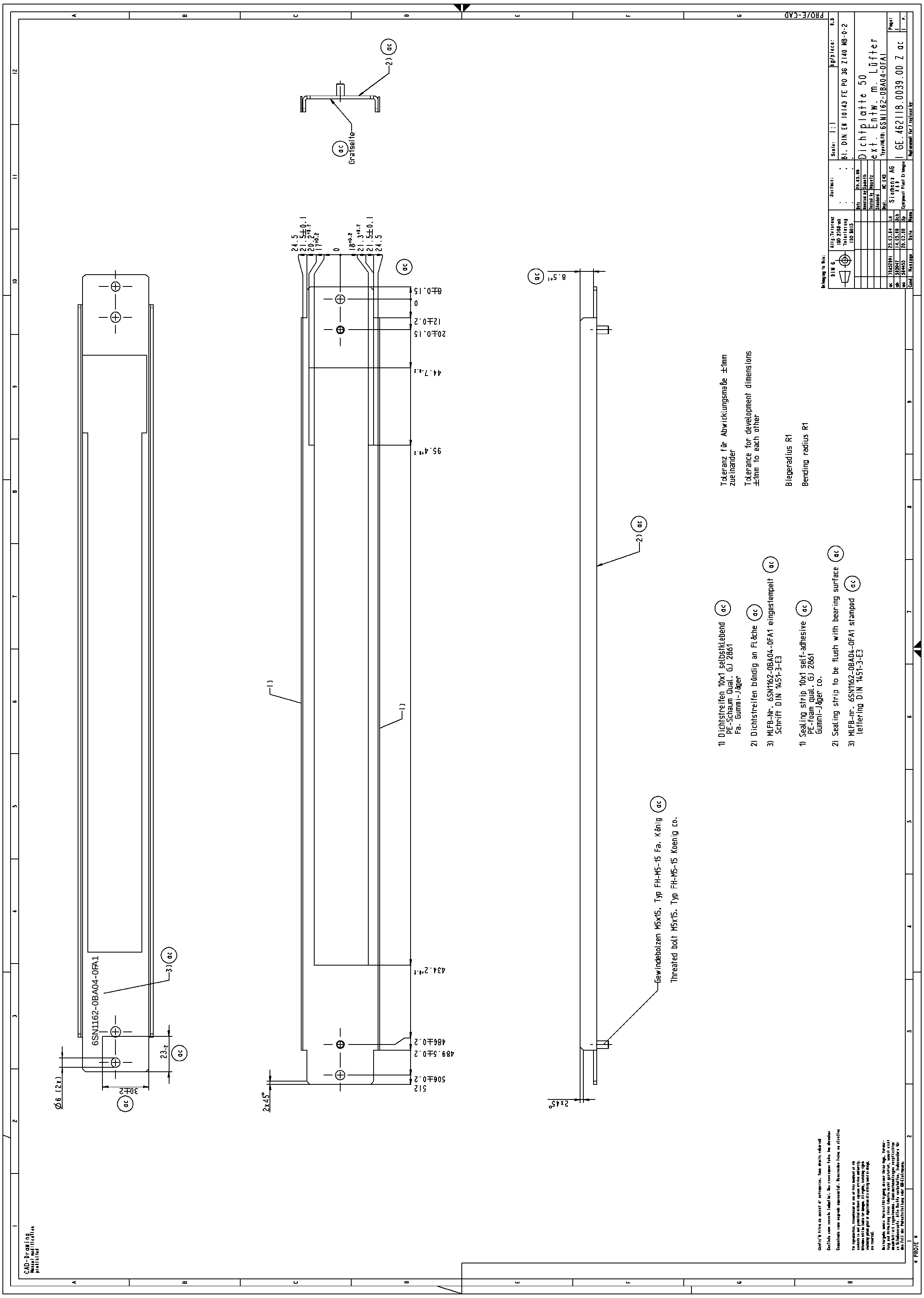


Fig. 11-44 External cooling, mounting frame for cabinet installation module width 50 mm, 6SN1162–0BA04–0FA1

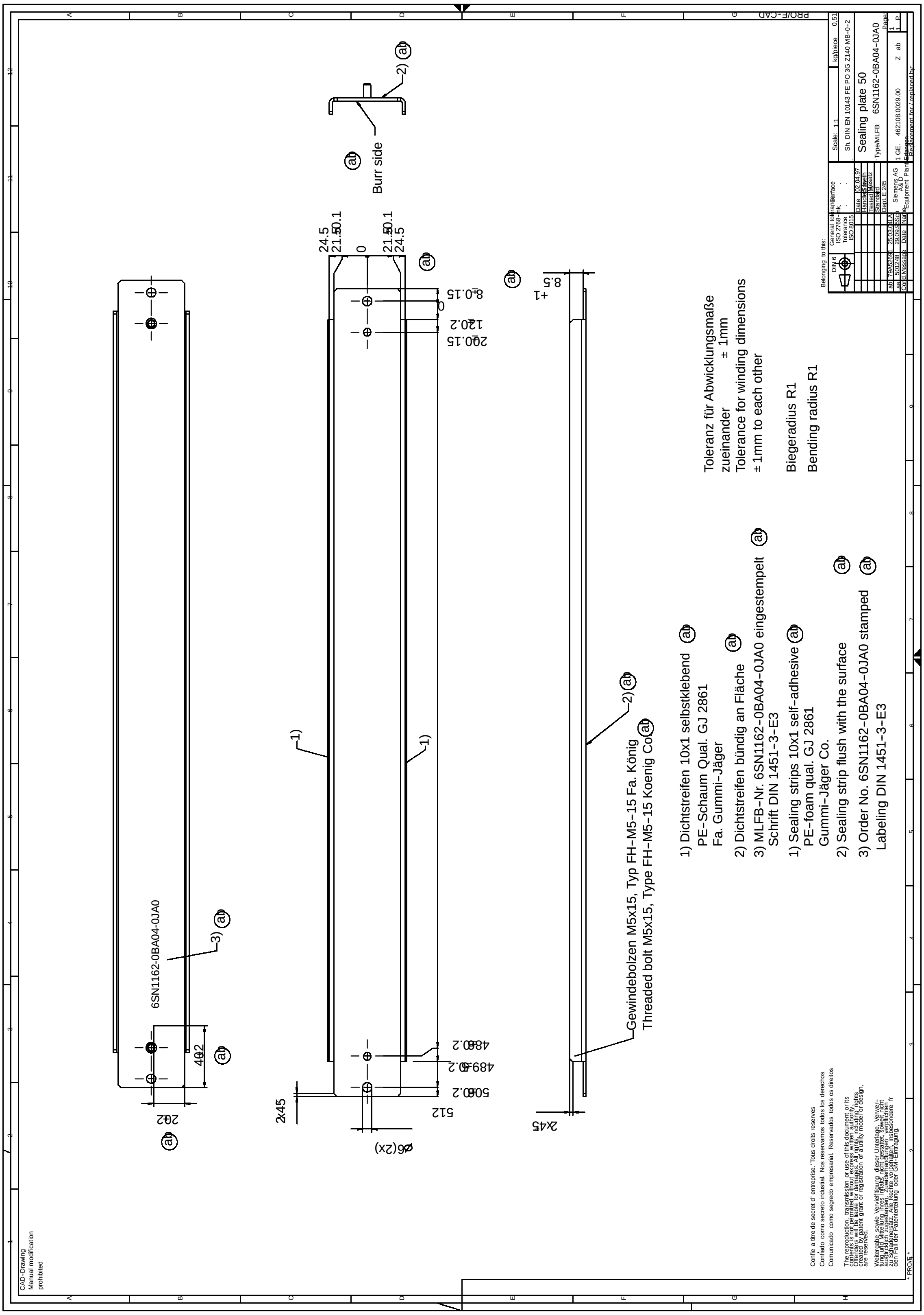


Fig. 11-45 External cooling, mounting frame for cabinet installation module width 50 mm, 6SN1162−0BA04−0JA0

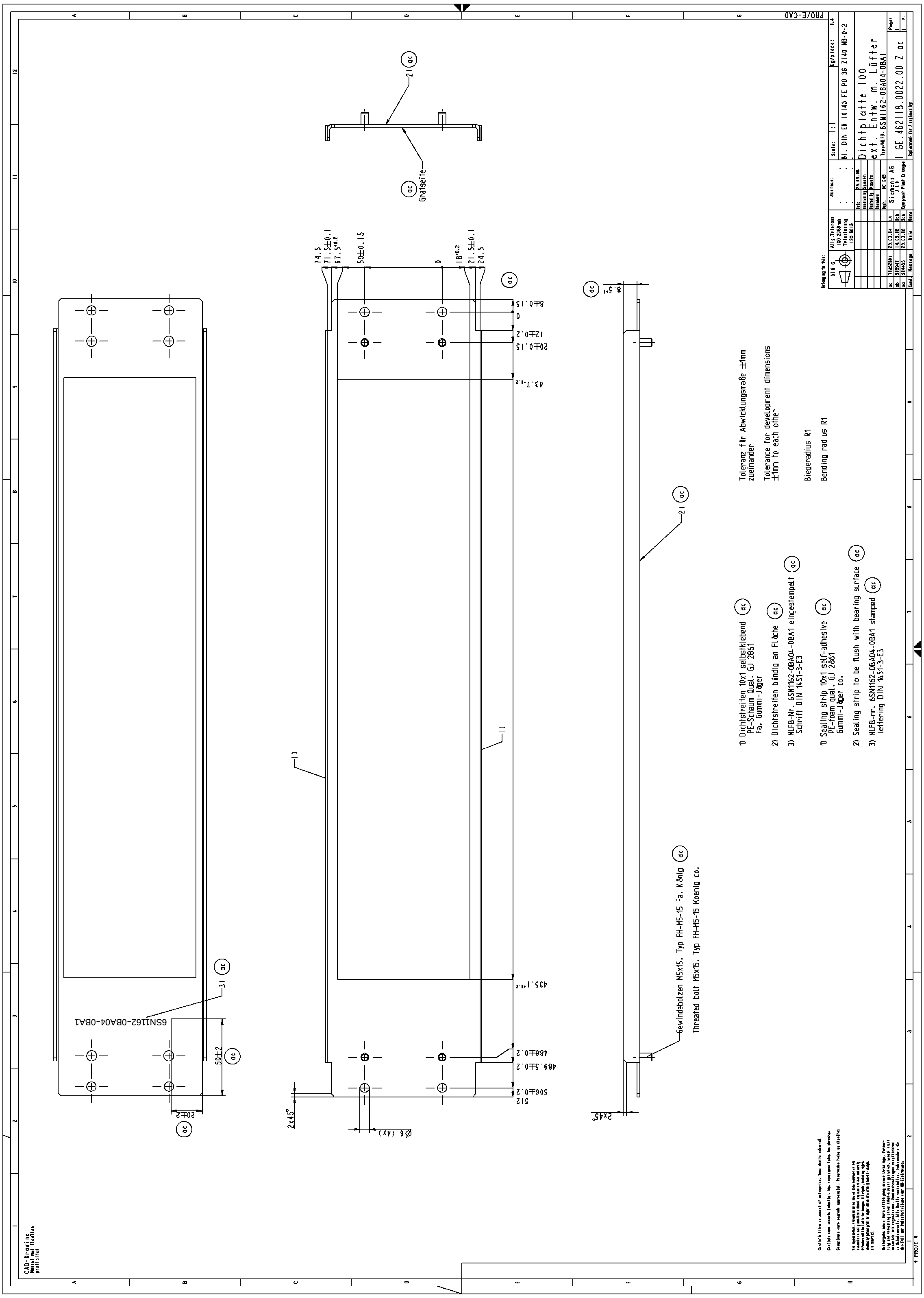


Fig. 11-46 External cooling, mounting frame for cabinet installation module width 100 mm, 6SN1162–0BA04–0BA1

