

SIEMENS



Hardware Installation Manual

SINAMICS

SINAMICS G120P

PM330 Power Modules

Edition

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SINAMICS G120P Power Module PM330

Hardware Installation Manual

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Legal information

Warning notice system

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

 DANGER

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

 WARNING
--

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

 CAUTION
--

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

NOTICE

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

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

Qualified Personnel

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

Proper use of Siemens products

Note the following:

 WARNING
--

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

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Disclaimer of Liability

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

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Basic safety instructions

1.1 General safety instructions



DANGER

Danger to life due to live parts and other energy sources

Touching live parts can result in death or severe injury.

- Only work on electrical equipment if you are appropriately qualified.
- Always observe the country-specific safety rules for all work.

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 zero-voltage state, from phase conductor to phase conductor and phase conductor to protective conductor.
 - Check that every auxiliary circuit is 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. Take measures to prevent reconnection of the energy sources.
6. Ensure that the correct machine is completely interlocked.

After you have completed the work, restore the operational readiness by following the above steps in the reverse order.



WARNING

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

In the event of a fault, touching live parts 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.
<ul style="list-style-type: none">• 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.
<ul style="list-style-type: none">• Connect cable shields and unused conductors of power cables (e.g. brake conductors) at least on one side to 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.
<ul style="list-style-type: none">• 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.
<ul style="list-style-type: none">• Only open plug connections when the equipment is in a voltage-free 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.
<ul style="list-style-type: none">• Tighten all power connections with the specified tightening torques, e.g. line 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.
<ul style="list-style-type: none">• Install devices without a protective enclosure 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 radios 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.
<ul style="list-style-type: none">• When close to components, switch off all wireless devices and mobile phones.

 WARNING
Danger to life due to the motor catching fire in the event of insulation overload
There is a greater load 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.
<ul style="list-style-type: none">• 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.
<ul style="list-style-type: none">• Ensure compliance with the specified minimum clearance as ventilation clearance for the respective component.

 **WARNING**

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

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

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

NOTICE

Device damage caused by incorrect voltage/insulation tests

Incorrect voltage/insulation tests can damage the device.

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

 **WARNING**

Danger to life due to inactive safety functions

Inactive or non-adapted safety functions can trigger machine malfunctions that can cause serious injury or death.

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

1.2 Safety instructions for electromagnetic fields (EMF)



WARNING

Danger to life from electromagnetic fields

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

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

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

1.3 Handling electrostatic sensitive devices (ESD)

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



NOTICE

Damage caused by electric fields or electrostatic discharge

Electric fields or electrostatic discharge can result in malfunctions as a result of damaged individual parts, 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 if you are first grounded by applying one of the following measures:
 - Wearing an ESD wrist strap
 - Wearing ESD shoes or ESD grounding straps in ESD areas with conductive flooring
- Only place electronic components, modules or devices on conductive surfaces (table with ESD surface, conductive ESD foam, ESD packaging, ESD transport container).

1.4 Industrial security

Note

Industrial security

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens products and solutions only represent one component of such a concept.

The customer is responsible for preventing unauthorized access to its plants, systems, machines and networks. Systems, machines and components should only be connected to the enterprise network or the internet if and to the extent necessary and with appropriate security measures (e.g. use of firewalls and network segmentation) in place.

Additionally, Siemens' guidance on appropriate security measures should be taken into account. For more information about industrial security, please visit:

Industrial security (<http://www.siemens.com/industrialsecurity>).

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends to apply product updates as soon as available and to always use the latest product versions. Use of product versions that are no longer supported, and failure to apply latest updates may increase customer's exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed at:

Industrial security (<http://www.siemens.com/industrialsecurity>).

WARNING

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

Software manipulations (e.g. viruses, trojans, malware or worms) can cause unsafe operating states in your system that may lead to death, serious injury, and property damage.

- Keep the software up to date.
- Incorporate the automation and drive components into a state-of-the-art, integrated industrial security concept for the installation or machine.
- Make sure that you include all installed products into the integrated industrial security concept.
- Protect files stored on exchangeable storage media from malicious software by with suitable protection measures, e.g. virus scanners.

Note

Industrial security Configuration Manual

You can find a Configuration Manual on the topic of industrial security at this address
(<https://support.industry.siemens.com/cs/ww/en/view/108862708>).

1.5 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. Uncontrolled motion of the driven machine or system components during commissioning, operation, maintenance and repair caused by, for example:
 - Hardware and/or software errors in the sensors, control system, actuators and cables and connections
 - Response times of the controller and drive
 - Operation and/or environmental conditions outside the specification
 - Condensation/conductive pollution
 - Parameterization, programming, cabling, and installation errors
 - Use of wireless devices/mobile phones in the immediate vicinity of electronic components
 - External influence/damage
 - X-ray, ionizing radiation and cosmic radiation
2. Unusually high temperatures - including open flames - as well as the emission of light, noise, particles, gases, etc. can occur inside and outside the components under fault conditions caused by, for example:
 - Component malfunctions
 - Software errors
 - Operation and/or environmental conditions outside the specification
 - External influence/damage
3. Hazardous shock voltages caused by, for example:
 - Component malfunctions
 - Influence of electrostatic charging
 - Induction of voltages in moving motors
 - Operation and/or environmental conditions outside the specification
 - Condensation/conductive pollution
 - External influence/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
6. Influence of network-connected communication systems, e.g. ripple-control transmitters or data communication via the network

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

Introduction

Power Module - PM330

The PM330 Power Module is a part of the modular family of SINAMICS G120 inverters.

PM330 Power Modules have been specifically optimized for driving pumps, fans, blowers and compressors with square-law load characteristic for use in HVAC applications. The Power Module is available with the "internal air cooling" cooling method.

The Power Modules are available for the following rated voltages and rated powers:

- 3 AC 380 V ... 480 V: 160 kW ... 560 kW
- 3 AC 500 V ... 690 V: 315 kW ... 630 kW

The Power Modules can be connected to the following line supply systems:

- TN system
- TT system
- IT system

690-V line supplies with grounded line conductor are not permitted.

As standard, a line reactor ($u_k \geq 2\%$) must be provided at the line input (see the following diagram).

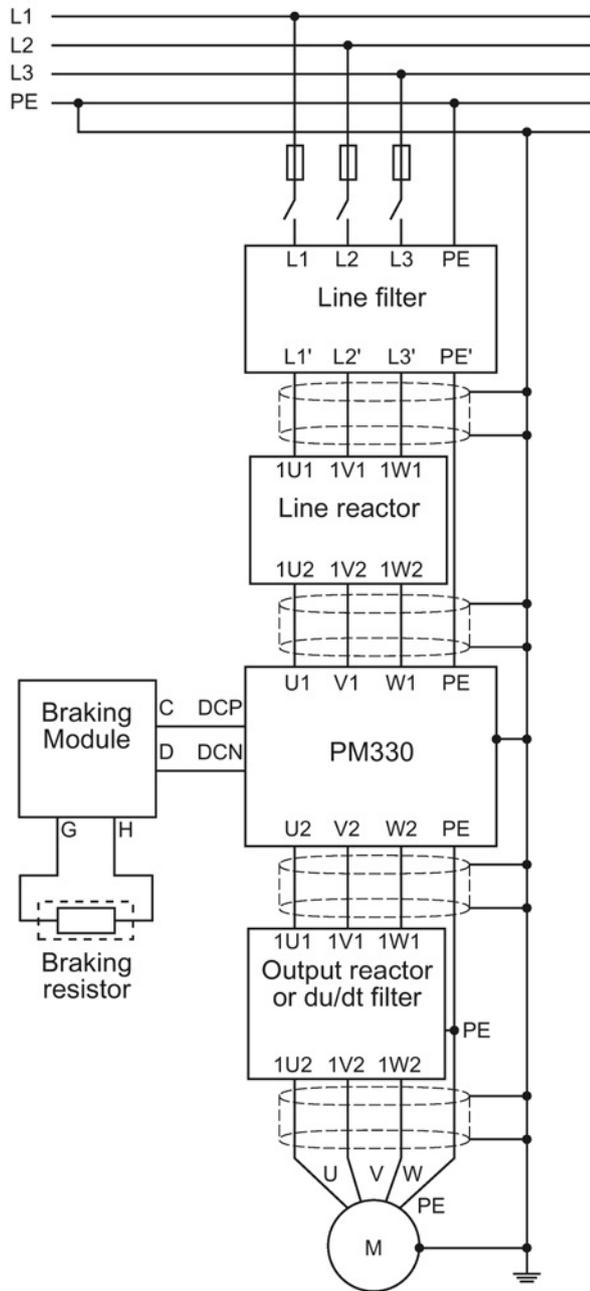


Figure 2-1 PM330 block diagram

Note

Principle of the precharging circuit

SINAMICS PM330 Power Modules include a half-controlled thyristor bridge as rectifier circuit. As a result of the precharging principle with phase control, precharging is only started when all of the enable signals are available and by setting the ON/OFF command (p0840 = 1).

The DC link is then fully charged after approximately 4 s.

The Power Modules can be used with the following Control Units, including all communication versions with firmware version from 4.6 HF7 and higher.

- CU230P-2 PN 6SL3243-0BB30-1FAx
- CU230P-2 DP 6SL3243-0BB30-1PAx
- CU230P-2 HVAC 6SL3243-0BB30-1HAx

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

Installing/Mounting

3.1 Installation conditions

Unpacking and disposal

Note

The converter packaging can be reused.

The individual components of the packaging can be recycled or disposed of in compliance with local regulations.

General rules for protecting Power Modules against environmental effects

To ensure that the Power Module is installed in the correct environmental conditions, please make sure that you adhere to the following guidelines:

- The Power Modules are designed:
 - to be installed in an electrical cabinet
 - with protection against the ingress of solid foreign objects ≥ 12.5 mm
 - without protection against the ingress of water
- Furthermore, observe the following conditions:
 - Ensure that the device is free of dust and dirt.
(when using a vacuum cleaner, this must comply with ESD equipment rules)
 - Keep the device away from water, solvents and chemicals.
Take care to install it away from potential water hazards, for example, do not install it beneath pipes that are subject to condensation. Avoid installing it where excessive humidity and condensation may occur.
 - Keep it within the maximum and minimum operating temperatures.
 - Ensure that the correct level of ventilation and air flow is provided.
 - Fast temperature changes of the air drawn in (e.g. by using cooling units) are not permitted due to the danger of condensation. Condensation is not permissible when switching on.
 - Ensure that all Power Modules and the cabinet are grounded according to the guidelines given in this chapter (see Chapter Connecting up, switching on (Page 31)).

It is only permissible that the Power Module is installed in a vertical position.

 WARNING
Danger to life due to voltage
To ensure safe operation of the equipment, it must be installed and commissioned by qualified personnel in full compliance with the warnings laid down in this manual.
It is especially important to comply with general and local installation and safety regulations for working on plants and systems with hazardous voltages (e.g. EN 61800-5-1) - as well as the relevant regulations regarding the correct use of tools and personal protective equipment (PPE).

Protection against the spread of fire

The device may only be operated 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 pollution

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 is permitted.

3.2 Power losses and air cooling requirements

General requirement

Installation in the cabinet and the cooling must guarantee that the air temperature - under all operating conditions and all possible cabinet equipment configurations - inside the Power Module at the top in the area of the rectifier modules is a maximum of 65 °C - and the air intake below the Control Unit (behind the left hand housing flap) is a maximum of 60 °C.

Cooling requirements

Depending on the power losses of the various components a specific cooling air flow is required to protect the components from overheating. The following equation shows you how to calculate the required air flow.

1. Add the power losses of the individual components.
2. Calculate the air flow required, using the formula.

$$\text{Air flow [l/s]} = \frac{\text{Power loss [W]}}{\Delta T \text{ [K]}} * 0.86$$

ΔT : Permissible temperature rise in the control cabinet

3. Ensure that the air intake and air discharge openings are adequately large so that the pressure drop in the cabinet at the required cooling air flow rate (for the Power Modules, see Specific technical data (Page 76)) remains ≤ 100 Pa, even when filter mats are used.
4. Ensure that no equipment is mounted that has a negative impact on the cooling air flow.
5. Ensure that the air openings in the Power Modules are free so that the airflow is not obstructed (for the necessary clearances, see Chassis units (Page 27)).
6. Avoid possible short-circuits in the airflow (= air circulates within the cabinet) by using the appropriate partitions, e.g. by using an air discharge duct up to the roof panel (see position ① in the following diagram).
When converter cabinets are lined up next to one another, then these cabinets must be separated from the adjacent cabinets using intermediate walls or panels.

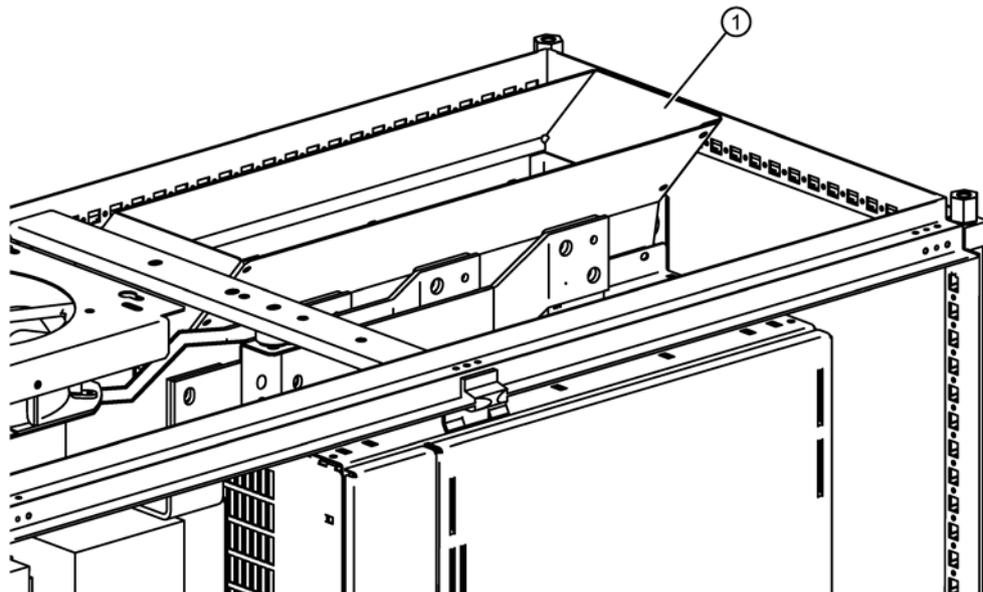


Figure 3-1 Example of an air discharge duct

7. Ensure that the electrical cabinet is adequately ventilated and is equipped with suitable air filters.

It is crucial that you comply with the replacement intervals of the air filter (see also Chapter Service and maintenance (Page 63)).

The power losses and the required cooling airflow of the Power Modules are specified in Chapter Specific technical data (Page 76).

The values are valid for:

- Rated output current
- 50 Hz output frequency
- 2 kHz pulse frequency

3.3 Mounting the Power Modules

 WARNING
Danger to life if the fundamental safety instructions and remaining risks are not carefully observed
The non-observance of the fundamental safety instructions and residual risks stated in Chapter Basic safety instructions (Page 9) can result in accidents with severe injuries or death.
<ul style="list-style-type: none">• Adhere to the fundamental safety instructions.• When assessing the risk, take into account residual risks.

The Power Modules are designed to be mounted in accordance with the dimension drawings, in a cabinet using screws, nuts and washers.

Note

EMC

- To comply with EMC specifications, it is recommended to mount the converter on an electrically conductive mounting panel in the cabinet. This mounting panel should be connected to the cabinet PE.
-

Note

Fixing elements used

The following fixing elements are used:

- M8 screw
- Washer according to DIN EN ISO 7093-1 and locking element

Tightening torques:

- electrical connections 50 Nm \pm 15 % (M12 bolts)
 - mechanical screw connections: 25 Nm \pm 15 % (M8 bolts)
-

Note

Adhesive label with danger and warning notes in English and French

The adhesive label with danger and warning notes in English and French subsequently shown is included with the converter.

- Attach the adhesive label in the appropriate language to the inside of the converter cabinet, where it is clearly visible at all times.
-

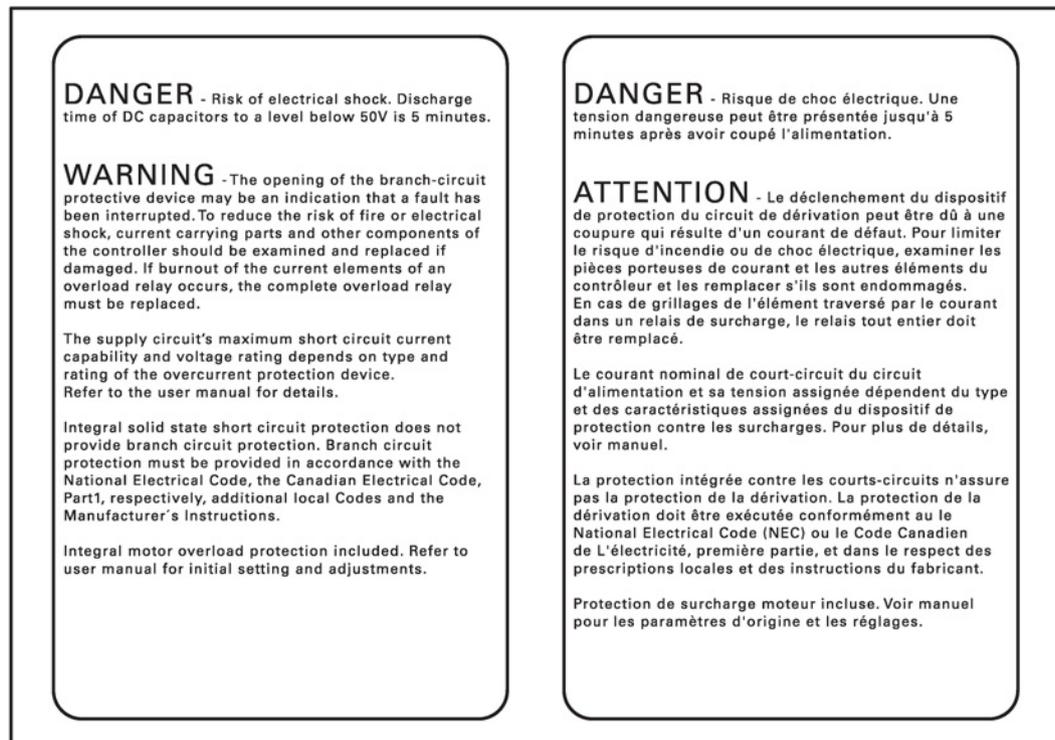


Figure 3-2 Adhesive label with danger and warning notes

Lifting Power Modules

The Power Modules can be lifted using the lifting eyebolts provided. Use a lifting harness where the ropes or chains are maintained in a vertical position. The device must not be lifted at an angle because this can damage the housing. Rope spreaders may have to be used.

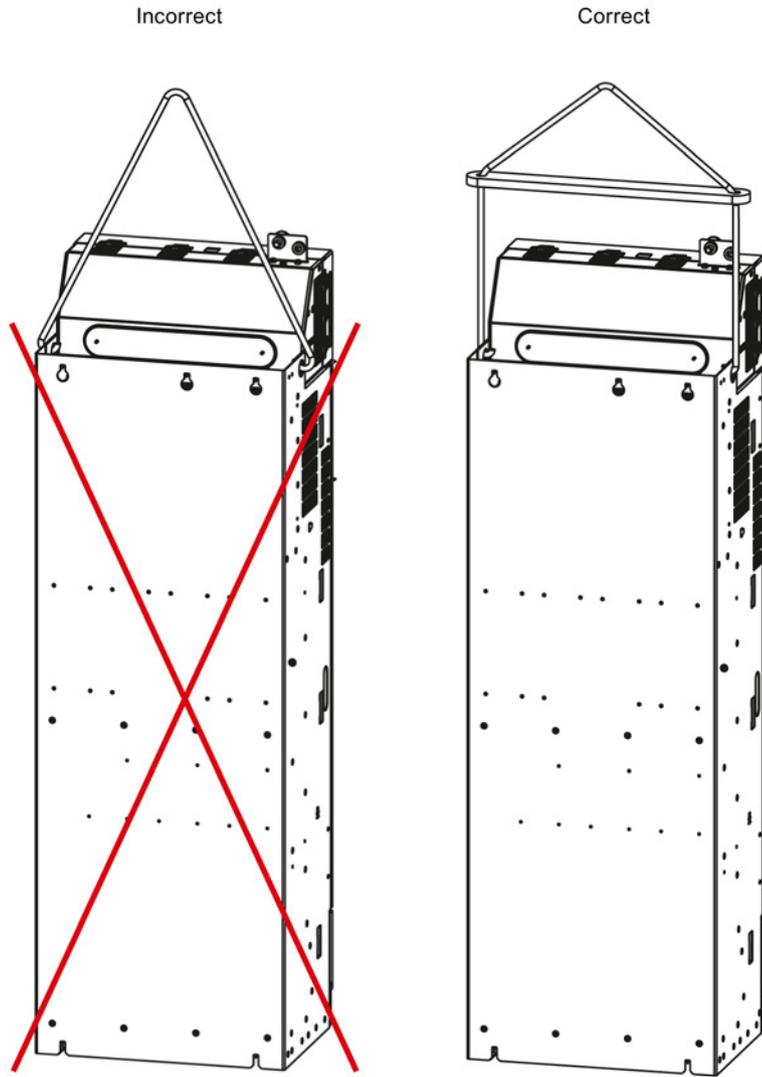


Figure 3-3 Lifting Power Modules

3.3.1 Chassis units

Drilling patterns, dimensions and clearances

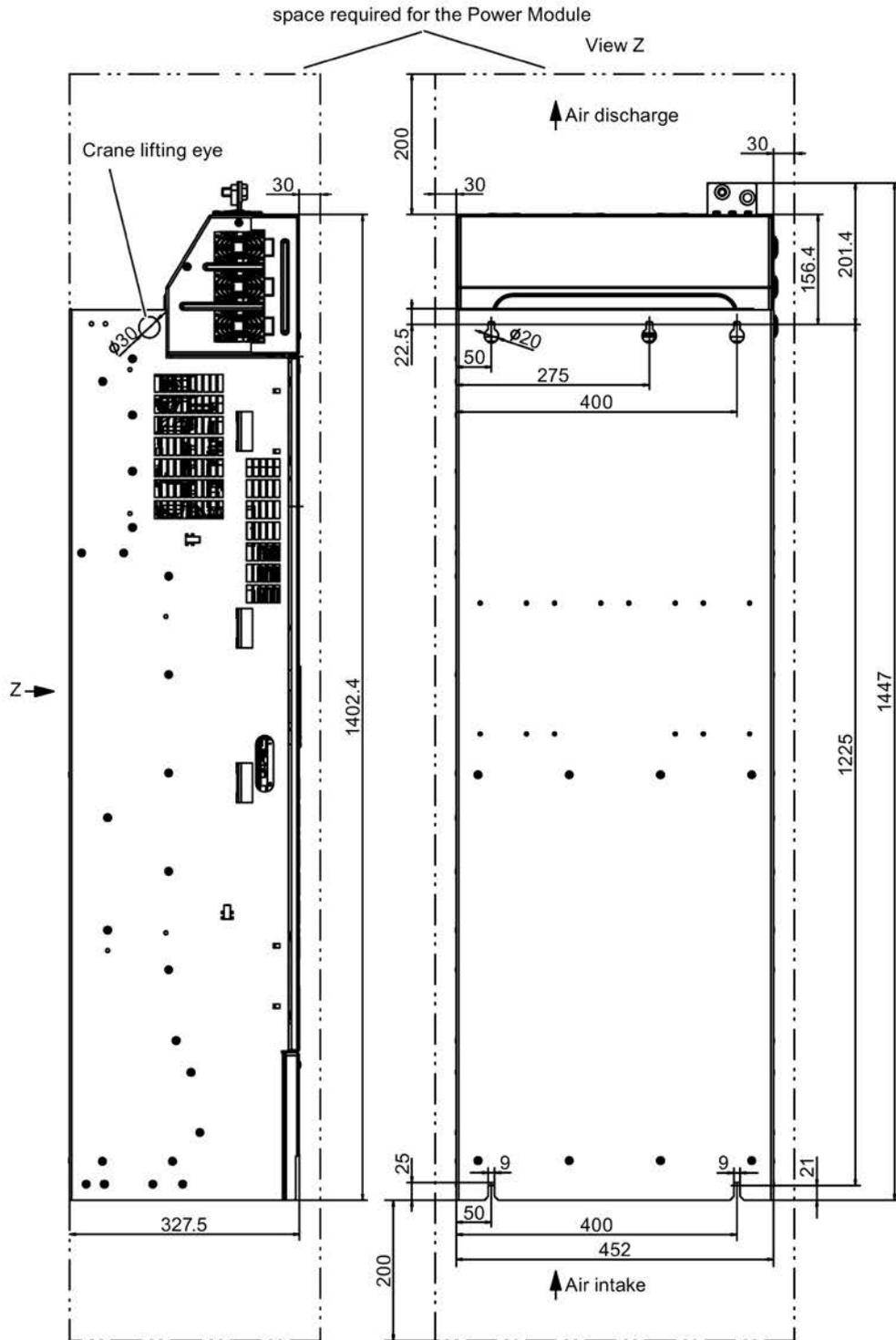


Figure 3-4 Dimension drawing of PM330 frame size GX, view from the side, view from the rear

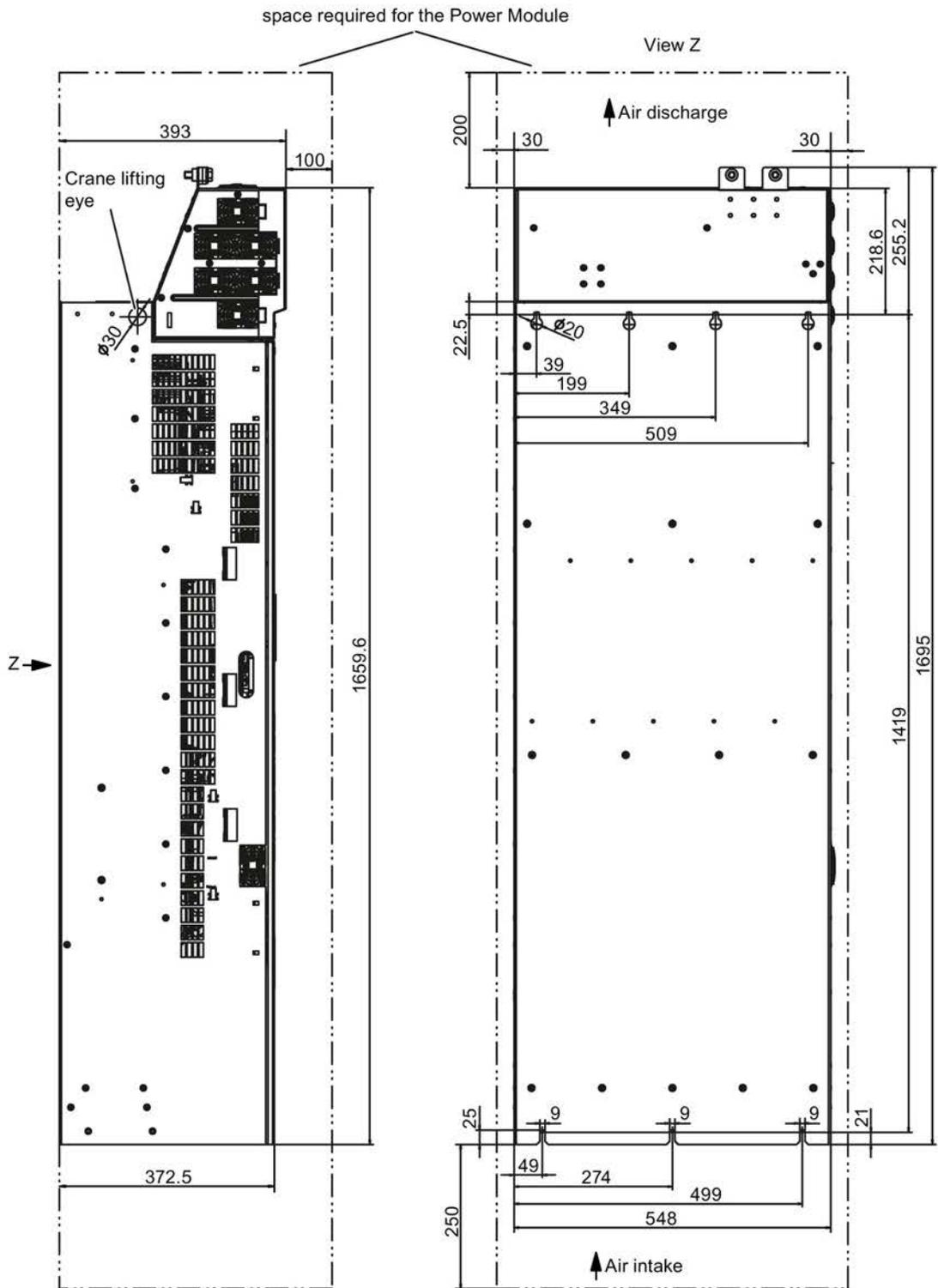


Figure 3-5 Dimension drawing of PM330 frame size HX, view from the side, view from the rear

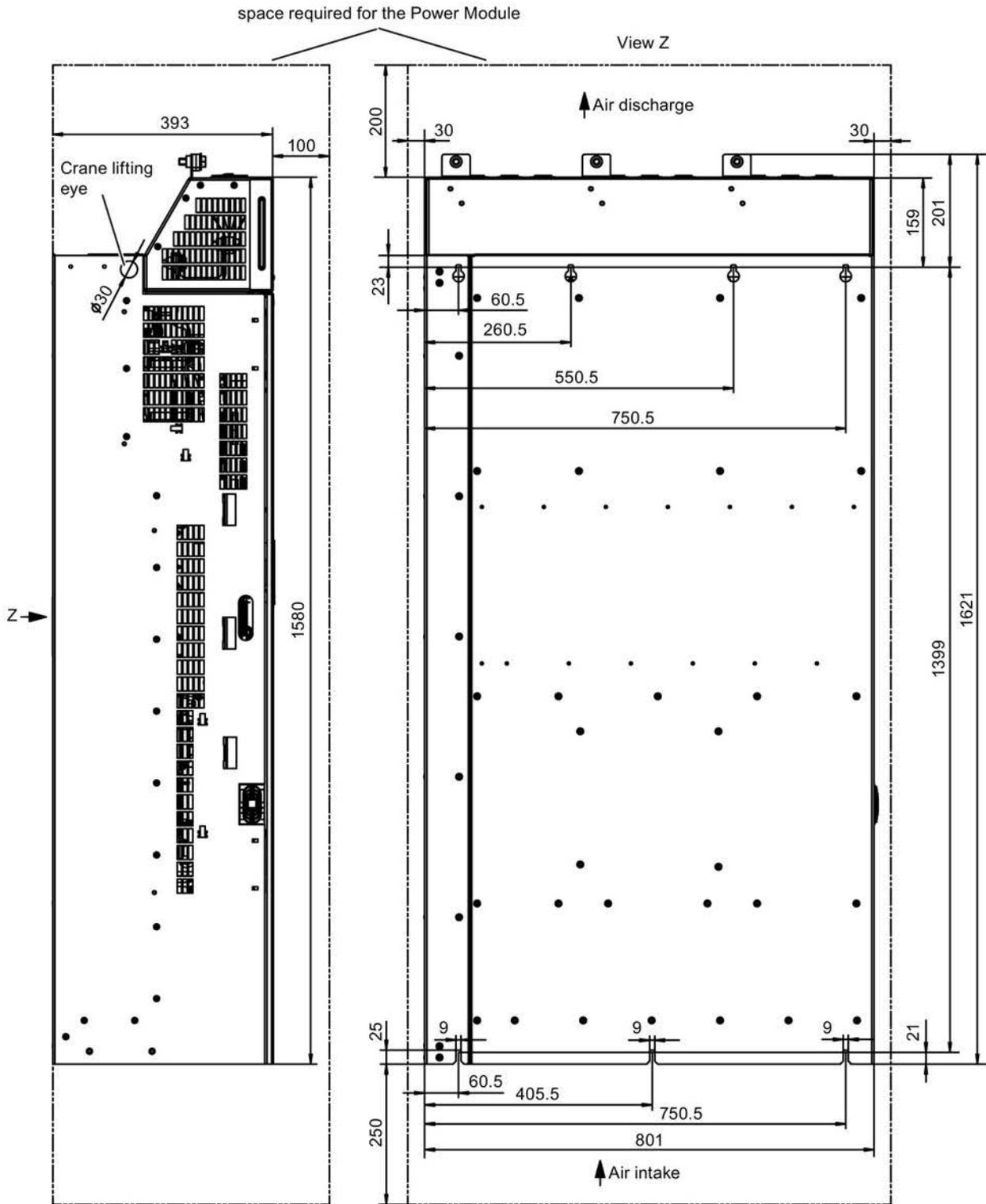


Figure 3-6 Dimension drawing of PM330 frame size JX, view from the side, view from the rear

3.4 Control Unit installation

After opening the left-hand housing flap, the Control Unit is plugged onto the Power Module. To remove the Control Unit, press the blue release knob at the top of the Control Unit.

