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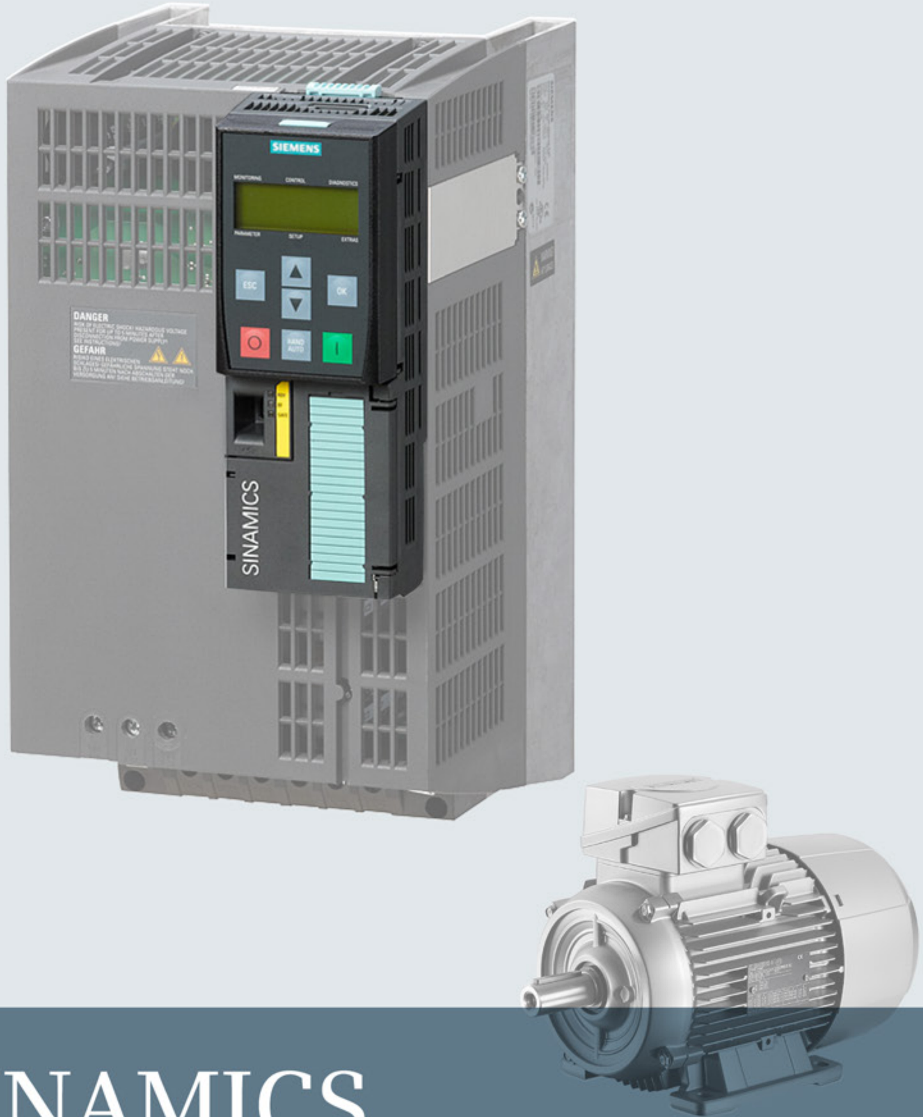

SINAMICS

SINAMICS G120 low voltage converters

Chassis devices with CU240B-2 and CU240E-2 Control Units

Operating instructions

Edition 04/2014

Answers for industry.

SIEMENS

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SINAMICS G120
Converter with the CU240B-2 and CU240E-2 Control Units

Operating Instructions

Edition 04/2014, Firmware V4.7

Original instructions
04/2014, FW V4.7
A5E34259001B AA

Legal information

Warning notice system

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

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

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

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

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

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

Qualified Personnel

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

Proper use of Siemens products

Note the following:

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

Trademarks

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Disclaimer of Liability

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

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Changes in this manual

Important changes with respect to the Manual, Edition 01/2013

New hardware	In Chapter
New Power Modules PM240-2, FSA … FSC	Description (Page 23) Technical data, PM240-2 (Page 326)
Output reactors for PM230 and PM240-2 Power Modules	Output reactor (Page 32)

New functions in the V4.7 firmware	In Chapter
Reducing the pulse frequency and increasing the current limit in the case of high-inertia starting.	Inverter temperature monitoring (Page 179)
Supporting the identification & maintenance data (I&M1 … 4)	Identification & maintenance data (I&M) (Page 302)

An overview of all the new and changed functions in the V4.7 firmware can be found in Section New and extended functions (Page 341).

Corrections	In Chapter
Macro 5 sets PROFIdrive telegram 352 (not telegram 1). Macro 14 sets PROFIdrive telegram 20 (telegram 1 in the previous edition).	Terminal strips on CU240E-2 Control Units (Page 69)
Acknowledge input in macros 19 and 20 is at digital input 4 (digital input 3 in the previous edition).	
Terminal 34 on the CU240E-2 Control Unit supplies the reference potential for terminals 6, 8 and 17 (6, 8 and 12 in the previous edition)	Terminal strips on CU240E-2 Control Units (Page 69)
When using an analog input as extended digital input, for a low signal, the analog input must be connected to ground (GND). The analog input must be connected to +10 V and GND using a change-over contact. An NO contact is not sufficient.	Digital inputs (Page 102)

Revised descriptions	In Chapter
STO safety function	Safe Torque Off (STO) safety function (Page 225)

Table of contents

1 Fundamental safety instructions

1.1 General safety instructions

⚠ DANGER

Danger to life due to live parts and other energy sources

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

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

Generally, six steps apply when establishing safety:

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

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

⚠ WARNING

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

Touching live components can result in death or severe injury.

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

⚠WARNING

Danger to life when live parts are touched on damaged devices

Improper handling of devices can cause damage.

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

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

⚠WARNING

Danger to life through electric shock due to unconnected cable shields

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

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

⚠WARNING

Danger to life due to electric shock when not grounded

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

- Ground the device in compliance with the applicable regulations.

⚠WARNING

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

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

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

⚠ WARNING

Danger to life due to fire spreading if housing is inadequate

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

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

⚠ WARNING

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

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

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

⚠ WARNING

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

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

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

⚠ WARNING

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

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

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

⚠ WARNING

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

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

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

NOTICE

Device damage caused by incorrect voltage/insulation tests

Incorrect voltage/insulation tests can damage the device.

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

⚠ WARNING

Danger to life when safety functions are inactive

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

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

Note

Important safety notices for Safety Integrated functions

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

WARNING

Danger to life or malfunctions of the machine as a result of incorrect or changed parameterization

As a result of incorrect or changed parameterization, machines can malfunction, which in turn can lead to injuries or death.

- Protect the parameterization (parameter assignments) against unauthorized access.
- Respond to possible malfunctions by applying suitable measures (e.g. EMERGENCY STOP or EMERGENCY OFF).

1.2 Safety instructions for electromagnetic fields (EMF)

WARNING

Danger to life from electromagnetic fields

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

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

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

1.3 Handling electrostatic sensitive devices (ESD)

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

NOTICE

Damage through electric fields or electrostatic discharge

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

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

1.4 Industrial security

Note

Industrial security

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

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

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

WARNING

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

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

- Keep the software up to date.

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

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

1.5 Residual risks of power drive systems

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

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

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

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

1. Unintentional movements of driven machine components during commissioning, operation, maintenance, and repairs caused by, for example,
   - Hardware and/or software errors in the sensors, control system, actuators, and cables and connections
   - Response times of the control system and of the drive
   - Operation and/or environmental conditions outside the specification
   - Condensation/conductive contamination
   - Parameterization, programming, cabling, and installation errors
   - Use of wireless devices/mobile phones in the immediate vicinity of the control system
   - External influences/damage

2. In the event of a fault, exceptionally high temperatures, including an open fire, as well as emissions of light, noise, particles, gases, etc. can occur inside and outside the inverter, e.g.:
   - Component failure
   - Software errors
   - Operation and/or environmental conditions outside the specification
   - External influences/damage

   Inverters of the Open Type/IP20 degree of protection must be installed in a metal control cabinet (or protected by another equivalent measure) such that contact with fire inside and outside the inverter is not possible.
3. Hazardous shock voltages caused by, for example,
   - Component failure
   - Influence during electrostatic charging
   - Induction of voltages in moving motors
   - Operation and/or environmental conditions outside the specification
   - Condensation/conductive contamination
   - External influences/damage
4. Electrical, magnetic and electromagnetic fields generated in operation that can pose a risk to people with a pacemaker, implants or metal replacement joints, etc., if they are too close
5. Release of environmental pollutants or emissions as a result of improper operation of the system and/or failure to dispose of components safely and correctly

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Note

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

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

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

Introduction

2

2.1 About this manual

Who requires the operating instructions and what for?

These operating instructions primarily address fitters, commissioning engineers and machine operators. The operating instructions describe the devices and device components and enable the target groups being addressed to install, connect-up, set, and commission the converters safely and in the correct manner.

What is described in the operating instructions?

These operating instructions provide a summary of all of the information required to operate the converter under normal, safe conditions.

The information provided in the operating instructions has been compiled in such a way that it is sufficient for all standard applications and enables drives to be commissioned as efficiently as possible. Where it appears useful, additional information for entry level personnel has been added.

The operating instructions also contain information about special applications. Since it is assumed that readers already have a sound technical knowledge of how to configure and parameterize these applications, the relevant information is summarized accordingly. This relates, e.g. to operation with fieldbus systems and safety-related applications.

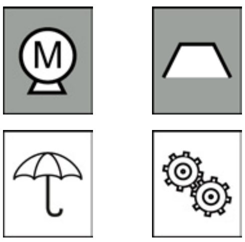
What is the meaning of the symbols in the manual?

An operating instruction starts here.

This concludes the operating instruction.

The subsequent text is applicable for an operator panel.

The following text applies if you are using a PC with STARTER.

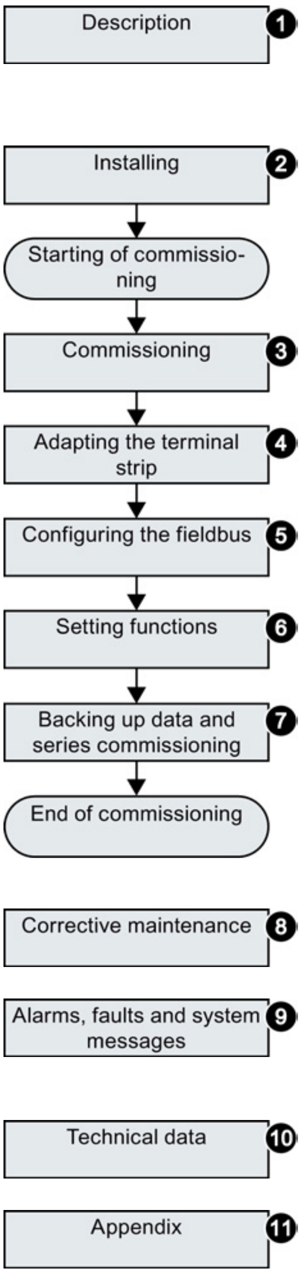


Examples of the inverter-function symbols

The description of the corresponding inverter function starts with one of these symbols.

See also: Overview of the inverter functions (Page 141).

2.2 Guide through this manual



① Inverter components and accessories.
Permissible motors.
Tools for commissioning.

② Installing and connecting the inverter and its components.
Install the inverter in accordance with EMC regulations.

③ Prepare for commissioning.
Restore the inverter to factory settings.
Define the inverter's basic settings.

④ Adjust the function of the inputs and outputs.

⑤ Configure communication via PROFIBUS or PROFINET.
Communication using other fieldbuses can be found in the "Fieldbus" function manual; see also: Manuals and technical support (Page 368).

⑥ Set the various functions, e.g. setpoint processing, motor control and protection functions.

⑦ Backup the inverter's settings to an external data storage medium, e.g. a memory card or an operator panel.

⑧ Replace the inverter and its components.
Firmware update.

⑨ Meaning of the LEDs on the front of the inverter.
System runtime.
Faults and warnings.

⑩ The most important technical data of the inverter.

⑪ Setting up the new inverter functions.
Application examples.

3 Description

Use for the intended purpose

The inverter described in this manual is a device for controlling an induction motor. The inverter is designed for installation in electrical installations or machines.

It has been approved for industrial and commercial use on industrial networks. Additional measures have to be taken when connected to public grids.

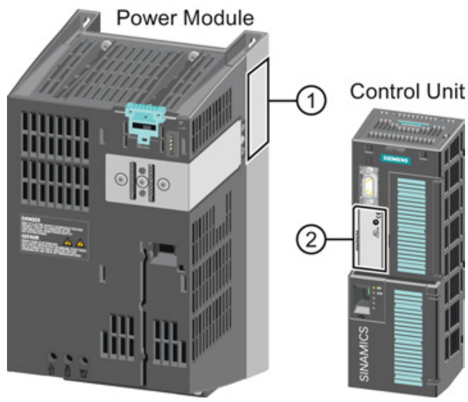
The technical specifications and information about connection conditions are indicated on the rating plate and in the operating instructions.

3.1 Identifying the converter

Main components of the inverter

Each SINAMICS G120 inverter comprises a Control Unit and a Power Module.

- The Control Unit controls and monitors the Power Module and the connected motor.
- The Power Modules are available for motors with a power range of between 0.37 kW and 250 kW.



The following data is provided on the Power Module type plate (①):

• Designation:	e.g. Power Module 240
• Technical data:	Voltage and current
• Order number:	e.g. 6SL3224-0BE13-7UA0
• Version:	e.g. A02

The following data can be found on the Control Unit type plate (②):

• Designation:	e.g. Control Unit CU240E-2 DP-F
• Order number:	e.g. 6SL3244-0BB13-1PA0
• Version:	e.g. A02 (hardware)

Additional converter components

The following components are available so that you can adapt the converter to different applications and ambient conditions:

- Line filter (Page 29)
- Line reactor (Page 30)
- Output reactor (Page 32)
- Sine-wave filter (Page 35)
- Braking resistor (Page 37)
- Brake Relay to control a motor holding brake (Page 38).

3.2 Overview of Control Units

Table 3- 1 Control Units CU240B-2 …

	The CU240B-2 Control Units differ with regard to the type of fieldbus.		
	Designation	CU240B-2	CU240B-2 DP
	Order number	6SL3244-0BB00-1BA1	6SL3244-0BB00-1PA1
	Fieldbus	USS, Modbus RTU	PROFIBUS DP

Table 3- 2 Control Units CU240E-2 …

	The CU240E-2 Control Units have, in comparison to the CU240B-2, an extended terminal strip with integrated safety functions. The CU240E-2 Control Units differ with regard to the type of fieldbus and the scope of the integrated safety functions.					
Designation	CU240E-2	CU240E-2 F	CU240E-2 DP	CU240E-2 DP-F	CU240E-2 PN	CU240E-2 PN-F
Order number	6SL3244-0BB12-1BA1	6SL3244-0BB13-1BA1	6SL3244-0BB12-1PA1	6SL3244-0BB13-1PA1	6SL3244-0BB12-1FA0	6SL3244-0BB13-1FA0
Fieldbus	USS, Modbus RTU	USS, Modbus RTU	PROFIBUS DP	PROFIBUS DP	PROFINET IO, EtherNet/IP	PROFINET IO, EtherNet/IP
Integrated safety functions	Basic functions	Extended functions	Basic functions	Extended functions	Basic functions	Extended functions

Memory cards

The following memory cards are available as medium to back up converter settings:

- Card without firmware: Order No. 6SL3054-4AG00-2AA0.
- Card with firmware: Order No. 6SL3054-7Ex00-2BA0.

  The digit at position x designates the firmware version:

  4.6 ≙ EG, 4.7 ≙ EH

Shield connection kit for the Control Unit

The shield connection kit is an optional component. The shield connection kit comprises the following components:

- Shield plate
- Elements for optimum shield support and strain relief of the signal and communication cables

Table 3- 3 Order numbers

Shield connection kit 2 for the CU240B-2 and CU240E-2 Control Units with all fieldbus interfaces except for PROFINET.	6SL3264-1EA00-0HA0
Shield connection kit 3 for the CU230P-2 and CU240E-2 Control Units with PROFINET interface.	6SL3264-1EA00-0HB0

3.3 Power Module

Important data on the Power Modules is provided in this section. Further information is contained in the hardware installation manuals listed in Section Manuals for your inverter (Page 368).

All power data refers to rated values or to power for operation with low overload (LO).

Which Power Module can I use with the Control Unit?

Table 3- 4 Permitted combinations of Control Unit and Power Module

Control Unit	Power Module					
	PM340 1AC	PM230 IP20 and push-through	PM240	PM240-2	PM250	PM260
CU240B-2…	---	✓	✓	✓	✓	✓
CU240E-2…	✓	✓	✓	✓	✓	✓

Figure 3-1 Power Modules with degree of protection IP20 FSA … FSGX

Figure 3-2 Power Modules with the push-through system FSA … FSC

PM230, 3 AC 400 V - Pump and fan applications

The PM230 Power Module is available without a filter or with integrated class A line filter.

Range of order numbers:
- IP20: 6SL3210-1NE…
- Push through: 6SL3211-1NE…

Frame size	FSA	FSB	FSC	FSD	FSE	FSF	
Power range (kW), IP20	0,37 … 3	4 … 7,5	11 … 18,5	22 … 37	45 … 55	75 … 90	
Power range (kW), PT	3	7,5	18,5	---	---	---	

PM340, 1 AC 200 V - Standard areas of application

The PM340 Power Module is available without a filter or with an integrated class A line filter with degree of protection IP20. The PM340 allows dynamic braking via an external braking resistor.

Order number range: 6SL3210-1SB1…

Frame size	FSA	FSB	FSC	FSD	FSE	FSF	FSGX
Power range (kW)	0.12 … 0.75	--	--	--	--	--	---

PM240, 3 AC 400 V - Standard areas of application

The PM240 Power Module is available without a filter or with an integrated class A line filter with degree of protection IP20. The PM240 allows dynamic braking via an external braking resistor.

Order number range: 6SL3224-0BE… and 6SL3224-0XE…

Frame size	FSA	FSB	FSC	FSD	FSE	FSF	FSGX
Power range (kW)	0.37 … 1.5	2.2 … 4	7.5 … 15	18.5 … 30	37 … 45	55 … 132	160 … 250

PM240-2, 3 AC 400 V - standard areas of application

The PM240-2 Power Module is available without a filter or with an integrated class A line filter. The PM240-2 permits dynamic braking via an external braking resistor.

Range of order numbers:

- IP20: 6SL3210-1PE…
- Push through: 6SL3211-1PE…

Frame size	FSA	FSB	FSC				
Power range (kW), IP20	0,55 … 3,0	4,0 … 7,5	11 … 15				
Power range (kW), PT	3,0	7,5	15				

PM250, 3 AC 400 V - Application areas with line regeneration

The PM250 Power Module is available without a filter or with an integrated class A line filter with degree of protection IP20. The PM250 permits dynamic braking with energy feedback into the line supply.

Order number range, IP20: 6SL3225-0BE …

Frame size	FSC	FSD	FSE	FSF			
Power range (kW)	7.5 … 15	18.5 … 30	37 … 45	55 … 90			

PM260, 3 AC 690 V - Application areas with line regeneration

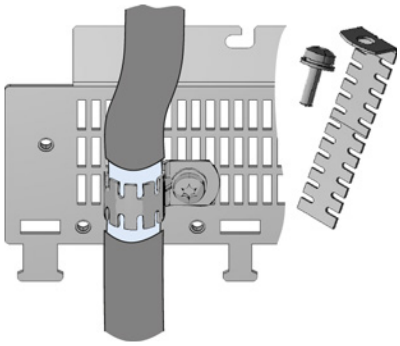
The PM260 Power Module is available without a filter or with an integrated class A line filter with degree of protection IP20. A sine-wave filter is fitted to the motor. The PM260 permits dynamic braking with energy feedback into the line supply.

Order number range, IP20: 6SL3225-0BH…

Frame size	FSD	FSF					
Power range (kW)	11 … 18.5	30 … 55					

3.3.1 Accessories for installation and shielding

Shield connection kit



The shield connection kit offers optimum shield support and strain relief for line and motor cables. It comprises a shield plate with serrated strips with screws.

Shield connection kits are available for frame sizes FSA … FSF.

- PM230 and PM240-2, FSA up to FSC:
  The shield connection kit belongs to the scope of supply of the Power Module.
- All other Power Modules:
  The shield connection kit is an optional component and must be ordered separately.

Adapter for rail mounting for PM240, PM250 and PM260, frame sizes FSA and FSB

You can use the adapter for rail mounting to mount the Power Module onto two mounting rails with a center-to-center distance of 100 mm.

Order numbers for shield connection kit and DIN rail mounting adapter

Frame size	Shield connection kit for Power Modules		Adapter for mounting on DIN rails
	PM240, PM250	PM260	
FSA	6SL3262-1AA00-0BA0	-	6SL3262-1BA00-0BA0
FSB	6SL3262-1AB00-0DA0	-	6SL3262-1BB00-0BA0
FSC	6SL3262-1AC00-0DA0	-	-
FSD	6SL3262-1AD00-0DA0	6SL3262-1FD00-0CA0	-
FSE	6SL3262-1AD00-0DA0	-	-
FSF	6SL3262-1AF00-0DA0	6SL3262-1FF00-0CA0	-

3.4 Components for the Power Modules

3.4.1 Line filter

With a line filter, the inverter can achieve a higher radio interference class. An external filter is not required for inverters with integrated line filter.

Adjacent examples of line filters.

Filters comply with Class A, or B according to EN55011: 2009.

for PM240 FSA

for PM240 FSGX

External line filters for PM240

Power Module 6SL3224-…		Power	Line filter, class A
FSA	…0BE13-7UA0, …0BE15-5UA0, …0BE17-5UA0, …0BE21-1UA0, …0BE21-5UA0	0.37 kW … 1.5 kW	6SE6400-2FA00-6AD0
FSF	…0BE38-8UA0, …0BE41-1UA0	110 kW … 132 kW	6SL3203-0BE32-5AA0
FSGX	…0XE41-3UA0, …0XE41-6UA0	160 kW … 200 kW	6SL3000-0BE34-4AA0
	…0XE42-0UA0	250 kW	6SL3000-0BE36-0AA0

Power Module 6SL3224-…		Power	Line filter, class B
FSA	…0BE13-7UA0, …0BE15-5UA0, …0BE17-5UA0, …0BE21-1UA0, …0BE21-5UA0	0.37 kW … 1.5 kW	6SE6400-2FB00-6AD0
FSB	…0BE22-2AA0, …0BE23-0AA0, …0BE24-0AA0	2.2 kW … 4.0 kW	6SL3203-0BE21-6SA0
FSC	…0BE25-5UA0, …0BE27-5UA0, …0BE31-1UA0	7.5 kW … 15.0 kW	6SL3203-0BD23-8SA0

External line filters for PM250

Power Module 6SL3225-…		Power	Line filter, class B
FSC	…0BE25-5AA0, …0BE27-5AA0, …0BE31-1AA0	7.5 kW … 15.0 kW	6SL3203-0BD23-8SA0

3.4.2 Line reactor

The line reactor supports the overvoltage protection, smoothes the harmonics in the line supply and bridges commutation dips. For the Power Modules subsequently listed, a line reactor is suitable in order to dampen the specified effects.

Adjacent examples of line reactors.

for PM240

for PM240-2

NOTICE
Damage to inverter as a result of a missing line reactor
Depending on the Power Module and line supply, if a line reactors is not used, this can result in damage to the inverter and other components in the electrical plant or system.
• Install a line reactor if the relative short-circuit voltage of the line supply is below 1%

Line reactors for PM240

Power Module 6SL3224-…		Power	Line reactor
FSA	…0BE13-7UA0, …0BE15-5UA0	0.37 kW … 0.55 kW	6SE6400-3CC00-2AD3
	…0BE17-5UA0, …0BE21-1UA0	0.75 kW … 1.1 kW	6SE6400-3CC00-4AD3
	…0BE21-5UA0	1.5 kW	6SE6400-3CC00-6AD3
FSB	…0BE22-2□A0, …0BE23-0□A0	2.2 kW … 3.0 kW	6SL3203-0CD21-0AA0
	…0BE24-0□A0	4.0 kW	6SL3203-0CD21-4AA0
FSC	…0BE25-5□A0, …0BE27-5□A0	7.5 kW … 11.0 kW	6SL3203-0CD22-2AA0
	…0BE31-1□A0	15.0 kW	6SL3203-0CD23-5AA0
FSD	…0BE31-5□A0, …0BE31-8□A0	18.5 kW … 22 kW	6SL3203-0CJ24-5AA0
	…0BE32-2□A0	30 kW	6SL3203-0CD25-3AA0
FSE	…0BE33-0□A0, …0BE33-7□A0	37 kW … 45 kW	6SL3203-0CJ28-6AA0
FSF	…0BE34-5□A0, …0BE35-5□A0	55 kW … 75 kW	6SE6400-3CC11-2FD0
	…0BE37-5□A0	90 kW	6SE6400-3CC11-7FD0
	…0BE38-8UA0	110 kW	6SL3000-0CE32-3AA0
	…0BE41-1UA0	132 kW	6SL3000-0CE32-8AA0
FSGX	…0XE41-3UA0	160 kW	6SL3000-0CE33-3AA0
	…0XE41-6UA0, …0XE42-0UA0	200 kW … 250 kW	6SL3000-0CE35-1AA0

Line reactors for PM240-2

Power Module 6SL321□-…		Power	Line reactor
FSA	…1PE11-8□L0, …1PE12-3□L0, …1PE13-2□L0	0.55 kW … 1.1 kW	6SL3203-0CE13-2AA0
	…1PE14-3□L0, …1PE16-1□L0, …1PE18-0□L0	1.5 kW … 3.0 kW	6SL3203-0CE21-0AA0

Line reactors for PM340 1AC

Order number 6SL3210-…		Power	Line reactor
FSA	…-1SB11-0□A0, …1SB12-3□A0	0.12 kW … 0.37 kW	6SE6400-3CC00-4AB3
	…-1SB14-0□A0	0.75 kW	6SE6400-3CC01-0AB3

3.4.3 Output reactor

Output reactors reduce the voltage stress on the motor windings. Further, they reduce the inverter load as a result of capacitive recharging currents in the cables. An output reactor is required for motor cables longer than 50 m, shielded or 100 m unshielded.

The output reactors are designed for pulse frequencies of 4 kHz.

Adjacent examples of output reactors.

for PM240 FSA, FSB

for FSGX

Output reactors for PM240 Power Module

Power Module 6SL3224-…		Power	Output reactor
FSA	…0BE13-7UA0, …0BE15-5UA0, …0BE17-5UA0, …0BE21-1UA0, …0BE21-5UA0	0.37 kW … 1.5 kW	6SE6400-3TC00-4AD2
FSB	…0BE22-2□A0, …0BE23-0□A0, …0BE24-0□A0	2.2 kW … 4.0 kW	6SL3202-0AE21-0CA0
FSC	…0BE25-5□A0, …0BE27-5□A0, …0BE31-1□A0	7.5 kW … 15.0 kW	6SL3202-0AJ23-2CA0
FSD	…0BE31-5□A0	18,5 kW	6SE6400-3TC05-4DD0
	…0BE31-8□A0	22 kW	6SE6400-3TC03-8DD0
	…0BE32-2□A0	30 kW	6SE6400-3TC05-4DD0
FSE	…0BE33-0□A0	37 kW	6SE6400-3TC08-0ED0
	…0BE33-7□A0	45 kW	6SE6400-3TC07-5ED0
FSF	…0BE34-5□A0	55 kW	6SE6400-3TC14-5FD0
	…0BE35-5□A0	75 kW	6SE6400-3TC15-4FD0
	…0BE37-5□A0	90 kW	6SE6400-3TC14-5FD0
	…0BE38-8UA0	110 kW	6SL3000-2BE32-1AA0
	…0BE41-1UA0	132 kW	6SL3000-2BE32-6AA0
FSGX	…0XE41-3UA0	160 kW	6SL3000-2BE33-2AA0
	…0XE41-6UA0	200 kW	6SL3000-2BE33-8AA0
	…0XE42-0UA0	250 kW	6SL3000-2BE35-0AA0

Output reactors for PM250 Power Module

Power Module 6SL3225-…		Power	Output reactor
FSC	…0BE25-5□A0, …0BE27-5□A0, …0BE31-1□A0	7.5 kW … 15.0 kW	6SL3202-0AJ23-2CA0
FSD	…0BE31-5□A0	18,5 kW	6SE6400-3TC05-4DD0
	…0BE31-8□A0	22 kW	6SE6400-3TC03-8DD0
	…0BE32-2□A0	30 kW	6SE6400-3TC05-4DD0
FSE	…0BE33-0□A0	37 kW	6SE6400-3TC08-0ED0
	…0BE33-7□A0	45 kW	6SE6400-3TC07-5ED0
FSF	…0BE34-5□A0	55 kW	6SE6400-3TC14-5FD0
	…0BE35-5□A0	75 kW	6SE6400-3TC15-4FD0
	…0BE37-5□A0	90 kW	6SE6400-3TC14-5FD0

Output reactors for PM230 Power Modules (IP20)

6SL3210-… Power Modules		Power	Output reactor
FSA	…1NE11-3□L0, …1NE11-7□L0, …1NE12-2□L0, …1NE13-1□L0, …1NE14-1□L0, …1NE15-8□L0	0.37 kW … 2.2 kW	6SL3202-0AE16-1CA0
	…1NE17-7□L0	3.0 kW	6SL3202-0AE18-8CA0
FSB	…1NE21-0□L0, …1NE21-3□L0, …1NE21-8□L0	4.0 kW … 7.5 kW	6SL3202-0AE21-8CA0
FSC	…1NE22-6□L0, …1NE23-2□L0, …1NE23-8□L0	11.0 kW … 18.5 kW	6SL3202-0AE23-8CA0
FSD	…1NE24-5□L0	22 kW	6SE6400-3TC03-8DD0
	…1NE26-0□L0	30 kW	6SE6400-3TC05-4DD0
FSE	…1NE27-5□L0	37 kW	6SE6400-3TC08-0ED0
	…1NE28-8□L0	45 kW	6SE6400-3TC07-5ED0
FSF	…1NE31-1□L0	55 kW	6SE6400-3TC14-5FD0
	…1NE31-5□L0	75 kW	6SE6400-3TC15-4FD0

Output reactors for PM230 push-through Power Modules

6SL3211-… Power Modules		Power	Output reactor
FSA	…1NE17-7□L0	3.0 kW	6SL3202-0AE18-8CA0
FSB	…1NE21-8□L0	7.5 kW	6SL3202-0AE21-8CA0
FSC	…1NE23-8□L0	18.5 kW	6SL3202-0AE23-8CA0

Output reactors for PM240-2 Power Modules (IP20)

6SL3210-… Power Modules		Power	Output reactor
FSA	…1PE11-8□L0, …1PE12-3□L0, …1PE13-2□L0, …1PE14-3□L0, …1PE16-1□L0	0.55 kW … 2.2 kW	6SL3202-0AE16-1CA0
	…1PE18-0UL0	3.0 kW	6SL3202-0AE18-8CA0

Output reactors for PM240-2 push-through Power Modules

6SL3211-… Power Modules		Power	Output reactor
FSA	…1PE16-1□L0	2.2 kW	6SL3202-0AE16-1CA0
	…1PE18-0UL0	3.0 kW	6SL3202-0AE18-8CA0

3.4.4 Sine-wave filter

The sine-wave filter at the inverter outputs almost sinusoidal voltages to the motor, so that you can use standard motors without special cables. The maximum permissible length of motor feeder cables is increased to 300 m.

for FSF

The following applies when using a sine-wave filter:

- Operation is only permissible with pulse frequencies from 4 kHz to 8 kHz.
  From 110 kW power rating of the Power Modules (according to the rating plate) only 4 kHz is permissible.
- The inverter power is reduced by 5%.
- The maximum output frequency of the inverter is 150 Hz at 380 V to 480 V.
- Operation and commissioning may only be performed with the motor connected, as the sine-wave filter is not no-load proof.
- An output reactor is superfluous.

Sine-wave filter for PM240 Power Module

Power Module 6SL3224-…		Power	Sine-wave filter
FSA	…0BE13-7UA0, …0BE15-5UA0, …0BE17-5UA0	0.37 kW … 0.75 kW	6SL3202-0AE20-3SA0
	…0BE21-1UA0, …0BE21-5UA0	1.1 kW … 1.5 kW	6SL3202-0AE20-6SA0
FSB	…0BE22-2□A0, …0BE23-0□A0	2.2 kW … 3.0 kW	6SL3202-0AE21-1SA0
	…0BE24-0□A0	4.0 kW	6SL3202-0AE21-4SA0
FSC	…0BE25-5□A0	7.5 kW	6SL3202-0AE22-0SA0
	…0BE27-5□A0, …0BE31-1□A0	11.0 kW … 15.0 kW	6SL3202-0AE23-3SA0
FSD	…0BE31-5□A0, …0BE31-8□A0	18.5 kW … 22 kW	6SL3202-0AE24-6SA0
	…0BE32-2□A0	30 kW	6SL3202-0AE26-2SA0
FSE	…0BE33-0□A0, …0BE33-7□A0	37 kW … 45 kW	6SL3202-0AE28-8SA0
FSF	…0BE34-5□A0, …0BE35-5□A0	55 kW … 75 kW	6SL3202-0AE31-5SA0
	…0BE37-5□A0	90 kW	6SL3202-0AE31-8SA0
	…0BE38-8UA0, …0BE41-1UA0	110 kW … 132 kW	6SL3000-2CE32-3AA0
FSGX	…0XE41-3UA0	160 kW	6SL3000-2CE32-8AA0
	…0XE41-6UA0	200 kW	6SL3000-2CE33-3AA0
	…0XE42-0UA0	250 kW	6SL3000-2CE34-1AA0

Sine-wave filter for PM250 Power Module

Power Modul 6SL3225-…		Power	Sine-wave filter
FSC	…0BE25-5□A0	7.5 kW	6SL3202-0AE22-0SA0
	…0BE27-5□ A0, …0BE31-1□A0	11.0 kW … 15.0 kW	6SL3202-0AE23-3SA0
FSD	…0BE31-5□A0, …0BE31-8□A0	18.5 kW … 22 kW	6SL3202-0AE24-6SA0
	…0BE32-2□A0	30 kW	6SL3202-0AE26-2SA0
FSE	…0BE33-0□A0, …0BE33-7□A0	37 kW … 45 kW	6SL3202-0AE28-8SA0
FSF	…0BE34-5□A0, …0BE35-5□A0	55 kW … 75 kW	6SL3202-0AE31-5SA0
	…0BE37-5□A0	90 kW	6SL3202-0AE31-8SA0

3.4.5 Braking resistor

The braking resistor allows loads with a high moment of inertia to be quickly braked.

The Power Module controls the braking resistor via its integrated braking module.

Adjacent, as example, a braking resistor for PM240 and PM340 Power Modules, frame size FSA, which can be mounted below the device.

Braking resistors for PM240

Power Modules			Braking Module	Braking resistor
6SL3224-…		Power	6SL3300-…	
FSA	…0BE13-7UA0, …0BE15-5UA0, …0BE17-5UA0, …0BE21-1UA0, …0BE21-5UA0	0.37 kW … 1.5 kW	---	6SE6400-4BD11-0AA0
FSB	…0BE22-2□A0, …0BE23-0□A0, …0BE24-0□A0	2.2 kW … 4.0 kW	---	6SL3201-0BE12-0AA0
FSC	…0BE25-5□A0, …0BE27-5□A0 …0BE31-1□A0	7.5 kW … 15.0 kW	---	6SE6400-4BD16-5CA0
FSD	…0BE31-5□A0, …0BE31-8□A0, …0BE32-2□A0	18.5 kW … 30 kW	---	6SE6400-4BD21-2DA0
FSE	…0BE33-0□A0, …0BE33-7□A0	37 kW … 45 kW	---	6SE6400-4BD22-2EA1
FSF	…0BE34-5□A0, …0BE35-5□A0, …0BE37-5□A0	55 kW … 90 kW	---	6SE6400-4BD24-0FA0
	…0BE38-8UA0, …0BE41-1UA0	110 kW … 132 kW	---	6SE6400-4BD26-0FA0
FSGX	…0XE41-3UA0	160 kW	---	6SL300-1BE31-3AA0
	…0XE41-6UA0, …0XE42-0UA0	200 kW … 250 kW	…1AE32-5AA0	6SL3000-1BE32-5AA0

Braking resistors for PM240-2

Power Module 6SL321□-…		Power	Braking resistor
FSA	…1PE11-8□L0, …1PE12-3□L0, …1PE13-2□L0	0.55 kW … 1.1 kW	6SL3201-0BE14-3AA0
	…1PE14-3□L0, …1PE16-1□L0, …1PE18-0□L0	1.5 kW … 3.0 kW	6SL3201-0BE21-0AA0

Braking resistors for PM340, 1AC

Order number 6SL3210-…		Power	Braking resistor
FSA	…-1SB11-0□A0 …-1SB12-3□A0 …-1SB14-0□A0	0.12 kW … 0.75 kW	6SE6400-4BC05-0AA0

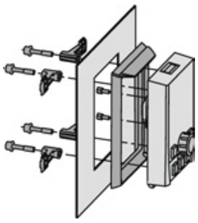
3.4.6 Brake Relay

The brake relay has a switch contact (NO contact) to control the motor brake coil.

Order no.: 6SL3252-0BB00-0AA0

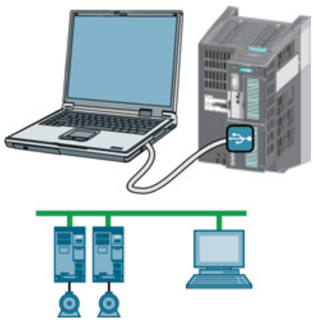
3.5 Tools to commission the converter

The following tools are used to commission, troubleshoot and control the inverter, as well as to backup and transfer the inverter settings.

<table>
<tr><th colspan="4">Operator panels</th><th>Order number</th></tr>
<tr><td></td><td>BOP-2 (Basic Operator Panel) - for snapping onto the inverter
• Two-line display
• Guided basic commissioning</td><td rowspan="2"></td><td rowspan="2">Door mounting kit for IOP/BOP-2
• For installation of the BOP-2 or IOP in a control cabinet door.
• Degree of protection with IOP: IP54 or UL Type 12
• Degree of protection with BOP-2: IP55</td><td rowspan="2">BOP-2:
6SL3255-0AA00-4CA1

IOP:
6SL3255-0AA00-4JA0

Door mounting kit:
6SL3256-0AP00-0JA0</td></tr>
<tr><td></td><td>IOP (Intelligent Operator Panel) - for snapping onto the inverter
• Plain text display
• Menu-based operation and application wizards</td></tr>
<tr><td colspan="2"></td><td colspan="2">For mobile use of the IOP:
IOP handheld with power supply unit and rechargeable batteries as well as RS232 connection cable
If you are using your own connection cable, carefully note the maximum permissible length of 5 m.</td><td>6SL3255-0AA00-4HA0</td></tr>
</table>

<table>
<tr><th colspan="3">PC tools</th></tr>
<tr><td rowspan="3"></td><td>STARTER
Connected to the inverter via USB port, PROFIBUS or PROFINET
Download: STARTER (http://support.automation.siemens.com/WW/view/en/10804985/130000)</td><td>STARTER on DVD:
6SL3072-0AA00-0AG0</td></tr>
<tr><td>Startdrive
Connected to the inverter via USB port, PROFIBUS or PROFINET
Download: Startdrive (http://support.automation.siemens.com/WW/view/en/68034568)</td><td>Startdrive on DVD:
6SL3072-4CA02-1XG0</td></tr>
<tr><td>SINAMICS PC Inverter Connection Kit 2
Contains the correct USB cable (3 m) to connect a PC to the inverter.</td><td>6SL3255-0AA00-2CA0</td></tr>
</table>

Installing

4

4.1 Overview of the inverter installation

Installing the inverter

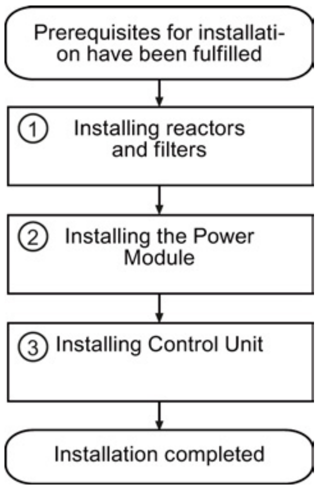
Precondition

Before installation, please check:

- Are the required inverter components available?
  - Power Module
  - Control Unit
  - Accessories, e.g. line reactor or braking resistor
- Do you have the necessary tools and small parts/components required to install the inverter?

Procedure

To install the inverter, proceed as follows:



1. Install the accessories (reactors, filter or braking resistor) for the Power Module:
   - Observe the installation instructions that are supplied with the accessories.
   - If you are using more than one base-mounted component, then you must observe the sequence when installing.

     See also Installing reactors, filters and braking resistors (Page 42).
2. Install the Power Module.

   See also Installing the Power Module (Page 43).

   You can find information about your Power Module in the corresponding Hardware Installation Manual (http://support.automation.siemens.com/WW/view/en/30563173/133300).
3. Install the Control Unit.

   See also Installing Control Unit (Page 63).

You have installed all of the inverter components, and you can now commission the inverter.

4.2 Installing reactors, filters and braking resistors

Installing reactors, filters and braking resistors

The installation of reactors, filters and braking resistors is described in the documentation provided. See also Section: Manuals and technical support (Page 368).

Installing base components

Reactors, filters and braking resistors are available as base components for the PM240 and PM250 Power Modules, frame sizes FSA, FSB and FSC. You can also install base components next to Power Modules.

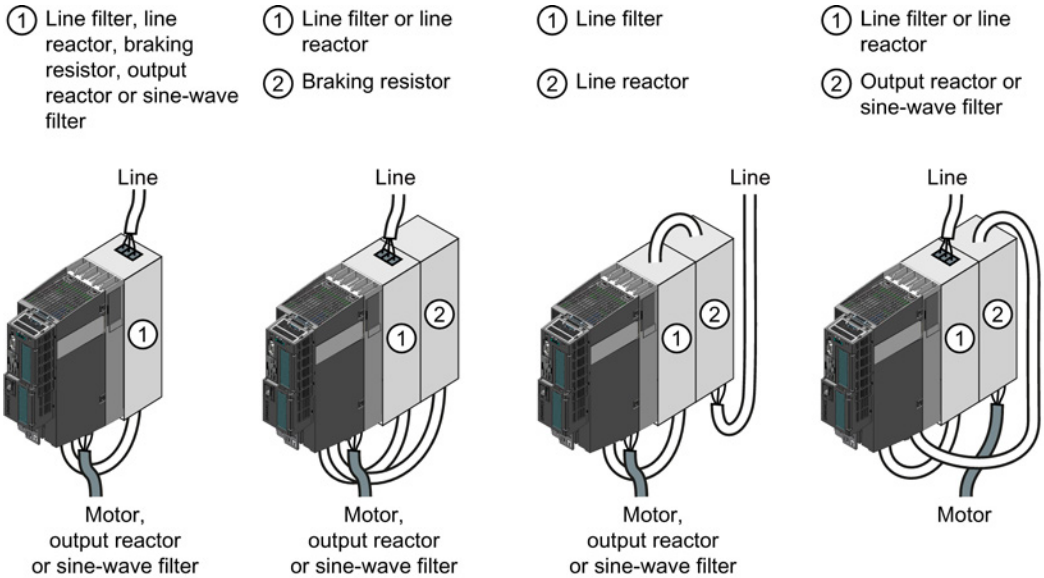


Figure 4-1 Permissible combination of base components

Table 4- 1 Permissible combinations as a function of the inverter frame size

		Base component ①	
		Line filter	**Line reactor**
Base component ②	**Line reactor**	FSA … FSC	---
	Output reactor	FSA … FSC	FSA … FSC
	Sine-wave filters	FSA	FSA
	Braking resistor	FSA, FSB	FSA, FSB

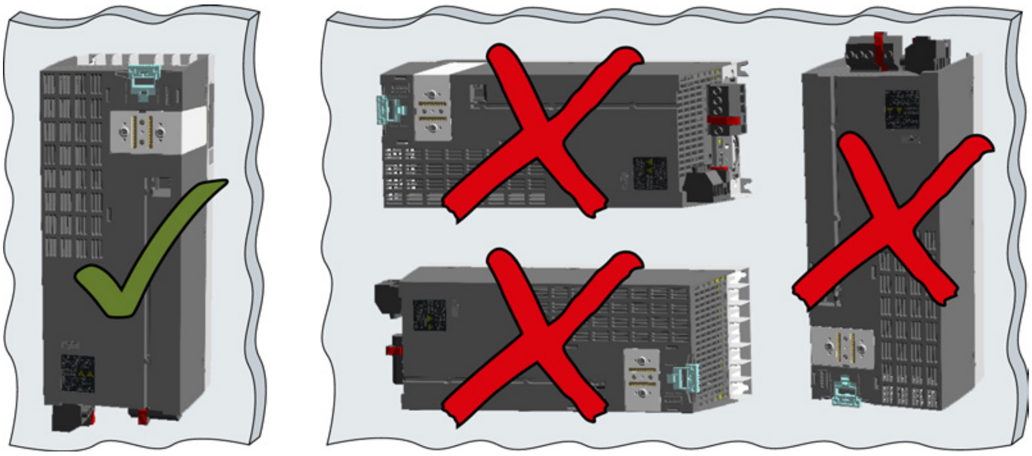
4.3 Installing the Power Module

Mounting Power Modules with degree of protection IP20

Procedure

Proceed as follows to correctly mount the Power Module:

1. Mount the Power Module in a control cabinet.
2. Maintain the minimum clearances to other components in the control cabinet specified below.
3. Install the Power Modules vertically with the line and motor connections facing downwards. It is not permissible to install them in any other position.



4. Position the Power Module in the control cabinet so that the cables for the motor and line supply are connected in accordance with the terminal layout.
5. Use the mounting devices specified below.
6. Comply with the torques of the mounting devices specified below.

You have correctly mounted the Power Module.

Mounting Power Modules using through-hole technology

We recommend that you use the optionally available mounting frame to mount the push-through unit in a control cabinet. This mounting frame includes the necessary seals and frame to ensure compliance with degree of protection IP54.

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

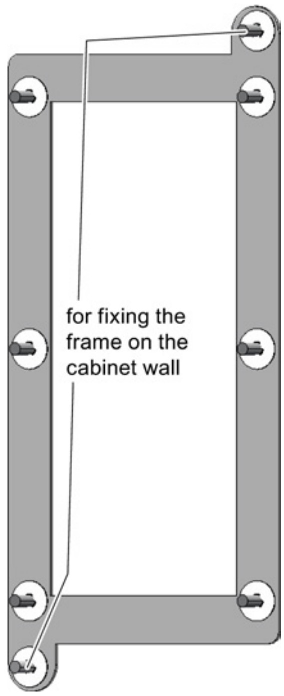
You must mount the inverter on unpainted metal surfaces in order to comply with EMC requirements.

Procedure

Proceed as follows to correctly mount the Power Module:

1. Prepare the cutout and the mounting holes for the Power Module and the mounting frame corresponding to the dimension drawings of the mounting frame.

   Also note that the PT Power modules must be vertically mounted with the line and motor connections facing downwards.
2. Position the mounting frame at the rear of the control cabinet and attach it to the control cabinet by tightening the corresponding screws by hand.
3. Attach the seal to the inner side of the control cabinet.
4. Mount the frequency inverter and initially tighten all of the mounting screws by hand.
5. Tighten the screws with a torque of 3 Nm.



Mounting frame

You have correctly mounted the Power Module.

Mounting additional components

Depending on the application, the following additional components, for example, may be required (also refer to Section Identifying the converter (Page 23)):

- Line reactors
- Filter
- Braking resistors
- Brake Relay

Information about mounting these components is provided in the instructions supplied.

4.3.1 Dimensions, hole drilling templates, minimum clearances, tightening torques

Dimensions and drilling patterns for Power Modules with IP20 degree of protection

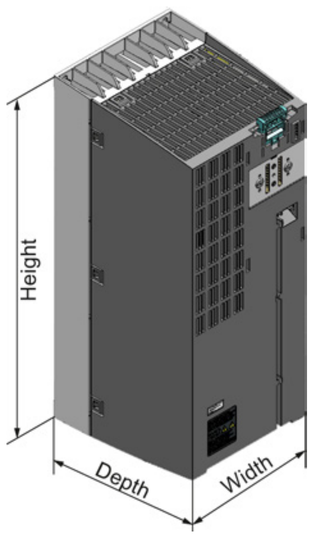
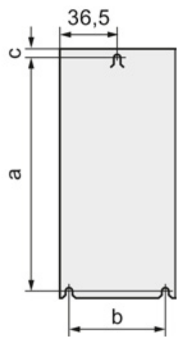
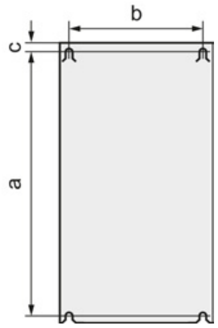
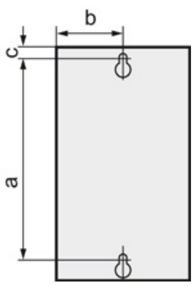
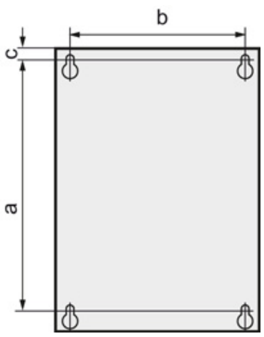
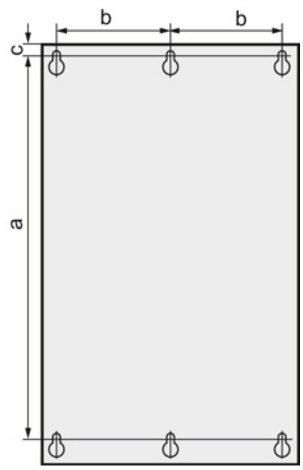
<table>
<tr><th colspan="2">Defining the dimensions</th><th colspan="2">Drilling patterns for the PM230 and PM240-2 Power Modules</th></tr>
<tr><td colspan="2">
</td><td>FSA

</td><td>FSB, FSC

</td></tr>
<tr><td colspan="4">Drilling patterns for all other Power Modules</td></tr>
<tr><td>FSA

</td><td colspan="2">FSB…FSF

</td><td>FSGX

</td></tr>
</table>

Table 4- 2 Dimensions for PM230

Frame size	Dimensions (mm)					
	Height[1)]	Width	Depth[2)]	a	b	c
FSA	196	73	165	186	62,3	6
FSB	292	100	165	281	80	6
FSC	355	140	165	343	120	6
FSD without filter	419	275	204	325	235	11
FSD with filter	512	275	204	419	235	11
FSE without filter	499	275	204	405	235	11
FSE with filter	635	275	204	541	235	11
FSF without filter	634	350	316	598	300	11
FSF with filter	934	350	316	899	300	11

1) When using a shield connection kit:
FSA: + 80 mm; FSB: + 78 mm; FSC: + 77 mm; FSD, FSE, FSF: + 123 mm

2) Total depth of the inverter: See below.

Table 4- 3 Mounting hardware and clearances to other devices for PM230

Frame size	Hardware	Tightening torque (Nm)	Clearances (mm)		
			Top	Bottom	Lateral
FSA	M4 screws	2,5	80	100	0[1)]
FSB	M4 screws	2,5	80	100	0[1)]
FSC	M5 screws	3	80	100	0[1)]
FSD without filter	M6 screws	6	300	300	0[1)]
FSD with filter	M6 screws	6	300	300	0[1)]
FSE without filter	M6 screws	6	300	300	0[1)]
FSE with filter	M6 screws	6	300	300	0[1)]
FSF without filter	M8 screws	13	350	350	0[1)]
FSF with filter	M8 screws	13	350	350	0[1)]

1) You can mount the Power Modules without any lateral clearance. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm.

Table 4- 4 Dimensions for PM240

Frame size	Dimensions (mm)					
	Height1)	Width	Depth2)	a	b	c
FSA	173	73	145	160	36,5	--
FSB	270	153	165	258	133	--
FSC	355	140	165	343	120	6
FSD without filter	419	275	204	325	235	11
FSD with filter	512	275	204	419	235	11
FSE without filter	499	275	204	405	235	11
FSE with filter	635	275	204	541	235	11
FSF without filter	634	350	316	598	300	11
FSF with filter	934	350	316	899	300	11
FSGX	1533	326	547	1506	125	14,5

1) When using a shield connection kit:
FSA: + 80 mm; FSB: + 78 mm; FSC: + 77 mm; FSD, FSE, FSF: + 123 mm

2) Total depth of the inverter: See below.

Table 4- 5 Mounting hardware and clearances to other devices for PM240

Frame size	Hardware	Tightening torque (Nm)	Clearances (mm)		
			Top	Bottom	Lateral
FSA	M4 screws	2,5	100	100	30 1)
FSB	M4 screws	2,5	100	100	40 1)
FSC	M5 screws	3,5	80	100	50 1)
FSD	M6 screws	6	300	300	0 2)
FSE	M6 screws	6	300	300	0 2)
FSF	M8 screws	13	350	350	0 2)
FSGX	M8 screws	13	250	150	50

1) You can mount the Power Modules without any lateral clearance up to an ambient temperature of 40 °C in operation. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm.

2) You can mount the Power Modules without any lateral clearance. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm.

Table 4- 6 Dimensions for PM240-2

Frame size	Dimensions (mm)					
	Height1)	Width	Depth2)	a	b	c
FSA	196	73	165	186	62,3	6
FSB	292	100	165	281	80	6
FSC	355	140	165	343	120	6

1) Additional height with shield connection kit: FSA: + 80 mm; FSB: + 78 mm; FSC: + 77 mm

2) Total depth of the inverter: See below.

Table 4- 7 Mounting hardware and clearances to other devices for PM240-2

Frame size	Hardware	Tightening torque (Nm)	Clearances (mm)		
			Top	Bottom	Lateral
FSA	M4 screws	2,5	80	100	0[1)]
FSB	M4 screws	2,5	80	100	0[1)]
FSC	M5 screws	2,5	80	100	0[1)]

1) You can mount the Power Modules without any lateral clearance. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm.

Table 4- 8 Dimensions and clearances for the PM340 1AC

Frame size	Dimensions (mm)					
	Height[1)]	Width	Depth[2)]	a	b	c
FSA	173	73	145	160	36,5	--

1) With shield connection kit: +84 mm

2) Total depth of the inverter: See below.

Table 4- 9 Mounting materials for PM340 1AC

Frame size	Hardware	Tightening torque (Nm)	Clearances (mm)		
			Top	Bottom	Lateral
FSA	M4 screws	2,5	100	100	30[1)]

1) At ambient temperatures in operation up to 40 °C without any lateral clearance. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm.

Table 4- 10 Dimensions for PM250

Frame size	Dimensions (mm)					
	Height[1)]	Width	Depth[2)]	a	b	c
FSC	355	140	165	343	120	6
FSD without filter	419	275	204	325	235	11
FSD with filter	512	275	204	419	235	11
FSE without filter	499	275	204	405	235	11
FSE with filter	635	275	204	541	235	11
FSF without filter	634	350	316	598	300	11
FSF with filter	934	350	316	899	300	11

1) Additional height with shield connection kit: FSC: +89 mm; FSD…FSF: +123 mm

2) Total depth of the inverter: See below.

Table 4- 11 Mounting hardware and clearances to other devices for PM250

Frame size	Hardware	Tightening torque (Nm)	Clearances (mm)		
			Top	Bottom	Lateral
FSC	M5 screws	2,5	80	100	50[1]
FSD	M6 screws	6	300	300	0[2]
FSE	M6 screws	6	300	300	0[2]
FSF	M8 screws	13	350	350	0[2]

[1] You can mount the Power Modules without any lateral clearance up to an ambient temperature of 40 °C in operation. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm.

[2] You can mount the Power Modules without any lateral clearance. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm.

Table 4- 12 Dimensions for PM260

Frame size	Dimensions (mm)					
	Height[1]	Width	Depth[2]	a	b	c
FSD without filter	419	275	204	325	235	11
FSD with filter	512	275	204	419	235	11
FSF without filter	634	350	316	598	300	11
FSF with filter	934	350	316	899	300	11

[1] Additional height with shield connection kit: +123 mm

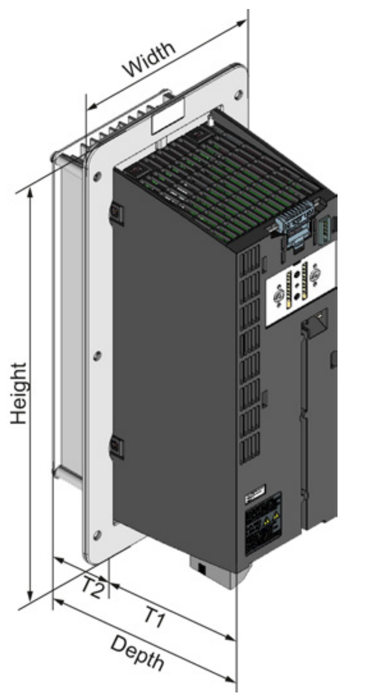
[2] Total depth of the inverter: See below.

Table 4- 13 Mounting hardware and clearances to other devices for PM260

Frame size	Hardware	Tightening torque (Nm)	Clearances (mm)		
			Top	Bottom	Lateral
FSD	M6 screws	6	300	300	0[1]
FSF	M8 screws	13	350	350	0[1]

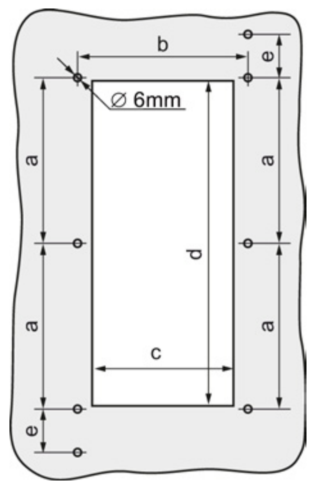
[1] You can mount the Power Modules without any lateral clearance. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm.

Dimensions and drilling patterns for Power Modules with through-hole technology



Mounting cutout in the control cabinet for the PM230 and PM240-2 Power Modules;
Holes for fastening the mounting frame

FSA, FSB



FSC

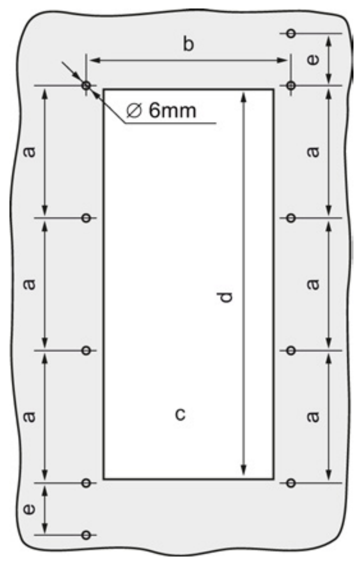


Table 4- 14 Dimensions for PM230 in push-through technology

Frame size	Dimensions (mm)									
	Height[1)]	Width	Depth[2)]	T1	T2	a	b	c	d	e
FSA	238	126	171	118	54	103	106	88	198	27
FSB	345	154	171	118	54	147,5	134	116	304	34,5
FSC	411	200	171	118	54	123	174	156	365	30,5

1) With shield connection kit: FSA: +84 mm; FSB: +85 mm; FSC: +89 mm

3) Total depth of the inverter: See below.

Table 4- 15 Mounting hardware and clearances to other devices for PM230 in push-through technology

Frame size	Hardware	Tightening torque (Nm)	Clearances (mm)		
			Top	Bottom	Lateral
FSA	M5 screws	3	80	100	0[1)]
FSB	M5 screws	3	80	100	0[1)]
FSC	M5 screws	3	80	100	0[1)]

1) You can mount the mounting frames without any lateral clearance. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm.

Table 4- 16 Dimensions for PM240-2 in push-through technology

Frame size	Dimensions (mm)									
	Height[1)]	Width	Depth[2)]	T1	T2	a	b	c	d	e
FSA	238	126	171	118	54	103	106	88	198	27
FSB	345	154	171	118	54	147,5	134	116	304	34,5
FSC	411	200	171	118	54	123	174	156	365	30,5

1) With shield connection kit: FSA: +84 mm; FSB: +85 mm; FSC: +89 mm

2) Total depth of the inverter: See below.

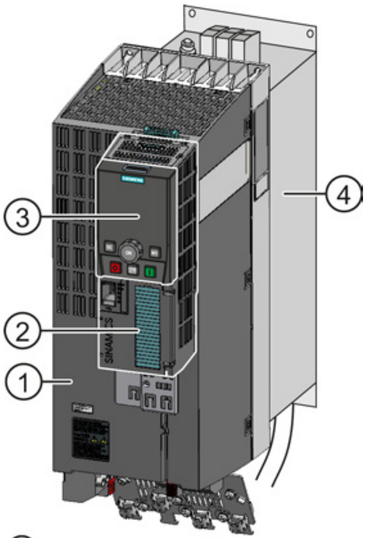
Table 4- 17 Mounting hardware and clearances to other devices for PM240-2 in push-through technology

Frame size	Hardware	Tightening torque (Nm)	Clearances (mm)		
			Top	Bottom	Lateral
FSA	M5 screws	3	80	100	0[1)]
FSB	M5 screws	3	80	100	0[1)]
FSC	M5 screws	3	80	100	0[1)]

1) You can mount the mounting frames without any lateral clearance. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm.

Total depth of the inverter

Power Modules frame sizes FSA … FSF



① Power Module
② Control Unit
③ Intelligent Operator Panel IOP
④ Base components: Filters, reactors or braking resistors

① + ②

As a minimum, the inverter comprises a Power Module and an inserted Control Unit:

Overall depth of the inverter = depth of the Power Module + 41 mm (Control Unit)

① + ② + ③

Inverter with inserted operator panel:

- Overall depth of the inverter = depth of the Power Module + 54 mm (Control Unit + Basic Operator Panel BOP-2)
- Overall depth of the inverter = depth of the Power Module + 63 mm (Control Unit + Intelligent Operator Panel IOP)

① + ② + ③ + ④

Power Module (degree of protection IP20) on a base component:

The overall inverter depth increases by the depth of the base component.

Power Modules frame sizes FSGX (160 kW … 250 kW)

Total depth of the inverter = depth of the Power Module

4.3.2 Connecting the line supply, motor, and inverter components

4.3.2.1 Permissible line supplies

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

Above an installation altitude of 2000 m, the permissible line supplies are restricted. See also: Restrictions for special ambient conditions (Page 340).

TN line system

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

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

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

Preconditions and restrictions when connecting an inverter to a TN line system

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

Examples for Power Modules connected to a TN line supply

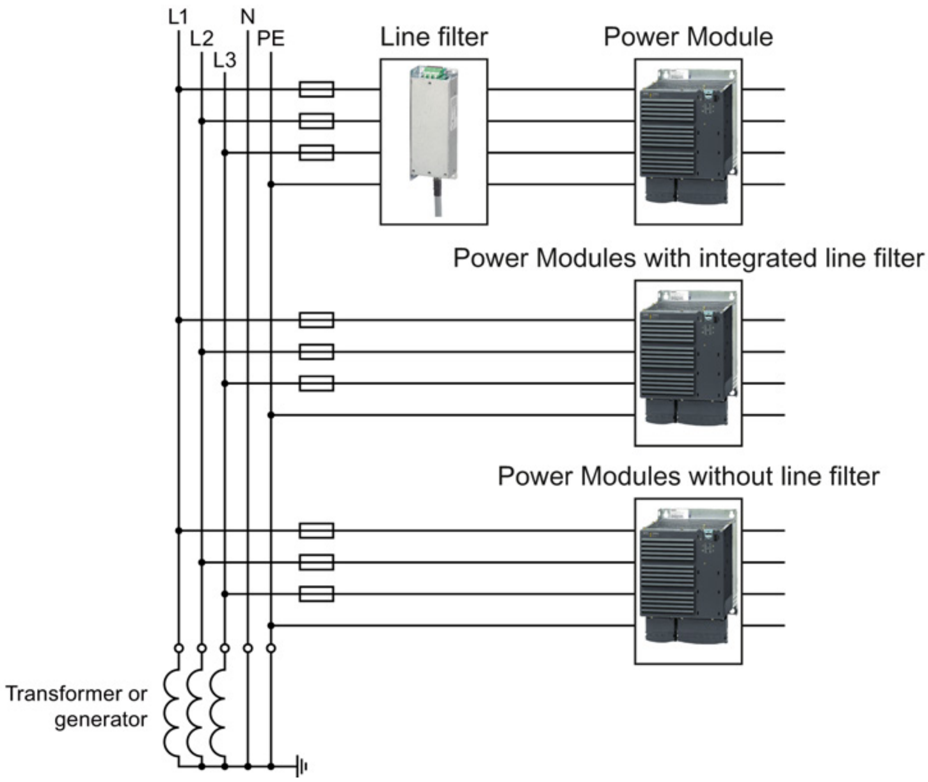


Figure 4-2 TN line supply with separate transfer of N and PE and with a grounded neutral point

TT system

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

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

Preconditions and restrictions when connecting an inverter to a TT line system

- Inverter with integrated or external line filter:
  - Operation on TT line supply systems with grounded neutral point permissible.
  - Operation on TT line systems without grounded neutral point not permissible.
- Inverter without line filter:
  - Operation on TT line systems is permissible.

Examples for Power Modules connected to a TT line supply

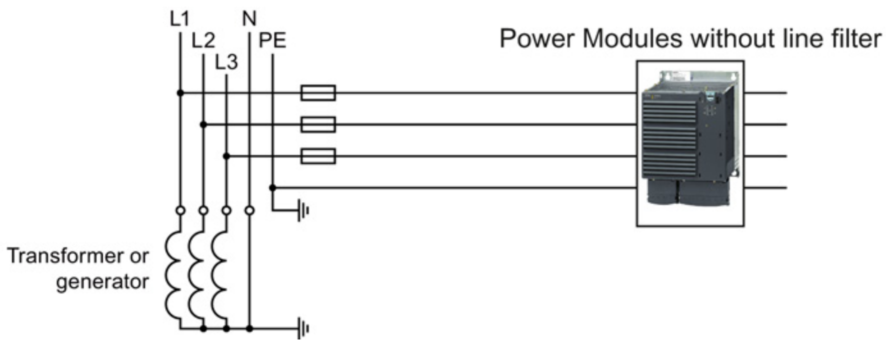


Figure 4-3 TT line system where the neutral conductor N is transferred

IT system

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

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

Preconditions and restrictions when connecting an inverter to an IT line system

- Inverter with integrated or external line filter:
  - Operation on IT line systems is not permissible.
- Inverter without line filter:
  - Operation on IT line systems is permissible.

Examples for Power Modules connected to an IT line supply

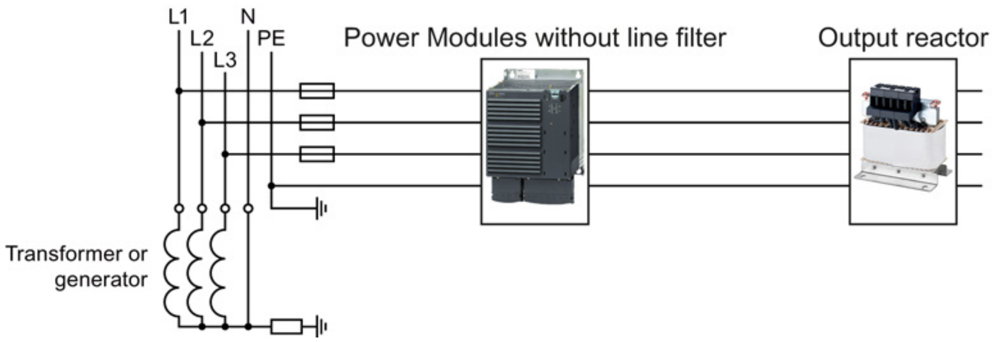


Figure 4-4 IT line supply where the neutral conductor N is transferred and with impedance with respect to the PE protective conductor

Behavior of the inverter when a ground fault occurs

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

4.3.2.2 Connecting the inverter

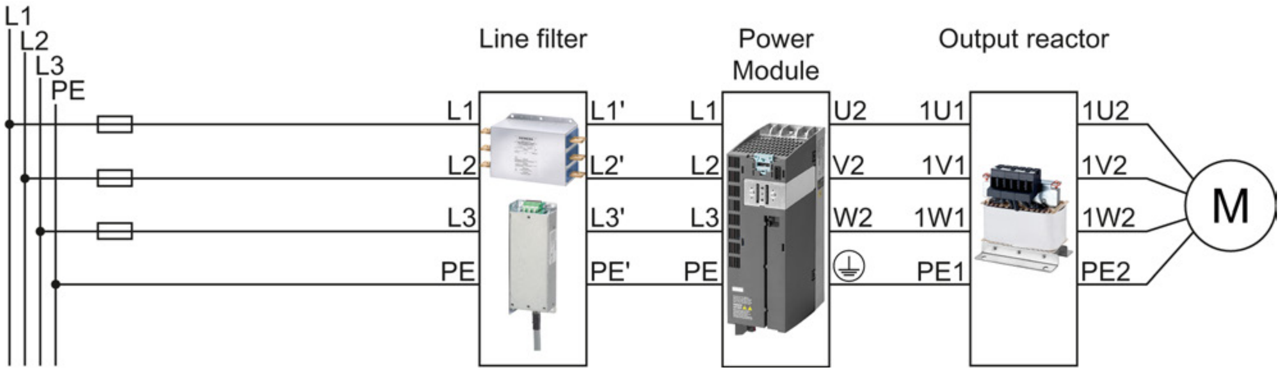


Figure 4-5 Connecting the PM230 IP20 and push-through Power Module

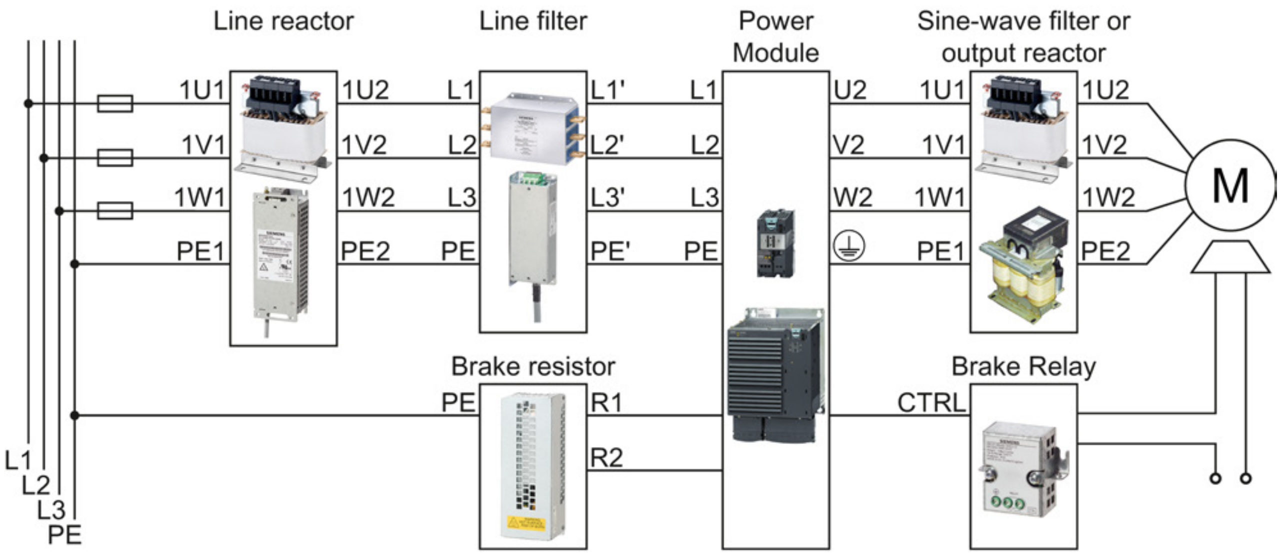


Figure 4-6 Connecting the PM240, PM240-2 IP20 and push-through Power Modules

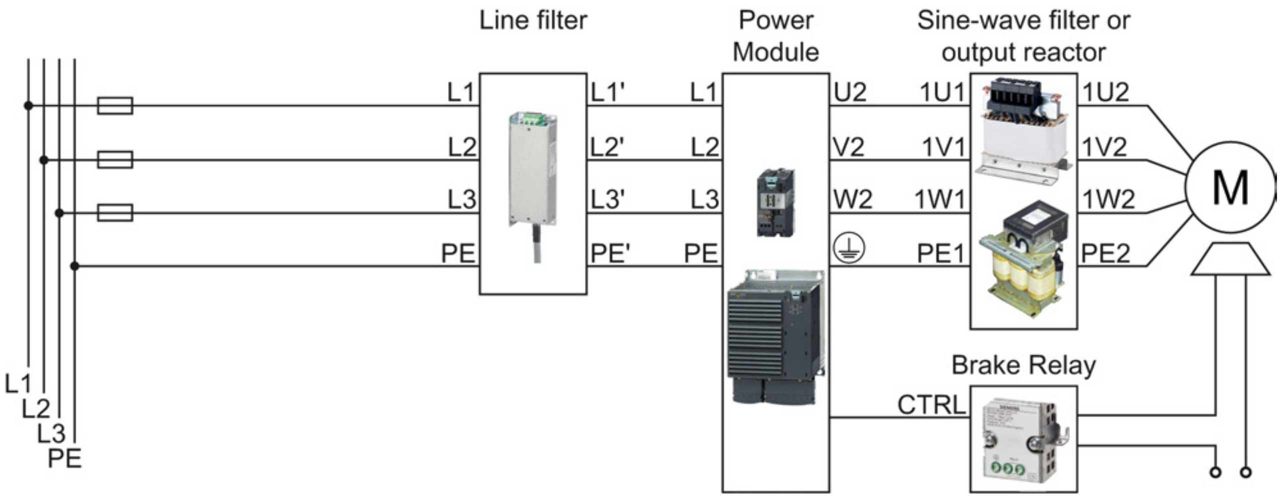


Figure 4-7 Connecting the PM250 Power Module

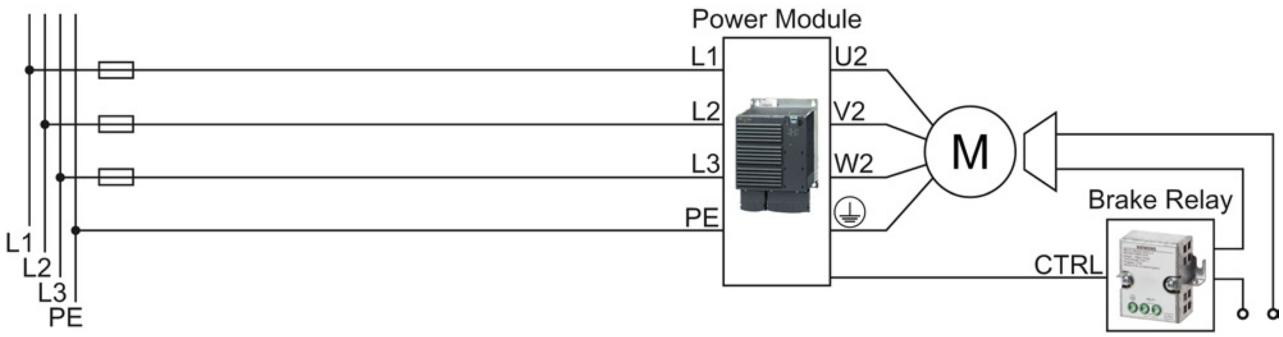


Figure 4-8 Connecting the PM260 Power Module

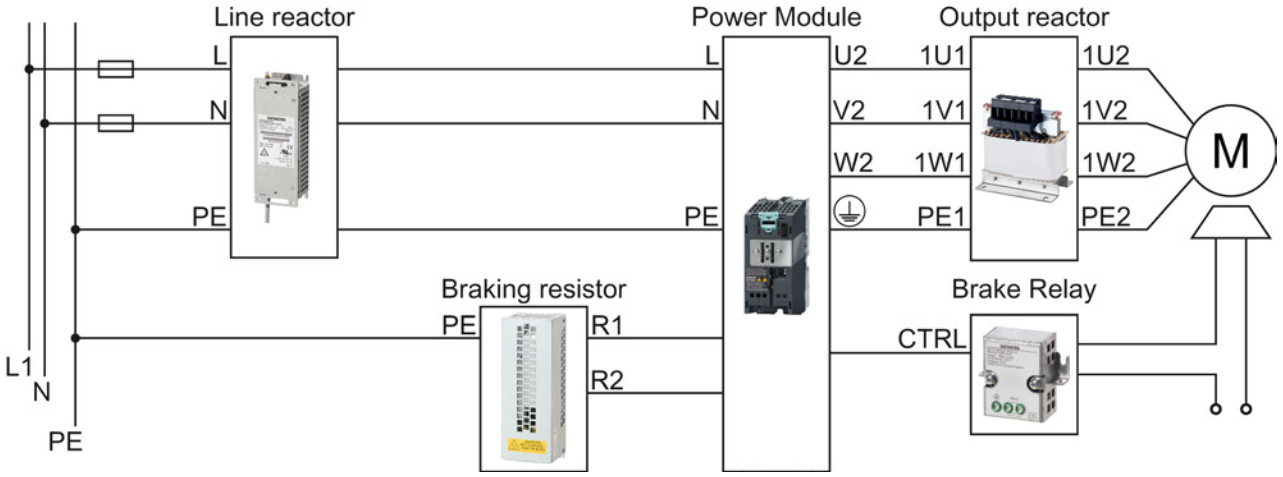


Figure 4-9 Connecting the PM340 1AC Power Module

DANGER

((Electric shock through contact with the motor connections))

As soon as the converter is connected to the line supply, the motor connections of the converter may carry dangerous voltages. When the motor is connected to the converter, there is danger to life through contact with the motor terminals if the terminal box is open.

- Close the terminal box of the motor before connecting the converter to the line supply.

Connecting the line supply cable to the converter

Procedure

To connect the converter to the supply system, proceed as follows:

1. If available, open the terminal covers of the converter.
2. Connect the line supply to terminals U1/L1, V1/L2, and W1/L3.
3. Connect the protective conductor of the line supply to terminal PE of the converter.
4. If available, close the terminal covers of the converter.

You have connected the line supply cable to the converter.

Connecting the motor cable to the converter

Procedure

To connect the motor cable to the converter, proceed as follows:

1. If available, open the terminal covers of the converter.
2. Connect the motor to terminals U2, V2, and W2.
   Carefully observe the regulations for EMC-compliant wiring:
   Connecting inverters in compliance with EMC (Page 78)
3. Connect the protective conductor of the motor to the ⏚ terminal of the converter.
4. If available, close the terminal covers of the converter.

You have therefore connected the motor line to the converter.

Connecting a motor cable to an induction motor

Procedure

To connect the motor cable to an induction motor proceed as follows:

1. Open the motor terminal box.
2. Connect the motor in either a star or delta connection.

   Additional information on this is provided in the Section Star-delta motor connection and application examples (Page 345).
3. If you are using a shielded motor cable, you must do the following:
   – Expose the shield of the motor cable in the area of the cable entry in the terminal box.
   – Attach the cable shield to the motor terminal box using a suitable screw connection.
4. Close the motor terminal box.

You have connected the motor cable to the induction motor.

Permissible cable lengths

The permissible cables and cable lengths are specified in the Hardware Installation Manual of the Power Module or in Catalog D31.

Note

- Please observe the data on the rating plate (type plate) and the associated circuit diagrams.
- Use shielded control cables.
- Observe the EMC notes provided by the manufacturer of the converter

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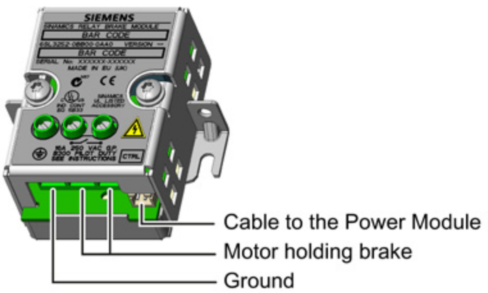
4.3.2.3 Connecting a motor holding brake

Connecting a Brake Relay and a motor holding brake



The Brake Relay serves as an interface between the Power Module and the motor's brake coil.

