Equipment Manual 04/2007 Edition

# SINAMICS S120

## Chassis Power Units Liquid Cooled

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# Chassis Power Units Liquid Cooled

Equipment Manual

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## Safety guidelines

This Manual contains information which you should carefully observe to ensure your own personal safety and the prevention of material damage. Notices which are relevant to your own personal safety are highlighted by a safety alert symbol; notices which are relevant only to equipment and property damage have no safety alert symbol. The warnings appear in decreasing order of risk as given below.



**Danger**

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



**Alarm**

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



**Caution**

“Caution” with a warning triangle indicates that minor personal injury can result if proper precautions are not taken.

**Caution**

"Caution" without a warning triangle indicates that material damage can result if proper precautions are not taken.

**Notice**

“Important” indicates that an unwanted result or situation can result if the appropriate advice is not taken into account.

If several hazards of different degrees occur, the hazard with the highest degree must always be given priority. A warning notice accompanied by a safety alert symbol indicating a risk of bodily injury can also indicate a risk of property damage.

## Qualifiziertes Personal

The associated device/system may only be set up and operated using this documentation. The device/system must only be commissioned and operated by **qualified personnel**. Qualified persons are defined as persons who are authorized to commission, to ground, and to tag circuits, equipment, and systems in accordance with established safety practices and standards.

## Proper use

Please note the following:



**Alarm**

The equipment may only be used for single purpose applications explicitly described in the catalog and in the technical description and it may only be used along with third-party devices and components recommended by Siemens. This product can only function correctly and safely if it is transported, stored, set up, and installed correctly, and operated and maintained as recommended.

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Siemens AG
Automation and Drives
Industrial Automations
4848, 90327 Nuremberg
Germany

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# Foreword

## Information on the SINAMICS S documentation

The SINAMICS S documentation is divided into the following areas:

- General Documentation / Catalogs
- Manufacturer/service documentation
- Electronic documentation

This documentation is an integral part of the manufacturer/service documentation developed for SINAMICS. All documents can be obtained separately.

You can obtain detailed information about the documents named in the documentation overview and other documents available for SINAMICS from your local Siemens office.

For the sake of simplicity, this documentation does not contain all detailed information about all types of the product and cannot cover every conceivable case of installation, operation, or maintenance.

The contents of this documentation are not part of an earlier or existing agreement, a promise, or a legal agreement, nor do they change this. All obligations entered into by Siemens result from the respective contract of sale that contains the complete and sole valid warranty arrangements. These contractual warranty provisions are neither extended nor curbed as a result of the statements made in this documentation.

## Audience

This documentation is aimed at machine and plant builders, commissioning engineers, and service personnel who use SINAMICS.

## Objective

This manual describes the hardware components of the SINAMICS S system. It provides information about installation, electrical connection, and cabinet design.

## Technical support

If you have any questions, please get in touch with our Hotline:

**European and African time zones**

A&D Technical Support

Tel.: +49 (0) 180 5050 - 222

Fax: +49 (0) 180 5050 - 223

Internet: http://www.siemens.com/automation/support-request

E-mail: adsupport@siemens.com

**Asian and Australian time zones**

A&D Technical Support

Tel.: +86 1064 719 990

Fax: +86 1064 747 474

Internet: http://www.siemens.com/automation/support-request

E-mail: adsupport@siemens.com

**American time zone**

A&D Technical Support

Tel.: +1 423 262 2522

Fax: +1 423 262 2289

Internet: http://www.siemens.com/automation/support-request

E-mail: adsupport@siemens.com

**Note**

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

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

## Internet Address

Up-to-date information about our products can be found on the Internet at the following address:

http://www.siemens.com/motioncontrol

You can find information on SINAMICS S120 at:

http://www.siemens.com/sinamics

## ESD notices



**Caution**

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

Regulations for handling ESD components:

- When handling electronic components, you must ensure that the person carrying out the work, the work place, and packaging are properly grounded.
- Personnel in ESD areas with conductive flooring may only handle electronic components if:
- They are grounded with an ESD wrist band
- They are wearing ESD shoes or ESD shoe grounding straps
- Electronic boards should only be touched if absolutely necessary. They must only be handled on the front panel or, in the case of printed circuit boards, at the edge.
- Electronic boards must not come into contact with plastics or items of clothing containing synthetic fibers.
- Boards must only be placed on conductive surfaces (work surfaces with ESD surface, conductive ESD foam, ESD packing bag, ESD transport container).
- Do not place boards near display units, monitors, or television sets (minimum distance from screen: 10 cm).
- Measurements must only be taken on boards when the measuring instrument is grounded (via protective conductors, for example) or the measuring probe is briefly discharged before measurements are taken with an isolated measuring device (for example, touching a bare metal housing).

## Safety information



**Danger**

Commissioning shall not start until you have ensured that the machine in which the components described here are to be installed complies with Directive 98/37/EC.

SINAMICS S equipment must only be commissioned by suitably qualified personnel.

The personnel must take into account the information provided in the technical customer documentation for the product, and be familiar with and observe the specified danger and warning notices.

When electrical equipment and motors are operated, the electrical circuits automatically conduct a dangerous voltage.

Dangerous mechanical movements may occur in the system during operation.

All work on the electrical system must be carried out when the system has been disconnected from the power supply.



**Alarm**

Correct and safe operation of SINAMICS S equipment assumes correct transportation, storage, setup, and installation, as well as careful operation and maintenance.

The details in the catalogs and proposals also apply to the design of special equipment versions.

In addition to the danger and warning information provided in the technical customer documentation, the applicable national, local, and system-specific regulations and requirements must be taken into account.

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

**Note**

When operated in dry operating areas, SINAMICS equipment with three-phase motors conforms to low-voltage Directive 73/23/EEC.

SINAMICS equipment with three-phase motors conforms to EMC Directive 89/336/EEC in the configurations specified in the associated EC Certificate of Conformity.

**Caution**

Operating the equipment in the immediate vicinity (< 1.5 m) of mobile telephones with a transmitter power of > 1 W may lead to incorrect operation.

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# System Overview

# 1

## 1.1 The SINAMICS range of drives

### Application

SINAMICS is the new range of converters from Siemens designed for industrial mechanical and plant engineering applications. SINAMICS offers solutions for all drive tasks:

- Simple pump and fan applications in the process industry.
- Complex individual drives in centrifuges, presses, extruders, elevators, as well as conveyor and transport systems.
- Drive line-ups in textile, plastic film, and paper machines, as well as in rolling mill plants.
- Highly dynamic servo drives for machine tools, as well as packaging and printing machines.

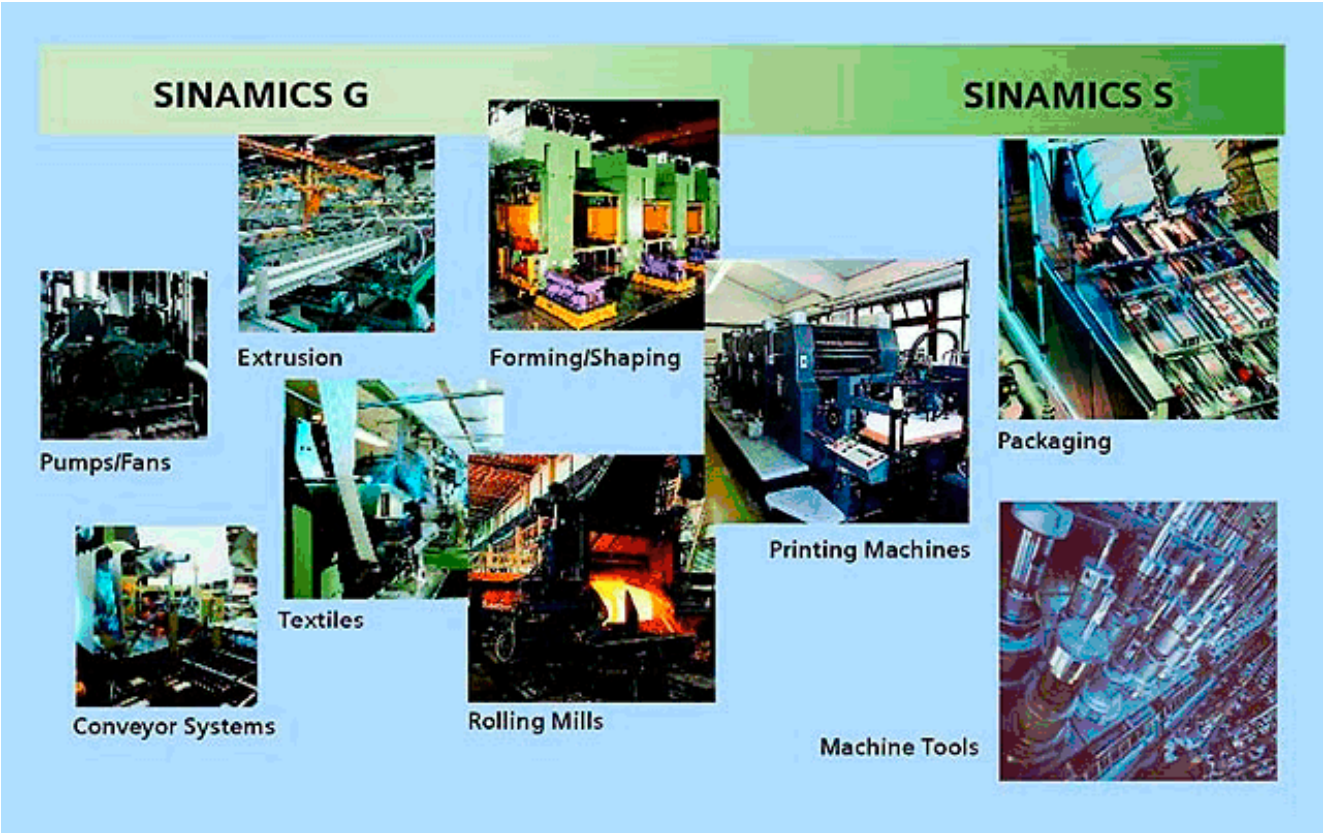



Fig. 1-1 SINAMICS applications

## Product variants

Depending on the application, the SINAMICS range offers the ideal version for any drive task.

- SINAMICS G is designed for standard applications with induction motors. These applications have less stringent requirements regarding the dynamics and accuracy of the motor speed.
- SINAMICS S handles complex drive tasks with synchronous/induction motors and fulfills stringent requirements regarding
  - Dynamics and accuracy,
  - Integration of extensive technological functions in the drive control system

## Platform concept and Totally Integrated Automation

All SINAMICS versions are based on a platform concept. Joint hardware and software components, as well as standardized tools for design, configuration, and commissioning tasks ensure high-level integration across all components. SINAMICS handles a wide variety of drive tasks with no system gaps. The different SINAMICS versions can be easily combined with each other.

SINAMICS is part of the Siemens "Totally Integrated Automation" concept. Integrated SINAMICS systems covering configuration, data storage, and communication at automation level ensure low-maintenance solutions with the SIMATIC, SIMOTION, and SINUMERIK control systems.

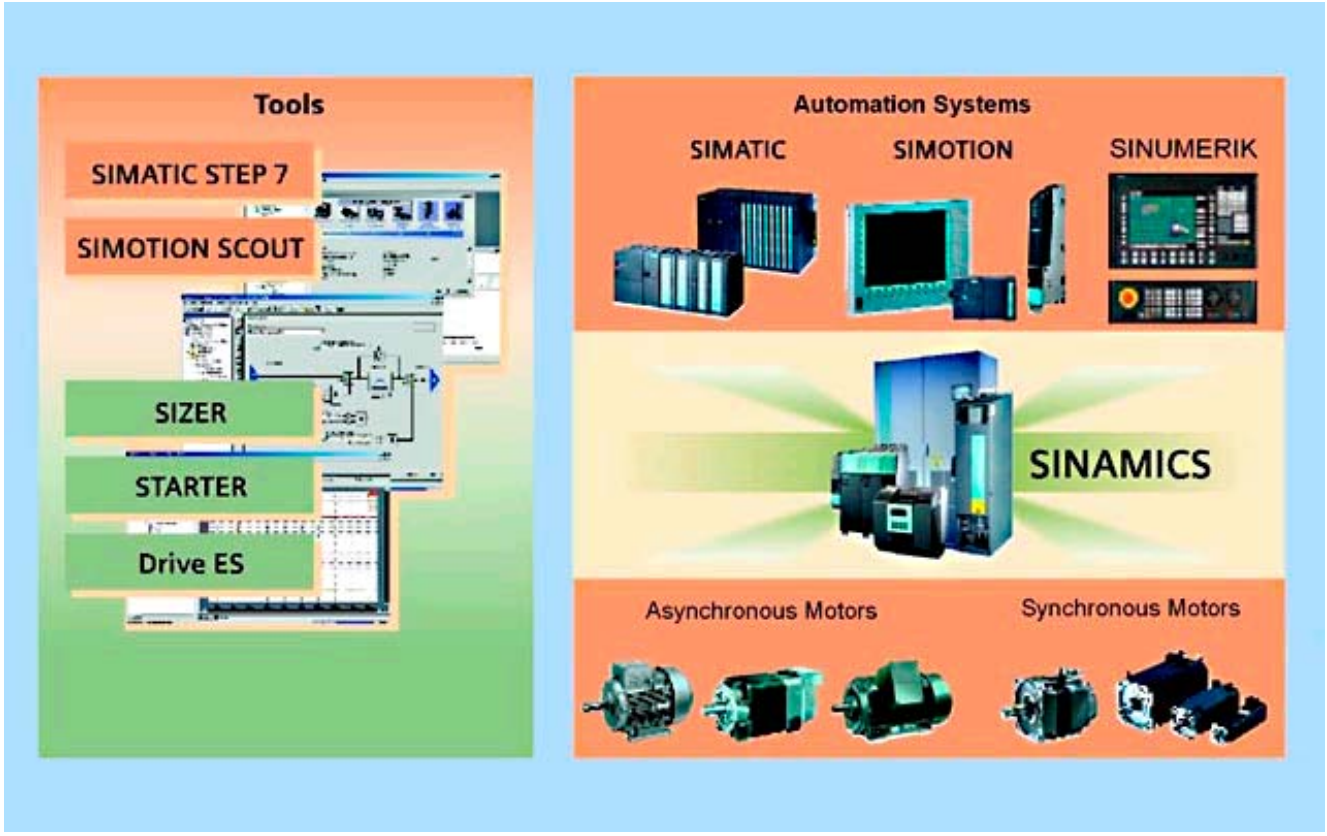



Fig. 1-2 SINAMICS as part of the Siemens modular automation concept

### Quality to DIN EN ISO 9001

SINAMICS is able to meet the highest requirements in terms of quality. Comprehensive quality assurance measures in all development and production processes ensure a consistently high level of quality.

Of course, our quality assurance system is certified by an independent authority to DIN EN ISO 9001.

### Universal applications

SINAMICS meets the requirements of relevant international standards and regulations - from the EN European standards through IEC to UL and cULus.

**Note**

A list of certified components is available on request from your local Siemens office.

## 1.2 SINAMICS S120 drive system

### Modular system for sophisticated drive tasks

SINAMICS S120 solves complex drive tasks for a wide range of industrial applications and is, therefore, designed as a modular system. Users can choose from many different harmonized components and functions to create a solution that best meets their requirements. SIZER, a high-performance engineering tool, makes it easier to choose and determine the optimum drive configuration. SINAMICS S120 is supplemented by a wide range of motors. Whether synchronous or asynchronous, all motor types are supported by SINAMICS S120.

### Particularly suitable for multi-axis applications

Coordinated drives that carry out drive tasks together are used in many mechanical and plant engineering applications, including running gears in gantry cranes, stretching systems in the textile industry, or paper machines and rolling mills. These require drives with a connected DC link, which allows cost-saving energy balancing between braking and driving axes.

SINAMICS S120 features Power Modules (AC-AC converters), Line Modules (infeed modules) and Motor Modules (inverter modules) covering a wide power range which, having been designed for seamless integration, pave the way for compact multi-axis drive configurations.

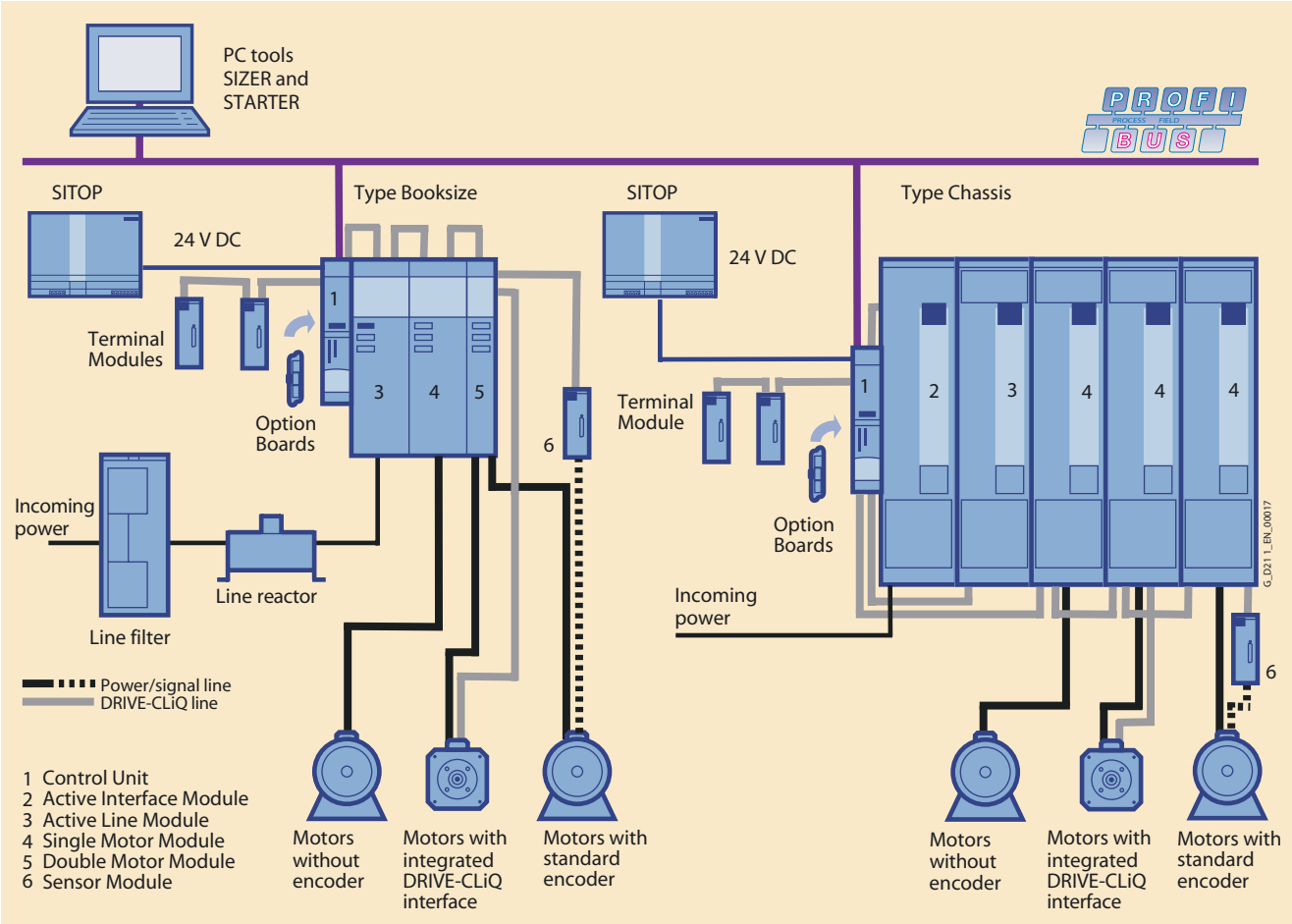



Fig. 1-3 Overview of the SINAMICS S120 system

## New system architecture with a central Control Unit

Electronically coordinated individual drives work together to perform your drive tasks. Higher-level controllers operate the drives to achieve the required coordinated movement. This requires cyclic data exchange between the control and all the drives. This exchange always had to take place via a field bus, which required a great deal of time and effort for installation and configuration. SINAMICS S120 takes a different approach. A central Control Unit controls the drive for all connected axes and also establishes the technological links between the drives and/or axes. Since all the required data is stored in the central Control Unit, it does not need to be transferred. Inter-axis connections can be established within a Control Unit and easily configured in the STARTER commissioning tool using a mouse.

Simple technological tasks can be carried out by the SINAMICS S120 Control Unit itself. For complex numerical or motion-control tasks, high-performance SIMOTION D modules are used instead.

## DRIVE-CLiQ – a digital interface between all components

All SINAMICS S120 components, including the motors and encoders, are interconnected via a joint serial interface called DRIVE-CLiQ. The standardized cables and connectors reduce the variety of different parts and cut storage costs.

Converter boards (sensor modules) for converting standard encoder signals to DRIVE-CLiQ are available for third-party motors or retrofit applications.

## Electronic type plates in all components

All SINAMICS S120 components with a DRIVE-CLiQ interface have an electronic rating plate This electronic type plate contains all the relevant technical data about that particular component. In the motors, for example, this data includes the parameters of the electric equivalent circuit diagram and characteristic values for the built-in motor encoder. The Control Unit records this data automatically via DRIVE-CLiQ so that it does not need to be entered during commissioning or when the equipment is replaced.

In addition to the technical data, the type plate includes logistical data (manufacturer ID, order number, and globally unique ID). Since this data can be called up electronically on site or remotely, all the components used in a machine can always be individually identified, which helps simplify servicing.

## SINAMICS S120 components

The SINAMICS S120 components are primarily used for multi-axis drive tasks.

The following power components are available:

- **Line-side power components**, such as fuses, contactors, line reactors and line filters for switching the power supply and complying with EMC regulations.
- **Power Modules** which function as both a power infeed and an inverter.
- **Line Modules**, which supply power centrally to the DC link.
- **DC link components** (optional), which stabilize the DC link voltage.
- **Motor Modules**, which act as inverters, receive power from the DC link, and supply the connected motors.
- **Motor-side power components**, such as motor reactors and dv/dt filters for reducing the voltage loads on the motor windings.

To carry out the required functions, SINAMICS S120 is equipped with:

- A **Control Unit** that carries out all drive and technological functions across all axes.
- **Supplementary system components** that enhance functionality and offer different interfaces for encoders and process signals.

The SINAMICS S120 components were developed for installation in cabinets. They have the following features and characteristics:

- Easy to handle, simple installation and wiring
- Practical connection system, cable routing in accordance with EMC requirements
- Standardized design, seamless integration.

## Boundary conditions for use

The Power Modules, Line Modules and Motor Modules are designed for connection to a liquid coolant circuit which must be provided by the customer.

The design of this liquid coolant circuit is an important factor in determining the operational reliability and service life of the equipment and the entire installation.

The main criteria are described in the following chapters.

# 1.3 Technical specifications

## Technical specifications

Unless explicitly specified otherwise, the following technical specifications are valid for all the following components of the SINAMICS S120 Liquid Cooled drive system.

Table 1-1 General technical specifications

| | |
|---|---|
| Electrical data | |
| Line connection voltage | 380 V 3 AC –10 % to 490 V 3 AC +10 % (-15 % < 1 min)<br>500 V 3 AC –10 % to 690 V 3 AC +10 % (-15 % < 1 min) |
| Line frequency | 47 Hz to 63 Hz |
| Output voltage | 0 to line connection voltage (depending on the infeed type) |
| Output frequency | 0 Hz to 300 Hz |
| Electronic power supply | 24 VDC (20.4 V - 28.8 V) |
| Short-circuit current rating SCCR in accordance with UL508C (up to 600 V) | • 1.1 kW - 298 kW: 42 kA<br>• 299 kW - 447 kW: 65 kA<br>• 448 kW - 671 kW: 84 kA<br>• 672 kW - 1193 kW: 170 kA<br>• >1194 kW: 200 kA |
| Radio interference suppression | Category C3 (environment 2) to EN 61800-3 |
| Overvoltage category | Class III to EN 60664-1 |
| Mechanical data | |
| Vibratory load<br>• Transportation [1]<br>• Operation | <br>• EN 60721-3-2, class 2M2<br>• Test values in accordance with EN 60068-2-6 test Fc:<br>– 10 to 58 Hz with constant deflection = 0.075 mm<br>– 58 to 200 Hz with constant acceleration = 9.81 m/s² (1 g) |
| Shock stressing<br>• Transportation [1]<br>• Operation | <br>• EN 60721-3-2, class 2M2<br>• Test values in accordance with EN 60068-2-27 test Ea:<br>98 m/s² (10 g) / 20 ms |
| Environmental requirements | |
| Degree of protection | IP00 acc. to EN 60529 |
| Protection Class | Class I (with protective conductor system) and class III (PELV) to EN 61800-5-1 |
| Cooling method | Liquid cooling |
| Cooling circuit (refer to Chapter 8)<br>• Max. system pressure with respect to atmosphere<br>• Pressure drop at rated volumetric flow<br>• Recommended pressure range<br>• Inlet temperature of liquid coolant | <br>• 600 kPa<br>• 70 kPa<br>• 80 kPa to 200 kPa<br>• Dependent on ambient temperature, no condensation permitted<br>– 0°C to + 45 °C without derating, >45 °C to + 50 °C see derating characteristics<br>– (antifreeze essential for temperature range between 0 °C and 5 °C; recommended antifreeze agent: "Antifrogen N" supplied by Clariant) |

[1] in packaging for transportation

| | |
|---|---|
| Permissible ambient temperature (air) in operation | • Dependent on inlet temperature of liquid coolant, no condensation permitted:<br>– 0 to 45 °C without derating<br>– > 45 °C to 50 °C refer to derating characteristics |
| Climatic ambient conditions | |
| • Storage [1]<br>• Transportation [1]<br>• Operation | • Class 1K3 acc. to EN 60721-3-1, temperature –40 °C to +70 °C<br>• Class 2K4 acc. to EN 60721-3-2, temperature –40 °C to +70 °C, max. air humidity 95 % at +40 °C<br>• Class 3K3 to EN 60721-3-3<br>Condensation, splashwater and ice formation are not permitted (EN 60204, Part 1) |
| Environmental class/harmful chemical substances | |
| • Storage [1]<br>• Transportation [1]<br>• Operation | • Class 1C2 to EN 60721-3-1<br>• Class 2C2 to EN 60721-3-2<br>• Class 3C2 to EN 60721-3-3 |
| Organic/biological influences | |
| • Storage [1]<br>• Transportation [1]<br>• Operation | • Class 1B1 to EN 60721-3-1<br>• Class 2B1 to EN 60721-3-2<br>• Class 3B1 to EN 60721-3-3 |
| Degree of pollution | 2 according to EN 61800-5-1<br>Appropriate measures (prevention of condensation and ingress of pollutants) must be taken by the customer to maintain the pollution level within tolerance. |
| **The Safety-Integrated safety function:**<br>The components must be protected against conducted contamination (e.g. by installing them in a cabinet with degree of protection IP54B to EN 60529).<br>Provided that conducted interference can be prevented at the installation site, the degree of protection for the cabinet can be decreased accordingly. | |
| Installation altitude | • ≤ 2000 m above sea level without derating<br>• > 2000 m above sea level, see derating characteristics |
| Certificates | |
| Conformity | CE (low-voltage and EMC Directives) |
| Approvals<br>(only up to 600 V 3 AC) | cULus (File Nos.: E192450), some approvals in preparation |

[1] in packaging for transportation

# 1.4 Structure of a drive system with SINAMICS S120 chassis liquid cooled

## 1.4.1 Structure of a drive system with SINAMICS S120 and Power Module

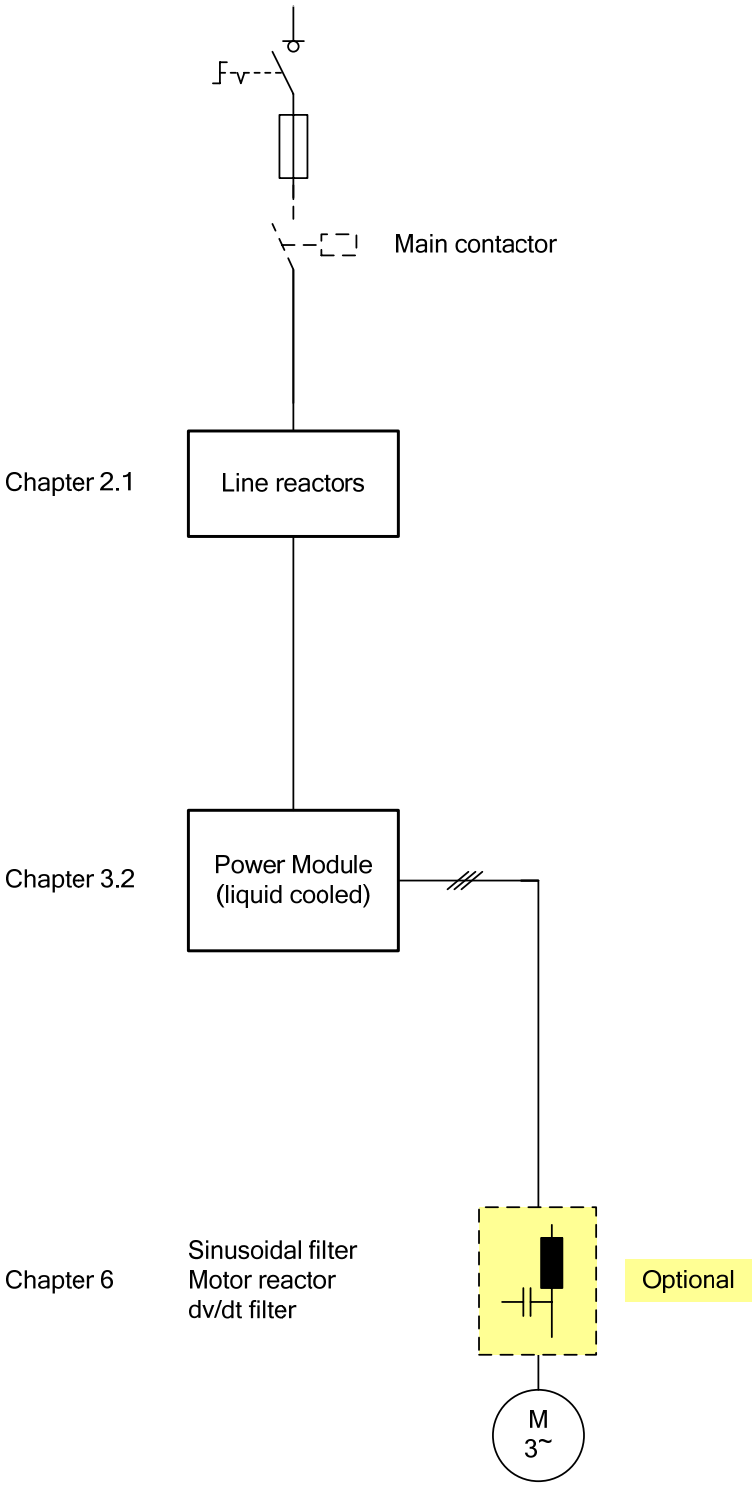



Fig. 1-4 Basic structure of a drive system with SINAMICS S120 and Power Module

## 1.4.2 Structure of a drive system with SINAMICS S120 and unregulated infeed

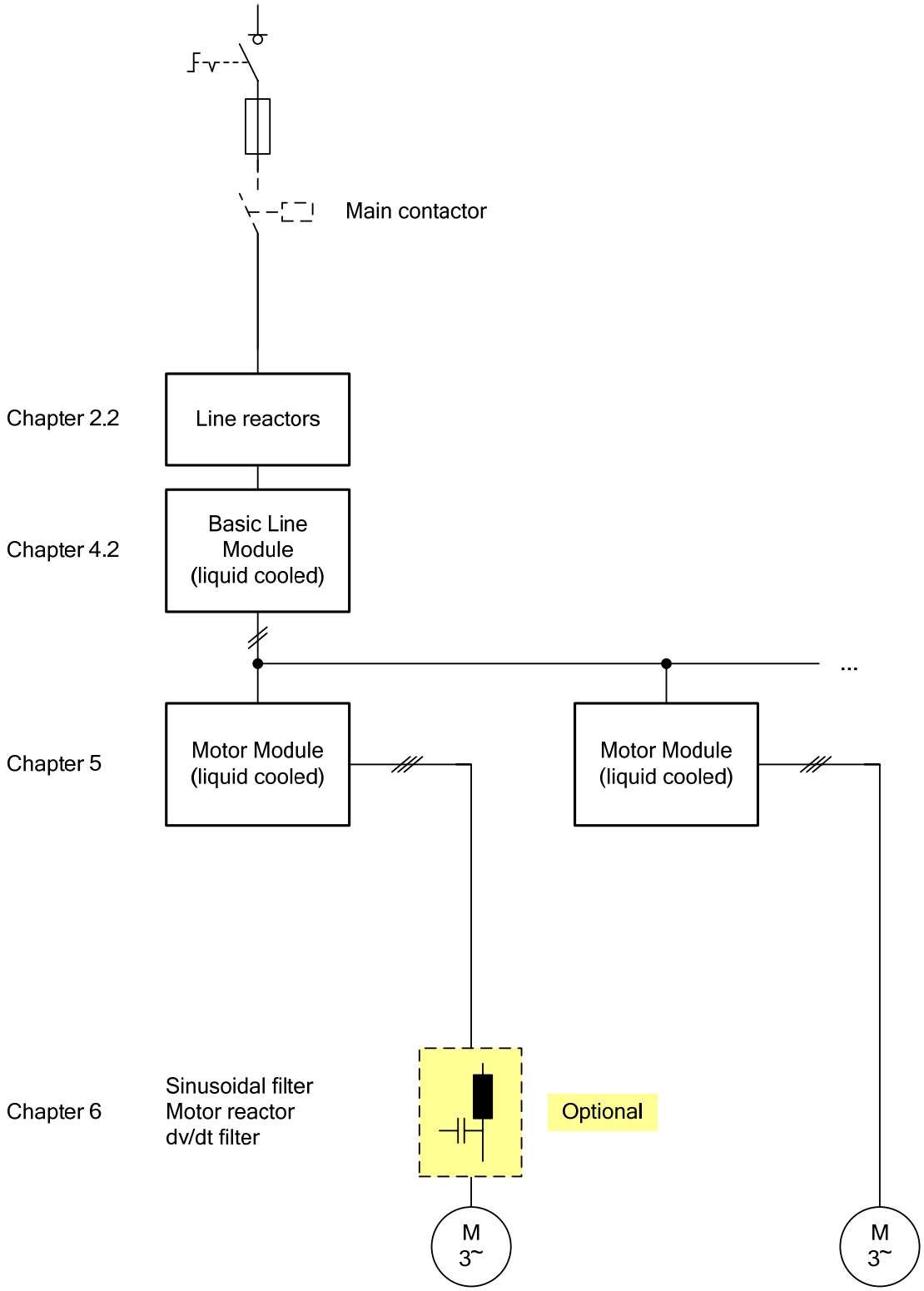



Fig. 1-5 Basic structure of a drive system with SINAMICS S120 (unregulated infeed)

# Line-Side Power Components

# 2

## 2.1 Line reactors for Power Modules

### 2.1.1 Description

The line reactors limit low-frequency line harmonics and relieve the semiconductors in the Power Modules. For this reason, line reactors must always be provided when Power Modules are used.

### 2.1.2 Safety information

**Caution**

The 100 mm clearances above and to the side of the components must be observed.

**Note**

The connection lines to the Power Module must be kept as short as possible (max. 5 m).

**Caution**

Using line reactors not approved by SIEMENS for SINAMICS:

- Can damage/destroy Power Module.

- Line harmonics that may interfere with or damage other loads connected to the same line supply.



**Caution**

The surface temperature of the line reactors may exceed 80 °C.

## 2.1.3 Dimension drawing

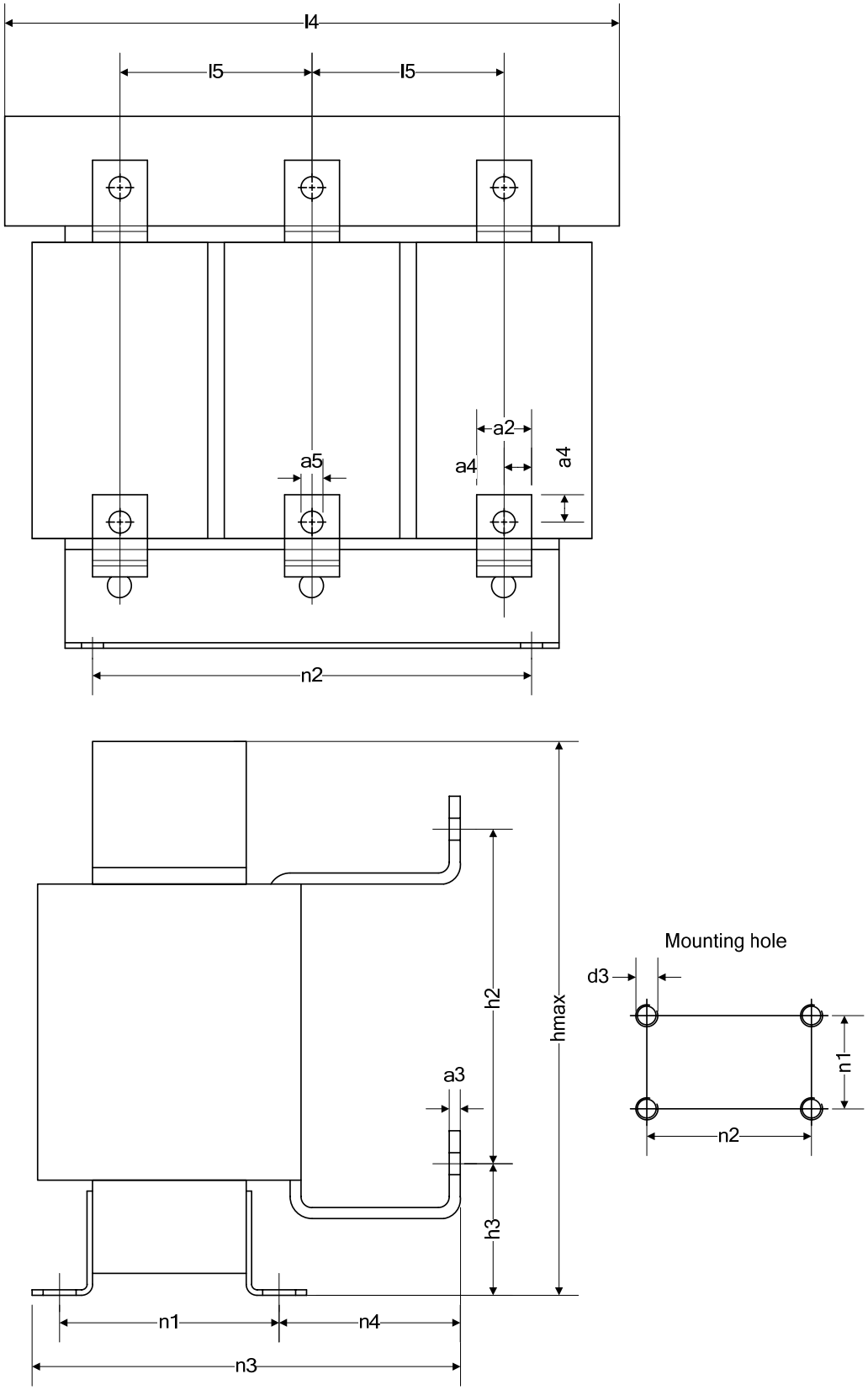



Fig. 2-1 Dimension drawing: Line reactor for Power Modules

Table 2-1 Dimensions of line reactors for Power Modules (all specifications in mm)

| 6SL3000- | 0CE32-3AA0 | 0CE32-8AA0 | 0CE33-3AA0 | 0CH35-1AA0 | |
|---|---|---|---|---|---|
| a2 | 25 | 25 | 25 | 30 | |
| a3 | 5 | 5 | 5 | 6 | |
| a4 | 12.5 | 12.5 | 12.5 | 15 | |
| a5 | 11 | 11 | 11 | 14 | |
| l4 | 270 | 270 | 270 | 300 | |
| l5 | 88 | 88 | 88 | 100 | |
| hmax | 248 | 248 | 248 | 269 | |
| h2 | 150 | 150 | 150 | 180 | |
| h3 | 60 | 60 | 60 | 60 | |
| n1 [1)] | 101 | 101 | 101 | 118 | |
| n2 [1)] | 200 | 200 | 200 | 224 | |
| n3 | 200 | 200 | 200 | 212.5 | |
| n4 | 84.5 | 84.5 | 84.5 | 81 | |
| d3 | M8 | M8 | M8 | M8 | |
| [1)] Dimensions n1 and n2 correspond to the drill hole spacing | | | | | |

## 2.1.4 Technical specifications

Table 2-2 Technical data of line reactors for Power Modules

| Order number | 6SL3000- | 0CE32-3AA0 | 0CE32-8AA0 | 0CE33-3AA0 | 0CH35-1AA0 | |
|---|---|---|---|---|---|---|
| Suitable for Power Module | 6SL3315- | 1TE32-1AA0 | 1TE32-6AA0 | 1TE33-1AA0 | 1TE35-0AA0 | |
| Rated power of the Power Modules | kW | 110 | 132 | 160 | 250 | |
| Rated voltage | V | 380 3 AC –10 % to 480 3 AC +10 % (-15 % < 1 min) | | | | |
| Rated current | A | 210 | 260 | 310 | 490 | |
| $I_{thmax}$ | A | 224 | 278 | 331 | 508 | |
| Power loss 50/60 Hz | kW | 0.243/0.274 | 0.219/0.247 | 0.236/0.267 | 0.323/0.365 | |
| Line supply/load connection | | M10 connecting lugs | M10 connecting lugs | M10 connecting lugs | M12 connecting lugs | |
| Degree of protection | | IP00 | IP00 | IP00 | IP00 | |
| Dimensions<br>Width<br>Height<br>Depth | <br>mm<br>mm<br>mm | <br>270<br>248<br>200 | <br>270<br>248<br>200 | <br>270<br>248<br>200 | <br>300<br>269<br>212.5 | |
| Weight | kg | 24.5 | 26 | 27.8 | 38 | |

# 2.2 Line reactors for Basic Line Modules

## 2.2.1 Description

Line reactors limit low-frequency reactions on the supply system and reduce the load on the semiconductors in the Basic Line Module. For this reason, line reactors must always be provided when Basic Line Modules are used.

## 2.2.2 Safety information

**Caution**

The 100 mm clearances above and to the side of the components must be observed.

**Note**

The connection lines to the Line Module must be kept as short as possible (max. 5 m).

**Caution**

Using line reactors not approved by SIEMENS for SINAMICS:

- Can damage/destroy Line Modules.

- Line harmonics that may interfere with or damage other loads connected to the same line supply.



**Caution**

The surface temperature of the line reactors may exceed 80 °C.

## 2.2.3 Dimension drawing

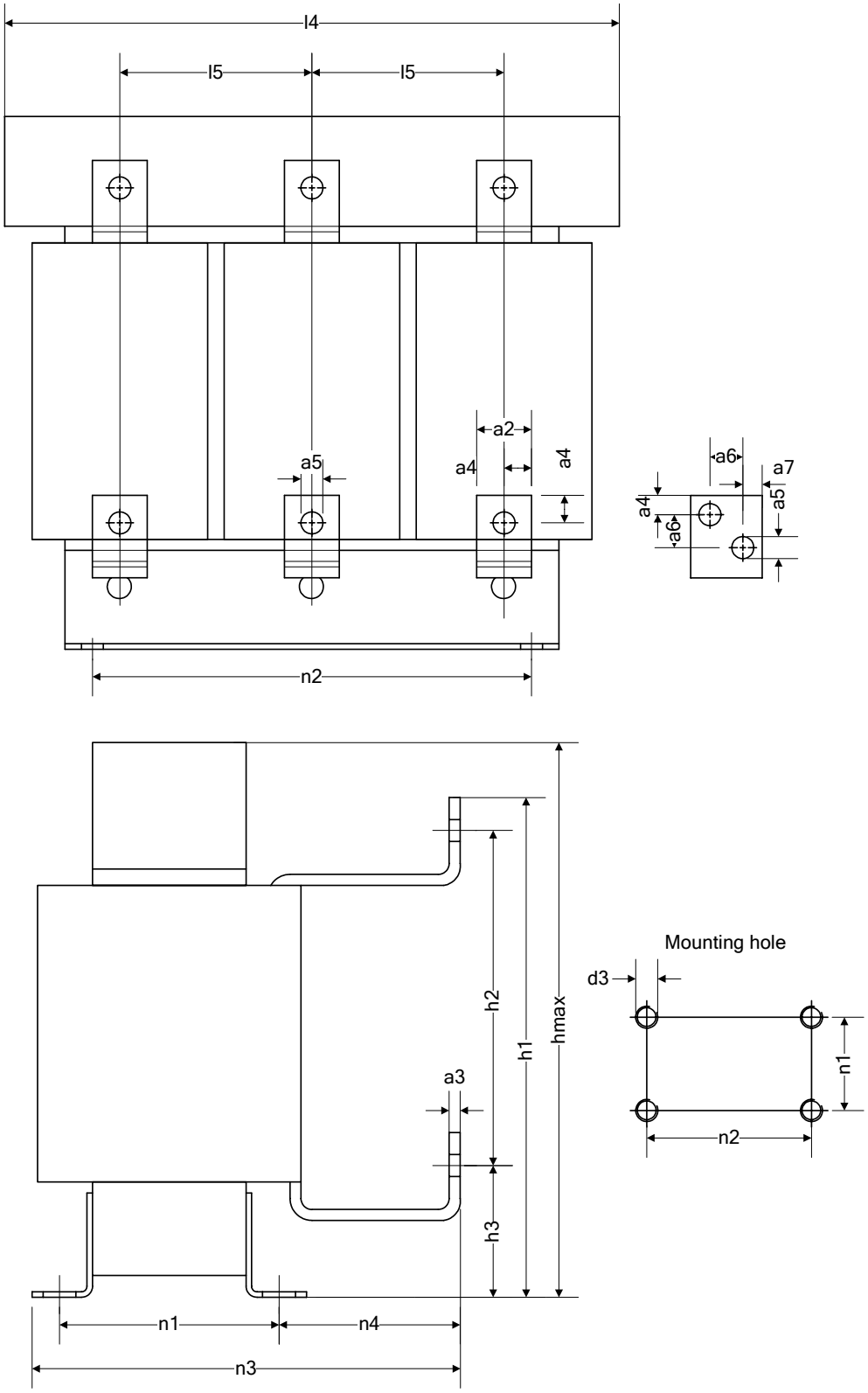



Fig. 2-2 Dimension drawing: line reactor for Basic Line Modules

Table 2-3 Dimensions of line reactors for Basic Line Modules (all specifications in mm)

| 6SL3000- | 0CE36-3AA0 | 0CE41-0AA0 | 0CH33-4AA0 | 0CH36-0AA0 | 0CH41-2AA0 | 0CH41-6AA0 |
|---|---|---|---|---|---|---|
| a2 | 30 | 50 | 25 | 30 | 60 | 60 |
| a3 | 6 | 8 | 5 | 6 | 12 | 12 |
| a4 | 15 | 25 | 12.5 | 15 | 25 | 25 |
| a5 | 14 | 14 | 11 | 14 | 14 | 18 x 14 |
| a6 | - | - | - | - | 26 | 26 |
| a7 | - | - | - | - | 17 | 17 |
| l4 | 300 | 350 | 270 | 350 | 460 | 445 |
| l5 | 100 | 120 | 88 | 120 | 152.5 | 152.5 |
| hmax | 269 | 321 | 248 | 321 | 435 | 435 |
| h1 | - | 397 | - | - | - | - |
| h2 | 180 | 252 | 150 | 198 | 278 | 278 |
| h3 | 60 | 120 | 60 | 75 | 120 | 120 |
| n1 [1)] | 118 | 138 | 101 | 138 | 155 | 170 |
| n2 [1)] | 224 | 264 | 200 | 264 | 356 | 356 |
| n3 | 212.5 | 211.5 | 200 | 232.5 | 235 | 250 |
| n4 | 81 | 60 | 84.5 | 81 | 60.5 | 60.5 |
| d3 | M8 | M8 | M8 | M8 | M12 | M12 |
| [1)] Dimensions n1 and n2 correspond to the drill hole spacing | | | | | | |

## 2.2.4 Technical specifications

Table 2-4 Technical specifications for line reactors for Basic Line Modules (380 V – 480 V 3 AC)

| Order number | 6SL3000- | 0CE36-3AA0 | 0CE41-0AA0 | | | |
|---|---|---|---|---|---|---|
| Suitable for Basic Line Module | 6SL3335- | 1TE37-4AA0 | 1TE41-2AA0 | | | |
| Rated power of the Basic Line Module | kW | 360 | 600 | | | |
| Rated voltage | V | 380 3 AC –10 % to 480 3 AC +10 % (-15 % < 1 min) | | | | |
| Rated current | A | 605 | 985 | | | |
| $I_{thmax}$ | A | 628 | 1022 | | | |
| Power loss 50/60 Hz | kW | 0.326/0.368 | 0.441/0.498 | | | |
| Line supply/load connection | | M12 connecting lugs | M12 connecting lugs | | | |
| Degree of protection | | IP00 | IP00 | | | |
| Dimensions<br>Width<br>Height<br>Depth | <br>mm<br>mm<br>mm | <br>300<br>269<br>212.5 | <br>350<br>321<br>211.5 | | | |
| Weight | kg | 41.4 | 69.6 | | | |

Table 2-5 Technical specifications for line reactors for Basic Line Modules (500 V – 690 V 3 AC)

| Order number | 6SL3000- | 0CH33-4AA0 | 0CH36-0AA0 | 0CH41-2AA0 | 0CH41-6AA0 | |
|---|---|---|---|---|---|---|
| Suitable for Basic Line Module | 6SL3335- | 1TG34-2AA0 | 1TG37-3AA0 | 1TG41-3AA0 | 1TG41-7AA0 | |
| Rated power of the Basic Line Module | kW | 355 | 630 | 1100 | 1370 | |
| Rated voltage | V | 500 3 AC –10 % to 690 3 AC +10 % (-15 % < 1 min) | | | | |
| Rated current | A | 330 | 575 | 1125 | 1600 | |
| $I_{thmax}$ | A | 342 | 597 | 1167 | 1600 | |
| Power loss 50/60 Hz | kW | 0.239/0.270 | 0.430/0.485 | 0.693/0.783 | 0.865/0.977 | |
| Line supply/load connection | | M12 connecting lugs | M12 connecting lugs | M12 connecting lugs | M12 connecting lugs | |
| Degree of protection | | IP00 | IP00 | IP00 | IP00 | |
| Dimensions<br>Width<br>Height<br>Depth | <br>mm<br>mm<br>mm | <br>270<br>248<br>200 | <br>350<br>321<br>232.5 | <br>460<br>435<br>235 | <br>445<br>435<br>250 | |
| Weight | kg | 38.9 | 63.8 | 147 | 134 | |

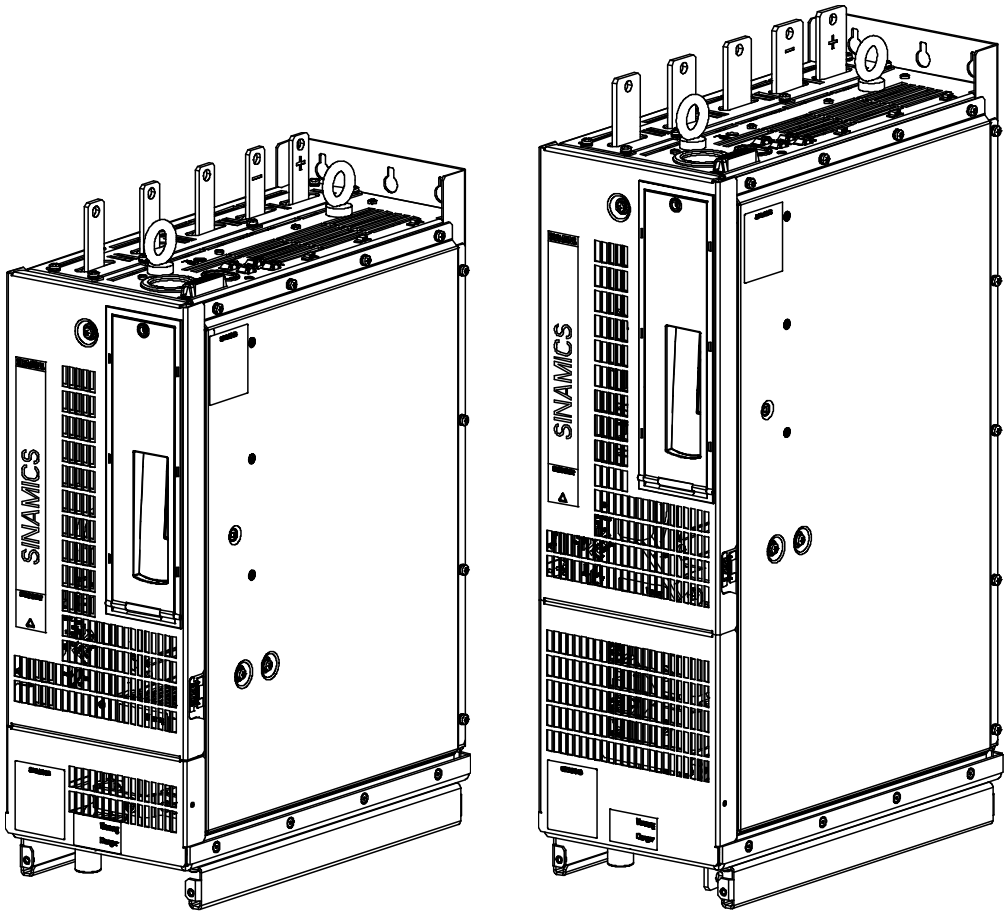
# Power Modules

# 3

## 3.1 Description

The drive line-up is connected to the power supply network via the Power Modules.

