SIEMENS

SINAMICS

SINAMICS S120

High Frequency Drive

System Manual

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SIEMENS

SINAMICS

S120
High Frequency Drive

System Manual

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Legal information

Warning notice system

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

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

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

⚠CAUTION
indicates that minor personal injury can result if proper precautions are not taken.

NOTICE
indicates that property damage can result if proper precautions are not taken.

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

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

⚠WARNING
Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

Trademarks

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Disclaimer of Liability

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

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Foreword

SINAMICS documentation

The SINAMICS documentation is organized in the following categories:

- General documentation/catalogs
- User documentation
- Manufacturer/service documentation

Additional information

You can find information on the following topics at the following address (http://w3.siemens.com/mcms/mc-solutions/en/motion-control/support/technical-documentation/Pages/technical-documentation.aspx):

- Ordering documentation/overview of documentation
- Additional links to download documents
- Using documentation online (find and search in manuals/information)

Please send any questions about the technical documentation (e.g. suggestions for improvement, corrections) to the following e-mail address (mailto:docu.motioncontrol@siemens.com).

My Documentation Manager

At the following address (http://www.siemens.com/mdm), you can find information on how to create your own individual documentation based on Siemens' content, and adapt it for your own machine documentation.

Training

At the following address (http://www.siemens.com/sitrain), you can find information about SITRAIN (Siemens training on products, systems and solutions for automation and drives).

FAQs

You can find Frequently Asked Questions in the Service&Support pages under Product Support (https://support.industry.siemens.com/cs/de/en/ps/faq).

SINAMICS

You can find information about SINAMICS at the following address (http://www.siemens.com/sinamics).

Usage phases and their documents/tools (as an example)

Table 1 Usage phases and the available documents/tools

Usage phase	Document/tool
Orientation	SINAMICS S Sales Documentation
Planning/configuration	• SIZER Engineering Tool • Configuration Manuals, Motors
Deciding/ordering	SINAMICS S120 catalogs • SIMOTION, SINAMICS S120 and Motors for Production Machines (Catalog PM 21) • SINAMICS and Motors for Single-axis Drives (Catalog D 31) • SINUMERIK & SINAMICS Equipment for Machine Tools (Catalog NC 61) • SINUMERIK 840D sl Type 1B Equipment for Machine Tools (Catalog NC 62)
Installation/assembly	• SINAMICS S120 Manual for Control Units and Additional System Components • SINAMICS S120 Manual for Booksize Power Units • SINAMICS S120 Manual for Chassis Power Units • SINAMICS S120 Manual for AC Drives • SINAMICS S120M Manual Distributed Drive Technology • SINAMICS S120 Manual Power Units Booksize C/D Type • SINAMICS HLA System Manual Hydraulic Drive
Commissioning	• STARTER Commissioning Tool • SINAMICS S120 Getting Started • SINAMICS S120 Commissioning Manual • SINAMICS S120 CANopen Commissioning Manual • SINAMICS S120 Function Manual • SINAMICS S120 Safety Integrated Function Manual • SINAMICS S120/S150 List Manual • SINAMICS HLA System Manual Hydraulic Drive
Usage/operation	• SINAMICS S120 Commissioning Manual • SINAMICS S120/S150 List Manual • SINAMICS HLA System Manual Hydraulic Drive
Maintenance/servicing	• SINAMICS S120 Commissioning Manual • SINAMICS S120/S150 List Manual
References	• SINAMICS S120/S150 List Manual

Target group

This documentation is intended for machine manufacturers, commissioning engineers, and service personnel who use the SINAMICS drive system.

Benefits

This manual provides all of the information, procedures and operator actions required for the particular usage phase.

Standard scope

The scope of the functionality described in this document can differ from that of the drive system that is actually supplied.

- Other functions not described in this documentation might be able to be executed in the drive system. However, no claim can be made regarding the availability of these functions when the equipment is first supplied or in the event of service.
- The documentation can also contain descriptions of functions that are not available in a particular product version of the drive system. The functionality of the supplied drive system should only be taken from the ordering documentation.
- Extensions or changes made by the machine manufacturer must be documented by the machine manufacturer.

For reasons of clarity, this documentation does not contain all of the detailed information on all of the product types, and cannot take into consideration every conceivable type of installation, operation and service/maintenance.

Technical Support

Country-specific telephone numbers for technical support are provided in the Internet at the following address (https://support.industry.siemens.com/sc/ww/en/sc/2090) in the "Contact" area.

EC Declaration of Conformity, certificates, certifications, manufacturers declarations

You can find the EC Declaration of Conformity for the relevant directives as well as the relevant certificates, prototype test certificates, manufacturers declarations and test certificates for functions relating to functional safety ("Safety Integrated") in the Internet at the following address (https://support.industry.siemens.com/cs/ww/en/ps/13231/cert).

You can obtain an up-to-date list of currently certified components on request from your local Siemens office. If you have any questions relating to certifications that have not yet been completed, please ask your Siemens contact person.

Note

You can find certificates for the North American market on the Internet page of the certifier:

- For products with UL certificate (http://database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/index.html)
- For products with TÜV SÜD certificate (https://www.tuev-sued.de/industry_and_consumer_products/certificates)
- For products with CSA certificate (http://www.csagroup.org/de/en/services/testing-and-certification/certified-product-listing)

Low-Voltage Directive

When operated in dry areas, SINAMICS S units conform to the Low-Voltage Directive 2006/95/EC.

EMC directive

SINAMICS S devices fulfill EMC Directive 89/336/EEC or 2014/130/EEC in the configuration specified in the associated EC Declaration of Conformity for EMC and when the Configuration Manual EMC Installation Guideline, article number 6FC5297-0AD30-0□P□, is implemented.

EMC limit values in South Korea

이 기기는 업무용(A급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.
For sellers or other users, please bear in mind that this device is an A-grade electromagnetic wave device.
This device is intended to be used in areas other than at home.

The EMC limit values to be observed for Korea correspond to the limit values of the EMC product standard for variable-speed electric drives EN 61800-3 of category C2 or the limit value class A, Group 1 to CISPR11. By implementing appropriate additional measures, the limit values according to category C2 or limit value class A, Group 1, are observed. Further, additional measures may be required, such as using an additional radio interference suppression filter (EMC filter).
The measures for EMC-compliant design of the system are described in detail in this manual respectively in the EMC Installation Guideline Configuration Manual.
The final statement regarding compliance with the standard is given by the respective label attached to the individual unit.

Ensuring reliable operation

The manual describes a desired state which, if maintained, ensures the required level of operational reliability and compliance with EMC limit values.

Should there be any deviation from the requirements in the manual, appropriate actions (e.g. measurements) must be taken to check/prove that the required level of operational reliability and compliance with EMC limit values are ensured.

Spare parts

Spare parts are available on the Internet at the following address (https://support.industry.siemens.com/sc/ww/en/sc/2110).

Ground symbols

Table 2 Symbols

Symbol	Meaning
	Connection for protective conductor (PE)
	Ground (e.g. M 24 V)
	Connection for function potential bonding

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Fundamental safety instructions

1

1.1 General safety instructions

⚠DANGER

Danger to life due to live parts and other energy sources

Death or serious injury can result when live parts are touched.

- Only work on electrical devices when you are qualified for this job.
- Always observe the country-specific safety rules.

Generally, six steps apply when establishing safety:

1. Prepare for shutdown and notify all those who will be affected by the procedure.
2. Disconnect the machine from the supply.
   - Switch off the machine.
   - Wait until the discharge time specified on the warning labels has elapsed.
   - Check that it really is in a no-voltage condition, from phase conductor to phase conductor and phase conductor to protective conductor.
   - Check whether the existing auxiliary supply circuits are de-energized.
   - Ensure that the motors cannot move.
3. Identify all other dangerous energy sources, e.g. compressed air, hydraulic systems, or water.
4. Isolate or neutralize all hazardous energy sources by closing switches, grounding or short-circuiting or closing valves, for example.
5. Secure the energy sources against switching on again.
6. Ensure that the correct machine is completely interlocked.

After you have completed the work, restore the operational readiness in the inverse sequence.

⚠WARNING

Danger to life through a hazardous voltage when connecting an unsuitable power supply

Touching live components can result in death or severe injury.

- Only use power supplies that provide SELV (Safety Extra Low Voltage) or PELV-(Protective Extra Low Voltage) output voltages for all connections and terminals of the electronics modules.

⚠WARNING

Danger to life when live parts are touched on damaged devices

Improper handling of devices can cause damage.

For damaged devices, hazardous voltages can be present at the enclosure or at exposed components; if touched, this can result in death or severe injury.

- Ensure compliance with the limit values specified in the technical data during transport, storage and operation.
- Do not use any damaged devices.

⚠WARNING

Danger to life through electric shock due to unconnected cable shields

Hazardous touch voltages can occur through capacitive cross-coupling due to unconnected cable shields.

- As a minimum, connect cable shields and the conductors of power cables that are not used (e.g. brake cores) at one end at the grounded housing potential.

⚠WARNING

Danger to life due to electric shock when not grounded

For missing or incorrectly implemented protective conductor connection for devices with protection class I, high voltages can be present at open, exposed parts, which when touched, can result in death or severe injury.

- Ground the device in compliance with the applicable regulations.

⚠WARNING

Danger to life due to electric shock when opening plug connections in operation

When opening plug connections in operation, arcs can result in severe injury or death.

- Only open plug connections when the equipment is in a no-voltage state, unless it has been explicitly stated that they can be opened in operation.

⚠WARNING

Danger to life due to fire spreading if housing is inadequate

Fire and smoke development can cause severe personal injury or material damage.

- Install devices without a protective housing in a metal control cabinet (or protect the device by another equivalent measure) in such a way that contact with fire is prevented.
- Ensure that smoke can only escape via controlled and monitored paths.

⚠WARNING

Danger to life through unexpected movement of machines when using mobile wireless devices or mobile phones

Using mobile wireless devices or mobile phones with a transmit power > 1 W closer than approx. 2 m to the components may cause the devices to malfunction, influence the functional safety of machines therefore putting people at risk or causing material damage.

- Switch the wireless devices or mobile phones off in the immediate vicinity of the components.

⚠WARNING

Danger to life due to the motor catching fire in the event of insulation overload

There is higher stress on the motor insulation through a ground fault in an IT system. If the insulation fails, it is possible that death or severe injury can occur as a result of smoke and fire.

- Use a monitoring device that signals an insulation fault.
- Correct the fault as quickly as possible so the motor insulation is not overloaded.

⚠WARNING

Danger to life due to fire if overheating occurs because of insufficient ventilation clearances

Inadequate ventilation clearances can cause overheating of components with subsequent fire and smoke. This can cause severe injury or even death. This can also result in increased downtime and reduced service lives for devices/systems.

- Ensure compliance with the specified minimum clearance as ventilation clearance for the respective component.

⚠WARNING

Danger of an accident occurring due to missing or illegible warning labels

Missing or illegible warning labels can result in accidents involving death or serious injury.

- Check that the warning labels are complete based on the documentation.
- Attach any missing warning labels to the components, in the national language if necessary.
- Replace illegible warning labels.

NOTICE

Device damage caused by incorrect voltage/insulation tests

Incorrect voltage/insulation tests can damage the device.

- Before carrying out a voltage/insulation check of the system/machine, disconnect the devices as all converters and motors have been subject to a high voltage test by the manufacturer, and therefore it is not necessary to perform an additional test within the system/machine.

⚠WARNING

Danger to life when safety functions are inactive

Safety functions that are inactive or that have not been adjusted accordingly can cause operational faults on machines that could lead to serious injury or death.

- Observe the information in the appropriate product documentation before commissioning.
- Carry out a safety inspection for functions relevant to safety on the entire system, including all safety-related components.
- Ensure that the safety functions used in your drives and automation tasks are adjusted and activated through appropriate parameterizing.
- Perform a function test.
- Only put your plant into live operation once you have guaranteed that the functions relevant to safety are running correctly.

Note

Important safety notices for Safety Integrated functions

If you want to use Safety Integrated functions, you must observe the safety notices in the Safety Integrated manuals.

1.2 Safety instructions for electromagnetic fields (EMF)

⚠WARNING

Danger to life from electromagnetic fields

Electromagnetic fields (EMF) are generated by the operation of electrical power equipment such as transformers, converters or motors.

People with pacemakers or implants are at a special risk in the immediate vicinity of these devices/systems.

- Ensure that the persons involved are the necessary distance away (minimum 2 m).

1.3 Handling electrostatic sensitive devices (ESD)

Electrostatic sensitive devices (ESD) are individual components, integrated circuits, modules or devices that may be damaged by either electric fields or electrostatic discharge.

NOTICE

Damage through electric fields or electrostatic discharge

Electric fields or electrostatic discharge can cause malfunctions through damaged individual components, integrated circuits, modules or devices.

- Only pack, store, transport and send electronic components, modules or devices in their original packaging or in other suitable materials, e.g conductive foam rubber of aluminum foil.
- Only touch components, modules and devices when you are grounded by one of the following methods:
  - Wearing an ESD wrist strap
  - Wearing ESD shoes or ESD grounding straps in ESD areas with conductive flooring
- Only place electronic components, modules or devices on conductive surfaces (table with ESD surface, conductive ESD foam, ESD packaging, ESD transport container).

1.4 Industrial security

Note

Industrial security

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, solutions, machines, equipment and/or networks. They are important components in a holistic industrial security concept. With this in mind, Siemens' products and solutions undergo continuous development. Siemens recommends strongly that you regularly check for product updates.

For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action (e.g. cell protection concept) and integrate each component into a holistic, state-of-the-art industrial security concept. Third-party products that may be in use should also be considered. For more information about industrial security, visit this address (http://www.siemens.com/industrialsecurity).

To stay informed about product updates as they occur, sign up for a product-specific newsletter. For more information, visit this address (http://support.automation.siemens.com).

⚠ WARNING

Danger as a result of unsafe operating states resulting from software manipulation

Software manipulation (e.g. by viruses, Trojan horses, malware, worms) can cause unsafe operating states to develop in your installation which can result in death, severe injuries and/or material damage.

- Keep the software up to date.

  You will find relevant information and newsletters at this address (http://support.automation.siemens.com).
- Incorporate the automation and drive components into a holistic, state-of-the-art industrial security concept for the installation or machine.

  You will find further information at this address (http://www.siemens.com/industrialsecurity).
- Make sure that you include all installed products into the holistic industrial security concept.

1.5 Residual risks of power drive systems

The control and drive components of a drive system are approved for industrial and commercial use in industrial line supplies. Their use in public line supplies requires a different configuration and/or additional measures.

These components may only be operated in closed housings or in higher-level control cabinets with protective covers that are closed, and when all of the protective devices are used.

These components may only be handled by qualified and trained technical personnel who are knowledgeable and observe all of the safety instructions on the components and in the associated technical user documentation.

When assessing the machine's risk in accordance with the respective local regulations (e.g., EC Machinery Directive), the machine manufacturer must take into account the following residual risks emanating from the control and drive components of a drive system:

1. Unintentional movements of driven machine components during commissioning, operation, maintenance, and repairs caused by, for example,
   - Hardware and/or software errors in the sensors, control system, actuators, and cables and connections
   - Response times of the control system and of the drive
   - Operation and/or environmental conditions outside the specification
   - Condensation/conductive contamination
   - Parameterization, programming, cabling, and installation errors
   - Use of wireless devices/mobile phones in the immediate vicinity of the control system
   - External influences/damage
2. In the event of a fault, exceptionally high temperatures, including an open fire, as well as emissions of light, noise, particles, gases, etc. can occur inside and outside the inverter, e.g.:
   - Component failure
   - Software errors
   - Operation and/or environmental conditions outside the specification
   - External influences/damage

   Inverters of the Open Type/IP20 degree of protection must be installed in a metal control cabinet (or protected by another equivalent measure) such that contact with fire inside and outside the inverter is not possible.

3. Hazardous shock voltages caused by, for example,
   - Component failure
   - Influence during electrostatic charging
   - Induction of voltages in moving motors
   - Operation and/or environmental conditions outside the specification
   - Condensation/conductive contamination
   - External influences/damage
4. Electrical, magnetic and electromagnetic fields generated in operation that can pose a risk to people with a pacemaker, implants or metal replacement joints, etc., if they are too close
5. Release of environmental pollutants or emissions as a result of improper operation of the system and/or failure to dispose of components safely and correctly

Note

The components must be protected against conductive contamination (e.g. by installing them in a control cabinet with degree of protection IP54 according to IEC 60529 or NEMA 12).

Assuming that conductive contamination at the installation site can definitely be excluded, a lower degree of cabinet protection may be permitted.

For more information about residual risks of the components in a drive system, see the relevant sections in the technical user documentation.

System overview

2

2.1 SINAMICS S120 High Frequency Drive components

System components

- Line-side power components such as fuses and contactors to switch the energy supply
- Line filter to comply with EMC regulations
- DC link components (Braking Module, Control Supply Module) used optionally for stabilizing the DC link voltage
- Additional system components and encoder system connections to expand the functionality and to handle various interfaces for encoders and process signals.

Components for High Frequency Drives

- HF Motor Module that operates as an inverter and provides the power supply for the connected motor.
- HF Sine Filter Module consisting of
  - HF Choke Module and
  - HF Damping Module.
- Voltage Protection Module to protect the DC link against high motor voltages (optional).

Additional SINAMICS components are required to provide the required functions:

- Control Unit for processing drive and technology functions.
- Active Line Module that has the function of centrally supplying the power to the DC link.
- Braking Module (optional)
- Control Supply Module (optional)

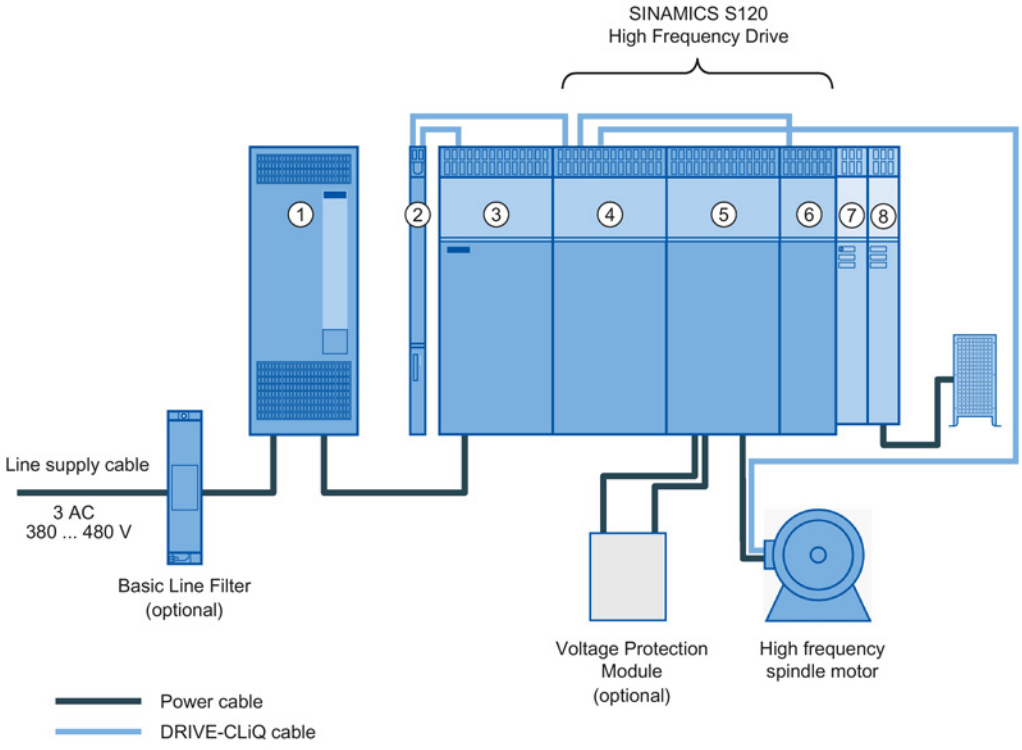
The SINAMICS S120 High Frequency Drive is exclusively intended for installation in a control cabinet.

Cooling methods

The SINAMICS S120 High Frequency Motor Module is available with liquid cooling.

The HF Sine Filter Module, comprising the HF Choke Module and the HF Damping Module, is available with the "Cold Plate" cooling type with additional internal fans.

2.2 Overview



① Active Interface Module booksize
② Control Unit NX15.3
③ Active Line Module booksize
④ HF Motor Module
⑤ HF Choke Module
⑥ HF Damping Module 〉 HF Sine Filter Module
⑦ Control Supply Module (optional)
⑧ Braking Module with braking resistor (optional)

Figure 2-1 Example of an HF drive line-up with Active Line Module booksize

WARNING

Risk of fire when using a synchronous motor without a Voltage Protection Module, Braking Module or Control Supply Module.

When a synchronous motor is not used together with a Voltage Protection Module, a Braking Module and a Control Supply Module then there is a risk of fire and associated smoke. This results in a risk of death.

- When using a synchronous motor, it is imperative that you always use a Voltage Protection Module, Braking Module and Control Supply Module.

2.3 System data

Unless explicitly specified otherwise, the following technical data are valid for components of the SINAMICS S120 drive system.

Table 2- 1 Electrical data

Line voltage	3-phase 380 … 480 VAC ±10%
Line frequency	47 … 63 Hz
Line supply types	TN systems
Electronics power supply	24 V DC -15/+20 % Safety extra low-voltage (PELV / SELV)
Short-circuit current rating (SCCR) in accordance with UL 508C (up to 600 V)	1.1 … 447 kW: 65 kA
DC link supply voltage	510 … 720 V DC
Radio interference suppression	Category C3 for plant and system versions in conformance with the documentation
Overvoltage category	III
Degree of contamination	2

Table 2- 2 Environmental conditions

Degree of protection	IPXXB acc. to IEC 60529, open type according to UL 508C
Protection class, line supply circuits Electronic circuits	I (with protective conductor connection) safety extra-low voltage (PELV / SELV)
Permissible cooling medium temperature (air) and installation altitude in operation	0 °C up to +40 °C and up to 1000 m above sea level without derating, From an altitude of 1000 m, the maximum ambient temperature is reduced by 3.5 K per 500 m. Maximum installation altitude: 4000 m above sea level
Chemically active substances	
Long-term storage in the transport packaging	Class 1C2 according to EN 60721-3-1
Transport in the transport packaging	Class 2C2 according to EN 60721-3-2
Operation	Class 3C2 according to EN 60721-3-3
Biological environmental conditions	
Long-term storage in the transport packaging	Class 1B1 according to EN 60721-3-1
Transport in the transport packaging	Class 2B1 according to EN 60721-3-2
Operation	Class 3B1 according to EN 60721-3-3
Vibratory load	
Long-term storage in the transport packaging	Class 1M2 in accordance with EN 60721-3-1
Transport in the transport packaging	Class 2M3 in accordance with EN 60721-3-2
Operation	Class 3M2 according to EN 60721-3-3

Shock stressing	
Long-term storage in the transport packaging	Class 1M2 in accordance with EN 60721-3-1
Transport in the transport packaging	Class 2M3 in accordance with EN 60721-3-2
Operation	Test values: 15 g / 11 ms
Climatic environmental conditions	
Long-term storage in the transport packaging	Class 1K4 acc. to EN 60721-3-1 Temperature: -25 … +55 °C
Transport in the transport packaging	Class 2K4 according to EN 60721-3-2 Temperature: -40°C ... +70°C
Operation	better than Class 3K3 according to EN 60721-3-3 Temperature: 0 … +40 °C without derating, >40 ... 55 °C see derating curves Relative humidity: 5 ... 95 % (no condensation) Oil mist, salt mist, ice formation, condensation, dripping water, spraying water, splashing water and water jets are not permitted

Table 2- 3 Certificates

Declarations of Conformity	CE
Approvals	USA approval (TÜV SÜD NRTL approval)

High Frequency Modules, line connection

3

To connect the SINAMICS S120 High Frequency Drive drive line-up to the line supply these components are used:

- Overcurrent protection device (line fuse or circuit breaker)
- Line contactor, line disconnector device (optional)
- Line filter
- Active Interface Module

Booksize

The line connection for an S120 High Frequency Drive with a booksize Active Line Module comprises, in addition to the regionally required protective devices, an optional line filter and an Active Interface Module.

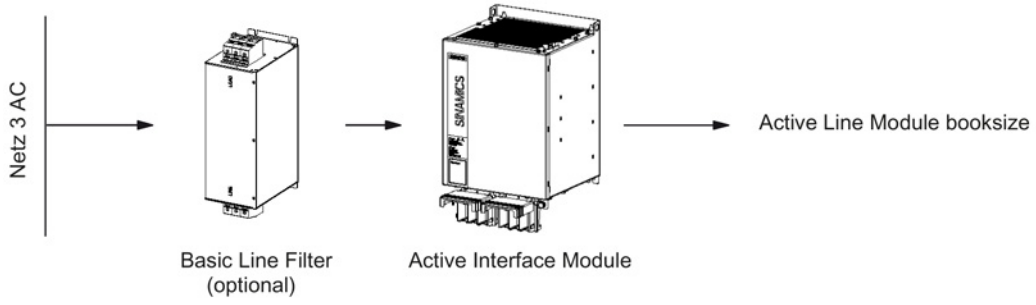


Figure 3-1 Overview diagram, line connection booksize

Note

With line filter, Active Interface Module and Active Line Module, the High Frequency drive attains radio interference voltage, Category C3 (I_{Line} > 100 A).

Chassis

The line interface for a SINAMICS S120 High Frequency Drive with an Active Line Module Chassis comprises, in addition to the regionally stipulated protective devices, an Active Interface Module – and depending on the frame size of the Active Interface Module, an additional bypass contactor. A drive line-up with chassis components can be implemented with radio interference voltage category C3.

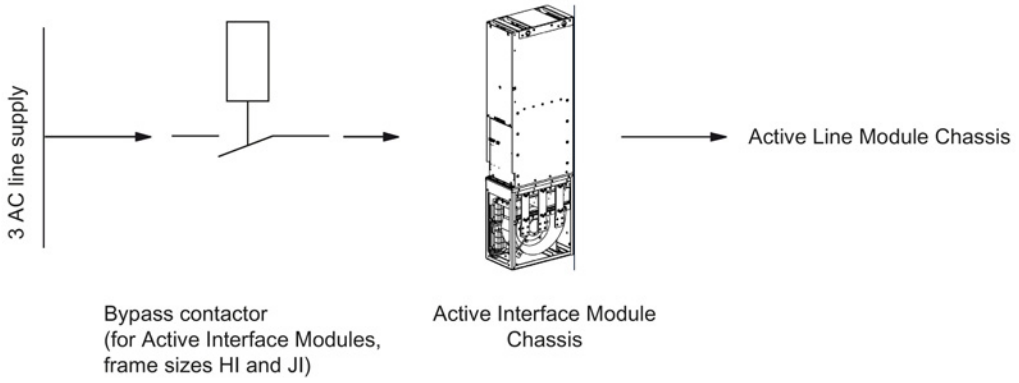


Figure 3-2 Block diagram, line connection, chassis

Note

You can find detailed information about the line interface in the SINAMICS S120 Manuals:

- Power components booksize manual (GH2)
- Power units chassis manual (GH3)

High Frequency Modules

4

4.1 Introduction

The SINAMICS S120 High Frequency Drive is an inverter with integrated output filter (HF Sine Filter Module) to control motors with high output frequencies (up to 2400 Hz). The High Frequency Drive is operated with a pulse frequency of 16 kHz or 32 kHz, and a current controller clock cycle of 62.5 µs or 31.25 µs.

High Frequency Drives are used for high-performance machining in tool and mold making for and for cutting gear wheels. It can be used in conjunction with high-speed spindle motors and torque motors.

High Frequency Drives are only designed for installation in control cabinets.

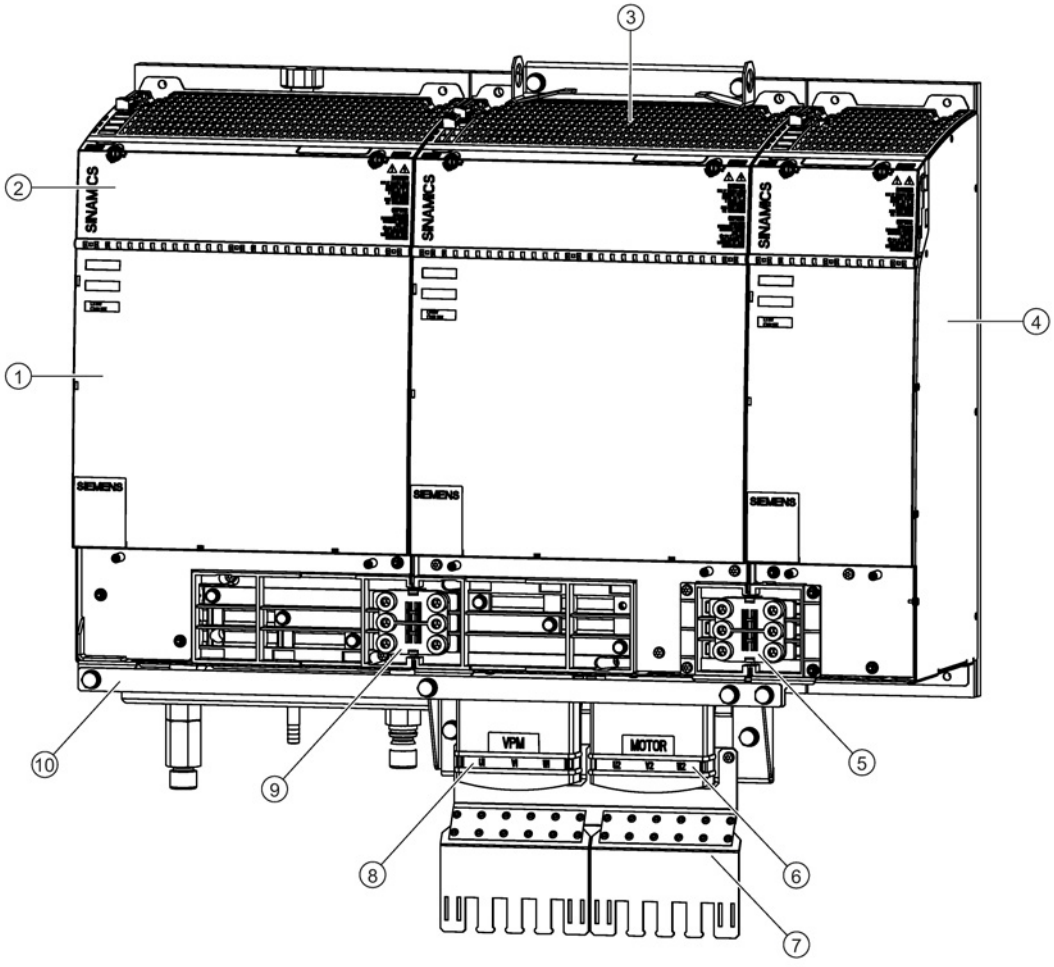
A High Frequency Drive consists of three components (HF modules), which can only be operated together in the HF line-up:

- HF Motor Module
- HF Choke Module (reactor module)
- HF Damping Module

HF Choke Modules and HF Damping Module together form the HF Sine Filter Module.

The HF line-up is supplied from the factory in individual components.

The diagram shows the arrangement of the components in the HF line-up.



① HF Motor Module
② DC link busbar (behind the protective cover)
③ HF Choke Module
④ HF Damping Module
⑤ Busbar connector, HF Damping Module - HF Choke Module
⑥ Motor connection
⑦ Shield connection plate
⑧ Connection for a Voltage Protection Module (VPM)
⑨ Busbar connector, HF Motor Module - HF Choke Module
⑧ Equipotential bonding bar

Figure 4-1 High Frequency Drive: Mechanical design

In addition, these components are required to operate a High Frequency Drive:

- Active Line Module in the booksize or chassis format in conjunction with an Active Interface Module
- Control Unit
- Voltage Protection Module (for synchronous motors)
- Braking Module (for synchronous motors)
- Control Supply Module (for synchronous motors)
- 24 V power supply, for example SITOP

Table 4- 1 HF module package Liquid Cooled

Article No.	Dimensions (W x H x D) [mm]	Technical data	Cooling
6SL3125-1UE32-2AD0	750 x 622 x 226	16 kHz, 400 V, 225 A	Liquid cooling

The HF module package includes the parts listed in the table.

Table 4- 2 Scope of supply

Designation	Article No.	Quantity
HF Motor Module	6SL3125-1UE32-2AA0	1
HF Choke Module	6SL3125-2UE32-2AA0	1
HF Damping Module	6SL3125-3UE32-2AA0	1
3-phase busbar connector for transverse busbar connections		2
Equipotential bonding bar		1
Shield connection plate		1
Terminal Kit		1

4.2 Safety instructions for High Frequency Modules

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

The non-observance of the fundamental safety instructions and residual risks stated in Chapter 1 can result in accidents with severe injuries or death.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account remaining risks.

⚠WARNING

Danger of death caused by high discharge currents when the external protective conductor is interrupted

Drive components conduct high discharge currents via the protective conductor. When the protective conductor is interrupted, touching live components can result in electric shock, which can lead to death or serious injuries.

- Ensure that the external protective conductor complies with at least one of the following conditions:
  - It is laid protected against mechanical damage.[1)]
  - If it consists of a single conductor, it has a cross section of at least 6 mm² Cu.
  - As a core of a multi-core cable, it has a cross section of at least 2.5 mm² Cu.
  - It has a parallel, second protective conductor with the same cross-section.
  - It corresponds to the local regulations for equipment with increased leakage current.

  [1)] Cables routed in control cabinets or enclosed machine enclosures are considered to be adequately protected against mechanical damage.

⚠DANGER

Danger of death due to electric shock resulting from residual charge of the DC link capacitors

As a result of the DC link capacitors, a hazardous voltage is present for up to 5 minutes after the power supply has been switched off.

Touching live components results in death or severe injury.

- Only open the DC link protective cover after 5 min. has elapsed.
- Before starting any work, measure the voltage at the DC link terminals DCP and DCN.

⚠DANGER

Danger to life as a result of electric shock when the DC link protective cover is open

Touching live components results in death or severe injury.

- Only operate the components with the protective cover of the DC link components closed.

⚠WARNING

Danger to life due to electric shock when connecting to the DC link

Incorrectly established connections can result in overheating and therefore fire with associated smoke. Further, there is risk of electric shock. This can result in severe injury or death.

- To connect to the DC link, only use the adapters that have been released for the purpose (DC link adapter and DC link rectifier adapter).

⚠WARNING

Danger to life due to electric shock as a result of missing DC link side covers

If the DC link side covers are missing, there is a risk of electric shock when coming into contact with the DC link.

- Mount the side covers supplied with the equipment at the first and last component in the drive line-up.
- Order any missing side covers (Article number: 6SL3162-5AA00-0AA0).

⚠WARNING

Risk of accident as a result of missing warning labels in the local language

Missing warning labels in the local language can result in accidents leading to death or severe injury.

- Attach warning labels in the local language on components.

NOTICE

Material damage caused by loose power connections

Insufficient tightening torques or vibration can result in faulty electrical connections. This can result in damage due to fire or malfunctions.

- Tighten all power connections with the specified tightening torques, e.g. line supply connection, motor connection, DC-link connections.
- Check the tightening torques of all power connections at regular intervals, and retighten them accordingly. This applies in particular after transport.

NOTICE

Damage when using incorrect DRIVE-CLiQ cables

Damage or malfunctions can occur on the devices or system when DRIVE-CLiQ cables are used that are either incorrect or have not been approved for this purpose.

- Only use suitable DRIVE-CLiQ cables that have been approved by Siemens for the particular application.

4.3 HF Motor Module

4.3.1 Description

An HF Motor Module is a power unit (inverter) that provides the power for the motor connected to it. An Active Line Module provides the power supply. From the 3-phase line voltage, this generates a regulated constant DC voltage in the DC link of the HF drive lineup.

The HF Motor Module must be connected with the Control Unit via DRIVE-CLiQ.

4.3.2 Interfaces

4.3.2.1 Overview

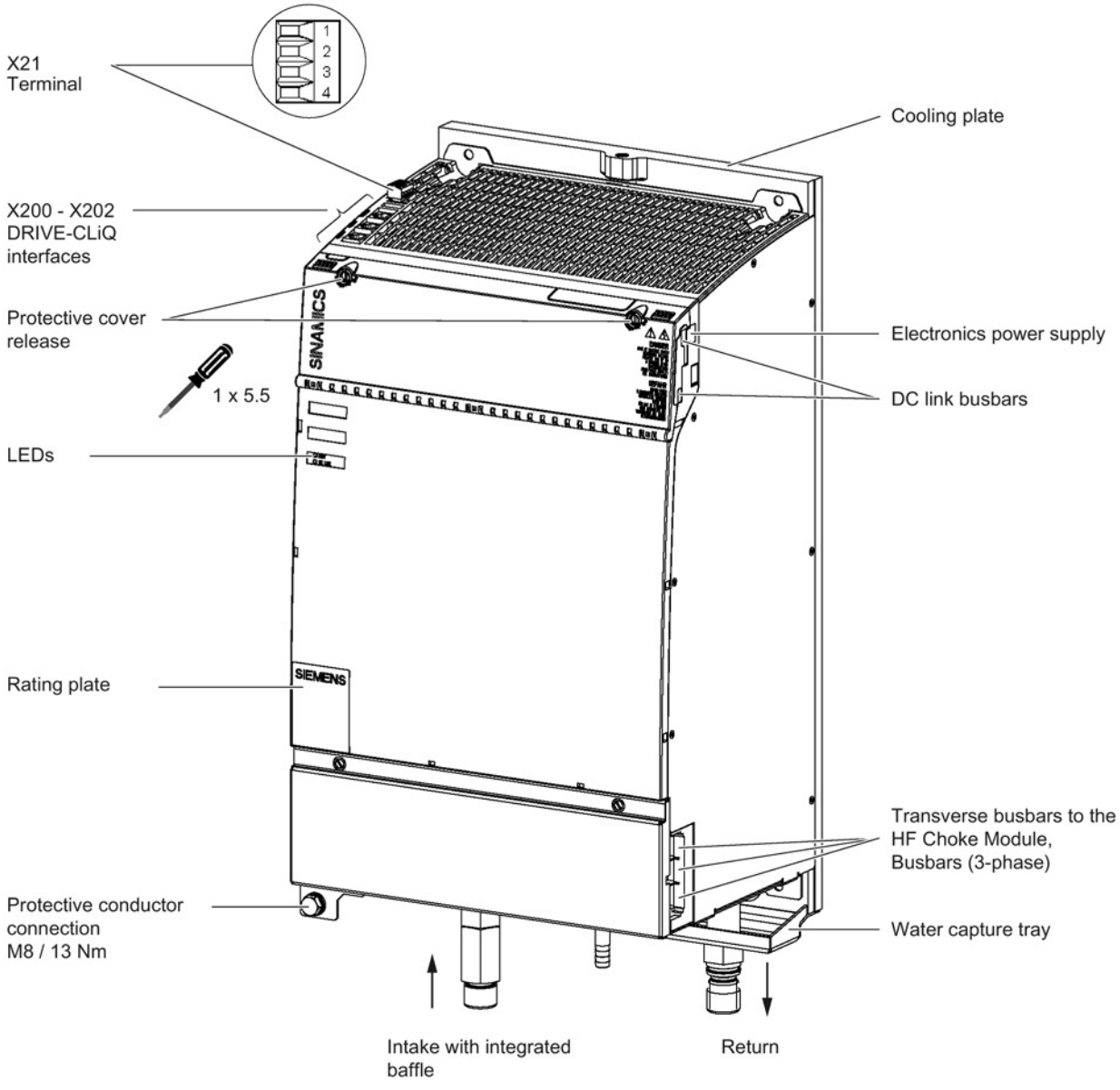
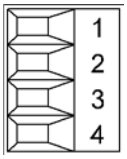


Figure 4-2 Interface overview of HF Motor Modules Liquid Cooled

4.3.2.2 X21 EP terminals/temperature sensor motor module

Table 4- 3 X21 EP terminal/temperature sensor

	Terminal	Function	Technical data
	1	+ Temp	Temperature sensors: KTY84–1C130 / PTC / bimetallic switch with NC contact
	2	- Temp	
	3	EP +24 V (enable pulses)	Supply voltage: 24 V DC (20.4 ... 28.8 V) Current consumption: 10 mA Isolated input Signal propagation times: L → H: 100 µs H → L: 1000 µs The pulse inhibit function is only available when Safety Integrated Basic Functions are enabled.
	4	EP M1 (Enable Pulses)	
Type: Screw terminal 1 (Page 172) Max. connectable cross-section: 1.5 mm²			

EP terminal

The filter times to debounce terminals X21.3 and X21.4 are set using parameters (see SINAMICS S120/S150 List Manual). Additional parameter settings are also required in order to prevent discrepancy errors when performing bit pattern tests (light/dark tests). For comprehensive information, see the SINAMICS S120 Safety Integrated Function Manual, Chapter "Controlling the safety functions".

⚠WARNING

Danger to life due to electric shock when connecting unsuitable voltages

Touching parts and components that are at excessively high voltages can result in death or severe injury.

- Only connect safety extra-low voltages (PELV/SELV) at terminals "EP +24 V" and "EP M1".

Note

Function of the EP terminals

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

Temperature sensor

⚠WARNING

Danger to life due to electric shock caused by voltage flashovers to the temperature sensor cable

Voltage flashovers to the signal electronics can occur for temperature sensors without safe electrical separation.

- Use temperature sensors that fully comply with the specifications of protective separation (safety isolation).
- If safe electrical separation cannot be guaranteed (for linear motors or third-party motors, for example), use a Sensor Module External (SME120 or SME125) or Terminal Module TM120.

NOTICE

Damage due to overheating, caused by a KTY temperature sensor that has been incorrectly connected

If the KTY temperature sensor was not connected with the correct polarity, motor overheating may not be detected.

- Connect the KTY sensor with the correct polarity.

NOTICE

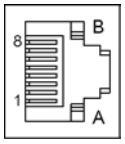
Device failure as a result of unshielded or incorrectly routed cables to temperature sensors

Unshielded or incorrectly routed cables to temperature sensors can result in interference being coupled into the signal processing electronics from the power side. This can result in significant disturbance of all signals (fault messages) up to failure of individual components (destruction of the devices).

- Only use shielded cables as temperature sensor cables.
- If temperature sensor cables are routed together with the motor cable, use separately shielded cables twisted in pairs.
- Connect the cable shield at both ends to ground potential through a large surface area.
- Recommendation: Use suitable MOTION CONNECT cables.

4.3.2.3 X200-X202 DRIVE-CLiQ interfaces

Table 4- 4 X200-X202 DRIVE-CLiQ interfaces

	Pin	Name	Technical data
	1	TXP	Transmit data +
	2	TXN	Transmit data -
	3	RXP	Receive data +
	4	Reserved, do not use	
	5	Reserved, do not use	
	6	RXN	Receive data -
	7	Reserved, do not use	
	8	Reserved, do not use	
	A	+ (24 V)	Power supply
	B	M (0 V)	Electronics ground

The blanking covers for the DRIVE-CLiQ interfaces are included in the scope of delivery.

Blanking covers (50 x) Article No.: 6SL3066-4CA00-0AA0

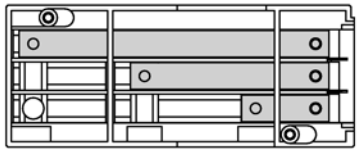
4.3.2.4 Protective conductor connection

Table 4- 5 Protective conductor connection for HF Motor Module

	Terminals	Technical data
	PE connection for attaching the equipotential bonding bar	Threaded hole: M8 Tightening torque: 13 Nm For ring cable lugs without insulation (Page 173)

4.3.2.5 Busbars

Table 4- 6 Busbars at the HF Motor Module

	Technical data
	Threaded hole: M5 Tightening torque: 3 Nm

4.3.3 Meaning of the LEDs

Table 4- 7 Meaning of the LEDs

State		Description, cause	Remedy
RDY	DC LINK		
Off	Off	The electronics power supply is missing or outside the permissible tolerance range.	–
Green	--	The component is ready for operation. Cyclic DRIVE-CLiQ communication is taking place.	–
	Orange	The component is ready for operation. Cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is present.	–
	Red	The component is ready for operation. Cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is too high.	Check the line supply voltage.
Orange	Orange	DRIVE-CLiQ communication is being established.	–
Red	--	This component has at least one fault. **Note:** The LED is controlled irrespective of the corresponding messages being reconfigured.	Resolve and acknowledge the fault.
Green/red (0.5 Hz)	--	Firmware is being downloaded.	–
Green/red (2 Hz)	--	Firmware download is complete. The system waits for POWER ON.	Carry out a POWER ON.
Green/orange or Red/orange	--	Recognition of components via LED is activated[1]. **Note:** Both options depend on the LED status when activated.	–

[1] See SINAMICS S120/S150 List Manual for the parameters to activate the recognition of components via LED

⚠DANGER

Danger to life as a result of electric shock when coming into contact with the DC link voltage

Irrespective of the state of the LED "DC LINK", hazardous DC link voltages can always be present.