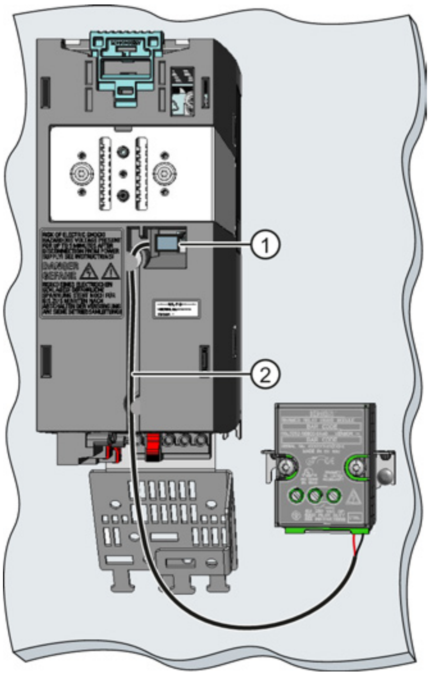
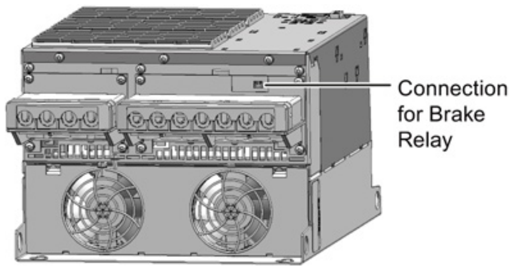
The Brake Relay can be mounted on a mounting plate, the cabinet panel or the inverter's shield connection kit.

For additional information, please refer to the associated installation instructions: Installation instructions for the Brake Relay (http://support.automation.siemens.com/WW/view/en/23623179).

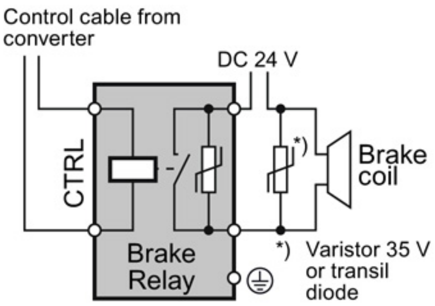
Procedure

Proceed as follows to connect the brake solenoid in the motor with the inverter:

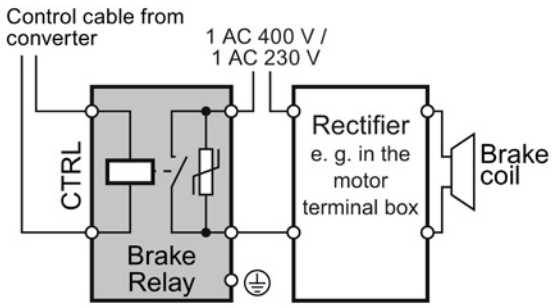
1. Connect the Brake Relay to the Power Module using the cable form provided.

Power Modules FSA … FSC	Power Modules FSD … FSF
	
• Connect the Brake Relay at the connector ① at the front of the Power Module. • Route the control cable in the guide ② on the Power Module.	Connect the Brake Relay at the connector on the lower side of the Power Module.

2. Connect the motor holding brake to the terminals of the Brake Relay.



24 V brake connection



440V brake connection

You have connected the brake solenoid in the motor with the inverter.

4.3.2.4 Connecting a braking resistor

⚠ WARNING

Danger to life due to fire spreading because of an unsuitable or improperly installed braking resistor

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

Using an unsuitable braking resistor can cause fires and smoke to develop. Possible consequences are severe personal injury or material damage.

- Only use the braking resistor approved for the inverter.
- Install the braking resistor in accordance with regulations.
- Monitor the temperature of the braking resistor.

⚠ CAUTION

Risk of burns due to touching hot surfaces

The temperature of braking resistors increases substantially during operation.

- Do not touch the braking resistor during operation.

Procedure

To connect the braking resistor and monitor the temperature of the braking resistor, proceed as follows:

1. Connect the braking resistor to terminals R1 and R2 of the inverter.
2. Ground the braking resistor directly to the control cabinet's grounding bar. The braking resistor must not be grounded via the PE terminals on the inverter.
3. If you have to fulfill EMC requirements, observe the rules for shielding.

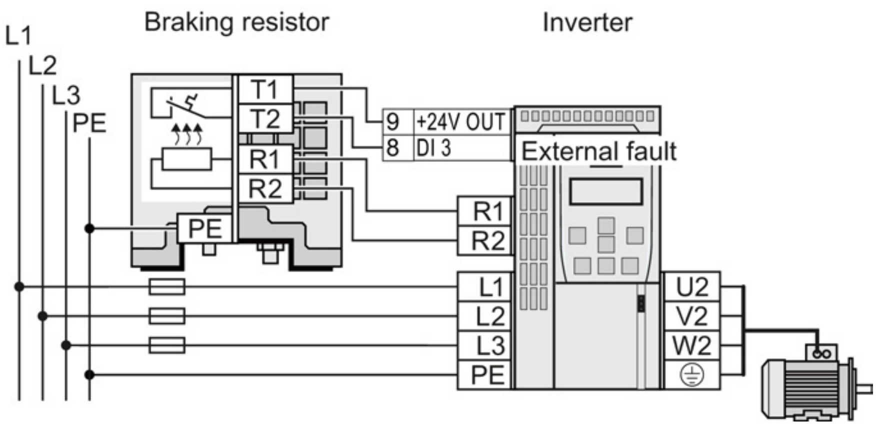


Figure 4-10 Braking resistor connections (example: temperature monitoring via DI 3)

4. Connect the temperature monitoring system of the braking resistor (terminals T1 and T2 on the braking resistor) to a free digital input of your choice on the inverter. Define the function of this digital input as external fault, e.g. for digital input DI 3: p2106 = 722.3.

You have connected the braking resistor and ensured that temperature monitoring is set up.

4.4 Installing Control Unit

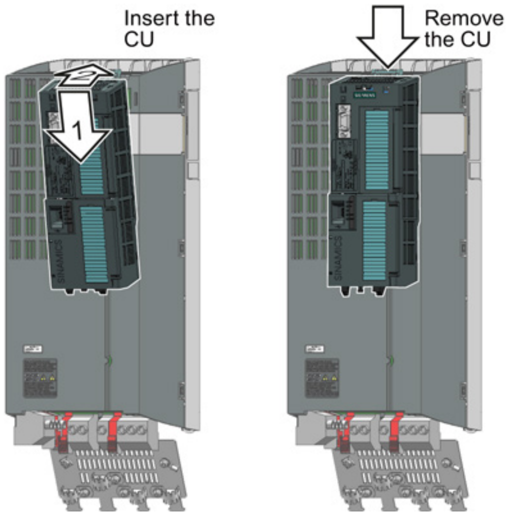
4.4.1 Snapping the Control Unit onto the Power Module

Installing the Control Unit on an IP20 Power Module

Procedure

Proceed as follows to connect Power Modules and Control Units:

1. Locate the lugs at the rear of the Control Unit in the matching recesses of the Power Module.
2. Mount the Control Unit onto the Power Module so that it audibly snaps into place.



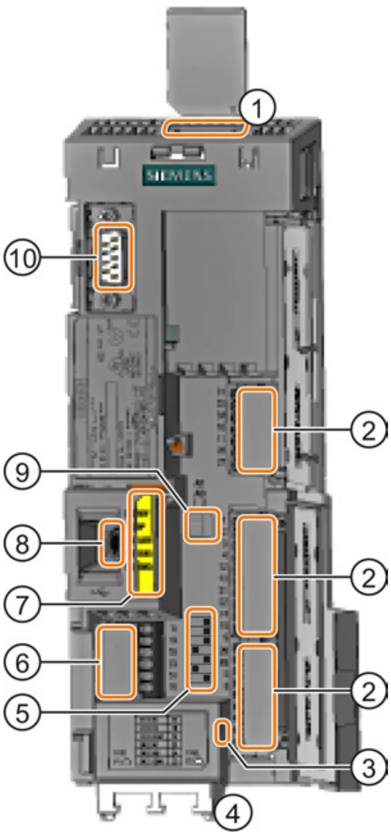
The Power Module and the Control Unit are now connected with one another.

To remove the Control Unit, press on the release button on the Power Module and withdraw the Control Unit.

4.4.2 Overview of the interfaces

Interfaces at the front of the Control Unit

To access the interfaces at the front of the Control Unit, you must lift the Operator Panel (if one is being used) and open the front doors.

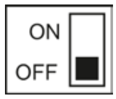


① Memory card slot

② Terminal strips

③ Depending on the fieldbus:

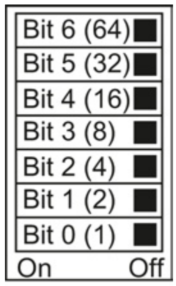
- USS, Modbus: Bus termination
- PROFIBUS, PROFINET, EtherNet/IP: No function



④ Fieldbus interfaces at the lower side

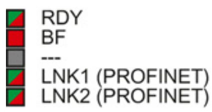
⑤ Selecting the fieldbus address:

- CU230P-2 DP
- CU230P-2 CAN
- CU230P-2 HVAC
- CU230P-2 BT



⑥ Terminal strips for the digital outputs

⑦ Status LED



⑧ USB interface for connection to a PC

⑨ Switch for AI0 and AI1 (U/I)

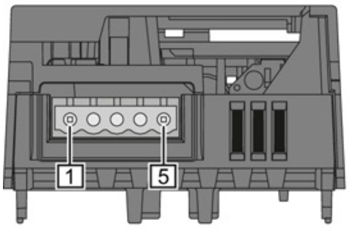
- I 0/4 mA … 20 mA
- U -10/0 V … 10 V

⑩ Connection to the operator panel

4.4.3 Fieldbus interface allocation

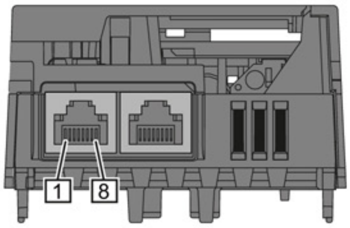
Interfaces at the lower side of the CU240B-2 and CU240E-2 Control Units

RS485 plug for USS and Modbus RTU (X128)



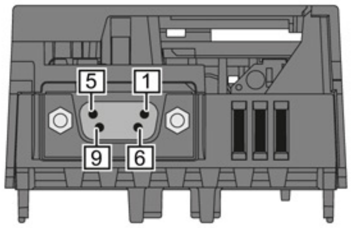
Pin	
1	0 V, reference potential
2	RS485P, receive and transmit (+)
3	RS485N, receive and transmit (-)
4	Cable shield
5	Not connected

RJ45 connector socket for PROFINET IO (X150 P1, X150 P2)



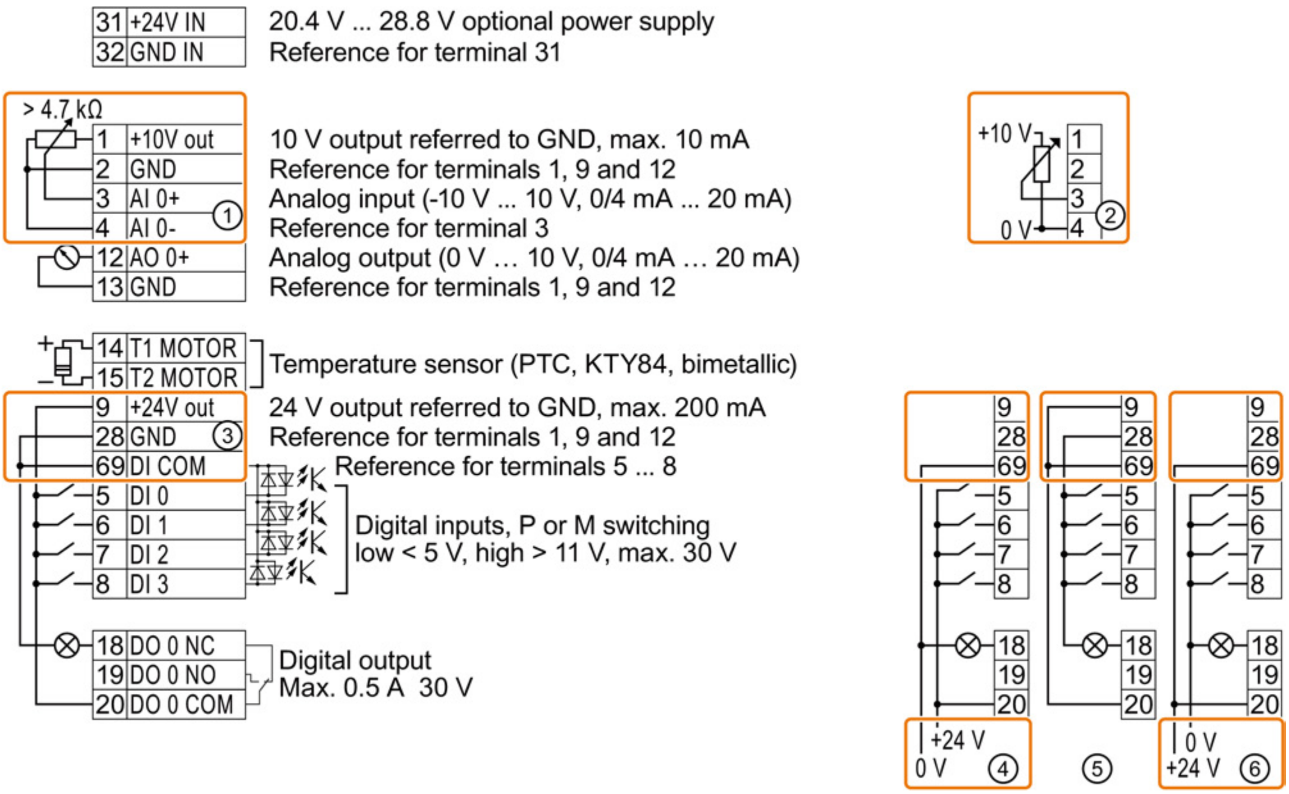
Pin	
1	RX+, receive data +
2	RX-, receive data -
3	TX+. Transmit data +
4	Not assigned
5	Not assigned
6	TX-, transmit data -
7	Not assigned
8	Not assigned

SUB-D socket for PROFIBUS DP (X126)



Pin	
1	Shield, grounding connection
2	Not assigned
3	RxD/TxD-P, receive and transmit (B/B')
4	CNTR-P, control signal
5	DGND, reference potential for data (C/C')
6	VP, supply voltage
7	Not assigned
8	RxD/TxD-N, receive and transmit (A/A')
9	Not assigned

4.4.4 Terminal strips on CU240B-2 Control Units



① The analog input is supplied from the internal 10 V voltage.

② The analog input is supplied from an external 10 V voltage.

③ Wiring when using the internal power supplies. Connection of a contact switching to P potential.

④ Wiring when using external power supplies. Connection of a contact switching to P potential.

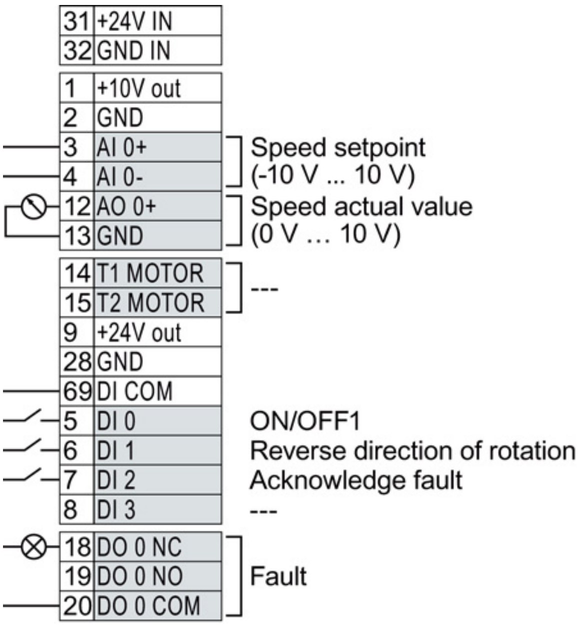
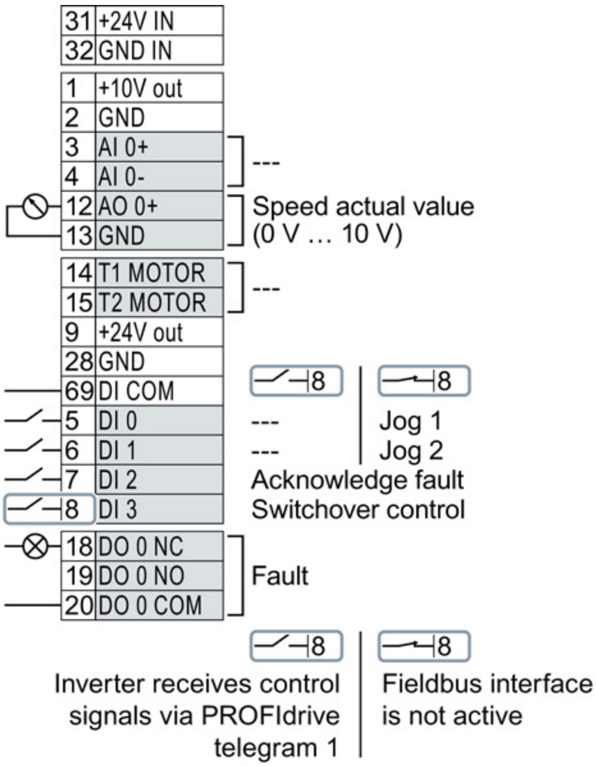
⑤ Wiring when using the internal power supplies. Connection of a contact switching to M potential.

⑥ Wiring when using external power supplies. Connection of a contact switching to M potential.

4.4.4.1 Factory setting of the CU240B-2 terminals

Factory setting of the CU240B-2

The factory setting of the terminals depends on whether the Control Unit has a PROFIBUS / PROFINET interface.

Factory setting of the terminals for Control Units with USS or Modbus interface	Factory setting of the terminals for Control Units with PROFIBUS or PROFINET interface
Fieldbus interface is not active.	The function of the fieldbus interface depends on DI 3.
	

Changing the function of terminals

The function of every color-coded terminal can be set.

In order that you do not have to successively change terminal for terminal, several terminals can be jointly set using default settings.

The factory settings described above for USS and PROFIBUS/PROFINET terminals correspond to default setting 12 (two-wire control using method 1) or default setting 7 (switchover between fieldbus and jog using DI 3).

See also: Default settings of the CU240B-2 terminals (Page 68).

4.4.4.2 Default settings of the CU240B-2 terminals

Default setting 7: Switch over between fieldbus and jogging using DI 3

Selected with

- STARTER: Fieldbus with data set switchover
- BOP-2: FB cdS

Factory setting for inverters with PROFIBUS interface

Terminal		PROFIdrive telegram 1	Fieldbus interface is not active.
3	AI 0	---	---
4			
5	DI 0	---	Jog 1
6	DI 1	---	Jog 2
7	DI 2	Acknowledge	Acknowledge
8	DI 3	Low	High

Default setting 9: Motorized potentiometer (MOP)

Selected with

- STARTER: standard I/O with MOP
- BOP-2: Std MoP

Fieldbus interface is not active.

3	AI 0	---
4		
5	DI 0	ON/OFF1
6	DI 1	MOP raise
7	DI 2	MOP lower
8	DI 3	Acknowledge

MOP = motorized potentiometer

Default setting 12: Two-wire control with method 1

Selected with

- STARTER: Standard I/O with analog setpoint
- BOP-2: Std ASP

Factory setting for inverters with USS interface

Fieldbus interface is not active.

3	AI 0	Setpoint
4		I U -10 V ... 10 V
5	DI 0	ON/OFF1
6	DI 1	Reversing
7	DI 2	Acknowledge
8	DI 3	---

Default setting 17: Two-wire control with method 2

Selected with

- STARTER: 2-wire (forward/backward 1)
- BOP-2: 2-wIrE 1

Default setting 18: Two-wire control with method 3

Selected with

- STARTER: 2-wire (forward/backward 2)
- BOP-2: 2-wIrE 2

Fieldbus interface is not active.

3	AI 0	Setpoint
4		I U -10 V ... 10 V
5	DI 0	ON/OFF1 clockwise
6	DI 1	ON/OFF1 counter-clockwise
7	DI 2	Acknowledge
8	DI 3	---

Default setting 19: Three-wire control with method 1

Selected with

- STARTER: 3-wire (enable/forward/backward)
- BOP-2: 3-wIrE 1

Fieldbus interface is not active.

3	AI 0	Setpoint
4		I U -10 V ... 10 V
5	DI 0	Enable / OFF1
6	DI 1	ON clockwise
7	DI 2	ON counter-clockwise
8	DI 3	Acknowledge

Default setting 20: Three-wire control with method 2

Selected with

- STARTER: 3-wire (enable/on/reverse)
- BOP-2: 3-wIrE 2

Fieldbus interface is not active.

3	AI 0	Setpoint
4		I U -10 V ... 10 V
5	DI 0	Enable / OFF1
6	DI 1	ON
7	DI 2	Reversing
8	DI 3	Acknowledge

Default setting 21: Fieldbus USS

Selected with

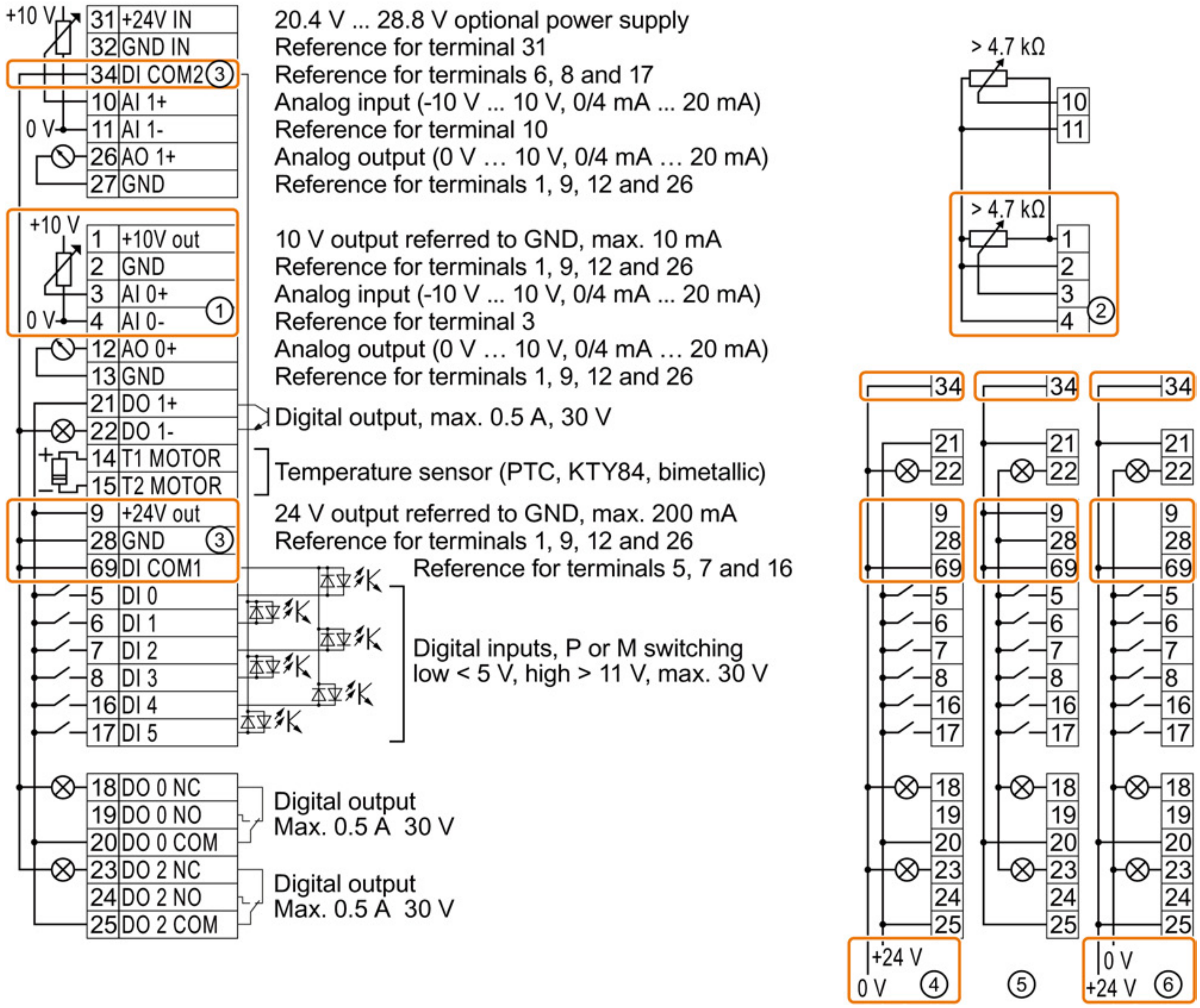
- STARTER: USS fieldbus
- BOP-2: FB USS

USS setting: 38,400 baud, 2 PZD, PKW variable

3	AI 0	---
4		
5	DI 0	---
6	DI 1	---
7	DI 2	Acknowledge
8	DI 3	---

4.4.5 Terminal strips on CU240E-2 Control Units

4.4.5.1 Terminal strips on CU240E-2 Control Units



① The analog inputs are supplied from an external 10 V source.

② The analog inputs are supplied from the internal 10 V voltage.

③ Wiring when using the internal power supplies. Connecting a contact switching to P.

④ Wiring when using external power supplies. Connecting a contact switching to P.

⑤ Wiring when using the internal power supplies. Connecting a contact switching to M.

⑥ Wiring when using external power supplies. Connecting a contact switching to M.

NOTICE

Damage to the CU240E-2 PN and CU240E-2 PN-F Control Units in the event of a short-circuit of the 24 V output

It is possible that the Control Units are defective if the following conditions occur simultaneously:

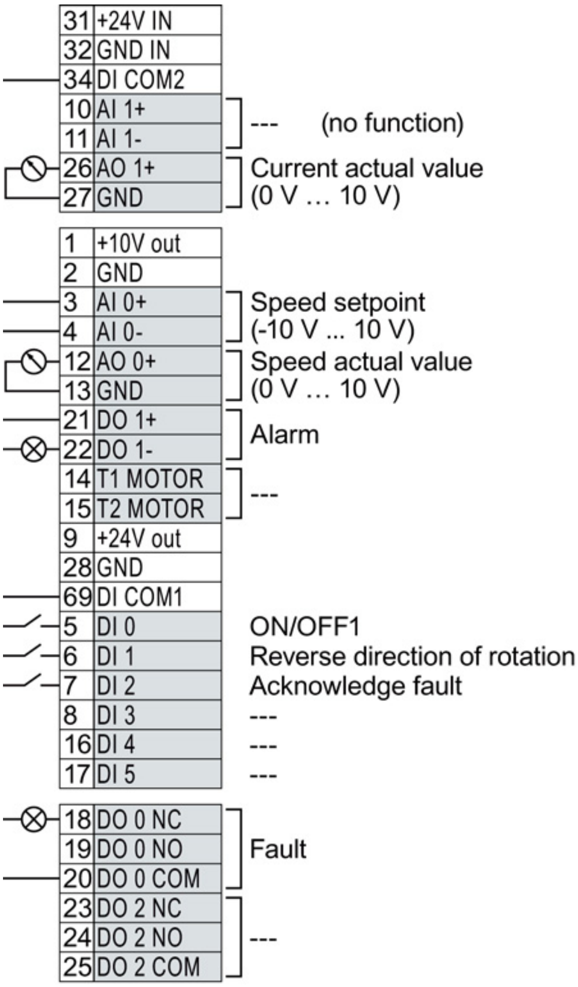
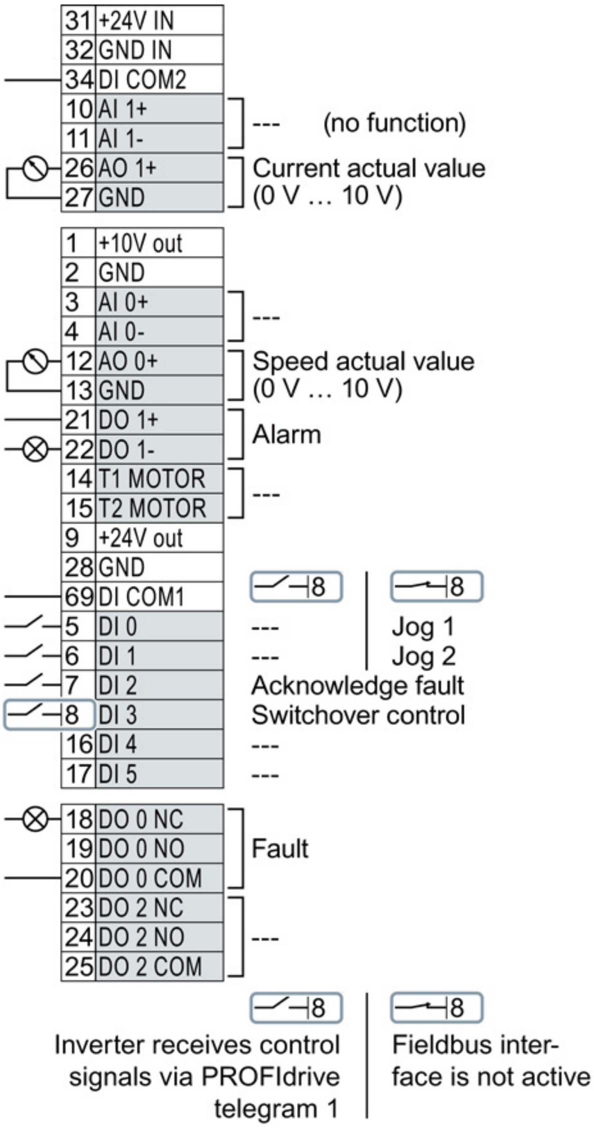
1. A short-circuit at the 24 V output occurs at terminal 9 when the inverter is operational.
2. The ambient temperature is at the upper permitted limit.
3. You have connected an external 24 V supply to terminals 31 and 32, and the voltage at terminal 31 is at the upper permitted limit.

In order to rule out damage to the Control Units, you have to prevent all three conditions occurring simultaneously.

4.4.5.2 Factory setting of the CU240E-2 terminals

Factory setting of the CU240E-2

The factory setting of the terminals depends on whether the Control Unit has a PROFIBUS / PROFINET interface.

<table>
<tr><th>Factory setting of the terminals for Control Units with USS or Modbus interface</th><th>Factory setting of the terminals for Control Units with PROFIBUS or PROFINET interface</th></tr>
<tr><td>Fieldbus interface is not active.

</td>
<td>The function of the fieldbus interface depends on DI 3.

</td></tr>
</table>

Changing the function of terminals

The function of every color-coded terminal can be set.

In order that you do not have to successively change terminal for terminal, several terminals can be jointly set using default settings.

The factory settings described above for USS and PROFIBUS/PROFINET terminals correspond to default setting 12 (two-wire control using method 1) or default setting 7 (switchover between fieldbus and jog using DI 3).

See also: Default settings of the CU240E-2 terminals (Page 73).

4.4.5.3 Default settings of the CU240E-2 terminals

Default setting 1: Two fixed speeds Selected with • STARTER: Conveyor technology with 2 fixed frequencies • BOP-2: coN 2 SP	**Default setting 2: Two fixed speeds with safety function** Selected with • STARTER: Conveyor systems with Basic Safety • BOP-2: coN SAFE	**Default setting 3: Four fixed speeds** Selected with • STARTER: Conveyor technology with 4 fixed frequencies • BOP-2: coN 4 SP
Fieldbus interface is not active. 3, 4 AI 0 --- 5 DI 0 ON/OFF1 clockwise 6 DI 1 ON / OFF1 counter-clockwise 7 DI 2 Acknowledge 8 DI 3 --- 16 DI 4 Fixed speed 3 17 DI 5 Fixed speed 4 DI 4 and DI 5 = high: The inverter adds both fixed speeds.	Fieldbus interface is not active. 3, 4 AI 0 --- 5 DI 0 ON / OFF1 fixed speed 1 6 DI 1 Fixed speed 2 7 DI 2 Acknowledge 8 DI 3 --- 16 DI 4, 17 DI 5 Reserved for safety function	Fieldbus interface is not active. 3, 4 AI 0 --- 5 DI 0 ON / OFF1 fixed speed 1 6 DI 1 Fixed speed 2 7 DI 2 Acknowledge 8 DI 3 --- 16 DI 4 Fixed speed 3 17 DI 5 Fixed speed 4 Multiple DIs = high: The inverter adds the corresponding fixed speeds.

Default setting 4: PROFIBUS or PROFINET Selected with • STARTER: Conveyor systems with fieldbus • BOP2: coN Fb	**Default setting 5: PROFIBUS or PROFINET with safety function** Selected with • STARTER: Conveyor systems with fieldbus and Basic Safety • BOP-2: coN Fb S	**Default setting 6: PROFIBUS or PROFINET with two safety functions** Selected with • STARTER: Fieldbus with Extended Safety • BOP-2: Fb SAFE
PROFIdrive telegram 352 3, 4 AI 0 --- 5 DI 0 --- 6 DI 1 --- 7 DI 2 Acknowledge 8 DI 3 --- 16 DI 4 --- 17 DI 5 ---	PROFIdrive telegram 352 3, 4 AI 0 --- 5 DI 0 --- 6 DI 1 --- 7 DI 2 Acknowledge 8 DI 3 --- 16 DI 4, 17 DI 5 Reserved for safety function	PROFIdrive telegram 1 3, 4 AI 0 --- 5 DI 0, 6 DI 1 Reserved for safety function 1 7 DI 2 Acknowledge 8 DI 3 --- 16 DI 4, 17 DI 5 Reserved for safety function 2 Only with Control Units CU240E-2 F, CU240E-2 DP-F, and CU240E-2 PN-F.

<table>
<tr>
<td colspan="2">Default setting 7: Switch over between fieldbus and jogging using DI 3
Selected with
STARTER: Fieldbus with data set switchover
BOP-2: FB cdS
Factory setting for inverters with PROFIBUS interface</td>
<td>Default setting 8: Motorized potentiometer (MOP) with safety function
Selected with
STARTER: MOP with Basic Safety
BOP-2: MoP SAFE</td>
</tr>
<tr>
<td>PROFIdrive telegram 1

3 AI 0 ---
4
5 DI 0 ---
6 DI 1 ---
7 DI 2 Acknowledge
8 DI 3 Low
16 DI 4 ---
17 DI 5 ---</td>
<td>Fieldbus interface is not active.

3 AI 0 ---
4
5 DI 0 Jog 1
6 DI 1 Jog 2
7 DI 2 Acknowledge
8 DI 3 High
16 DI 4 ---
17 DI 5 ---</td>
<td>Fieldbus interface is not active.

3 AI 0 ---
4
5 DI 0 ON / OFF1
6 DI 1 MOP raise
7 DI 2 MOP lower
8 DI 3 Acknowledge
16 DI 4 Reserved for safety
17 DI 5 function

MOP = motorized potentiometer</td>
</tr>
</table>

<table>
<tr>
<td>Default setting 9: Motorized potentiometer (MOP)
Selected with
STARTER: standard I/O with MOP
BOP-2: Std MoP</td>
<td>Default setting 12: Two-wire control with method 1
Selected with
STARTER: Standard I/O with analog setpoint
BOP-2: Std ASP
Factory setting for inverters with USS interface</td>
<td>Default setting 13: Setpoint via analog input with safety function
Selected with
STARTER: Standard I/O with analog setpoint and safety
BOP-2: ASPS</td>
</tr>
<tr>
<td>Fieldbus interface is not active.

3 AI 0 ---
4
5 DI 0 ON / OFF1
6 DI 1 MOP raise
7 DI 2 MOP lower
8 DI 3 Acknowledge
16 DI 4 ---
17 DI 5 ---

MOP = motorized potentiometer</td>
<td>Fieldbus interface is not active.

3 AI 0 Setpoint
4 I U -10 V ... 10 V
5 DI 0 ON / OFF1
6 DI 1 Reversing
7 DI 2 Acknowledge
8 DI 3 ---
16 DI 4 ---
17 DI 5 ---</td>
<td>Fieldbus interface is not active.

3 AI 0 Setpoint
4 I U -10 V ... 10 V
5 DI 0 ON / OFF1
6 DI 1 Reversing
7 DI 2 Acknowledge
8 DI 3 ---
16 DI 4 Reserved for safety
17 DI 5 function</td>
</tr>
</table>

<table>
<tr><td colspan="2">Default setting 14: Switch over between fieldbus and motorized potentiometer (MOP) using DI 3
Selected with
• STARTER: Process industry with fieldbus
• BOP-2: Proc Fb</td><td></td></tr>
<tr><td>PROFIdrive telegram 20
3 AI 0 ---
4
5 DI 0 ---
6 DI 1 External fault
7 DI 2 Acknowledge
8 DI 3 Low
16 DI 4 ---
17 DI 5 ---</td><td>Fieldbus interface is not active.
3 AI 0 ---
4
5 DI 0 ON / OFF1
6 DI 1 External fault
7 DI 2 Acknowledge
8 DI 3 High
16 DI 4 MOP raise
17 DI 5 MOP lower
MOP = motorized potentiometer</td><td></td></tr>
</table>

<table>
<tr><td colspan="2">Default setting 15: Switch over between analog setpoint and motorized potentiometer (MOP) using DI 3
Selected with
• STARTER: Process industry
• BOP-2: Proc</td><td>Default setting 17: Two-wire control with method 2
Selected with
• STARTER: 2-wire (forward/backward 1)
• BOP-2: 2-wIrE 1
Default setting 18: Two-wire control with method 3
Selected with
• STARTER: 2-wire (forward/backward 2)
• BOP-2: 2-wIrE 2</td></tr>
<tr><td>Fieldbus interface is not active.
3 AI 0 Setpoint
4 I U -10 V ... 10 V
5 DI 0 ON / OFF1
6 DI 1 External fault
7 DI 2 Acknowledge
8 DI 3 Low
16 DI 4 ---
17 DI 5 ---</td><td>Fieldbus interface is not active.
3 AI 0 ---
4
5 DI 0 ON / OFF1
6 DI 1 External fault
7 DI 2 Acknowledge
8 DI 3 High
16 DI 4 MOP raise
17 DI 5 MOP lower
MOP = motorized potentiometer</td><td>Fieldbus interface is not active.
3 AI 0 Setpoint
4 I U -10 V ... 10 V
5 DI 0 ON/OFF1 clockwise
6 DI 1 ON / OFF1 counter-clockwise
7 DI 2 Acknowledge
8 DI 3 ---
16 DI 4 ---
17 DI 5 ---</td></tr>
</table>

Default setting 19: Three-wire control with method 1 Selected with • STARTER: 3-wire (enable/forward/backward) • BOP-2: 3-wIrE 1	**Default setting 20: Three-wire control with method 2** Selected with • STARTER: 3-wire (enable/on/reverse) • BOP-2: 3-wIrE 2	**Default setting 21: Fieldbus USS** Selected with • STARTER: USS fieldbus • BOP-2: FB USS
Fieldbus interface is not active. 3, 4 AI 0 Setpoint I / U -10 V ... 10 V 5 DI 0 Enable / OFF1 6 DI 1 ON clockwise 7 DI 2 ON counter-clockwise 8 DI 3 --- 16 DI 4 Acknowledge 17 DI 5 ---	Fieldbus interface is not active. 3, 4 AI 0 Setpoint I / U -10 V ... 10 V 5 DI 0 Enable / OFF1 6 DI 1 ON 7 DI 2 Reversing 8 DI 3 --- 16 DI 4 Acknowledge 17 DI 5 ---	USS setting: 38400 baud, 2 PZD, PKW variable 3, 4 AI 0 --- 5 DI 0 --- 6 DI 1 --- 7 DI 2 Acknowledge 8 DI 3 --- 16 DI 4 --- 17 DI 5 ---

4.4.6 Wiring the terminal strip

WARNING

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

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

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

Note

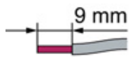
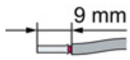
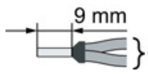
If your application requires UL certification, please note that the power supply of the digital output must comply with specific specifications. See also Section: Technical data (Page 303).

NOTICE
Damage to the inverter when using long signal cables
Using long cables at the inverter's digital inputs and 24 V power supply can lead to overvoltage during switching operations. Overvoltages can damage the inverter. • If you use cables of more than 30 m at the digital inputs and 24 V power supply, connect an overvoltage protection element between the terminal and the associated reference potential. We recommend using the Weidmüller overvoltage protection terminal with designation MCZ OVP TAZ DIODE 24VDC.

Procedure

Proceed as follows to connect the terminal strips:

1. Use a cable with the recommended cross-section, which has been appropriately prepared for use:

Solid or flexible cable	 9 mm 0.5 ... 1.5 mm²
Flexible conductor with non-insulated end sleeve	 9 mm 0.5 mm²
Flexible conductor with partially-insulated end sleeve	 9 mm 0.5 mm²
Two flexible cables with the same cross-section with partially insulated twin end sleeves	 9 mm 0.5 mm²

2. If you use shielded cables, then you must connect the shield to the mounting plate of the control cabinet or with the shield support of the inverter through a good electrical connection and a large surface area.
   See also: EMC installation guideline (http://support.automation.siemens.com/WW/view/en/60612658)
3. Use the shield connection plate of the Control Unit as strain relief, also see: Overview of Control Units (Page 24).

You have connected the terminal strip.

4.5 Connecting inverters in compliance with EMC

4.5.1 EMC-compliant connection of the converter

EMC-compliant installation of the inverter and motor are required in order to ensure disturbance-free operation of the drive.

Install and operate inverters with IP20 degree of protection in a closed control cabinet.

Inverters with degree of protection IP55 are suitable for installation outside a control cabinet.

An overview of control cabinet installation and cabling can be found in the following section. For further details, refer to the installation instructions of the Power Module.

The EMC-compliant connection of the inverter itself is described in the following sections.

4.5.2 Avoiding electromagnetic influence (EMI)

The inverters are designed for operation in industrial environments where high values of EMI are expected. Safe, reliable and disturbance-free operation is only guaranteed if the devices are installed by appropriately trained and qualified personnel.

Control cabinet design

- Connect the metallic parts and components of the control cabinet to the frame of the cabinet through a good electrical connection.
  - Side panels
  - Rear panels
  - Cover plate
  - Base plates

  Use the largest possible contact area or many individual screw connections.
- Connect the PE busbar and EMC shielding bus to the control cabinet frame using a good electrical connection established through the largest possible surface area.
- Connect all metal enclosures of the devices installed in the control cabinet (such as the inverter and line filter) to the control cabinet frame through a good electrical connection established through the largest possible surface area.

  We recommend that these devices are mounted on a bare metal plate with good conducting properties.

- For screw connections onto painted or anodized surfaces, establish a good conductive contact using one of the following methods:
  - Use special (serrated) contact washers that cut through the painted or anodized surface.
  - Remove the insulating coating at the contact locations.
- Equip the following components with interference suppression elements:
  - Coils of contactors
  - Relays
  - Solenoid valves
  - Motor holding brakes

  Interference suppression elements include RC elements or varistors for AC-operated coils and freewheeling diodes for DC-operated coils.

  Connect the interference suppression element directly at the coil.

Cable routing and shielding

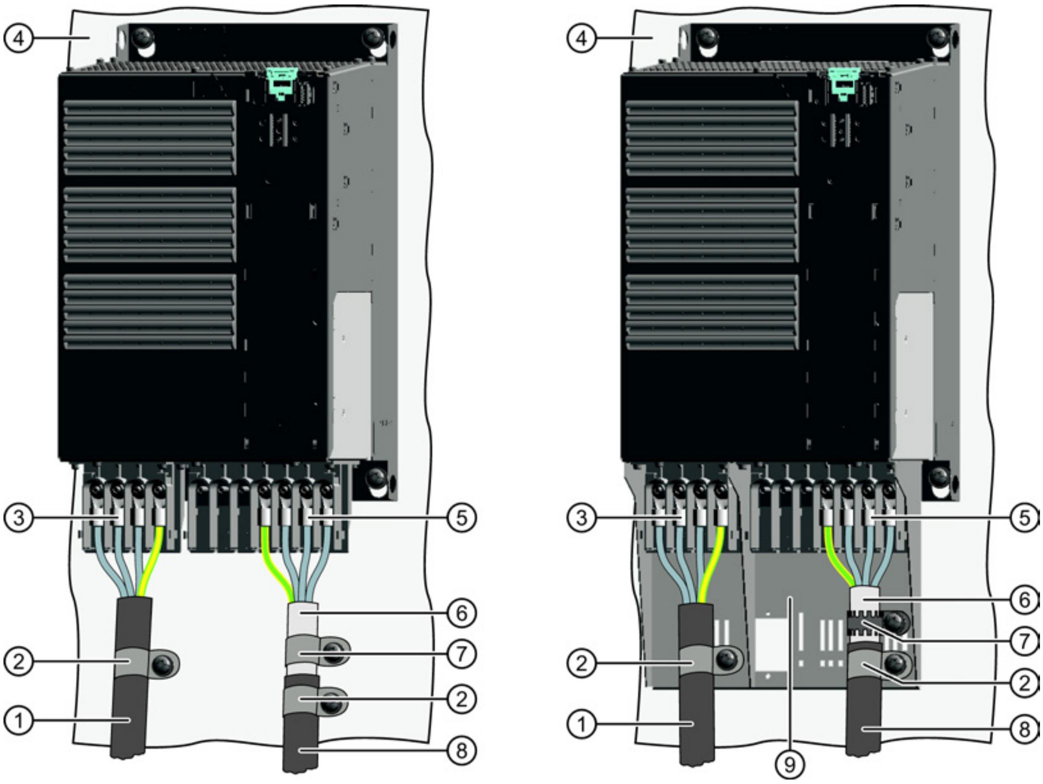
- Route all inverter power cables (line supply cables, connecting cables between the braking module and the associated braking resistance as well as the motor cables) separately away from signal and data cables. Maintain a minimum clearance of 25 cm. If cables can be separately routed, use metal partitions that have a good electrical connection to the mounting plate.
- Route the cables from the line supply to the line filter separately away from the following cables:
  - Cables between the line filter and inverter
  - Connecting cables between the braking module and associated braking resistor
  - Motor cables
- Signal and data cables as well as filtered line supply cables may only cross non-filtered power cables at right angles.
- Keep all cables as short as possible.
- Always route signal lines, data cables, and the associated potential equalizing cables in parallel with the shortest possible clearance between them
- Use shielded motor cables.
- Route the shielded motor cable separately from the cables to the motor temperature sensors (PTC/KTY).
- Use shielded signal and data cables.
- Connect the shields to the grounded enclosure at both ends with a good electrical connection through the largest possible surface area
- Connect the cable shields as closely as possible to the point where the cable enters the control cabinet.

- Use EMC shielded busbars for power cables.

  Use the shield connection elements in the inverter for signal and data cables.
- Do not interrupt any cable shields by using intermediate terminals.
- Use the appropriate EMC terminals for cable shields.

  The EMC terminals connect the cable shield with the EMC shielded busbar or with the shield connection element through a large conductive surface.

EMC-compliant wiring for Power Module with degree of protection IP20



The terminal cover is not shown in the diagram, so that it is easier to see how the cable is connected.

① Line connection cable (unshielded) for Power Modules with integrated line filter.

If you use an external line filter, you will need a shielded cable between the line filter and the Power Module.

② Strain relief

③ Line supply connection

④ Metal mounting plate (unpainted and with a good electrical conductivity)

⑤ Motor connection

⑥ Cable shield

⑦ Cable clamps for establishing the connection between the shield and the mounting plate through a large surface area

⑧ Motor connection cable (shielded)

⑨ Shield plate (option)

Figure 4-11 EMC-compliant wiring of a Power Module frame size E as example

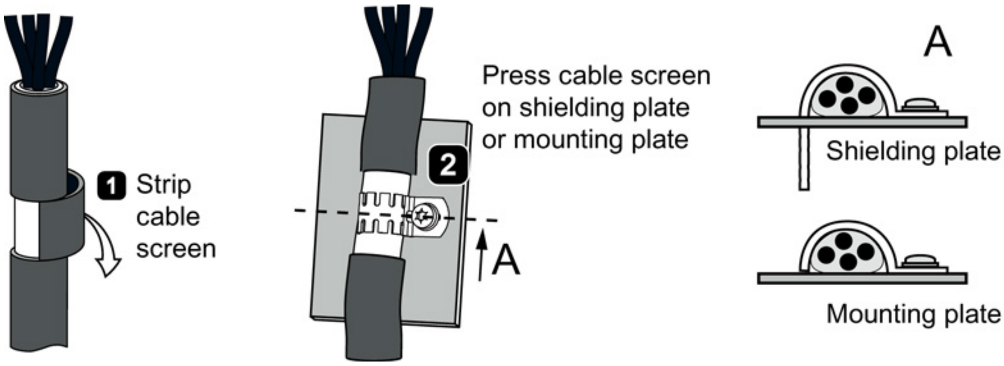


Figure 4-12 Shield connection - detail

Shielding with shield plate:

- Shield connection kits are available for Power Module FSA … FSF frame sizes (you will find more information in the D11.1 and D35 catalogs). The cable shields must be connected to the shield plate through the greatest possible surface area using shield clamps.

Shielding without shield plate:

- EMC-compliant shielding can also be implemented without using a shield plate. In this case, you must ensure that the cable shields are connected to the ground potential through the largest possible surface area.

EMC-compliant connection of the braking resistor

- Connect the braking resistor using a shielded cable.
- Connect the shield to the mounting plate or to the shield plate.
- To do this, use a cable clamp to establish an electrically conductive connection through a large surface area.

Commissioning 5

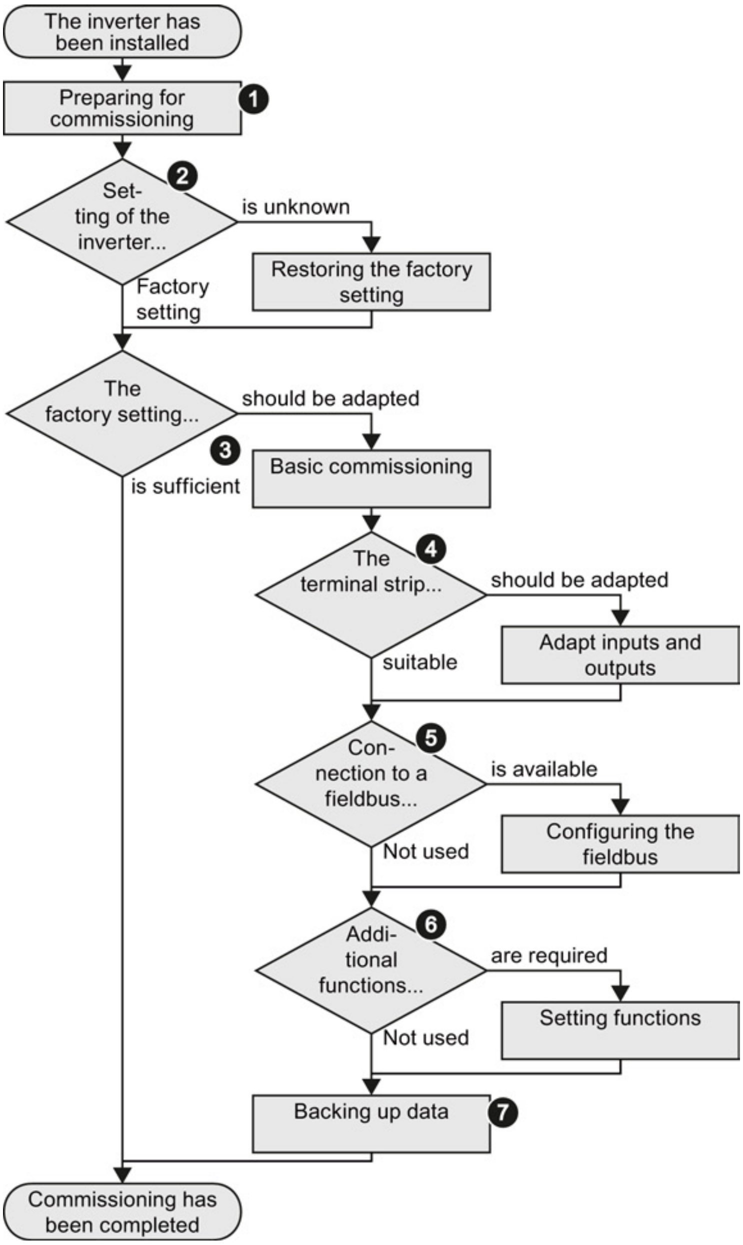
5.1 Commissioning guidelines

Procedure

Proceed as follows to commission the inverter:

1. Define the requirements of your application placed on the drive.
   → (Page 84) .
2. Reset the inverter when required to the factory setting.
   → (Page 88) .
3. Check whether the factory setting of the inverter is appropriate for your application.

   If not, start with the basic commissioning.
   → (Page 90).
4. Check whether you need to adapt the functions of the terminal strip that you specify in the basic commissioning.
   → (Page 101).
5. If necessary, adapt the communications interface in the inverter.
   → (Page 115) .
6. If necessary, set further functions in the inverter.
   → (Page 141) .
7. Save your settings.
   → (Page 243) .



You have commissioned the inverter.

5.2 Preparing for commissioning

Overview

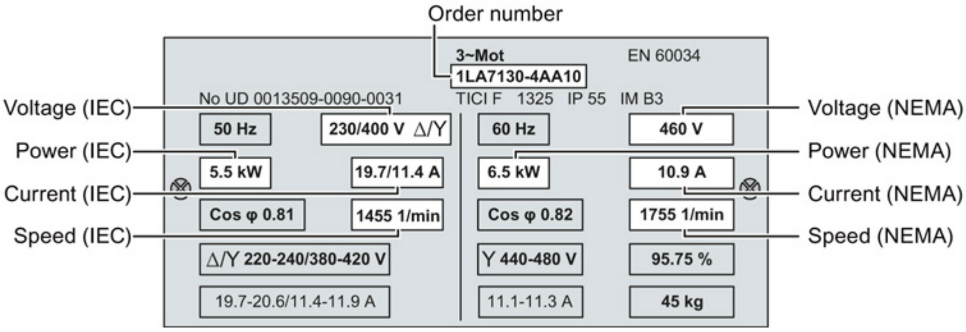
Before starting commissioning, you must know the answer to the following questions:

Inverter

- **What are the data specifications of my inverter?**
  → Identifying the converter (Page 23).
- **What inverter interfaces are active?**
  → Overview of the interfaces (Page 64).
- **How is the inverter integrated in the higher-level control system?**
- **How is my inverter set?**
  → Inverter factory setting (Page 85).
- **What technological requirements must the drive fulfill?**
  → Selecting the control mode (Page 86).
  → Defining additional requirements for the application (Page 87).

Motor

- **Which motor is connected to the inverter?**
  If you are using one of the STARTER commissioning tools or Startdrive and a SIEMENS motor, then you only need the order number of the motor. Otherwise, note down the data on the motor rating plate.



- **In which region of the world will the motor be used?**
  - Europe IEC: 50 Hz [kW]
  - North America NEMA: 60 Hz [hp] or 60 Hz [kW]
- **How is the motor connected?**
  Pay attention to the connection of the motor (star connection [Y] or delta connection [Δ]). Note the appropriate motor data for connecting.
- **What is the ambient temperature of the motor?**
  For commissioning, you will need the ambient temperature of the motor if it differs by more than 10 °C from the factory setting (20 °C).

5.2.1 Inverter factory setting

Motor

The inverter is set for an induction motor when first switching on the supply voltage or after restoring the factory settings. The motor data match the technical data of the inverter.

Switching the motor on and off

The inverter is set in the factory so that after it has been switched on, the motor accelerates up to its speed setpoint in 10 seconds (referred to 1500 rpm). After it has been switched off, the motor also brakes with a ramp-down time of 10 seconds.

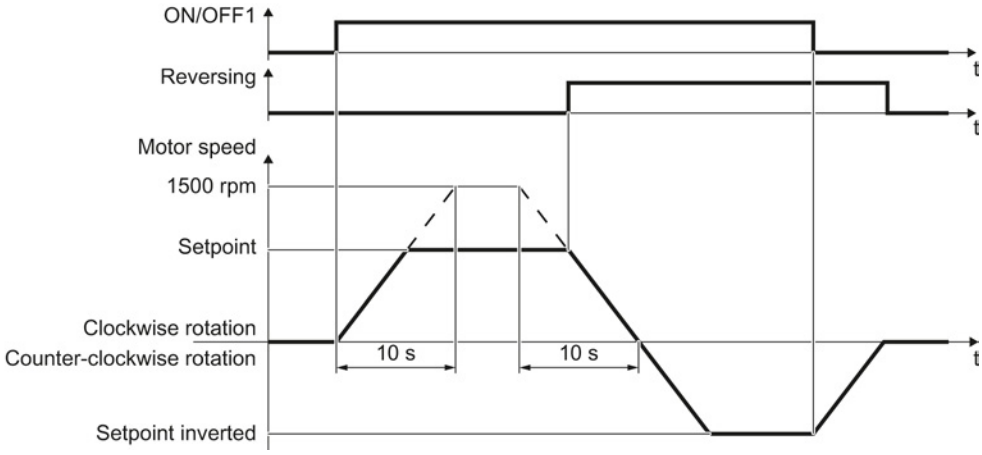


Figure 5-1 Switching on and switching off the motor and reversing in the factory setting

Switching the motor on and off in the jog mode

For inverters with PROFIBUS interface, operation can be switched over using digital input DI 3. The motor is either switched on and off via PROFIBUS – or operated in the jog mode via its digital inputs.

For a control command at the respective digital input, the motor rotates with ±150 rpm. The ramp-up and ramp-down times are also 10 seconds, referred to 1500 rpm.

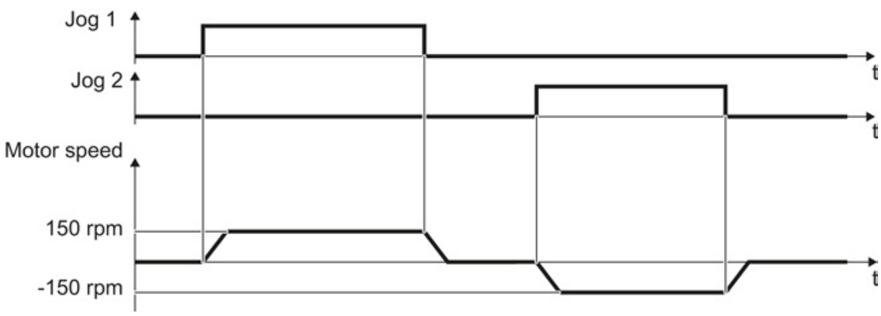
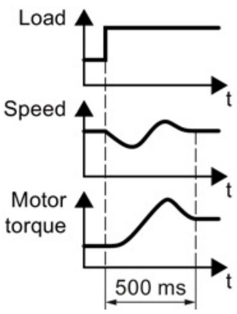
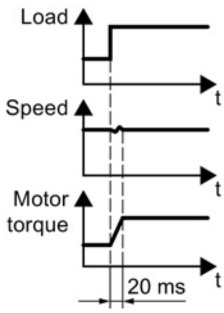


Figure 5-2 Jogging the motor in the factory setting

5.2.2 Selecting the control mode

Criteria for selecting either V/f control or vector control

	U/f control or FCC (flux current control)	Vector control without an encoder
Application examples	• Pumps, fans, and compressors with flow characteristic • Wet or dry blasting technology • Mills, mixers, kneaders, crushers, agitators • Horizontal conveyor technology (conveyor belts, roller conveyors, chain conveyors) • Basic spindles	• Pumps and compressors with displacement machines • Rotary furnaces • Extruder • Centrifuge
Motors that can be operated	The rated current of the motor must lie in the range of 13 % … 100 % of the rated current of the inverter.	
Properties of closed-loop motor control	• U/f and FCC are insensitive to inaccurate motor data settings, e.g. the motor temperature • U/f and FCC can be commissioned with just a few settings. • U/f and FCC respond to speed changes with a typical settling time of 100 ms … 200 ms • U/f and FCC respond to load surges with a typical settling time of 500 ms  • U/f and FCC are suitable for the following cases: – For motor power ratings < 45 kW – For accelerating times 0 → rated speed > 2 s – For applications with increasing load torque without load surges	• Vector control uses the Power Module, the motor and the mechanical system with a high degree of efficiency (95 % line voltage at the PM240 or PM240-2). • The vector control responds to speed changes with a typical settling time of < 100 ms. • The vector control responds to load surges with a typical settling time of 20 ms.  • We recommend vector control for motor power ratings > 45 kW • The vector control is required in the following cases: – For accelerating times 0 → rated speed < 2 s – For applications with fast and high load surges – For heavy duty starting using ≤ 90 % of the stall torque of the motor • Vector control typically achieves a torque accuracy of ± 5 % for 10 % … 100 % of the rated speed

	U/f control or FCC (flux current control)	Vector control without an encoder
Max. output frequency	240 Hz	200 Hz
Closed-loop torque control	Closed-loop torque control not possible	Closed-loop torque control without higher-level closed-loop speed control is possible

5.2.3 Defining additional requirements for the application

What speed limits should be set (minimum and maximum speed)?

- Minimum speed - factory setting 0 [rpm]
  The minimum speed is the lowest speed of the motor independent of the speed setpoint. A minimum speed is, for example, useful for fans or pumps.
- Maximum speed - factory setting 1500 [rpm]
  The inverter limits the motor speed to this value.

What motor ramp-up time and ramp-down time are needed for the application?

The ramp-up and ramp-down time define the maximum motor acceleration when the speed setpoint changes. The ramp-up and ramp-down time is the time between motor standstill and the maximum speed, or between the maximum speed and motor standstill.

- Ramp-up time - factory setting 10 s
- Ramp-down time - factory setting 10 s

5.3 Restoring the factory setting

There are cases where something goes wrong when commissioning a drive system e.g.:

- The line voltage was interrupted during commissioning and you were not able to complete commissioning.
- You got confused during the commissioning and you can no longer understand the individual settings that you made.
- You do not know whether the inverter was already operational.

In cases such as these, reset the inverter to the factory settings.

Resetting the safety functions to the factory settings

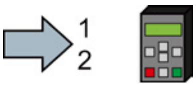
If the safety functions are enabled in your inverter, then the safety function settings are password-protected. You must know the password to reset the safety function settings.

Procedure

Proceed as follows to restore the inverter safety functions to the factory settings:

1. Go online
2. Call the safety functions screen form
3. In the "Safety Integrated" screen form, press the button for restoring the factory setting.
4. Enter the correct password.
5. Switch off the inverter supply voltage.
6. Wait until all LEDs on the inverter go dark.
7. Switch on the inverter supply voltage again.

You have restored the safety function settings of your inverter to the factory settings.



Proceed as follows to restore the inverter safety functions to the factory settings:

1. p0010 = 30Set
   Activate reset settings.
2. p9761 = …
   Enter the password for the safety functions
3. Start restoration using p970 = 5.
4. Wait until the inverter sets p0970 = 0.
5. Set p0971 = 1.
6. Wait until the inverter sets p0971 = 0.
7. Switch off the inverter supply voltage.
8. Wait until all LEDs on the inverter go dark.
9. Switch on the inverter supply voltage again.

You have restored the safety function settings of your inverter to the factory settings.

Restoring the inverter to the factory setting

Procedure

Proceed as follows to reset the inverter to factory settings:

1. Go online.
2. Select button

You have reset the inverter to factory settings.

Proceed as follows to reset the inverter to factory settings:

1. In the "Options" menu, select the "DRVRESET" entry
2. Confirm the reset using the OK key

You have reset the inverter to factory settings.

5.4 Basic commissioning

5.4.1 Basic commissioning with the BOP-2 operator panel

To do this, insert the Basic Operator Panel BOP-2 on the Control Unit of the inverter.

Procedure

Proceed as follows to install the BOP-2 operator panel:

1. Locate the lower edge of the BOP-2 housing into the matching recess of the Control Unit.
2. Press the BOP-2 onto the inverter until you hear the latching mechanism engage.

The BOP-2 operator panel is ready for operation when you connect the inverter to the power supply.

Setting the basic commissioning data

Basic commissioning is the first step of the commissioning procedure. The BOP-2 Operator Panel guides you through the basic commissioning process and prompts you to enter the most important data for your inverter.

Precondition

SP [1/min] [1/min]	You have inserted the BOP-2 Operator Panel on the inverter and connected the inverter to a power supply. The Operator Panel has powered up and displays setpoints and actual values.

Procedure

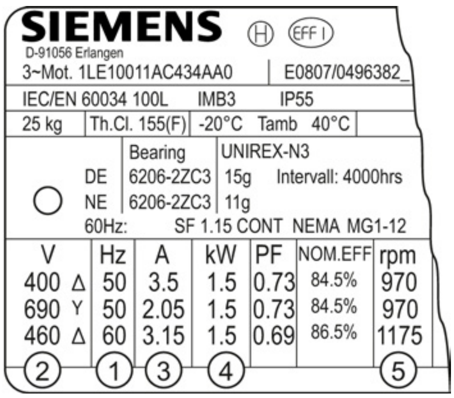
To enter the data for basic commissioning, proceed as follows:

1. ESC Press the ESC key.
2. Press one of the arrow keys until the BOP-2 displays the "SETUP" menu.
3. SETUP OK In the "SETUP" menu, press the OK key to start basic commissioning.
4. RESET OK If you wish to restore all of the parameters to the factory setting before the basic commissioning:
   4.1. Switch over the display using an arrow key: nO → YES
   4.2. Press the OK key.
5. CTRL MOD P1300 OK

VF LIN	V/f control with a linear characteristic for basic applications, e.g. horizontal conveyors.
VF QUAD	V/f control with a square-law characteristic for basic pump and fan applications.
SPD N EN	We recommend that you use vector control.

   Further information on the control types can be found in Section Selecting the control mode (Page 86)

6. Transfer the data from the motor rating plate to the inverter:



   6.1. EUR/USA P100 OK Motor standard
   KW 50HZ IEC
   HP 60HZ NEMA
   KW 60HZ IEC 60 Hz
   6.2. MOT VOLT P304 OK Rated voltage
   6.3. MOT CURR P305 OK Rated current
   6.4. MOT POW P307 OK IEC power (kW)
   NEMA (HP)
   6.5. MOT RPM P311 OK Rated speed

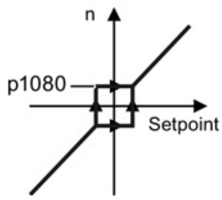
7. MOT ID P1900 [OK] Motor data identification

Select the method which the inverter uses to measure the data of the connected motor:

OFF	No measurement of motor data.
STIL ROT	Recommended setting: Measure the motor data at standstill and with the motor rotating.
STILL	Measure the motor data at standstill. Select this setting if one of the following cases is applicable: • You have selected the control mode "SPD N EN". However, the motor cannot rotate freely – for example, if the traversing range is mechanically limited. • You have selected V/f control as a control mode, e.g. "VF LIN" or "VF QUAD".
ROT	Measuring the motor data while it is rotating.

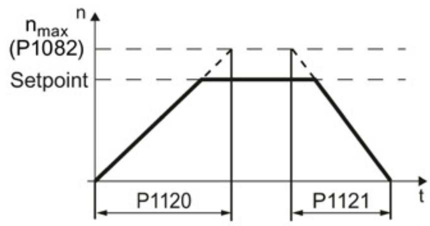
8. MAc PAr P15 [OK] Select the default setting for the interfaces of the inverter that is suitable for your application. You will find the default settings in Section: Terminal strips on CU240B-2 Control Units (Page 66).

9. MIN RPM P1080 [OK] Set the minimum speed of the motor.



10. RAMP UP P1120 [OK] Set the ramp-up time of the motor.

11. RAMP DWN P1121 [OK] Set the ramp-down time of the motor.



12. FINISH [OK] Complete the basic commissioning:

12.1. Switch over the display using an arrow key: nO → YES

12.2. Press the OK key.

You have entered all of the data that is necessary for the basic commissioning of your inverter.

Identifying the motor data and optimizing the closed-loop control

Following basic commissioning, the inverter generally has to measure other motor data and optimize its current and speed controllers.

To start motor data identification, you must switch on the motor. It does not matter whether you use the terminal strip, fieldbus, or operator panel to enter the ON command.

⚠ WARNING

Risk of fatal injury as a result of machine movements when switching on the motor

Switching on the motor for identification purposes may result in hazardous machine movements.

Secure dangerous machine parts before starting motor data identification:

- Before switching on, check that no parts are loose on the machine or can be spun out.
- Before switching on, ensure that nobody is working on the machine or located within its working area.
- Secure the machine's work area against unintended access.
- Lower hanging/suspended loads to the floor.

Preconditions

- In the basic commissioning, you have selected the motor identification (MOT ID). In this case, after the basic commissioning has been completed, the inverter issues the alarm A07991.

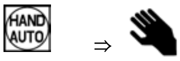
	You can recognize an active alarm from the corresponding symbol on the BOP-2.

- The motor has cooled down to the ambient temperature.

  If the motor is too hot, the motor data identification will provide incorrect values and the vector control can become unstable.

Procedure

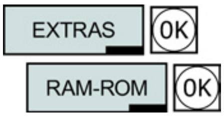
To initiate motor data identification and optimization of the vector control, proceed as follows:

1. 

Press the HAND/AUTO key. The BOP-2 displays the HAND symbol.

2. 
Switch on the motor.

3. 
Wait until the inverter switches off the motor after completion of the motor data identification. The measurement takes several seconds.

4. 

Save the measurements so that they are protected against power failure.

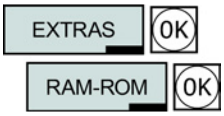

If you have also selected a rotating measurement in addition to the motor data identification, then the inverter again issues the alarm A07991.

5. 
Switch the motor on again in order to optimize the vector control.

6. 
Wait until the inverter switches off the motor after completion of the optimization. The optimization can take up to one minute.

7. 

Switch the inverter control from HAND to AUTO.

8. 

Save the measurements so that they are protected against power failure.

You have now completed motor data identification and the vector control has been optimized.

5.4.2 Basic commissioning with STARTER

STARTER and STARTER screen forms

STARTER is a PC-based tool to commission Siemens inverters. The graphic user interface of STARTER supports you when commissioning your inverter. Most inverter functions are combined in screen forms in STARTER.

The STARTER screen forms that are shown in this manual show general examples. The number of setting options available in screen forms depends on the particular inverter type.

Preconditions for basic commissioning

You require the following to commission the inverter using STARTER:

- An installed drive (motor and inverter)
- A computer with Windows XP or Windows 7
- The latest version of STARTER. STARTER download (http://support.automation.siemens.com/WW/view/en/10804985/133100)
- An appropriate USB cable. If you are not using the USB interface, but the PROFINET interface of the inverter, you can find information in section: Manuals for your inverter (Page 368).

Overview of basic commissioning

Commissioning using STARTER includes the following basic steps:

1. Create a STARTER project
2. Integrate an inverter into the project
3. Go online and start basic commissioning
4. Carry out basic commissioning
5. Identify motor data

Steps 1-5 are described below.

5.4.2.1 Generating a STARTER project

Procedure

1
2

In order to create a new project, proceed as follows:

1. In the STARTER menu, select "Project" → "New…".
2. Specify a name of your choice for the project.

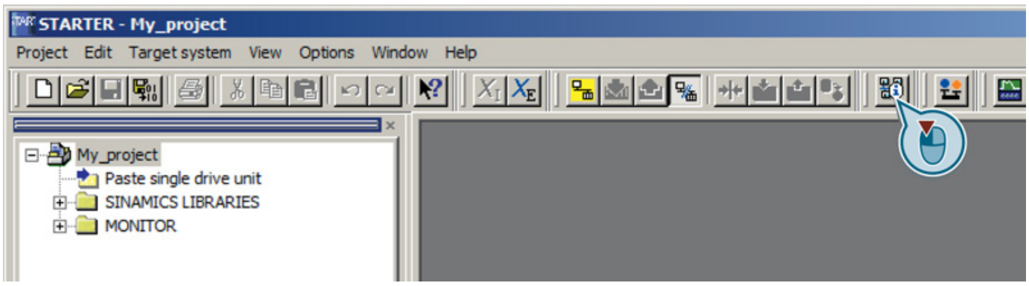
You have created a new STARTER project.

5.4.2.2 Transfer inverters connected via USB into the project

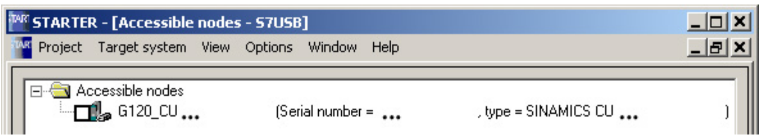
Procedure

Proceed as follows to transfer an inverter connected via USB into your project:

1. Switch on the inverter power supply.
2. First insert a USB cable into your PC and then into the inverter.
3. The PC operating system installs the USB driver when you are connecting the inverter and PC together for the first time.
   – Windows 7 installs the driver automatically.
   – For Windows XP you must acknowledge several system messages.
4. Start the STARTER commissioning software.
5. In STARTER, press the ("Accessible nodes") button.



6. When the USB interface is appropriately set, then the "Accessible nodes" screen form shows the inverters that can be accessed.



   If you have not correctly set the USB interface, then the following "No additional nodes found" message is displayed. In this case, follow the description below.
7. Select the inverter ☑.
8. Press the "Accept" button.

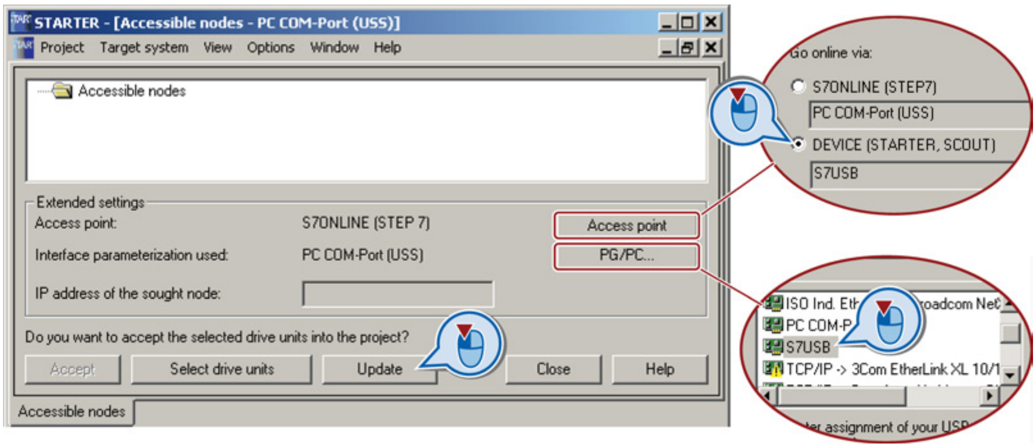
You have transferred an inverter accessible via the USB interface into your project.

Setting the USB interface

Procedure

Proceed as follows to set the USB interface in STARTER:

1. In this case set the "Access point" to "DEVICE (STARTER, Scout)" and the "PG/PC interface" to "S7USB".
2. Press the "Update" button.



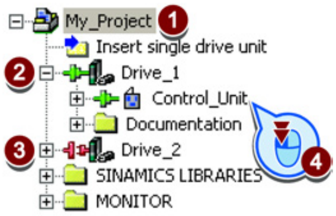
You have set the USB interface.

STARTER now shows the inverters connected via USB.

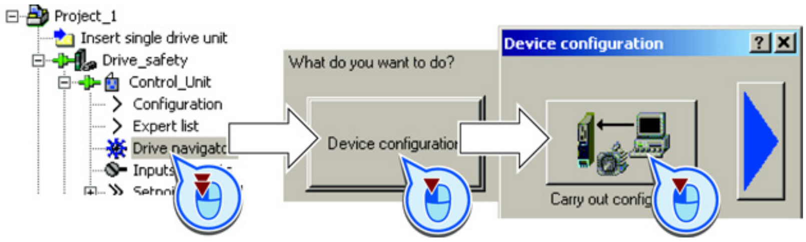
5.4.2.3 Go online and start wizard for basic commissioning

Procedure

Proceed as follows to start the basic commissioning online with the converter:



1. Select your project and go online: .
2. Select the device or the devices with which you wish to go online.
3. Download the hardware configuration found online in your project (PG or PC). STARTER shows you which converter it is accessing online and which offline:
   ② The converter is online
   ③ The converter is offline
4. When you are online, double-click on "Control Unit".
5. Start the wizard for basic commissioning.

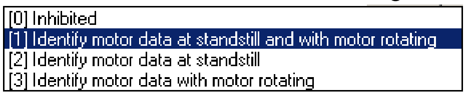


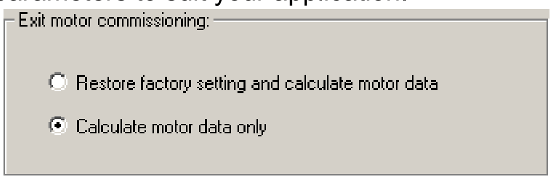
You are online and have started basic commissioning.

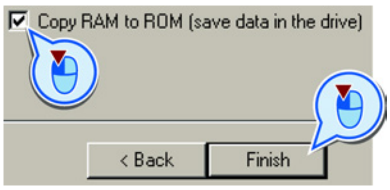
5.4.2.4 Carry-out basic commissioning

Procedure

Proceed as follows to carry out basic commissioning:

1. Control structure — Select the control mode.
   See also Section: Selecting the control mode (Page 86)
2. Defaults of the setpoin — Select the pre-assignment of the inverter interfaces.
   The possible configurations can be found in sections: Default settings of the CU240B-2 terminals (Page 68) and Default settings of the CU240E-2 terminals (Page 73).
3. Drive setting — Select the application for the inverter:
   Low overload for applications that only require a low dynamic performance, e.g.: pumps or fans.
   High overload for applications requiring a high dynamic performance, e.g. conveyor systems.
4. Motor — Select your motor.
5. Motor data — Enter the motor data according to the rating plate of your motor.
   If you have selected a motor based on its order number, the data has already been entered.
6. Drive functions — If you have set the "Vector control" control mode, then we recommend setting "[1] Identify motor data at standstill and with motor rotating".
   With this setting, the inverter optimizes its speed controller.
   

   If one of the following cases is applicable, select the setting "[2] Identify motor data at standstill":
   - You have selected "Vector control" as control mode; however, the motor cannot freely rotate, e.g. for mechanically limited traversing sections.
   - You have set "V/f control" as control mode.
7. Important parameters — Set the most important parameters to suit your application.
8. Calculation of the motc — We recommend the setting "Calculate motor data only".
   

9. Set the check mark for "RAM to ROM (save data in the drive)" in order to save your data in the inverter so that it is not lost when the power fails.
   Exit basic commissioning.
   

You have entered all of the data that is necessary for the basic commissioning of your inverter.

5.4.2.5 Identifying motor data

Preconditions

- In the basic commissioning, you have selected the motor identification (MOT ID). In this case, after the basic commissioning has been completed, the converter issues the alarm A07991.
- The motor has cooled down to the ambient temperature.

  If the motor is too hot, the motor data identification will provide incorrect values and the vector control will become unstable.

DANGER

Risk of injury or material damage as a result of machine movements when switching on the motor

Switching on the motor for identification purposes may result in hazardous machine movements.

Secure dangerous machine parts before starting motor data identification:

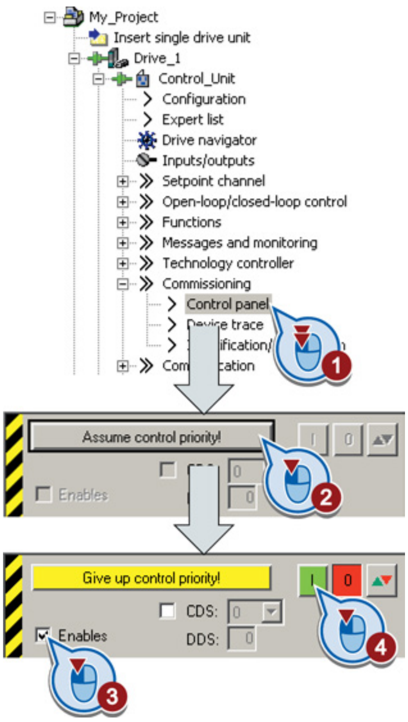
- Before switching on, check that no parts are loose on the machine or can be spun out.
- Before switching on, ensure that nobody is working on the machine or located within its working area.
- Secure the machine's work area against unintended access.
- Lower hanging/suspended loads to the floor.

Procedure

To initiate motor data identification and optimization of the motor control, proceed as follows:

1. Open by double-clicking on the control panel in STARTER.
2. Assume master control for the converter.
3. Set the "Enable signals"
4. Switch on the motor.

   The converter starts the motor data identification. This measurement can take several minutes. After the measurement, the converter switches off the motor.
5. Relinquish the master control after the motor data identification.
6. Click the Save (RAM to ROM) button.



You have now completed motor data identification.