A Power Module is a power unit (frequency inverter) that provides the power supply for the connected motor. The power from the 3-phase system is supplied via the 6-pulse rectifier. The output inverter produces a 3-phase, variable-voltage, variable-frequency system. A Power Module must be connected to a Control Unit via DRIVE-CLiQ. The open-loop and closed-loop control functions are stored in the Control Unit.




Frame size FL Frame size GL

Fig. 3-1 Overview of Power Modules in chassis format

### Characteristics of the Power Modules

- Version for 380 V 3 AC to 480 V 3 AC from 210 A to 490 A
- Suitable for TN, TT, and IT supply systems
- Liquid cooling
- Short-circuit/ground-fault-proof
- Electronic rating plate
- Operating status and error status via LEDs
- DRIVE-CLiQ interface for communication with the Control Unit and/or other components in the drive line-up.
- Integration in system diagnostics
- The Power Modules communicate with the higher-level Control Unit via DRIVE-CLiQ. The Control Unit in this case could be a CU310 or CU320 or a SIMOTION D Control Unit.
- An external 24 V DC supply is required to operate liquid-cooled Power Modules.
- The correct line reactor must be connected in series to achieve category 3 EMC conformance in accordance with EN 61800.

The volumetric flow of the coolant is monitored by the software. If the volumetric flow is continuously lower than the setpoint, an alarm (A5005) is first displayed. If this alarm remains active continually for the next 5 minutes, a fault message (F30047) is activated which shuts down the unit.

The fans for the internal electronic circuitry are only switched on when required.

## 3.2 Safety information



**Warning**

A hazardous voltage will be present in the component for a further 5 minutes after the system has been shutdown. Work cannot be carried out until this time has elapsed.

Before starting work, you should also measure the voltage after the 5 minutes have elapsed! The voltage can be measured on DC link terminals DCP and DCN.



**Caution**

The DC link discharge time hazard warning must be affixed to the component in the local language.

**Notice**

The clearances above, below, and in front of the component, which are specified in the dimension drawings, must be observed.



**Warning**

Cable shields and unused power cable conductors must be connected to PE potential to prevent capacitive cross-talk charges.

Non-observance can cause lethal shock voltages.

**Caution**

The busbars and coolant connections which stick out of the module must never be used as handles or support surfaces when the units are transported.

# 3.3 Interface description

## 3.3.1 Overview

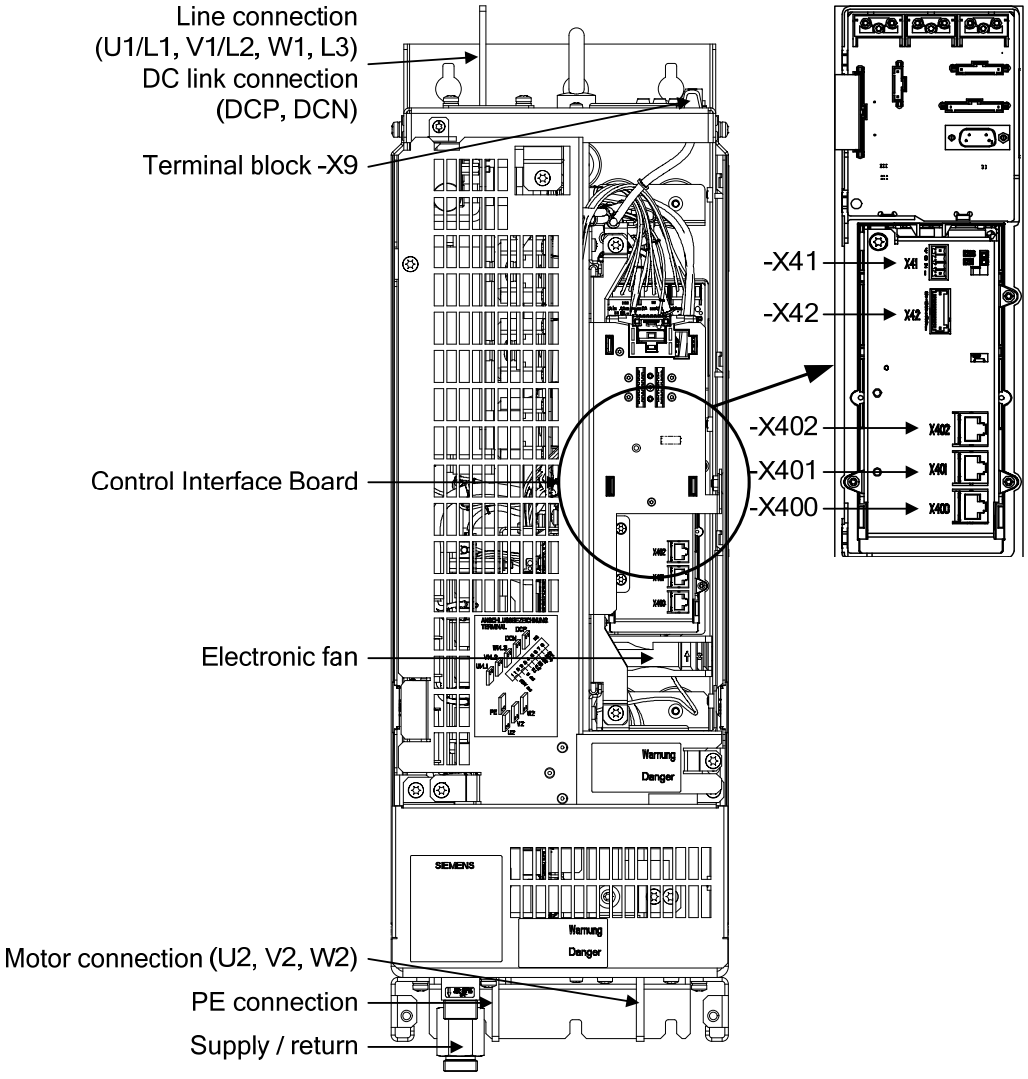



Fig. 3-2 Power Module, frame size FL

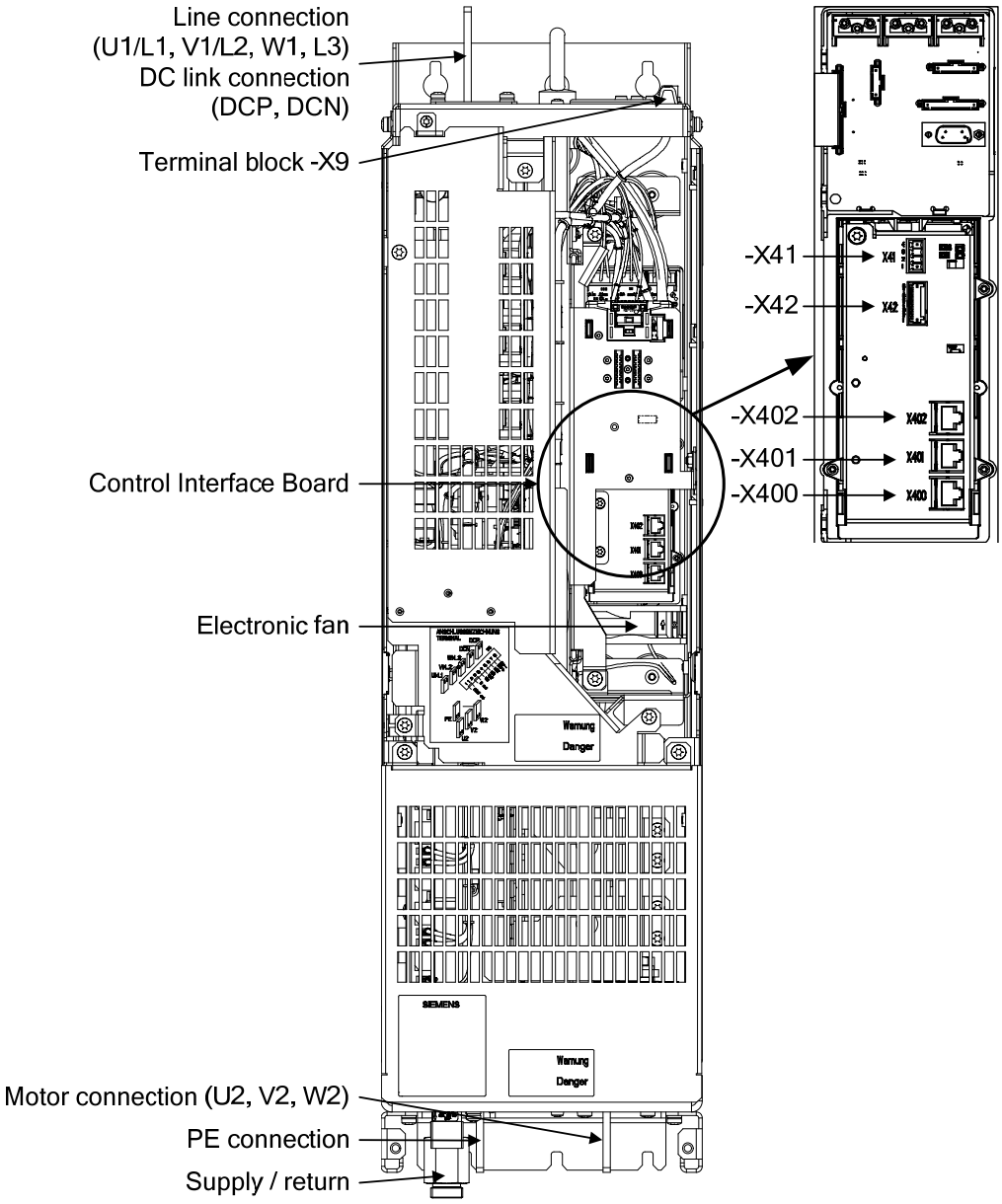



Fig. 3-3 Power Module, frame size GL

## 3.3.2 Connection example

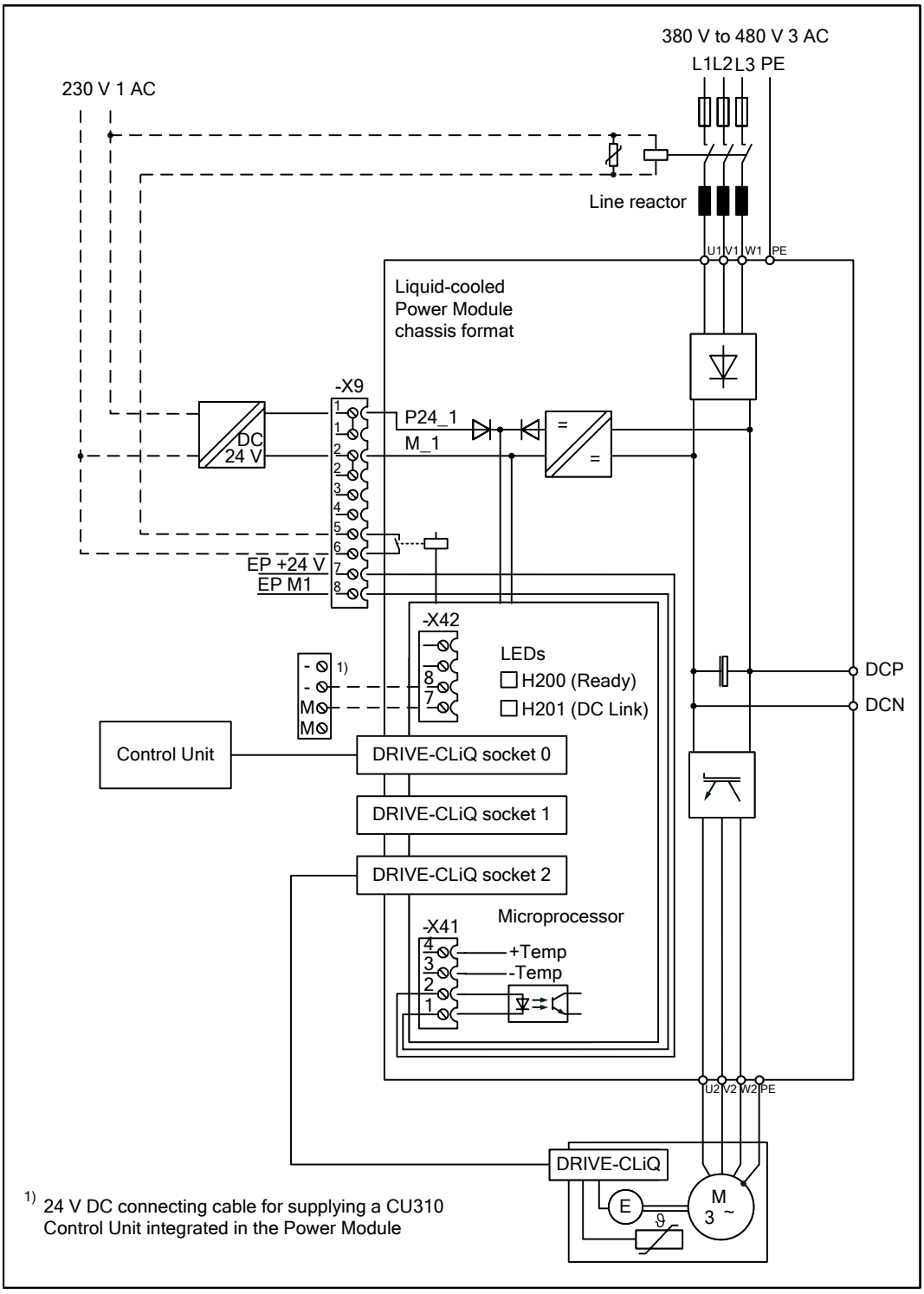



Fig. 3-4 Wiring diagram for the Power Module

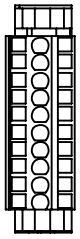
## 3.3.3 Line/DC link/motor connection

Table 3-1 Line/DC link/motor connection for Power Module

| Terminals | Technical specifications |
|---|---|
| U1/L1, V1/L2, W1/L3<br>3 AC power input | Voltage:<br>• 380 3 AC V to 480 V 3 AC<br>Connection lugs: d = 13 mm (M12 / 50 Nm) for ring cable lugs to DIN 46234 |
| DCP, DCN<br>DC link connection | Voltage:<br>• 1.35 x $U_{line}$<br>Connection lugs: d = 13 mm (M12 / 50 Nm) for ring cable lugs to DIN 46234 |
| U2, V2, W2<br>3 AC power output | Voltage:<br>• 0 V 3 AC to 0.72 x DC link voltage<br>Connection lugs: d = 13 mm (M12 / 50 Nm) for ring cable lugs to DIN 46234 |
| PE connection | Connection lugs: d = 13 mm (M12 / 50 Nm) for ring cable lugs to DIN 46234 |

## 3.3.4 Terminal block X9

Table 3-2 Terminal block X9

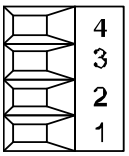
| | Terminal | Signal name | Technical specifications |
|---|---|---|---|
|  | 1 | P 24 V | Voltage: 24 V DC (20.4 V - 28.8 V)<br>Current input: see technical data (chapter 3.7) |
| | 2 | M | |
| | 3 | Reserved, do not use | |
| | 4 | | |
| | 5 | Main contactor control | 240 V AC: max. 8 A<br>30 V DC: max. 1 A |
| | 6 | | |
| | 7 | EP +24 V (Enable Pulses) | Supply voltage: 24 V DC (20.4 V - 28.8 V)<br>Current input: 10 mA<br>Signal propagation times:<br>L → H: 100 µs<br>H → L: 1000 µs |
| | 8 | EP M1 (Enable Pulses) | |
| Max. connectable cross-section 1.5 mm$^2$ | | | |

**Note**

When the STO (Safe Torque Off) or SS1 (Safe Stop 1) function is activated via terminals, a 24 V DC supply must be connected to terminal -X9:7 and terminal -X9:8 must be connected to ground. Upon removal, pulse suppression is activated.

## 3.3.5 Terminal block X41

Table 3-3 Terminal block X41

| | Terminal | Functions | Technical specifications |
|---|---|---|---|
|  | 4 | + Temp | Temperature sensor connection KTY84–1C130 / PTC |
| | 3 | - Temp | |
| | 2 | Reserved, do not use | Connected to terminal -X9:7 |
| | 1 | Reserved, do not use | Connected to terminal -X9:8 |
| Max. connectable cross-section 1.5 mm$^2$ | | | |

**Notice**

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

**Note**

A cable harness is used to connect terminals -X41:1 and -X41:2 to terminals -X9:8 and -X9:7.

## 3.3.6 Terminal block X42

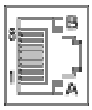
Reserved, do not use!

**Note**

The terminal strip supplies power to the CU310 Control Unit via a cable harness supplied with the device.

## 3.3.7 DRIVE-CLiQ interfaces X400-X402

Table 3-4 DRIVE-CLiQ interfaces X400-X402: Power Module

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

## 3.3.8 Cooling circuit connections

Table 3-5 Cooling circuit connections

| Connection | Technical specifications |
|---|---|
| Inlet, return | Screwed hose connection, male thread 3/4", flat sealing |
| Locked-rotor torque | 60 Nm |

**Note**

The seals for the screwed connections can be used only once when the cooling circuit is first assembled. The seals must be replaced if the circuit is disassembled and assembled again.

## 3.3.9 Meaning of the LEDs on the Control Interface Board in the Power Module

Table 3-6 Meaning of the LEDs on the control interface board in the Power Module

| LED state | | Description |
|---|---|---|
| H200 | H201 | |
| OFF | OFF | The electronics power supply is missing or lies outside permissible tolerance range. |
| Green | OFF | The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. |
| | Orange | The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.<br>The DC link voltage is present. |
| | Red | The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.<br>The DC link voltage is too high. |
| Orange | Orange | DRIVE-CLiQ communication is being established. |
| Red | --- | At least one fault is present in this component.<br>Note:<br>The LED is triggered independently from re-configuring the corresponding messages. |
| 0.5 Hz flashing light:<br>Green / red | --- | Firmware is being downloaded. |
| 2 Hz flashing light:<br>Green / red | --- | Firmware download is concluded. Wait for POWER ON. |
| 2 Hz flashing light:<br>Green orange or<br>red orange | --- | Component detection using LED is activated (p0124).<br>Note:<br>Both options depend on the LED status when component recognition is activated via p0124 = 1. |



**Warning**

Independent of the state of LED "H201", hazardous DC link voltages can always be available.

The warning information on the components must be carefully observed!

### Cause and rectification of faults

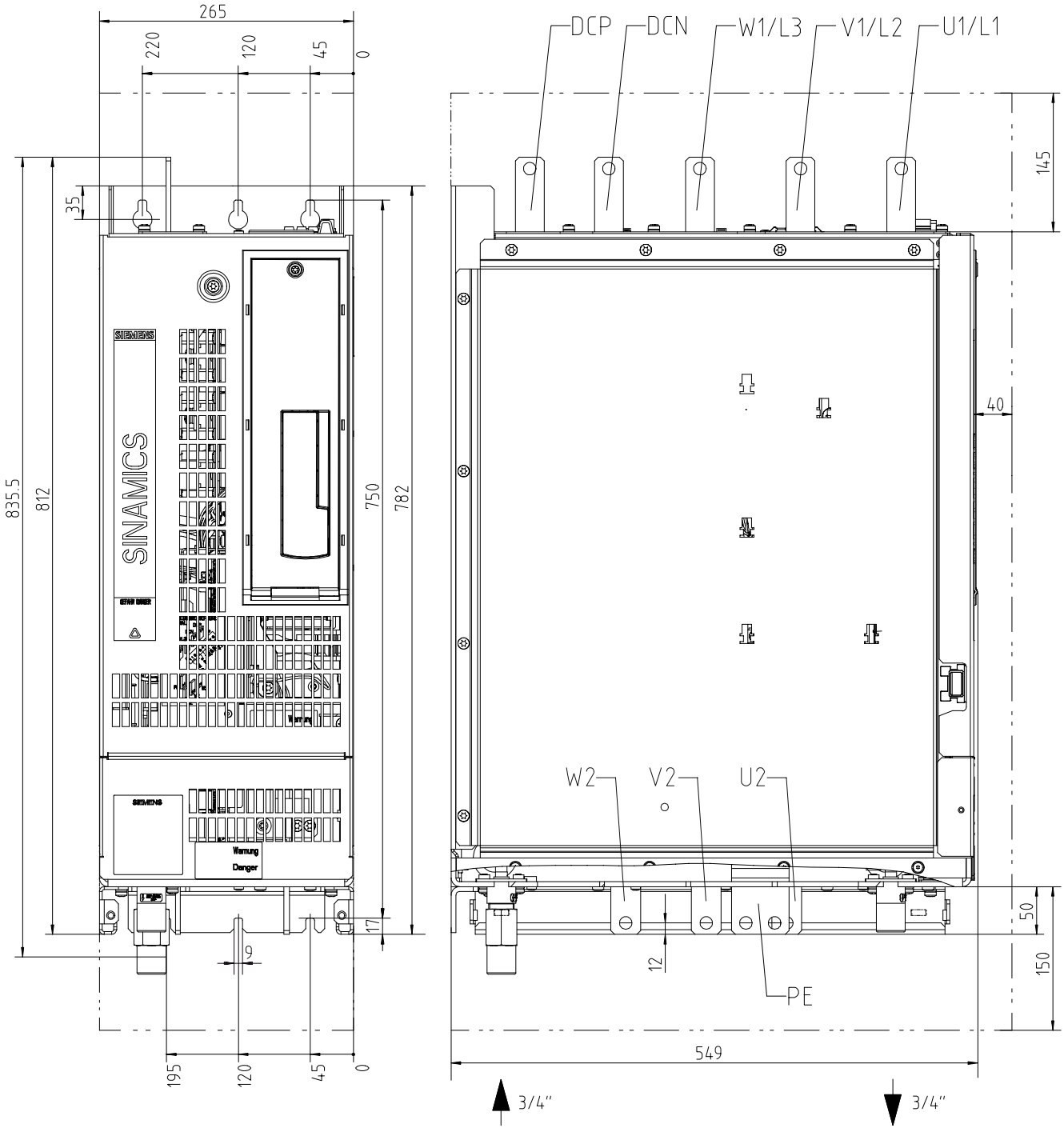
The following reference contains information about the cause and rectification of faults:

Reference: /IH1/ SINAMICS S120 Commissioning Manual

# 3.4 Dimension drawing

## Dimension drawing, frame size FL

The cooling clearances to be maintained are indicated by the dotted line.

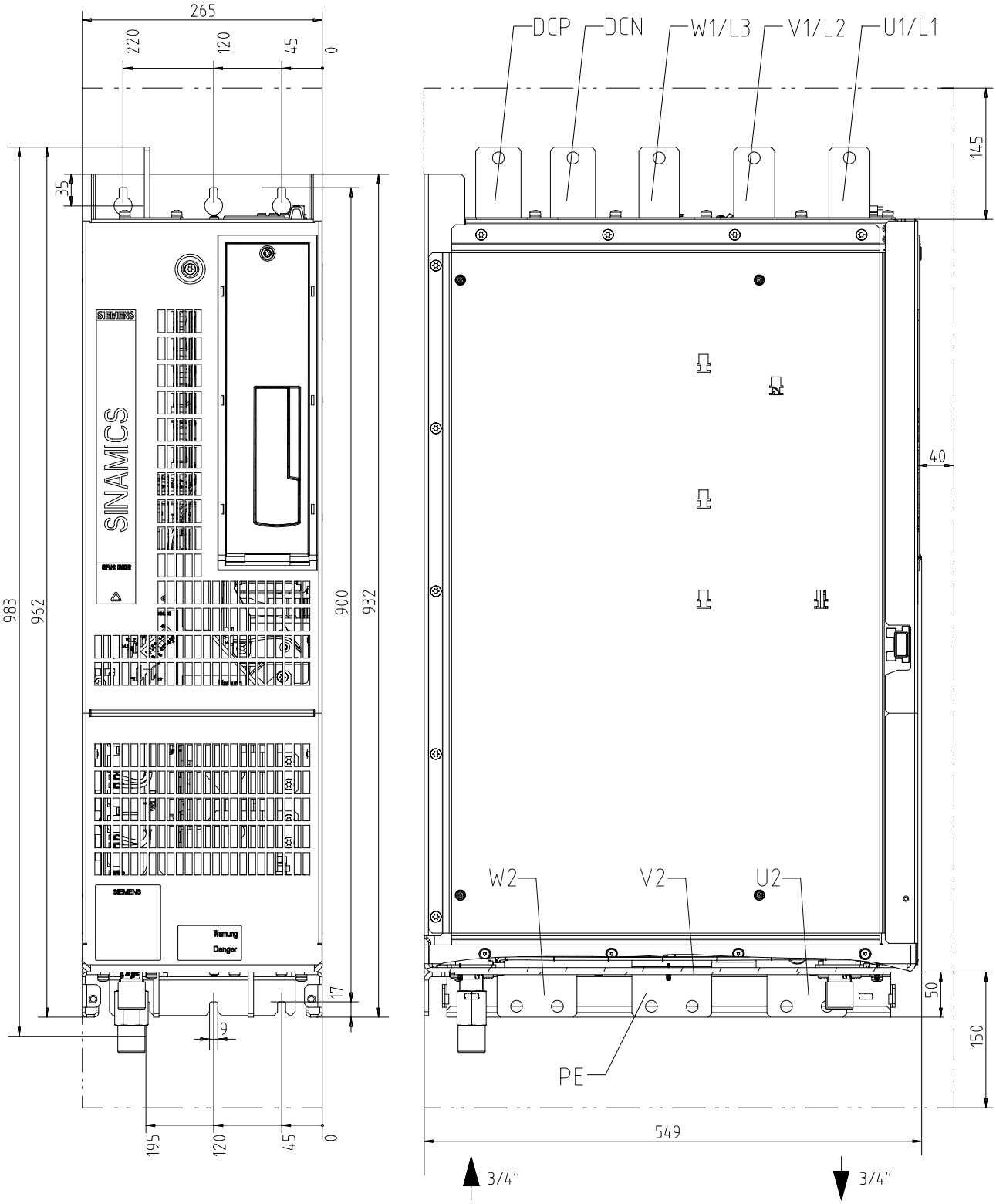



Front view Side view

Fig. 3-5 Dimension drawing of Power Module, frame size FL

## Dimension drawing, frame size GL

The cooling clearances to be maintained are indicated by the dotted line.




Front view Side view

Fig. 3-6 Dimension drawing of Power Module, frame size GL

# 3.5 Installation

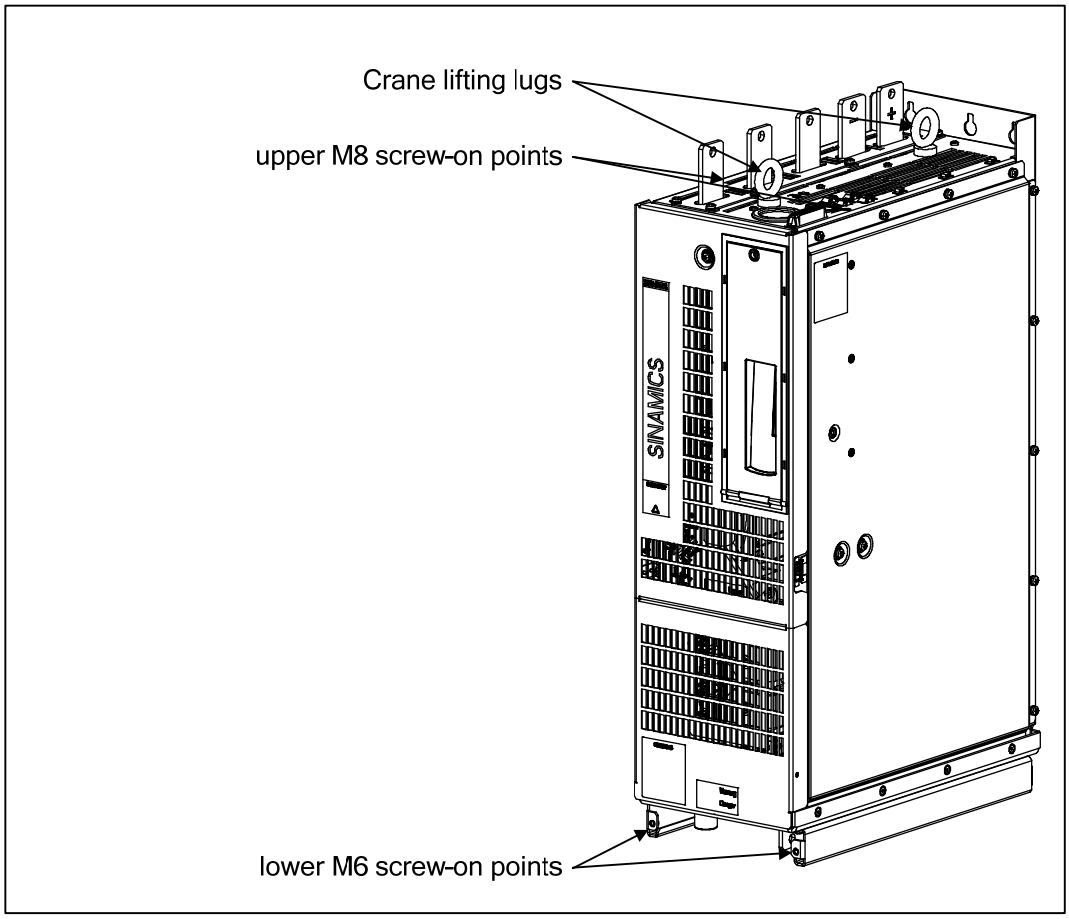



Fig. 3-7 Crane lifting lugs / screw coupling points for mechanical support

## Crane lifting lugs

Power Modules are fitted with crane lifting lugs as standard when shipped. The units can be hoisted from these lugs by a crane and transported from the pallet to the installation location.

**Note**

A thread for inserting a crane lifting lug is provided on the bottom of the Power Module. This allows the Power Module to be transported horizontally with a lifting harness.

**Warning**

A lifting harness with vertical ropes or chains must be used to prevent any risk of damage to the housing.

The crane lifting lugs must be removed after the modules have been installed. The lugs should be safely stored for future use.

## Screw coupling points for mechanical support

The Power Modules are provided with screw coupling points at the top and bottom so that they can be connected to modules mounted adjacently.

# 3.6 Electrical connection

## Operating a Power Module on an insulated network (IT)

When the device is operated on an insulated network (IT), the connection bracket for the interference-suppression capacitor must be removed.

To do so, loosen the two screws ("1" in Fig. 3-8) and remove the connection bracket. Once you have loosened the screws, turn the connection bracket to the side (to the right) first and then pull it forwards out of the unit.

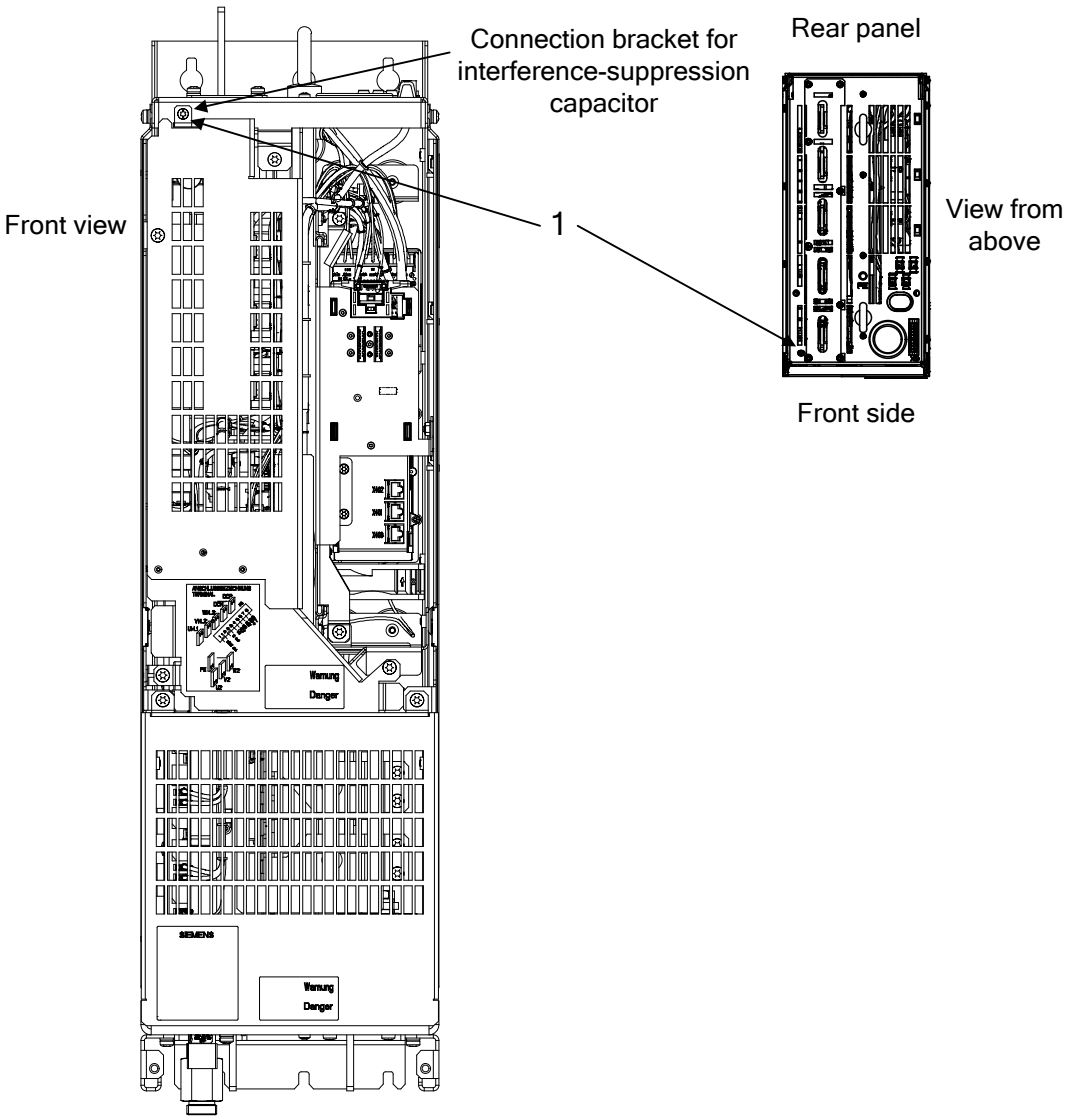



Fig. 3-8 Removing the connection bracket for the interference-suppression capacitor

**Warning**

Failing to remove the connection bracket for the interference-suppression capacitor on a non-grounded system/IT system can cause significant damage to the unit.

# 3.7 Technical specifications

Table 3-7 Technical specifications for Power Module (380 V – 480 V 3 AC)

| Order number | 6SL3315– | 1TE32-1AA0 | 1TE32–6AA0 | 1TE33–1AA0 | 1TE35–0AA0 |
|---|---|---|---|---|---|
| Rated output current $I_N$ | A | 210 | 260 | 310 | 490 |
| Base load current $I_L$ | A | 205 | 250 | 302 | 477 |
| Base load current $I_H$ | A | 178 | 233 | 277 | 438 |
| Max. output current $I_{max}$ | A | 307 | 375 | 453 | 715 |
| kVA rating [1] | kW | 110 | 132 | 160 | 250 |
| Power on basis of $I_H$ | kW | 90 | 110 | 132 | 160 |
| Rated input current | A | 230 | 285 | 338 | 537 |
| Line supply voltages<br>- Line voltage<br>- Line frequency<br>- Electronics power supply | <br>$V_{ACeff}$<br>Hz<br>$V_{DC}$ | <br>380 3 AC –10 % to 480 3 AC +10 % (-15 % < 1 min)<br>47 to 63 Hz<br>24 (20.4 – 28.8) | | | |
| DC link voltage | $V_{DC}$ | 1.35 x $U_{line}$ | | | |
| Output voltage | $V_{ACeff}$ | 0 to 0.72 x DC link voltage | | | |
| Rated pulse frequency | kHz | 2 | 2 | 2 | 2 |
| Max. pulse frequency without derating | kHz | 2 | 2 | 2 | 2 |
| Max. pulse frequency with derating | kHz | 8 | 8 | 8 | 8 |
| Electronics current drain (24 V DC) | A | 1.5 | 1.5 | 1.8 | 1.8 |
| Cooling type | | Liquid cooling with integrated stainless steel heat exchanger | | | |
| Power loss [2]<br>- Air / Coolant<br>- Total losses | <br>kW<br>kW | <br>0.06 / 2.45<br>2.51 | <br>0.07 / 3.09<br>3.16 | <br>0.09 / 3.43<br>3.52 | <br>0.14 / 5.49<br>5.63 |
| Max. coolant temperature:<br>- without derating<br>- with derating | <br>°C<br>°C | <br>45<br>50 | <br>45<br>50 | <br>45<br>50 | <br>45<br>50 |
| Cooling air requirement [3] | l/min | 9 | 9 | 12 | 12 |
| Liquid volume of integrated heat exchanger | dm³ | 0.52 | 0.52 | 0.88 | 0.88 |
| Typ. pressure drop with volumetric flow [4] | Pa | 70000 | 70000 | 70000 | 70000 |
| Sound pressure level | dB(A) | 52 | 52 | 52 | 52 |
| Line / DC link/motor connection | | Flange connection with screws M12 | | | |
| Max. connection cross-section<br>Line connection (U1/L1, V1/L2, W1/L3)<br>DC link connection (DCP, DCN)<br>Motor connection (U2, V2, W2)<br>PE connection | <br>mm²<br>mm²<br>mm²<br>mm² | <br>2 x 95<br>2 x 95<br>2 x 95<br>2 x 95 | <br>2 x 95<br>2 x 95<br>2 x 95<br>2 x 95 | <br>2 x 240<br>2 x 240<br>2 x 240<br>2 x 240 | <br>2 x 240<br>2 x 240<br>2 x 240<br>2 x 240 |
| Max. cable length | m | 300 (shielded) / 450 (unshielded) | | | |
| Schutzart | | IP00 | IP00 | IP00 | IP00 |
| Dimensions<br>Width<br>Height<br>Depth | <br>mm<br>mm<br>mm | <br>265<br>835.5<br>549 | <br>265<br>835.5<br>549 | <br>265<br>983<br>549 | <br>265<br>983<br>549 |
| Frame size | | FL | FL | GL | GL |
| Weight | kg | 77 | 77 | 108 | 108 |
| UL listed fuse [5]<br>Number (connected in parallel)<br>Rated current<br>Size acc. to DIN 43620-1 | | 3NE1 230-2<br>1<br>315<br>1 | 3NE1 331-2<br>1<br>350<br>1 | 3NE1 333-2<br>1<br>450<br>2 | 3NE1 230-2<br>2<br>315<br>1 |

[1] kVA rating refers to the rated motor power of a typical 6-pole motor supplied with 400 V.

[2] At rated pulse frequency

[3] This value applies to both coolant options, i.e. water and water / Antifrogen N mixture with 45 % Antifrogen N.

[4] This value applies to the water coolant option; for other coolant types, see Chapter 8.

[5] In order to build a UL-approved system, it is absolutely essential to use the specified fuses.

## 3.7.1 Overload capability

The Power Modules are equipped with an overload reserve e.g. to handle breakaway torques.

In drives with overload requirements, the appropriate base load current must, therefore, be used as a basis for the required load.

The criterion for overload is that the drive is operated with its base load current before and after the overload occurs (a load duration of 300 s is used as a basis here).

### Low overload

The base load current for low overload ($I_L$) is based on a load duty cycle of 110% for 60 s or 150% for 10 s.

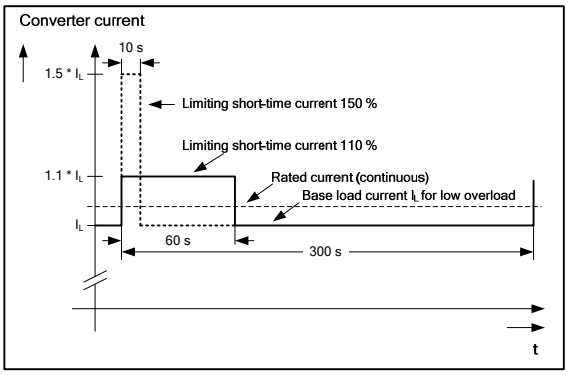



Fig. 3-9 Low overload

### High overload

The base load current for a high overload (IH) is based on a duty cycle of 150% for 60 s or 160% for 10 s.

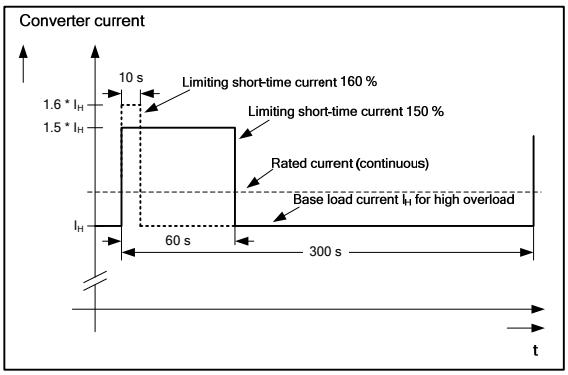



Fig. 3-10 High overload

## 3.7.2 Derating factors

### 3.7.2.1 Derating factors as a function of coolant temperature

SINAMICS S120 Liquid Cooled units are designed for cooling by $H_2O$ or by an $H_2O$ / Antifrogen N mixture. An $H_2O$ / Antifrogen N mixture must contain between 20 % and 45 % Antifrogen N.

When $H_2O$ is used as a coolant, the units can supply 100 % output current at temperatures between 5 °C and 45 °C, and 90 % output current at temperatures between 45 °C and 50 °C.

When the $H_2O$ / Antifrogen N mixture described above is used as a coolant, the units can supply 100 % output current at temperatures between 0 °C and 45 °C. The maximum output current decreases linearly to 90 % at temperatures between 45 °C and 50 °C.

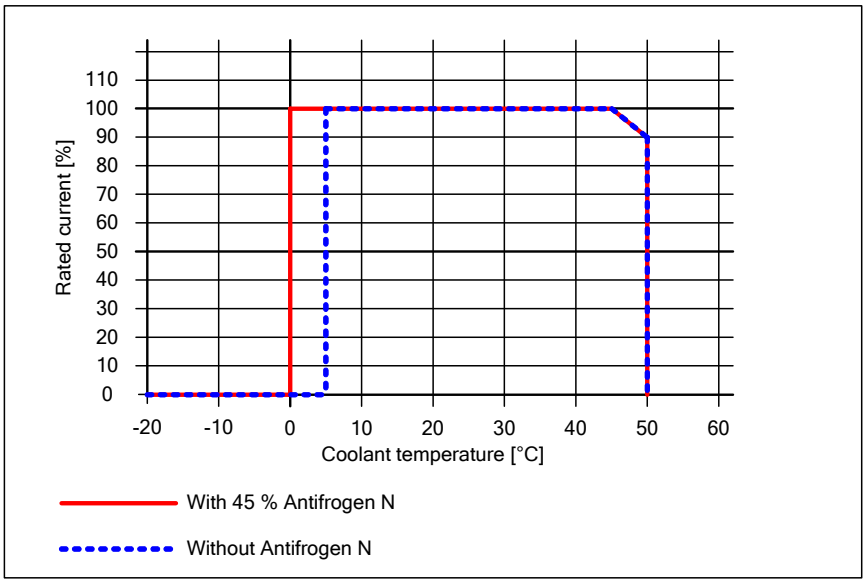



Fig. 3-11 Maximum output current as a function of coolant temperature

### 3.7.2.2 Derating factors as a function of ambient temperature

The units can supply 100 % output current at an ambient air temperature of between 0 °C and 45 °C. The maximum output current decreases linearly to 90 % at ambient air temperatures of between 45 °C and 50 °C.

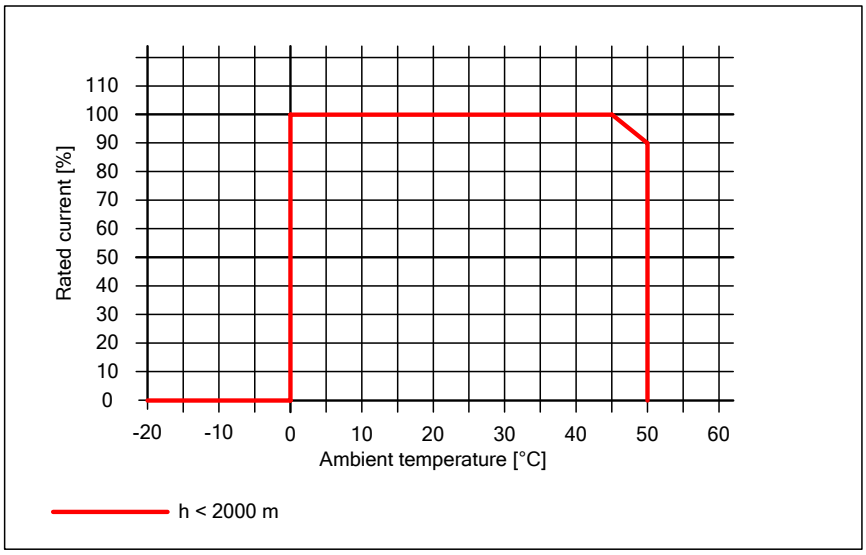



Fig. 3-12 Maximum output current as a function of ambient temperature

### 3.7.2.3 Derating factors as a function of installation altitude

When the units are operated at an installation altitude with reduced air pressure, the derating characteristic shown below applies to the output current or the ambient air temperature.

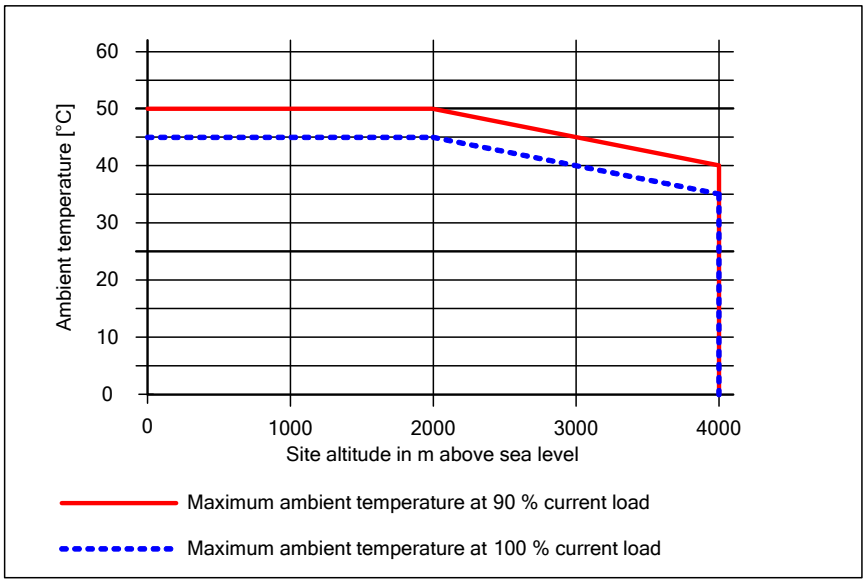



Fig. 3-13 Maximum ambient temperature as a function of installation altitude

### 3.7.2.4 Current derating as a function of pulse frequency

When the pulse frequency is increased, the derating factor of the output current must be taken into account.
This derating factor must be applied to the currents specified in the technical specifications in Table 3-7.

Table 3-8 Derating factor of the output current as a function of the pulse frequency for devices with a rated pulse frequency of 1.25 kHz

| Order no. 6SL3315-... | Power [kW] | Output current at pulse frequency of 2 kHz [A] | Derating factor at pulse frequency of 4 kHz | Derating factor at pulse frequency of 8 kHz |
|---|---|---|---|---|
| Supply voltage 380 – 480 V 3 AC | | | | |
| 1TE32-1AA0 | 110 | 210 | 82 % | 50 % |
| 1TE32-6AA0 | 132 | 260 | 83 % | 55 % |
| 1TE33-1AA0 | 160 | 310 | 88 % | 50 % |
| 1TE35-0AA0 | 250 | 490 | 78 % | 50 % |

**Note**

For pulse frequencies in the range between the specified fixed values, the relevant derating factors can be determined by linear interpolation.

# Line Modules

# 4

## 4.1 Introduction

The drive line-up is connected to the power supply network via the Line Modules.

Line Infeeds generate a DC voltage from the connected supply voltage that is then used to power the Motor Modules.

The Line and Interface Modules are suitable for direct operation on TN, IT, and TT systems.

### General characteristics of the Line Modules

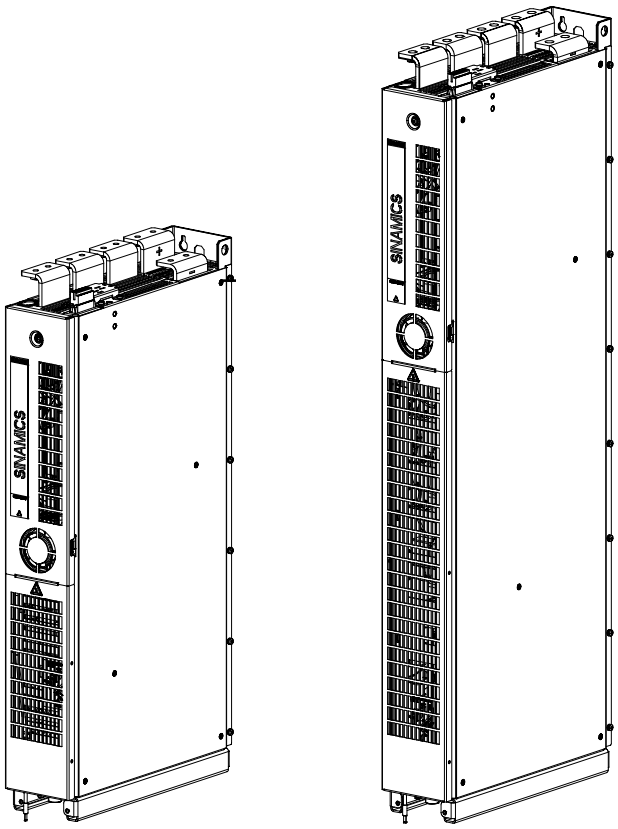
- Supply voltage:
  380 V 3 AC –10 % to 480 V 3 AC +10 % (-15 % < 1 min) (47 to 63 Hz)
  500 V 3 AC –10 % to 690 V 3 AC +10 % (-15 % < 1 min) (47 to 63 Hz)
- Suitable for TN, TT, and IT supply systems
- Operating status and error status via LEDs

# 4.2 Basic Line Modules

## 4.2.1 Description

Basic Line Modules supply power to the DC link.

They are suitable for applications in which no regenerative energy is present or in which energy is exchanged between the motor-side and regenerative axes in the DC link.




Frame size FBL Frame size GBL

Fig. 4-1 Overview of Basic Line Modules

### Principle of operation

One or more Motor Modules can be connected to the power supply network via the Basic Line Module. The Basic Line Module provides the DC link voltage for the Motor Modules.

The Basic Line Module is suitable for direct operation on TN, IT, and TT systems.

The volumetric flow of the coolant is monitored by the software. If the volumetric flow is continuously lower than the setpoint, an alarm (A5005) is first displayed. If this alarm remains active continually for the next 5 minutes, a fault message (F30047) is activated which shuts down the unit.

The fans for the internal electronic circuitry are only switched on when required.

## 4.2.2 Safety information



**Warning**

A hazardous voltage will be present in the component for a further 5 minutes after the system has been shutdown. Work cannot be carried out until this time has elapsed.

Before starting work, you should also measure the voltage after the 5 minutes have elapsed! The voltage can be measured on DC link terminals DCP and DCN.



**Caution**

The DC link discharge time hazard warning must be affixed to the component in the local language.

**Notice**

The clearances above, below, and in front of the component, which are specified in the dimension drawings, must be observed.

**Caution**

The busbars and coolant connections which stick out of the module must never be used as handles or support surfaces when the units are transported.