Death or serious injury can result when live parts are touched.

- Observe the warning information on the component.

4.3.4 Dimension drawing

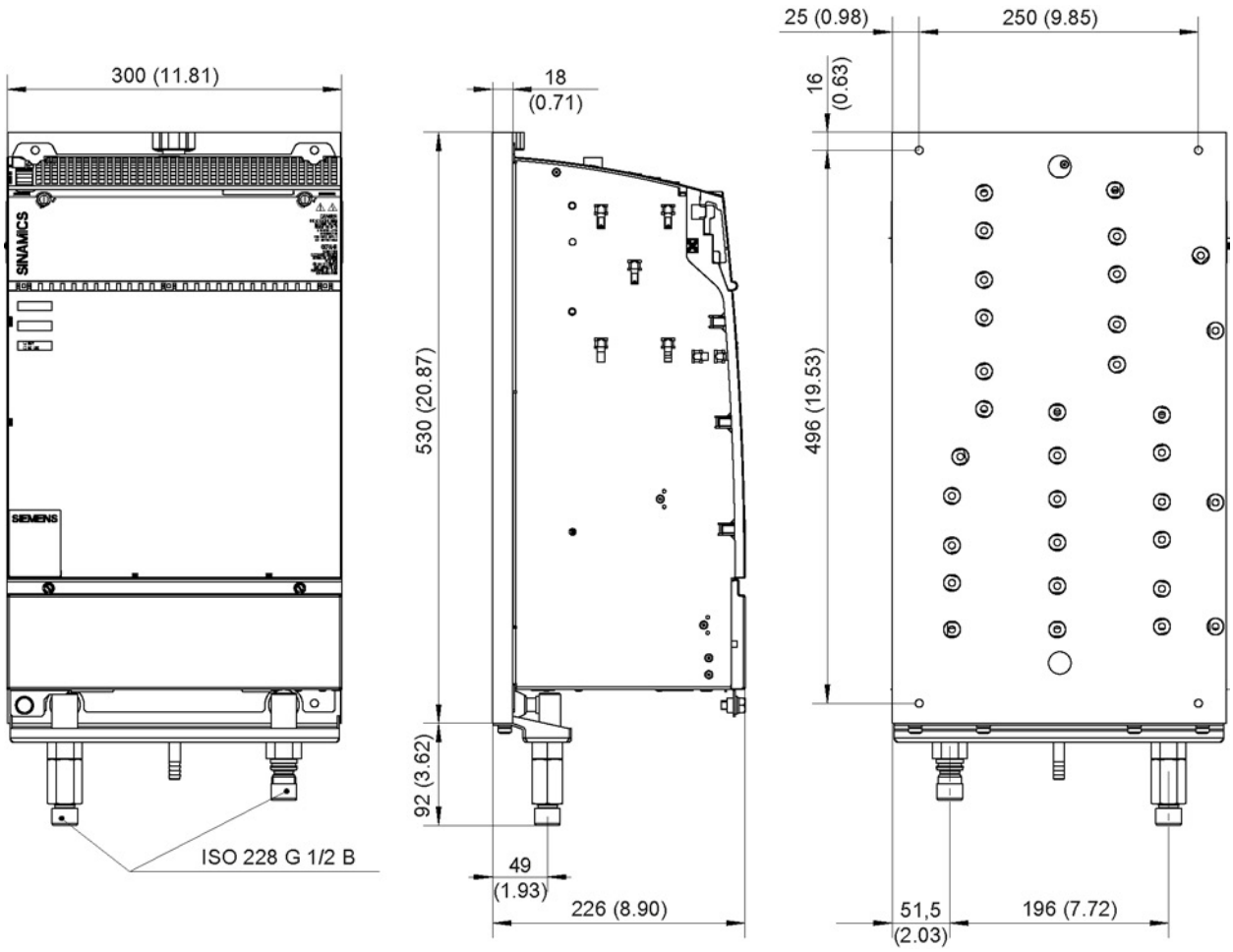


Figure 4-3 Dimension drawing of HF Motor Modules Liquid Cooled in mm and (inches)

4.4 HF Sine Filter Module

4.4.1 Description

The HF Sine Filter Module is the output filter (sine-wave filter) in the High Frequency Drive. It limits the harmonics and switching edges generated by the switching operations of the inverter to values that are permissible for the motor and can be tolerated. It opposes an excessively high dV/dt rise.

The HF Sine Filter Module comprises a HF Choke Module and a HF Damping Module. This filter means that the voltage between the motor terminals is almost sinusoidal. This reduces the voltage stress on the motor windings, which is excited by the pulse frequency of the HF Motor Module.

The HF Sine Filter Module must be mounted directly to the right of the HF Motor Module.

The HF module line-up can be operated with a pulse frequency of 16 kHz or 32 kHz. This increases the damping properties of the system.

HF Choke Module

The HF Choke Module contains the reactor of the sine-wave filter. It has a terminal block to connect the power cables to the motor and a terminal block to connect the Voltage Protection Module (VPM).

The following signals are acquired in the HF Choke Module, and transferred to the HF Damping Module for monitoring and diagnostics:

- Reactor temperature via KTY temperature sensor
- Overtemperature trip

HF Damping Module

The HF Damping Module contains the capacitors of the sine-wave filter. Further, part of the filter power loss is fed back into the DC link via this module. This is the reason that this module must be connected with the DC link.

4 measured values are acquired in the HF Damping Module, and transferred to the Control Unit via DRIVE-CLiQ:

- Filter currents in all 3 phases of the filter capacitors
- Damping voltage
- Device temperature
- Temperature of the HF Choke Module via the KTY temperature sensor

4.4.2 HF Choke Module interfaces

4.4.2.1 Overview

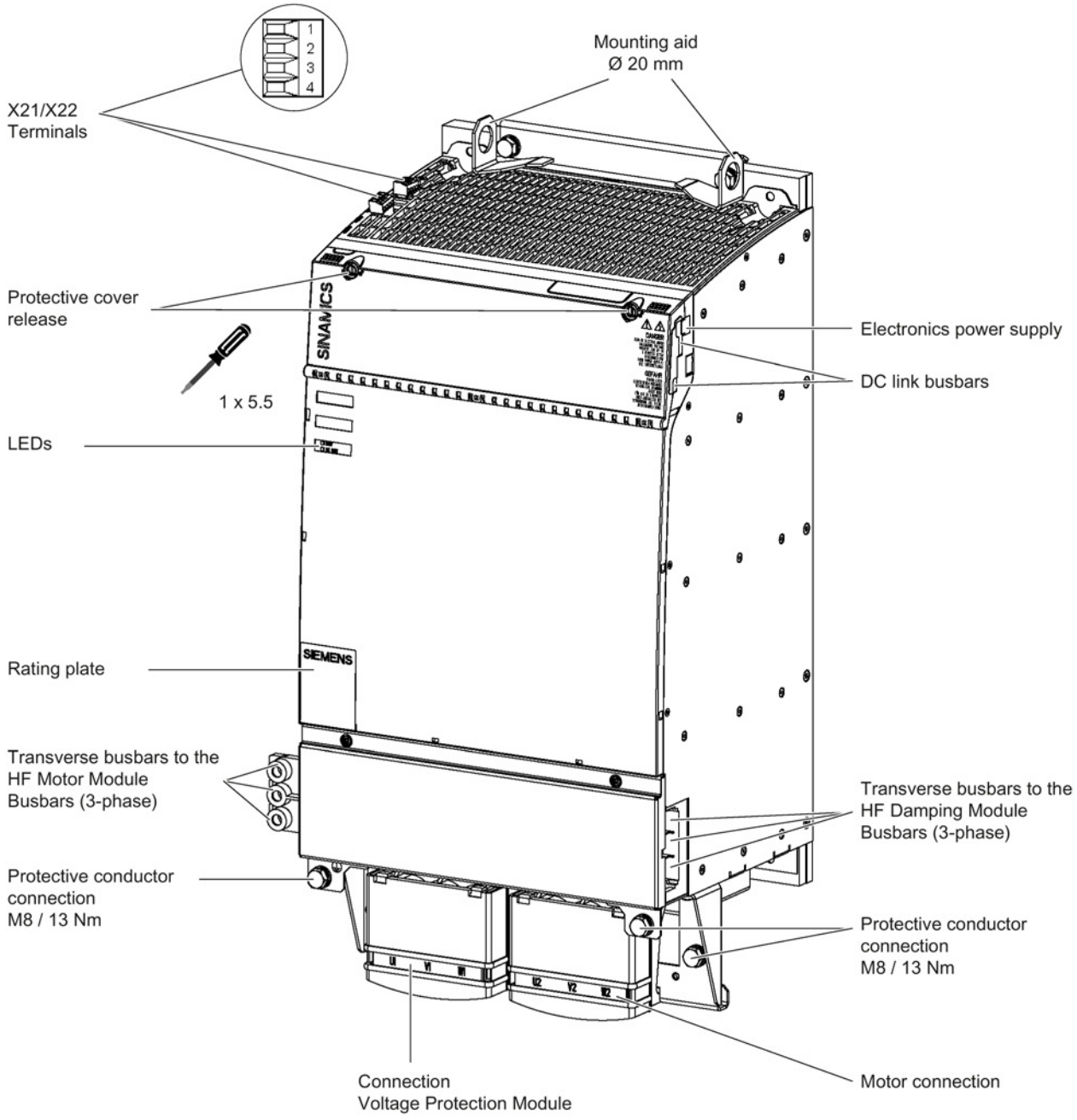
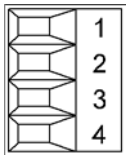


Figure 4-4 Interface overview, HF Choke Module

4.4.2.2 X21 outputs for temperature monitoring

Table 4- 8 X21 outputs for temperature monitoring

	Terminal	Function	Technical data
	1	+ KTY	Temperature HF Choke Module analog: KTY84-1C130 temperature sensor
	2	- KTY	
	3	+ Temp switch	Temperature monitoring for the HF Choke Module using the integrated bimetallic switch
	4	- Temp switch	
Type: Screw terminal 1 (Page 172) Max. connectable cross-section: 1.5 mm²			

Note

Internal fans

The internal fans of the HF Choke Module run permanently regardless of the temperature and whether the pulses are enabled.

Connect the terminals to transfer the temperature signals

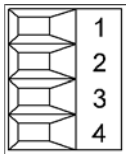
The HF line-up does not function without the X21 terminals being connected. Therefore, it is absolutely necessary that the following terminals are connected with one another to transfer the temperature signals from the HF Choke Module to the HF Damping Module:

- X21.1 and X21.2 on the HF Choke Module with X21.1 and X21.2 on the HF Damping Module
- X21.3 and X21.4 on the HF Choke Module with X21.3 and X21.4 on the HF Damping Module

Use shielded signal cables and connect the cable shields to the supplied shield terminal.

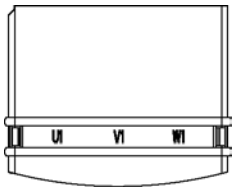
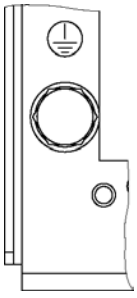
4.4.2.3 X22 fan control for commissioning

Table 4- 9 X22 fan control for commissioning

	Terminal	Function	Technical data
	1	n.c.	
	2	n.c.	
	3	Disable FAN	Using a jumper, the fans can be deactivated **for commissioning**.
	4	Disable FAN	
Type: Screw terminal 1 (Page 172) Max. connectable cross-section: 1.5 mm²			

4.4.2.4 Voltage Protection Module Connection

Table 4- 10 Voltage Protection Module Connection

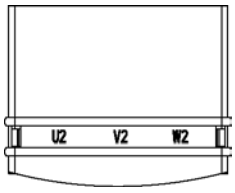
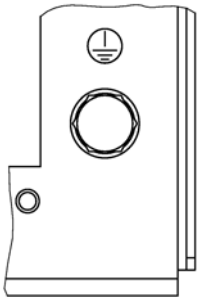
	Terminals	Technical data
	U1 V1 W1	Threaded bolts: M8 Tightening torque: 13 Nm For ring cable lugs without insulation (Page 173)
	PE connection	Threaded hole: M8 Tightening torque: 13 Nm For ring cable lugs without insulation (Page 173) Connection photograph, see Chapter Electrical connection (Page 62)

Note

The Voltage Protection Module power cables may have a maximum length of 3 m.

4.4.2.5 Motor connection

Table 4- 11 Motor connection

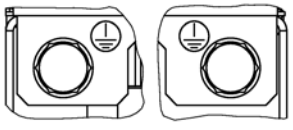
	Terminals	Technical data
	U2 V2 W2	Threaded bolts: M8 Tightening torque: 13 Nm For ring cable lugs without insulation (Page 173)
	PE connection	Threaded hole: M8 Tightening torque: 13 Nm For ring cable lugs without insulation (Page 173) Connection photograph, see Chapter Electrical connection (Page 62)

Note

The total length of the shielded power cables must not exceed 100 m.

4.4.2.6 Protective conductor connections for the equipotential bonding bar

Table 4- 12 Protective conductor connections HF Choke Module

	Terminals	Technical data
	PE connections directly at the housing to fix the equipotential bonding bar	Threaded hole: M8 Tightening torque: 13 Nm For ring cable lugs without insulation (Page 173)

4.4.2.7 Busbars

Table 4- 13 Busbars to the HF Motor Module

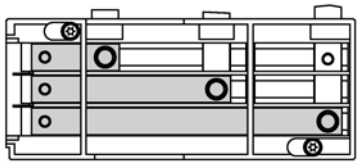
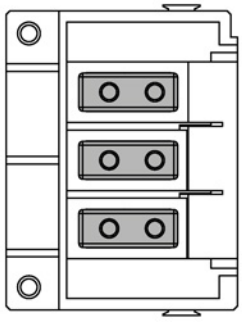
	Technical data
	Threaded hole: M5 Tightening torque: 3 Nm

Table 4- 14 Busbars to the HF Damping Module

	Technical data
	Threaded hole: M5 Tightening torque: 3 Nm

4.4.3 HF Damping Module interfaces

4.4.3.1 Overview

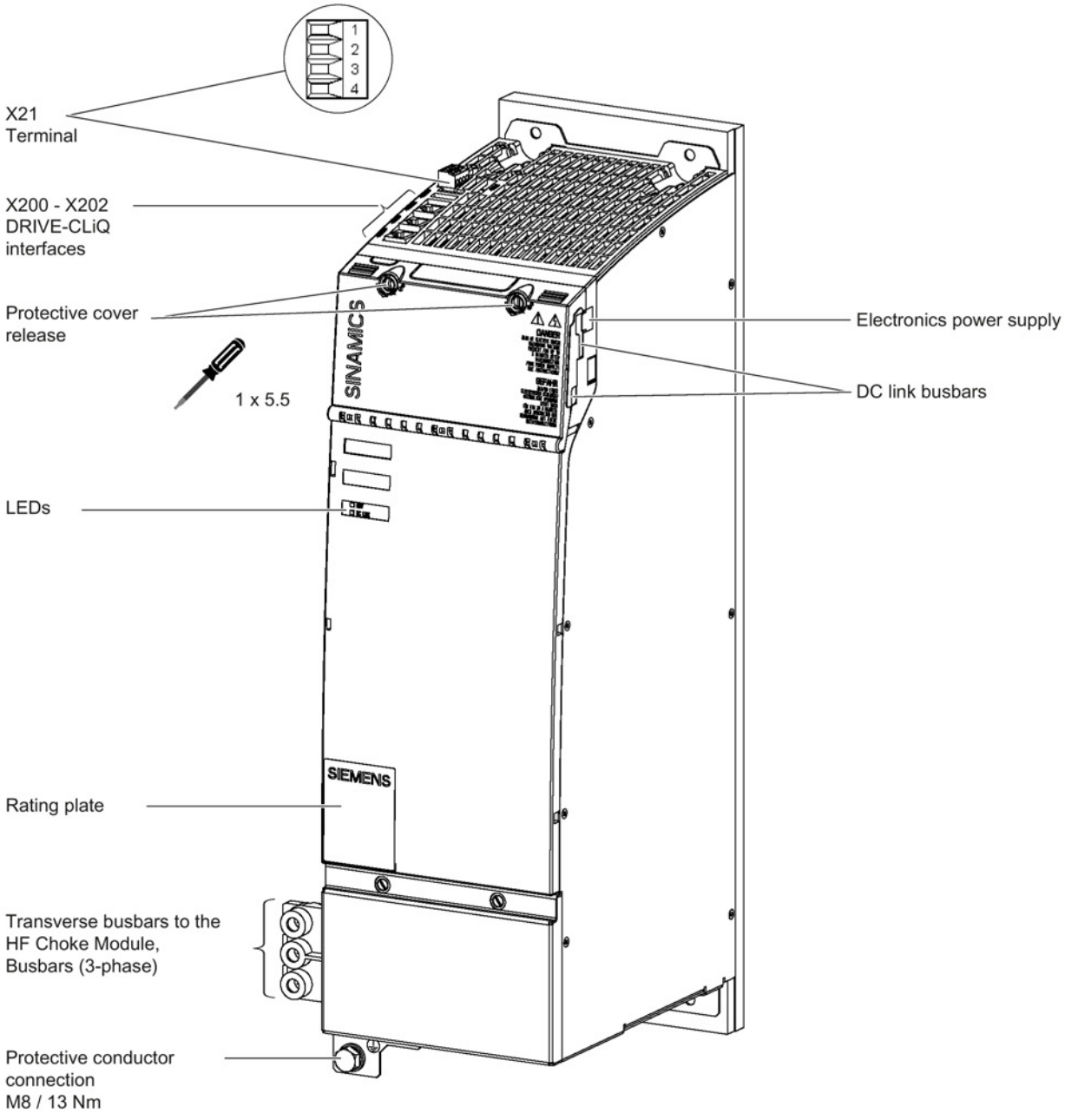
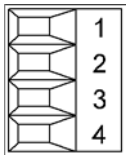


Figure 4-5 HF Damping Module interface overview

4.4.3.2 X21 inputs for temperature monitoring

Table 4- 15 X21 inputs for temperature monitoring

	Terminal	Function	Technical data
	1	+ Temp	Temperature HF Choke Module analog: KTY84-1C130 temperature sensor
	2	- Temp	
	3	+ Temp	Temperature Choke Module digital: Bimetallic switch
	4	- Temp	
Type: Screw terminal 1 (Page 172) Max. connectable cross-section: 1.5 mm^2			

Connect the terminals to transfer the temperature signals

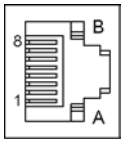
The HF line-up does not function without the X21 terminals being connected. Therefore, it is absolutely necessary that the following terminals are connected with one another to transfer the temperature signals from the HF Choke Module to the HF Damping Module:

- X21.1 and X21.2 on the HF Choke Module with X21.1 and X21.2 on the HF Damping Module
- X21.3 and X21.4 on the HF Choke Module with X21.3 and X21.4 on the HF Damping Module

Use shielded signal cables and connect the cable shields to the supplied shield terminal.

4.4.3.3 X200-X203 DRIVE-CLiQ interfaces

Table 4- 16 X200-X203 DRIVE-CLiQ interfaces

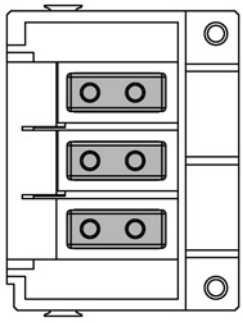
	Pin	Name	Technical data
	1	TXP	Transmit data +
	2	TXN	Transmit data -
	3	RXP	Receive data +
	4	Reserved, do not use	
	5	Reserved, do not use	
	6	RXN	Receive data -
	7	Reserved, do not use	
	8	Reserved, do not use	
	A	+ (24 V)	Power supply
	B	M (0 V)	Electronics ground

The blanking covers for the DRIVE-CLiQ interfaces are included in the scope of delivery.

Blanking covers (50 x) Article No.: 6SL3066-4CA00-0AA0

4.4.3.4 Busbars

Table 4- 17 Busbars to the HF Choke Module

	Technical data
	Threaded hole: M5 Tightening torque: 3 Nm

4.4.4 Meaning of the LEDs

Meaning of the LEDs on the HF Choke Module

Table 4- 18 Meaning of the LEDs

State		Description, cause	Remedy
RDY	DC LINK		
Off	Off	The electronics power supply is missing or outside the permissible tolerance range.	–
Green	--	The component is ready for operation.	–
Red	--	The temperature switch has responded (temperature monitoring for the HF Choke Module via the integrated bimetallic switch).	Check the cooling and fan.

⚠DANGER

Danger to life as a result of electric shock when coming into contact with the DC link voltage

Irrespective of the state of the LED "DC LINK", hazardous DC link voltages can always be present.

Death or serious injury can result when live parts are touched.

- Observe the warning information on the component.

Meaning of the LEDs on the HF Damping Module

Table 4- 19 Meaning of the LEDs

State		Description, cause	Remedy
RDY	DC LINK		
Off	Off	The electronics power supply is missing or outside the permissible tolerance range.	–
Green	--	The component is ready for operation. Cyclic DRIVE-CLiQ communication is taking place.	–
	Orange	The component is ready for operation. Cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is present.	–
	Red	The component is ready for operation. Cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is too high.	Check the line supply voltage.
Orange	Orange	DRIVE-CLiQ communication is being established.	–
Red	--	This component has at least one fault. **Note:** The LED is controlled irrespective of the corresponding messages being reconfigured.	Resolve and acknowledge the fault.
Green/red (0.5 Hz)	--	Firmware is being downloaded.	–
Green/red (2 Hz)	--	Firmware download is complete. The system waits for POWER ON.	Carry out a POWER ON.
Green/orange or Red/orange	--	Recognition of components via LED is activated[1)]. **Note:** Both options depend on the LED status when activated.	–

1) See SINAMICS S120/S150 List Manual for the parameters to activate the recognition of components via LED

⚠DANGER

Danger to life as a result of electric shock when coming into contact with the DC link voltage

Irrespective of the state of the LED "DC LINK", hazardous DC link voltages can always be present.

Death or serious injury can result when live parts are touched.

- Observe the warning information on the component.

4.4.5 Dimension drawings

4.4.5.1 HF Choke Module

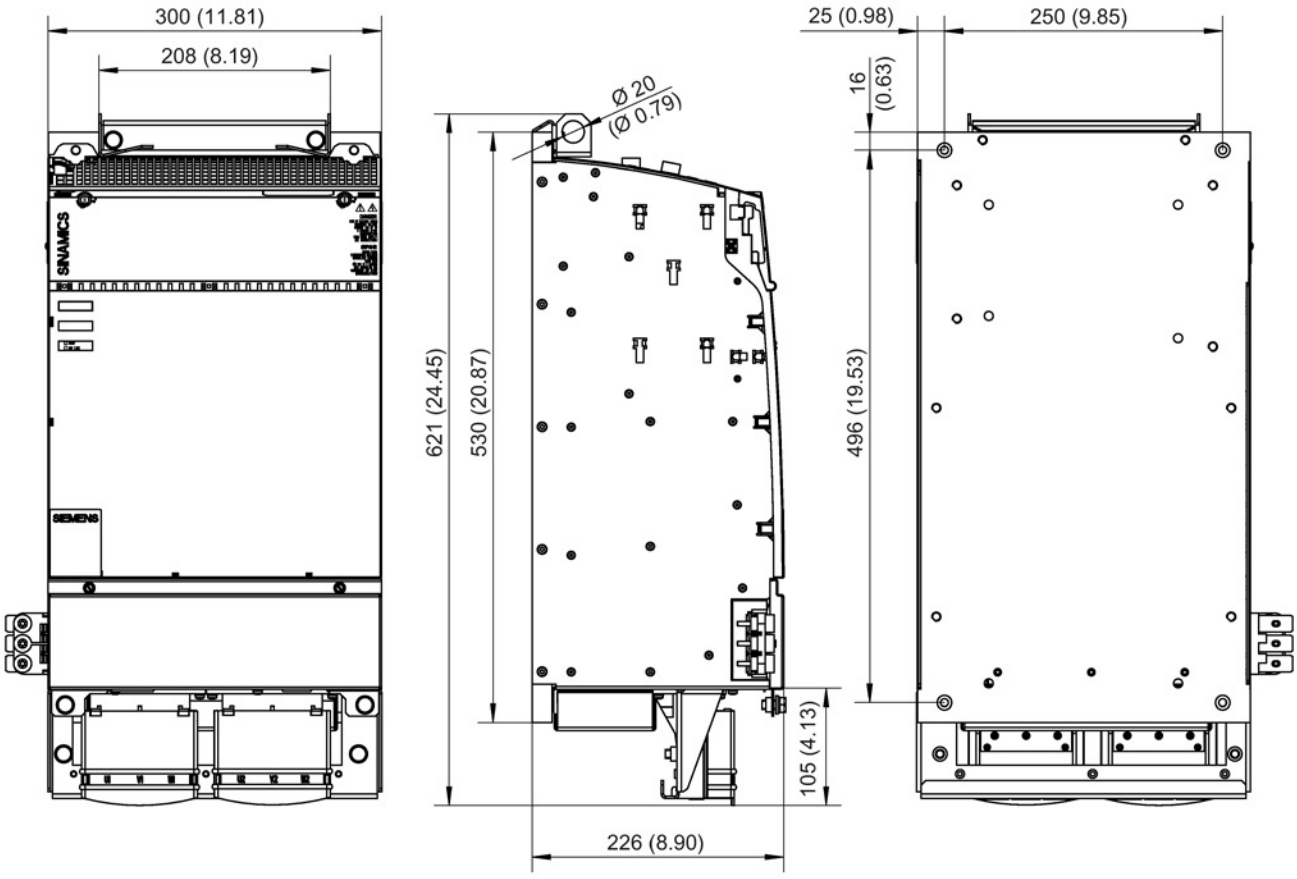


Figure 4-6 Dimension drawing HF Choke Module, all data in in mm (inches)

4.4.5.2 HF Damping Module

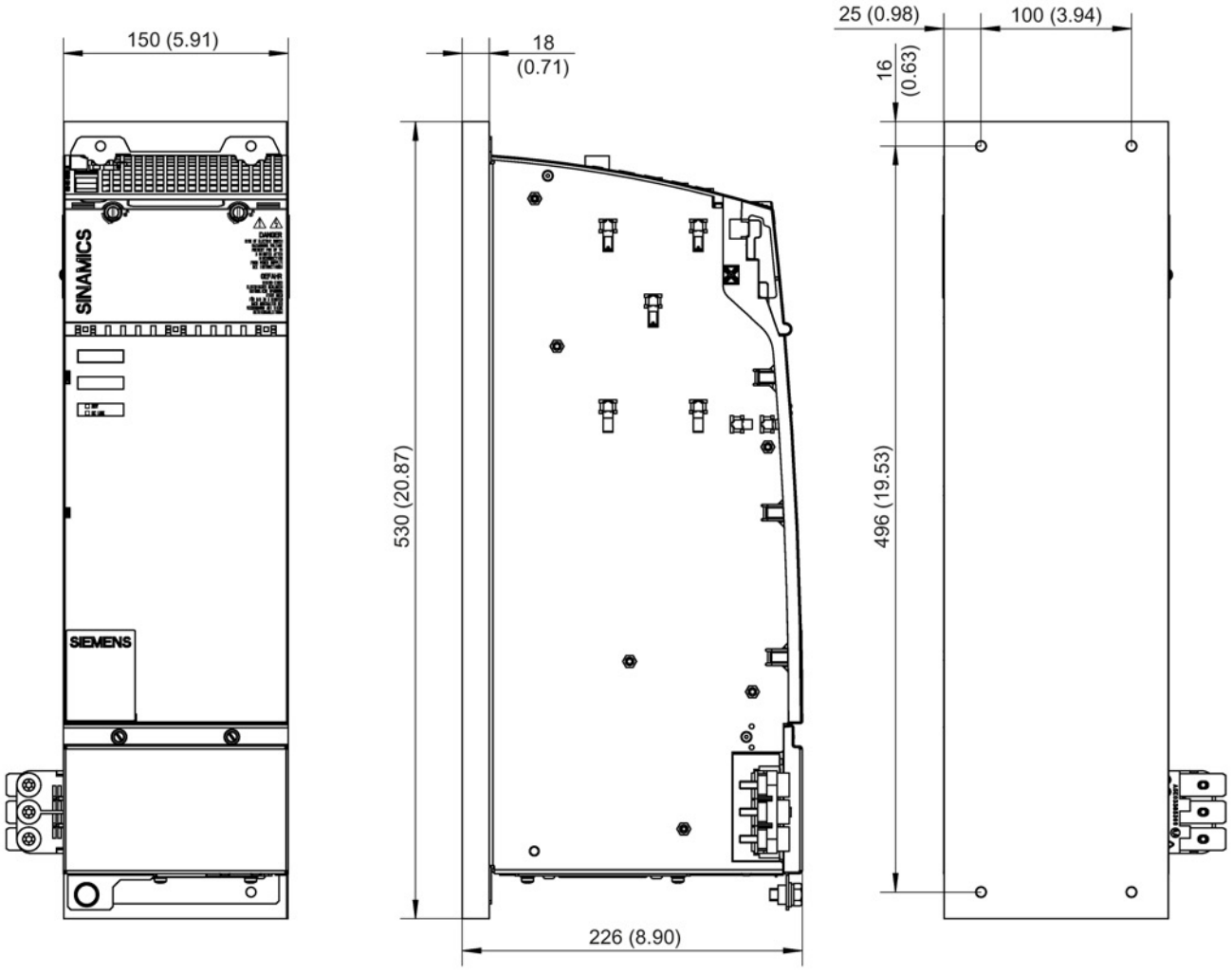


Figure 4-7 Dimension drawing HF Damping Module, all data in mm (inches)

4.5 Installation

The High Frequency Drive, depending on the area of application, can be operated with either an Active Line Module, chassis or booksize format. The HF drive lineup can be expanded using SINAMICS S120 Booksize components with cold plate cooling. This allows a uniform mounting depth of the components to be achieved, as well as a simple connection of the DC link and 24 V busbars.

The position of the High Frequency Drive can be chosen freely within the drive line-up.

Note

When installing the High Frequency Drive in the control cabinet, always ensure that the HF function line-up – Choke Module and HF Damping Module (HF Sine Filter Module) – is always directly to the right of the HF Motor Module.

Mounting position in the control cabinet

Always mount the SINAMICS S120 components in the control cabinet in a vertical position. Other permissible mounting positions are listed in the descriptions for the individual components.

NOTICE
Shorter component service life when the installation regulations are violated If you do not observe the guidelines for installing the HF line-up in the electrical cabinet, this can reduce the service life of the components and result in premature component failure. • Comply with the installation regulations of the HF lineup in the electrical cabinet.

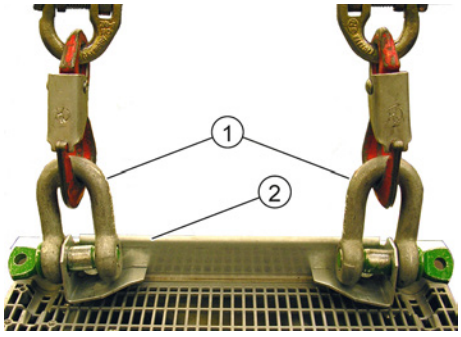
Cooling clearances

Table 4- 20 Cooling clearances, HF Modules

Above the HF Module	Below the HF Module
80 mm	80 mm

Use of the mounting aid

To lift the HF Choke Module from the transport pallet using a crane, shackles according to EN 13889 must be attached to the lifting lugs of the mounting aid.



① Shackles according to EN 13889 with a bolt diameter of approx. 16 mm
② Mounting aid

Figure 4-8 Mounting aid with shackles

NOTICE
Damage to the mounting aid when lifting without a shackle The HF Choke Module can be damaged if the crane hook is directly attached to the lifting eyes of the mounting aid. • Always use a shackle to lift the HF Choke Module.

Mounting plate

When installing the High Frequency Drive in a control cabinet, use a mounting plate with the following properties:

- Material: Aluminum
- Thickness: 15 mm
- Surface roughness: Rz25

Note

The mounting plate must be connected to the protective conductor connection of the control cabinet through a low impedance. See also Chapter Protective connections and equipotential bonding (Page 174).

Heat dissipation

It is not necessary to install a separate cold plate cooling to cool the HF Choke Module and HF Damping Module. The modules are cooled through the mounting plate. The mounting plate cooling assumes the internal cooling circuit in the cold plate of the HF Motor Module.

Drilling patterns

The drilling patterns shown below apply to the High Frequency drive with and without Active Line Module, booksize format.

Prepare the mounting plate as follows:

1. Machine the M6 threaded holes.
2. Countersink the holes with ∅ 18^{+2} mm (for details see the drilling pattern).

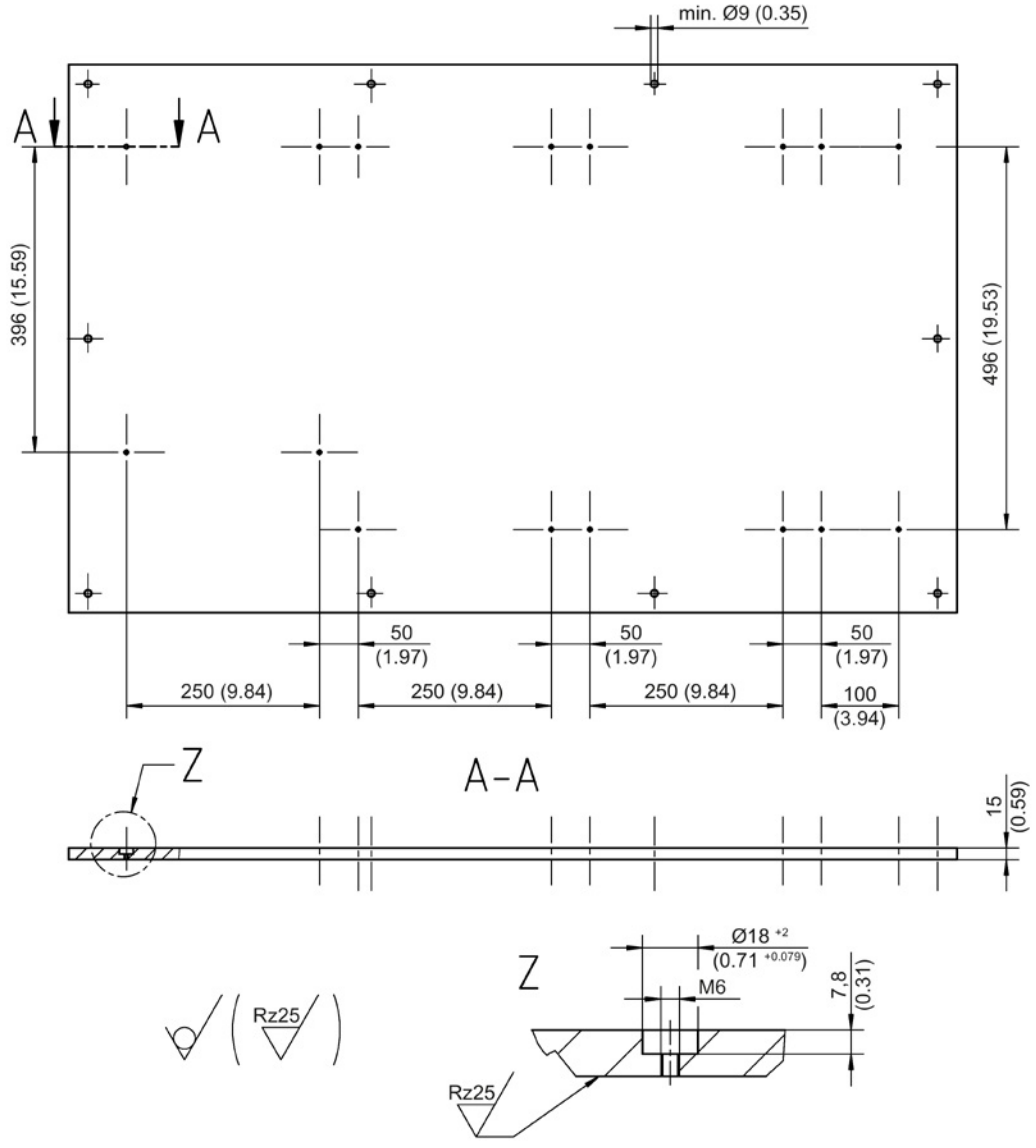


Figure 4-9 Drilling pattern for the High Frequency Drive with Active Line Module booksize, all data in mm and (inches)

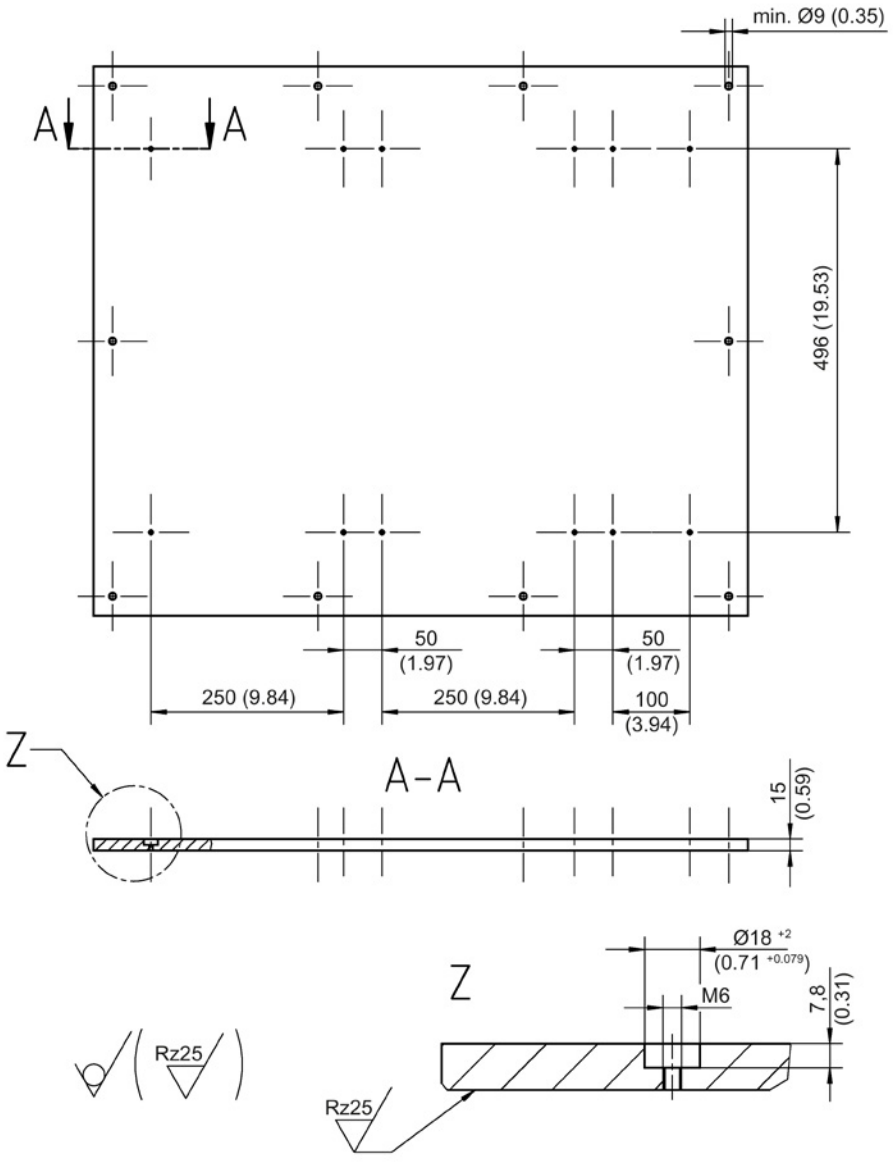
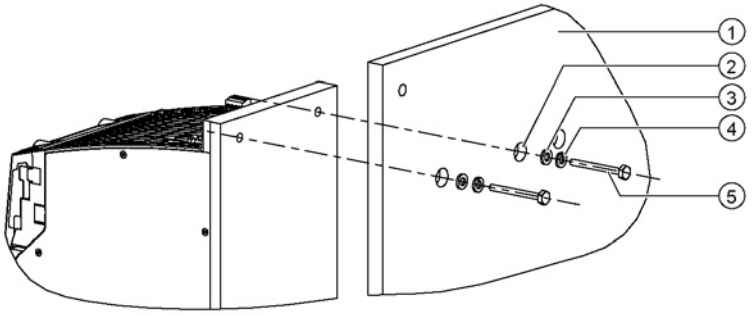


Figure 4-10 Drilling pattern for the High Frequency Drive without Active Line Module booksize, all data in mm and (inches)

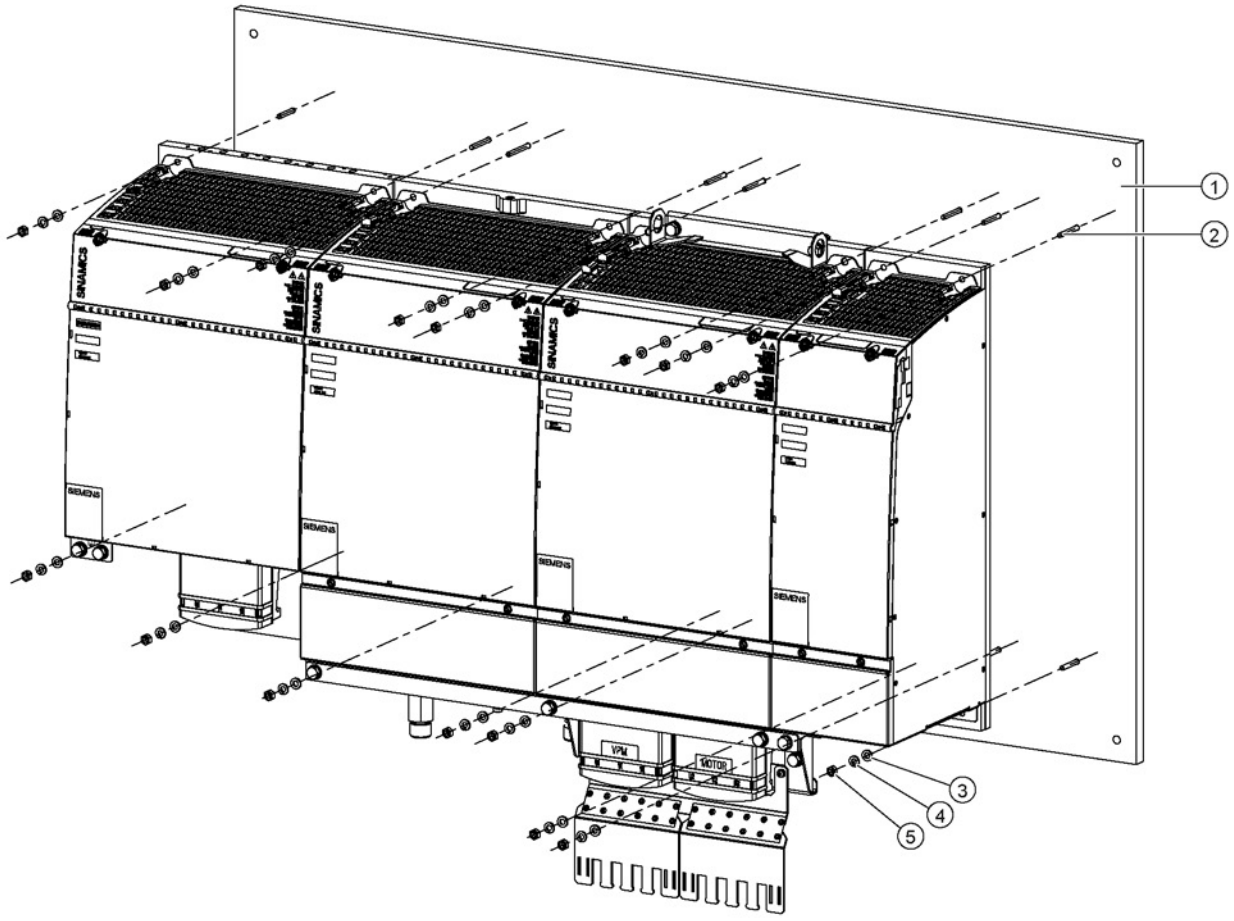
Mounting on the mounting plate

1. Individually mount the HF Modules one after the other on the mounting plate. Start with the left-hand component. First mount all of the modules of the DC link and the 24 V busbars before connecting them up.
2. Before mounting, insert the screws and washers into the mounting plate from the rear as shown below.