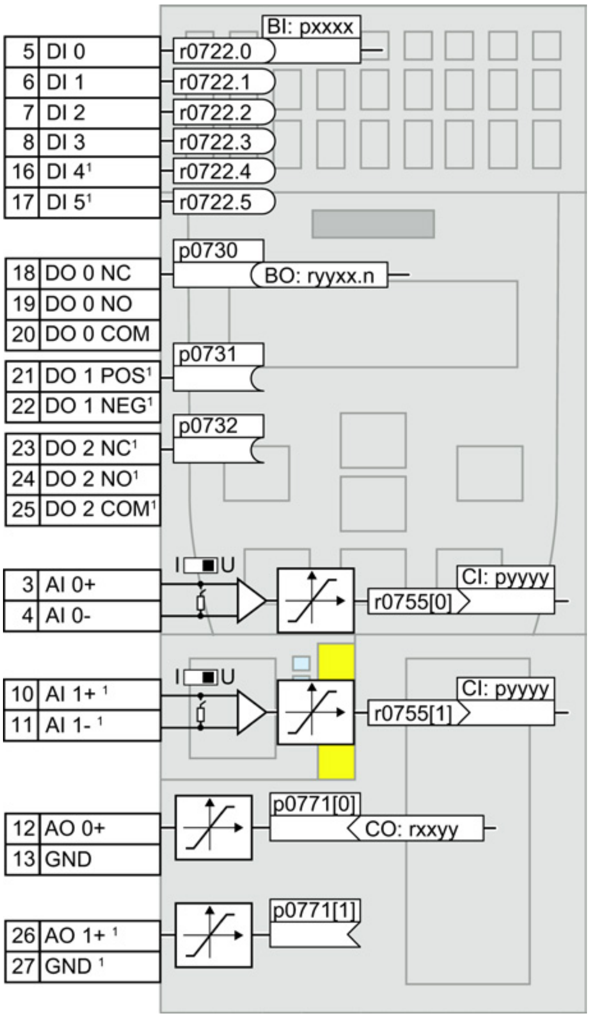
Self-optimization of the closed-loop control

If you have also selected a rotating measurement with self-optimization of the vector control in addition to the motor data identification, then you must switch on the motor again as described above and wait for the optimization run to be completed.

Adapt terminal strip 6

This chapter describes how you adapt the function of individual digital and analog inputs and outputs of the inverter.

If you adapt the function of an input or output, you overwrite the settings made during the basic commissioning.

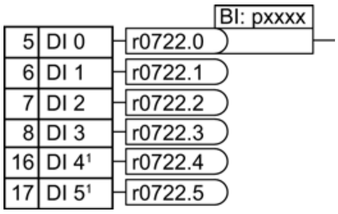


[1] Not available with Control Units CU240B-2 and CU240B-2 DP

Figure 6-1 Internal interconnection of the inputs and outputs

6.1 Digital inputs

Changing the function of a digital input



To change the function of a digital input, you must interconnect the status parameter of the digital input with a binector input of your choice.

See also Section: Interconnecting signals in the inverter (Page 357).

Binector inputs are marked with "BI" in the parameter list of the List Manual.

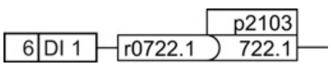
[1]Not available with CU240B-2 and CU240B-2 DP Control Units

Table 6- 1 Binector inputs (BI) of the inverter (selection)

BI	Significance	BI	Significance
p0810	Command data set selection CDS bit 0	p1036	Motorized potentiometer, setpoint, lower
p0840	ON/OFF1	p1055	Jog bit 0
p0844	OFF2	p1056	Jog bit 1
p0848	OFF3	p1113	Setpoint inversion
p0852	Enable operation	p1201	Flying restart enable signal source
p0855	Unconditionally release holding brake	p2103	1. Acknowledge faults
p0856	Enable speed controller	p2106	External fault 1
p0858	Unconditionally close holding brake	p2112	External alarm 1
p1020	Fixed speed setpoint selection bit 0	p2200	Technology controller enable
p1021	Fixed speed setpoint selection bit 1	p3330	Two/three-wire control, control command 1
p1022	Fixed speed setpoint selection bit 2	p3331	Two/three-wire control, control command 2
p1023	Fixed speed setpoint selection bit 3	p3332	Two/three-wire control, control command 3
p1035	Motorized potentiometer, setpoint, raise		

A complete list of the binector outputs is provided in the List Manual.

Changing the function of a digital input - Example



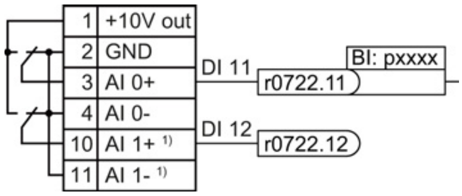
To acknowledge fault messages of the inverter using digital input DI 1, you must interconnect DI1 with the command to acknowledge faults (p2103): Set p2103 = 722.1.

Advanced settings

You can debounce the digital input signal using parameter p0724.

For more information, please see the parameter list and the function block diagrams 2220 f of the List Manual.

Analog inputs as digital inputs



To use an analog input as additional digital input, you must connect the analog input as shown, and interconnect one of the status parameters r0722.11 or r0722.12 with a binector input of your choice.

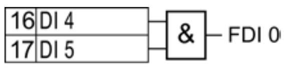
[1] Not available with CU240B-2 and CU240B-2 DP Control Units

6.2 Safety-related input

This manual describes the STO safety function with control via a safety-related input. All other safety functions, additional safety-related inputs of the inverter and the control of the safety functions via PROFIsafe are described in the Safety Integrated Function Manual.

Defining the safety-related input

If you use the STO safety function, then you must configure the terminal strip during the basic commissioning for a safety-related input, e.g. with p0015 = 2 (see Section Terminal strips on CU240E-2 Control Units (Page 69)).



The inverter combines digital inputs DI 4 and DI 5 to create a safety-related input.

See also Section: Safe Torque Off (STO) safety function (Page 225).

Note

Control Units CU240B-2 and CU240B-2 DP do not have a safety-relevant digital input.

What devices can be connected?

The safety-related input is designed for the following devices:

- Connection of safety sensors, e.g. emergency stop command devices or light curtains.
- Connection of pre-processing devices, e.g. fail-safe control systems and safety relays.

Signal states

The inverter expects signals with the same state at its safety-related input:

- High signal: The safety function is deselected.
- Low signal: The safety function is selected.

Fault detection

The inverter evaluates deviations in the two signals of the safety-related input. The inverter thus detects, for example the following faults:

- Cable break
- Defective sensor

The inverter cannot detect the following faults:

- Cross-circuit of the two cables
- Short-circuit between signal cable and 24 V power supply

Special measures when establishing connections

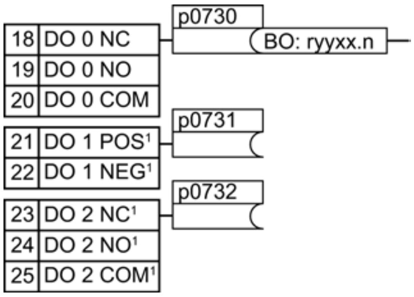
When routing cables over longer distances, e.g. between remote control cabinets, you have the following options to reduce the risk of damaged cables when your plant or machine is operating:

- Use shielded cables with grounded shield.
- Lay signal cables in steel pipes.

Examples of connecting a safety-related input can be found in Section: Connecting the safety-related input (Page 361).

6.3 Digital outputs

Changing the function of a digital output



To change the function of a digital output, you must interconnect the digital output with a binector output of your choice.

See also Section: Interconnecting signals in the inverter (Page 357).

Binector outputs are marked with "BO" in the parameter list of the List Manual.

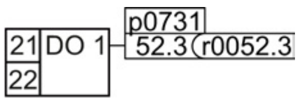
[1] Not available with CU240B-2 and CU240B-2 DP Control Units

Table 6- 2 Binector outputs (BO) of the inverter (selection)

0	Deactivating digital output	r0052.9	Process data control
r0052.0	Drive ready	r0052.10	f_actual >= p1082 (f_max)
r0052.1	Drive ready for operation	r0052.11	Alarm: Motor current/torque limit
r0052.2	Drive running	r0052.12	Brake active
r0052.3	Drive fault active	r0052.13	Motor overload
r0052.4	OFF2 active	r0052.14	Motor CW rotation
r0052.5	OFF3 active	r0052.15	Inverter overload
r0052.6	Closing lockout active	r0053.0	DC braking active
r0052.7	Drive alarm active	r0053.2	f_actual > p1080 (f_min)
r0052.8	Setpoint/actual value discrepancy	r0053.6	f_actual ≥ setpoint (f_setpoint)

The complete list of binector outputs is provided in the List Manual.

Changing the function of a digital output - Example



To output inverter fault messages via digital output DO 1, you must interconnect DO1 with the fault messages: Set p0731 = 52.3.

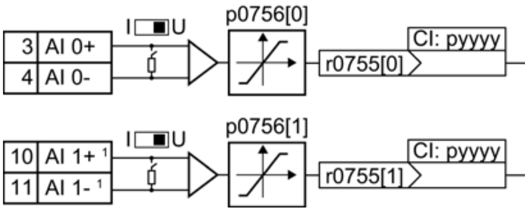
Advanced settings

You can invert the signal of the digital output using parameter p0748.

For more information, please see the parameter list and the function block diagrams 2230 f of the List Manual.

6.4 Analog inputs

Overview



[1]Not available with CU240B-2 and CU240B-2 DP Control Units

Changing the function of an analog input:

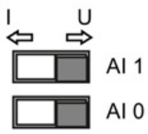
1. Define the analog input type using parameter p0756[x] and the switch on the inverter.
2. Define the function of the analog input by interconnecting parameter p0755[x] with a connector input CI of your choice.

   See also Section: Interconnecting signals in the inverter (Page 357).

Define the analog input type

The variable speed drive offers a series of default settings, which you can select using parameter p0756:

AI 0	Unipolar voltage input Unipolar voltage input monitored Unipolar current input Unipolar current input monitored Bipolar voltage input No sensor connected	0 V … +10 V +2 V … +10 V 0 mA … +20 mA +4 mA … +20 mA -10 V … +10 V	p0756[0] =	0 1 2 3 4 8
AI 1	Unipolar voltage input Unipolar voltage input monitored Unipolar current input Unipolar current input monitored Bipolar voltage input No sensor connected	0 V … +10 V +2 V … +10 V 0 mA … +20 mA +4 mA … +20 mA -10 V … +10 V	p0756[1] =	0 1 2 3 4 8

In addition, you must also set the switch associated with the analog input. You can find the switch on the Control Unit behind the lower front door. • Voltage input: Switch position U (factory setting) • Current input: Switch position I	

Characteristics

If you change the analog input type using p0756, then the inverter automatically selects the appropriate scaling of the analog input. The linear scaling characteristic is defined using two points (p0757, p0758) and (p0759, p0760). Parameters p0757 … p0760 are assigned to an analog input via their index, e.g. parameters p0757[0] … p0760[0] belong to analog input 0.

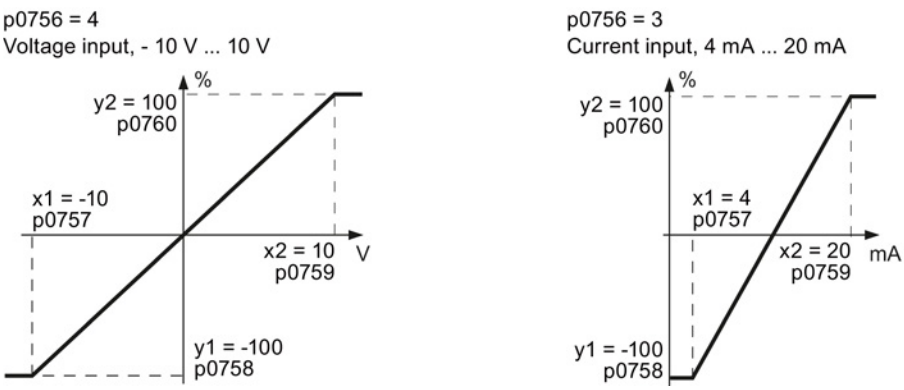


Figure 6-2 Examples for scaling characteristics

Parameter	Description
p0757	**x-coordinate of 1st characteristic point [V or mA]**
p0758	**y coordinate of the 1st characteristic point [% of p200x]** p200x are the parameters of the reference variables, e.g. p2000 is the reference speed
p0759	**x-coordinate of 2nd characteristic point [V or mA]**
p0760	**y-coordinate of 2nd characteristic point [% of p200x]**
p0761	**Wire breakage monitoring response threshold**

Adapting the characteristic

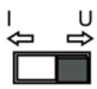
You must define your own characteristic if none of the default types match your particular application.

Example

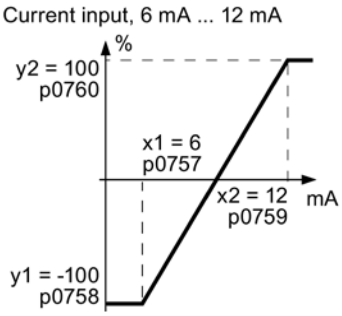
The inverter should convert a 6 mA … 12 mA signal into the value range -100 % … 100 % via analog input 0. The wire break monitoring of the inverter should respond when 6 mA is fallen below.

Precondition

You have set analog input 0 as a current input ("I") via the DIP switch on the Control Unit.



Procedure



Set the following parameters to set the analog input as current input with monitoring:

1. Set p7056[0] = 3
   This defines analog input 0 as a current input with wire-break monitoring.
2. Set p0757[0] = 6.0 (x1)
3. Set p0758[0] = -100.0 (y1)
4. Set p0759[0] = 12.0 (x2)
5. Set p0760[0] = 100.0 (y2)

Defining the function of an analog input

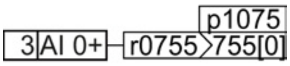
You define the analog input function by interconnecting a connector input of your choice with parameter p0755. Parameter p0755 is assigned to the particular analog input based on its index, e.g. parameter p0755[0] is assigned to analog input 0.

Table 6- 3 Connector inputs (CI) of the inverter (selection)

CI	Significance	CI	Significance
p1070	Main setpoint	p1522	Torque limit, upper
p1075	Supplementary setpoint	p2253	Technology controller setpoint 1
p1503	Torque setpoint	p2264	Technology controller actual value
p1511	Supplementary torque 1		

A complete list of the connector inputs is provided in the List Manual.

Defining the function of an analog input - example



To enter a supplementary setpoint via analog input AI 0, you must interconnect AI 0 with the signal source for the supplementary setpoint:

Set p1075 = 755[0].

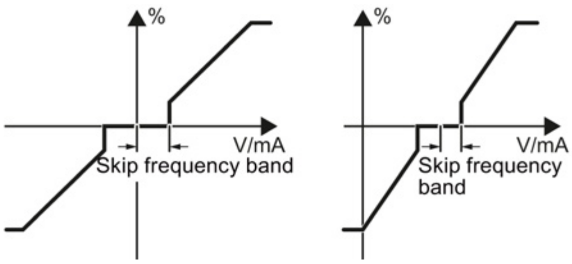
Advanced settings

Signal smoothing

When required, you can smooth the signal, which you read-in via an analog input, using parameter p0753.

For more information, see the parameter list and in the function block diagrams 9566 ff of the List Manual.

Skip frequency band



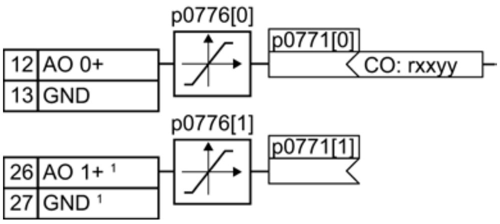
Interferences in the cable can corrupt small signals of a few millivolts. To be able to enter a setpoint of exactly 0 V via an analog input, you must specify a skip frequency band.

Skip frequency band of the analog input

p0764[0]	**Skip frequency band of the analog input AI 0** (factory setting: 0)
p0764[1]	**Skip frequency band of the analog input AI 1** (factory setting: 0)

6.5 Analog outputs

Overview



[1]Not available with CU240B-2 and CU240B-2 DP Control Units

Changing the function of an analog output:

1. Define the analog output type using parameter p0776.
2. Interconnect parameter p0771 with a connector output of your choice.

   See also Section: Interconnecting signals in the inverter (Page 357).

   Connector outputs are marked with "CO" in the parameter list of the List Manual.

Defining the analog output type

The inverter offers a series of default settings, which you can select using parameter p0776:

AO 0	Current output (factory setting) Voltage output Current output	0 mA … +20 mA 0 V … +10 V +4 mA … +20 mA	p0776[0] =	0 1 2
AO 1	Current output (factory setting) Voltage output Current output	0 mA … +20 mA 0 V … +10 V +4 mA … +20 mA	p0776[1] =	0 1 2

Characteristics

If you change the analog output type, then the inverter automatically selects the appropriate scaling of the analog output. The linear scaling characteristic is defined using two points (p0777, p0778) and (p0779, p0780).

Figure 6-3 Examples for scaling characteristics

Parameters p0777 … p0780 are assigned to an analog output via their index, e.g. parameters p0777[0] … p0770[0] belong to analog output 0.

Table 6- 4 Parameters for the scaling characteristic

Parameter	Description
p0777	**X coordinate of the 1st characteristic point [% of p200x]** p200x are the parameters of the reference variables, e.g. p2000 is the reference speed.
p0778	**Y coordinate of the 1st characteristic point [V or mA]**
p0779	**X coordinate of the 2nd characteristic point [% of p200x]**
p0780	**Y coordinate of the 2nd characteristic point [V or mA]**

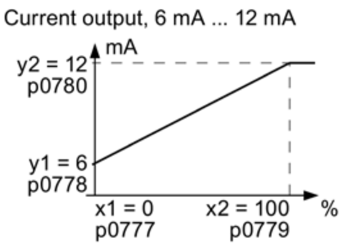
Setting the characteristic

You must define your own characteristic if none of the default types match your particular application.

Example:

The inverter should convert a signal in the value range -100% … 100% into a 6 mA … 12 mA output signal via analog output 0.

Procedure



Set the following parameters to set the characteristic to match the example:

1. Set p0776[0] = 2
   This defines analog output 0 as a current output.
2. Set p0777[0] = 0.0 (x1)
3. Set p0778[0] = 6.0 (y1)
4. Set p0779[0] = 100.0 (x2)
5. Set p0780[0] = 12.0 (y2)

Defining the function of an analog output

You define the analog output function by interconnecting parameter p0771 with a connector output of your choice. Parameter p0771 is assigned to the particular analog input via its index, e.g. parameter p0771[0] is assigned to analog output 0.

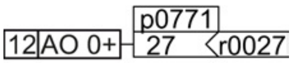
Table 6- 5 Connector outputs (CO) of the inverter (selection)

CO	Significance	CO	Significance
r0021	Actual frequency	r0026	Actual DC-link voltage
r0024	Output actual frequency	r0027	Output current
r0025	Output actual frequency		

A complete list of the connector outputs is provided in the List Manual.

For more information, please see the parameter list and the function block diagrams 2261 of the List Manual.

Defining the function of an analog output - example



To output the inverter output current via analog output 0, you must interconnect AO 0 with the signal for the output current: Set p0771 = 27.

Advanced settings

You can manipulate the signal that you output via an analog output, as follows:

- Absolute-value generation of the signal (p0775)
- Signal inversion (p0782)

Additional information is provided in the parameter list of the List Manual.

7 Configuring the fieldbus

Fieldbus interfaces of the Control Units

The Control Units are available in different versions for communication with higher-level controls with the subsequently listed fieldbus interfaces:

Fieldbus	Profiles			S7 communication [2)]	Control Unit
	PROFIdrive	PROFIsafe [1)]	PROFIenergy [2)]		
PROFIBUS (Page 121)	✓	✓	---	✓	CU240B-2 DP CU240E-2 DP CU240E-2 DP-F
PROFINET (Page 116)	✓	✓	✓	✓	CU240E-2 PN CU240E-2 PN-F
EtherNet/IP [2)]	---			---	
USS [2)]	---			---	CU240B-2 CU240E-2 CU240E-2 F
Modbus RTU [2)]	---			---	

[1)] Information on PROFIsafe can be found in the Safety Integrated Function Manual.

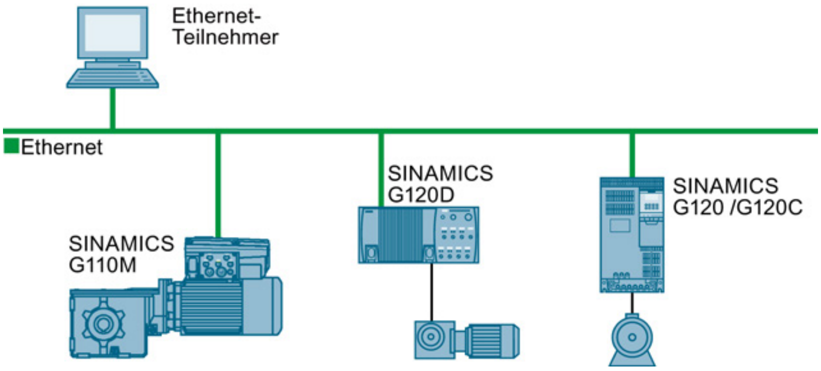
[2)] Information on the these fieldbuses, profiles and communication types can be found in the Fieldbuses Function Manual.

See also Section Manuals for your inverter (Page 368).

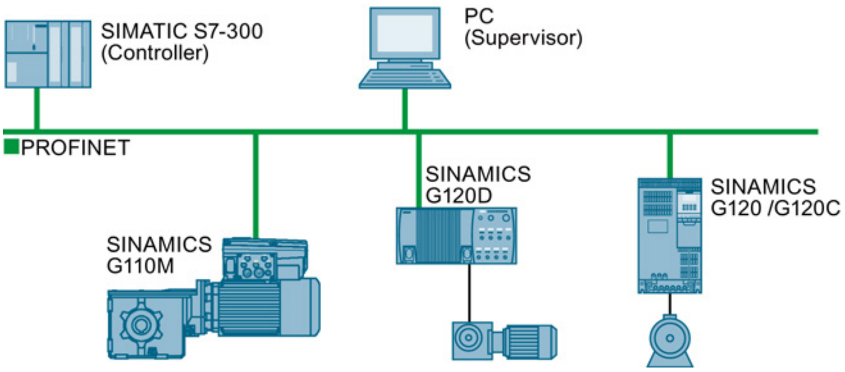
7.1 Communication via PROFINET

You can either communicate via Ethernet using the inverter, or integrate the inverter in a PROFINET network.

- The inverter as an Ethernet station (Page 368)



- PROFINET IO operation (Page 117)



In PROFINET IO operation, the inverter supports the following functions:

– RT

– IRT
The inverter transmits the clock synchronism but does not support clock synchronism.

– MRP
Media redundancy, impulsed with 200 ms
Requirement: Ring topology

– MRPD
Media redundancy, impulse-free
Requirement: IRT and the ring topology created in the control

– Diagnostic alarm
in accordance with the fault classes specified in the PROFIdrive profile. See Activating diagnostics via the control (Page 120).

– Device replacement without removable medium
Requirement: Topology created in the control

– Shared device
only in the case of control units with fail-safe functions (see Safety function manual)

Further information on PROFINET can be found on the Internet using the following links:

- General information about PROFINET can be found at Industrial Communication (http://www.automation.siemens.com/mcms/automation/en/industrial-communications/profinet/Pages/Default.aspx).
- The configuration of the functions is described in the PROFINET system description (http://support.automation.siemens.com/WW/view/en/19292127) manual.

This manual describes the control of the inverter using primary control. How to access the inverter as an Ethernet station is described in the Fieldbus function manual (Page 368) in the section "The inverter as an Ethernet station".

7.1.1 What do you need for communication via PROFINET?

Check the communication settings using the following table. If you answer "Yes" to the questions, you have correctly set the communication settings and can control the converter via the fieldbus.

Questions	Answer/description	Example
Is the inverter correctly connected to the bus network?	See: Integrating inverters into PROFINET (Page 118)	
Do the IP address and device name in the converter and controller match?	See Configuring communication to the control (Page 118)	See manuals for your inverter, fieldbus communication manual (Page 368)
Is the same telegram set in the converter as in the higher-level controller?	Set the telegram in the converter, see: Auto-Hotspot	
Are the signals that the converter and the controller exchange via PROFINET correctly interconnected?	PROFIdrive-compliant interconnection in the converter, see: PROFIdrive profile for PROFIBUS and PROFINET (Page 125)	

7.1.2 Integrating inverters into PROFINET

Procedure

To connect the inverter to a control via PROFINET, proceed as follows:

1. Integrate the inverter in the bus system (e.g. ring topology) of the control using PROFINET cables and the two PROFINET sockets X150-P1 and X150-P2.

   The position of the sockets and the pin assignment can be found in Section Fieldbus interface allocation (Page 65).

   The maximum permitted cable length from the previous station and to the subsequent one is 100 m.

2. Externally supply the inverter with 24 V DC through terminals 31 and 32.

   The external 24 V supply is only required if communications with the control should also run when the mains voltage is switched off.

You have connected the inverter to the control using PROFINET.

7.1.3 Configuring communication to the control

Configuring the communication using SIMATIC S7 control

- If the inverter is included in the hardware library of HW-Config, you can configure the inverter.
- You have the following options, if the inverter is not included in the hardware library:
  - Install the more up to date STARTER version
  - Install the GSDML of the inverter via "Install options/GSDML file" in HW Config.

Additional information on this topic is provided in the "Fieldbuses" Function Manual, also see Manuals for your inverter (Page 368).

Configuring the communication using a non-Siemens control

1. Import the device file (GSDML) of the inverter into the configuring tool of your control system.
2. Configure the communication.

Installing GSDML

Procedure

To install the GSDML of the inverter into the configuring tool of your control system, proceed as follows:

1. Load the GSDML to your PC.
   – On the Internet: GSDML (http://support.automation.siemens.com/WW/view/en/22339653/133100).
   – From your inverter:

     Insert a memory card into the converter.

     Set p0804 = 12.

     The inverter writes the GSDML as zipped file (*.zip) into directory /SIEMENS/SINAMICS/DATA/CFG on the memory card.
2. Unzip the GSDML file to a folder on your computer.
3. Import the GSDML into the configuring tool of your control system.

You have now installed the GSDML.

7.1.4 Select telegram

PROFIdrive telegrams

The following telegrams are available:

p0922 =
1: Standard telegram 1, PZD-2/2 (factory setting)
20: Standard telegram 20, PZD-2/6
350: SIEMENS telegram 350, PZD-4/4
352: SIEMENS telegram 352, PZD-6/6
353: SIEMENS telegram 353, PZD-2/2, PKW-4/4
354: SIEMENS telegram 354, PZD-6/6, PKW-4/4
999: Extend telegrams and change signal interconnection (Page 133)

A more detailed depiction of the individual telegrams can be found in Section Cyclic communication (Page 125).

Selecting a telegram

Procedure

Proceed as follows to set a specific telegram in the inverter:

Using STARTER or an operator panel, set parameter p0922 to the appropriate value.

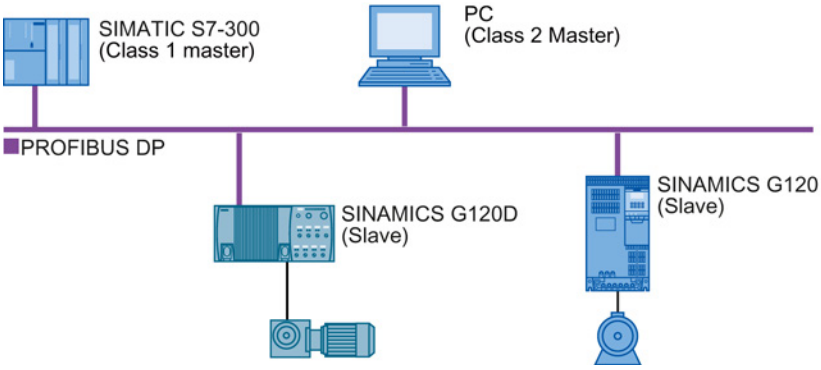
You have set a specific telegram in the inverter.

7.1.5 Activating diagnostics via the control

The converter provides the functionality to transmit fault and alarm messages (diagnostic messages) to the higher-level control according to the PROFIdrive error classes.

You must select the functionality in the higher-level control (see Manuals for your inverter (Page 368)) and activate it by booting up.

7.2 Communication via PROFIBUS



The PROFIBUS DP interface has the following functions:

- Cyclic communication
- Acyclic communication
- Diagnostic alarms

General information on PROFIBUS DP can be found on the Internet at the following links:

- PROFIBUS user organization (http://www.profibus.com/downloads/installation-guide/).
- Information about PROFIBUS DP (http://www.automation.siemens.com/net/html_76/support/printkatalog.htm).

7.2.1 What do you need for communication via PROFIBUS?

Check the communication settings using the following table. If you answer "Yes" to the questions, you have correctly set the communication settings and can control the converter via the fieldbus.

Questions	Description	Examples
Is the inverter correctly connected to the PROFIBUS?	See Section: Integrating inverters into PROFIBUS (Page 122).	---
Have you configured the communication between the inverter and the higher-level controller?	See Section: Configuring the communication using SIMATIC S7 control (Page 123)	See Manuals for your inverter (Page 368)
Do the addresses in the inverter and the higher-level controller match?	See Section: Setting the address (Page 123).	
Is the same telegram set in the higher-level controller and in the inverter?	Adapt the telegram in the inverter. See Section: Select telegram (Page 124).	
Are the signals that the inverter and the controller exchange via PROFIBUS correctly interconnected?	Adapt the interconnection of the signals in the controller to the inverter. For the PROFIdrive-compliant interconnection in the inverter, see also Section: PROFIdrive profile for PROFIBUS and PROFINET (Page 125).	

7.2.2 Integrating inverters into PROFIBUS

Procedure

To connect the inverter to a control via PROFIBUS DP, proceed as follows:

1. Integrate the inverter into the bus system (e.g. line topology) of the control using PROFIBUS cables via socket X126.

   The position of the sockets and the pin assignment can be found in Section Overview of the interfaces (Page 64).

   The maximum permitted cable length to the previous station and the subsequent one is 100 m at a baud rate of 1 Mbit/s.

2. Externally supply the inverter with 24 V DC through terminals 31 and 32.

   The external 24 V supply is only required if communications with the control should also run when the line voltage is switched off.

You have now connected the inverter to the control using PROFIBUS DP.

Communication with the controller even when the supply voltage on the Power Module is switched off

You must supply the Control Unit with 24 V DC at terminals 31 and 32 if you wish to maintain communication with the control system when the line voltage is switched off.

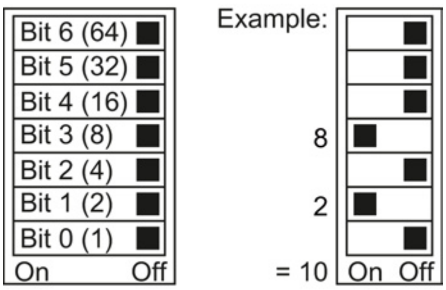
In the case of brief interruptions of the 24 V power supply, the inverter may signal a fault without communications with the control system being interrupted.

7.2.3 Configuring the communication using SIMATIC S7 control

- If the inverter is listed in the hardware library of HW-Conifg, you can configure the communication in the SIMATIC control.
- If the inverter is not listed in the hardware library, you can either install the newest STARTER version or install the GSD of the inverter through "Extras/GSD-Install file" in HW-Config. See also GSD (http://support.automation.siemens.com/WW/view/en/22339653/133100).

  When you have installed the GSD, configure the communication in the SIMATIC control.

7.2.4 Setting the address



You set the PROFIBUS address of the inverter using the address switch on the Control Unit, in parameter p0918 or in STARTER.

In parameter p0918 (factory setting: 126) or in STARTER, you can only set the address, if all address switches are set to "OFF" (0) or "ON" (1).

If you have specified a valid address with the address switches, this address will always be the one that takes effect and parameter p0918 cannot be changed.

Valid address range: 1 … 125

The positions of the address switches are described in Section: Overview of the interfaces (Page 64).

Procedure

To change the bus address, proceed as follows:

1. Set the address using one of the subsequently listed options:
   - using the address switch
   - from an operator panel using parameter p0918
   - in STARTER using screen form "Control Unit/Communication/PROFIBUS" – or using the expert list in parameter p0918

     After you have changed the address in STARTER, carry out RAM to ROM ( ).
2. Switch on the inverter power supply and, if available, the 24 V power supply for the Control Unit.
3. Switch on the voltages again after all LEDs at the inverter have gone dark.

You have now changed the bus address.

7.2.5 Select telegram

PROFIdrive telegrams

The following telegrams are available:

p0922 =	1:	Standard telegram 1, PZD-2/2 (factory setting)
	20:	Standard telegram 20, PZD-2/6
	350:	SIEMENS telegram 350, PZD-4/4
	352:	SIEMENS telegram 352, PZD-6/6
	353:	SIEMENS telegram 353, PZD-2/2, PKW-4/4
	354:	SIEMENS telegram 354, PZD-6/6, PKW-4/4
	999:	Extend telegrams and change signal interconnection (Page 133)

A more detailed depiction of the individual telegrams can be found in Section Cyclic communication (Page 125).

Selecting a telegram

Procedure

Proceed as follows to set a specific telegram in the inverter:

Using STARTER or an operator panel, set parameter p0922 to the appropriate value.

You have set a specific telegram in the inverter.

7.3 PROFIdrive profile for PROFIBUS and PROFINET

7.3.1 Cyclic communication

The send and receive telegrams of the inverter for the cyclic communication are structured as follows:

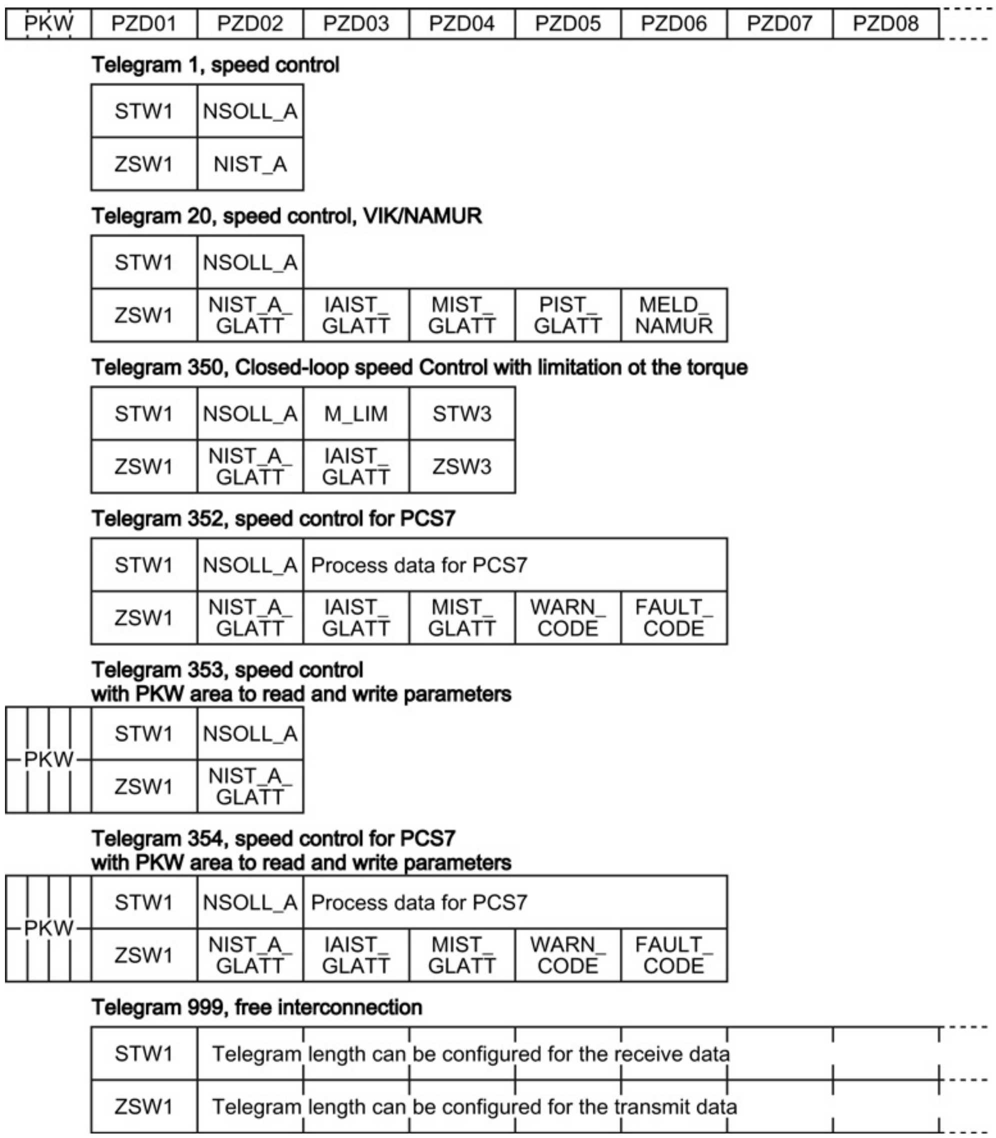


Figure 7-1 Telegrams for cyclic communication

Table 7- 1 Explanation of the abbreviations

Abbreviation	Explanation	Abbreviation	Explanation
STW	Control word	MIST_GLATT	Actual smoothed torque
ZSW	Status word	PIST_GLATT	Actual smoothed active power
NSOLL_A	Speed setpoint	M_LIM	Torque limit value
NIST_A	Speed actual value	FAULT_CODE	Fault number
NIST_A_GLATT	Smoothed actual speed value	WARN_CODE	Alarm number
IAIST_GLATT	Smoothed current actual value	MELD_NAMUR	Control word according to the VIK-NAMUR definition

Interconnection of the process data

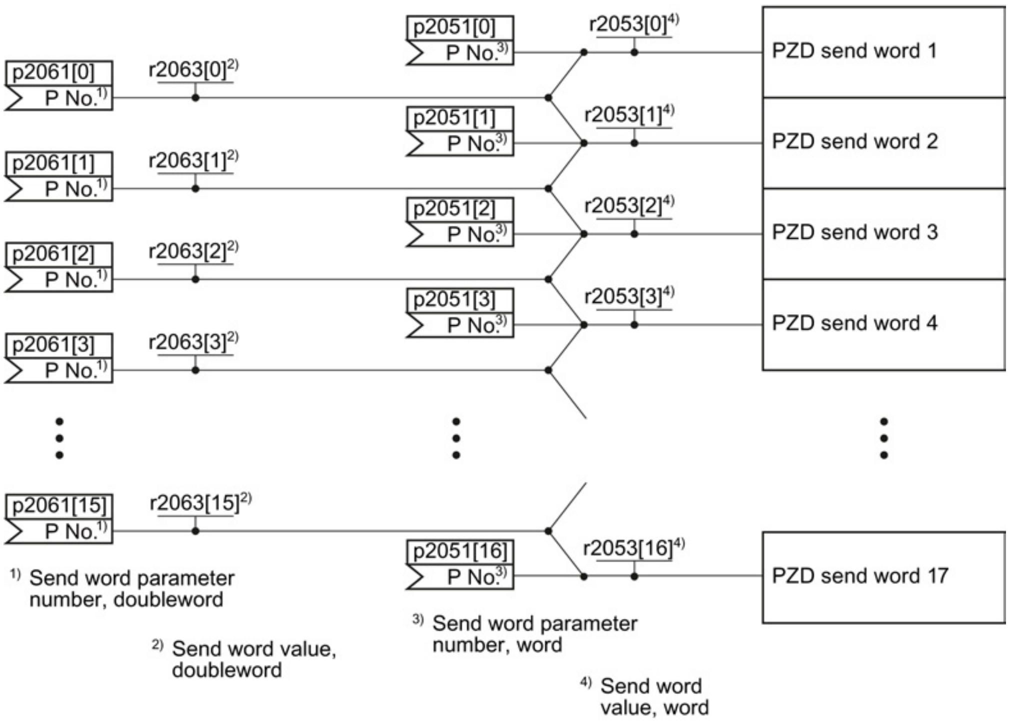


Figure 7-2 Interconnection of the send words

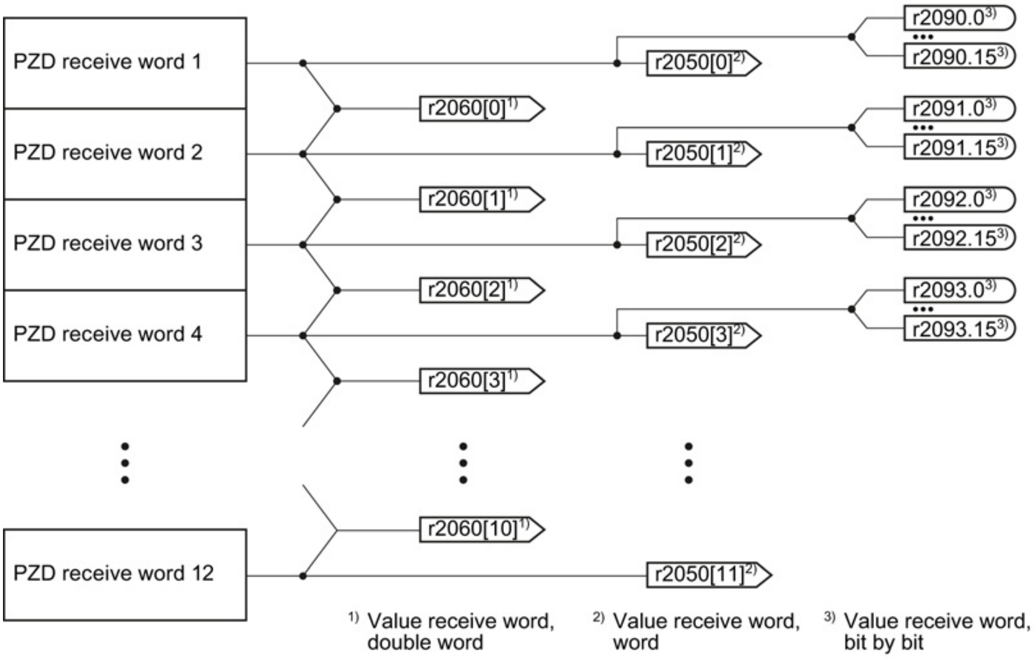


Figure 7-3 Interconnection of the receive words

The telegrams use - with the exception of telegram 999 (free interconnection) - the word-by-word transfer of send and receive data (r2050/p2051).

If you require an individual telegram for your application (e.g. for transferring double words), you can adjust one of the predefined telegrams via parameters p0922 and p2079. For details, please refer to the List Manual, function diagrams 2420 and 2472.

7.3.1.1 Control and status word 1

Control word 1 (STW1)

The control word 1 is pre-assigned as follows.

- Telegram 20 (VIK/NAMUR):
  - Bit 0 … 11 corresponds to PROFIdrive profile,
  - Bit 12… 15 manufacturer-specific
- Other telegrams:
  - Bit 0 … 10 corresponds to PROFIdrive profile,
  - Bit 11… 15 manufacturer-specific

Bit	Significance		Explanation	Signal interconnection in the inverter
	Telegram 20	All other telegrams		
0	0 = OFF1		The motor brakes with the ramp-down time p1121 of the ramp-function generator. The inverter switches off the motor at standstill.	p0840[0] = r2090.0
	0 → 1 = ON		The inverter goes into the "ready" state. If, in addition bit 3 = 1, then the inverter switches on the motor.	
1	0 = OFF2		Switch off the motor immediately, the motor then coasts down to a standstill.	p0844[0] = r2090.1
	1 = No OFF2		The motor can be switched on (ON command).	
2	0 = Quick stop (OFF3)		Quick stop: The motor brakes with the OFF3 ramp-down time p1135 down to standstill.	p0848[0] = r2090.2
	1 = No quick stop (OFF3)		The motor can be switched on (ON command).	
3	0 = Inhibit operation		Immediately switch-off motor (cancel pulses).	p0852[0] = r2090.3
	1 = Enable operation		Switch-on motor (pulses can be enabled).	
4	0 = Disable RFG		The inverter immediately sets its ramp-function generator output to 0.	p1140[0] = r2090.4
	1 = Do not disable RFG		The ramp-function generator can be enabled.	
5	0 = Stop RFG		The output of the ramp-function generator stops at the actual value.	p1141[0] = r2090.5
	1 = Enable RFG		The output of the ramp-function generator follows the setpoint.	
6	0 = Inhibit setpoint		The inverter brakes the motor with the ramp-down time p1121 of the ramp-function generator.	p1142[0] = r2090.6
	1 = Enable setpoint		Motor accelerates with the ramp-up time p1120 to the setpoint.	
7	0 → 1 = Acknowledge faults		Acknowledge fault. If the ON command is still active, the inverter switches to"closing lockout" state.	p2103[0] = r2090.7
8, 9	Reserved			
10	0 = No control via PLC		Inverter ignores the process data from the fieldbus.	p0854[0] = r2090.10
	1 = Control via PLC		Control via fieldbus, inverter accepts the process data from the fieldbus.	

Bit	Significance		Explanation	Signal interconnection in the inverter
	Telegram 20	All other telegrams		
11	0 = Direction reversal		Invert setpoint in the inverter.	p1113[0] = r2090.11
12	Not used			
13	---[1)]	1 = MOP up	Increase the setpoint saved in the motorized potentiometer.	p1035[0] = r2090.13
14	---[1)]	1 = MOP down	Reduce the setpoint saved in the motorized potentiometer.	p1036[0] = r2090.14
15	CDS bit 0	Reserved	Changes over between settings for different operation interfaces (command data sets).	p0810 = r2090.15

[1)] If you change over from another telegram to telegram 20, then the assignment of the previous telegram is kept.

Status word 1 (ZSW1)

The status word 1 is pre-assigned as follows.

- Bit 0 … 10 corresponds to PROFIdrive profile
- Bit 11… 15 manufacturer-specific

<table>
<tr><th rowspan="2">Bit</th><th colspan="2">Significance</th><th rowspan="2">Comments</th><th rowspan="2">Signal interconnection in the inverter</th></tr>
<tr><th>Telegram 20</th><th>All other telegrams</th></tr>
<tr><td>0</td><td colspan="2">1 = Ready to start</td><td>Power supply switched on; electronics initialized; pulses locked.</td><td>p2080[0] = r0899.0</td></tr>
<tr><td>1</td><td colspan="2">1 = Ready</td><td>Motor is switched on (ON/OFF1 = 1), no fault is active. With the command "Enable operation" (STW1.3), the inverter switches on the motor.</td><td>p2080[1] = r0899.1</td></tr>
<tr><td>2</td><td colspan="2">1 = Operation enabled</td><td>Motor follows setpoint. See control word 1, bit 3.</td><td>p2080[2] = r0899.2</td></tr>
<tr><td>3</td><td colspan="2">1 = Fault active</td><td>The inverter has a fault. Acknowledge fault using STW1.7.</td><td>p2080[3] = r2139.3</td></tr>
<tr><td>4</td><td colspan="2">1 = OFF2 inactive</td><td>Coast down to standstill is not active.</td><td>p2080[4] = r0899.4</td></tr>
<tr><td>5</td><td colspan="2">1 = OFF3 inactive</td><td>Quick stop is not active.</td><td>p2080[5] = r0899.5</td></tr>
<tr><td>6</td><td colspan="2">1 = Closing lockout active</td><td>It is only possible to switch on the motor after an OFF1 followed by ON.</td><td>p2080[6] = r0899.6</td></tr>
<tr><td>7</td><td colspan="2">1 = Alarm active</td><td>Motor remains switched on; no acknowledgement is necessary.</td><td>p2080[7] = r2139.7</td></tr>
<tr><td>8</td><td colspan="2">1 = Speed deviation within the tolerance range</td><td>Setpoint / actual value deviation within the tolerance range.</td><td>p2080[8] = r2197.7</td></tr>
<tr><td>9</td><td colspan="2">1 = Master control requested</td><td>The automation system is requested to accept the inverter control.</td><td>p2080[9] = r0899.9</td></tr>
<tr><td>10</td><td colspan="2">1 = Comparison speed reached or exceeded</td><td>Speed is greater than or equal to the corresponding maximum speed.</td><td>p2080[10] = r2199.1</td></tr>
<tr><td>11</td><td>1 = current or torque limit reached</td><td>1 = torque limit reached</td><td>Comparison value for current or torque has been reached or exceeded.</td><td>p2080[11] = r0056.13 / r1407.7</td></tr>
<tr><td>12</td><td>---1)</td><td>1 = Holding brake open</td><td>Signal to open and close a motor holding brake.</td><td>p2080[12] = r0899.12</td></tr>
<tr><td>13</td><td colspan="2">0 = Alarm, motor overtemperature</td><td>--</td><td>p2080[13] = r2135.14</td></tr>
<tr><td rowspan="2">14</td><td colspan="2">1 = Motor rotates clockwise</td><td>Internal inverter actual value > 0</td><td rowspan="2">p2080[14] = r2197.3</td></tr>
<tr><td colspan="2">0 = Motor rotates counterclockwise</td><td>Internal inverter actual value < 0</td></tr>
<tr><td>15</td><td>1 = CDS display</td><td>0 = Alarm, inverter thermal overload</td><td></td><td>p2080[15] = r0836.0 / r2135.15</td></tr>
</table>

1) If you change over from another telegram to telegram 20, then the assignment of the previous telegram is kept.

7.3.1.2 Control and status word 3

Control word 3 (STW3)

The control word 3 is pre-assigned as follows.

- Bit 0… 15 manufacturer-specific

Bit	Value	Significance Telegram 350	Explanation	Signal interconnection in the inverter 1)
0	1	Fixed setpoint, bit 0	Selects up to 16 different fixed setpoints.	p1020[0] = r2093.0
1	1	Fixed setpoint, bit 1		p1021[0] = r2093.1
2	1	Fixed setpoint, bit 2		p1022[0] = r2093.2
3	1	Fixed setpoint, bit 3		p1023[0] = r2093.3
4	1	DDS selection, bit 0	Changes over between settings for different motors (drive data sets).	p0820 = r2093.4
5	1	DDS selection, bit 1		p0821 = r2093.5
6	–	Not used		
7	–	Not used		
8	1	Technology controller enable	--	p2200[0] = r2093.8
9	1	DC braking enable	--	p1230[0] = r2093.9
10	–	Not used		
11	1	1 = Enable droop	Enable or inhibit speed controller droop.	p1492[0] = r2093.11
12	1	Torque control active	Changes over the control mode for vector control.	p1501[0] = r2093.12
	0	Closed-loop speed control active		
13	1	No external fault	--	p2106[0] = r2093.13
	0	External fault is active (F07860)		
14	–	Not used		
15	1	CDS bit 1	Changes over between settings for different operation interfaces (command data sets).	p0811[0] = r2093.15

1) If you switch from telegram 350 to a different one, then the inverter sets all interconnections p1020, … to "0". Exception: p2106 = 1.

Status word 3 (ZSW3)

The status word 3 is pre-assigned as follows.

- Bit 0… 15 manufacturer-specific

Bit	Value	Significance	Description	Signal interconnection in the inverter
0	1	DC braking active	--	p2051[3] = r0053
1	1	|n_act| > p1226	Absolute current speed > stationary state detection	
2	1	|n_act| > p1080	Absolute actual speed > minimum speed	
3	1	i_act ≧ p2170	Actual current ≥ current threshold value	
4	1	|n_act| > p2155	Absolute actual speed > speed threshold value 2	
5	1	|n_act| ≦ p2155	Absolute actual speed < speed threshold value 2	
6	1	|n_act| ≧ r1119	Speed setpoint reached	
7	1	DC link voltage ≦ p2172	Actual DC link voltage ≦ threshold value	
8	1	DC link voltage > p2172	Actual DC link voltage > threshold value	
9	1	Ramping completed	Ramp-function generator is not active.	
10	1	Technology controller output at lower limit	Technology controller output ≦ p2292	
11	1	Technology controller output at upper limit	Technology controller output > p2291	
12		Not used		
13		Not used		
14		Not used		
15		Not used		

7.3.1.3 Extend telegrams and change signal interconnection

When you have selected a telegram, the inverter interconnects the corresponding signals with the fieldbus interface. Generally, these interconnections are protected so that they cannot be changed. With the appropriate inverter settings, these interconnections can be changed.

Extend telegram

Every telegram can be extended, by "attaching" additional signals.

Procedure

Proceed as follows to extend a telegram:

1. Using STARTER or an operator panel, set parameter p0922 = 999.
2. Set parameter p2079 to the appropriate value of the corresponding telegram.
3. Interconnect additional PZD send words and PZD receive words with signals of your choice via parameters r2050 and p2051.

You have extended the telegram.

Parameter	Description	
p0922	**PROFIdrive telegram selection**	
	999:	Free telegram (message frame) configuration
p2079	**PROFIdrive PZD telegram selection extended**	
	1: 20: 350: 352: 353: 354:	Standard telegram 1, PZD-2/2 Standard telegram 20, PZD-2/6 SIEMENS telegram 350, PZD-4/4 SIEMENS telegram 352, PZD-6/6 SIEMENS telegram 353, PZD-2/2, PKW-4/4 SIEMENS telegram 354, PZD-6/6, PKW-4/4
r2050[0…11]	**PROFIdrive PZD receive word** Connector output to interconnect the PZD (setpoints) in the word format received from the PROFIdrive controller.	
p2051[0…16]	**PROFIdrive PZD send word** Selection of the PZD (actual values) in the word format to be sent to the PROFIdrive controller.	

Selection of the PZD (actual values) in the word format to be sent to the PROFIdrive controller. For further information refer to the function block diagrams 2468 and 2470 of the List Manual.

Freely selecting the signal interconnection of the telegram

The signals in the telegram can be freely interconnected.

Procedure

Proceed as follows to change the signal interconnection of a telegram:

1. Using STARTER or an operator panel, set parameter p0922 = 999.
2. Using STARTER or an operator panel, set parameter p2079 = 999.
3. Interconnect additional PZD send words and PZD receive words with signals of your choice via parameters r2050 and p2051.

You have freely interconnected the signals transferred in the telegram.

Parameter	Description	
p0922	**PROFIdrive telegram selection**	
	999:	Free telegram (message frame) configuration
p2079	**PROFIdrive PZD telegram selection extended**	
	999:	Free telegram (message frame) configuration
r2050[0…11]	**PROFIdrive PZD receive word** Connector output to interconnect the PZD (setpoints) in the word format received from the PROFIdrive controller.	
p2051[0…16]	**PROFIdrive PZD send word** Selection of the PZD (actual values) in the word format to be sent to the PROFIdrive controller.	

For further information refer to the function block diagrams 2468 and 2470 of the List Manual.

7.3.1.4 Data structure of the parameter channel

Structure of the parameter channel

The parameter channel consists of four words. 1. and 2nd word transfer the parameter number and index as well as the type of job (read or write) The 3rd and 4th word contains the parameter contents. The parameter contents can be 16-bit values (such as baud rate) or 32-bit values (e.g. CO parameters).

Bit 11 in the 1st word is reserved and is always assigned 0.

Parameter channel						
PKE (1st word)			IND (2nd word)		PWE (3rd and 4th words)	
15 ... 12	11	10 ... 0	15 ... 8	7 ... 0	15 ... 0	15 ... 0
AK	SPM	PNU	Subindex	Page index	PWE 1	PWE 2

You can find examples of telegrams at the end of this section.

Request and response IDs

Bits 12 to 15 of the 1st word of the parameter channel contain the request and response identifier.

Table 7- 2 Request identifiers, control → inverter

Request identifier	Description	Response identifier	
		positive	negative
0	No request	0	7 / 8
1	Request parameter value	1 / 2	7 / 8
2	Change parameter value (word)	1	7 / 8
3	Change parameter value (double word)	2	7 / 8
4	Request descriptive element [1)]	3	7 / 8
6[2)]	Request parameter value (field) [1)]	4 / 5	7 / 8
7[2)]	Change parameter value (field, word) [1)]	4	7 / 8
8[2)]	Change parameter value (field, double word) [1)]	5	7 / 8
9	Request number of field elements	6	7 / 8

1) The required element of the parameter is specified in IND (2nd word).

2) The following request IDs are identical: 1 ≡ 6, 2 ≡ 7 3 ≡ 8.
We recommend that you use identifiers 6, 7, and 8.

Table 7- 3 Response identifiers, inverter → control

Response identifier	Description
0	No response
1	Transfer parameter value (word)
2	Transfer parameter value (double word)
3	Transfer descriptive element [1)]
4	Transfer parameter value (field, word) [2)]
5	Transfer parameter value (field, double word) [2)]
6	Transfer number of field elements
7	Inverter cannot process the request. In the most significant word of the parameter channel, the inverter sends an error number to the control, refer to the following table.
8	No master controller status / no authorization to change parameters of the parameter channel interface

1) The required element of the parameter is specified in IND (2nd word).

2) The required element of the indexed parameter is specified in IND (2nd word).

Table 7- 4 Error numbers for response identifier 7

No.	Description
00 hex	**Illegal parameter number** (access to a parameter that does not exist)
01 hex	**Parameter value cannot be changed** (change request for a parameter value that cannot be changed)
02 hex	**Lower or upper value limit exceeded** (change request with a value outside the value limits)
03 hex	**Incorrect subindex** (access to a subindex that does not exist.)
04 hex	**No array** (access with a subindex to non-indexed parameters)
05 hex	**Incorrect data type** (change request with a value that does not match the data type of the parameter)
06 hex	**Setting not permitted, only resetting** (change request with a value not equal to 0 without permission)
07 hex	**Descriptive element cannot be changed** (change request to a descriptive element error value that cannot be changed)
0B hex	**No master control** (change request but with no master control, see also p0927.)
0C hex	**Keyword missing**
11 hex	**Request cannot be executed due to the operating state** (access is not possible for temporary reasons that are not specified)
14 hex	**Inadmissible value** (change request with a value that is within the limits but which is illegal for other permanent reasons, i.e. a parameter with defined individual values)
65 hex	**Parameter number is currently deactivated** (depending on the mode of the inverter)
66 hex	**Channel width is insufficient** (communication channel is too small for response)
68 hex	**Illegal parameter value** (parameter can only assume certain values)
6A hex	**Request not included / task is not supported** (the valid request identifications can be found in table "Request identifications controller → inverter")
6B hex	**No change access for a controller that is enabled**. (operating status of the inverter prevents a parameter change)
86 hex	**Write access only for commissioning (p0010 = 15)** (operating status of the inverter prevents a parameter change)
87 hex	**Know-how protection active, access locked**
C8 hex	**Change request below the currently valid limit** (change request to a value that lies within the "absolute" limits, but is however below the currently valid lower limit)
C9 hex	**Change request above the currently valid limit** (example: a parameter value is too large for the inverter power)
CC hex	**Change request not permitted** (change is not permitted as the access code is not available)

Offset and page index of the parameter numbers

Parameter numbers < 2000	PNU = parameter number. Write the parameter number into the PNU (PKE bit 10 ... 0).
Parameter numbers ≥ 2000	PNU = parameter number - offset. Write the parameter number minus the offset into the PNU (PKE bit 10 … 0). Write the offset in the page index (IND bit 7 … 0).

Parameter number	Offset	Page index								
		Hex	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0000 … 1999	0	0 hex	0	0	0	0	0	0	0	0
2000 … 3999	2000	80 hex	1	0	0	0	0	0	0	0
6000 … 7999	6000	90 hex	1	0	0	1	0	0	0	0
8000 … 9999	8000	20 hex	0	0	1	0	0	0	0	0
10000 … 11999	10000	A0 hex	1	0	1	0	0	0	0	0
20000 … 21999	20000	50 hex	0	1	0	1	0	0	0	0
30000 … 31999	30000	F0 hex	1	1	1	1	0	0	0	0
60000 … 61999	60000	74 hex	0	1	1	1	0	1	0	0

Indexed parameters

For indexed parameters, you must write the index as hex value into the subindex (IND bit 15 … 8).

Parameter contents

Parameter contents can be parameter values or connectors.

Table 7- 5 Parameter values in the parameter channel

PWE, 3rd word	PWE, 4th word	
Bit 15 … 0	Bit 15 … 8	Bit 7 … 0
0	0	8-bit value
0	16-bit value	
32-bit value		

Table 7- 6 Connectors in the parameter channel

PWE, 3rd word	PWE, 4th word	
Bit 15 … 0	Bit 15 … 10	Bit 9 … 0
Number of the connector	3F hex	The index or bit field number of the connector

Telegram examples

Read request: Read out serial number of the Power Module (p7841[2])

To obtain the value of the indexed parameter p7841, you must fill the telegram of the parameter channel with the following data:

- **PKE, bit 12 … 15 (AK): = 6** (request parameter value (field))
- **PKE, bit 0 … 10 (PNU): = 1841** (Parameter number without offset)
  Parameter number = PNU + offset (page index)
  (7841 = 1841 + 6000)
- **IND, bit 8 … 15 (subindex): = 2** (Index of the parameter)
- **IND, bit 0 … 7 (page index): = 90 hex** (offset 6000 ≙ 90 hex)
- Because you want to read the parameter value, words 3 and 4 in the parameter channel for requesting the parameter value are irrelevant. They should be assigned a value of 0, for example.

<table>
<tr><td colspan="64">Parameter channel</td></tr>
<tr><td colspan="16">PKE, 1st word</td><td colspan="16">IND, 2nd word</td><td colspan="16">PWE1 - high, 3rd word</td><td colspan="16">PWE2 - low, 4th word</td></tr>
<tr><td colspan="4">15 ... 12</td><td>11</td><td colspan="11">10 ... 0</td><td colspan="8">15 ... 8</td><td colspan="8">7 ... 0</td><td colspan="16">15 ... 0</td><td colspan="6">15 ... 10</td><td colspan="10">9 ... 0</td></tr>
<tr><td colspan="4">AK</td><td></td><td colspan="11">Parameter number</td><td colspan="8">Subindex</td><td colspan="8">Page index</td><td colspan="16">Parameter value</td><td colspan="6">Drive object</td><td colspan="10">Index</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>

Figure 7-4 Telegram for a read request from p7841[2]

Write request: Change restart mode (p1210)

The restart mode is inhibited in the factory setting (p1210 = 0). In order to activate the automatic restart with "acknowledge all faults and restart for an ON command", p1210 must be set to 26:

- **PKE, bit 12 … 15 (AK): = 7** (change parameter value (field, word))
- **PKE, bit 0 … 10 (PNU): = 4BA hex** (1210 = 4BA hex, no offset, as 1210 < 1999)
- **IND, bit 8 … 15 (subindex): = 0 hex** (parameter is not indexed)
- **IND, bit 0 … 7 (page index): = 0 hex** (offset 0 corresponds to 0 hex)
- **PWE1, bit 0 … 15: = 0 hex**
- **PWE2, bit 0 … 15: = 1A hex** (26 = 1A hex)

<table>
<tr><td colspan="64">Parameter channel</td></tr>
<tr><td colspan="16">PKE, 1st word</td><td colspan="16">IND, 2nd word</td><td colspan="16">PWE1 - high, 3rd word</td><td colspan="16">PWE2 - low, 4th word</td></tr>
<tr><td colspan="4">15 ... 12</td><td>11</td><td colspan="11">10 ... 0</td><td colspan="8">15 ... 8</td><td colspan="8">7 ... 0</td><td colspan="16">15 ... 0</td><td colspan="16">15 ... 0</td></tr>
<tr><td colspan="4">AK</td><td></td><td colspan="11">Parameter number</td><td colspan="8">Subindex</td><td colspan="8">Page index</td><td colspan="16">Parameter value (bit 16 ... 31)</td><td colspan="16">Parameter value (bit 0 ... 15)</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td></tr>
</table>

Figure 7-5 Telegram, to activate the automatic restart with p1210 = 26

Write request: Assign digital input 2 with the function ON/OFF1 (p0840[1] = 722.2)

In order to link digital input 2 with ON/OFF1, you must assign parameter p0840[1] (source, ON/OFF1) the value 722.2 (DI 2). To do this, you must fill the telegram of the parameter channel as follows:

- **PKE, bit 12 … 15 (AK): = 7 hex** (change, parameter value (field, word))
- **PKE, bit 0 … 10 (PNU): = 348 hex** (840 = 348 hex, no offset, as 840 < 1999)
- **IND, bit 8 … 15 (subindex): = 1 hex** (CDS1 = index1)
- **IND, bit 0 … 7 (page index): = 0 hex** (offset 0 ≙ 0 hex)
- **PWE1, bit 0 … 15**: = **2D2 hex** (722 = 2D2 hex)
- **PWE2, bit 10 … 15: = 3F hex** (drive object - for SINAMICS G120, always 63 = 3f hex)
- **PWE2, bit 0 … 9: = 2 hex** (index of parameter (DI 2 = 2))

Parameter channel							
PKE, 1st word			IND, 2nd word		PWE1 - high, 3rd word	PWE2 - low, 4th word	
15 ... 12	11	10 ... 0	15 ... 8	7 ... 0	15 ... 0	15 ... 10	9 ... 0
AK		Parameter number	Subindex	Page index	Parameter value	Drive Object	Index
0 1 1 1	0	0 1 1 0 1 0 0 1 0 0 0	0 0 0 0 0 0 0 1	0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 0 1 1 0 1 0 0 1 0	1 1 1 1 1 1	0 0 0 0 0 0 0 0 1 0

Figure 7-6 Telegram, to assign DI 2 with ON/OFF1

"Reading and writing parameters" application example

See: Reading and writing parameters via PROFIBUS (http://support.automation.siemens.com/WW/view/en/8894584).

7.3.1.5 Slave-to-slave communication

"Direct data exchange" is sometimes called "slave-to-slave communication" or "data exchange broadcast". Here, slaves exchange data without any direct involvement of the master.

You can find more information in: "Manuals for your inverter in the fieldbus communications manual (Page 368)".

7.3.2 Acyclic communication

The inverter supports the writing and reading of parameters via acyclic communication:

- For PROFIBUS:

  Acyclic communication via data set47:
  up to 240 bytes per write or read request
- For PROFINET:

  Acyclic communication via B02E hex and B02F hex

More information on acyclic communication can be found in the Fieldbus function manual; see also Section: Manuals for your inverter (Page 368).

Setting functions 8

8.1 Overview of the inverter functions

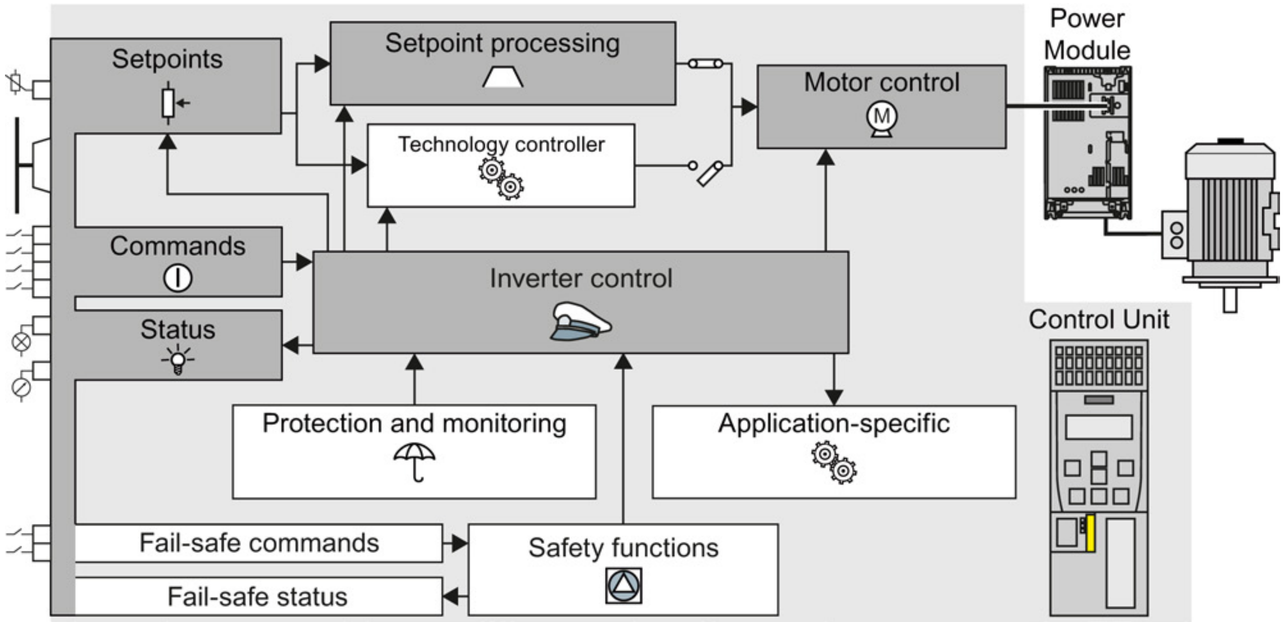
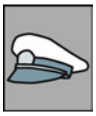
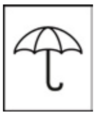
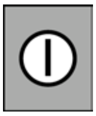
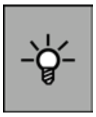
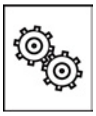
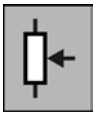
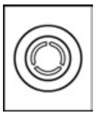
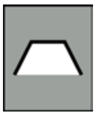
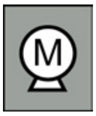


Figure 8-1 Overview of inverter functions

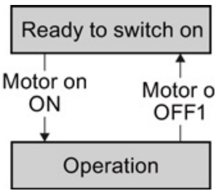
Functions relevant to all applications		Functions required in special applications only	
The functions that you require in each application are shown in a dark color in the function overview above. You set these functions during the basic commissioning, so that in many cases, the motor can be operated without having to make any additional settings.		The functions whose parameters you only need to adapt when actually required are shown in white in the function overview above.	
	**Inverter control** is responsible for all of the other inverter functions. Among other things, it defines how the inverter responds to commands from the higher-level control system. Inverter control (Page 143)		The **protection and monitoring** functions prevent damage to the motor, inverter and driven load, e.g. by monitoring the temperature or torque. Protection and monitoring functions (Page 179)
 	The **commands** from the higher-level control are sent to the inverter via digital inputs or the fieldbus. The inverter returns its **status signals** to the outputs of the Control Unit or to the fieldbus. Adapt terminal strip (Page 101) Configuring the fieldbus (Page 115)		The **application-specific** functions control, for example, a motor holding brake – or permit a higher-level closed-loop pressure or temperature control to be implemented using the technology controller. Application-specific functions (Page 188)
	You must define a **setpoint** , which defines the motor speed, for example. Setpoints (Page 154)		The **safety functions** fulfill increased requirements regarding the functional safety of the drive. Safe Torque Off (STO) safety function (Page 225)
	The **setpoint processing** uses a ramp-function generator to prevent speed steps occurring and to limit the speed to a permissible maximum value. Setpoint calculation (Page 161)		The extended safety functions monitor the drive speed. The extended safety functions are described in the "Safety Integrated Function Manual", also refer to Section: Manuals for your inverter (Page 368).
	The **motor closed-loop control** ensures that the motor follows the speed setpoint. You can select either vector control or U/f control. Motor control (Page 170)		

8.2 Inverter control

8.2.1 Switching the motor on and off

After switching the supply voltage on, the converter normally goes into the "ready to start" state. In this state, the converter waits for the command to switch-on the motor:

- The converter switches on the motor with the ON command. The converter changes to the "Operation" state.
- The converter brakes the motor after the OFF1 command. The converter switches off the motor once standstill has been reached. The converter is again "ready to start".



Converter states and commands for switching the motor on and off

In addition to the OFF1 command, there are other commands that are used to switch off the motor:

- OFF2 - the converter immediately switches off the motor without first braking it.
- OFF3 - this command means "quick stop". After OFF3, the converter brakes the motor with the OFF3 ramp-down time. After reaching standstill, the converter switches off the motor.
  The command is frequently used for exceptional operating situations where it is necessary to brake the motor especially quickly. Collision protection is a typical application for this function.
- Disable operation – The converter switches off the motor and blocks the setpoint.
- Enable operation – The converter switches on the motor and enables the setpoint.

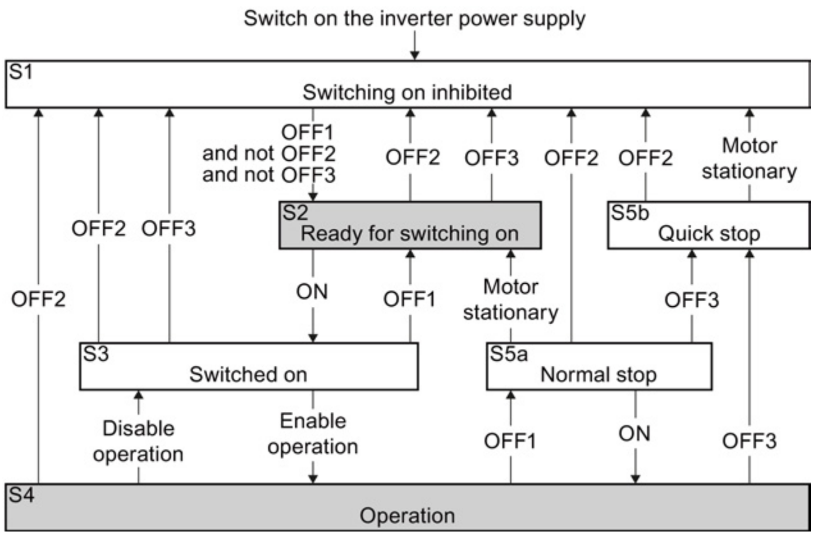


Figure 8-2 Internal sequence control of the converter when the motor is switched on and off

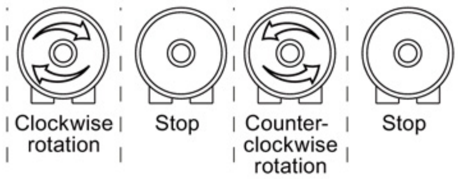
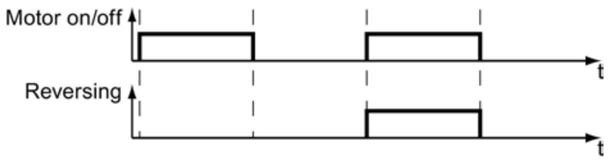
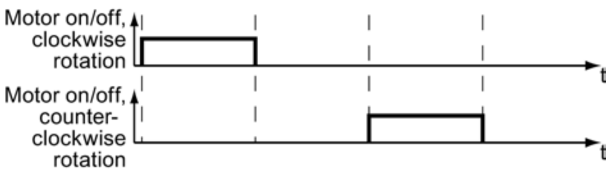
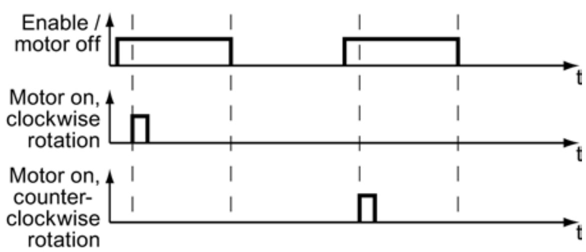
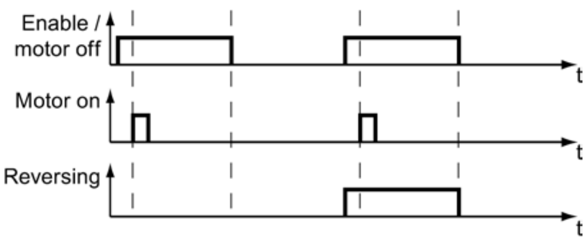
The abbreviations S1 … S5b to identify the converter states are defined in the PROFIdrive profile.

Converter status	Explanation
S1	In this state, the converter does not respond to the ON command. The converter goes into this state under the following conditions: • ON was active when switching on the converter. Exception: When the automatic start function is active, ON must be active after switching on the power supply. • OFF2 or OFF3 is selected.
S2	This state is required to switch on the motor.
S3	The converter waits for the operating enable.
S4	The motor is switched on.
S5a	The motor was switched off with OFF1 and brakes with the ramp-down time of the ramp-function generator.
S5b	The motor was switched off with OFF3 and brakes with the OFF3 ramp-down time.

8.2.2 Inverter control using digital inputs

Five different methods are available for controlling the motor via digital inputs.

Table 8- 1 Two-wire control and three-wire control

Behavior of the motor		
	**Control commands**	**Typical application**
	**Two-wire control, method 1** 1. Switching the motor on and off (ON/OFF1). 2. Reverse the motor direction of rotation.	Local control in conveyor systems.
	**Two-wire control, method 2 and two-wire control, method 3** 1. Switch the motor on and off (ON/OFF1), clockwise rotation. 2. Switch the motor on and off (ON/OFF1), counter-clockwise rotation.	Traction drives with control via joystick
	**Three-wire control, method 1** 1. Enable signal for switching the motor on and off (OFF1). 2. Switch on the motor (ON), clockwise rotation. 3. Switch on the motor (ON), counter-clockwise rotation.	Traction drives with control via joystick
	**Three-wire control, method 2** 1. Enable signal for switching the motor on and off (OFF1). 2. Switch on motor (ON). 3. Reverse the motor direction of rotation.	-

8.2.3 Two-wire control: method 1

You switch the motor on and off using a control command (ON/OFF1) while the other control command reverses the motor direction of rotation.

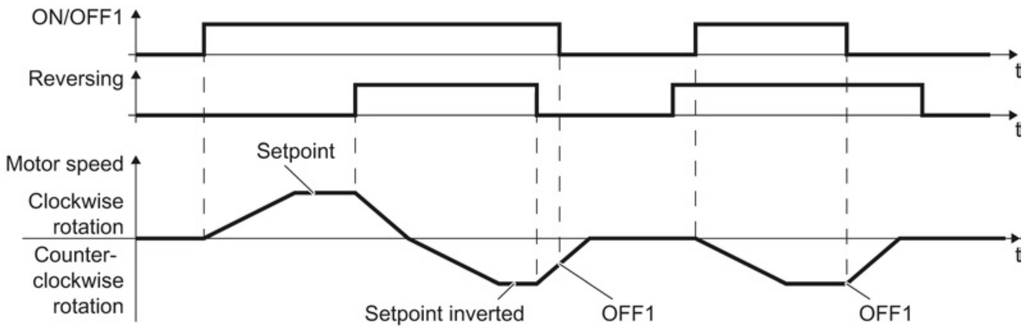


Figure 8-3 Two-wire control, method 1

Table 8- 2 Function table

ON/OFF1	Reversing	Function
0	0	OFF1: The motor stops.
0	1	OFF1: The motor stops.
1	0	ON: Clockwise motor rotation.
1	1	ON: Counter-clockwise motor rotation.

Parameter	Description		
p0015 = 12	**Macro drive unit**		
	Controlling the motor using the digital inputs of the inverter:	DI 0	DI 1
		ON/OFF1	Reversing
Advanced setting Interconnecting control commands with digital inputs of your choice.			
p0840[0 … n] = 722.x	**BI: ON/OFF1** (ON/OFF1) Example: p0840[0] = 722.3 ⇒ if CDS 0 (index[0]) is selected, the inverter receives its ON/OFF1 command via DI 3.		
p1113[0 … n] = 722.x	**BI: Setpoint inversion** (reversing)		

8.2.4 Two-wire control, method 2

You switch the motor on and off using a control command (ON/OFF1) and at the same time select clockwise motor rotation. You also use the other control command to switch the motor on and off, but in this case you select counter-clockwise rotation for the motor.

The inverter only accepts a new control command when the motor is at a standstill.

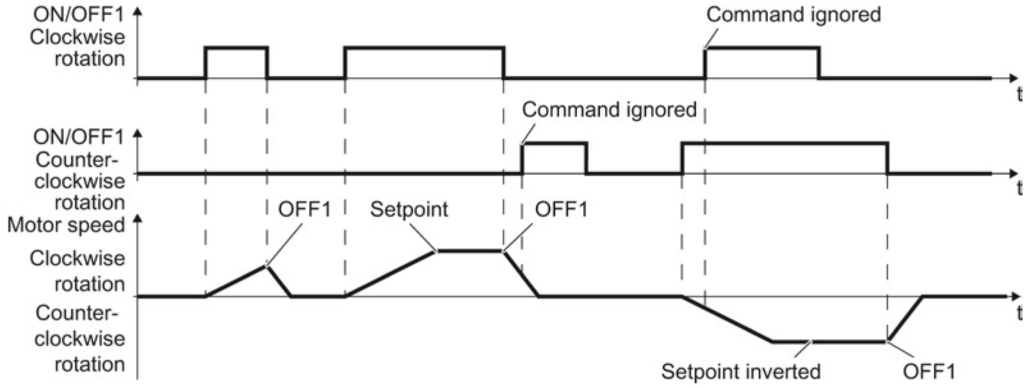


Figure 8-4 Two-wire control, method 2

Table 8- 3 Function table

ON/OFF1 clockwise rotation	ON/OFF1 counter-clockwise rotation	Function
0	0	OFF1: The motor stops.
1	0	ON: Clockwise motor rotation.
0	1	ON: Counter-clockwise motor rotation.
1	1	ON: The motor direction of rotation is based on the signal that assumes status "1" first.