## 4.2.3 Interface description

### 4.2.3.1 Overview

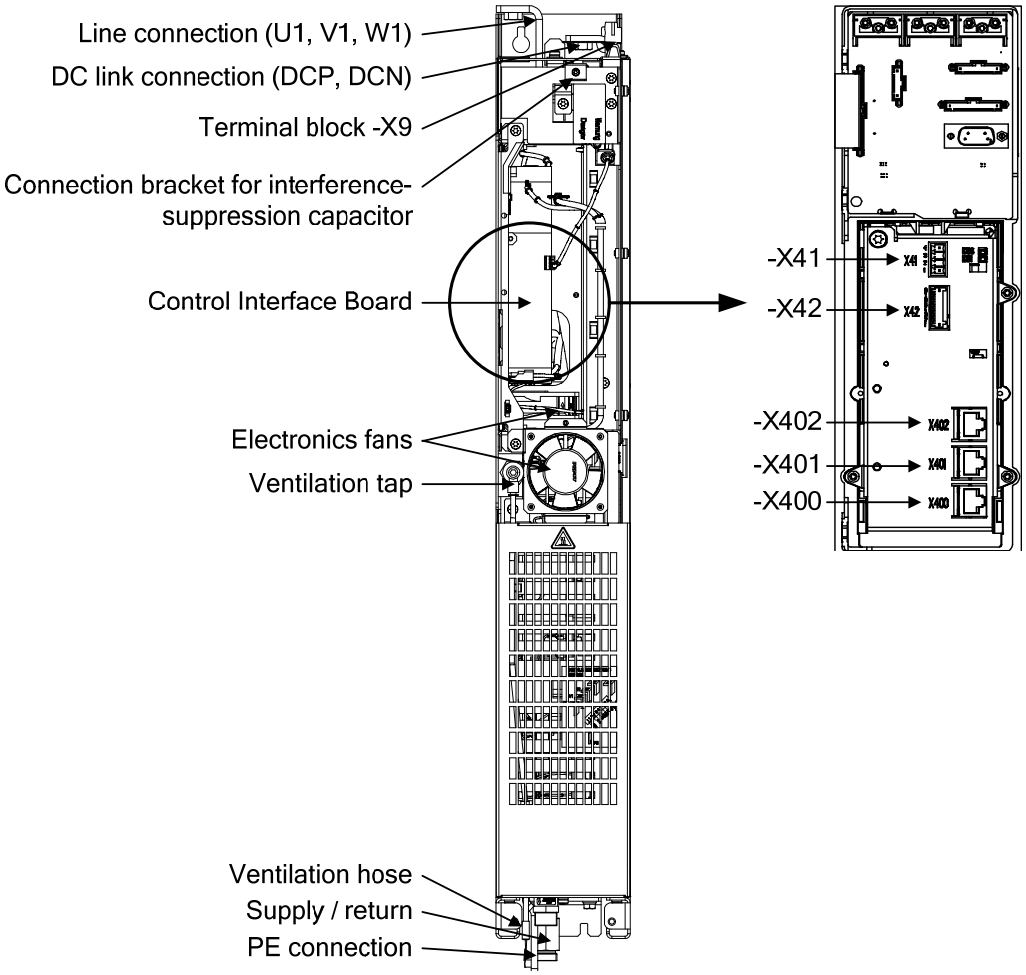



Fig. 4-2 Basic Line Module, frame size FBL

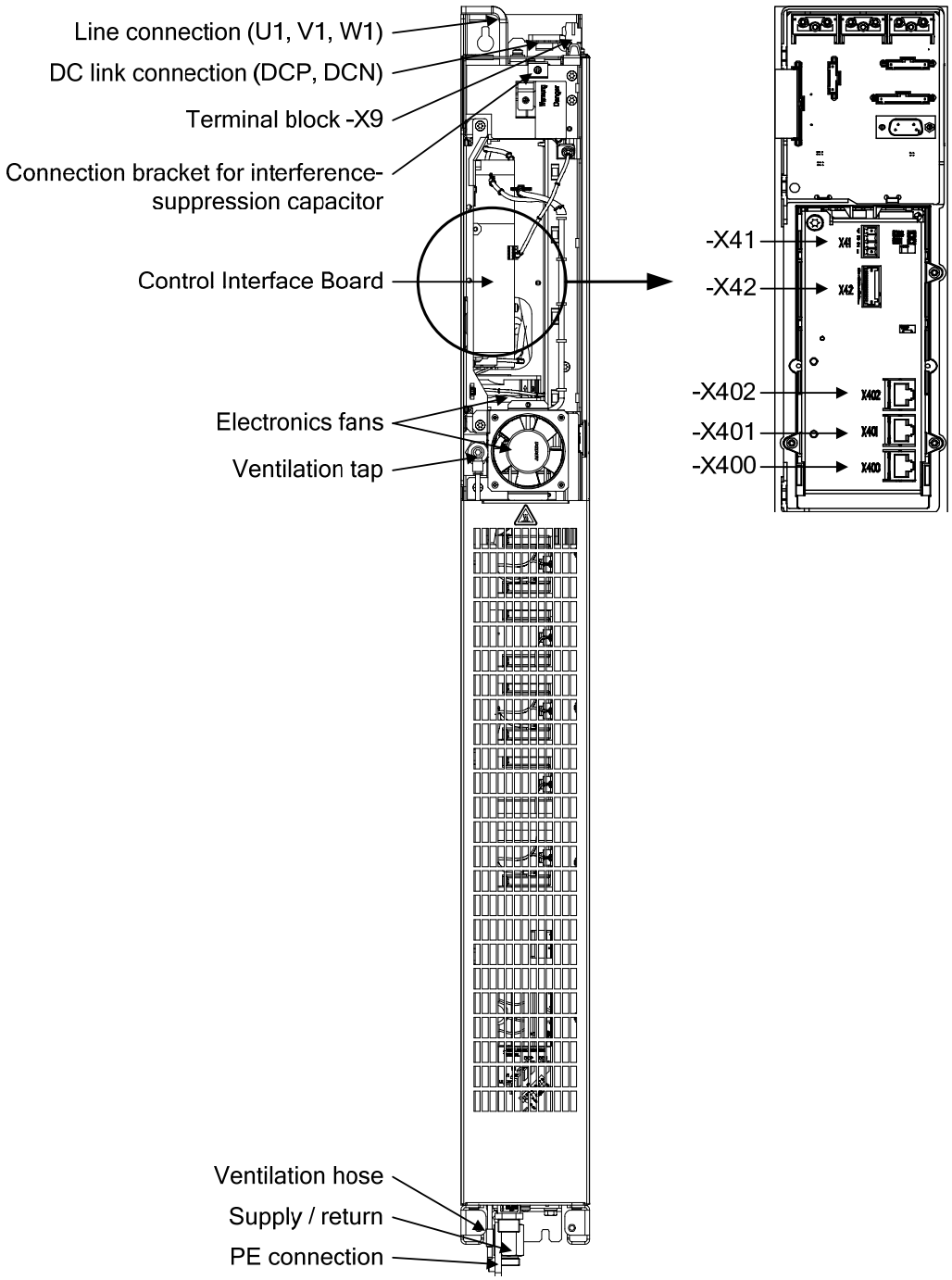



Fig. 4-3 Basic Line Module, frame size GBL

### 4.2.3.2 Connection example

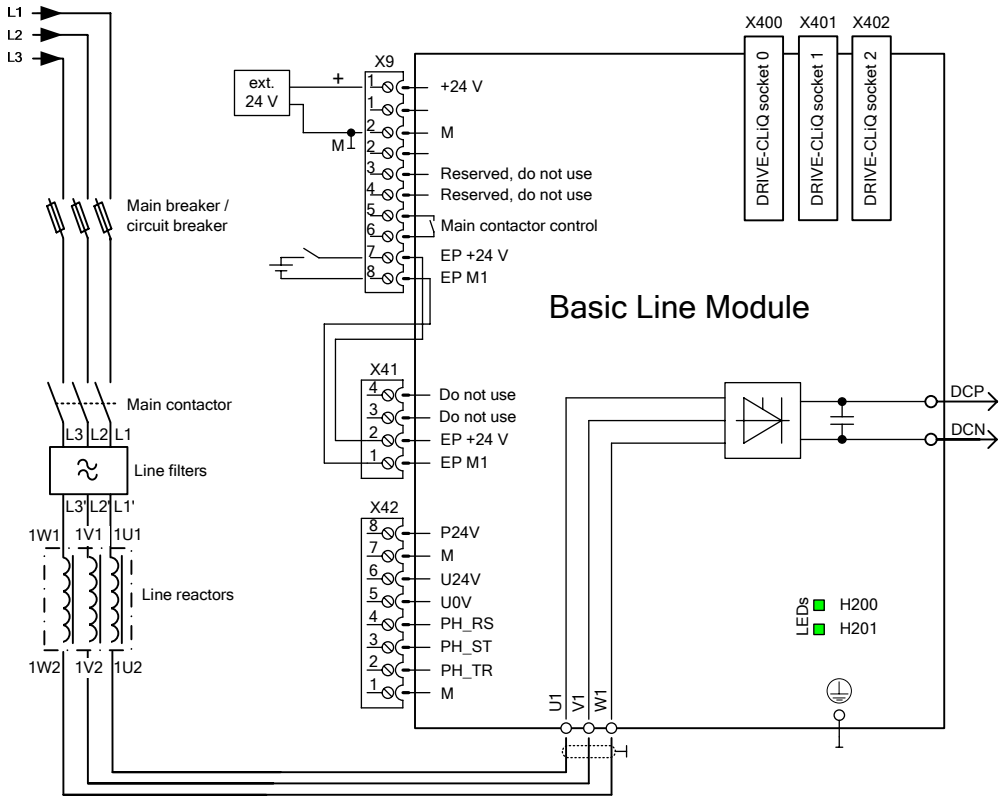



Fig. 4-4 Wiring diagram for the Basic Line Module

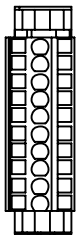
### 4.2.3.3 Line supply/load connection

Table 4-1 Line/load connection for the Basic Line Module

| Terminals | Technical specifications |
|---|---|
| U1, V1, W1<br>3 AC power input | Voltage:<br>• 380 V 3 AC –10 % to 480 V 3 AC +10 % (-15 % < 1 min)<br>• 500 V 3 AC –10 % to 690 V 3 AC +10 % (-15 % < 1 min)<br>Frequency: 47 Hz to 63 Hz<br>Connecting thread M12 / 50 Nm for ring cable lugs to DIN 46234 |
| DCP, DCN<br>DC power output | Voltage:<br>• 513 V to 648 V DC<br>• 675 V to 932 V DC<br>Connecting thread M12 / 50 for ring cable lugs to DIN 46234 |
| PE connection | Connecting thread M12 / 50 for ring cable lugs to DIN 46234 |

### 4.2.3.4 Terminal block X9

Table 4-2 Terminal block X9

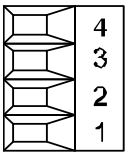
| | Terminal | Signal name | Technical specifications |
|---|---|---|---|
|  | 1 | P24 V | Voltage: 24 V DC (20.4 V – 28.8 V)<br>Current input: see technical data (chapter 4.2.7) |
| | 2 | M | |
| | 3 | Reserved, do not use | |
| | 4 | | |
| | 5 | Main contactor control | Voltage: 230 V AC |
| | 6 | | |
| | 7 | EP +24 V (Enable Pulses) | Supply voltage: 24 V DC (20.4 V – 28.8 V)<br>Current input: 10 mA<br>Signal propagation times:<br>L → H: 100 µs<br>H → L: 1000 µs |
| | 8 | EP M1 (Enable Pulses) | |
| Max. connectable cross-section 1.5 mm² | | | |

**Note**

For operation, 24 V DC must be connected to terminal 7 and ground to terminal 8. Upon removal, pulse inhibit is activated.

### 4.2.3.5 Terminal block X41

Table 4-3 Terminal block X41

| | Terminal | Functions | Technical specifications |
|---|---|---|---|
|  | 4 | Not used | |
| | 3 | Not used | |
| | 2 | Reserved, do not use | Connected to terminal -X9:7 |
| | 1 | Reserved, do not use | Connected to terminal -X9:8 |
| Max. connectable cross-section 1.5 mm² | | | |

**Note**

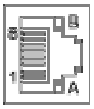
A cable harness is used to connect terminals -X41:1 and -X41:2 to terminals -X9:8 and -X9:7.

### 4.2.3.6 Terminal block X42

Reserved, do not use!

### 4.2.3.7 DRIVE-CLiQ interfaces X400, X401, X402

Table 4-4 DRIVE-CLiQ interfaces X400, X401, X402

| | PIN | Signal name | Technical specifications |
|---|---|---|---|
|  | 1 | TXP | Transmit data + |
| | 2 | TXN | Transmit data - |
| | 3 | RXP | Receive data + |
| | 4 | Reserved, do not use | |
| | 5 | Reserved, do not use | |
| | 6 | RXN | Receive data - |
| | 7 | Reserved, do not use | |
| | 8 | Reserved, do not use | |
| | A | + (24 V) | 24 V power supply |
| | B | GND (0 V) | Electronic ground |
| Blanking plate for DRIVE-CLiQ interface: Tyco, order no.: 969556-5 | | | |

### 4.2.3.8 Cooling circuit connections

Table 4-5 Cooling circuit connections

| Connection | Technical specifications |
|---|---|
| Inlet, return | Screwed hose connection, male thread 3/4", flat sealing |
| Locked-rotor torque | 60 Nm |

**Note**

The seals for the screwed connections can be used only once when the cooling circuit is first assembled. The seals must be replaced if the circuit is disassembled and assembled again.

### 4.2.3.9 Meaning of the LEDs on the Control Interface Board in the Basic Line Module

Table 4-6 Meaning of the LEDs on the control interface board in the Basic Line Module

| LED state | | Description |
|---|---|---|
| H200 | H201 | |
| OFF | OFF | The electronics power supply is missing or lies outside permissible tolerance range. |
| Green | OFF | The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. |
| | Orange | The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.<br>The DC link voltage is present. |
| | Red | The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.<br>The DC link voltage is too high. |
| Orange | Orange | DRIVE-CLiQ communication is being established. |
| Red | --- | At least one fault is present in this component.<br>Note:<br>The LED is triggered independently from re-configuring the corresponding messages. |
| 0.5 Hz flashing light:<br>Green / red | --- | Firmware is being downloaded. |
| 2 Hz flashing light:<br>Green / red | --- | Firmware download is concluded. Wait for POWER ON. |
| 2 Hz flashing light:<br>Green orange<br>or<br>red orange | --- | Component detection using LED is activated (p0124).<br>Note:<br>Both options depend on the LED status when component recognition is activated via p0124 = 1. |



**Warning**

Independent of the state of LED "H201", hazardous DC link voltages can always be available.

The warning information on the components must be carefully observed!

#### Cause and rectification of faults

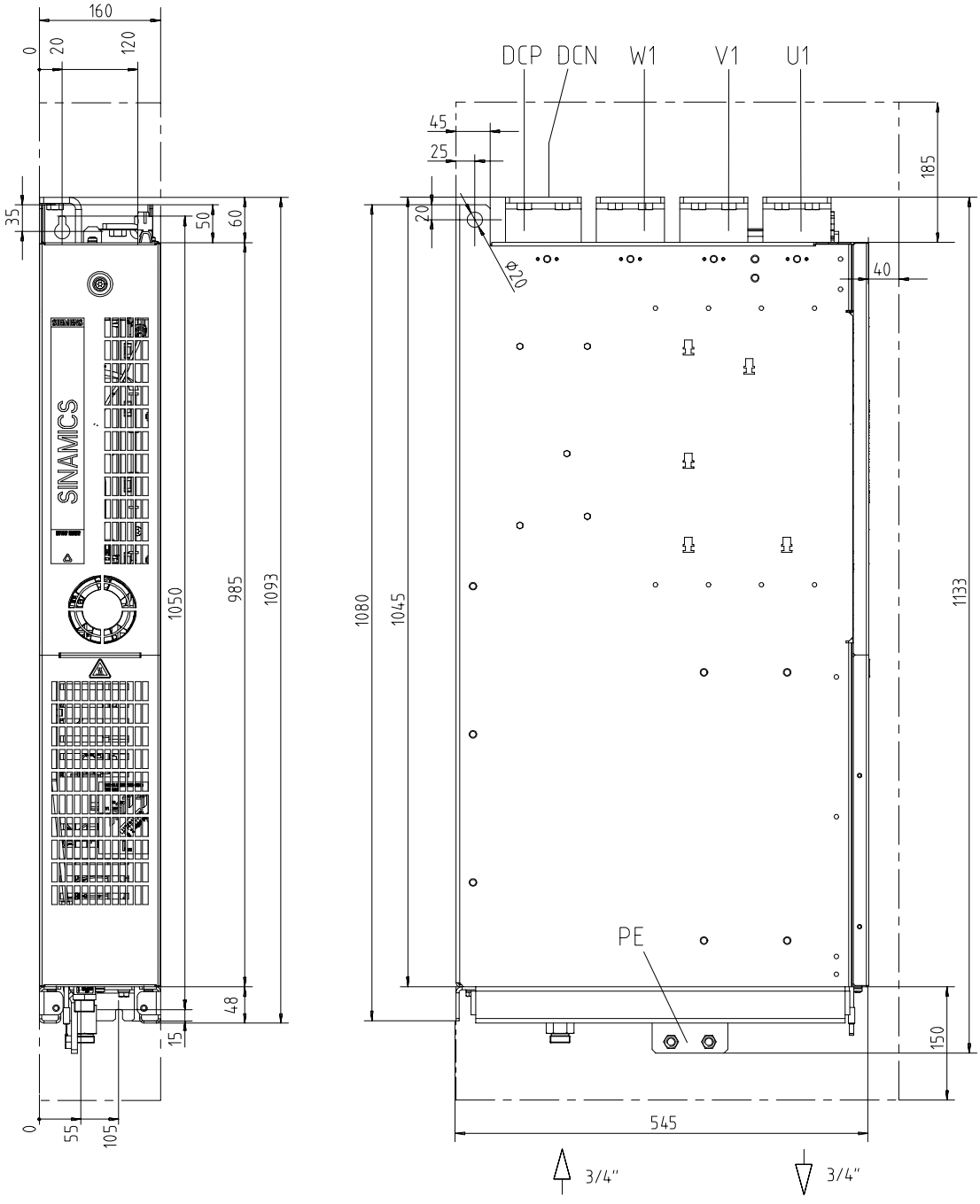
The following reference contains information about the cause and rectification of faults:

Reference: /IH1/ SINAMICS S120 Commissioning Manual

## 4.2.4 Dimension drawing

### Dimension drawing, frame size FBL

The cooling clearances to be maintained are indicated by the dotted line.

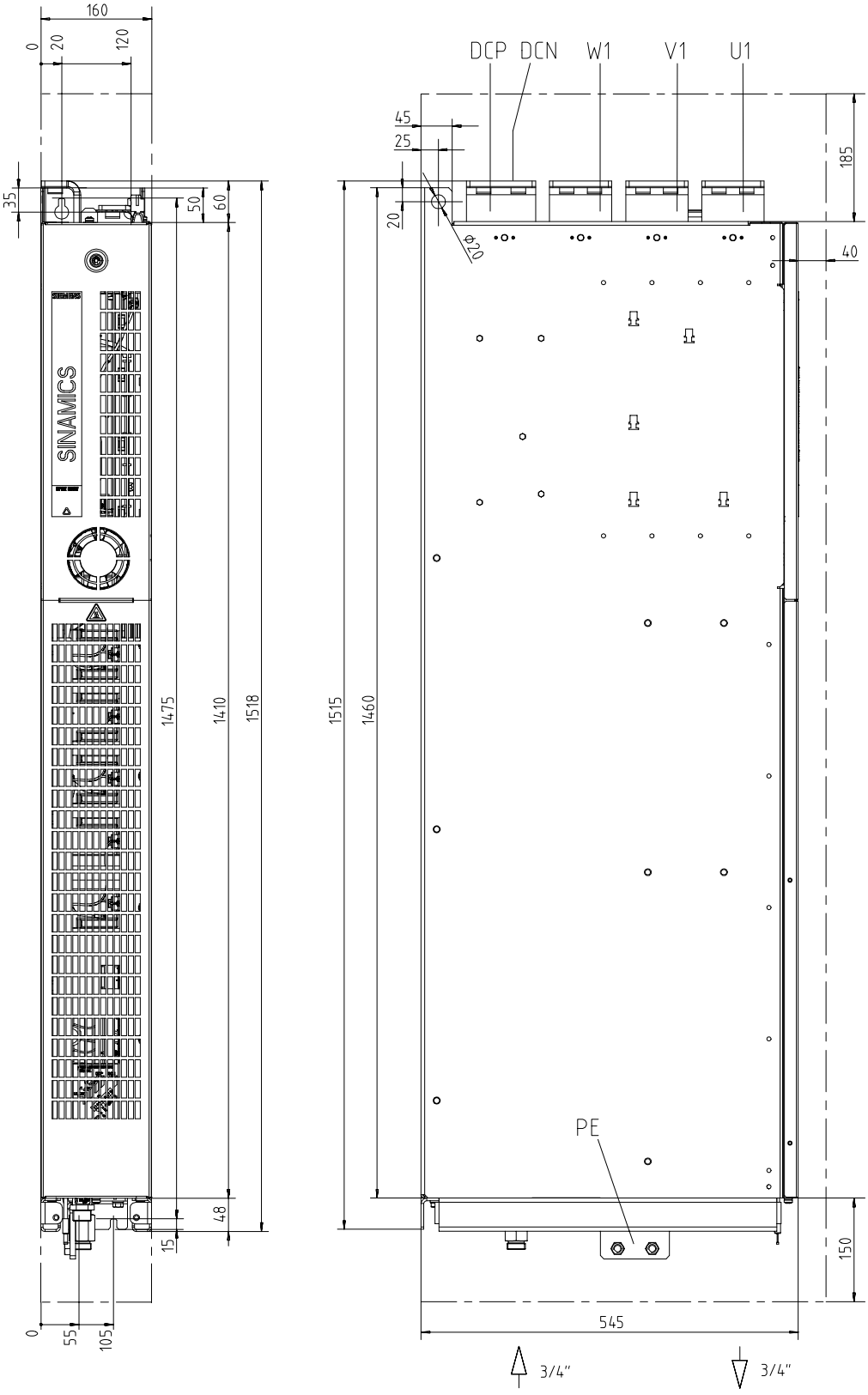



Front view Side view

Fig. 4-5 Dimension drawing of Basic Line Module, frame size FBL

## Dimension drawing, frame size GBL

The cooling clearances to be maintained are indicated by the dotted line.




Front view Side view

Fig. 4-6 Dimension drawing of Basic Line Module, frame size GBL

## 4.2.5 Installation

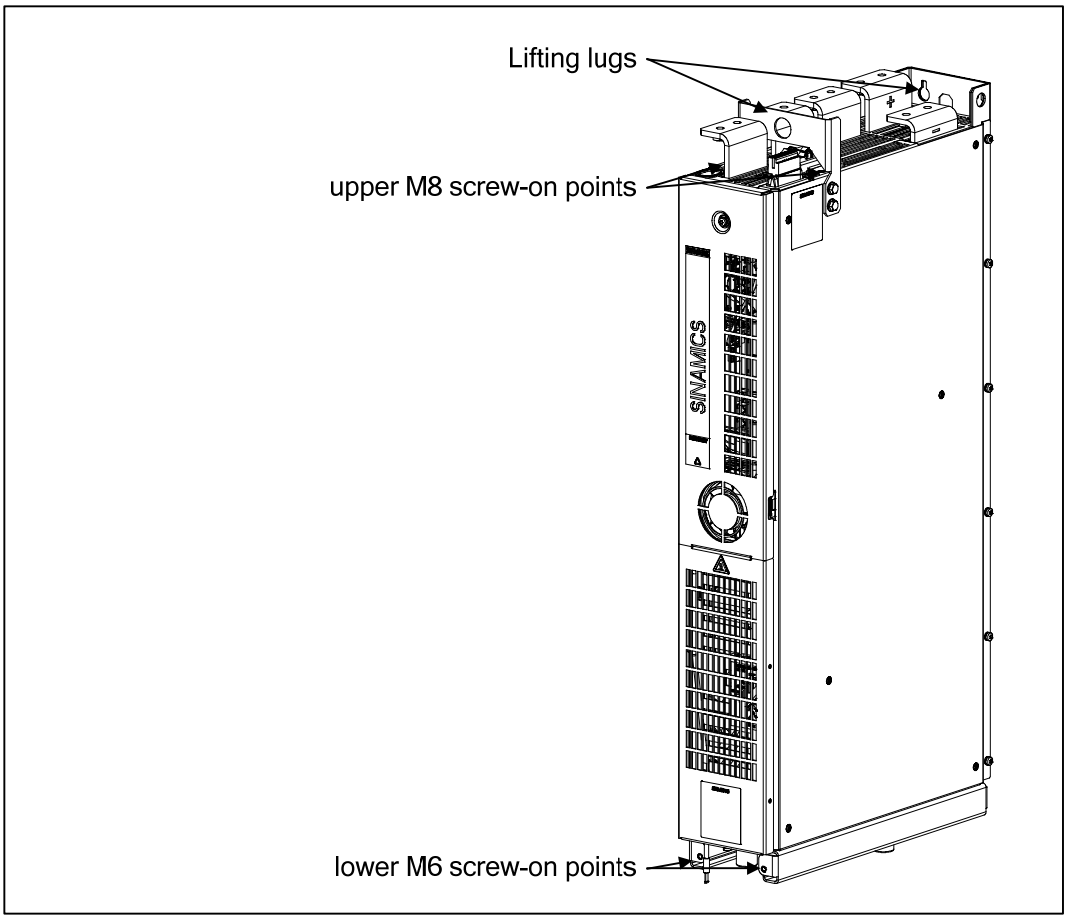



Fig. 4-7 Lifting lugs / screw coupling points for mechanical support

### Lifting lugs

Basic Line Modules are fitted with lifting lugs as standard when shipped. The units can be hoisted from these lugs by a crane and transported from the pallet to the installation location.

**Warning**

A lifting harness with vertical ropes or chains must be used to prevent any risk of damage to the housing.

Once the Basic Line Modules have been installed, the lifting lugs to the front of the units must be removed. The lugs should be safely stored for future use.

### Screw coupling points for mechanical support

Since the Basic Line Modules are housed in a very slim enclosure, they need to be mechanically supported against lateral movement and vibration if they are installed in a control cabinet. Screw coupling points are provided on the top and bottom of the units for this purpose.
If several modules are mounted adjacent to one another, they can be interconnected via the screw coupling points. When a single module is installed, lateral support can be provided by means of reinforcing plates inserted between the module and the cabinet.

## 4.2.6 Electrical connection

### Operating a Basic Line Module on an insulated network (IT)

When the device is operated on an insulated network (IT), the connection bracket for the interference-suppression capacitor must be removed.

To do so, loosen the two screws ("1" in Fig. 4-8) and pull the connection bracket out of the device.

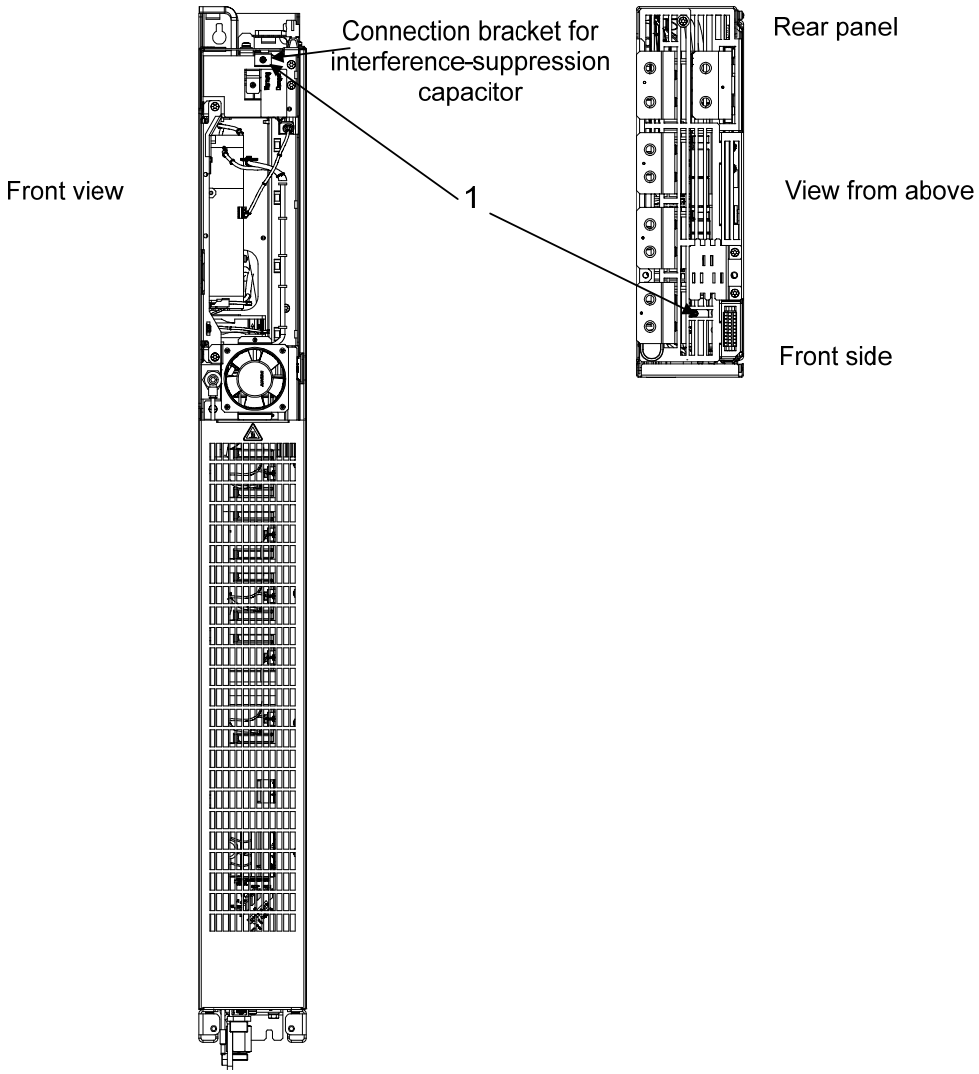



Fig. 4-8 Removing the connection bracket for the interference-suppression capacitor

**Warning**

Failing to remove the connection bracket for the interference-suppression capacitor on a non-grounded system/IT system can cause significant damage to the unit.

## 4.2.7 Technical specifications

Table 4-7 Technical specifications for Basic Line Modules (380 V – 480 V 3 AC)

| **Order number** | **6SL3335–** | **1TE37-4AA0** | **1TE41-2AA0** | | |
|---|---|---|---|---|---|
| kVA rating [1] | kW (Pn) | 360 | 600 | | |
| Max. infeed power | kW (Pmax) | 540 | 900 | | |
| Rated DC link current | A | 740 | 1220 | | |
| Base load DC link current | A | 578 | 936 | | |
| Maximum DC link current [2] | A | 1110 | 1830 | | |
| Input current for 480 V 3 AC | A | 610 | 1000 | | |
| Max. input current for 480 V 3 AC | A | 915 | 1500 | | |
| Line supply voltages:<br>- Line voltage<br>- Line frequency<br>- Electronics power supply | <br>$V_{Aceff}$<br>Hz<br>$V_{DC}$ | <br>380 3 AC –10 % to 480 3 AC +10 % (-15 % < 1 min)<br>47 to 63 Hz<br>24 (20.4 – 28.8) | | | |
| DC link voltage | $V_{DC}$ | 1.35 x $U_{line}$ | | | |
| Electronics current drain (24 V DC) | A | 0.7 | 0.7 | | |
| Cooling type | | Liquid cooling with integrated aluminium heat exchanger | | | |
| DC link capacitance | µF | 12000 | 20300 | | |
| Charging limit | µF | 96000 | 132400 | | |
| Power loss<br>- Air / Coolant<br>- Total losses | <br>kW<br>kW | <br>0.25 / 2.70<br>2.95 | <br>0.41 / 4.36<br>4.77 | | |
| Max. coolant temperature:<br>- without derating<br>- with derating | <br>°C<br>°C | <br>45<br>50 | <br>45<br>50 | | |
| Coolant requirement [3] | l/min | 9 | 9 | | |
| Liquid volume of integrated heat exchanger | dm³ | 0.45 | 0.45 | | |
| Typ. pressure drop with volumetric flow [4] | Pa | 70000 | 70000 | | |
| Sound pressure level | dB(A) | 54 | 54 | | |
| Line/power connection | | Flange connection with screws M12 | | | |
| Max. connection cross-section<br>Line connection (U1, V1, W1)<br>DC link connection (DCP, DCN)<br>PE connection | <br>mm²<br>mm²<br>mm² | <br>4 x 240<br>Busbar<br>2 x 240 | <br>4 x 240<br>Busbar<br>2 x 240 | | |
| Degree of protection | | IP00 | IP00 | | |
| Dimensions<br>Width<br>Height<br>Depth | <br>mm<br>mm<br>mm | <br>160<br>1153<br>545 | <br>160<br>1153<br>545 | | |
| Frame size | | FBL | FBL | | |
| Weight | kg | 108 | 108 | | |
| UL listed fuse [5]<br>Number (connected in parallel)<br>Rated current<br>Size acc. to DIN 43620-1 | | 3NE1 333-2<br>2<br>450<br>2 | 3NE1 435-2<br>2<br>560<br>3 | | |

[1] kVA rating refers to the rated motor power of a typical 6-pole motor supplied with 400 V.

[2] Valid for a 60 s duty cycle (overload period) and a duty cycle duration of 300 s based on the base load DC link current.

[3] This value applies to both coolant options, i.e. water and water / Antifrogen N mixture with 45 % Antifrogen N.

[4] This value applies to the water coolant option; for other coolant types, see Chapter 8.

[5] In order to build a UL-approved system, it is absolutely essential to use the specified fuses.

Table 4-8 Technical specifications for Basic Line Modules (500 V – 690 V 3 AC)

| Order number | 6SL3335– | 1TG34-2AA0 | 1TG37-3AA0 | 1TG41–3AA0 | 1TG41–7AA0 |
|---|---|---|---|---|---|
| kVA rating [1] | kW (Pn) | 355 | 630 | 1100 | 1370 |
| Max. infeed power | kW (Pmax) | 533 | 945 | 1650 | 2055 |
| Rated DC link current | A | 420 | 730 | 1300 | 1650 |
| Base load DC link current | A | 328 | 570 | 1014 | 1287 |
| Maximum DC link current [2] | A | 630 | 1095 | 1950 | 2475 |
| Input current for 690 V 3 AC | A | 340 | 600 | 1070 | 1350 |
| Max. input current for 690 V 3 AC | A | 510 | 900 | 1605 | 2025 |
| Line supply voltages:<br>- Line voltage<br>- Line frequency<br>- Electronics power supply | <br>$V_{Aceff}$<br>Hz<br>$V_{DC}$ | <br>500 3 AC –10 % to 690 3 AC +10 % (-15 % < 1 min)<br>47 to 63 Hz<br>24 (20.4 – 28.8) | | | |
| DC link voltage | $V_{DC}$ | 1.35 x $U_{line}$ | | | |
| Electronics current drain (24 V DC) | A | 0.7 | 0.7 | 0.7 | 0.7 |
| Cooling type | | Liquid cooling with integrated aluminium heat exchanger | | | |
| DC link capacitance | µF | 4800 | 7700 | 15500 | 19300 |
| Charging limit | µF | 38400 | 61600 | 124000 | 154400 |
| Power loss<br>- Air / Coolant<br>- Total losses | <br>kW<br>kW | <br>0.21 / 1.55<br>1.76 | <br>0.38 / 2.71<br>3.09 | <br>0.43 / 4.66<br>5.09 | <br>0.55 / 5.70<br>6.25 |
| Max. coolant temperature:<br>- without derating<br>- with derating | <br>°C<br>°C | <br>45<br>50 | <br>45<br>50 | <br>45<br>50 | <br>45<br>50 |
| Coolant requirement [3] | l/min | 9 | 9 | 12 | 12 |
| Liquid volume of integrated heat exchanger | dm³ | 0.45 | 0.45 | 0.79 | 0.79 |
| Typ. pressure drop with volumetric flow [4] | Pa | 70000 | 70000 | 70000 | 70000 |
| Sound pressure level | dB(A) | 54 | 54 | 56 | 56 |
| Line/power connection | | Flange connection with screws M12 | | | |
| Max. connection cross-section<br>Line connection (U1, V1, W1)<br>DC link connection (DCP, DCN)<br>PE connection | <br>mm²<br>mm²<br>mm² | <br>4 x 240<br>Busbar<br>2 x 240 | <br>4 x 240<br>Busbar<br>2 x 240 | <br>4 x 240<br>Busbar<br>2 x 240 | <br>4 x 240<br>Busbar<br>2 x 240 |
| Degree of protection | | IP00 | IP00 | IP00 | IP00 |
| Dimensions<br>Width<br>Height<br>Depth | <br>mm<br>mm<br>mm | <br>160<br>1153<br>545 | <br>160<br>1153<br>545 | <br>160<br>1508<br>545 | <br>160<br>1508<br>545 |
| Frame size | | FBL | FBL | GBL | GBL |
| Weight | kg | 108 | 108 | 185 | 185 |
| UL listed fuse [5]<br>Number (connected in parallel)<br>Rated current<br>Size acc. to DIN 43620-1 | | 3NE1 333-2<br>1<br>450<br>2 | 3NE1 331-2<br>2<br>350<br>2 | 3NE1 447-2<br>2<br>670<br>3 | 3NE1 435-2<br>3<br>560<br>3 |

[1] kVA rating refers to the rated motor power of a typical 6-pole motor supplied with 690 V.

[2] Valid for a 60 s duty cycle (overload period) and a duty cycle duration of 300 s based on the base load DC link current.

[3] This value applies to both coolant options, i.e. water and water / Antifrogen N mixture with 45 % Antifrogen N.

[4] This value applies to the water coolant option; for other coolant types, see Chapter 8.

[5] In order to build a UL-approved system, it is absolutely essential to use the specified fuses.

### 4.2.7.1 Derating factors

## Derating factors as a function of coolant temperature

SINAMICS S120 Liquid Cooled units are designed for cooling by $H_2O$ or by an $H_2O$ / Antifrogen N mixture. An $H_2O$ / Antifrogen N mixture must contain between 20 % and 45 % Antifrogen N.

When $H_2O$ is used as a coolant, the units can supply 100 % output current at temperatures between 5 °C and 45 °C, and 90 % output current at temperatures between 45 °C and 50 °C.

When the $H_2O$ / Antifrogen N mixture described above is used as a coolant, the units can supply 100 % output current at temperatures between 0 °C and 45 °C. The maximum output current decreases linearly to 90 % at temperatures between 45 °C and 50 °C.

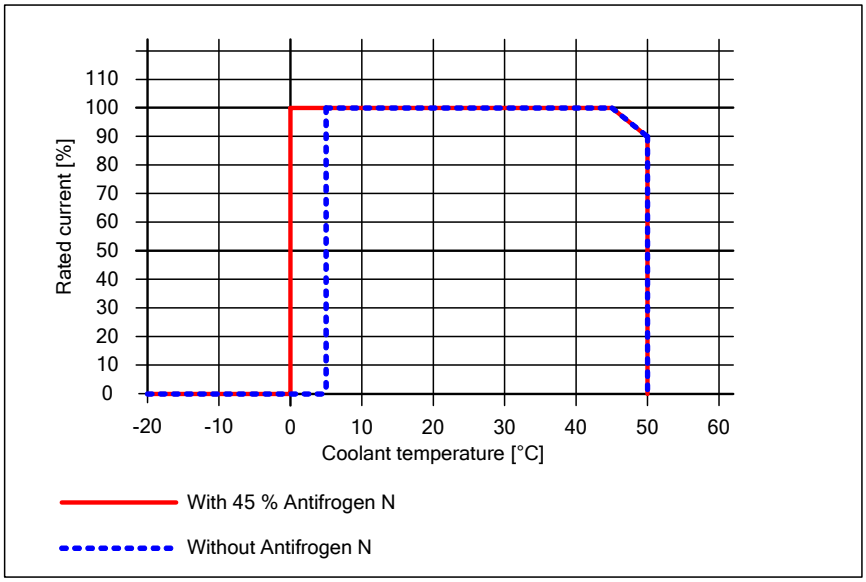



Fig. 4-9 Maximum output current as a function of coolant temperature

## Derating factors as a function of ambient temperature

The units can supply 100 % output current at an ambient air temperature of between 0 °C and 45 °C. The maximum output current decreases linearly to 90 % at ambient air temperatures of between 45 °C and 50 °C.

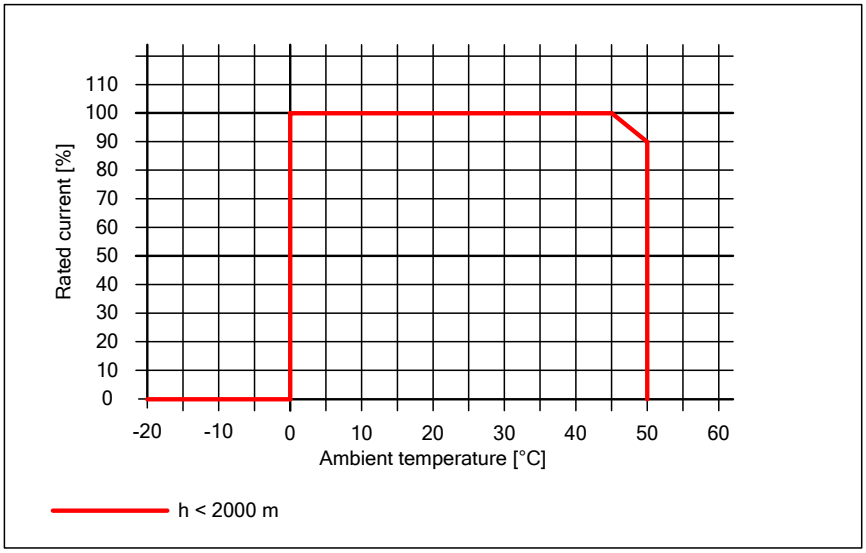



Fig. 4-10 Maximum output current as a function of ambient temperature

## Derating factors as a function of installation altitude

When the units are operated at an installation altitude with reduced air pressure, the derating characteristic shown below applies to the output current or the ambient air temperature.

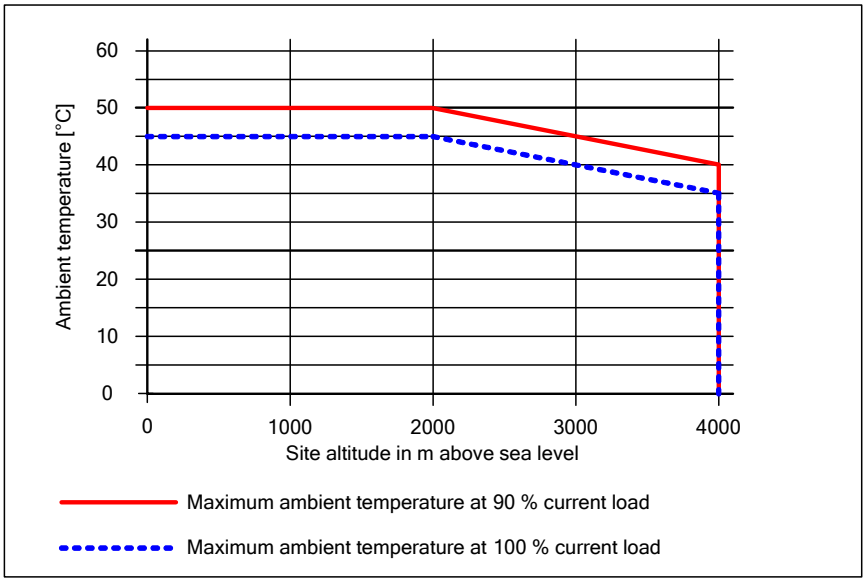


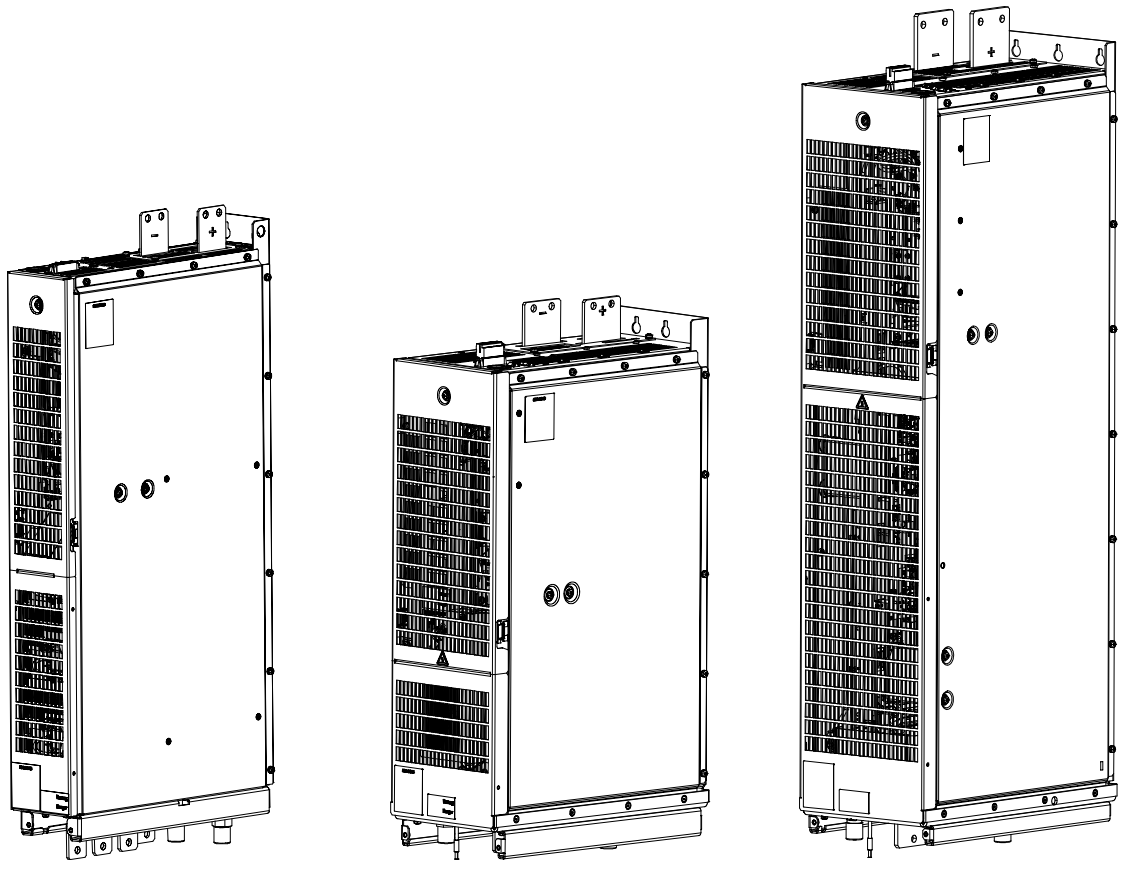

Fig. 4-11 Maximum ambient temperature as a function of installation altitude

# Motor Modules

# 5

## 5.1 Description

A Motor Module is a power unit (DC-AC inverter) that provides the power supply for the connected motor. Power is supplied by means of the DC link of the drive unit. A Motor Module must be connected to a Control Unit via DRIVE-CLiQ. The open-loop and closed-loop control functions are stored in the Control Unit.



Frame size GXL Frame size HXL Frame size JXL

Fig. 5-1 Overview of Motor Modules (chassis)

### Characteristics of the Motor Modules

- Version for 510 V DC to 720 V DC from 310 A to 490 A
  Version for 675 V DC to 1080 V DC from 575 A to 1270 A
- Liquid cooling
- Short-circuit/ground-fault-proof
- Electronic rating plate
- Operating status and error status via LEDs
- DRIVE-CLiQ interface for communication with the Control Unit and/or other components in the drive line-up.
- Integration in system diagnostics
- An external 24 V DC supply is required to operate liquid-cooled Motor Modules.

The volumetric flow of the coolant is monitored by the software. If the volumetric flow is continuously lower than the setpoint, an alarm (A5005) is first displayed. If this alarm remains active continually for the next 5 minutes, a fault message (F30047) is activated which shuts down the unit.

The fans for the internal electronic circuitry are only switched on when required.

## 5.2 Safety information



**Warning**

After disconnecting all the supply voltages, a hazardous voltage will be present in all components for another 5 minutes. Work cannot be carried out until this time has elapsed.

Before starting work, you should also measure the voltage after the 5 minutes have elapsed! The voltage can be measured on DC link terminals DCP and DCN.



**Caution**

The DC link discharge time hazard warning must be affixed to the component in the local language.

**Notice**

The clearances above, below, and in front of the component, which are specified in the dimension drawings, must be observed.



**Warning**

Cable shields and unused power cable conductors must be connected to PE potential to prevent capacitive cross-talk charges.

Non-observance can cause lethal shock voltages.

**Caution**

The busbars and coolant connections which stick out of the module must never be used as handles or support surfaces when the units are transported.