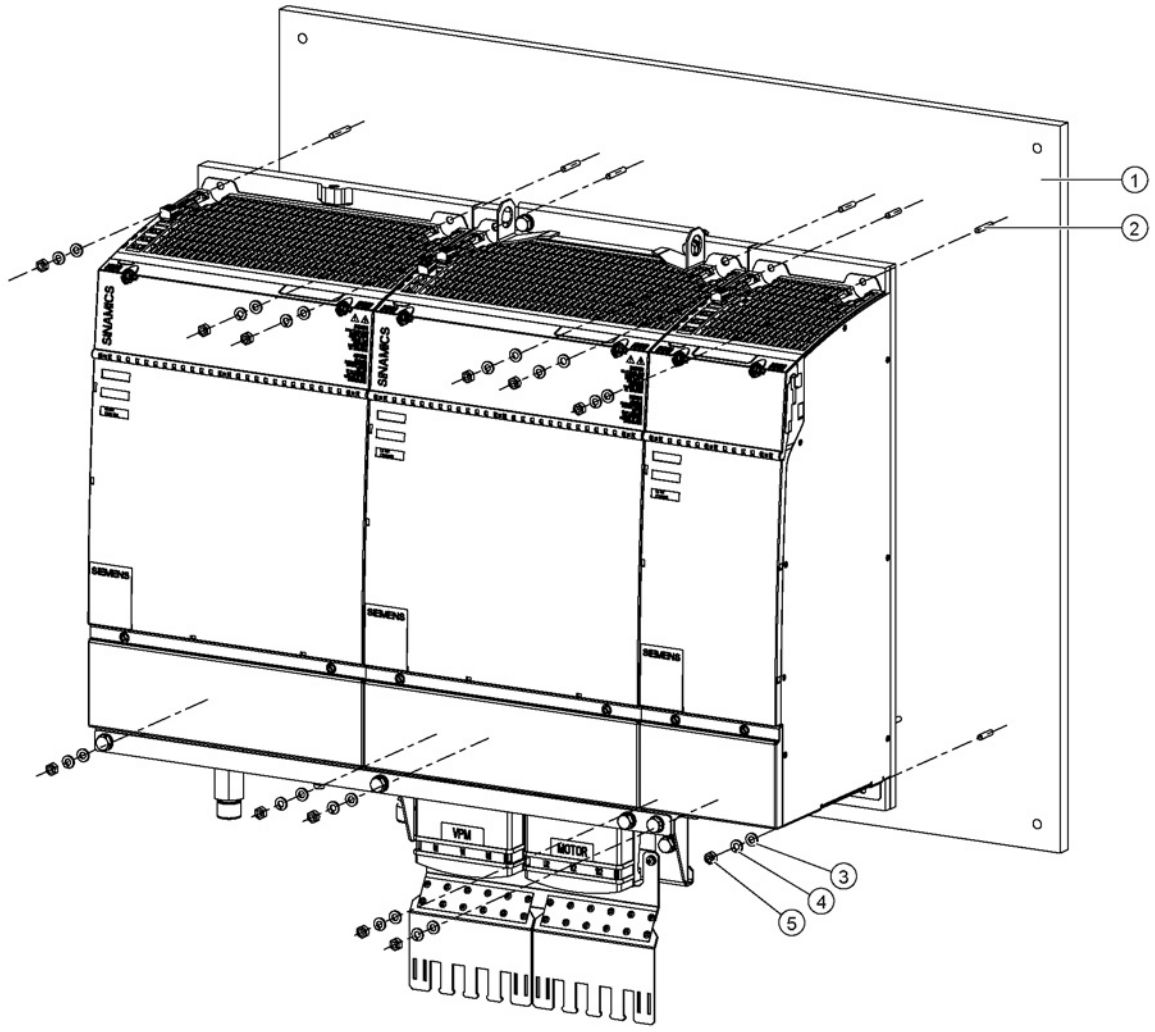
① Mounting plate
② Countersunk threaded hole
③ Washer
④ Spring washer
⑤ M6 hexagon screw

Figure 4-11 Preparing the mounting plate



① Mounting plate
② M6 hexagon screw
③ Washer
④ Spring washer
⑤ M6 nut, SW10
Tightening torque 10 Nm

Figure 4-12 Mounting the High Frequency Drive with a Active Line Module in the booksize format on a mounting plate



① Mounting plate
② M6 hexagon screw
③ Washer
④ Spring washer
⑤ M6 nut, SW10
Tightening torque 10 Nm

Figure 4-13 Mounting the High Frequency Drive on a mounting plate

4.6 Electrical connection

4.6.1 Connecting the DC-link busbars and 24 V busbars

1. Connect the DC link busbars of the HF modules the same as for standard booksize components.
2. Connect the 24 V busbars using the red 24 V connector provided in the accessories pack.
3. Mount the side cover for the DC link at the first and last component of the drive line-up.

⚠WARNING

Danger to life as a result of electric shock when connecting hazardous voltages to the 24 V busbars

When a hazardous voltage is connected to the 24 V busbars, you can suffer death or severe injury when coming into contact with the busbars.

- Only connect safety extra low voltages (PELV or SELV) to 24 V busbars.

Additional information and diagrams can be found in the SINAMICS S120 Manual for "Booksize Power Units" (Chapter: Electrical connection for Line Modules and Motor Modules).

Tightening torque of the screws

The tightening torque for DC link busbar screws is 1.8 Nm (tolerance: +30 %).

NOTICE

Material damage due to loose DC link connections

Insufficient tightening torques can result in faulty electrical connections. This can result in damage due to fire or malfunctions.

- Check the correct tightening torque of the DC link busbar screws (1.8 Nm) before commissioning with the system disconnected from the power supply and the DC link fully discharged.
- Check the screws at terminal connections, e.g. DC link busbars and motor terminals after transport or at the latest after every 5 years. If necessary, retighten the screws.

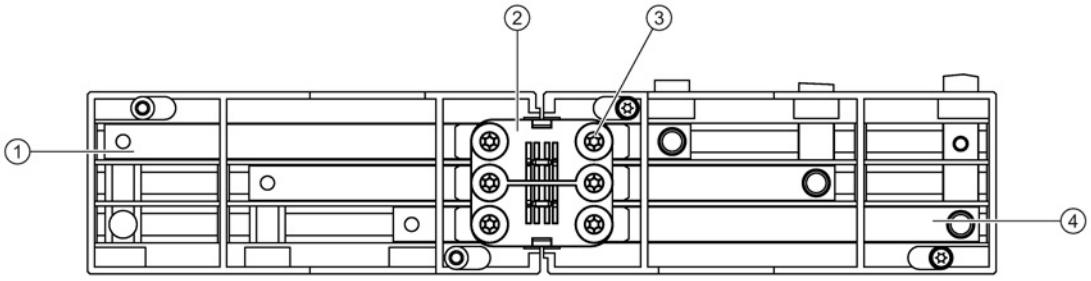
4.6.2 Connecting the busbars

Before commissioning the drive line-up, connect the busbars between:

- HF Motor Module and HF Choke Module
- HF Choke Module and HF Damping Module

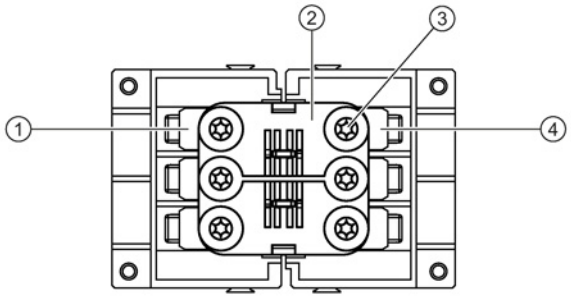
Mounting steps

1. Remove the busbar connections from the accessories pack.
2. Insert the connectors on the busbars and hold them in place.
3. Tighten the screws with a Torx screwdriver by hand and in a second step with the tightening torque of 3 Nm.



① Busbars (3-part) on the HF Motor Module
② Busbar connections
③ 6 screws (Torx T25, M5
④ Busbars (3-part) on the HF Choke Module

Figure 4-14 Connecting the busbars at the HF Motor Module and the HF Choke Module



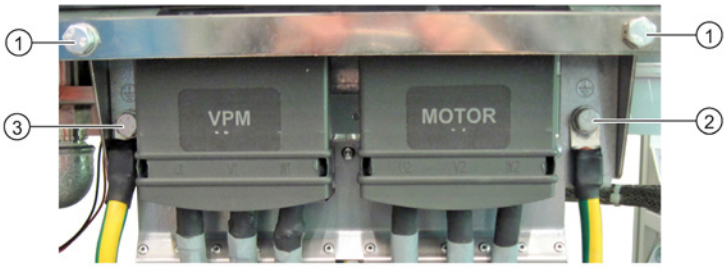
① Busbars (3-part) on the HF Choke Module
② Busbar connections
③ 6 screws (Torx T25, M5
④ Busbars (3-part) on the HF Damping Module

Figure 4-15 Connecting the busbars at the HF Choke Module and HF Damping Module

4.6.3 Protective conductor connection of the HF module

Protective conductor connections for Voltage Protection Module and the motor

The protective conductor of the power cables to the Voltage Protection Module and motor are connected to the HF Choke Module as shown below.



① Protective conductor connection for the equipotential bonding bar
② Protective conductor connection motor
③ Protective conductor connection Voltage Protection Module

Figure 4-16 Protective conductor connections at the HF Choke Module

Protective conductor connection via the equipotential bonding bar

The protective conductor connection between the HF modules must be established using the equipotential bonding bar supplied. The equipotential bonding bar is provided in the accessories pack.

The protective conductor connection of the HF module to the equipotential bonding bar of the control cabinet is established through a grounding cable, which is attached at the HF Motor Module.

1. Remove the M8 bolts with flat and spring washers from the following protective conductor connections:
   - HF Motor Module (left)
   - HF Choke Module at the left and right, directly at the housing
   - HF Damping Module
2. Fix the equipotential bonding bar (⑤) to the protective conductor connections of the housing of the HF Damping Module (⑥) and HF Choke Module (①) using the previously removed screws, washers and spring washers.
3. Attach the grounding cable of the cabinet with the ring cable lug to the equipotential bonding bar at the HF Motor Module (④), and fix both using the remaining screw.

Tightening torques: 13 Nm

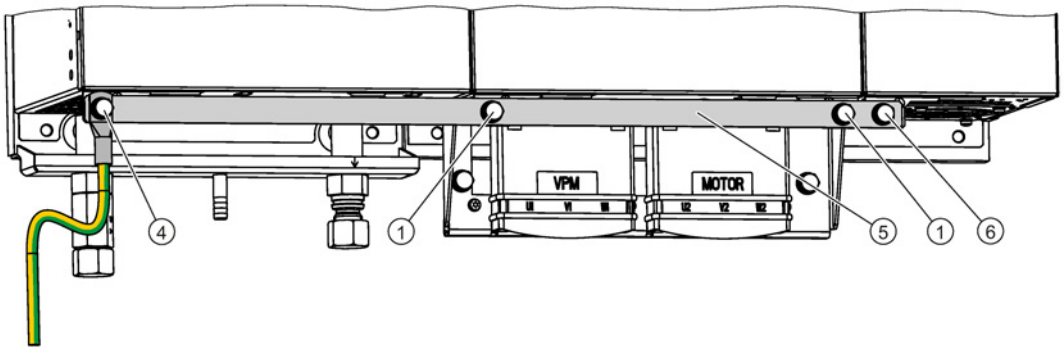
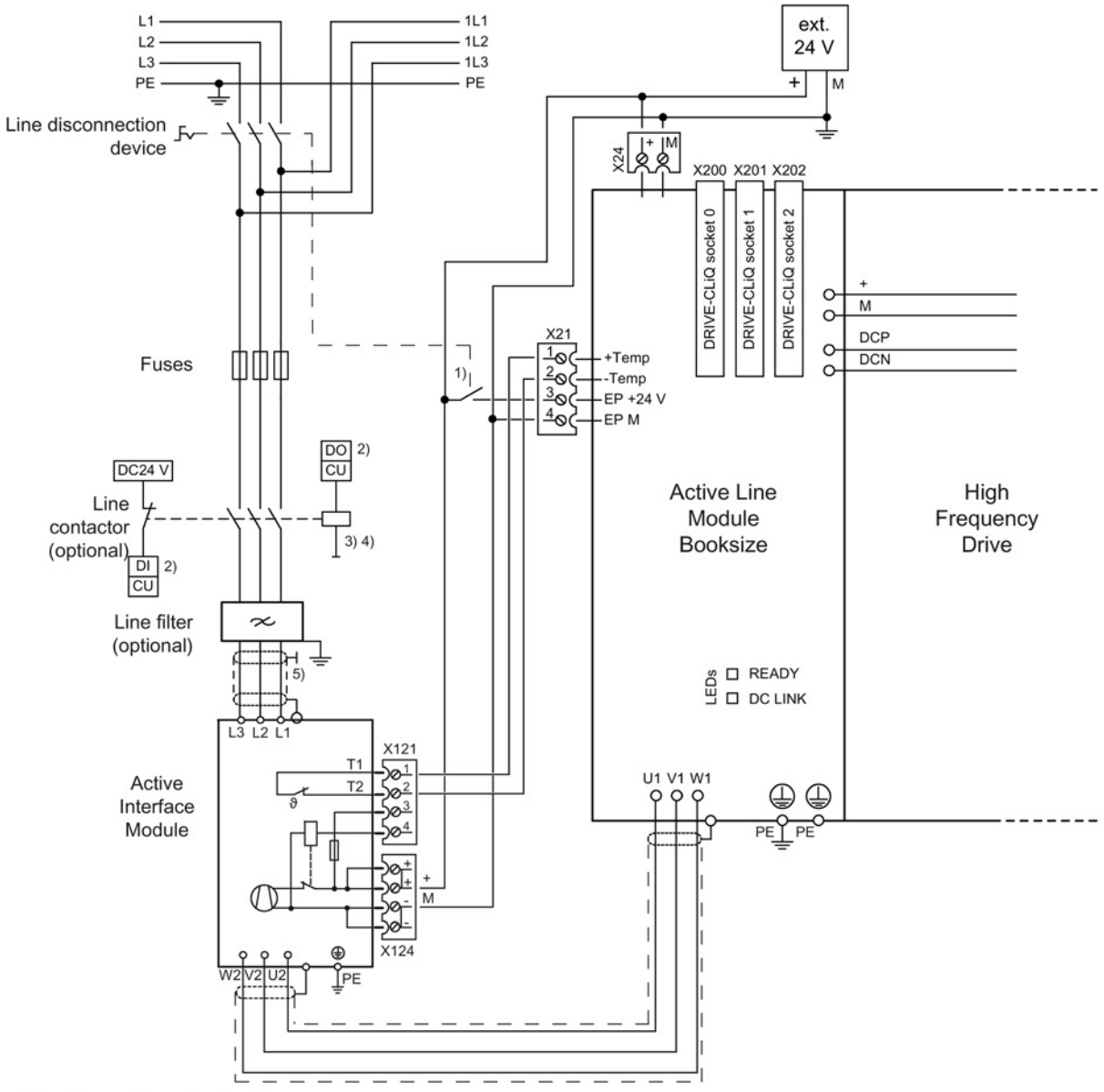


Figure 4-17 Installing the equipotential bonding bar

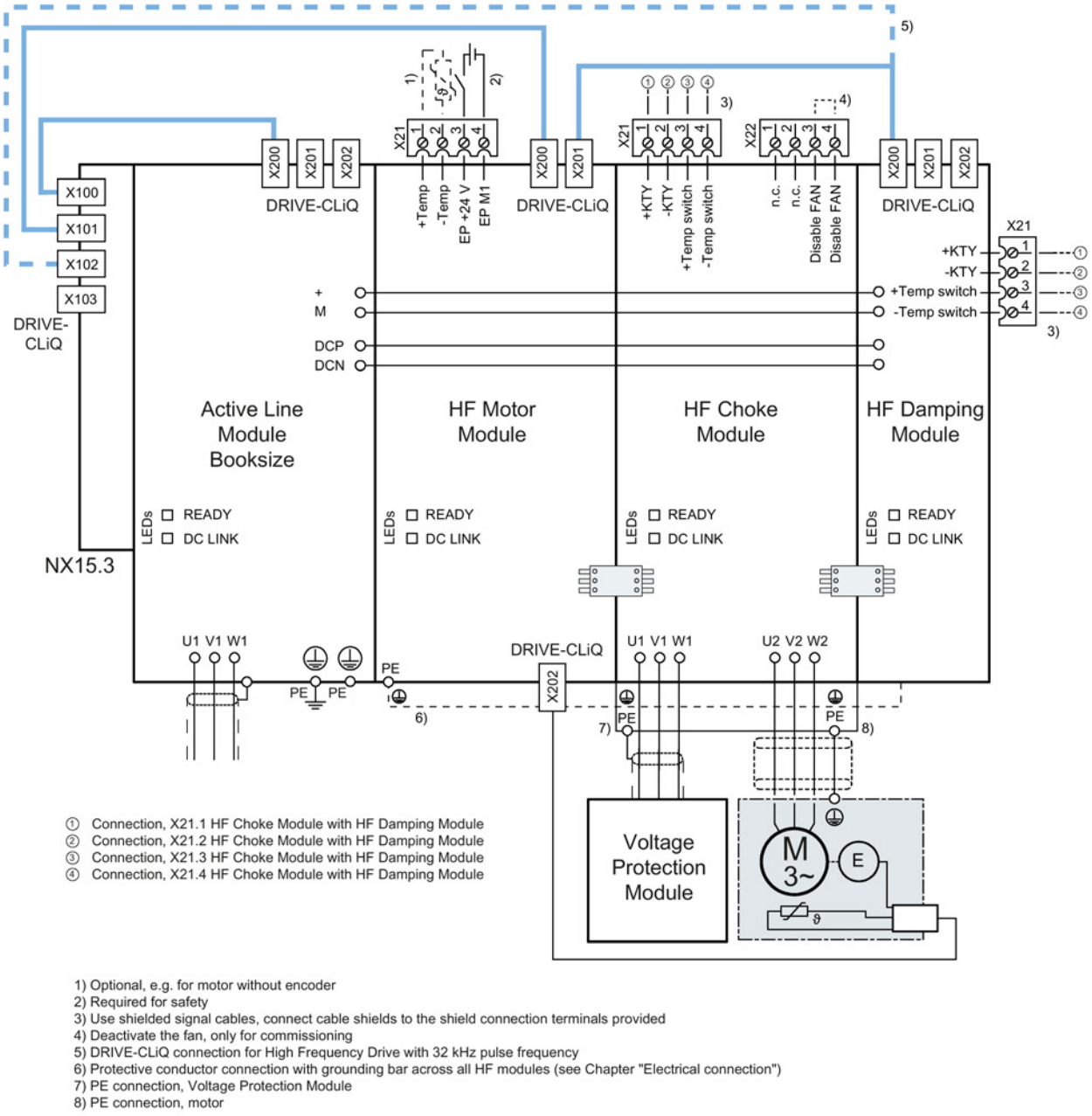
4.7 Connection examples

4.7.1 High Frequency Drive with components in the booksize format



1) Leading opening contact t > 10 ms
2) DI/DO controlled from the Control Unit.
3) No additional load permitted downstream of line contactor!
4) The current carrying capacity of the DO must be observed; an output coupling device must be used if required.
5) Contacting via rear mounting panel or shielding buses in accordance with EMC Directive.

Figure 4-18 Example for connecting a High Frequency Drive to the line supply via an Active Line Module in the booksize of format with Active Interface Module



1) Optional, e.g. for motor without encoder
2) Required for safety
3) Use shielded signal cables, connect cable shields to the shield connection terminals provided
4) Deactivate the fan, only for commissioning
5) DRIVE-CLiQ connection for High Frequency Drive with 32 kHz pulse frequency
6) Protective conductor connection with grounding bar across all HF modules (see Chapter "Electrical connection")
7) PE connection, Voltage Protection Module
8) PE connection, motor

Figure 4-19 Connection example for a High Frequency Drive with booksize infeed

4.7.2 High Frequency Drive with components in the chassis format

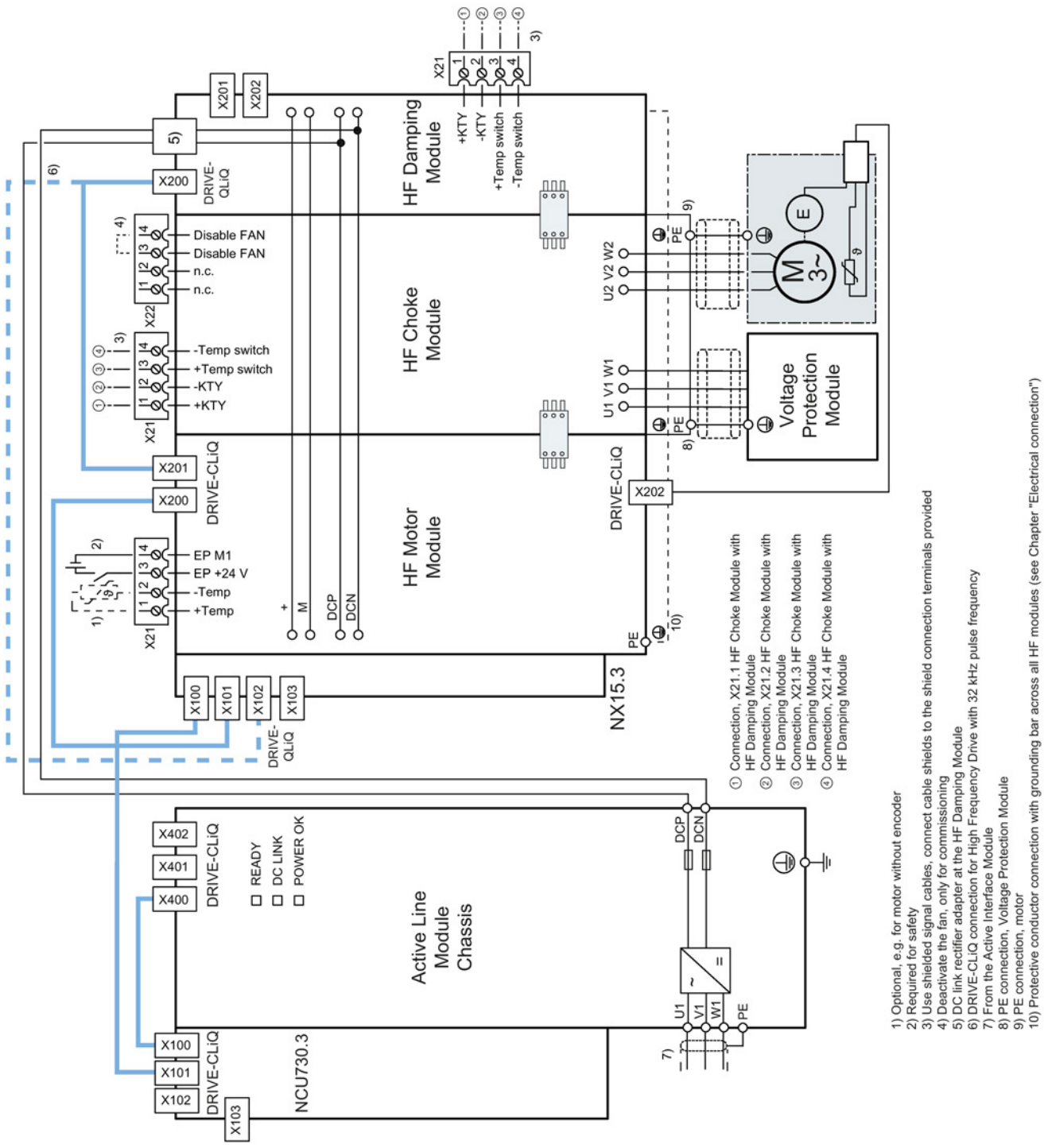


Figure 4-20 Connection example for a High Frequency Drive with chassis infeed

4.8 Technical data

Table 4- 21 Technical data of HF modules Liquid Cooled

High Frequency Drive Liquid Cooled		**6SL3125-1UE32-2AD0**
Output current		
Rated current (I_n)	A_{ACrms}	225
Base load current (I_H)	A	158
Intermittent duty current (I_{S6}) 40 %	$A_{ACrms(Is6)}$	292
Peak current (I_{max})[1]	A_{ACrms}	292
Output voltage	V_{ACrms}	0 … 480
DC link current ($I_{d\ max}$)	A_{DC}	200
DC link voltage (up to 2000 m above sea level)	V_{DC}	510 … 720
Input power based on I_n (600 V DC)	kW	120
DC link capacitance	µF	5800
Overvoltage trip	V_{DC}	820 ± 2 %
Undervoltage trip[2]	V_{DC}	380 ± 2 %
Electronics power supply (PELV/SELV)	V_{DC}	24 (20.4 … 28.8)
Electronics current consumption at 24 V DC (PELV/SELV)		
HF Motor Module	A_{DC}	0.8
HF Choke Module	A_{DC}	1.6
HF Damping Module	A_{DC}	0.9
Current carrying capacity		
DC link busbar	A_{DC}	200
24 V busbar	A_{DC}	20
Type rating[3]		
Based on I_n (600 VDC)	kW	120
Based on I_H	kW	85
Total power loss(including losses from the electronics)		
HF Motor Module	W	3019.2
HF Choke Module	W	598.4
HF Damping Module	W	61.6
Component of internal losses	W	926.8
Max. output frequency	Hz	1200
Max. Pulse frequency		
without derating	kHz	16
with derating	kHz	32
Max. ambient temperature		
without derating	°C	40
with derating	°C	55
Max. coolant temperature		
- without derating	°C	45
- with derating	°C	50
System pressure	kPa	600
Nominal flow rate for water with a 70 kPa pressure drop[4]	l/min	7
Internal volume of liquid	ml	100

High Frequency Drive Liquid Cooled		6SL3125-1UE32-2AD0
Sound pressure level		
HF Choke Module	dB(A)	< 73
HF Damping Module	dB(A)	< 60
Weight		
HF Motor Module	kg	30.5
HF Choke Module	kg	48.5
HF Damping Module	kg	14.0

1) $I_{max} = I_{S6} = 1.3 \times I_n$

2) Default for 400 V line supplies; undervoltage trip threshold is adjusted to the parameterized rated voltage

3) Rated power of a typical standard induction motor at 3 AC 400 V

4) This value applies when water is used as coolant; for other coolant types, see Section "Cooling circuit and coolant properties".

4.8.1 Characteristics

Rated duty cycles of HF modules

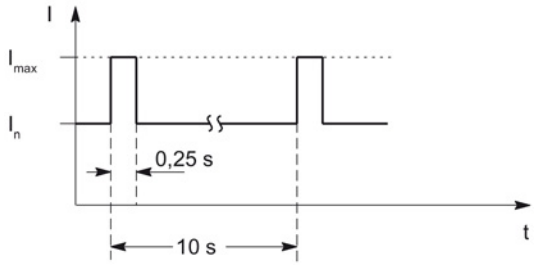


Figure 4-21 Load cycle with previous load

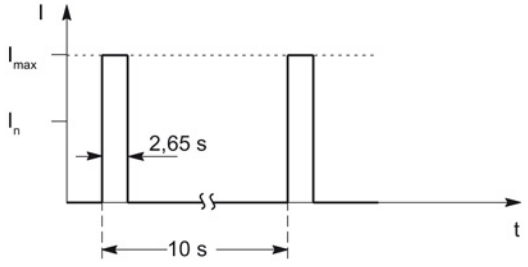


Figure 4-22 Load cycle without previous load

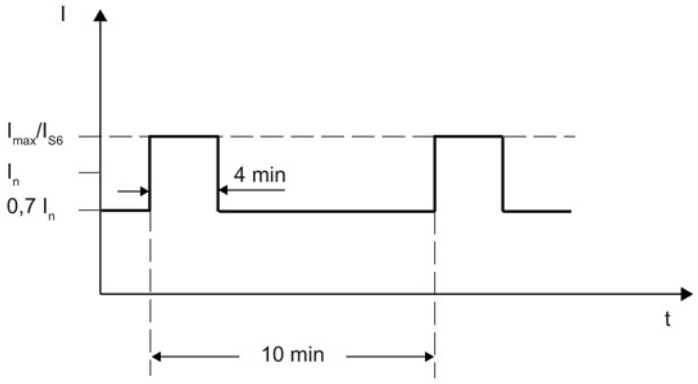


Figure 4-23 S6 duty cycle with initial load with a duty cycle duration of 600 s

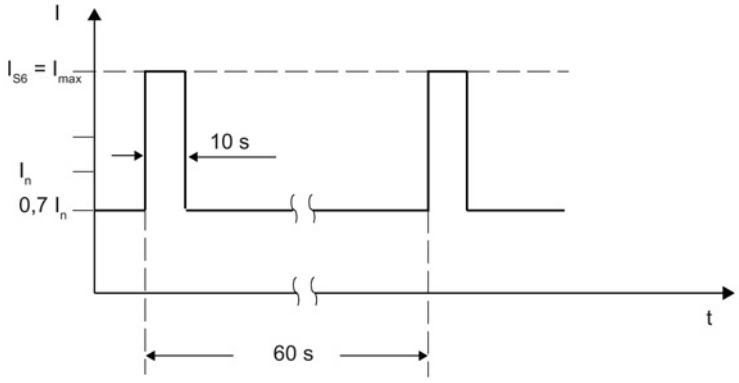


Figure 4-24 S6 duty cycle with initial load for a duty cycle duration of 60 s

Note

The overload factor is a maximum of 1.3 x I_n.

Derating characteristics H module

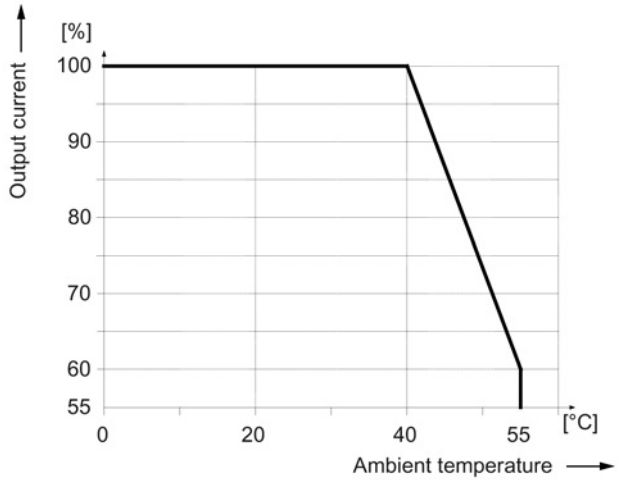


Figure 4-25 Output current as a function of the ambient temperature

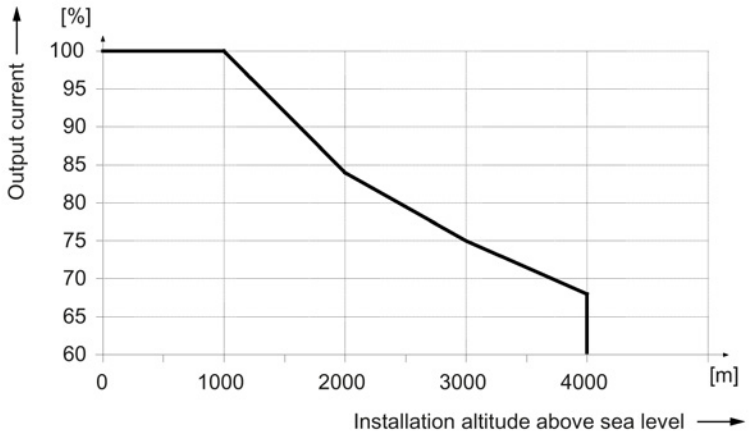


Figure 4-26 Output current as a function of the installation altitude

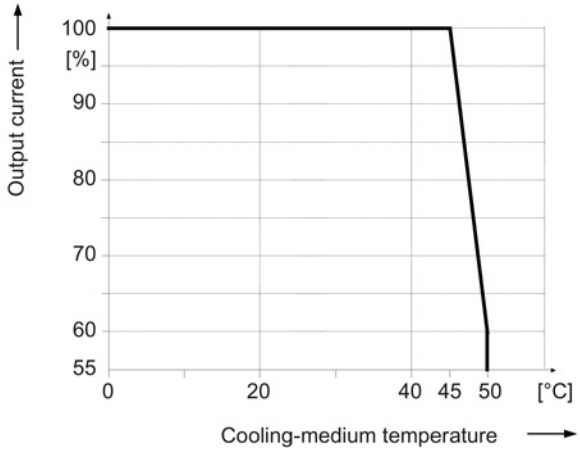


Figure 4-27 Output current as a function of the coolant temperature

If a 225 A HF drive is operated with a pulse frequency of 32 kHz, then the output current must be derated down to 60 % (135 A).

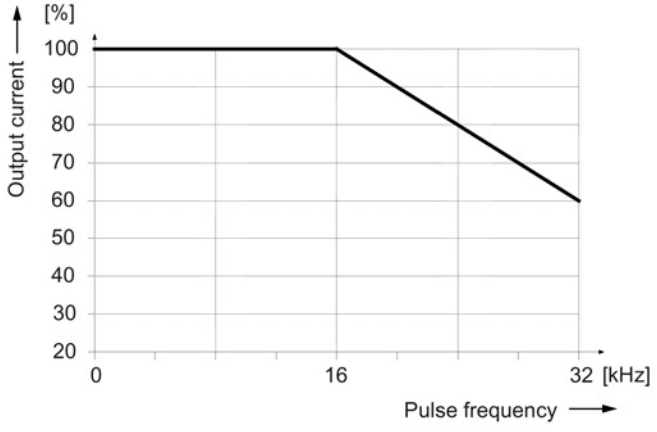


Figure 4-28 Output current as a function of the pulse frequency for a 225 A HF drive

Voltage Protection Module (VPM) 5

5.1 Description

The Voltage Protection Module (VPM) is used to limit the voltage when using synchronous motors. It is directly connected to the HF Choke Module.

If the line voltage fails at the maximum motor speed or the pulses at the HF Motor Module are canceled as a result of the power failure, the motor regenerates at a high voltage into the DC link.

The Voltage Protection Module measures the motor voltage. If the rectified motor voltage is > 800 V, an armature short-circuit is triggered. The motor is decelerated by the short-circuit. The energy remaining in the motor is converted to heat.

A VPM 200 Dynamik is used as Voltage Protection Module in a High Frequency Drive.

Table 5- 1 VPM 200 Dynamik interface overview

Type	Quantity
Signaling interface	1
PE connection	4
Load connecting bolt, input	5
Load connecting bolt, output	5

5.2 Safety instructions for Voltage Protection Modules

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

The non-observance of the fundamental safety instructions and residual risks stated in Chapter 1 can result in accidents with severe injuries or death.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account remaining risks.

⚠DANGER

Danger to life due to electric shock caused by residual charge of the DC-link capacitors

Due to the DC link capacitors of the inverter, a hazardous voltage is present in the DC link for up to 30 minutes after the power supply has been switched off.

Touching live components results in death or severe injury.

- Do not touch the Voltage Protection Module as long as it is under voltage (live).

⚠WARNING

Danger of death due to electric shock for an excessively high motor speed while the VPM is being ramped up

If the motor is operated with a speed higher than the field weakening threshold speed while the Voltage Protection Module is ramping up (see the technical data), the protection function of the VPM is inactive during this phase. As a consequence, high voltages can be injected into the DC link.

Touching live components results in death or severe injury.

- Only operate the motor below the field weakening threshold speed while the VPM is ramping up.

⚠WARNING

Danger to life due to electric shock if the insulation voltage is exceeded

An excessively high voltage will damage the insulation resulting in death or severe injury.

- Do not connect any motors whose electromotive force (EMF) exceeds the permissible value at the highest speed used.
- Route the cables so that they are protected to rule out any damage.

⚠WARNING

Danger to life through electric shock when using third-party motors

VPM can be used with third-party motors. If, when using third-party motors, the VPM does not limit the DC link voltage, this can result in death or severe injury.

- Please observe the following when using third-party motors:
  - Carry out a risk analysis.
  - Ensure that the third-party motors correspond to the electrical properties of the specified Siemens components.
  - Check the correct functioning of the VPM.

⚠WARNING

Danger to life when the drive automatically starts up in an uncontrolled fashion

If a drive inadvertently starts, this can result in accidents and possibly death.

- Take the appropriate measures to prevent the drive automatically starting up in an uncontrolled fashion.

NOTICE

Damage when using motors that are not short-circuit proof

Using motors that are not short-circuit proof in conjunction with a Voltage Protection Module can result in their destruction.

- Only use motors that are short-circuit proof.

⚠WARNING

Danger of fire through overheating due to insufficient ventilation clearances

Insufficient ventilation clearances can result in overheating with danger to persons as a result of smoke and fire. Further, increased failures can occur and the service life of components shortened.

- Maintain 200 mm ventilation clearances above and below the component.

NOTICE

Damage to devices as a result of incorrect connecting cables

Using incorrect connecting cables for Voltage Protection Modules can damage the connected components.

- Use shielded MOTION-CONNECT 800PLUS motor cables, type 6FX8.

5.3 Interfaces

5.3.1 Overview

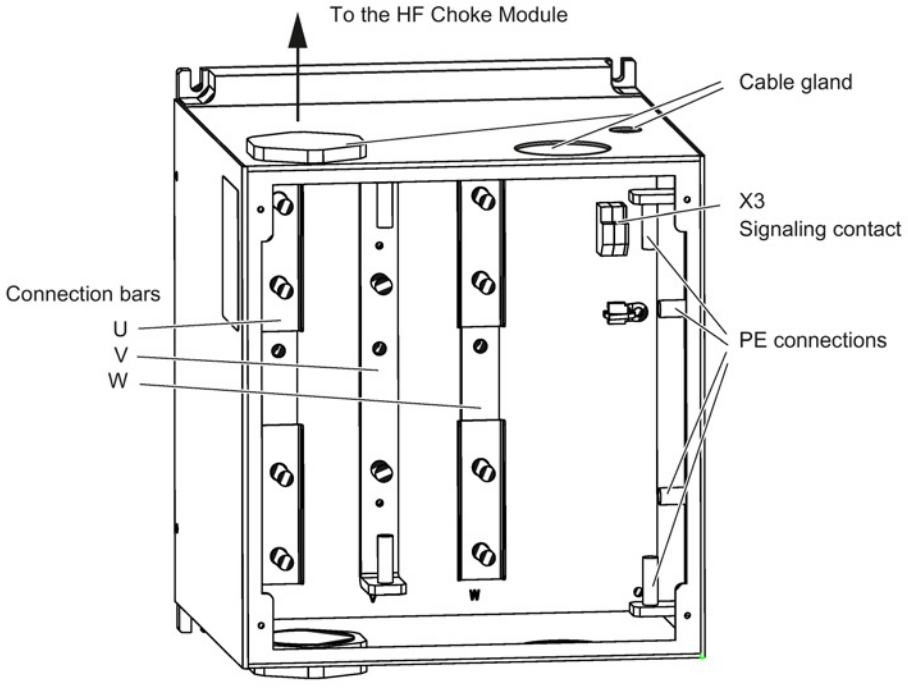


Figure 5-1 Interface overview, Voltage Protection Module VPM200 Dynamic (without cover)

Note

The housing is closed during operation to ensure the electrical terminals are covered.

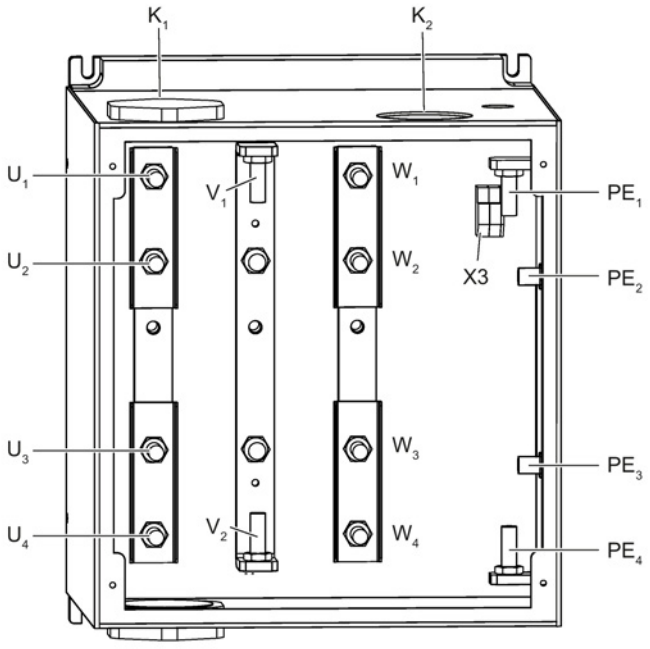


Figure 5-2 VPM 200 Dynamik connection points

Table 5- 2 Short designations

Short designation	Explanation
K_1, K_2	Cable 1 or 2 from the HF Choke Module
U_1, U_2, U_3, U_4	Connection bolts at the busbar U
V_1, V_2	Connection bolts at the busbar V
W_1, W_2, W_3, W_4	Connection bolts at the busbar W
PE_1, PE_2, PE_3, PE_4	Connection bolts at the busbar PE
U	Busbar U in the VPM
V	Busbar V in the VPM
W	Busbar W in the VPM

5.3.2 X3 signaling contact

Signaling interface X3 on the Voltage Protection Module is wired to a digital input (DI) on the Control Unit, which controls this spindle. If an armature short-circuit occurs, the pulses of the axis involved must remain inhibited. To do this, the connected digital input is interconnected to control bit OFF2 (pulse inhibit) (see SINAMICS S120/S150 List Manual). The signaling interface is operated with +24 V.

Table 5- 3 X3 signaling contact

Terminal	Designation	Technical data
1	Operating message for Control Unit	• Cable shield and VPM housing are connected via a cable. • Isolated contact, current carrying capacity: 30 V DC at 0.1 A
2	Operating voltage +24 V (from external source)	
Type: WAGO spring-loaded terminal, type 226-111 Max. connectable cross-section: 1.5 mm^2 shielded cable		
Cable entry: ∅ max. 9 mm • Screwed joint: 1 x M16, e.g. from the Pflitsch company, article designation: UNI DICHT EMV 2165211S05 • Locknut M16: GM216PA		

Operating message via signaling contact X3

After the VPM trips or a temperature sensor responds, signaling contact X3 opens and interrupts the inverter pulse enable.

The X3 signal contact automatically closes after t > 120 s, or after the temperature switch has been reset.

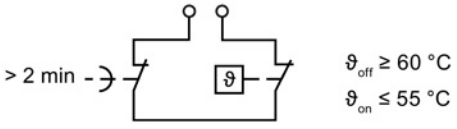


Figure 5-3 Signaling contact X3 of the Voltage Protection Module

⚠WARNING

Danger to life when the drive automatically starts up in an uncontrolled fashion

An uncontrolled automatic start of the drive can result in death or severe injury.

- Take measures to prevent the drive starting automatically in an uncontrolled fashion, as signal contact X3 restores the pulse enable after 2 minutes.

5.3.3 Connection busbars U, V, W, PE

As far as the power connections to the HF Choke Module are concerned, cables are routed through the cable entry of the Voltage Protection Module and attached to the connection bars inside the unit.

Table 5- 4 Connections U, V, W, and PE

	VPM 200 Dynamik
Connection bolt	M8 x 14[1)]
Cable lug	Tubular cable lug M8, 90° angled
Cable cross section	25, 35, 50 mm^2
Tightening torque	25 Nm
Cable entry	For cables with ∅40 mm max.
Gland[2)]	4 x M50, e.g. from the Pflitsch company, article designation: UNI DICHT EMV 250584117 Locknut M50: GM250PA

1) There are 4 connection points for phases U, W and PE - and there are 2 connection points for phase V.

2) The glands must be separately ordered.

Note

Power cables with cross-sections of > 50 mm^2 between the HF Choke Module and the Voltage Protection Module are implemented using 2 parallel cables.