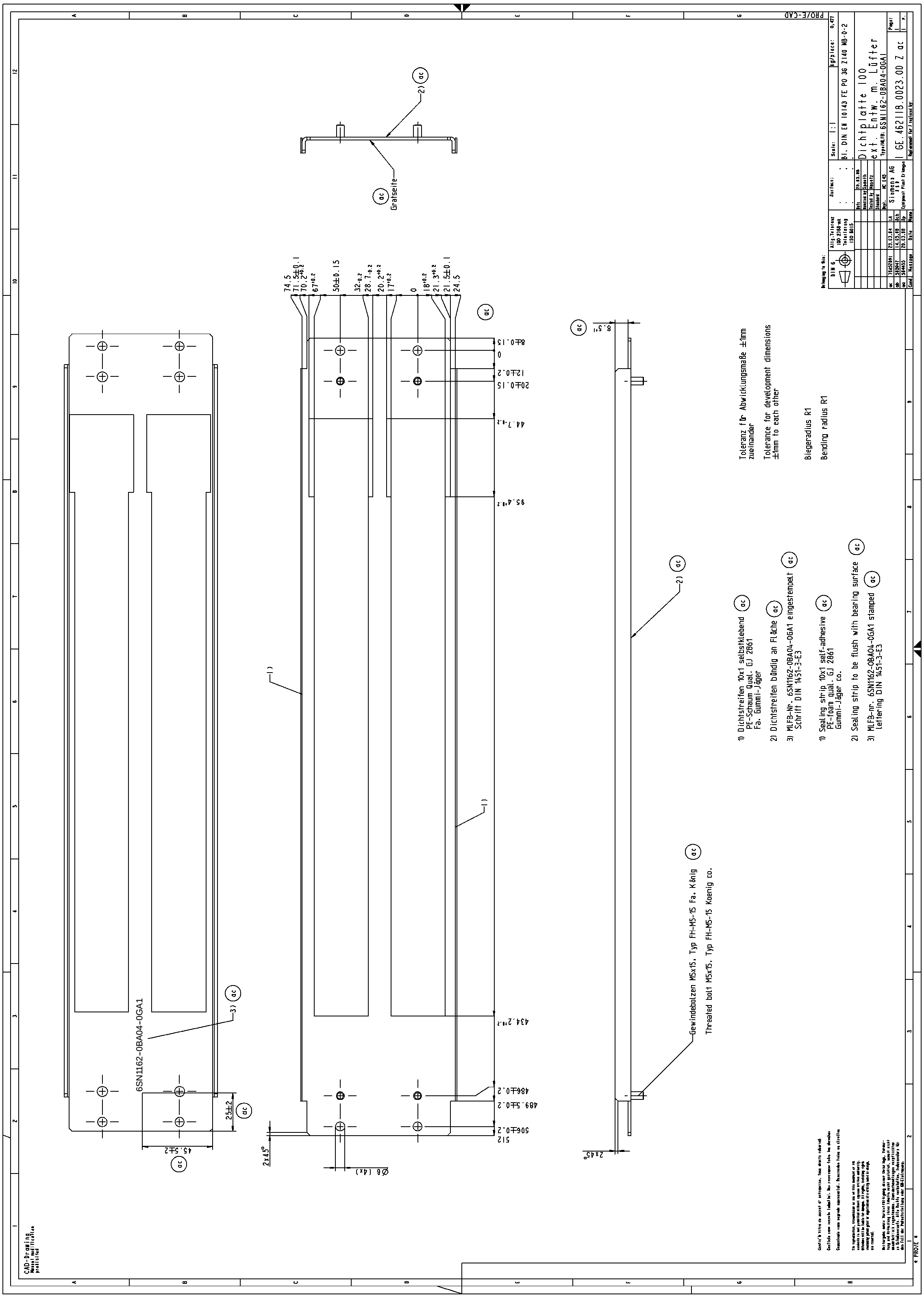


Fig. 11-47 External cooling, mounting frame for cabinet installation module width 100 mm, 6SN1162–0BA04–0GA1

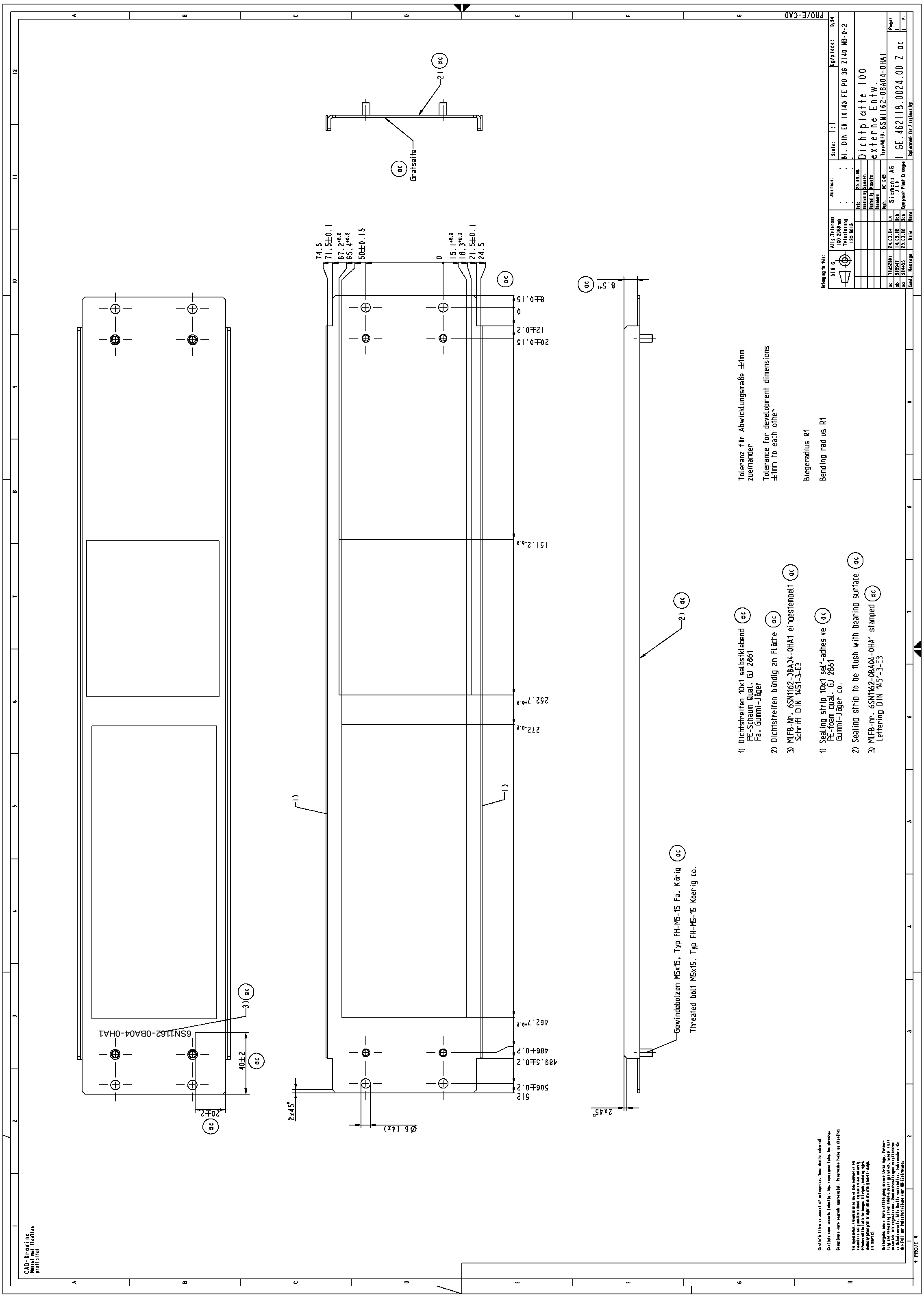


Fig. 11-48 External cooling, mounting frame for cabinet installation module width 100 mm, 6SN1162–0BA04–0HA1

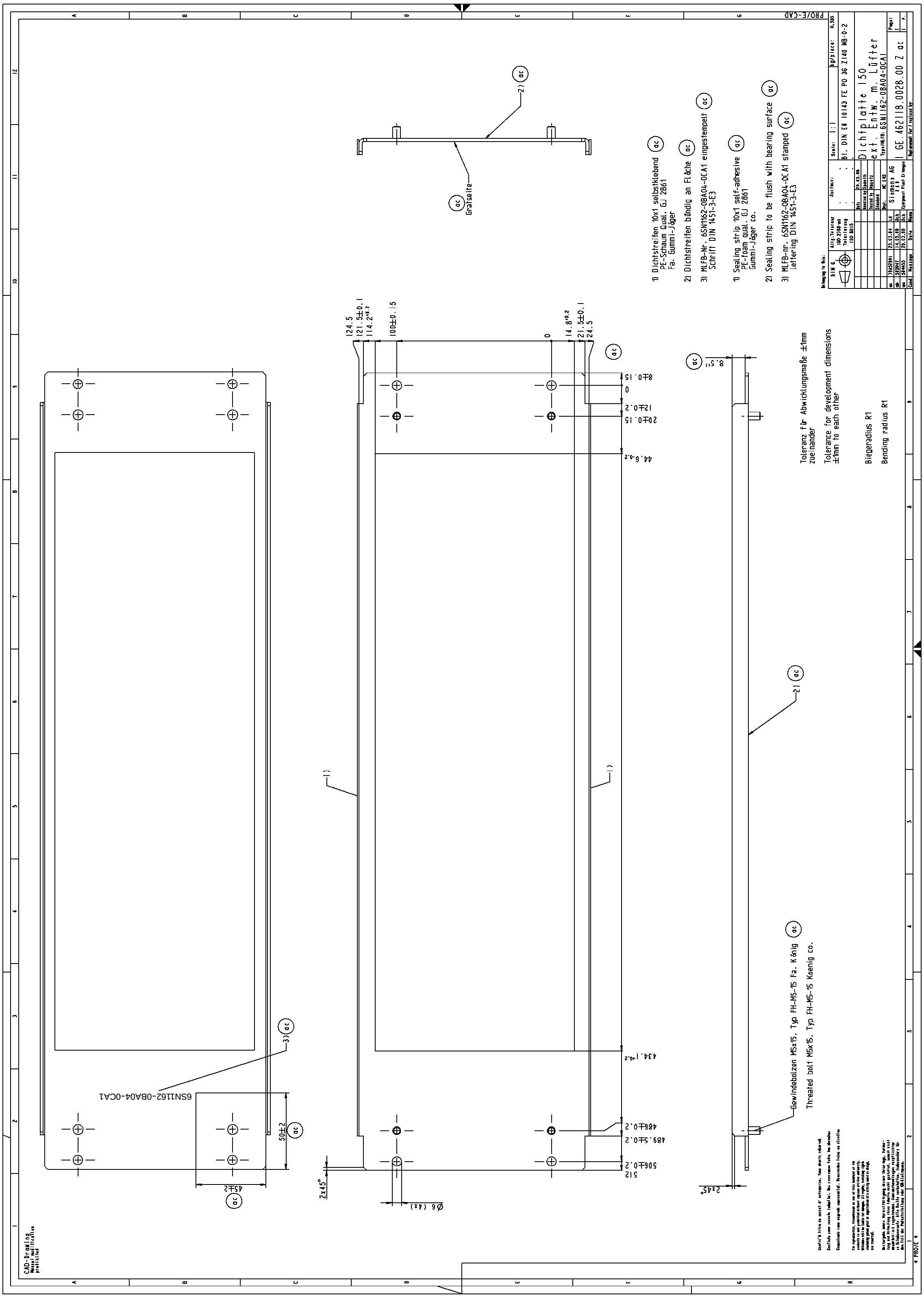


Fig. 11-49 External cooling, mounting frame for cabinet installation module width 150 mm, 6SN1162–0BA04–0CA1