# 5.3 Interface description

## 5.3.1 Overview

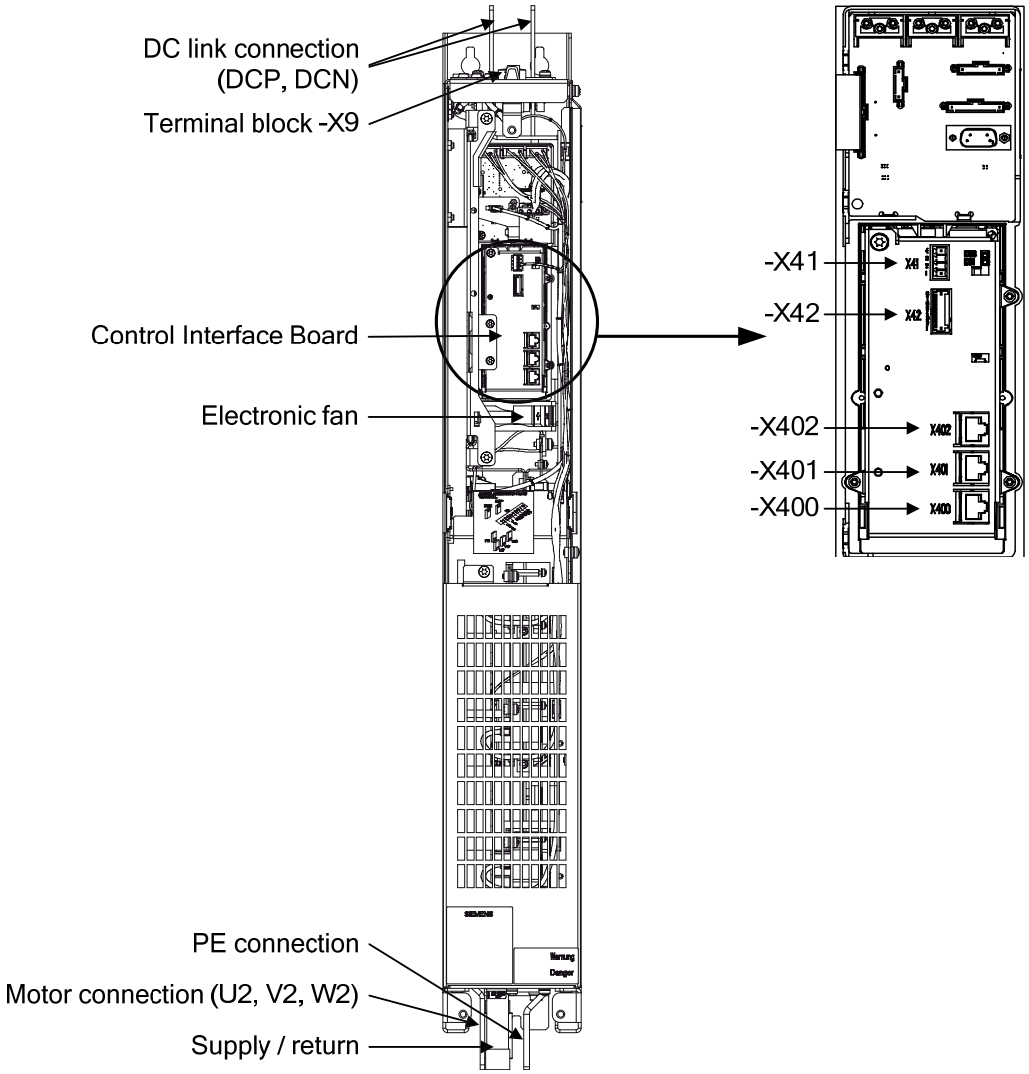



Fig. 5-2 Motor Module, frame size GXL

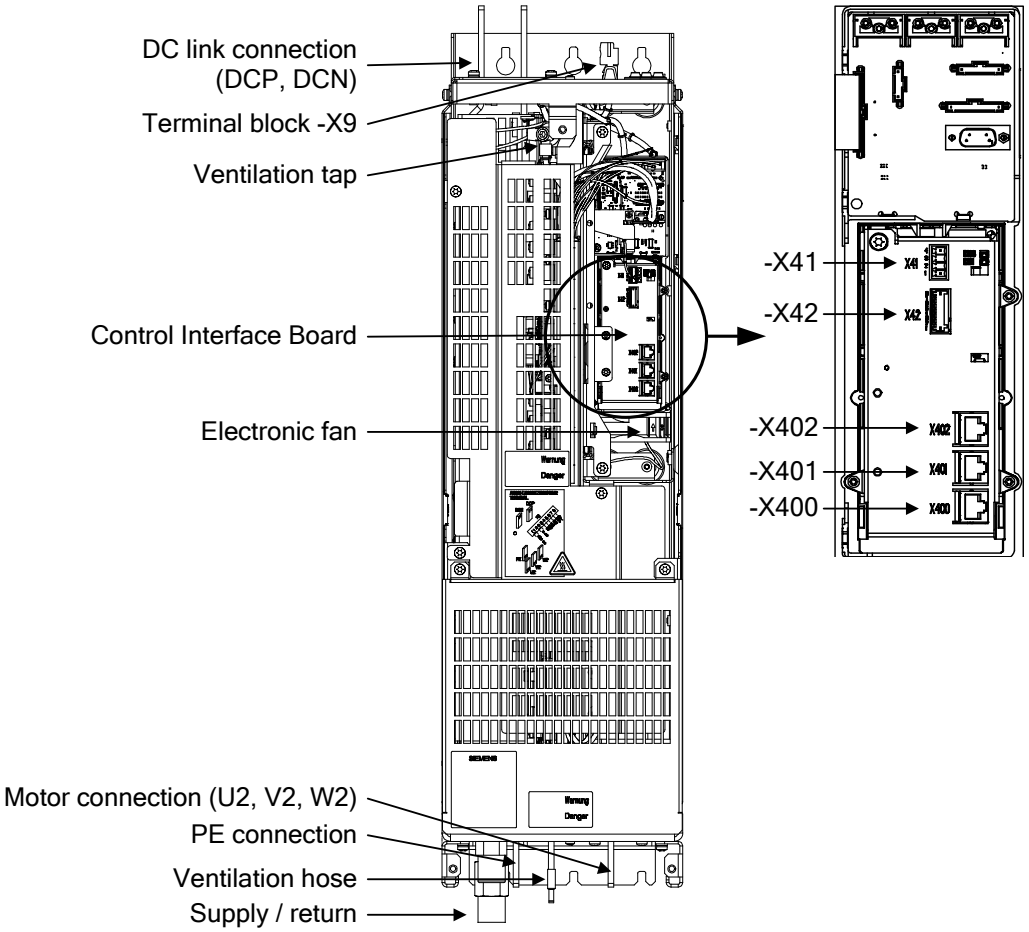



Fig. 5-3 Motor Module, frame size HXL

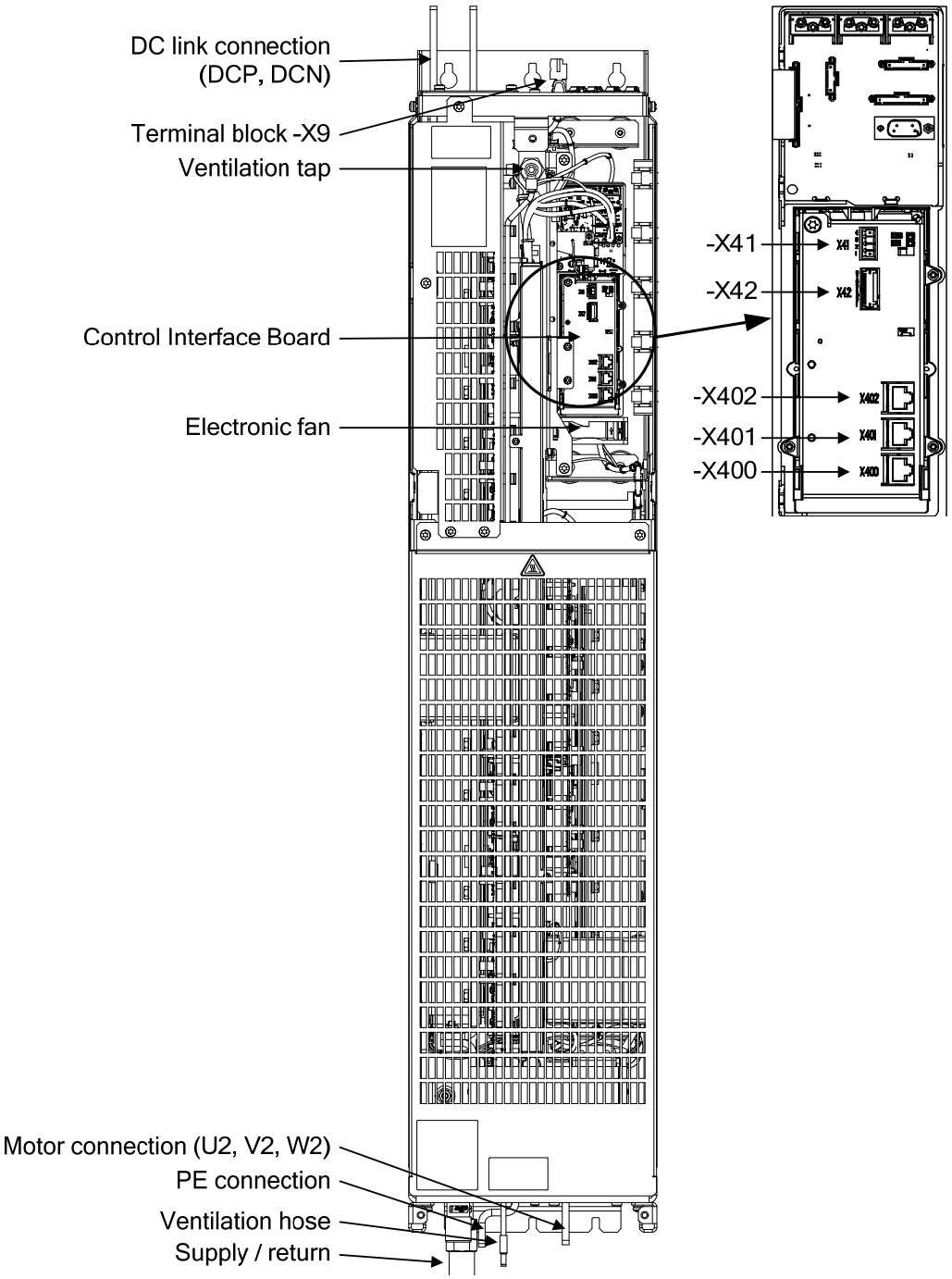



Fig. 5-4 Motor Module, frame size JXL

## 5.3.2 Connection example

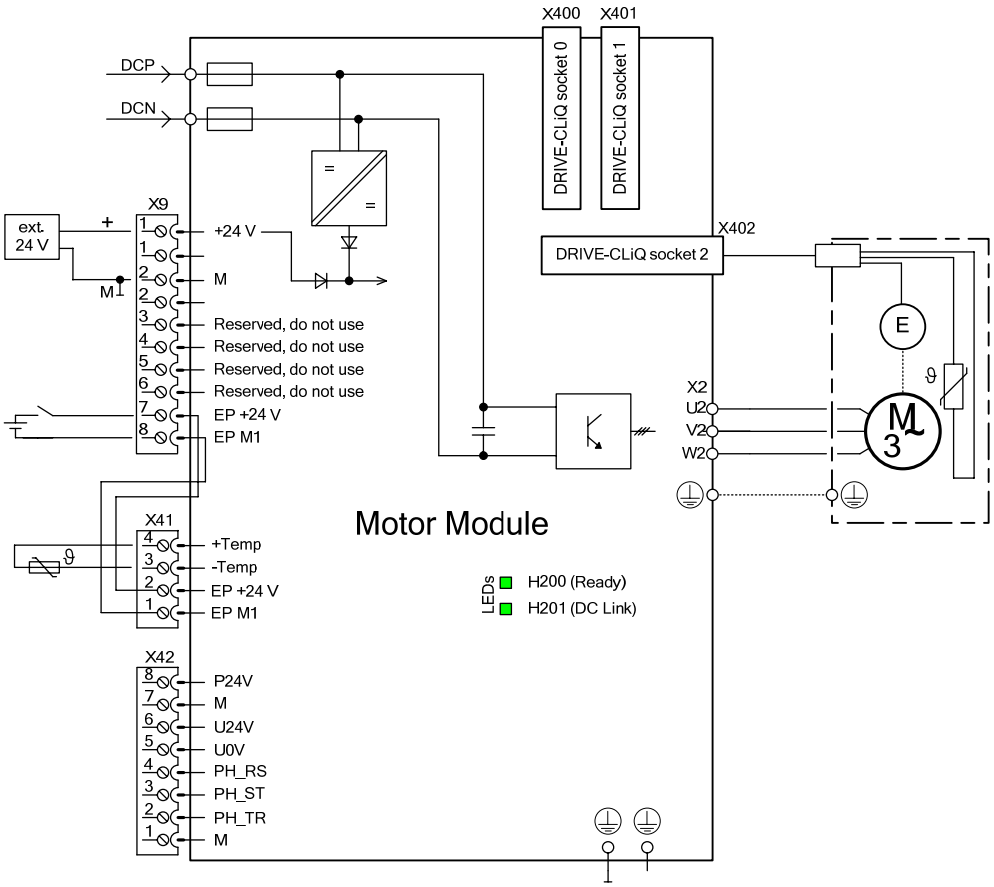



Fig. 5-5 Connection example for Motor Module

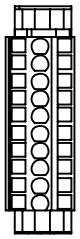
## 5.3.3 DC link/motor connection

Table 5-1 DC link/motor connection Motor Module

| terminals | Technical specifications |
|---|---|
| DCP, DCN<br>DC power input | Voltage:<br>• 510 V to 720 V DC<br>• 675 V to 1080 V DC<br>Connection lugs: d = 13 mm (M12 / 50 Nm) for ring cable lugs to DIN 46234 |
| U2, V2, W2<br>3 AC power output | Voltage:<br>• 0 V 3 AC to 0.72 x DC link voltage<br>Connection lugs: d = 13 mm (M12 / 50 Nm) for ring cable lugs to DIN 46234 |
| PE connection | Connection lugs: d = 13 mm (M12 / 50 Nm) for ring cable lugs to DIN 46234 |

## 5.3.4 Terminal block X9

Table 5-2 Terminal block X9

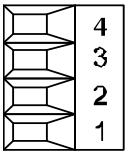
| | Terminal | Signal name | Technical specifications |
|---|---|---|---|
|  | 1 | P 24 V | Voltage: 24 V DC (20.4 V – 28.8 V)<br>Current input: see technical data (chapter 5.5) |
| | 2 | M | |
| | 3 | Reserved, do not use | |
| | 4 | | |
| | 5 | Reserved, do not use | |
| | 6 | | |
| | 7 | EP +24 V (Enable Pulses) | Supply voltage: 24 V DC (20.4 V – 28.8 V)<br>Current input: 10 mA<br>Signal propagation times:<br>L → H: 100 µs<br>H → L: 1000 µs |
| | 8 | EP M1 (Enable Pulses) | |
| Max. connectable cross-section 1.5 mm² | | | |

**Note**

When the STO (Safe Torque Off) or SS1 (Safe Stop 1) function is activated via terminals, a 24 V DC supply must be connected to terminal -X9:7 and terminal -X9:8 must be connected to ground. Upon removal, pulse suppression is activated.

## 5.3.5 Terminal block X41

Table 5-3 Terminal block X41

| | Terminal | Functions | Technical specifications |
|---|---|---|---|
|  | 4 | + Temp | Temperature sensor connection KTY84–1C130/PTC |
| | 3 | - Temp | |
| | 2 | Reserved, do not use | Connected to terminal -X9:7 |
| | 1 | Reserved, do not use | Connected to terminal -X9:8 |
| Max. connectable cross-section 1.5 mm² | | | |

**Notice**

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

**Note**

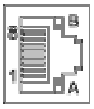
A cable harness is used to connect terminals -X41:1 and -X41:2 to terminals -X9:8 and -X9:7.

## 5.3.6 Terminal block X42

Reserved, do not use!

## 5.3.7 DRIVE-CLiQ interface X400-X402

Table 5-4 DRIVE-CLiQ interface X400-X402: Motor Module

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

## 5.3.8 Cooling circuit connections

Table 5-5 Cooling circuit connections

| Connection | Technical specifications |
|---|---|
| Inlet, return | Screwed hose connection, male thread 3/4", flat sealing |
| Locked-rotor torque | 60 Nm |

**Note**

The seals for the screwed connections can be used only once when the cooling circuit is first assembled. The seals must be replaced if the circuit is disassembled and assembled again.

## 5.3.9 Meaning of the LEDs on the Control Interface Board in the Motor Module

Table 5-6 Meaning of the LEDs on the Control Interface Board in the Motor Module

| LED state | | Description |
|---|---|---|
| H200 | H201 | |
| OFF | OFF | The electronics power supply is missing or lies outside permissible tolerance range. |
| Green | OFF | The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. |
| | Orange | The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.<br>The DC link voltage is present. |
| | Red | The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.<br>The DC link voltage is too high. |
| Orange | Orange | DRIVE-CLiQ communication is being established. |
| Red | --- | At least one fault is present in this component.<br>Note:<br>The LED is triggered independently from re-configuring the corresponding messages. |
| 0.5 Hz flashing light:<br>Green / red | --- | Firmware is being downloaded. |
| 2 Hz flashing light:<br>Green / red | --- | Firmware download is concluded. Wait for POWER ON. |
| 2 Hz flashing light:<br>Green orange<br>or<br>red orange | --- | Component detection using LED is activated (p0124).<br>Note:<br>Both options depend on the LED status when component recognition is activated via p0124 = 1. |



**Warning**

Independent of the state of LED "H201", hazardous DC link voltages can always be available.

The warning information on the components must be carefully observed!

### Cause and rectification of faults

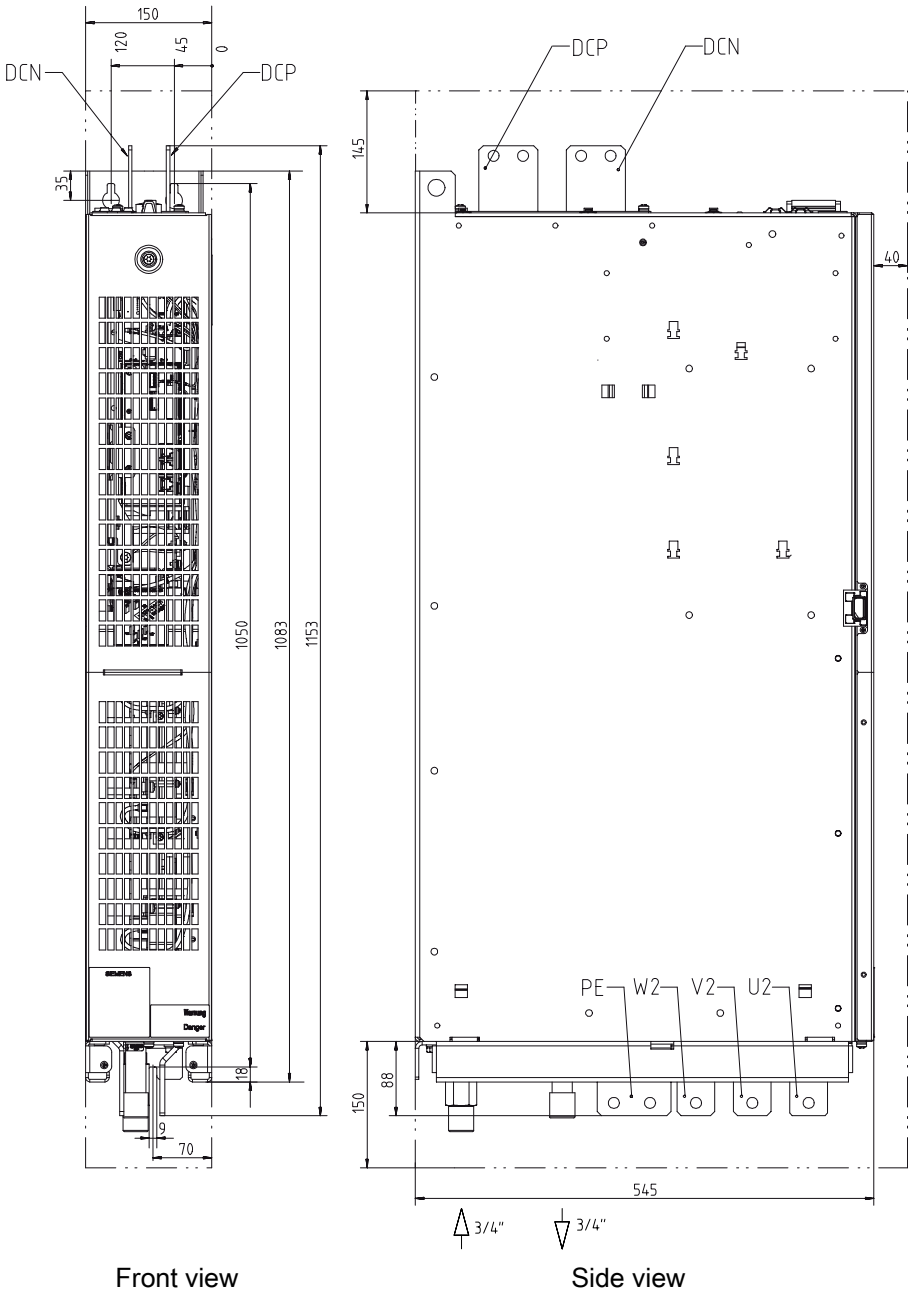
The following reference contains information about the cause of the faults and how they can be resolved:

Reference: /IH1/ SINAMICS S120 Commissioning Manual

# 5.4 Dimension drawing

## Dimension drawing, frame size GXL

The cooling clearances to be maintained are indicated by the dotted line.

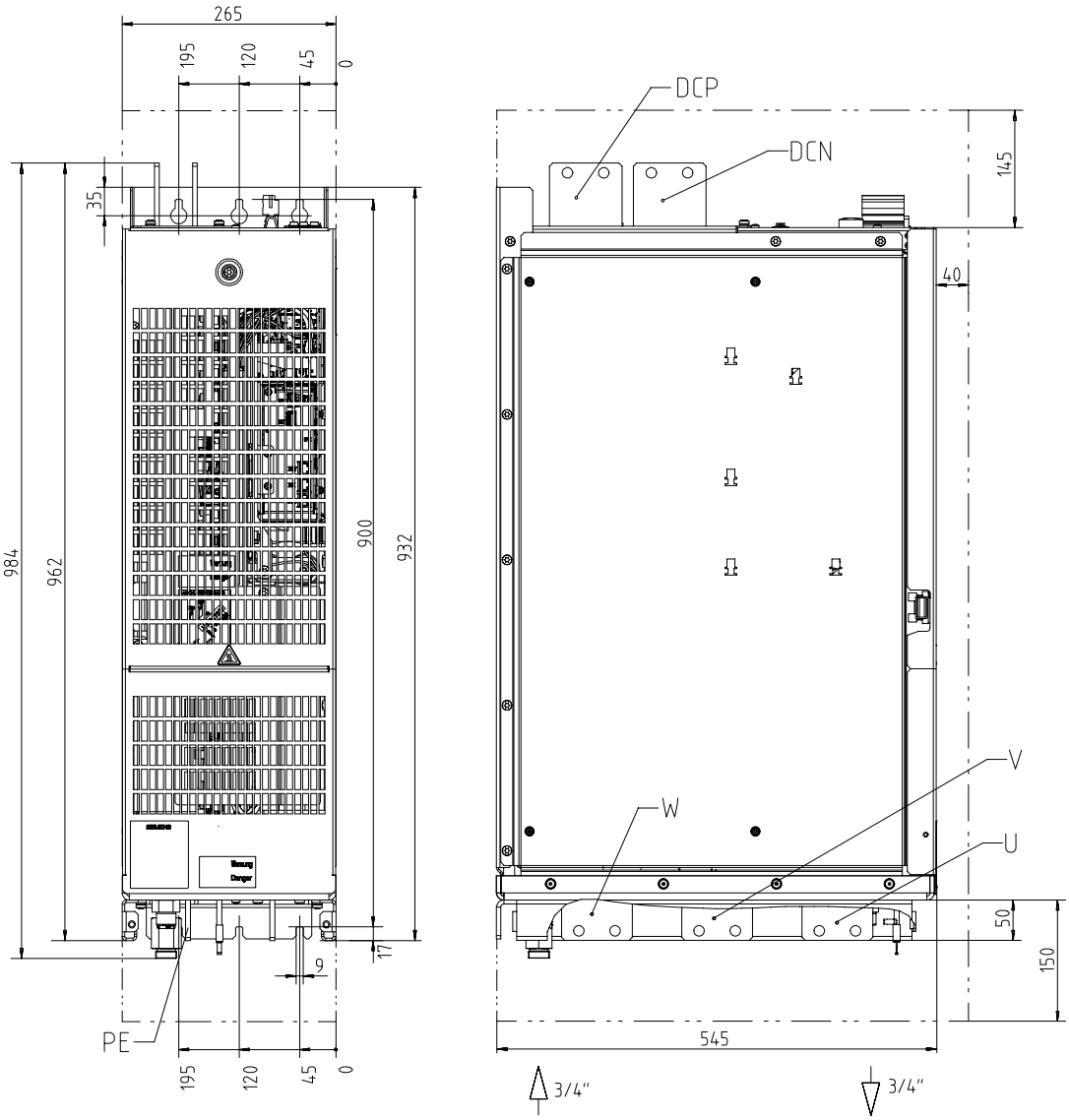



Front view Side view

Fig. 5-6 Dimension drawing of Motor Module, frame size GXL

## Dimension drawing, frame size HXL

The cooling clearances to be maintained are indicated by the dotted line.

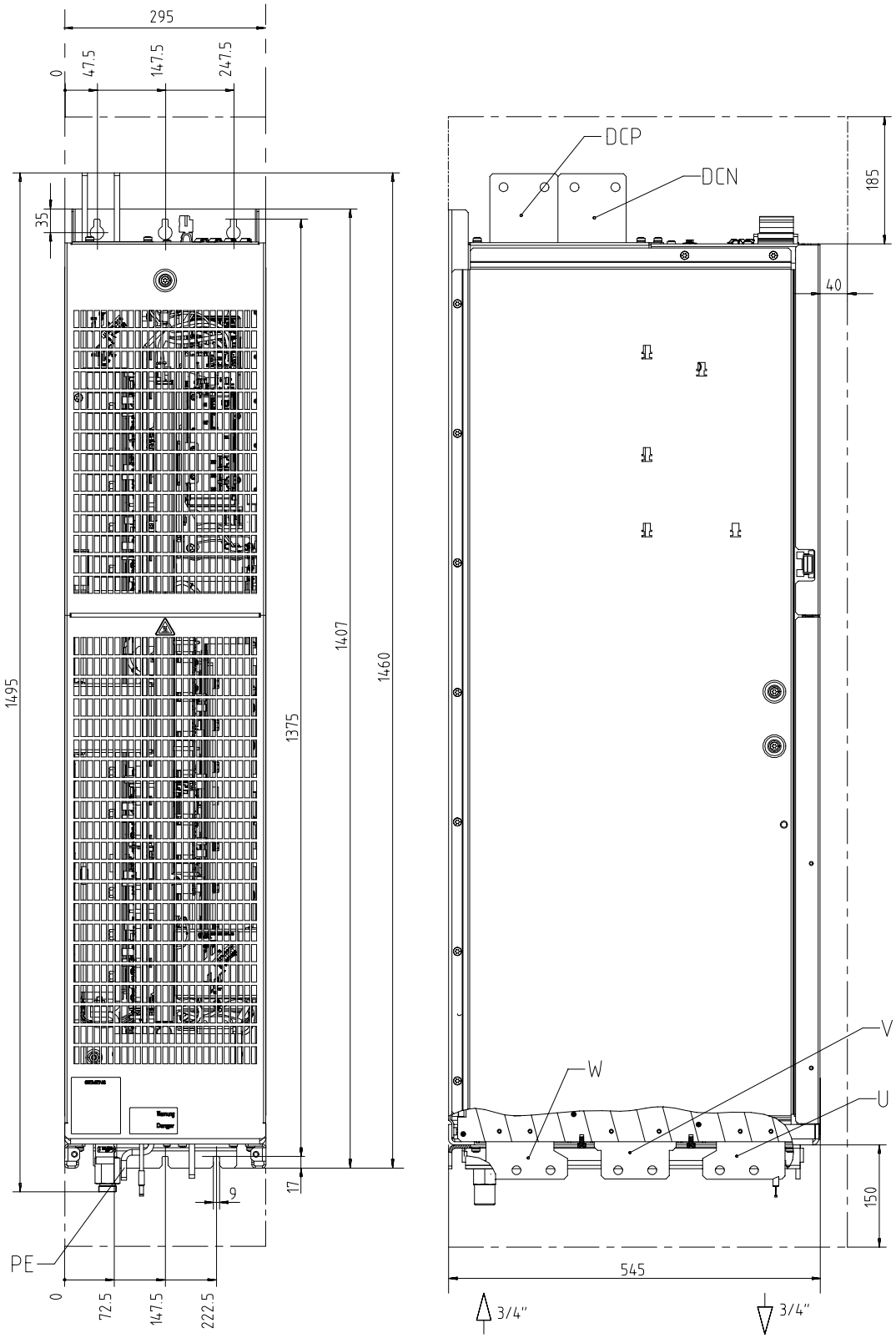



Front view Side view

Fig. 5-7 Dimension drawing of Motor Module, frame size HXL

## Dimension drawing, frame size JXL

The cooling clearances to be maintained are indicated by the dotted line.




Front view Side view

Fig. 5-8 Dimension drawing of Motor Module, frame size JXL

# 5.5 Installation

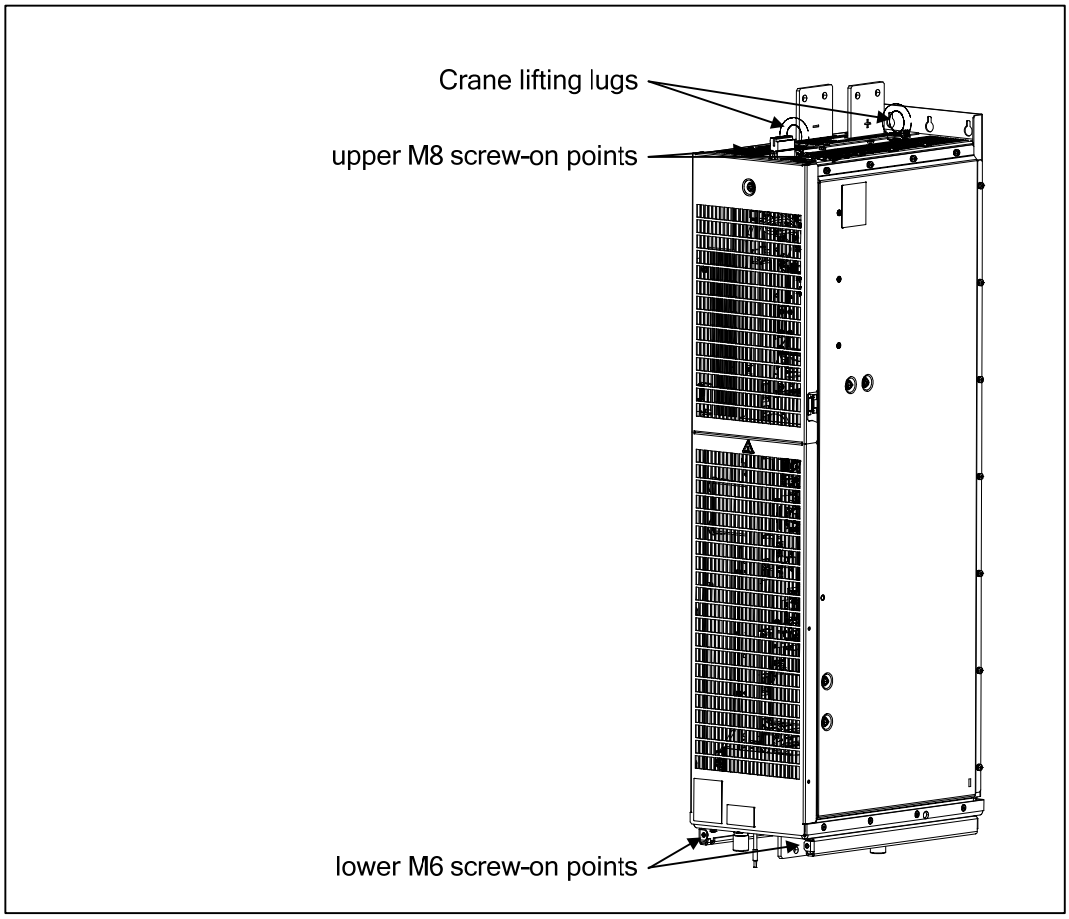



Fig. 5-9 Crane lifting lugs / screw coupling points for mechanical support

## Crane lifting lugs

Motor Modules are fitted with crane lifting lugs as standard when shipped. The units can be hoisted from these lugs and transported from the pallet to the installation location.

**Note**

A thread for inserting a crane lifting lug is provided on the bottom of the Motor Module. This allows the Motor Module to be transported horizontally with a lifting harness.

**Warning**

A lifting harness with vertical ropes or chains must be used to prevent any risk of damage to the housing.

The crane lifting lugs must be removed after the modules have been installed. The lugs should be safely stored for future use.

## Screw coupling points for mechanical support

The Motor Modules are provided with screw coupling points at the top and bottom so that they can be connected to modules mounted adjacently.

# 5.6 Technical specifications

Table 5-7 Technical specifications for the Motor Module, 510 V – 720 V DC

| **Order number** | **6SL3325–** | **1TE33-1AA0** | **1TE35–0AA0** | | |
|---|---|---|---|---|---|
| Rated output current $I_N$ | A | 310 | 490 | | |
| Base load current $I_L$ | A | 302 | 477 | | |
| Base load current $I_H$ | A | 277 | 438 | | |
| Max. output current $I_{max}$ | A | 453 | 715 | | |
| kVA rating [1] | kW | 160 | 250 | | |
| Power on basis of $I_H$ | kW | 132 | 200 | | |
| Rated DC link current | A | 378 | 598 | | |
| Connection voltages<br>- DC link voltage<br>- Electronics power supply | <br>$V_{DC}$<br>$V_{DC}$ | <br>510 to 720<br>24 (20.4 – 28.8) | | | |
| Output voltage | $V_{ACeff}$ | 0 to 0.72 x DC link voltage | | | |
| Rated pulse frequency | kHz | 2 | 2 | | |
| Max. pulse frequency without derating | kHz | 2 | 2 | | |
| Max. pulse frequency with derating | kHz | 8 | 8 | | |
| Electronics current drain (24 V DC) | A | 1.5 | 1.5 | | |
| Cooling type | | Liquid cooling with integrated stainless steel heat exchanger | | | |
| DC link capacitance | µF | 8400 | 9600 | | |
| Power loss [2]<br>- Air / Coolant<br>- Total losses | <br>kW<br>kW | <br>0.08 / 2.29<br>2.38 | <br>0.14 / 3.36<br>3.74 | | |
| Max. coolant temperature:<br>- without derating<br>- with derating | <br>°C<br>°C | <br>45<br>50 | <br>45<br>50 | | |
| Coolant requirement [3] | l/min | 12 | 12 | | |
| Liquid volume of integrated heat exchanger | dm³ | 0.91 | 0.91 | | |
| Typ. pressure drop with volumetric flow [4] | Pa | 70000 | 70000 | | |
| Sound pressure level | dB(A) | 52 | 52 | | |
| DC link/motor connection | | Flange connection with screws M12 | | | |
| Max. connection cross-section<br>DC link connection (DCP, DCN)<br>Motor connection (U2, V2, W2)<br>PE connection | <br>mm²<br>mm²<br>mm² | <br>2 x 240<br>2 x 240<br>2 x 240 | <br>2 x 240<br>2 x 240<br>2 x 240 | | |
| Max. cable length | m | 300 (shielded) / 450 (unshielded) | | | |
| Degree of protection | | IP00 | IP00 | | |
| Dimensions<br>Width<br>Height<br>Depth | <br>mm<br>mm<br>mm | <br>150<br>1153<br>545 | <br>150<br>1153<br>545 | | |
| Frame size | | GXL | GXL | | |
| Weight | kg | 80 | 80 | | |
| UL listed fuse [5]<br>Number (connected in parallel)<br>Rated current<br>Size acc. to DIN 43620-1 | | 3NE3 233<br>1<br>450<br>1 | 3NE3 336<br>1<br>630<br>2 | | |

[1] kVA rating refers to the rated motor power of a typical 6-pole motor supplied with 400 V.

[2] At rated pulse frequency

[3] This value applies to both coolant options, i.e. water and water / Antifrogen N mixture with 45 % Antifrogen N.

[4] This value applies to the water coolant option; for other coolant types, see Chapter 8.

[5] In order to build a UL-approved system, it is absolutely essential to use the specified fuses.

Table 5-8 Technical specifications for the Motor Module, 675 V – 1080 V DC

| Order number | 6SL3325– | 1TG35-8AA0 | 1TG38–1AA0 | 1TG41–0AA0 | 1TG41–3AA0 |
|---|---|---|---|---|---|
| Rated output current $I_N$ | A | 575 | 810 | 1025 | 1270 |
| Base load current $I_L$ | A | 560 | 790 | 1000 | 1230 |
| Base load current $I_H$ | A | 514 | 724 | 917 | 1136 |
| Max. output current $I_{max}$ | A | 840 | 1185 | 1500 | 1845 |
| kVA rating [1] | kW | 560 | 800 | 1000 | 1200 |
| Power on basis of $I_H$ | kW | 450 | 710 | 900 | 1000 |
| Rated DC link current | A | 702 | 990 | 1250 | 1550 |
| Connection voltages<br>- DC link voltage<br>- Electronics power supply | <br>$V_{DC}$<br>$V_{DC}$ | <br>675 to 1080<br>24 (20.4 – 28.8) | | | |
| Output voltage | $V_{ACeff}$ | 0 to 0.72 x DC link voltage | | | |
| Rated pulse frequency | kHz | 1.25 | 1.25 | 1.25 | 1.25 |
| Max. pulse frequency without derating | kHz | 1.25 | 1.25 | 1.25 | 1.25 |
| Max. pulse frequency with derating | kHz | 5 | 5 | 5 | 5 |
| Electronics current drain (24 V DC) | A | 1.46 | 1.46 | 1.46 | 1.46 |
| Cooling type | | Liquid cooling with integrated aluminium heat exchanger | | | |
| DC link capacitance | µF | 9670 | 14000 | 16000 | 19330 |
| Power loss [2]<br>- Air / Coolant<br>- Total losses | <br>kW<br>kW | <br>0.15 / 5.45<br>5.60 | <br>0.45 / 9.11<br>9.56 | <br>0.50 / 10.37<br>10.87 | <br>0.56 / 12.92<br>13.48 |
| Max. coolant temperature:<br>- without derating<br>- with derating | <br>°C<br>°C | <br>45<br>50 | <br>45<br>50 | <br>45<br>50 | <br>45<br>50 |
| Coolant requirement [3] | l/min | 16 | 27 | 27 | 27 |
| Liquid volume of integrated heat exchanger | dm³ | 0.74 | 1.56 | 1.56 | 1.56 |
| Typ. pressure drop with volumetric flow [4] | Pa | 70000 | 70000 | 70000 | 70000 |
| Sound pressure level | dB(A) | 54 | 56 | 56 | 56 |
| DC link/motor connection | | Flange connection with screws M12 | | | |
| Max. connection cross-section<br>DC link connection (DCP, DCN)<br>Motor connection (U2, V2, W2)<br>PE connection | <br>mm²<br>mm²<br>mm² | <br>Busbar<br>4 x 240<br>2 x 240 | <br>Busbar<br>4 x 240<br>2 x 240 | <br>Busbar<br>4 x 240<br>2 x 240 | <br>Busbar<br>4 x 240<br>2 x 240 |
| Max. cable length | m | 300 (shielded) / 450 (unshielded) | | | |
| Degree of protection | | IP00 | IP00 | IP00 | IP00 |
| Dimensions<br>Width<br>Height<br>Depth | <br>mm<br>mm<br>mm | <br>265<br>984<br>545 | <br>295<br>1496<br>545 | <br>295<br>1496<br>545 | <br>295<br>1496<br>545 |
| Frame size | | HXL | JXL | JXL | JXL |
| Weight | kg | 110 | 220 | 220 | 220 |
| UL listed fuse [5]<br>Number (connected in parallel)<br>Rated current<br>Size acc. to DIN 43620-1 | | 3NE3 232-0B<br>2<br>400<br>1 | 3NE3 335<br>2<br>560<br>2 | 3NE3 337-8<br>2<br>710<br>2 | 3NE3 340-8<br>2<br>900<br>2 |

[1] kVA rating refers to the rated motor power of a typical 6-pole motor supplied with 690 V.

[2] At rated pulse frequency

[3] This value applies to both coolant options, i.e. water and water / Antifrogen N mixture with 45 % Antifrogen N.

[4] This value applies to the water coolant option; for other coolant types, see Chapter 8.

[5] In order to build a UL-approved system, it is absolutely essential to use the specified fuses.

## 5.6.1 Overload capability

The Motor Modules are equipped with an overload reserve e.g. to handle breakaway torques.

In drives with overload requirements, the appropriate base load current must, therefore, be used as a basis for the required load.

The criterion for overload is that the drive is operated with its base load current before and after the overload occurs (a load duration of 300 s is used as a basis here).

### Low overload

The base load current for low overload ($I_L$) is based on a load duty cycle of 110% for 60 s or 150% for 10 s.

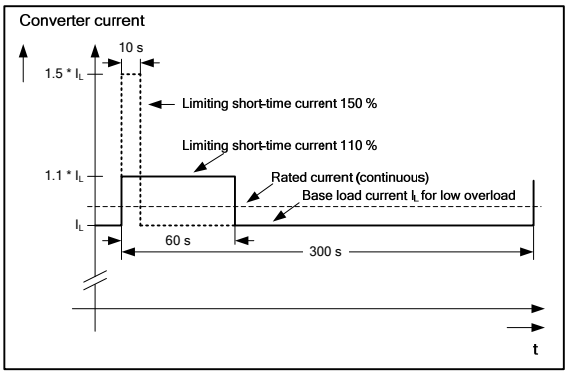



Fig. 5-10 Low overload

### High overload

The base load current for a high overload (IH) is based on a duty cycle of 150% for 60 s or 160% for 10 s.

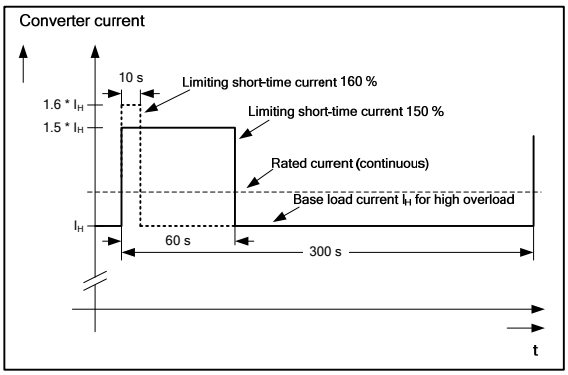



Fig. 5-11 High overload

## 5.6.2 Derating factors

### 5.6.2.1 Derating factors as a function of coolant temperature

SINAMICS S120 Liquid Cooled units are designed for cooling by $H_2O$ or by an $H_2O$ / Antifrogen N mixture. An $H_2O$ / Antifrogen N mixture must contain between 20 % and 45 % Antifrogen N.

When $H_2O$ is used as a coolant, the units can supply 100 % output current at temperatures between 5 °C and 45 °C, and 90 % output current at temperatures between 45 °C and 50 °C.

When the $H_2O$ / Antifrogen N mixture described above is used as a coolant, the units can supply 100 % output current at temperatures between 0 °C and 45 °C. The maximum output current decreases linearly to 90 % at temperatures between 45 °C and 50 °C.

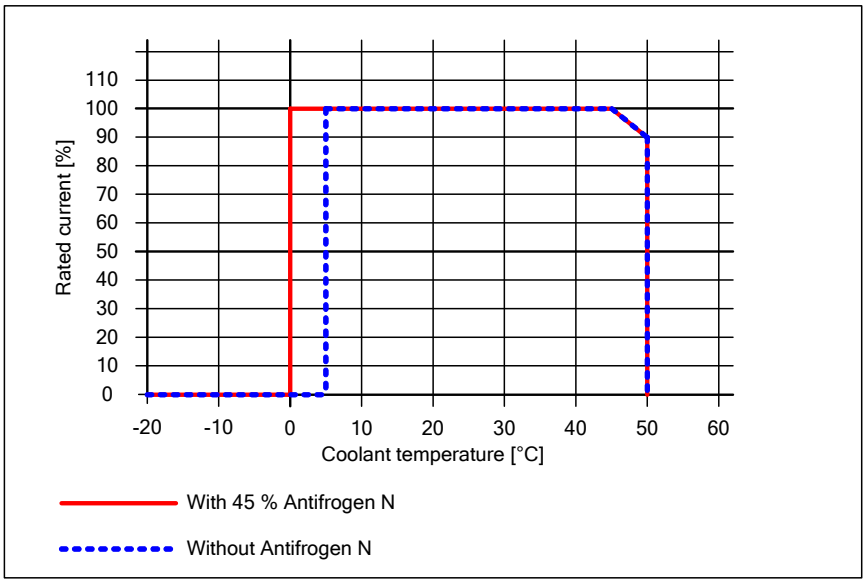



Fig. 5-12 Maximum output current as a function of coolant temperature

### 5.6.2.2 Derating factors as a function of ambient temperature

The units can supply 100 % output current at an ambient air temperature of between 0 °C and 45 °C. The maximum output current decreases linearly to 90 % at ambient air temperatures of between 45 °C and 50 °C.

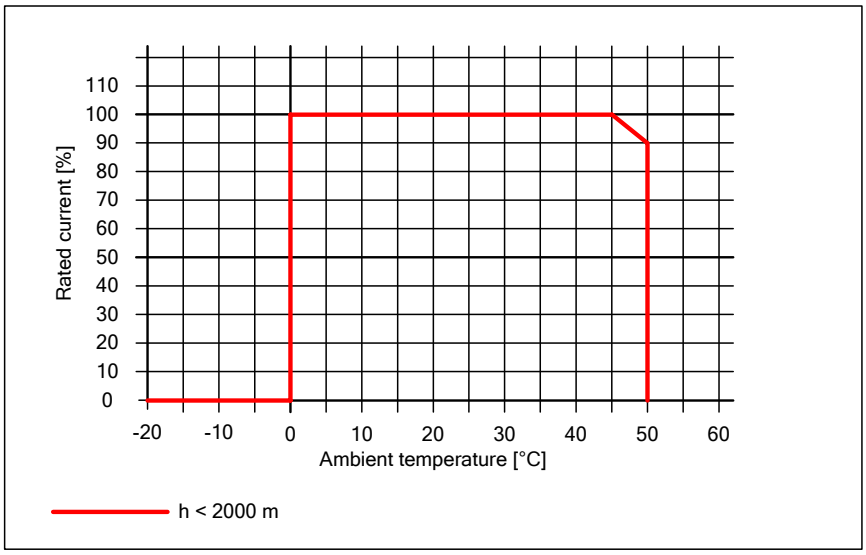



Fig. 5-13 Maximum output current as a function of ambient temperature

### 5.6.2.3 Derating factors as a function of installation altitude

When the units are operated at an installation altitude with reduced air pressure, the derating characteristic shown below applies to the output current or the ambient air temperature.

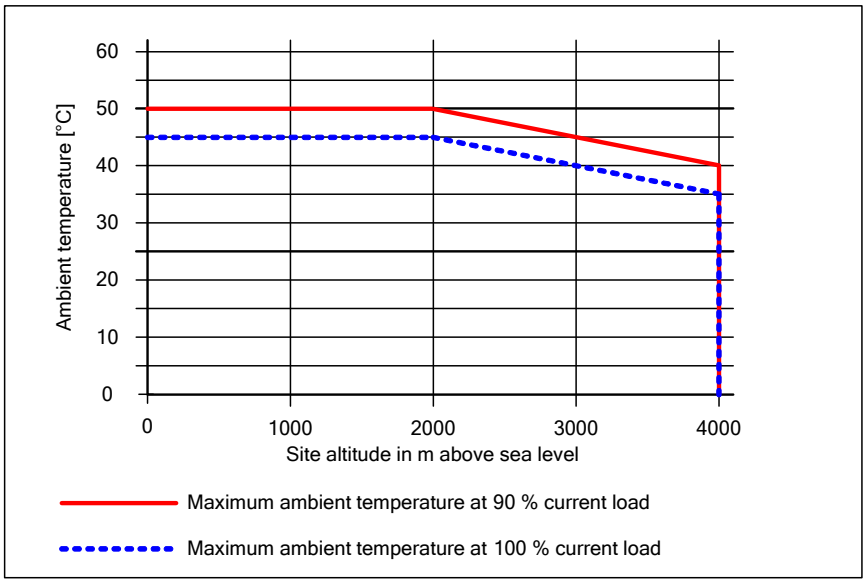



Fig. 5-14 Maximum ambient temperature as a function of installation altitude

### 5.6.2.4 Current derating as a function of pulse frequency

When the pulse frequency is increased, the derating factor of the output current must be taken into account.
This derating factor must be applied to the currents specified in the technical specifications in Table 5-7 and Table 5-8.

Table 5-9 Derating factor of the output current as a function of the pulse frequency for devices with a rated pulse frequency of 2 kHz

| Order no. 6SL3325-... | Power [kW] | Output current at pulse frequency of 2 kHz [A] | Derating factor at pulse frequency of 4 kHz | Derating factor at pulse frequency of 8 kHz |
|---|---|---|---|---|
| Connection voltage 510 – 720 V DC | | | | |
| 1TE33-1AA0 | 160 | 310 | 88 % | 50 % |
| 1TE35-0AA0 | 250 | 490 | 78 % | 50 % |

Table 5-10 Derating factor of the output current as a function of the pulse frequency for devices with a rated pulse frequency of 1.25 kHz

| Order no. 6SL3325-... | Power [kW] | Output current at pulse frequency of 1.25 kHz [A] | Derating factor at pulse frequency of 2.5 kHz | Derating factor at pulse frequency of 5 kHz |
|---|---|---|---|---|
| Connection voltage 675 – 1080 V DC | | | | |
| 1TG35-8AA0 | 560 | 575 | 85 % | 50 % |
| 1TG38-1AA0 | 800 | 810 | 95 % | 55 % |
| 1TG41-0AA0 | 1000 | 1025 | 86 % | 50 % |
| 1TG41-3AA0 | 1200 | 1270 | 79 % | 40 % |

**Note**

For pulse frequencies in the range between the specified fixed values, the relevant derating factors can be determined by linear interpolation.

### Maximum output frequencies achieved by increasing the pulse frequency

By multiplying the rated pulse frequency with a multiple integer, the following output frequencies can be achieved taking into account the derating factors in Table 5-9 and Table 5-10:

Table 5-11 Maximum output frequencies achieved by increasing the pulse frequency

| Pulse frequency [kHz] | Maximum output frequency [Hz] |
|---|---|
| 1.25 | 100 |
| 2 | 160 |
| 2.5 | 200 |
| 4 | 300 [1)] |
| 5 | 300 [1)] |

[1)] Due to the closed-loop control, the maximum output frequency is limited to 300 Hz.

## 5.6.3 Parallel switching of Motor Modules

The following rules must be followed for parallel switching of Motor Modules:

- Up to four identical Motor Modules can be switched parallel.
- Parallel switching can only be implemented with a common Control Unit.
- The length of the motor supply lines must be the same (symmetric structure).
- The motor modules must be supplied by a common intermediate circuit.
- For motors with a development system supply line with a minimum line length must be used, the respective line lengths are shown in the tables below.
- A derating factor of 5 % must be taken into account, regardless of the number of Motor Modules switched in parallel.

### Minimum line lengths for parallel switching and connection to a motor with development system

**Attention**

The minimum motor line lengths shown in the tables below must be complied with for parallel switching of two or more Motor Modules, and connection to a motor with a development system. If the required line length cannot be achieved in the application then a motor reactor must be provided.

Table 5-12 Motor Modules, 510 V - 720 V DC

| Order number | Power [kW] | Output current [A] | Minimum line length [m] |
|---|---|---|---|
| 6SL3320-1TE33-1AA0 | 160 | 310 | 20 |
| 6SL3320-1TE35-0AA0 | 250 | 490 | 15 |

Table 5-13 Motor Modules, 675 V - 1035 V DC

| Order number | Power [kW] | Output current [A] | Minimum line length [m] |
|---|---|---|---|
| 6SL3320-1TG35-8AA0 | 560 | 575 | 20 |
| 6SL3320-1TG38-1AA0 | 800 | 810 | 15 |
| 6SL3320-1TG41-0AA0 | 1000 | 1025 | 10 |
| 6SL3320-1TG41-3AA0 | 1200 | 1270 | 8 |

# Motor-Side Power Components

# 6

## 6.1 Sinusoidal Filter

### 6.1.1 Description

If a sinusoidal filter is connected to the output of the Power Modules or Motor Modules, the voltage between the motor terminals is virtually sinusoidal. This reduces the voltage load on the motor windings and prevents motor noise that would be induced by the pulse frequency.

Sinusoidal filters with an output of up to 200 kW are available.

The pulse frequency of the Power Modules or Motor Modules must be set to 4 kHz for the sinusoidal filters. This reduces the output current of the Power Modules or Motor Modules (see section 3.7.2.4 or 5.6.2.4)

When a sinusoidal filter is used, the available output voltage decreases by 15%.

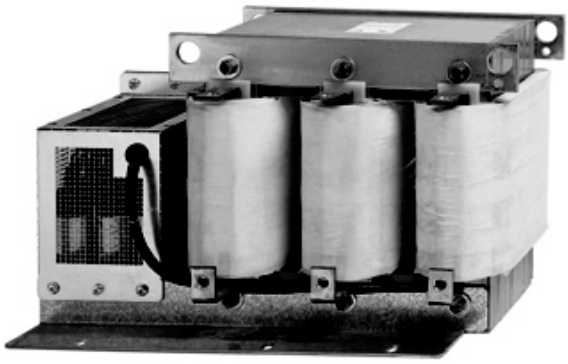


Fig. 6-1 Sinusoidal filter

## 6.1.2 Safety Information

**Caution**

The 100 mm clearances above and to the side of the component must be observed.

**Hinweis**

The connection lines to the Power Module or Motor Module must be kept as short as possible (max. 5 m).

**Caution**

The terminals must be correctly connected:

- Incoming cable from Power Module or Motor Module to 1U1, 1V1, 1W1, and
- Outgoing cable to the load 1U2, 1V2, 1W2.

Non-observance may damage the sinusoidal filter.

**Caution**

Using sinusoidal filters not approved by SIEMENS for SINAMICS can damage/destroy the Power Modules or Motor Modules.



**Caution**

The surface temperature of the sinusoidal filters may exceed 80°C.

**Caution**

If a sinusoidal filter is connected to the Power Module or Motor Module, the converter must be activated during commissioning (p0230 = 3) to prevent the filter from being destroyed.

If a sinusoidal filter is connected to the Power Module or Motor Module, the Power Module or Motor Module must not be operated without a connected motor because otherwise the filter can be destroyed.

**Caution**

The maximum permissible output frequency when sinusoidal filters are used is 150 Hz.