5.4 Connection example

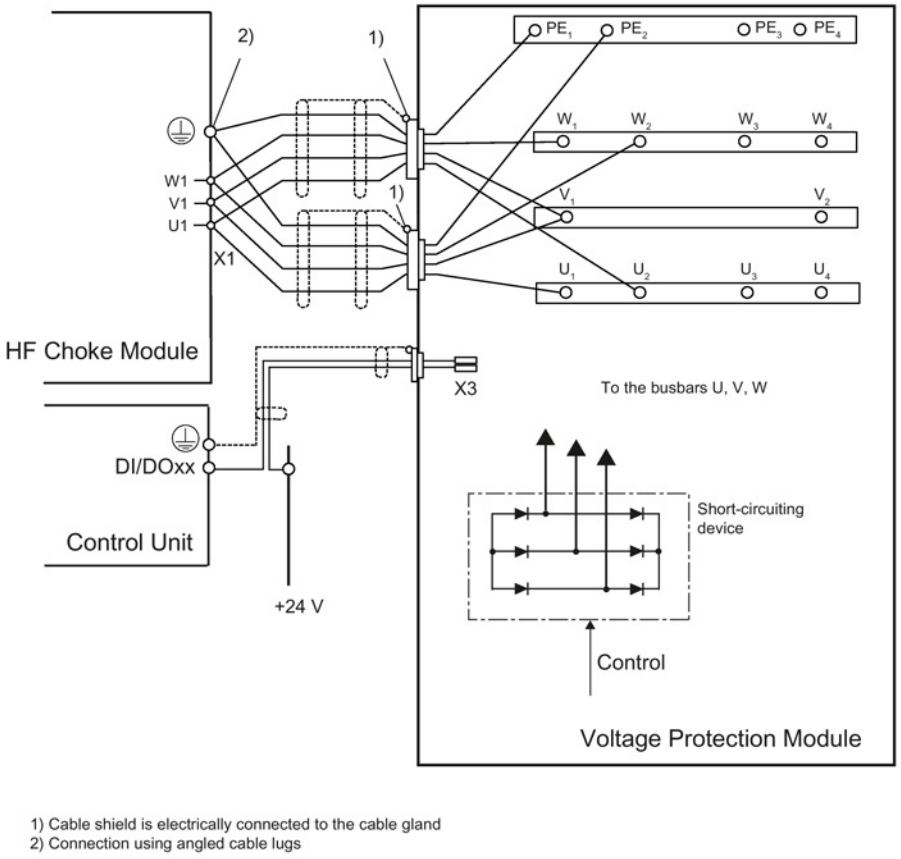


Figure 5-4 Connection example for a shared power cable at the VPM 200 Dynamik

Cable lengths

The maximum length of the power cable between the HF Choke Module and the Voltage Protection Module is 3 m. It must not include any switching elements.

The length of the signal cable must not exceed 10 m.

5.5 Dimension drawing

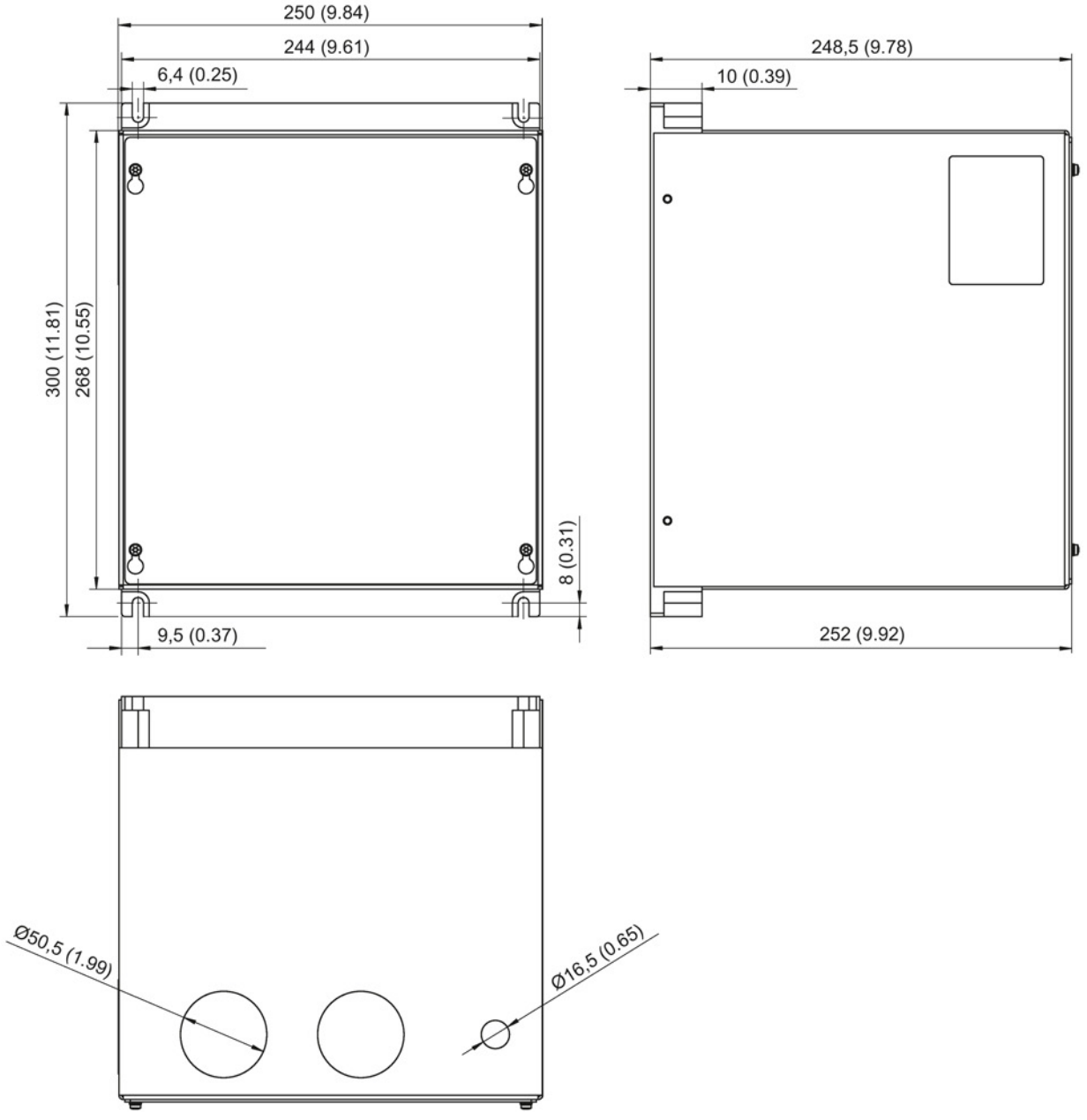


Figure 5-5 Dimension drawing of the Voltage Protection Module VPM 200 Dynamik, all data in mm (inches)

5.6 Installation

The Voltage Protection Module is installed in the control cabinet close to the HF Choke Module.

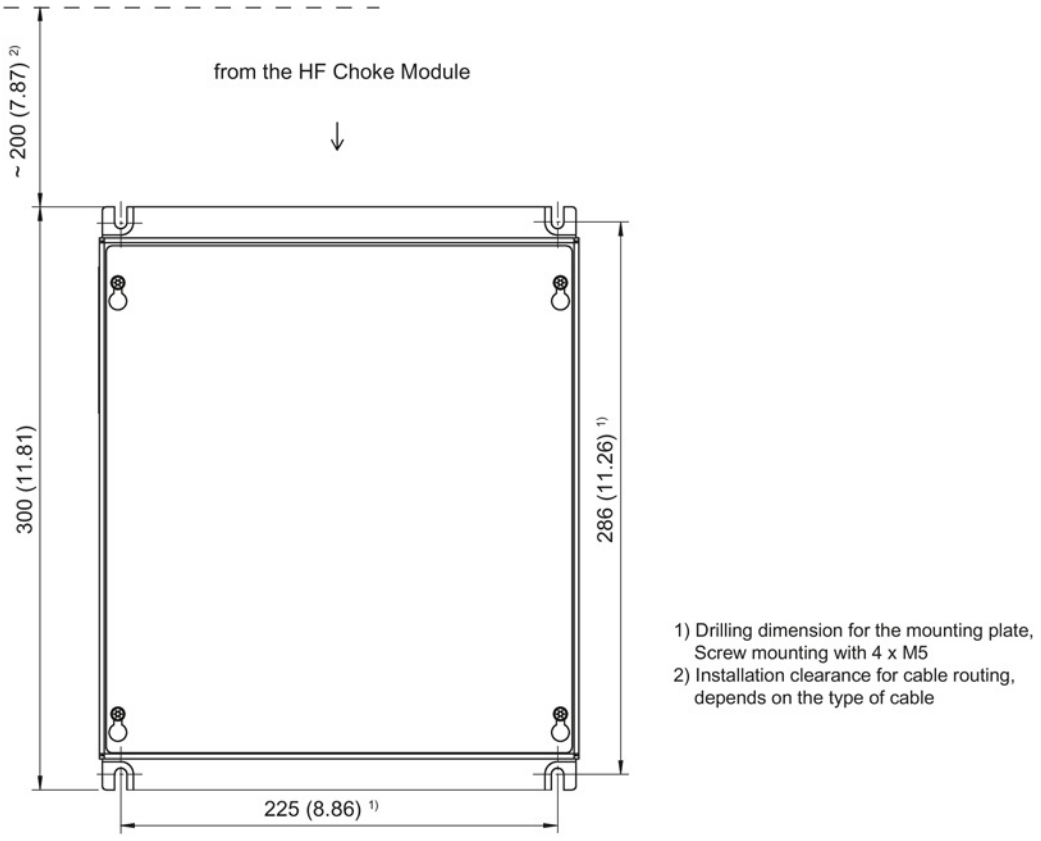


Figure 5-6 Mounting dimensions for a Voltage Protection Module VPM 200 Dynamik

5.7 Electrical connection

DANGER

Danger of death due to electric shock when live parts are touched

Death or serious injury can result when live parts are touched.

- Bring the system into a no-voltage condition by opening the main switch.
- Take measures to prevent reconnection of the energy sources.

Note

It is only permissible to open the enclosure cover to electrically connect the Voltage Protection Module.

Various preparatory work is required to connect the Voltage Protection Module to the HF Choke Module. Cable cross-sections are determined by the rated motor power and can be up to 2 x 50 mm^2 for each conductor.

Prepare the Voltage Protection Module to install cables

1. Loosen the 4 screws on the cover of the housing, so that the cover can be shifted in the cutouts.
2. Slide the enclosure cover to the widest part of the cutout and remove the cover.
3. Secure the cable glands for the signal cable and the power cables to the enclosure cable entries of the Voltage Protection Module.
4. Remove 300 mm of the power cable sheath (insulation) to expose the shield.
5. Strip the ends of the individual cores and attach the cable lugs.
6. Attach the signal cable to X3 and secure the cable with cable ties inside the Voltage Protection Module.

5.7.1 Connecting signaling contact X3

Signaling contact X3 must be wired before the power cables are connected.

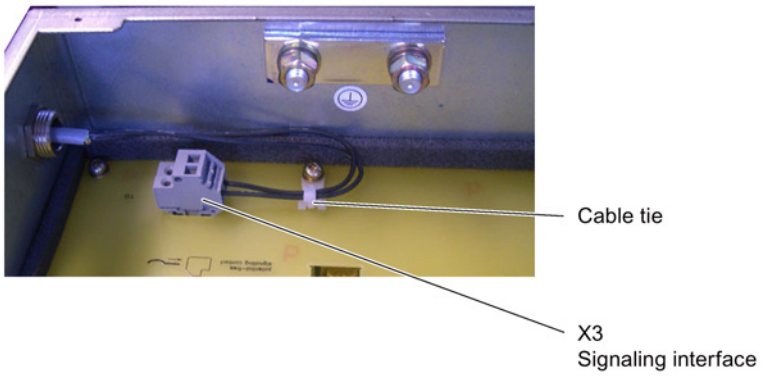


Figure 5-7 Connecting terminal X3 of the Voltage Protection Module

Note

Signaling contact X3 on the Voltage Protection Module is routed via a bistable relay. The relay may shift to the other switching state if subjected to excessive movement during transportation and installation. This may prevent the system from starting.

NOTICE

Damage when switching on the inverter as a result of a short circuit

After it has responded, the Voltage Protection Module generates a short-circuit as long as the motor is rotating. If the inverter is switched on, it can be damaged as a result of the short-circuit.

- Only switch on the inverter again once the motor has come to a complete standstill. The fact that signaling contact X3 has closed again does **not** prove this conclusively!

Cause and rectification of faults

Additional information about the cause of faults and how to rectify them is provided in the following document in the "Installation" section:

Operating Instructions for Voltage Protection Module VPM 200 Dynamik, Article No.: A5E00302261B

5.8 Technical data

Table 5- 5 Technical data, VPM 200 Dynamik

6SN1113–1AA00–1KCx		
Type of voltage		3-phase pulsed AC voltage, motor EMF
Ramp-up time for VPM	s	1 (from pulse enable)
Normal range of the DC link voltage: Lower limit Upper limit	 V_{DC} V_{DC}	 490 795
Operating range for VPM	V	830 … 2000 (peak value)
Motor EMF	kV_{rms}	< 1.4
Time range: 0 … 10 ms 10 … 500 ms 500 ms … 2 min > 2 min	 A A A A	Maximum permissible short-circuit current: 2000 600 200 0
Max. permissible short-circuit time	s	120
Protection class according to EN 61140		I
Protective separation		Between the signaling contact and motor cables U, V, W acc. to UL 508C
Degree of protection to EN 60529		IP20
Permitted humidity	%	< 90
Humidity classification according to EN 60721-3-3		Cl. 3K5, condensation and icing excluded Low air temperature 0 °C
Permissible ambient temperature, min. / max.	°C	0 / 55
Cooling method		Air-cooled, free convection
Weight	kg	approx. 13
Dimensions (W x H x D)	mm	300 x 250 x 260

Braking Modules

6

6.1 Braking Module Booksize

6.1.1 Description

The Braking Module Booksize is always used together with an external braking resistor. It has the following tasks:

- Specific stop of the drives in the event of a line failure
  (e.g. emergency retraction or EMERGENCY OFF category 1).
- Limit the DC link voltage for brief periods of generator operation (e.g. if the regenerative feedback capability of the Line Module is deactivated or is not adequately dimensioned).

The Braking Module includes the necessary power electronics and control. When the Braking Module is in operation, the power which is fed back into the DC link is dissipated via an external braking resistor.

External braking resistors

Braking resistors without thermostatic switch 6SN1113-1AA00-0DA0 (P_N = 0.3 kW) and 6SL3100-1BE31-0AA0 (P_N = 1.5 kW) can be operated at the Braking Module Booksize.
The cable lengths between the Braking Module and braking resistor is limited to a maximum of 10 m.
The scope of delivery of the braking resistor 6SN1113-1AA00-0DA0 includes a shielded connection cable (3 m, 3 x 1.5 mm^2).

Rapid discharge

Furthermore, the Braking Module Booksize can used with a braking resistor to quickly discharge the DC link capacitors The DC link is discharged in a controlled manner via the braking resistor once the infeed unit has been switched off and the line-up has been disconnected from the line supply (e.g. via the main switch or line contactor). The function can be activated via a digital input on the Braking Module. A quick discharge makes sense, for example, when maintenance tasks are to be performed at the Motor Module and/or motor installation (reduction of the discharge time).

⚠WARNING

Danger to life when live parts are touched after rapid discharge

On completion of quick discharge, a voltage of 30 V is still present at the DC link. If the fast discharge is interrupted before it has been completed, then this voltage can be more than 60 V. Touching live components can result in death or severe injury.

- Check the DC link to ensure that it is in a no voltage state before starting any work.

NOTICE

Damage to the Motor Module or connected motors for a fast discharge

For a fast discharge, the Motor Module or the connected motors can be damaged.

- For a rapid discharge, fully disconnect the drive system from the line supply.
- The motors must be at a standstill.

Monitoring functions

- Automatic detection of braking resistors and braking power monitoring
- I^2t monitoring of the braking resistors.
- Temperature monitoring of the Braking Module
- Short circuit and overload detection
- Ground fault detection

6.1.2 Safety instructions for Braking Modules Booksize

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 17) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.

⚠WARNING

Fire hazard due to overheating because of inadequate ventilation clearances

Inadequate ventilation clearances can cause overheating with a risk for personnel due to smoke and fire. This can also result in increased failure rates and a shorter service life of the components.

- Maintain the 80 mm clearances above and below the components.

NOTICE

Device failure as a result of unshielded or incorrectly routed cables to braking resistors

Unshielded or incorrectly routed cables to braking resistors can result in interference being coupled into the signal processing electronics from the power side. This can result in significant disturbance of all signals (fault messages) up to failure of individual components (destruction of the devices).

- Only use shielded cables for cables to braking resistors.

NOTICE

Danger to life through the use of non-approved braking resistors

Braking resistors can be damaged when using braking resistors other than those specified in this Manual.

- Only use braking resistors approved by Siemens.

6.1.3 Interface description

6.1.3.1 Overview

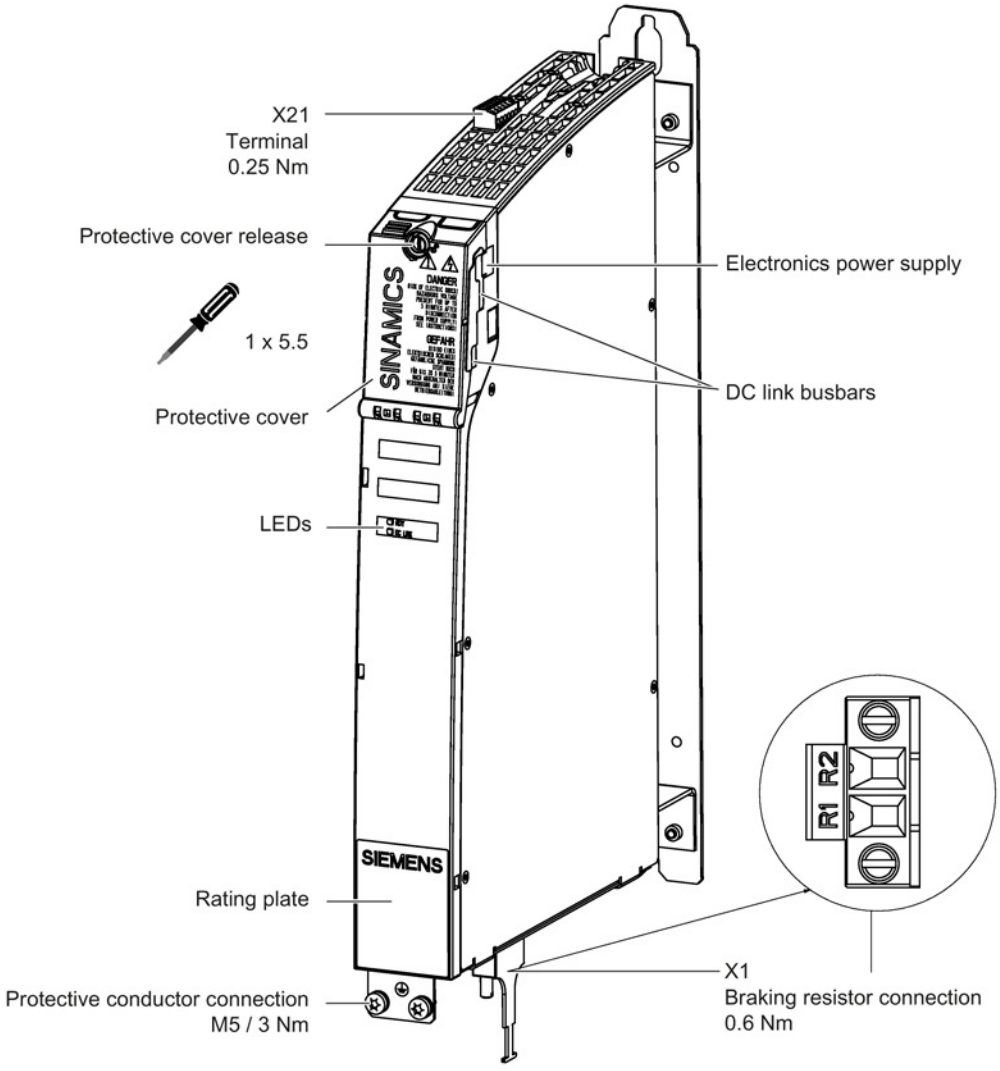


Figure 6-1 Interface overview, Braking Module Booksize

6.1.3.2 X1 braking resistor connection

Table 6- 1 X1 braking resistor connection

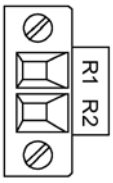
	Terminal	Designation	Technical data
	1	Braking resistor connection R1	Continuously short-circuit proof
	2	Braking resistor connection R2	
Type: Screw terminal 4 (Page 172) Max. cross-section that can be connected: 4 mm^2			

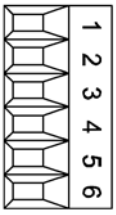
Table 6- 2 Braking resistors without a thermostatic switch for Braking Modules

Braking resistor	R in Ω	P_N in kW	P_{max} in kW
6SN1113-1AA00-0DA0	17	0,3	25
6SL3100-1BE31-0AA0	5,7	1,5	100

For detailed technical information on the braking resistors, see the section entitled Braking resistors (Page 117).

6.1.3.3 X21 digital inputs/outputs

Table 6- 3 X21 digital inputs/outputs

	Terminal	Designation[1)]	Technical data
	1	DI low: Enable Braking Module DI high: inhibit/acknowledge Edge change, high → low: fault acknowledgement	Voltage: -3 … +30 V Typical current drain: 10 mA at 24 V DC Level (incl. ripple) High level: 15 … 30 V Low level: -3 … +5 V
	2	DI low: braking resistor, not controlled manually DI high: Braking resistor controlled manually (quick discharge)[2)]	
		If X21.1 and X21.2 are activated simultaneously, the Braking Module inhibit has priority.	
	3	DO high: no prewarning DO low: Prewarning, disconnection imminent	Max. load current per output: 100 mA Continuously short-circuit proof Voltage: 24 V DC
	4	DO high: ready for operation, no fault DO low: Fault	
	5	Ground	
	6		
Type: Screw terminal 1 (Page 172) Max. cross-section that can be connected 1.5 mm^2:			

1) DI: digital input; DO: digital output; M: Electronics ground

2) The "fast discharge function" is used for discharging the capacitors in the DC link after the line supply has been interrupted. It may only be used a maximum of once or twice per week.

Terminal X21.1 - inhibit/acknowledge

Applying a high signal to terminal X21.1 inhibits the Braking Module. Fault messages that are available are acknowledged with a falling edge.

Terminal X21.3 - prewarning

When a prewarning is sent, disconnection of the braking module is imminent. This may be due to the following causes:

- The temperature of the Braking Module is 80 % of the maximum value.
- 80 % of the maximum switch on duration of the braking resistor has been reached (I^2t monitoring).
- 80 % of the maximum braking energy of the braking resistor has been reached.
- An incorrect braking resistor is connected (only braking resistors approved by Siemens for this component are automatically identified).

Terminal X21.4 - fault

The fault can have the following causes:

- Electronics power supply is missing or outside permissible tolerance range
- Enable missing (input terminal)
- Overtemperature

- Overcurrent trip
- I^2t monitoring has responded.
- Ground fault/short circuit

In the event of an overtemperature, the fault can only be acknowledged with X21.1 = high after a cooling-down time.

⚠WARNING

Danger to life as a result of a hazardous voltage at terminals X21

Hazardous voltages can be present at terminals X21 in the case of a fault. Touching live components can result in death or severe injury.

- Only connect protective extra low voltages at terminals X21.

6.1.4 Connection example

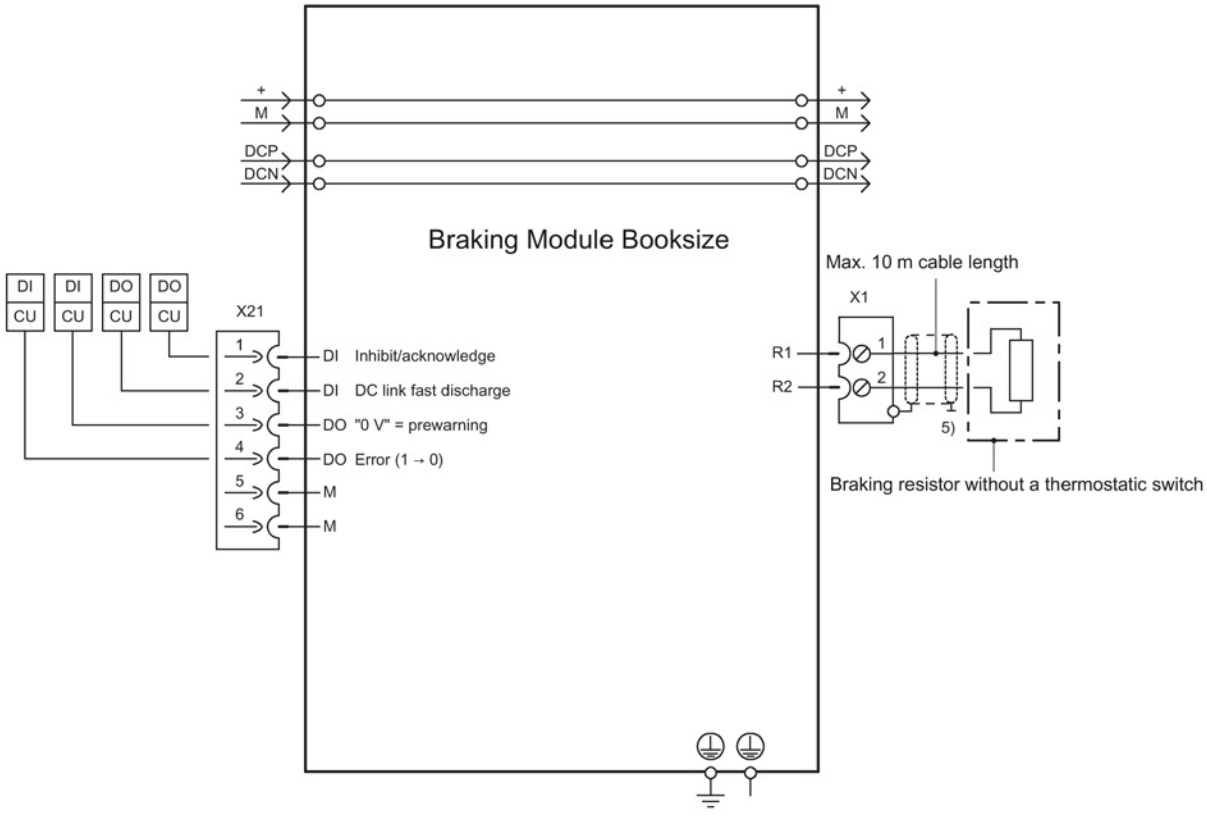


Figure 6-2 Connection example of a Braking Module Booksize

Information on how to parameterize the digital inputs or digital outputs, see the SINAMICS S120/S150 List Manual.

6.1.5 Meaning of the LEDs

Table 6- 4 Meaning of the LEDs on the Braking Module Booksize

LED	Color	Status	Description, cause	Remedy
READY	-	Off	The electronics power supply is missing or outside the permissible tolerance range. The component is deactivated via terminal.	–
	Green	Continuous light	The component is ready for operation.	–
	Red	Continuous light	Enable missing (input terminal) Overtemperature Overcurrent trip I^2t monitoring activated Ground fault/short circuit **Note:** In the event of an overtemperature, the error cannot be acknowledged until a cooling time has elapsed.	Troubleshoot the fault using the output terminals and acknowledge it using the input terminal.
DC LINK	-	Off	Only braking resistors approved by Siemens for this component are identified automatically. The component is not active.	–
	Green	Flashing light	The component is active (DC link is being discharged via the braking resistor).	–

6.1.6 Dimension drawing

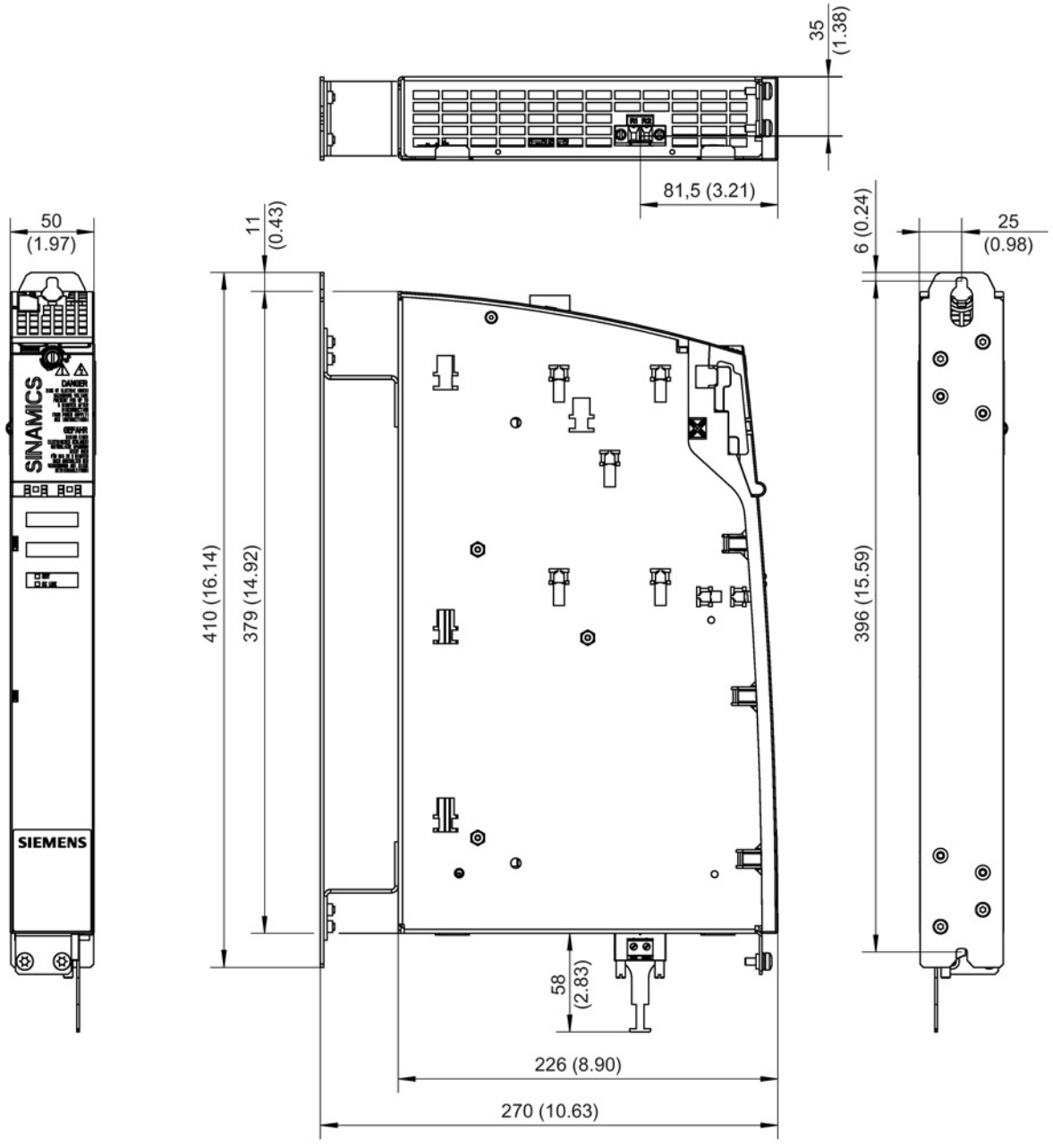
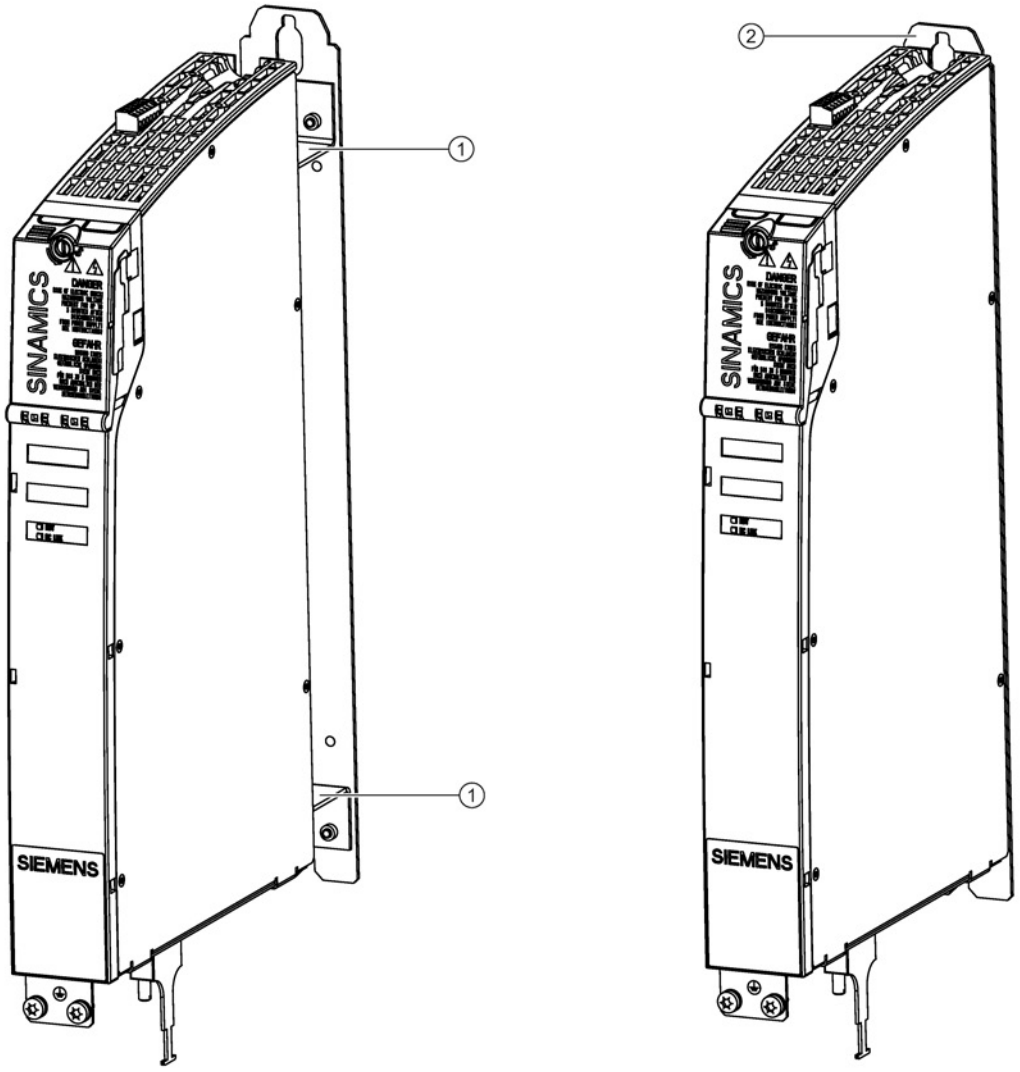


Figure 6-3 Dimension drawing of Braking Module, all dimensions in mm and (inches)

6.1.7 Installation



① Delivery condition with spacer - mounting depth for drive line-up in booksize format with internal air cooling
② Spacer removed - mounting depth for drive line-up in booksize format with external air cooling

Figure 6-4 Methods of installing Braking Modules with/without spacer elements

6.1.8 Technical data

6.1.8.1 Technical data

Table 6- 5 Technical data

6SL3100-1AE31-0ABx		
DC link voltage	V_{DC}	510 … 720
DC link capacitance	µF	110
ON threshold	V	770
Electronics power supply	V_{DC}	24 (20.4 … 28.8)
Electronics current consumption (at 24 V DC)	A_{DC}	0.5
Current carrying capacity DC link busbars 24 V busbars	 A_{DC} A_{DC}	 100 20
Braking power Max. Continuous braking power	 kW kW	 100 1.5
Power loss	W	20
Cooling method		Natural convection
Weight	kg	4.1

6.1.8.2 Characteristic curves

Duty cycle for braking resistors without a thermostatic switch

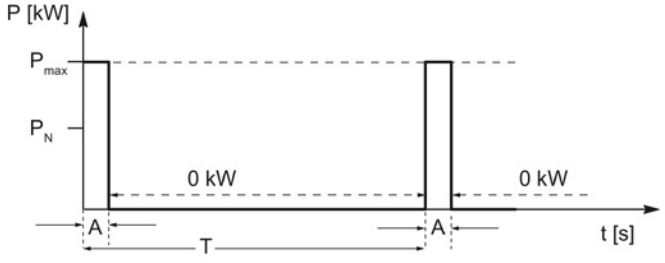


Figure 6-5 Duty cycle for braking resistors without a thermostatic switch

T [s] time period of braking duty cycle

A [s] load duration

P_N [kW] rated power (continuous power) of the braking resistor

P_{max} [kW] peak power of braking resistor (6 x P_N)

Table 6- 6 Duty cycles

	6SN1113–1AA00–0DA0		6SL3100–1BE31–0AAx	
	Short duty cycle	Long duty cycle	Short duty cycle	Long duty cycle
A [s]	0.1	0.4	1	2
T [s]	11.5	210	68	460

The following applies when connecting Braking Modules in parallel:

$P_{N\ total}$ = 0.9 x total P_N of single devices

$P_{max\ total}$ = total P_{max} of single devices

6.1.9 Configuration instructions

DC link capacitance

To operate Braking Modules, a minimum capacitance of 440 µF is required in the DC link for each Braking Module.

The capacitance of the Braking Module of 110 µF is included in the total capacitance value.

Note

Only the components that are connected to each other via the DC link busbar can be included in the total capacitance.

DC link cable

In a two-row or distributed drive line-up, the DC links are connected to each other via a DC link cable. When using a Braking Module in the drive line-up, this cable must not be longer than 10 m. The DC link cable must be twisted and have a minimum cross-section of at least 10 mm^2.

Parallel connection

The Braking Module Booksize Compact 6SL3400-1AE31-0AAx is recommended for the parallel connection of Braking Modules.

Parallel connection of the Braking Module 6SL3100-1AE31-0AAx should be avoided as power distribution between the modules is not guaranteed.

Note

When Braking Modules are connected in parallel, the DC link capacitance specified above must be available for each Braking Module.

6.2 Braking Module Booksize Compact

6.2.1 Description

The Braking Module Booksize Compact is always used together with a braking resistor. It has the following tasks:

- Controlled stop of the drives in the event of a power failure (e.g. emergency retraction or EMERGENCY OFF Category 1).
- Limit the DC link voltage for brief generator operation, e.g. if the energy recovery capability of the Line Module is deactivated or is not adequately dimensioned.

The Braking Module includes the necessary power electronics and control. When the module is in operation, the power which is fed back into the DC link is dissipated via an external braking resistor.

The Braking Module can be operated on 200 V or 400 V line supply systems; the 4-pin DIP switch on the top of the module is used to select which one applies in each case. The factory setting is 400 V.

When spacers (6SL3462-1CC00-0AA0) are used, the Braking Module Booksize Compact can be integrated into a drive line-up in booksize format with internal air cooling.

External braking resistors

Braking resistors can be operated with and without thermostatic switch at the Braking Module Booksize Compact. The DIP switch sets the type of braking resistor being used in each case. The factory setting is "braking resistor with a thermostatic switch".

The cable length between the Braking Module and the braking resistor is limited to 10 m.

Rapid discharge

Furthermore, the Braking Module Booksize Compact can be used with a braking resistor to quickly discharge the DC link. The DC link is discharged in a controlled manner via the braking resistor once the infeed unit has been switched off and the line-up has been disconnected from the line supply (e.g. via the main switch or line contactor). The function can be activated via a digital input on the Braking Module. A quick discharge makes sense, for example, when maintenance tasks are to be performed at the Motor Module and/or motor installation (reduction of the discharge time).

⚠WARNING

Danger to life when live parts are touched after rapid discharge

On completion of quick discharge, a voltage of 30 V is still present at the DC link. If the fast discharge is interrupted before it has been completed, then this voltage can be more than 60 V. Touching live components can result in death or severe injury.

- Check the DC link to ensure that it is in a no voltage state before starting any work.

NOTICE

Damage to the Motor Module or connected motors for a fast discharge

For a fast discharge, the Motor Module or the connected motors can be damaged.

- For a rapid discharge, fully disconnect the drive system from the line supply.
- The motors must be at a standstill.

Cooling methods

The Braking Module Booksize Compact can be operated with the following cooling methods:

- Internal air cooling
- Cold plate cooling

The required cooling method is set using the DIP switch The factory setting is "internal air cooling".

Internal fan

When the Braking Module is being used with internal air cooling, the internal fan starts up immediately and is subsequently controlled by the temperature.

If the DIP switch is set to cold plate cooling by mistake, the fan will still start up when a certain temperature threshold is reached, in order to prevent the Braking Module shutting down due to overtemperature. If this threshold is exceeded, an alarm is issued via the digital output "Prewarning". This ensures that an emergency stop can be performed if necessary.

Monitoring functions

- Automatic detection of braking resistors without thermostatic switch and corresponding braking power monitoring (only if the "Braking resistor without thermostatic switch" setting is used)
- I^2t monitoring of the Braking Module
- Temperature monitoring of the Braking Module
- Temperature monitoring of the connected braking resistor with thermostatic switch (only for setting "Braking resistor with thermostatic switch")
- Short-circuit and overload detection (for all braking resistors)
- Ground fault detection (for all braking resistors)

Parallel operation

Several Braking Modules Booksize Compact can be connected in parallel to increase the braking power. In this case, the braking energy is divided between the modules. Formulas for calculating the parallel connection are given in Chapter Notes on configuration (Page 116).

6.2.2 Safety instructions for Braking Modules Booksize Compact

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 17) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.

⚠WARNING

Fire hazard due to overheating because of inadequate ventilation clearances

Inadequate ventilation clearances can cause overheating with a risk for personnel due to smoke and fire. This can also result in increased failure rates and a shorter service life of the components.

- Maintain the 80 mm clearances above and below the components.

NOTICE

Device failure as a result of unshielded or incorrectly routed cables to braking resistors

Unshielded or incorrectly routed cables to braking resistors can result in interference being coupled into the signal processing electronics from the power side. This can result in significant disturbance of all signals (fault messages) up to failure of individual components (destruction of the devices).

- Only use shielded cables for cables to braking resistors.

NOTICE

Danger to life through the use of non-approved braking resistors

Braking resistors can be damaged when using braking resistors other than those specified in this Manual.

- Only use braking resistors approved by Siemens.