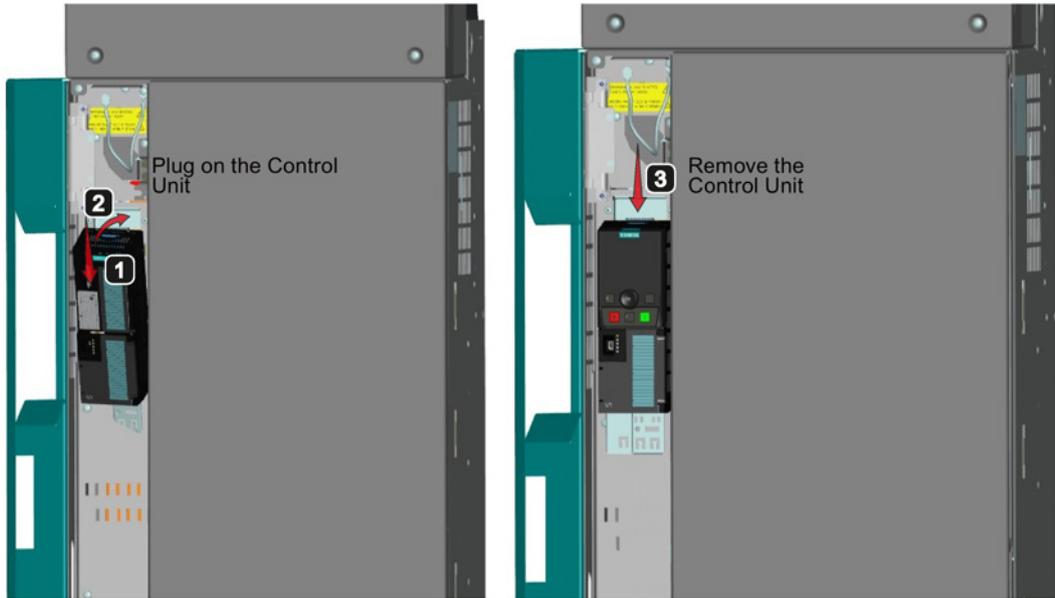


Figure 3-7 Mounting and removing the Control Unit

Note

Failure of the Control Unit as a result of overheating when the housing flap is open.

Adequate cooling of the Control Unit is not guaranteed when the housing flap is open. As a consequence, when the converter is operational, the Control Unit can overheat and thus fail.

- Close the housing flap when the converter is operational.

Note

Failure of the Control Unit as a result of overheating due to the fact that the cooling openings are covered over.

Adequate cooling of the Control Unit is not guaranteed when the cooling openings on the right-hand side of the Control Unit are covered over. As a consequence, when the converter is operational, the Control Unit can overheat and thus fail.

- Do not cover over the cooling openings on the right-hand side of the Control Unit.
-

Connecting up, switching on

Preconditions

Line and motor connections can be established once the converter has been properly installed. It is crucial that the following notes are observed.



! 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 five minutes after the power supply has been switched off.

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

- Only open the device after five minutes have elapsed.
- Measure the voltage before starting work on the DCP and DCN DC link terminals.

! WARNING

Danger of an accident due to missing warning labels in the national language.

Missing warning labels in the national language can result in death or serious injury.

- Attach the component warning labels in the national language.

NOTICE

Converter damaged due to overvoltage

Line-side overvoltages can damage the converter.

- Install the surge voltage protection device directly at the infeed point (before the main switch).

Note

Ensure that the appropriate circuit breakers or fuses with the specified current rating are connected between the power supply and the drive. The technical data contain information about the circuit breaker and fuses (see Specifications).

4.1 Cable lugs

Cable lugs

The cable connections on the devices are designed for cable lugs according to DIN 46234 or DIN 46235.

For connection of alternative cable lugs, the maximum dimensions are listed in the table below.

These cable lugs are not to exceed these dimensions, as mechanical fastening and adherence to the voltage distances is not guaranteed otherwise.

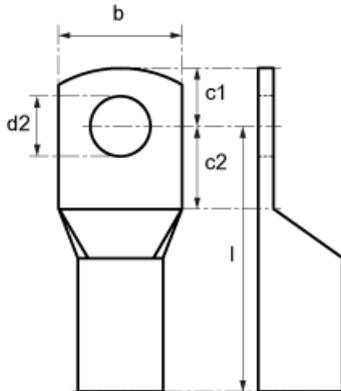


Figure 4-1 Dimensions of the cable lugs

Table 4- 1 Dimensions of the cable lugs

Screw / bolts	Connection cross-section [mm ²]	d2 [mm]	b [mm]	l [mm]	c1 [mm]	c2 [mm]
M12	240	13	42	92	24	13

The cable lugs can be attached as shown in the following diagram if, at one connection per phase, two cable lugs can be connected.



Figure 4-2 2 cable lugs per connection

4.2 Line, motor and DC link connection

Arrangement of the converter terminals, see Access to power and motor terminals (Page 36).

For all connections, carefully observe EMC regulations, see EMC compliant connection (Page 55).

4.2.1 Protective conductor



WARNING

Danger to life caused by high leakage currents for an interrupted protective conductor

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.

- Dimension the protective conductor as stipulated in the appropriate regulations.
- Connect the protective conductor to the lower PE connections.

Dimensioning the protective conductor

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

The minimum cross-section of all protective conductors routed in the control cabinet 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 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 of the line feeder cable:

- For permanent connections, 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 $\geq 2.5 \text{ mm}^2 \text{ Cu}$.

4.2.2 Line connection

Open the terminal covers of the converter.

Connect the protective conductor of the power supply cable to terminal PE of the inverter.

Connect the power supply cable to terminals U1, V1 and W1.

When using copper busbars, the same cross-sections should be used as the connecting busbars of the device itself:

- Frame size GX: 52 mm x 4 mm
- Frame size HX: 64 mm x 8 mm
- Frame size JX: 80 mm x 8 mm

4.2.3 Length of motor cables

With the following cable lengths, the inverters operate according to the datasheet specifications:

Table 4- 2 Permissible cable length depending on the EMC category

Cable used	Maximum cable lengths	EMC category (according to EN 61800-3)
Shielded cable, devices with external line filter	150 m	C2 *)
Shielded cable, devices without external line filter	150 m	C3 *) **)

*) EMC-compliant connection required, also see EMC compliant connection (Page 55)

***) For C3 applications with motor cable lengths in the range >100 m to 150 m an additional basic interference suppression module shall be provided on the line side (available on request).

Table 4- 3 Maximum cable lengths

Cable used	Maximum cable lengths	Output filter
Shielded cable, devices without output filter	150 m	--
Unshielded cable, devices without output filter	200 m	--
Shielded cable, devices with output filter	300 m	Output reactor, du/dt filter
	100 m	du/dt filter compact
Unshielded cable, devices with output filter	450 m	Output reactor, du/dt filter
	150 m	du/dt filter compact

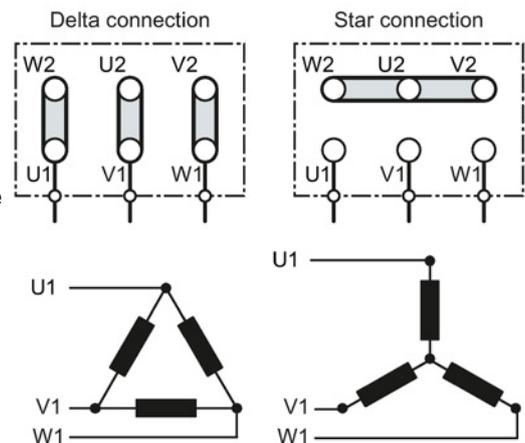
4.2.4 Motor connection

Star and delta connection

Siemens motors have a diagram inside the terminal box showing both connection methods:

- Star connection (Y)
- Delta connection (Δ)

The motor rating plate provides data about the correct connection.



Connecting the motor to the converter

Connect the protective conductor of the motor to the ⏚ terminal of the converter.

Connect the motor cable to terminals U2, V2 and W2.

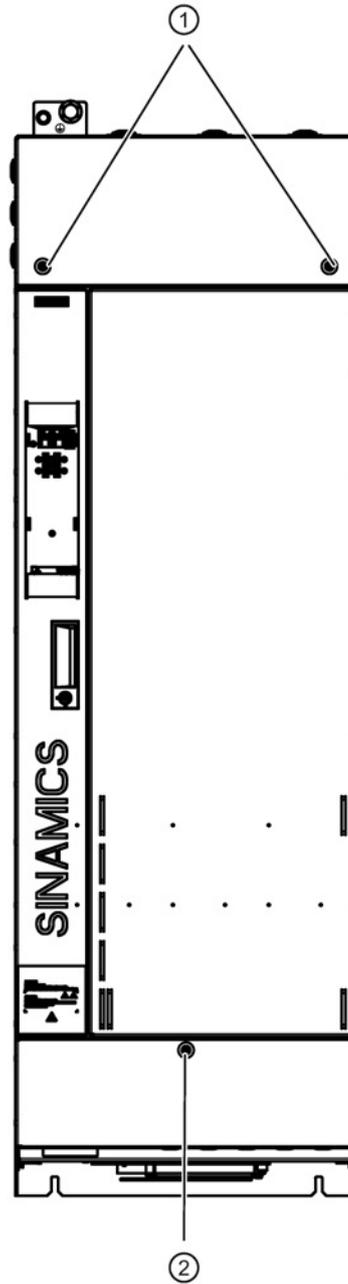
If available, close the terminal covers of the converter.

4.2.5 Access to power and motor terminals

Access to line and motor terminals

The line and motor terminals are accessible via the following steps:

1. Release the 2 screws from the cover of the line connection terminals and remove the cover towards the front.
2. For frame size GX and HX, release the screw from the cover of the motor connection terminals and remove the cover towards the front. For frame size JX, two screws are located in the cover.



Line and motor terminals

Frame sizes GX, HX

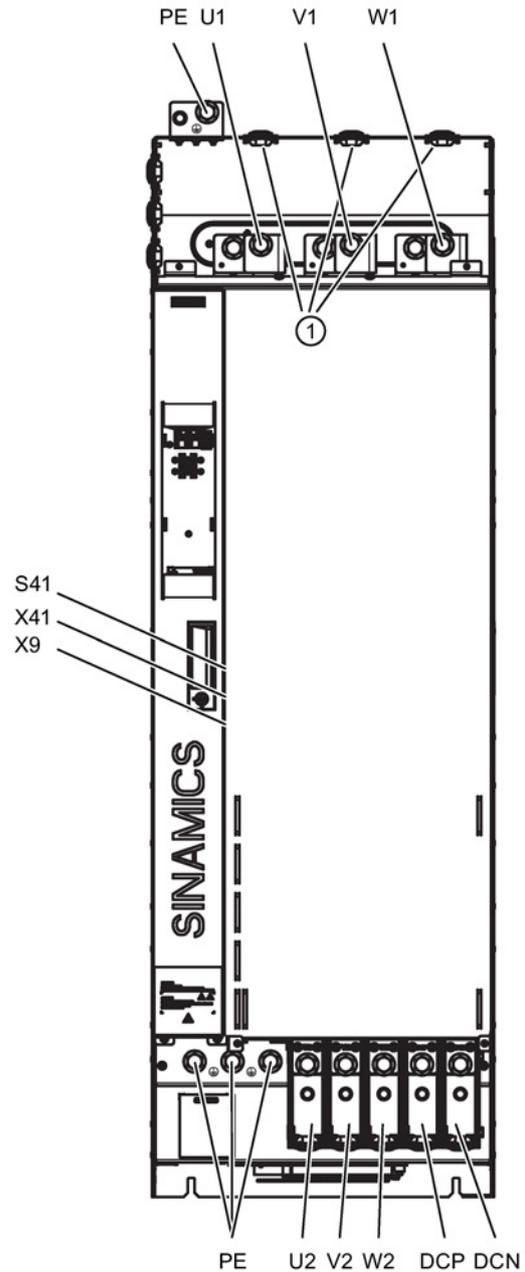
The diagram shows the layout of line and motor terminals and terminal strip X9.

Optionally, the line connection can be established using the "Installation set for line-side cable connection, left", see Installation set for line-side cable connection, left (Page 43)

Tightening torques for the line, motor and PE terminals (M12):
50 Nm

The cable entry protection (①) must be broken out corresponding to the diameter of the cable to be introduced.

After connecting, the covers of the line and motor terminals must be reinstalled (tightening torque: 6 Nm).



Frame size JX

The diagram shows the layout of line and motor terminals and terminal strip X9.

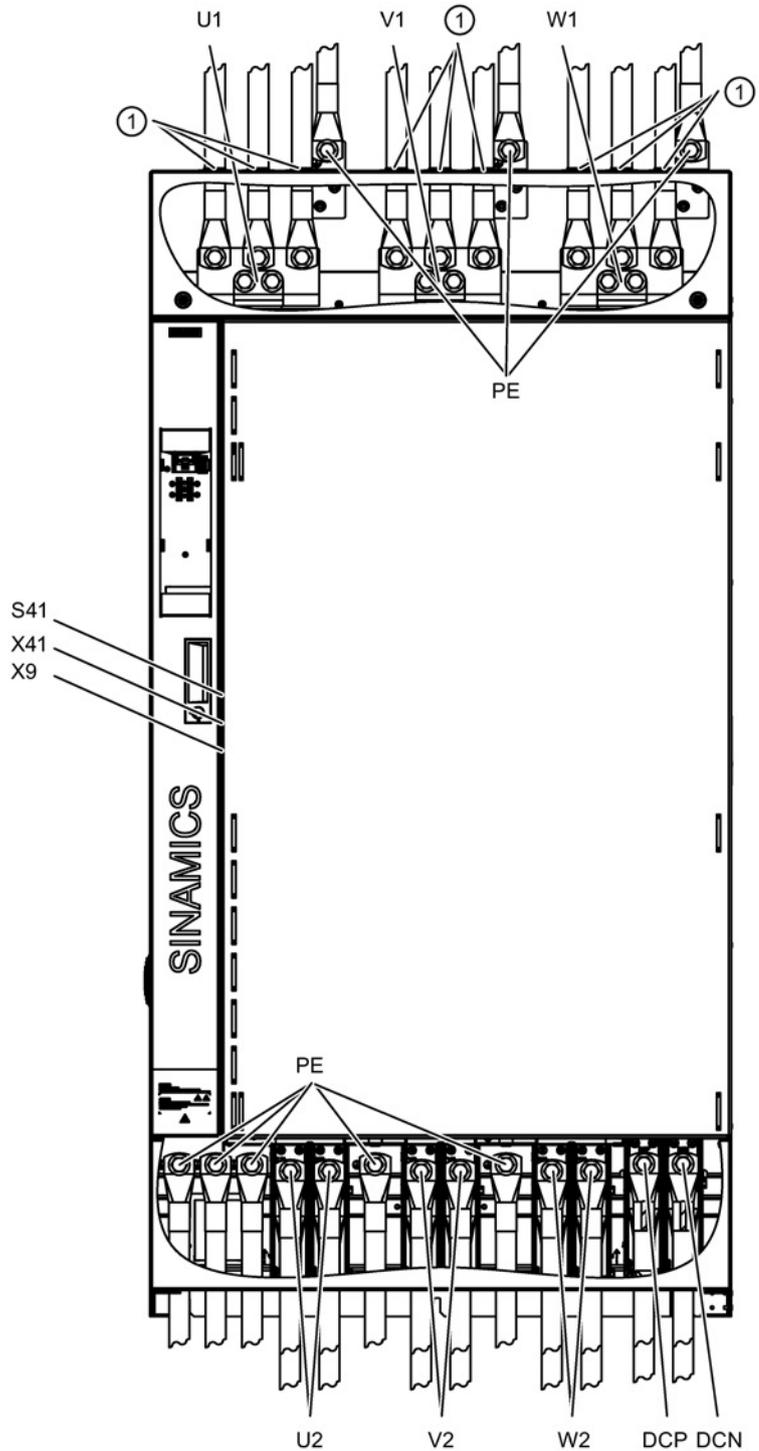
For frame size JX, only connection from the top or bottom is possible.

Tightening torques for the line, motor and PE terminals (M12): 50 Nm

The cable entry protection for the line connection (①) must be broken out corresponding to the diameter of the cable to be introduced.

The cable entry protection for the motor connection is described in the following section.

After connection, the covers of the line and motor terminals must be reinstalled (tightening torque: 6 Nm).



! WARNING

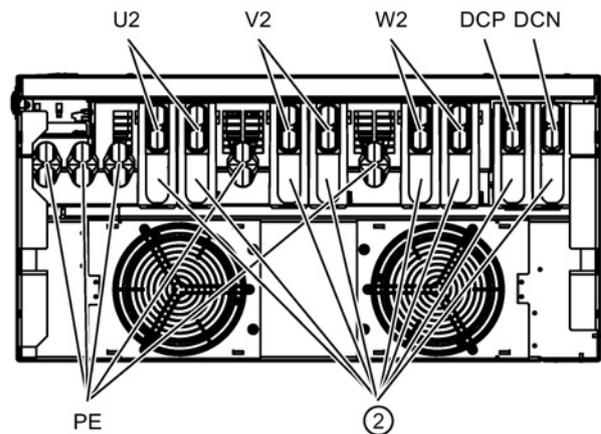
Danger to life as a result of electric shock when the line feeder cable installation is damaged

If the line feeder cables are incorrectly routed, the insulation can be damaged when coming in contact with the sharp edges of the PE connecting lugs - which can result in a short-circuit.

- When routing the line feeder cables, ensure that the insulation does not come into contact with the PE connecting lugs.

When using the front connections for U2, V2, W2, DCP, DCN, the front cable entry protection must be broken out according to the cable diameter to be introduced.

When using the rear connections for U2, V2, W2, DCP, DCN, the plastic panel (②) of the connection housing must be broken out and used at the point of the cable entry protection from the accessory pack according to the cable diameter to be introduced.



! WARNING

Danger to life through electric shock if the cable entry protection is not installed correctly.

A cable entry protection which is not broken out correctly may lead to dangerous touch voltage which can result in serious injury or death.

- Break the cable entry protection out in accordance with the required diameter of the cable in order to ensure degree of protection IP20.

4.2.6 DC link connection

Connecting an external Braking Module

PM330 Power Modules permit an external Braking Module to be connected via the DCP and DCN DC link connecting terminals.

Characteristic data of the connecting terminals (@ Uline rated 380 V – 480 V / 500 V – 600 V / 690 V):

- Supply voltage: up to 780 V / 970 V / 1160 V DC
- Current carrying capacity:
 - At a 45 °C ambient temperature:
 - 65 A / 52 A / 44 A continuous
 - 260 A / 210 A / 173 A for a 22 % mark-to-space ratio (20 s on, 70 s off)
 - At a 55 °C ambient temperature:
 - 49 A / 39 A / 33 A continuous
 - 195 A / 158 A / 130 A for a 22 % mark-to-space ratio (20 s on, 70 s off)

Supplementary rectifier for higher pulse line harmonics

When using DC link connecting terminals DCP and DCN as infeed for an external supplementary rectifier (current carrying capability, see the appropriate table in the Technical data), the rectifier must have as a minimum a fully-controlled 6-pulse diode three-phase bridge or a 6-pulse thyristor three-phase bridge and a 2 % line reactor.

The system (infeed transformer, reactor, busbars, fuses, ...) must be designed so that the current distribution of the individual subrectifiers corresponds to the theoretically expected value.

The short-circuit and overload protection must be adapted.

Note

It is only permissible to switch on the supplementary rectifier if the DC link has been precharged by the Power Module.

Signal X9.8:"DC Link Charged" can be used for this purpose.

4.3 Operation on a non-grounded line supply (IT system)

If the built-in unit is operated from a non-grounded supply (IT system), the connection to the basic interference suppression module of the Power Module must be opened.

NOTICE

Damage to the device through not removing the connection clip with a non-grounded line supply

Failure to open the connection to the basic interference suppression module on a non-grounded line supply (IT system) can cause significant damage to the device.

- With a non-grounded line supply (IT system) open the connection to the basic interference suppression module.

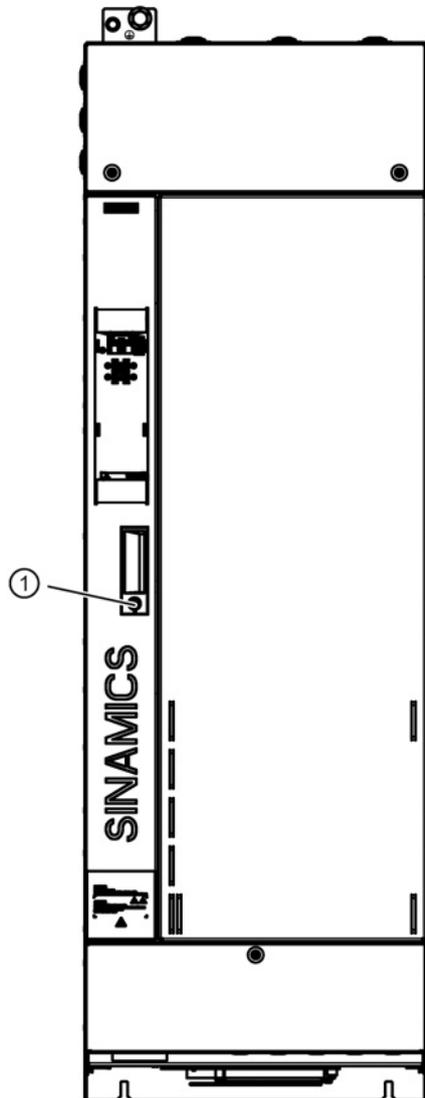


Figure 4-3 Opening the left-hand housing flap

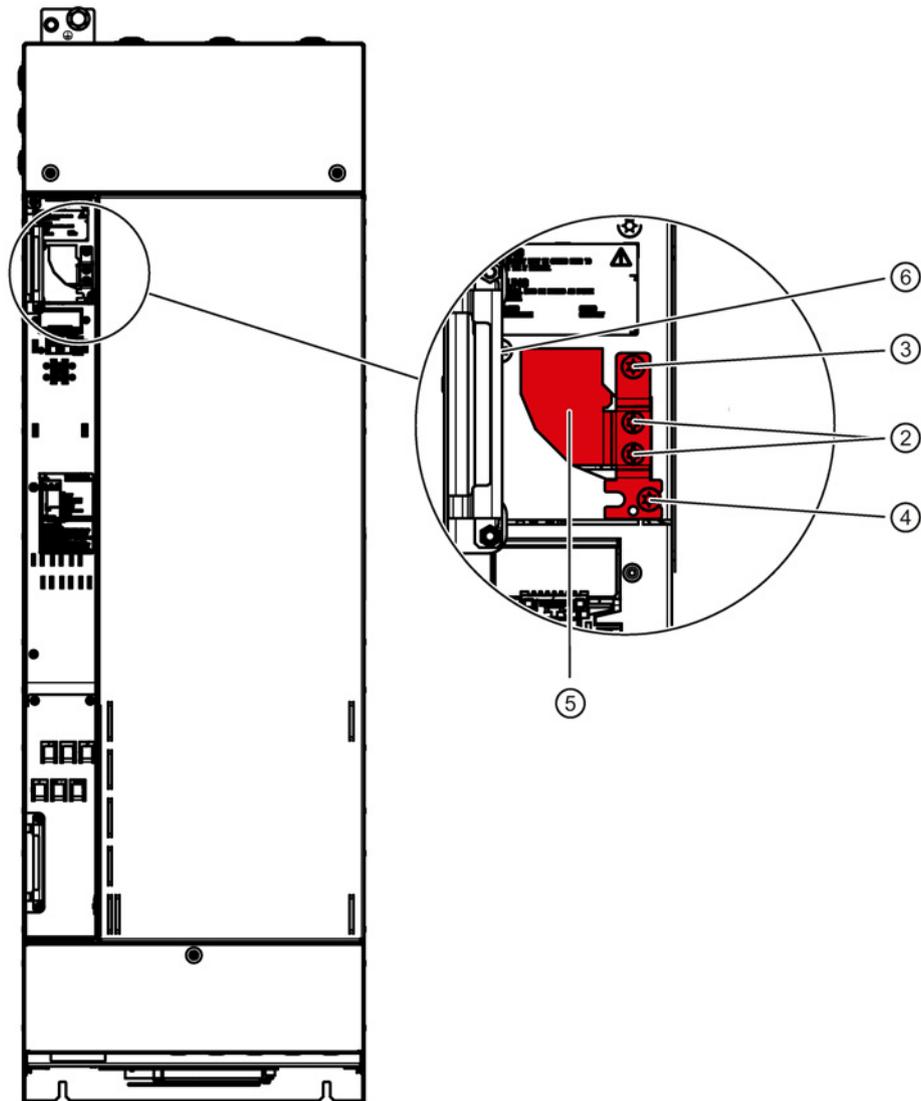


Figure 4-4 Open the connection to the interference suppression module

The connection is opened as follows:

1. Release the left-hand housing flap by rotating latch ① and opening the housing flap.
2. Release the two screws ②; they are captive.
3. Release screws ③, ④ and ⑥, but do not remove the screws.
4. Swivel the connection clip ⑤ around the axis of rotation of screw ③ towards the left, until the connection clip can be fastened using screw ⑥.
5. Tighten the screws ③, ④ and ⑥ with 6 Nm.

4.4 Installation set for line-side cable connection, left

Description

Alternatively, for devices, frame sizes GX and HX, the line connection can be established using the "Installation kit for line-side cable connection, left".

This means that it is possible to mount the Power Module at the top of the control cabinet without any clearance. This way it is possible to dissipate the power loss from the Power Module from the cabinet with low design overhead.

For devices, frame size JX, the line feeder cables can only be connected from the top.