<table>
<tr><th>Parameter</th><th colspan="3">Description</th></tr>
<tr><td rowspan="3">p0015 = 17</td><td colspan="3">Macro drive unit</td></tr>
<tr><td rowspan="2">Controlling the motor using the digital inputs of the inverter:</td><td>DI 0</td><td>DI 1</td></tr>
<tr><td>ON/OFF1 clockwise rotation</td><td>ON/OFF1 counter-clockwise rotation</td></tr>
<tr><td colspan="4">Advanced setting
Interconnecting control commands with digital inputs of your choice.</td></tr>
<tr><td>p3330[0 … n] = 722.x</td><td colspan="3">BI: 2/3 wire control command 1 (ON/OFF1 clockwise rotation)</td></tr>
<tr><td>p3331[0 … n] = 722.x</td><td colspan="3">BI: 2/3 wire control command 2 (ON/OFF1 counter-clockwise rotation)
Example: p3331[0] = 722.0 ⇒ if CDS 0 (index[0]) is selected, the inverter receives its ON/OFF1 counter-clockwise command via DI 0.</td></tr>
</table>

8.2.5 Two-wire control, method 3

You switch the motor on and off using a control command (ON/OFF1) and at the same time select clockwise motor rotation. You also use the other control command to switch the motor on and off, but in this case you select counter-clockwise rotation for the motor.

Unlike method 2, the inverter will accept the control commands at any time, regardless of the motor speed.

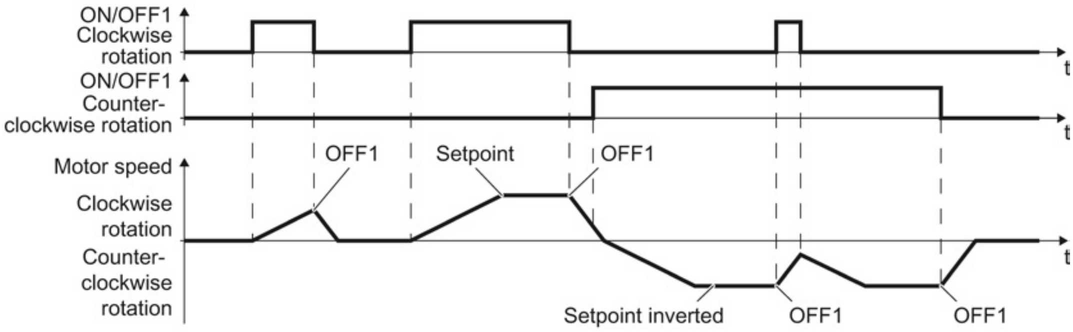


Figure 8-5 Two-wire control, method 3

Table 8- 4 Function table

ON/OFF1 clockwise rotation	ON/OFF1 counter-clockwise rotation	Function
0	0	OFF1: The motor stops.
1	0	ON: Clockwise motor rotation.
0	1	ON: Counter-clockwise motor rotation.
1	1	OFF1: The motor stops.

Parameter	Description		
p0015 = 18	**Macro drive unit**		
	Controlling the motor using the digital inputs of the inverter:	DI 0	DI 1
		ON/OFF1 clockwise rotation	ON/OFF1 counter-clockwise rotation
Advanced setting Interconnecting control commands with digital inputs of your choice.			
p3330[0 … n] = 722.x	**BI: 2/3 wire control command 1** (ON/OFF1 clockwise rotation)		
p3331[0 … n] = 722.x	**BI: 2/3 wire control command 2** (ON/OFF1 counter-clockwise rotation) Example: p3331[0] = 722.0 ⇒ if CDS 0 (index[0]) is selected, the inverter receives its ON/OFF1 counter-clockwise command via DI 0.		

8.2.6 Three-wire control, method 1

With one control command, you enable the two other control commands. You switch the motor off by withdrawing the enable (OFF1).

You switch the motor's direction of rotation to clockwise rotation with the positive edge of the second control command. If the motor is still switched off, switch it on (ON).

You switch the motor's direction of rotation to counter-clockwise rotation with the positive edge of the third control command. If the motor is still switched off, switch it on (ON).

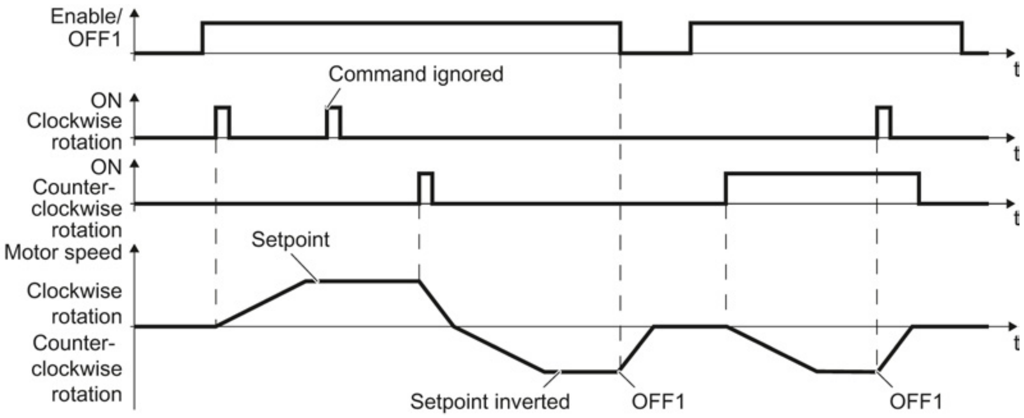


Figure 8-6 Three-wire control, method 1

Table 8- 5 Function table

Enable / OFF1	ON clockwise rotation	ON counter-clockwise rotation	Function
0	0 or 1	0 or 1	OFF1: The motor stops.
1	0→1	0	ON: Clockwise motor rotation.
1	0	0→1	ON: Counter-clockwise motor rotation.
1	1	1	OFF1: The motor stops.

<table>
<tr><th>Parameter</th><th colspan="4">Description</th></tr>
<tr><td rowspan="3">p0015 = 19</td><td colspan="4">Macro drive unit</td></tr>
<tr><td rowspan="2">Controlling the motor using the digital inputs of the inverter:</td><td>DI 0</td><td>DI 1</td><td>DI 2</td></tr>
<tr><td>Enable / OFF1</td><td>ON clockwise rotation</td><td>ON counter-clockwise rotation</td></tr>
<tr><td colspan="5">Advanced setting
Interconnecting control commands with digital inputs of your choice (DI x).</td></tr>
<tr><td>p3330[0 … n] = 722.x</td><td colspan="4">BI: 2/3 wire control command 1 (enable/OFF1)</td></tr>
<tr><td>p3331[0 … n] = 722.x</td><td colspan="4">BI: 2/3 wire control command 2 (ON clockwise rotation)</td></tr>
<tr><td>p3332[0 … n] = 722.x</td><td colspan="4">BI: 2/3 wire control command 3 (ON counter-clockwise rotation)
Example: p3332[0] = 722.0 ⇒ if CDS 0 (index[0]) is selected, the inverter receives its ON counter-clockwise command via DI 0.</td></tr>
</table>

8.2.7 Three-wire control, method 2

With one control command, you enable the two other control commands. You switch the motor off by withdrawing the enable (OFF1).

You switch on the motor with the positive edge of the second control command (ON).

The third control command defines the motor's direction of rotation (reversing).

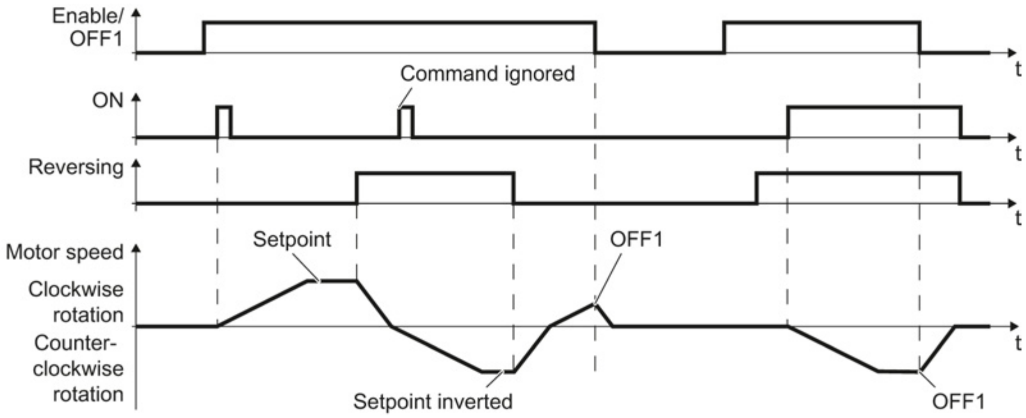


Figure 8-7 Three-wire control, method 2

Table 8- 6 Function table

Enable / OFF1	ON	Reversing	Function
0	0 or 1	0 or 1	OFF1: The motor stops.
1	0→1	0	ON: Clockwise motor rotation.
1	0→1	1	ON: Counter-clockwise motor rotation.

<table>
<tr><th>Parameter</th><th colspan="4">Description</th></tr>
<tr><td rowspan="3">p0015 = 20</td><td colspan="4">Macro drive unit</td></tr>
<tr><td rowspan="2">Controlling the motor using the digital inputs of the inverter:</td><td>DI 0</td><td>DI 1</td><td>DI 2</td></tr>
<tr><td>Enable / OFF1</td><td>ON</td><td>Reversing</td></tr>
<tr><td colspan="5">Advanced setting
Interconnecting control commands with digital inputs of your choice (DI x).</td></tr>
<tr><td>p3330[0 … n] = 722.x</td><td colspan="4">BI: 2/3 wire control command 1 (enable/OFF1)</td></tr>
<tr><td>p3331[0 … n] = 722.x</td><td colspan="4">BI: 2/3 wire control command 2 (ON)
Example: p3331[0] = 722.0 ⇒ if CDS 0 (index[0]) is selected, the inverter receives its ON command via DI 0.</td></tr>
<tr><td>p3332[0 … n] = 722.x</td><td colspan="4">BI: 2/3 wire control command 3 (reversing)</td></tr>
</table>

8.2.8 Running the motor in jog mode (JOG function)

The "Jog" function is typically used to slowly move a machine part, e.g. a conveyor belt.

With the "Jog" function, you switch the motor on and off using a digital input. When the motor is switched on, it accelerates to the jogging setpoint. There are two different setpoints available, e.g. for motor counter-clockwise rotation and clockwise rotation.

The same ramp-function generator acts on the setpoint as for the ON/OFF1 command.

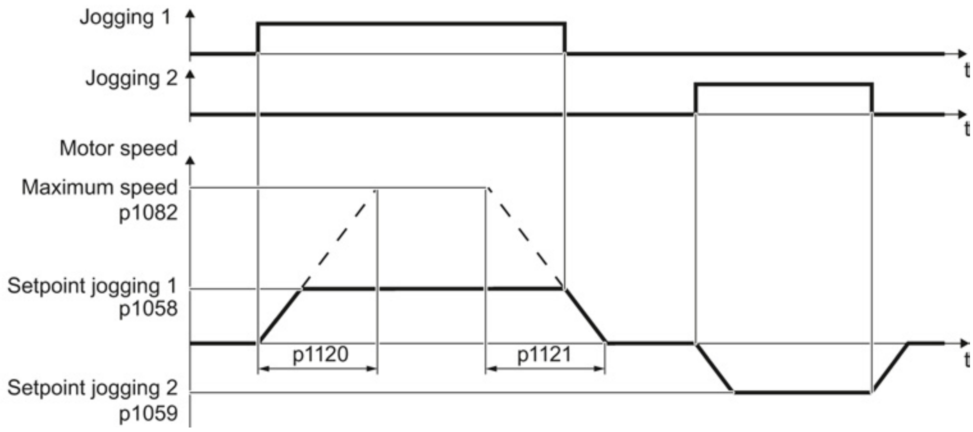
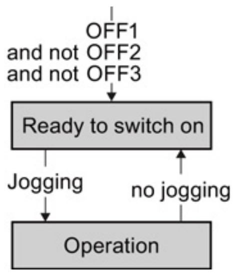


Figure 8-8 Behavior of the motor when "jogging"

The inverter must be ready to start before you issue the "Jog" control command. If the motor is already switched on, then the "Jog" command has no effect.



Jog settings

Parameter	Description	
p1058	**Jogging 1 speed setpoint** (factory setting 150 rpm)	
p1059	**Jogging 2 speed setpoint** (factory setting -150 rpm)	
p1082	**Maximum speed** (factory setting 1500 rpm)	
p1110	**Inhibit negative direction**	
	=0: Negative direction of rotation is enabled	=1: Negative direction of rotation is inhibited
p1111	**Inhibit positive direction**	
	=0: Positive direction of rotation is enabled	=1: Positive direction of rotation is inhibited
p1113	**Setpoint inversion**	
	=0: Setpoint is not inverted	=1: Setpoint is inverted
p1120	**Ramp-function generator ramp-up time** (factory setting 10 s)	
p1121	**Ramp-function generator ramp-down time** (factory setting 10 s)	
p1055 = 722.0	**Jog bit 0:** Select jogging 1 via digital input 0	
p1056 = 722.1	**Jog bit 1:** Select jogging 2 via digital input 1	

8.2.9 Switching over the inverter control (command data set)

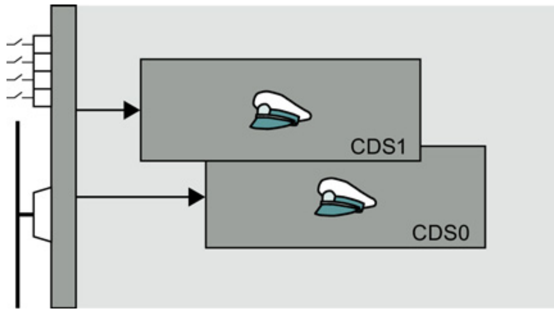
In several applications, the inverter must be able to be operated from different, higher-level control systems.

Example: You control the motor either from a central control system, via fieldbus or from a local control panel.

Command data set (CDS)

This means that you can set the inverter control in various ways and toggle between the settings. For instance, as described above, the inverter can either be operated via a fieldbus or via the terminal strip.

The settings in the inverter, which are associated with a certain control type of the inverter, are called command data set.



You select the command data set using parameter p0810. To do this, you must interconnect parameter p0810 with a control command of your choice, e.g. a digital input.

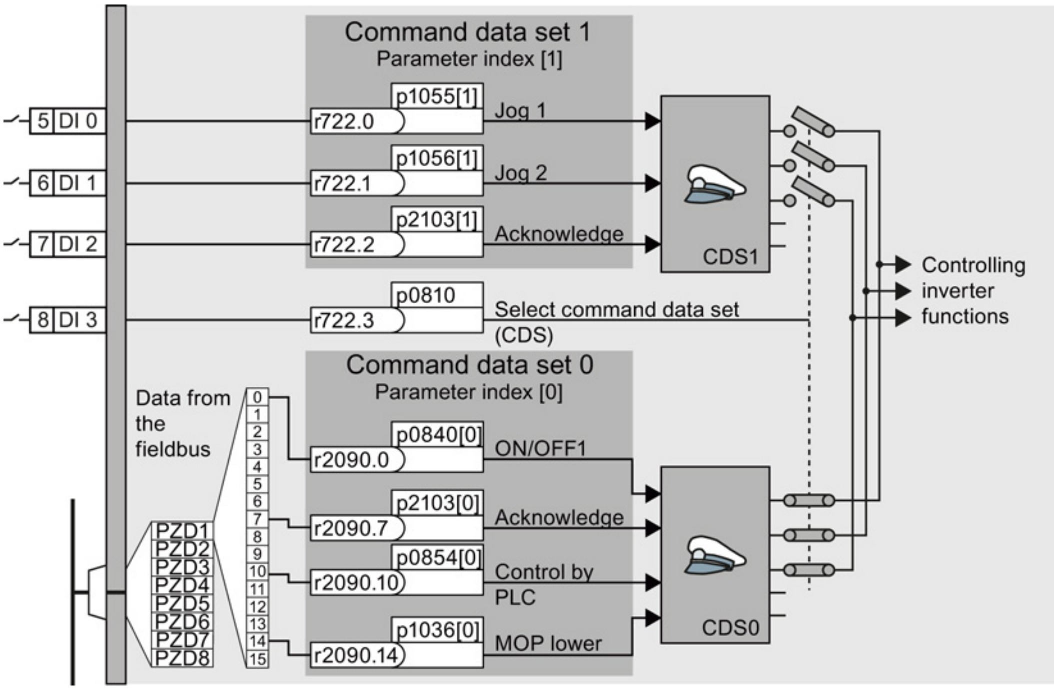


Figure 8-9 Example: Switching over the control via terminal strip to control via PROFIBUS or PROFINET

An overview of all the parameters that belong to the command data sets is provided in the List Manual.

Note

It takes approximately 4 ms to toggle between command data sets.

Advanced settings

To change the number of command data sets in STARTER, you must open your STARTER project offline.

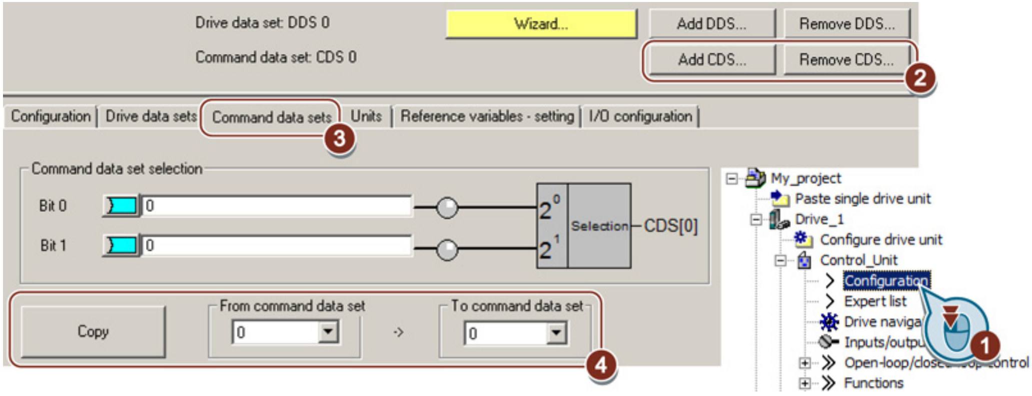


Figure 8-10 Editing command data sets in STARTER

① You can edit command data sets if, in the STARTER project tree, you select "Configuration".

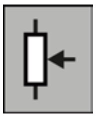
② If you require more than two command data sets, then add command data sets using this button or remove them.

③, ④ To simplify commissioning several command data sets, under the "Command data sets" tab there is a copy function.

Parameter	Description
p0010 = 15	**Drive commissioning:** Data sets
p0170	**Number of command data sets** (factory setting: 2) p0170 = 2, 3 or 4
p0010 = 0	**Drive commissioning:** Ready
r0050	**Displaying the number of the CDS that is currently active**
p0809[0]	**Number of the command data set to be copied (source)**
p0809[1]	**Number of the command data set to which the data is to be copied (target)**
p0809[2] = 1	**Copying is started** Once copying has been completed, the inverter sets p0809[2] to 0.
p0810	**Command data set selection CDS bit 0**
p0811	**Command data set selection CDS bit 1**
r0050	**Displaying the number of the CDS that is currently active**

8.3 Setpoints

8.3.1 Overview



The inverter receives its main setpoint from the setpoint source. The main setpoint generally specifies the motor speed.

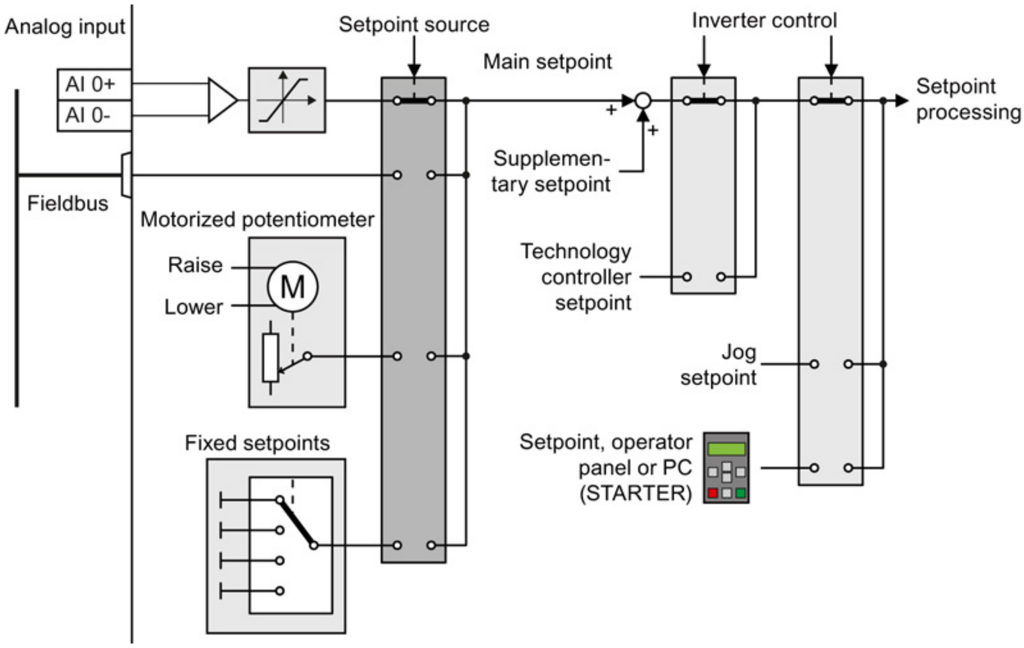


Figure 8-11 Setpoint sources for the inverter

You have the following options when selecting the source of the main setpoint:

- Inverter analog input.
- Inverter fieldbus interface.
- Motorized potentiometer simulated in the inverter.
- Fixed setpoints saved in the inverter.

You have the same selection options when selecting the source of the supplementary setpoint.

Under the following conditions, the inverter switches from the main setpoint to other setpoints:

- When the technology controller is active and appropriately interconnected, its output specifies the motor speed.
- When jogging is active.
- When controlling from an operator panel or the STARTER PC tool.

8.3.2 Analog input as setpoint source

Interconnecting an analog input

If you have selected a pre-assignment without a function of the analog input, then you must interconnect the parameter of the main setpoint with an analog input.

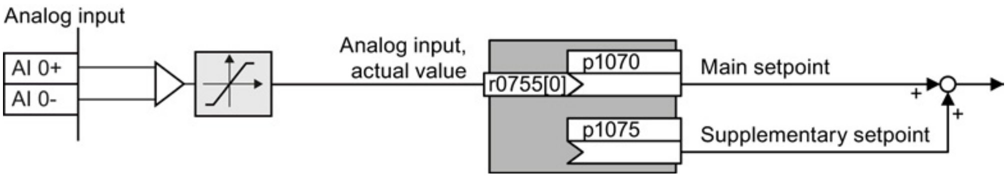


Figure 8-12 Example: Analog input 0 as setpoint source

Table 8- 7 Setting with analog input 0 as setpoint source

Parameter	Remark
p1070 = 755[0]	**Main setpoint** Interconnect the main setpoint with analog input 0
p1075 = 755[0]	**Additional setpoint** Interconnect the additional setpoint with analog input 0

You must adapt the analog input to the connected signal, e.g. ± 10 V or 4 … 20 mA. You will find additional information in the section: Analog inputs (Page 107).

8.3.3 Specifying the setpoint via the fieldbus

Interconnecting the fieldbus with the main setpoint

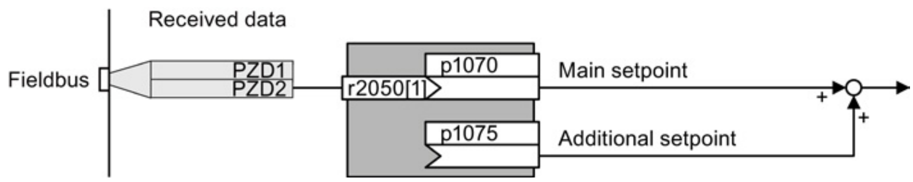


Figure 8-13 Fieldbus as setpoint source

Most standard telegrams receive the speed setpoint as a second process data PZD2.

Table 8- 8 Setting the fieldbus as setpoint source

Parameter	Remark
p1070 = 2050[1]	**Main setpoint** Interconnect the main setpoint with process data PZD2 from the fieldbus.
p1075 = 2050[1]	**Additional setpoint** Interconnect the additional setpoint with process data PZD2 from the fieldbus.

8.3.4 Motorized potentiometer as setpoint source

The "Motorized potentiometer" function emulates an electromechanical potentiometer. The output value of the motorized potentiometer can be continually set using the "up" and "down" control signals.

Interconnecting the motorized potentiometer (MOP) with the setpoint source

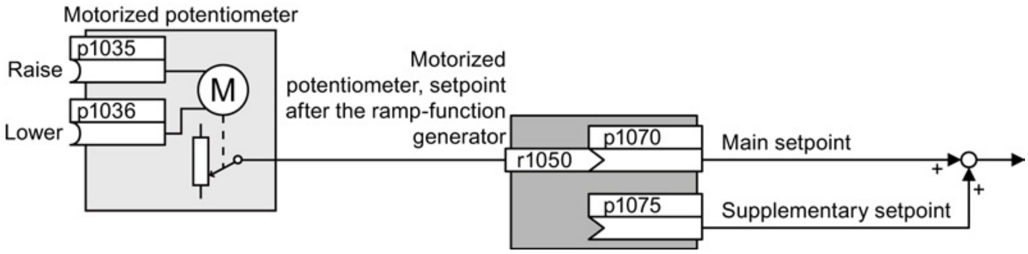


Figure 8-14 Motorized potentiometer as setpoint source

Table 8- 9 Basic setup of motorized potentiometer

Parameter	Description
p1047	**MOP ramp-up time** (factory setting: 10 s)
p1048	**MOP ramp-down time** (factory setting: 10 s)
p1040	**MOP start value** (factory setting: 0 rpm) Defines the start value [rpm], which is effective when switching on the motor.

Table 8- 10 Setting the MOP as setpoint source

Parameter	Remark	
p1070 = 1050	**Main setpoint** Interconnecting the main setpoint with MOP.	
p1035	**Motorized potentiometer, setpoint higher**	Interconnect these commands with signals of your choice.
p1036	**Motorized potentiometer, setpoint lower**	

Adapting the behavior of the motorized potentiometer

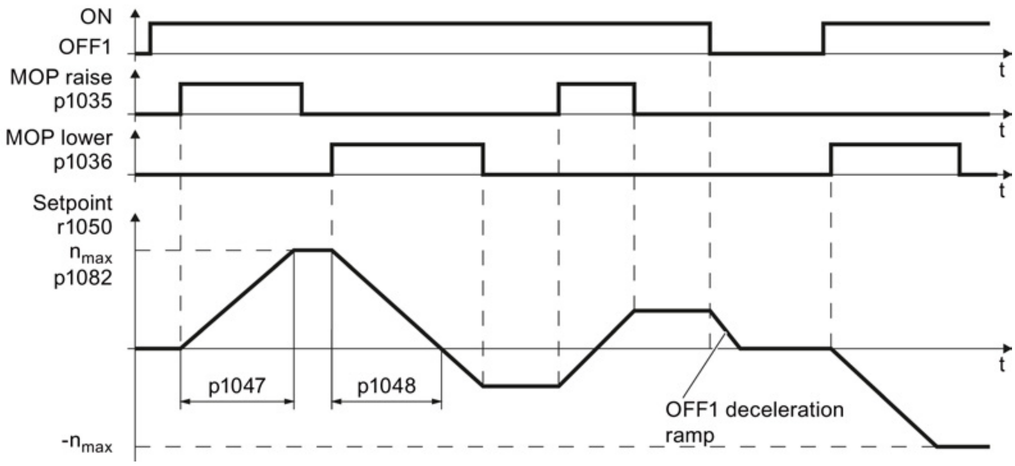


Figure 8-15 Function chart of motorized potentiometer

Table 8- 11 Extended setup of motorized potentiometer

Parameter	Description
p1030	**MOP configuration** (factory setting: 00110 bin) **Parameter value with five independently adjustable bits 00 … 04** **Bit 00:** Save setpoint after switching off motor 0: After the motor is switched on, p1040 is specified as the setpoint 1: Setpoint is saved after the motor is switched off and set to the saved value once it is switched on **Bit 01:** Configure ramp-function generator in automatic mode (1-signal via BI: p1041) 0: Without ramp-function generator in the automatic mode (ramp-up/ramp-down time = 0) 1: With ramp-function generator in the automatic mode In manual mode (0-signal via BI: p1041) the ramp-function generator is always active **Bit 02:** Configure initial rounding 0: Without initial rounding 1: With initial rounding. Using the initial rounding function it is possible to enter very small setpoint changes **Bit 03:** Store setpoint in power-independent manner 0: No power-independent saving 1: Setpoint is saved in the event of a power failure (bit 00 = 1) **Bit 04:** Ramp-function generator always active 0: Setpoint is only calculated with enabled pulses 1: The setpoint is calculated independent of the pulse enable.
p1037	**MOP maximum speed** (factory setting: 0 rpm) Automatically pre-assigned when commissioning
p1038	**MOP minimum speed** (factory setting: 0 rpm) Automatically pre-assigned when commissioning
p1043	**Motorized potentiometer, accept setting value** (factory setting: 0) Signal source for accepting the setting value. The motorized potentiometer accepts the setting value p1044 on signal change p1043 = 0 → 1.
p1044	**MOP setting value** (factory setting: 0) Signal source for the setting value.

For more information about the motorized potentiometer, refer to function diagram 3020 in the List Manual.

8.3.5 Fixed speed as setpoint source

In many applications after switching on the motor, all that is needed is to run the motor at a constant speed or to switch between different speeds.

Example: After it has been switched on, a conveyor belt only runs with two different velocities.

Interconnecting the fixed speeds with a main setpoint

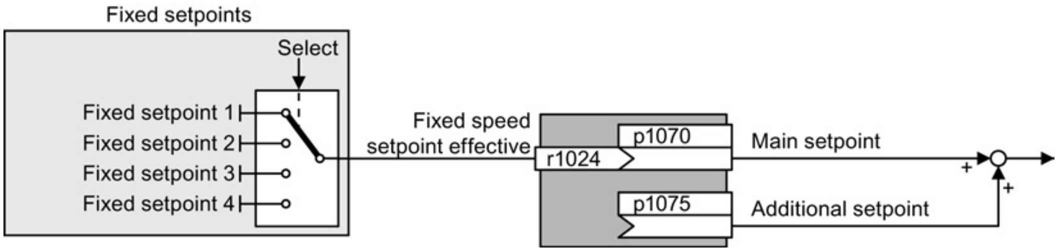


Figure 8-16 Fixed speeds as setpoint source

Table 8- 12 Setting the fixed speed as a setpoint source

Parameter	Remark
p1070 = 1024	**Main setpoint** Interconnecting the main setpoint with fixed speeds.
p1075 = 1024	**Additional setpoint** Interconnecting the additional setpoint with fixed speeds

Select direct or binary fixed setpoint

The converter distinguishes between two methods for selecting the fixed setpoints:

1. Direct selection:

   You set 4 different fixed setpoints. By adding one or more of the four fixed setpoints, up to 16 different resulting setpoints are obtained.

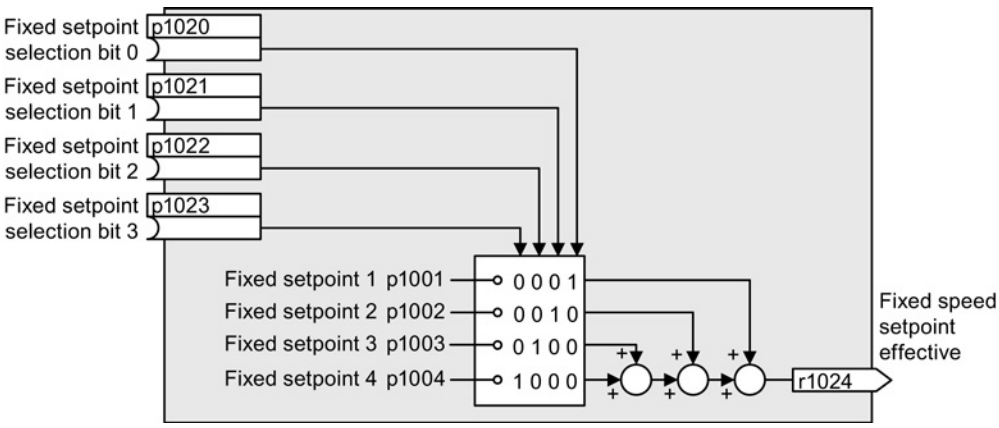


Figure 8-17 Simplified function diagram for directly selecting fixed setpoints

Additional information about direct selection can be found in function diagram 3011 in the List Manual.

2. Binary selection:

   You set 16 different fixed setpoints. You precisely select one of these 16 fixed setpoints by a combination of four selection bits.

   Additional information about binary selection can be found in function diagram 3010 in the List Manual.

Parameter for setting the fixed setpoints

Parameter	Description	
p1001	**Fixed speed setpoint 1** (factory setting: 0 rpm)	
p1002	**Fixed speed setpoint 2** (factory setting: 0 rpm)	
...	...	
p1015	**Fixed speed setpoint 15** (factory setting: 0 rpm)	
p1016	**Fixed speed setpoint mode** (factory setting: 1)	
	1:	Direct
	2:	Binary
p1020	**Fixed speed setpoint selection bit 0** (factory setting: 0)	
p1021	**Fixed speed setpoint selection bit 1** (factory setting: 0)	
p1022	**Fixed speed setpoint selection bit 2** (factory setting: 0)	
p1023	**Fixed speed setpoint selection bit 3** (factory setting: 0)	
r1024	**Fixed speed setpoint effective**	
r1025.0	**Fixed speed setpoint status**	
	1 signal	Fixed speed setpoint is selected

Example: Select two fixed setpoints directly

The motor should operate at different speeds as follows:

- The signal on digital input 0 switches the motor on and accelerates it to 300 rpm.
- The signal at digital input 1 accelerates the motor to 2000 rpm.
- The signals at the two digital inputs accelerate the motor to 2300 rpm.

Table 8- 13 Settings for the example

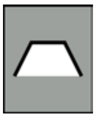
Parameter	Description
p1001 = 300.000	**Fixed speed setpoint 1** [rpm]
p1002 = 2000.000	**Fixed speed setpoint 2** [rpm]
p0840 = 722.0	**ON/OFF1:** Switch on motor with digital input 0
p1070 = 1024	**Main setpoint:** Interconnect the main setpoint with the fixed speed setpoint.
p1020 = 722.0	**Speed fixed setpoint selection Bit 0:** Interconnect fixed setpoint 1 with digital input 0 (DI 0).
p1021 = 722.1	**Fixed speed setpoint selection bit 1:** Interconnects fixed setpoint 2 with digital input 1 (DI 1).
p1016 = 1	**Fixed speed setpoint mode:** Select direct selection of the fixed setpoints.

Table 8- 14 Resulting fixed setpoints for the example above

Fixed setpoint selected by	Resulting setpoint
DI 0 = 0	Motor stops
DI 0 = 1 and DI 1 = 0	300 rpm
DI 0 = 1 and DI 1 = 1	2300 rpm

8.4 Setpoint calculation

8.4.1 Overview of setpoint processing



The setpoint can be modified as follows using the setpoint processing:

- Invert setpoint to reverse the motor direction of rotation (reversing).
- Inhibit positive or negative direction of rotation, e.g. for conveyor belts, pumps or fans.
- Skip frequency bands to prevent mechanical resonance effects.

  The skip frequency band at speed = 0 results in a minimum speed after switching on the motor.
- Limit to a maximum speed to protect the motor and mechanical system.
- Ramp-function generator to accelerate and brake the motor with an optimum torque.

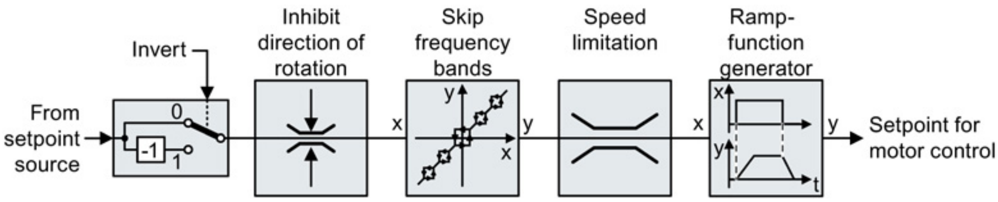
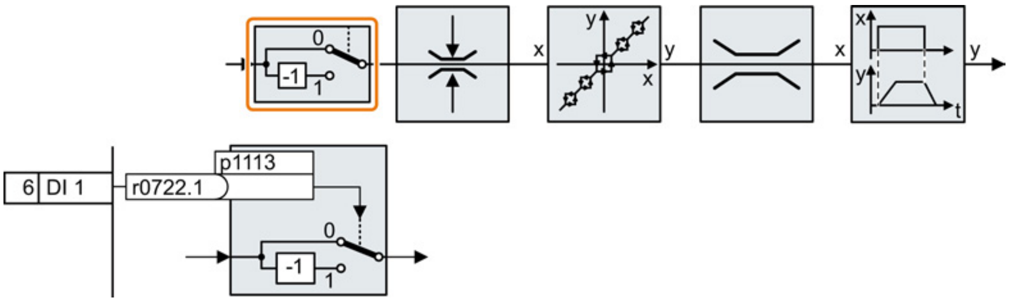


Figure 8-18 Setpoint processing in the converter

8.4.2 Invert setpoint

The inverter provides an option to invert the setpoint sign using a bit. As an example, the setpoint inversion is shown through a digital input.



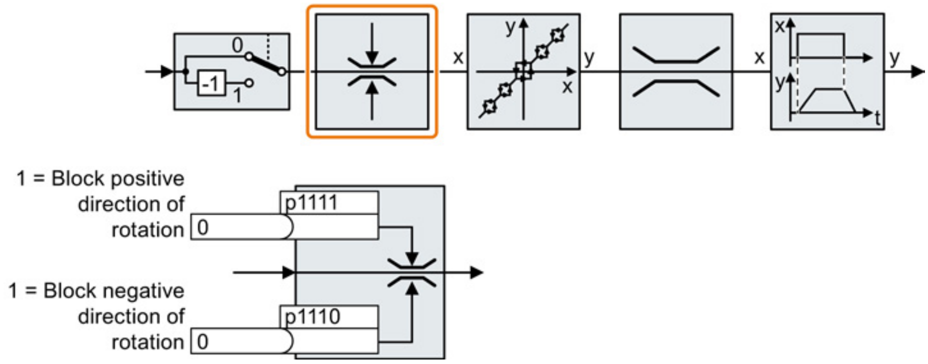
In order to invert the setpoint through the digital input DI 1, connect the parameter p1113 with a binary signal, e.g. the digital input 1.

Table 8- 15 Examples of settings to invert the setpoint

Parameter	Remark
p1113 = 722.1	**Setpoint inversion** Digital input 1 = 0: Setpoint remains unchanged. Digital input 1 = 1: Inverter inverts the setpoint.
p1113 = 2090.11	Invert setpoint via control word 1, bit 11.

8.4.3 Inhibit direction of rotation

In the factory setting of the inverter, both motor directions of rotation are enabled.



Set the corresponding parameter to a value = 1 to permanently block directions of rotation.

Table 8- 16 Examples of settings to inhibit the direction of rotation

Parameter	Remark
p1110 = 1	**Inhibit negative direction** Negative direction is permanently inhibited.
p1110 = 722.3	**Inhibit negative direction** Digital input 3 = 0: Negative direction of rotation is enabled. Digital input 3 = 1: Negative direction of rotation is inhibited.

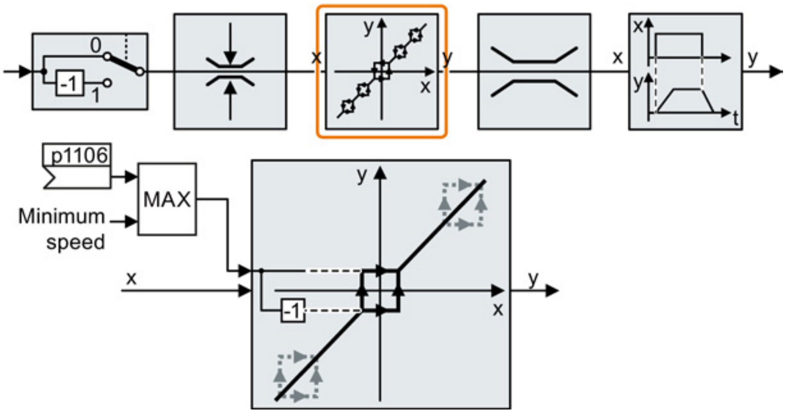
8.4.4 Skip frequency bands and minimum speed

Skip frequency bands

The converter has four skip frequency bands that prevent continuous motor operation within a specific speed range. You can find additional information in function diagram 3050 of the List Manual, see also: Manuals and technical support (Page 368).

Minimum speed

The converter prevents continuous motor operation at speeds < minimum speed.



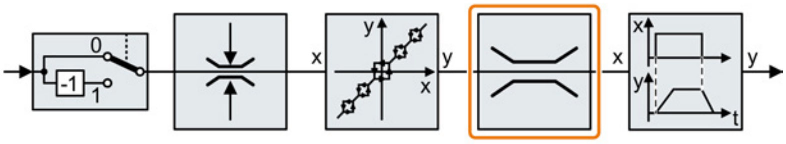
Speeds where the absolute value is less than the minimum speed are only possible during motor operation when accelerating or braking.

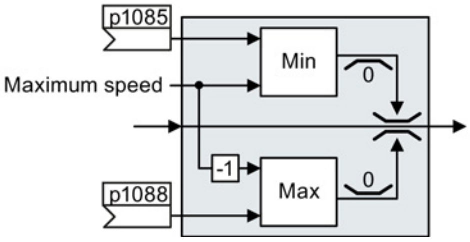
Table 8- 17 Setting the minimum speed

Parameter	Description
p1080	**Minimum speed** (factory setting: 0 rpm)
p1106	CI: Minimum speed signal source (factory setting: 0) Dynamic specification of the minimum speed

8.4.5 Speed limitation

The maximum speed limits the speed setpoint range for both directions of rotation.





The converter generates a message (fault or alarm) when the maximum speed is exceeded.

If you must limit the speed depending on the direction of rotation, then you can define speed limits for each direction.

Table 8- 18 Parameters for the speed limitation

Parameter	Description
p1082	**Maximum speed** (factory setting: 1500 rpm)
p1083	**Speed limit, positive direction of rotation** (factory setting: 210,000 rpm)
p1085	**CI: Speed limit, positive direction of rotation** (factory setting: 1083)
p1086	**Speed limit, negative direction of rotation** (factory setting: -210,000 rpm)
p1088	**CI: Speed limit, negative direction of rotation** (factory setting: 1086)

8.4.6 Ramp-function generator

The ramp-function generator in the setpoint channel limits the rate that the speed setpoint changes. As a consequence the motor accelerates and brakes more softly, reducing the stress on the mechanical system of the driven machine.

You can select between two different ramp-function generator types:

- Extended ramp-function generator

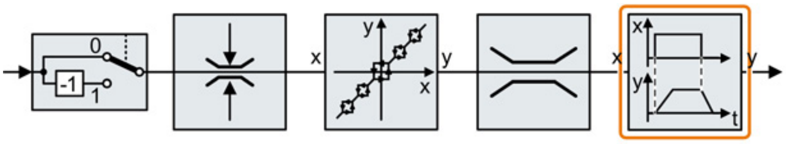
  The extended ramp-function generator limits acceleration and jerk. The motor accelerates especially gently. The extended ramp-function generator can also solve problems in machines with high breakaway torques.

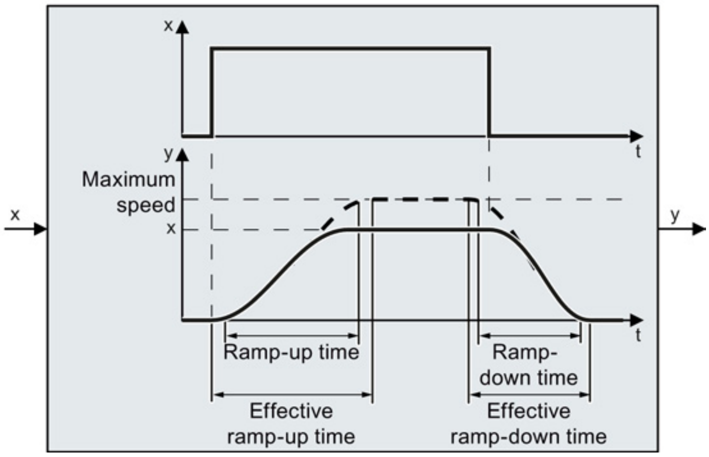
- Basic ramp-function generator

  The basic ramp-function generator limits the acceleration, however not the rate the acceleration changes (jerk).

Extended ramp-function generator

The ramp-up and ramp-down times of the extended ramp-function generator can be set independently of each other. The optimum times that you select depend on your particular application in question and can range from just a few 100 ms (e.g. for belt conveyor drives) to several minutes (e.g. for centrifuges).



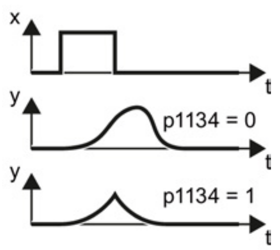


Initial and final rounding permit smooth, jerk-free acceleration and braking.

The ramp-up and ramp-down times of the motor are increased by the rounding times:

- Effective ramp-up time = p1120 + 0.5 × (p1130 + p1131).
- Effective ramp-down time = p1121 + 0.5 × (p1130 + p1131).

Table 8- 19 Additional parameters to set the extended ramp-function generator

Parameter	Description
p1115	**Ramp-function generator selection** (factory setting: 1) Select ramp-function generator: 0: Basic ramp-function generator 1: Extended ramp-function generator
p1120	**Ramp-function generator, ramp-up time** (factory setting: 10 s) Accelerating time in seconds from zero speed up to the maximum speed p1082
p1121	**Ramp-function generator, ramp-down time** (factory setting: 10 s) Braking time in seconds from the maximum speed down to standstill
p1130	**Ramp-function generator initial rounding time** (factory setting: 0 s) Initial rounding for the extended ramp-function generator. The value applies for ramp up and ramp down.
p1131	**Ramp-function generator final rounding time** (factory setting: 0 s) Final rounding for the extended ramp-function generator. The value applies for ramp up and ramp down.
p1134	**Ramp-function rounding type** (factory setting: 0) 0: Continuous smoothing 1: Discontinuous smoothing 
p1135	**OFF3 ramp-down time** (factory setting 0 s) The quick stop (OFF3) has its own ramp-down time.
p1136	**OFF3 initial rounding time** (factory setting: 0 s) Initial rounding for OFF3 for the extended ramp-function generator.
p1137	**OFF3 final rounding time** (factory setting: 0 s) Final rounding for OFF3 for the extended ramp-function generator.

You can find more information in function diagram 3070 and in the parameter list of the List Manual.

Setting the extended ramp-function generator

Procedure

Proceed as follows to set the extended ramp-function generator:

1. Enter the highest possible speed setpoint.
2. Switch on the motor.
3. Evaluate your drive response.
   – If the motor accelerates too slowly, then reduce the ramp-up time.

     An excessively short ramp-up time means that the motor will reach its current limiting when accelerating, and will temporarily not be able to follow the speed setpoint. In this case, the drive exceeds the set time.
   – If the motor accelerates too fast, then extend the ramp-up time.
   – Increase the initial rounding if the acceleration is jerky.
   – We recommend that you set the final rounding to the same value as the initial rounding.
4. Switch off the motor.
5. Evaluate your drive response.
   – If the motor decelerates too slowly, then reduce the ramp-down time.

     The minimum ramp-down time that makes sense depends on your particular application. Depending on the Power Module used, for an excessively short ramp-down time, the converter either reaches the motor current, or the DC link voltage in the converter becomes too high. Depending on the converter setting, the real braking time exceeds the set ramp-down time, or the converter goes into a fault condition when braking.
   – Extend the ramp-down time if the motor is braked too quickly or the converter goes into a fault condition when braking.
6. Repeat steps 1 … 5 until the drive behavior meets the requirements of the machine or plant.

You have set the extended ramp-function generator.

Basic ramp-function generator

When compared to the extended ramp-function generator, the basic ramp-function generator has no rounding times.

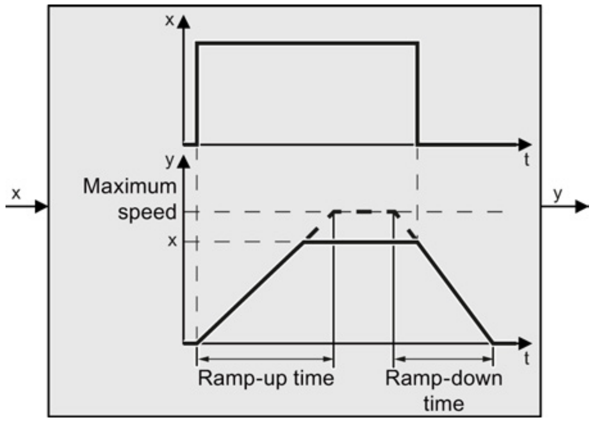


Table 8- 20 Parameters for setting the ramp-function generator

Parameter	Description
p1115 = 0	**Ramp-function generator selection** (factory setting: 1) Select ramp-function generator: 0: Basic ramp-function generator 1: Extended ramp-function generator
p1120	**Ramp-function generator, ramp-up time** (factory setting: 10 s) Accelerating time in seconds from zero speed up to the maximum speed p1082
p1121	**Ramp-function generator, ramp-down time** (factory setting: 10 s) Braking time in seconds from the maximum speed down to standstill
p1135	**OFF3 ramp-down time** (factory setting: 0 s) The quick stop (OFF3) has its own ramp-down time.

Changing the ramp-up and ramp-down times in operation

The ramping up and down time of the ramp-function generator can be changed during operation. The scaling value can come e.g. from the field bus.

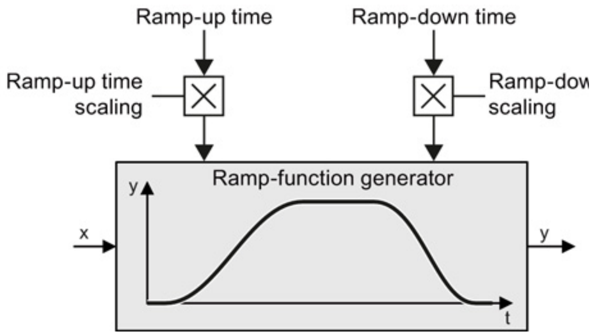


Table 8- 21 Parameters for setting the scaling

Parameter	Description
p1138	**Up ramp scaling** (factory setting: 1) Signal source for scaling the up ramp.
p1139	**Down ramp scaling** (factory setting: 1) Signal source for scaling the down ramp.

Example

In the following example, the higher-level control sets the ramp-up and ramp-down times of the inverter via PROFIBUS.

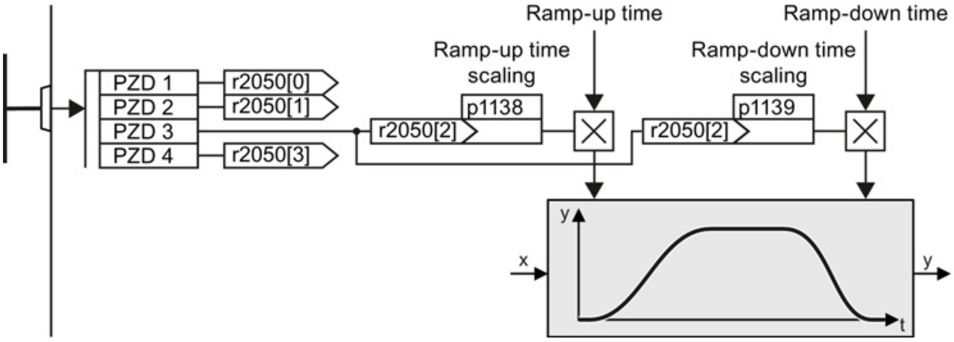


Figure 8-19 Example for changing the ramp-function generator times in operation

Preconditions

- You have commissioned the communication between the inverter and the control system.
- Free telegram 999 has been set in the inverter and in your higher-level control system. See also Section: Extend telegrams and change signal interconnection (Page 133).
- The controller sends the scaling value to the inverter in PZD 3.

Procedure

To interconnect the scaling of the ramp-up and ramp-down times with PZD receive word 3 from the fieldbus in the inverter, proceed as follows:

1. Set p1138 = 2050[2].

   This means that you have interconnected the scaling factor for the ramp-up time with PZD receive word 3.
2. Set p1139 = 2050[2].

   This means that you have interconnected the scaling factor for the ramp-down time with PZD receive word 3.

The inverter receives the value for scaling the ramp-up and ramp-down times via PZD receive word 3.

8.5 Motor control

Decision-making criteria for the control mode that is suitable for your application is provided in Section Selecting the control mode (Page 86)

8.5.1 V/f control

U/f control sets the voltage at the motor terminals on the basis of the specified speed setpoint.

The relationship between the speed setpoint and stator voltage is calculated using characteristic curves. The required output frequency is calculated on the basis of the speed setpoint and the number of pole pairs of the motor (f = n * number of pole pairs / 60, in particular: f_{max} = p1082 * number of pole pairs / 60).

The inverter provides the two most important characteristics (linear and square-law). User-defined characteristic curves are also supported.

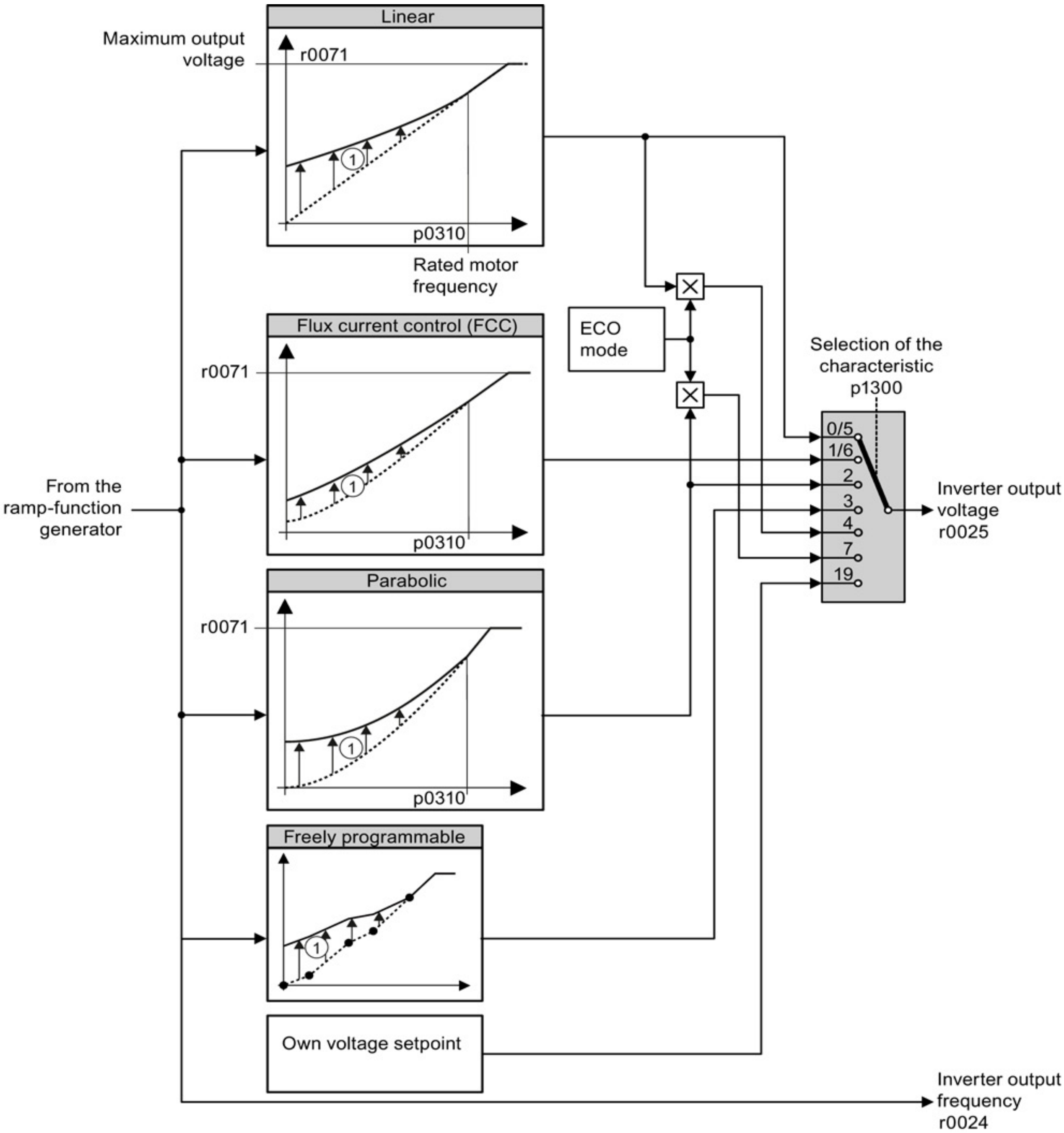
U/f control is not a high-precision method of controling the speed of the motor. The speed setpoint and the speed of the motor shaft are always slightly different. The deviation depends on the motor load.

If the connected motor is loaded with the rated torque, the motor speed is below the speed setpoint by the amount of the rated motor slip. If the load is driving the motor (i.e. the motor is operating as a generator), the motor speed is above the speed setpoint.

Parameter p1300 sets the characteristic curve.

8.5.1.1 Characteristics of U/f control

The converter has several U/f characteristics. Based on the characteristic, as the frequency increases, the converter increases the voltage at the motor.



① The voltage boost of the characteristic improves motor behavior at low speeds. The voltage boost is effective for frequencies < rated frequency

Figure 8-20 U/f characteristics of the converter

The converter increases its output voltage – also above the motor rated speed up to the maximum output voltage. The higher the line voltage, the greater the maximum converter output voltage.

If the converter has reached its maximum output voltage, then it can only increase its output frequency. From this point onwards, the motor is operated in field weakening; this means that the available torque linearly decreases with increasing speed.

The value of the output voltage at the rated motor frequency also depends on the following variables:

- Ratio between the converter size and the motor size
- Line voltage
- Line impedance
- Actual motor torque

The maximum possible output voltage as a function of the input voltage is provided in the technical data, also see Section Technical data (Page 303).

8.5.1.2 Selecting the U/f characteristic

Table 8- 22 Linear and parabolic characteristics

Requirement	Application examples	Remark	Characteristic	Parameter
The required torque is independent of the speed	Conveyor belts, roller conveyors, chain conveyors, eccentric worm pumps, compressors, extruders, centrifuges, agitators, mixers	-	Linear	p1300 = 0
		The inverter equalizes the voltage drops across the stator resistance. Recommended for motors less than 7.5 kW. Precondition: You have set the motor data according to the rating plate and have performed the motor identification after the basic commissioning.	Linear with Flux Current Control (FCC)	p1300 = 1
The required torque increases with the speed	Centrifugal pumps, radial fans, axial fans	Lower losses in the motor and inverter than for a linear characteristic.	Parabolic	p1300 = 2

Table 8- 23 Characteristics for special applications

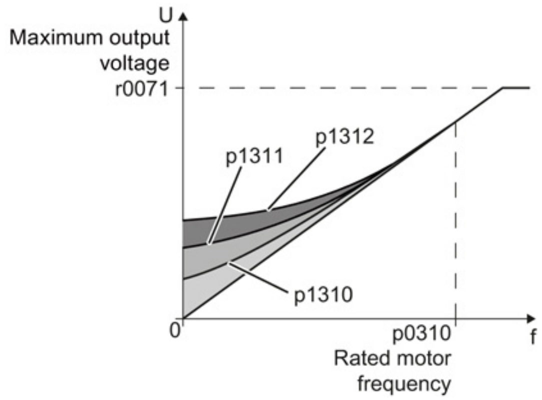
Requirement	Application examples	Remark	Characteristic	Parameter
Applications with a low dynamic response and constant speed	Centrifugal pumps, radial fans, axial fans	The ECO mode results in additional energy saving when compared to the parabolic characteristic. If the speed setpoint is reached and remains unchanged for 5 seconds, the inverter again reduces its output voltage.	ECO mode	p1300 = 4 or p1300 = 7
The inverter must keep the motor speed constant under all circumstances.	Drives in the textile sector	When the maximum current limit is reached, the inverter only reduces the stator voltage but not the speed.	Precise frequency characteristic	p1300 = 5 or p1300 = 6
Freely adjustable U/f characteristic	-	-	Adjustable characteristic	p1300 = 3
U/f characteristic with independent voltage setpoint	-	The interrelationship between the frequency and voltage is not calculated in the inverter, but is specified by the user.	Independent voltage setpoint	p1300 = 19

Additional information on U/f characteristics can be found in the parameter list and in the function diagrams 6300 ff of the List Manual.

8.5.1.3 Optimizing with a high break loose torque and brief overload

Setting the voltage boost for U/f control

The voltage boost acts on every U/f characteristic. The adjacent diagram shows the voltage boost using a linear characteristic as example.



Procedure

Proceed as follows to set the voltage boost:

Only increase the voltage boost in small steps. Excessively high values in p1310 ... p1312 can cause the motor to overheat and switch off (trip) the inverter due to overcurrent.

1. Power-up the motor with an average speed.
2. Reduce the speed to just a few revolutions per minute.
3. Check whether the motor rotates smoothly.
4. If the motor does not rotate smoothly, or even remains stationary, increase the voltage boost p1310 until you are satisfied with the motor behavior.
5. Accelerate the motor to the maximum speed with maximum load and check as to whether the motor follows the setpoint.
6. If, when accelerating, the motor stalls, increase the voltage boost p1311 until the motor accelerates to the maximum speed without any problems.

To achieve satisfactory motor behavior, you must increase the parameter p1312 only in applications with a significant breakaway torque.

You will find more information about this function in the parameter list and in function diagram 6300 of the List Manual.

You have set the voltage boost.

Parameter	Description
p1310	**Permanent voltage boost** (factory setting 50%) Compensates voltage drops as a result of long motor cables and the ohmic losses in the motor.
p1311	**Voltage boost when accelerating** (factory setting 0%) Provides additional torque when the motor accelerates.
p1312	**Voltage boost when starting** (factory setting 0%) Provides additional torque, however, only when the motor accelerates for the first time after it has been switched on ("break loose torque").

8.5.2 Vector control

8.5.2.1 Properties of the sensorless vector control

Sensorless vector control

Using a motor model, the vector control calculates the load and the motor slip. As a result of this calculation, the converter controls its output voltage and frequency so that the motor speed follows the setpoint, independent of the motor load.

Vector control is possible without directly measuring the motor speed and is therefore also called "sensorless vector control".

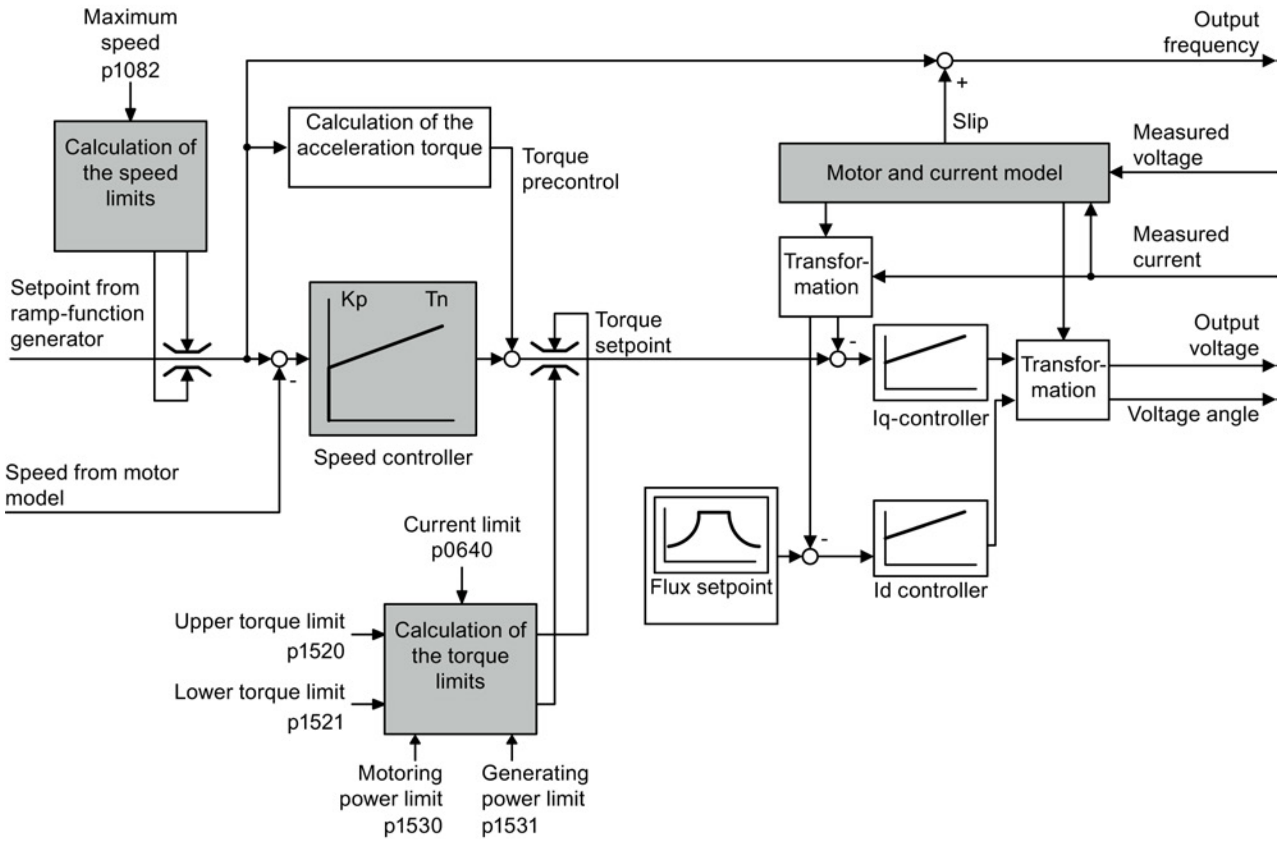


Figure 8-21 Simplified function diagram of sensorless vector control

You can find additional information on the vector control in the List Manual in function diagrams 6020 ff.

8.5.2.2 Select motor control

Vector control is already preset

To achieve a good controller response, you must adapt the elements marked in gray in the figure in the overview diagram above. If you selected vector control as control mode in the basic commissioning, you will have already set the following:

- The maximum speed for your application.
- The motor and current model: If the motor data in the inverter correspond to the motor data on the rating plate, then the motor and current model in the inverter are correct and the vector control can operate satisfactorily.
- The inverter calculates the torque limits matching the current limit that you have set for the basic commissioning.
  Regardless of it, you can also set additional positive and negative torque limits or limit the power of the motor.
- The inverter has a preset speed controller with self-optimization (rotating measurement). If you want to continue to optimize this setting, follow the instructions further down in this chapter.

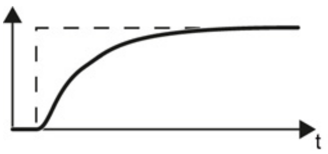
Select encoderless vector control

Set p1300 = 20.

8.5.2.3 Optimizing the closed-loop speed controller

Optimum control response - post optimization not required

You do not have to manually adapt the speed controller if, after the speed controller self optimization, the motor manifests the following acceleration response:



Optimum control response for applications that do not permit any overshoot.

The actual value approaches the setpoint without any significant overshoot.

Optimum control response for fast correction and quick compensation of noise components.

The actual value approaches the setpoint and slightly overshoots, maximum 10% of the setpoint step.

Control optimization required

In some cases, the self optimization result is not satisfactory, or the inverter cancels the self-optimization routine with a fault. Further, self optimization is not permissible in plants and systems in which the motor cannot freely rotate.

In these cases you must manually optimize the speed controller.

The examples listed below show you which variables you can use to adapt the control response.

The basic procedure is described in the following section for STARTER and the operator panel.

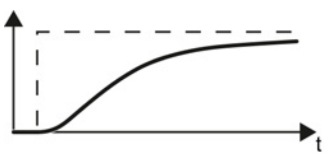
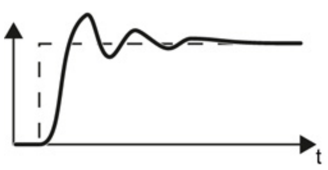
- K_P (p1470) Proportion share
- T_N (p1472) Integration time

Optimizing the speed controller

Procedure

To optimize the speed controller, proceed as follows:

1. Temporarily set the times of the ramp-function generator p1120 = 0 and p1121 = 0.
2. Temporarily set the pre-control of the speed controller p1496 = 0.
3. Enter a setpoint step and monitor the associated actual value, e.g. using the trace function in STARTER.
4. Optimize the controller by adjusting the controller parameters K_P and T_N.

	**The actual value only slowly approaches the setpoint.** • Increase the proportional component K_P and reduce the integration time T_N.
	**The actual value quickly approaches the setpoint, but overshoots too much.** • Decrease the proportional component K_P and increase the integration time T_N.

5. Set the ramp-up and ramp-down times of the ramp-function generator back to their original value.
6. Set the pre-control of the closed-loop speed controller to p1496 = 100%.

You have optimized the speed controller.

8.5.2.4 Torque control

Torque control is part of the vector control and normally receives its setpoint from the speed controller output. By deactivating the speed controller and directly entering the torque setpoint, the closed-loop speed control becomes closed-loop torque control. The inverter then no longer controls the motor speed, but the torque that the motor generates.

Typical applications for torque control

The torque control is used in applications where the motor speed is specified by the connected driven load. Examples of such applications include:

- Load distribution between master and slave drives:
  The master drive is speed controlled, the slave drive is torque controlled.
- Winding machines

Commissioning the torque control

The torque control only functions error-free if, during the basic commissioning, you correctly set the motor data and performed the motor data identification with the motor in the cold state.

See also Section: Basic commissioning (Page 90).

Table 8- 24 The most important torque control parameters

Parameter	Description
p1300	**Control mode:** 20: Vector control without speed encoder 22: Torque control without speed encoder
p0300 … p0360	**Motor data** is transferred from the rating plate during basic commissioning and calculated with the motor data identification
p1511	**Additional torque**
p1520	**Upper torque limit**
p1521	**Lower torque limit**
p1530	**Motoring power limit**
p1531	**Regenerative power limit**

Additional information about this function is provided in the parameter list and in function diagrams 6030 onwards in the List Manual.

8.6 Protection and monitoring functions

The frequency inverter offers protective functions against overtemperature and overcurrent for both the frequency inverter as well as the motor. Further, the frequency inverter protects itself against an excessively high DC link voltage when the motor is regenerating.

8.6.1 Inverter temperature monitoring

The inverter temperature is essentially defined by the following effects:

- The ambient temperature
- The ohmic losses increasing with the output current
- Switching losses increasing with the pulse frequency

Monitoring types

The inverter monitors its temperature using the following monitoring types:

- I^2t monitoring (alarm A07805, fault F30005)

  The I^2t monitoring calculates the inverter utilization on the basis of a current reference value predefined by the factory.

  – Actual current > reference value: The actual value of the utilization increases.

  – Actual current < reference value: The actual value of the utilization decreases or remains = 0.
- Measuring the chip temperature of the Power Module (alarm A05006, fault F30024)
- Measuring the heat sink temperature of the Power Module (alarm A05000, fault F30004)

Inverter response to thermal overload

Parameter	Description
r0036	**Power unit overload I^2t** [%]
r0037	**Power unit temperatures** [°C]
p0290	**Power unit overload response** Factory setting and the ability to be changed depends on the hardware. The dependency is described in the List Manual. A thermal overload is present if the inverter temperature is greater than that specified in p0292. You define how the inverter responds if there is a risk of thermal overload using this parameter. The details are described below.
p0292	**Power unit temperature warning threshold** (factory setting: Heat sink [0] 5 °C, power semiconductor [1] 15 °C) The value is set as a difference to the shutdown temperature.
p0294	**Power unit warning at I2t overload** (factory setting: 95 %)

Overload response for p0290 = 0

The inverter responds depending on the control mode that has been set:

- In vector control, the inverter reduces the output current.
- In U/f control, the inverter reduces the speed.

Once the overload condition has been removed, the inverter re-enables the output current or speed.

If the measure cannot prevent an inverter thermal overload, then the inverter switches off the motor with fault F30024.

Overload response for p0290 = 1

The inverter immediately switches off the motor with fault F30024.

Overload response for p0290 = 2

We recommend this setting for drives with square-law torque characteristic, e.g. fans.

The inverter responds in two stages:

1. If you operate the inverter with increased pulse frequency setpoint p1800, then the inverter reduces its pulse frequency starting at p1800.

   In spite of the temporarily reduced pulse frequency, the base load output current remains unchanged at the value that is assigned to p1800.

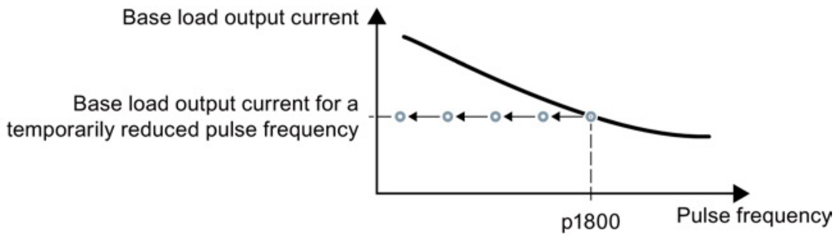


Figure 8-22 Derating characteristic and base load output current for overload

   Once the overload condition has been removed, the inverter increases the pulse frequency back to the pulse frequency setpoint p1800.

2. If it is not possible to temporarily reduce the pulse frequency, or the risk of thermal overload cannot be prevented, then stage 2 follows:
   - In vector control, the inverter reduces its output current.
   - In U/f control, the inverter reduces the speed.

   Once the overload condition has been removed, the inverter re-enables the output current or speed.

If both measures cannot prevent a power unit thermal overload, then the inverter switches off the motor with fault F30024.

Overload response for p0290 = 3

If you operate the inverter with increased pulse frequency, then the inverter reduces its pulse frequency starting at the pulse frequency setpoint p1800.

In spite of the temporarily reduced pulse frequency, the maximum output current remains unchanged at the value that is assigned to the pulse frequency setpoint. Also see p0290 = 2.

Once the overload condition has been removed, the inverter increases the pulse frequency back to the pulse frequency setpoint p1800.

If it is not possible to temporarily reduce the pulse frequency, or the measure cannot prevent a power unit thermal overload, then the inverter switches off the motor with fault F30024.

Overload response for p0290 = 12

The inverter responds in two stages:

1. If you operate the inverter with increased pulse frequency setpoint p1800, then the inverter reduces its pulse frequency starting at p1800.

   There is no current derating as a result of the higher pulse frequency setpoint.

   Once the overload condition has been removed, the inverter increases the pulse frequency back to the pulse frequency setpoint p1800.
2. If it is not possible to temporarily reduce the pulse frequency, or the risk of inverter thermal overload cannot be prevented, then stage 2 follows:
   - In vector control, the inverter reduces the output current.
   - In U/f control, the inverter reduces the speed.

   Once the overload condition has been removed, the inverter re-enables the output current or speed.

If both measures cannot prevent a power unit thermal overload, then the inverter switches off the motor with fault F30024.

Overload response for p0290 = 13

We recommend this setting for drives with high starting torque, e.g. horizontal conveyors or extruders.

If you operate the inverter with increased pulse frequency, then the inverter reduces its pulse frequency starting at the pulse frequency setpoint p1800.

There is no current derating as a result of the higher pulse frequency setpoint.

Once the overload condition has been removed, the inverter increases the pulse frequency back to the pulse frequency setpoint p1800.

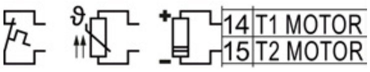
If it is not possible to temporarily reduce the pulse frequency, or the measure cannot prevent a power unit thermal overload, then the inverter switches off the motor with fault F30024.

8.6.2 Motor temperature monitoring using a temperature sensor

Connecting the temperature sensor

It is permissible to use one of the following sensors to protect the motor against overtemperature:

- Temperature switch (e.g. bimetallic switch)
- PTC sensor
- KTY84 sensor

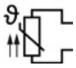


Connect the temperature sensor of the motor to terminals 14 and 15 of the inverter.

Temperature switch

The converter interprets a resistance ≥ 100 Ω as being an opened temperature switch and responds according to the setting for p0610.

PTC sensor



The converter interprets a resistance > 1650 Ω as being an overtemperature and responds according to the setting for p0610.

The converter interprets a resistance < 20 Ω as being a short-circuit and responds with alarm A07015. If the alarm is present for longer than 100 milliseconds, the converter shuts down with fault F07016.

KTY84 sensor

NOTICE
Motor overheating due to incorrectly connected KTY sensor
If a KTY sensor is connected with incorrect polarity, the motor can become damaged due to overheating, as the converter cannot detect a motor overtemperature condition. • Connect the KTY sensor with the correct polarity.

Using a KTY sensor, the converter monitors the motor temperature and the sensor itself for wire-break or short-circuit:

- Temperature monitoring:
  The converter uses a KTY sensor to evaluate the motor temperature in the range from -48° C ... +248° C.
  Use the p0604 or p0605 parameter to set the temperature for the alarm and fault threshold.
  – Overtemperature alarm (A07910):
    - motor temperature > p0604 and p0610 = 0

– Overtemperature fault (F07011):
  The converter switches off with fault in the following cases:
  - motor temperature > p0605
  - motor temperature > p0604 and p0610 ≠ 0

- Sensor monitoring (A07015 or F07016):
  – Wire-break:
    The converter interprets a resistance > 2120 Ω as a wire-break and outputs the alarm A07015. After 100 milliseconds, the converter changes to the fault state with F07016.
  – Short-circuit:
    The converter interprets a resistance < 50 Ω as a short-circuit and outputs the alarm A07015. After 100 milliseconds, the converter changes to the fault state with F07016.

Setting parameters for the temperature monitoring

Parameter	Description
p0335	**Specify the motor cooling** 0: Natural cooling - with fan on the motor shaft (factory setting) 1: Forced ventilation - with a separately driven fan 2: Liquid cooling 128: No fan
p0601	**Motor-temperature sensor type** 0: No sensor (factory setting) 1: PTC (→ p0604) 2: KTY84 (→ p0604, p0605) 4: Temperature switch
p0604	**Motor temperature alarm threshold** (factory setting 130° C)
p0605	**Motor temperature fault threshold** (factory setting 145° C) Setting for KTY84 sensor. The parameter has no significance for a PTC sensor.
p0610	**Motor overtemperature response** (factory setting: 12) Determines the behavior as soon as the motor temperature reaches the warning threshold p0604. 0: Alarm (A07910), no fault. 1: Alarm (A07910); the converter reduces the current limit and starts the timer. Shutdown with fault (F07011). 2: Alarm (A07910); the converter starts the timer. Shutdown with fault (F07011). 12: As for 2, but the converter considers the last shutdown temperature to calculate the motor temperature.
p0640	**Current limit** (input in A)

Additional information on the motor temperature monitoring can be found in function diagram 8016 of the List Manual.

8.6.3 Protecting the motor by calculating the motor temperature

The converter calculates the motor temperature based on a thermal motor model. Use the parameters below to set further variables for the temperature calculation of the motor.

Table 8- 25 Parameters for temperature acquisition without using a temperature sensor

Parameter	Description	
p0601	**Motor temperature sensor type** (factory setting: 0) 0: No sensor	
p0604	**Mot_temp_mod 2/KTY Warning threshold** (factory setting: 130 °C) Threshold for monitoring the motor temperature.. After exceeding the threshold, the converter reports fault F07011.	
p0605	**Mot_temp_mod 1/2 Threshold** (factory setting: 145 °C) Timer for monitoring the motor temperature in motortemperature model 2.. The converter starts the timer when the temperature warning threshold is exceeded (p0604).	
p0610	**Motor overtemperature response** (factory setting: 12) Determines the behavior as soon as the motor temperature reaches the warning threshold p0604.	
	0:	Warning (A07910), no fault.
	1:	Warning (A07910); current limit will be reduced and timer started. Shutdown with fault (F07011).
	2:	Warning (A07910); timer is started. Shutdown with fault (F07011).
	12:	As for 2 but the last shutdown temperature is used to calculate the motor temperature (factory setting).
p0611	**I2t motor model thermal time constant** (factory setting: 0 s) The parameter is only effective for synchronous motors. On selecting a motor from the motor list (p0301), the converter sets up the parameter value automatically.	
p0612	**Mot_temp_mod activation**	
	.00	1 signal: Activate motor temperature model 1 (I2t) for permanently excited synchronous motors
	.01	1 signal: Activate motor temperature model 2 for asynchronous motors
	.02	1 signal: Activate motor temperature model 3 for 1FK7 encoderless synchronous motors
	.09	1 signal: Activate motor temperature model 2 expansions
p0615	**Mot_temp_mod 1 (I2t) Interference threshold** (factory setting: 180 °C) Interference threshold for monitoring the motor temperature in motortemperature model 1. After exceeding the interference threshold, the converter reports fault F07011.	
p0621	**Identification of stator resistance (Rs) when switched on again** (factory setting: 0) The converter measures the current stator resistance and from this calculates the current motor temperature as the start value of the thermal motor model.	
	0:	No Rs identification
	1:	Rs identification on first switching on the motor
	2:	Rs identification each time the motor is switched on

Parameter	Description
p0622	**Motor excitation time for Rs_ident on switching on again** The converter sets the parameter value to the corresponding result of the motor data identification.
p0625	**Motor ambient temperature during commissioning** (factory setting: 20 °C) Motor ambient temperature given in °C at the time of motor data identification.