6.2.3 Interface description

6.2.3.1 Overview

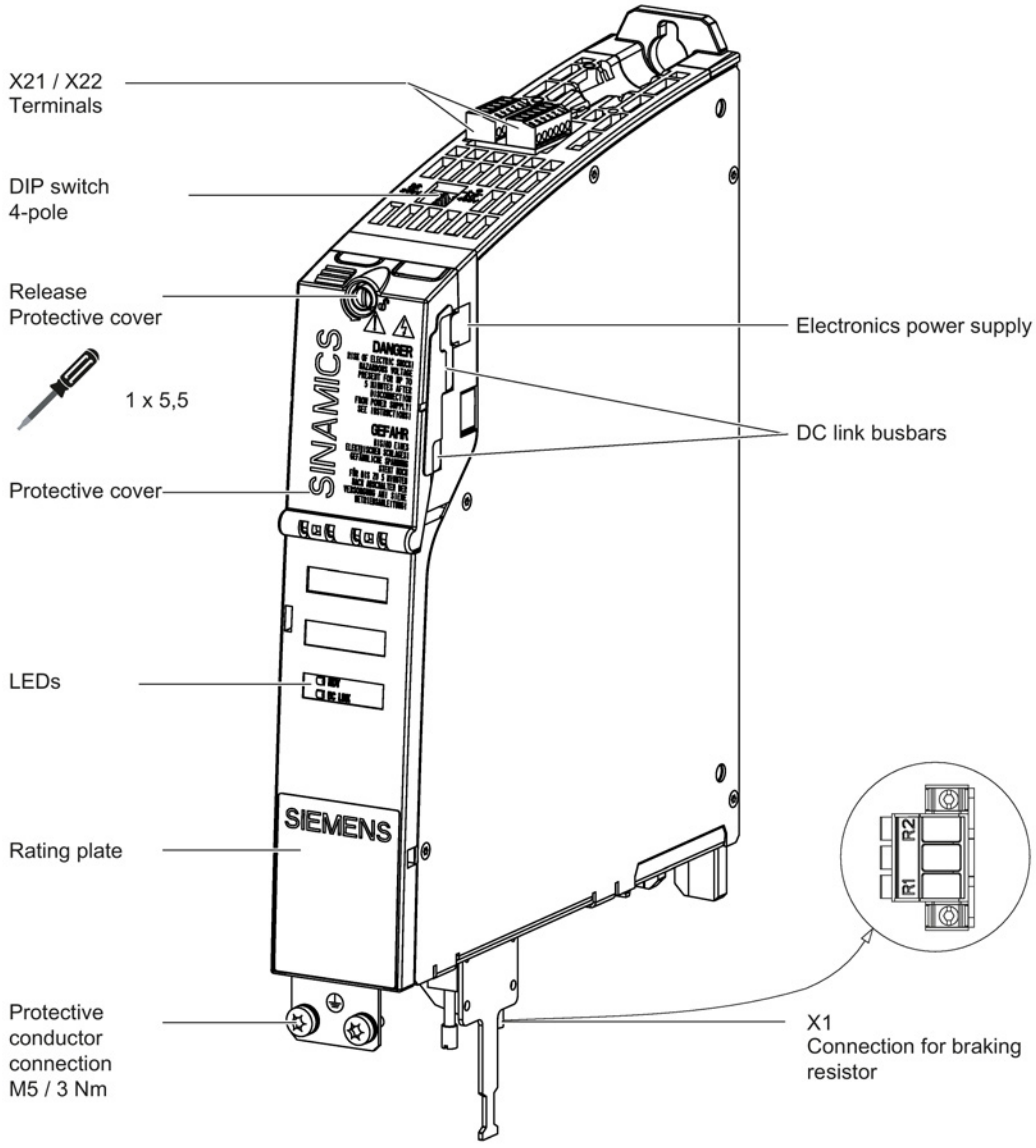
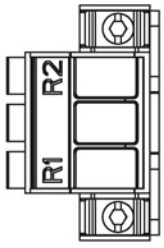


Figure 6-6 Interface overview, Braking Module Booksize Compact

6.2.3.2 X1 braking resistor connection

Table 6- 7 X1 braking resistor connection

	Terminal	Designation	Technical data
	1	Braking resistor connection R1	Continuously short-circuit proof
	2	Not assigned	
	3	Braking resistor connection R2	
Type: Screw terminal 5 (Page 172) Max. cross-section that can be connected: 6 mm^2			

Braking resistors without a thermostatic switch

The Braking Module Booksize Compact is only designed for operation with the braking resistors listed below.

Table 6- 8 Braking resistors without a thermostatic switch

Braking resistor	R in Ω	P_N in kW	P_{max} in kW
6SN1113-1AA00-0DA0	17	0,3	25
6SL3100-1BE31-0AA0	5,7	1,5	100

Braking resistors with a thermostatic switch

The Braking Module Booksize Compact is only designed for operation with the braking resistors listed below.

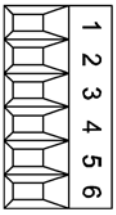
Table 6- 9 Braking resistors with a thermostatic switch

Braking resistor	R in Ω	P_N in kW	P_{20} in kW	P_{max} in kW
6SE7018-0ES87-2DC0	80	1,25	5	7,5
6SE7021-6ES87-2DC0	40	2,5	10	15
6SE7023-2ES87-2DC0	20	5	20	30

For detailed technical information on the braking resistors, see Chapter Braking resistors (Page 117).

6.2.3.3 X21 digital inputs/outputs

Table 6- 10 X21 digital inputs/outputs

	Terminal	Designation[1]	Technical data
	1	DI low: Enable Braking Module DI high: inhibit/acknowledge Edge change, high → low: fault acknowledgement	Voltage: -3 … +30 V Typical current drain: 10 mA at 24 V DC Level (incl. ripple) High level: 15 … 30 V Low level: -3 … +5 V
	2	DI low: braking resistor, not controlled manually DI high: Braking resistor controlled manually (quick discharge)[2]	
		If X21.1 and X21.2 are activated simultaneously, the Braking Module inhibit has priority.	
	3	DO high: no prewarning DO low: Prewarning:	Max. load current per output: 100 mA Continuously short-circuit proof Voltage: 24 V DC
	4	DO high: ready for operation, no fault DO low: Fault	
	5	Ground	
	6		
Type: Screw terminal 1 (Page 172) Max. cross-section that can be connected 1.5 mm^2:			

1) DI: digital input; DO: digital output; M: Electronics ground

2) The "fast discharge function" is used for discharging the capacitors in the DC link after the line supply has been interrupted.

Terminal X21.1 - inhibit/acknowledge

Applying a high signal to terminal X21.1 inhibits the Braking Module. Fault messages that are available are acknowledged with a falling edge.

Terminal X21.3 - prewarning

When a prewarning is sent, disconnection of the braking module is imminent. This may be due to the following causes:

- The temperature switch braking resistor has triggered (only if the "Braking resistor with thermostatic switch" setting is used)
- The temperature of the Braking Module is 80 % of the maximum value.
- The I^2t counter of the Braking Module has reached 80 % of the maximum value.
- The braking resistor has reached 80 % of the maximum permissible braking energy (only for setting "Braking resistor without thermostatic switch").
- An incorrect braking resistor is connected (only if the "braking resistor without a thermostatic switch" setting is used).

Terminal X21.4 - fault

In the event of an overtemperature fault, I^2t monitoring, or braking power monitoring, the fault will be acknowledged automatically after a cooling phase. Manual acknowledgment is not necessary!

⚠WARNING

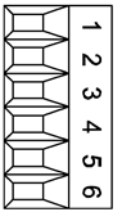
Danger to life as a result of a hazardous voltage at terminals X21

Hazardous voltages can be present at terminals X21 in the case of a fault. Touching live components can result in death or severe injury.

- Only connect protective extra low voltages at terminals X21.

6.2.3.4 X22 digital output/temperature switch

Table 6- 11 X22 digital output/temperature switch, braking resistor

	Terminal	Designation[1)]	Technical data
	1	+ Temp	Temperature switch of the braking resistor
	2	- Temp	
	3	Reserved	Not assigned!
	4	Reserved	
	5	DO high: 200 V supply system is selected DO low: 400 V supply system is selected	
	6	Reserved	Not assigned!
Type: Screw terminal 1 (Page 172) Max. cross-section that can be connected 1.5 mm^2:			

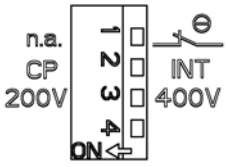
1) DO: digital output

6.2.3.5 DIP switch

The 4-pin DIP switch is located at the top of the Braking Module and sets the braking resistor being used, the cooling method, and the line voltage.

Make the required settings before the Braking Module is mounted in the control cabinet; once the module is mounted, the DIP switch can no longer be accessed from the front.

Table 6- 12 DIP switch for Braking Module Booksize Compact

	Switch	Switch position	Function	Factory setting
	1	ON	Braking resistor without a thermostatic switch	OFF
		OFF	Braking resistor with a thermostatic switch	
	2	ON	Cold plate cooling	OFF
		OFF	Internal air cooling	
	3	ON	200 V line voltage	OFF
		OFF	400 V line voltage	
	4	ON	Reserved	OFF
		OFF		

Note

Terminal assignment for "Braking resistor without a thermostatic switch" mode

For "braking resistor without a thermostatic switch" mode (switch 1 = ON) , terminals X22.1 and X22.2 must not be assigned for the Braking Module to work.

6.2.4 Connection examples

Braking resistor without thermostatic switch connected to a Braking Module Booksize Compact

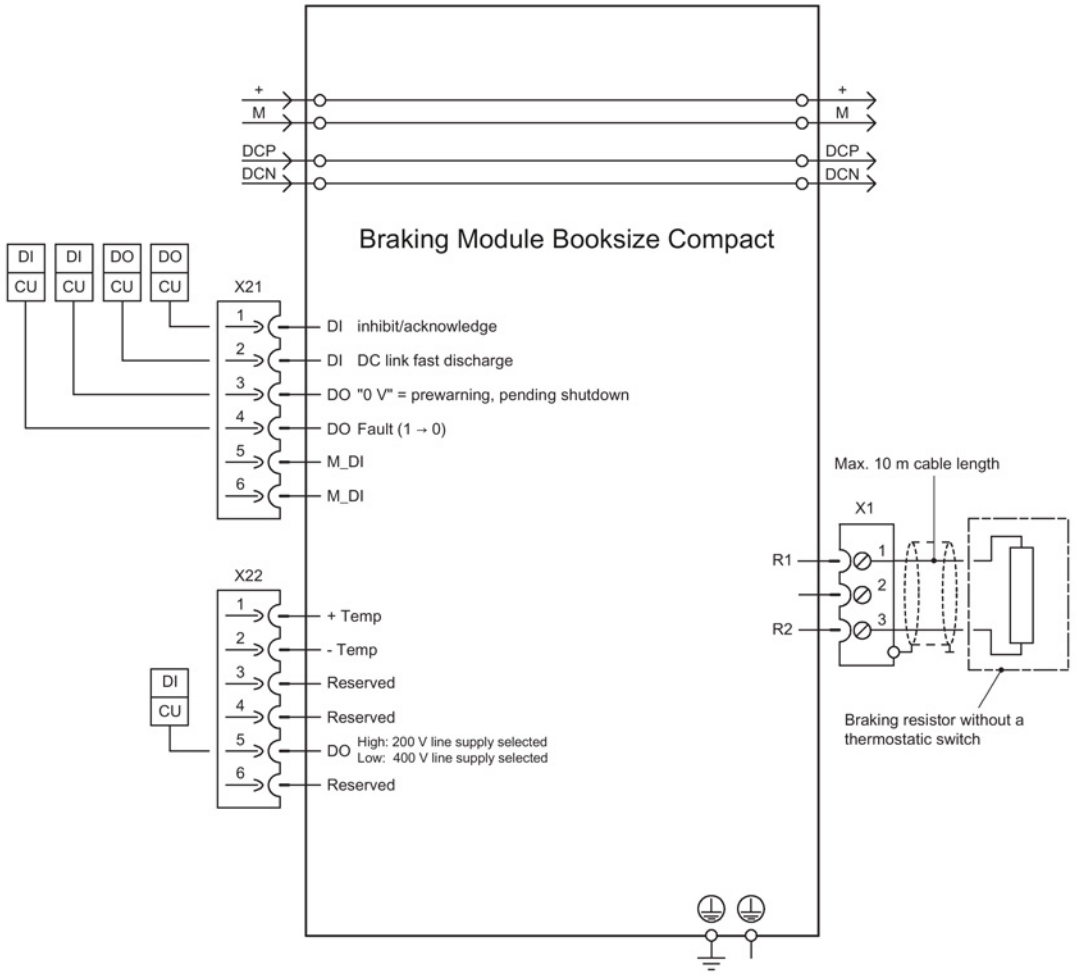


Figure 6-7 Connection example for Braking Module Booksize Compact and braking resistor without a thermostatic switch

Note

The digital inputs DI are isolated and are referenced to M_DI (X21.5 and X21.6).
The reference point of the digital outputs DO is the ground GND of the 24 V supply.

It is not permissible that the connections for the temperature switches (X22.1 and X22.2) are used/assigned for "braking resistor without a thermostatic switch" operation. Otherwise, malfunctions occur.

Braking resistor with thermostatic switch connected to a Braking Module Booksize Compact

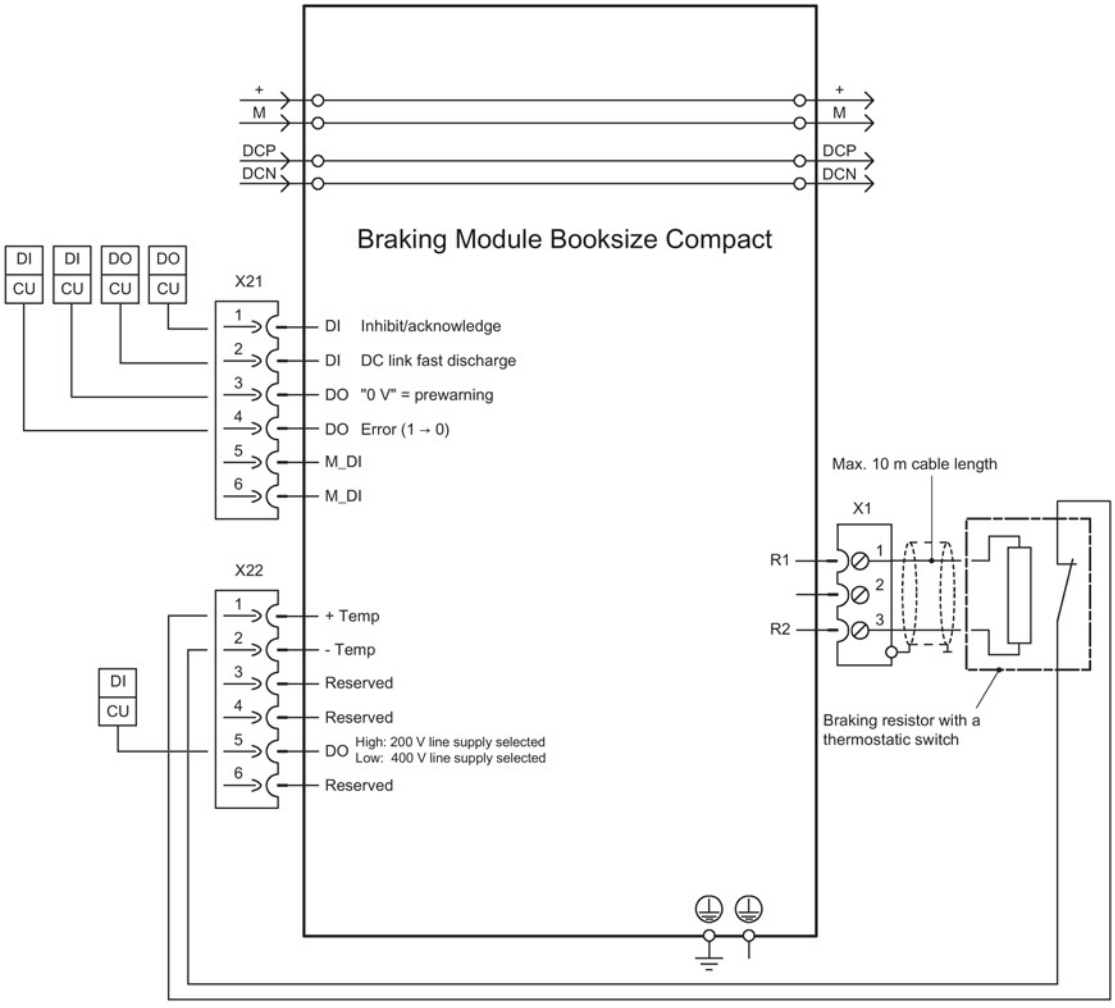


Figure 6-8 Connection example for Braking Module Booksize Compact and braking resistor with a thermostatic switch

Note

The digital inputs (DI) are isolated and are referenced to M_DI (X21.5 and X21.6).
The reference point of the digital outputs (DO) is the ground GND of the 24 V supply.

Information on how to parameterize the digital inputs or digital outputs, see the SINAMICS S120/S150 List Manual.

6.2.5 Meaning of LEDs on the Braking Module Booksize Compact

Table 6- 13 Meaning of LEDs on the Braking Module Booksize Compact

LED	Color	Status	Description	Remedy
READY	-	Off	The electronics power supply is missing or outside the permissible tolerance range.	Check the electronics power supply.
	Green	Continuous light	The component is ready for operation.	-
	Red	Continuous light	Enable missing (input terminal) Overtemperature of IGBT/braking resistor Overcurrent trip I^2t monitoring activated Braking power monitoring triggered Ground fault/short circuit **Comment:** In the event of overtemperature, I^2t monitoring or braking power monitoring, the fault will be acknowledged automatically after a cooling down phase. Manual acknowledgment is not possible.	Troubleshoot the fault using the output terminals and acknowledge it using the input terminal.
DC LINK	-	Off	The DC link voltage is not available, the electronics power supply is missing or is outside the permissible tolerance range. The component is not active.	
	Orange	Continuous light	The DC link voltage is present.	-
	Orange	Flashing light	The component is active. The DC link is being discharged via the braking resistor.	-

6.2.6 Dimension drawing

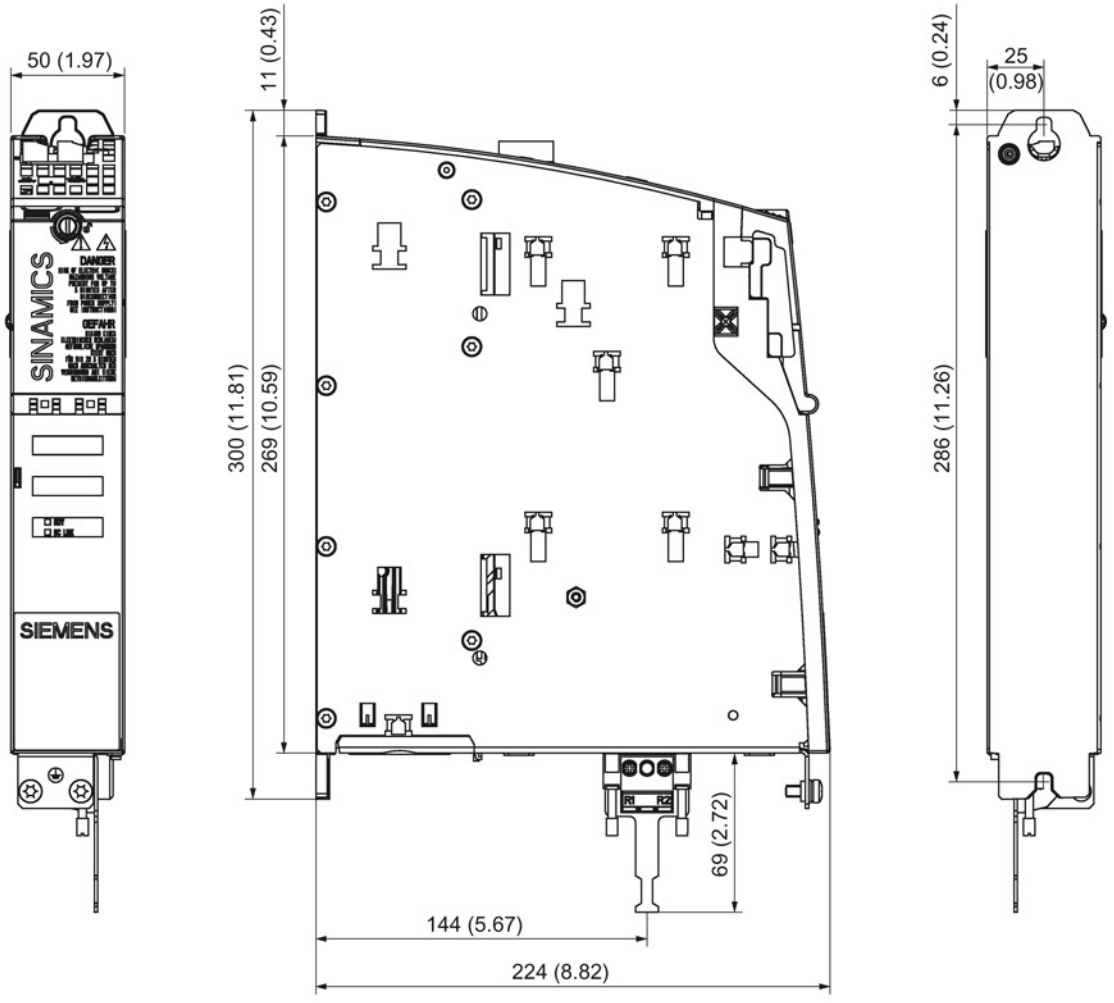
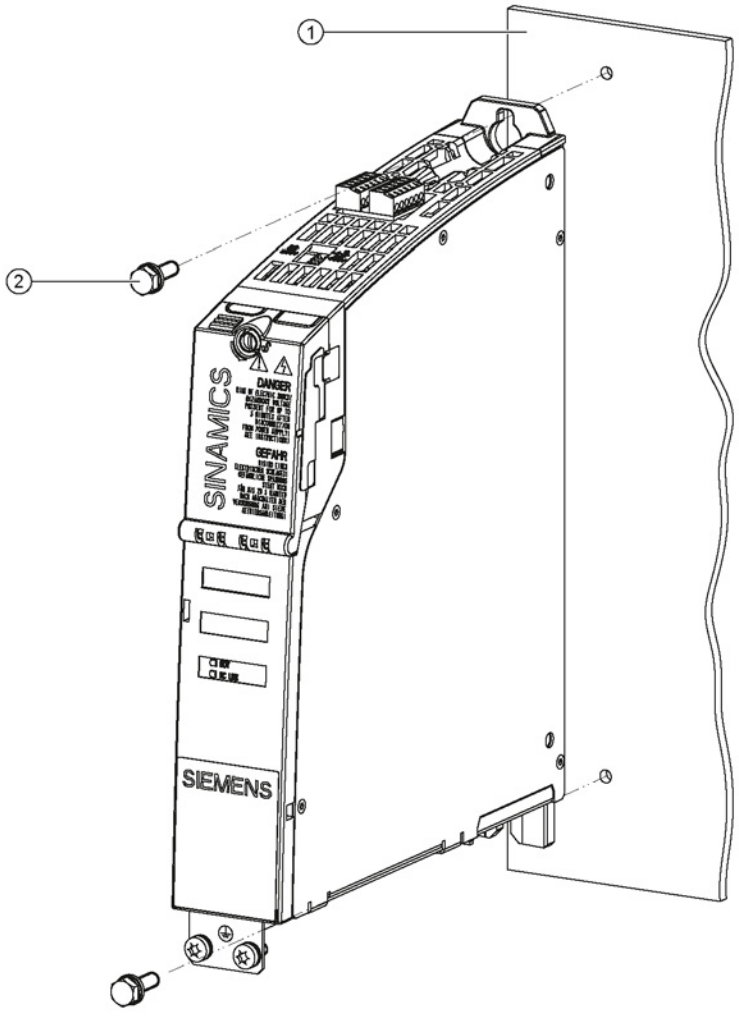


Figure 6-9 Dimension drawing of Braking Module Booksize Compact, all dimensions in mm and (inches)

6.2.7 Mounting

Mounting a Braking Module Booksize Compact with internal air cooling



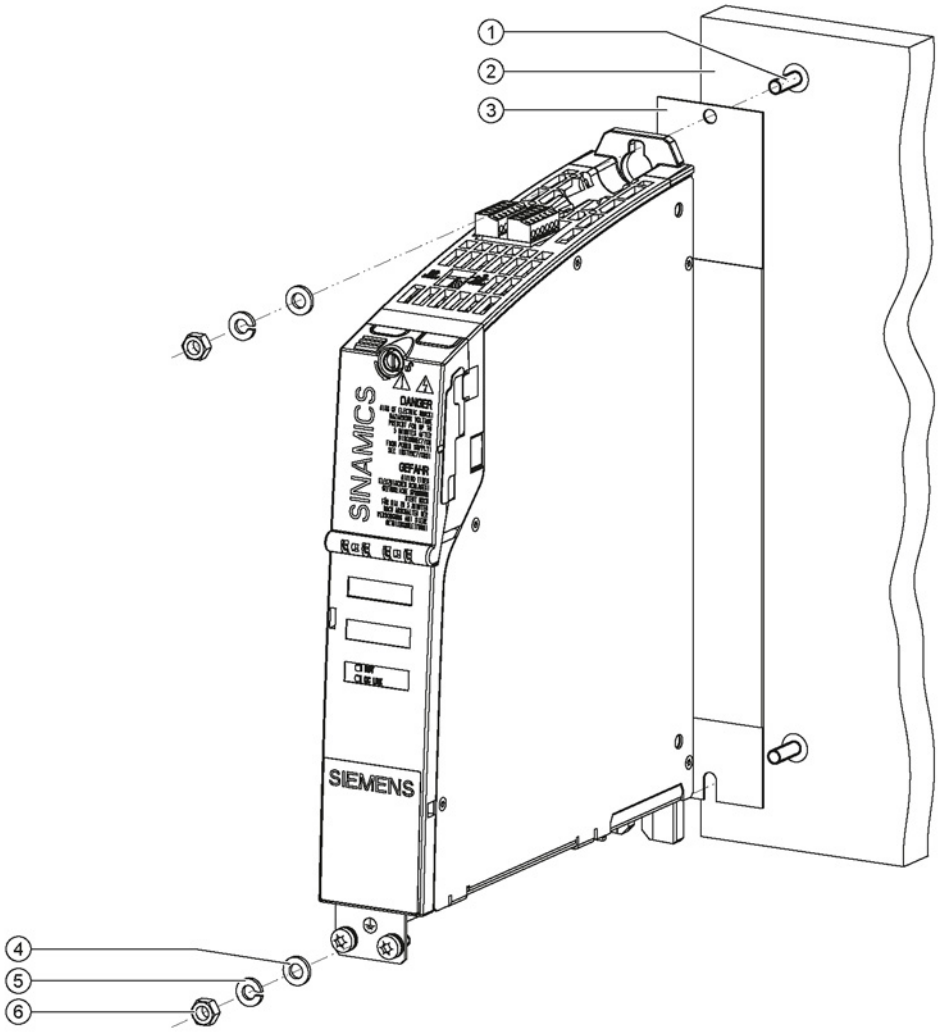
① Mounting wall
② M6 x 16 screw
Hex combination screw or hex screw with spring washer and plain washer

Figure 6-10 Mounting a Braking Module Booksize Compact with internal air cooling

Tightening torques:

1. Firstly, tighten the nuts by hand.
   Tightening torque: 0.5 Nm
2. Then tighten the nuts.
   Tightening torque: 6 Nm

Mounting a Braking Module Booksize Compact with cold plate



① Threaded bolts M6
② Cold plate (air or liquid cooling)
③ Heat-conducting foil
④ Washer
⑤ Spring washer
⑥ M6 nut

Figure 6-11 Mounting a Braking Module Booksize Compact with cold plate

Tightening torques:

1. Firstly, tighten the nuts by hand.
   Tightening torque: 0.5 Nm
2. Then tighten the nuts.
   Tightening torque. 10 Nm

Special points to note in relation to mounting on a cold plate

To improve heat transfer, a heat-conducting medium must be used. Special spherical-indented heat-conducting foil must be used for this purpose. Every Braking Module Booksize Compact is supplied with heat-conducting foil cut to the right size. Note the mounting position of the heat-conducting foil.

Note

- Also replace the heat-conducting foil when replacing a component.
- Only use heat-conducting foil released or supplied by Siemens.

	Article No.
Heat-conducting foil, 50 mm	6SL3162-6FB01-0AA0

6.2.8 Technical data

6.2.8.1 Technical specifications

Table 6- 14 Technical data

6SL3400-1AE31-0AAx			
Line supply		200 V	400 V
DC link voltage	V_{DC}	250 … 360	510 … 720
ON threshold	V_{DC}	400	760
Braking power Maximum[1)] Continuous braking power	 kW kW	 50 2.5	 100 5
Electronics power supply	V_{DC}	24 (20.4 … 28.8)	
Electronics current consumption (at DC 24 V) Standby mode	 A_{DC} A_{DC}	 0.2 0.4	
Current carrying capacity: DC link busbars 24 V busbar	 A_{DC} A_{DC}	 100 20	
Power loss Standby operation	 W W	 5 25	
Switching frequency	Hz	2000	
Cooling methods		Internal air cooling Cold plate cooling	
Max. Ambient temperature	° C	55	
Weight	kg	2.7	

1) At the upper switch-on threshold

6.2.8.2 Characteristic curves

Duty cycle for braking resistors without a thermostatic switch

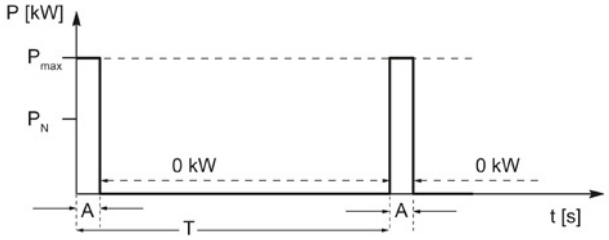


Figure 6-12 Duty cycle for braking resistors without a thermostatic switch

T [s] time period of braking duty cycle

A [s] load duration

P_N [kW] rated power (continuous power) of the braking resistor

P_{max} [kW] peak power of braking resistor (6 x P_N)

Table 6- 15 Duty cycles

	6SN1113–1AA00–0DA0		6SL3100–1BE31–0AAx	
	Short duty cycle	Long duty cycle	Short duty cycle	Long duty cycle
A [s]	0.1	0.4	1	2
T [s]	11.5	46	68	136

Duty cycles for braking resistors with a thermostatic switch

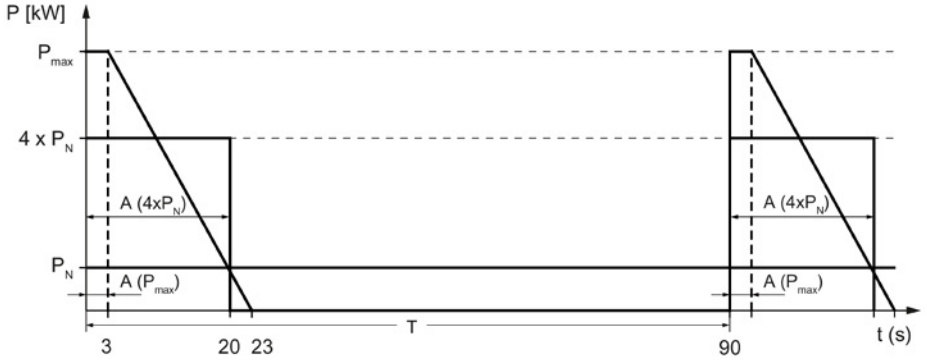


Figure 6-13 Duty cycles for braking resistors with a thermostatic switch

T [s] time period of braking duty cycle

A [s] load duration

P_N [kW] rated power (continuous power) of the braking resistor

P_{max} [kW] peak power of braking resistor (6 x P_N)

4 x P_N [kW] = power permitted every 90 s for 20 s

Table 6- 16 Duty cycles

	6SE7018-0ES87-2DC0		6SE7021-6ES87-2DC0		6SE7023-2ES87-2DC0	
	Duty cycle P_{max}	Duty cycle 4 x P_N	Duty cycle P_{max}	Duty cycle 4 x P_N	Duty cycle P_{max}	Duty cycle 4 x P_N
A [s]	3	20	3	20	3	20
T [s]	90	90	90	90	90	90

6.2.9 Configuration instructions

DC link capacitance

When configuring the drive line-up, please note that only one Braking Module Booksize Compact may be used per complete 500 µF DC link capacitance.

Table 6- 17 Configuration examples

DC link capacitance in µF	Max. number of Braking Modules
900	1
2400	4
9800	19

DC link cable

In a two-row or distributed drive line-up, the DC links are connected to each other via a DC link cable. When using a Braking Module Booksize Compact in the drive line-up, this cable must not be longer than 10 m. In all cases, the DC link cable must have low impedance and a cross-section of at least 10 mm^2.

Parallel operation

During configuration of parallel operation for Braking Modules Booksize Compact, dimensioning can only take 90% of the specified braking power into account. Only the peak powers may be added without derating.

The following applies when connecting Braking Modules in parallel:

$P_{N\ total}$ = 0.9 x total P_N of single devices

4 x $P_{N\ total}$ = 0.9 x sum (4 x P_N) of single devices

$P_{max\ total}$ = total P_{max} of single devices

Braking resistors

7

7.1 Description

A braking resistor is used to dissipate the excess DC link energy in generator operation. Braking resistors are connected to a Braking Module.

Resistors are available with and without thermostatic switch with various rated power levels. The thermostatic switch monitors the braking resistors for overtemperature and issues a signal at an isolated contact if the limit value is exceeded.

Braking resistor	Braking Module Booksize	Braking Module Booksize Compact
Braking resistors without a thermostatic switch		
6SN1113-1AA00-0DA0 Resistance: 17 Ω PN: 0.3 kW	x	x
6SL3100-1BE31-0AA0 Resistance: 5.7 Ω PN: 1.5 kW	x	x
Braking resistors with a thermostatic switch		
6SE7018-0ES87-2DC0 Resistance: 80 Ω PN: 1.25 kW		x
6SE7021-6ES87-2DC0 Resistance: 40 Ω PN: 2.5 kW		x
6SE7023-2ES87-2DC0 Resistance: 20 Ω PN: 5 kW		x

Installation

The braking resistors can be installed standing on the floor of the control cabinet or suspended. The braking resistors must be located outside the cooling airflow of the drive lineup.

Positioning the braking resistor outside the control cabinet or switchgear room enables the resulting thermal losses to be routed away. This reduces the level of air conditioning required.

Connection cables

A shielded connection cable (3 m, 3 x 1.5 mm^2) is supplied with braking resistor 6SN1113-1AA00-0DA0.

All other braking resistors are supplied without a connection cable. The maximum conductor cross-sections are listed in the technical data.

The maximum cable length for all braking resistors is 10 m.

7.2 Safety instructions for braking resistors

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 17) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.

⚠WARNING

Risk of fire due to ground fault/short-circuit

Inadequate installation of the cables to the braking resistor can result in a ground fault/short-circuit and place persons at risk as a result of the associated smoke and fire.

- Use the local installation regulations to avoid this fault.
- Protect the cables against mechanical damage.
- Also implement one of the following measures:
  - Use cables with double insulation.
  - Maintain adequate clearance, e.g. by using spacers.
  - Lay the cables in separate cable ducts or conduits.

⚠WARNING

Risk of fire through overheating if there are insufficient ventilation clearances

Inadequate ventilation clearances can cause overheating with a risk for personnel due to smoke and fire.

- Maintain a cooling clearance of 100 mm on all sides of the braking resistor

⚠ CAUTION
Risk of burns due to high surface temperatures The braking resistor can become very hot. You can get seriously burnt when touching the surface. • Mount the braking resistors so that contact is not possible. If this is not possible, attach a clearly visible and understandable warning notice at hazardous positions.

7.3 Dimension drawings

Braking resistors without a thermostatic switch

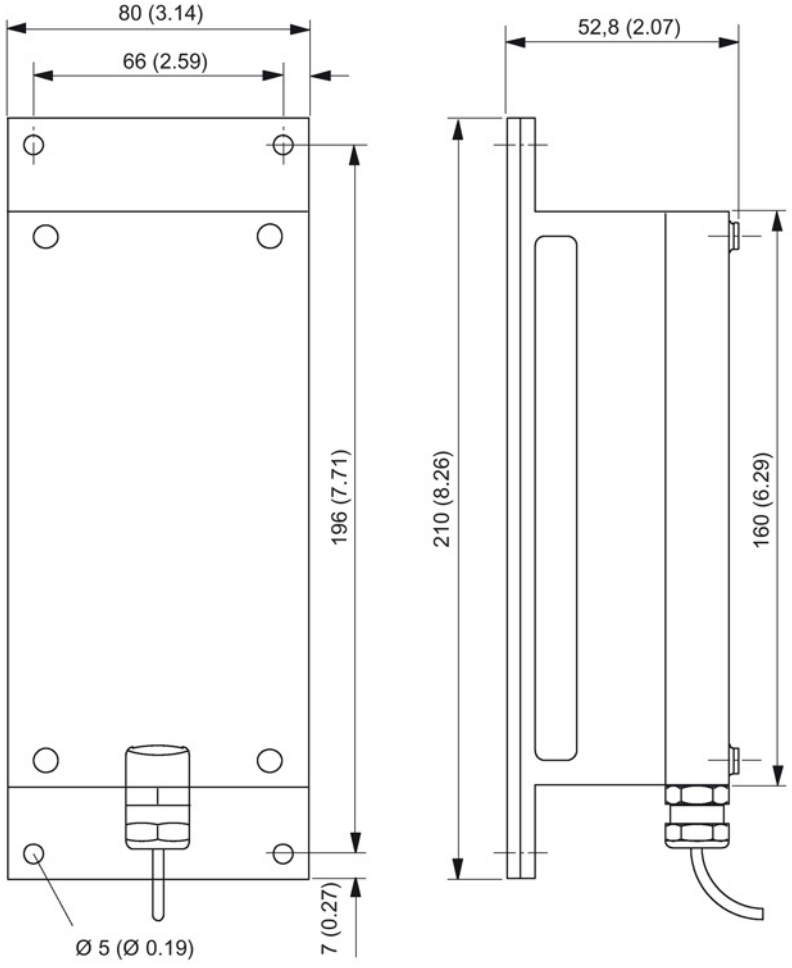


Figure 7-1 Dimension drawing of braking resistor 6SN1113-1AA00-0DA0 where P_n/P_{max} = 0.3 kW/25 kW, all dimensions in mm and (inches)

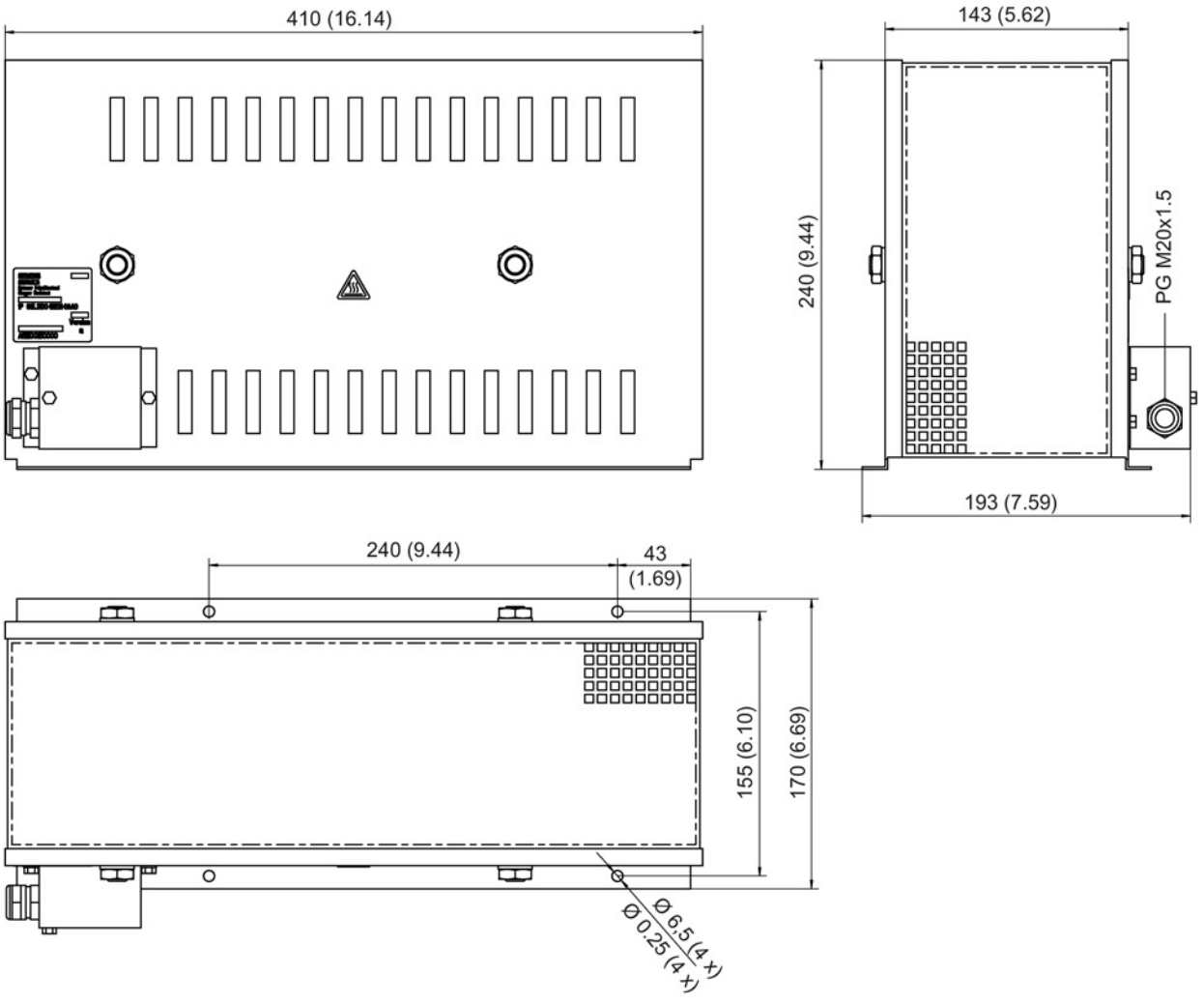


Figure 7-2 Dimension drawing of braking resistor 6SL3100-1BE31-0AA0 where P_n/P_{max} = 1.5 kW/100 kW, all dimensions in mm and (inches)

Braking resistors with a thermostatic switch

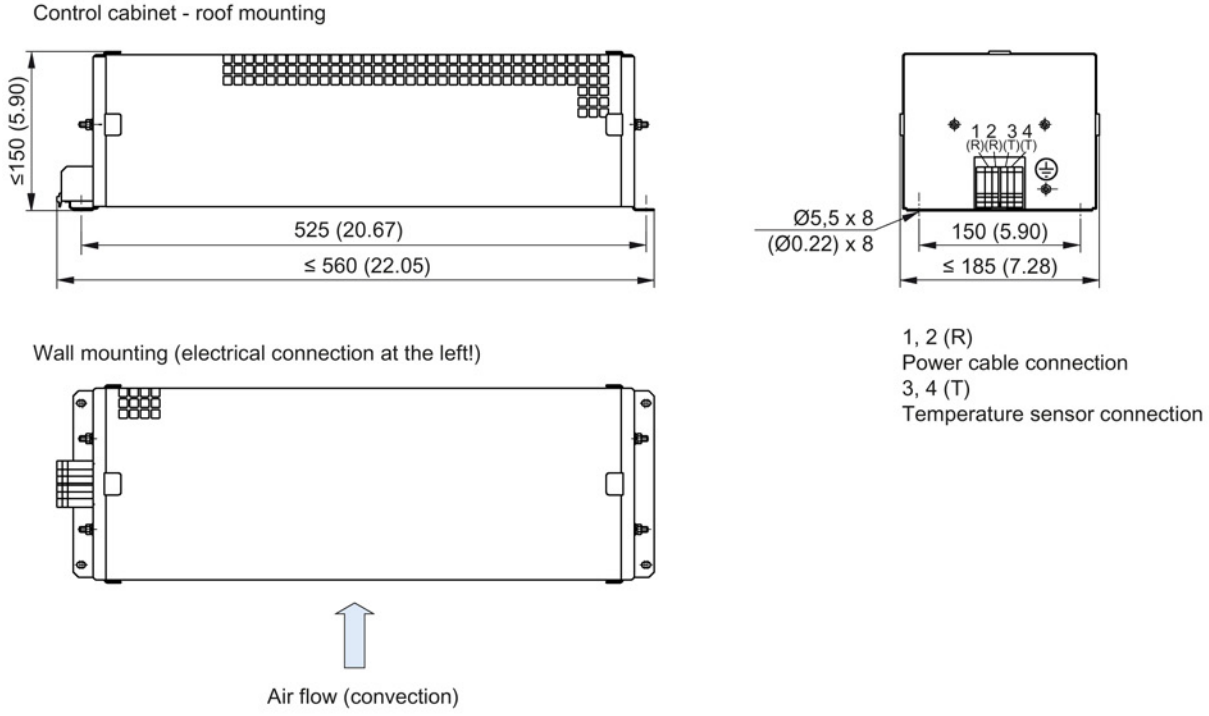


Figure 7-3 Dimension and installation drawing (roof and wall mounting) of braking resistor 6SE7018-0ES87-2DC0 where P_n/P_{max} = 1.25 kW/7.5 kW, all dimensions in mm and (inches)

