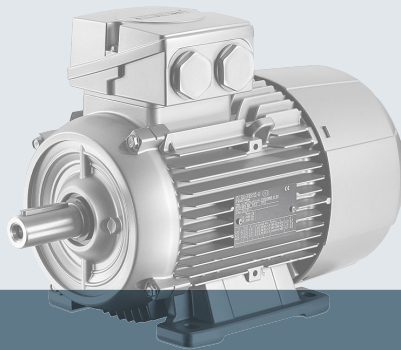
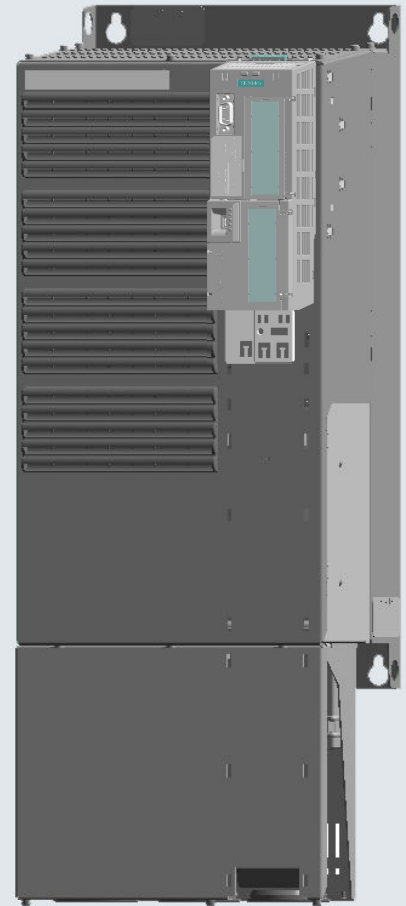
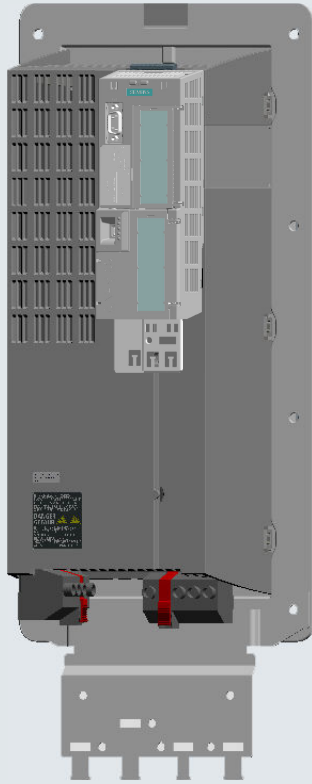


**SIEMENS**



# SINAMICS

## SINAMICS G120 inverters

PM230 Power Modules, IP20 / push-through technology (PT)

Hardware Installation Manual

Edition

08/2016



# SIEMENS

## SINAMICS

### SINAMICS G120P Power Module PM230, IP20 / Push- through technology (PT)

Hardware Installation Manual


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Edition 08/2016


## Legal information

### Warning notice system

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

 <b>DANGER</b>
indicates that death or severe personal injury <b>will</b> result if proper precautions are not taken.

 <b>WARNING</b>
indicates that death or severe personal injury <b>may</b> result if proper precautions are not taken.

 <b>CAUTION</b>
indicates that minor personal injury can result if proper precautions are not taken.

<b>NOTICE</b>
indicates that property damage can result if proper precautions are not taken.


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

### Qualified Personnel

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

### Proper use of Siemens products

Note the following:

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

### Trademarks

All names identified by ® are registered trademarks of Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

### Disclaimer of Liability

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

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## Changes in this manual

### Changes with respect to the manual, Edition 06/2014

The new PM230 FSA, FSB and FSC Power Modules support STO.

How can you identify a Power Module of the new series?

From the article number. The devices belonging to the new series have a "G" instead of an "L" at the last but one position. Otherwise, the article numbers are identical.





## Fundamental safety instructions

### 2.1 General safety instructions



#### **DANGER**

##### **Danger to life due to live parts and other energy sources**

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

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

Generally, six steps apply when establishing safety:

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

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



#### **WARNING**

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

Touching live components can result in death or severe injury.

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



**! WARNING**

**Danger to life when live parts are touched on damaged devices**

Improper handling of devices can cause damage.

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

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



**! WARNING**

**Danger to life through electric shock due to unconnected cable shields**

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

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



**! WARNING**

**Danger to life due to electric shock when not grounded**

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

- Ground the device in compliance with the applicable regulations.



**! WARNING**

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

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

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

**NOTICE**

**Material damage due to loose power connections**

Insufficient tightening torques or vibrations can result in loose electrical connections. This can result in damage due to fire, device defects or malfunctions.

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

 **WARNING****Danger to life due to fire spreading if housing is inadequate**

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

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

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

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

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

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


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

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


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

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

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

 <b>WARNING</b>
<b>Danger of an accident occurring due to missing or illegible warning labels</b>
Missing or illegible warning labels can result in accidents involving death or serious injury.
<ul style="list-style-type: none"><li>• Check that the warning labels are complete based on the documentation.</li><li>• Attach any missing warning labels to the components, in the national language if necessary.</li><li>• Replace illegible warning labels.</li></ul>

<b>NOTICE</b>
<b>Device damage caused by incorrect voltage/insulation tests</b>
Incorrect voltage/insulation tests can damage the device.
<ul style="list-style-type: none"><li>• Before carrying out a voltage/insulation check of the system/machine, disconnect the devices as all converters and motors have been subject to a high voltage test by the manufacturer, and therefore it is not necessary to perform an additional test within the system/machine.</li></ul>

 <b>WARNING</b>
<b>Danger to life when safety functions are inactive</b>
Safety functions that are inactive or that have not been adjusted accordingly can cause operational faults on machines that could lead to serious injury or death.
<ul style="list-style-type: none"><li>• Observe the information in the appropriate product documentation before commissioning.</li><li>• Carry out a safety inspection for functions relevant to safety on the entire system, including all safety-related components.</li><li>• Ensure that the safety functions used in your drives and automation tasks are adjusted and activated through appropriate parameterizing.</li><li>• Perform a function test.</li><li>• Only put your plant into live operation once you have guaranteed that the functions relevant to safety are running correctly.</li></ul>

---

**Note**

**Important safety notices for Safety Integrated functions**

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

---

## 2.2 Safety instructions for electromagnetic fields (EMF)



### WARNING

#### **Danger to life from electromagnetic fields**

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

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

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

## 2.3 Handling electrostatic sensitive devices (ESD)

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



### NOTICE

#### Damage through electric fields or electrostatic discharge

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

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

## 2.4 Industrial security

### Note

#### Industrial security

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

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

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



#### WARNING

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

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

- Keep the software up to date.  
You will find relevant information and newsletters at this address (<http://support.automation.siemens.com>).
- Incorporate the automation and drive components into a holistic, state-of-the-art industrial security concept for the installation or machine.  
You will find further information at this address (<http://www.siemens.com/industrialsecurity>).
- Make sure that you include all installed products into the holistic industrial security concept.



#### WARNING

##### **Danger to life due to software manipulation when using exchangeable storage media**

Storing files onto exchangeable storage media amounts to an increased risk of infection, e.g. with viruses and malware. As a result of incorrect parameterization, machines can malfunction, which in turn can lead to injuries or death.

- Protect files stored on exchangeable storage media from malicious software by taking suitable protection measures, e.g. virus scanners.

## 2.5 Residual risks of power drive systems

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

1. Unintentional movements of driven machine or system components during commissioning, operation, maintenance, and repairs caused by, for example,
  - Hardware and/or software errors in the sensors, control system, actuators, and cables and connections
  - Response times of the control system and of the drive
  - Operation and/or environmental conditions outside the specification
  - Condensation/conductive contamination
  - Parameterization, programming, cabling, and installation errors
  - Use of wireless devices/mobile phones in the immediate vicinity of electronic components
  - External influences/damage
  - X-ray, ionizing radiation and cosmic radiation
2. Unusually high temperatures, including open flames, as well as emissions of light, noise, particles, gases, etc., can occur inside and outside the components under fault conditions caused by, for example:
  - Component failure
  - Software errors
  - Operation and/or environmental conditions outside the specification
  - External influences/damage
3. Hazardous shock voltages caused by, for example:
  - Component failure
  - Influence during electrostatic charging
  - Induction of voltages in moving motors
  - Operation and/or environmental conditions outside the specification
  - Condensation/conductive contamination
  - External influences/damage
4. Electrical, magnetic and electromagnetic fields generated in operation that can pose a risk to people with a pacemaker, implants or metal replacement joints, etc., if they are too close
5. Release of environmental pollutants or emissions as a result of improper operation of the system and/or failure to dispose of components safely and correctly

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



# Introduction

## Overview

The Power Modules belong to the modular family of SINAMICS G120 inverters. A modular inverter comprises Control Unit and Power Module.


PM230 Power Modules have been specifically designed for pump and fan drives in industrial HVAC applications for a line voltage range from 3 AC 380 V ... 480 V. The Power Modules are available as built-in devices or in push-through technology.

They are available with a radio interference suppression filter, Category C2 according to EN61800-3, or without filter.

Depending on the power rating, they are available in frame sizes FSA ... FSF.

- FSA 0.37 kW ... 3 kW
- FSB 4 kW ... 7.5 kW
- FSC 11 kW ... 18.5 kW
- FSD 22 kW ... 30 kW
- FSE 37 kW ... 45 kW
- FSF 55 kW ... 75 kW

The power data refer to Low Overload operation.

 Overload capability of the inverter (Page 58)

## Control Units for the Power Modules

You can operate the Power Modules with a Control Unit from one of the following listed families from firmware version 4.4 and higher.

- CU230P-2
- CU240B-2
- CU240E-2


Operation with Control Units other than those listed above is not permitted.

---

### Note

#### Commissioning the inverter

You must first commission the inverter before you can use it. Commissioning is described in the operating instructions of the relevant Control Unit.

 Manuals for your inverter (Page 89).

---

## **STO with PM230 and CU240**

The PM230 FSA ... FSC Power Modules have been technically revised. Together with CU240 Control Units from software version V4.7 SP3, they support the STO safety function.

You can identify the new series of Power Modules as a result of the article number. The article numbers of the new Power Modules have a "G" instead of an "L" at the last but one position. Otherwise, the article numbers are identical.

## 3.1 Component specification according to UL

The components of the SINAMICS G120 product family are certified according to UL508C. The certification is indicated on the products using the UL Listing Mark.



You can find proof of the certification on the Internet UL certificates (<http://www.ul.com>) under "Tools / Online Certifications Directory" by entering the file number or the "Name".

The UL file number for the Power Modules of the SINAMICS G120 product family is:

- E121068 for FSA, FSB and FSC

The UL file number for the Power Modules of the SINAMICS G120 product family is:

- E192450 for FSD, FSE and FSF

## 3.2 Permissible motors

---

### Note

#### Motors for inverter operation

Only use motors that are suitable for operation with inverters with a DC link.

---


### Permissible motors

For the Power Modules, induction motors are permissible in the range from 25 % ... 150 % of the inverter power without any restrictions.


# Installing/mounting

## 4.1 Installation conditions


### General installation conditions

When installing the Power Modules, carefully observe the following sections in Chapter  Technical specifications (Page 57) in order to guarantee reliable, continuous and disturbance-free operation.

- Cable cross-sections and tightening torques
- Electromagnetic compatibility
- Ambient conditions
- General technical data
- The permissible fuses, power loss and the required cooling air quantities are listed in the specific technical data

The EMC-compliant connection is described in Section:  EMC-compliant installation of a plant or machine (Page 23).

### Inverters for plants and systems in the United States / Canada (UL/cUL)

- To ensure a design that is in conformance with UL/cUL, only use the approved fuses specified in Section "Technical data"  Detailed technical data (Page 64).
- Only use copper conductors approved for 75°C.
- The inverter features internal motor overload protection corresponding to UL508C. The protection threshold is 115% of the inverter full load current. When commissioning, you can adapt the motor overload protection using parameter p0640.

### Additional requirements for CSA compliance

Install the inverter with a surge protection device with the following attributes:

#### Frame sizes FSA ... FSC

- Rated voltage 480 V (phase with respect to ground), 480 V (phase to phase)
- Suitable for overvoltage category III
- Suitable for SPD applications, type 1 or type 2
- Terminal voltage, VPR = 2000 V

*4.1 Installation conditions*

**Frame sizes FSD ... FSF**

- Rated voltage 277 V (phase with respect to ground), 480 V (phase to phase)
- Suitable for overvoltage category III
- Terminal voltage VPR = 4000 V,

## 4.2 EMC-compliant installation of a plant or machine

The inverter is designed for operation in industrial environments where strong electromagnetic fields are to be expected.

Reliable and disturbance-free operation is only guaranteed for EMC-compliant installation.

To achieve this, subdivide the control cabinet and the machine or system into EMC zones:

### EMC zones

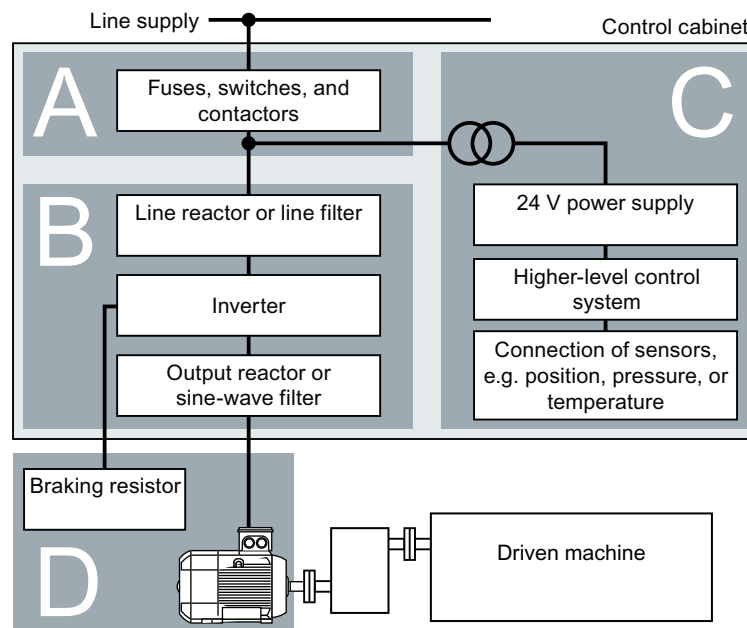


Figure 4-1 Example of the EMC zones of a plant or machine

#### Inside the control cabinet

- Zone A: Line supply connection
- Zone B: Power electronics  
Devices in Zone B generate energy-rich electromagnetic fields.
- Zone C: Control and sensors  
Devices in Zone C do not generate any energy-rich electromagnetic fields themselves, but their functions can be impaired by electromagnetic fields.
- Zone D: Motors, braking resistors outside the control cabinet  
Devices in Zone D generate electromagnetic fields with a significant amount of energy

#### Outside the control cabinet

- D: Motors, braking resistors outside the control cabinet  
Devices in Zone D generate electromagnetic fields with a significant amount of energy

### 4.2.1 Control cabinet

- Assign the various devices to zones in the control cabinet.
- Electromagnetically uncouple the zones from each other by means of one of the following actions:
  - Side clearance  $\geq 25$  cm
  - Separate metal enclosure
  - Large-area partition plates
- Route cables of various zones in separate cable harnesses or cable ducts.
- Install filters or isolation amplifiers at the interfaces of the zones.

#### Control cabinet assembly

- Connect the door, side panels, top and base plate of the control cabinet with the control cabinet frame using one of the following methods:
  - Electrical contact surface of several  $\text{cm}^2$  for each contact location
  - Several screw connections
  - Short, finely stranded, braided copper wires with cross-sections  $\geq 95 \text{ mm}^2 / 000 (3/0) (-2) \text{ AWG}$
- Install a shield support for shielded cables that are routed out of the control cabinet.
- Connect the PE bar and the shield support to the control cabinet frame through a large surface area to establish a good electrical connection.
- Mount the control cabinet components on a bare metal mounting plate.
- Connect the mounting plate to the control cabinet frame and PE bar and shield support through a large surface area to establish a good electrical connection.
- For screw connections onto painted or anodized surfaces, establish a good conductive contact using one of the following methods:
  - Use special (serrated) contact washers that cut through the painted or anodized surface.
  - Remove the insulating coating at the contact locations.

#### Measures required for several control cabinets

- Install equipotential bonding for all control cabinets.
- Screw the frames of the control cabinets together at several locations through a large surface area using serrated washers to establish a good electrical connection.
- In plants and systems where the control cabinets are lined up next to one another, and which are installed in two groups back to back, connect the PE bars of the two cabinet groups at as many locations as possible.