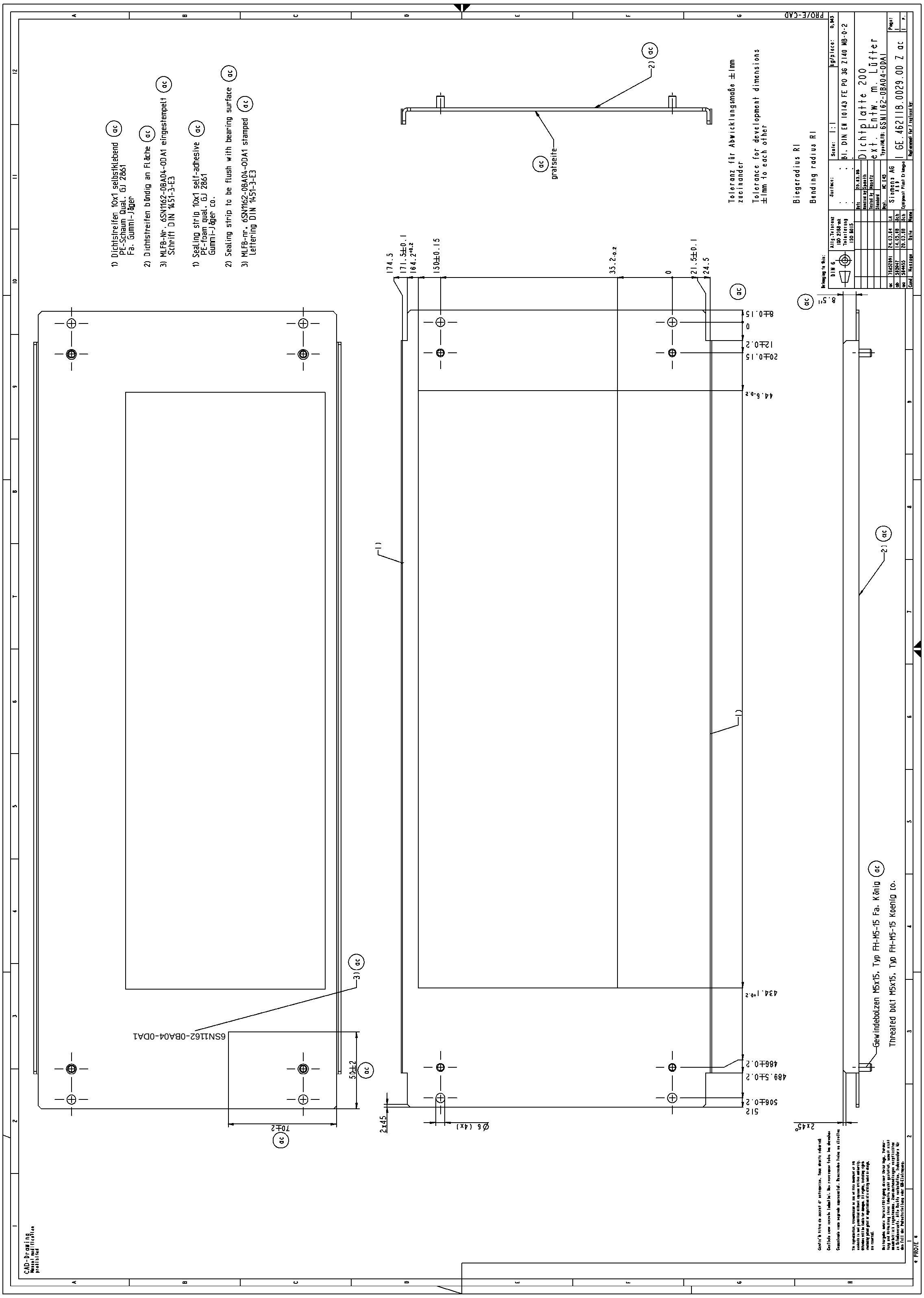


Fig. 11-50 External cooling, mounting frame for cabinet installation module width 200 mm, 6SN1162–0BA04–0DA1

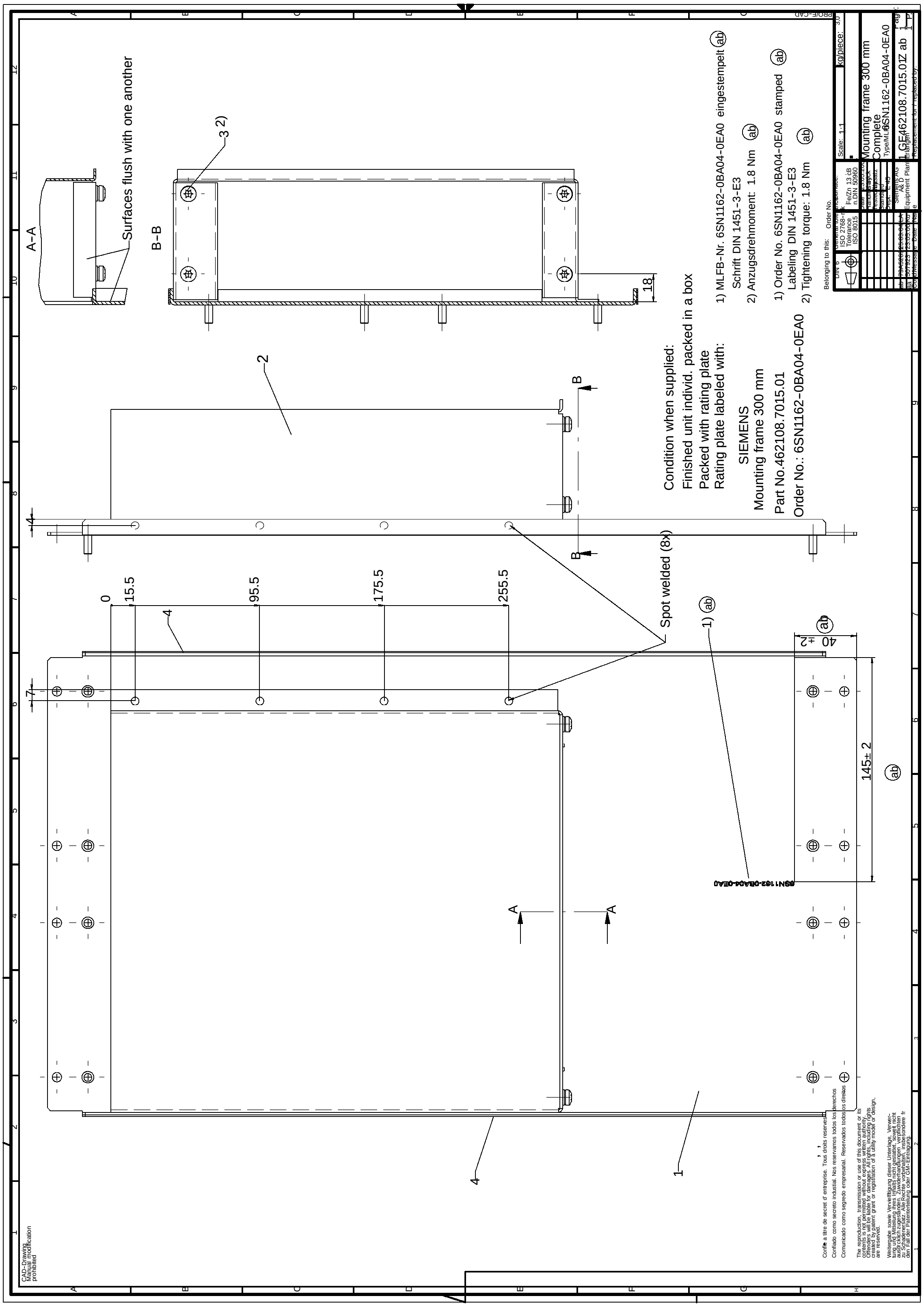


Fig. 11-51 External cooling, mounting frame for cabinet installation module width 300 mm, 6SN1162–0BA04–0EA0