## 6.1.3 Dimension Drawing

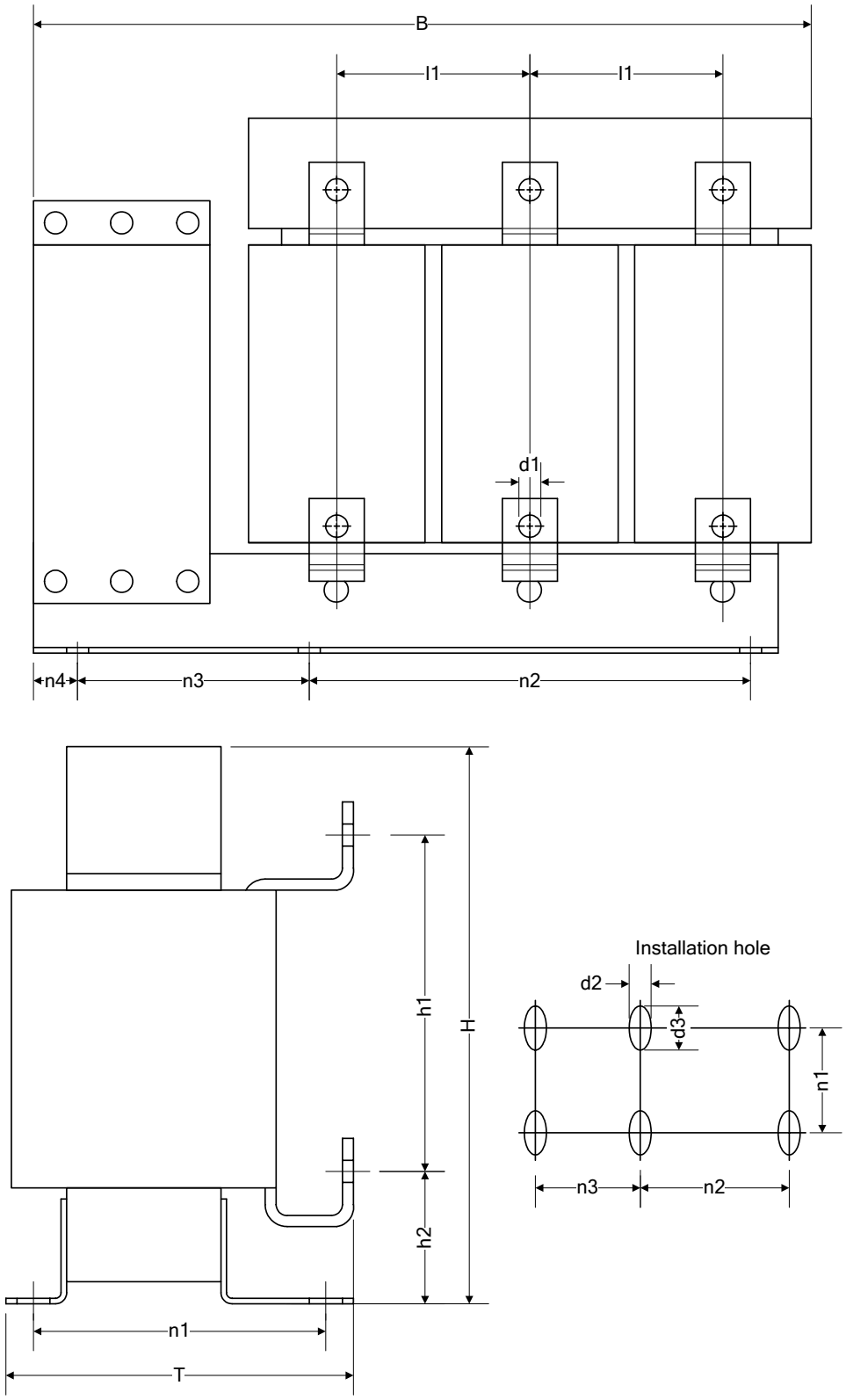



Fig. 6-2 Dimension drawing of sinusoidal filter

Table 6-1 Dimensions of the sinusoidal filter (all specifications in mm)

| 6SL3000- | 2CE32-3AA0 | 2CE32-8AA0 | 2CE34-1AA0 | |
|---|---|---|---|---|
| B | 620 | 620 | 620 | |
| H | 320 | 320 | 360 | |
| T | 300 | 300 | 370 | |
| l1 | 140 | 140 | 140 | |
| h1 | 180 | 180 | 220 | |
| h2 | 65 | 65 | 65 | |
| n1 [1)] | 280 | 280 | 320 | |
| n2 [1)] | 150 | 150 | 150 | |
| n3 [1)] | 225 | 225 | 225 | |
| n4 | 105 | 105 | 105 | |
| d1 | 12 | 12 | 12 | |
| d2 | 11 | 11 | 11 | |
| d3 | 22 | 22 | 22 | |
| [1)] Lengths n1, n2, and n3 correspond to the drill hole spacing | | | | |

## 6.1.4 Technical Specifications

Table 6-2 Technical specifications for the sinusoidal filter for 380 V – 480 V 3 AC

| Order number | 6SL3000- | 2CE32-3AA0 | 2CE32-3AA0 | 2CE32-8AA0 | 2CE34-1AA0 |
|---|---|---|---|---|---|
| Suitable for Power Module | 6SL3315- | 1TE32-1AA0 | 1TE32-6AA0 | 1TE33-1AA0 | 1TE35-0AA0 |
| Suitable for Motor Module | 6SL3325- | - | - | 1TE33-1AA0 | 1TE35-0AA0 |
| Rated current (output) of the Power Modules or Motor Modules with sinusoidal filter at pulse frequency of 4 kHz | | 170 A<br>(90 kW) | 215 A<br>(110 kW) | 270 A<br>(132 kW) | 380 A<br>(200 kW) |
| Output current at pulse frequency of 4 kHz | A | 225 | 225 | 276 | 408 |
| Maximum output frequency | Hz | 150 | 150 | 150 | 150 |
| Power loss<br>- at 50 Hz<br>- at 150 Hz | <br>kW<br>kW | <br>0.35<br>0.6 | <br>0.35<br>0.6 | <br>0.4<br>0.69 | <br>0.38<br>0.7 |
| Connections<br>- to Power Module or Motor Module<br>- Load | | Connection lugs M10<br>Connection lugs M10 | | | |
| Max. motor cable length between sinusoidal filter and motor | m | 300 (shielded)<br>450 (unshielded) | | | |
| Degree of protection | | IP00 | IP00 | IP00 | IP00 |
| Dimensions<br>Width<br>Height<br>Depth | <br>mm<br>mm<br>mm | <br>620<br>300<br>320 | <br>620<br>300<br>320 | <br>620<br>300<br>320 | <br>620<br>370<br>360 |
| Weight | kg | 124 | 124 | 127 | 198 |

# 6.2 Motor reactors

## 6.2.1 Description

Motor reactors reduce the voltage stress on the motor windings by reducing the voltage gradients at the motor terminals that occur when motors are fed from drive converters. At the same time, the capacitive charge/discharge currents that also occur on the output of the Power Module or Motor Module when long motor cables are used are reduced.

## 6.2.2 Safety information

**Caution**

The 100 mm clearances above and to the side of the components must be observed.

**Note**

The connecting cables to the Power Module or Motor Module must be kept as short as possible (max. 5 m).

**Caution**

When using motor reactors that SIEMENS has not approved for SINAMICS, then these can thermally damage the reactor.



**Caution**

The surface temperature of the motor reactors can exceed 80 °C.

**Caution**

The maximum permissible output frequency when motor reactors are used is 150 Hz.

## 6.2.3 Dimension drawing

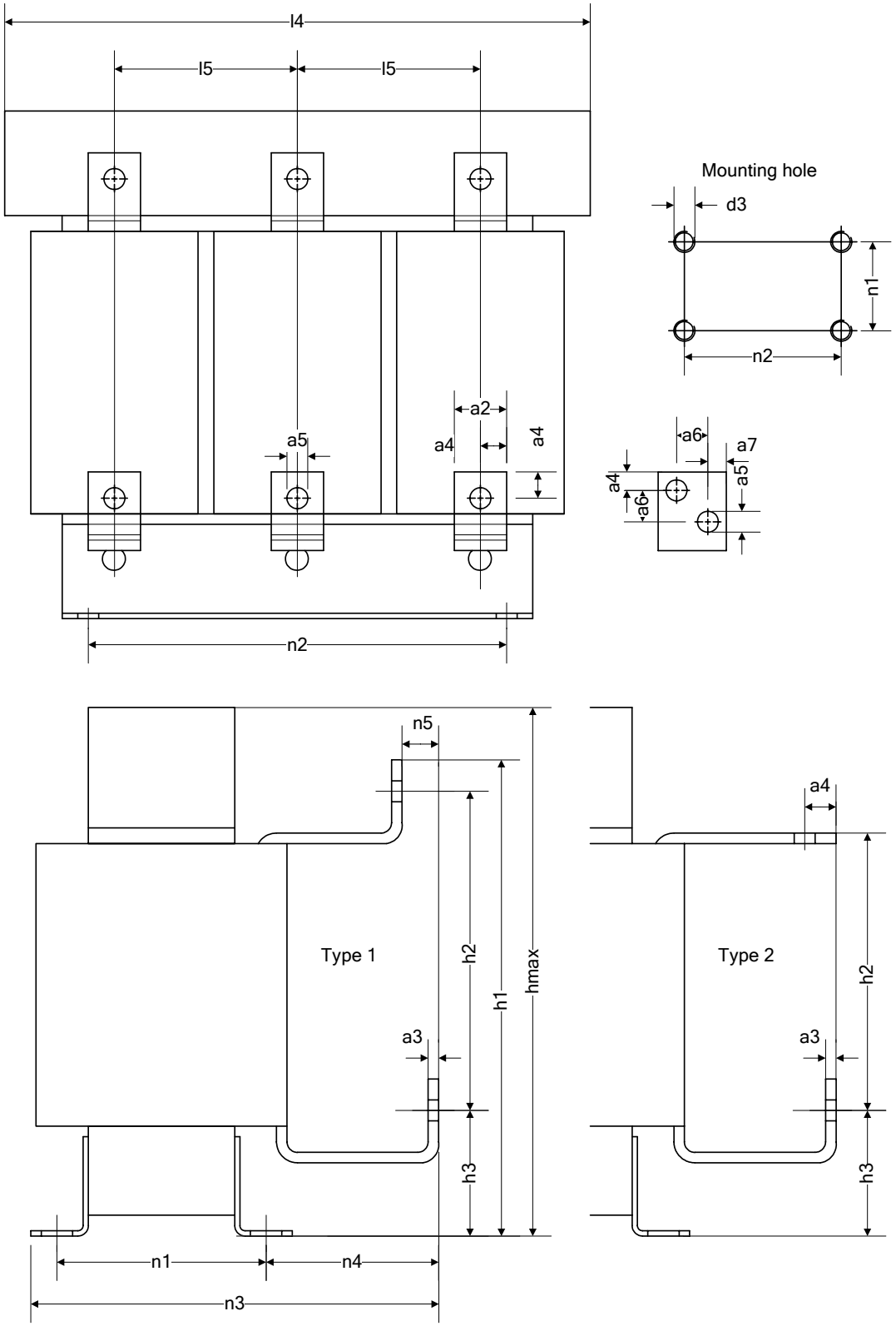



Fig. 6-3 Dimension drawing of motor reactor

Table 6-3 Dimensions of motor reactors (380 V – 480 V 3 AC) (all specifications in mm)

| 6SL3000- | 2BE32-1AA0 | 2BE32-6AA0 | 2BE33-2AA0 | 2BE35-0AA0 |
|---|---|---|---|---|
| Connection type | Type 1 | Type 1 | Type 1 | Type 1 |
| a2 | 25 | 25 | 25 | 30 |
| a3 | 5 | 5 | 5 | 6 |
| a4 | 12.5 | 12.5 | 12.5 | 15 |
| a5 | 11 | 11 | 11 | 14 |
| a6 | - | - | - | - |
| a7 | - | - | - | - |
| l4 | 300 | 300 | 300 | 300 |
| l5 | 100 | 100 | 100 | 100 |
| hmax | 285 | 315 | 285 | 365 |
| h1 | - | - | - | - |
| h2 | 194 | 227 | 194 | 245 |
| h3 | 60 | 60 | 60 | 60 |
| n1 [1)] | 163 | 183 | 163 | 183 |
| n2 [1)] | 224 | 224 | 224 | 224 |
| n3 | 257 | 277 | 257 | 277 |
| n4 | 79 | 79 | 79 | 79 |
| n5 | - | - | - | - |
| d3 | M8 | M8 | M8 | M8 |
| [1)] Dimensions n1 and n2 correspond to the drill hole spacing | | | | |

Table 6-4 Dimensions of motor reactors (500 V – 690 V 3 AC) (all specifications in mm)

| 6SL3000- | 2AH35-8AA0 | 2AH38-1AA0 | 2AH41-1AA0 | 2AH41-3AA0 |
|---|---|---|---|---|
| Connection type | Type 1 | Type 1 | Type 1 | Type 1 |
| a2 | 40 | 40 | 50 | 60 |
| a3 | 8 | 8 | 8 | 12 |
| a4 | 20 | 20 | 14 | 17 |
| a5 | 14 | 14 | 14 | 14 |
| a6 | - | - | 22 | 22 |
| a7 | - | - | - | 19 |
| l4 | 410 | 410 | 410 | 460 |
| l5 | 140 | 140 | 140 | 160 |
| hmax | 385 | 385 | 385 | 385 |
| h1 | 392 | 392 | 392 | 392 |
| h2 | 252 | 252 | 258 | 255 |
| h3 | 120 | 120 | 120 | 120 |
| n1 [1)] | 141 | 183 | 206 | 182 |
| n2 [1)] | 316 | 316 | 316 | 356 |
| n3 | 292 | 279 | 317 | 296 |
| n4 | 134.5 | 79.5 | 94.5 | 94.5 |
| n5 | 30 | - | - | - |
| d3 | M10 | M10 | M10 | M10 |
| [1)] Dimensions n1 and n2 correspond to the drill hole spacing | | | | |

## 6.2.4 Technical specifications

Table 6-5 Technical specifications for motor reactors (380 V – 480 V 3 AC)

| Order number | 6SL3000- | 2BE32-1AA0 | 2BE32-6AA0 | 2BE33-2AA0 | 2BE35-0AA0 |
|---|---|---|---|---|---|
| Suitable for Power Module | 6SL3315- | 1TE32-1AA0 | 1TE32-6AA0 | 1TE33-1AA0 | 1TE35-0AA0 |
| Suitable for Motor Module | 6SL3325- | - | - | 1TE33-1AA0 | 1TE35-0AA0 |
| Rated power of Power Module or Motor Modules | kW | 110 | 132 | 160 | 250 |
| Rated current | A | 210 | 260 | 310 | 490 |
| Power loss | kW | 0.486 | 0.5 | 0.47 | 0.5 |
| Connections<br>- to Power Module or Motor Module<br>- Load<br>- PE | | <br>M10<br>M10<br>M8 | <br>M10<br>M10<br>M8 | <br>M10<br>M10<br>M8 | <br>M10<br>M10<br>M8 |
| Max. permissible cable length between motor reactor and motor | m | 300 (shielded)<br>450 (unshielded) | | | |
| Degree of protection | | IP00 | IP00 | IP00 | IP00 |
| Dimensions<br>Width<br>Height<br>Depth | <br>mm<br>mm<br>mm | <br>300<br>285<br>257 | <br>300<br>315<br>277 | <br>300<br>285<br>257 | <br>300<br>365<br>277 |
| Weight, approx. | kg | 66 | 66 | 66 | 100 |

Table 6-6 Technical specifications for motor reactors (500 V – 690 V 3 AC)

| Order number | 6SL3000- | 2AH35-8AA0 | 2AH38-1AA0 | 2AH41-1AA0 | 2AH41-3AA0 |
|---|---|---|---|---|---|
| Suitable for Motor Module | 6SL3325- | 1TG35-8AA0 | 1TG38-1AA0 | 1TG41-0AA0 | 1TG41-3AA0 |
| Rated power of Motor Module | kW | 560 | 800 | 1000 | 1200 |
| Rated current | A | 575 | 810 | 1025 | 1270 |
| Power loss | kW | 0.8 | 1.0 | 1.05 | 0.95 |
| Connections<br>- to Motor Module<br>- Load<br>- PE | | <br>M12<br>M12<br>M8 | <br>M12<br>M12<br>M8 | <br>M12<br>M12<br>M8 | <br>M12<br>M12<br>M8 |
| Max. permissible cable length between motor reactor and motor | m | 300 (shielded)<br>450 (unshielded) | | | |
| Degree of protection | | IP00 | IP00 | IP00 | IP00 |
| Dimensions<br>Width<br>Height<br>Depth | <br>mm<br>mm<br>mm | <br>410<br>392<br>292 | <br>410<br>392<br>279 | <br>410<br>392<br>317 | <br>410<br>392<br>296 |
| Weight, approx. | kg | 80 | 146 | 163 | 166 |

# 6.3 dv/dt filter with Voltage Peak Limiter

## 6.3.1 Description

The dv/dt filter with VPL (Voltage Peak Limiter) consists of two components: The dv/dt reactor and the voltage limiting network (Voltage Peak Limiter), which limits voltage peaks and returns the energy to the DC link.

The dv/dt filters with Voltage Peak Limiter must be used for motors for which the voltage strength of the insulation system is unknown or insufficient. Standard motors of the 1LA5, 1LA6 and 1LA8 series only require them at supply voltages > 500 V +10%.

The dv/dt filters with Voltage Peak Limiter limit the rate of voltage rise to values < 500 V/µs and the typical voltage peaks at rated line voltage to the values below (with motor cable lengths of < 150 m):

< 1000 V with $U_{line}$ < 575 V

< 1250 V with 660 V < $U_{line}$ < 690 V.

### Components

The Order Nos. of the individual components (dv/dt reactor and voltage limiting network) are listed in the following table:

Table 6-7 dv/dt filter plus Voltage Peak Limiter, order numbers of individual components

| dv/dt filter plus Voltage Peak Limiter | dv/dt reactor | Voltage limiting network |
|---|---|---|
| Supply voltage 380 V – 480 V | | |
| 6SL3000-2DE32-6AA0 | 6SL3000-2DE32-6CA0 | 6SL3000-2DE32-6BA0 |
| 6SL3000-2DE35-0AA0 | 6SL3000-2DE35-0CA0 | 6SL3000-2DE35-9BA0 |
| Supply voltage 500 V – 690 V | | |
| 6SL3000-2DH35-8AA0 | 6SL3000-2DH35-8CA0 | 6SL3000-2DH35-8BA0 |
| 6SL3000-2DH38-1AA0 | 2 x 6SL3000-2DH38-1DA0 | 6SL3000-2DH38-1BA0 |
| 6SL3000-2DH41-3AA0 | 2 x 6SL3000-2DH41-3DA0 | 6SL3000-2DH41-3BA0 |



**Warning**

When a dv/dt filter with Voltage Peak Limiter is used, the pulse frequency of the Power Modules or Motor Module must not exceed 2.5 kHz or 4 kHz. Setting a higher pulse frequency could cause irreparable damage to the dv/dt filter.

Table 6-8 Max. pulse frequency when a dv/dt filter is used in devices with a rated pulse frequency of 2 kHz

| Order no | Power [kW] | Output current at pulse frequency of 2 kHz [A] | Max. pulse frequency when a dv/dt filter is used |
|---|---|---|---|
| Connection voltage: 510 – 720 V DC | | | |
| 6SL3315-1TE32-1AA0 | 110 | 210 | 4 kHz |
| 6SL3315-1TE32-6AA0 | 132 | 260 | 4 kHz |
| 6SL3315-1TE33-1AA0 | 160 | 310 | 4 kHz |
| 6SL3325-1TE33-1AA0 | 160 | 310 | 4 kHz |
| 6SL3315-1TE35-0AA0 | 250 | 490 | 4 kHz |
| 6SL3325-1TE35-0AA0 | 250 | 490 | 4 kHz |

Table 6-9 Max. pulse frequency when a dv/dt filter is used in devices with a rated pulse frequency of 1.25 kHz

| Order no | Power [kW] | Output current at pulse frequency of 1.25 kHz [A] | Max. pulse frequency when a dv/dt filter is used |
|---|---|---|---|
| Connection voltage: 675 – 1035 V DC | | | |
| 6SL3325-1TG35-8AA0 | 560 | 575 | 2.5 kHz |
| 6SL3325-1TG38-1AA0 | 800 | 810 | 2.5 kHz |
| 6SL3325-1TG41-0AA0 | 1000 | 1025 | 2.5 kHz |
| 6SL3325-1TG41-3AA0 | 1200 | 1270 | 2.5 kHz |

## 6.3.2 Safety information

**Caution**

The ventilation clearances of 100 mm above and below the components must be observed.

**Note**

The connecting cables to the Power Module or Motor Module must be kept as short as possible (max. 5 m).

**Caution**

The terminals on the voltage limiting network (Voltage Peak Limiter) must always be connected as specified below:

- Cable from the DC link to the Power Module or Motor Module to DCPS, DCNS and
- cable to the dv/dt reactor to 1U2, 1V2, 1W2.

Failure to connect the terminals correctly could damage the voltage limiting network.

**Caution**

dv/dt filters with Voltage Peak Limiter that SIEMENS has not approved for SINAMICS might sustain thermal damage when used in a SINAMICS unit.



**Caution**

The surface temperature of the dv/dt reactors can exceed 80 °C.

**Caution**

The maximum permissible output frequency when using dv/dt filters with Voltage Peak Limiter is 150 Hz.

### 6.3.3 Interface description

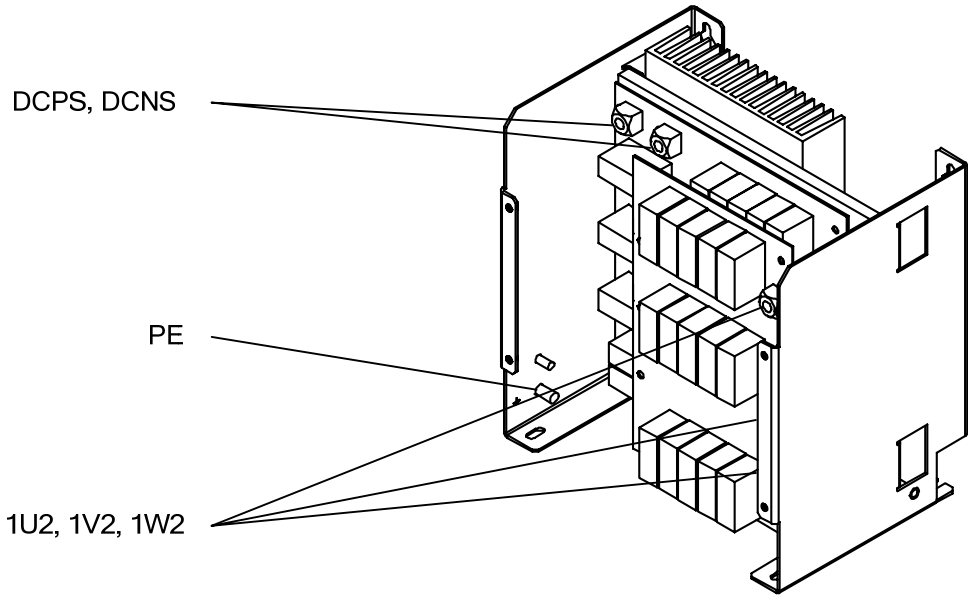



Fig. 6-4 Overview of voltage limiting network interfaces, type 1

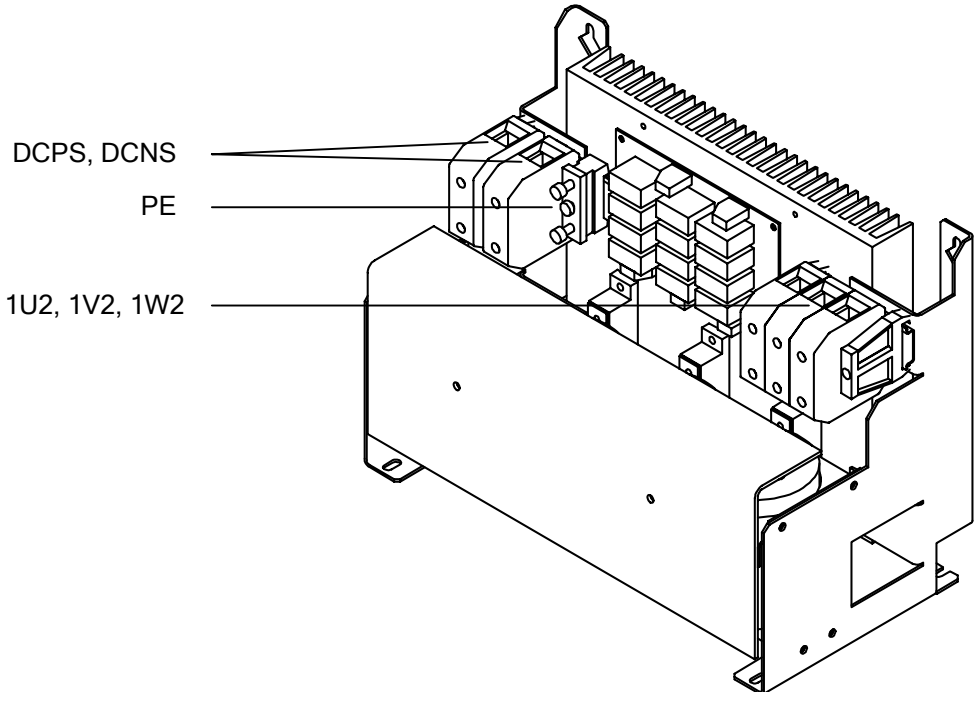



Fig. 6-5 Overview of voltage limiting network interfaces, type 2

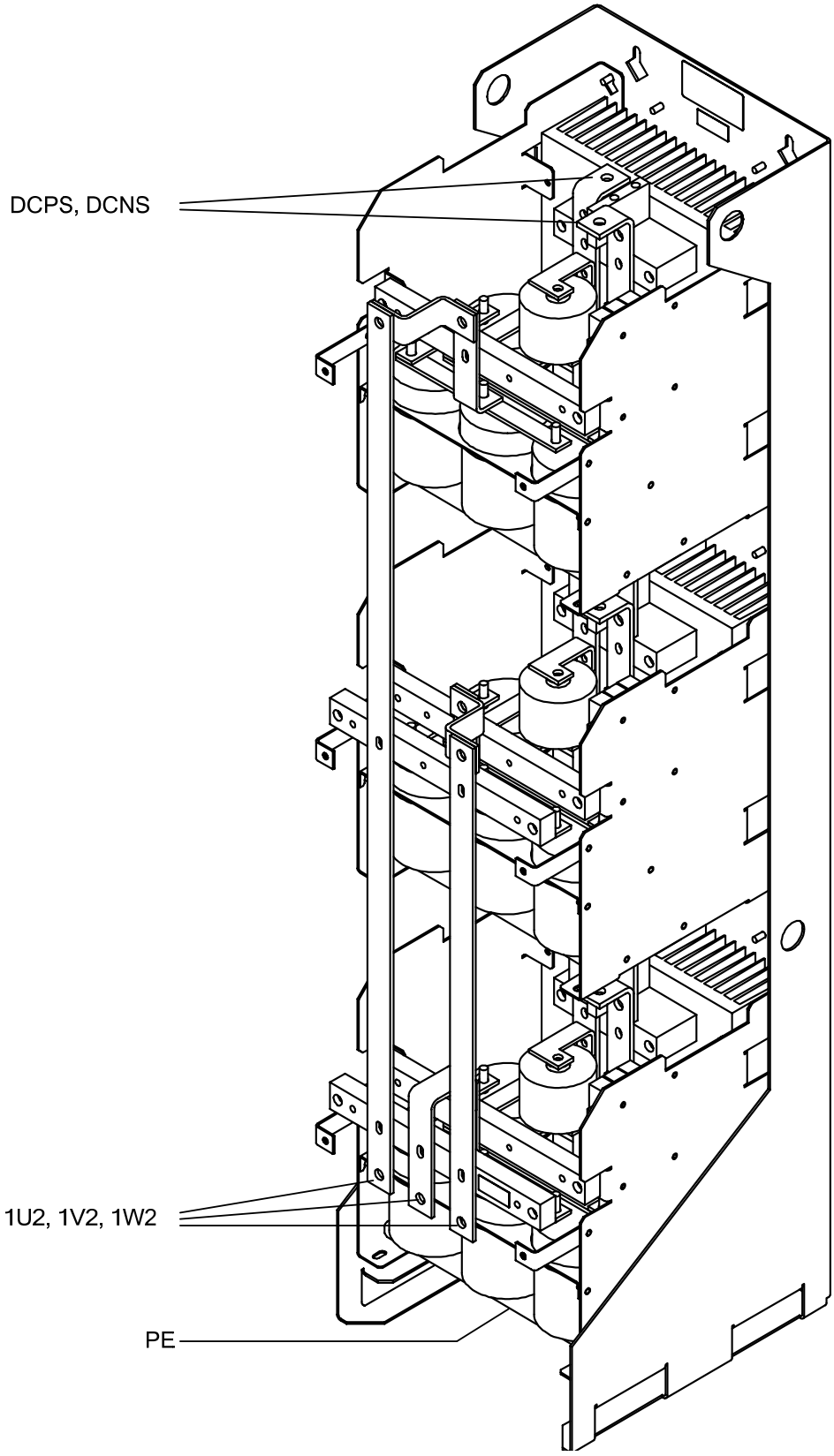



Fig. 6-6 Overview of voltage limiting network interfaces, type 3

## 6.3.4 Connecting the dv/dt filter with Voltage Peak Limiter

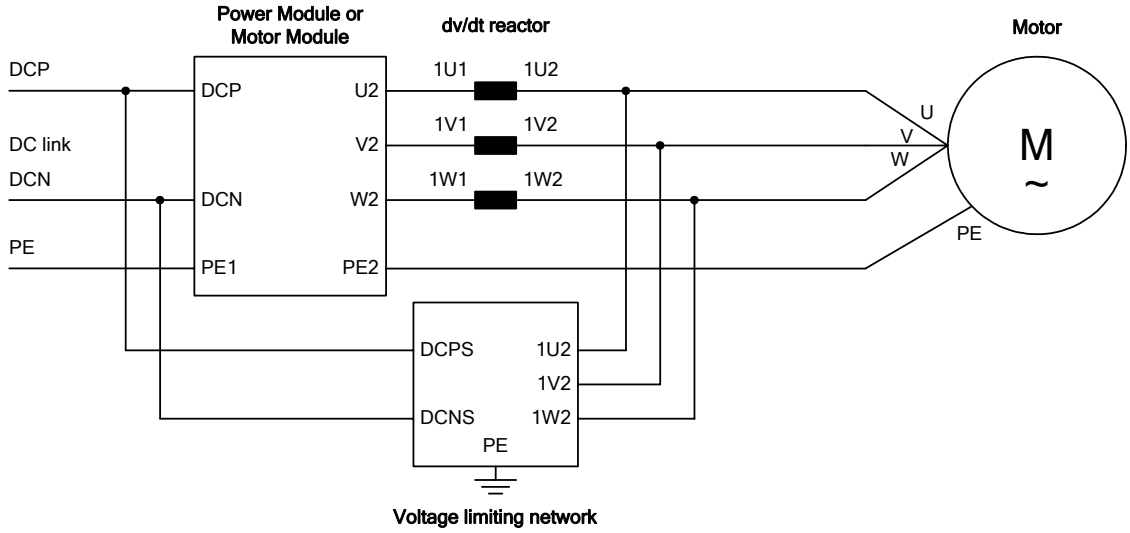



Fig. 6-7 Connecting the dv/dt filter with Voltage Peak Limiter for versions with one dv/dt reactor

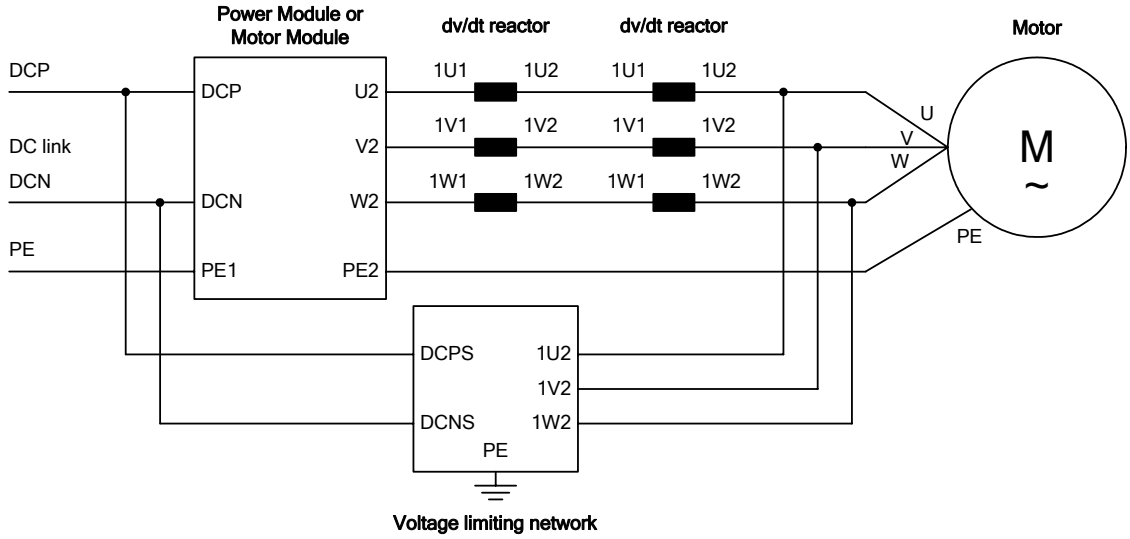



Fig. 6-8 Connecting the dv/dt filter with Voltage Peak Limiter for versions with two dv/dt reactors

## Cable cross-sections

Table 6-10 Cable cross-sections for connections between the dv/dt filter with Voltage Peak Limiter and the Power Module or Motor Module

| dv/dt filter plus Voltage Peak Limiter | Connection to DC link (DCPS / DCNS) [mm²] | Connection between dv/dt reactor and voltage limiting network (1U2, 1V2, 1W2) [mm²] |
|---|---|---|
| **Supply voltage: 380 V – 480 V** | | |
| 6SL3000-2DE32-6AA0 | 35 | 10 |
| 6SL3000-2DE35-0AA0 | 70 | 16 |
| **Supply voltage: 500 V – 690 V** | | |
| 6SL3000-2DH35-8AA0 | 120 | 35 |
| 6SL3000-2DH38-1AA0 | 2 x 70 | 70 |
| 6SL3000-2DH41-3AA0 | 2 x 120 | 120 |

**Note**

The connections should be kept as short as possible.
The maximum cable length for the specified connections is 5 m in each case.

## 6.3.5 Dimension drawing of dv/dt reactor

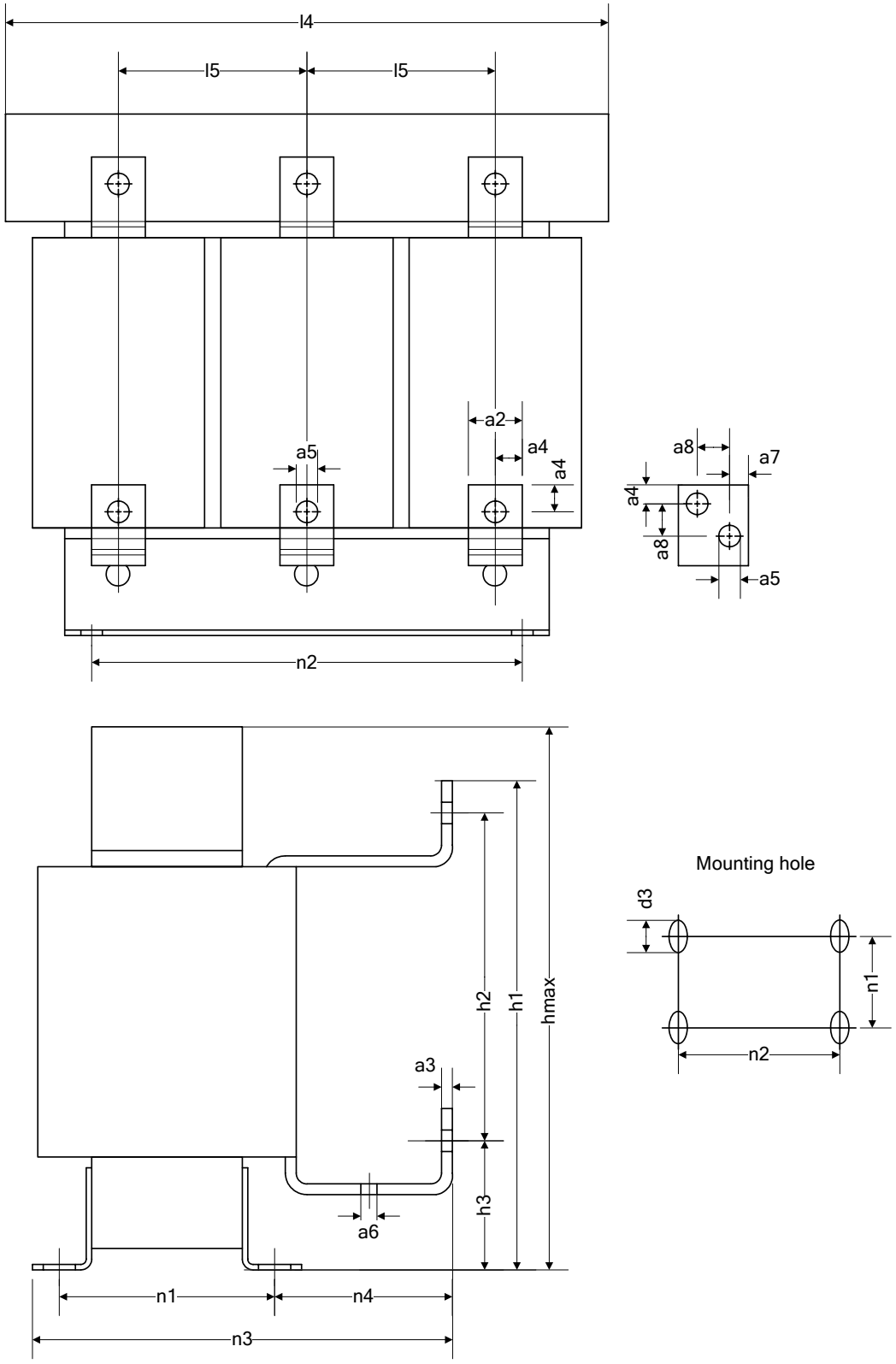



Fig. 6-9 Dimension drawing of dv/dt reactor

Table 6-11 Dimensions of dv/dt reactor (all specifications in mm)

| 6SL3000- | 2DE32-6CA0 | 2DE35-0CA0 | 2DH35-8CA0 | 2DH38-1DA0 | 2DH41-3DA0 |
|---|---|---|---|---|---|
| a2 | 25 | 30 | 40 | 50 | 60 |
| a3 | 5 | 6 | 8 | 8 | 10 |
| a4 | 14 | 17 | 22 | 16 | 19 |
| a5 | 10.5 x 14 | 15 x 18 | 14 x 18 | 14 x 18 | 14 x 18 |
| a6 | 7 | 9 | 11 | 11 | 11 |
| a7 | - | - | - | 14 | 17 |
| a8 | - | - | - | 22 | 26 |
| l4 | 410 | 460 | 460 | 445 | 445 |
| l5 | 135 | 152.5 | 152.5 | 145 | 145 |
| hmax | 370 | 370 | 385 | 385 | 385 |
| h2 | 258 | 240 | 280 | 255 | 250 |
| h3 | 76 | 83 | 78 | 114 | 121 |
| n1 [1)] | 141 | 182 | 212 | 212 | 212 |
| n2 [1)] | 316 | 356 | 365 | 341 | 341 |
| n3 | 229 | 275 | 312 | 312 | 312 |
| n4 | 72 | 71 | 78 | 78 | 78 |
| d3 | M10 (12 x 18) | M12 (15 x 22) | M12 (15 x 22) | M12 (15 x 22) | M12 (15 x 22) |
| [1)] Dimensions n1 and n2 correspond to the drill hole spacing | | | | | |

## 6.3.6 Dimension drawing of voltage limiting network

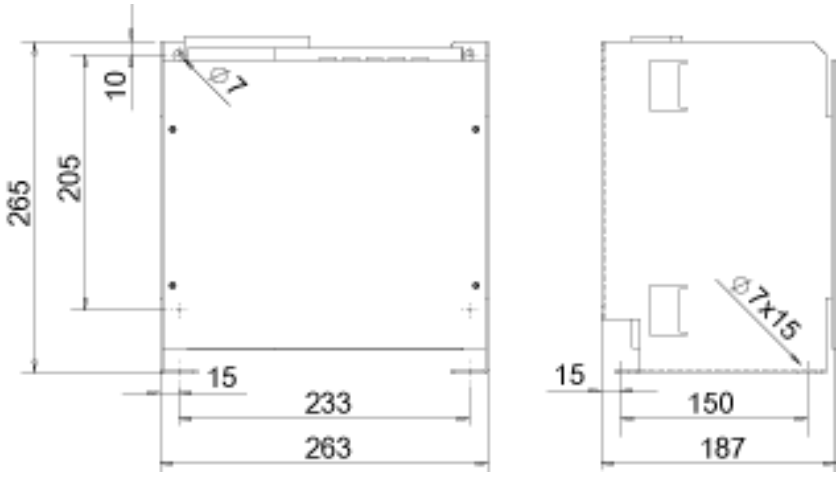



Fig. 6-10 Dimension drawing of voltage limiting network, type 1

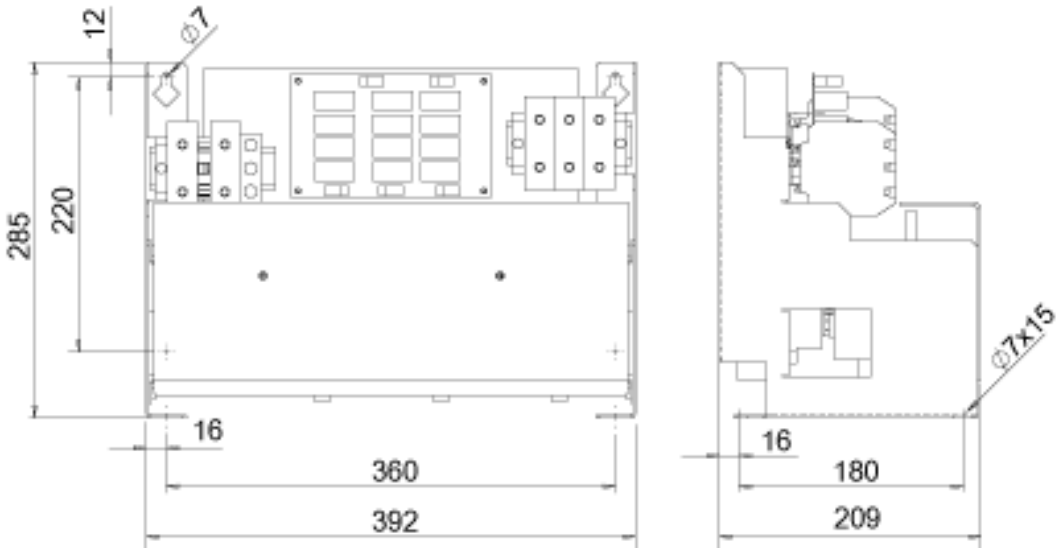



Fig. 6-11 Dimension drawing of voltage limiting network, type 2

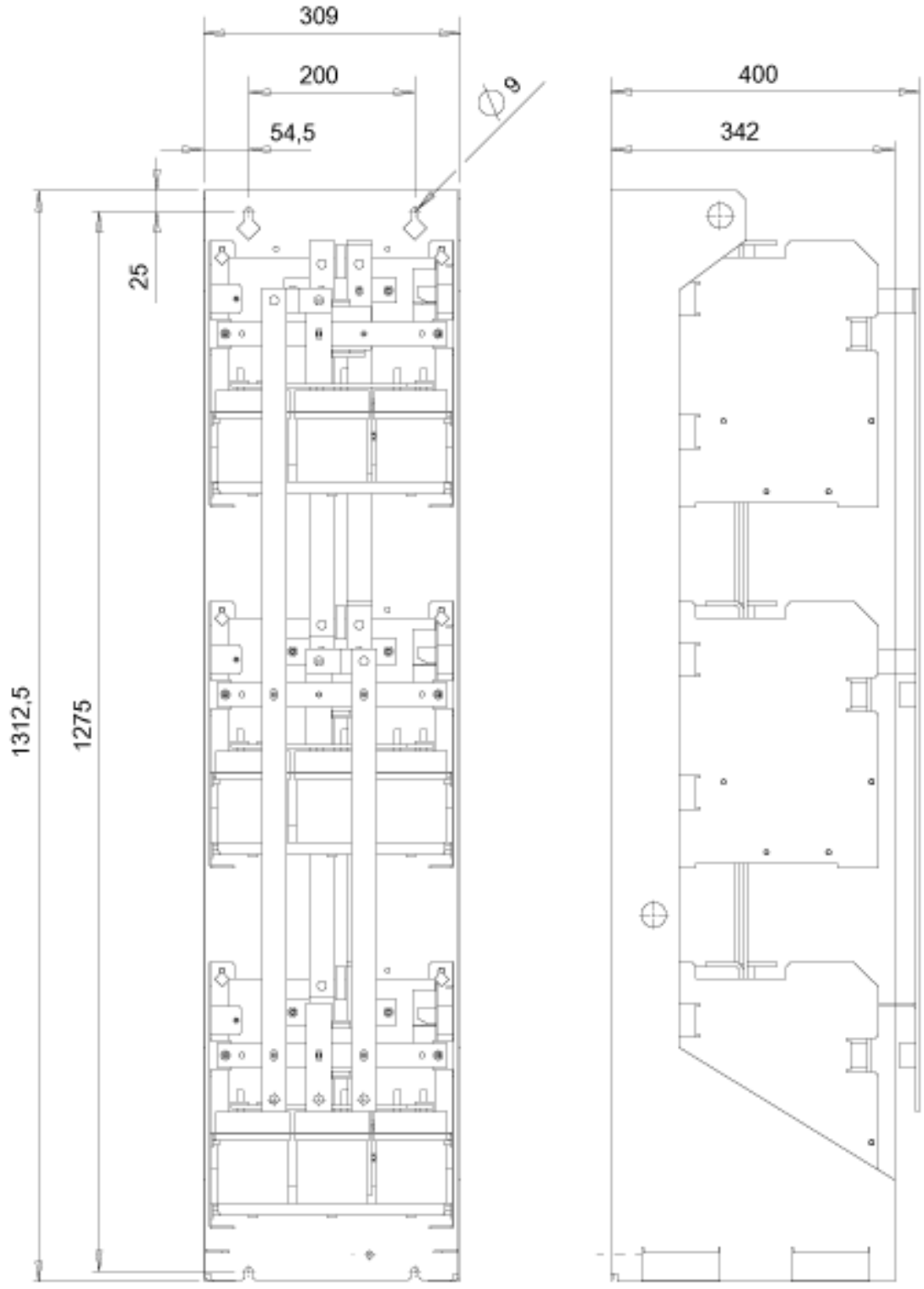



Fig. 6-12 Dimension drawing of voltage limiting network, type 3

Table 6-12 Assignment of the voltage limiting networks to dimension drawings

| Voltage limiting network | Dimension drawing type |
|---|---|
| **Supply voltage: 380 V – 480 V** | |
| 6SL3000-2DE32-6BA0 | Type 1 |
| 6SL3000-2DE35-0BA0 | Type 2 |
| **Supply voltage: 500 V – 690 V** | |
| 6SL3000-2DH35-8BA0 | Type 3 |
| 6SL3000-2DH38-1BA0 | Type 3 |
| 6SL3000-2DH41-3BA0 | Type 3 |

## 6.3.7 Technical specifications

Table 6-13 Technical specifications for dv/dt filter with Voltage Peak Limiter, 380 V – 480 V 3 AC

| **Order number** | **6SL3000-** | **2DE32-6AA0** | **2DE32-6AA0** | **2DE35-0AA0** | **2DE35-0AA0** |
|---|---|---|---|---|---|
| Suitable for Power Module | 6SL3315- | 1TE32-1AA0 | 1TE32-6AA0 | 1TE33-1AA0 | 1TE35-0AA0 |
| Suitable for Motor Module | 6SL3325- | - | - | 1TE33-1AA0 | 1TE35-0AA0 |
| Rated output of the Power Module or Motor Modules | kW | 110 | 132 | 160 | 250 |
| **dv/dt reactor** | | | | | |
| $I_{thmax}$ | A | 260 | 260 | 490 | 490 |
| Power loss, typical | kW | 0.573 | 0.573 | 0.696 | 0.696 |
| Connections<br>- to Power Module or Motor Module<br>- Load<br>- PE | | <br>M10<br>M10<br>M6 | <br>M10<br>M10<br>M6 | <br>M12<br>M12<br>M6 | <br>M12<br>M12<br>M6 |
| Max. permissible cable length between dv/dt reactor and motor | m | 300 (shielded)<br>450 (non-shielded) | | | |
| Degree of protection | | IP00 | IP00 | IP00 | IP00 |
| Dimensions<br>Width<br>Height<br>Depth | <br>mm<br>mm<br>mm | <br>410<br>370<br>229 | <br>410<br>370<br>229 | <br>460<br>370<br>275 | <br>460<br>370<br>275 |
| Weight, approx. | kg | 66 | 66 | 122 | 122 |
| **Voltage limiting network (Voltage Peak Limiter)** | | | | | |
| $I_{thmax}$ | A | 260 | 260 | 490 | 490 |
| Power loss | kW | 0.029 | 0.029 | 0.042 | 0.042 |
| Connections<br>- to dv/dt reactor<br>- DC<br>- PE | | <br>M8<br>M8<br>M8 | <br>M8<br>M8<br>M8 | <br>Terminal 70 mm²<br>Terminal 70 mm²<br>Terminal 35 mm² | <br>Terminal 70 mm²<br>Terminal 70 mm²<br>Terminal 35 mm² |
| Degree of protection | | IP00 | IP00 | IP00 | IP00 |
| Dimensions<br>Width<br>Height<br>Depth | <br>mm<br>mm<br>mm | <br>265<br>263<br>187 | <br>265<br>263<br>187 | <br>392<br>285<br>209 | <br>392<br>285<br>209 |
| Weight, approx. | kg | 6 | 6 | 16 | 16 |

Table 6-14 Technical specifications for dv/dt filter with Voltage Peak Limiter, 500 V – 690 V 3 AC

| Order number: | 6SL3000- | 2DH35-8AA0 | 2DH38-1AA0 | 2DH41-3AA0 | 2DH41-3AA0 |
|---|---|---|---|---|---|
| Suitable for Motor Module | 6SL3325- | 1TG35-8AA0 | 1TG38-1AA0 [1] | 1TG41-0AA0 [1] | 1TG41-3AA0 [1] |
| Rated output of the Motor Module | kW | 560 | 800 | 1000 | 1200 |
| **dv/dt reactor** | | | | | |
| $I_{thmax}$ | A | 575 | 810 | 1270 | 1270 |
| Power loss, typical | kW | 0.72 | 0.693 | 0.715 | 0.715 |
| Connections<br>- to Motor Module<br>- Load<br>- PE | | <br>M12<br>M12<br>M6 | <br>M12<br>M12<br>M6 | <br>M12<br>M12<br>M6 | <br>M12<br>M12<br>M6 |
| Max. permissible cable length between dv/dt reactor and motor | m | 300 (shielded)<br>450 (non-shielded) | | | |
| Degree of protection | | IP00 | IP00 | IP00 | IP00 |
| Dimensions<br>Width<br>Height<br>Depth | <br>mm<br>mm<br>mm | <br>460<br>385<br>312 | <br>445<br>385<br>312 | <br>445<br>385<br>312 | <br>445<br>385<br>312 |
| Weight, approx. | kg | 172 | 160 | 164 | 164 |
| **Voltage limiting network (Voltage Peak Limiter)** | | | | | |
| $I_{thmax}$ | A | 575 | 810 | 1270 | 1270 |
| Power loss | kW | 0.063 | 0.106 | 0.15 | 0.15 |
| Connections<br>- to dv/dt reactor<br>- DC<br>- PE | | <br>M8<br>M8<br>M8 | <br>M10<br>M10<br>M8 | <br>M10<br>M10<br>M8 | <br>M10<br>M10<br>M8 |
| Degree of protection | | IP00 | IP00 | IP00 | IP00 |
| Dimensions<br>Width<br>Height<br>Depth | <br>mm<br>mm<br>mm | <br>309<br>1312.5<br>400 | <br>309<br>1312.5<br>400 | <br>309<br>1312.5<br>400 | <br>309<br>1312.5<br>400 |
| Weight, approx. | kg | 48 | 72 | 72 | 72 |

**Note**

For versions with 2 dv/dt reactors, the cable lengths specified in the table must not be doubled.

[1] Two dv/dt reactors are required for these Motor Modules. The technical specifications provided apply to one dv/dt reactor.

# Cabinet Design and EMC

# 7

## 7.1 Information

### 7.1.1 General

The modular concept of SINAMICS S120 allows a wide range of potential device combinations. For this reason, it is impossible to describe each individual combination. This section instead aims to provide some basic information and general rules on the basis of which special device combinations can be physically constructed and to ensure electromagnetic compatibility.

The SINAMICS S120 components are designed for installation in housing, cabinet units or switching boxes made of steel that provide protection against shock and other environmental influences. These are also integrated in the EMC concept.

## 7.1.2 Safety information



**Warning**

When transporting the devices and replacing components, note the following:

- Some of the devices and components are heavy or top heavy.
- Due to their weight, the devices must be handled with care by trained personnel.
- Improper lifting and handling can cause serious or fatal injury to personnel and substantial property damage.

**Note**

When installing the cabinet unit, make sure that no foreign bodies – especially metallic objects, such as drill swarf, wire end ferrules, or cable cut-offs – fall into the device. If necessary, cover the ventilation slots.