Installing the "Mounting kit for line-side cable connection, left" 6SL3366-1LG00-0PA0 for frame size GX

The mounting kit is installed in 4 steps:

1. Remove the busbar adapter for the cable outlet towards the top ①.
Use the 7 screws (incl. PE) again for mounting the installation set.

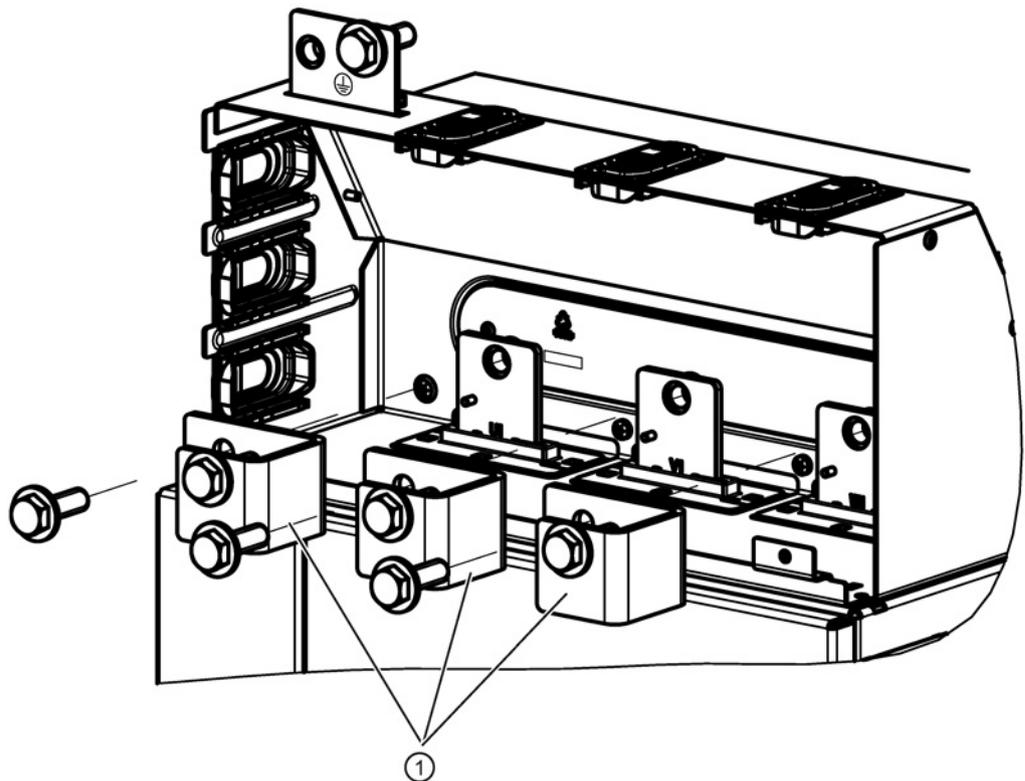


Figure 4-5 Installing the mounting kit, step 1

2. Mount the installation set ②, tightening torque: 50 Nm

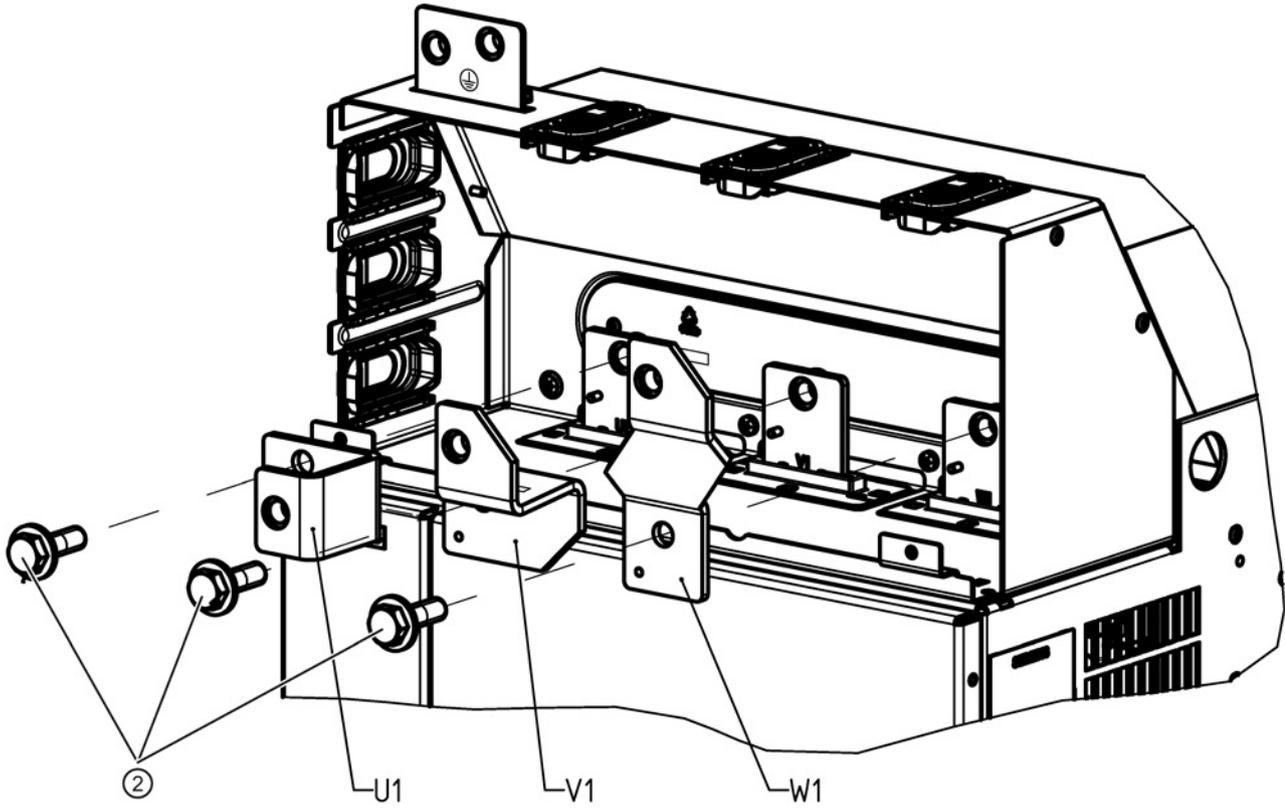


Figure 4-6 Installing the mounting kit, step 2

3. Final state with mounted installation set, tightening torque for the fixing screws ③: 50 Nm

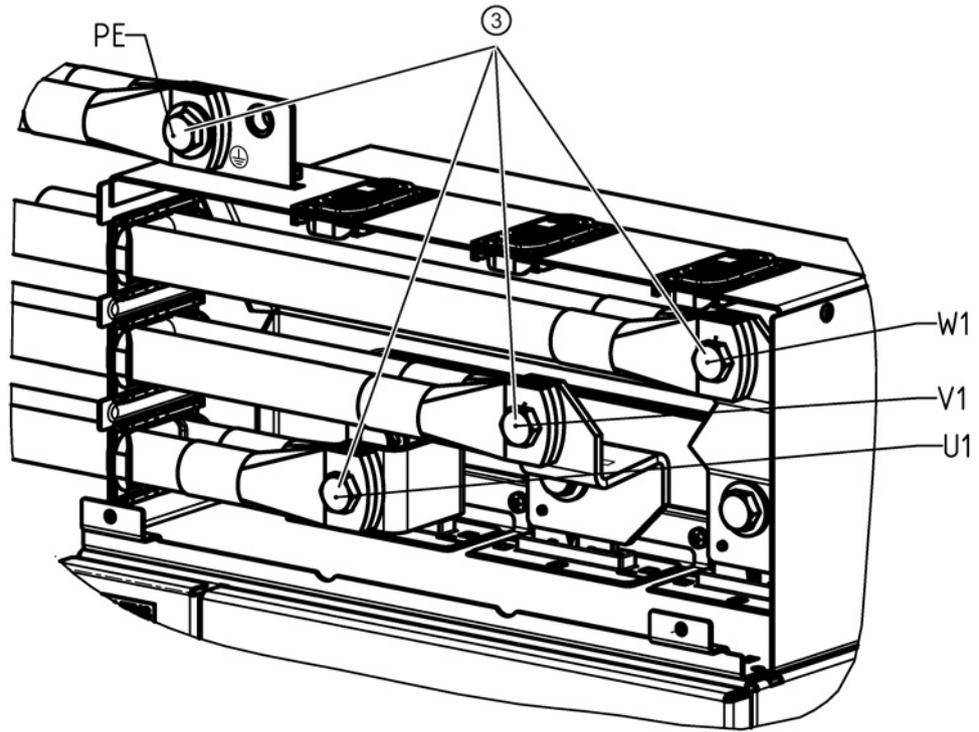


Figure 4-7 Installing the mounting kit, step 3

4. The cable entry protection ④ must be broken out corresponding to the diameter of the cable to be introduced.

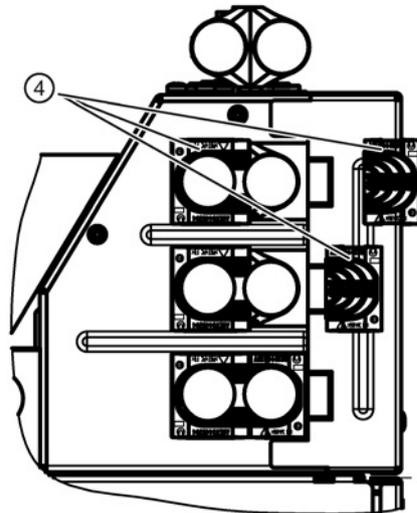


Figure 4-8 Installing the mounting kit, step 4

Installing the "Mounting kit for line-side cable connection, left" 6SL3366-1LH00-0PA0 for frame size HX

The mounting kit is installed in 4 steps:

1. Remove the busbar adapter for the cable outlet towards the top and the adapter for the PE connection towards the top ①.
Use the 14 screws (incl. PE) again for mounting the installation set.

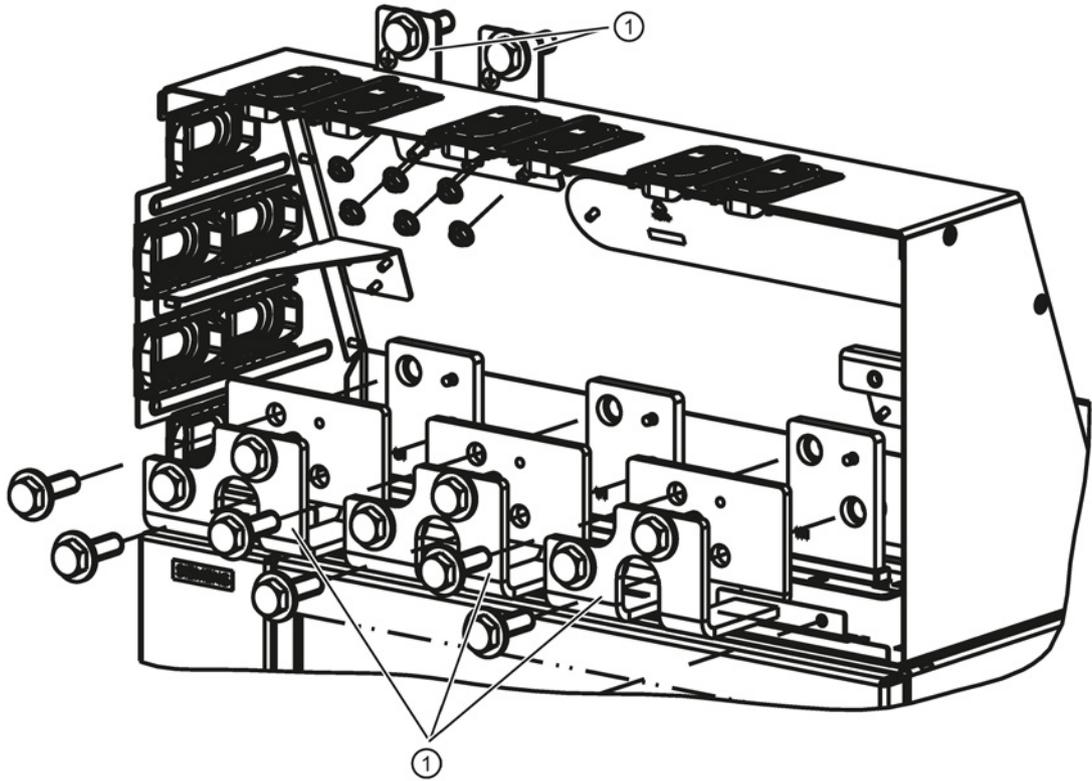


Figure 4-9 Installing the mounting kit, step 1

2. Mount the installation set for connections U1, V1, W1 ②, tightening torque: 50 Nm and the installation set ③, tightening torque: 6 Nm.
Tightening torque for screw ④: 3 Nm

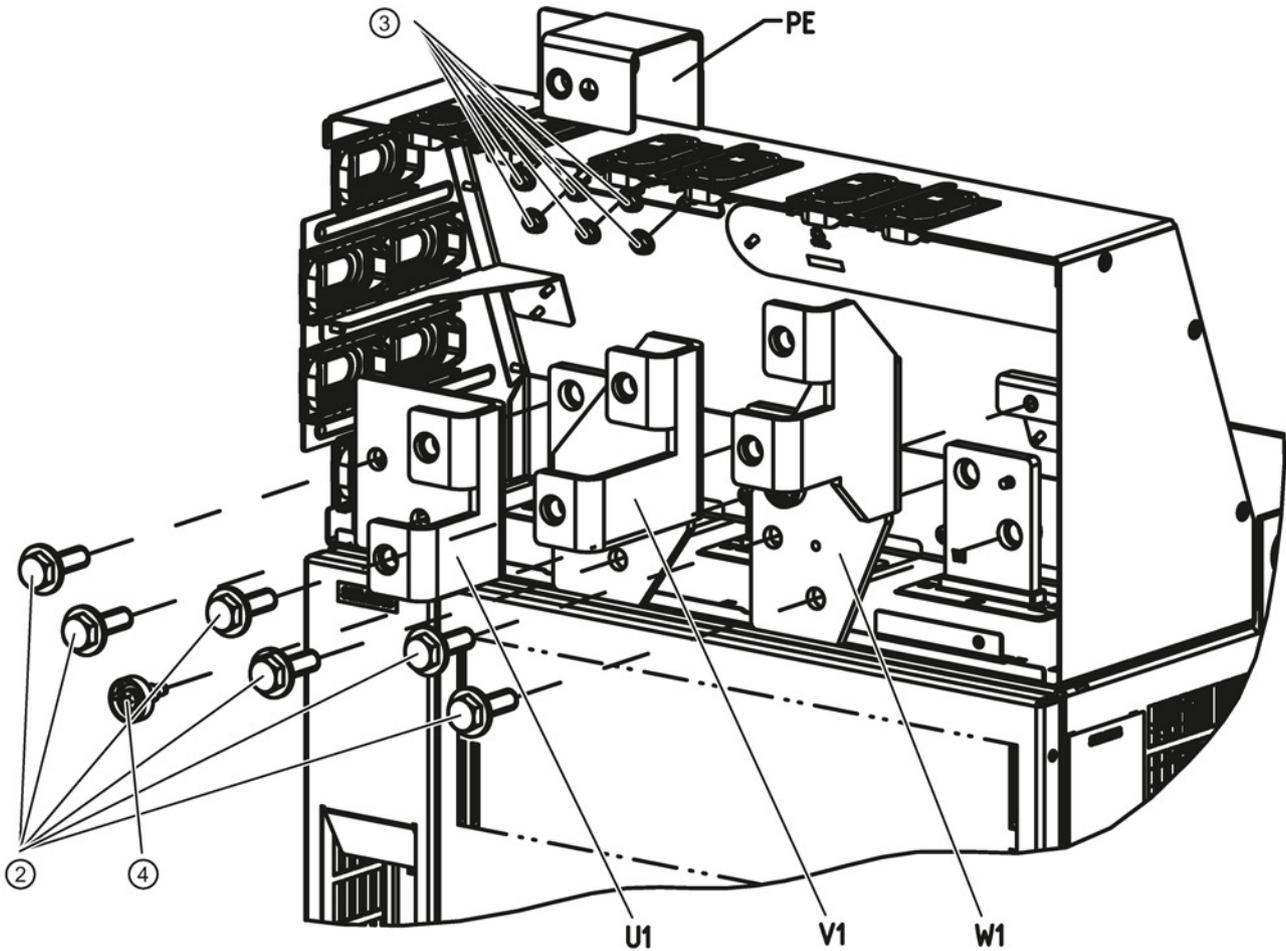


Figure 4-10 Installing the mounting kit, step 2

- 3. Final state with mounted installation set, tightening torque for the fixing screws ⑤: 50 Nm

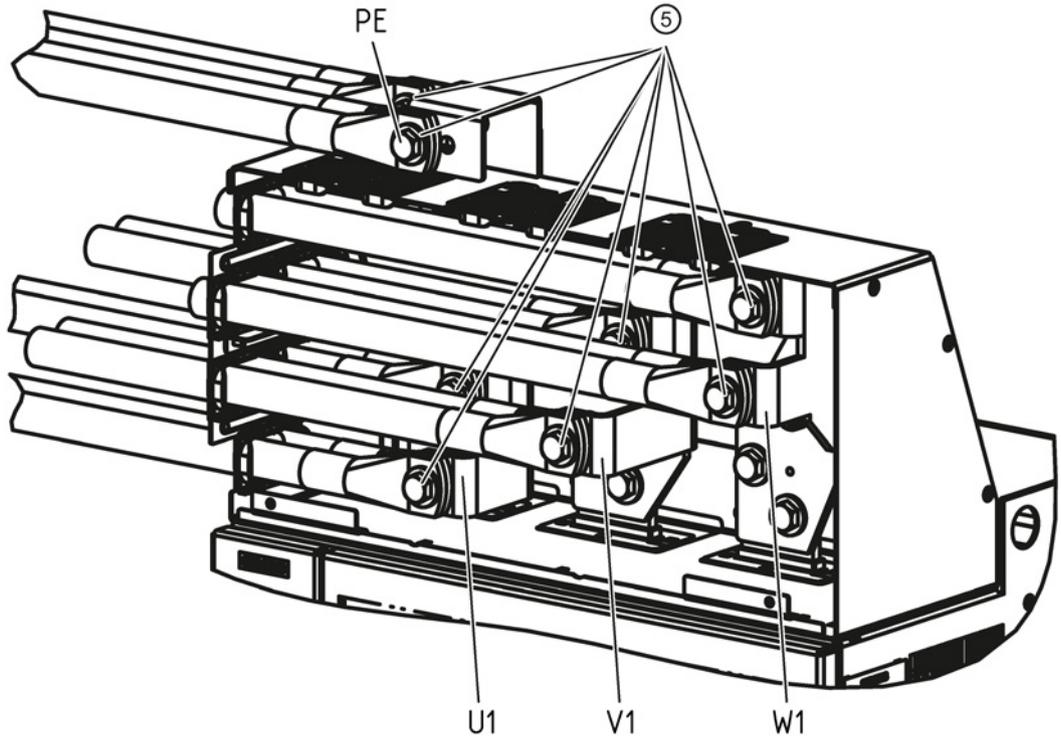


Figure 4-11 Installing the mounting kit, step 3

- 4. The cable entry protection ⑥ must be broken out corresponding to the diameter of the cable to be introduced.

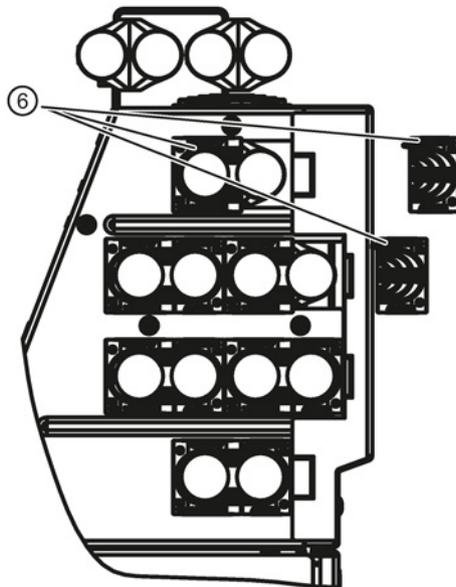


Figure 4-12 Installing the mounting kit, step 4

4.5 Terminal strip X9

Terminal strip X9 is used to connect an external 24 VDC power supply and to connect a main or bypass contactor.

Fault and alarm signals can be connected to the digital inputs. The digital output allows, for example, an external rectifier to be controlled.

The external 24 VDC power supply must be connected if the inverter is connected to the line supply via a main contactor (to start the Control Unit).

The power supply should be located directly next to the inverter (e.g. in the same cabinet). The cable length to terminal X9 must not exceed 30 m.

Terminal	Name	Meaning	In-put/output	Technical data
1	P24	External power supply	In-put/output ¹⁾	<ul style="list-style-type: none"> As input: 24 V DC (20.1 ... 28.8 V) Current consumption: max. 2 A
2	M	Electronics ground	Reference	<ul style="list-style-type: none"> As output: Load at X9:1 and X9:8 together: Max. 250 mA Overcurrent trip with restart attempt every 3.5 sec.
3	External alert	External alarm	Input	Voltage: -3 V ... +30 V
4	External fault	External fault	Input	Current consumption: 6.4 mA at 24 VDC
5	Stop 0	OFF 2	Input	1.3 mA at <5 V
6	Stop 1	OFF 3	Input	4 mA at 15 V 8 mA at 30 V Level (including ripple): High level: 15 V ... 30 V Low level: -3 V ... +5 V
7	M		Reference	
8	DC link charged	Feedback signal, "U _{DC link} charged"	Output	Voltage: 24 V DC <ul style="list-style-type: none"> for external supply via X9:1/2: max. load current: 500 mA without external supply via X9:1/2: Load at X9:1 and X9:8 together: max. 250 mA continuously short-circuit proof The output current is taken from the supply at X9, terminal 1.
9	NC	Not connected		
10	NC	Not connected		

Terminal	Name	Meaning	In-put/output	Technical data
11	Activation line contactor	Controlling the main contactor	Output	Contact type: NO contact Maximum load current: 4 A, 230 VAC, $\cos\phi = 0.6$ ind
12	Activation line contactor	Controlling the main contactor	Output	Floating A device to protect against overload and short-circuit is required to supply the unprotected output (e.g. 4 A / 250 V fuses). Surge suppressors must be connected to the excitation coil of the main contactor (e.g. RC element). To control the main contactor, the following contact characteristic values of the relay apply: <ul style="list-style-type: none"> • 250 V AC / 4 A (NC and NO), general purpose • 30 V DC / 4 A (NC and NO), general purpose • B300 (NC and NO), pilot duty • R300 (NC and NO), pilot duty • 24 V AC / 2.0 A (NC and NO), pilot duty

¹⁾ Using terminal X9:1/2 as an output only works for devices with function release (FS) 04 (see type plate)

Maximum connection cross section: 2.5 mm²

Minimum connection cross section: 0.2 mm²

Maximum tightening torque: 0.5 Nm (4.5 lbf in)

Inputs are low active.

All signal inputs are low active (wire-break-proof).

Controlling the main contactor

If the main contactor is controlled via terminals 11 and 12, then it is not necessary to use a control transformer to provide isolation from the line supply. A 250 V/4 A fuse must be used as protection.

When terminals 3 ... 6 are not used

If terminals 3 to 6 are not used, then you must connect 24 V DC to these.

To do this, use an external power supply or terminal 9 on the Control Unit.

For devices with function release (FS) 04 (see type plate), the supply can be implemented via terminals 3 ... 6 - or also without external power supply, using terminal X9:1.

The reference potential is terminal X9:2 and X9:7 - and terminal 28 on the Control Unit.

Insulated end sleeves

Insulated end sleeves according to DIN 46228-4 must be used.

Strain relief

For strain relief, the cables to the Control Unit and to the terminal X9 must be fastened to the lugs in the cable duct below terminal X9 (e.g. with cable ties).

If the cables are introduced at the side (at the height of terminal X9), the strain relief must be provided outside the Power Module.

4.6 Terminal block X41 / switch S41

PM330 Power Modules, from function release (FS) 04 (see type plate), are equipped with the safety subfunction Safe Torque Off.

This safety subfunction is controlled via terminal block X41 using digital inputs STO_A (X41:1/2) and STO_B (X41:3/4).

Diagnostics of this safety subfunction can also be realized via terminal block X41 using the two feedback signal contacts FB_A (X41:5/6) and FB_B (X41:7/8).

The two S41 switches are used to enable the STO function.

The power supply to control the STO inputs - as well as to diagnose the safety function (feedback signal contacts) - should be located in the direct vicinity of the inverter (e.g. in the same cabinet). The cable length to terminal block X41 must not exceed 30 m.

This safety subfunction is exclusively implemented in the hardware; as a consequence it is not described in the Safety Integrated Function Manual, and a description is provided in this document in Chapter "Fundamental safety technology principles (Page 93)".

4.6.1 Terminal strip X41

Terminal strip X41

Table 4- 4 Terminal strip X41

Terminal	Name	Meaning	In-put/output	Technical data
1	STO_A1	STO control, channel A	Input	Voltage: -3 V ... +30 V
2	STO_AM	Reference ground for input STO_A1	Reference	Signal level (including ripple): <ul style="list-style-type: none"> • High signal level: 15 V ... 30 V -> STO deselected (operation possible) • Low signal level: -3 V ... +5 V -> STO active (operation inhibited)
3	STO_B1	STO control, channel B	Input	
4	STO_BM	Reference ground for input STO_B1	Reference	Current consumption: 2 mA at <15 V 15 mA at 30 V 15 mA at 24 V
5	FB_A1	Feedback signal contact diagnostics channel A	Floating contact	Voltage: -3 V ... +30 V
6	FB_A2			Max. current for a resistive load: 500 mA
7	FB_B1	Feedback signal contact diagnostics channel B	Floating contact	Voltage: -3 V ... +30 V
8	FB_B2			Max. current for a resistive load: 500 mA

Maximum connection cross section: 1.5 mm²

Minimum connection cross section: 0.2 mm²

Maximum tightening torque: 0.22 Nm (1.9 lbf in)

Control cable capacitance

Maximum control cable capacitance: 330 pF/m

Insulated end sleeves

Insulated end sleeves according to DIN 46228-4 must be used.

Strain relief

For strain relief, the cables to the Control Unit and to the terminal X41 must be fastened to the lugs in the cable duct below terminal X9 (e.g. with cable ties).

If the cables are introduced at the side (at the height of terminal X9), the strain relief must be provided outside the Power Module.

4.6.2 Switch S41

Switch S41

The STO circuit is activated and/or deactivated using the two switches STO_A and STO_B.

The two switches must have the same switching state, both ON or both OFF. An unequal switching state is an undefined state.

The switch positions for "STO OFF" and "STO ON" can be identified on the adhesive label in the CU channel.

STO circuit deactivated

Both switches positioned towards the rear (STO OFF): STO circuit is deactivated.

Here, the STO inputs are deactivated by the two switches, and therefore STO deselected. Inverter operation is possible independent of the signal states at the STO inputs.

- The inverter is supplied in this state.
- Compatibility state to previous versions (FS < 04) without STO
- Applications where STO is not used.

STO circuit deactivated

Both switches positioned to the front (STO ON): STO circuit is activated.

In this switch position, the inverter can only be operated when both STO inputs, STO_A and STO_B have a high signal level. STO is initiated (wire-break-proof) by deactivating (low signal level) one or both inputs.

4.6.3 Schematic diagram of the safety relay at X41

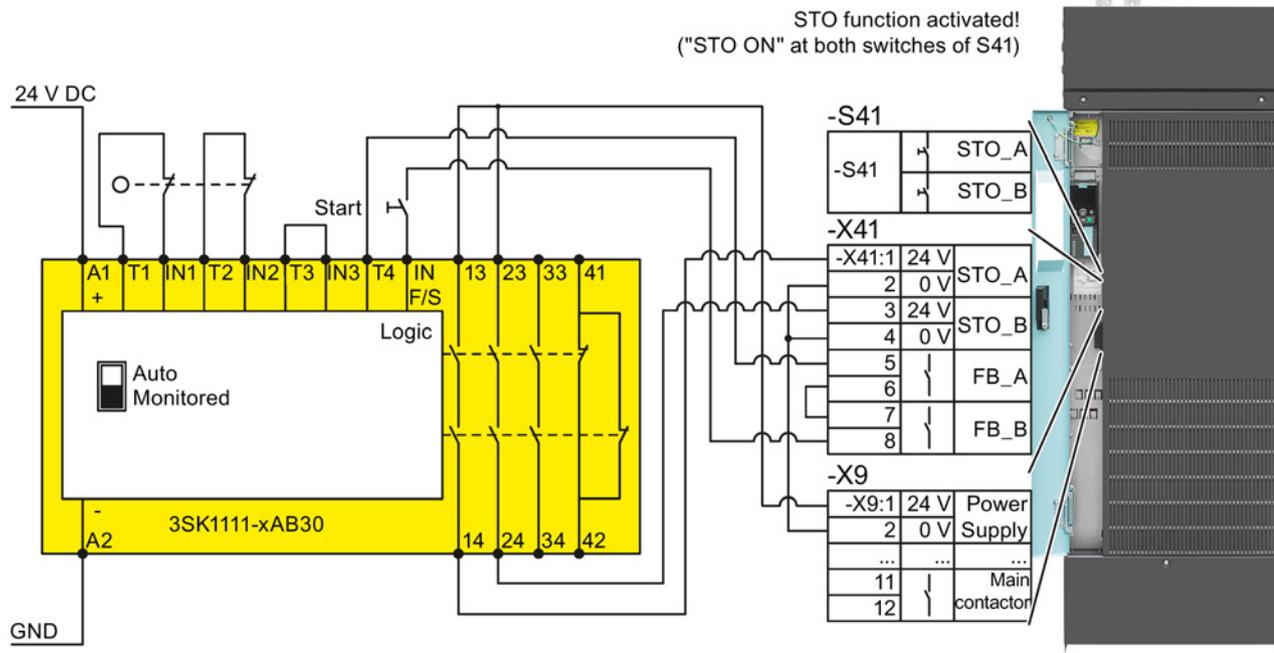


Figure 4-13 PM330 with safety relay, sensor and start button

Subdivision of the complete safety function into safety subfunctions is shown in the diagram. This example shows the safety function "Protection against restart when a protective device is open".