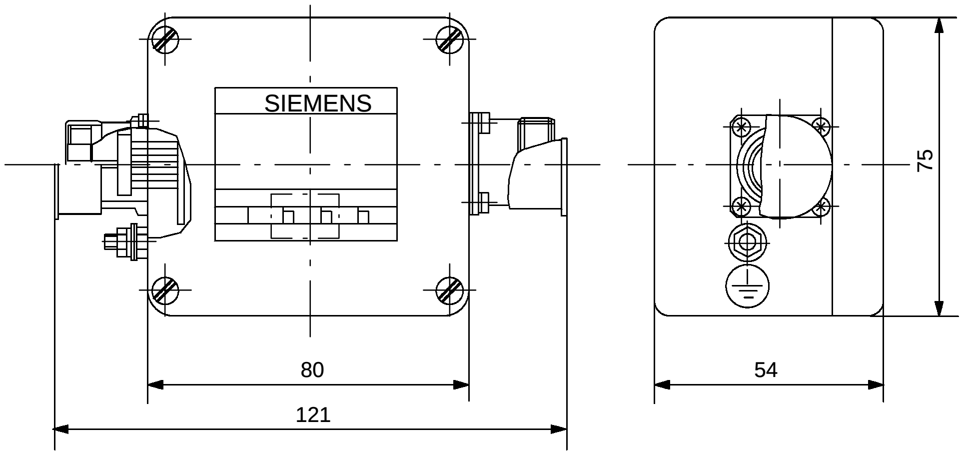


Fig. 11-52 Signal amplifier electronics SVE, 6SN1115–0AA12–0AA0

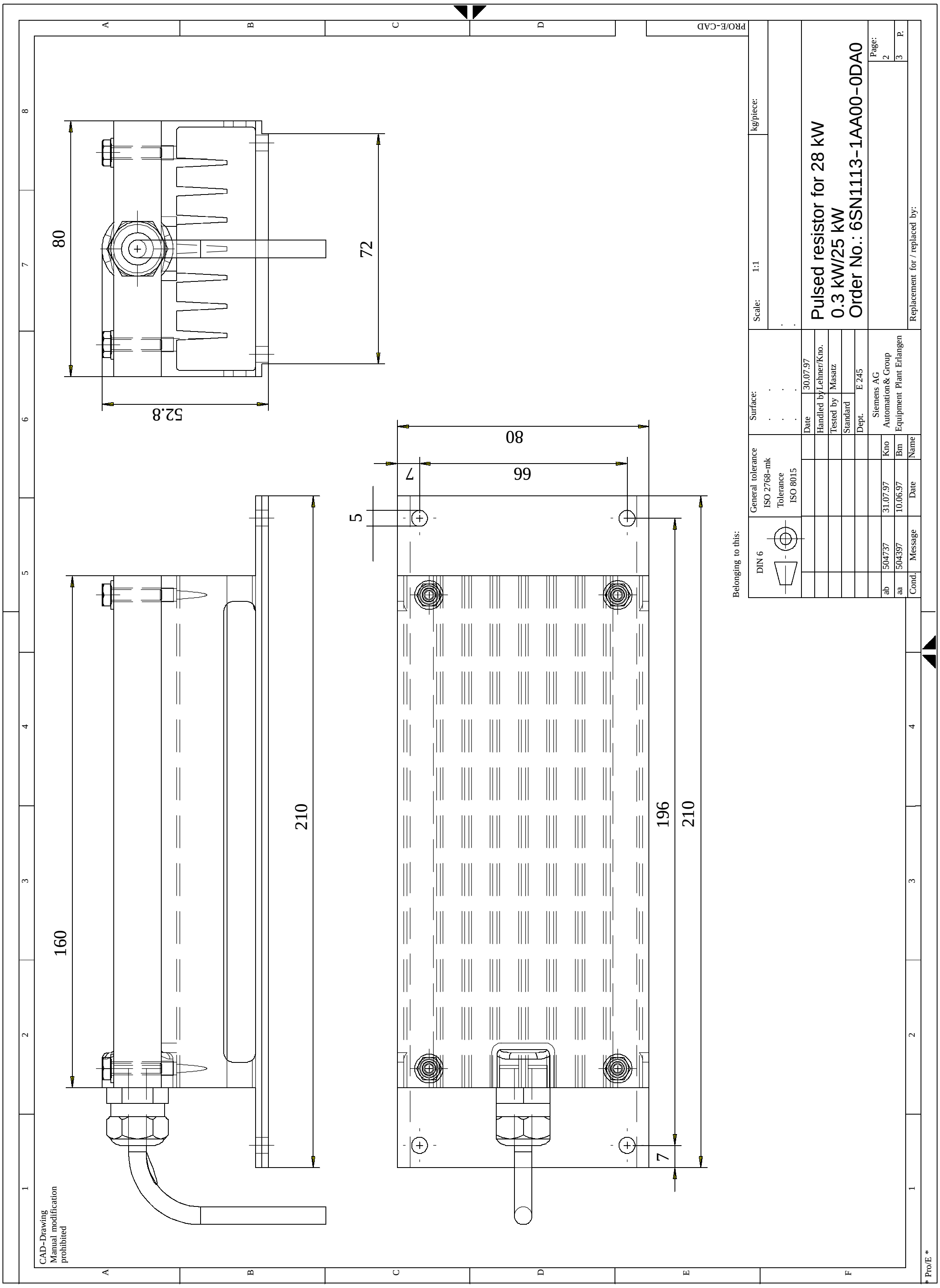


Fig. 11-53 External pulsed resistor for 28kW for UI module, SN1113–1AA00–0DA0

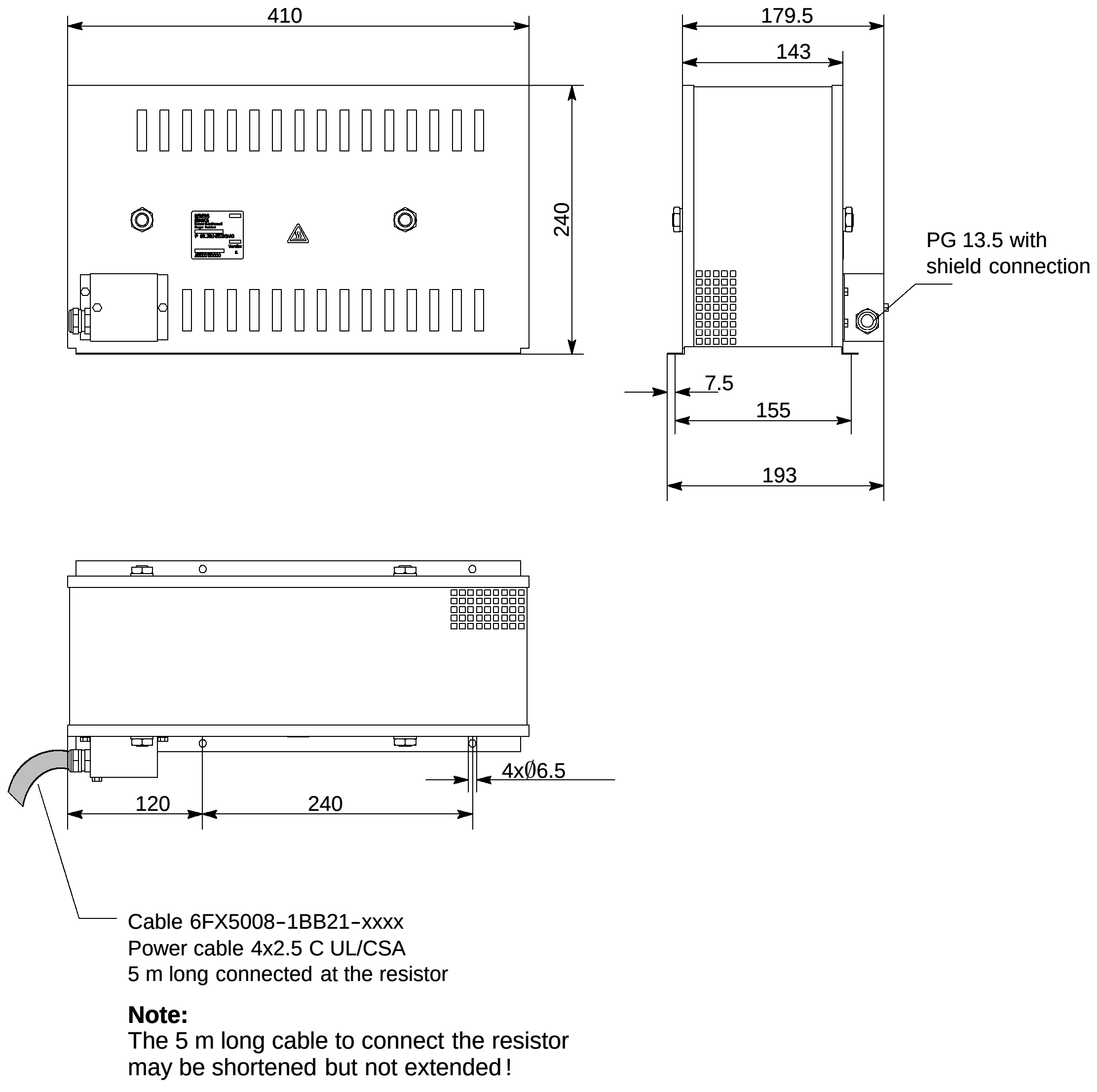
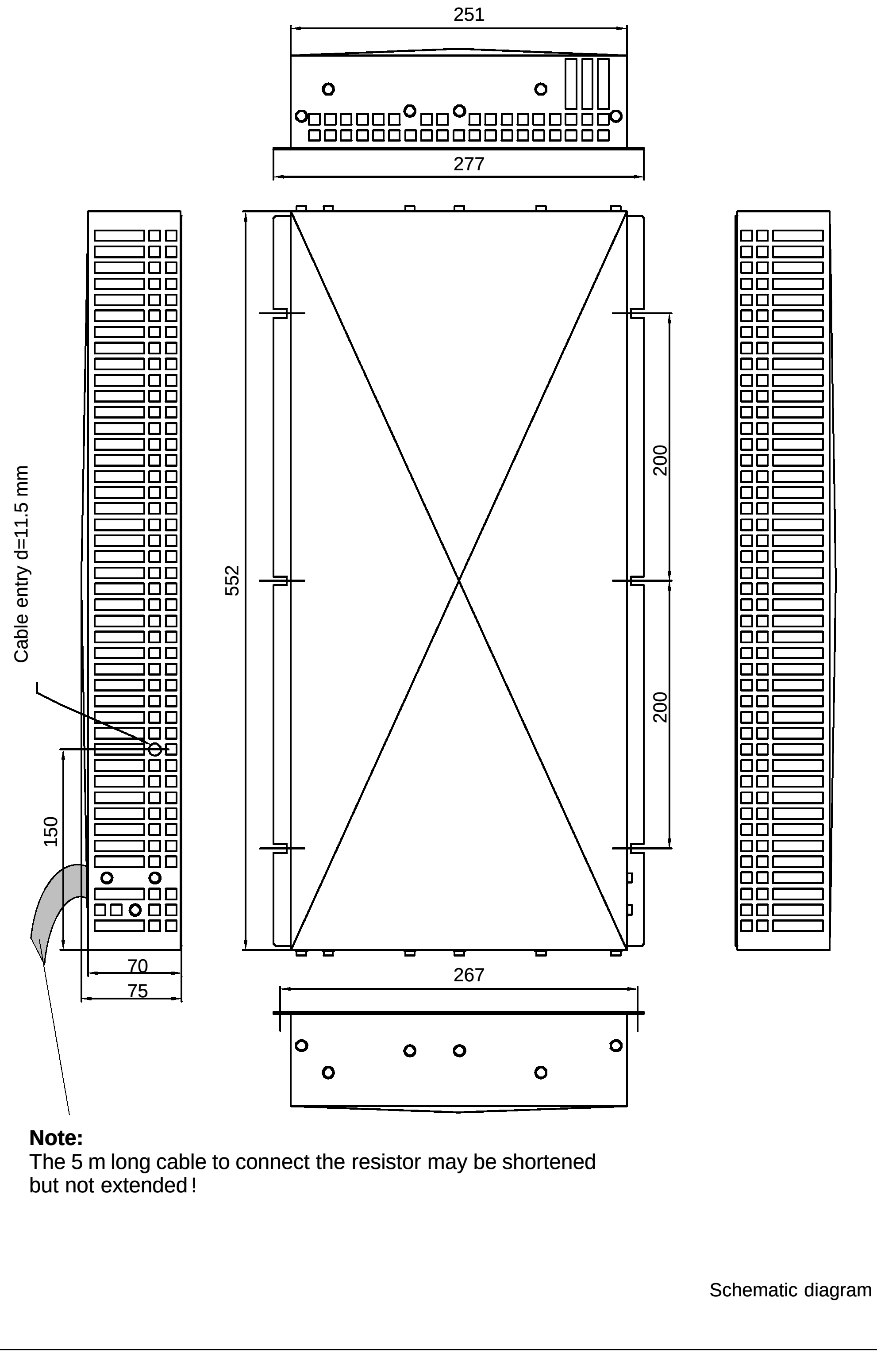


Fig. 11-54 External pulsed resistor Plus, 6SL3100–1BE22–5AA0



Note:
The 5 m long cable to connect the resistor may be shortened but not extended!

Fig. 11-55 Damping resistor for 3–phase HFD line/commutating reactors, 6SL3100–1BE21–3AA0