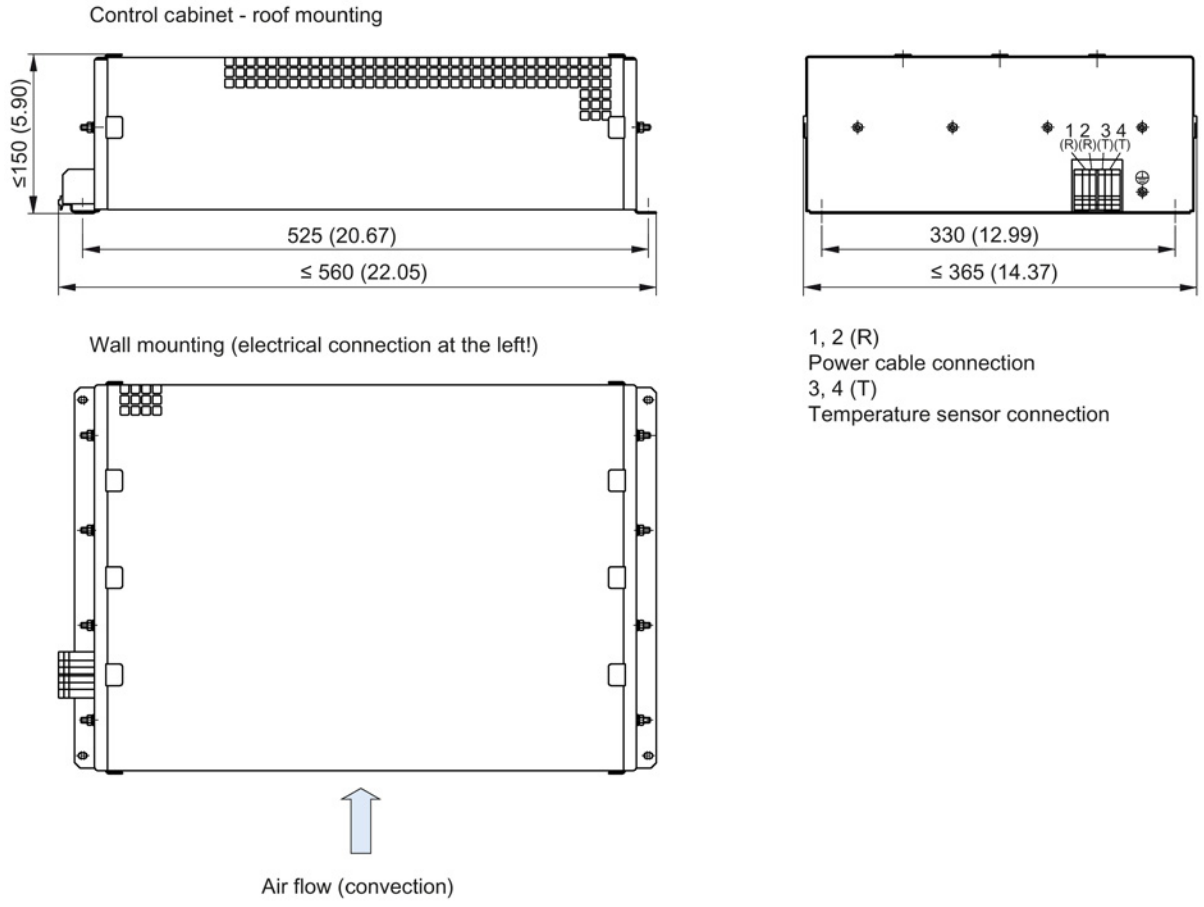
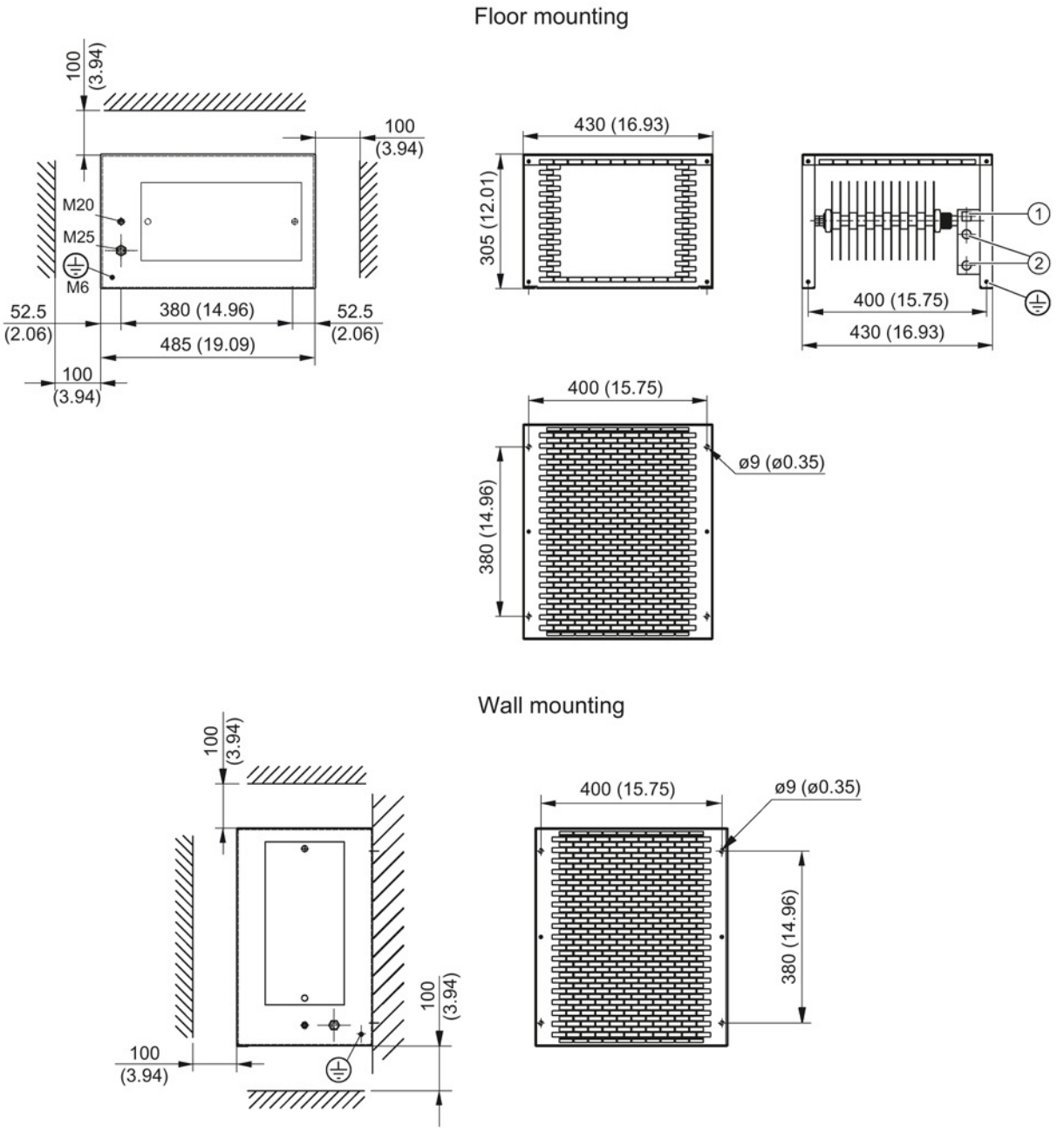


Figure 7-4 Dimension and installation drawing (roof and wall mounting) of braking resistor 6SE7021-6ES87-2DC0 where P_n/P_{max} = 2.5 kW/15 kW, all dimensions in mm and (inches)



① Thermostatic switch T1 / T2 connection, with connection cross-section 2.5 mm²

② Connection for power cable, 2 x M6 bolts

Figure 7-5 Dimension and installation drawing (floor and wall mounting) of braking resistor 6SE7023-2ES87-2DC0 where P_n/P_{max} = 5 kW/30 kW, all dimensions in mm and (inches)

7.4 Technical data

Table 7- 1 Technical data for braking resistors without a thermostatic switch

	Unit	6SN1113–1AA00–0DA0	6SL3100–1BE31–0AAx
Resistance R	Ω	17	5.7
Rated power P_N	kW	0.3	1.5
Peak power P_{max}	kW	25	100
Max. Energy consumption E_{max}	kWs	7.5	200
Power cable connection		Included in the scope of delivery; length 3 m, 3 x 1.5 mm^2	Screw terminal, 4 mm^2
Weight	kg	3.4	5.6
Dimensions (W x H x D)	mm	80 x 210 x 53	193 x 410 x 240
Degree of protection to EN 60529		IP54	IP20

Table 7- 2 Technical data for braking resistors with a thermostatic switch

	Unit	6SE7018-0ES87-2DC0	6SE7021-6ES87-2DC0	6SE7023-2ES87-2DC0
Resistance R	Ω	80	40	20
Rated power P_N	kW	1.25	2.5	5
Braking power 4 x P_N	kW	5	10	20
Peak power P_{max}[1)]	kW	7.5	15	30
Max. Energy consumption E_{max} at P_{max} at 4xP_n	 kWs kWs	 22.5 100	 45 200	 90 400
Thermostatic switch connection		Screw terminal[2)], 4 mm^2	Screw terminal[2)], 4 mm^2	Screw terminal, 2.5 mm^2
Power cable connection		Screw terminal[3)], 4 mm^2	Screw terminal[3)], 4 mm^2	M6 screw bolt for ring cable lug
PE connection		M5 bolt	M5 bolt	M6 bolt
Weight	kg	6	12	17
Dimensions (W x H x D)	mm	145 x 180 x 540	145 x 360 x 540	450 x 305 x 485
Degree of protection to EN 60529		IP20	IP20	IP20

1) Applies to a DC-link voltage of 760 V

2) Recommended connection cross-section: 0.75 to 1.5 mm^2

3) Recommended connection cross-section: 2.5 mm^2

7.4.1 Characteristic curves

Duty cycle for braking resistors without a thermostatic switch

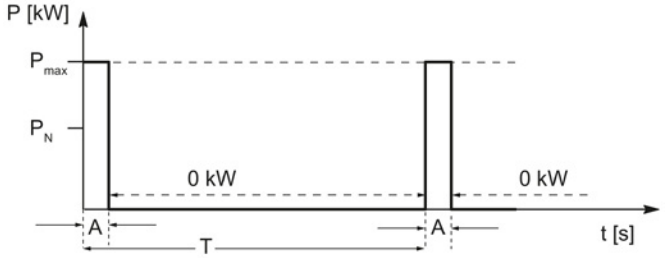


Figure 7-6 Duty cycle for braking resistors without a thermostatic switch

T [s]: Period duration of braking duty cycle

A [s]: Load duration

P_N [W]: Rated power (continuous power rating) of the braking resistor

P_{max} [W]: Peak power of braking resistor (6 x P_N)

Table 7- 3 Duty cycles for Braking Module Booksize

	6SN1113–1AA00–0DA0		6SL3100–1BE31–0AAx	
	Short duty cycle	Long duty cycle	Short duty cycle	Long duty cycle
A [s]	0.1	0.4	1	2
T [s]	11.5	210	68	460

Table 7- 4 Duty cycles for Braking Module Booksize Compact

	6SN1113–1AA00–0DA0		6SL3100–1BE31–0AAx	
	Short duty cycle	Long duty cycle	Short duty cycle	Long duty cycle
A [s]	0.1	0.4	1	2
T [s]	11.5	210	68	460

The following applies when connecting Braking Modules in parallel:

$P_{N\ total}$ = 0.9 x total P_N of single devices

$P_{max\ total}$ = total P_{max} of single devices

Duty cycles for braking resistors with a thermostatic switch

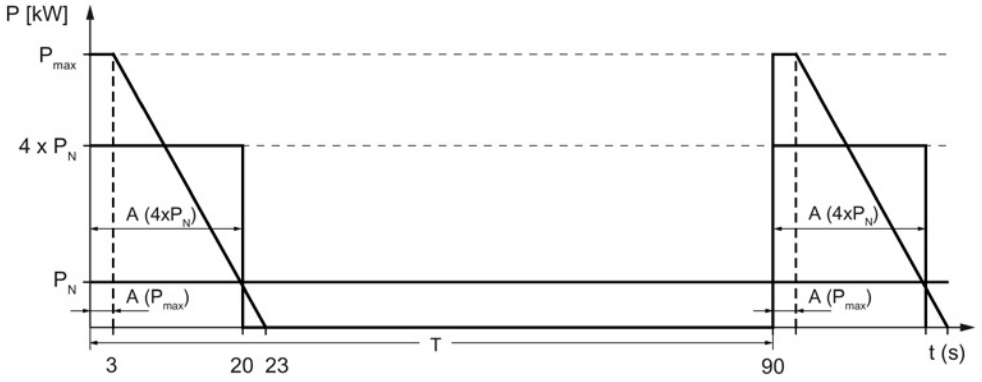


Figure 7-7 Duty cycles for braking resistors with a thermostatic switch

T [s]: Period duration of braking duty cycle

A [s]: Load duration

P_N [W]: Rated power (continuous power rating) of the braking resistor

P_{max} [W]: Peak power of braking resistor (6 x P_N)

4 x P_N [W] = power permitted every 90 s for 20 s

Table 7- 5 Duty cycles

	6SE7018-0ES87-2DC0		6SE7021-6ES87-2DC0		6SE7023-2ES87-2DC0	
	Duty cycle P_{max}	Duty cycle 4 x P_N	Duty cycle P_{max}	Duty cycle 4 x P_N	Duty cycle P_{max}	Duty cycle 4 x P_{N0}
A [s]	3	20	3	20	3	20
T [s]	90	90	90	90	90	90

The following applies when connecting Braking Modules in parallel:

$P_{N\ total}$ = 0.9 x total P_N of single devices

4 x $P_{N\ total}$ = 0.9 x sum (4 x P_N) of single devices

$P_{max\ total}$ = total P_{max} of single devices

Control Supply Module (CSM) 8

8.1 Description

The Control Supply Module provides an output voltage of 24 V - 28.8 V DC. The output voltage can be adjusted using an integrated potentiometer.

In normal operation, the Control Supply Module is supplied from the line voltage. When the power fails, the module automatically changes over to supply from the DC link. This makes it possible, for example, to execute retraction movements in the event of a power failure.

The Control Supply Module has safe electrical separation between the line potential and the DC link potential. This therefore ensures that the DC link is not unintentionally charged. The Control Supply Module can therefore remain connected to the supply if the Line Module is galvanically isolated from the line supply, for example using a line contactor.

The 24 V ground of the Control Supply Module is internally grounded.
The Control Supply Module is cooled using an internal fan.

Temperature and voltages are internally monitored.

Temperature monitoring:
In the event of an overtemperature in the Control Supply Module, a temperature advance warning is issued via a signaling contact. If the temperature falls below the limit value within the advance warning time, then the module remains operational and the signaling contact is de-energized. If the overtemperature condition persists, the module is switched off and restarted.

Voltage monitoring:
When the monitoring threshold (32 V) of the output voltage is exceeded for > 20 ms, the control supply module switches off and attempts a restart after 10 s. This is supplemented by a hardware-based overvoltage limiting. This prevents that more than 35 V can be output in the case of a fault.

The Control Supply Module can either be operated individually or in a parallel connection with a maximum of 10 devices. The switchover between single and parallel operation is realized in a no-current state using a DIP switch on the upper side of the module.

Note

Compatibility

The Control Supply Module 6SL3100-1DE22-0AA1 with extended functionality described here replaces Control Supply Module 6SL3100-1DE22-0AA0. The modules are upwards compatible (-0AA1 can be used as replacement part for -0AA0).

8.2 Safety instructions for Control Supply Modules

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 17) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.

⚠DANGER

Danger to life when live parts are touched when using the control supply module

The Control Supply Module has 2 supply circuits. Death or serious injury can result when live parts are touched.

- Switch off both supply circuits before you start any work.

⚠DANGER

Danger to life through electric shock due to the residual charge of the DC link capacitors

Due to the DC link capacitors, a hazardous voltage is present in the DC link for up to 5 minutes after the power supply has been switched off.

Contact with live parts can result in death or serious injury.

- Do not open the protective cover of the DC link until 5 minutes have elapsed.
- Measure the voltage before starting work on the DCP and DCN DC link terminals.

⚠DANGER

Danger to life through electric shock when the protective cover of the DC link is open

Contact with live parts can result in death or serious injury.

- Only operate the components with closed protective cover.

⚠WARNING

Danger to life through electric shock due to missing DC link side covers

There is a danger of an electric shock through contact when the side covers of the DC link are missing.

- Mount the side covers on the first and last component in the drive line-up.
- Order any missing side covers (Article number: 6SL3162-5AA00-0AA0).

⚠WARNING

Fire hazard due to overheating because of inadequate ventilation clearances

Inadequate ventilation clearances can cause overheating with a risk for personnel due to smoke and fire. This can also result in increased failure rates and a shorter service life of the component.

- Maintaining 80 mm ventilation clearances above and below the component is essential.

NOTICE

Material damage due to loose power connections

Insufficient tightening torques or vibration can result in faulty electrical connections. This can cause fire damage or malfunctions.

- Tighten all of the DC link busbar screws with the specified tightening torque (1.8 Nm, tolerance +30 %) an.
- Check the tightening torques of all power connections at regular intervals and tighten them when required. This applies in particular after transport.

NOTICE

Material damage due to loose power connections when using the 24 V terminal adapter

Insufficient tightening torques or vibration can result in faulty electrical connections. This can cause fire damage or malfunctions.

- When using the 24 V terminal adapter, it must be screwed onto the Control Supply Module. Tighten the enclosed EJOT-PT K30 x 16 screw with the specified tightening torque (0.5 Nm).
- Check the tightening torques of all power connections at regular intervals and tighten them when required. This applies in particular after transport.

8.3 Interface description

8.3.1 Overview

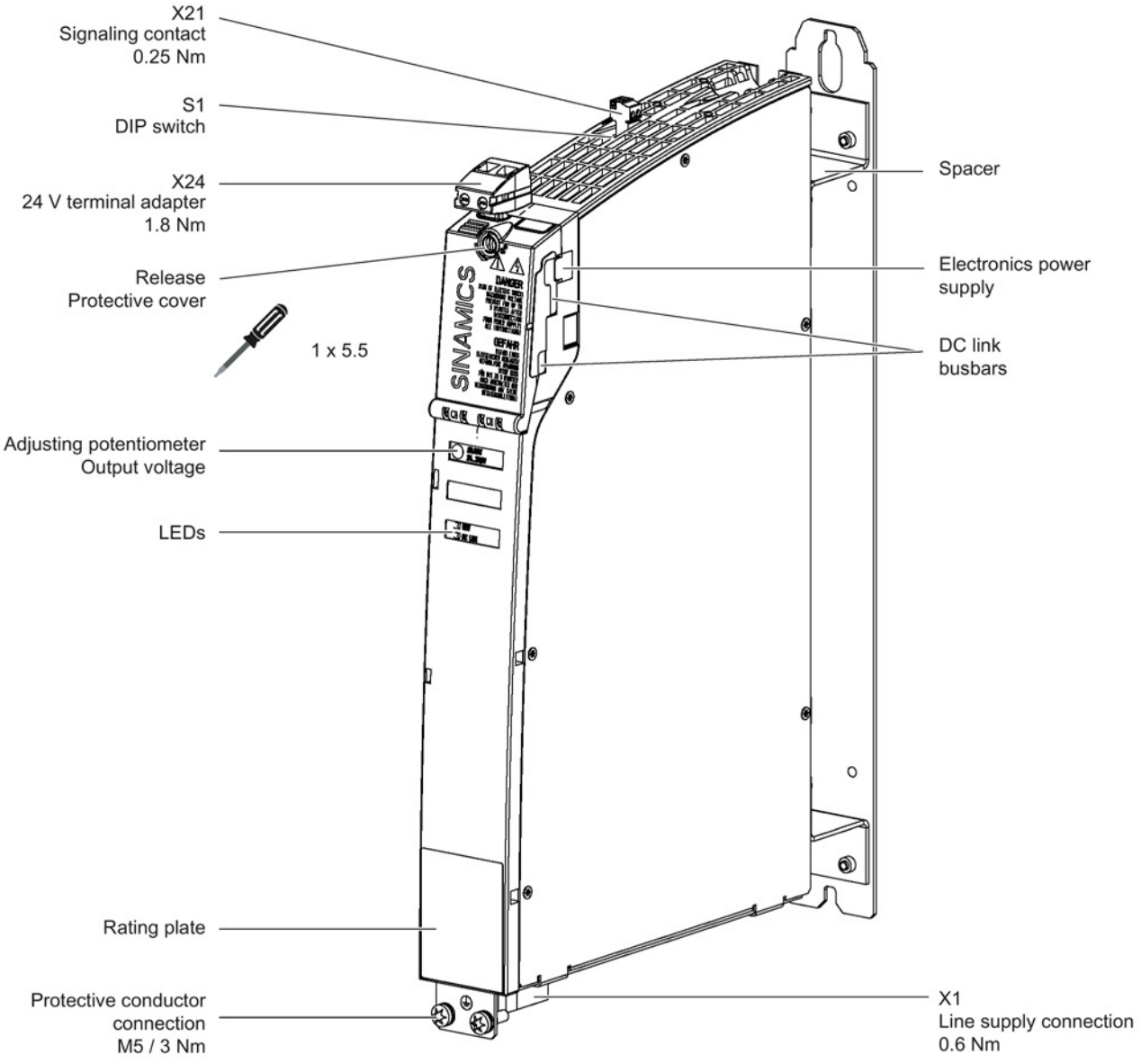
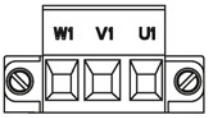
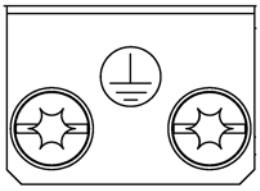


Figure 8-1 Interface overview, Control Supply Module

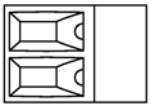
8.3.2 X1 line connection

Table 8- 1 X1 line connection

	Terminal	Technical data
	U1 V1 W1	Supply voltage: 3 AC 380 V … 480 V, 50 / 60 Hz Type: Screw terminal 4 (Page 172) Max. cross-section that can be connected: 4 mm² Tightening torque: 0.5 … 0.6 Nm
	PE connection	M5 screw / 3 Nm at the housing

8.3.3 X21 signaling contact

Table 8- 2 X21 signaling contact

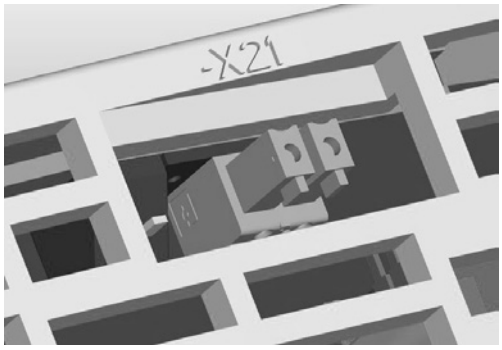
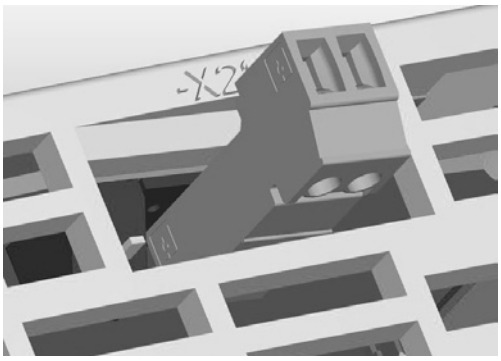
	Terminal	Technical data
	1 2	Voltage: 24 V DC Max. load current: 0.5 A (ohmic load)
Type: Screw terminal 1_1 (Page 172) Max. cross-section that can be connected 1.5 mm²		

The 2-pole terminal connector for the signaling contact is included in the Completion Kit provided.

The signaling contact can be connected with a digital input (DI) on the Control Unit or other digital interface (PLC, SCADA). In parallel or redundant operation the failure of a Control Supply Module is indicated in order to initiate a service call, for example.

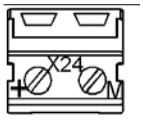
The signaling contact operates as an isolated NO contact. When the switch is closed, the Control Supply Module is "OK" and provides the output voltage. The switch opens in the event of a fault "Not OK" – when the overtemperature condition is still present, after a pre-warning, wire breakage, short-circuit etc. The Control Supply Module is correspondingly switched off.

Table 8- 3 Installing the signaling contact

	
Signaling contact without terminal connector in the delivery condition	Signaling contact, complete with terminal connector

8.3.4 X24 24 V terminal adapter

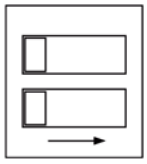
Table 8- 4 X24 24 V terminal adapter

	Terminal	Designation	Technical data
	+	24 V power supply	Supply voltage 24 ... 28.8 V DC
	M	Ground	Electronics ground
Type: Screw terminal 5 (Page 172) Max. cross-section that can be connected: 6 mm^2			

The 24 V terminal adapter is included in the scope of supply.

8.3.5 S1 DIP switch

Table 8- 5 DIP switch S1

	Terminal	Designation	Technical data
	1	Changeover switch, single operation / parallel operation	Left: Single operation Right: Parallel operation
	2	Dummy contact (not used)	Changing over the output characteristic

It is only permissible to changeover when in the no-voltage state.

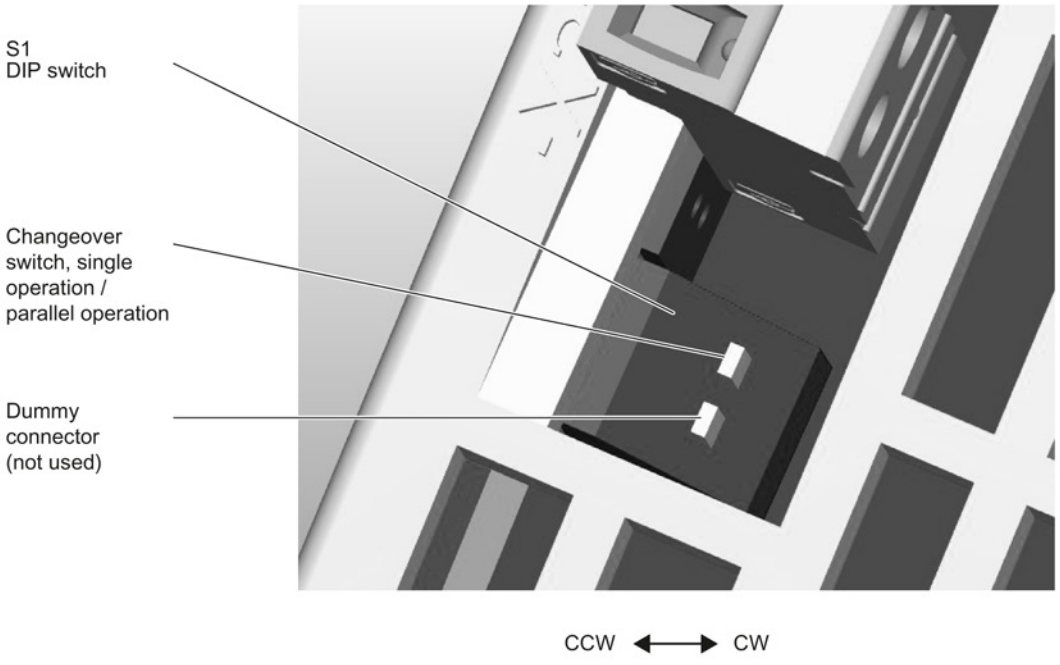


Figure 8-2 DIP switch on the upper side of the component

When delivered, "single operation" is set. Both switches are set to the left.

8.4 Connection examples

8.4.1 General information

The Control Supply Module is connected to the line supply (3-ph. 380 V AC -10 % to 480 V AC +10 %) via interface X1 (screw terminals 0.2 to 4 mm^2). This connection should preferably be made without using an isolating device (e.g. contactor).

The Control Supply Module has an internal line filter (Class A for TN systems), and the pre-charging circuit for the DC link inside the device is electrically isolated from the 24 V supply.

The Control Supply Module also features a current limitation function.

Note

If you use cables with a cross-section of 2.5 mm^2, no additional protection is required on the 24 V side for the following cable types:

- Cables of the XLPE type
- Cables of the EPR type
- Cable with a similar properties and which is thermally stable up to 90 °C

Note

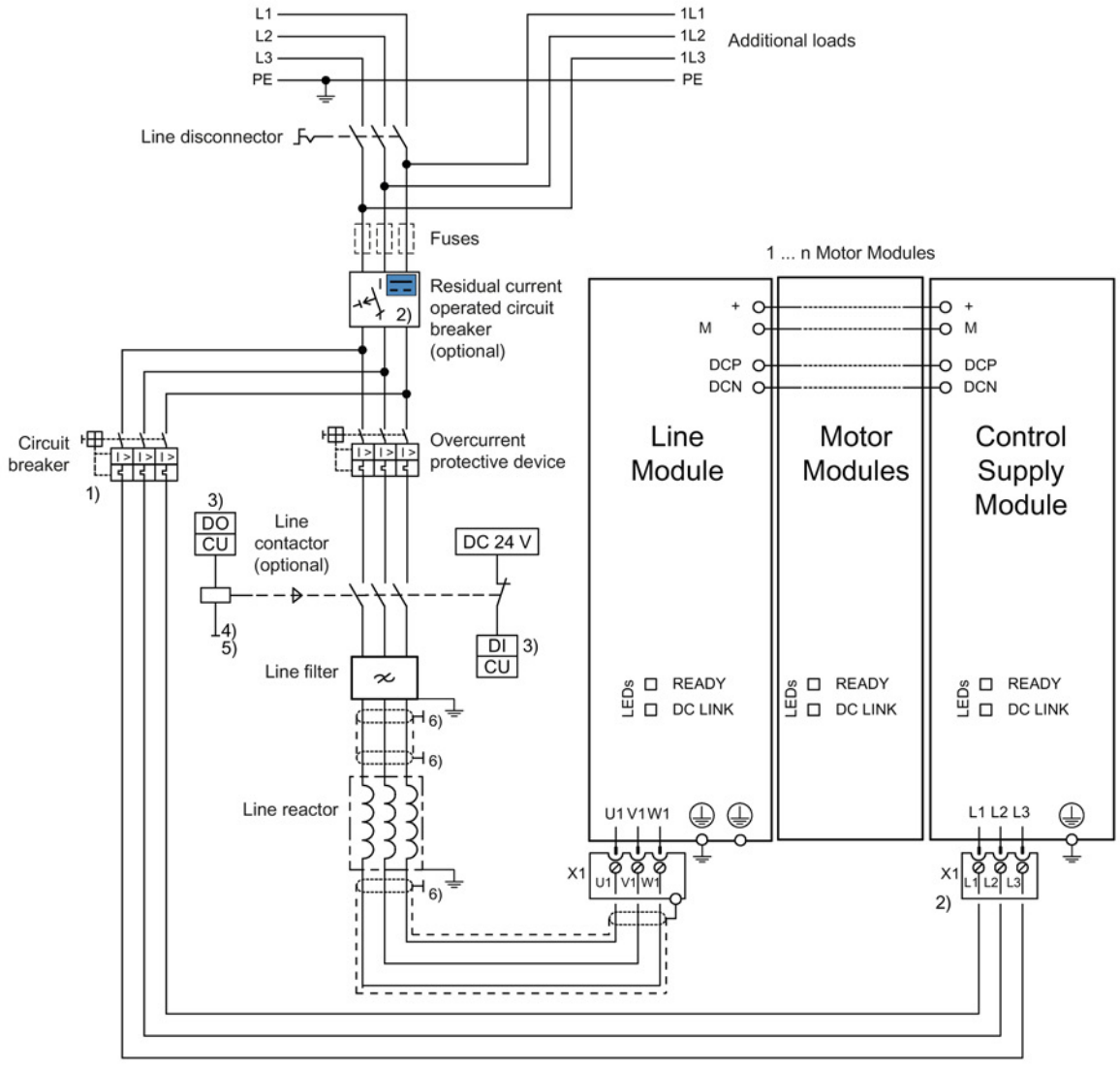
Observe the connection sequence

If a selectively tripping, AC/DC-sensitive RCCB is used for the drive line-up, the Control Supply Module must always be connected to the line supply downstream of this circuit breaker. Otherwise, the residual current operated circuit breaker will trip erroneously if the direct-current component is asymmetrically drawn in certain operating states.

8.4.2 Single operation

Within the drive line-up, the Control Supply Module must be connected to the drive line-up via the DC link busbars as well as the 24 V busbars. The red 24 V connector from the accessories pack provided must be inserted under all circumstances. The DIP switch on the Control supply Module must be set to "single mode" The connection can be established as shown below.

The supply for other 24 V loads outside the drive line-up using additional Control Supply Modules, whose outputs are not connected in parallel, must be realized using the 24 V terminal adapter (do not insert the red 24 V connector).



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

Figure 8-3 Connection example for Control Supply Module in single operation

8.5 Meaning of the LEDs

Table 8- 6 Meaning of the LEDs on the Control Supply Module

LED	Color	Status	Description
READY	-	Off	The electronics power supply is outside the permissible tolerance range or the temperature prewarning is active.
	Green	Continuous light	Ready The output voltage is in the tolerance range and the temperature prewarning is inactive.
DC LINK	-	Off	DC input voltage $U_{E\ DC}$ < 280 ... 300 V Buffer operation is not possible.
	Yellow	Continuous light	DC input voltage in the range 360 ... 380 V < $U_{E\ DC}$ < 820 V ± 3 % Buffer operation is possible
	Red	Continuous light	DC input voltage outside the tolerance range: $U_{E\ DC}$ < 360 ... 380 V or $V_{E\ DC}$ > 820 V ± 3 %

8.6 Dimension drawing

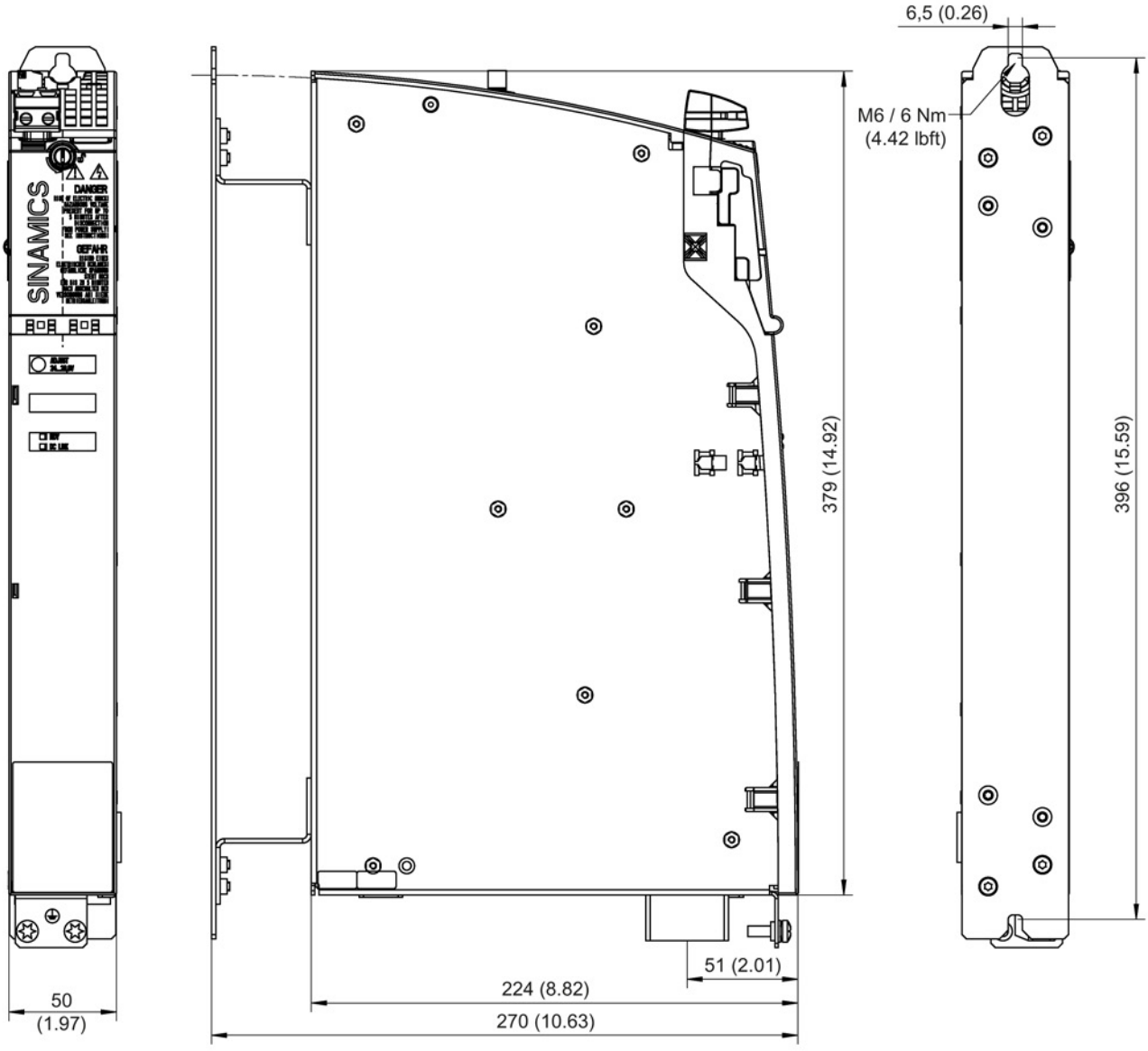
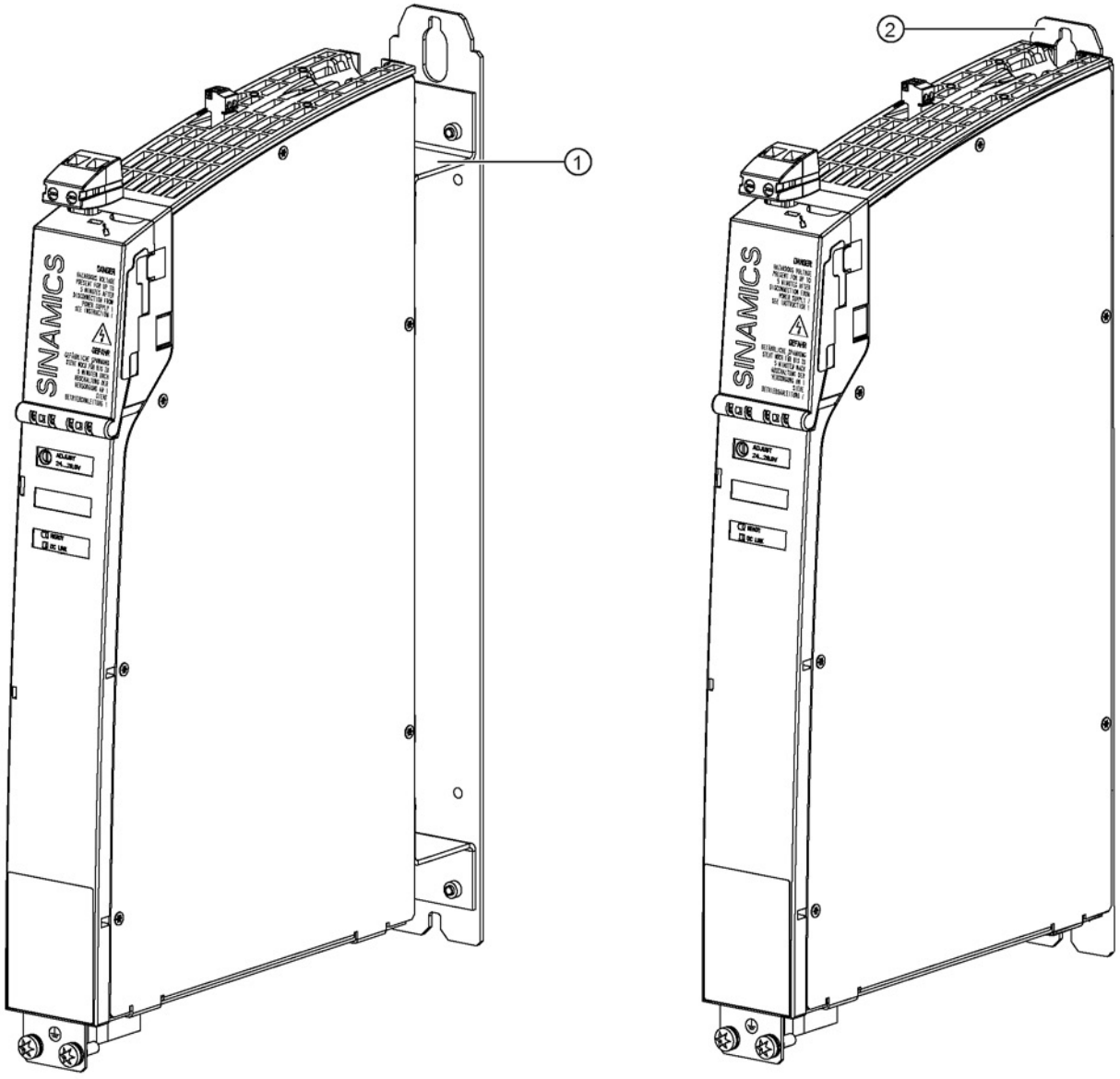


Figure 8-4 Dimension Control Supply Module, all dimensions in mm and (inches)

8.7 Installation



① Delivered with spacer - mounting depth for drive line-up in booksize format with internal air cooling
② Spacer removed - mounting depth for drive line-up in booksize format with external air cooling

Figure 8-5 Methods of installing the Control Supply Module with and without spacer

The Control Supply Module can be attached to the control cabinet panel with or without spacers.

8.8 Technical data

8.8.1 Technical data

Table 8- 7 Technical data

6SL3100-1DE22-0AA1	Unit	Value
Input data, AC input		
Line voltage Line frequency	V_{AC} Hz	3 AC 380 … 480 ± 15 % 45 … 66
Rated input current Rated value (at $V_{E\ rated}$)	 A_{AC}	 ≤ 2
Starting current inrush	A_{AC}	≤ 28 at > 5 ms
Input data, DC input		
Rated input voltage	V_{DC}	600
Input voltage range	V_{DC}	300 … 882
DC link voltage (continuous input voltage)	V_{DC}	430 … 800 300 … 430 < 1 min 800 … 853 < 1 min 853 … 882 < 10 s
Supply current (at 600 V)	A_{DC}	1.1
Overvoltage tripping Undervoltage tripping	V_{DC} V_{DC}	> 882 280 ± 3 %
Output data		
Rated output voltage $V_{A\ rated}$	V_{DC}	24 … 28.8
Rated output current $I_{A\ rated}$[1)]	A_{DC}	20
Rated output power $P_{A\ rated}$	W	520
Overcurrent limitation for short-circuit	A_{DC}	approx. 23
Surge suppression	V	< 35
Current carrying capacity of the 24 V busbar	A_{DC}	20
Residual ripple (clock frequency approx. 50 kHz)	mV_{pp}	< 100
Switching peaks (bandwidth 20 MHz)	mV_{pp}	< 200
Power loss ride-through (at 400 V AC)	ms	5
Power loss Line DC link	 W W	 70 65
Efficiency	%	> 83
Circuit breaker (UL) Type designation: Rated current: Resulting rated short-circuit current SCCR at 480 V AC:	 A kA	 3RV1021-1DA10 2.2 … 3.2 (setting value 3) 100

6SL3100-1DE22-0AA1	Unit	Value
Fuses (UL) Class RK1, listed JDDZ Rated current: resulting rated short-circuit current SCCR at 480 V AC:	 A kA	 6 200
Cooling method		Internal air cooling
Max. ambient temperature without derating with derating as of 26 V output voltage	 ° C ° C	 ≤ 40 > 40 … 55
Weight	kg	4.8

1) Above 40° C, a linear derating of the output current above a 26 V output voltage and higher must be observed

8.8.2 Characteristics

Derating characteristic

For ambient temperatures > 40 °C, a linear derating for the output current must be observed as of 26 output voltage.

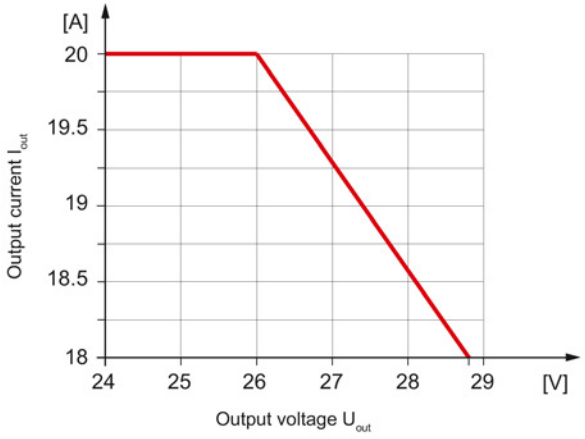


Figure 8-6 Current derating for ambient temperatures >40 °C as a function of the output voltage

DC link adapter

9

9.1 Description

The DC link adapter is used to directly feed the DC link voltage in the drive line-up. It is required for the High Frequency Drive if the infeed is realized via an Active Line Module in the chassis format. The supply is established at the side through the HF Damping Module. The connecting cable cross-section should be selected based on the total current required for all of the connected components. Shielded individual cores are recommended.

The connection cables must be fused accordingly.

9.2 Safety instructions for the DC link adapter

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

The non-observance of the fundamental safety instructions and residual risks stated in Chapter 1 can result in accidents with severe injuries or death.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account remaining risks.

⚠DANGER

Danger to life through electric shock when the protective cover of the DC link is open

Touching live components results in death or severe injury.