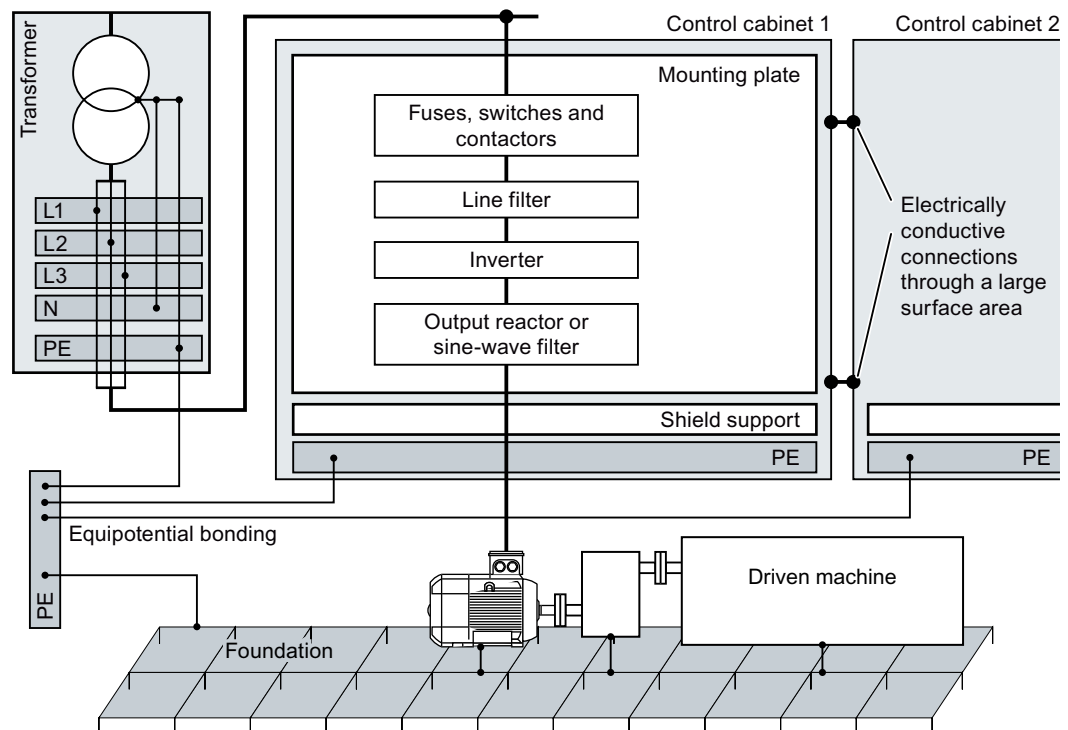


Figure 4-2 Grounding and high-frequency equipotential bonding measures in the control cabinet and in the plant/system

### Further information



Additional information about EMC-compliant installation is available in the Internet:

EMC installation guideline (<http://support.automation.siemens.com/WWW/view/en/60612658>)

### 4.2.2 Cables

Cables with a high level of interference and cables with a low level of interference are connected to the inverter:

- Cables with a high level of interference:
  - Cable between the line filter and inverter
  - Motor cable
  - Cable at the inverter DC link connection
  - Cable between the inverter and braking resistor
- Cables with a low level of interference:
  - Cable between the line and line filter
  - Signal and data cables

**Cable routing inside the cabinet**

- Route the power cables with a high level of interference so that there is a minimum clearance of 25 cm to cables with a low level of interference.  
If the minimum clearance of 25 cm is not possible, insert separating metal sheets between the cables with a high level of interference and cables with a low level of interference. Connect these separating metal sheets to the mounting plate to establish a good electrical connection.
- Cables with a high level of interference and cables with a low level of interference may only cross over at right angles:
- Keep all of the cables as short as possible.
- Route all of the cables close to the mounting plates or cabinet frames.
- Route signal and data cables - as well as the associated equipotential bonding cables - parallel and close to one another.
- Twist incoming and outgoing unshielded individual conductors. Alternatively, you can route incoming and outgoing conductors in parallel, but close to one another.
- Ground any unused conductors of signal and data cables at both ends.
- Signal and data cables must only enter the cabinet from one side, e.g. from below.
- Using shielded cables for the following connections:
  - Cable between the inverter and line filter
  - Cable between the inverter and output reactor or sine-wave filter

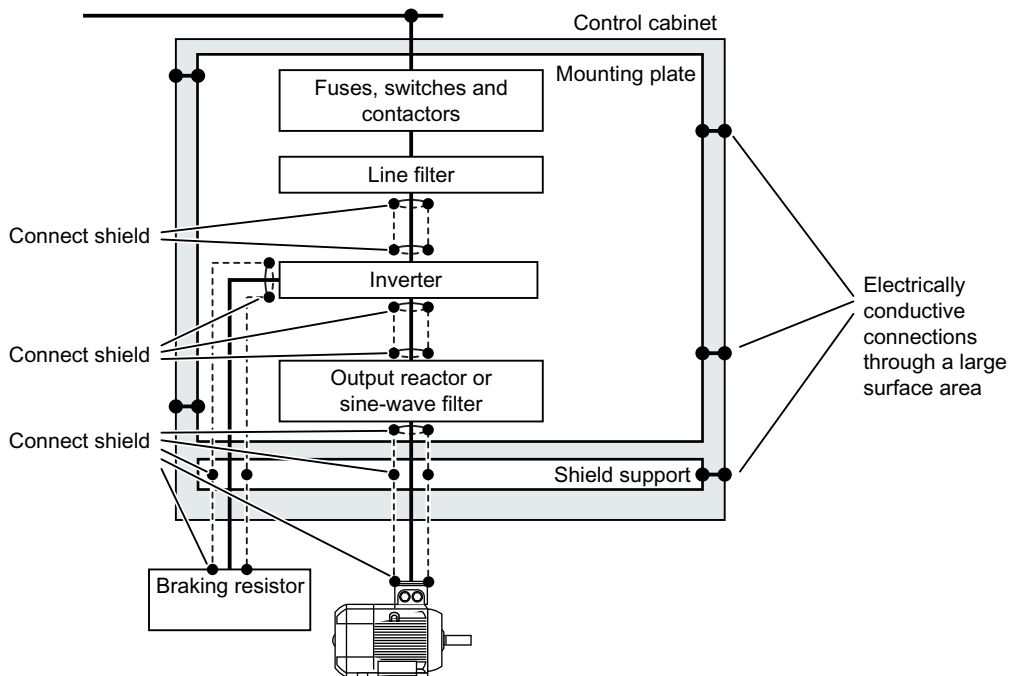


Figure 4-3 Routing inverter cables inside and outside a control cabinet

### Routing cables outside the control cabinet

- Maintain a minimum clearance of 25 cm between cables with a high level of interference and cables with a low level of interference.
- Using shielded cables for the following connections:
  - Inverter motor cable
  - Cable between the inverter and braking resistor
  - Signal and data cables
- Connect the motor cable shield to the motor enclosure using a PG gland that establishes a good electrical connection.

### Requirements relating to shielded cables

- Use cables with finely-stranded, braided shields.
- Connect the shield to at least one end of the cable.

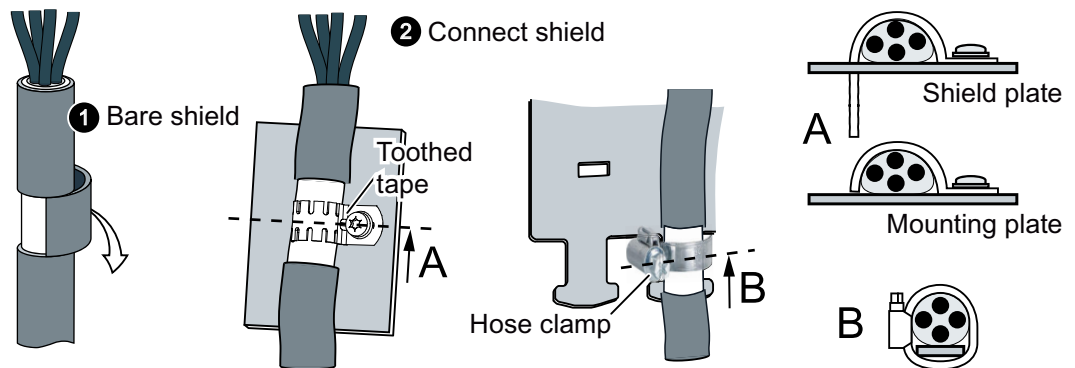


Figure 4-4 Examples for EMC-compliant shield support

- Attach the shield to the shield support directly after the cable enters the cabinet.
- Do not interrupt the shield.
- Only use metallic or metallized plug connectors for shielded data cables.

### **4.2.3 Electromechanical components**

#### **Radio interference suppression**

- Connect interference suppression elements to the following components:
  - Coils of contactors
  - Relays
  - Solenoid valves
  - Motor holding brakes
- Connect the interference suppression element directly at the coil.
- Use RC elements or varistors for AC-operated coils and freewheeling diodes or varistors for DC-operated coils.

## 4.3 Power losses and air cooling requirements

### Cooling requirements


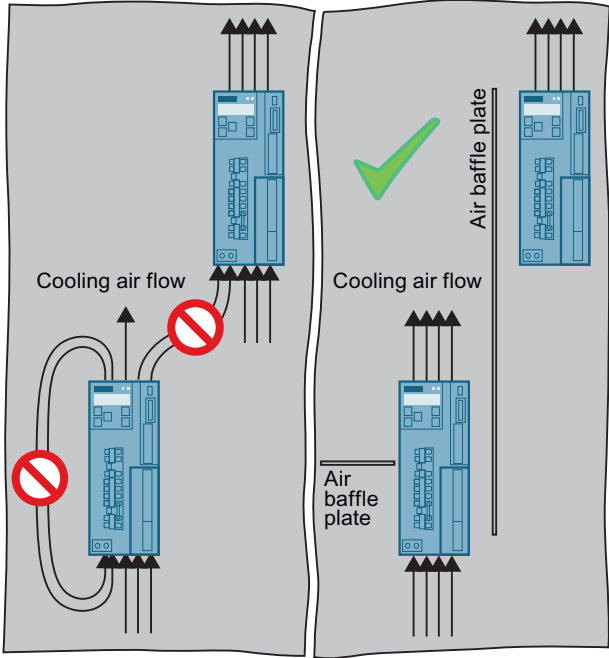
To protect the components from overheating, the control cabinet requires a cooling air flow, which depends on the power loss of the individual components.

Formula for calculating the cooling airflow:

$$\text{airflow [l/s]} = \text{power loss [W]} * 0.86 / \Delta T \text{ [K]}$$

- Power loss: Total of the power losses of the individual components.
- $\Delta T$ : Permissible temperature rise in the control cabinet

### Measures in order to ensure that the components are adequately cooled

- Add the power losses of the individual components.
    - Power Module data:  "Detailed technical data (Page 64)".
    - The Control Unit power loss is less than 0.04 kW.
    - Use the manufacturers data for components, for example reactors or filters
  - Calculate the air flow required, using the formula above.
  - Ensure that the control cabinet is appropriately ventilated and equipped with suitable air filters.
  - Ensure that the components maintain the specified clearances with respect to one another.
- 
- Ensure that the components are provided with adequate cooling air through the cooling openings.
  - Use the appropriate air barriers to prevent cooling air short circuits

### Power loss for modules in push-through technology (PT Power Modules)

When you use PT Power Modules, the majority of the power loss is dissipated through the heatsink located outside the control cabinet.

*4.3 Power losses and air cooling requirements*

The following losses occur in the cabinet when the device is operated with its rated data:

- FSA: 0.02 kW
- FSB: 0.045 kW
- FSC: 0.075 kW

## 4.4 Mounting the Power Modules

### Protection against the spread of fire

The device may be operated only in closed housings or in control cabinets with protective covers that are closed, and when all of the protective devices are used. The installation of the device in a metal control cabinet or the protection with another equivalent measure must prevent the spread of fire and emissions outside the control cabinet.

### Protection against condensation or electrically conductive contamination

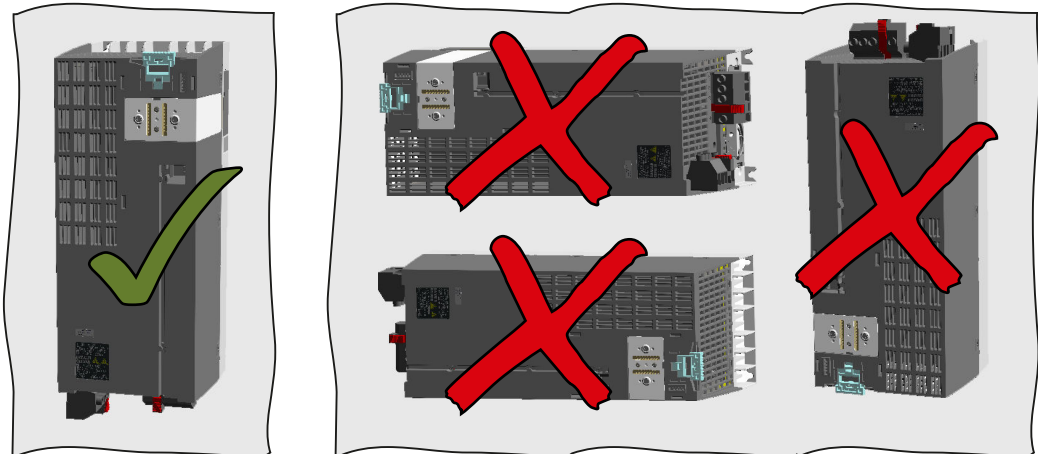
Protect the device, e.g. by installing it in a control cabinet with degree of protection IP54 according to IEC 60529 or NEMA 12. Further measures may be necessary for particularly critical operating conditions.

If condensation or conductive pollution can be excluded at the installation site, a lower degree of control cabinet protection may be permitted.

### Installing Power Modules

The following is required to correctly install a Power Module:

- Install the Power Module vertically with the motor connections facing downwards.



- Comply with the installation regulations specified in the following sections:
  - Minimum clearances to other components
  - Fixing elements
  - Tightening torques for fixing elements


### In addition, for Power Modules in push through technology (PT Power Module)

Use the optional mounting frames to mount a Power Module in push-through technology in a control cabinet. The mounting frames include the necessary seals and frames to ensure compliance with degree of protection IP55.

4.4 Mounting the Power Modules

If you do not use the optional mounting frames, then you must ensure that the required degree of protection is complied with using other appropriate measures.

Mounting instructions are provided in the following section:

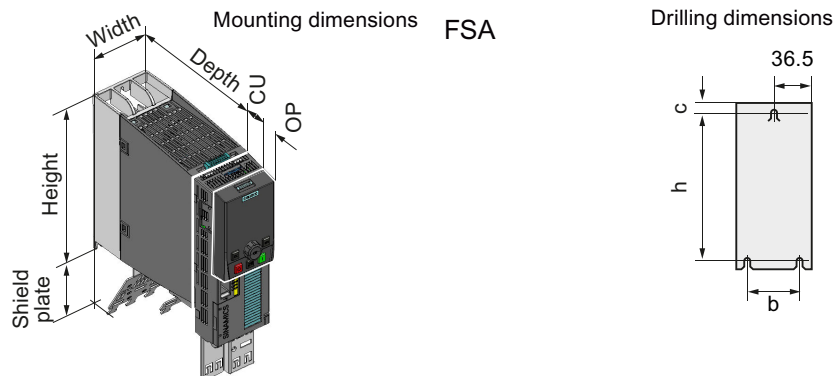
 Mounting frames for Power Module with push-through technology (Page 79)

4.4.1 Dimension drawings and drilling dimensions for IP20 Power Modules

Table 4-1 Mounting dimensions without Control Unit [mm]

Frame size	Width	Height		Depth without Control Unit (CU)
		without shield plate	with shield plate	
FSA	73	196	276	165
FSB	100	292	370	165
FSC	140	355	432	165
FSD without filter	275	419	542	204
FSD with filter	275	512	635	204
FSE without filter	275	499	622	204
FSE with filter	275	635	758	204
FSF without filter	350	634	792	316
FSF with filter	350	934	1092	316

The following dimension drawings and drilling patterns are not to scale.