**Note**

Safety regulations governing shock protection must be observed. See also EN 60204-1.

**Caution**

To ensure that the entire system works properly, you are advised to use the original Siemens accessories from catalog D21.1.

Before commissioning, check the tightening torque of all the terminal screws.



**Warning**

Cable shields and unused conductors of power cables must be connected to PE potential.

Non-observance can cause lethal shock voltages.

**Note**

In networks with grounded external conductor and a supply voltage >600 V AC, measures must be taken on the line side to limit occurring overvoltages to overvoltage category II in accordance with IEC 60664-1.

## 7.1.3 Standards and guidelines

The table below shows some important standards and guidelines that must be observed to ensure safe, EMC-compliant installation. The standards and guidelines apply to installations in industrial environments (other conditions apply to installations in public networks).

Table 7-1 Guidelines

| Guideline | Description |
|---|---|
| 73/23/EEC | Directive of the Council of February 19, 1973, on the approximation of the laws of the member states relating to electrical equipment designed for use within certain voltage limits<br>Low-Voltage Directive |
| 98/37/EC | Directive of the Council of 22.06.98, on the approximation of laws of the member states relating to machinery<br>Machine directive |
| 89/336/EEC | Directive of the Council of May 3, 1989 on the approximation of laws of the member states relating to electromagnetic compatibility<br>EMC Directive |

The table below lists some application-relevant standards.

Table 7-2 Standards

| Standard | Description |
|---|---|
| EN 292–1 | Safety of machinery<br>General Design Principles<br>Part 1: Basic terminology, methodology |
| EN 292–2 | Safety of machinery<br>General Design Principles<br>Part 2: General requirements |
| EN 954–1 | Safety of machinery<br>General Design Principles<br>Part 1: Safety-related parts of control systems |
| EN 1037 | Safety of machinery<br>Prevention of unexpected startup |
| EN 1921 | Safety of integrated manufacturing systems |
| EN 50178 | Electronic equipment for use in power installations |
| EN 60204–1 | Safety of machinery<br>Electrical equipment of machines<br>Part 1: General requirements |
| EN 60439–1 | Low-voltage switchgear and controlgear assemblies<br>Part 1: Type-tested and partially type-tested assemblies |
| EN 60529 | Degrees of protection provided by enclosures (IP code) |
| EN 61800–3 | Adjustable speed electrical power drive systems<br>Part 3: EMC product standard including specific test methods |
| UL 508C | Power conversion equipment |

# 7.2 Basic information about EMC

## 7.2.1 Introduction to EMC

EMC stands for "electromagnetic compatibility" and, according to the definition in the Directive, describes "the capability of a device to function satisfactorily in an electromagnetic environment without itself causing interference unacceptable for other devices in the environment.."

EMC, therefore, represents a quality standard for the following:

- Internal noise immunity: Resistance to internal electrical disturbances
- External noise immunity: resistance against external electromagnetic disturbances
- Emitted interference: environmental effects caused by electromagnetic emissions

To ensure that the chassis unit functions satisfactorily in the system, the environment subject to interference must also be taken into consideration.

## 7.2.2 Interference and noise immunity

The EMC depends on two aspects of the devices in question: interference and noise immunity. Electrical devices include noise sources (transmitters) and potentially susceptible equipment (receivers). A device can be both a noise source (power section of a converter) and potentially susceptible (control section of a converter) at the same time. Electromagnetic compatibility is ensured when the existing noise sources do not impair the function of potentially susceptible equipment.

Measures must be taken by the converter manufacturer and the operator to ensure the greatest possible level of operational reliability and noise immunity within the entire system (converters, automation systems, drive motors, and so on). Only when all of these measures have been taken are the satisfactory function of the converter and compliance with the legal requirements (89/336/EEC) ensured.

Interference from frequency converters is covered by European standard EN 61800-3, whereby conducted interference on the line connection is measured as a radio interference voltage under standardized conditions. Radio interference emission in the form of electromagnetic emissions. The standard defines limit values for "environment 1" (public networks) and "environment 2" (industrial networks).

Noise immunity describes the behavior of a device under the influence of electromagnetic interference. Product standard EN 61800-3 outlines the EMC requirements for "variable-speed drive systems". It specifies requirements for converters with operating voltages of less than 1000 V. Different environments and categories are defined depending on where the system is installed.

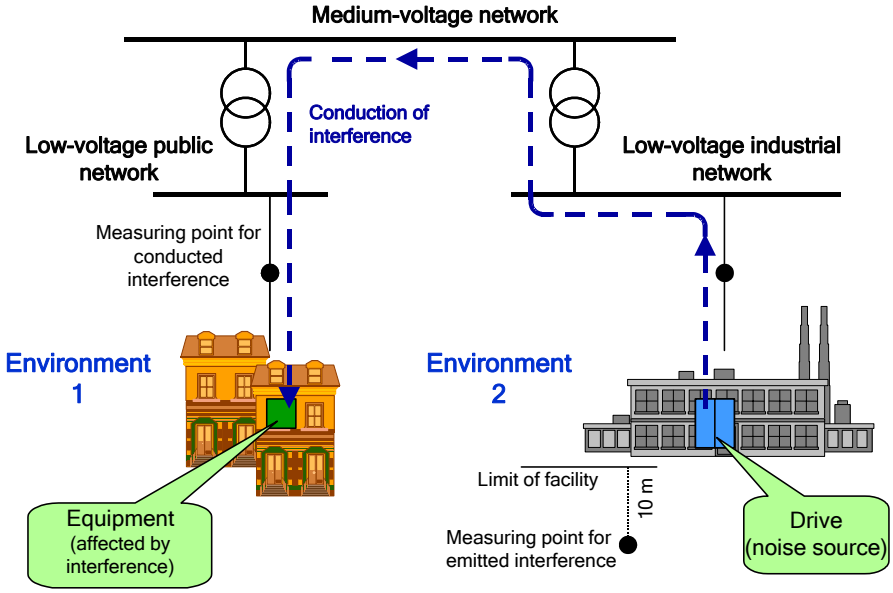



Fig. 7-1 Definition of environments 1 and 2

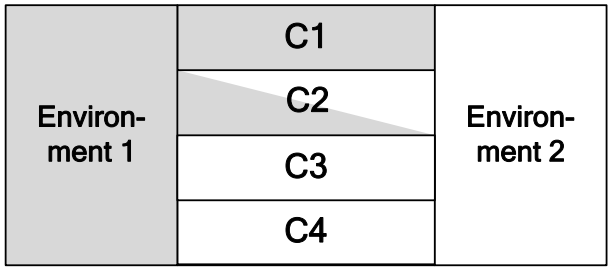



Fig. 7-2 Definition of categories C1 to C4

### Definition of environments 1 and 2

- Environment 1:
  Residential buildings or locations at which the drive system is connected to a public low-voltage supply without a transformer.
- Environment 2:
  Industrial locations supplied by a medium-voltage network via a separate transformer.

### Definition of categories C1 to C4

- Category C1:
  Rated voltage <1000 V; unrestricted use in environment 1.
- Category C2:
  Rated voltage for stationary drive systems <1000 V; for use in environment 2 For use in environment 1 only when sold and installed by skilled personnel.
- Category C3:
  Rated voltage <1000 V; use in environment 2 only.
- Category C4:
  Rated voltage ≥1000 V or for rated currents ≥400 A in complex systems in environment 2.

# 7.3 EMC-compliant drive installation

## 7.3.1 General

For information about EMC requirements, see EN 61800-3, EN 60439-1, and the recommendations in EN 60204-1. When components are installed in cabinets, the following aspects must also be taken into account to ensure compliance with the EMC Directive:

- Use of recommended power and signal cables
- Observance of information about cable shielding and equipotential bonding

## 7.3.2 EMC planning

The Basic Line Module infeeds when combined with the appropriate line reactor comply with the interference emission limits stipulated in EN 61800-3 for the second environment (industrial).

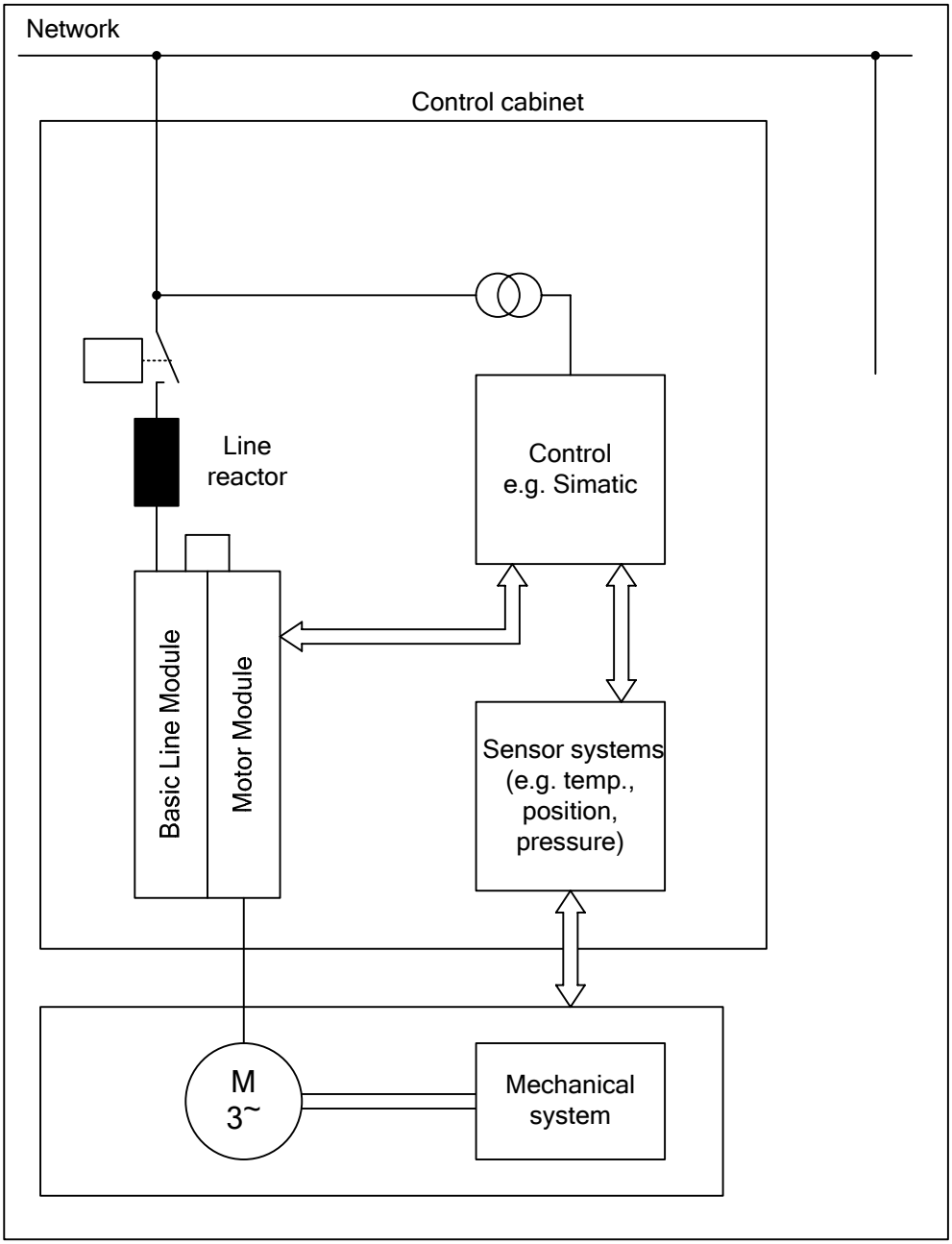



Fig. 7-3 Diagram of a drive system

The unit comprising the Basic Line Module and Motor Modules is located in the cabinet along with the associated control and sensor systems.

EMC measures address not only environmental influences outside the cabinet but also the effect of the devices within the cabinet.

## 7.3.3 The zone concept

The most cost-effective method of implementing EMC interference suppression measures within the cabinet is to ensure that noise sources and potentially susceptible equipment are installed separately from each other. This can be considered during the planning phase. A distinction is made here between noise sources (e.g. Power Module, Basic Line Modules, Motor Modules) and potentially susceptible equipment (e.g. automation devices, sensors, encoders).

The system is then divided into different EMC zones to which the devices are assigned. Different requirements regarding interference and noise immunity apply within each zone. When the cabinet is designed, the individual zones must be kept physically separate from each other. They can be separated by means of metal housing or – within a cabinet – by means of grounded separators. Filters may have to be installed at the zone interfaces. Unshielded cables can be used within a zone. All bus and signal cables that leave the cabinet must be shielded.

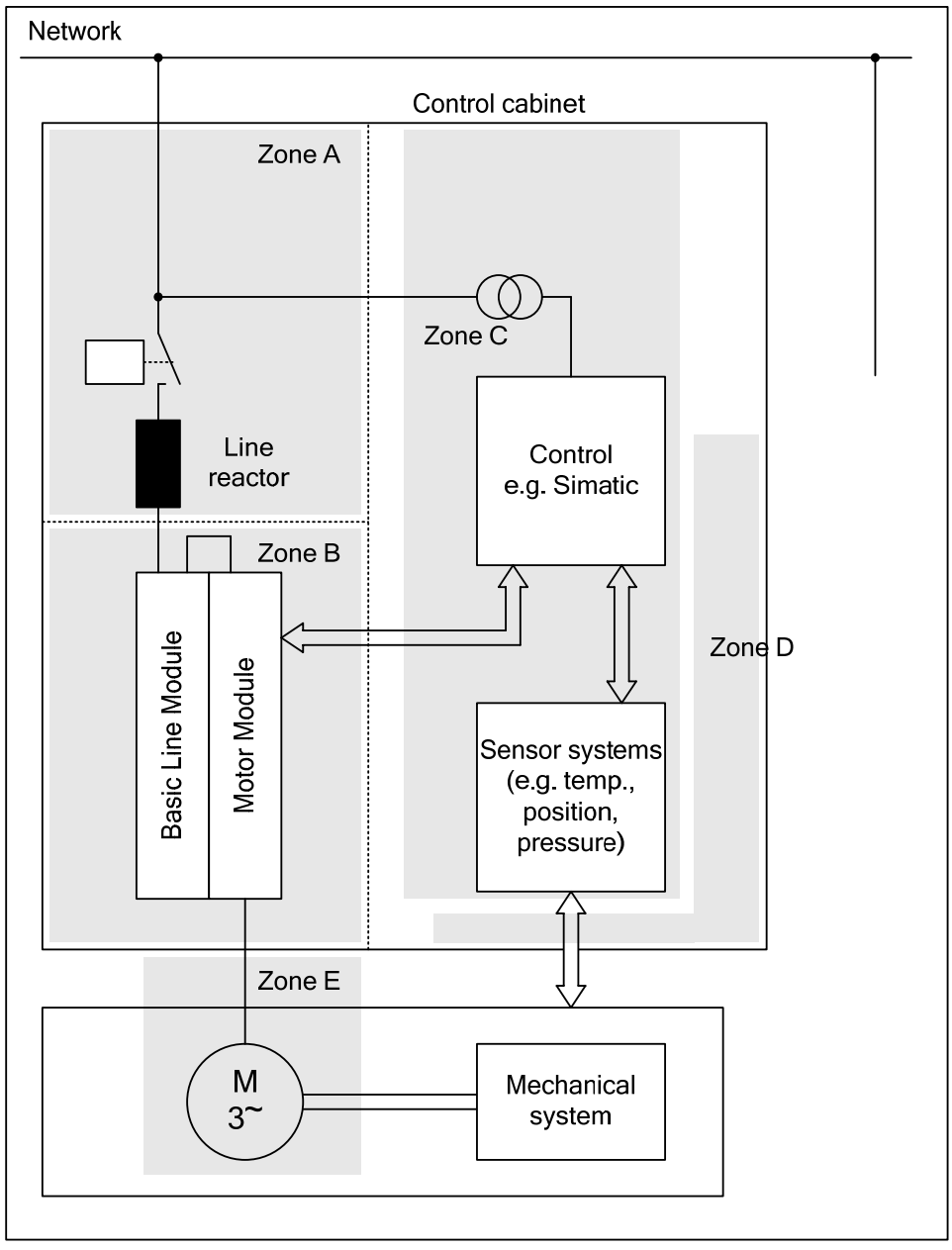



Fig. 7-4 Dividing a drive system into zones

- Zone A is the line connection for the cabinet, including the contactor and the line reactor. Interference in this zone should not exceed defined limits.
- Zone B contains the Power Module or Basic Line Module and the Motor Modules.
- Zone C contains potentially susceptible equipment (e.g. control and sensor systems).
- Zone D is the interface between the signal/control cables and the peripherals. A defined noise immunity level is required here.
- Zone E contains the AC motor and the motor cable.

## 7.3.4 Wiring and shielding

To ensure compliance with EMC requirements, different types of cable must be routed separately from other cables. To fulfill these requirements, the following cables must be shielded:

- Supply lines between the line power outlet and the Power Module or Basic Line Module
- All motor cables (brake cables can also be part of the motor cable)
- Cables for digital and analog inputs and outputs
- Signal cables for the encoder, resolver, or tachometers
- Cables for temperature sensors and other sensors

Power and signal cables must not be routed directly next to each other and, therefore, must be kept physically separate from each other (min. distance: of 20 cm). If this is not possible, separators must be installed between the signal and power cables. The separators must be grounded with the greatest possible surface area. If it cannot be avoided that signal and power cables cross, make sure that they cross at right angles only.

To prevent external interference from infiltrating the cabinet, the shields for the cables used must be grounded with the greatest possible surface area as close as possible to the cabinet inlet. Suitable shield buses or comb bars can be used here. The busbars must be connected conductively with the cabinet housing over the greatest possible surface area.

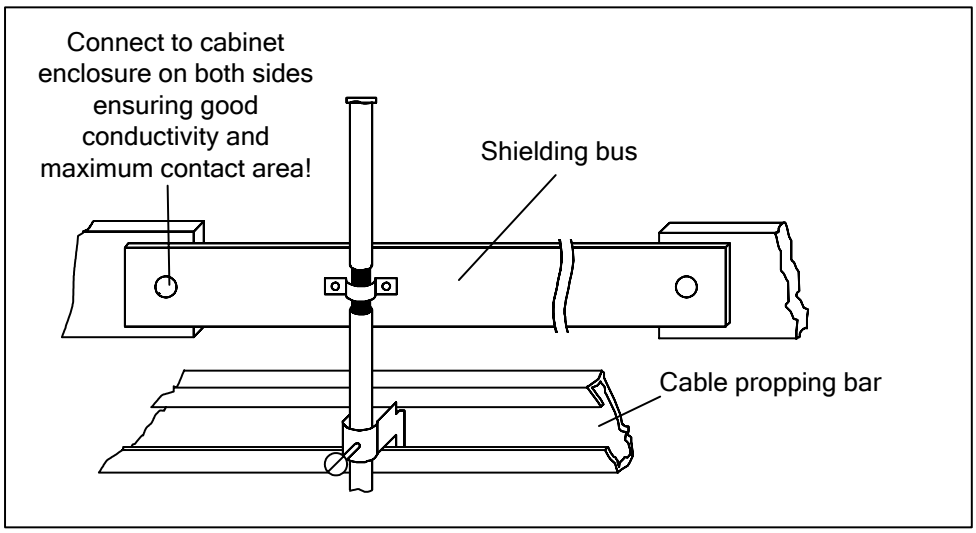



Fig. 7-5 Shield connection for motor cable at cabinet inlet

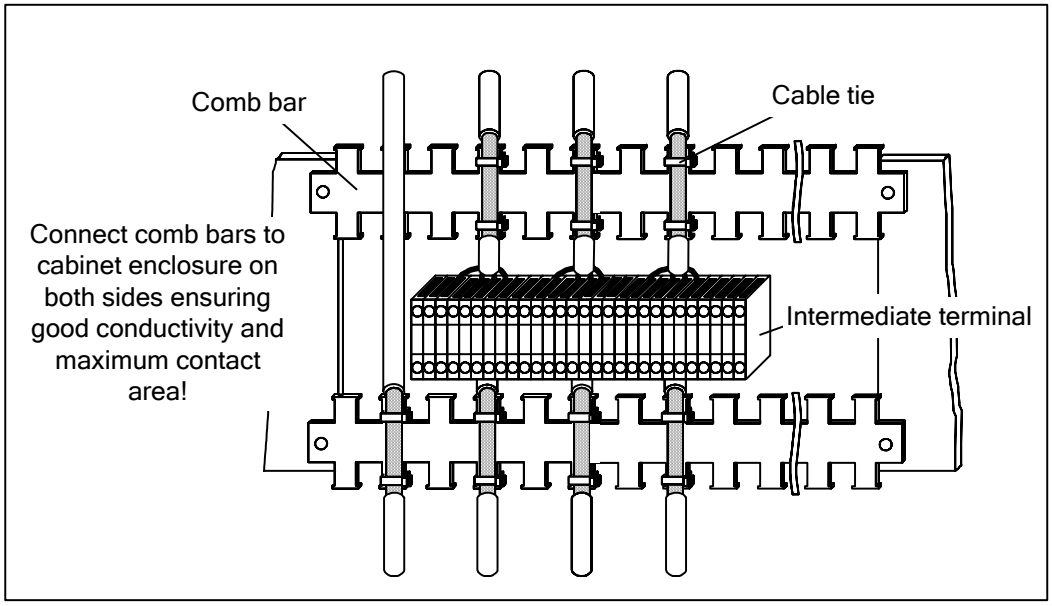



Fig. 7-6 Shield connection for the signal cables in the cabinet

All cables inside the cabinet must be connected as closely as possible to parts connected (grounded) to the cabinet ground, such as a mounting plate or cabinet wall. This also applies to reserve cables.

With good equipotential bonding (all metallic parts in the cabinet are connected to each other with the greatest possible surface area and with good conductance), the shields for analog signal cables must be connected to ground at both ends. If low-frequency interference occurs on analog cables, the shield only needs to applied at one end on the converter. The other end of the shield should be grounded via a capacitor (e.g. 10 nF/100 V, type MKT).

With digital signal cables, the shields must be applied with a good conductive connection and the greatest possible surface area at both ends (transmitter and receiver). The shields can be applied more than once inside and outside the cabinet. An equalizing conductor of at least 10 $mm^2$ must be routed in parallel with the shield if the equipotential bonding is not sufficient.

Whenever possible, only feed cables into the cabinet from side.

Encoder, resolver, or tachometer cables must have a shield. The shield must be applied with the greatest possible surface area on the tachometer, resolver, or encoder, as well as on the Power Module or Motor Module, and must not contain any gaps. Prefabricated cables with multiple shielding must be used for the encoder and resolver (see catalog D21.1).

When unshielded cables are used, avoid laying them close to noise sources (e.g. transformers). Signal cables (shielded and unshielded) must be kept at a good distance from strong external magnetic fields (e.g. transformers, reactors). In both cases, a minimum distance of 30 cm must be maintained.

Unshielded cables in the same circuit (outgoing/incoming conductors) must be twisted to prevent unnecessary frame antenna.

To reduce coupling capacitance and inductance, cables must not be unnecessarily long. Shielding effects can also be achieved by grounding reserve cores at both ends.

If the SINAMICS S120 chassis components are supplied externally with 230 V AC and 24 V DC, these supplies must not be used for multiple consumers that are physically separated from each other in different cabinets.

**Caution**

Connected power and signal cables must not cover any ventilation openings.

Signal cables must not be routed parallel to power cables.

Table 7-3 Maximum cable lengths

| Type | Maximum length [m] |
|---|---|
| 24 V DC power supply cables [1] | 10 |
| 24 V signal cables [1] | 30 |
| Power cable between Power Module or Motor Module and motor | 300 (shielded)<br>450 (unshielded) |
| DRIVE-CLiQ cables<br>• Inside cabinet unit<br>e.g. connection between CU320 and the first Power Module or Motor Module or between the Motor Modules<br>• DRIVE-CLiQ MOTION CONNECT connection cables for external components | 70<br>100 |

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

Table 7-4 Recommendations for overvoltage protection

| DC supply | 24 V signal cables |
|---|---|
| Weidmüller<br>Type: PU DS 24V 16A<br>Type no.: 868210 0000 | Weidmüller<br>Type no.: MCZ OVP TAZ |
| Fa. Weidmüller GmbH & Co. KG | |

## 7.3.5 Design

All metallic parts in the cabinet must be connected conductively with each other (not paint on paint) over the greatest possible surface area. Suitable contact or toothed lock washers may have to be used. Cabinet doors must be connected to the cabinet by means of ground strips, which should be as short as possible.

**Note**

Systems/machines are grounded primarily for safety reasons, although this does affect the interference and noise immunity of drives. A drive system can be ground in a radial manner or with the greatest possible surface area. Lattice grounding is recommended for drives, that is, all the parts to be grounded are connected to each other in a lattice manner.

If the drive line-up is arranged on a common unpainted metal-surfaced mounting plate (e.g. with a galvanized surface) or if several mounting plates are connected conductively with each other over the greatest possible surface area, no additional equipotential bonding is needed within the drive line-up because all parts of the switchgear assembly are connected to the protective conductor system.

The mounting plates are connected to the external protective conductor system by means of a finely-stranded copper conductor with a cross-section of 16 $mm^2$, including the outer conductor. As of a cross-section of 25 $mm^2$ copper, the outer cross-section of the finely-stranded conductor is halved.

If the devices are installed in the cabinet in any other way, equipotential bonding for each individual component must be carried out separately. Ensure that the cross-section of the outer conductor is sufficient.

Contactors, relays, solenoid valves, electrical operating hour counters, and so on in the cabinet must be connected to anti-interference elements. RC elements, diodes, or varistors can be used for this purpose. They must be connected on the appropriate coil.

The shielding between the motor and the Power Module or Motor Module must not be interrupted by additional components (e.g. fuses, contactors, reactors, or filters).

Automation devices and SINAMICS S120 devices should be connected to different power supply networks. If only a joint supply is available, the automation devices used should be isolated from the supply by means of isolating transformers.

Devices for controlling and monitoring the drives should be set up separately. A separate cabinet that is separated from the drive cabinet by means of a partition is recommended here. If this is not possible, suitable steel plates can be used.

## 7.4 Overview of devices required for operation

### 7.4.1 General

The following components are required for connection to the power supply network:

- Line disconnecting device
- Line fuse
- Line contactor (required with electrical isolation)
- Line reactor (for Power Module and Basic Line Module; see section 2.1 and 2.2)

### 7.4.2 Line disconnection devices

A line disconnecting device for the electrical equipment may be used for correct isolation of the drive line-up from the power supply. This line isolation device must be for electrical equipment of machinery in conformance with the requirements of EN 60204-1, Section 5.3. The relevant technical specifications of the devices used must be taken into account during selection. All consumers of the electrical equipment that are located downstream of the line disconnecting devices must be included in the selection.

### 7.4.3 Overcurrent protection by line fuse or circuit-breaker

The cables for the drive line-up power supply must be protected against overcurrents. NH, D, and DO-type fuses with a gL characteristics or suitable circuit-breakers can be used for this purpose.

### 7.4.4 Line contactor

Line contactors are required to provide electrical isolation between the drive line-up and the line supply.

For selection of the line contactor, the characteristic values in the technical specifications apply. The cable routing, the bundling factor, and the factor for the ambient temperature according to EN 60204-1 must be taken into account when the conductors to be connected are rated.

**Caution**

Line contactors must not be switched under load.

To limit the opening overvoltage, the contactor coils should be connected to an overvoltage limiter (e.g. flywheel diode or varistor).

# 7.5 Arrangement of components and equipment

## 7.5.1 General

The arrangement of the components in the cabinet takes the following into account:

- Space requirements
- Cable routing
- Air conditioning
- EMC

## 7.5.2 Drive line-up

The components must be arranged primarily in accordance with their function and the current capacity of the DC link.
The following criteria must be taken into account when the drive line-up for devices in chassis format is designed:

- Depending on the required Motor Modules, the Line Module must be positioned centrally.
- Only one Line Module can be used in a drive line-up.
- The Motor Modules must be positioned to the left or right of the Line Module with decreasing rated currents (i.e. the Motor Module with the highest rated current is positioned next to the Line Module on the left or right, while the Motor Module with the lowest rated current is at the end). When laying the cables or busbar for the DC link, you must ensure that the cable/busbar is compatible with the current-carrying capacity of all the connected Motor Modules.
- The drive line-ups must be configured in such a way that all the power cables for motor supply cables and power supply cables that should preferably be shielded do not exceed the lengths specified in Table 7-3.

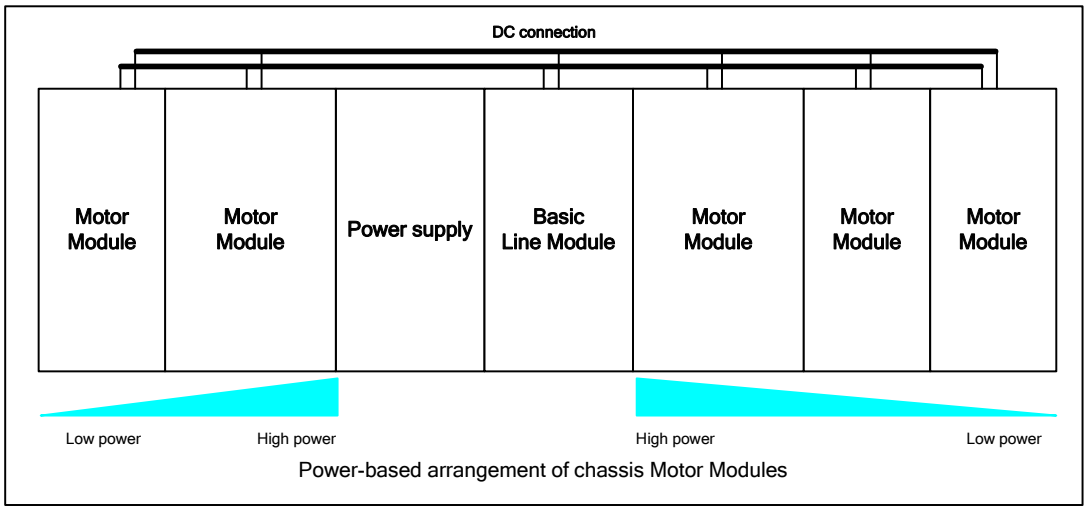



Fig. 7-7 Example of a drive line-up

All the components in the drive line-up should preferably be installed on a conductive mounting surface to minimize the impedance between the component and the mounting surface. If the mounting surface comprises more than one mounting plate, these must be connected conductively over the greatest possible surface area. If the components are installed individually, they must be grounded individually too.

# Cooling circuit and coolant properties

# 8

**Warning**

The equipment must be safely disconnected from the supply before any installation or service work is carried out on cooling circuit components.

The cooling circuit must always be designed and installed by an appropriately trained engineer.

## 8.1 Cooling circuits

### General information

The type of heatsink materials used requires two distinctly different recooling concepts.

Different materials are used to guide the coolant into the cooling plates of the SINAMICS S120 Liquid Cooled units, providing the user with a range of different options for the design of the cooling circuit.

The electrochemical processes that take place in a cooling system must be minimized by choosing the right materials. For this reason, mixed installations (i.e. a combination of different materials, such as copper, brass, iron, or halogenated plastic (PVC hoses and seals)) should not be used or limited to the absolutely essential minimum.

Please read the following definitions for clarification:

1. Closed cooling circuit
   The pressure compensator is closed (no ingress of oxygen) and is fitted with a pressure-relief valve (6 bar); it is always connected on the suction side of the pump! The coolant is guided only through the SINAMICS units, the recooling components and possibly to a motor (for example, see Fig. 8-1). The materials used in the cooling circuit comply with the recommendations in Section 8.3.
2. Open cooling circuit
   The coolant is guided through the SINAMICS units and the recooling components, as well as through components external to the cooling circuit. The materials used comply with the minimum requirements stipulated in Section 8.3.
3. Semi-open cooling circuit
   Oxygen can be transferred to the coolant only via the pressure compensator, otherwise as for 1.

Table 8-1 Cooling circuit for SINAMICS units

| SINAMICS units | Basic Line Module, frame sizes FBL, GBL<br>Motor Modules, frame sizes HXL, JXL | Power Modules, frame sizes FL, GL<br>Motor Modules, frame sizes GXL |
|---|---|---|
| Heatsink material | Aluminium | Stainless steel |
| Closed cooling circuit | The closed cooling circuit is the recommended standard solution! | The closed cooling circuit is the recommended standard solution! |
| Open cooling circuit | Not permissible! | Permissible |
| Semi-open cooling circuit | Permissible only with inhibitors and Antifrogen N with a proportion X of 20 % < X ≤ 45 %. | Permissible |
| Inhibitors required | Yes | No |

## Pressure

The maximum system pressure is 600 kPa. The lowest possible pressure should be selected to allow use of pumps with a flat characteristic.

Maximum permissible differential pressure for a heatsink: 200 kPa

The layout must be selected such that the total length of supply and drain pipe is equal for each SINAMICS unit or motor (see Fig. 8-1).

It is not permissible to create water cooling systems with series-connected modules and/or modules and motors as the increased volumetric flow increases the risk of cavitation and abrasion. This type of arrangement is acceptable only if the pressure difference per unit does not exceed 200 kPa.

## Installation

The connection between the units and cooling system should be designed with hoses for mechanical decoupling.

The following hose types are recommended:

- EPDM hoses with an electrical conductivity >$10^9$ ohms (e.g. Semperflex FKD supplied by Semperit, or
- DEMITEL made of PE / EPDM supplied by Telle
- Secured with clips conforming to DIN2817, available, e.g. from Telle, see Table 8-7.

Please note the following recommendations applicable to cooling circuit installation:

- Seals must be free of chloride, graphite and rust.
- As a result of negative experience with Teflon, Viton, AFM34 and EPDM are recommended instead.
- In order to prevent cavitation damage to the pump (but also in the heatsink), the pressure on the suction side of the pump must be a minimum of 30 kPa, or the geodesic height from the reservoir to the pump suction side must be >3 m (see Fig. 8-3) .
- To prevent blockages and corrosion, it is advisable to install an additional flushback filter in the circuit (so that residues can be rinsed out when the system is running).

### 8.1.1 Cooling circuit for aluminum heatsink

To ensure an optimum heatsink service life, please note the following recommendation for aluminum heatsinks (Basic Line Modules FBL and GBL, Motor Modules HXL and JXL):

- Closed cooling circuit made of stainless steel or ABS which transfers heat to a recooling system via a water-to-water heat exchanger.
- Cooling circuit pipes, fittings made of ABS, stainless steel (Nirosta) or common steel (ST37).

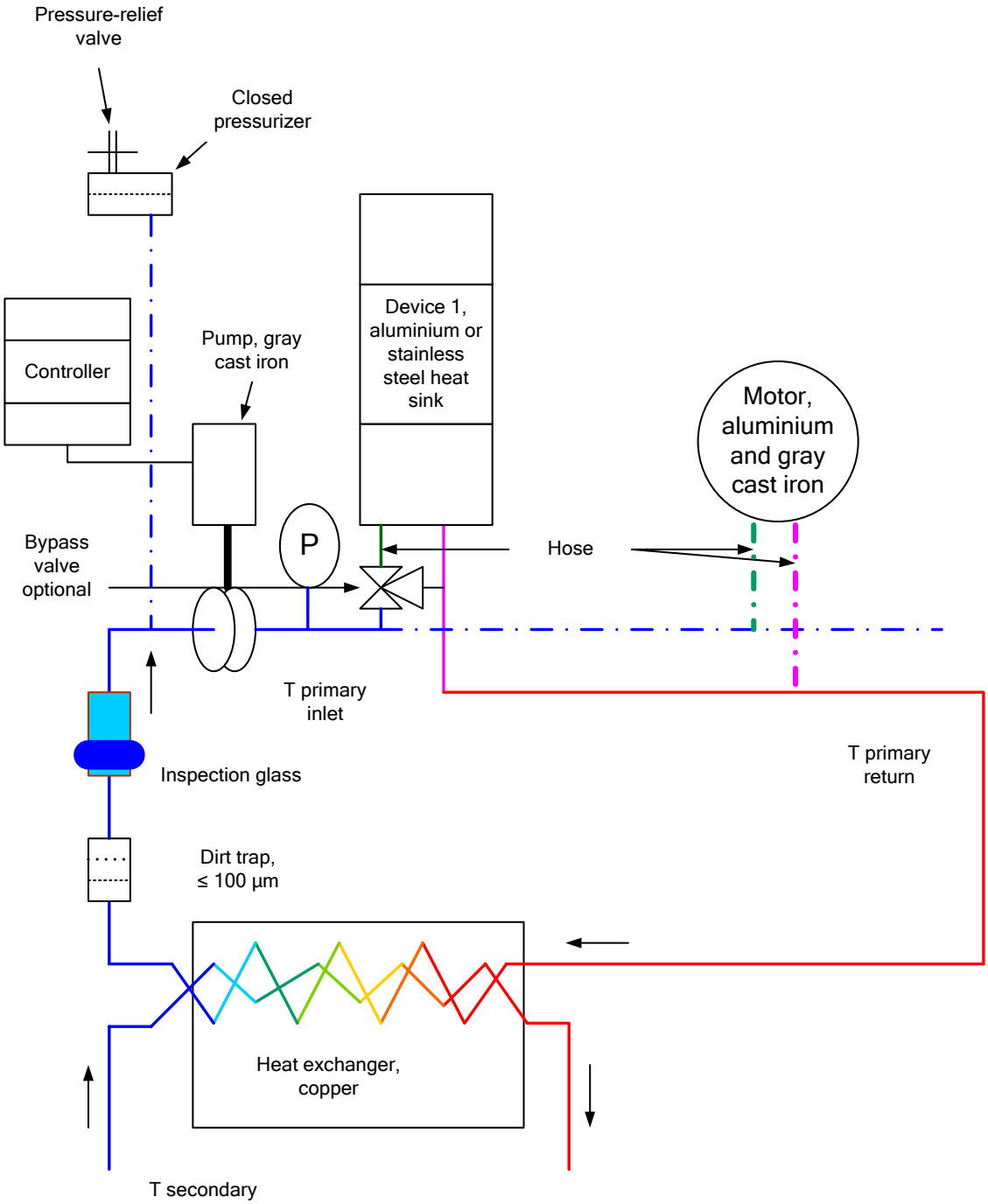



Fig. 8-1 Recommendations for a closed cooling circuit

**Note**

When arranging the units in the cooling circuit, please note that the Basic Line Modules and Motor Modules must always be positioned upstream of the motors.

Dirt traps (strainers), at least one pressure measuring point and a service inspection window are important.

Table 8-2 Components of a closed cooling circuit

| Component | Explanation |
|---|---|
| 1. Pressure-relief valve | Required in cooling circuits with aluminum owing to the hydroxide reaction with $H_2$ as the reaction product. |
| 2. Pressure compensator (pressurizer) | Closed pressurizer if possible, normal type used for heating systems suitable only for closed cooling circuits, with inhibitors and Antifrogen N. |
| 3. Pressure-relief dP valve | Required for systems with very powerful pumps and to dissipate $H_2$. |
| 4. Pump | Delivery area made of stainless steel, avoid use of grey cast iron wherever possible. |
| 5. Connecting pipes | Stainless steel, ABS, also common steel in closed circuits with inhibitors in the coolant. |
| 6. Inspection window | Recommended for diagnosing turbidity and discoloration of the coolant which can indicate ageing or corrosion problems. |
| 7. Dirt traps (strainers) | Dissolved substances (reaction products) must be trapped before they cause blockages in the heatsink! |
| 8. Pressure measuring point | Required for servicing. |
| 9. Connection hose | EPDM hose |
| 10. Heat exchanger | Ideally stainless steel, but a copper heat exchanger can be used as an alternative in closed circuits. |
| 11. Bypass valve | May be necessary to protect against condensation. |
| 12. Coolant | See Section 8.2 |

## 8.1.2 Cooling circuits for stainless steel heatsinks

To ensure an optimum heatsink service life, please note the following recommendation for stainless steel heatsinks (Power Modules FL and GL, Motor Modules GXL):

- Open or semi-open cooling circuit made of stainless steel or ABS which transfers heat to a recooling system via a water-to-water heat exchanger.
- Cooling circuit pipes, fittings made of ABS, stainless steel (Nirosta) or common steel (ST37).

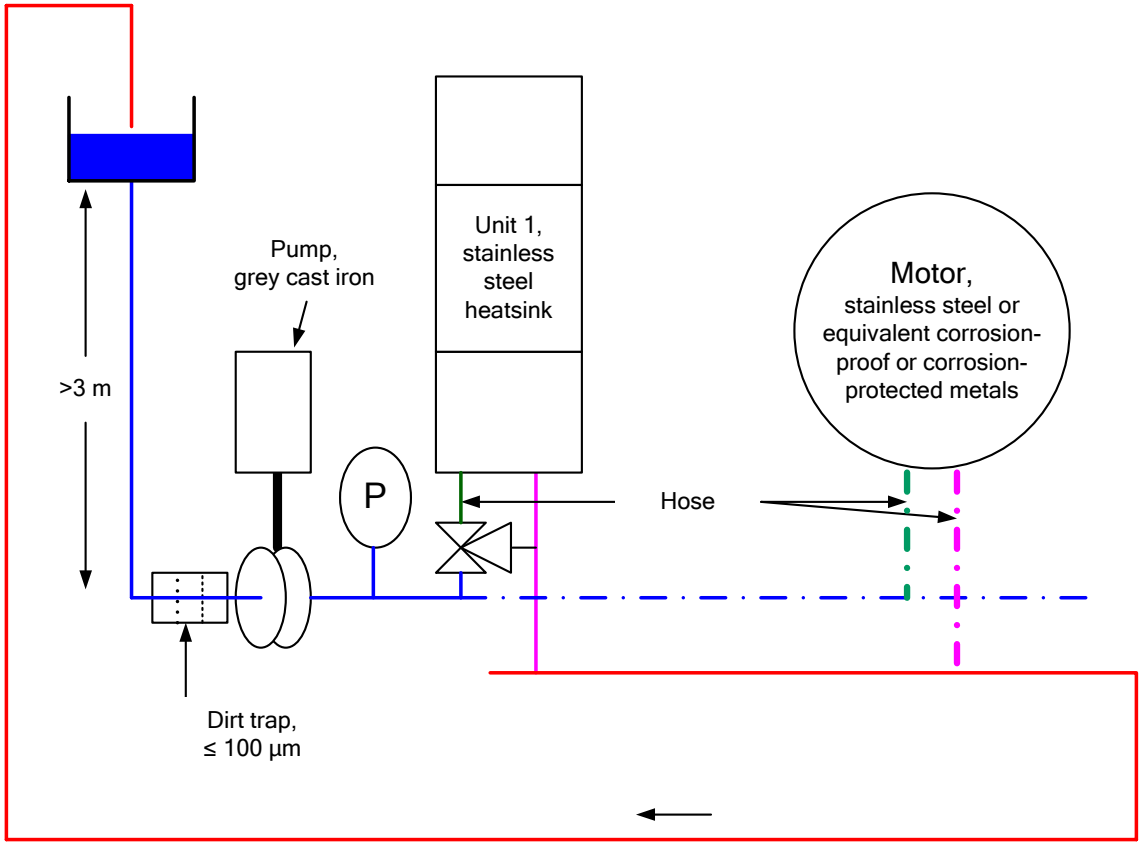



Fig. 8-2 Recommendations for an open cooling circuit

## 8.1.3 Prevention of cavitation

The following applies to all cooling circuits:

- The cooling circuit must always be designed in such a way that the pressure compensator is located on the suction side of the pump and as close as possible to the pump (see Fig. 8-3).
- The minimum pressure on the suction side of the pump must be approximately 30 kPa, or the geodesic height from the reservoir to the pump suction side must be >3 m.
- The pressure drop across a SINAMICS unit must not exceed 200 kPa in continuous operation, as the resultant increase in volumetric flow increases the risk of cavitation and/or abrasion.
- The guidelines given in Subsection 8.1.4 regarding series connections and maximum pressure must also be followed.

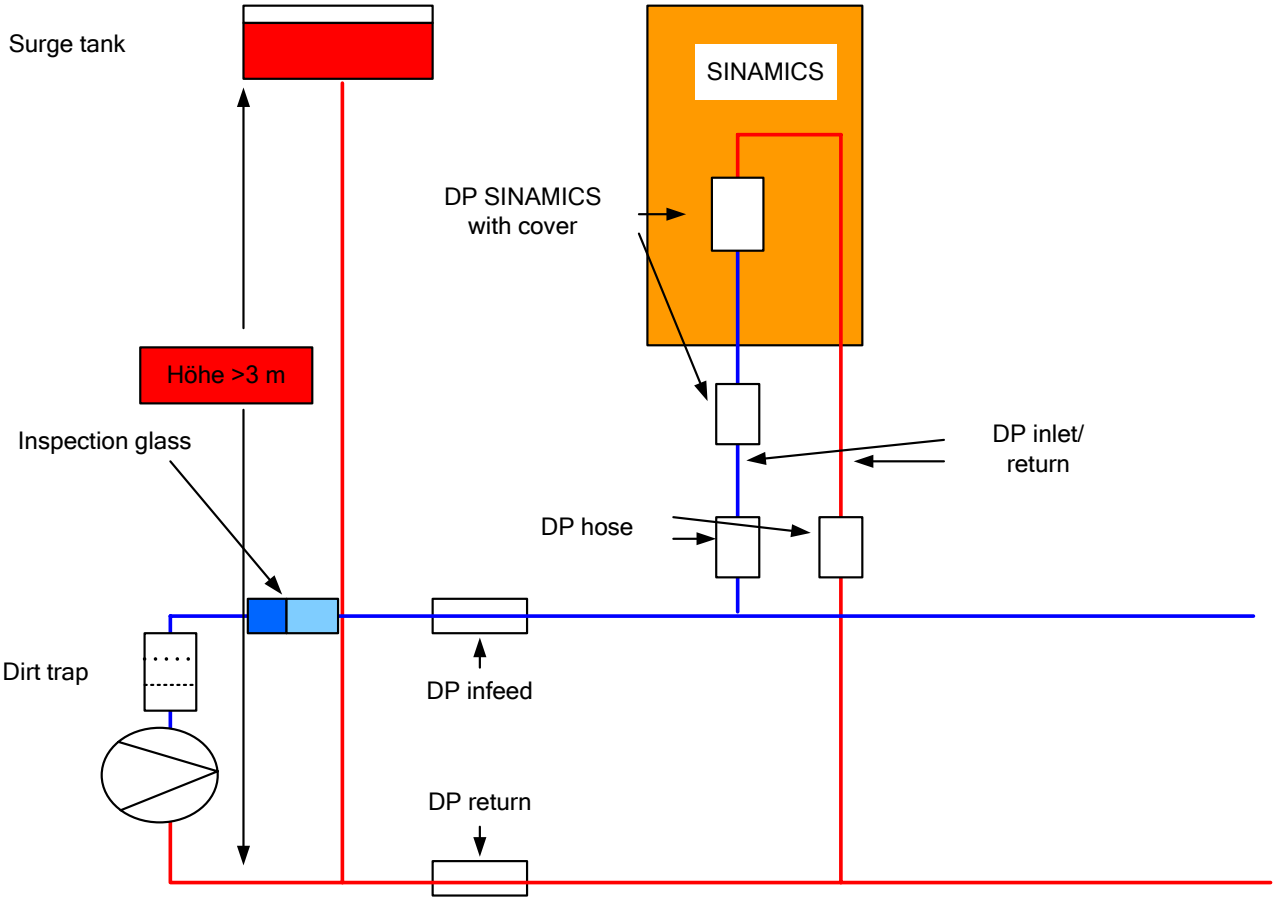



Fig. 8-3 Arrangement of pressure compensator, component pressure drops

## 8.1.4 Cooling circuit configuring information

The operating pressure must be set according to the flow conditions in the supply and return lines of the cooling circuit. The required coolant flow rate per time unit must be set according to the technical specifications of the devices. The units are normalized to a rated pressure of 70000 Pa (for coolant type $H_2O$) via an orifice.

If a mixture of Antifrogen N and $H_2O$ is used as a coolant, the rated pressure must be calculated according to the mixing proportions. The following table specifies the pressure drop across components at different coolant temperatures for a coolant with mixing proportion 45 % Antifrogen N.

Table 8-3 Pressure drop at different coolant temperatures

| SINAMICS units | dV/dt $H_2O$ [l/min] | dP $H_2O$ [Pa] | dPAntfrogen N 45 % 0 °C [Pa] | dPAntfrogen N 45 % 20 °C [Pa] | dPAntfrogen N 45 % 45 °C [Pa] | dPAntfrogen N 45 % 50 °C [Pa] |
|---|---|---|---|---|---|---|
| Power Module, frame size FL | 9 | 70000 | 121100 | 97300 | 80500 | 78400 |
| Power Module, frame size GL | 12 | 70000 | 121100 | 97300 | 80500 | 78400 |
| Basic Line Module, frame size FBL | 9 | 70000 | 121100 | 97300 | 80500 | 78400 |
| Basic Line Module, frame size GBL | 12 | 70000 | 121100 | 97300 | 80500 | 78400 |
| Motor Modules, frame size GXL | 12 | 70000 | 121100 | 97300 | 80500 | 78400 |
| Motor Modules, frame size HXL | 16 | 70000 | 121100 | 97300 | 80500 | 78400 |
| Motor Modules, frame size JXL | 27 | 70000 | 121100 | 97300 | 80500 | 78400 |

The maximum permissible differential pressure to atmosphere in the heatsink and thus in the cooling circuit must not exceed 6 bar. If the pump used can reach a maximum pressure in excess of this value, appropriate measures (safety valve p ≤ 6 bar, pressure control or similar, see Fig. 8-4) must be implemented by the customer to ensure that the maximum pressure limit is not exceeded.

The lowest possible differential pressure between the coolant in the supply and return lines should be selected to allow use of pumps with a flat characteristic.

The maximum differential pressure across a heatsink is 200 kPa; higher differential pressures significantly increase the risk of cavitation and abrasion (Fig. 8-4).

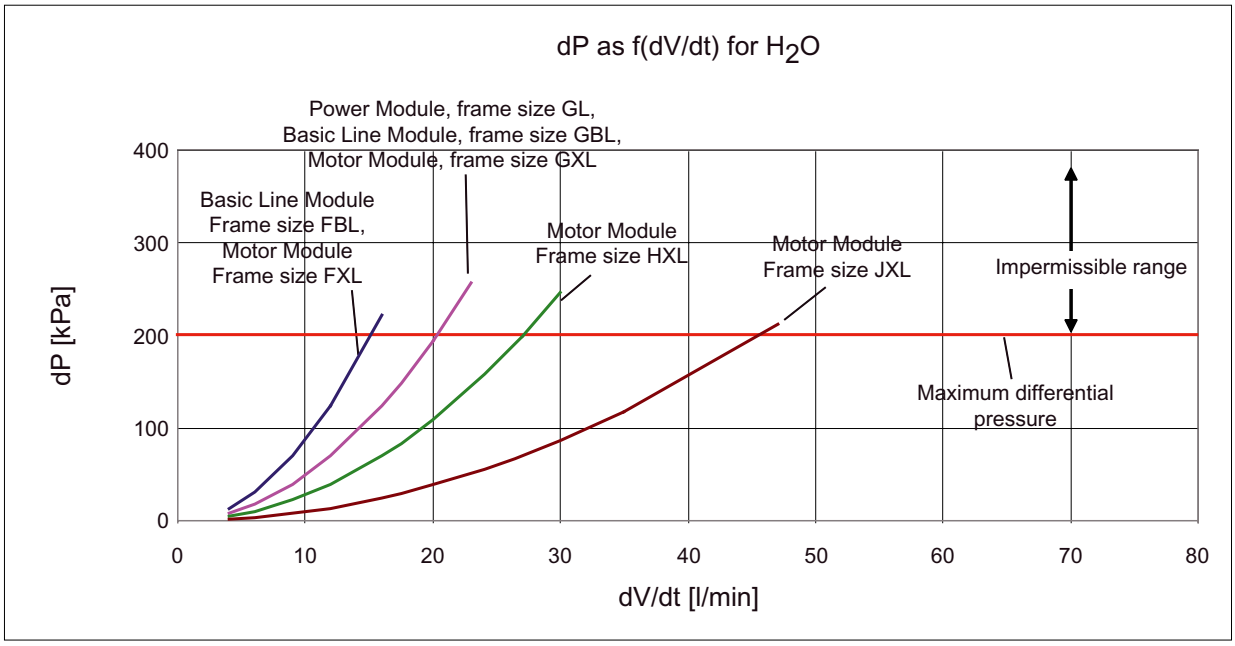



Fig. 8-4 Differential pressure as a function of volumetric flow

Water cooling systems with series-connected SINAMICS units cannot be recommended for the following reasons:

- The risk of cavitation and abrasion increases as a result of the high total volumetric flow.
- It is not possible to connect SINAMICS S120 in series because the total volumetric flow inherent to any constellation of series connection requires system pressures in the 600 kPa range or above.