This function is subdivided into the safety subfunctions:

- "Detect": Sensor, in this case, a cam-operated switch, which senses (detects) the position of the protective device.
- "Evaluate": A 3SK11... safety relay is used for evaluation
 - Evaluation and diagnostics of the sensor circuit
 - Control of the SINAMICS PM330 subsafety function
 - Diagnostics of the PM330 subsafety function
- "React": When activating the STO function at terminal strip X41 (low signal), the torque/force-generating energy fed to the drive is interrupted, and the state of the safety subfunction is signaled back to the safety relay.

Other application examples are provided in the annex to this document, see "Application examples for functional safety (STO / SS1-t) (Page 109)".

Validating/checking the safety function

Carefully check/test the safety function after commissioning the system for the first time, after carrying out any repairs and after each change to the machine/system.

These tests/checks must be performed by qualified personnel.

4.7 EMC compliant connection

4.7.1 Avoiding electromagnetic interference

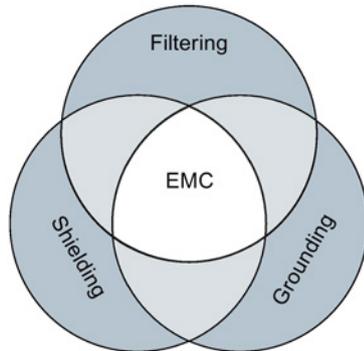


Figure 4-14 EMC measures

Installation in conformance with EMC requirements is only possible using simultaneous filtering, grounding and shielding.

The most important installation rules for converter and drive systems are described in the following sections.

4.7.2 EMC-compliant cabinet design

The most cost-effective method of implementing interference suppression measures within the control cabinet is to ensure that interference sources and potentially susceptible equipment are installed separately from each other. This separation must be taken into account already during the planning phase.

EMC zone concept within the control cabinet

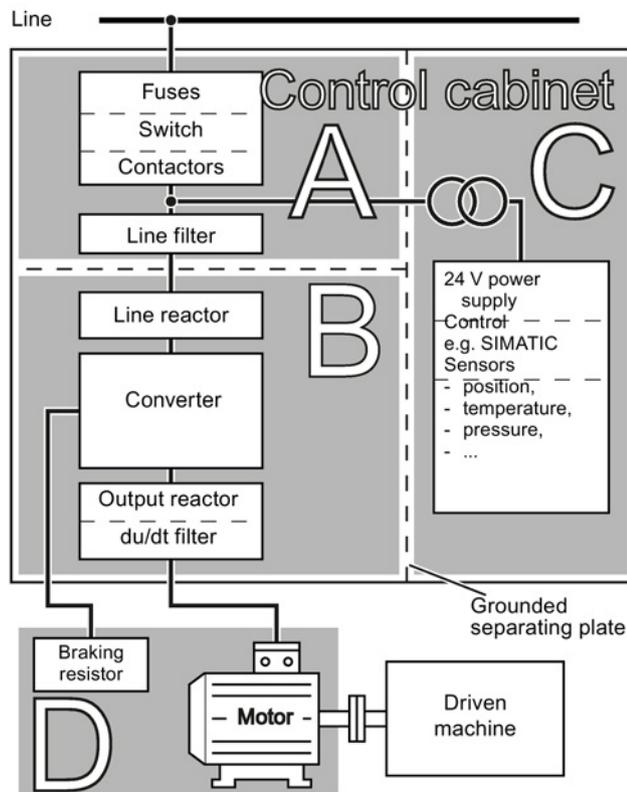
The control cabinet has to be divided into EMC zones and the devices within the control cabinet have to be assigned to these zones. The following example explains the zone concept in greater detail.

The zones must be decoupled electromagnetically. This decoupling can, for example, be achieved with large physical separations (approx. 25 cm). Better and space-saving is decoupling using separate metal enclosures or large metal partitions.

Cables within each zone can be unshielded. Cables of different zones must be separated and must not be laid in shared cable harnesses or cable ducts. Where necessary, filters and/or coupler blocks must be deployed at the zone interfaces. Coupler blocks with electrical isolation can effectively prevent the interference propagation between the zones.

All communication and signal cables that exit the control cabinet must be shielded. Additional isolation amplifiers must be used for longer analog signal cables. Sufficient space for connecting the cable shields must be provided, whereby the braided cable shield must be connected to the cabinet ground with excellent electrical conductivity and with a large

contact area. Care must be taken to prevent any potential differences regarding the ground potential between the zones. These must be avoided to protect the cable shields from excessively high equalizing currents.



- **Zone A:**
Line connection
 Limit values for conducted interference emissions and conducted interference immunity must not be exceeded
- **Zone B:**
Power electronics
 Sources of interference
- **Zone C:**
Control and sensors
 Potentially susceptible equipment (noise sinks)
- Zone D:**
Motor, braking resistor and corresponding cables
 Sources of interference

Division of the cabinet and the drive system into different EMC zones

4.7.3 Cabinet design

Control cabinet design

- All metal parts and components of the control cabinet (side panels, rear panels, roof and base plates) must be connected to the control cabinet frame through a good electrical connection – this is best achieved using the highest possible surface area or a high number of individual screw connections (to create a Faraday cage).
- The cabinet doors must be connected to the cabinet frame through short, wide ground straps with finely braided wires; preferably at the top, the center and at the bottom.
- The PE bar and the EMC shield bar must be connected to the control cabinet frame through a good electrical connection established through a large surface area.
- All of the metal enclosures of the devices and supplementary components installed in the cabinet – e.g. converter or line filter – must be connected to the control cabinet frame through a good electrical connection through the largest possible surface area. The most favorable design is to mount these devices and supplementary components on a bare

metal mounting plate with good conducting characteristics; this in turn is connected to the control cabinet frame through a good electrical connection and the largest possible surface area. It is especially important that they are connected to the PE and EMC shield bars.

- All of the connections must be implemented so that they are durable. Screw connections to painted or anodized metal components must either be established using special contact (serrated) washers that cut through the insulating surface - and therefore establish a metallic conducting contact - or the insulating surface must be removed at the contact locations.
- Coils of contactors, relays, solenoid valves and motor holding brakes must be equipped with interference suppression elements in order to dampen high-frequency radiation when switching-off (RC elements or varistors with AC coils and free-wheeling diodes or varistors for DC coils). The protective circuit must be directly connected at the coil.

4.7.4 Cabling

Routing cables inside the cabinet

- All power cables for the drive (line cables, DC link cables, connecting cables between the Braking Module and the associated braking resistor as well as motor cables) must be routed separately from signal and data cables. The minimum distance should be approximately 25 cm. Alternatively, the decoupling can be realized in the control cabinet using metal partitions (separating elements) connected to the mounting plate through a good electrical connection.
- Filtered line cables with a low noise level, i.e. line cables from the line supply to the line filter, must be separately routed away from non-filtered power cables with high noise levels (line cables between the line filter and rectifier, DC link cables, connecting cables between the Braking Module and the associated braking resistor as well as motor cables).
- Signal and data cables, as well as filtered line supply cables, may only cross non-filtered power cables at right angles to minimize coupled-in interference.
- Cables should be kept as short as possible, unnecessary cable lengths must be avoided.
- All cables must be routed as closely as possible to grounded housing components, such as mounting plates or the cabinet frame. This reduces interference radiation as well as coupled-in interference.
- Signal and data cables, as well as their associated equipotential bonding cables, must always be routed in parallel and with the shortest distance possible between them.
- When unshielded single-conductor cables are used within a zone, the feed and return lines must be either routed in parallel with the minimum possible distance between them, or twisted with one another.
- Spare conductors for signal and data cables must be grounded at both ends to create an additional shielding effect.
- Signal and data cables should enter the cabinet only at one point (e.g. from below).

- The shields of the signal cables at the Control Unit must be connected at the Power Module below the mounted Control Unit using the shield connecting terminals provided at the slits available for the purpose.
The cables are mechanically fixed (strain relief) using cable ties, also below the mounted Control Unit at the locations provided below the slits used for mounting.

Cables outside the cabinet

- All power cables (line cables, DC link cables, connecting cables between the Braking Module and the associated braking resistor as well as motor cables) must be routed separately from signal and data cables. The minimum distance should be approximately 25 cm.
- To achieve categories C2 and C3 according to EN 61800-3, a shielded cable must be used between the converter and motor, and for higher power ratings a symmetrical, 3-conductor three-phase cable should be used. Shielded cables with symmetrical three-phase conductors (L1, L2, and L3) and an integrated, 3-conductor, and symmetrically arranged PE conductor are ideal for this purpose.
- The shielded cable to the motor must be routed separately from the cables to the motor temperature sensors (PTC/KTY); this is because the cables to the motor temperature sensors should be treated as signal cables.
- Signal and data cables must be shielded to minimize coupled-in interference (capacitive, inductive, and radiated).
- Especially sensitive signal cables - such as setpoint and actual value cables - should be routed without any interruption with optimum shield support at both ends

Cable shields

- Shielded cables must have finely stranded braided shields. Shields that are not as finely braided, such as the concentric conductors used in Protodur NYCWY cables, do not have such an effective shielding effect. Foil shields have a significantly poorer shielding effect and are therefore unsuitable.
- Shields must be connected to the grounded housings at both ends with excellent electrical conductivity and a large contact area. Only when this method is used can coupled-in interference be minimized (capacitive, inductive, radiated).
- Wherever possible, cable shields should be connected directly after they enter the cabinet. The EMC shield bars should be used for power cables; the shield connection options provided in the built-in and cabinet units should be used for signal and data cables.
- Wherever possible, cable shields should not be interrupted by using intermediate terminals.
- In the case of both, the power cables and the signal and data cables, the cable shields should be connected by means of suitable EMC shield clips. The shield clips must connect the shield through a large surface area with low associated inductance to the EMC shield bar or the shield connection option for signal cables.
- Only metal or metallized plug housings should be used for plug-in connections for shielded data cables (e.g. PROFIBUS cables).

4.7.5 Equipotential bonding

Equipotential bonding

- Equipotential bonding within a cabinet element has to be established by means of a suitable mounting plate (back plane), to which all metallic housings of the devices and additional components integrated in the cabinet element (e. g. converter or line filter) are connected. The mounting plate has to be connected to the cabinet frame and to the PE or EMC busbar of the cabinet element with excellent electrical conductivity and a large contact area.
- Equipotential bonding between several cabinet elements has to be established by means of a PE busbar which runs through all the cabinet elements. In addition, the frames of the individual cabinet elements are screwed together several times with good conductivity ensured through the use of contact washers. If extremely long rows of cabinets are installed in two groups back to back, the two PE busbars of the cabinet groups must be connected to each other wherever possible.
- Equipotential bonding within the drive system has to be established by connecting all electrical and mechanical drive components (transformer, cabinet, motor, gearbox, and driven machine) to the grounding system. These connections are established by means of standard PE power cables, which do not need to have any special high-frequency attributes. In addition to these connections, the converter (as the source of the high-frequency interference) and all other components in each drive system (motor, gearbox, and driven machine) must be interconnected with respect to the high-frequency point of view. For this purpose cables with good high-frequency properties must be used.

Grounding and high-frequency equipotential bonding measures

The following figure illustrates all grounding and high-frequency equipotential bonding measures using the example of a cabinet with a SINAMICS G120.

The ground connections represent the conventional grounding system for the drive components.

They are made with standard, PE power conductors without special high-frequency properties and ensure low-frequency equipotential bonding as well as protection against injury.

The connections inside the SINAMICS cabinet provide a good electrical connection for high-frequency currents between the metal housings of the integrated components and the EMC shield busbar of the cabinet. These internal connections can be made over a large area using metal components of the cabinet. In this case, the contact surfaces must be bare metal and each contact point must have a minimum cross-section of several cm². Alternatively, these connections can be established using short, finely-stranded, braided copper cables with a higher cross-section ($\geq 95 \text{ mm}^2 / 000 (3/0) (-2) \text{ AWG}$).

The shield and the protective ground conductor of the motor cable provide the high-frequency equipotential bonding between the converter and the motor terminal box.

Therefore, connect the protective ground conductor and the cable shield to the motor and to the converter.

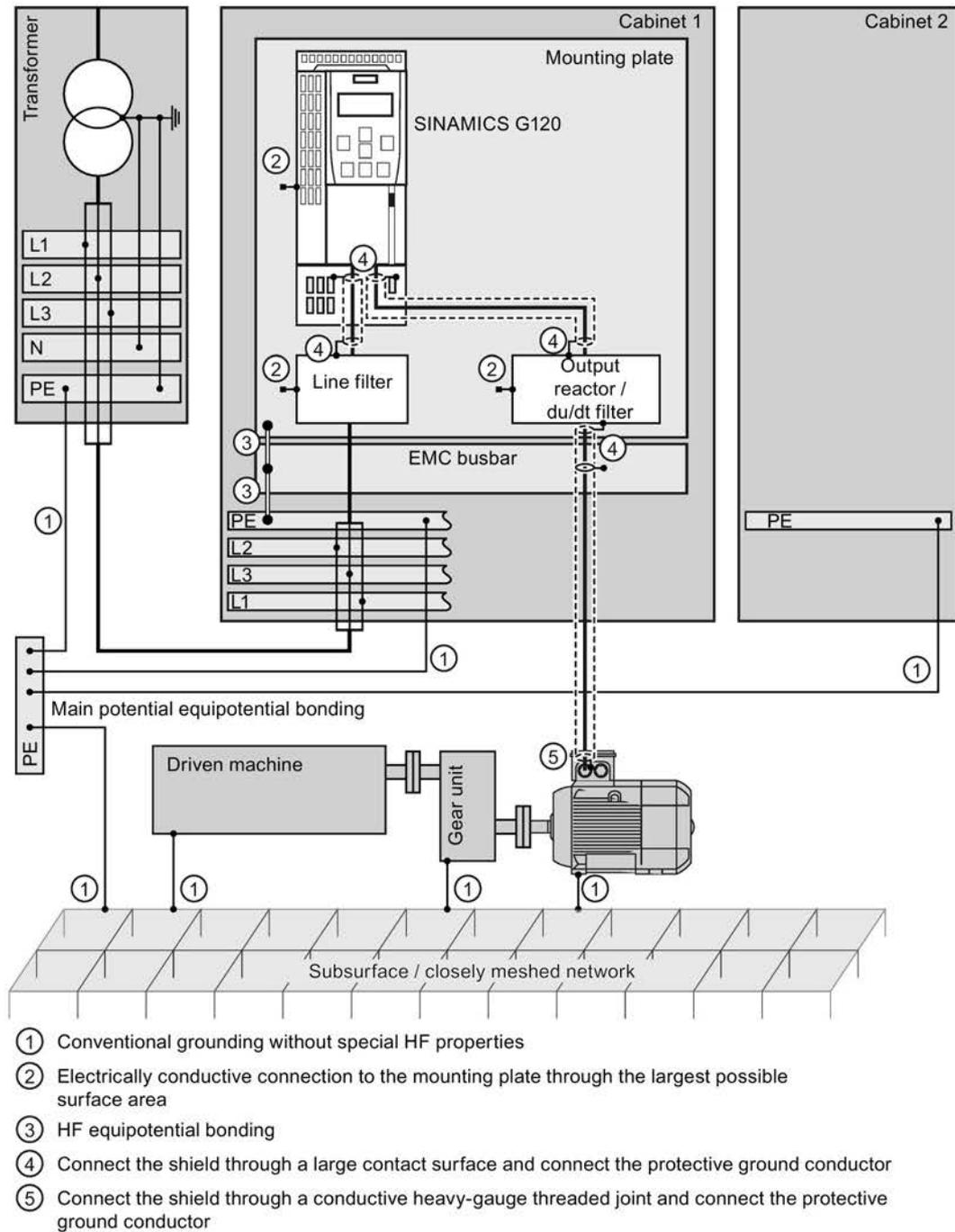


Figure 4-15 Grounding and high-frequency equipotential bonding measures in the drive system and in the plant

Additional measures

Finely stranded, braided copper cables have to be routed in parallel with the cable shields in the following cases:

- Old installations with existing unscreened cables
- Cables with poor high-frequency properties of the shield
- Installations with bad grounding systems

Connections shown in the following diagram offer a durable, high-frequency equipotential bonding between the motor enclosure, the motor terminal box, the driven load and the EMC rail/busbar.

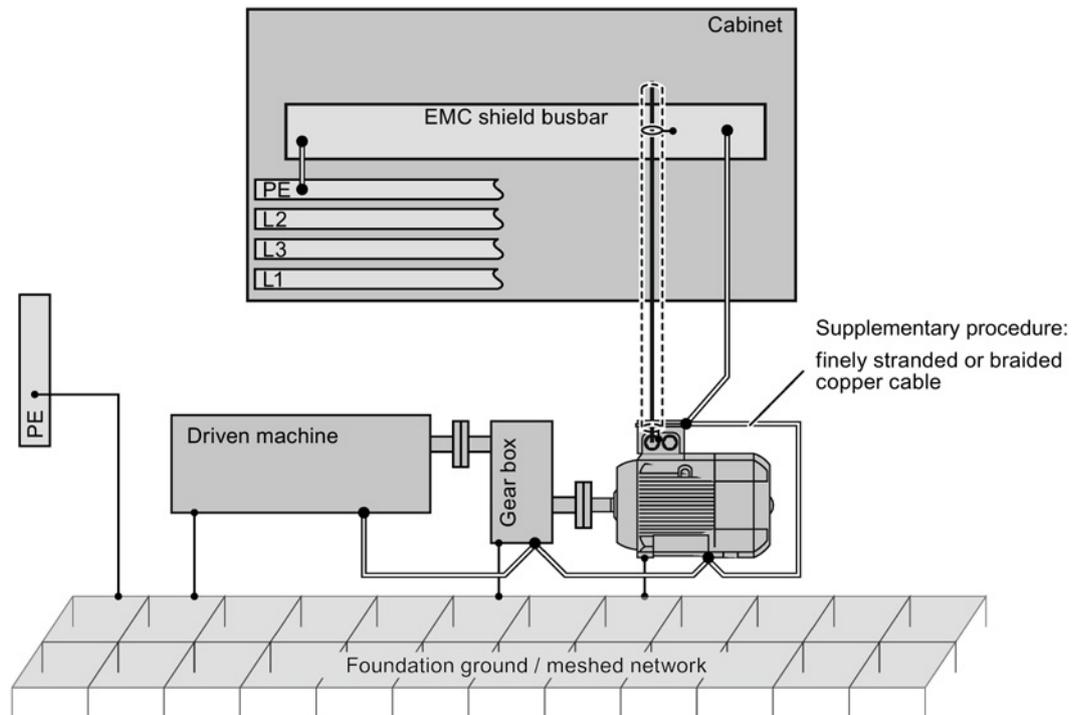


Figure 4-16 Additional high-frequency bonding of the drive system

4.8 Switching on

The inverter is switched on in the following steps:

- **Switch on the line voltage**
 - The power supply inside the inverter switches on,
 - the DC link is still not precharged.
- **Switch on the inverter, e.g. at the operator panel or with STARTER**
 - By issuing the ON/OFF command (ON button at the IOP or p0840 = 1 using STARTER).
 - The DC link is now precharged (this takes approx. 4 s).
- **Start the inverter**

depending on the parameter assignment, the inverter pulses must be separately enabled
- and the inverter then accelerates the motor up to the selected speed.

Service and maintenance

5.1 Maintenance

The purpose of maintenance is to maintain the specified condition of the Power Module. Dirt and pollution must be regularly removed, wearing parts must be replaced. The Power Module predominantly comprises electronic components. In addition to the fan or fans, the device hardly has any components that are subject to wear or that require service or maintenance.

The following points must always be carefully observed.

Dust deposits

Dust deposits inside the Power Module must be removed at regular intervals by qualified personnel in line with the relevant safety regulations. The unit must be cleaned using a brush and vacuum cleaner, and dry compressed air (max. 1 bar) for areas that cannot be easily reached. When using a vacuum cleaner, this must comply with ESD equipment rules.

Ventilation

When installing the devices in a cabinet, make sure that the cabinet ventilation slots are not obstructed. The fan must be checked to make sure that it is functioning correctly.

If dirt filters are used, the specified replacement intervals must be observed.

Cables and screw terminals

Cables and screw terminals must be checked regularly to ensure that they are secure, and if necessary, retightened. Retighten if necessary. The wiring must be checked for damage. Defective parts must be replaced immediately.

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.

Safety instructions for maintenance and repair work

 **WARNING**

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

The non-observance of the fundamental safety instructions and residual risks stated in Chapter Basic safety instructions (Page 9) can result in accidents with severe injuries or death.

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



 **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 five minutes after the power supply has been switched off.

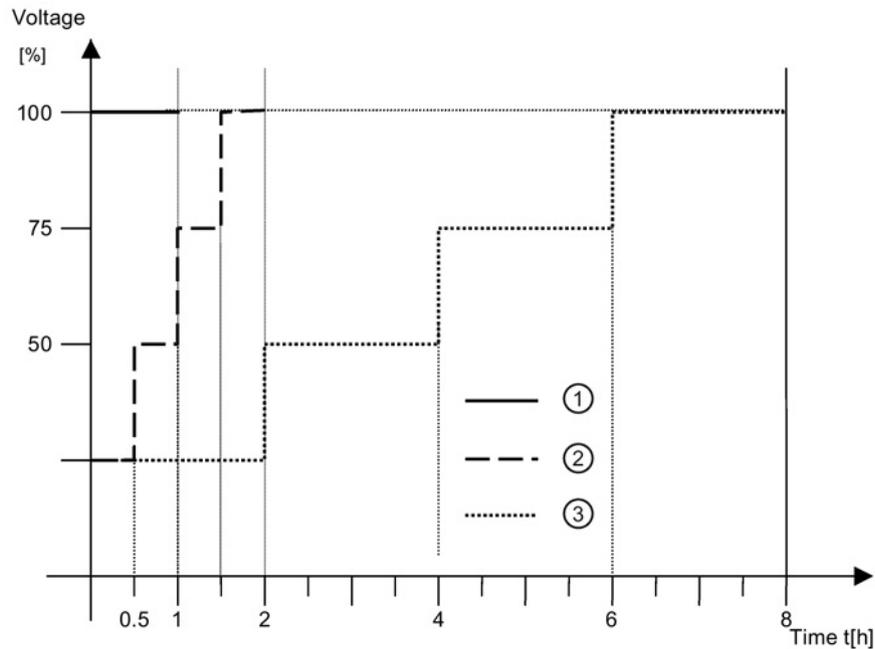
Contact with live parts can result in death or serious injury.

- Only open the device after five minutes have elapsed.
- Measure the voltage before starting work on the DCP and DCN DC link terminals.

5.2 Forming

Forming the DC link capacitors

If converters were not operational for longer than a year (if possible: storage temperature < 40 °C), the DC link capacitors should be formed. The date of manufacture and therefore the storage time can be determined based on the Power Module serial number. You can take the details about the measures required when forming from the following diagram.



Storage times less than 1 year: No measures required

- ① Storage times of between 1 and 2 years: Connect voltage for one hour before switching on
- ② Storage times of between 2 and 3 years: Form corresponding to the curve before switching on
- ③ Storage times of 3 and more years: Form corresponding to the curve before switching on

Figure 5-1 Measures when forming the DC link capacitors

Code to encrypt the date of manufacture

The date of manufacture is encrypted in positions 3 - 6 of the serial number.

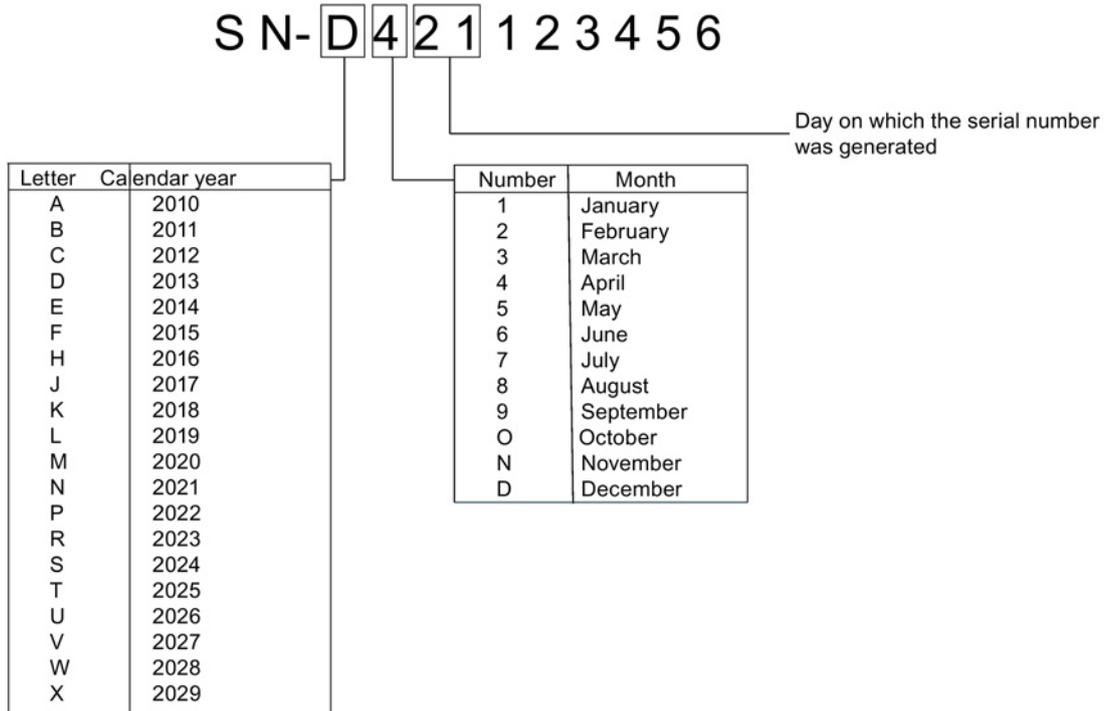


Figure 5-2 Code to encrypt the date of manufacture

In this example, the date of manufacture is April 21, 2013

5.3 Replacing the cooling fan

5.3.1 Service life of the cooling fan

Service life of the fan

The average service life of the fan is 50,000 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 in order to ensure that the drive remains ready for operation.

Note

Operating hours counter for the fan

The number of total operating hours are indicated in parameter p0251; alarm A30042 is output 500 hours before reaching and when reaching the end of the service life.

5.3.2 Fan replacement GX

Fan replacement for frame size GX

Removal

1. Switch off the converter.
2. Release the retaining screws (①). The screws are captive.
3. Shift the fan unit to the right, from position "2" to position "1" (this is marked on the housing).
The connector is simultaneously released.
4. Remove the cooling fan out from the converter (②).

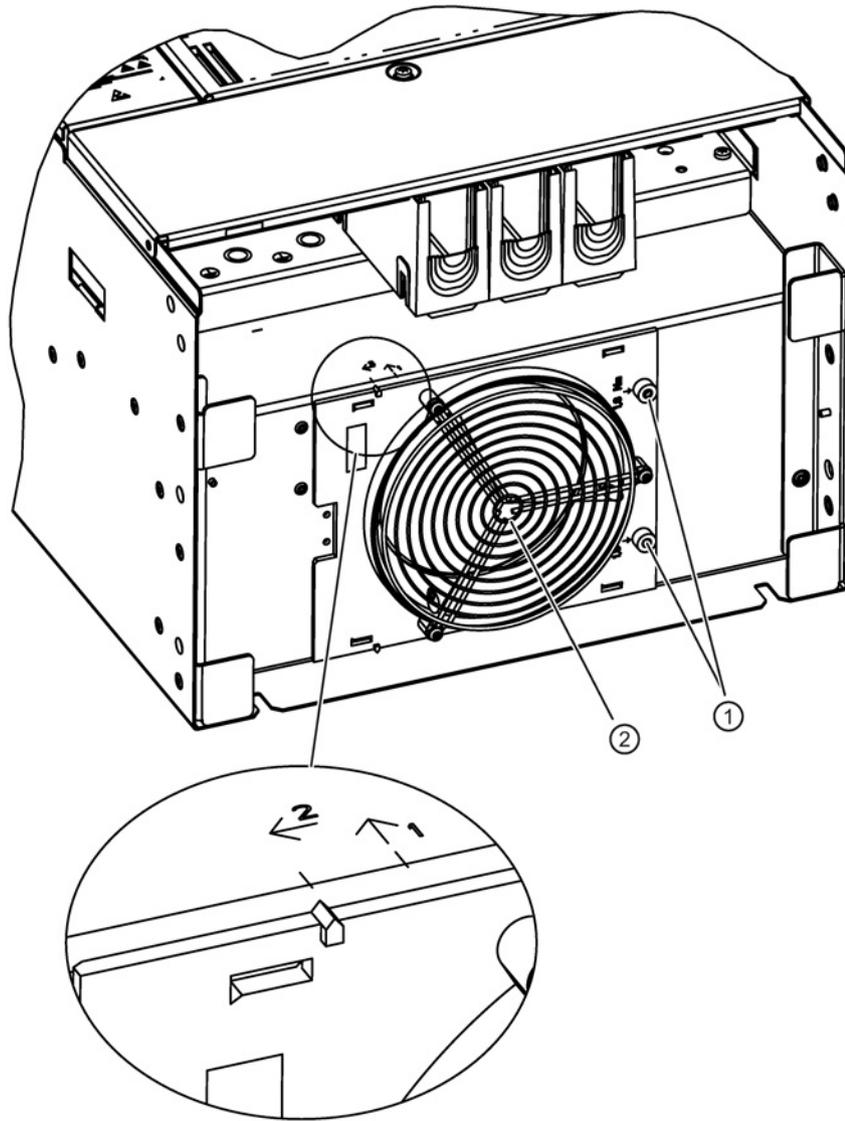


Figure 5-3 Fan removal for frame size GX, view from below

Installation

For re-installation, carry out the above steps in reverse order.