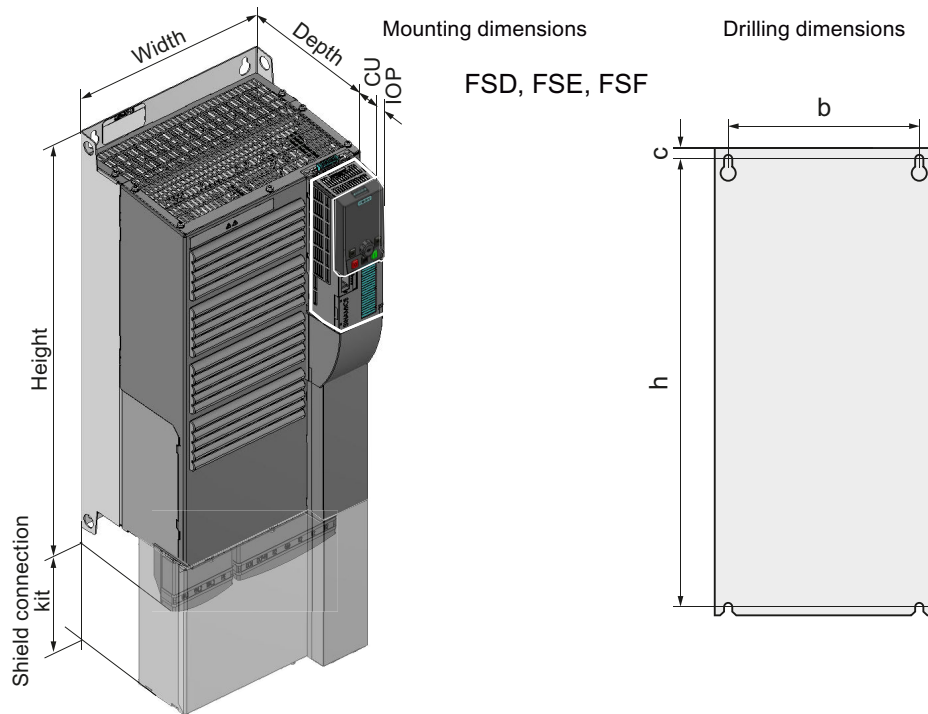
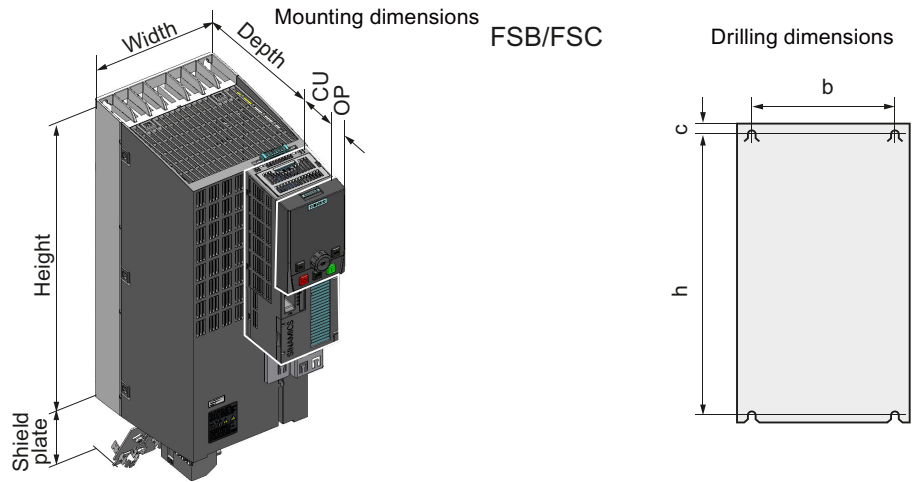


Table 4-2 Depth with Control Unit and operator panel

Depth (mm) with ...	CU230P-2	CU240B/E-2	CU250S-2
... Control Unit:	+ 59	+ 41	+ 62
... Control Unit and blanking cover / BOP-2:	+ 70	+ 52	+ 73
... Control Unit and IOP:	+ 81	+ 63	+ 84

Table 4-3 Drilling dimensions, cooling air clearances [mm] and fixing [Nm]

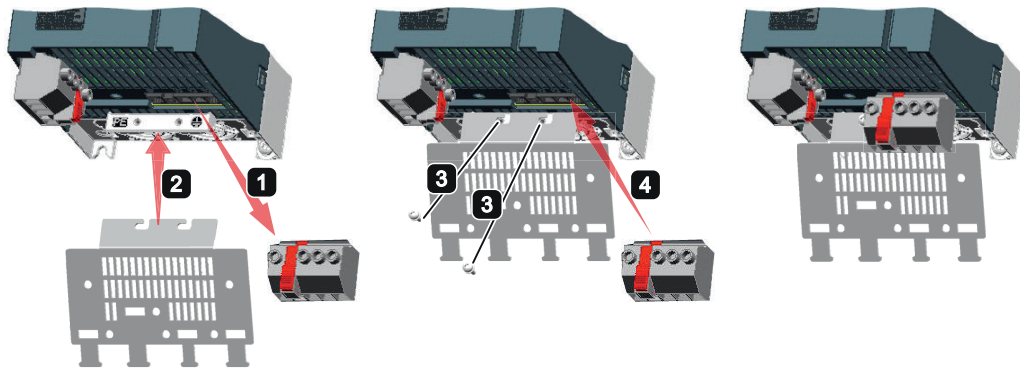
Frame size	Drilling dimensions			Cooling air clearances <sup>1)</sup>			Mounting
	b	h	c	Top	Bottom	Front	Screws/torque
FSA	62.3	186	6	80	100	---	2 x M4 / 2.5
FSB	80	281	6	80	100	---	4 x M4 / 2.5
FSC	120	343	6	80	100	---	4 x M5 / 3.0
FSD without filter	235	325	11	300	300	100	4 x M6 / 6.0
FSD with filter	235	419	11	300	300	100	4 x M6 / 6.0
FSE without filter	235	405	11	300	300	100	4 x M6 / 10
FSE with filter	235	451	11	300	300	100	4 x M6 / 10
FSF without filter	300	598	11	350	350	100	4 x M8 / 13
FSF with filter	300	899	11	350	350	100	4 x M8 / 13

<sup>1)</sup> You can mount the Power Modules without any lateral cooling air clearance. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm.

### Mounting the shield plate

#### FSA ... FSC

The shield plate is included in the scope of delivery of the device. Mount the shield plate as shown in the following diagram.



#### Frame sizes FSD ... FSF

Is available as accessory for frame sizes FSD ... FSF

 Shield connection kit (Page 88)

### 4.4.2 Dimension drawings and drilling dimensions for PT Power Modules

Table 4-4 Mounting dimensions without Control Unit (CU) [mm]

Frame size	Width	Height		Depth <sup>1)</sup>		
		without shield plate	with shield plate	T1 +T2	T1	T2
FSA	126	238	322	171	118	53
FSB	154	345	430	171	118	53
FSC	200	411	500	171	118	53

<sup>1)</sup> Panel thickness of the control cabinet ≤ 3.5 mm

The following dimension drawings and drilling patterns are not to scale.

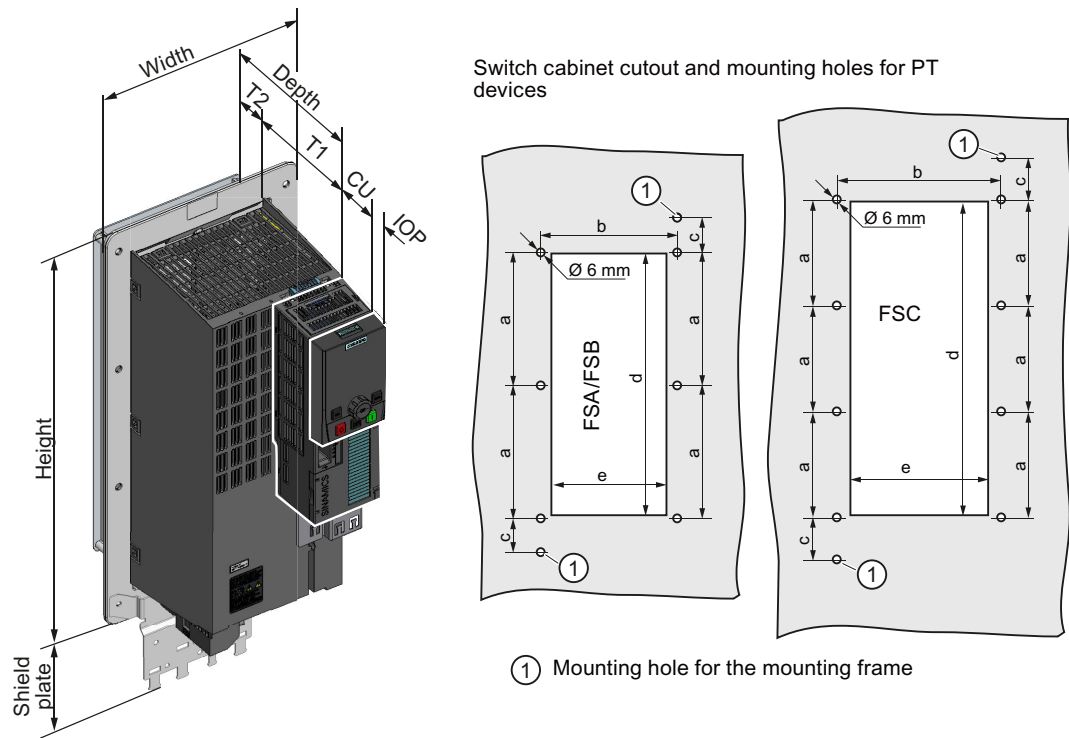


Table 4-5 Depth with Control Unit and operator panel

Control Unit	Power Module + Control Unit (mm)		Power Module + Control Unit + IOP (mm)		Power Module + Control Unit + BOP (mm)	
	Total	in the cabinet	Total	in the cabinet	Total	in the cabinet
CU230P-2	231	177.7	253	199.7	244	190.7
CU240B-2 / CU240E-2	212	158.7	234	180.7	225	171.7
CU250S-2	234	180.7	256	202.7	247	193.7

Table 4-6 Drilling dimensions, cooling air clearances [mm] and fixing [Nm]

Frame size	Section of the control cabinet					Cooling air clearances <sup>1)</sup>			Fixing Screws/torque
	a	b	c	d	e	Top	Bottom	Front	
FSA	103	106	27	198	88	80	100	100	8 x M5 / 3.5
FSB	148	134	34.5	304	116	80	100	100	8 x M5 / 3.5
FSC	123	174	30.5	365	156	80	100	100	10 x M5 / 3.5

<sup>1)</sup> You can mount the Power Modules without any lateral cooling air clearance. For tolerance reasons, we recommend a lateral clearance of 1 mm.

#### 4.4.2.1 Mounting the shield plate

The shield plates and fixings screws are included in the inverter accessory kit.

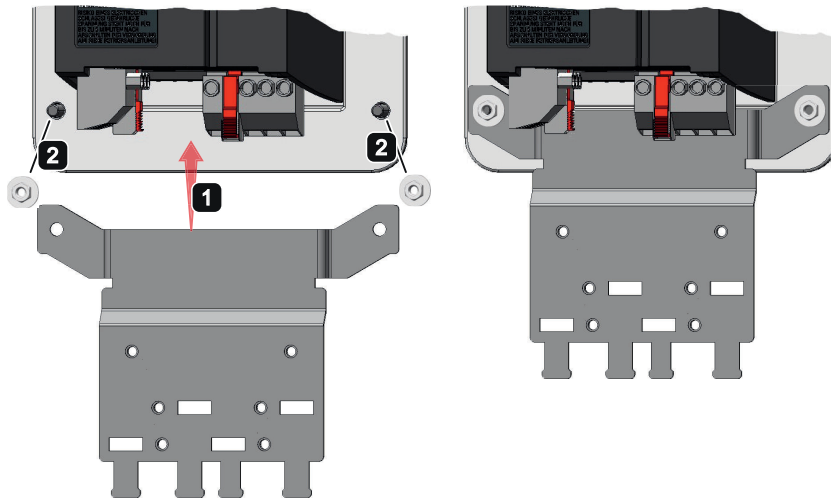




Figure 4-5 Mounting the shield plate

## 4.5 Supplementary components

Depending on the particular application, additional components may be required for your system. Information about additional components is provided in the following Sections:

 Connection overview (Page 46)

 Optional accessories (Page 79).



Install the inverters so that you are compliant with local regulations for erecting and installing low voltage systems.



**⚠ DANGER**

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

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

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

- Do not open the protective covers or the terminal covers of the device until 5 minutes have elapsed.
- Before starting any work, check that the system is in a voltage-free state by measuring all terminals, also to ground.
- Ensure that the associated warning plate in the appropriate language is attached.

**Note**

**Operating displays for inverter operation**

If, when switching over a function from ON to OFF, an LED or other similar display is not lit or not active; this does not indicate that the device is switched-off or in a no-current condition.

**Note**

**Safety devices**

Install suitable protective equipment between the line supply and inverter.



Technical specifications (Page 57)



To protect against indirectly touching part of the motor circuit of an inverter and to automatically shut down in the case of a fault according to DIN EN 60364-4-41 (VDE 0100-410). (<http://support.automation.siemens.com/WW/view/en/103474630>)

**⚠ WARNING**

**Danger to life due to fire or electric shock when using unsuitable residual current protection devices**

The inverter can cause a current to flow in the protective conductor. This current can cause the residual current device (RCD) or residual current monitoring (RCM) to incorrectly trip (nuisance trip). In the case of a fault (ground fault), the fault current can contain a DC component, which prevents the RCD/RCM from tripping, with the risk of subsequent fault or electric shock.

- Use the protection and monitoring devices recommended in the documentation.



<p><b>! CAUTION</b></p> <p><b>Risk of injury due to hot surfaces</b></p> <p>During operation and for a short time after the inverter shuts down, the surface of the device can reach a high temperature.</p> <ul style="list-style-type: none"> <li>• During this time, avoid any direct contact with the surface of the inverter.</li> </ul>
---

### Protection and monitoring equipment

To provide protection against short-circuit, use the overcurrent devices listed in Technical data (fuses, circuit breakers etc.).

If the apparent impedance of the line supply at the infeed point is not suitable, so that fuses do not rupture in the specified time in the case of insulation failure (ground fault, fault to frame), then you must use additional fault current protective devices RCD (RCCB or MRCD), type B.

In order that an RCD does not unnecessarily trip as a result of operational leakage currents, the following preconditions must be fulfilled:

- The neutral point of the line supply is grounded.
- For inverters with rated input currents  $\leq 125$  A referred to LO, use an RCCB type B with a response limit current of 300 mA. Connect the RCCB in series with the overcurrent protective devices.
- For inverters with rated input currents  $> 125$  A referred to LO, use a type B MRCD (for example, from the Bender company).

An MRCD comprises an RCM (differential current monitoring device), a measuring current transducer and a circuit breaker with additional undervoltage release, listed in the Technical data. An example of an MRCD design is provided in the following diagram.

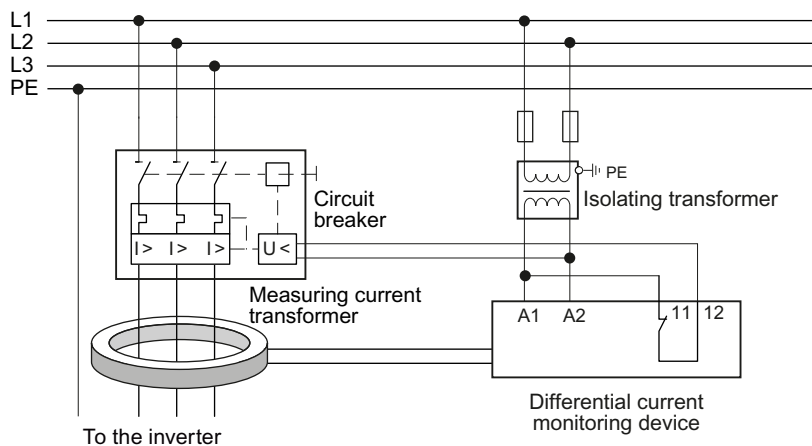


Figure 5-1 MRCD

- A dedicated RCD is used for every inverter.
- The motor cables are shorter than 50 m (164 ft) shielded, or 100 m (328 ft) unshielded. Additional information about motor cables

Length of motor cable (Page 47)



## 5.1 Permissible line supplies

### Note

#### Restrictions for installation altitudes above 2000 m

Above an installation altitude of 2000 m, the permissible line supplies are restricted.



Restrictions for special ambient conditions (Page 69)

### Note

#### Line requirement

The machine manufacturer must ensure that in operation the voltage drop between the transformer input terminals and the inverter when operated with its rated values is less than 1%.

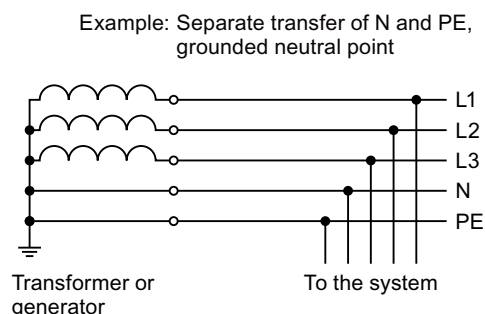
The inverter is designed for the following power distribution systems according to IEC 60364-1 (2005).

### 5.1.1 TN line system

A TN line system transfers the PE protective conductor to the installed plant or system using a cable.

Generally, in a TN line system the neutral point is grounded. There are versions of a TN system with a grounded line conductor, e.g. with grounded L1.

A TN line system can transfer the neutral conductor N and the PE protective conductor either separately or combined.



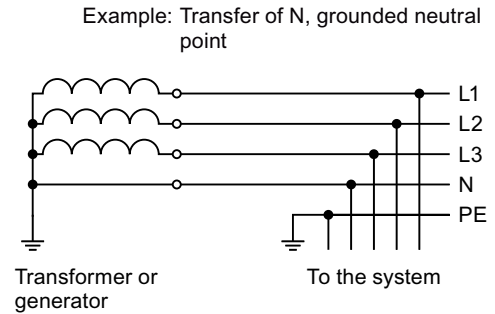
#### Inverter operated on a TN line system

- Inverter with integrated or external line filter:
  - Operation on TN line systems with grounded neutral point permissible.
  - Operation on TN line systems with grounded line conductor not permissible.
- Inverter without line filter:
  - Operation permissible on all TN line systems.

### 5.1.2 TT line system

In a TT line system, the transformer grounding and the installation grounding are independent of one another.

There are TT line supplies where the neutral conductor N is either transferred – or not.



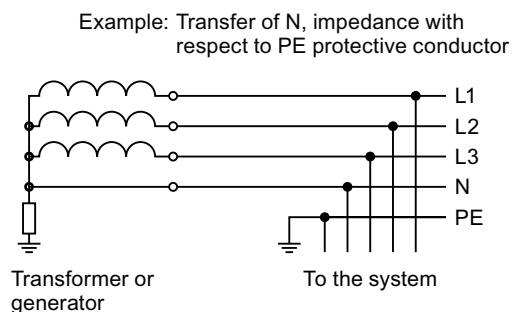
#### Inverter operated on a TT line system

- Inverter with integrated or external line filter:
  - Operation on TT line systems with grounded neutral point permissible.
  - Operation on TT line systems without grounded neutral point not permissible.
- Inverter without line filter:
  - Operation on all TT line systems permissible.
- For installations in compliance with IEC, operation on a TT line system is permissible. For installations in compliance with UL, operation on a TT line system is not permissible.

### 5.1.3 IT system

In an IT line system, all of the conductors are insulated with respect to the PE protective conductor – or connected to the PE protective conductor through an impedance.

There are IT systems with and without transfer of the neutral conductor N.



#### Inverter operated on an IT line system


- Inverters with integrated line filter:
  - Operation on IT line systems not permissible.
- Inverter without line filter:
  - Operation on all IT line systems permissible.

#### Behavior of the inverter when a ground fault occurs

In some instances, even for a ground fault, the inverter should still remain functional. In cases such as these, you must install an output reactor. This prevents an overcurrent trip or damage to the drive.