The characteristic curves for the pressure drop across the heatsinks as a function of the volumetric flow in Fig. 8-5 to Fig. 8-10 vary depending on the temperature and the Antifrogen N / water coolant mix.

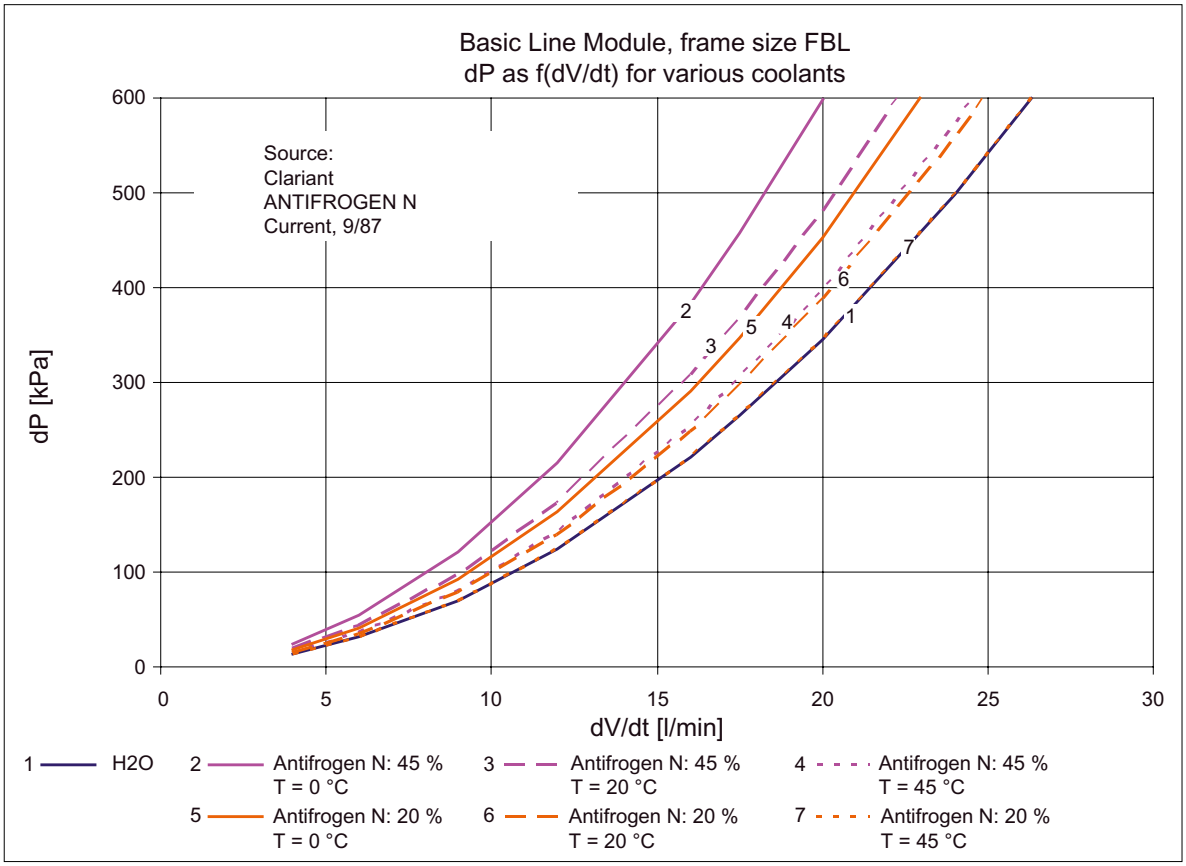



Fig. 8-5 Differential pressure as a function of volumetric flow for Basic Line Module, frame size FBL

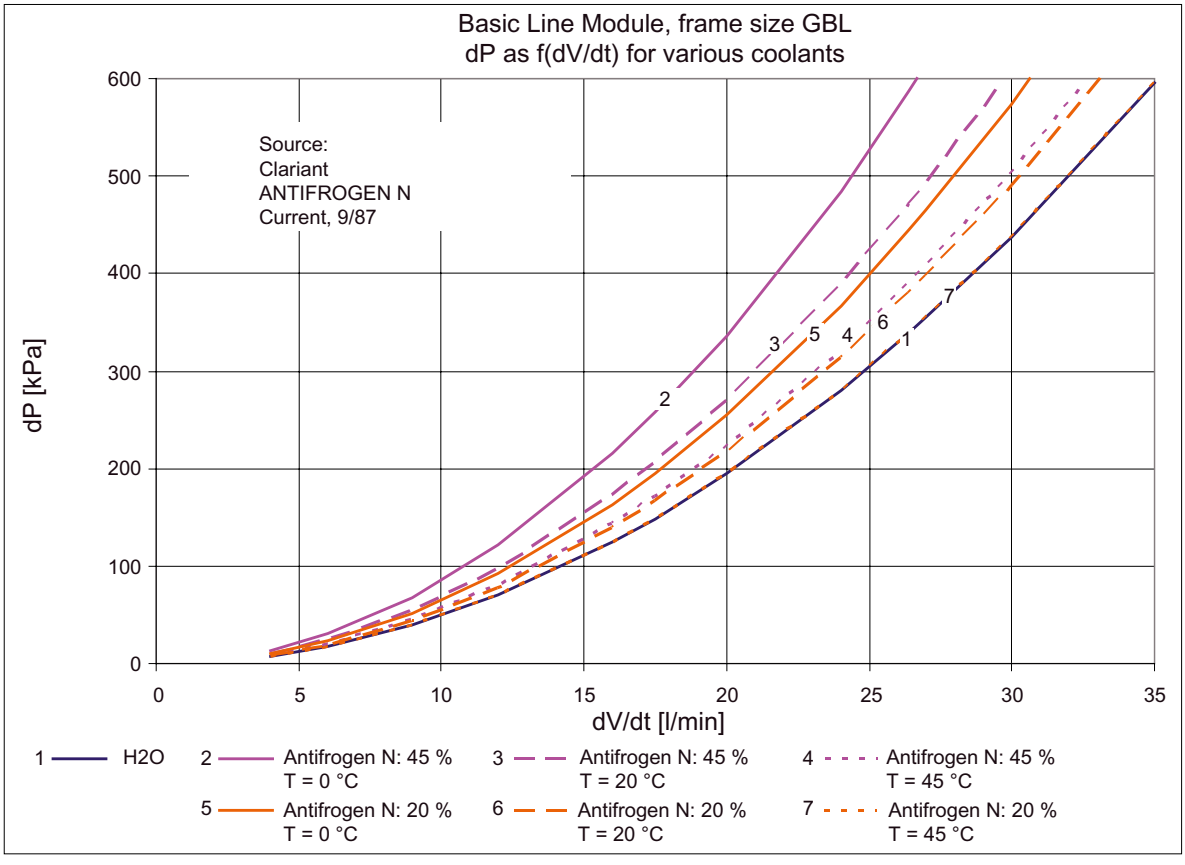



Fig. 8-6 Differential pressure as a function of volumetric flow for Basic Line Module, frame size GBL

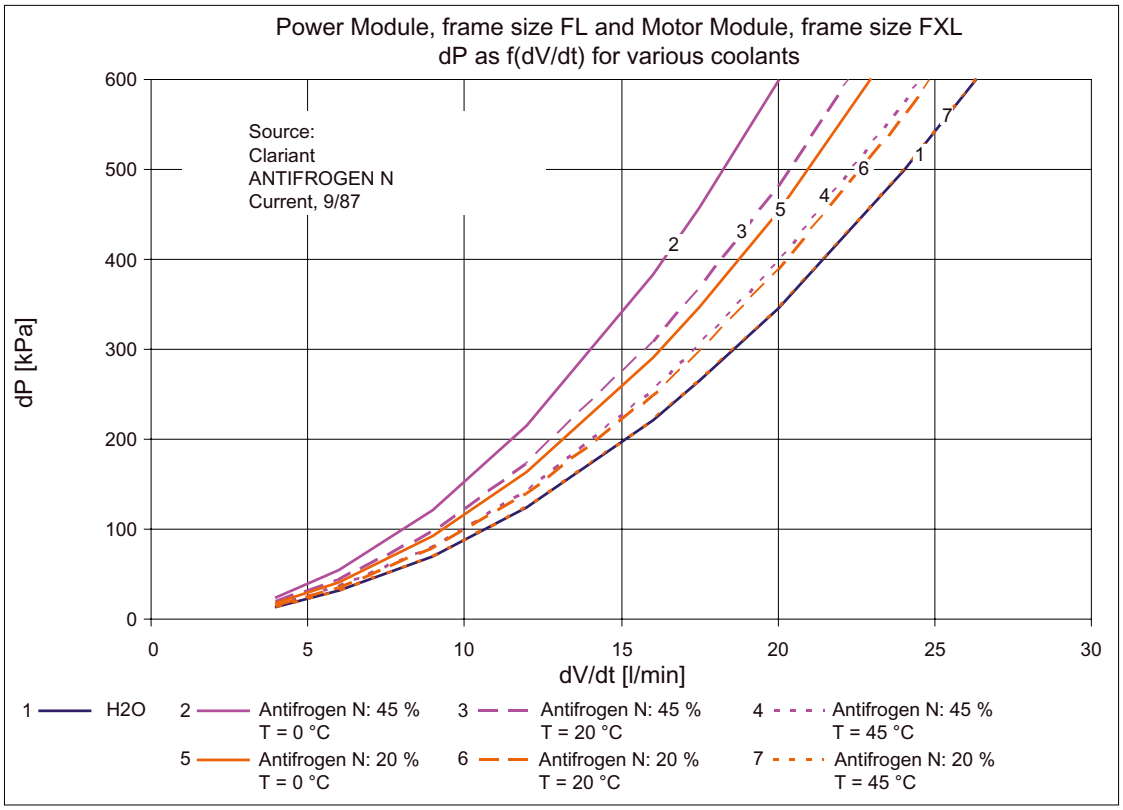



Fig. 8-7 Differential pressure as a function of volumetric flow for Power Module frame size FL, and Motor Module frame size FXL

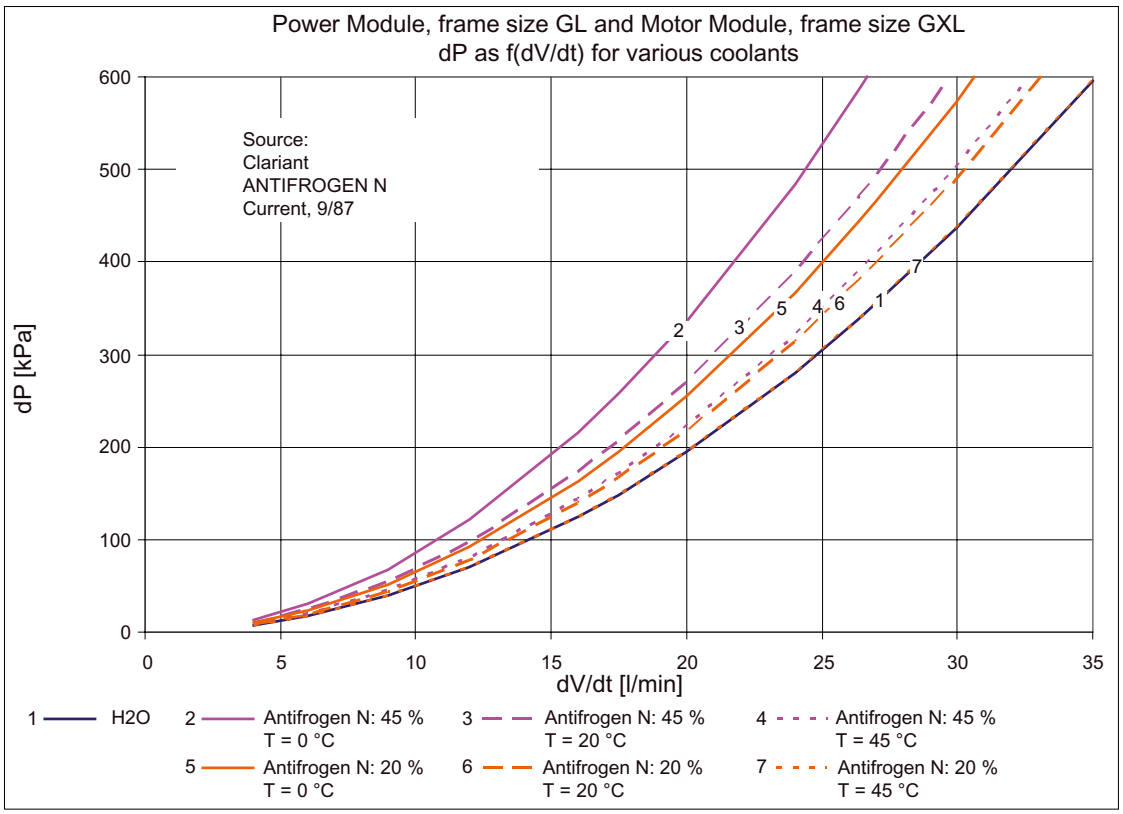



Fig. 8-8 Differential pressure as a function of volumetric flow for Power Module frame size GL, and Motor Module, frame size GXL

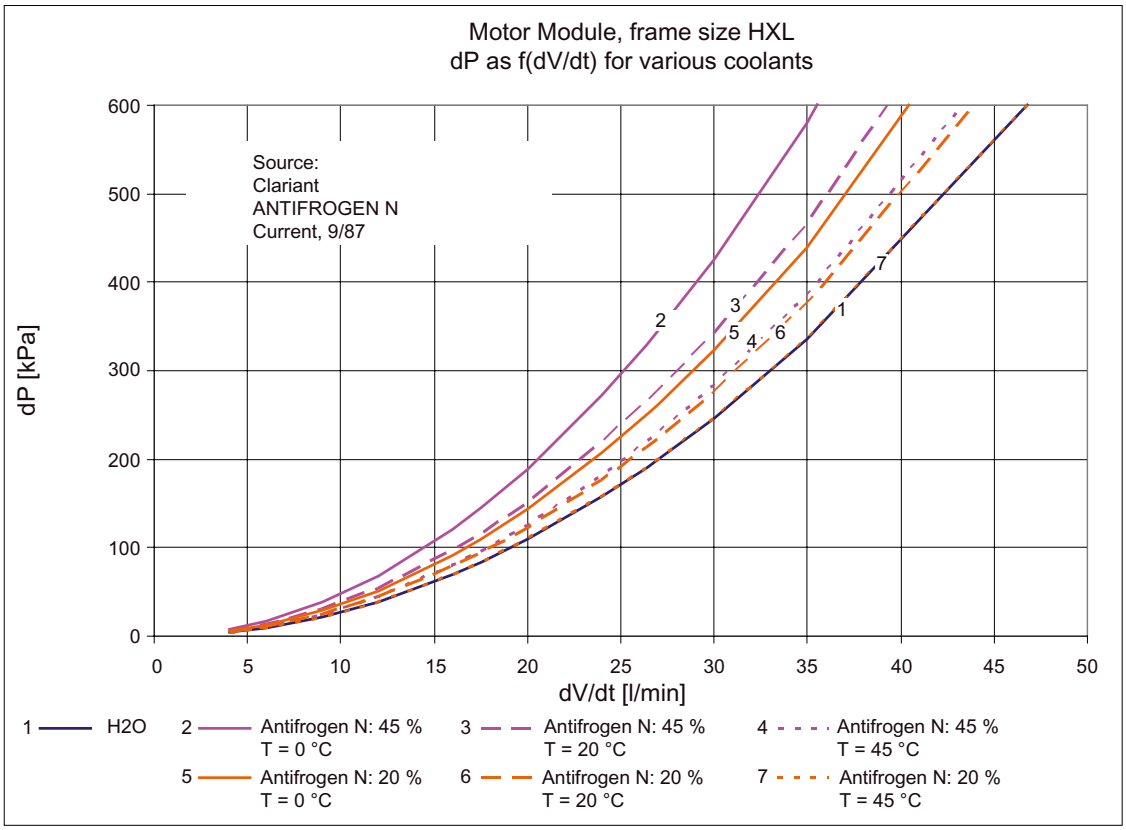



Fig. 8-9 Differential pressure as a function of volumetric flow for Motor Module, frame size HXL

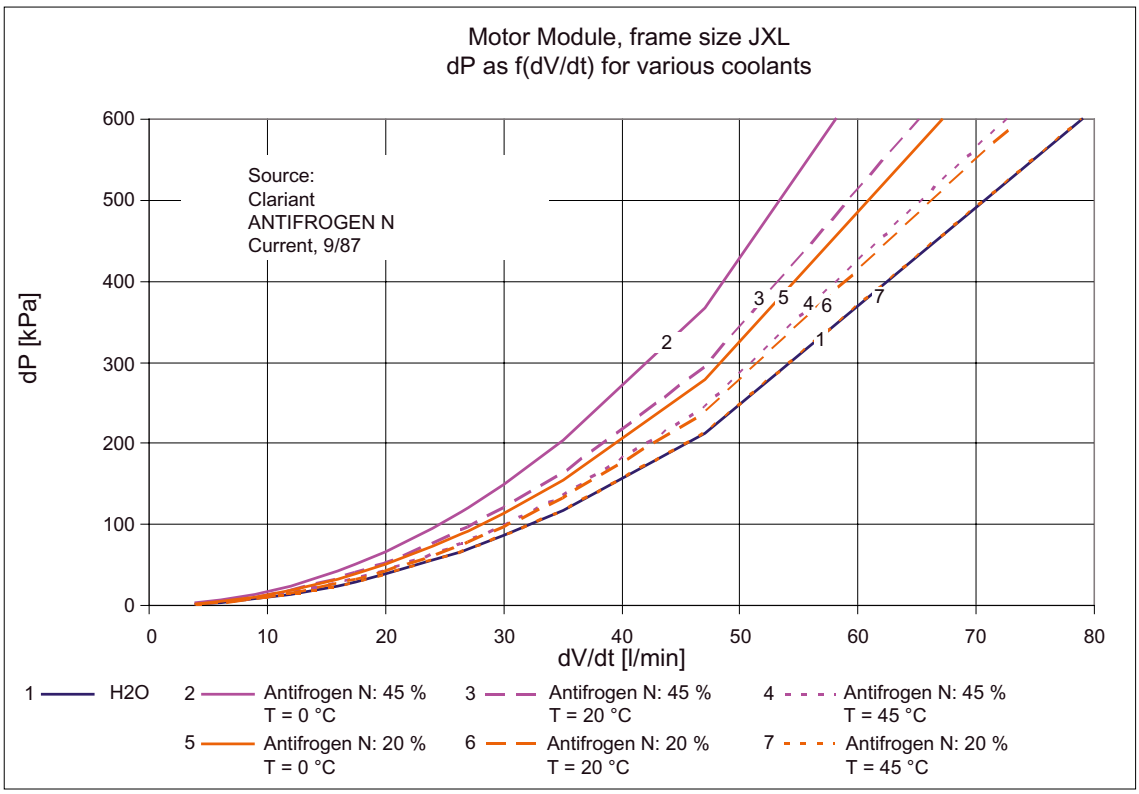



Fig. 8-10 Differential pressure as a function of volumetric flow for Motor Module, frame size JXL

Recommendation for dimensioning the cooling circuit:

The differential pressure between the supply and return lines should be selected such that the following applies:

$$\sum \mathrm{dPi} < \mathrm{dP_{Syst}} < \sum \mathrm{dPi} + 0.3\ \mathrm{bar}$$

The individual pressure drops Pi represent the pressure drops of components (heat exchanger, piping, 70 kPa for the SINAMICS units connected in parallel, valves, dirt traps, pipe bends, etc.).

The greatest care must be taken when routing pipes. The pipes must never come into contact with electrically live components; an insulation clearance of >13 mm must always be left between pipes and live parts! The pipes must be securely mounted and checked for leaks.

## 8.1.5 Equipotential bonding

All components in the cooling system (SINAMICS units, heat exchanger, piping system, pump, pressure compensator, etc.) must be connected to an equipotential bonding system. A copper bar or stranded copper with the appropriate conductor cross-sections must be used for this purpose to eliminate electrochemical processes.

If the installation comprises several control cabinets, these must be bolted together in a solid, conductive connection (e.g. bolt cabinet cross-beams together directly at several points to make conductive connection). This eliminates potential differences and thus the risk of electrochemical corrosion. A PE bar must be installed in every cabinet (including the recooling system) and the individual bars then interconnected.

## 8.2 Coolant definition

The coolant must fulfill the following requirements over the long term.

Table 8-4 Coolant definition

| | Coolant quality for aluminum heatsink (see Table 8-1) | Coolant quality for stainless steel heatsink (see Table 8-1) |
|---|---|---|
| Basic coolant mix | Deionized water with reduced conductivity (5…10 µS/cm), e.g. "battery water" with 0.2 % Nalco inhibitor 00GE056 (made by: Nalco) or Antifrogen N with a proportion X of 20% < X ≤ 45% (made by: Clariant)<br>or filtered drinking/urban water with 0.2 % Nalco inhibitor 00GE056 (made by: Nalco) or Antifrogen N with a proportion X of 20% < X ≤ 45% (made by: Clariant) of the quality specified below: | Filtered drinking/urban water of the quality specified below: |
| Chloride ions | < 40 ppm<br>Can be obtained by adding deionized water. | < 250 ppm |
| Sulfate ions | < 50 ppm | < 240 ppm |
| Nitrate ions | < 50 ppm | < 50 ppm |
| pH value | 5.5 – 8.0 | 6.5 - 9.5 |
| Conductivity | < 500 µS/cm | < 2500 µS/cm |
| Total hardness | < 170 ppm | < 170 ppm |
| Dissolved solids | < 340 ppm | < 340 ppm |
| Size of entrained particles | < 100 µm | < 100 µm |



**Warning**

According to Directive 98/83/EC, drinking water may contain up to 250 ppm of chloride! This value is too high for the heatsinks which may sustain serious damage if inhibitors are not added!

**Note**

We recommend that use is made of Nalco's services (Manufacturer: Nalco) for analyzing the water quality at the plant site.

To better explain the coolant recommendations in this document, a number of problems which can be encountered if the recommendations are ignored are listed in Table 8-5.

Table 8-5 Substances which can cause irreparable heatsink damage

| Coolant property or limit-value violation | Countermeasure |
|---|---|
| Sea water | Do not use sea water! |
| Water compliant with limit values | Use of inhibitors, Antifrogen N proportion X of 20 % < X ≤ 45 %, circuit must include a pressure-relief valve. |
| Oxygen transfer | Closed circuit with pressure-relief valve, use of inhibitors, Antifrogen N proportion X of 20 % < X ≤ 45 %. |
| Chloride | Use of inhibitors, Antifrogen N proportion X of 20 % < X ≤ 45 %. |
| Sulphate | Dilute with de-ionized water until the sulphate content is within tolerance. |
| Dissolved solids (e.g. sand) | Rinse cooling circuit without SINAMICS units. Install dirt trap (e.g. strainer, fine filter). |
| Total hardness | Use of inhibitors, Antifrogen N proportion X of 20 % < X ≤ 45 %. |
| Conductivity | Equipotential bonding of all circuit components. |
| Biological contamination | Use of biocides, dirt traps (e.g. strainer, fine filter). |
| Oil residue | Use of inhibitors or Antifrogen N proportion X of 20 % < X ≤ 45 %, rinse cooling circuit without SINAMICS units. |
| Mechanical contamination | Rinse cooling circuit without SINAMICS units. Install dirt trap (e.g. strainer, fine filter). |
| Inadequate equipotential bonding | Connect all components to equipotential bonding system (Subsection 8.1.5). |

## 8.2.1 Inhibitors, anti-freeze, biocides

Table 8-6 Overview and application of coolant additives

| | Application with SINAMICS S120 Liquid Cooled with aluminum-heatsink | Application with SINAMICS S120 Liquid Cooled with stainless steel-heatsink | Important note |
|---|---|---|---|
| Inhibitor use without antifreeze effect | Necessary | Not necessary | Inhibitor 0.2 % to 0.25 % of total volume! |
| Anti-freeze | Antifrogen N 20 % < X ≤ 45 %, no additional inhibitor required | Antifrogen N 20 % < X ≤ 45 % | |
| Biocide | Yes | Yes | Cooling circuit with open pressurizer |
| Anti-freeze + biocide | An Antifrogen N anti-freeze content of >20 % provides an adequate biocidal effect. | An Antifrogen N anti-freeze content of >20 % provides an adequate biocidal effect. | |

### Inhibitor use without antifreeze effect

The NALCO 00GE056 inhibitor (Manufacturer: Nalco) must always be used in a mixing proportion of 0.2 % to 0.25 %.

Inhibitors can be used only in water with the properties defined in Section 8.2 which must not contain any magnesium carbonate.

Control kits can be ordered from Nalco to check the inhibitor concentration.

## Anti-freeze protection

Antifrogen N (Manufacturer: Clariant) with a proportion X of 20 % < X ≤ 45 % is the anti-freeze used. Coolants containing 45 % Antifrogen N are anti-freeze-protected down to -30 °C.

Antifrogen N contains anti-corrosion inhibitors which permanently protect the metal in the cooling system against corrosion.

It is particularly important to ensure that the proportion of Antifrogen N is always >20 % when a system is refilled, otherwise the mixture becomes corrosive.

Inhibitors and Antifrogen N must not be mixed.

## Biocide

Closed cooling circuits with soft water (°DH>4) are susceptible to microbes. The risk of corrosion caused by microbes is virtually non-existent in chlorinated drinking water systems.

No strain of bacteria can survive if >20 % Antifrogen N is added.

The following types of bacteria are encountered in practice:

- Slime-forming bacteria
- Corrosive bacteria
- Iron-depositing bacteria

The type of bacteria determines the suitability of a biocide. At least one water analysis per annum (to determine the number of bacterial colonies) is recommended. Suitable biocides are available, for example, from Nalco (Manufacturer: Nalco).

**Note**

The type of bacteria determines the biocide.

The manufacturer's recommendations must be followed as regards the dosage and compatibility with any inhibitor used.

Biocides and Antifrogen N must not be mixed.

Antifrogen N has a biocidal effect even at the minimum required concentration of >20 %.

## 8.3 Materials

The following table lists a wide variety of materials and components which may or may not be used in a cooling circuit.

Table 8-7 Materials and components of a cooling circuit

| Material | Used as | Application with SINAMICS S120 Liquid Cooled |
|---|---|---|
| Zinc | Pipes, valves and fittings | Do not use zinc! |
| Brass | Pipes, valves and fittings | Can be used in closed circuits with inhibitor. |
| Copper | Pipes, valves and fittings | Can be used only in closed circuits with inhibitors in which the heatsink and copper component are separated (e.g. connection hose on units). |
| Common steel (e.g. St37) | Pipes | Permissible in closed circuits with inhibitors or Antifrogen N, check for oxide formation, inspection window recommended. |
| Cast steel, cast iron | Pipes, motors | Closed circuit and use of strainers and flushback filters.<br>Fe separator for stainless steel cooling circuit. |
| High-alloy steel, Group 1 (V2A) | Pipes, valves and fittings | Can be used for drinking or tap water with a chloride content up to <250 ppm, suitable according to definition in Section 8.2. |
| High-alloy steel, Group 2 (V4A) | Pipes, valves and fittings | Can be used for drinking or tap water with a chloride content up to <500 ppm, suitable according to definition in Section 8.2. |
| ABS **A**crylonitrile **B**utadiene **S**tyrene | Pipes, valves and fittings | Suitable according to definition in Section 8.2. Suitable for mixing with inhibitor and/or biocide as well as Antifrogen N. |
| Installation made of different materials (mixed installation) | Pipes, valves and fittings | Do not use a mixed installation. |
| PVC | Pipes, valves and fittings, hoses | Do not use PVC! |
| Hoses | | Reduce the use of hoses to a minimum (device connection). Must not be used as the main line for the whole system.<br>Recommendation: EPDM hoses with an electrical conductivity of >10^9 ohms (e.g. Semperflex FKD supplied by Semperit or DEMITTEL made of PE/EPDM supplied by Telle) |
| Seals | Pipes, valves and fittings | Use of Viton, AFM34, EPDM is recommended. |
| Hose connections | Pipe-hose transition | Secure with clips conforming to DIN2817, available, e.g. from Telle. |

## 8.4 Horizontal installation

SINAMICS S120 Liquid Cooled units can operate in a vertical position with the unit resting on its rear panel.

To prevent heat concentrations inside the units in this mounting position, an external fan needs to be installed which is capable of removing heated air from the devices.

A baffle (referred to below as air distribution baffle) must also be mounted above the unit. This ensures that the air is sucked through the IP20 covers in an even distribution over the entire length of the device, thereby ensuring that even components at the bottom (in Fig. 8-11 on left) of the module remain within the permissible tolerance range.

The components required for a horizontal mounting position can be seen in Fig. 8-11.

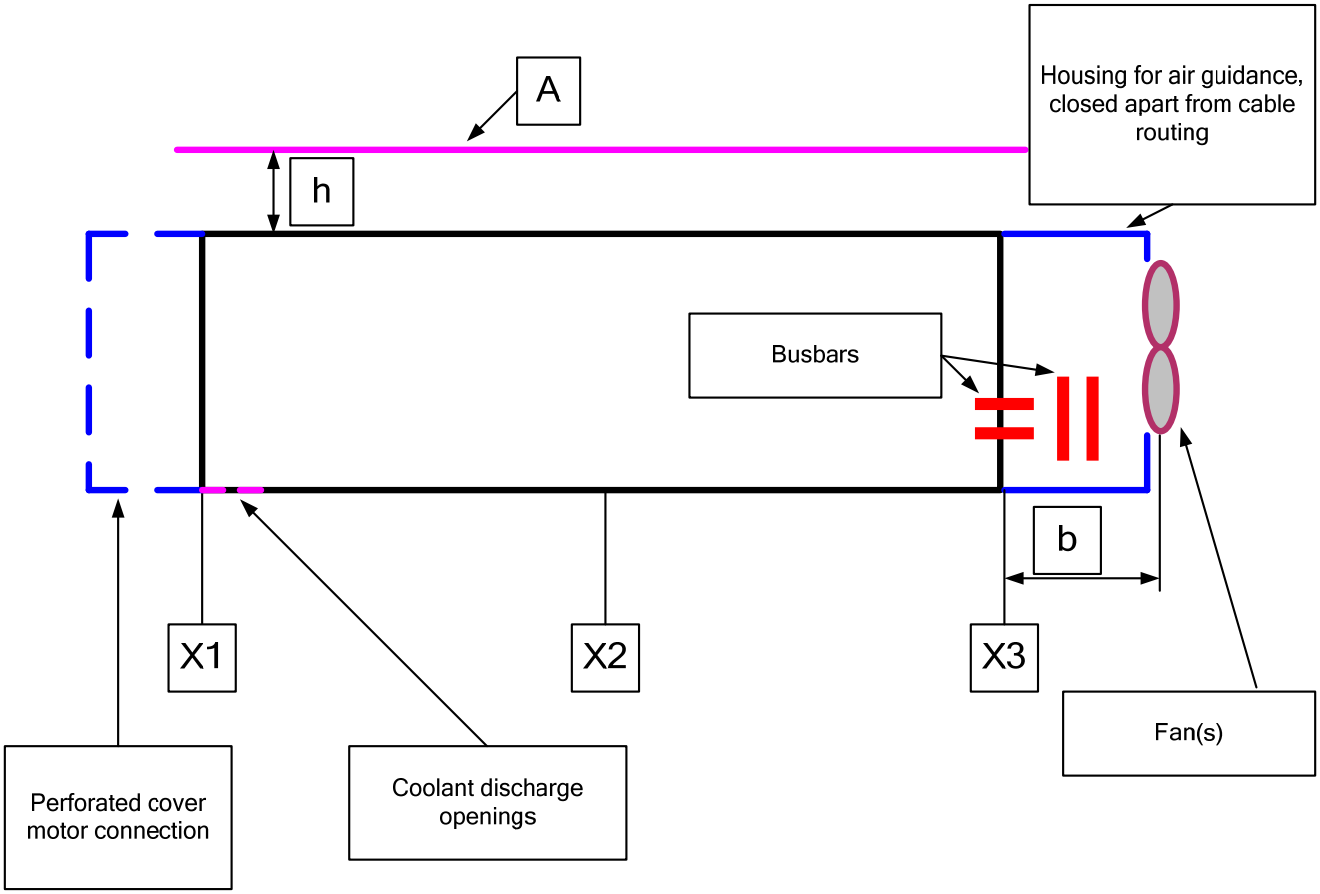



Fig. 8-11 Basic layout for horizontal mounting position.

The height h, the distance between the module top edge (horizontal) and the air distribution baffle A must be in the range 25 mm < h < 60 mm!

### Requirement for cover part "A"

In the case of a single module (Power Module, Basic Line Module or Motor Module) or a Motor Module mounted adjacent to a Basic Line Module: Baffle A is closed, the side openings ensure adequate distribution of air flow.

For configurations with several modules mounted adjacently, baffle A must be perforated. The perforation must be designed such that up to 60 % of the opening area is in the lower module half (Fig. 8-11, between X1 and X2).

## Housing for air guidance

The fan(s) can suck the air out of the module only if air cannot be sucked in between the module and the fan. A housing (enclosure) must therefore be provided between the fan and the module.

## Motor connection cover

The motor connection on a horizontally mounted module must be covered. This cover must be perforated. The perforations should have an opening area of 8 x 30 mm with a perforation spacing of 3 to 5 mm (Fig. 8-12).



Fig. 8-12 Example of protective cover for motor connection

The following table lists the fans required for different module types and also specifies the volumetric flow which must be provided through the SINAMICS device. The data must be regarded as minimum values.

If the specified fan is not available, an alternative fan can be used provided that its characteristic is higher than that of the minimum fan recommended. Data sheets for the recommended minimum fan with characteristic are available on request from EBM-Papst.

Table 8-8 Volumetric flow requirement and number of fans needed for horizontal mounting

| Type | Required volumetric air flow [dm³/s] | Number of fans Papst 4114NXH or Papst 4114NHH or Papst 4184NXH (120 x 120 mm) *) |
|---|---|---|
| Power Module FL, GL | 15 | 1 |
| Basic Line Module FBL, 740 A (400 V), 420 A (690 V) | 27 | 1 |
| Basic Line Module FBL, 1220 A (400 V), 730 A (690 V) | 44 | 2 |
| Basic Line Module GBL | 63 | 2 |
| Motor Module GXL | 15 | 1 |
| Motor Module HXL | 25 | 1 |
| Motor Module JXL | 63 | 2 |

*) Available at info2@de.ebmpapst.com

If the measures recommended above are not implemented, the equipment might malfunction in operation at air temperatures as low as 30 °C. This is because the current transformers would be overheat!

The coolant connection must be designed to prevent any coolant leakage into the unit. It is advisable to empty the coolant hoses before connecting them and to plug the heatsink before removing the coolant hoses.

## 8.5 Condensation protection

The customer must take measures to protect the units against condensation.

Condensation occurs when the inlet temperature of the coolant is significantly lower than room temperature (ambient temperature). The permissible temperature difference between coolant and air varies as a function of the relative humidity $\phi$ of the ambient air. The air temperature at which the aqueous phase drops out is referred to as the "dew point".

The table below shows the dew points (in °C) for an atmospheric pressure of 1 bar (≈ installation altitude: 0 to 500 m). If the temperature of the coolant is below the specified value, condensation may occur, i.e. the coolant temperature must always be ≥ the dew point temperature.

Table 8-9 Dew point temperature as a function of relative air humidity $\phi$ and room temperature at an installation altitude of 0 m.

| T room [°C] | $\phi$=20% | $\phi$=30% | $\phi$=40% | $\phi$=50% | $\phi$=60% | $\phi$=70% | $\phi$=80% | $\phi$=85% | $\phi$=90% | $\phi$=95% | $\phi$=100% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | <0 | <0 | <0 | 0.2 | 2.7 | 4.8 | 6.7 | 7.6 | 8.4 | 9.2 | 10 |
| 20 | <0 | 2 | 6 | 9.3 | 12 | 14.3 | 16.4 | 17.4 | 18.3 | 19.1 | 20 |
| 25 | 0.6 | 6.3 | 10.5 | 13.8 | 16.7 | 19.1 | 21.2 | 22.2 | 23.2 | 24.1 | 24.9 |
| 30 | 4.7 | 10.5 | 14.9 | 18.4 | 21.3 | 23.8 | 26.1 | 27.1 | 28.1 | 29 | 29.9 |
| 35 | 8.7 | 14.8 | 19.3 | 22.9 | 26 | 28.6 | 30.9 | 32 | 33 | 34 | 34.9 |
| 38 | 11.1 | 17.4 | 22 | 25.7 | 28.8 | 31.5 | 33.8 | 34.9 | 36 | 36.9 | 37.9 |
| 40 | 12.8 | 19.1 | 23.7 | 27.5 | 30.6 | 33.4 | 35.8 | 36.9 | 37.9 | 38.9 | 39.9 |
| 45 | 16.8 | 23.3 | 28.2 | 32 | 35.3 | 38.1 | 40.6 | 41.8 | 42.9 | 43.9 | 44.9 |
| 50 | 20.8 | 27.5 | 32.6 | 36.6 | 40 | 42.9 | 45.5 | 46.6 | 47.8 | 48.9 | 49.9 |

The dew point also depends on the absolute pressure, i.e. the installation altitude.

The dew points for low atmospheric pressure are lower than those at an altitude of 0 m, i.e. it is always acceptable to calculate the coolant supply temperature for an altitude of 0 m.

## 8.6 Degrees of protection

SINAMICS S120 Liquid Cooled units have degree of protection IP20 with the exception of the electrical connections (overall degree of protection IP00).

The temperature ranges specified in Section 3.7.2 also apply to units mounted in a control cabinet.

No additional measures need to be taken if the modules are mounted in a cabinet with degree of protection IP21.

However, if they are mounted in a cabinet with a degree of protection higher than IP21, a fan must be installed above the modules to dissipate any concentrated heat.

The table below specifies the required volumetric flows and the average rates of flow within a shrouding cover (400 mm high).

If several modules are installed in the same cabinet, then the required volumetric flow corresponds to the total volumetric flows of the individual components.

In configurations where a number of shrouding covers are interconnected, the total volumetric flow must also be calculated and a fan selected accordingly.

If a single module is installed in a cabinet with degree of protection IP54, then the fan can be dispensed with if the required volumetric flow for the module is <0.01 $m^3/s$.

Table 8-10 Required volumetric flows of shrouding cover fan with degree of protection >IP21

| Type | Required volumetric flow dV/dt of shrouding cover fan [$m^3/s$] | Average rate of flow [m/s] |
|---|---|---|
| Power Module FL, 210 A (400 V) | 0.0025 | 0.01 |
| Power Module FL, 260 A (400 V) | 0.0030 | 0.02 |
| Power Module GL, 310 A (400 V) | 0.0036 | 0.02 |
| Power Module GL, 490 A (400 V) | 0.0057 | 0.03 |
| Basic Line Module FBL, 740 A (400 V) | 0.0100 | 0.05 |
| Basic Line Module FBL, 1220 A (400 V) | 0.0170 | 0.09 |
| Basic Line Module FBL, 420 A (690 V) | 0.0090 | 0.05 |
| Basic Line Module FBL, 730 A (690 V) | 0.0160 | 0.08 |
| Basic Line Module GBL, 1300 A (690 V) | 0.0180 | 0.09 |
| Basic Line Module GBL, 1650 A (690 V) | 0.0230 | 0.12 |
| Motor Module GXL, 310 A (400 V) | 0.0035 | 0.02 |
| Motor Module GXL, 490 A (400 V) | 0.0056 | 0.03 |
| Motor Module HXL, 575 A (690 V) | 0.0065 | 0.03 |
| Motor Module JXL, 810 A (690 V) | 0.0187 | 0.10 |
| Motor Module JXL, 1025 A (690 V) | 0.0210 | 0.11 |
| Motor Module JXL, 1270 A (690 V) | 0.0236 | 0.12 |

Recommended fan: Supplied by EBM-Papst, type W2E200-HH38-01

## 8.7 Connection system

The electrical connections on the SINAMICS S120 Liquid Cooled units must be made with cables of the cross-section stipulated in the technical specifications for the relevant device.

The coolant connection is made using 3/4" couplings.

The supply and return connections on the SINAMICS devices must be made with flexible, non-conductive hose (see Section 8.3) so as to eliminate the risk of electrochemical corrosion, to reduce transfer of vibration and to dampen pressure transients in the coolant. The hose should be about 1.5 m in length (total of supply and return lines).

The coolant hoses should be connected before the units are mounted.

## 8.8 Commissioning, service

### Commissioning

Once the modules have been installed in the plant, the coolant circuit must be commissioned before the electrical systems.

- The heatsinks on Power Modules of frame sizes FL and GL and Motor Modules of frame size GXL need not be vented before they are filled for the first time.
- The heatsinks on Basic Line Modules of frame sizes FBL, GBL and Motor Modules of frame sizes HXL, JXL must be vented before they are filled for the first time.
  - For this purpose, the units are fitted with a vent valve at the top and a vent hose at the bottom. The air and/or coolant can be bled out of the unit via this hose and collected underneath so that it cannot leak into the module.
  - A stopper is inserted in the vent hose at the factory. This must be removed before the heatsink is vented and inserted again afterwards.

### Service

The recommended servicing procedure for the cooling circuit is to check the fill level and the coolant for discoloration or turbidity at least once a year.

If the coolant level has dropped, the loss should be corrected on closed or semi-open circuits with a preprepared mixture of battery water (see Section 8.2) and inhibitor or Antifrogen N.

# Maintenance and servicing

# 9

## 9.1 Chapter content

This chapter provides information on the following:

- Maintenance and servicing procedures that have to be carried out on a regular basis to ensure the availability of the components.
- Exchanging device components when the unit is serviced
- Reforming the DC link capacitors



**Danger**

Before carrying out any maintenance or repair work on the de-energized device, wait for 5 minutes after switching off the supply voltage. This allows the capacitors to discharge to a harmless level (< 25 V) after the supply voltage has been switched off.

Before starting work, you should also measure the voltage after the 5 minutes have elapsed! The voltage can be measured on DC link terminals DCP and DCN.



**Danger**

When the external power supply or the external 230 V AC auxiliary supply is connected, dangerous voltages are still present in the components even when the main circuit-breaker is open.

# 9.2 Maintenance

The device comprises mostly electronic components. Apart from the fan(s), therefore, it contains hardly any components that are subject to wear or that require maintenance or servicing. Maintenance is intended to ensure that the equipment remains in the specified condition. Inspections must be performed regularly, but at least once a year. Where necessary, contaminants must be removed and wearing parts replaced.

The following points must generally be observed.

## 9.2.1 Cleaning

### Dust deposits

Dust deposits inside the device must be removed at regular intervals (or at least once a year) by qualified personnel in line with the relevant safety regulations. The unit must be cleaned using a brush and vacuum cleaner, and dry compressed air (max. 1 bar) for areas that cannot be easily reached.

### Ventilation

The ventilation openings in the device must never be obstructed. The fans must be checked to make sure that they are functioning correctly.

### Cable and screw

Cable and screw terminals must be checked regularly to ensure that they are secure in position, and if necessary, retightened. Cabling must be checked for defects. Defective parts must be replaced immediately.

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**Note**

The actual intervals at which maintenance procedures are to be performed depend on the installation conditions (cabinet environment) and the operating conditions.

Siemens offers its customers support in the form of a service contract. For further details, contact your regional office or sales office.

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# 9.3 Servicing

Servicing involves activities and procedures for maintaining and restoring the operating condition of the devices.

## Required tools

The following tools are required for replacing components:

- Spanner or socket spanner (w/f 10)
- Spanner or socket spanner (w/f 13)
- Spanner or socket spanner (w/f 16/17)
- Spanner or socket spanner (w/f 18/19)
- Hexagon-socket spanner (size 8)
- Torque wrench up to 50 Nm
- Screwdriver size 1 / 2
- Screwdriver Torx T20
- Screwdriver Torx T30

## Tightening torques for current-carrying parts

When securing connections for current-carrying parts (DC link, motor connections, busbars), you must observe the following tightening torques.

Table 9-1 Tightening torques for connecting current-carrying parts

| Screw | Torque |
|---|---|
| M6 | 6 Nm |
| M8 | 13 Nm |
| M10 | 25 Nm |
| M12 | 50 Nm |

## 9.4 Replacing components



**Warning**

When transporting the devices and replacing components, note the following:

- Some of the devices and components are heavy or top heavy.
- Due to their weight, the devices must be handled with care by trained personnel.
- Improper lifting and handling can cause serious or fatal injury to personnel and substantial property damage.



**Warning**

The devices are operated on high voltages.
All connection work must be carried out when the cabinet is de-energized!
All work on the device must be performed by properly trained personnel. Death, serious injury, or substantial material damage can result if these warnings are not taken into account.
Work on an open device must be carried out with extreme caution because external line voltages may be present. The power and control terminals may be live even when the motor is not running.
Due to the DC link capacitors, dangerously high voltage levels are still present inside the device up to five minutes after it has been disconnected. For this reason, the cabinet should not be opened until after an appropriate period of time has elapsed.

**Caution**

The busbars and coolant connections which stick out of the module must never be used as handles or support surfaces when the units are transported.

## 9.4.1 Replacing the Control Interface Board, Power Module, frame size FL

### Replacing the Control Interface Board

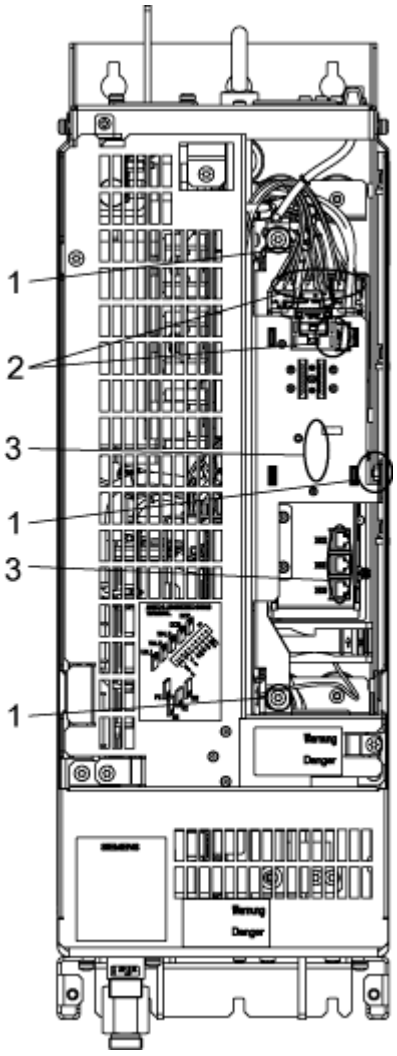



Fig. 9-1 Replacing the Control Interface Board, Power Module, frame size FL

### Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

### Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-1.

1. Undo the retaining screws for the control module holder and the electronics plug-in module (2 screws and one nut) and remove the control module holder.
2. Disconnect the plugs for the fiber optic cables and signal cables (5 plugs).
3. Remove the DRIVE-CLiQ cables and connections on –X41 / –X42 (5 plugs).

When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

The Control Interface Board can then be removed from the slide-in electronics unit.

**Caution**

When removing the ribbon cable connector, make sure that you actuate the locking lever on the connector very carefully (e.g. with a screwdriver) because otherwise the lock could be damaged.

### Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

When dealing with connectors with a lock, make sure that the locking lever is securely engaged once connected.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.2 Replacing the Control Interface Board, Power Module, frame size GL

### Replacing the Control Interface Board

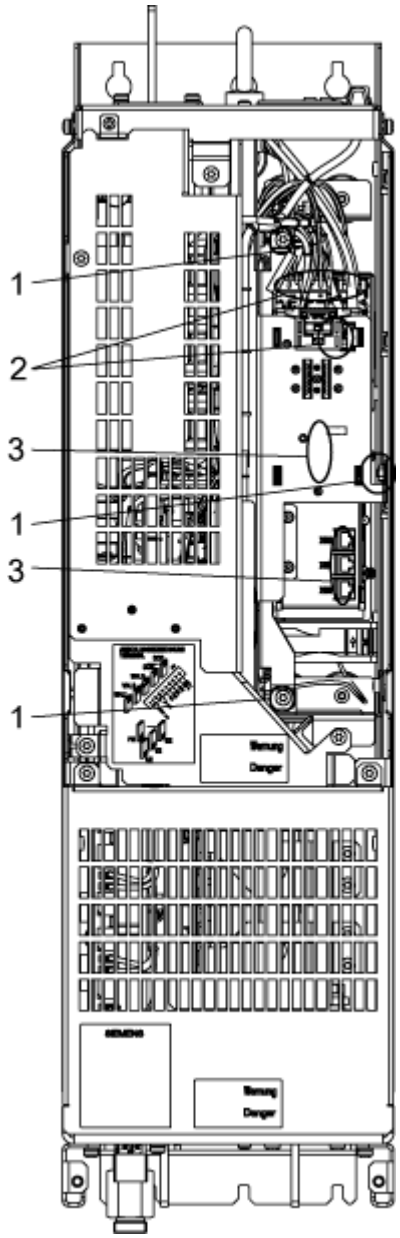



Fig. 9-2 Replacing the Control Interface Board, Power Module, frame size GL

### Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

### Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-2.

1. Undo the retaining screws for the control module holder and the electronics plug-in module (2 screws and one nut) and remove the control module holder.
2. Disconnect the plugs for the fiber optic cables and signal cables (5 plugs).
3. Remove the DRIVE-CLiQ cables and connections on –X41 / –X42 entfernen (5 plugs).

When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

The Control Interface Board can then be removed from the slide-in electronics unit.

**Caution**

When removing the ribbon cable connector, make sure that you actuate the locking lever on the connector very carefully (e.g. with a screwdriver) because otherwise the lock could be damaged.

### Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

When dealing with connectors with a lock, make sure that the locking lever is securely engaged once connected.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.3 Replacing the Control Interface Board, Motor Module, frame size GXL

### Replacing the Control Interface Board

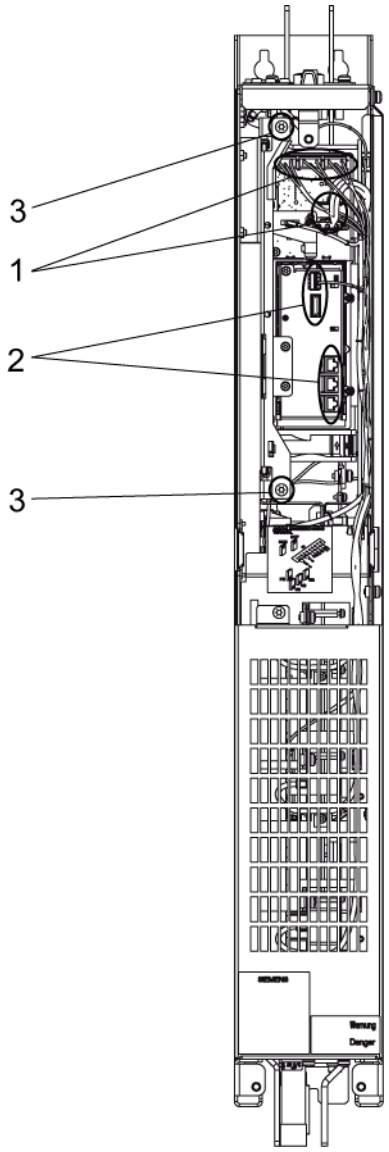



Fig. 9-3 Replacing the Control Interface Board, Motor Module, frame size GXL

### Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

### Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-3.

1. Disconnect the plugs for the fiber optic cables and signal cables (5 plugs).
2. Remove the DRIVE-CLiQ cables and connections on –X41 / –X42 entfernen (5 plugs).
3. Remove the retaining screws for the slide-in electronics unit (2 screws).
   When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

The Control Interface Board can then be removed from the slide-in electronics unit.

**Caution**

When removing the ribbon cable connector, make sure that you actuate the locking lever on the connector very carefully (e.g. with a screwdriver) because otherwise the lock could be damaged.

### Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

When dealing with connectors with a lock, make sure that the locking lever is securely engaged once connected.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.4 Replacing the Control Interface Board, Motor Module, frame size HXL

### Replacing the Control Interface Board

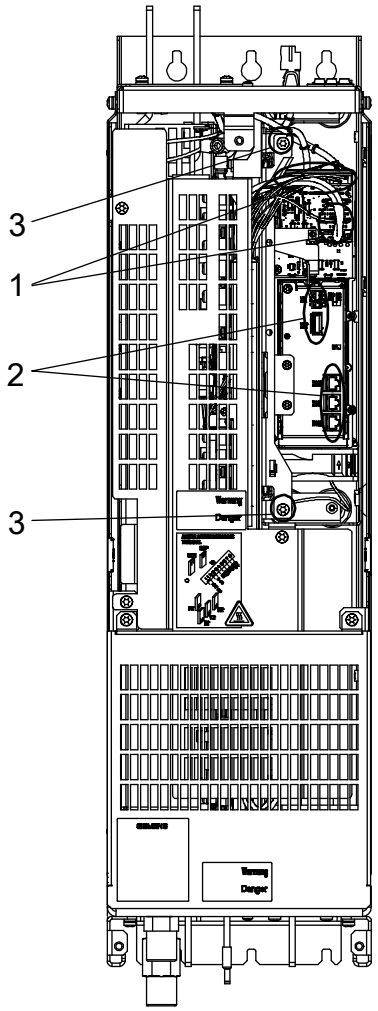



Fig. 9-4 Replacing the Control Interface Board, Motor Module, frame size HXL

### Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

### Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-4.