Tightening torque for the captive fixing screws: 1.8 Nm.

5.3.3 Fan replacement for HX, JX

Fan replacement for frame sizes HX and JX

Removal

1. Switch the converter off.
2. Remove the fixing screws from the left fan (①). The screws are captive.
3. Shift the fan unit to the right, from position "2" to position "1" (this is marked on the housing).
The connector is simultaneously released.
4. Remove the fan unit from the inverter (②).
5. Remove the fixing screws from the right fan (③). The screws are captive.
6. Shift the fan unit to the left, from position "2" to position "1" (this is marked on the housing).
The connector is released at the same time.
7. Remove the fan unit from the inverter (④).

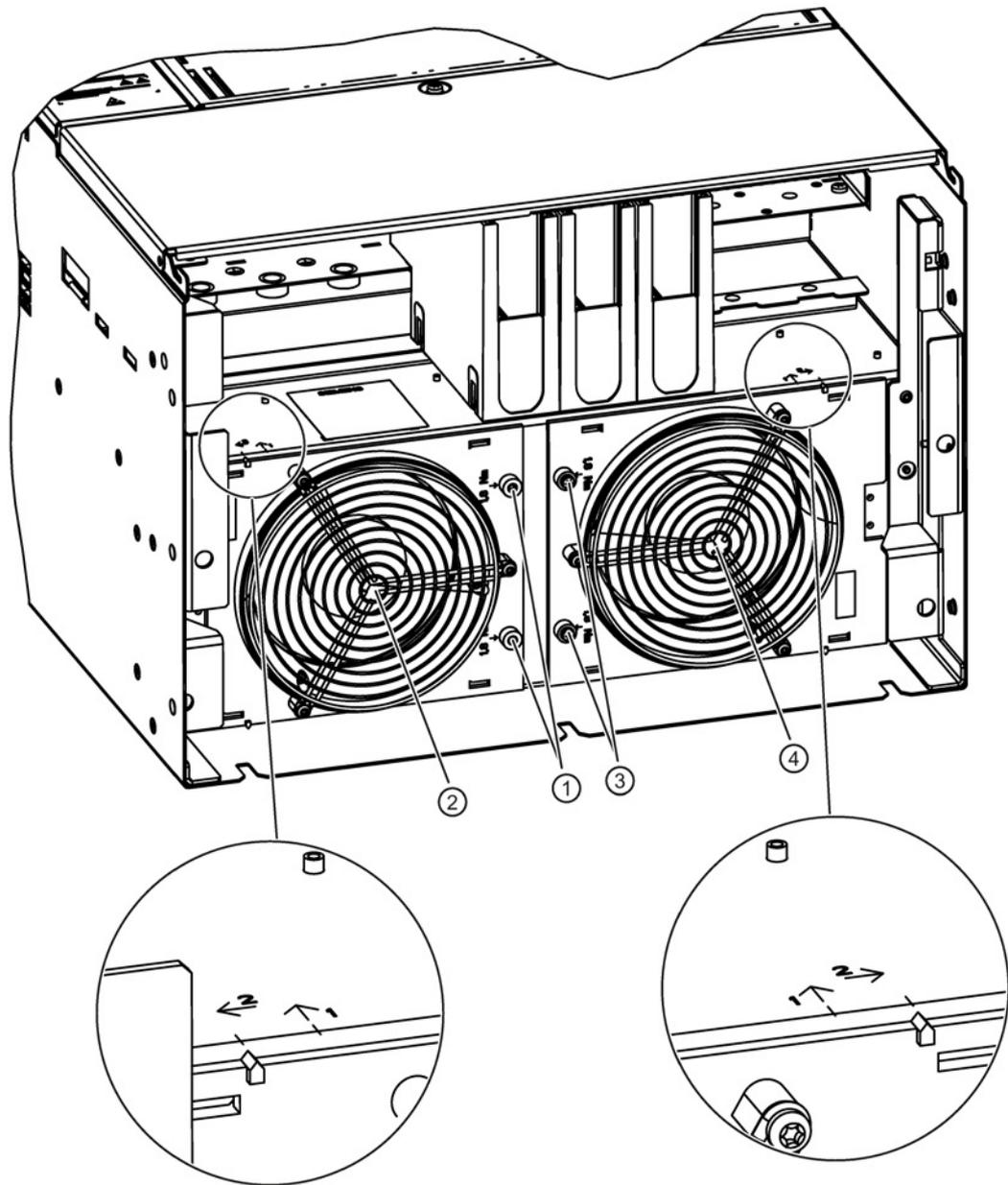


Figure 5-4 Fan removal for frame size HX, view from below (view is similar to frame size JX)

Installation

For re-installation, carry out the above steps in reverse order.

Tightening torque for the captive fixing screws: 1.8 Nm

Technical specifications

Converters for installation in the US (UL) and in Canada (cUL):

Use cUL- approved 3NE1 or 3NB3 fuses to ensure that the system is in conformance with cULus. Only use copper conductors approved for 75°C.

Input and output terminals must be connected using UL-approved ring cable lugs (UL Category ZMVV) for min. 480 V or 600 V - and the appropriate current carrying capacity (min. 125 % of the input/output current).

For the line connection of converter 6SL3310-1PE3-..... (Power Modules PM330) the power cables must be introduced into the terminal box from the top.

The converter can be connected to line supplies with overvoltage category III.

In conjunction with the Control Units, the converter has integrated motor overload protection. The overload protection responds at 115 % of the set rated motor current.

Refer to the associated operating instructions for further details on how to parameterize the Control Unit.

Note

The short-circuit protection integrated in the converter for the motor outputs does not provide any cable protection. The line protection must be secured in accordance with the requirements in this Manual, the National Electrical Code and other local requirements.

6.1 General technical data

Table 6- 1 General technical data

Electrical data	
Line system configurations	Grounded TN/TT systems or ungrounded IT systems (a grounded phase conductor is not permissible in 690 V line supplies)
Line requirement	A line reactor (2% u_k) must be connected in series
Line voltage	380 V (-10 %) ... 480 V (+10 %) 500 V (-10 %) ... 690 V (+10 %)
Line frequency	47 ... 63 Hz
Output frequency	0 ... 150 Hz (selecting an output frequency greater than 100 Hz works from SINAMICS firmware V4.7 SP6 HF3 and higher)
Displacement factor $\cos \varphi$ power factor λ	0.96 0.75 ... 0.93 (with line reactor $u_k = 2\%$)
Inverter efficiency	> 98%
Short-circuit current rating according to IEC, in conjunction with the specified fuses	160 ... 630 kW: 100 kA
Short-circuit current rating according to UL61800-5-1 (up to 480 V AC or 600 V AC), in conjunction with the specified fuses	160 ... 630 kW: 100 kA Can be used on line supplies that cannot supply more than 100 kA symmetrically at a maximum voltage of 480 V AC or 600 V AC when they are protected with the semiconductor fuses specified in Chapter "Technical Data" of this manual.
Overvoltage category	III according to EN 61800-5-1
Mechanical data	
Degree of protection	IP20
Protection class	according to EN 61800-5-1: Class I (with protective conductor system) and Class III (PELV)
Cooling method	Forced air cooling AF according to EN 60146
Sound pressure level L_{PA} (1 ma)	≤ 74 dB(A) ¹⁾
Touch protection	according to EN 61800-5-1: For the intended purpose
Compliance with standards	
Standards	EN 60146-1-1, EN 61800-2, EN 61800-3, EN 61800-5-1, EN 61800-5-2, EN 60204-1, EN 60529, EN 61508, EN 61511, EN ISO 13849 UL61800-5-1, CSA 22.2 No. 274-13
CE marking	in accordance with EMC Directive No. 2014/30/EU, Low Voltage Directive No. 2014/35/EU (up to FS < 04) and Machinery Directive No. 2006/42/EC (from FS \geq 04)
Radio interference suppression	In accordance with the EMC product standard for variable-speed drives EN 61800-3, "second environment" ²⁾ . Application in "first environment" possible with line filters.
Approval	cULus (File No.: E192450), CE, RCM, EAC, KC

Ambient conditions	During storage ³⁾	During transport ³⁾	During operation
Ambient temperature	-25° ... +55° C	-25 ... +70 °C -40 °C permitted for 24 h	0 ... +45 °C up to + 55 °C with derating
Relative humidity (no condensation) Corresponds to class	<i>5 to 95%</i> 1K4 according to EN 60721-3-1	5 ... 95% at 40° C 2K3 according to EN 60721-3-2	5 ... 95% 3K3 according to EN 60721-3-3
Environmental class / harmful chemical substances	1C2 according to EN 60721-3-1	2C2 according to EN 60721-3-2	3C2 according to EN 60721-3-3
Organic/biological influences (no conductive dust particles permitted)	1B1 according to EN 60721-3-1	2B1 according to EN 60721-3-2	3B1 according to EN 60721-3-3
Pollution degree	2 according to EN 61800-5-1		
Installation altitude	up to 1000 m above sea level without derating, > 1000 m above sea level with derating (see Chapter Derating as a function of the installation altitude (Page 89))		
Mechanical strength	During storage ³⁾	During transport ³⁾	During operation
Vibrational load - Displacement - Acceleration	Fc test according to EN 60068-2-6 ±1.5 mm for 5 ... 9 Hz 0.5 g at 9 ... 200 Hz	Fc test according to EN 60068-2-6 ±1.5 mm for 5 ... 9 Hz 0.5 g at 9 ... 200 Hz	Fc test according to EN 60068-2-6 0.075 mm for 10 ... 58 Hz 9.81 m/s ² (1 x g) at > 58 ... 200 Hz
Shock load - Displacement - Acceleration	Fc test according to EN 60068-2-6 ±1.5 mm for 5 ... 9 Hz 0.5 g at 9 ... 200 Hz	Fc test according to EN 60068-2-6 ±1.5 mm for 5 ... 9 Hz 0.5 g at 9 ... 200 Hz	Test according to EN 60068-2-27 (EA shock type) 49 m/s ² (5 x g)/30 ms 147 m/s ² (15 x g)/11 ms
Functional safety			
SIL claim limit	SIL 3 acc. to SIL CL to EN 61800-5-2 Depending on the application and the diagnostic test interval		
Achievable Category and Performance Level	Cat. 4 / PL e acc. to EN ISO 13849-1 Depending on the application and the diagnostic test interval		
PFH, PFH _D ⁴⁾	50 x 10 ⁻⁹ /h PFH acc. to IEC 61800-5-2, PFH _D acc. to IEC 62061		
TM: Usage time (mission time) ⁵⁾	20 years		
Response time when activating STO	Maximum 25 ms		

Deviations from the defined classes are shown in *italics*.

- 1) maximum sound pressure level, ascertained in the IP20 cabinet
- 2) Standard construction: Devices installed in the control cabinet with installation in conformance with EMC regulations, line reactor uk = 2%, shielded motor cable (e.g. Prototflex EMC) with max. 150 m cable length, line harmonics according to EN 61000-2-4: Class 2, THD(U) total = 8% for typical line conditions (RSC > 30 ... 50); THD(I) total: typically 30 ... 45 % (15 < RSC < 50)
- 3) in transport packaging
- 4) PFH, PFH_D: Probability of dangerous failures per hour.
- 5) EN 61800-5-2 mission time TM: Usage time, defined accumulated operating duration of the PDS(SR) over its complete service life.

Operating ranges

The converter can only be operated with reduced output current at low output frequencies. The connection is shown in the following diagram.

The diagram clearly demarcates continuous duty ranges from short-time duty ranges.

The operating ranges are used to ensure that the converter operates reliably at all times, including in particular in relation to lifetime expectancy.

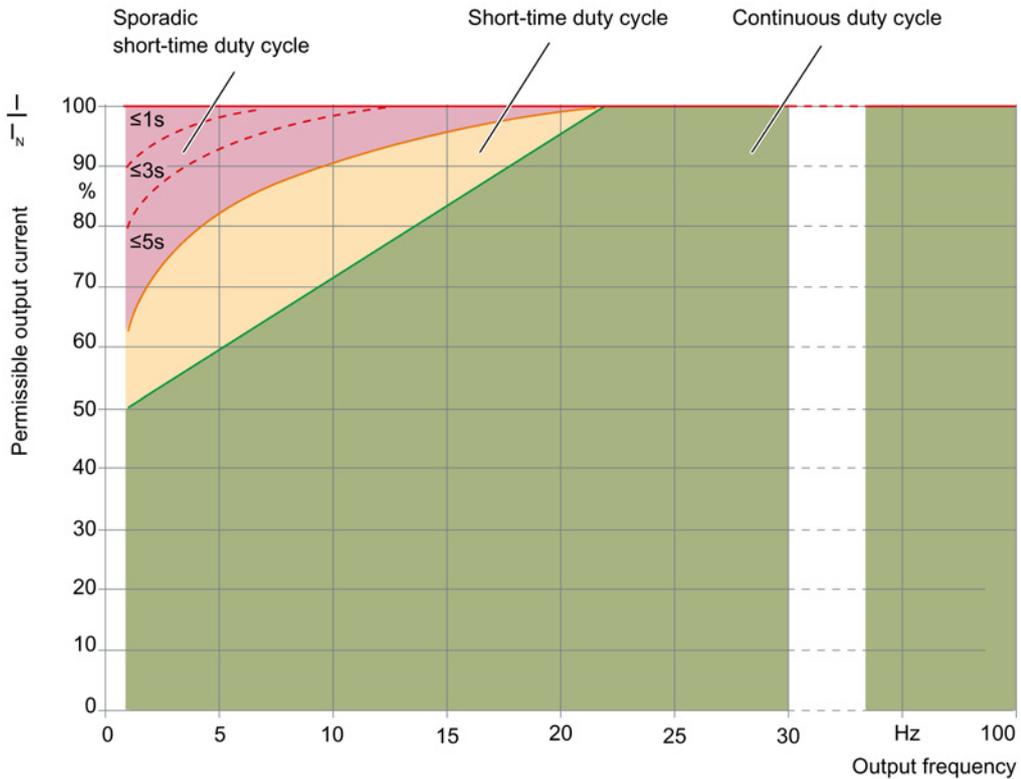


Figure 6-1 Operating ranges

Explanation of the operating ranges:

- **Continuous duty** (green range in the diagram)
 Continuous duty is permitted in this range without restriction.
- **Short-time operation** (yellow range in the diagram)
 In this range, operation for a total of 2 % of the total operating duration is permissible without noticeably reducing the converter service life. There is no overload reaction through the thermal monitoring model.
- **Sporadic short-time operation**(red range in the diagram)
 In this range, operation is only permissible for very brief and infrequent operating states of less than 0.1 % of the total operating duration, without noticeably reducing the converter service life. There is no overload reaction through the thermal monitoring model if the times stated in the diagram are complied with.

Permissible inverter overload

The inverters have different load capabilities, "High Overload" and "Low Overload", depending on the expected.

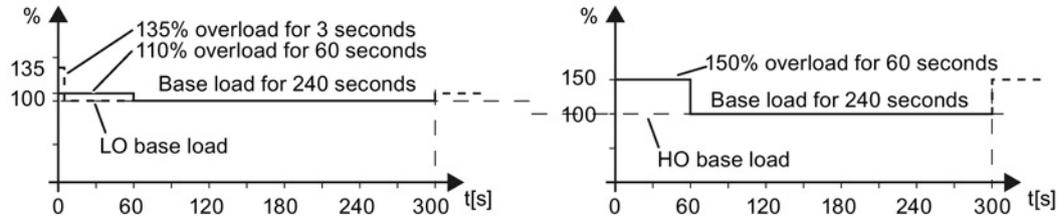


Figure 6-2 Load cycles, "Low Overload" and "High Overload"

Note

Please note the base load (100 % power or current) for Low Overload is higher than the base load for High Overload.

The load characteristics shown in the diagram are only examples. We recommend the use of the "SIZER" engineering software to select the appropriate Power Modules based on the load situation. See Configuring support (Page 104).

Definitions

- **LO base-load input current** 100 % of the permissible input current with a load cycle according to Low Overload.
- **LO base-load output current** 100 % of the permissible output current with a load cycle according to Low Overload.
- **LO base-load power** Power with LO base-load output current
- **HO base-load input current** 100 % of the permissible input current with a load cycle according to High Overload.
- **HO base-load output current** 100 % of the permissible output current with a load cycle according to High Overload.
- **HO base-load power** Power with HO base-load output current
- **Rated current I_N** Continuous current at the type rating, overload not possible

6.2 Specific technical data

Note

Recommended connection cross-sections

The recommended connection cross-sections are determined for copper cables at 45 °C ambient temperature and cables with a permitted operating temperature at the conductor of 70 °C (routing type C - factor for bundling 0.75 considered) according to DIN VDE 0298-4/08.03).

Protective conductor cross-section (S: Cross-section of the supply connection phase conductor, MS: Cross-section of the external protective conductor):

Minimum cross-sections:

- $S < 16 \text{ mm}^2 \rightarrow MS = S$
- $16 \text{ mm}^2 \leq S \leq 35 \text{ mm}^2 \rightarrow MS = 16 \text{ mm}^2$
- $S > 35 \text{ mm}^2 \rightarrow MS = 0.5 \times S$

Recommended cross-sections:

- $MS \geq S$
-

Table 6- 2 PM330 frame sizes GX, 3-phase 380 ... 480 VAC

Article No.	6SL3310-	1PE33-0AA0	1PE33-7AA0	1PE34-6AA0
Rated input current				
- at 380/400 V, 45° C		317 A	375 A	469 A
- at 480 V, 45° C		262 A	314 A	376 A
- at 380/400 V, 55° C		269 A	319 A	399 A
- at 480 V, 55° C		220 A	266 A	319 A
Rated input current DCP/DCN (for 2/3 of the inverter power)				
- at 510 V _{DC} , 45° C		255 A	315 A	392 A
- at 650 V _{DC} , 45° C		209 A	263 A	314 A
- at 510 V _{DC} , 55° C		217 A	268 A	333 A
- at 650 V _{DC} , 55° C		177 A	223 A	267 A
Rated output current I _N				
- at 380/400 V, 45° C		300 A	370 A	460 A
- at 480 V, 45° C		245 A	308 A	369 A
- at 380/400 V, 55° C		255 A	315 A	391 A
- at 480 V, 55° C		208 A	262 A	313 A
LO base load power		160 kW	200 kW	250 kW
LO base load input current at 400 V		307 A	365 A	459 A
LO base load output current at 400 V		290 A	360 A	450 A
HO base load power		132 kW	160 kW	200 kW
HO base load input current at 400 V		254 A	300 A	375 A
HO base load output current at 400 V		240 A	296 A	368 A
Fuse according to IEC		3NE1333-2 (450 A/690 V)	3NE1334-2 (500 A/690 V)	3NE1435-2 (560 A/690 V)
manufacturer:		Siemens AG	Siemens AG	Siemens AG
Maximum permissible line short-circuit current I _{kmax}		≤ 100 kA	≤ 100 kA	≤ 100 kA
Minimum line short-circuit current required I _{kmin} ¹⁾		> 3.5 kA	> 4.5 kA	> 7.0 kA
Fuse in compliance with UL ²⁾		3NE1333-2 (450 A/690 V)	3NE1334-2 (500 A/690 V)	3NE1435-2 (560 A/690 V)
Manufacturer:		Siemens AG	Siemens AG	Siemens AG
Maximum permissible line short-circuit current I _{kmax}		≤ 100 kA	≤ 100 kA	≤ 100 kA
Minimum line short-circuit current required I _{kmin} ¹⁾		> 3.5 kA	> 4.5 kA	> 7.0 kA
max. power loss, at I _N , 45° C, 400 V		3.642 kW	4.414 kW	5.125 kW
Required cooling air flow		210 l/s	210 l/s	210 l/s
Maximum connectable cross-section of the line, motor and DC-link cable		2 x 240 mm ² 2 x 500 kcmil	2 x 240 mm ² 2 x 500 kcmil	2 x 240 mm ² 2 x 500 kcmil
Recommended cable cross-section for 380 V/400 V				
- line cable		2 x 120 mm ²	2 x 120 mm ²	2 x 185 mm ²
- motor cable		2 x 95 mm ²	2 x 95 mm ²	2 x 150 mm ²
Recommended cable cross-section for 480 V				
- line cable		2 x 95 mm ²	2 x 120 mm ²	2 x 120 mm ²
- motor cable		2 x 70 mm ²	2 x 95 mm ²	2 x 120 mm ²
Recommended cable cross-section for 380 V/400 V				
- DC link infeed (2/3 inverter power)		2 x 120 mm ²	2 x 120 mm ²	2 x 150 mm ²
- Braking Module ³⁾		35 mm ²	35 mm ²	35 mm ²
Recommended cable cross-section for 480 V				
- DC link infeed (2/3 inverter power)		2 x 95 mm ²	2 x 95 mm ²	2 x 120 mm ²
- Braking Module ³⁾		35 mm ²	35 mm ²	35 mm ²

Technical specifications

6.2 Specific technical data

Article No.	6SL3310-	1PE33-0AA0	1PE33-7AA0	1PE34-6AA0
Tightening torque for line, motor, DC link, and ground cable		50 Nm / 443 lbf in	50 Nm / 443 lbf in	50 Nm / 443 lbf in
Dimensions: Width x height x depth [mm]		452 x 1447 x 327.5	452 x 1447 x 327.5	452 x 1447 x 327.5
Weight		98 kg	104 kg	109 kg

- 1) The line supply must be capable of supplying the minimum short-circuit current so that the fuses trigger and consequential damage is avoided.
Note: If the minimum short-circuit current is not reached, then the tripping time for the fuses increases, and this may result in consequential damage.
- 2) When semiconductor fuses are used, they must be mounted in the same higher construction as the inverter.
- 3) When connecting a Braking Module with rated power 50 kW, P₂₀ power 200 kW.

Table 6- 3 PM330, frame size HX, 3-phase 380 ... 480 VAC

Article No.	6SL3310-	1PE35-8AA0	1PE36-6AA0	1PE37-4AA0
Rated input current				
- at 380/400 V, 45° C		597 A	668 A	750 A
- at 480 V, 45° C		497 A	536 A	614 A
- at 380/400 V, 55° C		507 A	568 A	637 A
- at 480 V, 55° C		422 A	456 A	522 A
Rated input current DCP/DCN (for 2/3 of the inverter power)				
- at 510 V _{DC} , 45° C		498 A	558 A	626 A
- at 650 V _{DC} , 45° C		415 A	448 A	513 A
- at 510 V _{DC} , 55° C		423 A	474 A	532 A
- at 650 V _{DC} , 55° C		352 A	381 A	436 A
Rated output current I _N				
- at 380/400 V, 45° C		585 A	655 A	735 A
- at 480 V, 45° C		487 A	526 A	602 A
- at 380/400 V, 55° C		497 A	557 A	625 A
- at 480 V, 55° C		414 A	447 A	512 A
LO base load power		315 kW	355 kW	400 kW
LO base load input current at 400 V		581 A	653 A	734 A
LO base load output current at 400 V		570 A	640 A	720 A
HO base load power		250 kW	250 kW	315 kW
HO base load input current at 400 V		477 A	501 A	562 A
HO base load output current at 400 V		468 A	491 A	551 A
Fuse according to IEC		3NE1437-2 (710 A/690 V)	3NE1438-2 (800 A/690 V)	3NE1448-2 (850 A/690 V)
manufacturer:		Siemens AG	Siemens AG	Siemens AG
Maximum permissible line short-circuit current I _{kmax}		≤ 100 kA	≤ 100 kA	≤ 100 kA
Minimum line short-circuit current required I _{kmin} ¹⁾		> 10.0 kA	> 11.0 kA	> 13.0 kA
Fuse in compliance with UL ²⁾		3NE1437-2 (710 A/690 V)	3NE1438-2 (800 A/690 V)	3NE1448-2 (850 A/690 V)
Manufacturer:		Siemens AG	Siemens AG	Siemens AG
Maximum permissible line short-circuit current I _{kmax}		≤ 100 kA	≤ 100 kA	≤ 100 kA
Minimum line short-circuit current required I _{kmin} ¹⁾		> 10.0 kA	> 11.0 kA	> 13.0 kA
max. power loss, at I _N , 45° C, 400 V		6.791 kW	7.687 kW	8.385 kW
Required cooling air flow		360 l/s	360 l/s	360 l/s
Maximum connectable cross-section of the line, motor and DC-link cable		4 x 240 mm ² 4 x 500 kcmil	4 x 240 mm ² 4 x 500 kcmil	4 x 240 mm ² 4 x 500 kcmil
Recommended cable cross-section for 380 V/400 V				
- line cable		2 x 240 mm ²	3 x 150 mm ²	3 x 185 mm ²
- motor cable		2 x 185 mm ²	2 x 240 mm ²	2 x 240 mm ²
Recommended cable cross-section for 480 V				
- line cable		2 x 185 mm ²	2 x 240 mm ²	2 x 240 mm ²
- motor cable		2 x 150 mm ²	2 x 185 mm ²	2 x 240 mm ²
Recommended cable cross-section for 380 V/400 V				
- DC link infeed (2/3 inverter power)		2 x 185 mm ²	2 x 240 mm ²	3 x 150 mm ²
- Braking Module ³⁾		35 mm ²	35 mm ²	35 mm ²
Recommended cable cross-section for 480 V				
- DC link infeed (2/3 inverter power)		2 x 150 mm ²	2 x 185 mm ²	2 x 240 mm ²
- Braking Module ³⁾		35 mm ²	35 mm ²	35 mm ²

Technical specifications

6.2 Specific technical data

Article No.	6SL3310-	1PE35-8AA0	1PE36-6AA0	1PE37-4AA0
Tightening torque for line, motor, DC link, and ground cable		50 Nm / 443 lbf in	50 Nm / 443 lbf in	50 Nm / 443 lbf in
Dimensions: Width x height x depth [mm]		548 x 1695 x 393	548 x 1695 x 393	548 x 1695 x 393
Weight		151 kg	157 kg	159 kg
Minimum control cabinet size for installation of the Power Module (width x height x depth)		800 mm x 2000 mm x 600 mm		

- 1) The line supply must be capable of supplying the minimum short-circuit current so that the fuses trigger and consequential damage is avoided.
Note: If the minimum short-circuit current is not reached, then the tripping time for the fuses increases, and this may result in consequential damage.
- 2) When semiconductor fuses are used, they must be mounted in the same higher construction as the inverter.
- 3) When connecting a Braking Module with rated power 50 kW, P₂₀ power 200 kW.