More information on temperature calculation can be found in function plans 8016 and 8017 and the list manual.

8.6.4 Overcurrent protection

The vector control ensures that the motor current remains within the set torque limits.

If you use U/f control, you cannot set any torque limits. The U/f control prevents too high a motor current by influencing the output frequency and the motor voltage (I-max controller).

I_max controller

Requirements

The torque of the motor must decrease at lower speeds, which is the case, for example, with fans.

The load must not drive the motor continuously, e.g. when lowering hoisting gear.

Function

The I-max controller influences the output frequency and the motor voltage.

If the motor current reaches the current limit during acceleration, the I-max controller extends the acceleration operation.

If the load of the motor is so large during stationary operation that the motor current reaches the current limit, the I-max controller reduces the speed and the motor voltage until the motor current is in the permissible range again.

If the motor current reaches the current limit during deceleration, the I-max controller extends the deceleration operation.

Settings

You only have to change the factory settings of the I-max controller if the drive tends to oscillate when it reaches the current limit or if it is shut down due to overcurrent.

Table 8- 26 I-max controller parameters

Parameter	Description
p0305	**Rated motor current**
p0640	**Motor current limit**
p1340	**Proportional gain of the I-max controller for speed reduction**
p1341	**Integral time of the I-max controller for speed reduction**
r0056.13	**Status: I-max controller active**
r1343	**Speed output of the I-max controller** Shows the amount to which the I-max controller reduces the speed.

For more information about this function, see function diagram 6300 in the List Manual.

8.6.5 Limiting the maximum DC link voltage

How does the motor generate overvoltage?

An induction motor operates as a generator if it is driven by the connected load. A generator converts mechanical power into electrical power. The electrical power flows back into the inverter and causes V_{DC} in the inverter to increase.

Above a critical DC-link voltage both the inverter and the motor will be damaged. Before harmful voltages occur, the inverter switches off the connected motor with the fault

"DC-link overvoltage".

Protecting the motor and inverter against overvoltage

The Vdc_max control can be used with the PM230, PM240, PM240-2 and PM330 Power Modules. To the extent the application permits, the Vdc_max control prevents the DC-link voltage from reaching critical levels. The Vdc_max control increases the ramp-down time of the motor during braking, so that the motor feeds back only as little power to the inverter as is covered by the losses in the inverter.

The Vdc_max control is not suitable for applications where the motor is continuously in the generator mode. This includes, for example, cranes or applications involving braking large moments of inertia. Further information on inverter braking methods can be found in Section Electrically braking the motor (Page 195).

There are two different groups of parameters for the Vdc_max control, depending on whether the motor is being operated with U/f control or vector control.

Parameter for V/f control	Parameter for vector control	Description
p1280 = 1	p1240 = 1	**Vdc_max control Vdc monitoring configuration** (factory setting: 1) 1: Enable Vdc_max control
r1282	r1242	**Vdc_max control activation level** Shows the value of the DC-link voltage above which the Vdc_max control is active
p1283	p1243	**Vdc_max control dynamic factor** (factory setting: 100 %) Scaling control parameters p1290, p1291 and p1292
p1284	---	**Vdc_max controller time threshold** Setting for the monitoring time of the Vdc_max controller.
p1290	p1250	**Vdc_max control proportional gain** (factory setting: 1)
p1291	p1251	**Vdc_max control integral time** (factory setting p1291: 40 ms, factory setting p1251: 0 ms)
p1292	p1252	**Vdc_max control rate time** (factory setting p1292: 10 ms, factory setting p1252: 0 ms)
p1294	p1254	**Vdc_max control automatic sensing ON level** (factory setting p1294: 0, factory setting p1254: PM330/PM240 = 1, PM230 = 0) Activates or deactivates automatic detection of the switch-on levels of the Vdc_max control. 0: Automatic detection disabled 1: Automatic detection enabled
p0210	p0210	**Unit supply voltage** If p1254 or p1294 = 0, the inverter uses this parameter to calculate the switch-in thresholds of the Vdc_max control. Set this parameter to the actual value of the input voltage.

For more information about this function, see the List Manual (function diagrams 6320 and 6220).

8.7 Application-specific functions

The inverter offers a series of functions that you can use depending on your particular application, e.g.:

- Switching over units
- Braking functions
- Automatic restart and flying restart
- Basic process control functions
- Logical and arithmetic functions using function blocks that can be freely interconnected
- Energy-saving display for pumps and fans

Refer to the following sections for detailed descriptions.

8.7.1 Unit changeover

Description

With the unit changeover function, you can adapt the inverter to the line supply (50/60 Hz) and also select US units or SI units as base units.

Independent of this, you can define the units for process variables or change over to percentage values.

Specifically, you have the following options:

- Changing over the motor standard (Page 189) IEC/NEMA (adaptation to the line supply)
- Changing over the unit system (Page 190)
- Changing over process variables for the technology controller (Page 191)

Note

The motor standard, the unit system as well as the process variables can only be changed offline.

The procedure is described in Section Switching units with STARTER (Page 191).

Restrictions for the unit changeover function

- The values on the rating plate of the inverter or motor cannot be displayed as percentage values.
- Using the unit changeover function several times (for example, percent → physical unit 1 → physical unit 2 → percent) may lead to the original value being changed by one decimal place as a result of rounding errors.
- If the unit is changed over into percent and the reference value is then changed, the percentage values relate to the new reference value.
  Example:
  – For a reference speed of 1500 rpm, a fixed speed of 80% corresponds to a speed of 1200 rpm.
  – If the reference speed is changed to 3000 rpm, then the value of 80% is kept and now means 2400 rpm.

Reference variables for unit changeover

p2000 Reference frequency/speed

p2001 Reference voltage

p2002 Reference current

p2003 Reference torque

r2004 Reference power

p2005 Reference angle

p2006 Reference temperature

8.7.1.1 Changing over the motor standard

You change over the motor standard using p0100. The following applies:

- p0100 = 0: IEC motor (50 Hz, SI units)
- p0100 = 1: NEMA motor (60 Hz, US units)
- p0100 = 2: NEMA motor (60 Hz, SI units)

The parameters listed below are affected by the changeover.

Table 8- 27 Variables affected by changing over the motor standard

P no.	Designation	Unit for p0100 =		
		0*)	1	2
r0206	Power Module rated power	kW	HP	kW
p0307	Rated motor power	kW	HP	kW
p0316	Motor torque constant	Nm/A	lbf ft/A	Nm/A
r0333	Rated motor torque	Nm	lbf ft	Nm
r0334	Motor torque constant, actual	Nm/A	lbf ft/A	Nm/A
p0341	Motor moment of inertia	kgm^2	lb ft^2	kgm^2
p0344	Motor weight (for thermal motor type)	kg	Lb	kg
r1969	Speed_cont_opt moment of inertia determined	kgm^2	lb ft^2	kgm^2

*) Factory setting

8.7.1.2 Changing over the unit system

You change over the unit system using p0505. The following selection options are available:

- p0505 = 1: SI units (factory setting)
- p0505 = 2: SI units or % relative to SI units
- p0505 = 3: US units
- p0505 = 4: US units or % relative to US units

Note

Special features

The percentage values for p0505 = 2 and for p0505 = 4 are identical. For internal calculation and for the output of physical variables, it is, however, important whether the conversion is made to SI or US units.

In the case of variables for which changeover to % is not possible, the following applies:
p0505 = 1 ≙ p0505 = 2 and p0505 = 3 ≙ p0505 = 4.

In the case of variables whose units are identical in the SI system and US system, and which can be displayed as a percentage, the following applies:
p0505 = 1 ≙ p0505 = 3 and p0505 = 2 ≙ p0505 = 4.

Parameters affected by changeover

The parameters affected by changing over the unit system are grouped according to unit. An overview of the unit groups and the possible units can be found in the List Manual in the Section "Unit group and unit selection".

8.7.1.3 Changing over process variables for the technology controller

Note

We recommend that the units and reference values of the technology controller are coordinated and harmonized with one another during commissioning.

Subsequent modification in the reference variable or the unit can result in incorrect calculations or displays.

Changing over process variables of the technology controller

You change over the process variables of the technology controller using p0595. For physical values, you define the reference variable in p0596.

The parameters affected by changing over units of the technology controller belong to unit group 9_1. For details, please refer to the section titled "Unit group and unit choice" in the List Manual.

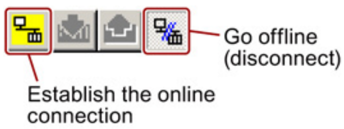
8.7.1.4 Switching units with STARTER

Precondition

The inverter must be in the offline mode in order to change over the units.

STARTER shows whether you change settings online in the inverter or change offline in the PC (Online mode / Offline mode).

You switch over the mode using the adjacent buttons in the menu bar.



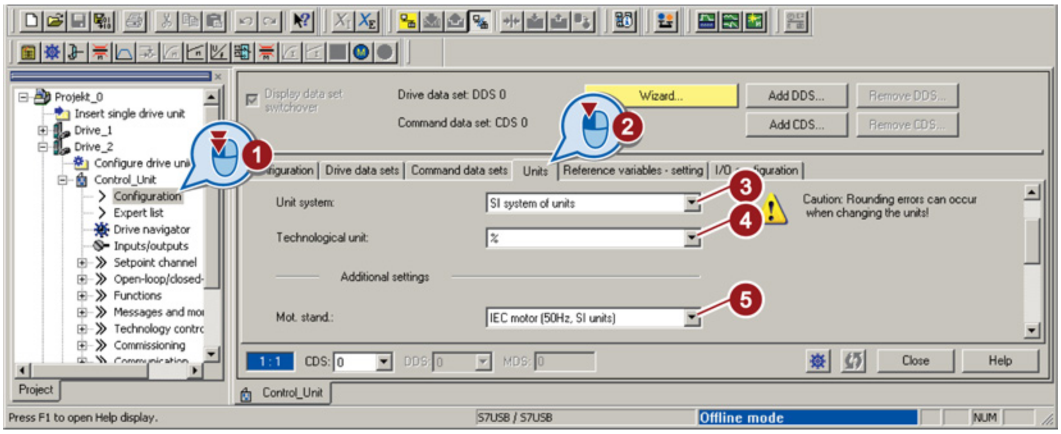
Procedure

1
2

To change over the units with STARTER, proceed as follows:

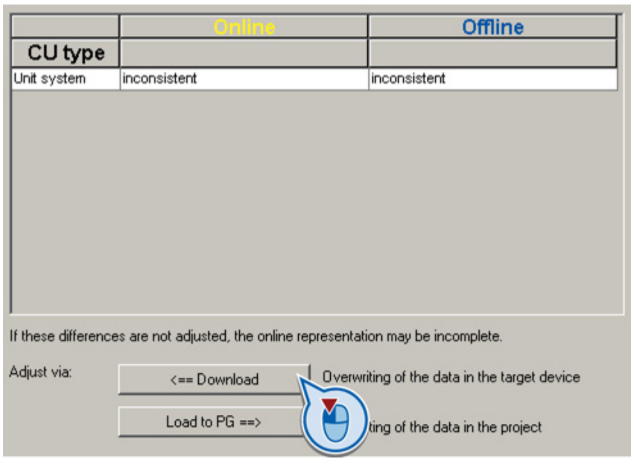
1. Select the configuration
2. Go to the "Units" tab in the configuration screen form to change over the units
3. Changing over the system of units

4. Select process variables of the technology controller
5. Adapting to the line supply



6. Save your settings.
7. Go online.

   The inverter signals that offline, other units and process variables are set than in the inverter itself.
8. Accept these settings in the inverter.



You have changed over the units.

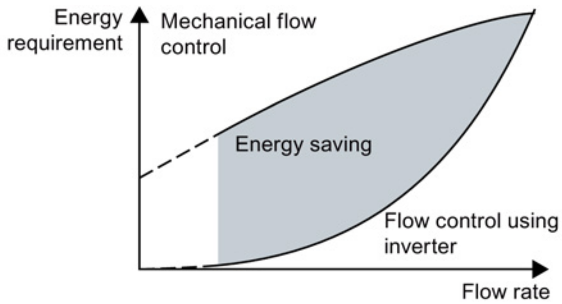
8.7.2 Calculating the energy saving

Background

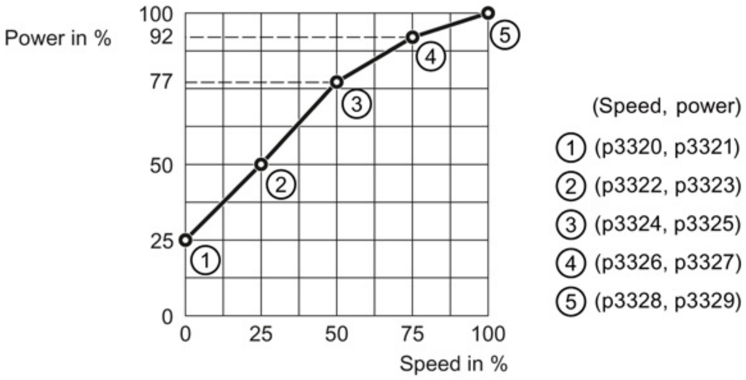
Fluid flow machines, which are used to control the flow rate using valves or throttles, run continuously at their rated speed. The lower the flow rate, the lower the system efficiency. The efficiency is the lowest when valves or throttles are completely closed. Further, undesirable effects can occur, e.g. the formation of vapor bubbles in liquids (cavitation) or the temperature rise of the medium being pumped increases.

The inverter controls the flow rate or the pressure by varying the speed of the fluid flow machine. As a consequence, over its complete operating range, a fluid-flow machine operates close to its maximum efficiency – and especially in partial load operation, uses less energy than for valve and throttle-based controls.

Function



The inverter calculates the energy saving of flow control using the inverter compared to mechanical flow control based on the flow characteristics saved. The calculation is suitable for fluid-flow machines, e.g. centrifugal pumps, fans, radial and axial compressors.

Parameter	Description
p3320 … p3329	**Flow characteristic**  Factory setting of the flow characteristic

Parameter	Description	
r0039	**Energy display** (kWh)	
	[0]	**Energy balance** Energy usage since the last reset
	[1]	Energy drawn since the last reset
	[2]	Energy fed back since the last reset
p0040	**Reset energy consumption display** A signal change 0 → 1 sets r0039[0…2] = 0 and r0041 = 0.	
r0041	**Energy consumption saved** (kWh) Energy saved referred to 100 operating hours. For less than 100 operating hours, the inverter interpolates the energy saving to 100 operating hours.	

Adapting the flow characteristic

Precondition

You require the following data to calculate the system-specific flow characteristic:

- Flow characteristics of the system manufacturer
- System characteristics for 5 different flow rates

Procedure

Proceed as follows to adapt the operating characteristic:

1. For a drive connected directly to the line supply, calculate the corresponding speeds required for 5 different flow rates.
2. Based on the flow characteristic of the system, calculate the power that the drive requires for the different flow rates.
3. Enter the values into the characteristic.

   You have adapted the flow characteristic, and you now obtain a precise result for the energy saving.

8.7.3 Electrically braking the motor

Regenerative power

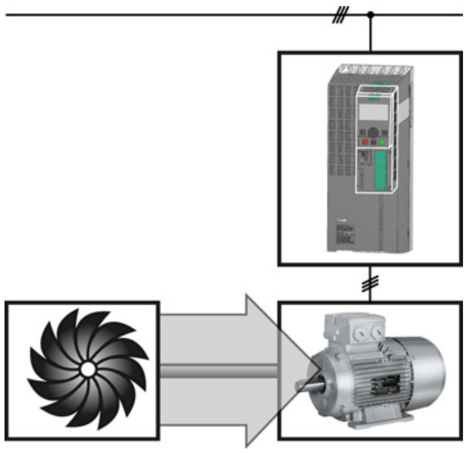
If a motor electrically brakes the connected load and the mechanical power exceeds the electrical losses, then it works as a generator. The motor converts mechanical power by generating electrical power.

When the motor operates as a generator, it attempts to transfer the power generated to the inverter.

Main features of the braking functions

DC braking

DC braking prevents the motor operating as generator. The inverter impresses a DC current in the motor. The DC current brakes the motor. The motor converts the mechanical power of the load into heat.



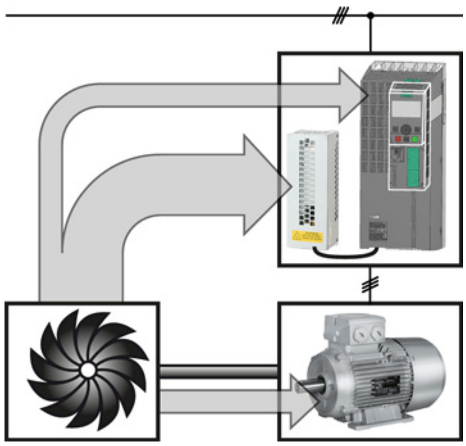
- *Advantage:* The motor brakes the load without the inverter having to process the regenerative energy
- *Disadvantages:* Significant increase in the motor temperature; no defined braking characteristics; no constant braking torque; no braking torque at standstill; regenerative power is lost as heat; does not function when the line supply fails

Compound braking

One version of DC braking. The inverter brakes the motor with a defined ramp-down time and superimposes a DC current on the output current.

Dynamic braking

The inverter converts the regenerative power into heat using a braking resistor.

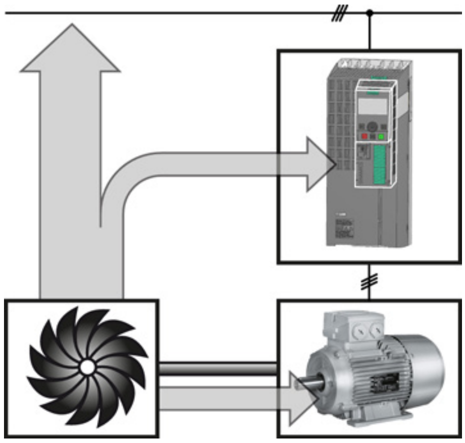


- *Advantages:* defined braking characteristics; no additional motor temperature increase; constant braking torque; in principle, also functions when the power fails
- *Disadvantages:* braking resistor required; regenerative power is dissipated as heat

Braking with regenerative feedback into the line supply

The inverter feeds the regenerative power back into the line supply.

- *Advantages:* Constant braking torque; the regenerative power is not completely converted into heat, but regenerated into the line supply; can be used in all applications; continuous regenerative operation is possible - e.g. when lowering a suspended load
- *Disadvantage:* Does not function when power fails



What braking method is suitable for what application?

Application examples	Electrical braking methods	Power Modules that can be used
Pumps, fans, mixers, compressors, extruders	Not required	PM240, PM340, PM250, PM260
Grinding machines, conveyor belts	DC braking, compound braking	PM240, PM340
Centrifuges, vertical conveyors, hoisting gear, cranes, winders	Dynamic braking	PM240, PM340
	Braking with regenerative feedback into the line supply	PM250, PM260

8.7.3.1 DC braking

DC braking is used for applications without regenerative feedback into the line supply, where the motor can be more quickly braked by impressing a DC current than along a braking ramp.

Typical applications for DC braking include:

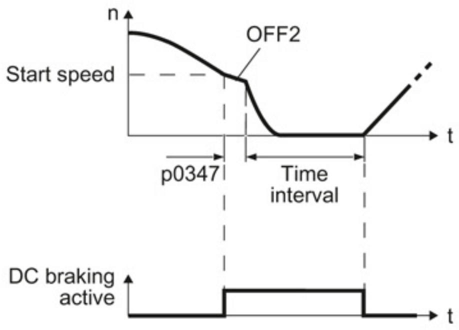
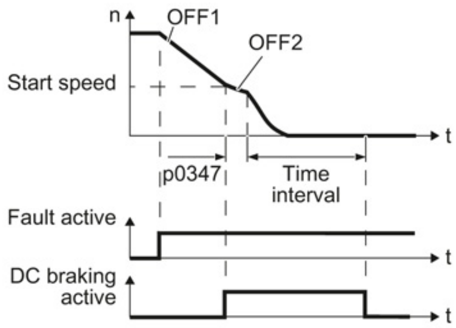
- Centrifuges
- Saws
- Grinding machines
- Conveyor belts

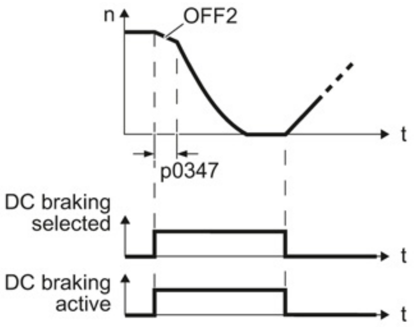
Function

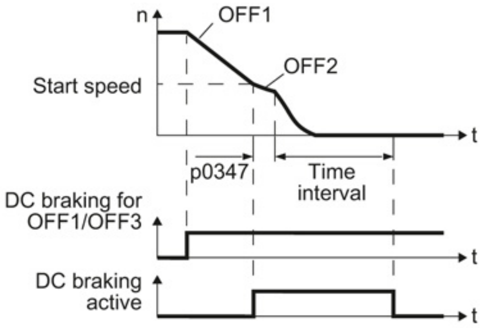
NOTICE
Motor damage caused by overheating
The motor can overheat if it is braked for long periods of time or frequently using DC braking. This may damage the motor. • Monitor the motor temperature. • If the motor gets too hot during operation you must select another braking method or give the motor more time to cool down.

With DC braking, the inverter outputs an internal OFF2 command for the time that it takes to de-energize the motor p0347 - and then impresses the braking current for the duration of the DC braking.

The DC-braking function is possible only for induction motors.

DC braking when falling below a start speed Precondition: p1230 = 1 and p1231 = 14	**DC braking when a fault occurs** Precondition: Fault number and fault response are assigned using p2100 and p2101
	

<table>
<tr>
<th>DC braking initiated using a control command
Precondition: p1231 = 4 and p1230 = control command, e.g. p1230 = 722.3 (control command via DI 3)</th>
<th>DC braking when switching off the motor
Precondition: p1231 = 5 or p1230 = 1 and p1231 = 14</th>
</tr>
<tr>
<td>


</td>
<td>


</td>
</tr>
</table>

DC braking when falling below a starting speed

1. The motor speed has exceeded the starting speed.
2. The inverter activates the DC braking as soon as the motor speed falls below the starting speed.

DC braking when a fault occurs

1. A fault occurs, which initiates DC braking as response.
2. The motor brakes along the down ramp to the speed for the start of DC braking.
3. DC braking starts.

DC braking initiated by a control command

1. The higher-level control issues the command for DC braking, e.g. using DI3: p1230 = 722.3.
2. DC braking starts.

If the higher-level control withdraws the command during DC braking, the inverter interrupts DC braking and the motor accelerates to its setpoint.

DC braking when the motor is switched off

1. The higher-level control switches off the motor (OFF1 or OFF3).
2. The motor brakes along the down ramp to the speed for the start of DC braking.
3. DC braking starts.

Settings for DC braking

Parameter	Description
p0347	**Motor de-excitation time** (calculated after the basic commissioning) The inverter can trip due to an overcurrent during DC braking if the de-excitation time is too short.
p1230	**DC braking activation** (factory setting: 0) Signal source to activate DC braking • 0 signal: Deactivated • 1 signal: Active
p1231	**Configuring DC braking** (factory setting: 0) 0 — No DC braking 4 — General release for DC braking 5 — DC braking for OFF1/OFF3 14 — DC braking below the starting speed
p1232	**DC braking braking current** (factory setting 0 A)
p1233	**DC braking duration** (factory setting 1 s)
p1234	**DC braking start speed** (factory setting 210000 rpm)
r1239	**DC braking status word** .08 — DC braking active .10 — DC braking ready .11 — DC braking selected .12 — DC braking selection internally locked .13 — DC braking for OFF1/OFF3

Table 8- 28 Configuring DC braking when faults occur

Parameter	Description
p2100	**Set fault number for fault response** (factory setting 0) Enter the fault number for which DC braking should be activated, e.g. p2100[3] = 7860 (external fault 1).
p2101 = 6	**Fault response setting** (factory setting 0) Assigning the fault response: p2101[3] = 6.
The fault is assigned an index of p2100. Assign the same index of p2100 or p2101 to the fault and fault response. The inverter's List Manual lists in the "Faults and alarms" list the possible fault responses for every fault. The "DCBRAKE" entry means that it is permissible to set DC braking as response for this particular fault.	

8.7.3.2 Compound braking

Typical applications for compound braking include:

- Centrifuges
- Saws
- Grinding machines
- Horizontal conveyors

For these applications, the motor is normally operated with a constant speed, and is only braked down to standstill after longer periods of time.

Principle of operation

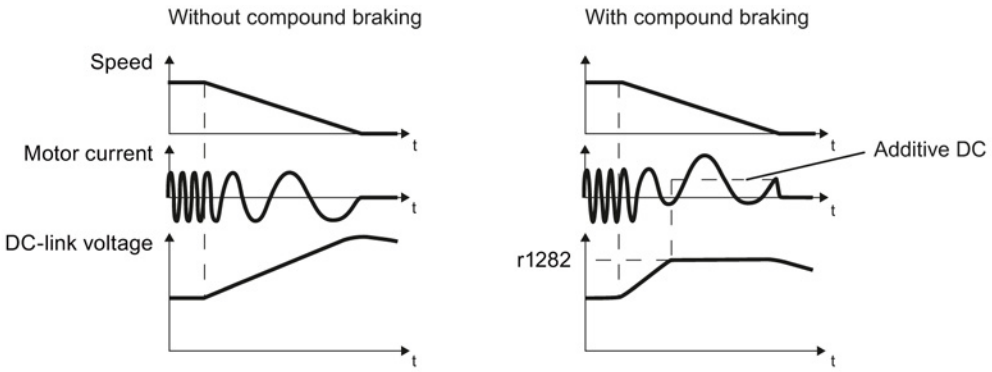


Figure 8-23 Motor brakes with and without active compound braking

Compound braking prevents the DC-link voltage increasing above a critical value. The inverter activates compound braking depending on the DC-link voltage. Above a DC-link voltage threshold (r1282), the inverter adds a DC current to the motor current. The DC current brakes the motor and prevents an excessive increase in the DC-link voltage.

Note

Compound braking is possible only with the U/f control.

Compound braking does not operate in the following cases:

- The "flying restart" function is active
- DC braking is active
- Vector control is selected

Setting and enabling compound braking

Parameter	Description
p3856	**Compound braking current (%)** With the compound braking current, the magnitude of the DC current is defined, which is additionally generated when stopping the motor for operation with U/f control to increase the braking effect. p3856 = 0 Compound braking locked p3856 = 1 … 250 Current level of the DC braking current as a % of the rated motor current (p0305) Recommendation: p3856 < 100% × (r0209 - r0331) / p0305 / 2
r3859.0	**Compound-braking status word** r3859.0 = 1: Compound braking is active

NOTICE
Motor damage from overheating with compound braking The motor will overheat if braking lasts too long or the motor is braked too often. This may damage the motor. Monitor the motor temperature. If the motor gets too hot during operation you must select another braking method or give the motor more time to cool down.

8.7.3.3 Dynamic braking

Typical applications for dynamic braking include:

- Horizontal conveyors
- Vertical and inclined conveyors
- Hoisting gear

For these applications, dynamic motor behavior with different speeds or continuous change of direction is required.

Principle of operation

⚠ CAUTION

Burns when touching a hot braking resistor

A braking resistor reaches high temperatures during operation. Touching the braking resistor may result in burns.

- Do not touch a braking resistor during operation.

The inverter controls the braking chopper depending on its DC-link voltage. The DC-link voltage increases as soon as the inverter absorbs the regenerative power when braking the motor. The braking chopper converts this power into heat in the braking resistor. This prevents the DC-link voltage from increasing above the limit value $U_{DC\ link,\ max}$.

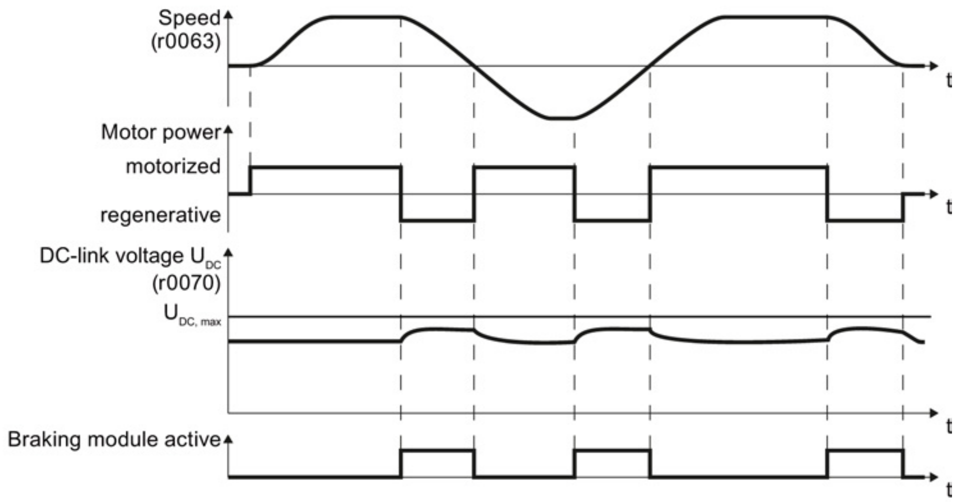


Figure 8-24 Simplified representation of dynamic braking with respect to time

Procedure: Set dynamic braking

In order to optimally utilize the connected braking resistor, you must know the braking power that occurs in your particular application.

Table 8- 29 Parameter

<table>
<tr><th>Parameter</th><th colspan="2">Description</th></tr>
<tr><td>p0219</td><td colspan="2">Braking power of the braking resistor (factory setting: 0 kW)
Set the maximum braking power that the braking resistor must handle in your particular application.
Under certain circumstances, for low braking power ratings, the inverter extends the ramp-down time of the motor.
Example: In your particular application, the motor brakes every 10 seconds. In so doing, the braking resistor must handle a braking power of 1 kW for 2 s. Use a braking resistor with a continuous power rating of 1 kW × 2 s / 10 s = 0.2 kW and set the maximum braking power to: p0219 = 1 (kW).</td></tr>
<tr><td rowspan="2">p0844</td><td colspan="2">No coast down/coast down (OFF2) signal source 1</td></tr>
<tr><td>p0844 = 722.x</td><td>Monitor the overtemperature of the braking resistor with digital input x of the inverter.</td></tr>
</table>

8.7.3.4 Braking with regenerative feedback to the line

Typical applications for braking with energy recovery (regenerative feedback into the line supply):

- Hoist drives
- Centrifuges
- Unwinders

For these applications, the motor must brake for longer periods of time.

The inverter can feed back up to 100% of its power into the line supply (referred to "High Overload" base load, see Section Technical data, PM250 (Page 332)).

Setting the braking with regenerative feedback to the line

Parameter	Description
Limiting the regenerative feedback for U/f control (p1300 < 20)	
p0640	**Motor series overload factor** (factory setting: 0.00 A, default for basic commissioning) It is only possible to limit the regenerative power with V/f control by limiting the motor current. If the current exceeds this value for longer than 10 s, the inverter shuts down the motor with fault F07806.
Limiting feedback with vector control (p1300 ≥ 20)	
p1531	**Regenerative power limit** (factory setting: 0.01 kW)

8.7.4 Motor holding brake

The motor holding brake prevents the motor turning when it is switched off. The converter has internal logic to optimally control a motor holding brake.

Function after OFF1 and OFF3 command

The inverter controls the motor holding brake in the following way:

- After the ON command (to switch on motor), the inverter magnetizes the motor.
- After the magnetizing time (p0346), the inverter issues the command to open the brake.
- The inverter keeps the motor at a standstill up until the end of the time in p1216. The motor holding brake must open within this time.
- At the end of the brake opening time the motor accelerates to the speed setpoint.
- After the OFF command (OFF1 or OFF3) the motor brakes to a standstill.
- When braking, the inverter compares the speed setpoint and the actual speed with the speed threshold p1226:

  If the speed setpoint falls below the threshold p1226, the inverter starts the time p1227.

  If the actual speed falls below the threshold p1226, the inverter starts the time p1228.
- As soon as the first of the two times (p1227 or p1228) has elapsed, the inverter issues the command to close the brake.

  The motor comes to a standstill but remains switched on.
- After the brake closing time p1217, the inverter switches off the motor.
  The motor holding brake must close within this time.

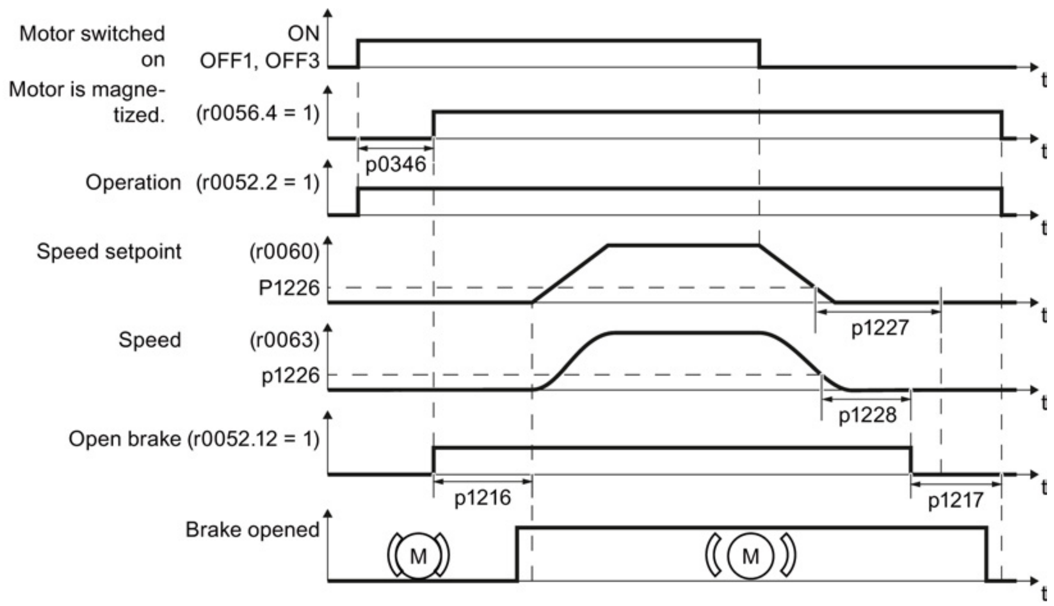


Figure 8-25 Controlling the motor holding brake when the motor is switched on and off

Function after OFF2

The brake closing time is not taken into account after an OFF2 command:

After an OFF2, the inverter issues the signal to immediately close the motor holding brake, independent of the motor speed.

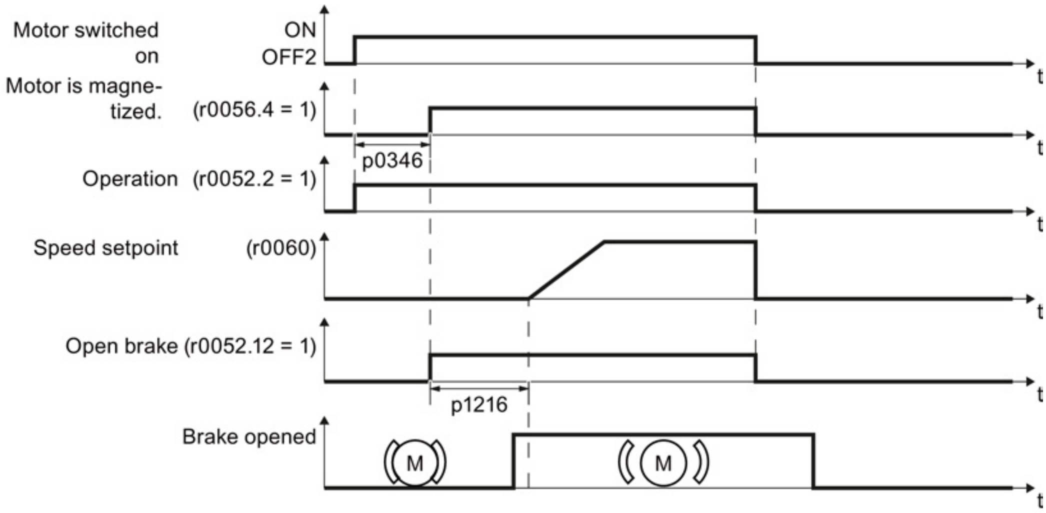


Figure 8-26 Controlling the motor holding brake after OFF2

Commissioning a motor holding brake

DANGER

Danger to life due to falling loads

For applications such as lifting equipment, cranes or elevators, there is a danger to life if the "Motor holding brake" function is incorrectly set.

- When commissioning the "Motor holding brake" function, secure any dangerous loads, e.g. by applying the following measures:
  - Lower the load down to the floor
  - Cordon off the hazardous area so that nobody can enter it

Precondition

The motor holding brake is connected to the inverter.

Procedure

Proceed as follows to commission the "Motor holding brake" function using an operator panel.

1. Set p1215 = 1.

   The "Motor holding brake" function" is enabled.
2. Check the magnetizing time p0346; the magnetizing time is pre-assigned during commissioning and must be greater than zero.
3. Take the opening and closing times of the connected brake from the technical data for the motor holding brake.
   – Depending on the brake size, brake opening times lie between 25 ms and 500 ms.
   – Depending on the brake size, brake closing times lie between 15 ms and 300 ms.
4. Set the following parameters in the inverter to match the opening and closing times of the brake:
   – Opening time ≤ p1216.
   – Closing time ≤ p1217.
5. Switch on the motor.
6. Check the acceleration behavior of the drive immediately after the motor has been switched on:
   – If the brake opens too late, the inverter accelerates the motor against the closed brake which results in a jerky motion.

     In this case, increase the opening time p1216.
   – After opening the brake, if the motor waits too long before it accelerates the motor, then reduce the opening time p1216.
7. If the load sags after switching on the motor, then you must increase the motor torque when opening the motor holding brake. Depending on the control mode, you must set different parameters:
   – U/f operation (p1300 = 0 to 3):
     Increase p1310 step-by-step.
     Increase p1351 step-by-step.
   – Vector control (p1300 ≥ 20):
     Increase p1475 in small steps.
8. Switch off the motor.
9. Check the braking behavior of the drive immediately after the motor has been switched off:
   – If the brake closes too late, the load briefly sags before the brake closes.

     In this case, increase the closing time p1217.
   – After closing the brake, if the motor waits too long before it switches off the motor, then reduce the closing time p1217.

You have commissioned the "Motor holding brake" function.

Table 8- 30 Setting the control logic of the motor holding brake

Parameter	Description
p1215 = 1	**Enable motor holding brake** 0 Motor holding brake locked (factory setting) 1 Motor holding brake just like the sequence control 2: Motor holding brake permanently open 3: Motor holding brake just like the sequential control, connected via BICO
p1216	**Motor holding brake opening time** (factory setting 0.1 s) p1216 > braking signal relay runtimes + brake release time
p1217	**Motor holding brake closing time** (factory setting 0.1 s) p1217 > braking signal relay runtimes + brake closing time
r0052.12	**"Open motor holding brake" command**

Table 8- 31 Advanced settings

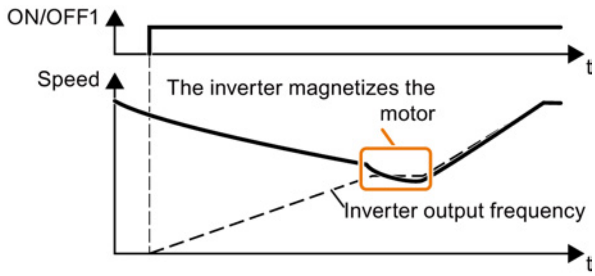
Parameter	Description
p0346	**Magnetizing time** (factory setting 0 s) During this time the induction motor is magnetized. The inverter calculates this parameter using p0340 = 1 or 3.
p0855	**Open motor holding brake (imperative)** (factory setting 0)
p0858	**Close motor holding brake (imperative)** (factory setting 0)
p1226	**Stationary state detection speed threshold** (factory setting 20 rpm) When braking with OFF1 or OFF3, when the speed falls below this threshold, standstill is detected and the monitoring time p1227 or p1228 is started
p1227	**Stationary state detection monitoring time** (factory setting 300 s)
p1228	**Pulse deletion delay time** (factory setting 0.01 s)
p1351	**Starting frequency, motor holding brake** (factory setting 0%) Setting the frequency set value at the slip compensation output when starting with motor holding brake. When the parameter p1351 is set to > 0, slip compensation is automatically switched on.
p1352	**Starting frequency for motor holding brake** (factory setting 1351) Setting the signal source for the frequency set value at the slip compensation output when starting with motor holding brake.
p1475	**Speed controller torque set value for motor holding brake** (factory setting 0) Setting the signal source for the torque set value when starting with motor holding brake.

8.7.5 Flying restart – switching on while the motor is running

If you switch on the motor while it is still running, then with a high degree of probability, a fault will occur due to overcurrent (overcurrent fault F07801). Examples of applications involving an unintentionally rotating motor directly before switching on:

- The motor rotates after a brief line interruption.
- An air flow turns the fan impeller.
- A load with a high moment of inertia drives the motor.

After the ON command, the "flying restart" function initially synchronizes the converter output frequency to the motor speed and then accelerates the motor up to the setpoint.



If the converter simultaneously drives several motors, then you must only use the "flying restart" function if the speed of all of the motors is always the same (group drive with a mechanical coupling).

Table 8- 32 Basic setting

Parameter	Description	
p1200	**Flying restart operating mode** (factory setting 0)	
	0	Flying restart is locked
	1	Flying restart is enabled, look for the motor in both directions, start in direction of setpoint
	4	Flying restart is enabled, only search in direction of setpoint

Table 8- 33 Advanced settings

Parameter	Description
p1201	**Flying restart enable signal source** (factory setting 1) Defines a control command, e.g. a digital input, through which the flying restart function is enabled.
p1202	**Flying restart search current** (factory setting 100%) Defines the search current with respect to the motor magnetizing current (r0331), which flows in the motor while the flying restart function is being used.
p1203	**Flying restart search speed factor** (factory setting 100%) The value influences the speed with which the output frequency is changed during the flying restart. A higher value results in a longer search time. If the converter does not find the motor, reduce the search speed (increase p1203).

8.7.6 Automatic switch-on

The automatic restart includes two different functions:

- The inverter automatically acknowledges faults.
- After a fault occurs or after a power failure, the inverter automatically switches-on the motor again.

The inverter interprets the following events as power failure:

- The inverter signals fault F30003 (DC-link undervoltage), as the line supply voltage of the inverter has briefly failed.
- The inverter power supply has failed for a long enough time so that the inverter has been switched-off.

⚠ WARNING
Injuries from the automated machine restart
When the "automatic restart" function is active (p1210 > 1), the motor automatically starts after a power failure. The movements that the machine executes may result in serious injuries. • Block the machine to prevent unintentional access. • Before working on the machine switch the automatic restart mechanism off.

Setting the automatic restart function

If it is possible that the motor is still rotating for a longer period of time after a power failure or after a fault, then in addition, you must activate the "flying restart" function, see Flying restart – switching on while the motor is running (Page 209).

Using p1210, select the automatic restart mode that best suits your application.

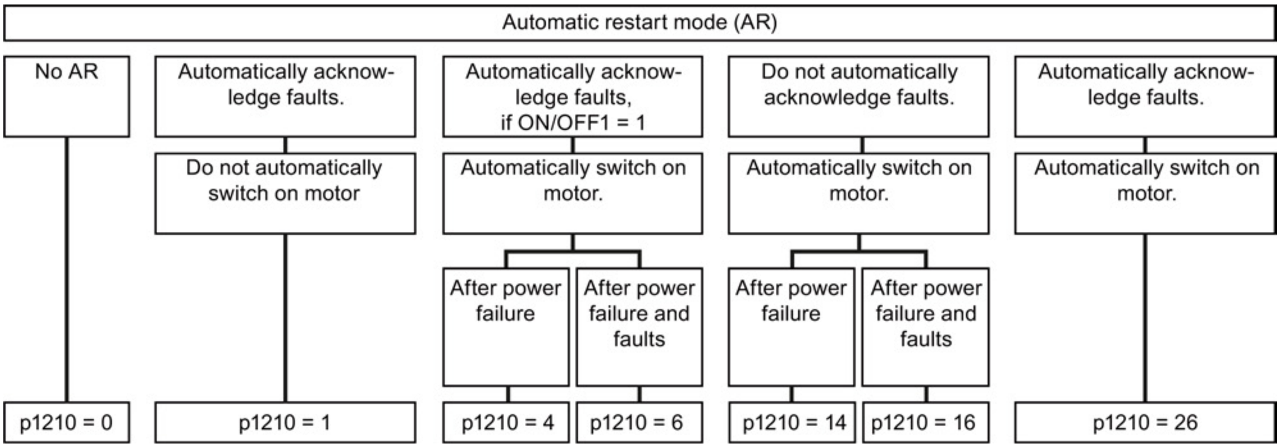
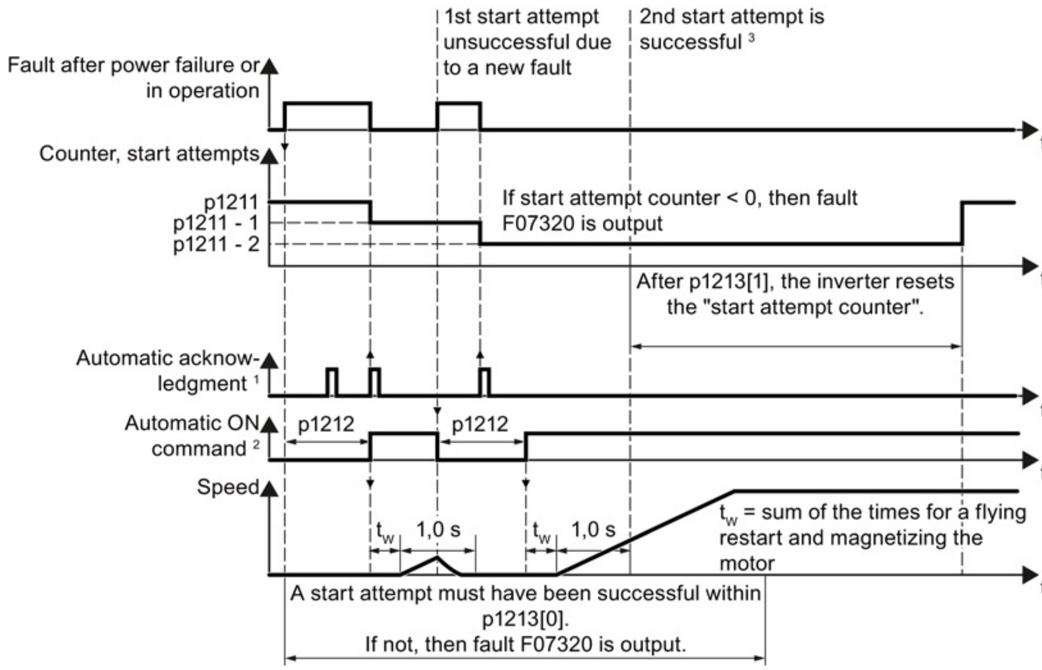


Figure 8-27 Automatic restart modes

The principle of operation of the other parameters is explained in the following diagram and in the table below.



1) The inverter automatically acknowledges faults under the following conditions:

- p1210 = 1 or 26: Always.
- p1210 = 4 or 6: If the command to switch-on the motor is available at a digital input or via the fieldbus (ON/OFF1 = 1).
- p1210 = 14 or 16: Never.

2) The inverter attempts to automatically switch the motor on under the following conditions:

- p1210 = 1: Never.
- p1210 = 4, 6, 14, 16, or 26: If the command to switch-on the motor is available at a digital input or via the fieldbus (ON/OFF1 = 1).

3) If no fault has occurred one second after the flying restart and magnetizing (r0056.4 = 1), the start attempt was successful.

Figure 8-28 Time response of the automatic restart

Parameter for setting the automatic restart

Parameter	Explanation	
p1210	**Automatic restart mode** (factory setting: 0)	
	0: 1: 4: 6: 14: 16: 26:	Disable automatic restart. Acknowledge all faults without restarting. Restart after power failure without further restart attempts. Restart after fault with further restart attempts. Restart after power failure after manual acknowledgement. Restart after fault after manual acknowledgement. Acknowledgement of all faults and restart with ON/OFF1 = 1 command.

<table>
<tr><th>Parameter</th><th>Explanation</th></tr>
<tr><td>p1211</td><td>Automatic restart start attempts (factory setting: 3)
This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26.
You define the maximum number of start attempts using p1211. After each successful acknowledgement, the inverter decrements its internal counter of start attempts by 1.
For p1211 = n, up to n + 1 start attempts are made. Fault F07320 is output after n + 1 unsuccessful start attempts.
The inverter sets the start attempt counter back again to the value of p1211, if one of the following conditions is fulfilled:
• After a successful start attempt, the time in p1213[1] has expired.
• After fault F07320, switch off the motor (OFF1) and acknowledge the fault.
• You change the start value p1211 or the mode p1210.</td></tr>
<tr><td>p1212</td><td>Automatic restart wait time start attempt (factory setting: 1.0 s)
This parameter is only effective for the settings p1210 = 4, 6, 26.
Examples for setting this parameter:
1. After a power failure, a certain time must elapse before the motor can be switched-on, e.g. because other machine components are not immediately ready. In this case, set p1212 longer than the time, after which all of the fault causes have been removed.
2. In operation, the inverter develops a fault condition. The lower you select p1212, then the sooner the inverter attempts to switch-on the motor again.</td></tr>
<tr><td>p1213[0]</td><td>Automatic restart monitoring time
for restart (factory setting: 60 s)
This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26.
With this monitoring function, you limit the time in which the inverter may attempt to automatically switch-on the motor again.
The monitoring function starts when a fault is identified and ends with a successful start attempt. If the motor has not successfully started after the monitoring time has expired, fault F07320 is signaled.
Set the monitoring time longer than the sum of the following times:
+ p1212
+ Time that the inverter requires to start the motor on the fly.
+ Motor magnetizing time (p0346)
+ 1 second
You deactivate the monitoring function with p1213 = 0.</td></tr>
<tr><td>p1213[1]</td><td>Automatic restart monitoring time
to reset the fault counter (factory setting: 0 s)
This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26.
Using this monitoring time, you prevent that faults, which continually occur within a certain time period, are automatically acknowledged each time.
The monitoring function starts with a successful start attempt and ends after the monitoring time has expired.
If the inverter has made more than (p1211 + 1) successful start attempts within monitoring time p1213[1], the inverter cancels the automatic restart function and signals fault F07320. In order to switch on the motor again, you must acknowledge the fault and set ON/OFF1 = 1.</td></tr>
</table>

Additional information is provided in the parameter list of the List Manual.

Advanced settings

If you with to suppress the automatic restart function for certain faults, then you must enter the appropriate fault numbers in p1206[0 … 9].

Example: p1206[0] = 07331 ⇒ No restart for fault F07331.

Suppressing the automatic restart only functions for the setting p1210 = 6, 16 or 26.

⚠ WARNING
Injury and property damage In the case of communication via the fieldbus interface, the motor restarts with the setting p1210 = 6, 16, 26 even if the communication link is interrupted. This means that the control cannot stop the motor. To avoid this dangerous situation, you must enter the fault code of the communications fault in parameter p1206. Example: A communication failure via PROFIBUS is signaled using fault code F01910. You should therefore set p1206[n] = 1910 (n = 0 … 9).

8.7.7 Kinetic buffering (Vdc min control)

Kinetic buffering increases the drive availability. The kinetic buffering utilizes the kinetic energy of the load to buffer line dips and failures. During a line dip, the inverter keeps the motor in the switched-on state for as long as possible. One second is a typical, maximum buffer time.

Preconditions

The following prerequisites must be fulfilled to practically use the "kinetic buffering" function:

- The driven load has a sufficiently high inertia.
- The application allows a motor to be braked during a power failure.

Function

When the line supply dips or is interrupted, the DC link voltage in the inverter decreases. At an adjustable threshold, kinetic buffering intervenes ($V_{DC\ min}$ control). The $V_{DC\ min}$ control forces the load to go into slightly regenerative operation. As a consequence, the inverter covers its power loss and the losses in the motor with the kinetic energy of the load. The load speed decreases; however, during kinetic buffering, the DC voltage remains constant. After the line supply returns, the inverter immediately resumes normal operation.

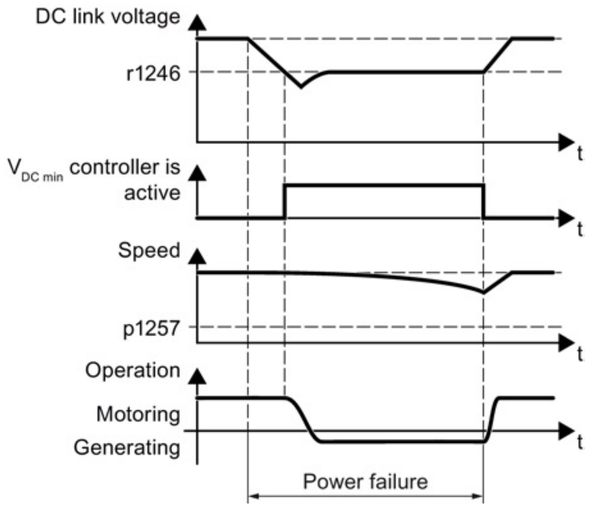


Figure 8-29 Principle mode of operation of kinetic buffering

Parameter	Description	
r0056.15	**Status word closed-loop control**	
	0 signal	$V_{DC\ min}$ controller is not active
	1 signal	$V_{DC\ min}$ controller is active (kinetic buffering)
p0210	**Device supply voltage** (factory setting: 400 V)	
p1240	**V_{DC} controller configuration** (factory setting: 1)	
	0	Inhibit V_{DC} controller
	1	Enable $V_{DC\ max}$ controller
	2	Enable $V_{DC\ min}$ controller (kinetic buffering)
	3	Enable $V_{DC\ min}$ controller and $V_{DC\ max}$ controller
p1245	**$V_{DC\ min}$ controller activation level** (kinetic buffering) (factory setting: 76 %)	
r1246	**$V_{DC\ min}$ controller activation level**[V] r1246 = p1245 × √2 × p0210	
p1247	**$V_{DC\ min}$ controller dynamic factor** (factory setting: 300 %)	
p1255	**$V_{DC\ min}$ controller time threshold** (factory setting: 0 s) Maximum duration of the kinetic buffering If kinetic buffering lasts longer than that specified in the parameter value, the inverter outputs fault F7406. A value of 0 deactivates the monitoring.	
p1257	**$V_{DC\ min}$ controller speed threshold** (factory setting: 50 rpm) When fallen below, the inverter outputs fault F7405.	

8.7.8 PID technology controller

8.7.8.1 Overview

The technology controller controls process variables, e.g. pressure, temperature, level or flow.

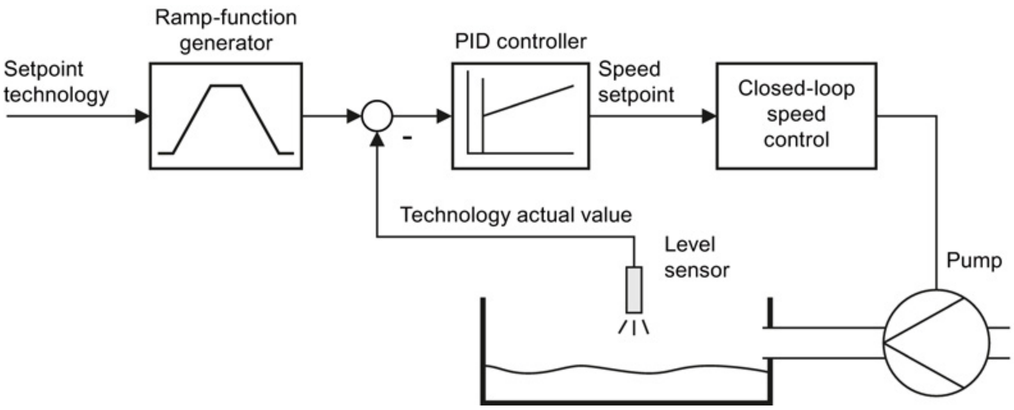


Figure 8-30 Example: Technology controller as a level controller

8.7.8.2 Setting the controller

Simplified representation of the technology controller

The technology controller is implemented as PID controller (controller with proportional, integral and differential component) and so can be adapted very flexibly.

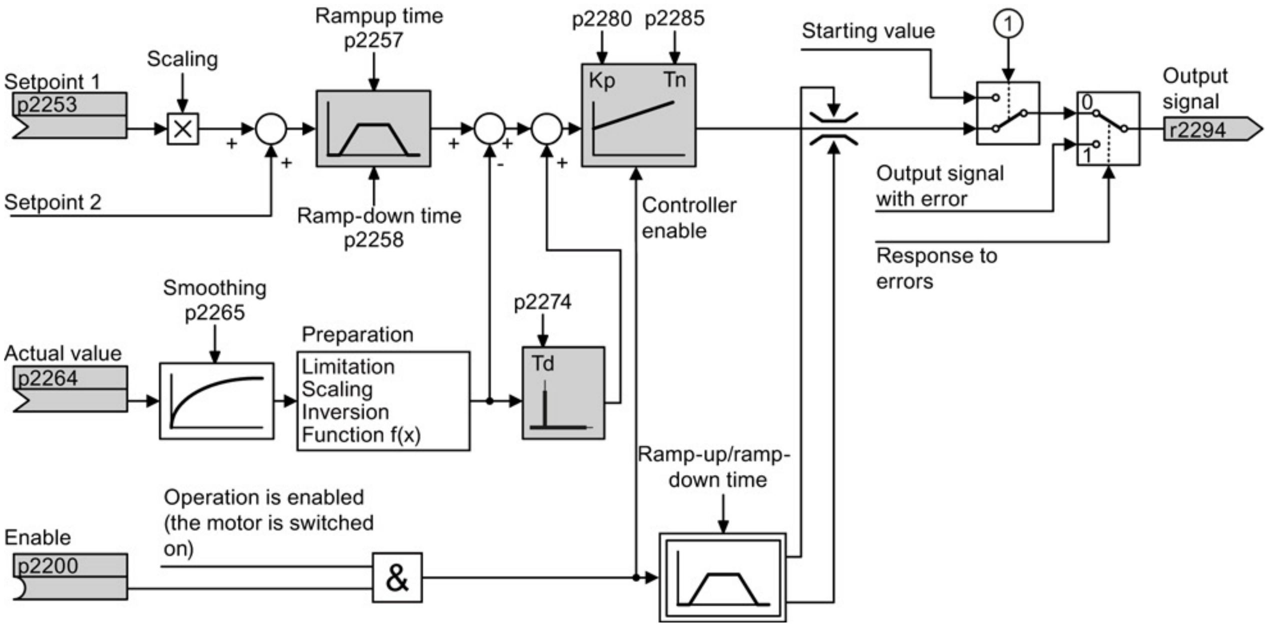


Figure 8-31 Simplified representation of the technology controller

① The inverter uses the start value if the following conditions are met simultaneously:

- The technology controller supplies the main setpoint (p2251 = 0).
- The ramp-function generator output of the technology controller has not yet reached the start value.

Setting the technology controller

Parameter	Remark
p2200 = 1	Enable technology controller.
p1070 = 2294	Interconnect the main speed setpoint with the output of the technology controller.
p2253	Define the setpoint for the technology controller. Example: p2253 = 2224: The inverter interconnects the fixed setpoint p2201 with the setpoint of the technology controller. p2220 = 1: The fixed setpoint p2201 is selected.
p2264	Define the setpoint for the technology controller.
p2257, p2258	Define the ramp-up and ramp-down times [s]
p2274	Differentiation time constant [s] The differentiation improves the rise time characteristics for very slow controlled variables, e.g. a temperature control. p2274 = 0: The differentiation is switched off.
p2280	Proportional gain K_P
p2285	Integral time T_N [s] Without an integral time, the controller cannot completely equalize deviations between the setpoint and actual value. p2285 = 0: The integral time is switched off.

Advanced settings

Parameter	Remark
Limiting the output of the technology controller In the factory setting, the output of the technology controller is limited to ± maximum speed. You must change this limit, depending on your particular application. Example: The output of the technology controller supplies the speed setpoint for a pump. The pump should only run in the positive direction.	
p2297 = 2291	Interconnect the upper limit with p2291.
p2298 = 2292	Interconnect the lower limit with p2292.
p2291	Upper limit for the technology controller output e.g.: p2291 =100
p2292	Lower limit for the technology controller output e.g.: p2292 = 0
Manipulating the actual value of the technology controller	
p2267, p2268	Limit the actual value
p2269	Scale the actual value
p2271	Invert the actual value
p2270	Actual value

For further information refer to the function block diagrams 7950 ff of the List Manual.

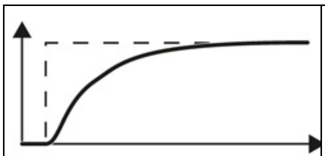
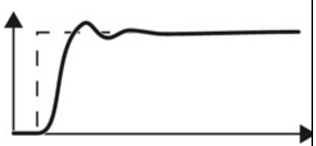
8.7.8.3 Optimizing the controller

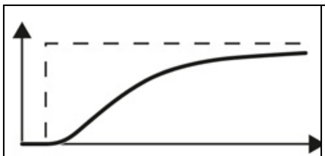
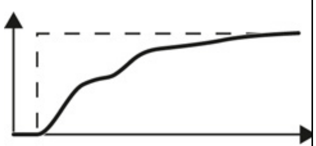
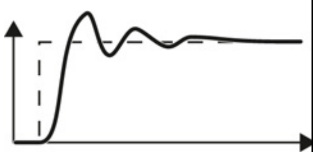
Setting the technology controller from a practical perspective

Procedure

Proceed as follows to set the technology controller:

1. Temporarily set the ramp-up and ramp-down times of the ramp-function generator (p2257 and p2258) to zero.
2. Enter a setpoint step and monitor the associated actual value, e.g. with the trace function of STARTER.
   The slower the response of the process to be controlled, the longer you must monitor the controller response. Under certain circumstances (e.g. for a temperature control), you need to wait several minutes until you can evaluate the controller response.

	**Optimum controller response for applications that do not permit any overshoot.** The actual value approaches the setpoint without any significant overshoot.
	**Optimum controller behavior for fast correction and quick compensation of disturbance components.** The actual value approaches the setpoint and slightly overshoots, maximum 10% of the setpoint step.

	**The actual value only slowly approaches the setpoint.** • Increase the proportional component K_P and reduce the integration time T_N.
	**Actual value only slowly approaches the setpoint with slight oscillation.** • Increase the proportional component K_P and reduce the rate time T_D (differentiating time).
	**The actual value quickly approaches the setpoint, but overshoots too much.** • Decrease the proportional component K_P and increase the integration time T_N.

3. Set the ramp-up and ramp-down times of the ramp-function generator back to their original value.

You have now set the technology controller.

8.7.9 Monitoring the load torque (system protection)

In many applications, it is advisable to monitor the motor torque:

- Applications where the load speed can be indirectly monitored by means of the load torque. For example, in fans and conveyor belts with too low a torque indicates that the drive belt is torn.
- Applications that are to be protected against overload or locking (e.g. extruders or mixers).
- Applications in which no-load operation of the motor represents an impermissible situation (e.g. pumps).

Load torque monitoring functions

The inverter monitors the motor torque in different ways:

- No-load monitoring
  The inverter generates a message if the motor torque is too low.
- Blocking protection:
  The inverter generates a message if the motor speed cannot track the speed setpoint despite generating maximum torque.
- Stall protection
  The inverter generates a message if the motor stalls and no longer generates a torque.
- Speed-dependent torque monitoring
  The inverter measures the actual torque and compares it with a set speed/torque characteristic.

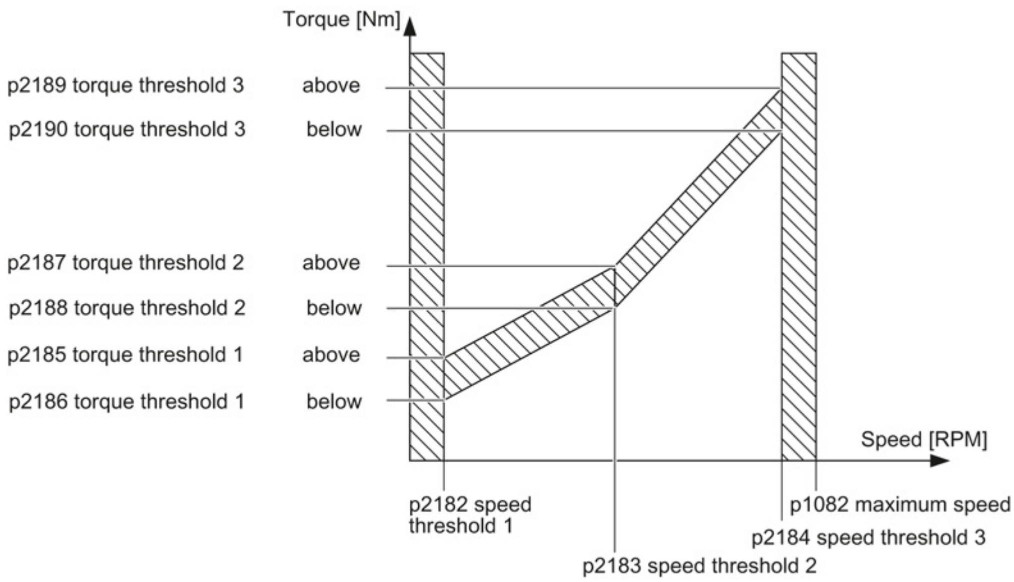


Figure 8-32 Load torque monitoring

Parameter	Description
No-load monitoring	
p2179	**Current limit for no-load detection** If the inverter current is below this value, the message "no load" is output.
p2180	**Delay time for the "no load" message**
Blocking protection	
p2177	**Delay time for the "motor locked" message**
Stall protection	
p2178	**Delay time for the "motor stalled" message**
p1745	**Deviation of the setpoint from the actual value of the motor flux as of which the "motor stalled" message is generated** This parameter is only evaluated as part of encoderless vector control.
Speed-dependent torque monitoring	
p2181	**Load monitoring, response** Setting the response when evaluating the load monitoring. 0: Load monitoring disabled >0: Load monitoring enabled
p2182	**Load monitoring, speed threshold 1**
p2183	**Load monitoring, speed threshold 2**
p2184	**Load monitoring, speed threshold 3**
p2185	**Load monitoring, torque threshold 1, upper**
p2186	**Load monitoring, torque threshold 1, lower**
p2187	**Load monitoring, torque threshold 2, upper**
p2188	**Load monitoring, torque threshold 2, lower**
p2189	**Load monitoring, torque threshold 3, upper**
p2190	**Load monitoring torque threshold 3, lower**
p2192	**Load monitoring, delay time** Delay time for the message "Leave torque monitoring tolerance band"

Additional information about these functions is provided in the function diagrams 8012 and 8013 as well as in the parameter list of the List Manual.

8.7.10 Load failure monitoring

Load failure

Using this function, the inverter monitors the speed or velocity of a machine component. The inverter evaluates whether an encoder signal is present. If the encoder signal fails for a time that can be adjusted, then the inverter signals a fault.

Examples of how the function can be used:

- Gearbox monitoring for traction drives and hoisting gear
- Drive belt monitoring for fans and conveyor belts
- Blocking protection for pumps and conveyor belts

Figure 8-33 Function plan and time response of load-interruption monitoring

Parameter	Description
p2192	**Load monitoring delay time** (factory setting 10 s) After the motor is switched on, if the "LOW" signal is present at the associated digital input for longer than this time, the inverter signals a load failure (F07936).
p2193 = 1…3	**Load monitoring configuration** (factory setting: 1) 0: Monitoring is deactivated 1: Torque monitoring (see Monitoring the load torque (system protection) (Page 219)) and load failure 2: Speed deviation monitoring (see below) and load failure 3: Load failure monitoring
p3232 = 722.x	**Load monitoring failure detection** (factory setting: 1) Connect the load monitoring to a DI x digital input of your choice.

For more information, see the List Manual (the parameter list and function diagram 8013).

8.7.11 Speed deviation monitoring

Speed deviation

Using this function, the inverter calculates and monitors the speed or velocity of a machine component. The inverter analyzes an encoder signal, calculates a speed from the signal, compares it to the motor speed and reports any excessive deviation between the encoder signal and the motor speed.

Examples of how the function can be used:

- Gearbox monitoring for traction drives and hoisting gear
- Drive belt monitoring for fans and conveyor belts
- Blocking protection for conveyor belts

You require a transmitter for this function, e.g. a proximity switch. The inverter analyzes an encoder signal at max. 32 kHz.

The function is only available with the CU240E-2 Control Unit via digital input DI 3.

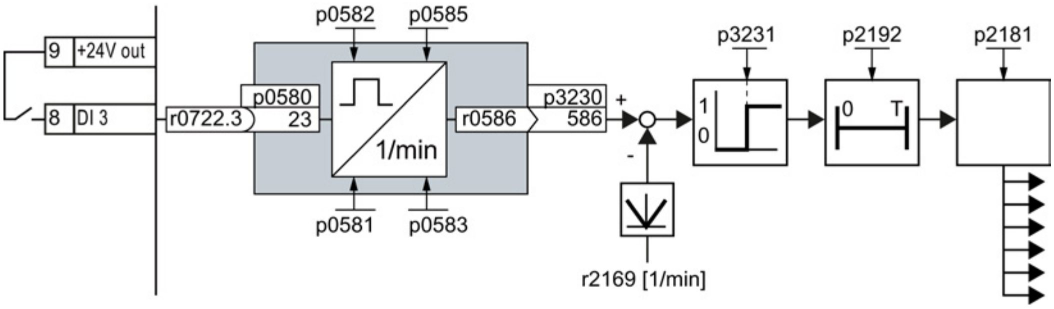


Figure 8-34 Speed deviation monitoring

The inverter determines the speed deviation from the calculated speed r0586 and the speed list value r2169. p2181 determines the response of the inverter if the deviation is excessive.

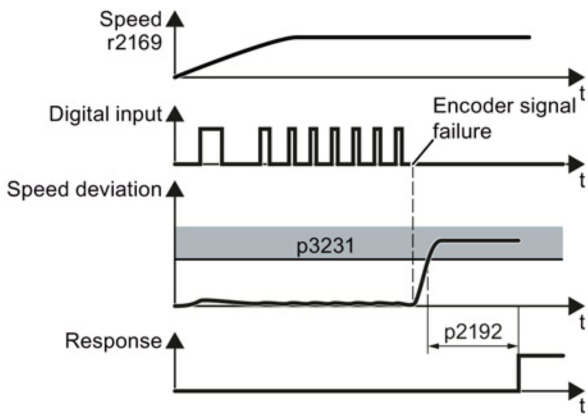


Figure 8-35 Time response of monitoring speed deviation

Parameter	Description
p0490	**Invert probe** [1)] (factory setting 0000bin) Using the 3rd bit of the parameter value, invert the input signals of digital input 3 for the probe.
p0580	**Probe** [1)] **Input terminal** (factory setting 0) Connect input of probe with a digital input.
p0581	**Probe** [1)] **Edge** (factory setting 0) Edge for analyzing the probe signal for measuring speed list value 0: 0/1 edge 1: 1/0 edge
p0582	**Probe** [1)] **Pulse per revolution** (factory setting 1) Number of pulses per revolution
p0583	**Probe** [1)] **Maximum measurement time** (factory setting 10 s) Maximum measurement time for the probe If there is no new pulse before the maximum measuring time elapses, the inverter sets the actual speed value in r0586 to zero. The time is restarted with the next pulse.
p0585	**Probe** [1)] **Gear ratio** (factory setting 1) The inverter multiplies the measured speed by the gear ratio before displaying it in r0586.
r0586	**Probe** [1)] **Speed list value** Result of the speed calculation
p2181	**Load monitoring response** (factory setting 0) Response for evaluating load monitoring.
	0 Load monitoring disabled
	1 A07920 for speed too low
	2 A07921 for speed too high
	3 A07922 for speed outside tolerance
	4 F07923 for speed too low
	5 F07924 for speed too high
	6 F07925 for speed outside tolerance
p2192	**Load monitoring delay time** (factory setting 10 s) Delay time for evaluating load monitoring.
p2193 = 2	**Load monitoring configuration** (factory setting: 1) 2: Speed deviation and load failure monitoring.
p3230 = 586	**Load monitoring actual speed value** (factory setting 0) Result of the speed calculation with the evaluation of the speed monitoring.
p3231	**Load monitoring speed deviation** (factory setting 150 rpm) Permissible speed deviation of load monitoring.

[1)] The "Probe" subfunction calculates the speed from the pulse signal of the digital input.

For more information, see the List Manual (the parameter list and function diagram 8013).

8.7.12 Free function blocks

8.7.12.1 Overview

The free function blocks permit configurable signal processing in the inverter.

The following free function blocks are available:

- AND, OR, XOR, and NOT logic
- RSR (RS flip-flop), DSR (D flip-flop) flip-flops
- Timers MFP (pulse generator), PCL (pulse shortening), PDE (ON delay), PDF (OFF delay), and PST (pulse stretching)
- ADD (adder), SUB (subtractor), MUL (multiplier), DIV (divider), AVA (absolute value generated), NCM (comparator), and PLI (polyline) arithmetic functions
- LIM (limiter), PT1 (smoothing), INT (integrator), DIF (differentiator) controllers
- NSW (analog) BSW (binary) switches
- LVM limit value monitoring

The number of free function blocks in the inverter is limited. You can only use a function block once. The inverter has 3 adders, for instance. If you have already configured three adders, then no other adders are available.

8.7.12.2 Further information

Example

You can find an example for using the free function blocks in Chapter Interconnecting signals in the inverter (Page 357).

Application description for the free function blocks

See also: FAQ (http://support.automation.siemens.com/WW/view/en/85168215)

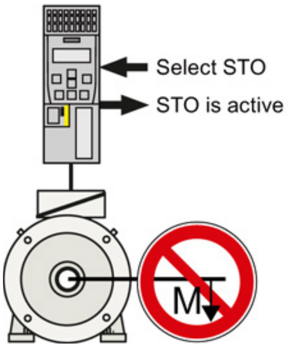
8.8 Safe Torque Off (STO) safety function

These operating instructions describe the commissioning of the STO safety function when it is controlled via a fail-safe digital input.

You will find a detailed description of all safety functions and control using PROFIsafe in the Safety Integrated Function Manual, see Section Manuals for your inverter (Page 368).

8.8.1 Function description

How does the STO safety function work?



The inverter with active STO function prevents machine components from inadvertently starting.

Table 8- 34 The principle of operation of STO

	Safe Torque Off (STO)	Standard inverter functions linked with STO
1.	The inverter recognizes the selection of STO via a safety-relevant input or via the PROFIsafe safe communication.	---
2.	The inverter prevents energy from being fed to the motor. When STO is active, the motor does not generate any torque.	If you use a motor holding brake, the inverter closes the brake.
3.	The inverter signals that "STO is active" via a safety-relevant output or via the PROFIsafe safe communication.	---

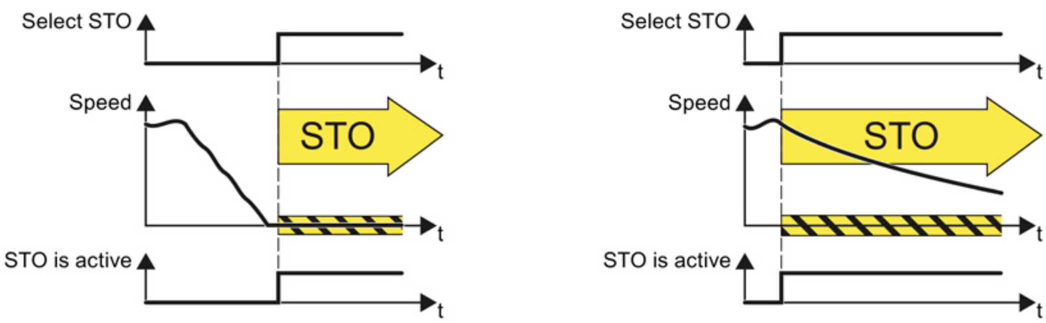


Figure 8-36 Functionality of STO when motor is rotating and at a standstill

If the motor is still rotating when STO is selected, then it coasts down to standstill.

The STO safety function is standardized

The STO function is defined in IEC/EN 61800-5-2:

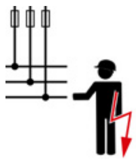
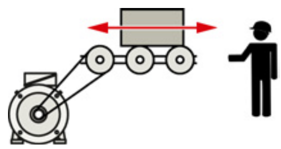
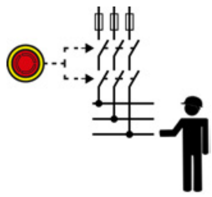
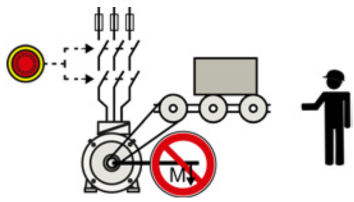
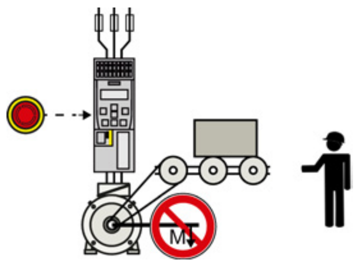
"[…] [The inverter] does not supply any energy to the motor which can generate a torque (or for a linear motor, a force)."

The STO inverter function complies with what is defined in the standard.

The distinction between 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.

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 restarting** Stopping or preventing the dangerous movement
Command:	**Emergency Off**	**Emergency Stop**
Classic solution:	Switch of the power supply: 	Switch-of the drive power supply: 
Solution with the STO safety function integrated in the drive:	STO is not suitable for safely switching of an electric voltage.	Select STO:  It is permissible that you switch of the inverter supply voltage as well. However, switching off the voltage is not required as a risk-reduction measurement.

Application examples for the STO function

The STO function is suitable for applications where the motor is already at a standstill or will come to a standstill in a short, safe period of time through friction. STO does not shorten the run-on of machine components with high inertia.

Examples	Possible solution
When the Emergency Stop button is pressed, a stationary motor should not unintentionally start.	• Wire the Emergency Stop button to a safety-related input of the inverter. • Select STO via the safety-related input.
A central emergency stop button must prevent the unintentional acceleration of several motors that are at a standstill.	• Evaluate the Emergency Stop button in a central control. • Select STO via PROFIsafe.

8.8.2 Prerequisite for STO use

In order to use the STO safety function, the machine manufacturer should have already performed a risk assessment, e.g. in compliance with EN ISO 1050, "Safety of machinery - Principles of risk assessment". The risk assessment must confirm that the inverter is permitted for use in accordance with SIL 2 or PL d.

8.8.3 Commissioning STO

8.8.3.1 Commissioning tools

We strongly recommend that you commission the safety functions using a PC tool.

If you use a PC tool for commissioning, then you set the functions using the graphic screen forms and you do not have to work with parameters. In this case, you can ignore the parameter tables in the following sections.

Table 8- 35 PC-based commissioning tools

Tool	Can be downloaded at no charge	Order number
STARTER	STARTER (http://support.automation.siemens.com/WW/view/en/10804985/130000)	6SL3072-0AA00-0AG0
Startdrive	Startdrive (http://support.automation.siemens.com/WW/view/en/68034568)	6SL3072-4CA02-1XG0

Commissioning the safety functions with STARTER is subsequently described.

A tutorial is available for Startdrive: Startdrive tutorial (http://support.automation.siemens.com/WW/view/en/73598459).

8.8.3.2 Protection of the settings from unauthorized changes

The safety functions are protected against unauthorized changes by a password.