1. Disconnect the plugs for the fiber optic cables and signal cables (5 plugs).
2. Remove the DRIVE-CLiQ cables and connections on –X41 / –X42 (5 plugs).
3. Remove the retaining screws for the slide-in electronics unit (2 screws).
   When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

The Control Interface Board can then be removed from the slide-in electronics unit.

**Caution**

When removing the ribbon cable connector, make sure that you actuate the locking lever on the connector very carefully (e.g. with a screwdriver) because otherwise the lock could be damaged.

### Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

When dealing with connectors with a lock, make sure that the locking lever is securely engaged once connected.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.5 Replacing the Control Interface Board, Motor Module, frame size JXL

### Replacing the Control Interface Board

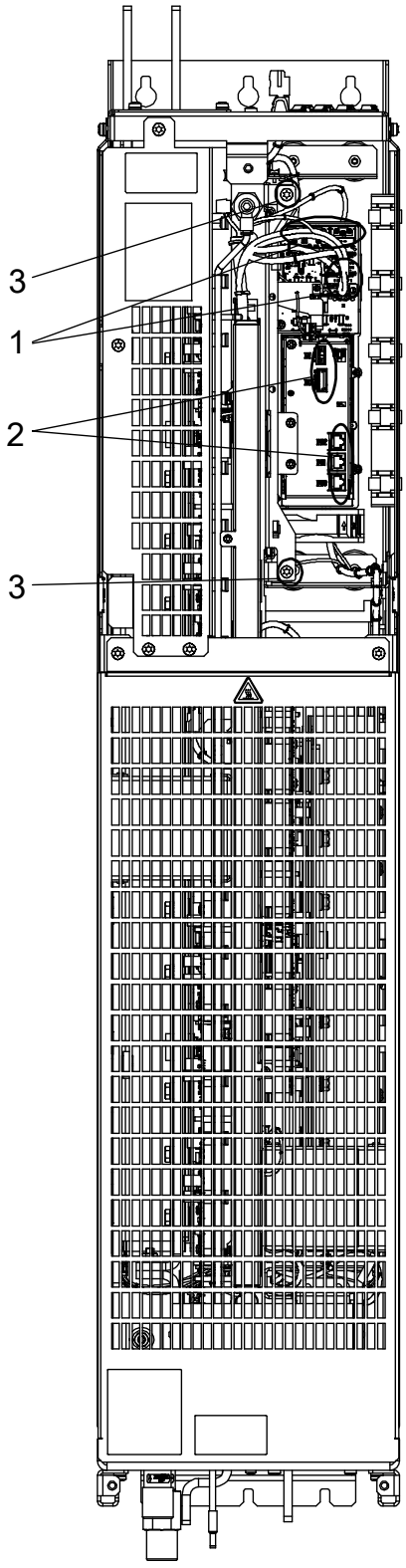



Fig. 9-5 Replacing the Control Interface Board, Motor Module, frame size JXL

### Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

### Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-5.

1. Disconnect the plugs for the fiber optic cables and signal cables (5 plugs).
2. Remove the DRIVE-CLiQ cables and connections on –X41 / –X42 (5 plugs).
3. Remove the retaining screws for the slide-in electronics unit (2 screws).
   When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

The Control Interface Board can then be removed from the slide-in electronics unit.

**Caution**

When removing the ribbon cable connector, make sure that you actuate the locking lever on the connector very carefully (e.g. with a screwdriver) because otherwise the lock could be damaged.

### Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

When dealing with connectors with a lock, make sure that the locking lever is securely engaged once connected.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.6 Replacing the Control Interface Board, Basic Line Module, frame size FBL

### Replacing the Control Interface Board

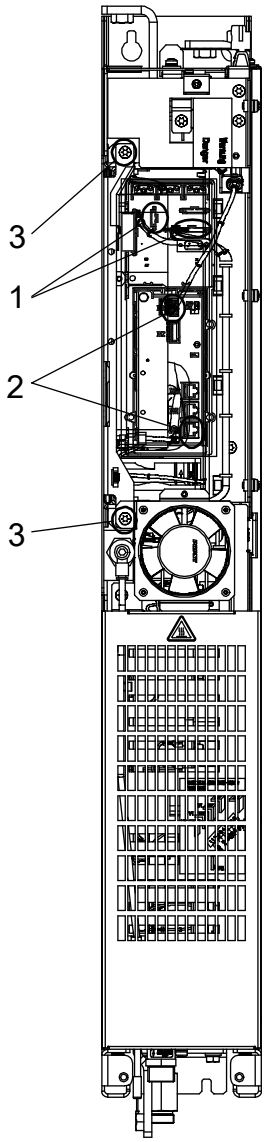



Fig. 9-6 Replacing the Control Interface Board, Basic Line Module, frame size FBL

### Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

### Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-6.

1. Disconnect the plugs for the signal cables (2 plugs).
2. Remove the DRIVE-CLiQ cable and connection on –X41 / –X42 (2 plugs).
3. Remove the retaining screws for the slide-in electronics unit (2 screws). The bottom screw also secures the front fan.
   When removing the slide-in electronics unit, you have to disconnect 2 further plugs one after the other (1 at the top, 1 below) and the PE connection (below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

The Control Interface Board can then be removed from the slide-in electronics unit.

**Caution**

When removing the ribbon cable connector, make sure that you actuate the locking lever on the connector very carefully (e.g. with a screwdriver) because otherwise the lock could be damaged.

### Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

When dealing with connectors with a lock, make sure that the locking lever is securely engaged once connected.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.7 Replacing the Control Interface Board, Basic Line Module, frame size GBL

### Replacing the Control Interface Board

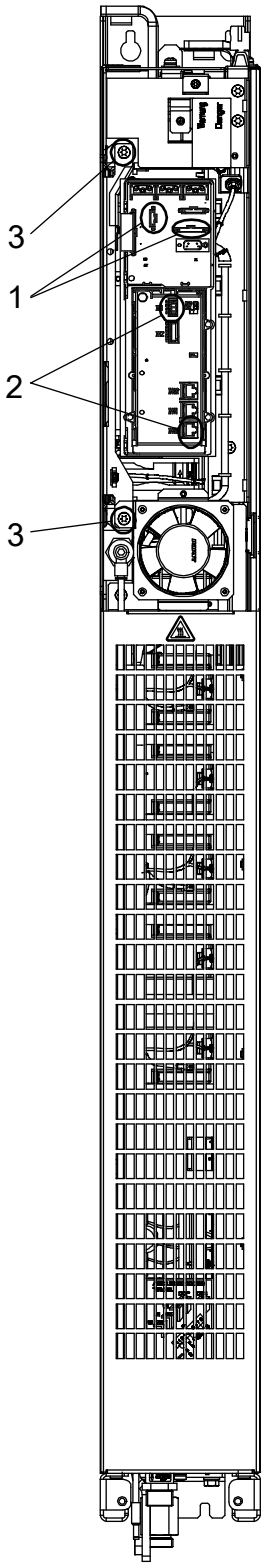



Fig. 9-7 Replacing the Control Interface Board, Basic Line Module, frame size GBL

### Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

### Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-7.

1. Disconnect the plugs for the signal cables (2 plugs).
2. Remove the DRIVE-CLiQ cable and connection on –X41 / –X42 (2 plugs).
3. Remove the retaining screws for the slide-in electronics unit (2 screws). The bottom screw also secures the front fan.
   When removing the slide-in electronics unit, you have to disconnect 2 further plugs one after the other (1 at the top, 1 below) and the PE connection (below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

The Control Interface Board can then be removed from the slide-in electronics unit.

**Caution**

When removing the ribbon cable connector, make sure that you actuate the locking lever on the connector very carefully (e.g. with a screwdriver) because otherwise the lock could be damaged.

### Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

When dealing with connectors with a lock, make sure that the locking lever is securely engaged once connected.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.8 Replacing the fan, Power Module, frame size FL

### Replacing the fan

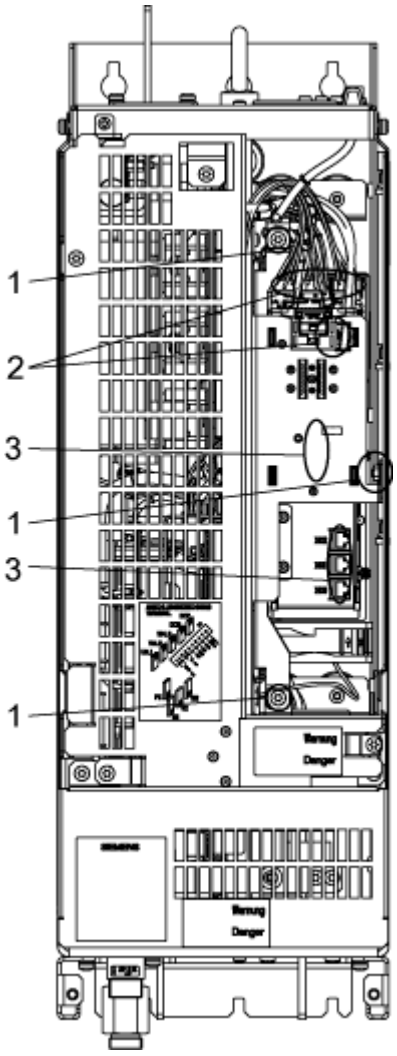



Fig. 9-8 Replacing the fan, Power Module, frame size FL

## Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables, including ambient temperature and the degree of cabinet protection and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the device is available.

## Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

## Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-8.

1. Undo the retaining screws for the control module holder and the electronics plug-in module (2 screws and one nut) and remove the control module holder.
2. Disconnect the plugs for the fiber optic cables and signal cables (5 plugs).
3. Remove the DRIVE-CLiQ cables and connections on –X41 / –X42 (5 plugs).

When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

You then have to remove the fan for the slide-in electronics unit.

You now have to remove the plug for the fan power supply from the slide-in electronics unit.

## Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.9 Replacing the fan, Power Module, frame size GL

### Replacing the fan

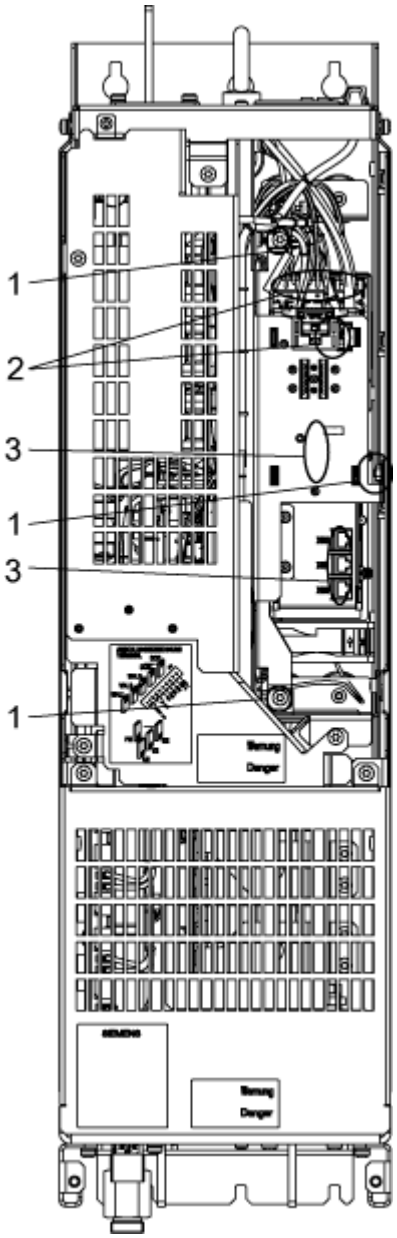



Fig. 9-9 Replacing the fan, Power Module, frame size GL

## Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables, including ambient temperature and the degree of cabinet protection and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the device is available.

## Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

## Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-9.

1. Undo the retaining screws for the control module holder and the electronics plug-in module (2 screws and one nut) and remove the control module holder.
2. Disconnect the plugs for the fiber optic cables and signal cables (5 plugs).
3. Remove the DRIVE-CLiQ cables and connections on –X41 / –X42 (5 plugs).

When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

You then have to remove the fan for the slide-in electronics unit.

You now have to remove the plug for the fan power supply from the slide-in electronics unit.

## Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.10 Replacing the fan, Motor Module, frame size GXL

### Replacing the fan

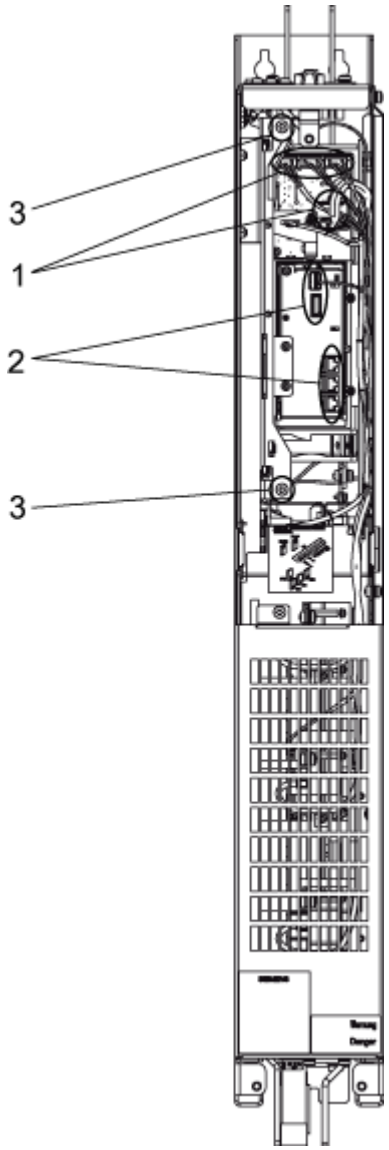



Fig. 9-10 Replacing the fan, Motor Module, frame size GXL

## Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables, including ambient temperature and the degree of cabinet protection and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the device is available.

## Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

## Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-10.

1. Disconnect the plugs for the fiber optic cables and signal cables (5 plugs).
2. Remove the DRIVE-CLiQ cables and connections on –X41 / –X42 (5 plugs).
3. Remove the retaining screws for the slide-in electronics unit (2 screws).
   When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

You then have to remove the fan for the slide-in electronics unit.

You now have to remove the plug for the fan power supply from the slide-in electronics unit.

## Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.11 Replacing the fan, Motor Module, frame size HXL

### Replacing the fan

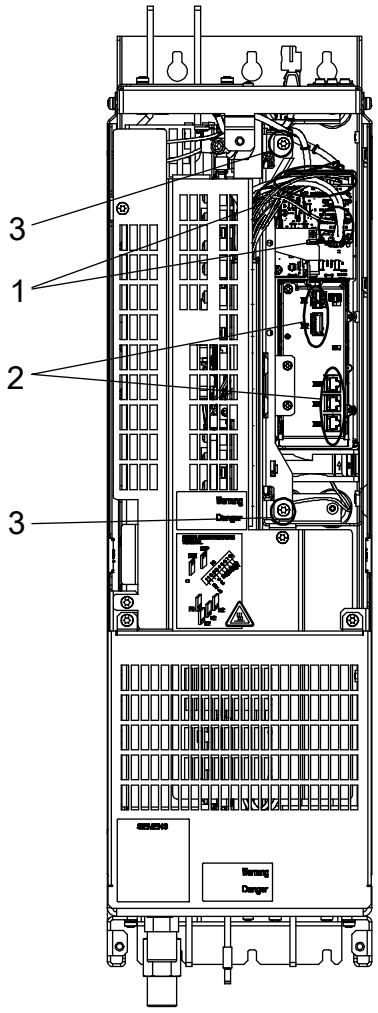



Fig. 9-11 Replacing the fan, Motor Module, frame size HXL

## Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables, including ambient temperature and the degree of cabinet protection and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the device is available.

## Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

## Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-11.

1. Disconnect the plugs for the fiber optic cables and signal cables (5 plugs).
2. Remove the DRIVE-CLiQ cables and connections on –X41 / –X42 (5 plugs).
3. Remove the retaining screws for the slide-in electronics unit (2 screws).
   When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

You then have to remove the fan for the slide-in electronics unit.

You now have to remove the plug for the fan power supply from the slide-in electronics unit.

## Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.12 Replacing the fan, Motor Module, frame size JXL

### Replacing the fan

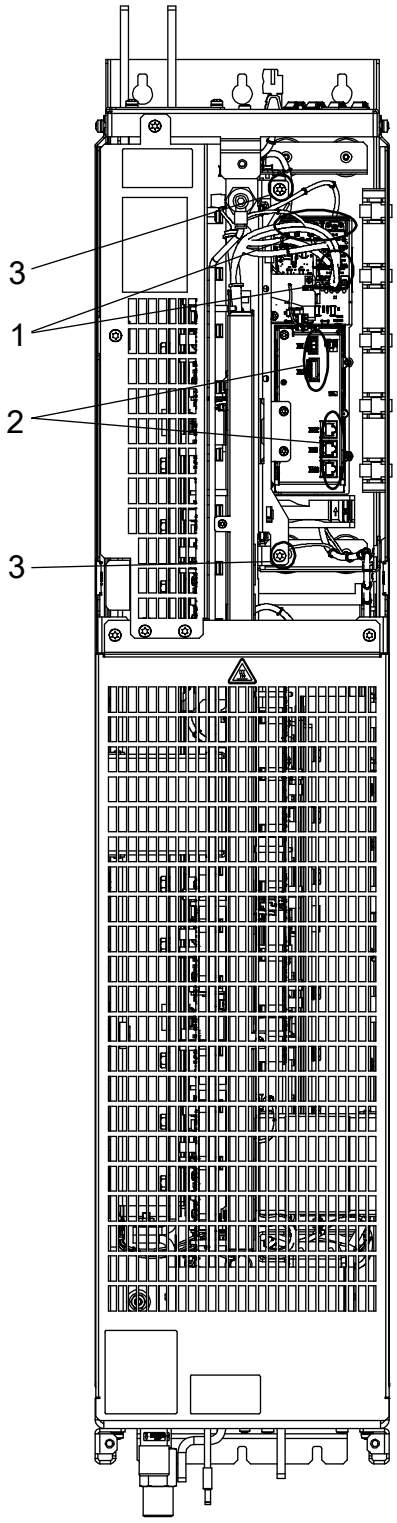



Fig. 9-12 Replacing the fan, Motor Module, frame size JXL

## Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables, including ambient temperature and the degree of cabinet protection and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the device is available.

## Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

## Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-12.

1. Disconnect the plugs for the fiber optic cables and signal cables (5 plugs).
2. Remove the DRIVE-CLiQ cables and connections on –X41 / –X42 (5 plugs).
3. Remove the retaining screws for the slide-in electronics unit (2 screws).
   When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

You then have to remove the fan for the slide-in electronics unit.

You now have to remove the plug for the fan power supply from the slide-in electronics unit.

## Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.13 Replacing the fan, Basic Line Module, frame size FBL

### Replacing the fan

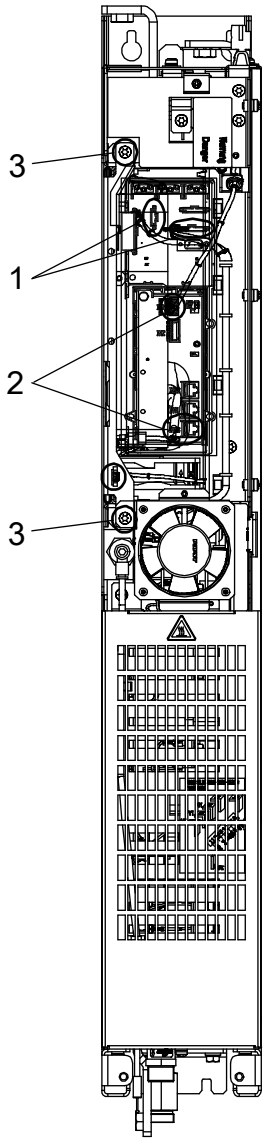



Fig. 9-13 Replacing the fan, Basic Line Module, frame size FBL

## Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables, including ambient temperature and the degree of cabinet protection and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the device is available.

## Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the front cover.

## Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-13.

1. Disconnect the plugs for the signal cables (2 plugs).
2. Remove the DRIVE-CLiQ cable and connection on –X41 / –X42 (2 plugs).
3. Remove the retaining screws for the slide-in electronics unit (2 screws). The bottom screw also secures the front fan.
   When removing the slide-in electronics unit, you have to disconnect 2 further plugs one after the other (1 at the top, 1 below) and the PE connection (below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

You then have to remove the fan for the slide-in electronics unit.

You now have to remove the plugs for the power supply for both fans from the slide-in electronics unit.

## Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.14 Replacing the fan, Basic Line Module, frame size GBL

### Replacing the fan

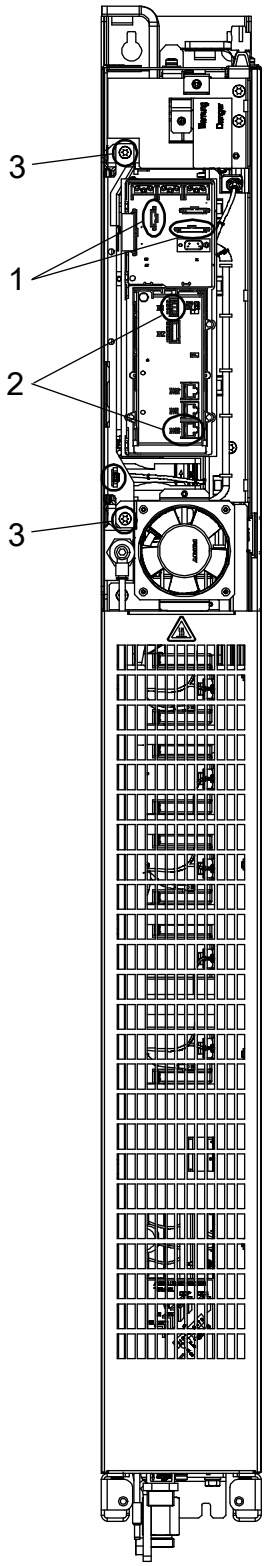



Fig. 9-14 Replacing the fan, Basic Line Module, frame size GBL

## Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables, including ambient temperature and the degree of cabinet protection and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the device is available.

## Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the front cover.

## Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-14.

1. Disconnect the plugs for the signal cables (2 plugs).
2. Remove the DRIVE-CLiQ cable and connection on –X41 / –X42 (2 plugs).
3. Remove the retaining screws for the slide-in electronics unit (2 screws). The bottom screw also secures the front fan.
   When removing the slide-in electronics unit, you have to disconnect 2 further plugs one after the other (1 at the top, 1 below) and the PE connection (below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

You then have to remove the fan for the slide-in electronics unit.

You now have to remove the plugs for the power supply for both fans from the slide-in electronics unit.

## Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.15 Replacing the Power Supply Board, Power Module, frame size FL

### Replacing the Power Supply Board

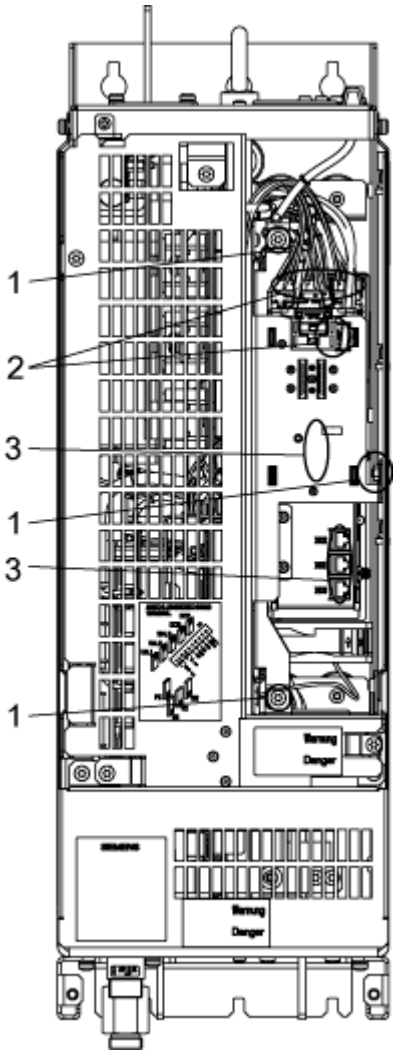



Fig. 9-15 Replacing the Power Supply Board, Power Module, frame size FL

### Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

### Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-15.

1. Undo the retaining screws for the control module holder and the electronics plug-in module (2 screws and one nut) and remove the control module holder.
2. Disconnect the plug connections for the fiber optic cables and signal cables (5 plugs).
3. Remove the DRIVE-CLiQ cables and connections on –X41 / –X42 (5 plugs).

When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

The Power Supply Board can then be removed from the slide-in electronics unit.

### Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.16 Replacing the Power Supply Board, Power Module, frame size GL

### Replacing the Power Supply Board

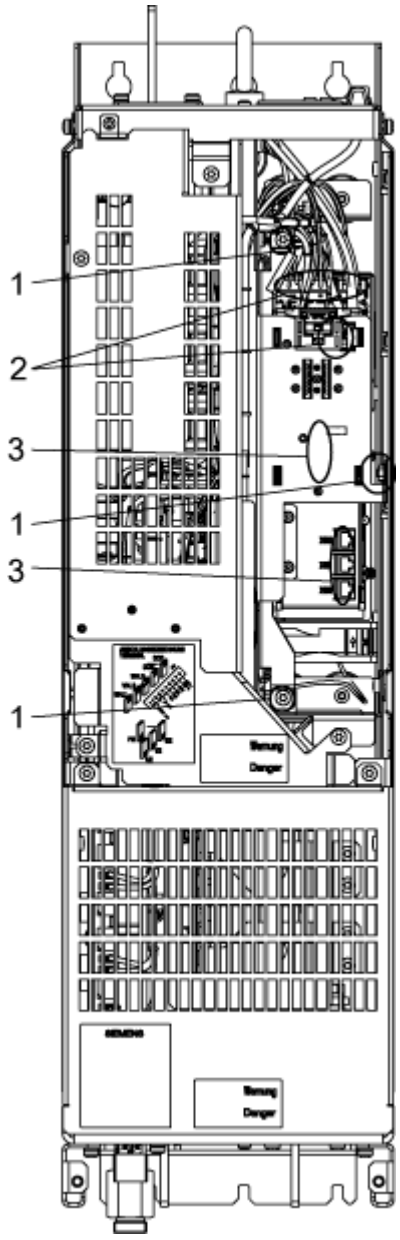



Fig. 9-16 Replacing the Power Supply Board, Power Module, frame size GL

### Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

### Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-16.

1. Undo the retaining screws for the control module holder and the electronics plug-in module (2 screws and one nut) and remove the control module holder.
2. Disconnect the plug connections for the fiber optic cables and signal cables (5 plugs).
3. Remove the DRIVE-CLiQ cables and connections on –X41 / –X42 (5 plugs).

When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

The Power Supply Board can then be removed from the slide-in electronics unit.

### Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.17 Replacing the Power Supply Board, Motor Module, frame size GXL

### Replacing the Power Supply Board

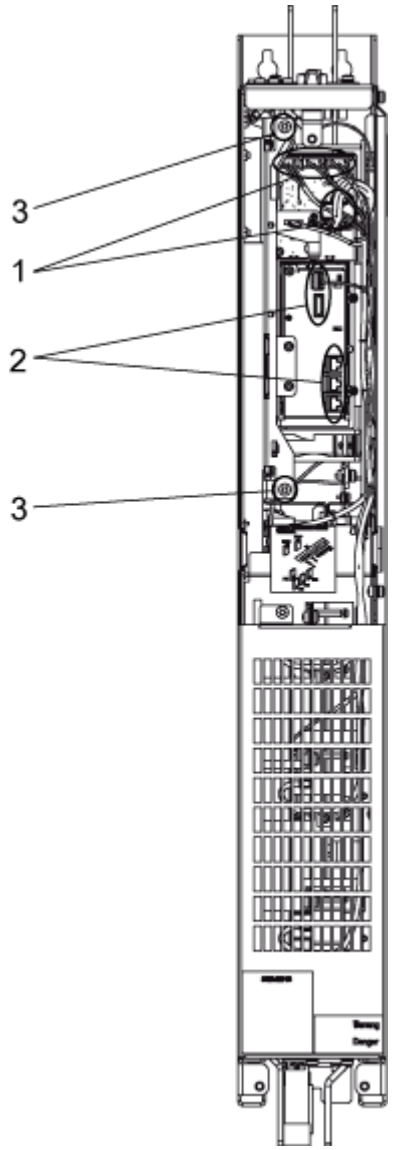



Fig. 9-17 Replacing the Power Supply Board, Motor Module, frame size GXL

### Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

### Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-17.

1. Disconnect the plug connections for the fiber optic cables and signal cables (5 plugs).
2. Remove the DRIVE-CLiQ cables and connections on –X41 / –X42 (5 plugs).
3. Remove the retaining screws for the slide-in electronics unit (2 screws).
   When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

The Power Supply Board can then be removed from the slide-in electronics unit.

### Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.18 Replacing the Power Supply Board, Motor Module, frame size HXL

### Replacing the Power Supply Board

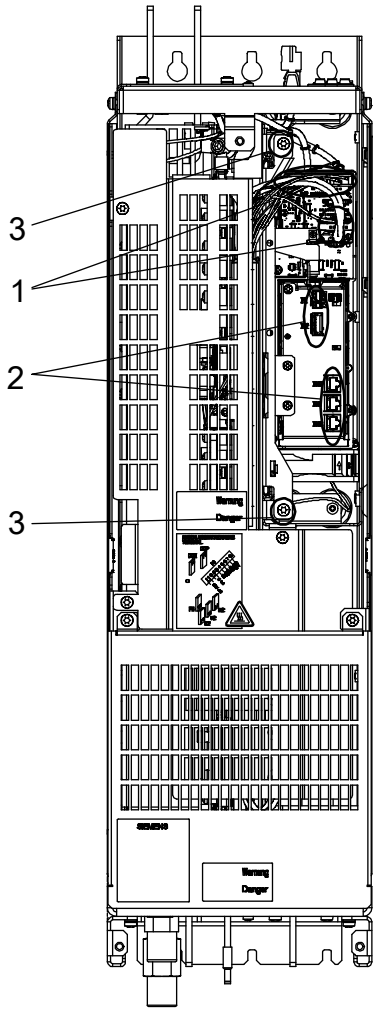



Fig. 9-18 Replacing the Power Supply Board, Motor Module, frame size HXL

### Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

### Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-18.

1. Disconnect the plug connections for the fiber optic cables and signal cables (5 plugs).
2. Remove the DRIVE-CLiQ cables and connections on –X41 / –X42 (5 plugs).
3. Remove the retaining screws for the slide-in electronics unit (2 screws).
   When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

The Power Supply Board can then be removed from the slide-in electronics unit.

### Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.19 Replacing the Power Supply Board, Motor Module, frame size JXL

### Replacing the Power Supply Board

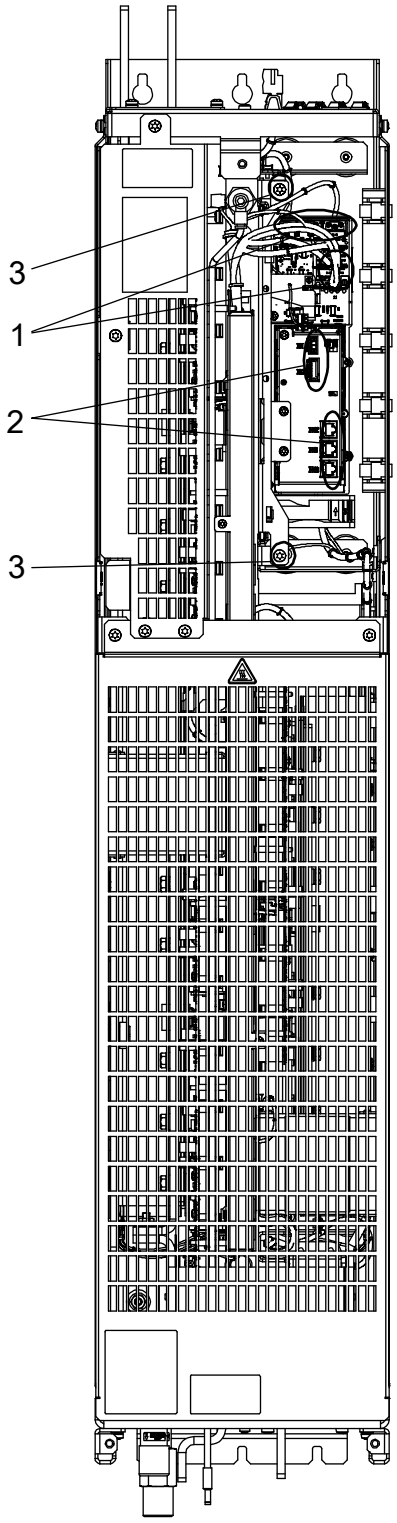



Fig. 9-19 Replacing the Power Supply Board, Motor Module, frame size JXL

### Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

### Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-19.

1. Disconnect the plug connections for the fiber optic cables and signal cables (5 plugs).
2. Remove the DRIVE-CLiQ cables and connections on –X41 / –X42 (5 plugs).
3. Remove the retaining screws for the slide-in electronics unit (2 screws).
   When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

The Power Supply Board can then be removed from the slide-in electronics unit.

### Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.20 Replacing the Power Supply Board, Basic Line Module, frame size FBL

### Replacing the Power Supply Board

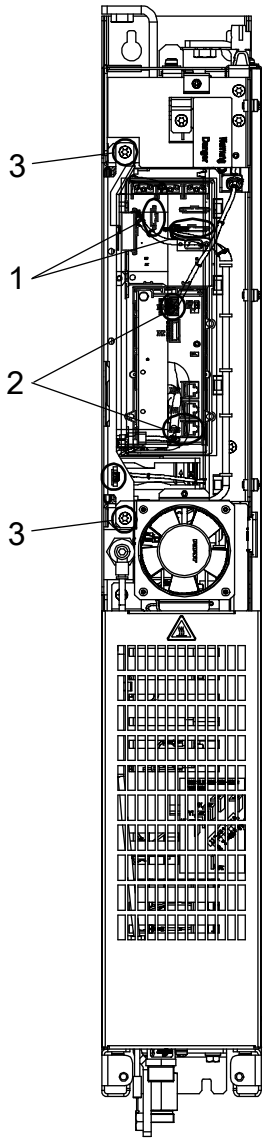



Fig. 9-20 Replacing the Power Supply Board, Basic Line Module, frame size FBL

### Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the front cover.

### Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-20.

1. Disconnect the plugs for the signal cables (2 plugs).
2. Remove the DRIVE-CLiQ cable and connection on –X41 / –X42 (2 plugs).
3. Remove the retaining screws for the slide-in electronics unit (2 screws). The bottom screw also secures the front electronics fan.
   When removing the slide-in electronics unit, you have to disconnect 2 further plugs one after the other (1 at the top, 1 below) and the PE connection (below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

The Power Supply Board can then be removed from the slide-in electronics unit.

### Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

The screwed connections for the protective covers must only be tightened by hand.

## 9.4.21 Replacing the Power Supply Board, Basic Line Module, frame size GBL

### Replacing the Power Supply Board

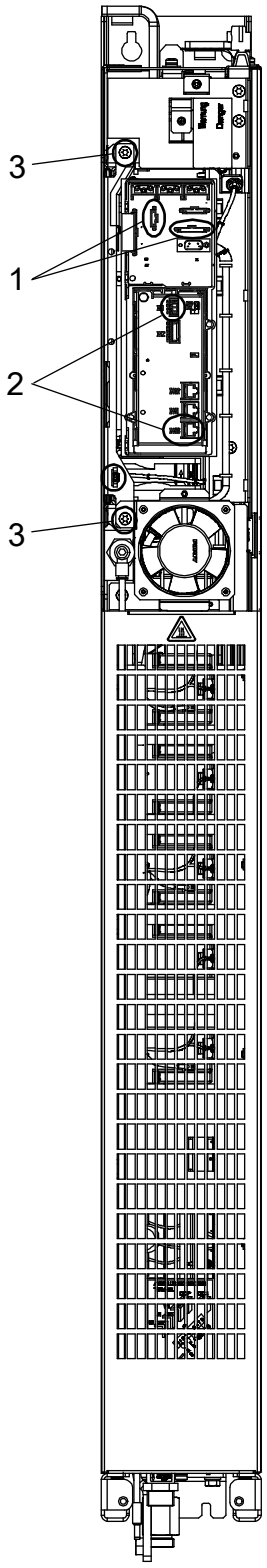



Fig. 9-21 Replacing the Power Supply Board, Basic Line Module, frame size GBL

### Preparatory steps

- Disconnect the drive line-up from the power supply.
- Allow unimpeded access.
- Remove the front cover.

### Removal steps

The steps for the removal procedure are numbered in accordance with Fig. 9-21.

1. Disconnect the plugs for the signal cables (2 plugs).
2. Remove the DRIVE-CLiQ cable and connection on –X41 / –X42 (2 plugs).
3. Remove the retaining screws for the slide-in electronics unit (2 screws). The bottom screw also secures the front electronics fan.
   When removing the slide-in electronics unit, you have to disconnect 2 further plugs one after the other (1 at the top, 1 below) and the PE connection (below).

**Caution**

When removing the fan, ensure that you do not damage any signal cables.

The Power Supply Board can then be removed from the slide-in electronics unit.

### Installation

To re-install the fan, carry out the above steps in reverse order.

**Caution**

The tightening torques specified in Table 9-1 must be observed.

Carefully re-establish the plug connections and ensure that they are secure.

The screwed connections for the protective covers must only be tightened by hand.

# 9.5 Reforming the DC link capacitors

## Description

If the Basic Line Module and Motor Module are kept in storage for more than two years, the DC link capacitors have to be reformed. If this is not done, the units could be damaged when they are operated under load.

If the cabinet is commissioned within two years of its date of manufacture, the DC link capacitors do not need to be reformed. The date of manufacture is indicated in the serial number on the type plate (see "Technical Specifications").

**Note**

The DC link capacitors are reformed by applying the rated voltage without load for at least 30 minutes at room temperature.

## Procedure

The DC link capacitors are reformed by applying the rated voltage without load for at least 30 minutes at room temperature.

## Type plate

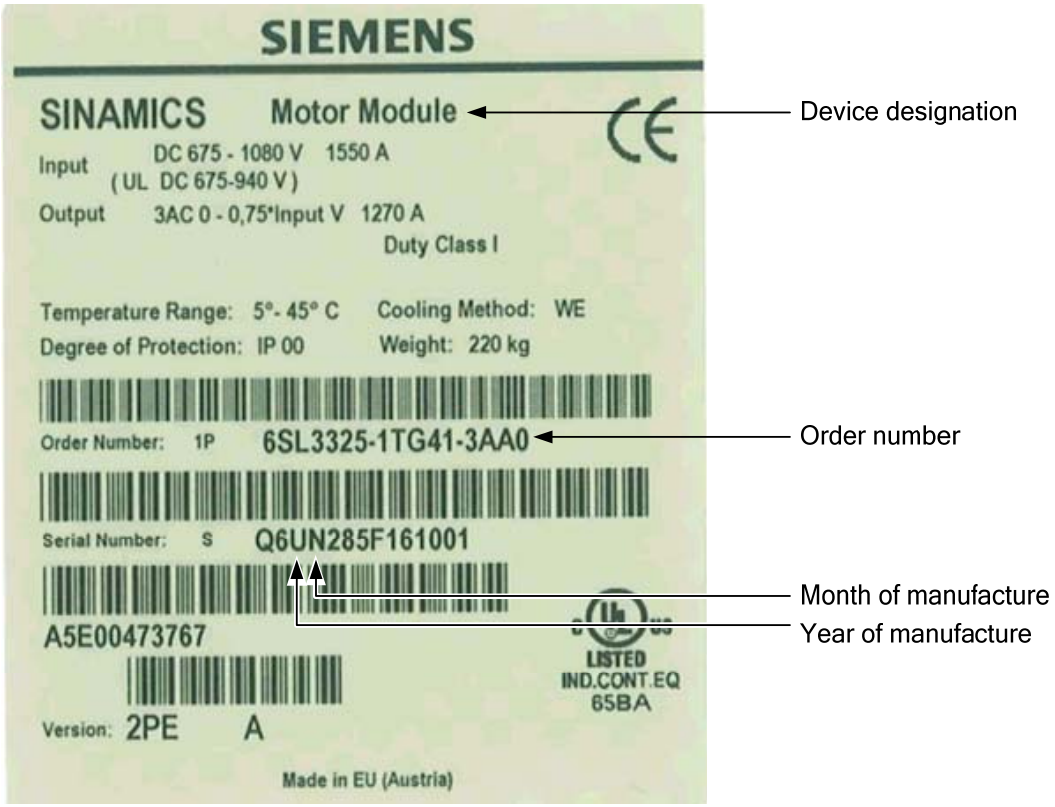



Fig. 9-22 Type plate for an Motor Module

## Date of manufacture

The date of manufacture can be determined as follows:

Table 9-2 Year and month of manufacture

| Character | Year of manufacture | | Character | Month of manufacture |
|---|---|---|---|---|
| T | 2005 | | 1 to 9 | January to September |
| U | 2006 | | O | October |
| V | 2007 | | N | November |
| W | 2008 | | D | December |

# List of Abbreviations

# 10

## 10.1 List of Abbreviations

Table 10-1 List of abbreviations

| Abbreviation | German | English |
|---|---|---|
| **A** | | |
| A... | Warnung | Alarm |
| AC | Wechselstrom | Alternating Current |
| ADC | Analog-Digital-Konverter | Analog Digital Converter |
| AI | Analogeingang | Analog Input |
| AO | Analogausgang | Analog Output |
| AOP | Advanced Operator Panel | Advanced Operator Panel |
| ASCII | Amerikanische Code-Norm für den Informationsaustausch | American Standard Code for Information Interchange |
| **B** | | |
| BB | Betriebsbedingung | Operating condition |
| BERO | Firmenname für einen Näherungsschalter | Tradename for a type of proximity switch |
| BI | Binektoreingang | Binector Input |
| BIA | Berufsgenossenschaftliches Institut für Arbeitssicherheit | Berufsgenossenschaftliches Institut für Arbeitssicherheit (German Institute for Occupational Safety) |
| BICO | Binektor-Konnektor-Technologie | Binector Connector Technology |
| BOP | Basic Operator Panel | Basic Operator Panel |
| **C** | | |
| C | Kapazität | Capacity |
| CAN | Serielles Bussystem | Controller Area Network |
| CBC | Kommunikationsbaugruppe CAN | Communication Board CAN |
| CBP | Kommunikationsbaugruppe PROFIBUS | Communication Board PROFIBUS |
| CD | Compact Disc | Compact Disc |
| CDS | Befehlsdatensatz | Command Data Set |
| CI | Konnektoreingang | Connector Input |
| CIB | Control Interface Board | Control Interface Board |
| CNC | Computerunterstützte numerische Steuerung | Computer Numerical Control |
| CO | Konnektorausgang | Connector Output |
| CO/BO | Konnektor-/Binektorausgang | Connector/Binector Output |
| COM | Mittelkontakt eines Wechselkontaktes | Medium contact of a change-over contact |
| CP | Kommunikationsprozessor | Communications Processor |

| Abbreviation | German | English |
|---|---|---|
| CPU | Zentralbaugruppe | Central Processing Unit |
| CRC | Checksummenprüfung | Cyclic Redundancy Check |
| CT | Konstantes Drehmoment | Constant Torque |
| CU | Control Unit | Control Unit |
| **D** | | |
| DAC | Digital-Analog-Konverter | Digital Analog Converter |
| DC | Gleichstrom | Direct Current |
| DCN | Gleichstrom negativ | Direct current negative |
| DCNA | Gleichstrom negativ Zusatzanschluss | Direct current negative auxiliary |
| DCP | Gleichstrom positiv | Direct current positive |
| DCPA | Gleichstrom positiv Zusatzanschluss | Direct current positive auxiliary |
| DDS | Antriebsdatensatz | Drive Data Set |
| DI | Digitaleingang | Digital Input |
| DI/DO | Digitaleingang/-ausgang bidirektional | Bidirectional Digital Input/Output |
| DMC | DRIVE-CLiQ Module Cabinet (Hub) | DRIVE-CLiQ Module Cabinet (Hub) |
| DO | Digitalausgang | Digital Output |
| DO | Antriebsobjekt | Drive Object |
| DPRAM | Speicher mit beidseitigem Zugriff | Dual Ported Random Access Memory |
| DRAM | Dynamischer Speicher | Dynamic Random Access Memory |
| DRIVE-CLiQ | Drive Component Link with IQ | Drive Component Link with IQ |
| DSC | Dynamic Servo Control | Dynamic Servo Control |
| **E** | | |
| EDS | Geberdatensatz | Encoder Data Set |
| EGB | Elektrostatisch gefährdete Baugruppen | Electrostatic Sensitive Devices (ESD) |
| EMV | Elektromagnetische Verträglichkeit | Electromagnetic Compatibility (EMC) |
| EN | Europäische Norm | European Standard |
| EnDat | Geber-Schnittstelle | Encoder-Data-Interface |
| EP | Impulsfreigabe | Enable Pulses |
| ES | Engineering System | Engineering System |
| **F** | | |
| F ... | Störung | Fault |
| FAQ | Häufig gestellte Fragen | Frequently Asked Questions |
| FCC | Function Control Chart | Function Control Chart |
| FCC | Flussstromregelung | Flux Current Control |
| FEPROM | Schreib- und Lesespeicher nichtflüchtig | Flash-EPROM |
| FG | Funktionsgenerator | Function Generator |
| FI | Fehlerstrom-Schutzschalter | Earth Leakage Circuit-Breaker (ELCB) |
| Float | Gleitkommazahl | Floating Point |
| FP | Funktionsplan | Function diagram |
| FW | Firmware | Firmware |
| **G** | | |
| GCP | Global-Control-Telegramm (Broadcast-Telegramm) | Global Control Telegram (Broadcast-Telegramm) |
| GSD | Gerätestammdatei: beschreibt die Merkmale eines PROFIBUS-Slaves | Device master file: describes the features of a PROFIBUS slave |

| Abbreviation | German | English |
|---|---|---|
| **H** | | |
| HLG | Hochlaufgeber | Ramp-function generator |
| HMI | Mensch-Maschine-Schnittstelle | Human Machine Interface |
| HTL | Hochpegellogik | High Threshold-Logic |
| HW | Hardware | Hardware |
| **I** | | |
| i. V. | in Vorbereitung: diese Eigenschaft steht zur Zeit nicht zur Verfügung | in preparation: this feature is currently not available |
| IBN | Inbetriebnahme | Commissioning |
| I/O | Eingang/Ausgang | Input/Output |
| ID | Identifizierung | Identifier |
| IEC | Internationale Norm in der Elektrotechnik | International Electrotechnical Commission |
| IGBT | Bipolartransistor mit isolierter Steuerelektrode | Insulated Gate Bipolar Transistor |
| IT | Drehstromversorgungsnetz ungeerdet | three-phase supply network, ungrounded |
| **J** | | |
| JOG | Tippen | Jogging |
| **K** | | |
| KDV | Kreuzweiser Datenvergleich | Data cross-checking |
| KIP | Kinetische Pufferung | Kinetic buffering |
| KTY | Spezieller Temperatursensor | Special temperature sensor |
| **L** | | |
| L | Induktivität | Inductance |
| LED | Leuchtdiode | Light Emitting Diode |
| LSB | Niederwertigstes Bit | Least Significant Bit |
| **M** | | |
| M | Masse | reference potential, zero potential |
| MB | Megabyte | Megabyte |
| MCC | Motion Control Chart | Motion Control Chart |
| MDS | Motordatensatz | Motor Data Set |
| MLFB | Maschinenlesbare Fabrikatebezeichnung | machine-readable product designation |
| MMC | Mensch Maschine Kommunikation | Man-Machine Communication |
| MSB | Höchstwertigstes Bit | Most significant Bit |
| MSCY_C1 | Zyklische Kommunikation zwischen Master (Klasse 1) und Slave | Master Slave Cycle Class 1 |
| **N** | | |
| NC | Öffner | Normaly Closed contact |
| NC | Numerische Steuerung | Numerical Control |
| NEMA | Normengremium in USA (United States of America) | National Electrical Manufacturers Association |
| NM | Nullmarke | Zero Mark |
| NO | Schliesser | Normaly Open contact |
| **O** | | |
| OEM | Original Equipment Manufacturer | Original Equipment Manufacturer |
| OLP | Busstecker für Lichtleiter | Optical Link Plug |
| OMI | Option Module Interface | Option Module Interface |

| Abbreviation | German | English |
|---|---|---|
| **P** | | |
| p ... | Einstellparameter | Adjustable parameter |
| PDS | Leistungsteildatensatz | Power Module Data Set |
| PE | Schutzerde | Protective Earth |
| PELV | Schutzkleinspannung | Protective Extra Low Voltage |
| PG | Programmiergerät | Programming terminal |
| PI | Proportional Integral | Proportional Integral |
| PLC | Speicherprogrammierbare Steuerung (SPS) | Programmable Logical Controller |
| PLL | Baustein zur Synchronisierung | Phase locked Loop |
| PNO | PROFIBUS Nutzerorganisation | PROFIBUS user organisation |
| PRBS | Weißes Rauschen | Pseudo Random Binary Signal |
| PROFIBUS | Serieller Datenbus | Process Field Bus |
| PS | Stromversorgung | Power Supply |
| PTC | Positiver Temperaturkoeffizient | Positive Temperature Coeffizient |
| PTP | Punkt zu Punkt | Point to Point |
| PWM | Pulsweitenmodulation | Pulse Width Modulation |
| PZD | PROFIBUS Prozessdaten | PROFIBUS Process data |
| **Q** | | |
| **R** | | |
| r ... | Beobachtungsparameter (nur lesbar) | Display Parameter (read only) |
| RAM | Speicher zum lesen und schreiben | Random Access Memory |
| RCD | Fehlerstrom-Schutzschalter | Residual Current Device |
| RJ45 | Norm. Beschreibt eine 8-polige Steckverbindung mit Twisted-Pair Ethernet. | Standard. Describes an 8-pole plug connector with twisted pair Ethernet. |
| RO | Nur lesbar | Read Only |
| RS232 | Serielle Schnittstelle | Serial Interface |
| RS485 | Norm. Beschreibt die Physik einer digitalen seriellen Schnittstelle. | Standard. Describes the physical characteristics of a digital serial interface. |
| **S** | | |
| S1 | Dauerbetrieb | Continuous operation |
| S3 | Aussetzbetrieb | periodic duty |
| SBC | Sichere Bremsenansteuerung | Safe Brake Control |
| SGE | Sicherheitsgerichtetes Eingangssignal | Safe input signal |
| SH | Sicherer Halt | Safe Standstill |
| SI | Safety Integrated | Safety Integrated |
| SIL | Sicherheitsintegritätsgrad | Safety Integrity Level |
| SLVC | Geberlose Vektorregelung | Sensorless Vector Control |
| SM | Sensor Module | Sensor Module |
| SMC | Sensor Module Cabinet | Sensor Module Cabinet |
| SME | Sensor Module External | Sensor Module External |
| SPS | Speicherprogrammierbare Steuerung | Programmable Logic Controller (PLC) |
| STW | PROFIBUS Steuerwort | PROFIBUS controlword |
| **T** | | |
| TB | Terminal Board | Terminal Board |
| TIA | Totally Integrated Automation | Totally Integrated Automation |

| Abbreviation | German | English |
|---|---|---|
| TM | Terminal Module | Terminal Module |
| TN | Drehstromversorgungsnetz geerdet | Three-phase supply network, grounded |
| TT | Drehstromversorgungsnetz geerdet | Three-phase supply network, grounded |
| TTL | Transistor-Transistor-Logik | Transistor-Transistor-Logik |
| **U** | | |
| UL | Underwriters Laboratories Inc. | Underwriters Laboratories Inc. |
| **V** | | |
| VC | Vektorregelung | Vector Control |
| Vdc | Zwischenkreisspannung | DC link voltage |
| VDE | Verband Deutscher Elektrotechniker | Association of German Electrical Engineers |
| VDI | Verein Deutscher Ingenieure | Association of German Engineers |
| VSM | Voltage Sensing Module | Voltage Sensing Module |
| VT | Variables Drehmoment | Variable Torque |
| **W** | | |
| WZM | Werkzeugmaschine | Machine tool |
| **X** | | |
| XML | Erweiterbare Auszeichnungssprache (Standardsprache für Web-Publishing und Dokumentenmanagement) | Extensible Markup Language |
| **Y** | | |
| **Z** | | |
| ZK | Zwischenkreis | DC link |
| ZSW | PROFIBUS Zustandswort | PROFIBUS statusword |

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# 11

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