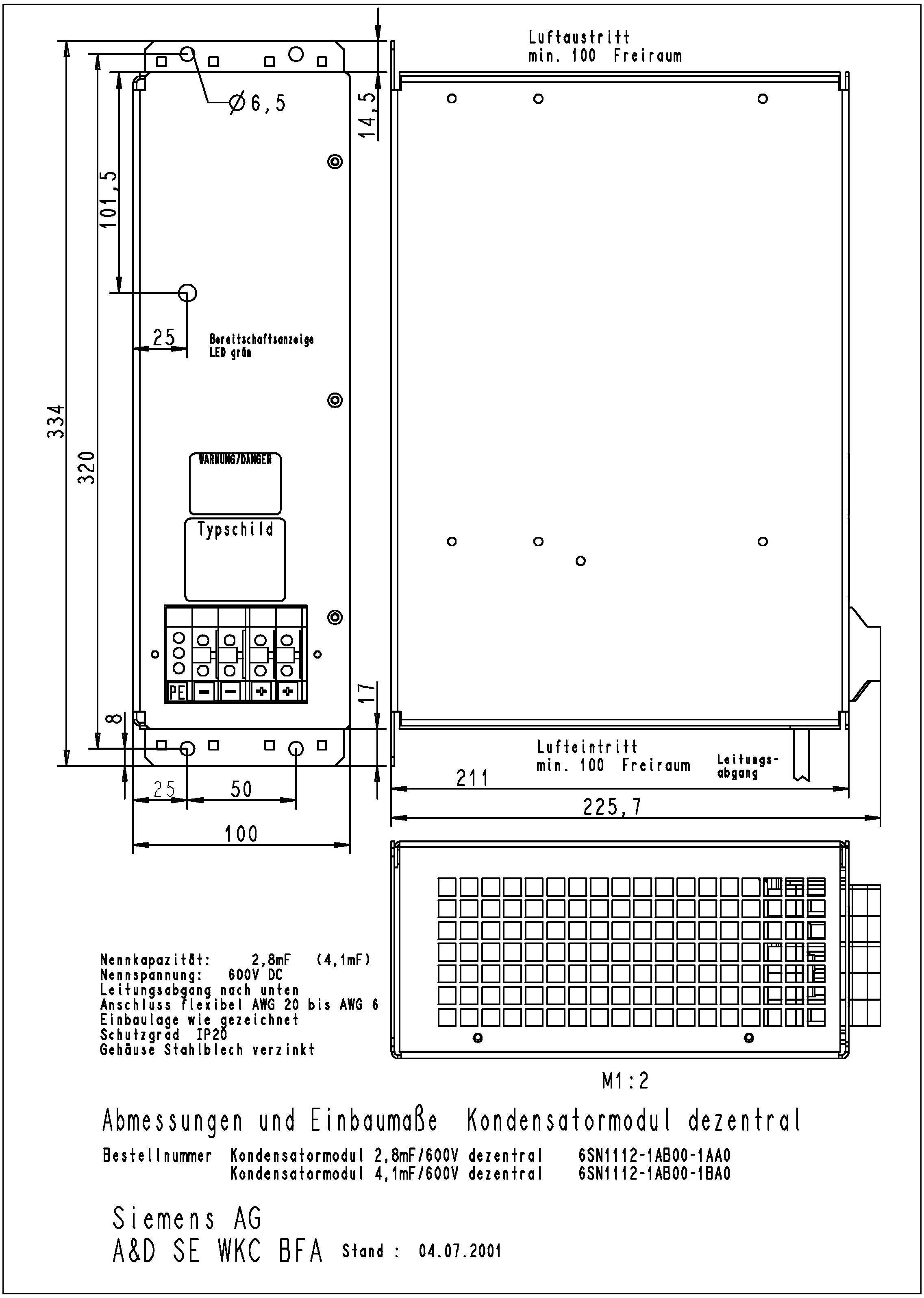


Fig. 11-56 Distributed capacitor modules, 6SN1112–1AB00–1xA0

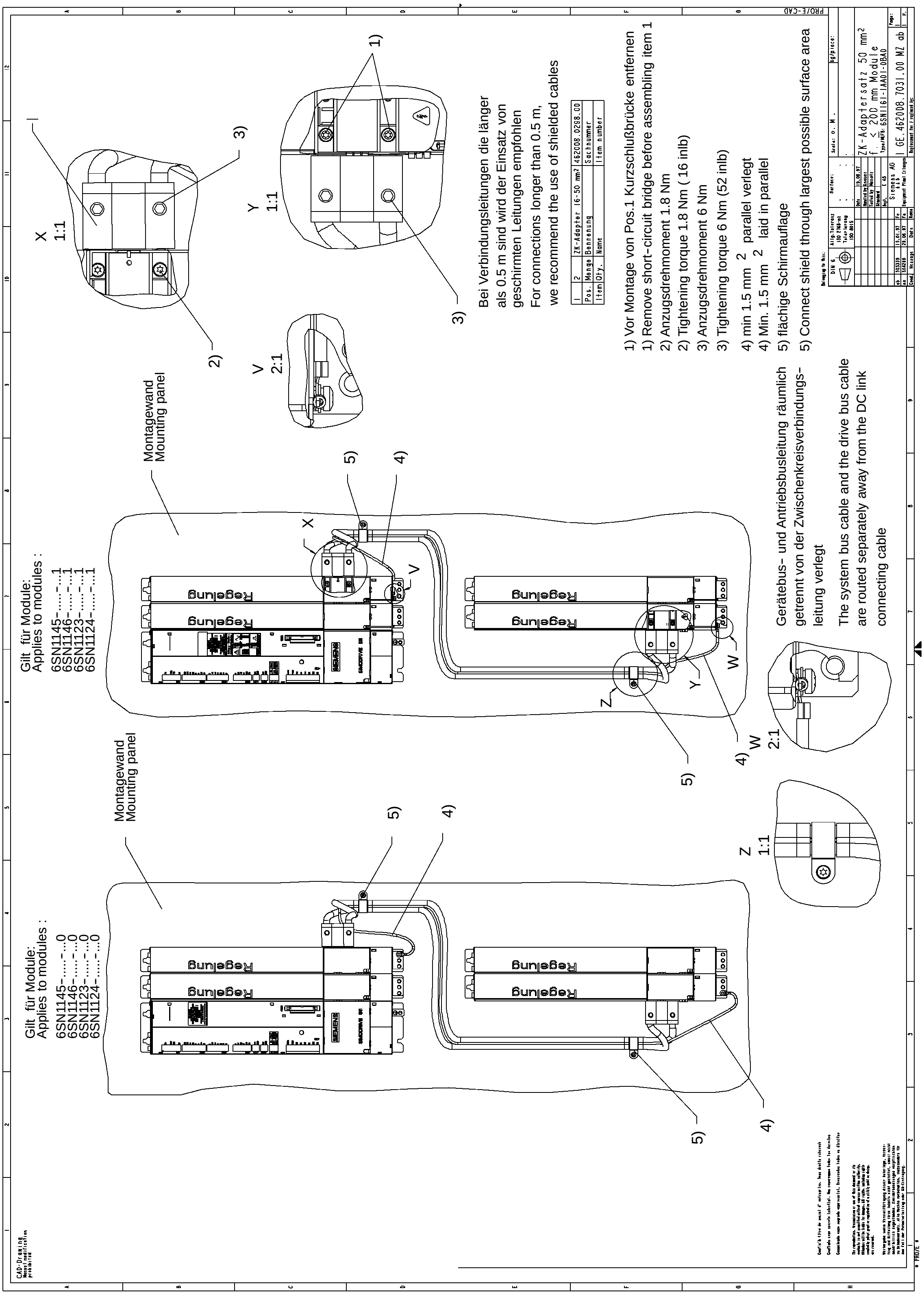


Fig. 11-57 DC link adapter set 50 mm^2 for modules <=200 mm

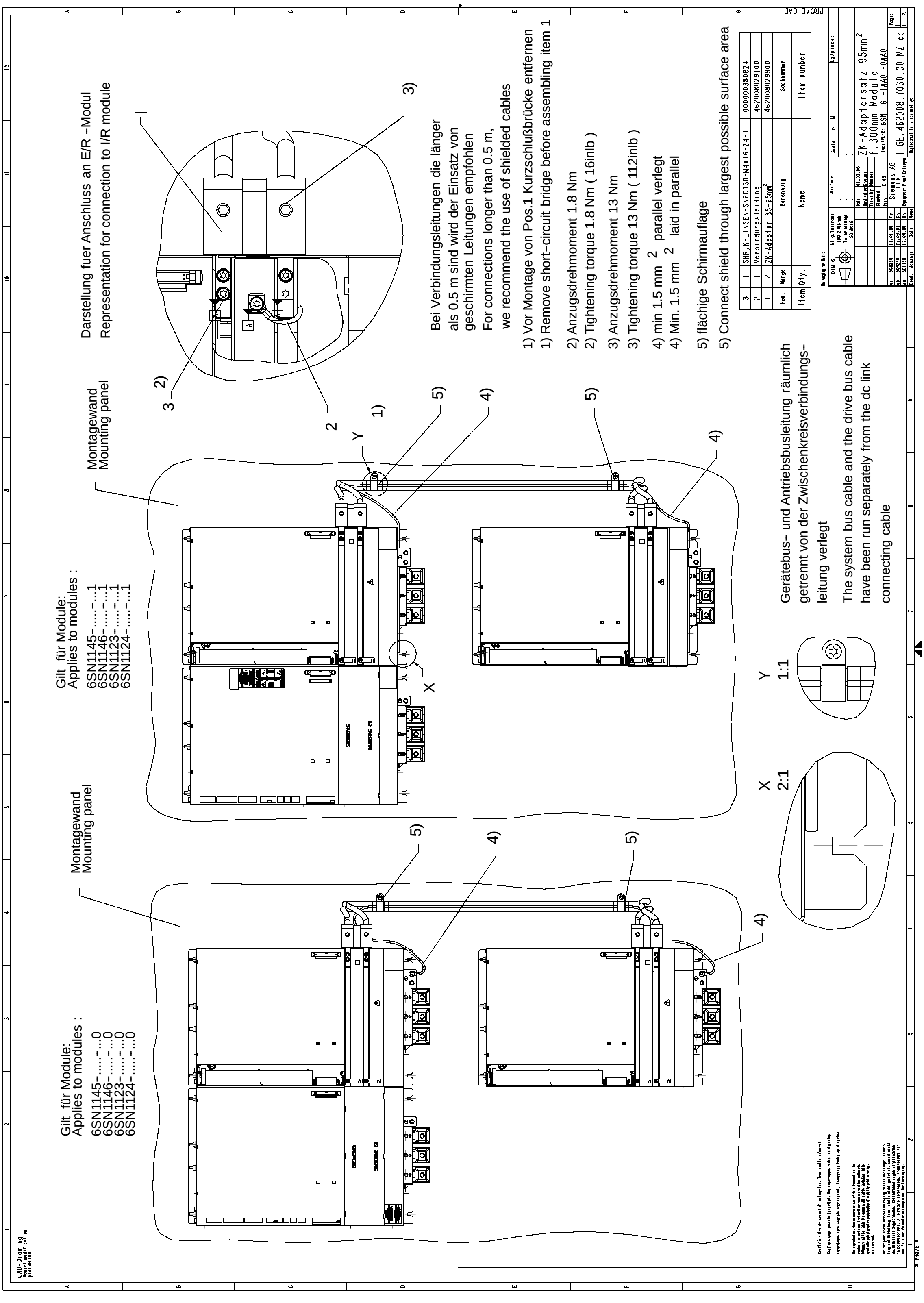


Fig. 11-58 DC link adapter set 95 mm^2 for modules 300 mm

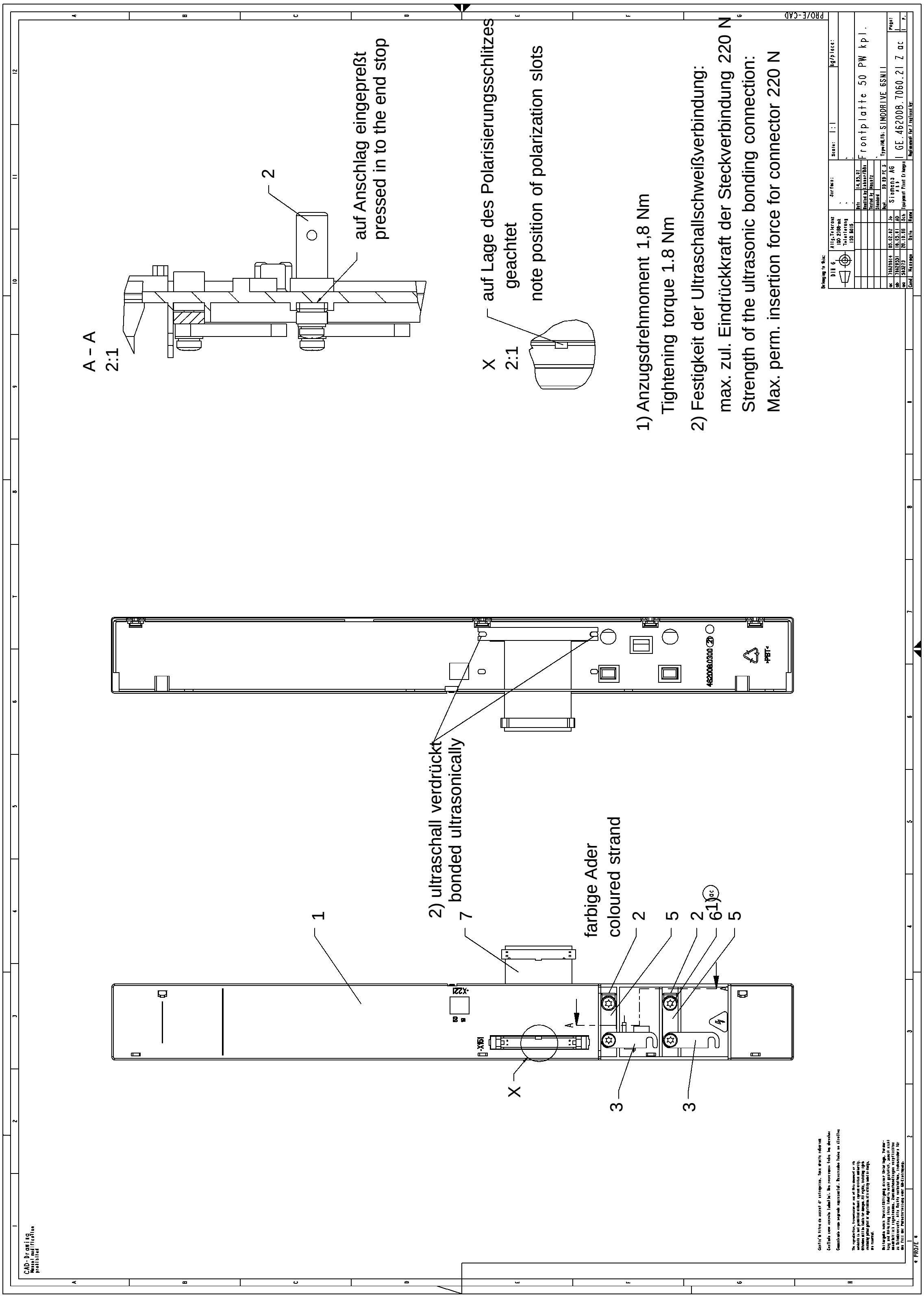
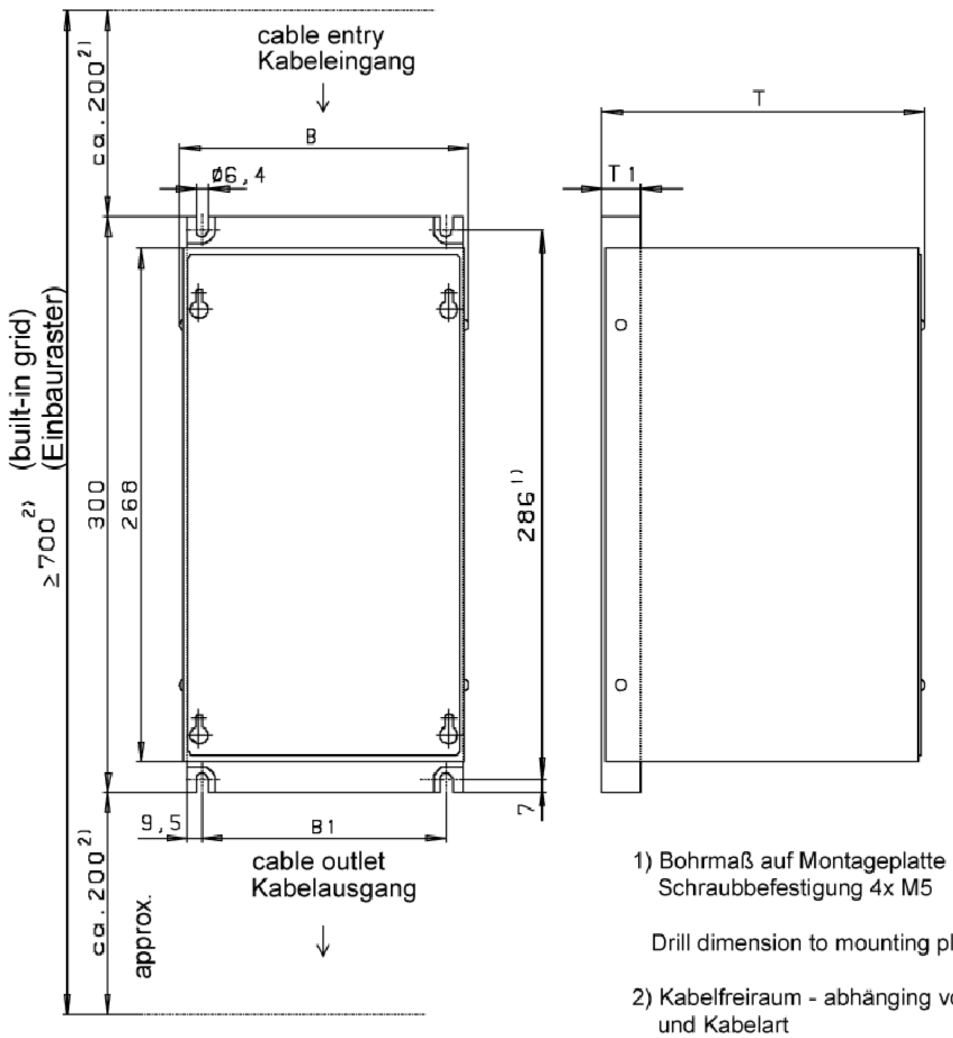