- Only operate the components with closed protective cover.

⚠DANGER

Danger to life through electric shock due to the residual charge of the DC-link capacitors

Because of the DC-link capacitors, a hazardous voltage is present for up to 5 minutes after the power supply has been switched off.

Touching live components results in death or severe injury.

- Do not open the protective cover of the DC link until 5 minutes have elapsed.
- Measure the voltage before starting work on the DCP and DCN DC-link terminals.

⚠WARNING

Risk of fire and device damage as a result of ground fault/short-circuit

The DC link connecting cables must be routed so that a ground fault or short circuit can be ruled out. A ground fault can result in fire with associated smoke.

- Comply with local installation regulations, which allow this fault to be ruled out.
- Protect the cables from mechanical damage.

In addition, apply one of the following measures:

- Using cables with double insulation.
- Observe adequate clearances, e.g. through the use of spacers.
- Route the cables in separate cable ducts or pipes.

⚠WARNING

Risk of fire due to overheating when permissible cable lengths are exceeded

Excessively long DC link cables can cause components to overheat with the associated risk of fire and smoke.

- Restrict the total length of the DC link including the connecting cables to a maximum of 10 m.

NOTICE

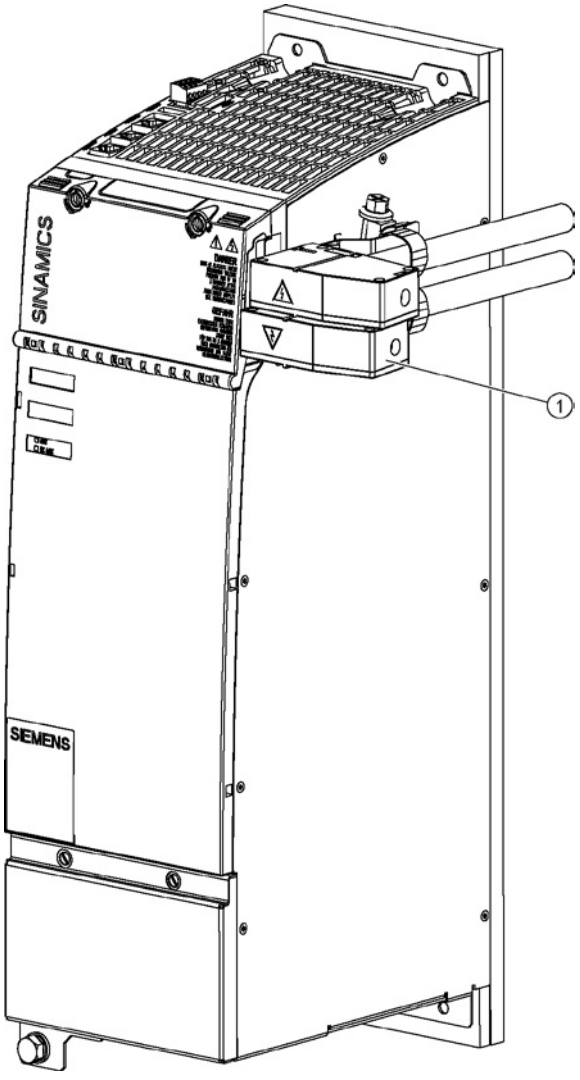
Material damage due to loose power connections

Insufficient tightening torques or vibration can result in faulty electrical connections. This can result in damage due to fire or malfunctions.

- Tighten all of the screws with the specified tightening torque.
- Check the tightening torques of all power connections at regular intervals and tighten them when required. This applies in particular after transport.

9.3 Interface description

9.3.1 Overview



① Installed DC link adapter

Figure 9-1 HF Damping Module with DC link adapter

9.3.2 DC link connection

Table 9- 1 DC link connection

Terminal	Function	Technical data
DCP	DC link positive	Current carrying capacity: 150 A connection cross-section: 35 … 95 mm² Stripped length: 27 mm
DCN	DC link negative	

9.4 Dimension drawing

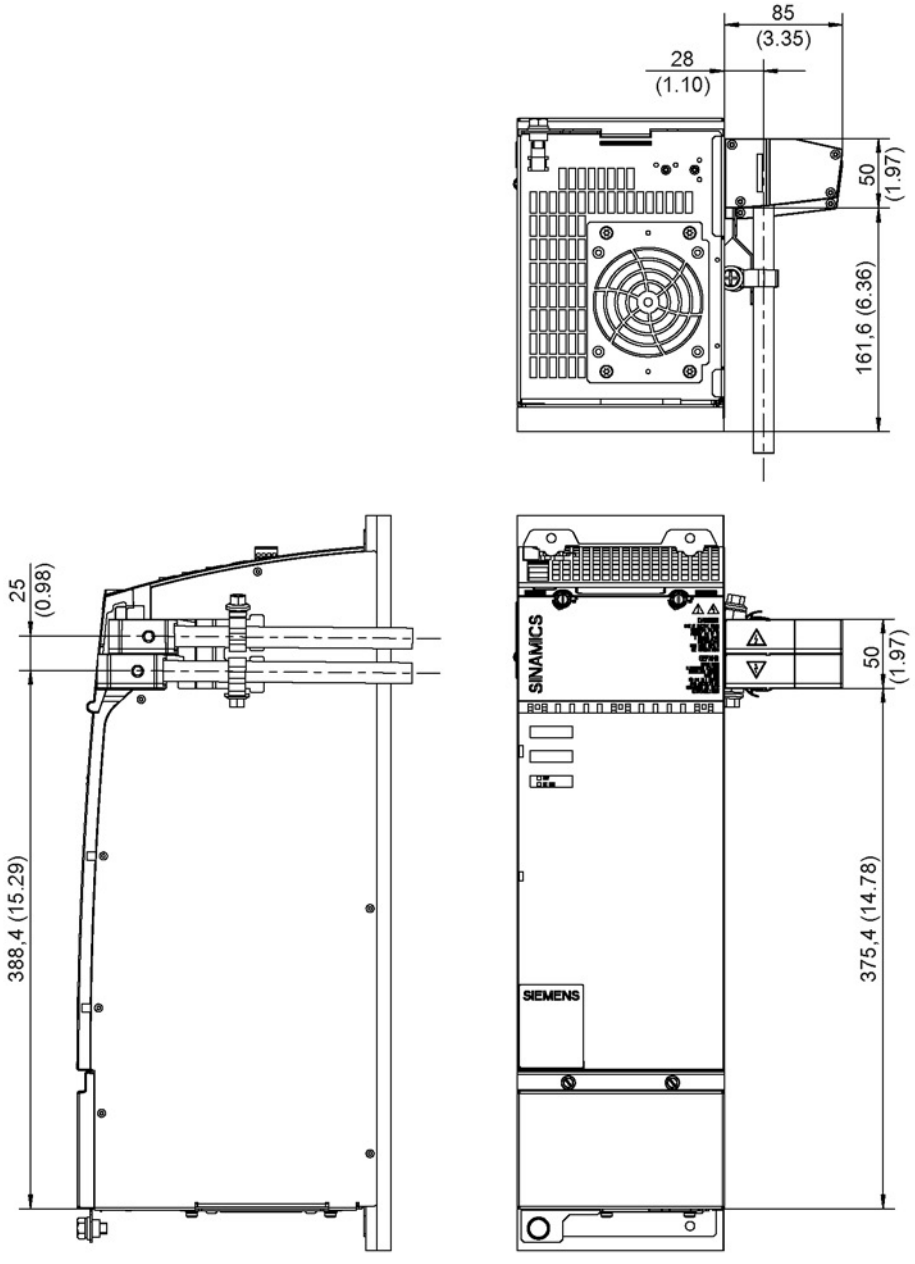


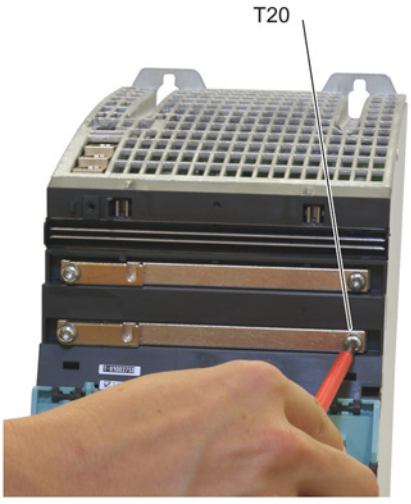
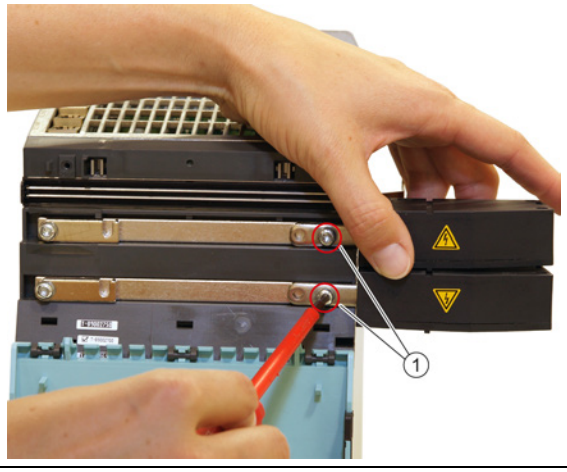
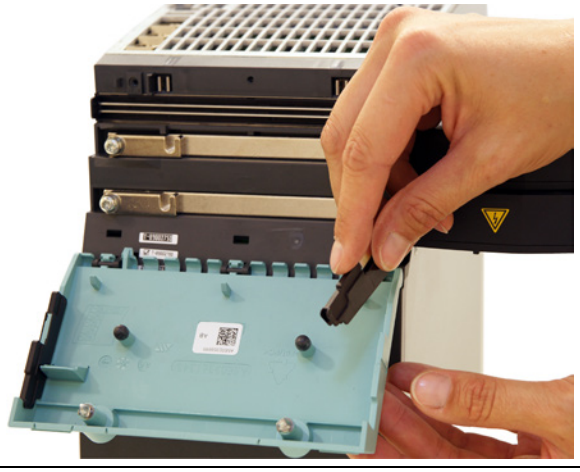
Figure 9-2 Dimension drawing of the HF Damping Module with DC link adapter, all dimensions in mm and (inches)

9.5 Installation

Required tools:

- Slot-head screwdriver (1 x 5.5) for releasing the protective cover
- Torx screwdriver T20 for DC link screws (Torx slot)

Table 9- 2 Installation of the DC link adapter at the HF Damping Module

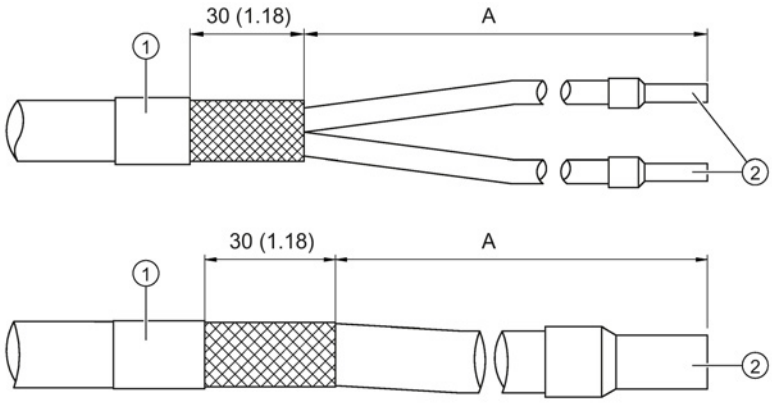
	
1. Release and open the protective cover of the DC link.	2. Remove the DC link screws.
	
3. Fix the DC link adapter (1.8 Nm) using the previously removed DC link screws. Use the **right-hand** holes ①.	4. Remove the DC link side cover and close the protective cover until you hear it engage.

⚠ DANGER
Danger to life through electric shock when touching the DC-link busbars
Touching live components results in death or severe injury. • Mount the busbars and clips of the DC link as well as the DC link adapter, so that after closing the DC link cover they cannot be touched.

9.6 Electrical connection

9.6.1 Preparing the cables

1. Prepare the DC link connecting cables as shown below.
2. Only use shielded cables with insulated end sleeves.



① Protective braided shield folded back and fixed using shrink-on sleeve
② Insulated end sleeve

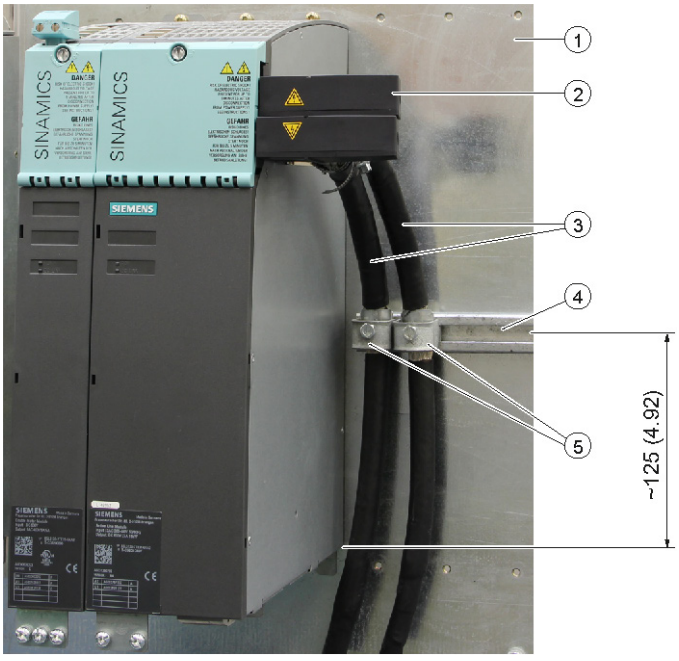
Figure 9-3 Single-core and two-core DC link connecting cable with insulated end sleeves, all dimensions in mm and (inch)

Refer to the table below for dimension A:

Conductor cross-section [mm²]	Mounting location of the DC link adapter at the drive line-up	Connection	A [mm]
50 / 70 / 95	Left	DCP	70
		DCN	60
	Right	DCP	60
		DCN	70

9.6.2 Fixing the cables to the rear cabinet panel

1. Fix the DC link connecting cables directly next to the last component at the rear control cabinet panel. Use the C-profile rails and the appropriate cable clamps from the Rittal company. The distance between the C profile rail and the lower side of the component is approximately 125 mm.
2. Appropriately insulate the cable cores at the connection location before mounting.



① Control cabinet panel
② DC link adapter
③ Cores of the DC link connecting cable
④ C-profile rail from Rittal company (article number 7831.570 / 7831.571)
⑤ Cable clamps for C profile rails from the Rittal company.

Figure 9-4 Fixing the DC link connecting cable to the control cabinet panel, dimensions in mm and (inch)

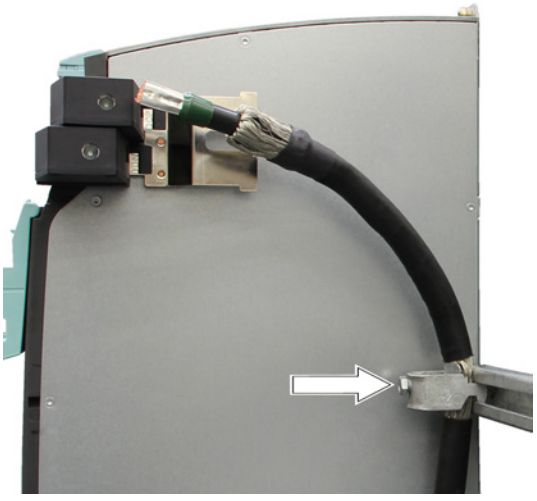
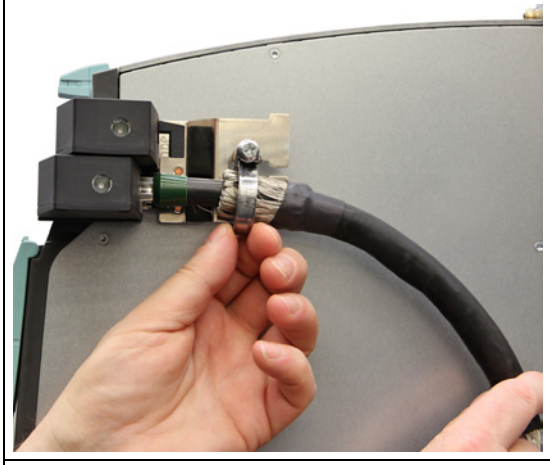
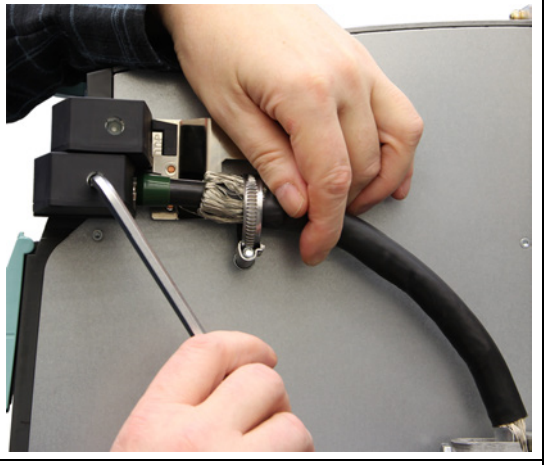
9.6.3 Cable connection and shield support

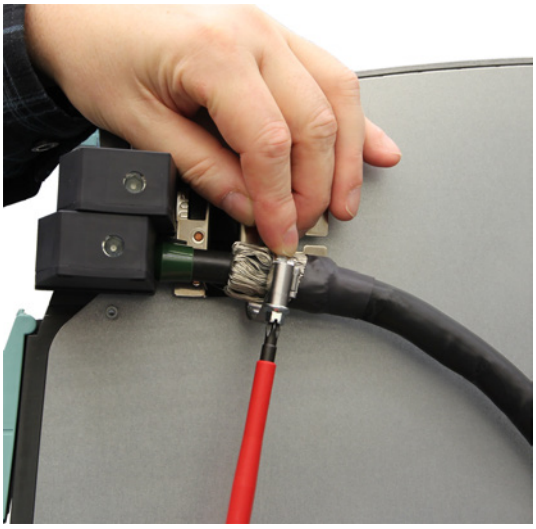
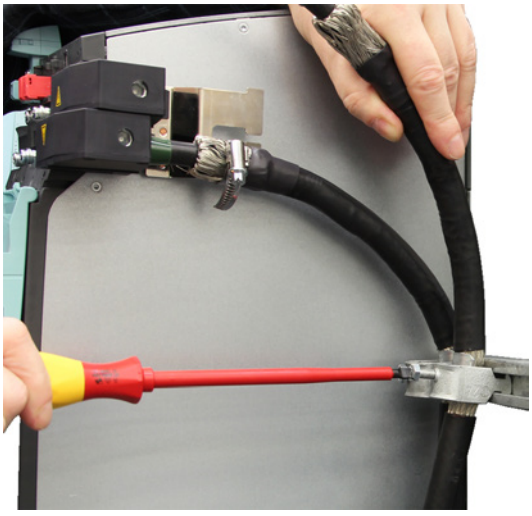
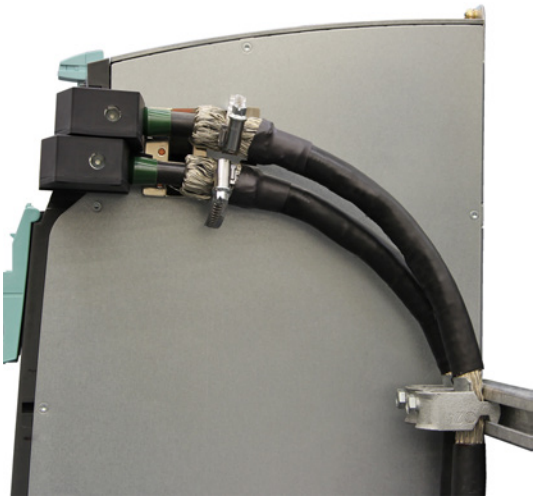
In order to simplify installing the DC link connecting cables at the DC link adapter, first fix the cables to the control cabinet panel (also see Chapter Fixing cables to the control cabinet panel (Page 147)).

Required tools:

- Size 6 Allen key to attach the cables
- Suitable tool for hose clamps, e.g. flat-bladed screwdriver

Table 9- 3 Connecting the DC link connecting cables to the DC link adapter

	
1. Fix the first core of the DC link connecting cable to the profile rail using a cable clamp.	2. Route the cable end through an appropriate cable clamp.
	
3. Slide the cable clamp onto the tongue, and then insert the end of the cable into the DCN connection of the DC link adapter.	4. Tighten the cable using an Allen key.

	
5. Tighten the screw of the hose clamp using a suitable screwdriver.	6. Fix the second core of the DC link connecting cable to the profile rail using a cable clamp. Connect the cable for the DCP connection as described under Points 2 to 5.
	The installed DC link connecting cable is shown in the adjacent diagram.

Note

After installing the cables, ensure that the EMC tongues of the DC link adapter are in contact with the side panel of the component.

9.7 Technical data

Table 9- 4 Technical specifications DC link adapter

6SL3162-2BM01-0AA0	Unit	Value
Current carrying capacity	A	150
Conductor cross-section	mm²	35 … 95
Stripped length	mm	27
Tightening torque Terminals DC link busbars	 Nm Nm	 13 1.8

Configuring 10

10.1 Features

10.1.1 Speed limitation

The SINAMICS S120 High Frequency Drive was developed for the operation of high-speed synchronous and induction motors.

In order to minimize the motor losses that occur, HF Drive operates with an output filter (HF Sine Filter Module), which significantly reduces the pulse-frequency components of the inverter output voltage at the motor terminals.

Operating the HF Sine Filter Module can mean that the motor speed is restricted.

There are two options available to counteract this speed limitation of the motor or restriction of the maximum inverter output frequency:

- Using a Voltage Protection Module (VPM) for synchronous motors
- Operate the HF Drive with a pulse frequency of 32 kHz, if the reduced inverter current is sufficient for the application.

The following table provides an overview of how a possible speed limitation can be avoided.

Table 10- 1 Measures to avoid speed limitation

	Synchronous motors	Induction motors
Connect a Voltage Protection Module (VPM)	X	--
Operate the HF Drive with 32 kHz pulse frequency (take derating into consideration)	X	X

Note

The Voltage Protection Module for synchronous motors must always be used together with a Braking Module and a Control Supply Module.

Calculating the maximum speed for synchronous and induction motors

Table 10- 2 Overview of parameters to calculate the speed

Parameter	Meaning		
r0297	Overvoltage threshold DC link 820 V		
p0233	Filter inductance, 0.036 mH		
p0234	Filter capacitance [µF]		
		Without additional capacitance	With additional capacitance
	16 kHz	11.9 µF	15.2 µF
	32 kHz	2.72 µF	3.4 µF
p0304	Rated motor voltage [V]		
p0310	Rated motor frequency [Hz]		
p0311	Rated motor speed [rpm]		
p0314	Motor pole pair number		
	Synchronous motor:	On the rating plate	
	Induction motor:	p0314 = (p0310 [Hz] • 60) / p0311 [rpm][1)]	
p0315	Motor pole pair width [mm]		
p0316	Motor torque constant, rotary [Nm/A]		
	Motor force constant, linear [N/A]		
p0317	Motor voltage constant [V]		
p0348	Speed at the start of field weakening [rpm] for V_{dc} = 600 V (425 V_{rms} / p0317 · 1000 rpm)		
p0353	Motor series inductance [mH]		
p0356	Motor stator leakage inductance [mH]		
p0358	Motor rotor leakage inductance [mH]		
p0360	Motor magnetizing inductance [mH]		
	Motor leakage inductance / armature inductance (incl. series inductance, if applicable)		
	Synchronous motor:	L_motor [mH] = p0356 + p0353	
	Induction motor:	L_motor [mH] = p0356 + p0360 - p0360^2 / (p0360 + p0358) + p0353	

1) The pole pair number for induction motors corresponds to the numbers in front of the decimal place of the calculated parameter.

The maximum motor speed for synchronous and induction motors can be calculated with the following formulas. Here, the parameters should be used in the units listed in the tables above.

HF Drive without VPM

- Synchronous motor, rotary

$$p1082\ [\frac{1}{min}] \le 4{,}33165 \cdot 10^9 \frac{-p0316 + \sqrt{p0316^2 + 4{,}86 \cdot 10^{-9} \cdot (r0297 \cdot p0314)^2 \cdot L\_motor \cdot p0234}}{r0297 \cdot p0314^2 \cdot L\_motor \cdot p0234}$$

- Linear motor

$$p1082\ [\frac{m}{s}] \le 11{,}49 \cdot p0315 \frac{\sqrt{p0316^2 \cdot p0315^2 + 0{,}191865 \cdot r0297^2 \cdot L\_motor \cdot p0234} - p0316 \cdot p0315}{r0297 \cdot L\_motor \cdot p0234}$$

- Induction motor
  The higher value from the two calculations indicates the maximum motor speed.

$$p1082\ [\frac{1}{min}] \le \frac{2{,}11383 \cdot 10^5}{p0314 \cdot \sqrt{(p0356 + p0360 + p0353) \cdot p0234}}$$

$$p1082\ [\frac{1}{min}] \le \frac{0{,}6364 \cdot r0297 \cdot p0311}{p0304}$$

HF Drive with VPM

- Synchronous motor

$$p1082\ [\frac{1}{min}] \le p0348 \cdot \frac{L\_motor + p0233}{p0233}$$

Note

Minimum value of the motor leakage inductance

The motor leakage inductance/armature inductance, including series inductance (L_motor), must not be less than 2 • p0233. If necessary, this condition must be complied with by using a suitable series inductance (p0353).

In order to compensate the shift of the filter resonant frequency as a result of the motor, from a motor leakage inductance/armature inductance of < 3.6 · p0233, an additional capacitance must be activated in the HF Sine Filter Module (p5174.0 = 1). The default setting for switching-in the additional capacitance is automatically applied when commissioning the system for the first time.

The capacitor can also be manually parameterized using parameter p5174.0 (see also Chapter Overview of important parameters (Page 164)).

- The parameter is activated if the motor leakage inductance is < 3.6 • p0233.
- The parameter is deactivated if the motor leakage inductance is > 3.6 • p0233.

Decision matrix to use the appropriate HF Drive

The basis of this decision matrix is the maximum speed of the connected motor.

Take into account the series inductance, if **L_motor < 2 • p0233**, so that **L_motor + p 0353 ≥ 2 • p0233**.

Is the output frequency < 1200 Hz?				
YES	Is the calculated maximum motor speed (in accordance with the formula with the filter of the HF Drive without VPM) less than the required maximum speed?			
	YES	Is the motor a short-circuit proof synchronous motor?		
		YES	Is the calculated maximum speed of the motor (in accordance with the formula with VPM) less than the required maximum speed?	
			YES	Use the HF Drive with VPM and the series inductance, which satisfies this formula.
			NO	Use the HF Drive with VPM.
		NO	Is the calculated maximum speed of the motor (according to the formula with filter of the HF Drive 32 kHz without VPM) less than the required maximum speed, or is the module current too low?	
			YES	The motor can only be operated up to the calculated speed as a maximum. Current and maximum speed must be weighed up against one other (HF Drive with 16 kHz <-> HF Drive with 32 kHz)
			NO	Operate the HF drive mit 32 kHz.
	NO	Operate the HF drive mit 16 kHz.		
NO	Is the calculated maximum speed of the motor (in accordance with the formula with the filter of the HF Drive at 32 kHz with VPM) less than the required maximum speed?			
	YES	Is the motor a short-circuit proof synchronous motor?		
		YES	Is the calculated maximum speed of the motor (in accordance with the formula with the filter of the HF Drive at 32 kHz with VPM) less than the required maximum speed?	
			YES	Operate the HF drive with 32 kHz and VPM - as well as the series inductance, which satisfies this formula.
			NO	Operate the HF drive mit 32 kHz.
		NO	With the HF drive, the motor can only be operated up to the calculated (maximum) speed at 32 kHz.	
	NO	Operate the HF drive mit 32 kHz.		

10.1.2 Star-delta or motor changeover

In principle, motors that can be changed over from a star-delta connection or motors with motor data set changeover can be operated on a High Frequency drive.
For the parameterization it is imperative that the motor leakage inductance/armature inductance must, for **all** connected motors, be either > 3.6 • p0233 or < 3.6 • p0233.

If this condition is not met, no star-delta changeover can be executed because the additional capacitance in the HF Sine Filter Module cannot be changed over depending on the data set.

10.1.3 Pole position identification

Synchronous motors

For synchronous motors, which are operated with pole position identification, the HF Sine Filter Module does not support the saturation-based technique (p1980 < 10).

Motors that are free to move

The motion-based pole position identification technique (p1980 = 10) can be used for motors that are free to move.

Motors with motor holding brake

The elasticity-based pole position identification technique (p1980 = 20) can be used for motors that are equipped with a holding brake.

10.2 Preconditions for commissioning

10.2.1 Checklists

Before commissioning the High Frequency Drive for the first time, check that all of the connected components are ready for operation. To do this, use the checklists that you can find in the SINAMICS S120 Commissioning Manual (IH1) in Chapter: "Preparing for commissioning / checklists for commissioning SINAMICS S":

- Checklist (1) for commissioning booksize power units
- Checklist (2) for commissioning chassis power units

10.2.2 Topology rules for DRIVE-CLiQ

When the Control Unit (CU320-2, NCU15.x) powers up, a component number is assigned to each component.

For the High Frequency Drive, fixed topology rules apply for DRIVE-CLiQ. This applies to:

- Connecting the HF modules to one other.
- Connecting the HF-module to a Control Unit (HF line-up).

If these rules are violated, an appropriate alarm will be output on the assigned Control Unit or the connected operator panel.

10.2.3 DRIVE-CLiQ topology at the High Frequency Drive

The diagrams show how the DRIVE-CLiQ cables between HF Motor Module, HF Choke Module and HF Damping Module must be connected to ensure an error-free function.

NOTICE
Damage when using incorrect DRIVE-CLiQ cables Damage or malfunctions can occur on the devices or system when DRIVE-CLiQ cables are used that are either incorrect or have not been approved for this purpose. • Only use suitable DRIVE-CLiQ cables that have been approved by Siemens for the particular application.

High Frequency Drive with 16 kHz

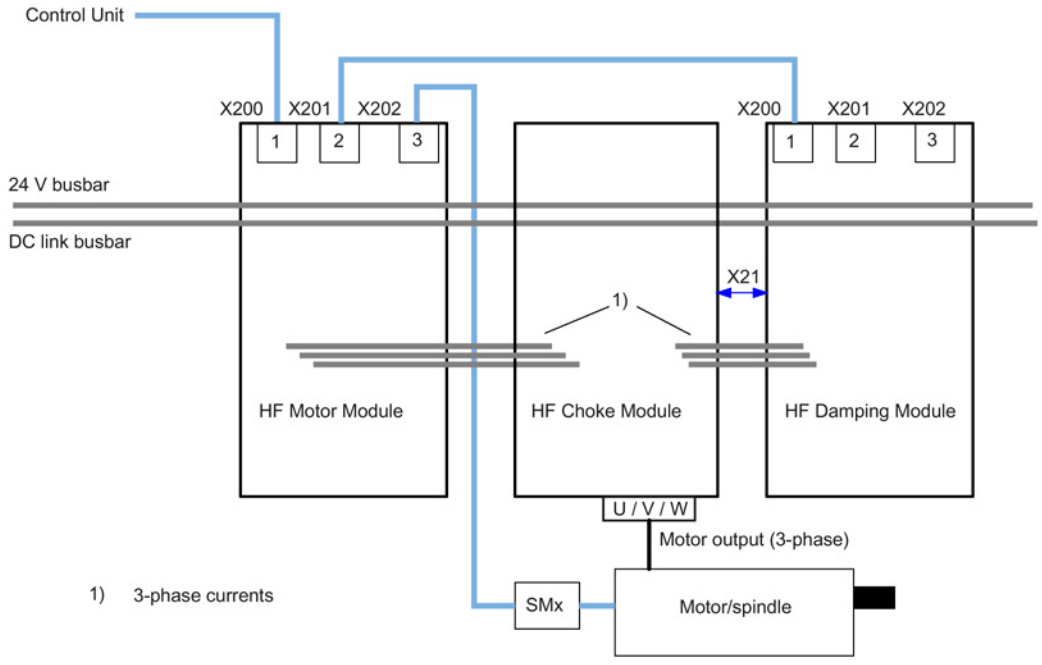


Figure 10-1 DRIVE-CLiQ topology at the High Frequency Drive (16 kHz)

High Frequency Drive with 32 kHz

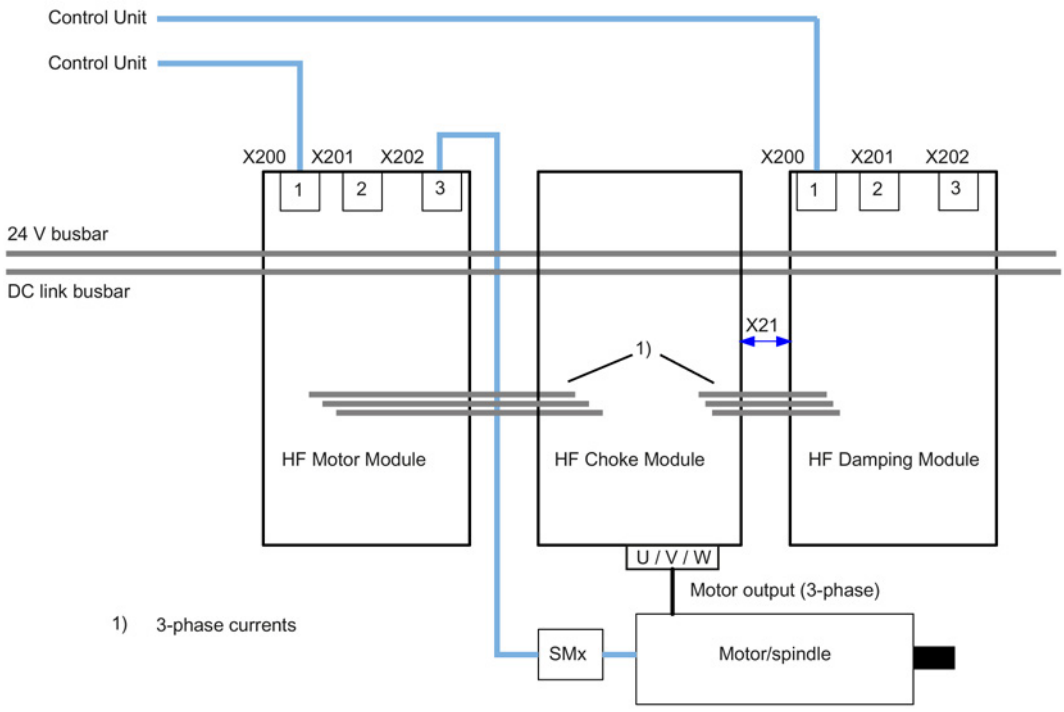


Figure 10-2 DRIVE-CLiQ topology at the High Frequency Drive (32 kHz)

DRIVE-CLiQ interface assignment

Table 10- 3 Assignment of the DRIVE-CLiQ interfaces at the HF Motor Module

DRIVE-CLiQ interface	Connection with
X200	X101/X102/X103/X100 of the Control Unit
X201	X200 HF Damping Module (only for 16 kHz)
X202	Motor encoder, spindle

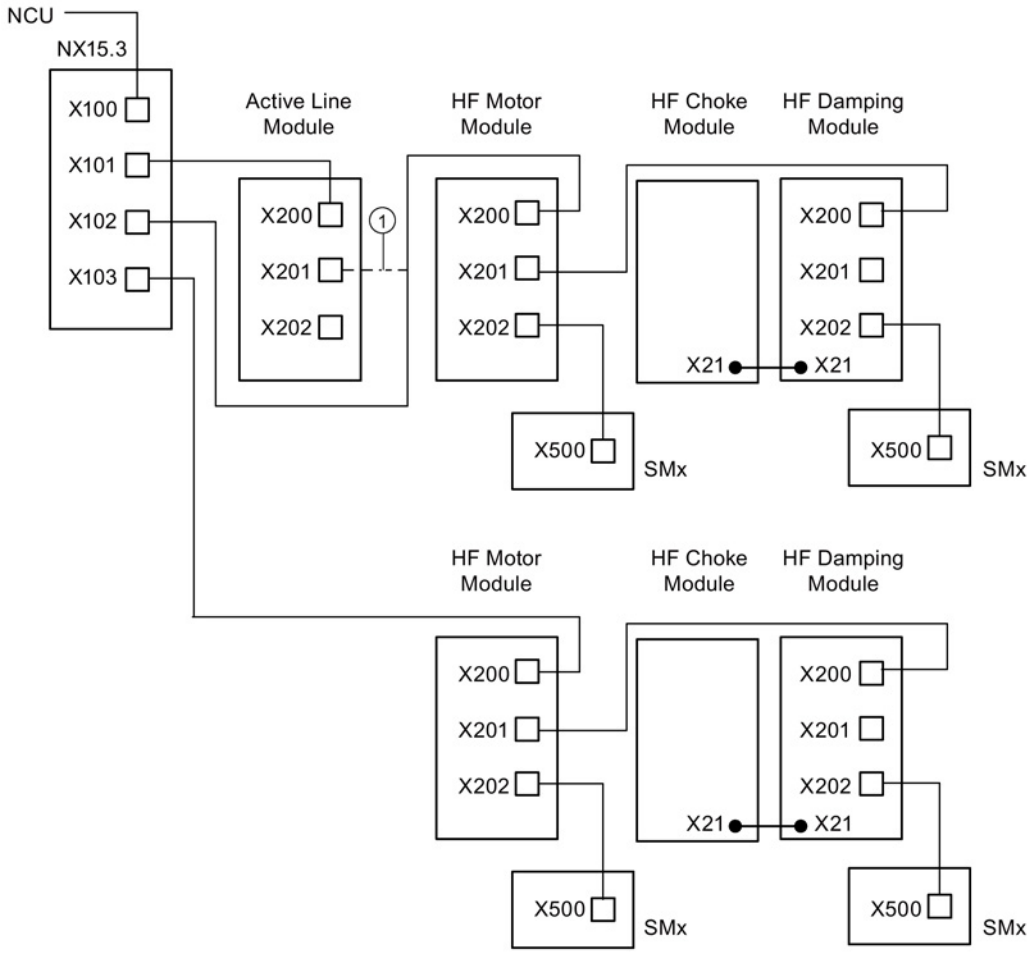
Table 10- 4 Assignment of the DRIVE-CLiQ interfaces at the HF Damping Module

DRIVE-CLiQ interface	Connection with
X200	X201 HF Motor Module (only for 16 kHz)
	X102 at the Control Unit (only for 32 kHz)

10.2.4 DRIVE-CLiQ topology at the HF line-up

To operate a High Frequency Drive with an NX module, the topology depends on the pulse frequency. An overview is shown in the table.

Pulse frequency	Module	Possible number of HF Drives
16 kHz	NX15	2 and infeed (optional)
32 kHz	NX15	1 and infeed (optional)



① For operation with only one HF Drive 16 kHz, the DRIVE-CLiQ cable can be directly connected from the Active Line Module to the HF Motor Module.

Figure 10-3 DRIVE-CLiQ topology for HF Drives 16 kHz (62.5 µs) with Active Line Module and NX module

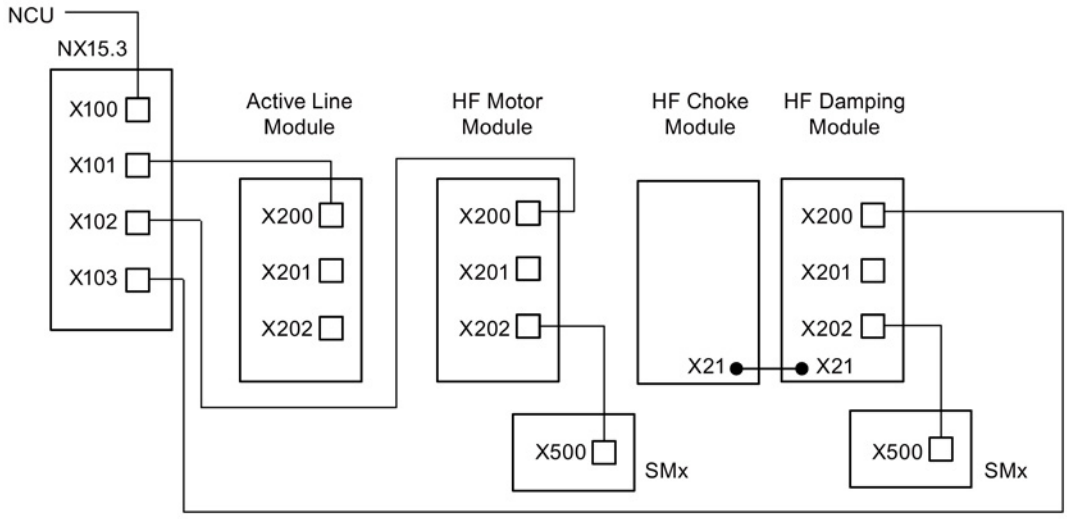


Figure 10-4 DRIVE-CLiQ topology for one HF Drive 32 kHz (31.25 µs) with Active Line Module and NX module

10.3 Commissioning with SINUMERIK Operate

10.3.1 Preconditions

For commissioning High Frequency Drive with SINUMERIK Operate, the following preconditions must be met:

- The High Frequency Drive is connected to an NX module corresponding to the topology rules (see DRIVE-CLiQ topology at the HF lineup (Page 158)).
- The High Frequency Drive is commissioned for the first time.
- The control line-up is switched on.
- The drive software is available in version 4.5 or higher.

10.3.2 Workflow

The commissioning of the HF Drive corresponds to the standard commissioning via HMI. A detailed description is provided in the SINUMERIK commissioning manual.

1. From the user interface in the "Startup" operating area, initiate the automated commissioning of the drive system.
2. Each component of the High Frequency Drive is allocated a dedicated component ID. A SERVO drive object belonging to the HF Motor Module is automatically created.
   The measuring systems, which are connected to interfaces X202 of the HF Motor Module and X202 of the HF Damping Module, are automatically assigned to the SERVO drive object. In this case, the assignments apply as follows:
   - p0161: HF Damping Module
   - p0162: HF Choke Module
3. The drive sets a current controller clock cycle (62.5 µs/31.25 µs) matching the High Frequency Drive.
4. You can optionally perform the following steps:
   - Manually assign a High Frequency Drive a SERVO drive object in the expert list using p0161/p0162.
   - Rename the individual components using the appropriate screen forms at the user interface.

Faults when commissioning the system for the first time

The High Frequency Drive is not automatically assigned in the following cases:

- The HF damping module is not connected
- The HF Damping Module is not connected corresponding to the DRIVE-CLiQ topology rules.

In these cases, connect the HF Damping Module according to the topology rules (see diagrams DRIVE-CLiQ topology at the High Frequency Drive (Page 156)).

10.3.3 Displaying the configuration/topology

To show the configuration and the topology at the user interface, a High Frequency Drive with a pulse frequency of 16 kHz connected to an NX15.3 has been commissioned.

Configuration view

To call the configuration of the HF line-up, at the user interface in the "Startup" operating area, change to "Drive system" > "Drive unit" > "Configuration".

The actual configuration is displayed as shown below.