Table 6- 4 PM330, frame size JX, 3-phase 380 ... 480 VAC

Article No.	6SL3310-	1PE38-4AA0	1PE38-8AA0	1PE41-0AA0
Rated input current				
- at 380/400 V, 45° C		870 A	945 A	1061 A
- at 480 V, 45° C		702 A	767 A	880 A
- at 380/400 V, 55° C		740 A	803 A	901 A
- at 480 V, 55° C		596 A	652 A	748 A
Rated input current DCP/DCN (for 2/3 of the inverter power)				
- at 510 V _{DC} , 45° C		715 A	775 A	870 A
- at 650 V _{DC} , 45° C		577 A	629 A	722 A
- at 510 V _{DC} , 55° C		608 A	659 A	739 A
- at 650 V _{DC} , 55° C		490 A	535 A	613 A
Rated output current I _N				
- at 380/400 V, 45° C		840 A	910 A	1021 A
- at 480 V, 45° C		677 A	739 A	847 A
- at 380/400 V, 55° C		714 A	774 A	868 A
- at 480 V, 55° C		576 A	628 A	720 A
LO base load power		450 kW	500 kW	560 kW
LO base load input current at 400 V		850 A	925 A	1039 A
LO base load output current at 400 V		820 A	890 A	1000 A
HO base load power		355 kW	400 kW	450 kW
HO base load input current at 400 V		696 A	756 A	816 A
HO base load output current at 400 V		672 A	728 A	786 A
Fuse according to IEC		2 x 3NE1334-2 // (2 x 500 A / 690 V)	2 x 3NE1435-2 // (2 x 560 A / 690 V)	2 x 3NE1436-2 // (2 x 630 A / 690 V)
manufacturer:		Siemens AG	Siemens AG	Siemens AG
Maximum permissible line short-circuit current I _{kmax}		≤ 100 kA	≤ 100 kA	≤ 100 kA
Minimum line short-circuit current required I _{kmin} ¹⁾		> 10.4 kA	> 14.0 kA	> 16.0 kA
Fuse in compliance with UL ²⁾		3NB3350-1KK26 (1000 A/690 V)	3NB3351-1KK26 (1100 A/690 V)	3NB3352-1KK26 (1250 A/690 V)
Manufacturer:		Siemens AG	Siemens AG	Siemens AG
Minimum line short-circuit current required I _{kmin} ¹⁾		8.6 kA	17.0 kA	18.0 kA
max. power loss, at I _N , 45° C, 400 V		10.418 kW	10.885 kW	12.495 kW
Required cooling air flow		450 l/s	450 l/s	450 l/s
Maximum connectable cross-section of the power cable		6 x 240 mm ² 6 x 500 kcmil	6 x 240 mm ² 6 x 500 kcmil	6 x 240 mm ² 6 x 500 kcmil
Maximum connectable cross-section of the motor cable		4 x 240 mm ² 4 x 500 kcmil	8 x 240 mm ² 8 x 500 kcmil	8 x 240 mm ² 8 x 500 kcmil
Maximum connectable cross-section of the DC link cable		4 x 240 mm ² 4 x 500 kcmil	4 x 240 mm ² 4 x 500 kcmil	4 x 240 mm ² 4 x 500 kcmil
Recommended cable cross-section for 380 V/400 V				
- line cable		4 x 185 mm ²	4 x 185 mm ²	4 x 240 mm ²
- motor cable ³⁾		4 x 150 mm ²	4 x 185 mm ²	4 x 240 mm ²
Recommended cable cross-section for 480 V				
- line cable		4 x 120 mm ²	4 x 150 mm ²	4 x 185 mm ²
- motor cable ³⁾		4 x 120 mm ²	4 x 150 mm ²	4 x 150 mm ²
Recommended cable cross-section for 380 V/400 V				
- DC link infeed (2/3 inverter power)		4 x 120 mm ²	4 x 150 mm ²	4 x 185 mm ²
- Braking Module ⁴⁾		35 mm ²	35 mm ²	35 mm ²

Technical specifications

6.2 Specific technical data

Article No.	6SL3310-	1PE38-4AA0	1PE38-8AA0	1PE41-0AA0
Recommended cable cross-section for 480 V - DC link infeed (2/3 inverter power) - Braking Module ⁴⁾		3 x 120 mm ² 35 mm ²	3 x 150 mm ² 35 mm ²	3 x 185 mm ² 35 mm ²
Tightening torque for line, motor, DC link, and ground cable		50 Nm / 443 lbf in	50 Nm / 443 lbf in	50 Nm / 443 lbf in
Dimensions: Width x height x depth [mm]		801 x 1621 x 393	801 x 1621 x 393	801 x 1621 x 393
Weight		235 kg	250 kg	250 kg

- 1) The line supply must be capable of supplying the minimum short-circuit current so that the fuses trigger and consequential damage is avoided.
Note: If the minimum short-circuit current is not reached, then the tripping time for the fuses increases, and this may result in consequential damage.
- 2) When semiconductor fuses are used, they must be mounted in the same higher construction as the inverter.
- 3) The motor cables must be evenly distributed at both connection chambers.
- 4) For connection of the Braking Module with rated power of 50 kW, P₂₀ power of 200 kW.

Table 6- 5 PM330, frame size HX, 3-phase 500 ... 690 VAC, Part 1

Article No.	6SL3310-	1PG33-7AA0	1PG34-0AA0	1PG34-5AA0
Rated input current				
- at 500 V, 45 °C		383 A	416 A	471 A
- at 600 V, 45 °C		367 A	412 A	459 A
- at 690 V, 45 °C		354 A	409 A	447 A
- at 500 V, 55 °C		326 A	354 A	400 A
- at 600 V, 55 °C		312 A	350 A	390 A
- at 690 V, 55 °C		301 A	348 A	380 A
Rated input current DCP/DCN (for 2/3 of the inverter power)				
- at 675 V _{DC} , 45 °C		314 A	341 A	385 A
- at 810 V _{DC} , 45 °C		301 A	337 A	376 A
- at 930 V _{DC} , 45 °C		290 A	335 A	366 A
- at 675 V _{DC} , 55 °C		267 A	290 A	328 A
- at 810 V _{DC} , 55 °C		255 A	287 A	319 A
- at 930 V _{DC} , 55 °C		246 A	284 A	311 A
Rated output current I_N				
- at 500 V, 45 °C		368 A	400 A	453 A
- at 600 V, 45 °C		353 A	396 A	441 A
- at 690 V, 45 °C		340 A	393 A	430 A
- at 500 V, 55 °C		313 A	340 A	385 A
- at 600 V, 55 °C		300 A	337 A	375 A
- at 690 V, 55 °C		289 A	334 A	366 A
LO base load power		315 kW	355 kW	400 kW
LO base load input current at 690 V		343 A	401 A	437 A
LO base load output current at 690 V		330 A	385 A	420 A
HO base load power		250 kW	315 kW	355 kW
HO base load input current at 690 V		283 A	327 A	362 A
HO base load output current at 690 V		272 A	314 A	348 A
Fuse according to IEC		3NE1333-2 (450 A/690 V)	3NE1334-2 (500 A/690 V)	3NE1435-2 (560 A/690 V)
manufacturer:		Siemens AG	Siemens AG	Siemens AG
Maximum permissible line short-circuit current I _{kmax}		≤ 100 kA	≤ 100 kA	≤ 100 kA
Minimum line short-circuit current required I _{kmin} ¹⁾		> 3.5 kA	> 4.5 kA	> 7.0 kA
Fuse in compliance with UL ²⁾		3NE1333-2 (450 A/690 V)	3NE1334-2 (500 A/690 V)	3NE1435-2 (560 A/690 V)
Manufacturer:		Siemens AG	Siemens AG	Siemens AG
Maximum permissible line short-circuit current I _{kmax}		≤ 100 kA	≤ 100 kA	≤ 100 kA
Minimum line short-circuit current required I _{kmin} ¹⁾		> 3.5 kA	> 4.5 kA	> 7.0 kA
max. power loss, at I _N , 45 °C, 690 V		5.402 kW	6.191 kW	6.884 kW
Required cooling air flow		360 l/s	360 l/s	360 l/s
Maximum connectable cross-section of the line, motor and DC-link cable		4 x 240 mm ² 4 x 500 kcmil	4 x 240 mm ² 4 x 500 kcmil	4 x 240 mm ² 4 x 500 kcmil
Recommended cable cross-section for 500 V				
- line cable		2 x 120 mm ²	2 x 150 mm ²	2 x 185 mm ²
- motor cable		2 x 120 mm ²	2 x 120 mm ²	2 x 150 mm ²
Recommended cable cross-section for 690 V				
- line cable		2 x 120 mm ²	2 x 150 mm ²	2 x 185 mm ²
- motor cable		2 x 95 mm ²	2 x 120 mm ²	2 x 150 mm ²

Technical specifications

6.2 Specific technical data

Article No.	6SL3310-	1PG33-7AA0	1PG34-0AA0	1PG34-5AA0
Recommended cable cross-section for 500 V - DC link infeed (2/3 inverter power)		2 x 95 mm ²	2 x 120 mm ²	2 x 150 mm ²
Recommended cable cross-section for 690 V - DC link infeed (2/3 inverter power)		2 x 95 mm ²	2 x 120 mm ²	2 x 150 mm ²
Tightening torque for line, motor, DC link, and ground cable		50 Nm / 443 lbf in	50 Nm / 443 lbf in	50 Nm / 443 lbf in
Dimensions: Width x height x depth [mm]		548 x 1695 x 393	548 x 1695 x 393	548 x 1695 x 393
Weight		158 kg	158 kg	162 kg
Minimum control cabinet size for installation of the Power Module (width x height x depth)		800 mm x 2000 mm x 600 mm		

- 1) The line supply must be capable of supplying the minimum short-circuit current so that the fuses trigger and consequential damage is avoided.
Note: If the minimum short-circuit current is not reached, then the tripping time for the fuses increases, and this may result in consequential damage.
- 2) When semiconductor fuses are used, they must be mounted in the same higher construction as the inverter.

Table 6- 6 PM330, frame size HX, 3-phase 500 ... 690 VAC, Part 2

Article No.	6SL3310-	1PG35-2AA0
Rated input current		
- at 500 V, 45 °C		537 A
- at 600 V, 45 °C		517 A
- at 690 V, 45 °C		499 A
- at 500 V, 55 °C		456 A
- at 600 V, 55 °C		440 A
- at 690 V, 55 °C		425 A
Rated input current DCP/DCN (for 2/3 of the inverter power)		
- at 675 V _{DC} , 45 °C		439 A
- at 810 V _{DC} , 45 °C		423 A
- at 930 V _{DC} , 45 °C		409 A
- at 675 V _{DC} , 55 °C		373 A
- at 810 V _{DC} , 55 °C		360 A
- at 930 V _{DC} , 55 °C		347 A
Rated output current I _N		
- at 500 V, 45 °C		516 A
- at 600 V, 45 °C		497 A
- at 690 V, 45 °C		480 A
- at 500 V, 55 °C		438 A
- at 600 V, 55 °C		422 A
- at 690 V, 55 °C		408 A
LO base load power		450 kW
LO base load input current at 690 V		489 A
LO base load output current at 690 V		470 A
HO base load power		400 kW
HO base load input current at 690 V		410 A
HO base load output current at 690 V		394 A
Fuse according to IEC		3NE1436-2 (630 A/690 V)
manufacturer:		Siemens AG
Maximum permissible line short-circuit current I _{kmax}		≤ 100 kA
Minimum line short-circuit current required I _{kmin} ¹⁾		> 8.5 kA
Fuse in compliance with UL ²⁾		3NE1436-2 (630 A/690 V)
Manufacturer:		Siemens AG
Maximum permissible line short-circuit current I _{kmax}		≤ 100 kA
Minimum line short-circuit current required I _{kmin} ¹⁾		> 8.5 kA
max. power loss, at I _N , 45 °C, 690 V		7.716 kW
Required cooling air flow		360 l/s
Maximum connectable cross-section of the line, motor and DC-link cable		4 x 240 mm ² 4 x 500 kcmil
Recommended cable cross-section for 500 V		
- line cable		3 x 120 mm ²
- motor cable		3 x 95 mm ²
Recommended cable cross-section for 690 V		
- line cable		3 x 120 mm ²
- motor cable		3 x 95 mm ²

Technical specifications

6.2 Specific technical data

Article No.	6SL3310-	1PG35-2AA0
Recommended cable cross-section for 500 V - DC link infeed (2/3 inverter power)		2 x 150 mm ²
Recommended cable cross-section for 690 V - DC link infeed (2/3 inverter power)		2 x 150 mm ²
Tightening torque for line, motor, DC link, and ground cable		50 Nm / 443 lbf in
Dimensions: Width x height x depth [mm]		548 x 1695 x 393
Weight		162 kg
Minimum control cabinet size for installation of the Power Module (width x height x depth)		800 mm x 2000 mm x 600 mm

- 1) The line supply must be capable of supplying the minimum short-circuit current so that the fuses trigger and consequential damage is avoided.
Note: If the minimum short-circuit current is not reached, then the tripping time for the fuses increases, and this may result in consequential damage.
- 2) When semiconductor fuses are used, they must be mounted in the same higher construction as the inverter.

Table 6- 7 PM330, frame size JX, 3 AC 500 V ... 690 V

Article No.	6SL3310-	1PG35-8AA0	1PG36-5AA0	1PG37-2AA0
Rated input current				
- at 500 V, 45 °C		596 A	679 A	753 A
- at 600 V, 45 °C		578 A	647 A	720 A
- at 690 V, 45 °C		555 A	618 A	690 A
- at 500 V, 55 °C		506 A	577 A	640 A
- at 600 V, 55 °C		492 A	550 A	612 A
- at 690 V, 55 °C		472 A	525 A	587 A
Rated input current DCP/DCN (for 2/3 of the inverter power)				
- at 675 V _{DC} , 45 °C		495 A	557 A	617 A
- at 810 V _{DC} , 45 °C		474 A	531 A	590 A
- at 930 V _{DC} , 45 °C		456 A	507 A	566 A
- at 675 V _{DC} , 55 °C		420 A	473 A	525 A
- at 810 V _{DC} , 55 °C		403 A	451 A	502 A
- at 930 V _{DC} , 55 °C		387 A	431 A	481 A
Rated output current I_N				
- at 500 V, 45 °C		581 A	654 A	725 A
- at 600 V, 45 °C		557 A	623 A	693 A
- at 690 V, 45 °C		535 A	595 A	665 A
- at 500 V, 55 °C		494 A	555 A	616 A
- at 600 V, 55 °C		473 A	530 A	589 A
- at 690 V, 55 °C		455 A	506 A	565 A
LO base load power		500 kW	560 kW	630 kW
LO base load input current at 690 V		540 A	602 A	675 A
LO base load output current at 690 V		520 A	580 A	650 A
HO base load power		450 kW	500 kW	560 kW
HO base load input current at 690 V		461 A	494 A	552 A
HO base load output current at 690 V		444 A	476 A	532 A
Fuse according to IEC		3NE1437-2 (710 A/690 V)	3NE1438-2 (800 A/690 V)	3NE1448-2 (850 A/690 V)
manufacturer:		Siemens AG	Siemens AG	Siemens AG
Maximum permissible line short-circuit current I _{kmax}		≤ 100 kA	≤ 100 kA	≤ 100 kA
Minimum line short-circuit current required I _{kmin} ¹⁾		> 10.0 kA	> 11.0 kA	> 13.0 kA
Fuse in compliance with UL ²⁾		3NE1437-2 (710 A/690 V)	3NE1438-2 (800 A/690 V)	3NE1448-2 (850 A/690 V)
Manufacturer:		Siemens AG	Siemens AG	Siemens AG
Maximum permissible line short-circuit current I _{kmax}		≤ 100 kA	≤ 100 kA	≤ 100 kA
Minimum line short-circuit current required I _{kmin} ¹⁾		> 10.0 kA	> 11.0 kA	> 13.0 kA
max. power loss, at I _N , 45 °C, 690 V		8.134 kW	8.828 kW	9.937 kW
Required cooling air flow		450 l/s	450 l/s	450 l/s
Maximum connectable cross-section of the power cable		6 x 240 mm ² 6 x 500 kcmil	6 x 240 mm ² 6 x 500 kcmil	6 x 240 mm ² 6 x 500 kcmil
Maximum connectable cross-section of the motor cable		4 x 240 mm ² 4 x 500 kcmil	4 x 240 mm ² 4 x 500 kcmil	4 x 240 mm ² 4 x 500 kcmil
Maximum connectable cross-section of the DC link cable		4 x 240 mm ² 4 x 500 kcmil	4 x 240 mm ² 4 x 500 kcmil	4 x 240 mm ² 4 x 500 kcmil

6.3 Derating data

Article No.	6SL3310-	1PG35-8AA0	1PG36-5AA0	1PG37-2AA0
Recommended cable cross-section for 500 V				
- line cable		2 x 240 mm ²	3 x 185 mm ²	3 x 185 mm ²
- motor cable ³⁾		2 x 185 mm ²	2 x 240 mm ²	2 x 240 mm ²
Recommended cable cross-section for 690 V				
- line cable		2 x 240 mm ²	3 x 150 mm ²	3 x 185 mm ²
- motor cable ³⁾		2 x 185 mm ²	2 x 240 mm ²	2 x 240 mm ²
Recommended cable cross-section for 500 V				
- DC link infeed (2/3 inverter power)		2 x 185 mm ²	2 x 185 mm ²	2 x 240 mm ²
Recommended cable cross-section for 690 V				
- DC link infeed (2/3 inverter power)		2 x 150 mm ²	2 x 185 mm ²	2 x 185 mm ²
Tightening torque for line, motor, DC link, and ground cable		50 Nm / 443 lbf in	50 Nm / 443 lbf in	50 Nm / 443 lbf in
Dimensions: Width x height x depth [mm]		801 x 1621 x 393	801 x 1621 x 393	801 x 1621 x 393
Weight		236 kg	236 kg	246 kg

- 1) The line supply must be capable of supplying the minimum short-circuit current so that the fuses trigger and consequential damage is avoided.
Note: If the minimum short-circuit current is not reached, then the tripping time for the fuses increases, and this may result in consequential damage.
- 2) When semiconductor fuses are used, they must be mounted in the same higher construction as the inverter.
- 3) The motor cables must be evenly distributed at both connection chambers.

6.3 Derating data

6.3.1 Derating factor of the output current as a function of the ambient temperature in operation

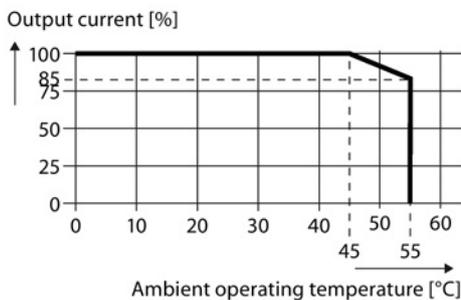


Figure 6-3 Derating factor of the output current as a function of the ambient temperature in operation

6.3.2 Derating as a function of the installation altitude

Voltage

The insulation clearances within the inverter are measured for surge voltages in accordance with overvoltage category III in compliance with EN 60664-1 for installation altitudes up to 2000 m above sea level.

Use of an isolating transformer to reduce transient overvoltages to IEC 61800–5–1

By using the isolating transformer, overvoltage category III is reduced to overvoltage category II. As a result, the requirements placed on the insulating capability of air are reduced. An additional (input) voltage derating is not necessary if the following basic conditions are met:

- The isolation transformer must be fed from a low-voltage or medium-voltage network; it must not be supplied directly from a high-voltage network.
- The isolating transformer may be connect to one or more inverters.
- The cables between the isolating transformer and the inverters must be routed in such a manner as to rule out a direct lightning strike, i.e. it is not permissible for overland lines to be used.
- The following supply system types are permissible:
 - TN supply systems with grounded star point (no grounded phase conductor)
 - IT supply systems (operation with a ground fault must be limited to the shortest time possible)

Note

The connected motors and power components must be considered separately.

Reduction of the output current

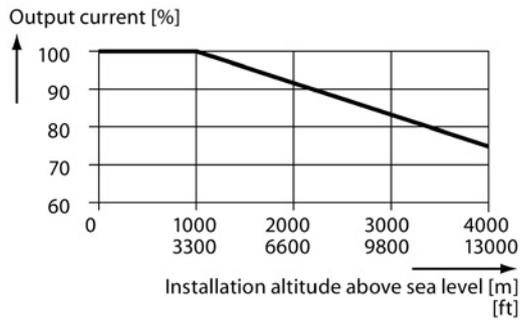


Figure 6-4 Derating of the output current in accordance with the installation altitude with frame size GX

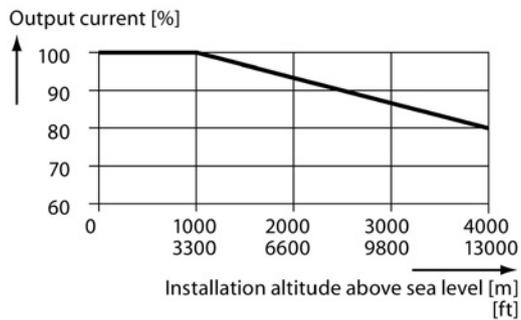


Figure 6-5 Derating of the output current as a function of the installation altitudes for frame sizes HX and JX

Decreasing the ambient temperature and the output current

The permissible output currents as a function of the installation altitude and ambient temperature are listed in the following tables.

Due to the reduced cooling efficiency as the altitude increases, it is necessary, on the one hand, to reduce the ambient temperature and, on the other, to reduce the power loss of the Power Module by reducing the output current, whereby ambient temperatures lower than 45 °C may be taken into consideration to compensate, and are taken into account in the tables. The values apply under the precondition that a cooling air flow through the devices is ensured as specified in the technical specifications.

Table 6- 8 Current derating as a function of the ambient temperature and installation altitude for frame size GX

Installation altitude above mean sea level in m	Current derating factor at an ambient temperature (air intake temperature) of							
	20 °C	25 °C	30 °C	35 °C	40 °C	45 °C	50 °C	55 °C
0 ... 1000	100%	100%	100%	100%	100%	100%	93%	85%
1001 ... 1500	100%	100%	100%	100%	100%	96%	89%	81%
1501 ... 2000	100%	100%	100%	100%	99%	92%	85%	78%
2001 ... 2500	100%	100%	100%	100%	94%	88%	81%	74%
2501 ... 3000	100%	100%	100%	96%	90%	83%	77%	71%
3001 ... 3500	100%	100%	97%	91%	85%	79%	73%	67%
3500 ... 4000	100%	98%	92%	86%	81%	75 %	69%	64%

Table 6- 9 Current derating as a function of the ambient temperature and installation altitude for frame sizes HX and JX

Installation altitude above mean sea level in m	Current derating factor at an ambient temperature (air intake temperature) of							
	20 °C	25 °C	30 °C	35 °C	40 °C	45 °C	50 °C	55 °C
0 ... 1000	100%	100%	100%	100%	100%	100%	93%	85%
1001 ... 1500	100%	100%	100%	100%	100%	97%	89%	82%
1501 ... 2000	100%	100%	100%	100%	100%	93%	86%	79%
2001 ... 2500	100%	100%	100%	100%	97%	90%	83%	76%
2501 ... 3000	100%	100%	100%	100%	94%	87%	80%	74%
3001 ... 3500	100%	100%	100%	96%	90%	84%	77%	71%
3500 ... 4000	100%	100%	98%	92%	86%	80%	74%	68%

6.3.3 Derating factor of the output current as a function of the line voltage

Table 6- 10 Derating of the output current as a function of the line voltage, 380 V ... 480 V 3 AC ±10 %

Power Module	Rated output current I _N at 380 V/400 V	380 V	400 V	415 V ¹⁾	460 V	480 V
6SL3310-1PE33-0AA0	300 A	100 %	100 %	96.6 %	86.2 %	81.6 %
6SL3310-1PE33-7AA0	370 A	100 %	100 %	96.9 %	87.8 %	83.7 %
6SL3310-1PE34-6AA0	460 A	100 %	100 %	96.4 %	85.4 %	80.6 %
6SL3310-1PE35-8AA0	585 A	100 %	100 %	96.9 %	87.8 %	83.7 %
6SL3310-1PE36-6AA0	655 A	100 %	100 %	96.4 %	85.4 %	80.6 %
6SL3310-1PE37-4AA0	735 A	100 %	100 %	96.6 %	86.6 %	82.1 %
6SL3310-1PE38-4AA0	840 A	100 %	100 %	96.4 %	85.4 %	80.6 %
6SL3310-1PE38-8AA0	910 A	100 %	100 %	96.4 %	85.8%	81.2%
6SL3310-1PE41-0AA0	1021 A	100 %	100 %	96.8 %	87.3%	83.0%

¹⁾ Full rated current up to 440 V, therefore no derating for 415 V ±5 %.

Table 6- 11 Derating of the output current as a function of the line voltage, 500 V ... 690 V 3 AC ±10 %

Power Module	Rated output current I _N at 500 V/690 V	500 V	575 V	600 V	660 V	690 V
6SL3310-1PG33-7AA0	368 A / 340 A	100 %	97.0%	95.9%	93.5%	92.6%
6SL3310-1PG34-0AA0	400 A / 393 A	100 %	99.3%	99.0%	98.6%	98.3%
6SL3310-1PG34-5AA0	453 A / 430 A	100 %	98.0%	97.3%	95.8%	95.0%
6SL3310-1PG35-2AA0	516 A / 480 A	100 %	97.3%	96.3 %	94.2%	93.1%
6SL3310-1PG35-8AA0	581 A / 535 A	100 %	96.9 %	95.4%	93.3 %	92.1 %
6SL3310-1PG36-5AA0	654 A / 595 A	100 %	96.5 %	95.3%	92.4%	91.0%
6SL3310-1PG37-2AA0	725 A / 665 A	100 %	96.7%	95.6%	93.0 %	91.7 %

6.3.4 Derating of the output current as a function of the pulse frequency

With the factory setting, the drive starts with a 4 kHz pulse frequency, and under load, automatically reduces the pulse frequency step-by-step to the frequencies required. When the load decreases, the pulse frequency is increased automatically up to 4 kHz.

The values of the rated current refer to a pulse frequency of 2 kHz at 45° C ambient temperature and are reached at any time by the automatic adaptation of the output pulse frequency.

Fundamental safety technology principles

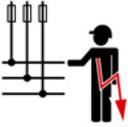
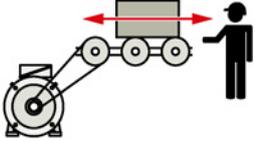
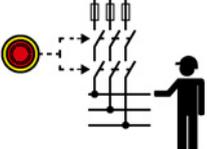
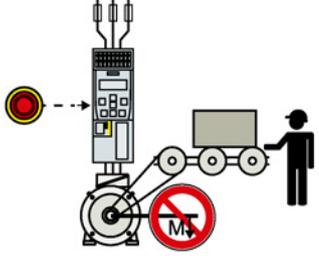
7.1 Standard stop functions

7.1.1 Emergency Off and Emergency Stop

"Emergency Off" and "Emergency Stop" are commands that minimize different risks in the machine or plant.

The STO function is suitable for achieving an Emergency Stop but not an Emergency Off.

You can review the details about the definitions in EN 60204-1.

Risk:	Risk of electric shock: 	Risk of unexpected motion: 
Measure to minimize risk:	Safe switch off Switching off the electric power supply for the installation, either completely or partially.	Safely stop and safely prevent re-starting Stopping or preventing the dangerous movement
Command:	Emergency Off	Emergency Stop
Solution:	Switch off the power supply: 	Select STO:  It is permissible that you switch off the inverter power supply as well. However, switching off the voltage is not required as a risk-reduction measure:

7.2 Standard safety functions according to EN 61800-5-2 / IEC 61508

7.2.1 Safe Torque Off (STO)

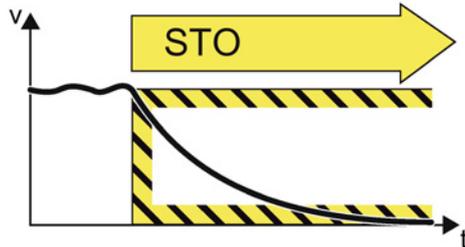


Figure 7-1 Safe Torque Off (STO)

Safe Torque Off is a safety subfunction that immediately ensures that torque or force-generating energy is not fed to the motor. This function corresponds to stop Category 0 according to EN 60204-1.

The Safe Torque Off (STO) function is used to safely disconnect the torque-generating energy feed to the motor; this is achieved in the power unit by preventing (through two channels), alternating voltage to be output to the motor.

The switch-on inhibit, which prevents automatic restart after deactivating STO, must be implemented by the upstream external monitoring and control system (e.g. 3SK1), according to the requirements of EN 60204-1, Chapter 9.2.5.

Typical applications

Applications include all machines and systems with moving axes (e.g. conveyor technology, fans). STO allows personnel to safely work with a protective door open; a classic emergency stop with electromechanical disconnection is not required. The inverter remains connected to the line and can be fully diagnosed.

7.2.2 Safe Stop 1 (SS1-t, time controlled)

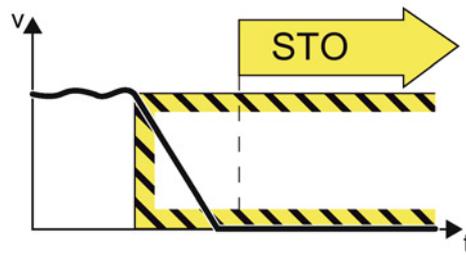


Figure 7-2 Safe Stop 1 (SS1-t, time controlled)

Safe Stop 1 (time controlled) causes the motor to be braked (this function is integrated in the drive) - and after a specified time interval, the Safe Torque Off function is initiated. This function corresponds to Stop Category 1 according to EN 60204-1.

The Safe Stop 1 function (SS1-t) function means that the motor is stopped and then the torque-generating energy is shut down (STO). When SS1-t is activated, the inverter brakes the motor along a braking ramp. This happens via the braking function integrated in the drive along the OFF3 ramp.

SS1-t corresponds to the SS1-t function according to EN 61800-5-2.

Typical applications

SS1-t can be used wherever the load torque cannot stop the motor in a sufficiently short time as a result of friction - or where there is a safety risk if the drive coasts down (STO).

Safety functions of PM330

8.1 Technical fundamentals of PM330 Power Module

8.1.1 General fundamentals and data

PM330 Power Modules are equipped with the safety subfunction Safe Torque Off (STO) from function release (FS) 04. An additional license is not required for this function; a speed encoder is also not necessary.

The STO circuit can be deactivated using the two switches -S41 STO_A and STO_B; for plants and systems where an STO function is not required, or for situations where this would represent a disturbance.

As described in Chapter "Schematic diagram of the safety relay at X41 (Page 54)", the complete STO function is subdivided into safety subfunctions.

React

The safety subfunction of the PM330 is controlled via terminal block X41 using digital inputs STO_A and STO_B. A low signal at the inputs (STO activated) interrupts the two redundant switch-off signal paths of the PM330 - the torque or force-generating energy fed to the drive.

To diagnose these two switch-off signal paths, the two feedback signal contacts FB_A and FB_B are made available at terminal strip X41 to the higher-level "Evaluate" safety subfunction.