Fig. 11-59 Front panel, PR module



1) Bohrmaß auf Montageplatte
Schraubbefestigung 4x M5

Drill dimension to mounting plate

2) Kabelfreiraum - abhänging vom Kabel und Kabelart

Cable clearance dependent on type and kind of cable

	weight Masse	B	B1	T	T1	
VPM 120	ca. 6 kg	150	125	180	20	mm
VPM 200	ca. 11 kg	250	225	190	30	mm

Fig. 11-60 VPM 120 / VPM 200, dimension drawing

■

Space for your notes

EC Declaration of Conformity

A

Note

An extract from the EC Declaration of Conformity No. 002 V 18/10/95 is shown below. A complete copy of the EC Declaration of Conformity can be found in the ”EMC Guidelines for the SINUMERIK and SIROTEC controls”.

SIEMENS

EG-Konformitätserklärung
EC Declaration of Conformity

No. E002 Version 02/01/10

Hersteller: SIEMENS AG
Manufacturer:

Anschrift: SIEMENS AG; A&D MC
Address: Frauenauracherstraße 80
91056 Erlangen

Produkt- bezeichnung: *Product description*
SINUMERIK 802D, 802S, 805, 805SM-P, 805SM-TW, 810, 810D
820, 840C, 840CE, 840D, 840DE, 840Di, FM NC
SIMOTION C230, C230-2, P350
SIMATIC FM 353, FM 354, FM 357
SIROTEC RCM1D, RCM1P
SIMODRIVE 610, 611, MCU, FM STEPDRIVE, POSMO A / SI / CA / CD

Die bezeichneten Produkte stimmen in den von uns in Verkehr gebrachten Ausführungen mit den Vorschriften folgender Europäischer Richtlinie überein:

The products described above in the form as delivered is in conformity with the provisions of the following European Directives:

89/336/EWG Richtlinie des Rates zur Angleichung der Rechtsvorschriften der Mitgliedstaaten über die elektromagnetische Verträglichkeit
(geändert durch 91/263/EWG, 92/31/EWG, 93/68/EWG und 93/97/EWG).

Council Directive on the approximation of the laws of the Member States relating to electromagnetic compatibility (amended by 91/263/EEC, 92/31/EEC, 93/68/EEC and 93/97/EEC).

Die Einhaltung dieser Richtlinie setzt einen EMV-gerechten Einbau der Produkte gemäß EMV-Aufbaurichtlinie für SINUMERIK, SIROTEC, SIMODRIVE (Best. Nr. 6FC 5297-0AD30-0AP0) in die Gesamtanlage voraus. Anlagenkonfigurationen, bei der die Einhaltung dieser Richtlinie nachgewiesen wurde, sowie angewandte Normen, siehe:

For keeping the directive, it is required to install the products according to "EMC Mounting regulation for SINUMERIK, SIROTEC, SIMODRIVE" (Order No. 6FC 5297-0AD30-0BP0). For details of the system configurations, which meet the requirements of the directives, as well as for the standards applied see:

- **Anhang A (Anlagenkonfigurationen)**	- *Annex A (system configurations)*	:	**Version 02/01/10**
- **Anhang B (Komponenten)**	- *Annex B (components)*	:	**Version 00/01/14**
- **Anhang C (Normen)**	- *Annex C (standards)*	:	**Version 00/11/27**

Erlangen, den / *the* 10.01.2002

Siemens AG

R. Müller
Entwicklungsleitung
Name, Funktion / *Name, function* — Unterschrift / *signature*

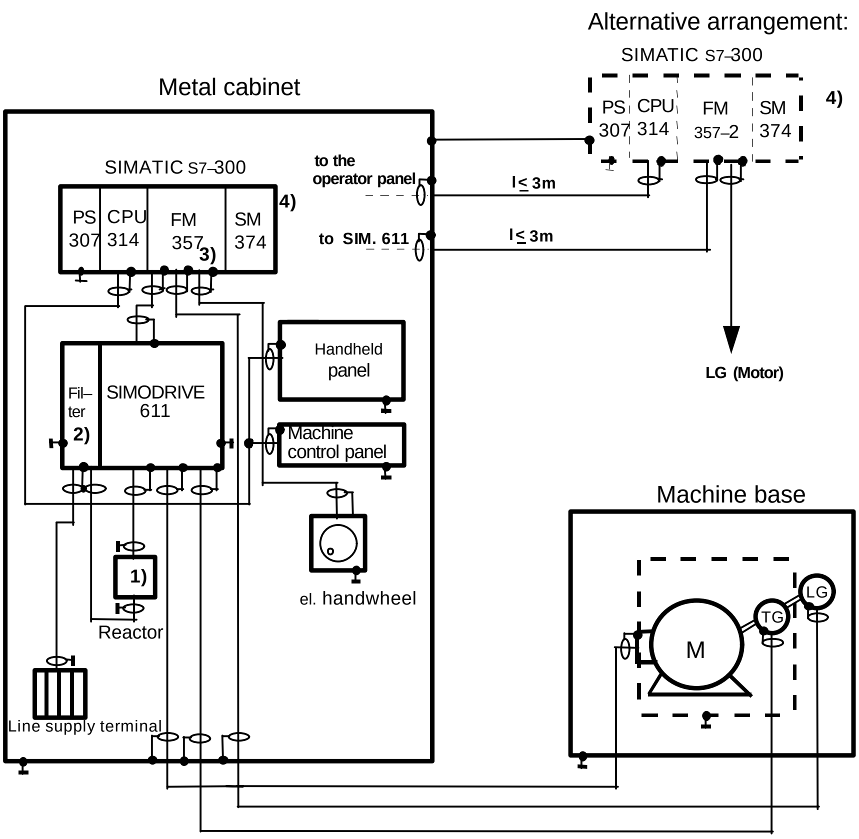
K. Krause
Qualitätsmanagement
Name, Funktion / *Name, function* — Unterschrift / *signature*

Diese Erklärung bescheinigt die Übereinstimmung mit den genannten Richtlinien, ist jedoch keine Zusicherung von Eigenschaften.
Die Sicherheitshinweise der mitgelieferten Produktdokumentation sind zu beachten.
This declaration certifies the conformity to the specified directives but contains no assurance of properties.
The safety documentation accompanying the product shall be considered in detail.

Appendix A of the EC Declaration of Conformity No. E002

A8: Typical system configuration

SIMATIC FM 357 (SINUMERIK FM NC)/SIMODRIVE 611 with analog setpoint interface



1) for I/R module and UI module 28 kW
2) Filter in the module group or separate
3) or FM NC
4) When using FM 357–2 and the new components, then it is also permissible to arrange/locate the SIMATIC components outside the cabinet (cable length between the cabinet and SIMATIC components ≤ 3 m)

- All components that are permitted according to the ordering documentation for the system group comprising SIMATIC FM 357, SINUMERIK FM NC and SIMODRIVE 611A, fulfill, in the group, Directive 89/336/EEC
- For conformity with standards, refer to Appendix C

Note:

In the schematic of the system configuration, only the basic measures to be in compliance with Directive 89/336/EEC of a typical system configuration are shown.
In addition, especially when deviating from this system configuration, the instruction information/instructions for a correct EMC system configur. and of the product documentation and EMC Design Guidelines for SINUMERIK; SIROTEC, SIMODRIVE (Order No. 6FC5297–0AD30–0BPX) should be carefully observed.

 Version 02/01/10

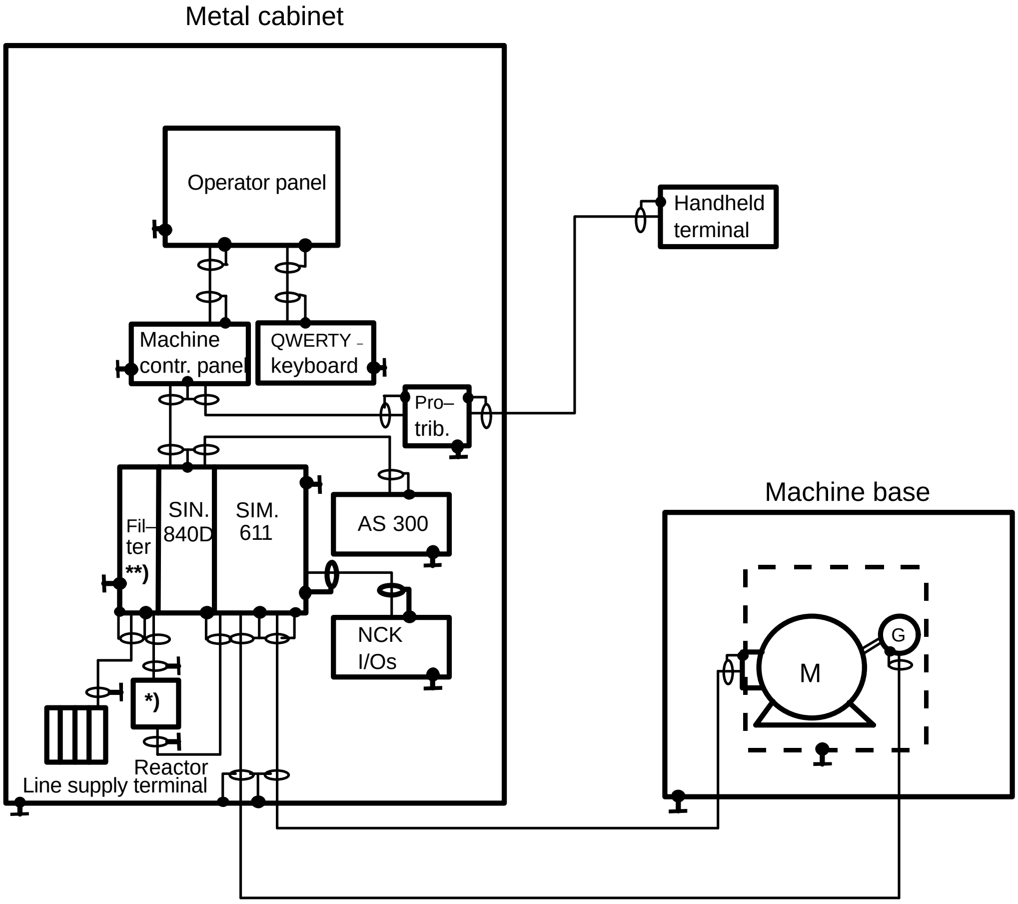
konf/erkl/002/anh_a A–8/23

A

Appendix A of the EC Declaration of Conformity No. E002

A9: Typical system configuration

SINUMERIK 840D/SIMODRIVE 611 with digital setpoint interface



*) for I/R module and UI module 28 kW
**) Filter in the module group or separate

- All components that are permitted according to the ordering documentation for the system group comprising SINUMERIK 840D and SIMODRIVE 611, fulfill, in the group, Directive 89/336/EEC
- For conformity with standards, refer to Appendix C