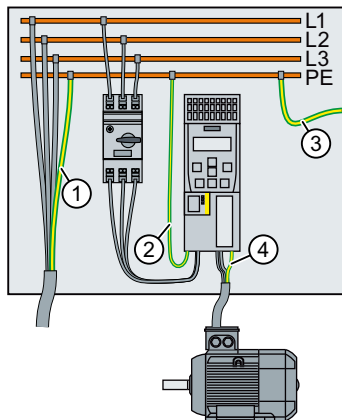
### 5.1.4 Protective conductor



 <b>WARNING</b>
<p><b>Danger to life caused by high leakage currents for an interrupted protective conductor</b></p> <p>The drive components conduct a high leakage current via the protective conductor. Touching conductive parts when the protective conductor is interrupted can result in death or serious injury.</p> <ul style="list-style-type: none"> <li>• Dimension the protective conductor as stipulated in the appropriate regulations.</li> </ul>

#### Dimensioning the protective conductor

Observe the local regulations for protective conductors subject to an increased leakage current at the site of operation.



- ① Protective conductor for line feeder cables
- ② Protective conductor for inverter line feeder cables
- ③ Protective conductor between PE and the electrical cabinet
- ④ Protective conductor for motor feeder cables

The minimum cross-section of the protective conductor ① ... ④ depends on the cross-section of the line or motor feeder cable:

- Line or motor feeder cable  $\leq 16 \text{ mm}^2$   
 ⇒ Minimum cross-section of the protective conductor = cross-section of the line or motor feeder cable
- $16 \text{ mm}^2 < \text{line or motor feeder cable} \leq 35 \text{ mm}^2$   
 ⇒ Minimum cross-section of the protective conductor =  $16 \text{ mm}^2$
- Line or motor feeder cable  $> 35 \text{ mm}^2$   
 ⇒ Minimum cross-section of the protective conductor =  $\frac{1}{2}$  cross-section of the line or motor feeder cable

Additional requirements placed on the protective conductor ①:

- For permanent connection, the protective conductor must fulfill at least one of the following conditions:
  - The protective conductor is routed so that it is protected against damage along its complete length.  
Cables routed inside electrical cabinets or enclosed machine housings are considered to be adequately protected against mechanical damage.
  - As a conductor of a multi-conductor cable, the protective conductor has a cross-section  $\geq 2.5 \text{ mm}^2 \text{ Cu}$ .
  - For an individual conductor, the protective conductor has a cross-section  $\geq 10 \text{ mm}^2 \text{ Cu}$ .
  - The protective conductor consists of two conductors with the same cross-section.
- When connecting a multi-core cable using an industrial plug connector according to EN 60309, the protective conductor must have a cross-section of  $\geq 2.5 \text{ mm}^2 \text{ Cu}$ .

## 5.2 Connecting the line and motor cable at the inverter

### 5.2.1 Connection overview

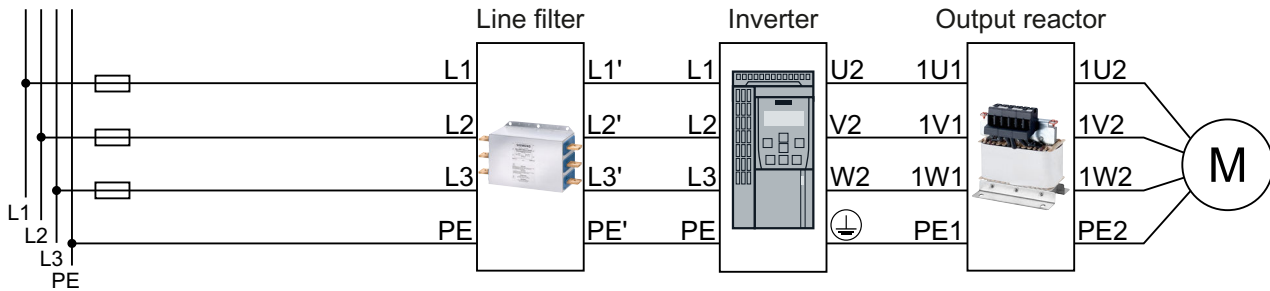


Figure 5-2 Connection overview

#### Note



#### Limit values for EMC classes, Category C2 or C1

In order to comply with limit values for EMC classes, Category C2 or C1, for certain Power Modules, ferrite cores must be installed when connecting to the line supply. Carefully observe the data in the following section:

 [Inverter applications \(Page 72\)](#)

### 5.2.2 Inverter terminals


Table 5-1 Connection, cross-section and tightening torque for PM230 Power Modules

Inverters	Connection		Cross-section, tightening torque		Stripped insulation length
			Metric	Imperial	
FSA	Line supply, motor		1 ... 2.5 mm <sup>2</sup> , 0.5 Nm	16 ... 14 AWG, 4.5 lbf in	8 mm
FSB			1.5 ... 6 mm <sup>2</sup> , 0.6 Nm	16 ... 10 AWG, 5.5 lbf in	8 mm
FSC			6 ... 16 mm <sup>2</sup> , 1.3 Nm	10 ... 6 AWG, 12 lbf in	10 mm
FSD	Line supply, motor		10 ... 35 mm <sup>2</sup> , 6 Nm	7 ... 2 AWG, 53 lbf in	--
FSE			25 ... 50 mm <sup>2</sup> , 6 Nm	3 ... 1 AWG, 53 lbf in	--
FSF			35 ... 120 mm <sup>2</sup> , 13 Nm	2 ... 4/0 AWG, 115 lbf in	--

### 5.2.3 Length of motor cable

Always dimension the motor cable so that the ohmic losses are less than 5 % of the inverter power rating.

The permissible length of the motor cable also depends on the quality of the motor cable and the inverter pulse frequency. The values specified below are applicable for high quality cables, such as CY100 or similar, and for the pulse frequencies set in the factory.

 Pulse frequency (Page 70).

If you set other pulse frequencies, then you must ensure that the EMC category is complied with on the plant or system side.

EMC-compliant wiring is required in order that the EMC category specified in the following table is attained.


 EMC-compliant installation of a plant or machine (Page 23)

Table 5-2 Permissible cable lengths

Length	Inverter, motor cable	EMC
25 m	<ul style="list-style-type: none"> <li>• Inverter with integrated filter (category C2),</li> <li>• Shielded motor cable</li> </ul>	Second environment, category C2
50 m	<ul style="list-style-type: none"> <li>• Inverter with integrated filter (category C2),</li> <li>• Shielded motor cable</li> </ul>	Second environment, category C3
	<ul style="list-style-type: none"> <li>• Inverter without filter</li> <li>• External category C1 filter</li> <li>• Shielded motor cable</li> </ul>	First environment, category C1
	<ul style="list-style-type: none"> <li>• Inverter with or without filter</li> <li>• Shielded motor cable</li> </ul>	No EMC category
100 m	<ul style="list-style-type: none"> <li>• Inverter with or without filter</li> <li>• Unshielded motor cable</li> </ul>	No EMC category
150 m	<ul style="list-style-type: none"> <li>• Inverter without filter</li> <li>• External category C1 filter</li> <li>• Shielded motor cable</li> <li>• Output reactor</li> </ul>	Second environment, category C2

### 5.2.4 Establishing connections

#### Procedure

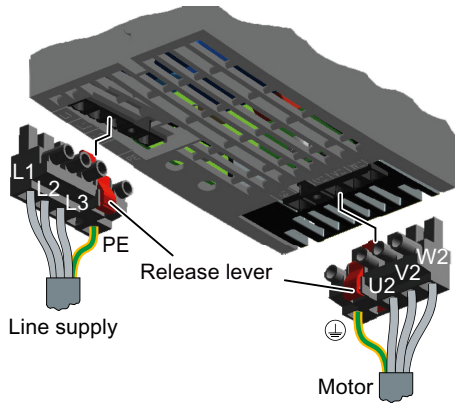


1. Proceed as follows to establish the connections:
2.
  1. Ensure that the device is in a no-voltage condition and the DC link is discharged.
  2. Establish the connections as described in the following sections.



This means that you have established the connections.

### Connections for frame sizes FSA ... FSC

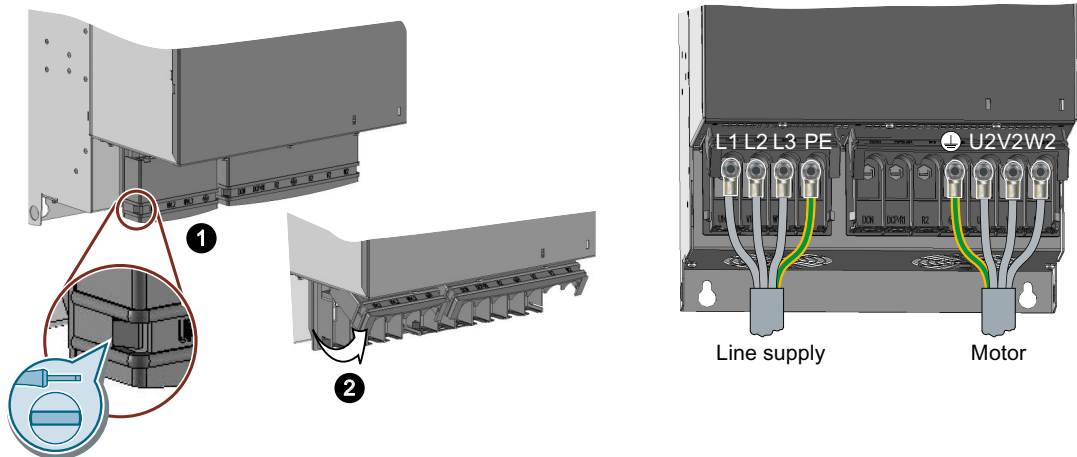


The Power Modules are equipped with withdrawable plug connectors that cannot be inadvertently interchanged.

To remove a plug connector, you must release it by pressing on the red lever.

### Connections for frame sizes FSD ... FSF

The line and motor connections have covers to prevent them from being touched.



You must open the cover to connect the line and motor:

1. Release the catches on both sides of the covers using a screwdriver.
2. Swivel the covers upwards.

Close the covers once you have connected the line and motor.

#### Connection rules for Power Modules, FSD ... FSF

Use UL-listed cable lugs (ZMVV) with the appropriate current rating for connecting the line and motor cables.

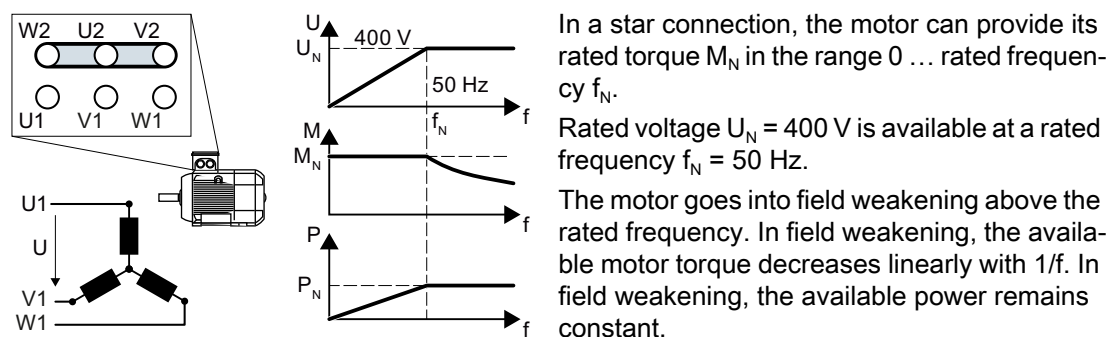
The covers of the power connections must be closed in order that the IP20 degree of protection is maintained.



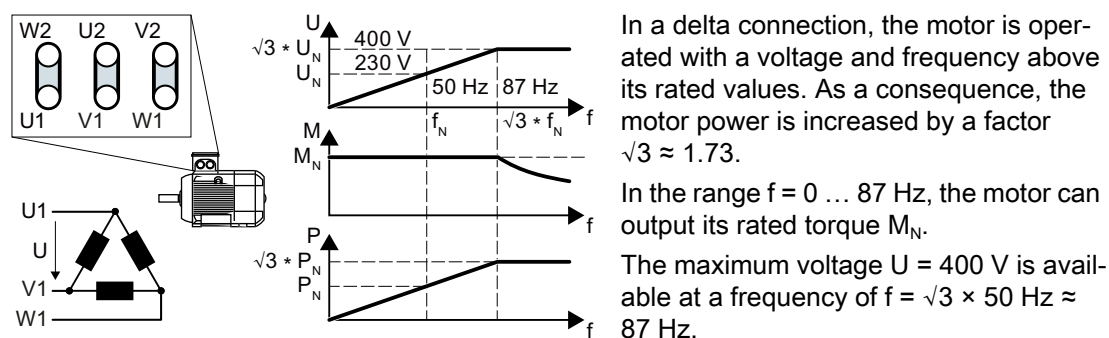
## 5.2.5 Connecting the motor to the inverter in a star or delta connection

Standard induction motors with a rated power of approximately  $\leq 3$  kW are normally connected in a star/delta connection (Y/ $\Delta$ ) at 400 V/230 V. For a 400-V line supply, you can connect the motor to the inverter either in a star or in a delta connection.

### Operating the motor in a star connection



### Operating the motor in a delta connection with 87 Hz characteristic



The motor only goes into field weakening above 87 Hz.

The higher motor power when operated with an 87 Hz characteristic has the following disadvantages:

- The inverter must supply approximately 1.73x current. Select an inverter based on its rated current - and not its rated power.
- The motor temperature increases more significantly than when operated with  $f \leq 50$  Hz.
- The motor must have windings that are approved for a voltage  $>$  rated voltage  $U_N$ .
- As the fan impeller rotates faster, the motor has a higher noise level than operation with  $f \leq 50$  Hz.



 **WARNING**

**Risk of fire or electric shock as a result of defective components**

If an overcurrent protection device responds, this can indicate that a fault current was interrupted.

Check the circuit components and all of the components of the inverter and replace defective parts and components to reduce the risk of a fire or an electric shock.

You must replace the complete overload relay if the current carrying element of the relay has burnt through.

## Repair


 **WARNING**

**Danger due to incorrect repair**

Repairs may only be carried out by Siemens Service, by repair centers authorized by Siemens or by authorized personnel who are thoroughly acquainted with all the warnings and operating procedures contained in this manual.

- Only use original spare parts when carrying out repairs.

## 6.1 Maintenance

The purpose of maintenance is to maintain the specified condition of the Power Module. Regularly remove dirt and pollution, and replace the fan in plenty of time.  Replacing the cooling fan (Page 53)

### Cleaning

#### Inverters with IP20 degree of protection

Clean the inverter with an anti-static brush, a vacuum cleaner and areas that are difficult to access, using dry compressed air (max. 1 bar).

#### Inverter with push-through technology

Clean the heatsink at regular intervals. If necessary, remove the air deflection plate at the rear. Use a torque of 2 Nm when reconnecting. The fans must be installed if you clean the heatsink using water.

### Ventilation

The devices must be installed in a cabinet. Ensure that the cabinet's ventilation slots are not blocked. Check that the fan is functioning correctly.

### Cables and screw terminals

Regularly check the cables for damage, and immediately replace any defective parts.

Regularly check that the screw terminals have been correctly tightened. Retighten the screws if necessary.

---

#### Note

The actual maintenance intervals depend on the installation and operating conditions.

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

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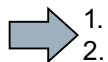
## 6.2 Replacing the cooling fan

### Service life of the fan

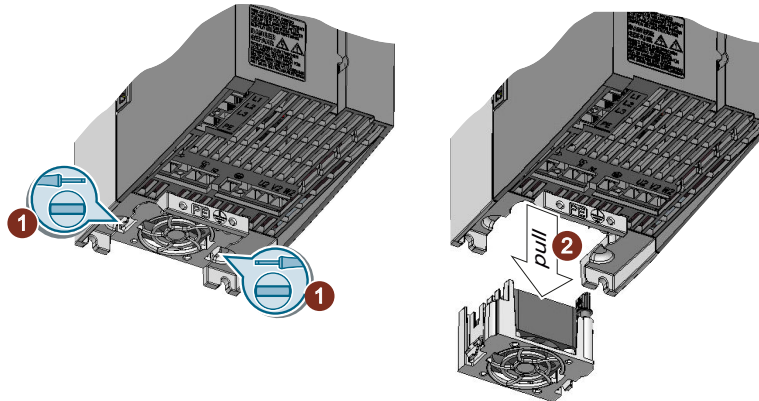
The average service life of the fan is 40,000 hours. In practice, however, the service life may deviate from this value. Especially a dusty environment can block up the fan.

The fan must be replaced in good time to ensure that the inverter is ready for operation.

### Replacing the fan modules for inverters, frame sizes FSA ... FSC



1. Proceed as follows to replace a fan module:
2.
  1. Switch-off the inverter, and wait 5 minutes until the DC link capacitors have been discharged.
  2. Withdraw the line and motor cable plug connectors and, if available, remove the braking resistor from the Power Module.
  3. Remove the shield plate from the Power Module.
  4. Remove the fan module from the Power Module in steps ① and ② as shown in the diagram. Use a screwdriver if necessary.



5. Install the new fan module in the inverse sequence.



You have replaced the fan module.