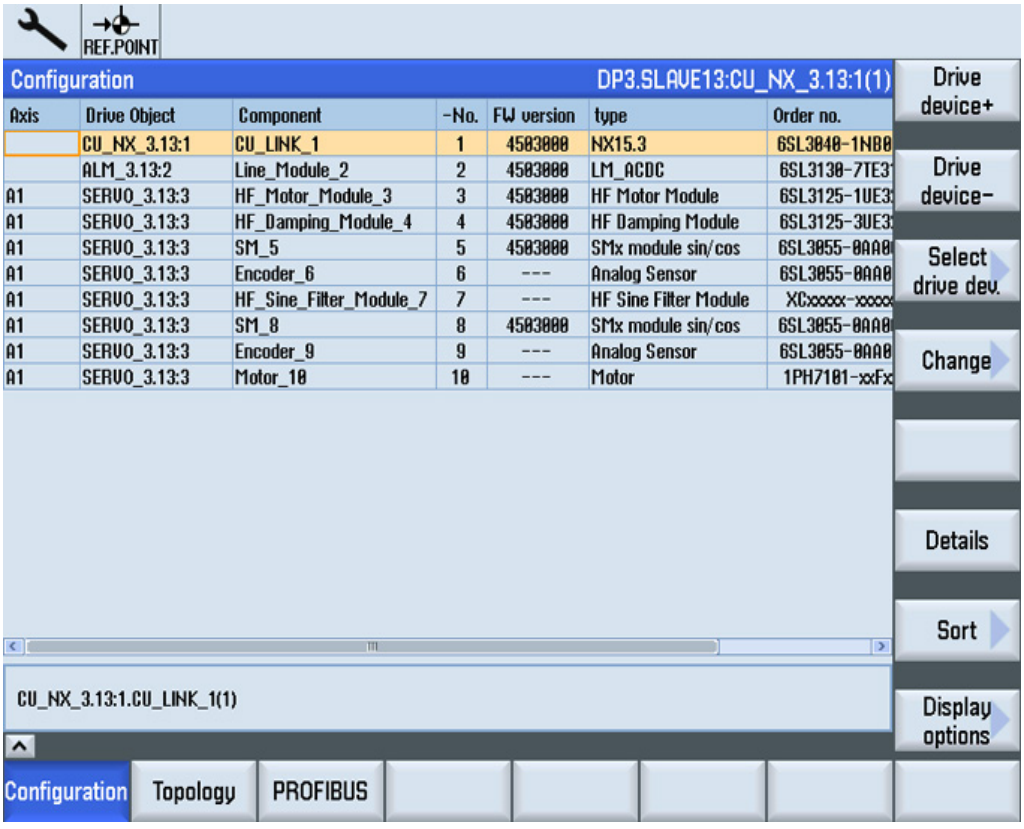


Figure 10-5 High Frequency Drive in the configuration view

Topology display

In order to show the HF line-up in the target topology that has been read out, at the user interface in the "Startup" operating area, change to
"Drive system" > "Drive unit" > "Topology". The High Frequency drive is displayed in the "Topology" window with its three individual modules, each of which has its own assigned component number.

Note

HF Sine Filter Module

The HF Sine Filter Module is only displayed if the DRIVE-CLiQ filter function is deactivated in the display options.

Figure 10-6 High Frequency Drive in the topology display (part 1)

Figure 10-7 High Frequency Drive in the topology display (part 2)

10.4 Overview of important parameters

A detailed description of the parameters listed below can be found in the following manual:

SINAMICS S120/S150 List Manual

Overview of important parameters:

- r5170[0...5] HF phase current actual values
- r5171 CO: HF damping voltage actual value
- r5172[0...3] CO: HF temperatures
- r5173 CO: HF Damping Module overload I^2t
- r5175[0...1] HF diagnostics
- p5174 HF control word
- p0161 HF Damping Module component number
- p0162 HF Choke Module component number
- p0233 power unit motor reactor
- p0234 power unit sine-wave filter capacitance
- p1980[0...n] PolID technique (the values of this parameter cannot be freely set.)

10.5 Alarm and fault messages

All alarm and fault messages are displayed on the operator panel. Detailed information on the displayed alarm and fault messages can be found in the SINUMERIK Diagnostics Manual, in the SINAMICS S120/S150 List Manual and in the online help for the control system.

10.6 Safety-related functions

Information on the safety-related functions, which apply for High Frequency Drive, can be found in the following manual:

SINAMICS S120 Function Manual Safety Integrated (FHS)

Cabinet design and EMC

11

11.1 General information

High Frequency Drives are only designed for installation in EMC-compliant control cabinets.

When operating components in the chassis and booksize formats, the information provided in these manuals regarding cabinet design and EMC apply:

- SINAMICS S120 Manual for Booksize Power Units (GH2)
- SINAMICS S120 Manual for Chassis Power Units (GH3)

11.2 Safety instructions for control panel manufacturing

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

The non-observance of the fundamental safety instructions and residual risks stated in Chapter 1 can result in accidents with severe injuries or death.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account remaining risks.

⚠WARNING

Danger to life due to malfunctions caused by conductive foreign matter

Foreign objects in the enclosure can cause the devices to malfunction. In turn, this affects the functional safety of machines and can therefore put people in danger or lead to material damage.

- Cover the ventilation slots during installation of the control cabinet to prevent drill swarf, end sleeves, and so on from falling into the enclosure, which could result in short-circuits or damage the insulation.
- Observe the safety regulations regarding touch protection. See also EN 60204-1.

⚠WARNING

Danger to life through electric shock due to unconnected cable shields

Hazardous touch voltages can occur through capacitive cross-coupling due to unconnected cable shields.

- Connect cable shields and unused conductors of power cables (e.g. brake conductors) at least on one side to the grounded housing potential.

NOTICE

Damage to the device and malfunctions as a result of static discharge

If static discharge occurs on surfaces or interfaces that cannot be easily accessed, this can cause defects and/or malfunctions.

- Only touch components, modules, and devices when you are grounded by one of the following methods:
  - Wear an ESD wrist strap
  - Wear ESD shoes or ESD grounding straps in ESD areas with conductive flooring

11.3 24 V DC supply voltage

11.3.1 General

The 24 VDC voltage is required to supply:

- The electronics of the SINAMICS components via the integrated 24 V busbar
- The electronics of the Control Units, option boards, Sensor Modules, and Terminal Modules, as well as the process voltage of their digital inputs
- The load voltage of the digital outputs

Note

The electronic power supply has to be provided by the user as described in Chapter System data (Page 27).

When connecting a DC power supply as specified in EN 60204-1:1997, sect. 4.3.3, malfunctions may occur due to the voltage interruptions permitted for them.

⚠WARNING

Danger of death as a result of hazardous voltages when connecting an unsuitable power supply

Death or serious injury can result when live parts are touched in the event of a fault.

- For all connections and terminals of the electronic boards, only use power supplies that provide SELV (Safety Extra Low Voltage) or PELV (Protective Extra Low Voltage) output voltages.

NOTICE

Damage to further loads due to overvoltage

Overvoltage from switched inducted loads (contactors, relays) can damage connected loads.

- Install suitable surge protection.

Note

Malfunction because 24 V supply voltage is too low

If the 24 V supply voltage falls short of the specified minimum value on a device in the assembly, a malfunction can occur.

- Select an input voltage that is high enough to ensure a sufficient voltage on the last device. Do not exceed the maximum value for the supply voltage. If required, supply the voltage to the assembly at various locations.

Detailed information on supplying components with 24 V DC can be found in these manuals:

- SINAMICS S120 Manual for Chassis Power Units (GH3)
- SINAMICS S120 Manual for Booksize Power Units (GH2)

11.3.2 24 V power supply and connection of components

Active Line Modules booksize, HF modules and DC link components are connected to the 24 V DC power supply via the integrated 24 V DC busbars. The current carrying capacity of these busbars is 20 A.The 24 V supply can be realized in various ways:

Using a Control Supply Module

When a Control Supply Module is used, the 24 V supply can be directly established via the busbars. The electronic current limiting function integrated in the Control Supply Module protects the busbar system when a fault occurs. Additional loads can be connected via the 24 V terminal adapter.

Note

When using cables with a cross-section of 2.5 mm^2, no additional protection is required on the 24 V side if a type XLPE or EPR cable, or a cable with a similar quality and with a thermal stability of up to 90 °C is used.

Using a SITOP Power modular 20 A

When using a SITOP Power modular 20 A, the 24 V terminal adapter must be used. The SITOP Power module should be located very close to the load (max. cable length 10 m). We recommend using miniature circuit breakers with tripping characteristic D as overcurrent protection devices for the cables and busbars.

Using an external 24 V power supply

When using an external 24 V power supply, the 24 V terminal adapter must be used. The external power supply should be located very close to the load (max. cable length 10 m). A SITOP Select module, type 6EP1961-2BA00, must be used as overcurrent protection device for the cables and busbars.

Using the red 24 V connectors

- A 24 V connector should be inserted onto the 24 V busbar between each Active Line Module booksize, HF Motor Module, HF Choke Module, HF Damping Module and DC link component.
- Attachment and removal are only permissible in a de-energized state.
- A maximum of 5 unplugging and plugging cycles is permissible.

Note

The red 24 V connectors must be attached before the drive line-up is commissioned.

11.3.3 Typical 24 V current consumption of the components

A separate 24 V power supply must be used for the SINAMICS S120 drive line-up.

The following table can be used to calculate the 24 V DC power supply. The values for typical current consumption are used as a basis for configuration.

Table 11- 1 Overview of the 24 V DC current consumption

Component	Typical current consumption [A_{DC}]
Control Unit	
NCU730.3 without load each digital output	 1.9 0.1
Active Interface Modules	
120 KW booksize	1.2
132 KW, 160 kW chassis	0.17
Active Line Modules	
120 kW Booksize Liquid Cooled	1.8
132 KW chassis	1.1
HF Motor Module 225 A	0.8
HF Choke Module 225 A	1.6
HF Damping Module 225 A	0.9
Braking Module	0.5

11.3.4 Selecting power supply units

It is recommended that the devices in the following tables are used.

Table 11- 2 SITOP Power modular

Rated output current [A]	Phases	Rated input voltage [V] Working voltage range [V]	Short-circuit current [A]	Article No.
20	1 / 2	AC 120 / 230 85 … 132 / 176 … 264	Approx. 23 (power up) Typ. 60 for 25 ms (operation)	6EP1336-3BA00-8AA0
	3	3 AC 230 / 400 … 288 / 500 320 … 550		6EP1436-3BA00-8AA0
40	1 / 2	AC 120 / 230 85 … 132 / 176 … 264	Approx. 46 (power up) Typ. 120 for 25 ms (operation)	6EP1337-3BA00-8AA0
	3	3 AC 230 / 400 … 288 / 500 320 … 550		6EP1437-3BA00-8AA0

Table 11- 3 Control Supply Module

Rated output current [A]	Phases	Input voltage range [V]	Short-circuit current [A]	Article No.
20	3	3 AC 380 -10% (-15% < 1 min) ... 3 AC 480 +10% DC 300 … 800	< 24	6SL3100-1DE22-0AAx

Table 11- 4 SITOP Select module

Rated output current [A]	Outputs	Rated input voltage [V]	Short-circuit current [mA]	Article No.
2 … 10	4	24 V DC	130 % of the set output current	6EP1961-2BA00

⚠WARNING

Danger to life through a hazardous voltage when connecting an unsuitable power supply

Death or serious injury can result when live parts are touched in the event of a fault.

- Connect the ground potential to the PE conductor connection.
- Mount the power supply close to the drive lineup.
  Ideally, they are mounted together on the same mounting plate. If different mounting plates are used, their electrical interconnection must comply with the EMC installation guideline.

11.4 Connection system

11.4.1 Connectable conductor cross-sections for line supply and power cables of the booksize components

Table 11- 5 Connectable cable cross-sections: Line feeder cable / motor cable

		Connection cross-section [mm²]					
Component	**Terminal type**	**25**	**35**	**50**	**70**	**95**	**120**
HF Choke Module 225 A[1)]	Threaded bolts M8/13 Nm	X	X	X	X	X	X
Active Line Module 80 kW / 120 kW [1)]	Threaded bolts M8/13 Nm				X	X	X
Active Interface Module 80 kW / 120 kW[1)]	Threaded bolts M8/13 Nm				X	X	X

1) Alternatively, two ring cable lugs without insulation for the parallel connection of two cables with a maximum cross-section of 50 mm² can also be connected to the threaded bolts respectively. Both cable lugs should be installed "back to back".

⚠ WARNING

Risk of fire due to overheating when permissible cable cross-sections are exceeded

The internal overload monitoring function of the power module only protects the cable if this is dimensioned/selected corresponding to the power module currents. Cables with an excessively low cross-section can overheat and result in fire and smoke.

- Always use cables with adequate cross-sections.
- If you select lower cross-sections, then you must ensure the appropriate level of cable protection in another way, e.g. by suitably setting the control parameters.

11.4.2 Screw terminals

The type of screw terminal can be taken from the interface description of the particular component.

Table 11- 6 Screw terminals

Screw terminal type			
1	Connectable cable cross-sections	Rigid, flexible With wire end ferrule, without plastic sleeve With wire end ferrule, with plastic sleeve	0.08 … 1.5 mm^2 0.25 … 1.5 mm^2 0.25 … 0.5 mm^2
	Stripped length	7 mm	
	Tool	Screwdriver 0.4 x 2.0 mm	
	Tightening torque	0.22 … 0.25 Nm	
1_1	Connectable cable cross-sections	Rigid, flexible With wire end ferrule, without plastic sleeve With wire end ferrule, with plastic sleeve	0.14 … 1.5 mm^2 0.25 … 1.5 mm^2 0.25 … 0.5 mm^2
	Stripped length	7 mm	
	Tool	0.4 x 2.5 mm screwdriver	
	Tightening torque	0.22 … 0.25 Nm	
4	Connectable cable cross-sections	Rigid, flexible With wire end ferrule, without plastic sleeve With wire end ferrule, with plastic sleeve	0.2 … 4 mm^2 0.25 … 4 mm^2 0.25 … 4 mm^2
	Stripped length	7 mm	
	Tool	0.6 x 305 mm screwdriver	
	Tightening torque	0.5 … 0.6 Nm	
5	Connectable cable cross-sections	Rigid, flexible With wire end ferrule, without plastic sleeve With wire end ferrule, with plastic sleeve	0.5 … 6 mm^2 0.5 … 6 mm^2 0.5 … 6 mm^2
	Stripped length	12 mm	
	Tool	Screwdriver 1.0 x 4.0 mm	
	Tightening torque	1.2 … 1.5 Nm	

11.4.3 Cable lugs

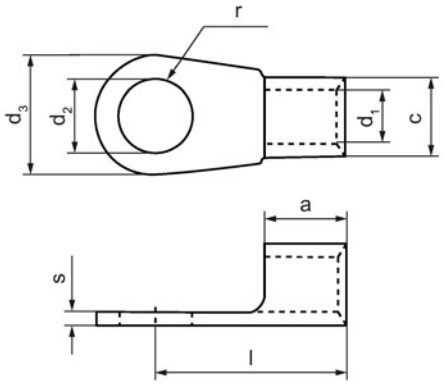


Figure 11-1 Dimension drawing of cable lugs

Table 11- 7 Dimensions of cable lugs

Screw/bolt	Cable cross-section [mm²]	a [mm]	c [mm]	d_1 [mm]	d_2 [mm]	d_3 [mm]	l [mm]	r [mm]	s [mm]
M8	25	11	12	7.5	8.4	16	25	10	1.5
M8	35	12	15	9	8.4	16	26	10	1.6
M8	50	16	17	11	8.4	18	34	10	1.8
M8	70	18	21	13	8.4	22	38	12	2
M8	95	20	23	15	8.4	24	42	12	2.5
M8	120	22	24	16.5	8.4	24	44	12	3

11.5 Protective connections and equipotential bonding

Protective connections

The SINAMICS S Booksize drive system is designed for use in cabinets with a PE conductor connection.

The protective conductor connection of the SINAMICS components must be connected to the protective conductor connection of the control cabinet as follows:

Table 11- 8 Conductor cross-sections for copper protective connections

Line feeder cable to Line Module [mm²]	Protective connection, copper [mm²]
Up to 16 mm²	The same as the line supply cable
From 16 mm² to 35 mm²	16 mm²
From 35 mm²	0.5 x line supply cable

For materials other than copper, the cross-section should be increased so that as a minimum, the same conductivity is attained.

All system components and machine parts must be incorporated in the protection concept.

The protective connection (PE connection) of the motors used must be established through the motor cable. For EMC reasons, these protective connections should be made at the HF Choke Module.

In order to maintain the EMC limit values, the drive line-up must be arranged on the mounting plate as specified in Chapter Installation (Page 55) . The mounting plate must be connected to the protective conductor connection of the control cabinet through a low impedance.

Copper cables with appropriate cross-sections (>2.5 mm²) must be used for the ground connection of PROFIBUS nodes.

For more information about grounding PROFIBUS, see:
http://www.profibus.com/fileadmin/media/wbt/WBT_Assembly_V10_Dec06/index.html

⚠WARNING

Danger to life as a result of electric shock and fire when operating outside closed electrical equipment rooms and/or control cabinets

Death or serious injury can result if you do not take suitable measures when installing the equipment to provide touch protection for live components or the propagation of a fire.

- Only operate the components in electrical equipment rooms or control cabinets that can be securely locked.

⚠WARNING

Danger of death caused by high discharge currents when the external protective conductor is interrupted

Drive components conduct high discharge currents via the protective conductor. When the protective conductor is interrupted, touching live components can result in electric shock, which can lead to death or serious injuries.

- Ensure that the external protective conductor complies with at least one of the following conditions:
  - It is laid protected against mechanical damage.[1)]
  - For an individual conductor, it has a cross-section of at least 10 mm² Cu.
  - As a core of a multi-core cable, it has a cross section of at least 2.5 mm² Cu.
  - It has a parallel, second protective conductor with the same cross-section.
  - It corresponds to the local regulations for equipment with increased leakage current.

[1)] Cables routed in control cabinets or enclosed machine enclosures are considered to be adequately protected against mechanical damage.

Functional equipotential bonding with protective conductor connection

The mounting plate, which is connected with the protective conductor connection of the control cabinet through a low impedance connection, simultaneously serves as the function equipotential bonding surface. This means that no additional functional equipotential bonding is required within the drive line-up.

When installing components on standard mounting rails, the data listed in the table also apply to the functional equipotential bonding. If only smaller conductor cross-sections are permissible on components, the largest cross-section must be used (e.g. 6 mm² for TM31 and SMC). These requirements also apply to distributed components located outside the control cabinet.

No functional equipotential bonding conductors are required for PROFIBUS inside a control cabinet. For PROFIBUS connections between different buildings or parts of buildings, a functional equipotential bonding must be routed in parallel to the PROFIBUS cable. The following cross-sections must be observed in accordance with IEC 60364-5-54:

- Copper 6 mm²
- Aluminum 16 mm²
- Steel 50 mm²

Additional information about equipotential bonding for PROFIBUS can be found at:
http://www.profibus.com/fileadmin/media/wbt/WBT_Assembly_V10_Dec06/index.html

Note

PROFINET

For installation guidelines and information of protective grounding and equipotential bonding for all PROFINET types and topologies, refer to DOWNLOADS at:
http://www.profibus.com

11.6 Arrangement of the devices

The arrangement of the components and equipment in the control cabinet takes account of:

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

The components of the HF line-up must be mounted on the mounting plate described in Chapter Installation (Page 55).

Components are usually located centrally in a cabinet. The necessary mounting and installation clearances above and below the components can possibly exceed the minimum clearances specified in the product documentation.

11.7 Cooling circuit and coolant properties

The cooling circuit is essentially designed as described in the following manual:

- SINAMICS S120 Manual for Booksize Power Units

In the corresponding chapters you will also find information on coolant properties.

Note

Special features of the High Frequency Drive

- Only use shielded coolant hoses or metal coolant pipes when the routing coolant within the EMC control cabinet.
- Connect the shields of the coolant hoses at both ends.
- You must install flow monitors to completely protect the devices.
  Recommendation: efector300 SM6000 from the ifm electronic GmbH company
  When the rated flow rate is fallen below, the pulses must be inhibited within 10 s.

NOTICE

Damage to the component as a result of liquids that have entered

Liquids that penetrate the equipment can cause short circuits in the components and damage the components.

- Use a rigid piping system when connecting the cooling circuit to the Motor Modules.
- Apply a thread locking compound/sealant to the screw connections of the cooling water connections to prevent them loosening and leaking. Use Loctite 577 liquid thread sealant and the associated Loctite 7091 activator. Carefully observe the application instructions of the associated product description from Loctite.

Service and maintenance 12

12.1 Replacing the fan

12.1.1 Safety instructions for replacing a fan

Note

- When replacing the fan, you must observe the ESD regulations (Page 21).
- Only qualified personnel are permitted to install spare parts.

⚠DANGER

Danger of death when live parts are touched

The fan must be in a no-voltage and disconnected state when it is replaced. A hazardous voltage is still present for up to 5 minutes after the power supply has been switched off.

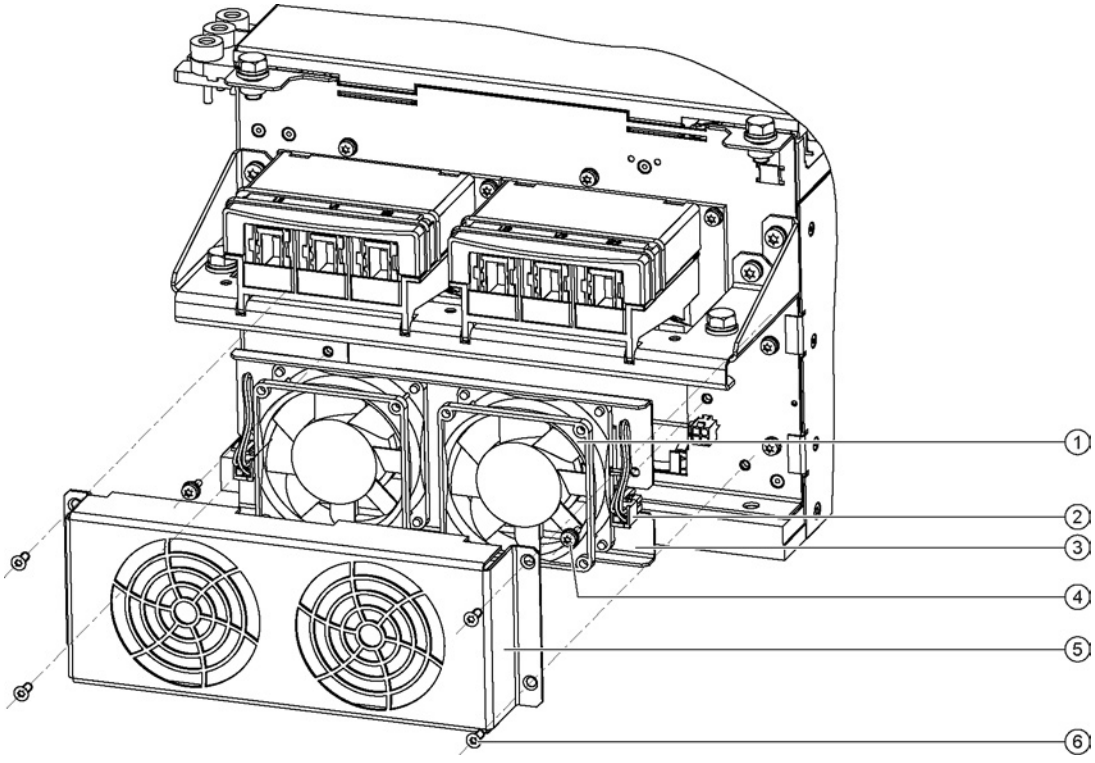
Touching live components results in death or severe injury.

- Only remove the fan cover or the fan support assembly after this time has expired.
- Before removing the component, check that the drive line-up is in a no-voltage condition.

12.1.2 Replacing the fan at the HF Choke Module

Removing fans

1. Remove the HF Choke Module from the drive line-up.
2. Remove the screws on the fan cover using a Torx T20 screwdriver.
3. Remove the fan cover.
4. Release the connecting plug and remove it.
5. Remove the screws from the fan support using a Torx T20 screwdriver.
6. Remove the fan support with the fans.



① Fans (2x)
② Connecting plug
③ Fan support
④ Oval head screws (2x), M4, Torx T20
⑤ Fan cover
⑥ Countersunk head screws (4x), M4, Torx T20

Figure 12-1 Remove the fans at the HF Choke Module

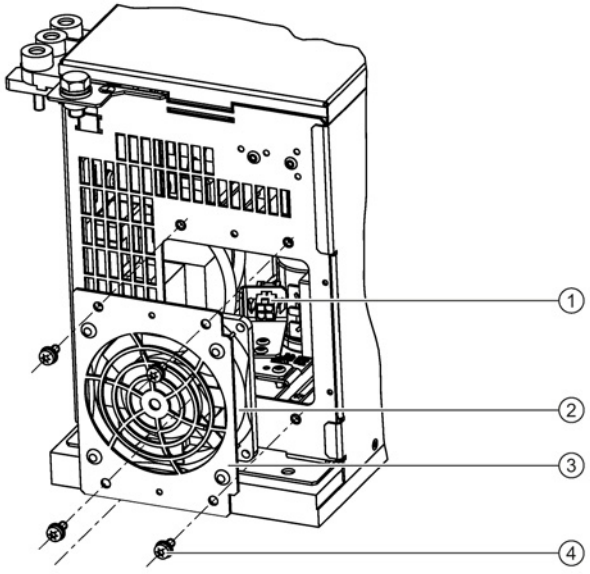
Installing the fan

1. Position the replacement fans on the fan support. Note the direction of the airflow from bottom to top (the arrow on the fan must point to the inside of the module).
2. Push the fan support and fan into the device. The connecting cables must not be crushed when doing this.
3. Tighten the oval head screws at the fan support (tightening torque: 1.8 Nm).
4. Insert the connecting plugs so that you can hear them engage.
5. Put the fan cover on. The connecting cables must not be damaged when doing this.
6. Screw the countersunk screws on the fan cover and tighten them crosswise (tightening torque: 1.8 Nm).

12.1.3 Replacing the fan at the HF Damping Module

Removing fans

1. Remove the HF Damping Module from the drive line-up.
2. Remove the retaining screws from the fan support using a Torx T20 screwdriver.
3. Release the connecting plug and remove it.
4. Remove the fan support with the fan.



① Connecting plug
② Fans
③ Fan support
④ Retaining screws (4x), M4, Torx T20

Figure 12-2 Remove the fans at the HF Damping Module

Installing the fan

1. Position the replacement fan on the fan support. Note the direction of the airflow from bottom to top (the arrow on the fan must point to the inside of the module).
2. Insert the connecting plug so that you can hear it engage.
3. Push the fan support and fan into the device. The connecting cable must not be crushed when doing this.
4. Tighten the retaining screws on the fan support and tighten them crosswise (tightening torque: 1.8 Nm).

12.2 Recycling and disposal

Dispose of the product according to the applicable national regulations.

The products described in this Equipment Manual are extensively recyclable on account of the low-toxic composition of the materials used. To recycle and dispose of your old device in an environmentally friendly way, please contact a company that disposes of electronic waste.

Appendix

A

A.1 List of abbreviations

Note

The following list of abbreviations includes all abbreviations and their meanings used in the entire SINAMICS family of drives.

Abbreviation	Source of the abbreviation	Meaning
A		
A...	Alarm	Alarm
AC	Alternating Current	Alternating current
ADC	Analog Digital Converter	Analog-digital converter
AI	Analog Input	Analog input
AIM	Active Interface Module	Active Interface Module
ALM	Active Line Module	Active Line Module
AO	Analog Output	Analog output
AOP	Advanced Operator Panel	Advanced Operator Panel
APC	Advanced Positioning Control	Advanced Positioning Control
AR	Automatic Restart	Automatic restart
ASC	Armature Short-Circuit	Armature short-circuit
ASCII	American Standard Code for Information Interchange	American standard code for information interchange
AS-i	AS-Interface (Actuator Sensor Interface)	AS interface (open bus system in automation technology)
ASM	Asynchronmotor	Induction motor
B		
BB	Betriebsbedingung	Operating condition
BERO	-	Proximity switch
BI	Binector Input	Binector Input
BIA	Berufsgenossenschaftliches Institut für Arbeitssicherheit	BG Institute for Occupational Safety and Health
BICO	Binector Connector Technology	Binector connector technology
BLM	Basic Line Module	Basic Line Module

Abbreviation	Source of the abbreviation	Meaning
BO	Binector Output	Binector output
BOP	Basic Operator Panel	Basic Operator Panel
C		
C	Capacitance	Capacitance
C...	-	Safety message
CAN	Controller Area Network	Serial bus system
CBC	Communication Board CAN	Communication Board CAN
CBE	Communication Board Ethernet	PROFINET communication module (Ethernet)
CD	Compact Disc	Compact disk
CDS	Command Data Set	Command data set
CF Card	CompactFlash Card	CompactFlash card
CI	Connector Input	Connector Input
CLC	Clearance Control	Clearance control
CNC	Computer Numerical Control	Computerized numerical control
CO	Connector Output	Connector output
CO/BO	Connector Output/Binector Output	Connector/binector output
COB ID	CAN Object-Identification	CAN object identification
CoL	Certificate of License	Certificate of License
COM	Common contact of a change-over relay	Center contact on a changeover contact
COMM	Commissioning	Commissioning
CP	Communication Processor	Communications processor
CPU	Central Processing Unit	Central processing unit
CRC	Cyclic Redundancy Check	Cyclic redundancy check
CSM	Control Supply Module	Control Supply Module
CU	Control Unit	Control unit
CUA	Control Unit Adapter	Control Unit Adapter
CUD	Control Unit DC MASTER	Control Unit DC MASTER
D		
DAC	Digital Analog Converter	Digital-analog converter
DC	Direct Current	Direct current
DCB	Drive Control Block	Drive Control Block
DCBRK	DC Brake	DC braking
DCC	Drive Control Chart	Drive Control Chart
DCN	Direct Current Negative	Direct current negative
DCP	Direct Current Positive	Direct current positive
DDS	Drive Data Set	Drive data set
DI	Digital Input	Digital input
DI/DO	Digital Input/Digital Output	Bidirectional digital input/output
DMC	DRIVE-CLiQ Hub Module Cabinet	DRIVE-CLiQ Hub Module Cabinet
DME	DRIVE-CLiQ Hub Module External	DRIVE-CLiQ Hub Module External

Abbreviation	Source of the abbreviation	Meaning
DMM	Double Motor Module	Double Motor Module
DO	Digital Output	Digital output
DO	Drive Object	Drive object
DP	Decentralized Peripherals	Distributed I/O
DPRAM	Dual Ported Random Access Memory	Dual-Port Random Access Memory
DQ	DRIVE-CLiQ	DRIVE-CLiQ
DRAM	Dynamic Random Access Memory	Dynamic Random Access Memory
DRIVE-CLiQ	Drive Component Link with IQ	Drive Component Link with IQ
DSC	Dynamic Servo Control	Dynamic Servo Control
DTC	Digital Time Clock	Timer
E		
EASC	External Armature Short-Circuit	External armature short-circuit
EDS	Encoder Data Set	Encoder data set
EEPROM	Electrically Erasable Programmable Read-Only Memory	Electrically Erasable Programmable Read-Only-Memory
ESD	Elektrostatisch gefährdete Baugruppen	Electrostatic sensitive devices
ELCB	Earth Leakage Circuit Breaker	Residual current operated circuit breaker
ELP	Earth Leakage Protection	Ground-fault monitoring
EMC	Electromagnetic Compatibility	Electromagnetic compatibility
EMF	Electromotive Force	Electromotive force
EMK	Elektromotorische Kraft	Electromotive force
EMV	Elektromagnetische Verträglichkeit	Electromagnetic compatibility
EN	Europäische Norm	European standard
EnDat	Encoder-Data-Interface	Encoder interface
EP	Enable Pulses	Enable pulses
EPOS	Einfachpositionierer	Basic positioner
ES	Engineering System	Engineering System
ESB	Ersatzschaltbild	Equivalent circuit diagram
ESD	Electrostatic Sensitive Devices	Electrostatic sensitive devices
ESM	Essential Service Mode	Essential service mode
ESR	Extended Stop and Retract	Extended stop and retract
F		
F...	Fault	Fault
FAQ	Frequently Asked Questions	Frequently asked questions
FBLOCKS	Free Blocks	Free function blocks
FCC	Function Control Chart	Function control chart
FCC	Flux Current Control	Flux current control
FD	Function Diagram	Function diagram
F-DI	Failsafe Digital Input	Fail-safe digital input
F-DO	Failsafe Digital Output	Fail-safe digital output

Abbreviation	Source of the abbreviation	Meaning
FEM	Fremderregter Synchronmotor	Separately excited synchronous motor
FEPROM	Flash-EPROM	Non-volatile write and read memory
FG	Function Generator	Function generator
FI	-	Residual current
FOC	Fiber-Optic Cable	Fiber-optic cable
FP	Funktionsplan	Function diagram
FPGA	Field Programmable Gate Array	Field programmable gate array
FW	Firmware	Firmware
G		
GB	Gigabyte	Gigabyte
GC	Global Control	Global control telegram (broadcast telegram)
GND	Ground	Reference potential for all signal and operating voltages, usually defined as 0 V (also referred to as M)
GSD	Gerätestammdatei	Generic station description: describes the features of a PROFIBUS slave
GSV	Gate Supply Voltage	Gate supply voltage
GUID	Globally Unique Identifier	Globally Unique Identifier
H		
HF	High frequency	High frequency
HFD	Hochfrequenzdrossel	High-frequency reactor
HLA	Hydraulic Linear Actuator	Hydraulic linear drive
HLG	Hochlaufgeber	Ramp-function generator
HM	Hydraulic Module	Hydraulic Module
HMI	Human Machine Interface	Human machine interface
HTL	High-Threshold Logic	Logic with high fault threshold
HW	Hardware	Hardware
I		
i. V.	In Vorbereitung	Under development: This property is currently not available
I/O	Input/Output	Input/output
I2C	Inter-Integrated Circuit	Internal serial data bus
IASC	Internal Armature Short-Circuit	Internal armature short-circuit
IBN	Inbetriebnahme	Commissioning
ID	Identifier	Identification
IE	Industrial Ethernet	Industrial Ethernet
IEC	International Electrotechnical Commission	International Electrotechnical Commission
IF	Interface	Interface
IGBT	Insulated Gate Bipolar Transistor	Bipolar transistor with insulated control electrode
IGCT	Integrated Gate-Controlled Thyristor	Semiconductor power switch with integrated control electrode

Abbreviation	Source of the abbreviation	Meaning
IL	Impulslöschung	Pulse suppression
IP	Internet Protocol	Internet Protocol
IPO	Interpolator	Interpolator
IT	Isolé Terre	Non-grounded three-phase line supply
IVP	Internal Voltage Protection	Internal voltage protection
J		
JOG	Jogging	Jog
K		
KDV	Kreuzweiser Datenvergleich	Crosswise data comparison
KHP	Know-how protection	Know-how protection
KIP	Kinetische Pufferung	Kinetic buffering
Kp	-	Proportional gain
KTY	-	Special temperature sensor
L		
L	-	Symbol for inductance
LED	Light Emitting Diode	Light emitting diode
LIN	Linearmotor	Linear motor
LR	Lageregler	Position controller
LSB	Least Significant Bit	Least significant bit
LSC	Line-Side Converter	Line-side converter
LSS	Line-Side Switch	Line-side switch
LU	Length Unit	Length unit
FO cable	Lichtwellenleiter	Fiber-optic cable
M		
M	-	Symbol for torque
M	Masse	Reference potential for all signal and operating voltages, usually defined as 0 V (also referred to as GND)
MB	Megabyte	Megabyte
MCC	Motion Control Chart	Motion Control Chart
MDI	Manual Data Input	Manual data input
MDS	Motor Data Set	Motor data set
MLFB	Maschinenlesbare Fabrikatebezeichnung	Machine-readable product code
MM	Motor Module	Motor Module
MMC	Man-Machine Communication	Man-machine communication
MMC	Micro Memory Card	Micro memory card
MSB	Most Significant Bit	Most significant bit
MSC	Motor-Side Converter	Motor-side converter
MSCY_C1	Master Slave Cycle Class 1	Cyclic communication between master (class 1) and slave

Abbreviation	Source of the abbreviation	Meaning
MSC	Motorstromrichter	Motor-side converter
MT	Messtaster	Probe
N		
N. C.	Not Connected	Not connected
N...	No Report	No report or internal message
NAMUR	Normenarbeitsgemeinschaft für Mess- und Regeltechnik in der chemischen Industrie	Standardization association for measurement and control in chemical industries
NC	Normally Closed (contact)	NC contact
NC	Numerical Control	Numerical control
NEMA	National Electrical Manufacturers Association	Standardization body in the US
NM	Nullmarke	Zero mark
NO	Normally Open (contact)	NO contacts
LSC	Netzstromrichter	Line-side converter
NVRAM	Non-Volatile Random Access Memory	Non-volatile read/write memory
O		
OA	Open Architecture	Software component (technology package) which provides additional functions for the SINAMICS drive system
OAIF	Open Architecture Interface	Version of the SINAMICS firmware from which the OA-application can be used
OASP	Open Architecture Support Package	Expands the STARTER commissioning tool by the corresponding OA-application
OC	Operating Condition	Operating condition
OEM	Original Equipment Manufacturer	Original equipment manufacturer
OLP	Optical Link Plug	Bus connector for fiber-optic cable
OMI	Option Module Interface	Option Module Interface
P		
p...	-	Adjustable parameters
P1	Processor 1	CPU 1
P2	Processor 2	CPU 2
PB	PROFIBUS	PROFIBUS
PcCtrl	PC Control	Master control
PD	PROFIdrive	PROFIdrive
PDS	Power unit Data Set	Power unit data set
PE	Protective Earth	Protective ground
PELV	Protective Extra Low Voltage	Safety extra-low voltage
PEM	Permanenterregter Synchronmotor	Permanent-magnet synchronous motor
PG	Programmiergerät	Programming device
PI	Proportional Integral	Proportional integral
PID	Proportional Integral Differential	Proportional integral differential
PLC	Programmable Logical Controller	Programmable logic controller

Abbreviation	Source of the abbreviation	Meaning
PLL	Phase-Locked Loop	Phase-locked loop
PM	Power Module	Power Module
PN	PROFINET	PROFINET
PNO	PROFIBUS Nutzerorganisation	PROFIBUS user organization
PPI	Point to Point Interface	Point-to-point interface
PRBS	Pseudo Random Binary Signal	White noise
PROFIBUS	Process Field Bus	Serial data bus
PS	Power Supply	Power supply
PSA	Power Stack Adapter	Power Stack Adapter
PTC	Positive Temperature Coefficient	Positive temperature coefficient
PTP	Point To Point	Point-to-point
PWM	Pulse Width Modulation	Pulse width modulation
PZD	Prozessdaten	Process data
Q		
R		
r...	-	Display parameters (read only)
RAM	Random Access Memory	Read/write memory
RCCB	Residual Current Circuit Breaker	Residual current operated circuit breaker
RCD	Residual Current Device	Residual current operated circuit breaker
RCM	Residual Current Monitor	Residual current monitor
RFG	Ramp-Function Generator	Ramp-function generator
RJ45	Registered Jack 45	Term for an 8-pin socket system for data transmission with shielded or non-shielded multi-wire copper cables
RKA	Rückkühlanlage	Cooling unit
RLM	Renewable Line Module	Renewable Line Module
RO	Read Only	Read only
ROM	Read-Only Memory	Read-only memory
RPDO	Receive Process Data Object	Receive Process Data Object
RS232	Recommended Standard 232	Interface standard for cable-connected serial data transmission between a sender and receiver (also known as EIA232)
RS485	Recommended Standard 485	Interface standard for a cable-connected differential, parallel, and/or serial bus system (data transmission between a number of senders and receivers, also known as EIA485)
RTC	Real Time Clock	Realtime clock
RZA	Raumzeigerapproximation	Space vector approximation
S		
S1	-	Continuous duty
S3	-	Intermittent duty
SAM	Safe Acceleration Monitor	Safe acceleration monitoring

Abbreviation	Source of the abbreviation	Meaning
SBC	Safe Brake Control	Safe brake control
SBH	Sicherer Betriebshalt	Safe operating stop
SBR	Safe Brake Ramp	Safe brake ramp monitoring
SBT	Safe Brake Test	Safe brake test
SCA	Safe Cam	Safe cam
SD Card	SecureDigital Card	Secure digital memory card
SDI	Safe Direction	Safe motion direction
SE	Sicherer Software-Endschalter	Safe software limit switch
SG	Sicher reduzierte Geschwindigkeit	Safely-limited speed
SGA	Sicherheitsgerichteter Ausgang	Safety-related output
SGE	Sicherheitsgerichteter Eingang	Safety-related input
SH	Sicherer Halt	Safe standstill
SI	Safety Integrated	Safety Integrated
SIL	Safety Integrity Level	Safety Integrity Level
SLM	Smart Line Module	Smart Line Module
SLP	Safely-Limited Position	Safely-limited position
SLS	Safely-Limited Speed	Safely-limited speed
SLVC	Sensorless Vector Control	Vector control without encoder (sensorless)
SM	Sensor Module	Sensor Module
SMC	Sensor Module Cabinet	Sensor Module Cabinet
SME	Sensor Module External	Sensor Module External
SMI	SINAMICS Sensor Module Integrated	SINAMICS Sensor Module Integrated
SMM	Single Motor Module	Single Motor Module
SN	Sicherer Software-Nocken	Safe software cam
SOS	Safe Operating Stop	Safe operating stop
SP	Service Pack	Service pack
SP	Safe Position	Safe position
SPC	Setpoint Channel	Setpoint channel
SPI	Serial Peripheral Interface	Serial peripheral interface
SPS	Speicherprogrammierbare Steuerung	Programmable logic controller
SS1	Safe Stop 1	Safe stop 1 (monitored for time and ramping up)
SS2	Safe Stop 2	Safe Stop 2
SSI	Synchronous Serial Interface	Synchronous serial interface
SSM	Safe Speed Monitor	Safe feedback from speed monitor
SSP	SINAMICS Support Package	SINAMICS support package
STO	Safe Torque Off	Safe torque off
STW	Steuerwort	Control word

Abbreviation	Source of the abbreviation	Meaning
T		
TB	Terminal Board	Terminal board
TIA	Totally Integrated Automation	Totally Integrated Automation
TM	Terminal Module	Terminal Module
TN	Terre Neutre	Grounded three-phase line supply
Tn	-	Integral time
TPDO	Transmit Process Data Object	Transmit process data object
TT	Terre Terre	Grounded three-phase line supply
TTL	Transistor-Transistor-Logic	Transistor-transistor logic
Tv	-	Rate time
U		
UL	Underwriters Laboratories Inc.	Underwriters Laboratories Inc.
UPS	Uninterruptible Power Supply	Uninterruptible power supply
UPS	Unterbrechungsfreie Stromversorgung	Uninterruptible power supply
UTC	Universal Time Coordinated	Universal time coordinated
V		
VC	Vector Control	Vector control
Vdc	-	DC-link voltage
VdcN	-	Partial DC link voltage, negative
VdcP	-	Partial DC link voltage, positive
VDE	Verband Deutscher Elektrotechniker	Verband Deutscher Elektrotechniker [Association of German Electrical Engineers]
VDI	Verein Deutscher Ingenieure	Verein Deutscher Ingenieure [Association of German Engineers]
VPM	Voltage Protection Module	Voltage Protection Module
Vpp	Volt peak to peak	Volt peak to peak
VSM	Voltage Sensing Module	Voltage Sensing Module
W		
WEA	Wiedereinschaltautomatik	Automatic restart
WZM	Werkzeugmaschine	Machine tool
X		
XML	Extensible Markup Language	Extensible markup language (standard language for web publishing and document management)
Y		
Z		
ZK	DC Link	DC Link
ZM	Zero Mark	Zero mark
ZSW	Status word	Status word

A.2 Documentation overview

General documentation/catalogs			
SINAMICS	G110	D11.1	- Inverter built-in units 0.12 kW up to 3 kW
	G120	D31	- SINAMICS Inverters for Single-Axis Drives and SIMOTICS Motors
	G130, G150	D11.1	- Inverter built-in units - Inverter cabinet units
	S120, S150	D21.3	- SINAMICS S120 Built-in units in the Chassis format and Cabinet Modules - SINAMICS S150 Drive Converter Cabinet Units
SIMOTION, SINAMICS	S120	PM21	SIMOTION, SINAMICS S120 and Motors for Production Machines
Manufacturer/service documentation			
SINAMICS	G110		- Getting Started - Operating instructions - List Manuals
	G120		- Getting Started - Operating instructions - Hardware Installation Manuals - Function Manual Safety Integrated - List Manuals
	G130		- Operating instructions - List Manual
	G150		- Operating instructions - List Manual
	GM150 SM120/SM150 GL150 SL150		- Operating instructions - List Manuals
	S110		- Manual - Getting Started - Function Manual - List Manual
	S120		- Getting Started - Commissioning Manual - Commissioning Manual CANopen - Function Manual Drive Functions - Function Manual Safety Integrated - Function Manual DCC - List Manual - Manual for Control Units and Additional Components - Manual PU Booksize - Manual PU Booksize C/D Type - Manual PU Chassis - Manual PU Chassis Liquid Cooled - Manual Cabinet Modules - Manual AC Drive - SINAMICS S120M Manual Distributed Drive Technology - SINAMICS HLA System Manual Hydraulic Drive
	S150		- Operating instructions - List Manual
Motors			- Configuration Manuals, Motors
General			- Configuration Manual, EMC Guidelines

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