Table 8- 36 Parameter

No.	Description
p9761	**Entering a password** (factory setting 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.
p9762	**New password**
p9763	**Confirm password**

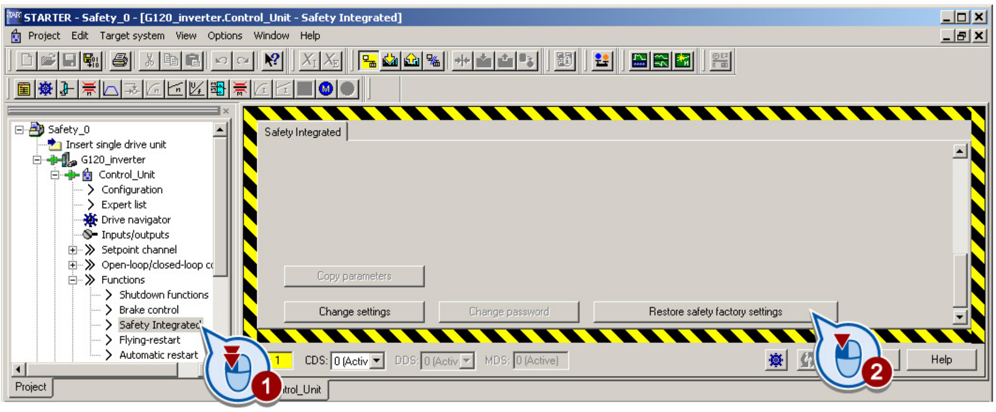
8.8.3.3 Resetting the safety function parameters to the factory setting

Procedure

1
2

To reset the safety function settings to the factory setting without changing the standard settings, proceed as follows:

1. Go online with STARTER
2. Open the screen form for the safety functions ①.



3. Press the button to restore the factory settings ②.
4. Enter the password,for the safety functions.
5. Confirm saving parameters (RAM to ROM).
6. Go offline with STARTER .
7. Switch off the inverter supply voltage.
8. Wait until all LED on the inverter go dark. Now switch on the inverter supply voltage again (power on reset).

You have restored the safety functions in the inverter to the factory settings.

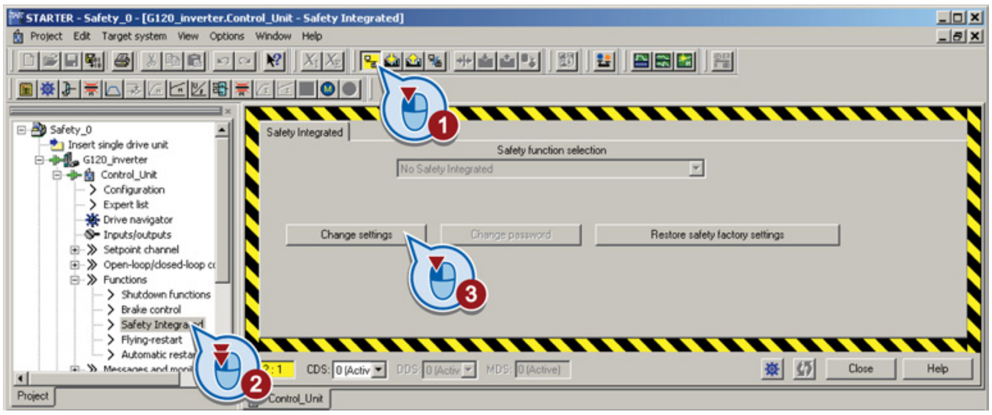
Parameters	Description	
p0010	**Drive, commissioning parameter filter**	
	0	Ready
	30	Parameter reset
p9761	**Enter a password** (factory setting: 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.	
p9762	**New password**	
p9763	**Password confirmation** Confirming the new Safety Integrated password.	
p0970	**Reset drive parameters**	
	5	Starts a safety parameter reset. After the reset, the inverter sets p0970 = 0.

8.8.3.4 Changing settings

Procedure

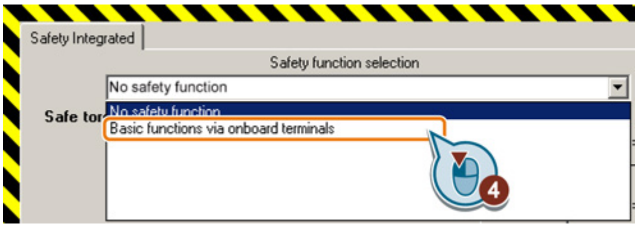
To start commissioning the safety functions, proceed as follows:

1. Go online with STARTER
2. In STARTER, select the fail-safe functions.
3. Select "Change settings".



Parameter	Description
p0010 = 95	**Drive commissioning parameter filter** Safety Integrated commissioning
p9761	**Enter a password** (factory setting: 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.
p9762	**New password**
p9763	**Confirm password**

4. Selecting "STO via terminal":



You have completed the following commissioning steps:

- You have started to commission the safety functions.
- You have selected the basic functions with control via onboard terminals of the inverter.

Table 8- 37 Parameter

Parameter	Description	
p9601	**Enable functions integrated in the drive** (factory setting: 0000 bin)	
	p9601 = 0	Safety functions integrated in the drive inhibited
	p9601 = 1	Enable basic functions via onboard terminals

The other selection options are described in the "Safety Integrated Function Manual". See also Section: Manuals for your inverter (Page 368).

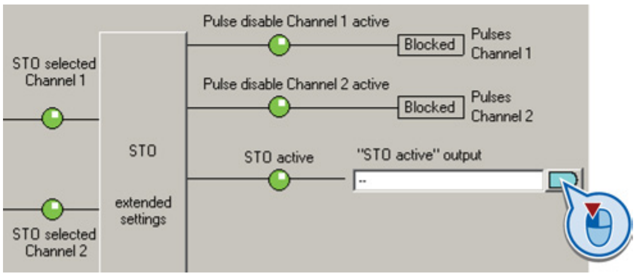
8.8.3.5 Interconnecting the "STO active" signal

If you require the feedback signal "STO active" of the inverter in your higher-level control system, then you must appropriately interconnect the signal.

Procedure

To interconnect the "STO active" checkback signal, proceed as follows:

1. Select the button for the feedback signal.



2. In the following selection menu, select the appropriate setting for your particular application.

You have interconnected the "STO active" checkback signal. The inverter signals "STO active" to the higher-level control after STO has been selected.

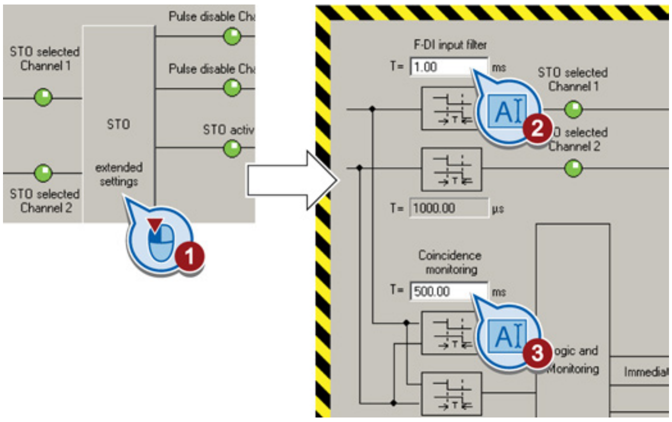
Parameter	Description
r9773.01	**1 signal**: STO is active in the drive

8.8.3.6 Setting the filter for safety-related inputs

Procedure

To set the input filter and simultaneity monitoring of the safety-related input, proceed as follows:

1. Select the advanced settings for STO.



2. Set the debounce time for the F-DI input filter.
3. Set the discrepancy for the simultaneity monitoring.
4. Close the screen form.

You have set the input filter and the simultaneity monitoring of the safety-related input.

Description of the signal filter

The following are available for the signal processing of the safety-related inputs:

- A tolerance for the simultaneous monitoring.
- A filter to suppress short signals, e.g. test pulses.

A tolerance for the simultaneous monitoring

The inverter checks whether the signals at both inputs always have the same signal status (high or low).

With electromechanical sensors (e.g. emergency stop buttons or door switches), the two sensor contacts never switch at exactly the same time and are therefore temporarily inconsistent (discrepancy). A long-term discrepancy indicates a fault in the wiring of a safety-related input, e.g. a wire break.

When appropriately set, the inverter tolerates brief discrepancies.

The tolerance time does not extend the inverter response time. The inverter selects its safety function as soon as one of the two F-DI signals changes its state from high to low.

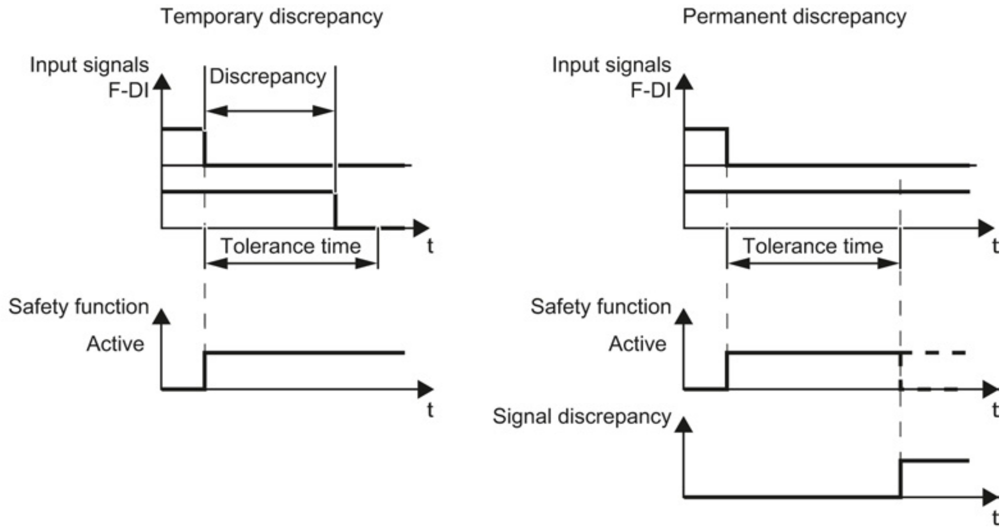


Figure 8-37 Tolerance regarding discrepancy

Filter to suppress short signals

The inverter normally responds immediately to signal changes at its safety-related inputs. This is not required in the following cases:

- When you interconnect a safety-related input of the inverter with an electromechanical sensor, contact bounce may result in signal changes occurring, to which the inverter responds.
- Several control modules test their safety-related outputs using bit pattern tests (light/darkness tests) to identify faults due to either short-circuiting or cross circuiting. When you interconnect a safety-related input of the inverter with a safety-related output of a control module, the inverter responds to these test signals.
  A signal change during a bit pattern test usually lasts:
  - On test: 1 ms
  - Off test: 4 ms

If the safety-related input signals too many signal changes within a certain time, then the inverter responds with a fault.

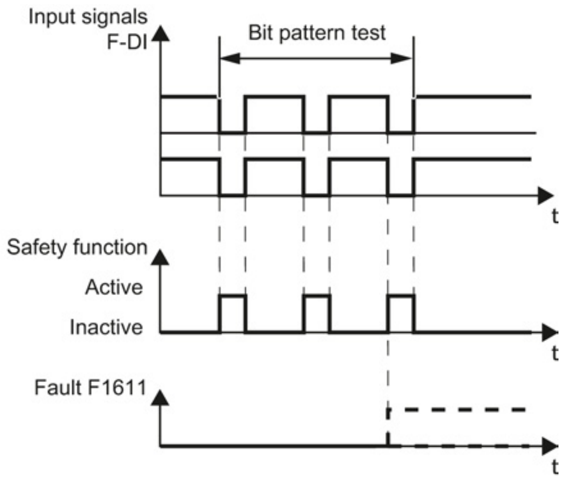


Figure 8-38 Inverter response to a bit pattern test

An adjustable signal filter in the inverter suppresses temporary signal changes using bit pattern test or contact bounce.

The filter increases the inverter response time. The inverter only selects its safety function after the debounce time has elapsed.

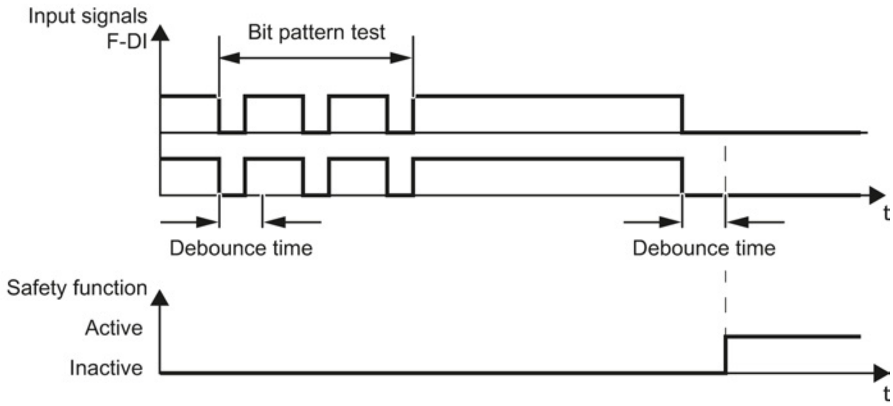


Figure 8-39 Filter for suppressing temporary signal changes

Parameter	Description
p9650	**F-DI changeover tolerance time** (factory setting: 500 ms) Tolerance time to change over the fail-safe digital input for the basic functions.
p9651	**STO debounce time** (factory setting: 1 ms) Debounce time of the fail-safe digital input for the basic functions.

Debounce times for standard and safety functions

The debounce time p0724 for "standard" digital inputs has no influence on the fail-safe input signals. Conversely, the same applies: The F-DI debounce time does not affect the signals of the "standard" inputs.

If you use an input as a standard input, set the debounce time using parameter p0724 .

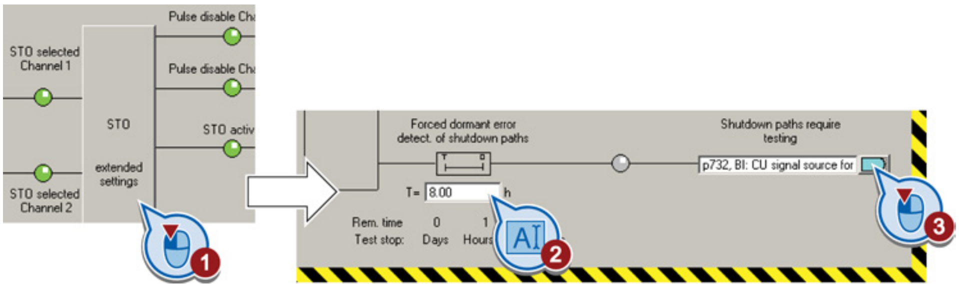
If you use an input as a fail-safe input, set the debounce time as described above.

8.8.3.7 Setting the forced checking procedure (test stop)

Procedure

To set the forced checking procedure (test stop) of the basic functions, proceed as follows:

1. Select the advanced settings for STO.



2. Set the monitoring time to a value to match your application.
3. Using this signal, the inverter signals that a forced checking procedure (test stop) is required.

   Interconnect this signal with an inverter signal of your choice.

You have set the forced checking procedure (test stop) for the basic functions.

Description

The forced checking procedure (test stop) of the basic functions is an inverter self test. The inverter checks its circuits to switch off the torque. If you are using the Safe Brake Relay, for a forced checking procedure, the inverter also checks the circuits of this component.

You start the forced checking procedure each time that the STO function is selected.

Using a timer block, the inverter monitors as to whether the forced checking procedure is regularly performed.

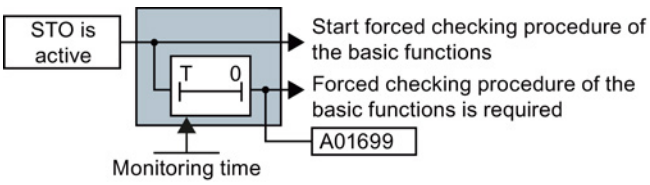


Figure 8-40 Starting and monitoring the forced checking procedure (test stop)

Parameter	Description
p9659	**Forced dormant error detection timer** (Factory setting: 8 h) Monitoring time for the forced dormant error detection.
r9660	**Forced dormant error detection remaining time** Displays the remaining time until the forced dormant error detection and testing the safety switch-off signal paths.
r9773.31	**1 signal: Forced dormant error detection is required** Signals for the higher-level control system.

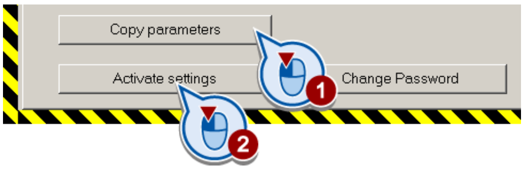
8.8.3.8 Activate settings

Activate settings

Procedure

To activate the settings for the safety functions, proceed as follows:

1. Press the "Copy parameters" button, to create a redundant image of your inverter settings.



2. Press the "Activate settings" button.
3. If the password is the factory default, you are prompted to change the password.
   If you try to set a password that is not permissible, the old password will not be changed.
4. Confirm the prompt for saving your settings (copy RAM to ROM).
5. Switch off the inverter supply voltage.
6. Wait until all LEDs on the inverter go dark (no voltage condition).
7. Switch on the inverter supply voltage again.

Your settings are now active.

Parameter	Description
p9700 = D0 hex	**SI copy function** (factory setting: 0) Starting the SI parameter copy function.
p9701 = DC hex	**Confirm data change** (factory setting: 0) Confirm SI basic parameter change.
p0010 = 0	**Drive commissioning parameter filter** 0: Ready
p0971 = 1	**Save parameter** 1: Save the drive object (copy from RAM to ROM) After the inverter has saved the parameters in a non-volatile fashion, then p0971 = 0.

8.8.3.9 Checking the assignment of the digital inputs

Checking the connection of digital inputs

The simultaneous connection of digital inputs with a safety function and a "standard" function may lead to the drive behaving in unexpected ways.

If you control the safety functions in the inverter using digital inputs, you must check whether these digital inputs are connected to a "standard" function.

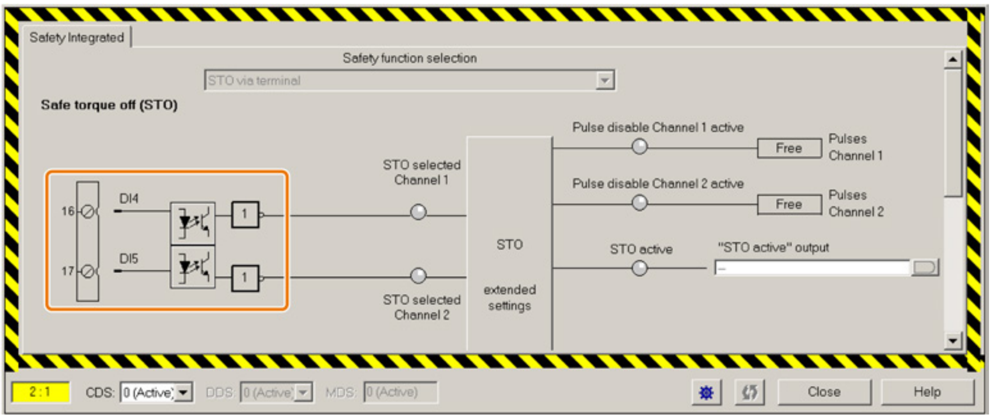


Figure 8-41 Example: Assignment of digital inputs DI 4 and DI 5 with STO

Procedure

In order to prevent the safety-related inputs of the safety functions unintentionally controlling "standard" functions in the inverter, proceed as follows:

1. Select the inputs/outputs in STARTER in the project navigator.
2. Select the screen for the digital inputs.
3. Remove all digital input interconnections that you use as safety-related input F-DI:
4. If you use the CDS dataset switchover, you must delete the digital input connections for all CDS.

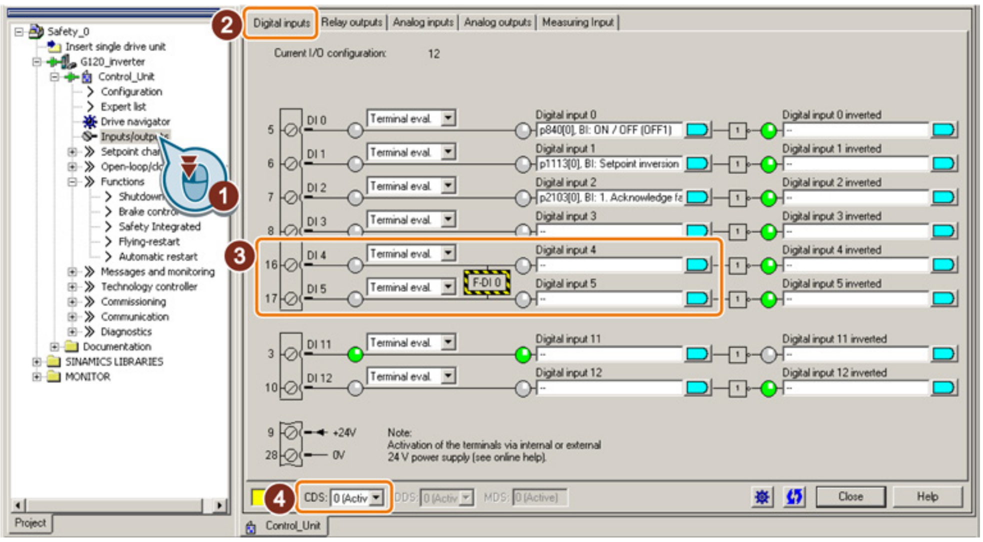


Figure 8-42 Removing the DI 4 and DI 5 digital-input connections

You have now prevented safety-related inputs in the safety functions controlling "standard" functions in the inverter.

8.8.3.10 Approval - completing commissioning

What is an acceptance?

The machine manufacturer is responsible in ensuring that his plant or machine functions perfectly. As a consequence, after commissioning, the machine manufacturer must check those functions or have them checked by specialist personnel, which represent an increased risk of injury to personnel or material damage. This acceptance or validation is, for example, also specified in the European machinery directive and essentially comprises two parts:

- Checking the safety-relevant functions and machine parts.

  → **Acceptance test**.
- Generate an "Acceptance report" that describes the test results.

  → **Documentation**.

Supply information for the validation, e.g. the harmonized European standards EN ISO 13849-1 and EN ISO 13849-2.

Acceptance test of the machine or plant

The acceptance test checks whether the safety-relevant functions in the plant or machine function correctly. The documentation of the components used in the safety functions can also provide information about the necessary tests.

Testing the safety-related functions includes e.g. the following:

- Are all safety equipment such as protective door monitoring devices, light barriers or emergency-off switches connected and ready for operation?
- Does the higher-level control respond as expected to the safety-relevant feedback signals of the inverter?
- Do the inverter settings match the configured safety-relevant function in the machine?

Acceptance test of the inverter

The acceptance test of the inverter is a part of the acceptance test of the entire machine or plant.

The acceptance test of the inverter checks whether the integrated drive safety functions are set up correctly for the planned safety function of the machine.

You can find examples for the acceptance test of integrated drive safety functions in section: Acceptance tests for the safety functions (Page 362).

Documentation of the inverter

The following must be documented for the inverter:

- The results of the acceptance test.
- The settings of the integrated drive safety functions.

  The commissioning tool STARTER logs the settings of the integrated drive functions, if necessary. See also Section: Documents for acceptance (Page 238).

The documentation must be signed.

Who may perform the acceptance test of the inverter?

Personnel from the machine manufacturer, who, on account of their technical qualifications and knowledge of the safety functions, are in a position to perform the acceptance test in the correct manner are authorized to perform the acceptance testing of the inverter.

Reduced acceptance test after function expansions

A full acceptance test is necessary only after first commissioning. A reduced acceptance test is sufficient when safety functions are expanded.

Measure	Acceptance test	
	Acceptance test	Documentation
Functional expansion of the machine (additional drive).	Yes. Only check the safety functions of the new drive.	• Supplement machine overview • Supplement inverter data • Add function table • Log the new checksums • Countersignature
Transfer of inverter settings to other identical machines by means of series commissioning.	No. Only check the control of all of the safety functions.	• Add machine description • Check checksums • Check firmware versions

Documents for acceptance

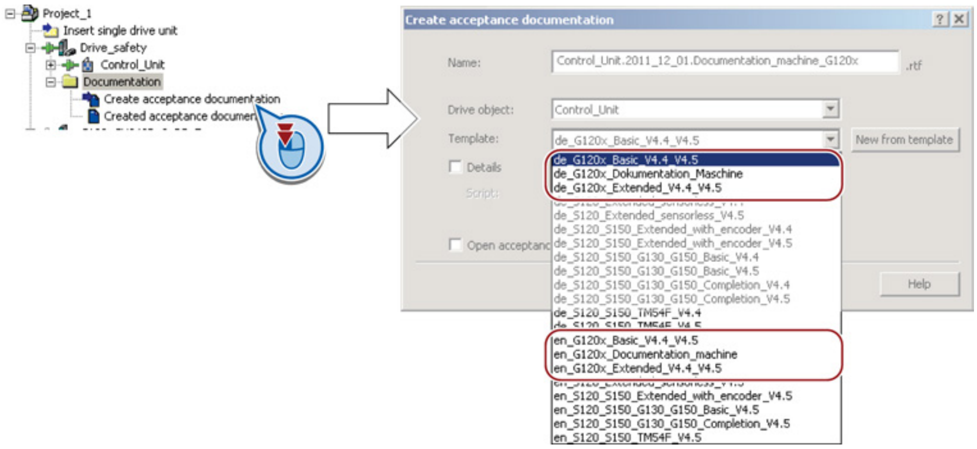
The STARTER provides you with a number of documents to be regarded as a recommendation for the acceptance tests of the safety functions.

Procedure

1
2

Proceed as follows to create the acceptance documentation for the drive using STARTER:

1. In STARTER, select "Create acceptance documentation":



   STARTER has templates in German and English.

2. Select the suitable template and create a report for each drive of your machine or system:
   – Template for the machine documentation:

     de_G120x_Dokumentation_Maschine: German template.

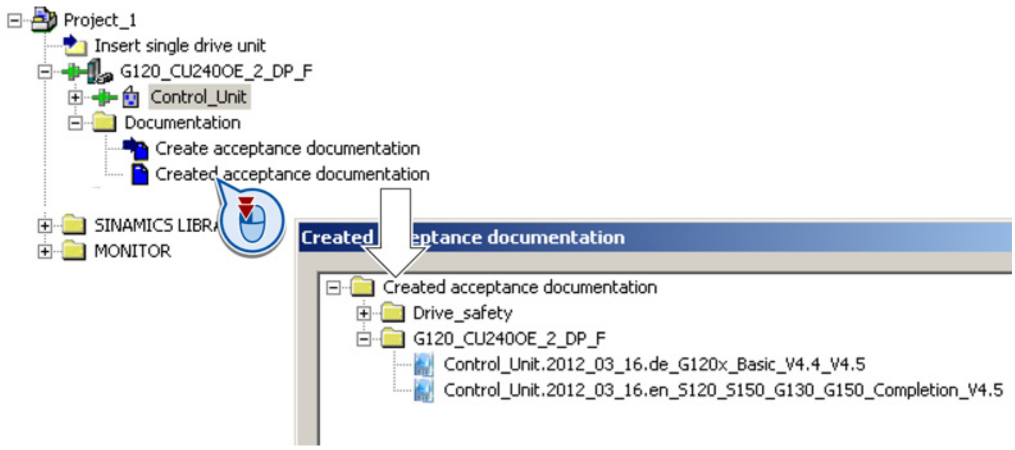
     en_G120x_Documentation_machine: English template.

   – Report of the settings for the basic functions, from firmware version V4.4 onwards:

     de_G120x_Basicc_V4.4…: German report.

     en_G120x_Basic_V4.4…: English report.

3. You load the created reports for archiving and the machine documentation for further processing:



4. Archive the reports and the machine documentation.

You have generated the documents to accept the safety functions.

The reports and the machine documentation can also be found in the section: Acceptance tests for the safety functions (Page 362).

8.9 Switchover between different settings

There are applications that require different inverter settings.

Example:

You connect different motors to one inverter. Depending on the particular motor, the inverter must operate with the associated motor data and the appropriate ramp-function generator.

Drive data sets (DDS)

Your can set several inverter functions differently and then switch over between the different settings.

The associated parameters are indexed (index 0, 1, 2 or 3). Using control commands select one of the four indexes and therefore one of the four saved settings.

The settings in the inverter with the same index are called the drive data set.

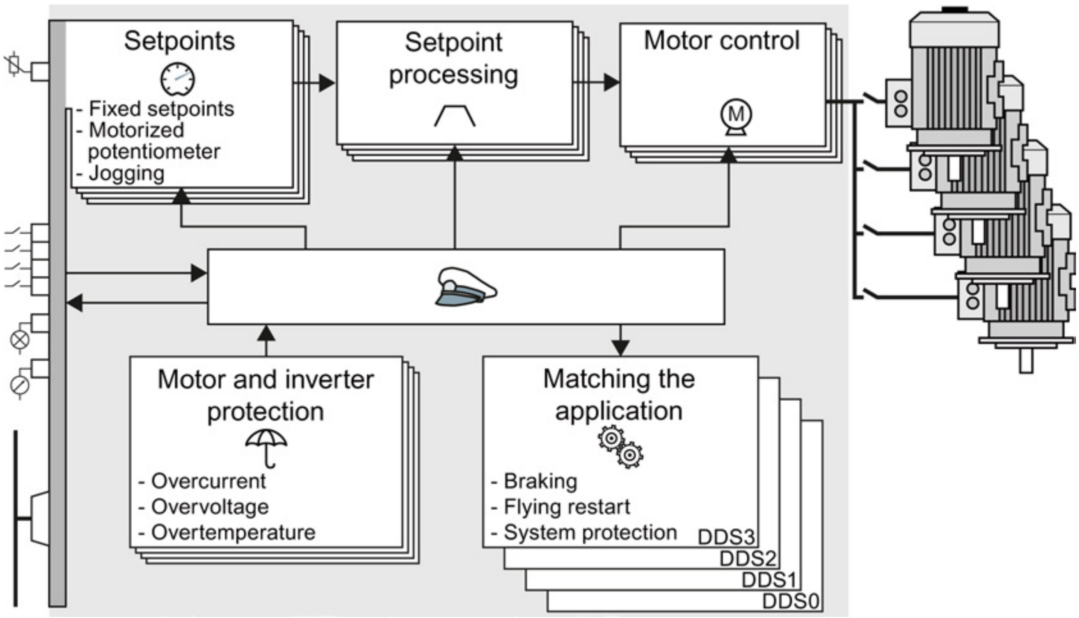


Figure 8-43 Switching over between different settings using drive data sets (DDS)

Using parameter p0180 you can define the number of drive data sets (1 ... 4).

Table 8- 38 Selecting the number of **drive data sets**

Parameter	Description
p0010 = 15	**Drive commissioning:** Data sets
p0180	**Drive data sets (DDS) number**(factory setting: 1)
p0010 = 0	**Drive commissioning:** Ready

Table 8- 39 Parameters for switching the drive data sets:

<table>
<tr><th>Parameter</th><th colspan="2">Description</th></tr>
<tr><td>p0820[0…n]</td><td>Drive data set selection DDS bit 0</td><td rowspan="2">If you use several command data sets CDS, then you must set this parameter for each CDS. The parameters are assigned to a CDS through their index:
CDS0: p0820[0], p0821[0]
CDS1: p0820[1], p0821[1]
…</td></tr>
<tr><td>p0821[0…n]</td><td>Drive data set selection DDS bit 1</td></tr>
<tr><td>p0826</td><td colspan="2">Motor changeover, motor number
Each drive data set is assigned a motor number:
p0826[0] = motor number for drive data set 0.
…
p0826[3] = motor number for drive data set 3.
If you operate the same motor with different drive data sets, then you must enter the same motor number in every index of parameter p0826. In this particular case, you can also switch over between the different drive data sets in operation.
If you operate different motors on one inverter, then you must number the motors in parameter p0826. In this case, you may only switch over the drive data sets in the "ready for operation" state with the motor switched-off. The switchover time is approx. 50 ms.</td></tr>
<tr><td>r0051</td><td colspan="2">Displaying the number of the DDS that is currently effective</td></tr>
</table>

For an overview of all the parameters that belong to the drive data sets and can be switched, see the List Manual.

Table 8- 40 Parameters for copying the drive data sets

Parameter	Description
p0819[0]	**Source drive data set**
p0819[1]	**Target drive data set**
p0819[2] = 1	**Start copy operation**

For more information, see the List Manual (the parameter list and function diagram 8565).

9 Backing up data and series commissioning

External data backup

After commissioning, your settings are saved in the converter so that they are protected against power failure.

We recommend that you additionally back up the settings on a storage medium outside the converter. Without backup, your settings could be lost if the converter developed a defect (see also Replacing the Control Unit without data backup (Page 269)).

The following storage media are available for your settings:

- Memory card
- PG/PC
- Operator panel

Note

Data backup using operator panels with USB connection with the PG/PC is not possible

If the converter is connected to a PG/PC via a USB cable, you can save any data on the memory card using an operator panel.

- Before you save data to the memory card using an operator panel, disconnect the USB connection between the PG/PC and converter.

Carrying out series commissioning

Series commissioning is the commissioning of several identical drives.

Precondition

The Control Unit to which the settings are transferred has the same order number and the same or a higher firmware version as the source Control Unit.

Overview

You must proceed as follows to carry out series commissioning:

1. Commission the first converter.
2. Back up the settings of the first converter to an external storage medium.
3. Transfer the settings of the first converter to another converter via the storage medium.

9.1 Backing up and transferring settings using a memory card

What memory cards do we recommend?

You will find the recommended memory cards in Section: Overview of Control Units (Page 24).

Using memory cards from other manufacturers

The inverter only supports memory cards up to 2 GB. SDHC cards (SD High Capacity) and SDXC cards (SD Extended Capacity) are not permitted.

If you use other SD or MMC memory cards, then you must format the memory card as follows:

- MMC: Format FAT 16
  - Insert the card into your PC's card reader.
  - Command to format the card:
    format x: /fs:fat (x: Drive code of the memory card on your PC)
- SD: Format FAT 16 or FAT 32
  - Insert the card into your PC's card reader.
  - Command to format the card:
    format x: /fs:fat or format x: /fs:fat32 (x: Drive code of the memory card on your PC.)

Functional restrictions with memory cards from other manufacturers

The following functions are either not possible – or only with some restrictions – when using memory cards from other manufacturers:

- Licensing functions is only possible using a recommended memory card.
- Know-how protection is only possible using a recommended memory card.
- Under certain circumstances, memory cards from other manufacturers do not support writing or reading data from/to the inverter.

9.1.1 Saving setting on memory card

We recommend that you insert the memory card before switching on the inverter. The inverter always also backs up its settings on an inserted card.

If you wish to backup the inverter settings on a memory card, you have two options:

Automatically backing up

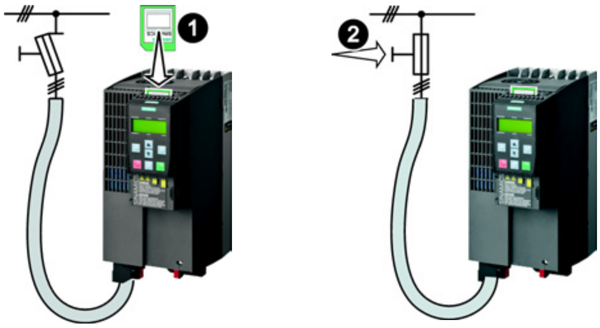
Preconditions

- The inverter power supply has been switched off.
- No USB cable is inserted in the inverter.

Procedure

Proceed as follows to automatically backup your settings:

1. Insert an empty memory card into the inverter.
2. Then switch-on the inverter power supply.



After the power supply has been switched on, the inverter copies its changed settings to the memory card.

Note

If the memory card is not empty, then the inverter accepts the data from the memory card. This data then overwrites the data in the inverter.

- Only use empty memory cards to automatically backup your settings.

Manually backing up

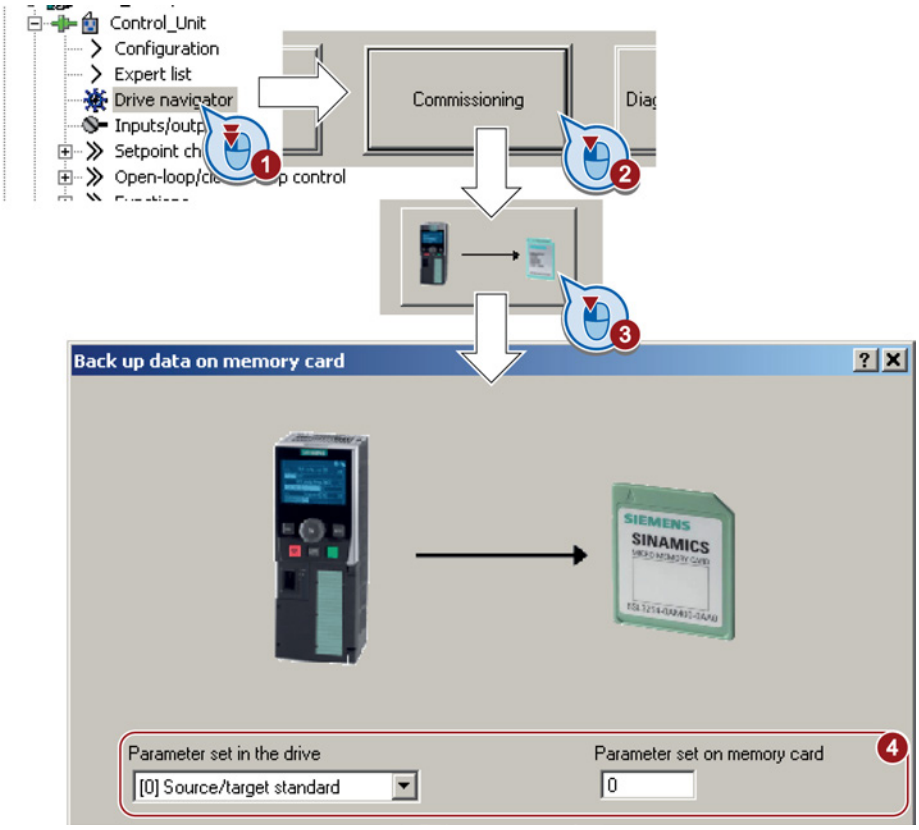
Preconditions

- The inverter power supply has been switched on.
- No memory card is inserted in the inverter.

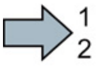
Procedure

Proceed as follows to back up your settings on a memory card:

1. Go online with STARTER, e.g. via a USB cable.
   In STARTER, press the "Copy RAM to ROM" button.
   In your drive, select "Drive Navigator".
2. Select the "Commissioning" button.
3. Select the button to transfer the settings to the memory card.
4. Select the settings as shown in the diagram and start the data backup.
5. Close the screen forms.

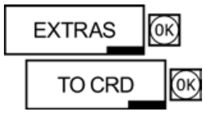


You have backed up the settings of the inverter on the memory card.



Proceed as follows to back up your settings on a memory card

1. Remove the USB cable if one is inserted in the inverter.
2. Plug a BOP-2 onto the inverter.
3. Go to the menu level "EXTRAS".
4. In the menu, select "EXTRAS" - "TO CRD".



You have backed up the settings of the inverter on the memory card.

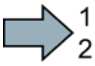
9.1.2 Transferring the setting from the memory card

Automatically transferring

Precondition

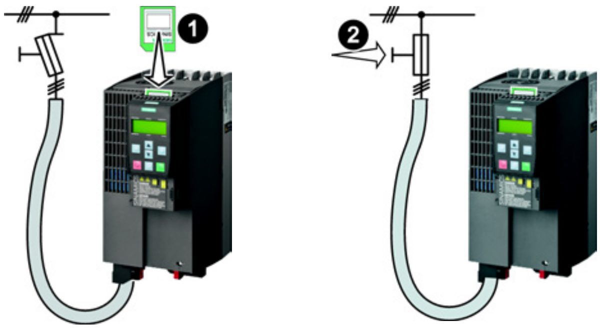
The inverter power supply has been switched off.

Procedure



Proceed as follows to automatically transfer your settings:

1. Insert the memory card into the inverter.
2. Then switch on the inverter power supply.



If there is valid parameter data on the memory card, then the inverter accepts the data from the memory card.

Manually transferring

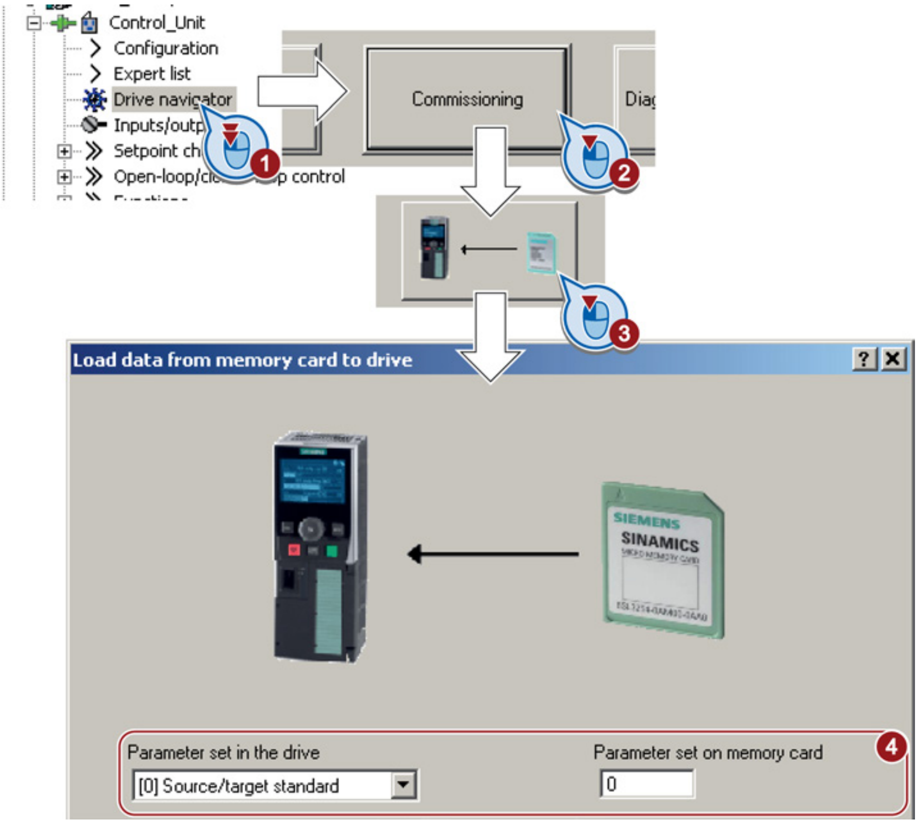
Preconditions

- The inverter power supply has been switched on.
- No memory card is inserted in the inverter.

Procedure

Proceed as follows to transfer settings from a memory card to the inverter:

1. Go online with STARTER, and in your drive, select the "Drive Navigator".
2. Select the "Commissioning" button.
3. Select the button to transfer the data from the memory card to the inverter.
4. Select the settings as shown in the diagram and start the data backup.

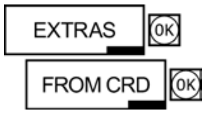


5. Close the screen forms.
6. Go offline with STARTER.
7. Switch off the inverter power supply.
8. Wait until all LED on the inverter go dark.
9. Switch on the inverter power supply again.

   Your settings become effective after this power-on reset.

You have now transferred your settings from a memory card to the inverter.

Proceed as follows to back up your settings on a memory card



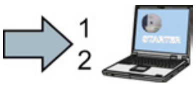
1. Remove the USB cable if one is inserted in the inverter.
2. Attach the BOP-2 operator panel to the inverter.
3. Go to the menu level "EXTRAS".
4. Start data transfer in the menu "EXTRAS" - "FROM CRD".
5. Switch off the inverter power supply.
6. Wait until all LEDs on the inverter are dark.
7. Switch on the inverter power supply again.
8. Your settings take effect after this power-on reset.

You have written the settings from the memory card to the inverter.

9.1.3 Safely remove the memory card

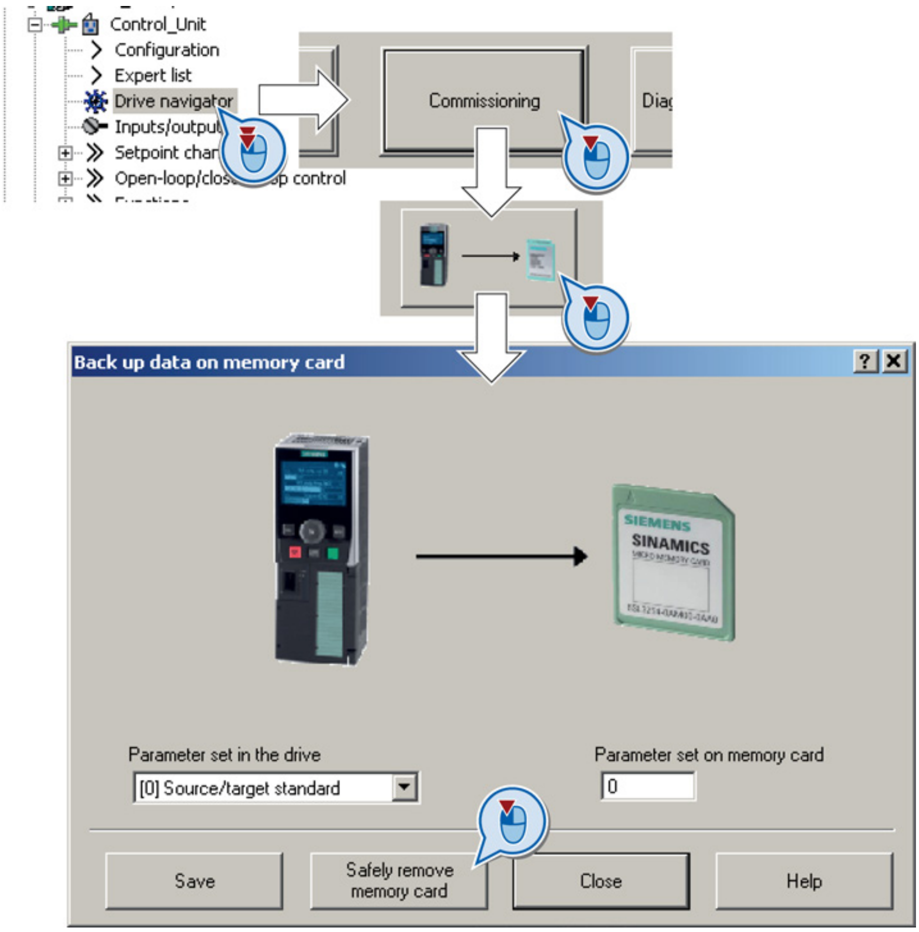
NOTICE
Data loss from improper handling of the memory card If you remove the memory card when the converter is switched on without implementing the "safe removal" function you may destroy the file system on the memory card. The data on the memory card are lost. The memory card will only function again after formatting. • Only remove the memory card using the "safe removal" function.

Procedure



To safely remove the memory card using STARTER, proceed as follows:

1. In the Drive Navigatorselect the following screen form:



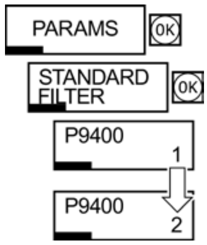
2. Click on the button to safely remove the memory card.
3. Remove the memory card from the inverter after the appropriate message has been output.

You have now safely removed the memory card from the inverter.

Safely removing a memory card using the BOP-2

Procedure

To safely remove the memory card using BOP-2, proceed as follows:



1. Go to parameter p9400. If a memory card is correctly inserted, then p9400=1.
2. Set 9400 = 2. BOP-2 shows "BUSY" for a few seconds and then jumps either to p9400 = 3 or p9400 = 100.
3. For p9400 = 3, remove the memory card from the inverter.
4. For p9400 = 100, it is not permissible that you remove the memory card.
   In this case, again set p9400 = 2.

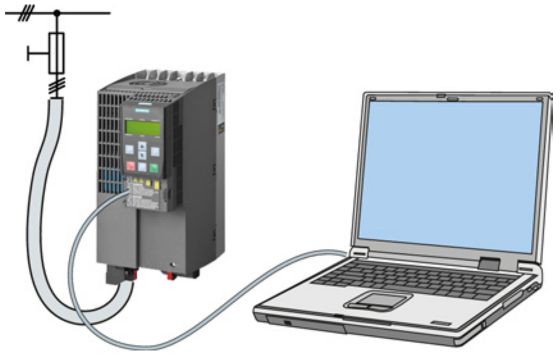
You have now safely removed the memory card using the BOP-2:

9.2 Backing up and transferring settings using STARTER

Precondition

With the supply voltage switched on, you can transfer the inverter settings from the inverter to a PG/PC, or the data from a PG/PC to the inverter.

This requires you to have installed the STARTER commissioning tool on your PG/PC.



You will find additional information about STARTER in Section Tools to commission the converter (Page 39).

Inverter → PC/PG

Procedure

To back up the settings, proceed as follows:

1. Go online with STARTER : .
2. Select the button "Download project to PG": .
3. To save the data in the PG, select the button: .
4. Go offline with STARTER : .

You have backed up the settings.

PC/PG → inverter

The procedure depends on whether you also transfer settings of safety functions or not.

Procedure without enabled safety functions

To load the settings from the PG to the inverter, proceed as follows:

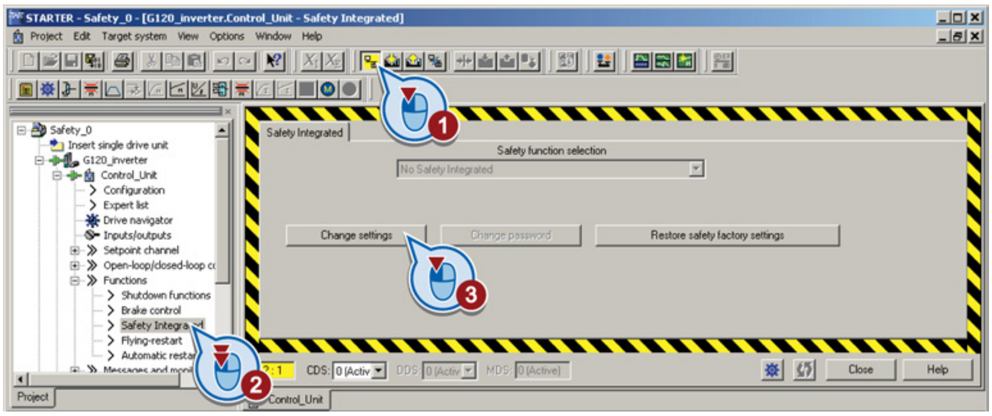
1. Go online with STARTER : .
2. Select the button "Download project to target system": .
3. To save the data in the inverter so that it is not lost when the power fails, select the "Copy RAM to ROM" button: .
4. Go offline with STARTER : .

You have transferred the settings from the PG to the inverter.

Procedure with enabled safety functions

To load the settings from the PG to the inverter and to activate the safety functions, proceed as follows:

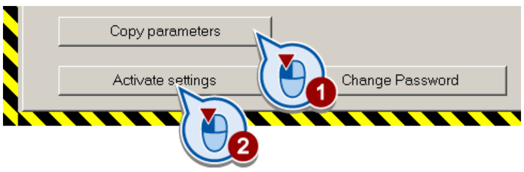
1. Go online with STARTER : .
2. Select the button "Download project to target system": .
3. Call the STARTER screen form for the safety functions.



You have transferred the settings from the PG to the inverter.

To activate the safety functions, proceed as follows:

1. Select the "Copy parameter" button.
2. Press the "Activate settings" button.



3. To save the data in the inverter, select the "Copy RAM to ROM" button: .

4. Go offline with STARTER : .
5. Switch off the inverter power supply.
6. Wait until all LED on the inverter go dark.
7. Switch on the inverter power supply again. Your settings only become effective after this power-on reset.

You have transferred the settings from the PG to the inverter and have activated the safety functions.

9.3 Saving settings and transferring them using an operator panel

Precondition

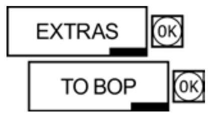
When the power supply is switched on, you can transfer the settings of the variable speed drive to the BOP-2 or vice versa.

Inverter → BOP-2

Procedure

To back up the settings on the BOP-2, proceed as follows:

1. Attach the operator panel to the inverter.
2. Start data transfer in the menu "EXTRAS" - "TO BOP".



You have backed up the settings on the BOP-2.

BOP-2 → inverter

Procedure

To transfer the settings to the inverter, proceed as follows:

1. Attach the operator panel to the inverter.
2. Start data transfer in the menu "EXTRAS" - "FROM BOP".
3. Switch off the inverter power supply.
4. Wait until all LEDs on the inverter are dark. Now switch on the inverter power supply again. Your settings only become effective after this power-on reset.

You have transferred the settings to the inverter.

9.4 Other ways to back up settings

In addition to the default setting, the inverter has an internal memory for backing up three other settings.

On the memory card, you can back up 99 other settings in addition to the default setting.

You will find additional information on the Internet at: Memory options (http://support.automation.siemens.com/WW/view/en/43512514).

Table 9- 1 Operation on the BOP-2

	Description	
	EXTRAS OK TO CRD OK	The converter writes its setting 0, 10, 11 or 12 to the memory card in accordance with p0802. The file on the memory card is assigned the number according to p0802.
	EXTRAS OK FROM CRD OK	The converter loads the setting with the number according to p0802 from the memory card and thus overwrites its setting 0, 10, 11 or 12.

9.5 Write and know-how protection

The inverter offers the option to protect configured settings from being changed or copied.

Write protection and know-how protection are available for this purpose.

9.5.1 Write protection

Write protection prevents converter settings from being inadvertently changed. If you work with the STARTER, the write protection is only effective online. The offline project of the Starter is not write-protected.

The write protection applies to all user interfaces, and thus also to parameter changes via a fieldbus.

The write protection is not password-protected.

Activate and deactivate write protection

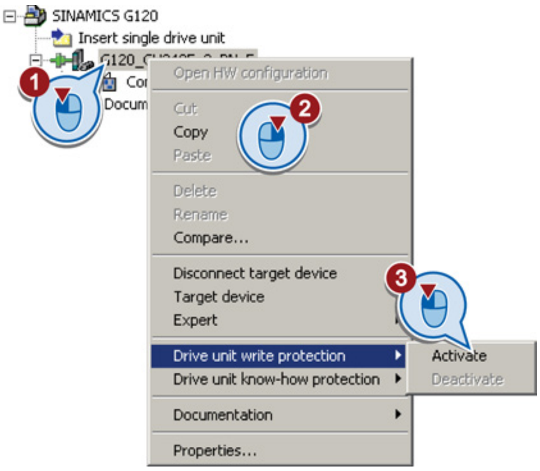
Precondition

You are online with STARTER.

Procedure

Proceed as follows to activate or deactivate the write protection:

1. Select the converter in your STARTER project with the left mouse button.
2. Open the shortcut menu with a right click.
3. Activate or deactivate write protection.
4. Press the "Copy RAM to ROM" button . Otherwise, your settings will be lost when the converter is switched off.



You have activated or deactivated write protection.

Points to note about restoring the factory settings

If you select "Reset to factory settings" using the button when write protection is active, the following confirmation prompt opens.

The confirmation prompt is not issued, if you select another way to restore the factory setting, e.g. using the expert list.

Note

Points to note regarding CAN, BACnet and MODBUS

Using these bus systems, parameter factory settings can be changed despite active write protection. So that write protection is also active when accessing via these fieldbuses, you must additionally set p7762 to 1.

This setting is only possible via the expert list.

Exceptions to write protection

Some functions are excluded from write protection, e.g.:

- Activating/deactivating write protection (p7761)
- Changing the access level (p0003)
- Saving parameters (p0971)
- Safely removing the memory card (p9400)
- Restoring the factory setting
- Importing settings from an external data backup, e.g. upload from a memory card to the converter.

The individual parameters that are excluded from the write protection, can be found in the List Manual in Chapter "Parameters for write protection and protection of know-how".

9.5.2 Know-how protection

Know-how protection

The know-how protection is used to encrypt configuring/engineering know-how, and protect it against being changed or copied.

The settings of the converter are protected by a password.

If the password is lost, only default settings are possible.

The active know-how protection provides the following:

- All setting parameters are invisible.
- Parameters cannot be changed with a commissioning tool, e.g. operator panel or STARTER.
- It is not possible to download the converter settings with the Starter or via a memory card
- It is not possible to use the trace function in the STARTER.
- Deleting the alarm history
- The STARTER dialog screens are disabled. The expert list in the STARTER contains only display parameters.

In the case of active know-how protection, support by technical support personnel is only possible with the consent of the machine manufacturer.

Copy protection

In conjunction with the copy protection, the converter settings can be coupled only to a single, pre-defined hardware.

The know-how protection with copy protection is possible only with the recommended Siemens memory card; also see Section: Overview of Control Units (Page 24)

Exception list

The active know-how protection permits an exception list for parameters to be defined that the customer may access.

If you remove the parameter for the password from the exception list, the know-how protection can only be undone by reverting to the factory settings.

Actions that are possible during active know-how protection

- Restoring factory settings
- Acknowledging messages
- Displaying messages
- Show message history
- Reading out diagnostic buffer
- Switching to the control panel (complete control panel functionality: Fetch master control, all buttons and setting parameters)
- Upload (only parameters that are accessible even though know-how protection is active)

The individual parameters that are excluded from the know-how protection can be found in the List Manual in Chapter "Parameters for write protection and protection of know-how".

Commissioning the converter with know-how protection

Procedure - overview

1. Commission the converter.
2. Create the exception list (Page 261).
3. Activate the know-how protection (Page 259).
4. Save the settings in the converter by copying RAM to ROM with or via p0971 = 1.
5. Save the project with on the PG/PC. Also back up any other project-related data (machine type, password, etc.) that may be required for the support of the end customer.

9.5.2.1 Settings for the know-how protection

Activating know-how protection

Preconditions

- You are online with STARTER.

  If you have created a project offline on your computer, you must download it to the inverter and go online.
- You have inserted the recommended Siemens card. See also Section: Overview of Control Units (Page 24).

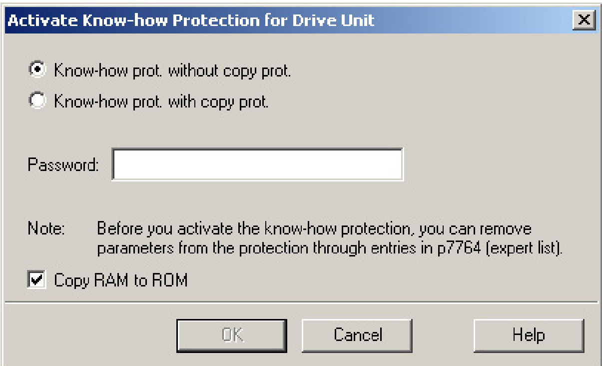
Procedure

1
2

Proceed as follows to activate know-how protection:

1. Select the inverter in the STARTER project, and then select "Know-how protection drive unit/activate ..." in the shortcut menu (see also Write protection (Page 256)).
2. Enter your password. Length of the password: 1 … 30 characters.

   For the password, we recommend that you only use characters from the ASCII character set. If you use any character for the password, then if changes are made to the Windows language settings after activating know-how protection, errors can occur when subsequently checking the password.



3. In this screen form, press the "Copy RAM to ROM" button. This means that you save your settings so that they are protected against power failure.

You have activated know-how protection.

Backing up settings on the memory card

When the know-how protection is activated, you can save the settings via p0971 on the memory card.

To do this, set p0971 = 1. The data is encrypted before being written to the memory card. After saving, p0971 is reset to 0.

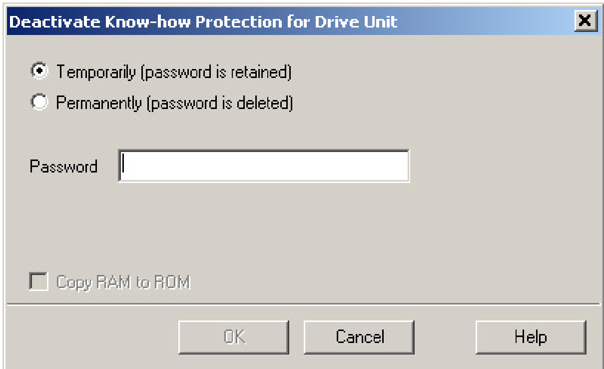
Deactivate know-how protection, delete password

Preconditions

- You are online with STARTER.
- You have inserted the recommended Siemens card. See also Section: Overview of Control Units (Page 24).

Procedure

Proceed as follows to deactivate know-how protection:



1. Select the inverter in the STARTER project, and right-click to open the dialog box "Know-how protection drive unit/deactivate …".
2. There, select the desired option.
   - Temporary status: Know-how protection is active again after switching the power supply off and on.
   - Final status: If you select "Copy RAM to ROM", the inverter immediately deletes the password. If you do not select "Copy RAM to ROM", the inverter deletes the password the next time the supply voltage is switched off.
3. Enter the password and exit the screen form with OK.

You have deactivated know-how protection.

Changing the password

Select the inverter in the STARTER project and open the dialog box via the shortcut menu "know-how protection drive unit/change password … ".

9.5.2.2 Creating an exception list for the know-how protection

Using the exception list, you as a machine manufacturer may make individual adjustable parameters accessible to end customers although know-how protection is active. You may define the exception list via parameters p7763 and p7764 in the expert list. Specify the number of parameters for the selection list in p7763. Assign the individual indexes to the parameter numbers of the selection list in p7764.

Procedure

Proceed as follows to change the number of parameters for the selection list:

1. Save the inverter settings via an upload ( ) on the PC/PG and go offline ( )
2. In the project on the PC, set p7763 to the desired value.
3. Save the project.
4. Go online and load the project into the inverter ( ).
5. Now make the additional settings in p7764.

You have modified the number of parameters for the selection list.

Factory setting for the exception list:

- p7763 = 1 (selection list contains precisely one parameter)
- p7764[0] = 7766 (parameter number for entering the password)

Note

Block access to the inverter as a result of incomplete exception lists

If you remove p7766 from the exception list, you can no longer enter a password and therefore no longer de-activate know-how protection.

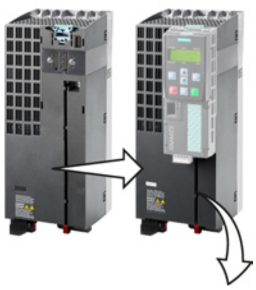
In this case to access the inverter again, you have to reset the inverter to the factory settings.

Corrective maintenance 10

10.1 Overview of replacing converter components

Permissible replacement of components

In the event of a long-term function fault, you must replace the Power Module or Control Unit. The inverter's Power Module and Control Unit can be replaced independently of each other.

Replacing the Power Module		Replacing the Control Unit	
Replacement: • Same type • Same power rating	Replacement: • Same type • Same frame size • *Higher* power rating	Replacement: • Same type • Same firmware version	Replacement: • Same type • *higher* firmware version (e.g. replace FW V4.2 by FW V4.3)
x kW x kW 	y kW > x kW 	Firmware A Firmware A 	Firmware A > Firmware B 
	Power Module and motor must be adapted to one another (ratio of motor and Power Module rated power > 1/8)	After replacing the Control Unit, you must restore the inverter's settings.	

⚠ WARNING
Risk of injury due to uncontrolled drive motion
Replacing inverters of different types can result in uncontrolled motion of the drive. • In all cases that are not permitted according to the table above, recommission the drive after replacing an inverter.

Special issue relating to communication via PROFINET: Device replacement without removable data storage medium

The inverter supports the PROFINET functionality, replacing the device without data storage medium.

Precondition

The topology of the PROFINET IO system with the IO device involved is configured in your higher-level control system.

Replacing the device

The Control Unit can be replaced without having to insert a removable data storage medium (e.g. a memory card) with the saved device names in the inverter – or having to reassign the device names with a PG.

Details of the device replacement without removable storage medium can be found in the PROFINET system description (http://support.automation.siemens.com/WW/view/en/19292127).

10.2 Replacing a Control Unit with enabled safety function

Replacing a Control Unit with data backup on a memory card

Precondition

You have a memory card with the actual settings of the Control unit to be replaced.

If you use a memory card with firmware, after the replacement, you obtain a precise copy (firmware and settings) of the replaced Control Unit.

Procedure

To replace the Control Unit, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables from the Control Unit.
3. Remove the defective Control Unit.
4. Remove the memory card from the old Control Unit and insert it in the new Control Unit.
5. Mount the new Control Unit on the Power Module. The new Control Unit must have the same order number and the same or higher firmware version as the Control Unit that was replaced.
6. Reconnect the signal cables of the Control Unit.
7. Connect up the line voltage again.
8. The inverter loads the settings from the memory card.
9. Check what the inverter reports after loading.
   - Alarm A01028:

     The loaded settings are not compatible with the inverter.

     Clear the alarm with p0971 = 1 and recommission the drive.
   - Fault F01641:

     Acknowledge the message.

     Carry out a **reduced** acceptance test; see Section: Reduced acceptance test after component replacement (Page 279).

You have replaced the Control Unit and transferred the safety function settings from the memory card to the new Control Unit.

Replacing a Control Unit with data backup in the PC

Precondition

You have backed up the actual settings of the Control Unit to be replaced to a PC using STARTER.

Procedure

To replace the Control Unit, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. Open the right project for the drive in STARTER.
8. Go online and transfer the settings from the PC to the inverter by pressing the  button.
   The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
9. In STARTER, select the screen form for the safety functions.
10. Select the "Change settings" button.
11. Select the "Activate settings" button.
12. Save your settings (copy RAM to ROM).
13. Switch off the inverter power supply.
14. Wait until all LEDs on the inverter go dark.
15. Switch on the inverter power supply again (power on reset).
16. Perform a **reduced** acceptance test, see the section Reduced acceptance test after component replacement (Page 279).

You have replaced the Control Unit and transferred the safety function settings from the PC to the new Control Unit.

Replacing the Control Unit with data backup in the operator Panel

Precondition

You have backed up the actual settings of the Control Unit to be replaced to an operator panel.

Procedure

To replace the Control Unit, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. Plug the Operator Panel into the Control Unit or connect the Operator Panel handheld device with the inverter.
8. Transfer the settings from the Operator Panel to the inverter.
9. Wait until the transfer is complete.
10. After loading, check whether the inverter outputs alarm A01028.
    - Alarm A01028:
      The loaded settings are not compatible with the inverter.
      Clear the alarm with p0971 = 1 and recommission the drive.
    - No alarm A01028: Proceed with the next step.
11. Switch off the inverter power supply.
12. Wait until all LEDs on the inverter go dark.
13. Switch on the inverter power supply again (power on reset).

    The inverter reports the faults F01641, F01650, F01680 and F30680. Ignore these faults, as they will be automatically acknowledged by the following steps.
14. Set p0010 to 95.
15. Set p9761 to the safety password.
16. Set p9701 to AC hex.
17. Set p0010 to 0.
18. Back up the settings so they are powerfail proof.
    - BOP-2 in the menu "EXTRAS" - "RAM-ROM".
    - IOP in the menu "SAVE RAM TO ROM".
19. Switch off the inverter power supply.
20. Wait until all LEDs on the inverter go dark.
21. Switch on the inverter power supply again (power on reset).
22. Perform a **reduced** acceptance test, see the section Reduced acceptance test after component replacement (Page 279).

You have replaced the Control Unit and transferred the safety function settings from the operator panel to the new Control Unit.

10.3 Replacing the Control Unit without the safety functions enabled

Replacing a Control Unit with data backup on a memory card

Procedure

Proceed as follows to exchange the Control Unit:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables from the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit onto the Power Module. The new Control Unit must have the same order number and the same or a higher firmware version as the Control Unit that was replaced.
5. Remove the memory card from the old Control Unit and insert it in the new Control Unit.
6. Reconnect the signal cables of the Control Unit.
7. Connect up the line voltage again.
8. The inverter loads the settings from the memory card.
9. After loading, check whether the inverter outputs Alarm A01028.
   - Alarm A01028:

     The settings that have been loaded are not compatible with the inverter.

     Clear the alarm with p0971 = 1, and recommission the drive.
   - No alarm A01028:

     The inverter accepts the settings that have been loaded.

You have successfully replaced the Control Unit.

Replacing a Control Unit with data backup in the PC

Procedure

Proceed as follows to exchange the Control Unit:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit onto the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. Open the project that matches the drive in STARTER.
8. Go online and transfer the settings from the PC into the inverter by pressing the button.
   The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
9. Save your settings (copy RAM to ROM).

You have successfully replaced the Control Unit.

10.4 Replacing the Control Unit without data backup

If you do not backup the settings, then you must recommission the drive after replacing the Control Unit.

Procedure

To replace the Control Unit without backed-up settings, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. Recommission the drive.

The Control Unit replacement has been completed after the drive has been successfully commissioned.

10.5 Replacing a Control Unit with active know-how protection

Replacing devices during know-how protection without copy protection

For know-how protection without copy protection, the converter settings can be transferred to another converter using a memory card.

See also:

- Saving setting on memory card (Page 245)
- Transferring the setting from the memory card (Page 247)

Replacing devices for know-how protection with copy protection

The know-how protection with copy protection prevents the inverter settings from being copied and passed on. This function is predominantly used by machine manufacturers.

If know-how protection with copy protection is active, the inverter cannot be replaced as described in "Overview of replacing converter components (Page 263)".

However, to allow the inverter to be replaced, you must use a Siemens memory card, and the machine manufacturer must have an identical machine that he uses as sample.

There are two options for replacing the device:

Option 1: The machine manufacturer only knows the serial number of the new inverter

- The end customer provides the machine manufacturer with the following information:
  - For which machine must the inverter be replaced?
  - What is the serial number (r7758) of the new inverter?
- The machine manufacturer goes online on the sample machine.
  - deactivates the know-how protection, see Settings for the know-how protection (Page 259)
  - enters the serial number of the new inverter in p7759
  - enters the serial number of the inserted memory card as reference serial number in p7769
  - activates the know-how protection with copy protection ("Copy RAM to ROM" must be activated!), see Settings for the know-how protection (Page 259)
  - writes the configuration with p0971 = 1 to the memory card
  - sends the memory card to the end customer
- The end customer inserts the memory card and switches on the inverter.

When powering up, the inverter checks the serial numbers of the card and when there is a match, the inverter goes into the "ready to start" state.

If the numbers do not match, then the inverter signals fault F13100 (no valid memory card).

Option 2: The machine manufacturer knows the serial number of the new inverter and the serial number of the memory card

- The end customer provides the machine manufacturer with the following information:
  - For which machine must the inverter be replaced?
  - What is the serial number (r7758) of the new inverter?
  - What is the serial number of the memory card?
- The machine manufacturer goes online on the sample machine.
  - deactivates the know-how protection, see Settings for the know-how protection (Page 259)
  - enters the serial number of the new inverter in p7759
  - enters the serial number of the customer's memory card as reference serial number in p7769
  - activates the know-how protection with copy protection ("Copy RAM to ROM" must be activated!), see Settings for the know-how protection (Page 259)
  - writes the configuration with p0971 = 1 to the memory card
  - copies the encrypted project from the card to his PC
  - for example, sends it by e-mail to the end customer
- The end customer copies the project to the Siemens memory card that belongs to the machine, inserts it in the inverter and switches on the inverter.

When powering up, the inverter checks the serial numbers of the card and when there is a match, the inverter goes into the "ready to start" state.

If the numbers do not match, then the inverter signals fault F13100 (no valid memory card).

10.6 Replacing a Power Module with enabled safety function

⚠DANGER
Danger from touching energized Power Module connections
After switching off the mains voltage, it will take up to 5 minutes until the capacitors in the Power Module are sufficiently discharged for the residual voltage to be safe. Death or serious injury will result if energized parts are touched. • Check the safe isolation of the Power Module connections before carrying out installation work.

NOTICE
Material damage from swapping the motor's connection lines
The direction in which the motor rotates switches if you swap the two phases of the motor line. A motor running backwards may damage the machine or installation. • Connect the three phases of the motor lines in the right order. • After replacing the Power Module, check the direction in which the motor rotates.

Procedure

To replace the Power Module, proceed as follows:

1. Switch off the main voltage of the Power Module.
   You can leave any external 24 V supply to the Control Unit switched on.
2. Remove the connecting cables of the Power Module.
3. Remove the Control Unit from the Power Module.
4. Replace the Power Module.
5. Mount the Control Unit onto the new Power Module.
6. Connect up the new Power Module using the connecting cables.
7. Switch on the line supply and, if necessary, the 24 V supply for the Control Unit.
8. The inverter reports F01641.
9. Perform a reduced acceptance test, see the Section Reduced acceptance test after component replacement (Page 279).

You have successfully replaced the Power Module.

10.7 Replacing a Power Module without the safety function being enabled

Procedure

Proceed as follows to exchange a Power Module:

1. Switch off the supply voltage to the Power Module.
   You do not have to switch off an external 24 V power supply for the Control Unit if one is being used.

> **DANGER**
>
> **Risk of electric shock from touching inverter connections**
>
> After the power supply has been switched off, it takes up to 5 min. until the capacitors in the inverter have discharged so that the remaining voltage is non-hazardous.
>
> Check the voltage at the inverter connections, before removing the connection cables.

2. Remove the connecting cables of the Power Module.
3. Remove the Control Unit from the Power Module.
4. Replace the old Power Module with the new Power Module.
5. Mount the Control Unit onto the new Power Module.
6. Connect up the new Power Module using the connecting cables.

> **NOTICE**
>
> **Material damage when interchanging the motor connecting cables**
>
> The direction in which the motor rotates switches if you exchange the two phases of the motor line.
>
> Connect the three phases of the motor lines in the right order.
>
> After exchanging the power module check the direction in which the motor rotates.

7. Switch on the line supply and, if being used, the 24 V supply of the Control Unit.

You have successfully replaced the Power Module.

10.8 Upgrading the firmware

When upgrading the firmware, you replace the inverter firmware by a later version. Only update the firmware to a later version if you require the expanded functional scope of the newer version.

Precondition

- The firmware version of your inverter is at least V4.5.
- You have the memory card with the firmware that matches the inverter.
- Inverter and memory card have different firmware versions.

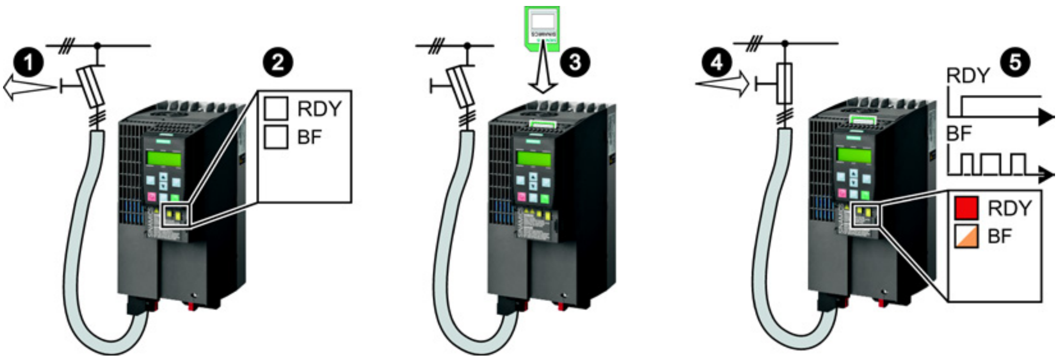
Procedure

Proceed as follows to upgrade the inverter firmware to a later version:

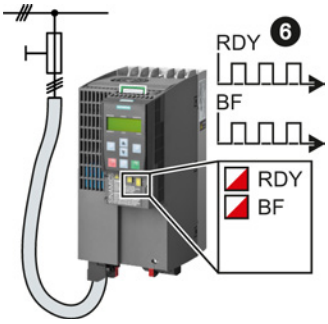
1. Switch off the inverter power supply.
2. Wait until all LEDs on the inverter go dark.
3. Insert the card with the matching firmware into the inverter slot until it latches into place.
4. Switch on the inverter power supply.
5. The inverter transfers the firmware from the memory card into its memory.

   The transfer takes approximately 5 … 10 minutes.

   While data is being transferred, the LED RDY on the inverter stays red. The LED BF flashes orange with a variable frequency.



6. At the end of the transfer, the LED RDY and BF slowly flash red (0.5 Hz).



Note

Corrupted firmware if the power supply fails during the transfer

The inverter firmware can be corrupted if the power supply fails during the transfer.

- Do not switch off the inverter power supply as long as data is being transferred.

---

7. Switch off the inverter power supply.
8. Wait until all LEDs on the inverter go dark.

   Decide whether you will withdraw the memory card from the inverter:

   – You leave the memory card in the inverter:

     When the memory card still does not contain any data backup of the inverter settings, in the next step, the inverter writes its settings to the memory card.

     When the memory card already contains a data backup of the inverter settings, in the next step, the inverter takes the settings from the memory card.

     Note

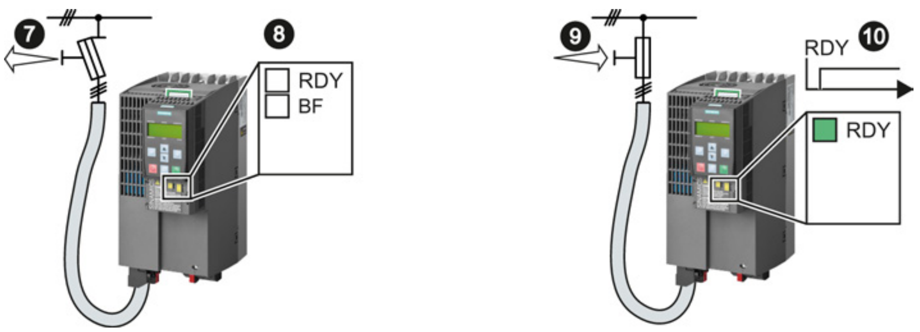
     The inverter takes the settings from the memory card

     The next steps can change the inverter settings.

     - If the memory card already contains settings, check as to whether these settings match the inverter.
     - Remove the memory card if these settings do not match the inverter.

   – You remove the memory card:

     The inverter keeps its settings.
9. Switch on the inverter power supply.
10. If the firmware upgrade was successful, after several seconds the inverter LED RDY turns green.



You have successfully updated the firmware to a more recent version. When upgrading, your settings in the inverter are kept.

10.9 Firmware downgrade

When downgrading the firmware, you replace the inverter firmware by an older version. Only downgrade the firmware to an older version if, after replacing an inverter, you require the same firmware in all of your inverters.

Precondition

- The firmware version of your inverter is at least V4.6.
- You have the memory card with the firmware that matches the inverter.
- Inverter and memory card have different firmware versions.
- You have backed up your settings on the memory card, in an operator panel or in a PC.

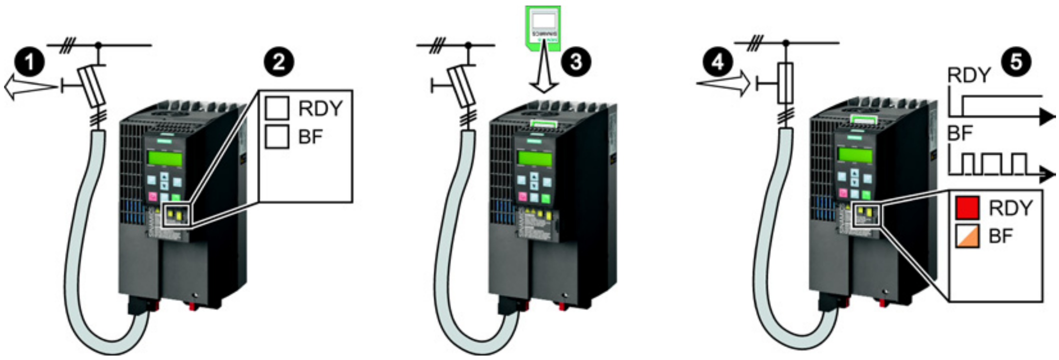
Procedure

Proceed as follows to downgrade the inverter firmware to an older version:

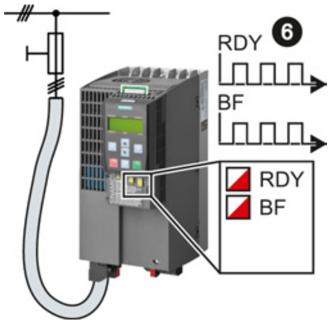
1. Switch off the inverter power supply.
2. Wait until all LEDs on the inverter go dark.
3. Insert the card with the matching firmware into the inverter slot until it latches into place.
4. Switch on the inverter power supply.
5. The inverter transfers the firmware from the memory card into its memory.

   The transfer takes approximately 5 … 10 minutes.

   While data is being transferred, the LED RDY on the inverter stays red. The LED BF flashes orange with a variable frequency.



6. At the end of the transfer, the LED RDY and BF slowly flash red (0.5 Hz).



Note

Corrupted firmware if the power supply fails during the transfer

The inverter firmware can be corrupted if the power supply fails during the transfer.

- Do not switch off the inverter power supply as long as data is being transferred.

7. Switch off the inverter power supply.
8. Wait until all LEDs on the inverter go dark.

   Decide whether you will withdraw the memory card from the inverter:

   – You leave the memory card in the inverter:

   When the memory card already contains a data backup of the inverter settings, in the next step, the inverter takes the settings from the memory card.