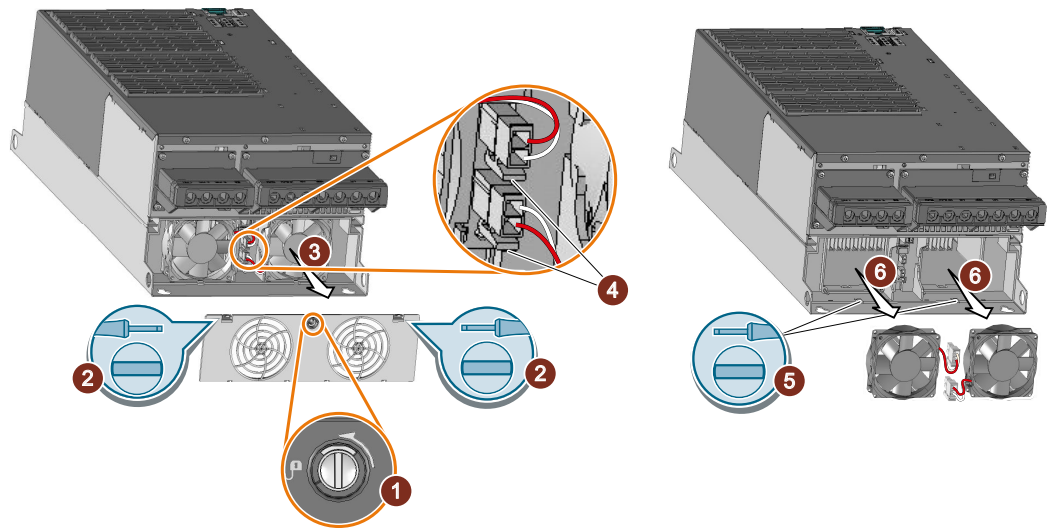
### Removing the fan from inverters, frame sizes FSD and FSE



1. Proceed as follows to replace a fan:
2.
  1. Switch-off the inverter, and wait 5 minutes until the DC link capacitors have been discharged.
  2. Disconnect all of the cables from the Power Module.
  3. Release the fan cover ①, ②
  4. Remove the fan cover ③
  5. Remove the fan connector ④
  6. Release the fan catches ⑤

6.2 Replacing the cooling fan

7. Remove the fan from the device ⑥



8. Install the new fan in the inverse sequence.

■ You have replaced the fan.

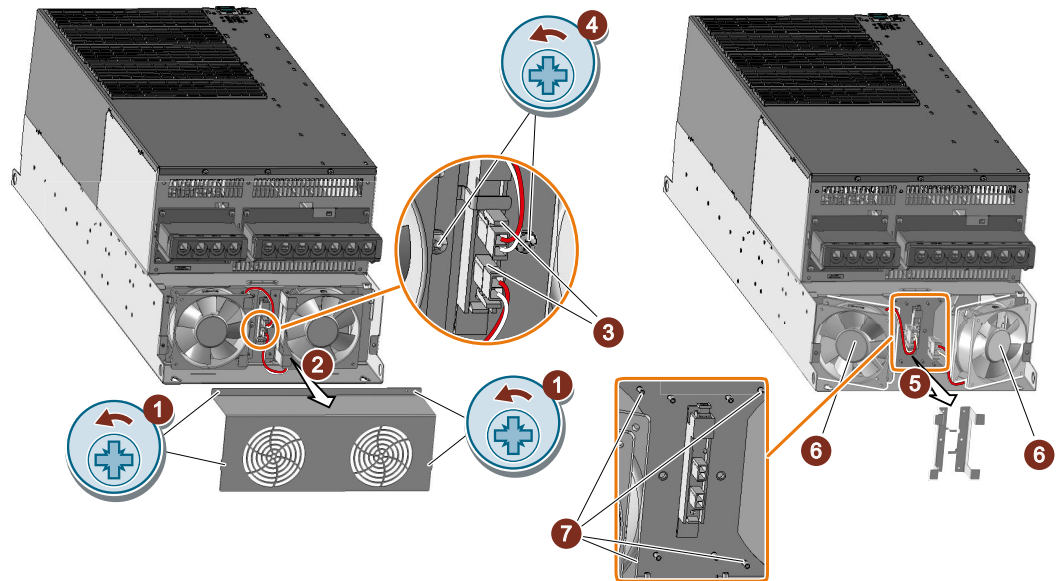
Replacing the fan for inverters, frame size FSF



1. Procedure

2. 1. Switch-off the inverter, and wait 5 minutes until the DC link capacitors have been discharged.
2. 2. Disconnect all of the cables from the Power Module.
3. 3. Release the four screws and remove the fan cover plate ①, ②
4. 4. Remove the fan connector ③
5. 5. Release the screws of the fan mounting bracket ④
6. 6. Remove the fan mounting bracket ⑤

7. Swivel the fan sideways towards the outside and then remove it from the inverter ⑥



8. Install the new fan in the inverse sequence.  
9. Additionally secure the fan using four M3 nuts on the guide bolts ⑥.

■ You have replaced the fan.





## Technical specifications

### Permissible motors

For the Power Modules, induction motors are permissible in the range from 25 % ... 150 % of the inverter power without any restrictions.

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### Note

#### Motors for inverter operation

Only use motors that are suitable for operation with inverters with a DC link.

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## 7.1 Overload capability of the inverter

Overload capability is the property of the inverter to temporarily supply a current that is higher than the rated current to accelerate a load. Two typical load cycles are defined to clearly demonstrate the overload capability: "Low Overload" and "High Overload"

### Definitions

#### Base load

Constant load between the accelerating phases of the drive

#### Low Overload

- **LO base load input current**  
Permissible input current for a "Low Overload" load cycle
- **LO base load output current**  
Permissible output current for a "Low Overload" load cycle
- **LO base load power**  
Rated power based on the LO base load output current

#### High Overload

- **HO base load input current**  
Permissible input current for a "High Overload" load cycle
- **HO base load output current**  
Permissible output current for a "High Overload" load cycle
- **HO base load power**  
Rated power based on the HO base load output current

If not specified otherwise, the power and current data in the technical data always refer to a load cycle according to Low Overload.

We recommend the "SIZER" engineering software to select the inverter.



You will find additional information about SIZER on the Internet: Download SIZER (<http://support.automation.siemens.com/WW/view/en/10804987/130000>).

### Load cycles and typical applications:

#### "Low Overload" load cycle

The "Low Overload" load cycle assumes a uniform base load with low requirements placed on brief accelerating phases. Typical applications when designing according to "Low Overload" include:

- Pumps, fans and compressors
- Wet or dry blasting technology
- Mills, mixers, kneaders, crushers, agitators
- Basic spindles
- Rotary kilns
- Extruders

#### "High Overload" load cycle

The "High Overload" load cycle permits, for reduced base load, dynamic accelerating phases. Typical applications when designing according to "High Overload" include:

- Horizontal and vertical conveyor technology (conveyor belts, roller conveyors, chain conveyors)
- Centrifuges
- Escalators/moving stairways
- Lifters/Lowerers
- Elevators
- Gantry cranes
- Cable railways
- Storage and retrieval machines

Typical inverter load cycles

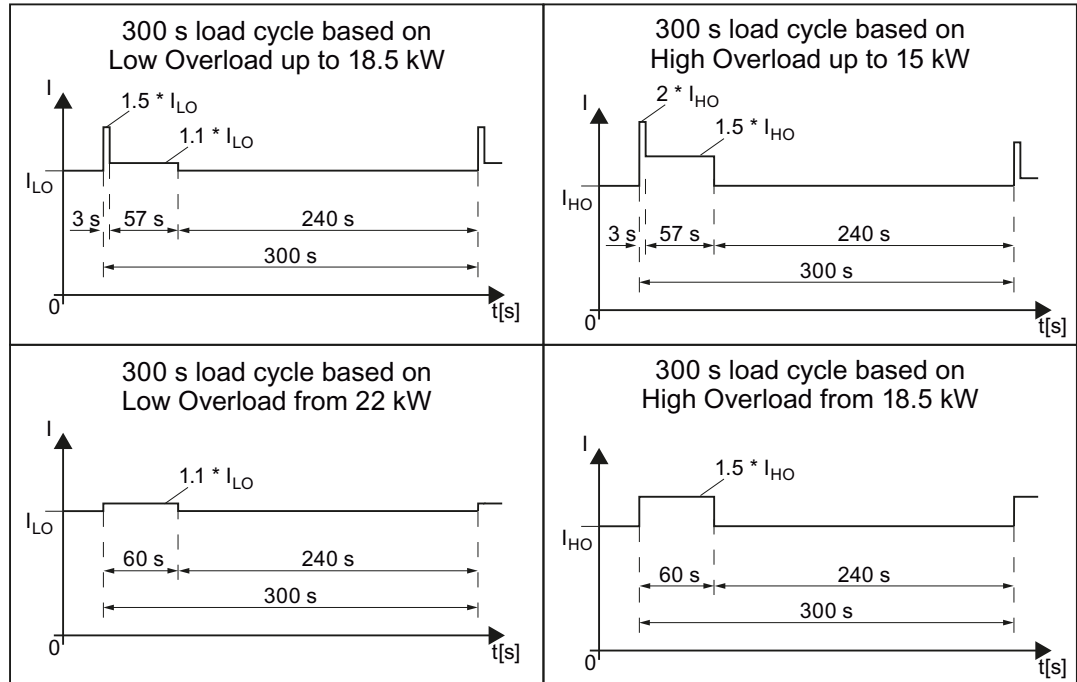




Figure 7-1 Duty cycles, "High Overload" and "Low Overload"

## 7.2 Cable cross-sections and tightening torques

Table 7-1 Connection, cross-section and tightening torque for PM230 Power Modules

Inverters	Connection		Cross-section, tightening torque		Stripped insulation length
			Metric	Imperial	
FSA	Line supply, motor	 Plug connector with screw terminals	1 ... 2.5 mm <sup>2</sup> , 0.5 Nm	16 ... 14 AWG, 4.5 lbf in	8 mm
FSB			1.5 ... 6 mm <sup>2</sup> , 0.6 Nm	16 ... 10 AWG, 5.5 lbf in	8 mm
FSC			6 ... 16 mm <sup>2</sup> , 1.3 Nm	10 ... 6 AWG, 12 lbf in	10 mm
FSD	Line supply, motor	 Cable lug	10 ... 35 mm <sup>2</sup> , 6 Nm	7 ... 2 AWG, 53 lbf in	--
FSE			25 ... 50 mm <sup>2</sup> , 6 Nm	3 ... 1 AWG, 53 lbf in	--
FSF			35 ... 120 mm <sup>2</sup> , 13 Nm	2 ... 4/0 AWG, 115 lbf in	--

## 7.3 Electromagnetic compatibility - overview

### Electromagnetic compatibility according to EN61800-3



Property	Version
Interference immunity	The inverters are suitable for use in the first and second industrial environments
Interference emission - second environment	Category C2 for inverters with integrated radio interference suppression filter
	Category C2 for inverters without filter with optional external radio interference suppression filter for grounded line supplies (recommended for operation in conjunction with a residual current protective device RCD)
	Category C3 for inverters with integrated radio interference suppression filter, format FSF
	Category C4 for inverters without integrated radio interference suppression filter for operation on IT line supplies

Additional information as well as conditions for using the inverter in the first environment are provided in the following Section:



Electromagnetic compatibility of variable-speed drives (Page 71).



## 7.4 Ambient conditions

Property	Version
<b>Ambient conditions for transport in the transport packaging</b>	
Climatic ambient conditions	- 40 °C ... + 70 °C, according to Class 2K4 to EN 60721-3-2 maximum humidity 95 % at 40 °C
Mechanical ambient conditions	FSA ... FSC: Shock and vibration permissible according to 1M2 to EN 60721-3-2 FSD ... FSF: Shock and vibration permissible according to 2M3 to EN 60721-3-2
Protection against chemical substances	Protected according to Class 2C2 to EN 60721-3-2
Biological environmental conditions	Suitable according to Class 2B1 to EN 60721-3-2
<b>Ambient conditions for long-term storage in the product packaging</b>	
Climatic ambient conditions	- 25 °C ... + 55 °C, according to Class 1K3 to EN 60721-3-1
Protection against chemical substances	Protected according to Class 1C2 to EN 60721-3-1
Biological environmental conditions	Suitable according to Class 1B1 according to EN 60721-3-1
<b>Ambient conditions in operation</b>	
Installation altitude	Up to 1000 m above sea level without derating, > 1000 m  Restrictions for special ambient conditions (Page 69)
Climatic ambient conditions <sup>1)</sup>	<ul style="list-style-type: none"> <li>• Temperature range without derating<sup>2)</sup> <ul style="list-style-type: none"> <li>– LO base load power: 0 °C...40 °C</li> <li>– HO base load power: 0 °C...40 °C</li> </ul> </li> <li>• For higher temperatures.  Restrictions for special ambient conditions (Page 69)</li> <li>• Relative humidity: 5 ... 95%, condensation not permitted</li> <li>• Oil mist, salt mist, ice formation, condensation, dripping water, spraying water, splashing water and water jets are not permitted</li> </ul>
Mechanical ambient conditions	FSA ... FSF: Vibration levels permissible according to Class 3M1 to EN 60721-3-3 FSA ... FSC: Shock, permissible according to Class 3M2 to EN 60721-3-3 FSD ... FSF: Shock permissible according to Class 3M1 to EN 60721-3-3
Protection against chemical substances	protected according to 3C2 acc. to EN 60721-3-3
Biological environmental conditions	suitable according to 3B1 acc. to EN 60721-3-3
Pollution	Suitable for environments with degree of pollution 2 according to EN 61800-5-1
Cooling	Forced air cooling AF, according to EN 60146
Cooling air	clean and dry air

<sup>1)</sup> Increased ruggedness regarding temperature range and relative humidity; therefore better than Class 3K3 to EN 60721-3-3

<sup>2)</sup> Observe the permissible ambient temperatures for the Control Unit and possibly the operator panel (IOP or BOP-2).

## 7.5 General technical data

Property	Version
Line voltage	3 AC 380 V ... 480 V $\pm$ 10 %
Output voltage	3 AC 0 V ... input voltage x 0.95 (max.)
Input frequency	50 Hz ... 60 Hz, $\pm$ 3 Hz
Output frequency	0 Hz ... 550 Hz, depending on the control mode
Power factor $\lambda$	0.9 for $U_k = 1$ %
Inrush current	< LO base load input current
Overvoltage category according to EN 60664-1	Overvoltage category III for industrial line supplies
Short-circuit current rating (SCCR)	65 kA rms with fuses, Class J or 3NE, rated voltage 600 V AC with the rated inverter current.
Line impedance	$U_k < 1$ %, a line reactor is not permitted
Pulse frequency	4 kHz (factory setting), Can be set in 2 kHz steps in the range 2 kHz ... 16 kHz. If you increase the pulse frequency, the inverter reduces the maximum output current.  Current reduction depending on pulse frequency (Page 70) <b>Note:</b> The specified EMC properties are only valid for the pulse frequencies set in the factory.
Electromagnetic compatibility	The devices are suitable for environments of category C2 according to IEC/EN 61800-3. Details:  Restrictions for special ambient conditions (Page 69)
Braking methods	DC braking, compound braking
Degree of protection according to EN 60529	Chassis devices IP20 Must be installed in a control cabinet PT devices IP20, IP55 Must be installed in a control cabinet at the control cabinet panel

## 7.6 Detailed technical data

### Note

#### Values for Low Overload and High Overload

The values for Low Overload (LO) are identical with those of the rated values.

#### Power loss of the Power Modules

The values specified for the power loss are typical values at 100% of the rated speed and 100% of the load corresponding to Low Overload.

Table 7-2 PM230, IP20, frame size A, 3 AC 380 V ... 480 V

Article no. - without filter	6SL3210-1NE11-3UG1	6SL3210-1NE11-7UG1	6SL3210-1NE12-2UG1
Article no. - with filter	6SL3210-1NE11-3AG1	6SL3210-1NE11-7AG1	6SL3210-1NE12-2AG1
LO base load power	0.37 kW	0.55 kW	0.75 kW
LO base load input current	1.3 A	1.8 A	2.3 A
LO base load output current	1.3 A	1.7 A	2.2 A
HO base load power	0.25 kW	0.37 kW	0.55 kW
HO base load input current	0.9 A	1.3 A	1.8 A
HO base load output current	0.9 A	1.3 A	1.7 A
Fuse according to IEC / UL	3NE1813-0	3NE1813-0	3NE1813-0
Fuse according to UL, Class J	2 A	4 A	4 A
Circuit breaker 3RV2711-1KD10	12.5 A	12.5 A	12.5 A
Power loss	0.04 kW	0.04 kW	0.05 kW
Required cooling air flow	1.5 l/s	1.5 l/s	4.5 l/s
Weight without filter	1.4 kg	1.4 kg	1.4 kg
Weight with filter	1.6 kg	1.6 kg	1.6 kg

Table 7-3 PM230, IP20, frame size A, 3 AC 380 V ... 480 V

Article no. - without filter	6SL3210-1NE13-1UG1	6SL3210-1NE14-1UG1	6SL3210-1NE15-8UG1
Article no. - with filter	6SL3210-1NE13-1AG1	6SL3210-1NE14-1AG1	6SL3210-1NE15-8AG1
LO base load power	1.1 kW	1.5 kW	2.2 kW
LO base load input current	3.2 A	4.2 A	6.1 A
LO base load output current	3.1 A	4.1 A	5.9 A
HO base load power	0.75 kW	1.1 kW	1.5 kW
HO base load input current	2.3 A	3.2 A	4.2 A
HO base load output current	2.2 A	3.1 A	4.1 A
Fuse according to IEC / UL	3NE1813-0	3NE1813-0	3NE1813-0
Fuse according to UL, Class J	6 A	6 A	10 A
Power loss	0.06 kW	0.07 kW	0.08 kW
Circuit breaker N3RV2711-1KD10	12.5 A	12.5 A	12.5 A
Required cooling air flow	4.5 l/s	4.5 l/s	4.5 l/s



Article no. - without filter	6SL3210-1NE13-1UG1	6SL3210-1NE14-1UG1	6SL3210-1NE15-8UG1
Article no. - with filter	6SL3210-1NE13-1AG1	6SL3210-1NE14-1AG1	6SL3210-1NE15-8AG1
Weight without filter	1.4 kg	1.4 kg	1.4 kg
Weight with filter	1.6 kg	1.6 kg	1.6 kg