Note:

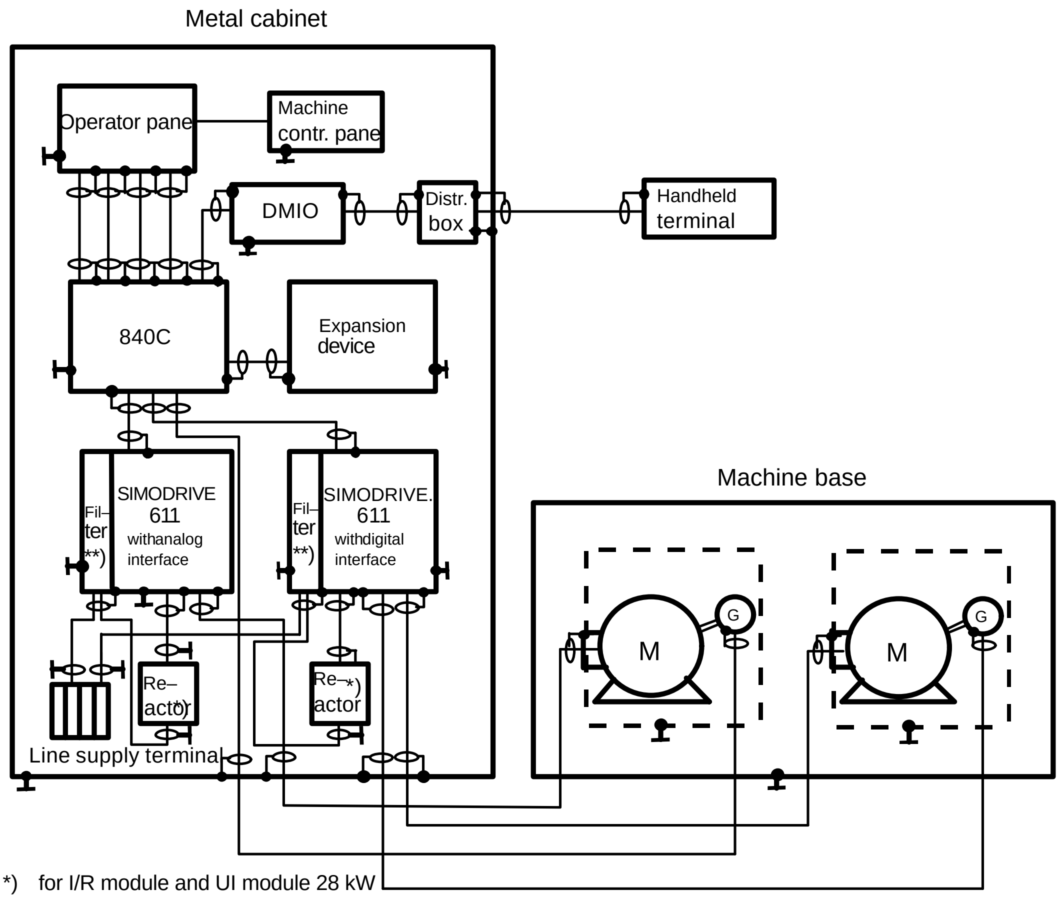
In the schematic of the system configuration, only the basic measures to be in compliance with Directive 89/336/EEC of a typical system configuration are shown.
In addition, especially when deviating from this system configuration, the instruction information/instructions for a correct EMC system configur. and of the product documentation and EMC Design Guidelines for SINUMERIK; SIROTEC, SIMODRIVE (Order No. 6FC5297–0AD30–0BPX) should be carefully observed.

 Version 02/01/10
konf/erkl/002/anh_a A–9/23

Appendix A of the EC Declaration of Conformity No. E002

A10: Typical system configuration

SINUMERIK 840C/SIMODRIVE 611 with analog and digital setpoint interface



*) for I/R module and UI module 28 kW

**) Filter in the module group or separate

- All components that are permitted according to the ordering documentation for the system group comprising SINUMERIK 840C and SIMODRIVE 611A/D, fulfill, in the group, Directive 89/336/EEC
- For conformity with standards, refer to Appendix C

Note:

In the schematic of the system configuration, only the basic measures to be in compliance with Directive 89/336/EEC of a typical system configuration are shown.
In addition, especially when deviating from this system configuration, the instruction information/instructions for a correct EMC system configur. and of the product documentation and EMC Design Guidelines for SINUMERIK; SIROTEC, SIMODRIVE (Order No. 6FC5297–0AD30–0BPX) should be carefully observed.

 Version 02/01/10

konf/erkl/002/anh_a A–10/23

A

Space for your notes

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
611 U HR	HR for High Resolution
AIE	Angular incremental encoder interface
Analog control	Control board with analog interface
ARM	Rotating induction motor
DC link	DC link
Digital control	Control board with digital interface
DMS	Direct measuring system
Drive module	General term for main spindle and feed modules
EnDat	Encoder–Data–Interface (bidirectional synchronous–serial interface)
EP	Electronic assessment factor
External cooling	Module with heatsink that extends beyond the rear panel, cooling on the customer side
FD module	Feed module
HFD	High–frequency reactor with damping
HGL	High–resolution position actual value
I/R module	Infeed/regenerative feedback module with regulated DC link voltage
IM	Induction motor
Internal cooling	Modules with integrated heatsink, in some cases with hose connection
L2DP	L2 distributed I/O
MCU	Motion Control Unit (single–axis positioning board)
MM	Monitoring module

MPI	Multi Point Interface
MSD module	Main spindle module
MSD option	Option module, main spindle options for FD module
NCU	Numerical Control Unit
NE module	Line supply infeed module (general term for UI and I/R modules)
OPI	Operator Panel Interface
Order No. [MLFB]	Machine readable product designation
PELV	Protective Extra Low Voltage
PM module	Power module
PPU	Protected Power Unit
PR module	Pulsed resistor module
PU	Units in a package
SAE	Current amplification electronics
SLM	Synchronous linear motor
SRM	Synchronous rotating motor
SSI	Synchronous serial interface
UI module	Infeed module with non–regulated DC link voltage and pulsed resistor
VDC link	DC link voltage
VPM	Voltage Protection Module

■

References

C

General Documentation

/BU/

SINUMERIK & SIMODRIVE
Catalog NC 60 • 2004
Order No.: E86060–K4460–A101–B1
Order No.: E86060–K4460–A101–B1 –7600 (English)

/KT101/

Power Supplies SITOP power/LOGO!power
Catalog KT 10.1 • 2004
Order No.: E86060–K2410–A101–A5

/KT654/

SIMODRIVE and POSMO
Catalog DA 65.4 • 2005
Order No.: E86060–K5165–A401–A2

/Z/

MOTION–CONNECT
Connections & System Components for SIMATIC, SINUMERIK, MASTERDRIVES, and SIMOTION
Catalog NC Z
Order No.: E86060–K4490–A101–B1
Order No.: E86060–K4490–A101–B1–7600 (English)

/NSK/

Low–Voltage Switchgear
Automation and Drives
Catalog NS K
Order No.: E86060–K1002–A101–A1

/PD10/

Transformers SIDAC–T
Catalog PD 10 2001
Order No.: E86060–K2801–A101–A1

/HBSI/

Safety Integrated
The Safety Program for Industries of the World
Application Manual
Order No.: 6ZB5000–0AA01–0BA0

Electronic Documentation

/CD1/ The SINUMERIK System (10/2005 Edition)
DOC ON CD
(includes all SINUMERIK 840D/840Di/810D/802D and SIMODRIVE publications)
Order No.: 6FC5 298–7CA00–0BG3

User Documentation

/PI/ **PCIN 4.4**
Software for data transmission to/from MMC module
Order No.: 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 1 (07/2005 Edition)
Order No.: 6FC5 397–7AP10–0BP0
Lists 2 (07/2005 Edition)
Order No.: 6FC5 397–3CP10–0BP0

/ASI/ Safety Integrated
Application Manual
Order No.: E20001–A110–M103

b) Hardware

/BHA/ SIMODRIVE **Sensor**
Absolute Value Encoder with PROFIBUS–DP
User Manual (HW) (07/2005 Edition)
Order No.: 6SN1197–0AB10–0YP4

/EMV/ SINUMERIK, SIROTEC, SIMODRIVE
EMC Design Guidelines
Configuration Manual (HW) (03/2004 Edition)
Order No.: 6FC5 297–0AD30–0BP2
You will find an up–to–date declaration of conformity in the Internet under
http://WWW4.ad.siemens.de

Please enter the ID No.: 15257461 in the ”Search” field (top right) and click on ”go”.

/PHD/
SINUMERIK 840D
Configuration Manual NCU (HW) (12/2004 Edition)
Order No.: 6FC5 297–7AC10–0BP0

/PMH/
SIMODRIVE 611
Configuration/Installation Manual
Hollow–Shaft Measuring System SIMAG H (07/2002 Edition)
Order No.: 6SN1197–0AB30–0BP1

/PMH2/
SIMODRIVE 611
Configuration Manual
Hollow–Shaft Measuring System SIMAG H2 (09/2005 Edition)
Order No.: 6SN1197–0AB30–0BP1

c) Software

/FB1/
SINUMERIK 840D/840Di/810D
Function Manual Basic Machine (Part 1) (08/2005 Edition)
Order No.: 6FC5397–0BP10–0AA0

/FB2/
SINUMERIK 840D/840Di/810D
Description of Functions Expansion Functions (Part 2) (08/2005 Edition)
Order No.: 6FC5397–1BP10–0AA0

/FB3/
SINUMERIK 840D/840Di/810D
Description of Functions Special Functions (Part 3) (08/2005 Edition)
Order No.: 6FC5397–2BP10–0AA0

/FBA/
SIMODRIVE 611 digital/SINUMERIK 840D/810D
Description of Functions, Drive Functions (10/2004 Edition)
Order No.: 6SN1 197–0AA80–1BP2

/FBAN/
SINUMERIK 840D/SIMODRIVE 611 digital
Description of Functions
ANA Module (02/2000 Edition)
Order No.: 6SN1 197–0AB80–0BP0

/FBHLA/
SINUMERIK 840D/SIMODRIVE 611 digital
Description of Functions
HLA Module (10/2003 Edition)
Order No.: 6SN1 197–0AB60–0BP3

/FBSI/
SIMODRIVE 611 digital/SINUMERIK 840D
Description of Functions **SINUMERIK Safety Integrated** (09/2005 Edition)
Order No.: 6FC5 297–7AB80–0BP3

/FBU/
SIMODRIVE **611 universal**
Description of Functions (09/2005 Edition)
Control Components for Closed–Loop Speed Control and Positioning
Order No.: 6SN1 197–0AB20–1BP3

/PFK6/
SIMODRIVE 611/MASTERDRIVE MC
Configuration Manual **AC Servomotors**
AC Servomotors 1FK6 (05/2003 Edition)
Order No.: 6SN1 197–0AD05–0BP0

/PFK7/
SIMODRIVE 611/MASTERDRIVE MC
Configuration Manual **AC Servomotors**
AC Servomotors 1FK7 (01/2003 Edition)
Order No.: 6SN1 197–0AD06–0BP0