   Note

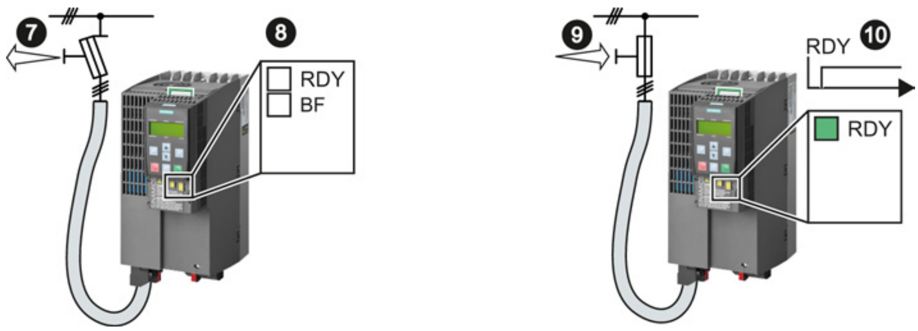
   The inverter takes the settings from the memory card

   The next steps can change the inverter settings.

   - If the memory card already contains settings, check as to whether these settings match the inverter.
   - Remove the memory card if these settings do not match the inverter.

   – You remove the memory card:

   The inverter is reset to the factory setting.
9. Switch on the inverter power supply.
10. If the firmware downgrade was successful, after several seconds the inverter LED RDY turns green.



After the firmware has been downgraded, the inverter has been reset to the factory settings.
11. If the memory card does not contain a data backup of the inverter settings, then you must transfer your settings to the inverter from another data backup.

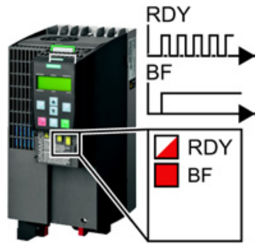
    See also Section: Backing up data and series commissioning (Page 243).

You have downgraded the firmware of the inverter to an older version and have transferred the backed up settings into the inverter.

10.10 Correcting an unsuccessful firmware upgrade or downgrade

How does the inverter signal an unsuccessful upgrade or downgrade?

The inverter signals an unsuccessful firmware upgrade or downgrade by a quickly flashing LED RDY and the lit LED BF.



Correcting an unsuccessful upgrade or downgrade

You can check the following to correct an unsuccessful firmware upgrade or downgrade:

- Does the firmware version of your inverter fulfill the preconditions?
  - For an upgrade, as a minimum V4.5.
  - For a downgrade, as a minimum V4.6.
- Have you correctly inserted the card?
- Does the card contain the correct firmware?
- Repeat the appropriate procedure.

10.11 Reduced acceptance test after component replacement

After a component has been replaced or the firmware updated, a reduced acceptance test of the safety functions must be performed.

Measure	Acceptance test	
	Acceptance test	**Documentation**
Replacing the Control Unit.	No. Only check the direction of rotation of the motor.	• Supplement inverter data • Log the new checksums • Countersignature
Replacing the Power Module.		Supplement the hardware version in the inverter data
Replace the motor with an identical pole pair number		No change.
Replace the gearbox with an identical ratio		
Replacing safety-related peripherals (e.g. Emergency Stop switch).	No. Only check the control of the safety functions that are influenced by the components that have been replaced.	No change.
Inverter firmware update.	No.	• Supplement firmware version in the inverter data • Log the new checksums • Countersignature.

10.12 If the converter no longer responds

If the inverter no longer responds

For example, when loading an incorrect file from the memory card, the inverter can go into a state where it can no longer respond to commands from the operator panel or from a higher-level control system. In this case, you must reset the inverter to its factory setting and recommission it. This inverter state is manifested in two different ways:

Case 1

- The motor is switched off.
- You cannot communicate with the inverter, either via the operator panel or other interfaces.
- The LEDs flicker and after 3 minutes the inverter has still not powered up.

Procedure

Proceed as follows to restore the inverter factory settings:

1. Remove the memory card if one is inserted in the inverter.
2. Switch off the inverter power supply.
3. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.
4. Repeat steps 2 and 3 as often as required until the inverter outputs fault F01018:
5. Set p0971 = 1.
6. Switch off the inverter power supply.
7. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.

   The inverter now powers up with the factory settings.
8. Recommission the inverter.

You have restored the inverter factory settings.

Case 2

- The motor is switched off.
- You cannot communicate with the inverter, either via the operator panel or other interfaces.
- The LEDs flash and are dark - this process is continually repeated.

Procedure

Proceed as follows to restore the inverter factory settings:

1. Remove the memory card if one is inserted in the inverter.
2. Switch off the inverter power supply.
3. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.
4. Wait until the LEDs flash orange.
5. Repeat steps 2 and 3 as often as required until the inverter outputs fault F01018.
6. Now set p0971 = 1.
7. Switch off the inverter power supply.
8. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.

   The inverter now powers up with the factory settings.
9. Recommission the inverter.

You have restored the inverter factory settings.

Alarms, faults and system messages 11

The converter has the following diagnostic types:

- LED

  The LED at the front of the converter immediately informs you about the most important converter states.

- Alarms and faults

  The converter signals alarms and faults via

  – the fieldbus

  – the terminal strip with the appropriate setting

  – a connected operator panel, or

  – STARTER

  Alarms and faults have a unique number.

- Identification & maintenance data (I&M)

  If requested, the converter sends data to the higher-level control via PROFIBUS or PROFINET:

  – Converter-specific data

  – Plant-specific data

11.1 Operating states indicated on LEDs

The LED RDY (Ready) is temporarily orange after the power supply voltage is switched-on. As soon as the color of the LED RDY changes to either red or green, the LEDs signal the inverter state.

Signal states of the LED

In addition to the signal states "on" and "off" there are two different flashing frequencies:

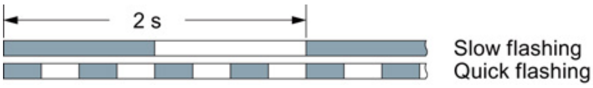


Table 11- 1 Inverter diagnostics

LED		Explanation
RDY	**BF**	
GREEN - on	Not relevant	There is presently no fault
GREEN - slow		Commissioning or reset to factory settings
RED - on	YELLOW - variable frequency	Firmware update in progress
RED - slow	RED - slow	Inverter waits until the power supply is switched off and switched on again after a firmware update
RED - fast	Not relevant	There is presently a fault
RED - fast	RED - fast	Incorrect memory card or unsuccessful firmware update

Table 11- 2 Communication diagnostics via PROFINET

LNK LED	Explanation
GREEN - on	The communication via PROFINET is in order.
GREEN - slow	Device naming is active.
Off	No communication via PROFINET.

Table 11- 3 Communication diagnostics via RS485

LED		Explanation
BF	**RDY**	
off	Not relevant	Data is being exchanged between the inverter and control
RED - slow	RED - slow	Inverter waits until the power supply is switched off and switched on again after a firmware update
	All other states	The bus is active, however the inverter is not receiving any process data
RED - fast	RED - fast	Incorrect memory card or unsuccessful firmware update
	All other states	No bus connection available
YELLOW - variable frequency	RED - on	Firmware update in progress

Table 11- 4 Communication diagnostics via PROFIBUS DP

LED		Explanation
BF	RDY	
GREEN - on	Not relevant	Data is being exchanged between the inverter and control
off		PROFIBUS interface is not being used.
RED - slow	RED - slow	Inverter waits until the power supply is switched off and switched on again after a firmware update
	All other states	Bus fault - configuration fault
RED - fast	RED - fast	Incorrect memory card or unsuccessful firmware update
	All other states	Bus error - no data exchange - inverter searches for baud rate - no connection
YELLOW - variable frequency	RED - on	Firmware update in progress

Table 11- 5 Diagnostics of the safety functions

SAFE LED	Meaning
YELLOW - on	One or more safety functions are enabled, but not active.
YELLOW - slow	One or more safety functions are active; no safety function faults have occurred.
YELLOW - rapid	The converter has detected a safety function fault and initiated a STOP response.

11.2 System runtime

By evaluating the system runtime of the inverter, you can decide whether you must replace components subject to wear such as fans, motors and gear units.

Principle of operation

The inverter starts the system runtime as soon as the inverter is supplied with power. The system runtime stops when the inverter is switched off.

The system runtime comprises r2114[0] (milliseconds) and r2114[1] (days):

System runtime = r2114[1] × days + r2114[0] × milliseconds

If r2114[0] has reached a value of 86,400,000 ms (24 hours), the inverter sets r2114[0] the value 0 and increases the value of r2114[1] by 1.

Using system runtime, you can track the chronological sequence of faults and alarms over time. When a corresponding message is triggered, the inverter transfers the parameter values r2114 to the corresponding parameters of the alarm or fault buffer.

Parameters	Description
r2114[0]	System runtime (ms)
r2114[1]	System runtime (days)

You cannot reset the system runtime.

11.3 Alarms

Alarms have the following properties:

- They do not have a direct effect in the converter and disappear once the cause has been removed
- They do not need have to be acknowledged
- They are signaled as follows
  - Status display via bit 7 in status word 1 (r0052)
  - At the Operator Panel with a Axxxxx
  - Via STARTER, if you click on TAB at the bottom left of the STARTER screen

In order to pinpoint the cause of an alarm, there is a unique alarm code and also a value for each alarm.

Alarm buffer

For each incoming alarm, the converter saves the alarm, alarm value and the time that the alarm was received.

	Alarm code	Alarm value		Alarm time received		Alarm time removed	
1. Alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
		I32	Float	Days	ms	Days	ms

Figure 11-1 Saving the first alarm in the alarm buffer

r2124 and r2134 contain the alarm value - important for diagnostics - as "fixed point" or "floating point" number.

The alarm times are displayed in r2145 and r2146 (in complete days) as well as in r2123 and r2125 (in milliseconds referred to the day of the alarm).
The converter uses an internal time calculation to save the alarm times. More information on the internal time calculation can be found in Chapter System runtime (Page 286).

As soon as the alarm has been removed, the converter writes the associated instant in time into parameters r2125 and r2146. The alarm remains in the alarm buffer even if the alarm has been removed.

If an additional alarm is received, then this is also saved. The first alarm is still saved. The alarms that have occurred are counted in p2111.

	Alarm code	Alarm value		Alarm time received		Alarm time, resolved	
1st alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
2nd alarm	[1]	[1]	[1]	[1]	[1]	[1]	[1]

Figure 11-2 Saving the second alarm in the alarm buffer

The alarm buffer can contain up to eight alarms. If an additional alarm is received after the eighth alarm - and none of the last eight alarms have been removed - then the next to last alarm is overwritten.

	Alarm code	Alarm value		Alarm time received		Alarm time, resolved	
1st alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
2nd alarm	[1]	[1]	[1]	[1]	[1]	[1]	[1]
3rd alarm	[2]	[2]	[2]	[2]	[2]	[2]	[2]
4th alarm	[3]	[3]	[3]	[3]	[3]	[3]	[3]
5th alarm	[4]	[4]	[4]	[4]	[4]	[4]	[4]
6th alarm	[5]	[5]	[5]	[5]	[5]	[5]	[5]
7th alarm	[6]	[6]	[6]	[6]	[6]	[6]	[6]
Last alarm	[7]	[7]	[7]	[7]	[7]	[7]	[7]

Figure 11-3 Complete alarm buffer

Emptying the alarm buffer: Alarm history

The alarm history traces up to 56 alarms.

The alarm history only takes alarms that have been removed from the alarm buffer. If the alarm buffer is completely filled - and an additional alarm occurs - then the converter shifts all alarms that have been removed from the alarm buffer into the alarm history. In the alarm history, alarms are also sorted according to the "alarm time received", however, when compared to the alarm buffer, in the inverse sequence:

- The youngest alarm is in index 8
- The second youngest alarm is in index 9
- etc.

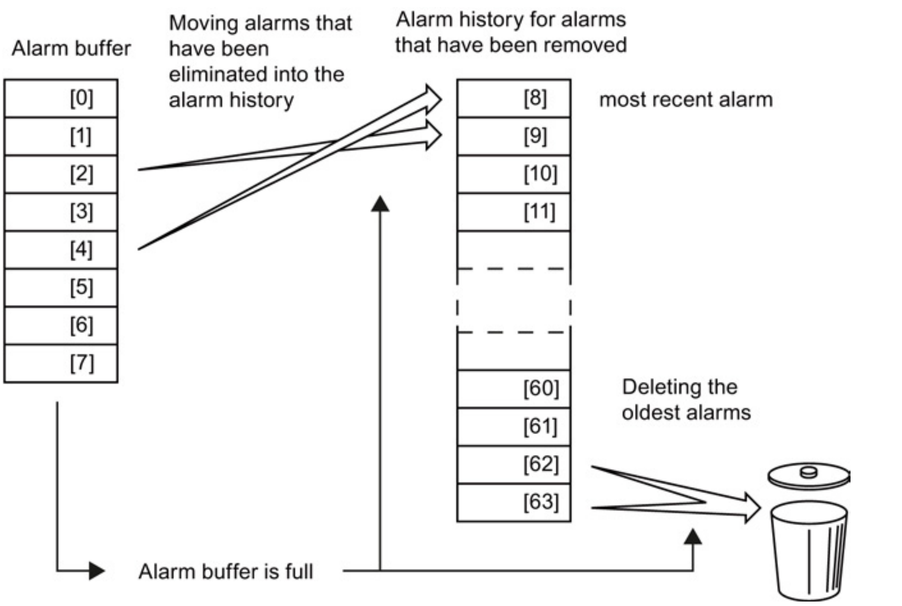


Figure 11-4 Shifting alarms that have been removed into the alarm history

Any alarms that have not been removed remain in the alarm buffer. The converter sorts the alarms and closes gaps between the alarms.

If the alarm history is filled up to index 63, each time a new alarm is accepted in the alarm history, the oldest alarm is deleted.

Parameters of the alarm buffer and the alarm history

Parameter	Description
r2122	**Alarm code** Displays the numbers of alarms that have occurred
r2123	**Alarm time received in milliseconds** Displays the time in milliseconds when the alarm occurred
r2124	**Alarm value** Displays additional information about the alarm
r2125	**Alarm time removed in milliseconds** Displays the time in milliseconds when the alarm was removed
p2111	**Alarm counter** Number of alarms that have occurred after the last reset When setting p2111 = 0, all of the alarms that have been removed from the alarm buffer [0...7] are transferred into the alarm history [8...63]
r2145	**Alarm time received in days** Displays the time in days when the alarm occurred
r2132	**Actual alarm code** Displays the code of the alarm that last occurred
r2134	**Alarm value for float values** Displays additional information about the alarm that occurred for float values
r2146	**Alarm time removed in days** Displays the time in days when the alarm was removed

Extended settings for alarms

Parameter	Description
You can change up to 20 different alarms into a fault or suppress alarms:	
p2118	**Setting the message number for the message type** Selection of the alarms for which the message type should be changed
p2119	**Setting the message type** Setting the message type for the selected alarm 1: Fault 2: Alarm 3: No message

You will find details in function diagram 8075 and in the parameter description of the List Manual.

11.4 Faults

A fault indicates a severe fault during inverter operation.

The inverter signals a fault as follows:

- At the operator panel with Fxxxxx
- At the inverter using the red LED RDY
- In bit 3 of status word 1 (r0052)
- Via STARTER

To delete a message, you must remedy the cause of the fault and acknowledge the fault.

Every fault has a unique fault code and also a fault value. You need this information to determine the cause of the fault.

Fault buffer of actual values

The inverter saves the time, fault code and fault value for every fault it receives.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0] I32	r2133[0] Float	r2130[0] Days	r0948[0] ms	r2136[0] Days	r2109[0] ms

Figure 11-5 Saving the first fault in the fault buffer

r0949 and r2133 contain the fault value - important for diagnostics - as "fixed point" or "floating point" number.

The "fault time received" is in parameter r2130 (in complete days) as well as in parameter r0948 (in milliseconds referred to the day of the fault). The "fault time removed" is written to parameters r2109 and r2136 when the fault has been acknowledged.
The inverter uses its internal time calculation to save the fault times. More information on the internal time calculation can be found in Chapter System runtime (Page 286).

If an additional fault occurs before the first fault has been acknowledged, then this is also saved. The first alarm remains saved. The fault cases that have occurred are counted in p0952. A fault case can contain one or several faults.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]
2nd fault	[1]	[1]	[1]	[1]	[1]	[1]	[1]

Figure 11-6 Saving the second fault in the fault buffer

The fault buffer can accept up to eight actual faults. The next to last fault is overwritten if an additional fault occurs after the eighth fault.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]
2nd fault	[1]	[1]	[1]	[1]	[1]	[1]	[1]
3rd fault	[2]	[2]	[2]	[2]	[2]	[2]	[2]
4th fault	[3]	[3]	[3]	[3]	[3]	[3]	[3]
5th fault	[4]	[4]	[4]	[4]	[4]	[4]	[4]
6th fault	[5]	[5]	[5]	[5]	[5]	[5]	[5]
7th fault	[6]	[6]	[6]	[6]	[6]	[6]	[6]
Last fault	[7]	[7]	[7]	[7]	[7]	[7]	[7]

Figure 11-7 Complete fault buffer

Acknowledgement

You have multiple options to acknowledge a fault, e.g.:

- PROFIdrive control word 1, bit 7 (r2090.7)
- Acknowledge via the operator panel
- Switch-off the inverter power supply and switch-on again.

Faults detected during the inverter-internal monitoring of hardware and firmware can be acknowledged only by switching the supply voltage off and on again. The list of faults in the List Manual contains a note on this limited acknowledgment possibility.

Emptying the fault buffer: Fault history

The fault history can contain up to 56 faults.

The acknowledgment has no effect as long as none of the causes for the faults in the buffer have been removed. If at least one of the faults in the fault buffer has been removed (the cause of the fault has been removed) and you acknowledge the faults, then the following happens:

1. The inverter accepts all faults from the fault buffer in the first eight memory locations of the fault history (indexes 8 ... 15).
2. The inverter deletes the faults that have been removed from the fault buffer.
3. The inverter writes the time of acknowledgment of the faults that have been removed into parameters r2136 and r2109 (fault time removed).

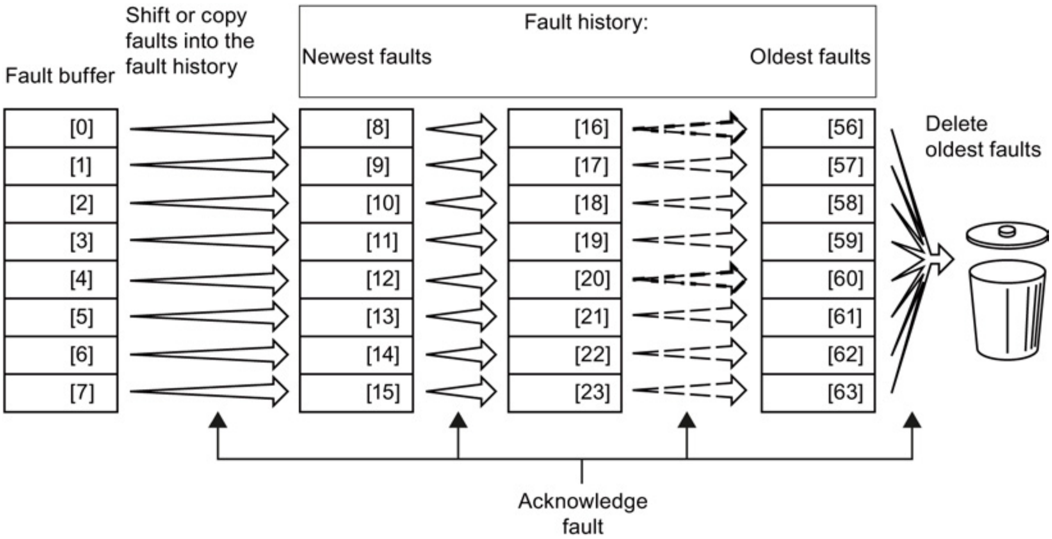


Figure 11-8 Fault history after acknowledging the faults

After acknowledgment, the faults that have not been removed are located in the fault buffer as well as in the fault history. For these faults, the "fault time coming" remains unchanged and the "fault time removed" remains empty.

If less than eight faults were shifted or copied into the fault history, the memory locations with the higher indexes remain empty.

The inverter shifts the values previously saved in the fault history by eight indexes. Faults, which were saved in indexes 56 … 63 before the acknowledgment, are deleted.

Deleting the fault history

If you wish to delete all faults from the fault history, set parameter p0952 to zero.

Parameters of the fault buffer and the fault history

Parameter	Description
r0945	**Fault code** Displays the numbers of faults that have occurred
r0948	**Fault time received in milliseconds** Displays the time in milliseconds when the fault occurred
r0949	**Fault value** Displays additional information about the fault
p0952	**Fault cases, counter** Number of fault cases that have occurred since the last acknowledgment. The fault buffer is deleted with p0952 = 0.
r2109	**Fault time removed in milliseconds** Displays the time in milliseconds when the fault occurred
r2130	**Fault time received in days** Displays the time in days when the fault occurred
r2131	**Actual fault code** Displays the code of the oldest fault that is still active
r2133	**Fault value for float values** Displays additional information about the fault that occurred for float values
r2136	**Fault time removed in days** Displays the time in days when the fault was removed

Extended settings for faults

Parameter	Description
You can change the fault response of the motor for up to 20 different fault codes:	
p2100	**Setting the fault number for fault response** Selection of the faults for which the fault response applies
p2101	**Setting, fault response** Setting the fault response for the selected fault
You can change the acknowledgment type for up to 20 different fault codes:	
p2126	**Setting the fault number for the acknowledgment mode** Selection of the faults for which the acknowledgment type should be changed
p2127	**Setting, acknowledgment mode** Setting the acknowledgment type for the selected fault 1: Can only be acknowledged using POWER ON 2: IMMEDIATE acknowledgment after removing the fault cause
You can change up to 20 different faults into an alarm or suppress faults:	
p2118	**Setting the message number for the message type** Selection of the message for which the message type should be changed
p2119	**Setting the message type** Setting the message type for the selected fault 1: Fault 2: Alarm 3: No message

You will find details in function diagram 8075 and in the parameter description of the List Manual.

11.5 List of alarms and faults

Axxxxx Alarm

Fyyyyy: Fault

Table 11- 6 The most important alarms and faults of the safety functions

Number	Cause	Remedy
F01600	STOP A Triggered	STO Select and then deselect again.
F01650	Acceptance test required	Carry out acceptance test and create test certificate. Switch the Control Unit off and then on again.
F01659	Write task for parameter rejected	Cause: The converter should be reset to the factory setting. The resetting of the safety functions is, however, not allowed, because the safety functions are currently enabled. Remedy with operator panel: p0010 = 30 — Parameter reset p9761 = … — Enter password for the safety functions. p0970 = 5 — Reset Start Safety Parameter. The converter sets p0970 = 5 if it has reset the parameters. Then reset the converter to the factory setting again.
A01666	Static 1 signal atF-DI for safe acknowledgment	F-DI to a logical 0 signal.
A01698	Commissioning mode active for safety functions	This message is withdrawn after the Safety commissioning has ended.
A01699	Shutdown path test required	After the next time that the "STO" function is deselected, the message is withdrawn and the monitoring time is reset.
F30600	STOP A Triggered	STO Select and then deselect again.

Table 11- 7 Faults, which can only be acknowledged by switching the converter off and on again (power on reset)

Number	Cause	Remedy
F01000	Software fault in CU	Replace CU.
F01001	Floating Point Exception	Switch CU off and on again.
F01015	Software fault in CU	Upgrade firmware or contact technical support.
F01018	Power-up aborted more than once	After this fault is output, the converter powers up with the factory settings. Remedy: Back up factory setting with p0971=1. Switch CU off and on again. Recommission the converter.
F01040	Parameters must be saved	Save parameters (p0971). Switch CU off and on again.
F01044	Loading of memory data card defective	Replace memory card or CU.
F01105	CU: Insufficient memory	Reduce number of data records.
F01205	CU: Time slice overflow	Contact technical support.
F01250	CU hardware fault	Replace CU.
F01512	An attempt has been made to establish an conversion factor for scaling which is not present	Create scaling or check transfer value.

Number	Cause	Remedy
F01662	CU hardware fault	Switch CU off and on again, upgrade firmware, or contact technical support.
F30022	Power Module: Monitoring U_{CE}	Check or replace the Power Module.
F30052	Incorrect Power Module data	Replace Power Module or upgrade CU firmware.
F30053	Error in FPGA data	Replace the Power Module.
F30662	CU hardware fault	Switch CU off and on again, upgrade firmware, or contact technical support.
F30664	CU power up aborted	Switch CU off and on again, upgrade firmware, or contact technical support.
F30850	Software fault in Power Module	Replace Power Module or contact technical support.

Table 11- 8 The most important alarms and faults

Number	Cause	Remedy
F01018	Power-up aborted more than once	1. Switch the module off and on again. 2. After this fault has been output, the module is booted with the factory settings. 3. Recommission the inverter.
A01028	Configuration error	Explanation: Parameterization on the memory card has been created with a different type of module (order number, MLFB) Check the module parameters and recommission if necessary.
F01033	Switching over units: Reference parameter value invalid	Set the value of the reference parameter not equal to 0.0 (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).
F01034	Switching over units: Calculation of the parameter values after reference value change unsuccessful	Select the value of the reference parameter so that the parameters involved can be calculated in the per unit notation (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).
A01053	System overload measured	The maximum computing power of the control unit was exceeded. The following measures reduce the load on the control unit: • Use only one data record (CDS and DDS) • Only use the safety features of the basic functions • Deactivate the technology controller • Use the simple ramp-function generator rather than the extended ramp-function generator • Do not use any free function components • Reduce the sampling time of the free function blocks
F01054	System limit exceeded	
F01122	Frequency at the probe input too high	Reduce the frequency of the pulses at the probe input.
A01590	Motor maintenance interval lapsed	Carry out maintenance and reset the maintenance interval (p0651).
A01900	PROFIBUS: Configuration telegram faulty	Explanation: A PROFIBUS master is attempting to establish a connection with a faulty configuration telegram. Check the bus configuration on the master and slave side.

Number	Cause	Remedy
A01910 F01910	Setpoint timeout	The alarm is generated when p2040 ≠ 0 ms and one of the following causes is present: • The bus connection is interrupted • The Modbus master is switched off • Communications error (CRC, parity bit, logical error) • An excessively low value for the fieldbus monitoring time (p2040)
A01920	PROFIBUS: Cyclic connection interrupt	Explanation: The cyclic connection to PROFIBUS master is interrupted. Establish the PROFIBUS connection and activate the PROFIBUS master with cyclic operation.
F03505	Analog input, wire break	Check the wiring for interruptions. Check the level of the injected signal. The input current measured by the analog input can be read out in r0752.
A03520	Temperature sensor fault	Check that the sensor is connected correctly.
A05000 A05001 A05002 A05004 A05006	Power Module overtemperature	Check the following: - Is the ambient temperature within the defined limit values? - Are the load conditions and duty cycle configured accordingly? - Has the cooling failed?
F06310	Supply voltage (p0210) incorrectly set	Check the set supply voltage and if required change (p0210). Check the line voltage.
F07011	Motor overtemperature	Reduce the motor load. Check the ambient temperature. Check the wiring and connection of the sensor.
A07012	I2t Motor Module overtemperature	Check and if necessary reduce the motor load. Check the motor's ambient temperature. Check the thermal time constant p0611. Check the overtemperature fault threshold p0605.
A07015	Motor temperature sensor alarm	Check that the sensor is connected correctly. Check the parameter assignment (p0601).
F07016	Motor temperature sensor fault	Make sure that the sensor is connected correctly. Check the parameterization (p0601). Deactivate the motor temperature sensor fault evaluation (p0607 = 0).
F07086 F07088	Switching over units: Parameter limit violation	Check the adapted parameter values and if required correct.
F07320	Automatic restart aborted	Increase the number of restart attempts (p1211). The actual number of start attempts is shown in r1214. Increase the wait time in p1212 and/or monitoring time in p1213. Connect an ON command (p0840). Increase the monitoring time of the power unit or switch off (p0857). Reduce the wait time for resetting the fault counter p1213[1] so that fewer faults are registered in the time interval.
A07321	Automatic restart active	Explanation: The automatic restart (AR) is active. During voltage recovery and/or when remedying the causes of pending faults, the drive is automatically switched back on.
F07330	Search current measured too low	Increase the search current (p1202), check the motor connection.

Number	Cause	Remedy
A07400	DC-link voltage maximum controller active	If it is not desirable that the controller intervenes: • Increase the ramp-down times. • Deactivate the Vdc_max control (p1240 = 0 for vector control, p1280 = 0 for U/f control).
A07409	U/f control, current limiting controller active	The alarm automatically disappears after one of the following measures: • Increase the current limit (p0640). • Reduce the load. • Slow down the ramp-ups for the setpoint speed.
F07426	Technology controller actual value limited	• Adapt the limits to the signal level (p2267, p2268). • Check the actual value scaling (p2264).
F07801	Motor overcurrent	Check the current limits (p0640). Vector control: Check the current controller (p1715, p1717). U/f control: Check the current limiting controller (p1340 … p1346). Increase the acceleration ramp (p1120) or reduce the load. Check the motor and motor cables for short-circuit and ground fault. Check the motor regarding the star/delta connection and rating plate parameterization. Check the power unit / motor combination. Select the flying restart function (p1200) if switched to rotating motor.
A07805	Drive: Power unit overload I2t	• Reduce the continuous load. • Adapt the load cycle. • Check the assignment of rated currents of the motor and power unit.
F07806	Regenerative power limit exceeded	Increase the deceleration ramp. Reduce the driving load. Use a power unit with higher energy recovery capability. For vector control, the regenerative power limit in p1531 can be reduced until the fault is no longer activated.
F07807	Short-circuit detected	• Check the inverter connection on the motor side for any phase-phase short-circuit. • Rule out that line and motor cables have been interchanged.
A07850 A07851 A07852	External alarm 1 … 3	The signal for "external alarm 1" has been triggered. Parameters p2112, p2116 and p2117 determine the signal sources for the external alarm 1… 3. Remedy: Remove the causes of these alarms.
F07860 F07861 F07862	External fault 1 … 3	Remove the external causes for this fault.
F07900	Motor blocked	Check that the motor can run freely. Check the torque limits (r1538 and r1539). Check the parameters of the "Motor blocked" message (p2175, p2177).
F07901	Motor overspeed	Activate the precontrol for the speed limiting controller (p1401 bit 7 = 1). Increase the hysteresis for overspeed signal p2162.

Number	Cause	Remedy
F07902	Motor stalled	Check whether the motor data has been set correctly and perform a motor identification. Check the current limits (p0640, r0067, r0289). If the current limits are too low, the drive cannot be magnetized. Check whether motor cables are disconnected during operation.
A07903	Motor speed deviation	Increase p2163 and/or p2166. Increase the torque, current and power limits.
A07910	Motor overtemperature	Check the motor load. Check the motor's ambient temperature. Check the KTY84 sensor. Check the overtemperatures of the thermal model (p0626 ... p0628).
A07920	Torque/speed too low	The torque deviates from the torque/speed envelope curve. • Check the connection between the motor and the load. • Adapt the parameterization corresponding to the load.
A07921	Torque/speed too high	
A07922	Torque/speed out of tolerance	
F07923	Torque/speed too low	• Check the connection between the motor and the load. • Adapt the parameterization corresponding to the load.
F07924	Torque/speed too high	
A07927	DC braking active	Not required
A07980	Rotary measurement activated	Not required
A07981	No enabling for rotary measurement	Acknowledge pending faults. Establish missing enables (see r00002, r0046).
A07991	Motor identification activated	Switch on the motor and identify the motor data.
F08501	Setpoint timeout	• Check the PROFINET connection. • Set the controller into the RUN mode. • If the fault occurs repeatedly, check the monitoring time set p2044.
F08502	Monitoring time, sign-of-life expired	• Check the PROFINET connection.
F08510	Send configuration data not valid	• Check the PROFINET configuration
A08511	Receive configuration data not valid	
A08526	No cyclic connection	• Activate the controller with cyclic operation. • Check the parameters "Name of Station" and "IP of Station" (r61000, r61001).
A08565	Consistency error affecting adjustable parameters	Check the following: • IP address, subnet mask or default gateway is not correct. • IP address or station name used twice in the network. • Station name contains invalid characters.

Number	Cause	Remedy
F08700	Communications error	A CAN communications error has occurred. Check the following: • Bus cable • Baud rate (p8622) • Bit timing (p8623) • Master Start the CAN controller manually with p8608 = 1 after the cause of the fault has been resolved!
F13100	Know-how protection: Copy protection error	The know-how protection and the copy protection for the memory card are active. An error occurred when checking the memory card. • Insert a suitable memory card and switch the inverter supply voltage temporarily off and then on again (POWER ON). • Deactivate the copy protection (p7765).
F13101	Know-how protection: Copy protection cannot be activated	Insert a valid memory card.
F30001	Overcurrent	Check the following: • Motor data, if required, carry out commissioning • Motor connection method (Y / Δ) • U/f operation: Assignment of rated currents of motor and Power Module • Line quality • Make sure that the line commutating reactor is connected properly • Power cable connections • Power cables for short-circuit or ground fault • Power cable length • Line phases If this doesn't help: • U/f operation: Increase the acceleration ramp • Reduce the load • Replace the power unit
F30002	DC-link voltage overvoltage	Increase the ramp-down time (p1121). Set the rounding times (p1130, p1136). Activate the DC-link voltage controller (p1240, p1280). Check the line voltage (p0210). Check the line phases.
F30003	DC-link voltage undervoltage	Check the line voltage (p0210).
F30004	Inverter overtemperature	Check whether the inverter fan is running. Check whether the ambient temperature is in the permissible range. Check whether the motor is overloaded. Reduce the pulse frequency.
F30005	I2t inverter overload	Check the rated currents of the motor and Power Module. Reduce the current limit p0640. When operating with U/f characteristic: Reduce p1341.

Number	Cause	Remedy
F30011	Line phase failure	Check the inverter's input fuses. Check the motor feeder cables.
F30015	Motor cable phase failure	Check the motor cables. Increase the ramp-up or ramp-down time (p1120).
F30021	Ground fault	• Check the power cable connections. • Check the motor. • Check the current transformer. • Check the cables and contacts of the brake connection (a wire might be broken).
F30027	Time monitoring for DC link pre-charging	Check the supply voltage at the input terminals. Check the line voltage setting (p0210).
F30035	Overtemperature, intake air	• Check whether the fan is running. • Check the fan filter elements. • Check whether the ambient temperature is in the permissible range.
F30036	Overtemperature, inside area	
F30037	Rectifier overtemperature	See F30035 and, in addition: • Check the motor load. • Check the line phases
A30049	Internal fan defective	Check the internal fan and if required replace.
F30059	Internal fan defective	Check the internal fan and if required replace.
A30502	DC-link overvoltage	• Check the unit supply voltage (p0210). • Check the dimensioning of the line reactor.
A30920	Temperature sensor fault	Check that the sensor is connected correctly.
A50001	PROFINET configuration error	A PROFINET controller is attempting to establish a connection with an incorrect configuration telegram. Check whether "Shared Device" is activated (p8929 = 2).
A50010	PROFINET name of station invalid	Correct name of station (p8920) and activate (p8925 = 2).
A50020	PROFINET: Second controller missing	"Shared Device" is activated (p8929 = 2). However, only the connection to a PROFINET controller is available.
For further information, please refer to the List Manual.		

For further information, please refer to the List Manual.

11.6 Identification & maintenance data (I&M)

I&M data

The inverter supports the following identification and maintenance (I&M) data.

I&M data	Format	Explanation	Associated parameters	Example for the content
I&M0	u8[64] PROFIBUS u8[54] PROFINET	Inverter-specific data, read only	-	See below
I&M1	Visible String [32]	Plant/system identifier	p8806[0 … 31]	"ak12-ne.bo2=fu1"
	Visible String [22]	Location code	p8806[32 … 53]	"sc2+or45"
I&M2	Visible String [16]	Date	p8807[0 … 15]	"2013-01-21 16:15"
I&M3	Visible String [54]	Any comment	p8808[0 … 53]	-
I&M4	Octet String[54]	Check signature to track changes for Safety Integrated. This value can be changed by the user. The test signature is reset to the value generated by the machine is p8805 = 0 is used.	p8809[0 … 53]	Values of r9781[0] and r9782[0]

When requested, the inverted transfers its I&M data to a higher-level control or to a PC/PG with installed STEP 7, STARTER or TIA-Portal.

I&M0

Designation	Format	Example for the content	Valid for PROFINET	Valid for PROFIBUS
Manufacturer-specific	u8[10]	00 … 00 hex	---	✓
MANUFACTURER_ID	u16	42d hex (=Siemens)	✓	✓
ORDER_ID	Visible String [20]	„6SL3246-0BA22-1FA0“	✓	✓
SERIAL_NUMBER	Visible String [16]	„T-R32015957“	✓	✓
HARDWARE_REVISION	u16	0001 hex	✓	✓
SOFTWARE_REVISION	char, u8[3]	„V“ 04.70.19	✓	✓
REVISION_COUNTER	u16	0000 hex	✓	✓
PROFILE_ID	u16	3A00 hex	✓	✓
PROFILE_SPECIFIC_TYPE	u16	0000 hex	✓	✓
IM_VERSION	u8[2]	01.02	✓	✓
IM_SUPPORTED	bit[16]	001E hex	✓	✓

12 Technical data

12.1 Technical data, CU240B-2 Control Unit

Table 12- 1

Feature	Data		
Order numbers	With RS485 interface for the following protocols: • USS • Modbus RTU		Order numbers: See Section Overview of Control Units (Page 24)
	With PROFIBUS interface		
Operating voltage	You have two options for the Control Unit power supply: • Supply from the Power Module • External supply via terminals 31 and 32 with 20.4 ... 28.8 VDC. Use a power supply with (PELV = Protective Extra Low Voltage according to EN 61800-5-1), Class 2. The 0 V of the power supply must be connected to the the PE of the system through a low resistance connection.		
	The power supply is electrically isolated from the control terminals.		
Current consumption	max 0.5 A		
Power loss	5.0 W	Plus power loss of the output voltages.	
Output voltages	+24 V out (terminal 9),18 V … 28.8 V, max. 100 mA		
	+10 V out (terminals 1 and 35), 9.5 V … 10.5 V, max. 10 mA		
Setpoint resolution	0.01 Hz		
Digital inputs	4 (DI 0 … DI 3)	• Low < 5 V, high > 11 V • Electrically isolated • 30 V maximum input voltage • 5.5 mA current consumption • SIMATIC-compatible • PNP/NPN switchable • 10 ms response time for debounce time p0724 = 0.	
Analog input	1 (AI 0)	• Differential input • Switchable: 0 V … 10 V, 0 mA … 20 mA or -10 V … +10 V • 12-bit resolution • 13 ms ± 1 ms response time • If AI 0 has been configured as additional digital input: Low < 1.6 V, high > 4.0 V, 13 ms ± 1 ms response time for a debounce time p0724 = 0.	

Feature	Data	
Digital output / relay output	1 (DO 0)	• 30 V DC / max. 0.5 A with resistive load • Update time 2 ms
	For applications which require UL certification, the voltage at DO 0 must not exceed 30 VDC referred to ground potential and must be supplied via a grounded class 2 power supply.	
Analog output	1 (AO 0)	• 0 V … 10 V or 0 mA … 20 mA • Reference potential: "GND" • 16-bit resolution • 4 ms update time
Temperature sensor	PTC	• Short-circuit monitoring 22 Ω • Switching threshold 1650 Ω
	KTY84	• Short-circuit monitoring < 50 Ω • Wire break > 2120 Ω
	Temperature switch with isolated contact.	
USB interface	Mini-B	
Dimensions (WxHxD)	73 mm × 199 mm × 39 mm	The depth specification is valid when mounting on the Power Module.
Weight	0.49 kg	
Memory cards	Slot for SD or MMC memory cards, also see Section: Overview of Control Units (Page 24)	
Operating temperature	0° C … 55° C	For operation without inserted operator panel.
	0° C … 50° C	For operation with inserted operator panel.
	Observe any possible restrictions regarding the operating temperature as a result of the Power Module.	
Storage temperature	- 40° C … 70° C	
Relative humidity	< 95 %	Condensation is not permissible.

12.2 Technical data, CU240E-2 Control Unit

Table 12- 2

Feature	Data	
Fieldbus interface	With RS485 interface for the following protocols: • USS • Modbus RTU	Order numbers: See Section Overview of Control Units (Page 24)
	With PROFIBUS interface	
	With PROFINET interface	
Operating voltage	You have two options for the Control Unit power supply: • Supply from the Power Module • External supply via terminals 31 and 32 with 20.4 ... 28.8 VDC. Use a power supply with (PELV = Protective Extra Low Voltage according to EN 61800-5-1), Class 2. The 0 V of the power supply must be connected to the the PE of the system through a low resistance connection.	
	The power supply is electrically isolated from the control terminals.	
Current consumption	max 0.5 A	
Power loss	5.0 W	Plus power loss of the output voltages.
Output voltages	+24 V out (terminal 9),18 V … 28.8 V, max. 100 mA	
	+10 V out (terminals 1 and 35), 9.5 V … 10.5 V, max. 10 mA	
Setpoint resolution	0.01 Hz	
Digital inputs	6 (DI 0 … DI 5)	• Low < 5 V, high > 11 V • Electrically isolated • 30 V maximum input voltage • 5.5 mA current consumption • SIMATIC-compatible • PNP/NPN switchable • 10 ms response time for debounce time p0724 = 0.
Pulse input	1 (DI 3)	Maximum frequency 32 kHz
Analog inputs	2 (AI 0, AI 1)	• Differential input • Switchable: 0 V … 10 V, 0 mA … 20 mA or -10 V … +10 V • 12-bit resolution • 13 ms ± 1 ms response time • If AI 0 has been configured as additional digital input: Low < 1.6 V, high > 4.0 V, 13 ms ± 1 ms response time for a debounce time p0724 = 0.

Feature	Data		
Digital outputs	3 (DO 0 … DO 2)		• DO 0: Relay output, 30 V DC / max. 0.5 A with resistive load • DO 1: Transistor output, 30 V DC / max. 0.5 A with resistive load, protection against incorrect voltage polarity. • DO 2: Relay output, 30 V DC / max. 0.5 A with resistive load. • 2 ms update time
	For applications which require UL certification, the voltage at DO 0 must not exceed 30 VDC referred to ground potential and must be supplied via a grounded class 2 power supply.		
Analog outputs	2 (AO 0, AO 1)		• 0 V … 10 V or 0 mA … 20 mA • Reference potential: "GND" • 16-bit resolution • 4 ms update time
Temperature sensor	PTC		• Short-circuit monitoring 22 Ω • Switching threshold 1650 Ω
	KTY84	• Short-circuit monitoring < 50 Ω • Wire break > 2120 Ω	
	Temperature switch with isolated contact.		
Fail-safe digital input	1 (DI 4 and DI 5)	• If you have enabled the basic functions of the safety functions, DI 4 and DI 5 form the fail-safe digital input. • Maximum input voltage 30 V, 5.5 mA • Response time: – Typical: 5 ms + debounce time p9651 – Typical, if debounce time = 0: 6 ms – Worst-case scenario: 15 ms + debounce time – Worst case, if debounce time = 0: 16 ms	
	The data of the extended functions of the safety functions can be found in the Safety Integrated Function Manual, see also Section: Manuals for your inverter (Page 368).		
PFH	5 × 10E-8	Probability of failure of the safety functions (Probability of Failure per Hour)	
USB interface	Mini-B		
Dimensions (WxHxD)	73 mm × 199 mm × 39 mm	The depth specification is valid when mounting on the Power Module.	
Weight	0.49 kg		
Memory cards	Slot for SD or MMC memory cards, also see Section: Overview of Control Units (Page 24)		

<table>
<tr><th>Feature</th><th colspan="2">Data</th></tr>
<tr><td rowspan="4">Operating temperature</td><td>0° C … 55° C</td><td>For operation without inserted operator panel.</td></tr>
<tr><td>0° C … 53° C</td><td>Only applies to Control Units with PROFINET interface without inserted operator panel when both of the following conditions are satisfied:
There is no lateral spacing between one Control Unit and the other.
For instance, this is the case if several Power Modules with Frame Size A are mounted directly side by side.
The input voltage of the associated Power Module is greater than 480 V.</td></tr>
<tr><td>0° C … 50° C</td><td>For operation with inserted operator panel.</td></tr>
<tr><td colspan="2">Observe any possible restrictions regarding the operating temperature as a result of the Power Module.</td></tr>
<tr><td>Storage temperature</td><td>- 40° C … 70° C</td><td></td></tr>
<tr><td>Relative humidity</td><td>< 95 %</td><td>Condensation is not permissible.</td></tr>
</table>

Note

Short-term voltage dips in the external 24 V supply (≤ 3 ms and ≤ 95% of the rated voltage)

When the mains voltage of the inverter is switched off, the inverter responds to short-term voltage dips in the external 24 V supply with fault F30074. Communication via fieldbus, however, remains in effect in this case.

12.3 Technical data, Power Modules

Note

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

The load cycles shown in the diagram are examples. We recommend the "SIZER" engineering software to select the inverter based on duty cycles. See Configuring support (Page 369).

Definitions

- **LO base load input current**

  100% of the permissible input current for a load cycle according to Low Overload.
- **LO base load output current**

  100% of the permissible output current for a load cycle according to Low Overload.
- **LO base load power**

  100 % of the inverter power for 100 % LO base load output current.
- **HO base load input current**

  100% of the permissible input current for a load cycle according to High Overload.
- **HO base load output current**

  100% of the permissible output current for a load cycle according to High Overload.
- **HO base load power**

  100 % of the inverter power for 100 % HO base load output current.

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

12.3.1 Technical data, PM230 IP20

Permissible converter overload

The converters have different power ratings "High Overload" and "Low Overload" depending on the expected load.

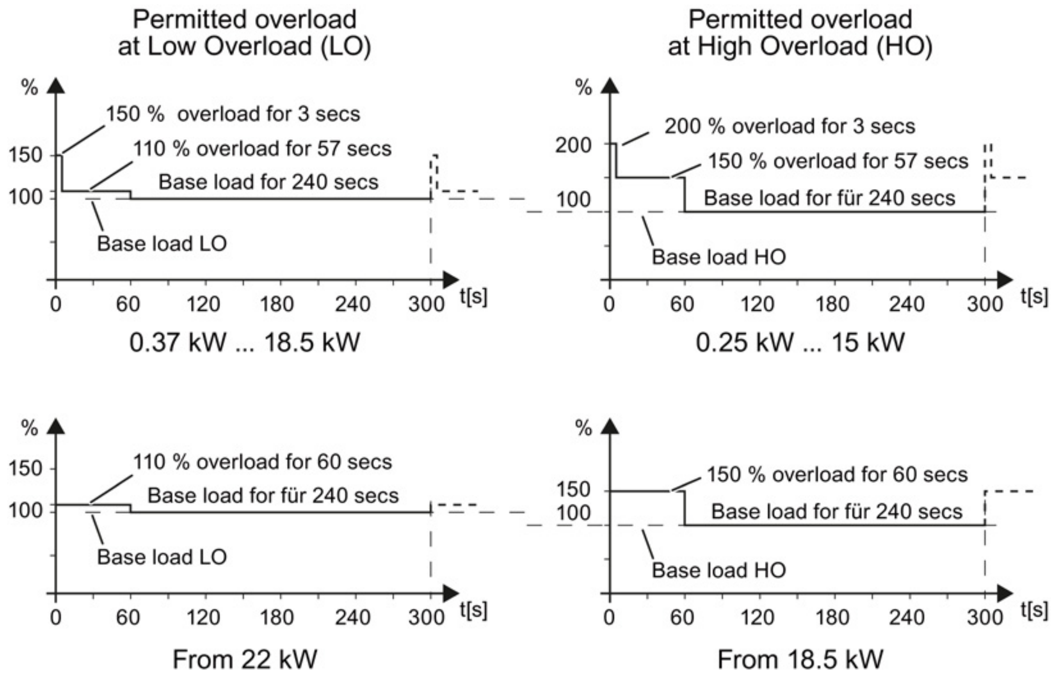


Figure 12-1 Duty cycles, "High Overload" and "Low Overload"

12.3.1.1 General data, PM230 - IP20

Property	Version		
Line voltage	380 V … 480 V 3-ph. AC ± 10 %		
Output voltage	0 V 3-ph. AC … input voltage x 0.95 (max.)		
Input frequency	50 Hz … 60 Hz, ± 3 Hz		
Output frequency	0 … 550 Hz, depending on the control mode		
Power factor λ	0.9		
Line impedance	Uk ≤ 1%, no line reactor permitted		
Inrush current	< LO base load input current		
Pulse frequency (factory setting)	4 kHz The pulse frequency can be increased in 2 kHz steps up to 16 kHz (up to 8 kHz for 55 kW and 75 kW). An increase in the pulse frequency results in a lower output current.		
Electromagnetic compatibility	Devices with filters in compliance with EN 61800-3: 2004 are suitable for Category C2 environments. Details, see manuals for your inverter, Hardware Installation Manual PM230 (Page 368)		
Braking methods	DC braking		
Degree of protection	IP20 built-in units PT devices	IP20 when mounted in a control cabinet IP54 on the control cabinet wall	
Operating temperature at	LO base load power without derating		0 °C … +40 °C
	HO base load power without derating		0 °C … +50 °C
	LO/HO base load power with derating:		Up to 60° C
	Details - (Page 340).		
Storage temperature	-40 °C … +70 °C		
Relative humidity	< 95% - condensation not permissible		
Pollution	Protected according to pollution degree 2 to EN 61800-5-1: 2007		
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995		
Shock and vibration	• Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997 • Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997 • Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995		
Installation altitude	without derating: with derating:	up to 1000 m above sea level up to 4000 m above sea level	For details, see Restrictions for special ambient conditions (Page 340)
Permissible short-circuit current	Frame size D ... F: 65 kA [1]		
Overvoltage category	Supply circuits: Non-supply circuits:	Overvoltage category III Overvoltage category II	
Standards	UL [1),2)], CE, C-tick The drive only satisfies the UL requirements when UL-certified fuses are used.		

1) If fuse-protected with a listed Class J or 3NE1 fuse, rated voltage 600 VAC with the rated current of the specific inverter.

2) UL available soon for frame sizes D … F

12.3.1.2 Power-dependent data, PM230, IP20

Note

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

Table 12- 3 PM230, IP20, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - without filter Order No. - with filter	6SL3210… 6SL3210…	…1NE11-3UL1 …1NE11-3AL1	…1NE11-7UL1 …1NE11-7AL1	…1NE12-2UL1 …1NE12-2AL1
LO base load power LO base load input current LO base load output current		0.37 kW 1.3 A 1.3 A	0.55 kW 1.8 A 1.7 A	0.75 kW 2.3 A 2.2 A
HO base load power HO base load input current HO base load output current		0.25 kW 0.9 A 0.9 A	0.37 kW 1.3 A 1.3 A	0.55 kW 1.8 A 1.7 A
Fuse according to IEC Fuse according to UL		3NE1 813-0 AJT2 / 3NE1 813-0	3NE1 813-0 AJT4 / 3NE1 813-0	3NE1 813-0 AJT4 / 3NE1 813-0
Power loss		0.04 kW	0.04 kW	0.05 kW
Required cooling air flow		1.5 l/s	1.5 l/s	4.5 l/s
Cross section of line and motor cables		1 … 2.5 mm² 18 … 14 AWG	1 … 2.5 mm² 18 … 14 AWG	1 … 2.5 mm² 18 … 14 AWG
Tightening torque for line and motor cables		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight without filter Weight with filter		1.4 kg 1.6 kg	1.4 kg 1.6 kg	1.4 kg 1.6 kg

Table 12- 4 PM230, IP20, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - without filter Order No. - with filter	6SL3210… 6SL3210…	…1NE13-1UL1 …1NE13-1AL10	…1NE14-1UL1 …1NE14-1AL1	…-1NE15-8UL1 …-1NE15-8AL1
LO base load power LO base load input current LO base load output current		1.1 kW 3.2 A 3.1 A	1.5 kW 4.2 A 4.1 A	2.2 kW 6.1 A 5.9 A
HO base load power HO base load input current HO base load output current		0.75 kW 2.3 A 2.2 A	1.1 kW 3.2 A 3.1 A	1.5 kW 4.2 A 4.1 A
Fuse according to IEC Fuse according to UL		3NE1 813-0 AJT6 / 3NE1 813-0	3NE1 813-0 AJT6 / 3NE1 813-0	3NE1 813-0 AJT10 / 3NE1 813-0
Power loss		0.06 kW	0.07 kW	0.08 kW
Required cooling air flow		4.5 l/s	4.5 l/s	4.5 l/s
Cross section of line and motor cables		1 … 2.5 mm² 18 … 14 AWG	1 … 2.5 mm² 18 … 14 AWG	1.5 … 2.5 mm² 16 … 14 AWG
Tightening torque for line and motor cables		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight without filter Weight with filter		1.4 kg 1.6 kg	1.4 kg 1.6 kg	1.4 kg 1.6 kg

Table 12- 5 PM230, IP20, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - without filter	**6SL3210…**	**…1NE17-7UL1**
Order No. - with filter	**6SL3210…**	**…1NE17-7AL1**
LO base load power		3 kW
LO base load input current		8.0 A
LO base load output current		7.7 A
HO base load power		2.2 kW
HO base load input current		6.1 A
HO base load output current		5.9 A
Fuse according to IEC		3NE1 813-0
Fuse according to UL		AJT10 / 3NE1 813-0
Power loss		0.11 kW
Required cooling air flow		4.5 l/s
Cross section of line and motor cables		1.5 … 2.5 mm^2 16 … 14 AWG
Tightening torque for line and motor cables		0.5 Nm / 4 lbf in
Weight without filter		1.4 kg
Weight with filter		1.6 kg

Table 12- 6 PM230, PT, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - without filter	**6SL3211…**	**…1NE17-7UL1**
Order No. - with filter	**6SL3211…**	**…1NE17-7AL1**
LO base load power		3 kW
LO base load input current		8.0 A
LO base load output current		7.7 A
HO base load power		2.2 kW
HO base load input current		6.1 A
HO base load output current		5.9 A
Fuse according to IEC		3NE1 813-0
Fuse according to UL		AJT10 / 3NE1 813-0
Power loss		0.11 kW
Required cooling air flow		4.5 l/s
Cross section of line and motor cables		1.5 … 2.5 mm^2 16 … 14 AWG
Tightening torque for line and motor cables		0.5 Nm / 4 lbf in
Weight without filter		1.7 kg
Weight with filter		1.9 kg

Table 12- 7 PM230, IP20, Frame Sizes B, 3 AC 380 V … 480 V

Order No. - without filter	**6SL3210…**	**…1NE21-0UL1**	**…1NE21-3UL1**	**…1NE21-8UL1**
Order No. - with filter	**6SL3210…**	**…1NE21-0AL1**	**…1NE21-3AL1**	**…1NE21-8AL1**
LO base load power LO base load input current LO base load output current		4 kW 10.5 A 10.2 A	5.5 kW 13.6 A 13.2 A	7.5 kW 18.6 A 18 A
HO base load power HO base load input current HO base load output current		3 kW 8.0 A 7.7 A	4 kW 10.5 A 10.2 A	5.5 kW 13.6 A 13.2 A
Fuse according to IEC Fuse according to UL		3NE1 813-0 AJT15 / 3NE1 813-0	3NE1 814-0 AJT20 / 3NE1 814-0	3NE1 815-0 AJT25 / 3NE1 815-0
Power loss		0.12 kW	0.15 kW	0.22 kW
Required cooling air flow		9.2 l/s	9.2 l/s	9.2 l/s
Cross section of line and motor cables		1.5 … 6 mm^2 16 … 10 AWG	1.5 … 6 mm^2 16 … 10 AWG	1.5 … 6 mm^2 16 … 10 AWG
Tightening torque for line and motor cables		0.6 Nm / 5 lbf in	0.6 Nm / 5 lbf in	0.6 Nm / 5 lbf in
Weight without filter Weight with filter		2.8 kg 3 kg	2.8 kg 3 kg	2.8 kg 3 kg

Table 12- 8 PM230, PT, Frame Sizes B, 3 AC 380 V … 480 V

Order No. - without filter	**6SL3211…**	**…1NE21-8UL1**
Order No. - with filter	**6SL3211…**	**…1NE21-8AL1**
LO base load power LO base load input current LO base load output current		7.5 kW 18.6 A 18 A
HO base load power HO base load input current HO base load output current		5.5 kW 13.6 A 13.2 A
Fuse according to IEC Fuse according to UL		3NE1 815-0 AJT25 / 3NE1 815-0
Power loss		0.22 kW
Required cooling air flow		9.2 l/s
Cross section of line and motor cables		1.5 … 6 mm^2 16 … 10 AWG
Tightening torque for line and motor cables		0.6 Nm / 5 lbf in
Weight without filter Weight with filter		3.4 kg 3.6 kg

Table 12- 9 PM230, IP20, Frame Sizes C, 3 AC 380 V … 480 V

Order No. - without filter **Order No. - with filter**	**6SL3210…** **6SL3210…**	**…1NE22-6UL1** **…1NE22-6AL1**	**…1NE23-2UL1** **…1NE23-2AL1**	**…1NE23-8UL1** **…1NE23-8AL1**
LO base load power LO base load input current LO base load output current		11 kW 26.9 A 26 A	15 kW 33.1 A 32 A	18.5 kW 39.2 A 38 A
HO base load power HO base load input current HO base load output current		7.5 kW 18.6 A 18 A	11 kW 26.9 A 26 A	15 kW 33.1 A 32 A
Fuse according to IEC Fuse according to UL		3NE1 803-0 AJT35 / 3NE1 803-0	3NE1 817-0 AJT45 / 3NE1 817-0	3NE1 817-0 AJT50 / 3NE1 817-0
Power loss		0.3 kW	0.35 kW	0.45 kW
Required cooling air flow		18.5 l/s	18.5 l/s	18.5 l/s
Cross section of line and motor cables		6 …16 mm^2 10 … 6 AWG	6 …16 mm^2 10 … 6 AWG	6 …16 mm^2 10 … 6 AWG
Tightening torque for line and motor cables		1.3 Nm / 12 lbf in	1.3 Nm / 12 lbf in	1.3 Nm / 12 lbf in
Weight without filter Weight with filter		4.5 kg 5.1 kg	4.5 kg 5.1 kg	4.5 kg 5.1 kg

Table 12- 10 PM230, PT, Frame Sizes C, 3 AC 380 V … 480 V

Order No. - without filter **Order No. - with filter**	**6SL3211…** **6SL3211…**	**…1NE23-8UL1** **…1NE23-8AL1**
LO base load power LO base load input current LO base load output current		18.5 kW 39.2 A 38 A
HO base load power HO base load input current HO base load output current		15 kW 33.1 A 32 A
Fuse according to IEC Fuse according to UL		3NE1 817-0 AJT50 / 3NE1 817-0
Power loss		0.45 kW
Required cooling air flow		18.5 l/s
Cross section of line and motor cables		6 …16 mm^2 10 … 6 AWG
Tightening torque for line and motor cables		1.3 Nm / 12 lbf in
Weight without filter Weight with filter		5.4 kg 6 kg

Table 12- 11 PM230, IP20, Frame Sizes D, 3 AC 380 V … 480 V

Order No. - without filter **Order No. - with filter**	**6SL3210…** **6SL3210…**	**…1NE24-5UL0** **…1NE24-5AL0**	**…1NE26-0UL0** **…1NE26-0AL0**
LO base load power LO base load input current LO base load output current		22 kW 42 A 45 A	30 kW 56 A 60 A
HO base load power HO base load input current HO base load output current		18.5 kW 36 A 38 A	22 kW 42 A 45 A
Fuse according to IEC Fuse according to UL		3NE1818-0 3NE1818-0	3NE1820-0 3NE1820-0
Power loss		0.52 kW	0.68 kW
Required cooling air flow		80 l/s	80 l/s
Cross section of line and motor cables		16 … 35 mm² 5 … 2 AWG	16 … 35 mm² 5 … 2 AWG
Tightening torque for line and motor cables		6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight without filter Weight with filter		11 kg 14 kg	11 kg 14 kg

Table 12- 12 PM230, IP20, Frame Sizes E, 3 AC 380 V … 480 V

Order No. - without filter **Order No. - with filter**	**6SL3210…** **6SL3210…**	**…1NE27-5UL0** **…1NE27-5AL0**	**…1NE28-8UL0** **…1NE28-8AL0**
LO base load power LO base load input current LO base load output current		37 kW 70 A 75 A	45 kW 84 A 90 A
HO base load power HO base load input current HO base load output current		30 kW 56 A 60 A	37 kW 70 A 75 A
Fuse according to IEC Fuse according to UL		3NE1021-0 3NE1021-0	3NE1022-0 3NE1022-0
Power loss		0.99 kW	1.2 kW
Required cooling air flow		80 l/s	80 l/s
Cross section of line and motor cables		25 … 50 mm² 3 … 1-1/0 AWG	25 … 50 mm² 3 … 1-1/0 AWG
Tightening torque for line and motor cables		6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight without filter Weight with filter		15 kg 22 kg	15 kg 22 kg

Table 12- 13 PM230, IP20, Frame Sizes F, 3 AC 380 V … 480 V

Order No. - without filter Order No. - with filter	6SL3210… 6SL3210…	…1NE31-1UL0 …1NE31-1AL0	…1NE31-5UL0 …1NE31-5AL0
LO base load power LO base load input current LO base load output current		55 kW 102 A 110 A	75 kW 135 A 145 A
HO base load power HO base load input current HO base load output current		45 kW 84 A 90 A	55 kW 102 A 110 A
Fuse according to IEC Fuse according to UL		3NE1224-0 3NE1224-0	3NE1225-0 3NE1225-0
Power loss		1.4 kW	1.9 kW
Required cooling air flow		150 l/s	150 l/s
Cross section of line and motor cables		35 … 120 mm^2 2 … 4/0 AWG	35 … 120 mm^2 2 … 4/0 AWG
Tightening torque for line and motor cables		13 Nm / 115 lbf in	13 Nm / 115 lbf in
Weight without filter Weight with filter		33 kg 48 kg	33 kg 48 kg

Current reduction depending on pulse frequency

Table 12- 14 Current reduction depending on the pulse frequency[1)]

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

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

12.3.2 Technical data, PM240

Permissible inverter overload

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

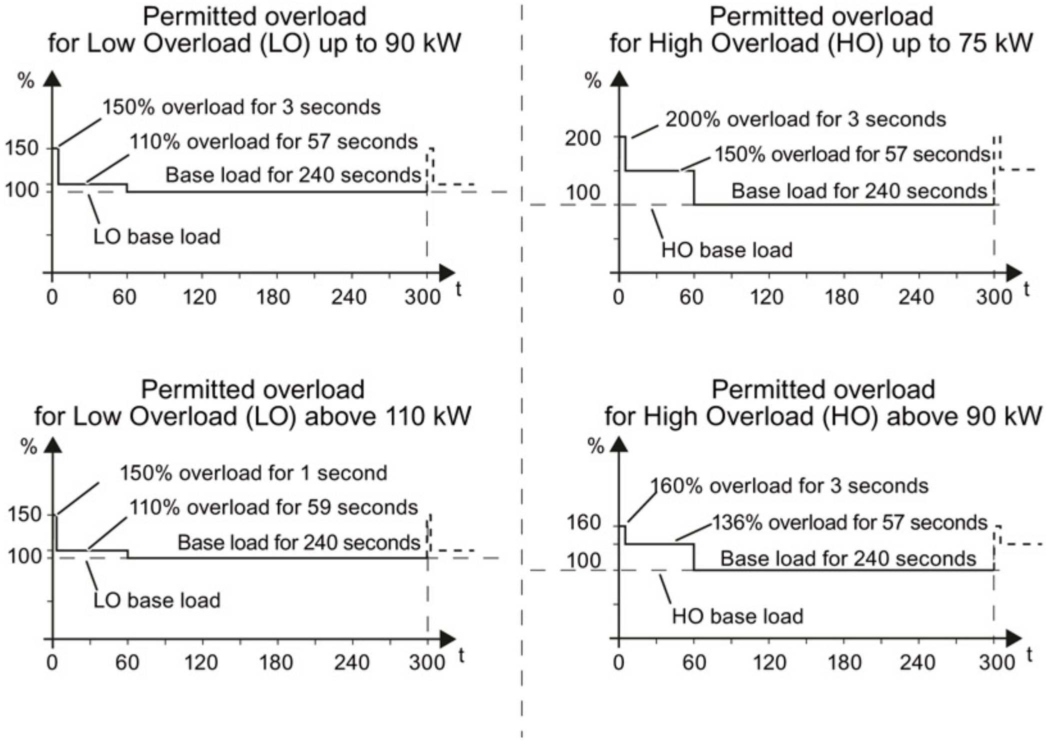


Figure 12-2 Load cycles, Low Overload" and "High Overload"

12.3.2.1 General data, PM240

Property	Version		
Line voltage	380 V … 480 V 3-ph. AC ± 10 %		
Output voltage	0 V 3-ph. AC … input voltage x 0.95 (max.)		
Input frequency	50 Hz … 60 Hz, ± 3 Hz		
Output frequency	0 … 550 Hz, depending on the control mode		
Power factor λ	0,7 ... 0,85		
Inrush current	< LO base load input current		
Pulse frequency (factory setting)	4 kHz for 0.37 kW ... 90 kW 2 kHz for 110 kW ... 250 kW The pulse frequency can be increased in 2 kHz steps. An increase in the pulse frequency results in a lower output current.		
Electromagnetic compatibility	The devices comply with EN 61800-3: 2004 suitable for Category C1 and C2 environments. Details, see manuals for your inverter, Hardware Installation Manual PM240 (Page 368)		
Braking methods	DC braking, compound braking, dynamic braking with integrated braking chopper		
Degree of protection	IP20 chassis units		
Operating temperature at	LO base load power without derating	All power ratings	0 °C … +40 °C
	HO base load power without derating	0.37 kW ... 110 kW	0 °C … +50 °C
	HO base load power without derating	132 kW … 200 kW	0 °C … +40 °C
	LO/HO base load power with derating:	All power ratings	Up to 60° C
Storage temperature	-40 °C … +70 °C		
Pollution	Protected according to pollution degree 2 to EN 61800-5-1: 2007		
Relative humidity	< 95% - condensation not permissible		
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995		
Shock and vibration	• Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997 • Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997 • Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995		
Installation altitude	without derating: 0.37 kW ... 132 kW up to 1000 m above sea level 160 kW ... 250 kW up to 2000 m above sea level with derating: all power ratings up to 4000 m above sea level	For details, see Restrictions for special ambient conditions (Page 340)	
Standards	UL, cUL, CE, C-tick, SEMI F47 The drive only satisfies the UL requirements when UL-certified fuses are used.		

12.3.2.2 Power-dependent data, PM240

Note

The given input currents are valid for operation without a line reactor for a line voltage of 400 V with Vk = 1 % referred to the rated power of the inverter. If a line reactor is used, the specified values are reduced by a few percent.

Note

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

Table 12- 15 PM240, IP20, frame sizes A, 3-ph. 380 V AC… 480 V

Order No. - without filter	6SL3224-…	…0BE13-7UA0	…0BE15-5UA0	…0BE17-5UA0
LO base load power LO base load input current LO base load output current		0.37 kW 1.6 A 1.3 A	0.55 kW 2.0 A 1.7 A	0.75 kW 2.5 A 2.2 A
HO base load power HO base load input current HO base load output current		0.37 kW 1.6 A 1.3 A	0.55 kW 2.0 A 1.7 A	0.75 kW 2.5 A 2.2 A
Fuse according to UL (from SIEMENS) Fuse according to UL (Class J, K-1 or K-5)		3NE1813-0, 16 A 10 A	3NE1813-0, 16 A 10 A	3NE1813-0, 16 A 10 A
Power loss		0.097 kW	0.099 kW	0.102 kW
Required cooling air flow		4.8 l/s	4.8 l/s	4.8 l/s
Cross section of line and motor cables		1 … 2.5 mm^2 18 … 14 AWG	1 … 2.5 mm^2 18 … 14 AWG	1 … 2.5 mm^2 18 … 14 AWG
Tightening torque for line and motor cables		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight		1.2 kg	1.2 kg	1.2 kg

Table 12- 16 PM240, IP20, frame sizes A, 3-ph. 380 V AC… 480 V

Order No. - without filter	6SL3224-…	…0BE21-1UA0	…0BE21-5UA0
LO base load power LO base load input current LO base load output current		1.1 kW 3.9 A 3.1 A	1.5 kW 4.9 A 4.1 A
HO base load power HO base load input current HO base load output current		1.1 kW 3.8 A 3.1 A	1.5 kW 4.8 A 4.1 A
Fuse according to UL (from SIEMENS) Fuse according to UL (Class J, K-1 or K-5)		3NE1813-0, 16 A 10 A	3NE1813-0, 16 A 10 A
Power loss		0.108 kW	0.114 kW
Required cooling air flow		4.8 l/s	4.8 l/s
Cross section of line and motor cables		1 … 2.5 mm^2 18 … 14 AWG	1 … 2.5 mm^2 18 … 14 AWG
Tightening torque for line and motor cables		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight		1.1 kg	1.1 kg

Table 12- 17 PM240, IP20, frame sizes B, 3-ph. 380 V AC… 480 V

Order No. - without filter **Order No. - with filter**	**6SL3224-…** **6SL3224-…**	**…0BE22-2UA0** **…0BE22-2AA0**	**…0BE23-0UA0** **…0BE23-0AA0**	**…0BE24-0UA0** **…0BE24-0AA0**
LO base load power		2.2 kW	3 kW	4 kW
LO base load input current		7.6 A	10.2 A	13.4 A
LO base load output current		5.9 A	7.7 A	10.2 A
HO base load power		2.2 kW	3 kW	4 kW
HO base load input current		7.6 A	10.2 A	13.4 A
HO base load output current		5.9 A	7.7 A	10.2 A
Fuse according to UL (from SIEMENS)		3NE1813-0, 16 A	3NE1813-0, 16 A	3NE1814-0, 20 A
Fuse according to UL (Class J, K-1 or K-5)		16 A	16 A	20 A
Power loss		0.139 kW	0.158 kW	0.183 kW
Required cooling air flow		24 l/s	24 l/s	24 l/s
Cross section of line and motor cables		1.5 … 6 mm² 16 … 10 AWG	1.5 … 6 mm² 16 … 10 AWG	1.5 … 6 mm² 16 … 10 AWG
Tightening torque for line and motor cables		1.5 Nm / 13 lbf in	1.5 Nm / 13 lbf in	1.5 Nm / 13 lbf in
Weight		4.3 kg	4.3 kg	4.3 kg

Table 12- 18 PM240, IP20, frame sizes C, 3-ph. 380 V AC… 480 V

Order No. - without filter **Order No. - with filter**	**6SL3224-…** **6SL3224-…**	**…0BE25-5UA0** **…0BE25-5AA0**	**…0BE27-5UA0** **…0BE27-5AA0**	**…0BE31-1UA0** **…0BE31-1AA0**
LO base load power		7.5 kW	11 kW	15 kW
LO base load input current		21.9 A	31.5 A	39.4 A
LO base load output current		18 A	25 A	32 A
HO base load power		5.5 kW	7.5 kW	11 kW
HO base load input current		16.7 A	23.7 A	32.7 A
HO base load output current		13.2 A	19 A	26 A
Fuse according to UL (from SIEMENS)		3NE1814-0, 20 A	3NE1814-0, 20 A	3NE1803-0, 35 A
Fuse according to UL (Class J, K-1 or K-5)		20 A	20 A	35 A
Power loss		0.240 kW	0.297 kW	0.396 kW
Required cooling air flow		55 l/s	55 l/s	55 l/s
Cross section of line and motor cables		4 … 10 mm² 12 … 8 AWG	4 … 10 mm² 12 … 8 AWG	4 … 10 mm² 12 … 8 AWG
Tightening torque for line and motor cables		2.3 Nm / 20 lbf in	2.3 Nm / 20 lbf in	2.3 Nm / 20 lbf in
Weight without filter		6.5 kg	6.5 kg	6.5 kg
Weight with filter		7 kg	7 kg	7 kg

Table 12- 19 PM240, IP20, frame sizes D, 3-ph. 380 V AC… 480 V

Order No. - without filter **Order No. - with filter**	**6SL3224-…** **6SL3224-…**	**…0BE31-5UA0** **…0BE31-5AA0**	**…0BE31-8UA0** **…0BE31-8AA0**	**…0BE32-2UA0** **…0BE32-2AA0**
LO base load power LO base load input current LO base load output current		18.5 kW 46 A 38 A	22 kW 53 A 45 A	30 kW 72 A 60 A
HO base load power HO base load input current HO base load output current		15 kW 40 A 32 A	18.5 kW 46 A 38 A	22 kW 56 A 45 A
Fuse according to UL (from SIEMENS) Fuse according to UL (Class J)		3NE1817-0 50 A, 600 V	3NE1818-0 ---	3NE1820-0 ---
Power loss		0.44 kW 0.42 kW	0.55 kW 0.52 kW	0.72 kW 0.69 kW
Required cooling air flow		22 l/s	22 l/s	39 l/s
Cross section of line and motor cables		10 … 35 mm² 7 … 2 AWG	10 … 35 mm² 7 … 2 AWG	16 … 35 mm² 5 … 2 AWG
Tightening torque for line and motor cables		6 Nm / 53 lbf in	6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight without filter Weight with filter		13 kg 16 kg	13 kg 16 kg	13 kg 16 kg

Table 12- 20 PM240, IP20, frame sizes E, 3-ph. 380 V AC… 480 V

Order No. - without filter **Order No. - with filter**	**6SL3224-…** **6SL3224-…**	**…0BE33-0UA0** **…0BE33-0AA0**	**…0BE33-7UA0** **…0BE33-7AA0**
LO base load power LO base load input current LO base load output current		37 kW 88 A 75 A	45 kW 105 A 90 A
HO base load power HO base load input current HO base load output current		30 kW 73 A 60 A	37 kW 90 A 75 A
Fuse according to UL (from SIEMENS) Fuse according to UL		3NE1021-0 ---	3NE1022-0 ---
Power losses without filter Power losses with filter		0.99 kW 1.04 kW	1.2 kW 1.2 kW
Required cooling air flow		22 l/s	39 l/s
Cross section of line and motor cables		25 … 35 mm² 3 … 2 AWG	25 … 35 mm² 3 … 2 AWG
Tightening torque for line and motor cables		6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight without filter Weight with filter		16 kg 23 kg	16 kg 23 kg

Table 12- 21 PM240, IP20, frame sizes F, 3-ph. 380 V AC… 480 V

Order No. - without filter **Order No. - with filter**	**6SL3224-…** **6SL3224-…**	**…0BE34-5UA0** **…0BE34-5AA0**	**…0BE35-5UA0** **…0BE35-5AA0**	**…0BE37-5UA0** **…0BE37-5AA0**
LO base load power LO base load input current LO base load output current		55 kW 129 A 110 A A	75 kW 168 A 145 A	90 kW 204 A 178 A
HO base load power HO base load input current HO base load output current		45 kW 108 A 90 A	55 kW 132 A 110 A	75 kW 169 A 145 A
Fuse according to UL (from SIEMENS) Fuse according to UL (Class J)		3NE1224-0 150 A, 600 V	3NE1225-0 200 A, 600 V	3NE1227-0 250 A, 600 V
Power losses without filter Power losses with filter		1.4 kW 1.5 kW	1.9 kW 2.0 kW	2.3 kW 2.4 kW
Required cooling air flow		94 l/s	94 l/s	117 l/s
Cross section of line and motor cables		35 … 120 mm^2 2 … 4/0 AWG	70 … 120 mm^2 2/0 … 4/0 AWG	95 … 120 mm^2 3/0 … 4/0 AWG
Tightening torque for line and motor cables		13 Nm / 115 lbf in	13 Nm / 115 lbf in	13 Nm / 115 lbf in
Weight without filter Weight with filter		36 kg 52 kg	36 kg 52 kg	36 kg 52 kg

Table 12- 22 PM240, IP20, frame sizes F, 3-ph. 380 V AC… 480 V

Order No. - without filter	**6SL3224-…**	**…0BE38-8UA0**	**…0BE41-1UA0**
LO base load power LO base load input current LO base load output current		110 kW 234 A 205 A	132 kW 284 A 250 A
HO base load power HO base load input current HO base load output current		90 kW 205 A 178 A	110 kW 235 A 205 A
Fuse according to UL (from SIEMENS) Fuse according to UL		3NE1227-0 300 A, 600 V, Class J	3NE1230-0 400 A, 600 V, Class J
Power loss		2.4 kW	2.5 kW
Required cooling air flow		117 l/s	117 l/s
Cross section of line and motor cables		95 … 120 mm^2 3/0 … 4/0 AWG	95 … 120 mm^2 3/0 … 4/0 AWG
Tightening torque for line and motor cables		13 Nm / 115 lbf in	13 Nm / 115 lbf in
Weight		39 kg	39 kg

Table 12- 23 PM240 frame sizes GX, 3-ph. 380 V AC… 480 V

Order No. - without filter	6SL3224-…	…0XE41-3UA0	…0XE41-6UA0	…0XE42-0UA0
LO base load power LO base load input current LO base load output current		160 kW 297 A 302 A	200 kW 354 A 370 A	240 kW 442 A 477 A
HO base load power HO base load input current HO base load output current		132 kW 245 A 250 A	160 kW 297 A 302 A	200 kW 354 A 370 A
Fuse according to IEC Fuse according to UL (from SIEMENS)		3NA3254 3NE1333-2	3NA3260 3NE1333-2	3NA3372 3NE1436-2
Power loss,		3.9 kW	4.4 kW	5.5 kW
Required cooling air flow		360 l/s	360 l/s	360 l/s
Cross section of line and motor cables		95 ... 2 x 240 mm^2 3/0 … 2 x 600 AWG	120 ... 2 x 240 mm^2 4/0 … 2 x 600 AWG	185 ... 2 x 240 mm^2 6/0 … 2 x 600 AWG
Tightening torque for line and motor cables		14 Nm / 120 lbf in	14 Nm / 120 lbf in	14 Nm / 120 lbf in
Weight		176 kg	176 kg	176 kg

Relationship between pulse frequency and output base-load current reduction

LO base load	Output base-load current at pulse frequency of							
	2 kHz	4 kHz	6 kHz	8 kHz	10 kHz	12 kHz	14 kHz	16 kHz
kW	A	A	A	A	A	A	A	A
0.37	--	1.30	1.11	0.91	0.78	0.65	0.59	0.52
0.55	--	1.70	1.45	1.19	1.02	0.85	0.77	0.68
0.75	--	2.20	1.87	1.54	1.32	1.10	0.99	0.88
1.1	--	3.10	2.64	2.17	1.86	1.55	1.40	1.24
1.5	--	4.10	3.49	2.87	2.46	2.05	1.85	1.64
2.2	--	5.90	5.02	4.13	3.54	2.95	2.66	2.36
3.0	--	7.70	6.55	5.39	4.62	3.85	3.47	3.08
4.0	--	10.20	8.67	7.14	6.12	5.10	4.59	4.08
7.5	--	18.00	16.20	13.30	11.40	9.50	8.60	7.60
11.0	--	25.00	22.10	18.20	15.60	13.00	11.70	10.40
15.0	--	32.00	27.20	22.40	19.20	16.00	14.40	12.80
18.5	--	38.00	32.30	26.60	22.80	19.00	17.10	15.20
22	--	45.00	38.25	31.50	27.00	22.50	20.25	18.00
30	--	60.00	52.70	43.40	37.20	31.00	27.90	24.80
37	--	75.00	63.75	52.50	45.00	37.50	33.75	30.00
45	--	90.00	76.50	63.00	54.00	45.00	40.50	36.00
55	--	110.0	93.50	77.00	--	--	--	--
75	--	145.0	123.3	101.5	--	--	--	--
90	--	178.0	151.3	124.6	--	--	--	--
110	205.0	178.0	--	--	--	--	--	--
132	250.0	205.0	--	--	--	--	--	--
160	302.0	250.0	--	--	--	--	--	--
200	370.0	302.0	--	--	--	--	--	--
250	477.0	370.0	--	--	--	--	--	--

12.3.3 Technical data, PM240-2

12.3.3.1 High overload - low overload PM240-2

Permissible inverter overload

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

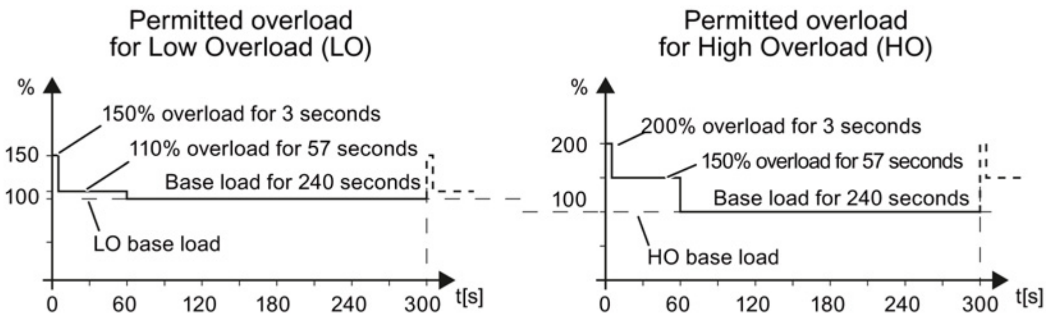


Figure 12-3 Load cycles, Low Overload" and "High Overload"

12.3.3.2 General data, PM240-2 - 400V

If not specified otherwise, the data listed here apply up to installation altitudes of 2000 m above sea level.
You can find the values for higher installation altitudes under "Restrictions for special ambient conditions (Page 340)".