Table 7-4 PM230, IP20, frame size A, 3 AC 380 V ... 480 V

Article no. - without filter	6SL3210-1NE17-7UG1
Article no. - with filter	6SL3210-1NE17-7AG1
LO base load power	3 kW
LO base load input current	8.0 A
LO base load output current	7.7 A
HO base load power	2.2 kW
HO base load input current	6.1 A
HO base load output current	5.9 A
Fuse according to IEC / UL	3NE1813-0
Fuse according to UL, Class J	10 A
Circuit breaker N3RV2711-1KD10	12.5 A
Power loss	0.11 kW
Required cooling air flow	4.5 l/s
Weight without filter	1.4 kg
Weight with filter	1.6 kg

Table 7-5 PM230, PT, frame size A, 3 AC 380 V ... 480 V

Article no. - without filter	6SL3211-1NE17-7UG1
Article no. - with filter	6SL3211-1NE17-7AG1
LO base load power	3 kW
LO base load input current	8.0 A
LO base load output current	7.7 A
HO base load power	2.2 kW
HO base load input current	6.1 A
HO base load output current	5.9 A
Fuse according to IEC / UL	3NE1813-0
Fuse according to UL, Class J	10 A
Power loss	0.11 kW
Required cooling air flow	4.5 l/s
Weight without filter	1.7 kg
Weight with filter	1.9 kg

Technical specifications

7.6 Detailed technical data

Table 7-6 PM230, IP20, frame size B, 3-phase 380 ... 480 VAC

Article no. - without filter	6SL3210-1NE21-0UG1	6SL3210-1NE21-3UG1	6SL3210-1NE21-8UG1
Article no. - with filter	6SL3210-1NE21-0AG1	6SL3210-1NE21-3AG1	6SL3210-1NE21-8AG1
LO base load power	4 kW	5.5 kW	7.5 kW
LO base load input current	10.5 A	13.6 A	18.6 A
LO base load output current	10.2 A	13.2 A	18 A
HO base load power	3 kW	4 kW	5.5 kW
HO base load input current	8.0 A	10.5 A	13.6 A
HO base load output current	7.7 A	10.2 A	13.2 A
Fuse according to IEC / UL	3NE1813-0	3NE1814-0	3NE1815-0
Fuse according to UL, Class J	15 A	20 A	25 A
Power loss	0.12 kW	0.15 kW	0.22 kW
Required cooling air flow	9.2 l/s	9.2 l/s	9.2 l/s
Weight without filter	2.8 kg	2.8 kg	2.8 kg
Weight with filter	3 kg	3 kg	3 kg

Table 7-7 PM230, PT, frame size B, 3 AC 380 V ... 480 V

Article no. - without filter	6SL3211-1NE21-8UG1
Article no. - with filter	6SL3211-1NE21-8AG1
LO base load power	7.5 kW
LO base load input current	18.6 A
LO base load output current	18 A
HO base load power	5.5 kW
HO base load input current	13.6 A
HO base load output current	13.2 A
Fuse according to IEC / UL	3NE1815-0
Fuse according to UL, Class J	25 A
Power loss	0.22 kW
Required cooling air flow	9.2 l/s
Weight without filter	3.4 kg
Weight with filter	3.6 kg

Table 7-8 PM230, IP20, frame size C, 3 AC 380 V ... 480 V

Article no. - without filter	6SL3210-1NE22-6UG1	6SL3210-1NE23-2UG1	6SL3210-1NE23-8UG1
Article no. - with filter	6SL3210-1NE22-6AG1	6SL3210-1NE23-2AG1	6SL3210-1NE23-8AG1
LO base load power	11 kW	15 kW	18.5 kW
LO base load input current	26.9 A	33.1 A	39.2 A
LO base load output current	26 A	32 A	38 A
HO base load power	7.5 kW	11 kW	15 kW
HO base load input current	18.6 A	26.9 A	33.1 A
HO base load output current	18 A	26 A	32 A

Article no. - without filter	6SL3210-1NE22-6UG1	6SL3210-1NE23-2UG1	6SL3210-1NE23-8UG1
Article no. - with filter	6SL3210-1NE22-6AG1	6SL3210-1NE23-2AG1	6SL3210-1NE23-8AG1
Fuse according to IEC / UL	3NE1803-0	3NE1817-0	3NE1817-0
Fuse according to UL, Class J	35 A	45 A	50 A
Power loss	0.3 kW	0.35 kW	0.45 kW
Required cooling air flow	18.5 l/s	18.5 l/s	18.5 l/s
Weight without filter	4.5 kg	4.5 kg	4.5 kg
Weight with filter	5.1 kg	5.1 kg	5.1 kg

Table 7-9 PM230, PT, frame size C, 3 AC 380 V ... 480 V

Article no. - without filter	6SL3211-1NE23-8UG1
Article no. - with filter	6SL3211-1NE23-8AG1
LO base load power	18.5 kW
LO base load input current	39.2 A
LO base load output current	38 A
HO base load power	15 kW
HO base load input current	33.1 A
HO base load output current	32 A
Fuse according to IEC / UL	3NE1817-0
Fuse according to UL, Class J	50 A
Power loss	0.45 kW
Required cooling air flow	18.5 l/s
Weight without filter	5.4 kg
Weight with filter	6 kg

Table 7-10 PM230, IP20, frame size D, 3 AC 380 V ... 480 V

Article no. - without filter	6SL3210-1NE24-5UL0	6SL3210-1NE26-0UL0
Article no. - with filter	6SL3210-1NE24-5AL0	6SL3210-1NE26-0AL0
LO base load power	22 kW	30 kW
LO base load input current	42 A	56 A
LO base load output current	45 A	60 A
HO base load power	18.5 kW	22 kW
HO base load input current	36 A	42 A
HO base load output current	38 A	45 A
Fuse according to IEC / UL	3NE1818-0	3NE1820-0
Power loss	0.52 kW	0.68 kW
Required cooling air flow	80 l/s	80 l/s
Weight without filter	11 kg	11 kg
Weight with filter	14 kg	14 kg

Technical specifications

7.6 Detailed technical data

Table 7-11 PM230, IP20, frame size E, 3 AC 380 V ... 480 V

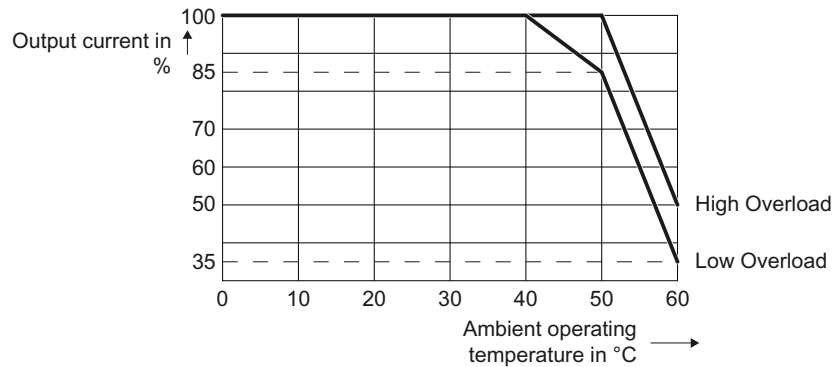
<b>Article no. - without filter</b>	<b>6SL3210-1NE27-5UL0</b>	<b>6SL3210-1NE28-8UL0</b>
<b>Article no. - with filter</b>	<b>6SL3210-1NE27-5AL0</b>	<b>6SL3210-1NE28-8AL0</b>
LO base load power	37 kW	45 kW
LO base load input current	70 A	84 A
LO base load output current	75 A	90 A
HO base load power	30 kW	37 kW
HO base load input current	56 A	70 A
HO base load output current	60 A	75 A
Fuse according to IEC / UL	3NE1021-0	3NE1022-0
Power loss	0.99 kW	1.2 kW
Required cooling air flow	80 l/s	80 l/s
Weight without filter	15 kg	15 kg
Weight with filter	22 kg	22 kg

Table 7-12 PM230, IP20, frame size F, 3 AC 380 V ... 480 V

<b>Article no. - without filter</b>	<b>6SL3210-1NE31-1UL0</b>	<b>6SL3210-1NE31-5UL0</b>
<b>Article no. - with filter</b>	<b>6SL3210-1NE31-1AL0</b>	<b>6SL3210-1NE31-5AL0</b>
LO base load power	55 kW	75 kW
LO base load input current	102 A	135 A
LO base load output current	110 A	145 A
HO base load power	45 kW	55 kW
HO base load input current	84 A	102 A
HO base load output current	90 A	110 A
Fuse according to IEC / UL	3NE1224-0	3NE1225-0
Power loss	1.4 kW	1.9 kW
Required cooling air flow	150 l/s	150 l/s
Weight without filter	33 kg	33 kg
Weight with filter	48 kg	48 kg

## 7.7 Restrictions for special ambient conditions

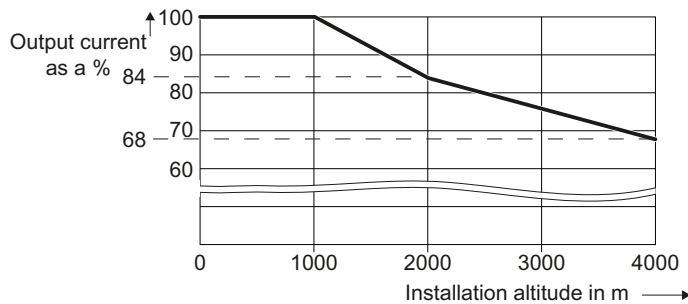
### Current de-rating depending on the ambient operating temperature



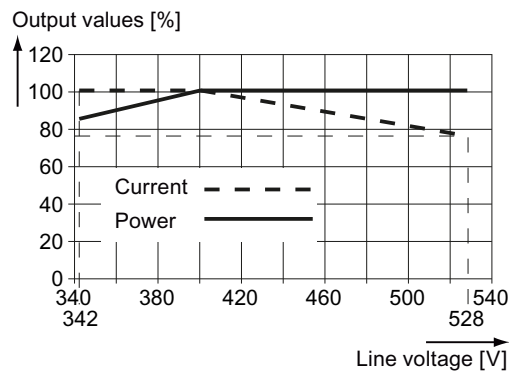
The Control Unit and operator panel can restrict the maximum permissible operating ambient temperature of the Power Module.

### Current derating depending on the installation altitude

Above 1000 m above sea level you must reduce the inverter output current as a result of the lower cooling capability of the air.



### Current and power limiting depending on the line voltage



### 7.7.1 Current reduction depending on pulse frequency

#### Current derating depending on the pulse frequency

LO base load	Output base-load current at a pulse frequency of							
	2 kHz	4 kHz	6 kHz	8 kHz	10 kHz	12 kHz	14 kHz	16 kHz
kW	A	A	A	A	A	A	A	A
0.37	--	1.30	1.11	0.91	0.78	0.65	0.59	0.52
0.55	--	1.70	1.45	1.19	1.02	0.85	0.77	0.68
0.75	--	2.20	1.87	1.54	1.32	1.10	0.99	0.88
1.1	--	3.10	2.64	2.17	1.86	1.55	1.40	1.24
1.5	--	4.10	3.49	2.87	2.46	2.05	1.85	1.64
2.2	--	5.90	5.02	4.13	3.54	2.95	2.66	2.36
3.0	--	7.70	6.55	5.39	4.62	3.85	3.47	3.08
4.0	--	10.20	8.67	7.14	6.12	5.10	4.59	4.08
5.5	--	13.20	11.22	9.24	7.92	6.60	5.94	5.28
7.5	--	18.00	15.30	12.60	10.80	9.00	8.10	7.20
11.0	--	26.00	22.10	18.20	15.60	13.00	11.70	10.40
15.0	--	32.00	27.20	22.40	19.20	16.00	14.40	12.80
18.5	--	38.00	32.30	26.60	22.80	19.00	17.10	15.20
22	--	45.00	38.25	31.50	27.00	22.50	20.25	18.00
30	--	60.00	51.00	42.00	36.00	30.00	27.00	24.00
37	--	75.00	63.75	52.50	45.00	37.50	33.75	30.00
45	--	90.00	76.50	63.00	54.00	45.00	40.50	36.00
55	--	110.0	93.50	77.00	66.00	55.00	49.50	44.00
75	--	145.0	123.3	101.5	--	--	--	--

The permissible cable length to the motor also depends on the cable type and the selected pulse frequency.

## 7.8 Electromagnetic compatibility of variable-speed drives

EMC (electromagnetic compatibility) means that the devices function satisfactorily without interfering with other devices and without being disrupted by other devices. This is true when the emitted interference (emission level) and the interference immunity are matched with each other.

The product standard IEC/EN 61800-3 describes the EMC requirements placed on "Variable-speed drive systems".

A variable-speed drive system (or Power Drive System PDS) consists of the inverter as well as the associated electric motors and encoders including the connecting cables.

The inverter comprises the Control Unit and Power Module.

The driven machine is not part of the drive system.

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### Note

#### PDS as component of machines or systems

When you integrate PDS into machines or systems, additional measures may be required so that the product standards of these machines or systems is complied with. The machine or system builder is responsible for taking these measures.

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## Environments and categories

### Environments

IEC/EN 61800-3 makes a distinction between the first and second environments - and defines different requirements for these environments.

- **First environment:**  
Residential buildings or locations at which the drive system is directly connected to a public low-voltage supply without intermediate transformer.
- **Second environment:**  
All locations that are connected to the public grid through their own, dedicated transformer. These are essentially industrial plants and systems.

### Categories

IEC/EN 61800-3 makes a distinction between four drive system categories:

- **Category C1:**  
Drive systems for rated voltages < 1000 V for unrestricted use in the first environment
- **Category C2:**  
Stationary drive systems for rated voltages < 1000 V for operation in the second environment.  
The drive system must be installed by appropriately qualified and trained personnel. Additional measures are required for operation in the first environment.

- **Category C3:**  
Drive systems for rated voltages < 1000 V - only for operation in the second environment.
- **Category C4:**  
Drive systems for IT line supplies for operation in complex systems in the second environment.  
An EMC plan must be created.

---

**Note**

**Appropriately trained and qualified personnel**

An appropriately trained and qualified person has the necessary experience for installing and/or commissioning drive systems (Power Drive Systems - PDS), including the associated EMC aspects.

---

## 7.8.1 Inverter applications

Inverters involve equipment used on a professional basis, deployed in certain areas of business and industry - and are not operated in the general public domain.



For an EMC-compliant installation, observe the information provided in the Configuration manual: EMC installation guideline (<http://support.automation.siemens.com/WW/view/en/60612658>).

The Power Modules described here are intended for operation in the first and second environments. Conditions for operation in the respective environment are subsequently listed.


### 7.8.1.1 Operation in the second environment

#### Interference immunity

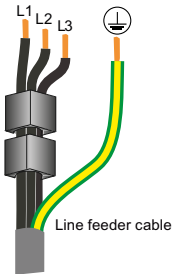
You do not have to take any additional measures regarding interference immunity.




#### Interference emission - operation in the second environment, Category C2

The drive system must comply with the following conditions in order to comply with the limit values of the second environment, Category C2:

- The drive system is installed by appropriately qualified personnel in compliance with EMC regulations - and the installation notes provided in the manual.
- You use a shielded motor cable with low capacitance.
- The pulse frequency is not higher than the value set in the factory.
- The drive system is connected to a TN or TT line supply.
- You comply with the permissible motor cable length.  
 Length of motor cable (Page 47).





- The current is not higher than the LO input current of the inverter (high-frequency, cable-conducted interference voltages).  
 Detailed technical data (Page 64).
- You use an inverter with integrated line filter
  - for inverters, frame sizes **FSA ... FSC** with **Profinet interface**, additionally:  
 The inverter is connected to the line supply through two ferrite cores, e.g. "Würth 742 - 712 - 22" or equivalent versions.
- You use an inverter without filter and use an external filter ( Line filters (Page 81) )
  - for inverters, frame sizes **FSB and FSC** , additionally:  
 The inverter is connected to the line supply through two ferrite cores, e.g. "Würth 742 - 712 - 22" or equivalent versions.
  - for inverters, frame size **FSD**, additionally:  
 The inverter is connected to the line supply through two ferrite cores, e.g. "Würth 742 - 701 - 91" or equivalent versions.
- With the external filters, from  "Line filters (Page 81)", the inverters without integrated filter comply with the requirements of the second environment, Category C2 with reference to interference emission.  
 If you use inverters without integrated filter or a filter other than those mentioned above, then you are responsible for verifying that the interference emission is limited.

### Interference emission - operation in the second environment, Category C4

When connected to IT line supplies, only filtered inverters are permissible. Use external filters without capacitors with respect to ground to limit symmetrical interference emission. When necessary, contact one of our Solution Partners (<https://www.automation.siemens.com/solutionpartner/partnerfinder/Home/Index?country=DE&program=1&technology=19&lang=en>).

### 7.8.1.2 Operation in the first environment

#### Interference immunity

You do not have to take any additional measures regarding interference immunity.

#### Interference emission - operation in the first environment, Category C2

In order that you may operate the drive system in the first environment, Category C2, then in addition to the requirements for use in the second environment, you must also observe the limit values related to harmonic currents.

---

#### Note


##### Maintaining the limit values for harmonic currents

With respect to the compliance with limits for harmonic currents, the EMC product standard EN61800-3 for PDS refers to compliance with standards EN 61000-3-2 and EN 61000-3-12.

---

##### Inverter with an LO base load power $\leq 1$ kW:

It cannot be guaranteed that the limit values are complied with corresponding to IEC 61000-3-2. The installation person/company or company operating the professionally used device must obtain authorization from the grid operator to connect the device regarding the harmonic currents.