/PFT6/
SIMODRIVE 611/MASTERDRIVE MC
Configuration Manual **AC Servomotors**
AC Servomotors 1FT6 (02/2004 Edition)
Order No.: 6SN1 197–0AD02–0BP0

/PJALS/
SIMODRIVE 611/MASTERDRIVE MC
Configuration Manual **AC Servomotors**
AC Servomotors, General Part (12/2004 Edition)
Order No.: 6SN1 197–0AD07–0BP2

/PJFE/
SIMODRIVE
Configuration Manual **Synchronous Build–in Motors 1FE1**
AC Motors for Main Spindle Drives (11/2004 Edition)
Order No.: 6SN1 197–0AC00–0BP5

/PJLM/
SIMODRIVE
Configuration Manual **Linear Motors** 1FN1, 1FN3 (06/2002 Edition)
ALL General Information on Linear Motors
1FN1 Three–Phase Linear Motors 1FN1
1FN3 Three–Phase Linear Motors 1FN3
CON Connection System
Order No.: 6SN1 197–0AB70–0BP4

/PJTM/
SIMODRIVE
Configuration Manual **Build–in Torque Motors**
Build–in Torque Motors 1FW6 (11/2003 Edition)
Order No.: 6SN1 197–0AD00–0BP2

/PMS/
SIMODRIVE
Configuration Manual **ECO Motor Spindle**
for Main Spindle Drives 2SP1 (10/2004 Edition)
Order No.: 6SN1 197–0AD04–0BP1

/POS3/
SIMODRIVE
User Manual **POSMO SI/CD/CA** (11/2005 Edition)
Order No.: 6SN2197–0AA20–1BP1

/PJM2/
SIMODRIVE 611, MASTERDRIVES MC
Configuration Manual **Induction Servomotors**
General Part (10/2003 Edition)
Order No.: 6SN1 197–0AC62–0BP0

/PPH2/
SIMODRIVE 611, MASTERDRIVES VC/MC
Configuration Manual **AC Induction Motors**
for Main Spindle Drives 1PH2 (10/2003 Edition)
Order No.: 6SN1 197–0AC63–0BP0

/PPH4/
SIMODRIVE 611, MASTERDRIVES VC/MC
Configuration Manual **AC Induction Motors**
for Main Spindle Drives 1PH4 (10/2003 Edition)
Order No.: 6SN1 197–0AC64–0BP0

/PPH7/
SIMODRIVE 611, MASTERDRIVES VC/MC
Configuration Manual **AC Induction Motors**
for Main Spindle Drives 1PH7 (05/2004 Edition)
Order No.: 6SN1 197–0AC65–0BP1

/PPM/
SIMODRIVE
Configuration Manual **Hollow Shaft Motors**
Hollow Shaft Motors for Main Spindle Drives
1PM6 and 1PM4 (08/2005 Edition)
Order No.: 6SN1 197–0AD03–0BP1

/SP/
SIMODRIVE **611–A/611–D,**
SimoPro 3.1
Program for Configuring Machine Tool Drives
Order No.: 6SC6 111–6PC00–0AA□
Ordering location: WK Fürth

d) Commissioning

/IAD/ SINUMERIK 840D/SIMODRIVE 611D
Commissioning Manual (11/2002 Edition)
(including a description of the start–up software SIMODRIVE 611D)
Order No.: 6FC5 297–6AB10–0BP2

/IADCCU/ SINUMERIK 810D CCU3
Commissioning Manual (11/2002 Edition)
Order No.: 6FC5 298–6CA00–0BG3

■

Certificates

D

Note

An excerpt is provided from the certification of the PROFIBUS User Organization e.V. and the certification of the ”Safe Standstill” function

The complete certification for the ”Safe standstill” function can be found as follows:

Reference: /PJU/ SIMODRIVE 611
Configuration Manual, Drive Converters

Note

Certificates for the products described in this documentation can be found under:

http://intra1.erlf.siemens.de/qm/home/index.html

Note

Listing and file names regarding UL/CSA/FM certification of SIEMENS SIMODRIVE products can be found under:

http://intra1.erlf.siemens.de/qm/Themen/ul_approbation.pdf

http://intra1.erlf.siemens.de/qm/Themen/ul_files.html

D

ZERTIFIKAT

Die PROFIBUS Nutzerorganisation e.V. erteilt der

Siemens AG, A&D MC E21
Frauenauracher Str. 80; D-91056 Erlangen
das Zertifikat Nr.: **Z00531**
für folgendes Produkt:

Name: **SIMODRIVE 611U MC, POSMO SI/CA/CD**
Modell: **Drive**
Version: **V2.2; SW/FW: 03.00.05; HW: 03.00 / 04.00**
GSD: **SI02808F.gsd**

Das Zertifikat bestätigt, daß das oben genannte Produkt die Prüfungen auf Konformität für PROFIBUS DP Slave-Geräte erfolgreich bestanden hat.

Die Prüfungen erfolgten gemäß „Test Specifications for PROFIBUS-DP Slaves, Version 2.0 from February 2000“ und „Test Specifications for PROFIBUS DP-V2 Master and Slave Devices from April 2002“ in dem von der PNO autorisierten Prüflabor bei der Siemens AG in Fürth. Prüfumfang und Prüfergebnis sind im Prüfbericht Nr. 249-4 protokolliert.

Dieses Zertifikat wird erteilt aufgrund der PNO-Richtlinie für Prüfen und Zertifizieren (PRZ) vom 01.08.1999 und ist gültig für einen Zeitraum von 3 Jahren bis zum 24. Februar 2006.

Karlsruhe, den 01.04.2003

(Bearbeiter)

Der Vorstand der PROFIBUS Nutzerorganisation:

(K.-P. Lindner) (Prof. K. Bender)

Fig. D-1 Certificate, PROFIBUS

Fachausschuß Eisen und Metall II
Prüf- und Zertifizierungsstelle
im BG-PRÜFZERT

Hauptverband der gewerblichen
Berufsgenossenschaften

BG-Prüfbescheinigung

01007
Bescheinigungs-Nummer

Name und Anschrift des Bescheinigungsinhabers: (Auftraggeber)	Siemens AG Automatisierungs- und Antriebstechnik Frauenauracher Str. 80, D-91056 Erlangen
Name und Anschrift des Herstellers:	siehe oben

Zeichen des Auftraggebers:	Zeichen der Prüf- und Zertifizierungsstelle:	Ausstellungsdatum:
	612.17-EM II	28.09.2001

Produktbezeichnung:	Anlaufsperre für Antriebsregelgeräte		
Typ:	SIMODRIVE 611 U		
Bestimmungsgemäße Verwendung:	Verhinderung von unerwartetem Anlauf. Kraftlos schalten des Antriebs		
Prüfgrundlage:	DIN EN 60204-1	"Elektrische Ausrüstung von Maschinen-Teil 1: Allgemeine Anforderungen"	11.98
	DIN EN 954-1	Sicherheit von Maschinen - Sicherheitsbezogene Teile von Steuerungen Teil 1 - Allgemeine Gestaltungsleitsätze	03.97
	Nr. I	Grundsätze für die Prüfung und Zertifizierung von Be- und Verarbeitungsmaschinen	05.01
Bemerkungen:	Prüfbericht Nr.: 3012-4/01 Die Anlaufsperre für Antriebsregelgeräte genügt den Anforderungen von DIN EN 954-1, Kat. 3 und kann in Verbindung mit Maschinensteuerungen, die Kat. 3 genügen, eingesetzt werden.		

Das geprüfte Baumuster entspricht der oben angegebenen Prüfgrundlage.
Der Bescheinigungsinhaber ist berechtigt, das umseitig abgebildete BG-PRÜFZERT-Zeichen an den mit dem geprüften Baumuster übereinstimmenden Produkten anzubringen, und zwar mit dem unter 'Bemerkungen' genannten Hinweis.
Diese Bescheinigung wird spätestens ungültig am:

30.09.2006

Weiteres über die Gültigkeit, eine Gültigkeitsverlängerung und andere Bedingungen regelt die Prüf- und Zertifizierungsordnung vom Oktober 1997.

Unterschrift (Körner)

Postadresse: Postfach 37 80, 55027 Mainz
Hausadresse: Wilh Theodor-Römheld-Str. 15, 55130 Mainz
Tel: 06131/802-0
Fax: 06131/802-220

PZB08
12.98

Fig. D-2 Certificate, "Safe standstill" function (German, Zertifikat Funktion "Sicherer Halt")

D

Fachausschuß Eisen und Metall II
Prüf- und Zertifizierungsstelle
im BG-PRÜFZERT

Hauptverband der gewerblichen
Berufsgenossenschaften

Translation

BG Test Certificate

01007
no. of certificate

Name and address of the holder of the certificate: (customer)	Siemens AG Automatisierungs- und Antriebstechnik Frauenauracher Str. 80, D-91056 Erlangen
Name and address of the manufacturer:	see above

Ref. of customer:	Ref. of Test and Certification Body:	Date of Issue:
	612.17-EM II	28.09.2001

Product designation:	Anlaufsperre für Antriebsregelgeräte (Starting inhibit circuit for drives)
Type:	SIMODRIVE 611 U
Intended purpose:	Prevention of unexpected start-up. De-energizing of drives

Testing based on:	EN 60 204-1	„Electrical equipment of machines Part 1- General requirements"	1997
	EN 954-1	„Safety of machinery – Safety related parts of control systems – Part 1 General principles for design"	1996
	No. I	Test principles for the testing and certification of machine tools and processing machinery	05.01
Remarks:	Test report no.: 3012-4/01 The starting inhibit circuit for drives is in compliance with the requirements of EN 954-1, cat. 3 and may be applied with category 3 machine control systems		

The type tested complies with the test basis specified above.
The holder of the certificate is entitled to affix the BG-PRÜFZERT mark shown overleaf to the products complying with the type tested, including the specification given under the heading 'remarks'.
The present certificate will become invalid at the latest on:

30.09.2006

Further provisions concerning the validity, the extension of the validity and other conditions are laid down in the Rules of Procedure for Testing and Certification of October 1997.

Signature (Körner)

PZB08e
12.98

Postal adress:
Postfach 37 80
55027 Mainz

Office:
Wilh Theodor-Römheld-Str. 15
55130 Mainz

Phone: 06131/802-0
Fax: 06131/802-220

In any case, the German original shall prevail.

Fig. D-3 Certificate, "Safe standstill" function (English)

TÜV

Certificate

Certificate no. CU 72052622 01

License Holder:
Siemens AG, A&D MC
Frauenauracher Str. 80

91056 Erlangen
Germany

Manufacturing Plant:
Siemens AG, A&D MC
Frauenauracher Str. 80

91056 Erlangen
Germany

Test report no.: USA-GG 30472653 002 **Client Reference:** Dietmar Wanner

Tested to:
UL 508:1999 R12.03
UL 508C R7.03
NFPA 79:2002
CAN/CSA C22.2 No. 14-95
IEC 61508-1:1998
IEC 61508-2:2000
IEC 61508-3:1998

Certified Product: Ind. Ctrl. Equip. for Safety-related Functions **License Fee - Units**

Listing Category: Industrial Control Equipment
for Safety-Related Functions and E-Stop (per NFPA 79):
Model Designation: SINUMERIK Safety Integrated
Drive Control, consisting of:
SINUMERIK 840D powerline or
SINUMERIK 840DE powerline and
SIMODRIVE 611 digital
Rated Voltage: 3 AC 480V, 60Hz
Rated Power: 3.7kW to 156kW
Protection Class: I
Special Remarks: To be installed according to the licensee's
installation instructions. Replaces Certificate CU72042952.
Appendix: 1

Inh. = 744937 / Deb. = 201200 / Fert. = 744937

Licensed Test mark:
TÜV Rheinland of North America, Inc.
C US

Signatures

Stephan Schmitt
President

Dipl.-Ing. M. Raap
QA Certification Officer

Date of Issue (day/mo/yr)
19/10/2005

TUV Rheinland of North America, Inc., 12 Commerce Road, Newtown, CT 06470, Tel (203) 426-0888 Fax (203) 426-4009

Fig. D-4 Certificate, SINUMERIK Safety Integrated

■

D

Space for your notes

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