These feedback signal contacts of the PM330 may only be used at digital inputs or in feedback circuits to diagnose the switch-off signal paths.

Evaluate

The "Evaluate" safety subfunction is realized using an application connected at terminal strip X41 of the PM330. This must handle the evaluation of the sensors ("Detect"), control the actuator of the PM330 ("React") - as well as the diagnostics of the safety subfunction ("React").

Detect

This document does not go into any more detail about the "Detect" safety subfunction. Refer to the appropriate manual "3SK1 safety relays".

8.1.2 PM330 application with safety relay

Using an appropriate PM330 application with a suitable safety relay (e.g. 3SK1), for the complete safety function, a Safety Integrity Level of 3 (SIL 3) according to EN 61800-5-2 or a Performance Level e (PL e) including Category 4 (Cat. 4) according to EN ISO 13849-1 can be achieved.

Achieving safety integrity level 3 (SIL 3) - or Performance Level e (PL e) including Category 4 (Cat. 4) - depends directly on the selected application and the test stop interval, see "Relationship between the test stop interval and SIL or PL and Cat. (Page 102)" and "Application examples for functional safety (STO / SS1-t) (Page 109)".

To achieve the diagnostics required for SIL 3 or PL e, Cat. 4, it is sufficient to integrate the two feedback signal contacts into the feedback circuit of a basic safety relay (e.g. 3SK1).

A fixed hardware filter in the two STO input circuits (≤ 4 ms) is used to filter out noise and brief signal changes - e.g. as a result of light and dark tests of the safety relays or as a result of contact bounce.

All safety-relevant signals, STO inputs as well as feedback signals of the switch-off signal paths are connected to the safety interface -X41, which means that they can be controlled and/or evaluated using external safety relays.

8.2 Safety functions that can be implemented

STO

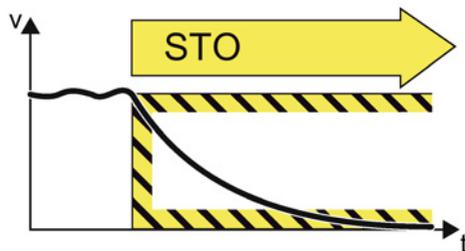


Figure 8-1 Safe Torque Off (STO)

The safety subfunction "React" is implemented in the PM330 Power Module, which in turn implements the safe shutdown response of the STO function.

This means that an STO function can be completely implemented using evaluation and monitoring devices (e.g. safety relay, F-PLC) connected at the safety interface -X41.

STO: Response and settings

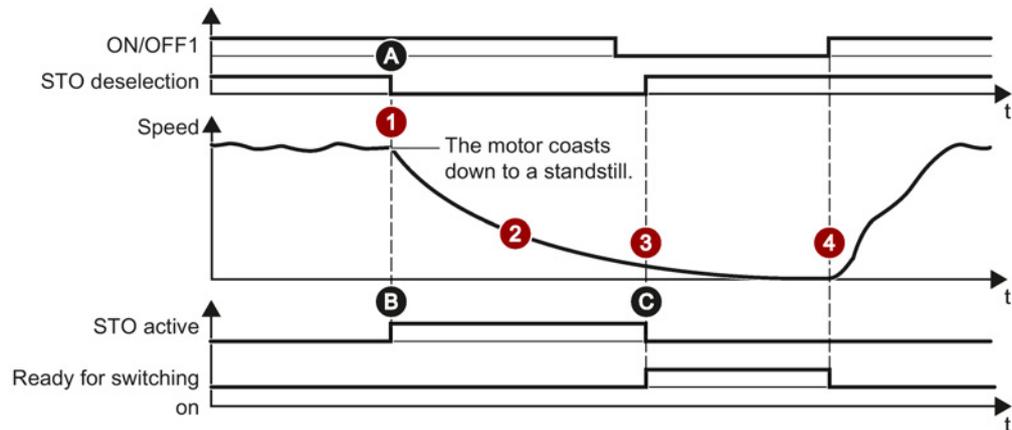


Figure 8-2 STO: Response

Description of the response	
1	STO is activated in operation. STO is activated via the two STO inputs at terminal strip X41 using the upstream external monitoring and control system (e.g. 3SK1).
2	After the response time, the drive immediately initiates STO. This reliably interrupts the torque-generating energy fed to the motor. The motor coasts down to standstill, and as a result of STO, the motor is safely prevented from restarting.
3	STO is deactivated by deactivating STO at the upstream external monitoring and control system (e.g. 3SK1), and the inverter is then ready to be switched on again. To enable the switch-off signal paths using the external monitoring and control system (e.g. 3SK1), the two feedback signal contacts of the PM330 at terminal strip X41 must be closed. Depending on the application, the start button may need to be pressed.
4	The inverter can be restarted with a positive signal edge at ON/OFF1.

Settings	
A	STO is selected using the two STO inputs at terminal strip X41. To be able to use the STO function, these must be enabled using the two enable switches S41 -> bring both switches into the front position (see Chapter "Switch S41 (Page 53)").
B	The status "[44] switching on inhibited – connect 24 V to terminal STO (hardware)" is shown in parameter r0002 and can be used for diagnostics. Using this to control specific functions, especially with regard to a safety function, is not permissible. In this case, directly use the monitoring and control system (e.g. 3SK1).
C	The torque-generating energy fed to the motor is safely interrupted by activating the STO function and is enabled again by deactivating the STO function. In addition, the standard acknowledgment mechanism or acknowledgment using the "Start" pushbutton must be performed.

SS1-t

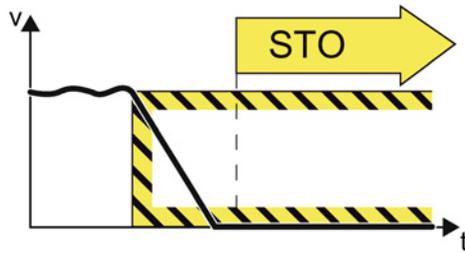


Figure 8-3 Safe Stop 1 (SS1-t, time controlled)

By using, e.g. a suitable safety relay, with time-delayed switch-off signal paths, in addition to the STO function, the SS1-t function can also be implemented.

In this case the safety relay requests braking along a braking ramp via terminal strip X9 (OFF3), for example; after a delay time has elapsed, it initiates an STO at the PM330.

SS1-t: Response and settings

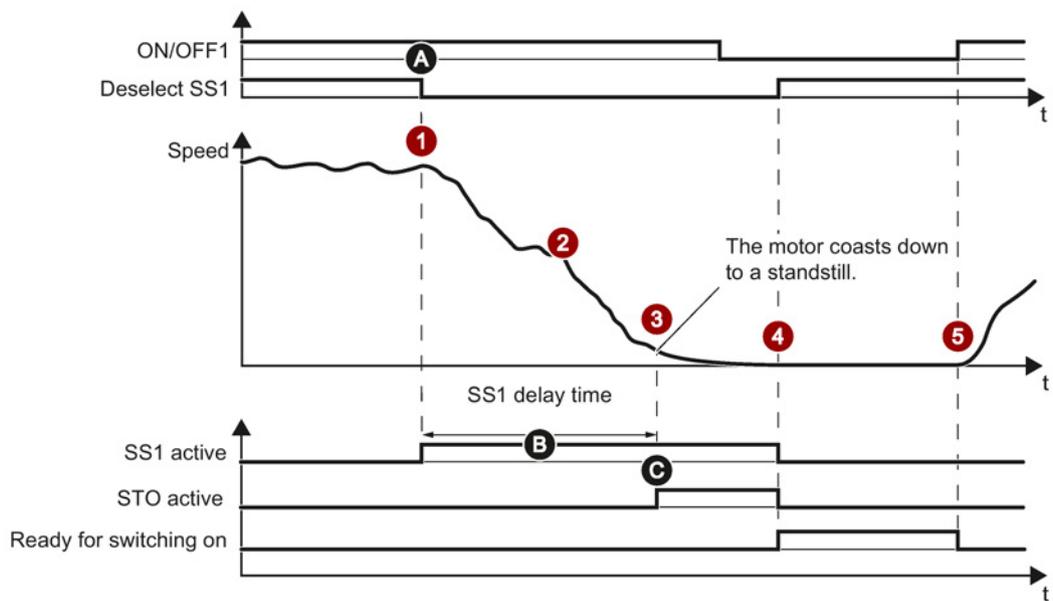


Figure 8-4 SS1-t: Response

Description of the response	
1	SS1-t is activated in operation.
2	After the response time in the drive has elapsed, the upstream external monitoring and control system (e.g. 3SK1) immediately initiates braking along the OFF3 ramp. At the same time, the SS1-t delay time is started internally in the external monitoring and control system (e.g. 3SK1).
3	After the SS1-t delay time has expired, the external monitoring and control system (e.g. 3SK1) activates the Safe Torque Off (STO) function. The motor coasts down to standstill, and as a result of STO, the motor is safely prevented from restarting.
4	SS1-t and STO are deactivated by deactivating SS1-t and STO at the upstream external monitoring and control system (e.g. 3SK1), and the inverter is then ready to be switched on again. To enable the switch-off signal paths using the external monitoring and control system (e.g. 3SK1), the two feedback signal contacts of the PM330 at terminal strip X41 must be closed. Depending on the application, the start button may need to be pressed.
5	The inverter can be restarted with the ON/OFF1 signal.

Settings	
A	SS1-t is activated via the DI at X9.
B	The drive is braked along the OFF3 ramp, and after the SS1-t delay time has expired, STO is automatically initiated in the external monitoring and control system (e.g. 3SK1) independent of the actual speed. The OFF3 ramp set in the Control Unit must be coordinated with the SS1-t delay time of the external monitoring and control system (e.g. 3SK1). These values are completely independent of one another. The delay time should be set longer than or equal to the braking ramp, as, after STO is initiated, the drive is no longer braked, but simply coasts down. In the diagram above, coasting down can be identified between point 3 and 4. On the other hand, the schematic diagram "SS1-t" shows that STO is activated after standstill. If the braking ramp does not result in standstill after an acceptable time, then if necessary and external braking chopper must be used.
C	The status SS1-t active can only be retrieved at the external monitoring and control system (e.g. 3SK1) via a contact or DO; the drive only knows the OFF3 status. As soon as STO is active, status "[44] switching on inhibited – connect 24 V to terminal STO (hardware)" is shown in parameter r0002 and can be used for diagnostics. Using this to control specific functions, especially regarding a safety function, is not permissible. In this case, directly use the monitoring and control system (e.g. 3SK1).

8.3 Validating/checking the safety function

Carefully check/test the safety function after commissioning the system for the first time, after carrying out any repairs and after each change to the machine/system.

These tests/checks must be performed by qualified personnel.

8.4 Diagnostics test/online test

In order to ensure that the function of the switch-off signal paths comply with the requirements laid down in the applicable standards, regulations and guidelines, these must be tested at regular intervals (diagnostics test interval, "Diagnostic test" in accordance with IEC 61800-5-2). As a consequence, possible faults are detected in an acceptable time. The intervals depend on the safety function and the desired/required SIL / PL, Cat.

Your task is to ensure that this test of the switch-off signal paths (test stop: activating and deactivating an STO) is performed at regular intervals.

The external safety relay (e.g. 3SK11...), an F-PLC or similar can, based on the signal change of the feedback signals of the PM330 Power Module, detect possible faults/errors in the switch-off signal paths, therefore initiating an STO in both channels. A fault is thus detected and the system can be repaired.

8.5 Relationship between the test stop interval and SIL or PL and Cat.

The hardware, the hardware structure and, where applicable, the software (when using parameterizable or programmable external safety components), must correspond to the required SIL / PL and Cat.

Also see the application examples in the annex.

- SIL 2 / PL d: Test stop at least once per year
- SIL 3 / PL e, Cat. 3: As a minimum, a test stop every 3 months
- SIL 3 / PL e, Cat. 4: Test stop at least once per day

8.6 Safe brake control/brake control in general

If brake control is required, see Chapter "Brake control via external relays/controls (Page 102)".

PM330 incl. CU230P-2 is not suitable for controlling a brake. Both devices do not have the appropriate signals and have no option of connecting a brake control. Existing contacts have the incorrect logical signal, and in addition are unsuitable from an electrical perspective.

-> external application-based brake control, see Chapter "Brake control via external relays/controls (Page 102)".

8.6.1 Brake control via external relays/controls

If a brake control, or more specifically safe brake control is required, then this must be implemented externally using an appropriate application, e.g. using a safety relay, a F-PLC or similar, outside of the PM330 and the CU230P-2.

It must also be taken into consideration that safe brake control also requires the appropriate brake diagnostics.

Appendix

A.1 Further information on your converter

A.1.1 Manuals for your inverter

Table A- 1 Manuals for your converter

Depth of the information	Manual	Contents	Languages	Download or article number
+	Getting Started Control Units CU230P-2; CU240B-2; CU240E-2	Installing the converter and commissioning.	German, English, French, Italian, Spanish, Chinese	Download manuals (https://support.industry.siemens.com/cs/ww/en/ps/13218/man) SINAMICS Manual Collection Documentation on DVD, Article No. 6SL3097-4CA00-0YG1
+	Getting Started SINAMICS G120 Power Module	Installing the Power Module		
++	Operating Instructions Control Units <ul style="list-style-type: none"> • CU230P-2 	Installing and commissioning the converter, adapting fieldbus interfaces, description of the converter functions, data backup and series commissioning, service and maintenance		
+++	Function Manual Fieldbuses	Configuring fieldbuses		
+++	Hardware Installation Manual	This manual		
+++	Operating and installation instructions	For converter accessories, e.g. operator panel, reactors or filter.		
+++	List Manual Control Units <ul style="list-style-type: none"> • CU230P-2 	Graphic function block diagrams. List of all parameters, alarms and faults.	German, English, French, Italian, Spanish, Russian, Chinese	

A.1.2 Configuring support

Table A- 2 Support when configuring and selecting the converter

Manual or tool	Contents	Languages	Download or article number
Catalog D 35	Ordering data and technical information for the standard SINAMICS G converters	English, German	All about SINAMICS G120 (www.siemens.com/sinamics-g120)
Online catalog (Industry Mall)	Ordering data and technical information for all SIEMENS products	English, German	
SIZER	The overall configuration tool for SINAMICS, MICROMASTER and DYNAVERT T drives, motor starters, as well as SINUMERIK, SIMOTION controls and SIMATIC Technology	English, German, Italian, French	You obtain SIZER on a DVD (Article number: 6SL3070-0AA00-0AG0) and in the Internet: Download SIZER (https://support.industry.siemens.com/cs/ww/en/ps/13434)
Configuration Manual	Selecting geared motors, motors, converters and braking resistor based on calculation examples	English, German	Engineering Manual Standard Drives (https://support.industry.siemens.com/cs/de/en/view/30779940)

A.1.3 Product Support

If you have further questions

You can find additional information on the product and more in the Internet under:Product support (<https://support.industry.siemens.com/sc/ww/en/sc/2090>).

In addition to our documentation, under this address we offer our complete knowledge base online: You can find the following information:

- Actual product information (Update), FAQ (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 drive technology via our contact database under "Contact & Partner".
- Information about local service, repair, spare parts and much more can be found under "Services".

A.1.4 Certificates

Downloading certificates

You can find the certificates in the Internet here: Certificates (<https://support.industry.siemens.com/cs/ww/en/ps/13218/cert>).

A.2 Electromagnetic compatibility

The SINAMICS G120 drives have been tested in accordance with the EMC product standard EN 61800-3:2004.

For precise data, refer to the declaration conformity

A.2.1 Definition of the EMC Environment and Categories

Classification of EMC behavior

The EMC environment and categories are defined in the EMC Product Standard EN 61800-3:2004., as follows:

Environments

First Environment

An environment that includes domestic premises and establishments that are connected directly to a public low-voltage line supply without the use of an intermediate transformer.

- Example: houses, apartments, commercial premises or offices in a residential building.

Second environment

An environment that includes all other establishments which are not connected directly to a public low-voltage line supply.

- Example: industrial and technical areas of buildings fed from a dedicated transformer.

Categories

Category C1

Power Drive System (PDS) of rated voltage less than 1000 V intended for use in the First (Domestic) Environment.

Category C2

Power Drive System (PDS) of rated voltage less than 1000 V, which is neither a plug-in device nor a movable device, and when used in the First Environment, is only intended to be installed and commissioned by a professional.

Note

An expert is a person or organization with the necessary experience for installing and/or commissioning drive systems (Power Drive Systems - PDS), including the associated EMC aspects.

Category C3

Power Drive System (PDS) of rated voltage less than 1000 V intended for use in the second (industrial) environment and not intended for use within the first (residential) environment.

A.2.2 Compliance with EMC Environment and Categories

EMC interference emission

Note

To comply with the requirements of EN 61800-3:2004, all drives must be installed in accordance with the manufacturer's instructions and EMC directives. See also: EMC compliant connection (Page 55).

Cable-conducted (interference voltage) and interference emissions

Category C1 – First environment

- The Power Modules are not intended for use in Category C1, the first environment. In order to be able to use Power Modules in Category C1 – first environment – the following additional measures must be applied (e.g. filter).

Category C2 – First environment - commercial use

Power Modules with additional line filter

- fulfill the requirements relating to cable-conducted noise interference emission (interference), if
 - a shielded cable with low capacitance is used,
 - the current does not exceed the rated input current (see Specific technical data (Page 76)),
 - the pulse frequency does not exceed 4 kHz, and
 - the cable is not longer than 150 m.
 - can cause high-frequency disturbances. In this case, damping measures may be required in order that the requirements relating to radiated noise interference can be fulfilled.
-

Note

Devices for use in Category C2 – first environment, commercial use – must be installed by a specialist with the appropriate experience for installing and/or commissioning power drive systems, including their EMC aspects.

Category C2 – Second environment

Power Modules with additional line filter

- fulfill the requirements relating to cable-conducted noise interference emission (interference), if
 - a shielded cable with low capacitance is used
 - the current does not exceed the rated input current (see Specific technical data (Page 76)),
 - the pulse frequency does not exceed 4 kHz, and
 - the cable is not longer than 150 m.
- can cause high-frequency disturbances. In this case, damping measures may be required in order that the requirements relating to radiated noise interference can be fulfilled.

Category C3 – Second (industrial) environment

- Power Modules can be installed in Category C3 – second environment – and do not require any authorization for connection.
- For motor cable lengths in the range >100 m to 150 m an additional basic interference suppression module shall be provided on the line side (available on request).

EMC / Immunity

The Power Modules have been tested in accordance with the immunity requirements of category C3 - Second Environment - and fulfill the requirements according to EN 61800-3.

Note

The immunity requirements apply equally to both filtered and unfiltered Power Modules.

Harmonic currents

Table A- 3 Typical harmonic currents of a 6-pulse rectifier with line reactor $u_k = 2 \%$

Typical harmonic current (% of rated input current) with line reactor $u_k = 2 \%$										
Line supply with average, relative short-circuit power (RSC = 50), $u_k = 2 \%$, with line reactor $u_k = 2 \%$										
h	1	5	7	11	13	17	19	23	25	THD(I)
I_h	100 %	37.1 %	12.4 %	6.9 %	3.2 %	2.8 %	1.9 %	1.4 %	1.3 %	40.0 %
Line supply with low relative short-circuit power (RSC < 15): "Weak line supply", $u_k = 6 \%$, with line reactor $u_k = 2 \%$										
h	1	5	7	11	13	17	19	23	25	THD(I)
I_h	100 %	22.4 %	7.0 %	3.1 %	2.5 %	1.3 %	1.0 %	0.8 %	0.7 %	23.8 %

h: Harmonic order number

Note

Installation of Power Modules in an environment of category C2

Power Modules which are installed in an environment of category C2 require a connection approval for the low-voltage supply system. Contact your local supply system operator in this case.

A.2.3 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 South 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 according to EN 55011. With suitable 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 are described in this Manual and/or the Configuration Manual "EMC Installation Guidelines".

Please note that the final statement on compliance with the standard is given by the respective label attached to the individual unit.

A.3 Application examples for functional safety (STO / SS1-t)

A.3.1 General requirements

Power supply:

The PM330 has an internal 24 V DC supply. This voltage is made available at X9:1/2; an external 24 V DC supply can also be connected here.

- The safety relay can be externally supplied with 24 V DC (see example).
- The safety relay can be supplied via the -X9 interface from the PM330.



WARNING

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

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

- 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.

Note

Together, the loads at X9:1 and X9:8 may be a maximum of 250 mA.

Cable length:

- Cable length between the safety relay and -X41 / -X9, max. 30 m

Diagnostics of the two switch-off signal paths:

- Connect both floating contacts of the PM330 into the feedback circuit of the safety relay

Executing a forced checking procedure (test stop):

- For example, a timer in the PLC program or in the ES software of the 3SK2
-> automated test stop/manual, based on an appropriate alarm
- Manual based on the user documentation etc.

Interrelationship, test stop interval to SIL / PL, Cat:

- SIL 2 / PL d: Test stop at least once per year
- SIL 3 / PL e, Cat. 3: As a minimum, a test stop every 3 months
- SIL 3 / PL e, Cat. 4: Test stop at least once per day

A.3.2 Stop Category 0 (STO)

A.3.2.1 SIRIUS 3SK1 with relay outputs, separate power supply for the 3SK1 and PM330

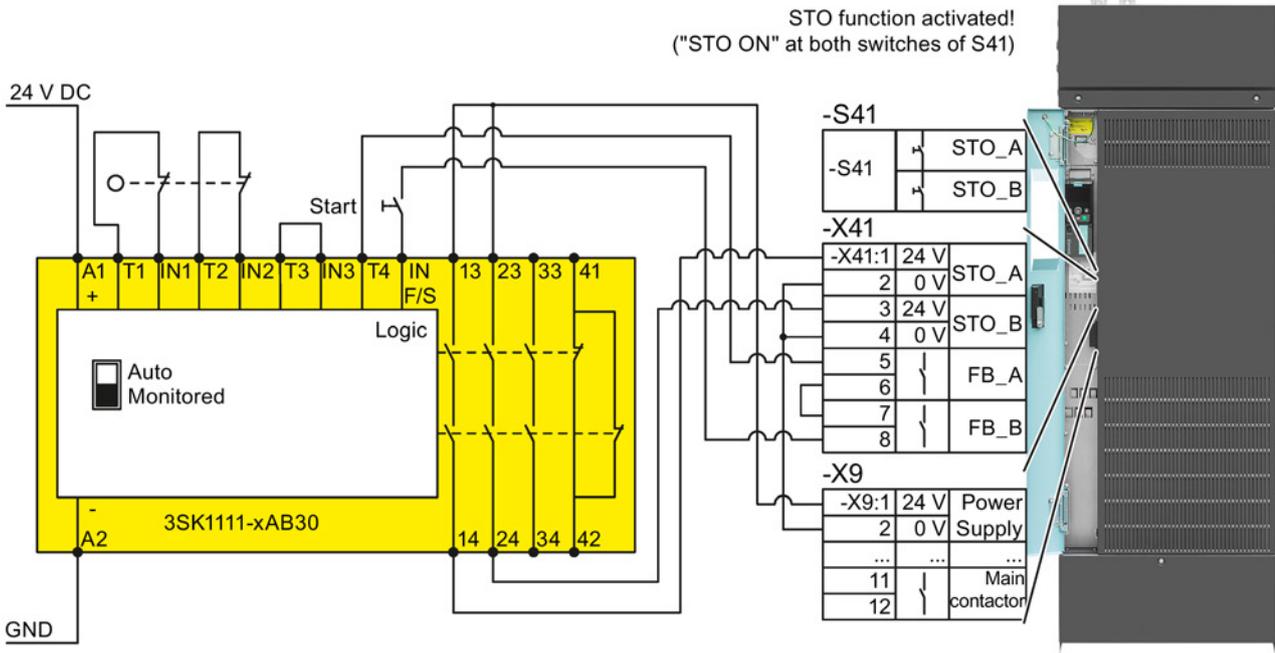


Figure A-1 STO with 3SK1111-xAB30 (3SK1 with relay outputs)

Start button

Manual reset function (start, acknowledgment), according to ISO 13849-1 depending on the application required, e.g. Emergency Stop, protective devices with rear access etc.

General requirements

See "General requirements (Page 109)".

Information about the application example

- The 3SK1 is externally supplied with 24 V DC through an SELV/PELV power source.
- The control of the PM330 is supplied from the integrated power supply.

-> electrical isolation between 3SK1 and PM330 possible, reason:

- STO inputs are optocoupler inputs
 - > electrical isolation between the input circuit and evaluation electronics
- Feedback circuits are floating contacts
 - > electrical isolation between the evaluation electronics and contact
- Separate voltage sources
 - > 3SK1 and PM330 are supplied by 2 separate voltage sources

As a consequence, in the example above, the sensor circuit length is no longer relevant for the PM330. The sensor circuit length is only defined by the restrictions relating to the 3SK1, refer to the 3SK1 equipment manual.

The cable length between PM330 and 3SK1 must not exceed 30 m.

Settings

- PM330: Activate the STO circuit, bring both activation switches S41 towards the front.
- CU230P-2: No settings are required in the CU230-2 for STO.
- 3SK1111: Set the switch to "Monitored" -> start using the start button if the application requires this function.

Display

Display in IOP or STARTER:

In IOP / STARTER, parameter r0002 is used as "Drive operating display".

Enable and inhibit signals as well as operating states are displayed here, e.g.:

- r0002 = [44] Switching on inhibited – connect 24 V to terminal STO (hardware)
 - STO active in one or both STO channels
- r0002 = [31] Ready for switching on – set "ON/OFF1" = "1/0" (p0840)
 - Drive is ready to switch on, the start signal is still missing
 - An STO is not available at any STO input-> STO_A and STO_B have a 1 signal

Display on the 3SK1111:

The 3SK1111 has 2 LEDs to display the operating state, see the 3SK1 documentation.

A.3.2.2 3SK1 power supply via X9 from the PM330

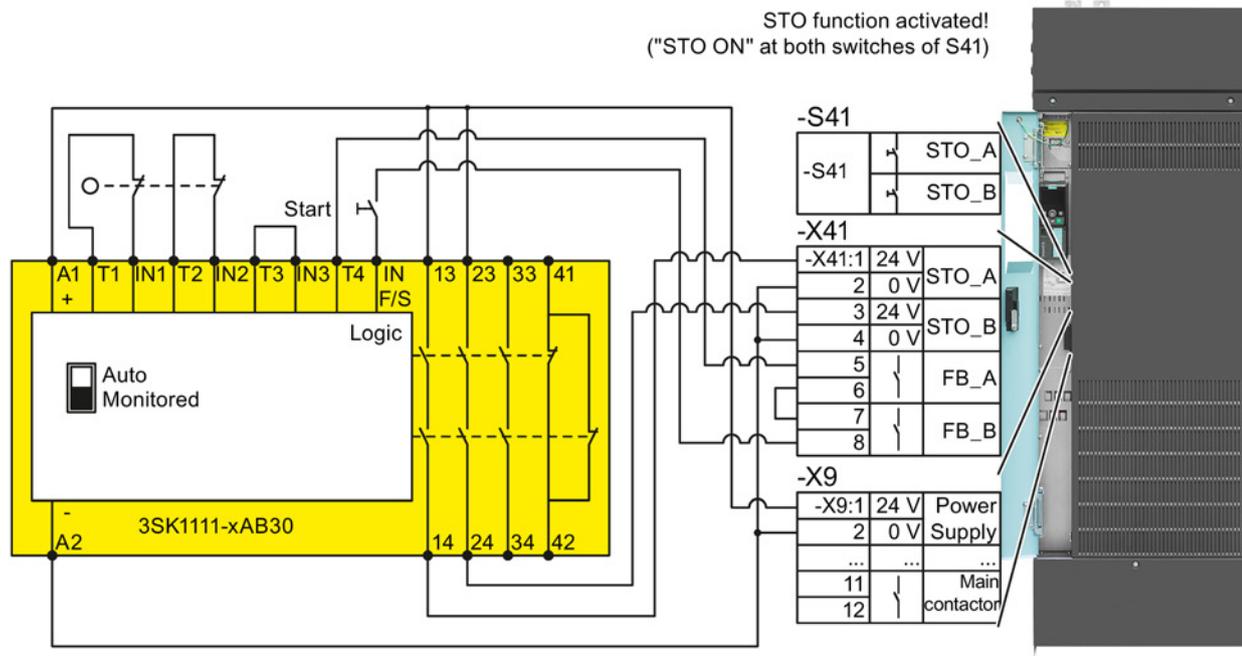


Figure A-2 3SK1 power supply via X9 from the PM330

Information about the application example

- The 3SK1 is supplied with 24 V DC via the -X9:1/2 terminal strip
- The control of the PM330 is supplied from the integrated power supply.

-> parasitic voltages can occur and/or faults and disturbances can be coupled-in.

Parasitic voltages can occur via the 3SK1 sensor circuit, especially when connecting to higher-level safety control systems.

In addition, faults can be coupled-in via the input circuit of the 3SK1 at the STO inputs of the PM330.

-> use a 3SK1 with relay contacts, and ensure consistent electrical isolation, see Chapter "SIRIUS 3SK1121 with relay outputs (Page 114)".