 Harmonic currents (Page 75)

##### Inverters with an LO base load input current $\leq 16$ A:

These devices are not subject to any limit values, and as a consequence can be connected to the public low-voltage grid without any prior consultation.

- **Inverters with an LO base load input current > 16 A and ≤ 75 A**

The drive system is in compliance with IEC/EN 61000-3-12 under the following precondition:


- Short-circuit power  $S_{SC}$  at the connection point of the customer's system to the public grid, is not greater or is equal to the value according to the following formula:  
 $S_{SC} \geq 120 \cdot \sqrt{3} \cdot U_{in} \cdot \text{LO base load input current}$   
 The installation company or company operating the drive system is responsible for ensuring that this device is only connected at a connection point with an appropriate short-circuit power (fault level).

**Example:** FSD inverter, 400 V, input current, 42 A:

$$S_{SC} \geq 120 \cdot \sqrt{3} \cdot 400 \text{ V} \cdot 42 \text{ A}$$

This corresponds to a low-voltage transformer with an apparent power rating of approximately 160 kVA ... 200 kVA with 4 % ... 6 %  $U_k$

If these preconditions do not apply, then the installation company or company operating the device must obtain authorization from the grid operator to connect the device regarding the harmonic currents.

 Harmonic currents (Page 75)

- **Inverters with an LO base load current > 75A**

There are no standard-related requirements for installing devices such as these. However, it is recommended to inform the grid operator when connecting such a device.

## 7.8.2 Harmonic currents

Table 7-13 Typical harmonic currents (%) of the inverter

Inverter	Harmonic number							
	5th	7th	11th	13th	17th	19th	23rd	25th
FSA ... FSF <sup>1)</sup>	20	14	9.1	7.7	5.9	5.3	4.3	4.0

<sup>1)</sup> Values referred to the LO input current

### 7.8.3 EMC limit values in South Korea

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

The EMC limit values to be observed for Korea correspond to the limit values of the EMC product standard for variable-speed electric drives EN 61800-3 of category C2 or the limit value class A, Group 1 to KN11.

By implementing appropriate additional measures, the limit values according to category C2 or limit value class A, Group 1, are observed.

Additional measures, such as the use of an additional RFI suppression filter (EMC filter), may be necessary.



In addition, measures for EMC-compliant configuration of the plant or system are described in detail in this manual and in the Configuration manual EMC installation guideline (<http://support.automation.siemens.com/WW/view/en/60612658>).

The final statement on compliance with the applicable standard is given by the respective label attached to the individual device.

## Spare parts and accessories

### 8.1 Product maintenance

Inverter components are being continuously developed within the scope of product update. The product update includes, for example, measures to increase the ruggedness or hardware changes, which are necessary as components are being discontinued.

These further developments are "spare parts-compatible" and do not change the article number.

In the scope of such spare parts-compatible ongoing development, plug connector or connection positions are sometimes slightly modified. This does not cause any problems when the components are properly used. Please take this fact into consideration in special installation situations (e.g. allow sufficient reserve regarding the cable length).

## 8.2 Spare parts

### Power Modules FSA

Fan kit 6SL3200-0SF12-0AA0 for

- all FSA Power Modules

### Power Modules FSB

Fan kit 6SL3200-0SF13-0AA0 for

- all FSB Power Modules

### Power Modules FSC

Fan kit 6SL3200-0SF14-0AA0 for

- all Power Modules FSC

### Power Modules FSD

Fan kit 6SL3200-0SF04-0AA0 for

- 6SL3225-0BE31-5AA0 (18.5 kW)
- 6SL3225-0BE31-8AA0 (22 kW)
- 6SL3225-0BE32-2AA0 (30 kW)

Fan kit 6SL3200-0SF05-0AA0 for

### Power Modules FSE

Fan kit 6SL3200-0SF04-0AA0 for

- 6SL3225-0BE33-0AA0 (37 kW)

Fan kit 6SL3200-0SF05-0AA0 for

- 6SL3225-0BE33-7AA0 (45 kW)

Cover kit 6SL3200-0SM11-0AA0 for

All Power Modules FSE

### Power Modules FSF

Fan kit 6SL3200-0SF06-0AA0 for

- 6SL3225-0BE34-5AA0 (55 kW)
- 6SL3225-0BE35-5AA0 (75 kW)
- 6SL3225-0BE37-5AA0 (90 kW)

Fan kit 6SL3200-0SF08-0AA0 for

Cover kit 6SL3200-0SM12-0AA0 for

all Power Modules FSF

## 8.3 Optional accessories

### 8.3.1 Mounting frames for Power Module with push-through technology



#### Order numbers for mounting frames

- FSA: 6SL3260-6AA00-0DA0
- FSB: 6SL3260-6AB00-0DA0
- FSC: 6SL3260-6AC00-0DA0

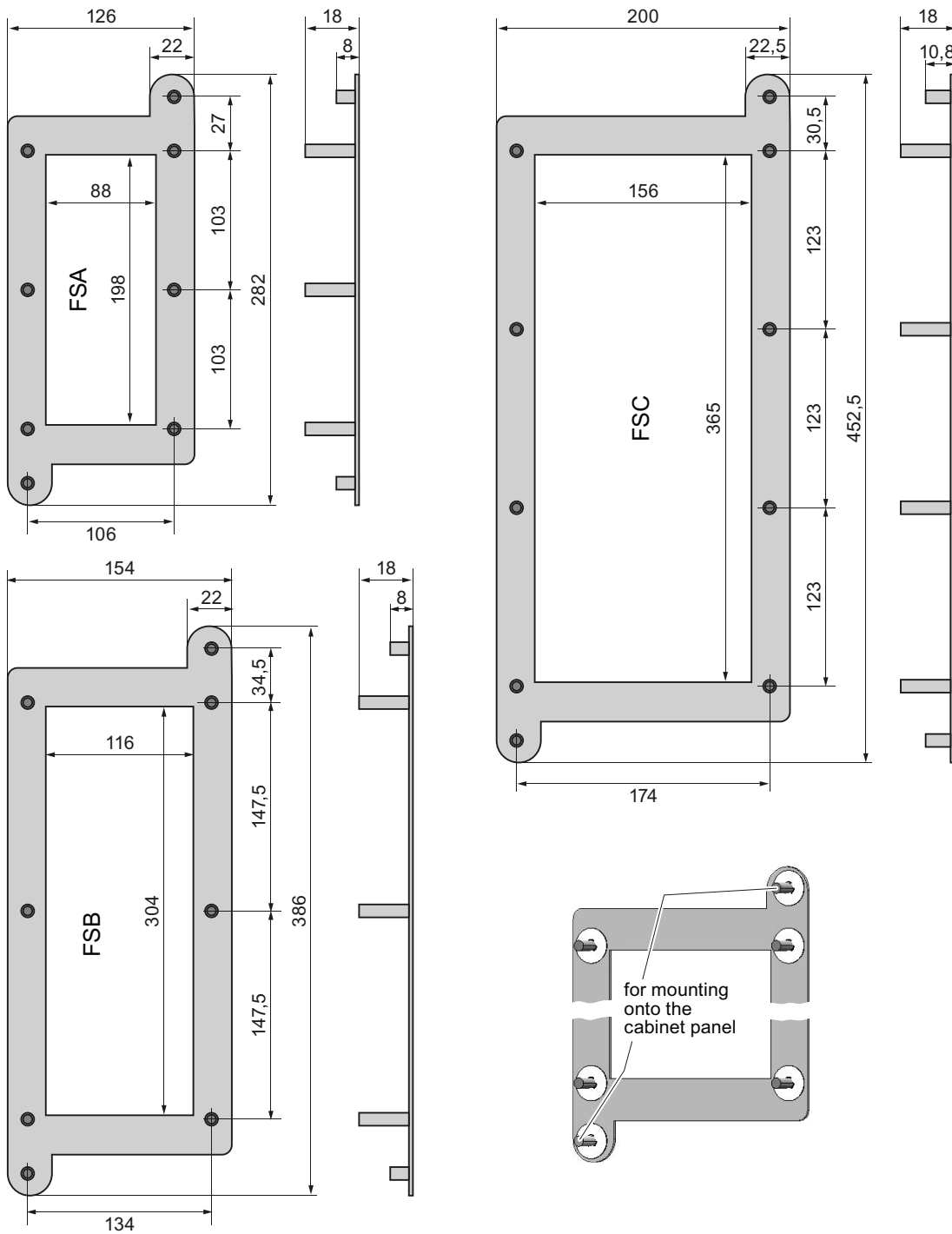
All of the necessary nuts and seals are included in the scope of delivery.

#### Mounting instructions for the mounting frames

##### Procedure

- 
1. Proceed as follows to correctly mount the Power Module:
  2.
    1. Prepare a cutout and holes in the control cabinet panel for the mounting frame corresponding to the dimension drawing.
    2. Insert the mounting frame from the rear of the control cabinet through the corresponding holes and fix it in place at the fixing screws for the control cabinet panel; tighten the two nuts by hand.
    3. Attach the seal to the inner side of the control cabinet.
    4. Insert the Power Module and tighten the screws by hand.
    5. Finally, tighten the eight or ten screws with a torque of 3.5 Nm.
-  You have correctly installed the Power Module.

Dimension drawings for mounting frames





## 8.3.2 Line filters

With a line filter, the inverter can achieve a higher radio interference class.

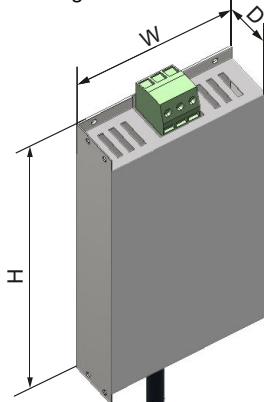
The line filters integrated in the inverter correspond to Category C2 according to EN 61800-3.

External filters are available for Category C2 or C1 according to EN 61800-3. Details are provided in the following tables.

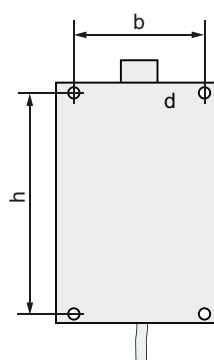
NOTICE
<b>The line filter is damaged when operated on inadmissible line supplies</b>
The line filter is only suitable for operation on TN or TT line systems with a grounded neutral point. The line filter is damaged if operated on all other line supplies.
<ul style="list-style-type: none"> <li>For inverters equipped with line filter, only connect to TN or TT line systems with a grounded neutral point.</li> </ul>

### Dimensions, drilling patterns and weights

Mounting dimensions



Drilling dimensions



Article number	Overall dimensions (mm)			Drilling dimensions (mm)			Weight (kg)
	W	H	D	b	h	Fixing	
6SL3203-0BE17-7BA0	73	202	65	62.3	186	4 x M4 / 2.5 Nm	1.8 kg
6SL3203-0BE21-8BA0	100	297	85	80	281	4 x M4 / 2.5 Nm	4.0 kg
6SL3203-0BE23-8BA0	140	359	95	120	343	4 x M5 / 6 Nm	7.3 kg
6SL3203-0BE27-5BA0	100	400	140	75	385	4 x M6 / 10 Nm	7.6 kg
6SL3203-0BE31-1BA0	110	480	140	85	465	4 x M6 / 10 Nm	11.9 kg
6SL3203-0BE31-8BA0	150	517	230	120	495	4 x M6 / 10 Nm	21.7 kg

## Technical data

Article number	Power loss (W) at 50 Hz	Connection (mm <sup>2</sup> )			Degree of protection
		Line supply	PE	Power Module	
6SL3203-0BE17-7BA0	13	Screw terminals 2.5 mm <sup>2</sup>	M5 studs	Integrated, 450 mm	IP20
6SL3203-0BE21-8BA0	22	6 mm <sup>2</sup> screw terminals	M5 studs	Integrated, 500 mm	IP20
6SL3203-0BE23-8BA0	49	16 mm <sup>2</sup> screw terminals	M6 studs	Integrated, 540 mm	IP20
6SL3203-0BE27-5BA0		Screw terminals 16 ... 50 mm <sup>2</sup>	M6 studs	integrated, 1 m	IP20
6SL3203-0BE31-1BA0		Screw terminals 16 ... 50 mm <sup>2</sup>	M6 studs	integrated, 1 m	IP20
6SL3203-0BE31-8BA0		Screw terminals 35 ... 150 mm <sup>2</sup>	M10 studs	integrated, 1.1 m	IP20

## Assignment table

Power Module			Line filter		
Article number		Frame size	Article number	Category	
6SL3210-1NE11-3UG1	6SL3210-1NE11-7UG1	FSA	6SL3203-0BE17-7BA0	C1	
6SL3210-1NE12-2UG1	6SL3210-1NE13-1UG1				
6SL3210-1NE14-1UG1	6SL3210-1NE15-8UG1				
6SL321 . -1NE17-7UG1					
6SL3210-1NE21-0UG1	6SL3210-1NE21-3UG1	FSB	6SL3203-0BE21-8BA0	C1	
6SL321 . -1NE21-8UG1					
6SL3210-1NE22-6UG1	6SL3210-1NE23-2UG1	FSC	6SL3203-0BE23-8BA0	C1	
6SL321 . -1NE23-8UG1					
6SL3210-1NE24-5UL0	6SL3210-1NE26-0UL0	FSD	6SL3203-0BE27-5BA0	C1	
6SL3210- 1NE27-5UL0	6SL3210- 1NE28-8UL0	FSE	6SL3203-0BE31-1BA0	C1	
6SL3210-1NE31-1UL0	6SL3210-1NE31-5UL0	FSF	6SL3203-0BE31-8BA0	C1	

. : Stands for 1 or 2:

- 1: Built-in device
- 2: Push-through device

## 8.3.3 Sine-wave filter

The sine-wave filter at the inverter output limits the voltage rate-of-rise and the peak voltages at the motor winding. The maximum permissible length of motor feeder cables is increased to 300 m.

The following applies when using a sine-wave filter:

- Operation is only permissible with pulse frequencies from 4 kHz to 8 kHz.
- The inverter power is reduced by 5%.
- The maximum output frequency of the inverter is 150 Hz at 380 V to 480 V.
- Operation and commissioning may only be performed with the motor connected, as the sine-wave filter is not no-load proof.
- An output reactor is superfluous.

### Sine-wave filter - design 1

Mounting dimensions

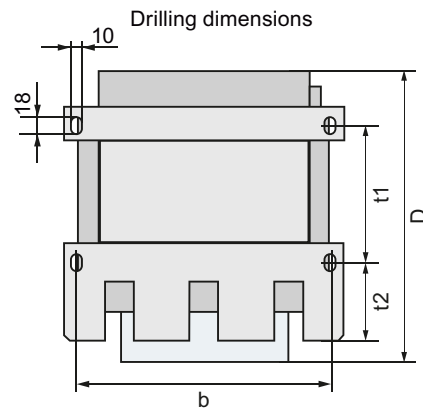
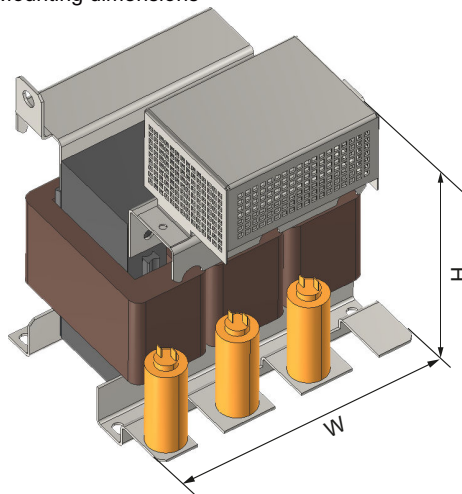


Figure 8-1 Dimensions and drilling patterns

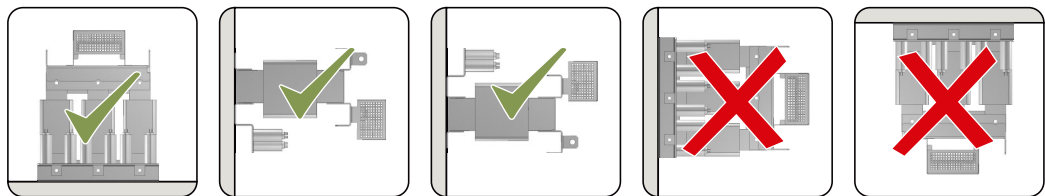


Figure 8-2 Mounting position

Table 8-1 Dimensions and weights

Sine-wave filter	Overall dimensions (mm)			Drilling dimensions (mm)			Fixing/torque (Nm)	Weight (kg)
	W	H	D	b	t1	t2		
6SL3202-0AE26-2SA0	250	315	262	230	127	90.5	4 x M6 / 7	34
6SL3202-0AE28-8SA0	275	368	275	250	132	100.5	4 x M8 / 13	45
6SL3202-0AE31-5SA0	350	440	305	320	156.5	113	4 x M8 / 13	63
6SL3202-0AE31-8SA0	350	468	305	320	156.5	113	4 x M8 / 13	80

8.3 Optional accessories

Table 8-2 Technical data

Article number	P <sub>loss</sub> <sup>1)</sup> (W)	Connection	Degree of protection
		Power Module / motor	
6SL3202-0AE26-2SA0	65	Screw terminals 25 ... 50 mm <sup>2</sup>	IP20
6SL3202-0AE28-8SA0	100	Screw terminals 25 ... 95 mm <sup>2</sup>	IP20
6SL3202-0AE31-5SA0	180	Screw terminals 50 ... 150 mm <sup>2</sup>	IP20
6SL3202-0AE31-8SA0	190	Screw terminals 50 ... 150 mm <sup>2</sup>	IP20