Property	Version
Line voltage	3 AC 380 V … 480 V -20 %, +10 %
Output voltage	3 AC 0 V … 0.95 * input voltage (max.) for U/f control systems 3 AC 0 V … 0.90 * input voltage (max.) for vector control
Input frequency	50 Hz … 60 Hz, ± 3 Hz
Output frequency	0 … 550 Hz, depending on the control mode
Line impedance	Uk ≥ 1%, a line reactor is required for lower values
Power factor λ	0.7 at Uk = 1 %
Inrush current	< LO base load input current
Overvoltage category	The inverter insulation is designed for surge voltages according to EN 60664-1 according to the following categories: Overvoltage category III: Supply circuits Overvoltage category II: Non-supply circuits
Pulse frequency	4 kHz (factory setting) Can be adjusted in 2 kHz steps from 4 kHz … 16 kHz. The output current is reduced if you increase the pulse frequency.
Short-circuit current rating (SCCR)	65 kA When fused using a type J or 3NE1 fuse, rated voltage 600 V AC with the rated current of the specific inverter.

Property	Version		
Electromagnetic compatibility	Devices with integrated filter are in accordance with IEC 61800-3 and are suitable for category C2 environments.		
Braking methods	DC braking, compound braking, dynamic braking with integrated braking chopper		
Degree of protection	Chassis devices PT devices	IP20 when installed in a control cabinet according to EN60529 IP54 at the control cabinet panel acc. to EN60529	
Operating temperature at	LO base load power without derating		-5 °C … +40 °C
	HO base load power without derating		-5 °C … +50 °C
	LO/HO base load power with derating:		-5 °C … + 60° C
Storage temperature	-40 °C … +70 °C		
Relative humidity	< 95% - condensation not permissible		
Pollution	Protected according to degree of pollution 2 to EN 61800-5-1		
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3		
Shock and vibration	• Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1 • Transport in the transport packaging according to Class 2M3 to EN 60721-3-2 • Vibration during operation according to Class 3M2 to EN 60721-3-3		
Installation altitude	without derating: with derating:	up to 1000 m above sea level up to 4000 m above sea level	Details see Section Restrictions for special ambient conditions (Page 340).
Standards	UL, cUL, CE, C-tick, SEMI F47 The drive only satisfies the UL requirements when UL-certified fuses are used.		

12.3.3.3 Power-dependent data PM240-2

Table 12- 24 PM240-2, IP20, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - without filter **Order No. - with filter**	**6SL3210…** **6SL3210…**	**…1PE11-8UL1** **…1PE11-8AL1**	**…1PE12-3UL1** **…1PE12-3AL1**	**…1PE13-2UL1** **…1PE13-2AL1**
LO base load power		0,55 kW	0,75 kW	1,1 kW
LO base load input current		2,3 A	2,9 A	4,1 A
LO base load output current		1,7 A	2,2 A	3,1 A
HO base load power		0,37 kW	0,55 kW	0,75 kW
HO base load input current		2,0 A	2,6 A	3,3 A
HO base load output current		1,3 A	1,7 A	2,2 A
Fuse according to IEC		3NA3 804 (4A)	3NA3 804 (4A)	3NA3 801 (6 A)
Fuse according to UL		4 A Class J	4 A Class J	6 A Class J
Power losses without filter		0,04 kW	0,04 kW	0,04 kW
Power losses with filter		0,04 kW	0,04 kW	0,04 kW
Required cooling air flow		5 l/s	5 l/s	5 l/s
Cross section of line and motor cables		1 … 2,5 mm^2 18 … 14 AWG	1 … 2,5 mm^2 18 … 14 AWG	1 … 2,5 mm^2 18 … 14 AWG
Tightening torque for line and motor cables		0,5 Nm / 4 lbf in	0,5 Nm / 4 lbf in	0,5 Nm / 4 lbf in
Weight without filter		1,4 kg	1,4 kg	1,4 kg
Weight with filter		1,5 kg	1,5 kg	1,5 kg

Table 12- 25 PM240-2, IP20, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - without filter **Order No. - with filter**	**6SL3210…** **6SL3210…**	**…1PE14-3UL1** **…1PE14-3AL1**	**…1PE16-1UL1** **…1PE16-1AL1**	**…1PE18-0UL1** **…1PE18-0AL1**
LO base load power		1,5 kW	2,2 kW	3,0 kW
LO base load input current		5,5 A	7,7 A	10,1 A
LO base load output current		4,1 A	5,9 A	7,7 A
HO base load power		1,1 kW	1,5 kW	2,2 kW
HO base load input current		4,7 A	6,1 A	8,8 A
HO base load output current		3,1 A	4,1 A	5,9 A
Fuse according to IEC		3NA3 803 (10 A)	3NA3 803 (10 A)	3NA3 805 (16 A)
Fuse according to UL		10 A Class J	10 A Class J	15 A Class J
Power losses without filter		0,07 kW	0,1 kW	0,12 kW
Power losses with filter		0,07 kW	0,1 kW	0,12 kW
Required cooling air flow		5 l/s	5 l/s	5 l/s
Cross section of line and motor cables		1 … 2,5 mm^2 18 … 14 AWG	1,5 … 2,5 mm^2 16 … 14 AWG	1,5 … 2,5 mm^2 16 … 14 AWG
Tightening torque for line and motor cables		0,5 Nm / 4 lbf in	0,5 Nm / 4 lbf in	0,5 Nm / 4 lbf in
Weight without filter		1,4 kg	1,4 kg	1,4 kg
Weight with filter		1,5 kg	1,5 kg	1,5 kg

Table 12- 26 PM240-2, PT, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - without filter	**6SL3211…**	**…1PE18-0UL1**
Order No. - with filter	**6SL3211…**	**…1PE18-0AL1**
LO base load power		3,0 kW
LO base load input current		10,1 A
LO base load output current		7,7 A
HO base load power		2,2 kW
HO base load input current		8,8 A
HO base load output current		5,9 A
Fuse according to IEC		3NA3 805 (16 A)
Fuse according to UL		15 A Class J
Power losses without filter		0,12 kW 1)
Power losses with filter		0,12 kW 1)
Required cooling air flow		7 l/s
Cross section of line and motor cables		1,5 … 2,5 mm² 16 … 14 AWG
Tightening torque for line and motor cables		0,5 Nm / 4 lbf in
Weight without filter		1,7 kg
Weight with filter		---

1) approx. 0.1 kW through the heatsink

Table 12- 27 PM240-2, IP20, Frame Sizes B, 3 AC 380 V … 480 V

Order No. - without filter	**6SL3210…**	**…1PE21-1UL0**	**…1PE21-4UL0**	**…1PE21-8UL0**
Order No. - with filter	**6SL3210…**	**…1PE21-1AL0**	**…1PE21-4AL0**	**…1PE21-8AL0**
LO base load power		4,0, kW	5,5 kW	7,5 kW
LO base load input current		13,3 A	17,2 A	22,2 A
LO base load output current		10,2 A	13,2 A	18,0 A
HO base load power		3,0 kW	4,0 kW	5,5 kW
HO base load input current		11,6 A	15,3 A	19,8 A
HO base load output current		7,7 A	10,2 A	13,7 A
Fuse according to IEC		3NE 1814-0 (20 A)	3NE 1815-0 (25 A)	3NE 1803-0 (35 A)
Fuse according to UL		20 A Class J	25 A Class J	35 A Class J
Power losses without filter		0,11 kW	0,15 kW	0,2 kW
Power losses with filter		0,11 kW	0,15 kW	0,2 kW
Required cooling air flow		9,2 l/s	9,2 l/s	9,2 l/s
Cross section of line and motor cables		1,5 … 6 mm² 16 … 10 AWG	1,5 … 6 mm² 16 … 10 AWG	1,5 … 6 mm² 16 … 10 AWG
Tightening torque for line and motor cables		0,6 Nm / 5 lbf in	0,6 Nm / 5 lbf in	0,6 Nm / 5 lbf in
Weight without filter		2,9 kg	2,9 kg	3,0 kg
Weight with filter		3,1 kg	3,1 kg	3,2 kg

Table 12- 28 PM240-2, PT, Frame Sizes B, 3 AC 380 V … 480 V

Order No. - without filter Order No. - with filter	6SL3211… 6SL3211…	...1PE21-8UL0 ...1PE21-8AL0
LO base load power LO base load input current LO base load output current		7,5 kW 22,2 A 18,0 A
HO base load power HO base load input current HO base load output current		5,5 kW 19,8 A 13,7 A
Fuse according to IEC Fuse according to UL		3NE 1803-0 (35 A) 35 A Class J
Power losses without filter Power losses with filter		0,2 kW 1) 0,2 kW 1)
Required cooling air flow		9,2 l/s
Cross section of line and motor cables		1,5 … 6 mm² 16 … 10 AWG
Tightening torque for line and motor cables		0,6 Nm / 5 lbf in
Weight without filter Weight with filter		3,6 kg 3,9 kg

1) approx. 0.18 kW through the heatsink

Table 12- 29 PM240-2, IP20, Frame Sizes C, 3 AC 380 V … 480 V

Order No. - without filter Order No. - with filter	6SL3210… 6SL3210…	…1PE22-7UL0 …1PE22-7AL0	…1PE23-3UL0 …1PE23-3AL0
LO base load power LO base load input current LO base load output current		11,0 kW 32,6 A 26,0 A	15,0 kW 39,9 A 32,0 A
HO base load power HO base load input current HO base load output current		7,5 kW 27,0 A 18,0 A	11,0 kW 36,0 A 26,0 A
Fuse according to IEC Fuse according to UL		3NE 1817-0 (50 A) 50 A Class J	3NE 1817-0 (50 A) 50 A Class J
Power losses without filter Power losses with filter		0,3 kW 0,3 kW	0,37 kW 0,37 kW
Required cooling air flow		18,5 l/s	18,5 l/s
Cross section of line and motor cables		6 …16 mm² 10 … 6 AWG	6 …16 mm² 10 … 6 AWG
Tightening torque for line and motor cables		1,3 Nm / 12 lbf in	1,3 Nm / 12 lbf in
Weight without filter Weight with filter		4,7 kg 5,3 kg	4,8 kg 5,4 kg

Table 12- 30 PM240-2, PT, Frame Sizes C, 3 AC 380 V … 480 V

Order No. - without filter	**6SL3211…**	**...1PE23-3UL0**
Order No. - with filter	**6SL3211…**	**...1PE23-3AL0**
LO base load power		15,0 kW
LO base load input current		39,9 A
LO base load output current		32,0 A
HO base load power		11,0 kW
HO base load input current		36,0 A
HO base load output current		26,0 A
Fuse according to IEC		3NE 1817-0 (50 A)
Fuse according to UL		50 A Class J
Power losses without filter		0,37 kW 1)
Power losses with filter		0,37 kW 1)
Required cooling air flow		18,5 l/s
Cross section of line and motor cables		6 …16 mm^2 10 … 6 AWG
Tightening torque for line and motor cables		1,3 Nm / 12 lbf in
Weight without filter		5,8 kg
Weight with filter		6,3 kg

1) approx. 0.35 kW through the heatsink

Current derating depending on the pulse frequency

Table 12- 31 Current derating depending on the pulse frequency 1) for 400 V devices

Order number	**LO base load output current for a pulse frequency of … [A]**						
	4 kHz	**6 kHz**	**8 kHz**	**10 kHz**	**12 kHz**	**14 kHz**	**16 kHz**
6SL3210-1PE11-8□L1	**1,7**	1,4	1,2	1,0	0,9	0,8	0,7
6SL3210-1PE12-3□L1	**2,2**	1,9	1,5	1,3	1,1	1,0	0,9
6SL3211-1PE13-2□L1	**3,1**	2,6	2,2	1,9	1,6	1,4	1,2
6SL3210-1PE14-3□L1	**4,1**	3,5	2,9	2,5	2,1	1,8	1,6
6SL3210-1PE16-1□L1	**5,9**	5,0	4,1	3,5	3,0	2,7	2,4
6SL321□-1PE18-0□L1	**7,7**	6,5	5,4	4,6	3,9	3,5	3,1
6SL3210-1PE21-1□L0	**10,2**	8,7	7,1	6,1	5,1	4,6	4,1
6SL3210-1PE21-4□L0	**13,2**	11,2	9,2	7,9	6,6	5,9	5,3
6SL321□-1PE21-8□L0	**18,0**	15,3	12,6	10,8	9,0	8,1	7,2
6SL3210-1PE22-7□L0	**26,0**	22,1	18,2	15,6	13,0	11,7	10,4
6SL321□-1PE23-3□L0	**32,0**	27,2	22,4	19,2	16	14,4	12,8

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

12.3.4 Technical data, PM250

12.3.4.1 High Overload - Low Overload

Permissible inverter overload

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

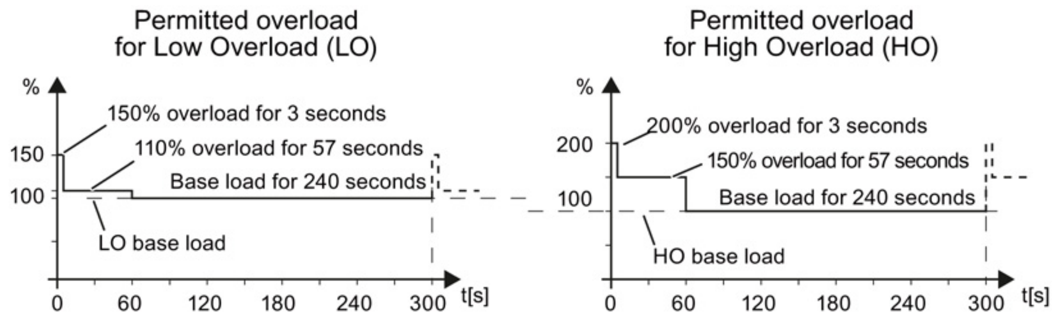


Figure 12-4 Load cycles, Low Overload" and "High Overload"

12.3.4.2 General data, PM250

Property	Version		
Line voltage	380 V … 480 V 3-ph. AC ± 10 %		
Output voltage	0 V 3-ph. AC … input voltage x 0.87 (max.)		
Input frequency	47 Hz … 63 Hz		
Power factor λ	0.9		
Inrush current	< LO base load input current		
Pulse frequency (factory setting)	4 kHz The pulse frequency can be adjusted up to 16 kHz in 2 kHz steps. The higher the pulse frequency, the lower the available output current. For details, see Power-dependent data, PM250 (Page 334).		
Electromagnetic compatibility	The devices comply with EN 61800-3: 2004 suitable for Category C1 and C2 environments.		
Braking methods	DC braking, energy recovery (up to 100% of the output power)		
Degree of protection	IP20 chassis units		
Operating temperature at	LO base load power without derating	0 °C … +40 °C	
	HO base load power without derating	0 °C … +50 °C	
	LO/HO base load power with derating:	Up to 60° C	
	For details, see Restrictions for special ambient conditions (Page 340).		
Storage temperature	-40 °C … +70 °C		
Relative humidity	< 95% - condensation not permissible		
Pollution	Protected according to pollution degree 2 to EN 61800-5-1: 2007		
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995		
Shock and vibration	• Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997 • Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997 • Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995		
Installation altitude	without derating: with derating:	up to 1000 m above sea level up to 4000 m above sea level	For details, see Restrictions for special ambient conditions (Page 340)
Standards	UL, CE, CE, SEMI F47 The drive only satisfies the UL requirements when UL-certified fuses are used.		

12.3.4.3 Power-dependent data, PM250

Note

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

Table 12- 32 PM250, IP20, Frame Sizes C, 3 AC 380 V … 480 V

Order No. - with filter	6SL3225-…	0BE25-5AA0	0BE27-5AA0	0BE31-1AA0
LO base load power LO base load input current LO base load output current		7.5 kW 18 A 18 A	11 kW 25 A 25 A	15 kW 32 A 32 A
HO base load power HO base load input current HO base load output current		5. 5 kW 13.2 A 13.2 A	7.5 kW 19 A 19 A	11 kW 26 A 26 A
Fuse		20 A, Class J	32 A, Class J	35 A, Class J
Power loss		0.24 kW	0.30 kW	0.31 kW
Required cooling air flow		38 l/s	38 l/s	38 l/s
Cross section of line and motor cables		2.5 … 10 mm^2 14 … 8 AWG	4.0 … 10 mm^2 12 … 8 AWG	4.0 … 10 mm^2 12 … 8 AWG
Tightening torque for line and motor cables		2.3 Nm / 20 lbf in	2.3 Nm / 20 lbf in	2.3 Nm / 20 lbf in
Weight		7.5 kg	7.5 kg	7.5 kg

Table 12- 33 PM250, IP20, Frame Sizes D, 3 AC 380 V … 480 V

Order No. - with filter	6SL3225-…	0BE31-5AA0	0BE31-8AA0	0BE32-2AA0
LO base load power LO base load input current LO base load output current		18.5 kW 36 A 38 A	22 kW 42 A 45 A	30 kW 56 A 60 A
HO base load power HO base load input current HO base load output current		15 kW 30 A 32 A	18.5 kW 36 A 38 A	22 kW 42 A 45 A
Fuse according to IEC Fuse according to UL		3NA3820 50 A, Class J	3NA3822 63 A, Class J	3NA3824 80 A, Class J
Power loss		0.44 kW	0.55 kW	0.72 kW
Required cooling air flow		22 l/s	22 l/s	39 l/s
Cross section of line and motor cables		10 … 35 mm^2 7 … 2 AWG	10 … 35 mm^2 7 … 2 AWG	16 … 35 mm^2 6 … 2 AWG
Tightening torque for line and motor cables		6 Nm / 53 lbf in	6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight		15 kg	15 kg	16 kg

Table 12- 34 PM250, IP20, Frame Sizes E, 3 AC 380 V … 480 V

Order No. - with filter 6SL3225-…	0BE33-0AA0	0BE33-7AA0
LO base load power LO base load input current LO base load output current	37 kW 70 A 75 A	45 kW 84 A 90 A
HO base load power HO base load input current HO base load output current	30 kW 56 A 60 A	37 kW 70 A 75 A
Fuse according to IEC Fuse according to UL	3NA3830 100 A, Class J	3NA3832 125 A, Class J
Power loss	1.04 kW	1.2 kW
Required cooling air flow	22 l/s	39 l/s
Cross section of line and motor cables	25 … 35 mm² 3 … 2 AWG	25 … 35 mm² 3 … 2 AWG
Tightening torque for line and motor cables	6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight	21 kg	21 kg

Table 12- 35 PM250, IP20, Frame Sizes F, 3 AC 380 V … 480 V

Order No. - with filter 6SL3225-…	0BE34-5AA0	0BE35-5AA0	0BE37-5AA0
LO base load power LO base load input current LO base load output current	55 kW 102 A 110 A	75 kW 135 A 145 A	90 kW 166 A 178 A
HO base load power HO base load input current HO base load output current	45 kW 84 A 90 A	55 kW 102 A 110 A	75 kW 135 A 145 A
Fuse according to IEC Fuse according to UL	3NA3836 160 A, Class J	3NA3140 200 A, Class J	3NA3144 250 A, Class J
Power loss	1.5 kW	2.0 kW	2.4 kW
Required cooling air flow	94 l/s	94 l/s	117 l/s
Cross section of line and motor cables	35 … 120 mm² 2 … 4/0 AWG	35 … 120 mm² 2 … 4/0 AWG	35 … 120 mm² 2 … 4/0 AWG
Tightening torque for line and motor cables	13 Nm / 115 lbf in	13 Nm / 115 lbf in	13 Nm / 115 lbf in
Weight	51 kg	51 kg	51 kg

Relationship between pulse frequency and current reduction

Table 12- 36 Current reduction depending on pulse frequency

Rated Power (LO)	Base load current (LO)	Base load current (LO) at pulse frequency of					
	4 kHz	6 kHz	8 kHz	10 kHz	12 kHz	14 kHz	16 kHz
kW	A	A	A	A	A	A	A
7.5	18.0	12.5	11.9	10.6	9.20	7.90	6.60
11	25.0	18.1	17.1	15.2	13.3	11.4	9.50
15	32.0	24.7	23.4	20.8	18.2	15.6	12.8
18.5	38.0	32.3	26.6	22.8	19.0	17.1	15.2
22	45.0	38.3	31.5	27.0	22.5	20.3	18.0
30	60.0	51.0	42.0	36.0	30.0	27.0	24.0
37	75.0	63.8	52.5	45.0	37.5	33.8	30.0
45	90.0	76.5	63.0	54.0	45.0	40.5	36.0
55	110	93.5	77.0	--	--	--	--
75	145	123	102	--	--	--	--
90	178	151	125	--	--	--	--

12.3.5 Technical data, PM260

12.3.5.1 High Overload - Low Overload

Permissible inverter overload

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

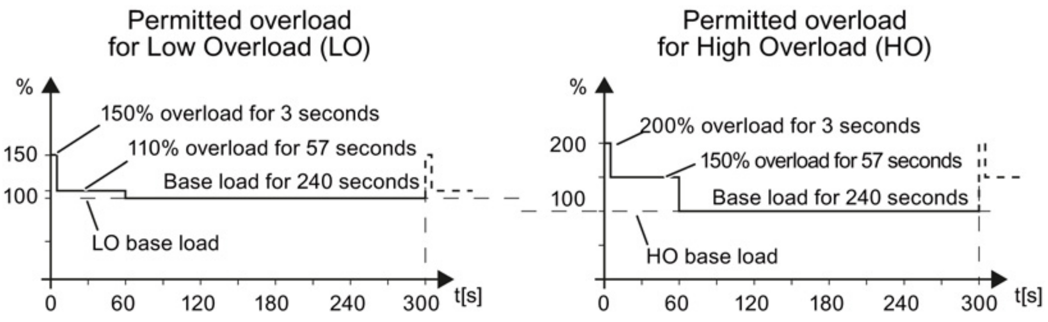


Figure 12-5 Load cycles, Low Overload" and "High Overload"

12.3.5.2 General data, PM260

Property	Version		
Line voltage	660 V ... 690 V 3-ph. AC ± 10% The power units can also be operated with a minimum voltage of 500 V –10 %. In this case, the power is linearly reduced.		
Input frequency	50 Hz … 60 Hz, ± 3 Hz		
Power factor λ	0.9		
Inrush current	< LO base load input current		
Pulse frequency	16 kHz		
Electromagnetic compatibility	The devices comply with EN 61800-3: 2004 suitable for Category C1 and C2 environments.		
Braking methods	DC braking, energy recovery (up to 100% of the output power)		
Degree of protection	IP20 chassis units		
Operating temperature at	LO base load power without derating		0 °C … +40 °C
	HO base load power without derating		0 °C … +50 °C
	LO/HO base load power with derating:		Up to 60° C
	For details, see Manuals for your inverter (Page 368).		
Storage temperature	-40 °C … +70 °C		
Relative humidity	< 95% - condensation not permissible		
Pollution	Protected according to pollution degree 2 to EN 61800-5-1: 2007		
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995		
Shock and vibration	• Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997 • Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997 • Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995		
Installation altitude	without derating: with derating:	up to 1000 m above sea level up to 4000 m above sea level	For details, see Manuals for your inverter (Page 368)
Standards	CE, C-TICK		

12.3.5.3 Power-dependent data, PM260

Note

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

Table 12- 37 PM260, IP20, Frame Sizes D - 3 AC 660 V … 690 V

Order No. - without filter **Order No. - with filter**	**6SL3225-…** **6SL3225-…**	**0BH27-5UA1** **0BH27-5AA1**	**0BH31-1UA1** **0BH31-1AA1**	**0BH31-5UA1** **0BH31-5AA1**
LO base load power LO base load input current LO base load output current		11 kW 13 A 14 A	15 kW 18 A 19 A	18.5 kW 22 A 23 A
HO base load power HO base load input current HO base load output current		7.5 kW 10 A 10 A	11 kW 13 A 14 A	15 kW 18 A 19 A
Fuse		20 A	20 A	32 A
Power losses without filter Power losses with filter				
Required cooling air flow		22 l/s	22 l/s	39 l/s
Cross section of line and motor cables		2.5 … 16 mm² 14 … 6 AWG	4 … 16 mm² 12 … 6 AWG	6 … 16 mm² 10 … 6 AWG
Tightening torque for line and motor cables		1.5 Nm / 53 lbf in	1.5 Nm / 53 lbf in	1.5 Nm / 53 lbf in
Weight without filter Weight with filter		22 kg 23 kg	22 kg 23 kg	22 kg 23 kg
Sound pressure level		< 64 dB(A)	< 64 dB(A)	< 64 dB(A)

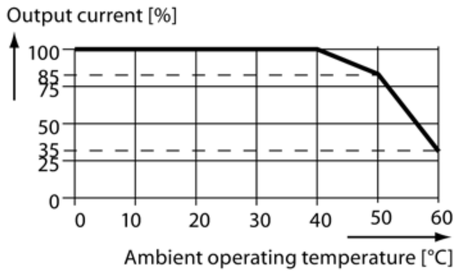
Table 12- 38 PM260, IP20, Frame Sizes F - 3 AC 660 V … 690 V

Order No. - without filter **Order No. - with filter**	**6SL3225-…** **6SL3225-…**	0BH32-2UA1 0BH32-2AA1	0BH33-0UA1 0BH33-0AA1	0BH33-7UA1 0BH33-7AA1
LO base load power LO base load input current LO base load output current		30 kW 34 A 35 A	37 kW 41 A 42 A	55 kW 60 A 62 A
HO base load power HO base load input current HO base load output current		22 kW 26 A 26 A	30 kW 34 A 35 A	37 kW 41 A 42 A
Fuse		50 A	50 A	80 A
Power losses without filter Power losses with filter				
Required cooling air flow		94 l/s	94 l/s	117 l/s
Cross section of line and motor cables		10 … 35 mm² 8 … 2 AWG	16 … 35 mm² 6 … 2 AWG	25 … 35 mm² 4 … 2 AWG
Tightening torque for line and motor cables		6 Nm / 53 lbf in	6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight without filter Weight with filter		56 kg 58 kg	56 kg 58 kg	56 kg 58 kg
Sound pressure level		< 70 dB(A)	< 70 dB(A)	< 70 dB(A)

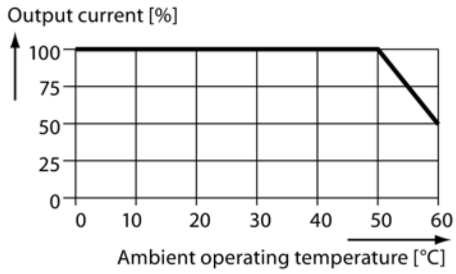
12.4 Restrictions for special ambient conditions

Current de-rating depending on the ambient operating temperature

Low Overload



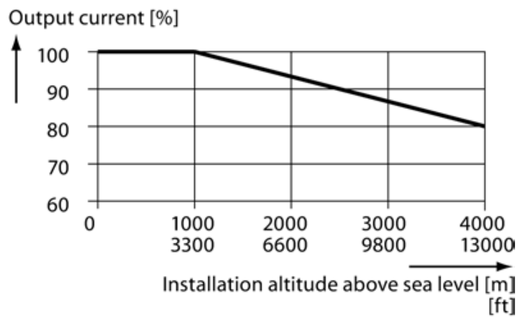
High Overload



NOTICE
Restrictions for the permissible ambient operating temperature as a result of the Control Unit or operator panel
For the permissible ambient operating temperature, also observe possible restrictions as a result of the Control Unit or an operator panel.

Current derating depending on the installation altitude

Above 1000 m above sea level you must reduce the inverter output current corresponding to the adjacent curve as a result of the lower cooling power of the air.



Permissible line supplies depending on the installation altitude

- Installation altitude up to 2000 m above sea level
  - Connection to every supply system permitted for the inverter.
- Installation altitudes between 2000 m and 4000 m above sea level
  - Connection to a TN system with grounded neutral point.
  - TN systems with grounded line conductor are not permitted.
  - The TN line system with grounded neutral point can also be supplied using an isolation transformer.
  - The phase-to-phase voltage does not have to be reduced.

Also observe restrictions related to the connection of components.

Appendix A

A.1 New and extended functions

A.1.1 Firmware version 4.5

Table A- 1 New functions and function changes in Firmware 4.5

	Function	SINAMICS					
			G120			G120D	
		G120C	CU230P-2	CU240B-2	CU240E-2	CU240D-2	CU250D-2
1	Support for the new Power Modules: • PM230 IP20 FSA … FSF • PM230 in a push-through FSA … FSC	-	✓	✓	✓	-	-
2	Support for the new Power Modules: • PM240-2 IP20 FSA • PM240-2 in push-through FSA	-	✓	✓	✓	-	-
3	New Control Units with PROFINET support	✓	✓	-	✓	✓	✓
4	Support of the PROFIenergy profile	✓	✓	-	✓	✓	✓
5	Shared device support via PROFINET	✓	✓	-	✓	✓	✓
6	Write protection	✓	✓	✓	✓	✓	✓
7	Know-how protection	✓	✓	✓	✓	✓	✓
8	Adding a second command data set (CDS0 → CDS0 … CDS1) (All other inverters have four command data sets)	✓	-	-	-	-	-
9	Position control and basic positioner	-	-	-	-	-	✓
10	Support of an HTL encoder	-	-	-	-	✓	✓
11	Support of an SSI encoder	-	-	-	-	-	✓
12	Fail-safe digital output	-	-	-	-	✓	✓

A.1.2 Firmware version 4.6

Table A- 2 New functions and function changes in Firmware 4.6

	Function	SINAMICS						
			G120				G120D	
		G120C	CU230P-2	CU240B-2	CU240E-2	CU250S-2	CU240D-2	CU250D-2
1	Support for the new Power Modules • PM240-2 IP20 FSB … FSC • PM240-2 in through-hole technology FSB ... FSC	-	✓	✓	✓	✓	-	-
2	Support for the new Power Modules • PM230 in through-hole technology FSD ... FSF	-	✓	✓	✓	-	-	-
3	Motor data preassignment for the 1LA/1LE motors via code number • During basic commissioning with the operator panel, set the motor data using a code number	✓	✓	✓	✓	✓	✓	✓
4	Extension to communication via CANopen • CAN velocity, ProfilTorque, SDO channel for each axis, system test with CodeSys, suppression of ErrorPassiv alarm	✓	✓	-	-	✓	-	-
5	Extension to communication via BACnet • Multistate value objects for alarms, commandable AO objects, objects for configuring the PID controller	-	✓	-	-	-	-	-
6	Communication via EtherNet/IP	✓	✓	-	✓	✓	✓	✓
7	Skip frequency band for analog input • A symmetrical skip frequency band can be set for each analog input around the 0 V range.	✓	✓	✓	✓	✓	✓	-
8	Changing the control of the motor holding brake	✓	-	✓	✓	✓	✓	-
9	Safety function SBC (Safe Brake Control) • Secure control of a motor holding brake when using the "Safe Brake Module" option	-	-	-	-	✓	-	-
10	Safety function SS1 (Safe Stop 1) without speed monitoring	-	-	-	-	✓	-	-
11	Straightforward selection of standard motors • Selection of 1LA... and 1LE... motors with an operator panel using a list containing code numbers	✓	✓	✓	✓	✓	✓	✓
12	Firmware update via memory card	✓	✓	✓	✓	✓	✓	✓
13	Safety info channel • BICO source r9734.0…14 for the status bits of the extended safety functions	-	-	-	✓	✓	✓	✓
14	Diagnostic alarms for PROFIBUS	✓	✓	✓	✓	✓	✓	✓

A.1.3 Firmware version 4.6.6

Table A- 3 New functions and function changes in Firmware 4.6.6

	Function	SINAMICS						
			G120				G120D	
		G120C	CU230P-2	CU240B-2	CU240E-2	CU250S-2	CU240D-2	CU250D-2
1	Support for the new Power Modules • PM330 IP20 GX	-	✓	-	-	-	-	-

A.1.4 Firmware version 4.7

Table A- 4 New functions and function changes in Firmware 4.7

	Function	SINAMICS								
			G120					G120D		
		G110M	G120C	CU230P-2	CU240B-2	CU240E-2	CU250S-2	CU240D-2	CU250D-2	ET 200pro FC
1	Supporting the identification & maintenance datasets (I&M1 … 4)	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Fall in pulse rate with increased drive power required by the motor • The inverter temporarily lowers the pulse frequency if required when the motor is started up, and simultaneously increases the current limit.	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	S7 communication • Direct data exchange from the inverter and human machine interface (HMI) • Increase in communication performance with the engineering tools and support of the S7 routing	✓	✓	✓	✓	✓	✓	✓	✓	-
4	The basic functions of Safety Integrated are unrestrictedly available in all control types with 1FK7 encoderless permanent-field synchronous motors	-	-	-	-	-	-	✓	-	-
5	Direct selection of the 1FK7 encoderless permanent-field synchronous motors using the order number with allocated code number • It is not necessary to input individual motor data	-	-	-	-	-	-	✓	-	-

	Function	SINAMICS								
			G120					G120D		
6	Pulse input as source of setpoint value • The inverter calculates its speed setpoint from a sequence of pulses at the digital input.	-	-	-	-	-	✓	-	-	-
7	Dynamic IP address assignment (DHCP) and temporary device names for PROFINET	✓	✓	✓	-	✓	✓	✓	✓	✓
8	PROFIenergy Slave profile 2 and 3	✓	✓	✓	-	✓	✓	✓	✓	✓
9	Uniform behavior for component replacement • After a component is replaced, an inverter with activated Safety Integrated will report what type of component has been replaced using a unique code.	✓	✓	-	-	✓	✓	✓	✓	✓
10	Improved direct-component control in PM230 • Optimized efficiency for pump and fan applications	-	-	✓	-	-	-	-	-	-
11	Rounding down of BACnet and macros	-	-	✓	-	-	-	-	-	-

A.2 Star-delta motor connection and application examples

Depending on your application, you can operate the motor in the star or delta connection (Y/Δ).

Examples for operating the converter and motor on a 400 V line supply

Assumption: The motor rating plate states 230/400 V Δ/Y.

Case 1: A motor is normally operated between standstill and its rated speed (i.e. a speed corresponding to the line frequency). In this case, you need to connect the motor in Y. Operating the motor above its rated speed is only possible in field weakening, i.e. the motor torque available is reduced above the rated speed.

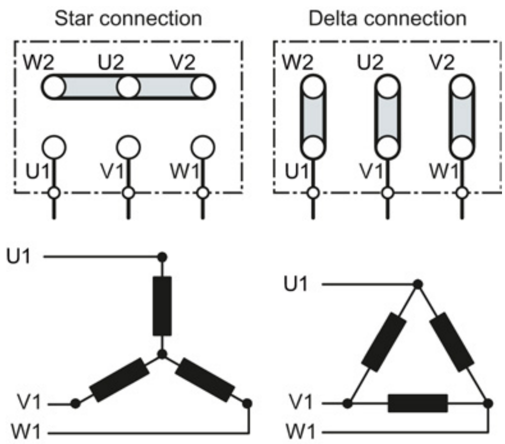
Case 2: If you want to operate the motor with the "87 Hz characteristic", you need to connect the motor in Δ.
With the 87 Hz characteristic, the motor's power output increases. The 87 Hz characteristic is mainly used with geared motors.

Before you connect the motor, ensure that the motor has the appropriate connection for your application:

Motor is connected in the star or delta configuration

With SIEMENS motors, you will see a diagram of both connection methods on the inside of the cover of the terminal box:

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



A.3 Parameter

Parameters are the interface between the firmware of the converter and the commissioning tool, e.g. an Operator Panel.

Adjustable parameters

Adjustable parameters are the "adjusting screws" with which you adapt the converter to its particular application. If you change the value of an adjustable parameter, then the converter behavior also changes.

Adjustable parameters are shown with a "p" as prefix, e.g. p1082 is the parameter for the maximum motor speed.

Display parameters

Display parameters allow internal measured quantities of the converter and the motor to be read.

The Operator Panel and STARTER represent display parameters with an "r" prefix, for example, r0027 is the parameter for the converter output current.

Parameters that in many cases help

Table A- 5 **How to switch to commissioning mode or restore the factory setting**

Parameter	Description
p0010	**Commissioning parameters** 0: Ready (factory setting) 1: Carry out basic commissioning 3: Carry out motor commissioning 5: Technological applications and units 15: Define number of data sets 30: Factory setting - initiate restore factory settings

Table A- 6 **How to determine the firmware version of the Control Unit**

Parameter	Description
r0018	**Firmware version is displayed**

Table A- 7 **How to select the command and setpoint sources for the inverter**

Parameter	Description
p0015	Additional information is available in Section Installing Control Unit (Page 63).

Table A- 8 **How to set the ramp-up and ramp-down**

Parameter	Description
p1080	**Minimum speed** 0.00 [rpm] factory setting
p1082	**Maximum speed** 1500.000 [rpm] factory setting
p1120	**Ramp-up time** 10.00 [s]
p1121	**Ramp-down time** 10.00 [s]

Table A- 9 **This is how you set the closed-loop type**

Parameter	Description
p1300	0: U/f control with linear characteristic 1: U/f control with linear characteristic and FCC 2: U/f control with parabolic characteristic 3: U/f control with adjustable characteristic 4: U/f control with linear characteristic and ECO 5: U/f control for drives requiring a precise frequency (textile area) 6: U/f control for drives requiring a precise frequency and FCC 7: U/f control with parabolic characteristic and ECO 19: U/f control with independent voltage setpoint 20: Speed control (without encoder) 22: Torque control (without encoder)

Not all Power Modules offer for selection all the listed control modes. The control modes permitted for your device are offered during the commissioning.

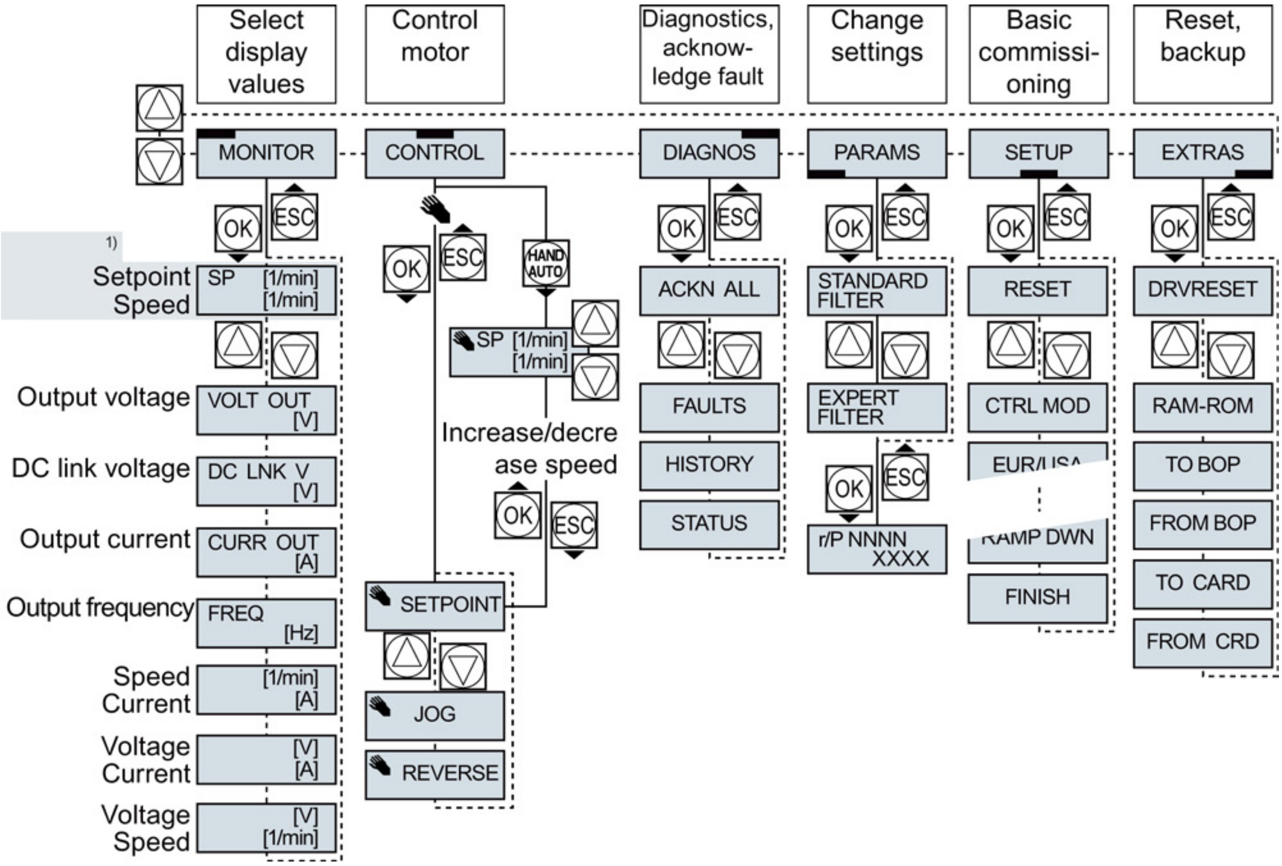
Table A- 10 **This is how you optimize the starting behavior of the U/f control for a high break loose torque and overload**

Parameter	Description
p1310	**Voltage boost to compensate ohmic losses** The voltage boost is active from standstill up to the rated speed. It is at its highest at speed 0 and continually decreases as the speed increases. Value of the voltage boost at speed 0 in V: 1.732 × rated motor current (p0305) × stator resistance (r0395) × p1310 / 100%
p1311	**Voltage boost when accelerating** The voltage boost is effective from standstill up to the rated speed. It is independent of the speed and has a value in V of: 1.732 × rated motor current (p0305) × stator resistance (p0350) × p1311 / 100%
p1312	**Voltage boost when starting** Setting to additionally boost the voltage when starting, however only when accelerating for the first time.

Table A- 11 How to change the inverter pulse frequency

Parameter	Description
p1800	**Setting the inverter pulse frequency** The pulse frequency depends on the power unit. You can find the setting limits and the factory setting in Section Technical data, Power Modules (Page 308). If you increase the pulse frequency, the inverter output current decreases (the maximum output current is displayed in r0076). If you use a sine-wave filter, you can only set the pulse frequency to values that are permissible for the filter. When operated with an output reactor, the pulse frequency is limited to a maximum of 4 kHz.

A.4 Handling the BOP 2 operator panel



1) Status display once the power supply for the inverter has been switched on.

Figure A-1 Menu of the BOP-2

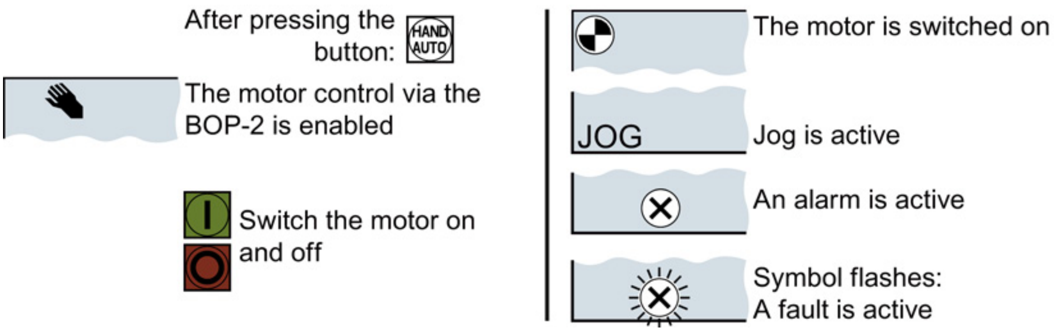


Figure A-2 Other keys and symbols of the BOP-2

A.4.1 Changing settings using BOP-2

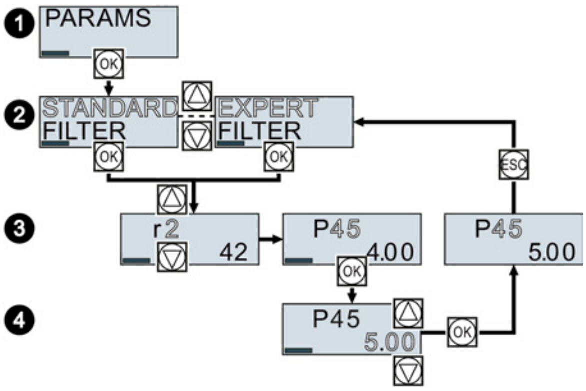
Changing settings using BOP-2

You can modify the settings of your inverter by changing the values of the its parameters. The inverter only permits changes to "write" parameters. Write parameters begin with a "P", e.g. P45.

The value of a read-only parameter cannot be changed. Read-only parameters begin with an "r", for example: r2.

Procedure

To change write parameters using the BOP-2, proceed as follows:



1. Select the menu to display and change parameters.
   Press the OK key.
2. Select the parameter filter using the arrow keys.
   Press the OK key.
   – STANDARD: The inverter only displays the most important parameters.
   – EXPERT: The inverter displays all of the parameters.
3. Select the required number of a write parameter using the arrow keys.
   Press the OK key.
4. Select the value of the write parameter using the arrow keys.
   Accept the value with the OK key.

You have now changed a write parameter using the BOP-2.

The inverter saves all the changes made using the BOP-2 so that they are protected against power failure.

A.4.2 Changing indexed parameters

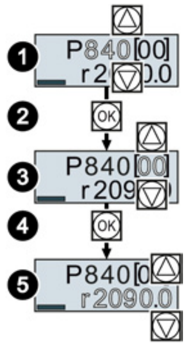
Changing indexed parameters

For indexed parameters, several parameter values are assigned to a parameter number. Each of the parameter values has its own index.

Procedure

To change an indexed parameter, proceed as follows:

1. Select the parameter number.
2. Press the OK key.
3. Set the parameter index.
4. Press the OK key.
5. Set the parameter value for the selected index.



You have now changed an indexed parameter.

A.4.3 Directly entering the parameter number and value

Directly select the parameter number

The BOP-2 offers the possibility of setting the parameter number digit by digit.

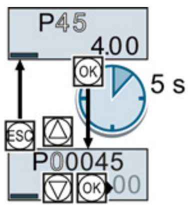
Precondition

The parameter number is flashing in the BOP-2 display.

Procedure

To select the parameter number directly, proceed as follows:

1. Press the OK button for longer than five seconds.
2. Change the parameter number digit-by-digit.
   If you press the OK button then the BOP-2 jumps to the next digit.
3. If you have entered all of the digits of the parameter number, press the OK button.



You have now entered the parameter number directly.

Entering the parameter value directly

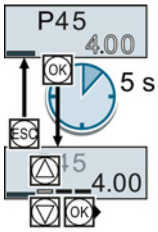
The BOP-2 offers the option of setting the parameter value digit by digit.

Precondition

The parameter value flashes in the BOP-2 display.

Procedure

To select the parameter value directly, proceed as follows:



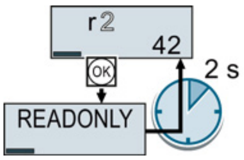
1. Press the OK button for longer than five seconds.
2. Change the parameter value digit-by-digit.
   If you press the OK button then the BOP-2 jumps to the next digit.
3. If you have entered all of the digits of the parameter value, press the OK button.

You have now entered the parameter value directly.

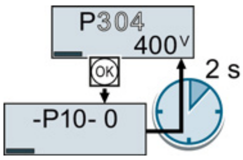
A.4.4 A parameter cannot be changed

When must you not change a parameter?

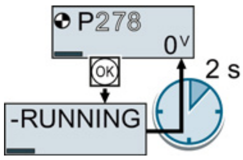
The converter indicates why it currently does not permit a parameter to be changed:



You have attempted to change a read-only parameter.



You must change to basic commissioning to set this parameter.



You must turn the motor off to set this parameter.

The operating state in which you can change a parameter is provided in the List Manual for each parameter.

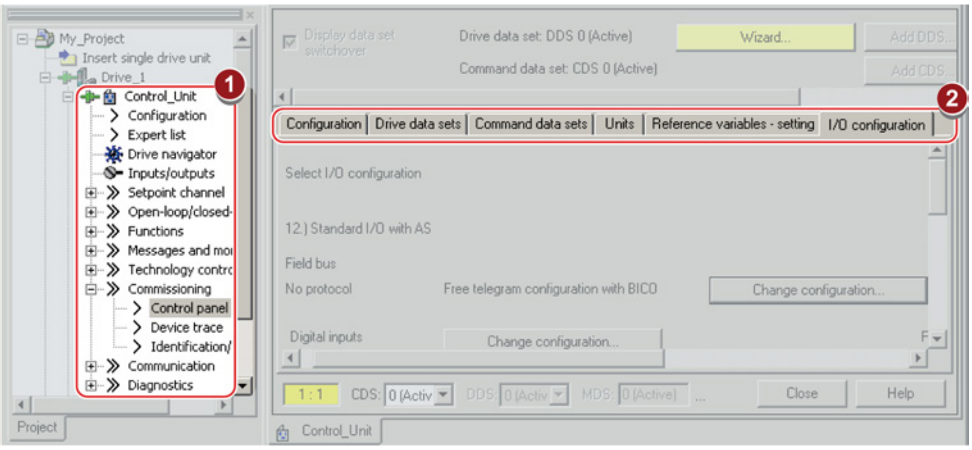
A.5 Handling STARTER

A.5.1 Change settings

After the basic commissioning, you can adapt the inverter to your application as described in the Commissioning guidelines (Page 83).

STARTER offers two options:

- Change the settings using the appropriate screen forms - **our recommendation.**
  ① Navigation bar: For each inverter function, select the corresponding screen form.
  ② tabs: Switch between screen forms.
  If you change the settings using screen forms you do not need to know the parameter numbers.



- You change the settings using the parameters in the expert list.
  If you wish to change the settings using the expert list, you need to know the corresponding parameter number and its significance.

Saving settings so that they are not lost when the power fails

The inverter initially only saves changes temporarily. You must do the following so that the inverter saves your settings securely in the event of a power failure.

Procedure

Proceed as follows to save your settings in the inverter so that they are not lost when the power fails:

1. Mark the appropriate drive in the project navigator.
2. Click the Save (RAM to ROM) button.

You have saved your settings securely in the inverter in case of a power failure.

Go offline

You can now exit the online connection after the data backup (RAM to ROM) with "Disconnect from target system".

A.5.2 Optimize the drive using the trace function

Description

The trace function is used for inverter diagnostics and helps to optimize the behavior of the drive. Start the function in the navigation bar using "... Control_Unit/Commissioning/Device trace".

In two settings that are independent of one another, using you can interconnect eight signals each. Each signal that you interconnect is active as standard

You can start a measurement as often as required; the results are temporarily stored (until you exit STARTER) under the "Measurements" tab, together with the date and time. When terminating STARTER or under the "Measurements" tab, you can save the measurement results in the *.trc format.

If you require more than two settings for your measurements, you can either save the individual traces in the project or export them in the *.clg format – and if necessary, load or import.

Recording

Recording is performed in a CU-dependent basic clock cycle. The maximum recording duration depends on the number of recorded signals and the trace clock cycle.

You can extend the recording duration by increasing the trace clock cycle by multiplying with an integer factor and then accepting the displayed maximum duration with . Alternatively, you can also specify the measurement period and then calculate the trace clock cycle of STARTER using .

Recording individual bits for bit parameters

You can record individual bits of a parameter (e.g. r0722) by allocating the relevant bit using "bit track" ().

Mathematical function

Using the mathematical function () you can define a curve, for example the difference between the speed setpoint and the actual speed value.

Note

If you use the "record individual bits" or "mathematical functions" option, then this is displayed under signal No. 9.

Trigger

You can create your own start condition (trigger) for the trace. With the factory setting (default setting) the trace starts as soon as you press the ▶ button (Start Trace). Using the button ▾, you can define another trigger to start the measurement.

Using pretrigger, set the time for the recording before the trigger is set. As a consequence, the trigger condition traces itself.

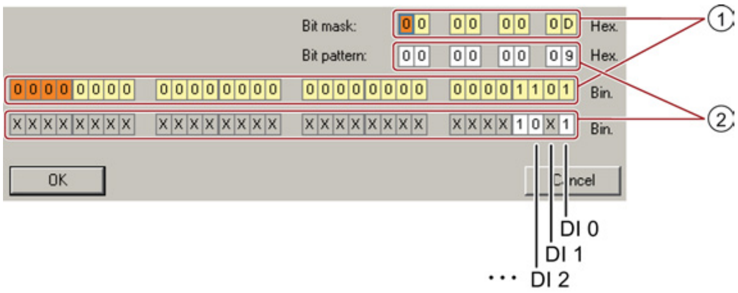
Example of a bit pattern as trigger:

You must define the pattern and value of a bit parameter for the trigger. To do so, proceed as follows:

Using ▾, select "Trigger to variable - bit pattern"

Using ..., select the bit parameter

Using bin..., open the screen form in which you set the bits and their values for the start condition



① Select the bits for the trace trigger, upper row hex format, lower row binary format

② Define the bits for the trace trigger, upper row hex format, lower row binary format

Figure A-3 Bit pattern

In the example, the trace starts if DI0 and DI3 are high and DI2 is low. The state of the other digital inputs is not relevant for the start of the trace.

Further, you can either set an alarm or fault as start condition.

Display options

In this area, you can set how the measurement results are displayed.

- Repeating measurements
  This places the measurements that you wish to perform at different times above one other.
- Arrange the curves in tracks
  This means you define whether the trace of all measured values is displayed with respect to a common zero line – or to separate zero lines.
- Measuring cursor on
  This allows you to analyze the measuring intervals in more detail.

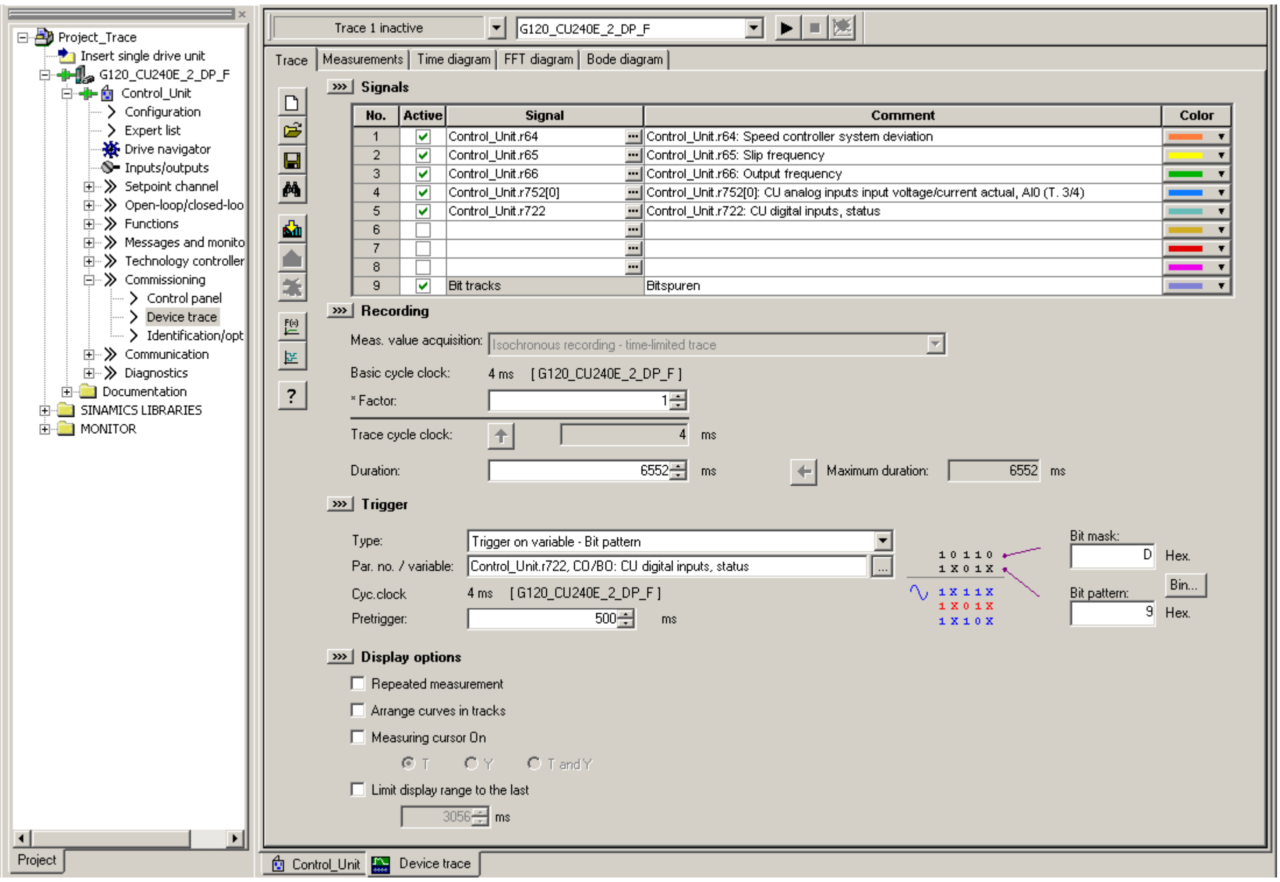


Figure A-4 Trace dialog box

A.6 Interconnecting signals in the inverter

A.6.1 Fundamentals

The following functions are implemented in the converter:

- Open-loop and closed-loop control functions
- Communication functions
- Diagnosis and operating functions

Every function comprises one or several blocks that are interconnected with one another.

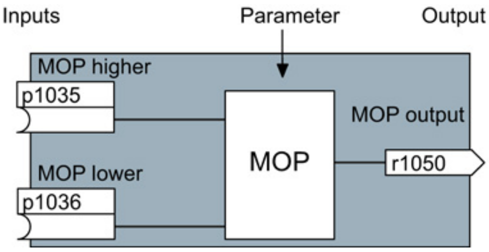


Figure A-5 Example of a block: Motorized potentiometer (MOP)

Most of the blocks can be adapted to specific applications using parameters.

You cannot change the signal interconnection within the block. However, the interconnection between blocks can be changed by interconnecting the inputs of a block with the appropriate outputs of another block.

The signal interconnection of the blocks is realized, contrary to electric circuitry, not using cables, but in the software.

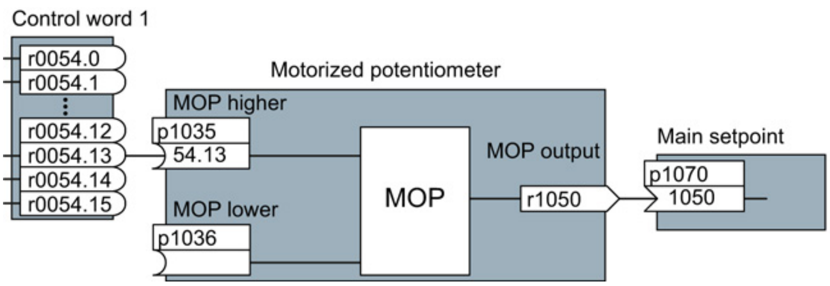


Figure A-6 Example: Signal interconnection of two blocks for digital input 0

Binectors and connectors

Connectors and binectors are used to exchange signals between the individual blocks:

- Connectors are used to interconnect "analog" signals. (e.g. MOP output speed)
- Binectors are used to interconnect "digital" signals. (e.g. 'Enable MOP up' command)

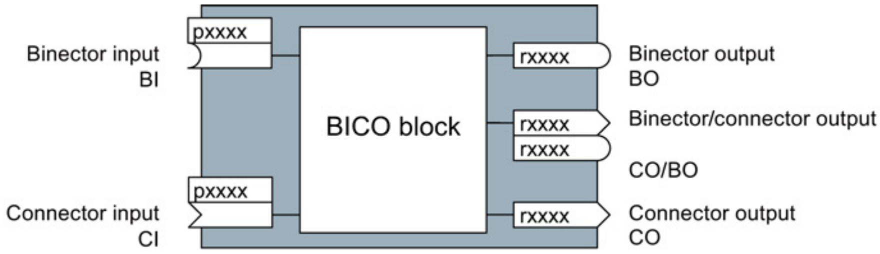


Figure A-7 Symbols for binector and connector inputs and outputs

Binector/connector outputs (CO/BO) are parameters that combine more than one binector output in a single word (e.g. r0052 CO/BO: status word 1). Each bit in the word represents a digital (binary) signal. This summary reduces the number of parameters and simplifies parameter assignment.

Binector or connector outputs (CO, BO or CO/BO) can be used more than once.

When must you interconnect signals in the converter?

If you change the signal interconnection in the converter, you can adapt the converter to a wide range of requirements. This does not necessarily have to involve highly complex functions.

Example 1: Assign a different function to a digital input.

Example 2: Switch the speed setpoint from the fixed speed to the analog input.

How much care is required when you change the signal interconnection?

Always take care when establishing internal signal interconnections. Note which changes you make as you go along since the process of analyzing them later can be quite difficult.

The STARTER commissioning tool offers signals in plain text and simplifies their interconnection.

Where can you find additional information?

- This manual is sufficient for simple signal interconnections (e.g. assigning a different function to digital inputs).
- The parameter list in the List Manual is sufficient for more complex signal interconnections.
- You can also refer to the function diagrams in the List Manual for complex signal interconnections.

A.6.2 Example

Moving a basic control logic into the inverter

A conveyor system is to be configured in such a way that it can only start when two signals are present simultaneously. These could be the following signals, for example:

- The oil pump is running (the required pressure level is not reached, however, until after 5 seconds)
- The protective door is closed

To implement this task, you must insert free function blocks between digital input 0 and the command to switch on the motor (ON/OFF1).

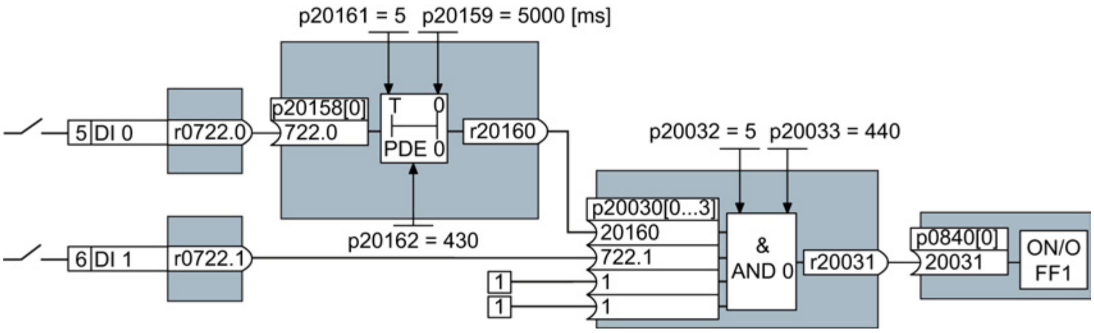


Figure A-8 Example: Signal interconnection for control logic

The signal of digital input 0 (DI 0) is fed through a time block (PDE 0) and is interconnected with the input of a logic block (AND 0). The signal of digital input 1 (DI 1) is interconnected to the second input of the logic block. The logic block output issues the ON/OFF1 command to switch-on the motor.

Setting the control logic

Parameter	Description
p20161 = 5	The time block is enabled by assigning to runtime group 5 (time slice of 128 ms)
p20162 = 430	Run sequence of the time block within runtime group 5 (processing before the AND logic block)
p20032 = 5	The AND logic block is enabled by assigning to runtime group 5 (time slice of 128 ms)
p20033 = 440	Run sequence of the AND logic block within runtime group 5 (processing after the time block)
p20159 = 5000.00	Setting the delay time [ms] of the time module: 5 seconds
p20158 = 722.0	Connect the status of DI 0 to the input of the time block r0722.0 = Parameter that displays the status of digital input 0.
p20030[0] = 20160	Interconnecting the time block to the 1st input of the AND
p20030[1] = 722.1	Interconnecting the status of DI 1 to the 2nd AND input r0722.1 = Parameter that displays the status of digital input 1.
p0840 = 20031	Interconnect the AND output to ON/OFF1

Explanation of the example using the ON/OFF1 command

Parameter p0840[0] is the input of the "ON/OFF1" block of the inverter. Parameter r20031 is the output of the AND block. To interconnect ON/OFF1 with the output of the AND block, set p0840 = 20031.

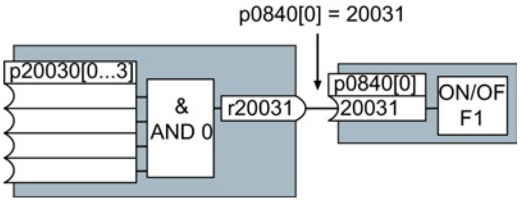


Figure A-9 Interconnecting blocks by setting p0840[0] = 20031

Principle for interconnecting blocks

Always interconnect the input (connector or binector input) with the signal source.

A.7 Connecting the safety-related input

The following examples show the interconnection of the safety-related input accordance with PL d to EN 13849-1 and SIL2 according to IEC61508. You can find further examples and information in the Safety Integrated Function Manual.

The examples comply with PL d according to EN 13849-1 and SIL2 according to IEC 61508 for the case that all components are installed within one control cabinet.

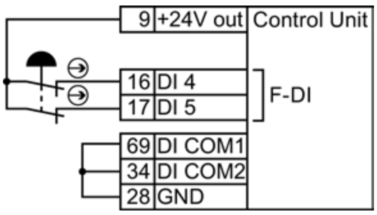


Figure A-10 Connecting a sensor, e.g. Emergency Stop mushroom pushbutton or limit switch

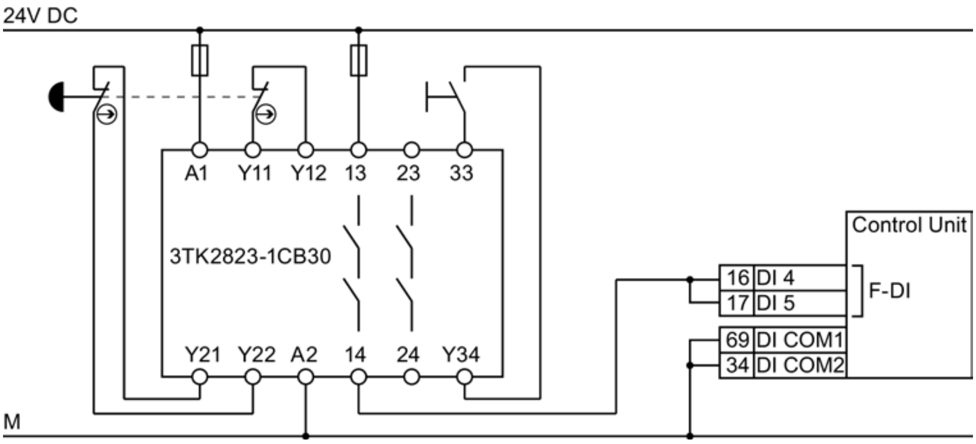


Figure A-11 Connecting a safety relay, e.g. SIRIUS 3TK28

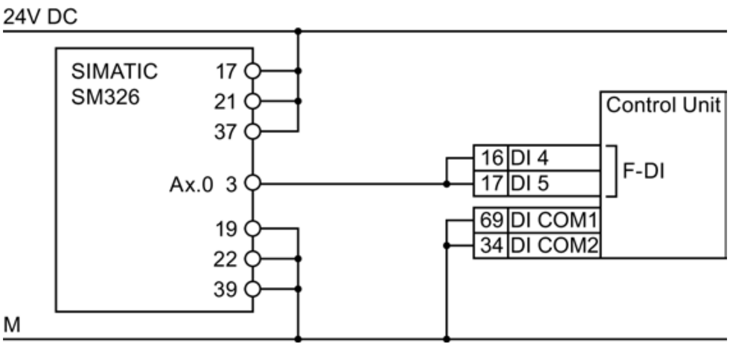


Figure A-12 Connecting an F digital output module, e.g. SIMATIC F digital output module

You can find additional connection options and connections in separate control cabinets in the Safety Integrated Function Manual, see Section: Manuals for your inverter (Page 368).

A.8 Acceptance tests for the safety functions

A.8.1 Recommended acceptance test

The following descriptions for the acceptance test are recommendations that illustrate the principle of acceptance. You may deviate from these recommendations if you check the following once you have completed commissioning:

- Correct assignment of the interfaces of each converter with the safety function:
  - Fail-safe inputs
  - PROFIsafe address
- Correct setting of the STO safety function.

Note

Perform the acceptance test with the maximum possible velocity and acceleration in order to test the expected maximum braking distances and braking times.

Note

Non-critical alarms

The following alarms are issued following each system ramp-up and are not critical for acceptance:

- A01697
- A01796

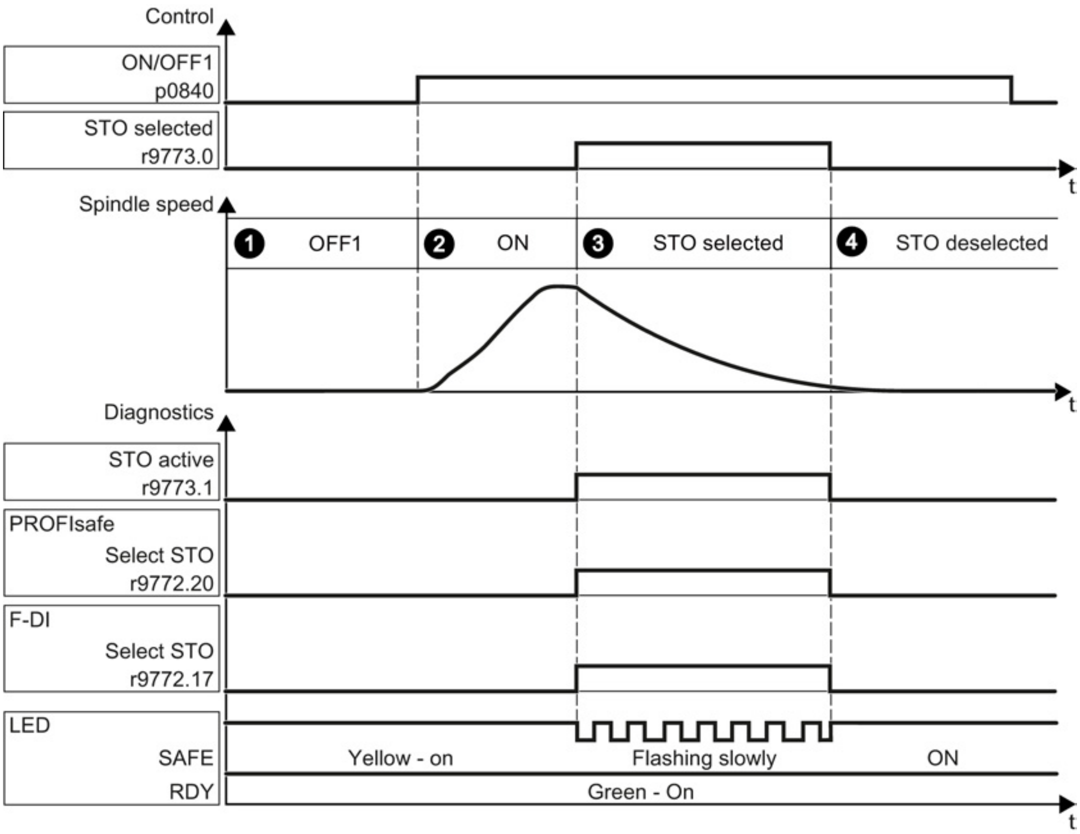


Figure A-13 Acceptance test for STO (basic functions)

Procedure

To perform an acceptance test of the STO function as part of the basic functions, proceed as follows:

<table>
<tr><th colspan="4"></th><th>Status</th></tr>
<tr><td rowspan="3">1.</td><td colspan="3">The inverter is ready</td><td></td></tr>
<tr><td colspan="3">• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).</td><td></td></tr>
<tr><td colspan="3">• STO is not active (r9773.1 = 0).</td><td></td></tr>
<tr><td rowspan="4">2.</td><td colspan="3">Switch on motor</td><td></td></tr>
<tr><td>2.1.</td><td colspan="2">Enter a speed setpoint ≠ 0.</td><td></td></tr>
<tr><td>2.2.</td><td colspan="2">Switch on the motor (ON command).</td><td></td></tr>
<tr><td>2.3.</td><td colspan="2">Check that the correct motor is running.</td><td></td></tr>
<tr><td rowspan="9">3.</td><td colspan="3">Select STO</td><td></td></tr>
<tr><td>3.1.</td><td colspan="2">Select STO while the motor is running
Test each configured activation, e.g. via digital inputs and PROFIsafe.</td><td></td></tr>
<tr><td rowspan="7">3.2.</td><td colspan="2">Check the following:</td><td></td></tr>
<tr><td>When controlled by PROFIsafe</td><td>For control via terminal</td><td></td></tr>
<tr><td>• The inverter signals the following:
"STO selection via PROFIsafe" (r9772.20 = 1)</td><td>• The inverter signals the following:
"STO Selection via terminal" (r9772.17 = 1)</td><td></td></tr>
<tr><td colspan="2">• If a mechanical brake is not available, the motor coasts down.
A mechanical brake brakes the motor and holds it to ensure that it remains at a standstill.</td><td></td></tr>
<tr><td colspan="2">• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).</td><td></td></tr>
<tr><td colspan="2">• The inverter signals the following:
"STO is selected" (r9773.0 = 1).
"STO is active" (r9773.1 = 1).</td><td></td></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><td rowspan="5">4.</td><td colspan="3">Deselect STO</td><td></td></tr>
<tr><td>4.1.</td><td colspan="2">Deselect STO.</td><td></td></tr>
<tr><td rowspan="3">4.2.</td><td colspan="2">Check the following:</td><td rowspan="2"></td></tr>
<tr><td colspan="2">• STO is not active (r9773.1 = 0).</td></tr>
<tr><td colspan="2">• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).</td><td></td></tr>
</table>

You have performed the acceptance test of the STO function.

A.8.2 Machine documentation

Machine or plant description

Designation	…
Type	…
Serial number	…
Manufacturer	…
End customer	…
Block diagram of the machine and/or plant: … … … … … … …	

Inverter data

Table A- 12 Hardware version of the safety-related inverter

Labeling the drive	Order number and hardware version of the inverter
…	…
…	…

Function table

Table A- 13 Active safety functions depending on the operating mode and safety equipment

Operating mode	Safety equipment	Drive	Selected safety function	Checked
…	…	…	…	
…	…	…	…	
Example:				
Automatic	*Protective door closed*	*Conveyor belt*	---	---
	Protective door open	*Conveyor belt*	*STO*	
	Emergency Stop button pressed	*Conveyor belt*	*STO*	

Acceptance test reports

File name of the acceptance reports	
…	…
…	…

Data backup

Data	Storage medium			Holding area
	Archiving type	Designation	Date	
Acceptance test reports	…	…	…	…
PLC program	…	…	…	…
Circuit diagrams	…	…	…	…

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 recorded above are correct.

Date	Name	Company/dept.	Signature
…	…	…	…

A.8.3 Log the settings for the basic functions, firmware V4.4 ... V4.7

Drive = <pDO-NAME_v>

Table A- 14 Firmware version

Name	Number	Value
Control Unit firmware version	r18	<r18_v>
SI version, safety functions integrated in the drive (processor 1)	r9770	<r9770_v>

Table A- 15 Monitoring cycle

Name	Number	Value
SI monitoring clock cycle (processor 1)	r9780	<r9780_v>

Table A- 16 Checksums

Name	Number	Value
SI module identifier, Control Unit	r9670	<r9670_v>
SI module identifier, Power Module	r9672	<r9672_v>
SI reference checksum SI parameters (processor 1)	p9799	<p9799_v>
SI reference checksum SI parameters (processor 2)	p9899	<p9899_v>

Table A- 17 Settings of the safety functions

Name	Number	Value
SI enable, functions integrated in the drive	p9601	<p9601_v>
Only for the CU250S-2 Control Unit SI enable safe brake control	p9602	<p9602_v>
SI PROFIsafe address	p9610	<p9610_v>
F-DI switch over discrepancy time	p9650	<p9650_v>
SI STO debounce time	p9651	<p9651_v>
Only for the CU250S-2 Control Unit SI Safe Stop 1 delay time	p9652	<p9652_v>
SI forced dormant error detection timer	p9659	<p9659_v>

Table A- 18 Safety logbook

Name	Number	Value
SI checksum to check changes	r9781[0]	<r9781[0]_v>
SI checksum to check changes	r9781[1]	<r9781[1]_v>
SI change control time stamp	r9782[0]	<r9782[0]_v>
SI change control time stamp	r9782[1]	<r9782[1]_v>

A.9 Manuals and technical support

A.9.1 Manuals for your inverter

Table A- 19 Manuals for your inverter

<table>
<tr><th>Depth of the information</th><th>Manual</th><th>Contents</th><th>Available languages</th><th>Download or order number</th></tr>
<tr><td>++</td><td>Getting Started Guide
for the SINAMICS G120 inverter with the CU230P-2; CU240B-2 and CU240E-2 Control Units</td><td>Installing the inverter and commissioning.</td><td rowspan="2">English, German, Italian, French, Spanish, Chinese</td><td rowspan="8">Download: (http://support.automation.siemens.com/WW/view/en/22339653/133300)
SINAMICS Manual Collection
Documentation on DVD, order number 6SL3097-4CA00-0YG0</td></tr>
<tr><td>+++</td><td>Operating instructions</td><td>(this manual)</td></tr>
<tr><td>+++</td><td>Function Manual for Safety Integrated
for the inverters SINAMICS G110M, G120, G120C, G120D and SIMATIC ET 200pro FC-2</td><td>Configuring PROFIsafe. Installing, commissioning and operating fail-safe functions of the inverter.</td><td rowspan="3">English, German, Chinese</td></tr>
<tr><td>+++</td><td>Fieldbus function manual
for the SINAMICS G120, G120C and G120D inverters</td><td>Configuring fieldbuses.</td></tr>
<tr><td>+++</td><td>List Manual
for the SINAMICS G120 inverter with the CU240B-2; CU240E-2 Control Units</td><td>Graphic function block diagrams.
Complete list of all parameters, alarms and faults.</td></tr>
<tr><td>+</td><td>Getting Started Guide
for the following SINAMICS G120 Power Modules:
• PM240, PM250 and PM260
• PM240-2
• PM230</td><td>Installing the Power Module</td><td rowspan="2">English</td></tr>
<tr><td>+</td><td>Installation Instructions
for reactors, filters and braking resistors</td><td>Installing components</td></tr>
<tr><td>+++</td><td>Hardware Installation Manual
for the following SINAMICS G120 Power Modules:
• PM230 IP20
• PM230 IP55
• PM240
• PM240-2
• PM250
• PM260</td><td>Installing power modules, reactors and filters.
Maintaining power modules.</td><td>English, German</td></tr>
</table>

Depth of the information	Manual	Contents	Available languages	Download or order number
+++	**Operating instructions** for the following operator panels: • BOP-2 • IOP	Operating Operator Panels, door mounting kit for mounting of IOP.		

A.9.2 Configuring support

Table A- 20 Support when configuring and selecting the inverter

Manual or tool	Contents	Available languages	Download or order number
Catalog D 31	Ordering data and technical information for the standard SINAMICS G inverters	English, German, Italian, French, Spanish	Everything about SINAMICS G120 (www.siemens.en/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 (Order number: 6SL3070-0AA00-0AG0) and in the Internet: Download SIZER (http://support.automation.siemens.com/WW/view/en/10804987/130000)

A.9.3 Product Support

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

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 Automation & Drives via our contact database under "Contact & Partner".
- Information about local service, repair, spare parts and much more can be found under "Services".

A.10 Mistakes and improvements

If you come across any mistakes when reading this manual or if you have any suggestions for how it can be improved, then please send your suggestions to the following address or by E-mail:

Siemens AG
Drive Technologies
Motion Control Systems
Postfach 3180
91050 Erlangen, Germany

E-mail (mailto:docu.motioncontrol@siemens.com)

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Further information

SINAMICS inverters:
www.siemens.com/sinamics

Safety Integrated:
www.siemens.com/safety-integrated

PROFINET:
www.siemens.com/profinet

Siemens AG
Industry Sector
Drive Technologies
Motion Control Systems
Postfach 3180
91050 ERLANGEN
GERMANY

Scan the QR code for additional information on SINAMICS G120.

www.siemens.com/drives