A.3.2.3 External power supply for 3SK1 and PM330

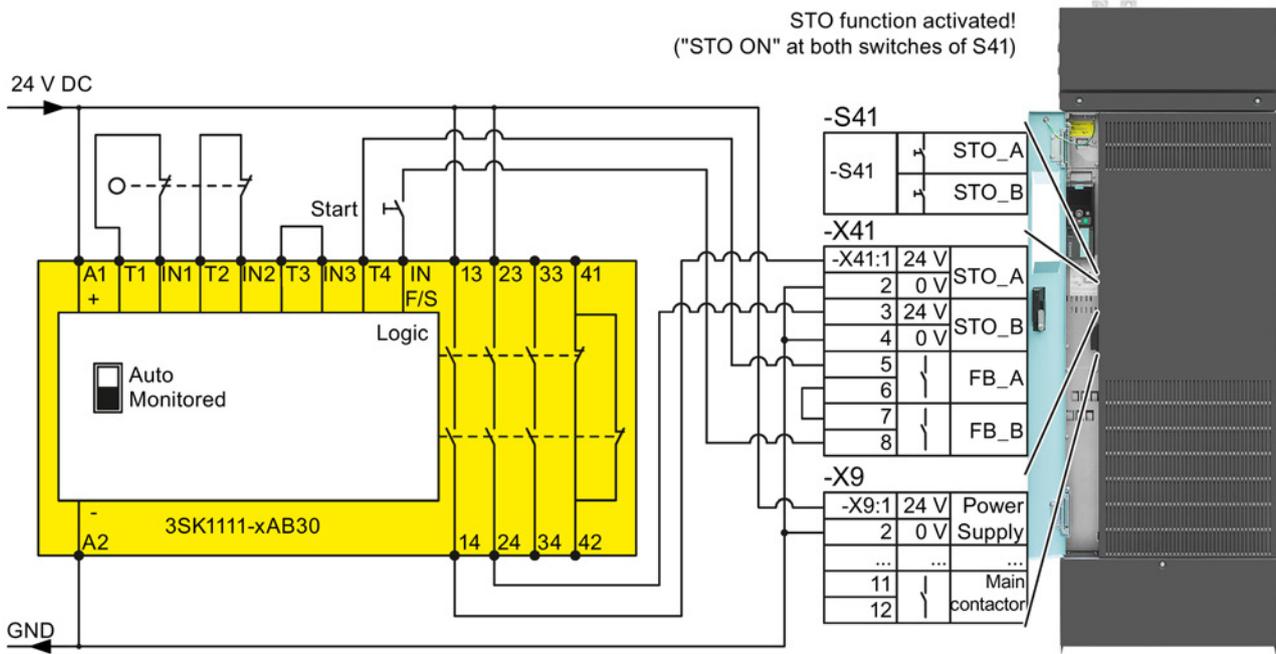


Figure A-3 External power supply for 3SK1 and PM330

Information about the application example

- The 3SK1 is externally supplied with 24 V DC through an SELV/PELV power source.
 - The PM330 control is externally supplied with 24 V DC through an SELV/PELV power source.
- > parasitic voltages can occur and/or faults and disturbances can be coupled-in.

A.3.3 Stop Category 1 (SS1-t)

A.3.3.1 SIRIUS 3SK1121 with relay outputs

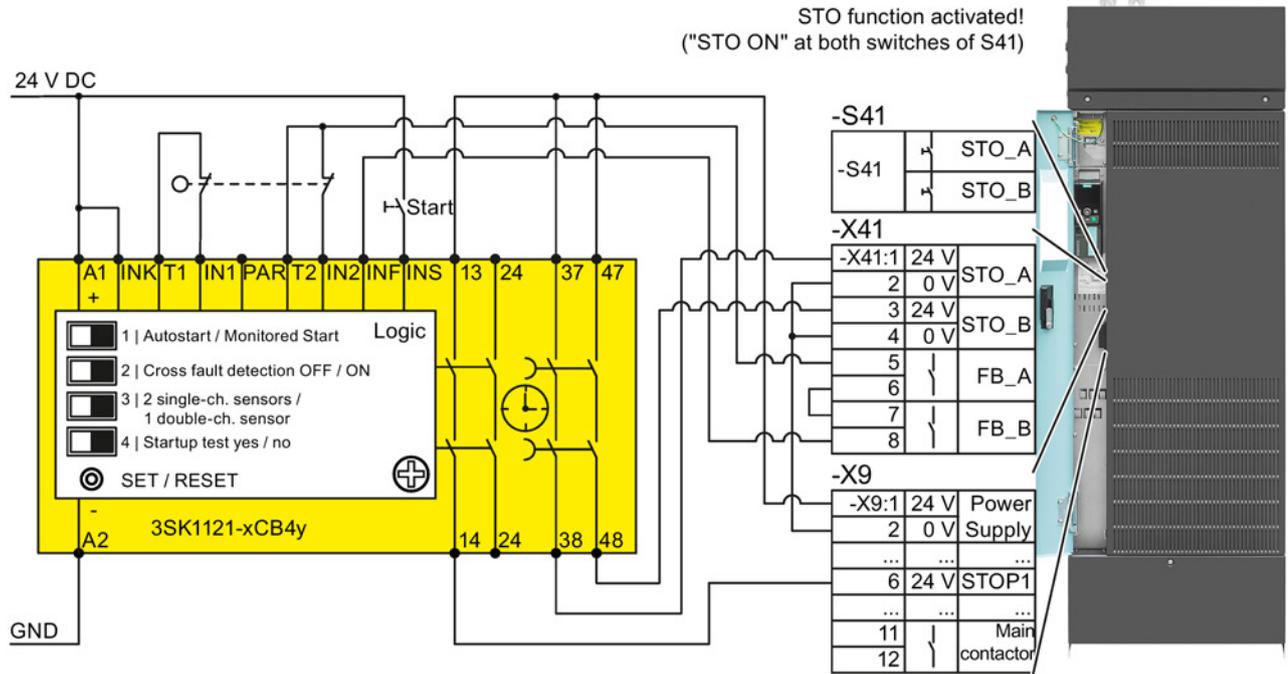


Figure A-4 SS1-t with 3SK1121-xCB4y (3SK11 with relay outputs)

Start button

Manual reset function (start, acknowledgment), according to ISO 13849-1 depending on the application required, e.g. Emergency Stop, protective devices with rear access etc.

General requirements

See "General requirements (Page 109)".

Align the OFF3 ramp time with the SS1-t monitoring time of the 3SK1 (the monitoring time should be longer than the ramp time).

Settings

- PM330: Activate the STO circuit, bring both activation switches S41 towards the front.
- CU230P-2: In the CU, the OFF3 ramp-down time (parameter p1135) must be set for SS1-t.
 Coordinate the ramp-down time with the SS1-t delay time
 If necessary, use a braking chopper to shorten the braking ramp.
 In this case, a risk assessment of the system/machine is required.
- 3SK1121:
 - Setting/adjusting the switch of the 3SK1 depends on the system/machine as well as the requirements, for example as derived from the risk assessment
 - Select the required 3SK112-xCB4y, 3SK1121 safety relays have different time ranges.
 - y = 1 -> adjustable time range, 0.05 to 3 s
 - y = 2 -> adjustable time range, 0.5 to 30 s
 - y = 4 -> adjustable time range, 5 to 300 s
 - Adjusting the required delay time for SS1-t.

This time defines the delay between the activation of SS1-t and when the actual STO safety function is initiated.

As a consequence, this time also defines how long the non-safe OFF3 function can actively brake along the ramp before the torque is shutdown - and the motor starts to coast down.

Current standards, directives and requirements relating to your specific application must be carefully taken into consideration here.

Notice: An excessively long delay time means that the drive is in a non-safe state for an unnecessarily long time.

Display

Display in IOP or STARTER:

In IOP / STARTER, parameter r0002 is used as "Drive operating display".

Enable and inhibit signals as well as operating states are displayed here, e.g.:

- r0002 = [44] Switching on inhibited – connect 24 V to terminal STO (hardware)
 - STO active in one or both STO channels
- r0002 = [31] Ready for switching on – set "ON/OFF1" = "1/0" (p0840)
 - Drive is ready to switch on, the start signal is still missing
 - An STO is not available at any STO input-> STO_A and STO_B have a 1 signal

Display on the 3SK1121:

The 3SK1121 has 2 LEDs to display the operating state, see the 3SK1121 documentation.

A.3.3.2 F-PLC

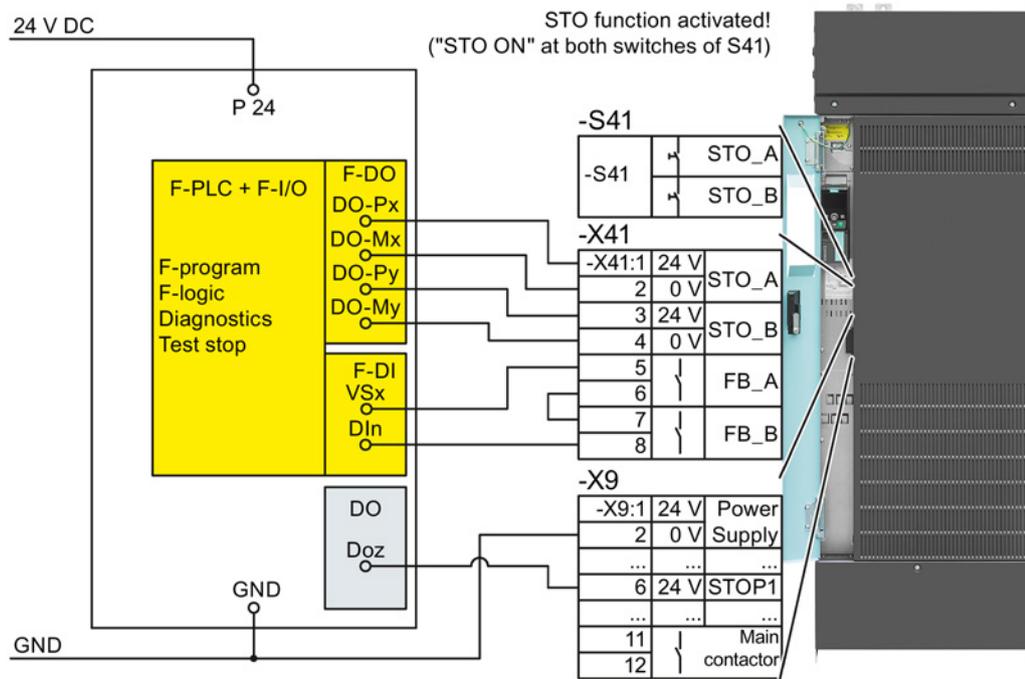


Figure A-5 SS1-t with an F-PLC

Start button

Manual reset function (start, acknowledgment), according to ISO 13849-1 depending on the application required, e.g. Emergency Stop, protective devices with rear access etc.

General requirements

See "General requirements (Page 109)".

The F-PLC must be externally supplied (max. 250 mA is generally not sufficient for an F-PLC).

Note

When using digital outputs, parasitic voltages can occur and external noise and disturbances can be coupled-in.

Settings

- PM330: Activate the STO circuit, bring both activation switches S41 towards the front.
- CU230P-2: No settings are required in the CU230-2 for STO.
- F-PLC: The F-PLC (e.g. a SIMATIC PLC) must be programmed in accordance with the safety functions required. This safety function is directly implemented in this F-program. The feedback inputs must be integrated for diagnostic purposes.

Display

Display in IOP or STARTER:

In IOP / STARTER, parameter r0002 is used as "Drive operating display".

Enable and inhibit signals as well as operating states are displayed here, e.g.:

- r0002 = [44] Switching on inhibited – connect 24 V to terminal STO (hardware)
 - STO active in one or both STO channels
- r0002 = [31] Ready for switching on – set "ON/OFF1" = "1/0" (p0840)
 - Drive is ready to switch on, the start signal is still missing
 - An STO is not available at any STO input-> STO_A and STO_B have a 1 signal

Display at the F-PLC:

Refer to the corresponding documentation for the display of the operating state at the F-PLC.

A.3.4 Troubleshooting examples

Description of the situation

STO is deactivated at the safety system sensor.

CU signals in the IOP, parameter r0002 = [44] "Switching on inhibited – connect 24 V to terminal STO (hardware)" -> STO is active in at least one channel of the PM330.

Only troubleshooting examples are described here; for a specific problem, refer to the operating instructions of the 3SK1 involved, e.g. the significance of LED 1.

3SK1111... safety relay used

Scenario 1:

- LED 1 DEVICE lights up green
 - > power supply and power up are OK
- LED 2 OUT is OFF
 - > the safety circuit is not enabled

Possible causes:

- Feedback circuit is not closed
 - The feedback circuit wiring is interrupted
 - The incorrect cycle output is being used
 - PM330 fault
- Fault in the 3SK1 feedback circuit
 - At least 1 switch-off signal path of the PM330 is still active (at least 1 of the two STO inputs has a high signal), e.g. cross-circuit fault in the 3SK1 enable circuit
- PM330 fault
 - PM330 power supply missing -> establish the power supply
 - One or two switch-off signal paths of the PM330 is/are defective
 - One or two feedback signal paths of the PM330 is/are defective
- Fault in the 3SK1 sensor circuit
 - 1 channel of the 3SK1 sensor circuit was not opened when activating STO (low signal)
 - > restart inhibit
 - > repair/replace the sensor
 - > or the wiring must be checked
- Start enable or acknowledgment missing
 - Start enable missing or actuated too long (switch 1 set to MONITORED)

Scenario 2:

- LED 1 DEVICE is OFF
 - > fault
- LED 2 OUT is OFF
 - > the safety circuit is not enabled

Possible causes:

- 3SK1 power supply missing
- Short or cross-circuit faults at the 3SK1
 - Between the cycle outputs
 - In or to the power supply
 - In the input circuit (sensor circuit)
 - In the enable circuits
 - In the feedback signal circuit

Safety relay 3SK1 Advanced or 3SK1112... being used**Scenario 3:**

- LED 1 DEVICE lights up green
 - -> power supply, power up and configuration are OK
- LED 2 OUT is OFF
 - -> the safety circuit is not enabled

Possible causes:

- LED 3 IN is OFF
 - > close sensor circuit through 2 channels
- LED 3 IN flashes green
 - LED 4 SF is OFF -> START button not pressed
 - LED 4 SF flashes red-> simultaneity for 1x2 channel sensor not met
 - LED 4 SF flashes red-> time monitoring for two-handed start violated
- LED 3 IN flashes yellow
 - LED 4 SF flashes red -> short-circuit T1/T2 with respect to ground or 24 V

Scenario 4:

- LED 1 DEVICE is OFF
-> group fault
- LED 2 OUT is OFF
-> the safety circuit is not enabled
- LED 3 IN flashes yellow
-> group fault, input circuit
- LED 4 SF is lit red
-> group fault

Possible causes:

- Group fault, cross-circuit fault in the input circuits

Scenario 5:

- LED 1 DEVICE is lit green
-> power supply, power up and configuration are OK
- LED 2 OUT flashes green
-> feedback circuit fault
- LED 3 IN flashes green
-> feedback circuit fault
- LED 4 SF flashes red
-> fault

Possible causes:

- Interruption in the feedback circuit wiring
- Incorrect feedback circuit wiring
- PM330 fault
 - PM330 power supply missing -> establish the power supply
 - One or two of the STO inputs of the PM330 has a high signal, e.g. as a result of short circuit or cross circuit fault in the wiring
 - One or two switch-off signal paths of the PM330 is/are defective
 - One or two feedback signal paths of the PM330 is/are defective

Scenario 6:

- LED 1 DEVICE is lit green
-> power supply, power up and configuration are OK
- LED 2 OUT flashes yellow
-> START button fault
- LED 3 IN is OFF
-> switch-on conditions not met
- LED 4 SF flashes red
-> fault

Possible causes:

- START button was pressed too long or has a short-circuit

A.4 Acceptance test/configuration test

The acceptance test checks that the safety subfunction implemented in the inverter has been correctly set. Where necessary, the complete safety function can also be checked. The following acceptance tests are examples which demonstrate the basic procedure. They are not suitable for every possible setting of the inverter.

Recommendations for the acceptance test

- Perform the acceptance test with the maximum possible velocity and acceleration to test the expected maximum braking distances and braking times.
- The trace function in the STARTER and Startdrive PC tools can simplify the acceptance test in certain applications: for example, if a drive in the machine is difficult to access. Therefore, we recommend that you use the trace function for some acceptance tests.
- If you have recorded a trace for an acceptance test, you have to proceed as follows:
 - When you save the trace, enter the storage location in the acceptance report.
 - If you print the trace, attach the printout to the acceptance report.
- If you can carry out the acceptance test without the trace function, there is no need to use the trace.
- After the acceptance test of the inverter's safety functions, you must also check whether the safety-related functions in the machine or system are functioning correctly.

A.4.1 Acceptance test STO

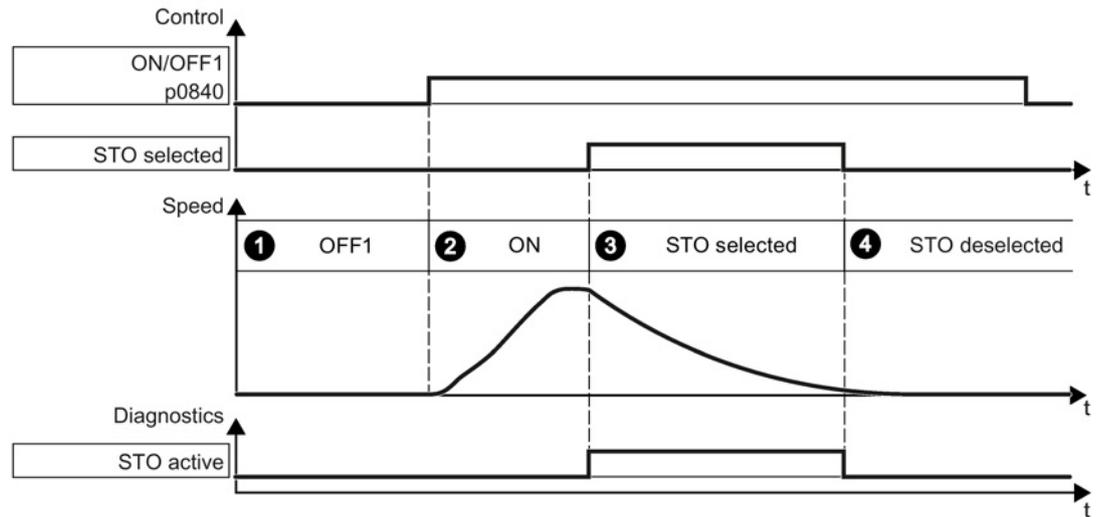


Table A- 4 Procedure for the STO acceptance test

		Status
1.	The inverter is ready for operation	
	<ul style="list-style-type: none"> The inverter signals neither faults nor alarms. STO is not active (r0002 ≠ 44). (e.g. R0002 = [31] Ready for switching on – set "ON/OFF1" = "1/0" (p0840) 	
2.	Switch on the motor	
	2.1. Enter a speed setpoint ≠ 0.	
	2.2. Switch on the motor (ON command).	
	2.3. Check that the correct motor is running.	
2.4.	Check the status of the safety relay LEDs (here in the example, a 3SK1112-... or 3SK112x-...)	
	<ul style="list-style-type: none"> LED (1) DEVICE = green LED (2) OUT = green-> 3SK1 output circuit closed LED (3) IN = green-> 3SK1 switch-on (close) conditions satisfied <ul style="list-style-type: none"> – Input circuit closed – Feedback circuit closed – Start button where necessary actuated LED (4) SF = OFF 	

		Status
3.	Activate STO	
3.1.	Activate STO while the motor is running.	
3.2.	Check the following: When controlled via terminals STO_A and STO_B on Power Module PM330P-2	
	<ul style="list-style-type: none"> The inverter signals: r0002 = [44] Switching on inhibited – connect 24 V to terminal STO (hardware) 	
	<ul style="list-style-type: none"> The inverter signals neither faults nor alarms. 	
	<ul style="list-style-type: none"> Motor coasts down. Wait until motor is at a standstill. 	
3.3.	Check the status LEDs of the safety relay (here in the example, a 3SK1112-... or 3SK112x-...)	
	<ul style="list-style-type: none"> LED (1) DEVICE = green LED (2) OUT = off -> 3SK1 output circuit open LED (3) IN = off -> 3SK1 switch-on (close) conditions not satisfied <ul style="list-style-type: none"> – Here, input circuit closed LED (4) SF = OFF 	
4.	Deactivate STO	
4.1.	Deactivate STO.	
4.2.	Check the following:	
	<ul style="list-style-type: none"> STO is not active (r0002 ≠ 44). (e.g. R0002 = [31] Ready for switching on – set "ON/OFF1" = "1/0" (p0840) 	
	<ul style="list-style-type: none"> The inverter signals neither faults nor alarms. 	
4.3.	Check the status of the safety relay LEDs (here in the example, a 3SK1112-... or 3SK112x-...)	
	<ul style="list-style-type: none"> LED (1) DEVICE = green LED (2) OUT = green-> 3SK1 output circuit closed LED (3) IN = green-> 3SK1 switch-on (close) conditions satisfied <ul style="list-style-type: none"> – Input circuit closed – Feedback circuit closed – Start button where necessary actuated LED (4) SF = OFF 	

A.4.2 SS1-t acceptance test

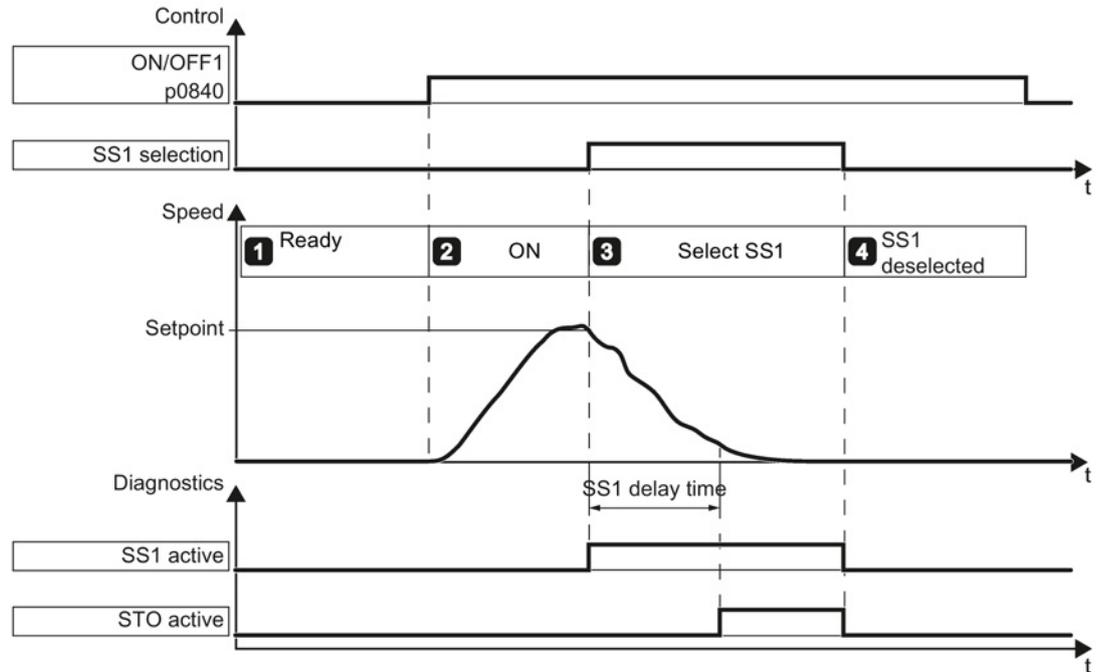


Table A- 5 Procedure for the SS1-t acceptance test

		Status
1.	The inverter is ready for operation	
	<ul style="list-style-type: none"> The inverter signals neither faults nor alarms. STO is not active (r0002 ≠ 44). (e.g. R0002 = [31] Ready for switching on – set "ON/OFF1" = "1/0" (p0840) 	
2.	Switch on the motor	
	2.1. Enter a speed setpoint ≠ 0.	
	2.2. Switch on the motor (ON command).	
	2.3. Check that the correct motor is running.	
	2.4. Check the status of the safety relay LEDs (here in the example, a 3SK1112-... or 3SK112x-...)	
	<ul style="list-style-type: none"> LED (1) DEVICE = green LED (2) OUT = green-> 3SK1 output circuit closed LED (3) IN = green-> 3SK1 switch-on (close) conditions satisfied <ul style="list-style-type: none"> – Input circuit closed – Feedback circuit closed – Start button where necessary actuated LED (4) SF = OFF 	

		Status
3.	Activate SS1-t	
3.1.	Activate SS1-t while the motor is running.	
3.2.	Check the following:	
	<ul style="list-style-type: none"> The motor brakes along the OFF3 ramp. OFF3 ramp is active (r0899.5 = 1) After the "SS1-t delay time" expires, the inverter signals: r0002 = [44] Switching on inhibited – connect 24 V to terminal STO (hardware) The inverter signals neither faults nor alarms. 	
3.3.	Check the status LEDs of the safety relay (here in the example, a 3SK112x-...)	
	<ul style="list-style-type: none"> LED (1) DEVICE = green LED (2) OUT = green/yellow flashing <ul style="list-style-type: none"> - -> instantaneous (non-delayed) output circuit of the 3SK1 open. (OFF2 control) - -> delayed output circuit of the 3SK1 still closed. (STO circuit) After the time set at the 3SK1 rotary controller has expired LED (2) OUT = off -> both 3SK1 output circuits open LED (3) IN = off -> 3SK1 switch-on (close) conditions not satisfied <ul style="list-style-type: none"> - Here, input circuit closed LED (4) SF = OFF 	
4.	Deactivate SS1-t	
4.1.	Deactivate SS1.	
4.2.	Check the following:	
	<ul style="list-style-type: none"> STO is not active (r0002 ≠ 44). (e.g. R0002 = [31] Ready for switching on – set "ON/OFF1" = "1/0" (p0840) The inverter signals neither faults nor alarms. 	
4.3.	Check the status LEDs of the safety relay (here in the example, a 3SK112x-...)	
	<ul style="list-style-type: none"> LED (1) DEVICE = green LED (2) OUT = green-> 3SK1 output circuit closed LED (3) IN = green-> 3SK1 switch-on (close) conditions satisfied <ul style="list-style-type: none"> - Input circuit closed - Feedback circuit closed - Start button where necessary actuated LED (4) SF = OFF 	

A.4.3 Documentation of the acceptance test

System or machine description

Designation	...
Type	...
Serial number	...
Manufacturer	...
End customer	...
Block diagram of the system or machine: <div style="text-align: center; padding: 10px;"> <p>...</p> <p>...</p> <p>...</p> <p>...</p> <p>...</p> <p>...</p> <p>...</p> <p>...</p> </div>	

Inverter data

Table A- 6 Hardware version of the safety-related inverter

Name of the drive	Article number and hardware version of the inverter
...	...
...	...

Function table

Table A- 7 Active safety functions depending on the operating mode and safety equipment

Operating mode	Safety equipment	Drive	Selected safety function	Checked
...	
...	
<i>Example:</i>				
<i>Operation</i>	<i>Protective door closed</i>	Fan	---	---
	<i>Protective door open</i>	Fan	<i>SS1-t (braking in 2 seconds)</i>	
	<i>Emergency Stop button active</i>	Fan	<i>STO</i>	

Logging the settings

File name of the log:	
...	
...	

Data backup

Data	Storage medium			Archive location
	Archive type	Designation	Date	
Log of the settings
Acceptance tests
STARTER traces
PLC program
Circuit diagrams

Enter the safety relay setting:

- Setting of the DIP switch and where relevant the rotary switch with the time.
- Documentation of the parameters for a parameterizable safety relay, e.g. a 3SK2...
- Logging the parameters for OFF2 when using SS1-t.

Countersignatures

Commissioning engineer

This confirms that the tests and checks have been carried out properly.

Date	Name	Company/dept.	Signature
...

Machine manufacturer

This confirms that the settings documented above are correct.

Date	Name	Company/dept.	Signature
...

A.5 Abbreviations

Abbreviation	State
3SK1	Siemens 3SK1 safety relay is used as external monitoring and control system
3SK2	Siemens 3SK2 parameterizable safety relay is used as external monitoring and control system
AC	Alternating current
CE	Communauté Européenne
CU	Control Unit
DC	DC current
DC	Diagnostics coverage, for a definition see EN 61800-5-2
DI	Digital input
DIP	DIP switch
DO	Digital output
ECD	Equivalent circuit diagram
EEC	European Community
ELCB	Earth leakage circuit breaker
EMC	Electromagnetic compatibility (EMC)
EMI	Electromagnetic interference
ESD	Electrostatic discharge
FS...	Frame size ...
GSG	Getting Started
HO	High overload
I/O	Input/output
IGBT	Insulated gate bipolar transistor
Cat.	Category, definition see EN ISO 13849-1.
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
PL	Performance Level, definition see EN ISO 13849-1
PM	Power Module
PPE	Personnel protective equipment
RCCB	Residual current operated circuit breaker
RCD	Residual current device
RFI	Radio frequency interference
SELV	Safety extra-low voltage
SIL	Safety Integrity Level, definition see EN 61800-5-2
SS1-t	Safe Stop 1, time controlled

Abbreviation	State
STO	Safe Torque Off
TM	EN 61800-5-2 mission time TM: Usage time, defined accumulated operating duration of the PDS(SR) over its complete service life.
VT	Variable torque
//	parallel

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Further information

Siemens:
www.siemens.com

Industry Online Support (service and support):
www.siemens.com/online-support

Industry Mall:
www.siemens.com/industrymall

Siemens AG
Process Industries and Drives
Large Drives
Postfach 4743
90025 Nuremberg
Germany

Scan the QR code for
product information