1) Power loss at 50 Hz

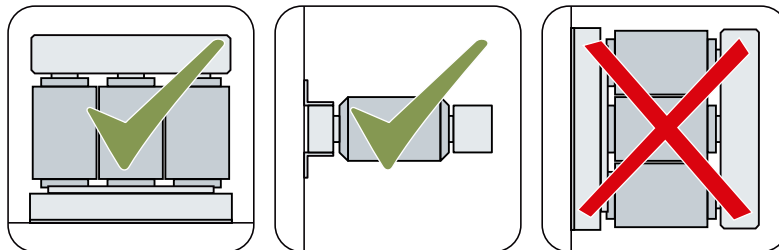
Table 8-3 Assignment table

Power Module			Sine-wave filters
Article number	Power (kW)	Frame size	Article number
6SL3210-1NE24-5 . L0	22	FSD	6SL3202-0AE26-2SA0
6SL3210-1NE26-0 . L0	30	FSD	6SL3202-0AE28-8SA0
6SL3210-1NE27-5 . L0	37	FSE	
6SL3210-1NE28-8 . L0	45	FSE	6SL3202-0AE31-5SA0
6SL3210-1NE31-1 . L0	55	FSF	
6SL3210-1NE31-5 . L0	75	FSF	6SL3202-0AE31-8SA0

### 8.3.4 Output reactors

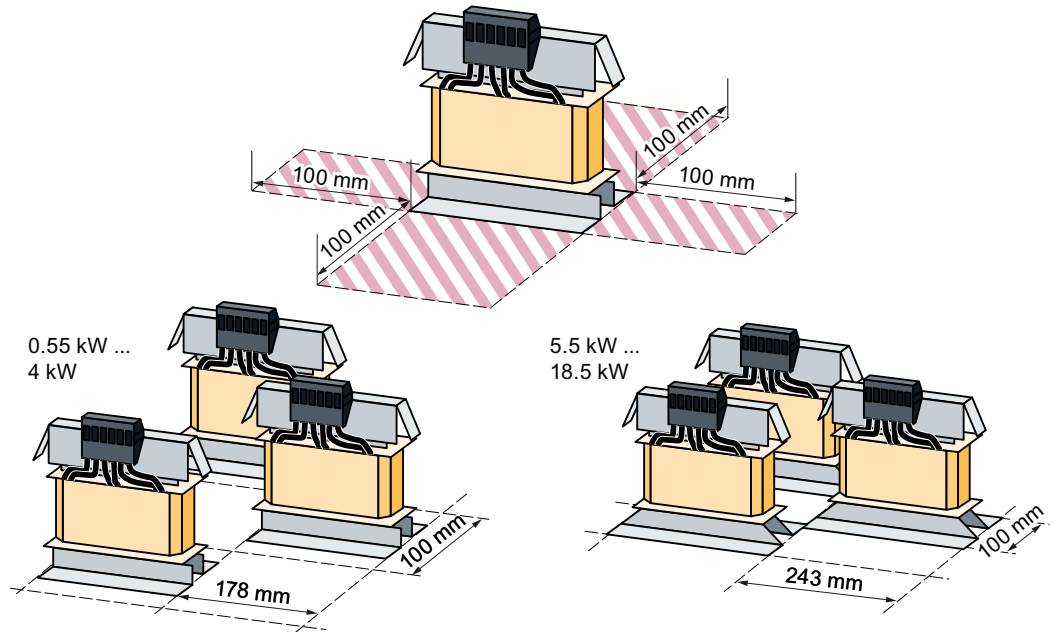
When using the output reactor it is not permissible that the output frequency exceeds 150 Hz. It is not permissible that the pulse frequency exceeds 4 kHz

#### Mounting position



### Clearances to other devices

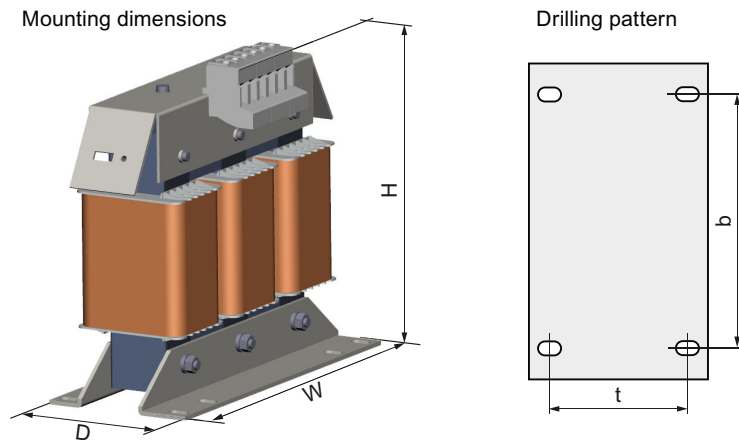
Keep shaded areas free of any devices and components.



Minimum clearances of the output reactor to other devices, space-saving mounting examples

#### 8.3.4.1 Output reactors for inverters FSA ... FSC

### Dimensions, drilling patterns and weights



## 8.3 Optional accessories

Table 8-4 Dimensions and weights

Article number	Overall dimensions (mm)			Drilling dimensions (mm)		Fixing/torque (Nm)	Weight (kg)
	W	H	D	b	t		
6SL3202-0AE16-1CA0	207	166	73	166	57	4 x M4 / 3 Nm	3.4
6SL3202-0AE18-8CA0	207	166	73	166	57	4 x M4 / 3 Nm	3.9
6SL3202-0AE21-8CA0	247	211	100	225	81	4 x M5 / 6 Nm	10.1
6SL3202-0AE23-8CA0	257	228	115	225	85	4 x M5 / 6 Nm	11.2

## Assignment table

Power Module			Output reactor
Article number	Power	Frame size	Article number
6SL3210-1NE11-3 . G1	0.37 kW	FSA	6SL3202-0AE16-1CA0
6SL3210-1NE11-7 . G1	0.55 kW		
6SL3210-1NE12-2 . G1	0.75 kW		
6SL3210-1NE13-1 . G1	1.1 kW		
6SL3210-1NE14-1 . G1	1.5 kW		
6SL3210-1NE15-8 . G1	2.2 kW		
6SL321 . -1NE17-7 . G1	3 kW	FSB	6SL3202-0AE18-8CA0
6SL3210-1NE21-0 . G1	4 kW		
6SL3210-1NE21-3 . G1	5.5 kW		
6SL321 . -1NE21-8 . G1	7.5 kW	FSC	6SL3202-0AE21-8CA0
6SL3210-1NE22-6 . G1	11 kW		
6SL3210-1NE23-2 . G1	15 kW		
6SL321 . 0-1NE23-8 . G1	18.5 kW		

## 8.3.4.2 Output reactors for inverters FSD ... FSF

## Dimensions, drilling patterns and weights

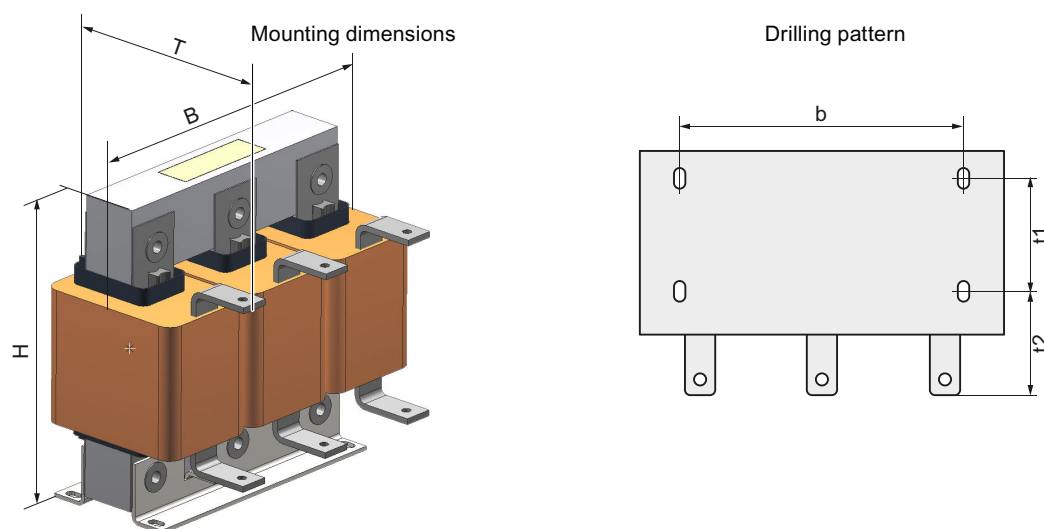


Figure 8-3 Dimensions and drilling patterns

Table 8-5 Dimensions and weights

Article number	Overall dimensions (mm)			Drilling dimensions (mm)			Fixing/torque (Nm)	Weight (kg)
	W	H	D	b	t1	t2		
6SE6400-3TC03-8DD0	225	210	179	176	93	75.5	4 x M6 / 7	19
6SE6400-3TC07-5ED0	270	248	209	200	102	91.5	4 x M8 / 13	26.5
6SE6400-3TC14-5FD0	350	321	288	264	140	134	4 x M8 / 13	57
6SL3000-2BE32-1AA0	300	285	257	224	165	78	4 x M8 / 13	60
6SL3000-2BE32-6AA0	300	315	277	224	185	78	4 x M8 / 13	66

## Assignment table

Power Module			Output reactor
Article number	Power	Frame size	Article number
6SL3210-1NE24-5 . L0	22 kW	FSD	6SL3202-0AE23-8CA0
6SL3210-1NE26-0 . L0	30 kW	FSD	6SE6400-3TC03-8DD0
6SL3210-1NE27-5 . L0	37 kW	FSD	6SE6400-3TC05-4DD0
6SL3210-1NE28-8 . L0	45 kW	FSE	6SE6400-3TC08-0ED0
6SL3210-1NE31-1 . L0	55 kW	FSE	6SE6400-3TC07-5ED0
6SL3210-1NE31-5 . L0	75 kW	FSF	6SE6400-3TC14-5FD0

### 8.3.5 Shield connection kit

The shield connection kit is used to connect the shield of the control and motor cables in an EMC-compliant fashion.

- The shield plate is included in the scope of delivery of Power Modules, frame sizes FSA ... FSC.
- For frame sizes FSD ... FSF, the shield connection kit can be ordered as option under the following article numbers.
  - FSD: 6SL3262-1AD00-0DA0
  - FSE: 6SL3262-1AD00-0DA0
  - FSF: 6SL3262-1AF00-0DA0



The mounting instructions for the shield connection kits, frame sizes FSD ... FSF are available in the Internet at (<https://support.industry.siemens.com/cs/ww/de/view/23621093/en>):



# Appendix

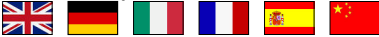

## A.1 Manuals and technical support

### A.1.1 Manuals for your inverter



Manuals with additional information that can be downloaded: EMC-compliant electrical cabinet design

- PM230, IP20 Hardware Installation Manual (<https://support.industry.siemens.com/cs/ww/de/view/109476290/en>)  
 Installing Power Modules, reactors and filters. Technical specifications, maintenance (this manual)
- PM230, IP55 Hardware Installation Manual (<https://support.industry.siemens.com/cs/ww/de/view/109217849/en>)  
 Installing Power Modules, reactors and filters. Technical data, maintenance
- CU230P-2 Compact Operating Instructions (<https://support.industry.siemens.com/cs/ww/en/view/109477360>)  
 Commissioning the inverter.
- CU240B/E-2 Compact Operating Instructions (<https://support.industry.siemens.com/cs/ww/en/view/109477361>)  
 Commissioning the inverter.
- CU230P-2 operating instructions (<https://support.industry.siemens.com/cs/ww/en/view/109478827>)  
 Installing, commissioning and maintaining the inverter. Advanced commissioning
- CU240B/E-2 operating instructions (<https://support.industry.siemens.com/cs/ww/en/view/109478828>)  
 Installing, commissioning and maintaining the inverter. Advanced commissioning
- CU230P-2 List Manual (<https://support.industry.siemens.com/cs/ww/en/view/109477248>)  
 Parameter list, alarms and faults. Graphic function diagrams
- CU240B/E-2 List Manual (<https://support.industry.siemens.com/cs/ww/en/view/109477251>)  
 Parameter list, alarms and faults. Graphic function diagrams

- EMC installation guideline (<http://support.automation.siemens.com/WW/view/en/60612658>)  
EMC-compliant control cabinet design, potential equalization and cable routing  

- Accessories manual (<https://support.industry.siemens.com/cs/ww/en/ps/13225/man>)  
Installation descriptions for inverter components, e.g. line reactors and line filters. The printed installation descriptions are supplied together with the components.  


## A.1.2 Configuring support

### Catalog

Ordering data and technical information for SINAMICS G inverters.



Catalog D31 for download or online catalog (Industry Mall):



All about SINAMICS G120 ([www.siemens.com/sinamics-g120](http://www.siemens.com/sinamics-g120))

### SIZER

The configuration tool for SINAMICS, MICROMASTER and DYNAVERT T drives, motor starters, as well as SINUMERIK, SIMOTION controllers and SIMATIC technology



SIZER on DVD:

Article number: 6SL3070-0AA00-0AG0



Download SIZER (<http://support.automation.siemens.com/WW/view/en/10804987/130000>)

### EMC (electromagnetic compatibility) technical overview

Standards and guidelines, EMC-compliant control cabinet design



EMC overview (<https://support.industry.siemens.com/cs/ww/en/view/103704610>)

### EMC Guidelines configuration manual

EMC-compliant control cabinet design, potential equalization and cable routing



EMC installation guideline (<http://support.automation.siemens.com/WW/view/en/60612658>)

## Safety Integrated for novices technical overview

Application examples for SINAMICS G drives with Safety Integrated



Safety Integrated for novices (<https://support.industry.siemens.com/cs/ww/en/view/80561520>)

### A.1.3 Product Support



You can find additional information on the product and more in the Internet under (<http://www.siemens.com/automation/service&support>)

This address provides the following:

- Actual product information (product memorandums), FAQs (frequently asked questions), downloads.
- The Newsletter contains the latest information on the products you use.
- The Knowledge Manager (Intelligent Search) helps you find the documents you need.
- Users and specialists from around the world share their experience and knowledge in the Forum.
- You can find your local representative for Automation & Drives via our contact database under "Contact & Partner".
- Information about local service, repair, spare parts and much more can be found under "Services".

## A.2 Directives and standards

### Relevant directives and standards

The following directives and standards are relevant for the inverters:



#### European Low Voltage Directive

The inverters fulfil the requirements stipulated in the Low-Voltage Directive 2014/35/EU, if they are covered by the application area of this directive.

#### European Machinery Directive

The inverters fulfil the requirements stipulated in the Machinery Directive 2006/42//EU, if they are covered by the application area of this directive.

However, the use of the inverters in a typical machine application has been fully assessed for compliance with the main regulations in this directive concerning health and safety.

#### European EMC Directive

By completely complying with IEC/EN 61800-3, it has been proven that the inverter is in compliance with directive 2004/108/EC or 2014/30/EU.

#### Underwriters Laboratories (North American market)

Inverters provided with one of the test symbols displayed fulfil the requirements stipulated for the North American market as a component of drive applications, and are appropriately listed.



#### EMC requirements for South Korea

The inverters with the KC marking on the rating plate satisfy the EMC requirements for South Korea.

#### Eurasian conformity

The inverters comply with the requirements of the Russia/Belarus/Kazakhstan customs union (EAC).



#### Australia and New Zealand (RCM formerly C-Tick)

The inverters showing the test symbols fulfil the EMC requirements for Australia and New Zealand.

#### Specification for semiconductor process equipment voltage drop immunity

The inverters comply with the requirements of standard SEMI F47-0706.

### Quality systems

Siemens AG employs a quality management system that meets the requirements of ISO 9001 and ISO 14001.

### Certificates for download



- EC Declaration of Conformity: (<https://support.industry.siemens.com/cs/ww/en/view/58275445>)
- Certificates for the relevant directives, prototype test certificates, manufacturers declarations and test certificates for functions relating to functional safety ("Safety Integrated"): (<http://support.automation.siemens.com/WW/view/en/22339653/134200>)
- Certificates of products that were certified by UL: (<http://database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/index.html>)
- Certificates of products that were certified by TÜV SÜD: ([https://www.tuev-sued.de/industry\\_and\\_consumer\\_products/certificates](https://www.tuev-sued.de/industry_and_consumer_products/certificates))

### Standards that are not relevant



#### China Compulsory Certification

The inverters do not fall in the area of validity of the China Compulsory Certification (CCC).

## A.3 Abbreviations

Abbreviation	State
AC	Alternating current
CE	Communauté Européenne
CU	Control Unit
DC	Direct current
DI	Digital input
DIP	DIP switch
DO	Digital output
ECD	Equivalent circuit diagram
EEC	European Economic Community
ELCB	Earth leakage circuit breaker
EMC	Electromagnetic compatibility (EMC)
EMI	Electromagnetic interference
FS...	Frame size ...
GSG	Getting Started Guide
HO	High overload
I/O	Input/Output
IGBT	Insulated gate bipolar transistor
LED	Light emitting diode
LO	Low overload
NC	NC contact
NEMA	National Electrical Manufacturers Association
NO	NO contact
OPI	Operating instructions
PELV	Protective extra low voltage
PM	Power Module
PPE	Personnel protective equipment
PT	Push-through technology
RCCB	Residual-current operated circuit breaker
RCD	Residual current device
RFI	Radio frequency interference
SELV	Safety extra-low voltage
VT	Variable torque

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## Further information

SINAMICS inverters:  
[www.siemens.com/sinamics](http://www.siemens.com/sinamics)

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Scan the QR code for  
further information  
on SINAMICS G120P.



[www.siemens.com/drives](http://www.siemens.com/drives)